High Performance, Vector Control Inverter

FRENIC-VG

User's Manual

MEHT286

Preface

This manual provides all the information on the FRENIC-VG series of inverters including its operating procedure, operation modes, and selection of peripheral equipment. Carefully read this manual for proper use. Incorrect handling of the inverter may prevent the inverter and/or related equipment from operating correctly, shorten their lives, or cause problems.

The table below lists the other materials related to the use of the FRENIC-VG. Read them in conjunction with this manual as necessary.

Name	Material No.	Description
Catalog	MEH659	Product scope, features, specifications, external drawings, and options of the product
Instruction Manual	INR-SI47-1580-E	Acceptance inspection, mounting & wiring of the inverter, operation using the keypad, running the motor for a test, troubleshooting, and maintenance and inspection

The materials are subject to change without notice. Be sure to obtain the latest editions for use.

Guideline for Suppressing Harmonics in Home Electric and General-purpose Appliances

Our three-phase, 200 V class series inverters of 3.7 kW or less (FRENIC-VG series) were the products of which were restricted by the "Guideline for Suppressing Harmonics in Home Electric and General-purpose Appliances" (established in September 1994 and revised in October 1999) issued by the Ministry of Economy, Trade and Industry.

The above restriction, however, was lifted when the Guideline was revised in January 2004. Since then, the inverter makers have individually imposed voluntary restrictions on the harmonics of their products.

We, as before, recommend that you connect a reactor (for suppressing harmonics) to your inverter. As a reactor, select a "DC REACTOR" introduced in this manual. For use of the other reactor, please inquire of us about detailed specifications.

Japanese Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage

Refer to this manual, Appendix B for details on this guideline.

How this manual is organized

This manual contains Chapters 1 through 13 and Appendices.

Chapter 1 OVERVIEW

This chapter describes the overview, features and the control system of the FRENIC-VG series and the recommended configuration for the inverter and peripheral equipment.

Chapter 2 SPECIFICATIONS

This chapter describes specifications of the output ratings, control system, dedicated motor specifications, and terminal functions for the FRENIC-VG series of inverters. It also provides descriptions of the external dimensions, examples of basic connection diagrams, and details of the protective functions.

Chapter 3 PREPARATION AND TEST RUN

This chapter describes the operating and storage environments, installation and wiring, typical connection diagram, names and functions of keypad components, keypad operation, and test run procedure.

Chapter 4 CONTROL AND OPERATION

This chapter provides the main block diagrams for the control logic of the FRENIC-VG series of inverters. It also contains overview tables of function codes and details of function codes.

Chapter 5 USING STANDARD RS-485

This chapter describes the use of standard RS-485 communications ports and provides an overview of the FRENIC-VG Loader.

Chapter 6 CONTROL OPTIONS

This chapter describes the FRENIC-VG's control options.

Chapter 7 APPLICATION EXAMPLES

This chapter gives application examples of the FRENIC-VG series of inverters.

Chapter 8 SELECTING PERIPHERAL EQUIPMENT

This chapter describes how to use a range of peripheral equipment and options, FRENIC-VG's configuration with them, and requirements and precautions for selecting wires and crimp terminals.

Chapter 9 SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

This chapter provides you with information about the inverter output torque characteristics, selection procedure, and equations for calculating capacities to help you select optimal motor and inverter models. It also helps you select braking resistors and inverter mode (HD, MD, or LD).

Chapter 10 ABOUT MOTORS

This chapter details vector motors that can be connected to the FRENIC-VG series of inverters.

Chapter 11 OPERATION DATA

This chapter provides the characteristics data of the FRENIC-VG series of inverters running.

Chapter 12 REPLACEMENT DATA

When replacing the former inverters (VG, VG3, VG5) with FRENIC-VG, refer to this section.

Chapter 13 TROUBLESHOOTING

This chapter describes troubleshooting procedures to be followed when the inverter malfunctions or detects an alarm or a light alarm condition. In this chapter, first check whether any alarm code or the "light alarm" indication (L-AL) is displayed or not, and then proceed to the troubleshooting items.

Appendices

CONTENTS

Chapter 6 CONTROL OPTIONS

Chapter 7 APPLICATION EXAMPLES

Chapter 8 SELECTING PERIPHERAL EQUIPMENT

Safety precautions

Read this manual thoroughly before proceeding with installation, connections (wiring), operation, or maintenance and inspection. Ensure you have sound knowledge of the device and familiarize yourself with all safety information and precautions before proceeding to operate the inverter.

Safety precautions are classified into the following two categories in this manual.

⚠WARNING	Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in death or serious bodily injuries.
⚠CAUTION	Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in minor or light bodily injuries and/or substantial property damage.

Failure to heed the information contained under the CAUTION title can also result in serious consequences. These safety precautions are of utmost importance and must be observed at all times.

Application

⚠WARNING

- The FRENIC-VG is designed to drive a three-phase induction motor. Do not use it for single-phase motors or for other purposes.

  Fire or an accident could occur.

- The FRENIC-VG may not be used for a life-support system or other purposes directly related to the human safety.
- Though the FRENIC-VG is manufactured under strict quality control, install safety devices for applications where serious accidents or property damages are foreseen in relation to the failure of it.

  An accident could occur.

Installation

⚠WARNING

- Install the inverter on a base made of metal or other non-flammable material.

  Otherwise, a fire could occur.

- Do not place flammable object nearby.

  Doing so could cause fire.

- Inverters with a capacity of 30 kW or above, whose protective structure is IP00, involve a possibility that a human body may touch the live conductors of the main circuit terminal block. Inverters to which an optional DC reactor is connected also involve the same. Install such inverters in an inaccessible place.

  Otherwise, electric shock or injuries could occur.

⚠CAUTION

- Do not support the inverter by its front cover during transportation.

  Doing so could cause a drop of the inverter and injuries.

- Prevent lint, paper fibers, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter or from accumulating on the heat sink.
- When changing the positions of the top and bottom mounting bases, use only the specified screws.

  Otherwise, a fire or an accident might result.

- Do not install or operate an inverter that is damaged or lacking parts.

  Doing so could cause fire, an accident or injuries.

Wiring

⚠WARNING

- If no zero-phase current (earth leakage current) detective device such as a ground-fault relay is installed in the upstream power supply line in order to avoid the entire power supply system's shutdown undesirable to factory operation, install a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) individually to inverters to break the individual inverter power supply lines only.

  Otherwise, a fire could occur.

- When wiring the inverter to the power source, insert a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) in the path of each pair of power lines to inverters. Use the recommended devices within the recommended current capacity.
- Use wires in the specified size.
- Tighten terminals with specified torque.

  Otherwise, a fire could occur.

- When there is more than one combination of an inverter and motor, do not use a multicore cable for the purpose of handling their wirings together.
- Do not connect a surge killer to the inverter's output (secondary) circuit.

  Doing so could cause a fire.

- Be sure to connect an optional DC reactor (DCR) when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity.

  Otherwise, a fire could occur.

- Ground the inverter in compliance with the national or local electric code.
- Be sure to ground the inverter's grounding terminals ⏚G.

  Otherwise, an electric shock or a fire could occur.

- Qualified electricians should carry out wiring.
- Be sure to perform wiring after turning the power OFF.

  Otherwise, an electric shock could occur.

- Be sure to perform wiring after installing the inverter unit.

  Otherwise, an electric shock or injuries could occur.

- Ensure that the number of input phases and the rated voltage of the product match the number of phases and the voltage of the AC power supply to which the product is to be connected.

  Otherwise, a fire or an accident could occur.

- Do not connect the power supply wires to output terminals (U, V, and W).
- When connecting a DC braking resistor (DBR), never connect it to terminals other than terminals P(+) and DB.

  Doing so could cause fire or an accident.

- In general, sheaths of the control signal wires are not specifically designed to withstand a high voltage (i.e., reinforced insulation is not applied). Therefore, if a control signal wire comes into direct contact with a live conductor of the main circuit, the insulation of the sheath might break down, which would expose the signal wire to a high voltage of the main circuit. Make sure that the control signal wires will not come into contact with live conductors of the main circuit.

  Doing so could cause an accident or an electric shock.

⚠WARNING⚠

- Before changing the switches or touching the control circuit terminal symbol plate, **turn OFF the power and wait at least five minutes for inverters with a capacity of 22 kW or below, or at least ten minutes for inverters with a capacity of 30 kW or above**. Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P(+) and N(-) has dropped to the safe level (+25 VDC or below).

  Otherwise, an electric shock could occur.

⚠CAUTION

- The inverter, motor and wiring generate electric noise. Be careful about malfunction of the nearby sensors and devices. To prevent them from malfunctioning, implement noise control measures.

  Otherwise an accident could occur.

Operation

⚠WARNING

- Be sure to mount the front cover before turning the power ON. Do not remove the cover when the inverter power is ON.
  Otherwise, an electric shock could occur.
- Do not operate switches with wet hands.
  Doing so could cause electric shock.
- If the auto-reset function has been selected, the inverter may automatically restart and drive the motor depending on the cause of tripping. Design the machinery or equipment so that human safety is ensured at the time of restarting.
  Otherwise, an accident could occur.
- If the stall prevention function (torque limiter) has been selected, the inverter may operate with acceleration/deceleration or speed different from the commanded ones. Design the machine so that safety is ensured even in such cases.
- The (STOP) key on the keypad is effective only when the keypad operation is enabled with function code F02 (= 0, 2 or 3). When the keypad operation is disabled, prepare an emergency stop switch separately for safe operations. Switching the run command source from keypad (local) to external equipment (remote) by turning ON the "Enable communications link" command ***LE*** disables the (STOP) key.
  To enable the (STOP) key for an emergency stop, select the STOP key priority with function code H96 (= 1 or 3).
- If any of the protective functions have been activated, first remove the cause. Then, after checking that the all run commands are set to OFF, release the alarm. If the alarm is released while any run commands are set to ON, the inverter may supply the power to the motor, running the motor.
  Otherwise, an accident could occur.
- If you enable the "Restart mode after momentary power failure" (Function code F14 = 3 to 5), then the inverter automatically restarts running the motor when the power is recovered.
  Design the machinery or equipment so that human safety is ensured after restarting.
- If the user configures the function codes wrongly without completely understanding this Instruction Manual and the FRENIC-VG User's Manual, the motor may rotate with a torque or at a speed not permitted for the machine.
  An accident or injuries could occur.
- Even if the inverter has interrupted power to the motor, if the voltage is applied to the main circuit input terminals L1/R, L2/S and L3/T, voltage may be output to inverter output terminals U, V, and W.
- Even if the run command is set to OFF, voltage is output to inverter output terminals U, V, and W if the servo-lock command is ON.
- Even if the motor is stopped due to DC braking or preliminary excitation, voltage is output to inverter output terminals U, V, and W.
  An electric shock may occur.
- The inverter can easily accept high-speed operation. When changing the speed setting, carefully check the specifications of motors or equipment beforehand.
  Otherwise, injuries could occur.

⚠CAUTION

- Do not touch the heat sink and braking resistor because they become very hot.
  Doing so could cause burns.
- The DC brake function of the inverter does not provide any holding mechanism.
  Injuries could occur.
- Ensure safety before modifying the function code settings.
  Run commands (e.g., "Run forward" ***FWD***), stop commands (e.g., "Coast to a stop" ***BX***), and speed change commands can be assigned to digital input terminals. Depending upon the assignment states of those terminals, modifying the function code setting may cause a sudden motor start or an abrupt change in speed.
- When the inverter is controlled with the digital input signals, switching run or speed command sources with the related terminal commands (e.g., ***SS1***, ***SS2***, ***SS4***, ***SS8***, ***N2/N1***, ***KP/PID***, ***IVS***, and ***LE***) may cause a sudden motor start or an abrupt change in speed.
  An accident or injuries could occur.

Maintenance and inspection, and parts replacement

⚠WARNING⚠

- Before proceeding to the maintenance/inspection jobs, **turn OFF the power and wait at least five minutes for inverters with a capacity of 22 kW or below, or at least ten minutes for inverters with a capacity of 30 kW or above**. Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P(+) and N(-) has dropped to the safe level (+25 VDC or below).

  Otherwise, an electric shock could occur.
- Maintenance, inspection, and parts replacement should be made only by qualified persons.
- Take off the watch, rings and other metallic objects before starting work.
- Use insulated tools.

  Otherwise, an electric shock or injuries could occur.
- Never modify the inverter.

  Doing so could cause an electric shock or injuries.

Disposal

⚠CAUTION

- Treat the inverter as an industrial waste when disposing of it.

  Otherwise injuries could occur.

Speed control mode

⚠CAUTION

- If the control parameters of the automatic speed regulator (ASR) are not appropriately configured under speed control, even turning the run command OFF may not decelerate the motor due to hunting caused by high gain setting. Accordingly, the inverter may not reach the stop conditions so that it may continue running.

  Even if the inverter starts deceleration, the detected speed deviates from the zero speed area before the zero speed control duration (F39) elapses due to hunting caused by high response in low speed operation. Accordingly, the inverter will not reach the stop conditions so that it enters the deceleration mode again and continues running.

  If any of the above problems occurs, adjust the ASR control parameters to appropriate values and use the speed mismatch alarm function in order to alarm-trip the inverter, switch the control parameters by speed, or judge the detection of a stop speed by commanded values when the actual speed deviates from the commanded one.

  An accident or injuries could occur.

Torque control mode

⚠CAUTION

- When the motor is rotated by load-side torque exceeding the torque command under torque control, turning the run command OFF may not bring the stop conditions so that the inverter may continue running.

  To shut down the inverter output, switch from torque control to speed control and apply a decelerate-to-stop or coast-to-stop command.

  An accident or injuries could occur.

GENERAL PRECAUTIONS

Drawings in this manual may be illustrated without covers or safety shields for explanation of detail parts. Restore the covers and shields in the original state and observe the description in the manual before starting operation.

Icons

The following icons are used throughout this manual.

Note This icon indicates information which, if not heeded, can result in the inverter not operating to full efficiency, as well as information concerning incorrect operations and settings which can result in accidents.

Tip This icon indicates information that can prove handy when performing certain settings or operations.

📖 This icon indicates a reference to more detailed information.

Chapter 1
OVERVIEW

This chapter describes the overview, features and the control system of the FRENIC-VG series and the recommended configuration for the inverter and peripheral equipment.

Contents

1.1 Overview

1.1.1 Industry-best control performance

- The FRENIC-VG implements vector control with a speed sensor (induction and synchronous motors), vector control without a speed sensor (induction and synchronous motors*1), V/f control (induction motors), and multi-drive functionality.
- Vector control with a speed sensor (for FRENIC-VG induction motors) delivers best-in-industry performance with a speed response of 600 Hz, current response of 2,000 Hz, speed control accuracy of ±0.005%, and torque control accuracy of ±3%.

*1 Available soon.

1.1.2 System support

- The FRENIC-VG ships standard with RS-485 communications functionality and optional support for T-Link, SX bus, and CC-Link interfaces.
- The UPAC optional card with user program functionality allows users to configure and develop proprietary systems, and dedicated package software is also available*1.
- The FRENIC-VG Loader, which offers extensive functionality including traceback and real-time trace capability, supports Windows XP, Vista, and 7.

*1 Available soon.

1.1.3 Extensive built-in functionality

- Extensive auto-tuning function for optimal control of all types of motors
- Built-in load oscillation suppression observer function and load compensation control function
- Extensive position control functionality, including zero-speed lock control
- Optional position synchronization control using pulse train input
- Optional orientation control*1

*1 Available soon.

1.1.4 Broad capacity and application ranges

- A single set of specifications supports a broad range of capacities—from 0.75 kW to 90 kW for 200 V circuits and 3.7 kW to 630 kW for 400 V circuits—simplifying the system development process.
- Three sets of ratings are supported by HD mode (constant-torque), which offers an overload rating of 150% for 1 min. and 200% for 3 sec.; LD mode (square deceleration torque), which supports motors with rated currents one step larger than the inverter and offers an overload rating of 120% for 1 min.; and MD mode, which supports motors with rated currents one step larger than the inverter while limiting the inverter’s internal switching frequency and offers an overload rating of 150% for 1 min.

1.1.5 Global support

- The standard model complies with UL/cUL*1 standards, CE Mark*1 requirements, and the RoHS Directive, making it possible to standardize equipment and machinery specifications both inside and outside Japan.
- The FRENIC-VG complies with the EN 61800-5-2 functional safety standard in its standard configuration*1.
- The OPC-VG1-SAFE functional safety option allows safety functionality to be expanded.
- The keypad offers standard support for eight languages*1, ensuring peace of mind when exporting devices or machinery that use the inverter.
- Optional support is available for various open networks.

*1 Available soon.

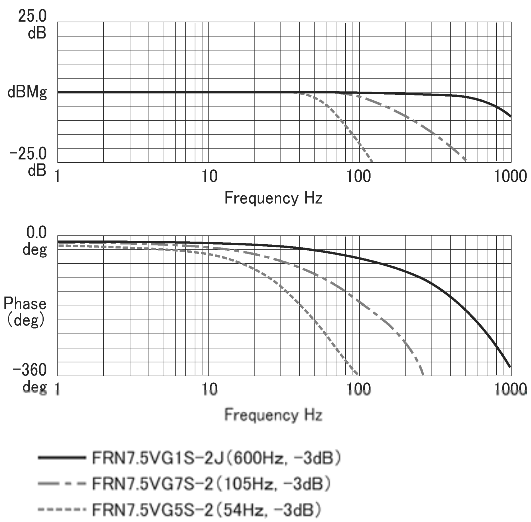
1.2 Features

The FRENIC-VG is a high-performance vector control inverter that provides a high degree of freedom in adjusting speed and torque.

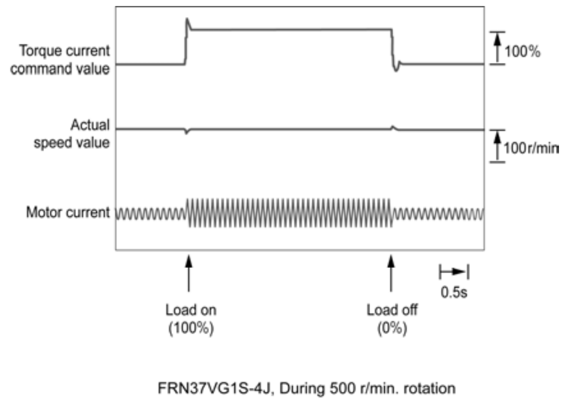
1.2.1 Best-in-industry control performance

- Speed response of 600 Hz (6× Fuji's previous VG7 model when using vector control with a speed sensor)
- Current response of 2,000 Hz (2× Fuji's previous VG7 model when using vector control with a speed sensor)
- Torque control accuracy (linear) of ±3% and speed control accuracy of ±0.005%

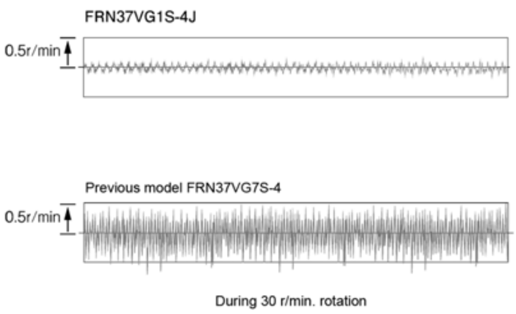
Speed response of 600 Hz



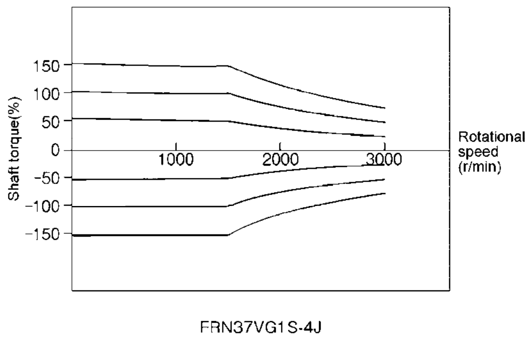
Tracking characteristics with impact load



Reduction of rotational unevenness to 1/3



Speed and torque characteristics



1.2.2 Support for various control methods (multi-drive function)

- Supports vector control with a speed sensor, vector control without a speed sensor, and V/f control for induction motors.
- Supports vector control with a speed sensor (requires optional card) and vector control without a speed sensor*1 for synchronous motors.

*1 Available soon.

1.2.3 Broad capacity range/flexible application range

- A single model supports a broad range of capacities from 0.75 kW to 630 kW, simplifying the system development process.
- The standard model supports three modes.

The operating mode is switched based on the motor's load conditions. In medium-duty (MD) and low-duty (LD) applications, the FRENIC-VG can drive motors one to two steps larger than the inverter.

Mode	Applied load	Characteristics	Applied overload rating
HD	High duty (standard)	Powerful, low noise	Current 150% for 1 min. / 200% for 3 sec.
MD	Medium duty	Can drive a motor one step larger than the inverter*1.	Current 150% for 1 min., carrier 2 to 4 kHz*2
LD	Low duty	Can drive a motor 1 to 2 steps larger than the inverter*1.	Current 120% for 1 min.

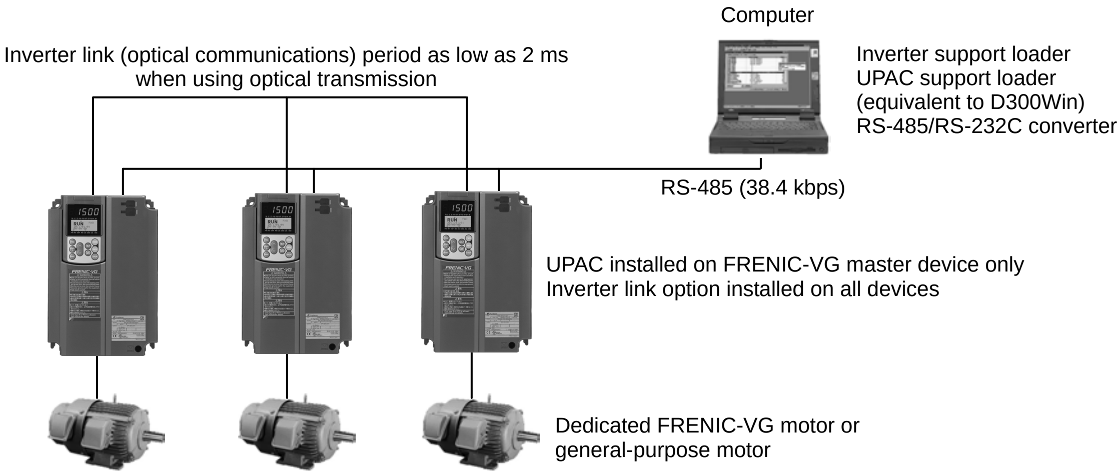
*1 Varies with motor specifications and supply voltage.
*2 Produces a higher level of noise. Verify suitability of environment in which motor will be installed.

1.2.4 User program functionality (option: UPAC)*1

- The optional UPAC (User Programmable Application Card), which provides user program functionality, allows certain aspects of inverter control and terminal functionality to be changed, making it possible for users to configure and develop proprietary systems.
- Dedicated package software is also available for functionality such as tension control, dancer control, and position control.

*1 Available soon.

UPAC system



1.2.5 Extensive network support

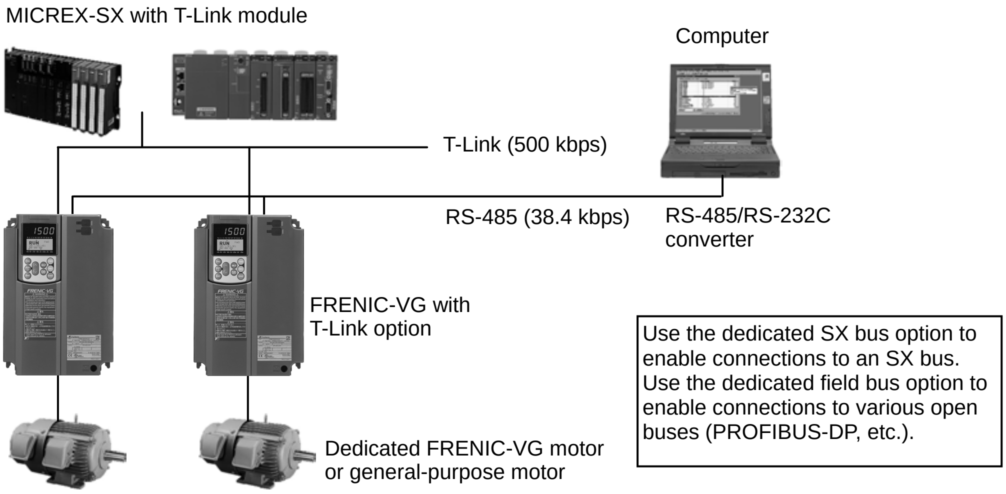
- The FRENIC-VG ships standard with RS-485 communications functionality and optional support for T-Link, SX bus, and CC-Link interfaces.
- It also supports various open buses (PROFIBUS-DP, etc.)*1.

  *1 Available soon.

RS-485 systems

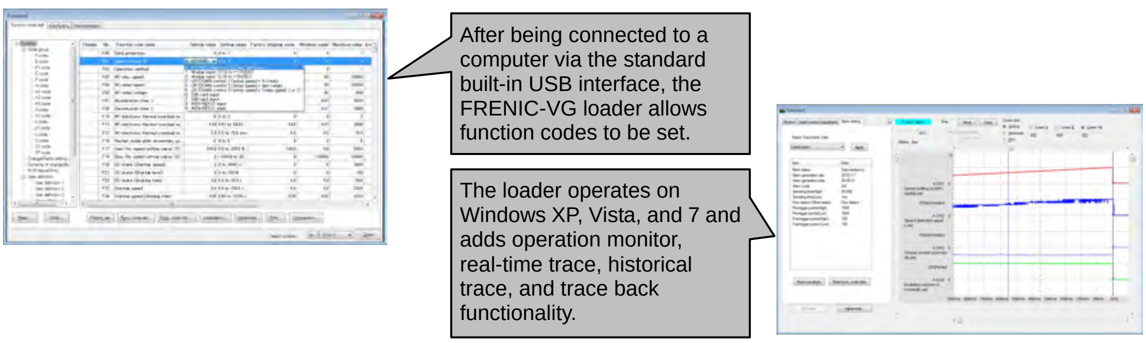
A standard RS-485 terminal is provided as a control circuit terminal, making it simple to implement multi-drop connections.

T-Link systems



1.2.6 Available inverter support loader

- An available inverter support loader (option) with Windows support simplifies the process of setting function codes.



1.2.7 Extensive built-in functionality

- Extensive auto-tuning functionality

  The motor constant can be tuned while the motor is in the stopped state.

  An online tuning function allows motor parameters to be revised while the motor continues to operate.

- Built-in observer function for suppressing load oscillation

- Load compensation control function

  Enables continuous speed control during low-duty operation.

- Extensive position control functionality
  - Zero-speed lock control
  - Optional position synchronization control using pulse train input
  - Optional orientation control*1

- Built-in braking unit

  The FRENIC-VG incorporates a built-in braking unit for use with capacities of 55 kW or less (for 200 V circuits) or 160 kW or less (for 400 V circuits), allowing a braking resistor to be connected directly to the FRENIC-VG unit. This feature helps make machinery and devices using the inverter more compact.

- Total of 23 I/O contacts

	Input	Output
Analog	3 contacts	3 contacts
Digital	11 contacts	6 contacts

- PG feedback interface
  - Standard built-in complementary PG interface (12 V, 15 V)
  - Optional line driver and resolver*1 support
  - Optional support for 4-bit signals, UVW, Z-phase, and EnDat*1 as magnetic position signals for driving synchronous motors

*1 Available soon.

1.2.8 Extensive maintenance and protective functionality

- A traceback function automatically records operating state data (traceback data) such as the speed, torque, current, and voltage immediately prior to a trip stop inside the inverter. The FRENIC-VG Loader can be used to capture traceback data and display the operating state immediately prior to a trip stop in chart form, making it easier to search for the causes of such events.
- A calendar and clock function records the time and date of trip stops, making it easier to search for the causes of such events.
- The inverter's operating state at the time of the most recent and three previous trip stops is stored and can be monitored on the keypad.
- By setting a specific alarm as a light failure target in advance, it is possible to display data on the keypad and generate "do" output without initiating a trip stop event.
- A psuedo-failure can be triggered by either keypad operation or the FRENIC-VG Loader. This capability can be used to check the trip stop sequence.
- I/O terminal check function
- Main circuit capacitor service life detection
- Inverter load rate measurement
- Recording and display of cumulative run time
- Display of operating state data such as output voltage, cooler temperature, and torque command value
- Configuration of the electronic thermal time constant, allowing the inverter to support a variety of motors
- The design life of various consumable parts inside the inverter has been extended to 10 years, which has allowed equipment maintenance cycles to be extended.

Consumable part	Design life
Cooling fan	10 years
Main circuit capacitor	10 years
Electrolytic capacitor on PCB	10 years
Fuse (90 kW or above)	10 years
Calendar/clock backup battery	5 years

Service life figures are based on the following conditions:

- Ambient temperature: 40°C

- Load factor: 100% (HD mode), 80% (MD/LD mode)

*Design life figures are calculated values and are not intended to serve as a guarantee of hardware performance.

- Extensive service life warnings

The inverter provides functionality designed to facilitate machinery maintenance.

Item	Purpose
Cumulative run time (unit: 1 hour)	Displays the total run time for the inverter. The amount of time during which the main power supply is supplied is indicated as a whole number of hours.
Cumulative motor run time (unit: 10 hours)	Displays the total run time for the motor. This figure is used to determine the service life of the machinery (load).
Cumulative startup count	Displays the number of motor startups. This figure can be used as a guide for timing the replacement of machinery parts (such as timing belts) that are placed under load during normal operation.
Equipment maintenance warning Cumulative motor run time (unit: 10 hours) Cumulative startup count	The inverter can output a warning signal when the set value is reached. This functionality makes it possible to manage the motor's cumulative run time and number of startups, which are useful in planning maintenance.
Display of inverter service life alarm	Displays the following: ・ Current capacitance of DC link bus capacitor ・ Total run time of the cooling fan (with on/off compensation) ・ Total run time of the electrolytic capacitor on the PCB

1.2.9 Environmental considerations

- Enhanced environmental resistance

The inverter offers improved resistance to harsh operating environments compared to conventional inverter models.

(1) Enhanced environmental resistance of the cooling fan

(2) Adoption of nickel and tin plating for copper bars

While the FRENIC-VG offers improved resistance to harsh operating environments compared to conventional models, special consideration concerning the operating environment is necessary in the following cases:

a. Environments where sulfide gas is present (some applications in tire manufacturing, paper manufacturing, sewage treatment, and fiber manufacturing)
b. Environments where conductive dust or foreign matter is present (metalworking, extruding machine or printing press operation, waste disposal, etc.)
c. Other: Where the inverter would be used in an environment that differs from the standard specifications

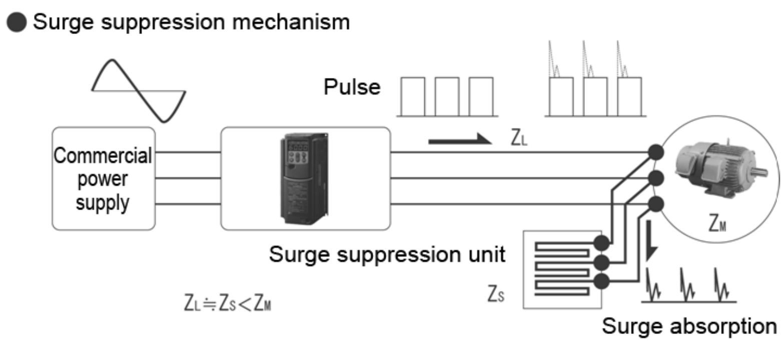
If you are considering using the inverter under any of the above conditions, please contact Fuji in advance.

● Protection against micro-surges (optional)

SSU surge suppression units (optional)

If the motor drive cable is too long, a very low surge voltage (micro-surge) may be generated at the motor connection ends. This surge voltage can cause deterioration of the motor, dielectric breakdown, and increased noise. A surge suppression unit can be used to suppress this surge voltage.

(1) Simply connecting a surge suppression unit to the motor dramatically reduces the surge voltage.
(2) Since no additional work is required, the units can be easily installed on existing equipment.
(3) The units can be used with motors with a capacity of 75 kW or less.
(4) The units require no power source or maintenance.
(5) Two types are available: one for 50 m motor cable and the other for 100 m motor cable.
(6) The units comply with environmental and safety standards (including the RoHS Directive).



● Compliance with the RoHS Directive

The FRENIC-VG complies with the Restriction of Hazardous Substances (RoHS) Directive in its standard configuration. It is an environmentally friendly inverter as use of the following six hazardous substances has been restricted.

Six hazardous substances

Lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ether (PBDE)

*Except certain parts on some models.

About the RoHS Directive

Directive 2002/96/EC, promulgated by the European Parliament and European Council, limits the use of specific hazardous substances in electrical and electronic devices.

1.2.10 Simple, interactive keypad

- A large, easy-to-read LED consisting of five 7-segment digits allows users to visually check monitor values with ease.
- A backlit dot matrix LCD allows users to set function codes and monitor multiple data points at the same time while displaying guidance.
- Standard copy function

  Function code data can be easily copied to another FRENIC-VG unit.
- Out-of-the-box remote operation

  Simply connect the inverter and keypad with a 10Base-T LAN cable to enable remote operation (at distances of up to 20 m).
- Standard support for eight languages (Japanese, English, German, French, Italian, Spanish, Chinese, and Korean)*1

  *1 German, French, Italian, and Spanish: Available soon.
- JOG (jogging) operation is possible with keypad key or terminal block input.
- A help key displays guidance on device operation.
- The calendar and clock function can display the time and date.

1.2.11 Compliance with overseas standards

- The FRENIC-VG complies with the following overseas standards in its standard configuration, allowing standardization of device and machinery specifications in Japan and overseas:

  EC directives: Low Voltage Directive*1, RoHS Directive, Machinery Directive*1, UL standards, cUL standards*1

Europe	North America, Canada
EC directives (CE marking)	UL standards, cUL standards

- The unit also complies with the EMC Directive when the standard model is combined with an optional component (EMC filter)*1.

  *1 Available soon.

1.2.12 Compliance with functional safety standards

- The FRENIC-VG incorporates an STO safety function that complies with the EN 61800-5-2 functional safety standard in its standard configuration*1.

- With the OPC-VG1-SAFE functional safety option, the unit provides STO, SS1, SLS, and SBC safety functions that comply with the EN 61800-5-2 functional safety standard*1.

  STO safety function: Safe torque off

  Functionality for immediately turning motor torque off (by interrupting output).

  SS1 safety function: Safe stop 1

  Functionality for decelerating the motor and immediately turning motor torque off with the STO function (by interrupting output) when a specified speed is reached or a specified time has elapsed.

  SLS safety function: Safely limited speed

  Functionality for ensuring that the motor speed does not exceed a specified speed.

  SBC safety function: Safe brake control

  Functionality for outputting a signal to control motor braking

  *1: Available soon.

1.2.13 Compatibility with legacy models

The FRENIC-VG is compatible with previous Fuji vector control inverters, making it easy to update to the FRENIC-VG.

- Compatibility with the FRENIC5000VG5S*1

  By changing FRENIC-VG VG5-compatible models to VG5 compatibility mode, the FRENIC-VG can be configured with VG5 function code without any need to change function code numbers or data definitions. A compatible adapter is available to allow mounting of the unit.

  *1: Available soon.

- Compatibility with the FRENIC5000VG7S

  Since the FRENIC-VG's function codes are compatible with the VG7's function codes, the FRENIC-VG can be configured with VG7 function codes without modification (except M3 function codes). Additionally, function codes can be captured from a VG7 unit with the FRENIC-VG Loader and copied to the FRENIC-VG without modification.

1.3 Control Methods

1.3.1 Control method features and applications

Inverter-based devices for varying AC motor speed are most commonly used to control the rotational speed of a load. This section describes the basic architecture of various speed control methods, their characteristics, and important information to consider when using them in various applications.

Speaking broadly, speed control systems can be classified as either open-loop or closed-loop control systems (see Figure 1.3.1).

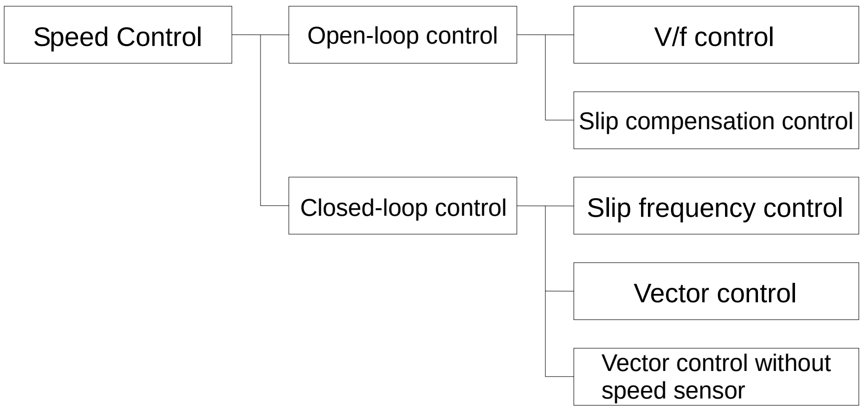


Figure 1.3.1 Classification of Speed Control Methods

1.3.1.1 Open-loop speed control

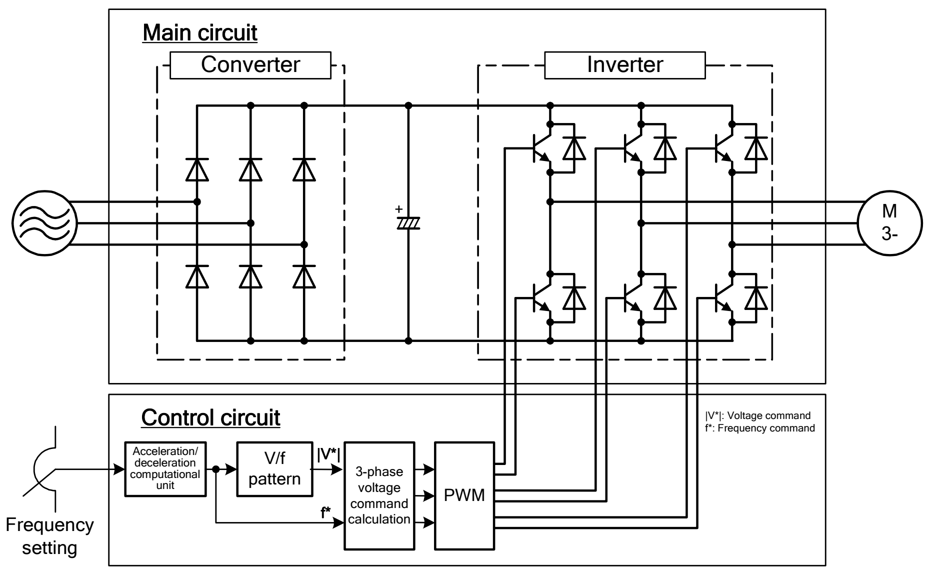


Figure 1.3.2 Open-loop Speed Control: Basic Architecture

As is illustrated in Figure 1.3.2, "Open-loop Speed Control: Basic Architecture," this approach attempts to control the load's rotational speed by means of the frequency of inverter output, without generating feedback in the form of speed information for the control target. As shown in Figure 1.3.3, induction motors' speed versus torque characteristics are characterized by a slight slope across frequencies f1 to f6. If the frequency of the voltage supplied to the motor remains constant, then there is little variation in rotational speed in response to variations in load; for example, slip at the rated torque is on the order of several percent. In other words, when controlling the motor's speed by changing the inverter's output frequency, V/f control, which controls the ratio between the motor's terminal voltage and the applied frequency, is generally used.

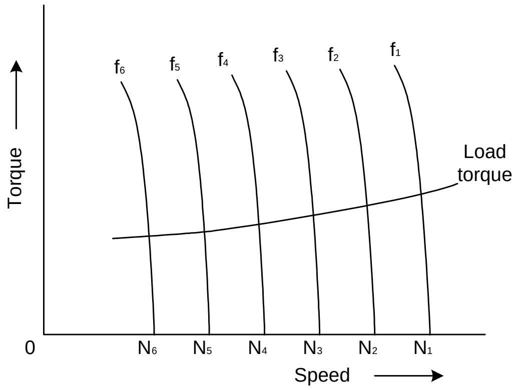


Figure 1.3.3 Speed Versus Torque Characteristics

Since open-loop control does not require a speed sensor, it is primarily used by general-purpose inverters in applications where fast response is not particularly important, for example to enable variable-speed operation of existing motors or with squared-deceleration torque loads such as fans or pumps.

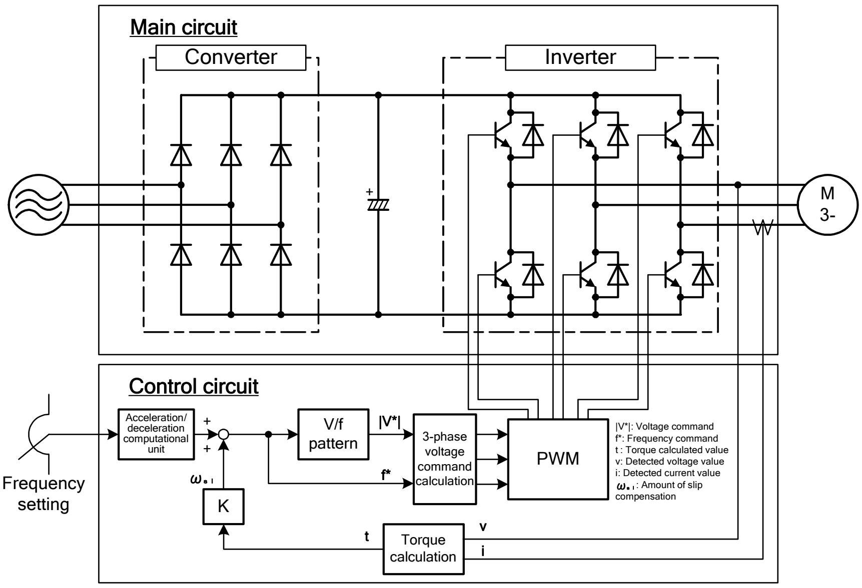


Figure 1.3.4 Speed Control Using the Slip Compensation Method

Factors determining the accuracy of the rotational speed in open-loop speed control include load torque fluctuations, accuracy of the output frequency, and supply voltage fluctuations. The slip compensation control method addresses load torque fluctuations by calculating the output torque from the motor's terminal voltage and primary current and compensating the inverter's output frequency accordingly in an attempt to maintain a constant rotational speed, as illustrated in Figure 1.3.4.

1.3.1.2 Closed-loop speed control

Closed-loop speed control compensates for speed fluctuations by generating feedback in the form of speed information.

Since highly accurate speed control is possible by generating feedback in the form of the control target's rotational speed, closed-loop speed control can be used in applications such as paper machines and machine tools.

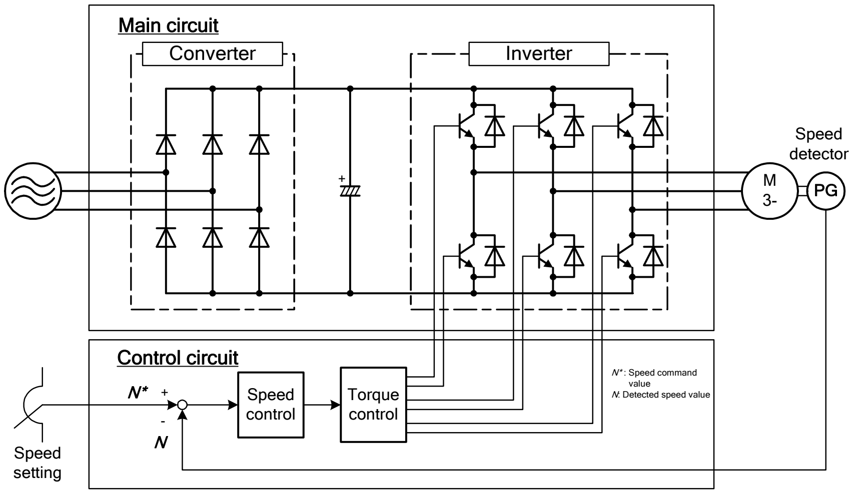


Figure 1.3.5 Closed-loop Speed Control: Basic Architecture

Figure 1.3.5 illustrates the basic architecture of the closed-loop speed control method. Speed information from a speed detection sensor such as a pulse generator (PG) is fed back to the system and compared to the speed command, and the inverter's output frequency is controlled so that the speed command and the detected speed value match.

Speed control methods include slip frequency control, vector control with a speed sensor, and vector control without a speed sensor. An overview of each of these control methods follows.

The FRENIC-VG series of high-performance vector control inverters uses closed-loop vector control to implement speed control.

(a) Slip frequency control

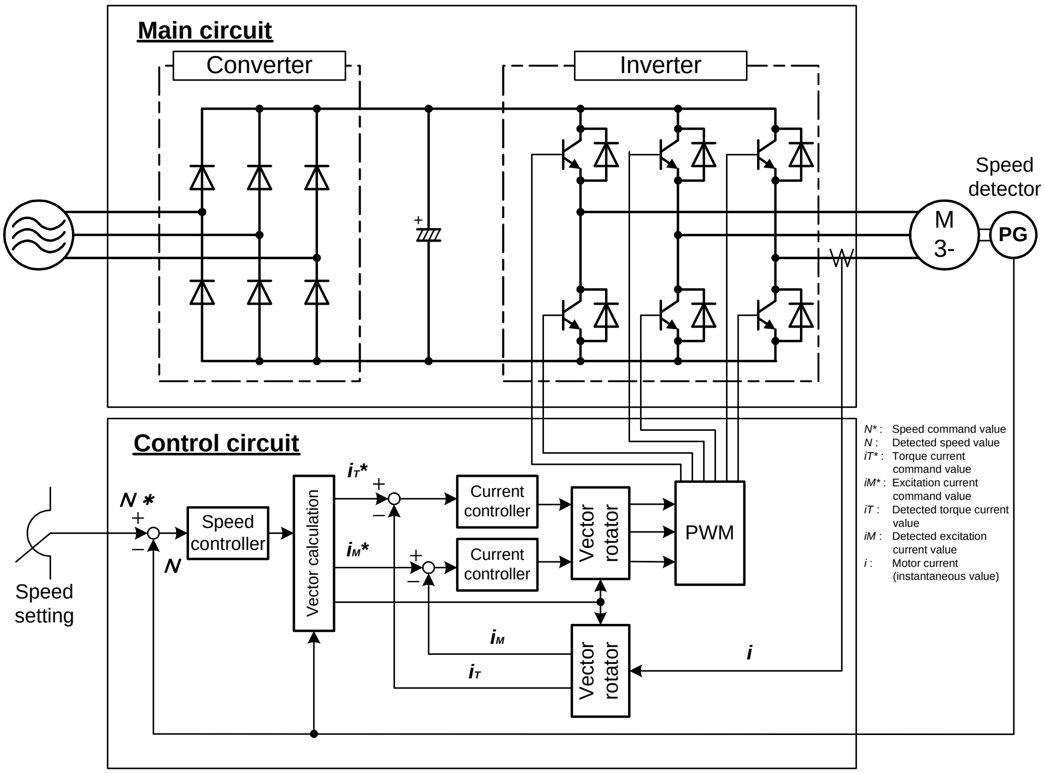


Figure 1.3.6 Slip Frequency Control Architecture

Figure 1.3.6 illustrates the architecture of the slip frequency control method. Output from the speed controller becomes the slip frequency based on the torque, and the inverter compensates for speed fluctuations by adding the slip frequency to the actual speed. Because this method is comparatively simple, it is used in applications such as speed control in general-purpose inverters. However, since basic control is performed using V/f control, this method is used in applications that do not require fast response.

(b) Vector control with a speed sensor

Vector control is used to implement fast response for AC motors. By controlling an AC motor's primary current, magnetic flux current, and torque current separately, vector control attempts to achieve a similar level of control performance as that for DC motors.

Vector control achieves performance that differs from the V/f control method in the following ways, making it well suited for use in applications that require fast response and high accuracy:

(1) Good acceleration and deceleration characteristics

(2) Broad speed control range

(3) Torque control capability

(4) Fast control response

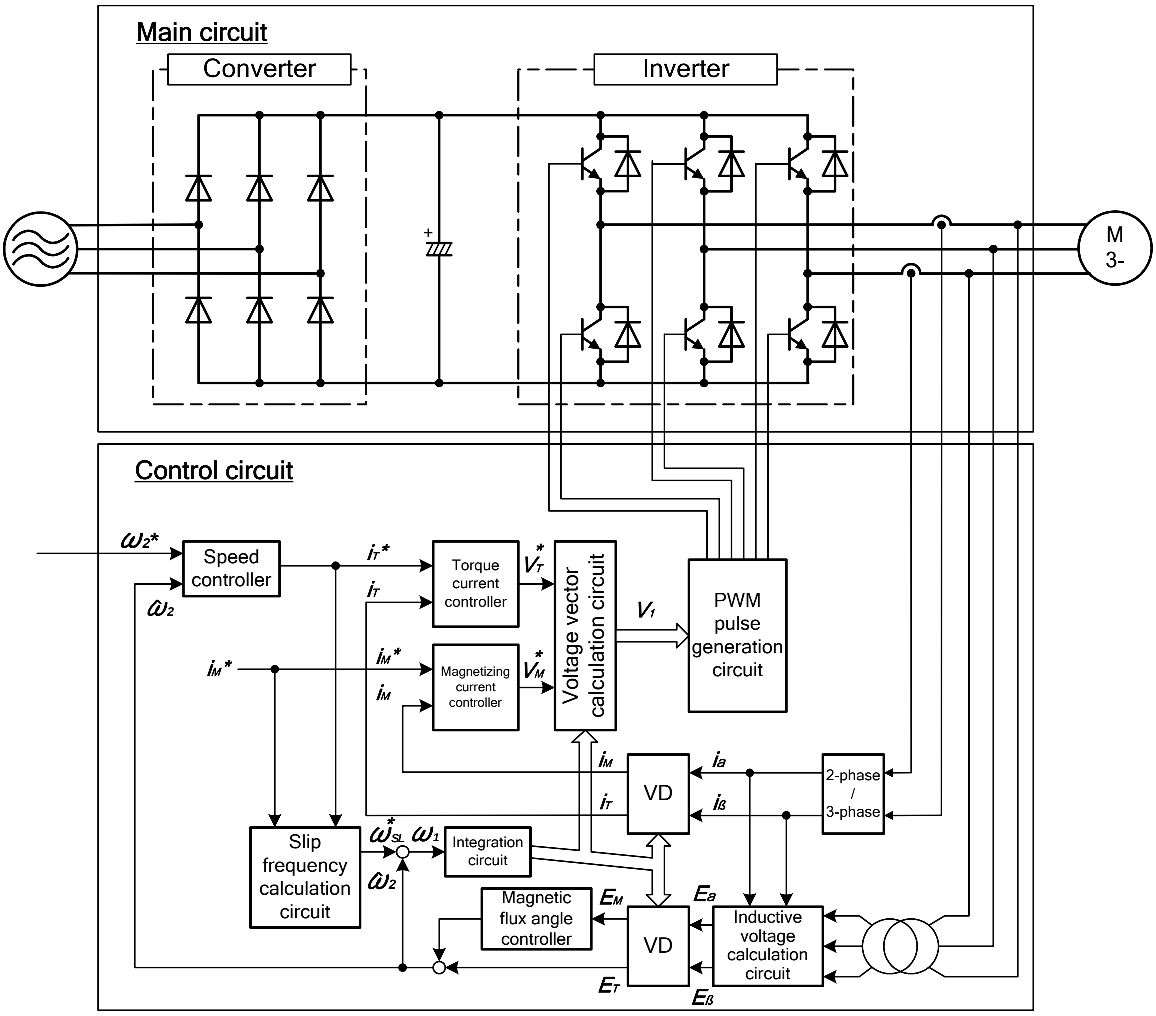


Figure 1.3.7 Example Vector Control Architecture

Figure 1.3.7 illustrates an example vector control architecture. Since the vector calculation unit uses the motor constant, performance varies greatly with the accuracy with which that constant is understood. Performance is also significantly affected by changes to the constant caused by temperature conditions. Since the control method is complex, this method is primarily used with combinations of dedicated inverters and dedicated motors.

(c) Vector control without a speed sensor

Vector control with a speed sensor offers exceptional performance in terms of fast response and high accuracy but suffers from issues such as the need to install a speed sensor and route wiring from the sensor to the inverter. By contrast, vector control without a speed sensor estimates the rotational speed based on the motor's terminal voltage and primary current without relying on sensor input and uses the estimated value as the speed feedback signal. Vector control without a speed sensor delivers performance that is slightly inferior to vector control with a speed sensor.

Figure 1.3.8 illustrates an example of vector control without a speed sensor.

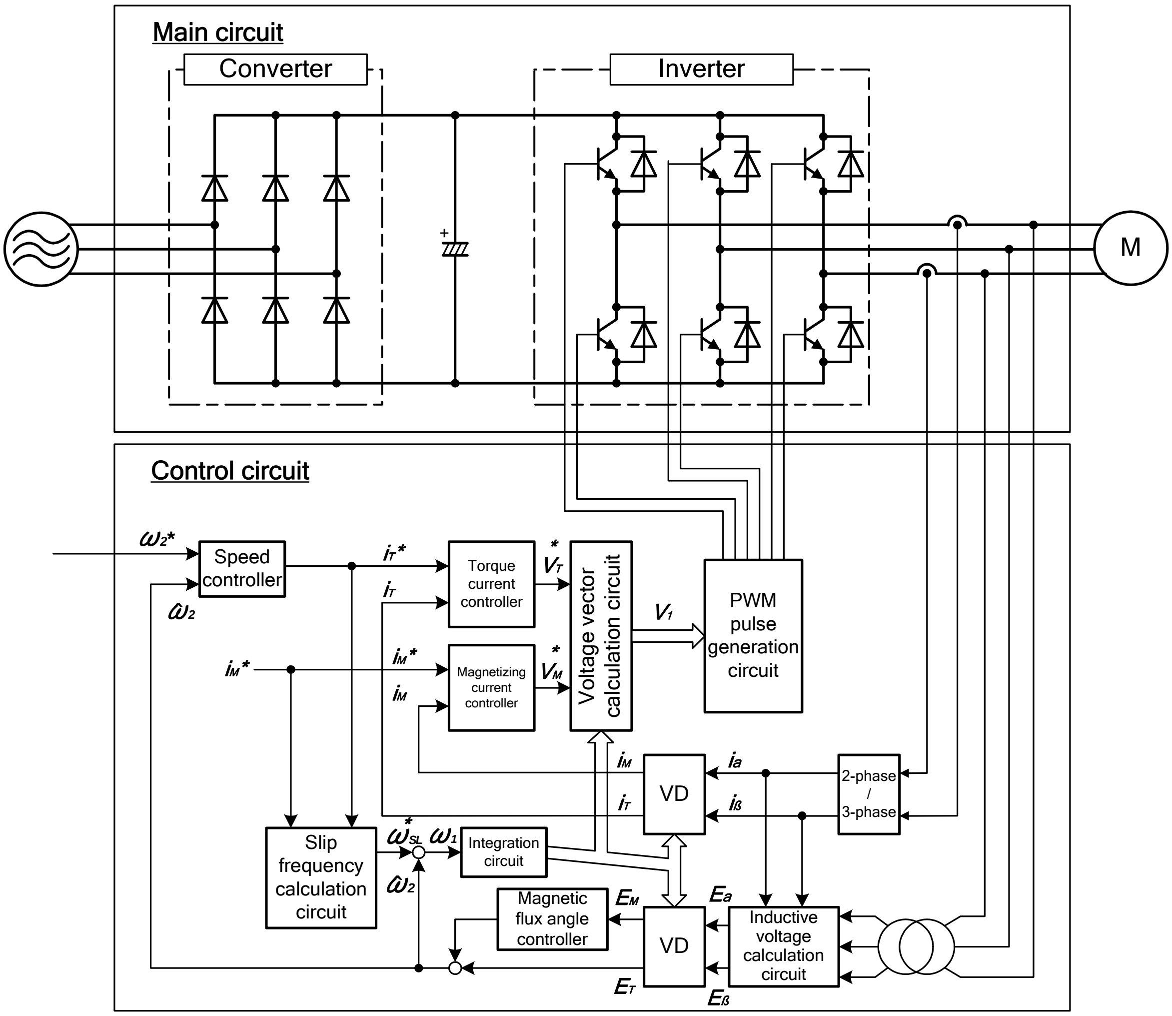


Figure 1.3.8 Example Architecture for Vector Control without a Speed Sensor

The FRENIC-VG can use this type of control when utilized in combination with a general-purpose motor. However, control performance and other specifications are slightly inferior to those of applications where the inverter is used in combination with a dedicated motor.

Chapter 2
SPECIFICATIONS

This chapter describes specifications of the output ratings, control system, dedicated motor specifications, and terminal functions for the FRENIC-VG series of inverters. It also provides descriptions of the external dimensions, examples of basic connection diagrams, and details of the protective functions.

Contents

2.1 Standard Model 1 (Basic Type)

2.1.1 HD (High Duty)-mode inverters for heavy load

Three-phase 200 V class series

	Type (FRN_ _ _VG1S-2□)	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
	Nominal applied motor (kW)	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
	Rated capacity (kVA) *1	1.9	3.0	4.1	6.8	10	14	18	24	28	34	45	55	68	81	107	131
	Rated current (A)	5	8	11	18	27	37	49	63	76	90	119	146	180	215	283	346
	Overload capability	150% of the rated current for 1 minute *2 200% of the rated current for 3 seconds *3															
Input power	Main power input: Phase, voltage, frequency	Three-phase, 200 to 230 V, 50/60 Hz										Three-phase, 200 to 220 V/50 Hz, 200 to 230 V/60 Hz *4					
Input power	Auxiliary control power input: Phase, voltage, frequency	Single-phase, 200 to 230V, 50/60 Hz															
Input power	Auxiliary fan power input: Phase, voltage, frequency *5	-											Single-phase 200 to 220 V/50 Hz, 200 to 230 V/60 Hz *4				
Input power	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less *6), Frequency: +5 to -5%															
Input power	Rated current (A) *7 (with DCR)	3.2	6.1	8.9	15.0	21.1	28.8	42.2	57.6	71.0	84.4	114	138	167	203	282	334
Input power	Rated current (A) *7 (without DCR)	5.3	9.5	13.2	22.2	31.5	42.7	60.7	80.1	97.0	112	151	185	225	270	—	—
Input power	Required capacity (kVA) *8	1.2	2.2	3.1	5.2	7.4	10	15	20	25	30	40	48	58	71	98	116
	Braking system, Braking torque	Braking resistor discharge control: 150% braking torque, Separately mounted braking resistor (option), Separately mounted braking unit (option for FRN75VG1S-2J or higher type)															
	Carrier frequency (kHz) *9	2 to 15														2 to 10	
	Approx. mass (kg)	6.2	6.2	6.2	6.2	6.2	6.2	11	11	11	12	25	32	42	43	62	105
	Enclosure	IP20, UL open type										IP00, UL open type (IP20 is optionally available.)					

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

Note: The above specifications apply when Function code F80 = 0 (HD mode).
A DC reactor (DCR) is provided as standard for HD-mode inverters of 75 kW or above.

*1 This specification applies when the rated output voltage is 220 V.

*2 When the inverter output frequency converted is less than 10 Hz, the inverter may trip earlier due to overload depending on the surrounding temperature and other conditions.

*3 When the inverter output frequency converted is less than 5 Hz, the inverter may trip earlier due to overload depending on the surrounding temperature and other conditions.

*4 Inverters of 200 to 230 V/50 Hz are available on request.

*5 Use this input as an AC fan power in a power system using a power regenerative PWM converter. (Usually, there is no need to use this input.)

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$$

If this value exceeds 2%, use an AC reactor (ACR).

*7 This specification is an estimate to be applied when the power supply capacity is 500 kVA (Inverter capacity x 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*8 This specification applies when a DC reactor (DCR) is used. (A DCR is optionally available for inverters of 55 kW or below.)

If the power source uses an electrical generator, it may burn due to the inverter harmonic current. To avoid such an accident, about three or four times the required capacity should be ensured. (About four times when no DCR is connected; about three times when a DCR is connected.)

*9 The inverter may automatically reduce the carrier frequency in accordance with the surrounding temperature or output current in order to protect itself.

Canceling the automatic lowering of the carrier frequency (H104, hundreds digit) lowers the inverter's continuous rated current according to the carrier frequency setting. (For the details about the rated current lowering characteristics, refer to Chapter 2, Section 2.1.4.)

Three-phase 400 V class series

Type (FRN_ _ _VG1S-4☐)	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
Nominal applied motor (kW)	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
Rated capacity (kVA) ***1**	6.8	10	14	18	24	29	34	45	57	69	85	114	134	160	192	231	287	316	396	445	495	563	731	891
Rated current (A)	9.0	13.5	18.5	24.5	32.0	39.0	45.0	60.0	75.0	91.0	112	150	176	210	253	304	377	415	520	585	650	740	960	1170
Overload capability	150% of the rated current for 1 minute ***2** 200% of the rated current for 3 seconds ***3**																							
Input power: Main power input: Phase, voltage, frequency	Three-phase, 380 to 480 V, 50/60 Hz											Three-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz ***4**												
Input power: Auxiliary control power input: Phase, voltage, frequency	Single-phase, 380 to 480 V, 50/60 Hz																							
Input power: Auxiliary fan power input: Phase, voltage, frequency ***5**	-											Single-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz ***4**												
Input power: Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less ***6**), Frequency: +5 to -5%																							
Input power: Rated current (A) ***7** (with DCR)	7.5	10.6	14.4	21.1	28.8	35.5	42.2	57.0	68.5	83.2	102	138	164	210	238	286	357	390	500	559	628	705	881	1115
Input power: Rated current (A) (without DCR)	13.0	17.3	23.2	33	43.8	52.3	60.6	77.9	94.3	114	140	-												
Input power: Required capacity (kVA) ***8**	5.2	7.4	10	15	20	25	30	40	48	58	71	96	114	140	165	199	248	271	347	388	436	489	610	773
Braking system, Braking torque	Braking resistor discharge control: 150% braking torque, Separately mounted braking resistor (option), Separately mounted braking unit (option for FRN200VG1S-4J or higher type)																							
Carrier frequency (kHz) ***9**	2 to 15											2 to 10											2 to 5	
Approx. mass (kg)	6.2	6.2	6.2	11	11	11	11	25	26	31	33	42	62	64	94	98	129	140	245	245	330	330	555	555
Enclosure	IP20, UL open type							IP00, UL open type (IP20 is optionally available.)																

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

Note: The above specifications apply when Function code F80 = 0 (HD mode).
A DC reactor (DCR) is provided as standard for HD-mode inverters of 75 kW or above.

*1 This specification applies when the rated output voltage is 440 V.

*2 When the inverter output frequency converted is less than 10 Hz, the inverter may trip earlier due to overload depending on the surrounding temperature and other conditions.

*3 When the inverter output frequency converted is less than 5 Hz, the inverter may trip earlier due to overload depending on the surrounding temperature and other conditions.

*4 For 380 to 398 V/50 Hz or 380 to 430 V/60 Hz, connector switching is required inside the inverter.
If the input voltage is 380 V, the output may be reduced. For details, refer to the User's Manual.

*5 Use this input as an AC fan power in a power system using a power regenerative PWM converter. (Usually, there is no need to use this input.)

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$$

If this value exceeds 2%, use an AC reactor (ACR).

*7 This specification is an estimate to be applied when the power supply capacity is 500 kVA (Inverter capacity x 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*8 This specification applies when a DC reactor (DCR) is used. (A DCR is optionally available for inverters of 55 kW or below.)

If the power source uses an electrical generator, it may burn due to the inverter harmonic current. To avoid such an accident, about three or four times the required capacity should be ensured. (About four times when no DCR is connected; about three times when a DCR is connected.)

*9 The inverter may automatically reduce the carrier frequency in accordance with the surrounding temperature or output current in order to protect itself.

Canceling the automatic lowering of the carrier frequency (H104, hundreds digit) lowers the inverter's continuous rated current according to the carrier frequency setting. (For the details about the rated current lowering characteristics, refer to Chapter 2, Section 2.1.4.)

2.1.2 MD (Medium Duty)-mode inverters for medium load

Three-phase 400 V class series

	Type (FRN_ _ _VG1S-4☐)	90	110	132	160	200	220	280	315	355	400
Nominal applied motor (kW) *7		110	132	160	200	220	250	315	355	400	450
Rated capacity (kVA) *1		160	192	231	287	316	356	445	495	563	640
Rated current (A)		210	253	304	377	415	468	585	650	740	840
Overload capability		150% of the rated current for 1 minute									
Input power	Main power input: Phase, voltage, frequency	Three-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz *2									
Input power	Auxiliary control power input: Phase, voltage, frequency	Single-phase, 380 to 480 V, 50/60 Hz									
Input power	Auxiliary fan power input: Phase, voltage, frequency *3	Single-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz *2									
Input power	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less *4), Frequency: +5 to -5%									
Input power	Rated current (A) *5 (with DCR)	210	238	286	357	390	443	559	628	705	789
Input power	(without DCR)	-									
Input power	Required capacity (kVA) *6	140	165	199	248	271	312	388	436	489	547
Braking system, Braking torque		Braking resistor discharge control: 150% braking torque, Separately mounted braking resistor (option), Separately mounted braking unit (option for FRN200VG1S-4J or higher type)									
Carrier frequency (kHz) *8		2 to 4									
Approx. mass (kg)		62	64	94	98	129	140	245	245	330	330
Enclosure		IP00, UL open type (IP20 is optionally available.)									

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

Note: The above specifications apply when Function code F80 = 3 (MD mode).
To use the inverter in the MD mode, inform your Fuji Electric representative of the MD-mode use when placing an order. The inverter comes with a DC reactor (DCR) suitable for the nominal applied motor as standard.

*1 This specification applies when the rated output voltage is 440 V.

*2 For 380 to 398 V/50 Hz or 380 to 430 V/60 Hz, connector switching is required inside the inverter.
If the input voltage is 380 V, the output may be reduced. For details, refer to the User's Manual.

*3 Use this input as an AC fan power in a power system using a power regenerative PWM converter. (Usually, there is no need to use this input.)

*4 $\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$

If this value exceeds 2%, use an AC reactor (ACR).

*5 This specification is an estimate to be applied when the power supply capacity is equal to "Inverter capacity x 10" and the power supply with %X = 5% is connected.

*6 This specification applies when a DC reactor (DCR) is used.

If the power source uses an electrical generator, it may burn due to the inverter harmonic current. To avoid such an accident, about three or four times the required capacity should be ensured. (About four times when no DCR is connected; about three times when a DCR is connected.)

*7 Depending on the load conditions, motor heating may increase due to the low carrier frequency. When placing an order for motors, therefore, specify the MD-mode use.

*8 Running the PMSM at low carrier frequency may overheat the permanent magnet due to the output current harmonics, resulting in demagnetization. The carrier frequency specification of the inverter is low (2 to 4 kHz), so be sure to check the allowable carrier frequency of the motor. If the MD-mode inverter is not applicable due to the low carrier frequency (2 to 4 kHz), consider the HD mode (H80 = 0).

2.1.3 LD (Low Duty)-mode inverters for light load

Three-phase 200 V class series

Type (FRN_ _ _VG1S-2☐)	30	37	45	55	75	90
Nominal applied motor (kW)	37	45	55	75	90	110
Rated capacity (kVA) *1	55	68	81	107	131	158
Rated current (A)	146	180	215	283	346	415
Overload capability	120% of the rated current for 1 minute					
Input power: Main power input: Phase, voltage, frequency	Three-phase, 200 to 220 V/50 Hz, 200 to 230 V/60 Hz *2					
Input power: Auxiliary control power input: Phase, voltage, frequency	Single-phase, 200 to 230 V, 50/60 Hz					
Input power: Auxiliary fan power input: Phase, voltage, frequency *3	-	Single-phase, 200 to 220 V/50 Hz, 200 to 230 V/60 Hz *2				
Input power: Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less *4), Frequency: +5 to -5%					
Input power: Rated current (A) *5 (with DCR)	138	167	203	282	334	410
Input power: Rated current (A) *5 (without DCR)	185	225	270	-	—	—
Input power: Required capacity (kVA) *6	48	58	71	98	116	143
Braking system, Braking torque	Braking resistor discharge control: 110% braking torque, Separately mounted braking resistor (option), Separately mounted braking unit (option for FRN75VG1S-2J or higher type)					
Carrier frequency (kHz) *7	2 to 10				2 to 5	
Approx. mass (kg)	25	32	42	43	62	105
Enclosure	IP00, UL open type (IP20 is optionally available.)					

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

Note: The above specifications apply when Function code F80 = 1 (LD mode).
To use the inverter of 55 kW or above in the LD mode, inform your Fuji Electric representative of the LD-mode use when placing an order. The inverter comes with a DC reactor (DCR) suitable for the nominal applied motor as standard.

*1 This specification applies when the rated output voltage is 220 V.

*2 Inverters of 200 to 230 V/50 Hz are available on request.

*3 Use this input as an AC fan power in a power system using a power regenerative PWM converter. (Usually, there is no need to use this input.)

*4 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$$

If this value exceeds 2%, use an AC reactor (ACR).

*5 This specification is an estimate to be applied when the power supply capacity is 500 kVA (Inverter capacity x 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*6 This specification applies when a DC reactor (DCR) is used. (A DCR is optionally available for the FRN45VG1S-2J or lower type.)

If the power source uses an electrical generator, it may burn due to the inverter harmonic current. To avoid such an accident, about three or four times the required capacity should be ensured. (About four times when no DCR is connected; about three times when a DCR is connected.)

*7 The inverter may automatically reduce the carrier frequency in accordance with the surrounding temperature or output current in order to protect itself.

Canceling the automatic lowering of the carrier frequency (H104, hundreds digit) lowers the inverter's continuous rated current according to the carrier frequency setting. (For the details about the rated current lowering characteristics, refer to Chapter 2, Section 2.1.4.)

Three-phase 400 V class series

Type (FRN_ _ _VG1S-4☐)		30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
Nominal applied motor (kW)		37	45	55	75	90	110	132	160	200	220	280	355	400	450	500	630	710
Rated capacity (kVA) ***1**		57	69	85	114	134	160	192	231	287	316	396	495	563	640	731	891	1044
Rated current (A)		75	91	112	150	176	210	253	304	377	415	520	650	740	840	960	1170	1370
Overload capability		120% of the rated current for 1 minute																
Input power	Main power input: Phase, voltage, frequency	Three-phase, 380 to 480 V, 50/60 Hz				Three-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz ***2**												
Input power	Auxiliary control power input: Phase, voltage, frequency	Single-phase, 380 to 480 V, 50/60 Hz																
Input power	Auxiliary fan power input: Phase, voltage, frequency ***3**	-				Single-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz ***2**												
Input power	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less ***4**), Frequency: +5 to -5%																
Input power	Rated current (A) ***5** (with DCR)	68.5	83.2	102	138	164	210	238	286	357	390	500	628	705	789	881	1115	1256
Input power	(without DCR)	94.3	114	140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Input power	Required capacity (kVA) ***6**	48	58	71	96	114	140	165	199	248	271	347	436	489	547	611	773	871
Braking system, Braking torque		Braking resistor discharge control: 110% braking torque, Separately mounted braking resistor (option), Separately mounted braking unit (option for FRN200VG1S-4J or higher type)																
Carrier frequency (kHz) ***7**		2 to 10				2 to 5												2
Approx. mass (kg)		25	26	31	33	42	62	64	94	98	129	140	245	245	330	330	555	555
Enclosure		IP00, UL open type (IP20 is optionally available.)																

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

Note: The above specifications apply when Function code F80 = 1 (LD mode).
To use the inverter of 55 kW or above in the LD mode, inform your Fuji Electric representative of the LD-mode use when placing an order. The inverter comes with a DC reactor (DCR) suitable for the nominal applied motor as standard.

*1 This specification applies when the rated output voltage is 440 V.

*2 For 380 to 398 V/50 Hz or 380 to 430 V/60 Hz, connector switching is required inside the inverter.
If the input voltage is 380 V, the output may be reduced. For details, refer to the User's Manual.

*3 Use this input as an AC fan power in a power system using a power regenerative PWM converter. (Usually, there is no need to use this input.)

*4 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$$

If this value exceeds 2%, use an AC reactor (ACR).

*5 This specification is an estimate to be applied when the power supply capacity is 500 kVA (Inverter capacity x 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*6 This specification applies when a DC reactor (DCR) is used. (A DCR is optionally available for the FRN45VG1S-4J or lower type.)

If the power source uses an electrical generator, it may burn due to the inverter harmonic current. To avoid such an accident, about three or four times the required capacity should be ensured. (About four times when no DCR is connected; about three times when a DCR is connected.)

*7 The inverter may automatically reduce the carrier frequency in accordance with the surrounding temperature or output current in order to protect itself.

Canceling the automatic lowering of the carrier frequency (H104, hundreds digit) lowers the inverter's continuous rated current according to the carrier frequency setting. (For the details about the rated current lowering characteristics, refer to Chapter 2, Section 2.1.4.)

2.1.4 Rated current derating

Canceling the automatic lowering of the carrier frequency (H104, Hundreds digit) when the inverter drives a permanent magnet synchronous motor (PMSM) derates the continuous rated current of the inverter according to the carrier frequency setting (F26). Select the inverter capacity and the carrier frequency (F26) which match the motor specifications, referring to the tables given below.

HD (High Duty)-mode inverters for heavy load

Three-phase 200 V class series

Nominal applied motor (kW)	Inverter type	Rated current (A)	Derated current (A) (Derating rate (%))													
			Carrier frequency setting made with F26 (kHz)													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.75	FRN0.75VG1S-2☐	5	5.00 **(100%)**				4.50 (90%)	3.80 (76%)	5.00 **(100%)**		4.55 (91%)		4.15 (83%)			3.50 (70%)
1.5	FRN1.5VG1S-2☐	8	8.00 **(100%)**				7.20 (90%)	6.08 (76%)	8.00 **(100%)**		7.28 (91%)		6.64 (83%)			5.60 (70%)
2.2	FRN2.2VG1S-2☐	11	11.0 **(100%)**				9.90 (90%)	8.36 (76%)	11.0 **(100%)**		10.0 (91%)		9.13 (83%)			7.70 (70%)
3.7	FRN3.7VG1S-2☐	18	18.0 **(100%)**				16.2 (90%)	13.6 (76%)	18.0 **(100%)**		16.3 (91%)		14.9 (83%)			12.6 (70%)
5.5	FRN5.5VG1S-2☐	27	27.0 **(100%)**				24.3 (90%)	20.5 (76%)	27.0 **(100%)**		24.5 (91%)		22.4 (83%)			18.9 (70%)
7.5	FRN7.5VG1S-2☐	37	37.0 **(100%)**				33.3 (90%)	28.1 (76%)	37.0 **(100%)**		33.6 (91%)		30.7 (83%)			25.9 (70%)
11	FRN11VG1S-2☐	49	49.0 **(100%)**				44.1 (90%)	37.2 (76%)	49.0 **(100%)**		44.5 (91%)		40.6 (83%)			34.3 (70%)
15	FRN15VG1S-2☐	63	63.0 **(100%)**				56.7 (90%)	47.8 (76%)	63.0 **(100%)**		57.3 (91%)		52.2 (83%)			44.1 (70%)
18.5	FRN18.5VG1S-2☐	76	76.0 **(100%)**				72.2 (95%)	66.8 (88%)	76.0 **(100%)**				69.9 (92%)			60 (79%)
22	FRN22VG1S-2☐	90	90.0 **(100%)**				85.5 (95%)	79.2 (88%)	90.0 **(100%)**				82.8 (92%)			71.1 (79%)
30	FRN30VG1S-2☐	119	119 **(100%)**				117 (99%)	109 (92%)	119 **(100%)**				113 (95%)			103 (87%)
37	FRN37VG1S-2☐	146	146 **(100%)**				144 (99%)	134 (92%)	146 **(100%)**				138 (95%)			127 (87%)
45	FRN45VG1S-2☐	180	180 **(100%)**				178 (99%)	165 (92%)	180 **(100%)**				171 (95%)			156 (87%)
55	FRN55VG1S-2☐	215	215 **(100%)**				212 (99%)	197 (92%)	215 **(100%)**				204 (95%)			187 (87%)
75	FRN75VG1S-2☐	283	283 **(100%)**		274 (97%)	263 (93%)	283 **(100%)**	271 (96%)	268 (95%)	254 ***1** (90%)						
90	FRN90VG1S-2☐	346	346 **(100%)**		335 (97%)	321 (93%)	346 **(100%)**	332 (96%)	328 (95%)	311 ***1** (90%)						

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

*1 The internal carrier frequency is 10 kHz independent of the F26 setting.

Three-phase 400 V class series

Nominal applied motor (kW)	Inverter type	Rated current (A)	Derated current (A) (Derating rate (%))													
			Carrier frequency setting made with F26 (kHz)													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15
3.7	FRN3.7VG1S-4☐	9	9.00 **(100%)**				8.55 (95%)	7.65 (85%)	9.00 **(100%)**				8.10 (90%)			6.84 (76%)
5.5	FRN5.5VG1S-4☐	13.5	13.5 **(100%)**				12.8 (95%)	11.4 (85%)	13.5 **(100%)**				12.1 (90%)			10.2 (76%)
7.5	FRN7.5VG1S-4☐	18.5	18.5 **(100%)**				17.5 (95%)	15.7 (85%)	18.5 **(100%)**				16.6 (90%)			14.0 (76%)
11	FRN11VG1S-4☐	24.5	24.5 **(100%)**				21.8 (89%)	17.6 (72%)	24.5 **(100%)**		22.2 (91%)		19.8 (81%)			16.4 (67%)
15	FRN15VG1S-4☐	32	32.0 **(100%)**				28.4 (89%)	23.0 (72%)	32.0 **(100%)**		29.1 (91%)		25.9 (81%)			21.4 (67%)
18.5	FRN18.5VG1S-4☐	39	39.0 **(100%)**				36.2 (93%)	32.3 (83%)	39.0 **(100%)**				34.7 (89%)			28.4 (73%)
22	FRN22VG1S-4☐	45	45.0 **(100%)**				41.8 (93%)	37.3 (83%)	45.0 **(100%)**				40.0 (89%)			32.8 (73%)
30	FRN30VG1S-4☐	60	60.0 **(100%)**				54.0 (90%)	45.0 (75%)	60.0 **(100%)**				51.0 (85%)		41.4 (69%)	
37	FRN37VG1S-4☐	75	75.0 **(100%)**				67.5 (90%)	56.2 (75%)	75.0 **(100%)**				63.7 (85%)		51.7 (69%)	
45	FRN45VG1S-4☐	91	91.0 **(100%)**				81.9 (90%)	68.2 (75%)	91.0 **(100%)**				77.3 (85%)		62.7 (69%)	
55	FRN55VG1S-4☐	112	112 **(100%)**				100 (90%)	84.0 (75%)	112 **(100%)**				95.0 (85%)		77.2 (69%)	
75	FRN75VG1S-4☐	150	150 **(100%)**		141 (94%)	115 (77%)	150 **(100%)**	130 (87%)	126 (84%)		111 ***1** (74%)					
90	FRN90VG1S-4☐	176	176 **(100%)**		165 (94%)	135 (77%)	176 **(100%)**	153 (87%)	147 (84%)		130 ***1** (74%)					
110	FRN110VG1S-4☐	210	210 **(100%)**		197 (94%)	161 (77%)	210 **(100%)**	182 (87%)	176 (84%)		155 ***1** (74%)					
132	FRN132VG1S-4☐	253	253 **(100%)**		237 (94%)	194 (77%)	253 **(100%)**	220 (87%)	212 (84%)		187 ***1** (74%)					
160	FRN160VG1S-4☐	304	304 **(100%)**		285 (94%)	234 (77%)	304 **(100%)**	264 (87%)	255 (84%)		224 ***1** (74%)					
200	FRN200VG1S-4☐	377	377 **(100%)**		354 (94%)	290 (77%)	377 **(100%)**	327 (87%)	316 (84%)		278 ***1** (74%)					
220	FRN220VG1S-4☐	415	415 **(100%)**		390 (94%)	319 (77%)	415 **(100%)**	361 (87%)	348 (84%)		307 ***1** (74%)					
280	FRN280VG1S-4☐	520	520 **(100%)**		488 (94%)	400 (77%)	520 **(100%)**	452 (87%)	436 (84%)		384 ***1** (74%)					
315	FRN315VG1S-4☐	585	585 **(100%)**		549 (94%)	450 (77%)	585 **(100%)**	509 (87%)	491 (84%)		432 ***1** (74%)					
355	FRN355VG1S-4☐	650	650 **(100%)**		611 (94%)	500 (77%)	650 **(100%)**	565 (87%)	546 (84%)		481 ***1** (74%)					
400	FRN400VG1S-4☐	740	740 **(100%)**		695 (94%)	569 (77%)	740 **(100%)**	643 (87%)	621 (84%)		547 ***1** (74%)					
500	FRN500VG1S-4☐	960	960 **(100%)**			960 ***2** **(100%)**										
630	FRN630VG1S-4☐	1170	1170 **(100%)**			1170 ***2** **(100%)**										

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

*1 The internal carrier frequency is 10 kHz independent of the F26 setting.
*2 The internal carrier frequency is 5 kHz independent of the F26 setting.

MD (Medium Duty)-mode inverters for medium load

Three-phase 400 V class series

Nominal applied motor (kW)	Inverter type	Rated current (A)	Derated current (A) (Derating rate (%))													
			Carrier frequency setting made with F26 (kHz)													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15
110	FRN90VG1S-4□	210	210 **(100%)**		210 ***1** **(100%)**											
132	FRN110VG1S-4□	253	253 **(100%)**		253 ***1** **(100%)**											
160	FRN132VG1S-4□	304	304 **(100%)**		304 ***1** **(100%)**											
200	FRN160VG1S-4□	377	377 **(100%)**		377 ***1** **(100%)**											
220	FRN200VG1S-4□	415	415 **(100%)**		415 ***1** **(100%)**											
280	FRN220VG1S-4□	468	468 **(100%)**		468 ***1** **(100%)**											
315	FRN280VG1S-4□	585	585.0 **(100%)**		585.0 ***1** **(100%)**											
355	FRN315VG1S-4□	650	650 **(100%)**		650 ***1** **(100%)**											
400	FRN355VG1S-4□	740	740 **(100%)**		740 ***1** **(100%)**											
450	FRN400VG1S-4□	840	840 **(100%)**		840 ***1** **(100%)**											

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

*1 The internal carrier frequency is 4 kHz independent of the F26 setting.

LD (Low Duty)-mode inverters for light load

Three-phase 200 V class series

Nominal applied motor (kW)	Inverter type	Rated current (A)	Derated current (A) (Derating rate (%))													
			Carrier frequency setting made with F26 (kHz)													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15
37	FRN30VG1S-2☐	146	146 **(100%)**					140 (96%)	138 (95%)		131 ***1** (90%)					
45	FRN37VG1S-2☐	180	180 **(100%)**					172 (96%)	171 (95%)		162 ***1** (90%)					
55	FRN45VG1S-2☐	215	215 **(100%)**					206 (96%)	204 (95%)		193 ***1** (90%)					
75	FRN55VG1S-2☐	283	283 **(100%)**					271 (96%)	268 (95%)		254 ***1** (90%)					
90	FRN75VG1S-2☐	346	342 (99%)	335 (97%)	346 **(100%)**	335 ***2** (97%)										
110	FRN90VG1S-2☐	415	410 (99%)	402 (97%)	415 **(100%)**	402 ***2** (97%)										

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

*1 The internal carrier frequency is 10 kHz independent of the F26 setting.
*2 The internal carrier frequency is 5 kHz independent of the F26 setting.

Three-phase 400 V class series

Nominal applied motor (kW)	Inverter type	Rated current (A)	Derated current (A) (Derating rate (%))													
			Carrier frequency setting made with F26 (kHz)													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15
37	FRN30VG1S-4☐	75	75.0 **(100%)**					66.0 (88%)	63.0 (84%)		54.0 ***1** (72%)					
45	FRN37VG1S-4☐	91	91.0 **(100%)**					80.0 (88%)	76.4 (84%)		65.5 ***1** (72%)					
55	FRN45VG1S-4☐	112	112 **(100%)**					99.0 (88%)	94.0 (84%)		80.6 ***1** (72%)					
75	FRN55VG1S-4☐	150	150 **(100%)**					132 (88%)	126 (84%)		108 ***1** (72%)					
90	FRN75VG1S-4☐	176	161 (92%)	151 (86%)	176 **(100%)**	153 ***2** (87%)										
110	FRN90VG1S-4☐	210	193 (92%)	180 (86%)	210 **(100%)**	182 ***2** (87%)										
132	FRN110VG1S-4☐	253	232 (92%)	217 (86%)	253 **(100%)**	220 ***2** (87%)										
160	FRN132VG1S-4☐	304	279 (92%)	261 (86%)	304 **(100%)**	264 ***2** (87%)										
200	FRN160VG1S-4☐	377	346 (92%)	324 (86%)	377 **(100%)**	327 ***2** (87%)										
220	FRN200VG1S-4☐	415	481 (92%)	356 (86%)	415 **(100%)**	361 ***2** (87%)										
280	FRN220VG1S-4☐	520	478 (92%)	447 (86%)	520 **(100%)**	452 ***2** (87%)										
355	FRN280VG1S-4☐	585	538 (92%)	503 (86%)	585 **(100%)**	508 ***2** (87%)										
400	FRN315VG1S-4☐	650	598 (92%)	559 (86%)	650 **(100%)**	565 ***2** (87%)										
450	FRN355VG1S-4☐	740	680 (92%)	636 (86%)	740 **(100%)**	643 ***2** (87%)										
500	FRN400VG1S-4☐	960	883 (92%)	825 (86%)	960 **(100%)**	835 ***2** (87%)										
630	FRN500VG1S-4☐	1170	1076 (92%)	1006 (86%)	1170 **(100%)**	1017 ***2** (87%)										
710	FRN630VG1S-4☐	1370	1287 (94%)	1219 (89%)	1370 **(100%)**	1287 ***2** (94%)										

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

*1 The internal carrier frequency is 10 kHz independent of the F26 setting.
*2 The internal carrier frequency is 5 kHz independent of the F26 setting.

2.2 Common Specifications

Item				Explanation
Control	Control method	For induction motor (IM)		• Vector control with speed sensor • Vector control without speed sensor • V/f control
		For permanent magnet synchronous motor (PMSM)		Vector control with speed sensor & magnetic pole position sensor
		Test mode		Simulation mode
Driving IM	Vector control with speed sensor	Setting resolution	Speed command	Analog setting: 0.005% of maximum speed Digital setting: 0.005% of maximum speed
			Torque command, Torque current command	0.01% of the rated torque
		Control accuracy	Speed	Analog setting: ±0.1% of maximum speed (at 25 ±10°C) Digital setting: ±0.005% of maximum speed (at -10 to +50°C)
			Torque	±3% of the rated torque (when a dedicated motor is in use)
		Control response	Speed	600 Hz *1
		Maximum speed		800 Hz (when converted to the inverter output frequency) *1 *2
		Speed control range		1 : 1500 When the base speed is 1500 r/min: 1 to 1500 r/min to maximum speed (in the case of the PG pulse resolution 1024 P/R) 1 : 6 (Constant torque range : Constant output range)
	Vector control without speed sensor	Setting resolution	Speed command	Analog setting: 0.005% of maximum speed Digital setting: 0.005% of maximum speed
			Torque command, Torque current command	0.01% of the rated torque
		Control accuracy	Speed	Analog setting: ±0.1% of maximum speed (at 25 ±10°C) Digital setting: ±0.1% of maximum speed (at -10 to +50°C)
			Torque	±5% of the rated torque
		Control response	Speed	40 Hz *1
		Maximum speed		500 Hz (when converted to the inverter output frequency) *1 *3
		Speed control range		1 : 250 When the base speed is 1500 r/min: 6 to 1500 r/min to maximum speed 1 : 4 (Constant torque range : Constant output range)
	V/f control	Setting resolution		Analog setting: 0.005% of maximum frequency Digital setting: 0.005% of maximum frequency
		Output frequency control accuracy		Analog setting: ±0.2% of maximum frequency (at 25 ±10°C) Digital setting: ±0.01% of maximum frequency (at -10 to +50°C)
		Maximum frequency		500 Hz
		Control range		0.2 to 500 Hz 1 : 4 (Constant torque range : Constant output range)

*1 The specified value denotes the maximum value. It may not be reached depending on the carrier frequency setting and other conditions.

*2 Under vector control with speed sensor: 400 Hz when the carrier frequency is 5 kHz, 150 Hz when it is 2 kHz.

*3 Under vector control without speed sensor: 250 Hz when the carrier frequency is 5 kHz, 120 Hz when it is 2 kHz.

Item				Explanation
Driving PMSM	Vector control with speed sensor	Setting resolution	Speed command	Analog setting: 0.005% of maximum speed Digital setting: 0.005% of maximum speed
			Torque command, Torque current command	0.01% of the rated torque
		Control accuracy	Speed	Analog setting: ±0.1% of maximum speed (at 25 ±10°C) Digital setting: ±0.005% of maximum speed (at -10 to +50°C)
			Torque	±3% of the rated torque (when a dedicated motor is in use)
		Control response	Speed	600 Hz *1
		Maximum speed		800 Hz (when converted to the inverter output frequency) *1 *2
		Speed control range		1 : 1500 When the base speed is 1500 r/min: 1 to 1500 r/min to maximum speed (in the case of the PG pulse resolution 1024 P/R)
Control functions	Start/stop operation			Keypad: (FWD) and (REV) keys (for forward/reverse rotation), (STOP) key (for stop) Digital input signals: "Switch normal/inverse operation," "Coast to a stop," "Reset alarm," "Select multistep speed," etc.
	Speed setting			Keypad: ∧ and ∨ keys External potentiometer: Three-terminal variable resistor (1 to 5kΩ) Analog input signals: 0 to ±10 V, 4-20 mA UP/DOWN control: When the digital input signal ***UP*** or ***DOWN*** is ON, the speed increases or decreases, respectively. Multistep speed: The combination of the four digital input signals ***SS1***, ***SS2***, ***SS4*** and ***SS8*** enables 15 different speeds to be selected. Digital signal: Using an option card enables speed setting with "16-bit parallel signals." Serial link operation: RS-485 (provided as standard). Various communication options are available. Jogging operation: (FWD) and (REV) keys or digital input on [FWD] and [REV] terminals in jogging mode.
	Speed detection			IM: +15 V, +12 V complementary output PG (insulation type), Maximum frequency receivable: 100 kHz +5 V line driver output PG: Maximum frequency receivable: 500 kHz when the communications option OPC-VG1-PG (insulation type) is mounted. PMSM: +5 V line driver output PG (insulation type): ABS type: Maximum frequency receivable: 100 kHz when the communications option OPC-VG1-PMPG is mounted. ABZ type: Maximum frequency receivable: 500 kHz when the communications option OPC-VG1-PG is mounted. High-resolution serial transmission system (TS5667N253: TAMAGAWA SEIKI, Co., Ltd.) 17 bits (one rotation) + 16 bits (multi-rotation) when the option card OPC-VG1-SPGT is mounted.
	Speed control			PI calculation with feed-forward terms. Control parameters switchable by external signals.
	Running status signal			Transistor output signals: "Inverter running," "Speed arrival," "Speed detected," "Inverter overload early warning," "Torque limiting," etc. Analog output signals: "Motor speed," "Output voltage," "Torque," "Load factor," etc.

*1 The specified value denotes the maximum value. It may not be reached depending on the carrier frequency setting and other conditions.

*2 Under vector control with speed sensor: 400 Hz when the carrier frequency is 5 kHz, 150 Hz when it is 2 kHz.

Item			Explanation
Control functions	Acceleration/ deceleration time		0.01 to 3600 s (Four independent settings can be made for each of acceleration and deceleration. They are selectable with external signals.) (S-curve acceleration/deceleration in addition to linear acceleration/deceleration)
Control functions	Speed setting gain		Proportional relationship between analog speed setting and motor speed can be specified in the range of 0 to 200%.
Control functions	Jump speed		Jump speed (3 points) and jump hysteresis width (1 point) can be specified.
Control functions	Auto search for idling motor speed		Automatically searches for the idling motor speed to be harmonized and starts to drive it without stopping it. (Available under vector control with/without speed sensor)
Control functions	Auto-restart after momentary power failure		Possible to restart the inverter after a momentary power failure without stopping the motor depending on the restart mode setting.
Control functions	Slip compensation		Compensates for decrease in speed according to the load for stabilized operation. (Available for IM under V/f control.)
Control functions	Droop control		The motor speed droops in proportion to output torque. (Not available under V/f control.)
Control functions	Torque limit		Limits the torque to the predetermined values (selectable from "common to 4 quadrants", "independent driving and braking", etc.) Analog and external signal (2 steps) settings are available.
Control functions	Torque control		Analog setting: 0 to ±10V/0 to ±150% (Up to 300% by gain adjustment) Digital setting: Using an option card enables torque control with "16-bit parallel signals."
Control functions	PID control		PID control with analog input Possible to select whether to use the PID output as speed setting or auxiliary setting to be added or subtracted to/from the main setting.
Control functions	Cooling fan ON/OFF control		Stops cooling fans when the motor is stopped and the temperature is low for lifetime extension and noise reduction of the cooling fans.
Control functions	Toggle monitor control		Monitors communication between the host equipment (PLC) and the inverter to see whether the communication is normal.
Control functions	Torque bias		The combination of the fixed value (one step, with the polarity switching function by the motor rotation direction) and digital input signals ***TB1*** and ***TB2*** provides three steps of torque bias internal setting. Analog setting (with Hold function) is available.
Control functions	Motor selection		Selectable from the three types of motors, by Function code F79. Switchable between the three types of motors by the combination of digital input signals.
Control functions	Temperature detection		NTC thermistor (Equivalent to Fuji Electric specifications) PTC thermistor exclusively used for protection from motor overheat (The trip level is specified by parameters.)
Control functions	Self-diagnostic function for PG detection circuit		Self-diagnoses the detection circuit of pulse encoder input signals (PA and PB).
Control functions	Load adaptive control		Calculates the maximum allowable elevating speed (e.g., vertical carrier machine) according to the load to improve the operation efficiency of the equipment.
Control functions	Multiplex system	Multiwinding motor drive	The option OPC-VG1-TBSI is required. Available only under vector control with/without speed sensor (available soon).
Control functions	Multiplex system	Reactor joint drive (Available soon)	The option OPC-VG1-TBSI is required. Available only under vector control with/without speed sensor (available soon).
Control functions	UP/DOWN control		Speed setting by the combination of digital input signals ***UP***, ***DOWN***, and ***CLR*** ("Clear ACC/DEC to zero")
Control functions	Stop function		Three types of the stop functions by digital input signals ***STOP1***, ***STOP2***, and ***STOP3***.
Control functions	PG pulse output		Outputs pulse generator signals (input pulses) with frequency divided to 1/n (where, n is programmable with Function code E29). Switchable between open collector and complementary (equivalent to the voltage on the [PGP] terminal) transistor outputs, by the slide switch in the inverter unit.

Item			Explanation
Control functions	Observer		Suppresses load disturbances and vibrations.
Control functions	Offline tuning		Tunes the motor while the motor is stopped or running, for setting up motor parameters.
Control functions	Online tuning		Tunes the motor parameters to compensate for the temperature change.
Control functions	Position control		Standard function: Position control by servo-lock and integrated oscillation circuit Option: OPC-VG1-PG (PR): For pulse command input of line driver type OPC-VG1-PGo (PR): For pulse command input of open collector type OPC-VG7-SPGT: 17-bit high resolution ABS encoder (available soon)
Control functions	Pulse train, synchronous operation		Option: OPC-VG1-PG (PR): For pulse command input of line driver type OPC-VG1-PGo (PR): For pulse command input of open collector type
Indication/Setting	Keypad	Display	7-segment LED monitor and backlit LCD
Indication/Setting	Keypad	Multilingual display	Japanese, English, Chinese, and Korean (French, Spanish, German, and Italian are available soon.)
Indication/Setting	Keypad	When the inverter is running or stopped	• Detected speed • Speed command • Output frequency • Reference torque current value • Torque command value • Torque calculation value • Power consumption (Motor output) • Output current • Output voltage • DC link circuit voltage • Magnetic-flux command value • Magnetic-flux calculation value • Load shaft speed • PID command value • PID feedback value • PID output value • Ai adjusted value (12) • Ai adjusted value (Ai1) • Ai adjusted value (Ai2) • Optional monitor 1 to 6 • Presence of digital input/output signal • Motor temperature • Heat sink temperature • Load factor • Input power • Input watt-hour • Operation time • Cumulative run time of the motor/Number of startups (for each motor), etc.
Indication/Setting	Keypad	When function codes are configured	Function code names and data are displayed.
Indication/Setting	Keypad	When an alarm occurs	Alarm factors that appear: • dbH (Braking resistor overheated) • dCF (DC fuse blown) • EF (Ground fault) • Er1 (Memory error) • Er2 (Keypad communications error) • Er3 (CPU error) • Er4 (Communications error) • Er5 (RS-485 communications error) • Er6 (Operation error) • Er7 (Output wire fault) • Er8 (A/D converter error) • Er9 (Speed mismatch) • Lin (Input phase loss) • LU (Undervoltage) • nrb (NTC wire break error) • OC (Overcurrent) • OH1 (Heat sink overheat) • OH2 (External alarm) • OH3 (Inverter internal overheat) • OH4 (Motor protection) • OL1 (Overload of motor 1) • OL2 (Overload of motor 2) • OL3 (Overload of motor 3) • OLU (Inverter overload) • OS (Overspeed) • OU (Overvoltage) • PG (PG wire break) • PbF (Charger circuit fault) • dbA (Braking transistor broken) • Err (Mock alarm) • OPL (Output phase loss) • dFA (DC fan locked) • ErH (Hardware error) • EC (Encoder communications error) • ErA (UPAC error) (Available soon) • Et1 (Encoder error) • Erb (Inter-inverter communications link error) • ECF (ENABLE circuit (safety stop circuit) failure) (Available soon) • dO (Excessive positioning deviation) • LoC (Start delay) • ArE (E-SX error) • ArF (Toggle abnormality error)

Item			Explanation
Indication/Setting	Keypad	When a light alarm occurs	The light-alarm display L-AL appears. The inverter retains the cause of the light alarm to display it.
		When the inverter is running or an alarm occurs	The inverter retains the latest and the last 10 alarm codes and the latest and the last three pieces of alarm information to display them. It also retains the detailed contents of the latest and the last 3 alarms (including light alarms) to display them. The calendar clock function retains the date and time when an alarm occurred to display them. (Precision: ±27 seconds/month (Ta = 25°C)) Data retention period: At least 5 years (at the surrounding temperature 25°C) *Backup battery: 30 kW or above (Battery integrated as standard) Up to 22 kW (Optional battery)
	FRENIC-VG Loader	Historical trace *1	Reads out the sampling data held in the inverter and shows it graphically. Sampling interval: 50 μs to 1 s
		Real-time trace *1	Reads out the current data of the running inverter and shows it graphically in real-time. Sampling interval: 1 ms to 1 s
		Traceback	Reads out the sampling data held in the inverter and shows it graphically when an alarm has occurred. Sampling interval: 50 μs to 1s (400 μs for sampling data except current) The sampling data is retained in the memory by the backup battery. Data retention period: At least 5 years (at the surrounding temperature 25°C) *Backup battery: 30 kW or above (Battery integrated as standard) Up to 22 kW (Optional battery)
		Operation monitor *1	I/O monitor, system monitor, alarm history monitor, etc.
		Configuration of function code	Shows the configuration of the function codes, as well as enabling editing, transmitting, comparing, and initialization.
	Charge lamp		Lights when power is applied to the inverter unit. (Lights when power is applied to the control circuit only.)
Maintenance	Main circuit capacitor life		Life judgment function installed
	Common functions		• Retains and displays the cumulative run time of the main circuit capacitor and the cumulative run time of cooling fans. • Retains and displays the inverter operation time. • Retains and displays the maximum output current and the maximum internal temperature for the past one hour.
Communications	RS-485		I/O terminals for RS-485 communication. Up to 31 inverter units can be connected in multi-drop connection. Half-duplex system
	USB		Accessible from the front, A connector type: mini B USB 2.0 Full Speed
Compatibility	VG7	Function code data	Compatible with the VG7 function codes, except function codes for the 3rd motor. (Using the VG7 function codes as is produces the same operation on the FRENIC-VG.) Possible to read out VG7 function code data using the FRENIC-VG Loader and write it as is into the FRENIC-VG. (Except special inverter versions)
		Various communications tools	Fully compatible with T-Link, SX-bus, and CC-Link. (Software in the host equipment PLC is available as is. Except special software.)
	Mounting adapter		Mounting adapters are provided for matching the FRENIC-VG with conventional models in mounting dimensions.

*1 Available in the paid-for version of FRENIC-VG Loader (WPS-VG1-PCL).

Item			Explanation	
Safety function	Provided as standard	Stop function	Safe Torque Off (STO) (Available soon) Opening the circuit between terminals [EN1] and [PS] or [EN2] and [PS] by the external digital input signal turns off the inverter's output transistor so that the motor coasts to a stop.	
Product standards	Conformity with standards		UL Standards and Canadian Standards UL, cUL (UL508C, C22.2 No.14) (during authentication) European Standards EN 61800-5-2: SIL2 (during authentication) EN 62061: SIL2 (during authentication) Machinery Directive ISO13849-1: PL-d (during authentication) EN 60204-1: Stop category 0 (during authentication) Low Voltage Directive EN 61800-5-1 (Overvoltage category: 3) (during authentication) EMC Standards EN 61800-3 (during authentication), EN 61326-3-1 (during authentication) (Emission) EMC-filter (optional): Category C2 (Immunity) 2nd Env.	
Environment	Installation location		Shall be free from corrosive gases, flammable gases, oil mist, dusts, and direct sunlight. (Pollution degree 2 (IEC60664-1)). Indoor use only.	
	Surrounding temperature		-10 to +50°C (-10 to +40°C when installed side-by-side without clearance (22 kW or below))	
	Relative humidity		5 to 95% RH (without condensation)	
	Altitude		Lower than 1,000 m	
	Vibration		200 V 55 kW, 400 V 75 kW or below 3 mm: 2 to less than 9 Hz, 9.8m/s^2: 9 to less than 20 Hz 2 m/ s^2: 20 to less than 55 Hz 1 m/ s^2: 55 to less than 200 Hz	200V 75 kW, 400 V 90 kW or above 3 mm: 2 to less than 9 Hz 2 m/s^2: 9 to less than 55 Hz 1 m/s^2: 55 to less than 200 Hz
	Storage temperature		-25 to +70°C	
	Storage humidity		5 to 95% RH (without condensation)	

2.3 External Dimensions

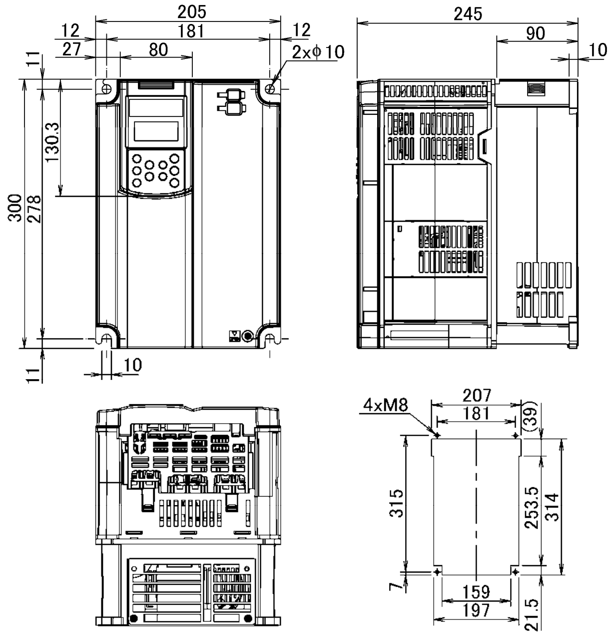
2.3.1 Standard models

The diagrams below show external dimensions of the FRENIC-VG series of inverters according to the inverter capacity. (Three-phase 200 V/400 V class series)

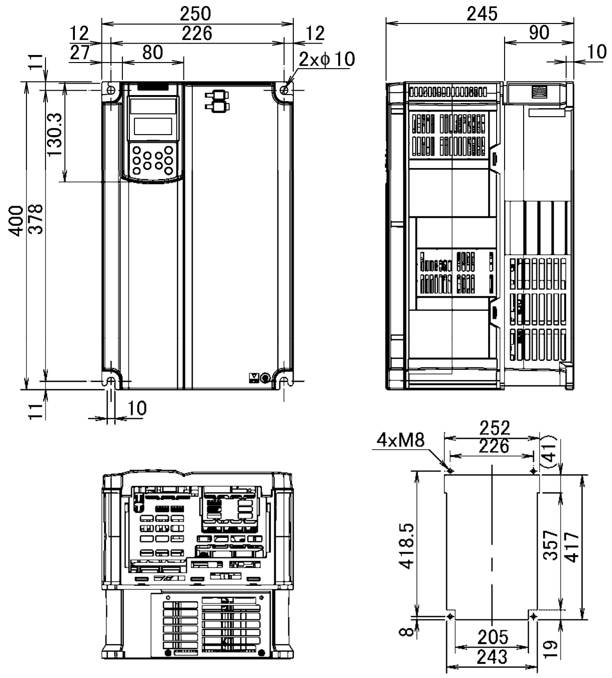
A figure given in the lower right-hand corner of each set of drawings shows the dimension of panel cutting required for external cooling. To employ external cooling for inverters of 22 kW or below, the optional mounting adapter for external cooling is necessary. For the external dimensions of the mounting adapter, refer to Chapter 8, Section 8.5.8 "Mounting adapter for external cooling."

(Unit: mm)

■ FRN0.75 to 7.5VG1S-2☐
■ FRN3.7 to 7.5VG1S-4☐



■ FRN11 to 22VG1S-2☐
■ FRN11 to 22VG1S-4☐

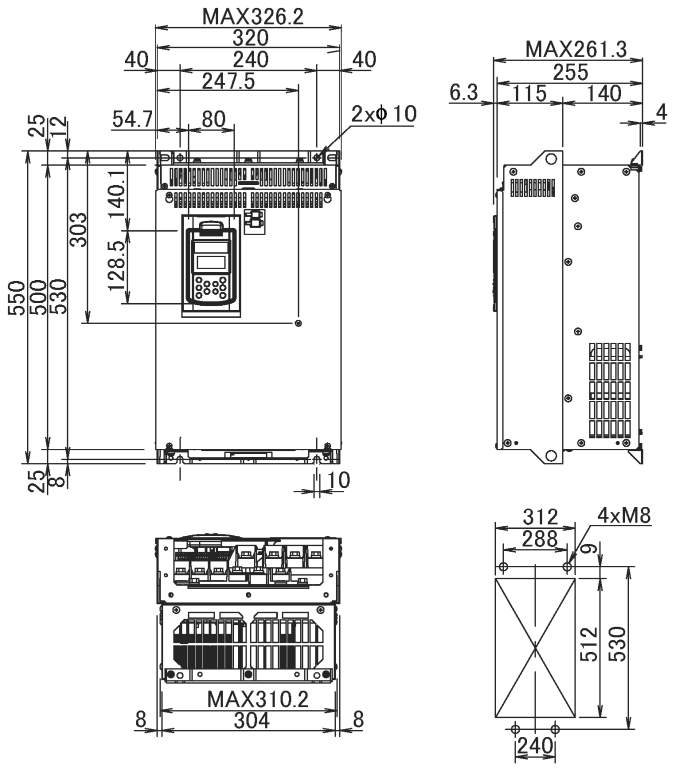


Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

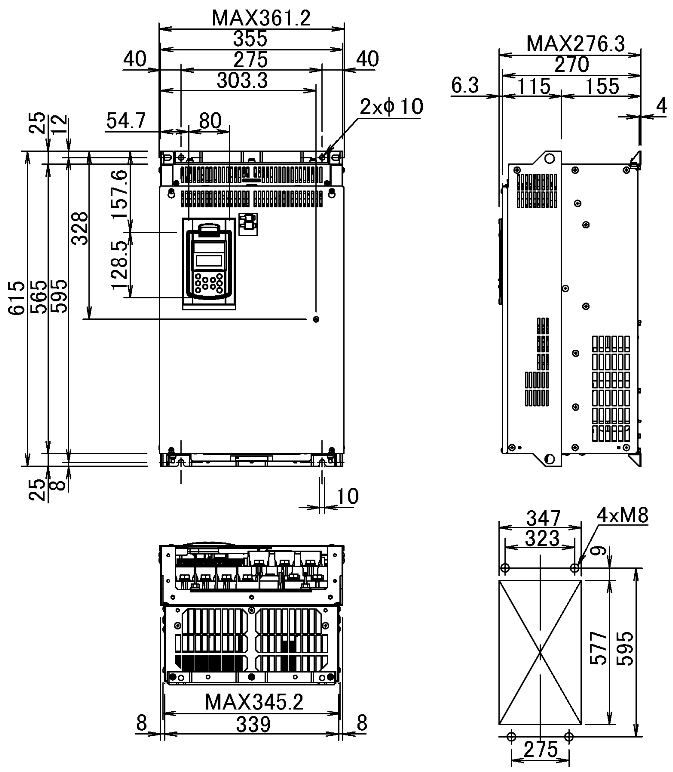
A figure given in the lower right-hand corner of each set of drawings shows the dimension of panel cutting required for employing external cooling. To employ external cooling for inverters of 30 kW or above, change the positions of the mounting bases. For details, refer to Chapter 3, Section 3.3.2 "Installing the Inverter, ■ When employing external cooling."

(Unit: mm)

■ FRN30VG1S-2☐
■ FRN30/37VG1S-4☐



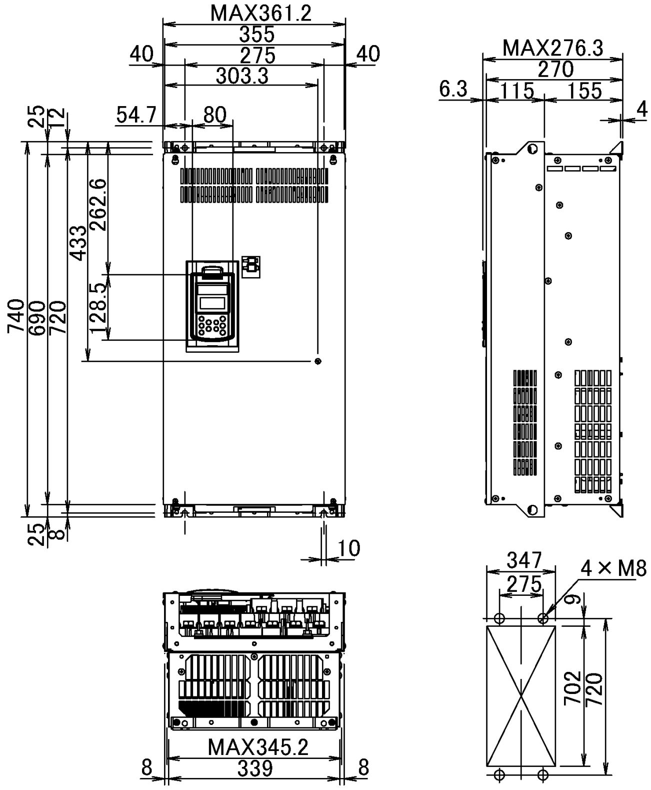
■ FRN37VG1S-2☐
■ FRN45VG1S-4☐



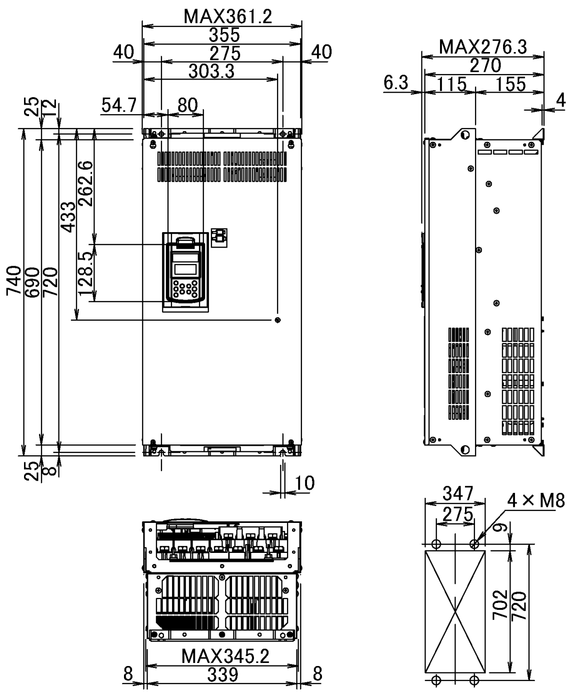
Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN45VG1S-2☐



■ FRN55VG1S-2☐



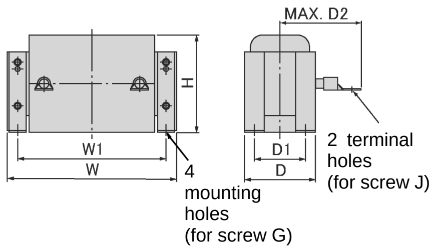


Figure C

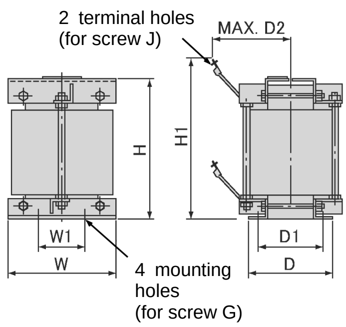


Figure D

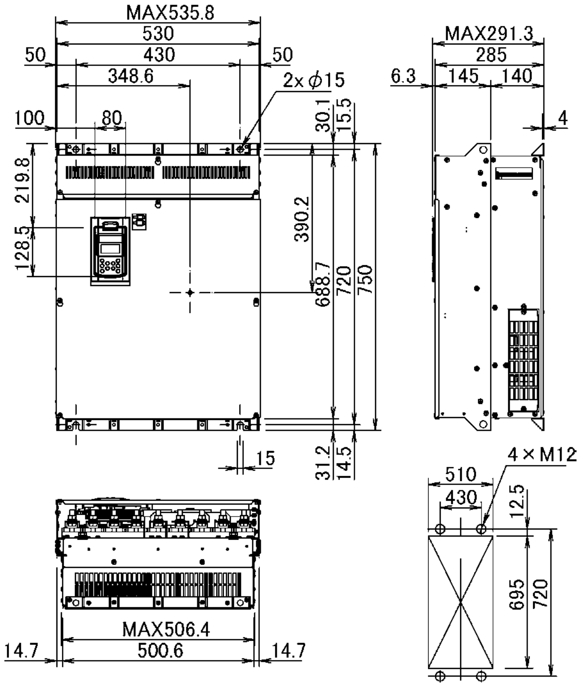
	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR2-55B *1	D	190	160	131	90	100	M6 (φ8)	210	250	M12	16
	DCR2-55C *1	C	255	225	96	76	140	M6 (7*13)	145	-	M12	11
LD mode	DCR2-75C	C	255	225	106	86	145	M6 (7*13)	145	-	M12	12

*1 The DCR2-55B and DCR2-55C are optionally available.

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN75VG1S-2☐



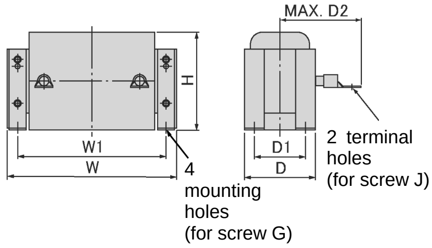
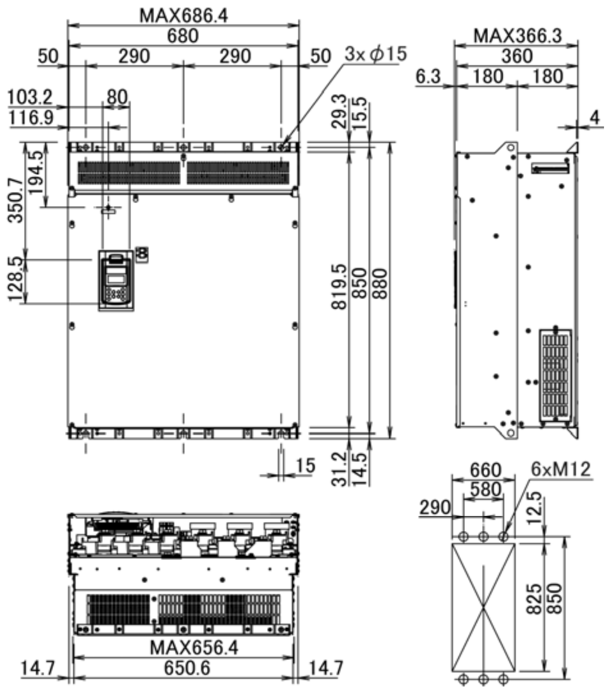


Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR2-75C	C	255	225	106	86	145	M6 (7*13)	145	-	M12	12
LD mode	DCR2-90C		255	225	116	96	155	M6 (7*13)	145	-	M12	14

■ FRN90VG1S-2☐



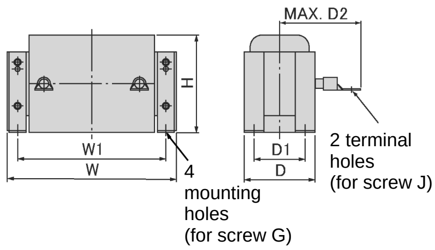


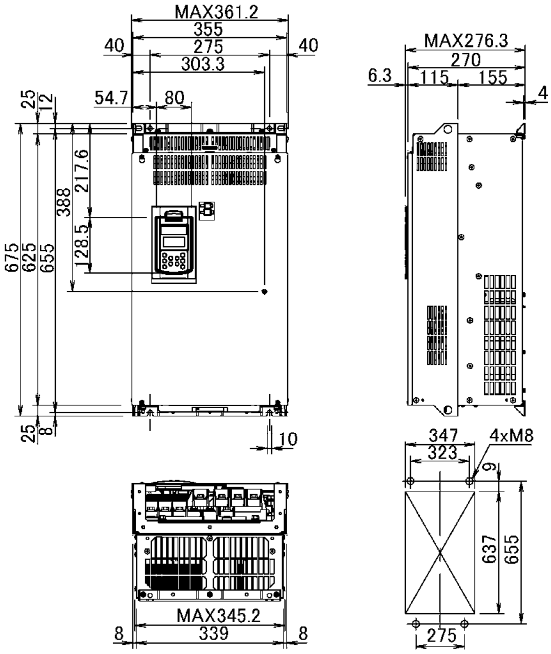
Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR2-90C	C	255	225	116	96	155	M6 (7*13)	145	-	M12	14
LD mode	DCR2-110C		300	265	116	90	185	M8 (10*18)	160	-	M12	17

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN55VG1S-4□



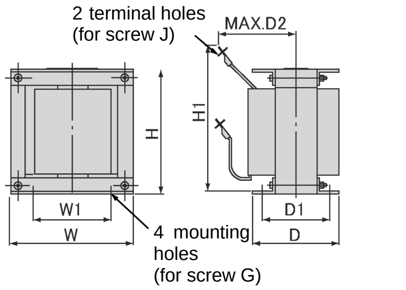


Figure B

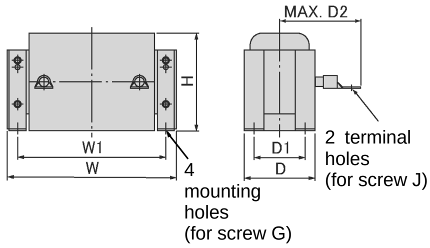
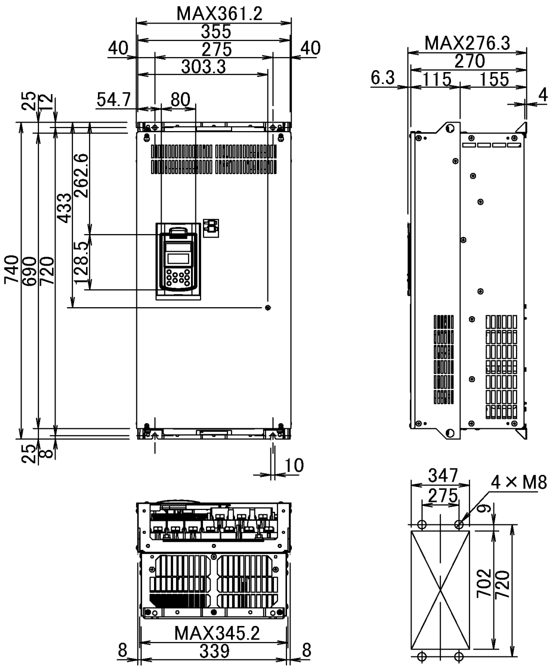


Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-55B *1	B	171	110	170	130	110	M6 (φ8)	150	210	M8	20
	DCR4-55C *1	C	255	225	96	76	120	M6 (7*13)	145	-	M10	11
LD mode	DCR4-75C	C	255	225	106	86	125	M6 (7*13)	145	-	M10	13

*1 The DCR4-55B and DCR4-55C are optionally available.

■ FRN75VG1S-4□



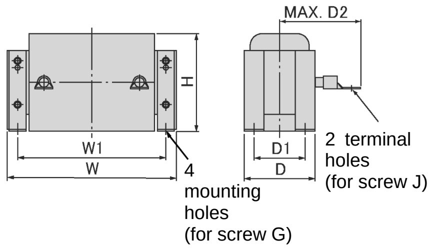


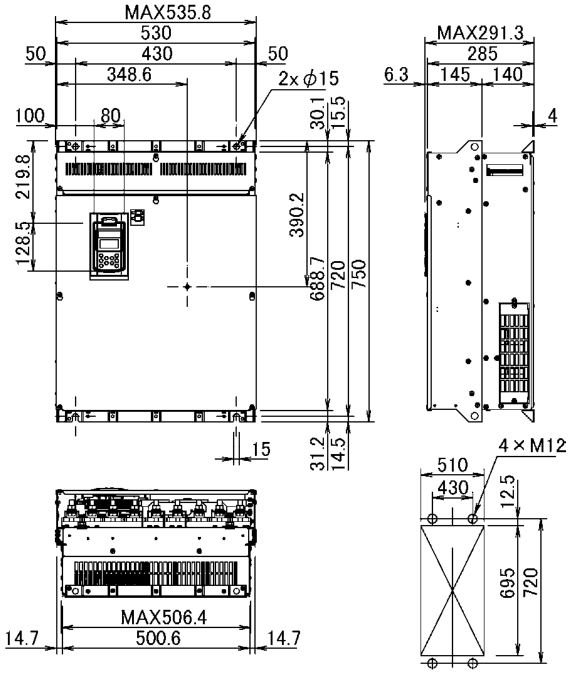
Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-75C	C	255	225	106	86	125	M6 (7*13)	145	-	M10	13
LD mode	DCR4-90C		255	225	116	96	140	M6 (7*13)	145	-	M12	15

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN90VG1S-4☐



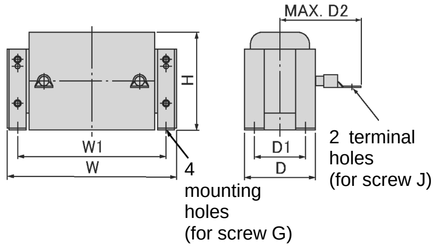
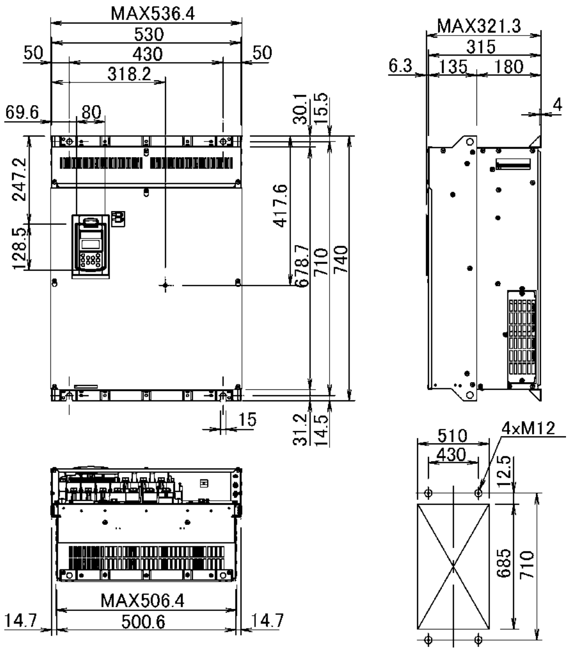


Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-90C	C	255	225	116	96	140	M6 (7*13)	145	-	M12	15
MD mode	DCR4-110C		300	265	116	90	175	M8 (10*18)	155	-	M12	19
LD mode												

■ FRN110VG1S-4☐



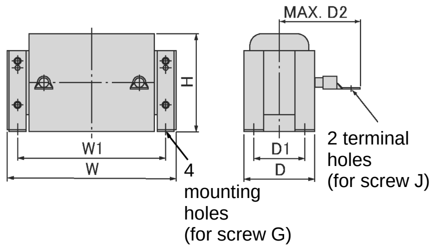


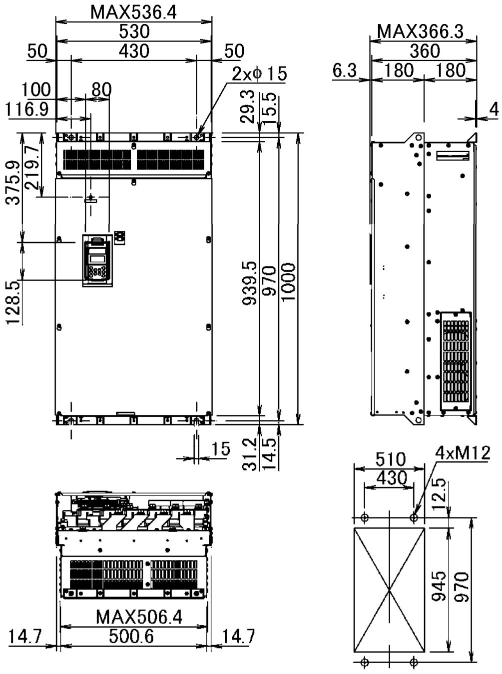
Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-110C	C	300	265	116	90	175	M8 (10*18)	155	-	M12	19
MD mode	DCR4-132C		300	265	126	100	180	M8 (10*18)	160	-	M12	22
LD mode												

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN132VG1S-4☐



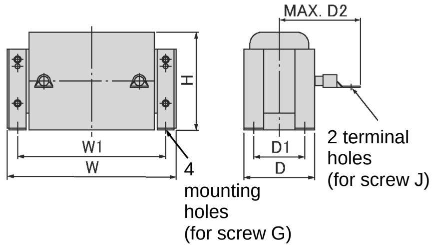
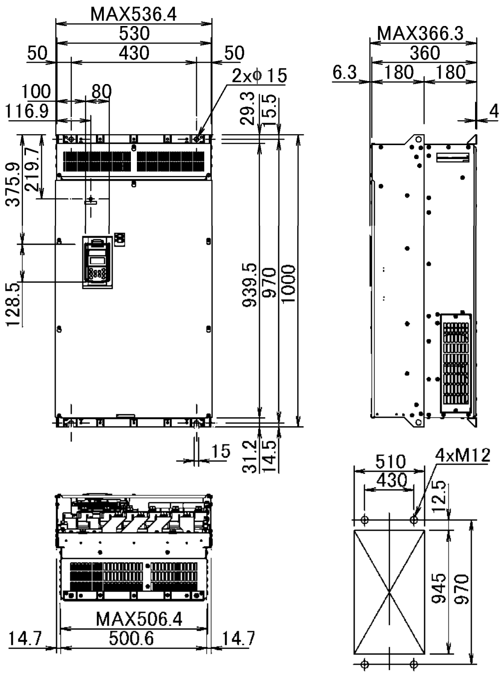


Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-132C	C	300	265	126	100	180	M8 (10*18)	160	-	M12	22
MD mode	DCR4-160C		350	310	131	103	180	M10 (12*22)	190	-	M12	26
LD mode												

■ FRN160VG1S-4☐



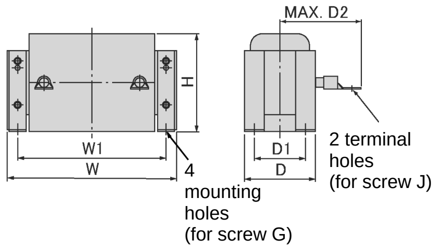


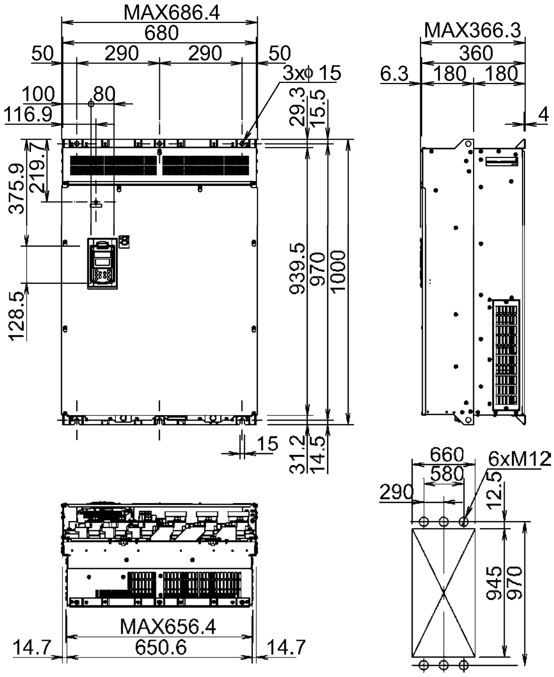
Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-160C	C	350	310	131	103	180	M10 (12*22)	190	-	M12	26
MD mode	DCR4-200C		350	310	141	113	185	M10 (12*22)	190	-	M12	30
LD mode												

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN200VG1S-4☐



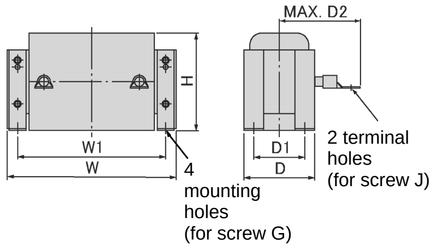
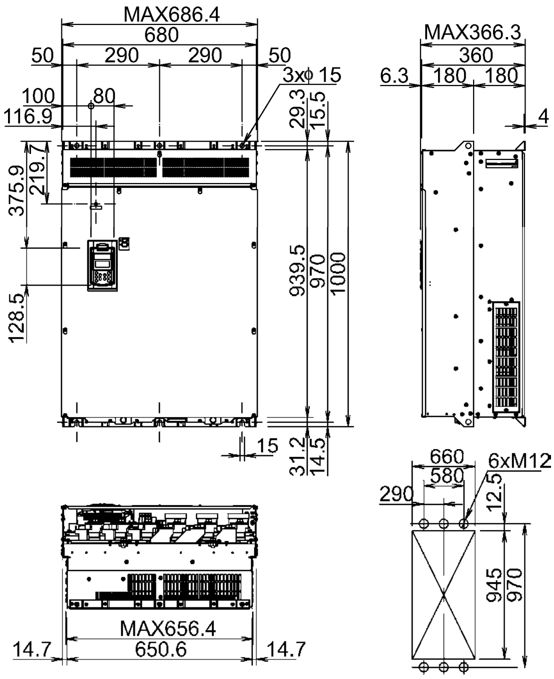


Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-200C	C	350	310	141	113	185	M10 (12*22)	190	-	M12	30
MD mode	DCR4-220C		350	310	146	118	200	M10 (12*22)	190	-	M12	33
LD mode												

■ FRN220VG1S-4☐



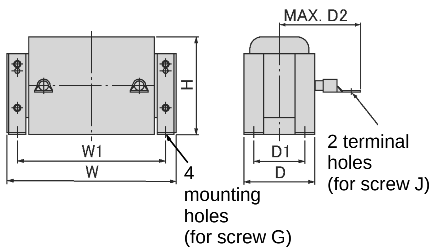


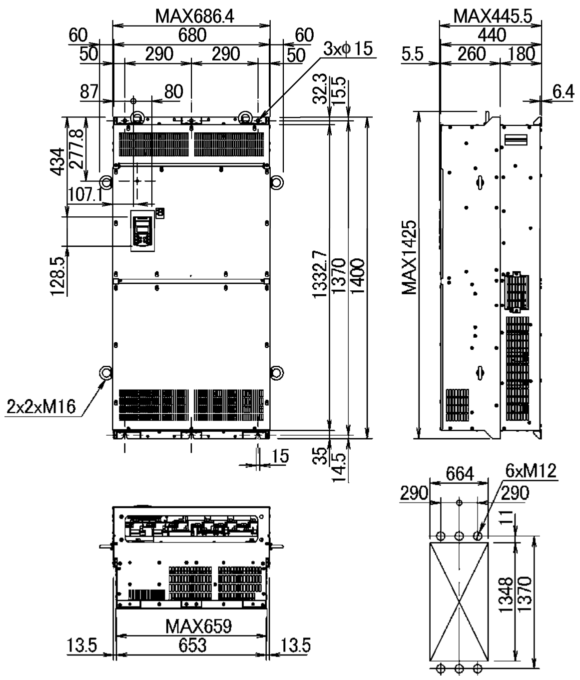
Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-220C	C	350	310	146	118	200	M10 (12*22)	190	-	M12	33
MD mode	DCR4-250C		350	310	161	133	210	M10 (12*22)	190	-	M12	35
LD mode	DCR4-280C		350	310	161	133	210	M10 (12*22)	190	-	M16	37

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN280VG1S-4□



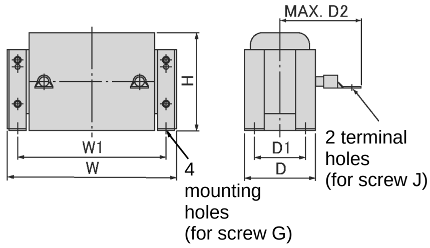


Figure C

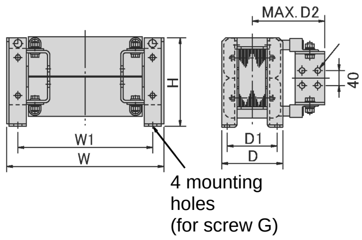
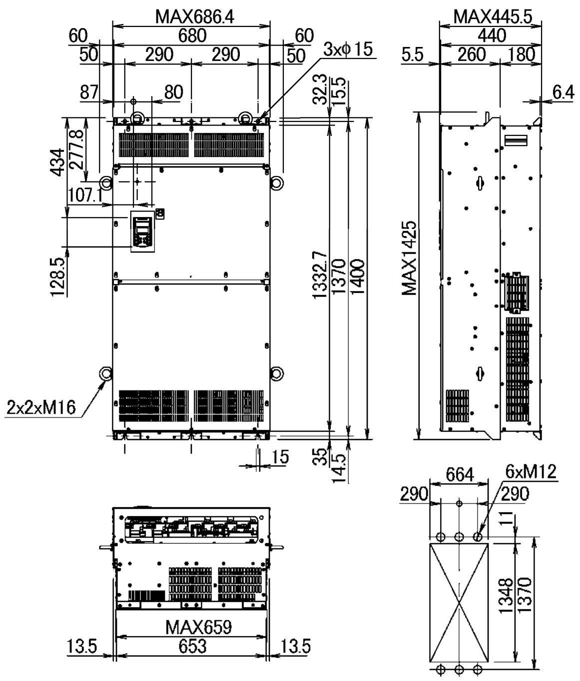


Figure E

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-280C	C	350	310	161	133	210	M10 (12*22)	190	-	M16	37
MD mode	DCR4-315C		400	345	146	118	200	M10 (12*22)	225	-	M16	40
LD mode	DCR4-355C	E	400	345	156	128	200	M10 (12*22)	225	-	4*M12	49

■ FRN315VG1S-4□



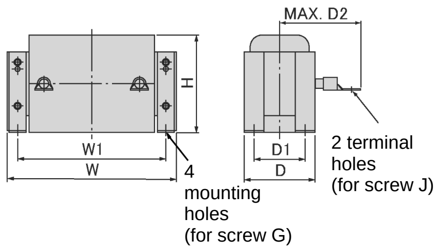


Figure C

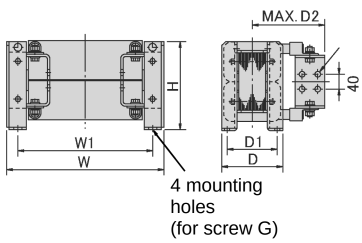


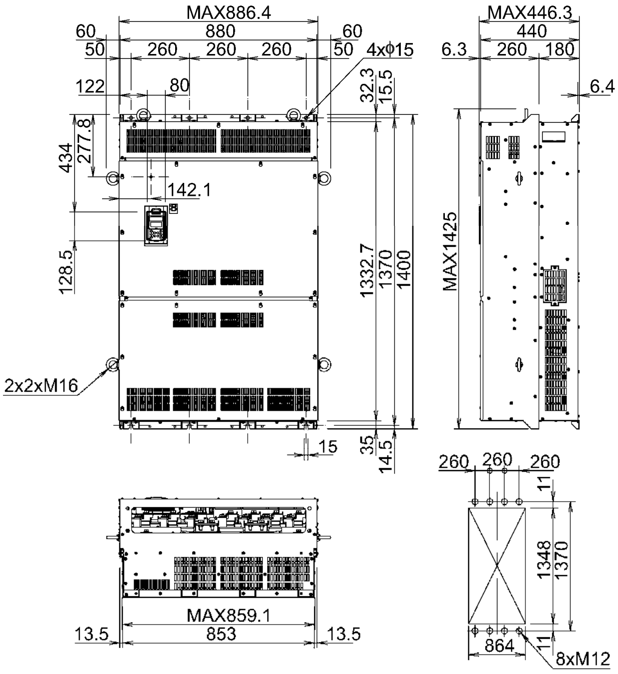
Figure E

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-315C	C	400	345	146	118	200	M10 (12*22)	225	-	M16	40
MD mode	DCR4-355C	E	400	345	156	128	200	M10 (12*22)	225	-	4*M12	49
LD mode	DCR4-400C		445	385	145	117	213	M10 (12*22)	245	-	4*M12	52

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN355VG1S-4□



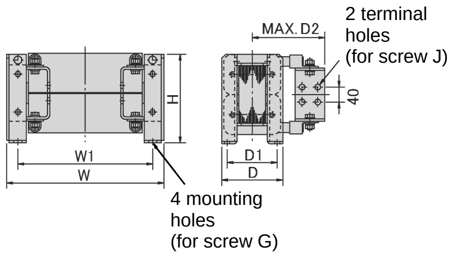
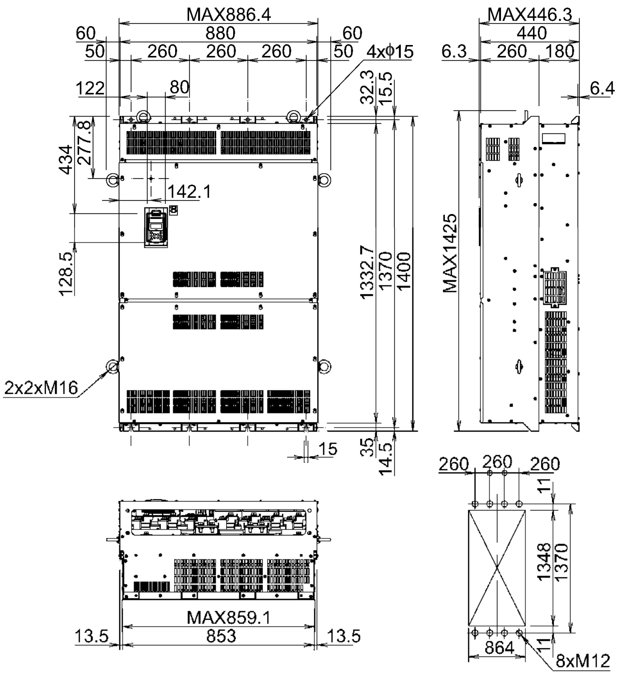


Figure E

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-355C	E	400	345	156	128	200	M10(12*22)	225	-	4*M12	49
MD mode	DCR4-400C		445	385	145	117	213	M10(12*22)	245	-	4*M12	52
LD mode	DCR4-450C		440	385	150	122	215	M10(12*22)	245	-	4*M12	62

■ FRN400VG1S-4□



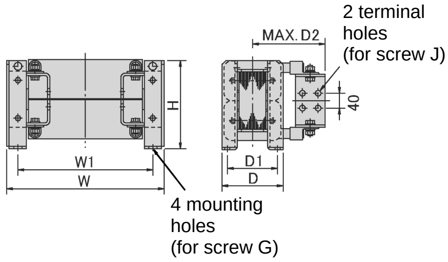


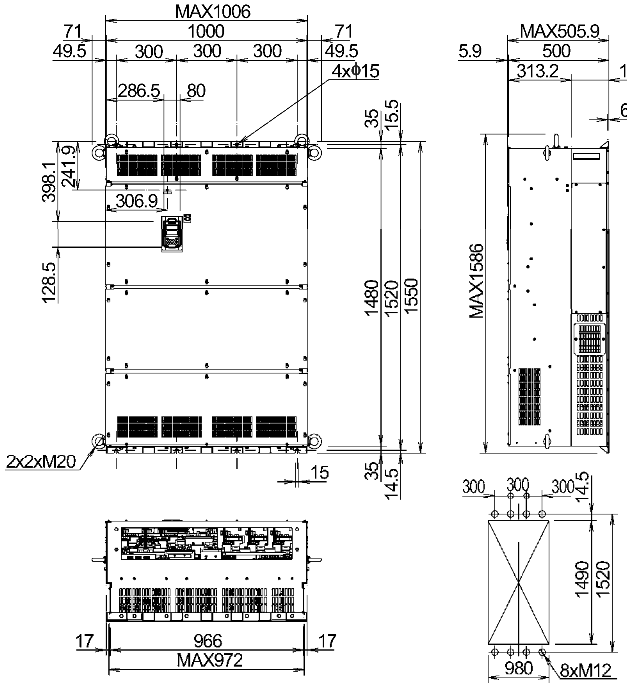
Figure E

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-400C	E	445	385	145	117	213	M10(12*22)	245	-	4*M12	52
MD mode	DCR4-450C		440	385	150	122	215	M10(12*22)	245	-	4*M12	62
LD mode	DCR4-500C		445	390	165	137	220	M10(12*22)	245	-	4*M12	72

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN500VG1S-4□



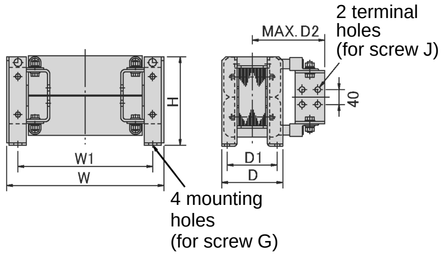


Figure E

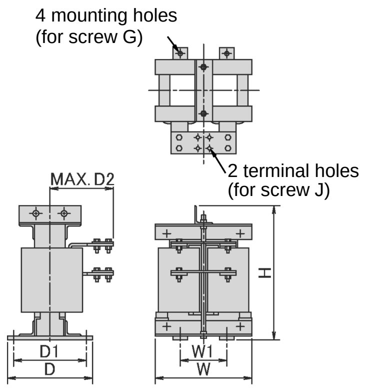
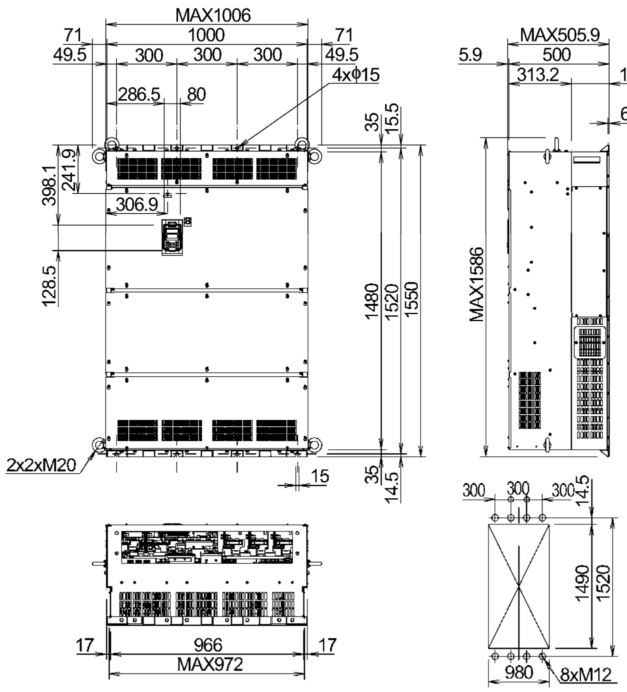


Figure F

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-500C	E	445	390	165	137	220	M10(12*22)	245	-	4*M12	72
LD mode	DCR4-630C	F	285	145	203	170	195	M12(14*20)	480	-	2*M12	75

■ FRN630VG1S-4□



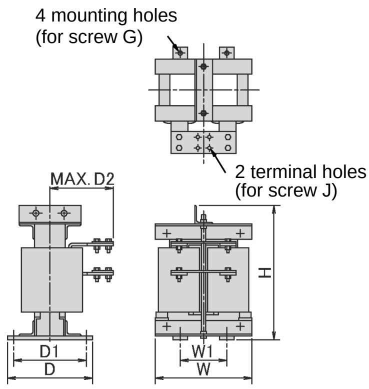


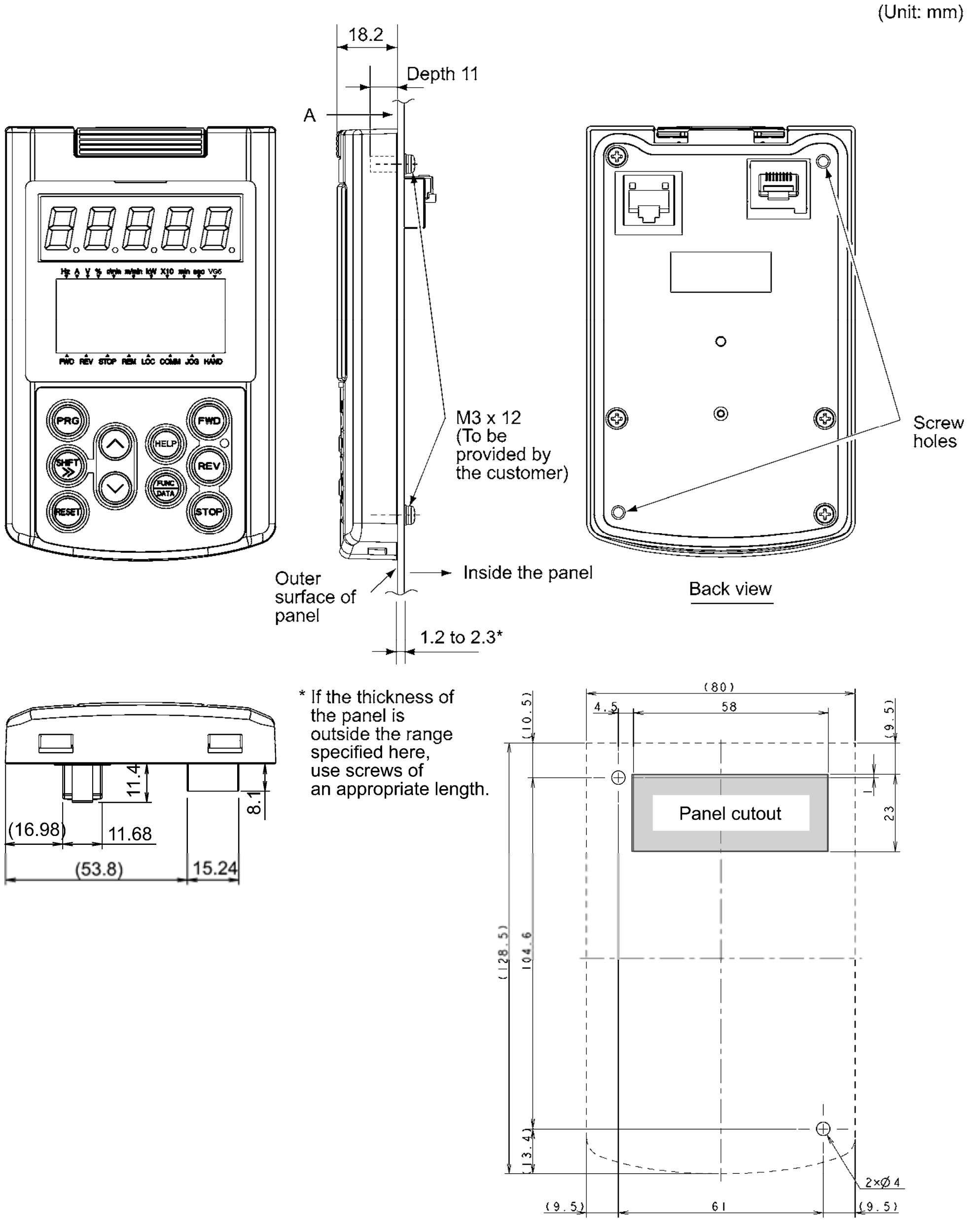
Figure F

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-630C	F	285	145	203	170	195	M12 (14*20)	480	-	2*M12	75
LD mode	DCR4-710C		340	160	295	255	225	M12 (φ15)	480	-	4*M12	95

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

2.3.2 Keypad

(Unit: mm)



Dimensions of panel cutting (viewed from A)

2.4 Dedicated Motor Specifications

2.4.1 Induction motor (IM) with speed sensor

● Standard specifications for three-phase 200 V series

Item		Specifications															
Dedicated motor rated output (kW)		0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
Applicable motor type (MVK_)		8095A	8097A	8107A	8115A	8133A	8135A	8165A	8167A	8184A	8185A	8187A	8207A	8208A	9224A	9254A	9256A
Moment of inertia of rotor (kg•m^2)		0.009	0.009	0.009	0.016	0.030	0.037	0.085	0.11	0.21	0.23	0.34	0.41	0.47	0.53	0.88	1.03
Rotor GD^2 (kg•m^2)		0.036	0.036	0.036	0.065	0.12	0.15	0.34	0.47	0.83	0.92	1.34	1.65	1.87	2.12	3.52	4.12
Rated speed/ Max. speed (r/min)		1500/3600									1500/3000				1500/2400		1500/ 2000
Vibration		V10 or less													V15 or less		
Cooling fan	Voltage (V)	200 to 210 V/50 Hz, 200 to 230 V/60 Hz													200/50 Hz, 200, 220 V/60 Hz		
	Number of phases/ poles	-	Single-phase, 4P					Three-phase, 4P									
	Input power (W)	-	40/50					90/120		150/210					80/120	270/390	
	Current (A)	-	0.29/0.27 to 0.31					0.49/0.44 to 0.48		0.75/0.77 to 0.8					0.76/ 0.8, 0.8	1.9/2.0, 2.0	
Approx. mass (kg)		28	29	32	46	63	73	111	133	190	197	235	280	296	380	510	570

● Standard specifications for three-phase 400 V series

Item		Specifications																	
Dedicated motor rated output (kW)		3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220
Applicable motor type (MVK_)		8115A	8133A	8135A	8165A	8167A	8184A	8185A	8187A	8207A	8208A	9224A	9254A	9256A	9284A	9286A	528KA	528LA	531FA
Moment of inertia of rotor (kg•m^2)		0.016	0.030	0.037	0.085	0.11	0.21	0.23	0.34	0.41	0.47	0.53	0.88	1.03	1.54	1.77	1.72	1.83	2.33
Rotor GD^2 (kg•m^2)		0.065	0.12	0.15	0.34	0.47	0.83	0.92	1.34	1.65	1.87	2.12	3.52	4.12	6.16	7.08	6.88	7.32	9.32
Rated speed / Max. speed (r/min)		1500/3600							1500/3000			1500/2400		1500/2000					
Vibration		V10 or less										V15 or less							
Cooling fan	Voltage (V)	200 to 210 V/50 Hz, 200 to 230 V/60 Hz			400 to 420 V/50 Hz, 400 to 440 V/60 Hz							400 V/50 Hz, 400, 440 V/60 Hz					380, 400, 415 V/50 Hz, 400, 440 V/ 60 Hz		
	Number of phases/ poles	Single-phase, 4P			Three-phase, 4P														
	Input power (W)	40/50			90/120		150/210					80/ 120	270/390				2200		3700
	Current (A)	0.29/0.27 to 0.31			0.27/ 0.24 to 0.25		0.38/0.39 to 0.4					0.39/ 0.4, 0.4	1.0/1.0, 1.0				4.6/4.3,4.1		7.8/ 7.1, 7.6
Approx. mass (kg)		46	63	73	111	133	190	197	235	280	296	380	510	570	710	760	1270	1310	1630

Item		Specifications					
Dedicated motor rated output (kW)		250	280	300	315	355	400
Applicable motor type (MVK_)		531GA	531HA	535GA	535GA	535HA	535JA
Moment of inertia of rotor (kg•m^2)		2.52	2.76	5.99	5.99	6.53	7.18
Rotor GD^2 (kg•m^2)		10.08	12.34	23.96	23.96	26.12	28.72
Rated speed / Max. speed (r/min)		1500/2000					
Vibration		V15 or less					
Cooling fan	Voltage (V)	400 V/50 Hz, 400, 440 V/60 Hz					
	Number of phases/ poles	Three-phase, 4P					
	Input power (W)	3700					
	Current (A)	7.8/7.1, 7.6					
Approx. mass (kg)		1685	1745	2230	2230	2310	2420

● Common specifications

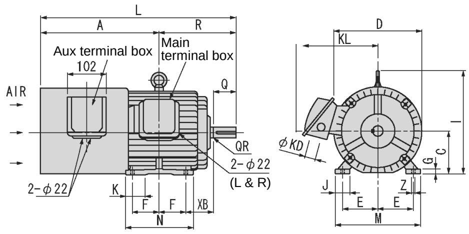
Item	Specifications
Insulation class, Number of poles	Class F, 4P
Terminal structure	Main terminal box (lug type): Three or six main circuit terminals, Two NTC thermistor terminals (MVK8 series), Three NTC thermistor terminals (MVK9 or MVK5 series. One terminal is reserved.) Auxiliary terminal box (terminal block): Pulse generator (PGP, PGM, PA, PB, SS), cooling fan (FU, FV or FU, FV, FW)
Mounting method	Foot mounted with bracket (IMB3), Note: Contact your Fuji Electric representative for other mounting.
Degree of protection, Cooling method	IP44, Totally enclosed forced-ventilation system with cooling fan motor. A cooling fan blows air over the motor toward the drive-end. *Only MVK8095A (0.75 kW): Self-cooling
Installation location	Indoors, 1000 m or less in altitude.
Ambient temperature, humidity	-10 to +40°C, 90% RH or less (no condensation)
Finishing color	Munsell N5
Standard conformity	MVK8 series: JEM1466 or JEC-2137-2000 MVK9 or MVK5 series: JEC-2137-2000
Standard accessories	Pulse generator (1024 P/R, +15V, complementary output), NTC thermistor(s) (1 or 2), and cooling fan (except MVK8095A)

Note 1: For applicable motors of 55 kW or above, the torque accuracy is ±5%. When higher accuracy is required, contact your Fuji Electric representative.

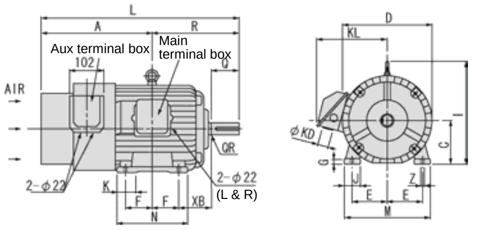
Note 2: For dedicated motors other than 4-pole ones with the base speed of 1500 r/min, contact your Fuji Electric representative.

● External dimensions of dedicated motors

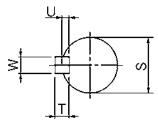
● Figure A



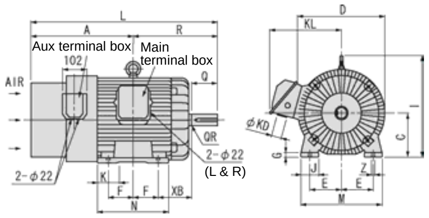
● Figure B



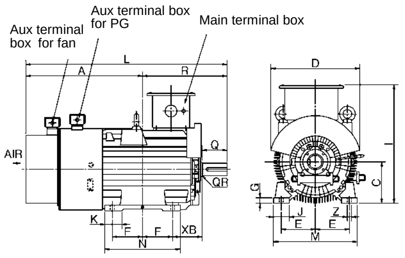
Shaft extension



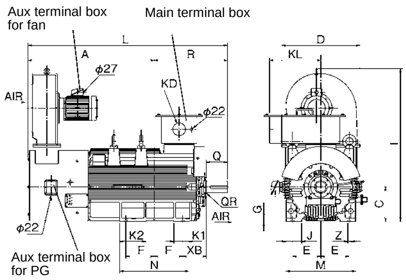
● Figure C



● Figure D



● Figure E



● Dimensions common to 200V and 400V series

Motor rated output (kW)	Motor type	Fig.	Dimensions (mm)																			Shaft extension (mm)						Approx .mass (kg)
			A	C	D	E	F	G	I	J	K	K1	K2	KD	KL	L	M	N	R	XB	Z	Q	QR	S	T	U	W	
0.75	MVK8095A	A	201.5	90	204	70	62.5	10	195	35.5	35.5	-	-	27	189	370	170	150	168.5	56	10	50	0.5	24j6	7	4	8	28
1.5	MVK8097A		277.5		203											446												29
2.2	MVK8107A		292	100		80	70	12.5	238	40	40				190	485	195	170	193	63	12	60		28j6				32
3.7	MVK8115A		299	112	236	95		14	270		50				205	499	224	175	200	70								46
5.5	MVK8113A	B	309	132	273	108		17	311	45				34	223	548	250	180	239	89		80		38k6	8	5	10	63
7.5	MVK8135A		328				89									586		212	258									73
11	MVK8165A	A	400	160	321	127	105	18	376	50	63			48	272	723	300	250	323	108	14.5	110	1	42k6			12	111
15	MVK8167A		422				127									767		300	345									133
18.5	MVK8184A		435	180	376	139.5	120.5	20	428	75	75				305	786.5	350	292	351.5	121			1.5	48k6	9	5.5	14	190
22	MVK8185A																											197
30	MVK8187A		454				139.5							60		824.5		330	370.5					55m6	10	6	16	235
37	MVK8207A	C	490	200	411	159	152.5	25	466	80	85			80	364	915.5	390	360	425.5	133	18.5	140	2	60m6	11	7	18	280
45	MVK8208A																											296
55	MVK9224A		723	225	445	178	143		515		95				391	1155	436	366	432	149				65m6				380
75	MVK9254A	D	693.5	250	545	203	155.5	30	743	100	120				106	1157	506	411	463.5	168	24			75m6	12	7.5	20	510
90	MVK9256A		711.5				174.5									1194		449	483.5									570
110	MVK9284A		764	280	605	228.5	184	35	798						203	1308	557	468	544	190		170		85m6	14	9	22	710
132	MVK9286A		789.5				209.5									1359		519	569.5									760
160	MVK528JA	E	1015.5		628		228.5	30	1234	125	-	120	210	102	413	1604	560	557	588.5				1					1230
200	MVK528LA																											1350
220	MVK531FA		1073	315	689	254	254	36	1425	150		140	240			1713	630	648	640	216	28		2	95m6			25	1690
250	MVK531GA																											1750
280	MVK531HA																											1820
300	MVK535GA		1111	355	778	305	355		1510	160		180	330			1956	730	890	845	280		210		100m6	16	10	28	2230
315																												
355	MVK535HA																											2310
400	MVK535JA																											2420

Note 1: The MVK8095A (0.75 kW) has a shaft-driven fan (Cooling system: IC410).

Note 2: The MVK8095A (0.75 kW) has a single cable lead-in hole of ϕ22.

Note 3: The MVK9224A (55 kW) has an auxiliary terminal box for fan, in addition to the configuration shown in Figure C.

Note 4: Dimensional tolerance of rotary shaft height C
C ≤ 250 mm: 0 to -0.5 mm, C > 250 mm: 0 to 1.0 mm

2.4.2 Permanent magnet synchronous motor (PMSM) with speed sensor

● Standard specifications for three-phase 200 V series

Item		Specifications											
Dedicated motor rated output (kW)		5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
Dedicated motor type (GNF_)		2114A	2115A	2117A	2118A	2136A	2137A	2139A	2165A	2167A	2185A	2187A	2207A
Moment of inertia of rotor (kg•m²)		0.018	0.021	0.027	0.036	0.065	0.070	0.090	0.153	0.191	0.350	0.467	0.805
Rotor GD² (kg•m²)		0.072	0.084	0.107	0.143	0.259	0.281	0.360	0.610	0.763	1.401	1.868	3.220
Base speed/Max. speed (r/min)		1500/2000											
Rated current (A)		20/20	29/29	42/42	57/57	71/70	82/81	113/108	144/144	165/165	200/200	270/270	316/316
Vibration		V10 or less											
Cooling fan	Voltage (V), Frequency (Hz)	200 to 240, 50/60							200 to 210/50, 200 to 230/60				
	Number of phases/poles	Three-phase, 2P							Three-phase, 4P				
	Input power (W)	38 to 44/56 to 58				54 to 58/70 to 78			90/120		150/210		
	Current (A)	0.13 to 0.16/0.18 to 0.16				0.18 to 0.18/0.22 to 0.21			0.49/ 0.44 to 0.48		0.75/0.77 to 0.8		
Approx. mass (kg)		51	55	69	78	100	106	127	170	192	247	325	420

● Standard specifications for three-phase 400 V series

Item		Specifications											
Dedicated motor rated output (kW)		5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
Dedicated motor type (GNF_)		2114A	2115A	2117A	2118A	2136A	2137A	2139A	2165A	2167A	2185A	2187A	2207A
Moment of inertia of rotor (kg•m²)		0.018	0.021	0.027	0.036	0.065	0.070	0.090	0.153	0.191	0.350	0.467	0.805
Rotor GD² (kg•m²)		0.072	0.084	0.107	0.143	0.259	0.281	0.360	0.610	0.763	1.401	1.868	3.220
Base speed/Max. speed (r/min)		1500/2000											
Rated current (A)		10/10	15/15	21/21	29/29	36/35	41/41	57/54	72/72	83/83	100/100	135/135	158/158
Vibration		V10 or less											
Cooling fan	Voltage (V), Frequency (Hz)	200 to 240, 50/60							400 to 420/50, 400 to 440/60				
	Number of phases/poles	Three-phase, 2P							Three-phase, 4P				
	Input power (W)	38 to 44/56 to 58				54 to 58/70 to 78			90/120		150/210		
	Current (A)	0.13 to 0.16/0.18 to 0.16				0.18 to 0.18/0.22 to 0.21			0.27/ 0.24 to 0.25		0.38/0.39 to 0.4		
Approx. mass (kg)		51	55	69	78	100	106	127	170	192	247	325	420

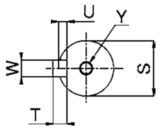
Item		Specifications							
Dedicated motor rated output (kW)		110	132	160	200	220	250	280	300
Dedicated motor type (GNF_)		2224B	2226B	2254B	2256B	2284B		2286B	
Moment of inertia of rotor (kg•m²)		0.882	0.994	1.96	2.22	2.89		3.24	
Rotor GD² (kg•m²)		3.53	3.98	7.84	8.88	11.6		13.0	
Base speed/Max. speed (r/min)		1500/2000							
Rated current (A)		198	232	273	340	369	420	480	520
Vibration		V10 or less							
Cooling fan	Voltage (V)	380, 400, 415/400, 415, 440, 460							
	Number of phases/poles	Three-phase, 4P							
	Power frequency (Hz)	50/60							
	Input power (W)	80/120		270/390					
	Current (A)	0.36, 0.38, 0.41/0.4, 0.4, 0.4, 0.4		0.95, 0.95, 1/1, 1, 1, 1					
Approx. mass (kg)		520	580	760	810	1020		1080	

● Common specifications

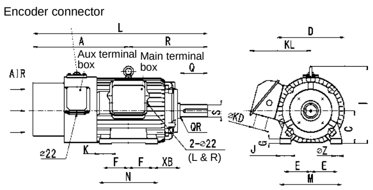
Item	Specifications
Insulation class, Number of poles	Class F, 6P
Terminal structure	Main terminal box (lug type): Three or six main circuit terminals, Two NTC thermistor terminals (Three for 110 kW or above. One terminal is reserved.) Auxiliary terminal box (terminal block): Cooling fan (FU, FV, FW)
	Pulse encoder (connector type), Cooling fan (FU, FV, FW)
Rotation direction	CCW when viewed from the drive side
Mounting method	Legs mounted (IMB3) Note: Contact your Fuji Electric representative for other mounting.
Overload resistance	150% for 1 minute
Time rating	S1
Degree of protection, Cooling method	IP44, Totally enclosed forced-ventilation system with cooling fan motor. A cooling fan blows air over the motor toward the drive-end.
Installation location	Indoors, 1000 m or less in altitude.
Ambient temperature, humidity	-10 to +40°C, 90% RH or less (no condensation)
Noise	5.5 to 90 kW: 80 dB (A) or less at 1 m, 110 to 300 kW: 90 dB(A) or less at 1 m
Vibration resistance	6.86 m/s^2 (0.7 G)
Finishing color	Munsell N1.2
Standard conformity	JEM1487: 2005
Standard built-in parts	Pulse encoder (1024 P/R, +5VDC, A, B, Z, U, V, W line driver output), One NTC thermistor (Two for 110 kW or above) and Cooling fan

● External dimensions of dedicated motors

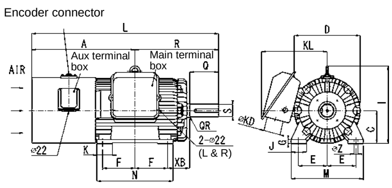
Shaft extension



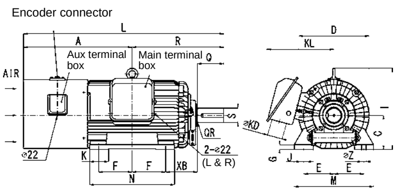
● Figure A



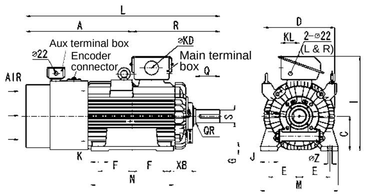
● Figure B



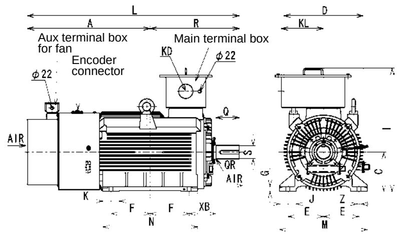
● Figure C



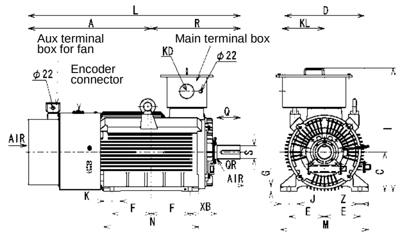
● Figure D



● Figure E



● Figure F



● Dimensions common to 200V and 400V series

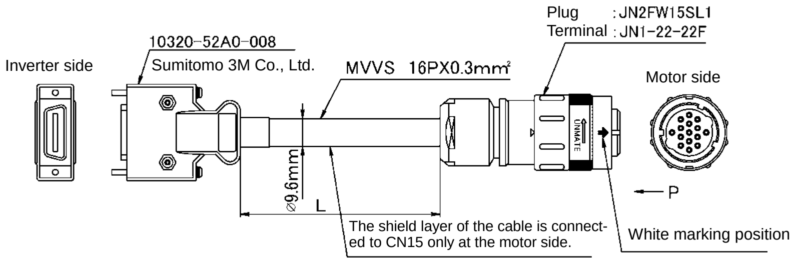
<table>
<tr><th rowspan="2">Motor rated output (kW)</th><th rowspan="2">Motor type</th><th rowspan="2">Flame no.</th><th rowspan="2">Fig.</th><th colspan="17">Dimensions (mm)</th><th colspan="7">Shaft extension (mm)</th><th rowspan="2">Approx. mass (kg)</th></tr>
<tr><th>A</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th><th>I</th><th>J</th><th>K</th><th>KD</th><th>KL</th><th>L</th><th>M</th><th>N</th><th>R</th><th>XB</th><th>Z</th><th>Q</th><th>QR</th><th>S</th><th>T</th><th>U</th><th>W</th><th>Y</th></tr>
<tr><td>5.5</td><td>GNF2114A</td><td rowspan="2">112Mh</td><td rowspan="7">A</td><td rowspan="2">335.5</td><td rowspan="4">112</td><td rowspan="4">235</td><td rowspan="4">95</td><td rowspan="2">70</td><td rowspan="2">14</td><td rowspan="4">270</td><td rowspan="2">40</td><td rowspan="7">50</td><td rowspan="2">34</td><td rowspan="2">200</td><td rowspan="2">555.5</td><td rowspan="2">224</td><td rowspan="2">175</td><td rowspan="2">220</td><td rowspan="2">70</td><td rowspan="2">12</td><td rowspan="2">80</td><td rowspan="2">0.5</td><td rowspan="2">38k6</td><td rowspan="4">8</td><td rowspan="4">5</td><td rowspan="2">10</td><td rowspan="7">M10X20</td><td>51</td></tr>
<tr><td>7.5</td><td>GNF2115A</td><td>55</td></tr>
<tr><td>11</td><td>GNF2117A</td><td rowspan="2">112Jh</td><td rowspan="2">380.5</td><td rowspan="2">100</td><td rowspan="2">18</td><td rowspan="2">55</td><td rowspan="4">48</td><td rowspan="2">235</td><td rowspan="2">698.5</td><td rowspan="2">228</td><td rowspan="4">238</td><td rowspan="2">318</td><td rowspan="7">108</td><td rowspan="5">14.5</td><td rowspan="5">110</td><td rowspan="2">1</td><td rowspan="2">42k6</td><td rowspan="2">12</td><td>69</td></tr>
<tr><td>15</td><td>GNF2118A</td><td>78</td></tr>
<tr><td>18.5</td><td>GNF2136A</td><td rowspan="2">132Lh</td><td rowspan="2">386</td><td rowspan="3">132</td><td rowspan="3">272</td><td rowspan="3">108</td><td rowspan="2">101.5</td><td rowspan="5">20</td><td rowspan="3">311</td><td rowspan="3">45</td><td rowspan="3">247</td><td rowspan="2">705.5</td><td rowspan="3">250</td><td rowspan="2">319.5</td><td rowspan="3">1.5</td><td rowspan="2">48k6</td><td rowspan="2">9</td><td rowspan="2">5.5</td><td rowspan="2">14</td><td>100</td></tr>
<tr><td>22</td><td>GNF2137A</td><td>106</td></tr>
<tr><td>30</td><td>GNF2139A</td><td>132Hh</td><td>424.5</td><td>140</td><td>60</td><td>782.5</td><td>313</td><td>358</td><td>55m6</td><td>10</td><td>6</td><td>16</td><td>127</td></tr>
<tr><td>37</td><td>GNF2165A</td><td>160Lg</td><td rowspan="3">B</td><td>470.5</td><td rowspan="2">160</td><td rowspan="2">319</td><td rowspan="2">139.5</td><td>127</td><td rowspan="2">376</td><td rowspan="2">75</td><td rowspan="2">75</td><td rowspan="9">80</td><td rowspan="2">320</td><td>845.5</td><td rowspan="2">350</td><td>300</td><td>375</td><td rowspan="3">18.5</td><td rowspan="5">140</td><td rowspan="5">2</td><td rowspan="2">60m6</td><td rowspan="3">11</td><td rowspan="3">7</td><td rowspan="3">18</td><td rowspan="5">M12X25</td><td>170</td></tr>
<tr><td>45</td><td>GNF2167A</td><td>160Jg</td><td>501</td><td>157.5</td><td>906.5</td><td>370</td><td>405.5</td><td>192</td></tr>
<tr><td>55</td><td>GNF2185A</td><td>180Lg</td><td>510</td><td rowspan="2">180</td><td rowspan="2">375</td><td rowspan="2">159</td><td>139.5</td><td rowspan="3">25</td><td rowspan="2">428</td><td>80</td><td>85</td><td rowspan="2">356</td><td>910.5</td><td>390</td><td>330</td><td>400.5</td><td>121</td><td>65m6</td><td>247</td></tr>
<tr><td>75</td><td>GNF2187A</td><td>180Jg</td><td>C</td><td>576</td><td>177.5</td><td rowspan="6">100</td><td rowspan="2">100</td><td>1061.5</td><td>420</td><td>450</td><td>485.5</td><td rowspan="4">168</td><td rowspan="6">24</td><td rowspan="2">75m6</td><td rowspan="2">12</td><td rowspan="2">7.5</td><td rowspan="2">20</td><td>325</td></tr>
<tr><td>90</td><td>GNF2207A</td><td>200Jg</td><td rowspan="3">D</td><td>618.5</td><td>200</td><td>410</td><td>178</td><td rowspan="2">200</td><td>549</td><td>107</td><td>1126.5</td><td>450</td><td>479</td><td>508</td><td>420</td></tr>
<tr><td>110</td><td>GNF2224B</td><td>225Kg</td><td>711</td><td rowspan="2">225</td><td rowspan="2">446</td><td rowspan="2">203</td><td rowspan="2">28</td><td rowspan="2">628</td><td rowspan="8">120</td><td rowspan="2">142</td><td>1249</td><td rowspan="2">506</td><td>526</td><td>538</td><td rowspan="8">170</td><td rowspan="8">1</td><td rowspan="2">85m6</td><td rowspan="8">14</td><td rowspan="8">9</td><td rowspan="2">22</td><td rowspan="8">M20×35</td><td>520</td></tr>
<tr><td>132</td><td>GNF2226B</td><td>225Hg</td><td>761</td><td>250</td><td>1349</td><td>626</td><td>588</td><td>580</td></tr>
<tr><td>160</td><td>GNF2254B</td><td rowspan="2">250Hg</td><td rowspan="2">E</td><td rowspan="2">829</td><td rowspan="2">250</td><td>508</td><td rowspan="2">228.5</td><td rowspan="6">280</td><td rowspan="2">32</td><td rowspan="2">763</td><td rowspan="2">203</td><td rowspan="2">1469</td><td rowspan="2">557</td><td rowspan="2">677</td><td rowspan="6">640</td><td rowspan="6">190</td><td rowspan="6">95m6</td><td rowspan="6">25</td><td>760</td></tr>
<tr><td>200</td><td>GNF2256B</td><td>505</td><td>810</td></tr>
<tr><td>220</td><td rowspan="2">GNF2284B</td><td rowspan="4">280Jf</td><td rowspan="4">F</td><td rowspan="4">881</td><td rowspan="4">280</td><td rowspan="4">570</td><td rowspan="4">254</td><td rowspan="4">35</td><td rowspan="4">878</td><td rowspan="4">120</td><td rowspan="4">102</td><td rowspan="4">303</td><td rowspan="4">1521</td><td rowspan="4">628</td><td rowspan="4">680</td><td rowspan="4">28</td><td>1020</td></tr>
<tr><td>250</td><td>1020</td></tr>
<tr><td>280</td><td rowspan="2">GNF2286B</td><td>1080</td></tr>
<tr><td>300</td><td>1080</td></tr>
</table>

Note 1: Models of 110 kW output or above are exclusive to direct connection. For indirect connection, contact your Fuji Electric representative.

Note 2: Dimensional tolerance of rotary shaft height C
C ≤ 250 mm: 0 to -0.5 mm, C > 250 mm: 0 to 1.0 mm

● Exclusive cables to inverter connection

Name	Specifications (Structure)
Exclusive cables to inverter connection	Overview



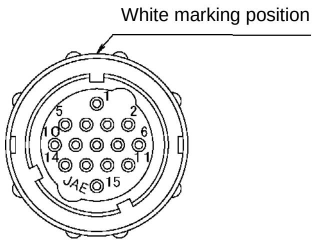
• Wiring

Connector # at the motor side	Connector # at the inverter side	Function
1	9 or 20	Power +5V
2	10 or 19	0V common
3	3	A phase
4	2	A phase reversed
5	5	B phase
6	4	B phase reversed
7	-	Z phase (*1)
8	-	Z phase reversed (*1)
9	8	Magnetic pole position F0
10	7	Magnetic pole position *F0
11	13	Magnetic pole position F1
12	12	Magnetic pole position *F1
13	15	Magnetic pole position F2
14	14	Magnetic pole position *F2
15	-	Shield layer

(*1) For the PG card (OPC-VG1-PMPG), no Z phase or Z phase reversed are required.

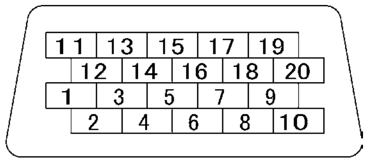
• Pin assignment

At the motor side



Viewed from P in the above figure

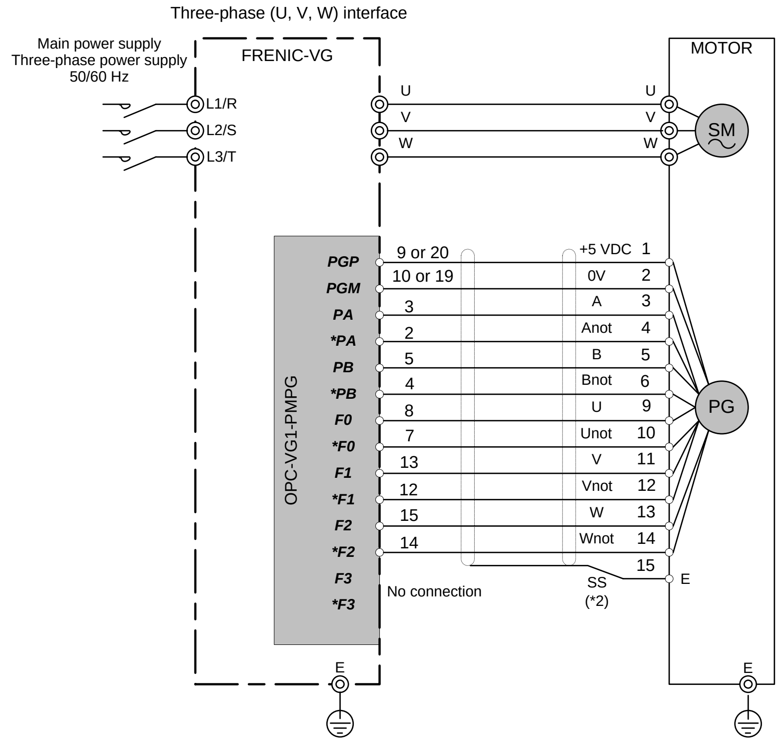
Optional OPC-VG1-PMPG connector



Inside the connector

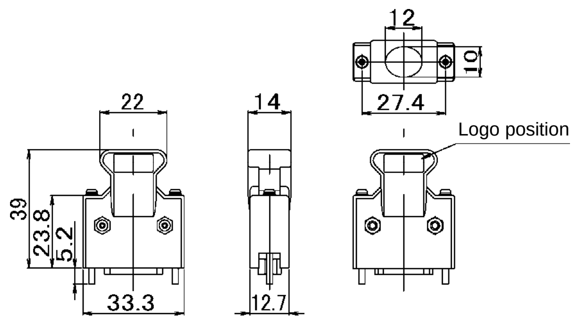
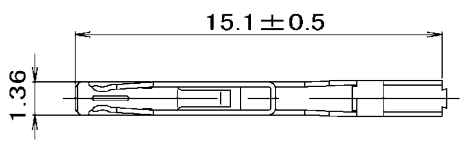
Models of cables

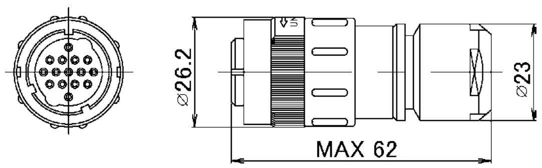
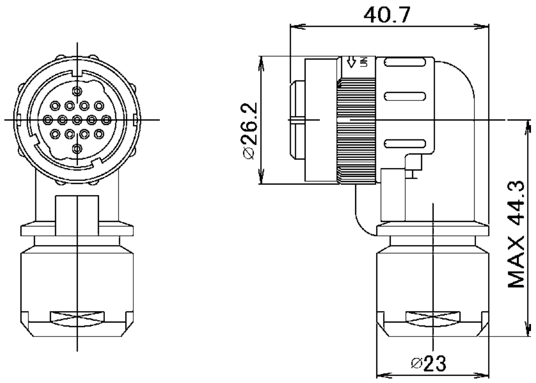
Wiring length	Model	L dimension
Max. 5 m	CB-VG1-PMPG-05S	5 m
Max. 10 m	CB-VG1-PMPG-10S	10 m
Max. 30 m	CB-VG1-PMPG-30S	30 m

Name	Specifications (Structure)
Connection example	 (*2) When the customer produces the inverter connection cable, the shield (SS) of the PG shield layer should be connected to CN15 at the motor side. No connection is required at the inverter side.

● **Reference: Connectors and contact terminals recommended**

The following specifications are recommended for customers who produce inverter connection cables.

<table>
<tr><td>At the inverter side: Connector (10320-52F0-008)
Sumitomo 3M Co., Ltd.</td><td>At the motor side: Connector contact terminal
(JN1-22-22F-PKG100)
Japan Aviation Electronics Industry, Limited</td></tr>
<tr><td>
</td><td>

Max. applicable wire size:
AWG20 (Outer dia. of coated cable: φ1.5 mm or less)</td></tr>
<tr><td>At the motor side: Straight plug connector (JN2DW15SL)
Japan Aviation Electronics Industry, Limited</td><td>At the motor side: Angle plug connector (JN2FW15SL1)
Japan Aviation Electronics Industry, Limited</td></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Note 1: The following specifications are recommended for PG shield layers.

Type	Braided, shielded wires (Twisted-pair cable (Outer dia.: Approx. φ10))
Number of cores	14 or more
Dia. of lead	0.2 to 0.3 mm^2
Outer dia. of coated cable	Max. φ1.5 mm

Note 2: The PKG in contact terminal models denotes that 100 terminals are packed in bulk.

Note 3: Joint with contact terminals should be presoldered.

2.5 Protective Functions

The table below lists the name of the protective functions, description, alarm codes on the LED monitor, and presence of alarm output at terminals [30A/B/C]. If an alarm code appears on the LED monitor, remove the cause of activation of the alarm function referring to Chapter 13 "TROUBLESHOOTING."

Class	Name	Description	LED monitor displays	Related function code
Protective functions	Braking transistor broken	If a breakdown of the braking transistor is detected, this protective function stops the inverter output. (Available for braking transistor built-in inverters) If this alarm is detected, be sure to shut down the power on the primary side of the inverter.	dbA	H103
	Braking resistor overheated	This function estimates the temperature of the braking resistor and stops the inverter output if the temperature exceeds the allowable value. It is necessary to configure Function codes E35 to E37 depending on the resistor (integrated or externally mounted).	dbH	E35 to E37
	DC fuse blown	If a fuse in the main DC circuit blows due to a short circuit in the IGBT circuit, this protective function displays the error to prevent the secondary damage. The inverter could be broken, so immediately contact your Fuji Electric representative. (For models of 75 kW or above in 200 V class series and 90 kW or above in 400 V class series)	dCF	
	Excessive positioning deviation	This function is activated when the positioning deviation between the command and the detected values exceeds "Setting of function code o18 (Excessive deviation value) x 10" in synchronous operation. Mounting an option makes 018 effective and displays it on the keypad.	dO	o18
	PG communications error	This function is activated if a PG communication error occurs when the 17-bit high resolution ABS interface (OPC-VG1-SPGT) is used.	EC	
	ENABLE circuit (safety stop circuit) failure	This function is activated when the input to either one of EN1 and EN2 is OFF for the duration exceeding 50 ms (which is regarded as a mismatch). The alarm state can be reset only by restarting the inverter. (Available soon.)	ECF	
	Ground fault	This function is activated when a ground fault is detected in the inverter output circuit. If the ground-fault current is large, the overcurrent protection may be activated. This protective function is to protect the inverter. For the sake of prevention of accidents such as human damage and fire, connect a separate earth-leakage protective relay or an earth-leakage circuit breaker (ELCB).	EF	H103
	Memory error	This function is activated when a memory error such as a data write error occurs. **Note:** The inverter memory uses a nonvolatile memory that has a limited number of rewritable times (100,000 to 1,000,000 times). Saving data with the full save function into the memory so many times unnecessarily will no longer allow the memory to save data, causing a memory error.	Er 1	
	Keypad communications error	This function is activated if a communications error occurs between the keypad and the inverter control circuit when the start/stop command given from the keypad is valid (Function code F02=0). **Note:** Even if a keypad communications error occurs when the inverter is being driven via the control circuit terminals or the communications link, the inverter continues running without displaying any alarm or issuing an alarm output (for any alarm).	Er2	F02
	CPU error	This function is activated if a CPU error occurs.	Er3	
	Network error	This function is activated: - if a communications error occurs due to noise when the inverter is being driven via the T-Link, SX-bus, E-SX bus, or CC-Link.	Er4	o30, o31, H107 E01 to E14 E15 to E28

Class	Name	Description	LED monitor displays	Related function code
Protective functions	RS-485 communications error	This function is activated: - if an RS-485 communications error occurs when the inverter is being driven via the RS-485 and Function code H32 is set to any of "0" through "2." - if Function code H38 is set within the range of 0.1 to 60.0 (s) and the communications link breaks for the specified period or longer.	Er-5	H32, H33, H38 H107
	Operation error	This function is activated: - if two or more network options (T-Link, SX-bus, E-SX bus, and CC-Link) are mounted. - if the SW configuration is the same on two or more PG options. (More than one PG option can be mounted.) - if auto tuning (Function code H01) is attempted when any of the digital input signals **BX**, ***STOP1***, ***STOP2*** and ***STOP3*** is ON. - if auto tuning is selected with Function code H01 but the (FWD) key on the keypad is not pressed within 20 seconds.	Er-6	H01
	Output wiring fault	This function is activated if the wires in the inverter output circuit are not connected during auto-tuning.	Er-7	H01
	A/D converter error	This function is activated if an error occurs in the A/D converter circuit.	Er-8	
	Speed not agreed	This function is activated if the deviation between the speed command (reference speed) and the motor speed (detected or estimated speed) becomes excessive. The detection level and detection time can be specified with function codes.	Er-9	E43, E44, E45 H108, H149
	UPAC error	Available soon	Er-A	
	Inter-inverter communications link error	This function is activated if a communications error occurs in the inverter-to-inverter communications link using a high-speed serial communication terminal block (option).	Er-b	H107
	Hardware error	Upon detection of an LSI failure on the printed circuit board, this function stops the inverter output.	Er-H	
	Mock alarm	This can be caused with keypad operation or FRENIC-VG Loader.	Err	H108, H142
	PG failure	This function is activated if a PG data error or PG failure is detected when the 17-bit high resolution ABS interface (OPC-VG1-SPGT) is used.	Et1	
	Input phase loss	This function protects the inverter when an input phase loss is detected. If the connected load is light or a DC reactor is connected to the inverter, this function may not detect input phase loss if any.	Lin	E45
	Start delay	This function is activated when the reference torque current (F44, F45) exceeds the specified level (H140) and the actual speed drops below the specified stop speed (F37), and then the state is kept for the specified duration (H141).	LoC	H108, H140, H141
	Undervoltage	This function is activated when the DC link bus voltage drops below the undervoltage detection level (180 VDC for 200 V series, 360 VDC for 400 V series). Note that, if the restart mode after momentary power failure is selected (F14 = 3, ,4 or 5), no alarm is output even if the DC link bus voltage drops.	LU	F14
	NTC wire break error	This function is activated if the thermistor wire breaks when the NTC thermistor is selected with Function code P30/A31/A131 for motor M1/M2/M3. This function works even at extremely low temperatures (approx. -30°C or below).	nrb	P30, A31, A131 H106
	Overcurrent	This function stops the inverter output when the output current to the motor exceeds the overcurrent level of the inverter.	OC	
	Heat sink overheat	This function is activated if the temperature surrounding the heat sink (that cools down the rectifier diodes and the IGBTs) increases due to stopped cooling fans.	OH1	

Class	Name	Description	LED monitor displays	Related function code
Protective functions	External alarm	This function is activated by digital input signal ***THR*** ("Enable external alarm trip"). Connecting an alarm contact of external equipment such as a braking unit or braking resistor to the control circuit terminal (to which the ***THR*** is assigned) activates this function according to the contact signal status.	OH2	E01-E14 H106
	Inverter internal overheat	This function is activated if the temperature surrounding the control printed circuit board increases due to poor ventilation inside the inverter.	OH3	
	Motor overheat	This function is activated if the temperature detected by the NTC thermistor integrated in a dedicated motor for motor temperature detection exceeds the motor overheat protection level (E30).	OH4	E30, H106
	Motor 1 overload	This function is activated by the electronic thermal overload protection if the motor 1 current (inverter output current) exceeds the operation level specified by Function code F11.	OL1	F11, H106
	Motor 2 overload	This function is activated by the electronic thermal overload protection if the motor 2 current (inverter output current) exceeds the operation level specified by Function code A33.	OL2	A33, H106
	Motor 3 overload	This function is activated by the electronic thermal overload protection if the motor 3 current (inverter output current) exceeds the operation level specified by Function code A133.	OL3	A133, H106
	Inverter overload	This function is activated if the output current exceeds the overload characteristic of the inverse time characteristic. It stops the inverter output depending upon the heat sink temperature and switching element temperature calculated from the output current.	OLU	F80
	Output phase loss	This function detects a break in inverter output wiring during running and stops the inverter output. (Available under vector control for IM with speed sensor.)	OPL	H103, P01 A01, A101
	Overspeed	This function Stops the inverter output if the detected speed is 120% or over of the maximum frequency. This function is activated if the motor speed (detected or estimated speed) exceeds 120% (adjustable with Function code H90) of the maximum speed (F03/A06/A106).	OS	H90
	Overvoltage	This function is activated if the DC link bus voltage exceeds the overvoltage detection level (405 VDC for 200 V series, 820 VDC for 400 V series) due to an increase of supply voltage or regenerative braking current from the motor. Note that the inverter cannot be protected from excessive voltage (high voltage, for example) supplied by mistake.	OU	
	PG wire break	This function is activated if a wire breaks in the PA/PB circuit on the PG terminal or in the power supply circuit. It does not work under vector control without speed sensor or under V/f control.	PG	H104
	Charger circuit fault	This function is activated if the bypass circuit of the DC link bus is not configured (that is, the magnetic contactor for bypass of the charging circuit is not closed) even after the main power is applied. (For models of 37 kW or above in 200 V class series and 75 kW or above in 400 V class series)	PbF	
	DC fan locked	This function is activated if the DC fan is stopped. (For models of 45 kW or above in 200 V class series and 75 kW or above in 400 V class series)	dFA	H108
	E-SX bus tact synchronization error	This error occurs when the E-SX tact cycle and inverter control cycle are out of synchronization with each other.	Ar-E	H108
	Toggle abnormality error	The inverter monitors 2-bit signals of toggle signal 1 ***TGL1*** and toggle signal 2 ***TGL2*** which are sent from the PLC. When the inverter receives no prescribed change pattern within the time specified by H144, this error occurs.	Ar-F	H107

Class	Name	Description	LED monitor displays	Related function code
Protective functions	Light alarm (warning)	This function displays L-AL on the LED monitor if a failure or warning registered as a light alarm occurs. It outputs the ***L-ALM*** signal on the Y terminal but it does not issue an alarm relay output ([30A], [30B], [30C]), so the inverter continues to run. <u>Light alarm objects (selectable)</u> Motor overheat (OH4), Motor overload (OL1 to OL3), NTC wire break error (nrb), External failure (OH2), RS-485 communications error (Er5), Network error (Er4), Toggle abnormality error (ArF), Mock alarm (Err), DC fan locked (dFA), Speed mismatch (Er9), E-SX bus tact synchronization error (ArE), Motor overheat early warning (mOH), Motor overload early warning (mOL), Lifetime alarm (LiF), Heat sink overheat early warning (OH), Inverter overload early warning (OL), Battery life expired (bAt), Start delay (LoC), Safety PCB light alarm (SnF) (Available soon) Light alarm objects can be checked on the keypad.	L-AL	H106-H111
	Surge protection	This function protects the inverter against surge voltages which might appear between one of the power lines, using surge absorbers connected to the main circuit power terminals (L1/R, L2/S, L3/T) and control power terminals (R0, T0).	-	
	Main power shut down	This function monitors the AC input power to the inverter and judges whether the AC input power (main power) is established. When the main power is not established, whether to run the inverter or not can be selected. (When the power is supplied via a PWM converter or the DC link bus, there is no AC input. In this case, do not change the data of Function code H76 from the default (H76 = 0).	-	H76

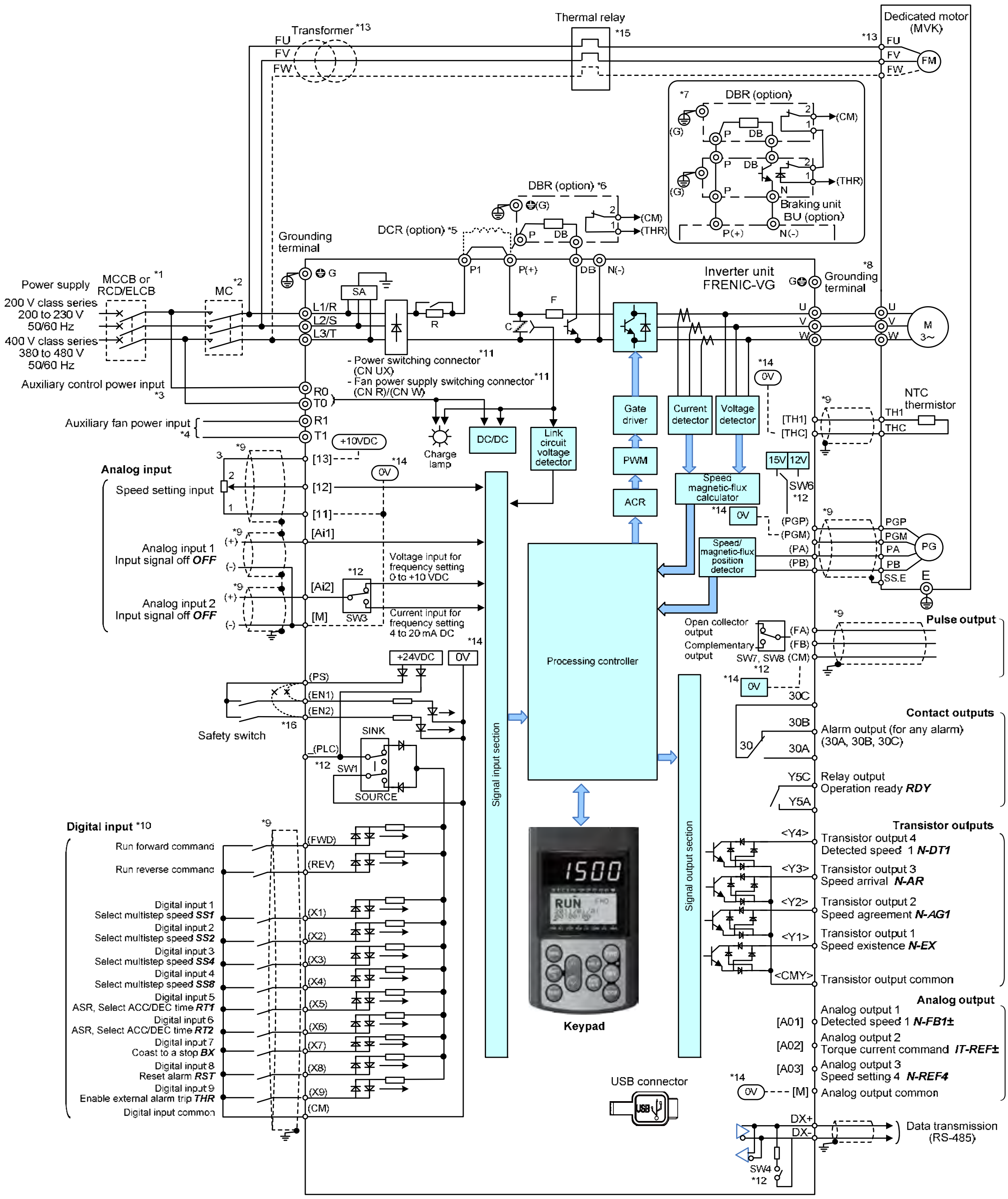
Notes

- All protective functions are automatically reset if the control power voltage decreases until the inverter control circuit no longer operates.
- The inverter retains the latest and the last 10 alarm codes and the latest and the last three pieces of alarm information.
- Stoppage due to a protective function can be reset by the RST key on the keypad or turning OFF and then ON between the X terminal (to which RST is assigned) and the CM. This action is invalid if the cause of an alarm is not removed.
- The inverter cannot reset until the causes of all alarms are removed. (The causes of alarms not removed can be checked on the keypad.)
- If an abnormal state is categorized as a light alarm, the 30A/B/C does not operate.

2.6 Connection Diagrams and Terminal Functions

2.6.1 Connection diagrams

2.6.1.1 Running the MVK type of an induction motor (dedicated motor)



(Note 1) Install a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection function) in the primary circuit of the inverter to protect wiring. Ensure that the circuit breaker capacity is equivalent to or lower than the recommended capacity.

(Note 2) Install a magnetic contactor (MC) for each inverter to separate the inverter from the power supply, apart from the MCCB or RCD/ELCB, when necessary.
Connect a surge absorber in parallel when installing a coil such as the MC or solenoid near the inverter.

(Note 3) To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect these terminals to the power supply lines. Without power supply to these terminals, the inverter can run.

(Note 4) Normally no need to be connected. Use these terminals when the inverter is equipped with a high power-factor, regenerative PWM converter (RHC series).

(Note 5) When connecting an optional DC reactor (DCR), remove the jumper bar from the main circuit terminals P1 and P(+).

Inverters of 75 kW or above and LD-mode inverters of 55 kW come with a DCR as standard. Be sure to connect the DCR.

Use a DCR when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity, or when there are thyristor-driven loads in the same power supply line.

(Note 6) Inverters of 55 kW or below (200 V class series) and those of 160 kW or below (400 V class series) have a built-in braking transistor, allowing a braking resistor (DBR) to be directly connected between terminals P(+) and DB.

(Note 7) When connecting an optional braking resistor (DBR) to inverters of 75 kW or above (200 V class series) or those of 200 kW or above (400 V class series), be sure to use an optional braking unit (BU) together.

Connect the BU between terminals P(+) and N(-). Auxiliary terminals [1] and [2] have polarity, so make connection as shown in the connection diagram.

(Note 8) A grounding terminal for a motor. It is recommended that the motor be grounded via this terminal for suppressing inverter noise.

(Note 9) For wiring enclosed with , use twisted or shielded wires.

In principle, the shielded sheath of wires should be connected to ground. If the inverter is significantly affected by external induction noise, however, connection to 0V ([M], [11], [THC]) or 0V ([CM], (PGM)) may be effective to suppress the influence of noise.

Keep the control circuit wiring away from the main circuit wiring as far as possible (recommended: 10 cm or more). Never install them in the same wire duct. When crossing the control circuit wiring with the main circuit wiring, set them at right angles.

(Note 10) The connection diagram shows factory default functions assigned to digital input terminals [X1] to [X9], transistor output terminals [Y1] to [Y4], and relay contact output terminals [Y5A/C].

(Note 11) Switching connectors in the main circuits. For details, refer to Chapter 3, Section 3.3.3.7 "Switching connectors."

(Note 12) Slide switches on the control printed circuit board (control PCB). Use these switches to customize the inverter operations. For details, refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches."

(Note 13) The cooling fan power supply for motors of 7.5 kW or less is single-phase. Connect terminals [FU] and [FV].

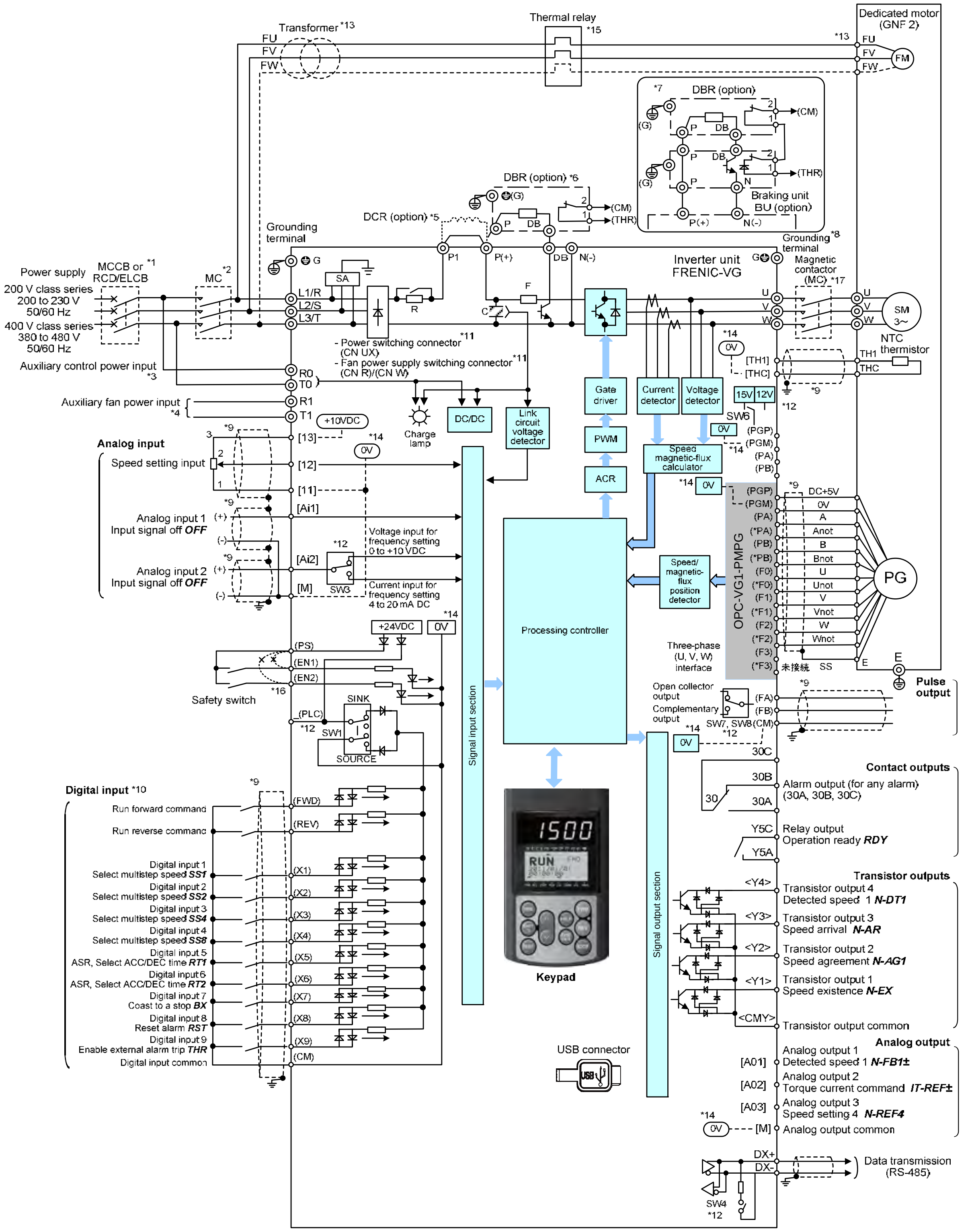
For motors of 7.5 kW or less (400 V class series), the power voltage/frequency rating of the cooling fan is 200 V/50 Hz or 200-230 V/60 Hz. For motors of 11 kW or above (400 V class series), it is 400-420 V/50 Hz or 400-440 V/60 Hz. To use the fan with power voltage other than the above specifications, a transformer is necessary.

(Note 14) 0V ([M], [11], [THC]) and 0V ([CM], (PGM)) are insulated inside the inverter unit.

(Note 15) Use the auxiliary contact (manual reset) of the thermal relay to trip the MCCB or MC.

(Note 16) Jumper bars are mounted between safety terminals [EN1]/[EN2] and [PS] by factory default. To use the safety function, remove the jumper bars before connection of safety devices.

2.6.1.2 Running the GNF2 type of a permanent magnet synchronous motor (dedicated motor)



(Note 1) Install a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection function) in the primary circuit of the inverter to protect wiring. Ensure that the circuit breaker capacity is equivalent to or lower than the recommended capacity.

(Note 2) Install a magnetic contactor (MC) for each inverter to separate the inverter from the power supply, apart from the MCCB or RCD/ELCB, when necessary.
Connect a surge absorber in parallel when installing a coil such as the MC or solenoid near the inverter.

(Note 3) To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect these terminals to the power supply lines. Without power supply to these terminals, the inverter can run.

(Note 4) Normally no need to be connected. Use these terminals when the inverter is equipped with a high power-factor, regenerative PWM converter (RHC series).

(Note 5) When connecting an optional DC reactor (DCR), remove the jumper bar from the main circuit terminals P1 and P(+).

Inverters of 75 kW or above and LD-mode inverters of 55 kW come with a DCR as standard. Be sure to connect the DCR.

Use a DCR when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity, or when there are thyristor-driven loads in the same power supply line.

(Note 6) Inverters of 55 kW or below (200 V class series) and those of 160 kW or below (400 V class series) have a built-in braking transistor, allowing a braking resistor (DBR) to be directly connected between terminals P(+) and DB.

(Note 7) When connecting an optional braking resistor (DBR) to inverters of 75 kW or above (200 V class series) or those of 200 kW or above (400 V class series), be sure to use an optional braking unit (BU) together.

Connect the BU between terminals P(+) and N(-). Auxiliary terminals [1] and [2] have polarity, so make connection as shown in the connection diagram.

(Note 8) A grounding terminal for a motor. It is recommended that the motor be grounded via this terminal for suppressing inverter noise.

(Note 9) For wiring enclosed with ⬚, use twisted or shielded wires.

In principle, the shielded sheath of wires should be connected to ground. If the inverter is significantly affected by external induction noise, however, connection to 0V ([M], [11], [THC]) or 0V ([CM], (PGM)) may be effective to suppress the influence of noise.

Keep the control circuit wiring away from the main circuit wiring as far as possible (recommended: 10 cm or more). Never install them in the same wire duct. When crossing the control circuit wiring with the main circuit wiring, set them at right angles.

(Note 10) The connection diagram shows factory default functions assigned to digital input terminals [X1] to [X9], transistor output terminals [Y1] to [Y4], and relay contact output terminals [Y5A/C].

(Note 11) Switching connectors in the main circuits. For details, refer to Chapter 3, Section 3.3.3.7 "Switching connectors."

(Note 12) Slide switches on the control printed circuit board (control PCB). Use these switches to customize the inverter operations. For details, refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches."

(Note 13) The cooling fan power supply for motors of 7.5 kW or less is single-phase. Connect terminals [FU] and [FV].

For motors of 7.5 kW or less (400 V class series), the power voltage/frequency rating of the cooling fan is 200 V/50 Hz or 200-230 V/60 Hz. For motors of 11 kW or above (400 V class series), it is 400-420 V/50 Hz or 400-440 V/60 Hz. To use the fan with power voltage other than the above specifications, a transformer is necessary.

(Note 14) 0V ([M], [11], [THC]) and 0V ([CM], (PGM)) are insulated inside the inverter unit.

(Note 15) Use the auxiliary contact (manual reset) of the thermal relay to trip the MCCB or MC.

(Note 16) Jumper bars are mounted between safety terminals [EN1]/[EN2] and [PS] by factory default. To use the safety function, remove the jumper bars before connection of safety devices.

(Note 17) If the activation of the inverter protective function may result in a high-speed motor rotation due to the load, be sure to insert an MC.

(Note 18) A single inverter cannot drive two or more PMSMs.

(Note 19) A PMSM (GNF2 type) cannot be driven by commercial power. Driving the PMSM may result in a motor burnout.

(Note 20) Driving a PMSM requires setting the inverter carrier frequency high in order to prevent permanent magnet overheat and demagnetization due to the output current harmonics (except Fuji GNF2 type). Be sure to check the allowable carrier frequency of the motor and determine the settings of the carrier frequency (F26) and automatic lowering of the carrier frequency (H104, Hundreds digit).

When canceling the automatic lowering of the carrier frequency, take care since it derates the continuous rated current of the inverter according to the carrier frequency setting (F26). (For the rated current derating, refer to Section 2.1.4.)

2.6.2 List of terminal functions

Main Circuit Terminals and Analog Input Terminals

Classifi-cation	Symbol	Name	Functions
Main circuit	L1/R, L2/S, L3/T	Main circuit power inputs	Connect the three-phase input power lines.
	U, V, W	Inverter outputs	Connect a three-phase motor.
	P (+), P1	DC reactor connection	Connect a DC reactor (DCR) for correcting power factor. HD- and MD-mode inverters: A DCR is provided as an option for inverters of 55 kW or below, and as standard for those of 75 kW or above. LD-mode inverters: A DCR is provided as an option for inverters of 45 kW or below, and as standard for those of 55 kW or above.
	P (+), N (-)	Braking unit connection	Connect a braking resistor (DBR) via a braking unit. For connection to the DC link bus.
	P (+), DB	External braking resistor connection	Connect an optional external braking resistor.
	⏚ G	Grounding for inverter	Grounding terminals of the inverter.
	R0, T0	Auxiliary power input for the control circuit	For a backup of the control circuit power supply, connect AC power lines same as that of the main power input.
	R1, T1	Auxiliary power input for the fans	For use in combination with a power regenerative PWM converter (RHC series), use these terminals for an auxiliary power input of the AC fans inside the inverter. (For 200 V class series of inverters with 37 kW or above and 400 V class series with 75 kW or above) Normally, no need to use these terminals.
Speed setting	[13]	Power supply for the potentiometer	Power supply (+10 VDC, 10 mA max.) for a speed command potentiometer (Variable resistor: 1 to 5kΩ).
	[12]	Setting voltage input	The speed is commanded according to the external analog voltage input. Reversed operation with ± signals: 0 to ±10V DC/0 to maximum speed
	[11]	Analog input common	Common for analog input signals.
Analog input	[Ai1]	Analog input 1	Selectable from the following functions to assign. Possible to make setting according to analog input voltage specified from the external equipment. 0: Input signal off (***OFF***) 1: Auxiliary speed setting 1 (***AUX-N1***) 2: Auxiliary speed setting 2 (***AUX-N2***) 3: Torque limiter (level 1) (***TL-REF1***) 4: Torque limiter (level 2) (***TL-REF2***) 5: Torque bias command (***TB-REF***) 6: Torque command (***T-REF***) 7: Torque current command (***IT-REF***) 8: Creep speed 1 under UP/DOWN control (***CRP-N1***) 9: Creep speed 2 under UP/DOWN control (***CRP-N2***) 10: Magnetic-flux reference (***MF-REF***) 11: Line speed detected (***LINE-N***) 12: Motor temperature (***M-TMP***) 13: Speed override (***N-OR***) 14: Universal Ai (***U-AI***) 15: PID feedback value 1 (***PID-FB1***) 16: PID command (***PID-REF***) 17: PID correction gain (***PID-G***) 18-24: Custom Ai1 to 7 (***C-AI 1 to 7***) 25: Main speed reference (***N-REFV***) 26: Current input speed reference (***N-REFC***) 27: PID feedback value 2 (***PID-FB2***) * Ai2 is switchable between voltage input and current input by using the internal switch. Note that current input supports "speed setting" only.
	[Ai2]	Analog input 2	
	[M]	Analog input common	Common for analog input signals.

Digital Input Terminals

Classifi-cation	Symbol	Name	Functions
Digital input (Sink/source switchable)	[FWD]	Run forward command Stop command	FWD-CM: ON Run the motor in the forward direction. FWD-CM: OFF Decelerate the motor to stop.
	[REV]	Run reverse command Stop command	REV-CM: ON Run the motor in the reverse direction. REV-CM: OFF Decelerate the motor to stop.
	[X1]	Digital input 1	0, 1, 2, 3: Select multistep speed (1 to 15 steps) (0: ***SS1***, 1: ***SS2***, 2: ***SS4***, 3: ***SS8***) 4, 5: Select ASR and ACC/DEC time (4 steps) (4: ***RT1***, 5: ***RT2***) 6: Enable 3-wire operation (***HLD***) 7: Coast to a stop (***BX***) 8: Reset alarm (***RST***) 9: Enable external alarm trip (***THR***) 10: Ready for jogging (***JOG***) 11: Select speed command N2/N1 (***N2/N1***) 12: Select motor 2 (***M-CH2***) 13: Select motor 3 (***M-CH3***) 14: Enable DC braking (***DCBRK***) 15: Clear ACC/DEC to zero (***CLR***) 16: Switch creep speed under UP/DOWN control (***CRP-N2/N1***) 17: UP (Increase speed under UP/DOWN control) (***UP***) 18: DOWN (Decrease speed under UP/DOWN control) (***DOWN***) 19: Enable data change with keypad (***WE-KP***) 20: Cancel PID control (***KP/PID***) 21: Switch normal/inverse operation (***IVS***) 22: Interlock (52-2) (***IL***) 23: Enable data change via communications link (***WE-LK***) 24: Enable communications link (***LE***) 25: Universal DI (***U-DI***) 26: Enable auto search for idling motor speed at starting (***STM***) 27: Synchronous operation command (***SYC***) 28: Lock at zero speed (***LOCK***) 29: Pre-excitation (***EXITE***) 30: Cancel speed limiter (***N-LIM***) 31: Cancel H41 (Torque command) (***H41-CCL***) 32: Cancel H42 (Torque current command) (***H42-CCL***) 33: Cancel H43 (Magnetic flux command) (***H43-CCL***) 34: Cancel F40 (Torque limiter mode 1) (***F40-CCL***) 35: Select torque limiter level 2/1 (***TL2/TL1***) 36: Bypass ACC/DEC processor (***BPS***) 37, 38: Select torque bias command 1/2 (37: ***TB1***, 38: ***TB2***) 39: Select droop control (***DROOP***) 40: Zero-hold Ai1 (***ZH-AI1***) 41: Zero-hold Ai2 (***ZH-AI2***) 42: Zero-hold Ai3 (***ZH-AI3***) 43: Zero-hold Ai4 (***ZH-AI4***) 44: Reverse Ai1 polarity (***REV-AI1***) 45: Reverse Ai2 polarity (***REV-AI2***) 46: Reverse Ai3 polarity (***REV-AI3***) 47: Reverse Ai4 polarity (***REV-AI4***) 48: Inverse PID output (***PID-INV***) 49: Cancel PG alarm (***PG-CCL***) 50: Cancel undervoltage alarm (***LU-CCL***) 51: Hold Ai torque bias (***H-TB***) 52: STOP1 (Decelerate to stop with normal deceleration time) (***STOP1***) 53: STOP2 (Decelerate to stop with deceleration time 4) (***STOP2***) 54: STOP3 (Decelerate to stop with max. braking torque) (***STOP3***) 55: Latch DIA data (***DIA***) 56: Latch DIB data (***DIB***) 57: Cancel multiplex system (***MT-CCL***) 58-67: Custom Di1-Di10 (***C-DI1*** to ***C-DI10***) 68: Select load adaptive parameters 2/1 (***AN-P1/2***) *1 69: Cancel PID components (***PID-CCL***) 70: Enable PID FF component (***PID-FF***) 71: Reset completion of speed limit calculation (***NL-RST***) *1 72: Toggle signal 1 (***TGL1***) 73: Toggle signal 2 (***TGL2***) 74: Cause external mock alarm (***FTB***) 75: Cancel NTC thermistor alarm (***NTC-CCL***) 76: Cancel lifetime alarm signal (***LF-CCL***) 77: Request for reading in serial PG absolute position (***SPG-AP***) *1 78: Switch PID feedback signals (***PID-1/2***) 79: Select PID torque bias (***TB-PID***) 80: Tune magnetic position (***MP-TUN***) *1 81: External electrical conditions (***RD***) *1 82: Startup conditions (***STRD***) *1 83: Continue to run at the time of communications link error (***LK-D***) *1
	[X2]	Digital input 2	
	[X3]	Digital input 3	
	[X4]	Digital input 4	
	[X5]	Digital input 5	
	[X6]	Digital input 6	
	[X7]	Digital input 7	
	[X8]	Digital input 8	
	[X9]	Digital input 9	
	[PLC]	PLC signal power	Connect the PLC output signal power supply. This terminal also supplies power to the load connected to the transistor output terminals. +24 V (22 to 27 V), 100 mA max.
	[CM]	Digital input common	Common terminal for digital input signals.

*1 Available soon

Classification	Symbol	Name	Functions
Digital input (Safety function)	[EN1], [EN2]	Safety function input terminals	Opening the circuit between [EN1] and [PS] or [EN2] and [PS] turns off the switching element of the inverter main circuit, shutting down output. (during authentication)
	[PS]		

Analog Output Terminals and Transistor Output Terminals

Classification	Symbol	Name	Functions
Analog output	[Ao1]	Analog output 1	Selectable from the following functions to assign. Possible to output monitor signals of 0 to ±10 VDC. 0: Detected speed (Speedometer, one-way deflection) (***N-FB1+***) 1: Detected speed (Speedometer, two-way deflection) (***N-FB1±***) 2: Speed setting 2 (Before acceleration/deceleration calculation) (***N-REF2***) 3: Speed setting 4 (ASR input) (***N-REF4***) 4: Detected speed (***N-FB2±***) 5: Detected line speed (***LINE-N±***) 6: Torque current command (Torque ammeter, two-way deflection) (***IT-REF±***) 7: Torque current command (Torque ammeter, one-way deflection) (***IT-REF+***) 8: Torque command (Torque meter, two-way deflection) (***T-REF±***) 9: Torque command (Torque meter, one-way deflection) (***T-REF+***) 10: Motor current rms value (***I-AC***) 11: Motor voltage rms value (***V-AC***) 12: Input power (***PWR***) 13: DC link circuit voltage (***V-DC***) 14: +10V output test (***P10***) 15: -10V output test (***N10***) 30: Universal AO (***U-AO***) 31-37: Custom Ao1 to Ao7 (***C-AO1*** to ***C-AO7***) 38: Input power (***PWR-IN***) 39: Magnetic pole position signal (***SMP***) 40: PID output value (***PID-OUT***)
	[Ao2]	Analog output 2	
	[Ao3]	Analog output 3	
	[M]	Analog output common	Common terminal for analog output signals.
Transistor output	[Y1]	Transistor output 1	Possible to output a signal selected from the following functions. 0: Inverter running (***RUN***) 1: Speed existence (***N-EX***) 2: Speed agreement (***N-AG1***) 3: Speed arrival signal (***N-AR***) 4, 5, 6: Detected speed 1/2/3 (4: ***N-DT1*** 5: ***N-DT2*** 6: ***N-DT3***) 7: Undervoltage detected (Inverter stopped) (***LU***) 8: Torque polarity detected (***B/D***) 9: Torque limiting (***TL***) 10, 11: Detected torque 1/2 (10: ***T-DT1***, 11: ***T-DT2***) 12: Keypad operation enabled (***KP***) 13: Inverter stopped (***STOP***) 14: Inverter ready to run (***RDY***) 15: Magnetic-flux detected (***MF-DT***) 16: Motor M2 selected (***SW-M2***) 17: Motor M3 selected (***SW-M3***) 18: Brake release signal (***BRK***) 19: Alarm content 1 (***AL1***) 20: Alarm content 2 (***AL2***) 21: Alarm content 3 (***AL4***) 22: Alarm content 4 (***AL8***) 23: Cooling fan in operation (***FAN***) 24: Resetting (***TRY***) 25: Universal DO (***U-DO***) 26: Heat sink overheat early warning (***INV-OH***) 27: Synchronization completion signal (***SY-C***) 28: Lifetime alarm (***LIFE***) 29: Under acceleration (***U-ACC***) 30: Under deceleration (***U-DEC***) 31: Inverter overload early warring (***INV-OL***) 32: Motor overheat early warring (***M-OH***) 33: Motor overload early warring (***M-OL***) 34: DB overload early warring (***DB-OL***) 35: Link transmission error (***LK-ERR***) 36: In limiting under load adaptive control (***ANL***) 37: In calculation under load adaptive control (***ANC***) 38: Analog torque bias being held (***TBH***) 39-48: Custom Do1-Do10 (***C-DO1*** to ***C-DO10***) 50: Z-phase detection completed (***Z-RDY***) *1 51: Multiplex system communications link being established (***MTS***) 52: Answerback to cancellation of multiplex system (***MEC-AB***) 53: Multiplex system master selected (***MSS***) 54: Multiplex system local station failure (***AL-SF***) 55: Stopped due to communications link error (***LES***) *1 56: Alarm output (for any alarm) (***ALM***) 57: Light alarm (***L-ALM***) 58: Maintenance timer (***MNT***) 59: Braking transistor broken (***DBAL***) 60: DC fan locked (***DCFL***)
	[Y2]	Transistor output 2	
	[Y3]	Transistor output 3	
	[Y4]	Transistor output 4	

*1 Available soon

Classification	Symbol	Name	Functions
Transistor output	[Y4]	Transistor output 4	61: Speed agreement 2 (***N-AG2***) 62: Speed agreement 3 (***N-AG3***) 63: Axial fan stopped (***MFAN***) 64: Answerback to toggle signal 1 (***TGL1-AB***) 65: Answerback to toggle signal 2 (***TGL2-AB***) 66: Answerback to droop control enabled (***DSAB***) 67: Answerback to cancellation of torque command/torque current command (***TCL-C)*** 68: Answerback to cancellation of torque limiter mode 1 (***F40-AB***) 71: 73 ON command (***PRT-73***) 72: Turn ON Y-terminal test output (***Y-ON***) 73: Turn OFF Y-terminal test output (***Y-OFF***) 74: Reading absolute position of serial PG in progress (***SPG-RD***) *1 75: System clock battery lifetime expired (***BATT***) 76: Magnetic position tuning in progress (***TUN-MG***) *1 77: SPGT battery warning (***SPGT-B***) *1 78: Electrical conditions ready (***ERD***) *1 79: IT detected in operation (***TCA***) *1 80: EN terminal detection circuit failure (***DECF***) *1 81: EN terminal OFF (***ENOFF***) *1 82: Safety function in progress (***SF-RUN***) *1 83: Motor stopped by safety function (***SF-STP***) *1 84: STO under testing by safety function (***SF-TST***) *1
	[CMY]	Transistor output common	Common terminal for transistor output signals.
Relay output	[Y5A], [Y5C]	Relay output	Same signals as listed in [Y1] to [Y4] are selectable.
	[30A], [30B], [30C]	Alarm relay output	Outputs a no-voltage contact signal (1C) when the protective function has been activated to stop the motor. Switchable whether excitation or non-excitation outputs an alarm.
Communication	[DX+], [DX-]	RS-485 communication input/output	Input/output terminals for RS-485 communication. Multi-drop connection enables up to 31 inverters to connect to one host equipment. Half-duplex mode.
	USB connector	USB port	Accessible from the front of the inverter. USB connector: mini B, USB 2.0 Full Speed
Speed detection	[PA], [PB]	Pulse generator 2-phase signal input	Connection of 2-phase signals sent from a pulse generator.
	[PGP], [PGM]	Pulse generator power supply	Power supply (+15 VDC, switchable to +12 VDC) to a PG.
	[FA], [FB]	Pulse generator output	Outputs frequency-divided (programmable with Function code E29), pulse generator signals. Switchable between open collector and complementary (equivalent to the voltage on the [PGP] terminal) transistor outputs.
	[CM]	Pulse generator output common	A common terminal for [FA] and [FB].
Temperature detection	[TH1], [THC]	NTC/PTC thermistor connection	Monitor of the motor temperature with NTC or PTC thermistor. For a PTC thermistor, the motor overheat protection level can be specified with Function code E32.

*1 Available soon

Chapter 3
PREPARATION AND TEST RUN

This chapter describes the operating and storage environments, installation and wiring, typical connection diagram, names and functions of keypad components, keypad operation, and test run procedure.

Contents

3.1 Before Use

3.1.1 Acceptance inspection (Nameplates and type of inverter)

Unpack the package and check the following:

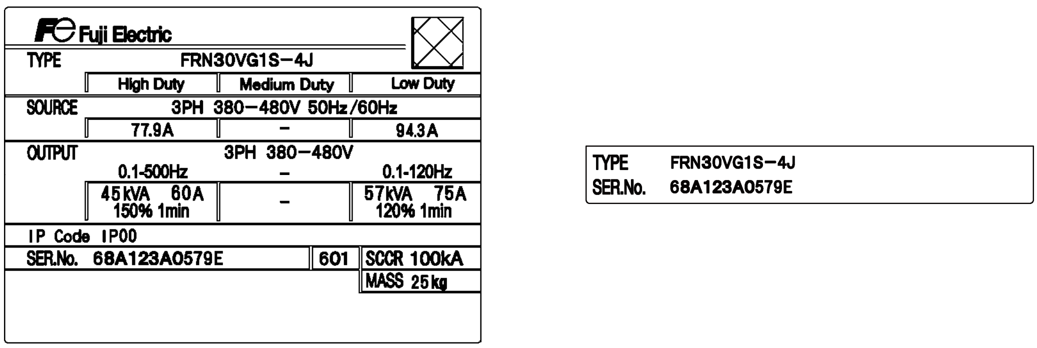
(1) An inverter and the following accessories are contained.

Accessories - DC reactor (DCR)
(for inverters of 75 kW or above and LD-mode inverters of 55 kW)

- Instruction manual
- CD-ROM (containing the FRENIC-VG User's Manual, FRENIC-VG Loader software (free version), and FRENIC-VG Loader Instruction Manual)

(2) The inverter has not been damaged during transportation—there should be no dents or parts missing.

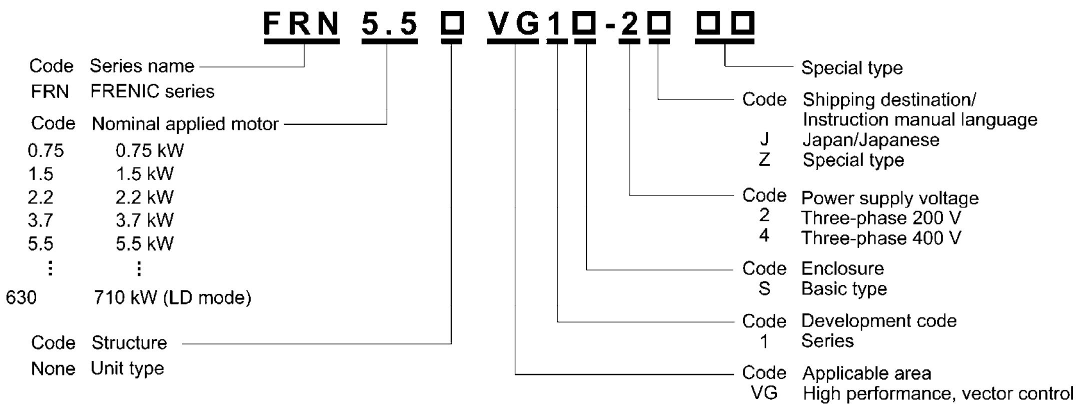
(3) The inverter is the type you ordered. You can check the type and specifications on the main and sub nameplates. (The main and sub nameplates are attached to the inverter as shown in Figure 3.1-2.) For inverters of 30 kW or above, the mass is printed on the main nameplate.



(a) Main Nameplate (b) Sub Nameplate

Figure 3.1-1 Nameplates

TYPE: Type of inverter



Note In this manual, inverter types are denoted as "FRN_ _ _VG1□-2□/4□."

The FRENIC-VG is available in two or three drive modes depending upon the inverter capacity: High Duty (HD) and Low Duty (LD) modes or High Duty (HD), Medium Duty (MD) and Low Duty (LD) modes. One of these modes should be selected to match the load property of your system. Specifications in each mode are printed on the main nameplate.

High Duty: HD mode designed for heavy duty load applications.
Overload capability: 150% for 1 min, 200% for 3 s. Continuous ratings = Inverter ratings

Medium Duty: MD mode designed for medium duty load applications.
Overload capability: 150% for 1 min. Continuous ratings = One rank higher capacity of inverters

Low Duty: LD mode designed for light duty load applications.
Overload capability: 120% for 1 min. Continuous ratings = One rank or two ranks higher capacity of inverters

SOURCE: Number of input phases (three-phase: 3PH), input voltage, input frequency, input current

OUTPUT: Number of output phases, rated output voltage, output frequency range, rated output capacity, rated output current, and overload capability

SCCR: Short-circuit capacity

MASS: Mass of the inverter in kilogram (for 30 kW or above)

SER. No.: Product number

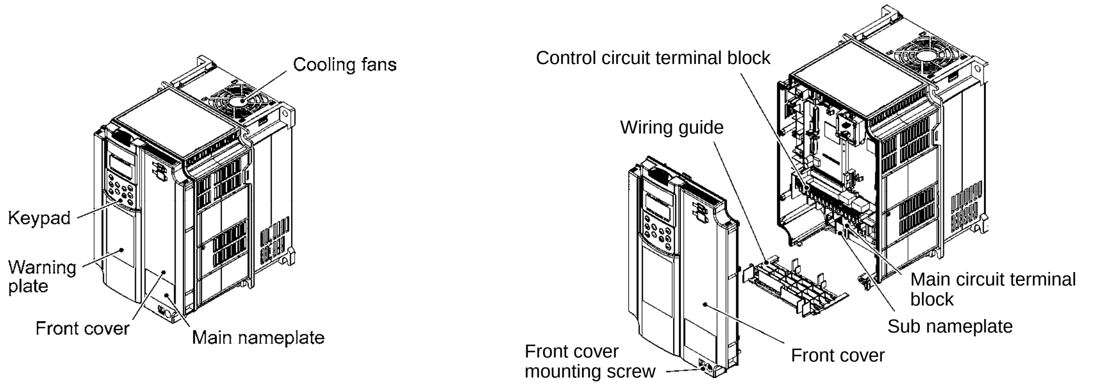
2 8 A 1 2 3 A 0 5 7 9 E

- Serial number of production lot
- Production month
  1 to 9: January to September
  X, Y, or Z: October, November, or December
- Production year: Last digit of year

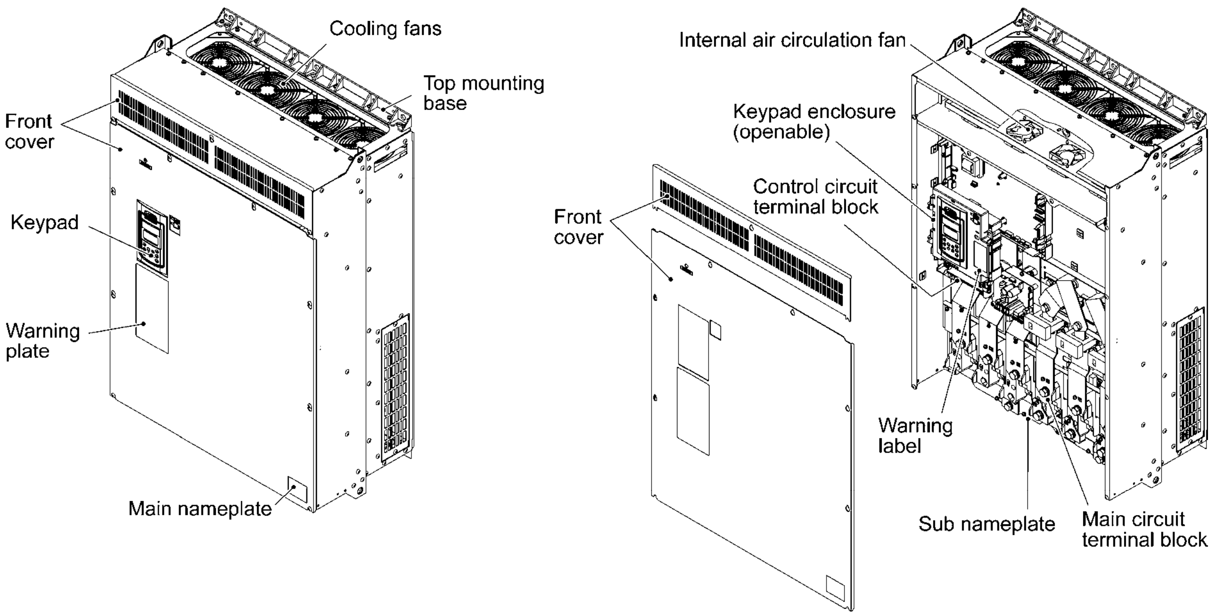
If you suspect the product is not working properly or if you have any questions about your product, contact your Fuji Electric representative.

3.1.2 External view and terminal blocks

(1) Outside and inside views



(a) FRN7.5VG1□-2□



(b) FRN220VG1□-4□

Figure 3.1-2 Outside and Inside Views of Inverters

(2) Warning plates and label

(a) FRN7.5VG1□-2□

(b) FRN220VG1□-4□

Figure 3.1-3 Warning Plates and Label

3.2 Precautions for Using Inverters

This section provides precautions in introducing inverters, e.g. precautions for installation environment, power supply lines, wiring, and connection to peripheral equipment. Be sure to observe those precautions.

3.2.1 Installation environment

Install the inverter in an environment that satisfies the requirements listed in Chapter 2, Section 2.2 "Common Specifications."

Fuji Electric strongly recommends installing inverters in a panel for safety reasons, in particular, when installing the ones whose enclosure rating is IP00.

When installing the inverter in a place out of the specified environmental requirements, it is necessary to derate the inverter or consider the panel engineering design suitable for the special environment or the panel installation location. For details, refer to the Fuji Electric technical information "Engineering Design of Panels" or consult your Fuji Electric representative.

The special environments listed below require using the specially designed panel or considering the panel installation location.

Environments	Possible problems	Sample measures	Applications
Highly concentrated sulfidizing gas or other corrosive gases	Corrosive gases cause parts inside the inverter to corrode, resulting in an inverter malfunction.	Any of the following measures may be necessary. - Mount the inverter in a sealed panel with IP6X or air-purge mechanism. - Place the panel in a room free from influence of the gases.	Paper manufacturing, sewage disposal, sludge treatment, tire manufacturing, gypsum manufacturing, metal processing, and a particular process in textile factories.
A lot of conductive dust or foreign material (e.g., metal powders or shavings, carbon fibers, or carbon dust)	Entry of conductive dust into the inverter causes a short circuit.	Any of the following measures may be necessary. - Mount the inverter in a sealed panel. - Place the panel in a room free from influence of the conductive dust.	Wiredrawing machines, metal processing, extruding machines, printing presses, combustors, and industrial waste treatment.
A lot of fibrous or paper dust	Fibrous or paper dust accumulated on the heat sink lowers the cooing effect. Entry of dust into the inverter causes the electronic circuitry to malfunction.	Any of the following measures may be necessary. - Mount the inverter in a sealed panel that shuts out dust. - Ensure a maintenance space for periodical cleaning of the heat sink in panel engineering design. - Employ external cooling when mounting the inverter in a panel for easy maintenance and perform periodical maintenance.	Textile manufacturing and paper manufacturing.
High humidity or dew condensation	In an environment where a humidifier is used or where the air conditioner is not equipped with a dehumidifier, high humidity or dew condensation results, which causes a short-circuiting or malfunction of electronic circuitry inside the inverter.	- Put a heating module such as a space heater in the panel.	Outdoor installation. Film manufacturing line, pumps and food processing.
Vibration or shock exceeding the specified level	If a large vibration or shock exceeding the specified level is applied to the inverter, for example, due to a carrier running on seam joints of rails or blasting at a construction site, the inverter structure gets damaged.	- Insert shock-absorbing materials between the mounting base of the inverter and the panel for safe mounting.	Installation of an inverter panel on a carrier or self-propelled machine. Ventilating fan at a construction site or a press machine.
Fumigation for export packaging	Halogen compounds such as methyl bromide used in fumigation corrodes some parts inside the inverter.	- When exporting an inverter built in a panel or equipment, pack them in a previously fumigated wooden crate. - When packing an inverter alone for export, use a laminated veneer lumber (LVL).	Exporting.

3.2.2 Storage environment

The storage environment in which the inverter should be stored after purchase differs from the installation environment. Store the inverter in an environment that satisfies the requirements listed below.

[1] Temporary storage

Table 3.2-1 Storage and Transport Environments

Item	Specifications	
Storage temperature ***1**	-25 to +70°C	Places not subjected to abrupt temperature changes or condensation or freezing
Relative humidity	5 to 95% ***2**	
Atmosphere	The inverter must not be exposed to dust, direct sunlight, corrosive or flammable gases, oil mist, vapor, water drops or vibration. The atmosphere must contain only a low level of salt. (0.01 mg/cm^2 or less per year)	
Atmospheric pressure	86 to 106 kPa (during storage)	
	70 to 106 kPa (during transportation)	

***1** Assuming comparatively short time storage, e.g., during transportation or the like.

***2** Even if the humidity is within the specified requirements, avoid such places where the inverter will be subjected to sudden changes in temperature that will cause condensation to form.

<u>Precautions for temporary storage</u>

(1) Do not leave the inverter directly on the floor.

(2) If the environment does not satisfy the specified requirements listed in Table 3.2-1, wrap the inverter in an airtight vinyl sheet or the like for storage.

(3) If the inverter is to be stored in a high-humidity environment, put a drying agent (such as silica gel) in the airtight package described in (2) above.

[2] Long-term storage

The long-term storage method of the inverter varies largely according to the environment of the storage site. General storage methods are described below.

(1) The storage site must satisfy the requirements specified for temporary storage.

However, for storage exceeding three months, the surrounding temperature range should be within the range from -10 to 30°C. This is to prevent electrolytic capacitors in the inverter from deterioration.

(2) The package must be airtight to protect the inverter from moisture. Add a drying agent inside the package to maintain the relative humidity inside the package within 70%.

(3) If the inverter has been installed to the equipment or panel at construction sites where it may be subjected to humidity, dust or dirt, then temporarily remove the inverter and store it in the environment specified in Table 3.2-1.

<u>Precautions for storage over 1 year</u>

If the inverter has not been powered on for a long time, the property of the electrolytic capacitors may deteriorate. Power the inverters on once a year and keep the inverters powering on for 30 to 60 minutes. Do not connect the inverters to the load circuit (secondary side) or run the inverter.

3.2.3 Wiring precautions

(1) Route the wiring of the control circuit terminals as far from the wiring of the main circuit as possible. Otherwise electric noise may cause malfunctions.

(2) Fix the control circuit wires inside the inverter to keep them away from the live parts of the main circuit (such as the terminal block of the main circuit).

(3) If more than one motor is to be connected to a single inverter, the wiring length should be the sum of the length of the wires to the motors.

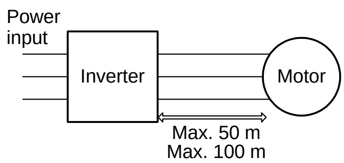
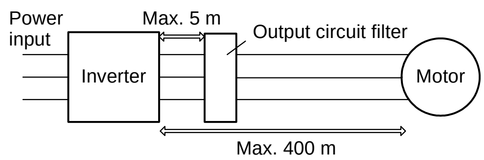
(4) Precautions for high frequency leakage currents

If the wiring distance between an inverter and a motor is long, high frequency currents flowing through stray capacitance across wires of phases may cause an inverter overheat, overcurrent trip, increase of leakage current, or it may not assure the accuracy in measuring leakage current. Depending on the operating condition, an excessive leakage current may damage the inverter.

To avoid the above problems when directly connecting an inverter to a motor, keep the wiring distance 50 m or less for inverters with a capacity of 3.7 kW or below, and 100 m or less for inverters with a higher capacity.

If the wiring distance longer than the specified above is required, lower the carrier frequency or insert an output circuit filter (OFL-□□□-□A) as shown below.

When a single inverter drives two or more motors connected in parallel (group drive), in particular, using shielded wires, the stray capacitance to the earth is large, so lower the carrier frequency or insert an output circuit filter (OFL-□□□-□A).

No output circuit filter installed	Output circuit filter installed
	

For an inverter with an output circuit filter installed, the total secondary wiring length should be 100 m or less (400 m or less under the V/f control).

If further longer secondary wiring is required, consult your Fuji Electric representative.

(5) Precautions for surge voltage in driving a motor by an inverter (especially for 400 V class motors)

If the motor is driven by a PWM-type inverter, surge voltage generated by switching the inverter component may be superimposed on the output voltage and may be applied to the motor terminals. Particularly if the wiring length is long, the surge voltage may deteriorate the insulation resistance of the motor. Implement any of the following measures.

- Use a motor with insulation that withstands the surge voltage. (All Fuji standard motors feature reinforced insulation.)
- Connect a surge suppressor unit (SSU50/100TA-NS) at the motor terminal.
- Connect an output circuit filter (OFL-□□□-□A) to the output terminals (secondary circuits) of the inverter.
- Minimize the wiring length between the inverter and motor (10 to 20 m or less).

(6) When an output circuit filter is inserted in the secondary circuit or the wiring between the inverter and the motor is long, a voltage loss occurs due to reactance of the filter or wiring so that the insufficient voltage may cause output current oscillation or a lack of motor output torque.

3.2.4 Precautions for connection of peripheral equipment

(1) Phase-advancing capacitors for power factor correction

Do not mount a phase-advancing capacitor for power factor correction in the inverter's input (primary) or output (secondary) circuit. Mounting it in the input (primary) circuit takes no effect. To correct the inverter power factor, use an optional DC reactor (DCR). Mounting it in the output (secondary) circuit causes an overcurrent trip, disabling operation.

An overvoltage trip that occurs when the inverter is stopped or running with a light load is assumed to be due to surge current generated by open/close of phase-advancing capacitors in the power system. An optional DC/AC reactor (DCR/ACR) is recommended as a measure to be taken at the inverter side.

Input current to an inverter contains a harmonic component that may affect other motors and phase-advancing capacitors on the same power supply line. If the harmonic component causes any problems, connect an optional DCR/ACR to the inverter. In some cases, it is necessary to insert a reactor in series with the phase-advancing capacitors.

(2) Power supply lines (Application of a DC/AC reactor)

Use an optional DC reactor (DCR) when the capacity of the power supply transformer is 500 kVA or more and is 10 times or more the inverter rated capacity or when there are thyristor-driven loads. If no DCR is used, the percentage-reactance of the power supply decreases, and harmonic components and their peak levels increase. These factors may break rectifiers or capacitors in the converter section of the inverter, or decrease the capacitance of the capacitors.

If the input voltage unbalance rate is 2% to 3%, use an optional DCR/ACR.

$$\text{Voltage unbalance (\%)} = \frac{\text{Max voltage (V)} - \text{Min voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67 \text{ (IEC 61800-3)}$$

(3) Optional DCR for correcting the inverter input power factor (for suppressing harmonics)

To correct the inverter input power factor (to suppress harmonics), use an optional DCR. Using a DCR increases the reactance of inverter’s power source so as to decrease harmonic components on the power source lines and correct the power factor of the inverter.

DCR models	Input power factor	Remarks
DCR2/4-□□/□□A/□□B	Approx. 90% to 95%	The last letter identifies the capacitance. These DCR models comply with "Standard Specifications for Public Building Construction" (Electric Equipment, 2010 version) supervised by the Ministry of Land, Infrastructure, Transport and Tourism. (The input power factor is 94% or above when the power factor of the fundamental harmonic is assumed as "1" according to the 2010 version.)
DCR2/4-□□C	Approx. 86% to 90%	Exclusively designed for nominal applied motor of 37 kW or above.

Note

- Select a DCR matching not the inverter capacity but the nominal applied motor capacity. Applicable reactor models differ depending upon the selected HD, MD, or LD mode even on the same type of inverters.
- Inverters of 75 kW or above and LD-mode inverters of 55 kW are provided together with a DCR as standard. Be sure to connect the DCR to the inverter.

(4) PWM converter for correcting the inverter input power factor

Using a PWM converter (High power-factor, regenerative PWM converter, RHC series) corrects the inverter power factor up to nearly "1." When combining an inverter with a PWM converter, disable the main power down detection by setting the function code H76 to "0" (default). If the main power down detection is enabled (H76 = 1), the inverter interprets the main power as being shut down, ignoring an entry of a run command.

(5) Molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB)

Install a recommended MCCB or RCD/ELCB (with overcurrent protection) in the primary circuit of the inverter to protect the wiring. Since using an MCCB or RCD/ELCB with a lager capacity than recommended ones breaks the protective coordination of the power supply system, be sure to select recommended ones. Also select ones with short-circuit breaking capacity suitable for the power source impedance.

Molded Case Circuit Breaker (MCCB) and
Residual-Current-Operated Protective Device (RCD)/Earth Leakage Circuit Breaker (ELCB)

<table>
<tr><th rowspan="2">Power supply voltage</th><th rowspan="2">Nominal applied motor (kW)</th><th rowspan="2">Inverter type</th><th rowspan="2">HD/MD/LD mode</th><th colspan="2">Rated current of MCCB and RCD/ELCB (A)</th></tr>
<tr><th>w/ DCR</th><th>w/o DCR</th></tr>
<tr><td rowspan="22">Three-phase 200 V</td><td>0.75</td><td>FRN0.75VG1□-2□</td><td>HD</td><td>5</td><td>10</td></tr>
<tr><td>1.5</td><td>FRN1.5VG1□-2□</td><td>HD</td><td rowspan="2">10</td><td>15</td></tr>
<tr><td>2.2</td><td>FRN2.2VG1□-2□</td><td>HD</td><td>20</td></tr>
<tr><td>3.7</td><td>FRN3.7VG1□-2□</td><td>HD</td><td>20</td><td>30</td></tr>
<tr><td>5.5</td><td>FRN5.5VG1□-2□</td><td>HD</td><td>30</td><td>50</td></tr>
<tr><td>7.5</td><td>FRN7.5VG1□-2□</td><td>HD</td><td>40</td><td>75</td></tr>
<tr><td>11</td><td>FRN11VG1□-2□</td><td>HD</td><td>50</td><td>100</td></tr>
<tr><td>15</td><td>FRN15VG1□-2□</td><td>HD</td><td>75</td><td>125</td></tr>
<tr><td>18.5</td><td>FRN18.5VG1□-2□</td><td>HD</td><td rowspan="2">100</td><td>150</td></tr>
<tr><td>22</td><td>FRN22VG1□-2□</td><td>HD</td><td>175</td></tr>
<tr><td>30</td><td rowspan="2">FRN30VG1□-2□</td><td>HD</td><td>150</td><td>200</td></tr>
<tr><td rowspan="2">37</td><td>LD</td><td rowspan="2">175</td><td rowspan="2">250</td></tr>
<tr><td rowspan="2">FRN37VG1□-2□</td><td>HD</td></tr>
<tr><td rowspan="2">45</td><td>LD</td><td rowspan="2">200</td><td rowspan="2">300</td></tr>
<tr><td rowspan="2">FRN45VG1□-2□</td><td>HD</td></tr>
<tr><td rowspan="2">55</td><td>LD</td><td rowspan="2">250</td><td rowspan="2">350</td></tr>
<tr><td rowspan="2">FRN55VG1□-2□</td><td>HD</td></tr>
<tr><td rowspan="2">75</td><td>LD</td><td rowspan="2">350</td><td rowspan="5">-</td></tr>
<tr><td rowspan="2">FRN75VG1□-2□</td><td>HD</td></tr>
<tr><td rowspan="2">90</td><td>LD</td><td rowspan="2">400</td></tr>
<tr><td rowspan="2">FRN90VG1□-2□</td><td>HD</td></tr>
<tr><td>110</td><td>LD</td><td>350</td></tr>
</table>

Molded Case Circuit Breaker (MCCB) and
Residual-Current-Operated Protective Device (RCD)/Earth Leakage Circuit Breaker (ELCB) (continued)

<table>
<tr><th rowspan="2">Power supply voltage</th><th rowspan="2">Nominal applied motor (kW)</th><th rowspan="2">Inverter type</th><th rowspan="2">HD/MD/LD mode</th><th colspan="2">Rated current of MCCB and RCD/ELCB (A)</th></tr>
<tr><th>w/ DCR</th><th>w/o DCR</th></tr>
<tr><td rowspan="46">Three-phase 400 V</td><td>3.7</td><td>FRN3.7VG1□-4□</td><td>HD</td><td>10</td><td>20</td></tr>
<tr><td>5.5</td><td>FRN5.5VG1□-4□</td><td>HD</td><td>15</td><td>30</td></tr>
<tr><td>7.5</td><td>FRN7.5VG1□-4□</td><td>HD</td><td>20</td><td>40</td></tr>
<tr><td>11</td><td>FRN11VG1□-4□</td><td>HD</td><td>30</td><td>50</td></tr>
<tr><td>15</td><td>FRN15VG1□-4□</td><td>HD</td><td rowspan="2">40</td><td>60</td></tr>
<tr><td>18.5</td><td>FRN18.5VG1□-4□</td><td>HD</td><td>75</td></tr>
<tr><td>22</td><td>FRN22VG1□-4□</td><td>HD</td><td>50</td><td>100</td></tr>
<tr><td>30</td><td rowspan="2">FRN30VG1□-4□</td><td>HD</td><td>75</td><td rowspan="3">125</td></tr>
<tr><td rowspan="2">37</td><td>LD</td><td rowspan="4">100</td></tr>
<tr><td rowspan="2">FRN37VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">45</td><td>LD</td><td rowspan="2">150</td></tr>
<tr><td rowspan="2">FRN45VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">55</td><td>LD</td><td rowspan="2">125</td><td rowspan="2">200</td></tr>
<tr><td rowspan="2">FRN55VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">75</td><td>LD</td><td rowspan="2">175</td><td rowspan="32">-</td></tr>
<tr><td rowspan="2">FRN75VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">90</td><td>LD</td><td rowspan="2">200</td></tr>
<tr><td rowspan="2">FRN90VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">110</td><td>MD/LD</td><td rowspan="2">250</td></tr>
<tr><td rowspan="2">FRN110VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">132</td><td>MD/LD</td><td rowspan="2">300</td></tr>
<tr><td rowspan="2">FRN132VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">160</td><td>MD/LD</td><td rowspan="2">350</td></tr>
<tr><td rowspan="2">FRN160VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">200</td><td>MD/LD</td><td rowspan="4">500</td></tr>
<tr><td rowspan="2">FRN200VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">220</td><td>MD/LD</td></tr>
<tr><td rowspan="3">FRN220VG1□-4□</td><td>HD</td></tr>
<tr><td>250</td><td>MD</td><td rowspan="3">600</td></tr>
<tr><td rowspan="2">280</td><td>LD</td></tr>
<tr><td rowspan="2">FRN280VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">315</td><td>MD</td><td rowspan="5">800</td></tr>
<tr><td>FRN315VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="3">355</td><td>FRN280VG1□-4□</td><td>LD</td></tr>
<tr><td>FRN315VG1□-4□</td><td>MD</td></tr>
<tr><td>FRN355VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="3">400</td><td>FRN315VG1□-4□</td><td>LD</td><td rowspan="7">1200</td></tr>
<tr><td>FRN355VG1□-4□</td><td>MD</td></tr>
<tr><td>FRN400VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">450</td><td>FRN355VG1□-4□</td><td>LD</td></tr>
<tr><td rowspan="2">FRN400VG1□-4□</td><td>MD</td></tr>
<tr><td rowspan="2">500</td><td>LD</td></tr>
<tr><td rowspan="2">FRN500VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">630</td><td>LD</td><td rowspan="2">1400</td></tr>
<tr><td rowspan="2">FRN630VG1□-4□</td><td>HD</td></tr>
<tr><td>710</td><td>LD</td><td>1600</td></tr>
</table>

⚠WARNING

If no zero-phase current (earth leakage current) detective device such as a ground-fault relay is installed in the upstream power supply line in order to avoid the entire power supply system's shutdown undesirable to factory operation, install a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) individually to inverters to break the individual inverter power supply lines only.

Otherwise, a fire could occur.

(6) Magnetic contactor (MC) in the inverter input (primary) circuit

Avoid frequent ON/OFF operation of the magnetic contactor (MC) in the input circuit; otherwise, the inverter failure may result. If frequent start/stop of the motor is required, use ***FWD***/***REV*** terminal signals or the FWD / REV / STOP keys on the inverter's keypad.

The frequency of the MC's ON/OFF should not be more than once per 30 minutes. To assure 10-year or longer service life of the inverter, it should not be more than once per hour.

Tip

- From the system's safety point of view, it is recommended to employ such a sequence that shuts down the magnetic contactor (MC) in the inverter input circuit with an alarm output signal ***ALM*** issued on inverter's programmable output terminals. The sequence minimizes the secondary damage even if the inverter breaks.

  When the sequence is employed, connecting the MC's primary power line to the inverter's auxiliary control power input makes it possible to monitor the inverter's alarm status on the keypad.

- The breakdown of a braking unit or misconnection of an external braking resistor may trigger that of the inverter's internal parts (e.g., charging resistor). To avoid such a breakdown linkage, introduce an MC and configure a sequence that shuts down the MC if a DC link voltage establishment signal is not issued within three seconds after the MC is switched on.

  For the braking transistor built-in type of inverters, assign a transistor error output signal ***DBAL*** on inverter's programmable output terminals to switch off the MC in the input circuit.

(7) Magnetic contactor (MC) in the inverter output (secondary) circuit

If a magnetic contactor (MC) is inserted in the inverter's output (secondary) circuit for switching the motor to a commercial power or for any other purposes, it should be switched on and off when both the inverter and motor are completely stopped. This prevents the contact point from getting rough due to a switching arc of the MC. The MC should not be equipped with any main circuit surge killer.

Applying a commercial power to the inverter's output circuit breaks the inverter. To avoid it, interlock the MC on the motor's commercial power line with the one in the inverter output circuit so that they are not switched ON at the same time.

(8) Surge absorber/surge killer

Do not install any surge absorber or surge killer in the inverter's output (secondary) lines.

3.2.5 Noise reduction

If noise generated from the inverter affects other devices, or that generated from peripheral equipment causes the inverter to malfunction, follow the basic measures outlined below.

(1) If noise generated from the inverter affects the other devices through power wires or grounding wires:

- Isolate the grounding terminals of the inverter from those of the other devices.
- Connect a noise filter to the inverter power wires.
- Isolate the power system of the other devices from that of the inverter with an insulated transformer.
- Decrease the inverter's carrier frequency (F26). (See **Note** below.)

(2) If induction or radio noise generated from the inverter affects other devices:

- Isolate the main circuit wires from the control circuit wires and other device wires.
- Put the main circuit wires through a metal conduit pipe, and connect the pipe to the ground near the inverter.
- Install the inverter into the metal panel and connect the whole panel to the ground.
- Connect a noise filter to the inverter's power wires.
- Decrease the inverter's carrier frequency (F26). (See **Note** below.)

(3) When implementing measures against noise generated from peripheral equipment:

- For inverter's control signal wires, use twisted or shielded-twisted wires. When using shielded-twisted wires, connect the shield of the shielded wires to the common terminals of the control circuit.
- Connect a surge absorber in parallel with magnetic contactor's coils or other solenoids (if any).

Note Running a permanent magnet synchronous motor (PMSM) at a low carrier frequency may heat the permanent magnet due to the output current harmonics, resulting in demagnetization. When decreasing the carrier frequency setting, be sure to check the allowable carrier frequency of the motor.

3.2.6 Leakage current

A high frequency current component generated by insulated gate bipolar transistors (IGBTs) switching on/off inside the inverter becomes leakage current through stray capacitance of inverter input and output wires or a motor. If any of the problems listed below occurs, take an appropriate measure against them.

Problem	Measures
An earth leakage circuit breaker* that is connected to the input (primary) side has tripped. *With overcurrent protection	1) Decrease the carrier frequency. (See **Note** given in Section 3.2.5 above.) 2) Make the wires between the inverter and motor shorter. 3) Use an earth leakage circuit breaker with lower sensitivity than the one currently used. 4) Use an earth leakage circuit breaker that features measures against the high frequency current component (Fuji SG and EG series).
An external thermal relay was falsely activated.	1) Decrease the carrier frequency. (See **Note** given in Section 3.2.5 above.) 2) Increase the current setting of the thermal relay. 3) Use the electronic thermal overload protection built in the inverter, instead of the external thermal relay.

3.2.7 Precautions in driving a permanent magnet synchronous motor (PMSM)

When using a PMSM, note the following.

- When using a PMSM other than the Fuji standard synchronous motor (GNF2), consult your Fuji Electric representative.
- A single inverter cannot drive two or more PMSMs.
- A PMSM cannot be driven by commercial power.

3.3 Mounting and Wiring the Inverter

3.3.1 Operating environment

Install the inverter in an environment that satisfies the requirements listed in Table 3.3-1.

Table 3.3-1 Environmental Requirements

<table>
<tr><th>Item</th><th colspan="4">Specifications</th></tr>
<tr><td>Site location</td><td colspan="4">Indoors</td></tr>
<tr><td>Surrounding temperature</td><td colspan="4">-10 to +50°C (Note 1)</td></tr>
<tr><td>Relative humidity</td><td colspan="4">5 to 95% (No condensation)</td></tr>
<tr><td>Atmosphere</td><td colspan="4">The inverter must not be exposed to dust, direct sunlight, corrosive gases, flammable gases, oil mist, vapor or water drops.
Pollution degree 2 (IEC60664-1) (Note 2)
The atmosphere can contain a small amount of salt. (0.01 mg/cm² or less per year)
The inverter must not be subjected to sudden changes in temperature that will cause condensation to form.</td></tr>
<tr><td>Altitude</td><td colspan="4">1,000 m max. (Note 3)</td></tr>
<tr><td>Atmospheric pressure</td><td colspan="4">86 to 106 kPa</td></tr>
<tr><td rowspan="2">Vibration</td><td colspan="2">55 kW or below (200 V class series)
75 kW or below (400 V class series)</td><td colspan="2">75 kW or above (200 V class series)
90 kW or above (400 V class series)</td></tr>
<tr><td>3 mm (Max. amplitude)
9.8 m/s²
2 m/s²
1 m/s²</td><td>2 to less than 9 Hz
9 to less than 20 Hz
20 to less than 55 Hz
55 to less than 200 Hz</td><td>3 mm (Max. amplitude)
2 m/s²
1 m/s²</td><td>2 to less than 9 Hz
9 to less than 55 Hz
55 to less than 200 Hz</td></tr>
</table>

(Note 1) When inverters are mounted side-by-side without any clearance between them (22 kW or below), the surrounding temperature should be within the range from -10 to +40°C.

(Note 2) Do not install the inverter in an environment where it may be exposed to lint, cotton waste or moist dust or dirt which will clog the heat sink of the inverter. If the inverter is to be used in such an environment, install it in a dustproof panel of your system.

(Note 3) If you use the inverter in an altitude above 1000 m, you should apply an output current derating factor as listed in Table 3.3-2.

Table 3.3-2 Output Current Derating Factor in Relation to Altitude

Altitude	Output current derating factor
1000 m or lower	1.00
1000 to 1500 m	0.97
1500 to 2000 m	0.95
2000 to 2500 m	0.91
2500 to 3000 m	0.88

3.3.2 Installing the Inverter

(1) Mounting base

Install the inverter on a base made of metal or other non-flammable material. Do not mount the inverter upside down or horizontally.

⚠WARNING
Install the inverter on a base made of metal or other non-flammable material. **Otherwise, a fire could occur.**

(2) Clearances

Ensure that the minimum clearances indicated in Figure 3.3-1 and Table 3.3-3 are maintained at all times. When mounting the inverter in the panel of your system, take extra care with ventilation inside the panel as the surrounding temperature easily rises. Do not mount the inverter in a small panel with poor ventilation.

Figure 3.3-1
Mounting Direction and
Required Clearances

■ When mounting two or more inverters

When mounting two or more inverters in the same unit or panel, basically lay them out side by side. When mounting them necessarily one above the other, be sure to separate them with a partition plate or the like so that any heat radiating from an inverter will not affect the one/s above.

As long as the surrounding temperature is 40°C or lower, inverters with a capacity of 22 kW or below can be mounted side by side without any clearance between them.

Table 3.3-3 Clearances (mm)

Inverter capacity	A	B	C
0.75 to 22 kW	20	100	0
30 to 220 kW	50		100
280 to 630 kW		150	150

C: Space required in front of the inverter unit

■ When employing external cooling

In external cooling, the heat sink, which dissipates about 70% of the total heat (total loss) generated into air, is situated outside the equipment or the panel. The external cooling, therefore, significantly reduces heat radiating inside the equipment or panel.

To employ external cooling for inverters with a capacity of 22 kW or below, use the mounting adapter for external cooling (option); for those with a capacity of 30 kW or above, simply change the positions of the mounting bases.

For the dimensional outline drawing of the mounting adapter (option), refer to Chapter 8, Section 8.5.8.

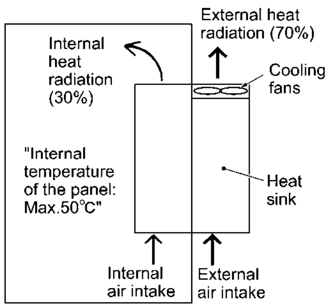


Figure 3.3-2 External Cooling

⚠CAUTION
Prevent lint, paper fibers, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter or from accumulating on the heat sink. **Otherwise, a fire or accident could occur.**

To utilize external cooling for inverters with a capacity of 30 kW or above, change the positions of the top and bottom mounting bases from the edge to the center of the inverter as shown below (Figure 3.3-3).

Screws differ in size and count for each inverter. Refer to the table below.

For the panel cutting size, refer to Chapter 2, Section 2.3 "External Dimensions."

Table 3.3-4 Screw Size, Count and Tightening Torque

Inverter type	Base fixing screw (Screw size and q'ty)	Case fixing screw (Screw size and q'ty)	Tightening torque (N·m)
FRN30VG1□-2□/FRN37VG1□-2□ FRN30VG1□-4□ to FRN55VG1□-4□	M6 × 20 5 pcs for upper side, 3 pcs for lower side	M6 × 20 2 pcs for upper side	5.8
FRN45VG1□-2□/FRN55VG1□-2□ FRN75VG1□-4□	M6 × 20 3 pcs each for upper and lower sides	M6 × 12 3 pcs for upper side	5.8
FRN75VG1□-2□ FRN90VG1□-4□/FRN110VG1□-4□	M5 ×12 7 pcs each for upper and lower sides	M5 × 12 7 pcs for upper side	3.5
FRN132VG1□-4□/FRN160VG1□-4□	M5 × 16 7 pcs each for upper and lower sides	M5 × 16 7 pcs for upper side	3.5
FRN90VG1□-2□ FRN200VG1□-4□/FRN220VG1□-4□	M5 × 16 8 pcs each for upper and lower sides	M5 × 16 8 pcs for upper side	3.5
FRN280VG1□-4□/FRN315VG1□-4□ FRN355VG1□-4□/FRN400VG1□-4□	M5 × 16 2 pcs each for upper and lower sides M6 × 20 6 pcs each for upper and lower sides	M5 × 16 2 pcs each for upper and lower sides M6 × 20 6 pcs each for upper and lower sides	3.5 5.8
FRN500VG1□-4□/FRN630VG1□-4□	M8 × 20 8 pcs each for upper and lower sides	M8 × 20 8 pcs each for upper and lower sides	13.5

1) Remove all of the base fixing screws and the case fixing screws from the top of the inverter.
2) Move the top mounting base to the center of the inverter and secure it to the case fixing screw holes with the base fixing screws. (After changing the position of the top mounting base, some screws may be left unused.)
3) Remove the base fixing screws from the bottom of the inverter, move the bottom mounting base to the center of the inverter, and secure it with the base fixing screws, just as in step 2). (Inverters with a capacity of 220 kW or below have no case fixing screws on the bottom.)

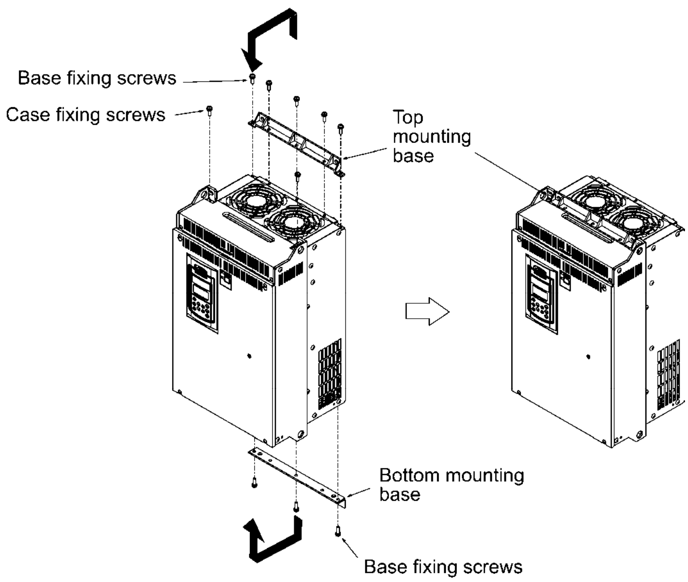


Figure 3.3-3 Changing the Positions of the Top and Bottom Mounting Bases

⚠CAUTION

When changing the positions of the top and bottom mounting bases, use only the specified screws.

Otherwise, a fire or accident could occur.

3.3.3 Wiring

Follow the procedure below. (In the following description, the inverter has already been installed.)

Note In tables given in this manual, inverter types are denoted as "FRN_ _ _VG1☐-2☐/4☐.

3.3.3.1 Removing and mounting the front cover and the wiring guide

⚠CAUTION
Be sure to disconnect the USB cable from the USB connector before removing the front cover. **Otherwise, a fire or accident could occur.**

(1) For inverters with a capacity of 22 kW or below

① First loosen the front cover fixing screw, hold the cover with both hands, slide it downward, tilt it toward you, and then pull it upward, as shown below.

② While pressing the wiring guide upward, pull it out toward you.

③ After carrying out wiring, put the wiring guide and the front cover back into place in the reverse order of removal.

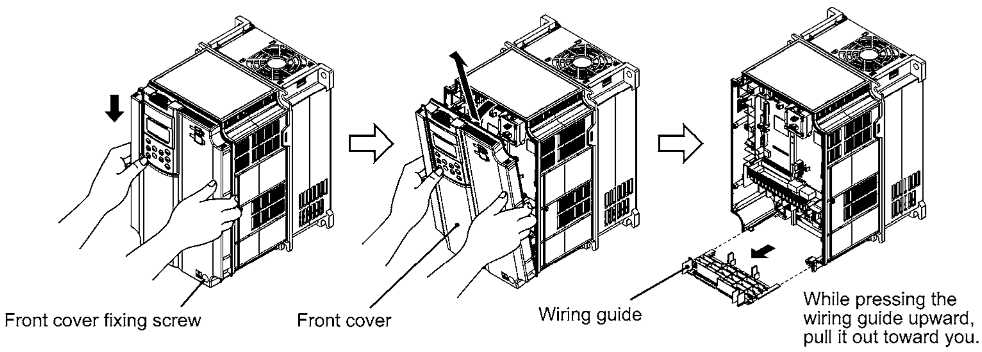


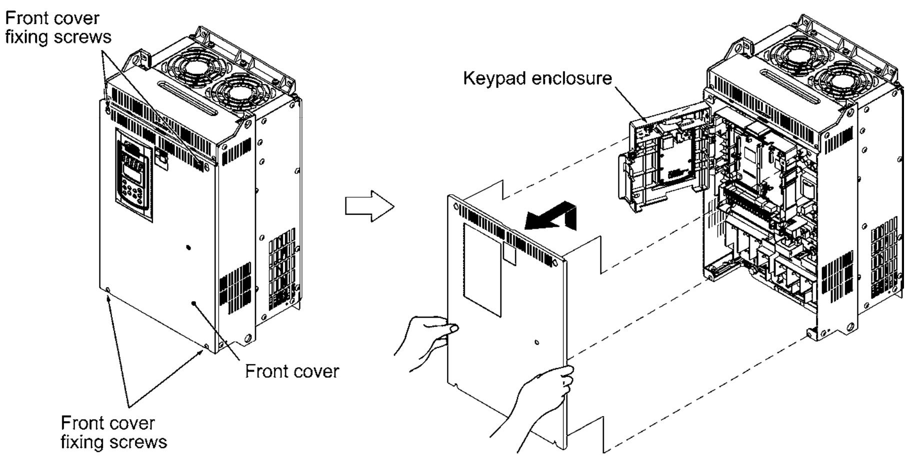
Figure 3.3-4 Removing the Front Cover and the Wiring Guide (FRN11VG1☐-2☐)

(2) For inverters with a capacity of 30 to 630 kW

① Loosen the four front cover fixing screws, hold the cover with both hands, slide it upward slightly, and pull it toward you, as shown below.

② After carrying out wiring, align the screw holes provided in the front cover with the screws on the inverter case, then put the front cover back into place in the reverse order of removal.

Tip To expose the control printed circuit board (control PCB), open the keypad enclosure.



Tightening torque: 1.8 N•m (M4)
3.5 N•m (M5)

Figure 3.3-5 Removing the Front Cover (FRN30VG1☐-2☐)

3.3.3.2 Screw specifications and recommended wire sizes

(1) Main circuit terminals

The tables and figures given below show the screw specifications and wire sizes. Note that the terminal arrangements differ depending on the inverter types. In each of the figures, two grounding terminals (⏚G) are not exclusive to the power supply wiring (primary circuit) or motor wiring (secondary circuit).

Use crimp terminals covered with an insulation sheath or with an insulation tube. The recommended wire sizes for the main circuits are examples of using a single HIV wire (for 75°C) at a surrounding temperature of 50°C.

Table 3.3-5 Screw Specifications

Inverter type		Refer to Section 3.3.3.3.	Screw specifications							
			Main circuit terminals		Grounding terminals		Auxiliary control power input terminals [R0, T0]		Auxiliary fan power input terminals [R1, T1]	
Three-phase 200 V	Three-phase 400 V		Screw size (Screw-driver size)	Tightening torque (N·m)	Screw size (Screw-driver size)	Tightening torque (N·m)	Screw size	Tightening torque (N·m)	Screw size	Tightening torque (N·m)
FRN0.75VG1□-2□	FRN0.75VG1□-4□	Figure A	M5 (No. 2)	3.5	M5 (No. 2)	3.5	M3.5	1.2	--	--
FRN1.5VG1□-2□	FRN1.5VG1□-4□									
FRN2.2VG1□-2□	FRN2.2VG1□-4□									
FRN3.7VG1□-2□	FRN3.7VG1□-4□									
FRN5.5VG1□-2□	FRN5.5VG1□-4□									
FRN7.5G1□-2□	FRN7.5VG1□-4□									
FRN11VG1□-2□	FRN11VG1□-4□	Figure B	M6 (No. 3)	5.8	M6 (No. 3)	5.8				
FRN15VG1□-2□	FRN15VG1□-4□									
FRN18.5VG1□-2□	FRN18.5VG1□4□									
FRN22VG1□-2□	FRN22VG1□-4□									
FRN30VG1□-2□	FRN30VG1□-4□	Figure C	M8	13.5	M8	13.5				
	FRN37VG1□-4□									
	FRN45VG1□-4□									
	FRN55VG1□-4□									
FRN37VG1□-2□	FRN75VG1□-4□	Figure D	M10	27					M3.5	1.2
FRN45VG1□-2□										
FRN55VG1□-2□										
--	FRN90VG1□-4□	Figure E								
--	FRN110VG1□-4□									
FRN75VG1□-2□	--	Figure F	M12	48	M10	27				
--	FRN132VG1□-4□	Figure G								
--	FRN160VG1□-4□									
FRN90VG1□-2□	FRN200VG1□-4□	Figure H								
	FRN220VG1□-4□									
--	FRN280VG1□-4□	Figure I								
--	FRN315VG1□-4□									
--	FRN355VG1□-4□	Figure J								
--	FRN400VG1□-4□									
--	FRN500VG1□-4□	Figure K								
--	FRN630VG1□-4□									

⚠WARNING⚠

When the inverter power is ON, a high voltage is applied to the following terminals.

Main circuit terminals: L1/R, L2/S, L3/T, P1, P(+), N(-), DB, U, V, W, R0, T0, R1, T1, AUX-contact (30A, 30B, 30C, Y5A, Y5C)

Insulation level

Main circuit — Enclosure : Basic insulation (Overvoltage category III, Pollution degree 2)
Main circuit — Control circuit : Reinforced insulation (Overvoltage category III, Pollution degree 2)
Relay output — Control circuit : Reinforced insulation (Overvoltage category II, Pollution degree 2)

An electric shock may occur.

Table 3.3-6 Recommended Wire Sizes

Power supply voltage	Nominal applied motor (kW)	Inverter type			Recommended wire size (mm^2)				
					Main circuit power input (L1/R, L2/S, L3/T)		Grounding [⏚G]	Inverter output [U, V, W]	DCR [P1, P(+)]
		HD mode	LD mode	MD mode	w/ DCR	w/o DCR			
Three-phase 200 V	0.75	FRN0.75VG1□-2□	--	--	2.0	2.0	2.0	2.0	2.0
	1.5	FRN1.5VG1□-2□	--	--					
	2.2	FRN2.2VG1□-2□	--	--					
	3.7	FRN3.7VG1□-2□	--	--					
	5.5	FRN5.5VG1□-2□	--	--		3.5	3.5	3.5	3.5
	7.5	FRN7.5VG1□-2□	--	--	3.5	5.5	5.5	5.5	5.5
	11	FRN11VG1□-2□	--	--	5.5	14		8.0	8.0
	15	FRN15VG1□-2□	--	--	14	22	8.0	14	14
	18.5	FRN18.5VG1□-2□	--	--					22
	22	FRN22VG1□-2□	--	--	22	38 ***1**	14	22	
	30	FRN30VG1□-2□	--	--	38	60		38	38
	37	FRN37VG1□-2□	FRN30VG1□-2□	--			22		60
	45	FRN45VG1□-2□	FRN37VG1□-2□	--	60	100		60	100
	55	FRN55VG1□-2□	FRN45VG1□-2□	--	100			100	
	75	FRN75VG1□-2□	FRN55VG1□-2□	--	150 ***2**	--		150 ***2**	150
	90	FRN90VG1□-2□	FRN75VG1□-2□	--	150			150	200
	110	--	FRN90VG1□-2□	--	200		38	200	250
Three-phase 400 V	3.7	FRN3.7VG1□-4□	--	--	2.0	2.0	2.0	2.0	2.0
	5.5	FRN5.5VG1□-4□	--	--					
	7.5	FRN7.5VG1□-4□	--	--			3.5		
	11	FRN11VG1□-4□	--	--		3.5		3.5	3.5
	15	FRN15VG1□-4□	--	--	3.5	5.5			5.5
	18.5	FRN18.5VG1□-4□	--	--	5.5	8.0 ***3**	5.5	5.5	
	22	FRN22VG1□-4□	--	--		14		8.0 ***3**	8.0 ***3**
	30	FRN30VG1□-4□	--	--	14	22	8.0	14	14
	37	FRN37VG1□-4□	FRN30VG1□-4□	--					22
	45	FRN45VG1□-4□	FRN37VG1□-4□	--	22	38		22	
	55	FRN55VG1□-4□	FRN45VG1□-4□	--			14	38	38
	75	FRN75VG1□-4□	FRN55VG1□-4□	--	38	--		60	60
	90	FRN90VG1□-4□	FRN75VG1□-4□	--	60				100
	110	FRN110VG1□-4□	FRN90VG1□-4□	FRN90VG1□-4□	100		22	100	
	132	FRN132VG1□-4□	FRN110VG1□-4□	FRN110VG1□-4□					150
	160	FRN160VG1□-4□	FRN132VG1□-4□	FRN132VG1□-4□	150			150	
	200	FRN200VG1□-4□	FRN160VG1□-4□	FRN160VG1□-4□			38	200	250
	220	FRN220VG1□-4□	FRN200VG1□-4□	FRN200VG1□-4□	200				
	250	--	--	FRN220VG1□-4□	250			250	325
	280	--	FRN220VG1□-4□	--				150x2	200x2
		FRN280VG1□-4□	--	--				325	
	315	FRN315VG1□-4□	--	FRN280VG1□-4□	150x2		60		
	355	FRN355VG1□-4□	FRN280VG1□-4□	FRN315VG1□-4□	200x2			200x2	250x2
	400	FRN400VG1□-4□	FRN315VG1□-4□	FRN355VG1□-4□			100	250x2	325x2
	450	--	FRN355VG1□-4□	FRN400VG1□-4□	250x2				
	500	FRN500VG1□-4□	FRN400VG1□-4□	--	325x2			325x2	325x3
	630	FRN630VG1□-4□	FRN500VG1□-4□	--	325x3			325x3	
	710	--	FRN630VG1□-4□	--	250x4			325x4	325x4

*1 Use the crimp terminal model No. 38-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*2 When using 150 mm^2 wires for main circuit terminals of FRN55VG1□-2□ (LD mode), use CB150-10 crimp terminals designed for low voltage appliances in JEM1399.

*3 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

Terminals common to all inverters	Recommended wire size (mm^2)	Remarks
Auxiliary control power input terminals R0 and T0	2.0	--
Auxiliary fan power input terminals R1 and T1	2.0	200 V class series with 37 kW or above and 400 V class series with 75 kW or above

(2) Control circuit terminals (common to all inverter types)

Table 3.3-7 lists the screw specifications and recommended wire size for wiring of the control circuit terminals. The control circuit terminals are common to all inverter types regardless of their capacities.

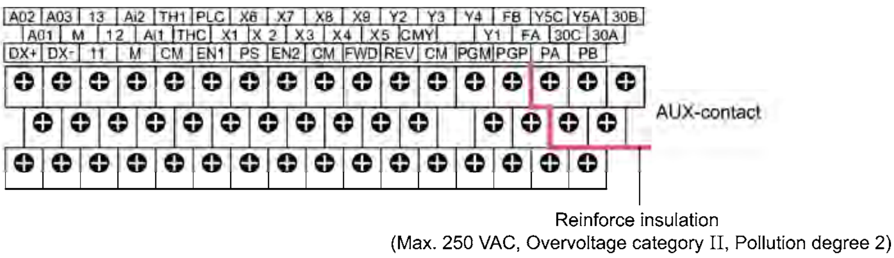
Table 3.3-7 Screw Specifications and Recommended Wire Size

Terminals common to all inverter types	Screw specifications		Recommended wire size (mm^2)
	Screw size	Tightening torque (N·m)	
Control circuit terminals	M3	0.7	1.25 *

* Using wires exceeding the recommended sizes may lift the front cover depending upon the number of wires used, impeding keypad's normal operation.

3.3.3.3 Arrangement of terminals

(1) Control circuit terminals (common to all inverter types)



(2) Main circuit terminals

Figure A

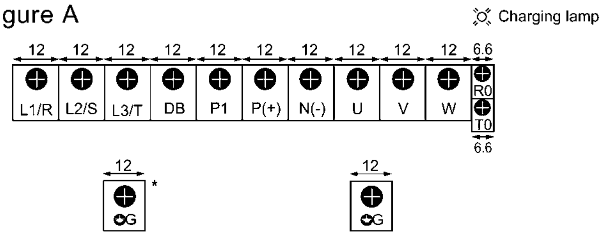


Figure B

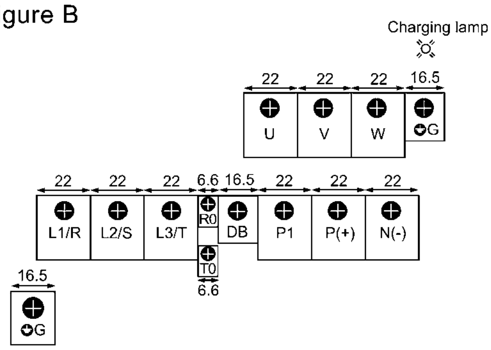


Figure C

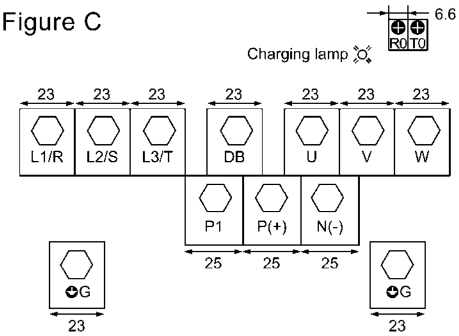


Figure D / Figure E

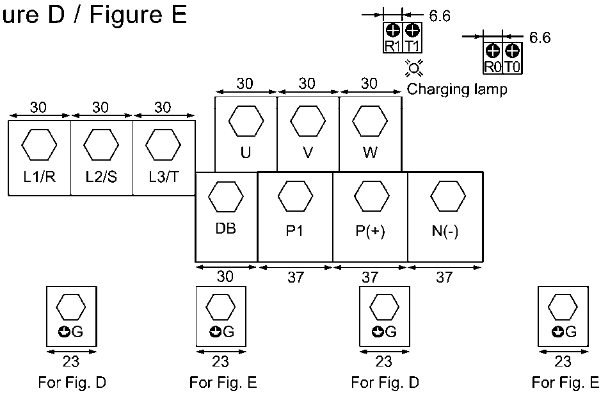


Figure F

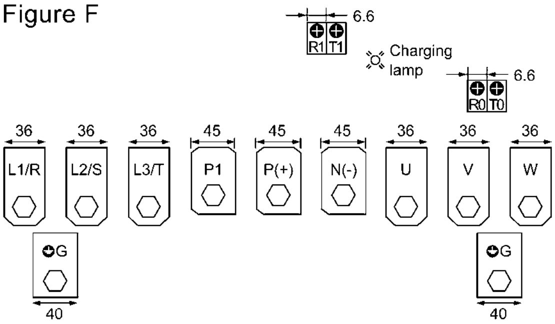


Figure G

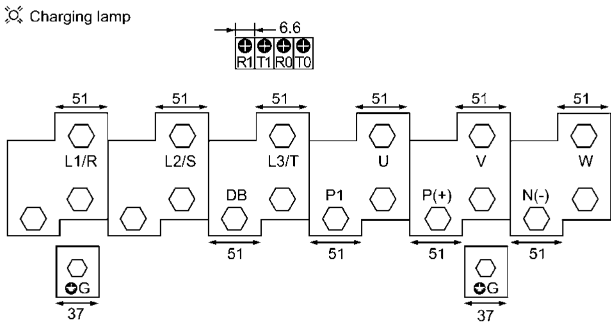


Figure H

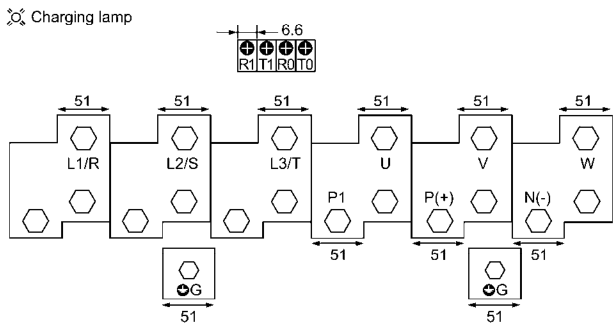


Figure I Charging lamp

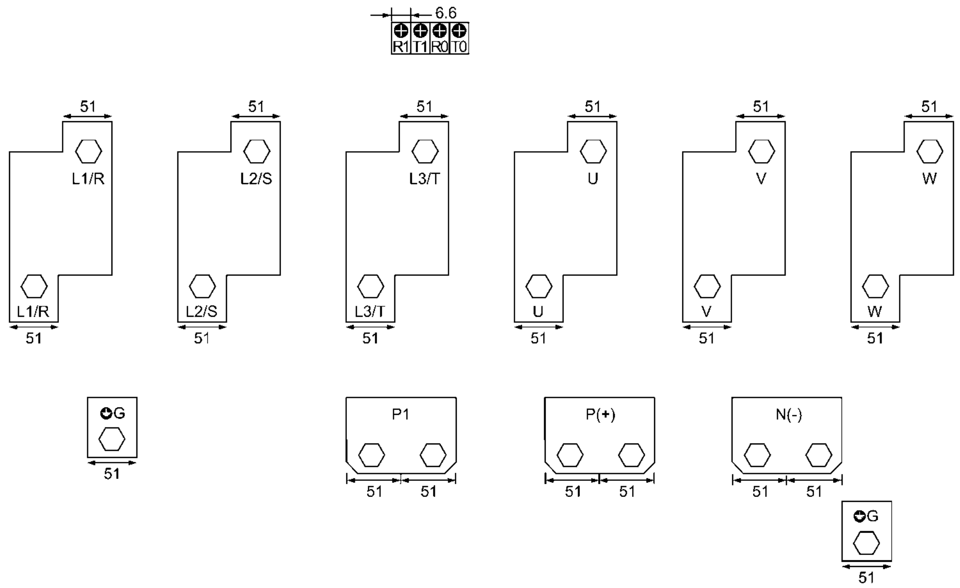


Figure J Charging lamp

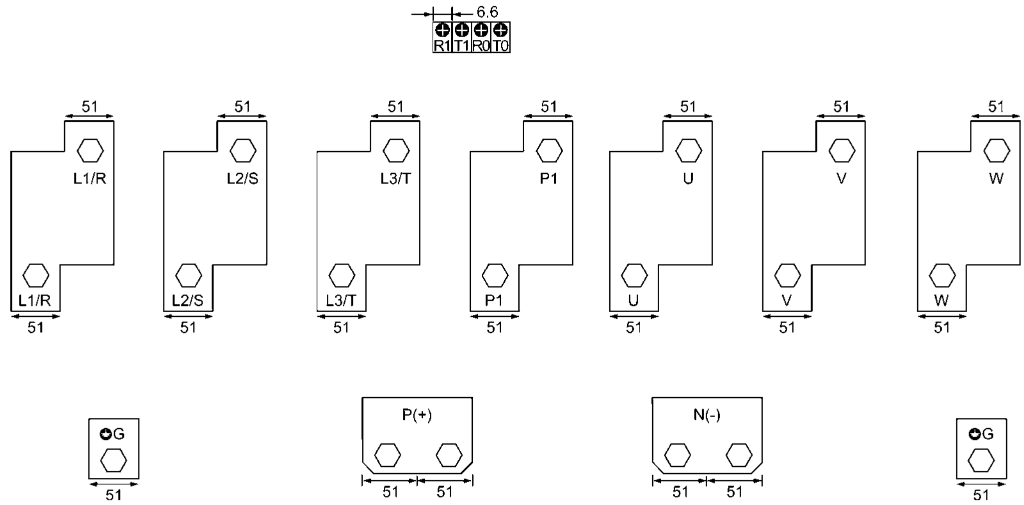
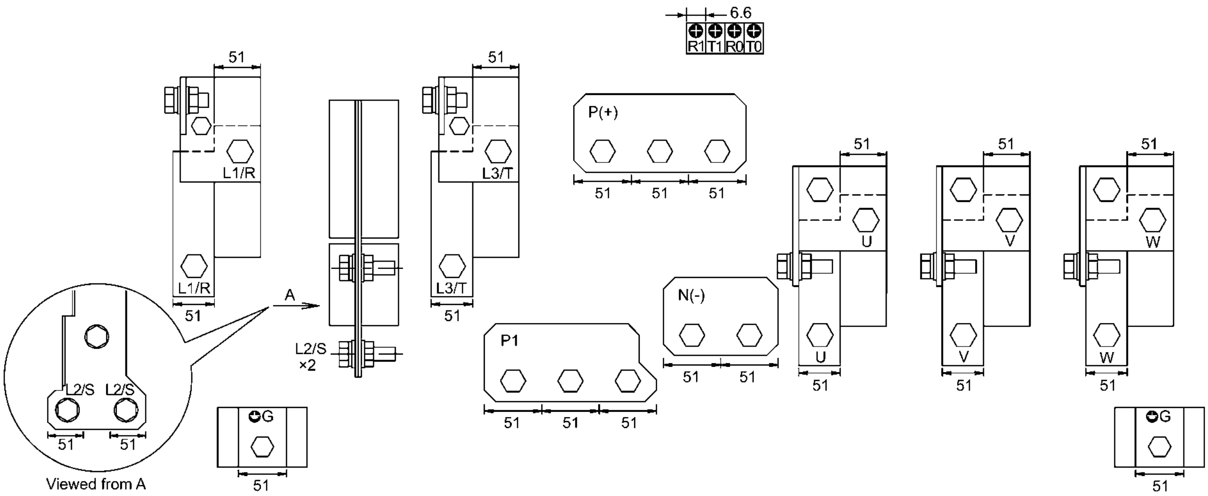


Figure K

Charging lamp



3.3.3.4 Wiring precautions

Follow the rules below when performing wiring for the inverter.

(1) Make sure that the source voltage is within the rated voltage range specified on the nameplate.

(2) Be sure to connect the three-phase power wires to the main circuit power input terminals L1/R, L2/S and L3/T of the inverter. If the power wires are connected to other terminals, the inverter will be damaged when the power is turned ON.

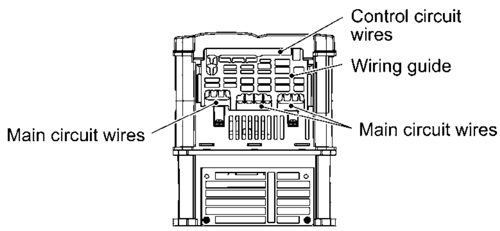
(3) Always connect the grounding terminal to prevent electric shock, fire or other disasters and to reduce electric noise.

(4) Use crimp terminals covered with insulated sleeves for the main circuit terminal wiring to ensure a reliable connection.

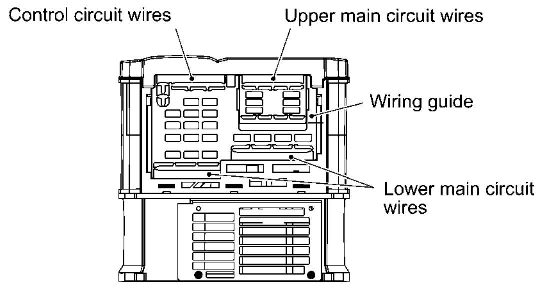
(5) Keep the power supply wiring (primary circuit) and motor wiring (secondary circuit) of the main circuit, and control circuit wiring as far away as possible from each other.

(6) After removing a screw from the main circuit terminal block, be sure to restore the screw even if no wire is connected.

(7) Use the wiring guide to separate wiring. For inverters with a capacity of 7.5 kW or below, the wiring guide separates the main circuit wires and the control circuit wires. For inverters with a capacity of 11 to 22 kW, it separates the upper and lower main circuit wires, and control circuit wires. Be careful about the wiring order.



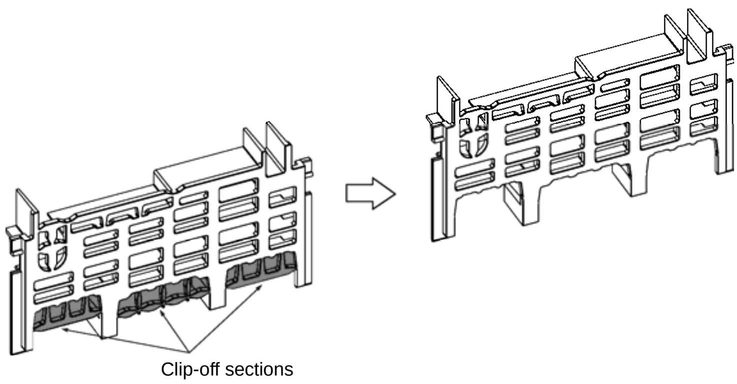
FRN7.5VG1☐-2☐



FRN22VG1☐-2☐

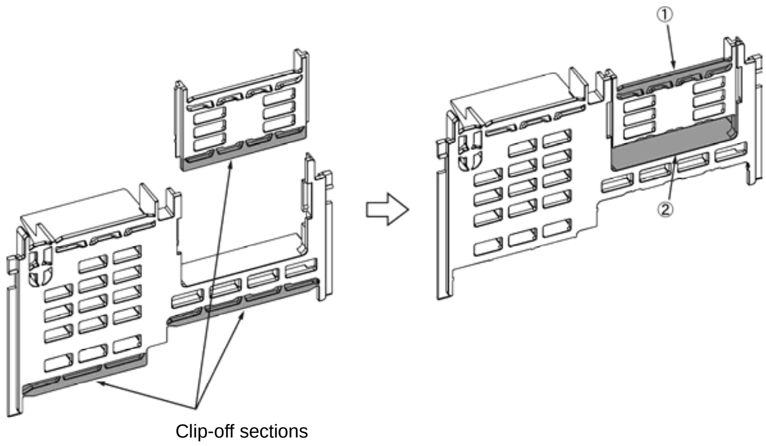
■ **Preparing for the wiring guide**

Inverters with a capacity of 22 kW or below are sometimes lacking in wiring space for main circuit wires depending upon the wire materials used. To assure a sufficient wiring space, remove the clip-off sections (see below) as required with a nipper. Note that the enclosure rating of IP20 is not ensured when the wiring guide itself is removed to secure a space for thick main circuit wiring.



Before removal of clip-off sections After removal of clip-off sections

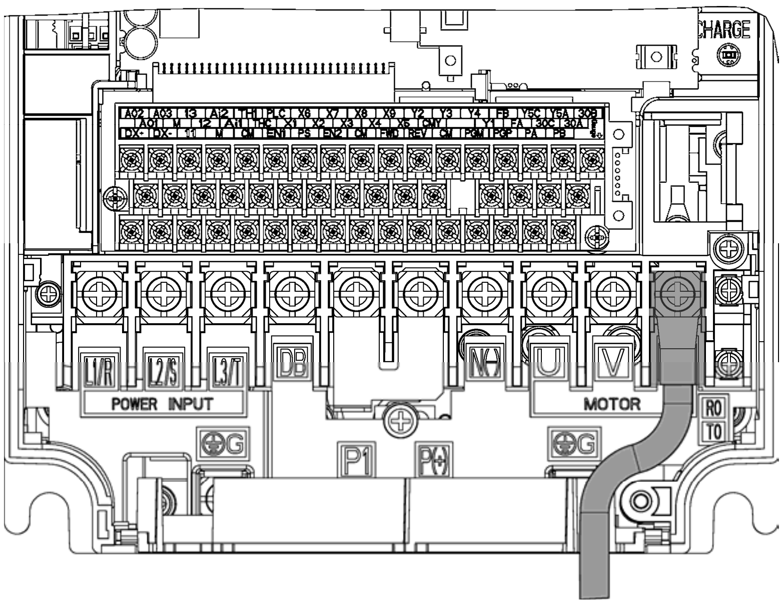
Wiring Guide (FRN7.5VG1☐-2☐)



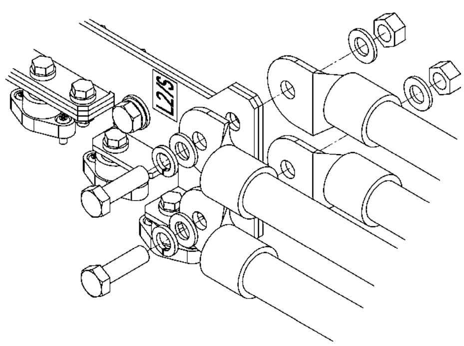
If the inverter output wire size is 22 mm², remove clip-off section ①; if it is 38 mm², remove clip-off section ② before wiring.

Wiring Guide (FRN22VG1□-2□)

(8) In some types of inverters, the wires from the main circuit terminal block cannot be straight routed. Route such wires as shown below so that the front cover is set into place.



(9) For inverters with a capacity of 500 kW or 630 kW, two L2/S input terminals are arranged vertically to the terminal block. When connecting wires to these terminals, use the bolts, washers and nuts that come with the inverter, as shown below.



⚠WARNING

- When wiring the inverter to the power source, insert a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) in the path of each pair of power lines to inverters. Use the recommended devices within the recommended current capacity.
- Be sure to use wires in the specified size.
- Tighten terminals with specified torque.

Otherwise, a fire could occur.

- When there is more than one combination of an inverter and motor, do not use a multicore cable for the purpose of handling their wirings together.
- Do not connect a surge killer to the inverter's output (secondary) circuit.

Doing so could cause a fire.

- Ground the inverter in compliance with the national or local electric code.
- Be sure to ground the inverter's grounding terminals ⏚G.

Otherwise, an electric shock or fire could occur.

- Qualified electricians should carry out wiring.
- Be sure to perform wiring after shutting down the power.

Otherwise, electric shock could occur.

- Be sure to perform wiring after installing the inverter unit.

Otherwise, electric shock or injuries could occur.

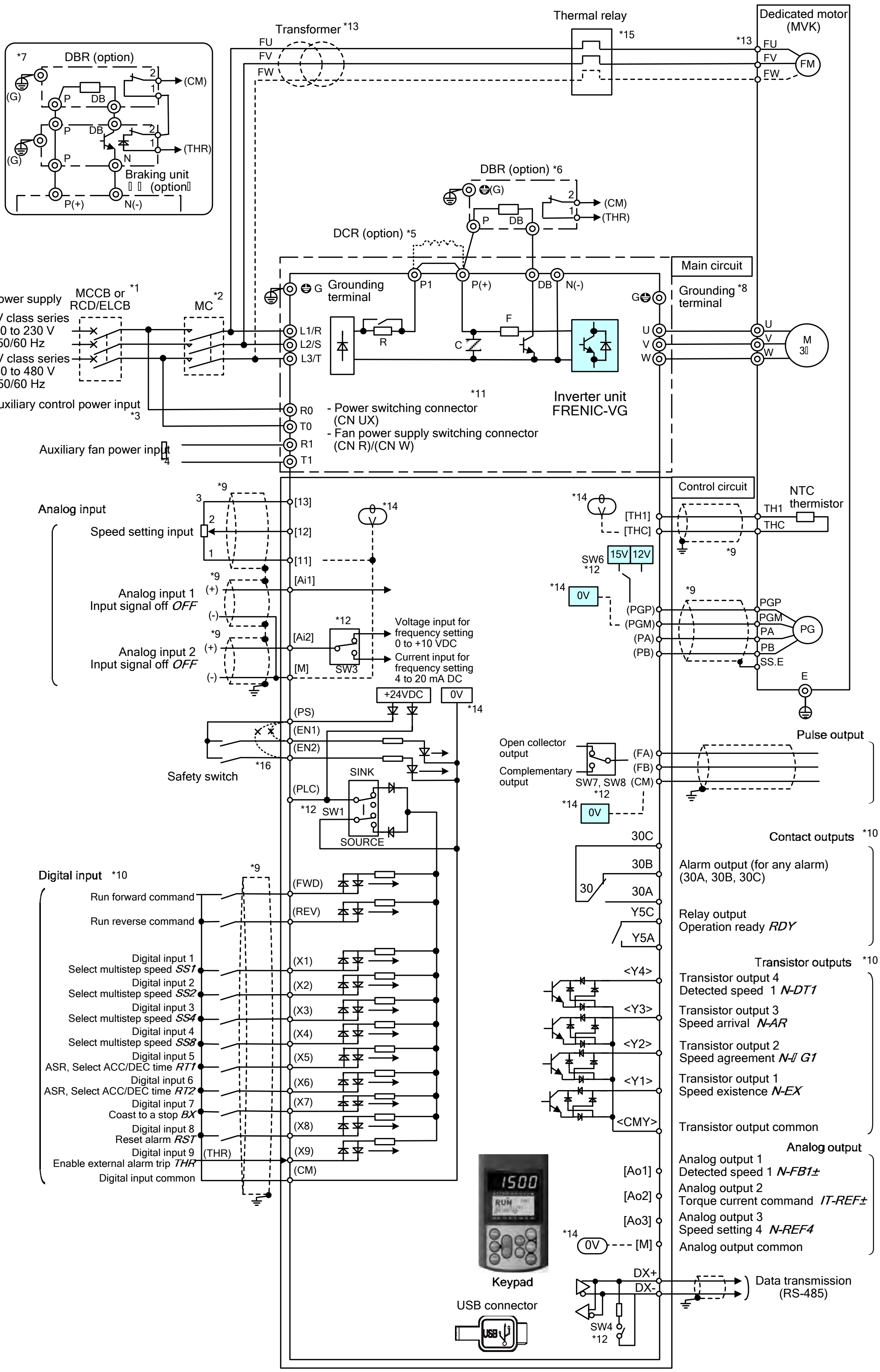
- Ensure that the number of input phases and the rated voltage of the product match the number of phases and the voltage of the AC power supply to which the product is to be connected.

Otherwise, a fire or an accident could occur.

- Do not connect the power source wires to inverter output terminals (U, V, and W).

Doing so could cause fire or an accident.

3.3.3.5 Connection diagram



(Note 1) Install a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection function) in the primary circuit of the inverter to protect wiring. Ensure that the circuit breaker capacity is equivalent to or lower than the recommended capacity.

(Note 2) Install a magnetic contactor (MC) for each inverter to separate the inverter from the power supply, apart from the MCCB or RCD/ELCB, when necessary.
Connect a surge absorber in parallel when installing a coil such as the MC or solenoid near the inverter.

(Note 3) To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect these terminals to the power supply lines. Without power supply to these terminals, the inverter can run.

(Note 4) Normally no need to be connected. Use these terminals when the inverter is equipped with a high power-factor, regenerative PWM converter (RHC series).

(Note 5) When connecting an optional DC reactor (DCR), remove the jumper bar from the main circuit terminals P1 and P(+).

Inverters of 75 kW or above and LD-mode inverters of 55 kW come with a DCR as standard. Be sure to connect the DCR.

Use a DCR when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity, or when there are thyristor-driven loads in the same power supply line.

(Note 6) Inverters of 55 kW or below (200 V class series) and those of 160 kW or below (400 V class series) have a built-in braking transistor, allowing a braking resistor (DBR) to be directly connected between terminals P(+) and DB.

(Note 7) When connecting an optional braking resistor (DBR) to inverters of 75 kW or above (200 V class series) or those of 200 kW or above (400 V class series), be sure to use an optional braking unit (BU) together.

Connect the BU between terminals P(+) and N(-). Auxiliary terminals [1] and [2] have polarity, so make connection as shown in the connection diagram.

(Note 8) A grounding terminal for a motor. It is recommended that the motor be grounded via this terminal for suppressing inverter noise.

(Note 9) For wiring enclosed with [ ], use twisted or shielded wires.

In principle, the shielded sheath of wires should be connected to ground. If the inverter is significantly affected by external induction noise, however, connection to (0V) ([M], [11], [THC]) or [0V] ([CM], (PGM)) may be effective to suppress the influence of noise.

Keep the control circuit wiring away from the main circuit wiring as far as possible (recommended: 10 cm or more). Never install them in the same wire duct. When crossing the control circuit wiring with the main circuit wiring, set them at right angles.

(Note 10) The connection diagram shows factory default functions assigned to digital input terminals [X1] to [X9], transistor output terminals [Y1] to [Y4], and relay contact output terminals [Y5A/C].

(Note 11) Switching connectors in the main circuits. For details, refer to Section 3.3.3.7 "Switching connectors."

(Note 12) Slide switches on the control printed circuit board (control PCB). Use these switches to customize the inverter operations. For details, refer to Section 3.3.3.9 "Setting up the slide switches."

(Note 13) The cooling fan power supply for motors of 7.5 kW or less is single-phase. Connect terminals [FU] and [FV].

For motors of 7.5 kW or less (400 V class series), the power voltage/frequency rating of the cooling fan is 200 V/50 Hz or 200-230 V/60 Hz. For motors of 11 kW or above (400 V class series), it is 400-420 V/50 Hz or 400-440 V/60 Hz. To use the fan with power voltage other than the above specifications, a transformer is necessary.

(Note 14) (0V) ([M], [11], [THC]) and [0V] ([CM], (PGM)) are insulated inside the inverter unit.

(Note 15) Use the auxiliary contact (manual reset) of the thermal relay to trip the MCCB or MC.

(Note 16) Jumper bars are mounted between safety terminals [EN1]/[EN2] and [PS] by factory default. To use the safety function, remove the jumper bars before connection of safety devices.

3.3.3.6 Detailed functions of main circuit terminals and grounding terminals

① Primary grounding terminal (⊜G) for inverter enclosure

Two grounding terminals (⊜G) are not exclusive to the power supply wiring (primary circuit) or motor wiring (secondary circuit). Be sure to ground either of the two grounding terminals for safety and noise reduction. The inverter is designed for use with safety grounding to avoid electric shock, fire and other disasters.

The grounding terminal for inverter enclosure should be grounded as follows:

1) Ground the inverter in compliance with the national or local electric code.

2) Use a thick grounding wire with a large surface area and keep the wiring length as short as possible.

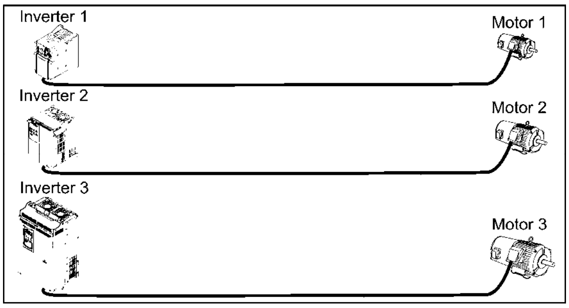
② Inverter output terminals U, V, and W and secondary grounding terminals (⊜G) for motor

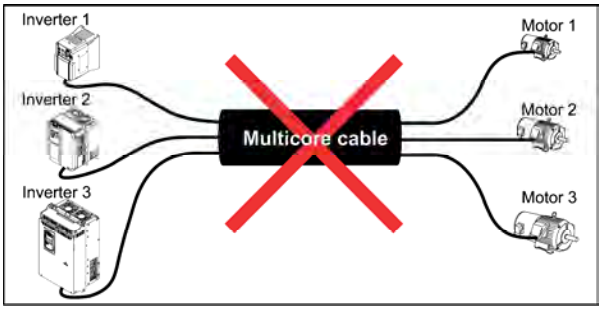
Inverter's output terminals should be connected as follows:

1) Connect the three wires of the 3-phase motor to terminals U, V, and W, aligning the phases each other.

2) Connect the secondary grounding wire to the grounding terminal (⊜G).

Note When there is more than one combination of an inverter and motor, do not use a multicore cable for the purpose of handling their wirings together.





③ DC reactor terminals P1 and P(+)

Connect a DC reactor (DCR) to these terminals for power factor correction.

1) Remove the jumper bar from terminals P1 and P(+).
(Inverters of 75 kW or above and LD-mode inverters of 55 kW are not equipped with a jumper bar.)

2) Connect an optional DCR to those terminals.

Note
- The wiring length should be 10 m or below.
- Do not remove the jumper bar when a DCR is not used.
- For inverters of 75 kW or above and LD-mode inverters of 55 kW, a DCR is provided as standard. Be sure to connect the DCR to the inverter.
- When a PWM converter is connected to the inverter, no DCR is required.

⚠WARNING
Be sure to connect an optional DC reactor (DCR) when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity. **Otherwise, a fire could occur.**

④ **DC braking resistor terminals P(+) and DB (Inverters of 55 kW or below for 200 V class series and those of 160 kW or below for 400 V class series)**

1) Connect an optional DBR to terminals P(+) and DB.

2) Arrange the DBR and inverter so that the wiring length comes to 5 m or less and twist the two DBR wires or route them together in parallel.

⚠WARNING
When connecting a DC braking resistor (DBR), never connect it to terminals other than terminals P(+) and DB. **Otherwise, a fire could occur.**

⑤ **DC link bus terminals P(+) and N(-)**

Capacity (kW)	Braking transistor	Built-in DC braking resistor (DBR)	Optional devices	Devices and terminals
75 to 90 (200 V) 200 to 630 (400 V)	None	None	Braking unit DC braking resistor (DBR)	Inverter–Braking unit: P(+) and N(-)

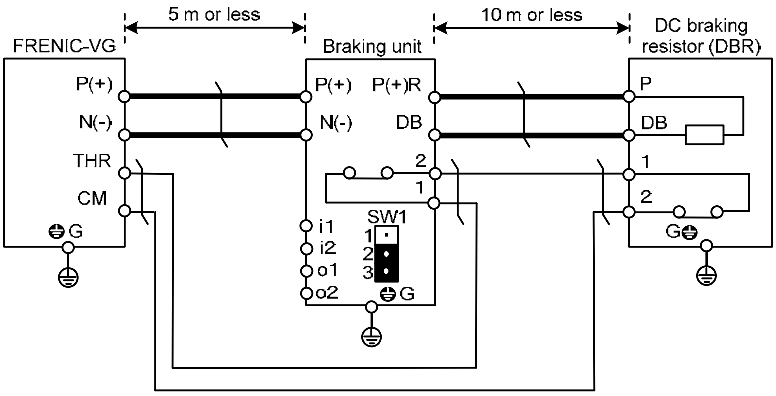
1) Connecting an optional braking unit or DC braking resistor (DBR)

Inverters of 75 kW or above (200 V class series) and those of 200 kW or above (400 V class series) require both a braking unit and DBR.

Connect the terminals P(+) and N(-) of a braking unit to those on the inverter. Arrange the inverter and the braking unit so that the wiring length comes to 5 m or less and twist the two wires or route them together in parallel.

Next, connect the terminals P(+) and DB of a DBR to those on the braking unit. Arrange the braking unit and DBR so that the wiring length comes to 10 m or less and twist the two wires or route them together in parallel.

For details about the wiring, refer to the Braking Unit Instruction Manual.



2) Connecting other external devices

A DC link bus of other inverter(s) or a PWM converter is connectable to these terminals.

For connection examples at the PWM converter side, refer to Chapter 8, Section 8.5.2 "Power regenerative PWM converters, RHC series."

⑥ Main circuit power input terminals L1/R, L2/S, and L3/T (three-phase input)

The three-phase input power lines are connected to these terminals.

1) For safety, make sure that the molded case circuit breaker (MCCB) or magnetic contactor (MC) is turned OFF before wiring the main circuit power input terminals.
2) Connect the main circuit power supply wires (L1/R, L2/S and L3/T) to the input terminals of the inverter via an MCCB or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB)*, and an MC if necessary.

   It is not necessary to align phases of the power supply wires and the input terminals of the inverter with each other.

* With overcurrent protection

Tip It is recommended to insert a manually operable magnetic contactor (MC) that allows you to disconnect the inverter from the power supply in an emergency (e.g., when the protective function is activated), preventing a failure or accident from causing secondary disasters.

⑦ Auxiliary control power input terminals R0 and T0

In general, the inverter runs normally without power supplied to the auxiliary control power input terminals R0 and T0. If the inverter main power is shut down, however, no power is supplied to the control circuit so that the inverter cannot issue a variety of output signals or display on the keypad.

To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect the auxiliary control power input terminals R0 and T0 to the power supply lines. If a magnetic contactor (MC) is installed in the inverter's primary circuit, connect the primary circuit of the MC to these terminals R0 and T0.

Terminal rating:

200 to 240 VAC, 50/60 Hz, Maximum current 1.0 A (200 V class series with 22 kW or below)
200 to 230 VAC, 50/60 Hz, Maximum current 1.0 A (200 V class series with 30 kW or above)
380 to 480 VAC, 50/60 Hz, Maximum current 0.5 A (400 V class series)

Note When introducing a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB), connect its output (secondary) side to terminals R0 and T0. Connecting its input (primary) side to those terminals causes the RCD/ELCB to malfunction since the input power voltage to the inverter is three-phase but the one to terminals R0 and T0 is single-phase. To avoid such problems, be sure to insert an insulation transformer or auxiliary B contacts of a magnetic contactor in the location shown below.

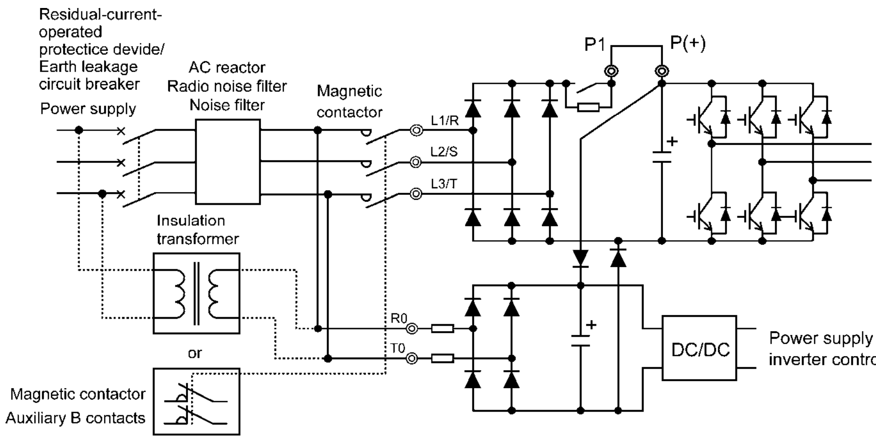


Figure 3.3-6 Connection Example of Residual-current-operated Protective Device (RCD)/ Earth Leakage Circuit Breaker (ELCB)

Note When connecting a PWM converter with an inverter, do not connect the power supply line directly to terminals R0 and T0. If a PWM is to be connected, insert an insulation transformer or auxiliary B contacts of a magnetic contactor at the power supply side.

For connection examples at the PWM converter side, refer to Chapter 8, Section 8.5.2 "Power regenerative PWM converters, RHC series."

⑧ **Auxiliary fan power input terminals R1 and T1**

The 200 V class series with 37 kW or above and 400 V class series with 75 kW or above are equipped with terminals R1 and T1. Only if the inverter works with the DC-linked power input whose source is a PWM converter, these terminals are used to feed AC power to the fans, while they are not used in any power system of ordinary configuration.

In this case, set up the fan power supply switching connectors (CN R and CN W).

Terminal rating:
(200 V class series with 37 kW or above)
200-220 VAC/50 Hz, 200-230 VAC/60 Hz, Maximum current 1.0 A

(400 V class series with 75 kW to 400 kW)
380-440 VAC/50 Hz, 380-480 VAC/60 Hz, Maximum current 1.0 A

(400 V class series with 500 kW and 630 kW)
380-440 VAC/50 Hz, 380-480 VAC/60 Hz, Maximum current 2.0 A

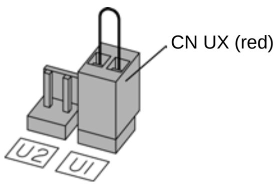
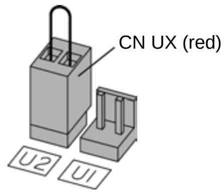
3.3.3.7 Switching connectors

■ **Power switching connectors (CN UX), for inverters of 75 kW or above (400 V class series)**

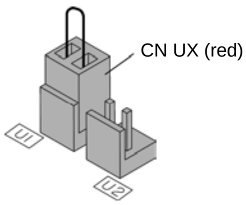
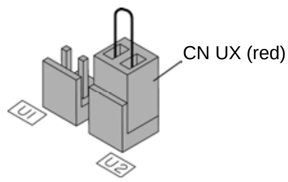
Inverters of 75 kW or above (400 V class series) are equipped with a set of switching connectors (male) which should be configured according to the power source voltage and frequency. By factory default, a jumper (female connector) is set to U1. If the power supply to the main power inputs (L1/R, L2/S, L3/T) or the auxiliary fan power input terminals (R1, T1) matches the conditions listed below, change the jumper to U2.

For the switching instructions, see Figures 3.3-7 and 3.3-8.

(a) FRN75VG1□-4□ to FRN110VG1□-4□

Connector configuration		
Power source voltage	398 to 440 V/50 Hz, 430 to 480 V/60 Hz (Factory default)	380 to 398 V/50 Hz 380 to 430 V/60 Hz

(b) FRN132VG1□-4□ to FRN630VG1□-4□

Connector configuration		
Power source voltage	398 to 440 V/50 Hz, 430 to 480 V/60 Hz (Factory default)	380 to 398 V/50 Hz, 380 to 430 V/60 Hz

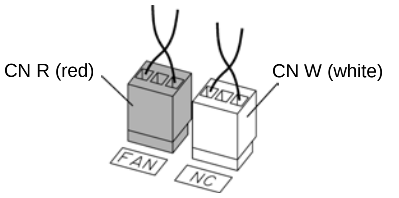
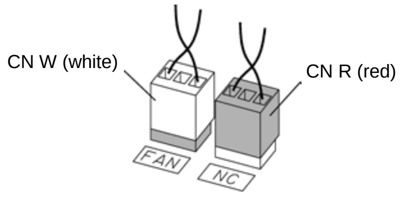
Note The allowable power input voltage fluctuation is within -15% to +10% of the power source voltage.

■ Fan power supply switching connectors (CN R and CN W), for inverters of 37 kW or above (200 V class series) and those of 75 kW or above (400 V class series)

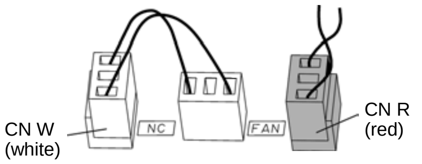
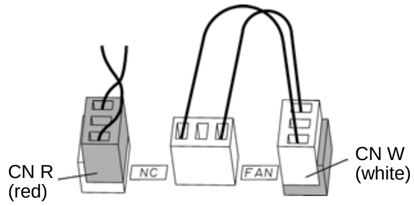
The standard FRENIC-VG series accepts DC-linked power input in combination with a PWM converter. The 200 V class series with 37 kW or above and 400 V class series with 75 kW or above, however, contain AC-driven components such as AC fans. To supply AC power to those components, exchange the CN R and CN W connectors as shown below and connect the AC power line to the auxiliary fan power input terminals (R1, T1).

For the switching instructions, see Figures 3.3-7 and 3.3-8.

(a) FRN37VG1□-2□ to FRN75VG1□-2□, FRN75VG1□-4□ to FRN110VG1□-4□

Connector configuration		
Use conditions	When not using terminal R1 or T1 (Factory default)	When using terminals R1 and T1 • Feeding the DC-linked power • Combined with a PWM converter

(b) FRN90VG1□-2□, FRN132VG1□-4□ to FRN630VG1□-4□

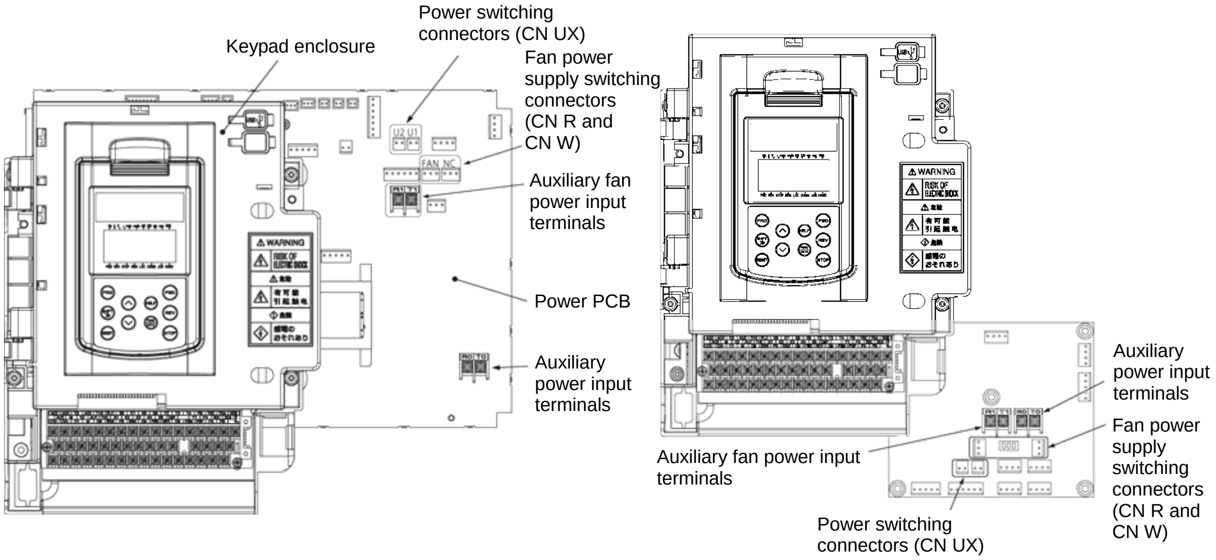
Connector configuration		
Use conditions	When not using terminal R1 or T1 (Factory default)	When using terminals R1 and T1 • Feeding the DC-linked power • Combined with a PWM converter

Note By factory default, the fan power supply switching connectors CN R and CN W are set on the FAN and NC positions, respectively. Do not exchange them unless you drive the inverter with a DC-linked power supply.

Wrong configuration of these switching connectors cannot drive the cooling fans, causing a heat sink overheat alarm OH1 or a charger circuit alarm PbF.

■ **Location of the switching connectors**

The switching connectors are located on the power printed circuit board (power PCB) as shown below.



(a) FRN37VG1□-2□ to FRN75VG1□-2□, FRN75VG1□-4□ to FRN110VG1□-4□

(b) FRN90VG1□-2□, FRN132VG1□-4□ to FRN630VG1□-4□

Figure 3.3-7 Location of Switching Connectors and Auxiliary Power Input Terminals

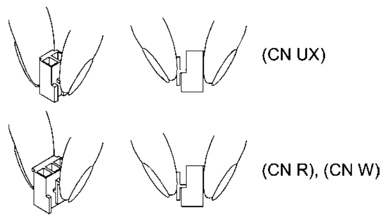


Figure 3.3-8 Inserting/Removing the Jumpers

Note: To remove each of the jumpers, pinch its upper side between your fingers, unlock its fastener, and pull it up.

When mounting it, fit the jumper over the connector until it snaps into place.

3.3.3.8 Detailed functions of control circuit terminals

⚠WARNING
In general, the covers of the control signal wires are not specifically designed to withstand a high voltage (i.e., reinforced insulation is not applied). Therefore, if a control signal wire comes into direct contact with a live conductor of the main circuit, the insulation of the cover might break down, which would expose the signal wire to a high voltage of the main circuit. Make sure that the control signal wires will not come into contact with live conductors of the main circuit. **Failure to observe these precautions could cause electric shock or an accident.**

⚠CAUTION
Noise may be emitted from the inverter, motor and wires. Take appropriate measures to prevent the nearby sensors and devices from malfunctioning due to such noise. It takes a maximum of 5 seconds to establish the input/output of the control circuit after the main power is turned ON. Take appropriate measures, such as external timers. **An accident could occur.**

Table 3.3-8 lists the symbols, names and functions of the control circuit terminals. The wiring to the control circuit terminals differs depending upon the setting of the function codes, which reflects the use of the inverter. Route wires properly to reduce the influence of noise.

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals

Classification	Symbol	Name	Functions
Analog input	[13]	Power supply for the potentiometer	Power supply (+10 VDC) for an external speed command potentiometer. (Variable resistor: 1 to 5kΩ) The potentiometer of 1/2 W rating or more should be connected.
	[12]	Analog setting voltage input	(1) The speed is commanded according to the external voltage input. • 0 to ±10 VDC/0 to maximum speed (2) Hardware specifications • Input impedance: 10kΩ • The maximum input is ±15 VDC, however, the voltage higher than ±10 VDC is regarded as ±10 VDC.
	[Ai1] [Ai2]	Analog input 1 Analog input 2	(1) Analog input voltage from external equipment. Possible to assign various signal functions (Input signal off, Auxiliary speed setting 1, Torque limiter (level 1, etc.), selected with Function codes E49 and E50 to these terminals. For details, refer to Chapter 4, Section 4.2 "Function Codes." (2) Hardware specifications Only for terminal [Ai2], the input is switchable between voltage and current with the SW3 configuration. (For details about slide switches, refer to Section 3.3.3.9.) To use terminal [Ai2] for current input speed setting (***N-REFC***), turn SW3 to the I position, set F01 or C25 to "9" and set E50 to "26." After that, check that the current input is normal on the I./O check screen (given in Section 3.4.4.5). Voltage input • Input impedance: 10kΩ • The maximum input is ±15 VDC, however, the voltage higher than ±10 VDC is regarded as ±10 VDC. Current input (only on terminal [Ai2]) • Input impedance: 250Ω • The maximum input is a maximum of 30 mADC; however, the current higher than 20 mADC is regarded as 20 mADC.
	[11] [M]	Analog input common	Common for analog input signals ([12], [Ai1] and [Ai2]). Isolated from terminals [CM], [CMY] and [PGM].

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

Classifi-cation	Symbol	Name	Functions

Note

- Since low level analog signals are handled, these signals are especially susceptible to the external noise effects. Route the wiring as short as possible (within 20 m) and use shielded wires. In principle, ground the shielded sheath of wires; if effects of external inductive noises are considerable, connection to terminal [11] may be effective. As shown in Figures 3.3-9 and 3.3-10, be sure to ground the single end of the shield to enhance the shield effect.
- Use a twin-contact relay for low level signals if the relay is used in the control circuit. Do not connect the relay's contact to terminal [11] or [M].
- When the inverter is connected to an external device outputting the analog signal, the external device may malfunction due to electric noise generated by the inverter. If this happens, according to the circumstances, connect a ferrite core (a toroidal core or equivalent) to the device outputting the analog signal or connect a capacitor having the good cut-off characteristics for high frequency between control signal wires as shown in Figures 3.3-9 and 3.3-10.
- Do not apply a voltage of +7.5 VDC or higher to terminal [C1]. Doing so could damage the internal control circuit.

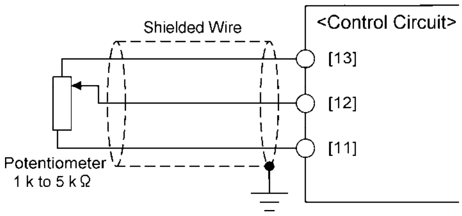


Figure 3.3-9 Connection of Shielded Wire

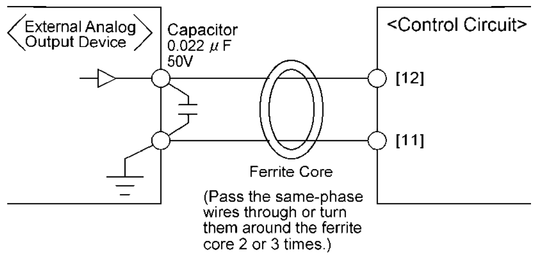


Figure 3.3-10 Example of Electric Noise Reduction

Classifi-cation	Symbol	Name	Functions
Digital input	[FWD]	Run forward command	(1) When terminals [FWD] and [CM] are closed, the motor runs in the forward direction; when they are opened, the motor decelerates to a stop. (2) Input mode, i.e. SINK/SOURCE, is changeable by using the slide switch SW1. (Refer to Section 3.3.3.9 "Setting up the slide switches.")
	[REV]	Run reverse command	(1) When terminals [REV] and [CM] are closed, the motor runs in the reverse direction; when they are opened, the motor decelerates to a stop. (2) Input mode, i.e. SINK/SOURCE, is changeable by using the slide switch SW1. (Refer to Section 3.3.3.9 "Setting up the slide switches.")
	[X1] [X2] [X3] [X4] [X5] [X6] [X7] [X8] [X9]	Digital input 1 Digital input 2 Digital input 3 Digital input 4 Digital input 5 Digital input 6 Digital input 7 Digital input 8 Digital input 9	(1) Various signals such as "Coast to a stop," "Enable external alarm trip," and "Select multistep speed" can be assigned to these terminals by setting Function codes E01 to E09. For details, refer to Chapter 4, Section 4.2 "Function Codes." (2) Input mode, i.e. SINK/SOURCE, is changeable by using the slide switch SW1. (Refer to Section 3.3.3.9 "Setting up the slide switches.") (3) Switches the logic value (1/0) for ON/OFF of the terminals [X1] to [X9]. If the logic value for ON of the terminal [X1] is 1 in the normal logic system, for example, OFF is 1 in the negative logic system and vice versa.

(Digital input circuit specifications)

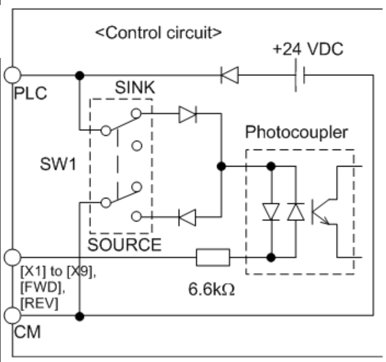
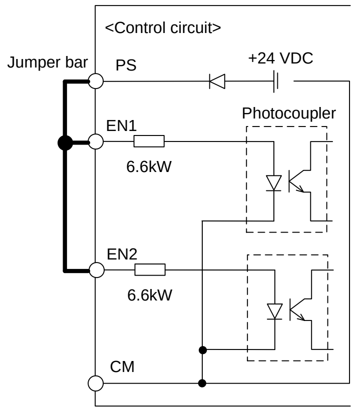


Figure 3.3-11 Digital Input Circuit

Item		Min.	Max.
Operating voltage (SINK)	ON level	0 V	2 V
	OFF level	22 V	27 V
Operating voltage (SOURCE)	ON level	22 V	27 V
	OFF level	0 V	2 V
Operating current at ON (Input voltage is at 0 V)		–	4.5 mA
Allowable leakage current at OFF		–	0.5 mA

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

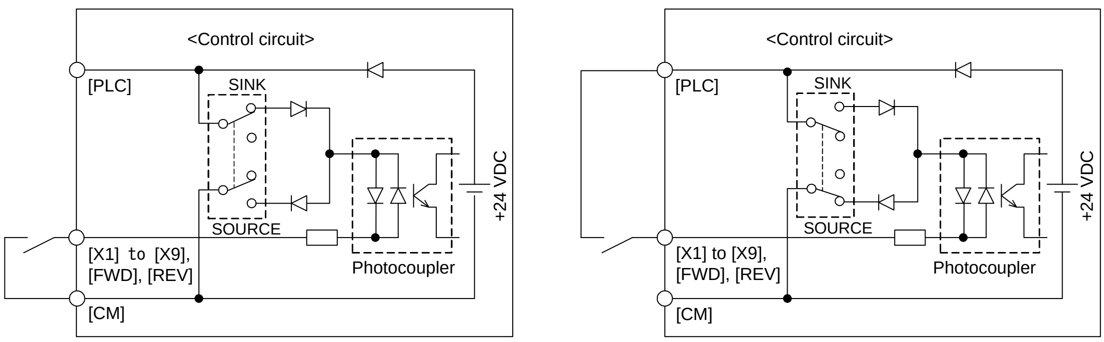
<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="5">Digital input</td><td>[EN1]
[EN2]</td><td>Enable input</td><td>(1) When [EN1]-[PS] or [EN2]-[PS] is opened (OFF), the inverter output transistor stops its operation. (Safe Torque Off, STO)
To enable the STO function, remove the jumper bars.
(2) The input mode of terminals [EN1] and [EN2] is fixed at SOURCE. It cannot be switched to SINK.
(3) When not using the Enable input function, short the circuit between [EN1]-[PS] and [EN2]-[PS] with jumper bars (that is, keep the short bars connected).
(Terminal EN circuit specification)


<table>
<tr><th colspan="2">Item</th><th>Min.</th><th>Max.</th></tr>
<tr><td rowspan="2">Operating voltage (SOURCE)</td><td>ON level</td><td>22 V</td><td>27 V</td></tr>
<tr><td>OFF level</td><td>0 V</td><td>2 V</td></tr>
<tr><td colspan="2">Operating current at ON (Input voltage is at 0 V)</td><td>–</td><td>4.5 mA</td></tr>
<tr><td colspan="2">Allowable leakage current at OFF</td><td>–</td><td>0.5 mA</td></tr>
</table></td></tr>
<tr><td>[PS]</td><td>[EN] terminal power</td><td>Power terminal for terminals [EN1] and [EN2].
This terminal outputs +24 VDC (Reference for terminal [CM]).</td></tr>
<tr><td>[PLC]</td><td>PLC signal power</td><td>(1) Connects to PLC output signal power supply.
Rated voltage: +24 VDC (Allowable range: +22 to +27 VDC), Maximum 100 mA DC
(2) This terminal also supplies a power to the load connected to the transistor output terminals. Refer to "Transistor output" described later in this table for more.</td></tr>
<tr><td>[CM]</td><td>Digital input common</td><td>Two common terminals for digital input signals
Electrically isolated from terminals [11], [M], and [CMY].</td></tr>
<tr><td>Tip</td><td colspan="2">

■ **Using a relay contact to turn [FWD], [REV], or [X1] to [X9] ON or OFF**

Figure 3.3-12 shows two examples of a circuit configuration that uses a relay contact to turn control signal input [X1] to [X9], [FWD], or [REV] ON or OFF. In circuit (a), the slide switch is turned to SINK, whereas in circuit (b) it is turned to SOURCE.

Note: To configure this kind of circuit, use a highly reliable relay. (Recommended product: Fuji control relay Model HH54PW.)



(a) With the switch turned to SINK (b) With the switch turned to SOURCE

Figure 3.3-12 Circuit Configuration Using a Relay Contact

</td></tr>
</table>

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

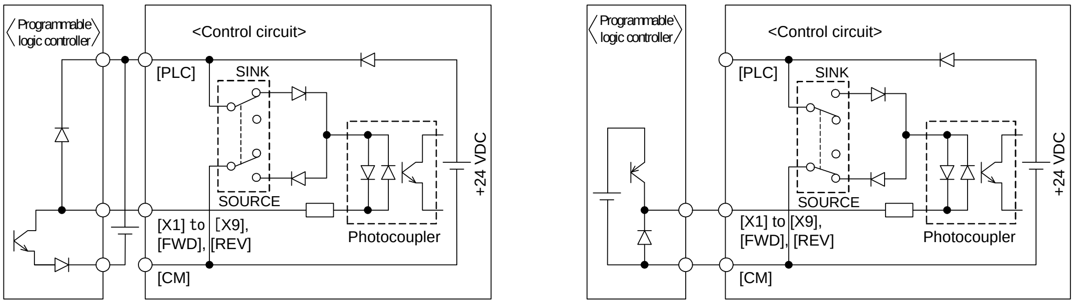
<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td>Digital input</td><td colspan="3">

Tip ■ **Using a programmable logic controller (PLC) to turn [FWD], [REV], or [X1] to [X9] ON or OFF**

Figure 3.3-13 shows two examples of a circuit configuration that uses a programmable logic controller (PLC) to turn control signal input [X1] to [X9], [FWD], or [REV] ON or OFF. In circuit (a), the slide switch is turned to SINK, whereas in circuit (b) it is turned to SOURCE.

In circuit (a) below, short-circuiting or opening the transistor's open collector circuit in the PLC using an external power supply turns ON or OFF control signal [FWD], [REV], or [X1] to [X9]. When using this type of circuit, observe the following:

- Connect the + node of the external power supply (which should be isolated from the PLC's power) to terminal [PLC] of the inverter.
- Do not connect terminal [CM] of the inverter to the common terminal of the PLC.



(a) With the switch turned to SINK (b) With the switch turned to SOURCE

Figure 3.3-13 Circuit Configuration Using a PLC

For details about the slide switch setting, refer to Section 3.3.3.9 "Setting up the slide switches."

</td></tr>
<tr><td rowspan="2">Analog output</td><td>[Ao1]

[Ao2]

[Ao3]</td><td>Analog output 1

Analog output 2

Analog output 3</td><td>(1) Output of monitor signals with analog voltage 0 to ±10 VDC.
Various signals such as "Detected speed," "Speed setting," and "Torque current command" can be assigned to these terminals by setting Function codes E67 to E71. For details, refer to Chapter 4, Section 4.2 "Function Codes."
(2) Hardware specifications
• Connectable impedance: Min. 3kΩ
• Gain adjustment range: 0.00 to ±100.00 times
Note: For these terminals, select devices having input terminals with a small capacitive load. Large capacitive load may cause the output to oscillate.</td></tr>
<tr><td>[M]</td><td>Analog common</td><td>Common for analog output signals ([Ao1], [Ao2] and [Ao3]).
Electrically isolated from terminals [CM], [CMY] and [PGM].</td></tr>
</table>

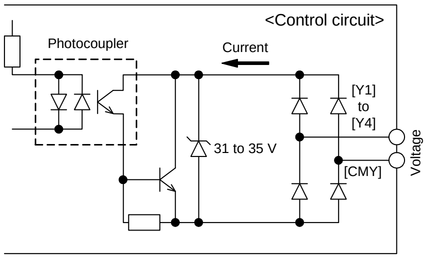
Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="3">Transistor output</td><td>[Y1]

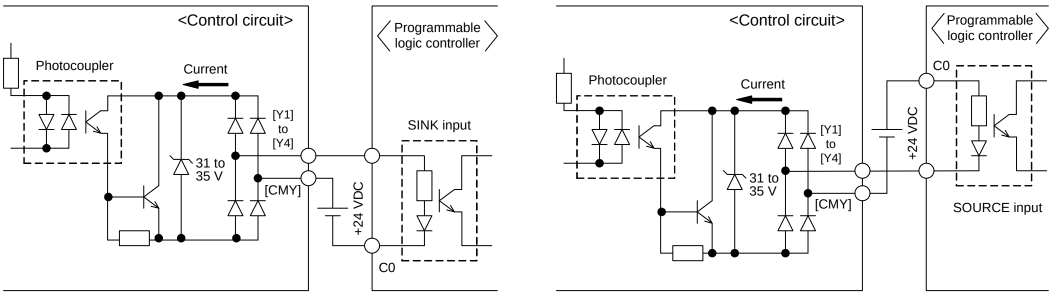
[Y2]

[Y3]

[Y4]</td><td>Transistor output 1
Transistor output 2
Transistor output 3
Transistor output 4</td><td>
(1) Various signals such as "Inverter running," "Speed valid," and "Speed agreement" can be assigned to these terminals by setting Function codes E15 to E18. For details, refer to Chapter 4, Section 4.2 "Function Codes."
(2) Switches the logic value (1/0) for ON/OFF of the terminals between [Y1] to [Y4], and [CMY]. If the logic value for ON between [Y1] to [Y4] and [CMY] is 1 in the normal logic system, for example, OFF is 1 in the negative logic system and vice versa.

(Transistor output circuit specification)


<table>
<tr><th colspan="2">Item</th><th>Max.</th></tr>
<tr><td rowspan="2">Operation voltage</td><td>ON level</td><td>2 V</td></tr>
<tr><td>OFF level</td><td>27 V</td></tr>
<tr><td colspan="2">Maximum current at ON</td><td>50 mA</td></tr>
<tr><td colspan="2">Leakage current at OFF</td><td>0.1 mA</td></tr>
</table>
Figure 3.3-14 Transistor Output Circuit

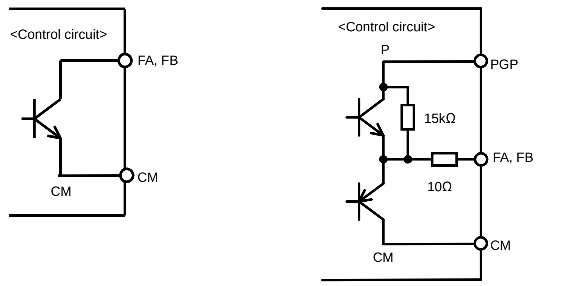
Note - When a transistor output drives a control relay, connect a surge-absorbing diode across relay’s coil terminals.
- When any equipment or device connected to the transistor output needs to be supplied with DC power, feed the power (+24 VDC: allowable range: +22 to +27 VDC, 100 mA max.) through the [PLC] terminal. Short-circuit between the terminals [CMY] and [CM] in this case.
</td></tr>
<tr><td>[CMY]</td><td>Transistor output common</td><td>Common terminal for transistor output signals
Electrically isolated from terminals [CM], [11], [M], and [PGM].</td></tr>
<tr><td colspan="3">
Tip ■ Connecting programmable logic controller (PLC) to terminal [Y1], [Y2], [Y3] or [Y4]
Figure 3.3-15 shows two examples of circuit connection between the transistor output of the inverter’s control circuit and a PLC. In example (a), the input circuit of the PLC serves as a SINK for the control circuit output, whereas in example (b), it serves as a SOURCE for the output.


(a) PLC serving as SINK (b) PLC serving as SOURCE
Figure 3.3-15 Connecting PLC to Control Circuit
</td></tr>
</table>

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

Classification	Symbol	Name	Functions
Relay output	[Y5A/C]	General purpose relay output	(1) A general-purpose relay contact output usable as well as the function of the transistor output terminal [Y1], [Y2], [Y3] or [Y4]. Contact rating: 250 VAC 0.3 A, cos ϕ = 0.3, 48 VDC, 0.5 A (2) Switching of the normal/negative logic output is applicable to the following two contact output modes: "Active ON" (Terminals [Y5A] and [Y5C] are closed (excited) if the signal is active.) and "Active OFF" (Terminals [Y5A] and [Y5C] are opened (non-excited) if the signal is active while they are normally closed.).
	[30A/B/C]	Alarm relay output (for any error)	(1) Outputs a contact signal (SPDT) when a protective function has been activated to stop the motor. Contact rating: 250 VAC, 0.3A, cos ϕ = 0.3, 48 VDC, 0.5A (2) Switching of the normal/negative logic output is applicable to the following two contact output modes: "Active ON" (Terminals [30A] and [30C] are closed (excited) if the signal is active.) and "Active OFF" (Terminals [30A] and [30C] are opened (non-excited) if the signal is active while they are normally closed.).
Communication	RJ-45 connector for the keypad	RS-485 communications port 1 (Connector for keypad)	Connector to join the keypad to the inverter. Power is supplied to the keypad from the inverter via a remote operation extension cable.
	[DX+]/ [DX-]	RS-485 communications port 2 (Terminals on control PCB)	Input/output terminals to transmit data through the RS-485 multipoint protocol between the inverter and a computer or other equipment such as a PLC. (For setting of the terminating resistor, refer to Section 3.3.3.9 "Setting up the slide switches.")
	USB connector	USB port (On the keypad)	A USB port connector (mini B) that connects an inverter to a computer. FRENIC-VG Loader (inverter support software*) running on the computer supports editing the function codes, transferring them to the inverter, verifying them, test-running an inverter and monitoring the inverter running status. * FRENIC-VG Loader (free version) is available as an install from the CD-ROM (that comes with the inverter as an accessory) or as a free download from our website at: http://www.fujielectric.com/products/inverter/download/ The free version supports editing, transferring and verifying of function codes and the traceback function.
Speed detection	[PA] [PB]	Pulse generator 2-phase signal input	The PG interface uses a complementary output mode. [PA]: Input terminal for A phase of the pulse generator [PB]: Input terminal B phase of the pulse generator When 12V power supply is in use: H level ≥ 9V, L level ≤ 1.5V When 15V power supply is in use: H level ≥ 12V, L level ≤ 1.5V Input pulse frequency: 100 kHz or below, Duty: 50 ±10% Wiring length (as a guide): 100 m or less (Note) False detection may occur due to noise. Make the wiring length as short as possible and take sufficient noise control measures.
	[PGP]	Pulse generator power supply	Power supply terminal for a pulse generator. Output: +12 VDC ±10% or +15 VDC ±10% Maximum current: 270 mA (For output voltage switch SW6, refer to Section 3.3.3.9 "Setting up the slide switches.")
	[PGM]	Common terminal	Common terminal for pulse generator power/signal. Electrically isolated from terminals [11], [M] and [CMY]. Not electrically isolated from terminal [CM], but not equivalent voltage.

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="2"></td><td>[FA]
[FB]</td><td>Pulse generator output</td><td>(1) This outputs pulse generator signals with frequency divided to 1/n (where, n is programmable with Function code E29).
(2) Switchable between open collector and complementary (equivalent to the voltage on the [PGP] terminal) transistor outputs.
(For switching, refer to Section 3.3.3.9 "Setting up the slide switches.")


(a) Open collector output (b) Complementary output
Figure 3.3-16 Pulse Output Circuit
<table>
<tr><th colspan="2">Items</th><th>Min.</th><th>Max.</th><th>Remarks</th></tr>
<tr><td rowspan="2">Output voltage (Open collector output)</td><td>Output voltage</td><td>-</td><td>2 V</td><td></td></tr>
<tr><td>Max. output current</td><td>-</td><td>15 mA</td><td></td></tr>
<tr><td rowspan="3">Output voltage (Complementary output)</td><td>Hi level output</td><td>PGP-3V</td><td>-</td><td></td></tr>
<tr><td>Low level output</td><td>-</td><td>2 V</td><td></td></tr>
<tr><td>Max. output current</td><td>-</td><td>20 mA</td><td></td></tr>
</table></td></tr>
<tr><td>[CM]</td><td>Pulse generator output common</td><td>Common terminal for [FA] and [FB].</td></tr>
<tr><td rowspan="2">Temperature detection</td><td>[TH1]</td><td>NTC/PTC thermistor connection</td><td>Monitors the motor temperature with NTC or PTC thermistor.
For a PTC thermistor, the motor overheat protection level can be specified with Function code E32.</td></tr>
<tr><td>[THC]</td><td>Common</td><td>Common terminal for NTC and PTC thermistors.
Electrically isolated from terminals [CM], [PGM], and [CMY]</td></tr>
</table>

■ Wiring for control circuit terminals

For FRN75VG1□-2□, FRN90VG1□-2□ and FRN132VG1□-4□ to FRN630VG1□-4□

(1) As shown in Figure 3.3-17, route the control circuit wires along the left side panel to the outside of the inverter.

(2) Secure those wires to the wiring support, using a cable tie (e.g., Insulok) with 3.8 mm or less in width and 1.5 mm or less in thickness.

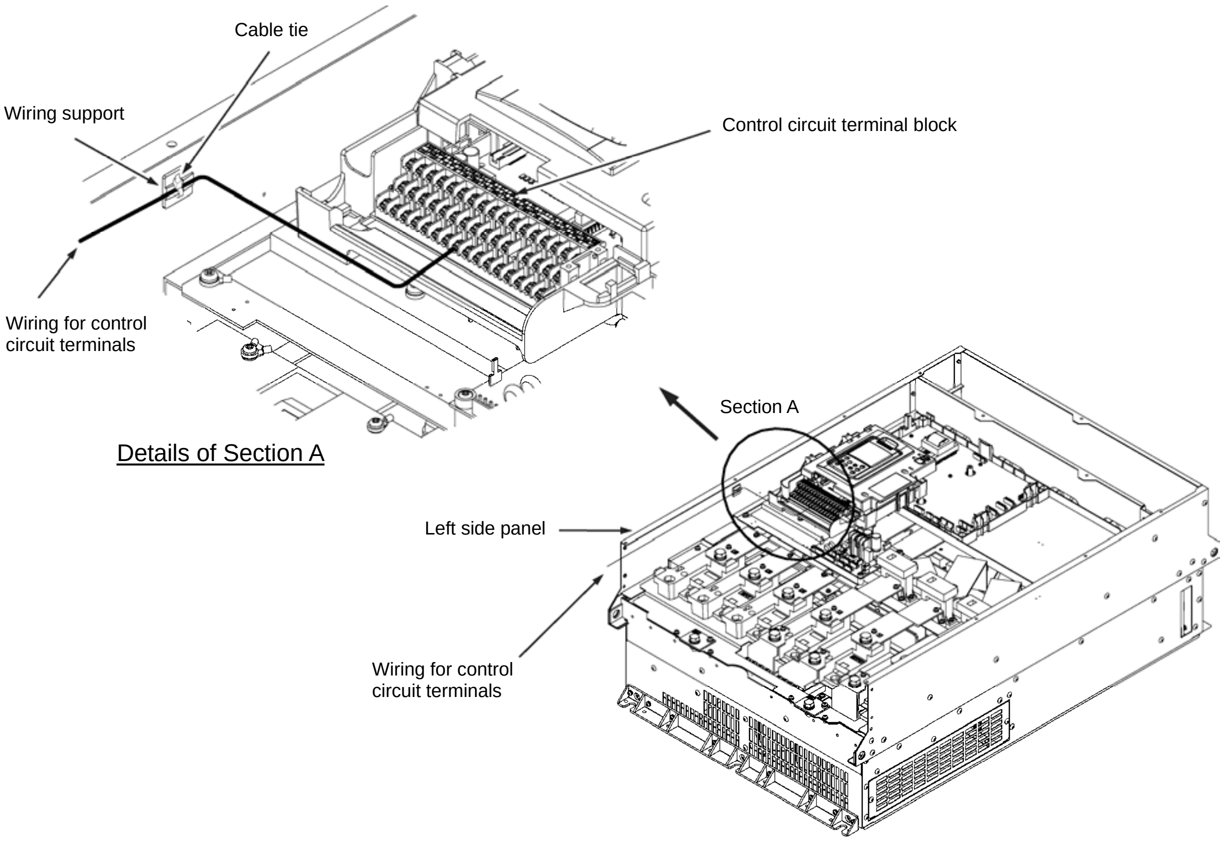


Figure 3.3-17 Wiring Route and Fixing Position for the Control Circuit Wires

Note

- Route the wiring of the control circuit terminals as far from the wiring of the main circuit as possible. Otherwise electric noise may cause malfunctions.
- Fix the control circuit wires with a cable tie inside the inverter to keep them away from the live parts of the main circuit (such as the terminal block of the main circuit).

3.3.3.9 Setting up the slide switches

⚠WARNING⚠

Before changing the switches or touching the control circuit terminal symbol plate, **turn OFF the power and wait at least five minutes for inverters of 22 kW or below, or at least ten minutes for those of 30 kW or above**. Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P(+) and N(-) has dropped to the safe level (+25 VDC or below).

An electric shock may result if this warning is not heeded as there may be some residual electric charge in the DC bus capacitor even after the power has been turned OFF.

Switching the slide switches located on the control PCB allows you to customize the operation mode of the analog output terminals, digital I/O terminals, and communications ports. The locations of those switches are shown in Figure 3.3-18 "Location of the Slide Switches on the Control PCB."

To access the slide switches, remove the front cover so that you can see the control PCB. For inverters with a capacity of 30 kW or above, open also the keypad enclosure.

📖 For details on how to remove the front cover and how to open and close the keypad enclosure, refer to Section 3.3.3.1 "Removing and mounting the front cover and the wiring guide."

Table 3.3-9 lists function of each slide switch.

Table 3.3-9 Function of Each Slide Switch

<table>
<tr><th>Switch</th><th>Function</th></tr>
<tr><td>SW1</td><td>Switches the service mode of the digital input terminals between SINK and SOURCE.
▪ This switches the input mode of digital input terminals [X1] to [X9], [FWD] and [REV] to be used as the SINK or SOURCE mode.
▪ Factory default: SINK</td></tr>
<tr><td>SW2</td><td>Reserved for particular manufacturers.</td></tr>
<tr><td>SW3</td><td>Switches the input mode of the analog input terminal [Ai2] between voltage and current.
<table>
<tr><th>Input form</th><th>SW3</th></tr>
<tr><td>Voltage input (Factory default)</td><td>V position</td></tr>
<tr><td>Current input</td><td>I position</td></tr>
</table></td></tr>
<tr><td>SW4</td><td>Switches the terminating resistor of RS-485 communications port 2 on the terminal block ON and OFF. (RS-485 communications port 2, for connecting the keypad)
▪ If the inverter is connected to the RS-485 communications network as a terminating device, turn SW3 to ON.</td></tr>
<tr><td>SW5</td><td>Reserved for particular manufacturers.</td></tr>
<tr><td>SW6</td><td>Switches the output voltage of terminal [PGP] between 12 V and 15 V.
Select the voltage level that matches the power voltage of the pulse generator to be connected.
<table>
<tr><th>Output voltage</th><th>SW5</th></tr>
<tr><td>12 V</td><td>12 V</td></tr>
<tr><td>15 V (Factory default)</td><td>15 V</td></tr>
</table></td></tr>
<tr><td>SW7
SW8</td><td>Switch the output mode of terminals [FA] and [FB] between open collector output and complementary output.
<table>
<tr><th>Output form</th><th>SW7
(Terminal [FA])</th><th>SW8
(Terminal [FB])</th></tr>
<tr><td>Open collector output (Factory default)</td><td>1</td><td>1</td></tr>
<tr><td>Complementary output</td><td>2</td><td>2</td></tr>
</table></td></tr>
</table>

Figure 3.3-18 shows the location of slide switches on the control PCB for the input/output terminal configuration.

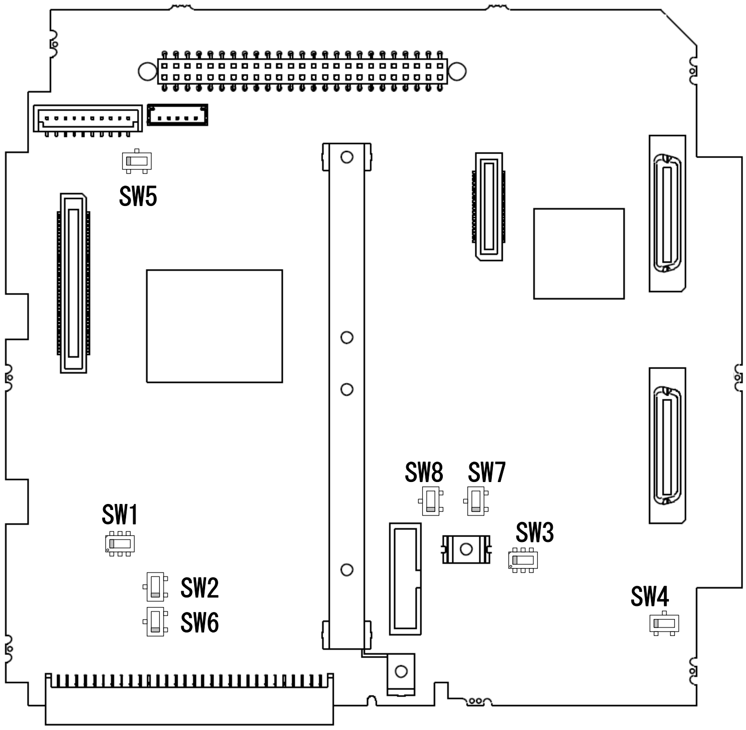


Figure 3.3-18 Location of the Slide Switches on the Control PCB

Switch Configuration and Factory Defaults

	SW1	SW2	SW3	SW4	SW5	SW6	SW7 SW8
Factory default	SINK ←	↓	V ←	OFF ←	←	↓ 15V	↓ 1
---	→ SOURCE		→ I	→ ON		12V ↑	2 ↑

Note To move a switch slider, use a tool with a narrow tip (e.g., a tip of tweezers). Be careful not to touch other electronic parts, etc. If the slider is in an ambiguous position, the circuit is unclear whether it is turned ON or OFF and the digital input remains in an undefined state. Be sure to place the slider so that it contacts either side of the switch.

SW2 and SW5 are reserved for particular manufacturers. Do not access them.

3.3.4 Mounting and connecting a keypad

3.3.4.1 Parts required for connection

To mount a keypad on a place other than an inverter, the parts listed below are needed.

Parts name	Model	Remarks
Extension cable (Note 1)	CB-5S, CB-3S and CB-1S	3 types available in length of 5 m, 3 m, and 1 m.
Fixing screw	M3 × □ (Note 2)	Two screws needed. (To be provided by the customer)

(Note 1) When using an off-the-shelf LAN cable, use a 10BASE-T/100BASE-TX straight type cable compliant with US ANSI/TIA/EIA-568A Category 5. (20 m or less)

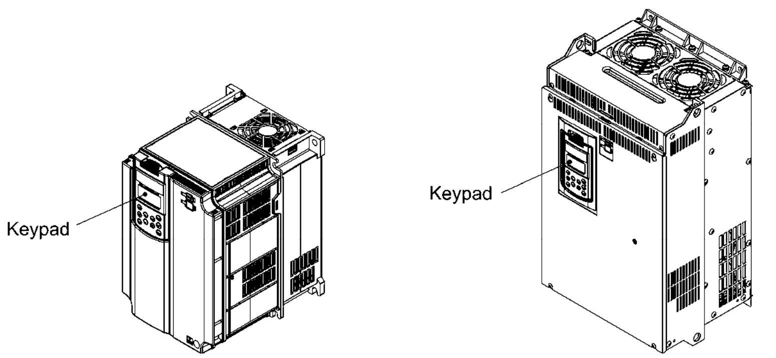
Recommended LAN cable
Manufacturer: Sanwa Supply Inc.
Model: KB-10T5-01K (1 m)
KB-STP-01K: (1 m) (Shielded LAN cable to make the inverter compliant with the EMC Directive)

(Note 2) When mounting on a panel wall, use the screws with a length suitable for the wall thickness.

3.3.4.2 Mounting procedure

You can install and/or use the keypad in one of the following three ways:

- ■ Mounting it directly on the inverter (See Figure 3.3-19 (a), (b).)
- ■ Mounting it on the panel (See Figure 3.3-20.)
- ■ Using it remotely in your hand (See Figure 3.3-21.)



(a) FRN15VG1□-2□ (b) FRN37VG1□-2□

Figure 3.3-19 Mounting the Keypad Directly on the Inverter

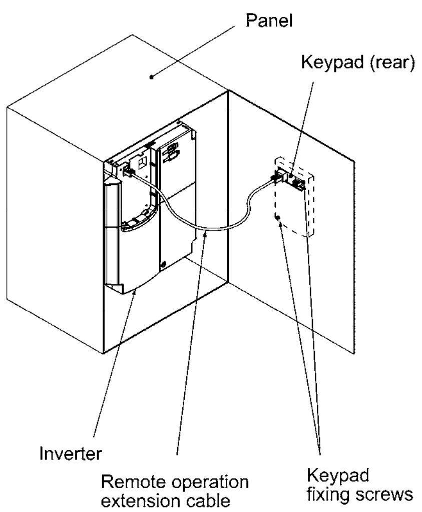


Figure 3.3-20 Mounting the Keypad on the Panel

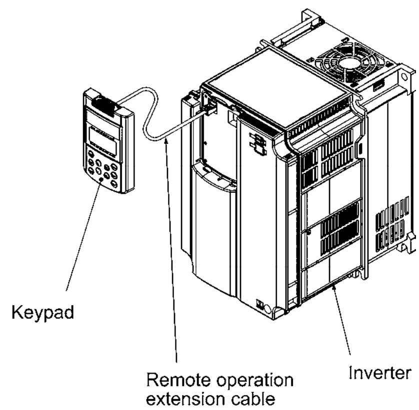


Figure 3.3-21 Using the Keypad Remotely in Your Hand

After completion of wiring, mount the keypad using the following procedure. Make sure that the inverter power is shut down beforehand.

■ **Removing and mounting the keypad from/onto the inverter**

(1) Remove the keypad by pulling it toward you with the hook held down as directed by the arrows in Figure 3.3-22.

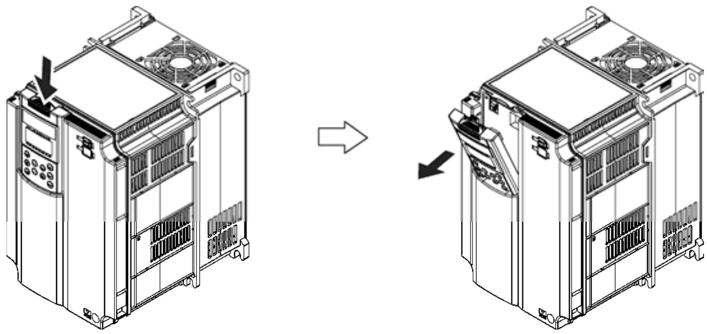


Figure 3.3-22 Removing a Keypad

(2) Put the keypad in the original slot while engaging its bottom latches with the holes (as shown below), and push it onto the case of the inverter (arrow ②) while holding it downward (against the terminal block cover) (arrow ①).

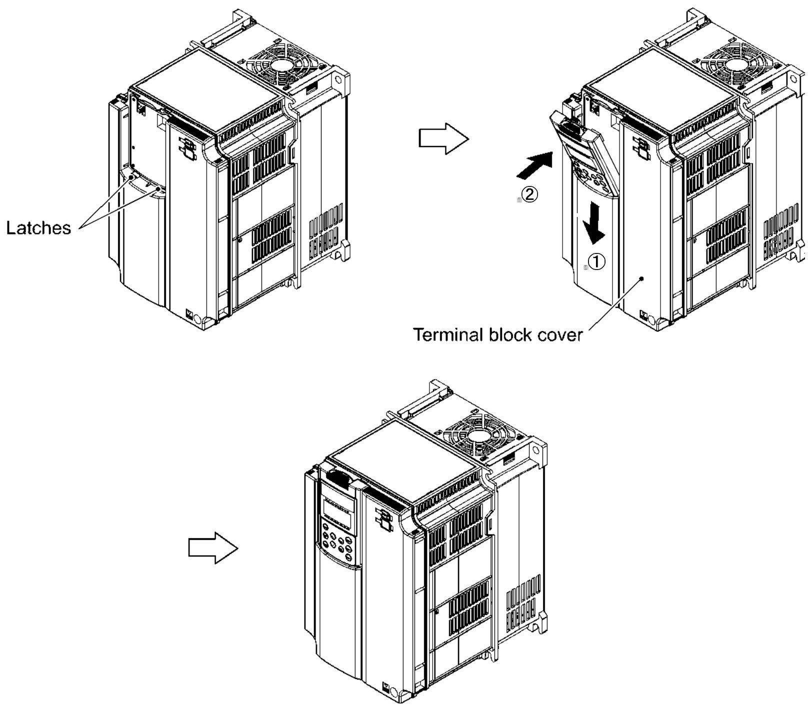


Figure 3.3-23 Mounting the Keypad

■ **Mounting the keypad on the panel**

(1) Cut the panel out for a single square area and perforate two screw holes on the panel wall as shown in Figure 3.3-24.

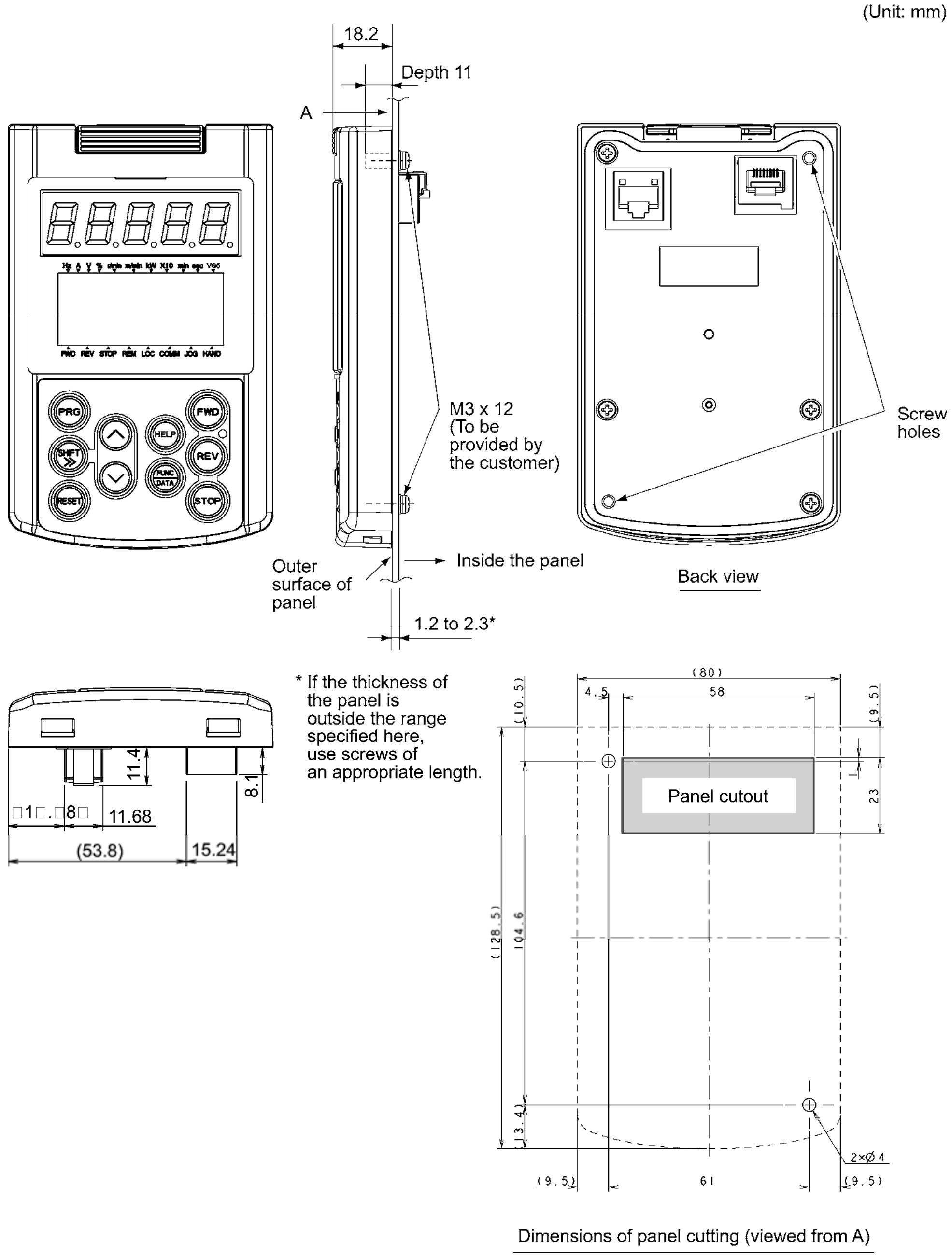


Figure 3.3-24 Location of Screw Holes and Dimension of Panel Cutout

(2) Mount the keypad on the panel wall with 2 screws as shown below. (Recommended tightening torque: 0.7 N•m)

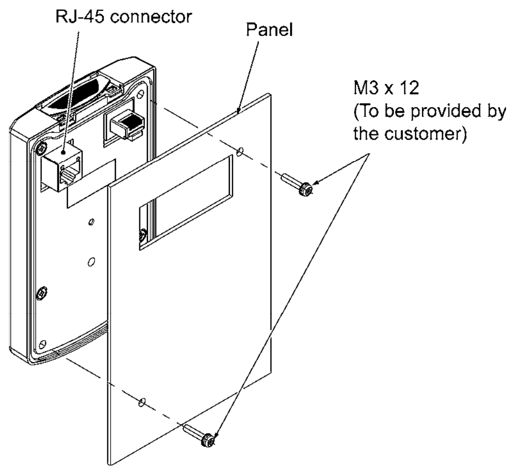


Figure 3.3-25 Mounting the Keypad

(3) Using a remote operation extension cable or a LAN cable, interconnect the keypad and the inverter (insert one end of the cable into the RS-485 port with RJ-45 connector on the keypad and the other end into that on the inverter) (See Figure 3.3-26).

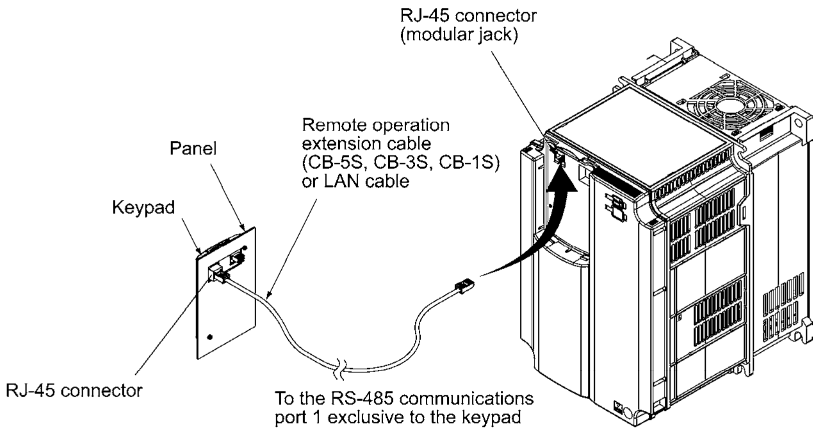


Figure 3.3-26 Connecting the Keypad to the Inverter with Remote Operation Extension Cable or an Off-the-shelf LAN Cable

⚠CAUTION

- The RJ-45 connector on the inverter is exclusive to communication via a touch panel. With the RJ-45 connector, neither RS-485 communication nor connection with FRENIC-VG Loader is possible.
- Do not connect the inverter to a LAN port of a computer, Ethernet hub, or telephone line. Doing so may damage the inverter or devices connected.

A fire or accident could occur.

■ Using the keypad remotely in hand

Follow step (3) of "Mounting the keypad on the panel" above.

3.3.5 USB connectivity

At the right side of the keypad mounting place, a USB port (mini B connector) is provided. To connect a USB cable, open the USB port cover as shown below.

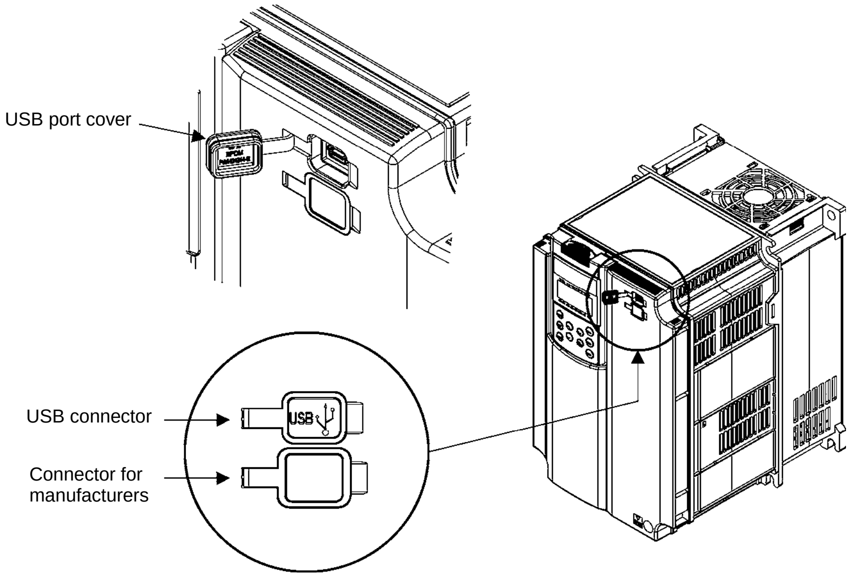


Figure 3.3-27 Connecting a USB Cable

Connecting the inverter to a PC with a USB cable enables remote control from FRENIC-VG Loader. On the PC running FRENIC-VG Loader, it is possible to edit, check and manage the inverter's function code data and monitor the real-time data and the running/alarm status of the inverter.

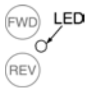
⚠CAUTION
Connector located beneath the USB connector is provided for particular manufacturers. Do not access it. **Otherwise, a fire or accident could occur.**

3.4 Operation Using the Keypad

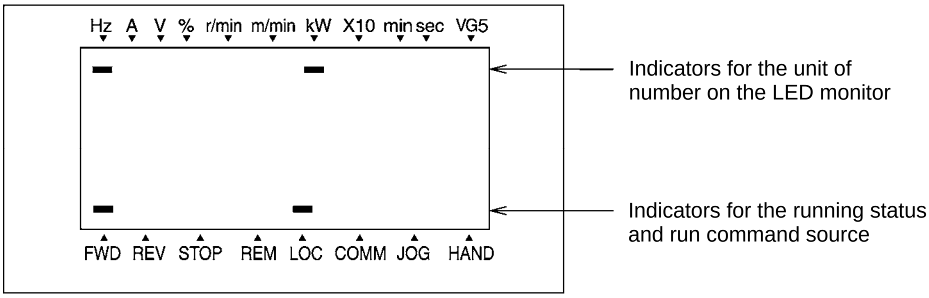
3.4.1 Names and functions of keypad components

The keypad allows you to start and stop the motor, view various data including maintenance information and alarm information, configure function codes, monitor I/O signal status, copy data, and calculate the load factor.

Table 3.4-1 Overview of Keypad Functions

Item	Monitors and Keys	Functions
Monitors		Five-digit, 7-segment LED monitor which displays the following according to the operation modes: ■ In Running mode: Running status information (e.g., detected speed, speed command, and torque command) ■ In Programming mode: Same as above. ■ In Alarm mode: Alarm code, which identifies the cause of alarm when the protective function is activated.
		LCD monitor which displays the following according to the operation modes: ■ In Running mode: Running status information ■ In Programming mode: Menus, function codes and their data ■ In Alarm mode: Alarm information, which identifies the cause of an alarm when the protective function is activated.
	Indicator indexes	In Running mode, these indexes show the unit of the number displayed on the 7-segment LED monitor and the running status information on the LCD monitor. For details, see the next page.
Programming keys	PRG	Switches the operation modes of the inverter.
	SHIFT	Shifts the cursor to the right for entry of a numerical value.
	RESET	Pressing this key after removing the cause of an alarm switches the inverter to Running mode. This key is used to reset settings or screen transition.
	∧ / ∨	UP and DOWN keys, which are used to select the setting items or change function code data.
	FUNC DATA	Function/Data key, which switches the operation mode as follows: ■ In Running mode: Pressing this key switches the information to be displayed concerning the status of the inverter (detected speed, speed command, torque command, etc.). ■ In Programming mode: Pressing this key displays the function code and establishes the newly entered data. ■ In Alarm mode: Pressing this key displays the details of the problem indicated by the alarm code that has come up on the LED monitor.
	STOP + ∧	This simultaneous keying toggles between the ordinary running mode and jogging mode. The current mode appears on the corresponding indicator.
	STOP + RESET	This simultaneous keying toggles between the remote and local modes. The current mode appears on the corresponding indicator.
	SHIFT + ∧ / ∨	This simultaneous keying jumps the cursor to the preceding/following function code group (F to M) in selecting a function code.
Operation keys	FWD	Starts running the motor in the forward rotation.
	REV	Starts running the motor in the reverse rotation.
	STOP	Stops the motor.
	HELP	Switches the screen to the operation guide display prepared for each operation mode or to the menu function guide display.
LED lamp		Lights when the inverter is running.

Details of Indicator Indexes



Type	Item	Description (information, condition, status)
Unit of number on LED monitor	Hz	Output frequency
	A	Output current
	V	Output voltage
	%	Torque command, calculated torque, and load factor
	kW	Input power and motor output
	r/min	Preset and actual (detected) motor speeds
	m/min	Preset and actual line speeds
	X10	Data exceeding 99,999
	min	Not used.
	sec	Not used.
	VG5	Not used.
Running status	FWD	Running in forward rotation
	REV	Running in reverse rotation
	STOP	No output frequency
Run command source	REM	Remote mode (Run command and speed command sources selected by F02 and F01) (In the remote mode, a run command entered via the communications link takes effect. This indicator goes off when H30 = 2 or 3.)
	LOC	Local mode (Run command and speed command sources from the keypad, independent of the setting of F02 and F01.)
	COMM	Via communications link
	JOG	Jogging mode
	HAND	Via keypad This indicator lights also: - in local mode or - in remote mode and when H30 = 0 and F02 = 0

3.4.2 Overview of operation modes

The FRENIC-VG features the following three operation modes.

Table 3.4-2 Operation Modes

Mode	Description
Running Mode	This mode allows you to specify run/stop commands in regular operation. It is also possible to monitor the running status in real time. If a light alarm occurs, the L-AL* appears on the LED monitor.
Programming Mode	This mode allows you to configure function code data and check a variety of information relating to the inverter status and maintenance.
Alarm Mode	If an alarm condition arises, the inverter automatically enters the Alarm mode in which you can view the corresponding alarm code* and its related information on the LED and LCD monitors.

* Alarm code that represents the cause(s) of the alarm(s) that has been triggered by the protective function. For details, refer to Chapter 2, Section 2.5 "Protective Functions."

Figure 3.4-1 shows the status transition of the inverter between these three operation modes.

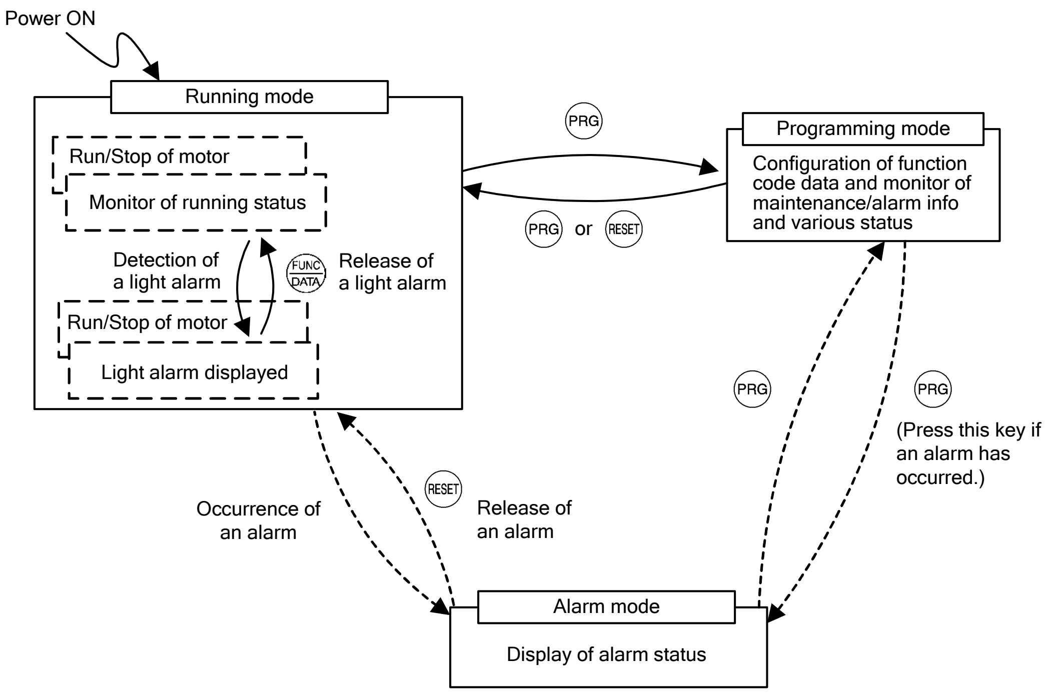


Figure 3.4-1 Status Transition between Operation Modes

3.4.3 Running mode

When the inverter is turned ON, it automatically enters Running mode in which you can:

[1] Configure speed commands,
[2] Run or stop the motor,
[3] Monitor the running status,
[4] Jog (inch) the motor, and
[5] Monitor light alarms.

3.4.3.1 Configuring the speed command

Using ∧ and ∨ keys (F01 = 0 (factory default))

(1) Set function code F01 at "0". This cannot be done when the keypad is in Programming mode or Alarm mode. To enable speed setting using the ∧ and ∨ keys, first switch the keypad to Running mode.

(2) Press the ∧ or ∨ key. The lowest digit on the LED monitor blinks. The 7-segment LED monitor displays the speed command and the LCD monitor displays the related information including the operation guide, as shown below.

(3) Press the ∧ or ∨ key again to change the frequency command. The new setting can be saved into the inverter's internal memory.

When the speed command source is other than digital setting, the LCD monitor displays the following.

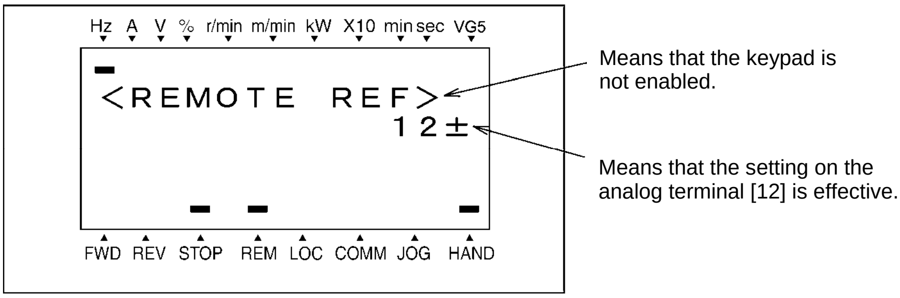


Table 3.4-3 lists the available command sources and their symbols.

Table 3.4-3 Available Command Sources

Symbol	Command source	Symbol	Command source	Symbol	Command source
HAND	Keypad	DIB	DIB card	PID-AI	PID analog input command Ai
12 ±	Voltage input on terminal [12] (with polarity)	MULTI	Terminal command ***SS8***, ***SS4***, ***SS2***, ***SS1*** ("Select multistep speed")	PID-HAND	PID keypad command
12	Voltage input on terminal [12] (without polarity)	LINK	Terminal command ***LE*** ("Enable communications link") H30: Communications Link Function (Link operation)	JOG	Jogging speed
U/D1	UP/DOWN control (Default = 0)	UPAC	UPAC SW1 (Speed command 1): Enable (Available soon)	LOADER	Inverter support software "FRENIC-VG Loader"
U/D2	UP/DOWN control (Default = Previous value)	PTI	Terminal command ***SYN*** ("Synchronous operation command (pulse train)"): Enable	AI-V	Voltage input on analog input terminal ***N-REFV***
U/D3	UP/DOWN control (Default = CRP1, 2)	ORT	Orientation (Available soon)	LOCAL	Keypad in local mode
DIA	DIA card	LOCK	Terminal command ***LOCK*** ("Servo-lock command")	AI-C	Current input on analog input terminal ***N-REFC***

3.4.3.2 Running or stopping the motor

By factory default, pressing the FWD key starts running the motor in the forward direction and pressing the REV key, in the reverse direction. Pressing the STOP key decelerates the motor to stop. The keypad operation is possible only in Running and Programming modes.

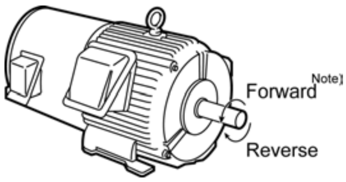


Figure 3.4-2 Rotation Direction of Motor

Note) The rotation direction of IEC-compliant motors is opposite to the one shown above.

■ **Displaying the running status on the LCD monitor**

(1) When function code F57 (LCD monitor, Item selection) = 0

The LCD monitor displays the current running status, the run command, and the date & time (calendar clock)*. (The upper indicators show the unit of values shown on the LED monitor, and the lower indicators, the running status and run command source.)

* If no backup battery is loaded (option for inverters of 22 kW or below), turning the power OFF resets the calendar clock.

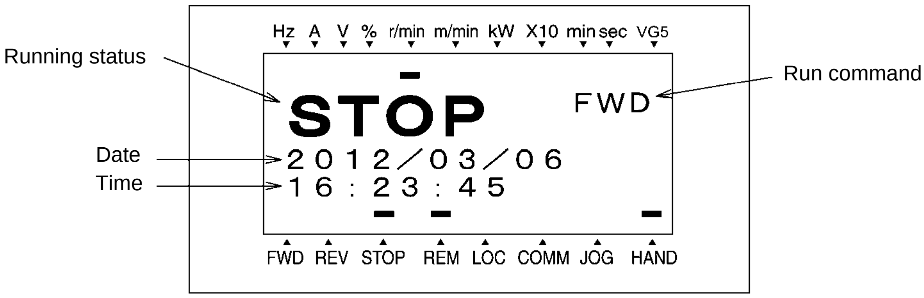


Figure 3.4-3 Display of Running Status

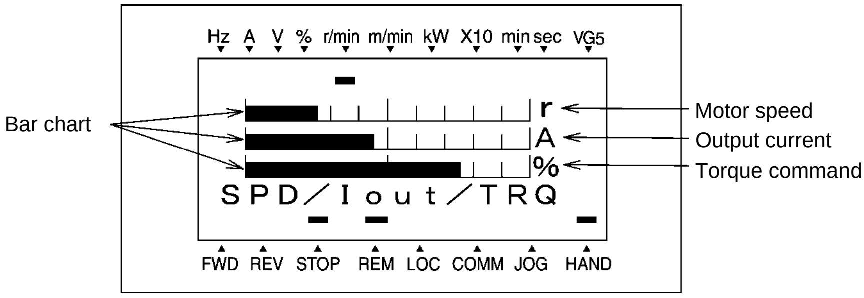
The running status and the run command are displayed as listed below.

Table 3.4-4 Running Status and Run Commands

Running mode display items	Meaning
Running status	RUN: The inverter is running. STOP: No run command is given and the inverter is stopped. JOG: The inverter is jogging.
Run commands	FWD: Run forward command entered. REV: Run reverse command entered. Blank: The inverter is stopped.

(2) <u>When function code F57 (LCD monitor, Item selection) = 1</u>

The LCD monitor displays the motor speed, output current, and torque command in a bar chart. (The upper indicators show the unit of the value shown on the LED monitor, and the lower indicators, the running status and run command source.)



The full scale (maximum value) for each parameter is as follows:

Motor speed:	Maximum frequency
Output current:	200% of motor rating
Torque command:	200% of motor rating

Figure 3.4-4 Bar Chart

3.4.3.3 Monitoring the running status on the LED monitor

The items listed below can be monitored on the 7-segment LED monitor. Immediately after the power is turned ON, the monitor item specified by function code F55 is displayed.

Pressing the FUNC/DATA key in Running mode switches between monitor items in the sequence shown in Table 3.4-5.

Table 3.4-5 Monitor Items

Page #	LED monitor: Running	LED monitor: Stopped	Digital setting mode: Digital speed setting	Digital setting mode: PID command	Unit	Resolution
0	MOTOR SPEED 1 *1	REFERENCE SPEED 4 *1	Speed command from keypad	PID command from keypad	r/min	0 to 9999: resolution 1 10000 to 30000: 10
1	REFERENCE SPEED 4 *1				r/min	
2	OUTPUT FREQUENCY				Hz	0.1 to 400.0: resolution 0.1
3	REFERENCE TORQUE CURRENT				%	1%
4	REFERENCE MOTOR TORQUE				%	1%
5	CAL MOTOR TORQUE *2				%	1%
6	MOTOR OUTPUT POWER (kW)				F60 = 0 (kW) F60 = 1 (HP)	0.01 to 99.99: 0.01 100.0 to 999.9: 0.1 1000 or above : 1
7	OUTPUT CURRENT				A	
8	OUTPUT VOLTAGE				V	1 V
9	DC LINK VOLTAGE				V	1 V
10	REFERENCE MAGNETIC FLUX				%	1%
11	CAL MAGNETIC FLUX				%	1%
12	MOTOR TEMPERATURE *3				-	1
13	LOAD SHAFT SPEED *4	LOAD SHAFT SPEED *4	Load speed command from keypad		r/min	1
14	LINE SPEED *4	LINE SPEED *4	Speed command from keypad		m/min	1
15	Ai (12) ADJUSTMENT				%	0.1%
16	Ai (Ai1) ADJUSTMENT				%	0.1%
17	Ai (Ai2) ADJUSTMENT				%	0.1%
18	Ai (Ai3) ADJUSTMENT *5				%	0.1%
19	Ai (Ai4) ADJUSTMENT *5				%	0.1%
20	PID REFERENCE *6				-	0.00 to ±9.99: 0.01 10.0 to ±99.9: 0.1 100 to ±999: 1
21	PID FEEDBACK *6					
22	PID OUTPUT *6					
23	OPTION MONITOR 1 (hex.) *7				in hexadecimal	1
24	OPTION MONITOR 2 (hex.) *7				in hexadecimal	1
25	OPTION MONITOR 3 (dec.) *7				in decimal	1, x 10
26	OPTION MONITOR 4 (dec.) *7				in decimal	1, x 10
27	OPTION MONITOR 5 (dec.) *7				in decimal	1, x 10
28	OPTION MONITOR 6 (dec.) *7				in decimal	1, x 10
29	-				-	-
30	LOAD FACTOR *1				%	1%
31	INPUT POWER				F60 = 0 (kW) F60 = 1 (HP)	0.01 to 99.99: 0.01 100.0 to 999.9: 0.1 1000 or above : 1
32	WATT-HOUR (Display value = Input watt-hour (kWh)/100)				kWh	0.1

*1 Shown as an absolute value.
*2 Under vector control, the inverter outputs the torque value to which the compensation for motor loss (iron loss) is added.
*3 "---" appears when no NTC thermistor is used.
*4 Limited to a maximum of 60,000 in display.
*5 Not shown when no AIO option is mounted.
*6 Not shown when the PID control is disabled.
*7 Shown or not shown, depending upon application. Option monitors 5 and 6 have a sign; option monitors 3 and 4 have not.

The LCD monitor (given below) shows information related to the item shown on the LED monitor. The monitor item on the LED monitor can be switched by pressing the FUNC/DATA key.

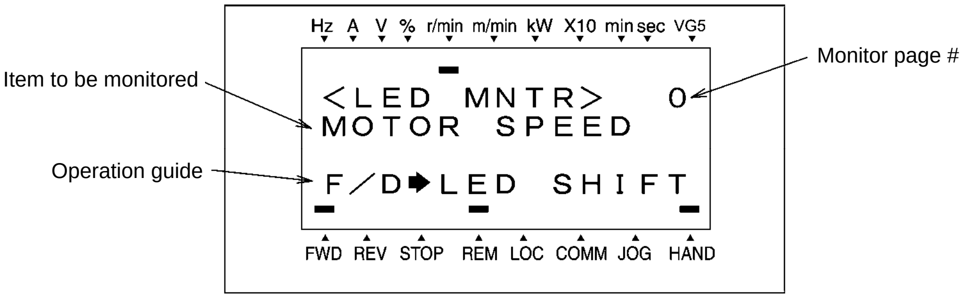


Figure 3.4-5 LCD Monitor Sample Detailed for the LED Monitor Item

3.4.3.4 Jogging (inching) the motor

To start jogging operation, perform the following procedure.

(1) Make the inverter ready to jog with the steps below.

1) Switch the inverter to Running mode.

2) Press the "STOP + ⋀ keys" simultaneously. The lower indicator above the "JOG" index comes ON.

(2) Jog the motor.

While the FWD or REV key is held down, the motor continues jogging. Releasing the key decelerates the motor to stop.

(3) Make the inverter exit from the ready-to-jog state and return to the normal operation state.

Press the "STOP + ⋀ keys" simultaneously. The lower indicator above the "JOG" index goes OFF.

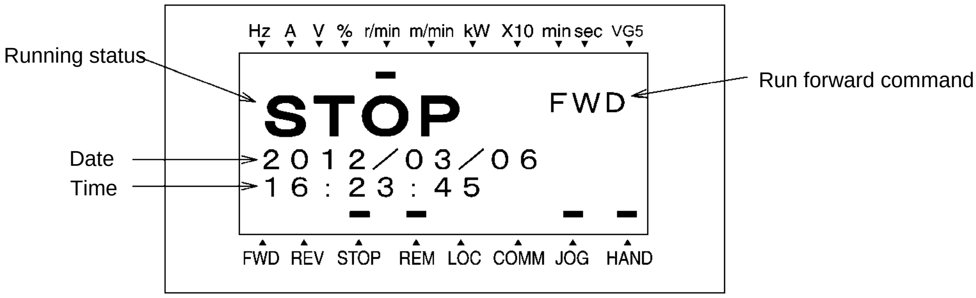


Figure 3.4-6 Display of Jogging Mode

3.4.3.5 Monitoring light alarms

The inverter identifies abnormal states in two categories--Heavy alarm and Light alarm. If the former occurs, the inverter immediately trips; if the latter occurs, the inverter shows the L-AL on the LED monitor and blinks the "L-ALARM" indication in the operation guide area on the LCD monitor but it continues to run without tripping.

Which abnormal states are categorized as a light alarm ("Light alarm" object) should be defined with function codes H106 to H111 beforehand.

Assigning the ***L-ALM*** signal to any one of the general-purpose, digital output terminals with any of function codes E15 to E27 (data = 57) enables the inverter to output the ***L-ALM*** signal on that terminal upon occurrence of a light alarm.

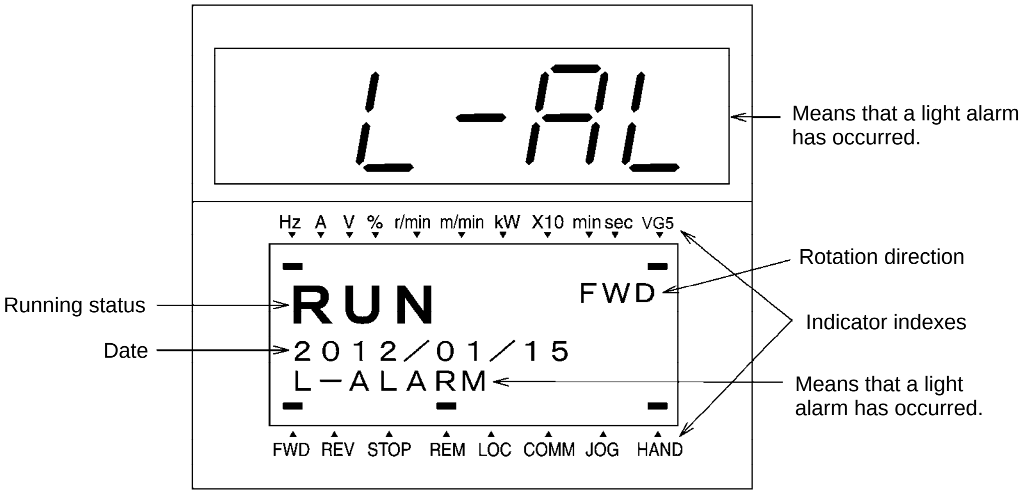


Figure 3.4-7 Display of Light Alarm

For details of the light alarm factors, refer to Chapter 13 "TROUBLESHOOTING."

■ **How to check a light alarm factor**

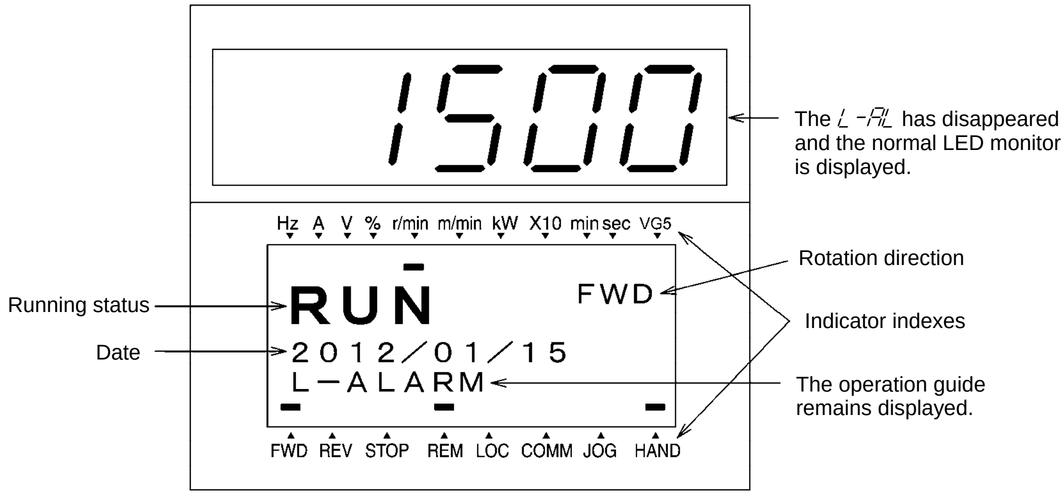
If a light alarm occurs, L-AL appears on the LED monitor. To check the current light alarm factor, switch to Programming mode by pressing the PRG key and select LALM1 on Menu #5 "Maintenance Information." For details of the menu transition of the maintenance information, refer to Section 3.4.4.6 "Reading maintenance information."

It is also possible to check the factors of the last three light alarms by selecting LALM2 (last) to LALM4 (3rd last).

■ How to remove the current light alarm

After checking the current light alarm, to switch the LED monitor from the L-AL indication back to the running status display, press the FUNC/DATA key in Running mode. To reset a light alarm via the communications link, use an alarm reset signal.

If the light alarm factor has been removed, the "L-ALARM" disappears and the ***L-ALM*** output signal turns OFF. If not (e.g. DC fan lock), the L-AL on the LED monitor disappears so that normal monitoring becomes available, but the "L-ALARM" remains displayed on the LCD monitor (as shown below) and the ***L-ALM*** output signal remains ON.



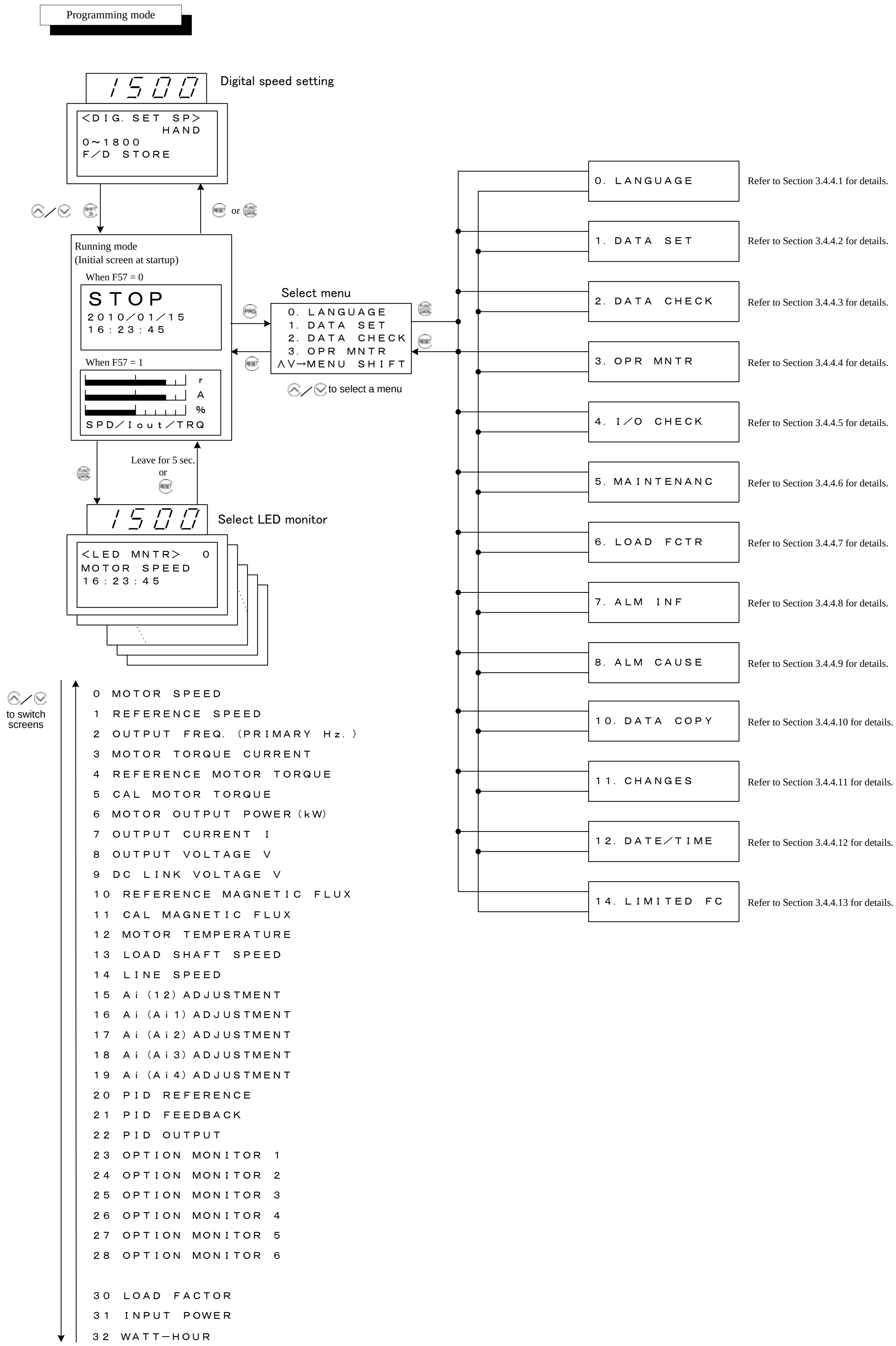
3.4.4 Programming mode

Programming mode allows you to set and check function code data and monitor maintenance information and input/output (I/O) signal status. The functions can be easily selected with a menu-driven system. Table 3.4-6 lists menus available in Programming mode.

Table 3.4-6 Menus Available in Programming Mode

Menu #	Menu	Used to:	Refer to Section:
0	Selecting language (LANGUAGE)	Change the display language on the LCD monitor.	3.4.4.1
1	Configuring function codes (DATA SET)	Display and change the data of the function code selected.	3.4.4.2
2	Checking function code data (DATA CHECK)	Display a function code and its data on the same screen. Also this menu is used to change the function code data or check whether the data has been changed from the factory default.	3.4.4.3
3	Monitoring the running status (OPR MNTR)	Display the running information required for maintenance or test running.	3.4.4.4
4	Checking I/O signal status (I/O CHECK)	Display external interface information.	3.4.4.5
5	Reading maintenance information (MAINTENANCE)	Display maintenance information including cumulative run time.	3.4.4.6
6	Measuring load factor (LOAD FCTR)	Measure the maximum output current, average output current, and average braking power.	3.4.4.7
7	Reading alarm information (ALM INF)	Display recent four alarm codes. Also this menu is used to view the information on the running status at the time the alarm occurred.	3.4.4.8
8	Viewing causes of alarm (ALM CAUSE)	Display the cause of the alarm.	3.4.4.9
9	Reading communications information (COMM INFO)	(Available soon.)	-
10	Copying data (DATA COPY)	Read or write function code data, as well as verifying it.	3.4.4.10
11	Checking changed function codes (CHANGES)	Display only the function code data that has been changed from the factory default.	3.4.4.11
12	Setting the calendar clock (DATE/TIME)	Display/hide the date and time and adjust the display format and data.	3.4.4.12
13	Compatibility with conventional inverter models (FORMER INV)	Not supported.	-
14	Limiting function codes to be displayed (LIMITED FC)	• Select whether to display all function codes or limited ones (selected in Loader). • Cancel the directory structure of function codes.	3.4.4.13

The screen transition and hierarchy structure in Running and Programming modes are shown below.



* If the screen system is password-protected, no menu can be selected until you enter the password.

■ Menu screen

Pressing the PRG key in Running mode calls up the menu screen.

Select the target menu by moving the cursor (flashing rectangle) with ∧/∨ key.

■ Configuring function code data

Figure 3.4-8 shows the LCD screen transition for Menu #0 "DATA SET."

A hierarchy exists among those screens that are shifted in the order of "Menu screen," "List of function code groups," and "List of function codes."

On the modification screen of the target function code, you can modify or check its data.

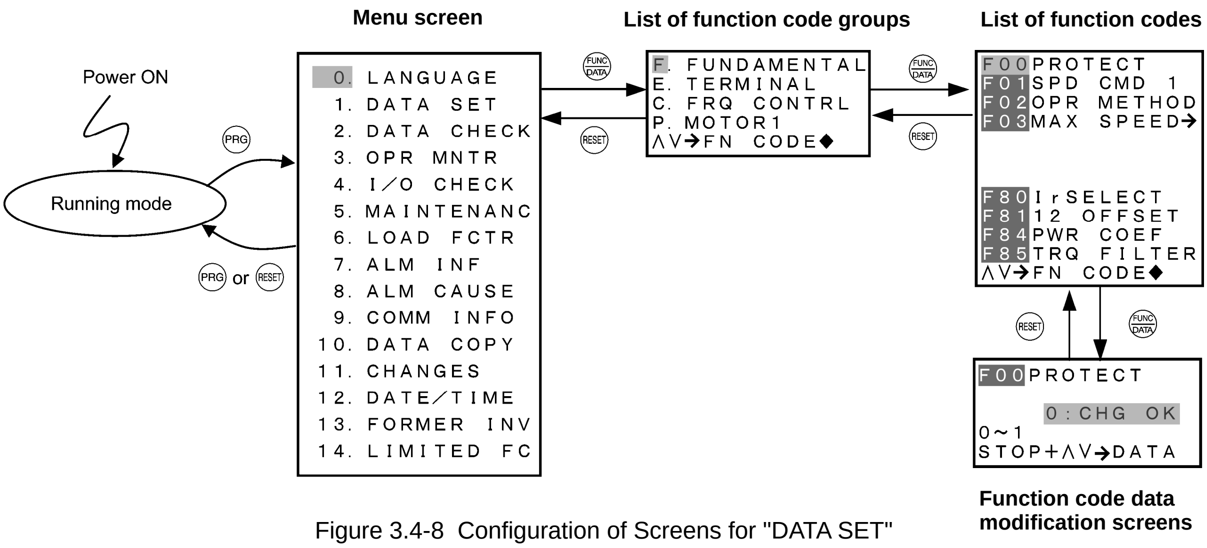
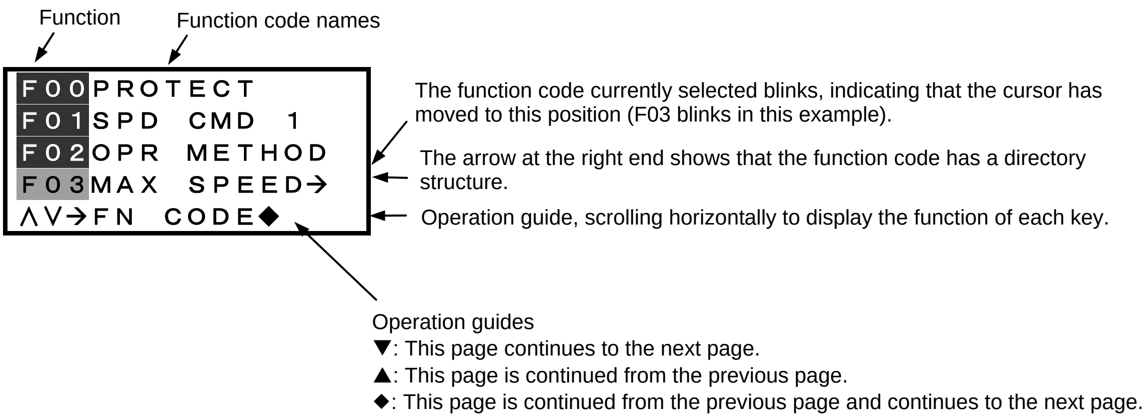


Figure 3.4-8 Configuration of Screens for "DATA SET"

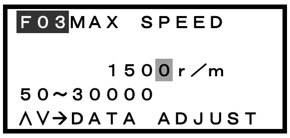
■ Screen samples for changing function code data

The "list of function codes" shows function codes, their names, and operation guides.



The "function code data modification screen" shows the function code, its name, its data (before and after change), allowable entry range, and operation guides.

<Before change>



<Changing data>

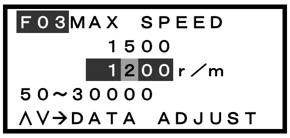


Figure 3.4-9 Screen Samples for Changing Function Code Data

Simultaneous keying of "(SHIFT) + (HELP) keys" switches the lower portion of the screen from the allowable entry range to the factory default. The same simultaneous keying switches it back to the allowable entry range.

A function code consists of an alphabet denoting a function code group and numerals.

Table 3.4-7 Function Code List

Function Code Group	Function	Description
F codes (Fundamental functions)	Fundamental functions	Functions to be used for basic motor running
E codes (Extension terminal functions)	Terminal functions	Functions concerning the selection of operation of the control circuit terminals; Functions concerning the display on the LED monitor
C codes (Control functions of frequency)	Control functions	Functions associated with speed settings
P codes (Motor 1 parameters)	Motor 1 parameters	Functions for configuring characteristics parameters (such as capacity) of the 1st motor
H codes (High performance functions)	High-level functions	Highly added-value functions; Functions for sophisticated control
A codes (Motor 2, 3 parameters)	Motor 2 parameters Motor 3 parameters	Functions for configuring characteristics parameters (such as capacity) of the 2nd or 3rd motor
o codes (Option functions)	Optional functions	Functions concerning optional features (The o codes are displayed only when the corresponding option is mounted on the inverter.)
L codes (Lift functions)	Vertical carrier machine functions	Functions to be used for vertical carrier machines
U codes (User functions)	User-defined functions	Functions to be used for UPAC option cards, etc.
SF code (Safety functions)	Safety functions	Functions concerning the safety card OPC-VG1-SAFE
S codes (Command functions)	Command data	These function codes can be modified via the integrated RS-485 interface or filedbus options (e.g., T-Link, SX-bus). The S fields are write-only and the M fields, read-only.
M codes (Monitor functions)	Monitor data	

■ Function codes requiring simultaneous keying

To modify the data for function code F00 (Data protection), H01 (Auto-tuning), H02 (Full save function), H03 (Data initialization), H142 (Mock alarm), L01 (Password data 1) or L02 (Password data 2), simultaneous keying of "STOP + ∧ keys" or "STOP + ∨ keys" is required.

■ Changing, validating, and saving function code data when the invert is running

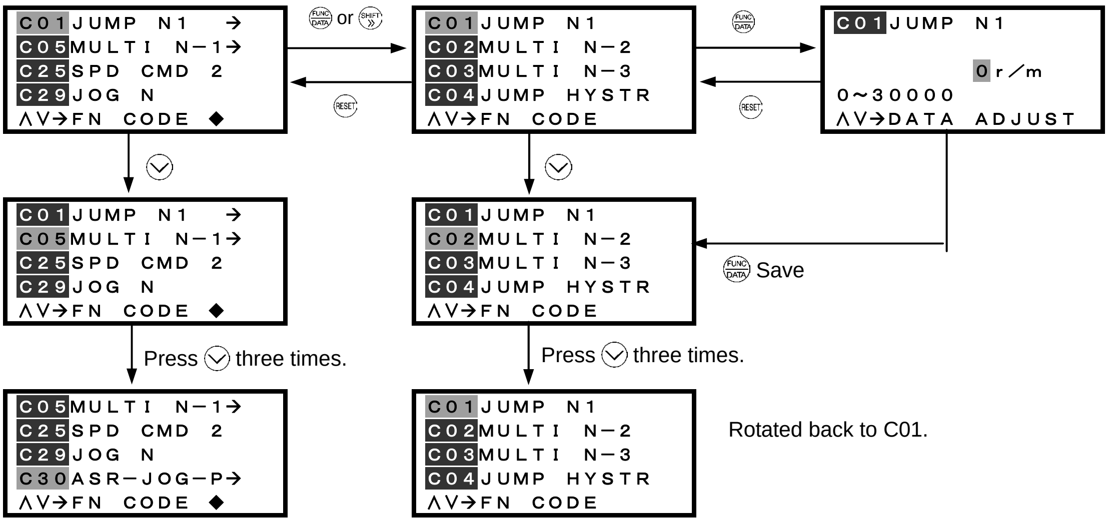
Some function codes can be modified while the inverter is running, whereas others cannot. Further, depending on the function code, modifications may or may not become effective immediately. For details, refer to the "Change when running" column in Chapter 4, Section 4.2.3.

■ Keypad directory structure

The keypad has a directory structure that includes the related function codes in a directory to make it easy to select a target function code from many function codes.

For example, function codes C01 to C04 are all related with the mechanical resonance point of the load and treated as the same function so that C02 to C04 are not located in the parent directory. At the right of C01, "→" appears indicating that C01 has a child directory. To access the child directory, move the cursor to that function code using the ∧ and ∨ keys and then press the FUNC/DATA or SHIFT key.

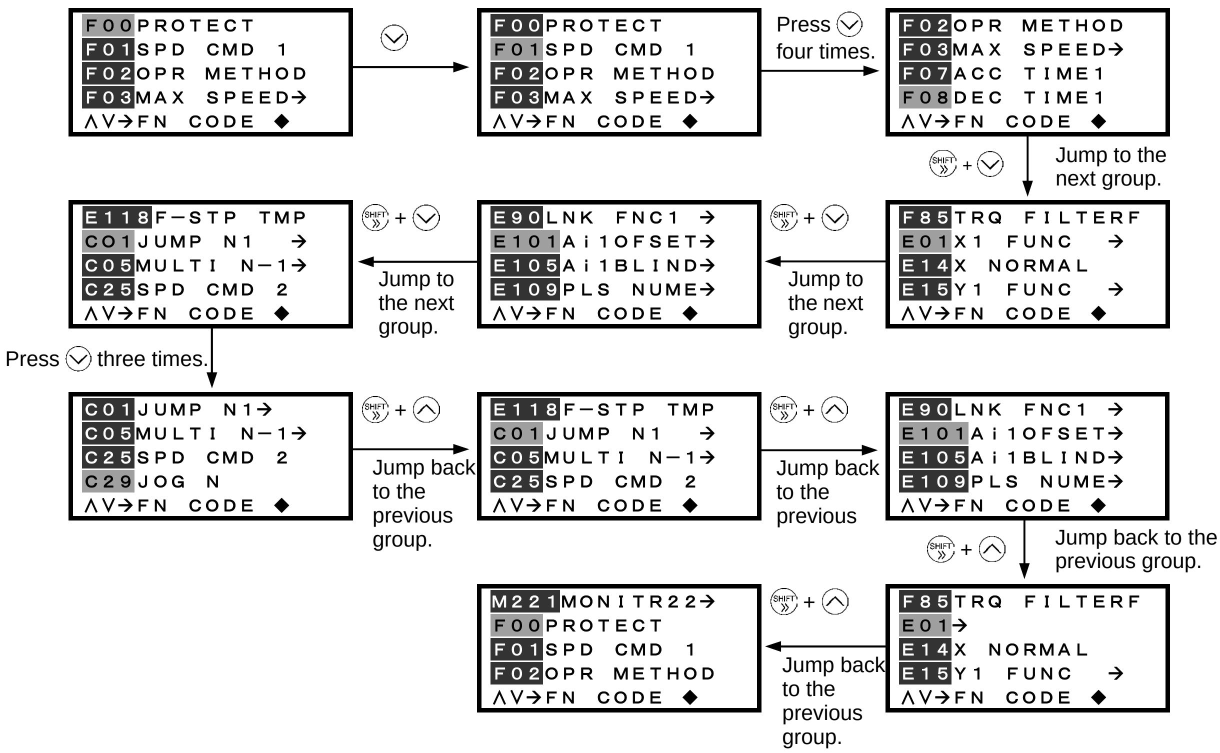
An example of selecting a function code with a child directory



■ Jumping by function code group

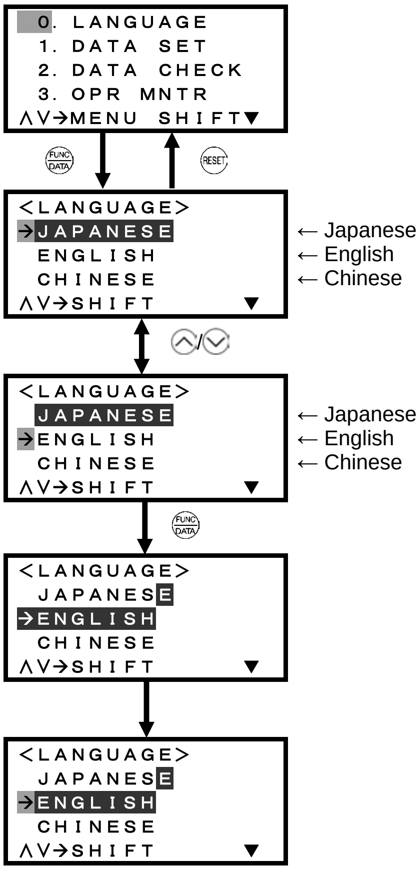
To call up a function code in a different group (E to M), press the SHIFT and ∧ keys or SHIFT and ∨ keys simultaneously to jump to the previous or next function code group.

In the case of a function code group having 100 or more function codes, this function jumps function codes in units of 100. (For example, F00 ⇒ E01 ⇒ E101 ⇒ • • •)



3.4.4.1 Selecting language -- Menu #0 "LANGUAGE"

Menu #0 "LANGUAGE" in Programming mode is used to select the display language from a choice of four languages (English, Japanese, Chinese and Korean) on the LCD monitor.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode.

Move the cursor at the left of the screen to "0. LANGUAGE" using the ∧ and ∨ keys. Then press the FUNC/DATA key to switch to the language selection screen.

Move the pointer → to the desired language using the ∧ and ∨ keys.

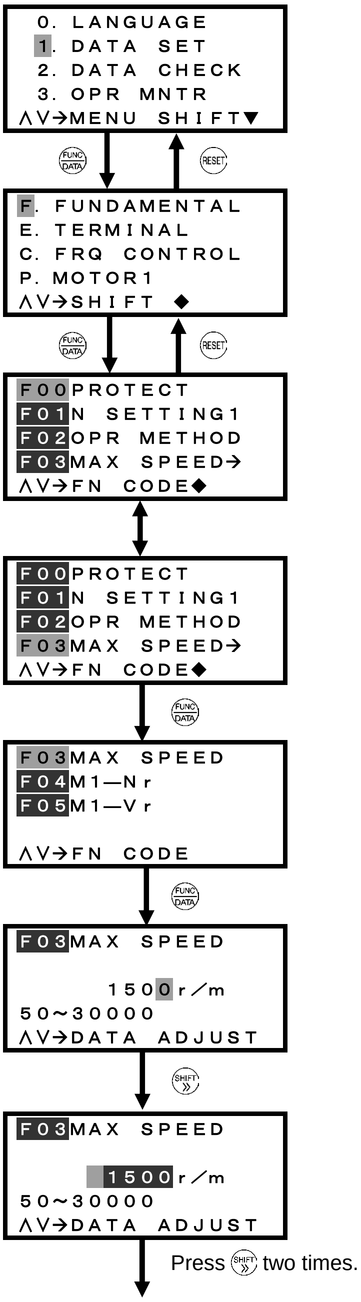
Press FUNC/DATA key to establish the selected language.

After a second, the screen automatically switches back to the submenu.

3.4.4.2 Configuring function codes -- Menu #1 "DATA SET"

Menu #1 "DATA SET" in Programming mode is used to configure function codes.

This section gives a description of the basic key operation, following the example of the data changing flow shown below. This example shows how to change F03 data (M1 maximum speed) from 1500 r/min to 1200 r/min.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode. Move the cursor (flashing rectangle) at the left of the screen to "1. DATA SET" using the ∧ and ∨ keys. Then press the FUNC/DATA key to switch to the function code configuration screen.

Function code groups (F, E, C, P…) appear.
Move the cursor to the desired function code group using the ∧ and ∨ keys.

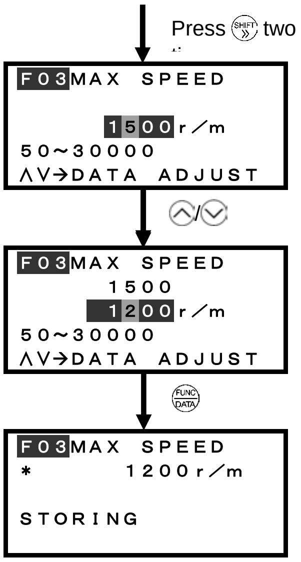
Move the cursor to the desired function code using the ∧ and ∨ keys.
At the right of F03, "→" appears indicating that F03 has a child directory. To access the child directory, move the cursor to that function code using the ∧ and ∨ keys and then press the FUNC/DATA or SHIFT key.

Press the FUNC/DATA key to move to the lower directory.

Press the FUNC/DATA key to establish the desired function code.

Press the SHIFT key to move the cursor from the units place to the ten-thousands place.

Press the SHIFT key to move the cursor from the ten-thousands place to the hundreds place.



Change the function code data using the ⌃ and ⌄ keys.
(In this example, change from 1500 r/min to 1200 r/min.)

Press the FUNC/DATA key to establish the function code data.

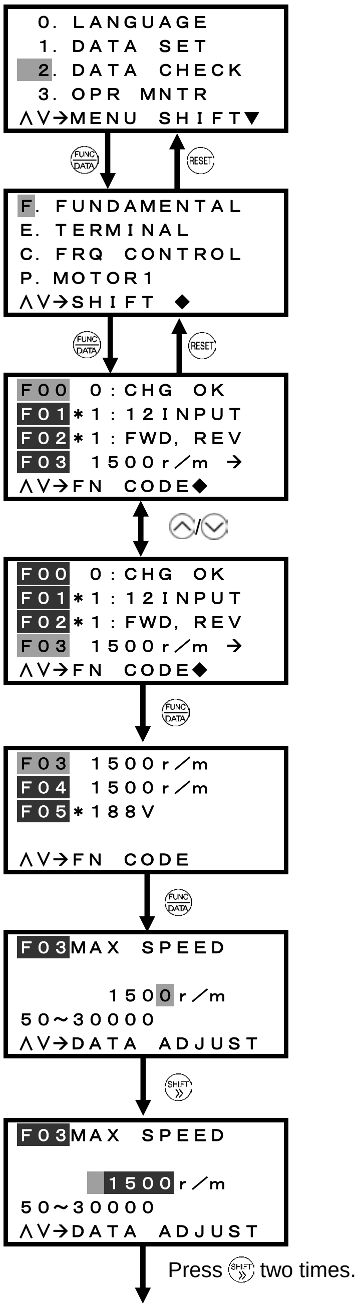
3.4.4.3 Checking function code data -- Menu #2 "DATA CHECK"

Menu #2 "DATA CHECK" in Programming mode is used to check function codes (together with their data) that have been changed. The function codes whose data have been changed from factory defaults are marked with ∗.

This section gives a description of the basic key operation, following the example of the data checking flow shown below. This example shows how to change F03 data (M1 maximum speed) from 1500 r/min to 1200 r/min.

In any of the following cases, change of function code data will be saved only into the volatile memory (RAM) and not be saved into the non-volatile memory. Such data is displayed with white letters on black background.

- After tuning, the full save function is not performed (H02 ≠ 1).
- After changing function code data via the communications link, the full save function is not specified (H02 ≠ 1).
- When terminal command ***LU-CCL*** ("Cancel undervoltage alarm") on any X terminal is enabled, function code data is changed.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode. Move the cursor (flashing rectangle) at the left of the screen to "2. DATA CHECK" using the ∧ and ∨ keys. Then press the FUNC/DATA key to switch to the function code configuration screen.

Function code groups (F, E, C, P…) appear.
Move the cursor to the desired function code group using the ∧ and ∨ keys.

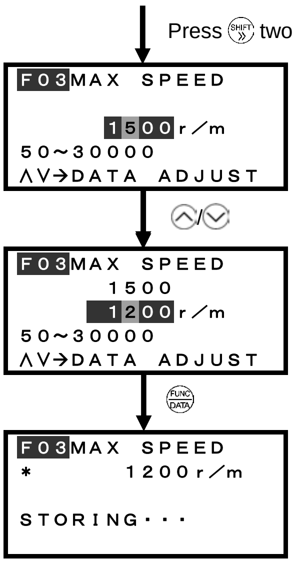
The function codes whose data has been changed from factory defaults are marked with an asterisk (*).

Move the cursor to the desired function code using the ∧ and ∨ keys.
At the right of F03, → appears indicating that F03 has a child directory. To access the child directory, move the cursor to that function code using the ∧ and ∨ keys and then press the FUNC/DATA or SHIFT key.

Press the FUNC/DATA key to move to the lower directory.

Press FUNC/DATA key to establish the desired function code.

Press the SHIFT key to move the changeable digit place (blinking), then change the function code data using the ∧ and ∨ keys.



Press key to establish the function code data.

3.4.4.4 Monitoring the running status -- Menu #3 "OPR MNTR"

Menu #3 "OPR MNTR" in Programming mode is used to check the running status during maintenance and test running.

```
 0. LANGUAGE
 1. DATA SET
 2. DATA CHECK
 3. OPR MNTR
∧∨→MENU SHIFT▼
```

To display this menu screen, press the (PRG) key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "3. OPR MNTR" using the (∧) and (∨) keys. Then press the (FUNC/DATA) key.

(FUNC/DATA) ↓ ↑ (RESET)

```
N*=×××××.×r/m
N =×××××.×r/m
f* =××××.×Hz
TRQ=××××.×%
∧∨→PAGE SHIFT 1
```

← Reference speed
← Motor speed
← Output frequency
← Reference motor torque

↕ (∧)/(∨)

```
TMP =   ±×××℃
Iout=×××.××A
Vout=   ×××V
FLX*=   ×××%
∧∨→PAGE SHIFT 2
```

← Motor temperature ("---" appears when no NTC thermistor is used.)
← Output current
← Output voltage
← Reference magnetic flux

↕ (∧)/(∨)

```
(1)  (2)  (3)
(4)   (5)
(6)  (7)  (8)  (9)
(10)  (11)
∧∨→PAGE SHIFT 3
```

(1) Current rating (2) Speed command source (3) PID control
(4) Motor selected (5) Drive control
(6) Run command (7) Current limit (8) Undervoltage/Voltage limit (9) Torque limit
(10) Run command source (11) Cause of trip

* For details, refer to Table 3.4-8.

↕ (∧)/(∨)

```
N  =××××.×r/m
LOD=××××.×r/m
LIN=××××.×m/m
SY-d= ×××
∧∨→PAGE SHIFT 4
```

← Motor speed
← Load shaft speed
← Line speed detection value
← Deviation in SY synchronous operation (This page is available soon.)

↕ (∧)/(∨)

```
SV  =×××.×
PV  =×××.×
MV  =×××.×
INTNL N-REF
∧∨→PAGE SHIFT 5
```

← PID command value
← PID feedback amount
← PID output value
← (12) PID command source (13) PID output destination
* For details, refer to Table 3.4-8.

↕ (∧)/(∨)

```
P  =×××.×p
E  =×××.×p
dP =×××.×p
MODE:
∧∨→PAGE SHIFT 6
```

← Current position pulse for position control (This page is available soon.)
← Target position pulse for position control
← Current deviation pulse for position control
← Position control status

↕ (∧)/(∨)

∧/∨

```
P4  =××××××××p
E4  =××××××××p
dp4=××××××××p
MODE:
∧∨→PAGE SHIFT 7
```

← 4-multiplied, current position pulse for position control (This page is available soon.)
← 4-multiplied, target position pulse for position control
← 4-multiplied, current deviation pulse for position control
← Position control status

∧/∨

```
ETI1=      ×××%
ETI2=      ×××%
ETI3=      ×××%

∧∨→PAGE SHIFT 8
```

← Remaining allowance for M1 motor overload (When it counts down to 0%, OL1 alarm is issued.)
← Remaining allowance for M2 motor overload (When it counts down to 0%, OL1 alarm is issued.)
← Remaining allowance for M3 motor overload (When it counts down to 0%, OL1 alarm is issued.)

Table 3.4-8 Running Status Items

	Symbol	Item	Description
(1)	HD	Current rating	HD (High Duty) mode selected (F80 = 0, 2)
	MD		MD (Medium Duty) mode selected (F80 = 3)
	LD		LD (Low Duty) mode selected (F80 = 1)
(2)	HAND	Speed command source	Keypad
	12±		Voltage input on terminal [12] (with polarity)
	12		Voltage input on terminal [12] (without polarity)
	U/D1		UP/DOWN control (Default = 0)
	U/D2		UP/DOWN control (Default = Previous value)
	U/D3		UP/DOWN control (Default = CPR1, 2)
	MULTI		Terminal command ***SS8***, ***SS4***, ***SS2***, ***SS1*** ("Select multistep speed")
	LINK		Terminal command ***LE*** ("Enable communications link via RS-485 or fieldbus") H30: Communications Link Function (Mode selection)
	PTI		Terminal command ***SYC*** ("Synchronization command") enabled
	LOCK		Terminal command ***LOCK*** ("Servo-lock command")
	JOG		Jogging speed
	LDR		"FRENIC-VG Loader"
	AI-V		Voltage input on analog input terminal AI-V
	AI-C		Current input on analog input terminal AI-C
	LOCAL		Keypad in local mode
(3)	----	PID control	PID control disabled
	PID		PID control enabled
(4)	M1	Motor selected	Motor 1 selected
	M2		Motor 2 selected
	M3		Motor 3 selected
(5)	PG_V	Drive control	Vector control with speed sensor
	SENS_LES		Vector control without speed sensor
	EMU		Simulation mode
	PMPG		Vector control for PMSM with speed sensor
	V/F		V/f control for IM
	MW_PGV_M		Vector control for IM with speed sensor (Multiwinding motor) (Master)
	MW_PGV_S		Vector control for IM with speed sensor (Multiwinding motor) (Slave)
	MW_LES_M		Vector control for IM without speed sensor (Multiwinding motor)(Master)
(6)	----	Run command	Both Run forward and Run reverse commands being OFF or ON
	FWD		Run forward command
	REV		Run reverse command
(7)	----	Current limit	No current limit
	IL		Current limiting
(8)	----	Undervoltage Voltage limit	Neither undervoltage nor voltage limited
	LU		Undervoltage detected
	VL		Voltage limited
(9)	----	Torque limit	No torque limit
	TL		Torque limiting
(10)	HAND	Run command source	Keypad (F02 = 0)
	TERM		External signals to terminals [FWD] and [REV] (F02 = 1)
	COMM		Via communications link
	LOCAL		Keypad in Local mode
(11)	----	Cause of trip	No cause of trip
	STP1		Input on STOP1 terminal
	STP2		Input on STOP2 terminal
	STP3		Input on STOP3 terminal
	BX		Coast to a stop
(12)	INTL	PID command source	Internal speed command
	AI		Analog input
	LINK		Communications link
	KP-ON		Terminal command ***KP/PID*** ON ("Cancel PID control")
(13)	----	PID output usage	PID output disabled
	T-LIM		Torque limiter
	T-REF		Torque command
	N-REF		Speed command
	N-AUX		Auxiliary speed (e.g., dancer control)

3.4.4.5 Checking I/O signal status -- Menu #4 "I/O CHECK"

Menu #4 "I/O CHECK" in Programming mode is used to check the I/O states of digital and analog signals during maintenance or test running.

```
1. DATA SET
2. DATA CHECK
3. OPR MNTR
4. I/O CHECK
∧∨→MENU SHIFT▼
```

To display this menu screen, press the PRG key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "4. I/O CHECK" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

FUNC/DATA ↓ ↑ RESET

```
REM   □×2  □×6
□FWD  □×3  □×7
□REV  □×4  □×8
□X1   □×5  □×9
∧∨→PAGE SHIFT 1
```

Digital input signals at the control circuit terminal block
□: Signal OFF, ■: Signal ON

Normal open/close settings of X terminals specified by function code E14 are reflected to these signals.

↕ ∧/∨

```
REM
□EN1
□EN2

∧∨→PAGE SHIFT 2
```

Digital input signals at the control circuit terminal block
□: Signal OFF, ■: Signal ON

↕ ∧/∨

```
COMM  □×2  □×6
□FWD  □×3  □×7
□REV  □×4  □×8
□X1   □×5  □×9
∧∨→PAGE SHIFT 3
```

Digital input signals via communications link
□: Signal OFF, ■: Signal ON

↕ ∧/∨

```
□Y1    □Y5A
□Y2
□Y3
□Y4
∧∨→PAGE SHIFT 4
```

Output signals from transistors at the control circuit terminal block
□: Signal OFF, ■: Signal ON

↕ ∧/∨

```
12  =±××.×V
Ai1=±××.×V
Ai2=±××.×V

∧∨→PAGE SHIFT 5
```

Analog input signals at the control circuit terminal block

← Analog input signal (12)
← Analog input signal (Ai1)
← Analog input signal (Ai2) (voltage/current)
The unit of Ai2 can be switched between V and mA by function code E50.
When E50 ≠ 26, the unit is V and when E50 = 26, mA.

↕ ∧/∨

```
AO1=±××.×V
AO2=±××.×V
AO3=±××.×V

∧∨→PAGE SHIFT 6
```

Analog output signals at the control circuit terminal block

← Analog output signal (Ao1)
← Analog output signal (Ao2)
← Analog output signal (Ao3)

↕ ∧/∨

```
□FWD□BRK□IL
□REV□NUV□ACC
□EXT□TL  □DEC
□INT□VL  □ALM
∧∨→PAGE SHIFT 7
```

← This screen is used to check the inverter running status.
□: Signal OFF,
■: Signal ON

FWD: Forward operation
REV: Reverse operation
EXT: Pre-exciting
INT: Inverter shut off
BRK: Braking

NUV: DC link bus voltage established
TL: Torque limiting
VL: Voltage limiting
IL: Current limiting

ACC: Accelerating
DEC: Decelerating
ALM: Alarm output (for any fault)

↕ ∧/∨

```
□PARA1□M1□JOG
□PARA2□M2
□PARA3□M3
□PARA4
∧∨→PAGE SHIFT 8
```

← Indicates currently effective sets.
□: Signal OFF, ■: Signal ON

PARA1: ASR1 being selected
PARA2: ASR2 being selected
PARA3: ASR3 being selected
PARA4: ASR4 being selected

M1: Motor 1 selected
M2: Motor 2 selected
M3: Motor 3 selected

JOG: Jogging mode

```
OPTION
A:(1)
B:(2)
C:(3)
∧∨→PAGE SHIFT 9
```

← Indicates the mounting status of the control options.

For the display content of (1) to (3), refer to the instruction manual of the corresponding option.

```
OPTION
D:(4)
E:(5)
F:(6)
∧∨→PAGE SHIFT 10
```

← Indicates the mounting status of the control options.

For the display content of (4) to (6), refer to the instruction manual of the corresponding option.

```
Ai3=±××.×V
Ai4=±××.×V
AO4=±××.×V
AO5=±××.×V
∧∨→PAGE SHIFT 14
```

← Indicates the I/O status of the AIO option.
(This page appears by mounting the AIO option card OPC-VG1-AIO.)

AIO I/O status 1 (Ai3) "0.0" when no AIO is connected
AIO I/O status 2 (Ai4) "0.0" when no AIO is connected
AIO I/O status 3 (Ao4)
AIO I/O status 4 (Ao5)

```
SD =±×××××P/s
LD =±×××××P/s
PR =±×××××P/s
PD =±×××××P/s
∧∨→PAGE SHIFT 15
```

← Indicates the PG signal input on the inverter.

[1] Input info of inverter PG signal: This appears when no PG (SD) is connected.
Input info of PG (SD) signal: This appears when a PG (SD) is mounted.
[2] Input info of PG (LD) signal: "---" appears when no PG (LD) is connected.
[3] Input info of PG (PR) signal: "---" appears when no PG (PR) is connected.
[4] Input info of PG (PD) signal: "---" appears when no PG (PD) is connected.

```
R□×11  C□×11
 □×12   □×12
 □×13   □×13
 □×14   □×14
∧∨→PAGE SHIFT 16
```

← Indicates the input status of the DIOA option.
□: Signal OFF, ■: Signal ON
(This page appears by mounting the DIO option card OPC-VG1-DIO and turning SW2 to the DIOA position.)

```
□Y11 □Y15
□Y12 □Y16
□Y13 □Y17
□Y14 □Y18
∧∨→PAGE SHIFT 17
```

← Indicates the output status of the DIOA option.
□: Signal OFF, ■: Signal ON
(This page appears by mounting the DIO option card OPC-VG1-DIO and turning SW2 to the DIOA position.)

```
□DIA □BCD □BIN
A =×××××
□DIB □BCD □BIN
B =×××××
∧∨→PAGE SHIFT 18
```

← Indicates the input status of the DIA option.
□: Signal OFF, ■: Signal ON

(This page appears by mounting the DI option card OPC-VG1-DI.)

The input statuses of the DIA and DIB options are shown in either of the following formats.
Bin format: 0 to FFFF
BCD format: 0 to 65535

```
X□21□25□29□33
□22□26□30□34
□23□27□31□35
□24□28□32□36
∧∨→PAGE SHIFT 19
```

← Indicates the input status of the DIOB option.
□: Signal OFF, ■: Signal ON
(This page appears by mounting the DIO option card OPC-VG1-DIO and turning SW2 to the DIOB position.)

```
□Y21 □Y25 □Y29
□Y22 □Y26 □Y30
□Y23 □Y27
□Y24 □Y28
∧∨→PAGE SHIFT 20
```

←Indicates the output status of the DIOB option.
□: Signal OFF, ■: Signal ON
(This page appears by mounting the DIO option card OPC-VG1-DIO and turning SW2 to the DIOB position.)

```
□ST1 □ST2 □RE
□SL1 □SL2
□SB+ □SB−
□BF1 □BF2
∧∨→PAGE SHIFT 21
```

← Indicates the I/O status of the SAFE option.
□: Signal OFF, ■: Signal ON
(Available soon)
(This page appears by mounting the functional safety option card OPC-VG1-SAFE.

3.4.4.6 Reading maintenance information -- Menu #5 "MAINTENANCE"

Menu #5 "MAINTENANCE" in Programming mode shows information necessary for performing maintenance on the inverter.

```
 2. DATA CHECK
 3. OPR MNTR
 4. I/O CHECK
 5. MAINTENANCE
∧∨→MENU SHIFT◆
```

To display this menu screen, press the (PRG) key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "5. MAINTENANCE" using the (∧) and (∨) keys. Then press the (FUNC/DATA) key.

(FUNC/DATA) ↓ ↑ (RESET)

```
TIME=×××××h
EDC =   ×××V
TMPI=   ×××℃
TMPF=   ×××℃
∧∨→PAGE SHIFT 1
```

← Cumulative run time
← DC link bus voltage
← Max. temperature inside the inverter (Refreshed every one hour.)
← Max. temperature of heat sink (Refreshed every one hour.)

↕ (∧)/(∨)

```
Imax=××.××A
CAP =  ×××%


∧∨→PAGE SHIFT 2
```

← Max. effective current (within an hour)
← Main capacitor capacity

↕ (∧)/(∨)

```
TCAP=×××××h
    (87600h)
TFAN=×××××h
    (87600h)
∧∨→PAGE SHIFT 3
```

← Cumulative run time of capacitors on the printed circuit board (Refreshed every 10 hours)
← Estimated remaining life of the capacitor on the printed circuit board (fixed)
← Cumulative run time of the cooling fan (Refreshed every 10 hours)
← Estimated remaining life of the cooling fan (fixed)

↕ (∧)/(∨)

```
NRK=(1)
NRR=(2)      (5)
NRO=(3)      (6)
NRL=(4)      (7)
∧∨→PAGE SHIFT 4
```

← (1) Number of communication retries for keypad
← (2) Number of communication retries, (5) Latest error code for RS-485 (See Table 3.4-9.)
← (3) Number of communication retries, (6) Latest error code for T-Link/CC-Link/SX-bus
← (4) Number of communication retries, (See Table 3.4-10.)
(7) Latest error code for high-speed serial communication dedicated terminal block (Available soon)

↕ (∧)/(∨)

```
MAIN=H1××××
MTR =H2××××
KP  =K ××××

∧∨→PAGE SHIFT 5
```

← ROM version of main control CPU (MAIN)
← ROM version of motor control CPU (MTR)
← ROM version of keypad (KP)

↕ (∧)/(∨)

```
OP_A =Q1××××
OP_B =Q1××××
OP_D =Q3××××

∧∨→PAGE SHIFT 6
```

← ROM version of 8-bit digital option CPU (OP1)
← ROM version of 8-bit digital option CPU (OP2)
← ROM version of 16-bit digital option CPU

"----" when no option is mounted.

↕ (∧)/(∨)

```
OP_C =Q2××××
OP_E =Q4××××
     =Q5××××

∧∨→PAGE SHIFT 7
```

← ROM version (Not used.)
← ROM version of functional safety card option CPU-S1 (Available soon)
← ROM version of functional safety card option CPU-S2 (Available soon)
"----" when no option is mounted.

↕ (∧)/(∨)

```
Wh   =××××××kWh      ← Input watt-hour
PD   =    ××××       ← Input watt-hour data
REMN=×××××           ← Remaining startup times before the next maintenance
REMT=××××0h          ← Remaining time before the next maintenance
∧∨→PAGE SHIFT 8
```

↕ ∧/∨

```
TNPIM=    ×××℃       ← Temperature inside the inverter (real-time value)
TNPFM=    ×××℃       ← Temperature of heat sink (real-time value)
CAPEH=××××0h         ← Lifetime of DC link bus capacitor (elapsed hours) (Refreshed every 10 hours)
CAPRH=××××0h         ← Lifetime of DC link bus capacitor (remaining hours) (Refreshed every 10 hours)
∧∨→PAGE SHIFT 9
```

↕ ∧/∨

```
NST1  =×××××         ← Number of startups 1 (1st motor)
NST2  =×××××         ← Number of startups 2 (2nd motor)
NST3  =×××××         ← Number of startups 3 (3rd motor)

∧∨→PAGE SHIFT10
```

These counters work when H82 ≠ 0.

↕ ∧/∨

```
MTIM1=××××0h         ← Cumulative run time (1st motor)  (Refreshed every 10 hours)
MTIM2=××××0h         ← Cumulative run time (2nd motor)  (Refreshed every 10 hours)
MTIM3=××××0h         ← Cumulative run time (3rd motor)  (Refreshed every 10 hours)

∧∨→PAGE SHIFT11
```

↕ ∧/∨

```
LALM1=×××            ← Light alarm (1) -- Latest
LALM2=×××            ← Light alarm (2) -- Last
LALM3=×××            ← Light alarm (3) -- 2nd last
LALM4=×××            ← Light alarm (4) -- 3rd last
∧∨→PAGE SHIFT15
```

*Shutting down the power clears light alarm history.

Table 3.4-9 List of RS-485 Error Codes

Display #	When function code M26 is:	Error content
--	0	No error
01	74	Format error
	75	Command error
02	78	Function code error
03	80	Data error
04	71	Checksum error, CRC error
05	72	Parity error
06	73	Overrun error, framing error
07	76	Communications link priority error
	79	Write-protected
	81	Error during writing

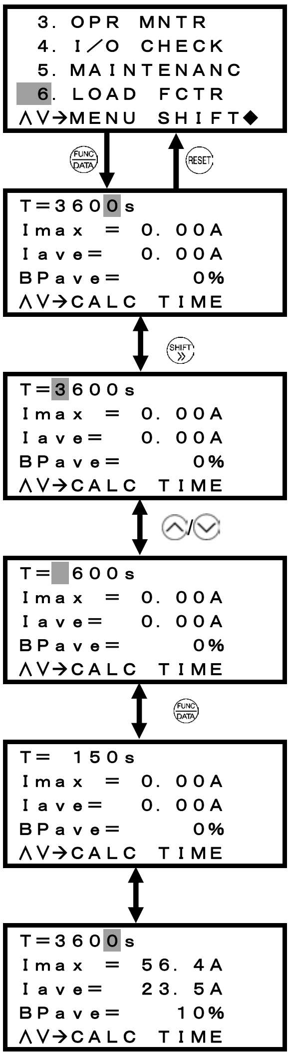
Table 3.4-10 List of Bus Error Codes

The following display numbers are shown as a bus error code.

Display #	Upper digits (T-Link)	Upper digits (CC-Link)	Lower digits (SX-bus)
--	No error	No error	No error
1	CRC check error Flag error		Light alarm: Communications data error
2	Transmission cycle timeout Frequent CRC errors (16 time or more)	Light alarm (CC-Link error)	Heavy alarm 1: Wire break
3	Overrun, underrun	Heavy alarm (option error)	Heavy alarm 2: Hardware defective, Mounting failure

3.4.4.7 Measuring load factor -- Menu #6 "LOAD FCTR"

Menu #6 "LOAD FCTR" in Programming mode is used to measure the maximum output current, the average output current, and the average braking power.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "6. LOAD FCTR" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

← Measurement period

Change the measurement period using the SHIFT, ∧ and ∨ keys.

← Measurement period (600 seconds)

Press the FUNC/DATA key to start measurement.

← Indicates the remaining measurement period. When this value comes to zero, measurement is completed.

← Reverts to the initial value.
← Maximum current
← Average current
← Average braking power (motor rated output/100%)

3.4.4.8 Reading alarm information -- Menu #7 "ALM INF"

Menu #7 "ALM INF" in Programming mode shows the past four alarm codes and the related alarm information on the current inverter conditions detected when the alarm occurred.

```
4. I/O CHECK
5. MAINTENANCE
6. LOAD FCTR
7. ALM INF
∧∨→MENU SHIFT◆
```

To display this menu screen, press the PRG key in Running mode to switch to Programming mode.

Move the cursor (flashing rectangle) at the left of the screen to "7. ALM INF" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

(FUNC/DATA ↓ / RESET ↑)

```
0/1= (1) (5) (9)
 -1= (2) (6) (10)
 -2= (3) (7) (11)
 -3= (4) (8) (12)
∧∨→HISTORY SHIF
```

← (1) Latest alarm code (5) Latest alarm, ID (9) Latest alarm, no. of occurrences (always 1)
← (2) 1st last alarm code (6) 1st last alarm, ID (10) 1st last alarm, no. of occurrences
← (3) 2nd last alarm code (7) 2nd last alarm, ID (11) 2nd last alarm, no. of occurrences
← (4) 3rd last alarm code (8) 3rd last alarm, ID (12) 3rd last alarm, no. of occurrences
Alarm ID: Blank (Alarm caused by the inverter), O (Alarm caused by multiplex system or other inverters)

(∧/∨)

Use the ∧ and ∨ keys to select the desired alarm.

```
0/1= (1) (5) (9)
 -1= (2) (6) (10)
 -2= (3) (7) (11)
 -3= (4) (8) (12)
∧∨→HISTORY SHIF
```

(FUNC/DATA)

Press the FUNC/DATA key to establish the selected alarm.

```
OCCURRED AT
2011/01/01
00:00:00

∧∨→PAGE SHIFT 1
```

← Date when an alarm occurred
← Time when an alarm occurred
Note: To record accurate date and time, it is necessary to mount a memory backup battery (Option for inverters of up to 22 kW, Attached as standard for those of 30 kW or above) and adjust the date and time.

(∧/∨)

```
RESET AT
2011/01/01
00:00:10

∧∨→PAGE SHIFT 2
```

← Date when an alarm was removed
← Time when an alarm was removed
Note: To record accurate date and time, it is necessary to mount a memory backup battery (Option for inverters of up to 22 kW, Attached as standard for those of 30 kW or above) and adjust the date and time.

(∧/∨)

```
N*=×××××.×r/m
N =×××××.×r/m
f* =  ×××.×Hz
TRQ=    ×××%
∧∨→PAGE SHIFT 3
```

← Speed setting 4 upon the occurrence of alarm
← Detected speed 1 upon the occurrence of alarm
← Reference output frequency upon the occurrence of alarm
← Reference torque upon the occurrence of alarm

The value is rounded to the first decimal place. If the absolute value of the detected speed is 10,000 or larger, the value is rounded to an integer.

(∧/∨)

```
TMP =  ±×××℃
Iout=×××.××A
Vout=    ×××V
FLX*=    ×××%
∧∨→PAGE SHIFT 4
```

← Motor temperature upon the occurrence of alarm ("---" appears when no NTC is mounted)
← Detected output current upon the occurrence of alarm
← Detected output voltage upon the occurrence of alarm
← Reference magnetic-flux value upon the occurrence of alarm

(∧/∨)

```
TIME= ×××××h
Mout= ×××.×kW
TMPIM=    ×××℃
TMPFM=    ×××℃
∧∨→PAGE SHIFT 5
```

← Cumulative operation hours upon the occurrence of alarm
← Reference motor output (in kW or HP) upon the occurrence of alarm *
← Inverter inside air temperature upon the occurrence of alarm (real-time value)
← Heat sink temperature upon the occurrence of alarm (real-time value)
* kW or HP can be selected with code F60.

(∧/∨)

```
EDC  =  ×××V



∧∨→PAGE  SHIFT 6
```

← DC link bus voltage at the time of an alarm

```
NRK=×××××
NRR=×××××
NRO=×××××
NRL=×××××
∧∨→PAGE  SHIFT 7
```

← No. of communication retries at the time of an alarm for keypad
← No. of communication retries at the time of an alarm for RS-485
← No. of communication retries at the time of an alarm for T-Link/CC-Link/SX-bus
← No. of communication retries at the time of an alarm for high-speed serial communication dedicated terminal block

```
REM    □X2  □X6
□FWD   □X3  □X7
□REV   □X4  □X8
□X1    □X5  □X9
∧∨→PAGE  SHIFT 8
```

(Terminal block)
□: Signal OFF, ■: Signal ON

```
REM
□EN1
□EN2

∧∨→PAGE  SHIFT 9
```

(Terminal block)
□: Signal OFF, ■: Signal ON

```
COMM   □X2  □X6
□FWD   □X3  □X7
□REV   □X4  □X8
□X1    □X5  □X9
∧∨→PAGE  SHIFT10
```

(Via communications link)
□: Signal OFF, ■: Signal ON

```
□Y1    □Y5A
□Y2
□Y3
□Y4
∧∨→PAGE  SHIFT11
```

□: Signal OFF, ■: Signal ON

```
□FWD□BRK□IL
□REV□NUV□ACC
□EXT□TL  □DEC
□INT□VL  □ALM
∧∨→PAGE  SHIFT12
```

□: Signal OFF, ■: Signal ON

FWD: Forward operation
REV: Reverse operation
EXT: Pre-exciting
INT: Inverter shut off
BRK: Braking
NUV: DC link bus voltage established (ready for operation)
TL: Torque limiting
VL: Voltage limiting
IL: Current limiting
ACC: Accelerating
DEC: Decelerating
ALM: Alarm output (for any fault)

```
R□X11  C□X11
 □X12   □X12
 □X13   □X13
 □X14   □X14
∧∨→PAGE  SHIFT13
```

(Shown only when DIO option is mounted)
□: Signal OFF, ■: Signal ON
(R: Terminal block, C: Via communications link)

```
□Y11 □Y15
□Y12 □Y16
□Y13 □Y17
□Y14 □Y18
∧∨→PAGE SHIFT 14
```

(Shown only when DIO option is mounted)
□: Signal OFF, ■: Signal ON

```
5= (1)
4= (2)
3= (3)
2= (4)
∧∨→PAGE SHIFT 16
```

← Multiple alarms 5 ((1) = Alarm code)
← Multiple alarms 4 ((2) = Alarm code)
← Multiple alarms 3 ((3) = Alarm code)
← Multiple alarms 2 ((4) = Alarm code)

```
(1)  (2)  (3)
(4)  (5)
(6)  (7)  (8)  (9)
(10)  (11)
∧∨→PAGE SHIFT 19
```

(1) Current rating (2) Speed command source (3) PID control
(4) Motor selected (5) Drive control
(6) Run command (7) Current limit (8) Undervoltage/Voltage limit (9) Torque limit
(10) Run command source (11) Cause of trip
* For details, refer to Table 3.4-8.

```
NST1 =xxxxx
NST2 =xxxxx
NST3 =xxxxx

∧∨→PAGE SHIFT 20
```

← Number of startups 1 (1st motor)
← Number of startups 2 (2nd motor)
← Number of startups 3 (3rd motor)

```
TRQI=xx. xx%
TRO =xx. xx%
TROI=xx. xx%
P    =xxxxxkW
∧∨→PAGE SHIFT 21
```

← Reference torque current at the time of an alarm
← Calculated torque at the time of an alarm
← Calculated torque current at the time of an alarm
← Input power at the time of an alarm

```
□ST1 □ST2 □RE
□SL1 □SL2
□SB+ □SB−
□BF1 □BF2
∧∨→PAGE SHIFT 22
```

← Indicates the I/O status of the SAFE option.
□: Signal OFF, ■: Signal ON
(Available soon)

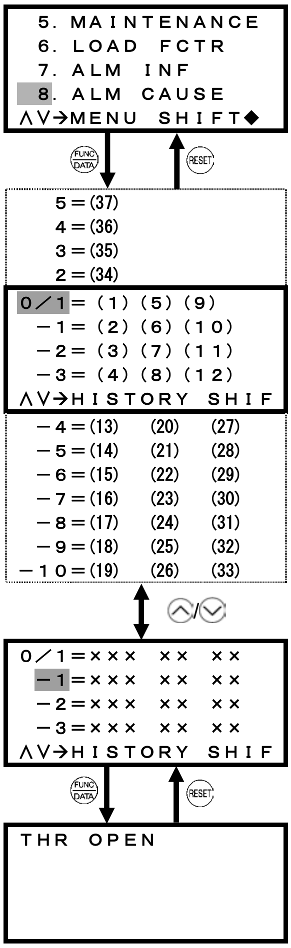
```
SUB=xxxx
AL=xxx AL=xxx
AL=xxx AL=xxx

∧∨→PAGE SHIFT 23
```

← Alarm sub-code (for manufacturers)
← Alarm whose cause is not removed yet (for the latest alarm only)

3.4.4.9 Viewing causes of alarm -- Menu #8 "ALM CAUSE"

Menu #8 "ALM CAUSE" in Programming mode shows the past four alarm codes and the related alarm information on the current inverter conditions detected when the alarm occurred.



To display this menu screen, press the (PRG) key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "8. ALM CAUSE" using the (∧) and (∨) keys. Then press the (FUNC/DATA) key.

← (37) Multiple alarms, 4th
← (36) Multiple alarms, 3rd
← (35) Multiple alarms, 2nd
← (34) Multiple alarms, 1st

← (1) Latest alarm code (5) Latest alarm, ID (9) Latest alarm, no. of occurrences (always 1)
← (2) 1st last alarm code (6) 1st last alarm, ID (10) 1st last alarm, no. of occurrences
← (3) 2nd last alarm code (7) 2nd last alarm, ID (11) 2nd last alarm, no. of occurrences
← (4) 3rd last alarm code (8) 3rd last alarm, ID (12) 3rd last alarm, no. of occurrences

← (13) 4th last alarm code (20) 4th last alarm, ID (27) 4th last alarm, no. of occurrences
← (14) 5th last alarm code (21) 5th last alarm, ID (28) 5th last alarm, no. of occurrences
← (15) 6th last alarm code (22) 6th last alarm, ID (29) 6th last alarm, no. of occurrences
← (16) 7th last alarm code (23) 7th last alarm, ID (30) 7th last alarm, no. of occurrences
← (17) 8th last alarm code (24) 8th last alarm, ID (31) 8th last alarm, no. of occurrences
← (18) 9th last alarm code (25) 9th last alarm, ID (32) 9th last alarm, no. of occurrences
← (19) 10th last alarm code (26) 10th last alarm, ID (33) 10th last alarm, no. of occurrences

Use the (∧) and (∨) keys to select the desired alarm and press the (FUNC/DATA) key to establish the selected alarm.

← Indicates cause of the alarm selected from alarm history
Shown at the left is the OH2 alarm.

If all the information for the selected alarm is not shown on the screen at a time, scroll over the descriptive information using the (∧) and (∨) keys.

< Alarm ID Details >

Display	Function
Blank	Ordinary alarm
O	Alarm caused by other inverters

Chap. 3 PREPARATION AND TEST RUN

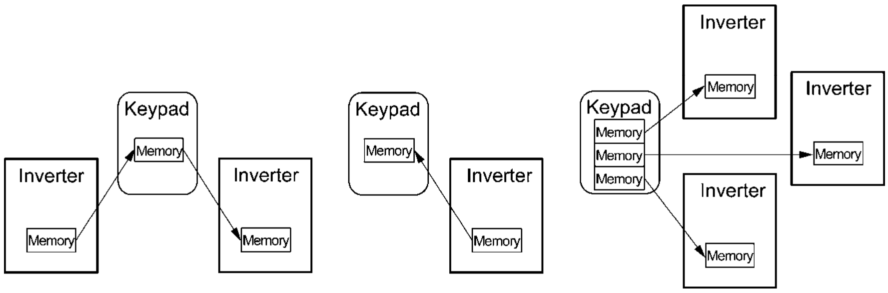
3.4.4.10 Copying data -- Menu #10 "DATA COPY"

Menu #10 "DATA COPY" in Programming mode provides "Read," "Write," and "Verify" functions, enabling the following applications. The keypad can hold three sets of function code data in its internal memory to use for three different inverters.

(a) Reading function code data already configured in an inverter and then writing that function code data altogether into another inverter.

(b) Copying the function code data saved in the inverter memory into the keypad memory for backup.

(c) Saving function code data in the keypad as master data for data management; that is, saving more than one set of function code data in the keypad and writing a set of data suited to the machinery into the target inverter.



(a) Copy (b) Backup (c) Data management

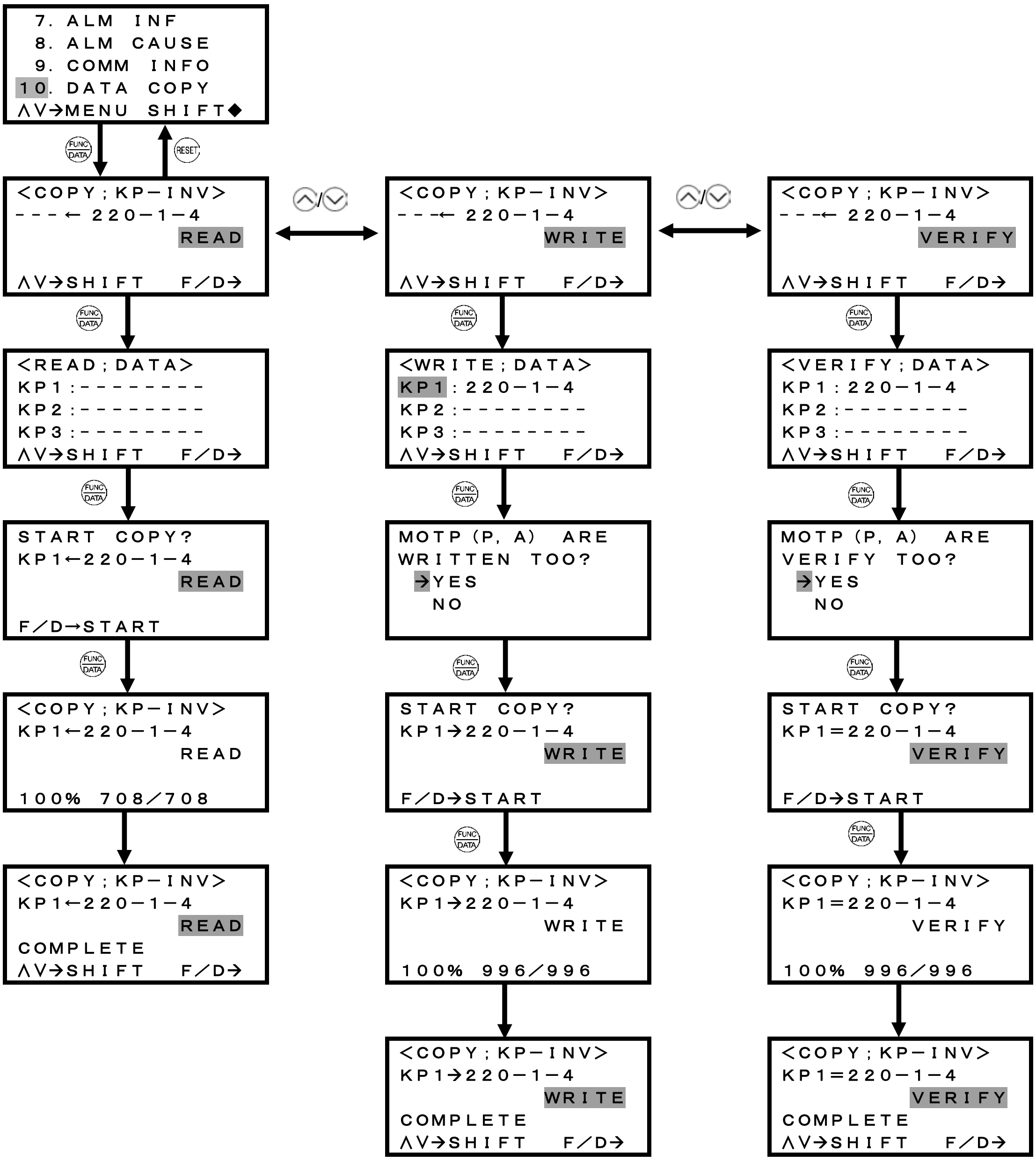
Table 3.4-11 details the data copying functions.

Table 3.4-11 List of Data Copying Functions

Operation	Description
Read: Read data	Reads out function code data from the inverter memory and stores it into the keypad memory.
Write: Write data	Writes the data held in the selected area of the keypad memory into the target inverter memory.
Verify: Verify data	Verifies the data held in the keypad memory against that in the inverter memory.

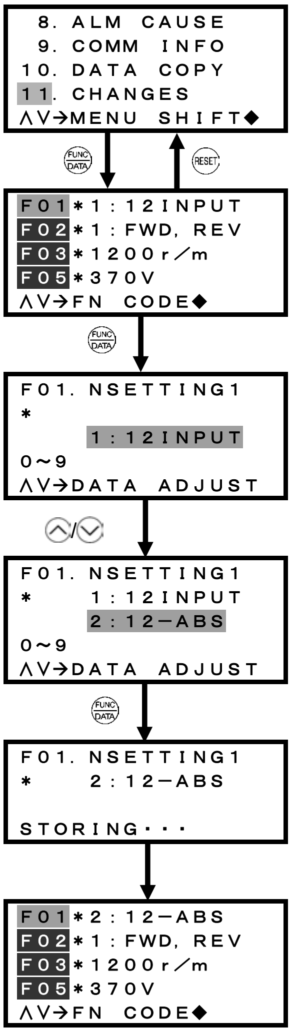
To display this menu screen, press the PRG key in Running mode to switch to Programming mode. Move the cursor (flashing rectangle) at the left of the screen to "10. DATA COPY" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

Use the ∧ and ∨ keys to select ""Read," "Write," or "Verify."



3.4.4.11 Checking changed function codes -- Menu #11 "CHANGES"

Menu #11 "CHANGES" in Programming mode shows only the function codes whose data has been changed from the factory defaults.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "11. CHANGES" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

The function codes whose data has been changed from factory defaults are marked with an asterisk (*).

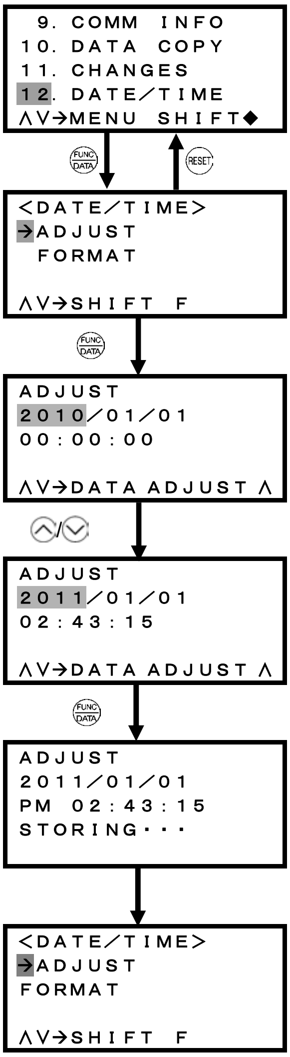
Just as in Section 3.4.4.2, "Configuring function codes--Menu #1 "DATA SET," the function code data can be modified.

3.4.4.12 Setting the calendar clock -- Menu #12 "DATE/TIME"

Menu #12 "DATE/TIME" in Programming mode is used to select the format of the calendar clock to be displayed in the operation guide line in Running mode and set the date and time.

⚠CAUTION
After mounting a memory backup battery (option for inverters of 22 kW or below, attached as standard for those of 33 kW or above), set the date and time. When a memory backup battery is not mounted, the calendar clock does not work correctly.

1) Setting the date and time



To display this menu screen, press the [PRG] key in Running mode to switch to Programming mode.

Move the cursor (flashing rectangle) at the left of the screen to "12. DATA/TIME" using the [∧] and [∨] keys. Then press the [FUNC/DATA] key.

Press [FUNC/DATA] key to establish the desired menu.

Use the [SHIFT] key to move the cursor to the desired item.

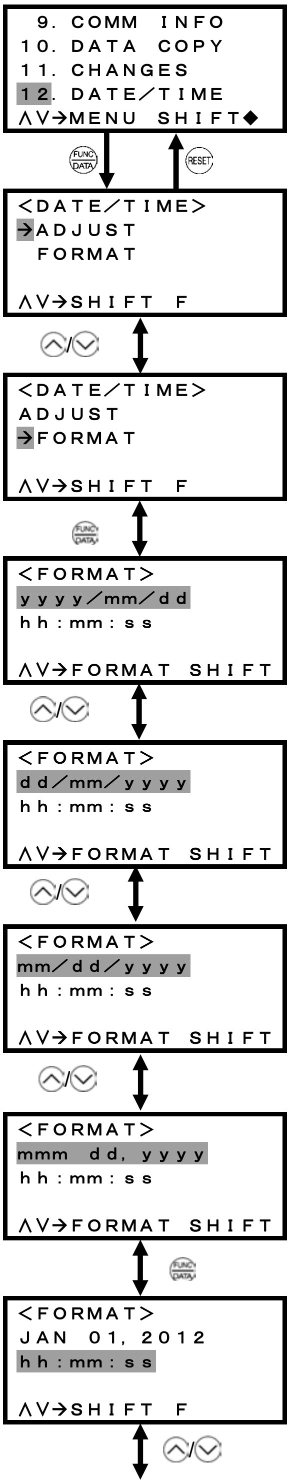
Change the date and time using the [∧] and [∨] keys.

If the relationship between the changed year, month, day, and time is invalid, "CANNOT SET" appears when the [FUNC/DATA] key is pressed.

After a second, the screen automatically switches back to the submenu.

Tip The calendar clock can also be set with FRENIC-VG Loader. For details, refer to the FRENIC-VG Loader Instruction Manual.

2) Selecting the display format



To display this menu screen, press the (PRG) key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "12. DATA/TIME" using the (∧) and (∨) keys. Then press the (FUNC/DATA) key.

Press (FUNC/DATA) key to establish the desired menu.

Move the pointer → using the (∧) and (∨) keys to the desired menu.

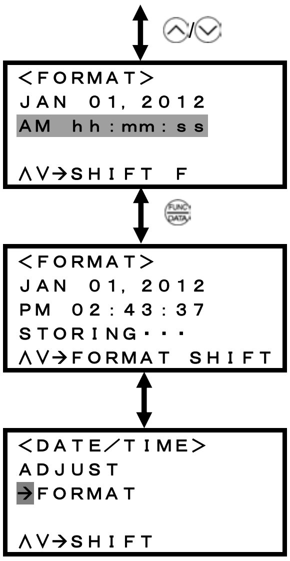
Press (FUNC/DATA) key to establish the desired menu.

Change the date format data using the (∧) and (∨) keys.

<List of date formats>

yyyy/mm/dd	Year/Month/Date
dd/mm/yyyy	Date/Month/Year
mm/dd/yyyy	Month/Date/Year
mmm dd, yyyy	Month Date, Year
<OFF>	No display

Press (FUNC/DATA) key to establish the newly specified date format.



Change the time format data using the ∧ and ∨ keys.

<List of time formats>

hh:mm:ss	0-24 hour: minutes: seconds
hh:mm:ss AM	0-12 hour: minutes: seconds AM/PM
AM hh:mm:ss	AM/PM 0-12 hour: minutes: seconds
<OFF>	No display

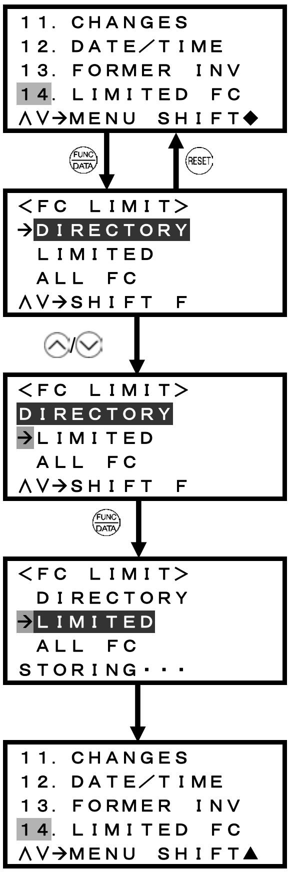
Press FUNC/DATA key to establish the newly specified time format.

After a second, the screen automatically switches back to the submenu.

3.4.4.13 Limiting function codes to be displayed -- Menu #14 "LIMITED FC"

Menu #14 "LIMITED FC" in Programming mode is used to display/hide the directory and select whether to display all function codes or limited ones selected in Loader.

Shown below is an example of selecting limited ones.



To display this menu screen, press the (PRG) key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "14. LIMITED FC" using the (∧) and (∨) keys. Then press the (FUNC/DATA) key.

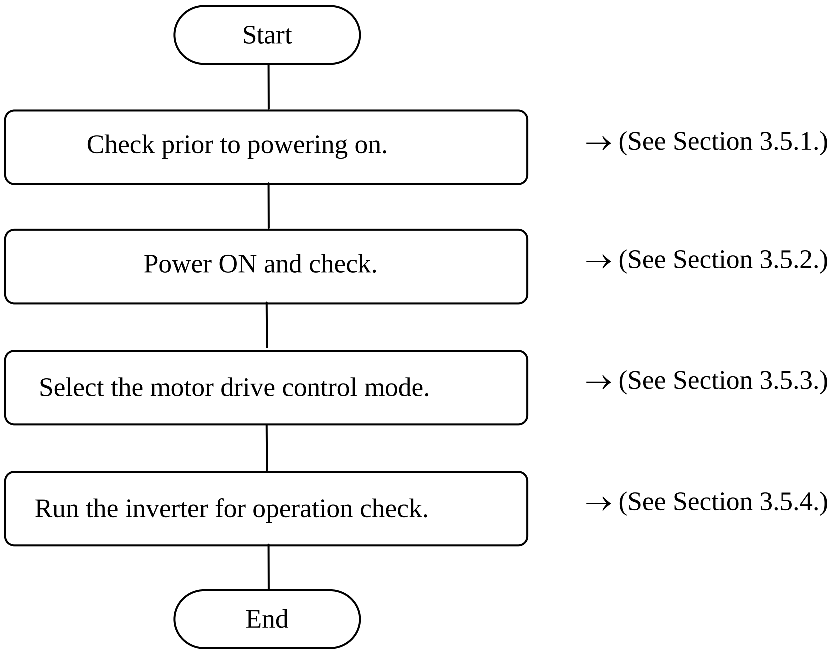
Move the pointer → using the (∧) and (∨) keys to the desired menu.

Press (FUNC/DATA) key to select "LIMITED."

After a second, the screen automatically switches back to the submenu.

3.5 Test Run Procedure

Make a test run of the motor using the flowchart given below.



3.5.1 Checking prior to powering On

Check the following before powering on the inverter.

(1) Check the wiring to the inverter input terminals L1/R, L2/S and L3/T and output terminals U, V, and W. Also check that the grounding wires are connected to the grounding terminals (⏚G) correctly. (See Figure 3.5-1.)

⚠WARNING
• Never connect power supply wires to the inverter output terminals U, V, and W. Doing so and turning the power ON breaks the inverter. • Be sure to connect the grounding wires of the inverter and the motor to the ground electrodes. **Otherwise, an electric shock could occur.**

(2) Check the control circuit terminals and main circuit terminals for short circuits or ground faults.

(3) Check for loose terminals, connectors and screws.

(4) Check that the motor is separated from mechanical equipment.

(5) Make sure that all switches of devices connected to the inverter are turned OFF. Powering on the inverter with any of those switches being ON may cause an unexpected motor operation.

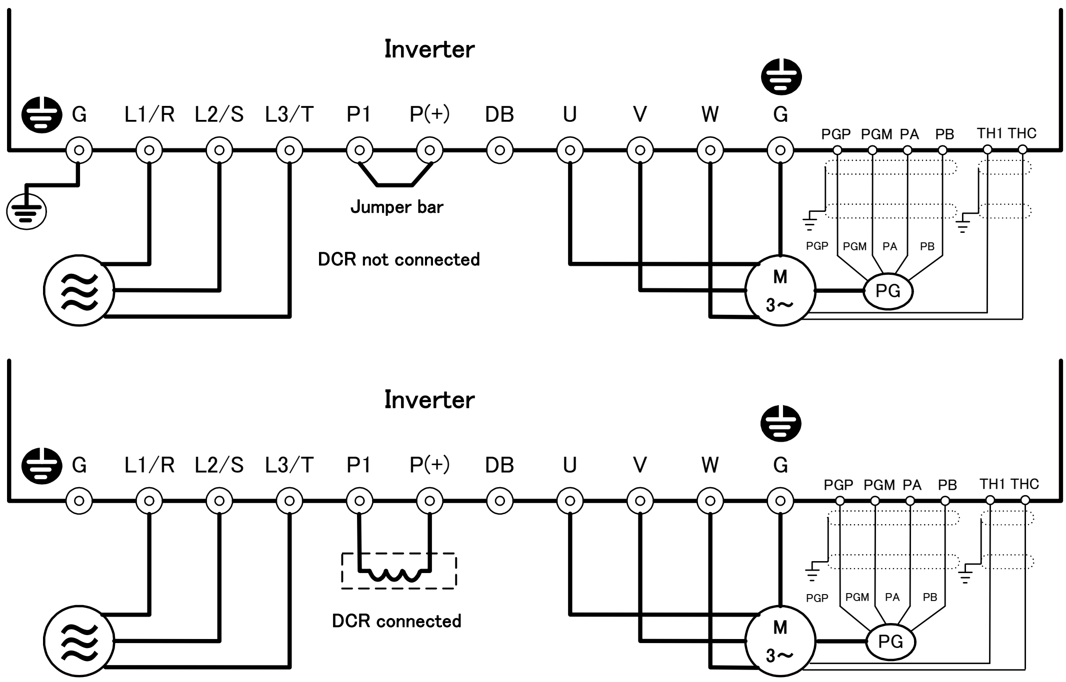
(6) Check that safety measures are taken against runaway of the equipment, e.g., a defense to prevent people from access to the equipment.

(7) Check that a power factor correction DC reactor (DCR) is connected to terminals P1 and P(+).

(Inverters of 75 kW or above and LD-mode inverters of 55 kW are provided together with a DCR as standard. Be sure to connect the DCR to the inverter.)

(8) Check that the PG (pulse generator) wiring is correct.

⚠CAUTION
Wrong wiring may break the PG.. If the inverter is powered on with wrong wiring, disconnect the PG signal wires from the inverter, keep only the PG powered on via the PGP and PGM, and then check that each signal is correctly output with an oscilloscope or recorder.



Note: In principle, the shielded sheath of wires should be connected to ground. If the inverter is significantly affected by external induction noise, however, connection to 0V may be effective to suppress the influence of noise.

Figure 3.5-1 Connection of Main Circuit Terminals (Vector dedicated motor connected)

3.5.2 Powering ON and checking

⚠WARNING

- Be sure to mount the front cover before turning the power ON. Do not remove the cover when the inverter power is ON.
- Do not operate switches with wet hands.

Otherwise, an electric shock could occur.

Turn the power ON and check the following points. The following is a case when no function code data is changed from the factory defaults.

(1) Check that the LED monitor displays 0 (indicating that the reference speed is 0 r/min) that is blinking. (See Figure 3.5-2.)
If the LED monitor displays any number except 0, press ⋀ / ⋁ key to set 0.

(2) Check that the built-in cooling fans rotate.

Figure 3.5-2 Display of the LED Monitor at Power-on

3.5.2.1 Checking the input state of PG (pulse generator) signals

Before proceeding to a test run of the inverter, rotate the motor shaft and check the digital input state of PG (pulse generator) signals on the screen shown below.

To call up the screen, switch the inverter operation mode from the Running mode to the Programming mode, select Menu #4 "I/O CHECK" on the menu screen, and select page 15 (shown below) using the ⋀/⋁ keys.

For detailed operation procedure, refer to Section 3.4.4.5.

```
SD  =±×××××P/s    ← PG (SD) signal input info (inverter or option)*
LD  =±×××××P/s    ← PG (LD) signal input info (option)
PR  =±×××××P/s    ← PG (PR) signal input info (option)
PD  =±×××××P/s    ← PG (PD) signal input info (option)
⋀⋁→PAGE  SHIF15
```

* When a PG (SD) option is mounted, the PG (SD) signal input info appears; when it is not, the inverter PG signal input info appears.

3.5.2.2 Mounting direction of a PG (pulse generator) and PG signals

The forward rotational direction of the dedicated motor (MVK type) is CCW when viewed from the motor output shaft as shown in Figure 3.5-3.

During rotation in the forward direction, the PG output pulse forms a forward rotation signal (B phase advanced by 90 degrees) shown in Figure 3.5-4, and during rotation in the reverse direction, a reverse rotation signal (A phase advanced by 90 degrees).

When mounting an external PG on motors other than the dedicated one, directly connect it to the motor, using a coupling, etc.

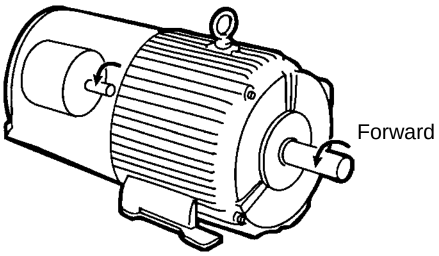


Figure 3.5-3 Forward Rotational Direction of Motor and PG

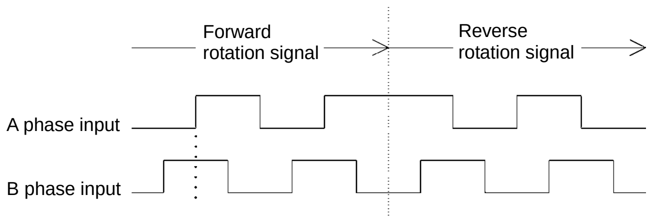


Figure 3.5-4 PG (Pulse Generator) Signal

3.5.3 Selecting a desired motor drive control

The FRENIC-VG supports the following motor drive controls.

Data for P01	M1 drive control	Speed feedback	Speed control	Refer to:
0	Vector control for IM with speed sensor	Yes	Speed control with automatic speed regulator (ASR)	Section 3.5.3.1
1	Vector control for IM without speed sensor	Estimated speed		Section 3.5.3.2
2	Simulation mode	Yes		Chapter 4, Section 4.3.4 "P codes"
3	Vector control for PMSM with speed sensor	Yes		Section 3.5.3.3
5	V/f control for IM	No	Frequency control	Section 3.5.3.4

3.5.3.1 Vector control for IM with speed sensor

Under vector control, the inverter detects the motor's rotational position and speed according to PG feedback signals and uses them for speed control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of components in vector.

The desired response can be obtained by adjusting the control constants (PI constants) with the speed regulator (PI controller).

This control enables the speed control with higher accuracy and quicker response than the vector control without speed sensor.

(A recommended motor for this control is a Fuji VG motor exclusively designed for vector control.)

Note Vector control regulating the motor current requires some voltage margin between the voltage that the inverter can output and the induced voltage of the motor. Usually a general-purpose motor is so designed that the voltage matches the commercial power. Under the control, therefore, it is necessary to suppress the motor terminal voltage to the lower level in order to secure the voltage margin required.

However, driving the motor with the motor terminal voltage suppressed to the lower level cannot generate the rated torque even if the rated current originally specified for the motor is applied. To ensure the rated torque, it is necessary to review the rated current. (This also applies to vector control without speed sensor.)

■ **For Fuji VG motor exclusively designed for vector control**

Configure the function codes as listed below. The machinery design values should match your machinery ones.

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET." For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	0: Vector control for IM with speed sensor	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	Motor to be applied	Motor to be applied
P28 A30 A130	M1 PG Pulse Resolution M2 PG Pulse Resolution M3 PG Pulse Resolution	1024	1024
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	1: NTC thermistor	1: NTC thermistor
F03	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration Time 1 **(Note)**		5.00 s
F08	Deceleration Time 1 **(Note)**		5.00 s

■ **For motors except Fuji VG motor**

To use motors except a Fuji VG motor when their motor parameters to be set to function codes are known, perform auto-tuning to automatically configure them.

Configure the function codes as listed below according to the motor ratings and your machinery design values. The motor ratings are printed on the motor's nameplate. For your machinery design values, ask system designers about them.

After configuring the function codes, perform motor parameter auto-tuning (H01 = 3 or 4).

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET." For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	0: Vector control for IM with speed sensor	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	37: Others (No modification is required for M2 or M3.)	Motor to be applied
P28 A30 A130	M1 Pulse Resolution M2 Pulse Resolution M3 Pulse Resolution	Match the specifications of the PG to be used.	1024
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	0: No thermistor	1: NTC thermistor
F04 A05 A105	M1 Rated Speed M2 Rated Speed M3 Rated Speed	Motor ratings (printed on the nameplate of the motor)	1500 r/min
F05	M1 Rated Voltage		Rated voltage of nominal applied motors
A04 A104	M2 Rated Voltage M3 Rated Voltage		80 V
P03	M1 Rated Capacity		Capacity of nominal applied motors
A02 A102	M2 Rated Capacity M3 Rated Capacity		0.00 kW
P04	M1 Rated Current		Rated current of nominal applied motors
A03 A103	M2 Rated Current M3 Rated Current		0.01 A
P05 A07 A107	M1 Poles M2 Poles M3 Poles		4 poles
F03 A06 A106	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration Time 1 **(Note)**		5.00 s
F08	Deceleration Time 1 **(Note)**		5.00 s

For the motor parameter auto-tuning procedure (H01 = 3 or 4), refer to Chapter 4, Section 4.3.5 "H Codes."

Function code	Name	Function code data	Factory default
H01	Tuning Selection	3: Auto tuning with motor stopped 4: Auto tuning with motor rotating	0: Disable

Note: Performing motor parameter auto-tuning (H01 = 3 or 4) automatically changes the data of function codes P06 through P11 and P15 through P21 for M1, A08 through A13 and A17 through A23 for M2, and A108 through A113 and A117 through A123 for M3. Be careful with this data change.

After tuning, be sure to perform the full save function (H02 = 1) to save the tuned data into the inverter.

3.5.3.2 Vector control for IM without speed sensor

Under this control, the inverter estimates the motor speed based on the inverter's output voltage and current to use the estimated speed for speed control. In addition, it controls the motor current and motor torque with quick response and high accuracy under vector control. No PG (pulse generator) is required.

The desired response can be obtained by adjusting the control constants (PI constants) and using the speed regulator (PI controller).

Applying "vector control without speed sensor" requires auto-tuning regardless of the motor type. (Even driving a Fuji VG motor exclusively designed for vector control requires auto-tuning.)

Configure the function codes as listed below according to the motor ratings and your machinery design values. The motor ratings are printed on the motor's nameplate. For your machinery design values, ask system designers about them.

■ **For Fuji VG motor exclusively designed for vector control**

Configure the function codes as listed below and perform motor parameter auto-tuning (H01 = 2)

📖 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET." For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	0: Vector control for IM with speed sensor	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	37: Others (No modification is required for M2 or M3.)	Motor to be applied
P30 A31 A131	M1 PG Pulse Resolution M2 PG Pulse Resolution M3 PG Pulse Resolution	1: NTC thermistor	1: NTC thermistor
F03 A06 A106	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed		5.00 s
F08	Acceleration Time 1 **(Note)**		5.00 s

📖 For the motor parameter auto-tuning procedure (H01 = 2), refer to Chapter 4, Section 4.3.5 "H Codes."

Function code	Name	Function code data	Factory default
H01	Tuning Selection	2: Auto-tuning (R1, Lσ)	0: Disable

Note Performing motor parameter auto-tuning (H01 = 2) automatically changes the data of function codes P06 and P07 for M1, A08 and A09 for M2, and A108 and A109 for M3. Be careful with this data change.

After tuning, be sure to perform the full save function (H02 = 1) to save the tuned data into the inverter.

■ **For motors except Fuji VG motor**

Configure the function codes as listed below and perform motor parameter auto-tuning (H01 = 3 or 4)

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET." For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	0: Vector control for IM with speed sensor	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	37: Others (No modification is required for M2 or M3.)	Motor to be applied
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	0: No thermistor	1: NTC thermistor
F04 A05 A105	M1 Rated Speed M2 Rated Speed M3 Rated Speed	Motor ratings (printed on the nameplate of the motor)	1500 r/min
F05 A04 A104	M1 Rated Voltage M2 Rated Voltage M3 Rated Voltage		Rated voltage of nominal applied motors
P03 A02 A102	M1 Rated Capacity M2 Rated Capacity M3 Rated Capacity		Capacity of nominal applied motors
P04 A03 A103	M1 Rated Current M2 Rated Current M3 Rated Current		Rated current of nominal applied motors
P05 A07 A107	M1 Poles M2 Poles M3 Poles		4 poles
F03 A06 A106	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration Time 1 **(Note)**		5.00 s
F08	Deceleration Time 1 **(Note)**		5.00 s

For the motor parameter auto-tuning procedure (H01 = 3 or 4), refer to Chapter 4, Section 4.3.5 "H Codes."

Function code	Name	Function code data	Factory default
H01	Tuning Selection	3: Auto tuning with motor stopped 4: Auto tuning with motor rotating	0: Disable

Note Performing motor parameter auto-tuning (H01 = 3 or 4) automatically changes the data of function codes P06 through P11 and P15 through P21 for M1, A08 through A13 and A17 through A23 for M2, and A108 through A113 and A117 through A123 for M3. Be careful with this data change.

After tuning, be sure to perform the full save function (H02 = 1) to save the tuned data into the inverter.

3.5.3.3 Vector control for PMSM with speed sensor and magnetic pole position sensor

Under this control, the inverter detects the motor's rotational position, speed and magnetic pole position according to feedback signals sent from the speed sensor and magnetic pole position sensor for speed control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of components in vector.

The desired response can be obtained by adjusting the control constants (PI constants) with the speed regulator (PI controller).

(A recommended motor for this control is Fuji GNF2 series exclusively designed for vector control.)

■ **For Fuji GNF2 motor exclusively designed for vector control**

Configure the function codes as listed below. The machinery design values should match your machinery ones. For details, contact your Fuji Electric representative.

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET." For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	3: Vector control for PMSM with speed sensor and magnetic pole position sensor	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	37: Others (No modification is required for M2 or M3.)	Motor to be applied
P28 A30 A130	M1 PG Pulse Resolution M2 PG Pulse Resolution M3 PG Pulse Resolution	1024	1024
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	1: NTC thermistor	1: NTC thermistor
o09 A59 A159	M1 ABS Signal Input Definition M2 ABS Signal Input Definition M3 ABS Signal Input Definition	Specify the absolute encoder signal interface according to the PG specifications. For GNF2 motors, set the function code data to "1." 1: 3 bits (terminals F0, F1 and F2) U, V, W phase interface	0
o10 A60 A160	M1 Magnetic Pole Position Sensor Offset M2 Magnetic Pole Position Sensor Offset M3 Magnetic Pole Position Sensor Offset	0.0 to 359.9 (0.0° to 359.9° CCW) Use the function code to adjust the magnetic pole position.	0000
o11 A61 A161	M1 Saliency Ratio (%Xq/%Xd) M2 Saliency Ratio (%Xq/%Xd) M3 Saliency Ratio (%Xq/%Xd)	1.000 to 3.000 Specify the saliency ratio of PMSM.	1.000
F03	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration time 1 **(Note)**		5.00 s
F08	Deceleration time 1 **(Note)**		5.00 s

Note: Since vector control for a Fuji GNF2 motor with speed sensor uses motor parameters, the following conditions should be satisfied; otherwise, full control performance may not be obtained.

- A single motor should be connected per inverter.
- Motor parameters are properly configured.

⚠CAUTION
Be sure to adjust the magnetic pole position (see below for the adjustment procedure): - when the inverter runs for the first time after purchase - after replacement of a motor, PG or inverter Running the inverter with the magnetic pole position (o10, A60, A160) not adjusted or with the position deviated greatly from the true value could run the motor in the opposite direction or out of control in the worst case. **An accident or injuries could occur.**

■ **Adjusting the magnetic pole position**

When the magnetic pole position has been adjusted at the time of shipment as requested by the user, no adjustment is required. When the inverter is shipped without adjustment (o10 = 0.0) or a PG is mounted or replaced at the site, check and adjust the magnetic pole position using the procedure given below.

Manual adjustment procedure

● Configure the following parameters beforehand.

- E69 (Terminal [Ao1] Function) : 26 (U phase voltage)
- E70 (Terminal [Ao2] Function) : 39 (Magnetic pole position signal ***SMP***)
- E84 (Ao1-5 Filter Setting) : 0.000 s (Cancel filter)

● Rotate the motor shaft by hand to check that the positional relationship between the waveforms on Ao1 and Ao2 is as shown below. If the waveforms are greatly misaligned, adjust the data of function code o10 to align the waveforms as shown below.

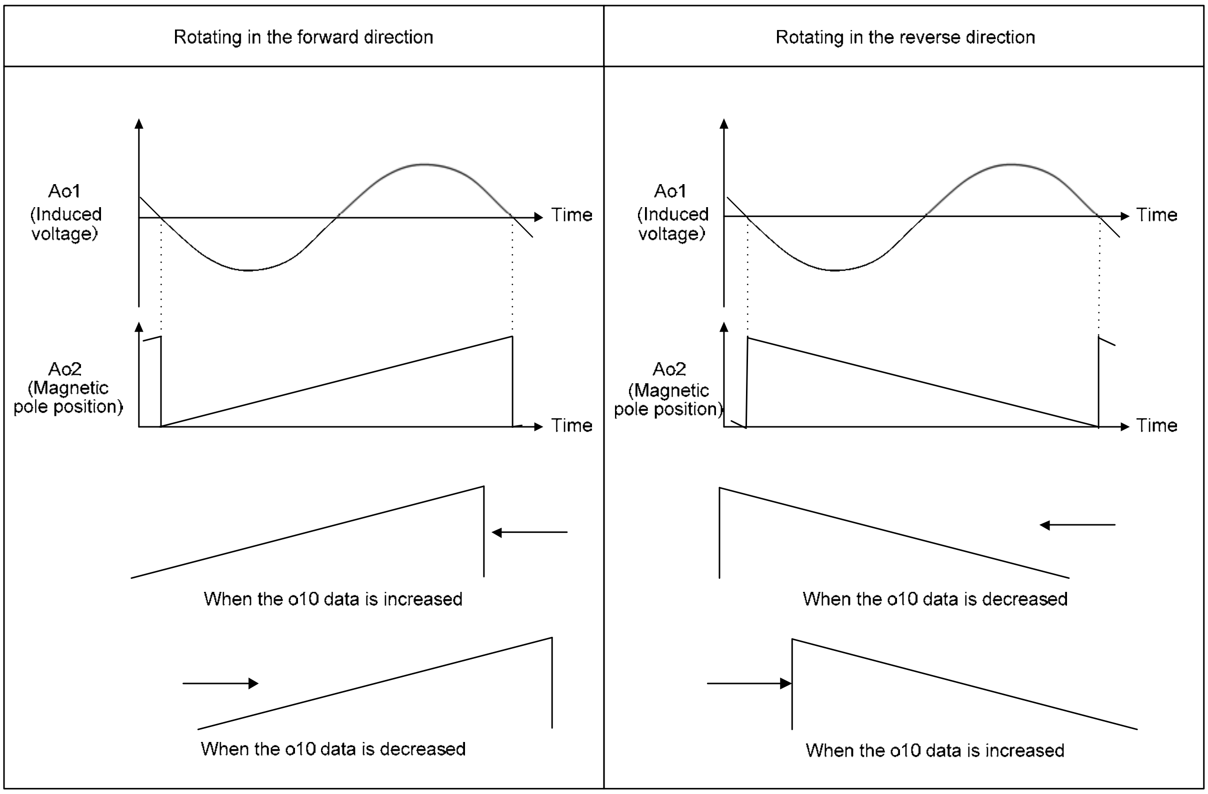


Figure 3.5-5 Adjustment of Magnetic Pole Position

Note: Wrong connection of motor power wires or encoder wires causes a PG alarm.

3.5.3.4 V/f control for IM

Under this control, the inverter drives a motor with the voltage and frequency according to the V/f pattern specified by function codes.

■ **For Fuji VG motor exclusively designed for vector control**

Configure the function codes as listed below. The machinery design values should match your machinery ones.

📖 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	5: V/f control for IM	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	Motor to be applied	Motor to be applied
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	1: NTC thermistor (Specify the thermistor as needed.)	1: NTC thermistor
F04 A05 A105	M1 Rated Speed M2 Rated Speed M3 Rated Speed	Motor ratings (printed on the nameplate of the motor)	1500 r/min
F05	M1 Rated Voltage		Rated voltage of nominal applied motors
A04 A104	M2 Rated Voltage M3 Rated Voltage		80 V
P33 A53 A153	M1 Maximum Output Voltage M2 Maximum Output Voltage M3 Maximum Output Voltage		Three-phase 200 V class series: 200 (V) Thee-phase 400 V class series: 400 (V)
F03 A06 A106	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration time 1 **(Note)**		5.00 s
F08	Deceleration time 1 **(Note)**		5.00 s
P35 A55 A155	M1 Torque Boost M2 Torque Boost M3 Torque Boost	2.0 (For constant torque load) **(Note)** In applications requiring a starting torque, adjust the torque boost (P35, A55, A155) within the range from 2.0 to 20.0.)	0.0 (Auto torque boost)

■ **For motors except Fuji VG motor**

Configure the function codes as listed below according to the motor ratings and your machinery design values. The motor ratings are printed on the motor's nameplate. For your machinery design values, ask system designers about them.

In applications requiring a starting torque, adjust the torque boost (P35, A55, A155) within the range from 2.0 to 20.0, or perform motor parameter auto-tuning (H01 = 2) and then set the torque boost (P31, A55, A155) to 0.0 (auto torque boost).

📖 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

Function code	Name	Function code data	Factory default
P01 A01 A101	M1 Drive Control M2 Drive Control M3 Drive Control	5: V/f control for IM	0: Vector control for IM
P02	M1 Selection	37: Others (No modification is required for M2 or M3.)	Motor to be applied
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	0: No thermistor	1: NTC thermistor
F04 A05 A105	M1 Rated Speed M2 Rated Speed M3 Rated Speed	Motor ratings (printed on the nameplate of the motor)	1500 r/min
F05	M1 Rated Voltage		Rated voltage of nominal applied motors
A04 A104	M2 Rated Voltage M3 Rated Voltage		80 V
P33 A53 A153	M1 Maximum Output Voltage M2 Maximum Output Voltage M3 Maximum Output Voltage		Three-phase 200 V class series: 200 (V) Thee-phase 400 V class series: 400 (V)
P03	M1 Rated Capacity		Capacity of nominal applied motors
A02 A102	M2 Rated Capacity M3 Rated Capacity		0.00 kW
P04	M1 Rated Current		Rated current of nominal applied motors
A03 A103	M2 Rated Current M3 Rated Current		0.01 A
P05 A07 A107	M1 Poles M2 Poles M3 Poles		4 poles
F03 A06 A106	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration time 1 **(Note)**		5.00 s
F08	Deceleration time 1 **(Note)**		5.00 s
P35 A55 A155	M1 Torque Boost M2 Torque Boost M3 Torque Boost	2.0 (For constant torque load)	0.0 (Auto torque boost)
P06	M1 %R1	To use the auto torque boost function (P35, A55, A155 = 0.0), be sure to perform motor parameter auto-tuning (H01 =2).	Depends on the rated capacity.
A08 A108	M2 %R1 M3 %R1		0.00%
P07	M1 %X		Depends on the rated capacity.
A09 A109	M2 %X M3 %X		0.00%

For the motor parameter auto-tuning procedure (H01 = 2), refer to Chapter 4, Section 4.3.5 "H Codes."

Function code	Name	Function code data	Factory default
H01	Tuning Selection	2: Auto-tuning (R1, Lσ)	0: Disable

Note Performing motor parameter auto-tuning (H01 = 2) automatically changes the data of function codes P06 and P07 for M1, A08 and A09 for M2, and A108 and A109 for M3. Be careful with this data change.

After tuning, be sure to perform the full save function (H02 = 1) to save the tuned data into the inverter.

3.5.4 Running the inverter for operation check

⚠WARNING

- If the user configures the function codes without completely understanding this Instruction Manual and the FRENIC-VG User's Manual, the motor may rotate with a torque or at a speed not permitted for the machine.
- When making a test run with a permanent magnet synchronous motor (PMSM), be sure to observe the test run procedure given in Section 3.5.4.2. If wiring between the inverter and motor or PG wiring is wrong, or the magnetic pole position offset is improper, the motor may run out of control.

An accident or injuries may result.

After completion of preparations for a test run as described above, start running the inverter for motor operation check using the following procedure.

⚠CAUTION

If any abnormality is found in the inverter or motor, immediately stop operation and investigate the cause referring to Chapter 13, "TROUBLESHOOTING."

3.5.4.1 Test run procedure for induction motor (IM)

(1) Turn the power ON and check that the reference speed is 0 r/min and it is blinking on the LED monitor.

(2) Set a low reference speed such as 100 r/min, using ∧ / ∨ keys. (Check that the speed is blinking on the LED monitor.)

(3) To run the motor in the forward direction, press the FWD key; to run it in the reverse direction, press the REV key. (Check that the speed is lit on the LED monitor.)

(4) Press the STOP key to stop the motor.

< Check points during a test run >

- Check that the motor is running in the forward direction when it is driven with the FWD key.
- Check that the motor is running in the reverse direction when it is driven with the REV key.
- Check for smooth rotation without motor humming or excessive vibration.
- Check for smooth acceleration and deceleration.

When no abnormality is found, press the FWD or REV key again to start driving the motor, then increase the reference speed using ∧ / ∨ keys. Check the above points again.

3.5.4.2 Test run procedure for permanent magnet synchronous motor (PMSM)

[1] Before proceeding with a test run

This section provides a test run procedure for the configuration consisting of the FRENIC-VG, the interface card for PMPG drive (OPC-VG1-PMPG), and a PMSM using a UVW phase detection PG (including GNF2 motor).

For a test run using a PMSM, it is recommended that the motor be disconnected from the equipment for testing it by itself. If it is impossible to drive the motor by itself due to the equipment, however, make a test run under the conditions that cause no problems even if the motor runs continuously in one direction (forward or reverse).

[2] Preparation for a test run

(1) Before turning the inverter power ON, make checking given in Section 3.5.1 "Checking Prior to Powering On."

(2) Check that wiring of the encoder (PG) is correct.

(For the connection diagram, refer to Chapter 2, Section 2.3.1.2 "In combination with a dedicated PMSM (GNF2 type).")

⚠CAUTION
Wrong wiring may break the PG..   If the inverter is powered on with wrong wiring, disconnect the PG signal wires from the inverter, keep only the PG powered on via the PGP and PGM, and then check that each signal is correctly output with an oscilloscope or recorder.

(3) Turn the power ON, make a note of the current configuration of all function codes, and then change the function code data as listed in Table 3.5-1.

(4) Check that the magnetic pole position offset (o10) is set to the previously specified value or manually adjusted value.

Replacing the motor or encoder requires adjustment of the magnetic pole position offset again.

Table 3.5-1 Configuration for Test Run of PMSM

Function code	Name	Current configuration before test run (Values given below are factory defaults)		Configuration for test run	
F01	Speed Command N1	0	The current configuration of function codes differs depending upon the equipment specifications. Make a note of the current configuration and then change the function code data as shown at the right.	0	0: Enable the ∧ and ∨ keys on the keypad (Digital speed setting)
F02	Operation Method	0		0	0: Enable the FWD, REV and STOP keys on the keypad to run or stop the motor.
F03	Maximum Speed M1	1500 r/min		750 r/min	Set about half of the current value (before test run).
F40	Torque Limiter Mode 1	0 (Disable)		3	3: Torque current limit
F44	Torque Limiter Level 1	150%		10%	If motor power wires or encoder wires are wrongly connected, the motor may run out of control, breaking the equipment. To suppress abrupt acceleration at the time of runaway, decrease the torque limiter level.
E45	Speed Disagreement Alarm	00 (Disable)		01	Speed disagreement alarm: Enable Power supply phase loss detection: Disable

Note 1: If the moment of inertia of the coupled equipment is large, the motor may not run at a test run. If it happens, adjust the torque limiter level 1 properly.

Note 2: After a test run, revert the function code data to the previous values.

[3] Test run

(1) Turn the power ON and check that the reference speed is 0 r/min and it is blinking on the LED monitor.

(2) Set a low reference speed such as 100 r/min, using ∧ / ∨ keys. (Check that the speed is blinking on the LED monitor.)

(3) Set the maximum speed (F03) to 750 r/min.

(4) Shift the LCD monitor to Menu #3 "OPR MNTR" to show the speed (N∗, N).

```
N∗=×××××. ×r/m
N  =×××××. ×r/m
f∗  =××××. ×Hz
TRQ=××××. ×%
∧∨→PAGE  SHIFT 1
```

(5) To run the motor in the forward direction, press the FWD key; to run it in the reverse direction, press the REV key.

Check that:

- The speed on the LED monitor comes ON instead of blinking
- The motor accelerates up to the specified speed.
- There is no abnormal discrepancy between the reference speed (*N) and the detected speed (N) shown on the LCD monitor.

(6) Press the STOP key to stop the motor.

(7) If no alarm occurs or no problem is found in motor running, increase the speed with the ∧ / ∨ keys.

(8) Turn the run command OFF.

< Check points during a test run >

- Check that the motor is running in the forward direction when it is driven with the FWD key.
- Check that the motor is running in the reverse direction when it is driven with the REV key.
- Check for smooth rotation without motor humming or excessive vibration.
- Check for smooth acceleration and deceleration.

When no abnormality is found, press the FWD or REV key again to start driving the motor, then increase the reference speed using ∧ / ∨ keys. Check the above points during a test run.

[4] Troubleshooting for motor abnormality

If any of the following abnormalities is found during a test run, follow the troubleshooting procedure in Table 3.5.-2.

- Turning the inverter ON triggers a P9 alarm.
- Entering a run command triggers a P9 or Er-9 alarm.
- Entering a run command does not run the motor or increase the speed.

Table 3.5-2 Troubleshooting for Motor Abnormality

Possible Causes	What to Check and Suggested Measures
(1) Setting of torque limiter level 1 too small relative to the load.	Check the setting of the torque limiter level 1 (F44). → Increase the F44 data in increments of 5%.
(2) Wrong wiring between the inverter and motor.	Check the wiring between the inverter and motor. → Correct the wiring.
(3) Wrong PG wiring.	Check the wiring of the PG. → Correct the wiring.
(4) PMSM magnetic pole position not matched.	Check the magnetic pole position. → Adjust the magnetic pole position (o10, A60, A160), referring to "■ Adjusting the magnetic pole position" in Section 3.5.3.3.

3.5.5 Selecting a speed command source

A speed command source is the keypad (⌃ / ⌄ keys) by factory default. This section provides the speed command setting procedures using the speed command sources of the keypad, external potentiometer, and speed selection terminal commands.

3.5.5.1 Setting up a speed command from the keypad

Follow the procedure given below.

(1) Configure the function codes as listed below.

Function code	Name	Function code data	Factory default
F01	Speed Command Source N1	0: Keypad (⌃ / ⌄ keys)	0

Note
- When the inverter is in Programming or Alarm mode, speed command setting with ⌃ / ⌄ keys is disabled. To enable it, switch to Running mode.
- If any of higher priority speed command sources (multistep speed commands and speed commands via communications link) is specified, the inverter may run at an unexpected speed.

(2) Press the ⌃ / ⌄ key to display the current speed command on the LED monitor. The least significant digit blinks.

(3) To change the speed command, press the ⌃ / ⌄ key again.

When you start specifying the speed command with the ⌃ / ⌄ key, the least significant digit on the display blinks; that it, the cursor lies in the least significant digit. Holding down the ⌃ / ⌄ key changes data in the least significant digit and generates a carry, while the cursor remains in the least significant digit.

(4) To save the new setting into the inverter's memory, press the FUNC/DATA key.

📖 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

3.5.5.2 Setting up a speed command with an external potentiometer

Follow the procedure given below.

(1) Configure the function codes as listed below.

Function code	Name	Function code data	Factory default
F01	Speed Command Source N1	1: Analog voltage input to terminal [12] (0 to ±10 V)	0

(2) Connect an external potentiometer to terminals [11] through [13] of the inverter.

(3) Rotate the external potentiometer to apply voltage to terminal [12] for a speed command input.

📖 For precautions in wiring, refer to Section 3.3 "Mounting and Wiring the Inverter."

📖 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

3.5.5.3 Setting up a speed command with multistep speed selection

Follow the procedure given below.

(1) Configure the function codes as listed below.

Function code	Name	Function code data	Factory default
E01 to E14	Terminal [X1] to [X14] Functions	0, 1, 2, 3: Multistep speed 1 to 15 (0: ***SS1***, 1: ***SS2***, 2: ***SS4***, 3: ***SS8***)	0
C05 to C19	Multistep speed 1 to 15	0 to 30000 r/min, 0.00 to 100.00%, or 0.0 to 999.9 m/m	0

Terminals [X11] to [X14] are available only when an optional OPC-VG1-DIOA is mounted.

Assign signals ***SS1***, ***SS2***, ***SS4*** and ***SS8*** to four out of digital input terminals [X1] to [X14] by four out of function codes E01 to E14 (data = 0, 1, 2 and 3). Specify multistep speed commands with C05 to C19.

Turning digital signals ***SS1***, ***SS2***, ***SS4*** and ***SS8*** ON/OFF selectively switches the multistep speed commands specified beforehand.

Combination of input signals				Selected speed command	
3 ***SS8***	2 ***SS4***	1 ***SS2***	0 ***SS1***		
OFF	OFF	OFF	ON	C05 (Multistep speed 1)	Function codes C05 to C19 Data setting range: 0 to 30000 r/min or 0.00 to 100.00% or 0.0 to 999.9 m/m
OFF	OFF	ON	OFF	C06 (Multistep speed 2)	
OFF	OFF	ON	ON	C07 (Multistep speed 3)	
OFF	ON	OFF	OFF	C08 (Multistep speed 4)	
OFF	ON	OFF	ON	C09 (Multistep speed 5)	
OFF	ON	ON	OFF	C10 (Multistep speed 6)	
OFF	ON	ON	ON	C11 (Multistep speed 7)	
ON	OFF	OFF	OFF	C12 (Multistep speed 8)	
ON	OFF	OFF	ON	C13 (Multistep speed 9)	
ON	OFF	ON	OFF	C14 (Multistep speed 10)	
ON	OFF	ON	ON	C15 (Multistep speed 11)	
ON	ON	OFF	OFF	C16 (Multistep speed 12)	
ON	ON	OFF	ON	C17 (Multistep speed 13)	
ON	ON	ON	OFF	C18 N-14/CREP1	
ON	ON	ON	ON	C19 N-15/CREP2	

(2) Connect a multistep speed switch to an X terminal and [CM].

(3) Turn the multistep speed switch ON (short-circuit). The combination of those input signals switches a multistep speed command.

📖 For precautions in wiring, refer to Section 3.3 "Mounting and Wiring the Inverter."

📖 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

Note: Enabling a multistep speed command with a multistep speed switch (ON between X terminal and [CM]) disables the speed command source N1 specified by F01.

3.5.6 Selecting a run command source

A run command source is the keypad (FWD / REV / STOP keys) by factory default.

3.5.6.1 Setting up a run command from the keypad

Follow the procedure given below.

(1) Configure the function codes as listed below.

Function code	Name	Function code data	Factory default
F02	Operation Method	0: Keypad (FWD / REV / STOP keys)	0: Keypad (FWD / REV / STOP keys)

(2) Press the FWD key to run the motor in the forward direction. Press the STOP key to stop it.

(3) Press the REV key to run the motor in the reverse direction. Press the STOP key to stop it.

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

3.5.6.2 Setting up a run command with digital input signals (terminals [FWD] and [REV])

Follow the procedure given below.

(1) Configure the function codes as listed below.

Function code	Name	Function code data	Factory default
F02	Operation Method	1: External digital input signal	0: Keypad (FWD / REV / STOP keys)

Note If terminal [FWD] and [REV] are ON, the F02 data cannot be changed. First turn those terminals OFF and then change the F02 data.

(2) Connect the run forward switch between terminals [FWD] and [CM] and the run reverse switch between [REV] and [CM].

Note Make sure that the SINK/SOURCE slide switch (SW1) is turned to the SINK position. If SW1 is in the SOURCE position, the inverter cannot run the motor.

(3) Turn the run forward switch or run reverse switch ON (short-circuit) to run the motor in the forward or reverse direction, respectively.

For precautions in wiring, refer to Section 3.3 "Mounting and Wiring the Inverter."

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

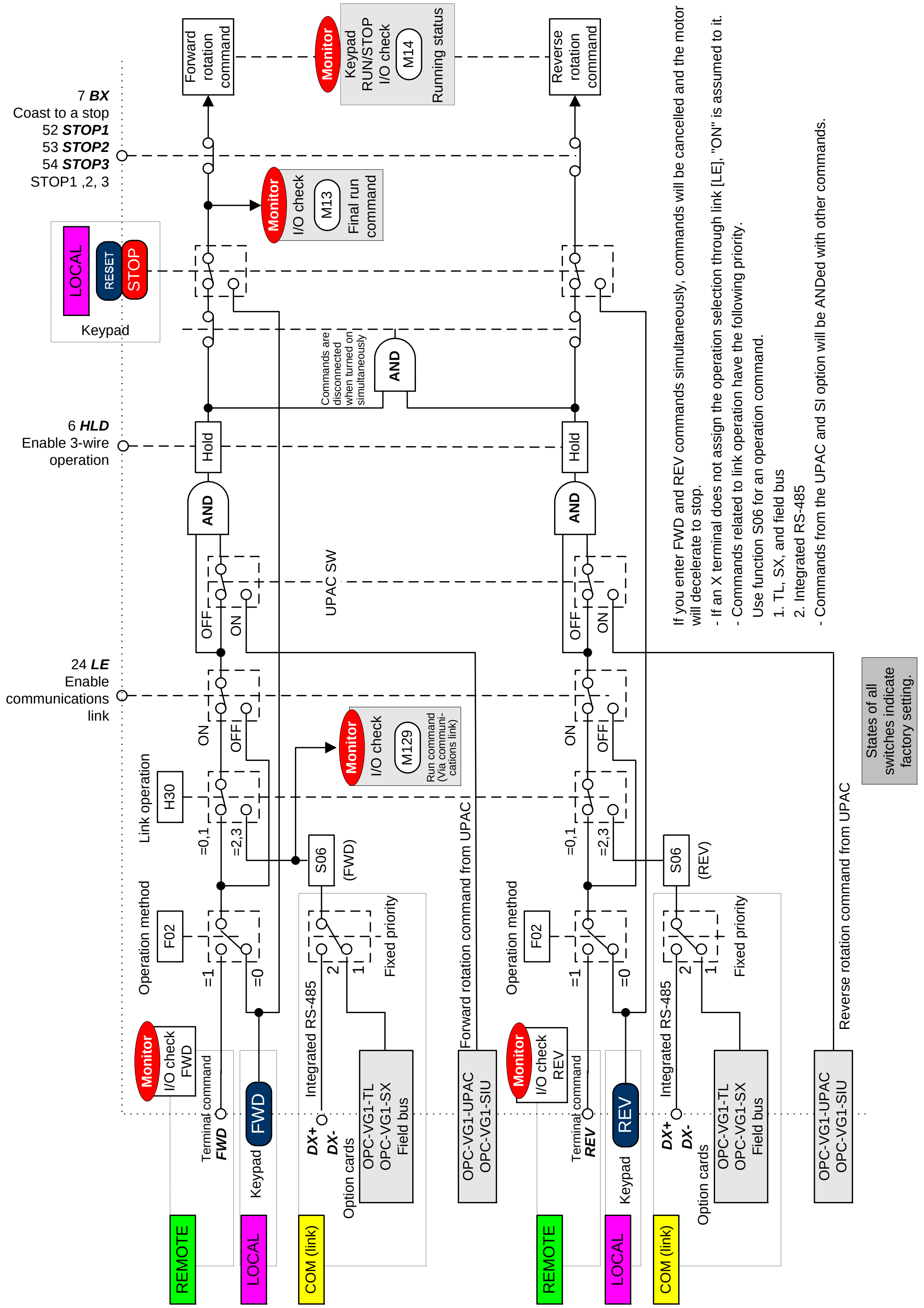
Chapter 4
CONTROL AND OPERATION

This chapter provides the main block diagrams for the control logic of the FRENIC-VG series of inverters. It also contains overview tables of function codes and details of function codes.

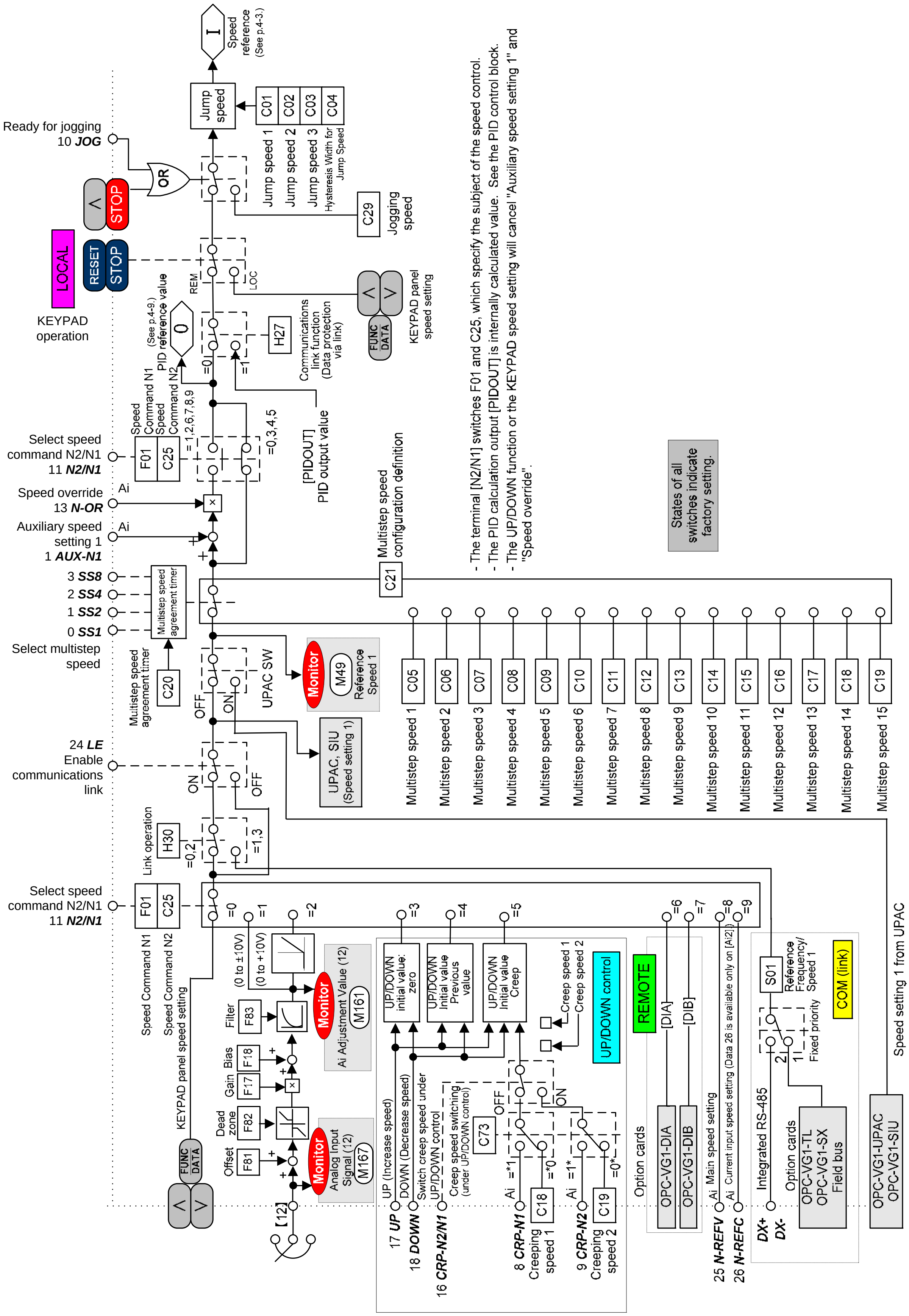
Contents

4.1 Block Diagrams for Control Logic

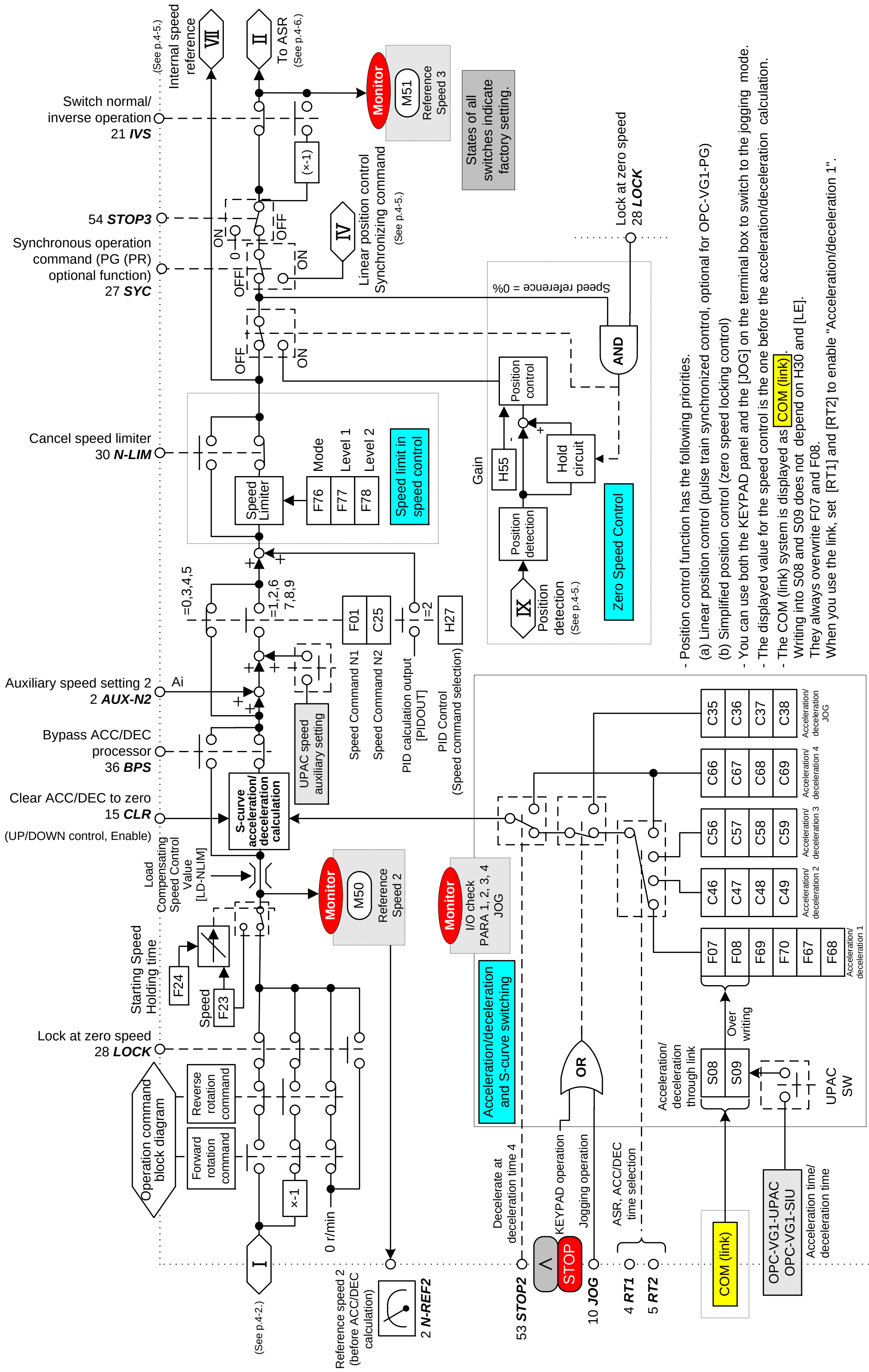
4.1.1 Operation Command



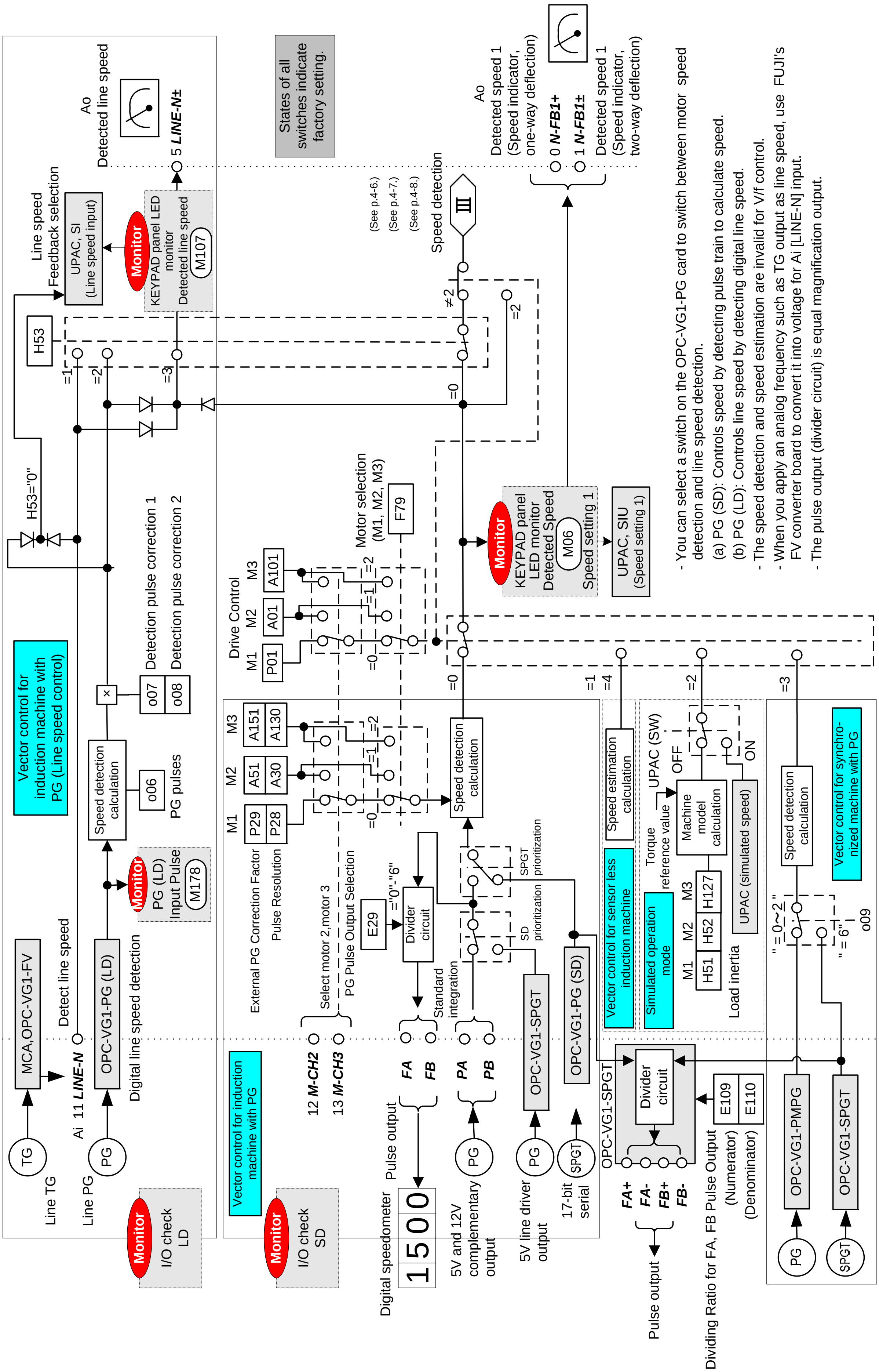
4.1.2 Speed Command Selection Section



4.1.3 Acceleration/deceleration Calculation, Speed Limiting, and Position Control Input Section

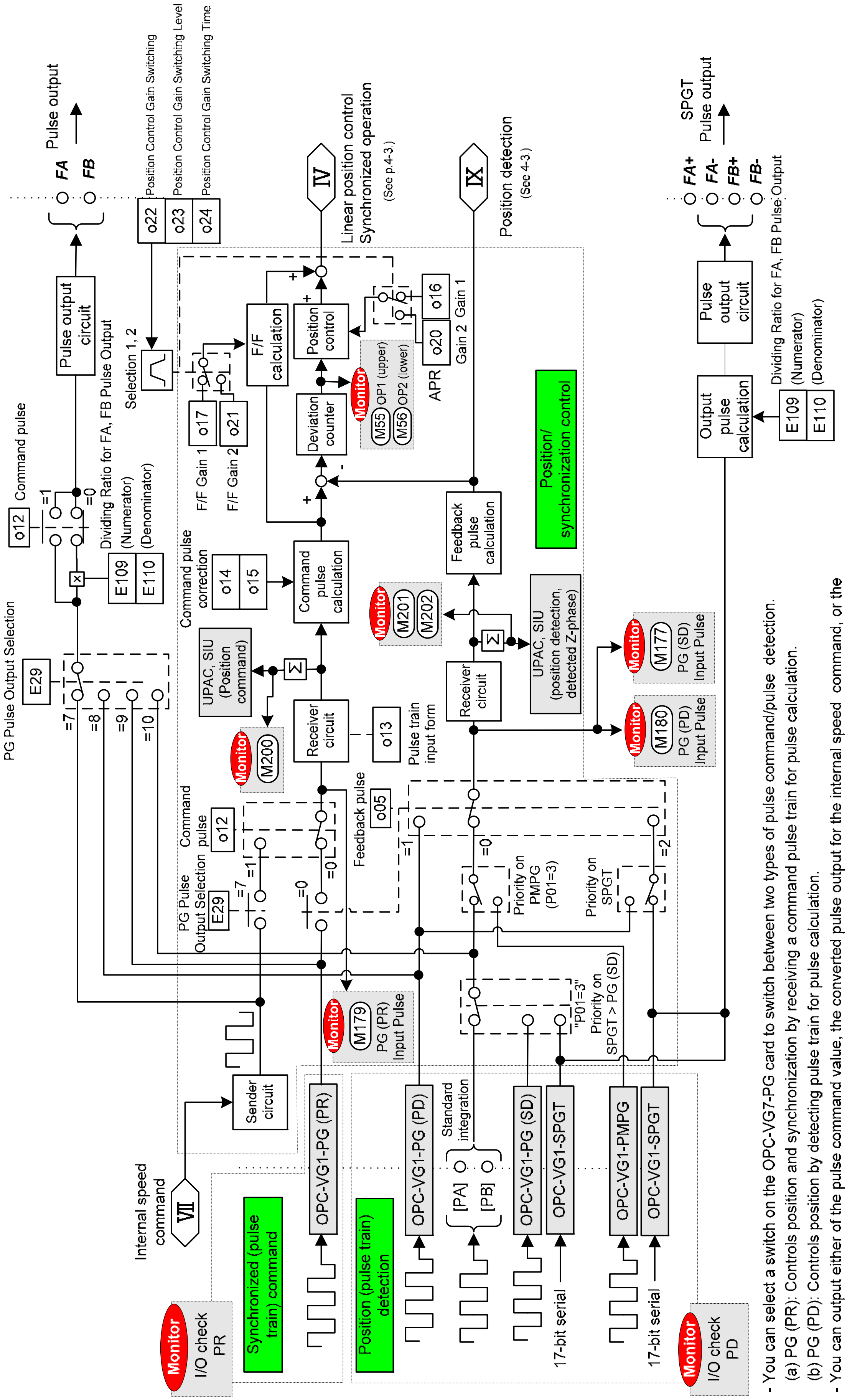


4.1.4 Motor Speed/Line Speed Detection



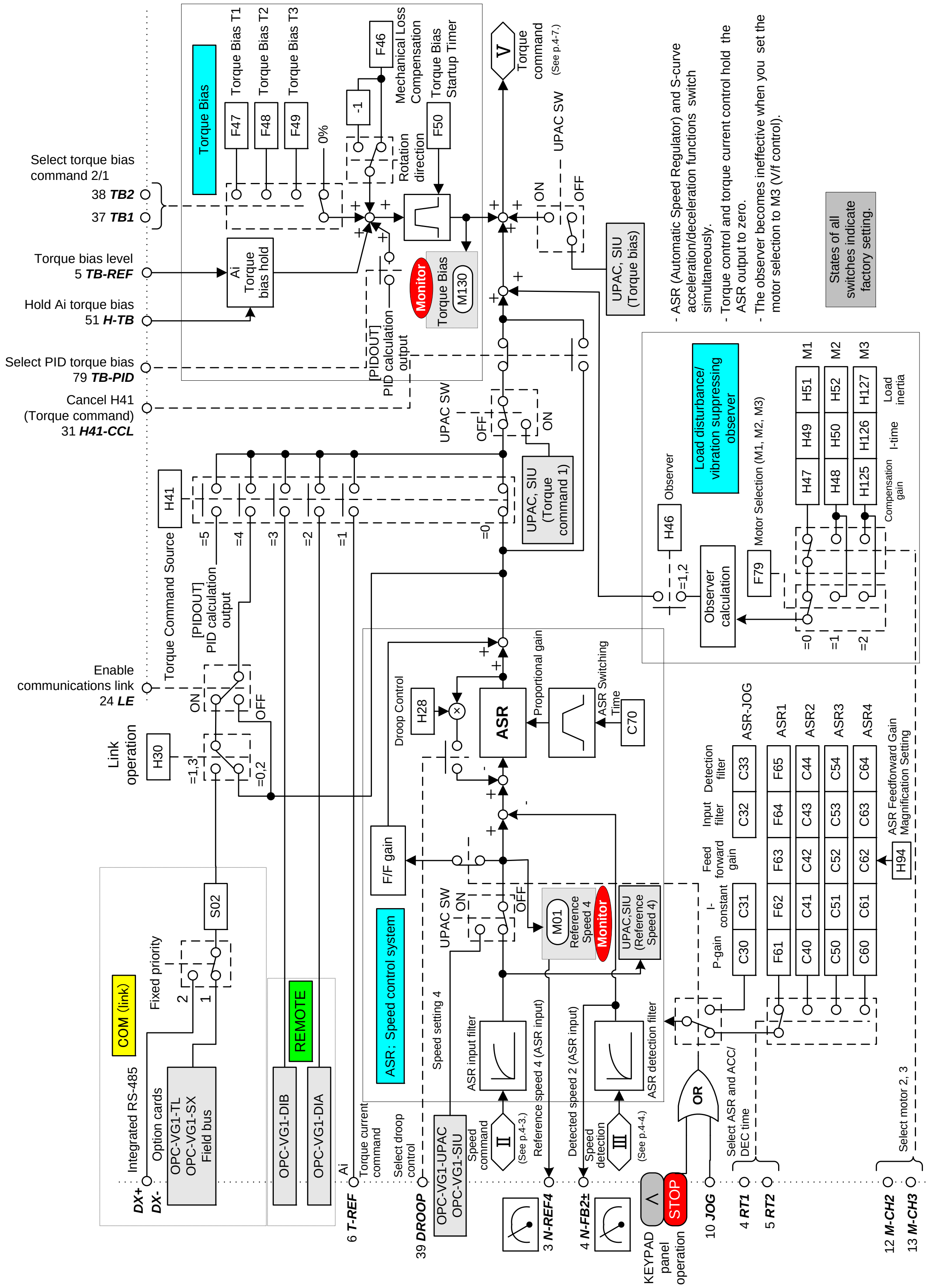
- You can select a switch on the OPC-VG1-PG card to switch between motor speed detection and line speed detection.
  (a) PG (SD): Controls speed by detecting pulse train to calculate speed.
  (b) PG (LD): Controls line speed by detecting digital line speed.
- The speed detection and speed estimation are invalid for V/f control.
- When you apply an analog frequency such as TG output as line speed, use FUJI's FV converter board to convert it into voltage for Ai [LINE-N] input.
- The pulse output (divider circuit) is equal magnification output.

4.1.5 Pulse Train Command Input Section and Position Detection Section

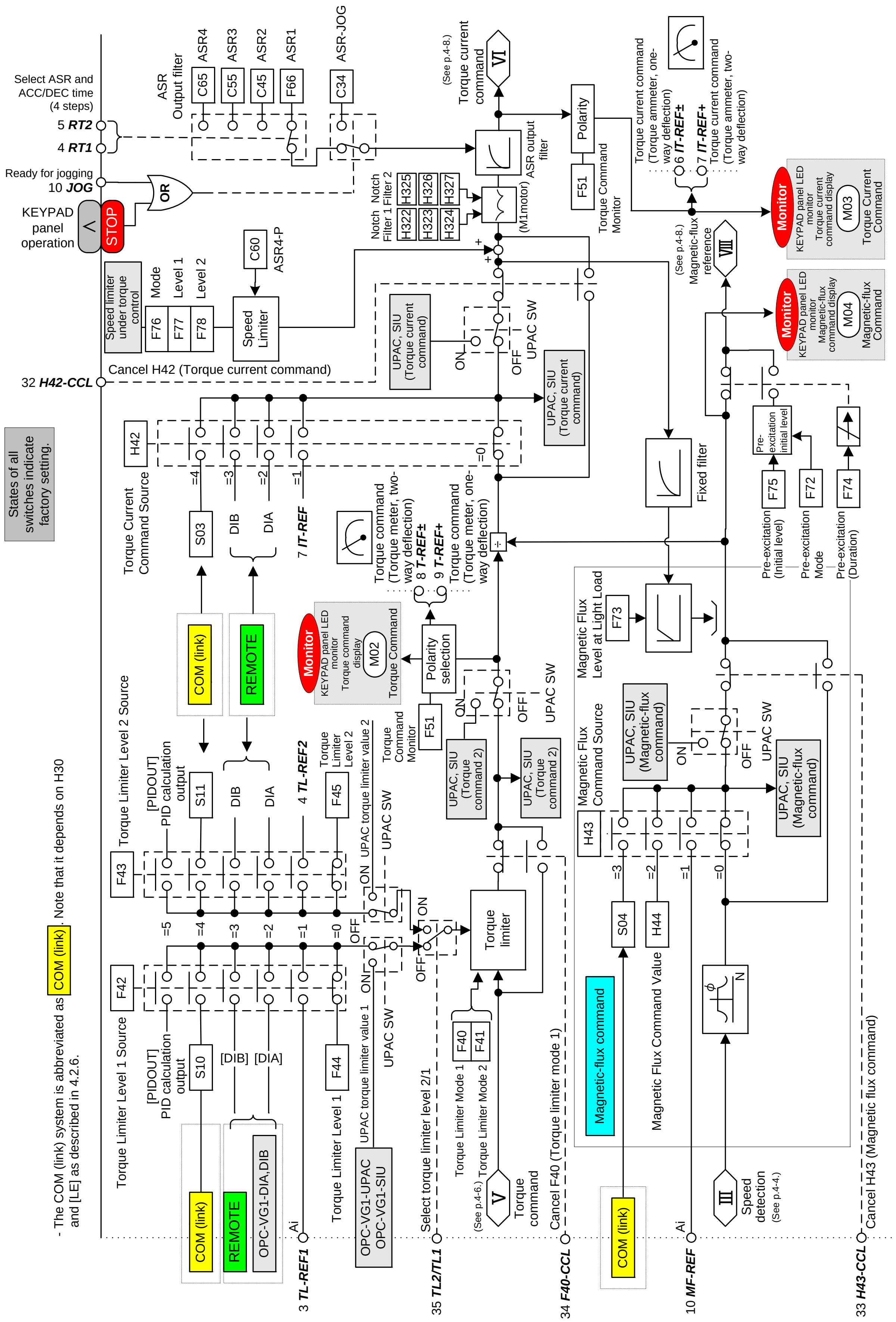


- You can select a switch on the OPC-VG7-PG card to switch between two types of pulse command/pulse detection.
(a) PG (PR): Controls position and synchronization by receiving a command pulse train for pulse calculation.
(b) PG (PD): Controls position by detecting pulse train for pulse calculation.
- You can output either of the pulse command value, the converted pulse output for the internal speed command, or the detected pulse value through the integrated [FA] and [FB] in the pulse output circuit.

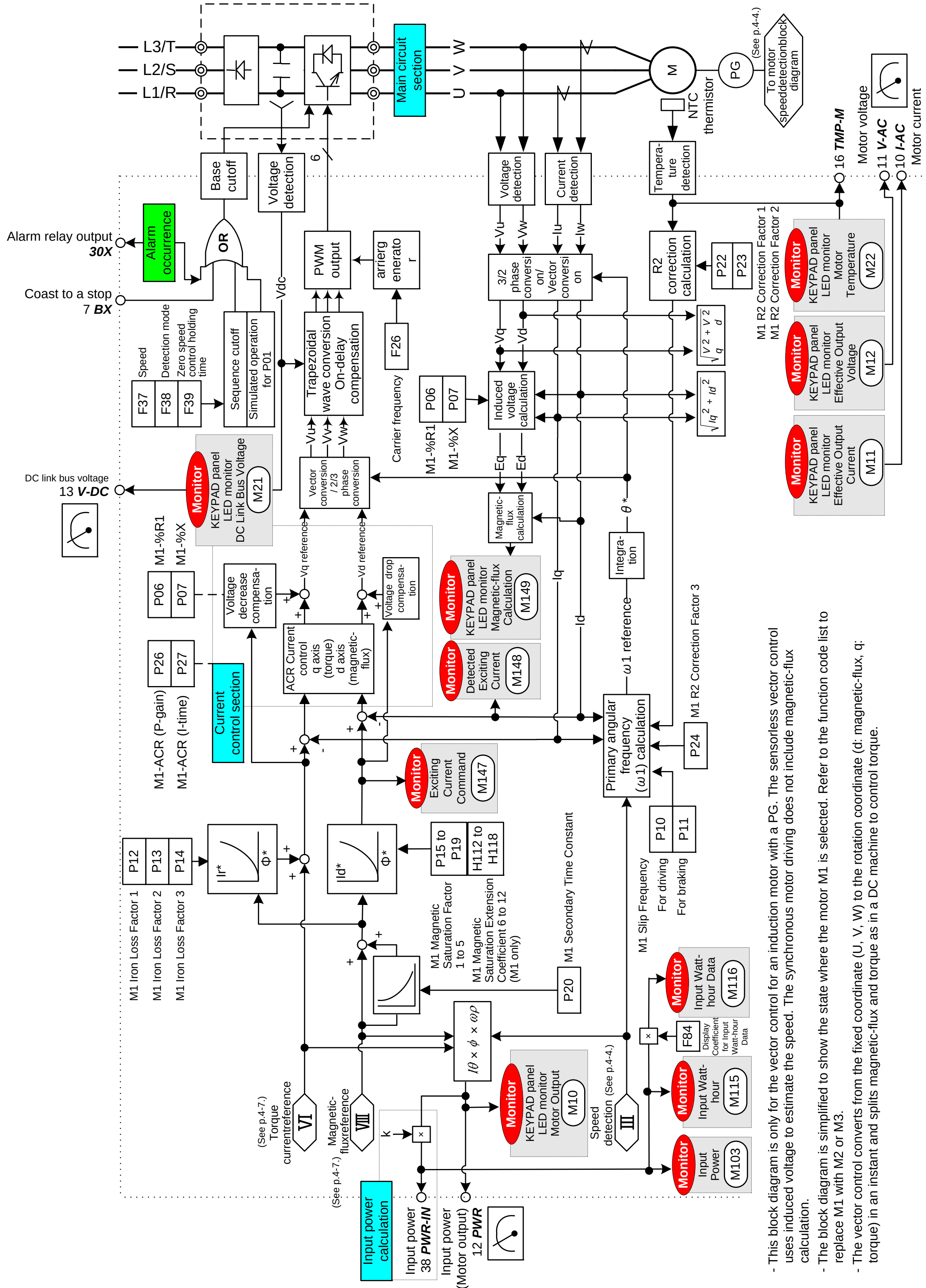
4.1.6 Speed Control and Torque Command Section



4.1.7 Torque Limit, Torque Current Command, and Magnetic-flux Command Section

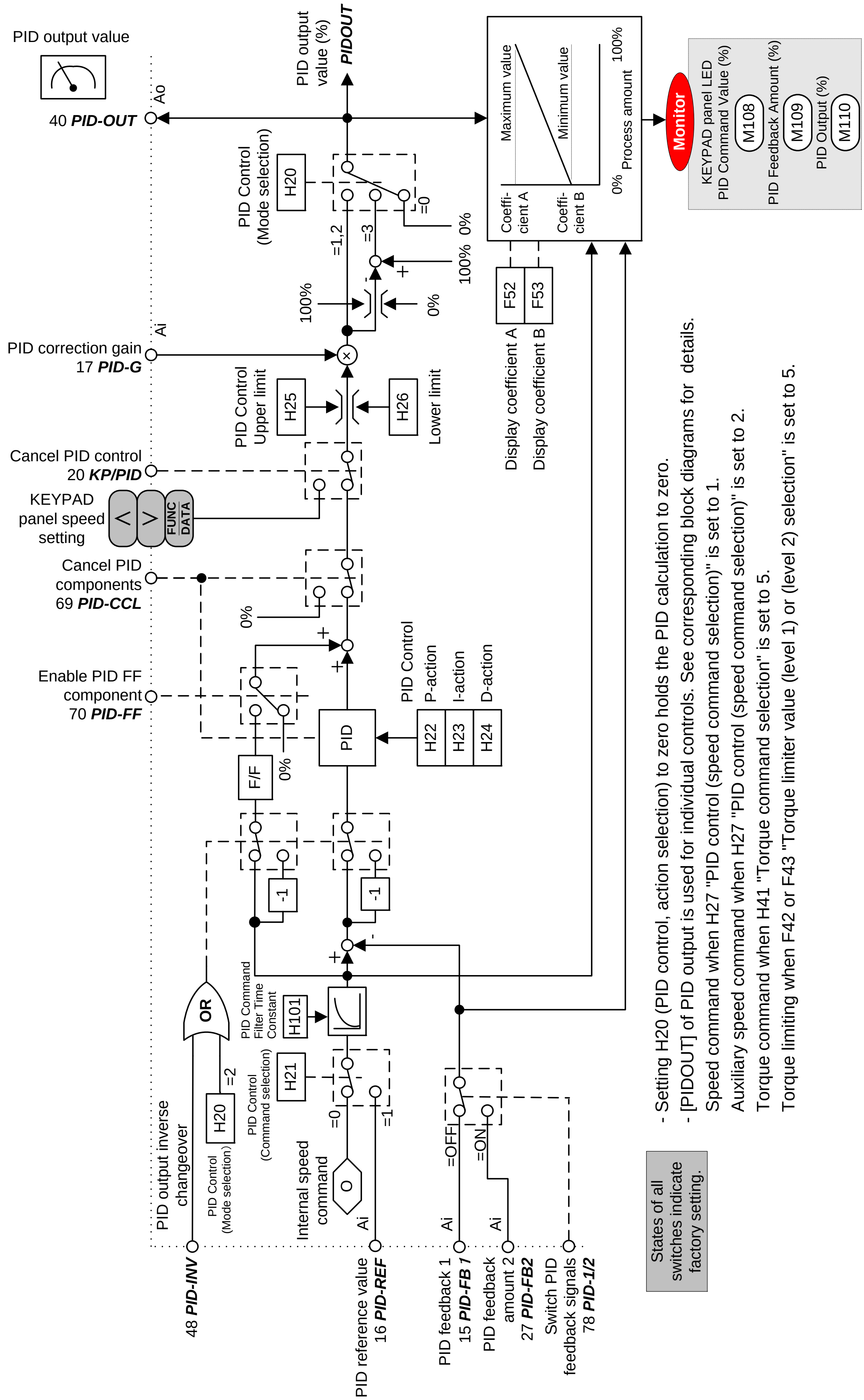


4.1.8 Current Control and Vector Control Section



- This block diagram is only for an induction motor with a PG. The sensorless vector control uses induced voltage to estimate the speed. The synchronous motor driving does not include magnetic-flux calculation.
- The block diagram is simplified to show the state where the motor M1 is selected. Refer to the function code list to replace M1 with M2 or M3.
- The vector control converts from the fixed coordinate (U, V, W) to the rotation coordinate (d: magnetic-flux, q: torque) in an instant and splits magnetic-flux and torque as in a DC machine to control torque.

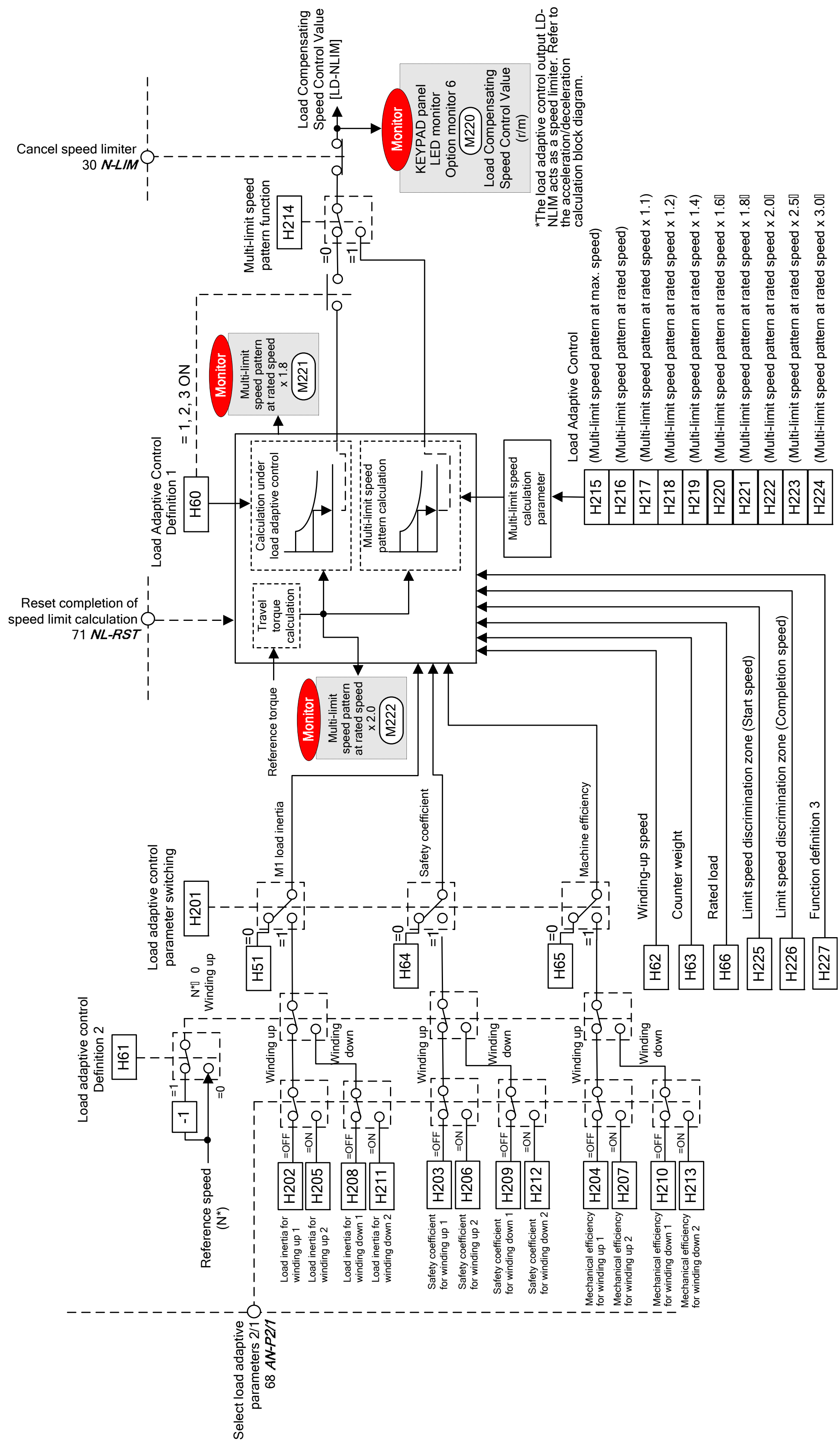
4.1.9 PID Calculation Section



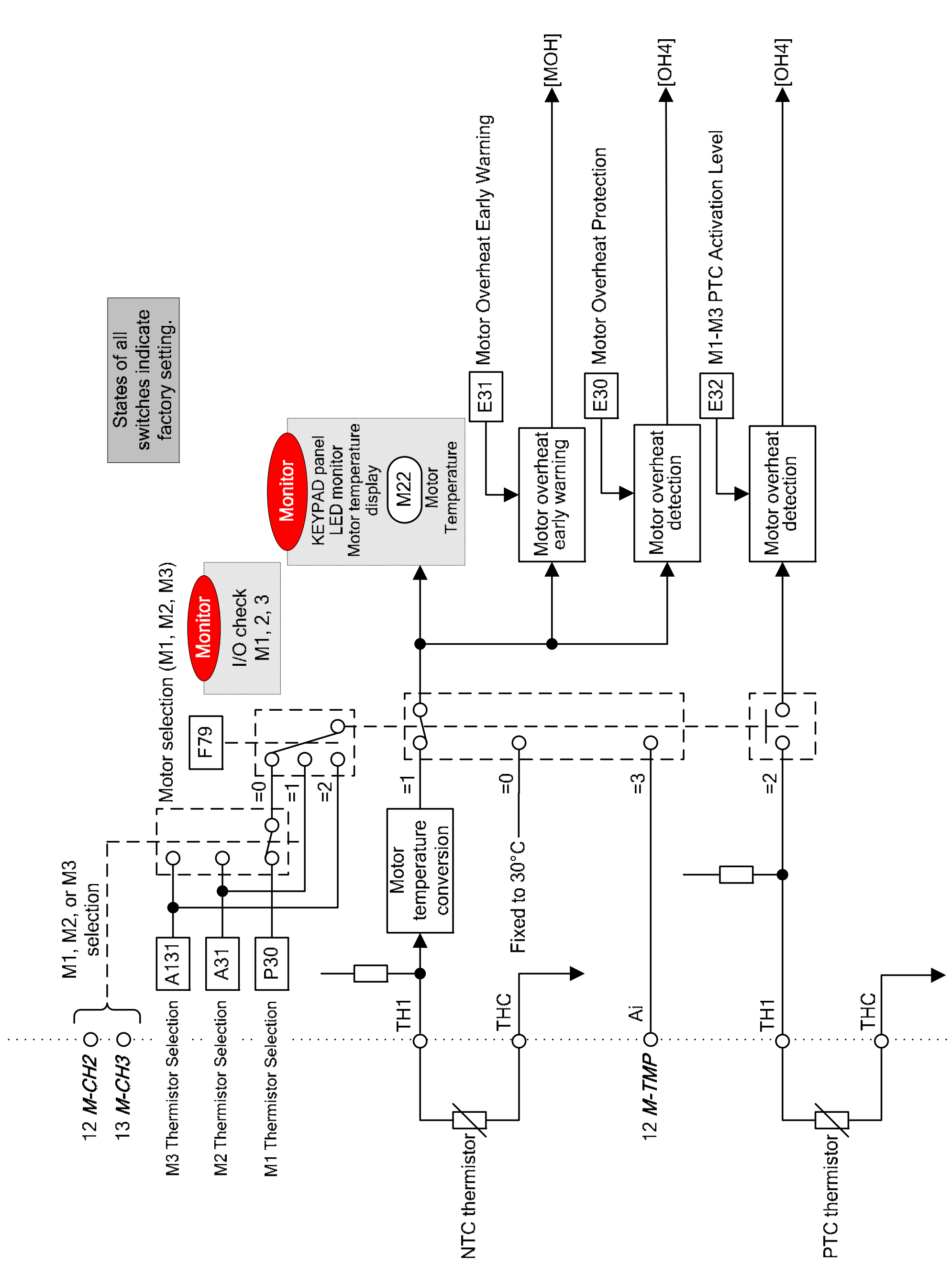
States of all switches indicate factory setting.

- Setting H20 (PID control, action selection) to zero holds the PID calculation to zero.
- [PIDOUT] of PID output is used for individual controls. See corresponding block diagrams for details.
  Speed command when H27 "PID control (speed command selection)" is set to 1.
  Auxiliary speed command when H27 "PID control (speed command selection)" is set to 2.
  Torque command when H41 "Torque command selection" is set to 5.
  Torque limiting when F42 or F43 "Torque limiter value (level 1) or (level 2) selection" is set to 5.

4.1.10 Load Adaptive Control Section

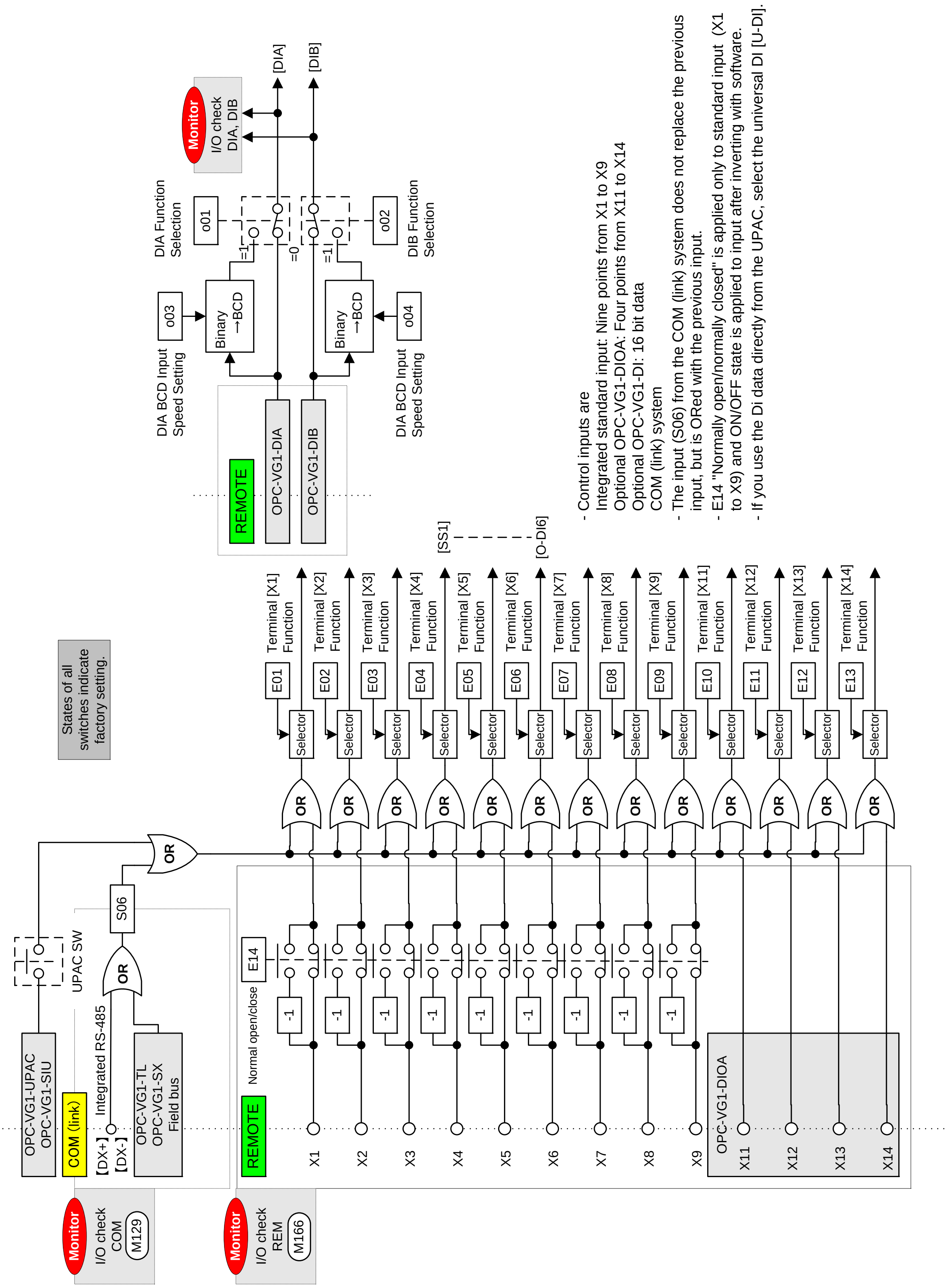


4.1.11 Motor Temperature Detection Section



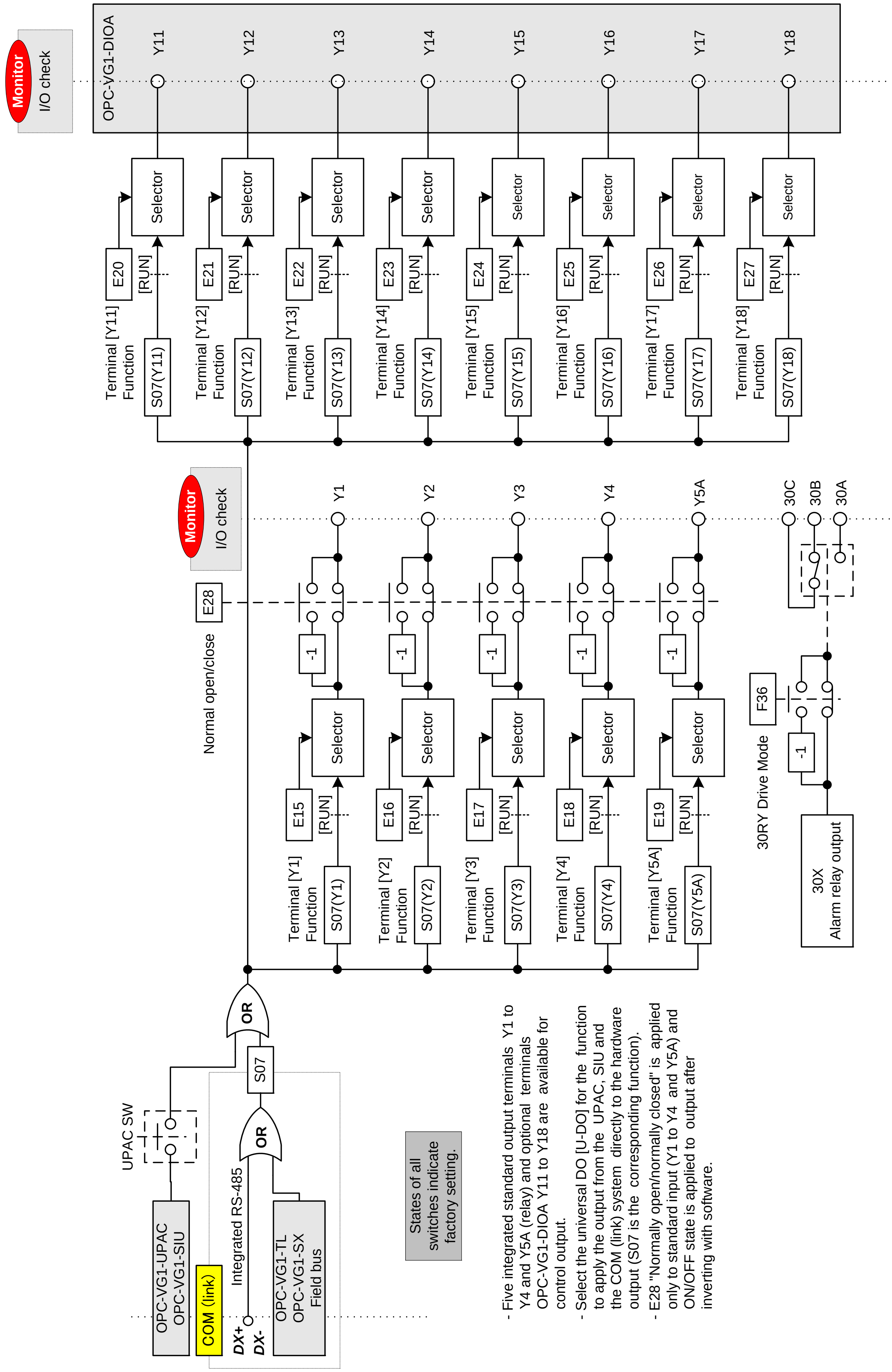
- For thermistor, you can select NTC, PTC thermistor or analog input.
  NTC (Negative Temperature Characteristic) thermistor: a thermistor having a negative relation between temperature and its resistance.
  PTC (Positive Temperature Characteristic) thermistor: a thermistor having a positive relation between temperature and its resistance.
- The motor temperature monitor displays only when an NTC thermistor is connected or Ai [M-TMP] is input. When a PTC thermistor is connected, "---" appears.
- Though thermistor is used for motor overheat protection, you can use an NTC thermistor for the secondary resistor compensation (R2 compensation) in primary angular frequency calculation to realize accurate torque control without being influenced by the motor temperature as described Section 4.2.8 "Current control and vector control section".

4.1.12 Function Selection Digital Input



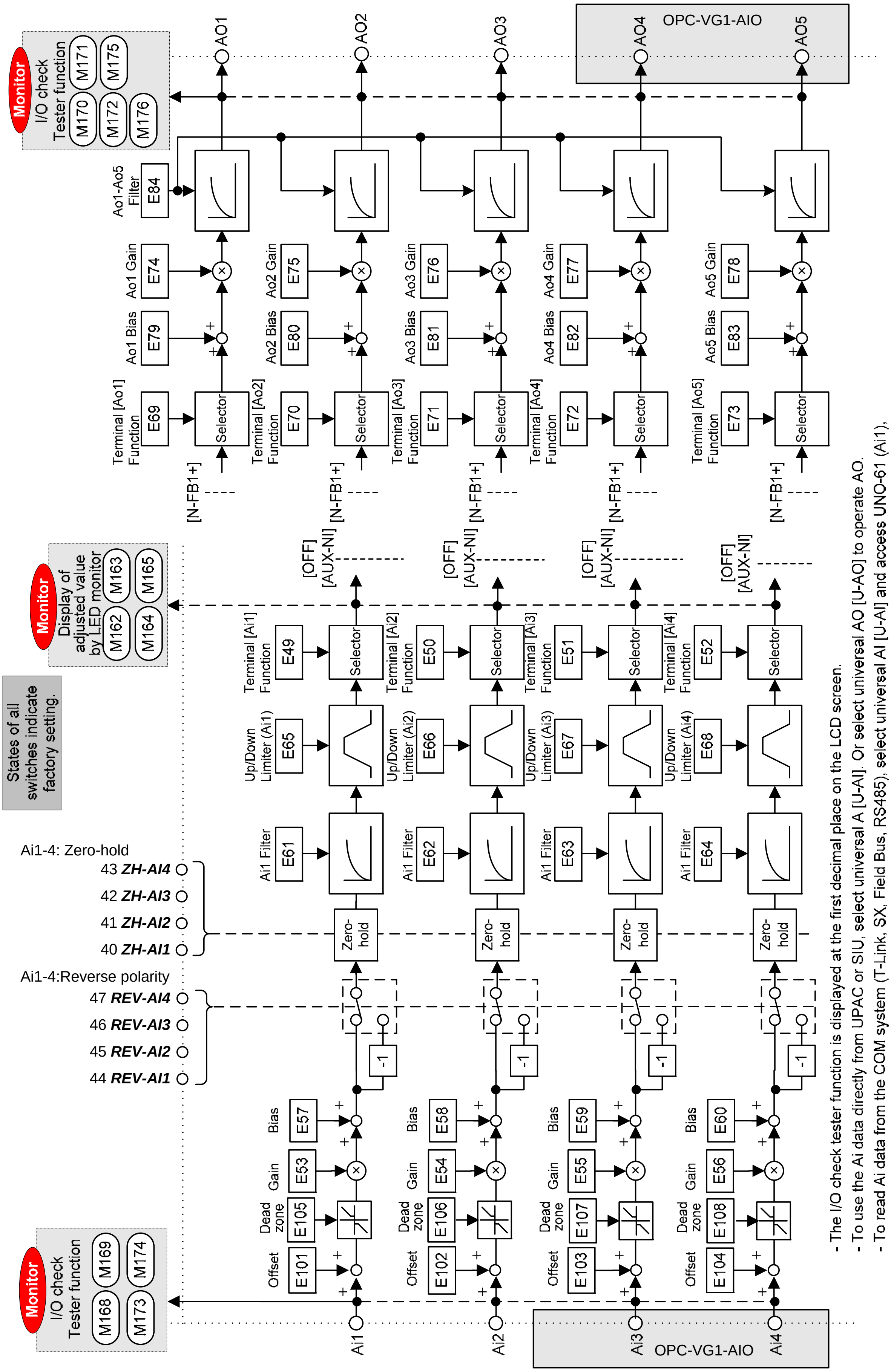
- Control inputs are
  Integrated standard input: Nine points from X1 to X9
  Optional OPC-VG1-DIOA: Four points from X11 to X14
  Optional OPC-VG1-DI: 16 bit data
  COM (link) system
- The input (S06) from the COM (link) system does not replace the previous input, but is ORed with the previous input.
- E14 "Normally open/normally closed" is applied only to standard input (X1 to X9) and ON/OFF state is applied to input after inverting with software.
- If you use the Di data directly from the UPAC, select the universal DI [U-DI].

4.1.13 Function Selection Digital Output/Fault Output



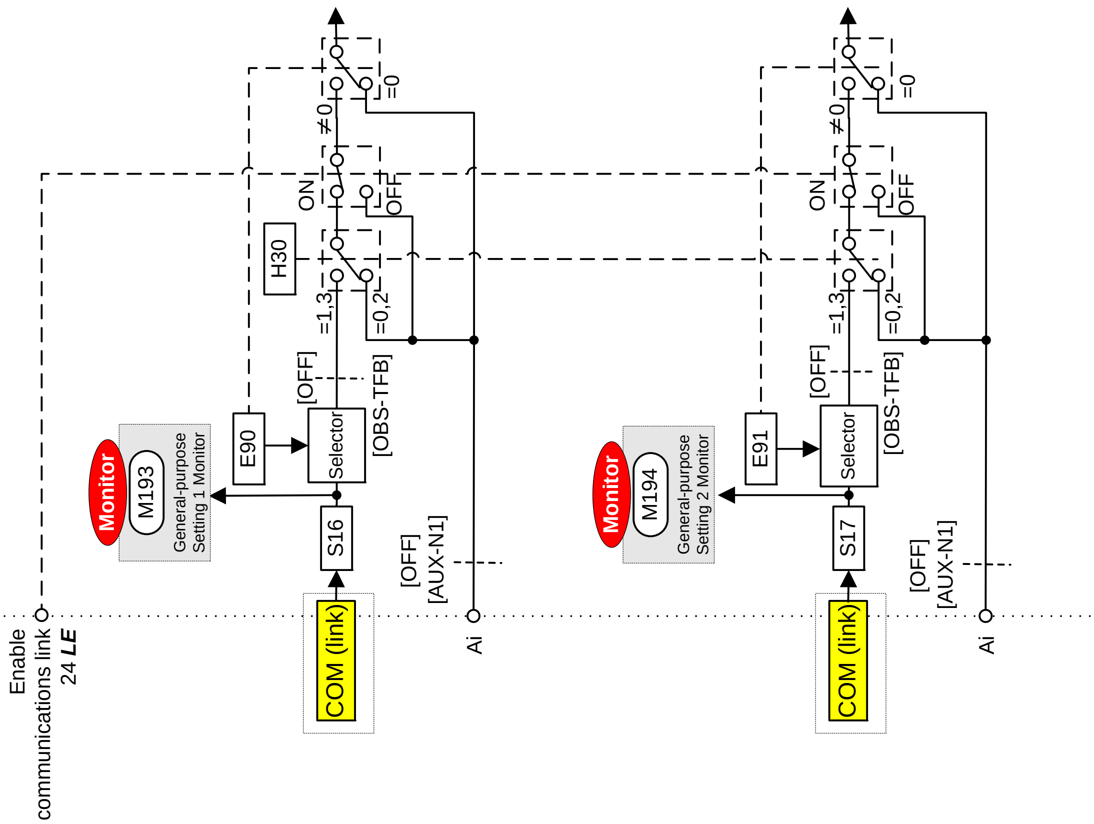
- Five integrated standard output terminals Y1 to Y4 and Y5A (relay) and optional terminals OPC-VG1-DIOA Y11 to Y18 are available for control output.
- Select the universal DO [U-DO] for the function to apply the output from the UPAC, SIU and the COM (link) system directly to the hardware output (S07 is the corresponding function).
- E28 "Normally open/normally closed" is applied only to standard input (Y1 to Y4 and Y5A) and ON/OFF state is applied to output after inverting with software.

4.1.14 Function Selection Analog Input/Output

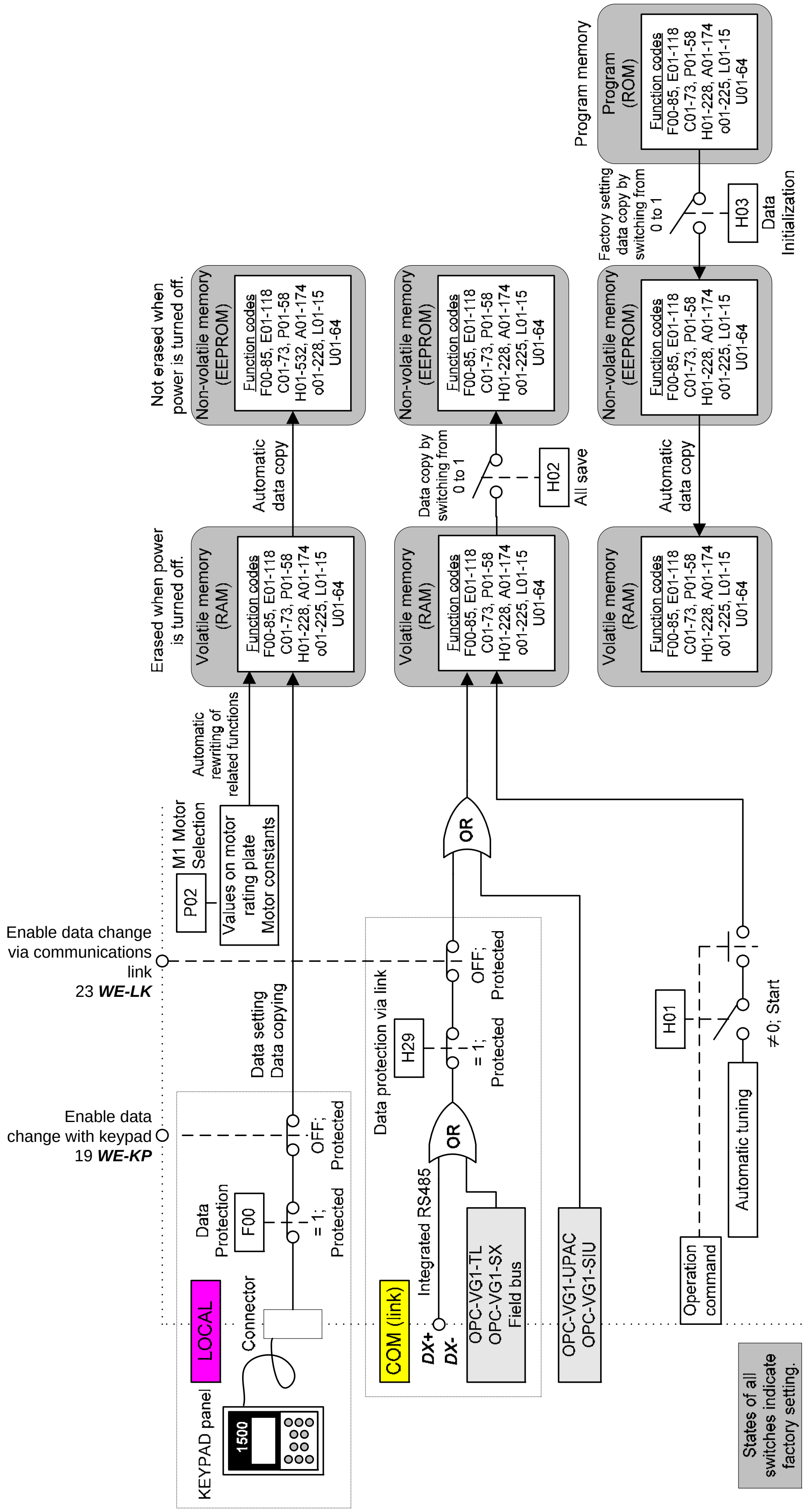


- The I/O check tester function is displayed at the first decimal place on the LCD screen.
- To use the Ai data directly from UPAC or SIU, select universal A [U-AI]. Or select universal AO [U-AO] to operate AO.
- To read Ai data from the COM system (T-Link, SX, Field Bus, RS485), select universal AI [U-AI] and access UNO-61 (Ai1), 62 (Ai2), 63 (Ai3) and 64 (Ai4). However, this function is invalid if a UPAC option is installed.

4.1.15 Link Command Function Selection



4.1.16 Enabling to Write to/Recording Function Codes



- Later writing has always priority. Data written last is maintained and previous data is deleted on writing.
- The all save and initialization procedures take about 2s. You cannot change data in this period.
- When you have not assigned the [WE-KP] or the [WE-LK] to X functions, they are assumed as "ON".
- You cannot enable or disable to write data from the UPAC, SIU.
- Data from the COM (link) or the UPAC are written to the RAM and are deleted when you turn off the power. If you want to keep them, execute the all save procedure.
- The H30 and [LE] define the access from the COM (link) to the function S area separately. See the block diagrams for operation commands and speed reference.
- You cannot use the COM (link) to change the function code P02.

4.2 Function Code Tables

4.2.1 Function Code Groups and Function Codes

F ＊＊＊

Code number

Function code group

Function code group		Function codes	Remarks	
Fundamental functions	**F** codes	F00 to F85		
Extension terminal functions	**E** codes	E01 to E118		
			E51, E52	For the OPC-VG1-AIO option (available soon).
			E55, E56	
			E59, E60	
			E63, E64	
			E67, E68	
			E72, E73	
			E77, E78	
			E82, E83	
			E103, E104	
			E107, E108	
Control functions	**C** codes	C01 to C73		
Motor **P**arameter functions M1	**P** codes	P01 to P51	For M1.	
High performance function	**H** codes	H01 to H228		
Alternative motor parameter functions M2/M3	**A** codes	A01 to A171	For M2 and M3.	
option functions	**o** codes	o05 to o197	o01 to o04	For the OPC-VG1-DIA, DIB option.
			o05	For the OPC-VG1-PG (PD) option.
			o06 to o08	For the OPC-VG1-PG (LD) option.
			o09 to o11	For the OPC-VG1-PMPG option.
			o12 to o19	For the OPC-VG1-PG (PR) option.
			o29 to o32	For communications options (e.g., OPC-VG1-TL, OPC-VG1-CCL).
			o33, o34, o50	For the high-speed serial communication terminal block OPC-VG1-TBSI.
			o35 and o36	For the OPC-VG1-SIU option (available soon).
			o122 to o197	For communications options.
Lift functions	**L** codes	L01 to L15		
User functions	**U** codes	U01 to U64	For the UPAC option.	
		U101 to U150	For manufacturers.	
Sa**F**ety functions	**SF** codes	SF00 to SF31	For functional safety. For details, refer to the Functional Safety Option Instruction Manual.	
Serial communication functions	**S** codes	S01 to S17	Commands	Accessible in local mode (keypad), via the communications link (T-Link, RS-485, SIU, SX-bus, and fieldbus), and via the UPAC.
Monitoring functions	**M** codes	M01 to M222	Data monitor	

4.2.2 About the Contents of Column Headers in Function Code Tables

<table>
<tr><th colspan="2">Column Headers</th><th>Description</th></tr>
<tr><td colspan="2">Function code</td><td>Function code group and code number</td></tr>
<tr><td rowspan="2">Communications address</td><td>485 No.</td><td>Address to be used to refer to or change function code data using a communications option.
Available for all communications options except OPC-VG1-TL.</td></tr>
<tr><td>Link No.</td><td>Address to be used to refer to or change function code data using a communications option (OPC-VG1-TL, OPC-VG1-SX, etc.).
Blank link number fields mean that the corresponding function codes cannot be accessed via a field option.</td></tr>
<tr><td colspan="2">Name</td><td>Name assigned to a function code.</td></tr>
<tr><td colspan="2">Dir.</td><td>Number of subdirectories in the keypad directory structure.
0: Parent directory having no subdirectories
1: Subdirectory
2 or more: Parent directory having the specified number of subdirectories</td></tr>
<tr><td colspan="2">Data setting range</td><td>Allowable data setting range and definition of each data.</td></tr>
<tr><td colspan="2">Change when running</td><td>Indicates whether the function code data can be changed or not when the inverter is running.
Y: Possible, N: Impossible</td></tr>
<tr><td colspan="2">Default setting</td><td>Data preset by factory default.
If data is changed from the factory default, it is displayed with an asterisk (*) on the keypad.
Using function code H03 reverts changed function code data to the default values.</td></tr>
<tr><td colspan="2">Data copying</td><td>Indicates whether or not the function code data can be copied when you copy the data stored in the keypad memory of a source inverter to other destination inverters.</td></tr>
<tr><td colspan="2">Initialization</td><td>Indicates whether or not the function code data can be initialized to the default value by function code H03 (Data initialization).
Y: Possible, N: Impossible</td></tr>
<tr><td colspan="2">Format type</td><td>Indicates a format type to be used to refer to or change function code data via the communications link.</td></tr>
<tr><td colspan="2">Drive control (Availability)</td><td>Indicates whether or not the function code is available to the individual drive controls.
Y: Available, N: Not available
Drive controls:
VC w/ PG: Vector control for induction motor (IM) with speed sensor
VC w/o PG: Vector control for induction motor (IM) without speed sensor
V/f: V/f control for induction motor (IM)
VC for PMSM: Vector control for permanent magnet synchronous motor (PMSM) with speed sensor</td></tr>
</table>

4.2.3 Function Code Tables

■ F codes (Fundamental Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
F00	0h	50h	Data Protection	0	0 or 1 0: Enable data change 1: Protect data This write-protects data from the keypad. H29 defines write-protect from the communications link (T-link, RS-485, etc.)	N	0	N	Y	40	Y	Y	Y	Y	
F01	1h	h	Speed Command N1	0	0 to 9 0: Keypad (⋀/⋁ keys) 1: Analog input to terminal [12](0 to ±10V) 2: Analog input to terminal [12](0 to +10V) 3: ***UP/DOWN*** control (Initial speed = 0) 4: ***UP/DOWN*** control (Initial speed = Last value) 5: ***UP/DOWN*** control (Initial speed = Creep speed 1 or 2) 6: DIA card input 7: DIB card input 8: ***N-REFV*** input to terminal [Ai1] 9: ***N-REFC*** input to terminal [Ai2] F01 defines the command source that specifies a speed command.	N	0	Y	Y	41	Y	Y	Y	Y	
F02	2h	h	Operation Method	0	0 or 1 0: Keypad (FWD/REV/STOP keys) (Local mode) 1: External signals to terminals ***FWD***/***REV*** (Remote mode) F02 defines a run command source. Switching between the Remote and Local modes is also possible with the simultaneous depression of the RESET + STOP keys on the keypad, which changes the F02 data.	N	0	Y	Y	42	Y	Y	Y	Y	
F03	3h	51h	Maximum Speed M1	3	50 to 30000 r/min	N	1500	Y	N	0	Y	Y	Y	Y	
F04	4h	52h	Rated Speed M1	1	50 to 30000 r/min	N	*	Y	N	0	Y	Y	Y	Y	
F05	5h	53h	Rated Voltage M1	1	80 to 999 V	N	*	Y	N	0	Y	Y	Y	Y	
F07	7h	54h	Acceleration Time 1	0	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
F08	8h	55h	Deceleration Time 1	0	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
F10	Ah	56h	M1 Electronic Thermal Overload Protection (Select motor characteristics)	3	0 to 2 0: Disable (For a VG-dedicated motor) 1: Enable (For a general-purpose motor with shaft-driven cooling fan) 2: Enable (For an inverter-driven motor with separately powered cooling fan)	Y	0	Y	N	85	Y	Y	Y	Y	
F11	Bh	57h	(Detection level)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	*	Y	N	13	Y	Y	Y	Y	
F12	Ch	58h	(Thermal time constant)	1	0.5 to 75.0 min	Y	*	Y	N	2	Y	Y	Y	Y	
F14	Eh	h	Restart Mode after Momentary Power Failure (Mode selection)	0	0 to 5 0: No restart (Trip immediately, with alarm LU) 1: No restart (Trip after recovery from power failure, with alarm LU) 2: No restart (Trip after decelerate-to-stop, with alarm LU) 3: Restart (Continue to run) 4: Restart at the frequency at which the power failure occurred 5: Restart at the starting frequency	Y	0	Y	Y	0	Y	Y	Y	Y	
F17	11h	h	Gain (for terminal [12] input)	0	0.0 to 200.0% Ratio to analog speed setting on terminal [12]. Limited to ±110% of the maximum speed.	Y	100.0	Y	Y	2	Y	Y	Y	Y	
F18	12h	h	Bias (for terminal [12] input)	0	-30000 to 30000 r/min Bias to analog speed setting on terminal [12]. Limited to ±110% of the maximum speed	Y	0	Y	Y	5	Y	Y	Y	Y	
F20	14h	59h	DC Braking (Braking starting speed)	3	0 to 3600 r/min	Y	0	Y	Y	0	Y	Y	Y	N	
F21	15h	5Ah	(Braking level)	1	0 to 100%	Y	0	Y	Y	16	Y	Y	Y	N	
F22	16h	5Bh	(Braking time)	1	0.0 to 30.0 s 0.0: Disable 0.1 to 30.0 s	Y	0.0	Y	Y	2	Y	Y	Y	N	

*Depending upon the inverter's capacity.

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
F23	17h	5Ch	Starting Speed (Speed)	0	0.0 to 150.0 r/min Limited in order not to lower to 0.1 Hz or below (under vector control w/o speed sensor and V/f control). Use F23 for assuring the torque at startup.	N	0.0	Y	Y	2	Y	Y	Y	Y	
F24	18h	5Dh	(Holding time)	0	0.00 to 10.00 s	N	0.00	Y	Y	3	Y	Y	Y	Y	
F26	1Ah	5Eh	Motor Sound (Carrier frequency)	0	2 to 15 kHz 2: 2 kHz 3: 3 kHz 4: 4 kHz 5: 5 kHz 6: 6 kHz 7: 7 kHz 8, 9: 8 kHz 10, 11: 10 kHz 12, 13, 14: 12 kHz 15: 15 kHz This controls the carrier frequency to reduce an audible noise generated by the motor or electromagnetic noise from the inverter itself, to suppress the resonance with the machinery, and to decrease a leakage current from the output circuit wirings.	N	8 for 55 kW or below 7 for 75 kW or above	Y	Y	10	Y	Y	Y	Y	
F36	24h	h	30RY Drive Mode	0	0 or 1 0: Excite relay (30) when an alarm occurs 1: Excite relay (30) when the inverter power is normally established	N	0	Y	Y	43	Y	Y	Y	Y	
F37	25h	60h	Stop Speed (Speed)	3	0.0 to 150.0 r/min Limited in order not to lower to 0.1 Hz or below (under vector control w/o speed sensor and V/f control).	N	10.0	Y	Y	2	Y	Y	Y	Y	
F38	26h	61h	(Detection mode)	1	0 or 1 0: Detected speed 1: Reference speed Fixed at "1" under V/f control	N	0	Y	Y	90	Y	N	N	Y	
F39	27h	62h	(Zero speed control holding time)	1	0.00 to 10.00 s Applies to when timing the application of the mechanical brake.	N	0.50	Y	Y	3	Y	N	N	Y	
F40	28h	63h	Torque Limiter Mode 1	12	0 to 3 0: Disable limiter 1: Enable torque limiter 2: Enable power limiter 3: Enable torque current limiter	N	0	Y	Y	44	Y	Y	N	Y	
F41	29h	64h	Torque Limiter Mode 2	1	0 to 3 0: Level 1 to all four quadrants 1: Level 1 to driving, Level 2 to braking 2: Level 1 to upper limit, Level 2 to lower limit 3: Level 1/Level 2 (switchable) to all four quadrants Levels 1 and 2 are specified by the source defined by F42 and F43, respectively.	N	0	Y	Y	45	Y	Y	Y	Y	
F42	2Ah	65h	Torque Limiter Level 1 Source	1	0 to 5 0: Function code F44 1: ***TL-REF1*** input to terminal [Ai] 2: DIA card 3: DIB card 4: Communications link 5: PID output	N	0	Y	Y	46	Y	Y	Y	Y	
F43	2Bh	66h	Torque Limiter Level 2 Source	1	0 to 5 0: Function code F45 1: ***TL-REF1*** input to terminal [Ai] 2: DIA card 3: DIB card 4: Communications link 5: PID output	N	0	Y	Y	47	Y	Y	Y	Y	
F44	2Ch	67h	Torque Limiter Level 1	1	-300 to 300%	Y	150	Y	Y	5	Y	Y	Y	Y	
F45	2Dh	68h	Torque Limiter Level 2	1	-300 to 300%	Y	10	Y	Y	5	Y	Y	Y	Y	
F46	2Eh	69h	Mechanical Loss Compensation	1	-300.00 to 300.00%	Y	0.00	Y	Y	7	Y	Y	N	Y	
F47	2Fh	6Ah	Torque Bias T1	1	-300.00 to 300.00% Torque biases T1 to T3 are switchable with DI.	Y	0.00	Y	Y	7	Y	Y	N	Y	
F48	30h	h	Torque Bias T2	1	-300.00 to 300.00%	Y	0.00	Y	Y	7	Y	Y	N	Y	
F49	31h	h	Torque Bias T3	1	-300.00 to 300.00%	Y	0.00	Y	Y	7	Y	Y	N	Y	
F50	32h	h	Torque Bias Startup Timer	1	0.00 to 1.00 s F50 specifies the time required for generating 300% torque.	Y	0.00	Y	Y	3	Y	Y	N	Y	
F51	33h	FBh	Torque Command Monitor (Polarity)	1	0 or 1 0: Torque polarity 1: + for driving, - for braking F51 specifies the polarity of torque related data output (e.g., Ao monitor, LED monitor, and LCD monitor).	Y	0	Y	Y	48	Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
F52	34h	h	LED Monitor (Display coefficient A)	8	-999.00 to 999.00 F52 specifies the conversion coefficient for displaying the load shaft speed and line speed on the LED monitor. Display value = Motor speed x (0.01 to 200.00) Only the setting range from 0.01 to 200.00 takes effect. The specification out of the range is limited.	Y	1.00	Y	Y	12	Y	Y	Y	Y	
F53	35h	h	(Display coefficient B)	1	-999.00 to 999.00 Display coefficient A: Maximum value Display coefficient B: Minimum value F52 and F53 specify the conversion coefficients for displaying the PID command, PID feedback amount, and PID output (process command). Display value = (Command or feedback value) x (Display coefficient A - B) + B	Y	1.00	Y	Y	12	Y	Y	Y	Y	
F54	36h	h	LED Monitor (Display filter)	1	0.0 to 5.0 s	Y	0.2	Y	Y	2	Y	Y	Y	Y	
F55	37h	h	(Item selection)	1	0 to 32	Y	0	Y	Y	49					
					0: Detected speed 1 or Reference speed 4 (r/min) (switchable with F56)						Y	Y	N	Y	
					1: Reference speed 4 (ASR input) (r/min)						Y	Y	Y	Y	
					2: Output frequency (after slip compensation) (Hz)						Y	Y	Y	Y	
					3: Reference torque current (%)						Y	Y	N	Y	
					4: Reference torque (%)						Y	Y	N	Y	
					5: Calculated torque (%)						Y	Y	Y	Y	
					6: Power consumption (Motor output) (kW or HP, switchable with F60)						Y	Y	Y	Y	
					7: Output current (A)						Y	Y	Y	Y	
					8: Output voltage (V)						Y	Y	Y	Y	
					9: DC link bus voltage (V)						Y	Y	Y	Y	
					10: Magnetic flux command (%)						Y	Y	N	N	
					11: Calculated magnetic flux (%)						Y	Y	N	N	
					12: Motor temperature (°C) (When no NTC thermistor is used, "---" appears.)						Y	Y	Y	Y	
					13: Load shaft speed (r/min) (Detected or commanded, switchable with F56)						Y	Y	N	Y	
					14: Line speed (m/min) (Detected or commanded, switchable with F56)						Y	Y	Y	Y	
					15: Ai adjustment value on [12] (%)						Y	Y	Y	Y	
					16: Ai adjustment value on [Ai1] (%)						Y	Y	Y	Y	
					17: Ai adjustment value on [Ai2] (%)						Y	Y	Y	Y	
					18: Ai adjustment value on [Ai3] (%)						Y	Y	Y	Y	
					19: Ai adjustment value on [Ai4] (%)						Y	Y	Y	Y	
					The following data will be hidden depending upon the mode or options. 20: PID command (%)						Y	Y	Y	Y	
					21: PID feedback amount (%)						Y	Y	Y	Y	
					22: PID output (%)						Y	Y	Y	Y	
					23: Option monitor 1 (HEX)						Y	Y	Y	Y	
					24: Option monitor 2 (HEX)						Y	Y	Y	Y	
					25: Option monitor 3 (DEC)						Y	Y	Y	Y	
					26: Option monitor 4 (DEC)						Y	Y	Y	Y	
					27: Option monitor 5 (DEC)						Y	Y	Y	Y	
					28: Option monitor 6 (DEC)						Y	Y	Y	Y	
					29: -						Y	Y	Y	Y	
					30: Load factor (%)						Y	Y	Y	Y	
					31: Input power (kW or HP, switchable with F60)						Y	Y	Y	Y	
					32: Input watt-hour (x 100 kWh)						Y	Y	Y	Y	
F56	38h	h	(Display when stopped)	1	0 or 1 0: Reference speed 1: Detected speed F56 switches the display data between the reference speed and detected one when the motor stops. It applies to the speed (F55 = 0), the load shaft speed (F55 = 13), and the line speed (F55 = 14).	Y	0	Y	Y	50	Y	Y	Y	Y	

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
F57	39h	h	LCD Monitor (Item selection)	1	0 or 1 0: Running status, rotation direction and operation guide 1: Bar charts for detected speed 1, current and reference torque F57 switches the Running mode screen.	Y	0	Y	Y	51	Y	Y	Y	Y	
F58	3Ah	h	(Language selection)	1	0 to 7 0: Japanese 1: English 2: German (Available soon) 3: French (Available soon) 4: Spanish (Available soon) 5: Italian (Available soon) 6: Chinese 7: Korean	Y	0	Y	Y	52	Y	Y	Y	Y	
F59	3Bh		(Contrast control)	1	0 (Low) to 10 (High)	Y	5	Y	Y	0	Y	Y	Y	Y	
F60	3Ch		Output Unit (HP/kW)	0	0 or 1 0: kW 1: HP F60 switches the display unit between kW and HP on the LED monitor and LCD monitor for the power consumption (F55 = 6) and input power (F55 = 31). It also switches the display table between kW and HP for motor 1 selection (P02).	Y	0	Y	Y	53	Y	Y	Y	Y	
F61	3Dh	6Bh	ASR1 (P-gain)	10	0.1 to 500.0 times	Y	10.0	Y	Y	2	Y	Y	N	Y	
F62	3Eh	6Ch	(Integral constant)	1	0.000 to 10.000 s P control when F62 = 0.000	Y	0.200	Y	Y	4	Y	Y	N	Y	
F63	3Fh	6Dh	(Feedforward gain)	1	0.000 to 9.999 s	Y	0.000	Y	Y	4	Y	Y	N	Y	
F64	40h	6Eh	(Input filter)	1	0.000 to 5.000 s	Y	0.040	Y	Y	4	Y	Y	Y	Y	
F65	41h	6Fh	(Detection filter)	1	0.000 to 0.100 s F65 specifies a time constant of the first order delay filter for detected speed.	Y	0.005	Y	Y	4	Y	Y	N	Y	
F66	42h	70h	(Output filter)	1	0.000 to 0.100 s F66 specifies a time constant of the first order delay filter for torque command.	N	0.002	Y	Y	4	Y	Y	N	Y	
F67	43h	71h	S-curve Acceleration 1 (Start)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
F68	44h	72h	(End)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
F69	45h	73h	S-curve Deceleration 1 (Start)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
F70	46h	74h	(End)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
F72	48h	h	Pre-excitation Mode	4	0 or 1 0: Cause pre-excitation at the time of startup (Pre-excitation continues for the duration specified by F74.) 1: Cause pre-excitation at the time of startup and stop. (Pre-excitation continues for the duration specified by F74 or until the magnetic flux command reaches the detection level specified by E48, whichever is earlier.)	N	0	Y	Y	230	Y	Y	N	N	
F73	49h	h	Magnetic Flux Level at Light Load	1	10 to 100%	Y	100	Y	Y	16	Y	N	N	N	
F74	4Ah	75h	Pre-excitation (Duration)	1	0.0 to 10.0 s Turning a run command (FWD, REV) ON automatically continues pre-excitation for the duration specified by F74.	N	0.0	Y	Y	2	Y	Y	N	N	
F75	4Bh	76h	(Initial level)	1	100 to 400%	N	100	Y	Y	0	Y	Y	N	N	
F76	4Ch	h	Speed Limiter (Mode)	3	0 to 3 0: Level 1 for forward rotation, Level 2 for reverse rotation 1: Level 1 for both forward and reverse rotations 2: Level 1 for upper limit, Level 2 for lower limit 3: Level 1 for forward rotation, Level 2 for reverse rotation (Terminal [12] input added as a bias)	N	0	Y	Y	91	Y	Y	Y	Y	
F77	4Dh	4Fh	(Level 1)	1	-110.0 to 110.0%	Y	100.0	Y	Y	6	Y	Y	Y	Y	
F78	4Eh	FEh	(Level 2)	1	-110.0 to 110.0%	Y	100.0	Y	Y	6	Y	Y	Y	Y	
F79	4Fh	77h	Motor Selection (M1, M2, M3)	0	0 to 2 0: Select M1 (Note that switching of contacts by X terminal functions has priority over this function code setting.) 1: Select M2 (X terminal functions disabled) 2: Select M3 (X terminal functions disabled) Select a motor to be used from M1, M2 and M3.	N	0	Y	N	54	Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
F80	50h	h	Switching between HD, MD and LD Drive Modes	0	0 to 3 0, 2: HD (High duty mode, overload capability 150%/200%) 1: LD (Low duty mode, overload capability 120%) 3: MD (Medium duty mode, overload capability 150%) F80 switches the drive mode between the HD, MD and LD.	N	0	Y	N	56	Y	Y	Y	Y	
F81	51h	h	Offset for Speed Setting on Terminal [12]	3	-30000 to 30000 r/min F81 specifies the offset for analog speed input on terminal [12].	Y	0	Y	Y	5	Y	Y	Y	Y	
F82	52h	h	Dead Zone for Speed Setting on Terminal [12]	1	0.0 to 150.0 r/min F82 specifies the dead zone speed for analog speed input on terminal [12] to limit the speed setting value within the range of ±F82 data to 0 r/min.	Y	0	Y	Y	2	Y	Y	Y	Y	
F83	53h	h	Filter for Speed Setting on Terminal [12]	1	0.000 to 5.000 s	Y	0.005	Y	Y	4	Y	Y	Y	Y	
F84	54h	h	Display Coefficient for Input Watt-hour Data	0	0.000 to 9999 F84 specifies a display coefficient for displaying the input watt-hour data (M116). M116 = F84 x M115 (Input watt-hour, kWh) Specification of 0.000 clears the input watt-hour data.	Y	0.010	Y	Y	101	Y	Y	Y	Y	
F85	55h	h	Display Filter for Calculated Torque	0	0.000 to 1.000 s F85 specifies a display filter for calculated torque output for monitoring (LED monitor and LCD monitor).	Y	0.100	Y	Y	4	Y	Y	Y	Y	

■ E codes (Extension Terminal Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
E01	101h	78h	Terminal [X1] Function	13	0 to 79	N	0	Y	Y	57					
					0, 1, 2, 3: Select multistep speed (1 to 15 steps) 0: ***SS1***, 1: ***SS2***, 2: ***SS4***, 3: ***SS8***						Y	Y	Y	Y	
					4,5: Select ASR and ACC/DEC time (4 steps) 4: ***RT1***, 5: ***RT2***						Y	Y	Y	Y	
					6: Enable 3-wire operation ***HLD***						Y	Y	Y	Y	
					7: Coast to a stop ***BX***						Y	Y	Y	Y	
					8: Reset alarm ***RST***						Y	Y	Y	Y	
					9: Enable external alarm trip ***THR***						Y	Y	Y	Y	
					10: Ready for jogging ***JOG***						Y	Y	Y	Y	
					11: Select speed command N2/N1 ***N2/N1***						Y	Y	Y	Y	
					12: Select motor 2 ***M-CH2***						Y	Y	Y	Y	
					13: Select motor 3 ***M-CH3***						Y	Y	Y	Y	
					14: Enable DC braking ***DCBRK***						Y	Y	Y	N	
					15: Clear ACC/DEC to zero ***CLR***						Y	Y	Y	Y	
					16: Switch creep speed under UP/DOWN control ***CRP-N2/N1***						Y	Y	Y	Y	
					17: UP (Increase speed) ***UP***						Y	Y	Y	Y	
					18: DOWN (Decrease speed) ***DOWN***						Y	Y	Y	Y	
					19: Enable data change with keypad ***WE-KP***						Y	Y	Y	Y	
					20: Cancel PID control ***KP/PID***						Y	Y	Y	Y	
					21: Switch normal/inverse operation ***IVS***						Y	Y	Y	Y	
					22: Interlock (52-2) ***IL***						Y	Y	Y	Y	
					23: Enable data change via communications link ***WE-LK***						Y	Y	Y	Y	
					24: Enable communications link ***LE***						Y	Y	Y	Y	
					25: Universal DI ***U-DI***						Y	Y	Y	Y	
					26: Enable auto search for idling motor speed at starting ***STM***						Y	Y	N	Y	
					27: Synchronous operation command (PG (PR) optional function) ***SYC***						Y	N	N	Y	
					28: Lock at zero speed ***LOCK***						Y	N	N	Y	
					29: Pre-excitation ***EXITE***						Y	Y	N	N	
					30: Cancel speed limiter ***N-LIM*** (Related codes: F76, F77, F78)						Y	Y	Y	Y	
					31: Cancel H41 (Torque command) ***H41-CCL***						Y	Y	N	Y	
					32: Cancel H42 (Torque current command) ***H42-CCL***						Y	Y	N	Y	
					33: Cancel H43 (Magnetic flux command) ***H43-CCL***						Y	N	N	N	
					34: Cancel F40 (Torque limiter mode 1) ***F40-CCL***						Y	Y	N	Y	
					35: Select torque limiter level 2/1 ***TL2/TL1***						Y	Y	N	Y	
					36: Bypass ACC/DEC processor ***BPS***						Y	Y	Y	Y	
					37, 38: Select torque bias command 37: ***TB1***, 38: ***TB2***						Y	Y	N	Y	
					39: Select droop control ***DROOP***						Y	Y	N	Y	
					40: Zero-hold Ai1 ***ZH-AI1***						Y	Y	Y	Y	
					41: Zero-hold Ai2 ***ZH-AI2***						Y	Y	Y	Y	
					42: Zero-hold Ai3 (AIO optional function) ***ZH-AI3***						Y	Y	Y	Y	
					43: Zero-hold Ai4 (AIO optional function) ***ZH-AI4***						Y	Y	Y	Y	
					44: Reverse Ai1 polarity ***REV-AI1***						Y	Y	Y	Y	
					45: Reverse Ai2 polarity ***REV-AI2***						Y	Y	Y	Y	
					46: Reverse Ai3 polarity (AIO optional function) ***REV-AI3***						Y	Y	Y	Y	
					47: Reverse Ai4 polarity (AIO optional function) ***REV-AI4***						Y	Y	Y	Y	
					48: Inverse PID output ***PID-INV***						Y	Y	Y	Y	
					49: Cancel PG alarm ***PG-CCL***						Y	N	N	Y	
					50: Cancel undervoltage alarm ***LU-CCL***						Y	Y	Y	Y	
					51: Hold Ai torque bias ***H-TB***						Y	Y	N	Y	
					52: STOP1 ***STOP1*** (Decelerate to stop with normal deceleration time)						Y	Y	Y	Y	
					53: STOP2 ***STOP2*** (Decelerate to stop with deceleration time 4)						Y	Y	Y	Y	
					54: STOP3 ***STOP3*** (Decelerate to stop with max. braking torque, ignoring the deceleration time setting)						Y	Y	Y	Y	
					55: Latch DIA data (DIA optional function) ***DIA***						Y	Y	Y	Y	
					56: Latch DIB data (DIB optional function) ***DIB***						Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
E01	101h	78h	Terminal [X1] Function	13	57: Cancel multiplex system ***MT-CCL***						Y	N	N	N	
					58-67: Custom Di1-Di10 ***C-DI1*** to ***C-DI10***						Y	Y	Y	Y	
					68: Select load adaptive parameters 2/1 ***AN-P2/1*** (Available soon)						Y	N	N	Y	
					69: Cancel PID components ***PID-CCL***						Y	Y	Y	Y	
					70: Enable PID FF component ***PID-FF***						Y	Y	Y	Y	
					71: Reset completion of speed limit calculation ***NL-RST*** (Available soon)						Y	Y	Y	Y	
					72: Toggle signal 1 ***TGL1***						Y	Y	Y	Y	
					73: Toggle signal 2 ***TGL2***						Y	Y	Y	Y	
					74: Cause external mock alarm ***FTB***						Y	Y	Y	Y	
					75: Cancel NTC thermistor alarm ***NTC-CCL***						Y	Y	Y	Y	
					76: Cancel lifetime alarm signal ***LF-CCL***						Y	Y	Y	Y	
					77: Request for reading in serial port PG absolute position ***SPG-AP*** (Available soon)						N	N	N	Y	
					78: Switch PID feedback signals ***PID-1/2***						Y	Y	Y	Y	
					79: Select PID torque bias ***TB-PID***						Y	Y	Y	Y	
					80: Tune magnetic pole position ***MP-TUN*** (Available soon)						N	N	N	Y	
					81: External electrical conditions ***RD*** (Available soon)						Y	Y	Y	Y	
					82: Startup conditions ***STRD*** (Available soon)						Y	Y	Y	Y	
					83: Continue to run at the time of communications link error ***LK-D*** (Available soon)						Y	Y	Y	Y	
E02	102h	79h	Terminal [X2] Function	1	0 to 79 (See Terminal [X1] Function.)	N	1	Y	Y	57	Y	Y	Y	Y	
E03	103h	7Ah	Terminal [X3] Function	1	0 to 79 (See Terminal [X1] Function.)	N	2	Y	Y	57	Y	Y	Y	Y	
E04	104h	7Bh	Terminal [X4] Function	1	0 to 79 (See Terminal [X1] Function.)	N	3	Y	Y	57	Y	Y	Y	Y	
E05	105h	7Ch	Terminal [X5] Function	1	0 to 79 (See Terminal [X1] Function.)	N	4	Y	Y	57	Y	Y	Y	Y	
E06	106h	7Dh	Terminal [X6] Function	1	0 to 79 (See Terminal [X1] Function.)	N	5	Y	Y	57	Y	Y	Y	Y	
E07	107h	7Eh	Terminal [X7] Function	1	0 to 79 (See Terminal [X1] Function.)	N	7	Y	Y	57	Y	Y	Y	Y	
E08	108h	7Fh	Terminal [X8] Function	1	0 to 79 See Terminal [X1] Function.)	N	8	Y	Y	57	Y	Y	Y	Y	
E09	109h	80h	Terminal [X9] Function	1	0 to 79 (See Terminal [X1] Function.)	N	9	Y	Y	57	Y	Y	Y	Y	
E10	10Ah	81h	Terminal [X11] Function	1	0 to 79 (See Terminal [X1] Function.)	N	25	Y	Y	57	Y	Y	Y	Y	
E11	10Bh	82h	Terminal [X12] Function	1	0 to 79 (See Terminal [X1] Function.)	N	25	Y	Y	57	Y	Y	Y	Y	
E12	10Ch	83h	Terminal [X13] Function	1	0 to 79 (See Terminal [X1] Function.)	N	25	Y	Y	57	Y	Y	Y	Y	
E13	10Dh	84h	Terminal [X14] Function	1	0 to 79 (See Terminal [X1] Function.)	N	25	Y	Y	57	Y	Y	Y	Y	
E14	10Eh	h	X Terminal Function (Normal open/close)	0	0000 to 01FF 0: Normal open 1: Normal close E14 specifies whether to open or close the contact for terminals [X1] to [X9].	N	0000	Y	Y	35	Y	Y	Y	Y	
E15	10Fh	85h	Terminal [Y1] Function	13	0 to 75	N	1	Y	Y	58					
					0: Inverter running ***RUN***						Y	Y	Y	Y	
					1: Speed valid ***N-EX***						Y	Y	Y	Y	
					2: Speed agreement 1 ***N-AG1***						Y	Y	N	Y	
					3: Speed arrival signal ***N-AR***						Y	Y	Y	Y	
					4: Speed detected 1 ***N-DT1***						Y	Y	Y	Y	
					5: Speed detected 2 ***N-DT2***						Y	Y	Y	Y	
					6: Speed detected 3 ***N-DT3***						Y	Y	Y	Y	
					7: Undervoltage detected (Inverter stopped) ***LU***						Y	Y	Y	Y	
					8: Torque polarity detected (braking/driving) ***B/D***						Y	Y	N	Y	
					9: Torque limiting ***TL***						Y	Y	Y	Y	
					10: Torque detected 1 ***T-DT1***						Y	Y	Y	Y	
					11: Torque detected 2 ***T-DT2***						Y	Y	Y	Y	
					12: Keypad operation enabled ***KP***						Y	Y	Y	Y	
					13: Inverter stopped ***STOP***						Y	Y	Y	Y	
					14: Inverter ready to run ***RDY***						Y	Y	Y	Y	
					15: Magnetic flux detected ***MF-DT***						Y	Y	N	N	
					16: Motor M2 selected ***SW-M2***						Y	Y	Y	Y	
					17: Motor M3 selected ***SW-M3***						Y	Y	Y	Y	
					18: Brake release signal ***BRK***						Y	Y	N	Y	
					19: Alarm content 1 ***AL1***						Y	Y	Y	Y	
					20: Alarm content 2 ***AL2***						Y	Y	Y	Y	
					21: Alarm content 4 ***AL4***						Y	Y	Y	Y	
					22: Alarm content 8 ***AL8***						Y	Y	Y	Y	
					23: Cooling fan in operation ***FAN***						Y	Y	Y	Y	
					24: Resetting ***TRY***						Y	Y	Y	Y	
					25: Universal DO ***U-DO***						Y	Y	Y	Y	

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
E15	10Fh	85h	Terminal [Y1] Function	13	26: Heat sink overheat early warning ***INV-OH***						Y	Y	Y	Y	
					27: Synchronization completion signal ***SY-C***						Y	N	N	N	
					28: Lifetime alarm ***LIFE***						Y	Y	Y	Y	
					29: Under acceleration ***U-ACC***						Y	Y	Y	Y	
					30: Under deceleration ***U-DEC***						Y	Y	Y	Y	
					31: Inverter overload early warning ***INV-OL***						Y	Y	Y	Y	
					32: Motor overheat early warning ***M-OH***						Y	Y	Y	Y	
					33: Motor overload early warning ***M-OL***						Y	Y	Y	Y	
					34: DB overload early warning ***DB-OL***						Y	Y	N	Y	
					35: Link transmission error ***LK-ERR***						Y	Y	Y	Y	
					36: In limiting under load adaptive control ***ANL***						Y	N	N	Y	
					37: In calculation under load adaptive control ***ANC***						Y	N	N	Y	
					38: Analog torque bias being held ***TBH***						Y	Y	N	Y	
					39 to 48: Custom Do1-Do10 ***C-DO1*** to ***C-DO10***						Y	Y	Y	Y	
					49: -						-	-	-	-	
					50: Z-phase detection completed ***Z-RDY***						Y	N	N	Y	
					51: Multiplex system communications link being established ***MTS***						Y	N	N	N	
					52: Answerback to cancellation of multiplex system ***MEC-AB***						Y	N	N	N	
					53: Multiplex system master selected ***MSS***						Y	N	N	N	
					54: Multiplex system local station failure ***AL-SF***						Y	N	N	N	
					55: Stopped due to communications link error ***LES*** (Available soon)						Y	Y	Y	Y	
					56: Alarm output (for any alarm) ***ALM***						Y	Y	Y	Y	
					57: Light alarm ***L-ALM***						Y	Y	Y	Y	
					58: Maintenance timer ***MNT***						Y	Y	Y	Y	
					59: Braking transistor broken ***DBAL***						Y	Y	Y	Y	
					60: DC fan locked ***DCFL***						Y	Y	Y	Y	
					61: Speed agreement 2 ***N-AG2***						Y	Y	N	Y	
					62: Speed agreement 3 ***N-AG3***						Y	Y	N	Y	
					63: Axial fan stopped ***MFAN***						Y	Y	Y	Y	
					64: -						-	-	-	-	
					65: -						-	-	-	-	
					66: Answerback to droop control enabled ***DSAB***						Y	Y	N	Y	
					67: Answerback to cancellation of torque command/torque current command (***H41-CCL***/***H42-CCL***) ***TCL-C***						Y	Y	N	Y	
					68: Answerback to cancellation of torque limiter mode 1 (F40-CCL) ***F40-AB***						Y	Y	Y	Y	
					71: 73 ON command ***PRT-73***						Y	Y	Y	Y	
					72: Turn ON Y-terminal test output ***Y-ON***						Y	Y	Y	Y	
					73: Turn OFF Y-terminal test output ***Y-OFF***						Y	Y	Y	Y	
					74: Reading absolute position of serial PG in progress (Available soon) ***SPG-RD***						N	N	N	Y	
					75: System clock battery lifetime expired ***BATT***						Y	Y	Y	Y	
					76: Magnetic pole position tuning in progress ***TUN-MG*** (Available soon)						N	N	N	Y	
					77: SPGT battery warning ***SPGT-B*** (Available soon)						Y	Y	Y	Y	
					78: Electrical conditions ready ***ERD*** (Available soon)						Y	Y	Y	Y	
					79: IT detected in operation ***TCA*** (Available soon)						Y	Y	Y	Y	
					80: EN terminal detection circuit failure ***DECF*** (Available soon)						Y	Y	Y	Y	
					81: EN terminal OFF ***ENOFF*** (Available soon)						Y	Y	Y	Y	
					82: Safety function in progress ***SF-RUN*** (Available soon)						Y	Y	Y	Y	
					83: Motor stopped by safety function ***SF-STP*** (Available soon)						Y	Y	Y	Y	
					84: STO under testing by safety function (Available soon) ***SF-TST***						Y	Y	Y	Y	
E16	110h	86h	Terminal [Y2] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	2	Y	Y	58	Y	Y	Y	Y	
E17	111h	87h	Terminal [Y3] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	3	Y	Y	58	Y	Y	Y	Y	
E18	112h	88h	Terminal [Y4] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	4	Y	Y	58	Y	Y	Y	Y	
E19	113h	89h	Terminal [Y5] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	14	Y	Y	58	Y	Y	Y	Y	

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
E20	114h	8Ah	Terminal [Y11] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E21	115h	8Bh	Terminal [Y12] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E22	116h	8Ch	Terminal [Y13] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E23	117h	8Dh	Terminal [Y14] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E24	118h	8Eh	Terminal [Y15] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E25	119h	8Fh	Terminal [Y16] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E26	11Ah	90h	Terminal [Y17] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E27	11Bh	91h	Terminal [Y18] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E28	11Ch	h	Y Terminal Function (Normal open/close)	0	0000 to 001F 0: Normal open 1: Normal close	N	0000	Y	Y	36	Y	Y	Y	Y	
E29	11Dh	92h	PG Pulse Output Selection	0	0 to 10 0: No dividing 1: 1/2 2: 1/4 3: 1/8 4: 1/16 5: 1/32 6: 1/64 0 to 6: Internal PG input is divided before output. 7: Internal speed command: Pulse oscillation mode 8: PG (PD): Detected pulse input oscillation mode 9: PG (PR): Pulse command input oscillation mode 10: Integrated PG, PG (SD): Detected speed pulse input oscillation mode 7 to 10: Input pulse is arbitrarily divided before output. (AB 90° phase difference signal)	N	0	Y	Y	92	Y	N	N	Y	
E30	11Eh	h	Motor Overheat Protection (Temperature)	8	50 to 200°C	Y	150	Y	Y	0	Y	Y	Y	Y	
E31	11Fh	h	Motor Overheat Early Warning (Temperature)	1	50 to 200°C	Y	75	Y	Y	0	Y	Y	Y	Y	
E32	120h	CDh	M1-M3 PTC Activation Level	1	0.00 to 5.00 V The PTC is activated if the input voltage of the PTC terminal exceeds this activation level when the PTC thermistor is selected (P30/A31/A131 = 2).	N	1.60	Y	Y	3	Y	Y	Y	Y	
E33	121h	h	Inverter Overload Early Warning	1	25 to 100%	Y	90	Y	Y	0	Y	Y	Y	Y	
E34	122h	h	Motor Overload Early Warning	1	25 to 100%	Y	90	Y	Y	0	Y	Y	Y	Y	
E35	123h	h	DB Overload Protection	1	0 to 100% E35 specifies %ED of the braking resistor relative to the inverter capacity. When E35 = 0, the overload protection function (dbH) is disabled.	Y	0	Y	Y	0	Y	Y	N	Y	
E36	124h	h	DB Overload Early Warning	1	0 to 100%	Y	80	Y	Y	0	Y	Y	N	Y	
E37	125h	h	DB Thermal Time Constant	1	0 to 1000 s	Y	300	Y	Y	0	Y	Y	N	Y	
E38	126h	93h	Speed Detection Mode	8	000 to 111 Detection mode of 0xE39/E40/E41 0: Detected speed 1: Reference speed Under V/f control, only the specified reference speed is valid.	Y	000	Y	Y	9	Y	Y	N	Y	
E39	127h	94h	Speed Detection Level 1	1	0 to 30000 r/min If ***N-FB1±*** (Detected speed 1) or ***N-REF4*** (Reference speed 4) exceeds this speed detection level 1, the inverter issues the detection signal.	Y	1500	Y	Y	0	Y	Y	Y	Y	
E40	128h	95h	Speed Detection Level 2	1	-30000 to 30000 r/min	Y	1500	Y	Y	5	Y	Y	Y	Y	
E41	129h	96h	Speed Detection Level 3	1	-30000 to 30000 r/min	Y	1500	Y	Y	5	Y	Y	Y	Y	
E42	12Ah	97h	Speed Arrival (Detection width)	1	1.0 to 20.0% If the detected speed comes within the range of ***N-REF2*** (Reference speed 2) ± this detection width, the inverter issues the detection signal.	Y	3.0	Y	Y	2	Y	Y	N	Y	
E43	12Bh	98h	Speed Agreement (Detection width)	1	1.0 to 20.0% If ***N-FB2±*** (Detected speed 2) is within the range of ***N-REF4*** (Reference speed 4) ± this detection width, the inverter issues the detection signal.	Y	3.0	Y	Y	2	Y	Y	N	Y	
E44	12Ch	99h	(Off-delay timer)	1	0.000 to 5.000 s	Y	0.100	Y	Y	4	Y	Y	N	Y	
E45	12Dh	9Ah	Speed Disagreement Alarm Phase Loss Detection Level	1	00 to 21 Units place: Speed disagreement alarm (Er-9) 0: Disable 1: Enable Tenths place: Power supply phase loss detection (Lin) 0: Standard level 1: For particular manufacturers. 2: Cancel	N	00	Y	Y	9	Y	Y	N	Y	
E46	12Eh	9Bh	Torque Detection Level 1	3	0 to 300% Calculated value under V/f control. If the torque command exceeds this setting, the inverter issues the detection signal.	Y	30	Y	Y	16	Y	Y	Y	Y	

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
E47	12Fh	9Ch	Torque Detection Level 2	1	0 to 300%	Y	30	Y	Y	16	Y	Y	Y	Y	
E48	130h	9Dh	Magnetic Flux Detection Level	1	10 to 100% If the magnetic flux value calculated exceeds this setting, the inverter issues the detection signal.	N	100	Y	Y	16	Y	Y	N	N	
E49	131h	h	Terminal [Ai1] Function	4	0 to 27	N	0	Y	Y	59					
					0: Shut down input signal ***OFF*** -						Y	Y	Y	Y	
					1: Auxiliary speed setting 1 ***AUX-N1*** ±10V/±Nmax						Y	Y	Y	Y	
					2: Auxiliary speed setting 2 ***AUX-N2*** ±10V/±Nmax						Y	Y	Y	Y	
					3: Torque limiter level 1 ***TL-REF1*** ±10V/±150%						Y	Y	N	Y	
					4: Torque limiter level 2 ***TL-REF2*** ±10V/±150%						Y	Y	N	Y	
					5: Torque bias ***TB-REF*** ±10V/±150%						Y	Y	N	Y	
					6: Torque command ***T-REF*** ±10V/±150%						Y	Y	N	Y	
					7: Torque current command ***IT-REF*** ±10V/±150%						Y	Y	N	Y	
					8: Creep speed 1 for UP/DOWN control ***CRP-N1*** ±10V/±Nmax						Y	Y	Y	Y	
					9: Creep speed 2 for UP/DOWN control ***CRP-N2*** ±10V/±Nmax						Y	Y	Y	Y	
					10: Magnetic flux reference ***MF-REF*** ＋10V/＋100%						Y	N	N	N	
					11: Detect line speed ***LINE-N*** ±10V/±Nmax						Y	Y	Y	Y	
					12: Motor temperature ***M-TMP*** ＋10V/200°C						Y	Y	Y	Y	
					13: Speed override ***N-OR*** ±10V/±50%						Y	Y	Y	Y	
					14: Universal Ai ***U-AI*** ±10V/±4000(h)						Y	Y	Y	Y	
					15: PID feedback 1 ***PID-FB1*** ±10V/±20000(d)						Y	Y	Y	Y	
					16: PID reference value ***PID-REF*** ±10V/±20000(d)						Y	Y	Y	Y	
					17: PID correction gain ***PID-G*** ±10V/±4000(h)						Y	Y	Y	Y	
					18 to 24: Custom Ai1 to Ai7 ***C-AI1*** to ***C-AI7***						Y	Y	Y	Y	
					25: Main speed setting ***N-REFV*** ±10V/±Nmax						Y	Y	Y	Y	
					26: Current input speed setting (4-20 mADC) ***N-REFC*** ±10V/±Nmax (Data 26 is available only on [Ai2].)						Y	Y	Y	Y	
					27: PID feedback amount 2 ***PID-FB2*** ±10V/±20000 (d)						Y	Y	Y	Y	
E50	132h	h	Terminal [Ai2] Function	1	0 to 27 (Refer to Terminal [Ai1] Function.)	N	0	Y	Y	59	Y	Y	Y	Y	
E51	133h	h	Terminal [Ai3] Function	1	0 to 27 (Refer to Terminal [Ai1] Function.) (Data 26 is available only on [Ai2].)	N	0	Y	Y	59	Y	Y	Y	Y	
E52	134h	h	Terminal [Ai4] Function	1	0 to 27 (Refer to Terminal [Ai1] Function.) (Data 26 is available only on [Ai2].)	N	0	Y	Y	59	Y	Y	Y	Y	
E53	135h	h	Ai1 Gain	4	-10.000 to 10.000 times	Y	1.000	Y	Y	8	Y	Y	Y	Y	
E54	136h	h	Ai2 Gain	1	-10.000 to 10.000 times	Y	1.000	Y	Y	8	Y	Y	Y	Y	
E55	137h	h	Ai3 Gain	1	-10.000 to 10.000 times	Y	1.000	Y	Y	8	Y	Y	Y	Y	
E56	138h	h	Ai4 Gain	1	-10.000 to 10.000 times	Y	1.000	Y	Y	8	Y	Y	Y	Y	
E57	139h	h	Ai1 Bias	4	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E58	13Ah	h	Ai2 Bias	1	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E59	13Bh	h	Ai3 Bias	1	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E60	13Ch	h	Ai4 Bias	1	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E61	13Dh	h	Ai1 Filter	4	0.000 to 0.500 s	Y	0.010	Y	Y	4	Y	Y	Y	Y	
E62	13Eh	h	Ai2 Filter	1	0.000 to 0.500 s	Y	0.010	Y	Y	4	Y	Y	Y	Y	
E63	13Fh	h	Ai3 Filter	1	0.000 to 0.500 s	Y	0.010	Y	Y	4	Y	Y	Y	Y	
E64	140h	h	Ai4 Filter	1	0.000 to 0.500 s	Y	0.010	Y	Y	4	Y	Y	Y	Y	
E65	141h	h	Up/Down Limiter (Ai1)	4	0.00 to 60.00 s E65 specifies the duration required when the inverter internal data changes from 0 V to 10 V if the voltage on terminal [Ai1] changes from 0 V to 10 V.	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E66	142h	h	Up/Down Limiter (Ai2)	1	0.00 to 60.00 s	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E67	143h	h	Up/Down Limiter (Ai3)	1	0.00 to 60.00 s	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E68	144h	h	Up/Down Limiter (Ai4)	1	0.00 to 60.00 s	Y	0.00	Y	Y	3	Y	Y	Y	Y	

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
E69	145h	h	Terminal [Ao1] Function	5	0 to 40	Y	1	Y	Y	60					
					0: Detected speed 1 (Speed indicator, one-way deflection) ***N-FB1+*** ±Nmax/10V						Y	Y	N	Y	
					1: Detected speed 1 (Speed indicator, two-way deflection) ***N-FB1±*** ±Nmax/±10V						Y	Y	N	Y	
					2: Reference speed 2 (before ACC/DEC calculation) ***N-REF2*** ±Nmax/±10V						Y	Y	Y	Y	
					3: Reference speed 4 (ASR input) ***N-REF4*** ±Nmax/±10V						Y	Y	Y	Y	
					4: Detected speed 2 (ASR input) ***N-FB2±*** ±Nmax/±10V						Y	Y	N	Y	
					5: Detected line speed ***LINE-N±*** ±Nmax/±10V						Y	Y	Y	Y	
					6: Torque current command (Torque ammeter, one-way deflection) ***IT-REF±*** ±150%/±10V						Y	Y	N	Y	
					7: Torque current command (Torque ammeter, two-way deflection) ***IT-REF+*** ±150%/10V						Y	Y	N	Y	
					8: Torque command (Torque meter, two-way deflection) ***T-REF±*** ±150%/±10V						Y	Y	N	Y	
					9: Torque command (Torque meter, one-way deflection) ***T-REF+*** ±150%/10V						Y	Y	N	Y	
					10: Motor current ***I-AC*** 200%/10V						Y	Y	Y	Y	
					11: Motor voltage ***V-AC*** 200%/10V						Y	Y	Y	Y	
					12: Input power (Motor output) ***PWR*** 200%/10V						Y	Y	Y	Y	
					13: DC link bus voltage ***V-DC*** 800V/10V						Y	Y	Y	Y	
					14: +10V test voltage output ***P10*** +10 VDC equivalent						Y	Y	Y	Y	
					15: -10V test voltage output ***N10*** -10 VDC equivalent						Y	Y	Y	Y	
					16: Motor temperature ***TMP-M*** ±200°C/±10V						Y	Y	Y	Y	
					28: Torque bias balance adjustment (Available soon) ***TBL*** ±150%/±10V						Y	Y	N	Y	
					29: Torque bias gain adjustment (Available soon) ***TBG*** ±150%/±10V						Y	Y	N	Y	
					30: Universal AO ***U-AO*** -						Y	Y	Y	Y	
					31-37: Custom Ao1-Ao7 ***C-AO1*** to ***C-AO7***						Y	Y	Y	Y	
					38: Input power ***PWR-IN*** 200%/10V						Y	Y	Y	Y	
					39: Magnetic pole position signal ***SMP*** TOP/5V						N	N	N	Y	
					40: PID output value ***PID-OUT*** ±200%/±10V						Y	Y	Y	Y	
E70	146h	h	Terminal [Ao2] Function	1	0 to 40 (Refer to Terminal [Ao1] function.)	Y	6	Y	Y	60	Y	Y	Y	Y	
E71	147h	h	Terminal [Ao3] Function	1	0 to 40 (Refer to Terminal [Ao1]1 function.)	Y	3	Y	Y	60	Y	Y	Y	Y	
E72	148h	h	Terminal [Ao4] Function	1	0 to 40 (Refer to Terminal [Ao1] function.)	Y	0	Y	Y	60	Y	Y	Y	Y	
E73	149h	h	Terminal [Ao5] Function	1	0 to 40 (Refer to Terminal [Ao1] function.)	Y	0	Y	Y	60	Y	Y	Y	Y	
E74	14Ah	h	Ao1 Gain	5	-100.00 to 100.00 times	Y	1.00	Y	Y	7	Y	Y	Y	Y	
E75	14Bh	h	Ao2 Gain	1	-100.00 to 100.00 times	Y	1.00	Y	Y	7	Y	Y	Y	Y	
E76	14Ch	h	Ao3 Gain	1	-100.00 to 100.00 times	Y	1.00	Y	Y	7	Y	Y	Y	Y	
E77	14Dh	h	Ao4 Gain	1	-100.00 to 100.00 times	Y	1.00	Y	Y	7	Y	Y	Y	Y	
E78	14Eh	h	Ao5 Gain	1	-100.00 to 100.00 times	Y	1.00	Y	Y	7	Y	Y	Y	Y	
E79	14Fh	h	Ao1 Bias	5	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E80	150h	h	Ao2 Bias	1	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E81	151h	h	Ao3 Bias	1	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E82	152h	h	Ao4 Bias	1	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E83	153h	h	Ao5 Bias	1	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E84	154h	h	Ao1-Ao5 Filter	0	0.000 to 0.500 s	Y	0.010	Y	Y	4	Y	Y	Y	Y	
E90	15Ah	h	Link Command Function Selection 1 (Available soon)	2	0 to 12	Y	0	Y	Y	231					
					0: Shut down input signal ***OFF***						Y	Y	Y	Y	
					1: Auxiliary speed setting 1 ***AUX-N1***						Y	Y	Y	Y	
					2: Auxiliary speed setting 2 ***AUX-N2***						Y	Y	Y	Y	
					3: Torque bias level ***TB-REF***						Y	Y	N	Y	
					4: Creep speed 1 for UP/DOWN control ***CRP-N1***						Y	Y	Y	Y	
					5: Creep speed 2 for UP/DOWN control ***CRP-N2***						Y	Y	Y	Y	
					6: Detect line speed ***LINE-N***						Y	Y	Y	Y	
					7: Motor temperature ***M-TMP***						Y	Y	Y	Y	
					8: Speed override ***N-OR***						Y	Y	Y	Y	
					9: PID feedback amount 1 ***PID-FB1***						Y	Y	Y	Y	
					10: PID command amount ***PID-REF***						Y	Y	Y	Y	
					11: PID correction gain ***PID-G***						Y	Y	Y	Y	
					12: PID feedback amount 2 ***PID-FB2***						Y	Y	Y	Y	
					13: Observer torque FB (Available soon) ***OBS-TFB***						Y	Y	N	Y	

Function code	Communications address: 485 No.	Communications address: Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control: VC w/ PG	Drive control: VC w/o PG	Drive control: V/f	Drive control: VC for PMSM	Remarks
E91	15Bh	h	Link Command Function Selection 2 (Available soon)	1	0 to 26 When E91 ≠ 0 (OFF), analog setting via the communications link (S17) has priority over Ai input specified by Ai function selection. (Refer to the Link Command Function Selection 1.)	Y	0	Y	Y	231	Y	Y	Y	Y	
E101	1E01h	h	Ai1 Offset	4	-100.00 to 100.00%	Y	0.00	Y	Y	7	Y	Y	Y	Y	
E102	1E02h	h	Ai2 Offset	1	-100.00 to 100.00%	Y	0.00	Y	Y	7	Y	Y	Y	Y	
E103	1E03h	h	Ai3 Offset	1	-100.00 to 100.00%	Y	0.00	Y	Y	7	Y	Y	Y	Y	
E104	1E04h	h	Ai4 Offset	1	-100.00 to 100.00%	Y	0.00	Y	Y	7	Y	Y	Y	Y	
E105	1E05h	h	Ai1 Dead Zone	4	0.00 to 10.00% Limits all command values except input values to 0 V.	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E106	1E06h	h	Ai2 Dead Zone	1	0.00 to 10.00%	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E107	1E07h	h	Ai3 Dead Zone	1	0.00 to 10.00%	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E108	1E08h	h	Ai4 Dead Zone	1	0.00 to 10.00%	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E109	1E09h	h	Dividing Ratio for FA, FB Pulse Output (Numerator)	2	1 to 65535 Specifies the numerator of the dividing ratio for FA and FB pulse output.	N	1000	Y	Y	0	Y	Y	N	Y	
E110	1E0Ah	h	(Denominator)	1	1 to 65535 Specifies the denominator of the dividing ratio for FA and FB pulse output.	N	1000	Y	Y	0	Y	Y	N	Y	
E114	1E0Eh	h	Speed Agreement 2 (Detection width)	4	1.0 to 20.0% If ***N-FB2*** ± (Detected speed 2) is within the range of ***N-REF4*** (Reference speed 4) ± this detection width, the inverter issues the speed agreement signal ***N-AG2***.	Y	3.0	Y	Y	2	Y	Y	N	Y	
E115	1E0Fh	h	(Off-delay timer)	1	0.000 to 5.000 s Specifies the off-delay timer of the speed agreement signal ***N-AG2***.	Y	0.100	Y	Y	4	Y	Y	N	Y	
E116	1E10h	h	Speed Agreement 3 (Detection width)	1	1.0 to 20.0% If ***N-FB2*** ± (Detected speed 2) is within the range of ***N-REF4*** (Reference speed 4) ± this detection width, the inverter issues the speed agreement signal ***N-AG3***.	Y	3.0	Y	Y	2	Y	Y	N	Y	
E117	1E11h	h	(Off-delay timer)	1	0.000 to 5.000 s Specifies the off-delay timer of the speed agreement signal ***N-AG3***.	Y	0.100	Y	Y	4	Y	Y	N	Y	
E118	1E12h	h	Temperature for Axial Fan Stop Signal	0	0 to 200°C If the NTC detection temperature of the motor having an NTC thermistor drops below this setting, the inverter turns ON the axial fan stopped signal ***MFAN***.	Y	0	Y	Y	0	Y	Y	Y	Y	

■ C codes (Control Functions)

Function code	Communications address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
C01	201h	h	Jump Speed 1	4	0 to 30000 r/min Enables the inverter to jump over a point on the reference speed in order to skip a resonance point of the driven machinery (load) and the motor speed. Up to three different jump points can be specified.	Y	0	Y	Y	0	Y	Y	Y	Y	
C02	202h	h	Jump Speed 2	1	0 to 30000 r/min	Y	0	Y	Y	0	Y	Y	Y	Y	
C03	203h	h	Jump Speed 3	1	0 to 30000 r/min	Y	0	Y	Y	0	Y	Y	Y	Y	
C04	204h	h	Hysteresis Width for Jump Speed	1	0 to 1000 r/min	Y	0	Y	Y	0	Y	Y	Y	Y	
C05	205h	9Eh	Multistep Speed 1	17	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21) Multistep speeds 1 to 15 can be switched by turning terminal commands ***SS1***, ***SS2***, ***SS4*** and ***SS8*** ON/OFF.	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C06	206h	9Fh	Multistep Speed 2	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C07	207h	A0h	Multistep Speed 3	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C08	208h	A1h	Multistep Speed 4	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C09	209h	A2h	Multistep Speed 5	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C10	20Ah	A3h	Multistep Speed 6	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C11	20Bh	A4h	Multistep Speed 7	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C12	20Ch	h	Multistep Speed 8	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C13	20Dh	h	Multistep Speed 9	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C14	20Eh	h	Multistep Speed 10	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C15	20Fh	h	Multistep Speed 11	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C16	210h	h	Multistep Speed 12	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C17	211h	h	Multistep Speed 13	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C18	212h	h	Multistep Speed 14/ Creeping Speed 1	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21) C18 and C19 apply also to the creep speed under UP/DOWN control.	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C19	213h	h	Multistep Speed 15/ Creeping Speed 2	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C20	214h	h	Multistep Speed Agreement Timer	1	0.000 to 0.100 s When ***SS1***, ***SS2***, ***SS4*** and ***SS8*** are kept at the same status for the duration specified by this function code, the inverter switches the reference speed.	Y	0.000	Y	Y	4	Y	Y	Y	Y	
C21	215h	h	Multistep Speed Configuration Definition	1	0 to 2 0: 0 to 30000 r/min 1: 0.00 to 100.00% 2: 0.0 to 999.9 m/min Defines the unit of multistep speed specified by C05 to C19. When C21 = 1, the percentage of the maximum speed (F03/A06/A40) of the selected motor applies.	N	0	Y	Y	93	Y	Y	Y	Y	
C25	219h	h	Speed Command N2	0	0 to 9 0: Keypad (⌃/⌄ keys) 1: Analog input to terminal [12](0 to ±10V) 2: Analog input to terminal [12](0 to ＋10V) 3: ***UP/DOWN*** control (Initial speed = 0) 4: ***UP/DOWN*** control (Initial speed = Last value) 5: ***UP/DOWN*** control (Initial speed = Creep speed 1 or 2) 6: DIA card input 7: DIB card input 8: N-REFV input to terminal [Ai1] 9: N-REFC input to terminal [Ai2] The speed command specified by this function code takes effect when X terminal command ***N2/N1*** is turned ON.	N	0	Y	Y	41	Y	Y	Y	Y	
C29	21Dh	h	Jogging Speed	0	0 to 30000 r/min Specifies the speed to be applied when the motor jogs.	Y	50	Y	Y	0	Y	Y	Y	Y	
C30	21Eh	h	ASR-JOG (P-gain)	9	0.1 to 500.0 times	Y	10.0	Y	Y	2	Y	Y	N	Y	
C31	21Fh	h	(I-constant)	1	0.000 to 10.000 s P control when C31 = 0.000	Y	0.200	Y	Y	4	Y	Y	N	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
C32	220h	h	(Input filter)	1	0.000 to 5.000 s	Y	0.040	Y	Y	4	Y	Y	Y	Y	
C33	221h	h	(Detection filter)	1	0.000 to 0.100 s	Y	0.005	Y	Y	4	Y	Y	N	Y	
C34	222h	h	(Output filter)	1	0.000 to 0.100 s	N	0.002	Y	Y	4	Y	Y	N	Y	
C35	223h	h	Acceleration Time for Jogging	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C36	224h	h	Deceleration Time for Jogging	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C37	225h	h	S-curve JOG (Start side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C38	226h	h	S-curve JOG (End side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C40	228h	h	ASR2 (P-gain)	10	0.1 to 500.0 times	Y	10.0	Y	Y	2	Y	Y	N	Y	
C41	229h	h	(I-constant)	1	0.000 to 10.000 s P control when C41 = 0.000	Y	0.200	Y	Y	4	Y	Y	N	Y	
C42	22Ah	h	(Feedforward gain)	1	0.000 to 9.999 s	Y	0.000	Y	Y	4	Y	Y	N	Y	
C43	22Bh	h	(Input filter)	1	0.000 to 5.000 s	Y	0.040	Y	Y	4	Y	Y	Y	Y	
C44	22Ch	h	(Detection filter)	1	0.000 to 0.100 s	Y	0.005	Y	Y	4	Y	Y	N	Y	
C45	22Dh	h	(Output filter)	1	0.000 to 0.100 s	N	0.002	Y	Y	4	Y	Y	N	Y	
C46	22Eh	h	Acceleration Time 2	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C47	22Fh	h	Deceleration Time 2	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C48	230h	h	S-curve 2 (Start side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C49	231h	h	S-curve 2 (End side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C50	232h	h	ASR3 (P-gain)	10	0.1 to 500.0 times	Y	10.0	Y	Y	2	Y	Y	N	Y	
C51	233h	h	(I-constant)	1	0.000 to 10.000 s P control when C41 = 0.000	Y	0.200	Y	Y	4	Y	Y	N	Y	
C52	234h	h	(Feedforward gain)	1	0.000 to 9.999 s	Y	0.000	Y	Y	4	Y	Y	N	Y	
C53	235h	h	(Input filter)	1	0.000 to 5.000 s	Y	0.040	Y	Y	4	Y	Y	Y	Y	
C54	236h	h	(Detection filter)	1	0.000 to 0.100 s	Y	0.005	Y	Y	4	Y	Y	N	Y	
C55	237h	h	(Output filter)	1	0.000 to 0.100 s	N	0.002	Y	Y	4	Y	Y	N	Y	
C56	238h	h	Acceleration Time 3	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C57	239h	h	Deceleration Time 3	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C58	23Ah	h	S-curve 3 (Start side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C59	23Bh	h	S-curve 3 (End side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C60	23Ch	h	ASR4 (P-gain)	10	0.1 to 500.0 times	Y	10.0	Y	Y	2	Y	Y	N	Y	
C61	23Dh	h	(I-gain)	1	0.000 to 10.000 s P control when C41 = 0.000	Y	0.200	Y	Y	4	Y	Y	N	Y	
C62	23Eh	h	(Feedforward gain)	1	0.000 to 9.999 s	Y	0.000	Y	Y	4	Y	Y	N	Y	
C63	23Fh	h	(Input filter)	1	0.000 to 5.000 s	Y	0.040	Y	Y	4	Y	Y	Y	Y	
C64	240h	h	(Detection filter)	1	0.000 to 0.100 s	Y	0.005	Y	Y	4	Y	Y	N	Y	
C65	241h	h	(Output filter)	1	0.000 to 0.100 s	N	0.002	Y	Y	4	Y	Y	N	Y	
C66	242h	h	Acceleration Time 4	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C67	243h	h	Deceleration Time 4	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C68	244h	h	S-curve 4 (Start side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C69	245h	h	S-curve 4 (End side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C70	246h	h	ASR Switching Time	0	0.00 to 2.55 s	Y	1.00	Y	Y	3	Y	Y	N	Y	
C71	247h	A5h	ACC/DEC Switching Speed	0	0.00 to 100.00%	Y	0.00	Y	Y	3	Y	Y	Y	Y	
C72	248h	A6h	ASR Switching Time	0	0.00 to 100.00%	Y	0.00	Y	Y	3	Y	Y	N	Y	
C73	249h	h	Creep Speed Switching (under UP/DOWN control)	0	00 to 11 (Creep Speed 1)(Creep Speed 2) 0: Function code setting (C18, C19) 1: Analog input (***CRP1***, ***CRP2***)	N	00	Y	Y	9	Y	Y	Y	Y	

■ P codes (Motor Parameter Functions M1)

Function code	Communications address: 485 No.	Communications address: Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control: VC w/ PG	Drive control: VC w/o PG	Drive control: V/f	Drive control: VC for PMSM	Remarks
P01	301h	h	M1 Drive Control	0	0 to 5 0: Vector control for IM with speed sensor 1: Vector control for IM without speed sensor 2: Simulation mode 3: Vector control for PMSM with speed sensor 4: -- 5: V/f control for IM	N	0	Y	N	55	Y	Y	Y	Y	
P02	302h	h	M1 Motor Selection	26	0 to 50 Display (kW, HP) changes by setting F60. 0 to 35: Settings for VG-dedicated motors Data at F04, F05, and P03 to P27 are automatically set and write-protected. 36: P-OTHER (P-OTR on the keypad) Data at F04, F05, and P03 to P27 are write-protected and cannot be overwritten. 37: OTHER Data at F04, F05, and P03 to P27 are write-protected and cannot be overwritten. 38 to 50: Settings for the motor only for FRENIC-VG (8-series) Data at F04, F05, and P03 to P27 are automatically set and write-protected. For the relationship between the setting data and the motor type, refer to "List of Applicable Motors" in Section 4.3.4, P02 codes.	N	*	Y	N	82	Y	Y	Y	Y	
P03	303h	A7h	M1 Rated Capacity	1	For inverters of 400 kW or below 0.00 to 500.00 kW when F60 = 0 0.00 to 600.00 HP when F60 = 1 For inverters of 500 kW or above 0.00 to 1200 kW when F60 = 0 0.00 to 1600 HP when F60 = 1 For multiwinding motors, set the motor capacity per wiring.	N	*	Y	N	3 13	Y	Y	Y	Y	
P04	304h	A8h	M1 Rated Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	N	*	Y	N	13	Y	Y	Y	Y	
P05	305h	A9h	M1 Number of Poles	1	2 to 100 poles	N	4	Y	N	1	Y	Y	Y	Y	
P06	306h	AAh	M1 %R1	1	0.00 to 30.00%	Y	*	Y	N	3	Y	Y	Y	Y	
P07	307h	ABh	M1 %X	1	0.00 to 200.00%	Y	*	Y	N	3	Y	Y	Y	Y	
P08	308h	ACh	M1 Exciting Current/Magnetic Flux Weakening Current (-Id)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	*	Y	N	13	Y	Y	Y	Y	
P09	309h	ADh	M1 Torque Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	*	Y	N	13	Y	Y	N	Y	
P10	30Ah	AEh	M1 Slip Frequency (For driving)	1	0.001 to 10.000 Hz	Y	*	Y	N	4	Y	Y	N	N	
P11	30Bh	AFh	(For braking)	1	0.001 to 10.000 Hz	Y	*	Y	N	4	Y	Y	N	N	
P12	30Ch	B0h	M1 Iron Loss Factor 1	1	0.00 to 10.00%	Y	*	Y	N	3	Y	Y	N	Y	
P13	30Dh	B1h	M1 Iron Loss Factor 2	1	0.00 to 10.00%	Y	*	Y	N	3	Y	Y	N	Y	
P14	30Eh	B2h	M1 Iron Loss Factor 3	1	0.00 to 10.00%	Y	*	Y	N	3	Y	Y	N	Y	
P15	30Fh	B3h	M1 Magnetic Saturation Factor 1	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 93.75%	Y	*	Y	N	2	Y	Y	N	N	
P16	310h	B4h	M1 Magnetic Saturation Factor 2	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 87.5%	Y	*	Y	N	2	Y	Y	N	N	
P17	311h	B5h	M1 Magnetic Saturation Factor 3	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 75%	Y	*	Y	N	2	Y	Y	N	N	
P18	312h	B6h	M1 Magnetic Saturation Factor 4	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 62.5%	Y	*	Y	N	2	Y	Y	N	N	
P19	313h	B7h	M1 Magnetic Saturation Factor 5	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 50%	Y	*	Y	N	2	Y	Y	N	N	
P20	314h	B8h	M1 Secondary Time Constant	1	0.001 to 9.999 s	Y	*	Y	N	4	Y	Y	N	N	
P21	315h	B9h	M1 Induced Voltage Factor	1	0 to 999 V	Y	*	Y	N	0	Y	Y	N	Y	
P22	316h	BAh	M1 R2 Correction Factor 1	1	0.500 to 5.000	Y	*	Y	N	4	Y	Y	N	Y	
P23	317h	BBh	M1 R2 Correction Factor 2	1	0.500 to 5.000	Y	*	Y	N	4	Y	Y	N	N	
P24	318h	BCh	M1 R2 Correction Factor 3	1	0.010 to 5.000	Y	*	Y	N	4	Y	Y	N	N	
P25	319h	BDh	M1 Exciting Current Correction Factor	1	0.000 to 5.000	Y	*	Y	N	4	Y	Y	N	N	
P26	31Ah	BEh	M1 ACR (P-gain)	1	0.1 to 20.0	Y	1.0	Y	N	2	Y	Y	N	Y	
P27	31Bh	BFh	(I-time)	1	0.1 to 100.0 ms	Y	1.0	Y	N	2	Y	Y	N	Y	

*Depending upon the inverter's capacity.

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
P28	31Ch	C0h	M1 Pulse Resolution	0	100 to 60000	N	1024	Y	N	0	Y	N	N	Y	
P29	31Dh	D6h	M1 External PG Correction Factor	0	0000 to 4FFF	N	4000	Y	N	9	Y	N	N	N	
P30	31Eh	C1h	M1 Thermistor Selection	0	0 to 3 0: No thermistor 1: NTC thermistor 2: PTC thermistor 3: Ai (***M-TMP***) The protection level of the motor protective functions should be specified by E30 to E32.	N	1	Y	N	84	Y	Y	Y	Y	
P32	320h	h	M1 Online Auto-tuning	0	0 or 1 0: Disable 1: Enable Enabling this auto-tuning activates the compensation function for the resistance change caused by the temperature rise of the motor running.	Y	0	Y	N	0	Y	Y	N	N	
P33	321h	h	M1 Maximum Output Voltage/ Maximum Voltage Limit	0	80 to 999 V	Y	220/ 440	Y	N	0	N	N	Y	Y	
P34	322h	h	M1 Slip Compensation	3	-20.000 to 5.000 Hz	Y	0.000	Y	N	8	N	N	Y	N	
P35	323h	h	M1 Torque Boost	1	0.0 to 20.0 Exclusive to V/f control. 0.0: Auto torque boost (for constant torque load) 0.1 to 0.9: For variable torque load 1.0 to 1.9: For proportional torque load 2.0 to 20.0: For constant torque load	Y	0.0	Y	N	2	N	N	Y	N	
P36	324h	h	M1 Output Current Fluctuation Damping Gain	1	0.00 to 1.00	Y	0.20	Y	N	3	N	N	Y	N	
P42	32Ah	h	M1 q-axis Inductance Magnetic Saturation Coefficient	9	0 to 100%	Y	100.0	Y	N	0	N	N	N	Y	
P43	32Bh	h	M1 Magnetic Flux Limiting Value	1	50.0 to 150.0%	Y	*	Y	N	2	N	N	N	Y	
P44	32Ch	h	M1 Overcurrent Protection Level	1	0.00: Disable 0.01 to 2000 A Specifies the allowable current value to prevent the permanent magnet of a PMSM from getting demagnetized. If the current exceeding this setting flows, an overcurrent alarm (OC) occurs.	N	0.00	Y	N	0	N	N	N	Y	
P45	32Dh	h	M1 Torque Correction Gain 1	1	0.00 to 10.00	Y	*	Y	N	3	N	N	N	Y	
P46	32Eh	h	M1 Torque Correction Gain 2	1	0.00 to 10.00	Y	*	Y	N	3	N	N	N	Y	
P47	32Fh	h	M1 Torque Correction Gain 3	1	-1.000 to 1.000	Y	*	Y	N	8	N	N	N	Y	
P48	330h	h	M1 Torque Correction Gain 4	1	-1.000 to 1.000	Y	*	Y	N	8	N	N	N	Y	
P49	331h	h	M1 Torque Correction Gain 5	1	-50.00 to 50.00	Y	*	Y	N	7	N	N	N	Y	
P50	332h	h	M1 Torque Correction Gain 6	1	-50.00 to 50.00	Y	*	Y	N	7	N	N	N	Y	
P51	333h	h	M1 Torque Correction Gain 7	1	-1.000 to 1.000	Y	*	Y	N	8	N	N	N	Y	

*Depending upon the inverter's capacity.

■ H codes (High Performance Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H01	401h	h	Auto-tuning	0	0 to 4 0: Disable	N	0	N	N	61	Y	Y	Y	Y	
					1: ASR auto-tuning (Available soon)						Y	Y	N	Y	
					2: Motor parameter auto-tuning (R1, Lσ)						Y	Y	Y	N	
					3: Auto-tuning with the motor stopped						Y	Y	N	N	
					4: Auto-tuning with the motor running						Y	Y	N	N	
					Upon completion of auto-tuning, the H01 data automatically reverts to "0." To save the tuned data, perform the Full save function (H02).										
H02	402h	Eh	Full Save Function	0	0 or 1 When tuning is executed at H01 and the internal data is written, or when the data is written by way of the link system (T-Link, field bus, and RS-458, etc.), the data goes out when the power supply of the inverter is turned off. This function must operate when preservation is necessary. After writing the data, this function's data code automatically returns to 0.	Y	0	N	N	11	Y	Y	Y	Y	
H03	403h	h	Data Initialization	0	0 or 1 Setting H03 to "1" reverts the function code data modified by the customer to the factory defaults. Initialization targets include all fields of F, E, C, H, o, L and U codes except motor parameter fields (P, A) and F04, F05, F10 to F12. Upon completion of the initialization, the H03 data automatically reverts to "0."	N	0	N	N	11	Y	Y	Y	Y	
H04	404h	h	Auto-reset (Times)	0	0 to 10 0: Disable 1 to 10 times The auto-resetting signal can be output to the output terminal.	N	0	Y	Y	0	Y	Y	Y	Y	
H05	405h	H	Auto-reset (Reset interval)	0	0.01 to 20.00 s	N	5.00	Y	Y	3	Y	Y	Y	Y	
H06	406h	h	Cooling Fan ON/OFF Control	0	0 or 1 0: Disable 1: Enable This control detects the temperature of the heat sink in the inverter unit and turns the cooling fan ON/OFF automatically. It is possible to output the ***FAN*** (Cooling fan in operation) signal in conjunction with this function.	N	0	Y	Y	68	Y	Y	Y	Y	
H08	408h	h	Rev. Phase Sequence Lock	0	0 or 1 0: Disable 1: Enable	Y	0	Y	Y	68	Y	N	N	Y	
H09	409h	C2h	Starting Mode (Auto search)	0	0 to 2 0: Disable 1: Enable (At restart after momentary power failure) 2: Enable Auto search detects the idling motor speed at starting and drives the motor at the same speed without stopping it.	Y	2	Y	Y	0	Y	Y	N	Y	
H10	40Ah	C3h	Energy-saving Operation	0	0 or 1 0: Disable 1: Enable	N	0	Y	Y	68	Y	N	N	N	
H11	40Bh	h	Automatic Operation OFF Function	0	0 to 4 0: Decelerate to stop when FWD-CM or REV-CM is opened 1: The inverter is turned off below the stop speed even for ON between FWD-CM and REV-CM. 2: Coast to stop when FWD-CM or REV-CM is opened 3: Decelerate to stop using ASR when FWD-CM or REV-CM is opened (under torque control) 4: Coast to stop when FWD-CM or REV-CM is opened (under torque control)	Y	0	Y	Y	0	Y	Y	Y	Y	
H13	40Dh	C4h	Restart Mode after Momentary Power Failure (Wait time)	5	0.1 to 5.0 s	N	0.5	Y	Y	2	Y	Y	Y	Y	
H14	40Eh	h	(Decrease rate in speed)	1	1 to 3600 r/min/s	Y	500	Y	Y	0	N	N	Y	N	
H15	40Fh	h	(Continuous running level)	1	3-phase 200 V: 200 to 300 V 3-phase 400 V: 400 to 600 V This setting applies when F14 = 2 (Trip after recovery from power failure) or F14 = 3 (Continue to run).	Y	235/ 470	Y	Y	0	Y	Y	Y	Y	
H16	410h	h	(Run command self-hold setting)	1	0 or 1 0: Setting made by H17 1: Maximum time (The inverter self-holds the run command while the control power supply in the inverter is established or until the DC link bus voltage comes to almost "0.")	N	1	Y	Y	94	Y	Y	Y	Y	
H17	411h	h	(Run command self-hold time)	1	0.0 to 30.0 s	N	30.0	Y	Y	2	Y	Y	Y	Y	

Function code	Communications address (485 No.)	Communications address (Link No.)	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control: VC w/ PG	Drive control: VC w/o PG	Drive control: V/f	Drive control: VC for PMSM	Remarks
H19	413h	C5h	Active Drive	0	0 or 1 0: Disable 1: Enable Under vector control, this function automatically limits the output torque to avoid an overload trip, etc.	N	0	Y	Y	68	Y	N	Y	Y	
H20	414h	C6h	PID Control (Mode selection)	8	0 to 3 0: Inactive 1: Active 2: Inverse action 1 3: Inverse action 2	N	0	Y	Y	69	Y	Y	Y	Y	
H21	415h	C7h	(Command selection)	1	0 or 1 0: Keypad or input to terminal [12] 1: Analog input ***PID-REF***	Y	0	Y	Y	70	Y	Y	Y	Y	
H22	416h	C9h	(P-action)	1	0.000 to 10.000 times	Y	1.000	Y	Y	4	Y	Y	Y	Y	
H23	417h	CAh	(I-action)	1	0.00 to 100.00 s	Y	1.00	Y	Y	3	Y	Y	Y	Y	
H24	418h	CBh	(D-action)	1	0.000 to 10.000 s	Y	0.000	Y	Y	4	Y	Y	Y	Y	
H25	419h	C8h	(Upper limit)	1	-300 to 300%	N	100	Y	Y	5	Y	Y	Y	Y	
H26	41Ah	CCh	(Lower limit)	1	-300 to 300%	N	-100	Y	Y	5	Y	Y	Y	Y	
H27	41Bh	CEh	(Speed command selection)	1	0 to 2 0: Disable 1: Select PID 2: Select auxiliary speed	N	0	Y	Y	95	Y	Y	Y	Y	
H28	41Ch	CFh	Droop Control	0	0.0 to 25.0%	Y	0.0	Y	Y	2	Y	Y	N	Y	
H29	41Dh	h	Communications Link Function (Data protection via link)	2	0 or 1 0: Writable to function code fields 1: Write-protect function code fields Setting H29 to "1" protects function code data from getting changed mistakenly via the link (T-Link, RS-485, etc.). Via the link, data can be written to the "function code fields" (given above) or "command data fields" (S fields). The S fields are defined by H30.	Y	0	Y	Y	40	Y	Y	Y	Y	
H30	41Eh	D0h	(Link operation)	1	0 to 3 Monitor / Command data / Run command (FWD, REV) 0: Y / N / N 1: Y / Y / N 2: Y / N / Y 3: Y / Y / Y	Y	0	Y	Y	72	Y	Y	Y	Y	
H31	41Fh	h	RS-485 Communication (Station address)	10	0 to 255 Broadcast: (0: RTU), (99: Fuji) Address: 1 to 255 Specify the station address of RS-485.	N	1	Y	N	0	Y	Y	Y	Y	
H32	420h	h	(Error processing)	1	0 to 3 0: Immediately trip with Er-5 1: Trip with Er-5 after running for the period specified by timer H33. 2: Trip with Er-5 if a communications error persists exceeding the period specified by timer H33. 3: Continue to run	Y	3	Y	Y	73	Y	Y	Y	Y	
H33	421h	h	(Timer)	1	0.01 to 20.00 s	Y	2.00	Y	Y	3	Y	Y	Y	Y	
H34	422h	h	(Baud rate)	1	0 to 4 0: 38400 bps 1: 19200 bps 2: 9600 bps 3: 4800 bps 4: 2400 bps	Y	0	Y	N	74	Y	Y	Y	Y	
H35	423h	h	(Data length)	1	0 or 1 0: 8 bits 1: 7 bits	Y	0	Y	N	75	Y	Y	Y	Y	
H36	424h	h	(Parity check)	1	0 to 2 0: None 1: Even parity 2: Odd parity	Y	1	Y	N	76	Y	Y	Y	Y	
H37	425h	h	(Stop bits)	1	0 or 1 0: 2 bits 1: 1 bit	Y	1	Y	N	77	Y	Y	Y	Y	
H38	426h	h	(Communications line break time)	1	0.0 to 60.0 s 0.0: Disable detection 0.1 to 60.0: Enable detection	Y	60.0	Y	Y	2	Y	Y	Y	Y	
H39	427h	h	(Response interval)	1	0.00 to 1.00 s	Y	0.01	Y	Y	3	Y	Y	Y	Y	
H40	428h	h	(Protocol selection)	1	0 to 2 0: Fuji general-purpose inverter protocol 1: SX protocol (Loader protocol) 2: Modbus RTU protocol To use the FRENIC-VG Loader, set H40 to "1."	N	1	Y	N	78	Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H41	429h	D1h	Torque Command Source	4	0 to 5 0: Internal ASR output 1: Ai terminal input ***T-REF*** 2: DIA card 3: DIB card 4: Communications link 5: PID	N	0	Y	Y	64	Y	Y	N	Y	
H42	42Ah	D2h	Torque Current Command Source	1	0 to 4 0: Internal ASR output 1: Ai terminal input ***IT-REF*** 2: DIA card 3: DIB card 4: Communications link	N	0	Y	Y	65	Y	Y	N	Y	
H43	42Bh	D3h	Magnetic Flux Command Source	1	0 to 3 0: Internal calculation 1: Ai terminal input ***MF-REF*** 2: Function code H44 3: Communications link	N	0	Y	Y	66	Y	N	N	N	
H44	42Ch	D4h	Magnetic Flux Command Value	1	10 to 100%	N	100	Y	Y	16	Y	N	N	N	
H46	42Eh	D7h	Observer (Mode selection)	7	0 to 2 0: Disable 1: Enable (Load disturbance observer) 2: Enable (Oscillation suppressing observer)	N	0	Y	Y	79	Y	Y	N	Y	
H47	42Fh	D8h	(M1 compensation gain)	1	0.00 to 1.00 times	Y	0.00	Y	Y	3	Y	Y	N	Y	
H48	430h	h	(M2 compensation gain)	1	0.00 to 1.00 times	Y	0.00	Y	Y	3	Y	Y	N	Y	
H49	431h	D9h	(M1 I-time)	1	0.005 to 1.000 s	Y	0.100	Y	Y	4	Y	Y	N	Y	
H50	432h	h	(M2 I-time)	1	0.005 to 1.000 s	Y	0.100	Y	Y	4	Y	Y	N	Y	
H51	433h	DAh	(M1 load inertia)	1	0.001 to 50.000 kg•m^2 The magnification is switchable by H228.	Y	*	Y	N	4	Y	Y	N	Y	
H52	434h	h	(M2 load inertia)	1	0.001 to 50.000 kg•m^2 The magnification is switchable by H228.	Y	0.001	Y	N	4	Y	Y	N	Y	
H53	435h	D5h	Line Speed Feedback Selection	0	0 to 3 0: Disable line speed (Integrated PG enabled) Note that Ai input or PG (LD) should be high level-select in UPAC. 1: Detect analog line speed (AI-LINE) 2: Detect digital line speed (PG(LD)) 3: High level selected signal (Select high level of motor speed and line speed.)	Y	0	Y	Y	67	Y	Y	Y	Y	
H55	437h	h	Zero Speed Control (Gain)	2	0 to 100 times For details, refer to X terminal command ***LOCK*** assigned by any of E01 to E13.	Y	5	Y	Y	0	Y	N	N	Y	
H56	438h	h	(Completion range)	1	0 to 100 pulses	Y	100	Y	Y	0	Y	N	N	Y	
H57	439h	h	Overvoltage Suppression	2	0 or 1 0: Disable 1: Enable	N	0	Y	Y	68	Y	Y	Y	Y	
H58	43Ah	h	Overcurrent Suppression	1	0 or 1 0: Disable 1: Enable	N	0	Y	Y	68	Y	Y	Y	Y	
H60	43Ch	h	Load Adaptive Control (Definition 1)	7	0 to 3 0: Disable 1: Method 1 2: Method 2 3: Method 3	N	0	Y	Y	80	Y	N	N	Y	
H61	43Dh	h	(Definition 2)	1	0 or 1 0: Winding up in forward rotation 1: Winding down in forward rotation	N	0	Y	Y	81	Y	N	N	Y	
H62	43Eh	h	(Winding-up speed)	1	0.0 to 999.9 m/min	N	0.0	Y	Y	2	Y	N	N	Y	
H63	43Fh	h	(Counter weight)	1	0.00 to 600.00 t	N	0.00	Y	Y	3	Y	N	N	Y	
H64	440h	h	(Safety coefficient)	1	0.50 to 1.20	N	1.00	Y	Y	3	Y	N	N	Y	
H65	441h	h	(Machine efficiency)	1	0.500 to 1.000	N	0.500	Y	Y	4	Y	N	N	Y	
H66	442h	h	(Rated load)	1	0.00 to 600.00 t	N	0.00	Y	Y	3	Y	N	N	Y	
H68	444h	h	Alarm Data Deletion	0	0 or 1 Setting H68 to "1" deletes all of the alarm history, alarm causes and alarm information held in the inverter memory. After that, the H68 data automatically reverts to "0."	Y	0	N	N	11	Y	Y	Y	Y	
H70	446h	h	Reserved 1	2	0 to 9999 Reserved. (Do not access this function code.)	N	0	Y	N	0	Y	Y	N	Y	
H71	447h	h	Reserved 2	1	0 to 10 Reserved. (Do not access this function code.)	N	0	N	N	62	Y	Y	Y	Y	
H74	44Ah	h	PG Detection Circuit Self-diagnosis Selection	0	0 or 1 0: Disable 1: Enable This function performs self-diagnosis of the speed detection circuit by pulse generator signals (PA, PB).	N	0	Y	Y	225	Y	Y	N	Y	

*Depending upon the inverter's capacity.

Function code	Communica-tions address 485 No.	Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	VC w/o PG	V/f	VC for PMSM	Remarks
H75	44Bh	h	Phase Sequence Configuration of Main Circuit Output Wires	0	0 or 1 0: Normal phase U-V-W 1: Reverse phase U-W-V Using this function allows the motor to run with the phase sequence of the motor wires arbitrarily changed.	N	0	Y	Y	197	Y	Y	Y	Y	
H76	44Ch	h	Main Power Down Detection	0	0 or 1 0: Disable 1: Enable Enable this function to enable the AC power monitor. Disable this function when DC power is supplied, e.g., connecting with a power regenerative converter.	Y	0	Y	Y	0	Y	Y	Y	Y	
H77	44Dh	h	Cooling Fan ON/OFF Control Continuation Timer	0	0 to 600 s Specifies the condition of the cooling fan ON/OFF control by H06.	Y	600	Y	Y	0	Y	Y	Y	Y	
H78	44Eh	h	Initialization of Startup Counter/ Total Run Time	6	0 to 6 0: Disable 1: M1 number of startups 2: M2 number of startups 3: M3 number of startups 4: M1 cumulative run time 5: M2 cumulative run time 6: M3 cumulative run time Initializes the number of startups and cumulative run time.	N	0	N	N	0	Y	Y	Y	Y	
H79	44Fh	h	Initialization of Cumulative Run Time of Cooling Fan	1	0 to 65535 (in units of 10 hours) Initializes the cumulative run time when the cooling fan is replaced. Usually, write "0" after replacement.	N	0	N	N	0	Y	Y	Y	Y	
H80	450h	h	Capacitance Measurement of DC Link Bus Capacitor	1	0 to 32767 When the capacitance measurement is user mode (H104), setting this function code at "0" and shutting down the inverter power starts measuring the initial value of the capacitance and sets the measurement result to this function code.	N	0	N	N	0	Y	Y	Y	Y	
H81	451h	h	Initialization of Service Life of DC Link Bus Capacitor	1	0 to 65535 (in units of 10 hours) Initializes the elapsed time of the DC link bus capacitor.	N	0	N	N	0	Y	Y	Y	Y	
H82	452h	h	Startup Count for Maintenance	1	0 to 65535 Specifies the number of startups for performing maintenance of the machinery.	Y	0	N	Y	0	Y	Y	Y	Y	
H83	453h	h	Maintenance Interval	1	0 to 65535 (in units of 10 hours) Specifies the maintenance interval for performing maintenance of the machinery.	Y	8760	N	Y	0	Y	Y	Y	Y	
H85	455h	h	Calendar Clock (Year/month)	4	0000 to FFFF Upper two digits: Year, Lower two digits: Month	Y	0001	N	Y	143	Y	Y	Y	Y	
H86	456h	h	(Day/hour)	1	0000 to FFFF Upper two digits: Date, Lower two digits: Time	Y	0100	N	Y	144	Y	Y	Y	Y	
H87	457h	h	(Minute/second)	1	0000 to FFFF Upper two digits: Minute, Lower two digits: Second	Y	0000	N	Y	145	Y	Y	Y	Y	
H88	458h	h	(Setting up clock)	1	0 or 1 0: Disable 1: Write the current date and time Setting H88 to "1" sets up the calendar clock in accordance with the settings of H85 to H87. After that, the H88 data automatically reverts to "0."	Y	0	N	N	11	Y	Y	Y	Y	
H89	459h	h	Speed Detection Monitor Selection (under V/f control) (Available soon)	0	0 or 1 0: Estimated value / No display 1: PG detected value / PG detected value	N	0	Y	Y	198	Y	Y	N	Y	
H90	45Ah	h	Overspeed Alarm Detection Level	0	100 to 160%	Y	120	Y	Y	0	Y	Y	N	Y	
H94	45Eh	h	ASR Feedforward Gain Magnification Setting (Available soon)	0	0 to 2 0: 1 time 1: 10 times 2: 100 times Switches the magnification setting of ASR1 to ASR4 feedforward gain.	Y	0	Y	Y	193	Y	Y	N	Y	
H99	463h	h	UP/DOWN S-curve Pattern Selection (Available soon)	0	0 or 1 0: Disable (compatible with VG7) 1: Enable (compatible with VG5)	N	0	Y	Y	0	Y	N	N	Y	
H101	1F01h	h	PID Command Filter Time Constant	0	0 to 5000 ms Specifies the time constant of the PID command filter (after switched by H21).	Y	0	Y	Y	0	Y	Y	Y	Y	
H102	1F02h	h	Magnetic Pole Position Offset Writing Permission (Available soon)	0	0 or 1 0: Disable, 1: Enable	Y	0	N	Y	68	N	N	N	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H103	1F03h	h	Protective/Maintenance Function Selection 1	9	0000 to 1111 Selects the protective functions individually. (0: Disable, 1: Enable) Thousands digit: Start delay (LOC) Hundreds digit: Ground fault (EF) Tenths digit: Output phase loss (OPL) Units digit: Braking transistor broken (dbA)	Y	0101	Y	Y	9	Y	Y	Y	Y	
H104	1F04h	h	Protective/Maintenance Function Selection 2	1	0000 to 1111 Selects the protective/maintenance functions individually. (0: Disable, 1: Enable) Thousands digit: PG wire break (PG) Hundreds digit: Lower the carrier frequency Tenths digit: Judge the life of DC link bus capacitor Units digit: Select life judgment threshold of DC link bus capacitor (0: Factory default level, 1: User setup level)	Y	1110	Y	Y	9	Y	Y	Y	Y	
H105	1F05h	h	Protective/Maintenance Function Selection 3	1	0000 to 1111 Selects the protective/maintenance functions individually. (0: Disable, 1: Enable) Thousands digit: -- Hundreds digit: -- Tenths digit: -- Units digit: --	Y	0000	Y	Y	9	Y	Y	Y	Y	
H106	1F06h	h	Light Alarm Object Definition 1	1	0000 to 1111 (0: Heavy alarm (Err), 1: Light alarm (L-AL)) Thousands digit: OH4 "Motor overheat" Hundreds digit: OL1-OL3 "Motor 1 to 3 overload" Tenths digit: nrb "NTC thermistor wire break error" Units digit: OH2 "External alarm"	N	0000	Y	Y	9	Y	Y	Y	Y	
H107	1F07h	h	Light Alarm Object Definition 2	1	0000 to 1111 (0: Heavy alarm (Err), 1: Light alarm (L-AL)) Thousands digit: Er5 "RS-485 communications error" Hundreds digit: Er4 "Network error" Tenths digit: Reserved Units digit: ArF "Toggle data error"	N	0000	Y	Y	9	Y	Y	Y	Y	
H108	1F08h	h	Light Alarm Object Definition 3	1	0000 to 1111 (0: Heavy alarm (Err), 1: Light alarm (L-AL)) Thousands digit: Err "Mock alarm" Hundreds digit: dFA "DC fan locked" Tenths digit: Er9 "Speed mismatch" LOC "Start delay" Units digit: ArE "E-SX bus tact synchronization error"	N	0000	Y	Y	9	Y	Y	Y	Y	
H109	1F09h	h	Light Alarm Object Definition 4	1	0000 to 1111 (0: Heavy alarm (Err), 1: Light alarm (L-AL)) Thousands digit: Reserved Hundreds digit: Reserved Tenths digit: Reserved Units digit: SnF "Safety printed circuit board light alarm" (Available soon)	N	0000	Y	Y	9	Y	Y	Y	Y	
H110	1F0Ah	h	Light Alarm Object Definition 5	1	0000 to 1111 (0: Not light alarm, 1: Light alarm (L-AL)) Thousands digit: MOH "Motor overheat early warning" MOL "Motor overload early warning" Hundreds digit: BaT "Battery life expired" Tenths digit: LiF "Life time early warning" Units digit: OH/OL "Heat sink overheat early warning / overload early warning"	N	0000	Y	Y	9	Y	Y	Y	Y	
H111	1F0Bh	h	Light Alarm Object Definition 6	1	0 or 1 0: Disable (L-AL not shown) 1: Enable (L-AL shown) Specified whether or not to display L-AL on the LED monitor when a light alarm occurs.	N	0	Y	Y	68	Y	Y	Y	Y	
H112	1F0Ch	h	M1 Magnetic Saturation Extension Coefficient 6	7	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 43.75%.	Y	43.8	Y	N	2	Y	N	N	N	
H113	1F0Dh	h	M1 Magnetic Saturation Extension Coefficient 7	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 37.5%.	Y	37.5	Y	N	2	Y	N	N	N	
H114	1F0Eh	h	M1 Magnetic Saturation Extension Coefficient 8	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 31.25%.	Y	31.3	Y	N	2	Y	N	N	N	
H115	1F0Fh	h	M1 Magnetic Saturation Extension Coefficient 9	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 25%.	Y	25.0	Y	N	2	Y	N	N	N	
H116	1F10h	h	M1 Magnetic Saturation Extension Coefficient 10	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 18.75%.	Y	18.8	Y	N	2	Y	N	N	N	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H117	1F11h	h	M1 Magnetic Saturation Extension Coefficient 11	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 12.5%.	Y	12.5	Y	N	2	Y	N	N	N	
H118	1F12h	h	M1 Magnetic Saturation Extension Coefficient 12	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 6.25%.	Y	6.3	Y	N	2	Y	N	N	N	
H125	1F19h	h	Observer (M3 compensation gain)	1	0.00 to 1.00 times	Y	0.00	Y	Y	3	Y	Y	N	Y	
H126	1F1Ah	h	(M3 integral time)	1	0.005 to 1.000 s	Y	0.100	Y	Y	4	Y	Y	N	Y	
H127	1F1Bh	h	(M3 load inertia)	1	0.001 to 50.000 kg•m^2 The magnification is switchable by H228.	Y	0.001	Y	Y	4	Y	Y	N	Y	
H134	1F22h	h	Speed Drop Detection Delay Timer	5	0.000 to 10.000 s	N	0.000	Y	Y	4	N	Y	N	N	
H135	1F23h	h	Speed Command Detection Level (FWD)	1	0.0 to 150.0 r/min	N	0.0	Y	Y	2	N	Y	N	N	
H136	1F24h	h	(REV)	1	0.0 to 150.0 r/min	N	0.0	Y	Y	2	N	Y	N	N	
H137	1F25h	h	Speed Drop Detection Level	1	0.0 to 150.0 r/min	N	0.0	Y	Y	2	N	Y	N	N	
H138	1F26h	h	Speed Command Detection Delay Timer	1	0.000 to 10.000 s	N	0.000	Y	Y	4	N	Y	N	N	
H140	1F28h	h	Start Delay Detection (Detection level)	1	0.0 to 300.0%	Y	150.0	Y	Y	2	Y	Y	N	Y	
H141	1F29h	h	(Detection timer)	1	0.000 to 10.000 s	Y	1.000	Y	Y	0	Y	Y	N	Y	
H142	1F2Ah	h	Mock Alarm	0	0 or 1 0: Disable 1: Cause a mock alarm When H108 does not define a mock alarm as a light alarm, a heavy alarm (Err) occurs; when it defines a mock alarm as a light alarm, a light alarm (L-AL) occurs. Holding down the STOP and FUNC/DATA keys simultaneously for three seconds also causes a mock alarm.	Y	0	N	N	11	Y	Y	Y	Y	
H144	1F2Ch	h	Toggle Data Error Timer	0	0.01 to 20.00 s H144 specifies the toggle data error detection time.	Y	0.10	Y	Y	3	Y	Y	Y	Y	
H145	1F2Dh	h	Reverse Run Prevention for Vector Control without Speed Sensor (Lower limit frequency selection)	4	0 to 3 0: Disable 1: Enable for FWD unipolar operation 2: Enable for REV unipolar operation 3: Enable for FWD/REV bipolar operation	N	0	Y	Y	202	N	Y	N	N	
H146	1F2Eh	h	(Lower limit frequency, FWD)	1	0.000 to 10.000 Hz	N	0.000	Y	Y	4	N	Y	N	N	
H147	1F2Fh	h	(Lower limit frequency, REV)	1	0.000 to 10.000 Hz	N	0.000	Y	Y	4	N	Y	N	N	
H148	1F30h	h	(Estimated primary frequency filter)	1	0 to 100 ms Increase this setting if the speed fluctuation is large under vector control without speed sensor.	N	0	Y	Y	0	N	Y	N	N	
H149	1F31h	h	Machine Runaway Detection Speed Setting	0	0.0 to 20.0% 0.0: Disable 0.1 to 20.0% Assuming the maximum speed as 100%.	N	0.0	Y	Y	2	Y	Y	N	Y	
H160	1F3Ch	h	M1 Initial Magnetic Pole Position Detection Mode (Available soon)	3	0 to 3 0: Pull-in by current for IPMSM (Interior Permanent Magnet Synchronous Motor) 1: Pull-in by current for SPMSM (Surface Permanent Magnet Synchronous Motor) 2: Alternate system for IPMSM (Available soon) 3: Alternate system for IPMSM (Available soon)	N	0	Y	N	0	N	N	N	Y	
H161	1F3Dh	h	M1 Pull-in Current Command (Available soon)	1	10 to 200% 100%/Motor rated current	N	80	Y	N	0	N	N	N	Y	
H162	1F3Eh	h	M1 Pull-in Frequency (Available soon)	1	0.1 to 10.0 Hz	N	1.0	Y	N	2	N	N	N	Y	
H163	1F3Fh	h	M1 Reference Current for Polarity Discrimination (Available soon)	1	0 to 200%	N	80	Y	N	0	N	N	N	Y	
H164	1F40h	h	M1 Alternating Voltage (Available soon)	1	0 to 100%	N	0	Y	N	0	N	N	N	Y	
H170	1F46h	h	M2 Initial Magnetic Pole Position Detection Mode (Available soon)	3	0 to 3 0: Pull-in by current for IPMSM (Interior Permanent Magnet Synchronous Motor) 1: Pull-in by current for SPMSM (Surface Permanent Magnet Synchronous Motor) 2: Alternate system for IPMSM (Available soon) 3: Alternate system for IPMSM (Available soon)	N	0	Y	N	0	N	N	N	Y	
H171	1F47h	h	M2 Pull-in Current Command (Available soon)	1	10 to 200% 100%/Motor rated current	N	80	Y	N	0	N	N	N	Y	
H172	1F48h	h	M2 Pull-in Frequency (Available soon)	1	0.1 to 10.0 Hz	N	1.0	Y	N	2	N	N	N	Y	
H173	1F49h	h	M2 Reference Current for Polarity Discrimination (Available soon)	1	0 to 200%	N	80	Y	N	0	N	N	N	Y	
H174	1F4Ah	h	M2 Alternating Voltage (Available soon)	1	0 to 100%	N	0	Y	N	0	N	N	N	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H180	1F50h	h	M3 Initial Magnetic Pole Position Detection Mode (Available soon)	8	0 to 3 0: Pull-in by current for IPMSM (Interior Permanent Magnet Synchronous Motor) 1: Pull-in by current for SPMSM (Surface Permanent Magnet Synchronous Motor) 2: Alternate system for IPMSM (Available soon) 3: Alternate system for IPMSM (Available soon)	N	0	Y	N	0	N	N	N	Y	
H181	1F51h	h	M3 Pull-in Current Command (Available soon)	1	10 to 200% 100%/Motor rated current	N	80	Y	N	0	N	N	N	Y	
H182	1F52h	h	M3 Pull-in Frequency (Available soon)	1	0.1 to 10.0 Hz	N	1.0	Y	N	2	N	N	N	Y	
H183	1F53h	h	M3 Reference Current for Polarity Discrimination (Available soon)	1	0 to 200%	N	80	Y	N	0	N	N	N	Y	
H184	1F54h	h	M3 Alternating Voltage (Available soon)	1	0 to 100%	N	0	Y	N	0	N	N	N	Y	
H201	2001h	h	Load Adaptive Control (Load adaptive control parameter switching) (Available soon)	13	0 or 1 0: Enable H51/H64/H65, Disable H202-H213 1: Disable H51/H64/H65, Enable H202-H213	N	0	Y	Y	0	Y	N	N	Y	
H202	2002h	h	(Load inertia for winding up 1) (Available soon)	1	0.001 to 50.000 kg•m² Applies to winding-up operation when ***AN-P2/1*** is OFF. The magnification is switchable by H228.	N	0.001	Y	Y	4	Y	N	N	Y	
H203	2003h	h	(Safety coefficient for winding up 1) (Available soon)	1	0.50 to 1.20 Applies to winding-up operation when ***AN-P2/1*** is OFF.	N	1.00	Y	Y	3	Y	N	N	Y	
H204	2004h	h	(Mechanical efficiency for winding up 1) (Available soon)	1	0.500 to 1.000 Applies to winding-up operation when ***AN-P2/1*** is OFF.	N	0.500	Y	Y	4	Y	N	N	Y	
H205	2005h	h	(Load inertia for winding up 2) (Available soon)	1	0.001 to 50.000 kg•m² Applies to winding-up operation when ***AN-P2/1*** is ON. The magnification is switchable by H228.	N	0.001	Y	Y	4	Y	N	N	Y	
H206	2006h	h	(Safety coefficient for winding up 2) (Available soon)	1	0.50 to 1.20 Applies to winding-up operation when ***AN-P2/1*** is ON.	N	1.00	Y	Y	3	Y	N	N	Y	
H207	2007h	h	(Mechanical efficiency for winding up 2) (Available soon)	1	0.500 to 1.000 Applies to winding-up operation when ***AN-P2/1*** is ON.	N	0.500	Y	Y	4	Y	N	N	Y	
H208	2008h	h	(Load inertia for winding down 1) (Available soon)	1	0.001 to 50.000 kg•m² Applies to winding-down operation when ***AN-P2/1*** is OFF. The magnification is switchable by H228.	N	0.001	Y	Y	4	Y	N	N	Y	
H209	2009h	h	(Safety coefficient for winding down 1) (Available soon)	1	0.50 to 1.20 Applies to winding-down operation when ***AN-P2/1*** is OFF.	N	1.00	Y	Y	3	Y	N	N	Y	
H210	200Ah	h	(Mechanical efficiency for winding down 1) (Available soon)	1	0.500 to 1.000 Applies to winding-down operation when ***AN-P2/1*** is OFF.	N	0.500	Y	Y	4	Y	N	N	Y	
H211	200Bh	h	(Load inertia for winding down 2) (Available soon)	1	0.001 to 50.000 kg•m² Applies to winding-down operation when ***AN-P2/1*** is ON. The magnification is switchable by H228.	N	0.001	Y	Y	4	Y	N	N	Y	
H212	200Ch	h	(Safety coefficient for winding down 2) (Available soon)	1	0.50 to 1.20 Applies to winding-down operation when ***AN-P2/1*** is ON.	N	1.00	Y	Y	3	Y	N	N	Y	
H213	200Dh	h	(Mechanical efficiency for winding down 2) (Available soon)	1	0.500 to 1.000 Applies to winding-down operation when ***AN-P2/1*** is ON.	N	0.500	Y	Y	4	Y	N	N	Y	
H214	200Eh	h	(Multi-limit speed pattern function) (Available soon)	14	0 or 1 0: Enable H60, Disable H215-H224 1: Disable H60, Enable H215-H224	N	0	Y	Y	0	Y	N	N	Y	
H215	200Fh	h	(Multi-limit speed pattern at max. speed) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the maximum speed.	N	50.0	Y	Y	2	Y	N	N	Y	
H216	2010h	h	(Multi-limit speed pattern at rated speed) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed.	N	100.0	Y	Y	2	Y	N	N	Y	
H217	2011h	h	(Multi-limit speed pattern at rated speed x 1.1) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*1.1.	N	90.9	Y	Y	2	Y	N	N	Y	
H218	2012h	h	(Multi-limit speed pattern at rated speed x 1.2) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*1.2.	N	83.3	Y	Y	2	Y	N	N	Y	
H219	2013h	h	(Multi-limit speed pattern at rated speed x 1.4) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*1.4.	N	71.4	Y	Y	2	Y	N	N	Y	
H220	2014h	h	(Multi-limit speed pattern at rated speed x 1.6) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*1.6.	N	62.5	Y	Y	2	Y	N	N	Y	
H221	2015h	h	(Multi-limit speed pattern at rated speed x 1.8) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*1.8.	N	55.5	Y	Y	2	Y	N	N	Y	
H222	2016h	h	(Multi-limit speed pattern at rated speed x 2.0) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*2.0.	N	50.0	Y	Y	2	Y	N	N	Y	

Function code	Communica-tions address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
H223	2017h	h	(Multi-limit speed pattern at rated speed x 2.5) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*2.5.	N	40.0	Y	Y	2	Y	N	N	Y	
H224	2018h	h	(Multi-limit speed pattern at rated speed x 3.0) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*3.0.	N	33.3	Y	Y	2	Y	N	N	Y	
H225	2019h	h	(Limit speed discrimination zone, Start speed) (Available soon)	1	0.1 to 100.0% Specifies the starting speed of the discrimination zone. The rated speed is assumed as 100%.	N	75.0	Y	Y	2	Y	N	N	Y	
H226	201Ah	h	(Limit speed discrimination zone, Completion speed) (Available soon)	1	0.1 to 100.0% Specifies the end speed of the discrimination zone. The rated speed is assumed as 100%.	N	93.7	Y	Y	2	Y	N	N	Y	
H227	201Bh	h	(Function definition 3) (Available soon)	1	0 to 2 0: Calculate the limit speed for winding-up and winding-down individually 1: Drive winding-down operation using the last limited speed result Enable the winding-down limit calculation under specific conditions 2: Drive winding-down operation using the last limited speed result Limit the winding-down speed with the rated speed under specific conditions	N	0	Y	Y	0	Y	N	N	Y	
H228	201Ch	h	Load Inertia Magnification Setting	0	0 to 2 0: 1 time (0.001 to 50.000 kg•m^2) 1: 10 times (0.01 to 500.00 kg•m^2) 2: 100 times (0.1 to 5000.0 kg•m^2) Switches the magnification of the load inertia (H51, H52, H202, H205, H208, H211).	N	0	Y	Y	193	Y	N	N	Y	
H322	2116h		Notch Filter 1 (Resonance frequency)	6	10 to 2000 Hz	Y	1000	Y	Y	0	Y	Y	N	Y	
H323	2117h		(Attenuation level)	1	0 to 40 dB	Y	0	Y	Y	0	Y	Y	N	Y	
H324	2118h		(Frequency range)	1	0 to 3	Y	2	Y	Y	0	Y	Y	N	Y	
H325	2119h		Notch Filter 2 (Resonance frequency)	1	10 to 2000 Hz	Y	1000	Y	Y	0	Y	Y	N	Y	
H326	211Ah		(Attenuation level)	1	0 to 40 dB	Y	0	Y	Y	0	Y	Y	N	Y	
H327	211Bh		(Frequency range)	1	0 to 3	Y	2	Y	Y	0	Y	Y	N	Y	

■ A codes (Alternative Motor Parameter Functions M2/M3)

Function code	Communications address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
A01	501h	h	M2 Drive Control	29	0 to 5 0: Vector control for IM with speed sensor 1: Vector control for IM without speed sensor 2: - 3: Vector control for PMSM with speed sensor 4: - 5: V/f control for IM	N	0	Y	N	228	Y	Y	Y	Y	
A02	502h	h	M2 Rated Capacity	1	For inverters of 400 kW or below 0.00 to 500.00 kW when F60 = 0 0.00 to 600.00 HP when F60 = 1 For inverters of 500 kW or above 0.00 to 1200 kW when F60 = 0 0.00 to 1600 HP when F60 = 1 For multiwinding motors, set the motor capacity per wiring.	N	0.00	Y	N	3 13	Y	Y	Y	Y	
A03	503h	h	M2 Rated Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	N	0.01	Y	N	13	Y	Y	Y	Y	
A04	504h	h	M2 Rated Voltage	1	80 to 999 V	N	80	Y	N	0	Y	Y	Y	Y	
A05	505h	h	M2 Rated Speed	1	50 to 30000 r/min	N	1500	Y	N	0	Y	Y	Y	Y	
A06	506h	h	M2 Max. Speed	1	50 to 30000 r/min	N	1500	Y	N	0	Y	Y	Y	Y	
A07	507h	h	M2 Number of Poles	1	2 to 100 poles	N	4	Y	N	1	Y	Y	Y	Y	
A08	508h	h	M2 %R1	1	0.00 to 30.00%	Y	0.00	Y	N	3	Y	Y	Y	Y	
A09	509h	h	M2 %X	1	0.00 to 200.00%	Y	0.00	Y	N	3	Y	Y	Y	Y	
A10	50Ah	h	M2 Exciting Current/Magnetic Flux Weakening Current (-Id)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	Y	Y	
A11	50Bh	h	M2 Torque Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	N	Y	
A12	50Ch	h	M2 Slip Frequency (For driving)	1	0.001 to 10.000 Hz	Y	0.001	Y	N	4	Y	Y	N	N	
A13	50Dh	h	(For braking)	1	0.001 to 10.000 Hz	Y	0.001	Y	N	4	Y	Y	N	N	
A14	50Eh	h	M2 Iron Loss Factor 1	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	Y	
A15	50Fh	h	M2 Iron Loss Factor 2	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	Y	
A16	510h	h	M2 Iron Loss Factor 3	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	Y	
A17	511h	h	M2 Magnetic Saturation Factor 1	1	0.0 to 100.0%	Y	93.8	Y	N	2	Y	Y	N	N	
A18	512h	h	M2 Magnetic Saturation Factor 2	1	0.0 to 100.0%	Y	87.5	Y	N	2	Y	Y	N	N	
A19	513h	h	M2 Magnetic Saturation Factor 3	1	0.0 to 100.0%	Y	75.0	Y	N	2	Y	Y	N	N	
A20	514h	h	M2 Magnetic Saturation Factor 4	1	0.0 to 100.0%	Y	62.5	Y	N	2	Y	Y	N	N	
A21	515h	h	M2 Magnetic Saturation Factor 5	1	0.0 to 100.0%	Y	50.0	Y	N	2	Y	Y	N	N	
A22	516h	h	M2 Secondary Time Constant	1	0.001 to 9.999 s	Y	0.001	Y	N	4	Y	Y	N	N	
A23	517h	h	M2 Induced Voltage Factor	1	0 to 999 V	Y	0	Y	N	0	Y	Y	N	Y	
A24	518h	h	M2 R2 Correction Factor 1	1	0.000 to 5.000	Y	1.000	Y	N	4	Y	Y	N	Y	
A25	519h	h	M2 R2 Correction Factor 2	1	0.000 to 5.000	Y	1.000	Y	N	4	Y	Y	N	N	
A26	51Ah	h	M2 R2 Correction Factor 3	1	0.010 to 5.000	Y	1.000	Y	N	4	Y	Y	N	N	
A27	51Bh	h	M2 Exciting Current Correction Factor	1	0.000 to 5.000	Y	0.000	Y	N	4	Y	Y	N	N	
A28	51Ch	h	M2 ACR (P-gain)	1	0.1 to 20.0	Y	1.0	Y	N	2	Y	Y	N	Y	
A29	51Dh	h	(I-time)	1	0.1 to 100.0 ms	Y	1.0	Y	N	2	Y	Y	N	Y	
A30	51Eh	h	M2 Pulse Resolution	0	100 to 60000	N	1024	Y	N	0	Y	N	N	Y	
A31	51Fh	h	M2 Thermistor Selection	0	0 to 3 0: No thermistor 1: NTC thermistor 2: PTC thermistor 3: Ai (***M-TMP***) The protection level of the motor protective functions should be specified by E30 to E32.	N	1	Y	N	84	Y	Y	Y	Y	
A32	520h	h	M2 Electronic Thermal Overload Protection (Select motor characteristics)	3	0 to 2 0: Disable (For a VG-dedicated motor) 1: Enable (For a general-purpose motor with shaft-driven cooling fan) 2: Enable (For an inverter-driven motor with separately powered cooling fan)	Y	0	Y	N	85	Y	Y	Y	Y	
A33	521h	h	(Detection level)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	Y	Y	
A34	522h	h	(Thermal time constant)	1	0.5 to 75.0 min	Y	0.5	Y	N	2	Y	Y	Y	Y	
A51	533h	h	M2 External PG Correction Factor	0	0000 to 4FFF	N	4000	Y	N	9	Y	N	N	N	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
A52	534h	h	M2 Online Auto-tuning	0	0 or 1 0: Disable 1: Enable	Y	0	Y	N	0	Y	Y	N	N	
A53	535h	h	M2 Maximum Output Voltage/ Maximum Voltage Limit	0	80 to 999 V	Y	80	Y	N	0	N	N	Y	Y	
A54	536h	h	M2 Slip Compensation	3	-20.000 to 5.000 Hz	Y	0.000	Y	N	8	N	N	Y	N	
A55	537h	h	M2 Torque Boost	1	0.0 to 20.0 Exclusive to V/f control. 0.0: Auto torque boost (for constant torque load) 0.1 to 0.9: For variable torque load 1.0 to 1.9: For proportional torque load 2.0 to 20.0: For constant torque load	Y	0.0	Y	N	2	N	N	Y	N	
A56	538h	h	M2 Output Current Fluctuation Damping Gain	1	0.00 to 1.00	Y	0.20	Y	N	3	N	N	Y	N	
A59	53Bh	h	M2 ABS Signal Input Definition	12	0 to 16 Specifies the operation interface to detect the magnetic pole position, in accordance with the encoder specifications. 0: 1 bit (Terminal; F0) Z-phase interface 1: 3 bits (Terminal: F0/F1/F2) U-,V-,W-phase interface 2: 4 bits (Terminal; F0/F1/F2/F3) Gray code interface 3-5: Reserved. 6: SPGT 17-bit serial interface 7-16: Reserved.	N	0	Y	N	0	N	N	N	Y	
A60	53Ch	h	M2 Magnetic Pole Position Offset	1	0.0 to 359.9 (0° to 359.9° CCW) Specifies the offset value for the PG reference position and the actual motor magnetic pole position.	Y	0.0	Y	N	2	N	N	N	Y	
A61	53Dh	h	M2 Salient Pole Ratio (%Xq/%Xd)	1	1.000 to 3.000 Specifies the saliency ratio of PMSM. Setting = Lq/Ld To drive a SPM motor, set 1.000.	N	1.000	Y	N	4	N	N	N	Y	
A62	53Eh	h	M2 q-axis Inductance Magnetic Saturation Coefficient	9	0.0 to 100.0%	Y	100.0	Y	N	2	N	N	N	Y	
A63	53Fh	h	M2 Magnetic Flux Limiting Value	1	50.0 to 150.0%	Y	*	Y	N	2	N	N	N	Y	
A64	540h	h	M2 Overcurrent Protection Level	1	0: Disable 1: 1 to 200% Specifies the allowable current value to prevent the permanent magnet of a PMSM from getting demagnetized. If the current exceeding this setting flows, an overcurrent alarm (OC) occurs.	N	*	Y	N	0	N	N	N	Y	
A65	541h	h	M2 Torque Correction Gain 1	1	0.00 to 10.00	Y	1.00	Y	N	3	N	N	N	Y	
A66	542h	h	M2 Torque Correction Gain 2	1	0.00 to 10.00	Y	1.00	Y	N	3	N	N	N	Y	
A67	543h	h	M2 Torque Correction Gain 3	1	-1000 to 1000	Y	0.000	Y	N	8	N	N	N	Y	
A68	544h	h	M2 Torque Correction Gain 4	1	-1000 to 1000	Y	0.000	Y	N	8	N	N	N	Y	
A69	545h	h	M2 Torque Correction Gain 5	1	-50.0 to 50.0	Y	0.00	Y	N	7	N	N	N	Y	
A70	546h	h	M2 Torque Correction Gain 6	1	-50.0 to 50.0	Y	0.00	Y	N	7	N	N	N	Y	
A71	546h	h	M2 Torque Correction Gain 7	1	-1000 to 1000	Y	0.000	Y	N	8	N	N	N	Y	
A101	2401h	h	M3 Drive Control	29	0 to 5 0: Vector control for IM with speed sensor 1: Vector control for IM without speed sensor 2: - 3: Vector control for PMSM with speed sensor 4: - 5: V/f control for IM	N	5	Y	N	228	Y	Y	Y	Y	
A102	2402h	E5h	M3 Rated Capacity	1	For inverters of 400 kW or below 0.00 to 500.00 kW when F60 = 0 0.00 to 600.00 HP when F60 = 1 For inverters of 500 kW or above 0.00 to 1200 kW when F60 = 0 0.00 to 1600 HP when F60 = 1 For multiwinding motors, set the motor capacity per wiring.	N	0.00	Y	N	3 13	Y	Y	Y	Y	
A103	2403h	E6h	M3 Rated Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	N	0.01	Y	N	13	Y	Y	Y	Y	
A104	2404h	E7h	M3 Rated Voltage	1	80 to 999 V	N	80	Y	N	0	Y	Y	Y	Y	

*Depending upon the inverter's capacity.

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
A105	2405h	E9h	M3 Rated Speed	1	50 to 30000 r/min	N	1500	Y	N	0	Y	Y	Y	Y	
A106	2406h	EAh	M3 Max. Speed	1	50 to 30000 r/min	N	1500	Y	N	0	Y	Y	Y	Y	
A107	2407h	EBh	M3 Number of Poles	1	2 to 100 poles	N	4	Y	N	1	Y	Y	Y	Y	
A108	2408h	ECh	M3 %R1	1	0.00 to 30.00%	Y	0.00	Y	N	3	Y	Y	Y	Y	
A109	2409h	EDh	M3 %X	1	0.00 to 200.00%	Y	0.00	Y	N	3	Y	Y	Y	Y	
A110	240Ah	EEh	M3 Exciting Current/Magnetic Flux Weakening Current (-Id)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	Y	Y	
A111	240Bh	h	M3 Torque Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	N	Y	
A112	240Ch	h	M3 Slip Frequency (For driving)	1	0.001 to 10.000 Hz	Y	0.001	Y	N	4	Y	Y	N	N	
A113	240Dh	h	(For braking)	1	0.001 to 10.000 Hz	Y	0.001	Y	N	4	Y	Y	N	N	
A114	240Eh	h	M3 Iron Loss Factor 1	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	N	
A115	240Fh	h	M3 Iron Loss Factor 2	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	Y	
A116	2410h	h	M3 Iron Loss Factor 3	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	Y	
A117	2411h	h	M3 Magnetic Saturation Factor 1	1	0.0 to 100.0%	Y	93.8	Y	N	2	Y	Y	N	N	
A118	2412h	h	M3 Magnetic Saturation Factor 2	1	0.0 to 100.0%	Y	87.5	Y	N	2	Y	Y	N	N	
A119	2413h	h	M3 Magnetic Saturation Factor 3	1	0.0 to 100.0%	Y	75.0	Y	N	2	Y	Y	N	N	
A120	2414h	h	M3 Magnetic Saturation Factor 4	1	0.0 to 100.0%	Y	62.5	Y	N	2	Y	Y	N	N	
A121	2415h	h	M3 Magnetic Saturation Factor 5	1	0.0 to 100.0%	Y	50.0	Y	N	2	Y	Y	N	N	
A122	2416h	h	M3 Secondary Time constant	1	0.001 to 9.999 s	Y	0.001	Y	N	4	Y	Y	N	N	
A123	2417h	h	M3 Induced Voltage Factor	1	0 to 999 V	Y	0	Y	N	0	Y	Y	N	Y	
A124	2418h	h	M3 R2 Correction Factor 1	1	0.500 to 5.000	Y	1.000	Y	N	4	Y	Y	N	Y	
A125	2419h	h	M3 R2 Correction Factor 2	1	0.500 to 5.000	Y	1.000	Y	N	4	Y	Y	N	N	
A126	241Ah	h	M3 R2 Correction Factor 3	1	0.010 to 5.000	Y	1.000	Y	N	4	Y	Y	N	N	
A127	241Bh	h	M3 Exciting Current Correction Factor	1	0.000 to 5.000	Y	0.000	Y	N	4	Y	Y	N	N	
A128	241Ch	h	M3 ACR P Gain	1	0.1 to 20.0	Y	1.0	Y	N	2	Y	Y	N	Y	
A129	241Dh	h	M3 ACR I time Constant	1	0.1 to 100.0 ms	Y	1.0	Y	N	2	Y	Y	N	Y	
A130	241Eh	h	M3 Pulse Resolution	0	100 to 60000	N	1024	Y	N	0	Y	N	N	Y	
A131	241Fh	F1h	M3 Thermistor Selection	0	0 to 3 0: No thermistor 1: NTC thermistor 2: PTC thermistor 3: Ai (***M-TMP***) The protection level of the motor protective functions should be specified by E30 to E32.	N	1	Y	N	84	Y	Y	Y	Y	
A132	2420h	F2h	M3 Electronic Thermal Overload Protection (Select motor characteristics)	3	0 to 2 0: Disable (For a VG-dedicated motor) 1: Enable (For a general-purpose motor with shaft-driven cooling fan) 2: Enable (For an inverter-driven motor with separately powered cooling fan) Using an NTC thermistor of a VG-dedicated motor activates the motor overheat protection. If it happens, disable the electronic thermal overload protection.	Y	0	Y	N	85	Y	Y	Y	Y	
A133	2421h	F3h	(Detection level)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	Y	Y	
A134	2422h	F4h	(Thermal time constant)	1	0.5 to 75.0 min	Y	0.5	Y	N	2	Y	Y	Y	Y	
A151	2433h	h	M2 External PG Correction Coefficient	0	0000 to 4FFF	N	4000	Y	N	9	Y	N	N	N	
A152	2434h	h	M3 Online Auto-tuning	0	0 to 1 0: Disable 1: Enable	Y	0	Y	N	68	Y	Y	N	N	
A153	2435h	E8h	M3 Maximum Output Voltage (at V/f maximum speed)	0	80 to 999 V	Y	80	Y	N	0	N	N	Y	Y	
A154	2436h	EFh	M3 Slip Compensation	3	-20.000 to 5.000 Hz	Y	0.000	Y	N	8	N	N	Y	N	
A155	2437h	F0h	M3 Torque Boost	1	0.0 to 20.0 Exclusive to V/f control. 0.0: Auto torque boost (for constant torque load) 0.1 to 0.9: For variable torque load 1.0 to 1.9: For proportional torque load 2.0 to 20.0: For constant torque load	Y	0.0	Y	N	2	N	N	Y	N	
A156	2438h	h	M3 Output Current Fluctuation Damping Gain	1	0.00 to 1.00	Y	0.20	Y	N	3	N	N	Y	N	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
A159	243Bh	h	M3 ABS Signal Input Definition	0	0 to 16 Specifies the operation interface to detect the magnetic pole position, in accordance with the encoder specifications. 0: 1 bit (Terminal; F0) Z-phase interface 1: 3 bits (Terminal: F0/F1/F2) U-,V-,W-phase interface 2: 4 bits (Terminal; F0/F1/F2/F3) Gray code interface 3-5: Reserved. 6: SPGT 17-bit serial interface 7-16: Reserved.	N	0	Y	N	0	N	N	N	Y	
A160	243Ch	h	M3 Magnetic Pole Position Offset	0	0.0 to 359.9 (0° to 359.9° CCW) Specifies the offset value for the PG reference position and the actual motor magnetic pole position.	Y	0.0	Y	N	2	N	N	N	Y	
A161	243Dh	h	M3 Salient Pole Ratio (%Xq/%Xd)	1	1.000 to 3.000 Specifies the saliency ratio of PMSM. Setting = Lq/Ld To drive a SPM motor, set 1.000.	N	1.000	Y	N	4	N	N	N	Y	
A162	243Ch	h	M3 q-axis Inductance Magnetic Saturation Coefficient	9	0.0 to 100.0%	Y	1.000	Y	N	2	N	N	N	Y	
A163	243Dh	h	M3 Magnetic Flux Limiting Value	1	50.0 to 150.0%	Y	1.000	Y	N	2	N	N	N	Y	
A164	2440h	h	M3 Overcurrent Protection Level	1	0: Disable 1: 1 to 200% Specifies the allowable current value to prevent the permanent magnet of a PMSM from getting demagnetized. If the current exceeding this setting flows, an overcurrent alarm (OC) occurs.	N	0.00	Y	N	0	N	N	N	Y	
A165	2441h	h	M3 Torque Correction Gain 1	1	0.00 to 10.00	Y	1.00	Y	N	3	N	N	N	Y	
A166	2442h	h	M3 Torque Correction Gain 2	1	0.00 to 10.00	Y	1.00	Y	N	3	N	N	N	Y	
A167	2443h	h	M3 Torque Correction Gain 3	1	-1.000 to 1.000	Y	0.000	Y	N	8	N	N	N	Y	
A168	2444h	h	M3 Torque Correction Gain 4	1	-1.000 to 1.000	Y	0.000	Y	N	8	N	N	N	Y	
A169	2445h	h	M3 Torque Correction Gain 5	1	-50.0 to 50.0	Y	0.00	Y	N	7	N	N	N	Y	
A170	2446h	h	M3 Torque Correction Gain 6	1	-50.0 to 50.0	Y	0.00	Y	N	7	N	N	N	Y	
A171	2447h	h	M3 Torque Correction Gain 7	1	-1.000 to 1.000	Y	0.000	Y	N	8	N	N	N	Y	

■ o codes (Option Functions)

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
o01	601h	F5h	DIA Function Selection	4	0 or 1 0 : Binary 1 : BCD	N	0	Y	Y	86	Y	Y	Y	Y	
o02	602h	F6h	DIB Function Selection	1	0 or 1 0 : Binary 1 : BCD	N	0	Y	Y	86	Y	Y	Y	Y	
o03	603h	h	DIA BCD Input Speed Setting	1	99 to 7999	N	1000	Y	Y	0	Y	Y	Y	Y	
o04	604h	h	DIB BCD Input Speed Setting	1	99 to 7999	N	1000	Y	Y	0	Y	Y	Y	Y	
o05	605h	h	PG (PD) Option Setting (Feedback pulse)	0	0 to 2 0: Build-in PG 1: PG(PD) option 2: SPGT option (Available soon)	N	0	Y	Y	96	Y	N	N	Y	
o06	606h	h	(Digital line speed detection definition, PG pulses)	3	100 to 60000 P/R	Y	1024	Y	Y	0	Y	Y	Y	Y	
o07	607h	h	(Digital line speed detection definition, Detection pulse correction 1)	1	1 to 9999	Y	1000	Y	Y	0	Y	Y	Y	Y	
o08	608h	h	(Digital line speed detection definition, Detection pulse correction 2)	1	1 to 9999	Y	1000	Y	Y	0	Y	Y	Y	Y	
o09	609h	h	M1 Absolute Signal Input Definition	3	0 to 16 Specifies the operation interface to detect the magnetic pole position, in accordance with the encoder specifications. 0: 1 bit (Terminal; F0) Z-phase interface (Available soon) 1: 3 bits (Terminal: F0/F1/F2) U-,V-,W-phase interface 2: 4 bits (Terminal; F0/F1/F2/F3) Gray code interface 3-5: Reserved. 6: SPGT 17-bit serial interface 7-16: Reserved.	N	0	Y	N	0	N	N	N	Y	
o10	60Ah	h	M1 Magnetic Pole Position Offset	1	0.0 to 359.9 (0° to 359.9° CCW) Specifies the offset value for the PG reference position and the actual motor magnetic pole position.	Y	0.0	Y	N	2	N	N	N	Y	
o11	60Bh	h	M1 Salient Pole Rate (%Xq/%Xd)	1	1.000 to 3.000 Specifies the saliency ratio of PMSM. Setting = Lq/Ld To drive an SPM motor, set 1.000.	N	1.000	Y	N	4	N	N	N	Y	
o12	60Ch	h	PG (PR) Pulse-train Option Setting (Command pulse)	8	0 or 1 0: PG(PD) option 1: Internal speed command	N	0	Y	Y	97	Y	N	N	Y	
o13	60Dh	h	(Pulse train input form)	1	0 to 2 0: Phase difference 90° between A-phase and B-phase 1: A-phase : Reference pulse, B-phase :Reference sign 2: A-phase : Forward pulse, B-phase : Reverse pulse	N	0	Y	Y	98	Y	N	N	Y	
o14	60Eh	F7h	(Command pulse correction 1)	1	1 to 9999	Y	1000	Y	Y	0	Y	N	N	Y	
o15	60Fh	F8h	(Command pulse correction 2)	1	1 to 9999	Y	1000	Y	Y	0	Y	N	N	Y	
o16	610h	F9h	(APR gain 1)	1	0.1 to 999.9 times	Y	1.0	Y	Y	2	Y	N	N	Y	
o17	611h	FAh	(Feedforward gain 1)	1	0.0 to 1.5 times	Y	0.0	Y	Y	2	Y	N	N	Y	
o18	612h	h	(Overdeviation width)	1	0 to 65535 pulses	Y	65535	Y	Y	0	Y	N	N	Y	
o19	613h	h	(Zero deviation width)	1	0 to 1000 pulses	Y	20	Y	Y	0	Y	N	N	Y	
o20	614h	h	APR Gain 2 (Available soon)	1	0.1 to 999.9 times	Y	1.0	Y	Y	2	Y	N	N	Y	
o21	615h	h	F/F Gain 2 (Available soon)	1	0.0 to 1.5 times	Y	0.0	Y	Y	2	Y	N	N	Y	
o22	616h	h	Position Control Gain Switching (Available soon)	3	0 to 3 0: Disable 1: Positional deviation (x 10) 2: Detected speed (10000/Maximum speed) 3: Speed command (10000/Maximum speed) Select a trigger to switch between the 1st and 2nd gains of the position control system. Switching gains can reduce noise or vibration when the inverter is stopped.	Y	0	Y	Y	229	Y	N	N	Y	
o23	617h	h	Position Control Gain Switching Level (Available soon)	1	0 to 10000	Y	0	Y	Y	0	Y	N	N	Y	
o24	618h	h	Position Control Gain Switching Time (Available soon)	1	0 to 1000 ms	Y	0	Y	Y	0	Y	N	N	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
o29	61Dh	h	Link Option Configuration (Continue-to-run signal processing in case of alarm) (Available soon)	4	0 to 2 0: Disable 1: Signal operation 1 (A heavy alarm that occurs at OFF immediately results in alarm Er-4.) (A light alarm that occurs at OFF follows the setting of o30.) 2: Signal operation 2 (A heavy alarm or light alarm that occurs at OFF follows the setting of o30.) When o29 = 1 or 2 and the ***LK-D*** signal (Continue to run for link error) is ON, a heavy alarm or light alarm that occurs follows the setting (o30 = 3).	Y	0	Y	Y	226	Y	Y	Y	Y	
o30	61Eh	h	(Communications error processing)	3	0 to 3 0: Immediately trip with alarm Er-4 1: Trip with alarm Er-4 after running for the period specified by timer o31 2: Trip with alarm (Er-4) if the communication error remains exceeding the period specified by timer o31. 3: Continue to run Specifies the error processing to be performed if a communications link error occurs. For CC-Link, when o30 = 0 to 3, the inverter produces different operation.	N	0	Y	Y	73	Y	Y	Y	Y	
o31	61Fh	h	(Timer)	1	0.01 to 20.00 s Specifies the duration from an occurrence of communications problem on the link until the inverter cause a communications error.	N	0.10	Y	Y	3	Y	Y	Y	Y	
o32	620h	h	(Link format selection)	1	0 to 4 0: Link format 1 1: Link format 2 2: Link format 3 3: Link format 4 4: Link format 5	N	0	Y	N	87	Y	Y	Y	Y	
o33	621h	h	Multiplex System (Control mode)	2	0 to 5 0: Disable 1: Multiwinding system 2: Multiplex system 1 (Available soon) 3: Multiplex system 2 (Available soon) 4: Reserved 1 5: Reserved 2 Selects whether or not to use a high-speed serial communications terminal block as a component of the multiwinding system or multiplex system. Refer to ***MT-CCL*** (Cancel multiplex system) in the description of E01 to E13 (Terminal X Function).	N	0	Y	Y	232	Y	N	N	N	
o34	622h	h	(No. of slave stations)	1	1 to 5 Specifies the numbers of slave units except a master unit when the multiplex system is enabled.	N	1	Y	Y	0	Y	N	N	N	
o50	632h	h	(Station number assignment)	0	0 to 5 0: Master 1-5: Slave 1 to 5	N	0	N	Y	0	Y	N	N	N	
o101	2501h	h	Bus Configuration Parameter 1 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o102	2502h	h	Bus Configuration Parameter 2 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o103	2503h	h	Bus Configuration Parameter 3 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o104	2504h	h	Bus Configuration Parameter 4 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o105	2505h	h	Bus Configuration Parameter 5 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o106	2506h	h	Bus Configuration Parameter 6 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o107	2507h	h	Bus Configuration Parameter 7 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o108	2508h	h	Bus Configuration Parameter 8 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o109	2509h	h	Bus Configuration Parameter 9 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o110	250Ah	h	Bus Configuration Parameter 10 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o111	250Bh	h	Bus Configuration Parameter 11 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o112	250Ch	h	Bus Configuration Parameter 12 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o113	250Dh	h	Bus Configuration Parameter 13 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o114	250Eh	h	Bus Configuration Parameter 14 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	

Function code	Communica-tions address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
o115	250Fh	h	Bus Configuration Parameter 15 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o116	2510h	h	Bus Configuration Parameter 16 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o117	2511h	h	Bus Configuration Parameter 17 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o118	2512h	h	Bus Configuration Parameter 18 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o119	2513h	h	Bus Configuration Parameter 19 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o120	2514h	h	Bus Configuration Parameter 20 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o121	2515h	h	Write/Read Function Code Setting (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o122	2516h	h	Write Function Code Assignment 1 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o123	2517h	h	Write Function Code Assignment 2 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o124	2518h	h	Write Function Code Assignment 3 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o125	2519h	h	Write Function Code Assignment 4 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o126	251Ah	h	Write Function Code Assignment 5 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o127	251Bh	h	Write Function Code Assignment 6 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o128	251Ch	h	Write Function Code Assignment 7 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o129	251Dh	h	Write Function Code Assignment 8 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o130	251Eh	h	Write Function Code Assignment 9 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o131	251Fh	h	Write Function Code Assignment 10 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o132	2520h	h	Write Function Code Assignment 11 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o133	2521h	h	Write Function Code Assignment 12 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o134	2522h	h	Write Function Code Assignment 13 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o135	2523h	h	Write Function Code Assignment 14 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o136	2524h	h	Write Function Code Assignment 15 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o137	2525h	h	Write Function Code Assignment 16 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o138	2526h	h	Write Function Code Assignment 17 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o139	2527h	h	Write Function Code Assignment 18 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o140	2528h	h	Write Function Code Assignment 19 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o141	2529h	h	Write Function Code Assignment 20 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o142	252Ah	h	Write Function Code Assignment 21 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o143	252Bh	h	Write Function Code Assignment 22 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o144	252Ch	h	Write Function Code Assignment 23 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o145	252Dh	h	Write Function Code Assignment 24 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o146	252Eh	h	Write Function Code Assignment 25 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o147	252Fh	h	Write Function Code Assignment 26 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o148	2530h	h	Write Function Code Assignment 27 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o149	2531h	h	Write Function Code Assignment 28 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o150	2532h	h	Write Function Code Assignment 29 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o151	2533h	h	Write Function Code Assignment 30 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o152	2534h	h	Write Function Code Assignment 31 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	

Function code	Communica-tions address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
o153	2535h	h	Write Function Code Assignment 32 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o154	2536h	h	Write Function Code Assignment 33 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o155	2537h	h	Write Function Code Assignment 34 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o156	2538h	h	Write Function Code Assignment 35 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o157	2539h	h	Write Function Code Assignment 36 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o158	253Ah	h	Write Function Code Assignment 37 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o159	253Bh	h	Write Function Code Assignment 38 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o160	253Ch	h	Read Function Code Assignment 1	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o161	253Dh	h	Read Function Code Assignment 2	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o162	253Eh	h	Read Function Code Assignment 3 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o163	253Fh	h	Read Function Code Assignment 4 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o164	2540h	h	Read Function Code Assignment 5 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o165	2541H	h	Read Function Code Assignment 6 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o166	2542h	h	Read Function Code Assignment 7 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o167	2543h	h	Read Function Code Assignment 8 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o168	2544h	h	Read Function Code Assignment 9 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o169	2545h	h	Read Function Code Assignment 10 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o170	2546h	h	Read Function Code Assignment 11 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o171	2547h	h	Read Function Code Assignment 12 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o172	2548h	h	Read Function Code Assignment 13 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o173	2549h	h	Read Function Code Assignment 14 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o174	254Ah	h	Read Function Code Assignment 15 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o175	254Bh	h	Read Function Code Assignment 16 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o176	254Ch	h	Read Function Code Assignment 17 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o177	254Dh	h	Read Function Code Assignment 18 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o178	254Eh	h	Read Function Code Assignment 19 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o179	254Fh	h	Read Function Code Assignment 20 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o180	2550h	h	Read Function Code Assignment 21 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o181	2551h	h	Read Function Code Assignment 22 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o182	2552h	h	Read Function Code Assignment 23 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o183	2553h	h	Read Function Code Assignment 24 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o184	2554h	h	Read Function Code Assignment 25 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o185	2555h	h	Read Function Code Assignment 26 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o186	2556h	h	Read Function Code Assignment 27 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o187	2557h	h	Read Function Code Assignment 28 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o188	2558h	h	Read Function Code Assignment 29 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o189	2559h	h	Read Function Code Assignment 30 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o190	255Ah	h	Read Function Code Assignment 31 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
o191	255Bh	h	Read Function Code Assignment 32 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o192	255Ch	h	Read Function Code Assignment 33 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o193	255Dh	h	Read Function Code Assignment 34 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o194	255Eh	h	Read Function Code Assignment 35 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o195	255Fh	h	Read Function Code Assignment 36 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o196	2560h	h	Read Function Code Assignment 37 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o197	2561h	h	Read Function Code Assignment 38 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o218	2612h	h	Reserved 1 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o219	2613h	h	Reserved 2 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o220	2614h	h	Reserved 3 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o221	2615h	h	Reserved 4 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o222	2616h	h	Reserved 5 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o223	2617h	h	Reserved 6 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o224	2618h	h	Reserved 7 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o225	2619h	h	Reserved 8 (Available soon)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	

■ L codes (Lift Functions)

Function code	Communications address: 485 No.	Communications address: Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control: VC w/ PG	Drive control: VC w/o PG	Drive control: V/f	Drive control: VC for PMSM	Remarks
L01	901h	h	Password Data 1		0 to 9999 A maximum of 8-digit password can be specified with L01 and L02 to restrict access to function code data or check it. Setting either one of L01 and L02 at any numeral except "0" enables password protection.	Y	0	N	N	0	Y	Y	N	Y	
L02	902h	h	Password Data 2	0	0 to 9999	Y	0	N	N	0	Y	Y	N	Y	
L03	903h	h	Lift Rated Speed	0	0.0 to 999.9 m/min	Y	100.0	Y	Y	2	Y	Y	N	Y	
L04	904h	h	Preset S-curve Pattern	11	0 to 2 0: Disable Normal accel/decel, S-curve (15 steps, S-curve 5) 1: Method 1 For VG3/VG5, accel/decel can be controlled via terminal [12] with ***SS1***, ***SS2***, and ***SS4*** all OFF. 2: Method 2 For VG7, zero speed is selected with ***SS1***, ***SS2***. Select S-curve pattern and application of multistep speed.	Y	0	Y	Y	80	Y	Y	N	Y	
L05	905h	h	S-curve Pattern 1	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L06	906h	h	S-curve Pattern 2	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L07	907h	h	S-curve Pattern 3	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L08	908h	h	S-curve Pattern 4	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L09	909h	h	S-curve Pattern 5	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L10	90Ah	h	S-curve Pattern 6	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L11	90Bh	h	S-curve Pattern 7	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L12	90Ch	h	S-curve Pattern 8	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L13	90Dh	h	S-curve Pattern 9	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L14	90Eh	h	S-curve Pattern 10	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L15	90Fh	h	Reserved for Particular Manufacturers	0	0 or 1 0: Not used. 1: Method 1	Y	0	Y	Y	80	Y	Y	N	Y	

■ U codes (User Functions)

Function code	Communica-tions address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
U01	B01h	DBh	USER P1	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U02	B02h	DCh	USER P2	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U03	B03h	DDh	USER P3	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U04	B04h	Deh	USER P4	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U05	B05h	DFh	USER P5	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U06	B06h	E0h	USER P6	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U07	B07h	E1h	USER P7	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U08	B08h	E2h	USER P8	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U09	B09h	E3h	USER P9	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U10	B0Ah	E4h	USER P10	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U11	B0Bh	h	USER P11 SX bus / E-SX Bus Communications Format	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U12	B0Ch	h	USER P12	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U13	B0Dh	h	USER P13 SX Bus Station Number Monitor	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U14	B0Eh	h	USER P14	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U15	B0Fh	h	USER P15	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U16	B10h	h	USER P16	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U17	B11h	h	USER P17	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U18	B12h	h	USER P18	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U19	B13h	h	USER P19	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U20	B14h	h	USER P20	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U21	B15h	h	USER P21	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U22	B16h	h	USER P22	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U23	B17h	h	USER P23	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U24	B18h	h	USER P24	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U25	B19h	h	USER P25	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U26	B1Ah	h	USER P26	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U27	B1Bh	h	USER P27	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U28	B1Ch	h	USER P28	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U29	B1Dh	h	USER P29	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U30	B1Eh	h	USER P30	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U31	B1Fh	h	USER P31	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U32	B20h	h	USER P32	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U33	B21h	h	USER P33	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U34	B22h	h	USER P34	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U35	B23h	h	USER P35	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U36	B24h	h	USER P36	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U37	B25h	h	USER P37	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U38	B26h	h	USER P38	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U39	B27h	h	USER P39	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U40	B28h	h	USER P40	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U41	B29h	h	USER P41	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U42	B2Ah	h	USER P42	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U43	B2Bh	h	USER P43	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U44	B2Ch	h	USER P44	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U45	B2Dh	h	USER P45	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U46	B2Eh	h	USER P46	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U47	B2Fh	h	USER P47	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U48	B30h	h	USER P48	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U49	B31h	h	USER P49	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U50	B32h	h	USER P50	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U51	B33h	h	USER P51	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U52	B34h	h	USER P52	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U53	B35h	h	USER P53	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U54	B36h	h	USER P54	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U55	B37h	h	USER P55	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U56	B38h	h	USER P56	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U57	B39h	h	USER P57	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U58	B3Ah	h	USER P58	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U59	B3Bh	h	USER P59	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U60	B3Ch	h	USER P60	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U61	B3Dh	4Bh	USER P61/U-Ai1	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U62	B3Eh	4Ch	USER P62/U-Ai2	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U63	B3Fh	4Dh	USER P63/U-Ai3	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U64	B40h	4Eh	USER P64/U-Ai4	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	

Function code	Communica-tions address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
U101	2701h	h	USER P101	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U102	2702h	h	USER P102	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U103	2703h	h	USER P103	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U104	2704h	h	USER P104	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U105	2705h	h	USER P105	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U106	2706h	h	USER P106	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U107	2707h	h	USER P107	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U108	2708h	h	USER P108	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U109	2709h	h	USER P109	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U110	270Ah	h	USER P110	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U111	270Bh	h	USER P111	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U112	270Ch	h	USER P112	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U113	270Dh	h	USER P113	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U114	270Eh	h	USER P114	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U115	270Fh	h	USER P115	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U116	2710h	h	USER P116	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U117	2711h	h	USER P117	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U118	2712h	h	USER P118	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U119	2713h	h	USER P119	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U120	2714h	h	USER P120	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U121	2715h	h	USER P121	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U122	2716h	h	USER P122	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U123	2717h	h	USER P123	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U124	2718h	h	USER P124	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U125	2719h	h	USER P125	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U126	271Ah	h	USER P126	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U127	271Bh	h	USER P127	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U128	271Ch	h	USER P128	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U129	271Dh	h	USER P129	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U130	271Eh	h	USER P130	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U131	271Fh	h	USER P131	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U132	2720h	h	USER P132	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U133	2721h	h	USER P133	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U134	2722h	h	USER P134	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U135	2723h	h	USER P135	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U136	2724h	h	USER P136	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U137	2725h	h	USER P137	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U138	2726h	h	USER P138	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U139	2727h	h	USER P139	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U140	2728h	h	USER P140	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U141	2729h	h	USER P141	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U142	272Ah	h	USER P142	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U143	272Bh	h	USER P143	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U144	272Ch	h	USER P144	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U145	272Dh	h	USER P145	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U146	272Eh	h	USER P146	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U147	272Fh	h	USER P147	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U148	2730h	h	USER P148	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U149	2731h	h	USER P149	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U150	2732h	h	USER P150	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	

■ SF codes (Safety Functions)

Function code	Communications address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
SF01	2801h	h	SS1 Level	0	0 to 30000 r/m	N	150	N	N	0	Y	Y	Y	Y	
SF02	2802h	h	SS1 Timer	0	0.01 to 3600 s	N	10.00	N	N	13	Y	Y	Y	Y	
SF03	2803h	h	SS1/SLS Deceleration Time	0	0.01 to 3600 s	N	5.00	N	N	13	Y	Y	Y	Y	
SF04	2804h	h	SLS Level	0	0 to 30000 r/m	N	300	N	N	0	Y	Y	Y	Y	
SF05	2805h	h	SLS Timer	0	0.01 to 3600 s	N	10.00	N	N	13	Y	Y	Y	Y	
SF06	2806h	h	SLS Upper Limit	0	0 to 30000 r/m	N	300	N	N	0	Y	Y	Y	Y	
SF07	2807h	h	Maximum Speed	0	0 to 30000 r/m	N	1500	N	N	0	Y	Y	Y	Y	
SF08	2808h	h	Upper Limit Monitor Wait Time	0	0.00 to 3600 s	N	0.00	N	N	13	Y	Y	Y	Y	
SF09	2809h	h	PG Breakdown Detection	0	0 or 1 0: Disable 1: Enable	N	1	N	N	68	Y	Y	Y	Y	
SF10	280Ah	h	PG Pulse Resolution	0	100 to 60000	N	1024	N	N	0	Y	N	N	Y	
SF11	280Bh	h	Speed Detection Filter	0	0.000 to 0.100 s	N	0.010	N	N	4	Y	Y	N	Y	
SF20	2814h	h	Terminal [SL1]/[SL2] Function	0	0 to 2 0: No function 1: SS1 function 2: SLS function	N	0	N	N	219	Y	Y	Y	Y	
SF21	2815h	h	SS1 Stop Mode	0	0 or 1 0: Speed monitor 1: Time monitor	N	1	N	N	220	Y	Y	Y	Y	
SF22	2816h	h	Encoder Selection	0	0 to 2 0: Recommended 15V encoder 1: Recommended 12V encoder 2: Unrecommended PE or no PE	N	0	N	N	221	Y	N	N	Y	
SF23	2817h	h	Fault Reaction Selection	0	0 or 1 0: STO 1: SS1	N	0	N	N	222	Y	Y	Y	Y	
SF24	2818h	h	SBC Function Selection	0	0 to 2 0: Disable 1: Enable, Via magnetic contactor 2: Enable, Brake direct connection	N	0	N	N	224	Y	Y	Y	Y	
SF25	2819h	h	SS1 Error Processing	0	0 to 1 0: Select fault reaction 1: Select notice	N	0	N	N	223	Y	Y	Y	Y	
SF26	281Ah	h	SLS Deceleration Error Processing	0	0 to 1 0: Select fault reaction 1: Select notice	N	0	N	N	223	Y	Y	Y	Y	
SF27	281Bh	h	SLS Upper Limit Error Processing	0	0 to 1 0: Select fault reaction 1: Select notice	N	0	N	N	223	Y	Y	Y	Y	
SF28	281Ch	h	Full Save of Safety Parameters	0	0 or 1	N	-	N	N	0	Y	Y	Y	Y	
SF30	281Eh	h	Password Authentication (1)	0	0000 to FFFF	N	0	N	N	9	Y	Y	Y	Y	
SF31	281Fh	h	Password Authentication (2)	0	0000 to FFFF	N	0	N	N	9	Y	Y	Y	Y	

■ S codes (Serial Communication Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
S01	701h	1h	Reference Frequency/Speed 1	7	-20000 to 20000 : (data)*Nmax/20000 r/min	Y	-	N	N	5	Y	Y	Y	Y	
S02	702h	2h	Torque Command	1	-327.68 to 327.67% : 0.01%/1d	Y	-	N	N	7	Y	Y	N	Y	
S03	703h	3h	Torque Current Command	1	-327.68 to 327.67% : 0.01%/1d	Y	-	N	N	7	Y	Y	N	Y	
S04	704h	4h	Magnetic-flux Command	1	-327.68 to 327.67% : 0.01%/1d	Y	-	N	N	7	Y	N	N	N	
S05	705h	5h	Orientation Position Command	1	0000 to FFFF	Y	-	N	N	9	Y	N	N	Y	
S06	706h	6h	Run Command 1	1	0000 to FFFF	Y	-	N	N	32	Y	Y	Y	Y	
S07	707h	7h	Universal Do	1	0000 to FFFF	Y	-	N	N	33	Y	Y	Y	Y	
S08	708h	8h	Acceleration Time	2	0.0 to 3600.0 s	Y	-	N	N	2	Y	Y	Y	Y	
S09	709h	9h	Deceleration Time	1	0.0 to 3600.0 s	Y	-	N	N	2	Y	Y	Y	Y	
S10	70Ah	Ah	Torque Limiter Level 1	2	-327.68 to 327.67% : 0.01%/1d	Y	-	N	N	7	Y	Y	N	Y	
S11	70Bh	Bh	Torque Limiter Level 2	1	-327.68 to 327.67% : 0.01%/1d	Y	-	N	N	7	Y	Y	N	Y	
S12	70Ch	Ch	Run Command 2	0	0000 to FFFF	Y	-	N	N	9	Y	Y	Y	Y	
S13	70Dh	h	Universal Ao	0	-16384 to 16384 (-10V to +10V)	Y	-	N	N	5	Y	Y	Y	Y	
S14	70Eh	h	Reference Speed (31 bits) Upper (Available soon)	0	0000 to FFFF r/min ±Maximum speed / ±Upper 16 bits out of 31 bits	Y	-	N	N	9	Y	Y	Y	Y	
S15	70Fh	h	Reference Speed (31 bits) Lower (Available soon)	0	0000 to FFFF r/min ±Maximum speed / ±Lower 16 bits out of 31 bits	Y	-	N	N	9	Y	Y	Y	Y	
S16	710h	h	General-purpose Setting 1 (Available soon)	0	-32768 to 32767 Assign functions using E90.	Y	-	N	N	5	Y	Y	Y	Y	
S17	711h	h	General-purpose Setting 2 (Available soon)	0	-32768 to 32767 Assign functions using E91.	Y	-	N	N	5	Y	Y	Y	Y	

■ M codes (Monitoring Functions)

Function code	Communications address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
M01	801h	Fh	Reference Speed 4 (ASR input)	15	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M02	802h	10h	Torque Command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	Y	
M03	803h	11h	Torque Current Command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	Y	
M04	804h	12h	Magnetic-flux Command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	N	
M05	805h	13h	Output Frequency Command	1	0.1 Hz/1d	N	-	N	N	2	Y	Y	Y	Y	
M06	806h	14h	Detected Speed	1	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	N	Y	
M07	807h	15h	Calculated Torque	1	0.01%/1d	N	-	N	N	7	Y	Y	Y	Y	
M08	808h	16h	Calculated Torque Current	1	0.01%/1d	N	-	N	N	7	Y	Y	Y	Y	
M09	809h	17h	Output Frequency	1	0.1 Hz/1d	N	-	N	N	2	Y	Y	Y	Y	
M10	80Ah	18h	Motor Output	1	0.1 kW/1d	N	-	N	N	2	Y	Y	Y	Y	
M11	80Bh	19h	Effective Output Current	1	0.1 A/1d	N	-	N	N	2	Y	Y	Y	Y	
M12	80Ch	1Ah	Effective Output Voltage	1	0.1 V/1d	N	-	N	N	2	Y	Y	Y	Y	
M13	80Dh	1Bh	Final Run Command	1	0000 to FFFF	N	-	N	N	32	Y	Y	Y	Y	
M14	80Eh	1Ch	Running Status	1	0000 to FFFF	N	-	N	N	21	Y	Y	Y	Y	
M15	80Fh	1Dh	Output Terminals Y1-Y18	1	0000 to FFFF	N	-	N	N	33	Y	Y	Y	Y	
M16	810h	1Eh	Latest Alarm Data (Multiple alarm, Trip cause)	4	0000 to 552F	N	-	N	N	14	Y	Y	Y	Y	
M17	811h	1Fh	Latest Alarm History	1	0000 to 552F	N	-	N	N	15	Y	Y	Y	Y	
M18	812h	20h	1st Last Alarm History	1	0000 to 552F	N	-	N	N	15	Y	Y	Y	Y	
M19	813h	21h	2nd Last Alarm History	1	0000 to 552F	N	-	N	N	15	Y	Y	Y	Y	
M20	814h	22h	Cumulative Run Time	7	0 to 65535 h	N	-	N	N	0	Y	Y	Y	Y	
M21	815h	23h	DC Link Bus Voltage	1	1 V/1d	N	-	N	N	0	Y	Y	Y	Y	
M22	816h	24h	Motor Temperature	1	1°C/1d	N	-	N	N	5	Y	Y	Y	Y	
M23	817h	25h	Model Code	1	0000 to FFFF 200V class series : 1313h 400V class series : 1314h	N	-	N	N	29	Y	Y	Y	Y	
M24	818h	26h	Capacity Code	1	0 to 34	N	-	N	N	28	Y	Y	Y	Y	
M25	819h	27h	Inverter ROM (Main Control) Version	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M26	81Ah	28h	Communications Error Code	1	0 to 65535	N	-	N	N	34	Y	Y	Y	Y	
M27	81Bh	29h	Alarm (Latest) Speed Command	19	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M28	81Ch	2Ah	Alarm (Latest) Torque Command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	Y	
M29	81Dh	2Bh	Alarm (Latest) Torque Current Command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	Y	
M30	81Eh	2Ch	Alarm (Latest) Magnetic-flux command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	N	
M31	81Fh	2Dh	Alarm (Latest) Output Frequency Command	1	0.1 Hz/1d	N	-	N	N	2	Y	Y	Y	Y	
M32	820h	2Eh	Alarm (Latest) Detected Speed	1	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	N	Y	
M33	821h	2Fh	Alarm (Latest) Calculated Torque	1	0.01%/1d	N	-	N	N	7	Y	Y	Y	Y	
M34	822h	30h	Alarm (Latest) Calculated Torque Current	1	0.01%/1d	N	-	N	N	7	Y	Y	Y	Y	
M35	823h	31h	Alarm (Latest) Output Frequency	1	0.1 Hz/1d	N	-	N	N	2	Y	Y	Y	Y	
M36	824h	32h	Alarm (Latest) Motor Output	1	0.1 kW/1d	N	-	N	N	2	Y	Y	Y	Y	
M37	825h	33h	Alarm (Latest) Effective Output Current	1	0.1 A/1d	N	-	N	N	2	Y	Y	Y	Y	
M38	826h	34h	Alarm (Latest) Effective Output Voltage	1	0.1 V/1d	N	-	N	N	2	Y	Y	Y	Y	
M39	827h	35h	Alarm (Latest) Run Command	1	0000 to FFFF	N	-	N	N	32	Y	Y	Y	Y	
M40	828h	36h	Alarm (Latest) Running Status	1	0000 to FFFF	N	-	N	N	21	Y	Y	Y	Y	
M41	829h	37h	Alarm (Latest) Output Signal	1	0000 to FFFF	N	-	N	N	33	Y	Y	Y	Y	
M42	82Ah	38h	Alarm (Latest) Cumulative Run Time	1	0 to 65535 h	N	-	N	N	0	Y	Y	Y	Y	
M43	82Bh	39h	Alarm (Latest) DC Link Bus Voltage	1	1 V/1d	N	-	N	N	0	Y	Y	Y	Y	
M44	82Ch	3Ah	Alarm (Latest) Inverter Internal Temperature	1	1°C/1d	N	-	N	N	5	Y	Y	Y	Y	
M45	82Dh	3Bh	Alarm (Latest) Heat Sink Temperature	1	1°C/1d	N	-	N	N	5	Y	Y	Y	Y	
M46	82Eh	3Ch	Capacity of Main Circuit Capacitor	3	0 to 100%	N	-	N	N	0	Y	Y	Y	Y	
M47	82Fh	3Dh	Service Life of Electrolytic Capacitor on PCB	1	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	
M48	830h	3Eh	Cooling Fan Service Life	1	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
M49	831h	3Fh	Reference Speed 1 (before multistep speed command)	3	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M50	832h	40h	Reference Speed 2 (before calculation of acceleration/deceleration)	1	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M51	833h	41h	Reference Speed 3 (after speed limiting)	1	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M52	834h	42h	Control Output 1	3	0000 to FFFF	N	-	N	N	125	Y	Y	Y	Y	
M53	835h	43h	Control Output 2	1	0000 to FFFF	N	-	N	N	126	Y	Y	Y	Y	
M54	836h	44h	Control Output 3	1	0000 to FFFF	N	-	N	N	127	Y	Y	Y	Y	
M55	837h	45h	Option Monitor 1	6	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M56	838h	46h	Option Monitor 2	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M57	839h	47h	Option Monitor 3	1	0 to 65535	N	-	N	N	0	Y	Y	Y	Y	
M58	83Ah	48h	Option Monitor 4	1	0 to 65535	N	-	N	N	0	Y	Y	Y	Y	
M59	83Bh	49h	Option Monitor 5	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M60	83Ch	4Ah	Option Monitor 6	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M61	83Dh	h	Current Date, Year/Month	3	0000 to FFFF Upper 2 digits: Year, Lower 2 digits: Month	N	-	N	N	143	Y	Y	Y	Y	
M62	83Eh	h	Current Date, Day/Hour	1	0000 to FFFF Upper 2 digits: Day, Lower 2 digits: Hour	N	-	N	N	144	Y	Y	Y	Y	
M63	83Fh	h	Current Date, Minute/Second	1	0000 to FFFF Upper 2 digits: Minute, Lower 2 digits: Second	N	-	N	N	145	Y	Y	Y	Y	
M64	840h	h	Date of Occurrence of Latest Alarm, Year/Month	3	0000 to FFFF Upper 2 digits: Year, Lower 2 digits: Month	N	-	N	N	143	Y	Y	Y	Y	
M65	841h	h	Date of Occurrence of Latest Alarm, Day/Hour	1	0000 to FFFF Upper 2 digits: Day, Lower 2 digits: Hour	N	-	N	N	144	Y	Y	Y	Y	
M66	842h	h	Date of Occurrence of Latest Alarm, Minute/Second	1	0000 to FFFF Upper 2 digits: Minute, Lower 2 digits: Second	N	-	N	N	145	Y	Y	Y	Y	
M67	843h	h	Date of Removal of Latest Alarm, Year/Month	3	0000 to FFFF Upper 2 digits: Year, Lower 2 digits: Month	N	-	N	N	143	Y	Y	Y	Y	
M68	844h	h	Date of Removal of Latest Alarm, Day/Hour	1	0000 to FFFF Upper 2 digits: Day, Lower 2 digits: Hour	N	-	N	N	144	Y	Y	Y	Y	
M69	845h	h	Date of Removal of Latest Alarm, Minute/Second	1	0000 to FFFF Upper 2 digits: Minute, Lower 2 digits: Second	N	-	N	N	145	Y	Y	Y	Y	
M70	846h	h	Latest Alarm Extension ID	17	0 or 1 0: Alarm at the local station 1: Alarm at the remote station	N	-	N	N	212	Y	Y	Y	Y	
M71	847h	h	Latest Multiple Alarm, 2nd	1	0000 to FFFF	N	-	N	N	14	Y	Y	Y	Y	
M72	848h	h	Latest Multiple Alarm, 3rd	1	0000 to FFFF	N	-	N	N	14	Y	Y	Y	Y	
M73	849h	h	Latest Multiple Alarm, 4th	1	0000 to FFFF	N	-	N	N	14	Y	Y	Y	Y	
M74	84Ah	h	Latest Multiple Alarm, 5th	1	0000 to FFFF	N	-	N	N	14	Y	Y	Y	Y	
M75	84Bh	h	Latest Alarm, Subcode	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M76	84Ch	h	Latest Alarm, Maximum Speed	1	0 to 65535 r/min	N	-	N	N	0	Y	Y	Y	Y	
M77	84Dh	h	Latest Alarm, Input Power	1	0.0 to 6553.5 kW	N	-	N	N	2	Y	Y	Y	Y	
M78	84Eh	h	Latest Alarm, Motor Temperature	1	1°C/1d	N	-	N	N	5	Y	Y	Y	Y	
M79	84Fh	h	Latest Alarm, Running Status 2 (a)	1	0000 to FFFF	N	-	N	N	141	Y	Y	Y	Y	
M80	850h	h	Latest Alarm, Running Status 2 (b)	1	0000 to FFFF	N	-	N	N	142	Y	Y	Y	Y	
M81	851h	h	Latest Alarm, Run Command (Communications Link)	1	0000 to FFFF	N	-	N	N	32	Y	Y	Y	Y	
M82	852h	h	Latest Alarm, Run Command 2 (Communications Link)	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M83	853h	h	Latest Alarm, For Particular Manufacturers	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M84	854h	h	Latest Alarm, M1 Number of Startups	1	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M85	855h	h	Latest Alarm, M2 Number of Startups	1	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M86	856h	h	Latest Alarm, M3 Number of Startups	1	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M87	857h	h	Latest Alarm, EN Terminal Input	1	0000 to FFFF	N	-	N	N	100	Y	Y	Y	Y	
M91	85Bh	h	Communications Error Flag 1 (Available soon)	2	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M92	85Ch	h	Communications Error Flag 2 (Available soon)	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M93	85Dh	h	Light Alarm (Latest)	4	0 to 255	N	-	N	N	102	Y	Y	Y	Y	
M94	85Eh	h	Light Alarm (2nd last)	1	0 to 255	N	-	N	N	102	Y	Y	Y	Y	
M95	85Fh	h	Light Alarm (3rd last)	1	0 to 255	N	-	N	N	102	Y	Y	Y	Y	
M96	860h	h	Light Alarm (4th last)	1	0 to 255	N	-	N	N	102	Y	Y	Y	Y	
M98	862h	h	EN Terminal Input	0	0000 to FFFF	N	-	N	N	100	Y	Y	Y	Y	
M100	2900h	h	Effective Parameter Set Condition	0	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
M101	2901h	h	Run Command 2 (Communications Link)	0	0000 to FFFF Monitors X terminal functions to be used exclusively via the communications link.	N	-	N	N	32	Y	Y	Y	Y	
M102	2902h	h	Load Factor	0	-327.68 to 327.67% Motor load factor, Motor rated load/100%	N	-	N	N	7	Y	Y	Y	Y	
M103	2903h	h	Input Power	0	0.0 to 6553.5 kW Input power to inverter	N	-	N	N	2	Y	Y	Y	Y	
M104	2904h	h	Running Status 2(a)	0	0000 to FFFF	N	-	N	N	141	Y	Y	Y	Y	
M105	2905h	h	Running Status 2(b)	0	0000 to FFFF	N	-	N	N	142	Y	Y	Y	Y	
M106	2906h	h	Detected Load Shaft Speed	0	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M107	2907h	h	Detected Line Speed	0	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M108	2908h	h	PID Command Value	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	Y	Y	
M109	2909h	h	PID Feedback Amount	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	Y	Y	
M110	290Ah	h	PID Output	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	Y	Y	
M112	290Ch	h	Remaining allowance for M1 motor overload	3	0 to 65535% When M112 = 0 (%), the inverter issues OL1 alarm.	N	-	N	N	0	Y	Y	Y	Y	
M113	290Dh	h	Remaining allowance for M2 motor overload	1	0 to 65535% When M113 = 0 (%), the inverter issues OL2 alarm.	N	-	N	N	0	Y	Y	Y	Y	
M114	290Eh	h	Remaining allowance for M3 motor overload	1	0 to 65535% When M114 = 0 (%), the inverter issues OL3 alarm.	N	-	N	N	0	Y	Y	Y	Y	
M115	290Fh	h	Input Watt-hour	4	0.000 to 9999 100 kWh/1.000d When this count exceeds 9999000 kWh, it automatically returns to "0."	N	-	N	N	101	Y	Y	Y	Y	
M116	2910h	h	Input Watt-hour Data	1	0000 to 9999 100 kWh/1.000d * Display coefficient M116 = M115 (Input watt-hour) x F84 (Display coefficient for input watt-hour data) Specifying the electric rate per 100 kWh with F84 shows the electricity price.	N	-	N	N	101	Y	Y	Y	Y	
M117	2911h	h	Input Watt-hour (Lower 16 bits)	1	(81920d/unit 100% rating)(kW) x Cumulative time (s) x 2^(-16)	N	-	N	N	9	Y	Y	Y	Y	
M118	2912h	h	Input Watt-hour (Upper 16 bits)	1	(81920d/unit 100% rating)(kW) x Cumulative time (s) x 2^(-32)	N	-	N	N	9	Y	Y	Y	Y	
M119	2913h	h	Inverter Internal Temperature (Real-time value)	2	-32768 to 32767℃	N	-	N	N	5	Y	Y	Y	Y	
M120	2914h	h	Heat Sink Temperature (Real-time value)	1	-32768 to 32767℃	N	-	N	N	5	Y	Y	Y	Y	
M121	2915h	h	Main Circuit Capacitor Service Life (Elapsed time)	0	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	
M123	2917h	h	M1 Number of Startups	3	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M124	2918h	h	M2 Number of Startups	1	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M125	2919h	h	M3 Number of Startups	1	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M126	291Ah	h	M1 Cumulative Motor Run Time	3	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	
M127	291Bh	h	M2 Cumulative Motor Run Time	1	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	
M128	291Ch	h	M3 Cumulative Motor Run Time	1	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	
M129	291Dh	h	Run Command (Via communications link)	0	0000 to FFFF	N	-	N	N	32	Y	Y	Y	Y	
M130	291Eh	h	Torque Bias	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	N	Y	
M131	291Fh	h	Magnetic Pole Position Signal	0	-32768 to 32767	N	-	N	N	5	N	N	N	Y	
M132	2920h	h	Universal AO1	0	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M133	2921h	h	Option AO1	0	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M134	2922h	h	Control Input 1	0	0000 to FFFF	N	-	N	N	133	Y	Y	Y	Y	
M135	2923h	h	Control Input 2	0	0000 to FFFF	N	-	N	N	134	Y	Y	Y	Y	
M136	2924h	h	Control Input 3	0	0000 to FFFF	N	-	N	N	135	Y	Y	Y	Y	
M137	2925h	h	Control Input 4	0	0000 to FFFF	N	-	N	N	136	Y	Y	Y	Y	
M138	2926h	h	Control Input 5	0	0000 to FFFF	N	-	N	N	137	Y	Y	Y	Y	
M139	2927h	h	Control Input 6	0	0000 to FFFF	N	-	N	N	138	Y	Y	Y	Y	
M140	2928h	h	Control Input 7	0	0000 to FFFF	N	-	N	N	139	Y	Y	Y	Y	
M141	2929h	h	Control Input 8	0	0000 to FFFF	N	-	N	N	140	Y	Y	Y	Y	
M142	292Ah	h	Control Output 4	0	0000 to FFFF (bit 0: E-SX bus tact synchronizing signal)	N	-	N	N	128	Y	Y	Y	Y	
M143	292Bh	h	Control Output 5	0	0000 to FFFF	N	-	N	N	129	Y	Y	Y	Y	
M144	292Ch	h	Control Output 6	0	0000 to FFFF	N	-	N	N	130	Y	Y	Y	Y	
M146	292Eh	h	Detected Speed 2	0	-32000 to 32000 r/min	N	-	N	N	5	Y	Y	N	Y	
M147	292Fh	h	Exciting Current Command	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	N	N	
M148	2930h	h	Detected Exciting Current	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	N	N	
M149	2931h	h	Magnetic-flux Calculation	0	0.00 to 655.35%	N	-	N	N	3	Y	Y	N	N	
M161	293Dh	h	Ai Adjustment Value (12)	5	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M162	293Eh	h	Ai Adjustment Value (Ai1)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M163	293Fh	h	Ai Adjustment Value (Ai2)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M164	2940h	h	Ai Adjustment Value (Ai3)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M165	2941h	h	Ai Adjustment Value (Ai4)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
M166	2942h	h	Input Signal (Terminal)	0	0000 to FFFF	N	-	N	N	32	Y	Y	Y	Y	
M167	2943h	h	Analog Input Signal (12)	3	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M168	2944h	h	Analog Input Signal (Ai1)	1	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M169	2945h	h	Analog Input Signal (Ai2)	1	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M170	2946h	h	Analog Output Signal (Ao1)	3	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M171	2947h	h	Analog Output Signal (Ao2)	1	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M172	2948h	h	Analog Output Signal (Ao3)	1	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M173	2949h	h	AIO Input/Output Status 1(Ai3)	4	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M174	294Ah	h	AIO Input/Output Status 1(Ai4)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M175	294Bh	h	AIO Input/Output Status 2(Ao4)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M176	294Ch	h	AIO Input/Output Status 2(Ao5)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M177	294Dh	h	PG(SD) Input Pulse	4	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M178	294Eh	h	PG(LD) Input Pulse	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M179	294Fh	h	PG(PR) Input Pulse	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M180	2950h	h	PG(PD) Input Pulse	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M181	2951h	h	DIOA Input Status (Terminal)	0	0000 to FFFF	N	-	N	N	146	Y	Y	Y	Y	
M182	2952h	h	DIOA Input Status (Via communications link)	0	0000 to FFFF	N	-	N	N	146	Y	Y	Y	Y	
M183	2953h	h	DIOB Option Input Status (Available soon)	0	0000 to FFFF	N	-	N	N	26	Y	Y	Y	Y	
M184	2954h	h	DIOB Option Output Status (Available soon)	0	0000 to FFFF	N	-	N	N	27	Y	Y	Y	Y	
M193	295Dh	h	General-purpose Setting 1 Monitor (Available soon)	0	-32768 to 32767 Monitors the S16 setting.	N	-	N	N	5	Y	Y	Y	Y	
M194	295Eh	h	General-purpose Setting 2 Monitor (Available soon)	0	-32768 to 32767 Monitors the S17 setting.	N	-	N	N	5	Y	Y	Y	Y	
M220	2A14h	h	Load Compensating Speed Control Value	3	-32000 to 32000: (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	N	Y	
M221	2A15h	h	Hoisting Load Calculation Result Monitor	1	0 to 65535 kg	N	-	N	N	0	Y	Y	N	Y	
M222	2A16h	h	Travel Torque Calculation Monitor	1	-327.68 to 327.67%	N	-	N	N	7	Y	Y	N	Y	

4.2.4 Data Format List

You can use the following formats to access function codes through the link and these formats are common to the FRENIC-VG.

4.2.4.1 Data Type 0 to 13

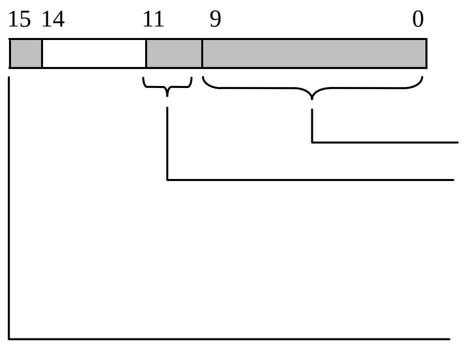
You can basically exchange data in the data types from 0 to 13.

Code	Description	Display/setting	Resolution	Notes
º0	Integer	0, 1, 2, 3, ...	1	
º1	Integer	0, 2, 4, 6, ...	2	Only for pole number of motor
º2		0.0, 0.1, 0.2, ...	0.1	
º3	Fixed point	0.00, 0.01, 0.02, ...	0.01	
º4		0.001, 0.002, 0.003, ...	0.001	
º5	Integer (signed)	-2, -1, 0, 1, 2, ...	1	
º6		-0.1, 0.0, 0.1, ...	0.1	
º7	Fixed point (signed)	-0.01, 0.00, 0.01, ...	0.01	
º8		-0.001, 0.000, 0.001, ...	0.001	
º9	Hexadecimal	1A8E	1h	Initial cursor position is left end. Cursor does not move automatically. When setting range is from 00 to 11, you should specify individual digits to set only 00, 01, 10, or 11.
10	Special data 3	0.75,1,2, ... 14,15		Carrier frequency setting
11	Operation data		1	Reset to 0 after writing
12	Exponent/mantissa 1		0.01	
13	Exponent/mantissa 2		0.01	

4.2.4.2 Data Type 12 to 145

The following data have special formats.

Type [12]: Time, current, power, PID process values



Mantissa Exponent = 0: 0 to 999, Exponent = 1 to 3: 100 to 999

Exponent 0: 0.01 times (0.00 to 9.99)

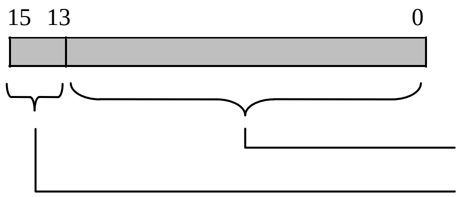
1: 0.1 times (10.0 to 99.9)

2: 1 times (100 to 999)

3: 10 times (1000 to 9990)

Polarity 0: Positive (+), 1: Negative (-)

Type [13]: Current and others



Mantissa Exponent = 0: 0 to 9999, Exponent = 1, 2, 3: 1000 to 9999

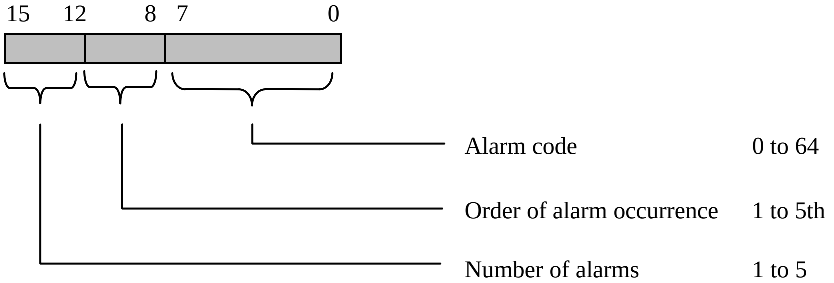
Exponent 0: 0.01 times (0.00 to 99.99)

1: 0.1 times (100.0 to 999.9)

2: 1 times (1000 to 9999)

3: 10 times (10000 to 99990)

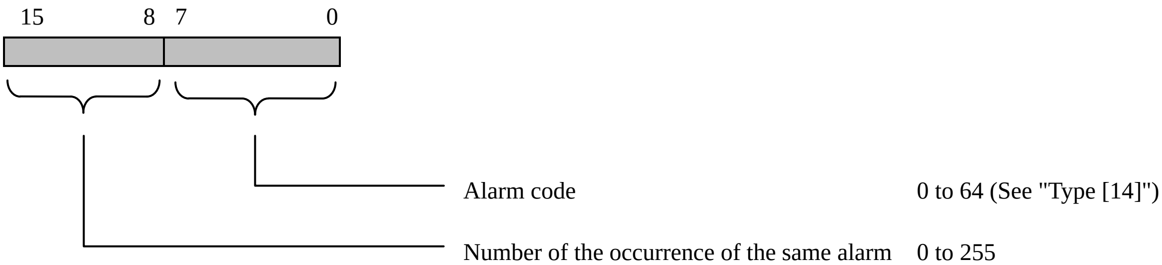
Type [14]: Cause of alarm



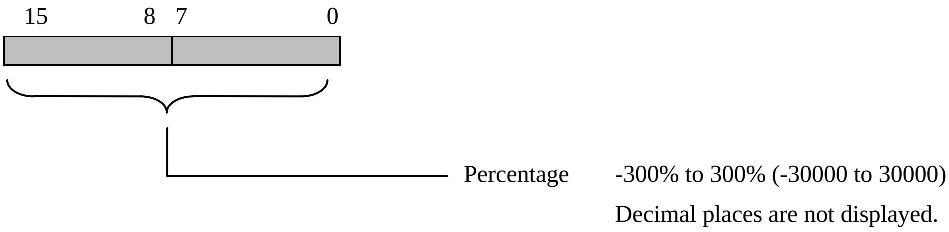
Alarm codes

Code	Display	Description	Code	Display	Description	Code	Display	Description
0	- - -	No alarm	22	OH2	External alarm	44	Ar-C	Error code C for specific user application
1	- - -	IPM error	23	OH3	Inverter internal overheat	45	Ar-d	Error code D for specific user application
2	dbH	Braking resistor overheated	24	OH4	Motor overheat	46	Ar-E	Error code E for specific user application
3	dCF	DC fuse blown	25	OL1	Motor 1 overload	47	Ar-F	Error code F for specific user application
4	dO	Excessive positioning deviation	26	OL2	Motor 2 overload	48	dbA	Braking transistor broken
5	EF	Ground fault	27	OL3	Motor 3 overload	49	ECF	ENABLE circuit (safety stop circuit) failure
6	Er-1	Memory error	28	OLU	Inverter overload	50	Er-H	Hardware error
7	Er-2	Keypad communications error	29	OS	Overspeed	51	Er-r	Mock alarm
8	Er-3	CPU error	30	OU	Overvoltage	52	LoC	Start delay
9	Er-4	Network error	31	PbF	Charger circuit fault	53	dFA	DC fan locked
10	Er-5	RS-485 communications error	32	PG	PG wire break	54	Et1	PG failure
11	Er-6	Operation error	33	Ar-1	Error code 1 for specific user application	55	- - -	No alarm
12	Er-7	Output wiring fault	34	Ar-2	Error code 2 for specific user application	56	EC	PG communication error
13	Er-8	A/D converter error	35	Ar-3	Error code 3 for specific user application	57	- - -	No alarm
14	Er-9	Speed not agreed	36	Ar-4	Error code 4 for specific user application	58	- - -	No alarm
15	Er-A	UPAC error	37	Ar-5	Error code 5 for specific user application	59	- - -	No alarm
16	Er-b	Inter-inverter communications link error	38	Ar-6	Error code 6 for specific user application	60	- - -	No alarm
17	Lin	Power supply phase loss	39	Ar-7	Error code 7 for specific user application	61	OPL	Output phase loss
18	LU	Undervoltage	40	Ar-8	Error code 8 for specific user application	62		
19	nrb	NTC thermistor wire break error	41	Ar-9	Error code 9 for specific user application	63		
20	OC	Overcurrent	42	Ar-A	Error code A for specific user application	64	- - -	No alarm
21	OH1	Heat sink overheat	43	Ar-b	Error code B for specific user application			

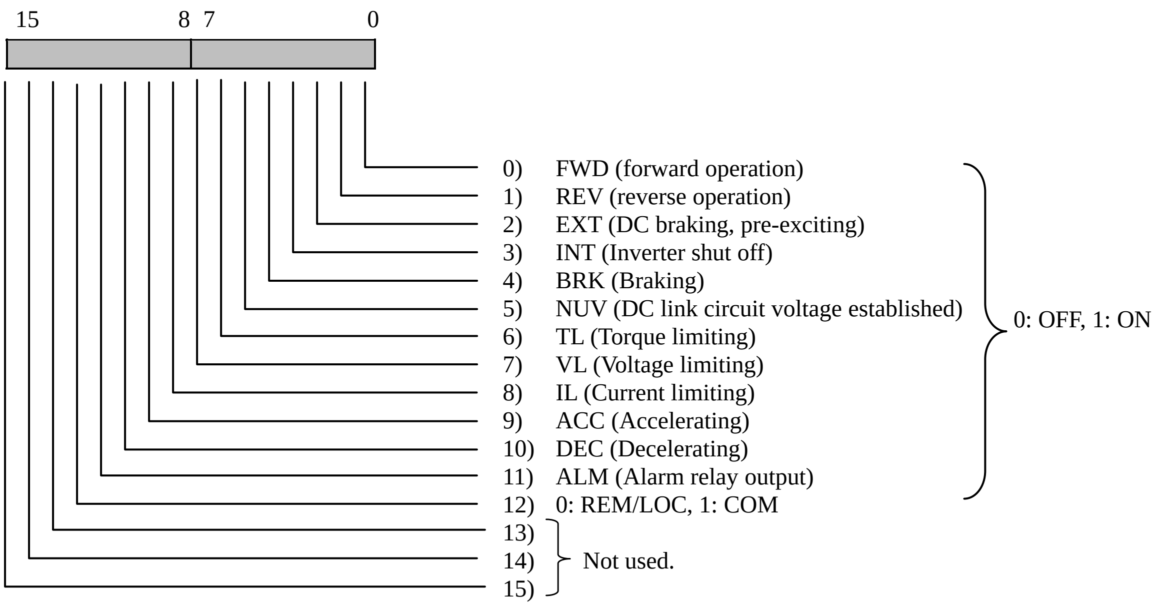
Type [15]: Alarm history



Type [16]: Percentage

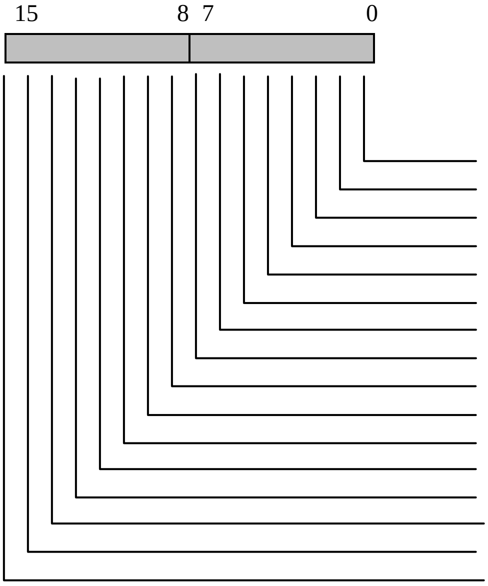


Type [21]: Operation status



Type [26]: DIOB option input state

Type [27]: DIOB option output state



Bit	[26] Input state	[27] Output state
0)	X21,	Y21
1)	X22,	Y22
2)	X23,	Y23
3)	X24,	Y24
4)	X25,	Y25
5)	X26,	Y26
6)	X27,	Y27
7)	X28,	Y28
8)	X29,	Y29
9)	X30,	Y30
10)	X31	
11)	X32	
12)	X33	
13)	X34	
14)	X35	
15)	X36	

0: OFF, 1: ON

Type [28]: Inverter capacity

Code	Inverter capacity	Code	Inverter capacity	Code	Inverter capacity	Code	Inverter capacity	Code	Inverter capacity
0	0.05	8	5.5	16	45	24	220	32	630
1	0.1	9	7.5	17	55	25	250	33	710
2	0.2	10	11	18	75	26	280	34	800
3	0.4	11	15	19	90	27	315		
4	0.75	12	18.5	20	110	28	355		
5	1.5	13	22	21	132	29	400		
6	2.2	14	30	22	160	30	OTHER		
7	3.7	15	37	23	200	31	500		

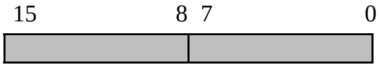
Type [29]: Inverter model (common to entire FUJI inverter system)

The number is fixed to 1313h or 1314h for the FRENIC-VG.

200 V system: fixed to 1313h

400 V system: fixed to 1314h

Type [31]: Speed



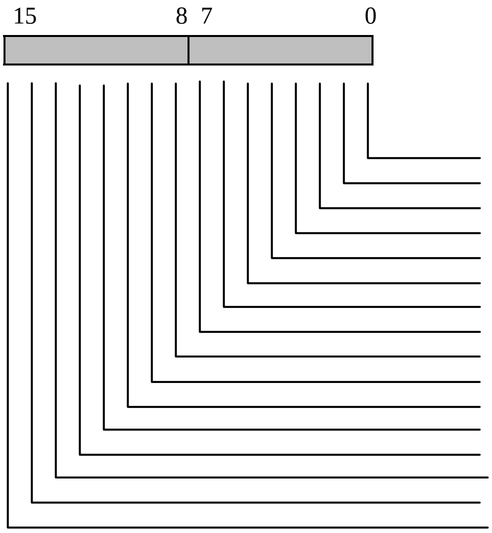
Data (0 to ±20,000) → (0 to ±24,000 × r/min): (Data) × Nmax/20,000 conversion

(Example) When the maximum speed is Nmax = 1,500 r/min,

- If you want to direct a speed command of 1,000 r/min,
  Specify a data of $\frac{1,000}{1,500} \times 20,000 \rightarrow \underline{13,333}$
- If the read out data is 3,500,
  You can determine the speed is $\frac{1,500}{20,000} \times 3,500 \rightarrow 262.5$ r/min

Type [32]: Operation commands, [33]: Y1 to Y18

This type is the same as S06 and S07.



Bit	[32]	[33]
0)	FWD (forward operation command)	Y1
1)	REV (reverse operation command)	Y2
2)	X1	Y3
3)	X2	Y4
4)	X3	Y5A
5)	X4	Not used.
6)	X5	Not used.
7)	X6	Not used.
8)	X7	Y11
9)	X8	Y12
10)	X9	Y13
11)	X11	Y14
12)	X12	Y15
13)	X13	Y16
14)	X14	Y17
15)	RST (RESET command)	Y18

0: OFF, 1: ON

Chap. 4 CONTROL AND OPERATION

Type [34]: Communication error codes

15 … 8	7 … 0

Description of alarms in the communication through the link (RS-485, T-Link, SX-bus, E-SX bus). The following data is set to the monitor data M26 according to the communication status. The codes listed in the column "KEYPAD panel display" is displayed on the KEYPAD panel as a communication error .

Code	KEYPAD panel display	Communication error name	Description	
0	-	No communication error	Normal communication A data is written to an unused address of the function code (writing to address out of the specified range is defined separately). Data is read from missing function code address in the middle of continuous read. The data will be "0000". Writing to the S area while link operation is disabled. The data will not be reflected and cause no error. A data out of range is written to the S area. The data is written after adjusted to the upper or the lower limit. Access from another link or the KEYPAD panel occurs during data writing (EEPROM other than the S area is accessed). Writing to operation data (such as tuning or initialization) during multiple function codes are being written once through the link. The inverter decides that the procedure is canceled and continues the writing. Writing to/reading from option function codes that are not displayed on the KEYPAD panel.	
1 to 32	-	-	-	
33 to 70	-	Not used		
71	04	Checksum error, CRC error	Software error	Checksum value or CRC value does not match.
72	05	Parity error	Hardware error	Parity does not match.
73	06	Others (such as overrun, framing)		Physical (reception) errors other than above.
74	01	Format error	Incorrect format. Characters requesting transmission are incorrect. Characters terminating transmission are not in the specified order.	
75	01	Command error	Codes other than the specified commands are transmitted.	
76	07	Link priority error	Writing to the S area through RS-485 while a link option is installed. Writing to the S area through a link with lower priority while multiple link options are installed.	
77	07	No right to write function code data	Not used	
78	02	Function code error	Access to a data out of the address range of the function codes (such as access to a data over F80). Writing data over 16 words.	
79	07	Error on writing to write-disabled data	Write-disabled function codes (Read-only data or the M area). Function codes write-disabled during operation. Writing through the link to data out of the S area in "write-disabled through link" mode. Note that F00 or "Write enable for KEYPAD" cannot protect from writing through the link. Function codes that cannot be written through the link (link function codes: H31 to 40). Writing to M1 function code (P) area when motor parameters are protected. Writing through the link in the copy mode operation of the KEYPAD panel.	
80	03	Data	Written data is out of the setting range in the area other than the S area.	
81	07	Error during writing	Another writing request comes from the same source while writing function code data (EEPROM other than the S area is accessed).	

Note: The alarm codes 1 to 32 constitute a code system specific to the FRENIC-VG different from the assignment for the general-purpose inverters.

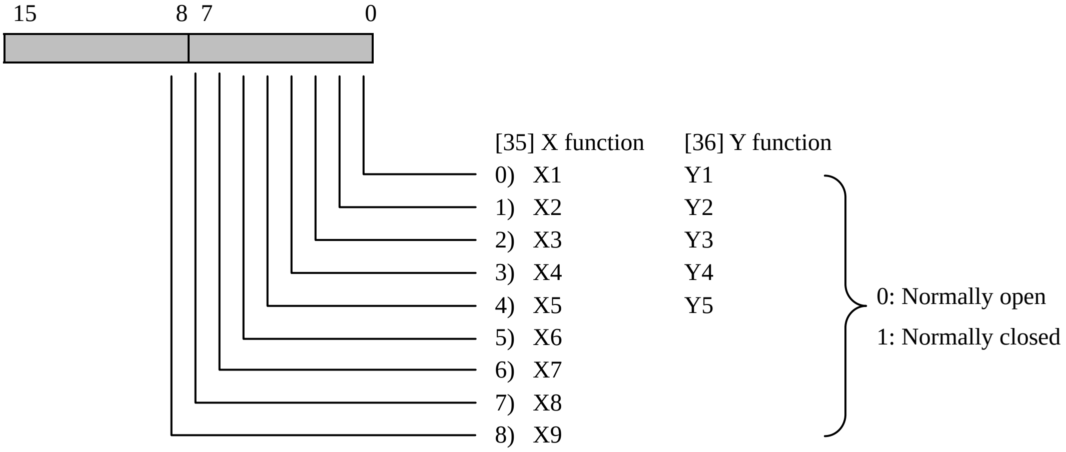
The communication error codes 71 to 81 are common to the different models. Note that some causes of alarm are specific to models.

The KEYPAD panel does not display raw communication error codes but the values in the "KEYPAD panel display" column in the table above.

The KEYPAD panel displays "＊＊" when it receives data that does not have a corresponding "KEYPAD panel display" in the table above.

Type [35]: X function normally open/closed

Type [36]: Y function normally open/closed



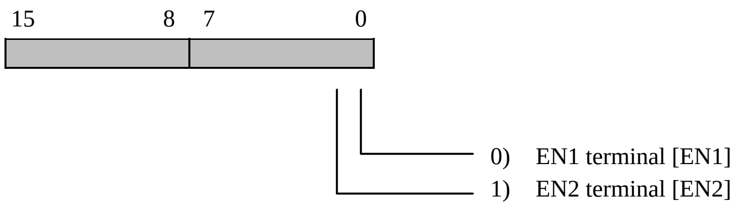
Type [40 to 99]

These types are reserved for the manufacturer. Users can considers these types as type [0] to use.

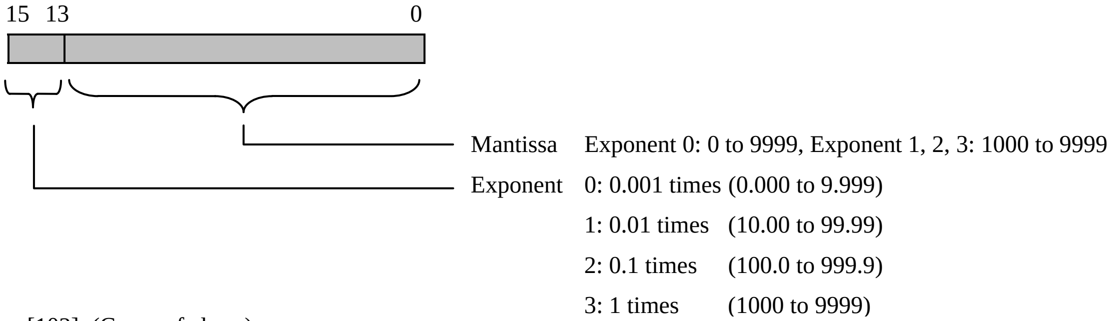
Type [82]: M1 Motor selection

Code	kW display	HP display	Code	kW display	HP display	Code	kW display	HP display
0	00: 0.75-2	00: 1-2	17	17: 3.7-4	17: 5-4	34	34: 200-4	34: 250-4
1	01: 1.5-2	01: 2-2	18	18: 5.5-4	18: 7.5-4	35	35: 220-4	35: 300-4
2	02: 2.2-2	02: 3-2	19	19: 7.5-4	19: 10-4	36	36: P-OTR	36: P-OTR
3	03: 3.7-2	03: 5-2	20	20: 11-4	20: 15-4	37	37: OTHER	37: OTHER
4	04: 5.5-2	04: 7.5-2	21	21: 15-4	21: 20-4	38	38: 30-2A	38: 40-2A
5	05: 7.5-2	05: 10-2	22	22: 18.5-4	22: 25-4	39	39: 55-2A	39: 75-2A
6	06: 11-2	06: 15-2	23	23: 22-4	23: 30-4	40	40: 75-2A	40: 100-2A
7	07: 15-2	07: 20-2	24	24: 30-4	24: 40-4	41	41: 90-2A	41: 125-2A
8	08: 18.5-2	08: 25-2	25	25: 37-4	25: 50-4	42	42: 30-4A	42: 40-4A
9	09: 22-2	09: 30-2	26	26: 45-4Y	26: 60-4Y	43	43: 55-4A	43: 75-4A
10	10: 30-2	10: 40-2	27	27: 45-4S	27: 60-4S	44	44: 75-4A	44: 100-4A
11	11: 37-2	11: 50-2	28	28: 55-4	28: 75-4	45	45: 90-4A	45: 125-4A
12	12: 45-2Y	12: 60-2Y	29	29: 75-4	29: 100-4	46	46: 110-4A	46: 150-4A
13	13: 45-2S	13: 60-2S	30	30: 90-4	30: 125-4	47	47: 132-4A	47: 175-4A
14	14: 55-2	14: 75-2	31	31: 110-4	31: 150-4	48	48: 160-4A	48: 200-4A
15	15: 75-2	15: 100-2	32	32: 132-4	32: 175-4	49	49: 200-4A	49: 250-4A
16	16: 90-2	16: 125-2	33	33: 160-4	33: 200-4	50	50: 220-4A	50: 300-4A

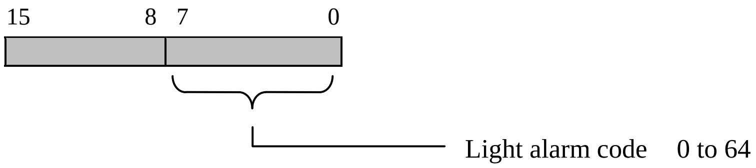
Type [100]: EN Input terminals



Type [101]: (Power)



Type [102]: (Cause of alarm)



Light alarm codes

Code	Display	Description	Code	Display	Description	Code	Display	Description
0	- - -	No alarm	30	- - -	No alarm	60	- - -	No alarm
1	- - -	No alarm	31	- - -	No alarm	61	- - -	No alarm
2	- - -	No alarm	32	- - -	No alarm	62	- - -	No alarm
3	- - -	No alarm	33	- - -	No alarm	63	- - -	No alarm
4	- - -	No alarm	34	- - -	No alarm	64	- - -	No alarm
5	- - -	No alarm	35	- - -	No alarm	65	- - -	No alarm
6	- - -	No alarm	36	- - -	No alarm	66	- - -	No alarm
7	- - -	No alarm	37	- - -	No alarm	67	- - -	No alarm
8	- - -	No alarm	38	- - -	No alarm	68	- - -	No alarm
9	Er4	Network error	39	- - -	No alarm	69	- - -	No alarm
10	Er5	RS-485 communications error	40	- - -	No alarm	70	- - -	No alarm
11	- - -	No alarm	41	- - -	No alarm	71	- - -	No alarm
12	- - -	No alarm	42	- - -	No alarm	72	- - -	No alarm
13	- - -	No alarm	43	- - -	No alarm	73	- - -	No alarm
14	Er9	Speed mismatch	44	- - -	No alarm	74	- - -	No alarm
15	- - -	No alarm	45	- - -	No alarm	75	- - -	No alarm
16	- - -	No alarm	46	ArE	E-SX bus tact synchronization error	76	- - -	No alarm
17	- - -	No alarm	47	ArF	Error code F for particular users	77	- - -	No alarm
18	- - -	No alarm	48	- - -	No alarm	78	- - -	No alarm
19	nrb	NTC thermistor wire break error	49	- - -	No alarm	79	- - -	No alarm
20	- - -	No alarm	50	- - -	No alarm	80	- - -	No alarm
21	- - -	No alarm	51	Err	Mock alarm	81	LiF	Life time early warning
22	OH2	External alarm	52	LOC	Start delay	82	OH	Heat sink overheat early warning
23	- - -	No alarm	53	dFA	DC fan locked	83	OL	Overload early warning
24	OH4	Motor overheat	54	- - -	No alarm	84	MOH	No alarm
25	OL1	Motor 1 overload (M1)	55	- - -	No alarm	85	MOL	No alarm
26	OL2	Motor 2 overload (M2)	56	- - -	No alarm	86	- - -	No alarm
27	OL3	Motor 3 overload (M3)	57	- - -	No alarm	87	BaT	Battery life expired
28	- - -	No alarm	58	- - -	No alarm	88	SnF	Safety printed circuit board light alarm (Available soon)
29	- - -	No alarm	59	- - -	No alarm			

Type [125]: Control output 1

Bits 15 … 8 | 7 … 0

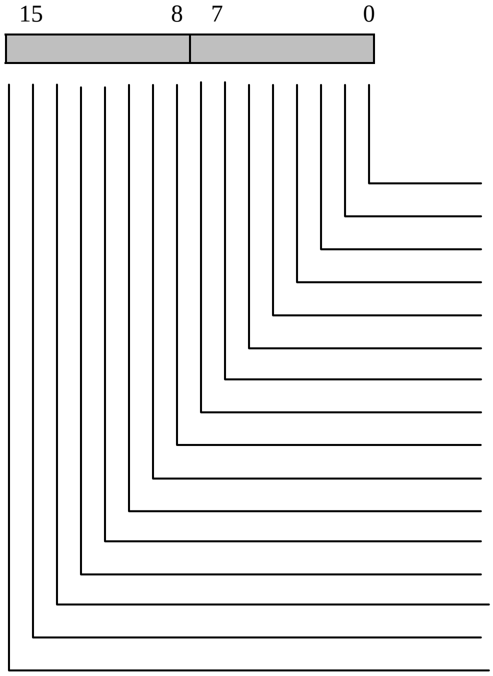
Bit	Description	Symbol
0)	Inverter running	***RUN***
1)	Speed valid	***N-EX***
2)	Speed agreement 1	***N-AG1***
3)	Speed arrival signal	***N-AR***
4)	Speed detected 1	***N-DT1***
5)	Speed detected 2	***N-DT2***
6)	Speed detected 3	***N-DT3***
7)	Undervoltage detected (Inverter stopped)	***LU***
8)	Torque polarity detected (braking/driving)	***B/D***
9)	Torque limiting	***TL***
10)	Torque detected 1	***T-DT1***
11)	Torque detected 2	***T-DT2***
12)	Keypad operation enabled	***KP***
13)	Inverter stopped	***STOP***
14)	Inverter ready to run	***RDY***
15)	Magnetic flux detected	***MF-DT***

Type [126]: Control output 2

Bits 15 … 8 | 7 … 0

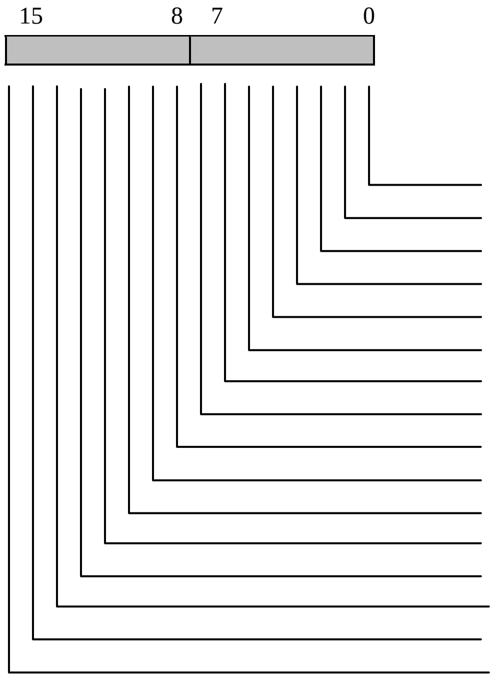
Bit	Description	Symbol
0)	Motor M2 selected	***SW-M2***
1)	Motor M3 selected	***SW-M3***
2)	Brake release signal	***BRK***
3)	Alarm content 1	***AL1***
4)	Alarm content 2	***AL2***
5)	Alarm content 4	***AL4***
6)	Alarm content 8	***AL8***
7)	Cooling fan in operation	***FAN***
8)	Resetting	***TRY***
9)	Universal DO	***U-DO***
10)	Heat sink overheat early warning	***INV-OH***
11)	Synchronization completion signal	***SY-C***
12)	Lifetime alarm	***LIFE***
13)	Under acceleration	***U-ACC***
14)	Under deceleration	***U-DEC***
15)	Inverter overload early warning	***INV-OL***

Type [127]: Control output 3



0) Motor overheat early warning ***M-OH***
1) Motor overload early warning ***M-OL***
2) DB overload early warning ***DB-OL***
3) Link transmission error ***LK-ERR***
4) In limiting under load adaptive control ***ANL***
5) In calculation under load adaptive control ***ANC***
6) Analog torque bias being held ***TBH***
7) Custom Do1 ***C-Do1***
8) Custom Do2 ***C-Do2***
9) Custom Do3 ***C-Do3***
10) Custom Do4 ***C-Do4***
11) Custom Do5 ***C-Do5***
12) Custom Do6 ***C-Do6***
13) Custom Do7 ***C-Do7***
14) Custom Do8 ***C-Do8***
15) Custom Do9 ***C-Do9***

Type [128]: Control output 4



0) Custom Do10 ***C-Do10***
1) Not used.
2) Z-phase detection completed* ***Z-RDY***
3) Multiplex system communications link being established ***MTS***
4) Answerback to cancellation of multiplex system ***MEC-AB***
5) Multiplex system master selected ***MSS***
6) Multiplex system local station failure ***AL-SF***
7) Stopped due to communications link error* ***LES***
8) Alarm output (for any alarm) ***ALM***
9) Light alarm ***L-ALM***
10) Maintenance timer ***MNT***
11) Braking transistor broken ***DBAL***
12) DC fan locked ***DCFL***
13) Speed agreement 2 ***N-AG2***
14) Speed agreement 3 ***N-AG3***
15) Axial fan stopped ***MFAN***

* Available soon

Type [129]: Control output 5

15 8 7 0

Bit	Description	Code
0)	Not used.	
1)	Not used.	
2)	Answerback to droop control enabled	***DSAB***
3)	Answerback to cancellation of torque command/torque current command	***TCL-C***
4)	Answerback to cancellation of torque limiter mode 1	***F40-AB***
5)	Not used.	-
6)	Not used.	-
7)	73 ON command	***PRT-73F***
8)	Turn ON Y-terminal test output	***Y-ON***
9)	Turn OFF Y-terminal test output	***Y-OFF***
10)	Reading absolute position of serial PG in progress*	**SPG-RD**
11)	System clock battery lifetime expired	***BATT***
12)	Magnetic position tuning in progress*	***TUN-MG***
13)	SPGT battery warning*	***SPGT-B***
14)	Electrical conditions ready*	***ERD***
15)	IT detected in operation*	***TCA***

* Available soon

Type [130]: Control output 6

15 8 7 0

Bit	Description	Code
0)	EN terminal detection circuit failure*	***DECF***
1)	EN terminal OFF*	***ENOFF***
2)	Safety function in progress*	***SF-RUN***
3)	In preparation	-
4)	In preparation	-
5)	In preparation	-
6)	In preparation	-
7)	In preparation	-
8)	In preparation	-
9)	In preparation	-
10)	In preparation	-
11)	In preparation	-
12)	In preparation	-
13)	In preparation	-
14)	In preparation	-
15)	In preparation	-

* Available soon

Type [133]: Control input 1

Bits 15 … 8 | 7 … 0

Bit	Description	Symbol
0)	Select multistep speed 1	***SS1***
1)	Select multistep speed 2	***SS2***
2)	Select multistep speed 4	***SS4***
3)	Select multistep speed 8	***SS8***
4)	Select ASR and ACC/DEC time 1	***RT1***
5)	Select ASR and ACC/DEC time 2	***RT2***
6)	Enable 3-wire operation	***HLD***
7)	Coast to a stop	***BX***
8)	Reset alarm	***RST***
9)	Enable external alarm trip	***THR***
10)	Ready for jogging	***JOG***
11)	Select speed command N2/N1	***N2/N1***
12)	Select motor 2	***M-CH2***
13)	Select motor 3	***M-CH3***
14)	Enable DC braking	***DCBRK***
15)	Clear ACC/DEC to zero	***CLR***

Type [134]: Control input 2

Bits 15 … 8 | 7 … 0

Bit	Description	Symbol
0)	Switch creep speed under UP/DOWN control	***CRP-N2/N1***
1)	UP (Increase speed)	***UP***
2)	DOWN (Decrease speed)	***DOWN***
3)	Enable data change with keypad	***WE-KP***
4)	Cancel PID control	***KP/PID***
5)	Switch normal/inverse operation	***IVS***
6)	Interlock (52-2)	***IL***
7)	Enable data change via communications link	***WE-LK***
8)	Enable communications link	***LE***
9)	Universal DI	***U-DI***
10)	Enable auto search for idling motor speed at starting	***STM***
11)	Synchronous operation command (PG (PR) optional function)	***SYC***
12)	Lock at zero speed	***LOCK***
13)	Pre-excitation	***EXITE***
14)	Cancel speed limiter	***N-LIM***
15)	Cancel H41 (Torque command)	***H41-CCL***

Type [135]: Control input 3

Bit	Function	Symbol
0)	Cancel H42 (Torque current command)	***H42-CCL***
1)	Cancel H43 (Magnetic flux command)	***H43-CCL***
2)	Cancel F40 (Torque limiter mode 1)	***F40-CCL***
3)	Select torque limiter level 2/1	***TL2/TL1***
4)	Bypass ACC/DEC processor	***BPS***
5)	Select torque bias command 1	***TB1***
6)	Select torque bias command 2	***TB2***
7)	Select droop control	***DROOP***
8)	Zero-hold Ai1	***ZH-AI1***
9)	Zero-hold Ai2	***ZH-AI2***
10)	Zero-hold Ai3 (AIO optional function)	***ZH-AI3***
11)	Zero-hold Ai4 (AIO optional function)	***ZH-AI4***
12)	Reverse Ai1 polarity	***REV-AI1***
13)	Reverse Ai2 polarity	***REV-AI2***
14)	Reverse Ai3 polarity (AIO optional function)	***REV-AI3***
15)	Reverse Ai4 polarity (AIO optional function)	***REV-AI4***

Type [136]: Control input 4

Bit	Function	Symbol
0)	Inverse PID output	***PID-INV***
1)	Cancel PG alarm	***PG-CCL***
2)	Cancel undervoltage alarm	***LU-CCL***
3)	Hold Ai torque bias	***H-TB***
4)	STOP1	***STOP1***
5)	STOP2	***STOP2***
6)	STOP3	***STOP3***
7)	Latch DIA data (DIA optional function)	***DIA***
8)	Latch DIB data (DIB optional function)	***DIB***
9)	Cancel multiplex system	***MT-CCL***
10)	Custom Di1	***C-DI1***
11)	Custom Di2	***C-DI2***
12)	Custom Di3	***C-DI3***
13)	Custom Di4	***C-DI4***
14)	Custom Di5	***C-DI5***
15)	Custom Di6	***C-DI6***

Type [137]: Control input 5

Bit	Description	Symbol
0)	Custom Di7	***C-DI7***
1)	Custom Di8	***C-DI8***
2)	Custom Di9	***C-DI9***
3)	Custom Di10	***C-DI10***
4)	Select load adaptive parameters 2/1*	***AN-P2/1***
5)	Cancel PID components	***PID-CCL***
6)	Enable PID FF component	***PID-FF***
7)	Reset completion of speed limit calculation*	***NL-RST***
8)	Toggle signal 1	***TGL1***
9)	Toggle signal 2	***TGL2***
10)	Cause external mock alarm	***FTB***
11)	Cancel NTC thermistor alarm	***NTC-CCL***
12)	Cancel lifetime alarm signal	***LF-CCL***
13)	Request for reading in serial port PG absolute position*	***SPG-AP***
14)	Switch PID feedback signals	***PID-FB2***
15)	Select PID torque bias	***TB-PID***

* Available soon

Type [138]: Control input 6

Bit	Description	Symbol
0)	Tune magnetic pole position*	***MP-TUN***
1)	External electrical conditions*	***RD***
2)	Startup conditions*	***STRD***
3)	Continue to run at the time of communications link error	***LK-D***
4)	In preparation	-
5)	In preparation	-
6)	In preparation	-
7)	In preparation	-
8)	In preparation	-
9)	In preparation	-
10)	In preparation	-
11)	In preparation	-
12)	In preparation	-
13)	In preparation	-
14)	In preparation	-
15)	In preparation	-

* Available soon

Type [139]: Control input 7

Type [140]: Control input 8

In preparation

Type [141]: Operation status 2(a)

Bits: 15 … 8 | 7 … 0

0), 1)
- 00: HD (High duty mode, overload capability) (F80 = 0, 2)
- 01: LD (Low duty mode, overload capability) (F80 = 1)
- 10: MD (Medium duty mode, overload capability) (F80 = 3)

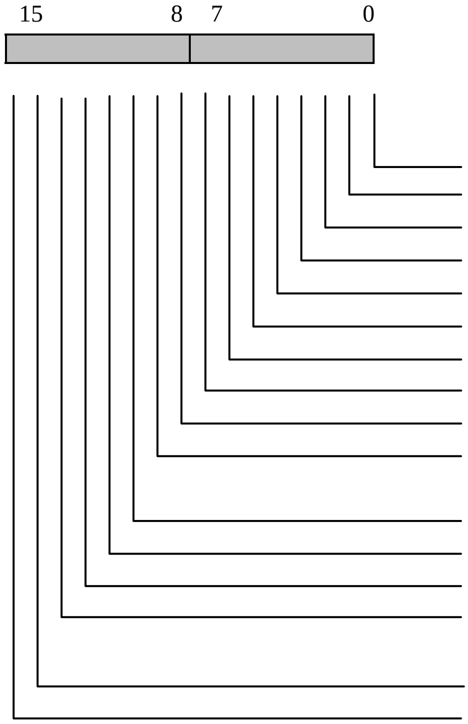
2), 3), 4), 5), 6)
- 00000(0): Keypad [HAND]
- 00001(1): Analog input to terminal [12](0 to ±10 V)
- 00010(2): Analog input to terminal [12](0 to +10 V)
- 00011(3): ***UP/DOWN*** control (Initial speed = 0)
- 00100(4): ***UP/DOWN*** control (Initial speed = Last value)
- 00101(5): ***UP/DOWN*** control (Initial speed = Creep speed 1 or 2)
- 00110(6): DIA card input [DIA]
- 00111(7): DIB card input [DIB]
- 01000(8): Select multistep speed (***SS8***, ***SS4***, ***SS2***, ***SS1***)
- 01001(9): Enable communications link (***LE***), H30: Communications Link Function (Link operation)
- 01010(10): UPAC SW1 (Speed command 1) enabled [UPAC]
- 01011(11): Synchronization operation command (PG (PR) optional function) ***SYC***
- 01100(12): Orientation[ORT]
- 01101(13): Lock at zero speed ***LOCK***
- 01110(14): Not used.
- 01111(15): Not used.
- 10000(16): Ready for jogging (***JOG***)
- 10001(17): Not used.
- 10010(18): ***N-REFV*** input to terminal [Ai1]
- 10011(19): ***N-REFC*** input to terminal [Ai2]
- 10100(20): Local mode keypad [LOCAL]

7), 8)
- 00: Motor 1
- 01: Motor 2
- 10: Motor 3

9), 10), 11), 12)
- 0000(0): Vector control with speed sensor
- 0001(1): Vector control without speed sensor
- 0010(2): Simulation mode
- 0011(3): Vector control for PMSM with speed sensor
- 0100(4): V/f control for IM
- 0101(5): Vector control with speed sensor (Multiwinding IM) (Master)
- 0110(6): Vector control with speed sensor (Multiwinding IM) (Slave)
- 0111(7): Vector control without speed sensor (Multiwinding IM) (Master)

13) FWD input (0: OFF, 1: ON)
14) REV input (0: OFF, 1: ON)
15) Not used.

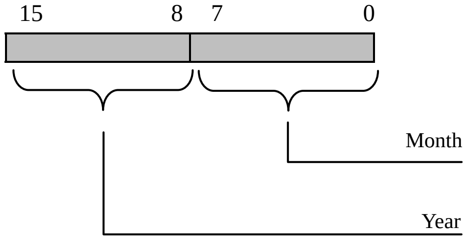
Type [142]: Operation status 2(b)



0) Current limit (0: No limit, 1: Under limiting)(*1)
1) Undervoltage (0: Normal, 1: Undervoltage)
2) Voltage limit (0: No limit, 1: Under limiting)(*1)
3) Torque limit (0: No limit, 1: Under limiting)(*1)
4) Not used.
5) Not used.
6) STOP1 input (0: OFF, 1: ON)
7) STOP2 input (0: OFF, 1: ON)
8) STOP3 input (0: OFF, 1: ON)
9) BX input (0: OFF, 1: ON)
10)–13)
0000(0): Keypad (F02 = 0) [REM] [HAND]
0001(1): ***FWD*** or ***REV*** (F02 = 1) [REM]
0010(2): Run command via communications link [COMM]
0011(3): Local mode keypad [LOC] [HAND]
14) Not used.
15) Not used.

(*1) Current limit, voltage limit and torque limit are the same as information in Type [21].

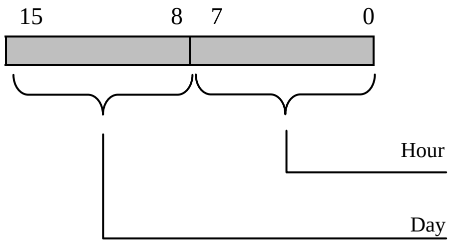
Type [143]: Calendar clock [Year/month]



Month: 1 to 12 months: 0001(1) to 1100(12)

Year: 2000 to 2099 years: 0000 0000(00) to 1001 1001(99)

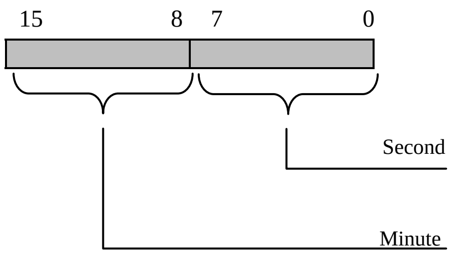
Type [144]: Calendar clock [Day/hour]



Hour: 0 to 23 hours: 0000 0000(0) to 0001 0111(23)

Day: 1 to 31 days: 0000 0001(1) to 0001 1111(31)

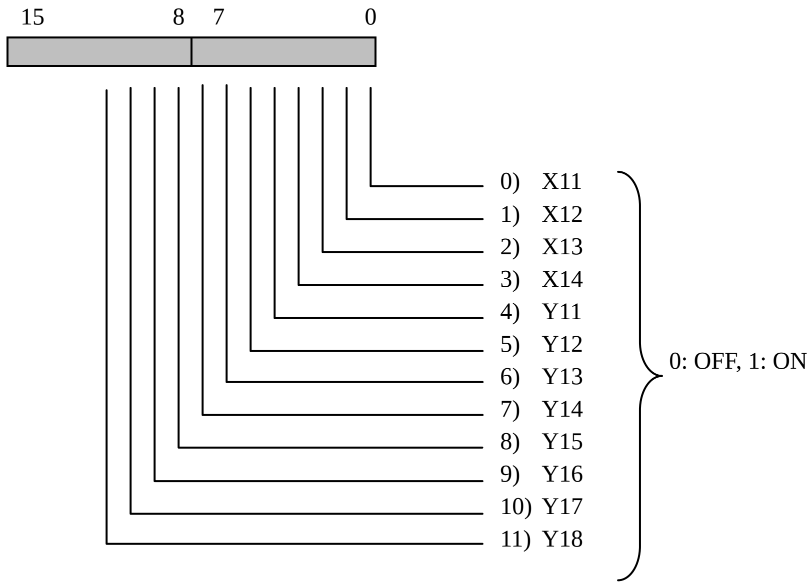
Type [145]: Calendar clock [Minute/second]



Second: 0 to 59 seconds: 0000 0000(0) to 0011 1011(59)

Minute: 0 to 59 minites: 0000 0000(0) to 0011 1011(59)

Type [146]: DIOA Input/output status



4.3 Details of Function Codes

4.3.1 F codes (Fundamental Functions)

F00	Data Protection

F00 specifies whether to protect setting data from accidentally getting changed from the keypad. When the data protection is enabled, the "DATA PRTC" displays on the LCD monitor.

This data protection applies to access to data from the keypad. The data protection for access via the communications link (RS-485, T-Link, SX-bus, fieldbus, etc.) can be defined with H29.

`F00 DATA PRTC`

Data =	0:	Allow data change.	0: CHGOK
	1:	Protect data.	1: PROTECT

Setting procedure

0 → 1: Press the (STOP) and (∧) keys simultaneously to change the value from 0 to 1, then press the (FUNC/DATA) key to establish the change.

1 → 0: Press the (STOP) and (∨) keys simultaneously to change the value from 1 to 0, then press the (FUNC/DATA) key to establish the change.

F01	Speed Command N1

F01 sets a command source that specifies a reference speed.

Using the terminal command ***N2/N1*** assigned to any digital input terminal switches a command source between the Speed command N1 specified by F01 and Speed command N2 specified by C25. For details about switching, refer to the ***N2/N1*** in the descriptions of E01 through E13 (data = 11).

`F01 SPD CMD 1`

Data =	0:	Enable the (∧) and (∨) keys on the keypad.	0: KEYPAD
	1:	Enable the voltage input to terminal [12] (0 to ±10 VDC).	1: 12INPUT
	2:	Enable the voltage input to terminal [12] (0 to +10 VDC).	2: 12(ABS)
	3:	Enable ***UP*** and ***DOWN*** terminal commands.*1 (Initial value: 0)	3: U/D(0)
	4:	Enable ***UP*** and ***DOWN*** terminal commands.*1 (Initial value: Last value)	4: U/D(BEF)
	5:	Enable ***UP*** and ***DOWN*** terminal commands.*1 (Initial value: CRP1, CRP2)	5: U/D(CRP)
	6:	Enable a DIA card	6: DIA CARD
	7:	Enable a DIB card	7: DIB CARD
	8:	Enable the reference speed setting to terminal [Ai1] to [Ai4]. (0 to ±10 VDC).*2	8: N-REFV
	9:	Enable the current input to terminal [Ai2] (4 to 20 mADC).*3	9: N-REFC

*1 The ***UP*** and ***DOWN*** should be assigned to digital input terminals (X terminals) with E01 to E13 (data = 17 and 18) beforehand.

*2 The ***N-REFV*** (Main speed setting) should be assigned to one of analog input terminals ([Ai1] to [Ai4]) with E49 to E52 (data = 25) beforehand.

*3 Exclusive to terminal [Ai2]. The ***N-REFC*** (Current input speed setting) should be assigned to analog input terminal [Ai2] with E50 (data = 26) beforehand.

Check the specified speed command with Menu #3 "Operation status monitor" on the keypad.

Shown at the right is the OPR MTR screen that appears when the inverter is running at 1200 r/min.

```
        1200
N*=1200.0r/m
N =1200.0r/m
f* =××××.×Hz
TRQ=××××.×%
∧∨→PAGE SHIFT 1
```

F02 Operation Method

F02 selects a command source that specifies a run command.

F02 OPR METHOD

Data = 0: Enable the (FWD), (REV), and (STOP) keys on the keypad (Local mode). 0: KEYPAD

1: Enable input terminal commands ***FWD*** and ***REV*** (Remote mode). 1: FWD, REV

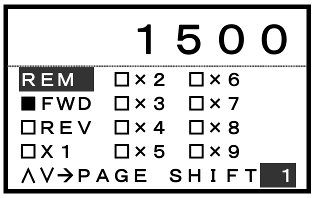
The remote and local modes can be switched also by pressing the (RESET) and (STOP) keys simultaneously. This key operation changes the setting of F02.

When H30 (Communications link operation) = "2" or "3," link operation has priority over the setting of F02.

When F02 = 0, entering a run command from the keypad turns the green LED lamp ON. When F02 = 1, to check the command status, use Menu #4 "I/O Checking" (REM screen) on the keypad and check that the box of the current input (***FWD*** or ***REV***) appears black (■).

Shown at the right is the I/O screen that appears when ***FWD*** is externally turned ON.

Note that the COMM screen in Menu #4 "I/O Checking" shows commands entered via the communications link. It has no relationship with terminal block commands.



F03 Maximum Speed M1

F03 specifies the maximum speed (r/min) for motor 1. Specifying the maximum speed exceeding the rating of the equipment driven by the inverter may damage the motor or the machinery. Make sure that the maximum speed setting matches the equipment rating.

The ratio between the inverter rated speed and the maximum speed should be 1 : 6 or below.

F03 M1—MAX

Data setting range: 50 to 30000 (r/min)

⚠CAUTION

Settings of some function codes (relating to the acceleration/deceleration time and the ASR P gain of analog speed setting) are based on the maximum speed (F03). Changing the maximum speed in the already adjusted system in order to decrease the top speed may cause the inverter to malfunction.

It is therefore necessary to change the ASR P gain (F61/C40/C50/C60) in proportion to the change of the F03 setting. When F03 = 1500 and F61 = 10.0, for example, changing the F03 setting from 1500 to 150 will cause hunting. This change means that the ASR P gain is multiplied by 10 (1500/150), so be sure to change the F61 setting from 10.0 to 1.0.

F04 Rated Speed M1

F04 specifies the rated speed in the constant torque range of motor 1. Set the rated speed printed on the nameplate labeled on the motor.

Selecting a VG-dedicated motor with P02 automatically configures the F04 data and does not allow it to be changed. Selecting the "P-OTR" with P02 does not allow the F04 data to be changed.

The ratio between the inverter rated speed and the maximum speed should be 1 : 6 or below.

F04 M1—Nr

Data setting range: 50 to 30000 (r/min)

F05 Rated Voltage M1

F05 specifies the rating of the output voltage to be supplied to motor 1. Set the rated voltage printed on the nameplate labeled on the motor.

Selecting a VG-dedicated motor with P02 automatically configures the F05 data and does not allow it to be changed. Selecting the "P-OTR" with P02 does not allow the F05 data to be changed.

F	0	5	M	1	–	V	r					

Data setting range: 80 to 999 (V)

F07 Acceleration Time 1

F08 Deceleration Time 1

F07 specifies the acceleration time, the length of time required for the speed to increase from "0" to the maximum speed. F08 specified the deceleration time, the length of time required for the speed to decrease from the maximum speed down to "0."

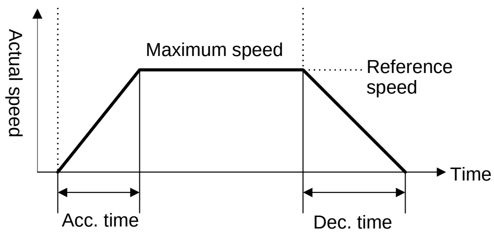
The actual acceleration/deceleration time is calculated based on the maximum speed (F03, A06, A106). See the expression given below.

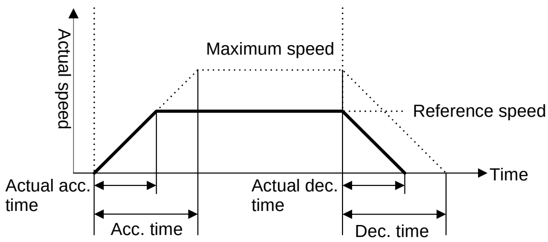
$$\text{Actual acceleration/deceleration time} = \text{F07/F08 setting} \times \frac{\text{Reference speed}}{\text{Maximum speed (F03, A06, A106)}}$$

If the S-curve acceleration/deceleration is selected, the actual acceleration/deceleration time becomes longer than the specified time. For details, refer to the description of F67.

F	0	7	A	C	C		T	I	M	E	1	
F	0	8	D	E	C		T	I	M	E	1	

Data setting range: 0.01 to 99.99 (s)
100.0 to 999.9 (s)
1000 to 3600 (s)





Writing data to S08 (Acceleration time) or S09 (Deceleration time) via the communications link (RS-485, T-Link, SX-bus, or fieldbus) automatically copies the data to F07 or F08 as is, respectively.

F10	M1 Electronic Thermal Overload Protection (Select motor characteristics)
F11	**M1 Electronic Thermal Overload Protection (Detection level)**
F12	**M1 Electronic Thermal Overload Protection (Thermal time constant)**

F10 through F12 specify the thermal characteristics of the motor (motor rotation, output current and running time) for its electronic thermal overload protection that is used to detect overload conditions of the motor inside the inverter. This function protects motor M1. When a dedicated motor for the FRENIC-VG is used, disable this function (no setting is required).

F10 M1-EOL-SEL

- Select motor characteristics

When a dedicated motor for the FRENIC-VG is used, connecting an NTC thermistor built in the motor with the FRENIC-VG activates the motor overheat protection so that no electronic thermal overload protection is required. Disable this function.

If the motor overheat protection by an NTC thermistor is not available, use F10 to select the motor cooling mechanisms (shaft-driven cooling fan or separately powered cooling fan) to specify its characteristics.

When 150% of the current specified by F11 flows for the time specified by F12, the inverter activates the motor overload protection and issues an alarm OL1.

Data = 0: Disable (For a dedicated motor for the FRENIC-VG. Protected by an NTC thermistor)
1: Enable (For a general-purpose motor with shaft-driven cooling fan)
2: Enable (For a Fuji inverter-driven motor with separately powered cooling fan)

F11 M1-EOL-LVL

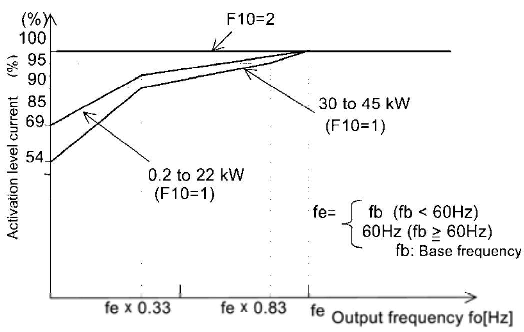
- Detection level

F11 specifies the level (current value) at which the electronic thermal overload protection becomes activated.

In general, set the F11 data to 1.0 to 1.1 times of the M1 rated current specified by P04.

By factory default, F11 data is set to the rated current of the Fuji general-purpose motor. To connect any other motor, change the setting.

Data setting range: 0.01 to 99.99 (A)
100.0 to 999.9 (A)
1,000 to 2,000 (A)



Activation level current and output frequency

F12 M1-EOL-TC

- Thermal time constant

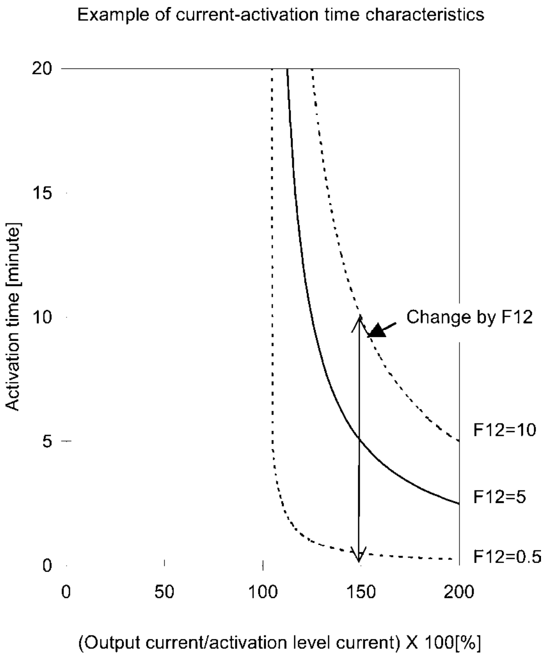
F12 specifies the thermal time constant of the motor. If the current of 150% of the overload detection level specified by F11 flows for the time specified by F12, the electronic thermal overload protection becomes activated to detect the motor overload.

The thermal time constant for general-purpose motors including Fuji motors is approx. 5 minutes for motors of 22 kW or below and 10 minutes for motors of 30 kW or above by factory default

Data setting range: 0.5 to 75.0 (min)

(Example) When the F12 data is set at 5 minutes

As shown at the right, the electronic thermal overload protection is activated to detect an alarm condition (alarm code OL1) when the output current of 150% of the overload detection level (specified by F11) flows for 5 minutes, and 120% for approx. 13 minutes.



Since the current flowing through a motor is not usually constant, the average current in a certain period is used to start the timer for the electronic thermal overload protection.

Note: In the case of the load which is repeatedly and very frequently driven by a motor, the motor current fluctuates largely so that it may enter the short-time rating (100% or more) range of the motor repeatedly. If it happens, refer to Chapter 9, Section 9.1.3.4 "Calculating the RMS rating of the motor" to calculate the equivalent effective current and limit this value under the rated current of a motor (in the case of a separately-powered cooling fan).

F14 Restart Mode after Momentary Power Failure (Mode selection)

F14 specifies the action to be taken by the inverter such as trip and restart in the event of a momentary power failure. You can select a function for detecting power failure and activating protective operation (alarm output, alarm display, inverter output cutoff) for undervoltage or an automatic restart function without stopping a coasting motor after the supply voltage recovery.

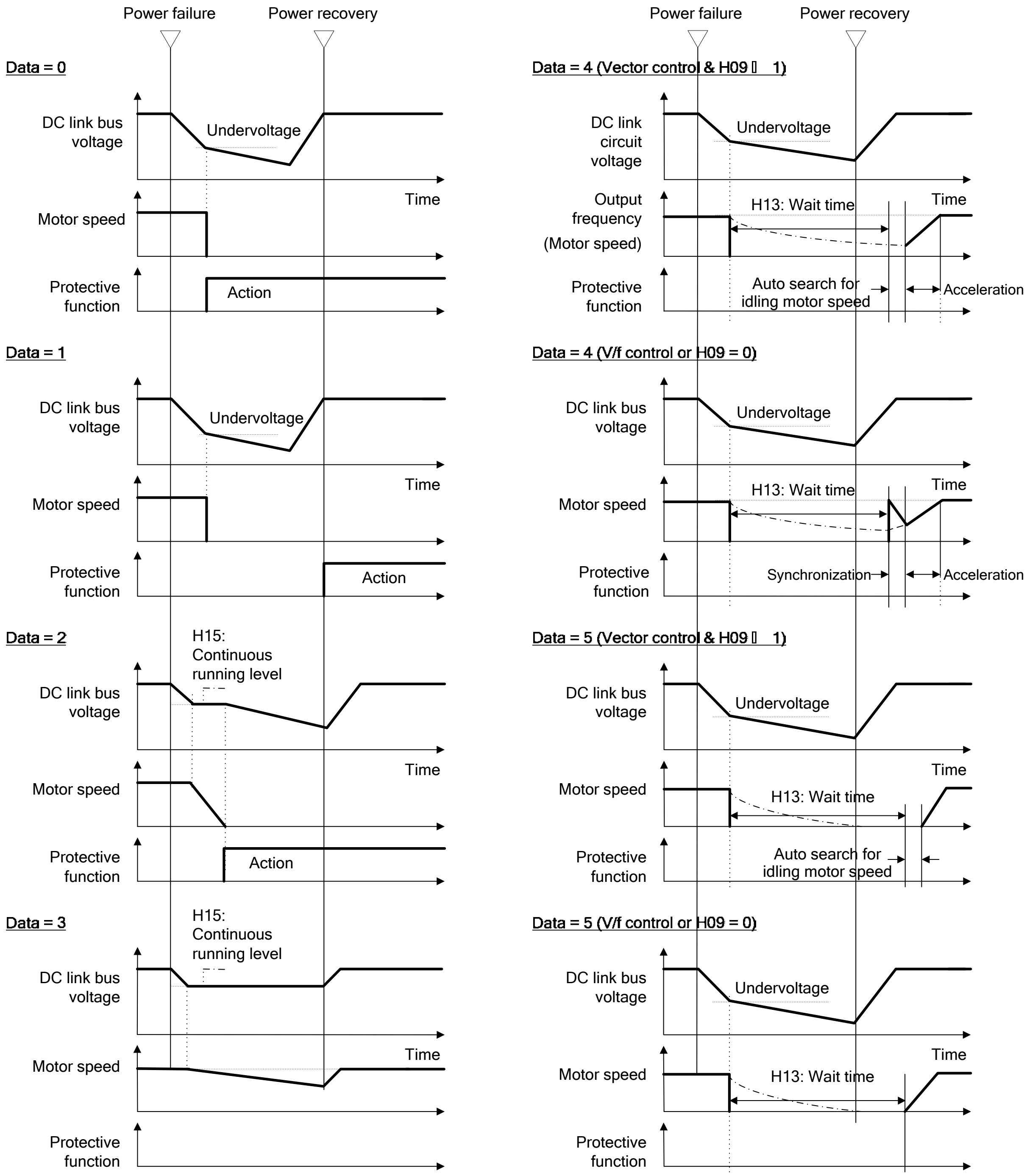
See the following table for more information on this function.

The restart mode related function codes include H13 to H17 (Restart Mode after Momentary Power Failure, Wait time, Decrease rate in speed, Continuous running level, Run command self-hold setting and Run command self-hold time), H09 (Starting Mode, Auto search), and E01 (Terminal [X1] Function ***STM***, data = 26 "Enable auto search for idling motor speed at starting"). Also be familiar with these functions.

To restart the inverter after momentary power failure under V/f control, enable the overcurrent suppression (H58 = 1).

F	1	4	R	E	S	T	A	R	T			

<table>
<tr><th>Data for F14</th><th>Function name</th><th>Operation on power failure</th><th colspan="2">Operation on power recovery</th></tr>
<tr><td>0</td><td>Inactive (immediate inverter trip)</td><td>If undervoltage is detected, the protective function LU is activated and output is turned off.</td><td>The inverter does not restart.</td><td rowspan="3">Enter commands for resetting the protective function and starting operation.</td></tr>
<tr><td>1</td><td>Inactive (inverter trip on recovery)</td><td>If undervoltage is detected, the protective function is not activated and output will be turned off.</td><td>The protective function LU is activated, but the operation does not restart,</td></tr>
<tr><td>2</td><td>Inactive (inverter trip after deceleration to a stop on power failure)</td><td>When the holding DC level (H15) "Restart after momentary power failure" is reached, the inverter decelerates a motor to stop. The DC voltage of the main circuit sharpens the deceleration slope so that the undervoltage protective function LU is not activated. The inverter collects the inertia energy of the load and controls the motor until it stops, then the undervoltage protective function LU is activated. If the amount of inertia energy from the load is small, and the undervoltage level is achieved during deceleration, the undervoltage protective function LU is then activated.</td><td>The protective function is activated, but the operation does not restart,</td></tr>
<tr><td>3</td><td>Active (continuous operation)</td><td>When the holding DC level is reached, energy is collected from the inertia amount of the load to extend the operation continuation time. If undervoltage is detected, the protective function is not activated, but the output is turned off.</td><td colspan="2">Operation restarts automatically. For a power recovery during a continued operation, the inverter accelerates to the original speed. If the inverter detected an undervoltage, operation automatically restarts at the speed when the undervoltage is detected.</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Active (restart at the speed on power failure)</td><td rowspan="2">If undervoltage is detected, the protective function is not activated and the output is turned off.</td><td colspan="2"><u>Vector control & H09 ≥ 1</u>
The inverter performs auto search for idling motor speed and restarts running the motor at the same speed as the motor.</td></tr>
<tr><td colspan="2"><u>V/f control or H09 = 0</u>
The inverter restarts running the motor at the speed at which the power failure occurred.</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Active (restart at the starting speed)</td><td rowspan="2">If undervoltage is detected, the protective function is not activated and the output is turned off.</td><td colspan="2"><u>Vector control & H09 ≥ 1</u>
The inverter performs auto search for idling motor speed and restarts running the motor at the same speed as the motor.</td></tr>
<tr><td colspan="2"><u>V/f control or H09 = 0</u>
The automatically restarts running the motor at 0 r/min.</td></tr>
</table>



Power failure
Power recovery
Data = 0
DC link bus voltage
Undervoltage
Time
Motor speed
Protective function
Action
Data = 1
DC link bus voltage
Undervoltage
Time
Motor speed
Protective function
Action
Data = 2
H15: Continuous running level
DC link bus voltage
Time
Motor speed
Protective function
Action
Data = 3
H15: Continuous running level
DC link bus voltage
Time
Motor speed
Protective function
Power failure
Power recovery
Data = 4 (Vector control & H09 ≠ 1)
DC link circuit voltage
Undervoltage
Output frequency
(Motor speed)
H13: Wait time
Time
Protective function
Auto search for idling motor speed
Acceleration
Data = 4 (V/f control or H09 = 0)
DC link bus voltage
Undervoltage
Motor speed
H13: Wait time
Time
Protective function
Synchronization
Acceleration
Data = 5 (Vector control & H09 ≠ 1)
DC link bus voltage
Undervoltage
Motor speed
H13: Wait time
Time
Protective function
Auto search for idling motor speed
Data = 5 (V/f control or H09 = 0)
DC link bus voltage
Undervoltage
Motor speed
H13: Wait time
Time
Protective function

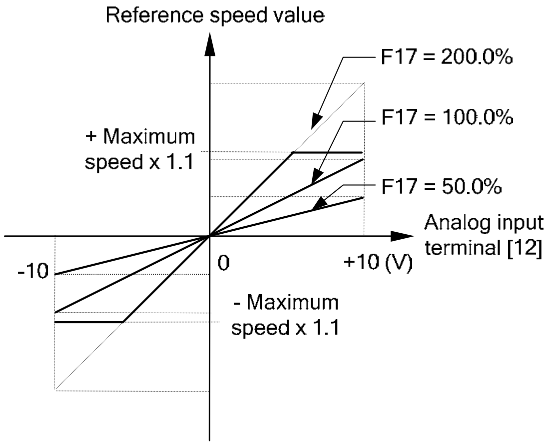
F17 Gain (for terminal [12] input)

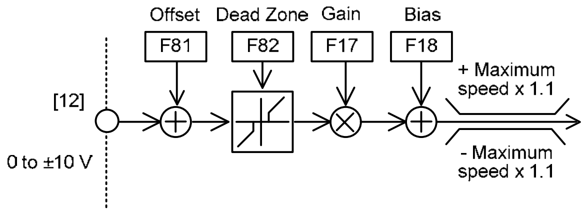
F17 specifies the proportion to the reference speed value (analog input) from control terminal [12]. The reference speed is limited to 110% (1.1 times) of ±maximum speed (F03).

Note: The reference speed value is finally limited by the speed limiter (F76, F77, F78).

F	1	7	G	A	I	N		(	1	2	)	

Data setting range: 0.0 to 200.0 (%)





F18 Bias (for terminal [12] input)

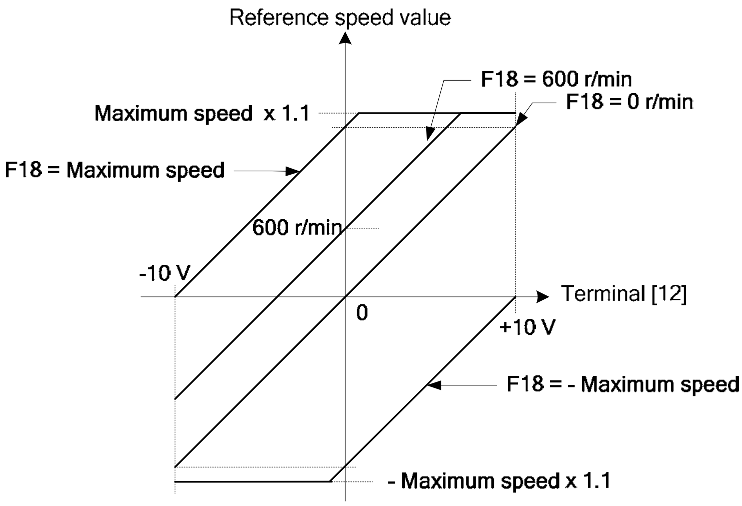
F18 specifies a bias speed to be added to the reference speed value (analog input) from control terminal [12].

The bias speed is limited to ±maximum speed (F03). The reference speed is limited to 110% (1.1 times) of ±maximum speed (F03).

Note: The reference speed value is finally limited by the speed limiter (F76, F77, F78).

F	1	8	B	I	A	S	(	1	2	)		

Data setting rage: 0 to 30,000 (r/min)



F20	DC Braking (Braking starting speed)
F21	DC Braking (Braking level)
F22	DC Braking (Braking time)

If you apply a DC voltage to an operating motor (set the output frequency to zero), the motor generates a braking torque to decelerate to stop. This is referred as DC brake and these functions specify the setting. If a motor does not stop within a DC braking time, the motor will coast. You can assign a digital signal input [DCBRK] to start the DC brake.

F	2	0	D	C		B	R	K		N		

- Starting speed

Set the starting speed of the DC brake during decelerating.

Setting range: 0 to 3,600 (r/min)

F	2	1	D	C		B	R	K		L	V	L

- Braking level

Sets the output current level of the DC braking. You can specify as a percentage of the inverter rated output (100%) with a minimum unit of 1%.

Setting range: 0 to 100 (%)

F	2	2	D	C		B	R	K		t		

- Braking time

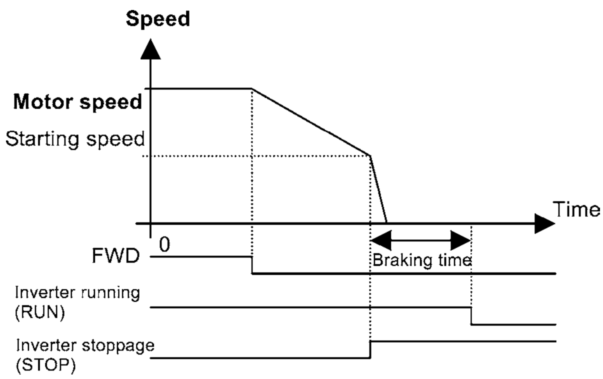
Sets the operation time for the DC braking

Setting range: 0.0: Inactive
0.1 to 30.0 (s)

DC brake operation

The DC brake is applied for a specified time after the speed reaches the starting speed level on deceleration of a motor. The inverter running (RUN) signal maintains ON during the DC braking and the inverter stoppage (STOP) signal turns on when the DC brake is activated.

Specify the slip frequency conversion speed level at F20. If a very large value is specified, the control becomes unstable, possibly causing overvoltage protection being activated.



⚠CAUTION

The brake function of the inverter does not provide a mechanical hold.

You may be injured.

F23	Starting Speed (Speed)
F24	**Starting Speed (Holding time)**

You can set a starting speed to assure a starting torque.

Under vector control

This function acts to release a mechanical brake. If you enter the operation command after setting the starting speed to 0 r/min, the brake will be released after the magnetic-flux and the torque reach a certain level. See E15 to E27 "Y function selection" for brake release signal.

Under V/f control

You can accelerate a motor after operating the motor at a starting speed for a certain period to establish the magnetic-flux on start.

F23 START N

- Starting speed

Sets the rotation at start.

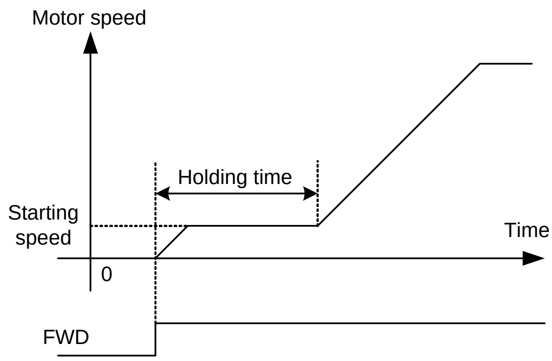
Setting range: 0.0 to 150.0 (r/min)

F24 HLD STARTt

- Holding time

Sets the period for maintaining the starting time.

Setting range: 0.00 to 10.00 (s)



Note: The holding time is not activated when you switch between forward and reverse rotation. The acceleration time does not include the holding time.

F26	Motor Sound (Carrier frequency)

F26 controls the carrier frequency to reduce an audible noise generated by the motor or electromagnetic noise from the inverter itself, avoid resonance with the machinery, and reduce the leakage current from the output (secondary) circuit.

F26 MTR SOUND

Data setting range: 2 to 15 (kHz) (The upper limit differs depending upon the capacity and current rating (HD/LD/MD).)

Carrier frequency	2 to 15 kHz
Motor sound noise emission	High to low
Ripples in output current waveform	Large to small
Leakage current	Low to high
Electromagnetic noise emission	Low to high

Note 1: Specifying a too low carrier frequency causes the output current waveform to have a large amount of ripples (harmonics components). As a result, the motor loss increases, causing the motor temperature to rise. Specifying a high carrier frequency increases the motor loss, causing the inverter temperature to rise.

Note 2: When F26 = 9, 8 kHz of the carrier frequency applies, when F26=11, 10 kHz, when F26 = 13 or 14, 12 kHz.

Note 3: Running a permanent magnet synchronous motor (PMSM) at a low carrier frequency may heat the permanent magnet due to the output current harmonics, resulting in demagnetization. When decreasing the carrier frequency setting, be sure to check the allowable carrier frequency of the motor.

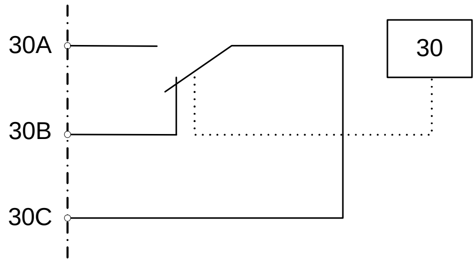
F36	30RY Drive Mode

F36 selects whether to activate (excite) the alarm output relay (30RY) in a normal state or in an abnormal state.

F	3	6	R	Y		M	O	D	E			

Data setting range: 0, 1

Data for F36	Normal state	Abnormal state
0	30A-30C: OFF 30B-30C: ON	30A-30C: ON 30B-30C: OFF
1	30A-30C: ON 30B-30C: OFF	30A-30C: OFF 30B-30C: ON



Note: When F36 = 1, the contacts between 30A and 30C are connected after the inverter control voltage is established (about five seconds after turning on). Since the relay is excited in a normal state, the relay can detect a wire break in the alarm output line.

F37	Stop Speed (Speed)
F38	Stop Speed (Detection mode)
F39	Stop Speed (Zero speed holding time)

F	3	7	S	T	O	P		N				

- Stop speed

F37 specifies the stop speed.

Data setting range: 0.0 to 150.0 (r/min)

F	3	8	D	E	T		S	I	G	N	A	L

- Detection mode

F38 specifies whether to detect the stop speed with the reference speed (Reference speed 4 (ASR input)) or detected speed (Detected speed 1).

Data setting range: 0: Detected speed
1: Reference speed

However, under V/f control or vector control without speed sensor, the reference speed only takes effect irrespective of the F38 setting.

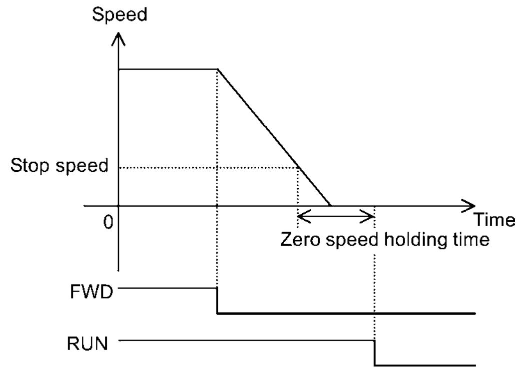
Under V/f control, the inverter stops its output when it detects the output frequency (M05), irrespective of the F38 setting.

F39 HLD STOP t

- Zero speed holding time

Data setting range: 0.00 to 10.00 (s)

The ***RUN*** signal ("Inverter running") will turns off at the end of the Zero speed holding time for continuing operation after the motor speed reaches the stop speed level.



This function is used to adjust the timing to apply a mechanical brake.

Under V/f control or vector control without speed sensor, however, this function is invalid. Even under vector control, when H41 (Torque command source) ≠ 0 or H42 (Torque current command source) ≠ 0, this function is invalid.

F40	Torque Limiter Mode 1
F41	Torque Limiter Mode 2

F40 specifies torque limiter mode 1 in which the torque limiter, power limiter or torque current limiter can be selected. In the mode, it is also possible to disable those limiters. Turning ON the terminal command ***F40-CCL*** ("Cancel F40"), which is functionally equivalent to F40 set at "0," also disables those limiters.

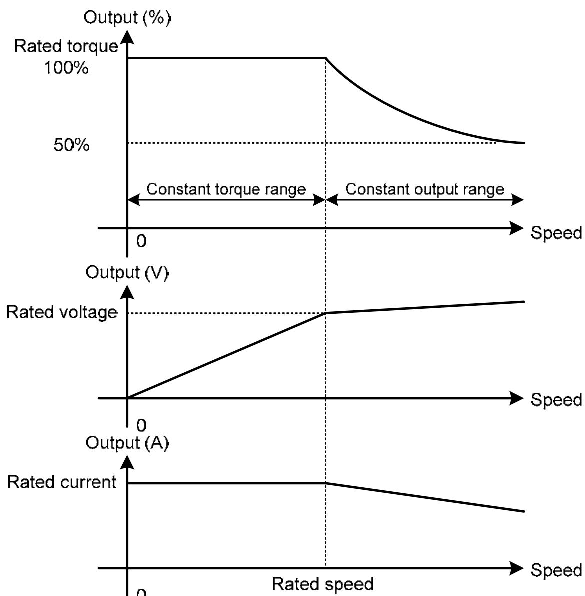
F40 TLIM MODE1

Data setting range: 0: Disable limiters
1: Enable torque limiter
2: Enable power limiter
3: Enable torque current limiter

Under V/f control, the torque current limiter is enabled irrespective of whether F40 is set at 1, 2 or 3.

<u>Background information</u>

The right graph shows a continuous permissible torque (not short-time rating) for forward rotation driving in the speed control range (0 to Rated speed to 200%). The control generally reduces magnetic-flux above the rated speed to extend the speed control range. The reduced output current in the right graph shows that the control reduces the current corresponding to the amount of the reduced magnetic-flux. This reduces the increase of the induced motor voltage to restrain the increase of the voltage output proportional to the speed.



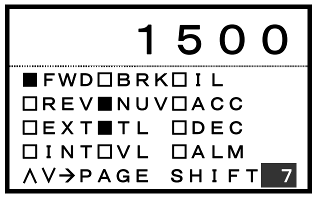
Output characteristic
(first quadrant, forward rotation driving)

Under the rated speed, the rated torque is effective. Since the torque is proportional to the product of the exciting current and the torque current, the current is limited in practice.

Over the rated speed, since the inverter capacity (output: power) restricts the torque, the output torque decreases in inverse proportion to the speed. The torque limiter condition switches depending upon whether the speed is less than or exceeds the rated speed.

You can use the "Operation monitor" of the "I/O check" of the KEYPAD panel to review the state of the torque limiter, the power limiter and torque current limiter status

■ TL in the right figure shows the torque limiter is active. When the torque limiter is not applied, the display turns to □ TL. You can also read the function code M14 "Operation status" through the link to confirm the state.



F41 specifies torque limiter mode 2 in which the configuration of target quadrants can be selected.

F41 TLIM MODE2

Data setting range: 0: Level 1 to all four quadrants
1: Level 1 to driving, Level 2 to braking
2: Level 1 to upper limit, Level 2 to lower limit
3: Level 1/Level 2 (switchable) to all four quadrants

The next section describes the actual limitations determined by the values set at F40 and F41. For level 1 and level 2 of each limitation, see the descriptions of F42 and F43.

Under V/f control, setting F41 at "3" produces the same result as "0."

Description and application of the limiter mode 1

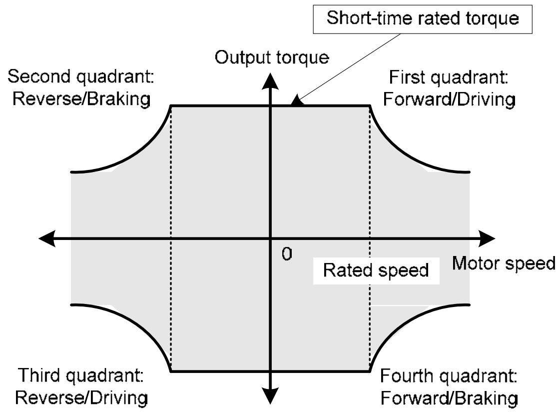
Limiter type	Limiter description	Application
Disable limiters F40 = 0 or ***F40-CCL*** = ON	Limits the torque by the maximum output current (One-minute, ten-second ratings) in the entire speed limiting range. $\tau\,(\text{Torque }\%) = \dfrac{\sqrt{Imax^2 - Im^2 - (I_T \times \frac{\text{Iron loss coefficient}}{100})^2}}{I_T} \times 100(\%)$ (Ex.) In the case of HD-mode inverters of 30 kW, 200 V, with FRENIC-VG dedicated motor, the maximum driving torque is 214%. Imax (Short-time rated current) = 238 (A) Im (Exciting current: P08) = 53.42 (A) It (Torque current: P09) = 108.18 (A) Iron loss coefficient: P12 = 2.50% $\tau\,(\text{Torque }\%) = \dfrac{\sqrt{238^2 - 53.42^2 - (\frac{108.18 \times 2.50}{100})^2}}{108.18} \times 100\,(\%)$ $\fallingdotseq 214(\%)$	Use for the shortest acceleration/deceleration with the inverter. Note: Check the operation sequence to avoid activating the protective function due to the inverter over load or the motor overload. For braking, check if disabled limiters do not cause any problems when you select braking resistor capacity for the operation sequence if you use power regenerative devices (RHR or RHC series) or connect braking resistors.
Enable torque limiter F41 = 1	Limits the output of the speed control unit (ASR). Restrain the torque (N· m) in terms of the percentage of the rated torque of a motor assumed as 100%. The maximum output current of the inverter may limit the torque in the constant output range depending on the set value for the limiter.	Use for constant torque control involving speed control and torque limiting such as winding or tension control.
Enable power limiter F41 = 2	Limits the torque by the power in the entire speed control range. Restrain the output capacity (power: kW) in terms of the percentage of the rated capacity of an inverter assumed as 100%. The maximum output current of the inverter may limit the torque in the constant torque range depending on the set value for the limiter.	Use for limiting braking torque such as stopping by braking capacity (power). Use for braking that uses the capacity of a braking resistor. Also use for stopping that uses only the inverter loss (kW) when you do not use an external braking resistor (DB).
Enable torque current limiter F41 = 3	Limits the torque in the constant torque range and limits the power in the constant output range. Restricts the torque current command in terms of the percentage of the rated torque current assumed as 100%. Since this control limits the torque current to a constant level, the control reduces the magnetic-flux in the constant output range, resulting in reducing torque accordingly.	Enables a limiter restricting below the short-time rated torque. Use when you limit the output torque for the motor temporarily.

See the following pages for detailed application examples.

(1) Disable limiters

Code	Set value	Description
F40	0	Disable limiters
F41	0, 1, 2, 3	Not effective

- Limits the torque by the maximum output current (one-minute, three-second ratings) in the entire speed limiting range. Use for the shortest acceleration/deceleration with the inverter.
- For driving, check the operation sequence to avoid activating the protective function due to the inverter overload or the motor overload.
- For braking, check if disabled limiters do not cause any problems when you select braking resistor capacity for the operation sequence if you use power regenerative devices (RHC series) or connect braking resistors.

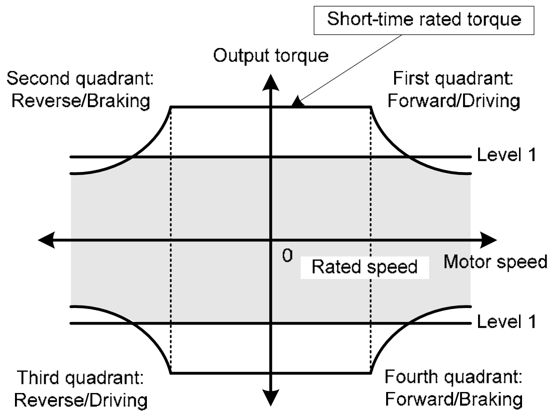


(2) Enable torque limiter

(2)-1 Level 1 to all four quadrants

Code	Set value	Description
F40	1	Enable torque limiter
F41	0	Level 1 to all four quadrants

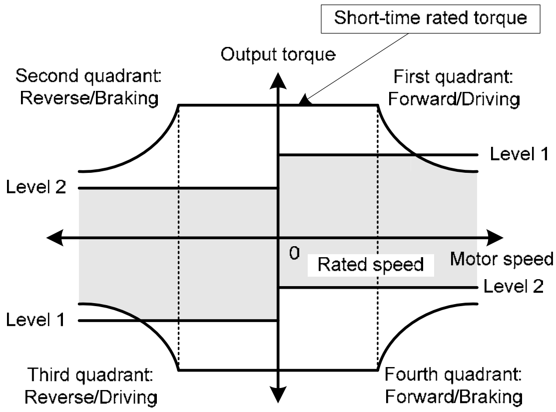
- The short-time rated torque limits the torque where the Level 1 exceeds the short-time rated torque as in the right figure.
- Though you can specify the Level 1 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.



(2)-2 Level 1 to driving, Level 2 to braking

Code	Set value	Description
F40	1	Enable torque limiter
F41	1	Level 1 to driving, Level 2 to braking

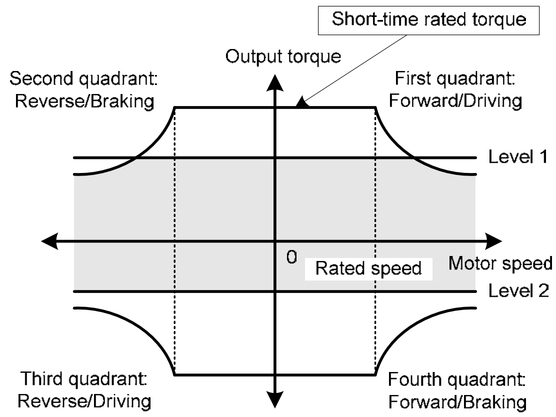
- The short-time rated torque limits the torque where the Level 1 or the Level 2 exceeds the short-time rated torque as in the right figure.
- Though you can specify the Level 1 and the Level 2 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.
- You can use this specification to set the Level 1 as the short-time rated torque for driving and to set the Level 2 as the braking torque limiter due to the brake capacity for braking.
- You cannot use the digital input [TL2/TL1] to switch between the Level 1 and the Level 2.

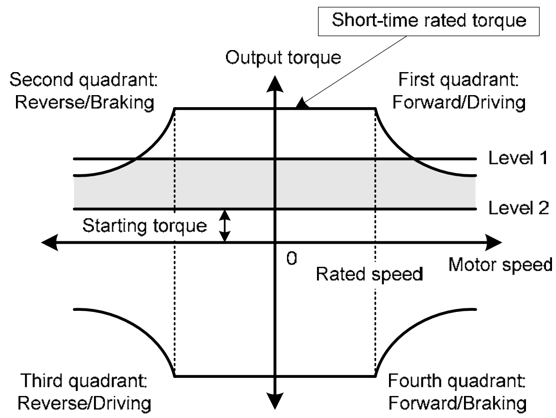


(2)-3 Level 1 to upper limit, Level 2 to lower limit

Code	Set value	Description
F40	1	Enable torque limiter
F41	2	Level 1 to upper limit, Level 2 to lower limit

- Plus and minus values specify Level 1 and Level 2. Make sure the setting polarity is correct. Usually **Level 1 is set to plus and Level 2 is set to minus**.
- The short-time rated torque limits the torque where the Level 1 or the Level 2 exceeds the short-time rated torque as in the right figure.
- You cannot use the digital input [TL2/TL1] to switch between the Level 1 and the Level 2.
- When you assign plus values both to the Level 1 and the Level 2, the entire valid torque range stays in plus (Level 1 > Level 2).
- When you assign minus values both to the Level 1 and the Level 2, the entire valid torque range stays in minus (|Level 1| < |Level 2|. e.g. Level 1=−10 and Level 2=−100).
- Use for applications such as winding control where starting torque is required (right figure).
- In this setting, a torque more than the starting torque is generated. The motor **may accelerate up to the hazard protective level (overspeed: OS, 120% of the maximum speed)** when the load is light. To avoid this situation, use the Speed limiter (function code: F76) as well.





⚠CAUTION

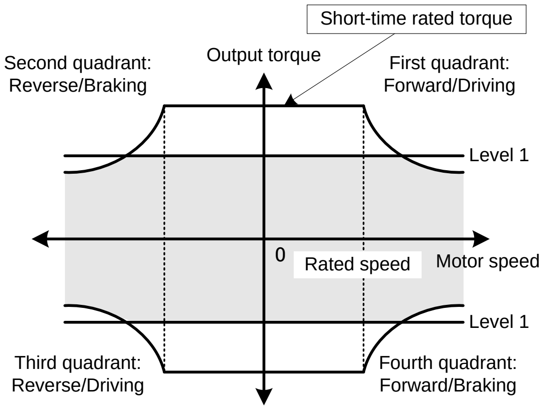
If you set the Level 2 larger than Level 1, the output torque will be fixed to the Level 1. Unless you want this operation, never use this setting. A motor may become out of control and dangerous.

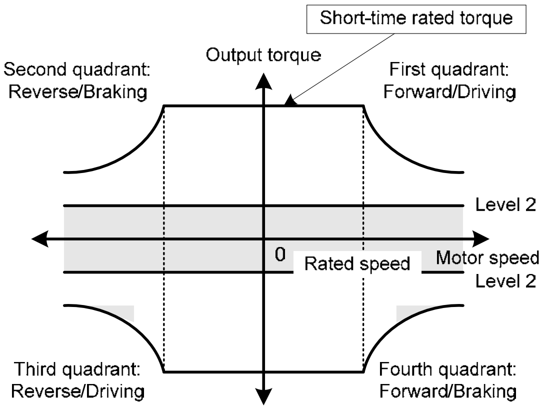
Accidents or physical injuries may occur.

(2)-4 Level 1/Level 2 (switchable) to all four quadrants

Code	Set value	Description
F40	1	Enable torque limiter
F41	3	Level 1/Level 2 (switchable) to all four quadrants

- When you turn on with assigning the torque limiter (Level 1, Level 2 selection) [TL2/TL1] signal to a digital input signal, you can switch between the Level 1 and the Level 2.





- The short-time rated torque limits the torque where the Level 1 or the Level 2 exceeds the short-time rated torque.
- Though you can specify the Level 1 and the Level 2 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.

(3) Enable power limiter

(3)-1 Level 1 to all four quadrants

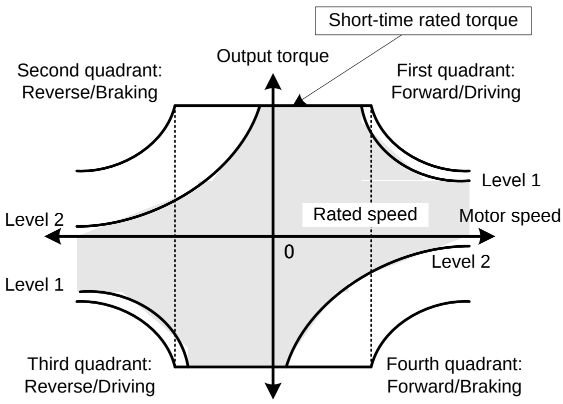
Code	Set value	Description
F40	2	Enable power limiter
F41	0	Level 1 to all four quadrants

- Though this setting is possible, there is no such an application.

(3)-2 Level 1 to driving, Level 2 to braking

Code	Set value	Description
F40	2	Enable power limiter
F41	1	Level 1 to driving, Level 2 to braking

- The short-time rated torque limits the torque where the Level 1 or the Level 2 exceeds the short-time rated torque as in the right figure.
- Though you can specify the Level 1 and the Level 2 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.
- If you set the Level 1 as the short-time rated torque for driving and set a capacity corresponding to the inverter loss for braking, you can use the inverter loss to enable the shortest stop without an external braking resistor.
- Use this setting for an application such as applying brake with the capacity of a braking resistor.



(3)-3 Level 1 to upper limit, Level 2 to lower limit

Code	Set value	Description
F40	2	Enable power limiter
F41	2	Level 1 to upper limit, Level 2 to lower limit

- Though this setting is possible, there is no such an application.

(3)-4 Level 1/Level 2 (switchable) to all four quadrants

Code	Set value	Description
F40	2	Torque limiter enabled
F41	3	Level 1/Level 2 (switchable) to all four quadrants

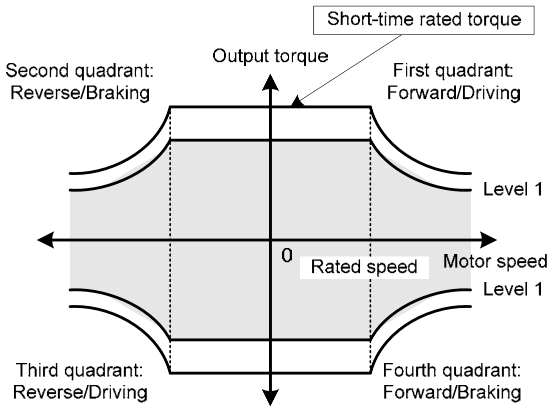
- Though this setting is possible, there is no such an application.

(4) Enable torque current limiter

(4)-1 Level 1 to all four quadrants

Code	Set value	Description
F40	3	Enable torque current limiter
F41	0	Level 1 to all four quadrants

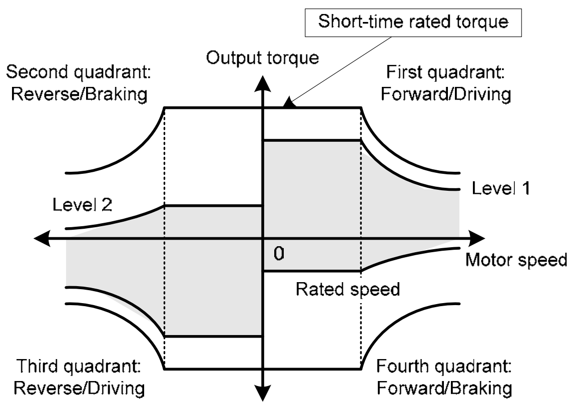
- Unless you set the Level 1 over the short-time rated torque, the short-time rated torque does not limit the torque.
- When protective actions (inverter overload OLU or motor overload OL1, OL2, OL3) occur frequently, you can lower the setting level to avoid this phenomenon.
- Though you can specify the Level 1 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.



(4)-2 Level 1 to driving, Level 2 to braking

Code	Set value	Description
F40	3	Enable torque current limiter
F41	1	Level 1 to driving, Level 2 to braking

- Unless you set the Level 1 and Level 2 over the short-time rated torque, the short-time rated torque does not limit the torque.
- Though you can specify the Level 1 and the Level 2 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.
- You can use this specification to set the Level 1 as the short-time rated torque for driving and to set the Level 2 as the braking torque limiter due to the brake capacity for braking.
- You cannot use the digital input [TL2/TL1] to switch between the Level 1 and the Level 2.



(4)-3 Level 1 to upper limit, Level 2 to lower limit

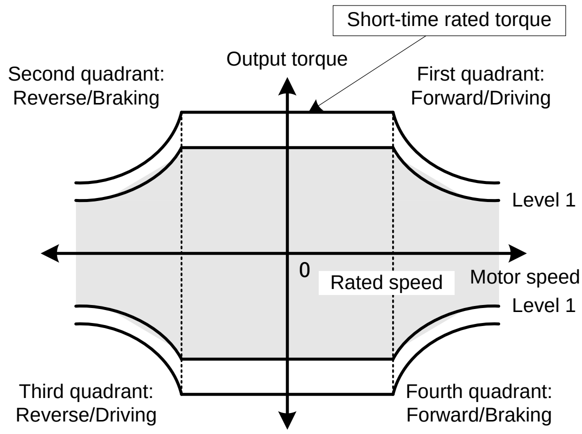
Code	Set value	Description
F40	3	Enable torque current limiter
F41	2	Level 1 to upper limit, Level 2 to lower limit

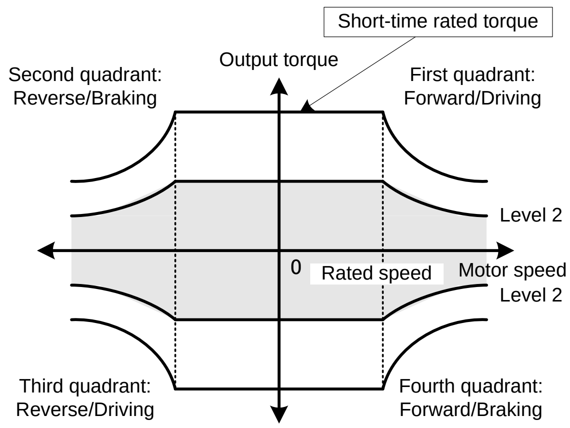
- Though this setting is possible, there is no such an application.

(4)-4 Level 1/Level 2 (switchable) to all four quadrants

Code	Set value	Description
F40	3	Enable torque current limiter
F41	3	Level 1/Level 2 (switchable) to all four quadrants

- When you turn on with assigning the torque limiter [TL2/TL1] (Level 1, Level 2 selection) to a digital input signal, you can switch between the Level 1 and the Level 2.





- Unless you set the Level 1 and Level 2 over the short-time rated torque, the short-time rated torque does not limit the torque.
- When protective actions (inverter overload OLU or motor overload OL1, OL2, OL3) occur frequently, you can lower the setting level to avoid this phenomenon. Though you can specify the Level 1 and Level 2 with both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.

F42	Torque Limiter Level 1 Source
F43	Torque Limiter Level 2 Source

Selects a mean that sets the torque limiter. These means are the function code, the analog input, the digital input card (DIA, DIB), the link (RS-485, T-Link, SX, field bus) and the PID output (PIDOUT)

When this function is activated (the torque limiter takes effect), the acceleration and the deceleration become longer than the set values.

F	4	2	T	−	L	I	M	−	L	V	L	1
F	4	3	T	−	L	I	M	−	L	V	L	2

- Level 1

Selects a mean that sets the Level 1

Data setting range: 0 (Function code F44)
1 (Ai [TL-REF1])
2 (DIA card)
3 (DIB card)
4 (Communications link)
5 (PID output)

- Level 2

Selects a mean that sets the Level 2

Data setting range: 0 (Function code F45)
1 (Ai [TL-REF2])
2 (DIA card)
3 (DIB card)
4 (Communications link)
5 (PID output)

< Setting example >

(1) Preparation

- Set 1, 2, or 3 to the function code F40 to enable the limiter.
- Use the function code F41 to set how to use the limiter Level 1 and Level 2.
- Use the function code F42 and F43 to assign inputs to the Level 1 and Level 2. If you want to set only the Level 1, use F42 only. Go to one of the steps from the following (2) to (6) according to the setting thus far.

(2) When using the function code

- Set 0 to both of the function code F42 and F43.
- Set a data for the Level 1 to F44 and that for the Level 2 to F45.

(3) When using the analog input

- Set 1 to both of the function code F42 and F43.
- Use E49 to E52 to select which analog input terminals among Ai1 to 4 (Ai3 and Ai4 are optional AIO) are used. Here we assume that Ai1 and Ai2 are assigned to the Level 1 and the Level 2 respectively.
- Connect the wires to the Ai1 and Ai2. An input of 10V corresponds to 150% (torque, power and torque current).
- See the "I/O check" screen of the KEYPAD panel to check if the inverter correctly recognizes the input while you are varying the voltage input from 0 to ±10V.
- See the description of the function codes E53 to E68 for voltage input setting (offset, dead zone, gain, bias, filter, and increment/decrement limiter).

(4) When using the DIA or the DIB card

- Set the hardware switch on the digital input card either to DIA or DIB.
- Set the function code F42 and F43 to 2 or 3 to use the DIA or the DIB respectively.
- You can assign the DIA (F42=2) to the Level 1 and the DIB (F43=3) to the Level 2 when you use two digital input cards and set one to DIA and the other to DIB.
- Connect the wires for the DIA and DIB cards. See the DI option section or the instruction manual supplied with the product for more details.
- See the "I/O check" screen of the KEYPAD panel to check if the inverter correctly recognizes the digital input.

(5) When using the communications link

- Set the function codes F42 and F42 to 4.
- Determine which link to be used. Refer the individual sections of the function description to study the detail of the links (RS-485, T-Link, SX, field bus).
- Set 1 or 3 to the function code H30 to enable the command data through the link. Note that setting 3 disables the operation through the terminal block and the KEYPAD panel.
- Write data from a master device (such as PC or PLC) to S10 (Limiter level 1) and S11 (Limiter level 2). The writing is complete when the normal response is sent back. You cannot confirm the writing on the inverter side. Since writing to S area (command data) is performed on the RAM (volatile memory) and written data disappear when your turn the inverter off, you should write necessary data every time when you turns on the inverter.

(6) When using the PID output

- Set 5 to the function code F42. Also set 5 to F43 to assign the PID output. Usually set the PID output to the upper limit and use the function code to set the lower limit.
- See the PID control block diagram (Section 4.1.9) or the PID description section to wire the system.
- You can display the PID output on the LED monitor of the KEYPAD panel.

F44	Torque Limiter Level 1
F45	Torque Limiter Level 2

Sets the torque limiter values (Level 1 and Level 2)

F	4	4	T	–	L	I	M	–	S	E	T	1
F	4	5	T	–	L	I	M	–	S	E	T	2

Data setting range: -300 to 300 (%)

F46	Mechanical Loss Compensation

Use to compensate the amount of the mechanical loss of a load.

F	4	6	T	–	M	E	C	–	L	O	S	

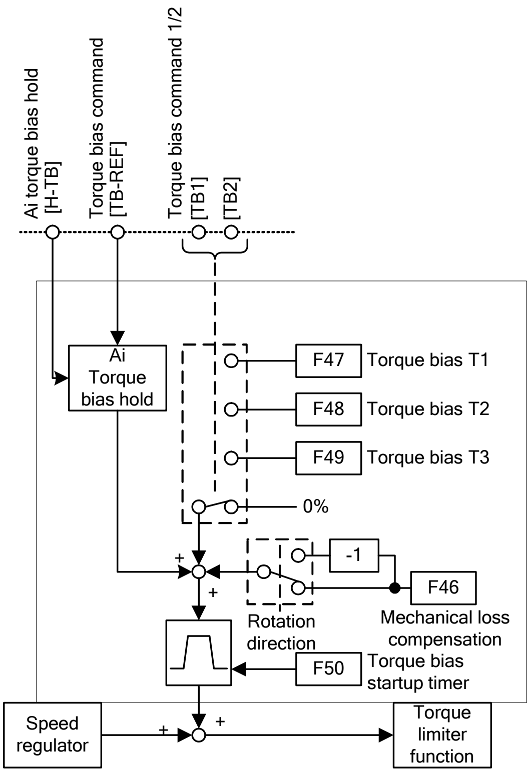
Data setting range: -300.00 to 300.00 (%)

F47	Torque Bias T1
F48	Torque Bias T2
F49	Torque Bias T3

You can add these setting values to the torque command values. The addition is conducted on a stage before the torque limiter. You can use the function selection Di, the torque bias command 1 [TB1] and the torque bias command 2 [TB2] to switch among three torque biases (T1, T2, T3).

F	4	7	T	–	B	I	A	S	1			
F	4	8	T	–	B	I	A	S	2			
F	4	9	T	–	B	I	A	S	3			

Data setting range: -300.00 to 300.00 (%)



F50	Torque Bias Startup Timer

Sets the time to increase the torque by 300%.

If there is a shock at the start of operation with a torque bias added, adjust this timer.

F	5	0	T	–	B	I	A	S	–	T	I	M

Data setting range: 0.00 to 1.00 (s)

F51 Torque Command Monitor (Polarity)

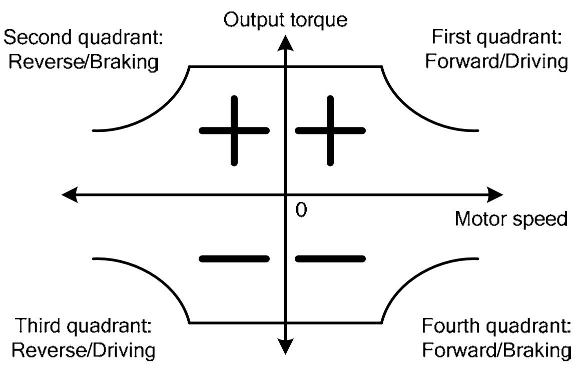
Sets the polarity for data display related to torque. (AO monitor, KEYPAD panel LED monitor, KEYPAD panel LCD monitor)

F51 T-REF-MNTR

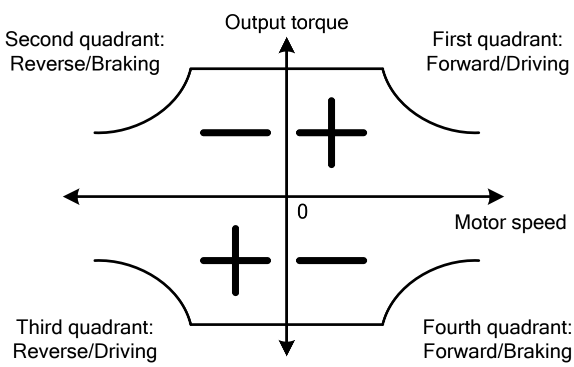
Data setting range: 0 (Torque polarity)
1 (+ for driving, − for braking)

The following table shows data related with torque. These values are displayed or transmitted with sign. Judge the meaning of signs from the F51 set value.

Display and output	Setting	Related data
KEYPAD panel LED monitor	3	Torque current command value
	4	Torque command value
	5	Calculated torque value
KEYPAD panel LCD monitor	Operation status monitor	Torque command value
	Alarm information	Torque command value on alarm
Analog output (AO1, 2, 3)	6	Torque current command value (torque ammeter, two-way deflection)
	8	Torque command value (torque meter, two-way deflection)
Function codes M (monitor codes)	M02	Torque command value
	M03	Torque current command value
	M07	Calculated torque value
	M08	Calculated torque current value
	M28	Torque command value on alarm
	M29	Torque current command value on alarm
	M33	Calculated torque value on alarm
	M34	Calculated torque current value on alarm



F51 = 0 (Torque polarity)



F51 = 1 (+for driving, −for braking)

F52	LED Monitor (Display coefficient A)
F53	**LED Monitor (Display coefficient B)**

Use these coefficients as conversion coefficient to determine the display values (process amount) of the load speed/line speed, the reference/feedback value of the PID regulator on the KEYPAD panel LED.

Data setting range: Display coefficient A: −999.00 to +999.00
Display coefficient B: −999.00 to +999.00

Load speed, line speed

Use the Display coefficient A of F52

Displayed value=Motor speed × (0.01 to 200.00)

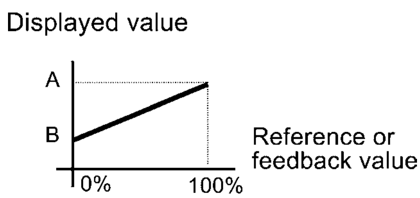
The effective display range is 0.01 to 200.00 while the setting range is ±999.00. The minimum value 0.01 or the maximum value 200.00 replaces a value out of the display range. Foe example, you should specify as F52=0.02 when the motor speed is 1500 (r/min) and the line speed is 30 (m/min).

Reference and feedback values for the PID regulator

Use F52 Display coefficient A to set the maximum value for display data and use F53 Display coefficient B to set the minimum value for display data.

Displayed value = (Reference or feedback value) × (Display coefficient A−B) + B

F	5	2	C	O	E	F		A				
F	5	3	C	O	E	F		B				



F54	LED Monitor (Display filter)

You do not have to display an instant value for some continuously changing data on the LED monitor of the KEYPAD panel. You can apply a filter for those data to prevent the flicker due to the change of the value.

Specify the time constant of the primary filter.

F	5	4	D	I	S	P	L	A	Y		F	L

Data setting range: 0.0 to 5.0 (s)

F55 LED Monitor (Item selection)

F55 specifies the running status item (listed below) to be monitored and displayed on the LED monitor.

F55 LED MNTR

Data for F55	Function	Unit	Description
0	Detected speed 1	(r/min)	Change display with F56 when motor is stopping
1	Speed command 4	(r/min)	Speed command 4 of ASR input
2	Output frequency	(Hz)	Slip included
3	Torque current command value	(%)	
4	Reference torque	(%)	
5	Calculated torque	(%)	
6	Input power	(kW, HP)	Switchable between kW and HP with F60.
7	Output current	(A)	
8	Output voltage	(V)	
9	DC link bus voltage	(V)	
10	Magnetic-flux command value	(%)	
11	Calculated magnetic-flux value	(%)	
12	Motor temperature	(°C)	Displays --- when NTC thermistor is not installed
13	Load shaft speed	(r/min)	Use F56 to change display when motor is stopping
14	Line speed	(m/min)	
15	Ai adjustment value (12)	(%)	
16	Ai adjustment value (Ai1)	(%)	
17	Ai adjustment value (Ai2)	(%)	
18	Ai adjustment value (Ai3)	(%)	Displayed when an option is used
19	Ai adjustment value (Ai4)	(%)	Displayed when an option is used
20	PID command value	(%)	Displayed in the PID mode
21	PID feedback value	(%)	
22	PID output value	(%)	
23	Option monitor 1	(HEX)	Displayed when an option is used (HEX: Hexadecimal data)
24	Option monitor 2	(HEX)	
25	Option monitor 3	(DEC)	Displayed when an option is used (DEC: Decimal data) Positive data.
26	Option monitor 4	(DEC)	
27	Option monitor 5	(DEC)	Displayed when an option is used (DEC: Decimal data) Positive and negative data.
28	Option monitor 6	(DEC)	
30	Load factor	(%)	
31	Input power	F60 = 0 (kW) F61 = 1 (HP)	
32	Input watt-hour	(kWh)	Input watt-hour x 100 (kWh)

- Values 20 to 22 display when H20 (PID Control, Mode selection) is set at "1" (Active), "2" (Inverse action 1) or "3" (Inverse action 2), respectively.
- Values 18, 19, 23 to 28 display when specific control options are mounted. See the corresponding option section in Chapter 6 for more details.

F56 LED Monitor (Display when stopped)

F56 switches the F55 data display between the detected data and reference data when the motor is stopped (No inverter output, STOP state).

F56 LED MNTR2

Data setting range: 0 (Display reference data)
1 (Display detected data (actual data))

F56 takes effect when F55 = 0 (Detected speed 1), = 13 (Load shaft speed), or = 14 (Line speed).

F57 LCD Monitor (Item selection)

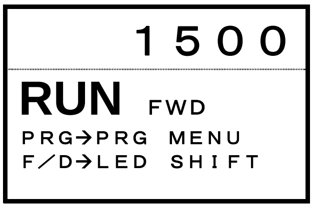
F57 selects the display contents of the LCD monitor in the Running mode.

F57 LCD MNTR

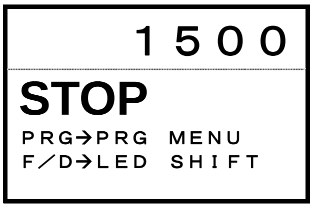
Data setting range: 0 (Running status, rotation direction, and date & time or operation guide)
1 (Bar graphs for motor speed, output current, and torque command value)

<u>When F57 = 0</u>

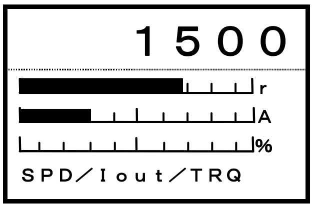
In running



At a stop



<u>When F57 = 1</u>



Full scale values for bar graphs

Display item	Full scale value
Motor speed	Maximum speed (F03, A06, and A106)
Output current	Motor rated current × 200%
Torque command value	Rated torque × 200%

Note: The scale is not adjustable.

F58 LCD Monitor (Language selection)

F58 selects a language to be displayed on the LCD monitor.

F	5	8	L	A	N	G	U	A	G	E		

Data for F58	Displayed language	Data for F58	Displayed language
0	Japanese	4	Spanish (Available soon)
1	English	5	Italian (Available soon)
2	German (Available soon)	6	Chinese
3	French (Available soon)	7	Korean

Note 1: The language in the LCD screens shown in this manual is English.

Note 2: L codes are displayed in Japanese, English or Chinese, P, A and o codes in Japanese or English, and U codes in English only.

Note 3: Even if Korean is selected, the function code names are shown in English.

Note 4: When F58 = 2 to 5, the LCD screens are shown in English.

F59 LCD Monitor (Contrast control)

F59 controls the contrast of the LCD monitor. Increasing the data value increases the contrast and decreasing it decreases the contrast.

F	5	9	C	O	N	T	R	A	S	T		

Data for F59	0, 1, 2 ………… 8, 9, 10	
Screen	Light	Dark

F60 Output Unit (HP/kW)

F60 switches the display unit of the inverter output (input power) shown on the LED monitor and LCD monitor and the display unit of M1 motor selection (P02) between kW and HP.

F	6	0	k	W	/	H	P					

Data setting range: 0 (kW)
1 (HP)

F61	ASR1 (P-gain)
F62	**ASR1 (Integral constant)**

F61 and F62 specifies the P-gain and integral constant of the ASR1.

F	6	1	A	S	R	1	–	P				
F	6	2	A	S	R	1	–	I				

Data setting range: F61 = 0.1 to 500.0 (times)
F62 = 0.000 to 10.000 (s) (Setting 0.000 disables the integral constant.)

■ **P gain**

Adjust according to the mechanical inertia (inertia and mechanical constant) connected to the motor shaft. The factory default value 10.0 corresponds to the inertia of a single FRENIC-VG motor. The following table provides a guideline for setting. If you drive a machine whose inertia is larger than that of the FRENIC-VG motor when converted into a motor shaft inertia, set a value larger than 10.0. See Chapter 2 "Specifications" for the inertia data of the standard motors.

Inertia	Single VG standard motor to Medium to Large
P gain	10.0 to Medium to Large

P gain = 1.0 is defined such that the torque command is 100% (corresponding to the maximum speed setting) when the speed deviation (speed command − observed speed) is 100%.

⚠CAUTION

If you set a too large value to gain compared with the inertia, though you can get faster control response, the motor may present an overshoot or a hunting. Also the motor or the machine may generate oscillation due to mechanical resonance or over-amplified noise.

If you set a too small value to gain compared with the inertia, the control response slows down and it may take time to settle down the speed fluctuation at low speed.

■ **Constant of integration**

Sets the constant of integration of the Automatic Speed Regulator (ASR). You can specify a value in the range from 0.000 to 10.000 s to set the speed deviation (speed command-observed speed) at steady state to zero. Setting 0.000 s disables the integration (P control only). The integration means to sum the deviation at a specified interval. A smaller interval means a smaller summation interval that presents faster response. On the other hand, larger interval extends summation interval to reduce the effect on the ASR. Set a small value to reach the speed reference faster while allowing overshoots.

⚠CAUTION

Integration action is a delay element. The constant of integration corresponds to the gain of a delay element. Increasing the response of the integration action makes the delay element larger, destabilizing the control system including motors and machines. The instability presents overshoots and oscillations. Thus, one measure to restrain the mechanical resonance such as abnormal mechanical noises from motors and gears is to increase the constant of integration.

However, if you do not want a slower response, the machine side may need measures such as reviewing machines presenting mechanical resonance. You can also use F66 "ASR output filter".

F63 ASR1 (Feedforward gain)

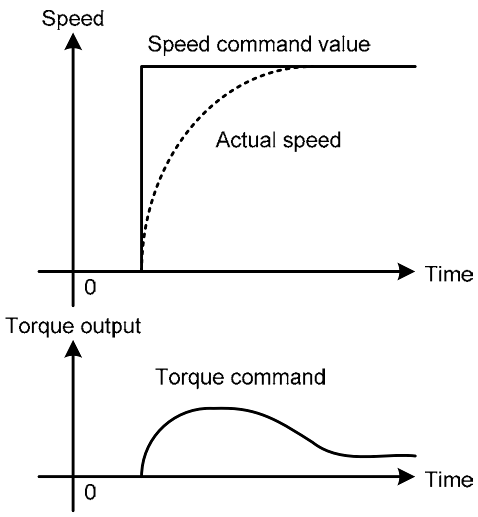
F63 specifies the feedforward gain for a feedforward control that adds torque determined by the change of the speed command to the torque command directly.

The PI control by the ASR is a feedback control adjusting the speed against the command according to its control result (Actual speed). This control can adjust deviations due to what are not measurable such as unexpected disturbances and uncertain characteristics of control subjects. However, known changes in command value are followed after they appear in the deviation (Speed command - Actual speed). Since you can obtain a control value (torque command) for a known factor, you can expect a faster control by adding it to the torque command directly. This function is provided for this purpose.

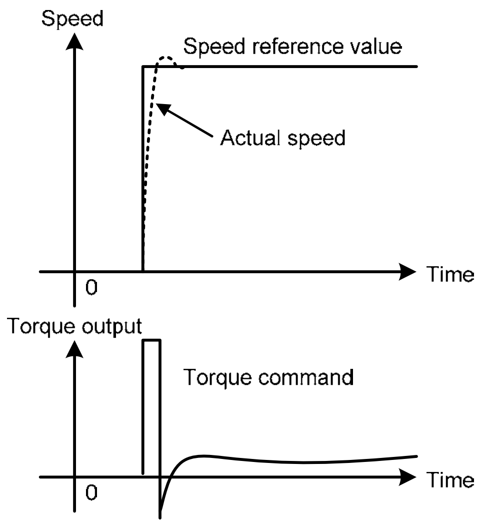
F63 ASR1–FF

Data setting range: 0.000 to 9.999 (s)

It is effective when the inertia is known. The differences in follow-up speed against the command value between the feedforward and non-feedforward controls are conspicuous as shown in the figures below. Note that it is necessary to balance the PI constants of the feedback control and this setting to obtain the maximum effect.



FF control disabled (PI feedback control only)



FF control enabled (PI feedback control also enabled)

Though increasing the P gain of the ASR realizes the effect described above, increased gain also increases response resulting in negative effects (such as mechanical resonance or vibration).

F64	ASR1 (Input filter)

F64 specifies the time constant for the first-order lag filter applied to a reference speed. Usually do not change the factory default.

Use this filter when you cannot stabilize the analog speed setting voltage at control terminal [12] after you failed to eliminate the causes. If noise is the case, first try measures in hardware such as separating control wiring, grounding, or connecting a capacitor to the terminal [12] and [11] in parallel before you use F64 as a software measure.

F	6	4	A	S	R	1	–	I	N			

Data setting range: 0.000 to 5.000 (s)

F65	ASR1 (Detection filter)

F65 specifies the time constant for the first-order lag filter applied to the detected speed. Usually do not change the factory default. In particular, it is not necessary to change the factory default when a pulse generator (PG) is used for speed detection. Use an oscilloscope to check the waveform if the output of the PG is unstable.

Use this filter when you use the line speed detection [LINE-N] signal for speed detection and the ripple presents on the signal. Note that a large setting will reduce the response of the speed control loop. A too large setting may destabilize the control.

F	6	5	A	S	R	1	–	D	E	T		

Data setting range: 0.000 to 0.100 (s)

F66 ASR1 (Output filter)

F66 specifies the time constant for the first-order lag filter applied to the torque command. Use this filter for a mechanical resonance after you failed to adjust the ASR gain or the constant of integration to eliminate it.

F	6	6	A	S	R	1	–	O	U	T		

Data setting range: 0.000 to 0.100 (s)

Check the cause and the oscillation frequency of a mechanical resonance such as a vibration by gear backrush or a rope vibration in a vertical transfer. You should take measures in the inverter side after you failed to investigate and fix machine devices to eliminate the resonance.

Measures to eliminate mechanical resonance

1) Reduce response speed

- Reduce the ASR P gain to reduce the amplitude of the resonance.
- Increase the ASR I constant to shift the resonance point to lower frequency to restrain the high frequency resonance.

2) Use ASR output filter

- Though you can reduce the resonance amplitude, excessive filter elements may cause instability.

3) Use oscillation suppressing observer

- See H46 "Observer type selection" for more details.

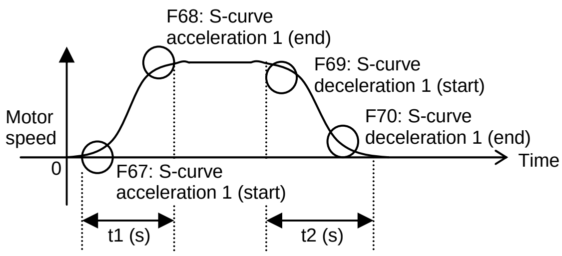
F67 S-curve Acceleration 1 (Start)

F68 S-curve Acceleration 1 (End)

F69 S-curve Deceleration 1 (Start)

F70 S-curve Deceleration 1 (End)

These function codes arrange the speed reference value to form a curve at the start and the end of acceleration and deceleration. You can realize smooth acceleration and deceleration actions without shocks.



F	6	7	S	–	A	C	C	–	S	T	1	
F	6	8	S	–	A	C	C	–	A	R	1	
F	6	9	S	–	D	E	C	–	S	T	1	
F	7	0	S	–	D	E	C	–	A	R	1	

Data setting range: 0 to 50 (%)

Setting the S-curve extends acceleration time 1 (F07) and deceleration time 1 (F08) according to the following expressions.

$$\text{t1 (s)} = \text{Acceleration time (s)} \times \left(1 + \frac{\text{S-curve acceleration start side (\%)}}{100\ (\%)} + \frac{\text{S-curve acceleration end side (\%)}}{100\ (\%)}\right) \text{(s)}$$

$$\text{t2 (s)} = \text{Deceleration time (s)} \times \left(1 + \frac{\text{S-curve deceleration start side (\%)}}{100\ (\%)} + \frac{\text{S-curve deceleration end side (\%)}}{100\ (\%)}\right) \text{(s)}$$

F72	Pre-excitation Mode

F72 specifies when pre-excitation should start. Pre-excitation flows exciting current through a motor beforehand in order to make the response quicker at the start of motor driving.

F 7 2 P R E E X S E L

Data setting range: 0

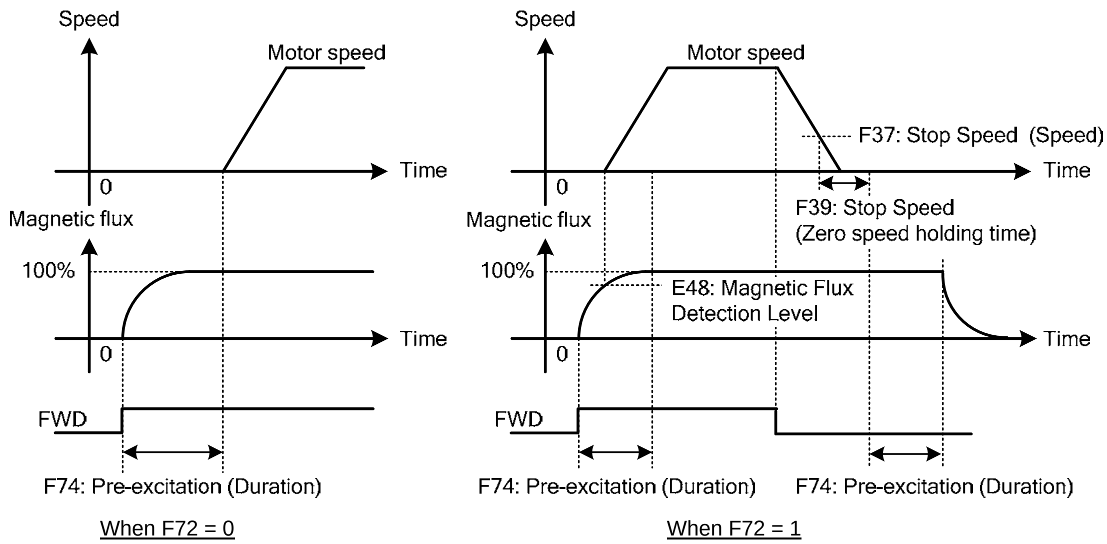
Cause pre-excitation at the time of a startup. Pre-excitation continues for the duration specified by F74

1

Cause pre-excitation at the time of a startup and stop.

At the time of a startup, pre-excitation continues for the duration specified by F74 or until the magnetic flux command reaches the detection level specified by E48, whichever is earlier.

After a stop, pre-excitation continues until the duration specified by F74 elapses. It is effective for starting the motor immediately following a stop (when pre-excitation is in progress), e.g., for inching (intermittent running).

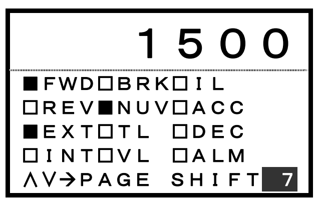


When F72 = 0, set the pre-excitation duration (F74) so that the motor starts rotating after the magnetic flux has been saturated (100%), as shown in the above graph.

Note: The motor may rotate during pre-excitation, so be sure to use a mechanical brake to avoid unexpected rotation.

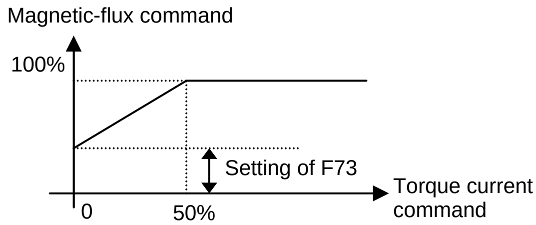
Even if F72 = 1, under vector control without speed sensor or under torque control, pre-excitation after a motor stop does not occur. When H09 ≠ 0 (Auto search is enabled) under vector control without speed sensor, pre-excitation at a startup caused when H72 = 0 applies.

Whether a motor is during pre-excitation or in normal operation can be checked with the running status page in Menu #4 "I/O CHECK." ■EXT indicates "during pre-excitation" and ☐EXT, "in normal operation."



F73	Magnetic Flux Level at Light Load

You can specify a small value to reduce the electromagnetic noise of a motor at light load. The magnetic-flux command decreases according to the torque current command to reduce the electromagnetic noise.



F	7	3	M	I	N		F	L	U	X		

Data setting range: 10 to 100 (%)

Note: F73 is valid only under vector control with speed sensor.

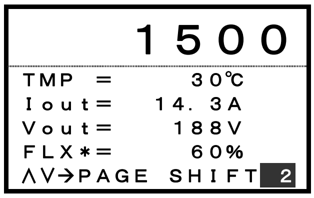
You can view the level (%) of the magnetic-flux command on the "Operation monitor" of the KEYPAD panel.

See "FLX*" (magnetic-flux command) on the operation monitor screen "Operation monitor".

The value is usually 100% and decreased in the low output range.

This function reduces the magnetic-flux according to the setting as shown in the graph. The graph shows that the magnetic-flux decreases to 60%

Under vector control without speed sensor, the magnetic flux level is fixed at 100%.



F74	Pre-excitation (Duration)

F74 specifies the pre-excitation duration.

F	7	4	P	R	E		E	X		t		

Data setting range: 0.0 to 10.0 (s)

F75	Pre-excitation (Initial level)

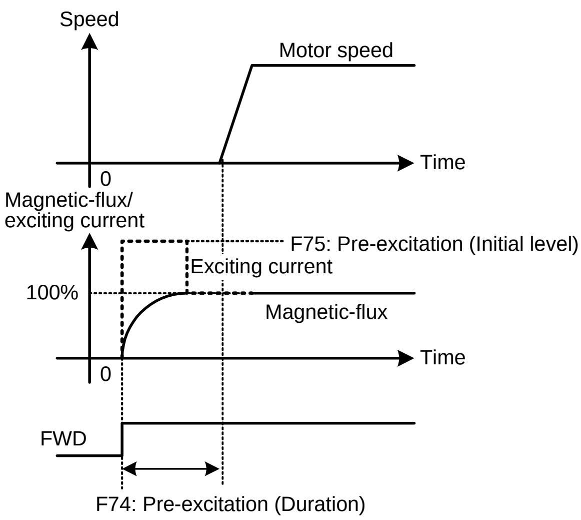
Sets the initial level of the pre-excitation.

F	7	5	F	L	U	X		F	O	R	C	E

Data setting range: 100 to 400 (%)

When you want to reduce the pre-excitation time (function code F74) to establish the magnetic-flux quickly, set the exciting current high.

The transient response to the exciting current command until the magnetic-flux is established 100% depends on the secondary time constant of a motor (exciting inductance/resistor). This function applies more than 100% of the exciting current to establish the magnetic-flux faster. The initial level ends when the magnetic-flux is established 100%, and the exciting current returns 100%.



Under vector control without speed sensor and when H09 = 1 or 2 (Auto search is enabled), the data setting range is limited to 200 to 400%. Even if F75 is set at 100%, 200% applies.

If a trip occurs in auto search with 60 Hz or higher (1800 r/min in terms of 4-pole motor), increasing the F75 setting may improve the problem.

F76	Speed Limiter (Mode)
F77	Speed Limiter (Level 1)
F78	Speed Limiter (Level 2)

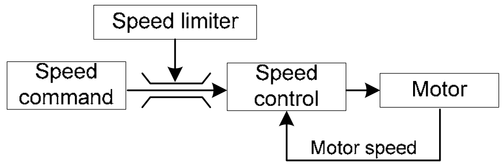
The speed control and the torque control (torque control, torque current control) differs in the usage of these function codes.

Usage for speed control

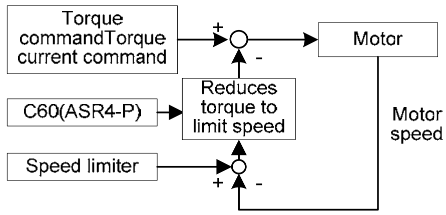
Since the inverter usually (factory setting) controls speed (internal ASR enabled, motor controlled by speed command), and the speed limiter is applied to the speed command (See "(1) Speed control") You can use the function code H41 "Torque command selection" and H42 "Torque current command selection" to select a specification other than the "internal ASR enabled" to operate the inverter to control the torque. This is the case, the speed control is applied to the motor speed (speed detection/speed estimation). Since the inverter does not control the speed, the control adds negative torque bias to the torque command when the motor accelerates beyond the limiter value. You can use the [I2] input as a bias for the speed limiter instead of the speed command (see "(2) Torque control").

You can set ON to the digital input signal [N-LIM] to disable (cancel) the speed limiter function.

(1) For speed control



(2) For torque control



(1) Speed control

You can set the speed limit to the speed command value.

F	7	6	N	–	L	I	M	–	M	O	D	E

- Method selection

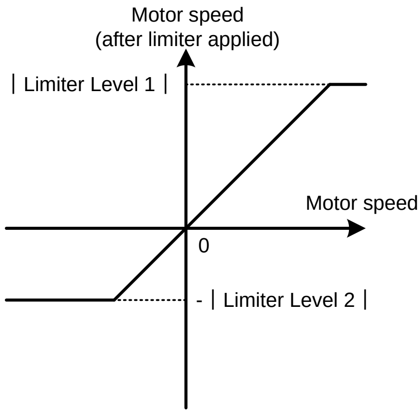
Data setting range: 0 (Limit forward (Level 1) and reverse (Level 2) individually.)
1 (Limit forward and reverse in Level 1.)
2 (Limit upper limit by Level 1 and the lower limit by Level 2.)
3 (Reserved. (Equivalent to "0").

F	7	7	N	–	L	I	M	–	L	V	L	1
F	7	8	N	–	L	I	M	–	L	V	L	2

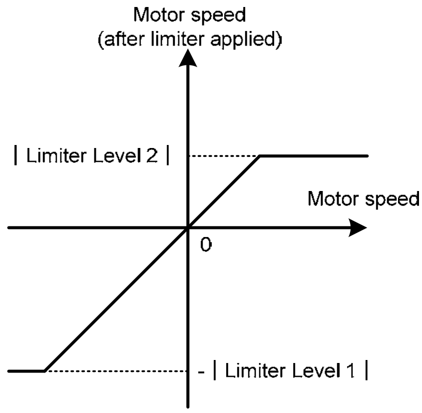
- Level 1, 2

Data setting range: -110.0 to 110.0 (%)

When F76 = 0, the upper and lower limit levels during FWD and REV operations switch between Levels 1 and 2.

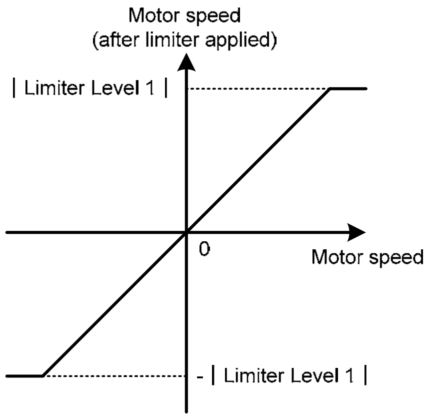


When F76 = 0, FWD = ON

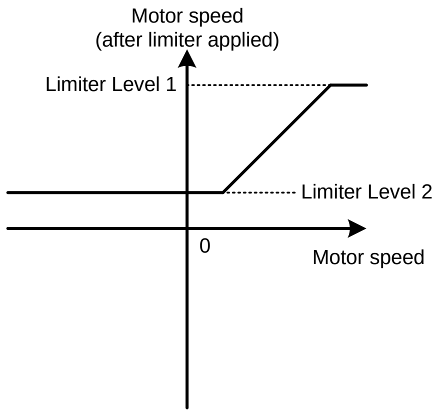


When F76= 0, REV = ON

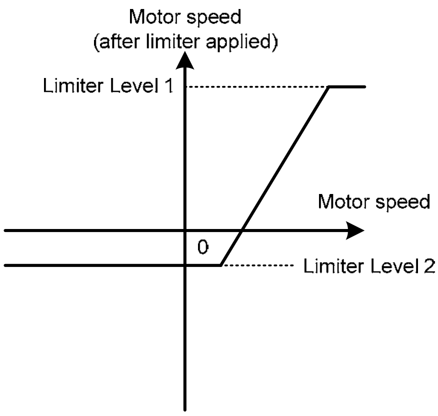
When F76 = 1 or 2, the speed limiter acts as shown below.



When F76 = 1



When F76 = 2



When F76 = 2

⚠CAUTION

Specify such that the limiter Level 1 > the limiter Level 2 for F76 = 2 (Upper limit by the Level 1 and the lower limit by the Level 2). If you specify as the limiter Level 1 < the limiter Level 2, the speed reference is fixed to the limiter Level 2. In this state, turning off the operation does reduce the speed reference and the operation continues.

You may be injured.

< Example of a setting inhibiting reverse rotation >

When you want to inhibit reverse rotation (forward rotation directed by reverse rotation command) while forward rotation command is directed, specify as F76 = 0, the limiter level 1 = 100.0% and the limiter level 2 = 0.0%.

(2) Torque control (torque command, torque current command)

F76 N-LIM-MODE

- Method selection

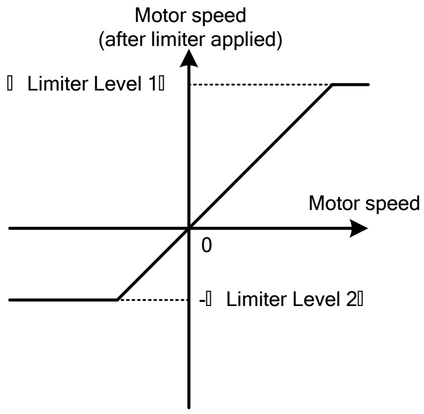
Data setting range: 0 (Limit forward and reverse individually. FWD and REV switch the levels.
1 (Level 1 limits forward and reverse.)
2 (Invalid (Even if specified, the setting is assumed to be "0."))
3 (Individual limiters for forward and reverse rotation. [12] input is added as a variable part of limiters.)

F77 N-LIM-LVL1
F78 N-LIM-LVL2

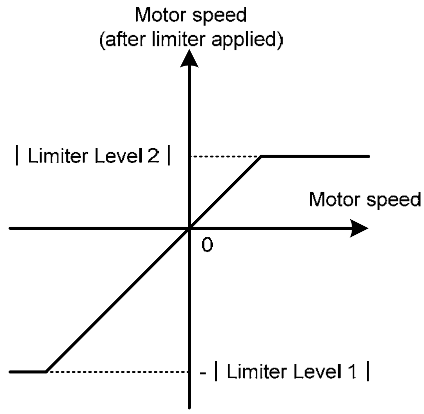
- Level 1, 2

Data setting range: -110.0 to 110.0 (%)

<u>When F76 = 0,</u> the upper and lower limit levels during FWD and REV operations switch between Levels 1 and 2.

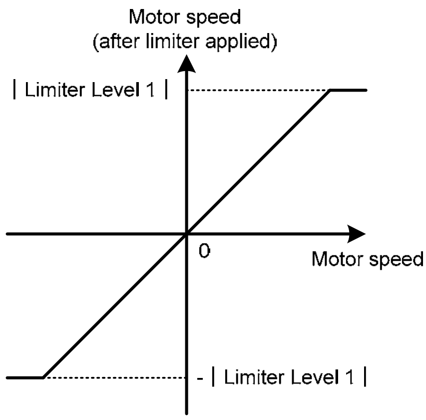


When F76 = 0, FWD = ON



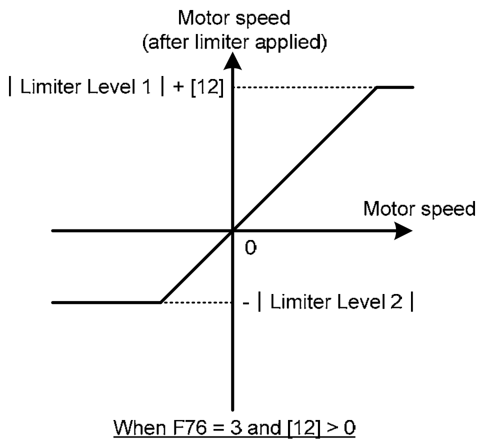
When F76= 0, REV = ON

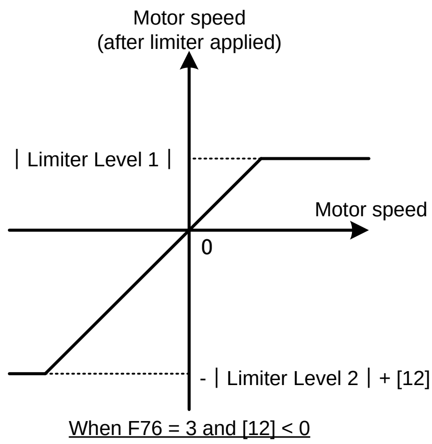
<u>When F76 = 1,</u> the speed limiter acts as shown below.



When F76 = 1

When F76 = 3, input to [12] acts as a bias as shown below.





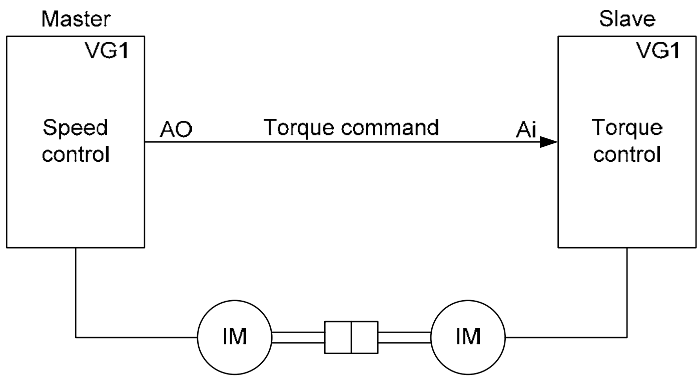
Input voltage for [12] is ± 10V at the maximum motor speed (± 100%).

Use C60 (ASR4-P) to adjust the speed stability under speed limit.

⚠CAUTION
When the magnetic flux decreasing function (F73) is used, the factory default of the ASR4 P-gain (C60 = 10) causes the response of the speed limiter to slower so that the speed may not be controlled. In particular, setting F73 data to an extremely small value (10% or 20%) may cause large speed hunting. If it happens, increase the C60 setting (ASR4 P-gain) or increase the F73 setting to stabilize the speed.

The torque limit in accordance with the line speed (input at [12]) can be added if F76 is "3."

To perform mechanically coupled operation with torque command handover (see the figure below), enter a slightly larger value (+5%) than that specified on the master as a speed limit level for the inverter (slave) driven under torque control.



Chap. 4 CONTROL AND OPERATION

F79 | Motor Selection (M1, M2, M3)

The FRENIC-VG can hold three sets of motor parameters (M1, M2 and M3) which can be selected by F79 or X terminal functions (***M-CH2*** and ***M-CH3***)

F79 M1-3SELECT

Data setting range: 0 (Select M1. Note that the terminal input has higher priority as shown below.)

When ***M-CH2*** and ***M-CH3*** = (OFF, OFF) or (ON, ON), or no ***M-CH2*** or ***M-CH3*** has been assigned, M1 is selected.
When ***M-CH2*** and ***M-CH3***) = (ON, OFF), M2 is selected.
When ***M-CH2*** and ***M-CH3***) = (OFF, ON), M3 is selected.

1 (Select M2.)

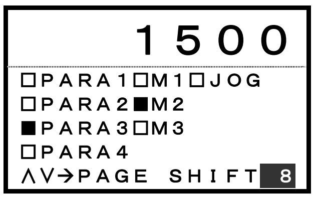
2 (Select M3.)

Merits and restrictions for selecting M1, M2, or M3

	When M1 (1st motor) is selected	When M2 (2nd motor) is selected	When M3 (3rd motor) is selected
Control type	Set by P01 Vector control for IM with speed sensor Vector control for IM without speed sensor Vector control for PMSM with speed sensor V/f control Simulation mode	Set by A01 Vector control for IM with speed sensor Vector control for IM without speed sensor Vector control for PMSM with speed sensor V/f control	Set by A101 Vector control for IM with speed sensor Vector control for IM without speed sensor Vector control for PMSM with speed sensor V/f control
Motor parameters	Function codes F03 to F05, F10 to F12, P03 to P51, H47, H49, H51, H112 to H118, H160 to H164, o09 to o11 When a FRENIC-VG motor is selected, the inverter automatically set data to the above function codes.	Function codes A02 to A71, H48, H50, H52, H170 to H174 To be set manually.	Function codes A102 to A171, H125 to H127, H180 to H184 To be set manually.
Protective functions specific to motor parameters	Provided. When a FRENIC-VG motor is selected with P02 (P02 = 0 to 35, 38 to 50) or P-OTHER is selected (P02 = 36), the write-protect function becomes activated.	Not provided.	Not provided.

You can use the "Effective sets of motors/parameters" on the "I/O check" screen of the KEYPAD panel to check the currently selected motor set (M1, M2, M3).

If the motor set 2 is selected, ■ M2 is indicated.



Answer back signals are put on the DO output [SW-M2] and [SW-M3] to indicate whether the motor switch among motor set (M1, M2, M3) is completed in the inverter. See E15 to E27 for more information. We recommend to prepare a sequence to check the DO for the answer back when you use the terminal input signals [MCH2] and [MCH3] to switch motors.

It is recommended to activate overcurrent suppression function (H58 = 1) when M3 is selected (V/f control).

F80 Switching between HD, MD and LD Drive Modes

F80 specifies whether to drive the inverter in the high duty (HD), medium duty (MD) or low duty (LD) mode.

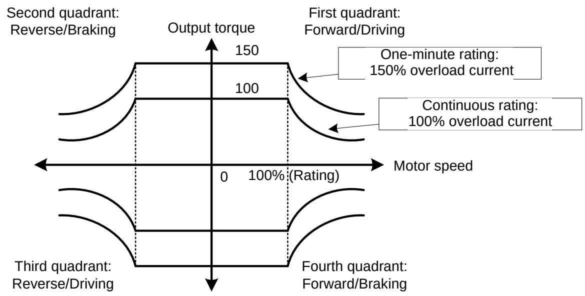
F80 Ir SELECT

Data setting range: 0, 2 (High Duty, overload current 150%-1 min, 200%-3 sec.)
1 (Low Duty, overload current 120%-1 min)
2 (Middle Duty, overload torque 150%-1 min)

Overload current means to apply overload limiter by torque current (corresponding armature current of a DC motor), and the torque decreases in proportion to the decrease of the magnetic-flux above the rated speed (100%).

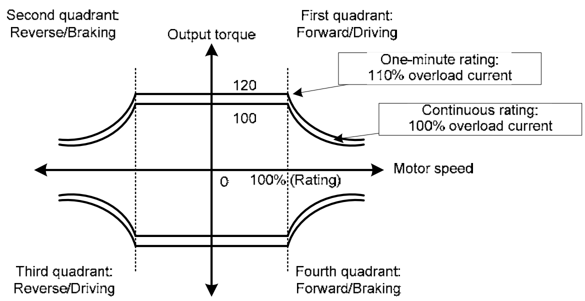
- Torque characteristics for HD mode

Application
Use for general constant torque applications including speed control with torque limit for winding machines, wire drawing machines, and test machines and control by direct torque command.



- Torque characteristics for LD/MD mode

Application
Use for applications that do not require overload capability for a short period such as extruding machines and centrifugal separators. Also suitable for applications where the operation cycle is short and torque is limited to 100% or less since the root-mean-square current exceeds the rated current of an inverter (Large press machines).



You can choose an inverter by one or two ranks lower than the HD-mode inverter. Note that the maximum carrier frequency is smaller than that in the HD mode. See Chapter 2, Section 2.1 "Standard Specifications" for more details

(Note) Replacing the HT-rating VG7 with the FRENIC-VG

The FRENIC-VG does not support the HT rating equivalent of the VG7. When replacing the HT-rating VG7, use the FRENIC-VG with one capacity rank higher.

Note that the 200 V class series inverters of 7.5 to 22 kW and 400 V class series ones of 18.5 to 22 kW can be replaced with the FRENIC-VG with the same capacity as long as the carrier frequency is 10 kHz or below.

Drive mode	Inverter capacity (kW)	Carrier frequency (kHz)	Applied motor (relative to the inverter capacity)	Overload rating
HD "Heavy duty load" (F80 = 0)	0.75 to 45 (200V) 3.7 to 55 (400V)	2 to 7 to 15	Same capacity	Current 150% 1 min 200% 3 s
	55 to 90 (200V) 75 to 400 (400V)	2 to 7 to 10		
	500 to 630 (400V)	2 to 5	Same capacity	
MD "Medium duty load" (F80 = 3)	90 to 400 (400V)	2 to 4	One rank higher capacity	Current 150% 1 min
LD "Low duty load" (F80 = 1)	30 to 90 (200V) 30 to 630 (400V)	2 to 10/6/4	One rank higher capacity	Current 120% 1 min

If the LD or MD mode is selected for the inverter capacity not available to the mode, the inverter runs in the HD mode.

F81 Offset for Speed Setting on Terminal [12]

F81 specifies an offset for analog speed input on terminal [12]. Use this setting for adjustment of out-of-offset signals sent from external equipment.

F81 12 OFFSET

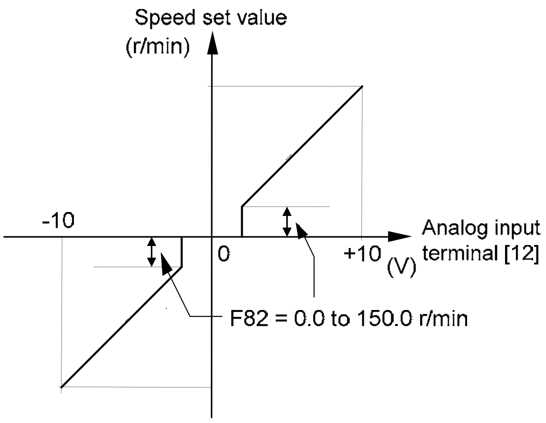
Data setting range: -30000 to 30000 (r/min)

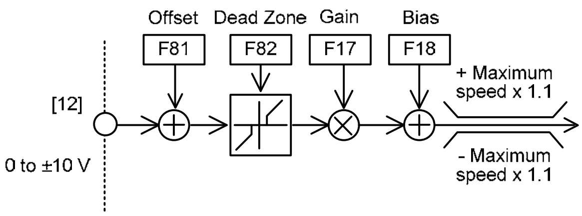
F82 Dead Zone for Speed Setting on Terminal [12]

F82 specifies the dead zone speed for analog speed input on terminal [12] to limit the ±speed setting value within the range of ±F82 data to 0 r/min.

F82 12 BLIND

Data setting range: 0.0 to 150.0 (r/min)





F83 Filter for Speed Setting on Terminal [12]

F83 specifies a time constant determining the first order delay of the analog speed input on terminal [12].

F	8	3	1	2		F	I	L	T	E	R	

Data setting range: 0.000 to 5.000 (s)

F84 Display Coefficient for Input Watt-hour Data

F84 specifies a display coefficient for displaying the input watt-hour data (M116).

Input watt-hour data (M116) = F84 x M115 (Input watt-hour) (Unit: 100 kWh)

F	8	4	P	W	R		C	O	E	F		

Data setting range: 0.000 to 9999
(Specification of "0.000" clears the input watt-hour data and stops counting.)

Setting the F84 data to 1/1000 of the electric rate per 100 kWh enables the total electricity price (in units of ¥1,000) to be displayed. If the electric rate is ¥18 per kWh, for example, setting the F84 data to "1.8" displays 18.00 (thousand yen) if the input watt-hour data is 10.00 (100 kWh).

F85 Display Filter for Calculated Torque

F85 specifies a display filter for outputting the calculated torque on the LED and LCD monitors.

F	8	5	T	R	Q		F	I	L	T	E	R

Data setting range: 0.000 to 1.000 (s)

4.3.2 E codes (Extension Terminal Functions)

E01 to E13	X Terminal Function

E01 to E13 assign commands (listed below) to general-purpose, programming digital input terminals, [X1] to [X9] and [X11] to [X14].

([X11] to [X14] are available when the optional OPC-VG1-DIOA is mounted or a communications option (e.g., RS-485, T-Link, SX-bus, and fieldbus) is mounted.)

Before using these terminal commands, see Chapter 4, Section 4.1 "Control Block Diagrams" and check the switching positions of the control contacts.

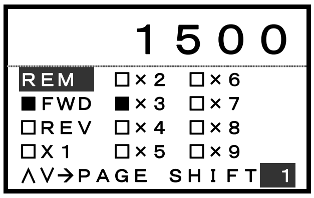
The FRENIC-VG runs under four drive controls: "Vector control for IM with speed sensor," "Vector control for IM without speed sensor," "V/f control for IM," and "Vector control for PMSM with speed sensor." Some terminal commands apply exclusively to the specific drive control, which is indicated in the "Drive control" column in the function code tables given in Section 4.2.

Using digital input terminals

A total of 13 digital inputs are available--nine on terminals [X1] to [X9] as standard and four on terminal [X11] to [X14] as option (when a DIOA option is mounted). Using the communications link (RS-485, T-Link, SX-bus and fieldbus) enables access to those 13 digital inputs.

Configuration procedure

- Select a desired function (***BX*** ("Coast to a stop") in this example).
- Assign ***BX*** to any one of terminal [X1] to [X9] and [X11] to [X14]. To assign it to terminal [X3], for example, set "7" to Function code E03.
- Turn [X3] ON from external equipment to activate ***BX*** ("Coast to a stop"). Turn it OFF to deactivate ***BX***.
- To check the ON/OFF status of [X3], use Menu #4 "I/O Checking" (REM screen) on the keypad and check that the box of the X3 appears black (■) as shown at the right.
- When accessing to the digital inputs via the communications link, see the COMM screen in Menu #4 "I/O Checking."



Configuring contacts ("normal open" or "normal close")

Terminals [X1] to [X9] can be configured individually as a "normal open" or "normal close" contact with Function code E14. For details refer to the description of E14.

E	0	1	X	1		F	U	N	C			
						|						
E	1	3	X	1	4		F	U	N	C		

Data setting range: 0 to 83

Function code data	Terminal commands assigned	Symbol	Function code data	Terminal commands assigned	Symbol
0, 1, 2, 3	Select multistep speed (1 to 15 steps)	***SS1***, ***SS2***, ***SS4***, ***SS8***	27	Synchronization operation command (PG (PR) optional function)	***SYC***
4,5	Select ASR and ACC/DEC time (4 steps)	***RT1, RT2***	28	Lock at zero speed	***LOCK***
6	Enable 3-wire operation	***HLD***	29	Pre-excitation	***EXITE***
7	Coast to a stop	***BX***	30	Cancel speed limiter	***N-LIM***
8	Reset alarm	***RST***	31	Cancel H41 (Torque command)	***H41-CCL***
9	Enable external alarm trip	***THR***	32	Cancel H42 (Torque current command)	***H42-CCL***
10	Ready for jogging	***JOG***	33	Cancel H43 (Magnetic flux command)	***H43-CCL***
11	Select speed command N2/N1	***N2/N1***	34	Cancel F40 (Torque limiter mode 1)	***F40-CCL***
12	Select motor 2	***M-CH2***	35	Select torque limiter level 2/1	***TL2/TL1***
13	Select motor 3	***M-CH3***	36	Bypass ACC/DEC processor	***BPS***
14	Enable DC braking	***DCBRK***	37, 38	Select torque bias command	***TB1,TB2***
15	Clear ACC/DEC to zero	***CLR***	39	Select droop control	***DROOP***
16	Switch creep speed under UP/DOWN control	***CRP-N2/N1***	40	Zero-hold Ai1	***ZH-AI1***
17	UP (Increase speed)	***UP***	41	Zero-hold Ai2	***ZH-AI2***
18	DOWN (Decrease speed)	***DOWN***	42	Zero-hold Ai3 (AIO optional function)	***ZH-AI3***
19	Enable data change with keypad	***WE-KP***	43	Zero-hold Ai4 (AIO optional function)	***ZH-AI4***
20	Cancel PID control	***KP/PID***	44	Reverse Ai1 polarity	***REV-AI1***
21	Switch normal/inverse operation	***IVS***	45	Reverse Ai2 polarity	***REV-AI2***
22	Interlock (52-2)	***IL***	46	Reverse Ai3 polarity (AIO optional function)	***REV-AI3***
23	Enable data change via communications link	***WE-LK***	47	Reverse Ai4 polarity (AIO optional function)	***REV-AI4***
24	Enable communications link	***LE***	48	Inverse PID output	***PID-INV***
25	Universal DI	***U-DI***	49	Cancel PG alarm	***PG-CCL***
26	Enable auto search for idling motor speed at starting	***STM***	50	Cancel undervoltage alarm	***LU-CCL***

Function code data	Terminal commands assigned	Symbol	Function code data	Terminal commands assigned	Symbol
51	Hold Ai torque bias	***H-TB***	72	Toggle signal 1	***TGL1***
52	STOP1 (Decelerate to stop with normal deceleration time)	***STOP1***	73	Toggle signal 2	***TGL2***
53	STOP2 (Decelerate to stop with deceleration time 4)	***STOP2***	74	Cause external mock alarm	***FTB***
54	STOP3 (Decelerate to stop with maximum braking torque, ignoring the deceleration time setting)	***STOP3***	75	Cancel NTC thermistor alarm	***NTC-CCL***
55	Latch DIA data (DIA optional function)	***DIA***	76	Cancel lifetime alarm signal	***LF-CCL***
56	Latch DIB data (DIB optional function)	***DIB***	77	Request for reading in serial port PG absolute position (Available soon)	***SPG-AP***
57	Cancel multiplex system	***MT-CCL***	78	Switch PID feedback signals	***PID-1/2***
58-67	Custom Di1-Di10	***C-DI1*** to ***C-DI10***	79	Select PID torque bias	***TB-PID***
68	Select load adaptive parameters 2/1 (Available soon)	***AN-P2/1***	80	Tune magnetic pole position (Available soon)	***MP-TUN***
69	Cancel PID components	***PID-CCL***	81	External electrical conditions (Available soon)	***RD***
70	Enable PID FF component	***PID-FF***	82	Startup conditions (Available soon)	***STRD***
71	Reset completion of speed limit calculation (Available soon)	***NL-RST***	83	Continue to run at the time of communications link error (Available soon)	***LK-D***

Function code data = 0, 1, 2, 3 Select multistep speed (1 to 15 steps) -- *SS1, SS2, SS4, SS8*

You can use external digital input signals to switch predetermined speeds specified by function codes from C05 to C19 "Multistep speed". Assign data 00 to 03 to digital terminals to select a speed by combining those terminal inputs.

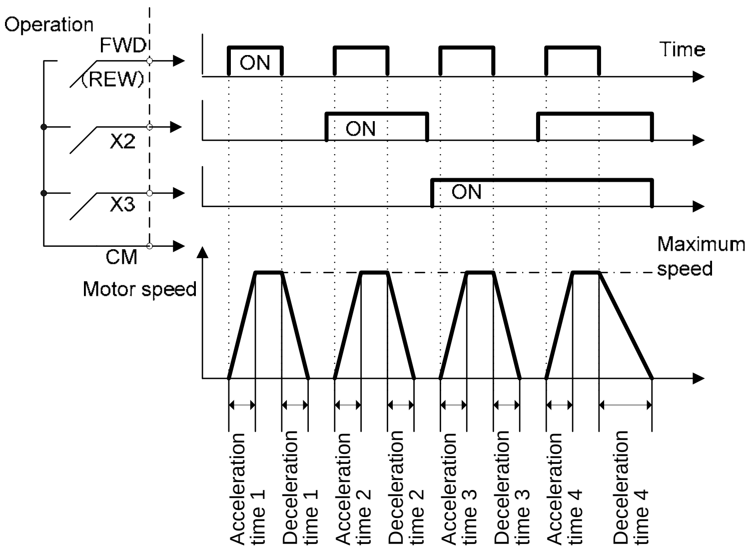
Input signal combination to select specified data				Speed to be selected	
3 ***SS8***	2 ***SS4***	1 ***SS2***	0 ***SS1***		
OFF	OFF	OFF	ON	C05 Multistep speed 1, N-1	Related function codes C05 to C19 Setting range 0 to 30000 r/min or 0.00 to 100.00% or 0.0 to 999.9 m/min
OFF	OFF	ON	OFF	C06 Multistep speed 2, N-2	
OFF	OFF	ON	ON	C07 Multistep speed 3, N-3	
OFF	ON	OFF	OFF	C08 Multistep speed 4, N-4	
OFF	ON	OFF	ON	C09 Multistep speed 5, N-5	
OFF	ON	ON	OFF	C10 Multistep speed 6, N-6	
OFF	ON	ON	ON	C11 Multistep speed 7, N-7	
ON	OFF	OFF	OFF	C12 Multistep speed 8, N-8	
ON	OFF	OFF	ON	C13 Multistep speed 9, N-9	
ON	OFF	ON	OFF	C14 Multistep speed 10, N-10	
ON	OFF	ON	ON	C15 Multistep speed 11, N-11	
ON	ON	OFF	OFF	C16 Multistep speed 12, N-12	
ON	ON	OFF	ON	C17 Multistep speed 13, N-13	
ON	ON	ON	OFF	C18 Multistep speed 14, N-14/ Creep speed 1, CREP1	
ON	ON	ON	ON	C19 Multistep speed 15, N-15/ Creep speed 2, CREP2	

<u>Function code data = 4, 5</u> Select ASR and ACC/DEC time (4 steps) -- *RT1*, *RT2*

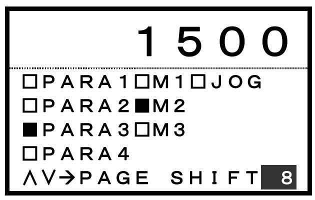
You can switch predetermined acceleration/deceleration times, ASR constants and S-curve accelerations/decelerations specified by function codes through external digital input signals. Assign data 04 to 05 to digital terminals to select acceleration/deceleration times, ASR constants and S-curve accelerations/decelerations.

Input signal combination to select specified data: 05 *RT2*	04 *RT1*	Acceleration/deceleration times to be selected	
OFF	OFF	F07 Acceleration Time 1 F08 Deceleration Time 1 F61 to F66 ASR1 constants F67 S-curve Acceleration 1 (Start) F68 S-curve Acceleration 1 (End) F69 S-curve Deceleration 1 (Start) F70 S-curve Deceleration 1 (End)	Related function codes F07, 08, F61 to F70 C40 to C69
OFF	ON	C40 to C45 ASR 2 constants C46 Acceleration Time 2 C47 Deceleration Time 2 C48 S-curve 2 (Start side) C49 S-curve 2 (End side)	
ON	OFF	C50 to C55 ASR 3 constants C56 Acceleration Time 3 C57 Deceleration Time 3 C58 S-curve 3 (Start side) C59 S-curve 3 (End side)	
ON	ON	C60 to C65 ASR 4 constants C66 Acceleration Time 4 C67 Deceleration Time 4 C68 S-curve 4 (Start side) C69 S-curve 4 (End side)	

Example: Four and five are assigned to the terminals [X2] and [X3].



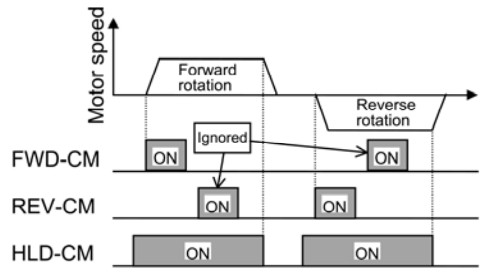
* If you switch the acceleration/deceleration times, the ASR constants and S-curve actions are switched simultaneously. You can see which set is currently selected from (1, 2, 3, 4) on the "I/O check" screen of the KEYPAD panel. When the data set 3 is selected, "■PARA3" is indicated on the display.



Function code data = 6
Enable 3-wire operation -- *HLD*

Use for 3-wire operation. When ***HLD-CM*** is ON, the FWD or the REV signal is self-held, and is canceled when ***HLD-CM*** is OFF.

When you want use this ***HLD*** function, you should assign a data 06 to a desired digital input terminal.

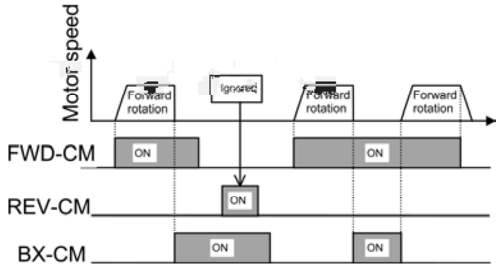


Function code data = 7 Coast to a stop-- *BX*

The inverter output is turned off and the motor enters into the coast-to-stop state, when ***BX-CM*** is ON.

The signal does not cause an alarm output. Also, this signal is not self-held.

When you want use this ***BX*** function, you should assign data a 07 to a desired digital input terminal.



Function code data = 8 Reset alarm -- *RST*

Switching the ***RST-CM*** from OFF to ON cancels the alarm relay output and the alarm display and restart operation while the protective function is active.

When you want use this ***RST*** function, you should assign a data 08 to a desired digital input terminal.

Function code data = 9 Enable external alarm trip -- *THR*

The factory setting for the trip command is an "NO terminal" (normally open).

When you use the trip command as an "NC terminal" (normally closed), follow the procedure described below.

When ***THR-CM*** is ON, the operation is assumed as normal. When ***THR-CM*** is turned OFF, the inverter output is turned off (motor is in the coast-to-stop state) and the alarm "OH2" is issued. You can use the trip command for the overheat protection of an external resistor.

<Application and notes>

- The ***THR*** function is assigned to the X9 terminal in the factory setting (function code E09=9, THR). Use the X9 as an external alarm as it is.
- Use the function code E14 "X function normally open/normally closed" to set the X9 terminal to an "NC terminal". To set as an "NC terminal", move the 9th ■ (X9 terminal) from the OP side to the CL side and use the FUNC DATA key to write.
- When you turn on the inverter while X9 ***THR-CM*** is open, the "OH2" alarm is issued. This is a normal state.
- Connect X9 ***THR*** and [CM] to the overheat detection contact of the braking resistor or the like.
- If you do not connect a braking resistor, short-circuit the ***THR-CM*** or move the 9th ■ (X9 terminal) from the CL side to the OP side again and use the FUNC DATA key to write.

Function code data = 10 Ready for jogging -- *JOG*

Use this function for an inching action such as work adjustment. You can operate at the jogging speed specified by the function C29 "Jogging speed" by turning on the signal between ***JOG*** and ***CM*** while the operation command (FWD-CM or REV-CM) is ON. You can also use the KEYPAD panel to switch to the jogging mode.

When you want to use this ***JOG*** function, you should assign a data 10 to a desired digital input terminal.

The function codes related to the jogging operation are C29 to C38. A dedicated speed control setting (such as gain) is available.

The indicator stays at the JOG position on the LCD monitor of the KEYPAD panel during the jogging operation.

Function code data = 11 Select speed command -- *N2/N1*

Use an external digital input signal to switch the speed setting method predetermined with function F01 "speed setting N1" and C25 "speed setting N2."

If you do not specify, F01 is selected.

Input signal to select specified data	Speed setting method to be selected
11	
OFF	F01 Speed Command N1
ON	C25 Speed Command N2

Function code data = 12, 13 Select motor 2, 3 -- *M-CH2, M-CH3*

You can use the external digital input signals to switch the predetermined motor parameters. You can use the terminal to switch only when F79 "Motor selection (M1, 2, 3)" is set to 0. If F79=1, the selection is fixed to the M2. If F79=2, the selection is fixed to the M3.

The switching result becomes effective when the operation command to the inverter is ON and the motor is in the stop state.

Input signal combination to select specified data		Motor to be selected	Related codes
13 ***M-CH3***	12 ***M-CH2***		
OFF	OFF	First motor	F03 to F05, F10 to F12, P01 to P51, H47, H49, H51, H112 to H118, H160 to H164, o09 to o11
OFF	ON	Second motor	A01 to A71, H48, H50, H52, H170 to H174
ON	OFF	Third motor	A101 to A171, H125 to H127, H180 to H184
ON	ON	First motor	F03 to F05, F10 to F12, P01 to P51, H47, H49, H51, H112 to H118, H160 to H164, o09 to o11

Note: Both ***M-CH2*** and ***M-CH3*** are ON, the first motor is selected. See also the description of the function code F79.

Note: When inverter is stopped, if motor switch 1/2 is changed during rotation of the connected motor (during naturally coasting or coasting with a load), the analog speed detection output, digital speed detection signal or the like may cause unpredictable operation.

<u>Function code data = 14</u> Enable DC braking -- *DCBRK*

When the external digital input signal is ON and the operation command is turned OFF (when you press the STOP key during the KEYPAD panel operation, or the both [FWD] and [REV] terminals are OFF during the external signal operation), the DC braking starts after the motor speed decreases to the predetermined rotation specified by the function code F20 "DC brake (Starting speed)", and the braking continues while the input signal is ON.

The longer period between F22 "DC brake (Braking time)" or the ON duration of the input signal ***DCBRK*** is selected.

Note that turning on the operation command will resume the operation. See also the description of the function codes F20 to 22.

Input signal to select specified data	Action to be selected
14	
OFF	DC braking active
ON	DC braking inactive

<u>Function code data = 15</u> Clear ACC/DEC to zero -- *CLR*

The external digital input signal clears the calculated speed of the acceleration/deceleration calculation unit. During the UP/DOWN operation in particular, this input signal clears the acceleration/deceleration and operates the inverter at 0r/min, the previous speed, or the creep speed specified by the C18 and 19 "Multistep speed".

<u>Function code data = 16</u> Switch creep speed under UP/DOWN control -- *CRP-N2/N1*

The external digital input signal switches the creep speed at the UP/DOWN selector unit.

Input signal to select specified data	Specified speed to be selected
16	
OFF	C18 Multistep Speed 15, N-15/Creep Speed 1, CREP1
ON	C19 Multistep Speed 16, N-16/Creep Speed 2, CREP2

<u>Function code data = 17</u> UP (Increase speed) -- *UP*

The external digital input signal increase the speed during the signal is ON. The maximum speed restricts the speed. The acceleration follows the specified acceleration time and S-curve acceleration.

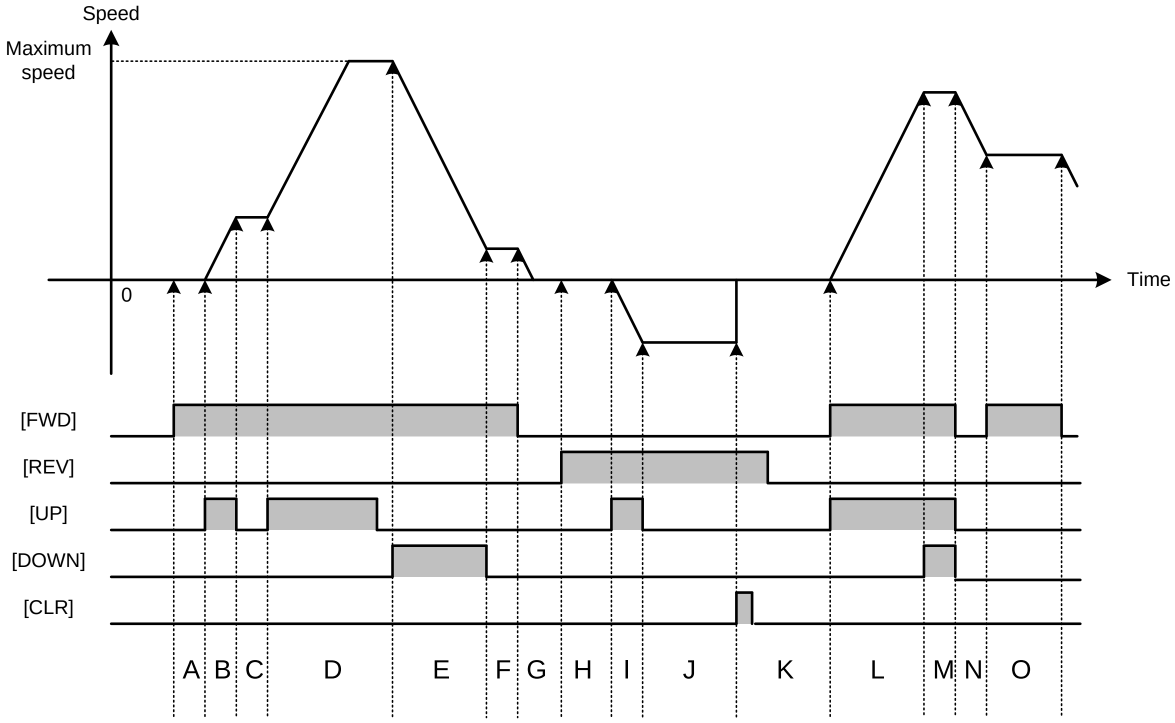
<u>Function code data = 18</u> DOWN (Decrease speed) -- *DOWN*

The external digital input signal decrease the speed during the signal is ON. The deceleration follows the specified deceleration time and S-curve deceleration. The current speed is maintained when the ***UP*** and the ***DOWN*** are pressed at the same time (no acceleration/deceleration).

There are three types of the UP/DOWN operations depending on the initial values. You can use the speed setting function (function code F01 or C25) to select them.

(1) UP/DOWN, Initial value = 0 r/min, N1 (F01)/N2 (C25) = 3

The following graph shows an operation with this function (The S-curve specification is not active in this example).

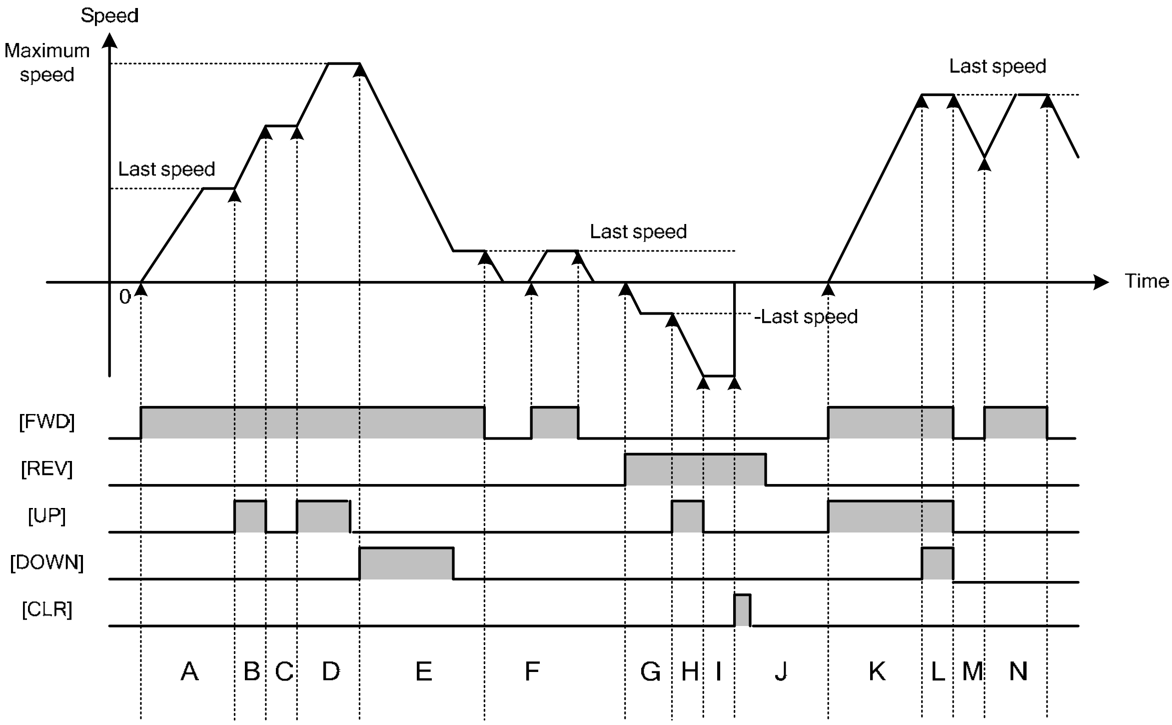


A: Operates at 0 r/min speed command
B: Accelerates in forward direction
C: Fixed to the speed command value when [UP] is set to OFF
D: Restricted by the maximum speed after acceleration in forward direction
E: Decelerates in forward direction
F: Fixed to the speed command value when [DOWN] is set to OFF
G: Decelerates to stop
H: Operates at 0r/min speed command value
I: Accelerates in reverse direction
J: Fixed to the speed command value when [UP] is set to OFF
K: Resets to 0r/min when [CLR] is set to ON
L: Accelerates in forward direction
M: Simultaneous [UP] and [DOWN] are treated as OFF. Fixed to the speed command value when both [UP] and [DOWN] are turned ON
N: Decelerates to stop
O: Continues operation at the speed just after [FWD] is set to ON.

(2) UP/DOWN, Initial value = Last value), N1 (F01)/N2 (C25) = 4

The following graph shows an operation with this function (The S-curve specification is not active in this example).

The last value is defined as the speed command value adopted when the last operation command (FWD, REV) is turned OFF. The last value is stored in the non-volatile memory (memory that retains data even when the power has been switched OFF), and becomes effective when the power is supplied again.



A: Accelerates in forward direction up to "+Last speed command value (speed command value just before the operation command is set to OFF)"

B: Accelerates in forward direction

C: Fixed to the speed command value when [UP] is set to OFF

D: Restricted by the maximum speed after acceleration in forward direction

E: Decelerates to stop. Fixed to the speed command value when [DOWN] is set to OFF

F: Stores the speed as a last value when the [FWD] is set to OFF. Accelerates in forward direction to the last value when the [FWD] is set to ON. Decelerates to stop when the [FWD] is set to OFF.

G: Accelerates in reverse direction up to "−Last speed command value"

H: Accelerates in reverse direction

I: Fixed to the speed command value when [UP] is turned OFF

J: Resets to 0 r/min when [CLR] is turned ON

K: Accelerates in forward direction

L: Simultaneous [UP] and [DOWN] are treated as OFF. Fixed to the speed command value when both [UP] and [DOWN] are turned ON

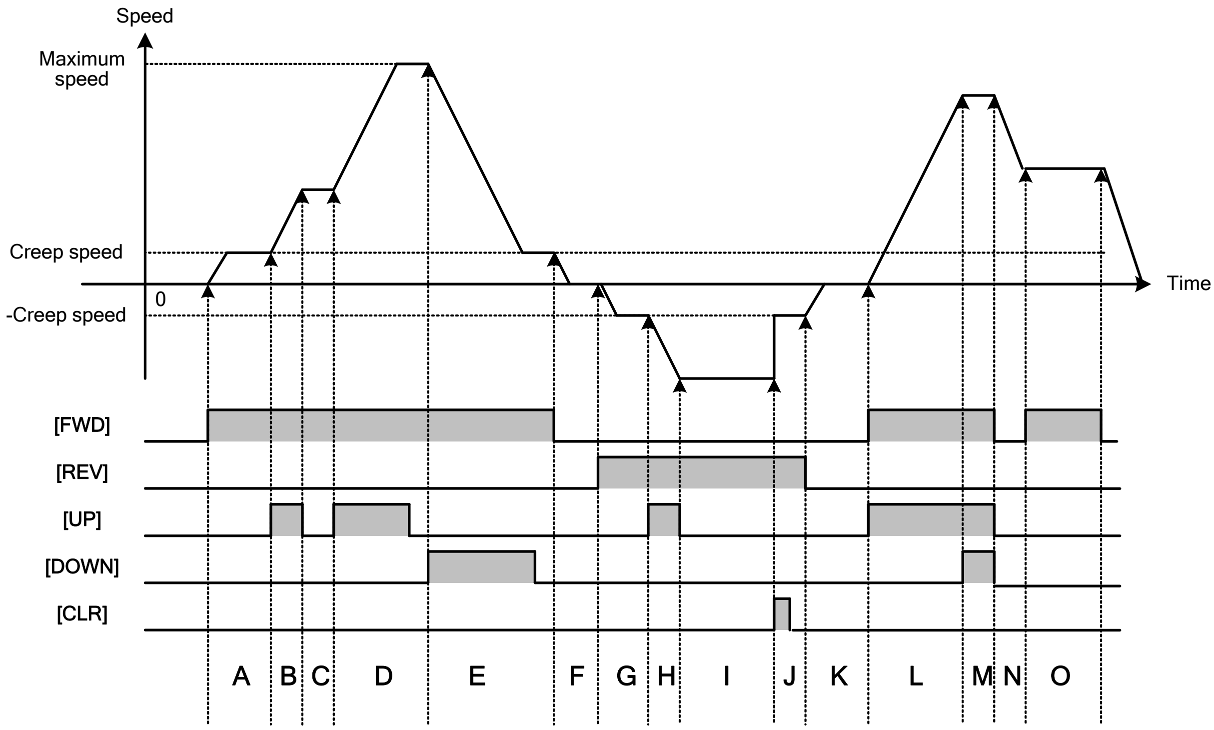
M: Decelerates to stop. Stores the speed as a last value when the [FWD] is set to OFF.

N: Accelerates in forward direction up to "+Last speed command value".

(3) UP/DOWN, Initial value = Creep speed 1 or 2, N1 (F01)/N2 (C25) = 5

The following graph shows an operation with this function (The S-curve specification is not active in this example).

- You can use the terminal inputs ***CRP-N2/N1*** to select the creep speed 1 or the creep speed 2.
- You should specify the function code C73 "Creep speed switching (on UP/DOWN control)" to choose the function codes C18 and C19 or the analog input signals (***CRP-N1*** and ***CRP-N2***). See the description of the C73 for more details.
- Because priority is given on the clearing process even if [FWD] or [REV] is turned off while [CLR] is turned on, the motor speed remains the creeping speed.
- The creeping speed continues even if the creeping speed is decreased after it is reached.
- A: Converted into an absolute value and processed into the input creep speed.



A: Accelerates in forward direction up to "+creep speed"
B: Acceleration in forward direction
C: Fixed to the speed command value when [UP] is turned OFF
D: Restricted by the maximum speed after acceleration in forward direction
E: Decelerates in forward direction down to "+creep speed"
F: Deceleration to stop
G: Accelerates in reverse direction to "−creep speed"
H: Acceleration in reverse direction
I: Fixed to the speed command value when [UP] is turned OFF
J: Resets to creep speed when [CLR] is set to ON
K: Deceleration to stop
L: Acceleration in forward direction
M: Simultaneous [UP] and [DOWN] are treated as OFF. Fixed to the speed command value when both [UP] and [DOWN] are turned ON
N: Deceleration to stop
O: If [FWD] is turned off temporarily and restored again during deceleration, the speed at the timing of activation of FWD is held if the speed is equal to or larger than the creeping speed. If the speed has dropped below the creeping speed, the speed increases to the creeping speed upon activation of FWD.

<u>Function code data = 19</u> Enable data change with keypad -- *WE-KP*

This function enables changes to the function codes through the KEYPAD panel only when the digital input signal ***WE-KP*** is applied to prevent unauthorized changes. You can make changes when 19 is not assigned to a terminal. This function enables/disables changes through the KEYPAD panel. Use "Write enable through link" to enable/disable changes through the link.

Input signal to select specified data	Function to be selected
19	
OFF	Changes to data disabled
ON	Changes to data enabled

Note: You cannot change the function codes if you set this data to a terminal by mistake. If this is a case, set ON to the terminal, and then set a correct data.

<u>Function code data = 20</u> Cancel PID control -- *KP/PID*

The external digital input signal disables the PID control.

Input signal to select specified data	Function to be selected
20	
OFF	PID control enabled
ON	PID control disabled

<u>Function code data = 21</u> Switch normal/inverse operation -- *IVS*

The external digital input signal switches the direction of the motor rotation.

Input signal to select specified data	Rotation direction to be selected		Normal/inverse
21	FWD command	REV command	
OFF	Forward rotation	Reverse rotation	Normal operation
ON	Reverse rotation	Forward rotation	Inverse operation

<u>Function code data = 22</u> Interlock (52-2) -- *IL*

When a magnetic contactor is provided to the output of the inverter, this magnetic contactor (52-2) opens to slow down the voltage drop in the DC circuit at a momentary power failure. As a result, the inverter may not detect the power failure to recover from the momentary power failure smoothly.

In such a case, use an external device to give a digital signal for informing the inverter of the momentary power failure.

The motor will restart smoothly after the power failure. Valid if the setting of F14 (restart after momentary power failure (action selection)) is "3," "4" or "5."

Input signal to select specified data	Function to be selected
22	
OFF	Momentary power failure detection through digital input disabled
ON	Momentary power failure detection through digital input enabled

<u>Function code data = 23</u> Enable data change via communications link -- *WE-LK*

This function enables changes to the function codes through RS-485, T-Link, SX, or field bus only when the digital input signal is applied to prevent unauthorized changes. You can make changes when 23 is not assigned to a terminal. Use aforementioned "Write enable for KEYPAD" to enable/disable changes through the KEYPAD.

Input signal to select specified data 23	Function to be selected	Applicable communication system
OFF	Changes to data disabled	Integrated RS-485 T-Link, SX-bus, Fieldbus
ON	Changes to data enabled	

Note: This function does not restrict the writing to the function code S (such as operation command, speed command) areas dedicated to the communication system. The next function "Operation selection through link" enables/disables writing to the S area.

<u>Function code data = 24</u> Enable communications link -- *LE*

The external digital input enables/disables the speed command and the operation command through the link (communication system). Assign a data 24 to a desired digital input terminal and the input signal applied to it switches between the enabled state and the disabled state.

When the operation selection is enabled or this function is not assigned, you can specify the sources of commands.

Input signal to select specified data 24	Function to be selected
OFF	Link commands disabled (link disabled regardless of setting by H30)
ON	Link commands enabled (setting by H30 enabled)

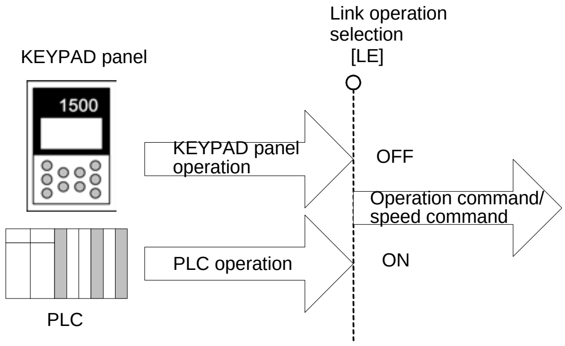
When the link is enabled, the following priority applies if speed commands and operation commands come from multiple communication systems.

Priority	Operation command (FWD, REV), speed command	Description of source of commands
1	Field options	One option selected from T-Link, SX-bus, and fieldbus can be installed at a time.
2	Integrated RS-485	Disabled when the option above is installed.

<Application example 1>

When you specify the operation command and the speed command from the KEYPAD panel and use the terminal function [LE] to switch to the operation command and the speed command from the PLC, the KEYPAD panel will be enabled if the terminal [LE] is OFF, and the PLC will be enabled if the terminal [LE] is ON.

The description "Not assigned (*)" in the following table on the next page indicates that a function 24 [LE] is not assigned to an X function terminal. If this is a case, the setting by the function code H30 becomes effective. The PLC operation requires option cards (If you use RS-485, an integrated function is available). See the descriptions of the option or RS-485 for more details.



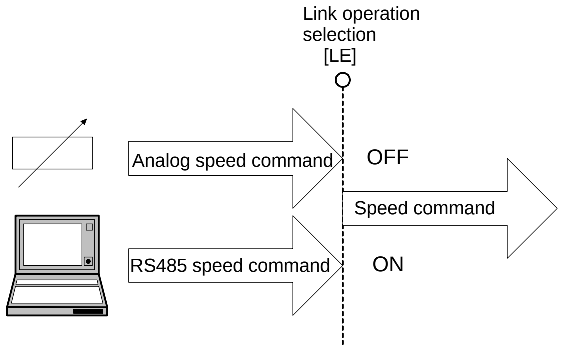
Chap. 4 CONTROL AND OPERATION

	Set value	Description	Terminal [LE]		
			OFF	ON	Not assigned (*)
Function code specification	F01 = 0	Operation command from KEYPAD panel	Enabled	Disabled	
	F02 = 0	Speed command from KEYPAD panel			
	H30 = 3	Initial setting enabling both speed command and operation command through link (PLC)	Disabled	Enabled	

<Application example 2>

When you select the operation command from the external signal ([FWD], [REV]) and the speed command from the analog terminal [12] input (0±10V) or the RS-485 communication (from master device such as a personal computer) using [LE] function, the analog terminal [12] will be enabled if the terminal [LE] is OFF, and the RS-485 will be enabled if the terminal [LE] is ON.

If you use RS-485, an integrated function is available. See the descriptions of RS-485 for more details.



	Set value	Description	Terminal [LE]		
			OFF	ON	Not assigned (*)
Function code specification	F01 = 1	Operation command from [FWD] and [REV]	Enabled (External signal is always selected)		
	F02 = 1	Speed command from analog input at terminal [12]	Enabled	Disabled	
	H30 = 1	Initial setting enabling only speed command from link (RS-485)	Disabled	Enabled	

<u>Function code data = 25</u> Universal DI -- *U-DI*

You can assign a data 25 to a digital terminal to designate it as a universal DI terminal. This function is provided to check the existence of an input signal through communication and does not affect the inverter operation.

There are following applications for this signal.

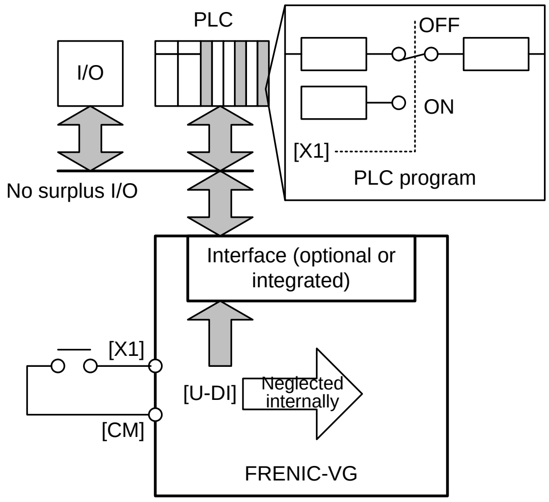
1) Check the ON/OFF state of the input signal through RS-485, T-Link, SX-bus, or fieldbus.

2) Use for an input to software created with the UPAC option without affecting the inverter operation.

<Application example>

You do not have enough numbers of I/O and want to use inverter control terminals to switch the control of a PLC program. If you choose [X1] as a control terminal:

1) Set the function code E01 "X1 function selection" to 25. This specification makes this input neglected by the inverter.
2) Use the PLC to read out (polling) the function code M13 "Operation method (final command)" through communication.
3) Since the data type of M13 is 32 (type), refer to the bit assignment under that data type to check the corresponding bit of X1 input.



Note that you can read out input information of an input terminal using the code M13 without assigning the [U-DI] to the terminal. The significance of the assignment is to avoid activating an assigned function to the terminal unless you do not assign the [U-DI].

Function code data = 26 Enable auto search for idling motor speed at starting -- ***STM***

The external digital input signal enables/disables the function H09 "Start mode (Rotating motor pick up)"

Assign a data 26 to a desired digital input terminal and the input signal applied to it switches between the enabled state and the disabled state.

Input signal to select specified data	Function to be selected
26	
OFF	Follow the setting of H09 (startup characteristics (rotating motor pickup mode)).
ON	The startup characteristics function is valid irrespective of the setting of H09 (rotating motor startup characteristics (pickup mode)).

<u>Function code data = 27</u> Synchronization operation command (PG (PR) optional function) -- *SYC*

This function switches between the speed command converted from a pulse train received as a position command via the position control and other speed command. You can use this function for a synchronized operation. You need an optional PG (PR).

Assign a data 27 to a desired digital input terminal and the state of the input signal applied to it selects the function.

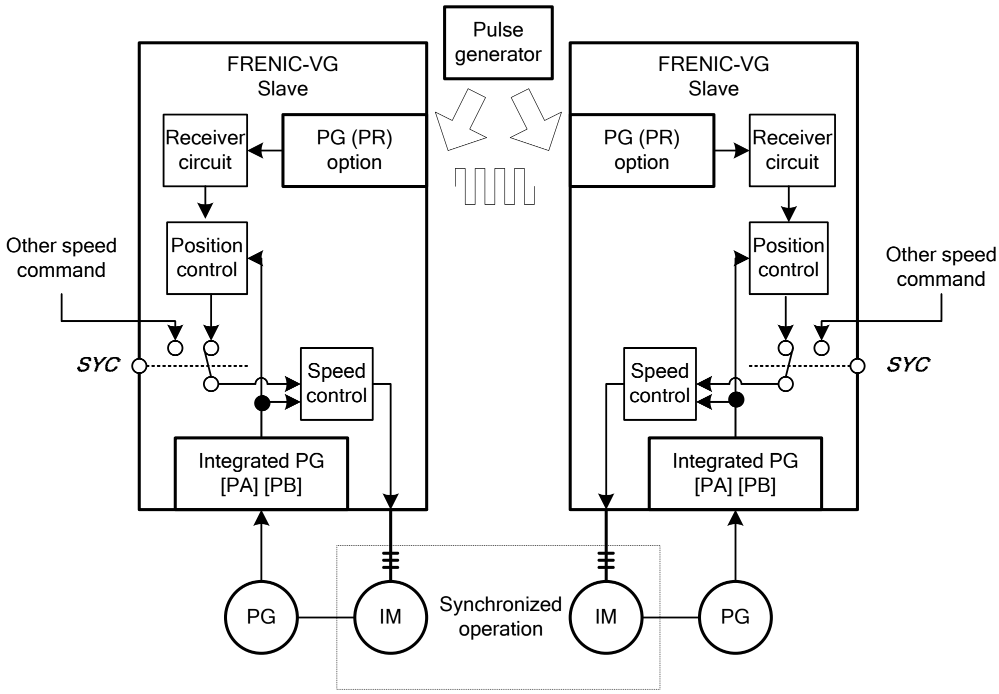
Input signal to select specified data 27	Function to be selected
OFF	Synchronized speed disabled (Other speed command enabled)
ON	Synchronized speed enabled

Also see E29 "PG pulse output selection", o12 to 19 "PG (PR) options", and the description on the PG (PR) options.

Note that the Zero speed locking command ***LOCK*** is disabled during the pulse train position control with ***SYC***.

<Application example 1> Synchronized operation by receiving pulse

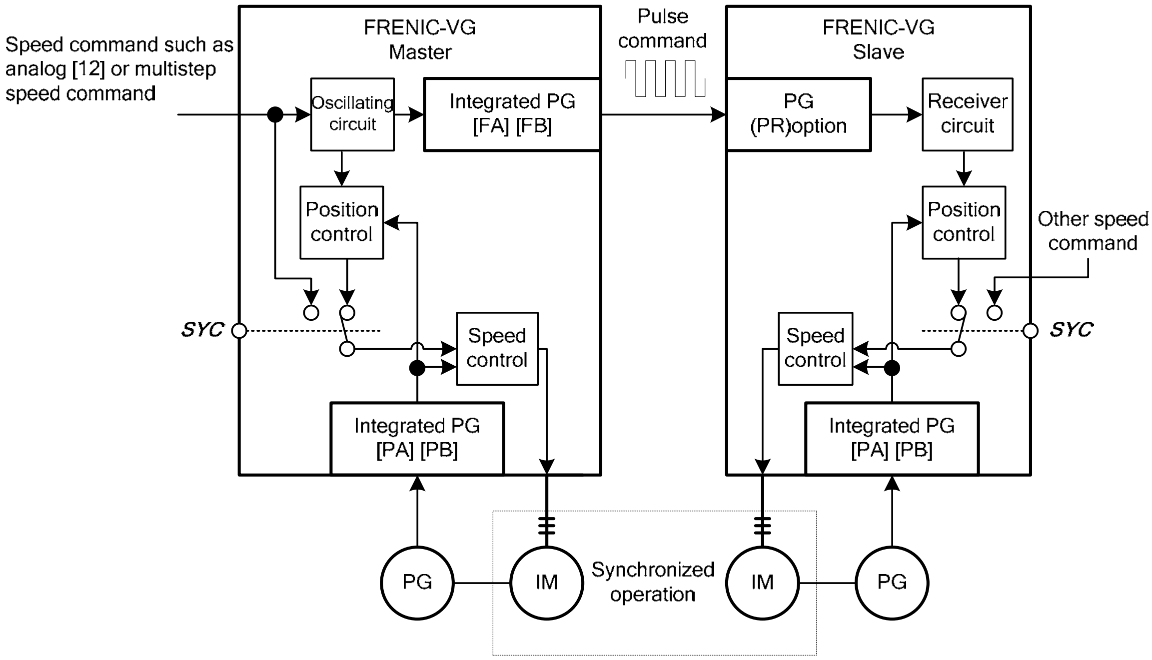
Apply a pulse train signal from the external pulse generator to the PG (PR) options of multiple inverters to be synchronized. The position command received by the option is converted into a synchronized speed command and the ***SYC*** enables the speed command.



<Application example 2> Synchronized operation by pulse generation

Pulse signal converted (oscillated) from an internal speed command (such as [12] input or multistep speed command) is also converted into a speed command through the position control and the ***SYC*** enables the resulting speed command. You can put the converted pulse signal to the output and apply it to the other inverters to synchronize the inverter with other inverters.

The motor speed of the master and the PG pulse number determines the pulse frequency. When you use a PG with 1024 P/R at 1500 r/min, the frequency is 1500×1024/60=25.6 kHz. The pulse compensation is available on the slave side. See the function codes o14 and o15 or the PG (PR) option for more details.



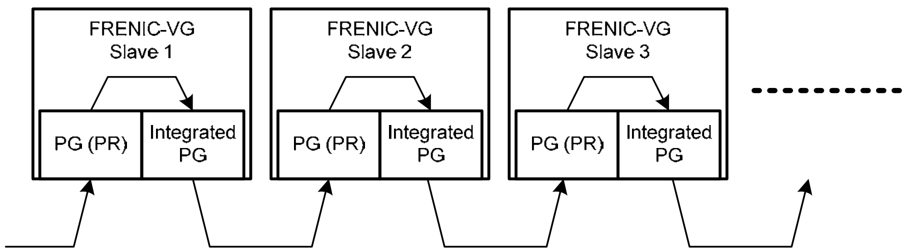
The complete synchronization (± 2 pulses or less) is possible both in the application example 1 and 2 during both transient and steady states.

About differences in methods

Method	Merits	Demerits
<Application example 1> Synchronized operation by receiving pulse	No position deviation	One PG (PR) option necessary Pulse generator necessary
<Application example 2> Synchronized operation by pulse generation	No position deviation One PG (PR) option can be omitted. No pulse generator	None
Master-slave operation (Master directly applies its PG signal to slaves)	None	Position deviation

<Application example> Synchronized operation for three or more inverters

Set E29 "PG pulse output selection" to 9 to directly supply the position command applied to the PG (PR) option to the [FA] and the [FB] of the integrated PG.

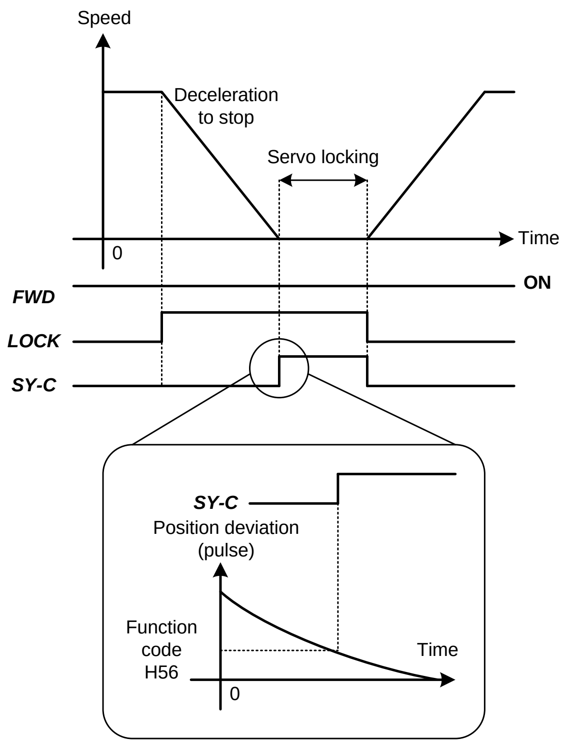


<u>Function code data = 28</u> Lock at zero speed -- *LOCK*

The external digital input signal conducts servo lock. Assign data 28 ***LOCK*** to a terminal and set the input signal ON.

Input signal to select specified data	Function to be selected
28	
OFF	Normal state
ON	Zero speed locking state

1) The inverter decelerates to stop (following an effective deceleration time setting) from the speed just after the [LOCK] is set to ON.
2) Position control (servo locking state) is applied with respect to the motor position (angle) when the speed command of the acceleration/deceleration calculation unit reaches to zero. The acceleration/ deceleration calculation unit declines a step speed command directed by the user in a specified acceleration/ deceleration time.
3) You can supply a resistive torque up to the short-time rating. The function code H55 "Zero speed control (Gain)" and the speed control system (ASR gain) control the magnitude of the torque in relation to the position deviation (position error).
4) Balance the speed control (ASR) gain (function codes F and C) and the position control gain (H55) to adjust the gain. The system may become unstable to present low frequency hunting when you increase the setting of the H55 while leaving ASR gain small.



5) A signal indicating completed servo locking appears on the DO as "Synchronization completion signal" when the position deviation converges into the setting range of the H56 "Zero speed control (completion range)".

   When PG (PR) option is used for synchronization control by pulse train, the zero speed locking command becomes invalid.
6) Because only one rotation is detected if the motor turns due to an external force after it is locked at zero speed, the DO output (synchronous control complete ***SYC***) may be turned on each time the predetermined position passes.

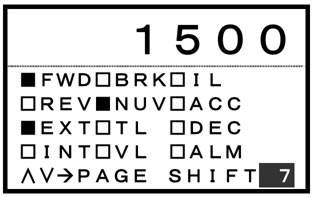
<u>Function code data = 29</u> Pre-excitation -- *EXITE*

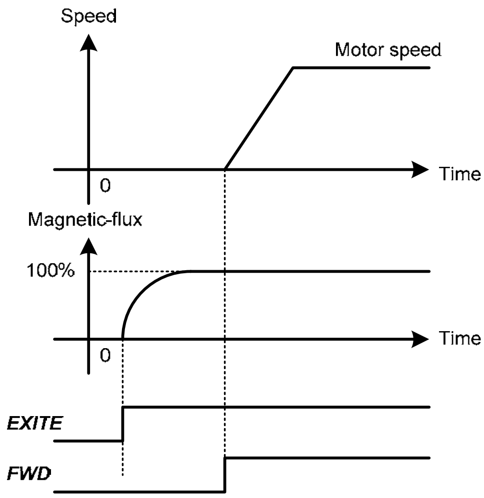
The external digital input signal switches the inverter in pre-exciting state. Assign a data 29 to a desired digital input terminal and the state of the input signal applied to it selects the function. When the operation command (FWD, REV) is set to ON, the state changes from pre-exciting to normal.

Input signal to select specified data	Function to be selected
29	
OFF	Normal state
ON	Pre-exciting state

You can also use the function codes F72, F74 and F75 to start the pre-exciting. See also the description of these functions.

You can use the "Operation status " of the "I/O check" screen of the KEYPAD panel to see whether the inverter is in the pre-exciting state or in the normal state. The ■EXT indicates the pre-exciting state and the □EXT indicates the normal operation. You can also read out the function code M14 "Operation status" through the link.





<u>Function code data = 30</u> Cancel speed limiter -- *N-LIM*

The external digital input signal disables the speed command limiter. Assign a data 30 to a desired digital input terminal and the state of the input signal applied to it selects the function. See the description of the function code F76 for more information on the speed command limiter function.

Input signal to select specified data	Function to be selected
30	
OFF	Speed limiter enabled
ON	Speed limiter disabled

<u>Function code data = 31</u> Cancel H41 (Torque command) -- *H41-CCL*

The external digital input signal cancels the setting specified by the H41 "Torque command selection" (0: internal ASR enabled). Assign a data 31 to a desired digital input terminal and the state of the input signal applied to it selects the function.

Input signal to select specified data	Function to be selected
31	
OFF	H41 setting enabled
ON	H41 setting disabled (internal ASR enabled)

<u>Application</u>

Use for applications that switch between speed control (internal ASR) and torque command control.

<u>Function code data = 32</u> Cancel H42 (Torque current command) -- *H42-CCL*

The external digital input signal cancels the setting specified by the H42 "Torque current command" (0: internal ASR enabled). Assign a data 32 to a desired digital input terminal and the state of the input signal applied to it selects the function.

Input signal to select specified data	Function to be selected
32	
OFF	H42 setting enabled
ON	H42 setting disabled (internal ASR enabled)

Application

Use for applications that switch between speed control (internal ASR) and torque current command control.

<u>Function code data = 33</u> Cancel H43 (Magnetic flux command) -- *H43-CCL*

The external digital input signal cancels the setting specified by the H43 "Magnetic-flux command selection" (0: internal calculation enabled). Assign a data 33 to a desired digital input terminal and the state of the input signal applied to it selects the function.

Input signal to select specified data	Function to be selected
33	
OFF	H43 setting enabled
ON	H43 setting disabled (internal calculation enabled)

<u>Function code data = 34</u> Cancel F40 (Torque limiter mode 1) -- *F40-CCL*

The external digital input signal cancels the setting specified by F40 "Torque limiter mode 1" (0: limiter disabled). Assign a data 34 to a desired digital input terminal and the state of the input signal applied to it switches between the enabled state and the disabled state.

Input signal to select specified data	Function to be selected
34	
OFF	F40 setting enabled
ON	F40 setting disabled (limiter disabled)

<u>Function code data = 35</u> Select torque limiter level 2/1 -- *TL2/TL1*

The external digital input signal switches the torque limiter value (level 1 or 2). Assign a data 35 to a desired digital input terminal and the state of the input signal applied to it switches between the level 1 and the level 2. This function is effective only when F41 "Torque limiter mode 2"=3.

Input signal to select specified data	Function to be selected
35	
OFF	F42: Torque limiter value (level 1) selection
ON	F43: Torque limiter value (level 2) selection

<u>Function code data = 36</u> Bypass ACC/DEC processor -- *BPS*

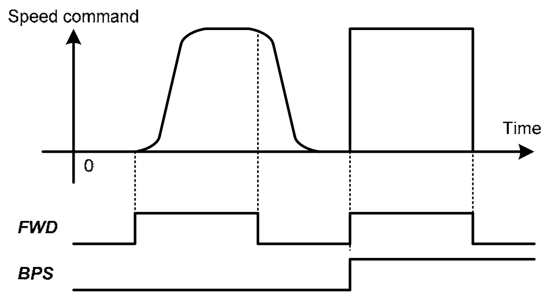
The external digital input signal bypasses the acceleration/deceleration calculation unit to disable the acceleration/deceleration time and the S-curve specifications. Assign a data 36 to a desired digital input terminal and the state of the input signal applied to it switches between the enabled state and the disabled state.

(The resultant setting is the same as the acceleration/deceleration time: 0.00s and the S-curve acceleration/deceleration: 0%)

Input signal to select specified data	Function to be selected
36	
OFF	Acceleration/deceleration calculation unit enabled
ON	Acceleration/deceleration calculation unit enabled

The speed command from the acceleration/deceleration calculation unit follows the acceleration/deceleration and S-curve settings as shown in the figure. Setting the [BPS] to ON cancels these functions to control the motor speed following a step-form speed command.

Use the dedicated jogging operation function codes (C30 to C38), not the ***BPS***, for jogging operation.



<u>Restrictions</u>

- When you use the ***BPS***, control functions such as the UP/DOWN control and the active drive (when V/f control is selected) are also disabled.
- The ***BPS*** does not affect the auxiliary speed setting 2 and the PID calculation output (speed command). For details, refer to the control block diagrams.

⚠CAUTION

Setting the ***BPS*** ON accelerates/decelerates the motor rapidly and the motor may accelerate at its maximum permissible torque and decelerate down to the zero speed. Use the ***BPS*** after you confirm that these are permissible actions of the mechanical system and the braking devices you use.

You may be injured.

<u>Function code data = 37, 38</u> Select torque bias command -- *TB1, TB2*

The external input digital signals can be used to switch among three types of torque biases predetermined by F47 to 49 "Torque bias T1, T2, and T3". See the function code F47 to 49 for more details.

Input signal combination to select specified data		Torque bias to be selected
38 ***TB2***	37 ***TB1***	
OFF	OFF	Torque bias disabled
OFF	ON	F47 torque bias T1 enabled
ON	OFF	F48 torque bias T2 enabled
ON	ON	F49 torque bias T3 enabled

<u>Function code data = 39</u> Select droop control -- *DROOP*

The external digital input signal switches between the droop control enabled state and the droop control disabled state. Assign a data 39 to a desired digital input terminal and the state of the input signal applied to it selects the function. See the function code H28 "Droop control" for more details.

Input signal to select specified data	Function to be selected
39	
OFF	Droop control disabled
ON	Droop control enabled

<u>Function code data = 40</u> Zero-hold Ai1 -- *ZH-AI1*
<u>Function code data = 41</u> Zero-hold Ai2 -- *ZH-AI2*
<u>Function code data = 42</u> Zero-hold Ai3 (AIO optional function) -- *ZH-AI3*
<u>Function code data = 43</u> Zero-hold Ai4 (AIO optional function) -- *ZH-AI4*

The external digital input signals fix the individual analog signals Ai1 to 4 to "0: input voltage invalid". Assign a data to a desired digital input terminal and the state of the input signal applied to it selects the function.

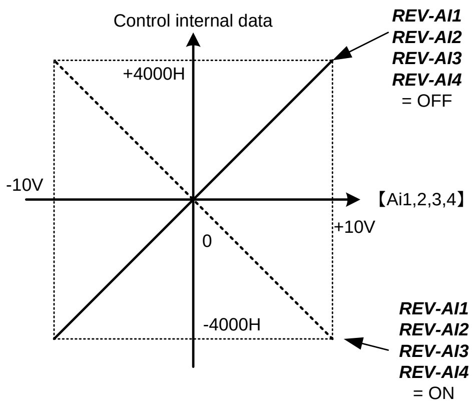
You need optional OPC-VG1-AIO for Ai3 and Ai4.

Input signal to select specified data	Function to be selected
40 to 43	
OFF	Ai input enabled ON
ON	Ai input held to zero

<u>Function code data = 44</u> Reverse Ai1 polarity -- *REV-AI1*
<u>Function code data = 45</u> Reverse Ai2 polarity -- *REV-AI2*
<u>Function code data = 46</u>
Reverse Ai3 polarity (AIO optional function) -- *REV-AI3*
<u>Function code data = 47</u>
Reverse Ai4 polarity (AIO optional function) -- *REV-AI4*

The external digital input signals invert the polarity of the input data from Ai1 to 4. Assign a data to a desired digital input terminal and the state of the input signal applied to it selects the function.

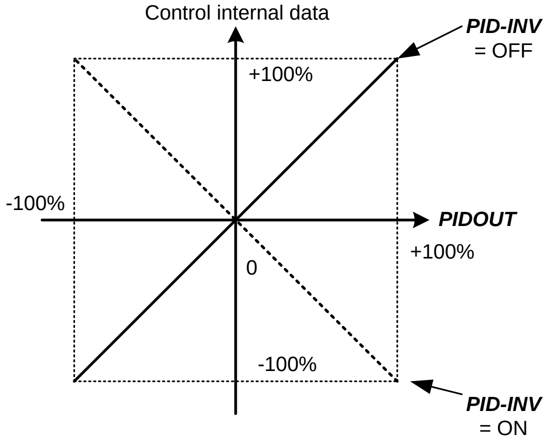
You need optional OPC-VG1-AIO for Ai3 and Ai4.



Input signal to select specified data	Function to be selected
44 to 47	
OFF	Normal operation
ON	Inverted polarity

<u>Function code data = 48</u> Inverse PID output -- *PID-INV*

The external digital input signal switches the PID output ***PIDOUT*** between the normal operation and the inverse operation. Assign a data 48 to a desired digital input terminal and the state of the input signal applied to it selects the function.



Input signal to select specified data	Function to be selected
48	
OFF	Normal PID output operation
ON	Inverse PID output operation

<u>Function code data = 49</u> Cancel PG alarm -- *PG-CCL*

The external digital input signal cancels the PG alarm (PG). This function is available when you select "vector control" for the function code P01, A01, or A101.

The inverter does not issue the alarm even when the PG wiring is disconnected during the input signal is ON. Assign a data 49 to a desired digital input terminal and the existence of the input signal cancels the PG alarm.

Input signal to select specified data	Function to be selected
49	
OFF	Normal operation
ON	PG alarm (PG) canceled

Actions on detecting PG disconnection

Alarm operation	***PG-CCL*** = OFF	***PG-CCL*** = ON
	Normal operation	PG alarm (PG) canceled
KEYPAD panel	Alarm mode	Operation mode
Alarm history	Recorded	Not recorded
Alarm DO output	PG disconnection output	No output
30X relay output	Alarm output	No output
Inverter output	Shut down	Normal operation

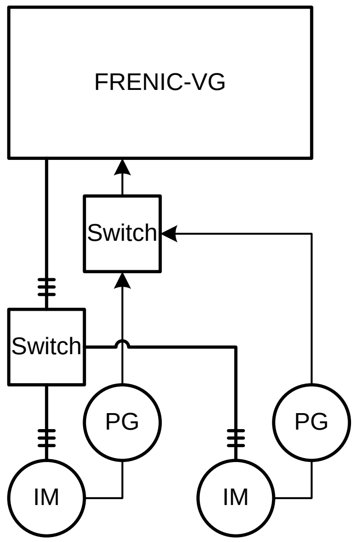
Application

Since this is a special function, limit your application to the following cases. When you use the function code E14 "X function normally open/normally closed", you can set to "normally closed (ON)" without actually short-circuiting terminals.

1) Use to apply the power to a system and test the system without connecting the PG signal.

2) When you use two motors by switching them with one unit, a momentary disconnection will present and the PG alarm (PG) is issued if the PGs are switched externally. Chancel the PG alarm (PG) at the sequence timing when the PGs are switched. Note that when you use FUJI's option (OPC-VG1-CPG) for PG switching, you do not need this canceling function.

3) Monitoring the current on the signal line detects the PG disconnection. The false detection may occur when the PG wiring has high impedance causing low current. Usually 0.6 mA or less is considered as a disconnection. If this is the case, you can operate with canceling the PG alarm as an emergency mean.



Operation with PG disconnected

A motor rotates at a slip frequency regardless of the speed command when the PG is disconnected (either PGP, PGM, PA, or PB is disconnected) and the PG alarm is canceled (***PG-CCL*** = ON).

Since the calculation of the speed control system (ASR) will saturate and increase the torque command and the torque current command to the maximum, either the inverter overload (OLU) or the motor overloads (OL1, OL2, OL3) when you use an electronic thermal overload relay will enter the alarm mode (Note that if you invert the A phase and the B phase of the PG signal, it will present the same phenomenon).

If you are sure that the PG wiring is disconnected, do not operate with canceling the PG alarm.

<Control mechanism>

The vector control of the FRENIC-VG is a slip frequency type vector control. The inverter obtains the motor speed (ωr) from the PG signal and the slip frequency (ωs) from the current detection to determine the output frequency to the motor (ω1 = ωr + ωs). In case of a PG disconnection, the motor speed is 0 (ωr = 0) and the output frequency to the motor becomes the slip frequency ωs.

In the speed control system (ASR), since the motor speed (ωr) does not follow the speed command (ωr*), the speed control system (ASR) conducts an integral operation (I constant of ASR) to increase the speed deviation (ωr*−ωr) and the saturation is reached in a short period. The output of the ASR is the torque command and this torque command is fixed to the maximum value resulting in an overload alarm (OLU).

<u>Function code data = 50</u> Cancel undervoltage alarm -- *LU-CCL*

The external digital input signal cancels the undervoltage alarm (LU). When the input signal is ON, the alarm is canceled.

Assign a data 50 to a desired digital input terminal and the existence of the input signal cancels the undervoltage alarm (LU).

Input signal to select specified data	Function to be selected
50	
OFF	Normal operation
ON	Undervoltage alarm (LU) canceled

Actions on detecting undervoltage inside the inverter

Alarm operation	***LU-CCL*** = OFF	***LU-CCL*** = ON
	Normal operation	Undervoltage alarm (LU) canceled
KEYPAD panel	Alarm mode	Running mode
Alarm history	Recorded	Not recorded
Alarm DO output	Output	No output
DO output for Stopping on undervoltage [LU]	Output	No output
30X relay output	Output	No output
Inverter output	Shut down	Normal operation

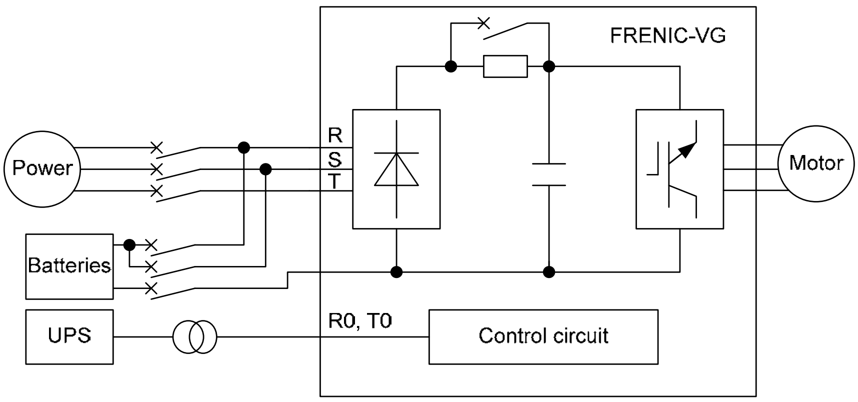
<u>Application</u>

Since this is a special function, limit your application to the following cases.

1) When the control power is supplied via [R0] and [T0] separately, shutting down the main circuit power causes the inverter to detect an undervoltage alarm (LU) and enter the Alarm mode. To avoid the alarm, use ***LU-CCL***.

2) To drive a lifting unit or the like at the time of a power failure, use ***LU-CCL***. Inverters of 30 kW or below (200 V class series) or those of 55 kW or below (400 V class series) can run even on the voltage lower than the undervoltage level (180 V for 200 V class series and 360 V for 400 V class series) as long as the inverter runs <u>at the low speed</u>, so use ***LU-CCL*** when configuring a system using an uninterruptible power supply (UPS), battery, stand-by generator and so on.

   Note: To run inverters of 37 kW or above (200 V class series) or those of 75 kW or above (400 V class series) on the voltage lower than the undervoltage level, a special type of inverters is needed. Contact your Fuji Electric representative.



3) During cancellation of an undervoltage alarm, no parameter change is allowed from the keypad.

<u>Function code data = 51</u> Hold Ai torque bias -- *H-TB*

The external digital input signal directs to preserve the torque bias data supplied via an analog input. Assign data 51 to a desired digital input terminal and the existence of the input signal preserves the analog data.

Input signal to select specified data	Function to be selected
51	
OFF	Torque bias hold disabled
ON	Torque bias hold enabled

<u>Function code data = 52</u> STOP1 (Decelerate to stop with normal deceleration time) -- *STOP1*

The external digital input signal directs to decelerate to stop with the currently specified/effective deceleration time and S-curve decelerations on start/end sides.

Assign data 52 to a desired digital input terminal and the existence of the input signal activates the operation.

Input signal to select specified data	Function to be selected
52	
OFF	Normal operation
ON	Deceleration to stop (effective deceleration time)

<u>Function code data = 53</u> STOP2 (Decelerate to stop with deceleration time 4) -- *STOP2*

The external digital input signal directs to decelerate to stop with the C67 "Deceleration time 4" and C68 and C69 "S-curve start/end side 4".

Assign data 53 to a desired digital input terminal and the existence of the input signal activates the operation.

Input signal to select specified data	Function to be selected
53	
OFF	Normal operation
ON	Deceleration to stop (Deceleration time 4)

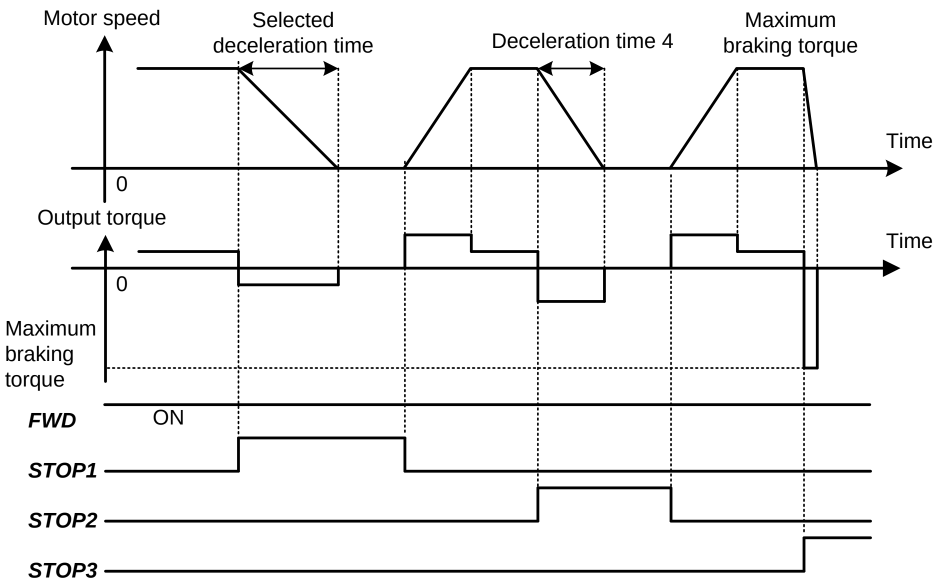
<u>Function code data = 54</u> STOP3 (Decelerate to stop with maximum braking torque) -- *STOP3*

Turning this external digital input signal ON causes the motor to decelerate to a stop with the maximum braking torque (or the torque limiter value in terms of the inverter maximum current when the torque limiter is disabled), ignoring the specified deceleration time. Note that, after the actual speed exceeds the rated speed the braking torque will be reduced.

When a braking unit (150% maximum torque) of the same capacity as the inverter is used, an overvoltage alarm (OU) may occur during deceleration to a stop. To avoid the alarm, use a braking unit with one rank higher or set the torque limiter value (braking) to 150%.

Assign data 54 to a desired digital input terminal and the existence of the input signal activates the operation.

Input signal to select specified data	Function to be selected
54	
OFF	Normal operation
ON	Deceleration to stop (with maximum braking torque)



<u>Function code data = 55</u> Latch DIA data -- *DIA*
<u>Function code data = 56</u> Latch DIB data -- *DIB*

The external digital input signal enables to read in a data through the DI option (OPC-VG1-DIA, DIB). The data is read when the input signal ***DIA*** or ***DIB*** is ON and the data is held when the input signal [DIA] or [DIB]is OFF. See the DI option section for more details.

Input signal to select specified data	Function to be selected
55	
OFF	Hold DIA data
ON	Read DIA data

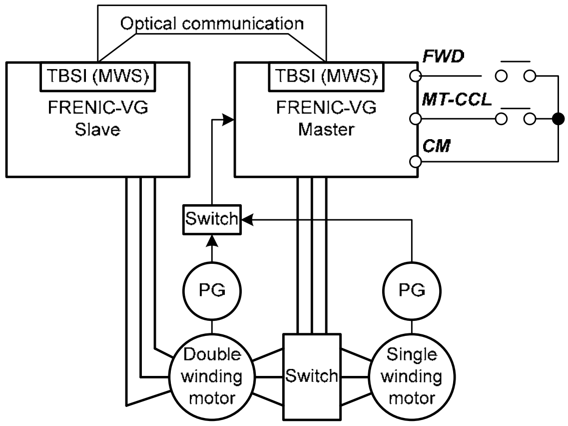
Input signal to select specified data	Function to be selected
56	
OFF	Hold DIB data
ON	Read DIB data

<u>Function code data = 57</u> Cancel multiplex system -- *MT-CCL*

The external digital input signal cancels the multiwinding drive with SI (MWS) option (OPC-VG1-TBSI) and switches to the standard single wining motor drive. The function code to switch to the multiwinding drive is o33 "Multiwinding system".

The right figure shows easy connection for changing drives between 2-winding motor and single-winding motor. In this circuit, the slave unit does not need operation command or feedback of PG, NTC signals. With change of motors, PG and NTC signals must be changed as well as the 2nd power circuit. To change PG and NTC signals, use the DI option (OPC-VG1-CPG).

For details of the multiplex system, refer to the description of Options.



Input signal to select specified data	Function to be selected when o33 = 1 (Multiwinding system)
57	
OFF	Multiwinding motor drive
ON	Single winding motor drive (Multiwinding cancelled)

<u>Function code data = 58 to 67</u> Custom Di1-Di10 -- *C-DI1* to *C-DI10*

Di terminal for manufacturer. Do not assign.

<u>Function code data = 68</u> Select load adaptive parameters 2/1 -- *AN-P2/1* (Available soon)

Turning this signal ON or OFF selects the load adaptive parameter 2 or 1, respectively.

Input signal to select specified data	Function to be selected
68	
OFF	Load adaptive parameter 1
ON	Load adaptive parameter 2

<u>Function code data = 69</u> Cancel PID components -- *PID-CCL*

When an integrated PID function is used, turning this signal ON zero-holds the PID output and clears the PID integral component memory.

Input signal to select specified data	Function to be selected
69	
OFF	Do not zero-hold the PID output.
ON	Zero-hold the PID output. Clear the PID integral component memory.

<u>Function code data = 70</u> Enable PID FF component -- *PID-FF*

When an integrated PID function is used, turning this signal ON enables the feedforward component.

Input signal to select specified data	Function to be selected
70	
OFF	Disable PID feedforward component
ON	Enable PID feedforward component

<u>Function code data = 71</u> Reset completion of speed limit calculation -- *NL-RST* (Available soon)

Turning this signal ON clears the load adaptive calculation result and calculates the limit speed again at the next acceleration time in the same direction.

Input signal to select specified data	Function to be selected
71	
OFF	Do not reset completion of speed limit calculation
ON	Reset completion of speed limit calculation

For details, refer to H214 to H227 (Load adaptive control parameter setting 2).

<u>Function code data = 72</u> Toggle signal 1 -- *TGL1*
<u>Function code data = 73</u> Toggle signal 2 -- *TGL2*

Assigning toggle signals 1 and 2 to two X terminals enables the toggle monitor control. If either one of those signals is not assigned, the toggle monitor control becomes disabled.

■ **What is toggle monitor control**

The toggle monitor control monitors whether the inverter and the host equipment mutually *function normally*. The "*function normally*" means not "no alarm has occurred" but "CPUs and I/O devices of both the inverter and the host equipment have not stopped."

(1) Toggle monitor method

<u>- This monitor is available to operations via the T-link, SX bus(*1), E-SX bus(*2) communications link.</u>
<u>- Operations via digital input terminals are not assumed.</u>

When H30 = 2 or 3, the target bit is operated via the communications link.

The toggle control uses digital inputs on X11 to X14 and does not use those on X1 to X9.

Toggle data (PLC ⇒ VG1) uses 2 bits out of bits 11 to 14 of function code S06 [Type 32].

The host equipment uses the above 2-bit data to transfer toggle data to the inverter in the sequence of 00→01→10→11→00 at the constant cycle.

The inverter checks that the transferred toggle data is incremented.

If the inverter detects a toggle data error during running and the error is not recovered within the detection time specified by H144, then the inverter trips with an alarm (Ar-F).

*1 For SX bus communication, the bus tact cycle of applications that send a transmission toggle at the MICREX-SX side should be 1 ms or more.

*2 As well, for E-SX but communication, the bus tact cycle should be 0.5 ms or more

(2) Toggle error detection alarm (*Ar-F*)

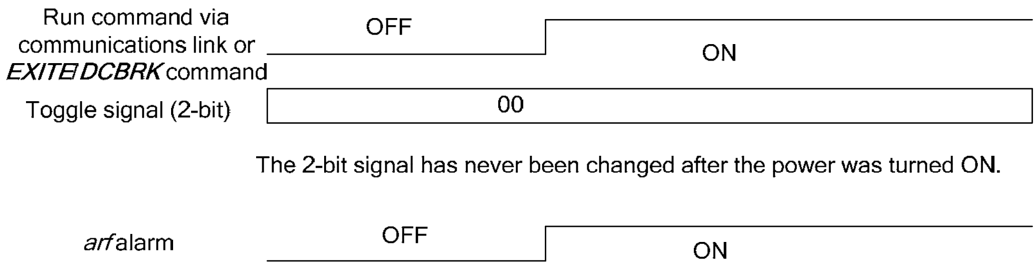
The toggle error detection alarm (*Ar-F*) is treated as a heavy alarm.

H144 specifies the toggle signal error detection time.

No.	Parameter name	Data setting range	Initial value	Remarks
H144	Toggle data error timer	0.01 to 20.00 s	0.10 s	Acts as a toggle signal error monitor timer.

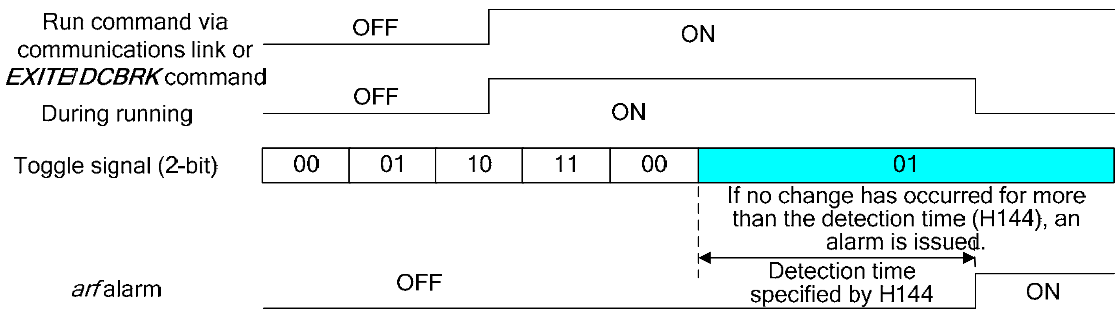
A toggle error detection alarm (*Ar-F*) occurs upon detection of any of the following conditions when a run command is given via the communications link or during running initiated by an auxiliary excitation command or DC braking command.

- When a toggle signal has never been changed, a run command or ***EXITE*** ("Pre-excitation")/***DCBRK*** ("Enable DC braking") is entered.



Note: When the power is turned ON, a run command is entered with the start of toggle signal monitor, an alarm *Ar-F* is issued. Therefore, enter a run command after at least one cycle of toggle signal like 00→01→10→11.

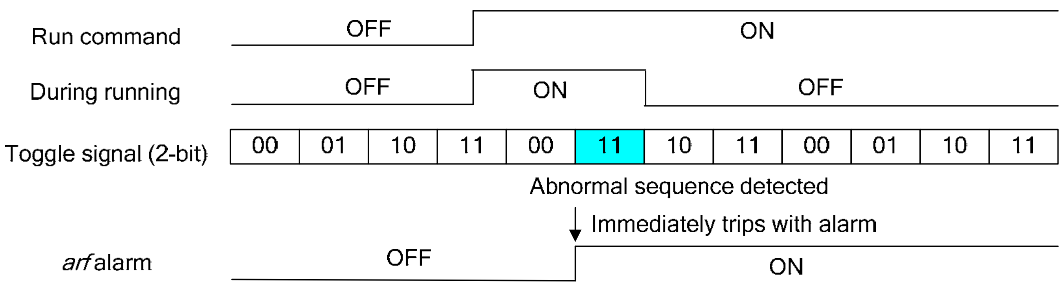
- During running, no change has occurred in a toggle signal for more than the detection time specified by H144.



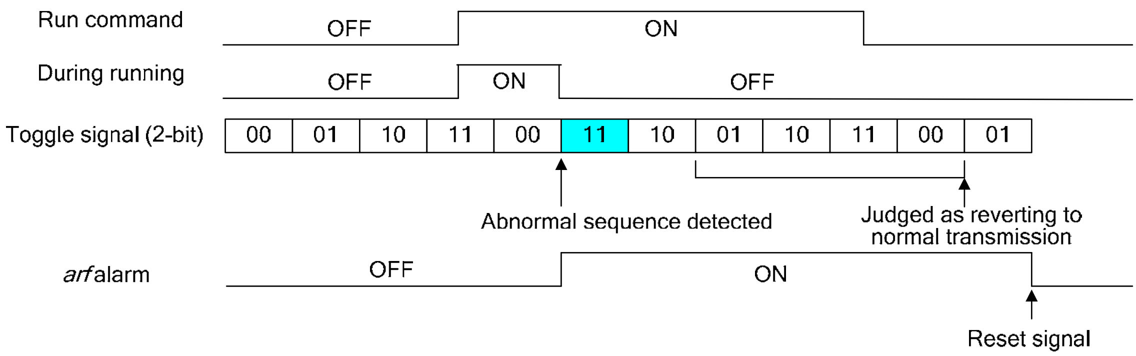
- During running, a toggle signal does not respond in the sequence of 00→01→10→11.

  If a change in a toggle signal is abnormal, the inverter immediately trips as a PLC program error. After detection of the error, normal sequence (00→01→10→11) of 2-bit signals is judged as a normal recovery.

  <u>Alarm occurrence example 1</u>



Alarm occurrence example 2 (Normal recovery after detection of an alarm)



Note: If a toggle error detection alarm (ar-f) occurs during pre-excitation or DC braking, disable (turn OFF) the ***EXCITE*** or ***DCBRK*** command, respectively. If the command remains enabled (ON), turning the alarm reset signal ON causes repeating of instantaneous cancellation and recurrence of ar-f alarm (chattering).

<u>Function code data = 74</u> Cause external mock alarm -- *FTB*

This external digital input signal causes a mock alarm (Er-r) in the inverter.

The factory default of this signal is Normal open contact.

When terminals [FTB] and [CM] are opened, it is treated as normal. Closing those terminals shuts down the inverter output so that the motor coasts to a stop.

For setting to use as Normal close contact, refer to the description of external alarm (OH2).

<u>Function code data = 75</u> Cancel NTC thermistor alarm -- *NTC-CCL*

This external digital input signal cancels an NTC thermistor wire break alarm (nr-b).

<u>Function code data = 76</u> Cancel lifetime alarm signal -- *LF-CCL*

This external digital input signal cancels a lifetime alarm signal ***LIFE***.

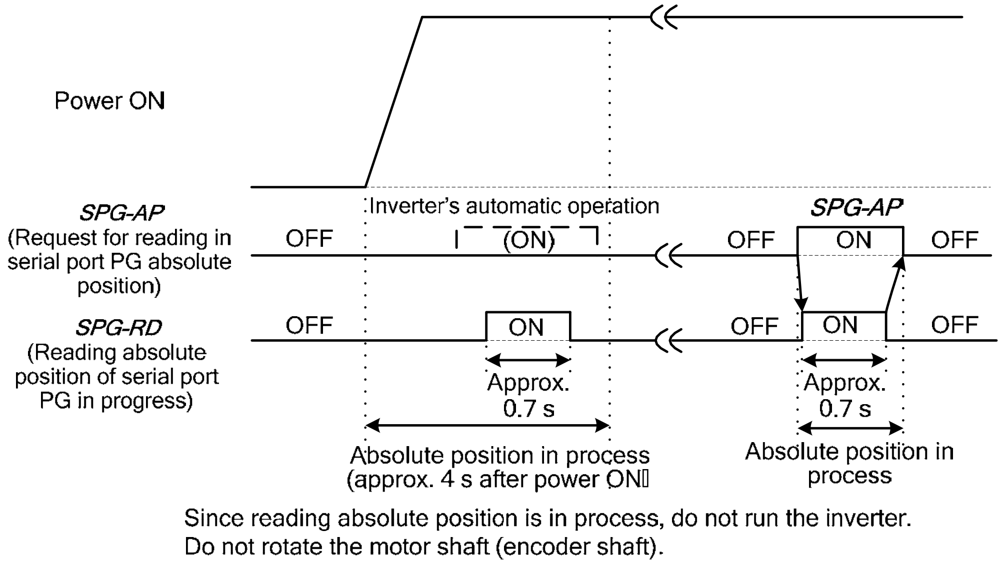
<u>Function code data = 77</u> Request for reading in serial port PG absolute position -- *SPG-AP* (Available soon)

When the inverter is used in combination with a permanent magnet synchronous motor (PMSM) equipped with a serial port PG, this external digital input signal causes the inverter to read in the absolute position of the serial port PG immediately after the power is turned ON.

To use the ***SPG-AP*** function, the serial port PG option (OPC-VG1-SPG) should be mounted and the ***SPG-AP*** should be assigned to any of the X terminals.

< Reading in the absolute position of a serial port PG >

- Immediately after the power is turned ON, the inverter automatically reads in the absolute position.
- Using this signal arbitrarily reads in the absolute position. As shown below, after checking that the ***SPG-RD*** signal ("Reading absolute position of serial port PG in progress") on a Y terminal is turned OFF, turn the ***SPG-AP*** OFF. Turning a run command ON at this moment does not allow inverter to run.



<u>Function code data = 78</u> Switch PID feedback signals -- *PID-1/2*

This external digital input signal switches between the PID feedback 1 ***PID-FB1*** and PID feedback 2 ***PID-FB2***, which are assigned to analog input terminals.

Input signal to select specified data	PID feedback to be selected (Analog input terminal)
78	
OFF	15: PID feedback 1 ***PID-FB1***
ON	27: PID feedback 2 ***PID-FB2***

<u>Function code data = 79</u> Select PID torque bias -- *TB-PID*

This external digital input signal enables PID output to be used as a torque bias.

Input signal to select specified data	Function to be selected
79	
OFF	Disable PID output as a torque bias
ON	Enable PID output as a torque bias

Function code data = 80 Tune magnetic pole position -- *MP-TUN* (Available soon)

When the inverter is used in combination with a permanent magnet synchronous motor (PMSM) equipped with an ABZ-phase encoder, it is necessary to tune the magnetic pole position before the initial operation after the power is turned ON. This external digital input signal initiates the magnetic pole position tuning.

Note: No magnetic pole position tuning is required when a starting operation is performed until the Z-phase is recognized after the power is turned ON or when the encoder of the PMSM is an absolute type of UVW -phase interface.

Function code data = 81 External electrical conditions -- *RD* (Available soon)
Function code data = 82 Startup conditions -- *STRD* (Available soon)

Function code data = 83 Continue to run at the time of communications link error -- *LK-D* (Available soon)

Turning this external digital input signal ON cancels a network alarm (Er-4) caused by a communication error detected by a communications option card such as T-link, SX bus and CC-Link to continue the inverter running. For details, refer to o29 (Continue-to-run signal processing in case of alarm).

Input signal to select specified data	Function to be selected
82	
OFF	Cause network alarm (Er-4)
ON	Cancel network alarm (Er-4)

E14	X Terminal Function (Normal open/close)

E14 configures terminals [X1] to [X9] individually as a "normal open" or "normal close" contact by software when they have no connections.

```
          1500
CLOSE/OPEN (X)
■■■■■■■■□OP
□□□□□□□□■CL
123456789
∧∨→DATA  ADJUST
```

OP: Normal open
CL: Normal close

Use this function for configuring a "normal close" contact for terminal command ***THR*** ("Enable external alarm trip"), for example.

<u>Configuration change example via the RS-485 communications link</u>

To configure terminal [X9] (***THR***) as a "normal close" contact and other X terminals, as a "normal open" contact, use the following.

(1) Assign bits in accordance with format [35]. Refer to Chapter 4, Section 4.2.4.2 "Data type 12-145."

To configure terminal [X9] as a "normal close" contact, the bit assignment is 0000 0001 0000 0000 (in binary).

(2) Convert the bit assignment from binary to hexadecimal format.

0000 0001 0000 0000 (binary) = 0100 (hexadecimal)

Set the hexadecimal data to E14 for configuring terminal [X9].

E	1	4	X		N	O	R	M	A	L		

E15 to E27 Y Terminal Function

Part of control signals and monitor signals can be selected and output to the terminals [Y1] to [Y18] and [Y5A]. The transistor signals are output to the terminals [Y1] to [Y18] and the relay contact signal to [Y5A]. Use of terminal functions from [Y11] to [Y18] requires the optional OPC-VG1-DIOA.

The valid and invalid functions vary according to the drive control (vector control for IM with/without speed sensor, vector control without speed sensor, V/f control and vector control for PMSM with speed sensor). For details, refer to the function code tables in Section 4.2.

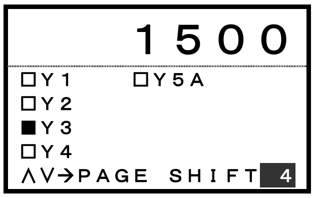
<Using digital output>

You can use a total of 13 terminals, which are five terminals from Y1 to Y4 and Y5A as standard and eight terminals from Y11 to Y18 (when a DIOA option is used). Similarly to the link function (RS-485, T-Link, SX, Field Bus), you can refer to the output of 13 points through the communications link.

You can use the function codes M52, M53, M54, M142, M143 and M144 (control output 1 to 6) to read all information (48 bits in total) that are available for the DO outputs through the communications link (RS-485, T-Link, SX bus, and fieldbus) and UPAC. For details, refer to M52 to M54 (data types 125 to 127) and M142 to M144 (data types 128 to 130) in the function code tables.

Setting procedure

- Select a function you want to use. We select the "Operation ready output" command as an example.
- Assign the "Operation ready output" command to one of the available terminals (Y1 to Y4, Y5A, Y11 to Y18). If you want to assign it to Y3, write a data, "14:RDY", to the function code E17 "Y3 function selection".
- Y3 terminal is set to ON after you turn on and the operation becomes ready.
- See the "I/O check" screen of the KEYPAD panel to confirm the ON/OFF status of the Y3. If you switch the Y3 from OFF to ON, □Y3 changes to ■Y3 on the screen shown on the right.



<You can specify as "NO terminal" or "NC terminal">

You can use the function code E28 to specify the state of individual terminals (standard 5 terminals only) as normally open ("NO terminal") or normally closed ("NC terminal"). See the function description of E28 for more information.

E	1	5	Y	1		F	U	N	C			
E	1	6	Y	2		F	U	N	C			
E	1	7	Y	3		F	U	N	C			
E	1	8	Y	4		F	U	N	C			
E	1	9	Y	5		F	U	N	C			
E	2	0	Y	1	1		F	U	N	C		
E	2	1	Y	1	2		F	U	N	C		
E	2	2	Y	1	3		F	U	N	C		
E	2	3	Y	1	4		F	U	N	C		
E	2	4	Y	1	5		F	U	N	C		
E	2	5	Y	1	6		F	U	N	C		
E	2	6	Y	1	7		F	U	N	C		
E	2	7	Y	1	8		F	U	N	C		

Data setting range: 0 to 75

Function code data	Terminal commands assigned	Symbol	Function code data	Terminal commands assigned	Symbol
0	Inverter running	***RUN***	24	Resetting	***TRY***
1	Speed valid	***N-EX***	25	Universal DO	***U-DO***
2	Speed agreement 1	***N-AG1***	26	Heat sink overheat early warning	***INV-OH***
3	Speed arrival signal	***N-AR***	27	Synchronization completion signal	***SY-C***
4	Speed detected 1	***N-DT1***	28	Lifetime alarm	***LIFE***
5	Speed detected 2	***N-DT2***	29	Under acceleration	***U-ACC***
6	Speed detected 3	***N-DT3***	30	Under deceleration	***U-DEC***
7	Undervoltage detected (Inverter stopped)	***LU***	31	Inverter overload early warning	***INV-OL***
8	Torque polarity detected (braking/driving)	***B/D***	32	Motor overheat early warning	***M-OH***
9	Torque limiting	***TL***	33	Motor overload early warning	***M-OL***
10	Torque detected 1	***T-DT1***	34	DB overload early warning	***DB-OL***
11	Torque detected 2	***T-DT2***	35	Link transmission error	***LK-ERR***
12	Keypad operation enabled	***KP***	36	In limiting under load adaptive control	***ANL***
13	Inverter stopped	***STOP***	37	In calculation under load adaptive control	***ANC***
14	Inverter ready to run	***RDY***	38	Analog torque bias being held	***TBH***
15	Magnetic flux detected	***MF-DT***	39-48	Custom Do1 to Do10	***C-DO1*** to ***C-DO10***
16	Motor M2 selected	***SW-M2***			
17	Motor M3 selected	***SW-M3***	49	-	-
18	Brake release signal	***BRK***	50	Z-phase detection completed (Available soon)	***Z-RDY***
19	Alarm content 1	***AL1***	51	Multiplex system communications link being established	***MTS***
20	Alarm content 2	***AL2***	52	Answerback to cancellation of multiplex system	***MEC-AB***
21	Alarm content 4	***AL4***	53	Multiplex system master selected	***MSS***
22	Alarm content 8	***AL8***	54	Multiplex system local station failure	***AL-SF***
23	Cooling fan in operation	***FAN***	55	Stopped due to communications link error	***LES***

Function code data	Terminal commands assigned	Symbol	Function code data	Terminal commands assigned	Symbol
56	Alarm output (for any alarm)	***ALM***	72	Turn ON Y-terminal test output	***Y-ON***
57	Light alarm	***L-ALM***	73	Turn OFF Y-terminal test output	***Y-OFF***
58	Maintenance timer	***MNT***	74	Reading absolute position of serial PG in progress (Available soon)	***SPG-AP***
59	Braking transistor broken	***DBAL***	75	System clock battery lifetime expired	***BATT***
60	DC fan locked	***DCFL***	76	Magnetic position tuning in progress (Available soon)	***TUN-MG***
61	Speed agreement 2	***N-AG2***	77	SPGT battery warning (Available soon)	***SPGT-B***
62	Speed agreement 3	***N-AG3***	78	Electrical conditions ready (Available soon)	***ERD***
63	Axial fan stopped	***MFAN***	79	IT detected in operation (Available soon)	***TCA***
64	-	-	80	EN terminal detection circuit failure (Available soon)	***DECF***
65	-	-	81	EN terminal OFF (Available soon)	***ENOFF***
66	Answerback to droop control enabled	***DSAB***	82	Safety function in progress (Available soon)	***SF-RUN***
67	Answerback to cancellation of torque command/torque current command	***TCL-C***	83	-	-
68	Answerback to cancellation of torque limiter mode 1	***F40-AB***	84	-	-
71	73 ON command	***PRT-73***			

0. Inverter running -- *RUN*

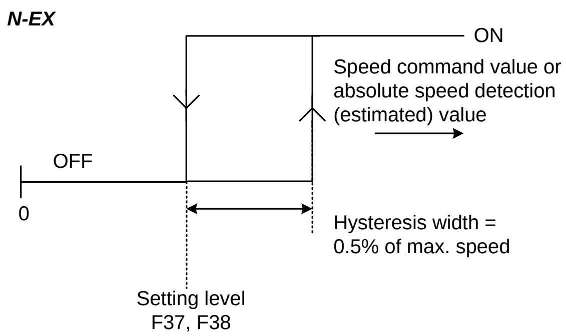
"Running" is defined as a state when the inverter supplies output. This signal is ON when the inverter is running and OFF when the inverter is stopping.

The inverter does not stop when it is decelerating after you turn OFF the FWD or the REV signal. The inverter shuts down the output and stops when the speed becomes less than the speed specified by F37 "Stop speed" and the zero speed continues for the time specified by F39 "Zero speed holding time". The status is running during DC braking, pre-exciting, and servo locking (synchronized control completed).

1. Speed valid -- *N-EX*

Turns ON when the absolute value of the speed command or the actual speed is more than the value specified by the function code F37 "Stop speed", and OFF when the value is less than the "Stop speed".

You can use the function code F38 "Stop speed (Detection method)" to select either the speed command or the actual speed.



2. Speed agreement 1 -- *N-AG1*

Turns ON when motor M1 is selected and the actual speed value falls in the detection range specified by the speed command value (Reference speed 4: ASR input).

See the function description of E44 "Speed agreement (Detection range) (Off delay timer)"and E45 "Enable/disable alarm for speed disagreement".

3. Speed arrival signal -- *N-AR*

Turns ON when the actual speed value reaches the speed command value (Speed command 1: acceleration/deceleration calculation unit input). See the function description of E42.

4 to 6. Speed detected 1, 2, 3 -- *N-DT1, N-DT2, N-DT3*

Turns ON when the observed speed reaches the Speed detection level 1 (E39), level 2 (E40), or level 3 (E41). See the function description of E39, 40, and 41.

7. Undervoltage detected (Inverter stopped) -- *LU*

Turns ON when the undervoltage protective function is active, or the DC link circuit voltage of the main circuit decreases down below the undervoltage detection level. This function is not active when the "undervoltage alarm cancel" signal is ON.

This signal turns OFF when the voltage recovers to exceed the undervoltage detection level.

Undervoltage detection level: 187.5 V for 200 V class series and 375 V for 400 V class series

8. Torque polarity detected (braking/driving) -- *B/D*

Provides a signal indicating whether the torque is for driving or for braking by detecting the polarity of the calculated torque inside the inverter.

Turns OFF for the driving torque and turns ON for the braking torque.

9. Torque limiting -- *TL*

Turns on when the torque command is limited by the torque limiter 1 or 2.

10, 11. Torque detected 1, 2 -- *T-DT1, T-DT2*

Turns on when the torque command increases over the Torque detection level 1 or 2 (E46 or E47).

12. Keypad operation enabled -- *KP*

Turns ON when the operation command keys (FWD, REV, STOP keys) directing running/stopping are effective (F02 "Operation method"=0).

13. Inverter stopped -- *STOP*

Supplies an inverted signal of the [RUN] signal indicating zero speed. Provides the ON signal during DC braking, pre-exciting, and servo locking (synchronized control completed).

14. Inverter ready to run -- *RDY*

Turns ON when the inverter is ready for the operation, for example, the power supply to the main and the control circuits are established or the inverter protective function is not active. Under a normal condition, the inverter becomes ready in about one second after you turn on. During operation with the UPAC option (o38 ≠ 0), [RDY] is turned on upon UPAC operation in addition to the above-mentioned condition. (It takes about 2 or 3s.)

This signal is turned off if the coast-to-stop command is turned on.

When the SX bus interface card (OPC-VG1-SX) or E-SX bus interface card (OPC-VG1-ESX) is mounted, the ON-conditions of ***RDY*** are as follows.

When commands via the SX bus or E-SX bus are enabled (H30 = 2 or 3 and ***LE*** = ON), ***RDY*** comes ON the moment the SX bus or E-SX bus becomes ready to communicate.

When commands via the SX bus or E-SX bus are disabled (H30 = 0 or 1 or ***LE*** = OFF), ***RDY*** comes ON as usual.

15. Magnetic flux detected -- *MF-DT*

Turns ON when the calculated magnetic-flux value exceeds the magnetic-flux detection level (E48-5%).

16, 17. Motor M2, M3 selected -- *SW-M2, SW-M3*

Provides the motor switching signal to the magnetic contactor for a motor according to the selected motor M1, M2, or M3 selected by the function code F79 or X control terminal.

Combination of the output signals		Motor to be selected
SW-M2	***SW-M3***	
OFF	OFF	Motor 1
OFF	ON	Motor 2
ON	OFF	Motor 3
ON	ON	Motor 1

18. Brake release signal -- *BRK* (Not available under V/f control)

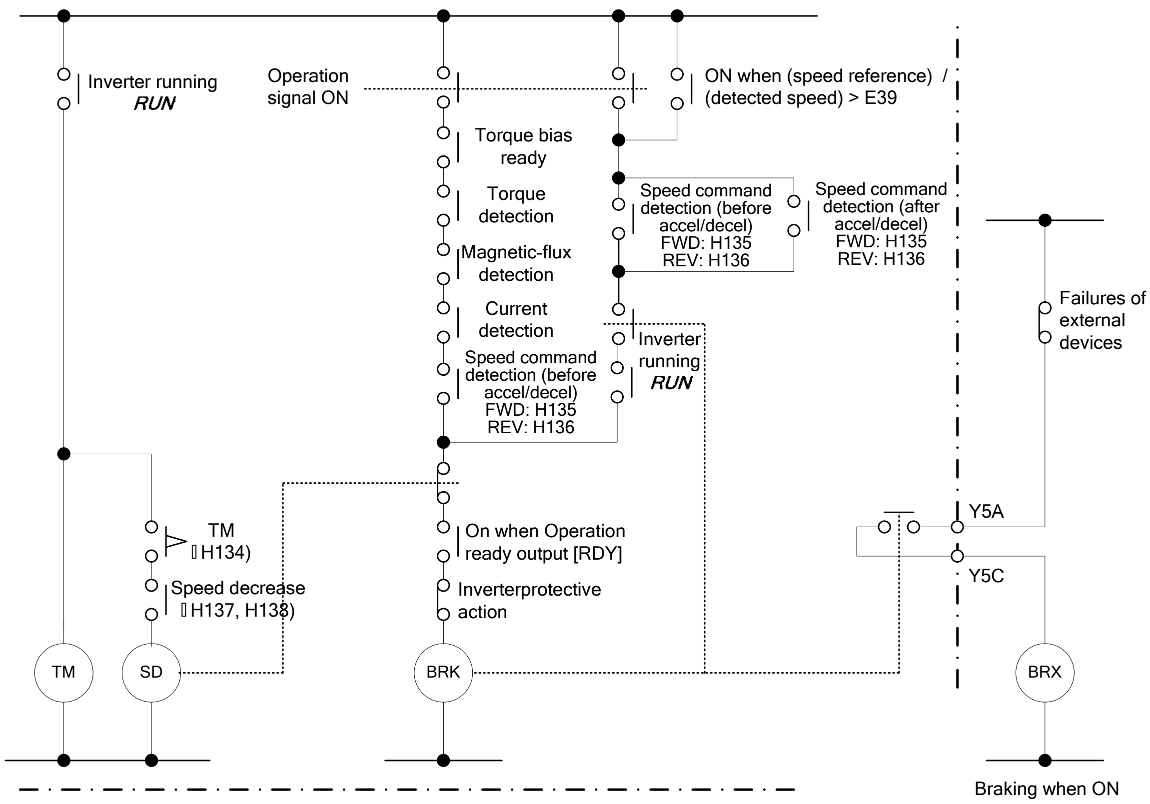
Provides the mechanical brake apply/release signal.

There are the torque bias (F47 to F50), torque detection levels 1 and 2 (E46, E47), magnetic-flux detection level (E48) and speed command detection level (H135, H136) as parameters (user-defined) for releasing (opening) brake.

There are the speed detection level 1 (E38, E39), speed decrease detection delay timer (H134, H137, H138) and speed command detection level (H135, H136) as parameter for applying brake.

Usually you should assign the brake releasing signal to the relay output (Y5A and Y5C) of the FRENIC-VG standard DO. This signal is connected to the external mechanical brake (BRX relay). The action of the mechanical brake is "NC contact".

Y5A-Y5C: Closing this releases brake and opening this applies brake.



Servo locking function (braking not by a mechanical brake but by the inverter output torque) is also available. See the zero speed locking command in E01 to E13 "X function selection" for more details. We recommend to use the servo lock function not independently but together with a mechanical brake.

< Setting >

Brake release sequence

When all of the following conditions 1) to 6) are met, ***BRK*** ("Brake release signal") is turned ON to release the mechanical brake.

1) ***RDY*** ("Inverter ready to run") ON
   After main power ON → DC link bus voltage established → initialization completed, ***RDY*** comes ON.

2) Current detection
   If the inverter detects current of 30% or more of the P08 (M1 exciting current) or A10 setting (M2 exciting current) when M1 or M2 is selected, respectively, it judges the state as detection of current.

   Note: When driving a permanent magnet synchronous motor (PMSM), the inverter judges 5% of the rated current as detection of current.

3) Completion of torque bias startup
   Torque bias can be added with F46 (Mechanical loss compensation), F47 to F49 (Torque bias T1 to T3) and F50 (Torque bias startup timer). The inverter defines the elapse of the time specified by F50 as completion of torque bias startup.

   When no torque bias is added, the inverter judges ***RUN*** ("Inverter running") ON as completion of torque bias startup.

4) Both ***FWD*** ("Run forward") and ***T-DT1*** ("Torque detected 1") ON, or both ***REV*** ("Run reverse") ON and ***T-DT2*** ("Torque detected 2") ON
   For ***FWD***, specify the torque detection level 1 with E46; for ***REV***, specify the torque detection level 2 with E47. When the torque command comes to be the torque detection level 1/2 or above, ***T-DT1*** or ***T-DT2*** is turned ON, respectively.

5) ***MF-DT*** ("Magnetic-flux detected") ON
   This signal is turned ON when the calculated magnetic-flux value comes to be "Magnetic-flux detection level (E48) - 5%" or above.

6) ***N-DT1*** ("Speed detected 1"), ***N-DT2*** ("Speed detected 2") or ***N-DT3*** ("Speed detected 3") ON
   For ***FWD*** or ***REV***, the speed detection signal is turned ON when the reference speed (before acceleration/deceleration) comes to be the speed command detection level (H135 or H136) or above.

Brake applying sequence

When any one of the following conditions 1) to 6) is met, ***BRK*** ("Brake release signal") is turned OFF to apply the mechanical brake.

1) Both run command (***FWD*** or ***REV***) and ***N-DT1*** ("Speed detected 1") OFF
   Specify the speed detection mode with E38 and the speed detection level 1 with E39. When "***N-FB1±*** ("Detected speed 1") / ***N-REF4*** ("Reference speed 4") ≤ (Speed detection level (E39) - 1% of maximum speed)," ***N-DT1*** goes OFF.

   If the speed detection level 1 (E39) is 1% or below of the maximum speed, ***N-DT1*** goes OFF when "***N-FB1±*** ("Detected speed 1") / ***N-REF4*** ("Reference speed 4") = 0 (r/min).

   Note: Under vector control without speed sensor, select ***N-REF4*** ("Reference speed 4"). (E39 = 1**).

2) ***RDY*** ("Inverter ready to run") OFF

3) ***RUN*** ("Inverter running") OFF

4) Inverter protective function (alarm) activated

5) ***N-DT1*** ("Speed detected 1"), ***N-DT2*** ("Speed detected 2") or ***N-DT3*** ("Speed detected 3") ON

   For ***FWD*** or ***REV***, the speed detection signal is turned ON when both the reference speed (before acceleration/deceleration) and the reference speed (after acceleration/deceleration) drops to "Speed command detection level (H135 or H136) - 0.5%" or below.

   (When H135 or H136 = 0.0 r/min, this condition is invalid.)

6) When the detected speed is kept at the speed decrease detection level (H137) or below during the time specified by the speed command detection delay timer (H138), the brake is applied irrespective of the presence of a run command.

   (When H137 = 0.0 r/min, this condition is invalid.)

Starting speed/Stop speed

Brake application and release timings can be adjusted with the starting speed (F23, F24) and stop speed (F37 to F39).

(1) At the time of start

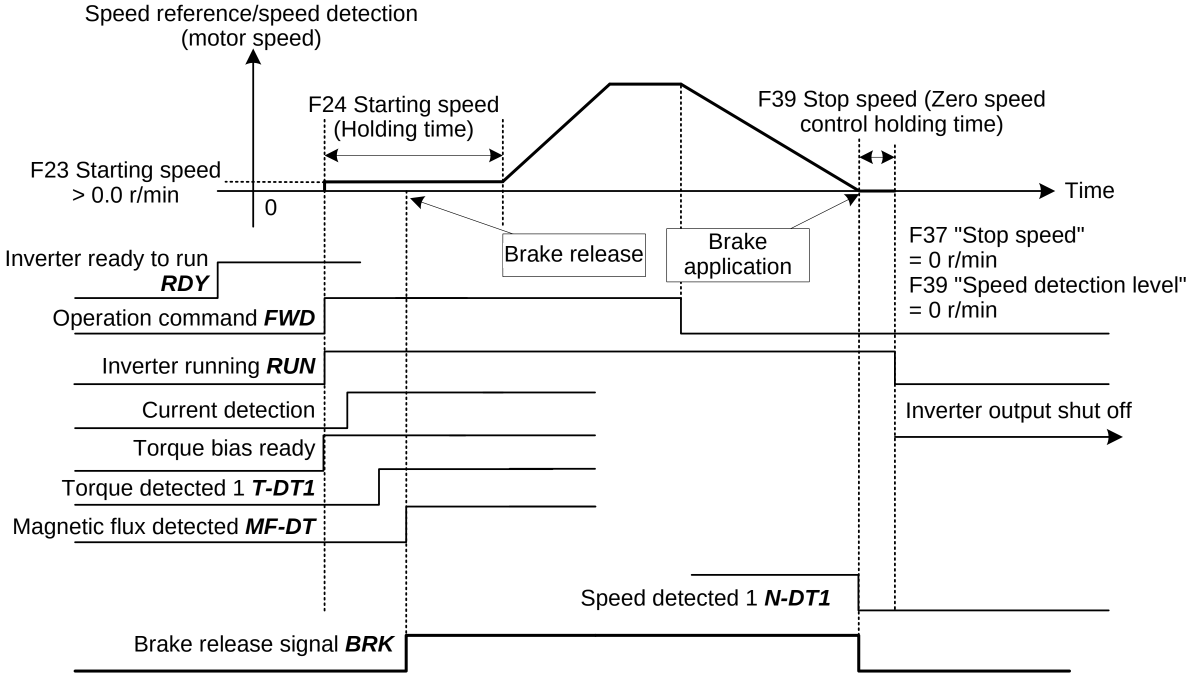
Starting speed without torque bias:
In order not to release brake during acceleration, set the starting speed (F23) to 0.1 r/min or above and set the torque detection level 1, 2 (E46, E47) so that ***T-DT1*** or ***T-DT2*** ("Torque detected 1 or 2") comes ON within the holding time (F24).

Starting speed with torque bias:
Set the starting speed (F23) to 0.0 r/min and set the torque detection level 1, 2 (E46, E47) so that ***BRD*** ("Brake release signal") comes ON within the holding time (F24).

(2) At the time of stop

Adjust the braking conditions to apply brake within the zero speed control holding time (F39).

Specifying the zero speed control (F37 = 0.0 r/min) and the speed detection level 1 (E39 = 0 r/min) enables ***BRD*** ("Brake release signal") to go off after the motor (machine) stops completely.



19-22. Alarm content -- *AL1, AL2, AL4, AL8*

Provides the operation status of the inverter protection function.

Alarm description (Inverter protective function)	Output terminal			
	AL1	***AL2***	***AL4***	***AL8***
No alarm	OFF	OFF	OFF	OFF
Overcurrent (EF, OC)	ON	OFF	OFF	OFF
Overvoltage (OU)	OFF	ON	OFF	OFF
Undervoltage (LU)	ON	ON	OFF	OFF
Main circuit error (dCF, PbF, dbA , ECF)	OFF	OFF	ON	OFF
CPU system error (Er1 , Er3, Er8, ErA (*1) SiF (*1) , SrF (*1))	ON	OFF	ON	OFF
Overheat (dbH, OH1, OH3, OH4, dFA)	OFF	ON	ON	OFF
Overload (OL1, OL2, OL3, OLU)	ON	ON	ON	OFF
Speed error (dO, Er9, OS, LOC)	OFF	OFF	OFF	ON
Input phase loss (Lin, OPL)	ON	OFF	OFF	ON
Inverter output circuit error (Er7)	OFF	ON	OFF	ON
Communication error (Er2, Er4, Er5, Erb)	ON	ON	OFF	ON
Signal disconnection (nrb, PG)	OFF	OFF	ON	ON
Operation procedure error (Er6)	ON	OFF	ON	ON
External fault (OH2, Err)	OFF	ON	ON	ON
Others (ErH, Ar1 to ArF)	ON	ON	ON	ON

(*1) Available soon

23. Cooling fan in operation -- *FAN*

This signal is associated with H06 "Fan stop operation" and is present when the cooling fan is operating.

24. Resetting -- *TRY*

This signal is issued when the protective function is conducting the retry operation if you set one or more to H04 "Auto reset (Times)".

25. Universal DO -- *U-DO*

You assign a data 25 to a digital output terminal to use it as a universal DO terminal. You can turn on/off through RS-485, field bus, and UPAC. This function simply set ON and OFF to the transistor and relay outputs without affecting the inverter functions.

The applications of this signal are:

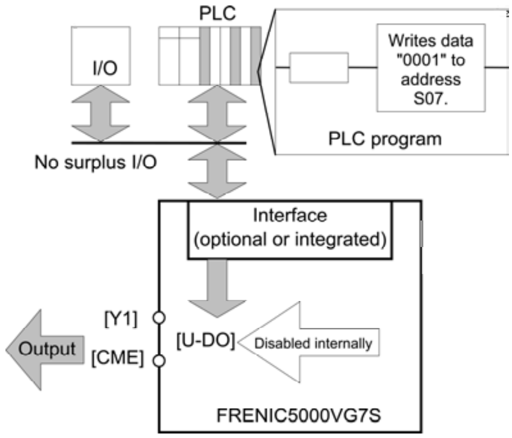
1) To set ON/OFF to the control terminal directly through RS-485 or field bus.
2) To put the output which are assigned by the software created by the UPAC option on a DO of the control terminals.

<Application>

You do not have enough numbers of I/O and want to use an inverter control terminal for a control output of a PLC program.

If you use the control terminal [Y1]:

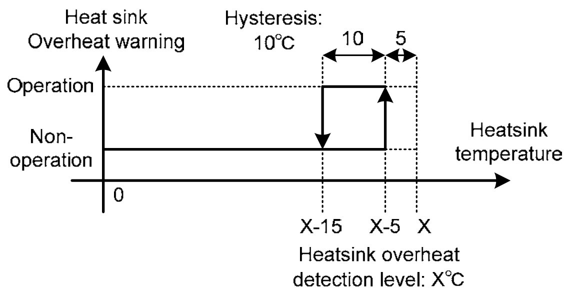
1) Set 25 [U-DO] to the function code E15 "Y1 function selection". Now the inverter does not use the Y1 terminal internally and you can use the terminal for the output of the communication.
2) Use the PLC to write "1" to the corresponding bit (data type: 33) of the function code S07 "Universal DO". You will write "0001 [h] " for [Y1].



26. Heat sink overheat early warning -- *INV-OH*

The heat sink overheat early warning will be issued when the temperature of the heat sink reaches the temperature five degrees less than the detection level of "Heat sink overheat alarm" (OH1). This is an early warning for the "Heat sink overheat alarm" which is present when the ambient temperature of the heat sink that cools the rectifier diode and the IGBT (PWM switching device) due to the failure of the cooling fan.

The heat sink overheat level (X°C) is set within the range of about 80 to 110°C based on the inverter capacity and short-time rating (HD, LD, and MD), and user cannot change it.



27. Synchronization completion signal -- *SY-C*

Turns ON when the synchronization completes within the pulse width specified by the function o19 "Deviation zero range" during the synchronizing operation with an option OPC-VG1-PG (PR). See the option section for more details.

It also turns ON when the lock completes within the pulse width specified by the function H56 "Zero speed control (completion range)". See the function description of the zero speed locking command (function code E01 to E13).

28. Lifetime alarm -- *LIFE*

Turns ON when the accumulated operation time of main circuit smoothing capacitor, the electrolytic capacitor on the control print circuit board, or the cooling fan.

The lifetime is determined by the following criteria and the lifetime is considered to be expired if either of them is reached. You can see them in the maintenance information of the KEYPAD panel.

Part	Life time determination level
Main circuit capacitor	85.0% or less of the initial value. Life time expires when CAP=85.0%.
Electrolytic capacitor on control print circuit board	Accumulated time: 87,600 hours
Cooling fan	87,600 hours Estimated life time in 45°C of inverter ambient temperature

This function indicates merely an approximate life span. Daily inspection and periodic inspection are necessary to avoid failures and keep operating at high reliability over a long period of time. (Refer to Chapter 8 in Instruction manual INR-HF51306x.)

29. Under acceleration -- *U-ACC*
30. Under deceleration -- *U-DEC*

Turns ON during acceleration or deceleration.

Acceleration or deceleration is determined by comparing the input to the acceleration/deceleration calculation unit (Speed reference 1) and the detected speed value. The Under-acceleration/ deceleration signal turns OFF when the speed reaches to a level specified by the function code E42 "Speed equivalent (Detection range)".

31. Inverter overload early warning -- *INV-OL*

Provides the overload early warning signal at a level specified by the Inverter overload early warning (E33). See the E33 "Inverter overload early warning" for more details.

32. Motor overheat early warning -- *M-OH*

Provides the overheat early warning signal at a level specified by the Motor overheat early warning (E31). See the E31 "Motor overheat early warning" for more details.

33. Motor overload early warning -- *M-OL*

Provides the overload early warning signal at a level specified by the Inverter overload early warning (E34). See the E34 "Inverter overload early warning" for more details.

34. DB overload early warning -- *DB-OL*

Provides the overload early warning signal at a level specified by the DB overload early warning (E36). See the E36 "DB overload early warning" for more details.

35. Link transmission error -- *LK-ERR* (Available soon)

Turns ON when a communication error occurs in the transmission through the link (RS-485, T-Link, SX, field bus). Turns OFF when the communication returns to normal.

36. In limiting under load adaptive control -- *ANL*

This signal comes ON when the reference speed is limited with the speed limiter value calculated under load adaptive control. Once this signal comes ON, it does not goes OFF until the inverter stops.

37. In calculation under load adaptive control -- *ANC*

This signal is turned ON during calculation of a movable load and speed limiter value under load adaptive control. Upon completion of calculation, this signal goes OFF.

Refer to the description given for function codes H60 to H66 and H201 to H228 (Load adaptive control).

38. Analog torque bias being held -- *TBH*

This signal is turned ON when an analog torque bias hold command is entered.

39-48. Custom Do1 to Do10 *C-DO1 to C-DO10*

Do terminals for manufacturer.

50. Z-phase detection completed -- *Z-RDY* (Available soon)

When the inverter is used in combination with a PMSM equipped with an ABZ encoder, this signal comes ON upon completion of Z-phase detection after the power is turned ON. Input of a run command before detection of a Z-phase causes an alarm Er7.

51. Multiplex system communications link being established -- *MTS*

This signal comes ON when the communications link of the multiplex system has been established.

52. Answerback to cancellation of multiplex system -- *MEC-AB*

This is an answerback signal for switching the digital input ***MT-CCL*** ("Cancel multiplex system").

53. Multiplex system master selected -- *MSS*

This signal comes ON when the master unit is configured with the multiplex system selected.

54. Multiplex system local station failure -- *AL-SF*

If an alarm occurs in a multiplex system, only the inverter (local station) that detects failure outputs this signal.

In the single-machine mode, this signal is functionally equivalent to "Alarm output (for any alarm)."

55. Stopped due to communications link error -- ***LES***

This signal applies when the CC-Link interface card is mounted. It comes ON when the inverter switches to a stop operation due to an occurrence of an alarm Er-4 or Er-5. Removing the alarm and restarting the inverter turns this signal OFF.

56. Alarm output (for any alarm) -- ***ALM***

The ALM can be output also via the Y terminal.

57. Light alarm -- ***L-ALM***

This signal comes ON when a light alarm has occurred. Removing the alarm factor automatically turns this signal OFF.

58. Maintenance timer -- ***MNT***

This signal comes ON when the total of the M1, M2 and M3 startups (M123 to M125) exceeds the H82 setting or the total of the M1, M2 and M3 cumulative motor run time (M126 to M128) exceeds the H83 setting.

Modifying either of the H82 or H83 setting that constitutes a forecasting factor turns this signal OFF.

59. Braking transistor broken -- ***DBAL***

This signal comes ON when the error factor of a braking transistor alarm (dbA) arises. Even if the alarm is defined as a light alarm, this signal comes ON.

60. DC fan locked -- ***DCFL***

This signal comes ON when the DC fan for circulating air inside the inverter is stopped for one second.

The above inverter state also constitutes a heavy or light alarm factor. Alarms can be defined by H108 as a heavy or light alarm.

61. Speed agreement 2 -- ***N-AG2***

This signal applies when motor M2 is selected. It comes ON when the deviation of the detected speed from the speed command value (Reference speed 4: ASR input) is within the allowable range.

For details, refer to the descriptions of E114 and E115 (Speed Agreement 2, Detection width and Off-delay timer) and E45 (Speed Disagreement Alarm).

62. Speed agreement 3 -- ***N-AG3***

This signal applies when motor M3 is selected. It comes ON when the deviation of the detected speed from the speed command value (Reference speed 4: ASR input) is within the allowable range.

For details, refer to the descriptions of E116 and E117 (Speed Agreement 3, Detection width and Off-delay timer) and E45 (Speed Disagreement Alarm).

63. Axial fan stopped -- ***MFAN***

This signal comes ON when the NTC detection temperature of the motor having an NTC thermistor drops below the setting specified by E118 and the inverter is stopped.

66. Answerback to droop control enabled -- *DSAB*

This signal is turned ON when the droop control is activated by turning ON the ***DROOP*** signal on an X terminal.

When the inverter is stopped or under torque control, even turning ON the ***DROOP*** signal does not turn this signal ON.

67. Answerback to cancellation of torque command/torque current command -- *TCL-C*

This is an answerback signal for switching between ***H41-CCL*** (Cancel H41 (Torque command)) and ***H42-CCL*** (Cancel H42 (Torque current command)).

68. Answerback to cancellation of torque limiter mode 1 -- *F40-AB*

This is an answerback signal for switching ***F40-CCL*** (Cancel F40 (Torque limiter mode 1)).

71. 73 ON command -- *PRT-73*

When a charger circuit is configured outside the inverter, use this signal as a 73 ON command for switching the charger resistor bypass circuit. Turning this signal ON bypasses the charger resistor.

72. Turn ON Y-terminal test output -- *Y-ON*

This signal comes ON when it is assigned to the Y terminal function. Use this signal to check the connection of Y terminals.

73. Turn OFF Y-terminal test output -- *Y-OFF*

This signal comes OFF when it is assigned to the Y terminal function. Use this signal to check the connection of Y terminals.

74. Reading absolute position of serial PG in progress -- *SPG-RD* (Available soon)

When the inverter is used in combination of a PMSM equipped with a serial PG, this signal is turned ON during reading of the serial PG absolute position. Refer to the ***SPG-AP*** on an X terminal (data = 77).

75. System clock battery lifetime expired -- *BATT*

This signal comes ON when the battery voltage level of the integrated battery (option for inverters of 22 kW or below, standard for those of 30 kW or above) drops. If this signal comes ON, replace the integrated battery as soon as possible.

76. Magnetic pole position tuning in progress -- *TUN-MG* (Available soon)

When the inverter is used in combination with a PMSM equipped with an ABZ-phase encoder, it is necessary to tune the magnetic pole position before the initial operation after the power is turned ON. In a sequence of tuning processes, during magnetic pole position tuning (approx. 0.8 s), this signal is turned ON.

For details, refer to the ***MP-TUN*** ("Tune magnetic pole position") on an X terminal (E01 to E13, data = 80).

77. SPGT battery warning -- *SPGT-B* (Available soon)
78. Electrical conditions ready -- *ERD* (Available soon)
79. IT detected in operation -- *TCA* (Available soon)

80. EN terminal detection circuit failure -- *DECF* (Available soon)

This signal comes ON when an Enable circuit failure is detected.

81. EN terminal OFF -- *ENOFF* (Available soon)

This signal comes ON when Enable input on the EN1 and EN2 terminals is OFF.

82. Safety function in progress -- *SF-RUN* (Available soon)

E28 Y Terminal Function (Normal open/close)

E28 specifies whether to open or close output terminals [Y1] to [Y5] by software.

OP: Open
CL: Close (short-circuit)

E	2	8	Y		N	O	R	M	A	L		

Example of configuration change through RS-485 or other communications links

To configure Y2 and Y5 as normally closed contacts and configure other Y functions as normally open contacts

1) Perform bit assignment in binary according to type [36] (refer to Section 4.2.3.2 Data Type).
2) Next, convert the bit-assigned binary data into a hexadecimal.
   0000 0000 0001 0010 (binary) = 0012 (hexadecimal) Enter this hexadecimal data.

E29 PG Pulse Output Selection

Use this function to provide different applications with the PG pulse signal.

E	2	9	P	G	–	P	L	S	–	O	U	T

1) You can divide the pulse signal to supply. Set value: 0: 1/1, 1: 1/2, 2: 1/4, 3: 1/8, 4: 1/16, 5: 1/32, 6: 1/64

   The input signal to the integrated PG is divided for output as presented above. You can use the divided signal for digital speedometer.
2) You can convert the internal speed command (digital and analog) into pulse to supply. See the <Application example 2> of Synchronization command [SYC] of the function codes E01 to E13 for more details.

   When E29 = 7: Pulse generation mode (A, B: Signals with 90° phase difference)
3) Converting the input via the PG interface card into arbitrary pulses to output

   When E29 = 8: OPC-VG1-PG (PD), pulse train detection input is directly supplied to the pulse output.

   When E29 = 9: OPC-VG1-PG (PR), pulse train command input is directly supplied to the pulse output.

   See the <Application example 3> of Synchronization command [SYC] of the function codes E01 to E13 for more details.
4) Converting the speed detection pulse input into arbitrary pulses to output

   When E29 = 10: Integrated PG, PG (SD), Detected speed pulse input oscillation mode

   When E29 = 7 to 10, arbitrary pulses can be output. For details, refer to the description of E109 and E110.

E30 Motor Overheat Protection (Temperature)

Sets the temperature at which the motor overheat alarm (OH4) is issued. Specify the protection level according to the isolation class of the motor.

E	3	0	M	–	P	R	T	–	C			

Data setting range: 50 to 200 (°C)

Note: The E30 setting takes effect when the selected motor (M1, M2 or M3) uses an NTC thermistor or the analog input signal ***M-TMP*** ("Motor temperature") is selected.

E31	Motor Overheat Early Warning (Temperature)

Sets the temperature at which the motor overheat early warning is issued before the overheat protection becomes active. The early warning signal is put on the DO to which [M-OH] is assigned.

E31 M-WARN-T

Data setting range: 50 to 200 (°C)

Note: This function is invalid if the PTC thermistor is used.

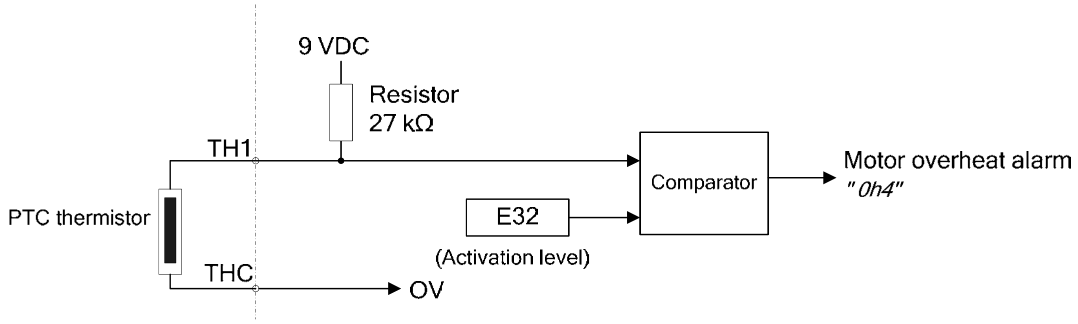
E32	M1-M3 PTC Activation Level

Activated when the input voltage from a PTC becomes higher than the specified voltage (activation level) if you select to use a thermistor.

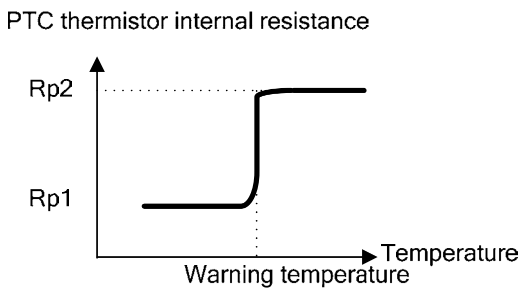
E32 M-PTC-LVL

Data setting range: 0.00 to 5.00 (V)

Connect a PTC thermistor as shown below.



The warning temperature depends on a PTC thermistor and the resistor of the PTC thermistor changes drastically at the warning temperature. The activation (voltage) level is specified by this change of the resistor.



The voltage level (activation level) can be calculated with the following expression.

Voltage level (V) = 9 V/(Rp + 270000) x Rp

Set the Rp within the following range.
Rp1 < Rp < Rp2

To determine Rp easily, use the following expression.
Rp (Ω) = (Rp1 + Rp2)/2

When a PTC thermistor wire breaks, the inverter recognizes Rp = (Ω) and issues a motor overheat alarm OH4.

E33 Inverter Overload Early Warning

Sets the level at which the overload early warning is issued before the Inverter overload protection becomes active. When you set 100%, the early warning is simultaneously issued with the overload protection (OLU). The early warning signal is put on the DO to which [INV-OL] is assigned.

E	3	3	I	N	V	–	O	L	W	A	R	N

Data setting range: 25 to 100 (%)

E34 Motor Overload Early Warning

Sets the level at which the overload early warning is issued before the Motor overload protection becomes active. When you set 100%, the early warning is simultaneously issued with the overload protection (OL 1). The early warning signal is put on the DO to which [M-OL] is assigned. This function is valid only if the first motor is selected. The motor overload early warning function does not operate if the second or third motor is selected.

E	3	4	M	–	O	L	–	W	A	R	N	

Data setting range: 25 to 100 (%)

E35 DB Overload Protection

Sets in %ED with respect to the inverter capacity. When you use a braking resistor with 10%ED, set as 10%. When the set value is zero, the overload protection (dbH) becomes disabled.

E	3	5	D	B	–	O	L	–	P	R	T	C

Data setting range: 0 to 100 (%)

E36 DB Overload Early Warning

Sets the level at which the overload early warning is issued before the DB overload protection becomes active. When you set 100%, the early warning is simultaneously issued with the overload protection (dbH). The early warning signal is put on the DO to which [DB-OL] is assigned.

E	3	6	D	B	–	O	L	–	W	A	R	N

Data setting range: 0 to 100 (%)

E37 DB Thermal Time Constant

Sets the thermal time constant of a DB resistor to be used.

E	3	7	D	B	–	T	H	–	T	C		

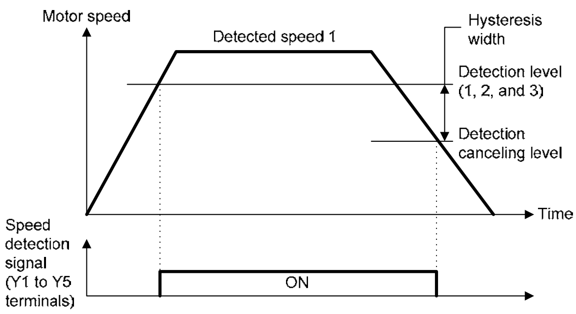
Data setting range: 0 to 1,000 (s)

E38	Speed Detection Mode
E39	Speed Detection Level 1
E40	Speed Detection Level 2
E41	Speed Detection Level 3

Provide signals when the Detected speed 1 [N-FB1±] /Speed reference 4 [N-REF4] exceeds the detection level (1, 2, and 3). The detected signals are present on the DO's to which [N-DT1], [N-DT2], and [N-DT3] are assigned. You can set the detection method (detection, speed reference) individually.

E	3	8	N	D	T		M	E	T	H	O	D
E	3	9	N	D	T	1	—	L	V	L		
E	4	0	N	D	T	2	—	L	V	L		
E	4	1	N	D	T	3	—	L	V	L		

- Detection level



Three types of speed detection level can be specified with E39 to E41.

If the specified speed detection level exceeds the maximum speed, the inverter interprets the detection level as the maximum speed. The hysteresis width is 1% of the maximum speed. If the specified speed detection level is 1% or less of the maximum speed, ***N-DT1***, ***N-DT2*** and ***N-DT3*** go OFF when (Speed detection level 1/Speed detection level 4) = 0 r/min.

E39: Level 1
Data setting range: 0 to 30,000 (r/min)

Note: The absolute value of the speed is used. When E39, E40, E41 = 0 (r/min), the ***N-DT1*** signal comes ON when (Speed detection level 1/Reference speed 4) ≠ 0 (r/min).

E40, E41: Level 2 and 3
Data setting range: 0 to ±30,000 (r/min)

Note: When E39, E40, E41 = 0 (r/min), ***N-DT2*** and ***N-DT3*** are always turned ON.

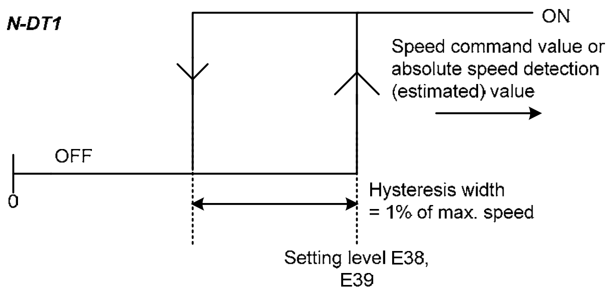
- Detection method

The detection method of the speed detection function can be individually specified.

Data setting range: 000 to 111
(0: speed detection (estimated).
1: speed reference)

E38 = □□□

Definition of E39
Definition of E41
Definition of E40

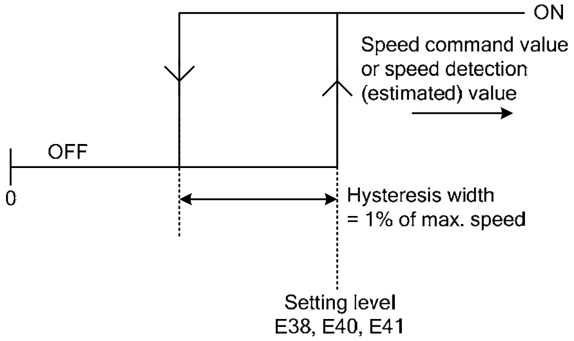


Speed detection is judged at speed detection 1 [N-FB1±].

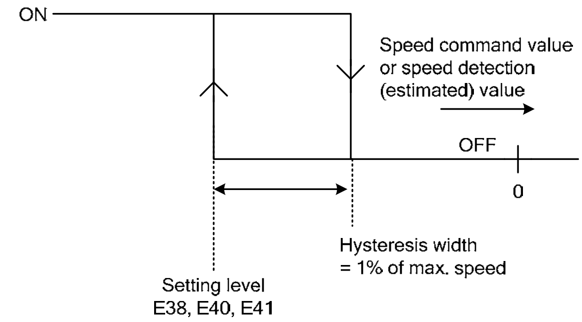
Speed setting is judged at speed reference 4 (ASR input) [N-REF4].

N-DT2 N-DT3

If the setting level is positive

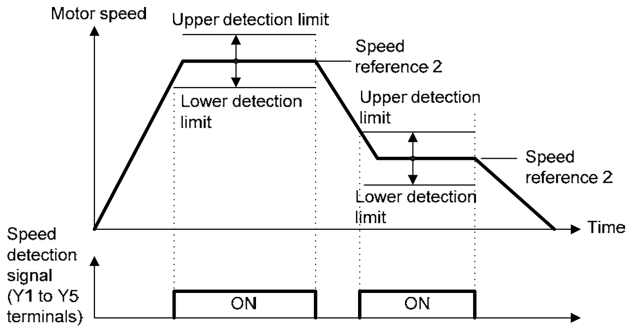


If the setting level is negative

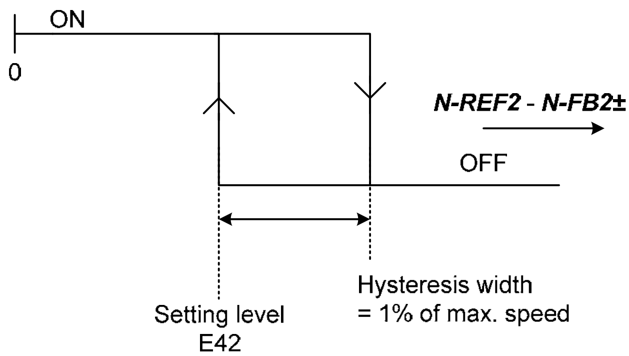


E42	Speed Arrival (Detection width)

Specifies the level (detection range) to determine whether the Detected speed 2 (ASR input) [N-FB2±] reaches the Speed reference 2 (before the acceleration/deceleration calculation) [N-REF2]. The inverter provides the detection signal when the detected speed is between the Speed reference 2 plus the hysteresis and the Speed reference 2 minus the hysteresis. The 100% means the maximum speed. The detection signal appears on the DO to which the [N-AR] is assigned.



N-AR



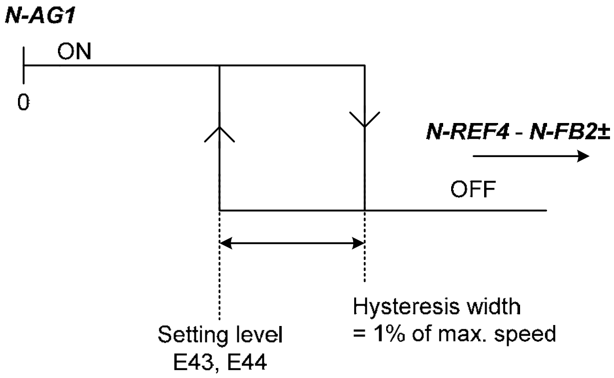
E	4	2	N	A	R	–	H	Y	S	T	R	

Data setting range: 1.0 to 20.0 (%)

E43	Speed Agreement (Detection width)
E44	**Speed Agreement (Off-delay timer)**

The ***N-AG1*** (Speed agreement signal) takes effect when motor M1 is selected.

Set the agreement levels (agreement ranges) of the Speed reference 4 (ASR input) [N-REF4] and the Detected speed 2 [N-FB2±]. The inverter provides the detection signal when the Detected speed 2 is between the Speed reference 4 plus the Detection range and the Speed reference 4 minus the Detection range.



The 100% means the maximum speed. The detection signal appears on the DO to which the [N-AR] is assigned. You can also set the off delay timer for the detection signal. If the Detected speed 2 goes out and returns to the detection range in a period specified by the off delay time, the detection signal will not be set to OFF.

For ***N-AG2*** and ***N-AG3*** (Speed agreement signals) to be applied when motor M2 and M3 are selected, respectively, refer to the descriptions of E114 to E117.

E	4	3	N	A	G		H	Y	D	T	R	
E	4	4	N	A	G		D	E	L	A	Y	

Data setting range: E43 = 1.0 to 20.0 (%)
E44 = 0.000 to 5.000 (s)

E45	Speed Disagreement Alarm Phase Loss Detection Level

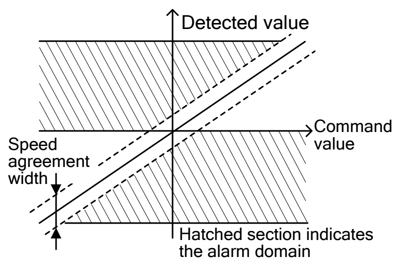
E45 specifies whether the Speed disagreement alarm (Er-9) is issued or not when the deviation between the Speed reference 4 (ASR input) and the Detected speed 2 remains for a certain period.

E	4	5	N	–	U	E	–	A	L	M		

Setting: □ □

- Speed disagreement alarm: 0: Disable 1: Enable
- Phase loss detection level: 0: Standard level
  1: Level for manufacturer
  2: Cancel

Note: When ***BRK*** (Brake release signal) is assigned to a Y terminal and H149 ≠ 0.0, the speed disagreement alarm (Er-9) takes effect and the speed agreement specified by E43 and E44 takes no effect.



E46 Torque Detection Level 1

E47 Torque Detection Level 2

Provides a detection signal when the torque command exceeds a specified value. You can specify two levels of detection level, level 1 and level 2. 100% means a torque command of the continuous rating. The detection signals appear on the DO's to which the [T-DT1] and [T-DT2] are assigned.

E	4	6	T	D	T	1	–	L	V	L		
E	4	7	T	D	T	2	–	L	V	L		

Data setting range: 0 to 300.0 (%)

Note: The calculated torque value is used for determination in V/f control.

E48 Magnetic Flux Detection Level

Provides a detection signal when the calculated magnetic-flux value exceeds a specified value. The detection signal appears on the DO to which the [M-DT] is assigned.

E	4	8	M	F	D	T	–	L	V	L		

Data setting range: 10 to 100 (%)

E49 to E52 Ai Terminal Function

E49 to E52 select functions to be assigned to analog input terminals [Ai1] to [Ai4], respectively.

Some functions are not available depending upon the drive control (vector control with/without speed sensor, V/f control and synchronous motor drive). For details, refer to Section 4.2 "Function Code Tables."

E	4	9	A	i	1		F	U	N	C		
E	5	0	A	i	2		F	U	N	C		
E	5	1	A	i	3		F	U	N	C		
E	5	2	A	i	4		F	U	N	C		

Data setting range: 0 to 27

Function code data	Terminal commands assigned	Symbol	Scale	Remarks
0	Shut down input signal	***OFF***	–	–
1	Auxiliary speed setting 1	***AUX-N1***	±10V/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
2	Auxiliary speed setting 2	***AUX-N2***	±10V/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
3	Torque limiter level 1	***TL-REF1***	±10V/±150%	100%: Motor rated torque
4	Torque limiter level 2	***TL-REF2***	±10V/±150%	100%: Motor rated torque
5	Torque bias	***TB-REF***	±10V/±150%	100%: Motor rated torque
6	Torque command	***T-REF***	±10V/±150%	100%: Motor rated torque
7	Torque current command	***IT-REF***	±10V/±150%	100%: Torque Current (P09, A11, A111)
8	Creep speed 1 for UP/DOWN control	***CRP-N1***	±10V/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
9	Creep speed 2 for UP/DOWN control	***CRP-N2***	±10V/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
10	Magnetic flux reference	***MF-REF***	+10V/+100%	-
11	Detect line speed	***LINE-N***	±10V/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
12	Motor temperature	***M-TMP***	+10V/200	-
13	Speed override	***N-OR***	±10V/±50%	-
14	Universal Ai	***U-AI***	±10V/±4000 (h)	-
15	PID feedback 1	***PID-FB1***	±10V/±20000 (d)	-
16	PID reference value	***PID-REF***	±10V/±20000 (d)	-
17	PID correction gain	***PID-G***	±10V/±4000 (h)	-
18-24	Custom Ai1 to Ai7	***C-AI1-7***	±10V/±7FFF (h)	-
25	Main speed setting	***N-REFV***	±10V /±Nmax	Nmax: Maximum Speed (F03, A06, A106)
26	Current input speed setting	***N-REFC***	4-20 mADC/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
27	PID feedback amount 2	***PID-FB2***	±10V/±20000 (d)	

<Using analog input>

There are 19 types of analog input functions from 0 to 18 available. You cannot use all of these functions at the same time. You can use total of four terminals, which are two terminals, [Ai1] and [Ai2], as standard and two terminals, [Ai3] and [Ai4], using optional AIO. The maximum number you can use is four unless you switch externally.

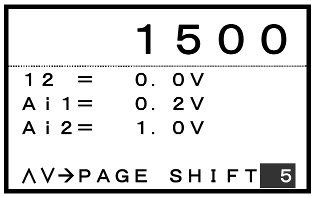
When you assign the same function to [Ai1] and [Ai2], the input to [Ai2] will become effective. When you install the AIO option and assign the same function to [Ai1], [Ai2], [Ai3], and [Ai4], the input to [Ai4] will become effective. (Priority order 1: [Ai1], 2: [Ai2], 3: [Ai3], 4: [Ai4])

Note that you should assign [U-AI] to all the analog input terminals at the same time.

Note: The current input function on terminal [Ai2] applies only to the ***N-REFC*** (Current input speed setting). The function cannot be used on terminal [Ai1].

Setting procedure

- Select a function you want to use. We select the "Torque bias" as an example.
- Assign the "Torque bias" function to one of the available terminals ([Ai1] to [Ai4]). If you want to assign it to [Ai2], write a data, "5:TB-REF", to the function code E50 "Ai2 function selection".
- Apply a voltage of ±10V/±150% to the analog terminal [Ai2] considering the scale conversion of the torque bias in mind. If you need the torque bias of 15%, you should apply +1.0V.
- See the "I/O check" screen of the KEYPAD panel to confirm that +1.0V is applied to [Ai2]. The right figure shows the screen you must view.
- You can specify the bias, the gain, the filter and the increment/ decrement limiter applied to the analog input.



Function	Application
Bias	Sets the bias.
Gain	Use to enlarge a small voltage range or to reduce a large voltage range. Use a minus value to invert the polarity.
Filter	Use to eliminate high frequency ripple and noise on the input voltage. Since you apply a low-pass filter, excessive setting may slow down the response.
Increment/decrement limiter	Slants a step input voltage. The specified values work as rising and falling times.

See the description of the individual function codes for more details.

- You can use the DI terminal input to hold the analog input to zero or to invert the polarity of the analog input. See Ai zero hold and Ai polarity change of E01 to E13 "X function selection" for more details.

See also the control block diagram to work with this function effectively.

0. Shut down input signal -- *OFF*

Select when you want assign no function to an analog input terminal.

Use when you do not use the analog input terminals.

1, 2. Auxiliary speed setting 1, 2 -- *AUX-N1, AUX-N2*

Assign a data 1 [AUX-N1] and a data 2 [AUX-N2], to desired analog input terminals to designate them as Auxiliary speed setting 1 and Auxiliary speed setting 2 terminals. See the table below and the control diagram for the points where the control inputs are applied. This function adds a speed (±10V corresponds ±maximum speed) to main speed command values ([12] input and the multistep speed command). Two points are available to add a speed.

Auxiliary speed setting	Point of application	Restrictions
1 ***AUX-N1***	After multistep speed command	Disabled when you use "0: KEYPAD panel" and "3, 4, 5: UP/DOWN functions" of the function codes F01 and C25.
2 ***AUX-N2***	After acceleration/deceleration calculation (acceleration/deceleration calculation applied to input is disabled)	

If auxiliary speed setting 2 is larger than the stop speed level (F37), the motor keeps rotating at auxiliary speed setting 2 even after the operation command (FWD, REV) is turned off. In this case, use the Ai zero hold function with X function selection to zero-hold the Ai input simultaneously when the operation command is turned off.

3, 4. Torque limiter level 1, 2 -- *TL-REF1, TL-REF2*

Assign a data 3 [TL-REF1] and a data 2 [TL-REF2] to desired analog input terminals to designate them as Torque limiter (level 1) and Torque limiter (level 2) terminals. See the function codes F40 to 43 for torque limiter.

5. Torque bias -- *TB-REF*

Assign a data 5 [TB-REF] to a desired analog input terminal to designate it as Torque bias command terminal. See the function code F47 to 49 for more details.

6. Torque command -- *T-REF*

Assign a data 6 [T-REF] to a desired analog input terminal to designate it as Torque command terminal. See the control block diagram and the function code H41 "Torque command selection" for more details.

7. Torque current command -- *IT-REF*

Assign a data 7 [IT-REF] to a desired analog input terminal to designate it as Torque current command terminal. See the control block diagram and the function code H42 "Torque current command selection" for more details.

8, 9. Creep speed 1, 2 for UP/DOWN control -- *CRP-N1, CRP-N2*

Assign a data 8 [CRP-N1] and a data 9 [CRP-N2] to desired analog input terminals to designate them as Creep speed 1 and Creep speed 2 terminals. See the UP/DOWN functions of the function codes E01 to 13 for more details.

The Ai input is processed as an absolute value.

10. Magnetic flux reference -- *MF-REF*

Assign a data 10 [MF-REF] to a desired analog input terminal to designate it as Magnetic-flux command terminal. See the control block diagram and the function code H43 "Magnetic-flux command value" for more details.

11. Detect line speed -- *LINE-N*

Assign a data 11 [LINE-N] to a desired analog input terminal to designate it as Detected line speed terminal. See the control block diagram and the function code H53 "Line speed feedback selection" for more details.

12. Motor temperature -- *M-TMP*

Assign M-TMP (data = 12) to a desired analog input terminal to designate it as Motor temperature terminal. When you use a FRENIC-VG dedicated motor, you can use the NTC thermistor supplied with a motor to detect the motor temperature and to protect the motor from overheat (OH4). When you use a motor with a PTC thermistor, you can use it for overheat protection. You can also use an electronic thermal relay for protection against motor overload (OL1, OL2, OL3).

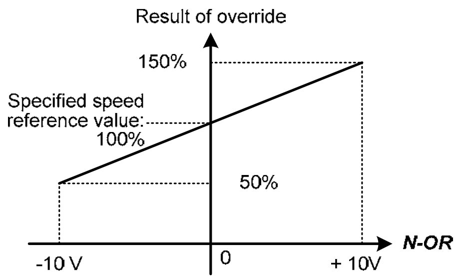
You can use this function to build your own motor overheat protection system detecting the motor temperature directly without using method mentioned above.

You can use the function code E30 "Motor overheat protection" and E31 "Motor overheat early warning" to specify the detection levels.

13. Speed override -- *N-OR*

Assign a data 13 [N-OR] to a desired analog input terminal to designate it as Speed override terminal.

You can supply +10V to override the speed with 150% of the speed reference and supply −10V to override with 50% of the speed reference. See the control diagram for a point of the control input.



Speed override	Point of application	Restrictions
13 ***N-OR***	Just after Auxiliary speed setting 1	Disabled when you use "0: KEYPAD panel" and "3, 4, 5: UP/DOWN functions" of the function codes F01 and C25. Used for acceleration/deceleration calculation. Restricted by the maximum speed.

<Application example>

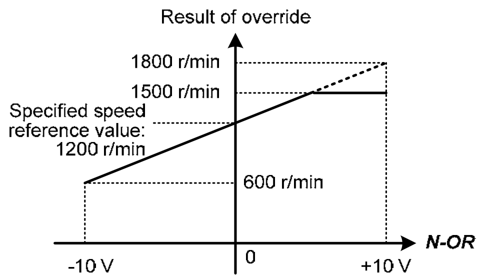
You can specify the coarse/fine adjustment of the speed.

Specified maximum speed value: 1,500 r/min
Specified speed reference value: 1,200 r/min (100%)
Input voltage applied to the terminal [N-OR]: ±10V

<u>Coarse adjustment</u>

As shown in the right graph, the overridden value is 600r/min for -10 V input and is restricted by the maximum speed for +10 V input.

Applying voltage enables coarse speed adjustment around the speed reference (1,200 r/min).

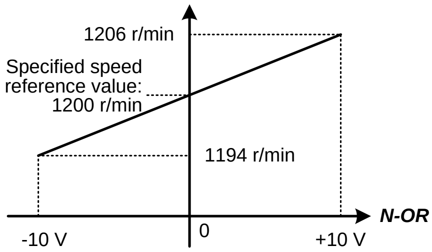


Fine adjustment

Set the gain of used [Ai] to 0,01 (function code E53 to 56).

As shown in the right graph, the overridden value is 1194r/min for -10V input and is 1206 r/min for +10V input. Applying voltage enables fine speed adjustment around the speed reference (1,200 r/min).

Either the reference value of the maximum speed or the precision of the analog input determines the resolution. In this example, the resolution is determined by the former one: 0.08 r/min.



The larger value between the following values determines the resolution.

Reference value of the maximum speed: 1,500 r/min ÷ internal data 20,000 = 0.075 r/min ≈ 0.08 r/min

Precision of the analog input: Unipolar scale (6 r/min) is divided into 15 bit. Thus, 6 r/min ÷ 32767 (15 bits) × 100 (scaling) = 0.018 r/min

14. Universal Ai -- *U-AI*

Assign a data 14 [U-AI] to a desired analog input terminal to designate it as Universal Ai terminal.

You can use this function to check the existence of the input signal through communication and this function does not affect the inverter operation.

You can use this signal to the following applications.

1) You can read out input signal as an analog data through RS-485 or optional field bus.
2) You can use Ai for an input to a software you create with the UPAC option or the PLC without affecting the inverter operation.

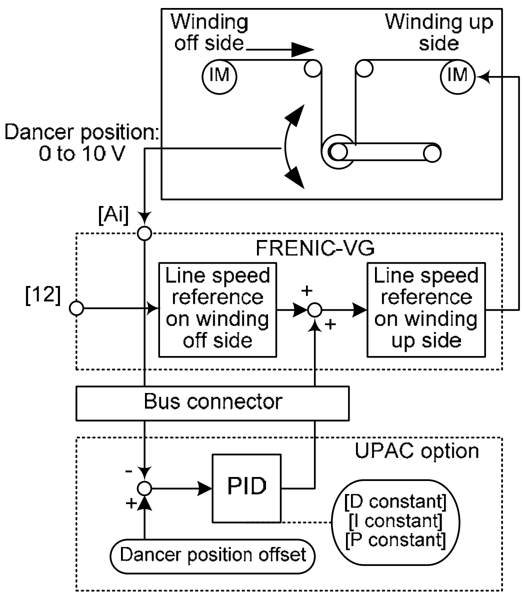
<Application example>

The right figure shows a diagram of a winding control utilizing dancer control.

The UPAC option uses PID control for dancer position control. The line speed command generated by adding the PID output to the line speed command for the winding off side received from [12] is supplied to the winding up side.

You can use an [Ai] terminal to read the dancer position detected by a potentiometer. If you assign Universal Ai [U-AI] to the AI input, the output of the potentiometer is directly available to the UPAC. See the description of the UPAC for more details on the UPAC.

You can also use [U-AI] to control in the same manner if you replace the UPAC option and the bus connector with the PLC and the communication line.



15. PID feedback 1 -- *PID-FB1*
16. PID reference value -- *PID-REF*
17. PID correction gain -- *PID-G*

Assign a data 15 [PID-FB], a data 16 [PID-REF] and a data 17 [PID-G] to desired analog input terminals to designate them as PID feedback value, PID command value, and PID correction value terminals, respectively.

These terminals can be used as input terminals for feedback signals, command signals and correction signals in the process under PID control. See the function codes H19 to H26 for more details on the PID functions.

18-24. Custom Ai1 to Ai7 -- *C-AI1* to ***C-AI7***

Reserved for options and special applications.

25. Main speed setting -- *N-REFV* ±10 V/±Nmax (Nmax: Maximum speed F03, A06, A40)

The voltage (±10 VDC, Maximum speed/±10 V) applied to an analog input terminal makes analog speed setting.

When using ***N-REFV*** on terminal [Ai2], set F01 data at "8" (***N-REFV***).

26. Current input speed setting (4-20 mADC) -- *N-REFC* 4-20 mADC/Nmax

This analog input is available only on terminal [Ai2].

The current (4 to 20 mADC, Maximum speed/20 mADC) applied to terminal [Ai2] makes analog speed setting.

When using ***N-REFC*** on terminal [Ai2], set F01 data at "9" (***N-REFC***) and turn SW3 to the I position. (For configuration of SW3, refer to Section 3.3.3.9.)

27. PID feedback amount 2 -- *PID-FB2*

This analog input is used to input feedback signals under PID process control.

Analog inputs ***PID-FB1*** (PID feedback amount 1) and ***PID-FB2*** (PID feedback amount 2) can be switched by the digital input signal ***PID-1/2*** (Switch PID feedback signals, data = 78).

For details about the PID control, refer to the descriptions of H20 to H26.

E53 to E56 | Ai Gain

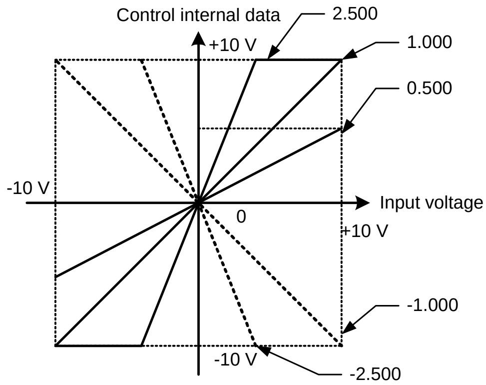
These function codes specify gains to be applied to analog input terminals [Ai1] to [Ai4].

E	5	3	G	A	I	N		A	i	1		
E	5	4	G	A	I	N		A	i	2		
E	5	5	G	A	I	N		A	i	3		
E	5	6	G	A	I	N		A	i	4		

Data setting range: -10.000 to 10.000 (times)

Note: Terminals [Ai3] and [Ai4] are available only when you install OPC-VG1-AIO.

The data changed with the ∧ or ∨ key at the keypad panel is valid. To save to the backup memory, press the FUNC/DATA key.



E57 to E60 | Ai Bias

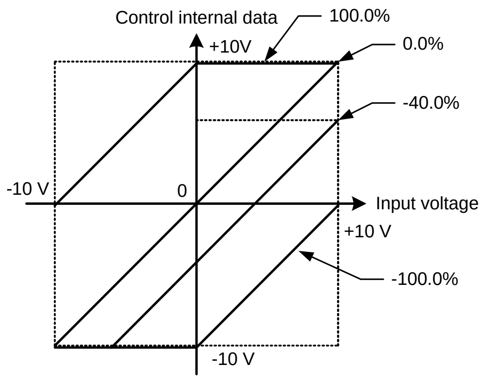
These function codes specify biases to be applied to analog input terminals [Ai1] to [Ai4]. A value of 100% corresponds to a doubled offset value.

E	5	7	B	I	A	S		A	i	1		
E	5	8	B	I	A	S		A	i	2		
E	5	9	B	I	A	S		A	i	3		
E	6	0	B	I	A	S		A	i	4		

Data setting range: -100.0 to 100.0 (%)

Note: Terminals [Ai3] and [Ai4] are available only when you install OPC-VG1-AIO.

The data changed with the ∧ or ∨ key at the keypad panel is valid. To save to the backup memory, press the FUNC/DATA key.



E61 to E64 Ai Filter

These function codes specify whether to apply a filter to analog input terminals [Ai1] to [Ai4], as well as specifying a time constant of the filter individually. The filter used here is a low-pass filter. The time constant means the time until the filter output data reaches 63% of the input data.

Since a large filter time constant decreases the response, consider the response of a mechanical system to determine the time constant. If the input voltage fluctuates due to noise, first try hardware measures, and then use this filter after you failed.

Use the function code (E65 to E68) to increase or decrease a command value gradually.

E	6	1	F	I	L	T	E	R		A	i	1
E	6	2	F	I	L	T	E	R		A	i	2
E	6	3	F	I	L	T	E	R		A	i	3
E	6	4	F	I	L	T	E	R		A	i	4

Data setting range: 0.000 to 0.500 (s)

Note: Terminals [Ai3] and [Ai4] are available only when you install OPC-VG1-AIO.

E65 to E68 Up/Down Limiter (Ai)

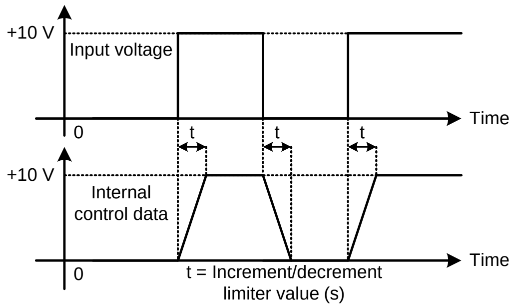
These function codes specify a time to increase a data inside the inverter from 0V to 10V when you change the input from 0 to 10V applied to analog input terminals [Ai1] to [Ai4].

<Application example>

When you use the analog torque command or the analog torque bias, you may not use a command that changes stepwise. A step-wise torque command may tear a paper in a paper rolling machine or present an elastic vibration (damping) when a subject matter has a large elastic modulus.

To avoid this phenomenon, though you should change the command with an external volume, you can use this Increment/decrement limiter to specify the automatic increase and decrease of an analog command value.

E	6	5	A	／	D		L	−	A	i	1	
E	6	6	A	／	D		L	−	A	i	2	
E	6	7	A	／	D		L	−	A	i	3	
E	6	8	A	／	D		L	−	A	i	4	



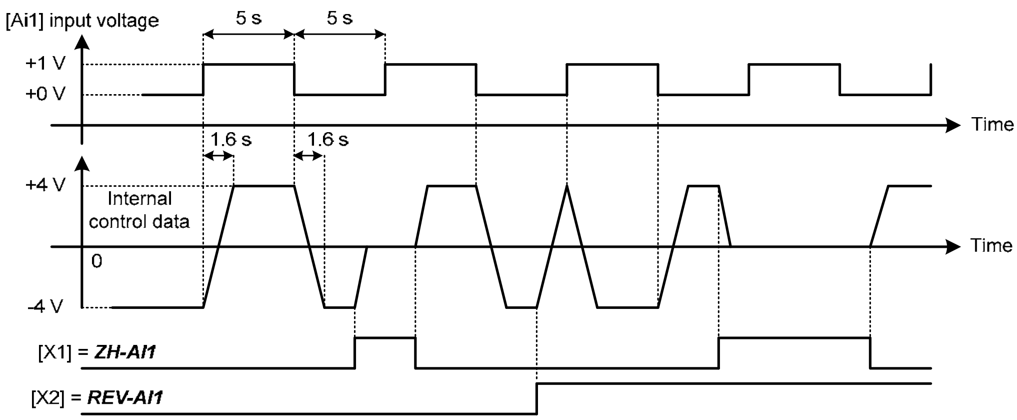
Data setting range: 0.00 to 60.00 (s)

Note: Terminals [Ai3] and [Ai4] are available only when the OPC-VG1-AIO is mounted.

Appendix

This section shows an example specifying the bias, the gain, and the increment/decrement limiter of [Ai1] and assigning "Ai1 zero hold" to [X1] function and "Ai1 polarity change" to [X2] function. See also the control block diagram for better understanding. The filter function is not included in this example, since you can use this function to eliminate noise, but should not use actively.

Function code	Set value
E01: Terminal [X1] Function	40: Zero-hold Ai1 ***ZH-AI1***
E02: Terminal [X2] Function	44: Reverse Ai1 polarity ***REV-AI1***
E53: Ai1 Gain	8.000 (magnification)
E57: Ai1 Bias	-50.0 (%)
E65: Up/Down Limiter (Ai1)	2.00 s



- The increment/decrement limiter set the time for the change of an internal control data by 8 V (-4 V ↔ 4 V) to 2.0 s × 8/10 = 1.6 s. Note that the increment/decrement limiter is applied not to the change of the input voltage from 0 to 1 V, but to the change of the internal data scaled by the gain.
- The change of the internal control data to 0 V follows the increment/decrement limiter when the zero hold signal [ZH-AI1]is applied.
- The change of the polarity of the internal control data follows the increment/decrement limiter when the polarity change signal [REV-AI1] is applied.

E69 to E73 Ao Terminal Function

E69 to E73 select functions to be assigned to analog output terminals [Ao1] to [Ao5], respectively.

Some functions are not available depending upon the drive control (vector control with/without speed sensor, V/f control and synchronous motor drive). For details, refer to Section 4.2 "Function Code Tables."

E	6	9	A	O	1		F	U	N	C		
E	7	0	A	O	2		F	U	N	C		
E	7	1	A	O	3		F	U	N	C		
E	7	2	A	O	4		F	U	N	C		
E	7	3	A	O	5		F	U	N	C		

Data setting range: 0 to 40

17 to 29 are reserved. Do not use them.

Function code data	Terminal commands assigned	Symbol	Scale	Remarks
0	Detected speed 1 (Speed indicator, one-way deflection)	***N-FB1+***	+Nmax/10V	Nmax: Maximum Speed (F03, A06, A106)
1	Detected speed 1 (Speed indicator, two-way deflection)	***N-FB1±***	±Nmax/±10V	Nmax: Maximum Speed (F03, A06, A106)
2	Reference speed 2 (before ACC/DEC calculation)	***N-REF2***	±Nmax/±10V	Nmax: Maximum Speed (F03, A06, A106)
3	Reference speed 4 (ASR input)	***N-REF4***	±Nmax/±10V	Nmax: Maximum Speed (F03, A06, A106)
4	Detected speed 2 (ASR input)	***N-FB2±***	±Nmax/±10V	Nmax: Maximum Speed (F03, A06, A106)
5	Detected line speed	***LINE-N±***	±Nmax/±10V	Nmax: Maximum Speed (F03, A06, A106)
6	Torque current command (Torque ammeter, one-way deflection)	***IT-REF±***	±150%/±10V	100%: Torque Current (P09, A11, A111)
7	Torque current command (Torque ammeter, two-way deflection)	***IT-REF+***	+150%/10V	100%: Torque Current (P09, A11, A111)
8	Torque command (Torque meter, two-way deflection)	***T-REF±***	±150%/±10V	100%: Motor rated torque
9	Torque command (Torque meter, one-way deflection)	***T-REF+***	+150%/10V	100%: Motor rated torque
10	Motor current	***I-AC***	200%/10V	100%: Rated Current (P04, A03, A103)
11	Motor voltage	***V-AC***	200%/10V	100%: Rated Voltage (F05, A04, A104)
12	Input power (Motor output)	***PWR***	200%/10V	100%: Motor rated torque
13	DC link bus voltage	***V-DC***	800V/10V	Maximum value 820V/10.25V
14	+10V test voltage output	***P10***	+10 VDC equivalent	-
15	-10V test voltage output	***N10***	-10 VDC equivalent	-
16	Motor temperature	***TMP-M***	±200°V/±10V	-
30	Universal AO	***U-AO***	±4000H/±10V	-
31-37	Custom Ao1-Ao7	***C-AO1-7***	±4000H/±10V	-
38	Input power	***PWR-IN***	200%/10V	100%: Inverter rated output
39	Magnetic pole position signal	***SMP***	TOP/5V	
40	PID output value	***PID-OUT***	±200%/±10V	

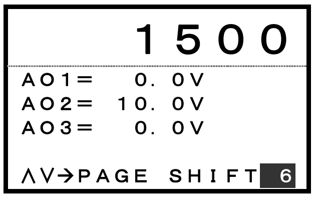
Note: Terminals [Ao4] and [Ao5] are available only when the OPC-VG1-AIO is mounted.

<Using analog output>

There are 5 types of analog output functions--three terminals [AO1], [AO2] and [AO3] as standard and additional two terminals [AO4] and [AO5] when an AIO option is mounted.

<u>Setting procedure</u>

- Check a device such as a meter including wires. Set data to 14 to check 10V output.
- Select a function you want to use. We select the "Detected Speed 1 (Speedometer, two-way deflection)" as an example.
- Assign the "Detected Speed 1 (Speedometer, two-way deflection)" function to one of the available terminals ([AO1] to [AO5]). If you want to assign it to [AO2], write a data, "1:N-FB1±", to the function code E70 "AO2 function selection".
- See the "I/O check" screen of the KEYPAD panel to confirm that [AO2] supplies +10.0V during operating a motor. The right figure shows the screen you must view.
- Connect a speedometer to the analog terminal [AO2].



- You can specify the bias, the gain, and the filter applied to the analog output.

Function	Application
Bias	Sets the bias.
Gain	Use to enlarge a small voltage range or to reduce a large voltage range. Use a minus value to invert the polarity.
Filter	You do not need to change the factory set data 0.010 s (10 ms). This filter does work for the noise affecting a device (such as a meter) and wires between the device and [AO] terminal. Take necessary measures against noise outside of the inverter.

See the description of the individual function codes for more details.

See also the control block diagram to work with this function effectively.

<u>Output resolution</u>

The AO converts 12-bit digital data into analog data for output. 11 bits are assigned to +12 V, thus binary data corresponding to 10V is 1705 (2047 × 10/12).

When using +10 V to supply a speed reference corresponding to the maximum speed of 1500 r/min, for example, the resolution is 1500/1700 = Approx. 0.88 r/min.

<u>Output cycle</u>

Output is supplied with a sampling cycle of approx. 1 ms.

0. Detected speed 1 (Speed indicator, one-way deflection) -- *N-FB1+*
1. Detected speed 1 (Speed indicator, two-way deflection) -- *N-FB1±*

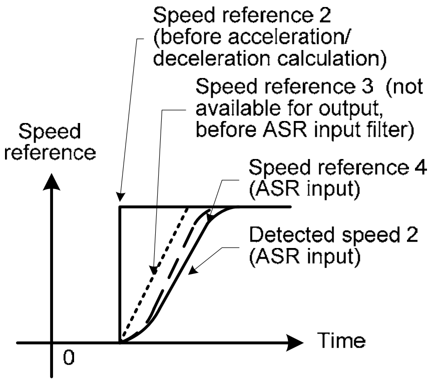
Assign a data 0 [N-FB1+] and 1 [N-FB1±] to desired analog output terminals to designate them as speedometer functions.

Use [N-FB1+] for a unipolar meter and use [N-FB1±] for a bipolar meter. This function detects encoded motor speed and supplies a data after the speed detection calculation or the speed estimation calculation.

2. Reference speed 2 (before ACC/DEC calculation) -- *N-REF2*
3. Reference speed 4 (ASR input) -- *N-REF4*
4. Detected speed 2 (ASR input) -- *N-FB2±*

Assign a data 2 [N-REF2], 3 [N-REF4] and 4 [N-FB1+] to desired analog output terminals to output the speed reference and detected speed of each of them. You can use these functions to measure and observe the follow-up and the deviation of the Detected speed 2 (ASR input) against individual speed references externally. Note that the Speed agreement (the comparison between [N-REF2] and [N-FB2±]) and the Speed equivalent ([N-REF4] and [N-FB2±]) of the inverter DO output use these data for output.

The speed reference 3 in the right graph is not available for an AO output.



5. Detected line speed -- *LINE-N±*

Assign a data 5 [LINE-N±] to a desired analog output terminal to designate it as line speed detection. The highest data among the analog line speed [LINE-N], the digital line speed, detected speed by PG (LD) and a data from integrated speed detection/estimation is provided to output.

6. Torque current command (Torque ammeter, one-way deflection) -- *IT-REF±*
7. Torque current command (Torque ammeter, two-way deflection) -- *IT-REF+*

Assign a data 6 [IT-REF±] and 7 [IT-REF+] to desired analog output terminals to designate them as torque ammeters.

Use [IT-REF+] for a unipolar meter and use [IT-REF±] for a bipolar meter. You can use the function code F51 "Torque command monitor (Polarity selection)" to select the output polarity.

8. Torque command (Torque meter, two-way deflection) -- *T-REF±*
9. Torque command (Torque meter, one-way deflection) -- *T-REF+*

Assign a data 8 [T-REF±] and 9 [T-REF+] to desired analog output terminals to designate them as torque meters.

Use [T-REF+] for a unipolar meter and use [T-REF±] for a bipolar meter. You can use the function code F51 "Torque command monitor (Polarity selection)" to select the output polarity.

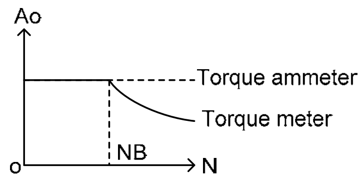
<u>Torque meter and torque ammeter</u>

A torque meter and a torque ammeter behave differently in constant output range over the rated speed (100%).

You can use the torque ammeter as a load meter (equivalent to load current).

You can use the torque meter as an output equivalent to actual torque reflecting torque decrement.

Though both of them provide the command values, you can use them as real torque and torque current since the FRENIC-VG controls the current.



10. Motor current -- *I-AC*
11. Motor voltage -- *V-AC*

Provide effective values of the output current and voltage supplied to the motor.

"100%" indicates the rated current and voltage of the motor.

12. Input power (Motor output) -- *PWR*

This analog signal outputs the motor output power. The "motor rated power (kW) x 2" is output as ±10 V.

13. DC link bus voltage -- *V-DC*

See the control block diagram given in Section 4.1.8.

14. +10V test voltage output -- *P10*

This analog signal outputs +10 V for adjustment of an analog meter. (Use this signal for an analog meter externally connected.)

15. -10V test voltage output -- *N10*

This analog signal outputs -10 V for adjustment of an analog meter. (Use this signal for an analog meter externally connected.)

16. Motor temperature -- *TMP-M*

This analog signal outputs the motor temperature converted from input values selected by P30, A31 or A131 (M1, M2 or M3 thermistor selection).

30. Universal AO -- ***U-AO***

This terminal is used to output analog data from the inverter via the communications link (RS-485).

Using an Ao terminal to output software made by a UPAC option or PLC makes the output free from the inverter operation.

31-37. Custom-Ao1 to Ao7 -- ***C-Ao1 to C-Ao7***

Ao terminals for manufacturers. Do not assign these signals.

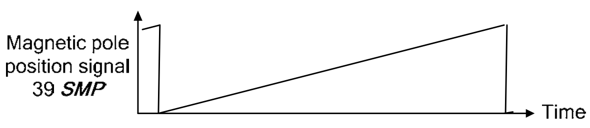
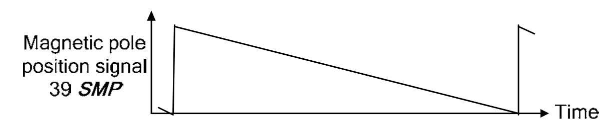
38. Input power -- ***PWR-IN***

This terminal supplies power to the inverter. The "inverter rated power (kW) x 2" is output as +10 V.

39. Magnetic pole position signal -- ***SMP***

This analog signal outputs the "pulse integrated value of the encoder attached to a PMSM" plus the magnetic pole position offset (o10 when motor M1 is selected), as a magnetic pole position signal.

Depending upon the whether the motor rotation is normal or reverse, the inverter operates as shown below. A single motor rotation outputs 1/2 cycle signal of the number of motor poles.

In the case of normal rotation	In the case of reverse rotation
	

The ***SMP*** is used for adjustment of the magnetic pole position in Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor and magnetic pole position sensor."

40. PID output value -- ***PID-OUT***

This signal is used to output PID output values under PID control.

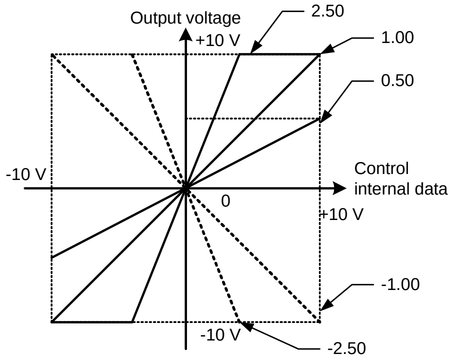
E74 to E78 Ao Gain

These function codes specify gains to be applied to analog output terminals [Ao1] to [Ao5].

E	7	4	G	A	I	N		A	O	1		
E	7	5	G	A	I	N		A	O	2		
E	7	6	G	A	I	N		A	O	3		
E	7	7	G	A	I	N		A	O	4		
E	7	8	G	A	I	N		A	O	5		

Data setting range: -100.00 to 100.00 (times)

Note: [Ao4] and [Ao5] are available only when the OPC-VG1-AIO is mounted.



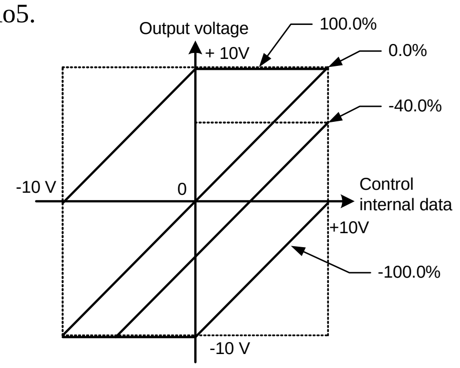
E79 to E83 Ao Bias

These function codes specify the bias of analog output Ao1 to Ao5.

E	7	9	B	I	A	S		A	O	1		
E	8	0	B	I	A	S		A	O	2		
E	8	1	B	I	A	S		A	O	3		
E	8	2	B	I	A	S		A	O	4		
E	8	3	B	I	A	S		A	O	5		

Data setting range: -100.00 to 100.00 (%)

Note: [Ao4] and [Ao5] are available only when the OPC-VG1-AIO is mounted.



E84 Ao1-Ao5 Filter

E84 specifies the time constant of the output filters for the analog output Ao1 to Ao5 simultaneously.

E	8	4	F	I	L	T		A	o	1	—	5

Data setting range: 0.000 to 0.500 (s)

Note: [Ao4] and [Ao5] are available only when the OPC-VG1-AIO is mounted.

E90 Link Command Function Selection 1 (Available soon)

When E90 ≠ 0, it is possible to set Ai input data with digital data via the communications link (S16, S17). The E90 setting has priority over Ai functions selected by E49 to E52.

E90 LNK FUC1

Data setting range: 0 to 12

Data for E90	Terminal commands assigned	Symbol	Scale	
			S code setting	Internal definition / Internal range
0	Shut down input signal	***OFF***	–	
1	Auxiliary speed setting 1	***AUX-N1***	-20000d to 20000d	(data)*Nmax/20000d -Nmax to Nmax
2	Auxiliary speed setting 2	***AUX-N2***	-20000d to 20000d	(data)*Nmax/20000d -Nmax to Nmax
3	Torque bias level	***TB-REF***	-32768d to 32767d	0.01%/1d -327.68 to 327.67%
4	Creep speed 1 for UP/DOWN control	***CRP-N1***	-20000d to 20000d	(data)*Nmax/20000d -Nmax to Nmax
5	Creep speed 2 for UP/DOWN control	***CRP-N2***	-20000d to 20000d	(data)*Nmax/20000d -Nmax to Nmax
6	Detect line speed	***LINE-N***	-20000d to 20000d	(data)*Nmax/20000d -Nmax to Nmax
7	Motor temperature	***M-TMP***	0d to 200d	1ºC/1d 0 to 200ºC
8	Speed override	***N-OR***	-5000d to 5000d	0.01%/1d -50.00 to +50.00%
9	PID feedback amount 1	***PID-FB1***	-22000d to 22000d	0.005%/1d -110.000 to 110.000%
10	PID command amount	***PID-REF***	-22000d to 22000d	0.005%/1d -110.000 to 110.000%
11	PID correction gain	***PID-G***	-16384d to 16384d	1 time/±16384d -1.0000 time to 1.0000 time
12	PID feedback amount 2	***PID-FB2***	-22000d to 22000d	0.005%/1d -110.000 to 110.000%
13	Observer torque FB (Available soon)	***OBS-TFB***	–	

For details, refer to the Ai1 function selection.

E91 Link Command Function Selection 2 (Available soon)

When E91 ≠ 0 (OFF), it is possible to select analog data via the communications link (S17) in priority to Ai input made by the Ai function selection.

E	9	1	L	N	K		F	U	C	2		

Data setting range: 0 to 12

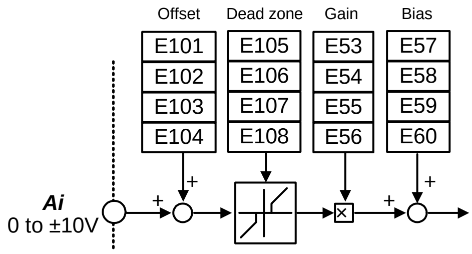
The setting contents are the same as for E90. Refer to the link command function selection 1.

E101 to E104 Ai Offset

These function codes specify Ai offsets. Only changing the function code data with the ∧ / ∨ keys makes the new data effective. To save it into the backup memory, it is necessary to press the FUNC/DATA key.

These function codes are functionally equivalent to E57 to E60.

Use these function codes for adjustment of out-of-offset signals sent from external equipment.



E	1	0	1	A	i	1		O	F	S	E	T
E	1	0	2	A	i	2		O	F	S	E	T
E	1	0	3	A	i	3		O	F	S	E	T
E	1	0	4	A	i	4		O	F	S	E	T

Data setting range: -100.00 to 100.00 (%)

Note: [Ai3] and [Ai4] are available only when the OPC-VG1-AIO is mounted.

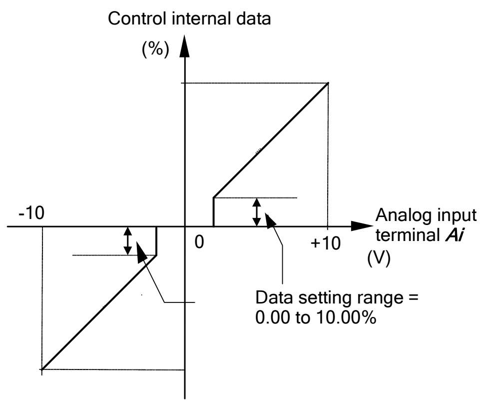
E105 to E108 Ai Dead Zone

These function codes specify Ai dead zones for analog input entered via analog input terminals [AI1] to [AI4]. Command values below this input will be limited to 0 V.

E	1	0	5	A	i	1		B	L	I	N	D
E	1	0	6	A	i	2		B	L	I	N	D
E	1	0	7	A	i	3		B	L	I	N	D
E	1	0	8	A	i	4		B	L	I	N	D

Data setting range: 0.00 to 10.00 (%)

Note: [Ai3] and [Ai4] are available only when the OPC-VG1-AIO is mounted.



E109 Dividing Ratio for FA, FB Pulse Output (Numerator)

E110 Dividing Ratio for FA, FB Pulse Output (Denominator)

E109 and E110 specify the numerator and denominator of the dividing ratio for FA and FB pulse output.

These settings are available when E29 = 7 to 10 or the SPGT option is mounted.

E	1	0	9	P	L	S		N	U	M	E		
E	1	1	0	P	L	S		D	E	N	O		

Data setting range: 1 to 65535

Note: Specify E109 and E110 data so that E109 ≤ E110. Even when E109 > E110, the dividing ratio comes to be "1."

E114 Speed Agreement 2 (Detection width)

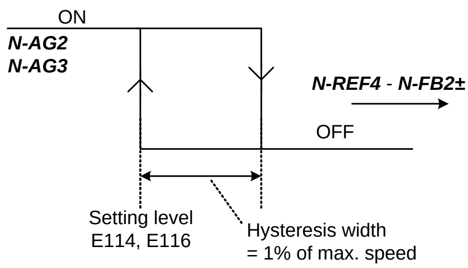
E115 Speed Agreement 2 (Off-delay timer)

The ***N-AG2*** signal (Speed agreement 2) is available when motor M2 is selected.

E114 specifies the detection width that is the agreement level between ***N-REF4*** (Reference speed 4, ASR input) and ***N-FB2±*** (Detected speed 2, ASR input).

If detected speed 2 is within the detection width (+ and - polarity) from reference speed 4, the inverter issues ***N-AG2*** (Speed agreement signal).

The off-delay timer of detected signals can be specified by E115. If detected speed 2 comes back to the detection width from reference speed 4, the detection signal does not go OFF.



E	1	1	4	N	–	A	G	2		R	N	G	
E	1	1	5	N	–	A	G	2		T	I	M	

Data setting range: E114 = 1.0 to 20.0 (%)
E115 = 0.000 to 5.000 (s)

E116 Speed Agreement 3 (Detection width)

E117 Speed Agreement 3 (Off-delay timer)

The ***N-AG3*** signal (Speed agreement 3) is available when motor M3 is selected.

These function codes are functionally equivalent to E114 and E115.

E	1	1	6	N	–	A	G	3		R	N	G	
E	1	1	7	N	–	A	G	3		T	I	M	

Data setting range: E116 = 1.0 to 20.0 (%)
E117 = 0.000 to 5.000 (s)

E118	Temperature for Axial Fan Stop Signal

When the NTC detection temperature of the motor equipped with an NTC thermistor drops below the setting specified by E118, the inverter turns ***MFAN*** (Axial fan stop signal) ON.

The ***MFAN*** is used to stop the axial fan (cooling fan) of the motor when the motor is stopped.

Note that when the inverter is running, the ***MFAN*** signal is always OFF irrespective of the E118 setting.

E	1	1	8	F	–	S	T	P		T	M	P	

Data setting range: 0 to 200 (ºC)

Note: This function is available when the NTC thermistor is selected for the selected motor (M1, M2 or M3). When any other thermistor setting is made, the ***MFAN*** is always OFF.

4.3.3 C codes (Control Functions)

C01	**Jump Speed 1**
C02	**Jump Speed 2**
C03	**Jump Speed 3**
C04	**Hysteresis Width for Jump Speed**

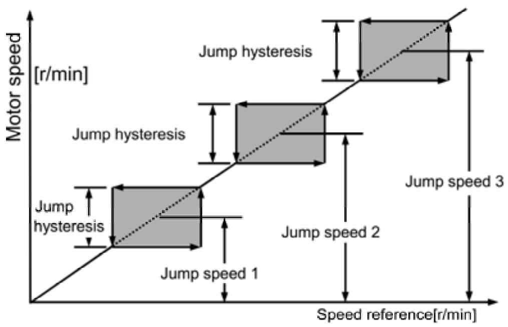
Jumps the speed reference to avoid mechanical resonance points of a load.

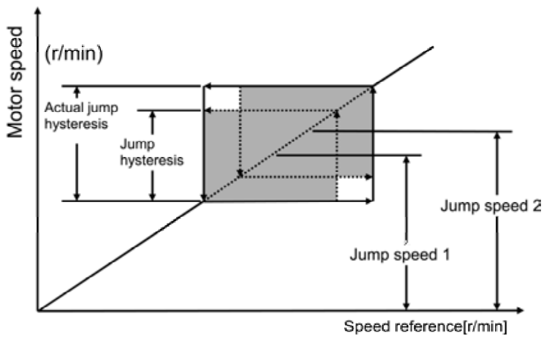
You can set three jump points. When you set the Jump speed 1 to 3 to 0 r/min, this function is disabled. The speed reference does not jump during acceleration/deceleration.

When specified ranges of jump speed overlap one another, the sum of them is considered as a jump range.

C	0	1	J	U	M	P		N	1			
C	0	2	J	U	M	P		N	2			
C	0	3	J	U	M	P		N	3			
C	0	4	J	U	M	P		H	Y	S	T	R

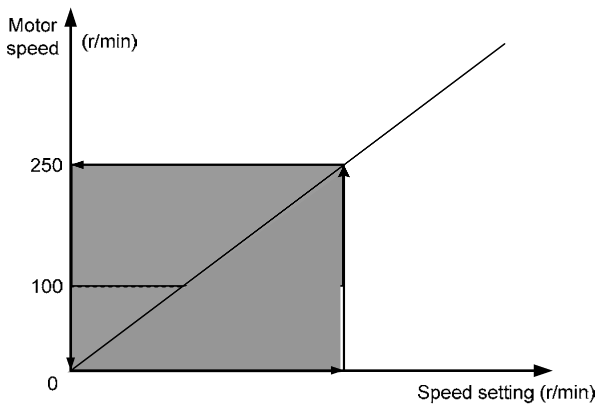
Data setting range: C01 to C03 = 0 to 30,000 (r/min)
C04 = 0 to 1,000 (r/min)





If the jump width is larger than twice the jump speed setting, the downward jump is limited at 0 r/min.

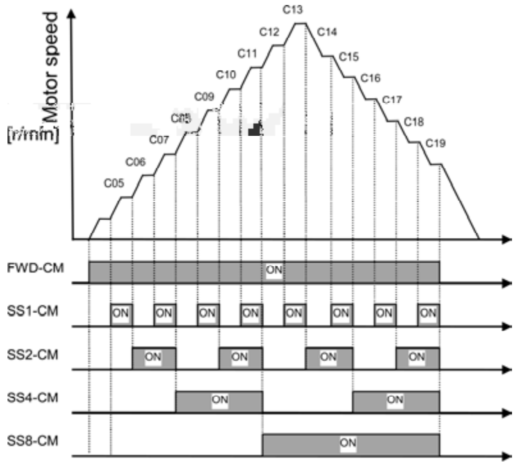
(Example) Jump speed = 100 (r/min)
Jump width = 300 (r/min)



C05 to C17	Multistep Speed 1 to 13

You can set ON or OFF to the terminal function ***SS1***, ***SS2***, ***SS4***, and ***SS8*** to switch among Multistep speed 1 to 15 (refer to E01 to E13 "X function selection" for setting the terminal function).

When a terminal among ***SS1***, ***SS2***, ***SS4***, and ***SS8*** is not defined, the terminal considered to be OFF. You can select 1r/min or 0.01% for a unit of a setting range according to the setting of C21 "Multistep setting definition". When you choose 0.01% for a unit, 100% is the maximum speed defined by the function code (F03, A06, or A106).



C	0	5	M	U	L	T	I		N	–	1	

ı

C	1	7	M	U	L	T	I		N	–	1	3

Data setting range: 0 to 30,000 (r/min), 0.00 to 100.00 (%) or 0.0 to 999.9 (m/min)

C18	Multistep Speed 14/Creeping Speed 1
C19	Multistep Speed 15/Creeping Speed 2

C18 and C19 also work as a creep speed function when you use the UP/DOWN function. See E01 to E09 "X function selection" for more details.

C	1	8	N	–	1	4	／	C	R	E	P	1
C	1	9	N	–	1	5	／	C	R	E	P	2

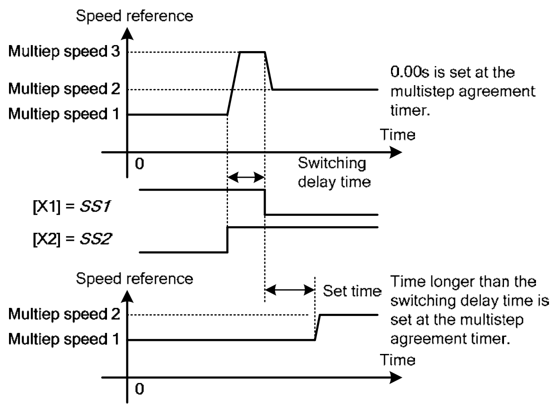
Data setting range: 0 to 30,000 (r/min), 0.00 to 100.00 (%) or 0.0 to 999.9 (m/min)

C20 Multistep Speed Agreement Timer

When the terminal function ***SS1***, ***SS2***, ***SS4***, and ***SS8*** do not change simultaneously, a speed reference out of the specification may be specified. When you use the Multistep speed reference agreement timer, the speed reference changes after ***SS1***, ***SS2***, ***SS4***, and ***SS8*** maintain the same state for a time specified by the Multistep speed reference agreement timer. Use this timer to use two or more terminals simultaneously among ***SS1***, ***SS2***, ***SS4***, and ***SS8*** to switch the speed. If you switch only one terminal, leave the setting to 0.000s.

< Application example >
This section shows an example to use terminals ***SS1*** and ***SS2*** to switch the multistep speed. When you want to change from the Multistep speed 1 to the Multistep speed 2, you should switch two terminals simultaneously.

- When you set the timer to 0.00s, the difference in switching timing of ***SS1*** and ***SS2*** activates the Multistep speed 3 for the delayed period and presents a operation pattern out of the specification as shown in the upper right graph.
- When you set the time of this function code to a period longer than the switching time, the switching to Multistep speed 2 occurs just when a specified time passes after ***SS1*** is set to OFF. You can avoid the Multistep speed 3 to be selected.



< Point >
The cycle sampling the terminal signals is about 500 μs (0.5 ms) in the FRENIC-VG. You do not have to set this function if your switching period is shorter than the sampling cycle.

C	2	0	M	L	T		N		T	I	M	E

Data setting range: 0.000 to 0.100 (s)

C21 Multistep Speed Configuration Definition

Sets the unit to specify the multistep speed.

C	2	1	M	L	T		U	N	I	T		

Data setting range: 0 (Specify the multi-step speed in r/min.)
1 (Specify in increments of 0.01%.)
2 (Specify in m/min. (L03 lifter rated speed must be specified.))

If the C21 setting is changed, enter C05 through C19 again.

C25 Speed Command N2

Sets a method to specify the speed command. When the X terminal function [N2/N1] is set to ON, the speed specified this function will be effective. See the description of F01 "Speed setting N1" for setting method you can select.

C	2	5	S	P	D		C	M	D		2	

C29 Jogging Speed

C29 JOG N

Data setting range: 0 to 30,000 (r/min)

Sets a speed for inching a motor in addition to the normal operation. You can use this function for positioning a work, for example.

You can choose the following two ways for the jogging operation.

- Turn on the X control terminal [JOG] to change to the jogging mode and set the operation command [FWD] or [REV] to ON.
- Set the ∧ and STOP keys on the KEYPAD panel to ON simultaneously to switch to the jogging mode and set the operation command [FWD] or [REV] to ON.

C30 to C69 ASR S-curve Acceleration/Deceleration 2, 3 and 4, and JOG Function Code Group

The function code group C30 to C38 becomes effective in the JOG mode.

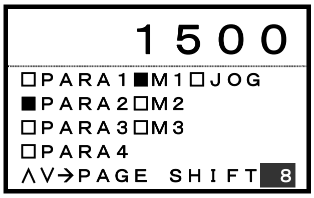
The terminal input signal [RT1] and [RT2] set the function code group C40 to C69 to either enabled or disabled. The speed limit function response gain in the torque control mode is adjusted with C60 (ASR4-P).

See E01 to E13 "X function selection" and the control block diagram for the details of switching.

Acceleration/deceleration time:	See the description of the function code F07 and F08.
S-curve setting:	See the description of the function codes F67 to F70. Note that you can set only the two points, the start and end sides, for the S-curve acceleration/deceleration 2,3, and 4 and the JOG.
ASR setting:	See the description of the function codes F61 to F65. Note that you cannot set the F/F gain to the ASR-JOG.

You can view the setting on the "I/O check" screen of the KEYPAD panel.

The right figure shows that the ASR2 and the S-curve deceleration (PARA 2) are selected.

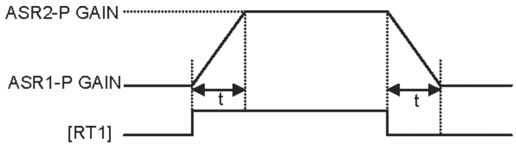


C70	ASR Switching Time

This function specifies the duration of the switching, when you use the X control terminals [RT1] and [RT2] to switch the ASRs.

This function change the P (gain) gradually in a specified time to reduce the mechanical shocks during the switching. Specify the time necessary to change the ASR gain 100 times.

The right figure shows an example to set the [RT1] to OFF, ON, then to ON to switch the gain between the ASR1 and ASR2.



$$t = \frac{|(\text{ASR2 P GAIN}) - (\text{ASR1 P GAIN})|}{100} \times \text{C70 (s)}$$

C	7	0	A	S	R		C	H		t		

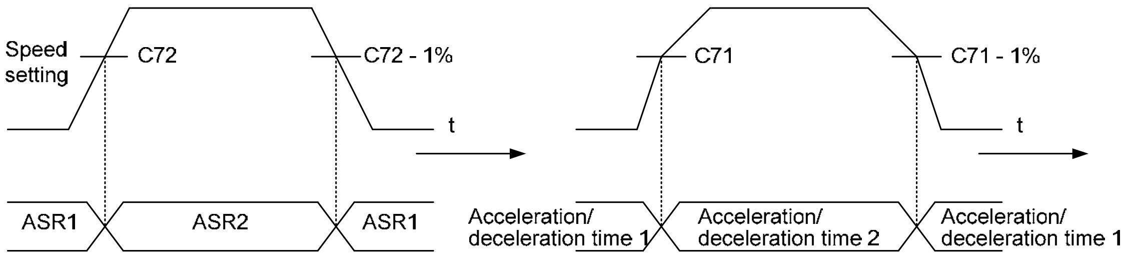
Data setting range: 0.00 to 2.55 (s)

C71	ACC/DEC Switching Speed
C72	ASR Switching Time

C	7	1	A	C	C	/	D	E	C		C	H
C	7	2	A	S	R		C	H		S	P	D

Data setting range: 0.00 to 100.00 (%)

If both X control terminals [RT1] and [RT2] are off, use the speed setting of this parameter to automatically switch the setting of acceleration/deceleration time ASR. (Deactivation of both [RT1] and [RT2] includes the case where [RT1] and [RT2] are not assigned to X control terminals.) When the speed setting (ASR input) exceeds the level specified at C71 and C72, changeover to acceleration/deceleration time 2 (ASR2) occurs. The hysteresis width is 1% of the maximum speed.



ASR1: F61-F66 settings are valid.
ASR2: C40-C45 settings are valid.

Acceleration/deceleration time 1:
F07, F08 and F67-F70 settings are valid.
Acceleration/deceleration time 2:
C46-C49 settings are valid.

If the setting is "0.00%," changeover does not occur. If the L04 (fixed S-curve pattern) is set at "1" or "2," the C71 and C72 settings are invalid. "100.00%" indicates the maximum speed set at function codes F03, A06 and A106.

Chap. 4 CONTROL AND OPERATION

C73	Creep Speed Switching (under UP/DOWN control)

Specifies whether to use a function or an analog input to set the creep speeds used in the UP/DOWN setting mode.

C	7	3	C	R	P		S	W	I	T	C	H

Data setting range: 00 to 11

Description: □ □

- First digit: Creep speed 2 (0: function code C19, 1: analog input [CRP-N2])
- Second digit: Creep speed 1 (0: function code C18, 1: analog input [CRP-N1])

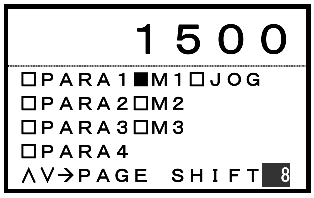
See the description of the UP/DOWN in the E01 to E13 "X function selection".

4.3.4 P codes (Motor Parameter Functions)

P codes specify motor parameters available when motor 1 (M1) is selected. To use motor 2 (M2) or motor 3 (M3), specify motor parameters with A codes.

M1, M2 and M3 can be switched with Function code F79 and terminal commands ***M-CH2*** and ***M-CH3*** (which are assigned to digital input terminals with E01 to E13). Refer to the related function code and terminal commands.

To check that M1 is selected, use Menu #4 "I/O Checking" on the keypad and check that the box of the M1 appears black (■) as shown at the right.



In addition to P codes, F03 to F05 and F10 to F12 are available when M1 is selected.

P01	M1 Drive Control

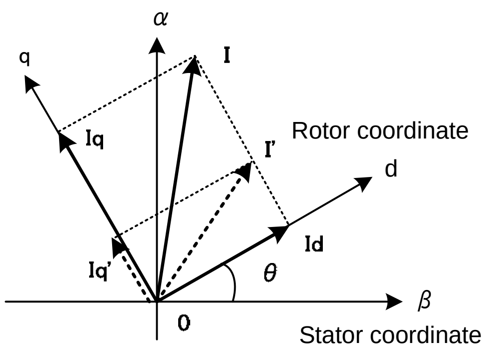
P01 specifies the drive control for motor 1, which can be selected from the following motor drive controls. Refer to the description of P02 in conjunction with that of P01.

P01 M1-CTL-MTD

Data = 0: Vector control for IM with speed sensor
1: Vector control for IM without speed sensor
2: Simulation mode
3: Vector control for PMSM with speed sensor
5: V/f control for IM

About vector control

The right figure shows a rotating coordinate (d-q axes) of a rotor on a coordinate (α-β axes) generated by two-phase conversion from a stator coordinate (U, V, W). θ shows the rotation position and indicates the position of the magnetic-flux (d axis=direction of magnetic flux) observed on the fixed coordinate (α-β axes).



The alternating current (I) flowing through the stator generates a rotating magnetic field. The rotor coordinate (d-q axes) rotates at the frequency of this alternating current. If you observe the current (I) from the rotor coordinate (d-q axes), the current (I) seems stationary. Thus, the alternating current (I) can be considered direct current value on the rotor coordinate (d-q axes). You can decompose the current into the d axis element and the q axis element (I → Iq + Id). The d axis current (Id) is defined as magnetic-flux current (exciting current) denoting a current required to generate a magnetic-flux. The q axis current (Iq) is defined as torque current (load current).

When a load changes to require Iq' (indicated by a dotted arrow in the figure) as the torque current, you should control the current by directing I' (indicated by a dotted arrow in the figure) as a current command while maintaining the magnetic-flux current (Id). The control that maintains the magnetic-flux (Id = constant) and changes the torque current (Iq) according to the load is referred as **vector control**. Since this control is similar to the control for the direct current motor where the magnetic-flux is maintained constant by the magnet and the rotor current is controlled according to the load, you can use the same control for a alternating current motor as for a direct current motor.

About vector control without speed sensor

This control utilizes vector control (similar to DC motor control) for a motor without a pulse generator. This control enables torque control, which is not available in V/f control. Use this control when you use existing general-purpose motors or motors to which you cannot install a PG.

Note that the control capability (such as speed control range, speed control response, and speed control accuracy) differs from that of control utilizing PG described in Chapter 2 "Specifications" when you select the control. If you need this capability, select vector control with PG for a motor with a PG.

Tune the motor parameter to control properly. Use the function code H01 to conduct tuning (set value 3 and 4).

<Control mechanism>

Vector control without speed sensor calculates the motor speed and the magnetic pole position. This control detects the output voltage and the output current and uses the motor parameters (R1, Lσ) identified through tuning to calculate the induced voltage. The magnetic flux position is determined since the Ed element obtained by decomposing this induced voltage into the d axis direction is 0. Since the Eq element on the q axis direction corresponds to the induced motor voltage and is proportional to the motor speed, you can obtain the motor speed. This control has the following restrictions compared with vector control with PG.

- Speed control range is limited at low speed due to the inferior accuracy of the induced motor voltage compared with that at high speed.
- Speed control response is low due to the slow convergence of the internal calculation.
- Speed control accuracy is inferior due to the accuracy of the speed calculation based on the induced voltage.

About simulation mode

Selecting the simulation mode (P01 = 2) enables the inverter to internally run in a state similar to the actual run without connecting a motor. Use the simulation mode for checking the system including I/Os or for testing at the time of system startup.

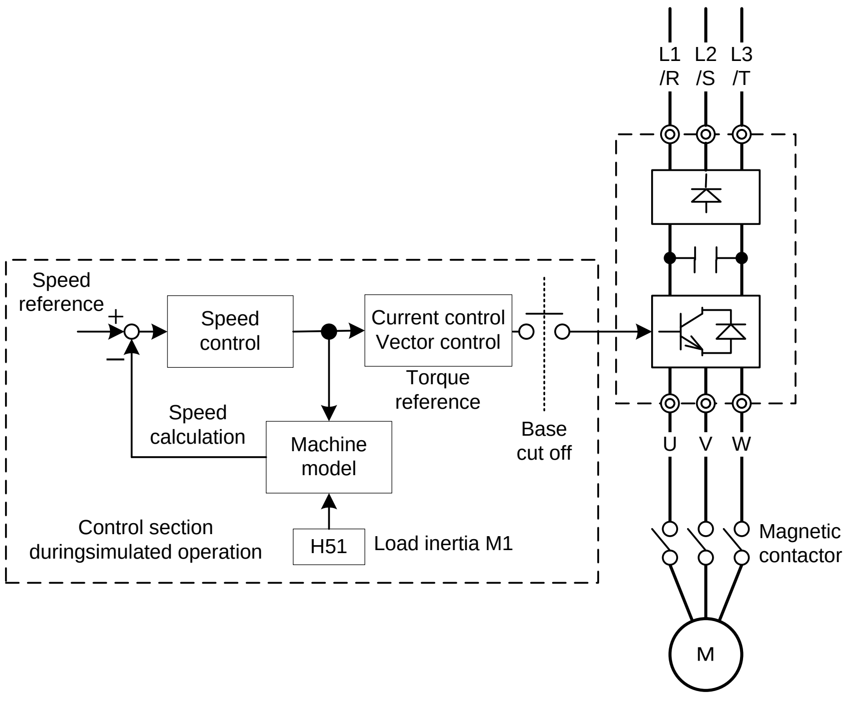
When P01 = 2, the inverter shifts to the simulation mode irrespective of the current motor state.

As shown below, giving a torque command to a machine model (Load inertia: H51) accelerates the model to a certain speed according to the load inertia. Since speed control is a type of feedback control, the machine model rotates to follow the reference speed in the end.

The running state can be checked on the LED monitor and LCD monitor or with monitor codes (M field). Note that neither current detection nor voltage detection is performed so that both the "output current" and "output voltage" on the LCD monitor show "0."

Individual function codes and protective functions are available as long as they are not restricted.

During simulation mode, the inverter shuts off the base (its output) so that no voltage is developed in the secondary side (U, V, W). For safety, however, cut off the secondary side or shut it off with a magnetic contactor or the like.



P02 M1 Motor Selection

P02 specifies the motor type to be used.

The configuration procedure of the related function codes differs between the use of the VG-dedicated motors except Fuji VG1 5-series motors (Setting: "0.75-2" to "220-4" and "30-2A" to "220-4A") and that of other motors (Setting: OTHER).

When the VG-dedicated motor is used, selecting the combination of "Capacity (kW)-Voltage (2, 4)" from a choice of "0.75-2" to "220-4" and "30-2A" to "220-4A" automatically sets the optimum values of the standard motors (see the table given on the next page) to F04, F05 and P03 to P27 and then write-protects those function codes.

When any other motor (Fuji VG1 5-series motors, Fuji motors, VG3, etc.) is used, select "OTHER."

P	0	2	M	1	–	S	E	L	E	C	T	

List of Applicable Motors

P02 data		Applicable Motor Models	P02 data		Applicable Motor Models
kW	HP		kW	HP	
00: 0.75-2	00: 1-2	MVK6096, MVK6095A	26: 45-4Y	26: 60-4Y	MVK6208, MVK8208A
01: 1.5-2	01: 2-2	MVK6097, MVK8097A	27: 45-4S	27: 60-4S	MVK6208, MVK8208A
02: 2.2-2	02: 3-2	MVK6107, MVK8107A	28: 55-4	28: 75-4	MVK9250
03: 3.7-2	03: 5-2	MVK6115, MVK8115A	29: 75-4	29: 100-4	MVK9252
04: 5.5-2	04: 7.5-2	MVK6133, MVK8133A	30: 90-4	30: 125-4	MVK9280
05: 7.5-2	05: 10-2	MVK6135, MVK8135A	31: 110-4	31: 150-4	MVK9282
06: 11-2	06: 15-2	MVK6165, MVK8165A	32: 132-4	32: 175-4	MVK9310
07: 15-2	07: 20-2	MVK6167, MVK8167A	33: 160-4	33: 200-4	MVK9312
08: 18.5-2	08: 25-2	MVK6184, MVK8184A	34: 200-4	34: 250-4	MVK9316
09: 22-2	09: 30-2	MVK6185, MVK8185A	35: 220-4	35: 300-4	MVK9318
10: 30-2	10: 40-2	MVK6206	36: P-OTR	36: P-OTR	--
11: 37-2	11: 50-2	MVK6207,MVK8207A	37: OTHER	37: OTHER	Fuji VG1 5-series motors Fuji motors, VG3, etc
12: 45-2Y	12: 60-2Y	MVK6208,MVK8208A	38: 30-2A	38: 40-2A	MVK8187A
13: 45-2S	13: 60-2S	MVK6208,MVK8208A	39: 55-2A	39: 75-2A	MVK9250
14: 55-2	14: 75-2	MVK9224A	40: 75-2A	40: 100-2A	MVK9254A
15: 75-2	15: 100-2	MVK9252	41: 90-2A	41: 125-2A	MVK9256A
16: 90-2	16: 125-2	MVK9280	42: 30-4A	42: 40-4A	MVK8187A
17: 3.7-4	17: 5-4	MVK6115, MVK8115A	43: 55-4A	43: 75-4A	MVK9224A
18: 5.5-4	18: 7.5-4	MVK6133, MVK8133A	44: 75-4A	44: 100-4A	MVK9254A
19: 7.5-4	19: 10-4	MVK6135, MVK8135A	45: 90-4A	45: 125-4A	MVK9256A
20: 11-4	20: 15-4	MVK6165, MVK8165A	46: 110-4A	46: 150-4A	MVK9284A
21: 15-4	21: 20-4	MVK6167, MVK8167A	47: 132-4A	47: 175-4A	MVK9286A
22: 18.5-4	22: 25-4	MVK6184, MVK8184A	48: 160-4A	48: 200-4A	MVK931LA
23: 22-4	23: 30-4	MVK6185, MVK8185A	49: 200-4A	49: 250-4A	MVK931MA
24: 30-4	24: 40-4	MVK6206	50: 220-4A	50: 300-4A	MVK931NA
25: 37-4	25: 50-4	MVK6207, MVK6207A			

Note: When using Fuji VG1 5-series motors, select "OTHER" for P02 and specify the motor parameters given in the User's Manual, Chapter 12.

The table below lists the function codes to be configured for IM when vector control is selected. Configure them sequentially from the top of the table.

Function codes to be configured for IM under vector control

<table>
<tr><th colspan="2">Function codes</th><th rowspan="2">FRENIC-VG, VG7S, and VG5-dedicated motors</th><th rowspan="2">VG3-dedicated motors and VG1 5-series motors</th><th rowspan="2">Fuji special motors</th><th rowspan="2">Other motors (incl. other manufacturers' motors)</th></tr>
<tr><th>For M1</th><th>Name</th></tr>
<tr><td>P01</td><td>Drive control</td><td colspan="2">0: Vector control for IM with speed sensor</td><td colspan="2">Select either one of the following items depending upon whether a sensor is mounted.
0: Vector control for IM with speed sensor
1: Vector control for IM without speed sensor</td></tr>
<tr><td>P02</td><td>Motor selection</td><td>Select from a choice of "0.75-2" to "220-4" and "30-2A" to "220-4A."
For the relationship between the setting data and the motor type, refer to Format [82] in the FRENIC-VG User's Manual, Chapter 4, Section 4.2.4.2, "Data type 12-145."</td><td colspan="3">Select "37: OTHER."
Selecting "36: P-OTR" automatically write-protects Function codes F04, F05, and P03 to P27. Make this choice if needed after completion of configuration of other function codes.</td></tr>
<tr><td>F04</td><td>Rated speed</td><td rowspan="17">Configuring P02 automatically sets the following function code data and write-protects it.
- Motor nameplate values
- Optimum motor parameter values
Turning the power OFF does not lose these values.
Do not perform auto-tuning of motor parameters with H01.</td><td rowspan="17">Manually enter data given in the FRENIC-VG User's Manual, Chapter 12, "Replacement Information."

Do not perform auto-tuning of motor parameters with H01.</td><td rowspan="16">For values to be set, consult your Fuji sales representative.</td><td rowspan="5">Enter the motor nameplate values manually.</td></tr>
<tr><td>F05</td><td>Rated voltage</td></tr>
<tr><td>P03</td><td>Rated capacity</td></tr>
<tr><td>P04</td><td>Rated current</td></tr>
<tr><td>P05</td><td>No. of poles</td></tr>
<tr><td>P06</td><td>%R1</td><td rowspan="11">Perform auto-tuning of motor parameters, referring to the auto-tuning procedure given in the description of H01.</td></tr>
<tr><td>P07</td><td>%X</td></tr>
<tr><td>P08</td><td>Exciting current</td></tr>
<tr><td>P09</td><td>Torque current</td></tr>
<tr><td>P10, P11</td><td>Slip frequency of motor for driving and braking</td></tr>
<tr><td>P12-P14</td><td>Iron loss factors 1-3</td></tr>
<tr><td>P15-P19</td><td>Magnetic saturation factors 1-5</td></tr>
<tr><td>P20</td><td>Secondary time constant</td></tr>
<tr><td>P21</td><td>Induced voltage factor</td></tr>
<tr><td>P22-P24</td><td>R2 correction factors 1-3</td></tr>
<tr><td>P25</td><td>Exciting current correction factor</td></tr>
<tr><td>P26, P27</td><td>ACR P-gain, Integral constant</td><td colspan="2">No change from the initial value is required.</td></tr>
<tr><td>P28</td><td>Pulse resolution</td><td colspan="4">Specify the pulse resolution of the motor PG.
Not valid under vector control without speed sensor.</td></tr>
<tr><td>P29</td><td>External PG correction factor</td><td colspan="4">If the motor PG is incorporated in the machinery, specify the correction factor to convert the number of pulses into the motor speed.
Not valid under vector control without speed sensor.</td></tr>
<tr><td>P30</td><td>Thermistor selection</td><td colspan="2">1: NTC thermistor</td><td colspan="2" rowspan="2">For details about motor protection, refer to the description of F10 in the FRENIC-VG User's Manual, Chapter 4, Section 4.3.1.</td></tr>
<tr><td>F10</td><td>Electronic thermal overload protection (Select motor characteristics)</td><td colspan="2">0: Disable (For VG-dedicated motors)</td></tr>
<tr><td>P32</td><td>Online auto-tuning</td><td colspan="4">Select whether to enable the compensation function for the resistance change due to the temperature rise of the motor running.
(No tuning starts when the NTC thermistor is enabled.)</td></tr>
</table>

Function codes		FRENIC-VG, VG7S, and VG5-dedicated motors	VG3-dedicated motors and VG1 5-series motors	Fuji special motors	Other motors (incl. other manufacturers' motors)
For M1	Name				
H01	Auto-tuning	Not required since configuring P02 as described above automatically sets the optimum values to the related function codes. Note that, perform auto-tuning (H01 = 2) when the impedance at the output side is not negligible because the wiring distance between the inverter and motor is long (100 m or more) or an output circuit filter (OFL) is connected.		Required. Be sure to perform auto-tuning with actual wiring. Refer to the auto-tuning procedure given in the description of H01.	
H02	Full save function	After performing auto-tuning with H01, be sure to execute the full save function (H02 = 1) to write the tuning result into the non-volatile memory. Not required if no auto-tuning is performed.			

Note: The VG-dedicated motors are the same as the VG7- and VG5-dedicated motors in shape and motor parameters.

The table below lists the function codes to be configured for PMSM when vector control is selected. Configure them sequentially from the top of the table.

When Fuji standard motors (GNF2 type) are used, the following function codes take effect. For other motors, consult your Fuji sales representative.

Function codes to be configured for PMSM under vector control

Function codes		FRENIC-VG dedicated motor	Other motors (incl. other manufacturers' motors)
For M1	Name		
P01	Drive control	3: Vector control for PMSM with speed sensor	3: Vector control for PMSM with speed sensor "Vector control without speed sensor" not supported.
P02	Motor selection	Select "37: OTHER." Selecting "36: P-OTR" automatically write-protects Function codes F04, F05, and P03 to P27. Make this choice if needed after completion of configuration of other function codes.	
P03	Rated capacity	For values to be set, consult your Fuji sales representative.	
P04	Rated current		
F05	Rated voltage		
F04	Rated speed		
F03	Maximum speed		
P05	No. of poles		
P06	%R1		
P07	%X		
P08	Magnetic flux weakening current		
P09	Torque current		
P21	Induced voltage factor		
P26, P27	ACR P-gain, Integral constant		
P28	Pulse resolution	Specify the pulse resolution of the motor PG. Not valid under vector control without speed sensor.	
P30	Thermistor selection	1: NTC thermistor	For details about motor protection, refer to the description of F10 in the FRENIC-VG User's Manual, Chapter 4, Section 4.3.1.
F10	Electronic thermal overload protection (Select motor characteristics)	0: Disable (For VG-dedicated motors)	
P33	Maximum voltage Limit	Specify the maximum voltage applicable to the motor.	
o09	Absolute signal input definition	Specify the data in accordance with the encoder specifications.	
o10	Magnetic pole position offset	For values to be set, consult your Fuji sales representative.	
o11	Salient pole rate (%Xq/%Xd)		
P12-P14	Iron loss factors 1-3		
P42	q-axis induction magnetic saturation coefficient		
P43	Magnetic flux limiting value		
P44	Overcurrent protection level		
P45-P51	Torque correction gain 1-7		
H01	Auto-tuning	For values to be set, consult your Fuji sales representative.	
H02	Full save function	After performing auto-tuning with H01, be sure to execute the full save function to write the tuning data into the non-volatile memory. Not required if no auto-tuning is performed.	

The table below lists the function codes to be configured for IM when V/f control is selected. Configure them sequentially from the top of the table.

Function codes to be configured for IM under V/f control

Function codes		FRENIC-VG, VG3-dedicated motors, and VG1 5-series motors	Other motors (incl. other manufacturers' motors)
For M1	Name		
P01	Drive control	5: V/f control for IM	
P02	Motor selection	Select "37: OTHER." Selecting "36: P-OTR" automatically write-protects Function codes F04, F05, and P03 to P27. Make this choice if needed after completion of configuration of other function codes.	
P03	Rated capacity	Manually enter data given in the FRENIC-VG User's Manual, Chapter 12, "Replacement Information." Do not perform auto-tuning of motor parameters with H01.	Enter the motor nameplate values manually.
P04	Rated current		
F03	Maximum speed		
F04	Rated speed		
F05	Rated voltage		
P05	No. of poles		
P06	%R1		Refer to the calculation procedures given in the description of P06 and P07 in the FRENIC-VG User's Manual, Chapter 4, Section 4.3.4.
P07	%X		
P08	Exciting current		Set the no-load current of the motor written on the motor test report.
P33	Maximum output voltage	Set the maximum voltage of the motor.	
P34	Slip compensation	Refer to the calculation procedure given in the description of P34 in the FRENIC-VG User's Manual, Chapter 4, Section 4.3.4.	
P35	Torque boost	0.0: Auto torque boost (factory default) If a starting torque is required, adjust the torque boost within the range of 0.1 to 20.0.	If the motor constant is unknown, set P35 to "2.0" (Manual boost). If a starting torque is required, adjust the torque boost within the range of 0.1 to 20.0.
P30	Thermistor selection	1: NTC thermistor	For details about motor protection, refer to the description of F10 in the FRENIC-VG User's Manual, Chapter 4, Section 4.3.1.
F10	Electronic thermal overload protection (Select motor characteristics)	0: Disable (For VG-dedicated motors)	
H01	Tuning	Not required since configuring P02 as described above automatically sets the optimum values to the related function codes. Note that, perform auto-tuning (H01 = 2) when the impedance at the output side is not negligible because the wiring distance between the inverter and motor is long (100 m or more) or an output circuit filter (OFL) is connected.	Required. Be sure to perform auto-tuning with actual wiring. Refer to the auto-tuning procedure given in the description of H01.
H02	Full save function	After performing auto-tuning with H01, be sure to execute the full save function to write the tuning data into the non-volatile memory. Not required if no auto-tuning is performed.	

Note: The VG-dedicated motors are the same as the VG7- and VG5-dedicated motors in shape and motor parameters.

P03 M1 Rated Capacity

P03 specifies the rated capacity of motor 1. Set the motor nameplate value.

For a multiwinding motor, set the motor capacity per winding.

P	0	3	M	1	–	C	A	P				

Data setting range: For inverters of 400 kW or below
0.00 to 500.00 (kW) when F60 = 0
0.00 to 600.00 (HP) when F60 = 1

For inverters of 500 kW or above
0.00 to 1200.00 (kW) when F60 = 0
0.00 to 1600.00 (HP) when F60 = 1

P04 M1 Rated Current

P04 specifies the rated current of motor 1. Set the motor nameplate value.

P	0	4	M	1	–	I	r					

Data setting range: 0.01 to 99.99 (A)
100.0 to 999.9 (A)
1000 to 2000 (A)

P05 M1 Number of Poles

P05 specifies the number of poles of motor 1. Set the motor nameplate value.

P	0	5	M	1	–	P	O	L	E	S		

Data setting range: 2 to 100

P06 M1 %R1

P	0	6	M	1	–	%	R	1				

Data setting range: 0.00 to 30.00 (%)

$$\%R1 = \left(\frac{(R1\,(\Omega) + \text{Cable resistance}\,(\Omega)) \times \text{P04: Motor rated current (A)}}{\text{F05: Motor rated voltage (V)}/\sqrt{3}} \right) \times 100\,(\%)$$

Use a value corresponding to the Y connection for one phase to specify R1 (Ω).

Use a value corresponding to one winding of multiwinding motor.

P07 M1 %X

P	0	7	M	1	–	%	X					

Data setting range: 0.00 to 200.00 (%)

$$\%X = \left(\frac{(L\sigma\,(H) + \text{Cable L}\,(H)) \times \text{P04: Motor rated current (A)}}{\text{F05: Motor rated voltage (V)}/\sqrt{3}} \times 2\pi \left(\frac{\text{P05: Pole numbers} \times \text{F04: Rated speed (r/min)}}{120} \right) \times 100\,(\%) \right)$$

Use a value corresponding to the Y connection to specify Lσ (H).

Use a value corresponding to one winding of multiwinding motor.

P08 M1 Exciting Current/Magnetic Flux Weakening Current (-Id)

Sets the effective current value of the motor 1 during no-load operation.

P	0	8	M	1	–	I	M					

Data setting range: 0.01 to 99.99 (A)
100.0 to 999.9 (A)
1,000 to 2,000 (A)

P09 M1 Torque Current

Sets the current contributing torque.

P	0	9	M	1	–	I	T					

Data setting range: 0.01 to 99.99 (A)
100.0 to 999.9 (A)
1,000 to 2,000 (A)

$$\text{P09: Torque current} = \sqrt{(\text{P04: Rated current})^2 - (\text{P08: Exciting current})^2}\ (A)$$

P10	M1 Slip Frequency (For driving)
P11	**M1 Slip Frequency (For braking)**

Sets the slips of the motor at rated speed and under rated load.

P	1	0	M	1	–	S	L	I	P	d		
P	1	1	M	1	–	S	L	I	P	b		

Data setting range: 0.001 to 10.000 (Hz)

$$\text{Slip frequency (Hz)} = \frac{\text{P05 : Pole numbers} \times \text{(Synchronized speed) (r/min) - F04 : Rated speed (r/min)}}{120}$$

P12	M1 Iron Loss Factor 1
P13	**M1 Iron Loss Factor 2**
P14	**M1 Iron Loss Factor 3**

P12 to P14 specify iron loss factors to compensate the iron loss (hysteresis loss, eddy current loss) caused inside the motor.

When using motors other than Fuji standard motors, set the iron loss compensation at 0.00%..

P	1	2	M	1	–	L	O	S	S	1		
P	1	3	M	1	–	L	O	S	S	2		
P	1	4	M	1	–	L	O	S	S	3		

Data setting range: 0.00 to 10.00 (%)

P15	M1 Magnetic Saturation Factor 1
P16	**M1 Magnetic Saturation Factor 2**
P17	**M1 Magnetic Saturation Factor 3**
P18	**M1 Magnetic Saturation Factor 4**
P19	**M1 Magnetic Saturation Factor 5**

P15 to P19 specify the magnetic saturation factors for the exciting current to apply when the magnetic-flux command is 93.75%, 87.5%, 75%, 62.5% and 50%, respectively.

Since the relationship between the exciting current (that generates magnetic-flux in an IM) and the magnetic flux is non-linear. To compensate it, specify the factors with these function codes.

P	1	5	M	1	–	S	A	T	1			
P	1	6	M	1	–	S	A	T	2			
P	1	7	M	1	–	S	A	T	3			
P	1	8	M	1	–	S	A	T	4			
P	1	9	M	1	–	S	A	T	5			

Data setting range: 0.0 to 100.0 (%)

P20	M1 Secondary Time Constant

The response of the magnetic-flux to the exciting current is a first-order lag. This time constant is defined as secondary time constant and you should set a value determined by the motor parameters as in the following equation. You can compensate the lag to lead.

P	2	0	M	1	–	N	D	–	T	C		

Data setting range: 0.001 to 9.999 (s)

Set value: Secondary time constant [s]=Lm [H] / R2 [Ω]
Lm: Exciting inductance, R2: Resistance of secondary winding

P21	M1 Induced Voltage Factor

The rotating magnetic field generated by the stator (primary winding) sections the rotor vertically to induce voltage on the secondary side in an induction machine. You can add voltage larger than this induced voltage to accelerate a motor. This function sets a coefficient to compensate this induced voltage.

P	2	1	M	1	–	E	M	F	–	C	O	F

Data setting range: 0 to 999 (V)

Set value: Effective induced voltage substituted by the voltage between the windings at the rated speed.

P22	M1 R2 Correction Factor 1
P23	M1 R2 Correction Factor 2
P24	M1 R2 Correction Factor 3

The resistance of the rotor (secondary resistor) is used to calculate the slip frequency in vector control of slip frequency type. The change in secondary resistance due to the temperature increase caused by the frequent operation or load may degrade the torque control accuracy. The inverter detect the temperature with an NTC thermistor and use R2 correction coefficient 1, 2, and 3 to estimate the rotor temperature to prevent the decrease of the torque control accuracy. Do not change these settings.

P	2	2	M	1	–	R	2	C	O	R	R	1
P	2	3	M	1	–	R	2	C	O	R	R	2
P	2	4	M	1	–	R	2	C	O	R	R	3

P25	M1 Exciting Current Correction Factor

Corrects the exciting inductance. Do not change these settings.

P	2	5	M	1	–	I	M		C	O	R	R

P26	M1 ACR (P-gain)
P27	**M1 ACR (I-time)**

Vector control feeds back the motor output current to control a motor to follow the current command. These functions specify the gain and the integration time for the current control (ACR). Usually you do not have to change from the factory setting.

When a winding has a large inductance, you should set a large P gain to compensate it in general. When a winding has a small inductance, you should set a small P gain to prevent OC (overcurrent) due to the overshoot of the current.

You should specify the integration time to reduce the steady-state deviation between the current command and the actual current to zero. Do not specify too small value otherwise a current hunting occurs.

P	2	6	M	1	–	A	C	R	–	P		
P	2	7	M	1	–	A	C	R	–	I		

P26 setting range: 0.1 to 20.0
P27 setting range: 0.1 to 100.0 (ms)

P28 M1 Pulse Resolution

P28 specifies the pulse resolution (P/R) of the speed detector PG of motor 1. Specification of a wrong value unstabilizes the detection of the speed and magnetic pole position, disabling accurate speed control or vector control.

P	2	8	M	1	–	P	G	–	P	L	U	S

Data setting range: 100 to 60,000

P29 M1 External PG Correction Factor

You need a correction coefficient to convert the output of a PG built in a machine system into the motor speed to control the speed. Set the coefficient here. Speed control by PG requires parameter setting at both P28 and P29.

P	2	9	P	G	–	C	O	M	P			

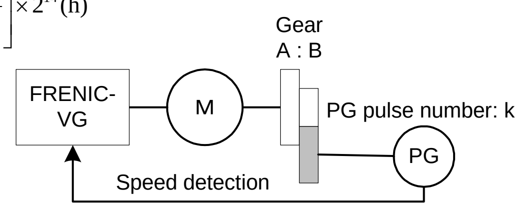
Data setting range: 0000 to 4FFF (h)

When you do not use an external PG, do not change from 4000h. The value of 4000h corresponds to a gear ratio of 1:1, i.e., a PG directly coupled to a motor. When you use a PG directly coupled to a motor, if you set a value other than 4000h, you cannot conduct speed and vector controls accurately.

Setting procedure
Suppose the gear ratio is A:B, specify the function code P28 and P29 as indicated below.

$$\text{Function code P28 (M1-PG pulse number)} = \text{Integer part of } \left| \text{k (PG pulse number)} \times \frac{B}{A} \right|$$

$$\text{Function code P29 (M1 external PG correction coefficient)} = \left[\frac{P28}{k \times B/A} \right] \times 2^{14} \text{(h)}$$



Setting example

If PG pulse number = 1,024 and the gear ratio A:B = 7:1, then:

$$\text{Function code P28 (M1-PG pulse number)} = \text{Integer part of } \left|1024\ (\text{PG pulse number}) \times \frac{1}{7}\right| = 146$$

$$\text{Function code P29 (M1 external PG correction coefficient)} = \left[\frac{\text{P28}}{k \times {}^{B}\!/_{A}}\right] \times 2^{14}(d) = \left[\frac{146}{1024 \times {}^{1}\!/_{7}}\right] \times 2^{14}(d) = 16352(d) = 3FE0(h)$$

P30	M1 Thermistor Selection

P30 selects a thermistor type or an analog input (0 to 10 V) sent from the temperature sensor for motor protection.

For FRENIC-VG motors (VG7S, VG5 and VG3), select an NTC thermistor. If the motor has a PTC thermistor of overheat protection, select a PTC thermistor.

P	3	0	M	1	–	T	H	R				

Data setting range: 0 (No thermistor)
1 (NTC thermistor (for VG standard motors))
2 (PTC thermistor)
3 (Ai [***M-TMP***])

The protection level of the motor can be specified by E30 (Motor Overheat Protection, Temperature).

P32	M1 Online Auto-tuning
A52	M2 Online Auto-tuning
A152	M3 Online Auto-tuning

P32, A52 and A152 select whether or not to perform auto-tuning for compensating constants change due to temperature rise.

- Perform auto-tuning of motor constants.
- Be sure to test-run the combination of the inverter and motor beforehand.
- Auto-tuning is not available when an NTC thermistor is used.

P	3	2		M	1	–	O	N		T	U	N	E
A	5	2		M	2	–	O	N		T	U	N	E
A	1	5	2	M	3	–	O	N		T	U	N	E

Data setting range: 0 (Disable)
1 (Enable)

P33	M1 Maximum Output Voltage/Maximum Voltage Limit

P33 is provided for V/f control and vector control for PMSM. Under V/f control, the P33 setting applies to the maximum output voltage, so specify the output voltage of the inverter running at high speed. The voltage higher than the source voltage cannot be output.

Under vector control for PMSM, the P33 setting applies to the maximum voltage limit value, so specify the maximum voltage that the inverter can output. Do not specify the voltage less than the rated voltage.

P	3	3	M	1	–	V	m	a	x			

Data setting range: 80 to 999 (V)

P34 M1 Slip Compensation

P34 is exclusive to V/f control. A change in the load torque will change the motor slip, resulting in the motor speed change. The slip compensation control adds a frequency proportional to the motor torque to the inverter output frequency and reduces the fluctuation of the motor speed due to torque change.

P	3	4	M	1	–	S	L	I	P	d		

Data setting range: -20.000 to 5.000 (Hz)

The slip compensation value can be calculated with the following expression.

$$\text{Slip compensation value} = \text{Base frequency} \times \frac{\text{Slip (r/min)}}{\text{Synchronous speed (r/min)}} \text{ (Hz)}$$

Where, Slip = Synchronous speed - Rated speed

When P34 = 0.000 (Hz), the slip compensation control is disabled.

P35 M1 Torque Boost

P35 is exclusive to V/f control. The following choices are available.

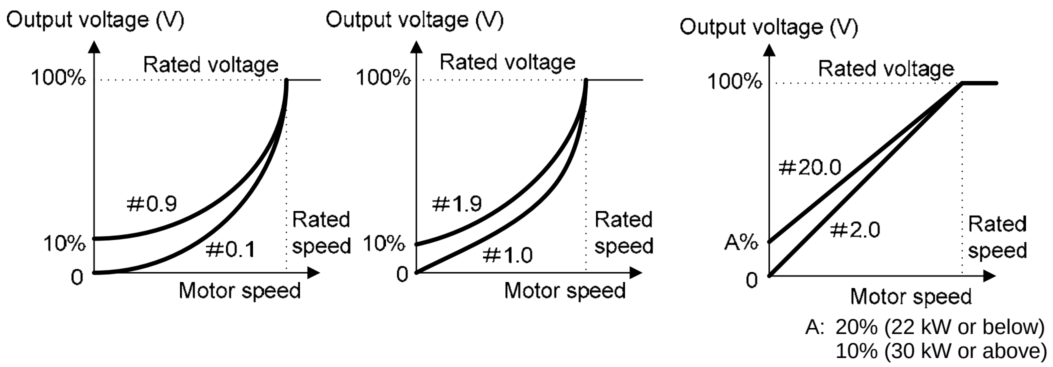
P	3	5		M	1	–	B	O	O	S	T		

- Load characteristics including automatic torque boost, variable torque load, proportional torque load, and constant torque load.
- Compensating insufficient magnetic-flux of a motor due to the voltage drop in the low frequency range and boosting torque at low speed operation (boosting V/f characteristic)

Data setting range	Description
0.0	Automatic torque boost characteristics to adjust torque boost value automatically for constant torque load changing linearly
0.1 to 0.9	Variable torque characteristics for fan/pump load
1.0 to 1.9	Linear torque characteristics for a load that has a middle characteristic between variable torque and constant torque characteristics
2.0 to 20.0	Constant torque characteristics changing linearly

Torque characteristic

<Variable torque characteristics> <Proportional torque characteristics> <Constant torque characteristics>



Note: When replacing the VG7 (22 kW or below) with the VG1, specify the torque boost according to the torque boost conversion table in Chapter 12, Section 12.5.

■ Guide for setting the torque boost

When adjusting the starting torque with manual boost (Setting data: 2.0 to 20.0) since the motor characteristics are unknown, use the following as a guide.

Motor capacity (kW)	Torque boost 1 to 3 P35, A55, A155
0.4	5.2 to 8.4 to 11.6
0.75 to 2.2	5.1 to 8.1 to 11.2
3.7	4.5 to 7.0 to 9.4
5.5	4.2 to 6.4 to 8.6
7.5	4.0 to 6.0 to 7.9
11	3.6 to 5.2 to 6.7
15	3.3 to 4.5 to 5.8
18.5 to 22	3.0 to 4.0 to 5.0
30 to 630	2.0 to 5.0

Note: Increasing the torque boost value results in overexcitation in the low-speed domain. Keeping the inverter running with the overexcited state may cause the motor to overheat. Check the characteristics of the motor to be driven.

P36 M1 Output Current Fluctuation Damping Gain

P36 is exclusive to V/f control. When the inverter output current fluctuates due to the motor characteristics or backlash at the load side, adjust the damping gain. Do not change the factory default unless otherwise needed.

P	3	6	M	1	–	D	U	M	P		G	

Data setting range: 0.00 to 1.00

4.3.5 H codes (High Performance Functions)

H01	Auto-tuning

For inverters connected with a standard motor, no motor parameter tuning is required.

Perform auto-tuning correctly, referring to the tables and the flowcharts given on the following pages.

<u>Tuning procedure</u>

Change the H01 data to the desired value by pressing the (STOP) + (∧) keys or (STOP) + (∨) keys (simultaneous keying), and then press the (FUNC/DATA) key to start auto-tuning. Upon completion of auto-tuning, the H01 data automatically reverts to "0."

The tuning result is written to the volatile memory (RAM) that loses the data when the power is turned OFF. After completion of tuning, therefore, be sure to use the full save function (H02) to write the data to the non-volatile memory.

The ASR auto-tuning (H01 = 1) should be performed, if needed, after motor parameters have been established (automatically, manually, or by tuning). (Available soon)

Tuning of a permanent magnet synchronous motor (PMSM) is available soon.

<u>Tuning notes</u>

Under any of the following conditions, no tuning is normally performed. Review the current settings.

(1) "NOT EXECUTE" appears on the LCD monitor.

In the case of M1, when H01 = any of 2 to 4, P02 ≠ 37 (OTHER).
⇒ Function codes to be tuned are write-protected. Set P02 to "37" (OTHER).

The JOG mode is selected. (The JOG indicator on the LCD monitor is lit.)
⇒ Cancel the JOG mode by pressing the (STOP) + (∧) keys (simultaneous keying).
⇒ If digital input signal ***JOG*** is ON, turn it OFF.

Tuning is in progress from the FRENIC-VG Loader.
⇒ When tuning is in progress from the FRENIC-VG Loader, do not change function code data from the keypad.

(2) Alarm Er-6 (Operation error) occurs.

The simulation mode is selected (P01 = 2).
⇒ No tuning is possible in the simulation mode.

The "V/f control for IM" is selected (P01/A01/A101 = 5).
⇒ Under V/f control, tuning by H01 = 1, 3 or 4 cannot be performed.

The "Vector control for PMSM with speed sensor" is selected (P01/A01/A101 = 3).
⇒ Under Vector control for PMSM, tuning by H01 = 3 cannot be performed.

Any of digital input signals ***BX***, ***STOP1***, ***STOP2*** and ***STOP3*** is ON.
Either one of safety function input terminals [EN1] and [EN2] is OFF.
⇒ When any of ***BX***, ***STOP1***, ***STOP2*** and ***STOP3*** is ON and either of [EN1] and [EN2] is OFF, no tuning starts.

The multiwinding motor drive system is selected.
⇒ No tuning is possible in the multiwinding motor drive system.

(3) Alarm Er-7 (Output wiring fault) occurs.

A phase is missing in the connection between the inverter and the motor.
⇒ Connect the motor to the inverter correctly.

The brake is applied to the motor.
⇒ For auto-tuning with the motor running (H01 = 4), be sure to release the brake so that the motor can rotate.

H01 TUN MODE

The tuning type, data to be tuned, and tuning content differ depending upon the motor drive control. Select the tuning suitable for the drive control (P01).

When P01 = 0 or 1 (Vector control for IM with/without speed sensor) → go to [1] below.
When P01 = 3 (Vector control for PMSM with speed sensor) → (Available soon)
When P01 = 5 (V/f control for IM) → go to [2] below.

[1] Under vector control for IM with/without speed sensor

Data for H01	Tuning type		Data to be tuned	Tuning content	Usage
1	ASR (Auto speed regulator) auto-tuning (To be performed after establishment of motor parameters) (Available soon)		ASR-P (gain) ASR-I (integral constant) Compensation gain Integral time Load inertia	The inverter measures the motor-shaft converted load inertia (mechanical time constant) of the connected machinery, calculates the optimum gain and integral constant, and sets them to the corresponding function codes.	Perform this tuning for a motor integrated in the machinery to tune the ASR. Particularly, perform this tuning for using the observer (H46) if the motor-shaft converted load inertia is unknown.
2	Motor parameter tuning	R1, Lσ	P06, P07 when M1 is selected A08, A09 when M2 is selected A108, A109 when M3 is selected	The inverter measures the motor primary resistance (%R1) and leakage reactance (Lσ) at the rated speed and sets them to the corresponding motor parameters (M1, M2, or M3).	Perform this tuning for VG standard motors (VG3, VG5 and VG7) when the impedance at the output side is not negligible because the wiring distance between the inverter and motor is long (100 m or more) or an output circuit filter (OFL) is connected.
3		Tuning with the motor stopped	P06 to P25 when M1 is selected A08 to A27 when M2 is selected A108 to A123 when M3 is selected	The inverter measures the %R1 and %X with the motor stopped, just as when H01 = 2. After that, the inverter measures the exciting current, rated load slip, magnetic saturation factors, induced voltage, secondary time constant, R2 compensation factors, exciting current compensation factors with the motor stopped, tunes them, and sets them to the corresponding motor parameters (M1, M2, or M3).	Perform this tuning beforehand when driving a non-standard motor or a special-purpose motor whose motor parameters are unknown. Perform this tuning when using the FRENIC-VG to drive a motor integrated in the existing machinery and not separated from it. Note that the tuning accuracy is slightly lower than that obtained by tuning with the motor running (H01 = 4).
4		Tuning with the motor running		The inverter measures the %R1 and %X with the motor stopped, just as when H01 = 2. After that, the inverter measures the exciting current, rated load slip, magnetic saturation factors, induced voltage, secondary time constant, R2 compensation factors, exciting current compensation factors with the motor running, tunes them, and sets them to the corresponding motor parameters (M1, M2, or M3).	Perform this tuning beforehand when driving a non-standard motor or a special-purpose motor whose motor parameters are unknown. Since this tuning involves motor rotation, separate the motor from the machinery and make sure that there is no danger in rotating the motor before performing this tuning. The motor runs in accordance with the specified acceleration/ deceleration time.

⚠CAUTION

When motor parameters are configured at the time of shipment, use those parameter values as is.

An accident or injuries could occur.

[2] Under V/f control for IM

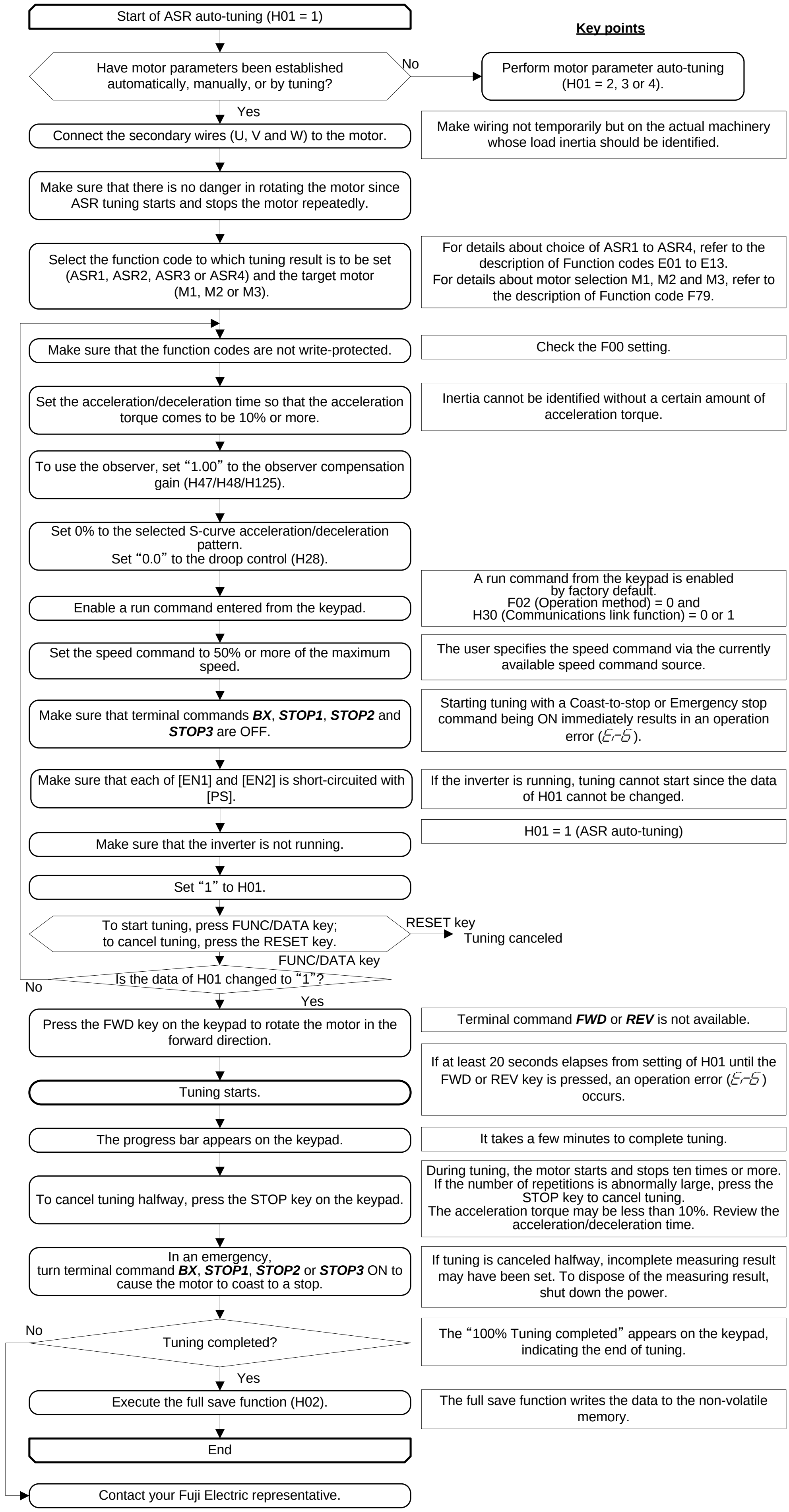
Data for H01	Tuning type		Data to be tuned	Tuning content	Usage
1	ASR (Auto speed regulator) auto-tuning Not available under V/f control.		--	--	--
2	Motor parameter tuning	R1, Lσ	P06, P07 when M1 is selected A08, A09 when M2 is selected A108, A109 when M3 is selected	The inverter measures the motor primary resistance (%R1) and leakage reactance (Lσ) at the rated speed and sets them to the corresponding motor parameters (M1, M2, or M3).	Perform this tuning when the impedance at the output side is not negligible because the wiring distance between the inverter and motor is long (100 m or more) or an output circuit filter (OFL) is connected.
3		Tuning with the motor stopped Not available under V/f control.	--	--	--
4		Tuning with the motor running Not available under V/f control.	--	--	--

⚠CAUTION

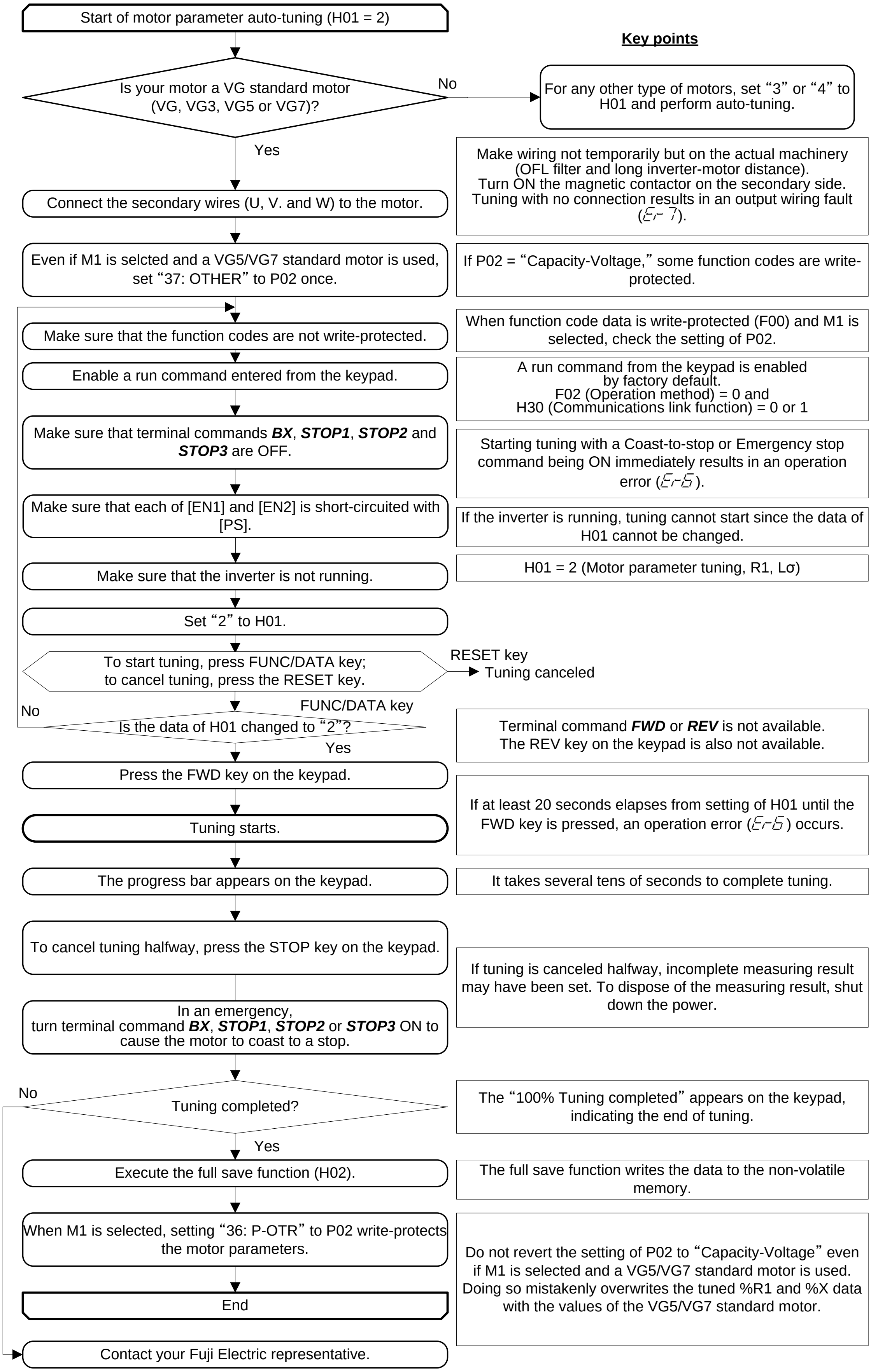
- At the time of shipment, the torque boost function is set to "Auto torque boost." T use the inverter in applications requiring a starting torque, be sure to perform motor parameter auto-tuning.

An accident or injuries could occur.

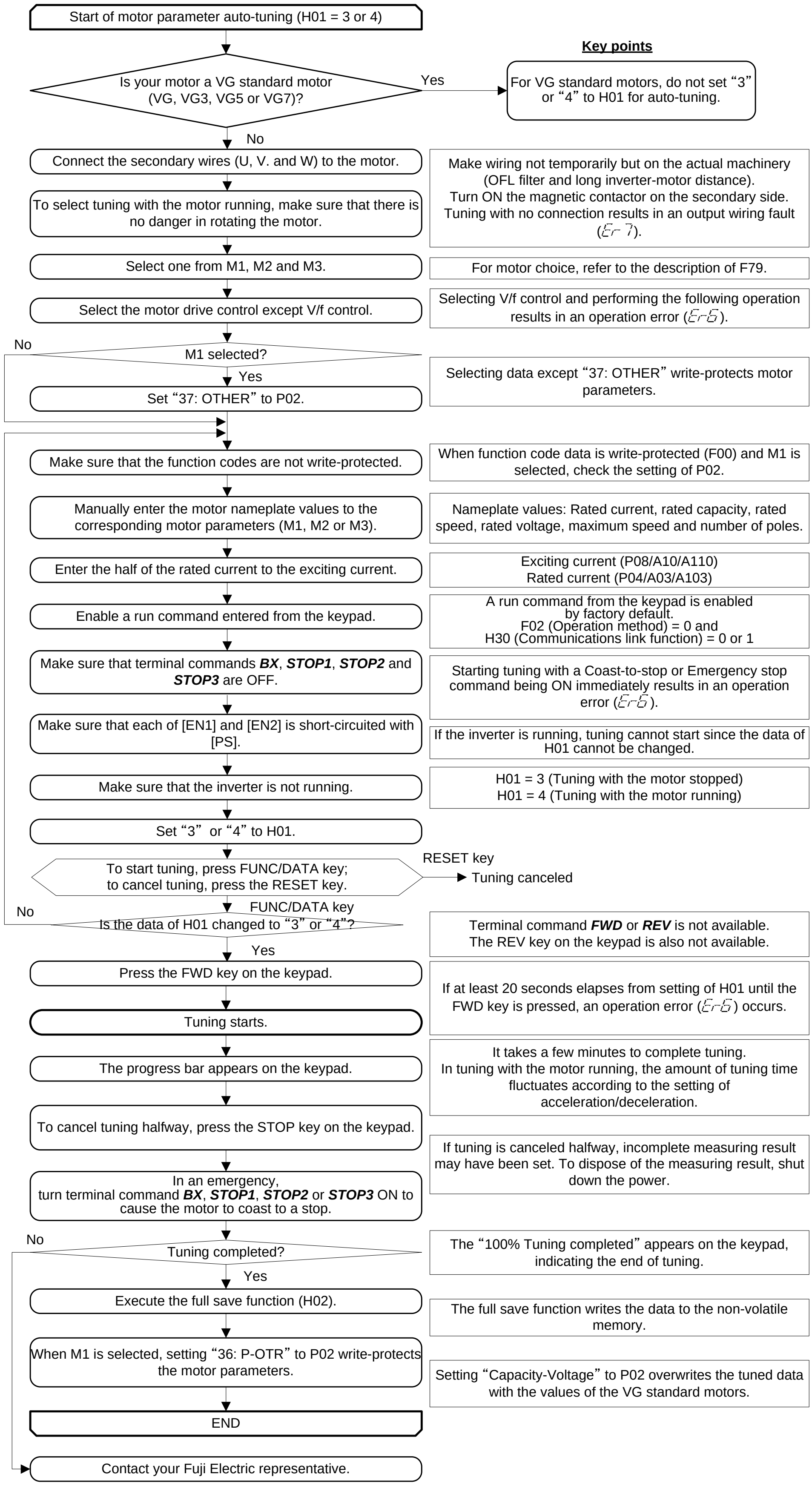
ASR (Auto speed regulator) auto-tuning procedure (H01 = 1) (Available soon)



Motor parameter auto-tuning procedure (H01 = 2)



Auto-tuning (with the motor stopped/running) procedure (H01 = 3 or 4)



⚠WARNING

When H01 = 1 or 4, the motor rotates during tuning. Make sure that there is no danger in rotating the motor.

Injuries could occur.

H02	Full Save Function

When you execute H01 "Tuning operation" to rewrite the internal data or you rewrite data through the link (RS-485 or field bus), the data are written to the volatile memory (RAM) temporarily and the data are erased when you turn off the power. Execute this function when you want to save these data (to write to the non-volatile memory).

H	0	2	A	L	L		S	A	V	E		

Set the value
1 and press STOP and ∧ keys at the same time to execute.

When you use the All save, you may delete previous data.

H03	Data Initialization

Set the value 1 and press STOP and ∧ keys at the same time to initialize set values to the factory setting. When the initialization is complete, the set values return to zero automatically. Not all functions execute initialization. See the function code list for more details.

H	0	3	D	A	T	A		I	N	I	T	

Set the value
1 and press STOP and ∧ keys at the same time to execute.

When you use the Data initializing, you may delete previous data.

H04	Auto-reset (Times)
H05	Auto-reset (Reset interval)

The Auto-reset function cancels the inverter protective function to restart the inverter automatically without alarm and output shut-off after the inverter protective function is activated. These functions set the number of canceling the protective function and the wait time between the activation and the cancellation of the protective function.

H	0	4	A	U	T	O	–	R	E	S	E	T
H	0	5	R	E	S	E	T		I	N	T	

Setting range (number): 0: Auto-reset disabled
1 to 10 (times)

(Wait time): 0.01 to 20.00 (s)

Set H04 "Auto-reset (Number)" to 0 when you do not use the auto-reset function

Inverter protective functions you can reset to restart

OC: Overcurrent	dbH: Braking resistor overheat
OU: Overvoltage	OL1, OL2, OL3: Motor 1,2, and 3 overload
OH1: Overheating at heat sink	OLU: Inverter overload
OH3: Inverter internal overheat	

When you set 1 to 10 to H04 "Auto-reset (Number)", the auto-reset is activated and inverter start command is automatically directed after a time specified by H05 "Auto-reset (Reset interval)" has passed. If the cause of the alarm does not exist any more, the inverter starts without entering the alarm mode. Otherwise, the protective function is activated again to wait for the time specified by H05 "Auto-reset (Reset interval)". If the cause of the alarm still exists after the inverter restarts specified times by H04 "Auto-reset (Number)", then the inverter enters the alarm mode.

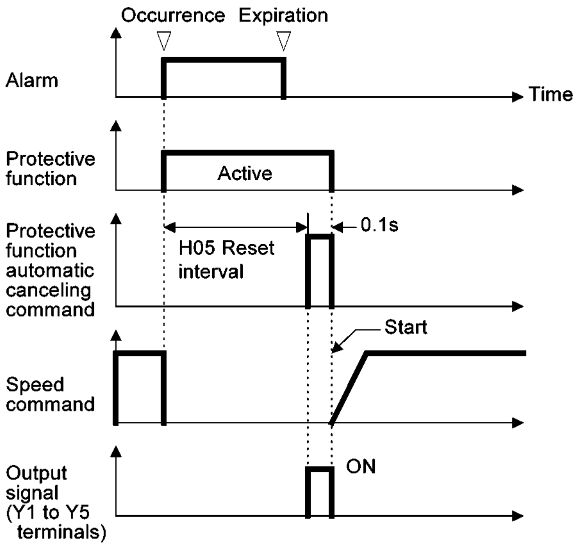
You can use the terminal [Y1] to [Y5] and [Y11] to [Y18] to monitor the retry operation. Note that if you want to use [Y11] to [Y18], you need the option OPC-VG1-DIOA. You can also use the link to poll M15 to read out the terminal information.

⚠WARNING

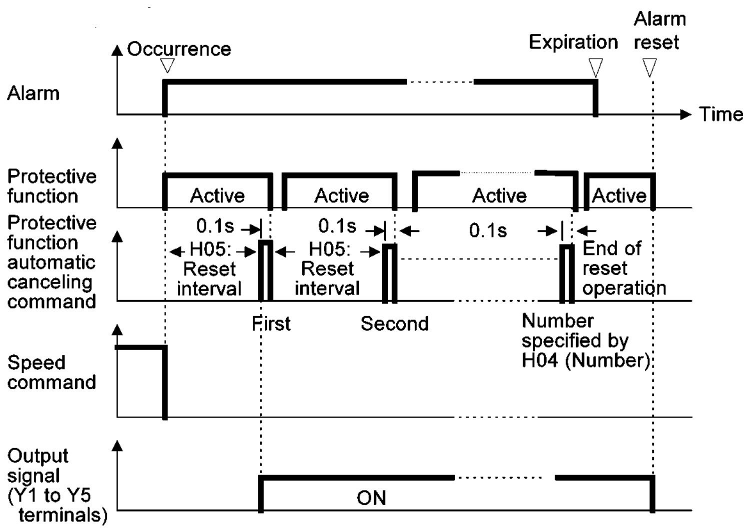
When you select the restart function, the inverter may restart automatically depending on the cause a trip after the inverter stops due to the trip. You must design your machine such that the machine restarts without causing any danger to persons.

Otherwise the restart may cause accidents.

Retry successful case



Retry failed case



H06	Cooling Fan ON/OFF Control

You can select whether to enable automatic ON/OFF operation of the cooling fan by detecting the temperature of the heat sink inside the inverter when the power is supplied to the inverter.

Set value: 0: Fan ON/OFF operation disabled
1: Fan ON/OFF operation enabled

H	0	6	F	A	N		S	T	O	P		

H08	Rev. Phase Sequence Lock

You can inhibit the reverse rotation of a mechanical devise that should not do so. This function is not available when you use V/f control.

H	0	8	P	R	T	D	–	I	N	V	T	

Set value: 0: Disabled
1: Enable

Use the function code F76 to F78 "Speed limiter" to inhibit the reverse operation directed by negative [12] input or [REV] input. This function uses torque control to inhibit the reverse operation due to an undershoot in stopping operation.

H09	Starting Mode (Auto search)

Restarts a motor smoothly when the motor starts after a momentary power failure or an external force is coasting the motor.

Detects the speed of a motor and supplies the same speed as that of the motor to start. Thus, the motor starts smoothly without presenting any shocks.

Under UP/DOWN control, auto search mode is disabled.

When using the inverter under vector control without speed sensor, use auto search in 60 Hz (1800 r/min in terms of 4-pole motors) or below.

If a trip occurs in auto search in 60 Hz (1800 r/min in terms of 4-pole motors) or higher, the following may improve the problem.

(1) Change the carrier frequency (F26),

(2) Increase the initial level of pre-excitation (F75), and

(3) Perform motor tuning.

Under vector control without speed sensor, the property cannot be satisfied due to external factors such as load conditions, motor parameters and wiring length, so make a sufficient operation check before actual operation.

H	0	9	S	T	A	R	T		C	H	A	R

Set value: 0: Disabled
1: Enable

Setting range: 0, 1, and 2

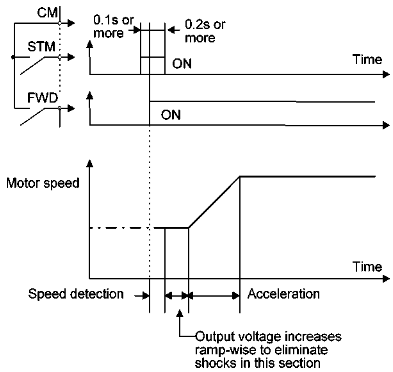
Set value	Normal start	Start after momentary power failure
0	Disabled	Disabled
1	Disabled	Enabled
2	Enabled	Enabled

Description of the set values

1: Enabled when F14 "Restart mode after momentary power failure (Select)" is set to 3, 4, or 5. Also starts the motor at the coasting speed.

2: Starts the motor at the detected coasting speed after any start situation including the ON operation command regardless of the occurrence of a momentary power failure.

Assign a setting value 26 (Pick up start mode) to either of the terminal from [X1] to [X9] to switch this function externally to apply the function to a normal ON operation command.



H10	Energy-saving Operation

To reduces the output voltage automatically during constant speed operation with light load to operate at a state where the product of voltage and current (power) is the smallest. This function is not available for V/f control.

H	1	0	A	U	T	O	–	E	N	G	Y	

Set value: 0: Disabled
1: Enable

H11	Automatic Operation OFF Function

Turns off the operation automatically when the motor speed decreases down under the F37 "Stop speed" while the FWD or REV command is present, or coasts the motor instead of decelerating the motor to stop when the input is set to OFF.

H	1	1	A	U	T	O		O	F	F		

Set value:
0: The motor decelerates to stop when the FWD-CM and the REV-CM are OFF (normal).
1: The motor operation is set to OFF when the speed is F37 under the "Stop speed" while the FWD-CM and the REV-CM are ON.
2: The motor coasts to stop when the FWD-CM and the REV-CM are OFF.
3: The motor decelerates to stop with ASR when the FWD-CM and the REV-CM are OFF (under torque control).
4: The motor coasts to stop when the FWD-CM and the REV-CM are OFF (under torque control).

When H11 = 3 or 4 and under ASR control, the motor decelerates to stop (H11 = 0). When H11 = 0 to 2, the operation is common to the ASR control and torque control.

When H11 = 0 or 3, turn OFF in accordance with F37 (Stop speed).

When H11 = 1 under vector control without speed sensor or V/f control, auto search is automatically disabled.

H13 Restart Mode after Momentary Power Failure (Wait time)

Waits for a time specified this function after power recovery and restarts.

H	1	3	R	E	S	T	A	R	T		t	

Setting range: 0.1 to 5.0 (s)

H14 Restart Mode after Momentary Power Failure (Decrease rate in speed)

In restart mode after momentary power failure under V/f control, if the inverter output frequency and motor rotation speed are not synchronized with each other, an overcurrent flows, activating the current limiter.

Upon detection of the current limiter operation, the inverter automatically increase the output frequency (r/min) to synchronize with the motor rotation speed. H14 specifies the decrease rate in speed (r/min/s).

H	1	4	F	A	L	L		R	A	T	E	

Setting range: 1 to 3,600 (r/min/s)

Note: Increasing the decrease rate may perform regenerative control the moment the inverter output frequency (r/min) and the motor rotation speed are synchronized with each other, causing an overvoltage trip. Decreasing it may lengthen the current limit operation duration until the synchronization, activating the inverter overload protection.

H15 Restart Mode after Momentary Power Failure (Continuous running level)

If you select setting 2 (deceleration to a stop on power failure) or 3 (continuous operation) in Restart mode after momentary power failure (F14: Action selection), this function affects them. At both settings, control operation starts when the main circuit DC voltage drops below this setting level.

H	1	5	H	O	L	D		V				

Setting range: 200V: 200 to 300 (V)
400V: 400 to 600 (V)

H16 Restart Mode after Momentary Power Failure (Run command self-hold setting)

Holds the operation command when the control power supply is maintained in the inverter or until the main circuit DC power supply voltage decreases about to zero (recognized as "momentary power failure") when you specifies 1.

Holds the operation command for a time specified by the H17 "Auto-restart (Operation command selfhold time)" when you specifies 0.

H	1	6	S	L	F	H	L	D		S	E	L

Setting range: 0 or 1

0: Hold a run command for the time specified by H17

1: Hold a run command until the main circuit power comes to be almost zero

H17 Restart Mode after Momentary Power Failure (Run command self-hold time)

When the power to the main power supply and the external control circuit (relay sequence) discontinues on power failure, the operation command given to the inverter becomes OFF in general.

This function sets the time to hold the operation command. When the period of a power failure exceeds the self-hold time, the inverter recognizes the power failure here cancels the "restart after momentary power failure" mode and restarts normally on power recovery (you can consider this setting as permissible momentary power failure time).

H	1	7	S	E	L	F	H	O	L	D	t	

Setting range: 0.0 to 30.0 (s)

H19 Active Drive

In the vector control mode, the output torque is automatically limited to avoid a trip caused by an overload or the like.

If 60s or a longer acceleration time is selected under V/f control, the acceleration time is automatically lengthened three-folded to avoid alarms.

H	1	9	A	C	T	–	D	R	I	V	E	

Setting range: 0: Disabled
1: Enabled

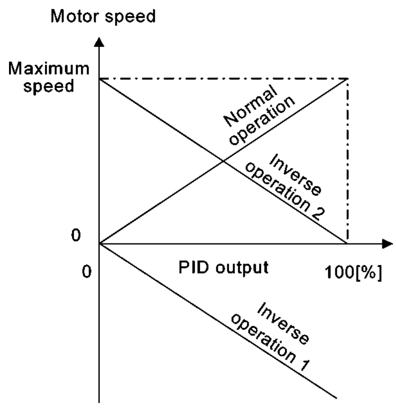
Before a trip is caused due to an inverter overload (OLU), heat sink overheat (OH1) or inverter inside overheat (OH3), the torque command value is limited or the acceleration time is extended to avoid alarms.

H20 PID Control (Mode selection)

PID control uses a sensor attached to a subject of control to detect the controlled value (feedback value) and compares it with the reference value (such as speed reference). When there is a deviation between them, the control behaves to decrease the deviation to zero. This is a control to match the feedback value with the reference value.

This control is applied to process control such as dancer control, tension control and extruders.

You can select normal or inverse operation for the output of the PID regulator and set increase or decrease to the rotation of a motor receiving the output of the PID regulator.



H	2	0	P	I	D		C	O	M	N	D	

Setting range: 0: Disabled
1: Enabled (normal operation)
2: Enabled (inverse operation 1)
3: Enabled (inverse operation 2)

H21 PID Control (Command selection)

Select the source of the reference value applied to the PID regulator.

Set value: 0: KEYPAD panel or [12] terminal input
1: Analog input Ai [PID-REF]

You can assign [PID-FB] to an analog input Ai to specify the feed back value applied to the PID regulator. You cannot specify a feed back value other than this voltage input.

You can view the process values of the reference value and the feedback value according to set values of the F52 "Display coefficient A" and F53 "Display coefficient B". See the function description of F52 and F53 for more details.

H	2	1	P	I	D		R	E	F	E	R	

H22	**PID Control (P-action)**
H23	**PID Control (I-action)**
H24	**PID Control (D-action)**

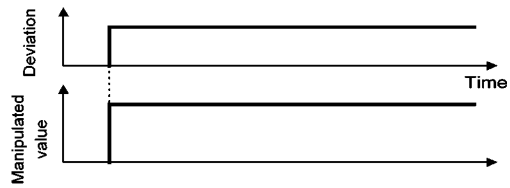
H	2	2	P	–	G	A	I	N				
H	2	3	I	–	G	A	I	N				
H	2	4	D	–	G	A	I	N				

H22 setting range: 0.000 to 10.000 (times)
H23 setting range: 0.00 to 100.00 (s)
H24 setting range: 0.000 to 10.000 (s)

You do not use P: Gain, I: Integral time, or D: Differential time individually, but use them by combining them as P control, PI control, PD control, and PID control in general.

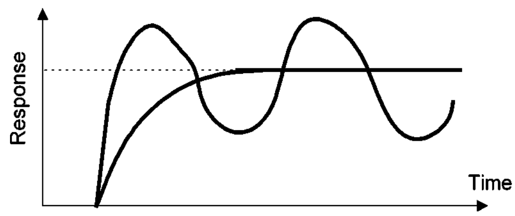
P control action

This action is referred to as P control action when a manipulated value (Speed command, Auxiliary speed command, and Torque limiter) and deviation has a linear relation. Thus P control action provides a manipulated value proportional to the deviation.



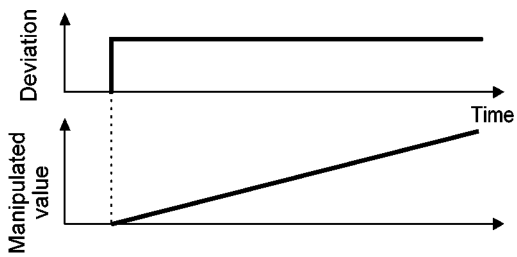
Note that you cannot use only P control action to decrease the deviation to zero.

P: gain is a parameter to define a degree of the response to a deviation. When you set a large gain, you will have a quick response. Too large gain presents an oscillation. Too small gain slows down the response.



I control action

This action is referred to as I control action when a manipulated value (Speed command, Auxiliary speed command, and Torque limiter) changes at a speed in proportion to deviation. Thus, I control action provides an integrated deviation as a manipulated value. I control action behaves to conform the controlled value (feedback value) to the reference value (such as speed command). However I control cannot responds to a deviation changing quickly.

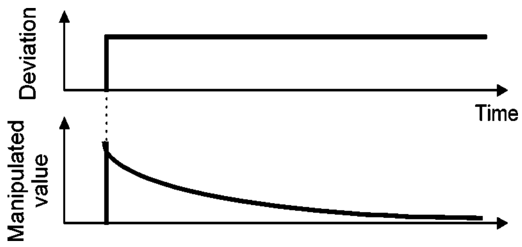


You can use I: integral time as a parameter to determine the effect of I control action. If you set a large integral time, you will have a slow response. A large integral time also decreases the repulsive force.

A small integral time quickens response. However, too small integral time will cause an oscillation.

D control action

This action is referred to as D control action when a manipulated value (Speed command, Auxiliary speed command, and Torque limiter) is proportional to differential of deviation. Thus D control action provides a differential of deviation as a manipulated value to respond a quick change.



You can use D: differential time as a parameter to determine the effect of D control action. A large differential time attenuates an oscillation caused by P control action quickly when a deviation occurs.

Too large differential time may induce even a larger oscillation. A small differential time decreases attenuation action applied to a deviation.

PI control action

When you use only P control action, the deviation still remains. PI control, P control action combined with I control action, is used in general to eliminate this residual deviation. PI control always behaves to eliminate a deviation due to a change of reference value or a continual disturbance. However if you increase I control action, the control cannot respond a fast deviation.

You can use only P control action for a load including an integral element.

PD control action

PD control action generates a larger manipulated value than that of D control action to restrain the increase of the deviation. When the deviation decreases, P control action is restrained.

If a subject of control contains an integral element, sole P control action will present an oscillating response due to the integral element. If this is a case, you can use PD control to attenuate the oscillation caused by sole P control action. You apply this control to a process that does not have selfdamping action.

PID control action

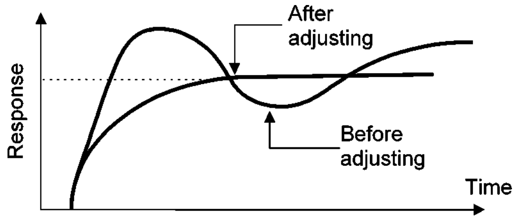
PID control action combines I control action, which acts to reduce deviation and D control action, which acts to restrain oscillation with P control action. You can obtain a stable response with no deviation.

This control is effective when applied to a load which respond slowly.

Adjusting PID setting

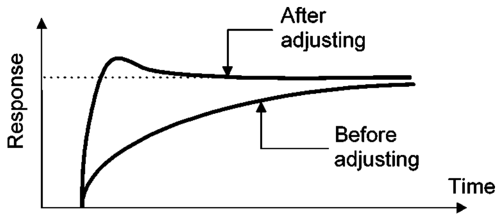
We recommend you to use an oscilloscope to view a response waveform and adjust PID setting. Adjust following the procedure described below.

- Increase H22 "PID control setting (P control action)" (P gain) as long as it does not present an oscillation.
- Decrease H23 "PID control setting (I control action)" (I integral time) as long as it does not present an oscillation.
- Increase H24 "PID control setting (D control action)" (D differential time) as long as it does not present an oscillation.

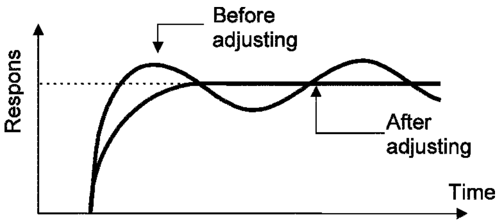


Follow the procedure below to adjust the response waveform.

- To restrict overshoot
  Increase H23 "PID control setting (I control action)" (I integral time). Decrease H24 "PID control setting (D control action)" (D differential time).

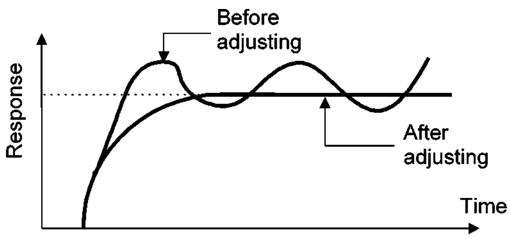


- To stabilize fast (accepting some overshoots.)
  Decrease H23 "PID control setting (I control action)" (I integral time). Increase H24 "PID control setting (D control action)" (D differential time).



- To restrain an oscillation whose cycle is longer than H23 "PID control setting (I control action)" (I integral time).

  Increase H23 "PID control setting (I control action)" (I integral time).



- To restrain a oscillation whose cycle is about the same as the H24 PID control setting (D control action)" (D differential time)

  Decrease H24 "PID control setting (D control action)" (D differential time).

  Decrease H22 "PID control setting (P control action)" (P gain) if you set 0.0 and the oscillation still exists

H25	PID Control (Upper limit)
H26	**PID Control (Lower limit)**

Set the upper and lower limiters applied to PID control.

H	2	5	P	I	D		U	P	P	E	R	
H	2	6	P	I	D		L	O	W	E	R	

Setting range: -300 to 300 (%)

H27	PID Control (Speed command selection)

Selects a destination of PID output to be used as a speed command.

H	2	7	P	I	D		S	P		R	E	F

Setting 0: Disabled
1: PID
2: Auxiliary speed setting range: -300 to 300 (%)

Usage	Destination of connection	Parameter setting
Parameter setting	Speed command	H27=1
Dancer control	Auxiliary speed command	H27=2
Torque control (tension control)	Torque command	H27=0 & H41=5
	Torque control value	H27=0 & (F42 or F43=5)

H28	Droop Control

When you use multiple motors to drive a single machine, a motor whose speed is higher has to drive a larger load. Droop operation balances load by adding a drooping characteristic to speed. This function is not available for V/f control.

H	2	8	D	R	O	O	P					

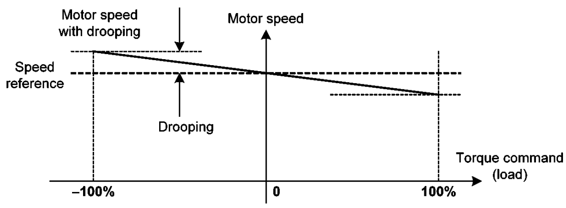
Setting range: 0.0 to 25.0 (%)

Set a drooping amount at 100% of torque command.

A value set to 100% corresponds to the maximum speed. When the maximum speed is 1,500r/min and the drooping is set to 10%, then the drooping speed is -150.0 r/min at 100% of torque command (load).

The droop function becomes valid after the [DROOP] contact input and ON "DROOP ON" are turned on.

If the droop gain is too large, the motor speed may increase too much under a control load, causing an excessive speed alarm (OS). If this happens, decrease the gain.



H29 Communications Link Function (Data protection via link)

Protects code data from false writing through different types of communication systems (such as integrated RS-485 and field bus).

H29 LINK PROCT

Set value: 0: Write enabled
1: Write protected

You should use H30 "Serial link" to define the write operation to the S area (function codes including operation commands and speed commands) separately.

When you assign [WE-LINK] to a digital input, you can protect from writing by short-circuiting between [WE-LINK] and [COM].

H30 Communications Link Function (Link operation)

Uses different types of communication systems (such as integrated RS-485 and field bus) to enable/disable command data (such as speed command, position command, torque command) and operation commands (FWD and REV), control inputs (X1-X9, X11-X14). Monitoring (access to M area) is always available. The command data correspond to S01 to S05 and S08 to S12. The operation commands correspond to the lowest two bits of S06.

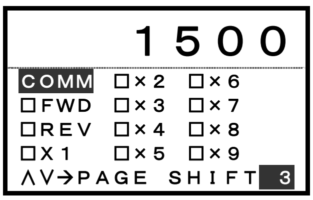
When you assign [LE] to a digital input, you can connect between [LE] and [CM] to enable the setting by H30 and open to disable operations specified through the link (set to H30=0 regardless of the setting by H30).

H30 LINK FUNC

Set value:

	Monitor	Command data (Speed commands, torque commands, etc.)	S06		Terminal block	
			Run commands (FWD, REV) Control inputs (X1 to X9, X11 to X14)	Reset command (RST)	FWD, REV (F02 = 1)	X1 to X9 (X11 to X14)
0	○	×	×	○	○	○
1	○	○	×	○	○	○
2	○	×	○	○	×	○
3	○	○	○	○	×	○

Note: If run commands and control inputs are enabled on both S06 and terminal block, they are ORed.



You can use the KEYPAD panel to check the operation commands from the link, and I/O check of control input.

H31 to H40 RS-485 Communication

Protects code data from false writing through different types of communication systems (such as integrated RS-485 and field bus).

Sets different types of specifications for RS-485 communication. Specify according to your host device.

See "Standard RS-485 interface" for the communication protocol.

H31 Station address

Sets the station address of RS-485

Setting range: 0 to 255 (Broad cast: (0: RTU), (99: FUJI)/address: 1 to 255)

H32 Action on error occurrence

Setting range: 0 to 3

Setting:
- 0: Immediate trip upon communication error
- 1: Trip upon communication error after continuation of operation for the time set at H33 "timer interval"
- 2: Trip upon communication error if the error persists after the time set at H33 "timer action time" has elapsed
- 3: Operation continues even if a communication error occurs. (The transmitted operation command is automatically restored after the cause of the failure is removed.)

H33 Timer operation time

Specify a procedure when an error occurs and an error handling time.

Timer operation time: 0.01 to 20.00 (s)

H34 Transmission rate

Specifies transmission rate.

Set value:
- 0: 38,400 (bps)
- 1: 19,200 (bps)
- 2: 9,600 (bps)
- 3: 4,800 (bps)
- 4: 2,400 (bps)

H35 Data length

Specifies data length.

Set value:
- 0: 8 (bit)
- 1: 7 (bit)

(The SX protocol and Modbus RTU protocol are fixed at 8 bits irrespective of the H35 setting.)

H36 Parity bit

Specifies parity bit.

Set value:
- 0: None
- 1: Even parity
- 2: Odd parity

(The SX protocol is fixed at the even parity irrespective of the H36 setting.)

H37 Stop bit

Specifies stop bit.

Set value: 0: 2 (bit)
1: 1 (bit)
(With the Modbus RTU protocol, the stop bit is automatically selected according to the parity bit selected at H36 irrespective of the H37 setting. See page 6-2.)

H38 Continued communication disconnected time

Specifies a time to wait to provide a trip signal (Er-5) after detecting discontinued access due to disconnection during operation through RS-485 in a system where the station is always accessed in a certain period.

Setting range: 0: Detection disabled
0.1 to 60.0 (s)

H39 Interval time

Specifies a time between the completion of receiving a request from a host device (personal computer or PLC) and the start of responding to the request.

Setting range: 0.00 to 1.00 (s)

H40 Protocol selection

Specifies a communication protocol.

Set value: 0: FUJI general-purpose inverter protocol
1: SX bus protocol (loader protocol)
2: Modbus RTU protocol

Set 1 to connect to VG1S support loader.

Set 0 to control FUJI general-purpose inverters and VG1S inverters connected through the common RS-485 communication.

Note: Modbus RTU is a communication protocol defined by Modicon company.

H41	Torque Command Source

Selects an element with which you provide the torque command. See the control block diagram for more details.

H	4	1	T	–	R	E	F		S	E	L	

Setting value: 0: Internal ASR data
1: Ai input [T-REF]
2: DIA card
3: DIB card
4: Link (S02)
5: PID output

Use also the speed limiter setting (F76 to F78) when you use the torque command

⚠WARNING

Make sure to use the speed limiter in cooperation with the torque command or the torque current command. You can avoid the motor overrun.

Accidents or physical injuries may occur.

⚠WARNING

- Under torque control, if the motor is rotated by the load with torque exceeding a torque command, even turning the run command OFF may not stop the motor but keep it running.

  To shut down the inverter output, take measures such as "Switch to speed control and decelerate to stop," "Shut down with a coast-to-stop command (***BX***)," or "Use automatic operation OFF function (H11 = 2 to 4)."

Accidents or physical injuries may occur.

⚠WARNING

- Under torque control, the inverter may not detect a power failure depending upon the load state. If it happens, input a power failure signal to the BX terminal to stop the inverter.

Accidents or physical injuries may occur.

H42 Torque Current Command Source

Selects an element with which you provide the torque command. See the control block diagram for more details.

H	4	2	I	T		R	E	F		S	E	L

Setting value: 0: Internal ASR data
1: Ai input [T-REF]
2: DIA card
3: DIB card
4: Link (S03)

Use also the speed limiter setting (F76 to F78) when you use the torque command

⚠WARNING

Make sure to use the speed limiter in cooperation with the torque command or the torque current command. You can avoid the motor overrun.

Accidents or physical injuries may occur.

⚠WARNING

- Under torque control, if the motor is rotated by the load with torque exceeding a torque command, even turning the run command OFF may not stop the motor but keep it running.

  To shut down the inverter output, take measures such as "Switch to speed control and decelerate to stop," "Shut down with a coast-to-stop command (***BX***)," or "Use automatic operation OFF function (H11 = 2 to 4)."

Accidents or physical injuries may occur.

⚠WARNING

- Under torque control, the inverter may not detect a power failure depending upon the load state. If it happens, input a power failure signal to the BX terminal to stop the inverter.

Accidents or physical injuries may occur.

H43 Magnetic Flux Command Source

Selects an element with which you provide the magnetic-flux command.

If the Ai input and link are selected, magnetic flux command inputs within 10% are fixed at 10%.

H	4	3	M		R	E	F		S	E	L	

Setting value: 0: Internal calculated value
1: Ai input [MF-REF]
2: Function code H44
3: Link (S04)

H44	Magnetic Flux Command Value

Specifies magnetic-flux command value. This function becomes available when you set 2 to H43.

H	4	4	M		R	E	F					

Setting value: 10 to 100 (%)

H46	Observer (Mode selection)

Specifies an inertia of a mechanical system or uses the ASR tuning to measure the inertia, operates an internal machine model in the inverter, estimates a load torque that becomes a disturbance element or a oscillation element, adds a value to the torque command to counteract the load torque to increase the speed response against a load disturbance and to damp an oscillation generated by the mechanical resonance quickly.

H	4	6	O	B	S		M	O	D	E		

Setting value: 0: Disabled
1: Load disturbance observer
2: Oscillation suppressing observer

Note: When a load inertia specified by H51 or H52 and H127 has a large error, you cannot obtain an expected performance. Specify an accurate value.

H47, H48, H125	Observer (M1, M2, M3 compensation gain)
H49, H50, H126	Observer (M1, M2, M3 I-time)
H51, H52, H127	Observer (M1, M2, M3 load inertia)

Specifies the compensation gain, the integral time, and the load inertia for the observer function.

H	4	7		M	1	–	O	B	S	–	P		
H	4	8		M	2	–	O	B	S	–	P		
H	1	2	5	M	3	–	O	B	S	–	P		
H	4	9		M	1	–	O	B	S	–	I		
H	5	0		M	2	–	O	B	S	–	I		
H	1	2	6	M	3	–	O	B	S	–	I		
H	5	1		M	1	–	I	N	E	R	T	I	A
H	5	2		M	2	–	I	N	E	R	T	I	A
H	1	2	7	M	3	–	I	N	E	R	T	I	A

H47, 48, 125 setting range: 0.00 to 1.00 (times)
H49, 50, 126 setting range: 0.005 to 1.000 (s)
H51, 52, 127 setting range: 0.001 to 50.000 (kg•m2)

Specify a load inertia of motor shaft conversion in kg•m2. You can also use ASR tuning by H01 "Tuning operation selection" to measure the inertia.

H53 Line Speed Feedback Selection

You can select an element for the speed feedback

H	5	3	N	–	F	B		S	E	L		

Set value: 0: Line speed disabled (integrated PG enabled)
However, with UPAC, Ai input or PG(LD) high select
1: Analog line speed detection [LINE-N]
2: Digital line speed detection (optional OPC-VG1-PG (LD))
3: High selector (select the higher speed between the motor speed or line speed)

About High selector

When you conduct a line speed control, and a line PG fails and presents a speed feedback of 0r/min, the inverter provides a command corresponding the maximum torque (torque limiter value if you use it) to accelerate the motor to the maximum speed to follow up the speed command. To change the feedback input from the line PG to a motor PG to prevent overrun when the line PG is disconnected is referred as "High selector". Make sure to use this High selector when you do not have a protective mean to detect the PG disconnection for line speed control.

Note: When you use a motor PG and the optional OPC-VG1-PG (LD), a protective function of "PG disconnection alarm" becomes available.

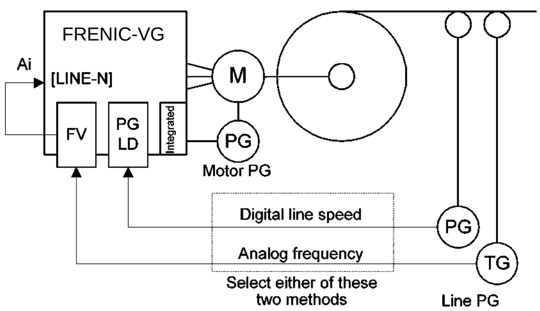
If P01 (M1 control method) is set at “2” (simulation mode), the line speed feedback automatically becomes invalid.

<Application example of line speed control>

The right figure illustrates an example of line speed control with PG.

When the line PG output is analog frequency, then use the FUJI FV card (MCA, OPC-VG1-FV) to convert the analog frequency into voltage to supply the voltage output to Ai [LINE-N]. Also specifies H53 as High selector.

When the line PG output is digital pulse, then use FUJI PG card (OPC-VG1-PG (LD)). See also the description of o06, o07, and o08 and the control block diagram.



H55 Zero Speed Control (Gain)

H56 Zero Speed Control (Completion range)

Specifies the gain of the servo locking command and the range of completion to provide the servo locking completion signal. See the section of [LOCK] of the function code E01 to E13 "X function selection"

H	5	5	Z	E	R	O	–	G	A	I	N	

Setting range: 0 to 100 (times)

H	5	6	Z	E	R	O	–	H	I	S	S	

Setting range: 0 to 100 (pulse)

H57 Overvoltage Suppression

When the DC link circuit voltage exceeds the overvoltage protection level during braking operation, the overvoltage (OV) trip occurs. This function limits the braking torque to zero before the overvoltage trip during the braking operation. The link circuit voltage decreases after 0 limiting, and the brake torque recovers automatically. This operation repeats to restrain the overvoltage trip.

You can use only inverter loss energy to apply brake without braking devices (braking resistor and PWM converter). When you want to use this function, see also "Power limiter" of the function code F40 to F45 "Torque limiter"

H	5	7	O	U		P	R	E	V	E	N	T

Set value: 0: Disabled
1: Enabled

Note: The torque generated by the motor may decrease under a suppressed voltage state. Do not use this function for vertical transportation applications.

In case of V/f control, too short a deceleration setting may disable overvoltage suppression. If overvoltage suppression is disabled, extend the deceleration time.

H58 Overcurrent Suppression

The overcurrent trip occurs when the motor current changes suddenly to become more than the protection level. The overcurrent suppressing function restrains the inverter from supplying a current more than the protection level when the load changes.

H	5	8	O	C		P	R	E	V	E	N	T

Set value: 0: Disabled
1: Enabled

Note: The torque generated by the motor may decrease under a suppressed voltage state. Do not use this function for vertical transportation applications.

H60 to H66 Load Adaptive Control

This function is related with the load adaptive control (H201 to H227). Refer to Section 4.1 "Control Block Diagrams."

Use this function to lift faster in case of small loads when compared with the speed at the rated load, thereby improving the efficiency of operation of the equipment.

Internal calculation of the inverter estimates the load during acceleration up to the rated (base) motor speed to calculate the maximum operable speed and perform speed limit control. Operation at the same speed in the up- and down-winding cycles with the same load is a major feature. As well, the maximum speed calculation correction function is added so that the up-/down-winding operation at the rated load is always at the rated (base) motor speed. The function can be used for lifting equipment equipped with a counterweight.

H	6	0	L	O	A	D		C	O	N	1	
H	6	1	L	O	A	D		C	O	N	2	
H	6	2	L	I	F	T		S	P	E	E	D
H	6	3	C		W	E	I	G	H	T		
H	6	4	S	A	F	E		C	O	E	F	
H	6	5	M		E	F	F	I	C	I	E	N
H	6	6	R		L	O	A	D				

Note: The load adaptive control is valid with the M1 motor only. Specify the same torque limit value for driving and braking.

Use acceleration/deceleration time 1 during operation under load adaptive control. Do not change the acceleration/deceleration time setting during load adaptive control operation.

This function is related with the multi-limit speed pattern function (H214 to H227). For load adaptive control and multi-limit speed pattern, refer to Section 4.1 "Control Block Diagrams."

H51 Observer setting (load inertia of M1) 0.001 to 50.000 (kgm^2)

H202, H205, H208, H211 load inertia 0.001 to 50.000 ($kg{\cdot}m^2$)

Specify the inertia without a load converted to the M1 motor shaft.

Note: In a multi-winding system, specify the quotient of the total inertia divided by the number of windings. For example, for a motor with two windings, specify a half the total inertia.

Chap. 4 CONTROL AND OPERATION

H60 Load adaptive control definition 1

Select the control method.

Setting: 0: The load adaptive control is made invalid.
1: Speed limit at almost same speed in up- and down-winding cycles
2: Regular speed limit
3: Limit invalid during driving operation and speed limit during braking operation

H61 Load adaptive control definition 2

Define the relationship between the direction of rotation of motor and lifting direction.

Setting: 0: Winding up during forward rotation of motor
1: Winding down during forward rotation of motor

Note: Setting H201 data to "0" also reverses the torque polarity in travel torque calculation.

H62 Up-winding speed 0.0 to 999.9 [m/min]

Specify the lifting speed at the rated (base) motor speed. Note that this is not the maximum speed.

H63 Weight of counterweight 0 to 600.00 [t]

Specify for lifting equipment equipped with a counterweight. Specify the weight of the counterweight.

H64, H203, H206, H209, H212 Safety factor 0.50 to 1.20

H65, H204, H207, H210, H213 Machine efficiency 0.500 to 1.000

Specify the total efficiency of the equipment.

H66 Rated load 0 to 600.00 [t]

The parameter is necessary for the correction of the maximum speed calculation so that operation at the rated (base) motor speed is assured during up-/down-winding cycles at the rated load.

Note: Include the mass of the spreader and head block, too, in the setting. For a multi-winding system, specify the quotient of the total mass divided by the number of windings. For example, for a motor with two windings, specify a half the total mass.

Specify H51, H202, H205, H208, H211 (observer setting (M1 load inertia)), H61 (load adaptive control definition 2), H62 (winding-up speed), H63 (weight of counterweight), and H65, H204, H207, H210, H213 (machine efficiency) according to the specification of the machine. The speed limit is set in a constant-output pattern according to the rated motor output. The rated motor output serving as a basis for the calculation of the speed limit can be adjusted with H65, H203, H206, H209, H212 (safety factor).

To operate at almost the same speed in the winding-up and winding-down cycles of the same load, specify setting “1” as H60 (load adaptive control definition 1).

To operate at the rated (basic) motor speed in the winding-up and winding-dowm cycles of the rated load, specify H66 (rated load). If the estimated inverter load exceeds the rated load, limit the motor speed using the rated speed (basic speed).

To determine the maximum speed under consideration for the machine efficiency, specify setting "2" as H60 (load adaptive control definition 1). The down-winding speed (during braking operation) becomes higher by the machine efficiency when compared with the winding-up speed (driving operation).

To invalidate load adaptive control during driving operation and validate the control only during braking operation, specify setting "3" as H60 (load adaptive control definition 1). The control becomes invalid in the winding-up cycle (during driving operation) and the control becomes valid in the winding-down cycle.

To invalidate load adaptive control, specify setting "0" as H60 (load adaptive control definition 1). Or turn on the speed command value limit cancellation [N-LIM] of function selection D1 (X terminal function). Only the speed limit caused by load adaptive control becomes invalid. Because the estimated load is calculated and the speed limit is calculated, the speed limit value calculation result obtained with the option monitor 6 mentioned later is effective, too.

Use option monitor 6 or M220 (Load compensating speed control value), M221 (Hoisting load calculation result monitor (kg)) and M222 (Travel torque calculation monitor (%)) to check the limit value calculation result. (Valid if H60 (load adaptive control definition 1) is set at "1," "2" or "3.")

Use function selection DO (Y terminal function) to check the activation state of load adaptive control.

Under load adaptive control limitation [ANL]:

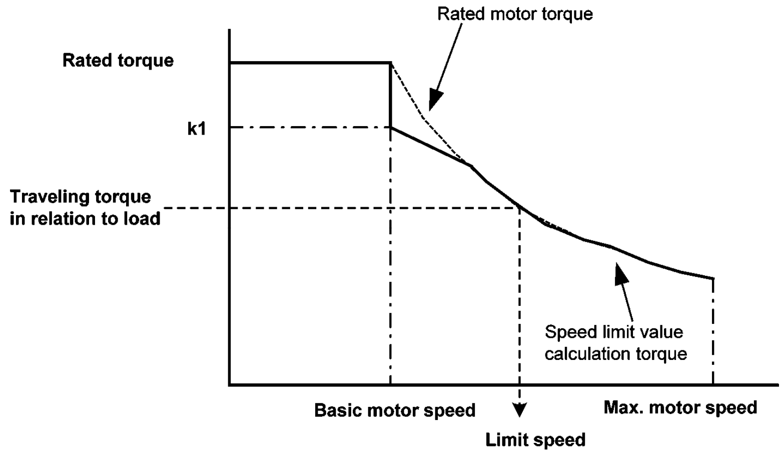
The function turns on when the speed setting is limited by the speed limit value calculated in the load adaptive control mode. Once turned on, the function does not turn off until the inverter is stopped.

During load adaptive control calculation [ANC]:

The signal is on during calculation of the load and speed limit in the load adaptive control mode. Upon completion of calculation, the signal is turned off and the result of calculation of limit value of option monitor 6 is updated to the latest data. The signal is turned off when the inverter is stopped.

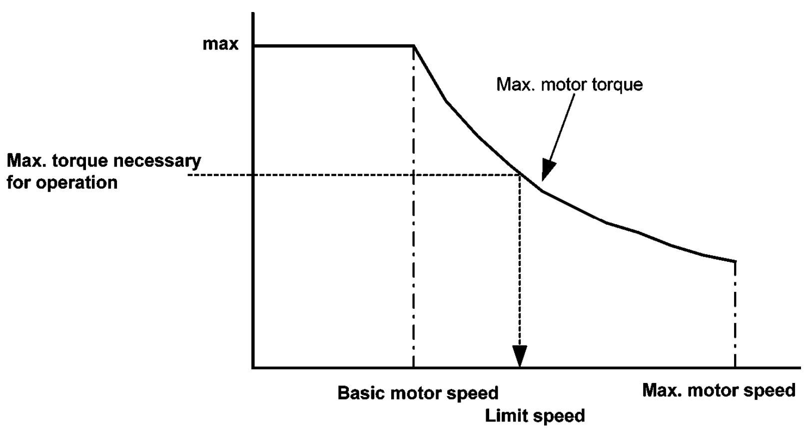
Speed limit pattern diagram

If setting of H60 load adaptive control definition 1 = 1



k1 indicates the motor torque determined from H66 (rated load) and H62 (rated lifting speed). The motor speed is limited by the base speed with the loads exceeding the rated load. The rated motor torque can be operated, using H64, H203, H206, H209, H212 (safety factor).

If setting of H60 load adaptive control definition 1 = 2 or 3



The limit speed is obtained from the relationship between the maximum motor torque and maximum torque necessary for acceleration/deceleration. The maximum motor torque can be operated, using H64, H203, H206, H209, H212 (safety factor).

Chap. 4 CONTROL AND OPERATION

H68	Alarm Data Deletion

Deletes the alarm history and the alarm information maintained in the inverter completely.

The corresponding functions are the KEYPAD panel alarm information, the alarm history and the source of alarms.

Setting the H68 data to "1" clears all data and automatically returns to "0."

H	6	8	A	L	A	R	M		D	A	T	A

H70	Reserved 1

H71	Reserved 2

These functions are reserved for makers to adjust the inverter.

H	7	0	M	A	K	E	R	1				
H	7	1	M	A	K	E	R	2				

⚠WARNING

Do not change.

Accident and/or injury may result.

H74	PG Detection Circuit Self-diagnosis Selection

Performs self diagnosis of the pulse encoder 2-phase signal input terminals (PA, PB) and the pulse encoder output terminals (FA, FB). Set the 1000's digit of H104 to 0 (disable PG power break alarm selection) and E29 (PG pulse output selection) to 7, shut off the inverter power, and connect PA to FA and PB to FB with external wiring. By setting this function code to "1", a speed pattern generated automatically by the inverter is output from the pulse encoder output terminals (FA, FB). The speed of this pattern is detected by the pulse encoder 2-phase signal input terminals (PA, PB), and by comparing with the speed pattern that is output, diagnosis of the PG detection circuit is accomplished. If the diagnosis result is normal, "COMPLETE OK!" appears. If not normal "PG CIR ERR" or "A/B PHASE ERR" appears. After diagnosis is completed, the H74 setting automatically returns to "0".

The time required for PG circuit diagnosis is about 12 seconds. While in progress, diagnosis can be canceled by pressing the STOP key or RESET key.

H	7	4	P	G		S	E	L	F			

Setting 0: No operation
1: Run PG circuit diagnosis

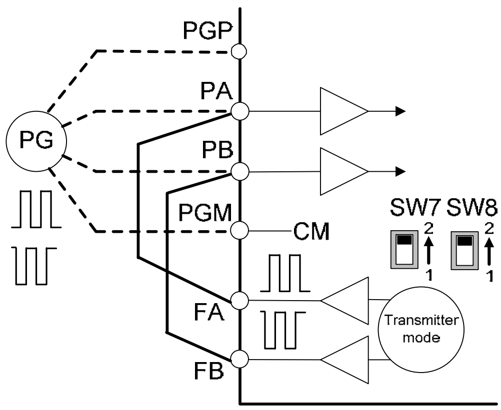
Note: When the PG(SD)/PGo(SD) card (option) is installed, this function cannot be used. (Er-6 will result.))

Set the pulse encoder output (FA, FB) in complementary output (SW7 = 2, SW8 = 2) .
(Refer to switching of each switch in 3.3.3.9.)

Execution is possible with only the control power (R0, T0) on.

After diagnosis is finished, return the settings of H104 and E29 to their original values.

After diagnosis is finished, shut off the power of the inverter (including R0, T0) and remove the external wiring.



• PG detection circuit Display during self diagnosis

```
H74PG SELF
  0:INACTIV
  1:ACTIVE
0~1
STOP+∧∨→DATA S
ET
```

Change the data of the function code with the ∧/∨ keys.

(FUNC/DATA ↓ / RESET ↑)

```
PG SELF-CHECK

FWD→START
```

After "STOP+∧∨→DATA SET" appears, the FWD/STOP key operations appear alternately.

(FWD ↓ / RESET ↑)

Start PG detection circuit self diagnosis with FWD key ON.

```
PG SELF-CHECK

 ■■■■      50%
STOP→STOP
```

When 100% appears, PG detection circuit self diagnosis is finished.

Forcible stop is possible with STOP key or RESET key ON.

```
PG SELF-CHECK

COMPLETE OK!
```

If the diagnosis result is normal, "COMPLETE OK!" appears.

After about 1.5 seconds, the function code list screen appears.

```
H75UVW PHS
H76RST OFF
H77F-TIM
H78MNT INIT →
∧∨→FN CODE◆
```

The H74 setting automatically returns to "0".

<Screen when the result is abnormal 1>

```
PG SELF-CHECK

A/B PHASE ERR
```

If the polarity of the detected speed value is reversed, "A/B PHASE ERR" appears.

Move to the function code setting screen with RESET key or STOP key ON.

<Screen when the result is abnormal 2>

```
PG SELF-CHECK

 PG CIR ERR
```

If the speed detection circuit is abnormal, "PG CIR ERR" appears.

Move to the function code setting screen with RESET key or STOP key ON.

H75 Phase Sequence Configuration of Main Circuit Output Wires

The motor wiring is normally connected in a normal phase connection; however, if the wiring is connected in a reverse phase connection, this function code can be set to reverse phase to make the run command match the rotation direction.

H	7	5	U	V	W		P	H	S			

Setting 0: UVW normal phase connection
1: UVW reverse phase connection

H76 Main Power Down Detection

The main power break detection function monitors the main power of the inverter (RST AC voltage input). When set to "1", the monitor functions below operate.

If a main power break is detected while the inverter is stopped, the charge resistance bypass circuit in the inverter opens. If a brief main power break occurs while the inverter is stopped, charging will take place through the charge resistance circuit when the power is restored, enabling the suppression of surge current.

Note: If "0" (No main power AC input monitor) is set and the main power is turned off/on quickly while the inverter is stopped, the charge resistance in the inverter will be bypassed and excessive surge current may damage the inverter.

When the main power is OFF, a power interruption will be detected and inverter output will not start even if the DC link bus voltage is above the undervoltage level. During inverter output, a power interruption is detected based on the DC link bus voltage only.

When a main power break is detected, ________ (underline) will appear in the LED monitor of the display.

However, when DC power is supplied and inverter AC input power is not supplied, such as when a power regeneration converter is connected, always set to "0" (No main power AC input monitor".

H	7	6	R	S	T		O	F	F			

Setting 0: No main power AC input monitor
1: Main power AC input monitor

H77 Cooling Fan ON/OFF Control Continuation Timer

This sets the condition for the cooling fan ON-OFF function by H06. While the inverter is stopped, if the detected fan temperature is below a fixed value for the time set with this setting, the cooling fan turns OFF.

H	7	7	F	–	T	I	M					

Setting: 0 to 600 sec

H78 Initialization of Startup Counter/Total Run Time

This function initializes the M1 - M3 start counts and M1 - M3 cumulative run times (clear to zero). When doing maintenance work on the motor or machine, you can individually initialize the data of each.

H	7	8	M	N	T		I	N	I	T		

Setting 0: No operation
1: Initialize M123 "M1 start count"
2: Initialize M124 "M2 start count"
3: Initialize M125 "M3 start count"
4: Initialize M126 "M1 cumulative run time"
5: Initialize M127 "M2 cumulative run time"
6: Initialize M128 "M3 cumulative run time"

H79 Initialization of Cumulative Run Time of Cooling Fan

The data for the initial value setting of the cooling fan aggregate run time can be changed. When the cooling fan is replaced, set "1". When "1" is set, "0" is written to the aggregate time internally. When replacing the inverter control board, write down the data of this function code before replacing the board, and then reset the data after replacement to continue the aggregate run time. The setting automatically reverts to "0" after it is written.

H	7	9	F	A	N		T	–	I	N	I	

Setting: 0 to 65535 (units of 10 hours)

H80 Capacitance Measurement of DC Link Bus Capacitor

When the capacitor capacitance measurement method is user mode (1's digit of H104 is 1), this function code is used. Read and understand the following explanation.

When initial value measurement of the user setting capacitor capacitance is started, the measurement result is written. When the inverter power is shut off with this setting set to "1", initial value measurement of the user setting capacitor capacitance starts and the measurement result is written to this code.

User mode capacitor capacitance measurement is performed when the power is shut off if the AND conditions below are met.

- Inverter is stopped
- Undervoltage alarm has not occurred
- Cooling fan is running (will be forcibly stopped by the inverter when the power is shut off)

H	8	0	C	C	–	I	N	I	T			

Setting: 0 to 32767

<u>When the capacitor capacitance measurement method is the factory default standard (1's digit of H104 is 0)</u>

Measurement is performed when the power is shut off if all measurement conditions in the table below are ○. The measurement conditions vary depending on whether or not the predicted life (LIFE) is selected with Y function selection. The measurement result is shown in M46 "main circuit capacitor capacitance (%)" and M121 "main circuit capacitor life (elapsed time)". In the M121 elapsed time, the capacitance decrease rate and capacitor life time obtained by capacitor capacitance measurement are converted to an elapsed time that overwrites the previous value.

When the capacitor capacitance measurement method is the user measurement value standard (1's digit of H104 is 1)

The measurement conditions are different from the factory default standard. Refer to the table below.

Measurement condition	Factory default standard (H104=***0)		User measurement value standard (H104=***1)
	No LIFE assignment	LIFE assignment	
Gate signal OFF	○	○	○
Cooling fan running	○	○	○
Not undervoltage	○	○	○
Terminal inputs all OFF	○ *1	○ *1	-
Option card not installed	○	- *2	-

*1 Terminal information after normal open/close processing.

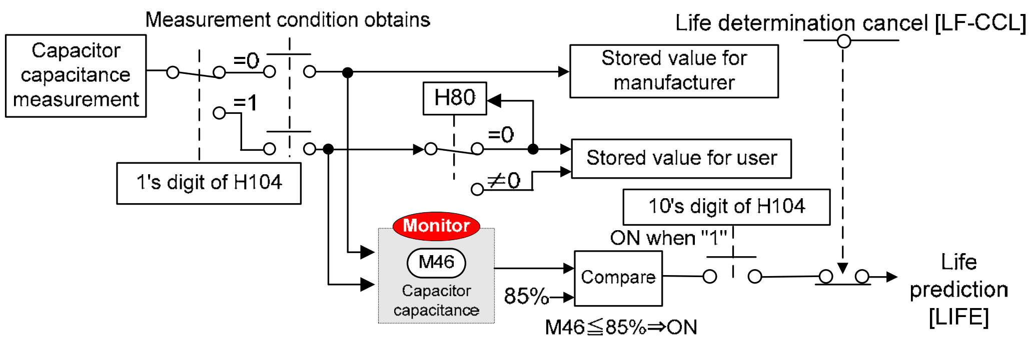
*2 When life information (LIFE) is assigned, measurement is also performed when an option card other than UPAC is installed.

Measurement will take place under the following conditions, however, the result will not be correct.

- When a breaking unit or other inverter is connected to the P (+), N (-) main circuit terminals by DC bus connection.
- RS-485 communication is used.
- Power is supplied from the R0, T0 auxiliary power.

By assigning the life prediction (LIFE) signal to one of the function codes of the Y function selection setting (E15 to E19), a life prediction signal is output to the general-purpose output (Y1 to Y5) when all of the conditions below are met.

- M46 "main circuit capacitor capacitance (%)" is 85% or lower
- The 10's digit of H104 is 1 (default value)
- Life determination cancel LF-CCL is OFF



H81 Initialization of Service Life of DC Link Bus Capacitor

The data for the initial value setting of the main circuit capacitor life aggregate time can be changed. When the main circuit capacitor is replaced, set "1". When "1" is set, "0" is written to the aggregate time internally. When replacing the inverter control board, write down this function code before replacing the board, and then reset after replacement to continue the aggregate time. The setting automatically reverts to "0" after it is written.

H	8	1	C	–	T	I	M	E		I	N	I

Setting: 0 to 65535 (units of 10 hours)

H82 Startup Count for Maintenance

When the total value of M123 "M1 start count" to M125 "M3 start count" becomes larger than this setting, a maintenance prediction (MNT) signal is output. By setting a start count for machine maintenance, external notification of maintenance timing is possible. The function code is the same for each motor. When the setting is "0", the start count stops.

H	8	2	M	N	T		S	T	R	T		

Setting: 0 to 65535
0: No operation
1 to 65535: Set time

H83 Maintenance Interval

This sets the inverter run time for performing machine maintenance. When the total value of M126 "M1 cumulative run time" to M128 "M3 cumulative run time" becomes larger than this setting, a maintenance prediction (MNT) signal is output. The function code is the same for each motor.

H	8	3	M	N	T		T	I	M	E		

Setting: 0 to 65535 (units of 10 hours)
0: No operation
1 to 65535: Set time

H85-H88	Calendar Clock

This is primarily used to set the date and time in the internal clock of the inverter via the communication option. The date and time can be displayed regularly on the LCD. The date and time are also used as a time stamp for detailed alarm information and the support loader trace-back function

The date and time can be easily set using the keyboard from "12. DATE TIME" in the menu of program mode.

By setting the date and time in H85 to H87 and then setting "1" in H88, the date and time are applied to the internal clock. The setting of H88 automatically reverts to "0" after the date and time are written.

H	8	5	Y	／	M		S	E	T			
H	8	6	D	／	H		S	E	T			
H	8	7	M	／	S		S	E	T			

Setting: 0 to FFFF

H	8	8	W	R	－	T	I	M	E			

Setting 0: No operation
1: Write time

The setting range is January 1, 2000, 00:00:00 to December 31, 2099, 23:59:59.

For example to set April 1, 2011, 13:15:00, write the values below.

Set H85 = 0B04, H86 = 010D, H87 = 0F00 in hexadecimal.
Set H88 = 1 to write the above values to the internal clock.

Valid numbers for each item are shown below.

Year: 00h - 63h, Month: 01h - 0Ch, Day: 01h - 1Fh, Hour: 00h - 17h, Min: 00h - 3Bh, Sec: 00h - 3Bh

* If values other than the above are set and "write time" is performed with H88, the individual values that are out of range are invalidated and not applied to the clock. Values that are valid are applied to the clock.

H89	Speed Detection Monitor Selection (under V/f control) (Available soon)

In V/f control, the speed detection monitor display method when motor speed detection can be used (internal PG or PG(SD)) can be selected.

If the setting is "1" and there is a break in the PG line, it will no longer be possible to display the correct motor speed; however, a PG break alarm will not occur.

H	8	9	N	－	M	O	N		S	E	L	

Setting: 0 to 1
0: No display, or speed command value
1: PG detection value

H90 Overspeed Alarm Detection Level

The detection level of the overspeed alarm (OS) can be set. 100% represents the maximum speed. Disabled during V/f control.

H	9	0	O	S		L	V	L				

Setting: 100 to 160%

H94 ASR Feedforward Gain Magnification Setting (Available soon)

H94 switches the ASR1-4 FF (gain) setting. Valid for function codes F63, C42, C52 and C62.

H	9	4	A	S	R		F	F		E	X	T

Setting: 0 to 2

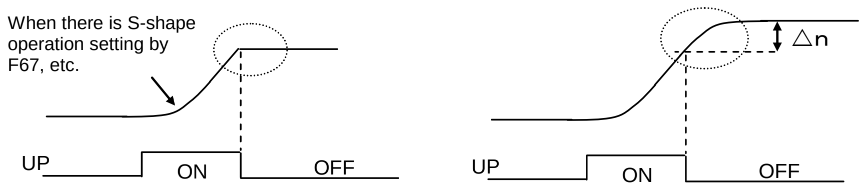
0: x1 (0.000 to 9.999 s)
1: x10 (0.00 to 99.99 s)
2: x100 (0.00 to 99.99 s)

H99 UP/DOWN S-curve Pattern Selection (Available soon)

H99 defines whether there is S-shape operation of the speed command when the UP/DOWN command is OFF.

S-shape operation of the speed command when the UP/DOWN command is ON is determined by the S-shape setting of F67, etc.

When the setting is "1", S-shape operation increases the speed by the width of the S-shape (△n).



S-shape operation when setting = 0   S-shape operation when setting = 1

H	9	9	U	/	D		S	–	C	A	N	

Setting: 0 to 1

0: Cancel S-shape (VG7 compatible)
1: Enable S-shape (VG5 compatible)

H101 PID Command Filter Time Constant

H101 specifies the time constant for the PID command (after H21 switching) filter.

H	1	0	1	P	I	D		F	I	L	T		

Setting: 0 to 5000 ms

H102 — Magnetic Pole Position Offset Writing Permission (Available soon) <ABZ only>

After the encode position offset is read, this enables data writing to function codes o10 "M1 magnetic pole position offset", A60 "M2 magnetic pole position offset", and A160 "M3 magnetic pole position offset".

H	1	0	2	S	M	–	O	F	S		W	R	

Setting: 0 (disable), 1 (enable)

H103 — Protective/Maintenance Function Selection 1

Protection operations can be individually selected.

To enable a protection operation, refer to the table below and set the appropriate digit to "1".

H	1	0	3	P	R	O	T		O	P	E	1	

Setting: 0000 to 1111

1000's digit:	Start delay alarm operation selection (LOC)	[0: Disable, 1: Enable] (default: 0)
100's digit:	Grounding fault alarm operation selection (EF)	[0: Disable, 1: Enable] (default: 1)
10's digit:	Output open-phase alarm operation selection (OPL)	[0: Disable, 1: Enable] (default: 0)
1's digit:	Braking transistor error operation selection (dbA)	[0: Disable, 1: Enable] (default: 1)

Braking transistor error (1's digit)

Selects whether errors of the braking transistor for braking resistor drive are detected.

If you are not using a braking resistor and do not want this alarm to occur, set to "0".

Output open-phase (10's digit)

Select whether the output open-phase alarm operates.

Grounding fault (100's digit)

Select whether the grounding fault alarm operates.

Start delay (1000's digit)

Select whether the start delay alarm operates.

H104 Protective/Maintenance Function Selection 2

Protection operations and main circuit capacitor life determination operations can be individually selected.

To enable a protection operation, refer to the table below and set the appropriate digit to "1".

H	1	0	4	P	R	O	T		O	P	E	2	

Setting: 0000 to 1111

1000's digit:	PG power break alarm (PG) operation selection	[0: Disable, 1: Enable] (default: 1)
100's digit:	Carrier frequency reduction function selection	[0: Disable, 1: Enable] (default: 1)
10's digit:	Main circuit capacitor life determination selection	[0: Disable, 1: Enable] (default: 1)
1's digit:	Main circuit capacitor capacitance measurement selection (0: Factory default standard, 1: User measurement standard)	[0: Disable, 1: Enable] (default: 0)

<u>Main circuit capacitor capacitance measurement selection (1's digit)</u>

Select whether the standard level for determining the life of the main circuit capacitor capacitance is the factory default standard or the user set standard. Also see the explanation of function code H80.

<u>Main circuit capacitor life determination selection (10's digit)</u>

Select whether decreased main circuit capacitor capacitance is the factor for the life prediction signal (LIFE).

Also see the explanation of function code H80.

<u>Carrier frequency auto reduction selection (100's digit)</u>

This function automatically reduces the carrier frequency before an inverter cooling fan overheating (OH1) or inverter internal heating (OH3) alarm occurs in order to avoid the alarm. Select the operation of this function. When the carrier frequency is reduced, motor noise increases.

Note: When a synchronous motor is driven, the inverter carrier frequency is sometimes set higher to prevent overheating of the permanent magnet and demagnetization of the magnet due to inverter high frequency output current (excluding our GNF2 model). Carefully check the carrier frequency allowed by the motor before deciding the carrier frequency (F26) and carrier frequency auto reduction selection (H104) settings. If you cancel the carrier frequency auto reduction selection function (H104), exercise caution as the carrier frequency setting may cause a reduction of the unit's continuous rated current (for rated current reduction characteristics, refer to section 2.1.4). The setting of this digit cannot be changed during operation.

<u>PG power break alarm selection (1000's digit)</u>

Select whether the PG power loss alarm (PG) operates.

H105 Protective/Maintenance Function Selection 3 (Available soon)

Protection operations can be individually selected.

To enable a protection operation, refer to the table below and set the appropriate digit to "1".

H	1	0	5	P	R	O	T		O	P	E	3	

Setting: 0000 to 1111

1000's digit: Not used
100's digit: Not used
10's digit: Not used
1's digit: Not used

H106 to H111 | Light Alarm Object Definition 1 to 6

When an error is detected and the error is a minor error, the light alarm (L-AL) display can be shown and operation can be continued without tripping the inverter.

"1" can be set in bits corresponding to any of the light alarm causes to treat those causes as light alarms and not have the alarm relay output (30RY) operate.

H106 L-ALM 1

Setting: 0000 to 1111

□□□□ (0: Heavy alarm, 1: Light alarm)
- Bit 0 (rightmost): External alarm [OH2]
- Bit 1: NTC thermistor wire break [nrb]
- Bit 2: Motor overload [OL1] [OL2] [OL3] (same for M1-M3)
- Bit 3 (leftmost): Motor overheat [OH4]

H107 L-ALM 2

Setting: 0000 to 1111

□□□□ (0: Heavy alarm, 1: Light alarm)
- Bit 0 (rightmost): Toggle error [ArF]
- Bit 1: Reserved
- Bit 2: Network error [Er4]
- Bit 3 (leftmost): RS-485 error [Er5]

H108 L-ALM 3

Setting: 0000 to 1111

□□□□ (0: Heavy alarm, 1: Light alarm)
- Bit 0 (rightmost): E-SX error [ArE]
- Bit 1: Speed does not match [Er9], start delay [LOC]
- Bit 2: DC fan lock [daft]
- Bit 3 (leftmost): Mock alarm [Err]

H109 L-ALM 4

Setting: 0000 to 1111

□□□□ (0: Heavy alarm, 1: Light alarm)
- Bit 0 (rightmost): Safety board light alarm [SnF] (Available soon)
- Bit 1: Reserved
- Bit 2: Reserved
- Bit 3 (leftmost): Reserved

H110 L-ALM 5

Setting: 0000 to 1111

□□□□ (0: Not light alarm, 1: Light alarm)
- Bit 0 (rightmost): Fan overheat prediction [OH], inverter overload prediction [OL]
- Bit 1: Life prediction [LiF]
- Bit 2: Battery life [BaT]
- Bit 3 (leftmost): Motor overheat prediction [MOH], motor overload prediction [MOL]

Set whether the LED display shows [L-AL] when a light alarm occurs.

H	1	1	1	L	–	A	L	M		6			

Setting: 0 to 1
- 0: Disable (L-AL not displayed)
- 1: Enable (L-AL displayed)

H112 to H118 M1 Magnetic Saturation Extension Coefficients 6-12

The excitation current (current that creates magnetic flux in the induction motor) and magnetic flux are in a non-linear relationship to maintain the saturation characteristics. When the saturation characteristics are significant in an application that exceeds a fixed output range of 1:2, set a correction factor.

For normal use, do not change.

(These become function codes that expand the characteristics of P15 to P19.)

Only valid when vector control with speed sensor (induction motor) is selected. Only applies to the M1 motor. The M2 and M3 motors do not have a function code that is equivalent to this function code.

H	1	1	2	M	1	–	S	A	T	6			
H	1	1	3	M	1	–	S	A	T	7			
H	1	1	4	M	1	–	S	A	T	8			
H	1	1	5	M	1	–	S	A	T	9			
H	1	1	6	M	1	–	S	A	T	1	0		
H	1	1	7	M	1	–	S	A	T	1	1		
H	1	1	8	M	1	–	S	A	T	1	2		

Setting: 0.0 to 100.0%

H134 Speed Drop Detection Delay Timer

Adds speed drop detection signal and speed setting detection signal conditions to the ON/OFF conditions of the break release signal (BRK). For details on the brake release signal (BRK), refer to the explanation of 18: brake release signal (BRK) in function codes E01 - E13 (X terminal function).

Function code H134 sets the time interval from the point that the inverter is running until the speed drop detection function starts operating.

H	1	3	4	D	E	L	A	Y		T	I	M	

Setting range: 0.000 to 10.000 s

H135	Speed Command Detection Level (forward)
H136	**Speed Command Detection Level (reverse)**

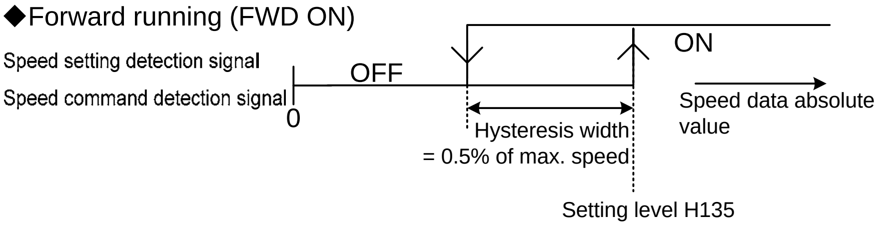
When speed setting 2 (before acceleration/deceleration calculation) rises higher than this setting, the speed setting detection signal turns ON. This is included in the brake release signal ON (brake release) conditions.

When speed setting 2 (before acceleration/deceleration calculation) or speed setting 3 (after acceleration/deceleration calculation) drops lower than this setting, the speed setting detection signal turns OFF. This is included in the brake release signal OFF (brake on) conditions. While running by run forward command, the H135 level is valid, and while running by run reverse command, the H136 level is valid.

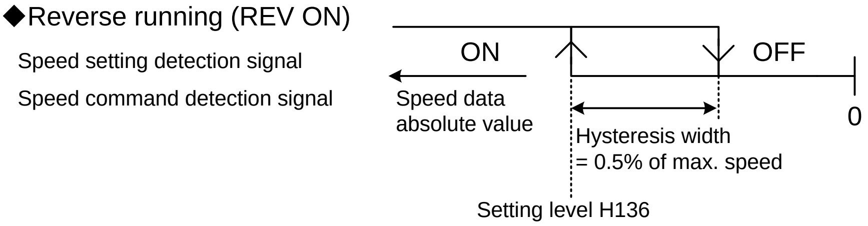
H	1	3	5	N	R	E	F		L	E	V	L	F
H	1	3	6	N	R	E	F		L	E	V	L	R

Setting range: 0.0 to 150.0 r/min

◆Forward running (FWD ON)



◆Reverse running (REV ON)

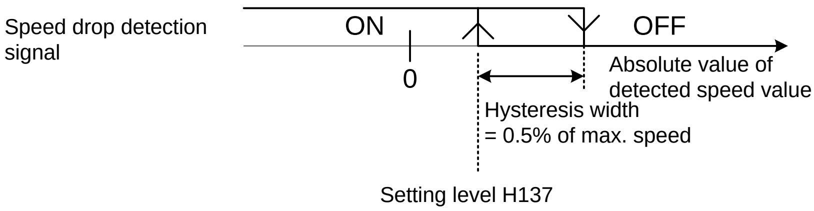


H137	Speed Drop Detection Level

When the absolute value of the detected speed value falls below this setting, the speed drop detection signal turns ON and the brake release signal turns OFF (brake on).

H	1	3	7	N	D	E	C		L	E	V	L	

Setting range: 0.0 to 150.0 r/min



H138	Speed Drop Detection Delay Timer

On delay timer for the speed drop detection signal. When the on delay timer is operating, the speed drop detection signal does not turn ON when the detected speed value is higher than H138 + 1%.

H	1	3	8	N	D	E	C		T	I	M	R	

Setting range: 0.000 to 10.000 s

H140	Start Delay Detection (Detection level)
H141	Start Delay Detection (Detection timer)

When the torque current command value is higher than the level set with this function code, and the actual speed value or estimated speed value is lower than the speed set with function code F37 "Stop speed" over the time set in function code H141, the start delay alarm (LOC) occurs.

H	1	4	0	S	R	T		D	L	Y		L	

Setting range: 0.0 to 300.0%

H	1	4	1	S	R	T		D	L	Y		T	

Setting range: 0.000 to 10.000 s

Note: Under vector control without speed sensor, whether the speed is less than the stop speed (F37) is judged by the estimated speed value. There may be deviations in alarm detection due to error in the estimated speed. The effect of estimated speed error is greater when the stop speed is low. Be aware of this when using this function code.

H142	Mock Alarm

During setup, an alarm can be simulated to check the external sequence.

Setting method

Press the STOP and ∧ keys simultaneously or the STOP and ∨ keys simultaneously, change to any set value, and then enter with the FUNC/DATA key. After the mock alarm occurs, the set value automatically reverts to 0 and alarm reset can be performed.

If the mock alarm has been defined as a "light alarm" in function code H108 "light alarm definition 3", light alarm (L-ALM) can be assigned to one of the function codes of the Y function selection settings (E15 to E19) to allow the mock alarm status to be output to a general purpose output (Y1 to Y5). When this is done, the alarm relay output relay (30RY) does not operate. When defined as a "heavy alarm", the mock alarm status shows "Er-r".

Alarm data of the mock alarm (alarm history and other information related to the alarm) is recorded in the same way as alarm data during normal operation, and you can check the data.

To erase the alarm data after you have completed setup, use H68 "delete alarm data" in the same way as when deleting alarm data of an alarm that occurred during operation.

A mock alarm also occurs if you hold down STOP and FUNC/DATA at least 3 seconds on the touch panel.

H	1	4	2	S	I	M		A	L	M			

Setting 0: No operation
1: Mock alarm occurs

H144 Toggle Data Error Timer

The error detection time for the toggle signal can be set.

Refer to the explanation of 72, 73: toggle signal 1, 2 in X function selection.

H	1	4	4	T	G	L		E	R	R		T	

Setting range: 0.01 to 20.00 (sec)

H145 Reverse Run Prevention for Vector Control without Speed Sensor (Lower limit frequency selection)

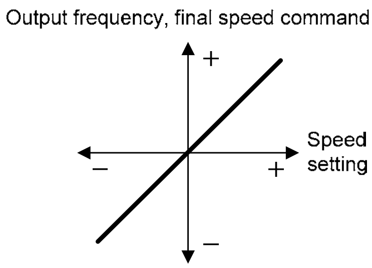
To improve speed control characteristics of ultra-low speed under vector control without speed sensor, a lower limit frequency can be set for the speed command value and estimated speed value (primary estimated frequency value).

H	1	4	5	L	–	L	I	M		S	E	L	

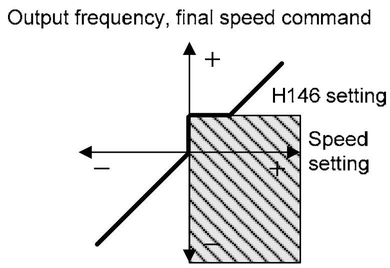
Setting range: 0 to 3

- 0: Disable
- 1: Enable for FWD polarity operation (enable in start delay during hoisting operation (FWD command, speed command+))
- 2: Enable for REV polarity operation (enable in start delay during lowering operation (REV command, speed command+))
- 3: Enable for both FWD and REV polarities (enable in start delay of both hoisting and lowering)

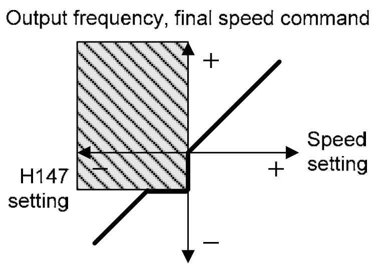
Limiting takes place in the shaded areas shown below. When the estimated speed value (primary estimated frequency value) is in a shaded area, the speed command is limited by the lower limit frequency.



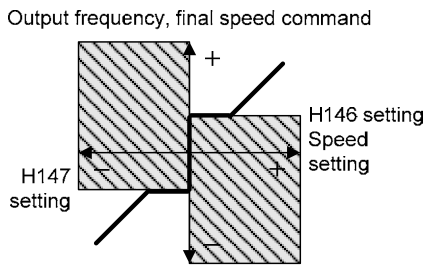
H145 = 0 (function disabled)



H145 = 1 (FWD polarity enabled)



H145 = 2 (REV polarity enabled)



H145 = 3 (FWD/REV both enabled)

⚠CAUTION

When enabling this function, set the start characteristic (H09) to 0 (no operation). When using the function with the speed setting by analog input near 0 (V), deviations in the analog voltage polarity will cause the limiting operation to become unstable. Take measures such as setting a dead zone (F82). There are restrictions on this function as noted above. Understand these restrictions before using the function.

H146	Reverse Run Prevention for Vector Control without Speed Sensor (Lower limit frequency, FWD)

Set the lower limit frequency when H145 = 1 is set. As a guideline, set the motor slippage frequency.

H	1	4	6	L	–	L	I	M		F	W	D	

Setting range: 0.000 to 10.000 Hz

H147	Reverse Run Prevention for Vector Control without Speed Sensor (Lower limit frequency, REV)

Set the lower limit frequency when H145 = 2 is set. As a guideline, set the motor slippage frequency.

H	1	4	7	L	–	L	I	M		R	E	V	

Setting range: 0.000 to 10.000 Hz

H148	Reverse Run Prevention for Vector Control without Speed Sensor (Estimated primary frequency filter)

Set the primary delay filter time constant for the estimated speed value (primary estimated frequency value).

Use for speed changes under vector control without speed sensor.

H	1	4	8	P	R	I	–	F		F	I	L	

Setting range: 0 to 100 ms

H149	Machine Runaway Detection Speed Setting

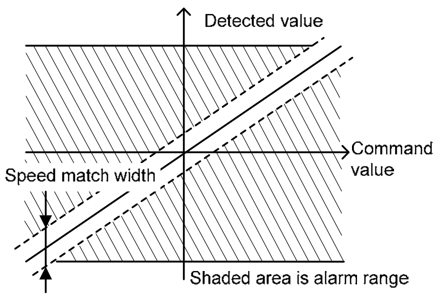
During operation (after the machine brake is released), if the speed is higher than the speed command value (speed setting 4: ASR input) and the speed with a deviation setting applied to the actual speed value, machine runaway is detected and a speed mismatch alarm (Er-9) is output. A setting of 100% represents the maximum speed.

This function is invalid when the brake release signal (BRK) is not assigned to the Y function terminal.

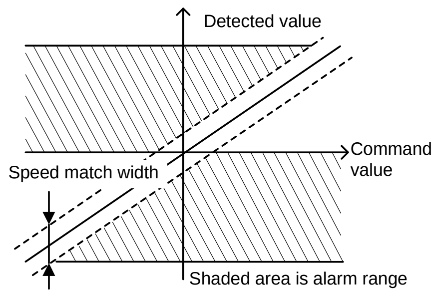
The speed mismatch alarms set with function codes E43 to E45 do not occur when the speed command value (speed setting 4: ASR input) polarity and actual speed value polarity match and the actual speed value is less than the speed command value. The speed mismatch alarm set with this function is output regardless of the above underlined conditions.

H	1	4	9	M	–	S	P	D					

Setting 0.0: Disable
0.1 to 20.0%



Speed mismatch alarm conditions (machine runaway detection)



Speed mismatch alarm conditions (by E43 - E4)

Note: The operation of the speed mismatch alarm is defined by the function code E45 operation definition.

H160	M1 Initial Magnetic Pole Position Detection Mode (Available soon)
H170	M2 Initial Magnetic Pole Position Detection Mode (Available soon)
H180	M3 Initial Magnetic Pole Position Detection Mode (Available soon)

Function codes for the synchronous motor. These set the initial magnetic pole position detection method.

H	1	6	0	M	1	–	S	M		I	N	I	
H	1	7	0	M	2	–	S	M		I	N	I	
H	1	8	0	M	3	–	S	M		I	N	I	

Setting 0: IPM (embedded magnet) Motor current drawing method
1: SPM (surface magnet) Motor current drawing method
2: IPM motor alternation method (Available soon)
3: SPM motor alternation method (Available soon)

H161	M1 Pull-in Current Command (Available soon)
H171	M2 Pull-in Current Command (Available soon)
H181	M3 Pull-in Current Command (Available soon)

Current command value for magnetic pole position detection. Normally there is no need to change the factory default value.

H	1	6	1	M	1	–	P	–	U	P		T	
H	1	7	1	M	2	–	P	–	U	P		T	
H	1	8	1	M	3	–	P	–	U	P		T	

Setting: 10 to 200% (100% / motor rated current)

H162	M1 Pull-in Frequency (Available soon)
H172	M2 Pull-in Frequency (Available soon)
H182	M3 Pull-in Frequency (Available soon)
H163	M1 Reference Current for Polarity Discrimination (Available soon)
H173	M2 Reference Current for Polarity Discrimination (Available soon)
H183	M3 Reference Current for Polarity Discrimination (Available soon)
H164	M1 Alternating Voltage (Available soon)
H174	M2 Alternating Voltage (Available soon)
H184	M3 Alternating Voltage (Available soon)

Used for magnetic pole position detection. Normally there is no need to change the factory default value.

H201 to H213 | Load Adaptive Control Parameter Settings 1 (Available soon)

Parameters used for load compensation control.

For details, refer to the explanation of functions H60 to H66.

H	2	0	1	L	D		A	D	P		S	W	

Settings 0: H51, H64, H65 enabled, H202-H213 disabled
1: H51, H64, H65 enabled, H202-H213 disabled

Set the inertia for M1 motor axis conversion not including the applied load.

For multi-winding systems, or for synchronous driving of a load with multiple motors, divide the total inertia by the number of windings or the number of motors and set the resulting value. For example, for a two-winding motor, set 1/2 the value of the total inertia.

H202, H205: Load inertia (hoisting 1, 2); H208, H211: load inertia (lowering 1, 2)

H	2	0	2	L	D	–	J		U	P	1		
H	2	0	5	L	D	–	J		U	P	2		
H	2	0	8	L	D	–	J		U	P	1		
H	2	1	1	L	D	–	J		U	P	2		

Setting: 0.001 to 50.000 kg•m^2

H203, H206: Safety factor (hoisting 1, 2); H209, H212: Safety factor (lowering 1, 2)

H	2	0	3	S	A	F	E		U	P	1		
H	2	0	6	S	A	F	E		U	P	2		
H	2	0	9	S	A	F	E		D	N	1		
H	2	1	2	S	A	F	E		D	N	2		

Setting: 0.5 to 1.20

H204, H207: Machine efficiency (hoisting 1, 2); H210, H213: Machine efficiency (lowering 1, 2)

Set the total efficiency of the machine.

H	2	0	4	M	–	E	F		U	P	1		
H	2	0	7	M	–	E	F		U	P	2		
H	2	1	0	M	–	E	F		D	N	1		
H	2	1	3	M	–	E	F		D	N	2		

Setting: 0.500 to 1.000

Chap. 4 CONTROL AND OPERATION

H214 to H227	Load Adaptive Control Parameter Settings 2 (Available soon)

H214 = 1 enables the multi restriction speed pattern function. For the relation to the H201 - H213 load compensation control function, refer to the explanation of functions H60 - H66.

Set the torque level of each limit speed point as indicated below.

H215 - H224: Multi limit speed pattern (*)

* H215: Maximum speed, H216: Rated speed, H217: Rated speed × 1.1, H218: Rated speed × 1.2
H219: Rated speed × 1.4, H220: Rated speed × 1.6, H221: Rated speed × 1.8, H222: Rated speed × 2.0
H223: Rated speed × 2.5, H224: Rated speed × 3.0

H215	MUL-NMAX
H216	MUL-NRAT
H217	MUL-L1.1
H218	MUL-L1.2
H219	MUL-L1.4
H220	MUL-L1.6
H221	MUL-L1.8
H222	MUL-L2.0
H223	MUL-L2.5
H224	MUL-L3.0

Setting: 0.1 to 100.0%

<Setting notes>

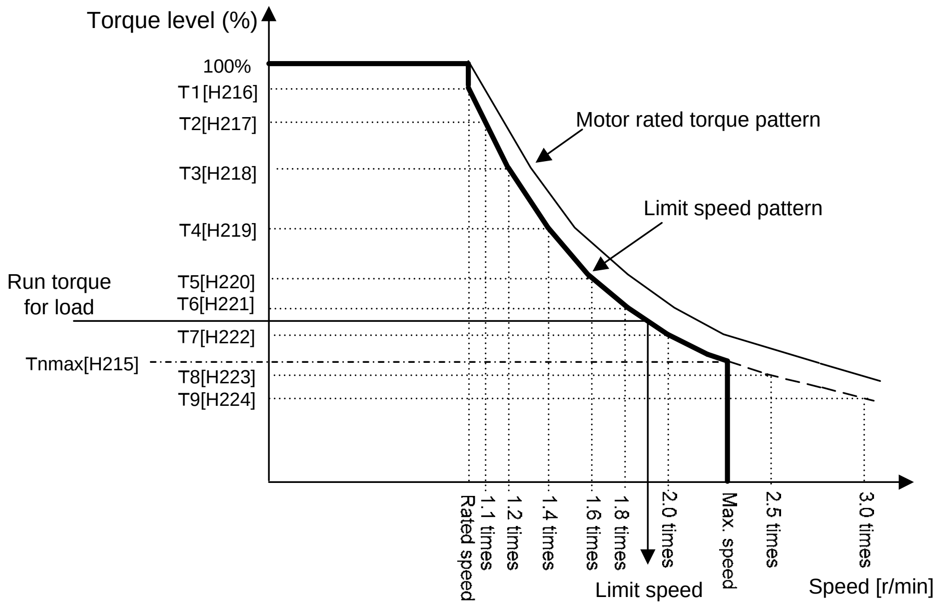
A torque level setting for a limit speed point that exceeds the maximum speed will be invalid.

The settings for T1 to T9 should increase in order from T1 (T1 < T2 < ...T9).

Set the torque level Tnmax for the maximum speed to a smaller value than the torque levels set for the limit speed points less than the maximum speed.

The multi limit speed pattern (bold line below) is limited to within the rated motor torque pattern (fine line below).

<Limit pattern graph>

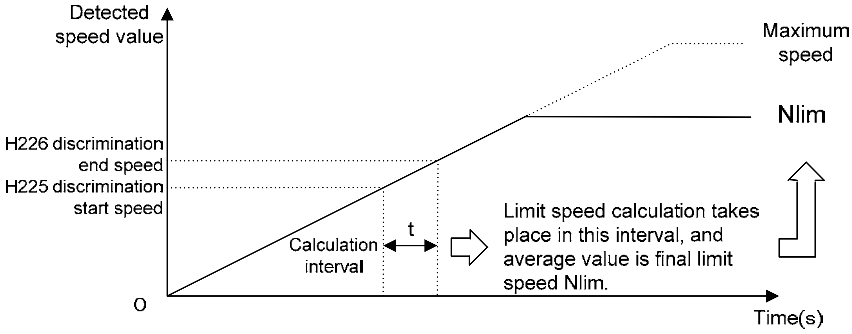


H225: Limit speed discrimination interval (start speed), H226: Limit speed discrimination interval (end speed)

The limit speed is calculated within the discrimination speed interval. Set with the rated speed 100%.

H	2	2	5	L	I	M	—	N		S	R	T	
H	2	2	6	L	I	M	—	N		E	N	T	

Setting: 0.1 to 100.0%



Within the calculation interval, the limit speed is calculated from the torque command that occurs and the instantaneous value of the acceleration data. When the speed reaches the limit completion speed, the average value of the calculated results is used as the final limit speed.

Example: When rated speed F04 = 1500 r/min, H225 = 75.0%, H226 = 93.7%, acceleration time F07 = 5 s, maximum speed F03 = 3000 r/min,

- Discrimination start speed = 1125.0 r/min (1500×0.75)
- Discrimination end speed = 1405.5 r/min (1500×0.937)
- Calculation interval t = (1405.5 - 1125)/3000 × 5 s = 0.935 s

* In this example, operation takes place according to the speed command value. If a torque restriction is triggered or the detected speed value does not accord with the speed command, the time t will be different.

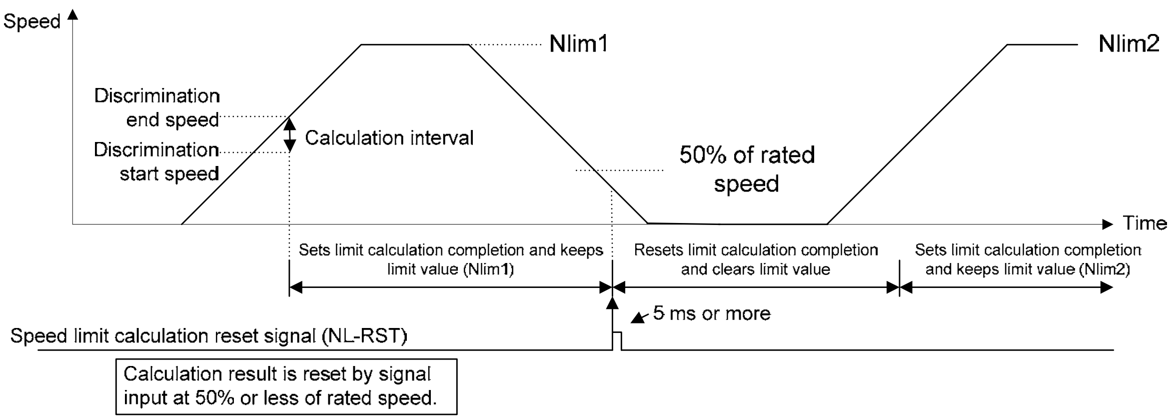
- When the discrimination start speed is greater than the discrimination end speed (H225 > H226), load compensation calculation is performed when the speed set for the discrimination end speed is reached.
- When the discrimination interval is short or the torque command value varies widely, deviations occur in the calculation results.
- When there are wide variations in the torque command value, adjust the speed control factor (ASR) to decrease the variations in the torque command value.

When a speed limit calculation reset signal (NL-RST) is assigned to the digital input signal and turned ON, the load compensation calculation result is cleared and the limit speed is recalculated the next time reacceleration occurs in the same direction.

Calculation result clear conditions

The speed command value has dropped to under 50% of the rated speed.

Input the speed limit calculation reset signal (NL-RST) 5 ms or more.



Each time the polarity of the speed command value changes (hoisting lowering), the limit speed is calculated when acceleration takes place, regardless of the speed limit calculation reset signal (NL-RST).

H227: Load compensation control definition 3

H	2	2	7	L	O	A	D		C	O	N	3	

Setting value 0: Separate limit speed calculation for hoisting and lowering

1: A limit speed is calculated when hoisting. When lowering, the speed is limited by the result of the previous hoisting calculation.

However, when one of the following conditions obtains, limit speed calculation also takes place when lowering.

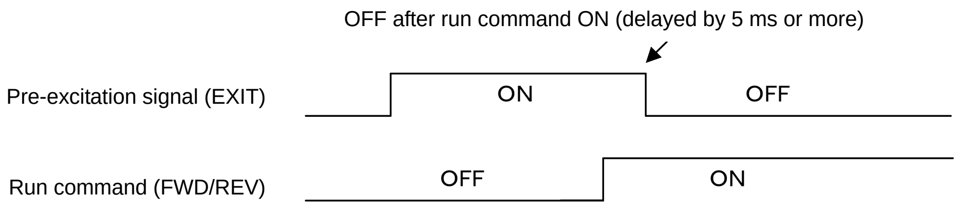
1) The first operation after powering on is lowering.
2) A limit speed was not calculated for the previous hoisting operation.
   ⇒ The previous hoisting took place at a speed under the H226 limit speed discrimination interval (end speed)
3) Lowering was performed after pre-excitation was stopped (Note 1)

2: A limit speed is calculated when hoisting. When lowering, the speed is limited by the result of the previous hoisting calculation.

However, when one of the following condition obtains, the lowering speed is limited by the rated speed.

1) The initial operation after powering on is lowering.
2) A limit speed was not calculated for the previous hoisting operation.
   ⇒ The previous hoisting took place at a speed under the H226 limit speed discrimination interval (end speed)
3) Lowering was performed after pre-excitation was stopped (Note 1)

Note 1: If the pre-excitation signal is turned OFF first when switching from pre-excitation operation to speed control operation (FWD/REV ON), condition (3) will obtain and the previous hoisting limit speed will be cleared. Use a sequence in which the pre-excitation signal is turned off after the run command is input, as shown below.



H228	Load Inertia Magnification Setting

Change the multiplier setting of "load inertia" of H51, H52, H127, H202, H205, H208, H211

H	2	2	8	I	N	R	T		1	0			

Setting: 0 x 1 (0.001 to 50.000 kg•m^2)
1 x10 (0.01 to 500.00 kg• m^2)
2 x100 (0.1 to 5,000.0 kg• m^2)

H322, H325	Notch Filters 1 and 2 (Resonance frequency)
H323, H326	**Notch Filters 1 and 2 (Attenuation level)**
H324, H327	**Notch Filters 1 and 2 (Frequency range)**

Set this to dampen resonance in the mechanical system. A maximum of 2 resonance points can be dampened.

H	3	2	2	N	F	1	–	F	R	Q			
H	3	2	5	N	F	2	–	F	R	Q			

Setting: 10 to 2,000 Hz

The notch filter frequency is limited internally based on the setting of F26 "carrier frequency". Carrier frequencies and corresponding notch filter setting ranges are shown below. If the setting exceeds the upper limit, the upper limit is applied.

2 kHz, 5 kHz, 10 kHz, 11 kHz : 10 to 2000 Hz
4 kHz, 7 kHz, 8 kHz, 9 kHz, 15 kHz : 10 to 1500 Hz
3 kHz, 6 kHz, 12 kHz, 13 kHz, 14 kHz : 10 to 1000 Hz

H	3	2	3	N	F	1	–	A	T	T			
H	3	2	6	N	F	2	–	A	T	T			

Setting: 0 to 40 dB

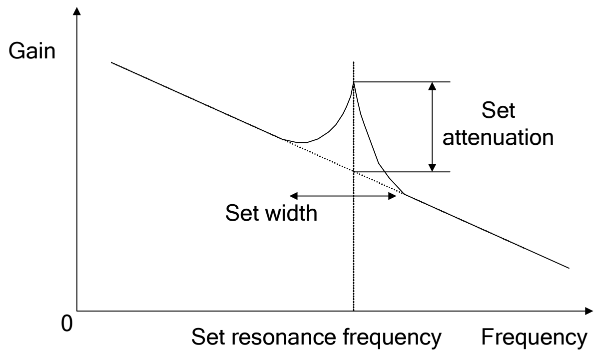
H	3	2	4	N	F	1	–	W	I	D			
H	3	2	7	N	F	2	–	W	I	D			

Setting: 0 to 3

Setting method

Set a notch filter frequency, attenuation, and width appropriate for the resonance point in the machine.

Four increments are available for the width setting. A larger setting allows a wider frequency band to be covered. Normally a setting of "2" is recommended.



Machine resonance point

⚠CAUTION

- Setting an attenuation that is too large may cause unstable control. Do not set higher than necessary.

4.3.6 A codes (Alternative Motor Functions)

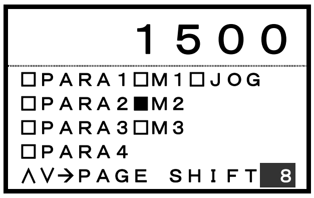
A codes are motor parameters that become available when motor M2 or M3 is selected. These codes are used when a single FRENIC-VG drives two or three motors while switching them.

Any of M1 to M3 can select vector control or V/f control.

A01 to A61	M2 Drive Control
A101 to A161	M3 Drive Control

To select M2 or M3, use F79 (Motor Selection) and terminal input signals ***M-CH2*** and ***M-CH3***.

See the individual descriptions and check in Menu #4 "I/O checking" that M2 or M3 is selected. ■ indicates "selected". Check that ■M2 or ■M3 is indicated.



A01 to A61 for M2 are functionally equivalent to A101 to A161 for M3 except that codes differ by one hundred. Those codes are functionally equivalent to P codes (M1).

There are no P02-equivalent code for M2 and M3, so M2 and M3 motor parameters cannot be set automatically. For FRENIC-VG dedicated motors or VG series conventional motors, this manual provides motor parameters. Set them manually. For other motors, perform auto-tuning.

Auto-tuning initiated by H01 applies to the currently selected motor.

Function codes to be configured for IM under vector control

The table below lists the function codes to be configured for IM when vector control is selected. Configure them sequentially from the top of the table. (For details, refer to P02 (M1 Motor Selection).

Function codes			
M1	M2	M3	Name
P01	A01	A101	Drive control
P02	A02	A102	Motor selection
F04	A03	A103	Rated speed
F05	A04	A104	Rated voltage
P03	A05	A105	Rated capacity
P04	A06	A106	Rated current
P05	A07	A107	No. of poles
P06	A08	A108	%R1
P07	A09	A109	%X
P08	A10	A110	Magnetic flux weakening current
P09	A11	A111	Torque current
P10, P11	A12, A13	A112, 113	Slip frequency of motor for driving and braking
P12-P14	A14-A16	A114-A116	Iron loss factors 1-3
P15-P19	A17-A21	A117-A121	Magnetic saturation factors 1-5
P20	A22	A122	Secondary time constant
P21	A23	A123	Induced voltage factor
P22-P24	A24-A26	A124-A126	R2 correction factors 1-3
P25	A27	A127	Exciting current correction factor
P26, P27	A28, A29	A128, A129	ACR P-gain, Integral constant
P28	A30	A130	Pulse resolution
P30	A31	A131	Thermistor selection
F10	A32	A132	Electronic thermal overload protection (Select motor characteristics)
H01	H01	H01	Auto-tuning

Note 1: FRENIC-VG dedicated motors are the same as the VG7 or VG5 standard motors in shape and electrical constants (motor parameters).

Function codes to be configured for PMSM under vector control

The table below lists the function codes to be configured for PMSM when vector control is selected. Configure them sequentially from the top of the table.

Function codes			
M1	M2	M3	Name
P01	A01	A101	Drive control
P03	A02	A102	Rated capacity
P04	A03	A103	Rated current
F05	A04	A104	Rated voltage
F04	A05	A105	Rated speed
F03	A06	A106	Maximum speed
P05	A07	A107	No. of poles
P06	A08	A108	%R1
P07	A09	A109	%X
P08	A10	A110	d-axis current
P09	A11	A111	q-axis current
P21	A23	A123	Induced voltage factor
P26, P27	A28, A29	A128, A129	ACR P-gain, Integral constant
P28	A30	A130	Pulse resolution
P30	A31	A131	Thermistor selection
F10	A32	A132	Electronic thermal overload protection (Select motor characteristics)
P33	A53	A153	Maximum voltage Limit
o09	A59	A159	Absolute signal input definition
o10	A60	A160	Magnetic pole position offset
o11	A61	A161	Salient pole rate (%Xq/%Xd)
P42	A62	A162	q-axis induction magnetic saturation coefficient
P43	A63	A163	Magnetic flux limiting value
P44	A64	A164	Overcurrent protection level
P45-P51	A65-A71	A165-A171	Torque correction gain 1 to 7

Function codes to be configured for IM under V/f control

The table below lists the function codes to be configured for IM when V/f control is selected. Configure them sequentially from the top of the table.

			Function codes
M1	M2	M3	Name
P01	A01	A101	Drive control
P03	A02	A102	Rated capacity
P04	A03	A103	Rated current
F03	A04	A104	Maximum speed
F04	A05	A105	Rated speed
F05	A06	A106	Rated voltage
P05	A07	A107	No. of poles
P06	A08	A108	%R1
P07	A09	A109	%X
P08	A10	A110	Magnetic flux weakening current
P33	A53	A153	Maximum voltage Limit
P34	A54	A154	Slip compensation
P35	A55	A155	Torque boost
P30	A31	A131	Thermistor selection
F10	A32	A132	Electronic thermal overload protection (Select motor characteristics)
H01			Auto-tuning
H02			Full save function

4.3.7 o codes (Option Functions)

OPC-VG1-DIA, DIB

Use this option to specify the digital speed command, torque limiter value, torque command, and torque current command. When you install two option cards, you use hardware switches to distinguish them as DIA and DIB. See the control option section for more details.

o01	DIA Function Selection
o02	DIB Function Selection

Select the data format for the digital speed command, torque limiter value, torque command, and torque current command.

o	0	1	D	I	A		F	U	N	C		
o	0	2	D	I	B		F	U	N	C		

1) See the function description of the function code F01 "Speed setting N1" to use for the speed command.
2) See the function description of the function code F42 "Torque limiter value selection" to use for the torque limiter value.
3) See the function description of the function code H41 "Torque command selection" to use for the torque command.
4) See the function description of the function code H42 "Torque current command selection" to use for the torque current command.

Set value: 0 or 1
0: Binary
1: BCD

o03	DIA BCD Input Speed Setting
o04	DIB BCD Input Speed Setting

Specify BCD data for setting the maximum speed of DIA and DIB inputs. Use when you want to enter "machine operation speed" directly to specify input data.

o	0	3	B	C	D		C	M	N	D		A
o	0	4	B	C	D		C	M	N	D		B

Data setting range: 99 to 7,999

OPC-VG1-PG/PGo

Use this option for the following applications.

1) Place the switch in the PD position to use position control (orientation) through pulse calculation.
2) Set the switch to LD to detect the line speed.
3) Place the switch in the PR position to use the pulse train synchronous operation.
4) Place the switch in the SD position to use for speed detection.

⚠CAUTION

The model of the PG interface option varies according to the difference in the electric specification.

OPC-VG1-PG: 5V line driver
OPC-VG1-PGo: Open collector, voltage output

o05	PG (PD) Option Setting (Feedback pulse)

Switches the source of the position detection signal between the integrated PG and the optional PG interface card. Use for synchronous operation and the position control for orientation.

o	0	5	P	L	S		F	E	D		S	L

Data setting range: 0 (Integrated PG (15, 12V complementary output))
(PG interface card OPC-VG1-PMPG for PMSM drive)

1 (PG interface card OPC-VG1-PG (PD) (5V line driver output))

2 (High-resolution serial PG interface card OPC-VG1-SPGT) (Available soon)

When function code P01, A01, A101 (M1/M2/M3 Drive Control) = 3 (Vector control of PMSM) and the PG interface card OPC-VG1-PMPG for PMSM drive is mounted, setting o05 at "0" enables signals to the OPC-VG1-PMPG.

o06	PG (PD) Option Setting (Digital line speed detection definition, PG pulses)
o07	PG (PD) Option Setting (Digital line speed detection definition, Detection pulse correction 1)
o08	PG (PD) Option Setting (Digital line speed detection definition, Detection pulse correction 2)

Specify to use the PG (LD) option for line speed control. A PG disconnection activates a protective function (PG alarm).

The pulse correction is for speed detection. Speed=(Correction 1/Correction 2)×Input pulse

o	0	6	L	S	–	P	G		D	E	F	
o	0	7	L	S	–	P	L	S		C	P	1
o	0	8	L	S	–	P	L	S		C	P	2

Data setting range: o06 = 100 to 60,000 (P/R)
o07, o08 = 1 to 9,999

Chap. 4 CONTROL AND OPERATION

o09	**M1 Absolute Signal Input Definition**
A59	**M2 ABS Signal Input Definition**
A159	**M3 ABS Signal Input Definition**

These function codes are exclusive to PMSM. They select the interface system of encoder ABS signals.

	o	0	9	M	1	–	A	B	S		D	E	F
	A	5	9	M	2	–	A	B	S		D	E	F
A	1	5	9	M	3	–	A	B	S		D	E	F

Data setting range: 0 (1 bit (terminal: F0). Z-phase interface (Available soon))
1 (3 bits (terminals: F0, F1 and F2). U-/V-/W-phase interface)
2 (4 bits (terminals: F0, F1, F2 and F3). Gray code interface)
3 to 5 (Not used.)
6 (SPGT 17-bit serial interface)
7 to 16 (Not used.)

o10	**M1 Magnetic Pole Position Offset**
A60	**M2 Magnetic Pole Position Offset**
A160	**M3 Magnetic Pole Position Offset**

These function codes are exclusive to PMSM. They define an offset value relative to the encoder reference position and actual motor magnetic pole position.

	o	1	0	M	1	–	S	M		O	F	S	
	A	6	0	M	2	–	S	M		O	F	S	
A	1	6	0	M	3	–	S	M		O	F	S	

Data setting range: 0.0 to 359.9 CCW

Enter the offset value printed on the corresponding motor test report or adjust the magnetic pole position according to the adjustment procedure.

o11	**M1 Salient Pole Rate (%Xq/%Xd)**
A61	**M2 Salient Pole Ratio (%Xq/%Xd)**
A161	**M3 Salient Pole Ratio (%Xq/%Xd)**

These function codes are exclusive to PMSM. They specify the difference in reactance due to the difference in magnetic resistance on the q axis and the d axis in terms of the ratio of the q axis value/d axis value.

	o	1	1	M	1	–	X	q	/	X	d		
	A	6	1	M	2	–	X	q	/	X	d		
A	1	6	1	M	3	–	X	q	/	X	d		

Data setting range: 1.000 to 3.000

To drive an SPM motor, set 1,000.

It is necessary to calculate the salient pole ratio from the design value of each motor. When the design value is unknown, contact your Fuji Electric representative.

o12	PG (PR) Pulse-train Option Setting (Command pulse)

Select a pulse output source from the PG (PR) option and internal speed data.

o	1	2	P	L	S		R	E	F		S	L

Data setting range: 0 (PG (PR) option)
1 (Internal speed command)

For details, see the control block diagram given in Section 4.1.5.

o13	PG (PR) Pulse-train Option Setting (Pulse train input form)

Select the input form of the signal supplied to the PG (PR) option.

o	1	3	P	L	S		S	T	A	T	E	

Data setting range: 0 (90° phase difference between phases A and B)
1 (Phase A: Command pulse, Phase B: Command code (sign))
2 (Phase A: Forward pulse, Phase B: Reverse pulse)

This pulse configuration choice takes effect only against the pulse train command (PG (PR)).

Line speed detection (PG (LD)) with 90° phase difference only can be received.

o14	PG (PR) Pulse-train Option Setting (Command pulse correction 1)
o15	PG (PR) Pulse-train Option Setting (Command pulse correction 2)

Set when you install the PG (PR) option card to conduct synchronized operation. You can change the position command data entered into the pulse train card to change the speed ratio between the master motor and the slave motor.

o	1	4	P	L	S		C	O	R	R		1
o	1	5	P	L	S		C	O	R	R		2

Data setting range: 1 to 9,999

Internal data = Input pulse× (Pulse correction 1/Pulse correction 2)

o16	PG (PR) Pulse-train Option Setting (APR gain 1)

You can specify a data to improve the position control response in pulse train operation. You can also reduce the steady-state deviation in the steady-state operation. Since too large setting may present a motor hunting, increase gradually from a small value to adjust.

o	1	6	A	P	R	–	P	–	G	A	I	N

Data setting range: 0.1 to 999.9

o17 PG (PR) Pulse-train Option Setting (Feedforward gain 1)

The setting can reduce the steady-state deviation. The setting of 1.0 provides the smallest deviation. You do not have to change from 0.0 in general.

o	1	7	F	/	F		G	A	I	N		

Data setting range: 0.0 to 1.5

o18 PG (PR) Pulse-train Option Setting (Overdeviation width)

The difference (deviation) between the internal position command and actual motor revolutions exceeds 10 folds of this setting, an "excessive deviation alarm (dO)" is caused, letting the motor coast to stop.

o	1	8	D	E	V		O	V	E	R		W

Data setting range: 0 to 65,535

o19 PG (PR) Pulse-train Option Setting (Zero deviation width)

When the current position of the motor comes into this range of a reference position, the inverter provides the "zero deviation" signal. You can use the zero deviation signal to detect that the motor locates almost at the target position. The inverter provides the zero deviation signal on the DO to which you can assign a function.

o	1	9	D	E	V		Z	E	R	O		W

Data setting range: 0 to 1,000

o20 APR Gain 2 (Available soon)

o21 F/F Gain 2 (Available soon)

o20 and o21 are functionally equivalent to o16 (APR Gain 1) and o17 (F/F Gain 1), respectively.

o	2	0	A	P	R		G	A	I	N	2	

Data setting range: 0.1 to 999.9

o	2	1	F	/	F		G	A	I	N	2	

Data setting range: 0.0 to 1.5

o22 Position Control Gain Switching (Available soon)

o22 specifies a factor that switches between gain 1 (o16, o17) and gain 2 (o20, o21) of the APR and F/F in a position control system.

Switching the gain can reduce noise or vibration at the time of a stop under position control.

o22 GAIN SEL

Data setting range: 0 (Disable)
1 (Positional deviation (x 10))
2 (Detected speed (10,000/maximum speed))
3 (Speed command (10,000/maximum speed))

When o22 = 0 (Disable), o16 (APR Gain 1) and o17 (F/F Gain 1) take effect.

o23 Position Control Gain Switching Level (Available soon)

o24 Position Control Gain Switching Time (Available soon)

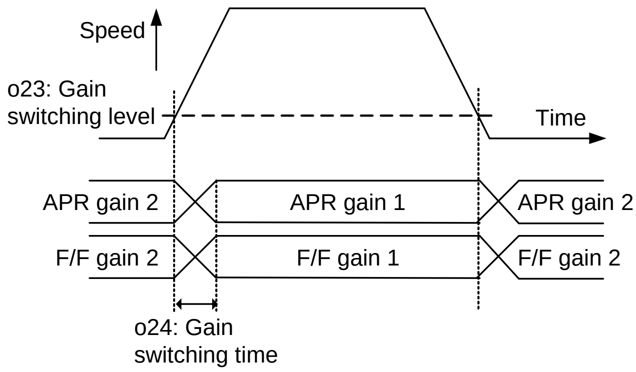
If the detected value of a factor selected by o22 drops below the switching level specified by o23, the APR and F/F gains are switched from 1 to 2 in accordance with the switching time specified by o24. The hysteresis width is 1% of the maximum speed (Setting: 10,000).

o23 SEL LVL

Data setting range: 0 to 10,000

In gain switching, the function codes are selected as follows.

	APR gain	F/F gain
Switching level or above	o16	o17
Switching level or below	o20	o21



o29 Link Option Configuration (Continue-to-run signal processing in case of alarm) (Available soon)

o29 specifies ***LK-D*** signal processing to be followed if ***LK-D*** (Continue to run at the time of communications link error) is assigned to an X terminal and a communications link error (heavy alarm or light alarm) occurs.

When o29 = 1 or 2 and the communications controller power supply (that was shut down with ***LK-D*** being ON) is recovered after ***LK-D*** is turned OFF, the inverter prevents a communications link error (Er-4) from occurring.

If no ***LK-D*** is assigned to an X terminal, the processing for ***LK-D*** being OFF applies.

o	2	9	L	K	–	D		O	P	E		

Data setting range: 0 (Disable)

1 (Communications error processing 1)
For errors that occurred with ***LK-D*** ON: Continue to run for both heavy and light alarms.
For errors that occurred with ***LK-D*** OFF: Follow o30 for light alarm, Immediately trip with Er-4 for heavy alarm.

2 (Communications error processing 2)
For errors that occurred with ***LK-D*** ON: Continue to run for both heavy and light alarms.
For errors that occurred with ***LK-D*** OFF: Follow o30 for both heavy and light alarms.

o30 Link Option Configuration (Communications error processing)

o30 specifies error processing to be performed if a communications link error occurs.

o	3	0	M	O	D	E		O	N		E	R

Data setting range: 0 to 3

0 (Immediately trip with Er-4.)
1 (Continue to run for the time specified by o31 and then trip with Er-4.)
2 (If a communications error has persisted for the time specified by o31, trip with Er-4.)
3 (Continue to run even if a communications error occurs. Removing the error factor automatically restores the run command transferred via the communication link.)

o31 Link Option Configuration (Timer)

If a communications link error occurs and persists during the period specified by o31, the inverter causes an alarm.

o	3	1	T	I	M	E	R		T	L		

Data setting range: 0.01 to 20.00 (s)

o32	Link Option Configuration (Link format selection)

o32 specifies the link format to be used by a link option.

o	3	2	F	O	R	M	A	T		S	E	L

Data setting range: 0 to 4
0 (Link format 1)
1 (Link format 2)
2 (Link format 3)
3 (Link format 4)
4 (Link format 5)

<u>OPC-VG1-TBSI</u>

Using this option can connect two or more inverters via the high-speed serial communications link, enabling multiwinding motors to be driven.

o33	Multiplex System (Control mode)

o33 selects whether or not to use a high-speed serial communications terminal block OPC-VG1-TBS1 as a component of the multiwinding system or multiplex system

Refer to ***MT-CCL*** (Cancel multiplex system) in the description of E01 to E13 (Terminal X Function).

o	3	3	M	W	S		A	C	T	I	V	E

Data setting range: 0 (Disable (single motor operation))
1 (Multiwinding system
2 (Multiplex system 1)
3 (Multiplex system 2)
4 (Reserved 1)
5 (Reserved 2)

o34	Multiplex System (No. of slave stations)

Specifies the number of slave stations for the multiplex system.

o	3	4	M	W	S		S	L	A	V	E	S

Data setting range: 1 to 5

o50	Multiplex System (Station number assignment)

o50 assigns the station number of the multiplex system (High-speed serial communications terminal block OPC-VG1-TBS1).

o	5	0	M	W	S		S	T	–	N	O	

Data setting range: 0 (Master)
1 to 5 (Slave)

4.3.8 L codes (Lift Functions)

L01	Password Data 1
L02	Password Data 2

⚠CAUTION

Handle the password with care. If you set the password by mistake, you cannot refer to or change the function code. The person who is responsible for specifying the password must manage the password carefully.

You can specify an 8-digit password by combining L01 and L02. You can use the password to restrict the change and the reference to the function codes. When you specify a non-zero value to either L01 or L02, the restriction by password will become effective.

Password setting procedure

Change the current value to an arbitrary value by pressing the STOP and ∧ keys or STOP and ∨ keys simultaneously, and then press the FUNC/DATA key to establish it.

L	0	1	P	A	S	S	W	O	R	D	1	
L	0	2	P	A	S	S	W	O	R	D	2	

Setting range: 0 to 9,999

Setting password

When you set non-zero data to L01 or L02 and open the program menu, you will not view "1. Set data" and "2. Check data", but "3. Operation monitor" and the rest. See the figure right below.

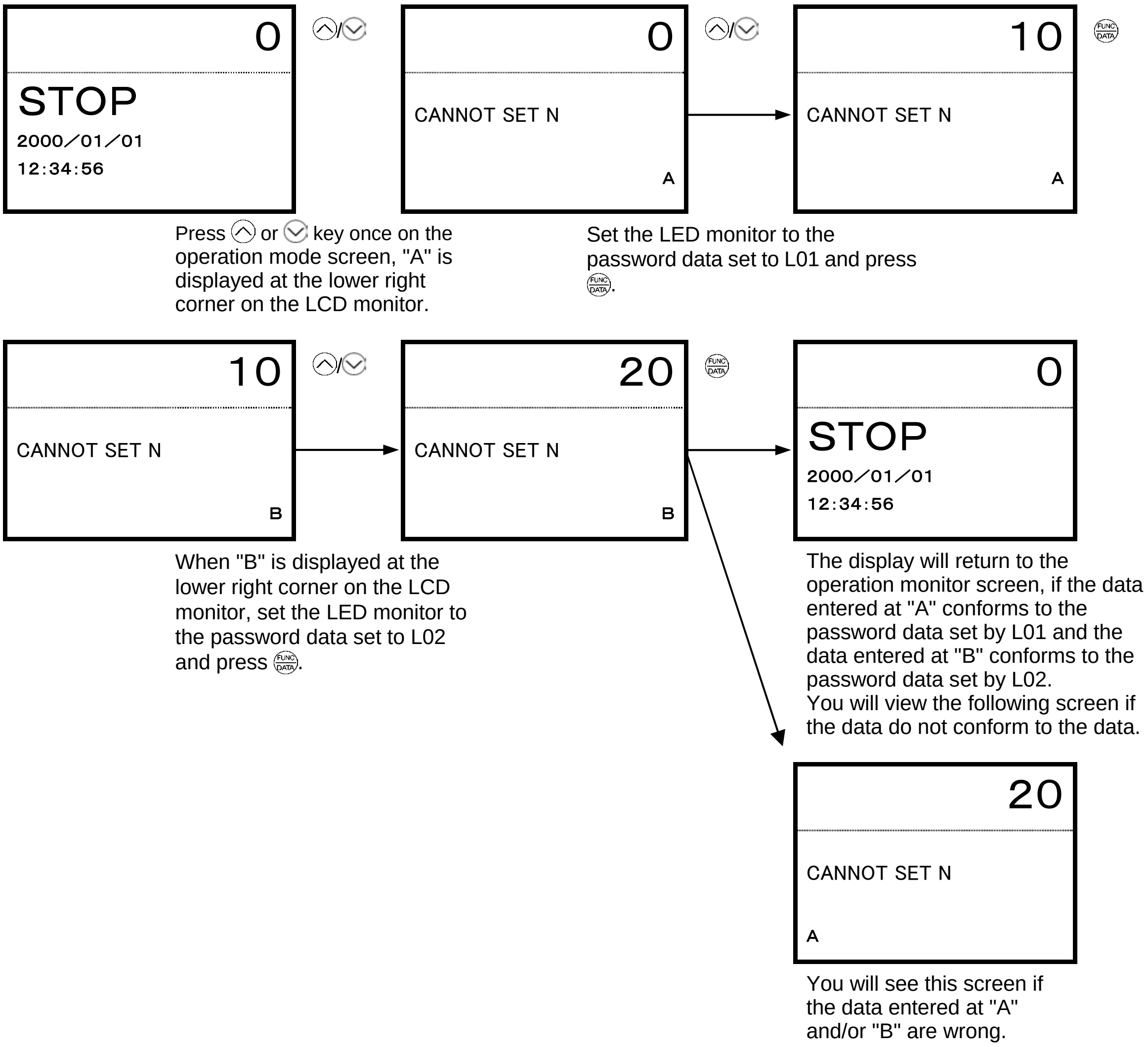
Usual program menu screen
(password is not specified or is disabled)

```
 0. LANGUAGE
 1. DATA SET
 2. DATA CHECK
 3. OPR MNTR
 4. I/O CHECK
 5. MAINTENANC
 6. LOAD FCTR
 7. ALM INF
 8. ALM CAUSE
 9. COMM INFO
10. DATA COPY
11. CHANGES
12. DATE/TIME
13. FORMER INV
14. LIMITED FC
```

Program menu screen
when password is enabled

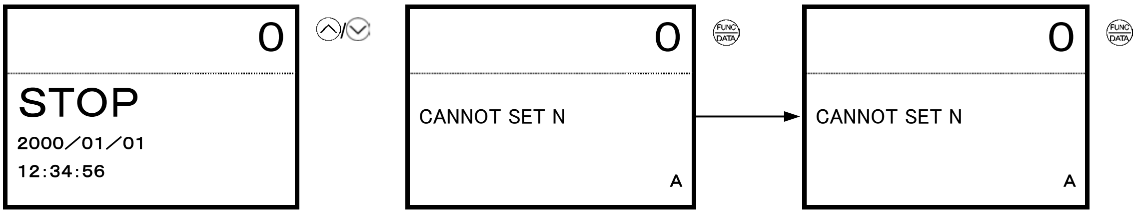
```
3. OPR MNTR
4. I/O CHECK
5. MAINTENANC
6. LOAD FCTR
7. ALM INF
8. ALM CAUSE
9. COMM INFO
```

To disable password (ex. password: L01=10, L02=20)



Note: Canceling password described above will become ineffective after you turn off the inverter

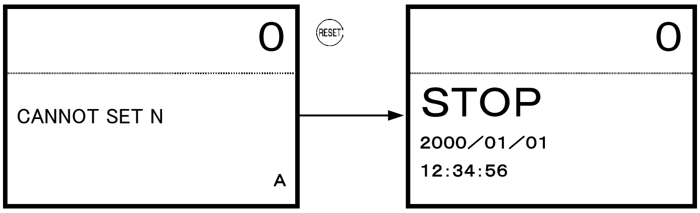
To enable password again after disabled



Press ∧ or ∨ key once on the operation mode screen, "A" is displayed at the lower right corner on the LCD monitor.

Check if "0" appears on the LED monitor press FUNC/DATA.

Check if "0" appears on the LED monitor press FUNC/DATA.



Press RESET when "A" is displayed again at the lower right corner on the LCD monitor.

L03 Lift Rated Speed

This function code is necessary to calculate the estimated travel distance on deceleration.

L03 LIFT–BASE

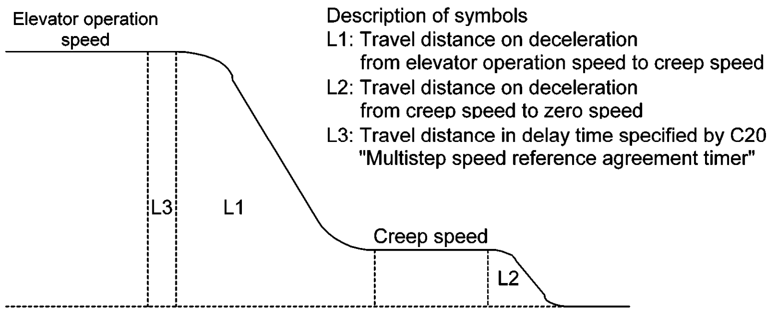
Setting range: 0.0 to 999.9 (m/min)

About the estimated travel distance on deceleration

You can display an estimated travel distance from the deceleration start point to the stopping point to check the consistency of the decelerating pattern.

The estimated travel distance on deceleration is an addition of travel distance on deceleration from the lift operation speed to the creep speed and that from the creep speed to the zero speed and does not include the travel distance by the constant operation at the creep speed (L1, L2, L3 in the graph below).

[Operation pattern]



The estimated travel distance on deceleration appears on the "Option monitor 3, 4" on the LED monitor of the KEYPAD panel.

This function is effective when L04 1 or 2.
Option monitor 3: Travel distance from the operation speed 1 after deceleration operation.
Option monitor 4: Travel distance from the operation speed 2 after deceleration operation.

Function data codes used for the estimated travel distance on deceleration.

Description	L04 = 1		L04 = 2	
	Code	Name	Code	Name
Lift rated speed	L03	Lift rated speed	←	←
Operation speed 1	C09	Multistep speed 5	←	←
Operation speed 2	C11	Multistep speed 7	C10	Multistep speed 6
Creep speed	C07	Multistep speed 3	←	←
Deceleration time from operation speed 1	F08	Deceleration time 1	←	←
Deceleration time from operation speed 2	C47	Deceleration time 2	←	←
Deceleration time from creep speed	C36	Deceleration time JOG	←	←
S-curve setting on decelerating from operation speed 1	L10	S-curve 6	←	←
S-curve setting on decelerating from operation speed 2	L12	S-curve 8	←	←
S-curve setting on reaching creep speed	L07	S-curve 3	←	←
S-curve setting on decelerating from creep speed	L08	S-curve 4	←	←
S-curve setting on reaching zero speed	L06	S-curve 2	←	←
Delay time by the speed reference agreement timer	C20	Multistep speed reference agreement timer	←	←

L04 Preset S-curve Pattern

Specifies the application of S-curve setting and the multistep speed.

L	0	4	S	–	C	U	R	V	E			

Setting range: 0 to 2

0: FRENIC-VG standard (VG7S-compatible) multistep speed and S-curve setting
15 steps of multistep speed (C05 to C19)
S-curve applied to four sections (F67 to F70)

1: Lift application compatible with VG3N and VG5N
7 steps of multistep speed (C05 to C11)
S-curve applied to eight sections (L05 to L12)

2: FRENIC-VG (VG7S-compatible) lift application original mode
7 steps of multistep speed (C05 to C11)
S-curve applied to ten sections (L05 to L14)

L05 to L14 S-curve Patterns 1 to 10

L	0	5	S	–	C	R	V		S	E	T	1

|

L	1	4	S	–	C	R	V		S	E	1	0

Setting range: 0 to 50 (%)

Introduction to an operation example in each mode

(A) FRENIC-VG standard (VG7S-compatible) multistep speed and S-curve setting

Since this operation mode uses the standard multistep speed and the S-curve, see the description of the individual function codes.

(B) Lift application compatible with VG3N and VG5N

Set ON/OFF to the terminal functions [SS1], [SS2], and [SS4] to switch the multistep speed as described in the following table.

Terminal function			Multistep speed setting		
SS4	SS2	SS1	Code	Name	Description
OFF	OFF	OFF	–	–	External speed setting
OFF	OFF	ON	C05	Multistep speed 1	Zero speed
OFF	ON	OFF	C06	Multistep speed 2	Inching speed
OFF	ON	ON	C07	Multistep speed 3	Creep speed
ON	OFF	OFF	C08	Multistep speed 4	Maintenance operation speed
ON	OFF	ON	C09	Multistep speed 5	Operation speed 7
ON	ON	OFF	C10	Multistep speed 6	Zero speed
ON	ON	ON	C11	Multistep speed 7	Operation speed 2

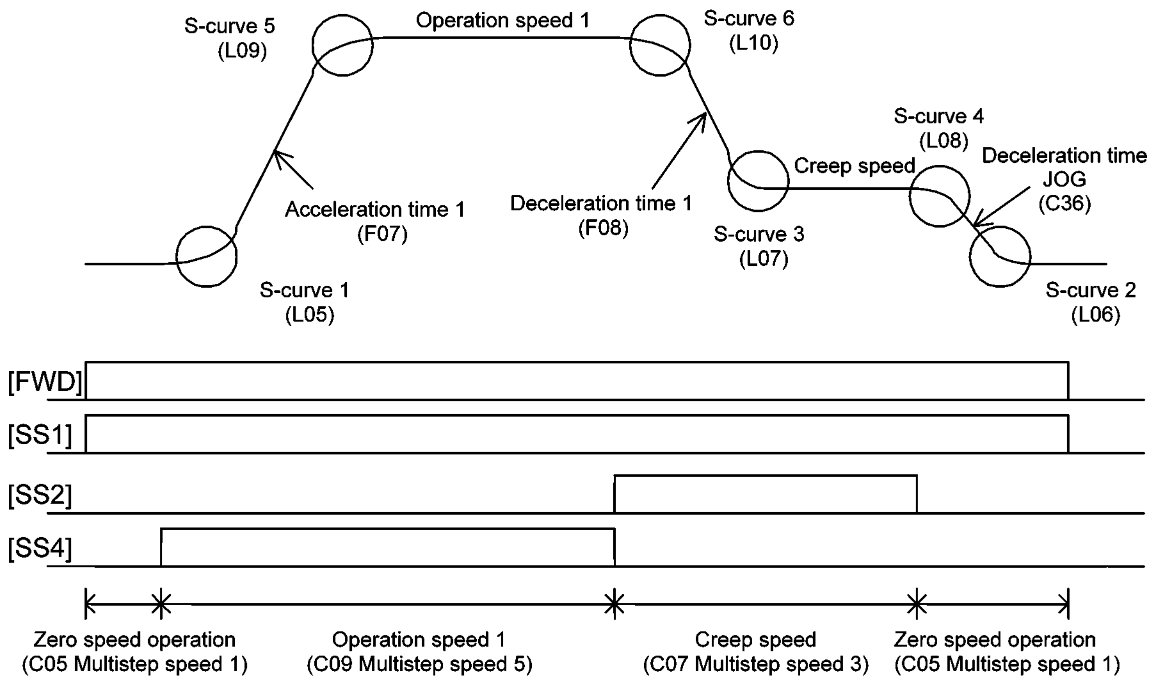
The following table shows how the acceleration/deceleration times are assigned to the multistep speed.

Speed			Acceleration		Deceleration	
Code	Name	Description	Code	Name	Code	Name
C06	Multistep speed 2	Inching speed	F07	Acceleration time 1	F08	Deceleration time 1
C07	Multistep speed 3	Creep speed	C35	Acceleration time JOG	C36	Deceleration time JOG
C08	Multistep speed 4	Maintenance operation speed	F07	Acceleration time 1	F08	Deceleration time 1
C09	Multistep speed 5	Operation speed 1	F07	Acceleration time 1	F08	Deceleration time 1
C11	Multistep speed 7	Operation speed 2	C46	Acceleration time 2	C47	Deceleration time 2

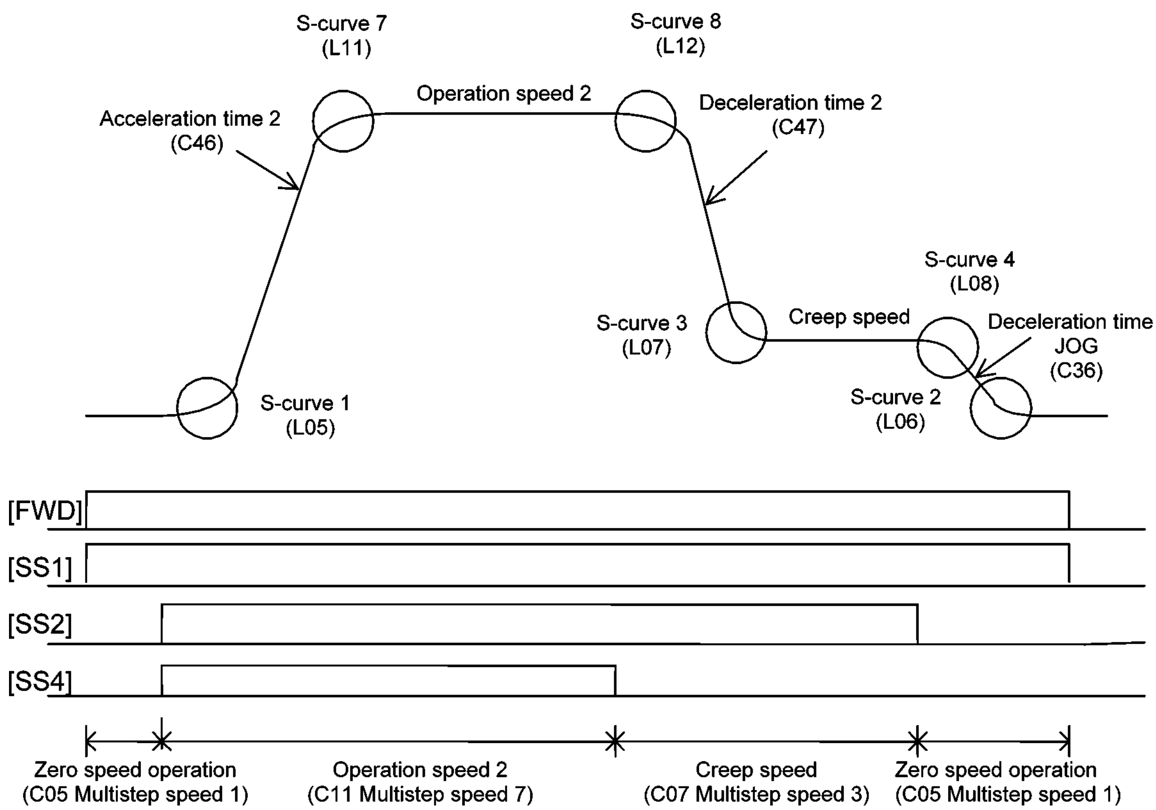
The following table shows how S-curve setting is applied to the multistep speed.

S curve setting		Application
Code	Name	
L05	S-curve 1	Acceleration start side from Zero speed
L06	S-curve 2	Deceleration end side to Zero speed
L07	S-curve 3	Acceleration end side to Creep speed
L08	S-curve 4	Deceleration start side from Creep speed
L09	S-curve 5	Acceleration end side to Operation speed 1, Maintenance operation speed, or Inching speed
L10	S-curve 6	Deceleration start side from Operation speed 1, Maintenance operation speed, or Inching speed
L11	S-curve 7	Acceleration end side to Operation speed 2
L12	S-curve 8	Deceleration start side from Operation speed 2

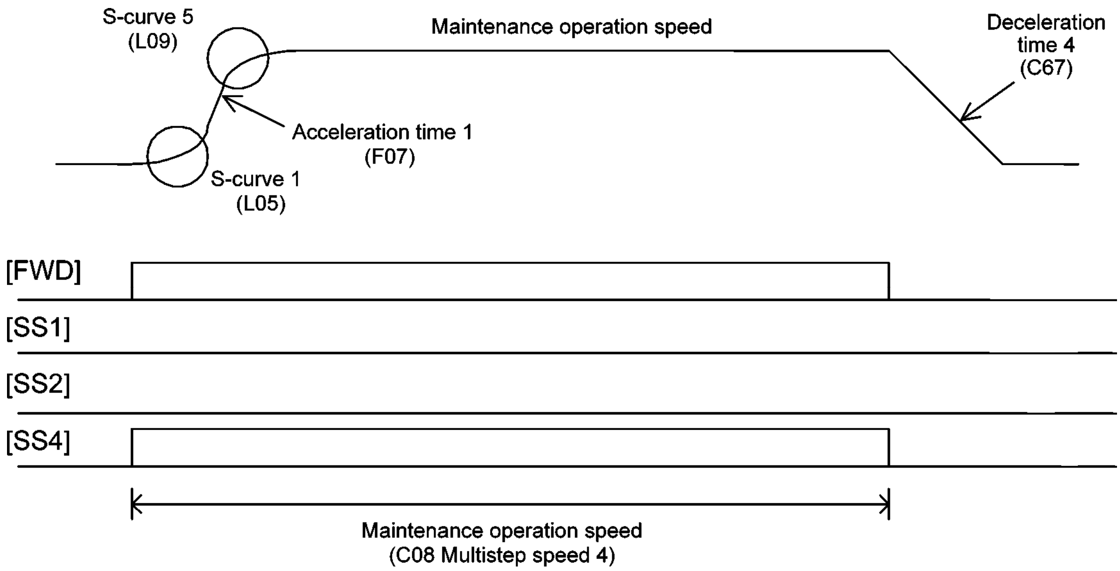
(1) Operation speed 1



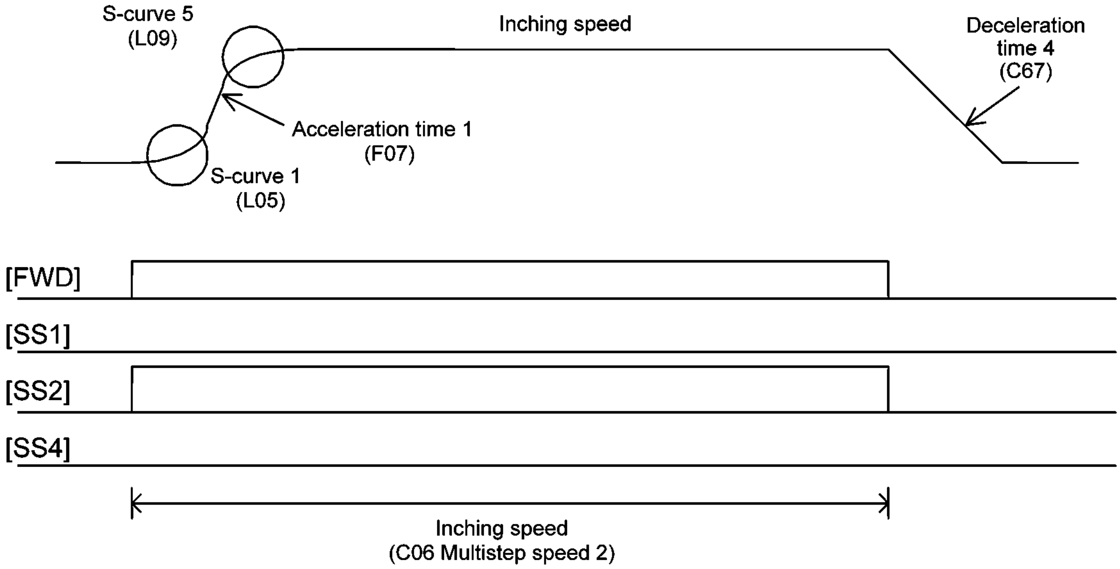
(2) Operation speed 2



(3) Maintenance operation speed



(4) Inching speed



(C) FRENIC-VG (VG7S-compatible) lift application original mode

Set ON/OFF to the terminal functions [SS1], [SS2], and [SS4] to switch the multistep speed as described in the following table.

Terminal function			Multistep speed setting		
SS4	SS2	SS1	Code	Name	Description
OFF	OFF	OFF	–	–	Zero speed
OFF	OFF	ON	C05	Multistep speed 1	Emergency lift speed
OFF	ON	OFF	C06	Multistep speed 2	Inching speed
OFF	ON	ON	C07	Multistep speed 3	Creep speed
ON	OFF	OFF	C08	Multistep speed 4	Maintenance operation speed
ON	OFF	ON	C09	Multistep speed 5	Operation speed 1
ON	ON	OFF	C10	Multistep speed 6	Operation speed 2
ON	ON	ON	C11	Multistep speed 7	Operation speed 3

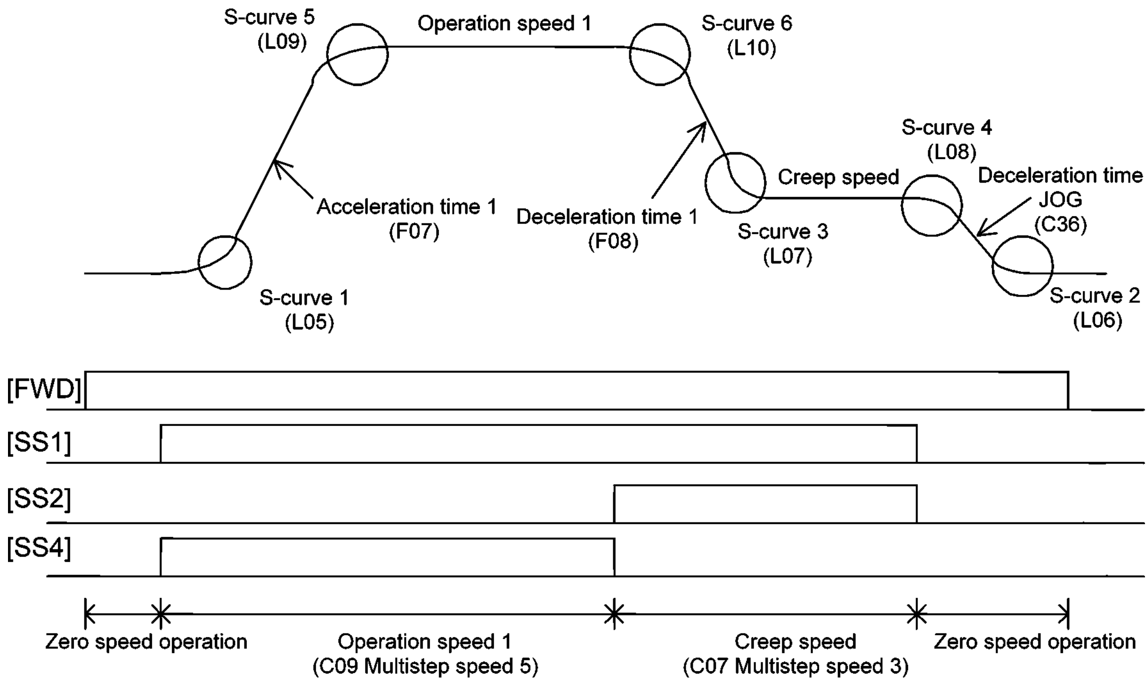
The following table shows how the acceleration/deceleration times are assigned to the multistep speed.

Speed			Acceleration		Deceleration	
Code	Name	Description	Code	Name	Code	Name
C05	Multistep speed 1	Emergency lift speed	C56	Acceleration time 3	C57	Deceleration time 3
C06	Multistep speed 2	Inching speed	F07	Acceleration time 1	F08	Deceleration time 1
C07	Multistep speed 3	Creep speed	C35	Acceleration time JOG	C36	Deceleration time JOG
C08	Multistep speed 4	Maintenance operation speed	F07	Acceleration time 1	F08	Deceleration time 1
C09	Multistep speed 5	Operation speed 1	F07	Acceleration time 1	F08	Deceleration time 1
C10	Multistep speed 6	Operation speed 2	C46	Acceleration time 2	C47	Deceleration time 2
C11	Multistep speed 7	Operation speed 3	C56	Acceleration time 3	C57	Deceleration time 3

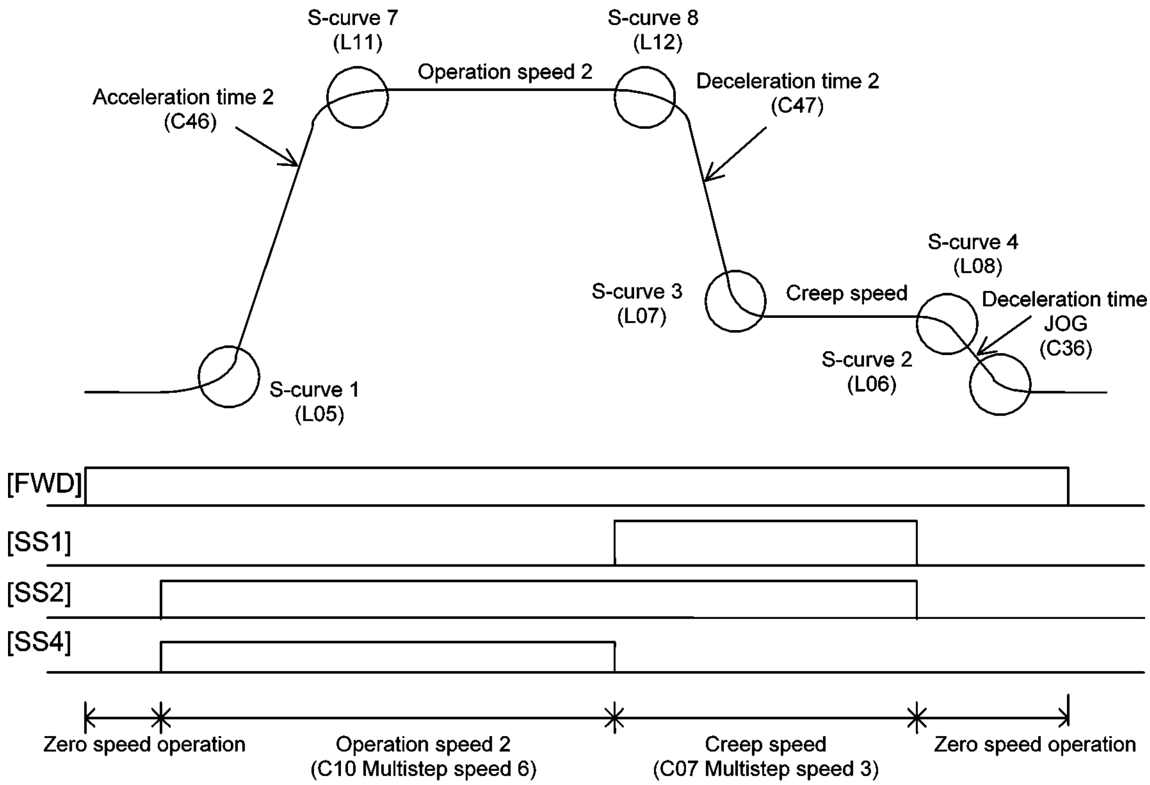
The following table shows how S-curve setting is applied to the multistep speed.

S curve setting		Application
Code	Name	
L05	S-curve 1	Acceleration start side from Zero speed
L06	S-curve 2	Deceleration end side to Zero speed
L07	S-curve 3	Acceleration end side to Creep speed
L08	S-curve 4	Deceleration start side from Creep speed
L09	S-curve 5	Acceleration end side to Operation speed 1, Maintenance operation speed, or Inching speed
L10	S-curve 6	Deceleration start side from Operation speed 1, Maintenance operation speed, or Inching speed
L11	S-curve 7	Acceleration end side to Operation speed 2
L12	S-curve 8	Deceleration start side from Operation speed 2
L13	S-curve 9	Acceleration end side to Operation speed 3 or Emergency lift speed
L14	S-curve 10	Deceleration start side from Operation speed 3 or Emergency lift speed

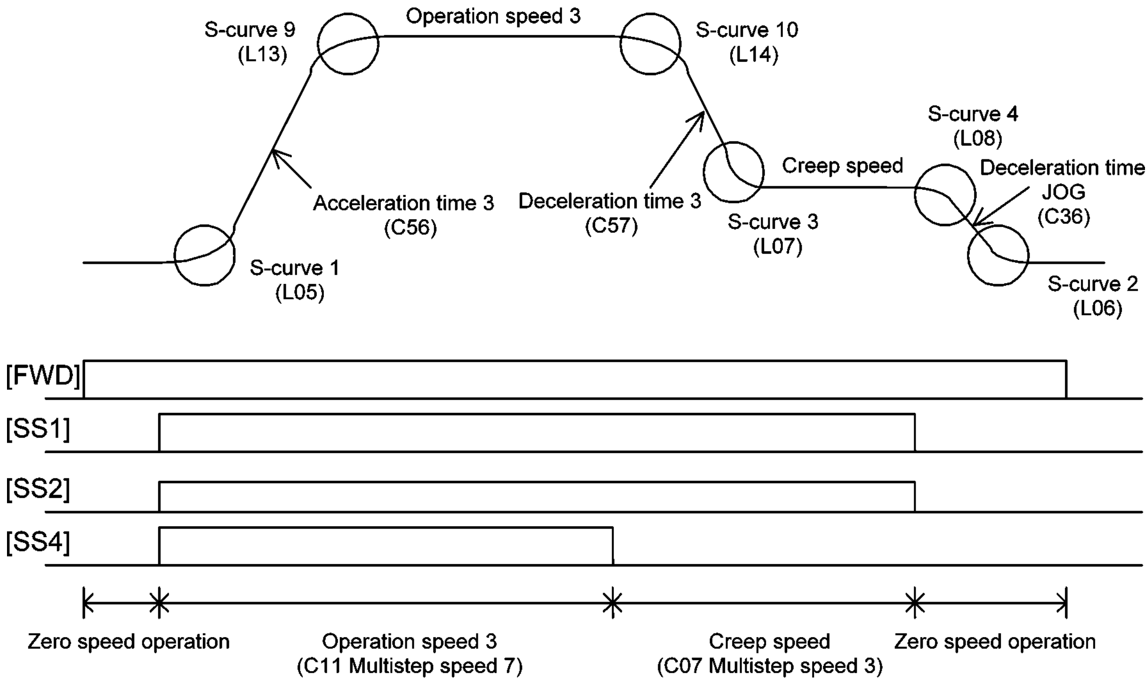
(1) Operation speed 1



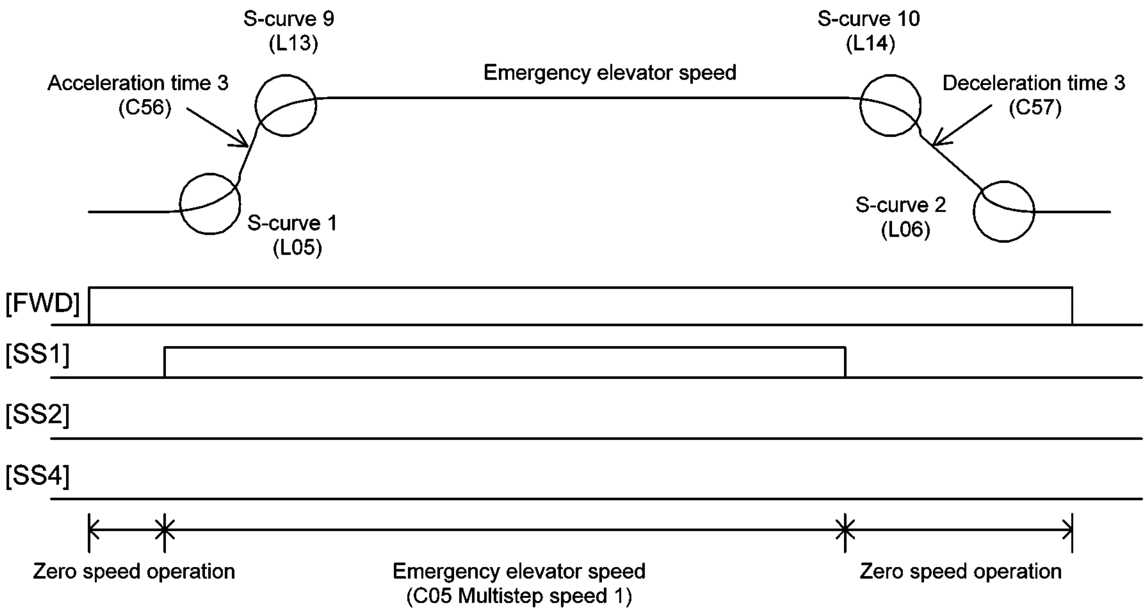
(2) Operation speed 2



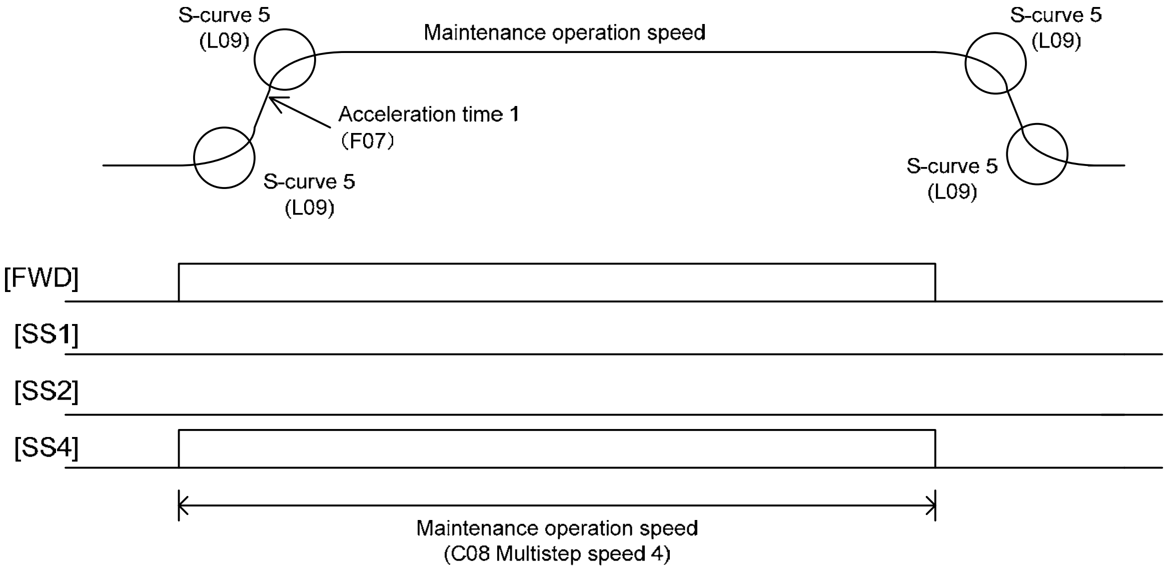
(3) Operation speed 3



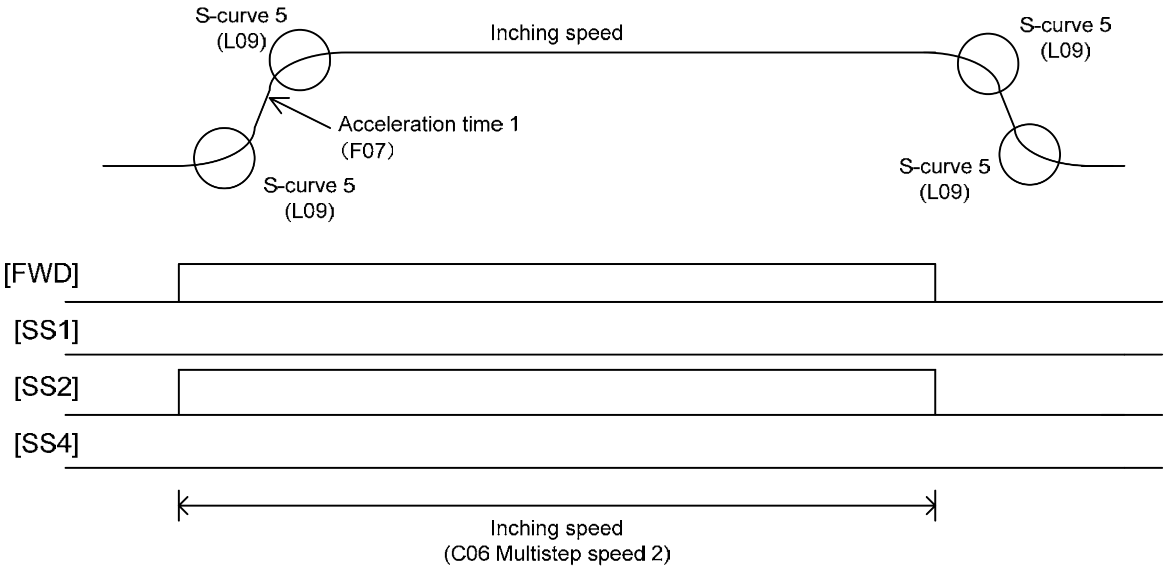
(4) Emergency lift speed



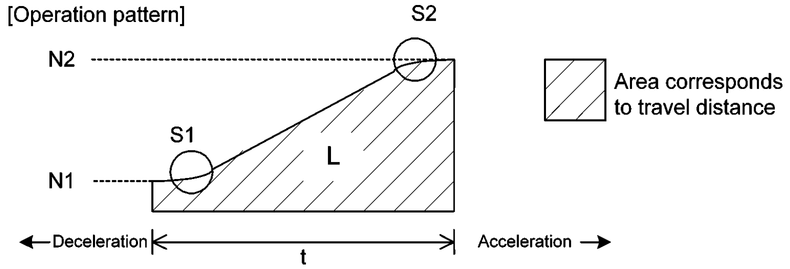
(5) Maintenance operation speed



(6) Inching speed



How to calculate acceleration/deceleration times and travel distance



[Description of symbols]

Nmax (r/min): Maximum motor speed
N1 (r/min): Speed reference before acceleration (after deceleration)
N2 (r/min): Speed reference after acceleration (before deceleration)
S1 (%): S-curve portion at the beginning of acceleration (at the end of deceleration)
S2 (%): S-curve portion at the end of acceleration (at the beginning of deceleration)
T (s): Acceleration (deceleration) reference time (time from zero to Nmax (Nmax to 0))
Vmax (m/min): Elevation speed at the maximum motor speed (Maximum elevation speed)
t (s): Acceleration (deceleration) time
L (m): Travel distance

1) When the S curve portion fits in a specified speed range ………… $\frac{N2-N1}{Nmax} \geq \frac{S1+S2}{100}$

Acceleration (deceleration) time

$$t = \left(\frac{N2-N1}{Nmax} + \frac{S1+S2}{100} \right) \times T$$ ………… [Equation 1]

Travel distance

$$L = \frac{T \times Vmax}{120} \times \left[\frac{S1^2 - S2^2}{30000} + \frac{S2}{50} \times \frac{N2-N1}{Nmax} + \left(\frac{N2-N1}{Nmax} \right)^2 \right] + \frac{t \times Vmax}{60} \times \frac{N1}{Nmax}$$

………… [Equation 2]

2) When the S curve portion exceeds a specified speed range ……… $\frac{N2-N1}{Nmax} < \frac{S1+S2}{100}$

Acceleration (deceleration) time

$$t = \frac{S1+S2}{50} \sqrt{\frac{N2-N1}{Nmax} \times \frac{100}{S1+S2}} \times T$$ ………… [Equation 3]

Travel distance

$$L = \left(\sqrt{\frac{N2-N1}{Nmax} \times \frac{100}{S1+S2}} \right)^3 \times \frac{T \times Vmax}{90} \times \frac{S1^2 + 2 \times S2^2 + 3 \times S1 \times S2}{10000} \times \frac{t \times Vmax}{60} \times \frac{N1}{Nmax}$$

………… [Equation 4]

L15	Reserved for Particular Manufacturers

This is a function code for adjustment by the manufacturer.

L15 MAKER

Setting range: 0 to 2

FRENIC-VG

5

Chapter 5
USING STANDARD RS-485

This chapter describes the use of standard RS-485 communications ports and provides an overview of the FRENIC-VG Loader.

Contents

5.1 Standard RS-485 Communications Ports

The FRENIC-VG has standard 1-channel RS-485 communications ports. The RS-485 communications ports are assigned in the control terminal block, enabling easy multi-drop connection.

RS-485 enables the following communications functions.

(1) Communication through Modbus RTU / Fuji general-purpose inverter protocol

The FRENIC-VG can be connected to a host (master) device such as a PC, PLC, or display/operation device. Through the interface, you can execute run/stop commands, monitor the running status, and change the function code data.

(2) Connection to FRENIC-VG Loader

The FRENIC-VG Loader can be installed on a PC to enable connection between FRENIC-VG and RS-485. Through the interface, you can use the various functions of the FRENIC-VG Loader such as editing the function code data, tracing the running data in real time, and tracing back the running data from the time when an alarm occurs. Multi-drop connection through RS-485 enables you to access up to 31 FRENIC-VG inverters with one FRENIC-VG Loader.

The FRENIC-VG Loader can also be connected to the built-in USB port of the FRENIC-VG. However, in this case it would be a one-to-one connection.

Note

- The RJ-45 connector for the keypad is intended solely for communication using the keypad, and cannot be used for RS-485 communication.
- Do not connect the inverter to a PC LAN port, Ethernet hub, or telephone line. Doing so may result in damage to the inverter or connected device.

The application can be used when a run command is executed and a break in communication is detected or an alarm occurs. If a communication error occurs during operation, it is possible to issue an er5 alarm (RS-485 alarm) after the application starts up. At this time, the inverter output cuts off and the motor idles.

5.1.1 RS-485 common specifications

<table>
<tr><th>Items</th><th colspan="5">Specifications</th></tr>
<tr><td>Protocol</td><td>SX protocol
(For FRENIC-VG Loader)</td><td colspan="3">Modbus RTU</td><td>Fuji general-purpose inverter protocol</td></tr>
<tr><td>Compliance</td><td>Loader dedicated protocol (Not disclosed)</td><td colspan="3">Modicon Modbus RTU-compliant</td><td>Fuji general-purpose inverter protocol</td></tr>
<tr><td>Protocol selection</td><td>Function code H40 = "1"</td><td colspan="3">Function code H40 = "2"</td><td>Function code H40 = "0"</td></tr>
<tr><td>Messaging system</td><td>Command message</td><td colspan="3">RTU (Remote Terminal Unit) mode only
ASCII mode not yet supported
Query/Broadcast message</td><td>Polling/Selecting/Broadcast</td></tr>
<tr><td rowspan="2">Electrical specifications, Transmission speed</td><td colspan="5">EIA RS-485</td></tr>
<tr><td colspan="5">2,400 4,800 9,600 19,200 38,400 bps</td></tr>
<tr><td>Synchronization</td><td colspan="5">Asynchronous start-stop system (UART)</td></tr>
<tr><td>Transmission mode</td><td colspan="5">Half-duplex</td></tr>
<tr><td>Transmission type</td><td colspan="5">Direct link to inverter 1:N (1 ≤ N ≤ 31)</td></tr>
<tr><td>Transmission character format</td><td colspan="4">HEX</td><td>ASCII 7 bits or 8 bits</td></tr>
<tr><td>Data length</td><td>8 bits (fixed) (Note 3)</td><td colspan="3">8 bits (fixed) (Note 2)</td><td>H35 data length setting
7 or 8 bits selectable</td></tr>
<tr><td>Stop bit</td><td>1 bit (fixed) (Note 3)</td><td>2 bits
(Note 2)</td><td colspan="2">1 bit (Note 2)</td><td>H37 stop bit setting
1 or 2 bits selectable</td></tr>
<tr><td>Parity</td><td>Even (fixed) (Note 3)</td><td>None</td><td>Even</td><td>Odd</td><td>H36 parity setting
None, Even, or Odd selectable</td></tr>
<tr><td>Error checking</td><td>Sum-check
(1 byte BCC)</td><td colspan="3">CRC-16
Generator polynomial;
$X^{16}+X^{15}+X^{2}+1$</td><td>Sum-check
(2 byte BCC)</td></tr>
<tr><td>Logical station selection</td><td>1-255; logical station</td><td colspan="3">0; Broadcast
1-247; logical station</td><td>99; Broadcast (Note 1)
1-31; logical station</td></tr>
<tr><td>Frame length</td><td>Variable length</td><td colspan="3">Variable length</td><td>Normal transmission:
16 bytes (fixed)
High-speed transmission:
8 or 12 bytes (fixed)</td></tr>
<tr><td>Max. transfer data (1 message)</td><td>Write:16 words
Read: 99 words</td><td colspan="3">Write:16 words
Read: 99 words</td><td>1 word</td></tr>
<tr><td>Disconnection detection time</td><td colspan="5">Communication disconnection time (TimeOut) can be set with function code H38. Operates only during operation through 485.</td></tr>
<tr><td>Cable length</td><td colspan="5">Non-isolated: Max. 10 m
Isolated: Max. 500 m
* For isolation, use a commercially-available 485/485 isolating device (repeater), and a 485/232C isolated converter.
* Inverters generate noise. Use a converter with superior noise resistance.
Recommended converters: KS-485PTI, KS-10PTI, USB-485I RJ45-T4P (System Sacom Sales Corporation)</td></tr>
</table>

(Note 1) For Broadcast, only communications command codes (S codes) are enabled. Other function codes are disabled.

(Note 2) With RTU protocol, H37 stop bit setting is not required because the stop bit is selected automatically in accordance with the parity selection status (H36 parity setting).

(Note 3) With SX protocol, it is not necessary to change the H35-H37 settings because the data length, stop bit, and parity are fixed.

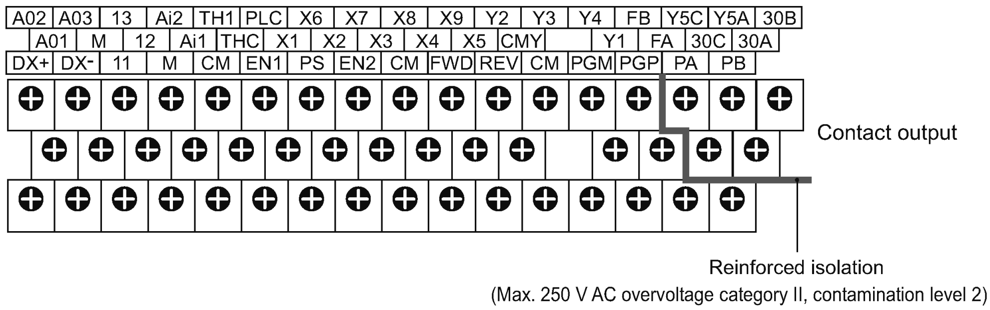
5.1.2 Terminal specifications for RS-485 communications

The FRENIC-VG has terminals for RS-485 communications on the control circuit terminal block.

Signal name	Function	Remarks
DX -	RS-485 data (-)	Built-in terminating resistor: 112Ω Open/close by SW4*
DX +	RS-485 data (+)	

*For details about SW4, refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches."

As there is no earth terminal for the shield, the shield wire must be earthed on the host device side.



5.1.3 Connection method

(1) Multi-drop connection using the RS-485 communications port

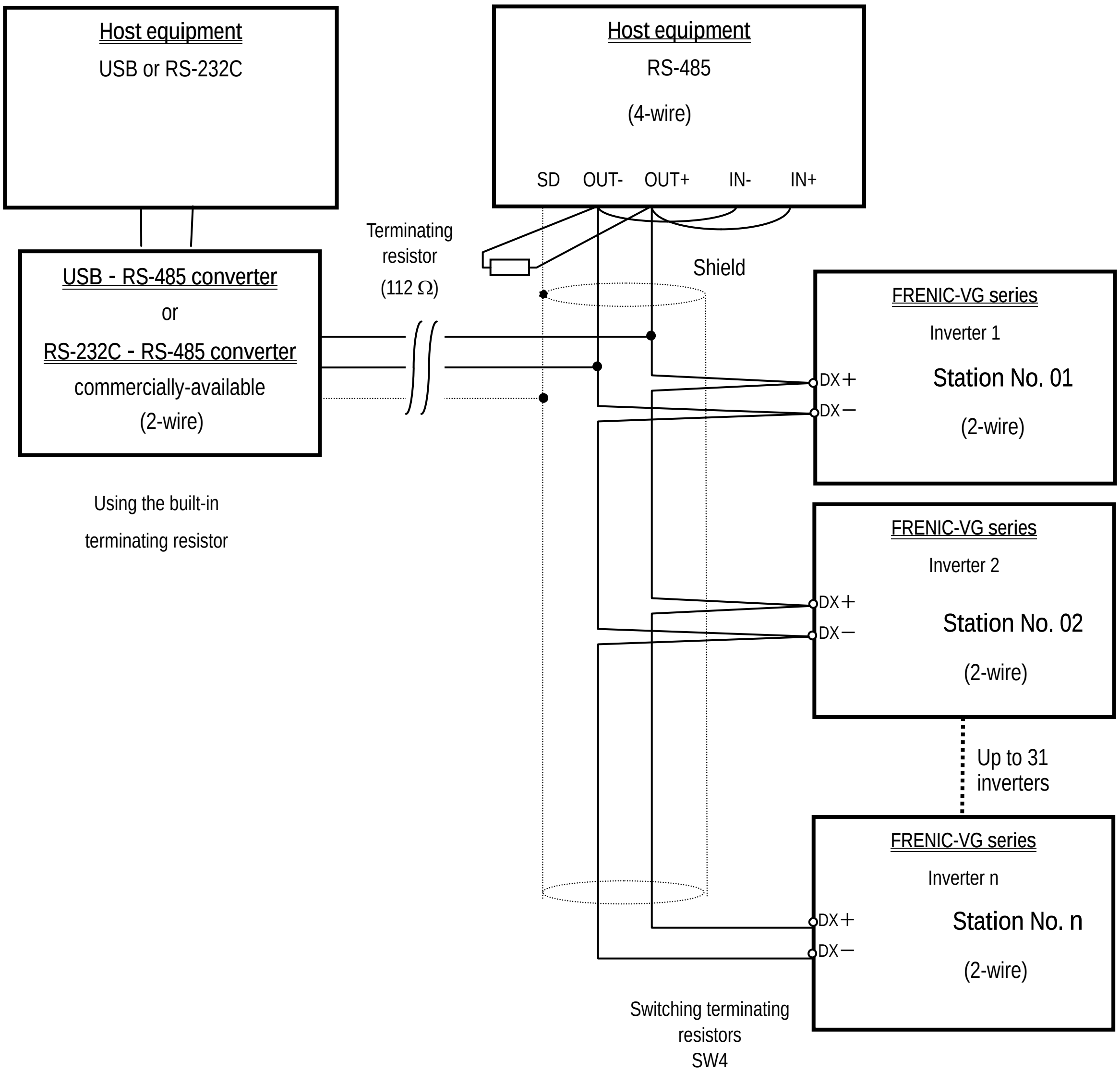


Figure 5.1 Multi-drop Connection Diagram (Connecting to the Terminal Block)

Note

Use cables and converters meeting the specifications for proper connection to the RS-485 port. (Refer to Section 5.1.4 "Communications support devices.")

The shield must be earthed on the host device side.

(2) Connection with a 4-wire type host device

Although the cables used with the converter are 2-wire types, some host devices use 4-wire type cables. When connecting to such a host device, it is necessary to change to a 2-wire type connection by connecting the driver output on the host device side with the receiver input using transition wiring.

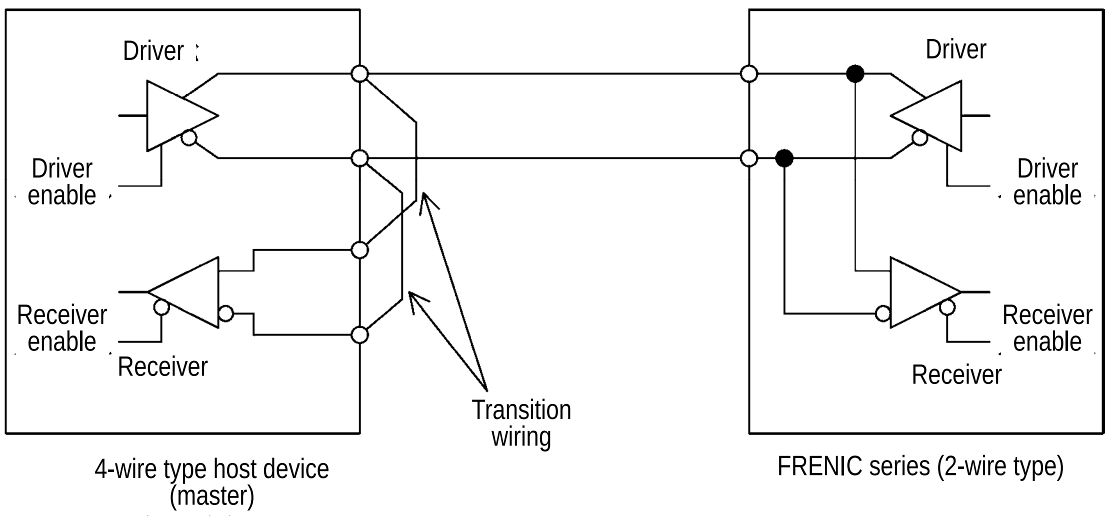


Fig 5.2 Connection with a 4-wire type host device

Note

- The driver circuit on the host device side requires a function to change the output to high impedance (driver enable: OFF). Always check that products using the RS-485 protocol have this function.
- The output of the driver circuit on the host device side should be changed to high impedance (driver enable: OFF), except during transmission.
- During host device transmission, disable the host device receiver circuit (receiver enable: OFF) so that you don't receive back the data that you sent. If it is not possible to disable the host device receiver circuit, program the system to discard the data you sent.

5.1.4 Communications support devices

This section describes the devices required for connecting the inverter to a PC having no RS-485 interface or for connecting two or more inverters in multi-drop network.

5.1.4.1 Converters

Usually PCs are not equipped with an RS-485 communications port. Therefore, it is necessary to use an RS-232C-RS-485 converter or a USB-RS-485 converter. To run the loader correctly, use a converter satisfying the recommended specifications given below. If you use a converter other than a recommended one, the loader may not operate properly.

Recommended converter specifications

Send/receive switching:	Auto-switching by monitoring of send/receive data status at the PC (RS-232C)
Electric isolation:	Electrically isolated from the RS-485 port
Fail-safe:	Fail-safe facility*
Other requirements:	Superior noise immunity

* The fail-safe facility refers to a feature that ensures the RS-485 receiver's output at "High" logic even if the RS-485 receiver's input is opened or short-circuited or all the RS-485 drivers are inactive. Refer to Figure 5.3 Communications Level Conversion.

Recommended converter

System Sacom Sales Corporation: KS-485PTI (RS-232C - RS-485 converter)
: USB-485I RJ45-T4P (USB - RS-485 converter)

Send/receive switching system

The RS-485 communications system of the inverter acts in half-duplex mode (2-wire) so the converter must feature a send/receive switching circuit. Generally, the switching system may be either one of the following.

(1) Auto-switching by monitoring of send/receive data

(2) Switching by RS-232C control signal of RTS or DTR (hardware flow control system)

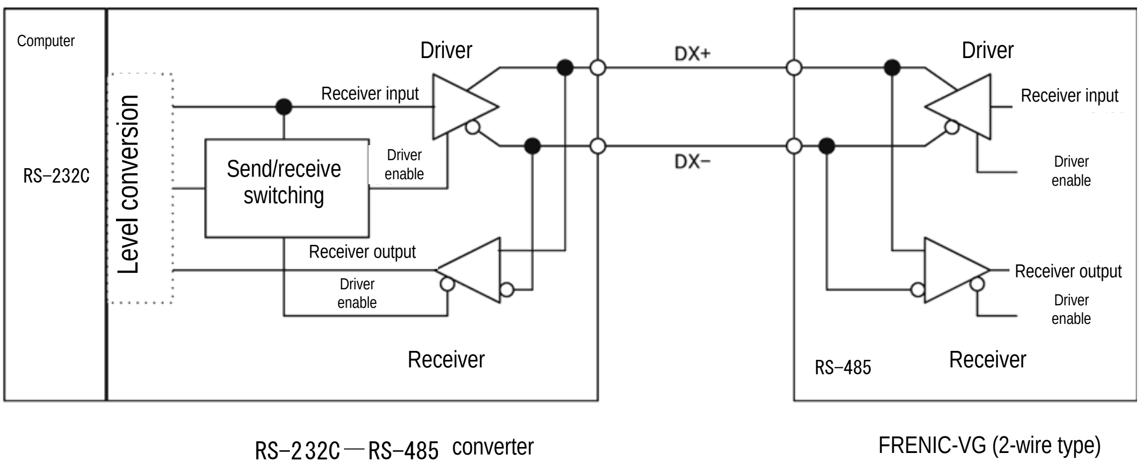


Figure 5.3 Communications Level Conversion

5.1.4.2 Cables

To ensure the reliability of connection, use twisted pair shield cables for long distance transmission AWG 16 to 26.

Recommended cable manufacturer: FURUKAWA Electric Co., LTD

AWM2789 Cable for long distance connection

Type (Product code): DC23225-2PB

5.1.5 Link functions

Communications functions such as RS-485 are called link functions. Command data (S range) is used to access the inverter from the host via a link function to issue start, stop, and speed/torque setting commands. Function code H30 and the "24: Link run selection signal [LE]" X function are used to switch between (REM/LOC/COM) enabling the command data (S range) and enabling commands issued from the actual terminal block and keypad. Refer to Chapter 4, Section 4.1 "Block Diagrams for Control Logic" for more details.

Function code H29 and the "23: Allow link edit command [WE-LK]" X function are used to control writing to function codes (F, E, C, P, H, A, o, L, U) via the link function. Refer to Chapter 4, Section 4.1 "Block Diagrams for Control Logic" for more details.

5.1.5.1 Link command permission selection

<u>Link switching</u>

You can switch modes as shown below by assigning "24: Link run selection signal [LE]" to the X function input terminal.

Link run selection signal [LE] assignment	Input terminal	Status
Not assigned	-	Link command allowed mode
Assigned	ON	
	OFF	Link command disallowed mode

In link command disallowed mode, writing command data and run operation data via the link function is enabled, <u>but the data is not reflected in the actual run operation</u>. It is possible to set up the data in advance in link command disallowed mode, and then switch to link command allowed mode to reflect the data in the actual run operation.

Note · The run operation may start when the [LE] terminal is switched from OFF to ON.

Link commands

In link command allowed mode, you can use function code H30 (link function) to link (COM) the command data and the run operation command, and switch between Remote and Local. At this time, REM (Remote: run operation via terminal block) or LOC (Local: run operation via keypad) is displayed.

H30 data	Link command allowed mode		Link command disallowed mode
	Command data (S01-S05, S10-S12)	Run operation command (FWD, REV)	
0	Disallow link (REM/LOC)	Disallow link (REM/LOC)	Disallow link (REM/LOC)
1	Allow link (COM)	Disallow link (REM/LOC)	
2	Disallow link (REM/LOC)	Allow link (COM)	
3	Allow link (COM)	Allow link (COM)	

These functions enable a flexible system structure, with run commands issued via the terminal block and speed commands issued via RS-485.

5.1.5.2 Link edit permission selection

Link edit switching

You can write protect the function codes (F, E, C, P, H, A, o, L, U) as shown below by assigning "23: Allow link edit command [WE-LK]" to the X function input terminal.

Allow link edit command assignment	Input terminal	Status
Assigned	-	Link edit allowed mode (Function code write enabled)
Not assigned	ON	
	OFF	Link edit disallowed mode (Function code write protected)

Link edit

You can use function code H29 (allow link edit command) to control writing to function codes (F, E, C, P, H, A, o, L, U) in the link edit allowed mode.

H29 data	Link edit allowed mode	Link edit disallowed mode
0	Function code (F, E, C, P, H, A, o, L, U) write enabled	Function code (F, E, C, P, H, A, o, L, U) write protected
1	Function code (F, E, C, P, H, A, o, L, U) write protected	

5.1.5.3 S range option priority

If the system has field options (T link, field bus, SX, SI (UPAC), etc.), writing to the S range (run operation command, command data) via RS-485 is disabled and the options are given priority. However, reading and writing function code data via RS-485 is constantly enabled.

5.1.6 Referencing and changing data

If the system does not have field options, writing to the S range (run operation command, command data) via RS-485 constantly enabled.

Additionally, refer to the communications address, 485 No. in Chapter 4, Section 4.2 "Function Code Tables" for details on referencing and changing function codes. Take note of restrictions such as data ranges and disabled changes during operation.

5.1.6.1 Write restrictions for function codes

Writing to (selecting) function codes (F, E, C, P, H, A, o, L, U) is subject to the following restrictions.

(1) Writing to volatile memory

In order to enable a high-speed writing response when writing via RS-485, the system uses volatile memory (RAM: Random Access Memory, memory that is discarded when the system is switched OFF). If you need to keep the data after the system is switched OFF, issue the H02 [Save All] function code to write the data to non-volatile memory.

Writing using function code H02 takes about 2 seconds. Do not attempt to perform another write operation while the system is writing data to the memory.

(2) Writing via RS-485 disabled mode

You will receive a negative response if you attempt to write to any of the following function codes.

Code	Name	Reason
P02	M1 mode selection	Other codes are automatically updated when P02 is changed. Updates are generally written to non-volatile memory. For P02 only, however, updates are written to volatile memory (discarded when system switched OFF), resulting in inconsistent codes when the system is switched OFF and ON again. Only change P02 via the keypad. However, writing is enabled when using FRENIC-VG Loader software (SX protocol).
H31	Station address	If changed, communications operations are disabled
H34 to H37	(UART setting)	RS-485 hardware settings
H40	Protocol selection	If changed, communications operations are disabled

(3) Continuous writing disabled mode

When using ModBus RTU, you can continuously write 16 pieces of data. When doing so, do not include the following codes in the continuous write group. If you attempt to write with these codes in the group, the system will return a negative response. Fuji general-purpose inverter protocol and ModBus RTU can be written individually.

Code	Name	Reason
H02	Save all function	Internal data is updated at the same time as operation is performed. This updated data is overwritten by continuously written data.
H03	Data initialization	
H68	Alarm data deletion	
H79	Cooling fan cumulative run time default setting	
H80	Main circuit condenser capacity default setting	
H81	Main circuit condenser cumulative lifetime default setting	

(4) Data protection

Writing via RS-485 is not restricted by function code F00 [Protect Data]. This code only protects data in the case of keypad operation.

Writing via RS-485 is restricted by function code H29 [Protect Link Function] and the [WE-LK] X function (Refer to section 5.1.5.2).

However, writing to H29 is enabled even in link edit disallowed mode.

5.1.6.2 Negative response and error response

If you attempt to perform the write operation when the communication data contains an error or the inverter is not ready, the system will return a negative response and the write operation will not be performed. You can check the error details with function code M26 or the keypad maintenance screen. For details, refer to the section on type [34] communication error codes in Chapter 4, Section 4.2 "Function Code Tables."

Additionally, Modbus RTU protocol uses special codes (subcodes) for error responses. For details, refer to the section on Modbus RTU.

5.1.6.3 No response

If the hardware on the inverter side detects a parity error or framing error, or the software detects a sum-check error or CRC error because the communication data is physically damaged, the system will return no response. You can check the reason for no response with function code M26 or the keypad I/O check.

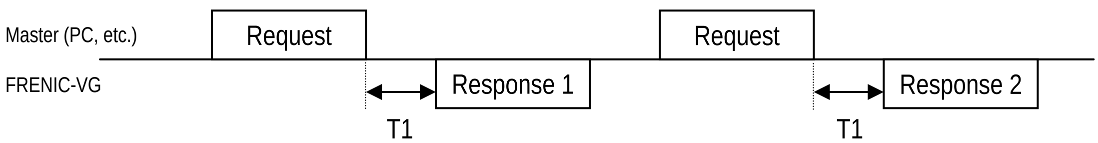
If the character interval of the data on the host side is greater than 20 ms due to a host hardware error, the inverter will return no response. At this time, the communication data will be reset.

5.1.7 RS-485 function codes

Function code		Data setting	Remarks
H31	RS-485 setting (station address)	0 to 255 1 to 247: RTU 1 to 31: Fuji general-purpose	Specify station number when connecting to inverter No response returned when Broadcast is selected 0: Broadcast when RTU selected 99: Broadcast when Fuji general-purpose selected
H32	RS-485 setting (error measure selection)	0; Forced stop 1; Stop after fixed time 2; Stop after error continues longer than operation time 3; Continue operation	RAS
H33	RS-485 setting (timer time)	0.01 to 20.00 s	
H34	RS-485 setting (transmission rate)	0; 38,400 bps 1; 19,200 bps 2; 9,600 bps 3; 4,800 bps 4; 2,400 bps	Default communications setting
H35	RS-485 setting (data length selection)	0; 8 bit 1; 7 bit	
H36	RS-485 setting (parity bit selection)	0; None 1; Even 2; Odd	
H37	RS-485 setting (stop bit selection)	0; 2 bit 1; 1 bit	
H38	RS-485 communication downtime	0.1 to 60.0 s 0.0; disabled	
H39	Response interval time	0.00 to 1.00 s	
H40	RS-485 protocol selection	0; Fuji general-purpose 1; SX protocol (loader protocol) 2; Modbus RTU	Protocol switching

5.1.7.1 Response interval time (H39)

Set the time until the inverter returns a response when a request is received from an upper level device such as a computer. This function enables you to match the timing by setting the response interval time, even if the computer processes slowly.



T1 = response interval time + Td (inverter operation delay time; 0-30 ms).

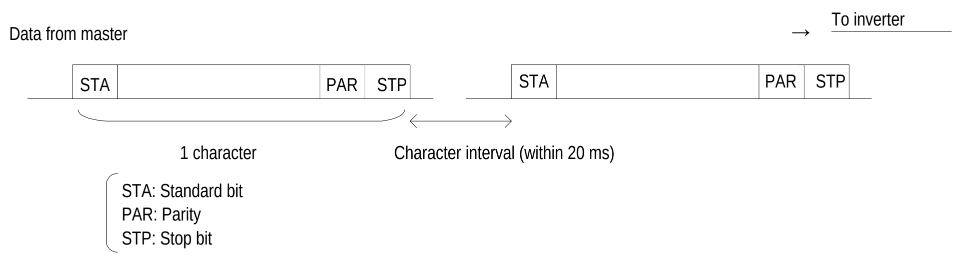
Use the H39 code to set the time within the range of 0.00-1.00 s.

5.1.7.2 Disconnection detection time (H38)

If communication from the master (PLC, PC) during RS-485 linked operation (S06: operation command FWD, REV) exceeds the specified time, an RS-485 communication error (*er5*) is immediately generated. When performing non-fixed cycle communications, disable this function (setting: “0”). When performing fixed cycle communications, set H38 to a longer time than the cycle time before using the disconnection detection function.

5.1.7.3 Character timeouts

The receiving interval of transmissions is monitored with a fixed timer. If the character interval of the data sent from the master exceeds the timer time, this function determines that the operation is not fixed or that there has been a disconnection. The function operates with a **fixed timer of 20 ms** based on the slowest communication speed of 2400 bps, allowing for a character interval of 5 ms to 4.6 ms (12-11 bit/2400). Be aware that, if the character interval exceeds this time, communications on the inverter side will be reset.



5.1.7.4 Timeouts on the master side

Specify the time allowed before determining that the master side (PLC, PC) will timeout if the response from the inverter is interrupted. The specified time common to Fuji inverters (G, C, E, VG) is **500 ms or more**. Always set the timout for the master device to this time or longer. The response is normally returned within the internal process time (about 1 ms) + the interval timer time (H39 setting). Therefore, the timeout for the master device can be set to a little longer than the interval timer time. However, the actual timeout time should be set to 500 ms or more to allow for multiple connections to other types of devices (G/E series).

5.1.8 Host side procedures

Please follow the flow chart for each frame transmission procedure.

For both reading and writing, always confirm the response before sending the next frame. If there is no response from the inverter after a certain time, execute a timeout and retry. (If you attempt to start a retry before a timeout, the request frame will not be received properly.)

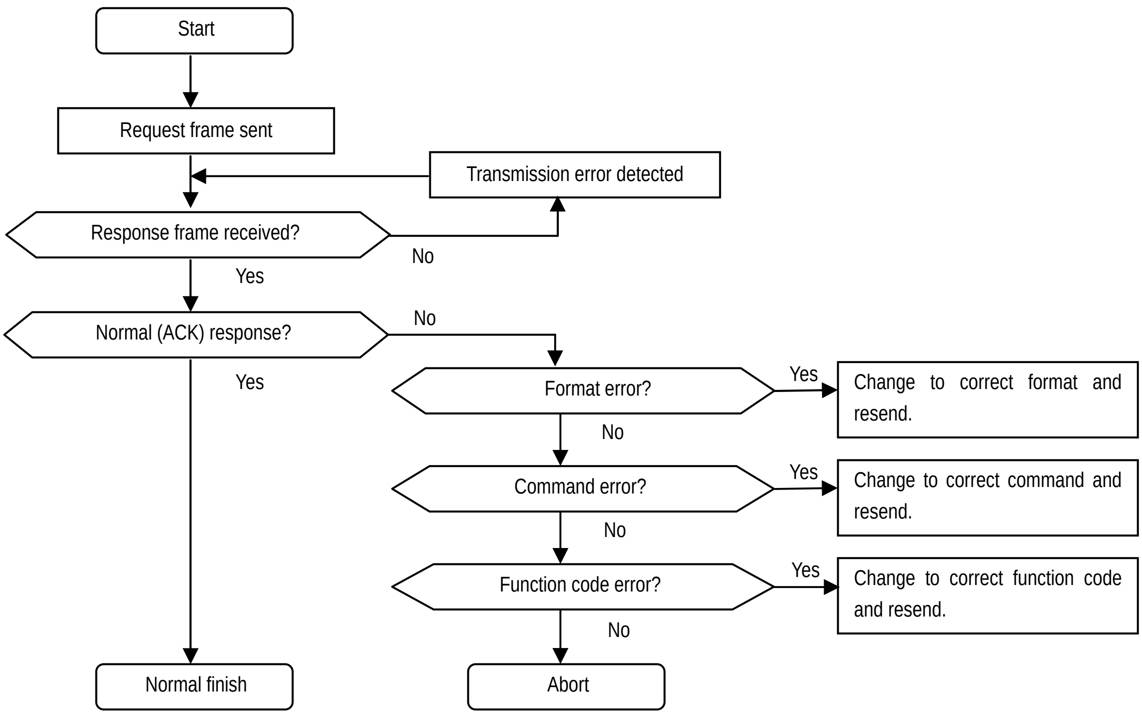
Retry

When executing a retry, either use a standard frame to resend the data that was sent before no response was received or execute polling (M26) to enable the error details to be read, and then check that the response was normal. (When checking the response, you will need to determine whether a further timeout is necessary.)

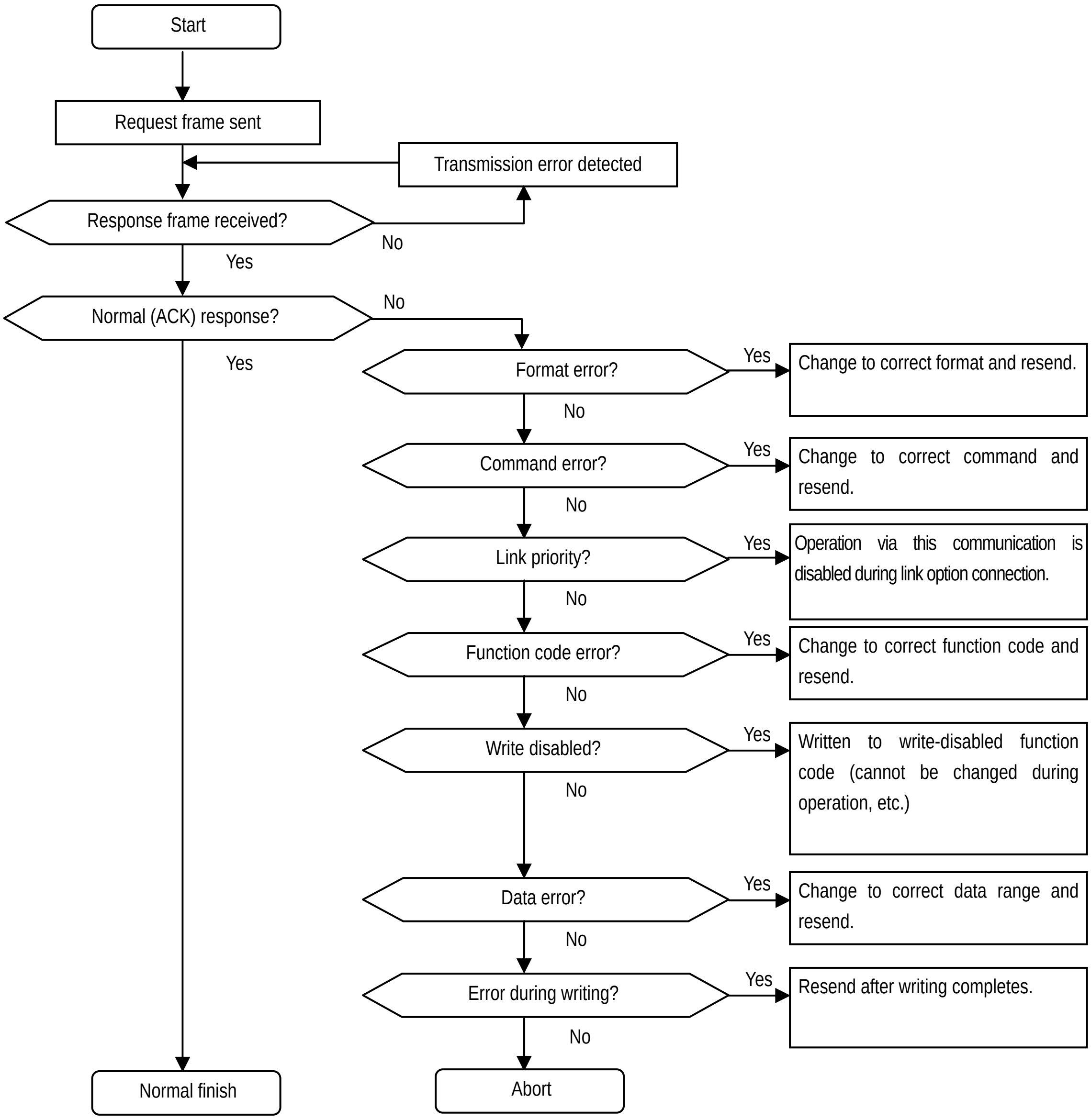
If the response is normal, this indicates that some kind of temporary transmission error such as noise occurred, and normal communications should be possible thereafter. (If there is frequent reoccurrence of this phenomenon, it is necessary to investigate further to determine whether there is an error.)

If there is again no response, execute further retries. If the number of retries exceeds the preset value (normally about 3 times), there may be a problem with the hardware or the software of an upper level device. As there is no response from the specified station, it will be necessary to abort and investigate further.

5.1.8.1 Read procedure



5.1.8.2 Write procedure



5.1.9 RAS

5.1.9.1 Communication errors

Depending on the usage environment, noise generated by the inverter may prevent normal communications or cause equipment such as instrumentation on the master and converters to malfunction. The following measures may be effective in such cases. Please also refer to the appendix on electrical noise.

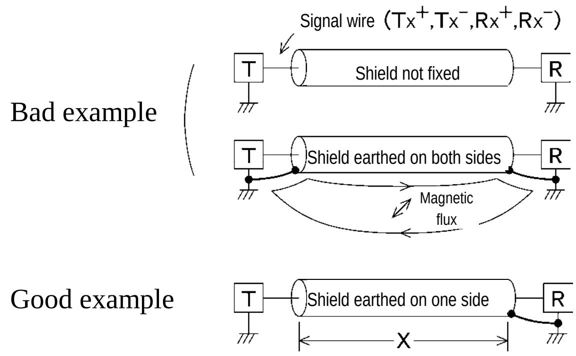
(1) Measures on side receiving noise

Isolated converter: Deletes common mode noise exceeding the specified operating voltage range of the receiver, such as with long wiring layouts. However, the isolated converter itself may malfunction as a result of noise so it is necessary to use a converter with strong noise immunity.

Twisted pair shield wire: The shield protects against static induction noise. Make sure to earth one side.

The twisting protects against electromagnetic induction noise. Where possible, use wires with a short twist pitch. When using long wiring layouts where crosstalk could be a problem, consider using separate shields for sending and receiving.

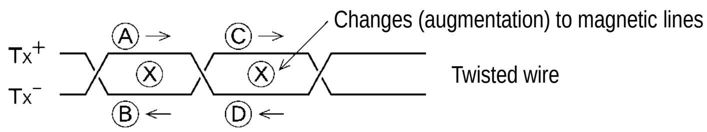
Effect of shield



The shield acts as an antenna, picking up noise. If the circuit is looped between the shield and the ground and the earth is not close, the electrical potential may differ, resulting in noise from the flow of current through the loop. Additionally, noise may be caused by variations in the magnetic flux in the loop.

In section X in the diagram, the effect of static induction can be completely eradicated.

Effect of twist



If there is a uniform magnetic flux downwards as you look at the page and it changes (augmentation), electromotive forces are generated in the direction of the arrows in the diagram.The strength of electromotive forces (A) to (D) is the same, and the directions are as shown. On line Tx+, (B) and (C) move in opposite directions and therefore cancel each other out. This is the same for (A) and (D) and, therefore, normal mode noise due to electromagnetic inductance does not occur. However, it may not be possible to completely suppress noise due to conditions such as a non-uniform twist pitch. If the lines are parallel, normal mode noise will occur.

Terminating resistor: To suppress ringing due to signal reverberation, position terminating resistors with resistance equivalent to the cable impedance (100 Ω) at both ends of the wiring.

Separate wiring: Do not bundle power wires (input: R, S, T; output: U, V, W) with RS-485 communication wires. Separating the wiring can help to suppress inductance noise.

Change earth: Do not use a common earth for instrumentation and the inverter. Noise may propagate from the earth wire. Additionally, use thick earth wires.

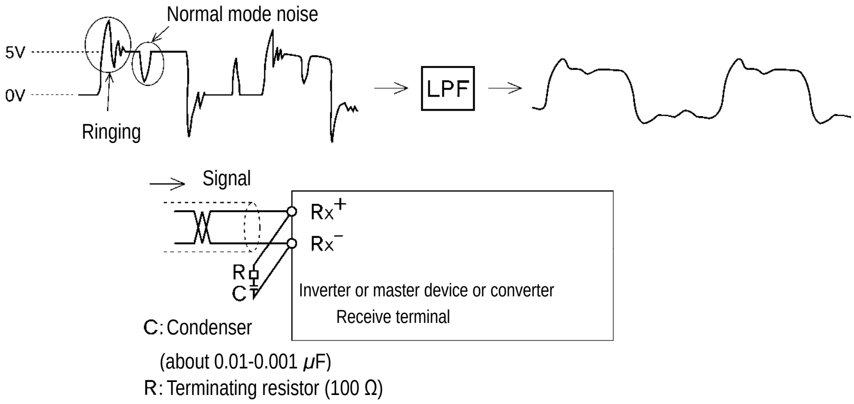
Isolated power supply: Noise may propagate from the power supply of instrumentation.

To isolate the wiring from the power supply of the inverter, it is recommended to change the power wiring, or use an isolated transformer (TRAFY) for the power supply or a noise-suppressing transformer.

Filtering: To cut ringing and high-frequency noise, create a (low pass filter) LPF by connecting a condenser in parallel at the signal input/output terminal.

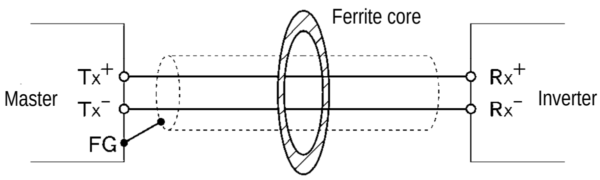
Effect of filtering

This method separates ringing due to signal reverberation and normal mode noise from the normal signal. Generally, the former is a higher frequency than the signal and so can be separated with a LPF.



Add inductance components: Insert inductance components such as choke coils in series in the signal circuit, or pass the cable through a ferrite core ring. This will help to keep the impedance of the signal lines high to counteract high frequency noise.

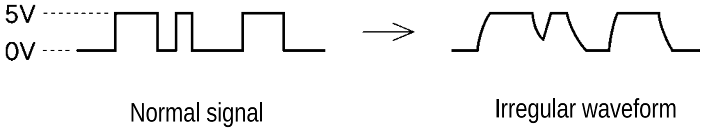
Adding inductance components



Pass through or wind 2-3 times

⚠CAUTION

When filtering and adding inductance components, with fast communication speeds the signal waveform may become irregular, causing transmission errors. If this happens, use function code H34 to slow down the communication speed.



(2) Measures on side generating noise

Carrier frequency:	It is possible to lower the noise level by lowering the setting of function code F26 [Motor operation noise (carrier frequency)]. However, be aware that lowering the carrier frequency can result in higher levels of noise from other sources.
Equipment:	It is possible to contain noise (radiation/inductance) by passing the power wires through a metal duct or using a metal control panel.
Isolated power supply:	It is possible to curb the propagation of noise (conductance) by using an isolated transformer for the inverter power supply.

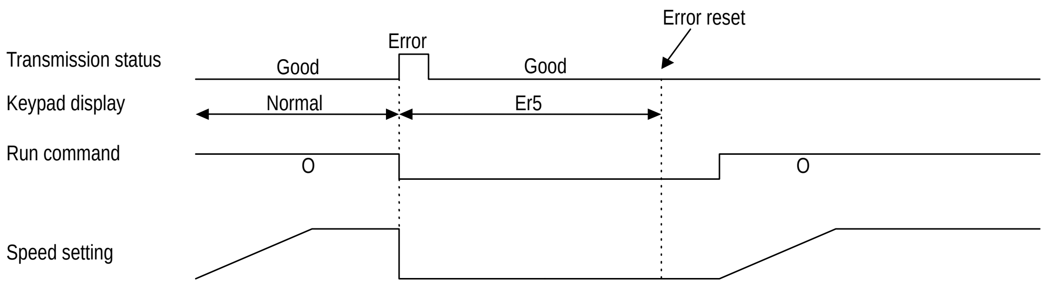
(3) Measures to lower noise level

Consider using a zero-phase reactor (9.6.5) and an EMC filter (9.6.2). Normally, you should consider measure (3) if measures (1) and (2) do not lower the noise to the allowable level for the equipment.

5.1.10 Communication error measures

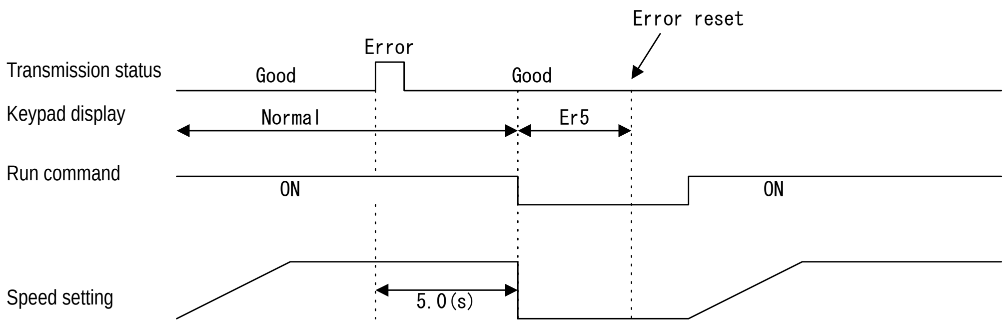
When executing run commands or applying command data via RS-485, it is possible to continue running the inverter without tripping the alarm, even if there is a transmission error, by implementing the following measures. The following examples show communication alarms (keypad displays *er5*) generated when operating the inverter from the master side.

(a) H32 = 0; Forced stop (Forced stop: idling stop during alarm)

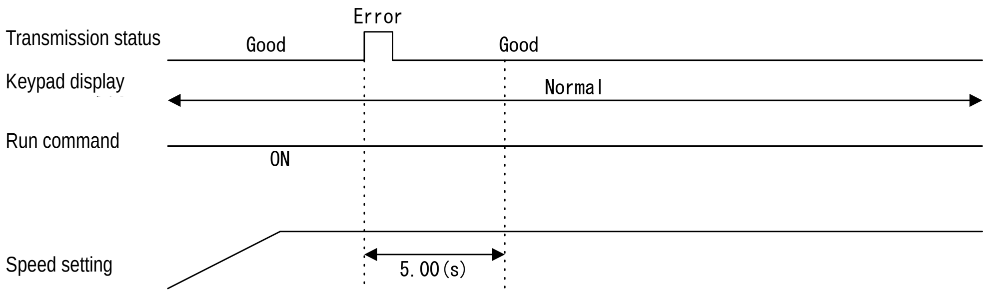


(b) H32 = 1; Idling stop after set time elapses following transmission error

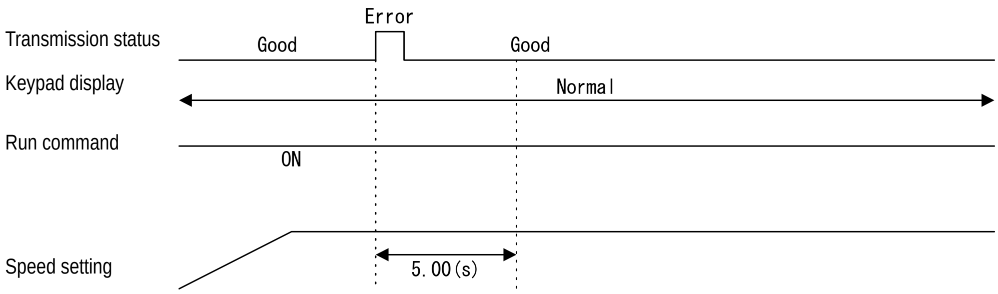
(Operation stops after continuing for timer set time, H33: timer time = 5.00 s)



(c) H32 = 2; Operation continues if cause of transmission error is resolved within timer time set in (b) above. (Operation stops after error continues beyond timer set time, H33: timer time = 5.00 s)



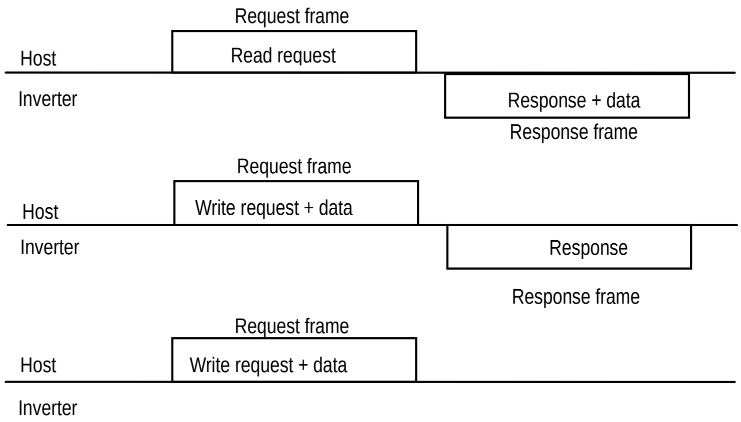
(d) H32 = 3; Operation continues even after transmission error occurs (continued operation).



5.2 Fuji General-purpose Communications

5.2.1 Message format

Polling/selecting is used for the response message format. The inverter is in a constant standby state, waiting for either selecting (write request) or polling (read request) from the host (PC, PLC).
The inverter receives a request frame with the same station address from the host while in the standby state. If the frame is received normally, the request is processed and a positive response frame (in the case of polling, the data is returned with the response) is returned. If the frame is not received normally, a negative response frame is returned. In the case of a broadcast (all-station selecting), no response is returned.



Explanation: Broadcast (all-station selecting)
If the station number (station address) of a frame is set to “99”, it is processed by all inverters as a broadcast. By using a broadcast, you can execute run commands and frequency commands for all inverters simultaneously. (This is enabled only for S codes with standard frames, and a to f and m commands with W, E, and option frames.)

5.2.2 Transmission frame

There are two types of transmission frame: a standard frame which allows you to use all communications functions, and an option frame which allows you to perform high speed communications but is restricted to monitoring and sending commands to the inverter.
With both the standard frame and option frame, all constituent characters (including BCC) of the frame are displayed as ASCII characters. The table below shows the transmission frame length for each of these frame types.

Frame type			Frame length
Standard frame	Selecting	Request	16 byte
		Response	16 byte
	Polling	Request	16 byte
		Response	16 byte
Option frame	Selecting	Request	12 byte
		Response	8 byte
	Polling	Request	8 byte
		Response	12 byte

5.2.3 Standard frame

Request frame [Host → Inverter]

0	1 2	3	4	5	6 7	8	9 12	13	14 15	
SOH	Station No.	ENQ	Command	Type	Function code No.	SP	Data	ETX	BCC	
1	2	1	1	1	2	1	4	1	2	(byte)

BCC target (Station No. through ETX)

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Transmission begins
1	Station No.	'0' - '3', '9'	30_H - 33_H, 39_H	Inverter station address (Decimal: tens place)
2		'0' - '9'	30_H - 39_H	Inverter station address (Decimal: ones place)
3	ENQ	ENQ	05_H	Transmission frame
4	Command	 'R' 'W' 'A' 'E'	 52_H 57_H 41_H 45_H	Request command Polling (read) Selecting (write) High speed response selecting (write) - Note 1 Alarm reset
5	Type	 'F' 'E' 'C' 'P' 'H' 'A' 'L' 'U' 'o' 'S' 'M'	 46_H 45_H 43_H 50_H 48_H 41_H $4C_H$ 55_H $6F_H$ 53_H $4D_H$	Function code type Basic function Terminal function Control function Motor 1 High level function Motor 2, 3 Elevator data User function Option Command data Monitor data
6	Function code No.	'0' - '9'	30_H - 39_H	Function code No. (Decimal: tens place)
7		'0' - '9'	30_H - 39_H	Function code No. (Decimal: ones place)
8	SP	' '	20_H	Unused (fixed space)
9	Data	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	1st character (Hexadecimal: thousands place)
10		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	2nd character (Hexadecimal: hundreds place)
11		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	3rd character (Hexadecimal: tens place)
12		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	4th character (Hexadecimal: ones place)
13	ETX	ETX	03_H	Transmission ends
14	BCC	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 1 (Hexadecimal: tens place)
15		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 2 (Hexadecimal: ones place)

Note 1: FRENIC-VG returns a response when the request is received, regardless of the write type.
With FRENIC-VG, both normal selecting (W) and high speed response selecting (A) are the same operation.

ACK response frame [Inverter → Host]

0	1 2	3	4	5	6 7	8	9 12	13	14 15	
SOH	Station No.	ACK	Command	Type	Function code No.	SP	Data	ETX	BCC	
1	2	1	1	1	2	1	4	1	2	(byte)

BCC target (bytes 1 to 13)

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01H	Transmission begins
1	Station No.	'0' - '3', '9'	30_H - 33_H, 39_H	Inverter station address (Decimal: tens place)
2		'0' - '9'	30_H - 39_H	Inverter station address (Decimal: ones place)
3	ACK	ACK	06_H	Transmission frame Positive response: No receiving error or request logic error
4	Command	 'R' 'W' 'A' 'E'	 52_H 57_H 41_H 45_H	Request command answer back Polling (read) Selecting (write) High speed response selecting (write) Alarm reset
5	Type	 'F' 'E' 'C' 'P' 'H' 'A' 'L' 'U' 'o' 'S' 'M'	 46_H 45_H 43_H 50_H 48_H 41_H $4C_H$ 55_H $6F_H$ 53_H $4D_H$	Function code type Basic function Terminal function Control function Motor 1 High level function Motor 2, 3 Elevator data User function Option Command data Monitor data
6	Function code No.	'0' - '9'	30_H - 39_H	Function code No. (Decimal: tens place)
7		'0' - '9'	30_H - 39_H	Function code No. (Decimal: ones place)
8	SP			Unused
9	Data	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	1st character (Hexadecimal: thousands place)
10		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	2nd character (Hexadecimal: hundreds place)
11		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	3rd character (Hexadecimal: tens place)
12		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	4th character (Hexadecimal: ones place)
13	ETX	ETX	03_H	Transmission ends
14	BCC	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 1 (Hexadecimal: tens place)
15		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 2 (Hexadecimal: ones place)

NAK response frame [Inverter → Host]

0	1 2	3	4	5	6 7	8	9 12	13	14 15	
SOH	Station No.	NAK	Command	Type	Function code No.	SP	Data	ETX	BCC	
1	2	1	1	1	2	1	4	1	2	(byte)

BCC target (bytes 1 to 13)

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Transmission begins
1	Station No.	'0' - '3', '9'	30_H - 33_H, 39_H	Inverter station address (Decimal: tens place)
2		'0' - '9'	30_H - 39_H	Inverter station address (Decimal: ones place)
3	NAK	NAK	15_H	Transmission frame Negative response: Request logic error
4	Command - Note 1	 'R' 'W' 'A' 'E'	 52_H 57_H 41_H 45_H	Request command answer back Polling (read) Selecting (write) High speed response selecting (write) Alarm reset
5	Type - Note 1	 'F' 'E' 'C' 'P' 'H' 'A' 'L' 'U' 'o' 'S' 'M'	 46_H 45_H 43_H 50_H 48_H 41_H $4C_H$ 55_H $6F_H$ 53_H $4D_H$	Function code type Basic function Terminal function Control function Motor 1 High level function Motor 2, 3 Elevator data User function Option Command data Monitor data
6	Function code No. - Note 1	'0' - '9'	30_H - 39_H	Function code No. (Decimal: tens place)
7		'0' - '9'	30_H - 39_H	Function code No. (Decimal: ones place)
8	SP	' '	20_H	Unused (fixed space)
9	Data	' '	20_H	Unused (fixed space)
10		' '	20_H	Unused (fixed space)
11		'4', '5'	34_H, 35_H	Communication error code 1 (Hexadecimal: tens place)
12		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Communication error code 2 (Hexadecimal: ones place)
13	ETX	ETX	03_H	Transmission ends
14	BCC	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 1 (Hexadecimal: tens place)
15		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 2 (Hexadecimal: ones place)

Note 1: Space (' ' = 20H) is specified for transmission format errors and transmission command errors.

5.2.4 Option frame

Selecting request frame [Host → Inverter]

0	1 2	3	4	5 8	9	10 11	
SOH	Station No.	ENQ	Command	Data	ETX	BCC	
1	2	1	1	4	1	2	(byte)

BCC target (bytes 1 to 9)

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Transmission begins
1	Station No.	'0' - '3', '9'	30_H - 33_H, 39_H	Inverter station address (Decimal: tens place)
2		'0' - '9'	30_H - 39_H	Inverter station address (Decimal: ones place)
3	ENQ	ENQ	05_H	Transmission request
4	Command			Request command
		'a'	61_H	Speed setting 1 (S01)
		'b'	62_H	Torque command (S02)
		'c'	63_H	Torque current command (S03)
		'd'	64_H	Magnetic flux command (S04)
		'e'	65_H	Orientation position command (S05)
		'f'	66_H	Run command (S06)
		'm'	$6D_H$	Reset command: All "0"
5	Data	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	1st character (Hexadecimal: thousands place)
6		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	2nd character (Hexadecimal: hundreds place)
7		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	3rd character (Hexadecimal: tens place)
8		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	4th character (Hexadecimal: ones place)
9	ETX	ETX	03_H	Transmission ends
10	BCC	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 1 (Hexadecimal: tens place)
11		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 2 (Hexadecimal: ones place)

Selecting response frame [Inverter → Host]

0	1 2	3	4	5	6 7
SOH	Station No.	ACK/NAK	Command	ETX	BCC
1	2	1	1	1	2 (byte)

BCC target (bytes 1 to 5: Station No., ACK/NAK, Command, ETX)

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Transmission begins
1	Station No.	'0' - '3', '9'	30_H - 33_H, 39_H	Inverter station address (Decimal: tens place)
2		'0' - '9'	30_H - 39_H	Inverter station address (Decimal: ones place)
3	ACK/NAK	 ACK NAK	 06_H 15_H	Transmission response Positive response: No receiving error or request logic error Negative response: Request logic error
4	Command	 'a' 'b' 'c' 'd' 'e' 'f' 'm'	 61_H 62_H 63_H 64_H 65_H 66_H $6D_H$	Request command Speed setting 1 (S01) Torque command (S02) Torque current command (S03) Magnetic flux command (S04) Orientation position command (S05) Run command (S06) Reset command: All "0"
5	ETX	ETX	03_H	Transmission ends
6	BCC	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 1 (Hexadecimal: tens place)
7		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 2 (Hexadecimal: ones place)

Polling request frame [Host → Inverter]

0	1 2	3	4	5	6 7	
SOH	Station No.	ENQ	Command	ETX	BCC	
1	2	1	1	1	2	(byte)

BCC target (bytes 1 to 5)

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Transmission begins
1	Station No.	'0' - '3', '9'	30_H - 33_H, 39_H	Inverter station address (Decimal: tens place)
2		'0' - '9'	30_H - 39_H	Inverter station address (Decimal: ones place)
3	ENQ	ENQ	05_H	Transmission request
4	Command			Request command
		'g'	67_H	Speed detection value (M06)
		'h'	68_H	Torque command monitor (M07)
		'i'	69_H	Torque current monitor (M08)
		'j'	$6A_H$	Output frequency monitor (M09)
		'k'	$6B_H$	Run status monitor (M14)
5	ETX	ETX	03_H	Transmission ends
6	BCC	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 1 (Hexadecimal: tens place)
7		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 2 (Hexadecimal: ones place)

Polling response frame [Inverter → Host]

0	1 2	3	4	5 8	9	10 11	
SOH	Station No.	ACK/NAK	Command	Data	ETX	BCC	
1	2	1	1	4	1	2	(byte)

BCC target (bytes 1 to 9)

Byte	Field	Values		Description
		ASCII format	Hexadecimal format	
0	SOH	SOH	01_H	Transmission begins
1	Station No.	'0' - '3', '9'	30_H - 33_H, 39_H	Inverter station address (Decimal: tens place)
2		'0' - '9'	30_H - 39_H	Inverter station address (Decimal: ones place)
3	ACK/NAK			Transmission response
		ACK	06_H	Positive response: No receiving error or request logic error
		NAK	15_H	Negative response: Request logic error
4	Command			Request command
		'g'	67_H	Speed detection value (M06)
		'h'	68_H	Torque command monitor (M07)
		'i'	69_H	Torque current monitor (M08)
		'j'	$6A_H$	Output frequency monitor (M09)
		'k'	$6B_H$	Run status monitor (M14)
5	Data	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	1st character (Hexadecimal: thousands place)
6		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	2nd character (Hexadecimal: hundreds place)
7		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	3rd character (Hexadecimal: tens place)
8		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	4th character (Hexadecimal: ones place)
9	ETX	ETX	03_H	Transmission ends
10	BCC	'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 1 (Hexadecimal: tens place)
11		'0' - '9', 'A' - 'F'	30_H - 39_H, 41_H - 46_H	Sum-check 2 (Hexadecimal: ones place)

5.2.5 Negative response frame

In cases where the length of the response frame varies according to the command type, if the command type character is determined properly, the frame length designated for that command is generally used for the response.

No.	Frame/command type	Cause of error	Negative response frame	Error code (M26)
1	Standard frame Option frame	ENQ not detected in designated position	Standard frame (Length: 16 bytes)	Format error [74]
2	Non-designated command	Non-designated command (not R, W, A, E, a-k, m) detected	Standard frame (Length: 16 bytes)	Command error [75]
3	Selecting command (a-f, m)	ETX not detected in designated position	Option frame (Length: 8 bytes)	Format error [74]
4	Polling command (g-k)	ETX not detected in designated position	Option frame (Length: 12 bytes)	Format error [74]

Note: If a negative response such as a format error or command error is returned with a standard frame as in No. 1 & 2, the contents of the command type, function code type, and function code number fields are not specified.

5.2.6 Field descriptions

5.2.6.1 Data field

Standard frame

8	9	10	11	12
SP additional data	1st character	2nd character	3rd character	4th character

Option frame

5	6	7	8
1st character	2nd character	3rd character	4th character

Except for some special cases, the length of all data is 16 bits. In the data field of a transmission frame, the data format is hexadecimal (0000H-FFFFH), and each digit is expressed as an ASCII code. Additionally, for negative integer data (signed data), two's complement is used to represent the negative data.

Notes:
- Use alphabetical capitals for hexadecimal A-F.
- For polling, set all request frame data fields to zero ('0') before sending.
- For selecting, ACK response frame data field contents are not specified.

Example: Function code S01 (speed setting 1): 500 r/min (Max. speed: 1500 r/min)

1) Calculate the default in accordance with the S01 data format (±20,000/max. speed).

Data = 500r/min × ±20,000/1500r/min (CW: +, CCW: -)
= ±6666.6
≈ ±6667

2) Convert the data to hexadecimal. (negative data: two's complement)

Data = 6667 (CW)
= 1A0BH
Data = -6667 (CCW)

= 0 - 6667 = 65536 - 6667 = 58869
= E5F5H

3) Set the data.

Position	Default (CW)	Default (CCW)
1st character	ASCII '1'	ASCII 'E'
2nd character	ASCII 'A'	ASCII '5'
3rd character	ASCII '0'	ASCII 'F'
4th character	ASCII 'B'	ASCII '5'

5.2.6.2 Sum-check field

This field contains data used to check for errors in the transmission frame when sending data. The data is calculated by adding all fields except for the S0H and sum-check fields in 1 byte increments. The lowest 1 byte of data is expressed as an ASCII code.

Example: Sum result = 0123H

Position	Default
Sum-check 1	ASCII ‘2’
Sum-check 2	ASCII ‘3’

5.2.7 Communication examples

This section illustrates representative communication examples. (In all cases, the station number is 12.)

5.2.7.1 Standard frame

(1) S01: Selecting speed setting 1 (write)
300r/min command × 20000 / max. speed: 1500 = 4000d = 0FA0H

Request frame (Host → Inverter)

SOH	1	2	ENQ	W	S	0	1	SP	0	F	A	0	ETX	7	D

ACK response frame (Inverter → Host)

SOH	1	2	ACK	W	S	0	1	SP	0	F	A	0	ETX	7	E

NAK response frame (Inverter → Host)...........................Link priority error

SOH	1	2	NAK	W	S	0	1	SP	0	0	4	C	ETX	7	D

(2) M09: Polling output frequency (read)

Request frame (Host → Inverter)

SOH	1	2	ENQ	R	M	0	9	SP	0	0	0	0	ETX	5	3

ACK response frame (Inverter → Host)...........................30.00 Hz ($0BB8_H$ → 3000d → 30.00)

SOH	1	2	ACK	R	M	0	9	SP	0	B	B	8	ETX	8	0

Chap.5 USING STANDARD RS-485

5.2.7.2 Option frame

(1) Selecting run command (write)

Request frame (Host → Inverter) ....FWD command

SOH	1	2	ENQ	f	0	0	0	1	ETX	9	2

ACK response frame (Inverter → Host)

SOH	1	2	ACK	f	ETX	D	2

NAK response frame (Inverter → Host)...........................Cause of error confirmed to be “M26: Send error process code”

SOH	1	2	NAK	f	ETX	E	1

(2) Polling torque command value (read)

Request frame (Host → Inverter)

SOH	1	2	ENQ	h	ETX	D	3

ACK response frame (Inverter → Host)...........................85.00% (2134_H → 8500d → 85.00)

SOH	1	2	ACK	h	2	1	3	4	ETX	9	E

(3) Selecting run command with broadcast (write)

Request frame (Host → Inverter) ....REV command

SOH	9	9	ENQ	f	0	0	0	2	ETX	A	2

Broadcast returns no response.

5.2.7.3 ASCII code table

10_H place / 01_H place	00_H	10_H	20_H	30_H	40_H	50_H	60_H	70_H	80_H Note 1
0_H	NUL	DLE	SP	0	@	P	‘	p	E1
1_H	SOH	DC1	!	1	A	Q	a	q	H1
2_H	STX	DC2	"	2	B	R	b	r	H2
3_H	ETX	DC3	#	3	C	S	c	s	H3
4_H	EOT	DC4	$	4	D	T	d	t	H4
5_H	ENQ	NAK	%	5	E	U	e	u	H5
6_H	ACK	SYN	&	6	F	V	f	v	A1
7_H	BEL	ETB	‘	7	G	W	g	w	o1
8_H	BS	CAN	(	8	H	X	h	x	o2
9_H	HT	EM	)	9	I	Y	i	y	U1
A_H	LF	SUB	*	:	J	Z	j	z	SF
B_H	VT	ESC	+	;	K	[	k	{	-
C_H	FF	FS	,	<	L	＼	l	|	-
D_H	CR	GS	-	=	M	]	m	}	-
E_H	SO	RS	.	>	N	^	n	~	-
F_H	SI	US	/	?	O	_	o	DEL	-

Shaded codes are used with this communication.

Example: For "0," ASCII code is "30_H." For "1," ASCII code is "31_H."

Note 1: Codes after "80_H" are unique codes specified by Fuji Electric.
For settings, use binary.

5.2.7.4 Program example

This program is written in Microsoft QuickBASIC (MS-DOS QBasic), and runs in accordance with Fuji general-purpose inverter protocol.

```
100   'FGI-Bus Sample Program(MS-DOS QBasic)
110   '
120   OPEN "COM1:38400,E,8,1" FOR RANDOM AS #1          'ComPort:BaudRate,Parity,DataBits,StopBits
130   soh$ = CHR$(1)              'FunctionCode H34,     H36,       H35,      H37
140   etx$ = CHR$(3)
150   enq$ = CHR$(5)
160   ack$ = CHR$(6)
170   nak$ = CHR$(&H15)
180   esc$ = CHR$(&H1B)
190   CLS
200   '
1000  PRINT "Select Operation 1:Read,2:Write"
1010  key$ = INKEY$
1020  IF key$ = "1" THEN 2000
1030  IF key$ = "2" THEN 3000
1040  GOTO 1010
1050  '
2000  '==== Read(F03) ====         'Refarence User's Manual 6-19
2010  cmd$ = soh$                 'SOH
2020  cmd$ = cmd$ + "01"          'Address(01 - 31) FunctionCode: H31
2030  cmd$ = cmd$ + enq$          'ENQ
2040  cmd$ = cmd$ + "R"           'Command(R,W,A,E)
2050  cmd$ = cmd$ + "F03"         'Code(F00...)
2060  cmd$ = cmd$ + " 0000"       'Data(0000 - FFFF)
2070  cmd$ = cmd$ + etx$          'ETX
2080  GOTO 4000
2090  '
3000  '==== Write(F03:1500r/m) ====             'Refarence User's Manual 6-19
3010  cmd$ = soh$                 'SOH
3020  cmd$ = cmd$ + "01"          'Address(01 - 31) FunctionCode: H31
3030  cmd$ = cmd$ + enq$          'ENQ
3040  cmd$ = cmd$ + "W"           'Command(R,W,A,E)
3050  cmd$ = cmd$ + "F03"         'Code(F00...)
3060  cmd$ = cmd$ + " 05DC"       'Data(0000 - FFFF)
3070  cmd$ = cmd$ + etx$          'ETX
3080  '
4000  '==== Send ====
4010  buf$ = cmd$
4020  GOSUB calcbcc
4030  cmd$ = cmd$ + bcc$          'Add BCC
4040  '
4050  PRINT #1, cmd$              'Send
4060  '
5000  '==== Receive ====
5010  recv$ = INPUT$(1, #1)       'Receive
5020  IF recv$ = soh$ THEN answer$ = ""
5030  answer$ = answer$ + recv$
5040  IF recv$ <> etx$ THEN 5010
5050  answer$ = answer$ + INPUT$(2, #1)
5060  PRINT "Received Data:"; answer$
5070  '
5080  PRINT "Hit any key (ESC -> End)"
5090  key$ = INKEY$
5100  IF key$ = "" THEN 5090
5110  IF key$ <> esc$ THEN 1000
5120  CLOSE #1
5130  END
5140  '
6000  calcbcc:
6010  b = 0
6020  c = 2
6030  char$ = MID$(buf$, c, 1)
6040  b = b + ASC(char$)          'Add
6050  c = c + 1
6060  IF char$ <> etx$ THEN 6030
6070  b = b AND &HFF
6080  bin = INT(b / 16)
6090  GOSUB bintoasc              'BCC1(8bit High)Character
6100  bcc$ = ascii$
6110  bin = b MOD 16
6120  GOSUB bintoasc              'BCC2(8bit Low)Character
6130  bcc$ = bcc$ + ascii$        'BCC1+2(Character)
6140  RETURN
6150  '
7000  bintoasc: 'Digit"0 - 15" to Character"0 - F"
7010  IF bin < 10 THEN ascii$ = CHR$(ASC("0") + bin) ELSE ascii$ = CHR$(ASC("A") + bin - 10)
7020  RETURN
```

5.3 Modbus RTU

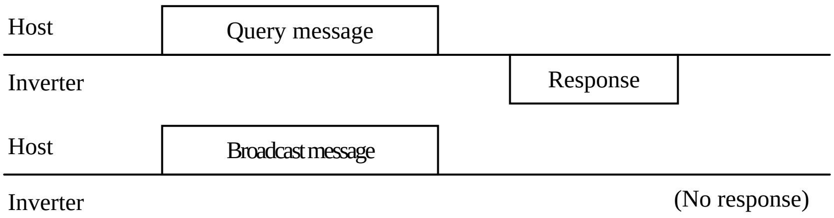
This communications protocol was created overseas. Where possible, English text is used alongside the Japanese.

5.3.1 Message format

The normal format for sending RTU messages is as follows.

1. Query

2. Broadcast



The inverter receives a message with the same station address from the host while in the standby state. If the message is received normally, the request is processed and a normal response is returned. If the message is not received normally, an error response is returned. In the case of a broadcast, no response is returned. There are four types of message: Query, Normal response, Error response, and Broadcast.

<u>Query</u>

The host sends a message to a single inverter.

<u>Normal response</u>

After the query from the host is received, the request is processed and a normal response is returned.

<u>Error response</u>

An error response is returned if the inverter receives the query but the requested function cannot be activated. A message indicating the reason why the requested function cannot be activated is sent with the error response. However, in the case of a CRC error or physical sending error, no response is returned.

<u>Broadcast</u>

The master uses a “0” address to send a message to all slaves. All slaves that receive the broadcast message activate the requested function. This process ends with the time out on the master side.

5.3.2 Transmission frame

The transmission frame is as follows.

1 byte	1 byte	max. 203 bytes	2 bytes
Station address	FC (function code)	Information	Error check

(1) Station address (station number)

Station addresses **0 to 247** are selectable with a 1 byte length.

Selecting a “0” address selects all slave stations and, therefore, the message will be a broadcast message.

(2) FC (function code)

Function codes are defined with values of 0 to 255 with a length of 1 byte, as shown below. The shaded sections indicate codes used with FRENIC-VG. Do not use “unused” function codes. Doing so will result in an error response being returned.

FC	Description
0 to 2	Unused
3	Read function code Data size: max. 99
4 to 5	Unused
6	Write function code Data: 1
7	Unused
8	Maintenance code
9 to 15	Unused
16	Continuously write function code Data size: max. 16
17 to 127	Unused
128 to 255	Reserved for Exception Response

(3) Information

Information fields contain all information items (function code, byte count, data size, data, etc.). For details on information fields for each message type (broadcast, query, normal response, error response), refer to Section 5.3.2.1 “Reading function codes”, Section 5.3.2.2 “Writing single function codes”, and Section 5.3.2.3 “Writing multiple function codes”.

(4) Error check

Error check fields contain data 2 bytes in length for the CRC-16 check method.

Because information fields vary in length, it is necessary to calculate the frame length required to calculate the CRC-16 code from the FC and byte count data.

5.3.2.1 Reading function codes

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	03	Function code	Read data size (max. 99)	Error check

Normal response

1 byte	1 byte	1 byte	2 to 198 bytes	2 bytes
Station No.	03	Byte count	Read data size (max. 198)	Error check
			Hi, Lo, Hi, Lo, Hi, Lo,···	

Setting "Query"

This request cannot be used with broadcasts. Station number "0" cannot be used.

FC = 03

Function codes are 2 bytes in length and composed of an identification code and a number (Ex. "F40" = F + 40). The Hi side corresponds to identification codes F, E-, L. The Lo side corresponds to the number. The setting data range is 0-9, 11 (F-L, U) on the Hi side, and 0-99 on the Lo side. For example, the setting data for F20 is "0014h".

Setting	Identification code	Name	Setting	Identification code	Name
0	F	Basic function	30	E1	Terminal function 1
1	E	Terminal function	31	H1	High level function 1
2	C	Control function	32	H2	High level function 2
3	P	Motor 1 function	33	H3	High level function 3
4	H	High level function	34	H4	High level function 4
5	A	Motor 2 function	35	H5	High level function 5
6	o	Option function	36	A1	Motor 3 function
7	S	Command/function data	37	o1	Option function 1
8	M	Monitor data	38	o2	Option function 2
9	L	Elevator function	39	U1	User function 1
11	U	User function		SF	
			41	M1	Monitor data function 1
			42	M2	Monitor data function 2

The length of read data is 2 bytes. The setting range is 1-99 (words). Make sure to set read data so that it does not exceed the upper limit offset 99 of the function code. Otherwise, an error response will be returned.

Interpreting "Normal response"

The byte count data range is 2-198. A byte count is twice the size of read data (1-99) for a query.

In the response, read data is listed in the order of Hi bytes and then Lo bytes for each word of data, and each word of data is listed in the order of the function code (address) requested with the query, and then the address +1, +2, etc. Missing function codes (F09, etc.) will be returned as "0000".

5.3.2.2 Writing single function codes

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	06	Function code	Write data	Error check
			Hi Lo	

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	06	Function code	Write data	Error check
			Hi Lo	

Setting “Query”

Broadcasts can be used if the address is “0”. In this case, the broadcast request is processed by all inverters and no response is returned.

FC = 06

Function codes are 2 bytes in length and composed of an identification code and a number.

For details on identification codes, refer to the table in Section 5.3.2.1. The length of read data fields is fixed at 2 bytes.

Interpreting “Normal response”

A normal response uses the same frame as a query.

5.3.2.3 Writing multiple function codes

Query

1 byte	1 byte	2 bytes	2 bytes	1 byte	2 to 32 bytes	2 bytes
Station No.	16	Function code	Write data size	Byte count	Write data	Error check

Hi, Lo, Hi, Lo,⋯

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	16	Function code	Write data size	Error check

Setting “Query”

Broadcasts can be used if the address is “0”. In this case, the broadcast request is processed by all inverters and no response is returned.

FC = 16

Function codes are 2 bytes in length and composed of an identification code and a number.

For details on identification codes, refer to the table in Section 5.3.2.1. The length of read data fields is fixed at 2 bytes.

The setting range is 1-16. If you set a value of 17 or more, an error response will be returned. The byte count is 1 byte in length. The setting range is 2-32. Set the byte count to twice the size of the write data. The first 2 bytes of write data should be set to a Lo code (function code requested by the query), and subsequent data should be Hi codes set in ascending order (address +1, address +2, etc).

Interpreting “Normal response”

The returned function code and write data size values are the same as for the query.

5.3.2.4 Maintenance code

This function is used to check communication line connections (hardware).

Query

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	08	Diagnosis code 00 00	Data	Error check

Normal response

1 byte	1 byte	2 bytes	2 bytes	2 bytes
Station No.	08	Diagnosis code 00 00	Data	Error check

Setting “Query”

Broadcasts cannot be used for this query.

FC = 08

Diagnosis codes should be 2 bytes in length and fixed as 0x0000. If you set the data to a value other than 0x0000, an error response will be returned. The data should be 2 bytes in length. The content of the data can be set arbitrarily.

Interpreting “Normal response”

A normal response is the same as a query.

5.3.2.5 Error response

If an incorrect query is received, the query is not processed and an error response is returned.

Error response

1 byte	1 byte	1 byte	2 bytes
Station No.	Exception function	Sub code	Error check

Interpreting “Error response”

This is the same as for a station number request. The exception function adds 128 to the FC of the query message.

For example, if FC = 3, then exception function = 3 + 128 = 131 (83_H). The subcode indicates the reason for the exception, as shown in the table below.

Sub code	Item		Details	M26	Keypad
1	Incorrect FC		FC other than 3, 6, 8, 16 received	75	01
2	Incorrect address	Incorrect function code	Range exceeded or non-existent code (F81, etc.) received	78	02
		Incorrect data size	Attempted to write more than 16W of data		
		Diagnosis code error (maintenance code)	Diagnosis code setting is not “0”		
3	Incorrect data	Data range error	Write data range exceeds writable range	80	03
7	NAK	Link priority	Attempted to write command data or run command data with field option (T link, SX, etc.) applied	76	07
		Write disabled	(1) Change during operation disabled (2) Write disabled (Read only, M range) (3) Link function edit allowed mode (4) Write via RS-485 disabled (H31, H34-37, H40, P02) (5) F04, F05, P03-P27 (M1 motor parameter protected)	79	

5.3.3 Error checking

5.3.3.1 CRC-16

When sending data, CRC data is used to check for errors in the transmission frame.

CRC is the most effective system for error checking. At the sending side, the CRC value is calculated and added to the last level of the frame. Then, at the receiving side, the CRC value is calculated again in the same way based on the received data. The two CRC values are then cross-checked.

<u>Simplified steps for calculating CRC</u>

- Convert the data to a polynomial (Ex. 1100 0000 0010 0001 → X15+X14+X5+1) and then divide this polynomial by a generating polynomial (17 bit; X16 X15+X2+1). The remainder (16 bit) is the CRC value.
- Add the "remainder" to the last level of the data, disregarding the quotient, and send the message.
- The recipient divides the received message (with the CRC value added) by the generating polynomial. If the "remainder" is zero, the message has been received without errors.

<u>CRC-16</u>

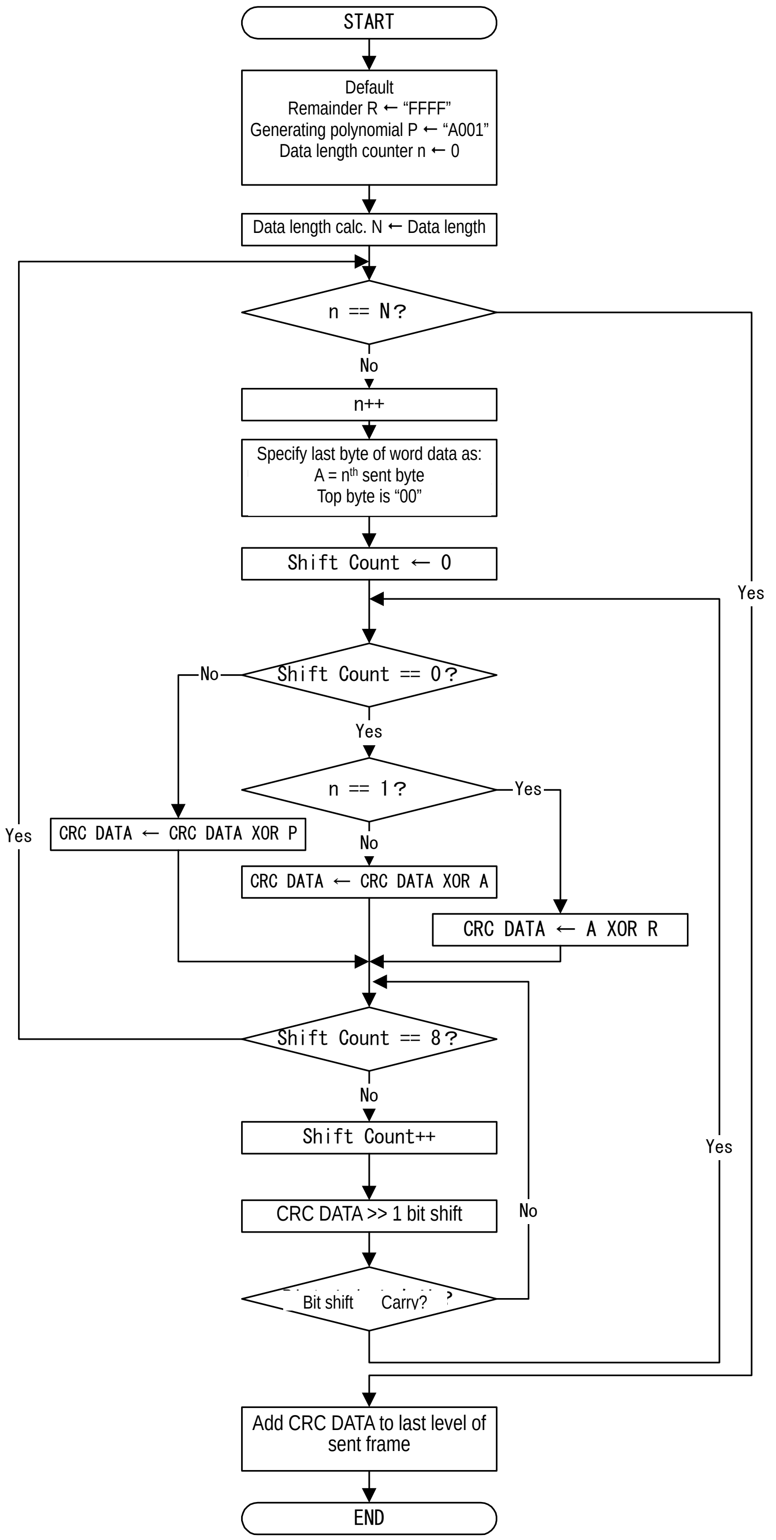
A generating polynomial is expressed as factors of X such as "X^3+X^2+X", rather than binary codes such as "1110".

Although any kind of generating polynomial can be used, some standard types are defined and proposed for optimal error detection.

For RTU, the "$\mathbf{X^{16}+X^{15}+X^2+1}$" generating polynomial, which corresponds to "1 1000 0000 0000 0101" in binary code, is used. The CRC that is generated with this polynomial is known as "**CRC-16**".

5.3.3.2 CRC-16 algorithm

The following diagram shows the CRC-16 calculation algorithm. Please also refer to the calculation example in Section 5.3.3.3.



CRC DATA is 1 word of memory. It is updated in the calculation process and finally added to the sent frame as a check code.

When the message is received, the same algorithm is used. The CRC calculated at the receiving side must then be cross-checked with the CRC that was sent.

5.3.3.3 CRC-16 calculation example

The following is an example of read data that is sent:

Station number: 1, FC = 03, function code P49 (P = code 03, 49 = 31 Hex), read data size: 20 items, G.P (generating polynomial): 1010 0000 0000 0001.

Address	FC	Function code		Read data size	
01	03	03	31	00	14

N	PROCESS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Flag
1	Initial data R="FFFF"	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2	1st data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
3	CRC = No.1 X or No.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
4	Shift >> 2 (up to flag=1)	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	CRC = No.4 X or G.P	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	
6	Shift >> 2	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
7	CRC = No.6 X or G.P	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	
8	Shift >> 2	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
9	CRC = No.8 X or G.P	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	
10	Shift >> 2 (8 shift end)	0	0	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1
11	CRC = No.10 X or G.P	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	
12	2nd data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
13	CRC = No.11 X or No.12	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	
14	Shift >> 1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1
15	CRC = No.14 X or G.P	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	
16	Shift >> 1	0	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1
17	CRC = No.16 X or G.P	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	
18	Shift >> 2	0	0	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1
19	CRC = No.18 X or G.P	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	
20	Shift >> 2	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	1
21	CRC = No.20 X or G.P	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
22	Shift >> 2 (8 shift end)	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0
23	3rd data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
24	CRC = No.22 X or No.23	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1	
25	Shift >> 1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1
26	CRC = No.25 X or G.P	1	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	
27	Shift >> 6	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	1
28	CRC = No.27 X or G.P	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1	
29	Shift >> 1	0	1	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1
30	CRC = No.29 X or G.P	1	1	1	1	0	0	0	1	0	1	1	0	0	0	0	0	
31	4th data byte	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	
32	CRC = No.30 X or No.31	1	1	1	1	0	0	0	1	0	1	0	1	0	0	0	1	
33	Shift >> 1	0	1	1	1	1	0	0	0	1	0	1	0	1	0	0	0	1
34	CRC = No.33 X or G.P	1	1	0	1	1	0	0	0	1	0	1	0	1	0	0	1	

N	PROCESS	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Flag
35	Shift >> 1	0	1	1	0	1	1	0	0	0	1	0	1	0	1	0	0	1
36	CRC = No.35 X or G.P	1	1	0	0	1	1	0	0	0	1	0	1	0	1	0	1	
37	Shift >> 1	0	1	1	0	0	1	1	0	0	0	1	0	1	0	1	0	1
38	CRC = No.37 X or G.P	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	
39	Shift >> 1	0	1	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1
40	CRC = No.37 X or G.P	1	1	0	0	0	0	1	1	0	0	0	1	0	1	0	0	
41	Shift >> 3	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	1
42	CRC = No.41 X or G.P	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	1	
43	Shift >> 1	0	1	0	1	1	1	0	0	0	0	1	1	0	0	0	1	1
44	CRC = No.43 X or G.P	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	
45	5th data byte	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
46	CRC = No.44 X or No.45	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	
47	Shift >> 5	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	1
48	CRC = No.47 X or G.P	1	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0	
49	Shift >> 3	0	0	0	1	0	1	0	0	1	1	1	1	1	1	0	0	0
50	6th data byte	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	
51	CRC = No.49 X or No.50	0	0	0	1	0	1	0	0	1	1	1	0	1	0	0	0	
52	Shift >> 4	0	0	0	0	0	0	0	1	0	1	0	0	1	1	1	0	1
53	CRC = No.52 X or G.P	1	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1	
54	Shift >> 1	0	1	0	1	0	0	0	0	1	0	1	0	0	1	1	1	1
55	CRC = No.54 X or G.P	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1	0	
56	Shift >> 2	0	0	1	1	1	1	0	0	0	0	1	0	1	0	0	1	1
57	CRC = No.56 X or G.P	1	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0	
58	Shift >> 1	0	1	0	0	1	1	1	0	0	0	0	1	0	1	0	0	0
	Send CRC	4				E				1				4				

Following the above calculation, the sent data is as follows.

Address	FC	Function code		Read data size		CRC check	
01	03	03	31	00	14	14	4E

5.3.3.4 Calculating frame length

In order to calculate CRC-16, it is necessary to know the message length, which is variable. The lengths of all message types can be determined from the table below.

FC	Name	Length of query broadcast message excluding CRC code	Length of response message excluding CRC code
3	Read function code	6 bytes	3 + 3rd byte
6	Write single function code	6 bytes	6 bytes
8	Maintenance code	6 bytes	6 bytes
16	Write multiple function codes	7 + 7th byte	6 bytes
128-255	Exception function	Unused	3 bytes

Note: 7th and 3rd denote the byte count value for the information field.

5.3.4 Communication examples

This section illustrates representative communication examples. (In all cases, the station number is 5.)

5.3.4.1 Reading

(1) M06: Read speed detection value.

Query (Host → Inverter)

05	03	08	06	00	01	67	EF

Normal response (Inverter → Host)

05	03	02	27	10	53	B8

Speed detection value: 2710_H → 10000d

$$10000 \times \frac{\text{Max. speed}}{20000} = 750 \text{ (r/min)}$$

(Max. speed: 1500r/min)

(2) S01: Write 400r/min to speed setting 1. (Max. speed: 1500r/min)

$$400 \text{ (r/min)} \times \frac{20000}{1500} = 5333\text{d} = 14D5_H$$

Query (Host → Inverter)

05	06	07	01	14	D5	16	65

Normal response (Inverter → Host)

05	06	07	01	14	D5	16	65

5.4 FRENIC-VG Loader Overview

FRENIC-VG Loader is a software tool that supports the operation of the inverter via a USB link. It allows you to remotely run or stop the inverter, edit, set, or manage the function codes, monitor operation data, as well as monitor information such as the running status and alarm history.

Note With non-standard series inverters such as special order-made inverters, FRENIC-VG Loader may not be able to display some function codes normally.

For details, refer to the FRENIC-VG Loader Instruction Manual.

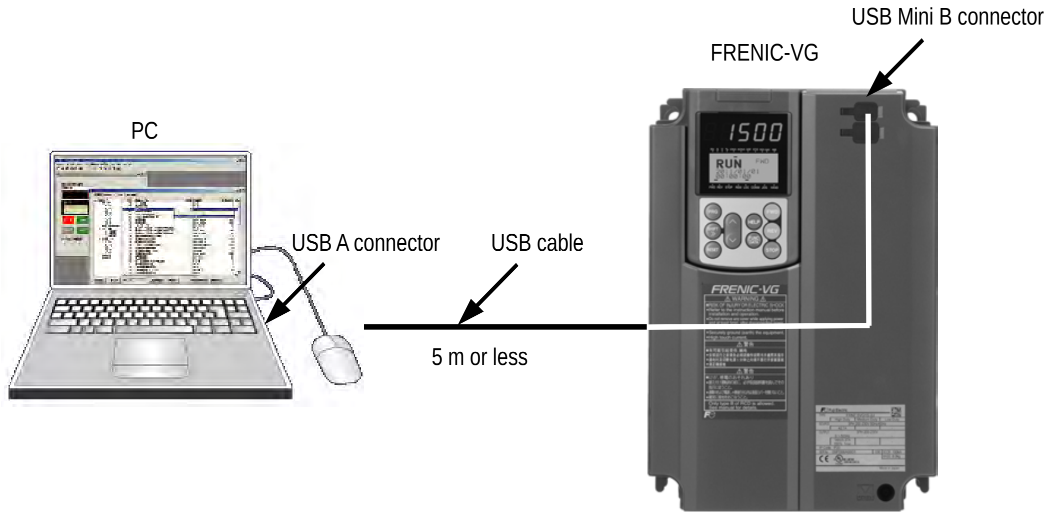
5.4.1 Specifications

Item		Specifications	Remarks
Name		Inverter support loader (FRENIC-VG Loader)	
Supported inverter		FRN-VG1S	
No. of inverters connectable		USB: 1 inverter only RS-485: max. 31 inverters	
Recommended cables		USB: USB Mini B (5-pin), 5 m or less RS-485: Shielded twisted pair	
Operating environment	OS	Microsoft Windows XP (Japanese version) Microsoft Windows Vista (Japanese version) Microsoft Windows 7 (Japanese version)	32-bit version only
	Memory	512 MB or more RAM	1 GB or more recommended
	Hard disk	25 MB or more free space	
	Serial ports	USB RS-232C (conversion to RS-485 communication required to connect inverters)	
	Monitor	1024 x 768 or higher	
Transmission specifications	COM ports	COM1 to COM255	
	Transmission rate	USB: 12 (Mbps) fixed RS-485: 38400, 19200, 9600, 4800, 2400 (bps)	38400 bps or more recommended
	Character length	8 bits	Fixed
	Stop bit length	1 bit	Fixed
	Parity	Even	Fixed
	No. of retries	None or 1 to 10	No. of retries before detecting communications error
	Timeout setting	100 ms, 300 ms, 500 ms, 1.0 s to 1.5 s to 1.9 s, 2.0 to 9.0 s, 0 to 60.0 s	

5.5 Connection

5.5.1 USB connection

The inverter is equipped with a USB port, enabling direct connection to a computer which is also equipped with a USB port. FRENIC-VG Loader software can be used by connecting a single inverter to a single computer.



5.5.1.1 RS-485 connection

The inverter's control circuit terminal block is equipped with an RS-485 terminal. An RS-485 converter is required for connection to a computer. FRENIC-VG Loader software can be used by connecting up to 31 inverters to a single computer.

🕮 For details on connection, refer to Section 5.1.3 "Connection method."

🕮 For details on RS-485 converters, refer to Section 5.1.4 "RS-485 Communications support devices."

5.5.2 Function overview

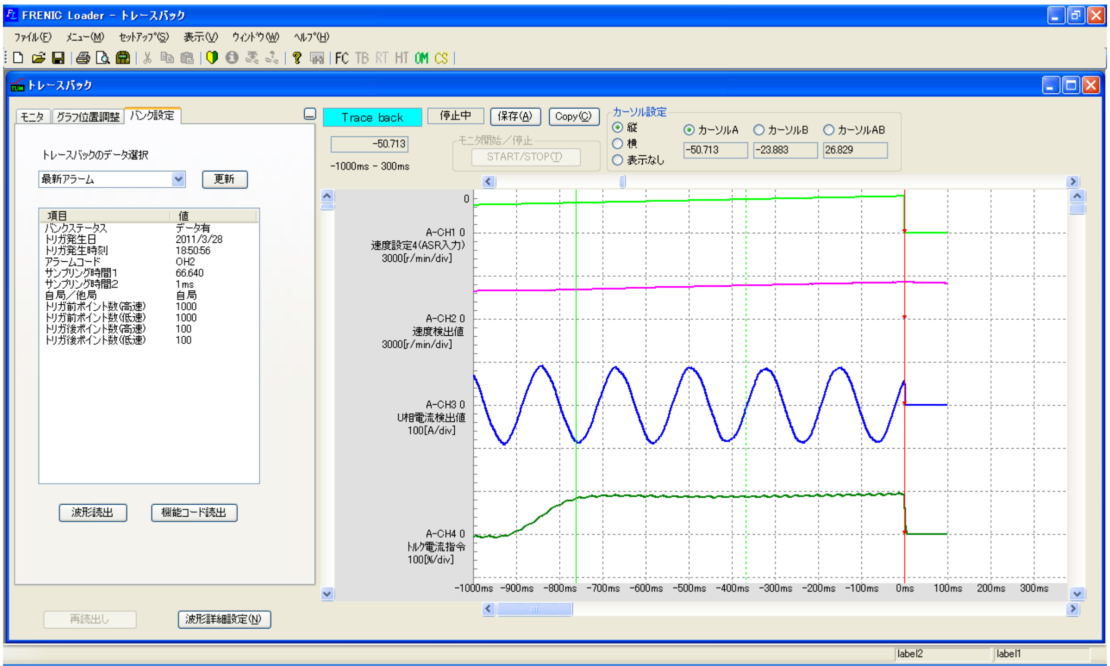
5.5.2.1 Setting function codes

You can set, edit, and check the setting of the inverter's function code data. In "Function code edit", you can list and edit function code details such as the function code No., name, setting value, setting range, and factory default.

5.5.2.2 Trace back

Trace back uses waveform information to monitor the running status of inverters when an alarm occurs.

- Sampling time: Current (500 μs or less), no current (1 to 200 ms)
- Display data size: Analog: 8 channels, digital: 16 channels
- Data selection size: Analog: 32 items, digital: 211 items
- Data amount: 1100 points/channel (before trigger: 1000 points, after trigger: 100 points)



FRENIC-VG

6

Chapter 6
CONTROL OPTIONS

This chapter describes the FRENIC-VG's control options.

Contents

6.1 Common Specifications

6.1.1 Specifications table

Table 6.1.1

Category	Name	Model	Switch-accessible functions	Specifications	See section
Analog cards	F/V converter (*1)	OPC-VG1-FV		F/V converter	6.9
	Synchro interface (*1)	OPC-VG1-SN		Dancer control synchro interface circuit	6.10
	Aio expansion card	OPC-VG1-AIO		2 [Ai] + 2 [Ao] expansion card	6.13
	Ai expansion card	OPC-VG1-AI		2 [Ai] expansion card	-
Digital 8-bit (A and B ports only)	Di interface card	OPC-VG1-DI		16-bit Di binary or BCD 4-digit + sign speed command, torque command, and torque current command configuration	6.11
	Dio expansion card	OPC-VG1-DIO		When using the DIOA setting: Function selection Di × 4-bit + function selection Do × 8-bit expansion	6.12
				When using the DIOB setting (*1): UPAC I/O expansion Di × 16-bit + Do × 10-bit	6.12
	T-link interface card	OPC-VG1-TL		T-link interface card	6.4
	CC-Link interface card	OPC-VG1-CCL		CC-Link-compliant card	6.7
	PG interface card	OPC-VG1-PG	OPC-VG1-PG(SD)	+5 V line driver type encoder interface (A, B, Z signals) (500 kHz) Motor speed, line speed, position command, position detection	6.2
			OPC-VG1-PG(LD)		
			OPC-VG1-PG(PR)		
			OPC-VG1-PG(PD)		
		OPC-VG1-PGo	OPC-VG1-PGo(SD)	Open collector type encoder interface (A, B, Z signals) Motor speed, line speed, position command, position detection	
			OPC-VG1-PGo(LD)		
			OPC-VG1-PGo(PR)		
			OPC-VG1-PGo(PD)		
		OPC-VG1-SPGT		17-bit high-resolution ABS encoder interface	6.8
	Synchronous motor drive PMPG interface card	OPC-VG1-PMPG		+5 V line driver output / A, B, magnetic pole positions (max. 4-bit)	6.3
		OPC-VG1-PMPGo		Open collector output	
Digital 16-bit (D port only)	SX bus interface card	OPC-VG1-SX		SX bus interface card	6.5
	E-SX bus interface card	OPC-VG1-ESX		E-SX bus interface card	6.15
Safety card (*1) (E port only)	Functional safety card	OPC-VG1-SAFE		Safety standard-compliant card	-
Control circuit terminal (F port only)	High-speed serial communications-compatible terminal block	OPC-VG1-TBSI		Multiplex systems such as multi-winding motor drive systems (2 windings or more) and inductively coupled systems (*1)	6.6
Standalone options (*1)	F/V converter	MCA-VG1-FV		F/V converter	6.9
	Synchro interface	MCA-VG1-SN		Dancer control synchro interface circuit	6.10
	PG signal switch	MCA-VG1-CPG		PG/NTC signal switch (2-signal switch)	6.14
Loaders	Inverter support loader	WPS-VG1-STR		Windows CD-ROM (free edition)	-
		WPS-VG1-PCL		Windows CD-ROM (paid edition)	-

(*1) Available soon

The following table indicates which control options can be used in combination:

Table 6.1.2

CN	Port	Category	Max. no. of options installed			
			Pattern 1	Pattern 2	Pattern 3	Pattern 4
3	A	Digital 8-bit	1	1	1	1
2	B	Digital 8-bit	1	1	0	0
10	D	Digital 16-bit	1	0	0	1
16	E	Safety cards	0	0	1	1
1	F	Control circuit terminals	1	1	1	1

Constraints when an OPC control option is installed

Table 6.1.3 indicates which options can be used simultaneously.

OK: Can be used simultaneously. NG: Cannot be used simultaneously.

Table 6.1.3

	AIO	DI	DIO	TL	CCL	PG/ PGo	PMPG/ PMPGo	SPGT	ESX	SX	TBSI
VG1-AIO	NG										
VG1-DI	OK	OK									
VG1-DIO	OK	OK	OK								
VG1-TL	OK	OK	OK	NG							
VG1-CCL	OK	OK	OK	NG	NG						
VG1-PG/PGo	OK	OK	OK	OK	OK	OK(*2)					
VG1-PMPG/ PMPGo	OK	OK	OK	OK	OK	OK	NG				
VG1-SPGT	NG(*1)	OK	OK	OK	OK	OK	NG	NG			
VG1-ESX	OK	OK	OK	NG	NG	OK	OK	OK	NG		
VG1-SX	OK	OK	OK	OK	NG	OK	OK	OK	NG	NG	
VG1-TBSI	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	NG

*1) Contact your Fuji sales representative if you need to use this combination of options.

*2) The following constraints apply to use of the PG interface card (OPC-VG1-PG/PGo):

	VG1-PG/PGo(SD)	VG1-PG/PGo(LD)	VG1-PG/PGo(PR)	VG1-PG/PGo(PD)
VG1-PG/PGo(SD)	NG			
VG1-PG/PGo(LD)	OK	NG		
VG1-PG/PGo(PR)	OK	NG	NG	
VG1-PG/PGo(PD)	OK	NG	NG	NG

6.1.2 Inspecting options after delivery

6.1.2.1 Inspecting options

⚠CAUTION

- Do not use products with damaged or missing parts.
  Doing so may result in bodily injury or damage.

Once you receive the product you ordered, check the following items:

(1) Verify that the product you received is in fact the product you ordered. Check the type/model printed on the option.

Example type/model: OPC-VG1-TL

- Option name: TL → T-link interface
- Host inverter name: VG1 → FRENIC-VG

(2) Check the product for damage sustained during shipment.

(3) Verify that all accessories are included in the packaging.

Table 6.1.4 Accessories

Option model	Screws/spacers	Other (power supply harnesses, optical cables, plugs and housings)
OPC-VG1-FV, SN, AIO	Screws (M3): 3 Spacers: 3	±15 V use (CN12 connections)
OPC-VG1-DI		±24 V use (CN24 and CN25 connections) Sumitomo 3M Limited Plug: 10120-3000PE, Housing: 10320-52A0-008
OPC-VG1-DIO		±24 V use (CN24 and CN25 connections) Sumitomo 3M Limited Plug: 10136-3000PE, Housing: 10336-52A0-008
OPC-VG1-TL, CCL		
OPC-VG1-PG/PGo		
OPC-VG1-PMPG/ PMPGo		Sumitomo 3M Limited Plug: 10120-3000PE, Housing: 10320-52A0-008
OPC-VG1-SPGT		
OPC-VG1-SX, ESX	Screws (M3): 2 Spacers: 4	
OPC-VG1-TBSI		Plastic optical cable (5 m, 1 per card)
MCA-VG1-FV, SN, CPG		
WPS-VG1-STR, PCL		

6.1.2.2 Operating environment

Options are designed for use in the same operating environment as the FRENIC-VG.

Table 6.1.5 Operating Environment

<table>
<tr><th>Item</th><th colspan="4">Specifications</th></tr>
<tr><td>Location</td><td colspan="4">Indoors</td></tr>
<tr><td>Ambient temperature</td><td colspan="4">-10 to +50°C</td></tr>
<tr><td>Relative humidity</td><td colspan="4">5% to 95% (non-condensing)</td></tr>
<tr><td>Atmosphere</td><td colspan="4">Avoid exposure to dust, direct sunlight, corrosive gases, oil mist, steam, and water droplets. Avoid exposure to excessive salt content. Avoid use in environments where abrupt changes in temperature may cause condensation or freezing.</td></tr>
<tr><td>Elevation</td><td colspan="4">1000 m or less</td></tr>
<tr><td rowspan="5">Oscillation</td><td colspan="2">55 kW or less (200 V circuits),
75 kW or less (400 V circuits)</td><td colspan="2">75 kW or more (200 V circuits),
90 kW or more (400 V circuits)</td></tr>
<tr><td>3 mm
(max. amplitude)</td><td>Greater than or equal to 2 Hz and less than 9 Hz</td><td>3 mm
(max. amplitude)</td><td>Greater than or equal to 2 Hz and less than 9 Hz</td></tr>
<tr><td>9.8m/s^2</td><td>Greater than or equal to 9 Hz and less than 20 Hz</td><td>2m/s^2</td><td>Greater than or equal to 9 Hz and less than 55 Hz</td></tr>
<tr><td>2m/s^2</td><td>Greater than or equal to 20 Hz and less than 55 Hz</td><td>1m/s^2</td><td>Greater than or equal to 55 Hz and less than 200 Hz</td></tr>
<tr><td>1m/s^2</td><td>Greater than or equal to 55 Hz and less than 200 Hz</td><td></td><td></td></tr>
</table>

Note: Use of options in an operating environment that does not satisfy these conditions may result in decreased performance and service life or equipment failure.

6.1.3 Storing options

6.1.3.1 Temporary storage

Options should be stored in an environment that satisfies the conditions listed in Table 6.1.6.

Table 6.1.6 Storage Environment

Item	Specifications	
Ambient temperature	-10 to +50°C	Avoid use in environments where abrupt changes in temperature may cause condensation or freezing.
Storage temperature (Note 1)	-25 to +70°C	
Relative humidity	5 to 95% (Note 2)	
Atmosphere	Avoid exposure to dust, direct sunlight, corrosive gases, flammable gas, oil mist, steam, water droplets and oscillation. Avoid exposure to excessive salt content.	

(Note 1): Storage temperatures assume short-term exposure as during shipment.

(Note 2): Condensation or freezing may occur in locations where there are significant changes in temperature, even if the humidity satisfies the specifications. Avoid storage in such locations.

(1) Do not place options directly on the floor. Instead, store on a table or shelf.

(2) If the storage environment does not satisfy the conditions listed in Table 6.1.6, wrap the option in a vinyl sheet, polyethylene film designed for packaging use, or other material.

(3) If exposure to humidity is a concern, place a desiccant (silica gel, etc.) inside the packaging and then wrap as described in (2) above.

6.1.3.2 Long-term storage

The method used to store options for an extended period of no use after purchase varies greatly with the storage environment. If the device must be stored under precisely controlled conditions, consult the company from which you purchased the product or your nearest Fuji sales office with information about the specific specifications.

Generally speaking, the following storage practices should be observed:

(1) Options should be stored in an environment that meets the temporary storage conditions.

(2) Options should be packaged carefully to prevent the incursion of humidity and foreign matter. Enclose a desiccant (silica gel, etc.) in the packaging. See JIS Z 0301 (damp-proof packaging methods) for the quantity of desiccant to use. Aim for a relative humidity of 70% or less inside the packaging.

When the option is to be installed in the FRENIC-VG and then left unused in a device or control panel for a period of time, particularly at a location where construction work is being carried out, the device is likely to be exposed to humidity and dust. In such situations, remove the entire FRENIC-VG inverter and store it in an environment that satisfies the conditions listed in Table 6.1.6.

6.1.4 Installing internal options (OPC-VG1-□□)

6.1.4.1 Removing the front cover

⚠CAUTION

- Inappropriate installation or removal of the product may cause damage to the product.
- Shut off the inverter's input power supply and verify that the charge lamp (CHARGE) has gone out before installing or removing options. When external control circuits are powered by separate power supplies, the inverter's 30A, 30B, 30C, Y5A, and Y5C control terminals may be energized, even when all inverter main circuits, control, and auxiliary power supplies are off (open). To avoid electric shock, ensure that all external power supplies are off (open).

Remove the inverter's front cover as shown in the following figures. Note that the method for removing the cover depends on which inverter model (capacity) you are using.

FRN22VG1S-2J/4J (22 kW) or lower

As shown in Figure 6.1.1, loosen the one mounting screw on the front cover at location (a) and grip the top of the cover to remove it.

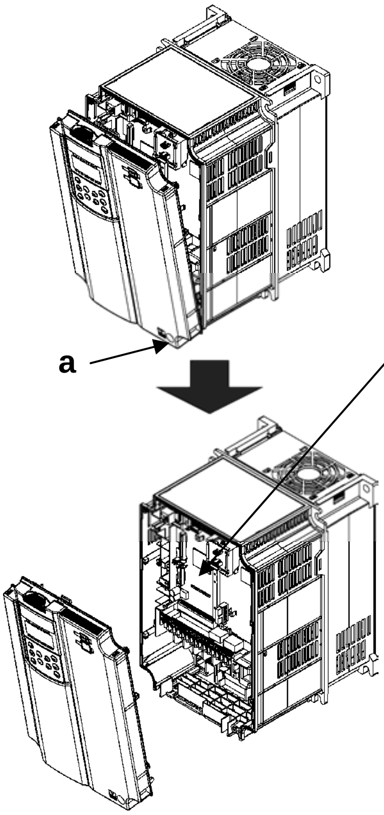


Figure 6.1.1 Removing the Front Cover FRN22VG1S-2J/4J (22 kW) or lower

FRN30VG1S-2J/4J (30 kW) or greater

(1) As shown in Figure 6.1.2, remove the mounting screws on the front cover at location (b) (the number of screws varies with the inverter's capacity) and remove the front cover.

(2) Open the keypad case.

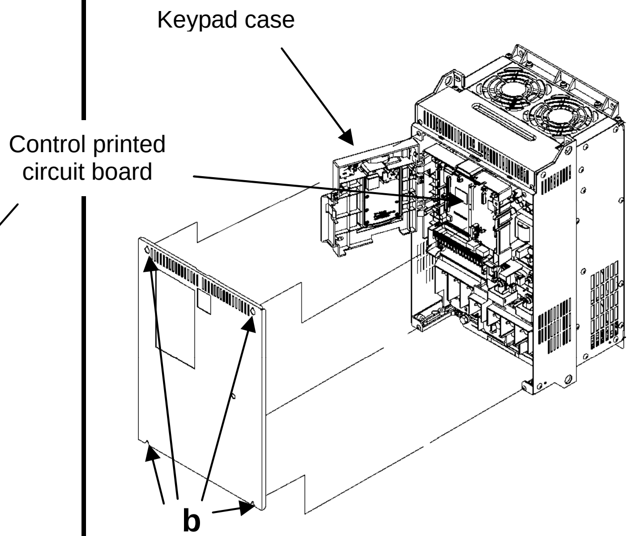


Figure 6.1.2 Removing the Front Cover FRN30VG1S-2J/4J (30 kW) or greater

6.1.4.2 Installing a digital 8-bit communications option card

The following options ("communications option cards") are connected to either the CN2 (lower) or CN3 (upper) connector on the control printed circuit board.

Options
OPC-VG1-TL
OPC-VG1-CCL

- When not using the communications option card at the same time as a digital 16-bit option (OPC-VG1-SX, etc.), follow "**Installation method 1**" below.
- When using the communications option card at the same time as a digital 16-bit option (OPC-VG1-SX, etc.), follow "**Installation method 2**" below.

■ **Installation method 1 (when not using the option at the same time as a digital 16-bit option card)**

(When connecting the card to CN2 [the lower connector])

(1) Attach the three included spacers (d) to the three option mounting fixtures (a) through (c) on the control printed circuit board.

(2) Install the communications option card so that connector CN1 (on the back of the communications option card) connects to connector CN2 on the control printed circuit board.

(3) Tighten the three included screws (e) to secure the communications option card in place.

(4) Referring to Figures 6.1.1 and 6.1.2, "Removing the Front Cover," reverse the procedure to reattach the front cover.

(When connecting the card to CN3 [the upper connector])

(1) Attach the three included spacers (d) to the three option mounting fixtures (a) through (c) on the control printed circuit board.

(2) Install the communications option card so that connector CN1 (on the back of the communications option card) connects to connector CN3 on the control printed circuit board.

(3) Tighten the three included screws (e) to secure the communications option card in place.

(4) Referring to Figures 6.1.1 and 6.1.2, "Removing the Front Cover," reverse the procedure to reattach the front cover.

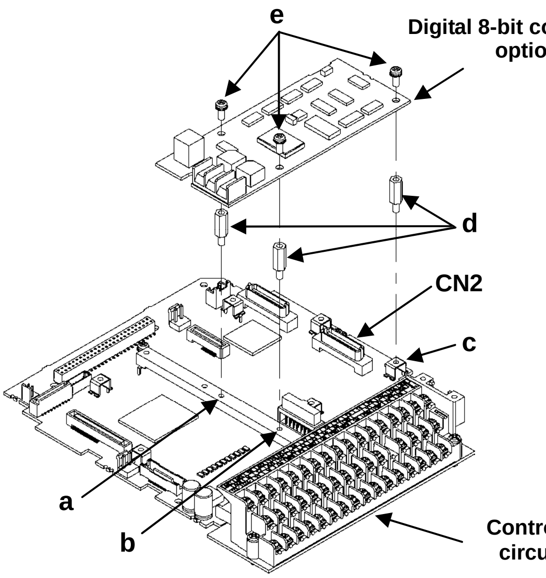


Figure 6.1.3 Installing a Communications Option Card (Connected to CN2)

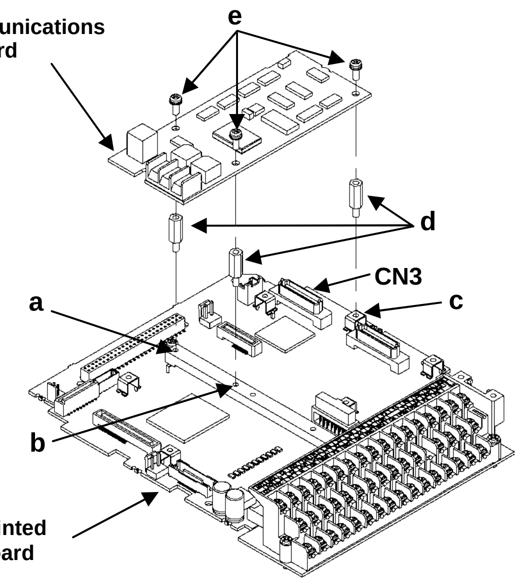
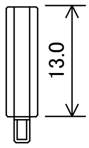


Figure 6.1.4 Installing a Communications Option Card (Connected to CN3)

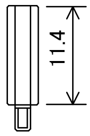
■ Installation method 2 (when using the option at the same time as a digital 16-bit option card)

⚠CAUTION

The dimensions of the spacers included with communications option cards and those included with digital 16-bit option cards differ slightly. See the following diagram when determining which spacers to use. Use of the wrong spacers may damage the product.



Spacers included with communications option cards



Spacers included with digital 16-bit option cards

(Unit: mm)

(When connecting to CN2 [the lower connector])

(1) Install the digital 16-bit option, connecting it to the CN10 connector on the control printed circuit board.

(2) Attach the two screws (a) included with the digital 16-bit option to mounting holes ① and ② on the digital 16-bit option, and attach four spacers (b) to holes ③ through ⑥.

(3) Attach one spacer (d) included with the communications option card to the option mounting fixture (c) on the control printed circuit board.

(4) Install the communications option card so that connector CN1 (on the back of the communications option card) connects to connector CN2 on the control printed circuit board.

(5) Tighten the three included screws (e) to secure the communications option card in place.

(6) Referring to Figures 6.1.1 and 6.1.2, "Removing the Front Cover," reverse the procedure to reattach the front cover.

(When connecting to CN3 [the upper connector])

(1) Install the digital 16-bit option, connecting it to the CN10 connector on the control printed circuit board.

(2) Attach the two screws (a) included with the digital 16-bit option to mounting holes ① and ② on the digital 16-bit option, and attach four spacers (b) to holes ③ through ⑥.

(3) Attach one spacer (d) included with the communications option card to the option mounting fixture (c) on the control printed circuit board.

(4) Install the communications option card so that connector CN1 (on the back of the communications option card) connects to connector CN3 on the control printed circuit board.

(5) Tighten the three included screws (e) to secure the communications option card in place.

(6) Referring to Figures 6.1.1 and 6.1.2, "Removing the Front Cover," reverse the procedure to reattach the front cover.

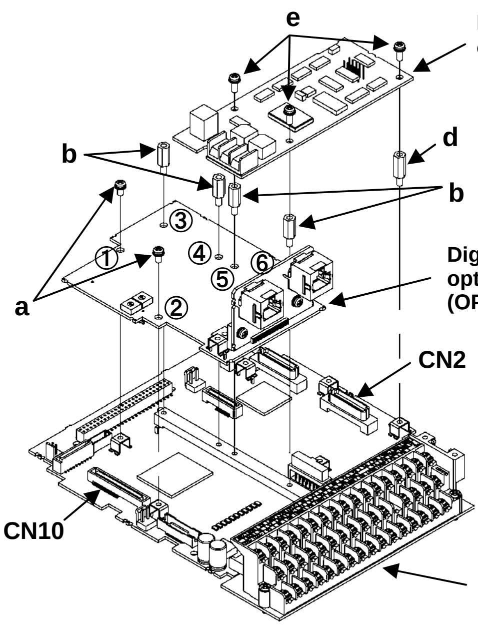


Figure 6.1.5 Installing a Communications Option Card (Connected to CN2)

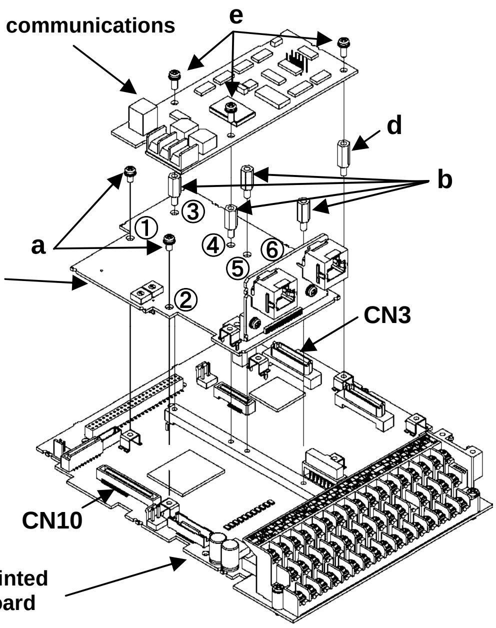


Figure 6.1.6 Installing a Communications Option Card (Connected to CN3)

6.1.4.3 Installing a digital 8-bit option card

The following options ("digital option card") can be connected to either the CN2 (lower) or CN3 (upper) connector on the control printed circuit board. However, the OPC-VG1-SPGT must be connected to CN2 (the lower connector).

Options
OPC-VG1-PG/PGo
OPC-VG1-PMPG/ PMPGo
OPC-VG1-SPGT

- When not using the digital option card at the same time as a digital 16-bit option (OPC-VG1-SX, etc.), follow "**Installation method 1**" below.
- When using the digital option card at the same time as a digital 16-bit option (OPC-VG1-SX, etc.), follow "**Installation method 2**" below.

■ **Installation method 1 (when not using the option at the same time as a digital 16-bit option card)**

(When connecting to CN2 [the lower connector])

(1) Attach the three included spacers (d) to the three option mounting fixtures (a) through (c) on the control printed circuit board.

(2) Install the digital option card so that connector CN1 (on the back of the digital option card) connects to connector CN2 on the control printed circuit board.

(3) Connect the power supply harness running from the top of the digital option card to CN24 on the control printed circuit board. For OPC-VG1-SPGT, connect the harness to CN12.

(4) Tighten the three included screws (e) to secure the digital option card in place.

(5) Referring to Figures 6.1.1 and 6.1.2, "Removing the Front Cover," reverse the procedure to reattach the front cover.

(When connecting to CN3 [the upper connector])

(1) Attach the three included spacers (d) to the three option mounting fixtures (a) through (c) on the control printed circuit board.

(2) Install the digital option card so that connector CN1 (on the back of the digital option card) connects to connector CN3 on the control printed circuit board.

(3) Connect the power supply harness running from the top of the digital option card to CN25 on the control printed circuit board.

(4) Tighten the three included screws (e) to secure the digital option card in place.

(5) Referring to Figures 6.1.1 and 6.1.2, "Removing the Front Cover," reverse the procedure to reattach the front cover.

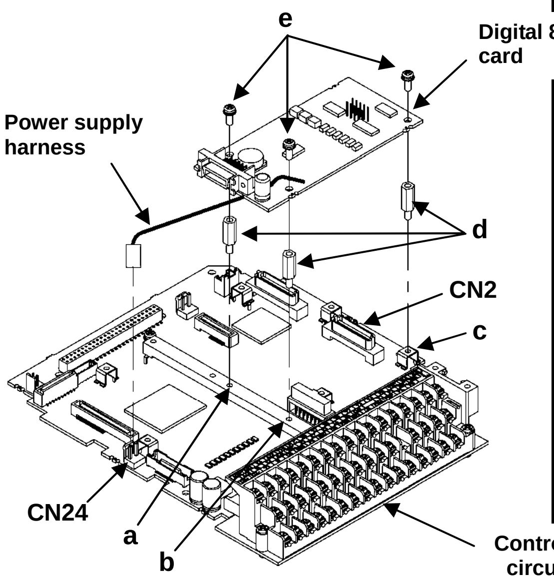


Figure 6.1.7 Installing a Digital Option Card (Connected to CN2)

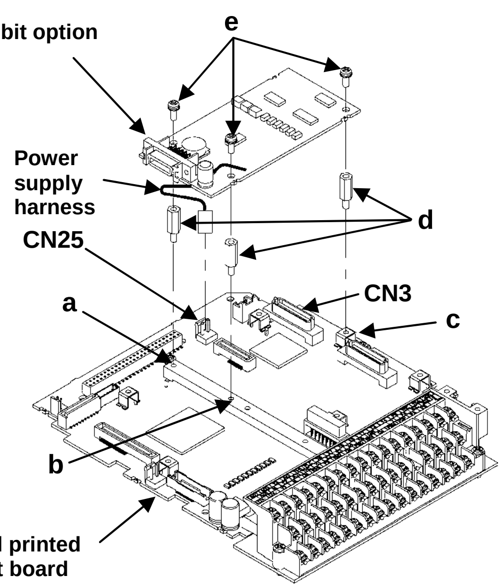
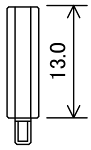


Figure 6.1.8 Installing a Digital Option Card (Connected to CN3)

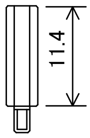
■ Installation method 2 (when using the option at the same time as a digital 16-bit option card)

⚠CAUTION

The dimensions of the spacers included with digital option cards and those included with digital 16-bit option cards differ slightly. See the following diagram when determining which spacers to use. Use of the wrong spacers may damage the product.



Spacers included with digital option cards



Spacers included with digital 16-bit option cards

(Unit: mm)

(When connecting to CN2 [the lower connector])

(1) Install the digital 16-bit option, connecting it to the CN10 connector on the control printed circuit board.

(2) Attach the two screws (a) included with the digital 16-bit option to mounting holes ① and ② on the digital 16-bit option, and attach four spacers (b) to holes ③ through ⑥.

(3) Attach one spacer (d) included with the digital option card to the option mounting fixture (c) on the control printed circuit board.

(4) Install the digital option card so that connector CN1 (on the back of the digital option card) connects to connector CN2 on the control printed circuit board.

(5) Connect the power supply harness running from the top of the digital option card to CN24 on the control printed circuit board. For OPC-VG1-SPGT, connect the harness to CN12.

(6) Tighten the three included screws (e) to secure the digital option card in place.

(7) Referring to Figures 6.1.1 and 6.1.2, “Removing the Front Cover,” reverse the procedure to reattach the front cover.

(When connecting to CN3 [the upper connector])

(1) Install the digital 16-bit option, connecting it to the CN10 connector on the control printed circuit board.

(2) Attach the two screws (a) included with the digital 16-bit option to mounting holes ① and ② on the digital 16-bit option, and attach four spacers (b) to holes ③ through ⑥.

(3) Attach one spacer (d) included with the digital option card to the option mounting fixture (c) on the control printed circuit board.

(4) Install the digital option card so that connector CN1 (on the back of the digital option card) connects to connector CN3 on the control printed circuit board.

(5) Connect the power supply harness running from the top of the digital option card to CN25 on the control printed circuit board.

(6) Tighten the three included screws (e) to secure the digital option card in place.

(7) Referring to Figures 6.1.1 and 6.1.2, “Removing the Front Cover,” reverse the procedure to reattach the front cover.

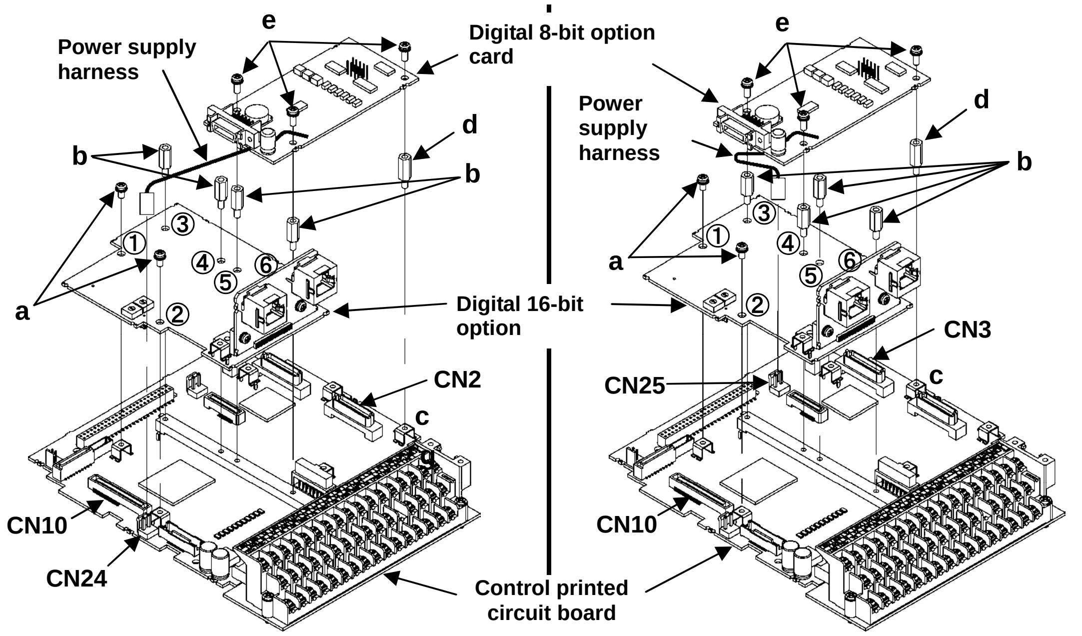


Figure 6.1.9 Installing a Digital Option Card (Connected to CN2)

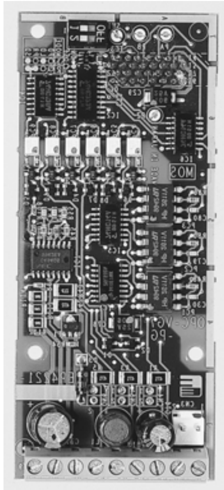
Figure 6.1.10 Installing a Digital Option Card (Connected to CN3)

6.1.4.4 Installing a digital 16-bit option card

Install the digital 16-bit option card by following steps (1) and (2) in "Installation method 2 (<u>when using the option at the same time</u> as a digital 16-bit option card)" in "6.1.4.2 Installing a digital 8-bit communications option card."

6.2 PG Interface Expansion Card

6.2.1 Product overview



The PG interface expansion card is used when performing speed control using an interface such as a line driver output type encoder, or when performing synchronized operation or rotational positioning (orientation) of multiple motors. Since the FRENIC-VG's built-in PG interface generates 15 V and 12 V complementary (totem pole, push-pull) output, the built-in PG interface function is used when performing speed control with PG feedback using a normal FRENIC-VG standard motor.

(1) Principal applications

- When interfacing with a PG that is not supported by the built-in PG interface, for example a 5 V line driver output type PG interface
- When you wish to detect the line speed using a PG installed on the line
- When you wish to drive the motor using pulse train commands or perform synchronized operation (*1)
- When you wish to perform orientation (rotational positioning) (requires separate UPAC option) (*1)
  To provide separate support for applications such as this one, switches SW1 and SW2 on the PG interface expansion card can be set to SD, LD, PR, or PD (from the top in order).

(*1) Available soon

(2) Hardware

Since the interface uses photocoupler insulation, PG wiring may be up to 50 m long with line driver signals and a small wiring voltage drop.

(3) Broken wire detection function

The broken wire detection function can be used when using SD motor speed detection. When a broken wire is detected, the inverter will display alarm PG, and the interruption of inverter output will cause the motor to perform a free-run stop. However, this function is not available when using the open collector/voltage output model (OPC-VG1-PGo). The FRENIC-VG ships with PG broken wire detection cancelation functionality in its standard configuration.

(4) PG interface expansion card function codes

PG interface expansion card codes (o05 to 08 and o12 to 19) are used for pulse compensation and other functionality when performing position and line control.

(5) PG frequency division output

As with the built-in PG, when performing speed control with the optional PG set to SD, the FA and FB built-in terminal blocks can be used to generate open collector output and complementary output by dividing the pulse signal frequency.

(6) Input format selection

When using the PG interface expansion card to perform speed detection (SD, LD), input signals are fixed to two signals (A- and B-phase) with a 90° phase difference. When receiving a pulse train (PR), you can select from three signal types using function codes (o13: pulse train input format selection).

6.2.2 Model and specifications

6.2.2.1 Model

⚠CAUTION
• There are two models for the PG interface expansion card, reflecting differences in the external equipment output interface: OPC-VG1-PG: Line driver signals OPC-VG1-PGo: Open collector/voltage output Exercise care that you do not specify the wrong model when purchasing one of the cards.

The model for the FRENIC-VG's PG option reflects differences in the external equipment output interface (line driver output versus open collector output/voltage output). Since the interface type cannot be selected with switches, it is necessary to determine which interface you require before purchase (OPC-VG1-PG, OPC-VG1-PGo).

Applications can be changed after purchase using hardware switches on the PG interface expansion card (SW1, SW2).

Model format:

OPC-VG1-PG□(□□)

- **PD** (pulse detection): For pulse detection
- **LD** (line speed detection): For line speed detection
- **PR** (pulse reference): For pulse command input
- **SD** (speed detection): For motor speed detection

- None: Line driver output model (provides PG broken wire detection function when SD is selected)
- **o**: Open collector output and voltage output model (no PG broken wire detection function)

PG: Pulse generator interface expansion card

VG1 → FRENIC-VG inverter

Accessories

Spacers: 3

Screws (M3): 3

SW1 and SW2 settings

For example, to perform speed control for a motor that includes a line driver output type encoder, you would order the OPC-VG1-PG and select SD with the switches as the speed control application. To perform synchronized operation based on received pulse trains, set the switches to PR.

Table 6.2.1 Option Switch Settings

Function	SW1	SW2	
PD	OFF	OFF	
LD	ON	OFF	
PR	OFF	ON	(Factory default)
SD	ON	ON	

6.2.2.2 Specifications

⚠CAUTION

- Failure to set the switches on the PG interface expansion card (SW1, SW2) correctly will prevent the system from operating properly. Read information about the settings below and be sure to set the switches correctly.
- When performing rotational positioning, set the switches to PG (PD). Use of the card in this configuration requires the separate UPAC option.

Table 6.2.2 Hardware specifications

Item	Specifications	
Model	OPC-VG1-PG	OPC-VG1-PGo
Signal type	Line driver output (recommended AM26LS31PC or equivalent)	Open collector output Voltage output
Mode switching	SW1 and SW2 on the PG interface expansion card are used to switch modes as follows: (SW1, SW2) = (OFF, OFF) : (ON, OFF) : (OFF, ON) : (ON, ON) = **PD : LD : PR : SD**	
Applications	Motor speed detection (SD), Line speed detection (LD), Pulse detection (PD), Pulse command input (PR)	
PG power supply	**The PG interface expansion card uses a 5 V power supply.** [PGP] terminal: +5 V ±5%, 250 mA [PGM] terminal: Common Includes an overcurrent protection function. Internal photocoupler insulation (connected to [PGM] and [CM] on the inverter's control Pt board; isolated from [M])	
Signal pins	[PA], [*PA], [PB], [*PB], [PZ], [*PZ] Photocoupler insulation	[PA], [PB], [PZ] Photocoupler insulation ([*PA], [*PB], and [*PZ] are not used.)
Connections (see basic connection diagram)	Line driver output type Connect a 5 V power supply to [PGP] and [PGM]. Other 5 V power supplies cannot be used. Since a balanced circuit is used, it is necessary to use twisted-pair shielded cable for wiring.	Open collector output type Built-in 5 V pull-up, sink current: 8 mA max./circuit (Can be used when connected to the FRENIC-VG's [FA] and [FB] terminals.) Voltage output type L level voltage detection: 0 V to 2 V or less H level voltage detection: 4 V to 15 V
Input format	Can select from 3 types using the o13 function code (pulse train input format selection). 2 signals (A- and B-phase) with 90° phase difference A-phase: Command pulse; B-phase: Command code A-phase: Run forward pulse; B-phase: Run reverse pulse	
Pulse output	Open collector output or complementary output can be generated by dividing the frequency of the input pulse with the inverter's built-in [FA], [FB], and [CM] terminals. Max. output frequency: 100 kHz; 15 mA max., 1.5 mA min., 27 V max./circuit	
Max. input pulse frequency	500 kHz, duty: 50 ±10%	100 kHz, duty: 50 ±10%
Allowable wiring length	Approx. 50 m Shorter wiring lengths are required when there is a high voltage drop. For wiring runs of 50 m or greater, use an insulation converter as described in "6.2.4.2 Wiring."	10 m or less Keep wiring runs as short as possible to avoid the effects of noise.
Power supply	24 V Supplied from the inverter's printed circuit board. Connect the power supply harness to CN24 or CN25 on the inverter.	

Input signal format (run reverse signals * omitted)

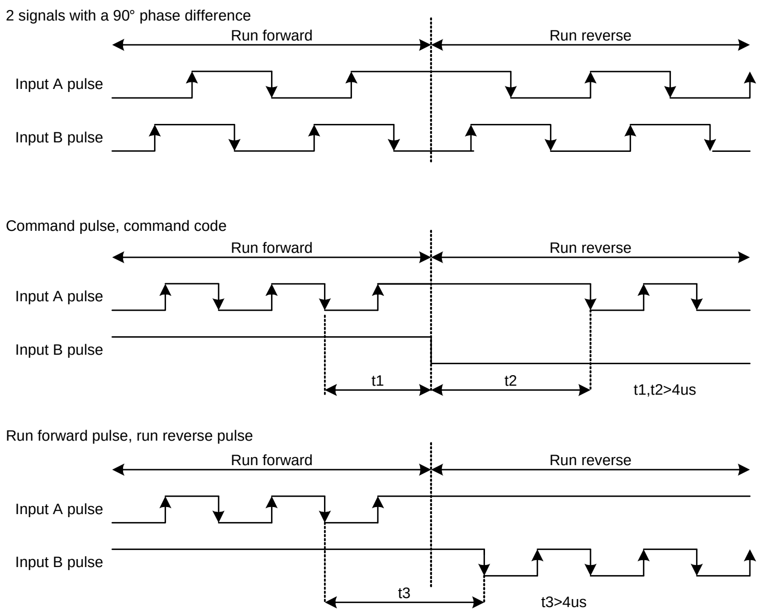


Figure 6.2.1

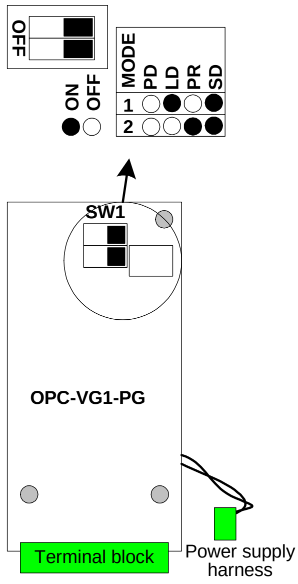
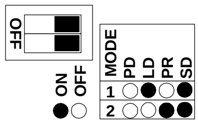


Figure 6.2.2

Software specifications

(1) Speed control specifications



Specifications are the same as when the built-in PG interface is used.

Figure 6.2.3

Table 6.2.3

Item		Speed control specifications
Card type (setting)		OPC-VG1-PG□(SD)
Motor control method		Vector control for IM with speed sensor
Speed control Vector control with speed sensor	Control range	1:1500 (min. speed: base speed, 1.0 to 1,500 r/min. with 4P conversion, using 1024 P/R) 1:6 (constant torque region:constant output region)
	Speed control accuracy	Analog setting: ±0.1% of max. speed Digital setting: ±0.005% max. speed
PG interface functionality		When the PG interface expansion option is installed and set to SD, the built-in PG function is disabled, and the PG option takes priority.
Broken wire detection function		Yes
Frequency division output		Output can be generated by dividing the frequency of PG interface expansion card pulses input from the standard [FA] and [FB] terminals.

(2) Line speed control specifications

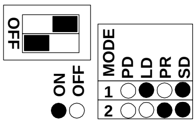


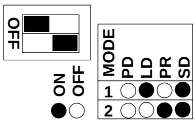
Figure 6.2.4

This configuration is used when controlling the line speed of a winding device using a PG installed on the line, rather than motor speed control.

Table 6.2.4

Item		Line speed control specifications
Card type (setting)		OPC-VG1-PG□(LD)
Control method		Vector control with speed sensor (induction motor, line speed control) Line speed control is built into the standard configuration.
Line speed Vector control with speed sensor	Control range	1:1500 (min. speed: base speed, 1.0 to 1,500 r/min. with 4P conversion, using 1024P/R) 1:6 (constant torque region:constant output region)
	Speed control accuracy	Analog setting: ±0.1% of max. speed Digital setting: ±0.005% max. speed
PG interface functionality		With the PG interface expansion card installed and the LD setting active: Function code H53 = 2: Line speed detection enabled Function code H53 = 3: High selector (line speed detection, motor speed detection using built-in PG) The encoder pulse count can be set using the o06 function code.
Pulse compensation		Compensation can be performed using the o07 and 08 function codes.
Broken wire detection function		None
Application functionality		The speed can be set for 15 speed stages in m/min. (function codes C05 to C21). Line speed detection (±max. speed/±10 V) output can be generated for AO output.
Frequency division output		Output can be generated by dividing the frequency of standard built-in PG interface input (line PG is not output).

(3) Pulse train and synchronous drive specifications



Operation conforms to pulse train input.
Master/slave synchronized operation is possible.

Figure 6.2.5

Table 6.2.5

Item		Pulse train and synchronous drive specifications
Card format (setting)		OPC-VG1-PG□(PR)
Broken wire detection function		None
Synchronous drive	Function	Ships standard with a built-in synchronous drive function.
	No. of synchronous units connectable	Supports cascading connections (see Figure 6.2.6). When using open collector output from a pulse oscillator or insulated pulse amp and connecting the devices in parallel, the number of units connectable depends on the requirement of 8 mA of sink current per circuit. For example, if the output maximum rating for the devices is 25 mA, up to 3 can be connected (24 mA = 3 × 8 mA).
Speed control	Valid setting range	0 to ±30,000 r/min. However, the input pulse frequency cannot exceed 500 kHz (OPC-VG1-PG) or 100 kHz (OPC-VG1-PGo).
	Speed control accuracy	±0.005% of maximum speed (Accuracy relative to steady-state deviation due to temperature fluctuations or load.)
Position control	Position response	10 Hz Response is adjusted using the APR gain and ASR gain.
	Synchronous accuracy (see following figure)	Within ±2 pulses (F/F gain is set to 1.0 during steady-state or transient operation) When F/F gain ≠ 1.0, steady-state or transient deviations may occur.
	Lock accuracy	Within ±1 pulse Opposing torque can be 150%.

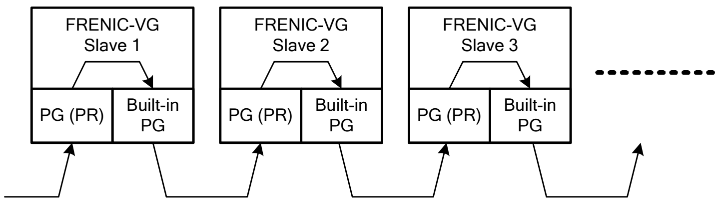
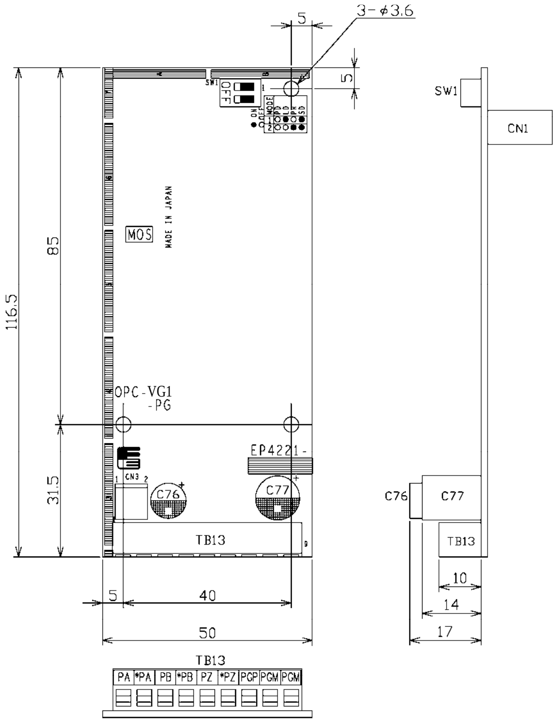
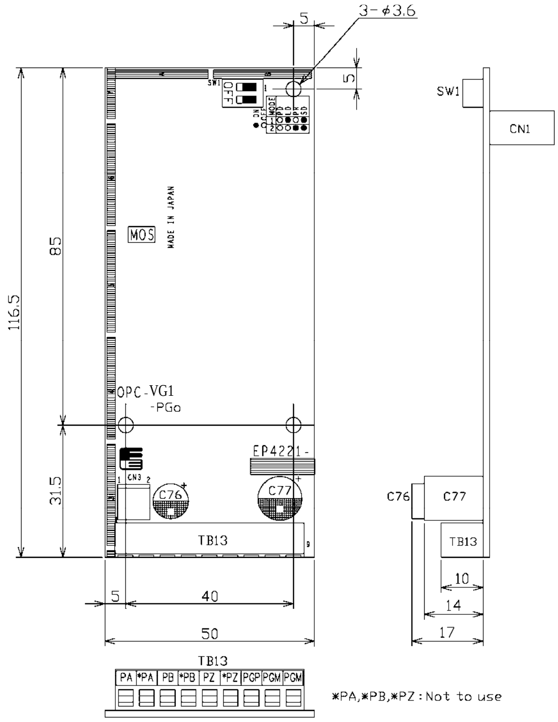


Figure 6.2.6

6.2.3 External dimension diagram





(Unit: mm)

Figure 6.2.7 OPC-VG1-PG Outline Drawing

Figure 6.2.8 OPC-VG1-PGo Outline Drawing

6.2.4 Basic connection diagram

Refer to "6.1.4 Installing Built-in Options (OPC-VG1-□□)" before performing wiring or connection work.

⚠WARNING

- Performing connection work in an inappropriate manner may result in electric shock, fire, or other damage. Qualified electricians should carry out wiring. When touching electrical circuits, for example when performing connection work after the unit has been energized, shut off the power supply's circuit breaker to prevent electric shock.
- The smoothing capacitor remains charged even when the circuit breaker is shut off and will cause an electric shock when touched. Verify that the inverter's charge lamp ("CHARGE") has turned off and use a tester or other instrument to verify that the inverter's DC voltage has fallen to a safe level.

⚠CAUTION

- Do not use products with damaged or missing parts. Doing so may result in bodily injury or damage.
- Inappropriate installation or removal of the product may cause damage to the product.
- Failure to set the switches on the PG interface expansion card (SW1, SW2) correctly will prevent the system from operating properly. Read information about the settings below and be sure to set the switches correctly.

6.2.4.1 Terminal connections

The PG interface expansion card's connection terminals use a wire size of 16 to 26 AWG. When using the connection terminals with stripped wires, strip to a length of 6 mm. When using crimp contacts, use a rod-shaped terminal with vinyl insulation. Insert the wire so that it is held in place on the top of the terminal block's fixture and tighten the screw to hold it in place.

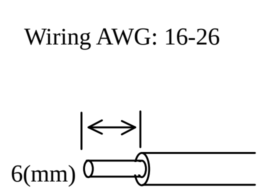


Figure 6.2.9 End of Wire at the PG Interface Expansion Card's Connection Terminal

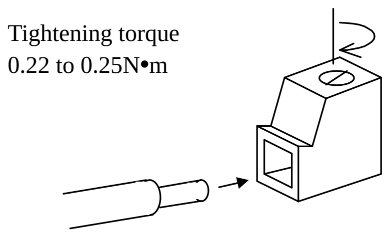


Figure 6.2.10 Connecting a Wire to the PG Interface Expansion Card's Terminal

6.2.4.2 Wiring

Wiring between the PG interface expansion card and a pulse generator, PG, or other device

- Use shielded wire for PG interface expansion card wiring. Wiring length is subject to constraints depending on the interface type (see table below).
- Connect the shielded wire's housing to the external device or the motor's earth terminal and leave open at the inverter.
- To prevent malfunctions due to noise on PG interface expansion card wiring, leave as much distance as possible between wiring and the inverter's main circuit wiring and other power lines (10 cm or more) and never place wiring in the same conduit as power lines.

Table 6.2.6

External interface	Wiring length guideline	Application
Line driver type	Within 50 m	Use when connecting a line driver output type encoder. The 50 m figure for wiring length is a guideline based on the assumption that measures have been taken to limit the voltage drop, for example by using thicker signal wires for power lines (PGP, PGM).
Open collector output type	Within 10 m	Can be used when connecting the master device's [FA] and [FB] open collector outputs to [PA] and [PB] on the slave PGo (PR).
Voltage output type		Use when connecting a voltage output device or a device that uses an external power supply. It is necessary to exercise caution concerning the maximum voltage of 15 V and threshold values. (L level voltage detection: 0 V to 2 V; H level voltage detection: 4 V to 15 V)

Recommended insulation converters (insulated amps)

- When the wiring length will be 50 m or greater with a line driver type device (combination of motor PG and FRENIC-VG), use an insulation converter. The insulated amp type and manufacturer are as follows:

  SHC-205P05D (Faith, Inc.): 200 V power supply input
  SHC-105P05D (Faith, Inc.): 100 V power supply input

- When connecting multiple FRENIC-VG units in parallel to the slave device using open collector type signaling, the maximum number of slave devices is one. When connecting two or more devices, use an insulated amp. The insulated amp type and manufacturer are as follows:

  SHC-205C24C (Faith, Inc.): 200 V power supply input
  SHC-105C24C (Faith, Inc.): 100 V power supply input

6.2.4.3 Speed control

This connection example illustrates how to drive a motor (a Fuji servomotor, etc.) to which a line driver output type encoder or open collector or complementary type encoder.

Since the speed is detected and calculated based on received pulses, the PG interface expansion card must be set to SD. Since frequency division output can be generated using FA and FB, this approach can be used with a digital speedometer or other instrument.

When using a complementary output type encoder that supports 15 V and 12 V output, use the inverter’s PGP and PGM terminals. In this configuration, the common line is connected to the PG interface expansion card.

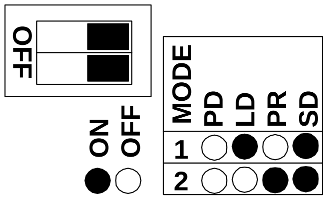


Figure 6.2.11

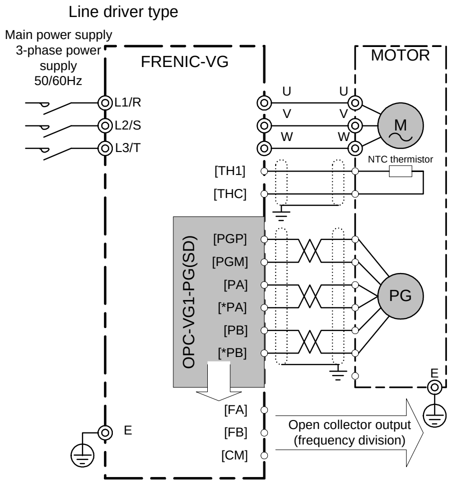


Figure 6.2.12

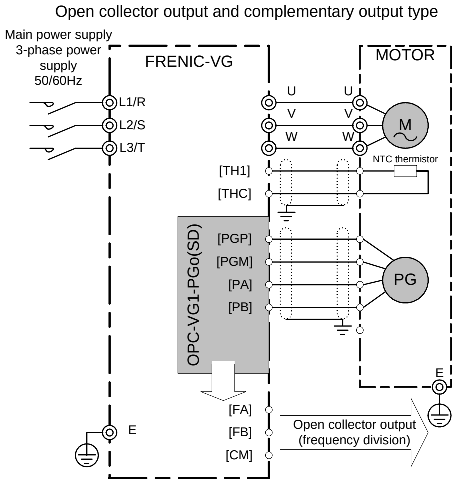


Figure 6.2.13

Note: As a rule, shielded wires are earthed. However, if excessive induced noise from external sources affects the system, the effects of such noise can be reduced by connecting shielded wires to 0 V.

6.2.4.4 Line speed control

This connection example illustrates how to perform speed control after installing a line driver output type encoder on a system's winding line. Since motor speed feedback and line speed feedback can be detected simultaneously, it is possible to prevent a runaway operation scenario resulting from a cause such as a paper tear on the line. When using the PG interface expansion card in an application such as this one, it must be set to LD.

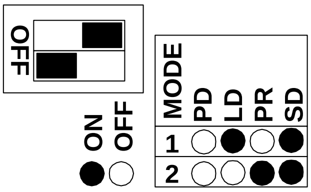


Figure 6.2.14

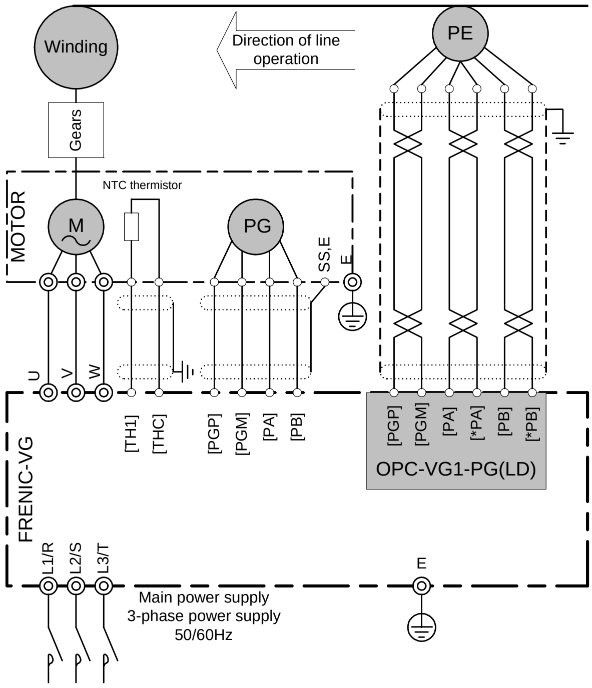


Figure 6.2.15

Note: As a rule, shielded wires are earthed. However, if excessive induced noise from external sources affects the system, the effects of such noise can be reduced by connecting shielded wires to 0 V.

6.2.4.5 Pulse train operation and synchronized operation

⚠CAUTION
• When using the FRENIC-VG's [FA] and [FB] open collector outputs to perform master/slave synchronized operation, separate open collector wiring from power lines and keep wiring runs as short as possible. When using long-distance wiring, it is recommended to provide a separate converter to convert the signals into line driver signals.

When using the PG interface expansion card in this application, set switch SW1 to PR.

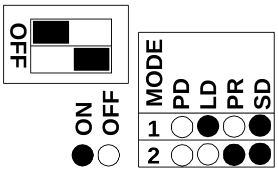


Figure 6.2.16

(1) Line driver output

The PG interface expansion card operates by receiving pulse commands from an external pulse generator or PG.

Since the FRENIC-VG receiving these signals can generate open collector output ([FA] and [FB]), the pulse signals can be passed to the next FRENIC-VG. In this way, multiple FRENIC-VG units can be driven synchronously.

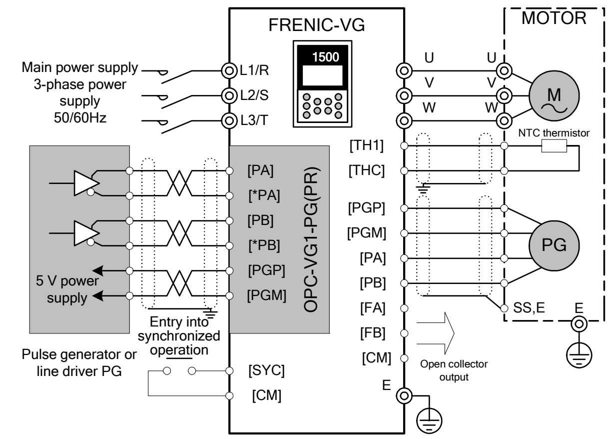


Figure 6.2.17

(2) Open collector output

Open collector output can be used when driving multiple FRENIC-VG units synchronously. The open collector output ([FA] and [FB]) generated by the master FRENIC-VG is connected to the slave FRENIC-VG's PG interface expansion card. The slave operates by receiving these pulse commands.

Since the FRENIC-VG receiving these signals can generate open collector output ([FA] and [FB]), the pulse signals can be passed to the next FRENIC-VG. In this way, multiple FRENIC-VG units can be driven synchronously.

It is recommended to install a zero-phase ferrite ring (ACL-40B) as shown in the figure to the right in order to ensure a noise margin, among other benefits.

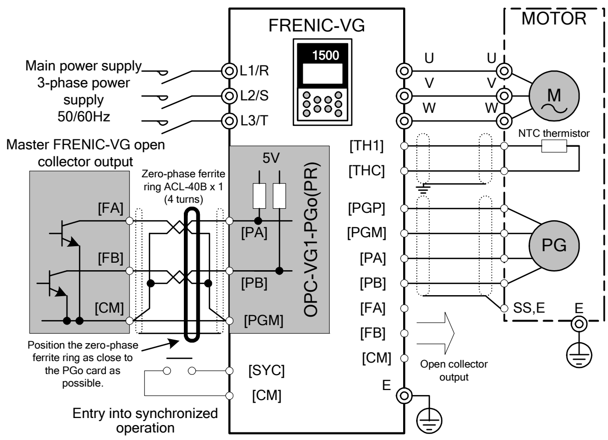


Figure 6.2.18

Precautions

The OPC-VG1-PGo (open collector type) is not suited to use in applications characterized by a challenging noise environment in which signals are routed alongside motor power lines or where wiring is run over long distances, reducing the noise margin.

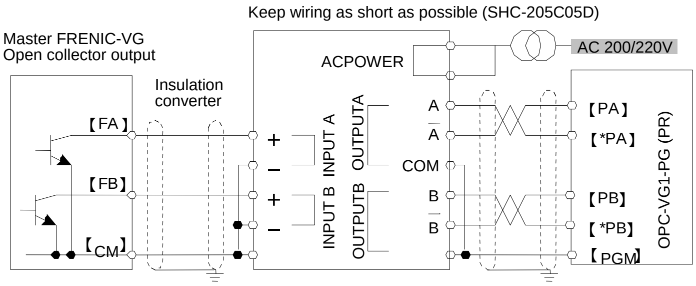


Figure 6.2.19

In such applications, it is recommended to use the architecture shown in the figure to the right, which utilizes the OPC-VG1-PG (line driver type).

Recommended insulation converter: SHC-205C05D (Faith, Inc.)

Note: As a rule, shielded wires are earthed. However, if excessive induced noise from external sources affects the system, the effects of such noise can be reduced by connecting shielded wires to 0 V.

6.2.5 Synchronized operation

6.2.5.1 Synchronized operation system architecture

Systems for synchronously operating motors with a FRENIC-VG utilize master/slave connections, cascading connections, or pulse train commands from a PLC or other external transmitter.

(1) Master/slave connections

⚠CAUTION

- When using a master/slave connection, up to one FRENIC-VG can be connected in parallel to the slave side of the system (8 mA sink current/1 circuit). Use a cascading connection if you need to connect two or more FRENIC-VG units as slaves.
- When the direction of rotation for slave motors will be opposite that of the master, use the IVS contact instead of the REV contact.

This technique allows open collector pulse output from one FRENIC-VG (the master) to be passed to PG card input of another FRENIC-VG (the slave) that you wish to operate synchronously.

Up to one FRENIC-VG can be connected in this way, as shown below.

Table 6.2.7

Master open collector output [FA], [FB], and [CM] terminals	Slave OPC-VG1-PGo [PA], [PB], and [CM] terminals
15 mA max. per circuit	8 mA max. per circuit

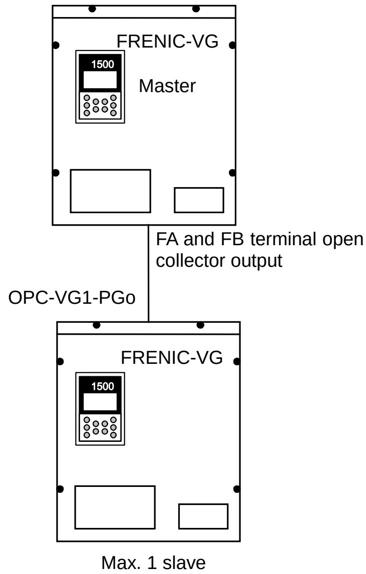


Figure 6.2.20

When using master/slave synchronized operation, the slave's synchronized operation speed is obtained by multiplying the master's speed by the pulse compensation factor (function codes o14 and 15).

Change the slave motor's direction of rotation with each slave unit's [IVS] contact (forward operation/reverse operation). The [REV] contact cannot be used in this configuration.

Table 6.2.8

Master's direction of rotation	Slave [IVS]	Slave's direction of rotation
Forward	OFF	Same as master
Forward	ON	Opposite of master
Reverse	OFF	Same as master
Reverse	ON	Opposite of master

(2) Cascading connections

⚠CAUTION

- When using a cascading connection, set function code E29 (PG pulse output selection) to 9 for slave units (slave 1, 2, etc., but not the master) in order to avoid a delay between the master and the final slave unit.

This connection method is used when connecting two or more slave units in a master/slave connection.

The description in (1) above applies between the master and the first slave unit, but function code E29 must be set between the first and second slave units.

This setting is needed so that pulse train commands from the master are passed as pulse train signals to slave 2 without being subject to software processing by slave 1.

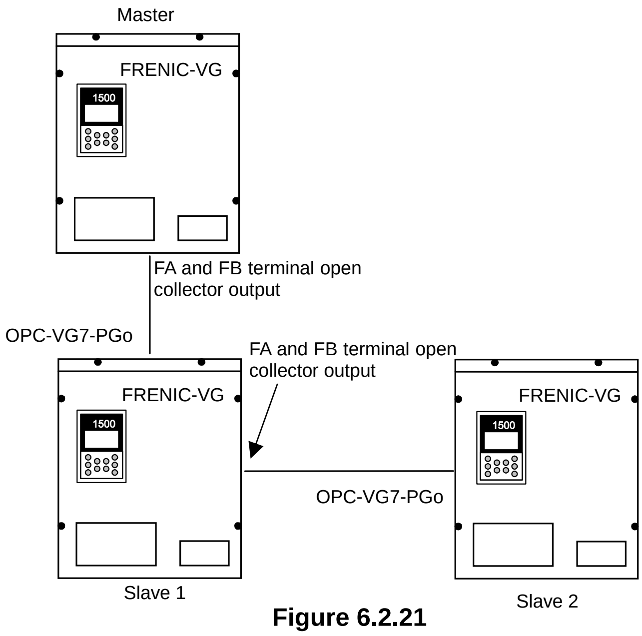


Figure 6.2.21

Table 6.2.9

Function code	Name	Setting
E29	PG pulse output selection	9: PG (PR) Generates open collector output for position command pulse input without other modification.

(3) Pulse transmitter

⚠CAUTION

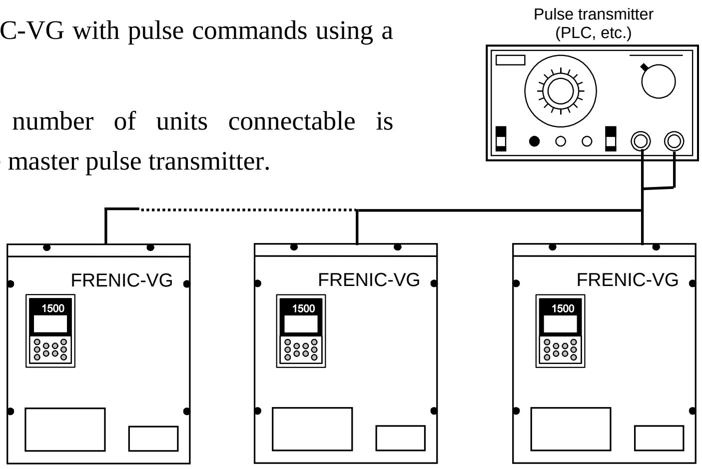
- In pulse train operation using a pulse transmitter, the number of slave units that can be connected is determined by the transmitter's current capacity (8 mA sink current/circuit).
- When the direction of rotation for slave motors will be opposite that of the master, the direction is determined by the [IVS] contact and the pulse input format. Set function code o13 (pulse train input format selection) according to the pulse format.

This technique drives the master FRENIC-VG with pulse commands using a PLC or other pulse transmitter.

As illustrated below, the maximum number of units connectable is determined by the current capacity of the master pulse transmitter.

Table 6.2.10

Master pulse transmitter	Slave OPC-VG1-PGo [PA], [PB], and [CM] terminals
Current capacity per circuit	8 mA max. per circuit
16 mA or greater	2 units
24 mA or greater	3 units
x mA or greater	Whole number of units given by (x / 8)



The number of slave units depends on the transmitter's drive current capacity.

Figure 6.2.22

The direction of rotation for slave motors is determined by [IVS] and the pulse input format.

Table 6.2.11

(1)	(2)	(3)	IVS	Slave direction of operation
B-phase high	A-phase input	B-phase, 90° advance	OFF	Forward
B-phase high	A-phase input	B-phase, 90° advance	ON	Reverse
B-phase low	B-phase input	B-phase, 90° delay	OFF	Reverse
B-phase low	B-phase input	B-phase, 90° delay	ON	Forward

Pulse input format

(1) Command pulse/command code

(2) Forward run pulse/reverse run pulse

(3) Two signals with a 90° phase difference

Select the pulse input format with function code o13.

6.2.5.2 Synchronized operation method

⚠WARNING

- Manipulate the [FWD] terminal and [SYC] (the contact input terminal) simultaneously during pulse train operation.
- When [FWD] turns on with a delay after [SYC] turns on while a pulse train continues to be input, the motor may accelerate to its maximum speed in order to eliminate the accumulated deviations.

Risk of bodily injury

⚠CAUTION

- Operating the motor with an incorrect allocation of the function selection input function code's data may result in bodily injury or equipment damage. Re-check allocation prior to operation.

Risk of equipment damage

Synchronized operation signal [SYC]

During pulse train operation, allocate one of the contacts X1 to X14 to 27 (SYC) for the slave motor and manipulate [SYC] together with the [FWD] signal.

Table 6.2.12

Function code	Function name	Pulse train function
E01 to E13	X1 to X14 function selection	In order to perform position control operation, allocate the synchronized operation instruction ([SYC]: 27) to one of the contact input terminals listed to the left.

(1) Master/slave synchronized operation

⚠CAUTION
• When performing master/slave operation, use of an F/F gain other than 1.0 will cause a steady-state deviation to remain between the master and slave. Steady-state deviations can be reduced with the APR gain and F/F gain, but adjustments made using the F/F gain may cause overshoot.

In order to perform synchronized operation with a master/slave connection, maintain the [FWD] terminal and contact input signal [SYC] in the “on” state at all times. Doing so will cause the slave unit to operate in synchronization with the master unit, allowing the slave unit to be stopped in the servo-lock state by stopping the master.

- Change the slave motor’s direction of rotation with [IVS]. Do not use the [REV] terminal.

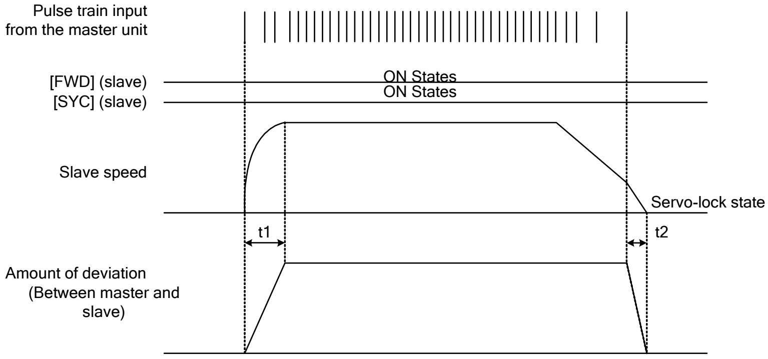


Figure 6.2.23

Slave acceleration and deceleration times

The slave motor’s acceleration (t1) and deceleration (t2) times will lag slightly behind the master. As illustrated in the above figure, the slave will operate while maintaining a pulse deviation (steady-state deviation) relative to the master.

Steady-state deviation

The slave motor will operate while maintaining a steady deviation relative to the master. This deviation will be eliminated when the motor stops, and the motor will enter the servo-lock state when a deviation of zero is reached.

This steady-state deviation is the difference between the number of command pulses from the master during constant-speed operation and the number of position detection pulses for the slave.

The steady-state deviation can be adjusted with the APR gain and F/F gain. For more information, see the section on PG interface expansion card function codes.

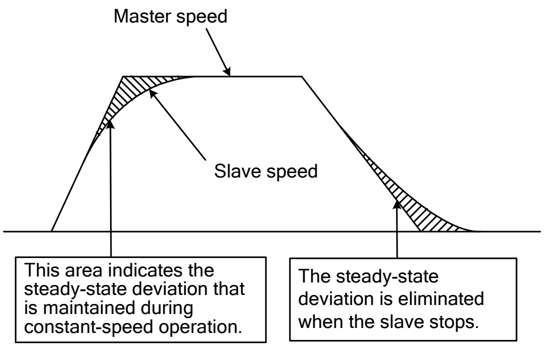


Figure 6.2.24

(2) Pulse train operation using a pulse transmitter

⚠CAUTION

- During pulse train operation, function code acceleration and deceleration time settings are disabled. Perform frequency control with the pulse transmitter. Starting operation while a high-frequency pulse train command has been given may cause the motor to accelerate rapidly.

Risk of bodily injury

Start and stop operation by simultaneously manipulating the [FWD] terminal and the contact input [SYC]. Turning [FWD] on alone will trigger operation with another speed command.

The acceleration and deceleration times cannot be controlled by the FRENIC-VG. Instead, perform frequency control with the pulse transmitter.

Times t1 (S) and t2 (S) in Figure 6.2.25 cannot be controlled by the inverter.

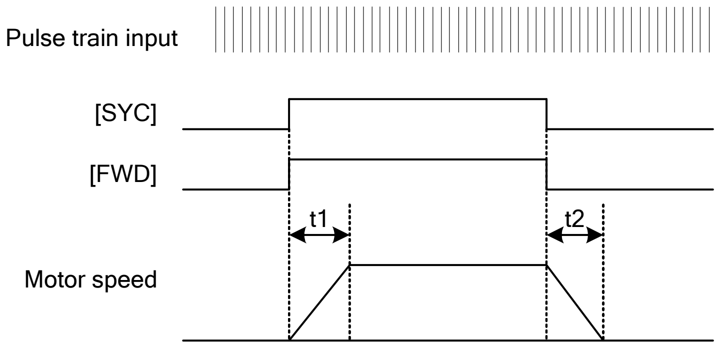


Figure 6.2.25

6.2.5.3 Function codes

⚠WARNING

- Incorrect use of function code data may result in a hazardous state. Consequently, re-check data after finishing setting and writing data.

Risk of accident

⚠CAUTION

- Suddenly setting a high gain value with ASR (gain and integration time) function codes or otherwise failing to write appropriate data may cause the motor to exhibit hunting behavior, causing damage to the motor and device as well as bodily injury.
- Risk of bodily injury
- Changing data for function code o17 (F/F gain 1) may cause an overshoot if the speed changes abruptly. When connecting the PG interface expansion card to devices that do not deal well with an overshoot, set this function code to 0.0.

Risk of equipment damage

Chap. 6 CONTROL OPTIONS

Table 6.2.13 lists function codes related to pulse train operation. See the control block diagrams in Chapter 4 for more information.

Table 6.2.13

No.	Parameter name		Setting range	Setting description
	Name	Keypad display		
o12	Command pulse selection	PLS REF SL	0, 1	0: PG (PR) option 1: Internal speed command
o13	Pulse train input format selection	PLS STATE SL	0 to 2	0: Two signals with a 90° phase difference between the A- and B-phases 1: A-phase command pulse, B-phase command code 2: A-phase run forward pulse, B-phase run reverse pulse
o14	Command pulse compensation 1	PLS CORR 1	1 to 9999	Allows the command pulse count ratio to be changed.
o15	Command pulse compensation 2	PLS CORR 2	1 to 9999	
o16	APR gain 1	APR-P-GAIN	0.1 to 999.9[times]	Position controller gain
o17	F/F gain 1	F/F GAIN	0.0 to 1.5[times]	Feed forward gain
o18	Deviation overrun width	DEV OVER W	1 to 65535[pulse]	Allows 10 to 655,350 pulses to be set (10 x the setting).
o19	Deviation zero width	DEV XERO W	1 to 1000[pulse]	Sets 1 to 1,000 pulses.
F64	ASR1 input filter	ASR1-IN	0.000 to 5.000[s]	Sets the time constant for the primary delay filter relative to the speed setting.

(1) Command pulse selection (o12)

Set to 0 when performing position control using pulses input to the PG (PR) option. Normally, the slave setting is 0.

By contrast, set to 1 at the master when you wish to send the same pulse to the slave while triggering pulse oscillation with an internal speed command and using pulse train operation for the master based on that signal.

[About o12 = 1 operation]

Internal speed commands ([12] input and multi-stage speed commands, etc.) are converted into pulse signals (oscillations), and those pulse signals are converted back into speed commands as part of position control and enabled with [SYC]. To synchronize operation with other inverters, converted pulse signals are output as-is and received by the PGo (PR) option.

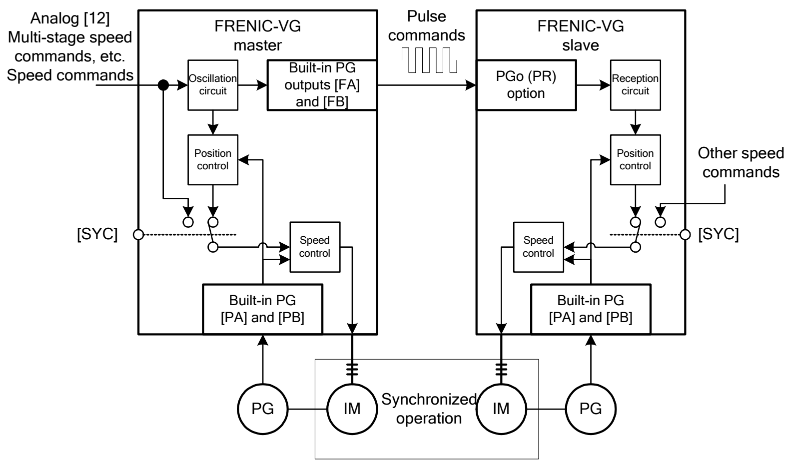


Figure 6.2.26

<u>Precautions</u>

When internal speed commands are used to generate oscillation with a pulse train using the o12 = 1 technique, processing is performed to correct the remainder portion of each pulse. For example, when using a 1024p/r encoder, conversion of a 1,500 r/min. command into a pulse generates 25.6 kHz pulse output without any problem. However, a speed command of 1,000 r/min. yields a pulse of 17.06666… kHz due to the remainder in the division operation. Remainders are corrected one by one. This correction processing causes a slight amount of speed fluctuation, but smoothing by the speed command filter prevents it from becoming a problem. Additionally, since synchronization accuracy is maintained by means of remainder correction processing, the problem of missing pulses (positional shifts) does not occur.

(2) Pulse train input format selection (o13)

Set to reflect the pulse format that will be input to the A- and B-phases. Set to 0 when using a master/slave connection.

(3) Command pulse compensation 1, 2 (o14, o15)

Position command data being input to the pulse train card can be changed with command pulse compensation 1 and 2. This functionality can be used to change the ratio of the speeds of the master motor and slave motor during synchronized operation.

$$\text{Position command pulse} = (\text{Command pulse input from external source}) \times \frac{\text{Command pulse compensation 1}}{\text{Command pulse compensation 2}} \times \frac{\alpha}{4}$$

α: Input format constant	Command pulse/command code or run forward/run reverse pulse:	α = 1
	Two signals with a 90° phase difference:	α = 4

[Example]

In synchronized operation with a master/slave connection with a slave that uses gears, assume that the gear ratio is a:b and that the input pulse is transformed into b:a by command pulse compensation (b = command pulse compensation 1; a = command pulse compensation 2).

$$\text{Position command pulse} = (\text{Command pulse input from external source}) \times \frac{b}{a} \times \frac{\alpha}{4}$$

If the gear ratio is 1:3, the actual settings would be as follows:

Table 6.2.14

Command pulse compensation 1	900	300	・・・	30	3
Command pulse compensation 2	300	100	・・・	10	1

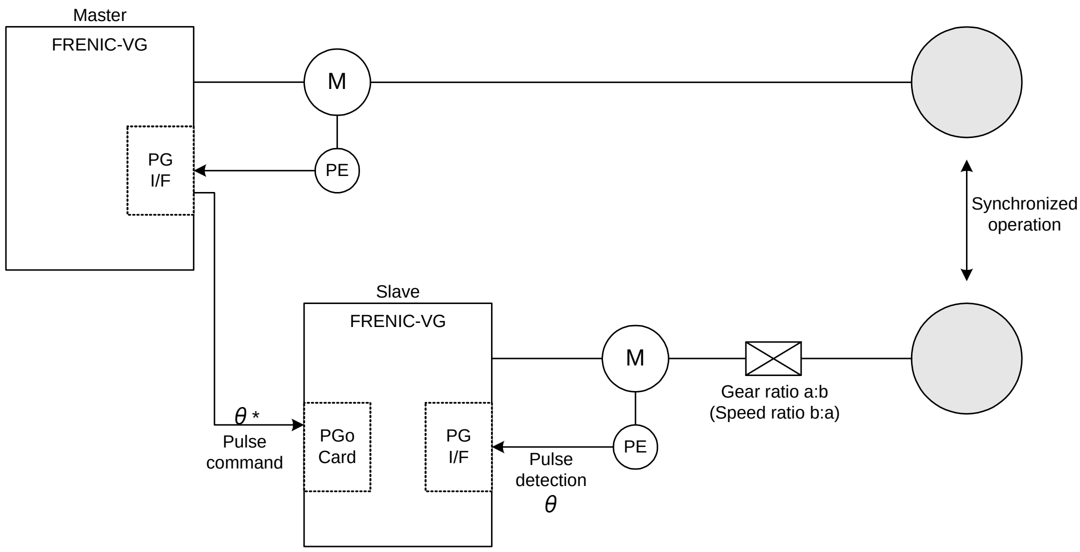


Figure 6.2.27

(4) APR gain 1 (o16)

By adjusting the APR gain, it is possible to improve speed response during pulse train operation. Additionally, it is possible to reduce the steady-state speed deviation during constant-speed operation. However, since use of an excessively large APR gain setting carries the risk of causing the motor to exhibit hunting behavior, it is recommended to start the adjustment process with a small value and then gradually increase it.

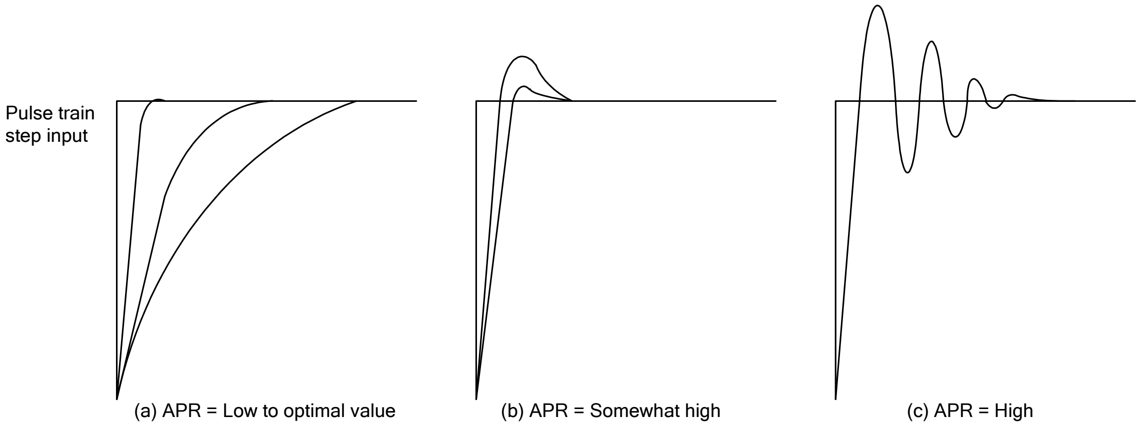


Figure 6.2.28

To improve the ASR response during pulse train operation, write 0 (s) to the ASR input filters. Setting the filters to large values may cause the motor to hunt.

(5) F/F gain 1 (o17)

The steady-state deviation can be reduced with the F/F gain value. The deviation is minimized with a setting of 1.0, but the F/F gain should be set to 0.0 when used in combination with machinery that does not do well with an overshoot.

The following figure illustrates the speed response when using step input consisting of position command pulses. With an F/F gain of 0.0 and an optimal APR gain setting, no overshoot occurs (a). However, a steady-state deviation is maintained during machinery operation.

By contrast, the steady-state deviation decreases to almost zero when the F/F gain is 1.0. However, an overshoot occurs (b) in order to eliminate the deviation that has accumulated by the time the target speed is reached. Additionally, the motor may accelerate to its maximum speed at this time. Consequently, a setting of 0.0 should be used in order to avoid overshoot.

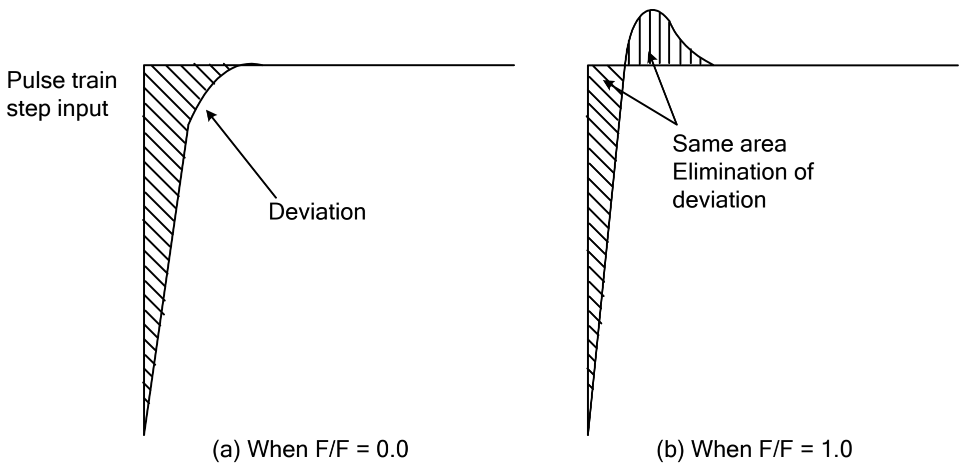


Figure 6.2.29

The following equation describes the relationship between the F/F gain and the APR gain:

$$|\text{Steady-state deviation}| = \frac{|1 - G_{FF}|}{G_{APR}} \times \alpha \times (\text{input frequency})$$

GFF: F/F gain, GAPR: APR gain,
α: Input format constant (α = 4 if 90° phase difference; otherwise, α = 1)

(6) Deviation overrun alarm width (o18)

A deviation overrun occurs when the difference between the internal command position and the actual amount of motor rotation (i.e., the deviation) is equal to or greater than this setting, causing the motor to perform a free-run stop. The keypad LED will display "dO," and the LCD will display alarm information related to the deviation overrun.

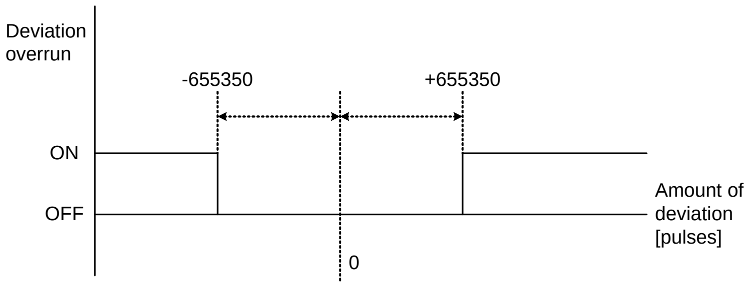


Figure 6.2.30

Deviation overrun alarms can be canceled by turning off the position control [SYC] and inputting the [RST] signal (see Figure 6.2.31).

Deviation overruns occur when the motor fails to track position commands. Although the initial value (factory setting) is 65,535 pulses (internally the setting is multiplied by 10), it should be set to about 2 times the position deviation that occurs during normal operation. If the function code APR gain and F/F gain settings have not been configured with optimal values, the motor may exhibit hunting behavior.

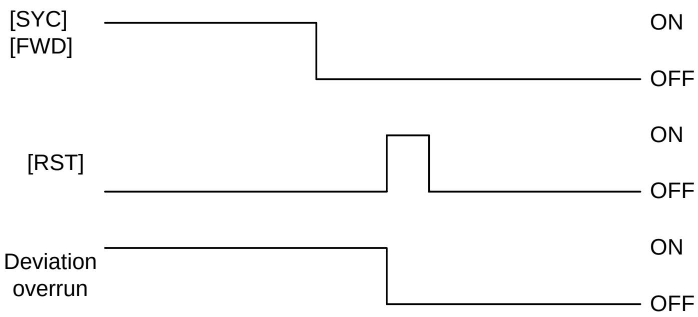


Figure 6.2.31

If that occurs, this value must be set again so that a deviation overrun alarm occurs immediately and the motor performs a free-run stop. Note that using a setting that is too low may cause the alarm to be triggered during acceleration and deceleration.

(7) Deviation zero width (o19)

The synchronization control complete signal is output when the motor's current position falls within the range defined by this setting from the target position. This functionality allows detection of the fact that the motor has almost reached the target position. The magnitude of this setting does not affect the positioning system. The synchronization control complete signal is assigned by allocating 27 [SY-C] to an output selected with the Y1 to Y5 functions.

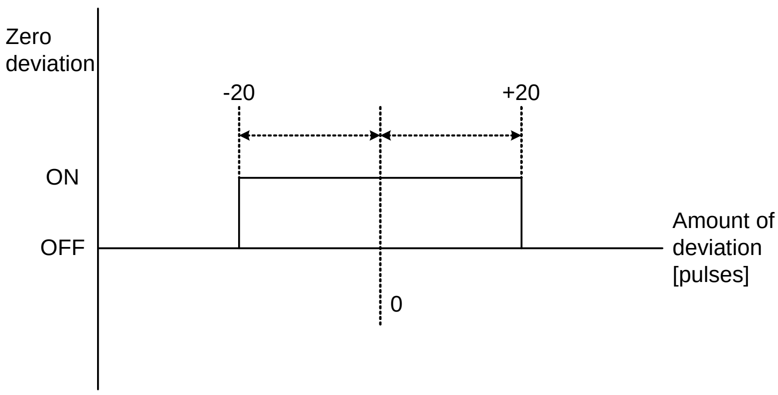


Figure 6.2.32

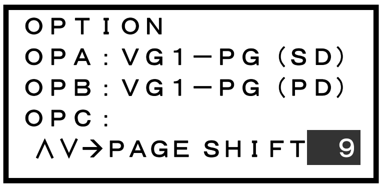
Figure 6.2.32 illustrates the [SY-C] output state when the value 20 is allocated to the deviation zero width.

6.2.6 Check functions

6.2.6.1 Optional equipment check

You can check on the keypad whether the PG interface expansion card is set to SD, LD, PR, or PD.

From the Operating Mode screen, go to the Program Menu screen and select “4. I/O check.” Use the ∧ and ∨ keys to switch screens and check the setting on screen 9 as shown in the figure to the right.



For more information, see the section on keypad operation.

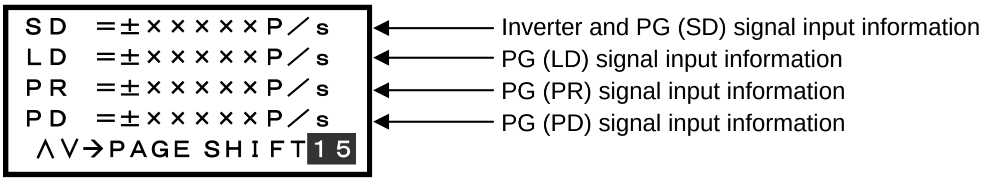
The figure to the right illustrates the screen that would be displayed when two PG interface expansion cards are installed and set to PG (PD) and PG (SD).

6.2.6.2 I/O check

You can check the PG interface expansion card’s digital input status on the inverter’s keypad.

From the Operating Mode screen, go to the Program Menu screen and select “4. I/O check.” Use the ∧ and ∨ keys to switch screens and check the setting on screen 15 as shown in the figure below.

For more information, see the section on keypad operation.



6.2.7 Protective functionality

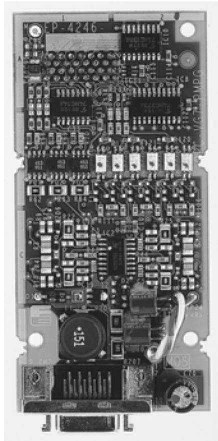
When the inverter’s protective functionality operates, the inverter immediately displays an alarm, displays the alarm name on the keypad’s LED, and allows the motor to free-run. When this functionality operates, resume operation after clearing the cause of the malfunction. Avoid automatically resetting the alarm, for example with an external sequence. Table 6.2.15 lists alarms related to the PG interface expansion card. For more information about other alarms, see “Protective Operation” in the inverter’s operating manual.

Table 6.2.15 List of Alarm Protective Functions

Alarm display	30X	Alarm cause
d0	Operation	This position deviation overrun error occurs when the load causes the motor startup to lag relative to the pulse train command, creating a position deviation that exceeds a previously set value. The threshold is set with function code o18 (deviation overrun width).
PG	Operation	A broken wire was detected due to an interruption in a PG signal when line driver operation (OPC-VG1-PG) was selected while using the SD setting.

6.3 Synchronous Motor Drive PG Interface Card

6.3.1 Product overview



Using this option allows the FRENIC-VG to drive a synchronous motor. When detecting magnetic pole positions using only the Z-phase, use the OPC-VG1-PG (SD) option. Synchronous motors offer advantages over induction motors in the form of their smaller size and lower energy consumption. Used in combination with this option, the FRENIC-VG can drive not only Fuji motors (GNF2 series motors, ES motors, and AC servomotors), but any synchronous motor with a compatible encoder interface. However, it cannot be used with motors that utilize serial encoders such as Fuji's FALDIC α dedicated motor. Choose the OPC-VG1-PMPG for line driver output or the OPC-VG1-PMPGo for open collector output.

(1) Maximum rotational speed of 30,000 r/min.
The synchronous motor drive PG interface card can generate output at up to 800 Hz when using a carrier frequency of 10 kHz, allowing it to drive a motor at up to 30,000 rpm with a 2P motor conversion. However, in fact the encoder's input frequency is limited to 100 kHz. For example, using a 256P/R encoder, the card can drive a motor at up to 100 kHz / 256 × 60 = 23,438 r/min.

(2) Magnetic pole position interface
The card can drive a motor with an encoder interface that satisfies the following specifications:

1) Synchronous motors that output magnetic pole positions using 4-bit Gray codes
2) Synchronous motors that output magnetic pole positions using 3-bit codes (U-, V-, and W-phase)

(3) Broken wire detection function
The card can use the broken wire detection function. When a broken wire is detected, the inverter will display alarm P9 and shut off its output, causing the motor to perform a free-run stop. However, this function cannot be used with the open collector output model (OPC-VG1-PMPGo). The FRENIC-VG's PG broken wire detection cancelation function can be used in the standard configuration.

(4) Synchronous motor, ES motor, and AC servomotor drive
The synchronous motor drive PG interface card can drive Fuji synchronous motors (GNF2), ES motors (GRK2), and AC servomotors (GRH). The user need only set several motor parameters.

When driving GRK series motors, choose the PMPGo card, since the included encoder generates open collector output. In this application, be sure to attach a zero-phase ferrite ring to counteract line noise.

(5) Small-capacity motor drive
The FRENIC-VG line starts with inverters rated for 0.75 kW in a 200 V circuit. However, these inverters can also drive 0.2 kW and 0.4 kW synchronous motors. The user need only set several motor parameters.

(6) IPM and SPM motor drive
Synchronous motors are classified as either internal permanent magnet (IPM) or surface permanent magnet (SPM) devices, depending on the method with which the magnetic poles are incorporated into the motor. The FRENIC-VG can drive both types. In particular, it is possible to set the salient pole ratio using function codes. This capability allows the motor's reluctance torque (torque that takes advantage of differences in magnetic resistance) to be used, increasing efficiency.

6.3.2 Model and specifications

6.3.2.1 Model

⚠CAUTION
• There are two models for the synchronous motor drive PG interface card, reflecting differences in the external equipment output interface: OPC-VG1-PMPG: Line driver signals OPC-VG1-PMPGo: Open collector/voltage output Exercise care that you do not specify the wrong model when purchasing one of the cards.

The model for the FRENIC-VG's PG option reflects differences in the external equipment output interface (line driver output versus open collector output/voltage output). Since the interface type cannot be selected with switches, it is necessary to determine which interface you require before purchase (OPC-VG1-PMPG or OPC-VG1-PMPGo).

Model format:

OPC-VG1-PMPG□

- □ — None: Line driver model
  o: Open collector model
- Option name: PMPG → Permanent magnet synchronous motor drive with PG synchronized drive option
- VG1 → FRENIC-VG inverter

Accessories

Plug (Model: 20-pin 10120-3000PE by Sumitomo 3M Limited)
Housing (cover) (Model: 20-pin 10320-52A0-008 by Sumitomo 3M Limited)
Spacers: 3
Screws (M3): 3

6.3.2.2 Specifications

Table 6.3.1 Hardware Specifications

Item	Specifications	
Model	OPC-VG1-PMPG	OPC-VG1-PMPGo
Signal type	Line driver output (recommended AM26LS31PC or equivalent)	Open collector output
PG power supply	The synchronous motor drive PG interface card uses a 5 V power supply. [PGP] pin: +5 V ±5%, 250 mA, [PGM] pin: Common, Includes an overcurrent protection function. Internal photocoupler insulation (connected to [PGM] and [CM] on the inverter’s control Pt board; isolated from [M])	
		The inverter’s PG power supply (+15 V, +12 V) can also be used to power the motor encoder. Connect after checking the motor encoder’s specifications.
Input signal terminals	Speed detection incremental signals: [PA], [*PA], [PB], [*PB] Magnetic pole position detection absolute signals: [F0], [*F0], [F1], [*F1], [F2], [*F2], [F3], [*F3] Photocoupler insulation	Speed detection incremental signals: [PA], [PB] Magnetic pole position detection absolute signals: [F0], [F1], [F2], [F3] Photocoupler insulation
Broken wire detection function	Yes	No
Connections	Supply the 5 V power supply from [PGP] and [PGM]. Since a balanced circuit is used, it is necessary to use twisted-pair shielded cable for wiring.	Built-in 5 V pull-up; sink current: approx. 11 mA/circuit
Maximum input pulse frequency	100 kHz; duty: 50 ±10%	
Allowable wiring length	Approx. 50 m Shorter wiring lengths are required when there is a high voltage drop.	10 m or less Keep wiring runs as short as possible to avoid the effects of noise. Be sure to connect a zero-phase ferrite ring.
Power supply	24V Supplied from the inverter’s printed circuit board. Connect the power supply harness to CN24 or CN25 on the inverter.	

Table 6.3.2 Software Specifications

Item		Specifications
Motor control method		Vector control for PMSM with speed sensor When function code P01 (M1 control method selection), A01 (M2 control method selection), or A101 (M3 control method selection) = 3
Speed control Vector control with speed sensor	Control range	1:1500 (min. speed: base speed, 1.5 to 1,500 r/min. with 4P conversion, using 1024P/R)
	Speed control accuracy	Analog setting: ±0.1% of max. speed Digital setting: ±0.005% of max. speed
PG interface functionality		When the PMPG option is installed and function code P01 (M1 control method selection), A01 (M2 control method selection), or A101 (M3 control method selection) = 3, the built-in PG interface is disabled, and the PMPG option takes priority.
Broken wire detection function		Yes
Frequency division output		No
Magnetic pole position detection function		Configured with function code o09 (ABS signal input definition). o09 = 1: 3-bit detection; [F0] [F1] [F2] : U-/V-/W-phase detection o09 = 2: 4-bit detection; [F0] [F1] [F2] [F3]: Gray code detection

6.3.2.3 Using the card in combination with a Fuji motor

Table 6.3.3 GRK-type ES Motors

Motor type	GRK2200M	GRK2400M	GRK2750M	GRK2151A	GRK2221A	GRK2301A	GRK2371A
FRENIC-VG model	FRN0.75VG1S-2J		FRN1.5VG1S-2J	FRN2.2VG1S-2J	FRN3.7VG1S-2J		
Rated output (kW)	0.2	0.4	0.75	1.5	2.2	3.0	3.7
Rated torque (N･m)	0.955	1.91	3.58	7.16	10.5	14.3	17.7
Rated rotational speed (r/min.)	2000						
Max. rotational speed (r/min.)	2500						
Max. torque (N･m)	1.43	2.87	5.38	10.8	15.8	21.5	26.5
Rated current (A)	1.2	2.3	4.0	8.6	13.0	17.2	21.0
Max. current (A)	2.0	3.6	6.0	13.0	19.5	25.8	31.5

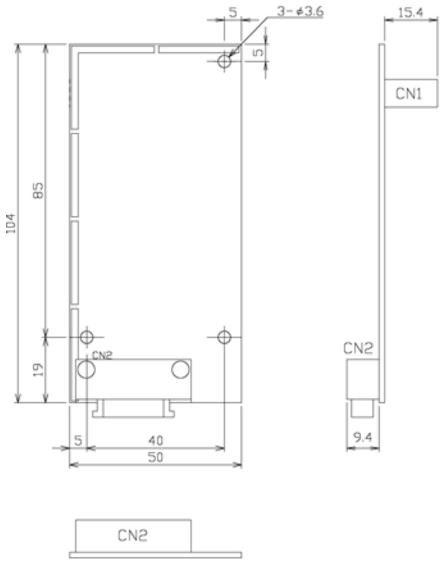
* Contact Fuji if you wish to use the card with a motor with a rating of less than 0.2 kW.
* Contact Fuji for more information about how to configure the FRENIC-VG with motor parameters.
* Choose the OPC-VG1-PMPGo since these motors use 1000P/R pulse encoders and open collector output.
* The encoder interface provides A-, B-, Z-, 1- (U-), 2- (V-), and 3- (W-)phase terminals, which should be connected for U, V, and W 3-bit magnetic pole position detection. The Z-phase need not be connected.

Table 6.3.4 GRH-type ES Motors

Motor type	GRH.30BG	GRH.50BG	GRH1.1BG	GRH1.5BG	GRH1.8BG	GRH2.7BG
FRENIC-VG model	FRN0.75VG1S-2J	FRN1.5VG1S-2J	FRN2.2VG1S-2J	FRN3.7VG1S-2J		FRN5.5VG1S-2J
Rated output (kW)	0.3	0.5	1.1	1.5	1.8	2.7
Rated torque (N･m)	0.955	1.59	3.50	4.77	6.88	10.3
Rated rotational speed (r/min.)	3000				2500	
Max. rotational speed (r/min.)	3000				2500	
Max. torque (N･m)	2.86	5.73	11.5	15.7	18.0	26.3
Rated current (A)	1.9	2.7	5.4	7.0	8.3	13
Max. current (A)	5.7	8.1	16.2	21.0	21.7	33.2

* Contact Fuji for more information about how to configure the FRENIC-VG with motor parameters.
* Choose the OPC-VG1-PMPG since these motors use 2000P/R pulse encoders and line driver output.
* The encoder interface provides A-, B-, Z-, 1- (U-), 2- (V-), and 3- (W-)phase terminals, which should be connected for U, V, and W 3-bit magnetic pole position detection. The Z-phase need not be connected.

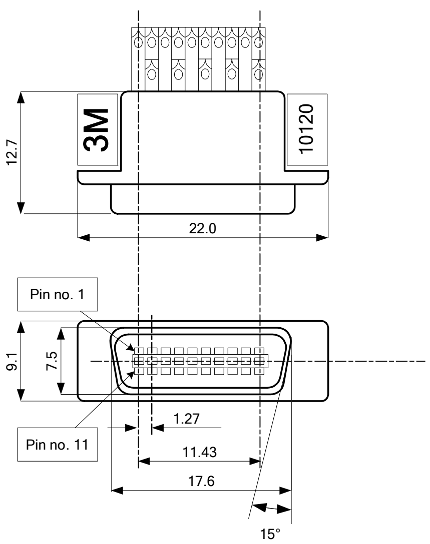
6.3.3 External dimension diagram

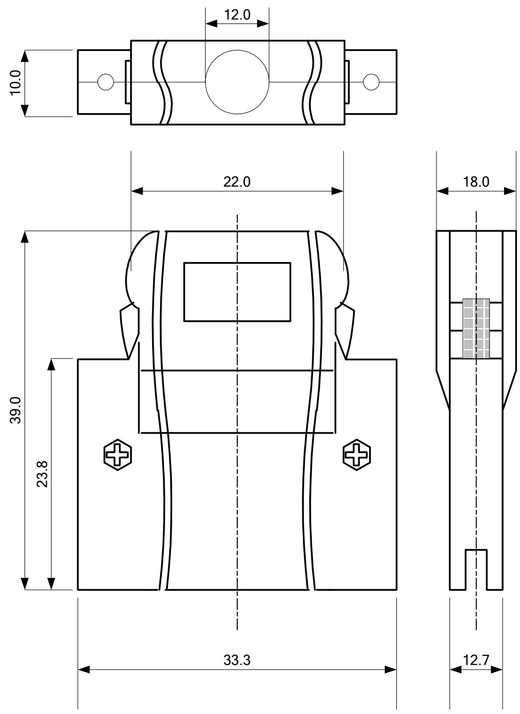


(Unit: mm)

Figure 6.3.1 OPC-VG1-PMPG/PMPGo Outline Diagram

Accessories





Model: 10120-3000PE
Specifications: 20-pin from
Sumitomo 3M Limited

Figure 6.3.2 Plug

Model: 10320-52A0-008
Specifications: 20-pin from
Sumitomo 3M Limited

Figure 6.3.3 Housing

*Plug and housing are included with the product.

6.3.4 Basic connection diagram

Refer to "6.1.4 Installing Built-in Options (OPC-VG1-□□)" before performing wiring or connection work.

⚠WARNING

- Performing connection work in an inappropriate manner may result in electric shock, fire, or other damage. Qualified electricians should carry out wiring. When touching electrical circuits, for example when performing connection work after the unit has been energized, shut off the power supply's circuit breaker to prevent electric shock.
- The smoothing capacitor remains charged even when the circuit breaker is shut off and will cause an electric shock when touched. Verify that the inverter's charge lamp ("CHARGE") has turned off and use a tester or other instrument to verify that the inverter's DC voltage has fallen to a safe level.

⚠CAUTION

- Do not use products with damaged or missing parts. Doing so may result in bodily injury or damage.
- Inappropriate installation or removal of the product may cause damage to the product.

Table 6.3.5 Terminal Function Descriptions

Pin no.	Name	Function	Pin no.	Name	Function
1	-		11	-	
2	*PA	A-phase reverse	12	*F1	Magnetic pole position *F1
3	PA	A-phase	13	F1	Magnetic pole position F1
4	*PB	B-phase reverse	14	*F2	Magnetic pole position *F2
5	PB	B-phase	15	F2	Magnetic pole position F2
6	-		16	-	
7	*F0	Magnetic pole position *F0	17	*F3	Magnetic pole position *F3
8	F0	Magnetic pole position F0	18	F3	Magnetic pole position F3
9	PGP	5 V PG power supply	19	PGM	0 V PG common
10	PGM	0 V PG common	20	PGP	5 V PG power supply

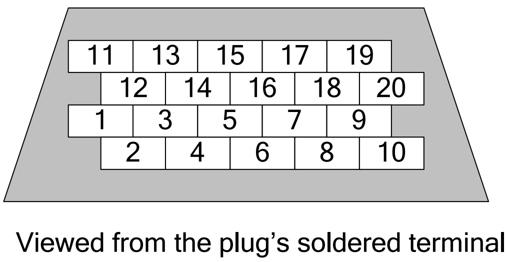


Figure 6.3.4

6.3.4.1 Line driver type

Choose the OPC-VG1-PMPG when using a line driver output type motor encoder. The following figure illustrates wiring connections used when detecting magnetic pole positions using 4-bit Gray codes and 3-phase U, V, and W signals (GNF2 series and GRH series motors).

Additionally, the OPC-VG1-PG (SD) option can also be used when detecting magnetic pole positions with the Z-phase alone.

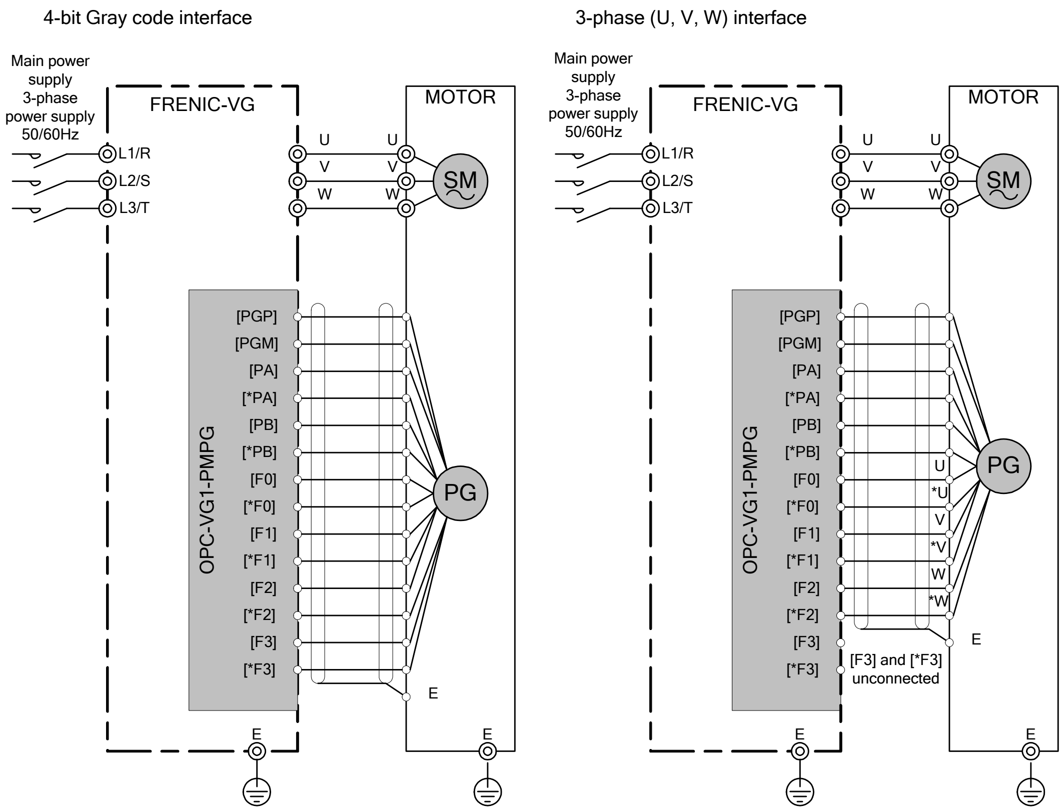


Figure 6.3.5

6.3.4.2 Open collector output type

Choose the OPC-VG1-PMPGo when using an open collector output type motor encoder. The following figure illustrates wiring connections used when detecting magnetic pole positions using 3-phase U, V, and W signals (GRK-type ES motors).

Since open collector connections offer low resistance to noise, use as short a wiring run as possible and connect zero-phase ferrite rings on the primary and secondary sides of the inverter.

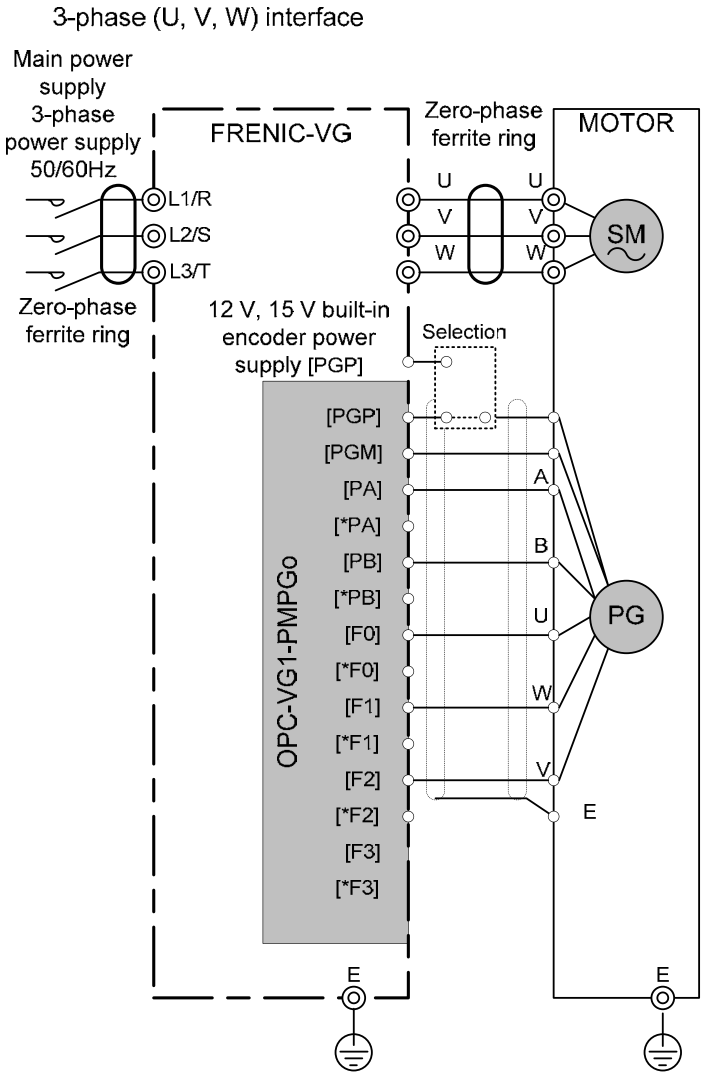


Figure 6.3.6

<u>Precautions</u>

(1) Read over the motor specifications carefully before connecting the power supply to the motor encoder.

(2) The synchronous motor drive PG interface card provides a 5 V power supply. The inverter's encoder power supply can also be used to provide a 15 V or 12 V power source.

(3) The OPC-VG1-PGo option can also be used when detecting magnetic pole positions with the Z-phase alone.

6.3.4.3 Connection Diagram for Fuji servos

Change the shielding connection used for PG wiring from the motor's E terminal to the inverter's PGM terminal in order to secure a noise margin to protect against improper operation of encoder signals. Additionally, connecting shielding to the motor's E terminal is an effective way to reduce radiated noise.

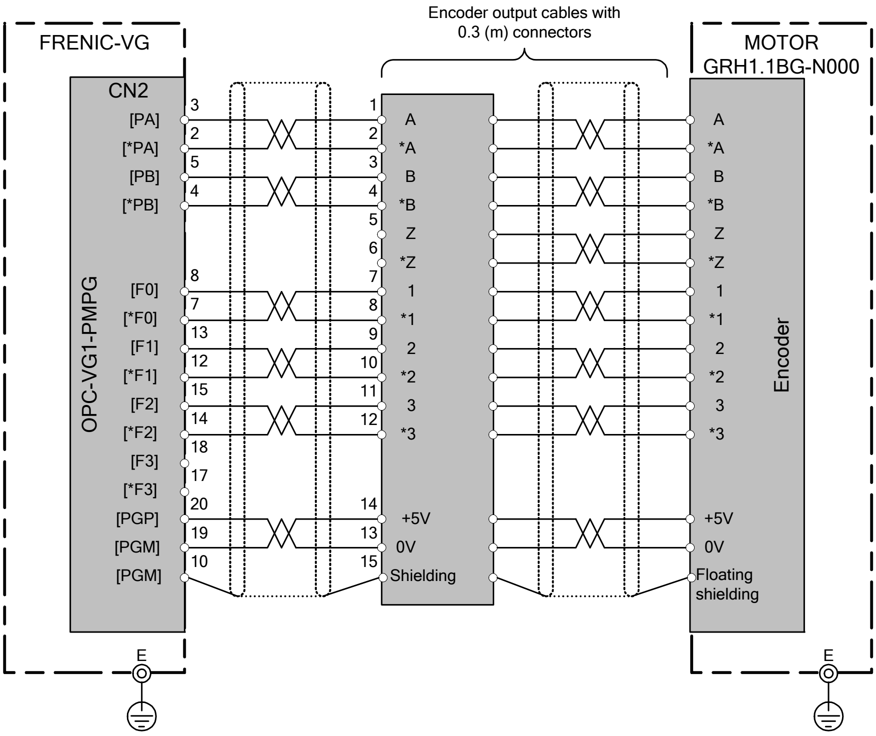


Figure 6.3.7

Precautions

- The encoder's shielding (15-pin) is not connected to the motor's earth (E) terminal.

6.3.5 Function codes

⚠WARNING

- Incorrect use of function code data may result in a hazardous state. Consequently, re-check data after finishing setting and writing data.

Risk of accident

6.3.5.1 Synchronous motor drive PG interface card function codes

The following function codes can be used when the PMPG option or PMPGo option is installed:

Table 6.3.6

No.	Parameter name		Setting range	Setting description
	Name	Keypad display		
o09	M1 ABS Signal input definition	ABS DEF	0 to 16	Set according to the motor encoder's specifications. Defines the operating interface for detecting magnetic pole positions. 0: 1-bit (terminal: F0) Z-phase interface (available soon) 1: 3-bit (terminals: F0, F1, F2) U-/V-/W-phase interface 2: 4-bit (terminals: F0, F1, F2, F3) Gray code interface 3 to 5: Reserved 6: SPGT 17-bit serial interface 7 to 16: Reserved
A59	M2 ABS Signal input definition			
A159	M3 ABS Signal input definition			
o10	M1 Magnetic pole position detection offset	SM-OFS	0.0 to 359.9	Set when you wish to compensate for divergence from the true value after aligning magnetic pole positions. 0.0 to 359.9 (0.0° to 359.9° moving counterclockwise)
A60	M2 Magnetic pole position detection offset			
A160	M3 Magnetic pole position detection offset			
o11	M1 Salient pole ratio (%Xq/%Xd)	Xq/Xd	1.000 to 3.000	Set when driving an IPM motor. This setting is used to control the IPM motor's reluctance torque. Set to 1.000 when driving an SPM motor.
A61	M2 Salient pole ratio (%Xq/%Xd)			
A161	M3 Salient pole ratio (%Xq/%Xd)			

6.3.5.2 Motor parameters

Motor parameters must be set to reflect the motors being used (M1 to M3). For more information, see the description of P codes and A codes in Chapter 4.

6.3.6 Check functions

6.3.6.1 Optional equipment check

You can check on the keypad whether the PMPG/PMPGo option is installed.

From the Operating Mode screen, go to the Program Menu screen and select “4. I/O check.” Use the ∧ and ∨ keys to switch screens and check the setting on screen 9 as shown in the figure to the right.

```
OPTION
A：VG1－PMPG
B：
C：
∧∨→PAGE SHIFT 9
```

For more information, see the section on keypad operation.

The figure to the right illustrates the screen that would be displayed when the PMPG/PMPGo card is installed.

6.3.7 Protective functionality

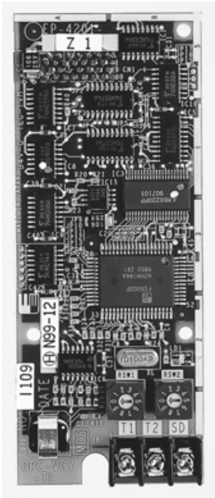
When the inverter’s protective functionality operates, the inverter immediately displays an alarm, displays the alarm name on the keypad’s LED, and allows the motor to free-run. When this functionality operates, resume operation after clearing the cause of the malfunction. Avoid automatically resetting the alarm, for example with an external sequence. Table 6.3.7 lists alarms related to the synchronous motor drive PG interface card. For more information about other alarms, see “Protective Operation” in the inverter’s operating manual.

Table 6.3.7 List of Alarm Protective Functions

Alarm display	30X	Alarm cause
Pg	Operation	When the PMPG card is installed and the PG signal is interrupted, or when wiring has been corrected erroneously

6.4 T-Link Interface Card

6.4.1 Product overview



Use this option to control FRENIC-VG using the Fuji programmable logic controller MICREX-SX (T-Link module).

Main Usage

Using this option, you can:

- Input signals to start or stop operation, etc.: FWD, REV, X1 - X9, X11 - X14, RST
- Set the speed commands: 16-bit binary data
- Monitor the operation status (bit data)
  Running forward, running reverse, during DC braking or pre-exciting, inverter shutdown, braking, DC link bus voltage established, torque limiting, output current limiting, during acceleration, during deceleration, alarm relay output, remote/local, write error from T-link, and data writing in progress
- Monitor motor speed; 16-bit binary data
- Monitor the operation status (word data)
  (Speed command, output frequency, torque command, output current, output voltage, cumulative run time, etc.)
- Reference and change function codes
  Function code which can be changed during operation using the touch panel ⇒ Can be changed (and checked) during operation
  Function code which cannot be changed during operation using the touch panel ⇒ Cannot be changed (but can be checked) during operation
- Monitor that the upper-level device and inverter are interoperating normally using the toggle monitor control.

Function codes which can be accessed using this option are limited. For details, refer to "4.2 Function Code List" in Chapter 4.

6.4.2 Model and specifications

6.4.2.1 Inverter type

Model elements: OPC-VG1-TL

- VG1: Name of equipped inverter VG1 → FRENIC-VG
- TL: Option name: TL → T-Link interface card

Accessories

Spacer x 3

M3 screw x 3

6.4.2.2 Specifications

⚠CAUTION

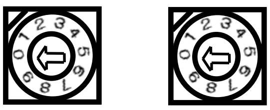
- The system will not operate correctly if the switches (RSW1 and RSW2) on this option are not set properly. Read the instruction below and set them accordingly.
- Be sure to power off the inverter before setting the switches (RSW1 and RSW2) on this option.

Table 6.4.1 Hardware Specifications

Item	Specifications
Name	T-Link Interface Card
Transmission specifications	T-Link slave, I/O transmission
Transmission speed	500 kbps
Number of words occupied in transmission	Selected by the function code o32 "Transmission format selection" Total of 16 words (8 words + 8 words): 8 words for MICREX → FRENIC-VG and 8 words for FRENIC-VG → MICREX Total of 8 words (4 words + 4 words): 4 words for MICREX → FRENIC-VG and 4 words for FRENIC-VG → MICREX
Terminal	TX+, TX-, SD
Rotary switches RSW1 and RSW2	Address setting, 99W space 4W+4W: Up to 12 cards can be connected. 8W+8W: Up to 6 cards can be connected.

Rotary switches RSW1, 2

Set the station address using the rotary switches RSW1 and RSW2 on the option board.



RSW1 RSW2

Figure 6.4.1

RSW1: Upper (x10)

RSW2: Lower (x1)

* When two or more cards are used, do not allocate the same station address to multiple stations.
* The factory default is RSW1=0 and RSW2=0 (address = 00).

Table 6.4.2 Software Specifications

Item		Specifications
Data update interval		4 ms
Operation	Run command	Running forward/reverse alarm reset, X1-X14 commands
	Speed command	16-bit binary data, setting resolution 0.005% (against the highest speed)
	Operation state output	Operating, braking, torque limiting, alarm relay output signals, etc.
		Motor speed, torque current command, etc.
Function code		You can reference and change the 255 functions assigned to the link numbers in the function code list.
Optional function code		o30 - o32 (Displayed on the touch panel when this option is installed)
Protective Function		Er-4: Network failure (T-Link error) * Light alarm: o30 and o31 can be used to control the Er-4 alarm. * Heavy alarm: Momentary alarm

* Light alarm: E.g., Signal noise. If the noise is not frequent, the Er-4 alarm can be controlled by o30 and o31 to continue operation.
* Heavy alarm: Fatal failure such as power down on MICREX, disconnection of communication, and hardware failure.

6.4.3 External dimensions

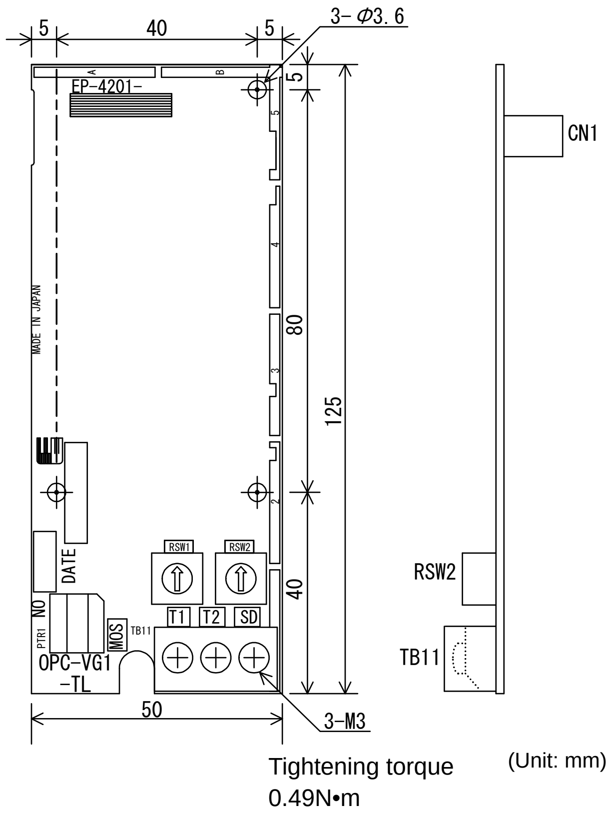


Figure 6.4.2

6.4.3.1 Terminal function

(1) Terminal arrangement

Terminal TB11	T1	T2	SD

(2) Terminal description

Table 6.4.3

Terminal symbol	Name	Description
T1 T2 SD (shielded)	T-Link cable connection terminal	For T-Link cable connection

* All terminals are open upon shipment.

6.4.4 Basic connection diagram

Refer to "6.1.4 Installing Internal Options (OPC-VG1-□□)" before connecting the cables.

⚠WARNING
• Incorrect cabling may cause a disaster such as electrical shock or fire. Only a qualified person should perform cabling. Before touching the power supply circuit (e.g., for cabling after power on), be sure to turn off (i.e., open) the circuit breaker to prevent electrical shock. • Note that the smoothing capacitor is charged after turning off (i.e., opening) the circuit breaker and touching it causes an electrical shock. Ensure that the charge lamp (CHARGE) of the inverter has gone off and that the DC voltage of the inverter has lowered to a safety level using a tester.

⚠CAUTION
• Do not use the product that is damaged or lacking parts to prevent an injury or damage. • Incorrect handling in installation/removal jobs could result in a broken product.

The basic connection diagram is shown on the next page. When connecting the cables, observe the following precautions.

[Notes on connection]

(1) Use either of the following cables as a T-Link communications cable.

- Furukawa Electric twisted pair cable
  CPEV-SB 0.9 dia. x 1 pair
- Furukawa Electric twisted pair cable
  KPEV-SB 0.5 mm^2 x 1 pair

Refer to the document of MICREX for the cable specifications.

(2) Connect the terminal resistor 100 Ω supplied with the T-Link master to the both ends of the T-Link.

(3) Bes sure to connect the T-Link cable without going over the same line twice as shown in the basic connection diagram (Figure 6.4.3).

Correct transmission cannot be performed if the cable branches.

(4) To prevent an error due to noises, keep the T-Link cable apart from the main circuit cables of the inverter and other power cables <u>as apart as possible (30 cm or more)</u> and never put it in the same duct.

Basic Connection Diagram

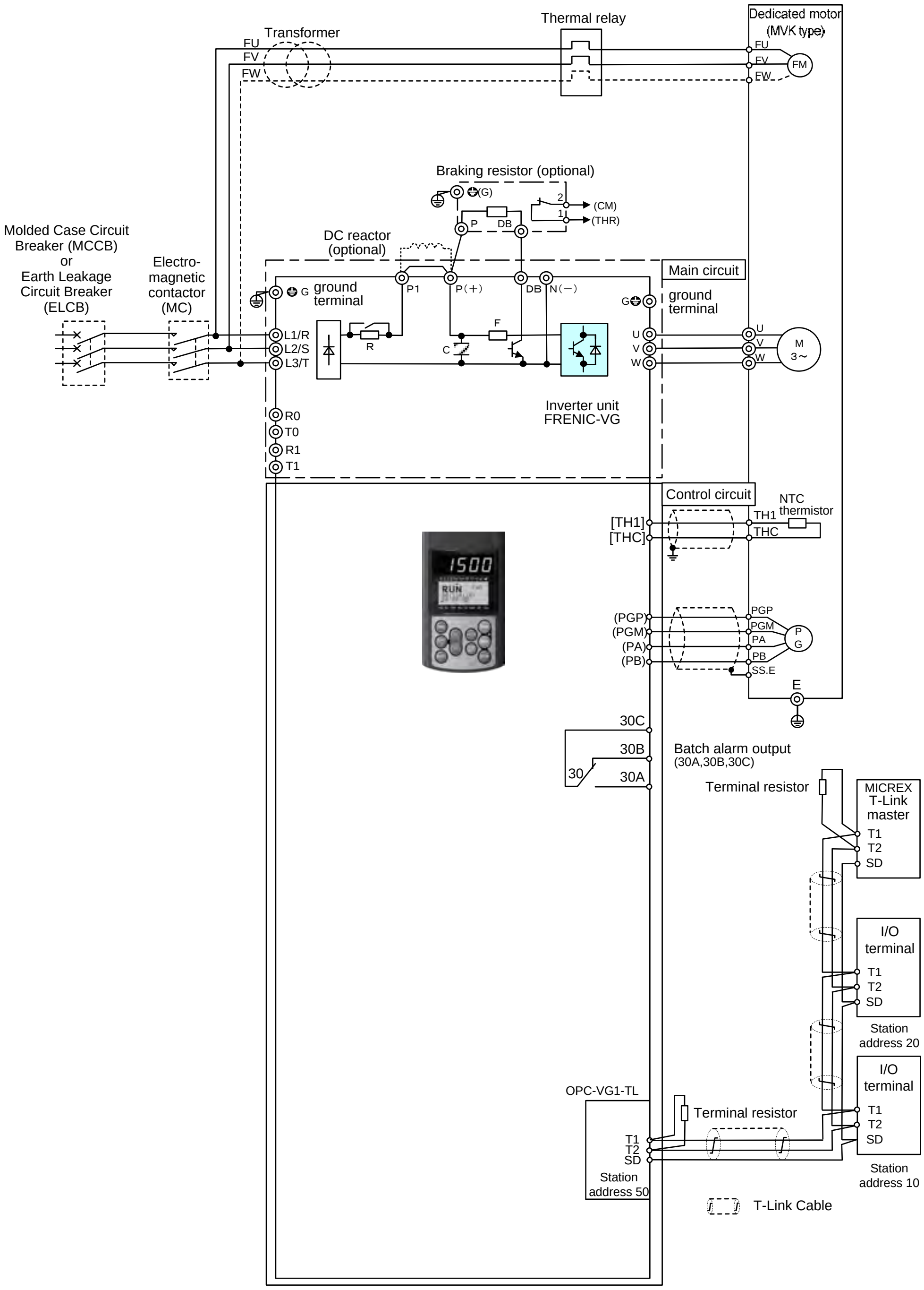


Figure 6.4.3

6.4.5 Function code

⚠WARNING

- Incorrect function code data may result in a dangerous situation. After setting and writing the data, check it again.

  An accident could occur.

By installing the T-Link interface card, the dedicated funciton codes of o29 to o32 will be available.

Table 6.4.4

No.	Function code name		Available scope	Description
	Name	Touch panel display		
o29	Operation continuation signal operation upon alarm	LK-D OPE	0	Invalid
			1	Available soon
			2	
o30	Error processing after detection of transmission failure	MODE ON ER	0	Immediately force operation to stop upon communication error (light alarm) occurrence (Er-4 alarm: coast to stop).
			1	After a communication error (light alarm) occurs, continue operation for the timer time (run command from the previous communication is held in the communication error state). Force operation to stop after the timer time (Er-4 alarm: coast to stop). If the communication recovers during the timer time, the command received in communication is run. But, operation is forced to stop it the error persists after the timer time.
			2	After a communication error (light alarm) occurs, continue operation for the timer time (run command from the previous communication is held in the communication error state). Force operation to stop if the communication error persists after the timer time. If the communication recovers during the timer time, the command received in communication is run.
			3	No alarm (Er-4) even when a communication error (light alarm) occurs. The run command from the previous communication is held in the communication error state. If the communication recovers, the command received in communication is run.
o31	Operation time after detection of transmission failure	TIMER TL	0.01 to 20.00s	Operation time timer value [s] for a communication error (light alarm) is effective when o30=1 or 2.
o32	Transmission format selection	4W/8W SEL	0, 1	0: Format 1 (Standard format 4 W + 4 W) 1: Format 2 (FRENIC-VG format 8 W + 8 W)
			2 to 4	For CC-Link option. Not used for T-Link option.

H107	Light alarm target definition 2	L-ALM 2	0000 to 1111	Select the alarm operation upon occurrence of an inter-inverter link communication error (Er-4) and toggle error (Ar-F). Er-4 and Ar-F represent the number of hundreds and the number of units, respectively. 0 in the corresponding decimal place: Alarm occurrence, 1: Light alarm (L -AL)
E10 | E13	Select X11 - X14 function.	X11to X14 FUNC	***1**	Select the command when each of the X11 to X14 bits is 1. To perform toggle monitoring with the X terminal bits, set TGL1 and TGL2 for two of the terminals.

***1** For the details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

6.4.6 Protective operation

6.4.6.1 Light and heavy alarms

Failures of the he T-Link interface card are classified into light and heavy alarms depending on the severity level.

Upon occurrence of this failure, the inverter outputs Er-4 "network error" and the motor coasts to stop.

Table 6.4.5

Item		Light alarm	Heavy alarm	
Cause		Noise on communication line	Disconnection of communication line MICREX (PLC) power off	T-Link option hardware failure (damage, failure) Duplicated address (setting error of RSW1 and RSW 2)
Reset method		Resolve the cause (or wait for communication recovery) and give a reset command (touch panel, RST, or remote reset).		Remove the hardware failure and reset the power supply.
Failure state control	o29=0	Alarms can be controlled with the function codes o30 and o31.	Momentary Er-4 alarm	
	o29=1	Available soon		
	o29=2			

Note: "Give a reset command" means supplying a reset input to the inverter in one of the following methods.

* Touch panel (RESET) key input
* Assign the failure reset RST with the X function selection and digitally input the command.
* Input the reset command via the communication line.

For a heavy alarm, the CPU may also require reset depending on the CPU state of MICREX.

You can check the communication error code for light and heavy alarms on the communication state screen of the maintenance information on the touch panel. To access this screen, press the (PRG) key to return to the menu screen, and move the arrow on the left edge of the screen to "5. Maintenance" using the (∧)/(∨) key, then press the (FUNC DATA) key. Press the (∨) key three times to show the screen below.

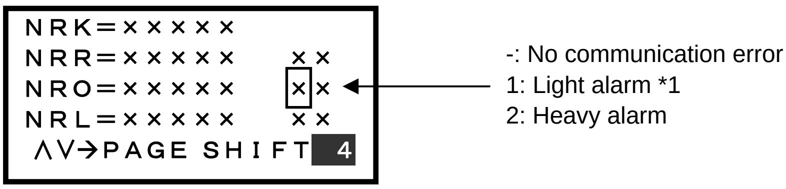


Figure 6.4.4

*1 When o30=0, a heavy alarm may be displayed as a light alarm depending on the timing. This does not occur when o30=1 or 2, or o31=0.10 or higher.

6.4.6.2 Protective operation function code

The following explains how to control the Er-4 alarm when a light alarm occurs while an operation command is given from MICREX via the T-Link.

[Operation Description]

The following describes an example of operation when operation and speed commands are given from MICREX and a communication error occurs during operation.

*1 During this period of time, if communication recovers and new settings are not sent, commands (for operation or speed, or both) received upon error occurrence are held.

(1) When function code o30 = 0

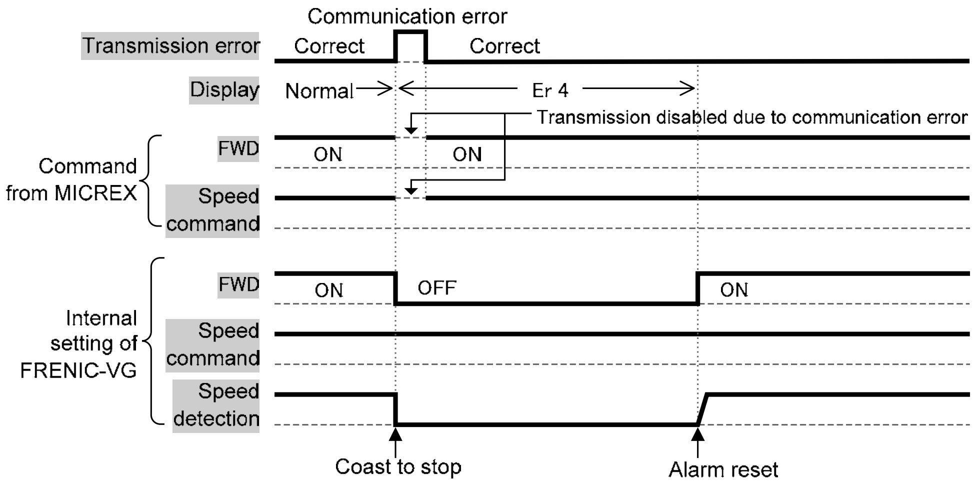


Figure 6.4.5

(2) When the function code o30 = 1 and o31 = 5.0 (when a communication error occurs, the motor coasts to stop in five seconds.)

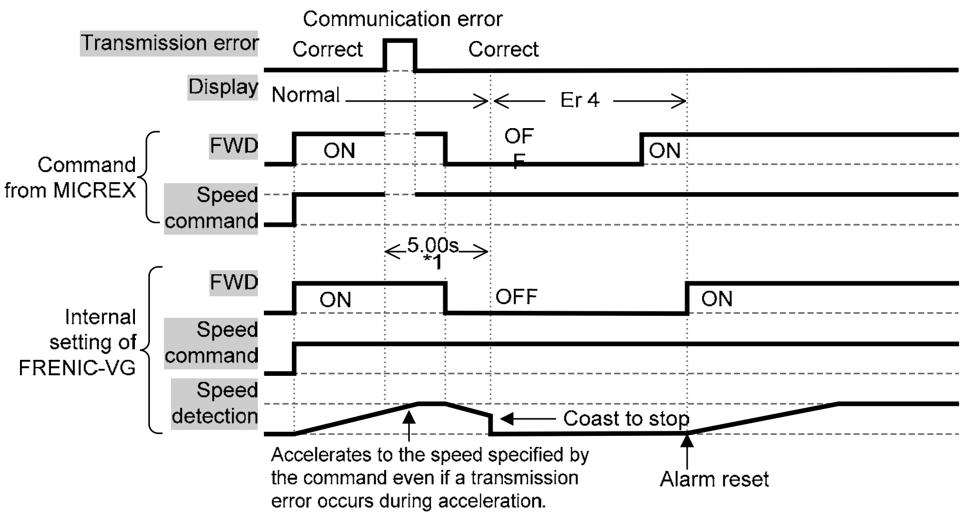


Figure 6.4.6

(3) When the function code o30 = 2 and o31 = 5.0
(the communication error persists in five seconds after its occurrence and the Er-4 alarm occurs)

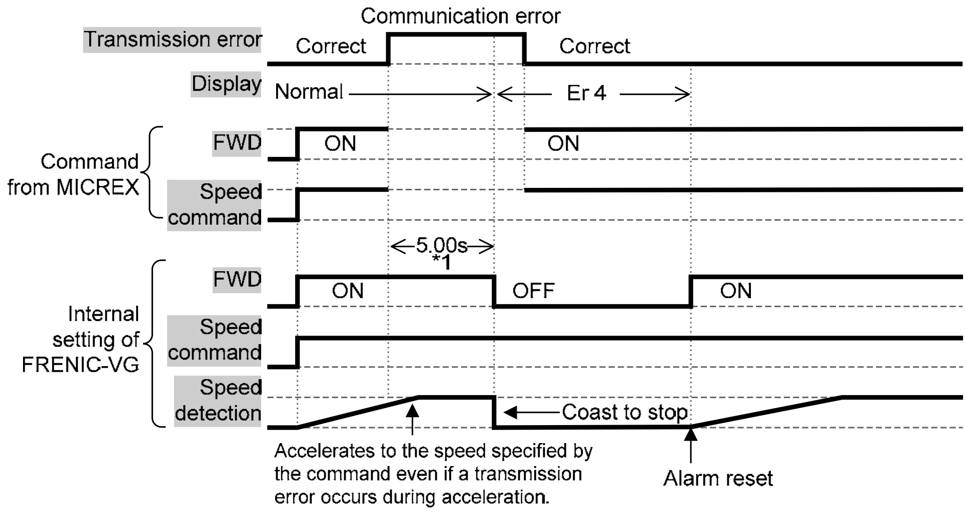


Figure 6.4.7

(4) When the function code o30 = 2 and o31 = 5.0 (a communication error occurs and the communication recovers in five seconds)

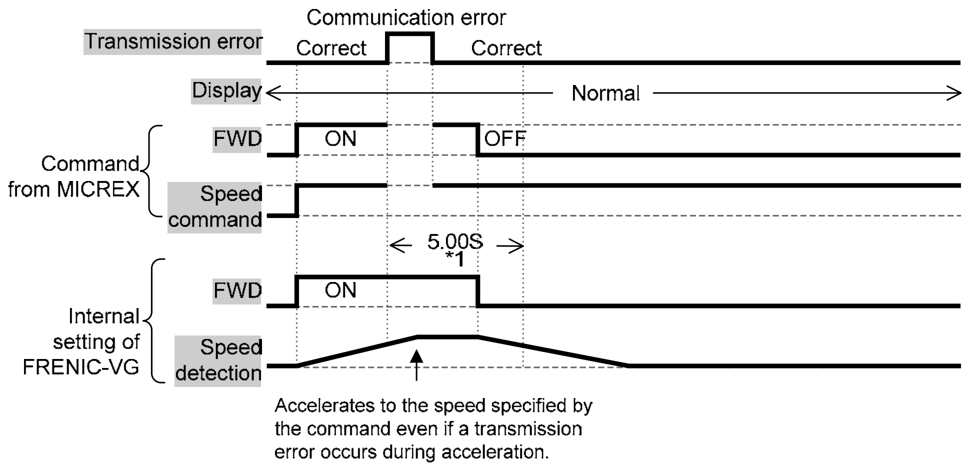


Figure 6.4.8

(5) When function code o30 = 3

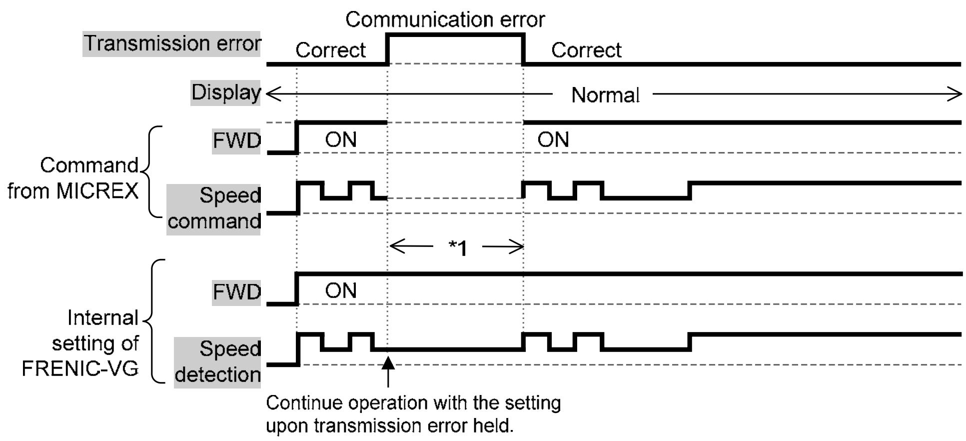


Figure 6.4.9

6.4.7 Data allocation addresses

6.4.7.1 Transmission format

One the following two transmission formats can be selected by the function code o32 "Transmission format selection".

(1) o32=0 (format 1, standard format: number of words occupied 4W+4W)

(2) o32=1 (format 2, FRENIC-VG format: number of words occupied 8W+8W)

6.4.7.2 Occupied area

As shown in the figure below, within the input/output relay area, contiguous eight or sixteen words are occupied, and the two digits of the address (WB00** in the figure) are set by the rotary switches RSW1 and RSW2 on the option card.

Note: The bit address allocation is different between the Fuji programmable logic controllers MICREX-F and MICREX-SX as shown below.

MICREX-F: LSB bit is shown as F and MSB bit is shown as 0.
MICREX-SX: LSB bit is shown as 0 and MSB bit is shown as F.

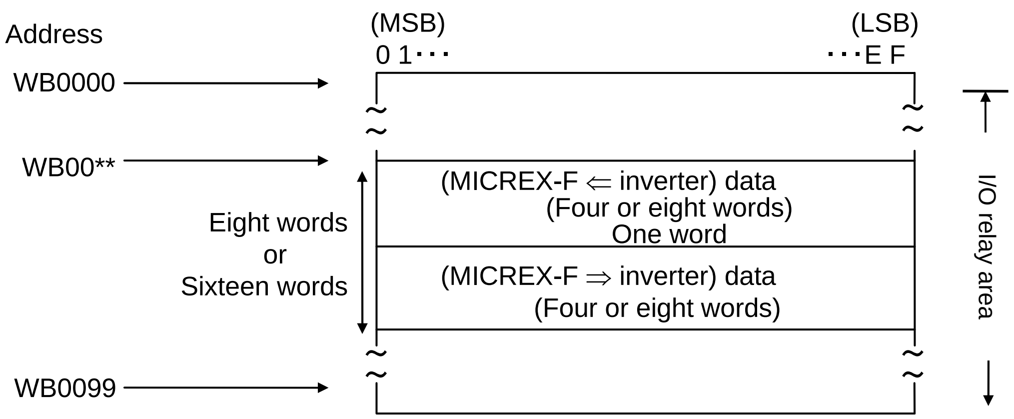


Figure 6.4.10 MICREX-F Area

6.4.7.3 Allocated Address

(1) Format 1 (Standard format 4 W + 4 W)

Top Address	Offset	(MSB) 0 1･･･ 7	8 ･･･E F (LSB)	
WB00**	+ 0	Operation state (refer to * 6.4.8.1 (1))		INV ⇓ MICREX
WB00**	+ 1	Motor speed (M06)		
WB00**	+ 2	Polling function code address	Empty (Fixed to 0)	
WB00**	+ 3	Polling function code data		
WB00**	+ 4	Operation command/Di/RESET input (S06)		MICREX ⇓ INV
WB00**	+ 5	Speed command (S01)		
WB00**	+ 6	Selecting function code address	Polling function code address	
WB00**	+ 7	Selecting function code data		

Figure 6.4.11

(2) Format 2 (FRENIC-VG format 8W+8W)

Top Address	Offset	(MSB) 0 1··· 7	8 ···E F (LSB)	Direction
WB00**	+ 0	Polling function code (1)	Polling function code (2)	INV ⇓ MICREX
WB00**	+ 1	Polling function code (3)	Polling function code (4)	
WB00**	+ 2	Polling function code (1) data		
WB00**	+ 3	Polling function code (2) data		
WB00**	+ 4	Polling function code (3) data		
WB00**	+ 5	Polling function code (4) data		
WB00**	+ 6	Motor speed (M06)		
WB00**	+ 7	Operation state (refer to * 6.4.8.1 (1))		
WB00**	+ 8	Selecting function code (1)	Selecting function code (2)	MICREX ⇓ INV
WB00**	+ 9	Selecting function code (3)	Selecting function code (4)	
WB00**	+ 10	Selecting function code (1) data		
WB00**	+ 11	Selecting function code (2) data		
WB00**	+ 12	Selecting function code (3) data		
WB00**	+ 13	Selecting function code (4) data		
WB00**	+ 14	Polling function code (1)	Polling function code (2)	
WB00**	+ 15	Polling function code (3)	Polling function code (4)	

(MSB) 0 1··· ← 7 8 → ···E F (LSB)

Figure 6.4.12

6.4.8 Transmission format

6.4.8.1 Data format (FRENIC-VG ⇒ MICREX)

(1) Operate state (1 for all ON)

(MSB) (LSB)

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
BUSY	ERR	-	RL	ALM	DEC	ACC	IL	-	TL	NUV	BRK	INT	EXT	REV	FWD

FWD : Running forward
REV : Running reverse
EXT : DC braking or pre-exciting
INT : Inverter shutdown
BRK : Braking
NUV : DC link bus voltage
TL : Torque limiting
IL : Current limiting
ACC : Accelerating
DEC : Decelerating
ALM : Batch failure
RL : Communication selection (1: H30=2 or 3)
ERR : Function code access error
BUSY : Writing function code

- ERR is cleared to "0" when selecting (writing) and polling (reading) of the function code has been done correctly. If any of selecting or polling is not performed correctly, ERR is set to "1". The error cause in this case can be checked with the function code M26 (see the table below). When ERR is set to "1", resolve the cause and perform selecting or polling again. If the operation is successful, both of ERR and M26 are cleared to "0".

M26 value	Write/read error
78	Access to unused function code
79	Writing to a read-only function code
	Writing to a function code (during operation) which cannot be changed during operation
	Writing to a function code which cannot be changed with FWD/REV ON.
80	Writing out-of-range data

BUSY is set to "1" while writing (processing) data. When writing consecutive data, wait for BUSY to be cleared to "0" and write the next data. A writing request made while this bit is set to "1" is ignored.

(2) Motor speed

(MSB) (LSB)

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Motor speed (decimal) x 20000 / maximum speed => 16-bit data															

The maximum speed is set with the function code. Obtain a r/min value by calculating backward using the above formula. If data is negative (complement of 2), it is a reverse speed command.

(3) Polling function code address and data

Format 1

Polling function code address	Empty (Fixed to 0)
Polling function code data	

"Polling function code address" (eight bits) stores the link number corresponding to the function code requested for polling from MICREX. Its data is stored in "Polling function code data". Refer to "Function Code List" for the link numbers.

Format 2

Polling function code (1)	Polling function code (2)
Polling function code (3)	Polling function code (4)
Polling function code (1) data ⇓ Polling function code (4) data	

"Polling function code (1) to (4)" (eight bits each) store the link number corresponding to the function code requested for polling from MICREX. Their data are stored in "Polling function code (1) to (4) data".

6.4.8.2 Data format (MICREX ⇒ FRENIC-VG)

(1) Operation command/Di/RESET input (1 for all ON)

(MSB) (LSB)

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
RST	X14	X13	X12	X11	X9	X8	X7	X6	X5	X4	X3	X2	X1	REV	FWD

FWD and REV are available when the link command is permitted as instructed in "6.3.9.1 Link Command Permission Selection". X1 to X14 and RST are always available.

(2) Speed command

(MSB) (LSB)

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Speed command (decimal) x 20000 / maximum speed => 16-bit data															

The above is the same as the motor speed. The maximum speed is set with the function code. Provide the speed value as 16-bit data of the value calculated above. (Handle negative data as a complement of 2.)

(3) Polling and selecting function code address and selecting function code data

Format 1

(MSB) 0 1 … 7 8 … E F (LSB)

0 – 7	8 – F
Selecting function code address	Polling function code address
Selecting function code data	

Write the function code data using the "selecting function code address" (8 bits) and "selecting function code data" (16 bits) above. Also, specify the link number corresponding to the function code number requested for polling using the "polling function code address" (8 bits).

Format 2

(MSB) 0 1 … 7 8 … E F (LSB)

0 – 7	8 – F
Selecting function code (1)	Selecting function code (2)
Selecting function code (3)	Selecting function code (4)
Selecting function code (1) data ⇓ Selecting function code (4) data	
Polling function code (1)	Polling function code (2)
Polling function code (3)	Polling function code (4)

"Selecting function code (1) to (4)" (eight bits each) store the link number corresponding to the function code selected by MICREX. Write the data to "Selecting function code (1) to (4) data".

Note: Upon selecting, be sure to write the link number and data together.

Use the "polling function code (1) to (4)" (8 bits) to specify the link number corresponding to the function code number requested for polling.

Selecting is available when editing links is permitted in "6.4.9.2 Link Edit Permission Selection". Pay attention to writing limitation including changing not available during operation.

6.4.9 Link function

Use the function code H30 and X function "24: Link Operation Selection [LE]" to switch the command data (S area) target (REM/LOC/COM). Also refer to the control block diagram in Chapter 4.

Use the function code H29 and X function "23: Link Edit Permission Command [WE-LK]" to control writing of the function codes (F, E, C, P, H, A, o, U) from the link. Also refer to the control block diagram in Chapter 4.

6.4.9.1 Link command permission selection

Link Switch

By assigning "24: Link Operation Selection [LE]" to the X function input terminal, the mode is switched as shown below.

Table 6.4.6

Link operation selection signal assignment	Corresponding input terminal	Status
Not assigned	-	Link command permission mode
Assigned	ON	Link command permission mode
Assigned	OFF	Link command prohibition mode

In the link command prohibition mode, command data and operation data can be written from a link but the data will not be reflected. You can set data in advance in the link command prohibition mode, and then switch to the link command permission mode to reflect the data.

Link Command

In the link command permission mode, use the function code H30 (link function) to switch the command data and operation command between link (COM) and remote/local. REM (remote: terminal table) and LOC (local: touch panel) are shown here.

Table 6.4.7

<table>
<tr><th rowspan="2">H30 value</th><th colspan="2">Link command permission mode</th><th rowspan="2">Link command prohibition mode</th></tr>
<tr><th>Command data
(S01 to S05, S08 to S12)</th><th>Operation command
(FWD and REV)</th></tr>
<tr><td>0</td><td>Link prohibited (REM/LOC)</td><td>Link prohibited (REM/LOC)</td><td rowspan="4">Link prohibited
(REM/LOC)</td></tr>
<tr><td>1</td><td>Link permitted (COM)</td><td>Link prohibited (REM/LOC)</td></tr>
<tr><td>2</td><td>Link prohibited (REM/LOC)</td><td>Link permitted (COM)</td></tr>
<tr><td>3</td><td>Link permitted (COM)</td><td>Link permitted (COM)</td></tr>
</table>

This functionality allows for flexible system construction where you can give operation commands from terminal table and speed command via communication.

6.4.9.2 Link edit permission selection

Link Edit Switch

By assigning "23: Link Edit Permission Command [WE-LK]" to the X function input terminal, you can protect the function code (F, E, C, P, H, A, o, U) from being written as shown below.

Table 6.4.8

Link edit permission command assignment	Corresponding input terminal	Status
Not assigned	-	Link edit permission mode (F to U can be written)
Assigned	ON	
	OFF	Link edit prohibition mode (F to U cannot be written)

Link Edit

With the function code H29, you can control writing to the function code (F, E, C, P, H, A, o, U) in the link edit permission mode.

Table 6.4.9

H29 data	Link edit permission mode	Link edit prohibition mode
0	Code (F, E, C, P, H, A, o, U) can be written	Code (F, E, C, P, H, A, o, U) cannot be written
1	Code (F, E, C, P, H, A, o, U) cannot be written	

6.4.9.3 Data transmission example

The following explains a data transmission example using the transmission format.

(1) Speed setting

From MICREX, give commands to run forward (FWD) at 785 r/min.
(Condition: Function code H30 "Link Operation"=3, maximum speed 1500 r/min, T-Link station address: 10, 8+8 words)

Give S06 the forward running command (FWD: ON) and S01 the speed command.

WB18	0	6	0	1	Function code S06, S01 selecting (link No. 06h, 01h)
19	0	0	0	0	Selecting dummy data
20	0	0	0	1	Function code S06 FWD: ON
21	2	8	E	3	Function code 01 Speed setting 785/1500×20000＝10467＝28E3 (h)

↓ After acceleration completes

WB16	2	8	E	3	Monitor the motor speed.

(2) Torque command monitor

Monitor the torque command value from MICREX.
(Condition: T-Link station address: 24, 8+8 words)

WB38	1	0	0	0	Torque command value monitor (link No. 10h)
39	0	0	0	0	

↓ After read completes

WB24	1	0	0	0	When the link number requesting polling is returned to this area, reading is completed.
25	0	0	0	0	Torque command value monitor data
26	1	3	8	8	1388 (h) × 100 (%) / 10000＝50 (%)
27	0	0	0	0	
28	0	0	0	0	↓
29	0	0	0	0	From the above, the torque command value is "50% of drive".

(3) Function code data setting

Set the function code S08 "Acceleration time" to 30.5 seconds from MICREX.
(Condition: T-Link station address: 58, 4+4 words)

WB62	0	0	0	0	Function code S08 selecting (Link No. 08h)
63	0	0	0	0	131 (h) ＝305,305×0.1s＝30.5s
64	0	8	0	8	
65	0	1	3	1	Poll the function code S08 to confirm setting completion.

↓After writing completes

WB58	*	*	*	*	Poll the function code S08.
59	*	*	*	*	131 (h) ＝305,305×0.1s＝30.5s
60	0	8	0	0	(Data is correctly set.)
61	0	1	3	1	

(4) Toggle monitor

Monitor data toggling between MICREX and the inverter. This example set the X12 terminal to TGL1 and X13 terminal to TGL2.(*1)

Set E11=72 (TGL1), E12=73 (TGL2), H30=3, H144=0.10 (100 ms) in advance.

This sets
transmission toggle (MICREX→VG1): %QW254.0.10.13 bit 11= TGL1 and bit 12= TGL2.

The inverter monitors the toggle pattern sent from MICREX while the operation command is ON, and generates the toggle error Ar-F if the toggle signal cannot be received within the time specified with H144.

*1 For the details of the toggle, refer to E01 to E13 toggle signal explanation in Chapter 4, Section 4.3 "Details of Function Codes."

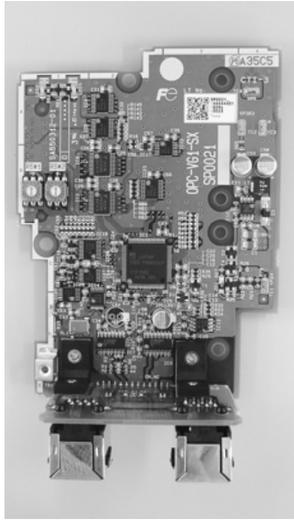
*2 By setting the inverter function code H107, the inverter can continue operation with L-AL display. Refer to the description of H107 in Chapter 4, Section 4.3 "Details of Function Codes."

%QW254.0.10.13	*	0	0	0	Send 0→1→2→3→0 to *・・・(toggle pattern)
				↓	After sending toggle
%QW254.0.10.13	*	0	0	1	Operation command (FWD)=ON

Note: If the network error Er-4 (light and heavy alarm 1) occurs while sending the toggle pattern, the toggle error Ar-F may occur after the communication recovers. To avoid the toggle error Ar-F, stop sending the toggle pattern while the network error Er-4 is occurring.

6.5 SX Bus Interface Card

6.5.1 Product overview



Use this option to control FRENIC-VG using the Fuji programmable logic controller MICREX-SX via the SX bus.

Main Usage

Using this option, you can:

- Input signals to start or stop operation, etc.: FWD, REV, X1 - X9, X11 - X14, RST
- Set the speed commands: 16-bit binary data
- Monitor the operation status (bit data)

  Running forward, running reverse, during DC braking or pre-exciting, inverter shutdown, braking, DC link bus voltage established, torque limiting, output current limiting, during acceleration, during deceleration, alarm relay output, remote/local, write error from T-link, and data writing in progress
- Monitor motor speed; 16-bit binary data
- Monitor the operation status (word data)
  (Speed command, output frequency, torque command, output current, output voltage, cumulative run time, etc.)
- Reference and change function codes
- Monitor that the upper-level device and inverter are interoperating normally using the toggle monitor control.

Function codes which can be accessed using this option are limited. For details, refer to "4.2 Function Code List" in Chapter 4.

6.5.2 Model and specifications

6.5.2.1 Inverter type

Model elements: OPC-VG1-SX

- VG1: Name of equipped inverter VG1 → FRENIC-VG
- SX: Option name: SX→SX bus interface card

Accessories

Spacer x 4
M3 screw x 2

6.5.2.2 Specifications

⚠CAUTION

- The system will not operate correctly if the switches (RSW1 and RSW2) on this option are not set properly. Read the instruction below and set them accordingly.
- Be sure to power off the inverter before setting the switches (RSW1 and RSW2) on this option.

Table 6.5.1 Hardware Specifications

Item	Specifications
Name	SX Bus Interface Option
Transmission specifications	SX-bus slave, I/O transmission
Transmission speed	25 Mbps
Number of words occupied in transmission	Selected by the function code U11 "Transmission format selection" U11=0: Standard format (16 words 8W+8W) U11=1: UPAC compatible format (51 words 29W+22W) U11=2: Monitoring format (16 words 4W+12W) U11=3: Standard format 2 (set by 485No) (16 words 8W+8W)
Terminal/bus cable	IN, OUT/SX bus dedicated cable *NP1C-P3(0.3 m) to NP1C-25(25 m)
Rotary switches RSW1, 2	Station address setting. You can assign any station address from 1 to 238.
Status display LED RUN, ERR	Displays the status of the self station (operation and error) with LEDs.

(1) Rotary switches <u>RSW1 and RSW2</u>

Set the station address using the rotary switches RSW1 and RSW2 on the option board. In the hexadecimal display, "RSW1" represents the upper 4 bits and "RSW2" represents the lower 4 bits. For the SX bus station address, read it in decimal values.

Example) Station address 194 is C2(h) and set RSW1=C and RSW2=2.

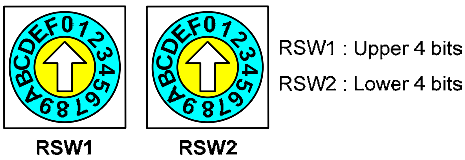


Figure 6.5.1

* Set the same SX bus station address set in the MICREX-SX system definition. Since the address assigned by MICREX-SX is used as the actual SX bus station address, it may be different from the setting value of this rotary switch.
(You can check the address with the function code U13 "SX bus station address monitor".)

* When two or more cards are used, do not allocate the same SX bus station address to multiple stations.

* The factory default is RSW1=0 and RSW2=0 (address = 00).

* The RSW1 and RSW2 settings are recognized upon "power on" and "reset" of the SX bus (MICREX-SX).

* When RSW1=0 and RSW2=0 (station address＝00) are set, communication is only possible when there is no degenerate system start-up. (If there is degenerate system start-up, MICREX-SX will encounter a heavy alarm and the address specified in the system definition of MICREX-SX is used.)

* Even while the SX bus communication is established, and if a slave with an address duplicated with another slave on the SX bus is connected, the slave which has already established communication does not encounter an error and continues operation.

2) Status display LED RUN, ERR

The RUN and ERR LEDs on the option board display the status of the self station (operation and error). Since the option itself determines the status as a slave, the status may be different from RUN and ALM shown on the CPU of MICREX-SX.

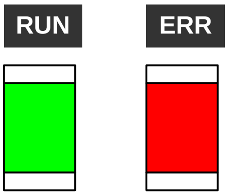


Figure 6.5.2

Table 6.5.2 LED Display

LED States	RUN	ERR
ON	• Link established (Light alarm if ERR is on)	• Error (light or heavy alarm) is occurring
Flashing	• Initial wait status • Inverter power OFF	–
OFF	• SX bus power OFF • self station being reset (Heavy alarm if ERR is ON)	• Link established • SX bus power OFF • Inverter being reset

Table 6.5.3 Software Specifications

Item		Specifications
Data update interval Note		Min. 400 µs
Operation	Run command	Running forward/reverse alarm reset, X1-X14 commands
	Speed command	16-bit binary data
	Operation state output	Bit data for operating, braking, torque limiting, alarm relay output signals, etc.
		Word data for motor speed, torque current command, etc.
Function code		You can reference and change the 255 functions assigned to the link numbers in the function code list. You can reference and change the function code with 485No. if the standard format 2 transmission format is selected.
Optional function code		o30, o31, U01 - 11, U13, U60 - 64
Protective Function		Er-4: Network failure (SX bus error) Light alarm*1: o30 and o31 can be used to control the Er-4 alarm. Heavy alarm *2: Momentary alarm Ar-F : Toggle error Monitors the 2-bit signals for the toggle signal 1 [TGL1] and toggle signal 2 [TGL2] sent from PLC, and generates this error if these the specified change pattern cannot be received within the time specified by H144. *3

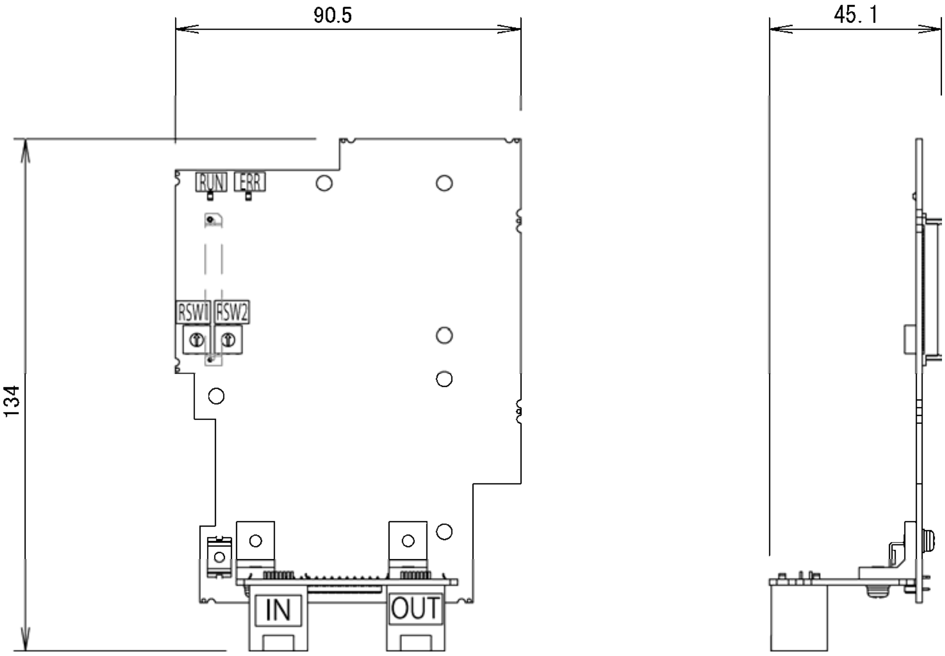
*1 Light alarm: E.g., Signal noise. If the noise is not frequent, the Er-4 alarm can be controlled by o30 and o31 to continue operation.

*2 Heavy alarm: Fatal failure such as hardware failure.

*3 For the details of the toggle signals and toggle error, refer to TGL1 and TGL2 in E01 to E13 toggle signal explanation in "4.3 Function Code Details".

Note: The data update frequency depends on the carrier frequency setting, MICREX-SX SX bus tact frequency, and application program task frequency.

6.5.3 External Dimensions



(Unit: mm)

Figure 6.5.3 Option Print Board External Dimensions

■**Connectors CN2, CN3**

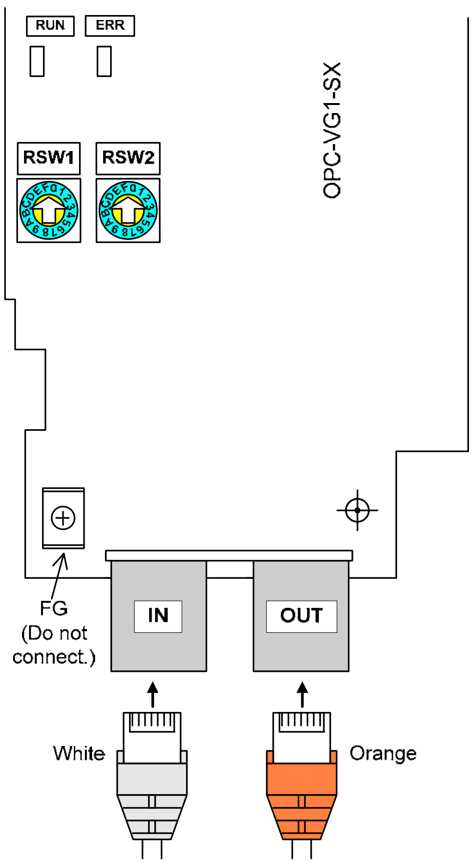


Figure 6.5.4

* FG terminal connection is not necessary. Do not connect it. Refer to "6.1.4 Installing internal options (OPC-VG1-☐☐)" before connecting the cables.

* This option print board does not include the SX bus cable (dedicated) and terminating connector. Prepare a cable for the bus connection distance. If the option is used at both ends of the SX bus, connect the terminating connector to one of the connector end. The terminating connector is supplied with the CPU module of MICREX-SX.

6.5.4 Basic connection diagram

Refer to "6.1.4 Installing internal options (OPC-VG1-☐☐)" before connecting the cables.

⚠WARNING
• Incorrect cabling may cause a disaster such as electrical shock or fire. Only a qualified person should perform cabling. Before touching the power supply circuit (e.g., for cabling after power on), be sure to turn off (i.e., open) the circuit breaker to prevent electrical shock. • Note that the smoothing capacitor is charged after turning off (i.e., opening) the circuit breaker and touching it causes an electrical shock. Ensure that the charge lamp (CHARGE) of the inverter has gone off and that the DC voltage of the inverter has lowered to a safety level using a tester. • Since the SX bus is powered from the PLC power supply module, ensure that the MICREX-SX and inverter power supplies are off when installing or removing this option.

⚠CAUTION
• Do not use the product that is damaged or lacking parts to prevent an injury or damage. • Incorrect handling in installation/removal jobs could result in a broken product.

The basic connection diagram is shown on the next page. When connecting the cables, observe the following precautions.

[Notes on connection]

(1) Be sure to use SX-bus dedicated cables.

Model: NP1C-P3 (0.3 m) to NP1C-25 (25 m)

Refer to the manual of MICREX-SX (hardware) for the cable specifications.

(2) Before proceeding with connection, make sure that both the MICREX-SX and the inverter are powered OFF.

(3) Put the terminating connectors (that come with the CPU module of the MICREX-SX) in both ends of the SX bus.

(4) To prevent an error due to noises, keep the SX bus cable apart from the main circuit cables of the inverter and other power cables as apart as possible (30 cm or more) and never put it in the same duct.

(5) One end of the SX-bus cable should be connected with the OUT connector on the base board, and the other end, with the IN connector. The OUT-OUT or IN-IN connection does not enable communication and the system does not operate. Route SX-bus cables so that the bending radius is at least 50 mm.

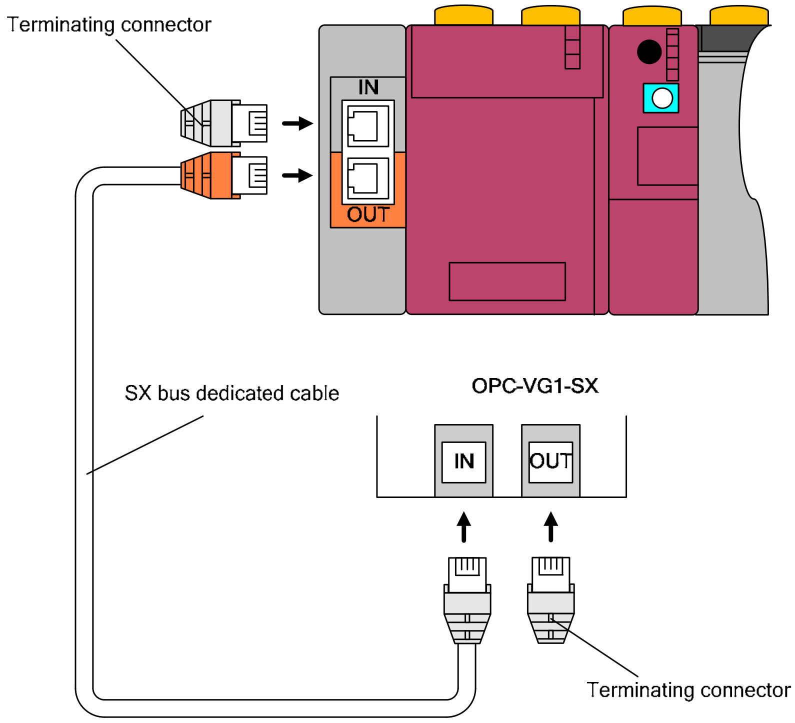
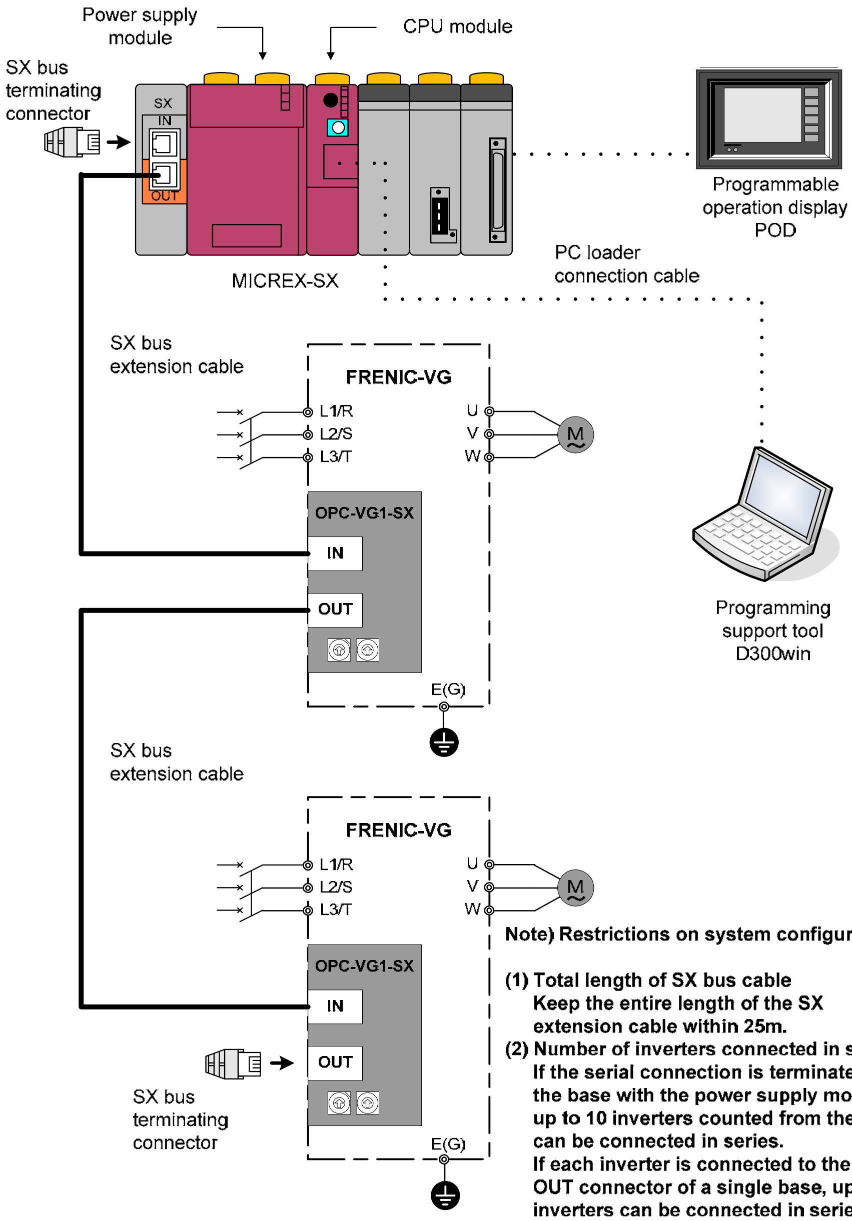

Terminating connector
IN
OUT
SX bus dedicated cable
OPC-VG1-SX
IN
OUT
Terminating connector

Figure 6.5.5

Basic Connection Diagram



Note) Restrictions on system configuration

(1) Total length of SX bus cable
Keep the entire length of the SX extension cable within 25m.

(2) Number of inverters connected in series
If the serial connection is terminated by the base with the power supply module, up to 10 inverters counted from the base can be connected in series.
If each inverter is connected to the IN/OUT connector of a single base, up to 10 inverters can be connected in series for each connector.

Figure 6.5.6

6.5.5 Function code

⚠WARNING

- Incorrect function code data may result in a dangerous situation. After setting and writing the data, check it again.

An accident could occur.

In addition to the standard function code, you can set the optional dedicated function codes o30, o31, U01- 11, U13, U60 - 64.

Table 6.5.4

No.	Function code name		Setting range	Description
	Name	Keypad display		
H30	Link function	LINK FUNC	0 to 3	3: Set the operation command and command data valid via SX.
o30 *1	Error processing after detection of transmission failure	MODE ON ER	0	Immediately force operation to stop upon communication error (light alarm) occurrence (Er-4 alarm: coast to stop).
			1	After a communication error (light alarm) occurs, continue operation for the timer time (run command from the previous communication is held in the communication error state). Force operation to stop after the timer time (Er-4 alarm: coast to stop). If the communication recovers during the timer time, the command received in communication is run. But, operation is forced to stop it the error persists after the timer time.
			2	After a communication error (light alarm) occurs, continue operation for the timer time (run command from the previous communication is held in the communication error state). Force operation to stop if the communication error persists after the timer time. If the communication recovers during the timer time, the command received in communication is run.
			3	No alarm (Er-4) even when a communication error (light alarm) occurs. The run command from the previous communication is held in the communication error state. If the communication recovers, the command received in communication is run.
o31 *1	Operation time after detection of transmission failure	TIMER TL	0.01 - 20.00s	Operation time timer value [s] for a communication error (light alarm) is effective when o30=1 or 2.
U01 - 10	Universal data	USER P01 - 10	-32768 to 32767	You can read and write data as universal data via communication without affecting the inverter.
U11	SX transmission format selection	USER P11	0	Standard format selection Occupied words: 16 words (8W+8W)
			1	UPAC compatible format selection Occupied words: 51 words (29W+22W)
			2	Monitoring format selection Occupied words: 16 words (4W+12W)
			3	Standard format 2 (485No) selection Occupied words: 16 words (8W+8W)
			4-15	Reserved
U13	SX bus station address monitor	USER P13	1 to 238	You can check the SX bus station address of the self station assigned by MICREX-SX in the system configuration definition with this function code. Read-only
U60	U-Ai/ pulse data monitor selection	USER P60	0	Defines U61 - U63 as the user function codes or universal Ai monitor.
			1	Defines U61 to U63 as pulse data monitor.

No.	Function code name		Setting range	Description
	Name	Keypad display		
U61	U-Ai1/ Pulse train position command monitor	USER P61	-32768 to 32767	When U-Ai1 is selected: Universal Ai1(±16384/±10V) can be monitored. When pulse data is selected: Pulse train position command (PG(PR) input) data can be monitored.
U62	U-Ai2/ Position detection monitor	USER P62	-32768 to 32767	When U-Ai2 is selected: Universal Ai2(±16384/±10V) can be monitored. When pulse data is selected: Position detection (internal or PG(PD) input) data can be monitored.
U63	U-Ai3/ Position detection (Z-phase input) monitor	USER P63	-32768 to 32767	When U-Ai3 is selected: Universal Ai3(±16384/±10V) can be monitored. When pulse data is selected: Position detection (PG(PD) Z-phase input) data can be monitored.
U64	U-Ai4/ USER function code	USER P64	-32768 to 32767	When U-Ai4 is selected: Universal Ai4(±16384/±10V) can be monitored. If U-Ai is not defined, it acts as the user function code to read and write data as universal data without affecting the inverter operation.
H107	Light alarm target definition 2	L-ALM 2	0000 to 1111	Select the alarm operation upon occurrence of a SX bus error (Er-4) and toggle error (Ar-F). Er-4 and Ar-F represent the number of hundreds and the number of units, respectively. 0 in the corresponding decimal place: Alarm occurrence, 1: Light alarm (L -AL)
E10 | E13	Select X11 - X14 function.	X11 ~ X14 FUNC	*2	Select the command when each of the X11 to X14 bits is 1. To perform toggle monitoring with the X terminal bits, set TGL1 and TGL2 for two of the terminals.
o160 *3	Function code monitor (1) setting		0000h - FFFFh	Only available when the standard format 2 is used. Sets the function code continuously monitored by the function code monitor (1) with 485No.
o161 *3	Function code monitor (2) setting		0000h - FFFFh	Only available when the standard format 2 is used. Sets the function code continuously monitored by the function code monitor (2) with 485No.

*1 For the details of o30 and o31, refer to "6.5.6.2 Protective operation function code".

*2 For the details, refer to "4.3 Function Code Details".

*3 For the details of o160 and o161, refer to "6.5.8.1 (4) ② Function code monitor".

*4 For the details of user function code, refer to "6.5.5.1 Function code".

・ For other function codes, refer to Chapter 4.

6.5.5.1 Function code

U01 - U10	USER P01 - 10

You can read and write data as universal data via communication without affecting the inverter.

You can read values set with the keypad of the inverter (local) from MICREX-SX (remote), or check values set with the MICREX-SX with the keypad. The set value does not affect the inverter operation at all.

U11	SX transmission format

Select the transmission format used to communicate on the SX bus. Be sure to select the same format as specified in the CPU system configuration definition.

Setting range 0: Standard format (specified with the link No.) (8W+8W)
1: UPAC compatible format (29W+22W)
2: Monitoring format (4W+12W)
3: Standard format 2 (specified with 485No) (8W+8W)
4 - 15: Reserved

Note: When the T-Link interface option is also installed, the transmission format is fixed to the monitoring format and the U11 value is automatically changed to "2". However, be sure to set U11=2 for safety.

U13	SX bus station address monitor

You can check the SX bus station address of the self station assigned by MICREX-SX in the system configuration definition with this function code. (read-only). Be sure that the address is same as the one set with the rotary switches RSW1 and RSW2.

Note: This function code displays the station address in decimal. When configuring the station address with the station address switches, assign it in hexadecimal.

U60	U-Ai/pulse data monitor selection

Select whether the function codes U61 - U63 can monitor the U-Ai (universal Ai) or pulse data. U64 is excluded from pulse data monitoring.

The default value is U60=0 and the U-Ai function is not selected, and U61 to U64 all act as the user function codes. When U61 to U64 are set for monitoring (rather than as the user function codes), do not write data to them.

① When U60=0

U-Ai function is selected	U61	U62	U63	U64
Not selected	User function code	User function code	User function code	User function code
Selected	U-Ai1 monitor	U-Ai2 monitor	U-Ai3 monitor	U-Ai4 monitor

② When U60=1

<table>
<tr><th>U-Ai function is selected</th><th>U61</th><th>U62</th><th>U63</th><th>U64</th></tr>
<tr><td>Not selected</td><td rowspan="2">Pulse train position command (PG(PR) input) monitor</td><td rowspan="2">Position detection (internal or PG(PD) input) monitor</td><td rowspan="2">Position detection (PG(PD) Z-phase input) monitor</td><td>User function code</td></tr>
<tr><td>Selected</td><td>U-Ai4 monitor</td></tr>
</table>

- When the U-Ai function is selected, the universal Ai (U-AI) is selected with Ai function selection (E49-E52).
- U-Ai3 and U-Ai4 are only valid when OPC-VG1-AIO or OPC-VG1-AI is installed.

U61 - U63	U-Ai/pulse data monitor
U64	USER function code/U-Ai4

Data selected by the setting of the function code U60 and Ai function selection is allocated.
Specifications of each data are explained below.

① USER function code

Similar to U01 to U10, you can read and write data as universal data via communication without affecting the inverter.

② U-Ai (universal Ai)

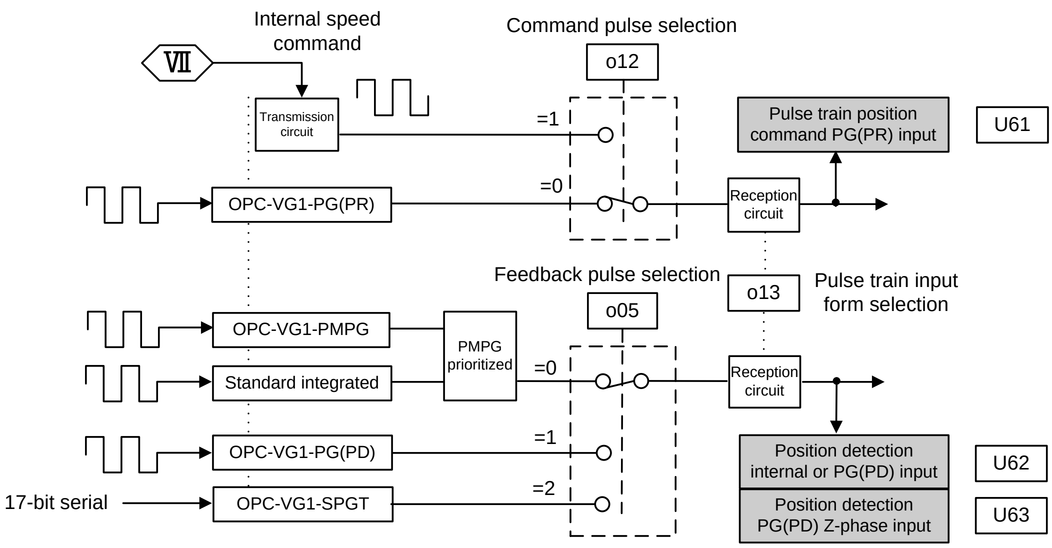
You can read the analog quantity of a signal input to the Ai terminal of the inverter via the SX bus. When using this function, set the corresponding Ai terminal function to U-AI using the function codes E49-E52. This input data is simply provided to check existence of a signal via the SX bus, and does not affect the inverter operation at all.

Note: If you change the Ai terminal function to other than U-AI while U-Ai is used, U61 to U64 hold the values before change.

③ Pulse data

You can monitor pulse data when controlling synchronization and position with the pulse train.

Block Diagram Related to Pulse Data



Note: Detection of the Z-phase standard position is enabled only when the OPC-VG1-PG(PD) option is installed. If this PG is selected while this option is not installed or the o05 feedback pulse is selected, the monitor data of U62 and U63 cannot be referenced.

Figure 6.5.7

*How to obtain pulse data

The PG pulse data is incremented in B-phase forward (running forward) and decremented in A-phase forward (running backward). Therefore, obtain the difference of data sampled this time and last time for the t (ms) task, and add it for every t (ms) to calculate the pulse count value. As the pulse count value is obtained by multiplying the encoder value by four, the formula is "4×encoder pulse count／revolution".

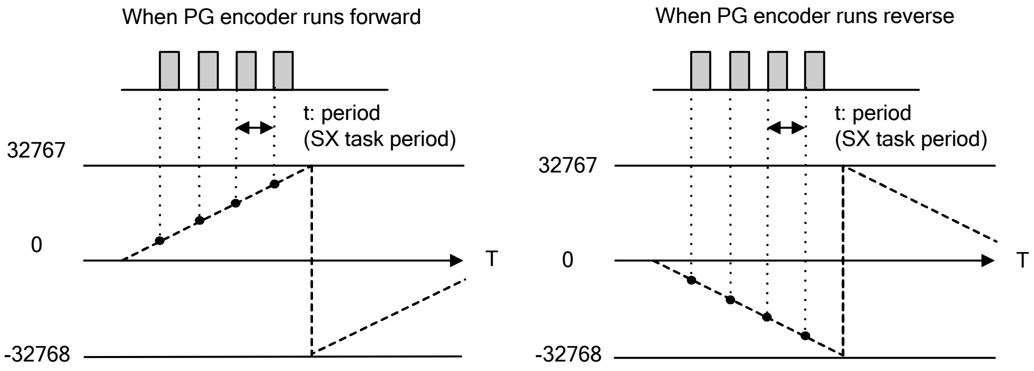


Figure 6.5.8

*How to detect Z phase

The PG pulse can be obtained as mentioned above. However, with differences of the U62 "Position detection (internal or PG(PD) input monitor" and U63 "Position detection (Z-phase input) (PG(PD) monitor" within a task as PG_CNT and PG_CNT_Z respectively, the added data within the task period (tms) is cleared to 0 by hardware Z-phase detection as shown in the figure below. By comparing each memory within the next task, Z phase is detected if they do not match.

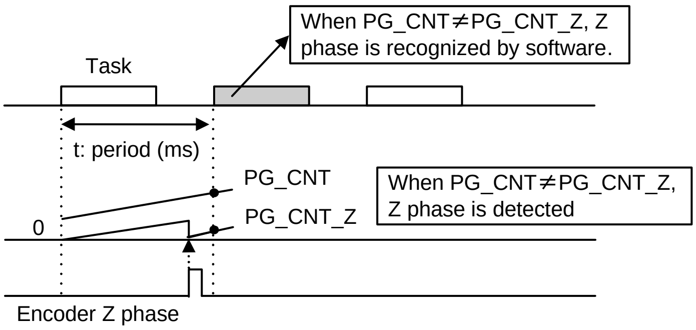


Figure 6.5.9

Note: Detection of the Z-phase standard position is enabled only when the OPC-VG1-PG(PD) option is installed. If this PG is selected while this option is not installed or the o05 feedback pulse is selected, the monitor data of U63 cannot be referenced.

6.5.6 Protective operation

6.5.6.1 Light and heavy alarms

The SX bus option can encounter light and heavy alarms depending on the failure level.

Upon occurrence of this failure, the inverter outputs Er-4 "network error" and the motor coasts to stop.

Table 6.5.5

Item	Light alarm	Heavy alarm 1	Heavy alarm 2
Card LED States	ERR ■ (ON) RUN ■ (ON)	ERR ■ (ON) RUN ■ (ON)	Undefined
Cause	• Communication data error due to noises on the communication line, etc.	• All masters go down • Disconnection detected • SX bus power down	• Option hardware failure • Option installation failure
Reset method *1	Resolve the cause (or wait for communication recovery) and give a reset command (keypad, RST, or remote reset).		Resolve the alarm cause and power cycle the inverter.
Failure state control	Alarm is only detected while operation commands are given via the SX bus.		
	Alarms can be controlled with the function codes o30 and o31.	An Er-4 alarm immediately occurs upon heavy alarm.	
Communication error code displayed on keypad *2	1	2	3
Alarm sub code *3	1 (hex)	2 (hex)	4 (hex)

*1 "Give a reset command" means supplying a reset input to the inverter in one of the following methods.

* Keypad (RESET) key input
* Assign the failure reset RST with the X function selection and digitally input the command.
* Input the reset command via the communication line.

For a heavy alarm, the CPU may also require reset depending on the CPU state of MICREX-SX.

*2 You can check the communication error code for light and heavy alarms on the communication state screen of the maintenance information on the keypad. To access this screen, press the (PRG) key to return to the menu screen, and move the arrow on the left edge of the screen to "5. Maintenance" using the ∧/∨ key, then press the (FUNC/DATA) key. Press the ∨ key three times to show the screen below. Note that this error code displays the first cause for Er-4. Since every heavy alarm 1 is preceded with a light alarm, this code shows the light alarm even for a heavy alarm 1 when o30=0.

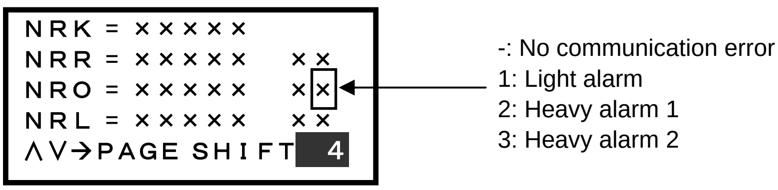


Figure 6.5.10

*3 You can check the Er-4 alarm sub code on the alarm history selection of the alarm information on the keypad. To access this screen, press the PRG key to return to the menu screen, and move the arrow on the left edge of the screen to "7. Alarm information" using the ∧/∨ key, then press the FUNC/DATA key. On the latest and last three alarm history item screen, select an item you are interested in, press the FUNC/DATA key, and then press the ∧ key once to show the screen below. Note that this error code displays the first cause for Er-4. Since every heavy alarm 1 is preceded with a light alarm, this code shows the light alarm even for a heavy alarm 1 when o30=0.

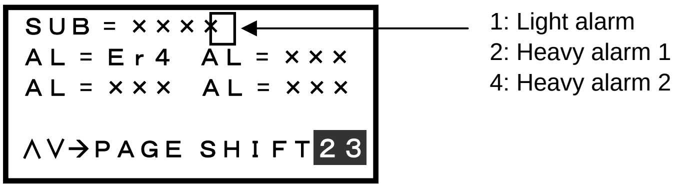


Figure 6.5.11 Alarm Subcode Confirmation Screen

6.5.6.2 Protective operation function code

The following explains how to control the Er-4 alarm when a light alarm occurs while an operation command is given from MICREX-SX via the SX bus.

[Operation Description]

The following describes an example of operation when operation and speed commands are given from MICREX-SX and a communication error occurs during operation.

*1 During this period of time, if communication recovers and new commands or settings are not sent, commands (for operation or speed, or both) received upon error occurrence are held.

(1) When function code o30 = 0

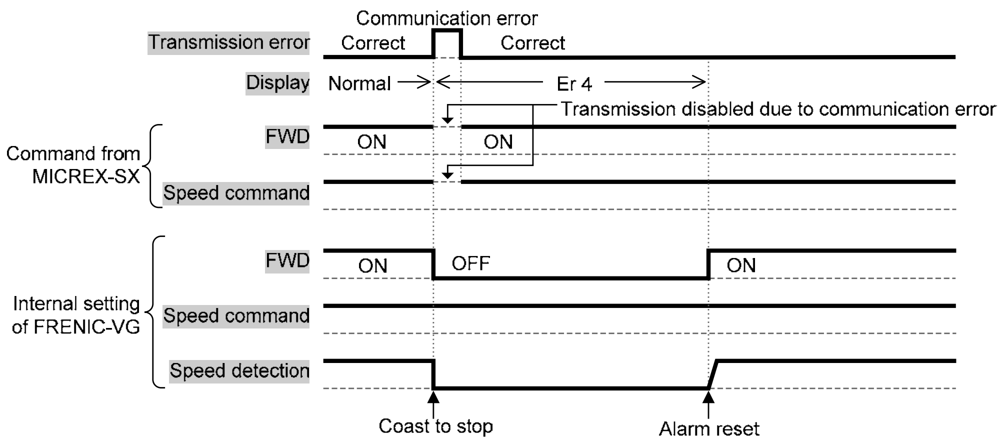


Figure 6.5.12

(2) When the function code o30 = 1 and o31 = 5.0 (when a communication error occurs, the motor coasts to stop in five seconds.)

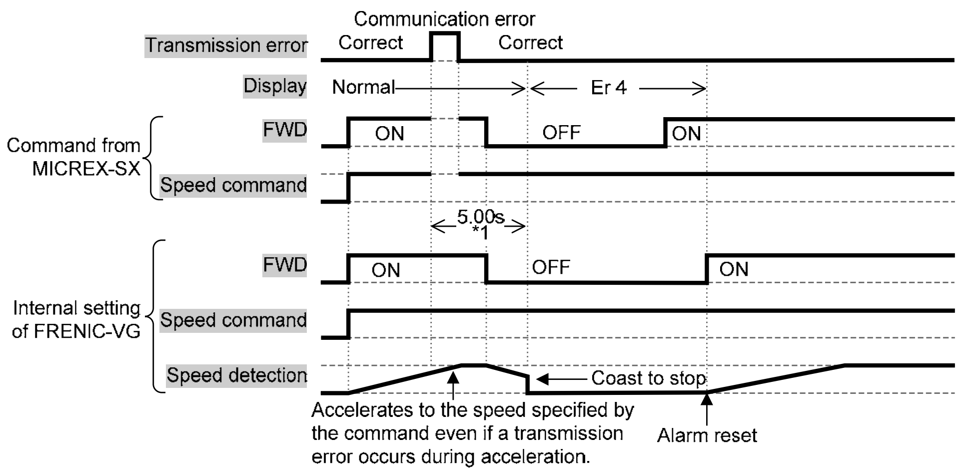


Figure 6.5.13

(3) When the function code o30 = 2 and o31 = 5.0
(the communication error persists in five seconds after its occurrence and the Er-4 alarm occurs)

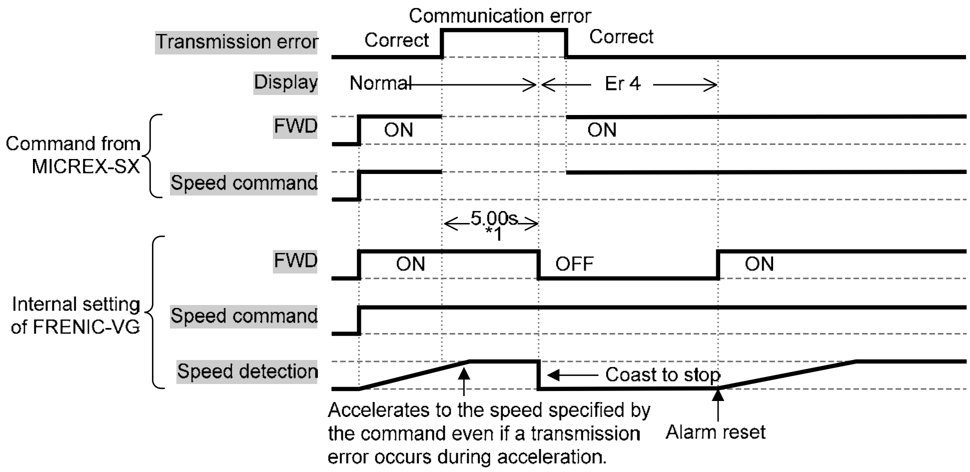


Figure 6.5.14

(4) When the function code o30 = 2 and o31 = 5.0 (a communication error occurs and the communication recovers in five seconds)

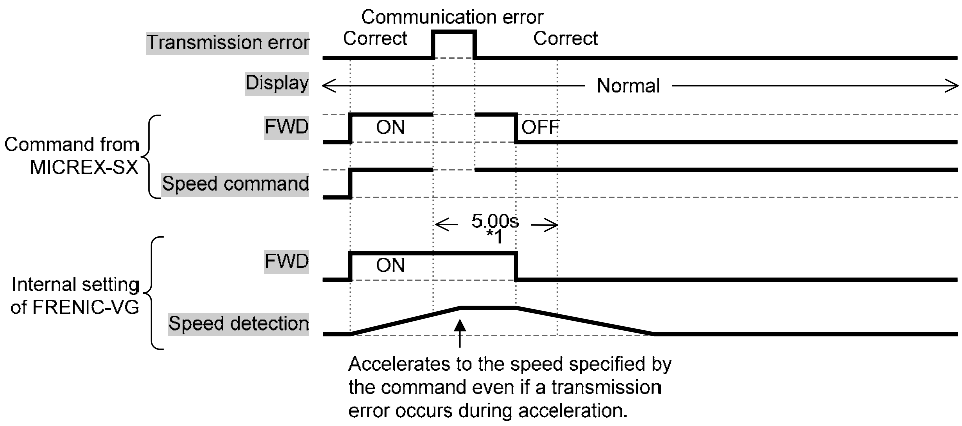


Figure 6.5.15

(5) When function code o30 = 3

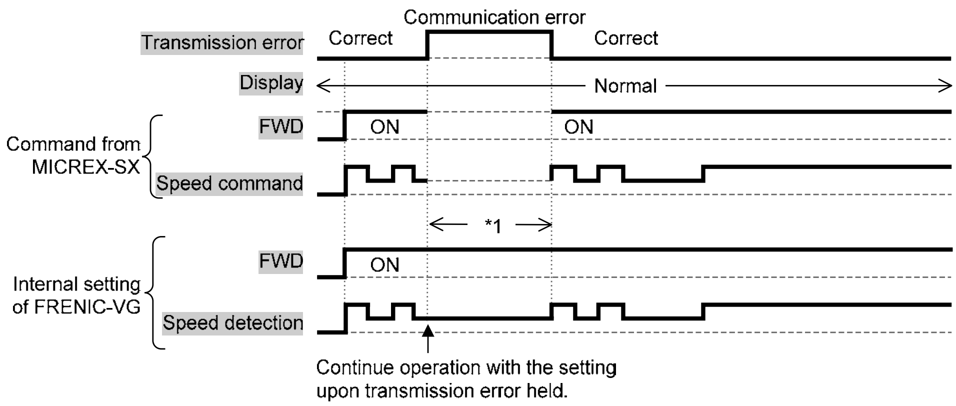


Figure 6.5.16

6.5.7 Data allocation addresses

6.5.7.1 Transmission format

One the following four transmission formats can be selected by the function code U11 "SX bus transmission format selection".

(1) Standard format (U11=0)

This is the basic format which allows for monitoring of the motor speed and operation status as well as read and write of four function codes for each (specified by the link No.).

(2) UPAC compatible format (U11=1)

This format provides the control variables which can be used for the UPAC option card (OPC-VG1-UPAC) as fixed frame. Two function codes can be read and written for each.

(3) Monitoring format (U11=2)

This format is dedicated for monitoring and eight function codes can be read, but not be written.

(4) Standard format 2 (U11=3)

This is the basic format which allows for monitoring of the motor speed and operation status as well as read and write of two function codes for each (specified by the 485No).

6.5.7.2 Area occupied and data allocation addresses

(1) Standard format (specified by link No.)

When the standard format is selected (U11=0), as shown in the figure below, out of the I/Q area of the MICREX-SX, 16 words are used for each FRENIC-VG, with the lower 8 words are used for read and upper 8 words are used for write.

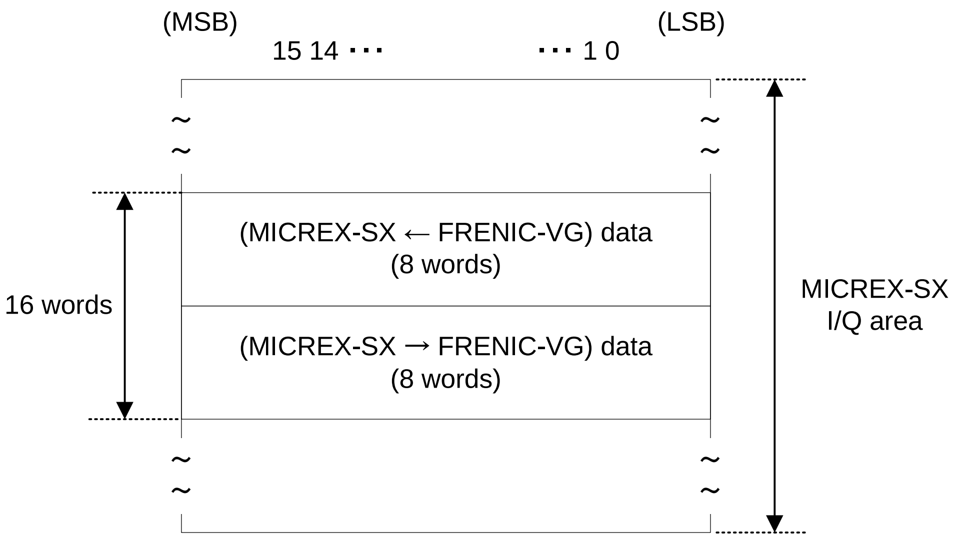


Figure 6.5.17

Address	(MSB) 15 14 … 8	7 … 10 (LSB)	Direction
%IW***. 0	Polling function code (1)	Polling function code (2)	FRENIC-VG ⇓ MICREX-SX
%IW***. 1	Polling function code (3)	Polling function code (4)	
%IW***. 2	Polling function code (1) data		
%IW***. 3	Polling function code (2) data		
%IW***. 4	Polling function code (3) data		
%IW***. 5	Polling function code (4) data		
%IW***. 6	Motor speed (M06)		
%IW***. 7	Operation state (refer to * 6.5.8.1 (1))		
%QW***. 8	Selecting function code (1)	Selecting function code (2)	MICREX-SX ⇓ FRENIC-VG
%QW***. 9	Selecting function code (3)	Selecting function code (4)	
%QW***. 10	Selecting function code (1) data		
%QW***. 11	Selecting function code (2) data		
%QW***. 12	Selecting function code (3) data		
%QW***. 13	Selecting function code (4) data		
%QW***. 14	Polling function code (1)	Polling function code (2)	
%QW***. 15	Polling function code (3)	Polling function code (4)	

Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Figure 6.5.18

(2) UPAC compatible format

When the UPAC compatible format is selected (U11=1), as shown in the figure below, out of the I/Q area of the MICREX-SX, 51 words are used for each FRENIC-VG, with the lower 29 words are used for read and upper 22 words are used for write.

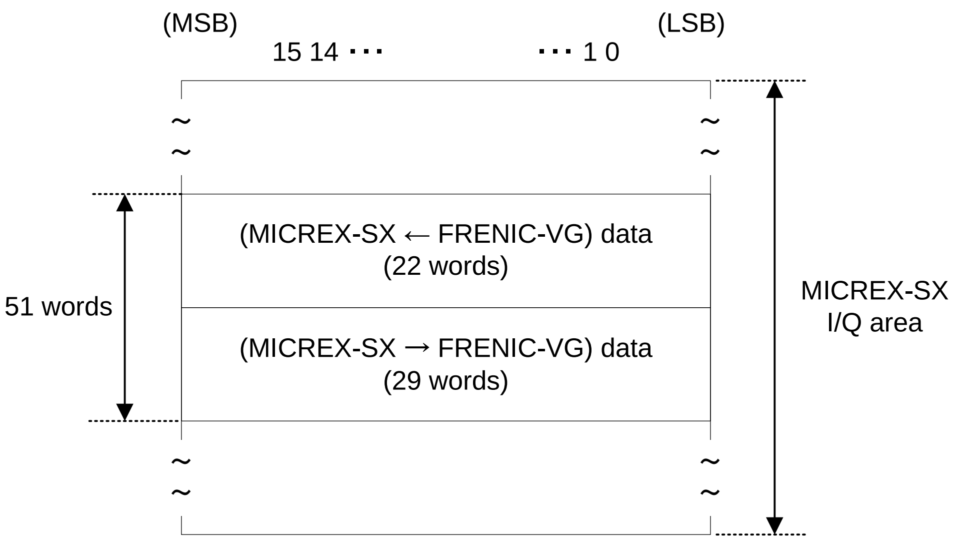


Figure 6.5.19

Address	(MSB) 15 14 … … 10 (LSB)
%IW***. 0	Speed setting 4/Frequency command monitor
%IW***. 1	Torque command 2
%IW***. 2	Torque current command (final)
%IW***. 3	Magnetic flux command (final)
%IW***. 4	Actual speed (detected)
%IW***. 5	Control data (CW) (Standard ＋DIOA, 16 bits)
%IW***. 6	Operation status (SW)
%IW***. 7	Speed setting 1/Frequency command (for V/f)
%IW***. 8	Line speed input
%IW***. 9	Pulse train position command (PG (PR))
%IW***. 10	Position detection (internal or PG (PD))
%IW***. 11	Position detection (PG (PD) Z-phase input)
%IW***. 12	Position command
%IW***. 13	VG DI (DIOB option: 16 bits)
%IW***. 14	FRENIC-VG Ai (Ai1)
%IW***. 15	FRENIC-VG Ai (Ai2)
%IW***. 16	VG Ai (AIO/AI option, Ai3)
%IW***. 17	VG Ai (AIO/AI option, Ai4)
%IW***. 18	Polling function code 1 address
%IW***. 19	Polling function code 1 data
%IW***. 20	Polling function code 2 address
%IW***. 21	Polling function code 2 data

FRENIC-VG ⇓ MICREX-SX

Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Figure 6.5.20

Address	(MSB) 15 14 … …10 (LSB)
%QW***. 22	Speed setting 1/Frequency command (for V/f)
%QW***. 23	Torque command 1
%QW***. 24	Torque current command
%QW***. 25	Magnetic flux command
%QW***. 26	Control data (CW)
%QW***. 27	VG DO1 (standard＋DIOA: 13 bits)
%QW***. 28	Acceleration time
%QW***. 29	Deceleration time
%QW***. 30	Torque limiting value level 1
%QW***. 31	Torque limiting value level 2
%QW***. 32	Speed setting 4/Frequency command (for V/f)
%QW***. 33	Torque command 2
%QW***. 34	Torque bias
%QW***. 35	Speed supplement command
%QW***. 36	Actual speed (simulated)
%QW***. 37	Selecting function code 1 address
%QW***. 38	Selecting function code 1 data
%QW***. 39	Selecting function code 2 address
%QW***. 40	Selecting function code 2 data
%QW***. 41	Polling function code 1 address
%QW***. 42	Polling function code 2 address
%QW***. 43	VG DO2 (DIOB option: 10 bits)
%QW***. 44	FRENIC-VG AO (AO1)
%QW***. 45	FRENIC-VG AO (AO2)
%QW***. 46	FRENIC-VG AO (AO3)
%QW***. 47	FRENIC-VG AO (AIO option, AO4)
%QW***. 48	FRENIC-VG AO (AIO option, AO5)
%QW***. 49	Dynamic SW1
%QW***. 50	Dynamic SW2

MICREX-SX ⇓ FRENIC-VG

Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Refer to "6.5.8 Transmission Format" for the transmission format.

Figure 6.5.21

(3) Monitoring format

When the monitoring format is selected (U11=2), as shown in the figure below, out of the I/Q area of the MICREX-SX, 16 words are used for each FRENIC-VG, with the lower 4 words are used for read and upper 12 words are used for write.

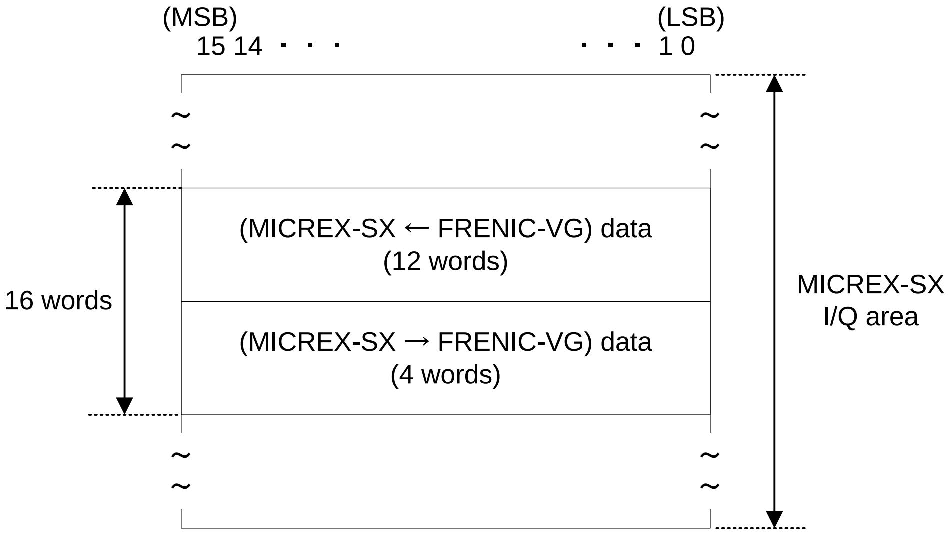


Figure 6.5.22

	(MSB) 15 14 … 8	7 …1 0 (LSB)	
%IW***. 0	Polling function code (1)	Polling function code (2)	FRENIC-VG ⇓ MICREX-SX
%IW***. 1	Polling function code (3)	Polling function code (4)	
%IW***. 2	Polling function code (5)	Polling function code (6)	
%IW***. 3	Polling function code (7)	Polling function code (8)	
%IW***. 4	Polling function code (1) data		
%IW***. 5	Polling function code (2) data		
%IW***. 6	Polling function code (3) data		
%IW***. 7	Polling function code (4) data		
%IW***. 8	Polling function code (5) data		
%IW***. 9	Polling function code (6) data		
%IW***. 10	Polling function code (7) data		
%IW***. 11	Polling function code (8) data		
%QW***. 12	Polling function code (1)	Polling function code (2)	MICREX-SX ⇓ FRENIC-VG
%QW***. 13	Polling function code (3)	Polling function code (4)	
%QW***. 14	Polling function code (5)	Polling function code (6)	
%QW***. 15	Polling function code (7)	Polling function code (8)	

Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Figure 6.5.23

(4) Standard format 2 (specified with 485No)

When the standard format 2 is selected (U11=3), as shown in the figure below, out of the I/Q area of MICREX-SX, 16 words are used for each FRENIC-VG, with the lower 8 words are used for read and upper 8 words are used for write.

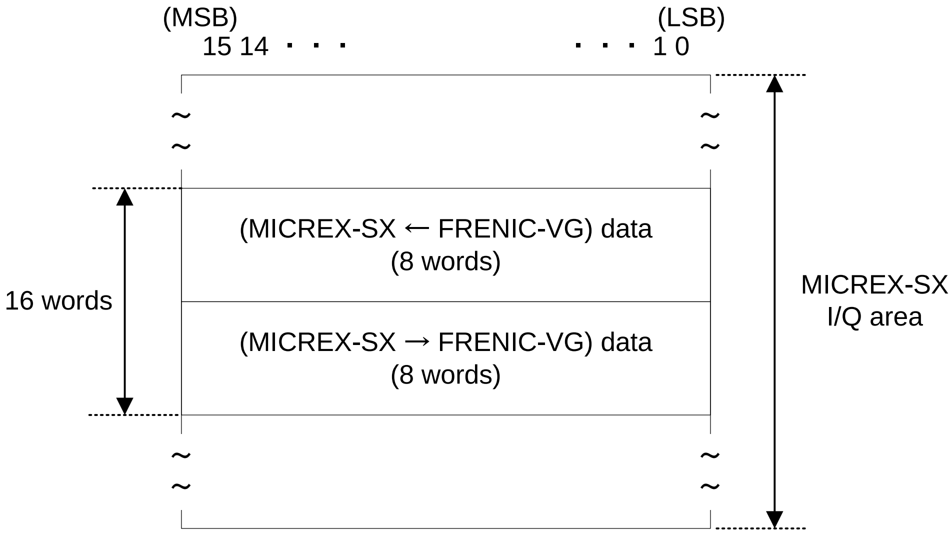


Figure 6.5.24

Address	(MSB) 15 14 … 8 / 7 … 1 0 (LSB)	Direction
%IW***. 0	Polling function code 485No (1)	FRENIC-VG ⇓ MICREX-SX
%IW***. 1	Polling function code 485No (2)	
%IW***. 2	Polling function code (1) data	
%IW***. 3	Polling function code (2) data	
%IW***. 4	Function code monitor (1)	
%IW***. 5	Function code monitor (2)	
%IW***. 6	Motor speed (M06)	
%IW***. 7	Operation state (refer to * 6.5.8.1 (1))	
%QW***. 8	Selecting function code 485No (1)	MICREX-SX ⇓ FRENIC-VG
%QW***. 9	Selecting function code 485No (2)	
%QW***. 10	Selecting function code (1) data	
%QW***. 11	Selecting function code (2) data	
%QW***. 12	Speed command (S01)	
%QW***. 13	Operation command/Di/RESET input (S06)	
%QW***. 14	Polling function code 485No (1)	
%QW***. 15	Polling function code 485No (2)	

Note: *** represents the SX bus station address set by "RSW1" and "RSW2".

Figure 6.5.25

6.5.8 Transmission format

6.5.8.1 Data Format (FRENIC-VG ⇒ MICREX-SX)

(1) When standard format (specified by link No.) is selected

① Operate state (1 for all ON)

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
BUSY	ERR	-	RL	ALM	DEC	ACC	IL	-	TL	NUV	BRK	INT	EXT	REV	FWD

FWD : Running forward
REV : Running reverse
EXT : DC braking or pre-exciting
INT : Inverter shutdown
BRK : Braking
NUV : DC link bus voltage

TL : Torque limiting
IL : Current limiting
ACC : Accelerating
DEC : Decelerating
ALM : Batch failure

RL : Communication selection (1: H30 = 2 or 3)
ERR : Function code access error
BUSY : Writing function code

- ERR is cleared to "0" when selecting (writing) and polling (reading) of the function code has been done correctly. If any of selecting or polling is not performed correctly, ERR is set to "1". The error cause in this case can be checked with the function code M26 (see the table below). When ERR is set to "1", resolve the cause and perform selecting or polling again. If the operation is successful, both of ERR and M26 are cleared to "0".

M26 value	Write/read error
78	Access to unused function code
79	Writing to a read-only function code
	Writing to a function code (during operation) which cannot be changed during operation
	Writing to a function code which cannot be changed with FWD/REV ON.
80	Writing out-of-range data

*1 If multiple errors occur simultaneously, the following priority is applied to the M26 error cause.
Selecting (2) > Selecting (1) > Polling (2) > Polling (1)
(For example, if selecting (2) and polling (1) are faulty, the cause for the selecting (2) error is stored in M26.)

- BUSY is set to "1" while writing (processing) data. When writing consecutive data, wait for BUSY to be cleared to "0" and write the next data. A writing request made while this bit is set to "1" is ignored.

② Motor speed

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Motor speed (decimal) x 20000 / maximum speed ⇒ 16-bit data															

The maximum speed is set with the inverter function code F03. Obtain a r/min value by calculating backward using the above formula. If data is negative (complement of 2), it is a reverse speed command.

③ Polling function code address and data

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Polling function code (1)								Polling function code (2)							
Polling function code (3)								Polling function code (4)							
Polling function code (1) data ⇓ Polling function code (4) data															

"Polling function code (1) to (4)" (eight bits each) store the link number corresponding to the function code requested for polling from MICREX-SX. Their data are stored in "Polling function code (1) to (4) data".

(2) When UPAC compatible format is selected

① Speed setting 4/frequency command monitor, actual speed (detected), speed setting 1/frequency command (for V/f), line speed input

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Motor speed (decimal) x 20000 / maximum speed ⇒ 16-bit data															

The maximum speed is set with the function code. Obtain a r/min value by calculating backward using the above formula. If data is negative (complement of 2), it is a reverse speed command.

② Torque command 2, torque current command (final)

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Torque command data															

Torque command 2 data, torque current command data: 0.01%/1d (100% = rated toque)

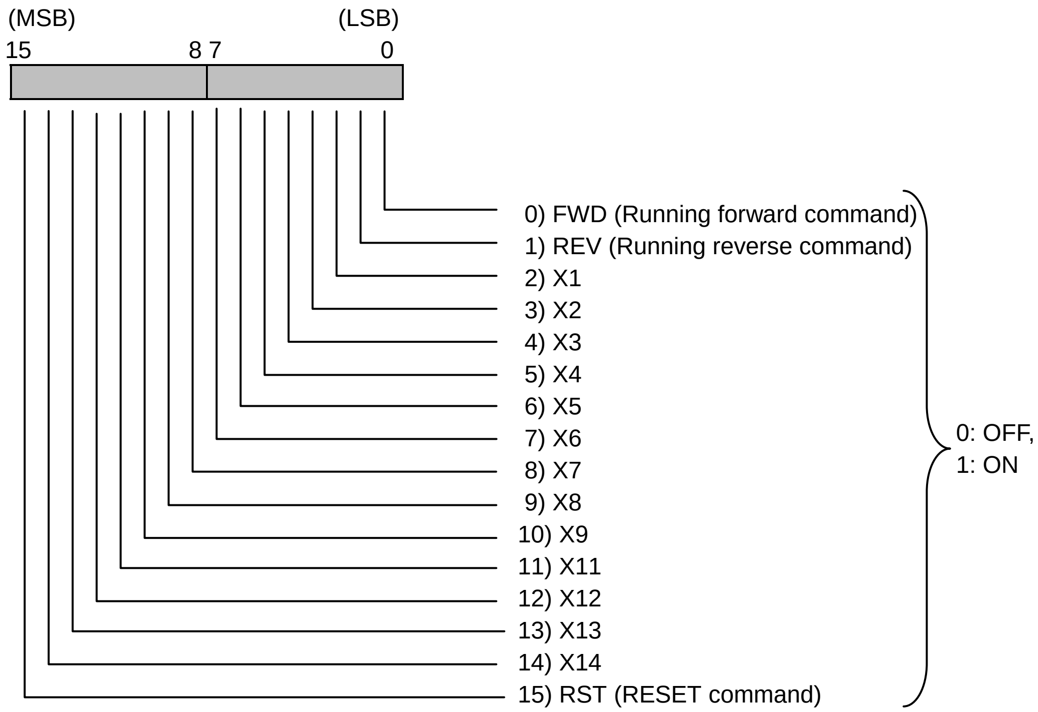
③ Magnetic flux command (final)

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Magnetic flux command data															

Magnetic flux command data: 0.01%/1d

④ Control data (CW) (Standard ＋DIOA, 16 bits)



⑤ Operation status (SW)

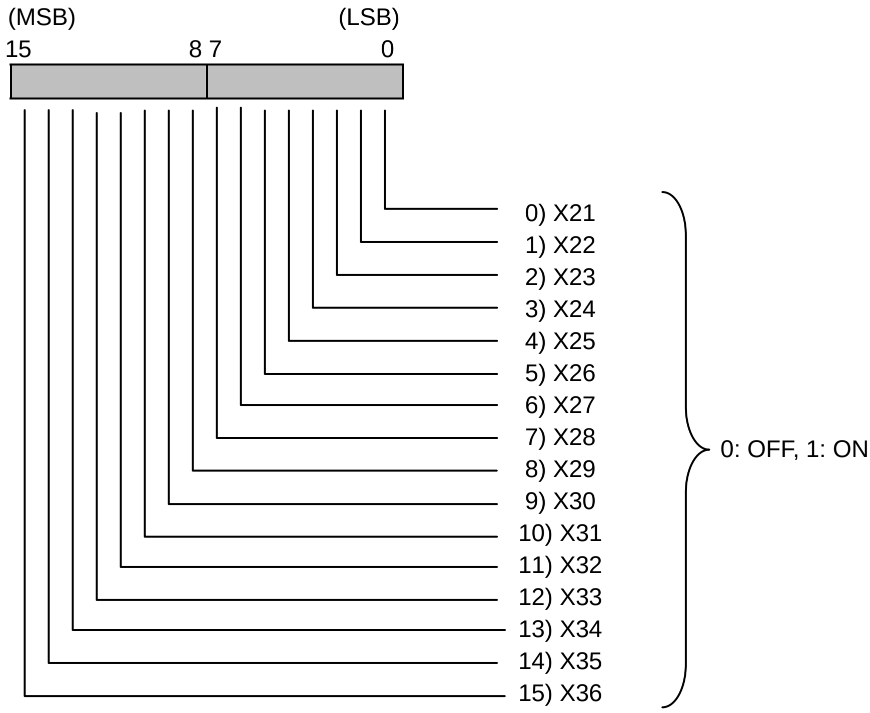
Refer to the operation status of the standard format.

⑥ Pulse train position command (PG (PR)), position detection (internal or PG (PD)), position detection (Z-phase input) (PG (PD))

Refer to the explanation of U61 - U63 in "6.4.5.1 Function Code".

⑦ Position command (available soon)

⑧ VG DI (DIOB option: 16 bits)



⑨ VG Ai (Ai1), VG Ai (Ai2), VG Ai (AIO/AI option, Ai3), VG Ai (AIO/AI option, Ai4)

(MSB) 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	(LSB) 0
VG Ai data															

VG Ai data: ±10 V = ±4000 h (±16384d)

⑩ Polling function code address and data

(MSB) 15	14	...	1	(LSB) 0
Polling function code 1 address				
Polling function code 1 data				
Polling function code 2 address				
Polling function code 2 data				

"Polling function code 1, 2 address" (16 bits each) store the link number corresponding to the function code requested for polling from MICREX-SX. Their data are stored in "Polling function code 1, 2 data".

Note:

⑥ The PG option (OPC-VG1-PG/PGo) is necessary to reference data for the pulse train position command and position detection (excluding internal data).

⑧ The DIO option (OPC-VG1-DIO) is necessary to reference data for the VG DI (DIOB option: 16 bits).

⑨ The AIO option (OPC-VG1-AIO) or AI option (OPC-VG1-AI) is necessary to reference data for VG Ai (AIO/AI option, Ai3) / (AIO/AI option, Ai4).
To enable this data, you need to assign the corresponding Ai terminal functions to the universal Ai (U-AI) using the function codes E49 to E52. If they are not assigned, the value will be 0.

When using Ai2, set the SW3 on the control board to the V side.
(For the switch, refer to "3.3.3.9 Switch Operation".)

(3) When monitoring format is selected

① Polling function code address and data

(MSB) 15 14 ... 8 | 7 ... 1 0 (LSB)

15 14 … 8	7 … 1 0
Polling function code (1)	Polling function code (2)
Polling function code (3)	Polling function code (4)
Polling function code (5)	Polling function code (6)
Polling function code (7)	Polling function code (8)
Polling function code (1) data ⇓ Polling function code (8) data	

"Polling function code (1) to (8)" (eight bits each) store the link number corresponding to the function code requested for polling from MICREX-SX. Their data are stored in "Polling function code (1) to (8) data".

(4) When standard format 2 (specified with 485No) is selected

① Polling function code address and data

(MSB) 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0 (LSB)
Polling function code 485No (1)															
Polling function code 485No (2)															
Polling function code (1) data															
Polling function code (2) data															

"Polling function code 485No (1) to (2)" (16 bits each) store the 485No corresponding to the function code requested for polling from MICREX-SX. The corresponding link numbers are stored in "Polling function code (1) to (2) data".

② Function code monitor

(MSB) 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0 (LSB)
Function code monitor (1)															
Function code monitor (2)															

"Function code monitor (1), (2)" are the constant monitor of the function code. Set the target function code 485No with the function code o160 for "Function code monitor (1)" and o161 for "Function code monitor (2)".

③ Motor speed

Refer to the motor speed of the standard format.

④ Operation status

Refer to the operation status of the standard format.

6.5.8.2 Data format (MICREX-SX ⇒ FRENIC-VG)

(1) When standard format is selected

① Selecting function code address and selecting function code data

(MSB) 15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0 (LSB)
Selecting function code (1)	Selecting function code (2)
Selecting function code (3)	Selecting function code (4)
Selecting function code (1) data	
⇓	
Selecting function code (4) data	

"Selecting function code (1) to (4)" (eight bits each) store the link number corresponding to the function code selected by MICREX-SX. Write the data to "Selecting function code (1) to (4) data". Note that writing to the function code with this selecting function is done per the tact period of MICREX-SX.

Note 1) Upon selecting, be sure to write the link number and data together.

Note 2) If multiple selecting errors occur simultaneously with the selecting function codes (1) to (4), the following priority is applied to the function code M26 error cause.
Selecting function code (4) > (3) > (2) > (1)

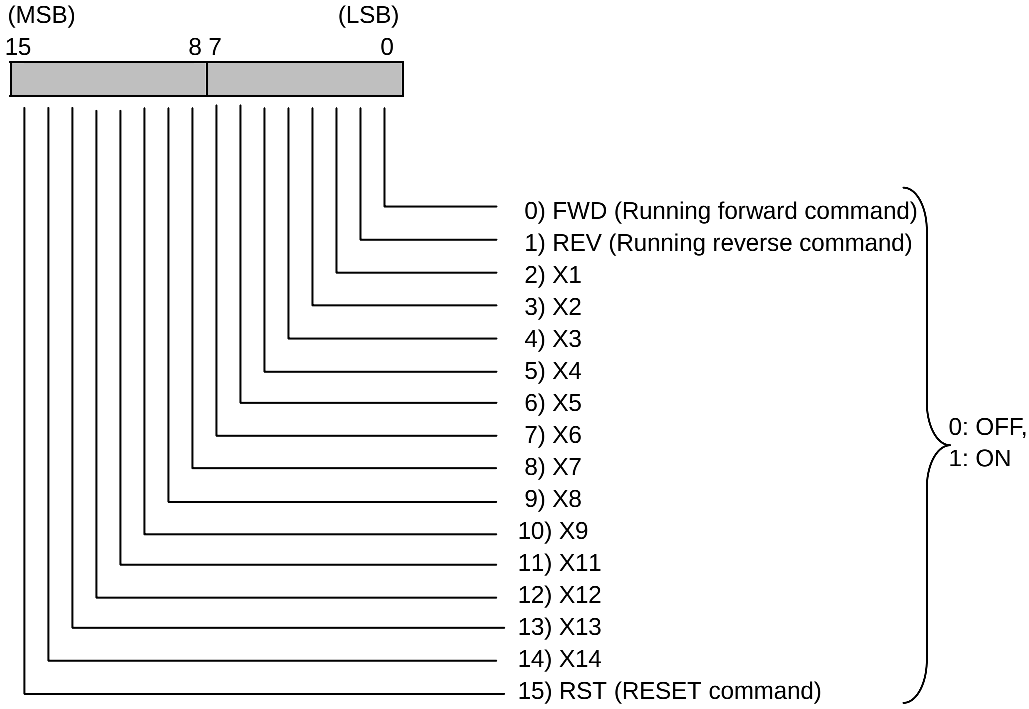
② Polling function code address

(MSB) 15 14 … 8	7 … 1 0 (LSB)
Polling function code (1)	Polling function code (2)
Polling function code (3)	Polling function code (4)

Use the "polling function code (1) to (4)" (8 bits) to specify the link number corresponding to the function code number requested for polling.

(2) When UPAC compatible format is selected

① Control data (CW)



- FWD, REV and X1 to X14 are available when the link command is permitted as instructed in "6.4.9.1 Link Command Permission Selection". RST is always available.
- Note that the operation command (FWD/REV) specifications are different from when the UPAC option is used as shown below (available soon for the UPAC option).
- The AND condition of the operation commands defined in the UPAC option specifications is invalidated (deleted) for the SX bus option (when the UPAC compatible format is selected) (available soon for the UPAC option).

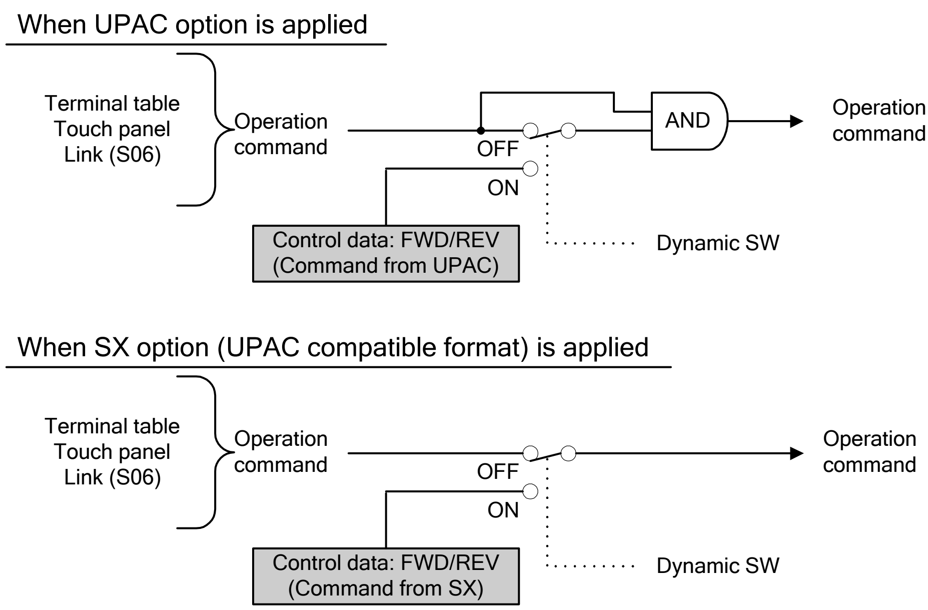


Figure 6.5.26

② Speed setting 1/frequency command (for V/f), speed setting 4/frequency command (for V/f), speed supplement command, actual speed (simulated)

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Speed command (decimal) x 20000 / maximum speed ⇒ 16-bit data															

The above is the same as the motor speed. The maximum speed is set with the function code. Provide the speed value as 16-bit data of the value calculated above. (Handle negative data as a complement of 2.)

③ Torque command 1, torque command 2, torque current command, torque limiting level 1, torque limiting level 2, torque bias

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Torque command data															

Torque command data: 0.01%/1d (100% = rated toque)

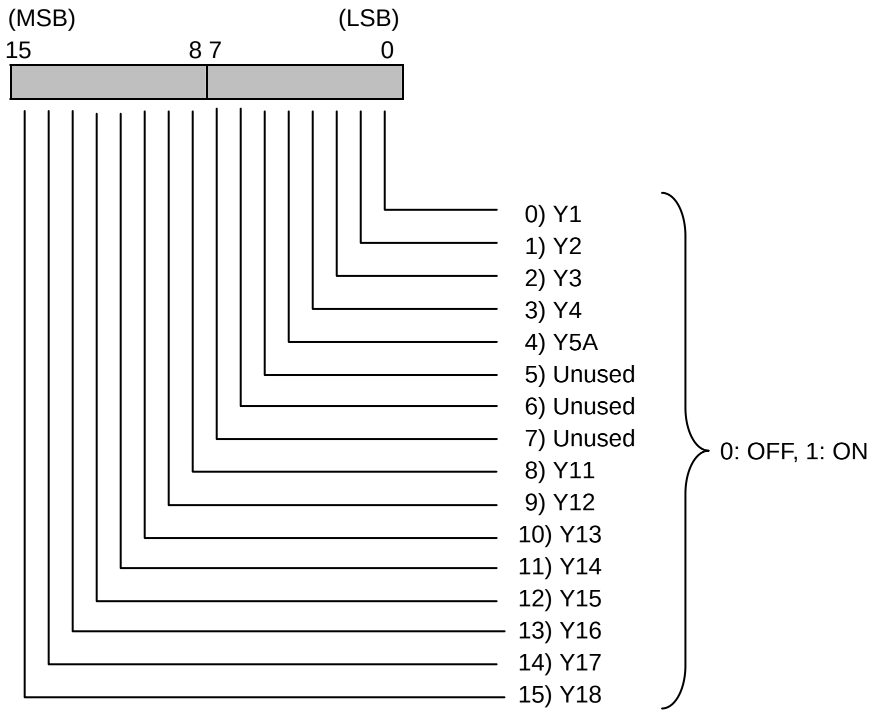
④ Magnetic flux command

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Magnetic flux command data															

Magnetic flux command data: 0.01%/1d

⑤ VG DO1 (standard＋DIOA: 13 bits)



⑥ Acceleration time, deceleration time

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Acceleration (deceleration) time data															

Acceleration (deceleration) time data: 0.1s/1d

⑦ Selecting function code address and selecting function code data

(MSB) (LSB)

15 14 … 1 0
Selecting function code 1 address
Selecting function code 1 data
Selecting function code 2 address
Selecting function code 2 data

"Selecting function code 1, 2 address" (16 bits each) write the link number corresponding to the function code selected by MICREX-SX. Write the data to "Selecting function code 1, 2 data".

Note: • Upon selecting, be sure to write the link number and data together.

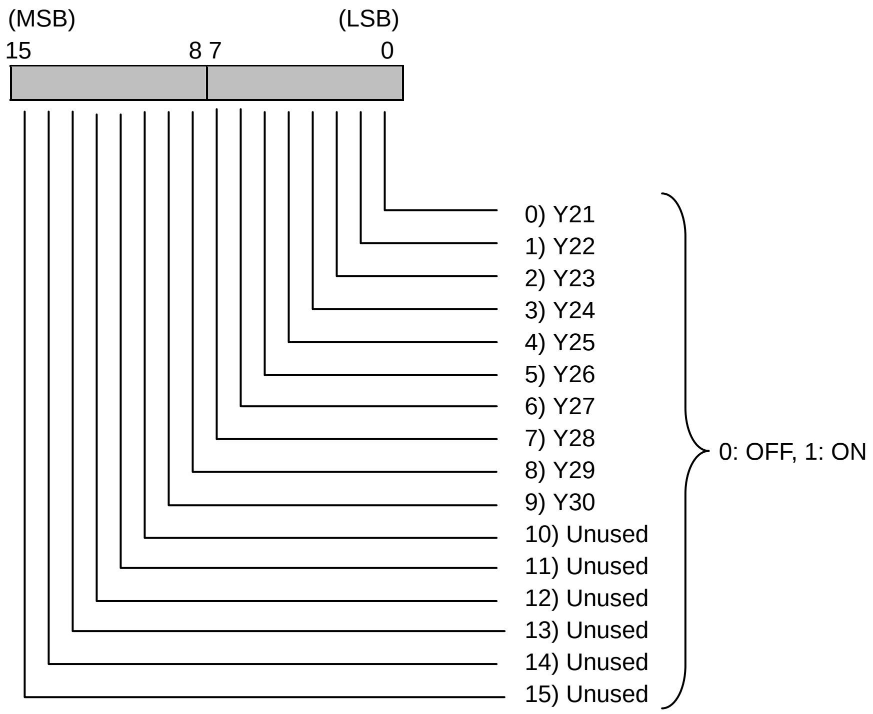
• Writing from this frame to the S code is prohibited. For a command equivalent to the S code, give commands from each dedicated frame.

⑧ Polling function code address

(MSB) 15	14	…	1	(LSB) 0
Polling function code 1 address				
Polling function code 2 address				

Use the "polling function code 1, 2 address" (16 bits) to specify the link number corresponding to the function code number requested for polling.

⑨ VG DO2 (DIOB option: 10 bits)



⑩ VG AO (AO1), VG AO (AO2), VG AO (AO3), VG AO (AIO option, AO4), VG AO (AIO option, AO5)

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
FRENIC-VG Ao data															

VG Ao data: ±10V=±4000h(±16384d)

⑪ Dynamic SW1

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SW16	SW15	SW14	SW13	SW12	SW11	SW10	SW9	SW8	SW7	SW6	SW5	SW4	SW3	SW2	SW1

Dynamic SW2

(MSB) (LSB)

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
-	-	-	-	-	SW27	SW26	SW25	SW24	SW23	SW22	SW21	SW20	SW19	SW18	SW17

Each bit value indicates the dynamic switch number. The dynamic switch for each control variable is as shown below.

1: Enabled (Dynamic switch is enabled and the control variable data is reflected.)
0: Disabled (Dynamic switch is disabled and the control variable data is not reflected.)

Note:

- Note that the definition of the dynamic switch is different from the UPAC option.

  By default, all dynamic switches are set to 0 (disabled). When the control variable (MICREX-SX→VG) is enabled in the UPAC compatible format, be sure to enable the corresponding dynamic switch.
- Refer to the UPAC SW shown in the control block diagram in Chapter 4 for the position of each dynamic switch.

SW1: Speed setting 1/Frequency command (for V/f)
SW2 : Torque command 1
SW3 : Torque current command
SW4 : Magnetic flux command
SW5 : Control data (CW)
SW6 : FRENIC-VG DO1(standard + DIOA: 13 bits)
SW7 : Acceleration time
SW8 : Deceleration time
SW9 : Torque limiting value level 1
SW10 Torque limiting value level 2
SW11 Speed setting 4/Frequency command (for V/f)
SW12 : Torque command 2
SW13: Torque bias
SW14: Speed supplement command
SW15: Actual speed (simulated)
SW16: Selecting function code 1 address
SW17: Selecting function code 1 data
SW18: Selecting function code 2 address
SW19: Selecting function code 2 data
SW20: Polling function code 1 address
SW21: Polling function code 2 address
SW22: FRENIC-VG DO2(DIOB option: 10 bits)
SW23: FRENIC-VG AO(AO1)
SW24: FRENIC-VG AO(AO2)
SW25: FRENIC-VG AO(AO3)
SW26: FRENIC-VG AO(AIO option AO4)
SW27: FRENIC-VG AO(AIO option AO5)

The relationship between the dynamic switch setting, link function selection (function code H30), and link operation selection (digital input LE) is shown below.

Table 6.5.6

<table>
<tr><th rowspan="2">H30 value</th><th rowspan="2">Link operation selection LE</th><th colspan="3">Dynamic SW status</th></tr>
<tr><th>Command data SW1 to 4, 9 to 15</th><th>Operation command/control input SW5</th><th>Other SW6 to 8, 16 to 27</th></tr>
<tr><td>0</td><td>—</td><td>Fixed to off</td><td rowspan="3">Fixed to off</td><td rowspan="7">Can be switched</td></tr>
<tr><td rowspan="2">1</td><td>ON</td><td>Can be switched</td></tr>
<tr><td>OFF</td><td rowspan="3">Fixed to off</td></tr>
<tr><td rowspan="2">2</td><td>ON</td><td>Can be switched</td></tr>
<tr><td>OFF</td><td>Fixed to off</td></tr>
<tr><td rowspan="2">3</td><td>ON</td><td>Can be switched</td><td>Can be switched</td></tr>
<tr><td>OFF</td><td>Fixed to off</td><td>Fixed to off</td></tr>
</table>

Note:

⑤ The DIO option (OPC-VG1-DIO) is necessary to reference data Y11-Y18 for the FRENIC-VG DO1 (standard + DIOA: 13 bits). This command is effective without regard to the status of the function code H30 and link operation selection LE.

⑨ The DIO option (OPC-VG1-DIO) is necessary to reference data for the FRENIC-VG DO2 (DIOB option: 10 bits). This command is effective without regard to the status of the function code H30 and link operation selection LE.

⑩ AIO option (OPC-VG1-AIO) is necessary to reference data for the FRENIC-VG AO (AIO option, AO4) / (AIO option, AO5). To output this command to the AO terminal, you need to assign the corresponding AO terminal functions to the universal AO (U-A0) using the function codes E69 to E73. This command is effective without regard to the status of the function code H30 and link operation selection LE.

(3) When monitoring format is selected

① Polling function code address

(MSB) 15 14 ... 8 7 ... 1 0 (LSB)

Bits 15–8	Bits 7–0
Polling function code (1)	Polling function code (2)
Polling function code (3)	Polling function code (4)
Polling function code (5)	Polling function code (6)
Polling function code (7)	Polling function code (8)

Use the "polling function code (1) to (8)" (8 bits) to specify the link number corresponding to the function code number requested for polling.

(4) When standard format 2 (specified with 485No) is selected

① Selecting function code 485No, selecting function code data

(MSB) 15 14 ... 1 0 (LSB)

Bits 15–0
Selecting function code 485No (1)
Selecting function code 485No (2)
Selecting function code (1) data
Selecting function code (2) data

"Selecting function code 485No (1), (2)" (16 bits each) write the 485No. corresponding to the function code selected by MICREX-SX. Write the data to "Selecting function code (1), (2) data".

Note 1) Upon selecting, be sure to write the 485No. and data together.

Note 2) When writing data "0" to the function code F00 (485No.=0000h), first write data other than 0 or write to a function code other than F00, then write to F00.

Note 3) When the same function code is set to the selecting function codes (1) and (2), the selecting function code (2) takes precedence.

② Speed command (S01)

Refer to "(2) Speed command" in Section 6.3.8.2 of the T-Link interface.

③ Operation command/Di/RESET input (S06)

Refer to "(1) Operation command/Di/RESET input" in Section 6.3.8.2 of the T-Link interface.

④ Polling function code 485No

(MSB) 15 14 ... 1 0 (LSB)

Bits 15–0
Polling function code 485No (1)
Polling function code 485No (2)

Use the "polling function code 485No (1), (2)" (16 bits) to specify the 485No. corresponding to the function code number requested for polling.

6.5.9 Link function

- Refer to "6.3.9 Link function" of the T-Link interface.
- When both of the SX bus interface card and T-Link interface card are installed, the link function targets communication via the T-Link.
- When only the SX bus interface card is installed and the monitoring format is selected, the link function targets communication from the integrated RS-485.

6.5.10 Data transmission example

The following explains a data transmission example using the transmission format.

(1) Speed setting

From MICREX-SX, give commands to run forward (FWD) at 750r/min.
(Condition: Function code U11 "SX transmission format selection"= 0, H30 "Link operation"=3, maximum speed 1500 r/min, SX bus station address: 10)

Give S06 the forward running command (FWD: ON) and S01 the speed command.

%QW10.8	0	6	0	1	Function code S06, S01 selecting (link No. 06h, 01h)
%QW10.9	0	0	0	0	Selecting dummy data
%QW10.10	0	0	0	1	Function code S06 FWD=ON
%QW10.11	2	7	1	0	Function code S01 Speed setting 750/1500*20000=10000=2710(h)

↓ After acceleration completes

%IW10.6	2	7	1	0	Monitor the motor speed.

(2) Torque command monitor

Monitor the torque command value from MICREX-SX.
(Condition: Function code U11 "SX transmission format selection"= 0, SX bus station address: 10)

%QW10.14	1	0	0	0	Torque command monitor (link No. 10h)
%QW10.15	0	0	0	0	

↓ After read completes

%IW10.0	1	0	0	0	When the link number requesting polling is returned to this area, reading is completed.
%IW10.1	0	0	0	0	Torque command value monitor data
%IW10.2	1	3	8	8	1388(h)×100(%)/ 10000 = 50(%)
%IW10.3	0	0	0	0	↓
%IW10.4	0	0	0	0	From the above, the torque command value is "50% of drive".
%IW10.5	0	0	0	0	

(3) Function code data setting

From MICREX-SX, set the function code S08 "Acceleration time" to 30.5s.
(Condition: Function code U11 "SX transmission format selection"= 0, SX bus station address: 10)

%QW10.8	0	8	0	0	Function code S08 selecting (Link No. 08h)
%QW10.9	0	0	0	0	
%QW10.10	0	1	3	1	30.5=305 x 0.1s=305=131(h)
%QW10.11	0	0	0	0	
%QW10.12	0	0	0	0	
%QW10.13	0	0	0	0	
%QW10.14	0	8	0	0	Poll the function code S08 to confirm setting completion.

↓ After writing completes

%IW10.0	0	8	0	0	Poll the function code S08.
%IW10.1	0	0	0	0	
%IW10.2	0	1	3	1	131(h)=305×0.1s=30.5s (Data is correctly set.)
%IW10.3	0	0	0	0	
%IW10.4	0	0	0	0	
%IW10.5	0	0	0	0	

(4) Toggle monitoring

Monitor data toggling between MICREX-SX and the inverter. This example set the X12 terminal to TGL1 and X13 terminal to TGL2.(*1)

Set E11=72 (TGL1), E12=73 (TGL2), H30=3, H144=0.10 (100 ms) in advance.

This sets transmission toggle (MICREX-SX→VG1): %QW254.0.10.13 bit 11= TGL1 and bit 12= TGL2.

The inverter monitors the toggle pattern sent from MICREX-SX while the operation command is ON, and generates the toggle error Ar-F if the toggle signal cannot be received within the time specified with H144.

*1 For the details of the toggle, refer to E01 to E13 toggle signal explanation in "4.3 Function Code Details".

*2 By setting the inverter function code H107, the inverter can continue operation with L-AL display. Refer to the description of H107 in "4.3 Function Code Details".

*3 The tact period for an application which sends toggle patterns on the MICREX-SX side should be 1 ms or longer.

%QW254.0.10.13	*	0	0	0	Send 0→1→2→3→0 to *…(toggle pattern)
				↓	After sending toggle
%QW254.0.10.13	*	0	0	1	Operation command (FWD)=ON ⇒ Ar-F does not occur if the sent toggle is correct.

Note: If the network error Er-4 (light and heavy alarm 1) occurs while sending the toggle pattern and keeps the operation, the toggle error Ar-F may occur after the communication recovers. To avoid the toggle error Ar-F, stop sending the toggle pattern while the network error Er-4 is occurring.

6.5.11 System configuration definition

For the MICREX-SX series, you need to use the programming support tool Expert (D300win) to construct the system, configure the entire system for operation, set operation, and set individual modules.

The following describes how to configure the system definition of the inverter, which is connected to the SX bus as a slave module. For configuration of the PC, memory, program, and other individual modules than the inverter, refer to each user's manual of the corresponding MICREX-SX series product.

6.5.11.1 Programming support tool expert (D300win)

D300win is program creation system software for the MICREX-SX series. Note that you must use particular versions of D300win to configure the system definition of FRENIC-VG. Use a version shown below (or later). Screenshots may differ depending on the version used.

Expert (D300win) Version
  V3 series: 3.0.0.0 or later
  V2 series: 2.2.2.0 or later

Note: If you have a (registered) version of D300win which does not support FRENIC-VG, contact our sales personnel to upgrade it. You can check the current version of D300win by choosing [Information] from the [Help] menu.

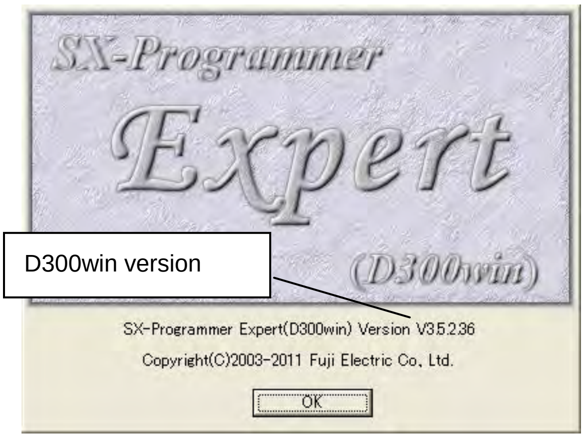


Figure 6.5.27

Note
When configuring the system definition including VG1, set the SX bas tact to 1 ms or longer.

[1] System definition window

In system definition, you construct the system using the SX bus, configure the entire system for operation, configure operation, and configure individual modules. Double-click the [System_Definition] icon in the [Physical Hardware] configuration subtree to open the system configuration definition screen.

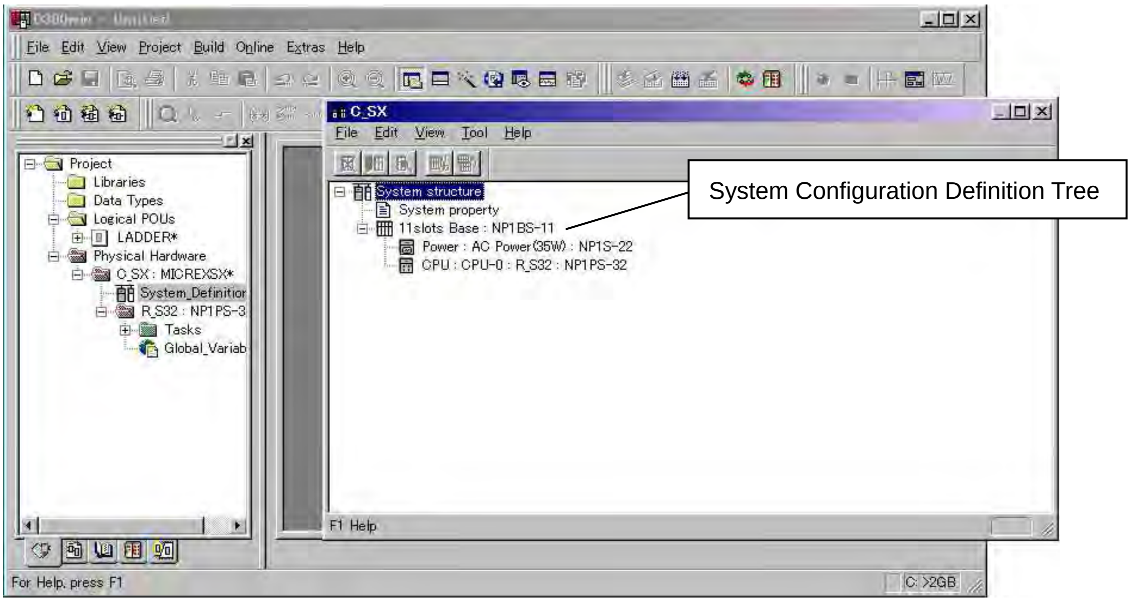


Figure 6.5.28

[2] Adding a module

⚠CAUTION
• If the transmission format settings are different, a heavy alarm occurs and communication is not available. Be sure to check the following for the correct settings.

For the MICREX-SX series, it is necessary to register all the modules (including the inverter) to use in the system configuration definition of the PC system.

To add the module (inverter), right-click the base module on the system configuration definition tree, and select [Insert] to open the [Module insert] dialog box.

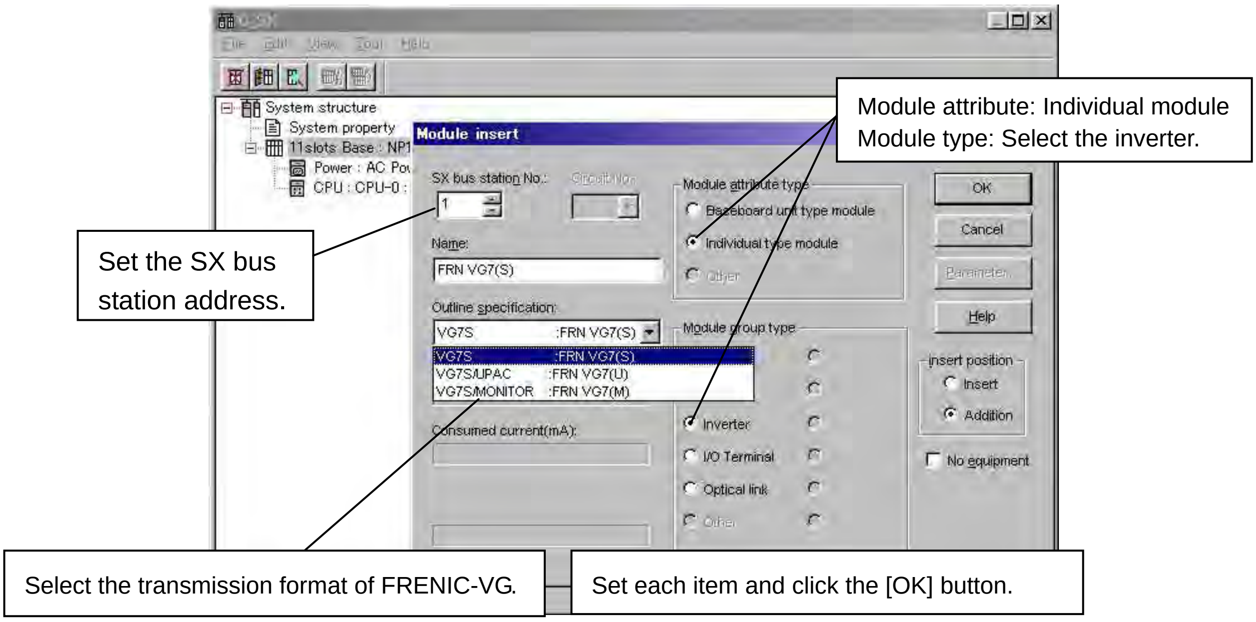


Figure 6.5.29

(1) Transmission format selection

In the [Summary Specifications] list box, select the transmission format of FRENIC-VG. For the detailed specifications of each transmission format, refer to the function code U11 "SX transmission format selection".

- Standard format 1 and 2 ⇒ VG7: FRN VG7(S)
  (for the latest version,
  VG1/VG7 (STD1): FRENIC-VG (S1))
- UPAC compatible format ⇒ VG7S/UPAC: FRN VG7 (U)
  (for the latest version,
  VG1/VG7 (UPAC): FRENIC-VG (U))
- Monitoring format ⇒ VG7S/MONITOR: FRN VG7 (M)
  (for the latest version,
  VG1/VG7 (MONITOR): FRENIC-VG (M))

Note: Be sure to select the same format as the function code U11. If the settings are different, the heavy alarm "Device configuration error" occurs and communication will not be available.

(2) I/O group setting

Allocate the module (inverter) in the MICREX-SX CPU. Incorrect allocation of the I/O group disables input/output control from the CPU.

Right-click the CPU on the system configuration definition tree, and select [Properties] to open the [Module Properties] dialog box.

Click the parameter and the [I/O Group Setting] tab to open the [I/O Group Setting] dialog box.

Note: In a multi-processor system, if an individual CPU module has a different control target, configure the I/O group for an individual CPU.

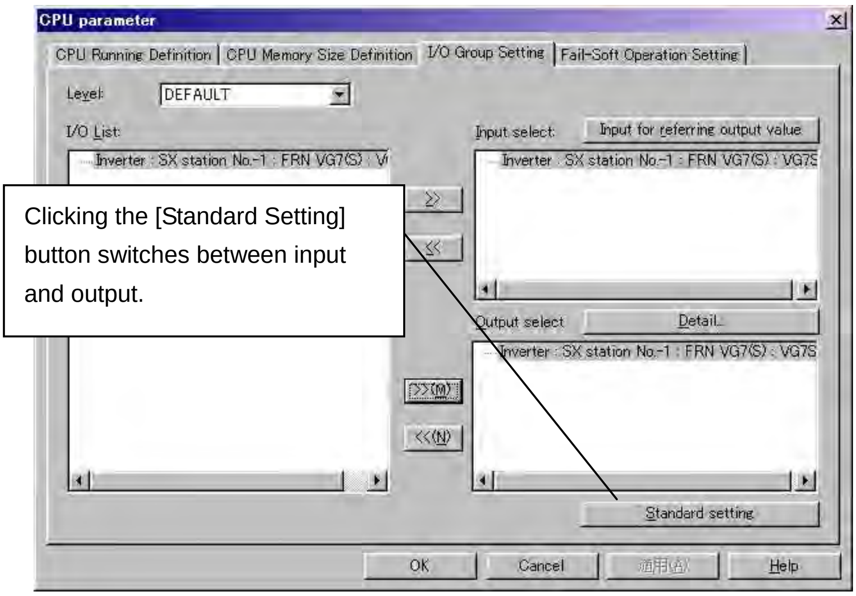


Figure 6.5.30

[3] Degenerate setting

The SX bus option supports the degenerate and degenerate system start-up operations. Each operation has restrictions including the degenerated condition and system settings. For the details, refer to the user's manual (reference) of each MICREX-SX series product.

The following explains the degenerate setting and degenerate system start-up setting. These settings are not required if the degenerate setting and degenerate system start-up operations are not necessary.

(1) Degenerate Setting

With the degenerate setting enabled, even when an inverter error occurs and the inverter stops, other normal module can continue operation.

Open the [CPU Parameter] dialog box, and click the [Degenerate Setting] tab.

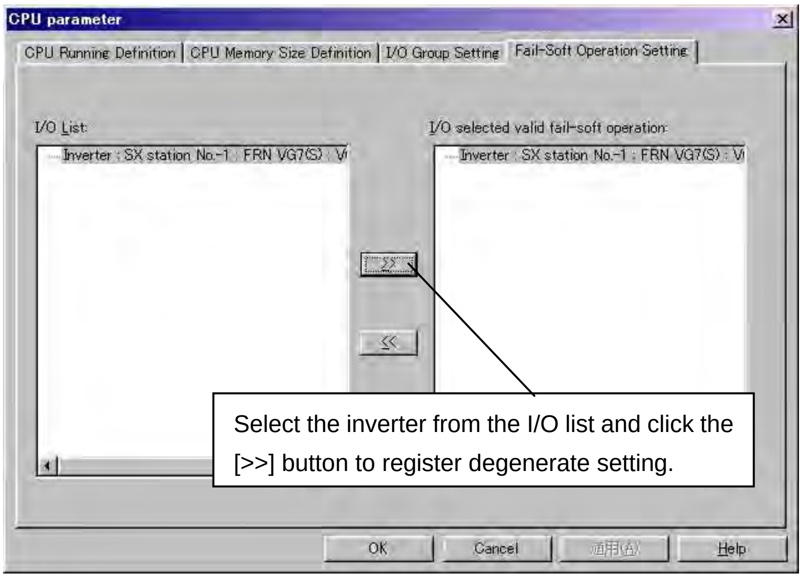


Figure 6.5.31

(2) Degenerate System Start-up Setting

With the degenerate system start-up setting enabled, when the SX bus system launches with the inverter powered off, the system will start up after the configuration check standby time, excluding the inverter, in a light alarm state.

In the [System Properties] dialog box, click the [Degenerate System Start-up Operation Definition] tab.

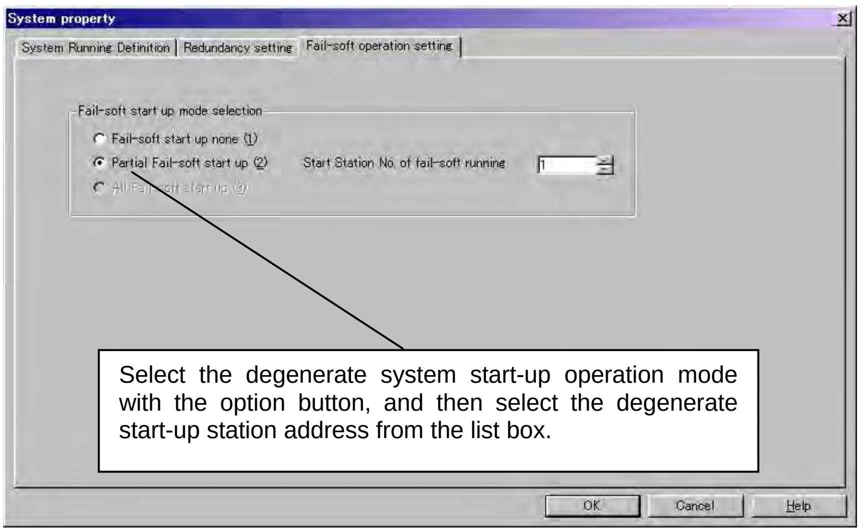


Figure 6.5.32

6.5.11.2 Application program examples

The following explains a data transmission example using the MICREX-SX application program.

(1) Speed setting

From MICREX-SX, give commands to run forward (FWD) at 750r/min.
(Condition: Function code U11 "SX transmission format selection"= 0, H30 "Link Operation"=3, maximum speed 1500r/min, SX bus station address: 10)

Give S06 the forward running command (FWD: ON) and S01 the speed command.

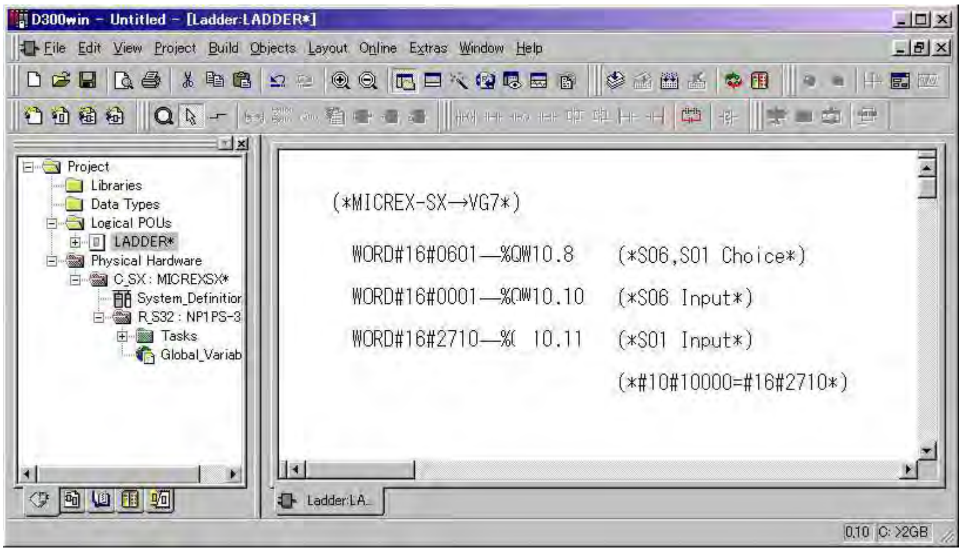


Figure 6.5.33

(2) Torque command monitor

Monitor the torque command value from MICREX-SX.
(Condition: Function code U11 "SX transmission format selection"= 0, SX bus station address: 10)

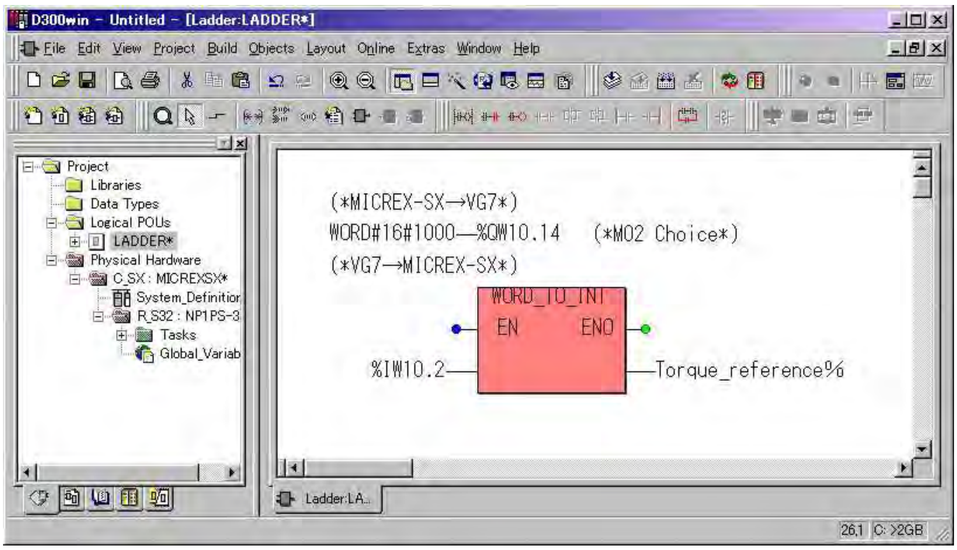


Figure 6.5.34

(3) Function code data setting

From MICREX-SX, set the function code S08 "Acceleration time" to 30.5s.
(Condition: Function code U11 "SX transmission format selection"= 0, SX bus station address: 10)

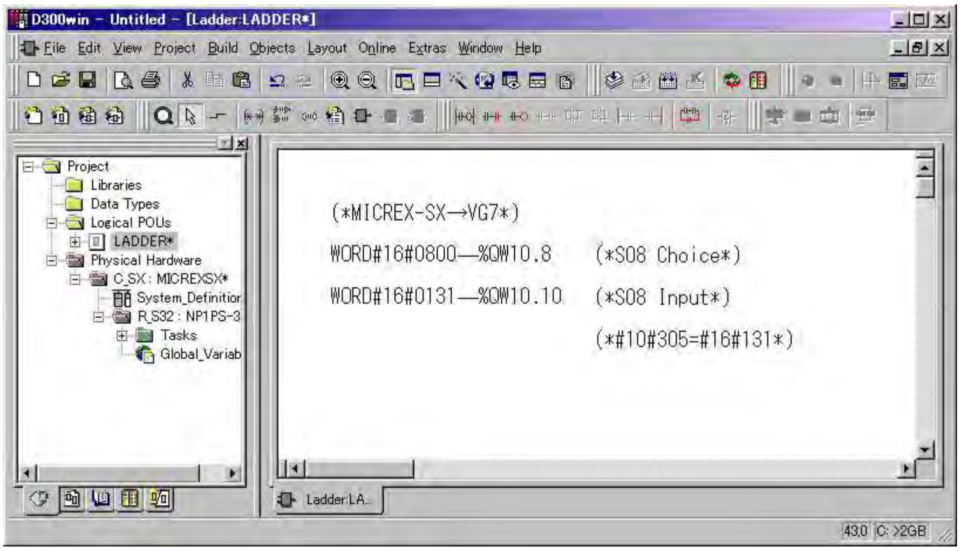


Figure 6.5.35

6.5.12 Multiple option application examples

6.5.12.1 Installed with T-Link interface card

The following shows an example where the T-Link interface card (OPC-VG1-TL) and SX bus interface card (OPC-VG1-SX).

Connection example

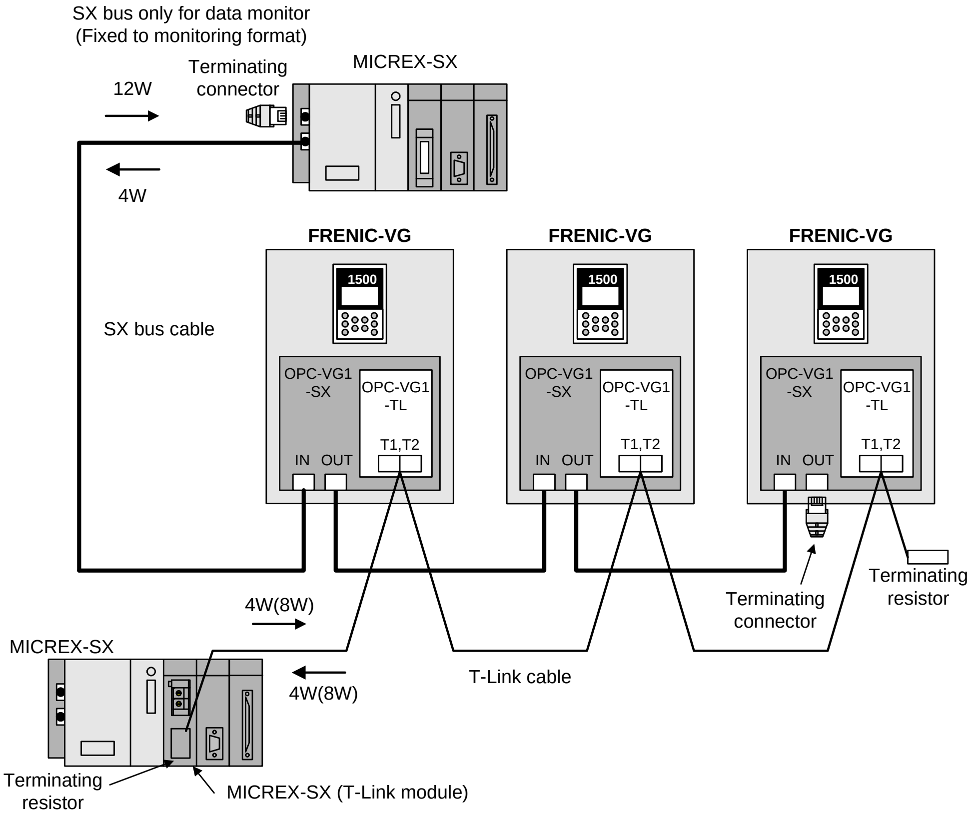


Figure 6.5.36

Features

You can construct the command system (T-Link) and monitoring system (SX bus) with separate link systems. While giving command via the T-Link, you can perform high-speed data monitoring via the SX bus.

Detailed specifications

(1) The transmission format of the SX bus is fixed to the monitoring format and dedicated to monitoring.
You need to configure the monitoring format with transmission format selection (U11) and system configuration definition.

(2) The link function (link command switch, link edit switch, etc.) is enabled for the T-Link.

(3) The communication error monitoring target is the T-Link, and communication errors occurring on the SX bus will not be detected.

(4) For the detailed specifications of the T-Link, refer to "6.3 T-Link Interface".

6.5.12.2 Installed with high-speed serial communication-capable terminal table

The following shows an example where the high-speed serial communication-capable terminal table (OPC-VG1-TBSI) and SX bus interface card (OPC-VG1-SX) are installed simultaneously to drive the multi-winding motor.

Connection example

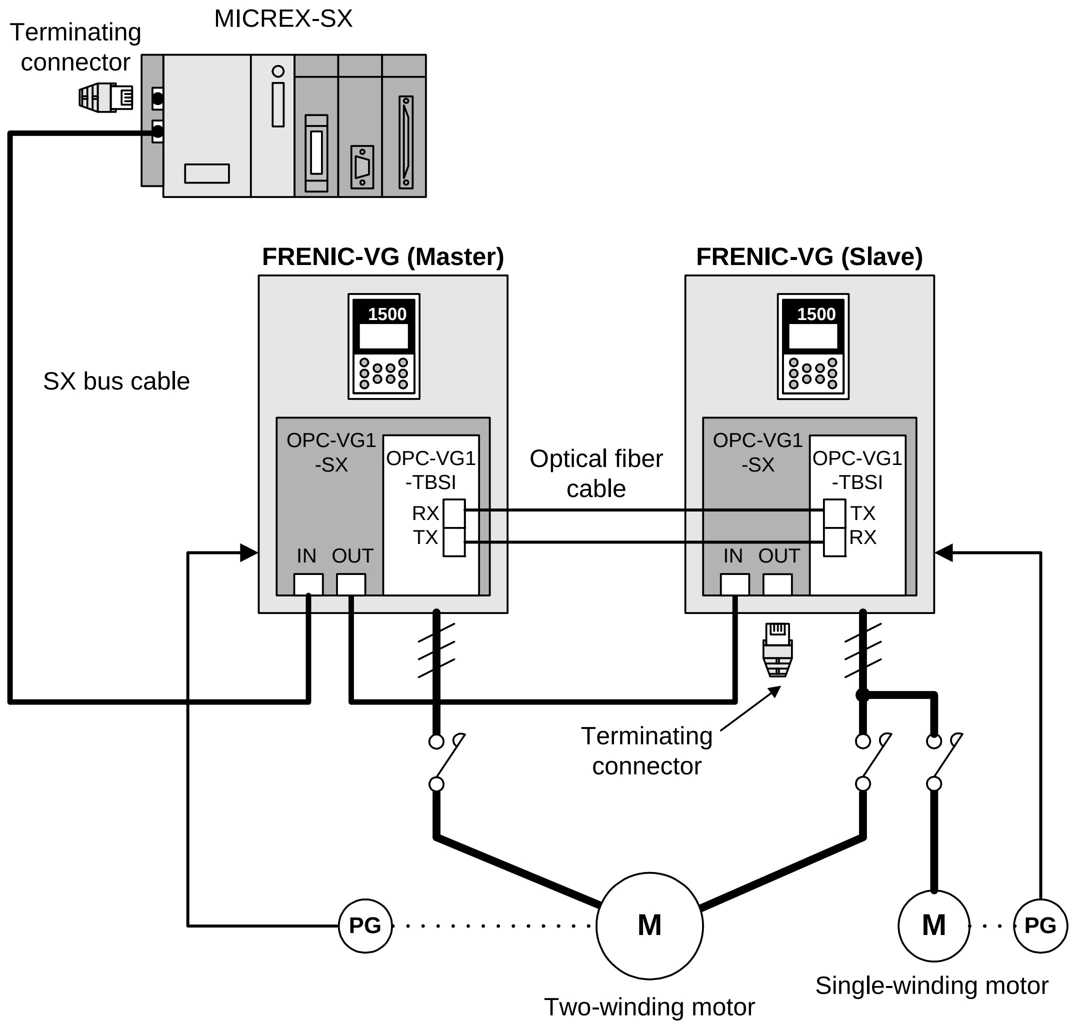


Figure 6.5.37

Features

You can link with a multi-winding motor drive system which can drive a high-capacity motor via the SX bus, to implement wire-saving, high-speed, and high-performance control.

If the SX bus option is also installed on the slave side, single-winding motors can be individually driven by switching the drive motors.

Detailed specifications

(1) While driving a multi-winding motor, if a control command is input via the SX bus to the slave inverter, the data will not be reflected. The motor operates according to commands given to the master inverter.

(2) Refer to the "6.6 High-Speed Serial Communication-Capable Terminal Table" for the detailed specifications of the multi-winding motor drive system card.

6.6 High-Speed Serial Communication-Capable Terminal Table

6.6.1 Product overview

6.6.1.1 Multi-winding motor drive

(1) Overview

By connecting multiple FRENIC-VGs with the high-speed serial communication-capable terminal table via optical fiber cables, you can drive an induction motor (hereafter referred to as "motor") with 2 to 6 turns of multiple turns (hereafter referred to as "multi-winding").

The command to specify how much current each winding of the motor should bear is given in a moment from the master inverter to each slave inverter, via the high-speed serial communication (optical link) of this optical fiber cable. By controlling the current for each winding with this command (feedback control), each inverter can drive the multi-winding motor.

The maximum capacity of the FRENIC-VG unit is 630 kW. To drive a 1200 kW motor, three 400 kW inverters or two 630 kW inverters can be connected.

(2) Sensorless control (available soon)

You can also vector-control a multi-winding motor with no PG sensor.

(3) Wire saving

A single inverter is specified as the master and others as slaves by setting the function codes. The master inverter gives operation and speed commands, as with the standard product, and connects the motor encoder for feedback (not required for sensorless control).

On the contrary, the slave inverter only controls the current and does not require operation and speed command connection. It only requires the main circuit wiring, external alarm output, and optical fiber cable.

(4) Multi-winding motor drive/single-winding (standard) motor drive switching

After driving a single multi-winding motor with multiple inverters, if each inverter needs to drive individual motor (hereafter referred to as "single-winding motor") at 1-to-1 correspondence, you can switch multi-winding and single-winding motor driving with a digital input signal.

Since the motor constants for up to three motors can be preset in each inverter, the motor constants used can also be switched with the digital input signal at the same time the motor drive is switched.

However, if you are using the PG or NTC signal, switch these signals externally. Our optional product MCA-VG1-CPG is the dedicated option for this external switching. Switch the secondary power lines using an electromagnetic contactor.

6.6.2 Model and specifications

6.6.2.1 Model

Model elements: OPC-VG1-TBSI

- Name of equipped inverter VG1 -> FRENIC-VG
- Option name: TBSI -> High-speed serial communication-capable terminal table

Accessories

Plastic optical fiber cable (with connector) x1, 5 m

6.6.2.2 Specifications

⚠CAUTION

・ The system will not operate correctly if the function code setting is not correct. Read the instruction below and set them accordingly.

Table 6.6.1 Communication Specifications

Item	Specifications
Data transmission method	Loopback method Asynchronous serial communication using plastic optical fiber
Transmission rate	2.5 Mbps
Error check method	Hardware: parity, framing, overrun Software: BCC, timeout monitoring
Transmission distance	When using the plastic optical fiber cable: 5m (0 to 70°C)/Inter-inverter (Contact us if a cable longer than 5m is required.)

Table 6.6.2 Plastic Optical Fiber Cable Specifications

Item	Min.	Max.	Unit	Remarks
Storage temperature range	-40	+75	°C	
Tension		50	N	30 minutes or less
Short-time bending radius	10	–	mm	Will stop operation within one hour and the inter-inverter link error Er-b occurs.
Long-time bending radius	35	–	mm	If bent for 35mm or less for a long period of time, the inter-inverter link error Er-b may occur. Curvature should be kept 35 mm or more.
Tensile strength (long time)	–	1	N	
Flexibility	–	1000	Times	Bend for 90 degrees on 10 mm mandrel (core bar, main axis)
Shock	–	0.5	kg	Shock test is in accordance with MIL-1678, Mothod2030, Procefurel.
Guaranteed minimum distance	10		m	Minimum guaranteed value due to transmission loss (0 to 70°C)
Weight	4.6		g/m	

Table 6.6.3 Software Specifications

Item		Specifications
Applicable motor capacity		HD/LD/MD specifications (up to 630 kW x 6-winding available)
Motor control method		Vector control with speed sensor, Vector control without speed sensor (available soon) (Note: V/f control and synchronous motor control not available)
Speed control	Maximum output frequency	120 Hz
	Control scope	1:1500 (vector control), 1:250 (sensorless control)
	Control accuracy	±0.005% of maximum speed (digital), ±0.1% (analog, 25±10°C)
	Setting resolution	0.005% of maximum speed
Control function		The following restriction is applied. ・The monitor function of the slave unit is restricted.
Multi-winding/single-winding switching		System definition is configured using the function code o33 "Multi-system control method". 0: High-speed serial communication not used, single-winding drive (factory setting) 1: High-speed serial communication used, multi-winding drive 2, 3: Multi-system 1, 2 (available soon)
		When the function code o33 is set to 1 "Multi-winding system", multi-winding and single-winding can be dynamically switched using the digital input signal MT-CCL.
Station address setting		The inverter station address is set using the function code o50 "Multi-system station address setting". For example, set the master to "0", slave 1 to "1", and slave 2 to "2".
Slave count setting		The number of optically linked slaves is set using the function code o34 "Multi-system slave count setting". For example, when four inverters are linked, the number of slaves is "3".
Protective function	Protective function occurrence process	All unit batch alarm mode: Touch panel alarm mode All unit batch alarm output: 30x output All unit batch inverter output shutdown However, all units should coast to stop with an external sequence upon 30x operation.
	Communication alarm function Operation procedure alarm function	Due to a communication error of the optical fiber cable or setting error of a related function code, the inter-inverter link error Er-b or operation procedure alarm operation Er-6 occurs.
	Protective function cancellation process	By giving the reset command to any of the units optically linked, all units will be batch reset.

<u>Multi-winding motor specifications</u>

Common-mode current is applied to the common-mode windings.
This drives a motor with capacity of the summed number of inverters.
For example, by using four (n=4) 200 kW inverters to drive a four-winding motor, up to 800 kW output is available.

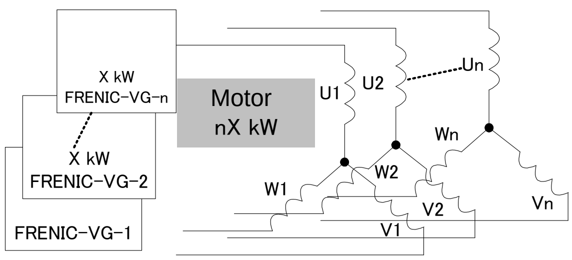


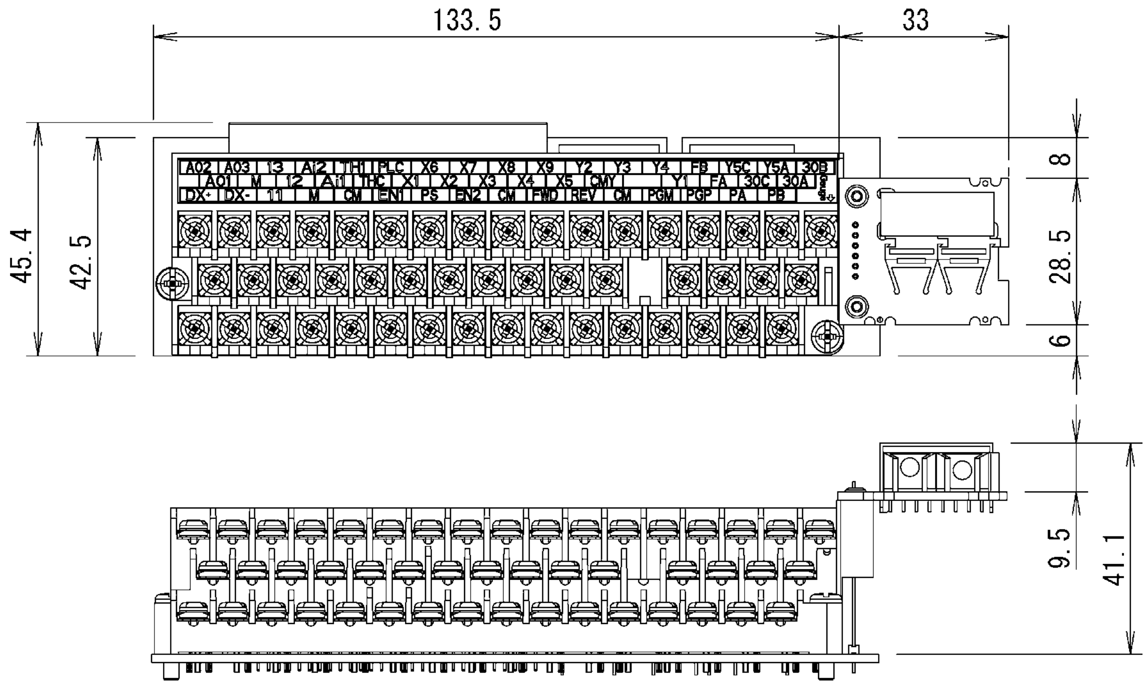
Figure 6.6.1

The relationship between the number of windings and the number of motor poles is as listed below because the former should be a divisor of the latter.

Table 6.6.4

Number of windings (n)	4P	6P	8P	12P
2	○	○	○	○
3	-	○	-	○
4	○	-	○	○
5	-	-	-	-
6	-	○	-	○

6.6.3 External dimensions



(Unit: mm)

Figure 6.6.2 External Dimensions of Option

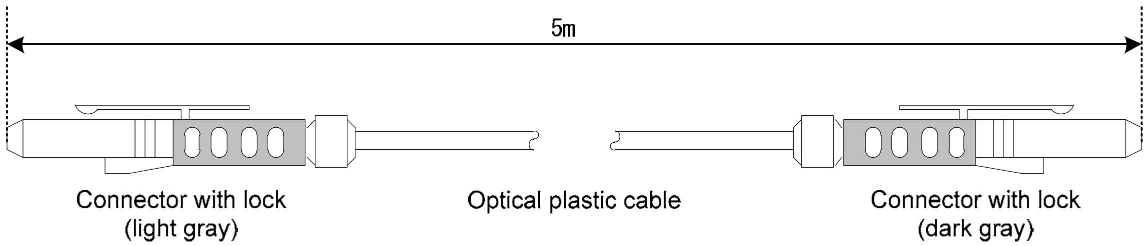


Figure 6.6.3 Plastic Optical Fiber Cable (Accessory)

6.6.4 Basic connection diagram

⚠WARNING

- Incorrect cabling may cause a disaster such as electrical shock or fire. Only a qualified person should perform cabling. Before touching the power supply circuit (e.g., for cabling after power on), be sure to turn off (i.e., open) the circuit breaker to prevent electrical shock.
- Note that the smoothing capacitor is charged after turning off (i.e., opening) the circuit breaker and touching it causes an electrical shock. Ensure that the charge lamp (CHARGE) of the inverter has gone off and that the DC voltage of the inverter has lowered to a safety level using a tester.

⚠CAUTION

- Do not use the product that is damaged or lacking parts to prevent an injury or damage.
- Incorrect handling in installation/removal jobs could result in a broken product.

6.6.4.1 Connecting optical fiber cable

⚠CAUTION

- The cable may be pinched by the surface cover. To protect the cable, it is required to attach a fixing jig to guide the route or spiral tube around the cable.
- If the plastic optical fiber is bent with curvature of 35 mm or less for a long period of time, the inter-interval link error "Er-b" may occur to generate an alarm, causing the inverter output shutdown and leaving the motor to coast to stop. Keep the curvature 35 mm or more.
- The plastic optical fiber allows a strong light (e.g., flashlight) to pass. A strong light may cause the inter-interval link error "Er-b" to generate an alarm.

Use the supplied optical fiber cable to connect the inverter and the high-speed serial communication-capable terminal table. Note that the colors of the plugs at the ends of the cable are different; light gray and dark gray. Be sure to match the colors of the plug and connector when connecting them. Connect the inverters in a daisy-chain method. For example, when connecting three inverters (1, 2, and 3), use three cables to connect them in a loop in such a way: **1→2→3→1**.

Table 6.6.5 Optical Connectors of High-Speed Serial Communication-Capable Terminal Table

Part number	Name	Color	Overview
T-1528	TX	Light gray	Transmitter (optical communication)
R-2528	RX	Dark gray	Receiver (optical communication)

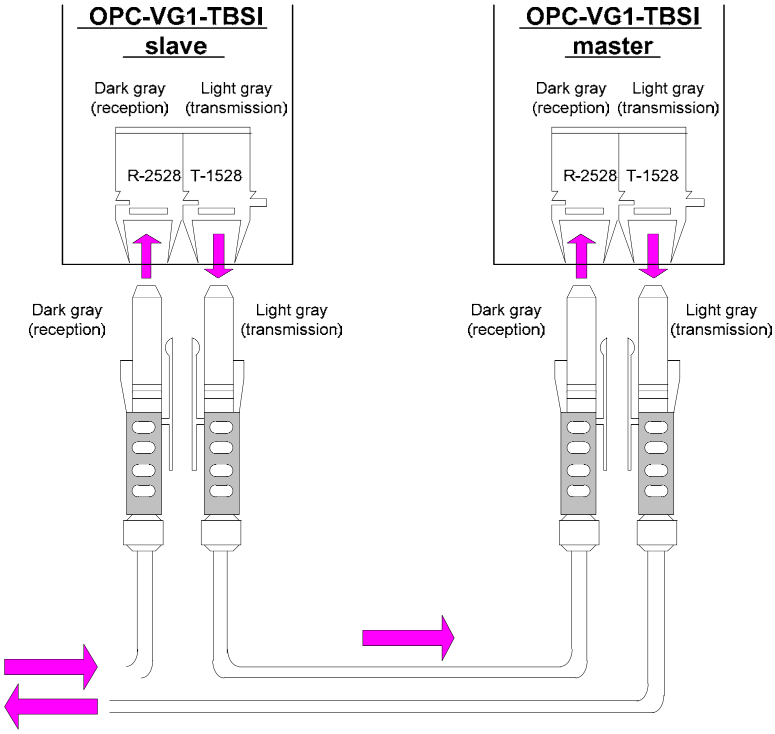

OPC-VG1-TBSI
slave
Dark gray
(reception)
Light gray
(transmission)
R-2528
T-1528
OPC-VG1-TBSI
master
Dark gray
(reception)
Light gray
(transmission)
R-2528
T-1528
Dark gray
(reception)
Light gray
(transmission)
Dark gray
(reception)
Light gray
(transmission)

Figure 6.6.4

6.6.4.2 Basic connection diagram of entire system

⚠WARNING

- For safety, design the external circuit so that all inverter units should coast to stop when an alarm occurs (30x operation).

A connection example is shown below.

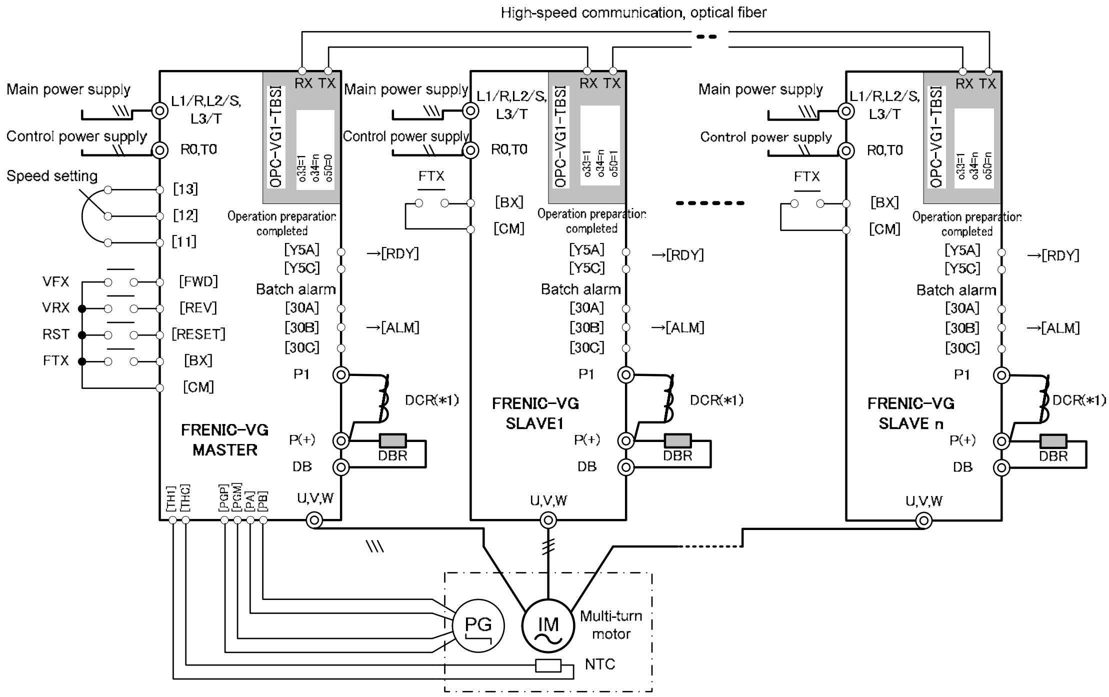


Figure 6.6.5

Special notices

(1) For safety, make sure that all inverter units should coast to stop when an alarm occurs (30x operation). Coast to stop command should be input to the contact BX.

(2) Make sure that FWD and REV are available only when all inverter units are ready for operation (RDY). This example shows an example where the operation ready signal is assigned to the relay output.

(3) The reset command (RST) to the master inverter unit can cancel alarms of all inverter units.

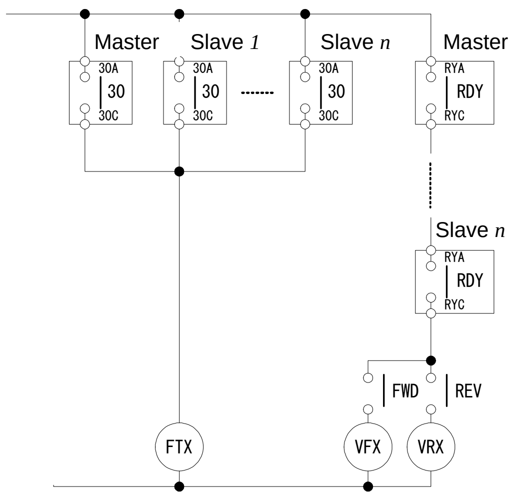


Figure 6.6.6

Note

(1) The DC reactor (DCR) is optional for 55 kW or lower and included for 75 kW or higher.

(2) Braking resistor (DBR) is optional.

6.6.5 Function code setting

⚠WARNING

- Incorrect function code data may result in a dangerous situation. After setting and writing the data, check it again.

Failure to observe this precaution could cause an accident.

Table 6.6.6

No.	Parameter name		Setting range	Description
	Name	keypad display		
o33	Multi-system control method	MUL MTD	0 to 5	0: High-speed serial communication not used, single-winding drive (factory setting) 1: High-speed serial communication used, multi-winding drive 2: Multi-system 1 3: Multi-system 2
o34	Multi-system slave count	MWS SLAVES	1 to 5	When the multi-system is enabled, set the number of slave units (excluding the master).
o50	Multi-system station address setting	MWS ST-NO	0 to 5	0: Master 1 - 5: Slave

6.6.5.1 Number of units setting

Set the number of slave inverter units connected via the optical fiber cable using the function code. Note that this is not the number of all inverters including the master.

Table 6.6.7 Number of Units and Function Code

Item	Function	o34 value	Remarks
Function code o34	Multi-system slave count	1	1 master + 1 slave = System with total of 2 units
		2	1 master + 2 slaves = System with total of 3 units
		3	1 master + 3 slaves = System with total of 4 units
		4	1 master + 4 slaves = System with total of 5 units
		5	1 master + 5 slaves = System with total of 6 units

Setting example

(1) 2-unit system
Set o34=1 for all systems.

(2) 4-unit system
Set o34=3 for all systems.

Note: Set the multi-system station addresses (o50) in the order connected to the master.
<Bad setting example>
Master (o50=0), slave 1 (o50=2)
Slave 2 (o50=1), slave 3 (o50=3)
* Bad setting is underlined.

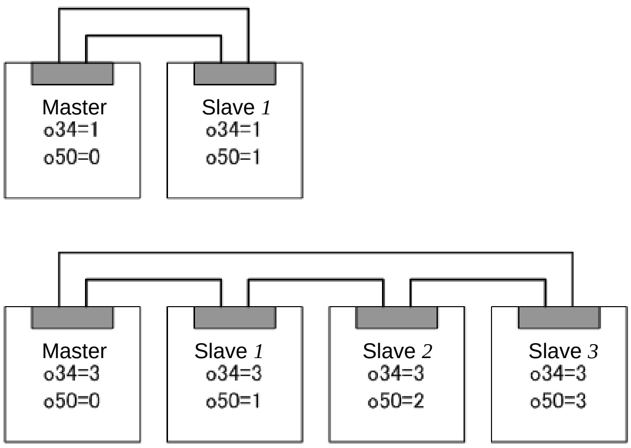


Figure 6.6.7

When the o34 setting is not correct, the system may not operate with no alarm indication. Check the setting again.

6.6.5.2 Switching multi- and single-motor drive

You can cancel the multi-winding motor drive and switch to the normal single-winding motor drive using the external digital input signal MT-CCL.

Figure 6.6.8 shows a simple connection example to switch between the two-winding and single-winding motor drive. In this case, the slave inverter unit does not need the operation command as well as the PG and NTC signal feedback. When switching the motors, it is also required to switch the PG and NTC signals in addition to the secondary power line.

If switching is also required for the slave, you need to manipulate the MT-CCL signal.

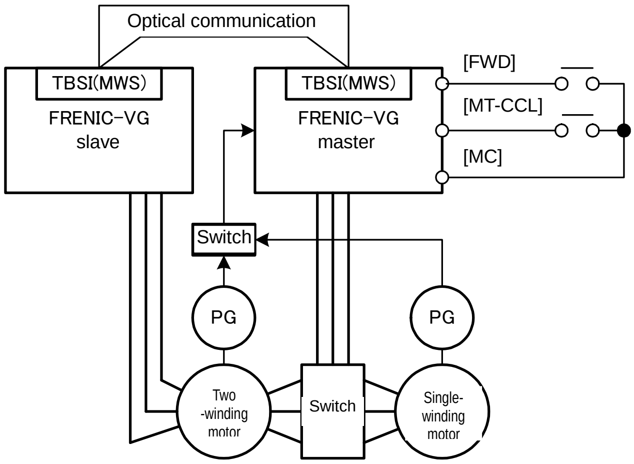


Figure 6.6.8

Table 6.6.8 Multi-Winding/Single-Winding Switching Specifications

Item	Function	Setting	Remarks
Function code o33	Multi-system control method	0: Disabled (single-winding drive) 1: Multi-winding system 2: Multi-system 1 3: Multi-system 2 4: Reserved 1 5: Reserved 2	Be sure to set to "1" when driving the multi-winding motor.
Digital input signal	Multi-system cancellation	Set value 57 MT-CCL	With function code o33=1 "Multi-winding system enabled" Contact ON (closed): Single-winding drive (multi-winding cancelled) Contact OFF (open): Multi-winding drive

6.6.6 Preparation for operation

⚠CAUTION

- After installation, cabling, and switch setting have been done, check the following before powering on the inverter:

  (1) Cabling is correct.

  (2) No wire dust or screw is left.

  (3) Screws and terminals are not loose.

  (4) Wire of the press-fit terminal does not contact other terminals.

Refer to Chapter 3 "Preparation and Test Run" for preparation.

6.6.6.1 Operation

(1) Power on

⚠CAUTION

If any one of the inverter units within a multi-winding system is not powered on and operation is started, the inter-inverter link error "Er-b" occurs. However, no alarm will be indicated until you start operation (FWD, REV).

It is not required to power on the inverters simultaneously or power them on in a particular sequence. Since no alarm will be indicated until you start operation (FWD, REV), you can power them on in an arbitrary order.

(2) Setting before operation

⚠CAUTION

Some function code settings need to be the same between the master and slave(s). If they differ, normal operation is not possible.

Set the following function codes to the same values for the master and slave(s) before operation. While they are set to the same values at factory, you need to check them again.

Table 6.6.9

Codes set to be same	Function	Remarks
F03 - F05, P, A all codes	Motor constant	Be sure to set them correctly.
F36	30Ry mode	Required to design a failure sequence externally.
F80	Current rating switching	Be sure to set them correctly.
H04, H05	Retry operation	You do not need to set them if the retry operation is not enabled.
o33 and o34	Multi-winding dedicated code	Be sure to set them correctly.

(3) Operation method

⚠CAUTION
・ Give the operation and speed commands to the master only. ・ Connect the PG and NTC feedback signals to the master only. (PG connection is not necessary for sensorless operation.) ・ If the feedback is supplied to the slave(s) only, correct operation is not possible.

(3)-1 Operation and command input

Give the commands (speed, torque, torque limiting) to the master inverter unit only. Optically linked slave inverter units can be considered as hardware which only controls current.

The operation method and command input method are the same as the standard product.

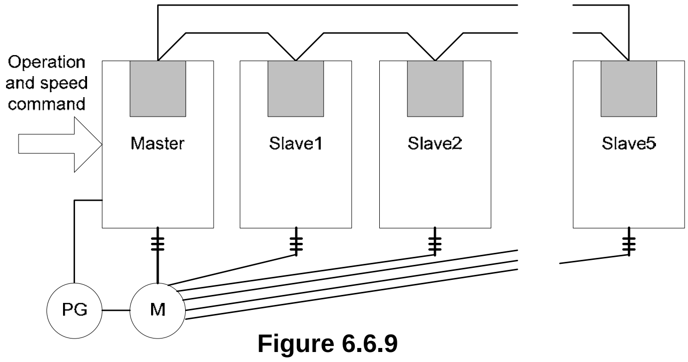


Figure 6.6.9

(3)-2 I/O function

You can use the master in the same way as the standard product.

The functionality of the slave is restricted as listed below.

Table 6.6.10

	Available functions for multi-winding slave (Functions not listed are unavailable.)	Terminal symbol	Remarks
DI	Coast to stop command	BX	Causes all units of the system to coast to stop.
	Error reset	RST	Resets all units of the system.
	External alarm	THR	
	Motor M2 selection	M-CH2	
	Motor M3 selection	M-CH3	
	Keypad edit permission command	WE-KP	
	Universal DI	U-DI	
	Short voltage cancel	LU-CCL	
	Multi-system cancel	MT-CCL	
	Safety function input terminal	EN1, EN2	Causes all units of the system to coast to stop. However, output shutdown by hardware is done only for units which have detected the signal.
DO	Operating	RUN	Functions with the operation information from the master.
	Operation preparation completed	RDY	
	Motor M2 selected	SW-2	
	Alarm contents	AL1 - 4	Output with alarm information from the master added.
	Cooling fan operating	FAN	
	Universal DO	U-DO	
	Cooling fin overheat prediction	INV-OH	
	Life prediction	LIFE	
	Inverter overload prediction	INV-OL	
	DB overload prediction	DB-OL	
	Transmission error	LK-ERR	
	Multi-system communication established	MTS	
	Multi-system cancel response	MEC-AB	
	Multi-system self station failure	AL-SF	
	Batch alarm	ALM	
	Light alarm	L-ALM	
	Maintenance prediction	MNT	
	Braking transistor error	DBAL	
	DC fan lock signal	DCFL	
	73 input command	PRT-73F	
	Y terminal test output ON	Y-ON	
	Y terminal test output OFF	Y-OFF	
AI	All invalidated		
AO	Torque current command (torque ammeter, swing in both directions)	IT-REF±	Outputs the torque current command from the master.
	Torque current command (torque ammeter, swing in one direction)	IT-REF+	
	Motor current	I-AC	
	Motor voltage	V-AC	
	DC intermediate voltage	VDC	
	+10, -10V test	P10, N10	

(Note) 0 display for A0, unless otherwise noted.

(3)-3 Keypad function

You can use the master in the same way as the standard product.

Only the functions listed below are available for the slave. Functions not listed are disabled (0 is displayed).

Table 6.6.11 LED Monitor

Name	Remarks
Output frequency command value	Displays the primary square frequency command value from the master.
Torque current command value	Displays the torque current command value from the master.
Calculated torque value	Displays the calculated torque value for a single slave.
Detected output current value	Displays the detected current value for a single slave.
Detected output voltage value	Displays the detected voltage value for a single slave.
Detected DC intermediate voltage value	Displays the detected intermediate voltage value for a single slave.
Calculated magnetic flux value	Displays the calculated magnetic flux value for a single slave.

Table 6.6.12 Operation Status Monitor

Name	Remarks
Output frequency command value	Displays the primary square frequency command value from the master.
Detected output current value	Displays the detected current value for a single slave.
Detected output voltage value	Displays the detected voltage value for a single slave.

Table 6.6.13 Alarm Information

Name	Remarks
Output frequency at an alarm occurrence command value	Displays the primary square frequency command value from the master.
Detected output current value at an alarm occurrence	Displays the detected current value for a single slave.
Detected output voltage value at an alarm occurrence	Displays the detected voltage value for a single slave.
Accumulated operation time upon alarm occurrence	Single slave
Motor output command value upon alarm occurrence	Outputs the value multiplied by the number of inverters.
Inverter temperature upon alarm occurrence	Displays the internal temperature of a single slave.
Cooling fin temperature upon alarm occurrence	Cooling fin temperature of a single slave
Communication status upon alarm occurrence (four points)	

* In addition, I/O check, maintenance information, load rate measurement, I/O status upon alarm, alarm history, and copy functions are all enabled.

Chap. 6 CONTROL OPTIONS

(3)-4 Function code (F - U)

You can use the master in the same way as the standard product. The functionality of the slave is restricted as listed below. Refer to the following table to confirm the restrictions on the slave. In particular, make sure to set the codes indicated as "1" to the same values between the master and slave.

0: Setting is disabled.
1: Setting is enabled (and must be the same as the master).
2: Setting is enabled (and does not need to be the same as the master).
3: Setting is enabled (and setting specific to multi-winding is necessary).

Table 6.6.14 F00 to F85 on Slave

Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
F00	2	F11	0	F24	0	F42	0	F51	2	F60	2	F69	0	F80	1
F01	0	F12	0	F26	0	F43	0	F52	2	F61	0	F70	0	F81	0
F02	2	F14	0	F27	0	F44	0	F53	2	F62	0	F73	0	F82	0
F03	1	F17	0	F36	1	F45	0	F54	2	F63	0	F74	0	F83	0
F04	1	F18	0	F37	0	F46	0	F55	2	F64	0	F75	0	F84	2
F05	1	F20	0	F38	0	F47	0	F56	2	F65	0	F76	0	F85	0
F07	0	F21	0	F39	0	F48	0	F57	2	F66	0	F77	0		
F08	0	F22	0	F40	0	F49	0	F58	2	F67	0	F78	0		
F10	0	F23	0	F41	0	F50	0	F59	2	F68	0	F79	2		

Table 6.6.15 E01 to E118 on Slave

Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
E01	2	E14	2	E27	2	E40	0	E53	0	E66	0	E79	2	E106	0
E02	2	E15	2	E28	2	E41	0	E54	0	E67	0	E80	2	E107	0
E03	2	E16	2	E29	0	E42	0	E55	0	E68	0	E81	2	E108	0
E04	2	E17	2	E30	0	E43	0	E56	0	E69	2	E82	2	E109	0
E05	2	E18	2	E31	0	E44	0	E57	0	E70	2	E83	2	E110	0
E06	2	E19	2	E32	0	E45	0	E58	0	E71	2	E84	2	E114	0
E07	2	E20	2	E33	0	E46	0	E59	0	E72	2	E90	0	E115	0
E08	2	E21	2	E34	0	E47	0	E60	0	E73	2	E91	0	E116	0
E09	2	E22	2	E35	2	E48	0	E61	0	E74	2	E101	0	E117	0
E10	2	E23	2	E36	2	E49	0	E62	0	E75	2	E102	0	E118	0
E11	2	E24	2	E37	2	E50	0	E63	0	E76	2	E103	0		
E12	2	E25	2	E38	0	E51	0	E64	0	E77	2	E104	0		
E13	2	E26	2	E39	0	E52	0	E65	0	E78	2	E105	0		

Note: For E01 - E13, E15 - E27, and E69 - E73, only the functions listed in Table 6.6.10 are available.

* C01 - C73: All 0

* P01 to P27: 1, P28 to P58: 0

Table 6.6.16 H01 to H227 on Slave

Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
H01	0	H20	0	H36	2	H53	0	H74	0	H90	0	H118	1		
H02	2	H21	0	H37	2	H55	0	H75	0			H142	2		
H03	2	H22	0	H38	2	H56	0	H76	2			H149	0		
H04	1	H23	0	H39	2	H57	0	H77	2	H105	2				
H05	1	H24	0	H40	2	H58	0	H78	2	H106	2				
H06	2	H25	0	H41	0	H60	0	H79	2	H107	2				
H08	0	H26	0	H42	0	H61	0	H80	2	H108	2				
H09	0	H27	0	H43	0	H62	0	H81	2	H109	2				
H10	0	H28	0	H44	0	H63	0	H82	2	H110	2				
H11	0	H29	2	H46	0	H64	0	H83	2	H111	2				
H13	0	H30	1	H47	0	H65	0	H84	2	H112	1				
H14	0	H31	2	H48	0	H66	0	H85	2	H113	1				
H15	0	H32	2	H49	0	H67	0	H86	2	H114	1				
H16	0	H33	2	H50	0	H68	2	H87	2	H115	1				
H17	0	H34	2	H51	0	H70	0	H88	2	H116	1				
H19	0	H35	2	H52	0	H71	0			H117	1				

∗ H201 - H227: All 0

∗ A01 - A29, A32 - A34: 1, A30, A31, A51, A71 - A74: 0
A101 - A129, A132 - A134: 1, A130, A131, A151, A171 - A174: 0

Table 6.6.17 o01 to o50 on Slave

Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
o01	0	o04	0	o07	0	o13	0	o16	0	o19	0	o32	2	o50	3
o02	0	o05	0	o08	0	o14	0	o17	0	o30	2	o33	3		
o03	0	o06	0	o12	0	o15	0	o18	0	o31	2	o34	3		

∗ L01- L15: All 0

∗ U code: All 2

(3)-5 Function code (S: Command data)

You can use the master in the same way as the standard product. The functionality of the slave is restricted to S06 "Operation command 1" and S07 "Universal DO". However, the functions listed in Table 6.6.10 are only available.

(3)-6 Function code (M: Monitor)

You can use the master in the same way as the standard product. The functionality of the slave is restricted as listed below. Refer to the following table to confirm the restrictions on the slave.

0: Data becomes 0.
1: Data is valid.
2: Data is valid (shows data specific to multi-winding)

Table 6.6.18 M01 to M222 on Slave

Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class	Code	Class
M01	0	M22	0	M43	1	M65	1	M86	1	M114	0	M139	1	M162	0
M02	0	M23	1	M44	1	M66	1	M91	1	M115	1	M140	1	M163	0
M03	1	M24	1	M45	1	M67	1	M92	1	M116	1	M141	1	M164	0
M04	0	M25	1	M46	1	M68	1	M93	1	M119	1	M142	1	M165	0
M05	1	M26	1	M47	1	M69	1	M94	1	M120	1	M143	1	M166	1
M06	1	M27	0	M48	1	M70	1	M95	1	M121	1	M144	1	M167	1
M07	1	M28	0	M49	0	M71	1	M96	1	M123	1	M147	0	M168	1
M08	1	M29	1	M50	0	M72	1	M100	1	M124	1	M148	1	M169	1
M09	1	M30	0	M51	0	M73	1	M101	1	M125	1	M149	1	M170	1
M10	2	M31	1	M52	1	M74	1	M102	0	M126	1	M150	1	M171	1
M11	1	M32	1	M53	1	M75	1	M103	1	M127	1	M151	1	M172	1
M12	1	M33	1	M54	1	M76	0	M104	1	M128	1	M152	1	M177	0
M13	1	M34	1	M55	1	M77	1	M105	1	M129	1	M153	1	M178	0
M14	1	M35	1	M56	1	M78	0	M106	0	M130	0	M154	1	M179	0
M15	1	M36	2	M57	1	M79	1	M107	0	M132	1	M155	1	M180	0
M16	1	M37	1	M58	1	M80	1	M108	0	M133	1	M156	1	M185	0
M17	1	M38	1	M59	1	M81	1	M109	0	M134	1	M157	1	M186	1
M18	1	M39	1	M60	1	M82	1	M110	0	M135	1	M158	1	M221	0
M19	1	M40	1	M62	1	M83	1	M111	1	M136	1	M159	1	M222	0
M20	1	M41	1	M63	1	M84	1	M112	0	M137	1	M160	1		
M21	1	M42	1	M64	1	M85	1	M113	0	M138	1	M161	0		

6.6.7 Protective Function

⚠WARNING

- In a multi-system with two or more inverter units, if any one of the inverter enters an alarm state due to some reason, continuing operation with the remaining unit(s) may not be able to provide sufficient torque and normal operation of the system may not be possible. To prevent this situation, the multi-system puts all inverters linked via the high-speed serial communication-capable terminal table in the alarm state in a moment (within several milliseconds). You also need to design a sequence to stop all the inverters using 30X (Batch alarm output).
- After the inverter protective function has acted and the cause has been removed, giving the alarm reset signal with the operation command ON (closed) will start the inverters. To prevent an injury, check that the operation command is OFF (open) before giving the alarm reset signal.

⚠CAUTION

- If the optical cable connecting the inverters get broken during operation, correct operation becomes impossible and the inverters are forced to enter the alarm state (inter-inverter link error Er-b). The motors will coast to stop. This alarm does not act while the inverter is stopped.

6.6.7.1 Inter-inverter link error (Er-b)

If the optical cable connecting the inverters get broken or comes off from the connector during operation, the inverters are forced to enter the alarm state with the inter-inverter link error Er-b , and the motors will coast to stop.

Er-b can occur if a related function code is not set correctly.

While the alarm cause is not resolved, giving the reset command (from the keypad, terminal block, or communication system) does not cancel the alarm state. Be sure to resolve the cause before resetting the system.

Troubleshooting Er-b

Er-b can be caused by the following reasons:

(1) The optical cable is not connected or inserted to the connector incompletely.

(2) The optical cable is bent with curvature of 35 mm or less.

(3) The colors of the optical cable plugs and the connectors of the print board (light gray and dark gray) do not match.

(4) Optical cable connection does not form a loop. Be sure that signals from the master are looped back.

(5) Multi-system station address o50 settings are duplicated.

(6) The operation command (FWD/REV) was input before the optical link communication is established.

(7) Strong light (e.g., flashlight) is applied to the optical fiber.

If the alarm Er-b cannot be cancelled after checking and removing these causes, the optical cable and/or optical link option print board may be faulty. Contact your local sales office or service center.

6.6.7.2 Operation procedure error (Er-6)

The operation procedure error (Er-6) can occur in the following cases:

(1) The multi-system station address o50 value is greater than the number of slave o34 value.

(2) The motor control method is set to other than vector control.

6.6.7.3 Process in Protective Operation

(1) Batch alarm process

When the master inverter unit enters the alarm state, the alarm is indicated on all stations via the optical link, the 30X operation is executed, and the inverters are shut down.

* "o" (other station) is shown for alarm indication on the slave inverters.

Example: Inter-Inverter Link Error (Er-b)
Master inverter unit alarm indication : Er-6
Slave inverter unit alarm indication : oEr-6

When a slave inverter unit enters the alarm state, the alarm is indicated on all stations via the optical link, the 30X operation is executed, and the inverters are shut down.

* "o" (other station) is shown for alarm indication on the master inverter.

Example: Inter-Inverter Link Error (Er-b)
Master inverter unit alarm indication : oEr-6
Slave inverter unit alarm indication : Er-6

(2) Reset process

When giving the reset command from the master, all stations are batch reset if the alarm cause has been removed.

When giving the reset command from a slave, all stations are batch reset if the alarm cause has been removed.

Table 6.6.19 Reset Target

	Master alarm state	Slave alarm state	Reset target
Reset command from master	Valid	Valid	All units
Reset command from slave	Valid	Valid	All units

(3) Disabling disconnection detection

The slave inverter unit does not require feedback of the PG and NTC signals. Therefore, on an inverter configured as a slave in a multi-system, PG and NTC disconnection detection is disabled.

6.7 CC-Link Interface Card

6.7.1 Product overview

This card is used for a CC-Link master (Mitsubishi Electric PLC, etc.) to control FRENIC-VG via CC-Link.

CC-Link is an abbreviation of Control & Communication Link developed by Mitsubishi Electric Corporation as a next generation FA field network. The CC-Link system connects input/output units, special function units (e.g., inverter), etc., via dedicated cables, allowing the CPU for PLC to control such units. The CC-Link system can achieve wire-saving and high-speed data communications.

Major application

This card is available for the following.

- Applicable for CC-Link Ver. 1.10 and Ver. 2.00
- Supports new FRENIC-VG mode and existing FRENIC5000VG7 compatible mode
- Input of signals for operation, stop, etc.;FWD, REV, X1 to X9, X11 to X14, RST
- Setting of speed commands; 16-bit binary data
- Monitoring running status (bit data)
  Running forward, running reverse, with speed, speed match, arrival at speed, speed detection, operation preparation completed, alarm relay output, during monitoring, speed setting completed, command code execution completed, alarm state, remote station ready
- Monitoring motor speed; 16-bit binary data
- Monitoring running status (Word data)
  Speed command, output frequency, torque command value, output current, output voltage, cumulative run time, etc.
- Reference/change of function codes

6.7.2 Model and specifications

6.7.2.1 Model

Model content: OPC-VG1-CCL

- Mounted inverter name VG1 -> FRENIC-VG
- Option name: CCL -> CC-Link interface card

Accessories

Spacers: 3
Screws (M3): 3

6.7.2.2 Specifications

⚠CAUTION

- Incorrect setting of the switches (RSW1, 2, 3) on the option prevents the system from running normally. Fully understand the following settings to set them correctly.
- When setting the switches (RSW1, 2, 3) on the option, turn OFF the power supply to the inverter.

Table 6.7.1 Hardware Specifications

Item	Specifications
Name	CC-Link Interface Card
Station type	Remote device station
Number of units connectable	Up to 42 units, which can be shared with other models*1
Number of stations occupied	1 station occupied (all Ver. 1, Ver. 2)
Terminal block for connection	Five terminal blocks (M3 X 5 screws)
Connection cable	CC-Link dedicated cable, and cable applicable for CC-Link Ver. 1.10 * The recommended CC-Link cable is FANC-110SBH made by Kuramo Electric Co., Ltd. For details, refer to CC-Link Catalog or Mitsubishi Electric Corporation FA Equipment Technical Information Service MELFANS website (http://www.nagoya.melco.co.jp/). For details about wiring for CC-Link, refer to the CC-Link Master User's Manual or CC-Link Cable Wiring Manual published by the CC-Link Partner Association. The CC-Link Cable Wiring Manual is available as a free download from the CC-Link Partner Association's website (http://www.cc-link.org/jp/material/).
Rotary switch RSW1, 2	Station address setting. Addresses 1 to 64 can be specified.
Rotary switch RSW3	Transmission speed (baud rate) can be specified: 10 M, 5 M, 2.5 M, 625 K, 156 Kbps
LED status indicators	L.RUN:..... Lights when the communications card is normally receiving refresh data. It goes off if data transmission is interrupted for a certain period of time. L.ERR: ..... Lights when a communication error occurs in this station. The LED blinks when the rotary switch is operated while the power is turned ON. SD:............ Lights during data transmission. RD: .... Lights during data reception.

*1 Number of units connectable Since the number of stations occupied differs depending on the use of a different unit (remote I/O station or remote device station) or use of different profiles, both the formulae must be satisfied.

□ Formula 1: (1xa) + (2xb) + (3xc) + (4xd) □ 64

a: Number with 1 station occupied, b: Number with 2 stations occupied, c: Number with 3 stations occupied, d: Number with 4 stations occupied

□ Formula 2: (16xA) + (54xB) + (88xC) □ 2304

A: Remote I/O station.. Max. 64 units
B: Remote device station.. Max. 42 units
C: Local station, standby master station, intelligent device station .... Max. 26 units

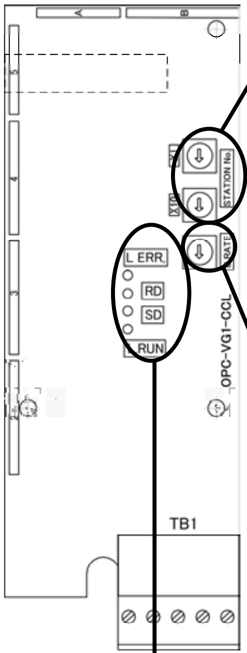


Figure 6.7.1

Rotary switch RSW1, 2

Before turning on the power supply to the inverter, specify inverter station addresses in the range of 1 to 64.

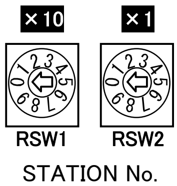


Figure 6.7.2

Note 1: Do not change station address settings when the inverter power is ON. If a station address is changed when the power is ON, the station address after the change is not available to provide data communications.

Note 2: If a station address is double assigned or is set out of the allowable range, normal communications cannot be carried out. (L.ERR LED lights.)

Note 3: Specify consecutive station addresses in connection order. (If station addresses are not specified consecutively, specify a "reserved station address" for each skipped station address.)

Transmission baud rate setting switch RSW3

Before turning on the power supply to the inverter, specify transmission baud rate in the range of 0 to 4.

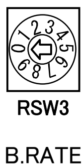


Figure 6.7.3

Table 6.7.2 Baud rate specification

Number	Baud rate
0	156 Kbps（Factory default）
1	625 Kbps
2	2.5 Mbps
3	5 Mbps
4	10 Mbps
5 - 9	Setting error (L.ERR LED lights)

LED status indicators

The link status of CC-Link can be checked with four LEDs.

Chap. 6 CONTROL OPTIONS

Table 6.7.3 LED status indicator specifications

Status				Operation Status
L.RUN	L.ERR	SD	RD	
●	○	★	●	Normal communications
●	★	★	●	Normally communicating. But sometimes a CRC error occurs due to electrical noise.
●	★	○	●	Received data contains a CRC error, so the communications card cannot respond.
●	○	○	●	Data destined for this station does not come.
○	★	★	●	Responding to polling. But refresh data received contains a CRC error.
○	★	○	●	Data destined for this station contains a CRC error.
○	○	○	●	No data destined for this station. Or data destined for this station cannot be received due to electrical noise.
○	●	○	●○	Baud rate, station address incorrectly specified.
●	★ (0.8-second intervals)	★	●	Baud rate or station address changed before completion.
○	○	★	●	Link has not been started up.
○	○	○	○	Data cannot be received due to wire break, power down, hardware reset in progress, Er-3 power area failure

●: ON, ○: OFF, ★: Blinking (It may seem to be ON depending on the current transmission baud rate.)

Note 1: If LED lights due to a pattern other than the above, it can be assumed hardware error has occurred. Contact us.

Terminal block

FG	SLD	DG	DB	DA

Figure 6.7.4

Table 6.7.4 Terminal Block Specifications

Terminal Name	ID Color of Wire Sheath	Description	Remarks
DA	Blue	For communication data	
DB	White		
DG	Yellow		
SLD	Metallic	For connecting shielded wire of cable	SLD and FG are connected within the card.
FG	-	For earth	

Table 6.7.5 Software specifications

Item		Specifications
CC-Link version		Ver. 1.10 and Ver. 2.00 (Selectable with function code o32)
Operation	Run command	Run forward and reverse commands, Alarm reset command, X1 to X9 and X11 to X13 commands
	Speed command	16-bit binary data
	Running status output	Bit data for running, braking, torque limiting, alarm relay output signal, etc.
		Word data for motor speed, torque current command, etc.
Function code		VG1 mode (Ver. 1/Ver. 2): All function codes can be referred to or changed. VG7 compatible mode (Ver. 1): 255 types of function codes assigned to link Nos. in the function code list can be referred to or changed.
Option function code		o30, o31, o32 ....The factory default is "0".
Protective functions		Er-4: Network error (CC-Link error) * Light alarm: Communications link error (Function codes o30 and o31 are available to control the Er-4 alarm.) * Heavy alarm: Option card error, CC-Link version error (The stop method can be selected with function code o30 or o31.)

* Light alarm: If signal noise or others do not occur frequently, Er-4 alarm function codes o30 and o31 are available for control.

* Heavy alarm: Fatal failure, such as hardware failure

6.7.3 External dimension drawing

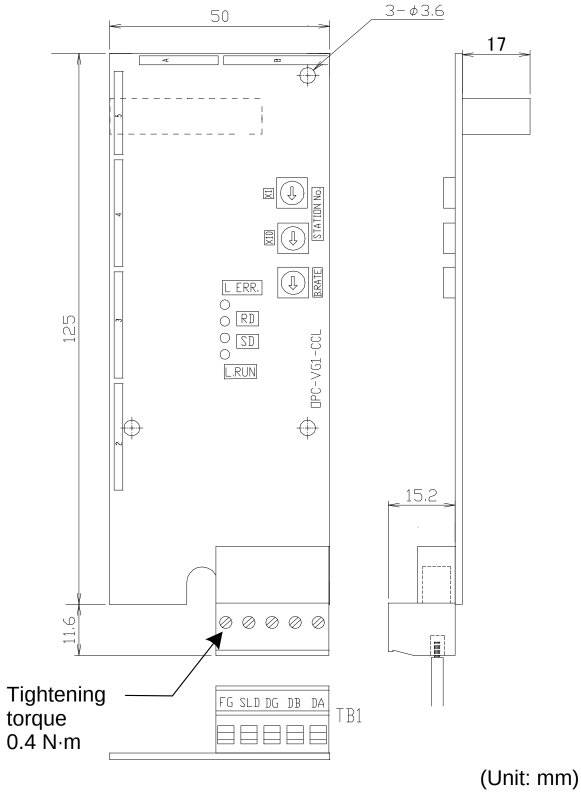


Figure 6.7.5 Option PCB Outline Drawing

6.7.4 Basic connection diagram

Refer to “6.1.4 Installing internal options (OPC-VG1-□□)”, and then perform wiring and connecting jobs.

⚠WARNING

- Incorrect handling in connecting wires could cause an accident such as electric shock or fire. Qualified electricians should carry out connecting wires. If connecting wires, for example, after the power is turned ON requires any touching of an electric circuit, turn OFF (open) the breaker on the power supply side to prevent electric shock.
- Since the smoothing condenser has been charged although the breaker is turned OFF (open), touching of an electric circuit causes an electric shock. Turn OFF the charge lamp (CHARGE) of the inverter, and confirm, with a tester, etc., that the DC voltage of the inverter has been reduced to the safety voltage.

⚠CAUTION

- Do not use the product that is damaged or lacking parts. Doing so could cause injury or damage.
- Incorrect handling in installation/removal could result in a broken product.

The basic connection diagram is shown below. When connecting the communications card, observe the following precautions.

[Connecting precautions]

(1) Use dedicated cables (refer to 6. 7.2.2 “Specifications") for CC-Link connection.
Be sure not to use soldered cables, which could cause disconnection or wire break.

(2) Use terminating registers that came with the PLC.

(3) For the maximum number of communications cards, refer to the number of units connectable in 6. 7.2.2 “Specifications".

When an inverter is connected

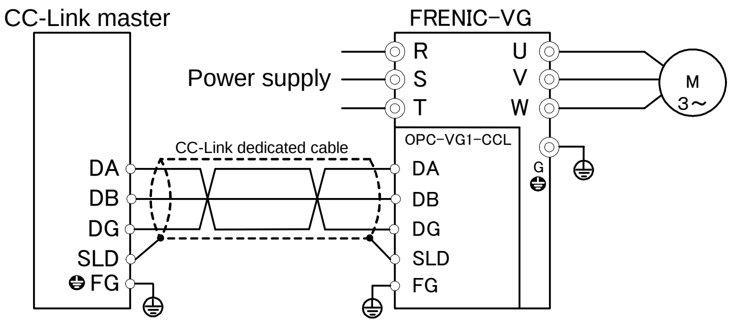


Figure 6.7.6 Inverter connection diagram (1 unit)

When two or more inverters are connected

For the number of inverters connectable, refer to Section 6.7.2.2 "Specifications."

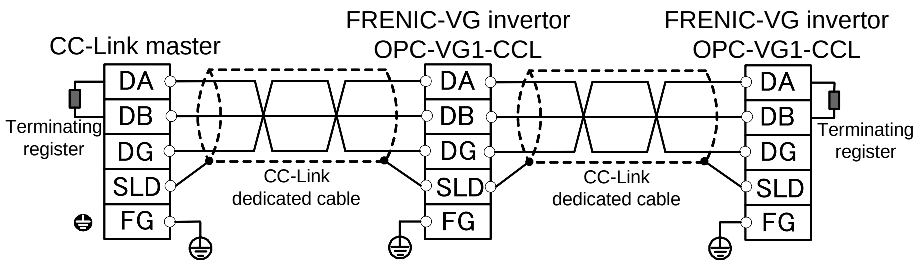


Figure 6.7.7 Inverter Connection Diagram (Two or More Inverters)

6.7.5 Function code

⚠CAUTION
・ Configuring the function codes wrongly may lead to dangerous conditions. When data has been set or written, be sure to confirm the data again. **Failure to observe this precaution could cause an accident.**

6.7.5.1 Standard function code

Standard function codes accessible from CC-Link differ depending on profile selection (o32). They are as shown in Table 6.7.6.

Note 1: When function codes are written via CC-Link, they are all written into volatile memory (RAM: data in memory is erased by turning off the power supply). Turning OFF the control power to the inverter therefore erases written data. Execute function code H02 "Save All Function", if necessary, to write data into non-volatile memory (EEPROM: data in memory is not erased even by turning OFF the power supply).

Table 6.7.6 Standard Function Codes Accessible from CC-Link

Profile selection (o32)	Accessible standard function code
VG7 compatible mode (o32=0)	Only the function codes corresponding to link No *1 in the function code list can be referred to and changed.
VG1 mode (o32=1 to 4)	Function codes (almost all function codes *2) corresponding to 485No *1 in the function code list can be referred to and changed.

*1 For 485No and link No, refer to Chapter 4, Section 4.2 “Function Code Tables."

*2 Excepting for writing H01 and P02, all function codes are accessible.

6.7.5.2 Communication dedicated function codes

Common data formats (S code and M code) are available as communication dedicated specifications. Excepting standard function codes, command/monitor related data is defined. For details on the communication dedicated function codes, refer to Chapter 4. However, when the following communication dedicated codes are written via CC-Link, the restrictions shown in Table 6.7.7 are applied. (They can be read.)

Table 6.7.7 Restrictions on Writing of Communication Dedicated Function Codes

Profile selection (o32)	Restrictions on Writing of Communication Dedicated Function Codes
VG7 compatible mode (o32=0)	No data can be written into S01 speed command or S06 operation command 1.
VG1 mode (o32=1 to 4)	Restrictions on writing are not applied. However, if speed command by writing S01/S06, operation command, remote output, speed command by remote register, and operation command are carried out simultaneously, priority is given to the remote output and remote register.

6.7.5.3 Option dedicated function codes

Reloading the CC-Link card can operate o30 to o32 not only as standard function codes but also as option dedicated function codes.

Table 6.7.8 Option Dedicated Function Codes

<table>
<tr><th rowspan="2">No.</th><th colspan="2">Function code name</th><th rowspan="2">Setting range</th><th rowspan="2"></th><th rowspan="2">Description</th></tr>
<tr><th>Name</th><th>Keypad display</th></tr>
<tr><td rowspan="8">o30</td><td rowspan="8">Operation when an error occurs
Note 1</td><td rowspan="8">MODE ON ER</td><td rowspan="2"><u>0</u></td><td>Light alarm</td><td>If a failure occurs, and remains unsolved even after the operation continues for the time of the timer (o31), the motor coasts to stop with Er-4 alarm generated.</td></tr>
<tr><td>Heavy alarm</td><td>If a failure occurs, immediate coast to a stop. Then Er-4 alarm is generated.</td></tr>
<tr><td rowspan="2">1</td><td>Light alarm</td><td>If a failure occurs, and remains unsolved even after the operation continues for the time of the timer (o31), the Er-4 alarm is generated after stoppage.</td></tr>
<tr><td>Heavy alarm</td><td>If a failure occurs, Er-4 alarm is generated after deceleration to stop.</td></tr>
<tr><td rowspan="2">2</td><td>Light alarm</td><td>If a failure occurs, and remains unsolved even after the operation continues for the time of the timer (o31), Er-4 is displayed after stoppage (without alarm relay output). The motor restarts after returning to communications.</td></tr>
<tr><td>Heavy alarm</td><td>If a failure occurs, Er-4 alarm is generated after deceleration to stop.</td></tr>
<tr><td rowspan="2">3</td><td>Light alarm</td><td>When a failure occurs, Er-4 alarm is not generated.</td></tr>
<tr><td>Heavy alarm</td><td>If a failure occurs, Er-4 alarm is generated after deceleration to stop.</td></tr>
<tr><td>o31</td><td>Operation time when an error occurs</td><td>TIMER TL</td><td>0.01 to <u>0.10</u> to 20.00s</td><td colspan="2">Timer value for operation continuation time upon light alarm (enabled with o30=0, 1 ,2)</td></tr>
<tr><td rowspan="5">o32</td><td rowspan="5">Format selection
Note 2</td><td rowspan="5">FORMAT SEL</td><td><u>0</u></td><td colspan="2">VG7 compatible mode with 1 station occupied (CC-Link Ver. 1)</td></tr>
<tr><td>1</td><td colspan="2">1 X mode with 1 station occupied (CC-Link Ver. 1)</td></tr>
<tr><td>2</td><td colspan="2">2 X mode with 1 station occupied (CC-Link Ver. 2)</td></tr>
<tr><td>3</td><td colspan="2">4 X mode with 1 station occupied (CC-Link Ver. 2)</td></tr>
<tr><td>4</td><td colspan="2">8 X mode with 1 station occupied (CC-Link Ver. 2)</td></tr>
</table>

Note 1: For details on o30 and o31, refer to 6.7.6 “Protection operation."

Note 2: If the o32 value has been changed, the inverter power must be turned ON again to reflect the change content upon the operation.

6.7.6 Protection operation

6.7.6.1 Light alarm and heavy alarm

Light alarm or heavy alarm is generated in the CC-Link card, depending on an error level. Occurrence of such an error makes the inverter generate Er-4 "Network error" alarm, resulting in coast to stop or deceleration to stop.

Table 6.7.9 Light Alarm and Heavy Alarm

Item	Light alarm (operation in case of CC-Link error)	Heavy alarm (in case of option error)
Cause of the error	・Master down, wire break detection ・Communication data error (Noise applied to communications line, etc.)	・Option card hardware error ・Defective installation of option card
Reset method Note 2	Perform resetting after removal of alarm cause (automatic release after returning to communications). Note 1:	After the inverter power is turned OFF, remove the alarm cause, and then turn ON the inverter power.
Alarm output control	・Only in CC-Link operation mode (refer to "6.7.13 Link Function"), error is detected ・Function code o30 or o31 is available to control the alarm output method when an error is detected.	Function code o30 or o31 is available to control the alarm output method when an error is detected.
Communications error code Note 5	2	3

Table 6.7.10 Operation in Case of Light Alarm (CC-Link Error)

o30 setting	When an error occurs in communications line			Communication error remains after the time specified by o31			When communications error is removed		
	Operation status	Display	Alarm relay output	Operation status	Display	Alarm relay output	Operation status	Display	Alarm relay output
0	Operation continues	Normal display	Not output	Coast to a stop	Immediately Er-4 lights	Output	Stop status continues	Er-4 continues	Output continues
1	Operation continues	Normal display	Not output	Decelerate to stop Note 3	After stop Er-4 lights	After stop output	Stop status continues	Er-4 continues	Output continues
2	Operation continues	Normal display	Not output	Decelerate to stop Note 3, Note 4	After stop Er-4 lights	Not output	Restart Note 3	Normal display	Not output
3	Operation continues	Normal display	Not output	←	←	←	←	←	←

Table 6.7.11 Operation in Case of Heavy Alarm (Option Error)

o30 setting	When an option error occurs			Communication error remains after the time specified by o31			When the option error is removed		
	Operation status	Display	Alarm relay output	Operation status	Display	Alarm relay output	Operation status	Display	Alarm relay output
0	Coast to a stop	Immediately Er-4 lights	Immediate output	Stop status continues	Er-4 continues	Output continues	←	←	←
1	Decelerate to stop Note 3	After stop Er-4 lights	After stop output	Stop status continues	Er-4 continues	Output continues	←	←	←
2	Decelerate to stop Note 3	After stop Er-4 lights	After stop output	Stop status continues	Er-4 continues	Output continues	←	←	←
3	Decelerate to stop Note 3	After stop Er-4 lights	After stop output	Stop status continues	Er-4 continues	Output continues	←	←	←

Note 1: "Perform resetting" means reset input by one of the following methods.

* Entry by RESET key on the keypad
* Error reset [RST] is assigned by selecting X function to set the applicable X terminal to ON (assigned to X8 by factory default).
* Entry of reset command from communications

Note 2: In case of light alarm (o30=0/1), resetting can be performed unless alarm cause has been removed completely. In case of the light alarm (o30=2) or heavy alarm, however, resetting cannot be done until the cause has completely been removed.

Note 3: With o30=1, 2, or 3: For deceleration to stop, the motor stops with the time of deceleration (F08, C47, C57, or C67) specified at that time.
With o30=2: For restart, the motor accelerates in the acceleration time (F07, C46, C56, or C66) specified at that time.

Note 4: With o30=2, if an error in communications circuit is removed during deceleration, the motor reaccelerates at that time.

Note 5: Communications error codes for light alarm/heavy alarm can be confirmed on the communications status screen for maintenance information of the keypad.

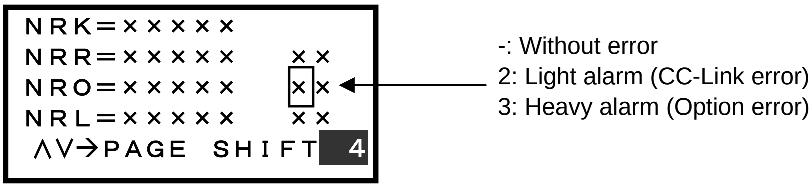


Figure 6.7.8 Communication Error Codes

6.7.6.2 Protection Operation Function Codes

This section describes operation to be performed when communications link errors occur in a state, where running command or speed command is given via CC-Link, while the inverter is running.

(1) Function code o30=0, o31=5.00 (Communication error continues for 5 or more seconds, and the motor coasts to stop)

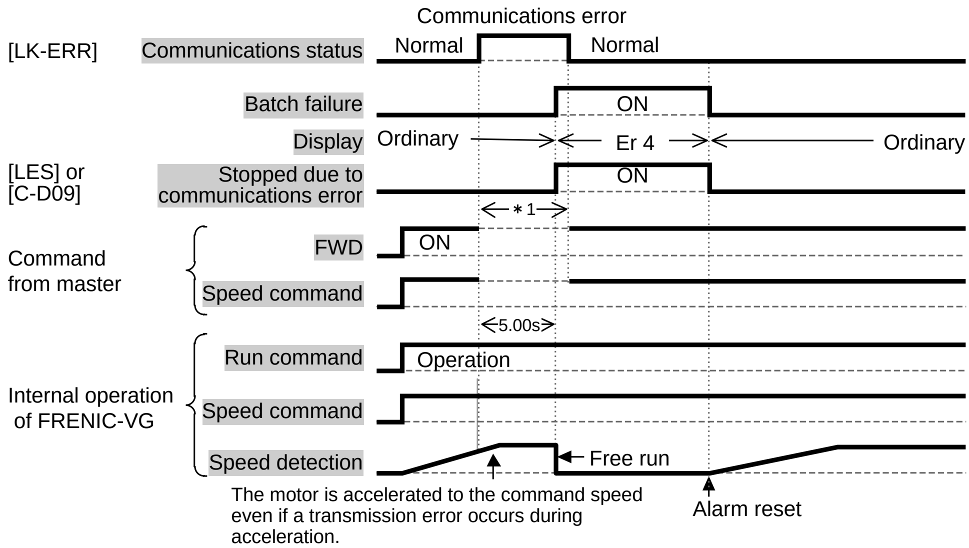


Figure 6.7.9

(2) Function code o30=0, o31=5.00 (Communication error continues for 5 or more seconds, and the motor decelerates to stop)

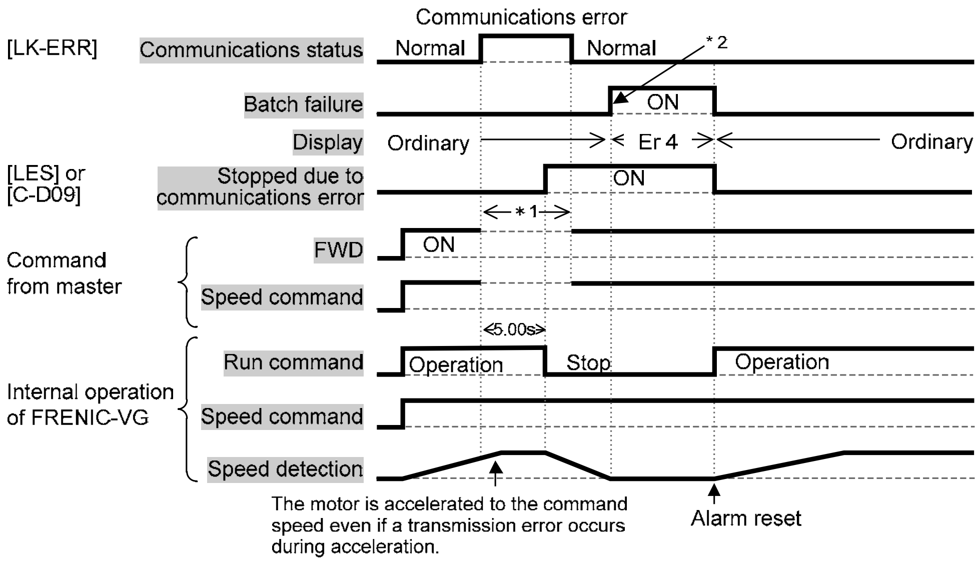


Figure 6.7.10

*1) For the period until the recovery of communications, the command just before the occurrence of the communications error (run command and/or speed command) is retained.

*2) During DC braking [DCBRK] or pre-exciting [EXITE] in deceleration to stop, alarm relay output is not performed until the stop of these commands.

(3) Function code o30=2, o31=5.00 (Communication error continues for 5 or more seconds, and the motor decelerates to stop)

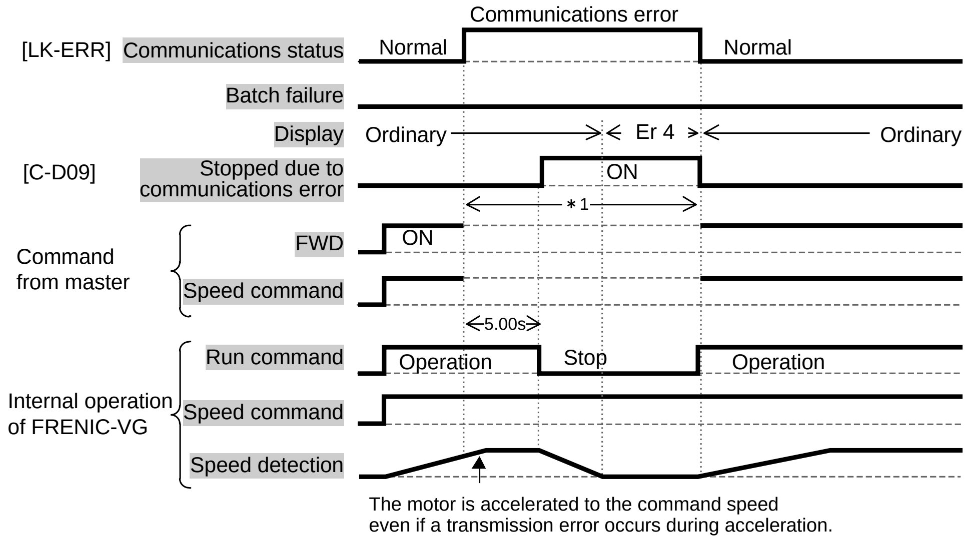


Figure 6.7.11

(4) Function code o30=2, o31=5.00 (After communication error continues for 5 or more seconds, returns to communications during deceleration to stop)

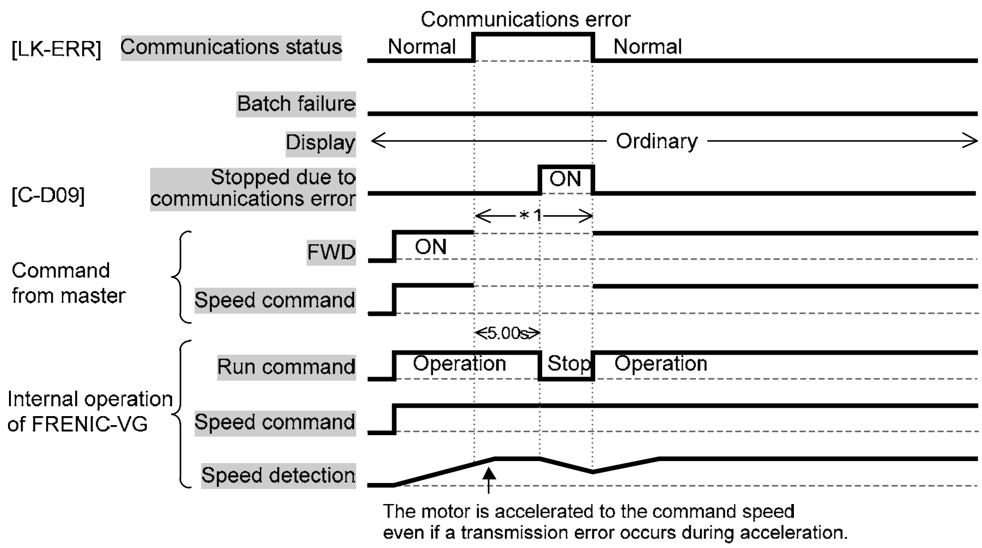


Figure 6.7.12

*1) For the period until the recovery of communications, the command just before the occurrence of the communications error (run command and/or speed command) is retained.

Chap. 6 CONTROL OPTIONS

(5) <u>For function code o30=3 (operation continues)</u>

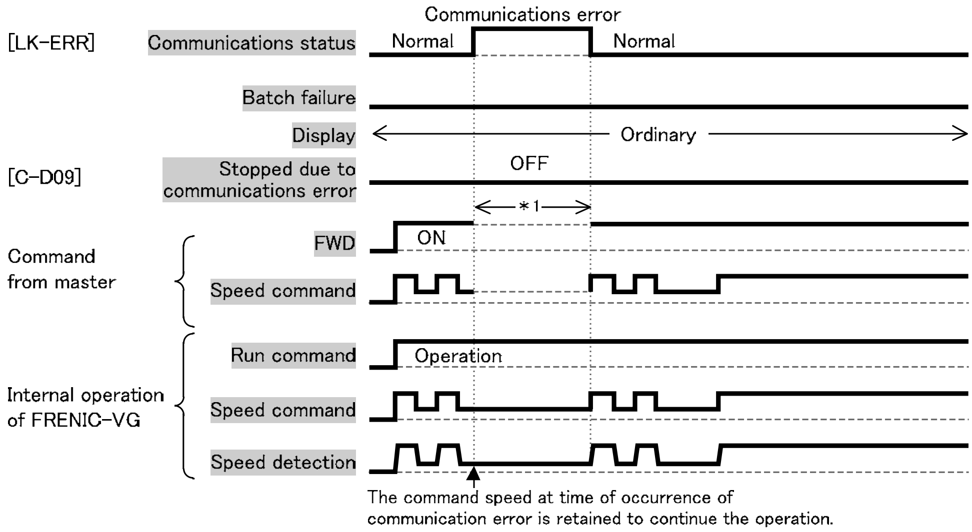


Figure 6.7.13

*1) For the period until the recovery of communications, the command just before the occurrence of the communications error (run command and/or speed command) is retained.

6.7.7 Applicable format list

This option card supports formats shown in Table 6.7.12.

Table 6.7.12 Applicable Format List

Function code	Name	Initial value	Setting	Description	Reference page
o32 *1	Format selection	0	0	VG7 compatible mode with 1 station occupied (CC-Link Ver. 1) *2	6-6-148
			1	1 X mode with 1 station occupied (CC-Link Ver. 1)	6-6-153
			2	2 X mode with 1 station occupied (CC-Link Ver. 2) *3	6-6-159
			3	4 X mode with 1 station occupied (CC-Link Ver. 2) *3	6-6-160
			4	8 X mode with 1 station occupied (CC-Link Ver. 2) *3	6-6-162

*1 If the o32 value has been changed, the inverter power must be turned ON again to reflect the change content upon the operation.

*2 The program used for the FRENIC5000VG7S series is available.

*3 When 2 X, 4 X, or 8 X mode of CC-Link Ver. 2 is used, station information at the master station must also be set to 2 X, 4 X, or 8 X, respectively.

6.7.8 VG7 compatible mode with 1 station occupied (o32=0)

6.7.8.1 Remote I/O signal in the VG7 compatible mode

Table 6.7.13 Remote Output Signal in VG7 Compatible Mode (Master -> FRENIC-VG)

<table>
<tr><th>Device No.</th><th>Signal name</th><th colspan="2">Description</th></tr>
<tr><td>RYn0</td><td>Run forward command</td><td>OFF: Stop command
ON: Run forward command (counterclockwise viewed from the motor axis direction)</td><td rowspan="2">Simultaneously turning RYn0 and RYn1 ON is functionally equivalent to a stop command.</td></tr>
<tr><td>RYn1</td><td>Run reverse command</td><td>OFF: Stop command
ON: Run reverse command (counterclockwise viewed from the motor axis direction)</td></tr>
<tr><td>RYn2</td><td>Terminal X1 function</td><td rowspan="4">Multiple speed (SS1/SS2/SS4/SS8) is selectable by combinations of terminals.</td><td rowspan="8">Functions to be provided by factory default are shown at left. Setting terminal X function can change the function of terminal X.</td></tr>
<tr><td>RYn3</td><td>Terminal X2 function</td></tr>
<tr><td>RYn4</td><td>Terminal X3 function</td></tr>
<tr><td>RYn5</td><td>Terminal X4 function</td></tr>
<tr><td>RYn6</td><td>Terminal X5 function</td><td rowspan="2">ASR and acceleration/deceleration (RT1/RT2) can be selected by combinations of terminals.</td></tr>
<tr><td>RYn7</td><td>Terminal X6 function</td></tr>
<tr><td>RYn8</td><td>Terminal X8 function</td><td>Works as error reset (RST) when turned ON.</td></tr>
<tr><td>RYn9</td><td>Terminal X7 function</td><td>Works as coast to stop command (BX) when turned ON. (output shut down on the secondary side)</td></tr>
<tr><td>RYnA</td><td rowspan="2">Not used.</td><td colspan="2" rowspan="2">Should be turned OFF.</td></tr>
<tr><td>RYnB</td></tr>
<tr><td>RYnC</td><td>Monitor command</td><td colspan="2">Turning the monitor command (RYnC) ON sets the monitored value to RWrn, turning the "Monitoring" signal (RXnC) ON. Note 1</td></tr>
<tr><td>RYnD</td><td>Speed setting command (RAM)</td><td colspan="2">Turning the speed setting command (RYnD) ON writes the speed command (RWwn+1) into the inverter's volatile memory (RAM). Note 2
Upon completion of writing, the speed setting completed signal (RXnD) is turned ON.</td></tr>
<tr><td>RYnE</td><td>Not used.</td><td colspan="2">Should be turned OFF.</td></tr>
<tr><td>RYnF</td><td>Command code execution request</td><td colspan="2">Turning the command code request signal (RYnF) ON executes processing corresponding to command codes specified in the command code (RWwn+2). Note 3
After execution of those command codes, the "Command code execution completed" signal (RXnF) is turned ON. If a command code execution error occurs, the response code (RWrn+2) is set to a value other than "0".</td></tr>
<tr><td>RY(n+1)0
|
RY(n+1)9</td><td>Not used.</td><td colspan="2">Should be turned OFF.</td></tr>
<tr><td>RY(n+1)A</td><td>Alarm reset request flag</td><td colspan="2">When an inverter alarm is generated, turning the alarm reset request flag ON resets the inverter, turning the alarm status flag (RX(n+1)A) OFF. Note 4</td></tr>
<tr><td>RY(n+1)B
|
RY(n+1)F</td><td>Not used.</td><td colspan="2">Should be turned OFF.</td></tr>
</table>

n: Value determined by a station address

Note 1: While the "Monitor command" (RYnC) is ON, the monitored values are constantly updated.

Note 2: While the "Speed setting" (RYnD) is ON, the value of speed command (RWwn+1) is constantly reflected on the speed.

Note 3: While the command code execution request is ON, the command code is constantly executed. (When reading, the read value is constantly updated. When writing, the written value is constantly reflected.)

Note 4: When the "Alarm reset request flag" signal (RY(n+1)A) is ON, alarm reset is constantly executed. After the release of the alarm, this signal should therefore be turned OFF. Alarm reset can be done regardless of operation mode.

Table 6.7.14 Remote Input Signal in VG7 Compatible Mode (FRENIC-VG -> Master)

Device No.	Signal name	Description	
RXn0	Running forward	OFF: Except running in forward direction (Stopped or Rotating in reverse direction) ON: Rotating in forward direction	
RXn1	Running reverse	OFF: Except running in reverse direction (Stopped or Rotating in forward direction) ON: Rotating in reverse direction	
RXn2	Terminal Y1 function	With speed. Turned ON with (N-EX)	Functions to be provided by factory default are shown at left. Setting terminal Y function can change output contents.
RXn3	Terminal Y2 function	Speed match. Turned ON with (N-AG1).	
RXn4	Terminal Y3 function	Arrival at speed. Turned ON with (N-AR).	
RXn5	Terminal Y4 function	Speed detection 1. Turned ON with (N-DT1)	
RXn6	Terminal Y5 function	Operation preparation completed. Turned ON with (RDY).	
RXn7	Alarm relay output	Inverter's protection function is operated, and the signal is turned ON when output stops.	
RXn8 | RXnB	Not used.	-	
RXnC	Monitoring	The "Monitoring" signal (RXnC) is turned ON when turning the "Monitor command" (RYnC) ON specifies a monitored value for remote register RWrn (refer to Table 6.7.16). Turning the "Monitor command" (RYnC) OFF turns this signal OFF.	
RXnD	Speed setting completed (RAM)	This signal is turned ON when turning the "Speed setting command" signal (RYnD) ON writes a speed command into the inverter's volatile memory (RAM). Turning the "Speed setting command" signal (RYnD) OFF turns the "Speed setting completed" signal (RXnD) OFF.	
RXnE	Not used.	-	
RXnF	Command code execution completed	This signal is turned ON when turning the "Command code execution request" (RYnF) ON has completed the execution of processing corresponding to the command code (RWwn+2). Turning the "Command code execution request" (RYnF) OFF turns the "Command code execution completed" signal (RXnF) OFF.	
RX(n+1)0 | RX(n+1)9	Not used.	-	
RX(n+1)A	Alarm state flag	This signal is turned ON when an inverter alarm (alarm other than Er-3) is generated.	
RX(n+1)B	Remote station ready	This signal is turned ON when completing initial data setting places the inverter in the ready status after the inverter has been powered ON or the hardware has been reset. (This signal is used for interlocking with reading or writing from/to the master unit.) This signal is turned OFF concurrently when the "Alarm state flag" (RX(n+1)A) is turned ON if the inverter alarm is generated.	
RX(n+1)C | RX(n+1)F	Not used.	-	

n: Value determined by a station address

Note 1: When the condition setting switch of the master unit for "Input data status of data link error station (SW4)" is set to ON, input data from the data link error station is retained in the status just before the occurrence of the error. Note that this remains signals, e.g., remote station ready, etc., ON even if an inverter alarm is generated.

Note 2: If an operation command is output from the master when the instruction via communications is disabled (H30=0, 1, or [LE] instruction OFF), the inverter does not run. However, the input signals "Speed setting completed" and "Command code execution completed" signal are turned ON. Care must be taken for this. In addition, "I/O check" can be performed on the keypad to confirm whether input signal is issued from the link (COM), even if the command via communications is disabled.

6.7.8.2 Remote register in VG7 compatible mode (o32=0)

Table 6.7.15 Remote Register in VG7 Compatible Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWwn+0	Monitor code	This signal sets a monitor code to be referred to (refer to Table 6.7.17). After the setting is completed, turning RYnC signal ON sets the monitor data to RWrn.	
RWwn+1	Speed command	Specify the speed command. After it is set in this register, turning ON the RYnD described above writes the speed to the inverter. After completion of writing, the RXnD is turned ON.	0 to ±20000 (Nmax with ±20000) Supporting of writing data into volatile memory (RAM) only
RWwn+2	Command code	Command codes (refer to Table 6.7.18) are set to execute operation mode rewrite, function code read, write, reference of alarm history, alarm reset, etc. After register setting is completed, turning RYnF ON executes the commands. Completion of command execution turns RXnF ON.	
RWwn+3	Write data	Set data to be specified with the commands above (if necessary). After writing the command codes above and setting this register, turn the RYnF ON. If no write data is required, zero "0" should be written.	All data can be written into volatile memory (RAM) only. Execute "H02 All Save function", if necessary, to write data into non-volatile memory (EEPROM).

n: Value determined by a station address

Table 6.7.16 Remote Register in VG7 Compatible Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWrn+0	Monitored value	A monitored value specified with RWwn monitor code is set.	
RWrn+1	Motor speed	Current motor speed is constantly set.	0 to ±20000 (Nmax with ±20000)
RWrn+2	Response code	Response codes corresponding to RWwn+2 command code (refer to Table 6.7.19) are set. For normal response, "0" is set. If data is incorrect, the codes are set to a value other than "0".	
RWrn+3	Read data	If the command code has normally been executed, the response data for that command (specified by the command code) is automatically written.	

n: Value determined by a station address

6.7.8.3 Monitor code/command code (o32=0) in VG7 compatible mode

Table 6.7.17 Monitor Code (o32=0)

Code No.	Description	Unit	Remarks
0000_H	No monitoring (Fixed to 0)	—	
0001_H	Output frequency	0.01 Hz	In units of 0.1 Hz
0002_H	Output current	0.1 A	
0003_H	Output voltage	0.1 V	
0004_H	No monitoring (Fixed to 0)	—	
0005_H	Speed setting	1 r/min	
0006_H	Operation speed	1 r/min	
0007_H	Torque command value	0.1%	
0008_H	DC link bus voltage	0.1 V	In units of 1 V
0009_H | $000D_H$	No monitoring (Fixed to 0)		
$000E_H$	Motor output	0.01 kW	In units of 0.1 kW
$000F_H$	Operation command	—	
0010_H	Output terminate status	—	
0011_H	Torque current command value	0.1%	
0012_H	Flux command	0.01%	
0013_H	Position detection pulse	1 pulse	Quad multiplication of built-in PG
0014_H	Cumulative run time (Cumulative power-ON time)	1 hr	
0015_H | 0019_H	No monitoring (Fixed to 0)		

□Detailed description on operation command

b15							b8	b7							b0
RST	X14	X13	X12	X11	X9	X8	X7	X6	X5	X4	X3	X2	X1	REV	FWD

Figure 6.7.14

□Detailed description on output terminate status

b15							b8	b7							b0
Y18	Y17	Y16	Y15	Y14	Y13	Y12	Y11	-	-	-	Y5A	Y4	Y3	Y2	Y1

- : Empty (Fixed to 0)

Figure 6.7.15

Chap. 6 CONTROL OPTIONS

Table 6.7.18 Command Code (o32=0)

Item		Code number	Description	Remarks
Operation mode read Note 1		$007B_H$	0000_H: Link operation (CC-Link) 0001_H: Terminal command for external drive 0002_H: Keypad operation	0:(LE=ON & H30≠0) 1:(LE=OFF | H30=0) & F02=1 2:(LE=OFF | H30=0) & F02=0
Writing of operation mode Note 1		$00FB_H$	0000_H: Link operation (CC-Link) 0001_H: Terminal command for external drive	0: LE=ON 1: LE=OFF ・Assignment of LE to terminal X gives priority to the terminal. ・0 with the power turned OFF
Reading of alarm history No.1/No.2		0074_H	Reading of history No. 1/history No.2	L byte: History No.1, H byte: History No.2
Reading of alarm history No.3/No.4		0075_H	Reading of history No.3/history No.4	L byte: History No.3, H byte: History No.4
Reading of alarm history No.5/No.6		0076_H	Reading of history No.5/history No.6	L byte: History No.5, H byte: History No.6
Reading of alarm history No.7/No.8		0077_H	Reading of history No.7/history No.8	L byte: History No.7, H byte: History No.8
Reading of speed command		$006D_H$	Read speed command	0 to ±20000 (Max. with ±20000) Also accessible from remote register
Writing of speed command		$00ED_H$	Write speed command	
Reading of function code		0000_H to 0063_H	Read or write link Nos. 0 to 255 by the combinations with link parameter extension setting.	For the link No./data format, refer to Chapter 4, Section 2 "Function Code List."
Writing of function code Note 2		0080_H to $00E3_H$		
Reset alarm		$00FD_H$	9696_H: Reset the alarm.	Only during link operation
Link parameter extension setting	Read	$007F_H$ Note 3	For selection of the area accessed by reading/writing function codes 0000_H : Link Nos. 0 to 99 0001_H : Link Nos. 100 to 199 0002_H : Link Nos. 200 to 255	
	Write	$00FF_H$ Note 3		

Note 1: Link operation selection [LE] is switched by switching the operation mode from CC-Link, as follows.

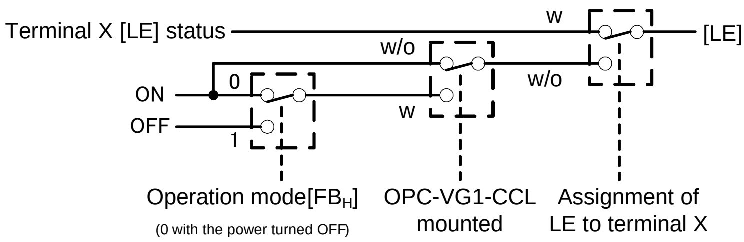


Figure 6.7.16 Link Operation Selection [LE] with CC-Link Used

Note 2: Writing a function code sets a value given by adding the offset value of 80_H to the link No.

Example: Function code "F03: M1 maximum speed" Link № 51_H

The command code for reading the function code is "51_H". The function code for writing function code is "$D1_H$", which is obtained by adding the offset value of 80_H.

Note 3: With code 007F, read the extension code setting. With code 00FF, write extension code setting.

Table 6.7.19 Response Code (o32=0)

Code number	Item	Description
0000_H	Normal (No error)	Command code execution normally completed
0001_H	Write mode error	・Function code was written while the inverter was running ・Function code was written while EEPROM was being written. ・Function code was written at the time of transmission error. ・S code was written when upper link was enabled. ・Function code was written in a mode where edition is not permitted.
0002_H	Function code selection error	An inaccessible link No. was set.
0003_H	Out of setting range	Set data is out of changeable range.

6.7.9 1 X mode with 1 station occupied (o32=0)

6.7.9.1 Remote I/O signal in 1 X mode (o32=1)

Table 6.7.20 Remote Output (Master -> FRENIC-VG)

Device No.	Signal name	Description	
RYn0	Run forward command	OFF: Stop command ON: Run forward command (counterclockwise viewed from the motor axis direction)	Simultaneously turning RYn0 and RYn1 ON is functionally equivalent to a stop command.
RYn1	Run reverse command	OFF: Stop command ON: Run reverse command (counterclockwise viewed from the motor axis direction)	
RYn2	Terminal X1 function	Multiple speed (SS1/SS2/SS4/SS8) is selectable by combinations of terminals.	Functions to be provided by factory default are shown at left. Setting terminal X function can change the function of terminal X. (Function code E01-E10)
RYn3	Terminal X2 function		
RYn4	Terminal X3 function		
RYn5	Terminal X4 function		
RYn6	Terminal X5 function	ASR and acceleration/deceleration (RT1/RT2) can be selected by combinations of terminals.	
RYn7	Terminal X6 function		
RYn8	Terminal X8 function	Works as error reset (RST) when turned ON.	
RYn9	Terminal X7 function	Works as coast to stop command (BX) when turned ON. (output shut down on the secondary side)	
RYnA	Terminal X9 function	External alarm OH2 is generated when turned ON.	
RYnB	Terminal X11 function	Command assigned with inverter function code E10	
RYnC	Monitor command	Turning the monitor command (RYnC) ON specifies a monitored value for monitored values 1 to 6, turning the "Monitoring" signal (RXnC) ON. Note 1	
RYnD	Speed setting command (RAM)	Turning the speed setting command (RYnD) ON writes the speed command (RWwn+1) into the inverter's volatile memory (RAM). Note 2 Upon completion of writing, the speed setting completed signal (RXnD) is turned ON.	
RYnE	Not used.	-	
RYnF	Command code execution request	Turning the command code request signal (RYnF) ON executes processing corresponding to command codes specified in command codes 1 to 6. Note 3 After execution of those command codes, the "Command code execution completed" signal (RXnF) is turned ON. If a command code execution error occurs, the response code (RWrn+2) is set to a value other than "0".	
RY(n+1)0 | RY(n+1)3	Not used.	Should be turned OFF.	
RY(n+1)4	Terminal X12 function	Command assigned with inverter function code E11	
RY(n+1)5	Terminal X13 function	Command assigned with inverter function code E12	
RY(n+1)6	Terminal X14 function	Command assigned with inverter function code E13	
RY(n+1)7 | RY(n+1)9	Not used.	Should be turned OFF.	
RY(n+1)A	Alarm reset request flag	When an inverter alarm is generated, turning the alarm reset request flag ON resets the inverter, turning the alarm status flag (RX(n+1)A) OFF. Note 4	
RY(n+1)B | RY(n+1)F	Not used.	Should be turned OFF.	

n: Value determined by a station address

Note 1: While the "Monitor command" (RYnC) is ON, the monitored values are constantly updated.

Note 2: While the "Speed setting" (RYnD) is ON, the value of speed command (RWwn+1) is constantly reflected on the speed.

Note 3: When the command execution request is switched from OFF to ON, the command code is executed only once.

Note 4: When the "Alarm reset request flag" signal (RY(n+1)A) is ON, alarm reset is constantly executed. After the release of the alarm, this signal should therefore be turned OFF. Alarm reset can be done regardless of operation mode.

Table 6.7.21 Remote Input (FRENIC-VG->Master)

Device No.	Signal name	Description	
RXn0	Running forward	OFF: Except running in forward direction (Stopped or Rotating in reverse direction) ON: Rotating in forward direction	
RXn1	Running reverse	OFF: Except running in reverse direction (Stopped or Rotating in forward direction) ON: Rotating in reverse direction	
RXn2	Terminal Y1 function	With speed. Turned ON with (N-EX)	Functions to be provided by factory default are shown at left. Setting terminal Y function can change output contents.
RXn3	Terminal Y2 function	Speed match. Turned ON with (N-AG1).	
RXn4	Terminal Y3 function	Arrival at speed. Turned ON with (N-AR).	
RXn5	Terminal Y4 function	Speed detection 1. Turned ON with (N-DT1)	
RXn6	Terminal Y5 function	Operation preparation completed. Turned ON with (RDY).	
RXn7	Alarm relay output	Inverter's protection function is operated, and the signal is turned ON when output stops.	
RXn8	Terminal Y11 function	Status assigned with inverter function E20	
RXn9	Terminal Y12 function	Status assigned with inverter function E21	
RXnA	Terminal Y13 function	Status assigned with inverter function E22	
RXnB	Terminal Y14 function	Status assigned with inverter function E23	
RXnC	Monitoring	The "Monitoring " signal (RYnC) is turned OFF when turning the "Monitor command" (RYnC) ON specifies a monitored value for monitored values 1 to 6. Turning the "Monitor command" (RYnC) OFF turns this signal OFF.	
RXnD	Speed setting completed (RAM)	This signal is turned ON when turning the "Speed setting command" signal (RYnD) ON writes a speed command into the inverter's volatile memory (RAM). Turning the "Speed setting command" signal (RYnD) OFF turns the "Speed setting completed" signal (RXnD) OFF.	
RXnE	Not used.	-	
RXnF	Command code Execution completed	This signal is turned ON when turning the "Command code execution request" (RYnF) ON has completed the execution of processing corresponding to command codes 1 to 6. Turning the "Command code execution request" (RYnF) OFF turns the "Command code execution completed" signal (RXnF) OFF.	
RX(n+1)0 | RX(n+1)9	Not used.	-	
RX(n+1)A	Alarm status flag	This signal is turned ON when an inverter alarm (alarm other than Er-3) is generated.	
RX(n+1)B	Remote station ready	This signal is turned ON when completing initial data setting places the inverter in the ready status after the inverter has been powered ON or the hardware has been reset. (This signal is used for interlocking with reading or writing from/to the master unit.) This signal is turned OFF concurrently when the "Alarm state flag" (RX(n+1)A) is turned ON if the inverter alarm is generated.	
RX(n+1)C | RX(n+1)F	Not used.	-	

n: Value determined by a station address

Note 1: When the condition setting switch of the master unit for "Input data status of data link error station (SW4)" is set to ON, input data from the data link error station is retained in the status just before the occurrence of the error. Note that this remains signals, e.g., remote station ready, etc., ON even if an inverter alarm is generated.

Note 2: If an operation command is output from the master when the instruction via communications is disabled (H30=0, 1, or [LE] instruction OFF), the inverter does not run. However, the input signals "Speed setting completed" and "Command code execution completed" signal are turned ON. Care must be taken for this. In addition, "I/O check" can be performed on the keypad to confirm whether input signal is issued from the link (COM), even if the command via communications is disabled.

6.7.9.2 Remote register signal in 1 X mode (o32=1)

Table 6.7.22 Remote Register in 1 X Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWwn+0	Monitor code 2/ Monitor code 1	Write the codes (listed in Table 6.7.24) of monitor items to be referred to. After that, turning the RYC ON stores the value of those monitor items into RWrn+0 and RWrn+1.	The lower and upper bytes correspond to monitor codes 1 and 2, respectively.
RWwn+1	Speed command/ torque command *1	Specify the speed command (for speed control) or torque command (for torque control). When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	0 to ±20000 (Nmax with ±20000 in the speed command, and 0.01%/1d in the torque command) Supporting of writing data into volatile memory (RAM) only
RWwn+2	Command code 1 (485 No. system)	Command codes (Table 6.7.25) are set to execute rewriting of operation mode, reading of inverter function codes, writing, reference of alarm history, alarm reset, etc. After register writing is completed, turning RYnF ON executes the commands. Completion of command execution turns RXnF ON.	
RWwn+3	Write data	If data is to be written with RWwn+2 command code used, set the data in this register. After writing the RWwn+2 command codes and setting this register, turn the RYnF ON. If no write data is required, zero "0" should be written.	All data can be written into volatile memory (RAM) only. Execute "H02 All Save function", if necessary, to write data into non-volatile memory (EEPROM).

n: Value determined by a station address

*1 With H41 (torque command selection) = 4 (link enabled), RWwn+1 = torque command value. With H41≠4, RWwn+1 = speed command value.

Table 6.7.23 Remote Register in 1 X Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWrn+0	Monitored value 1	When RYnC is turned ON, the monitored value specified with monitor code 1 is output.	
RWrn+1	Monitored value 2	When RYnC is turned ON, the monitored value specified with monitor code 2 is output.	
RWrn+2	Response code	Response codes corresponding to RWwn+2 command code (refer to Table 6.7.26) are set. For normal response, "0" is set. If data is incorrect, the codes are set to a value other than "0".	
RWrn+3	Read data	If the command code has normally been executed, the response data for that command (specified by the command code) is automatically written.	

n: Value determined by a station address

6.7.9.3 Monitor code/command code (o32=1 to 4)

Table 6.7.24 Monitor Code List (With o32 = 1 to 4)

Code No.	Monitor item	Unit	Remarks
00_H	RWr0, RWr4-7: No monitoring (Fixed to 0) RWr1: Motor speed	—	
01_H	Output frequency	0.01 Hz	
02_H	Output current	0.01 A/0.1 A	Rating of less than 75 kW: Unit of 0.01 Rating of 75 kW or more: Unit of 0.1
03_H	Output voltage	0.1 V	
05_H	Speed setting	1 r/min	
06_H	Rotating speed	1 r/min	
07_H	Calculated torque	0.1%	
08_H	DC link bus voltage	0.1 V	
09_H | $0A_H$	No monitoring (Fixed to 0)	—	
$0B_H$	Output current peak value	0.01 A/0.1 A	Rating of less than 75 kW: Unit of 0.01 Rating of 75 kW or more: Unit of 0.1
$0D_H$	Power consumption (input power)	0.01 kW/0.1 kW	
$0E_H$	Motor output	0.01 kW/0.1 kW	
$0F_H$	Operation command	—	
10_H	Output terminate status	—	
11_H	Motor load (torque current)	0.1%	
12H	Flux command	0.01%	
13H	Position pulse	1 pulse	
14H	Cumulative power-ON time	1 hr	
15H | 16H	No monitoring (Fixed to 0)	—	
17H	Cumulative motor 1 run time	1 hr	
18H	Motor load factor	0.1%	
19H	Input watt-hour	1 kWhr	
20H	Torque command	0.1%	
21H	Torque current command	0.1%	
22H	Motor output	0.01 kW/0.1 kW	Rating of less than 75 kW: Unit of 0.01 Rating of 75 kW or more: Unit of 0.1
23H | 33H	No monitoring (Fixed to 0)	—	
34H	PID command value	0.1%	
35H	PID feedback	0.1%	
36H	PID deviation	0.1%	

Detailed description on operation command

b15							b8	b7							b0
RST	X14	X13	X12	X11	X9	X8	X7	X6	X5	X4	X3	X2	X1	REV	FWD

Figure 6.7.17

Detailed description on output terminate status

b15							b8	b7							b0
Y18	Y17	Y16	Y15	Y14	Y13	Y12	Y11	-	-	-	Y5A	Y4	Y3	Y2	Y1

- : Empty (Fixed to 0)

Figure 6.7.18

Table 6.7.25 Command Code List (With o32 = 1 to 4)

Item	Code number	Description	Remarks
Reading of function code	0000$_H$ to FF63$_H$	Reads or writes data from/to inverter's function codes.	Inverter's function codes should be specified in the format shown in Table 6.7.27.
Writing of function code	0080$_H$ to FFE3$_H$	Writes data into inverter's function codes.	Data cannot be written into function code H01 or P02.
Reading of operation mode	007B$_H$	0000$_H$: Link operation (CC-Link) 0001$_H$: Terminal command for external drive 0002$_H$: Keypad operation 0003$_H$: Others	0000$_H$: [LE]=ON and H30≠0 0001$_H$: ([LE]=OFF or H30=0) and F02=1 0002$_H$: ([LE]=OFF or H30=0) and F02=0 0003$_H$: Others
Writing of operation mode	00FB$_H$	0000$_H$: Link operation (CC-Link) 0001$_H$: Terminal command for external drive 0002$_H$: Keypad operation	0000$_H$: Writing of H30=3, [LE]=ON *1 0001$_H$: Writing of H30=0, F02=1 0002$_H$: Writing of H30=0, F02=1, F01=0
Alarm code Reading of latest and last codes	0074$_H$	Alarm content Reading of latest and last codes.	Lower byte: Latest alarm code Higher byte: Last alarm code
Alarm code Reading of 2nd last and 3rd last codes	0075$_H$	Alarm content Reading of 2nd last and 3rd last codes.	Lower byte: 2nd last alarm code Higher byte: 3rd last alarm code
Alarm code Reading of 4th last and 5th last codes	0076$_H$	Alarm content Reading of 4th last and 5th last codes.	Lower byte: 4th last alarm code Higher byte: 5th last alarm code
Alarm code Reading of 6th last and 7th last codes	0077$_H$	Alarm content Reading of 6th last and 7th last codes.	Lower byte: 6th last alarm code Higher byte: 7th last alarm code
Reading of speed command	006D$_H$	Reads out the speed command value. (Monitoring of frequency set via CC-Link)	The allowable setting range is from 0 to +/-20000. Specify the ratio of the frequency relative to the maximum frequency (defined by F03 in Hz) being assumed as 20000.
Writing of speed command	00ED$_H$	Write speed command	
Clear alarm history	00F4$_H$	9696$_H$: Clears alarm history.	
Function code initialization	00FC$_H$	9696$_H$: H03=1	
Inverter reset	00FD$_H$	9696$_H$: Clear alarm	

*1 Assignment of [LE] to terminal X gives priority to [LE] via terminal X.

Table 6.7.26 Response Code List (With o32 = 1 to 4)

Code number	Item	Description
00$_H$	Normal (No error)	Command code execution normally completed
01$_H$	Write mode error	・Function code was written while the inverter was running ・Function code was written while E2PROM was being written. ・Function code was written at the time of transmission error. ・S code was written when upper link (loader etc.) was enabled. ・Function code was written in a mode where edition is not permitted.
02$_H$	Function code selection error	・Accessed to a nonexistent function code ・Data was written to a read only function code.
03$_H$	Out of setting range	Set data is out of changeable range.

Chap. 6 CONTROL OPTIONS

Table 6.7.27 Function Code Selection by Command Code (With o32=1 to 4)

<table>
<tr><td colspan="8">(bit 15)</td><td></td><td colspan="7">(bit 0)</td></tr>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">Identification code (table below)</td><td>0: Read
1: Write</td><td colspan="7">Function code No. (low-order 2 digits）*1
00 to 99 (00h to 63h)</td></tr>
</table>

*1 Even when a function code No. exceeds 99 (example: E101, etc.) is specified, set low order 2 digits.
(Example: the code No. is E101 -> Identification of function code "E1": 1Eh, function code No.: 01h)

Function code		Type Code	Group name	Remarks
F		00h	Fundamental function	
E	E01 to E99	01h	Terminal functions	
E1	E100 to E199	1Eh		
C		02h	Control function	
P		03h	Motor parameter M1	
H	H01 to H99	04h	High performance function	
H1	H100 to H199	1Fh		
H2	H200 to H299	20h		
A	A01 to A99	05h	Motor parameters M2 and M3	
A1	A100 to A199	24h		
o	o01 to o99	06h	Option function	
o1	o100 to o199	25h		
S		07h	Communication command function	
M	M01 to M99	08h	Communication monitor function	Read only
M1	M100 to M199	29h		
M2	M200 to M299	2Ah		
L		09h	Elevator function	
U	U01 to U99	0Bh	User function	
U1	U101 to U199	27h		
SF		28h	Safety function	Read only

Function code selection by command codes

- Example 1: When reading of M126 "Cumulative M1 motor run time" is selected,
  identification code M1->29h, function code No. 26->1Ah, write/read bit -> 0 => command code ＝ <u>291Ah</u>
- Example 2: S08 "Acceleration time" is specified by writing it
  Identification code S->07h, function code No. 7 -> 07h, read/write bit -> 1 □ Command code = <u>0787h</u>

6.7.10 2 X mode with 1 station occupied (o32=2）

6.7.10.1 Remote I/O signal in 2 X mode (o32=2)

o32=1 Same as the case of 1 X mode with 1 station occupied

6.7.10.2 Remote register signal in 2 X mode (o32=2)

Table 6.7.28 Remote Register in 2 X Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWwn+0	Monitor code 2/ Monitor code 1	Write the codes (listed in Table 6.7.24) of monitor items to be referred to. After that, turning the RYC ON stores the value of those monitor items into RWrn+0 and RWrn+1.	The lower and upper bytes correspond to monitor codes 1 and 2, respectively.
RWwn+1	Speed command/ torque command*1	Specify the speed command (for speed control) or torque command (for torque control). When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	0 to ±20000 (Nmax with ±20000 in the speed command, and 0.01%/1d in the torque command) Supporting of writing data into volatile memory (RAM) only
RWwn+2	Command code 1 (485 No. system)	Command codes (Table 6.7.25) are set to execute rewriting of operation mode, reading of inverter function codes, writing, reference of alarm history, alarm reset, etc. After register writing is completed, turning RYnF ON executes the commands. Completion of command execution turns RXnF ON.	
RWwn+3	Write data	If data is to be written with RWwn+2 command code used, set the data in this register. After writing the RWwn+2 command codes and setting this register, turn the RYnF ON. If no write data is required, zero "0" should be written.	All data can be written into volatile memory (RAM) only. Execute "H02 All Save function", if necessary, to write data into non-volatile memory (EEPROM).
RWwn+4	Monitor code 3	Specify the code (listed in Table 6. 7.24) of monitor item to be referred to. After that, turning the RYnC ON stores the data of the monitor item into the RWrn+□. (□ denotes any of the corresponding register numbers 4 to 7.)	
RWwn+5	Monitor code 4		
RWwn+6	Monitor code 5		
RWwn+7	Monitor code 6		

n: Value determined by a station address

*1 With H41 (torque command selection) = 4 (link enabled), RWwn+1 = torque command value. With H41≠4, RWwn+1 = speed command value.

Table 6.7.29 Remote Register in 2 X Mode (FRENIC-VG->Master)

Address	Signal name	Description	Remarks
RWrn+0	Monitored value 1	When RYnC is turned ON, the monitored value specified with monitor code 1 is output.	
RWrn+1	Monitored value 2	When RYnC is turned ON, the monitored value specified with monitor code 2 is output.	
RWrn+2	Response code	Response codes corresponding to RWwn+2 command code (refer to Table 6.7.26) are set. For normal response, "0" is set. If data is incorrect, the codes are set to a value other than "0".	
RWrn+3	Read data	If the command code has normally been executed, the response data for that command (specified by the command code) is automatically written.	
RWrn+4	Monitored value 3	Outputs data of the monitor items specified with monitor codes 3 to 6 when RYnC is ON.	Available with 2 X setting
RWrn+5	Monitored value 4		
RWrn+6	Monitored value 5		
RWrn+7	Monitored value 6		

n: Value determined by a station address

6.7.11 4 X mode with 1 station occupied (o32=3）

6.7.11.1 Remote I/O signal in 4 X mode (o32=3)

o32=1 Same as the case of 1 X mode with 1 station occupied

6.7.11.2 Remote register signal in 4 X mode (o32=3)

Table 6.7.30 Remote Register in 4 X Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWwn+0	Monitor code 2/ Monitor code 1	Specify the codes (listed in Table 6.7.24) of monitor items to be referred to. After that, turning the RYnC ON stores the value of those monitor items into RWrn+0 and RWrn+1.	The lower and upper bytes correspond to monitor codes 1 and 2, respectively.
RWwn+1	Speed command	Specify the speed command (for speed control) or torque command (for torque control). When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	0 to ±20000 (Nmax with ±20000) Supporting of writing data into volatile memory (RAM) only
RWwn+2	Command code 1 (485 No. system)	Command codes (Table 6.7.25) are set to execute rewriting of operation mode, reading of inverter function codes, writing, reference of alarm history, alarm reset, etc. After register writing is completed, turning RYnF ON executes the commands. Completion of command execution turns RXnF ON.	
RWwn+3	Write data	If data is to be written with RWwn+2 command code used, set the data in this register. After writing the RWwn+2 command codes and setting this register, turn the RYnF ON. If no write data is required, zero "0" should be written.	All data can be written into volatile memory (RAM) only. Execute "H02 All Save function", if necessary, to write data into non-volatile memory (EEPROM).
RWwn+4	Monitor code 3	Specify the code (refer to Table 6.7.24) of monitor item to be referred to. After that, turning the RYnC ON stores the data of the monitor item into the RWrn+□. (□ denotes any of the corresponding register numbers 4 to 7.)	
RWwn+5	Monitor code 4		
RWwn+6	Monitor code 5		
RWwn+7	Monitor code 6		
RWwn+8	Alarm history	Specify an alarm code to be read by writing 0000, 0100, 0200, 0300, 0400, 0500, 0600, 0700, 0800, 0900, or 0A00 into RWwn+8, corresponding to the latest, 2nd last, 3rd last, 4th last, 5th last, 6th last, 7th last, 8th last, 9th last, or 10th last error, respectively. (Don't care for the lower 8 bits.) The content of the specified alarm code and its related information are stored in RWr+8, 9, A, B, and C. For 0Bxx or later, the alarm codes are responses fixed to 0000.	Latest: 0000 Last: 0100 2nd last: 0200 ↓ 7th last: 0700 8th last: 0800 9th last: 0900 10th last: 0A00
RWwn+9 | RWwn+B	Not used.	Should be set to 0000h.	
RWwn+C	Torque command value	Specify the torque command. When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	
RWwn+D | RWwn+F	Not used.	Should be set to 0000h.	

n: Value determined by a station address

Table 6.7.31 Remote Register in 4 X Mode (FRENIC-VG->Master)

Address	Signal name	Description	Remarks
RWrn+0	Monitored value 1	When RYnC is turned ON, the monitored value specified with monitor code 1 is output.	
RWrn+1	Monitored value 2	When RYnC is turned ON, the monitored value specified with monitor code 2 is output.	
RWrn+2	Response code	Response codes corresponding to RWwn+2 command code (refer to Table 6.7.26) are set. For normal response, "0" is set. If data is incorrect, the codes are set to a value other than "0".	
RWrn+3	Read data	If the command code has normally been executed, the response data for that command (specified by the command code) is automatically written.	
RWrn+4	Monitored value 3	Outputs data of the monitor items specified with monitor codes 3 to 6 when RYnC is ON.	
RWrn+5	Monitored value 4		
RWrn+6	Monitored value 5		
RWrn+7	Monitored value 6		
RWrn+8	Alarm code	The content of the alarm code specified in RWwn+8 is automatically written into the lower 8 bits of RWrn+8. The upper 8 bits of RWwn+8 will be echoed back into the upper 8 bits of RWrn+8.	For the alarm code, refer to Chapter 4, Section 4.2.4.2, Type [14].
RWrn+9	Motor speed at the time of latest alarm	The motor speed with the alarm, specified with RWwn+8, generated is stored. For alarms other than the latest one, response is given with "0".	0 to ±20000 (Nmax with ±20000) Supported only for the latest alarm.
RWrn+A	Output current at the time of latest alarm.	This register stores the output current applied at the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Rating of less than 75 kW: Unit of 0.01 A Rating of 75 kW or more: Unit of 0.1 A
RWrn+B	Output voltage at the time of latest alarm.	This register stores the output voltage applied at the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Unit of 0.1 V. "0" except for the latest alarm.
RWrn+C	Cumulative power-ON time at the latest alarm occurrence	This register stores the cumulative power-ON time elapsed until the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Unit: 1 h
RWrn+D | RWrn+F	Not used.	-	

n: Value determined by a station address

Chap. 6

CONTROL OPTIONS

6.7.12 8 X mode with 1 station occupied (o32=4)

6.7.12.1 Remote I/O signal in 8 X mode (o32=4)

o32=1 Same as the case of 1 X mode with 1 station occupied

6.7.12.2 Remote register signal in 8 X mode (o32=4)

Table 6.7.32 Remote Register Signal in 8 X Mode (Master -> FRENIC-VG)

Address	Signal name	Description	Remarks
RWwn+0	Monitor code 2/ Monitor code 1	Specify the codes (listed in Table 6.7.24) of monitor items to be referred to. After that, turning the RYnC ON stores the value of those monitor items into RWrn+0 and RWrn+1.	The lower and upper bytes correspond to monitor codes 1 and 2, respectively.
RWwn+1	Speed command	Specify the speed command (for speed control) or torque command (for torque control). When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	0 to ±20000 (Nmax with ±20000) Supporting of writing data into volatile memory (RAM) only
RWwn+2	Command code 1 (485 No. system)	Command codes (Table 6.7.25) are set to execute rewriting of operation mode, reading of inverter function codes, writing, reference of alarm history, alarm reset, etc. After register writing is completed, turning RYnF ON executes the commands. Completion of command execution turns RXnF ON.	
RWwn+3	Write data	If data is to be written with RWwn+2 command code used, set the data in this register. After writing the RWwn+2 command codes and setting this register, turn the RYnF ON. If no write data is required, zero "0" should be written.	All data can be written into volatile memory (RAM) only. Execute "H02 All Save function", if necessary, to write data into non-volatile memory (EEPROM).
RWwn+4	Monitor code 3	Specify the code (refer to Table 6.7.24) of monitor item to be referred to. After that, turning the RYnC ON stores the data of the monitor item into the RWrn+□. (”□ denotes any of the corresponding register numbers 4 to 7.)	
RWwn+5	Monitor code 4		
RWwn+6	Monitor code 5		
RWwn+7	Monitor code 6		
RWwn+8	Alarm history	Specify an alarm code to be read by writing 0000, 0100, 0200, 0300, 0400, 0500, 0600, 0700, 0800, 0900, or 0A00 into RWwn+8, corresponding to the latest, 2nd last, 3rd last, 4th last, 5th last, 6th last, 7th last, 8th last, 9th last, or 10th last error, respectively. (Don't care for the lower 8 bits.) The content of the specified alarm code and its related information are stored in RWrn+8, 9, A, B, and C. For 0Bxx or later, the alarm codes are responses fixed to 0000.	Latest: 0000 Last: 0100 2nd last: 0200 ↓ 7th last: 0700 8th last: 0800 9th last: 0900 10th last: 0A00
RWwn+9 | RWwn+B	Not used.	Should be set to 0000h.	
RWwn+C	Torque command value	Specify the torque command. When the command has been set in this register, turning RYnD ON reflects the command on the inverter. Completion of the reflection turns RXnD ON.	
RWwn+D | RWwn+F	Not used.	Should be set to 0000h.	
RWwn+10	Command code 2	Use these registers in the same way as RWwn+2. After writing into these registers, turning the RYnF ON executes these command codes in the order of RWwn+2, 10, 12, 14, 16, and 18. Upon completion of execution of RWwn+18, the RXnF is turned ON. To nullify the execution of RWwn+10 to 18, $FFFF_H$ should be written into these registers.	

Address	Signal name	Description	Remarks
RWwn+11	Write data 2	If data is to be written with RWwn+10, 12, 14, 16, and 18 command codes used, set the data in this register. RWwn+10, 12, 14, 16, and 18 correspond to 11, 13, 15, 17, and 19, respectively. Set the register corresponding to the command codes of RWwn+10, 12, 14, 16, and 18, and then turn RYnF ON. If write codes are unnecessary, "0" should be written.	
RWwn+12	Command code 3	Same as command code 2	
RWwn+13	Write data 3	Same as write data 2	
RWwn+14	Command code 4	Same as command code 2	
RWwn+15	Write data 4	Same as write data 2	
RWwn+16	Command code 5	Same as command code 2	
RWwn+17	Write data 5	Same as write data 2	
RWwn+18	Command code 6	Same as command code 2	
RWwn+19	Write data 6	Same as write data 2	
RWwn+1A | RWwn+1F	Not used.	Should be set to 0000h.	

n: Value determined by a station address

Table 6.7.33 Remote Register in 8 X Mode (FRENIC-VG->Master)

Address	Signal name	Description	Remarks
RWrn+0	Monitored value 1	When RYnC is turned ON, the monitored value specified with monitor code 1 is output.	
RWrn+1	Monitored value 2	When RYnC is turned ON, the monitored value specified with monitor code 2 is output.	
RWrn+2	Response code	Response codes corresponding to RWwn+2 command code (refer to Table 6.7.26) are set. For normal response, "0" is set. If data is incorrect, the codes are set to a value other than "0".	
RWrn+3	Read data	If the command code has normally been executed, the response data for that command (specified by the command code) is automatically written.	
RWrn+4	Monitored value 3	Outputs data of the monitor items specified with monitor codes 3 to 6 when RYnC is ON.	
RWrn+5	Monitored value 4		
RWrn+6	Monitored value 5		
RWrn+7	Monitored value 6		
RWrn+8	Alarm code	The content of the alarm code specified in RWwn+8 is automatically written into the lower 8 bits of RWrn+8. The upper 8 bits of RWwn+8 will be echoed back into the upper 8 bits of RWrn+8.	For the alarm code, refer to Chapter 4, Section 4.2.4.2, Type [14].
RWrn+9	Motor speed at the time of latest alarm	The motor speed with the alarm, specified with RWwn+8, generated is stored. For alarms other than the latest one, response is given with "0".	0 to ±20000 (Nmax with ±20000) Supported only for the latest alarm.
RWrn+A	Output current at the time of latest alarm.	This register stores the output current applied at the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Rating of less than 75 kW: Unit of 0.01 A Rating of 75 kW or more: Unit of 0.1 A
RWrn+B	Output voltage at the time of latest alarm.	This register stores the output voltage applied at the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Unit of 0.1 V. "0" except for the latest alarm.
RWrn+C	Cumulative power-ON time at the latest alarm occurrence	This register stores the cumulative power-ON time elapsed until the occurrence time of the alarm specified in RWwn+8. "0" is written except for the latest alarm.	Unit: 1 h
RWrn+D | RWrn+F	Not used.	-	-

Address	Signal name	Description	Remarks
RWwn+10	Response code 2	Turning the RYnF ON stores the response code (Table 6.7.26) corresponding to the command code specified in RWwn+10, 12, 14, 16, and 18. If the command code has normally been executed, zero (0) is automatically written; if any error has occurred during processing of the command code, any value other than zero is written.	Enabled with 8X setting
RWwn+11	Read data 2	If the command code specified in RWw10, 12, 14, 16, or 18 has normally been executed, the response data for that command code is automatically written.	
RWwn+12	Response code 3	Same as command code 2	
RWwn+13	Read data 3	Same as write data 2	
RWwn+14	Response code 4	Same as command code 2	
RWwn+15	Read data 4	Same as write data 2	
RWwn+16	Response code 5	Same as command code 2	
RWwn+17	Read data 5	Same as write data 2	
RWwn+18	Response code 6	Same as command code 2	
RWwn+19	Read data 6	Same as write data 2	
RWwn+1A | RWwn+1F	Not used.	-	

n: Value determined by a station address

6.7.13 Link function

The availability (REM/LOC/COM) of the command data (S area) is switched by function code H30 "Link operation" and X function "24: link operation selection [LE]". Be familiar with this together with the control block (refer to Chapter 4).

Writing the standard function codes (F, E, C, P, H, A, o, U, and L) from a link is controlled by function code H29 "link function code protection" and X function "23: link edition permission command [WE-LK]". Be failiar with this together with the control block (refer to Chapter 4).

6.7.13.1 Link command permission selection

Performing the operation of the inverter via CC-Link requires switching of the mode to the link command permission mode to select a command (other than 0) via communications by function code H30 "Link operation". (The system configuration is so flexible that switching a value selected for "link operation", for example, can select an operation command on the terminal block and a speed command through communications).

Table 6.7.34

Condition			Mode
Assignment status of 24: link operation selection [LE] to function codes E01 to E13 "X function selection"	Not assigned (Factory default)	Command code FB_H (Operation mode) = 0	Link command permission mode
		Command code FB_H (Operation mode) = 1.2	Link command no permission mode
	Assigned	When applicable terminal X is ON	Link command permission mode
		When applicable terminal X is OFF	Link command no permission mode

Table 6.7.35

H30 setting	Link command permission mode		Link command no permission mode	
	Command data (S01 to S05, S08 to S17)	Operation command (S06)	Command data (S01 to S05, S08 to S17)	Operation command (S06)
0	×	×	×	
1	○	×	×	
2	×	○	×	
3	○	○	×	

O: Command enabled via communications, X: Command disabled via communications (operated by the command from terminal block or keypad)

Note 1: S code (command data/operation data) can be written even in the link command no permission status.

Note 2: Writing data into function code S08 "Acceleration time"/S09 "Deceleration time" is independent of link command permission mode and function code H30 "link operation". The data is always overwritten into function code F07/F08 "acceleration/deceleration time".

6.7.13.2 Link edition permission selection

Confirmation (reading) of function codes via CC-Link is always enabled. For changing (writing) function codes, however, function code H29 "link function code protection" must be write-enabled (=0) in the link edition permission mode. (It is put in "link edition permission mode" by factory default.)

Table 6.7.36

Condition			Mode
Assignment status of 23: link edition permission command [WE-LK] to function codes E01 to E13 "X function selection"	Not assigned (Factory default)		Link edition permission mode
	Assigned	When applicable terminal X is ON	Link edition permission mode
		When applicable terminal X is OFF	Link edition no permission mode

Table 6.7.37

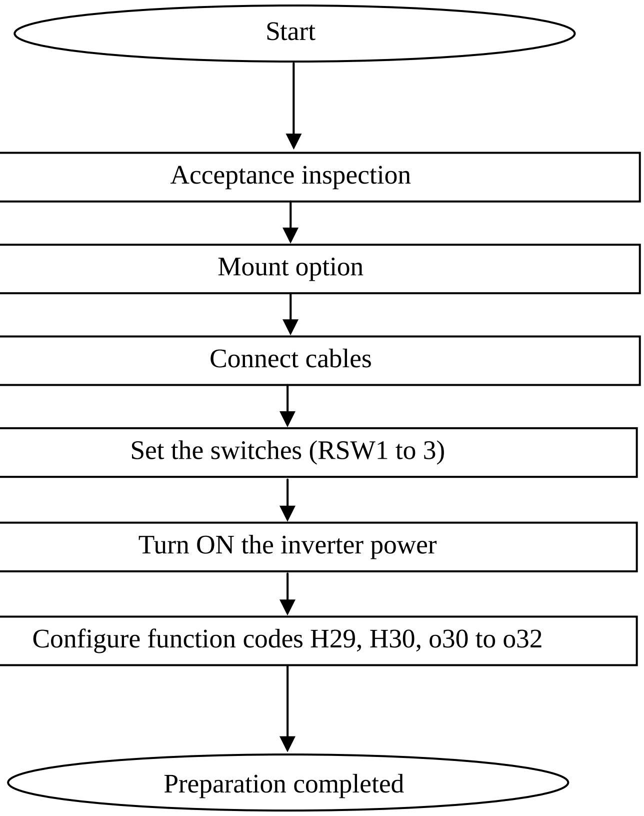
H29 setting	Link edition permission mode	Link edition no permission mode
0	○	×
1	×	×

O: Function codes (F, E, C, P, H, A, o, L, and U) are write-enabled, X: Function codes are write-disabled

Note 1: Wiring into S codes (command data, operation data, etc.) is always enabled regardless of this function.

6.7.14 Setting-up procedure

The following flow shows the initial setting-up procedure for the CC-Link option, using the procedure given in this chapter.



Now the inverter is ready to run via CC-Link.

After the CC-Link master becomes ready, run the master to operate the inverter via CC-Link.

6.7.15 Application program examples

6.7.15.1 System configuration

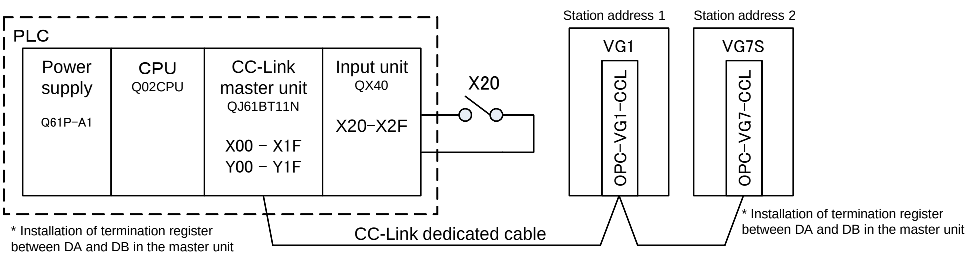


Figure 6.7.19 System Configuration

6.7.15.2 Master unit outline

This section outlines the CC-Link master unit necessary for execution of application program examples. For details, refer to Mitsubishi Electric CC-Link System Master Local Unit user's manual (volume on details).

6.8 17-bit High Resolution ABS Interface Card

6.8.1 Product overview

This option allows FRENIC-VG to interface with the high resolution serial PG manufactured by Tamagawa Seiki Co., Ltd.

(1) 17-bit high resolution ABS interface card

Available for induction motor/synchronous motor control PG serial interface (speed/position feedback)

Available for machine axis serial PG interface (position feedback) (available in the near future)

For the connectable PG format, refer to Table 6.8.1.

(2) Pulse frequency dividing output

Feedback signals from serial PG are frequency-divided to output pulse signals.

⚠CAUTION
・ This option and some of other options cannot be mounted at the same time. If this option is combined with an option that cannot be mounted at the same time, operation procedure error Er6 is output.

6.8.2 Model and specifications

6.8.2.1 Model

Model content: OPC-VG1-SPGT

VG1 — Mounted inverter name VG1 -> FRENIC-VG

SPGT — Option name: SPGT -> High resolution serial PG Interface option

Accessories

Three spacers

Terminating resistance (220 Ω, 1/4 W)

⚠CAUTION
・Do not use the product that is damaged or lacking parts. **Doing so could cause injury or damage.**

6.8.2.2 Specifications

Table 6.8.1 Hardware Specifications

Item	Specifications
Applicable PG model	Serial PG manufactured by Tamagawa Seiki Co., Ltd. TS5667N253/TS5667N650 (17-bit absolute encoder)
Allowable revolution speed	TS5667N253: 3,000 r/min TS5667N650: 1,500 r/min
Power supply for PG	Power is supplied from this option board to PG. Voltage: 5 V ± 5 %, and current: 70 mA, Typ. (during normal operation)
Allowable wire length/connection	50 m max. Wire is short when the voltage drop is high. The following distribution cables have been prepared, but are arranged separately. WSC-P06P05-W (5 m) WSC-P06P10-W (10 m) WSC-P06P15-W (15 m) WSC-P06P20-W (20 m) If a cable required is longer than 20 m, contact us separately. If the cable is longer than 50 m, the attached terminating resistance must be installed.
Power supply for option board	The power is supplied from the PCB of the main unit (15 V). Connect the power harness to CN12 of the main unit.
Pulse frequency dividing output	5V Line driver A-/B-phase signal output (FA+/-, FB+/-) Signals obtained by frequency-dividing 17-bit serial data are output. Maximum frequency of 1 MHz. Note that the frequency dividing rate is "function code E109/E110". *Calculation example of output frequency (E109=1000, E110=32767, P28=32768, Serial PG installation axis frequency = 25 Hz) When a 17-bit serial encoder is used, the number of PG pulses (P28) is "17 bit-2 bit=32768". Pulse output (Hz) = (E109/E110) X 25 (Hz) X P28 (1000/32767) X 25(Hz) X 32768 = 25.001 kHz (A-/B-phase output)

Chap. 6 CONTROL OPTIONS

Table 6.8.2 Software Specifications

Item		Specifications
Motor drive control		For induction motor: Vector control with speed sensor Function codes P01, A01, and A101, "Drive control selection" = "0" For synchronous motor: Vector control with speed sensor Function codes P01, A01, and A101, "Drive control selection" = "3"
Speed control	Speed control range	1:1500 (minimum speed: Base speed, 1 to 1500 r/min when converted with 4P) 1:6 (Constant torque area: constant output area, with induction motor) May not be achieved in a synchronous motor due to electric characteristics of the motor.
	Speed control accuracy	Analog setting: ±0.1% of maximum speed Digital setting: ±0.005% of maximum speed
Position control (pulse train synchronous operation) (available soon)	Position response	10 Hz Response is adjusted with APR gain and ASR gain.
	Position precision	Within encoder ±2 bits (At the time of steady state/ transition, F/F gain = setting of 1.0) With F/F gain ≠1.0, steady state/transition deviation occurs.
	Lock precision	Within encoder ± 2 bits, 150% is allowed for resistance torque.
Serial PG interface function	With the motor integrated/ directly connected	Specify function codes P01, A01, and A101 with "Drive control selection" = "0 (induction motor)" or "3 (synchronous motor)" are set. When the SPGT option is mounted, SPGT pulse train fed back is automatically selected to disable the integrated PG input PA/PB terminal.
	For machine axis pulse feedback (available in the near future)	The machine axis position can be controlled with signals from serial PG mounted in the machine axis. The motor requires an independent PG to detect motor speed/position.
	Serial PG dedicated alarm	Mounting this option adds the following protection functions to the standard functions in connection with the interface with PG. Encoder error (Et 1), encoder communication error (EC)
Position control dedicated function (available soon)	Control	Synchronous operation system *The straight line position control system should be constructed on the UPAC or SX (PLC) side.
	Monitor	1-rotation data (17 bits), multi-rotation data (16 bits)
	I/O terminal function	X function selection/Y function selection

6.8.3　　External dimension drawing

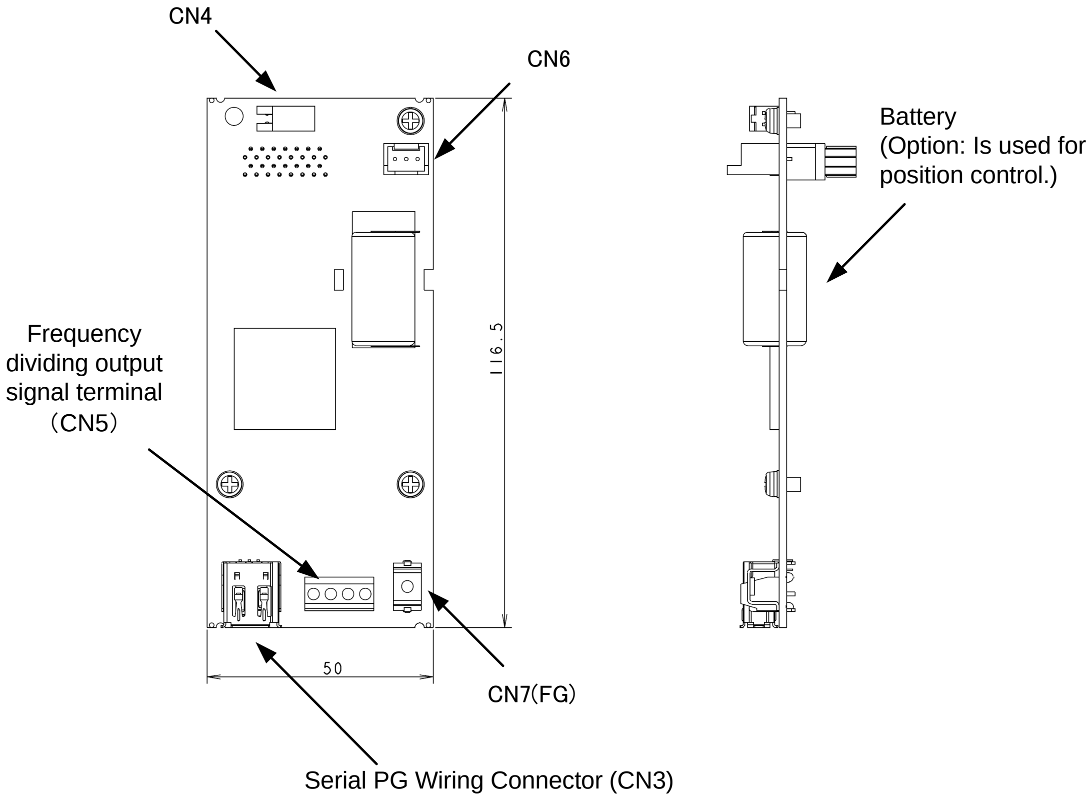


Figure 6.8.1　Card Outline Drawing

6.8.4 Connection

Refer to 6.1.4 “Installing internal options (OPC-VG1-□□)”, and then perform wiring and connecting wires.

This option should be mounted at port B (CN2).

⚠WARNING

- Incorrect handling in connecting job could cause an accident such as electric shock or fire. Qualified electricians should carry out connecting wires. If connecting wires, for example, after the power is turned ON requires any touching of an electric circuit, turn OFF (open) the breaker on the power supply side to prevent electric shock.
- Since the smoothing condenser has been charged although the breaker is turned OFF (open), touching an electric circuit causes an electric shock. Confirm, with a tester, etc., that the charge lamp (CHARGE) of the inverter is turned OFF and the DC voltage of the inverter has been reduced to the safety voltage.

⚠CAUTION

- Do not use the product that is damaged or lacking parts. Doing so could cause injury or damage.
- Incorrect handling in installation/removal could result in a broken produce.

6.8.4.1 Connector and terminal specifications

Connector specifications for serial PG wiring

・Model : 53984-0671 (Molex) (IEEE1394)

Pin No.	Signal name	Function
1	P5	5 V power supply
2	M	GND
3	BAT+	Battery output (+)
4	BAT-	Battery output (-)
5	SIG-	Serial communication (-)
6	SIG+	Serial communication (+)

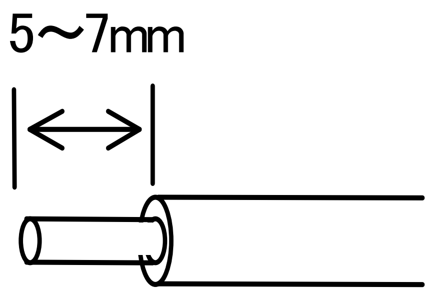


Figure 6.8.2 Connector Layout

Frequency output signal terminal

Applicable wire: AWG24-18 (0.25 to 0.75 mm^2)

Tightening torque: 0.22 to 0.25 N・m

Pin No.	Signal name	Function
1	FA+	A-phase differential output (+)
2	FA-	A-phase differential output (-)
3	FB+	B-phase differential output (+)
4	FB-	B-phase differential output (-)

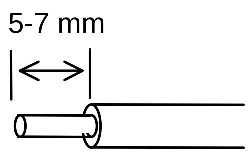
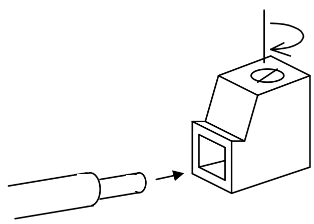


Figure 6.8.3 Wire Tip Treatment



FG terminal

Recommended wire size: 1.25 mm^2

Tightening torque: 0.7 N・m

6.8.4.2 Basic connection diagram

When motor-integrated or directly-connected high resolution serial PG is used to perform control

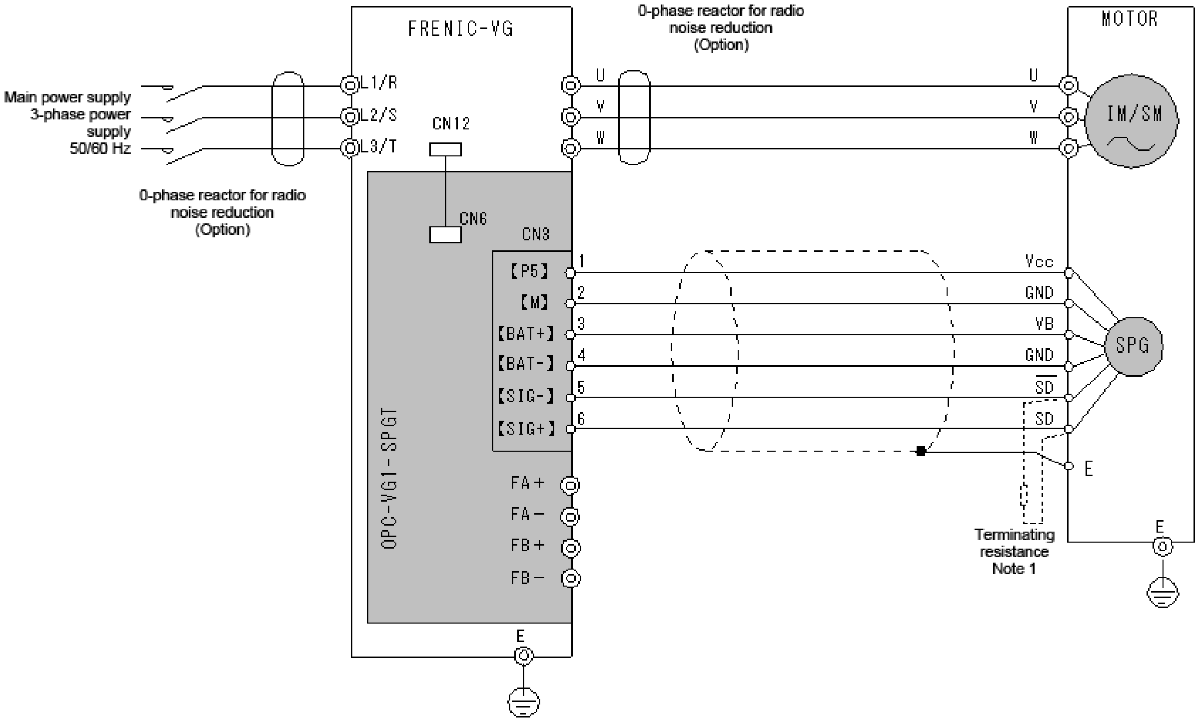


Figure 6.8.4

When high resolution serial PG mounted in the machine axis is used to perform control (available soon)

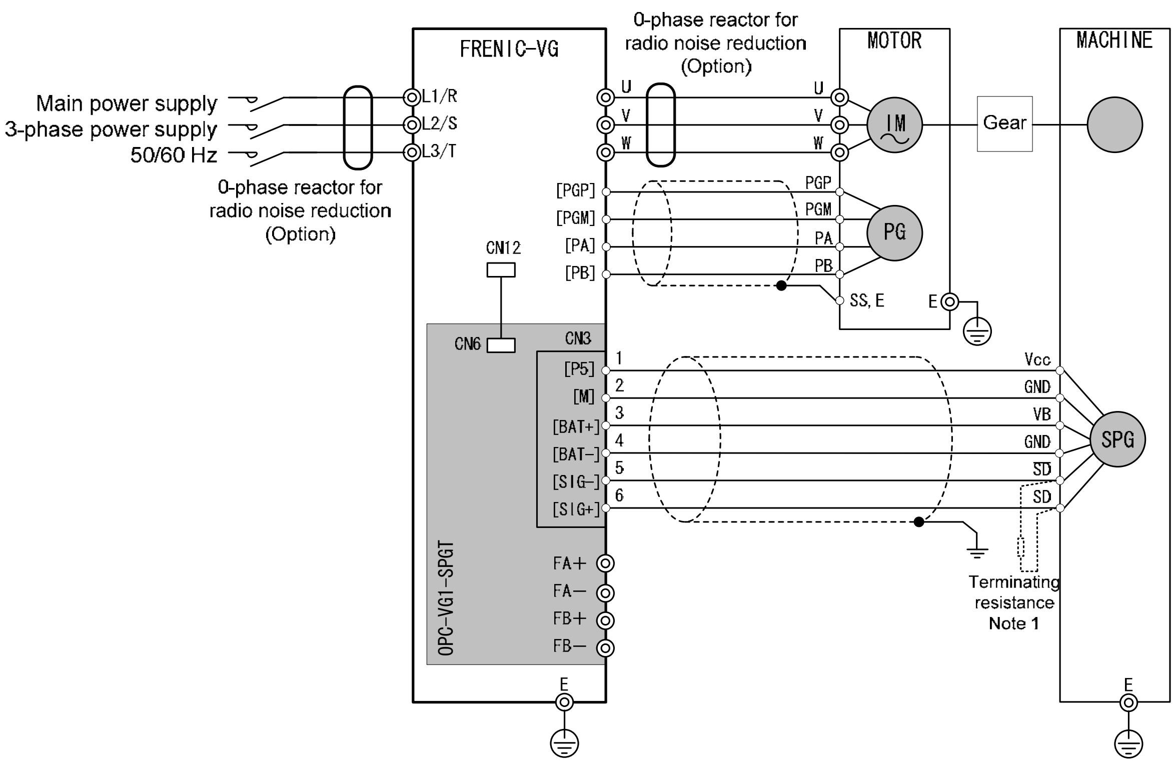


Figure 6.8.5

Note 1: If the cable is longer than 50 m, install the supplied terminating resistance (220 Ω, 1/4 W) between the encoder terminal $\overline{\text{SD}}$ and the SD terminal.

When frequency dividing output pulse of the master axis is used for synchronous operation as a pulse command (available soon)

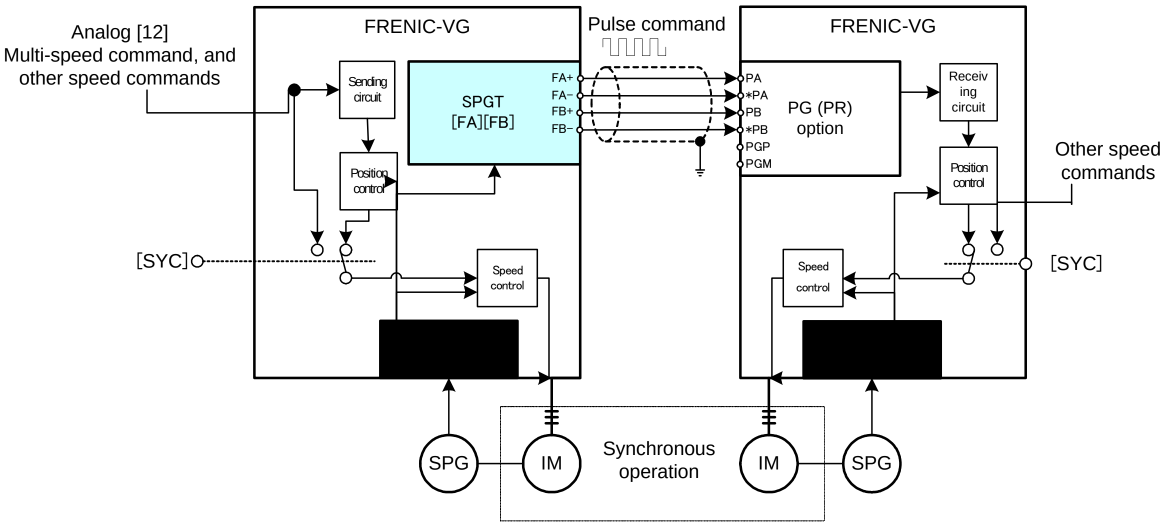


Figure 6.8.6

6.8.5 Function code

⚠WARNING

- Configuring the function codes wrongly may lead to dangerous conditions. When data has been set or written, be sure to confirm the data again.

Failure to observe this precaution could cause an accident.

Mounting this option board can perform driving in combinations with the induction motor or synchronous motor. In addition, position control can be done. Function code settings in each condition are as follows.

Table 6.8.3

<table>
<tr><th rowspan="2">Motor</th><th rowspan="2">Serial PG installation position</th><th rowspan="2">Position control (available in the near future)</th><th colspan="3">Setting function code</th></tr>
<tr><th>P01, A01, A101</th><th>o09, A59, A159</th><th>o05</th></tr>
<tr><td rowspan="3">Induction motor</td><td rowspan="2">Motor (including 1-to-1 machine axis)</td><td>No</td><td rowspan="3">0</td><td rowspan="3">-</td><td>-</td></tr>
<tr><td>Yes</td><td>-</td></tr>
<tr><td>Machine axis (Motor with standard PG)</td><td>Yes</td><td>2</td></tr>
<tr><td rowspan="3">Synchronous motor</td><td rowspan="2">Motor (including 1-to-1 machine axis)</td><td>No</td><td rowspan="3">3</td><td>6</td><td>-</td></tr>
<tr><td>Yes</td><td>6</td><td>-</td></tr>
<tr><td>Machine axis (Motor with PMPG)</td><td>Yes</td><td>0 to 2</td><td>2</td></tr>
</table>

Note: "-" indicates setting is unnecessary (optional).

6.8.5.1 Function codes related to motor control

Motor parameters must be set according to the motor (M1 to 3) in use. For details, refer to the explanation on P code and A code in Chapter 4.

(1) For induction motor

Set P28 (with M1 selected), A30 (with M2 selected), and A130 (with M3 selected) according to the maximum speed of the motor.

(2) For synchronous motor

With the following contents, set the codes.

- Motor parameter (supports the synchronous motor)
- Magnetic pole position adjustment of synchronous motor
- Inverter's function codes

For magnetic pole position adjustment of synchronous motor

When the card is combined with a motor for the first time after the purchase to drive a synchronous motor, the confirmation, adjustment and setting of the magnetic pole position are required. (Settings differ depending on the motor.)

Set the magnetic pole position offset value of the applicable motor, or confirm and adjust the magnetic pole position according to the following procedure. (If the values described in the test report have been set, confirm the position according to the following procedure,)

If the card was already combined for operation after it had been purchased, if PG is installed later, or if replacement of PG is required, the confirmation, adjustment and setting must be performed without fail.

⚠CAUTION
・ The adjustment of magnetic pole position must observe the following. ・ If the operation is for the first time after the purchase or after the replacement of the motor, PG, or inverter unit, the adjustment must be performed without fail. ・ If the operation is performed without adjusting the magnetic pole position (o10, A60, A160) or when settings significantly deviate from true values, operation in opposite direction or runaway may occur in the worst cases. **Failure to observe this precaution could cause an accident.** **Failure to observe this precaution could cause injury.**

◆ Pre-setting of parameters

E69 (Ao1 assignment) : 26 (U-phase voltage)
E70 (Ao2 assignment) : 39 (SMP)
E84 (Ao1-5 filter setting) : 0.000s (Filter cancel)

◆ Rotating the motor manually, confirm that the position relationships between Ao1 and Ao2 waveforms are as shown below.

If waveform is significantly broken, adjust the value of o10 (with M1 selected), A60 (with M2 selected), or A160 (with M3 selected) to achieve the relationships shown in Figure 6.8.7.

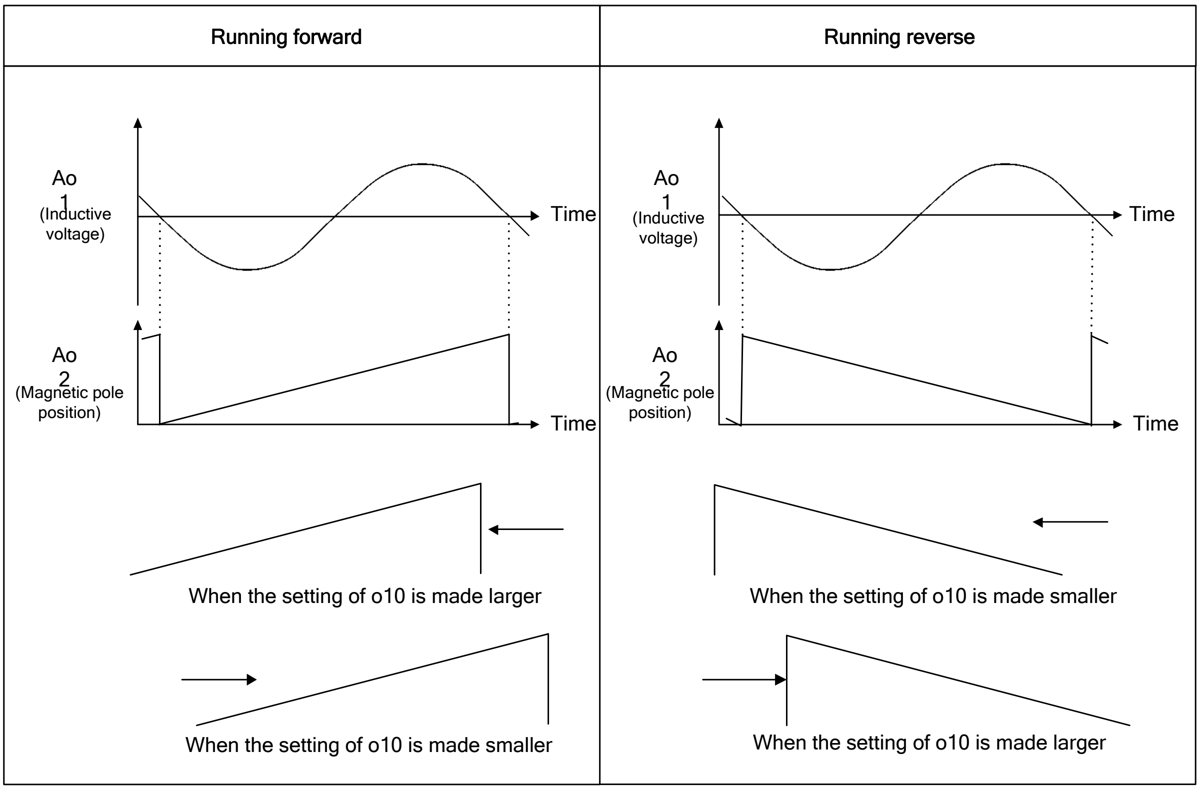


Figure 6.8.7 Adjustment of Magnetic Pole Position

Inverter's function codes

o09	**M1 ABS signal input definition**
A59	**M2 ABS signal input definition**
A159	**M3 ABS signal input definition**

Function code for synchronous motor. It selects an interface system for encoder ABS signal.

	o	0	9	M	1	–	A	B	S		D	E	F
	A	5	9	M	2	–	A	B	S		D	E	F
A	1	5	9	M	3	–	A	B	S		D	E	F

Setting range
- 0: 1 bit (terminal; F0) Z-phase interface (available in the near future)
- 1: 3 bits (Terminal; F0, F1, F2) U-/V-/W-phase interface
- 2: 4 bits (Terminal; F0, F1, F2, F3) Gray code interface
- 3-5: Not used.
- 6: SPGT 17-bit serial interface
- 7-16: Not used.

o10	**M1 magnetic pole position offset**
A60	**M2 magnetic pole position offset**
A160	**M3 magnetic pole position offset**

Function code for synchronous motor. It defines the offset to encoder reference position and actual motor magnetic pole position.

	o	1	0	M	1	–	S	M		O	F	S	
	A	6	0	M	2	–	S	M		O	F	S	
A	1	6	0	M	3	–	S	M		O	F	S	

Setting range: 0.0 to 359.9/0 to 359.9° CCW direction

Enter the value described in the test report of the applicable motor or make adjustments according to the magnetic pole position adjustment procedure.

o11	**M1 salient pole ratio (%Xq, %Xd)**
A61	**M2 salient pole ratio (%Xq, %Xd)**
A161	**M3 salient pole ratio (%Xq, %Xd)**

Function code for synchronous motor. It uses a q-axis/d-axis ratio to set a difference in reactance given by the difference in magnetic resistance between the q-axis and the d-axis of the IPM motor.

	o	1	1	M	1	–	X	q	／	X	d		
	A	6	1	M	2	–	X	q	／	X	d		
A	1	6	1	M	3	–	X	q	／	X	d		

Setting range: 1.000 to 3.000

The value must be calculated based on the setting of each motor. If the value is unknown, contact us. For the SPM motor, it should be set to 1.000.

6.8.6 Protective functions

6.8.6.1 Alarm display list

Mounting this option card adds the standard protection functions as well as the following protection functions.

Item	Content	Display	Related code
Encoder error 1	ABS encoder position detection data error. (Serial communications are carried out normally.) As an alarm release method, resupply the power.	Et1	
Encoder communications error	The operation is performed when serial communications with the ABS encoder cannot be established. The operation is performed when communications cannot be established between the option card and the inverter.	EC	
Operation procedure error	The operation is performed when two or more communications options are mounted. With SPGT mounted, installing SPGT on the A-port side (CN3 side) activates the operation.	Er6	

6.8.6.2 Actions to be taken for alarms

Item	Possible cause	Action to be taken
Et1	Data received from the encoder is wrong.	Use shielded wire to prevent being affected by noise.
	The encoder has been broken.	Replace the encoder.
EC	Communications with the encoder are interrupted. Disconnection or poor connection of encoder cable	・Visually check the encoder cable and check the disconnection status. ・Check the encoder model. ・Check that the encoder terminating resistance (220Ω, 1/4W) has been installed. ・Check that the option card power connector is connected appropriately. ・Insert the ferrite core.
	Inappropriate installation of the option card	・Check the installation of the option card and the length of the spacer.
Er6	Combinations of options that cannot be mounted at the same time.	・Remove option cards, if any, that cannot be mounted at the same time.
	SPGT is mounted on the A-port side (CN3 side).	・Check and correct the mounting place of SPGT. ・Mount SPGT on the B-port side (CN2 side).

6.8.7 Check function

6.8.7.1 Option mounting check

```
OPTION
A:
B:VG1-SPGT
C:
∧∨→PAGE SHIFT 9
```

Checking for mounting of the SPGT option can be checked on the keypad.

Move from the operation mode screen to the program menu screen, and select "4. I/O check" with the ∧/∨ key to switch the screen. As shown at right, screen 9 is available to check for mounting of it.

For details, refer to the keypad operation procedure.

If the SPGT card has been mounted, the screen is displayed as shown at right.

6.8.8 Related option

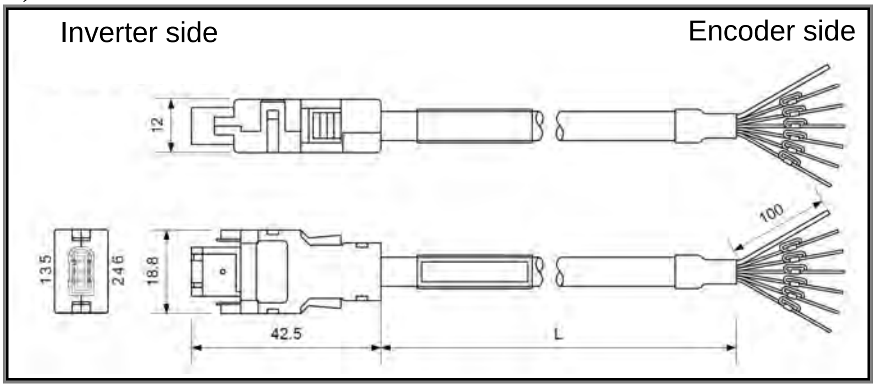
■ Distribution cable (Product to be arranged independently)

Length and model

L [mm]	Model	Terminal treatment on the PG side	Remarks
$5{,}000^{+500}$	WSC-P06P05-W	Unfastened leads (Illustration A)	
	WSC-P06P05-E	Connector (Illustration B)	
$10{,}000^{+1{,}000}$	WSC-P06P10-W	Unfastened leads (Illustration A)	
	WSC-P06P10-E	Connector (Illustration B)	
$15{,}000^{+1{,}500}$	WSC-P06P15-W	Unfastened leads (Illustration A)	
	-	-	
$20{,}000^{+2{,}000}$	WSC-P06P20-W	Unfastened leads (Illustration A)	
	WSC-P06P20-E	Connector (Illustration B)	
$50{,}000^{+2{,}000}$	WSC-P06P50	Connector (Illustration B)	Handled as a special-purpose item.

When an applicable serial PG is incorporated into our motor, PG wire can support either unfastened leads (terminal block) or connector.

(Illustration A)



Connector model

	Connector on the inverter side
Plug housing main unit	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Manufactured by Molex

Figure 6.8.8 Cable for Encoder Connection

Chap. 6 CONTROL OPTIONS

Green

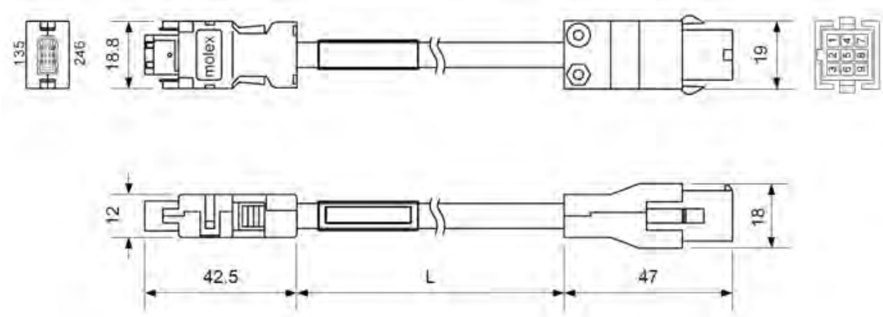
Pin No.		1	2	3	4	5	6	Case
Green	①	Red	Black	Orange	Orange/white	Sky blue	Sky blue/white	Protection tube
	②	White	Black	Yellow	Brown	Red	Blue	
Signal name		P5	M5	BAT+	BAT－	SIG+ ※1	SIG－ ※2	

For green, either 1) or 2) is applicable.

※1 : Connect the negative logic side of the communications signal.

※2 : Connect the positive logic side of the communications signal.

(Illustration B)



Connector model

Connector on the inverter side

Plug housing main unit	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Manufactured by Molex

Connector on the motor side

Cap housing	1-172332-9
Socket	170361-1
Cover (X2)	316455-1
Screw (X2)	XPB M2.6×10
Nut (X2)	M2.6

Manufactured by Tyco Electronics

Green

Option card side		1	2	3	4	5	6	Shell
Motor side		7	8	1	2	5	4	3
Green	①	Red	Black	Orange	Orange/ white	Blue/white	Blue	Shield
	②	White	Black	Yellow	Brown	Blue	Red	Shield
Signal name		P5	M5	BAT+	BAT-	SIG+ *1	SIG－ *2	FG

*1: Connect the negative logic side of the communications signal.

*2: Connect the positive logic side of the communications signal.

* When you prepare cables, the following electric wires are recommended.

Recommended electric wires

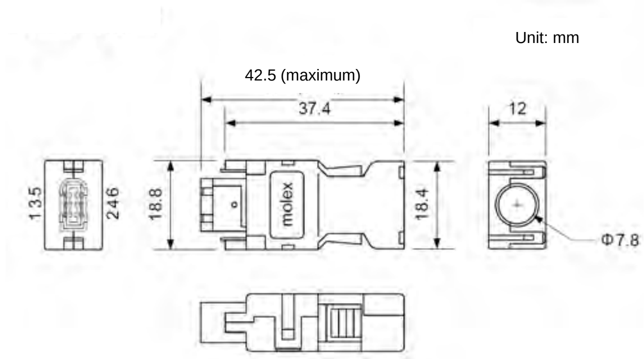
When the cable length is 10 m or less: RMCV-SB-A-AWG#25/2P+AWG#23/2C or AWG#23/3P

When the cable length is more than 10 m and less than or equal to 50 m: RMCV-SB-A AWG#25/2P+AWG#17/2C or the equivalent

Connector kit

・Connector on the inverter side
Model: WSK-P06P-M

Outline drawing



Component parts

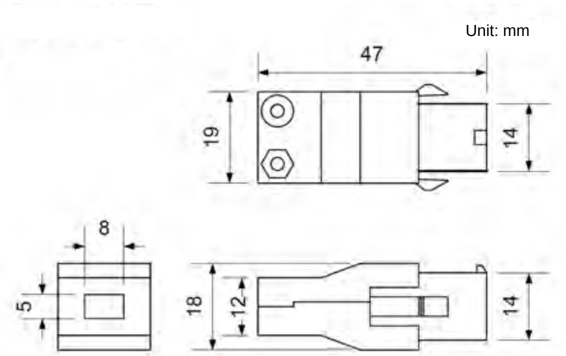
Plug housing main unit	54180-0619
Plug shell cover	58299-0626
Plug shell body	58300-0626
Plug mold cover (A)	54181-0615
Plug mold cover (B)	54182-0605
Cable clamp	58303-0000
Clamp screw	59832-0009

Manufactured by Molex

* The connector manufacturer's models are subject to change without notice.

・Connector on the motor side
Model: WSK-P09P-D

Outline drawing



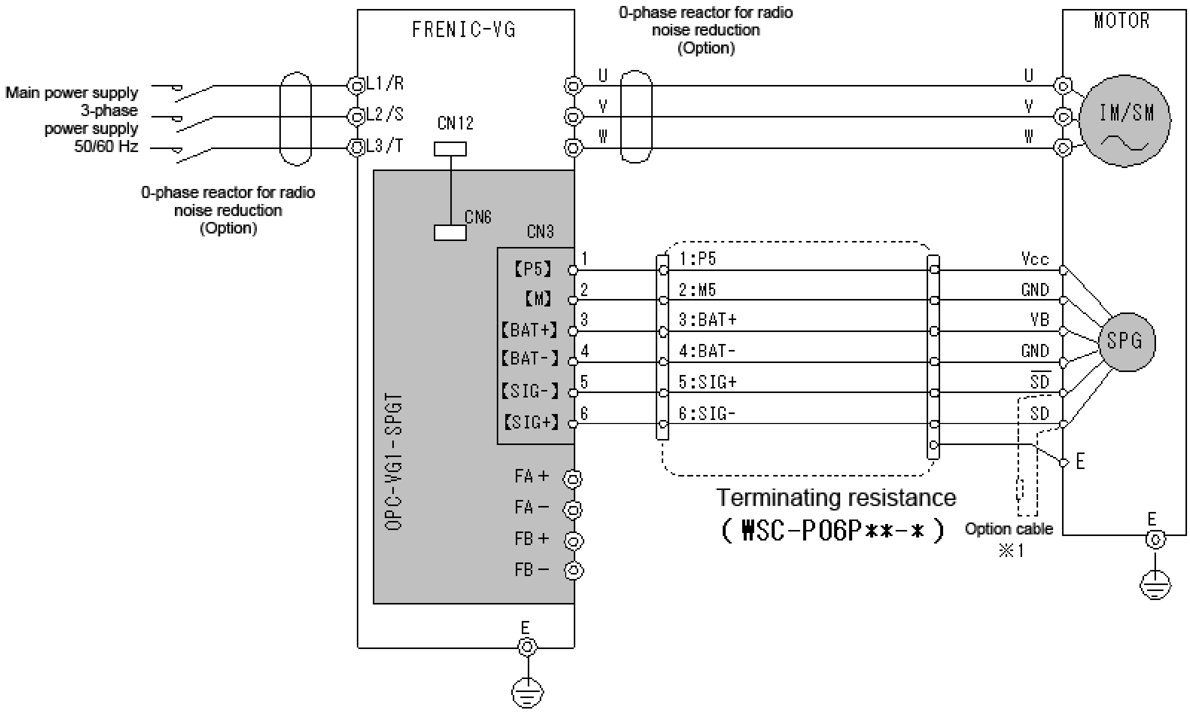
Component parts

Cap	172161-9
Cap cover	316455-1
Socket	170365-1 (Unfastened status) 170361-1 (Concatenate)
Socket	170366-1 (Unfastened status) 170362-1 (Concatenate)

Manufactured by Tyco Electronics

* The connector manufacturer's models are subject to change without notice.

■ Wiring connection diagram with option cables used



Note 1: If the cable is longer than 50 m, install the supplied terminating resistance (220Ω, 1/4W) between the encoder terminal $\overline{SD}$ and the SD terminal.

6.9 F/V Converter (available soon)

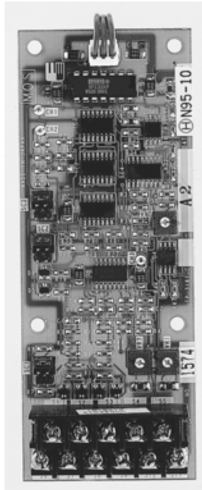
6.9.1 Product overview

OPC-VG1-FV is one of the FRENIC-VG analog interface option OPC series products. A single unit of the FRENIC-VG analog interface option OPC series product can be installed in a single FRENIC-VG inverter unit.

OPC-VG1-FV converts frequency signals into voltage signals. It is used to detect a signal (e.g., line speed) by a pulse encoder and convert it into an analog signal.

MCA-VG1-FV is an optional unit containing OPC-VG1-FV for separate installation.

MCA-VG1-FV can be used in combination with other model (FRENIC series inverter).



⚠WARNING

- The switches and volumes inside the option have been adjusted at the factory. Never touch a volume or switch other than those used for adjustment by the user.

⚠CAUTION

- Install the MCA (separate installation) type with the connection terminal side down, near the inverter, and connect the cables so that no noise will be applied to signals.

  The MCA (separate installation) type requires a separate power supply (±15 V DC), which is not supplied from FRENIC-VG. Prepare a stabilized power supply (±15 V) separately.

6.9.2 Model and specifications

6.9.2.1 Model

Model elements: MCA/OPC-VG1-FV

- Installation method, OPC → Integrated,
  MCA → Separate installation
- Name of equipped inverter VG1 → FRENIC-VG
- Option name; FV → FV converter

OPC type accessories

Spacer x 3

M3 screw x 3

Power supply harness (for ±15V power supply) x 1

6.9.2.2 Specifications

⚠CAUTION
• The MCA (separate installation) type requires a separate power supply (±15V), which is not supplied from FRENIC-VG. Prepare a stabilized power supply (±15V) separately.

(1) Hardware specifications

Table 6.9.1 General Specifications

Item	Specifications	
	OPC-VG1-FV	MCA-VG1-FV
Voltage and required power supply	P: ＋15.0 VDC ±2.0 V Approx. 65 mA (Supplied from the control printed board CN12)	Supplied from the motherboard printed board
	N: -15.0 VDC ±2.0 V Approx. 35 mA (Supplied from the control printed board CN12)	Supplied from an external source (±15V) to the motherboard
Frequency input	5 kHz to 40 kHz Internally switched	

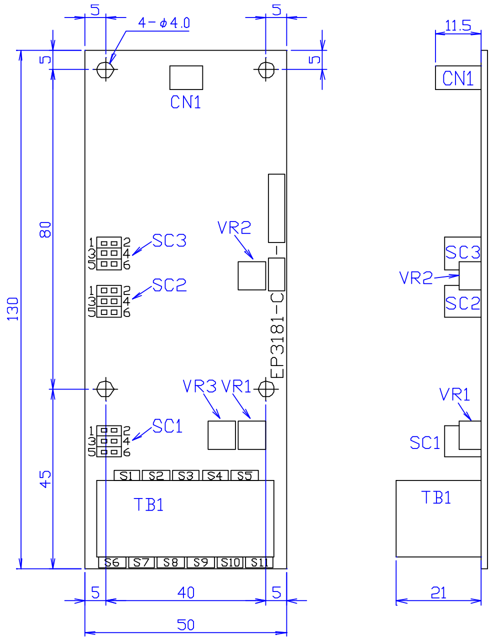
Table 6.9.2 I/O Terminal Specifications

Terminal	Usage	I/O scope quantity	Remarks		
S1 S7 S6(M)	A-phase pulse (Refer to the basic connection diagram for connection of each terminal.)	MAX 5 V to 15 V square wave	Voltage pulse (Complementary) input	SC1: 1-2 3-4 switching	Input Impedance 10 kΩ
		MAX 5 V square wave Positive phase/negative phase input	Line driver input	SC1: 5-6 short-circuit	
S3 S9 S8(M)	B-phase pulse (Refer to the basic connection diagram for connection of each terminal.)	MAX 5 V to 15 V square wave	Voltage pulse (Complementary) input	SC1: 1-2 3-4 switching	Input Impedance 10 kΩ
		MAX 5 V Square wave Positive phase/negative phase input	Line driver input	SC1: 5-6 short-circuit	
S5	F/V output	0 to + 10 V, MAX 3.4 mA $R_L \geq 3.0$ kΩ	Single polarity, positive output without regard to the PG phase		
S4	F/V output	0 to + 10 V, MAX 3.4 mA $R_L \geq 3.0$ kΩ	Double polarity, negative output with A-phase delayed (switched by SC3) Polarity switching available. Refer to "6.9.5 Adjustment Method" for the details.		
S10(M) S11(M)	Reference potential	0 V	Common to the M terminal of the inverter.		
S2	Empty pin				

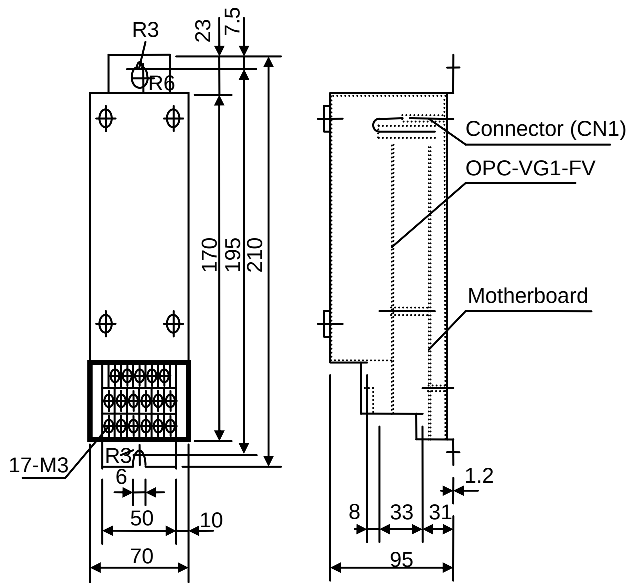
Table 6.9.3 List of Input Terminals on MCA-VG1-FV Motherboard Printed Board

Terminal	Usage	Level/type	Specifications	Remarks
S1 S2 S3	Empty pin			
P15	Power supply voltage	P	Within DC + 15 V ±2.0 V Approx. 65 mA	Prepare a separately installed stabilized power supply (±15 V).
M		M	0 VDC	
N15		N	Within -15 ±2.0 VDC Approx. 35 mA	

6.9.3 External dimensions



Unit: mm



Unit: mm

Figure 6.9.1 OPC-VG1-FV External Dimensions **Figure 6.9.2 MCA-VG1-FV External Dimensions**

Terminal Table Arrangement

OPC-VG1-FV side Terminal table (11-M3)

	S1	S2	S3	S4	S5
S6	S7	S8	S9	S10	S11

Motherboard side Terminal table (6-M3)

S1	S2	S3	P15	M	N15

Figure 6.9.3 MCA-VG1-FV Terminal Table Arrangement

6.9.4 Internal block diagram

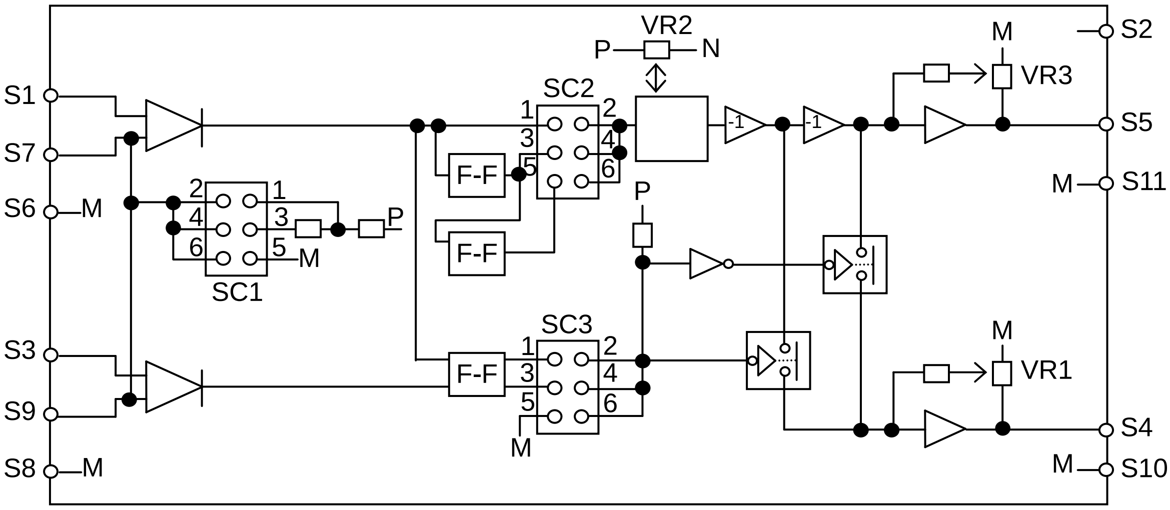


Figure 6.9.4 Internal Block Diagram

6.9.5 Adjustment method

⚠WARNING

- The switches and volumes inside the option have been adjusted at the factory. Never touch a volume or switch other than those used for adjustment by the user.

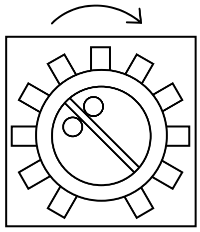
(1) Adjust SC1 to SC3 depending on the input form and usage.

(2) Set VR1 and VR3 as 0 notch.

(3) Adjust VR2 so that the voltage output S4 and S5 become minimum with the minimum frequency input.

(4) Adjust VR1 and VR3 so that the voltage output S4 and S5 become maximum with the maximum frequency input.

(5) Repeat (3) and (4) until the settings converge.
(For S4, the polarity of the output is reversed depending on the A- and B- phases when SC3: 1-2 is shorted.)



Turning each volume clockwise increases the set value.

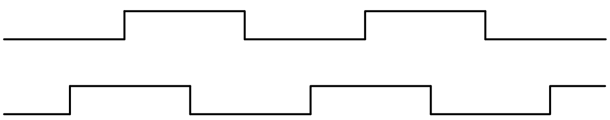
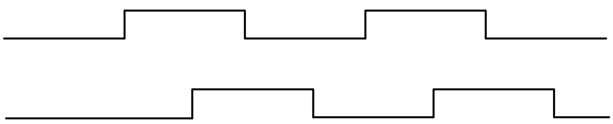
Figure 6.9.5

Table 6.9.4

Adjustment position	Name	Adjustment contents
SC1	Input frequency switching Common to A- and B-phase pulses	1-2 side: (Threshold level 5.1 V) V_L = 0 to 1 V, V_H = 8 to 15 V
		3-4 side: (Threshold level 2.5 V) V_L = 0 to 1 V, V_H = 3.5 to 5 V
		5-6 side: (A, A, etc. for differential input)
SC2	Input frequency division switching	1-2 side: Maximum input frequency 5 to 10 kHz
		3-4 side: Maximum input frequency 10 to 20 kHz
		5-6 side: Maximum input frequency 20 to 40 kHz
SC3	F/V output polarity switching	1-2 side: Double polarity (S4 becomes negative with A-phase delayed) *Note 1
		3-4 side: Single polarity, output polarity is fixed (S4 is positive).
		5-6 side: Single polarity, output polarity is fixed (S4 is negative).
VR1	Gain adjustment	Adjust the gain against the voltage output S4.
VR2	Bias adjustment	Adjust the F/V bias.
VR3	Gain adjustment	Adjust the gain against the voltage output S5.

* Refer to Note 1.

Table 6.9.5

	Input square wave (voltage pulse input)	S4 output
A-phase delay	A-phase / B-phase 	Negative polarity
A-phase advance	A-phase / B-phase 	Positive polarity

• Factory setting

SC1 to SC3: 1-2 side.

VR1 to VR3: With the pulse input 0 to 15 V, 0 to 10 kHz, the voltage output (S5) is 0 to +10 V and voltage output (S4) is 0 to ±10 V, double polarity (A-phase is delayed after B-phase for negative polarity).

6.9.6 Basic connection diagram

Refer to Section 6.1.4 "Installing internal options (OPC-VG1-□□)" before performing wiring or connection work.

⚠WARNING
• Incorrect cabling may cause a disaster such as electrical shock or fire. Only a qualified person should perform cabling. Before touching the power supply circuit (e.g., for cabling after power on), be sure to turn off (i.e., open) the circuit breaker to prevent electrical shock. Note that the smoothing capacitor is charged after turning off (i.e., opening) the circuit breaker and touching it causes an electrical shock. Ensure that the charge lamp (CHARGE) of the inverter has gone off and that the DC voltage of the inverter has lowered to a safety level using a tester.

⚠CAUTION
• Do not use the product that is damaged or lacking parts to prevent an injury or damage. • Incorrect handling in installation/removal jobs could result in a broken product. Install the MCA (separate installation) type with the connection terminal side down, near the inverter, and connect the cables so that no noise will be applied to signals.

Chap. 6 CONTROL OPTIONS

(1) For voltage output PG

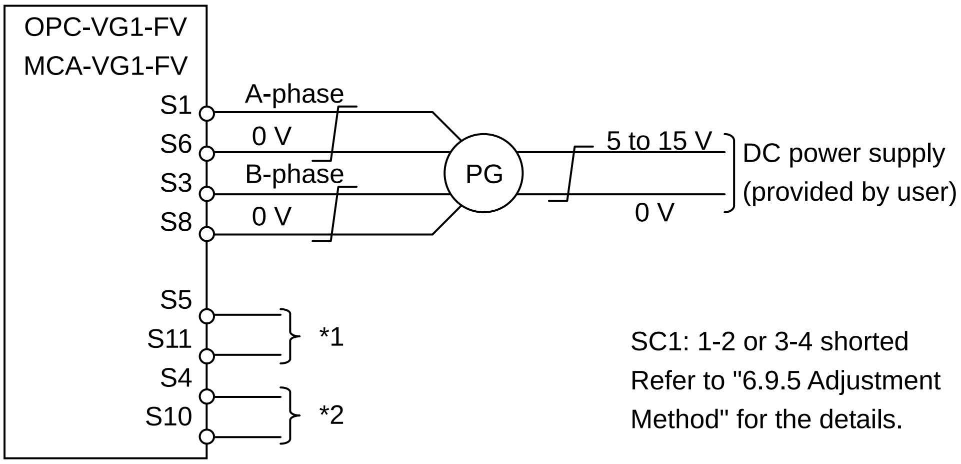


Figure 6.9.6

(2) For line driver PG

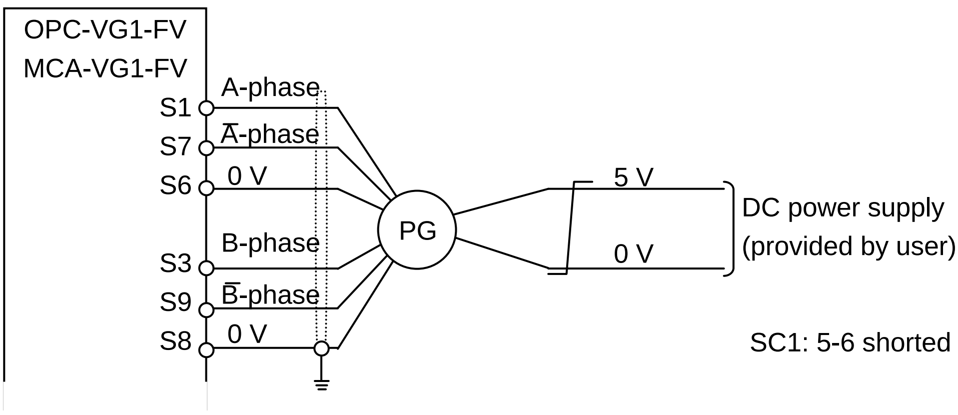


Figure 6.9.7

Note: The shielded wire is basically connected to the earth. However, if external induction noises greatly affects the wire, connect it to 0 V to suppress the noise effect.

When using output from this printed board (OPC-VG1-FV or MCA-VG1-FV) to control the line speed or motor speed (whichever prioritized) via FRENIC-VG, connect the voltage output terminal S4 to Ai1 (or Ai2) and S10 to M (0V) on the inverter, and configure the parameter settings (*3) before use.

*1, *2 Output terminal specifications.

Refer to the "Hardware Specifications I/O Terminal Specifications" when using the option for other purposes.

*3 Parameter setting example

(When inputting the line speed (F/V output) to Ai1 in controlling the line speed or motor speed (whichever prioritized))

Refer to H53 in Chapter 4, Section 4.3 "Details of Function Codes" and perform the following settings:

1. Set E49 "Ai1 FUNC" to "11".
2. Set H53 "N - FB SEL" to "3".
3. If the gain adjustment for line speed is necessary, use E53 "Ai1 GAIN".

(3) Complementary explanation of PG output form

(3)-1 Voltage Output: Circuit to output from the collector side of the transistor earthed via the emitter.

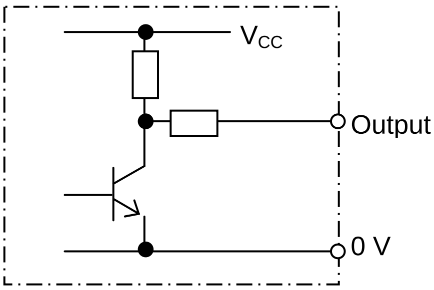


Figure 6.9.8 Voltage Output

(3)-2 Line driver: Signals are output in the positive or negative phase. Applied to high-speed transmission.

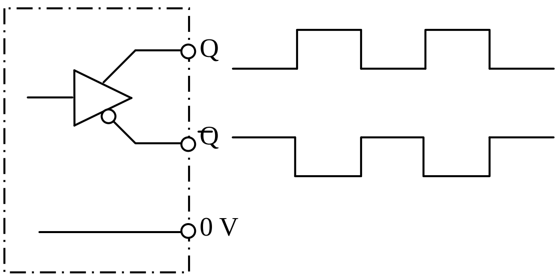


Figure 6.9.9 Line Driver Output

(3)-3 Complementary: Constant-voltage output circuit with the emitter follower matched. Applied to high-speed response and/or long-distance transmission.

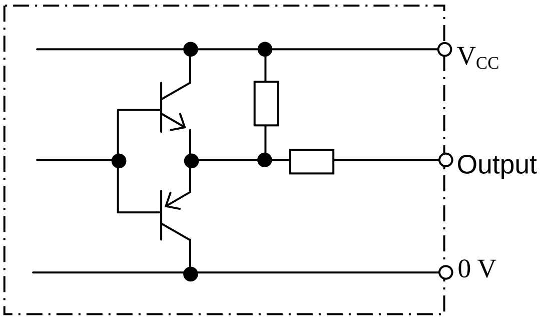


Figure 6.9.10 Complementary Output

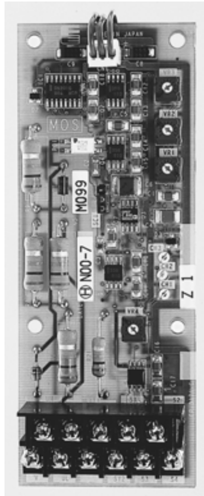
6.10 Synchro Interface (available soon)

6.10.1 Product overview

The OPC-VG1-SN is an OPC series interface option for the FRENIC-VG. The OPC series consists of printed circuit board-type control options that are installed into the inverter unit. One analog interface option OPC series product can be installed in each inverter unit.

The OPC-VG1-SN, which is used to perform position control using a synchro transmitter, converts synchro transmitter signals to signals in the range of 0 V to ±10 V.

The MCA-VG1-SN is a standalone option unit with built-in OPC-VG1-SN functionality. It can also be used in combination with other models (FRENIC series inverters).



⚠WARNING
• The synchro interface's internal switches and knobs are pre-adjusted at the factory. Never touch knobs, switches, or other adjustments other than those designed to be adjusted or set by the user.

⚠CAUTION
• Place the MCA (standalone type) vertically with the connection terminals facing down near the inverter and connect wiring so as to protect signals from noise. The MCA (standalone type) uses a separate power supply (±15 V). You will need to provide a stabilized power supply (±15 V DC) since power is not supplied from the FRENIC-VG.

6.10.2 Model and specifications

6.10.2.1 Model

Model format: MCA/OPC-VG1-SN

Installation method: OPC → Internal type,
MCA → Standalone type

Host inverter name: VG1 → FRENIC-VG

Option name: SN → Synchro converter

OPC type accessories

Spacers: 3

Screws (M3): 3

Power supply harness (for ±15 V power supply): 1

6.10.2.2 Specifications

⚠CAUTION

- The MCA (standalone type) uses a separate power supply (±15 V). You will need to provide a stabilized power supply (±15 V DC) since power is not supplied from the FRENIC-VG.

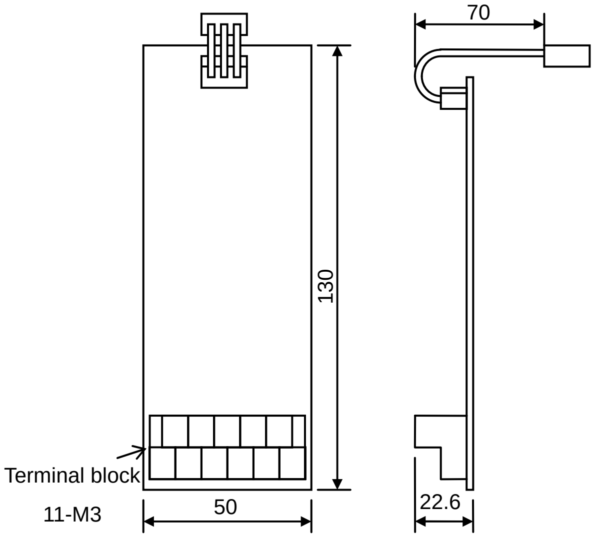
Table 6.10.1 I/O Terminal Specifications

Pin	Application	I/O range	Remarks
UH-V	Synchro synchronous power supply	180 VAC to 235 VAC, 50/60 Hz	Input capacity: Approx. 4 VA
UL-V		90 VAC to 121 VAC, 50/60 Hz	Input capacity: Approx. 2 VA
SY1 to SY2	Synchro output signals	31 VAC to 78 VAC, 50/60 Hz	Approx. 0.3 VA/78 V (110 V AC max)
S1	Potential auxiliary input (position voltage signal input)	-10V to 10V	Input impedance: Approx. 13 k (10 V max.)
S3	Position meter output	-10V to 10V	Load impedance: 2.5 kΩ or greater
S4	Position output	-10V to 10V	
S2	Reference voltage	M (0V)	

Table 6.10.2 MCA-VG1-SN Motherboard Printed Circuit Board Input Terminals

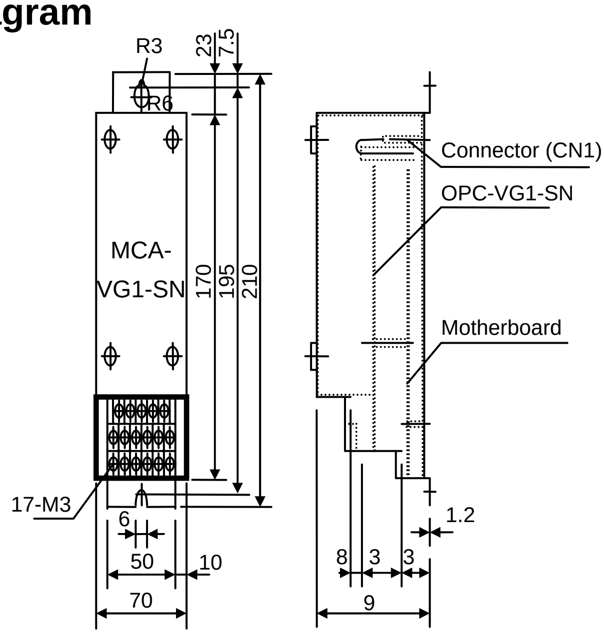
Pin	Application	Level/type	Specifications	Remarks
S1 S2 S3	Unused pins			
P15	Supply voltage	P	Max. +15 VDC ± 2.0 V Approx. 65 mA	Provide a separate stabilized power supply (±15 V).
M		M	0 VDC	
N15		N	Max. +15 VDC ± 2.0 V Approx. 35 mA	

6.10.3 External dimension diagram



Unit: mm

Figure 6.10.1 OPC-VG1-SN External Dimensions



Unit: mm

Figure 6.10.2 MCA-VG1-SN External Dimensions

■Terminal block layout

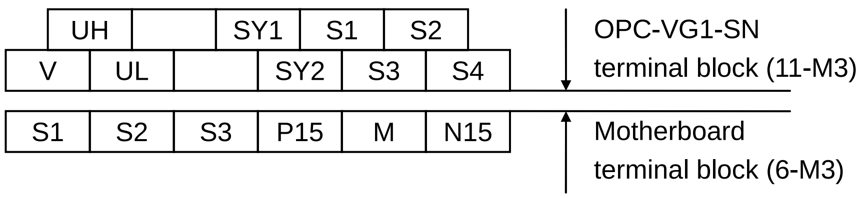
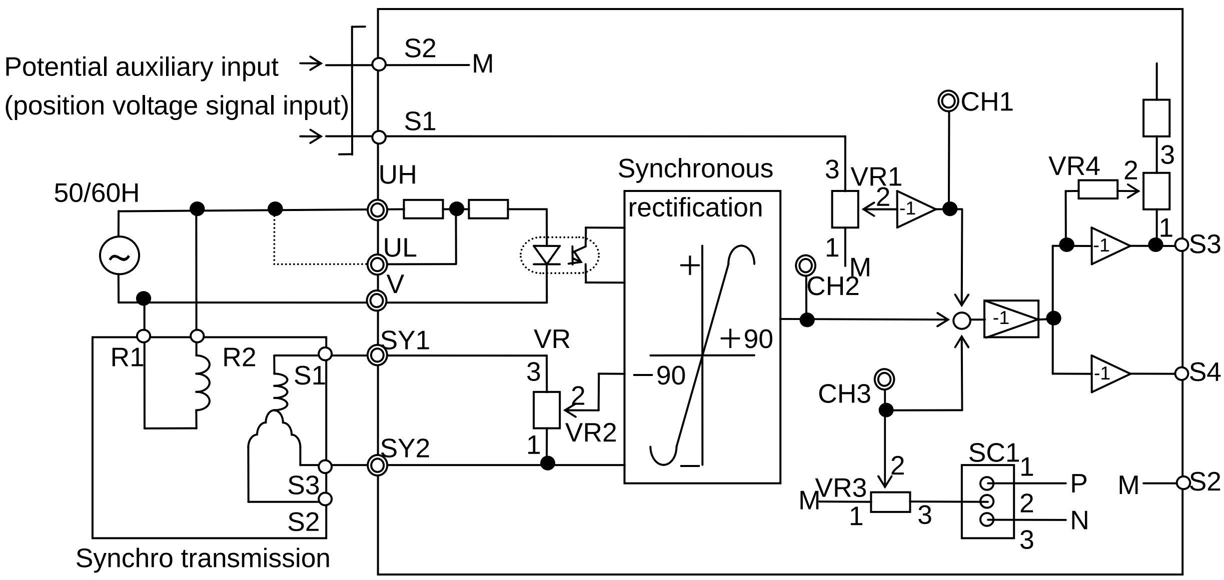


Figure 6.10.3 MCA-VG1-SN Terminal Block Layout

6.10.4 Internal block diagram



Internal block diagram

Figure 6.10.4 Internal Block Diagram

Chap. 6 CONTROL OPTIONS

6.10.5 Adjustment method

⚠WARNING
• The synchro interface's internal switches and knobs are pre-adjusted at the factory. Never touch knobs, switches, or other adjustments other than those designed to be adjusted or set by the user.

6.10.5.1 Description of adjustment locations

Table 6.10.3

Adjustment location	Name	Adjustment description
SC1	Bias load switching	1-2 shorted: Bias voltage (+)
		2-3 shorted: Bias voltage (-)
VR1	Potential auxiliary input signal adjustment	Adjusts the potential auxiliary input signal from 0 V to voltage input (S1).
VR2	Synchro transmitter output adjustment	Adjusts synchro transmitter output using voltage division.
VR3	Bias adjustment	Adjusts the bias voltage (as selected with SC1) (0 V to ±10.7 V).
VR4	Position meter output adjustment	Adjusts position meter output from -10 V to +10 V (gain 0.7 to 1.77).

Adjustment locations

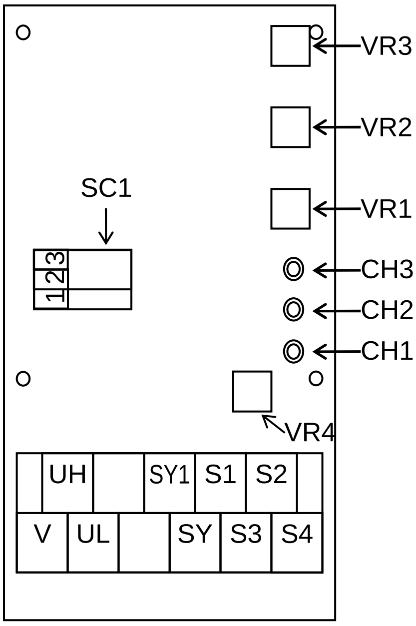


Figure 6.10.5 Adjustment Locations

• Fuji factory adjustment settings

SC1: The unit ships with 1-2 shorted.

VR1: The unit is adjusted to yield a CH1 voltage of -10 V (so that the amp gain is 1) when the potential auxiliary input signal (S1) is +10 V.

VR2: The unit is adjusted to yield voltage output (S4) of ±10 V DC with input of 78 V AC, assuming that synchro transmitter output is 78 V AC with an operating angle of ±60°C.

VR3: The unit ships with a 0 notch setting (CH3 voltage: 0 V).

VR4: The unit is adjusted so that voltage output (S5) is the same as voltage output (with an output stage amp gain of 1).

6.10.5.2 Installing and adjusting the synchro interface

Refer to Section 6.1.4 "Installing internal options (OPC-VG1-□□)" before performing wiring or connection work.

⚠WARNING

- Performing connection work in an inappropriate manner may result in electric shock, fire, or other damage. Qualified electricians should carry out wiring. When touching electrical circuits, for example when performing connection work after the unit has been energized, shut off the power supply's circuit breaker to prevent electric shock.

  The smoothing capacitor remains charged even when the circuit breaker is shut off and will cause an electric shock when touched. Verify that the inverter's charge lamp ("CHARGE") has turned off and use a tester or other instrument to verify that the inverter's DC voltage has fallen to a safe level.

⚠CAUTION

- Do not use products with damaged or missing parts. Doing so may result in bodily injury or damage.
- Inappropriate installation or removal of the product may cause damage to the product.

  Place the MCA (standalone type) vertically with the connection terminals facing down near the inverter and connect wiring so as to protect signals from noise.

- Install the controlled device so that the synchro transmitter's output increases as the speed increases. (The voltage output S4 provides the maximum compensation to increase the speed at positive polarity [+10 V].) To change the polarity, change the SY1 and SY2 connections.
- When installing the synchro transmitter on a piece of machinery, adjust the angle so that the synchro output is 0 V at the center of the synchro movable shaft's maximum span of motion. After adjusting the configuration with VR2 so that the voltage output (S4) is 10 V DC in the maximum speed-increasing direction, verify that the voltage output (S4) is -10 V DC (±0.5 V) in the maximum speed-decreasing direction.
- Refer to the following figures since the speed-increasing direction changes based on the location in which the synchro transmitter is installed (relative to the inverter). (When performing winding control, see Figure 6.10.6; when performing rewinding control, see Figure 6.10.7.)

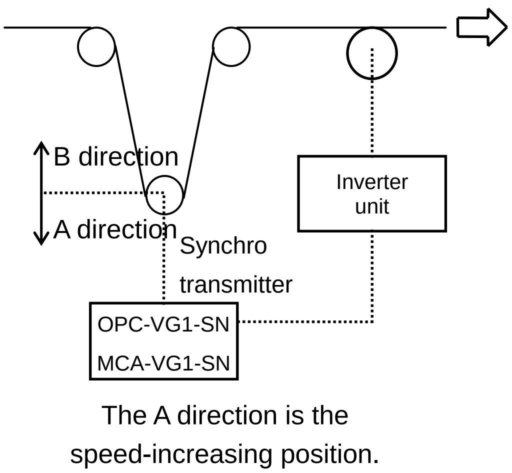


Figure 6.10.6

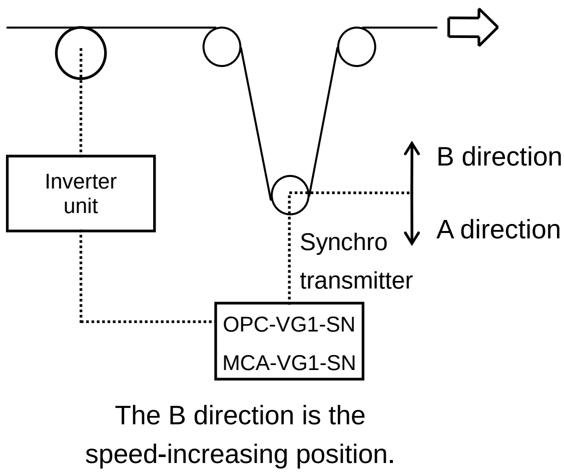
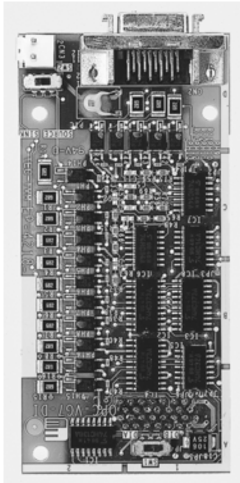


Figure 6.10.7

6.11 DI Interface Card

6.11.1 Product overview



The OPC-VG1-DI option allows use of input including speed settings, torque commands, torque current commands, and torque limits as 16-bit digital data.

Two DI interface cards may be installed at once by choosing DIA or DIB with a switch on each card. In this way, it is possible to perform control with 16-bit digital input for speed settings and torque limits at the same time.

(1) Photocoupler insulation

The input interface uses photocoupler insulation. Signal wires can be up to dozens of meters long.

(2) Sink/source

The input interface can be switched between current sink output (“sink”) and current source output (“source”). Typically, sink interfaces are commonly used in Japan and the U.S. Such interfaces are characterized by a voltage of 0 V when the signal is active. By contrast, source interfaces are often used in Europe. In such interfaces, active signals result in a positive voltage. When the PLC terminal is used with a circuit that manipulates the inverter’s built-in digital input terminals (FWD, REV, X1 to 9), the OPC-VG1-DI cannot be used. Please contact Fuji for more information.

(3) I/O check function

Regardless of whether DIA or DIB has been selected, the state of each input signal can be checked on the keypad and via the unit’s communications interfaces (RS-485, T-link, CC-Link, SX bus, Fieldbus, UPAC, etc.).

(4) Option function codes

Option function codes allow selection of binary input (0000 0000 0000 0000) or BCD input (7999). Additionally, functionality for holding data values based on contact input is provided to allow elimination of variation in the lower bits of digital data when signals are relayed via an external A/D converter.

6.11.2 Model and specifications

6.11.2.1 Model

Model format: OPC-VG1-DI

- Host inverter name: VG1 → FRENIC-VG
- Option name: DI → Digital input option

Accessories

Flag (type: 20-pin 10120-3000PE by Sumitomo 3M Limited)
Housing (cover) (type: 20-pin 10320-52A0-008 by Sumitomo 3M Limited)
Spacers: 3
Screws (M3): 3
Power supply harness (for 24 V power supply): 1

[Installation constraints]

(1) Supported option combinations

• Two DI interface cards may be installed at the same time as long as they are set as DIA and DIB.

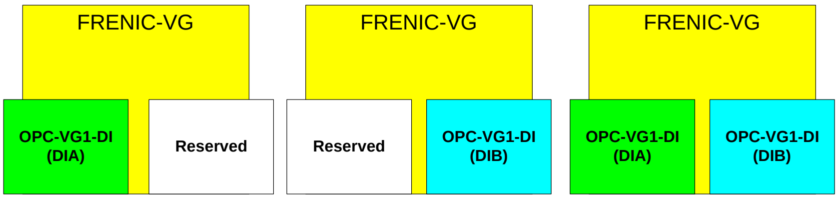


Figure 6.11.1

(2) Unsupported combinations (will result in an operation procedure error)

When two cards are being used at the same time, both cannot be set to either DIA or DIB. Attempting to use the inverter in this configuration will result in operation procedure error Er-6.

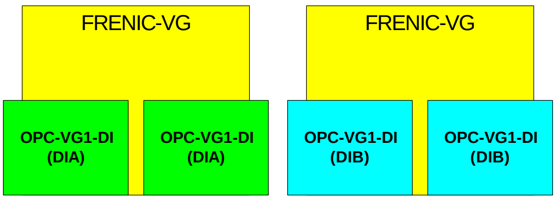


Figure 6.11.2

6.11.2.2 Specifications

⚠CAUTION

- Failure to set the switches on the DI interface expansion card (SW1, SW2) correctly will prevent the system from operating properly. Read information about the settings below and be sure to set the switches correctly.

Table 6.11.1 Hardware specifications

Item		Specifications
Name		DI interface card
Type		OPC-VG1-DI *SW1 is used to switch between the DIA and DIB settings.
Input	No. of contacts	16 contacts (4 bits × 4 digits)
	Ground	CM; common ground for all 4 contacts
	Circuits	Photocoupler insulation SW2 is used to switch between current sink output (sink) and current source output (SOURCE). Flowing current per circuit: Approx. 3 mA
Power supply		24 V Power is supplied from the inverter's printed circuit board. Connect the power supply harness to CN24 or CN25 on the inverter.

(1) Printed circuit board switch

Figure 6.11.3 illustrates the general position of the switches as seen from the top surface of the printed circuit board.

- Use SW2 on the DI interface card's printed circuit board to select between sink and source control input.
- Use SW1 on the card's printed circuit board to select between the DIA and DIB settings.

Table 6.11.2

Switch	Factory default
SW2	SINK
SW1	DIA

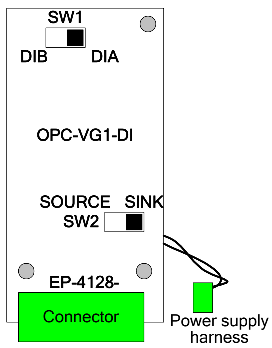


Figure 6.11.3

(2) Input circuits

The following figure illustrates the circuit architecture for the SW2 sink and source settings:

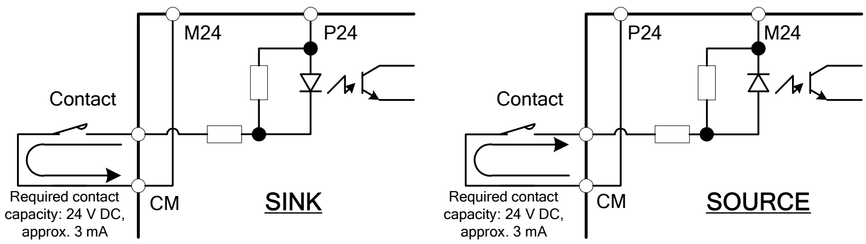


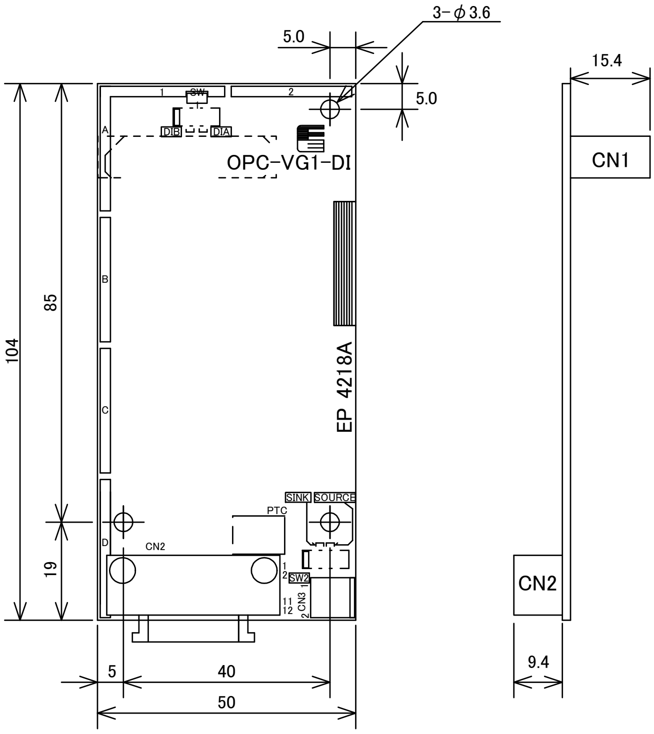
Figure 6.11.4

The option supplies a 24 V power supply (P24: 24 V; M24: ground).

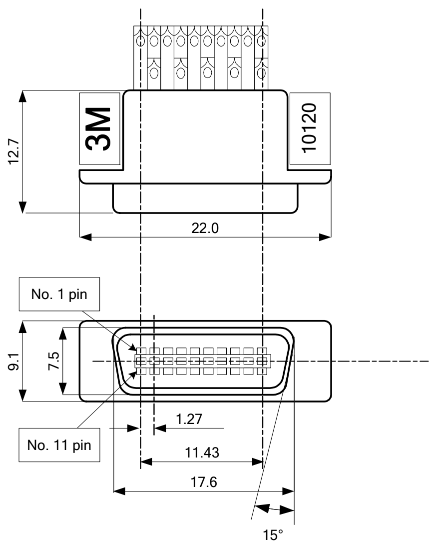
Table 6.11.3 Software specifications

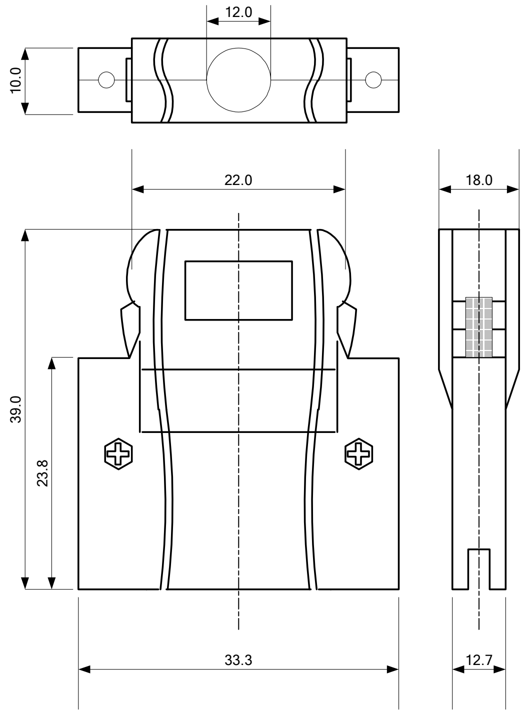
Item	Specifications	
Input data read period	Values are read at a period of 1 ms and are locked when 2 consecutive readings agree.	
Data latch function	Input data hold based on the [DIA] and [DIB] contacts	
Applications	Speed settings:	Input is enabled by setting function code F01 or C25 to 6 (DIA) or 7 (DIB).
	Torque commands:	Input is enabled by setting function code H41 to 2 (DIA) or 3 (DIB).
	Torque current commands:	Input is enabled by setting function code H42 to 2 (DIA) or 3 (DIB).
	Torque limit commands:	Torque limit level 1 input is enabled by setting function code F42 to 2 (DIA) or 3 (DIB).
	Torque limit commands:	Torque limit level 2 input is enabled by setting function code F43 to 2 (DIA) or 3 (DIB).

6.11.3 External dimension drawing



■Accessories





Model: 10120-3000PE
Specifications: 20-pin from
Sumitomo 3M Limited

Figure 6.11.5 Plug

Model: 10320-52A0-008
Specifications: 20-pin from
Sumitomo 3M Limited

Figure 6.11.6 Housing

* Plug and housing are included with the product.

6.11.4 Basic connection diagram

Refer to Section 6.1.4 "Installing internal options (OPC-VG1-□□)" before performing wiring or connection work.

⚠WARNING

- Performing connection work in an inappropriate manner may result in electric shock, fire, or other damage. Qualified electricians should carry out wiring. When touching electrical circuits, for example when performing connection work after the unit has been energized, shut off the power supply's circuit breaker to prevent electric shock.

  The smoothing capacitor remains charged even when the circuit breaker is shut off and will cause an electric shock when touched. Verify that the inverter's charge lamp ("CHARGE") has turned off and use a tester or other instrument to verify that the inverter's DC voltage has fallen to a safe level.

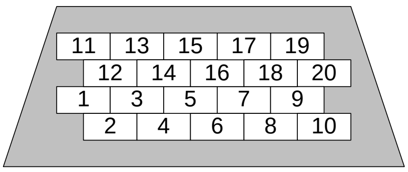
⚠CAUTION

- Do not use products with damaged or missing parts. Doing so may result in bodily injury or damage.

  Inappropriate installation or removal of the product may cause damage to the product.

Table 6.11.4 Terminal Function Descriptions

Pin No.	Name	Function		Pin No.	Name	Function	
		BINARY	BCD			BINARY	BCD
[1]	CM			[11]	CM		
[2]	DI0	$2^0 = 1$	$1\times10^0 = 1$	[12]	DI8	$2^8 = 256$	$1\times10^2 = 100$
[3]	DI1	$2^1 = 2$	$2\times10^0 = 2$	[13]	DI9	$2^9 = 512$	$2\times10^2 = 200$
[4]	DI2	$2^2 = 4$	$4\times10^0 = 4$	[14]	DI10	$2^{10} = 1024$	$4\times10^2 = 400$
[5]	DI3	$2^3 = 8$	$8\times10^0 = 8$	[15]	DI11	$2^{11} = 2048$	$8\times10^2 = 800$
[6]	CM			[16]	CM		
[7]	DI4	$2^4 = 16$	$1\times10^1 = 10$	[17]	DI12	$2^{12} = 4096$	$1\times10^3 = 1000$
[8]	DI5	$2^5 = 32$	$2\times10^1 = 20$	[18]	DI13	$2^{13} = 8192$	$2\times10^3 = 2000$
[9]	DI6	$2^6 = 64$	$4\times10^1 = 40$	[19]	DI14	$2^{14} = 16384$	$4\times10^3 = 4000$
[10]	DI7	$2^7 = 128$	$8\times10^1 = 80$	[20]	DI15	$2^{15} = 32768$	Sign (ON: negative)



Viewed from the plug's soldered terminal

Figure 6.11.7

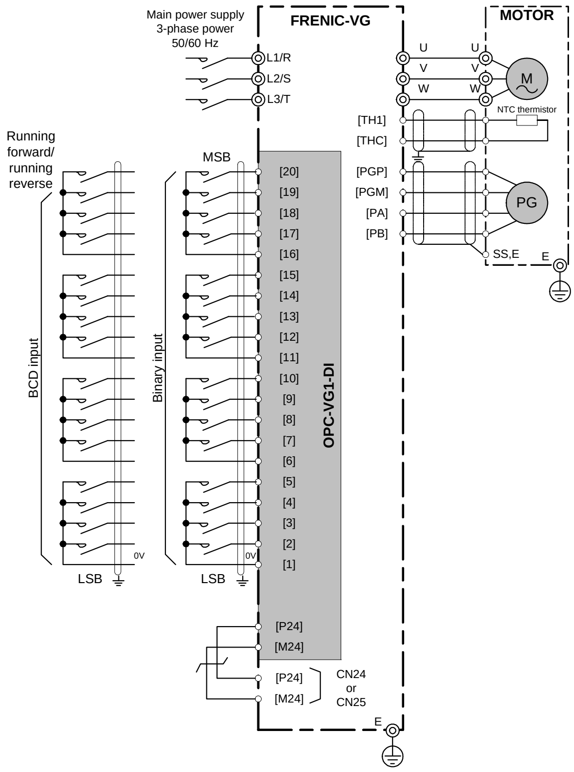


Figure 6.11.8

Note: As a rule, shielded wires are earthed. However, if excessive induced noise from external sources affects the system, the effects of such noise can be reduced by connecting shielded wires to 0 V.

6.11.5 Function codes

⚠WARNING
• Incorrect use of function code data may result in a hazardous state. Consequently, re-check data after finishing setting and writing data. **Risk of accident**

Installation of the DI interface card allows use of function codes o01 to o04. These function codes are not normally (when the option had not been installed) displayed on the keypad.

Table 6.11.5

No.	Parameter name		Setting range	Setting description
	Name	Keypad display		
o01	DIA function selection	DIA FUNC	0, 1	0: Binary 1: BCD
o02	DIB function selection	DIB FUNC	0, 1	0: Binary 1: BCD
o03	DIA BCD input setting	BCD CMND A	99 - 7999	
o04	DIB BCD input setting	BCD CMND B	99 - 7999	

6.11.5.1 Data latch function

DI input data is normally captured internally and applied inside the inverter every 1 ms. A data latch function can be used when you wish to hold DI input data or reduce variation in lower bits when capturing input from an external A/D converter.

[Setting method]

Set function codes X1 to X14 corresponding to the desired contact to 55 (DIA) or 56 (DIB) to assign data latch operation. Then set the contact in question as follows:

On: Normal capture

Off: DI input hold (data is not captured, and the last data value before the contact was turned off)

6.11.5.2 Selecting binary or BCD input

(1) Example input when o01 and o02 are set to binary input
Values from -32,768 to 32,767 are valid.

Table 6.11.6

(MSB)															(LSB)	Converted data
20	19	18	17	15	14	13	12	10	9	8	7	5	4	3	2	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
0	1	0	0	1	1	1	0	0	0	1	0	0	0	0	0	20000
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	32767
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-32768
1	1	0	0	1	1	1	0	0	0	1	0	0	0	0	0	-20000
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	-2
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1

(2) Example input when o01 and o02 are set to BCD input
Values from -7,999 to 7,999 are valid.

Table 6.11.7

(MSB)															(LSB)	Converted data
20	19	18	17	15	14	13	12	10	9	8	7	5	4	3	2	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	4620
0	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1	7999
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	-2
1	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	-462
1	1	1	1	1	0	0	1	1	0	0	1	1	0	0	1	-7999

Sign	Thousands place	Hundreds place	Tens place	Ones place

6.11.5.3 Controlled variable input

(1) Speed settings

When using DI input to set the speed, set function code F01 or C25 (whichever is to be enabled) according to the switch state (DIA or DIB). For example, to enable F01 on a card set to DIA, set F01 to 6.

Control inputs [N2/N1] are used to switch between F01 and C25.

Table 6.11.8

When set to binary input	Set the maximum speed (F03) to 1,500 r/min.
To assign a speed setting of 600 r/min.	$600 \times \frac{20000}{1500} = 8000(d)$ $= 1F40(h)$ = Input 0001_1111_0100_0000 (B) to the DI card.
To assign a speed setting of -1000 r/min.	$-1000 \times \frac{20000}{1500} = -13333(d)$ $= CBEB(h)$ = Input 1100_1011_1100_1011(B) to the DI card.

BCD input is used in applications where the motor speed is converted to the machine speed. For example, when a motor operating at 1,500 r/min. is connected to a machinery shaft via a 5:1 gear, the machinery shaft will rotate at 300.0 r/min. DI input of 3,000 while using a BCD setting (o03 or o04) of 3,000 with these function codes would result in rotation of 300.0 r/min. (1,500 r/min. for the motor).

Table 6.11.9

When set to BCD input	Set the maximum speed (F03) to 1,500 r/min. Set the BCD input setting (o03 or o04) to 3,000. (When the motor operates at 1,500 r/min., the machinery shaft will rotate at 300.0 r/min.)
To set the machinery shaft to a speed of 75.0 r/min. (375 r/min. for the motor)	$75.0 = 0750(BCD)$ = Input 0000_0111_0101_0000 (B) to the DI card.
To set the machinery shaft to a speed of -300.0 r/min. (-1500 r/min. for the motor)	$-300.0 = (-)3000(BCD)$ = Input 1011_0000_0000_0000(B) to the DI card.

(2) Torque, torque current, and torque limit input

When assigning DI input to torque (torque commands, torque current commands, and torque limits), it is necessary to define DIA and DIB use with the function codes H41, H42, F42, and F43 according to the function being used. For more information, see the corresponding sections of Chapter 4.

Table 6.11.10

When set to binary input	The torque scale uses the value 10,000 to represent 100%.
To assign 70% torque	$70 \times \frac{10000}{100} = 7000(d)$ $= 1B58(h)$ = Input 0001_1011_0101_1000(B) to the DI card.
To assign -25% torque	$-25 \times \frac{10000}{100} = -2500(d)$ $= F63C(h)$ = Input 1111_0110_0011_1100(B) to the DI card.

⚠CAUTION

- When using DI input as the speed setting and torque, install two cards for use as DIA and DIB. When the unit is configured so that the same DI input is used as both the speed setting and the torque, the torque setting takes priority.

  Example: When the function code F01 (speed setting N1) is set to 6 (DIA) and the function code H41 (torque command selection) is set to 2 (DIA), the inverter's internal controlled variable for the speed setting will be calculated using the torque command formula.

6.11.6 Check functions

6.11.6.1 Option installation check

```
OP—A：VG1—DIA
OP—B：
OP—C：

∧V→PAGE SHIFT 9
```

You can check on the keypad whether the DI interface card is set to DIA or DIB.

From the Operating Mode screen, go to the Program Menu screen and select “4. I/O check.” Use the (∧) and (∨) keys to switch screens and check the screen corresponding to the DI interface card.

For more information, see the section on keypad operation.

If the card is set to DIA, ☐ will change to ■ on the LCD screen, as shown in the sample to the right.

6.11.6.2 I/O check

```
■DIA ■BCD ☐BIN
A  =×××××
☐DIB ☐BCD ☐BIN
B  =×××××
∧V→PAGE SHIFT 18
```

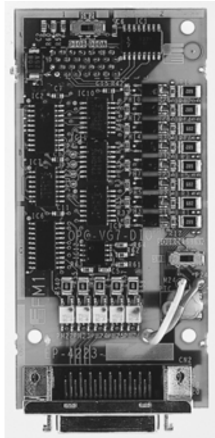
You can check the DI interface card’s digital input status on the inverter’s keypad. From the Operating Mode screen, go to the Program Menu screen and select “4. I/O check.” Use the (∧) and (∨) keys to switch screens and check the screen corresponding to the DI interface card.

Input data is displayed as “XXXXX” in the screenshot to the right.

For example, an indication of “A = 4000” would indicate BCD input of 4000.

6.12 DIO Expansion Card

6.12.1 Product overview



The use of optional OPC-VG1-DIO expansion cards makes it possible to add I/O points, i.e., up to 16 DI points and 10 DO points can be added per optional expansion card. The use of the OPC-VG1-UPAC as another option (available soon) will enable user programs to operate these optional I/O points.

(1) Main applications

Use SW2 on the optional expansion card to select DIOA or DIOB.

If DIOA is selected:

If DIOA is selected, four DI points and eight DO points will be available. In that case, the control functions of the FRENIC-VG will be available as well. These control functions include input control functions, such as coast-to-stop command, multistep speed change, servo lock functions, and output control functions, such as speed agreement and running functions.

If DIOB is selected:

If DIOB is selected, 16 DI points and 10 DO points will be available. These I/O points are operable through an UPAC option. That is, these I/O will be operable on user programs written with an UPAC option.

The I/O control of DIOB cards mounted to other inverters will be possible if a terminal block supporting high-speed serial communication is mounted in addition to the UPAC option.

(2) Photocoupler insulation

The I/O interface block is photocoupler insulated.

(3) Sink/Source

The I/O interface block allows the section of current sink output (hereinafter referred to as SINK) and current source output (hereinafter referred to as SOURCE).

The output interface block allows bi-directional power connections.

Interfaces in general often used in Japan and the United States has SINK output. This output is set to 0 V with signals activated. Interfaces often used in Europe has SOURCE output. This output is set to +V with signals activated.

OPC-VG1-DIO expansion cards will not be available if a PLC terminal is used for the circuit in control of the built-in digital input pins (FWD, REV, and X1-9) of the FRENIC-VG. For details, contact your Fuji Electric representative.

(4) I/O check functions

The selection of either DIOA or DIOB makes it possible to confirm the ON/OFF status of each I/O signal through the keypad or over communication (RS-485, T Link, CC-Link, SX bus, and UPAC).

(5) Optional function codes

Function codes to allocate FRENIC-VG I/O control functions will be operable if DIOA is selected. Specifically, the corresponding function codes (E10 to E13 and E20 to E27) will be displayed on the keypad by selecting DIOA if the option is mounted. Use these functions to allocate functions to four DI points and eight DO points.

(6) UPAC function

Optional I/O points will be operable through the program for the UPAC option if DIOB is selected. Optional I/O points will be operable in the same manner if DIOA is selected. Therefore, up to 20 DI points and 18 DO points will be operable if two DIO expansion cards as options are used and one of the expansion cards is set to DIOA and the other one is set to DIOB. This means that the operation of up to 31 DI points and 23 DO points will be available to a single FRENIC-VG unit with consideration of the number of built-in I/O points.

The two DIO expansion cards mounted cannot be both set to DIOA or DIOB. If such settings are made, operating procedure alarm Er-5 will result.

6.12.2 Models and specifications

6.12.2.1 Models

⚠CAUTION
• An UPAC option will be required if an optional DIO expansion card is set to DIOB (16 DI points and 10 DO points). The standard I/O functions of the FRENIC-VG will be available if the optional DIO expansion card is set to DIOA.

An optional DIO expansion card for the FRENIC-VG incorporates a hardware switch (SW1), with which DIOA or DIOB will be selectable according to the application.

Model legend: OPC-VG1-DIO

- Name of inverter mounted: VG1→ FRENIC-VG
- Name of option: DIO → Digital I/O option

Accessories

Plug (Model: Sumitomo 3M's 10136-3000VE for 36 pins)
Housing (Model: Sumitomo 3M's 10336-52F0-008 for 36 pins)
Spacer: 3
Screw (M3): 3

[Mounting restrictions]

(1) Mountable combinations

- Two optional DIO expansion cards will be mountable if one of them is set to DIOA and the other one is set to DIOB.
- Use the optional UPAC card as well in the case of making DIOB settings.

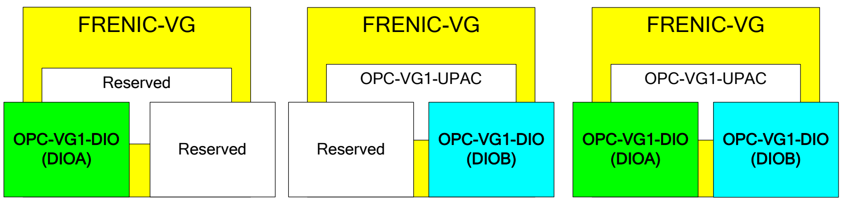


Figure 6.12.1

(2) Combinations not mountable (operating procedure error)

The two DIO expansion cards mounted cannot be both set to DIOA. The two DIO expansion cards mounted cannot be both set to DIOB, either. If such settings are made, operating procedure error Er-6 will result.

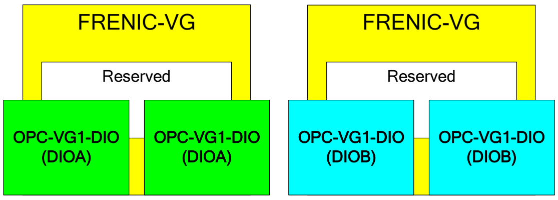


Figure 6.12.2

6.12.2.2 Specifications

⚠CAUTION
• The system will not operate normally if settings for the switches (SW1 and SW2) on the optional expansion cards are wrong. Refer to the following settings and make correct settings.

Table 6.12.1 Hardware Specifications

Item		Specification	
		DIOA	DIOB (dedicated to UPAC)
Name		DIO expansion card	
Model		OPC-VG1-DIO *DIOA or DIOB is selected with SW2.	
Input	Number of points	4 (X11-X14)	16 (X21-X36)
	Ground	CM: Ground common to all the four points.	
	Circuit	Photocoupler-insulated circuit SW1 is used to select current sink output (SINK) or current source output (SOURCE). Rated continuous current per circuit: Approximately 3 mA	
Output	Number of points	8 (Y11-Y18)	10 (Y21-Y30)
	Ground	CME: Ground common to both two points.	
	Circuit	Photocoupler-insulated circuit (50 mA DC max. at 28 V max.) Bi-directional connections possible. (SINK and SOURCE)	
Power supply		24 V Power is supplied through the PCB of the FRENIC-VG. Connect the power supply harness to CN24 or CN25 of the FRENIC-VG.	

(1) PCB switch

Figure 7-41 shows approximate positions of the switches seen from the front side of the PCB.

- Use SW1 on the PCB of the optional expansion card to select SINK or SOURCE control input. Not control output switching is available.
- Use SW2 on the PCB of the optional expansion card to select DIOA or DIOB.

Table 6.12.2

Switch	Factory default
SW1	SINK
SW2	DIOA

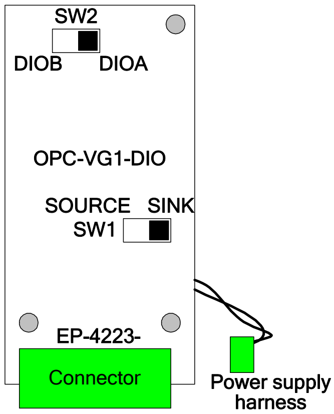


Figure 6.12.3

(2) Input circuit

The respective circuit configurations below show examples of SW1 set to SINK and SOURCE.
In these cases, 24-V power is supplied from the optional expansion card. (P24: 24 V; M24: Ground)

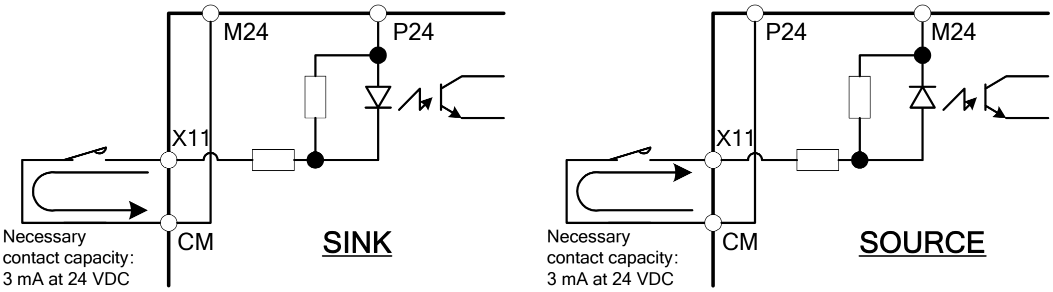


Figure 6.12.4

(3) Output circuit

The output interface block allows bi-directional power connections. The CME is common to all contacts (Y11 to Y30). Therefore, no bi-directional signals can coexist.

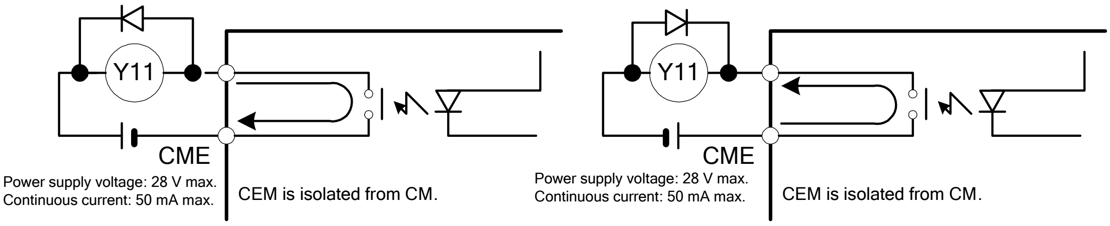


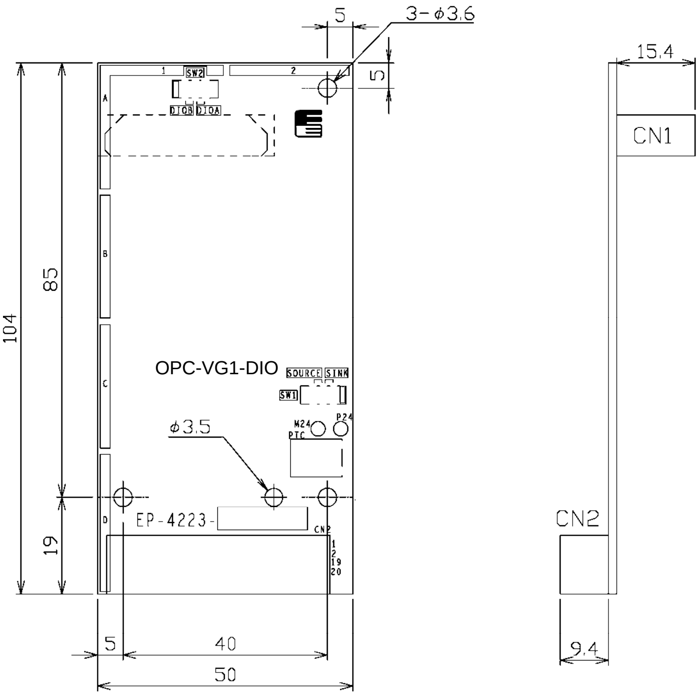
Figure 6.12.5

As shown in Figure 6.12.5, connect a surge-absorbing diode to both ends of the excitation coil when connecting the control relay.

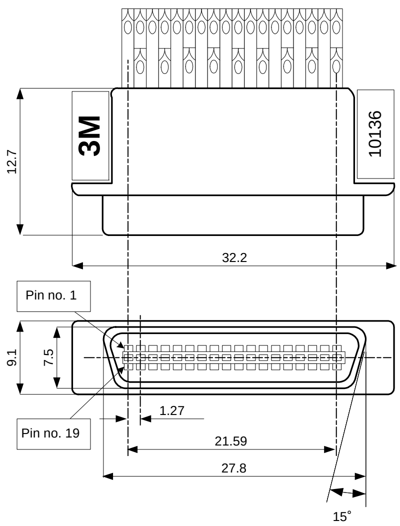
Table 6.12.3 Software Specifications

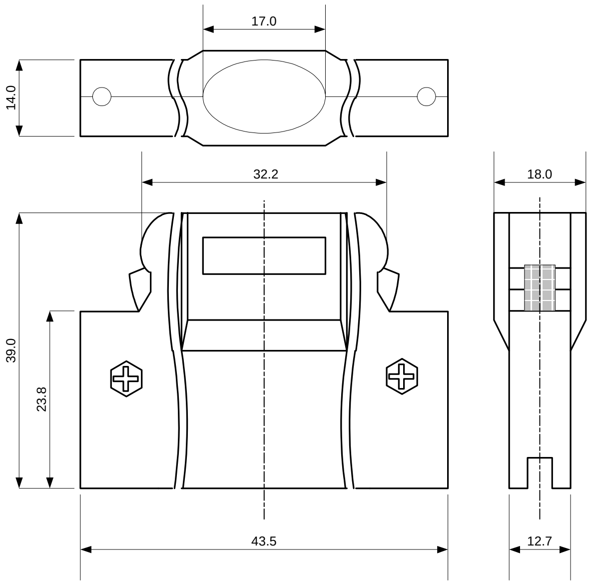
Item		Specification
Input data	Read cycle	Data is read at 1-ms cycles and determined if the data consecutively read twice coincides.
	Function allocation	Possible if DIOA is used. See table 6.12.6.
Output data	Refresh cycle	Refreshed at 1-ms cycles. Some output functions may be refreshed at cycles longer than 1 ms.
	Function allocation	Possible if DIOA is used. See table 6.12.7.

6.12.3 Dimensions



Accessories





Model: 10136-3000VE
Specifications: Sumitomo 3M's for 36 pins

Figure 6.12.6 Plug

Model: 10336-52F0-008
Specifications: Sumitomo 3M's for 36 pins

Figure 6.12.7 Housing

* The plug and housing are provided with the product.

6.12.4 Basic schematic diagrams

Refer to 6.1.4 Installing Internal Options (OPC-VG1-□□) and wire and connect the FRENIC-VG.

⚠WARNING

- Improper connections may result in disasters, such as electric shocks or fires. Qualified electricians should carry out wiring. Turn OFF the breaker on the power supply side for electric shock prevention in the case of touching the electric circuit during connection work.

  Do not touch the smoothing capacitors soon after the breaker is turned OFF, because the smoothing capacitors will store charge for a while and an electric shock will be received. Check with a multimeter that the DC voltage on the inverter is low enough after the CHARGE lamp of the inverter is turned OFF.

⚠CAUTION

- Do not use the product that is damaged or lacking parts. Otherwise, injury and damage may result.

  Incorrect handling in installation/removal jobs could cause a failure.

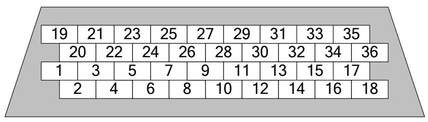
6.12.4.1 Basic schematic diagram (DIOA)

Table 6.12.4 shows the plug pin arrangement.

Figure 6.12.4

Pin no.	Name	Function
[1]	CM	Common (M24)
[2]	X11	Control input X11
[3]	X12	Control input X12
[4]	X13	Control input X13
[5]	X14	Control input X14
[6]	CM	Common (M24)
[7]-[12]	-	Not connected

Pin no.	Name	Function
[13]	Y11	Control output Y11
[14]	Y12	Control output Y12
[15]	Y13	Control output Y13
[16]	Y14	Control output Y14
[17]	Y15	Control output Y15
[18]	CME	Output common
[19]-[30]	-	Not connected
[31]	Y16	Control output Y16
[32]	Y17	Control output Y17
[33]	Y18	Control output Y18
[34],[35]	-	Not connected
[36]	CME	Output common



Viewed from the soldered pin side of the plug

Figure 6.12.8

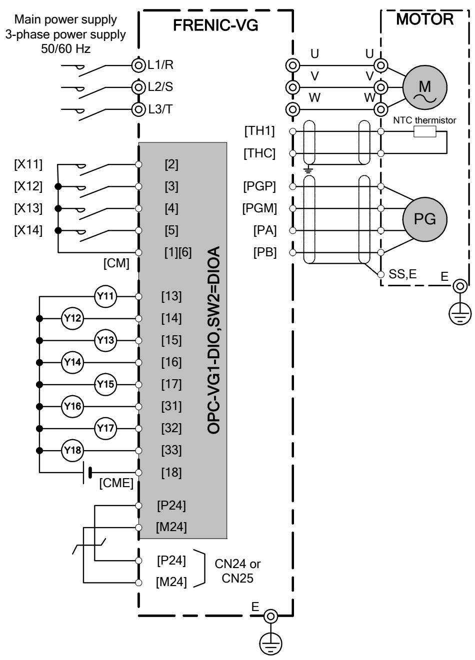


Figure 6.12.9

Note: The shielded wire should be basically earthed. If strong inductive noise interferes with the FRENIC-VG, however, the influence of the noise may be suppressed by connecting the shielded wire to the 0-V line.

6.12.4.2 Basic schematic diagram (DIOB)

Only the use of the OPC-VG1-UPAC as another option (available soon) will make it possible to operate the I/O points of the DIO expansion card.

Table 6.12.5 shows the plug pin arrangement.

Figure 6.12.5

Pin no.	Name	Function	Pin no.	Name	Function
[1]	CM	Common (M24)	[13]	Y21	Control output Y21
[2]	X21	Control input X21	[14]	Y22	Control output Y22
[3]	X22	Control input X22	[15]	Y23	Control output Y23
[4]	X23	Control input X23	[16]	Y24	Control output Y24
[5]	X24	Control input X24	[17]	Y25	Control output Y25
[6]	CM	Common (M24)	[18]	CME	Output common
[7]	X25	Control input X25	[31]	Y26	Control output Y26
[8]	X26	Control input X26	[32]	Y27	Control output Y27
[9]	X27	Control input X27	[33]	Y28	Control output Y28
[10]	X28	Control input X28	[34]	Y29	Control output Y29
[11]	-	Not connected	[35]	Y30	Control output Y30
[12]	-	Not connected	[36]	CME	Output common
[19]	CM	Common (M24)			
[20]	X29	Control input X29			
[21]	X30	Control input X30			
[22]	X31	Control input X31			
[23]	X32	Control input X32			
[24]	CM	Common (M24)			
[25]	X33	Control input X33			
[26]	X34	Control input X34			
[27]	X35	Control input X35			
[28]	X36	Control input X36			
[29]	-	Not connected			
[30]	-	Not connected			

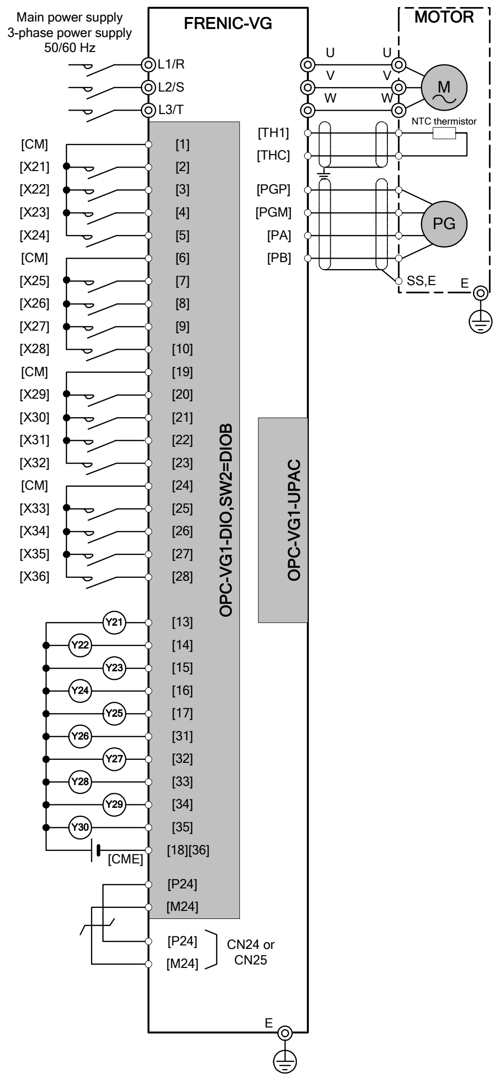
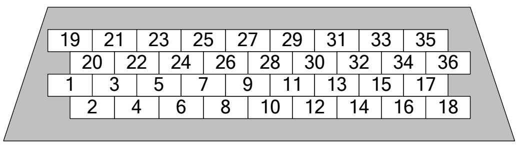


Figure 6.12.10



Viewed from the soldered pin side of the plug

Figure 6.12.11

Note: The shielded wire should be basically earthed. If strong inductive noise interferes with the FRENIC-VG, however, the influence of the noise may be suppressed by connecting the shielded wire to the 0-V line.

6.12.5 Function codes

⚠WARNING

- A dangerous condition may result if a mistake is made in function code data. Check the data again after the data is set and entered.

  Otherwise, an accident could occur.

6.12.5.1 DIOA selected

(1) Input

The following functions can be set freely to four digital input pins (X11 to X14).

The functions are set with functions codes E10 through E13.

Table 6.12.6

Set value	Function	Symbol	Set value	Function	Symbol
0,1,2,3	Multistep speed setting (1 to 15 steps)	[SS1, 2, 3 ,4]	31	H41 [Torque command] cancel	[H41-CCL]
4,5	ASR, Acceleration and deceleration selection (4 steps)	[RT1, RT2]	32	H42 [Torque current command] cancel	[H42-CCL]
6	Self hold selection	[HLD]	33	H43 [Magnetic flux reference] cancel	[H43-CCL]
7	Coast-to-stop command	[BX]	34	F40 [Torque limiting mode 1] cancel	[F40-CCL]
8	Error reset	[RST]	35	Torque limiting (level 1 or level 2 selection)	[TL2/TL1]
9	External alarm	[THR]	36	Bypass	[BPS]
10	Jogging operation	[JOG]	37,38	Torque bias command 1/2	[TB1, TB2]
11	Speed setting N2/Speed setting N1	[N2/N1]	39	Drooping selection	[DROOP]
12	Motor M2 selection	[M-CH2]	40	Ai1 zero-hold	[ZH-AI1]
13	Motor M3 selection	[M-CH3]	41	Ai2 zero-hold	[ZH-AI2]
14	DC braking command	[DCBRK]	42	Ai3 zero-hold (AIO optional function)	[ZH-AI3]
15	ACC/DEC zero-clear command	[CLR]	43	Ai4 zero-hold (AIO optional function)	[ZH-AI4]
16	UP/DOWN setting creeping speed change	[CRP-N2/N1]	44	Ai1 polarity changeover	[REV-AI1]
17	UP/DOWN setting UP command	[UP]	45	Ai2 polarity changeover	[REV-AI2]
18	UP/DOWN setting DOWN command	[DOWN]	46	Ai3 polarity changeover (AIO optional function)	[REV-AI3]
19	Keypad editing permit command (data changeable)	[WE-KP]	47	Ai4 polarity changeover (AIO optional function)	[REV-AI4]
20	PID control cancel	[KP/PID]	48	PID output reverse operation selection	[PID-INV]
21	Forward/Reverse operation selection	[IVS]	49	PG alarm cancel	[PG-CCL]
22	Interlock (52-2)	[IL]	50	Undervoltage cancel	[LU-CCL]
23	Link editing permit command	[WE-LK]	51	Ai torque bias hold	[H-TB]
24	Link operation selection	[LE]	52	STOP1 (decelerates to stop in normal controlled stop time)	[STOP1]
25	Universal DI	[U-DI]	53	STOP2 (decelerates to stop in controlled stop time 4)	[STOP2]
26	Starting characteristic selection	[STM]	54	STOP3 (decelerates to stop with maximum braking torque)	[STOP3]
27	Synchronized operation command (PG (PR) optional function)	[SYC]	55	DIA data latch	[DIA]
28	Zero-speed lock command	[LOCK]	56	DIB data latch	[DIB]
29	Pre-excitation command	[EXITE]	57	Multiplex system cancel	[MT-CCL]
30	Speed command limiting cancel	[N-LIM]	58-67	Custom Di1-Di10	[C-DI1-10]

(2) Output

The following functions can be set freely to eight digital output pins (Y11 to Y18).

The functions are set with functions codes E20 through E27.

Table 6.12.7

Set value	Function	Symbol	Set value	Function	Symbol
0	Running	[RUN]	20	Alarm content	[AL2]
1	Speed provided	[N-EX]	21	Alarm content	[AL4]
2	Speed agreement	[N-AG]	22	Alarm content	[AL8]
3	Speed equivalence	[N-AR]	23	Cooling fan running	[FAN]
4	Speed detection 1	[N-DT1]	24	Auto-restart function running	[TRY]
5	Speed detection 2	[N-DT2]	25	Universal DO	[U-DO]
6	Speed detection 3	[N-DT3]	26	Cooling fin overheat early warning	[INV-OH]
7	Undervoltage stopping	[LU]	27	Synchronous control completion	[SY-C]
8	Torque polarity detection (braking/driving)	[B/D]	28	Life early warning	[LIFE]
9	Torque limiting	[TL]	29	Acceleration	[U-ACC]
10	Torque detection 1	[T-DT1]	30	Deceleration	[U-DEC]
11	Torque detection 2	[T-DT2]	31	Inverter overload early warning	[INV-OL]
12	Keypad panel operation	[KP]	32	Motor overheating early warning	[M-OH]
13	Stopping	[STOP]	33	Motor overload early warning	[M-OL]
14	Operation preparation completion	[RDY]	34	DB overload early warning	[DB-OL]
15	Magnetic flux detection signal	[MF-DT]	35	Transmission error	[LK-ERR]
16	Motor M2 selection state	[SW-M2]	36	Response load control limiting	[ANL]
17	Motor M3 selection state	[SW-M3]	37	Response load control calculation	[ANC]
18	Brake release signal	[BRK]	38	Analog torque bias holding	[TBH]
19	Alarm content	[AL1]	39-48	Custom Do1-Do10	[C-DO1-10]

* Refer to Chapter 4 for set values, functions, and symbols other than the above.

Function Codes

The following function codes are used to allocate I/O functions.

Table 6.12.8

No.	Parameter name		Setting range	Description
	Name	Keypad display		
E10	X11 function selection	X11 FUNC	0-76	See Chapter 4
E11	X12 function selection	X12 FUNC	0-76	
E12	X13 function selection	X13 FUNC	0-76	
E13	X14 function selection	X14 FUNC	0-76	
E20	Y11 function selection	Y11 FUNC	0-81	See Chapter 4
E21	Y12 function selection	Y12 FUNC	0-81	
E22	Y13 function selection	Y13 FUNC	0-81	
E23	Y14 function selection	Y14 FUNC	0-81	
E24	Y15 function selection	Y15 FUNC	0-81	
E25	Y16 function selection	Y16 FUNC	0-81	
E26	Y17 function selection	Y17 FUNC	0-81	
E27	Y18 function selection	Y18 FUNC	0-81	

6.12.5.2 DIOB selected

Only the use of the OPC-VG1-UPAC as another option (available soon) will make it possible to operate the following functions.

DIOB functions are allocated to control variables (to be specific, global variables allocated to the control variables) that will be available at the time of selecting a six-unit FRENIC-VG system.

To use DIOB functions, select the corresponding control variables from the list of control variables or specify the address (%IQ area) of each DIOB function and register the control variable, and check the box in the system definition.

The optional OPC-VG1-SIU module is required to operate DIOB options INV2 through INV6.

Table 6.12.9

Address	No	Area	Name	Data category	Type	Direction	
%IW1.13	14	INV1	DI control of INV1 (DIOB option; 16 bits)	Data category; 26	W	INV12,3,4,5,6→UPAC	The UPAC is in DI control of INV1 through INV6. Used by INV1 through INV6.
%IW2.13	14	INV2	DI control of INV2 (DIOB option; 16 bits)	Data category; 26	W		
%IW3.13	14	INV3	DI control of INV3 (DIOB option; 16 bits)	Data category; 26	W		
%IW4.13	14	INV4	DI control of INV4 (DIOB option; 16 bits)	Data category; 26	W		
%IW5.13	14	INV5	DI control of INV5 (DIOB option; 16 bits)	Data category; 26	W		
%IW6.13	14	INV6	DI control of INV6 (DIOB option; 16 bits)	Data category; 26	W		
%QW1.41	24	INV1	DO control of INV1 (DIOB option; 10 bits)	Data category; 27	W	UPAC→INV1,2,3,4,5,6	The UPAC is in DO control of INV1 through INV6. Used by INV1 through INV6.
%QW2.41	24	INV2	DO control of INV2 (DIOB option; 10 bits)	Data category; 27	W		
%QW3.41	24	INV3	DO control of INV3 (DIOB option; 10 bits)	Data category; 27	W		
%QW4.41	24	INV4	DO control of INV4 (DIOB option; 10 bits)	Data category; 27	W		
%QW5.41	24	INV5	DO control of INV5 (DIOB option; 10 bits)	Data category; 27	W		
%QW6.41	24	INV6	DO control of INV6 (DIOB option; 10 bits)	Data category; 27	W		

6.12.6 Check function

6.12.6.1 Mounting check on optional cards

```
OP—A：VG1—DIOA
OP—B：
OP—C：

∧V→PAGE SHIFT 9
```

When an optional DIO expansion card is mounted, it will be possible to check with the keypad whether the optional DIO expansion card is set to DIOA or DIOB.

Go to the Program Menu screen from the Operation Mode screen and select “4. I/O CHECK”. Select the screen with the UP and DOWN keys (∧ and ∨) and check the screen corresponding to the optional DIO expansion card.

For details, refer to the information provided in this manual on how to operate the keypad.

As shown in the LCD screen example on the right-hand side, the corresponding number will be highlighted (□→■) if DIOA is set.

6.12.6.2 I/O check

It is possible to check with the keypad of the inverter the digital I/O status of optional DIO expansion cards. Go to the Program Menu screen from the Operation Mode screen and select “4. I/O CHECK.” Select the screen with the UP and DOWN keys (∧ and ∨) and check the screen corresponding to the optional DIO expansion card.

The number corresponding to a contact will be highlighted (□→■) if the contact is ON.

```
R□×11  C□×11
 □×12   □×12
 □×13   □×13
 □×14   □×14
∧V→PAGE SHIFT16
```

DIOA I/O status

```
X□21□25□29□33
 □22□26□30□34
 □23□27□31□35
 □24□28□32□36
∧V→PAGE SHIFT19
```

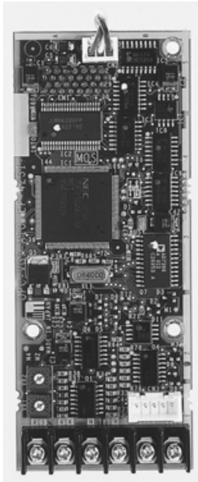
DIOB input status

```
□Y21 □Y25 □Y29
□Y22 □Y26 □Y30
□Y23 □Y27
□Y24 □Y28
∧V→PAGE SHIFT20
```

DIOB output status

6.13 AIO Expansion Card

6.13.1 Product overview



The FRENIC-VG incorporates six built-in analog I/O points, i.e., one I/O point each allocated to pin numbers [Ai1], [Ai2], [AO1], [AO2], and [AO3] besides an input point (speed command input dedicated) dedicated to number 12.

The use of an optional OPC-VG1-AIO expansion card makes it possible to add 2 [Ai] and 2 [AO] points.

(1) Main applications

The OPC-VG1-AIO enables control functions that are the same as those of the built-in analog I/O of the FRENIC-VG. For example, the available analog input functions include auxiliary speed setting 1, torque bias, torque command, and magnetic flux reference functions and analog output functions include speedometer, torque meter, torque current meter, and line speed detection functions.

(2) Covering a shortage of analog I/O points

Apply the OPC-VG1-AIO to a system employing the UPAC (available soon) or control system that uses the built-in PID control of the inverter if the number of built-in analog I/O points is insufficient.

In the case of using the WPS-VG1-TEN in tension control, for example, the three built-in points of the FRENIC-VG will be all occupied for line speed, tension setting, and tension detection purposes. This expansion card will be required if the user wants to add one more point to such a system.

If the system, however, uses the OPC-VG1-SN as an optional synchronous interface for dancer control, this expansion card cannot be used due to the mounting limits on the analog option. Furthermore, if the built-in PID control of the inverter is used, the PID command (for process settings) and PID feedback amount (process amount) will occupy Ai1 and Ai2. This expansion card will be required if the user wants to add a point, e.g., a PID correction gain, to the system.

6.13.2 Models and specifications

6.13.2.1 Models

⚠CAUTION
• Only a single optional AIO expansion card can be mounted on the control PCB. The optional AIO expansion card cannot be mounted if an OPC-VG1-SPGT or other optional (FV or SN) analog card is already mounted.

Model legend: OPC-VG1-AIO

- Name of inverter mounted: VG1→ FRENIC-VG
- Name of option: AIO → Analog I/O option

Accessories

Spacer: 3

Screw (M3): 3

Power supply harness (±15 V power supply): 1

[Mounting restrictions]

(1) Combinations not mountable

The optional AIO expansion card cannot be mounted if an OPC-VG1-SPGT, OPC-VG1-FV, or other optional (SN) analog card is already mounted.

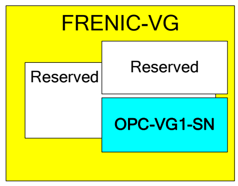


Figure 6.13.1

6.13.2.2 Specifications

⚠CAUTION

- The built-in variable resistors (VR1 and VR2) of the optional AIO expansion card are adjusted before shipping. Never touch the variable resistors.

Table 6.13.1 Hardware Specifications

Item		Specification
Name		AIO Expansion Card
Model		OPC-VG1-AIO
Input	No. of points	2 ([Ai3] and [Ai4])
	Ground	[M] (internally connected to built-in control terminal [M] of the card)
	Circuit	Input voltage: 0 to ±10 VDC; resolution: 11 bits (signed) Input impedance: 10 kΩ
Output	No. of points	2 ([AO4] and [AO5])
	Ground	[M] (internally connected to built-in control terminal [M] of the card)
	Circuit	Output voltage: 0 to ±10 VDC; resolution: 12 bits (signed) Output impedance: 3 kΩ min.
Power supply		±15 V Power is supplied through the PCB of the FRENIC-VG. Connect the power supply harness to CN12 of the FRENIC-VG.
VR1 and VR2		These variable resistors are adjusted before shipping. Never touch them.

Table 6.13.2 Software Specifications

Item		Specification
Input data	Read cycle	1 ms
	Function allocation	Set with functional codes E51 and E52.
	Input processing	Bias, gain, filter, increment/decrement limiter, zero-hold, polarity changeover, offset, and dead zone settings are possible individually.
Output data	Refresh cycle	1 ms
	Function allocation	Set with functional codes E72 and E73.
	Output processing	Bias and gain settings are possible individually. Filter settings for all AO functions are possible.

(1) Input

Two analog input points ([Ai3] and [Ai4]) can be freely set to the following functions.

The functions are set with functions codes E51 through E52. Ai3 takes precedence if the same function is set to both [Ai3] and [Ai4]. [Ai1] takes precedence if the same function is set to [Ai1] through [Ai4].

Table 6.13.3 Allocation of Input Functions

Set value	Function	Symbol	Scale
0	Input signal shutoff	[OFF]	—
1	Auxiliary speed setting 1	[AUX-N1]	±10 V/± N_{max}
2	Auxiliary speed setting 2	[AUX-N2]	±10 V/± N_{max}
3	Torque limiting (level 1)	[TL-REF1]	±10 V/±150%
4	Torque limiting (level 2)	[TL-REF2]	±10 V/±150%
5	Torque bias	[TB-REF]	±10 V/±150%
6	Torque command	[T-REF]	±10 V/±150%
7	Torque current command	[IT-REF]	±10 V/±150%
8	Creep speed 1 for UP/DOWN setting	[CRP-N1]	±10 V/± N_{max}
9	Creep speed 2 for UP/DOWN setting	[CRP-N2]	±10 V/± N_{max}
10	Magnetic flux reference	[MF-REF]	+10 V/+100%
11	Line speed detection	[LINE-N]	±10 V/± N_{max}
12	Motor temperature	[M-TMP]	+10 V/+200°C
13	Speed override	[N-OR]	±10 V/±50%
14	Universal AI	[U-AI]	±10 V/±4000(h)
15	PID feedback amount	[PID-FB]	±10 V/±100%
16	PID command value	[PID-REF]	±10 V/±100%
17	PID correction gain	[PID-G]	±10 V/±100%
18-24	Custom-AI1-7	[C-AI1-7]	±10 V/±7FFF(h)

* Refer to Chapter 4 for set values and functions other than the above.

(2) Output

Two analog output points ([AO4] and [AO5]) can be freely set to the following functions.

The functions are set with functions codes E72 and E73.

Table 6.13.4 Allocation of Output Functions

Set value	Function	Symbol	Scale
0	Speed detection 1 (Speedometer, single deflection)	[N-FB1+]	+ N_{max}/10 V
1	Speed detection 1 (Speedometer, double deflection)	[N-FB1±]	± N_{max}/±10 V
2	Speed setting 2 (before acceleration and deceleration operation)	[N-REF2]	± N_{max}/±10 V
3	Speed setting 4 (ASR input)	[N-REF4]	± N_{max}/±10 V
4	Speed detection 2 (ASR input)	[N-FB2±]	± N_{max}/±10 V
5	Line speed detection	[LINE-N±]	± N_{max}/±10 V
6	Torque current command (Torque ammeter, double deflection)	[IT-REF±]	±150%/±10 V
7	Torque current command (Torque ammeter, single deflection)	[IT-REF+]	+150%/+10 V
8	Torque command (Torque meter, double deflection)	[T-REF±]	±150%/10 V
9	Torque command (Torque meter, single deflection)	[T-REF+]	+150%/+10 V
10	Motor current	[I-AC]	200%/+10 V
11	Motor voltage	[V-AC]	200%/+10 V
12	Power consumption	[PWR]	200%/+10 V
13	DC intermediate voltage	[V-DC]	800V/+10 V
14	+10 V output test	[P10]	+10 V equivalent output
15	-10V output test	[N10]	-10 V equivalent output
30	Universal AO	[U-AO]	±4000(h)/±10 V
31-37	Custom-AO1-7	[C-AO1-7]	±4000(h)/±10 V

* Nmax: Maximum speed of motor currently selected (set value of F03 or A06 or A106)

* Refer to Chapter 4 for set values and functions other than the above.

6.13.3 Dimensions

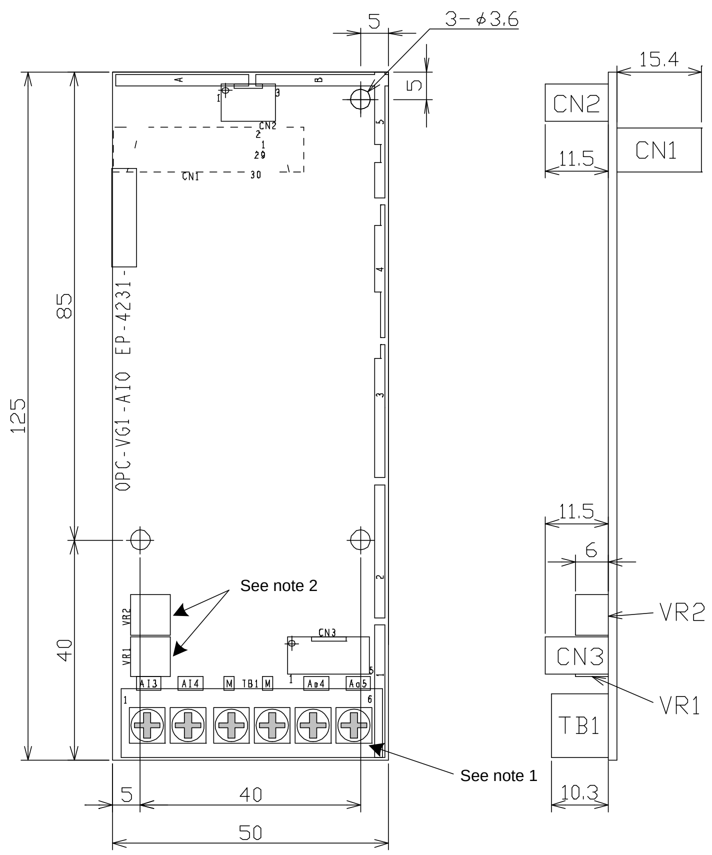


Figure 6.13.2

Note 1: Terminal screw size: M3

Note 2: The variable resistors (VR1 and VR2) are adjusted before shipping. Never make VR1 or VR2 setting changes.

6.13.3.1 Specifications

Refer to Section 6.1.4 "Installing internal options (OPC-VG1-□□)" before performing wiring or connection work.

⚠WARNING
• Improper connections may result in disasters, such as electric shocks or fires. Qualified electricians should carry out wiring. Turn OFF the breaker on the power supply side for electric shock prevention in the case of touching the electric circuit during connection work. Do not touch the smoothing capacitors soon after the breaker is turned OFF, because the smoothing capacitors will store charge for a while and an electric shock will be received. Check with a multimeter that the DC voltage on the inverter is low enough after the CHARGE lamp of the inverter is turned OFF.

⚠CAUTION
• Do not use the product that is damaged or lacking parts. Otherwise, injury and damage may result. Incorrect handling in installation/removal jobs could cause a failure.

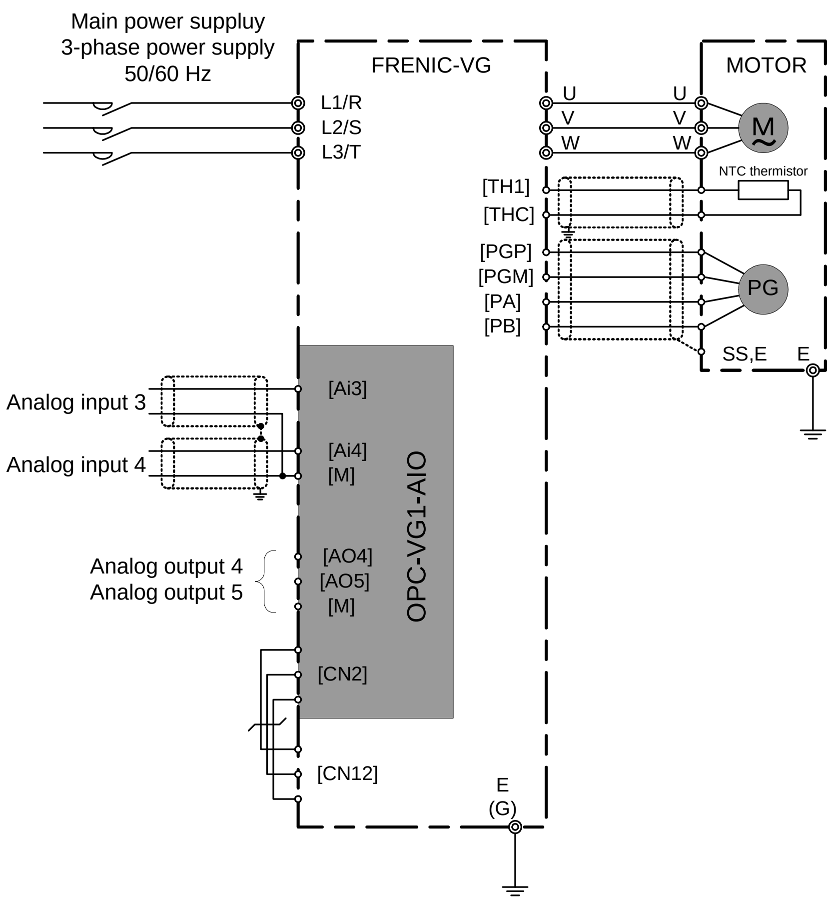


Figure 6.13.3

6.13.4 Function codes

⚠WARNING

- A dangerous condition may result if a mistake is made in function code data. Check the data again after the data is set and entered.

  Otherwise, an accident could occur.

⚠CAUTION

- The keypad will not display any optional function codes of the optional AIO expansion card (i.e., E51, E52, E55, E56, E59, E60, E63, E64, E67, E68, E72, E73, E77, E78, E82, E83, E103, E104, E107, or E108) unless the optional AIO expansion card is mounted. These optional function codes will be displayed only after the optional expansion card is mounted.

Function codes E51, E52, E55, E56, E59, E60, E63, E64, E67, E68, E72, E73, E77, E78, E82, E83, E103, E104, E107, and E108 will be operable with this optional expansion card mounted.

The keypad will display these function codes with the optional AIO expansion card mounted. Otherwise, the keypad will not display the functions.

Table 6.13.5

No.	Parameter name		Setting range	Description
	Name	Keypad display		
E51	Ai3 function selection	Ai3 FUNC	0-27	See Chapter 4
E52	Ai4 function selection	Ai4 FUNC	0-27	
E55	Ai3 gain setting	GAIN Ai3	-10.000-10.000 (times)	
E56	Ai4 gain setting	GAIN Ai4	-10.000-10.000 (times)	
E59	Ai3 bias setting	BIAS Ai3	-100.0-100.0(%)	
E60	Ai4 bias setting	BIAS Ai4	-100.0-100.0(%)	
E63	Ai3 filter setting	FILTER Ai3	0.000-0.500(s)	
E64	Ai4 filter setting	FILTER Ai4	0.000-0.500(s)	
E67	Increment/decrement limiter (Ai3)	A/D-L-Ai3	0.00-60.00(s)	
E68	Increment/decrement limiter (Ai4)	A/D-L-Ai4	0.00-60.00(s)	
E72	AO4 function selection	AO4 FUNC	0-40	
E73	AO5 function selection	AO5 FUNC	0-40	
E77	AO4 gain setting	GAIN AO4	-100.00-100.00 (times)	
E78	AO5 gain setting	GAIN AO5	-100.00-100.00 (times)	
E82	AO4 bias setting	BIAS AO4	-100.0-100.0(%)	
E83	AO5 bias setting	BIAS AO5	-100.0-100.0(%)	
E84	AO1-5 filter setting	FILT AO1-5	0.000-0.500(s)	
E103	Ai3 offset	Ai3 OFSET	-100.00-100.00(%)	
E104	Ai4 offset	Ai4 OFSET	-100.00-100.00(%)	
E107	Ai3 dead zone	Ai3 BLIND	0.00-10.00(%)	
E108	Ai4 dead zone	Ai4 BLIND	0.00-10.00(%)	

Chap. 6 CONTROL OPTIONS

6.13.5 Check function

(1) Optional Module Mounting Check

It is possible to check with the keypad whether the optional AIO expansion card is correctly mounted.

```
OP—A：VG1—AIO
OP—B：
OP—C：

∧V→PAGE SHIFT 9
```

Go to the Program Menu screen from the Operation Mode screen and select “4. I/O CHECK.”

Select the screen with the UP and DOWN keys (∧ and ∨) and check the screen corresponding to the optional AIO expansion card.

For details, refer to the information provided in this manual on how to operate the keypad.

As shown in the LCD screen example on the right-hand side, the corresponding number will be highlighted (□→■) if it is correctly mounted.

(2) I/O check

It is possible to check with the keypad of the inverter the I/O status of optional AIO expansion cards.

```
<LED MNTR>    18
Ai  ADJUSTMENT
(Ai3)

F/D→LED  SHIFT
```

Check with Monitor LED

Press the FUNC/DATA key (FUNC DATA) in the operation mode screen and select the corresponding item.

The 7-segment LED indicator will display the current analog input status in percentage.

Analog input gain and bias settings can be made by referring to the LED indicator.

(The LED indicator will not display any analog output status).

Check with LCD screen

Go to the Program Menu screen from the Operation Mode screen and select “4. I/O CHECK.”

Select the screen with the UP and DOWN keys (∧ and ∨) and check the screen corresponding to the optional AIO expansion card.

The screen will display the input voltages of [Ai3] and [Ai4] and the output voltages of [AO4] and [AO5].

```
Ai3=±××.×V     ← AIO I/O status 1 (Ai3): "0,0" if not connected.
Ai4= ××.×V     ← AIO I/O status 1 (Ai4): "0,0" if not connected.
AO4=±××.×V     ← AIO I/O status 1 (Ao4)
AO5=±××.×V     ← AIO I/O status 1 (Ao5)
∧V→PAGE SHIFT 14
```

6.14 Optional PG Changeover Card (available soon)

6.14.1 Product overview

This optional card enables a single FRENIC-VG inverter to select and drive two motors provided with speed sensors alternately.

The motors are selected by switching pulse generator (PG) and NTC thermistor signals.

This optional card does not incorporate a function to switch the U, V, or W output wire to the motors. Select the wires with a magnetic contactor (MC) or similar device externally. Switching signals can be output from the FRENIC-VG.

Main Applications

• Multi-winding motor drive
• Driving of a number of motors with a single inverter.

6.14.2 Model and specifications

6.14.2.1 Model

Model legend: MCA-VG1-CPG

- VG1: Name of inverter mounted: VG1→ FRENIC-VG
- CPG: Name of option: CPG→PG changeover unit

6.14.2.2 Specifications

Table 6.14.1 Hardware Specifications

Item	Specification
Name	PC Changeover Card
Changeover signal	Selection of either NTC or PG signal with the SEL terminal.
PG signal	15-V complementary output
NTC signal	Analog signal at 0 to 10 V
Current consumption	80 mA max. at 24 V

6.14.3 Dimensions

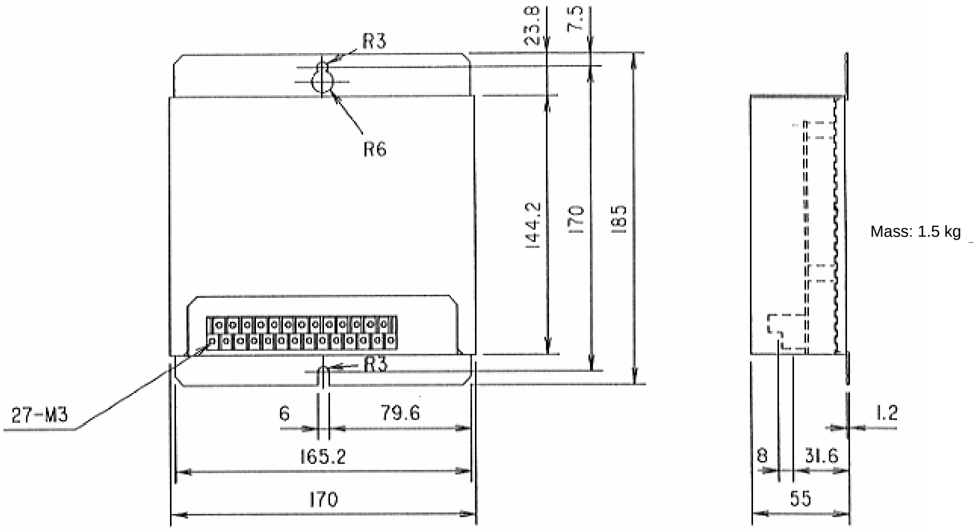


Figure 6.14.1 Product Dimensions

	TT1	TC1	PA1	PP1			PA	PGP		TT2	TC2	PA2	PP2
			PB1	PM1	THT	THC	PB	PGM	P24	SEL		PB2	PM2

Screw size: M3

Figure 6.14.2 Terminal Arrangement

6.14.4 Installation method

Mount the PG changeover card (unit) with an M5 bolt each on the upper and lower sides of the unit to a sturdy structure so that the characters on the label of the unit will be visible on the front side.

⚠WARNING
• Install the card on metallic or other nonflammable structure. **Otherwise, a fire may result.**

⚠CAUTION
• Make sure that no foreign substances, such as lint, paper, wood chips, dust, or scrap metal will penetrate into the unit. **Otherwise, a fire may result.**

6.14.5 Basic schematic diagram

Refer to 6.1.4 Installing Internal Options (OPC-VG1-□□) and wire and connect the FRENIC-VG.

⚠WARNING
• Improper connections may result in electric shocks or fires. Qualified electricians should carry out wiring. Turn OFF the breaker on the power supply side for electric shock prevention in the case of touching the electric circuit during connection work. Do not touch the smoothing capacitors soon after the breaker is turned OFF, because the smoothing capacitors will store charge for a while and an electric shock will be received. Check with a multimeter that the DC voltage on the inverter is low enough after the CHARGE lamp of the inverter is turned OFF.

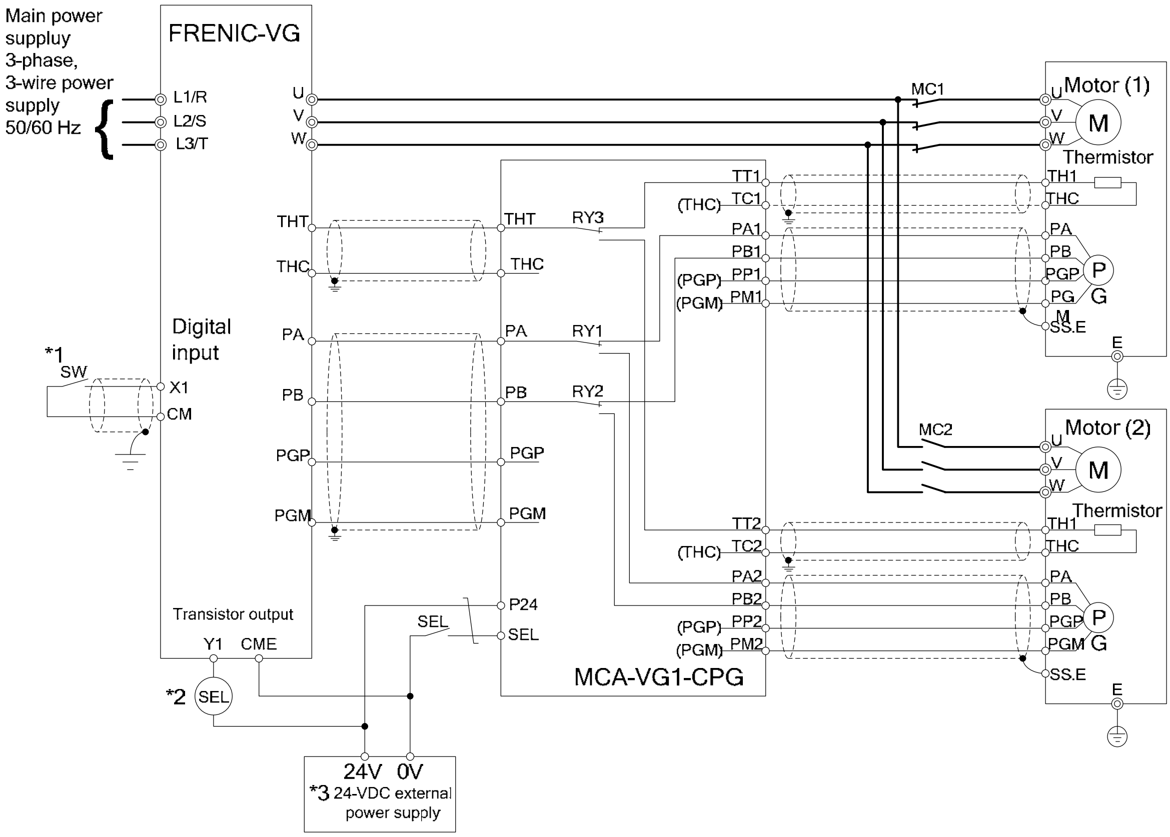
⚠CAUTION
• Do not use the product that is damaged or lacking parts. Otherwise, injury and damage may result. Incorrect handling in installation/removal jobs could cause a failure.

There are terminal blocks under the lower part of the unit (see figure 6.14.1 and figure 6.14.2). Wire the terminal blocks with the following items kept on mind.

Make sure that the terminal blocks are wired as shown in figure 6.14.3. Prepare a circuit that switches over the main circuit wires (U, V, and W) in synchronization with the SEL contacts. Use crimp terminals with high connection reliability to wire the terminals. Check the following items on completion of wiring work.

a. Check that the wires are connected correctly.
b. Check that no wires are left unconnected.
c. Check that no terminals or wires are short-circuited or resulting in ground faults.

Basic Schematic Diagram



Note: The shielded wire should be basically earthed. If strong inductive noise interferes with the FRENIC-VG, however, the influence of the noise may be suppressed by connecting the shielded wire to the 0 V line.

Figure 6.14.3 Schematic Diagram of Inverter Unit

*1 The above example shows the following allocation of digital input (X1) and transistor output (Y1).

Table 6.14.2

Function code	Function name	Set value	Description	Operation
E01	X1 function selection	12	Motor M2 selection	Select motor 2 with the SW turned ON.
E15	Y1 function selection	16	Motor M2 selection state	Turn ON the SEL with the SW turned ON.

*2 Prepare a different circuit so that the main circuit wires will be switched over with the coil (SEL) as shown below.

Table 6.14.3

SW	SEL	MC1	MC2	Motor selection
OFF	OFF	ON	OFF	1
ON	ON	OFF	ON	2

*3 Current required by 24-V power supply: 70 mA + Coil (SEL) driving current

Conformable Wire Size

Use wires with a thickness ranging from 0.5 to 1.25 (mm^2).

For the wiring of the main circuit terminals (U, V, and W), refer to the Operation Manual and User’s Manual for this inverter.

6.14.6 Operation method

The encoder (1) and NTC thermistor (1) will be connected when the SEL terminal of the terminal block and the 0-V external power supply terminal are open.

The encoder (2) and NTC thermistor (2) will be connected when the SEL terminal of the terminal block and the 0-V external power supply terminal are closed.

Table 6.14.4

SEL terminal	Encoder and NTC thermistor connected
OFF	Encoder (1) and NTC thermistor (1)
ON	Encoder (2) and NTC thermistor (2)

⚠CAUTION

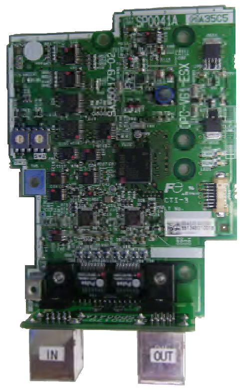
- No functions are incorporated to change over the motor power wires (U, V, and W). Use a magnetic contactor (MC) to change them over externally.
- Never make connection changes while the motor during conduction.

  Otherwise, the motor may go out of control or the inverter may malfunction.
- The PG signal common terminal (PGM) and thermistor common terminal (THC) are isolated from each other. Do not short-circuit them with external wires.
- Do not use more than one unit to change over three or more motors. (The power supply to the PG is not changed over. Therefore, the current may exceed the PG current capacity limit of the inverter.)

  Otherwise, the inverter may be damaged.

6.15 E-SX Bus Interface Card

6.15.1 Product overview



This option card is used to control the FRENIC-VG from the Fuji Programmable Logic Controller MICREX-SX SPH3000MM via the E-SX bus.

Main uses

The following can be performed from the option card.

- Input of run, stop, and other signals: FWD, REV, X1 - X9, X11 - X14, RST
- Speed command and torque command settings: 16-bit binary data
- Operation status monitor (bit data)
  Running forward, running reverse, during DC breaking or during pre-excitation, inverter shutdown, braking, DC link established, torque limiting, output current limiting, during acceleration, during deceleration, alarm relay, remote/local, write error from link, data writing (processing) in progress
- Motor speed / torque monitor: 16-bit binary data
- Operation status monitor (word data)
  (Speed command, output frequency, torque command, output current, output voltage, cumulative run time, etc.)
- Referencing/changing function codes
- The tact cycle of the PLC (SPH3000MM) and the control cycle of the inverter can be synchronized by E-SX bus.*1
- Toggle monitor control enables monitoring of whether the mutual functioning of the host device and inverter is normal.

*1 For synchronization, refer to "6.15.10 Synchronization of E-SX bus tact cycle and inverter control cycle".

6.15.2 Model and specifications

6.15.2.1 Model

Model details: OPC-VG1-ESX

- VG1: Installed inverter name: VG1→FRENIC-VG
- ESX: Option name: ESX→E-SX bus interface card

Accessories

Spacers: 4
Screws (M3): 2

6.15.2.2 Specifications

⚠CAUTION

- If the rotary switches (SW1, 2) on the option are not set correctly, the system will not operate properly. Set as indicated below, taking care to ensure that all settings are correct.
- Set the rotary switches (SW1, 2) on the option with the inverter power OFF.

Table 6.15.1 Hardware Specifications

Item	Specifications
Name	E-SX Bus Interface Option
Transmission specifications	E-SX bus slave, I/O transmission
Transmission speed	100 Mbps
Distance between stations	Maximum 100 m
Total extension distance	Maximum 1,000 m
E-SX bus consumption current	Normal operation: Maximum 6 mA, bypass operation (inverter power OFF): Maximum 93 mA
Number of words occupied in transmission	16 words (I area 8 words / Q area 8 words)
Terminals / bus cable	IN, OUT / E-SX bus cable *NU1C-P3 (0.3 m) - NU1C-A0 (100 m)
Rotary switches RSW 1, 2	Station address setting, any station address from 1 to 283 can be assigned.
Status display LED RUN, ERR	Status of local station (running/error) is indicated by LED

(1) Rotary switches SW1, 2

The station address is set with rotary switches SW1 and SW2 on the option board. The display is hexadecimal, with "SW1" corresponding to the upper 4 bits and "SW2" corresponding to the lower 4 bits. For the E-SX bus station address, read as a decimal display.

Example: For station address 194, this is C2 (h), and SW1 = C, SW2 = 2 are set.

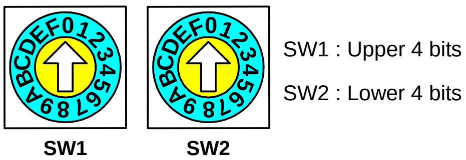


Figure 6.15.1 Station Address Setting Switches

* Set the same address as the E-SX bus address set in the MICREX-SX system definitions. The address assigned from MICREX-SX will be the actual E-SX bus address, so this may differ from the set values of these rotary switches. (This can be checked in Function Code U13 "SX Bus Address Monitor".)

* When multiple units are used, make sure that duplicate E-SX bus addresses are not set.

* The factory defaults are SW1 = 0, SW2 = 0 (station address 00 (h)). In this case, the station address set in the "Expert (D300win)" support tool system definitions is set (no degenerate system startup). If there is degenerate system startup, a heavy alarm will occur on the MICREX-SX.

* SW1 and SW2 settings are detected during "power on" and "reset" of the E-SX bus (MICREX-SX).

Chap. 6 CONTROL OPTIONS

(2) Status display LED <u>RUN, ERR</u>

The status of the local station (running/error) is indicated by the RUN/ERR LED on the option board. The option determines the status of the local station, which is a slave station, and thus this may differ from the RUN/ALM status displayed on the MICREX-SX CPU.

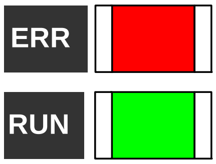


Table 6.15.2 LED Display

Status of slave		RUN (green)	ERR (red)
Initial	E-SX bus transmission not received	□OFF	□OFF
	E-SX bus transmission received	■Flashing	□OFF
Normal		■ON	□OFF
Heavy alarm	Option hardware error	□OFF	■ON
	Master down detected	■ON	■ON
Light alarm ・ Local station setting error (does not match master or station address outside range) ・ Communication error detected (missed reception 3 tacts in succession) ・ Other inverter alarm occurred		■ON	■ON
Inverter power OFF (including bypass operation)		□OFF	□OFF

Table 6.15.3 Software Specifications

Item		Specifications
Data update cycle (*1)		Minimum 250 μs
Operation	Run command	Run forward and reverse commands, alarm reset command, X1 to X14 commands
	Speed/torque command	1-word data
	Operation status output	Bit data of running, braking, torque limiting, alarm relay and other signals
		Return speed (1 word), torque output (1 word), current return position (2 words) (supported in near future)
Option function codes		o30, o31, U11 to U13
Protective functions		Er-4: Network error (E-SX bus error) (*2) *Light alarm: Er-4 alarm action can be set with o30, o31. *Heavy alarm: Immediate Er-4 alarm. Ar-F: Toggle error (*3) The 2-bit signals sent by the PLC, toggle signal 1 TGL1 and toggle signal 2 TGL2, are monitored, and this error occurs if the specified change pattern is not received before the time set in H144 elapses. Ar-E: E-SX bus tact synchronization error (*4) Occurs when synchronization of the E-SX tact cycle and inverter control cycle is lost due to noise or other factors.

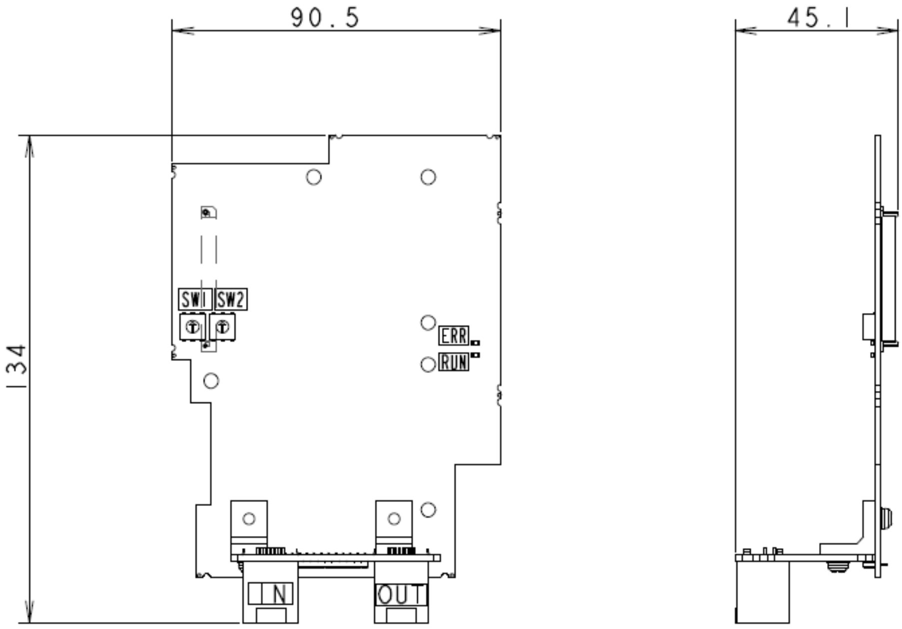
*1 The data update cycle depends on the carrier frequency setting, E-SX bus tact cycle of the MICREX-SX, and task cycle of the application program.

*2 For light and heavy alarms, refer to "6.15.6 Protective operations".

*3 For details on toggle signals and toggle errors, refer to "TGL1" and "TGL2" in the explanation of E01 to E13 in Chapter 4, Section 4.3 "Details of Function Codes." The toggle pattern for ON/OFF of TGL1 and TGL2 must be created in the MICREX-SX program.

*4 For E-SX bus tact synchronization errors (Ar-E), refer to Section 6.15.10 "Synchronization of E-SX bus tact cycle and inverter control cycle."

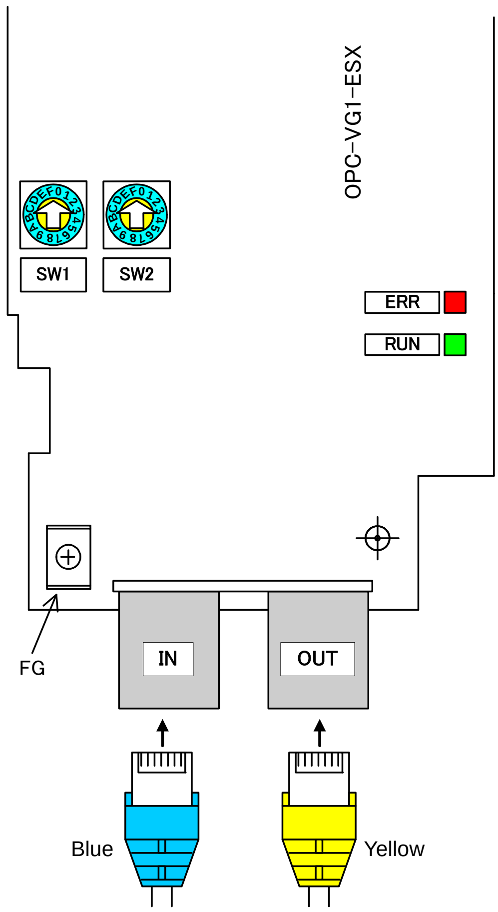
6.15.3 External dimension drawings



(Unit: mm)

Figure 6.15.2 Option Print Board Outline Drawings

■ **E-SX bus cable connections**



- Connection of the FG terminal is not necessary. Do not connect. For the installation procedure, refer to Section 6.1.4 "Installing internal options (OPC-VG1-□□)."
- A connector to which the E-SX bus cable is not connected should be left unconnected. Never connect a terminating connector.

Figure 6.15.3 E-SX Bus Cable Connections

6.15.4 Basic connections

Perform the wiring and connection work as explained in Section 6.1.4 "Installing internal options (OPC-VG1-□□)."

⚠WARNING
• Risk of electric shock, fire, and other hazards if improper wiring work is performed. Only a qualified electrician should make the connections. If it is necessary to touch electrical circuits to make connections after the power has been connected, switch the power breaker to the OFF (open) position to prevent electric shock. • Even when the breaker is OFF (open), the smoothing capacitor is charged and will cause electric shock if touched. Make sure the inverter CHARGE lamp is off and use a tester to verify that the DC voltage of the inverter has fallen to a safe level. • The E-SX bus voltage is supplied from the PLC power module. Before installing or removing this option, make sure that the MICREX-SX power and inverter power are OFF.

⚠CAUTION
• Do not use a product if parts are damaged or missing. Risk of injury and damage. • Improper work when installing or removing the product may cause product damage.

Follow the rules below when making connections.

[Rules for connections]

(1) Use dedicated cables for the E-SX bus.

Model: NU1C-P3 (0.3 m) to NU1C-A0 (100 m)

For cable specifications, refer to the MICREX-SX manual (Hardware).

(2) Before performing work, make sure that both the MICREX-SX and the inverter are powered OFF.

(3) For the E-SX bus cable wiring, the main circuit wires of the inverter should be kept as far away as possible (at least 30 cm) from other power lines to prevent malfunctioning due to noise. Never insert in the same duct.

(4) Connect the wiring of the E-SX bus cable from OUT to IN on the SPH3000MM, or from IN to OUT. Communication is not possible with an OUT-OUT or IN-IN connection, and thus the system will not operate. Connection of a terminating connector is prohibited. Never connect a terminating connector.

Example of basic connections

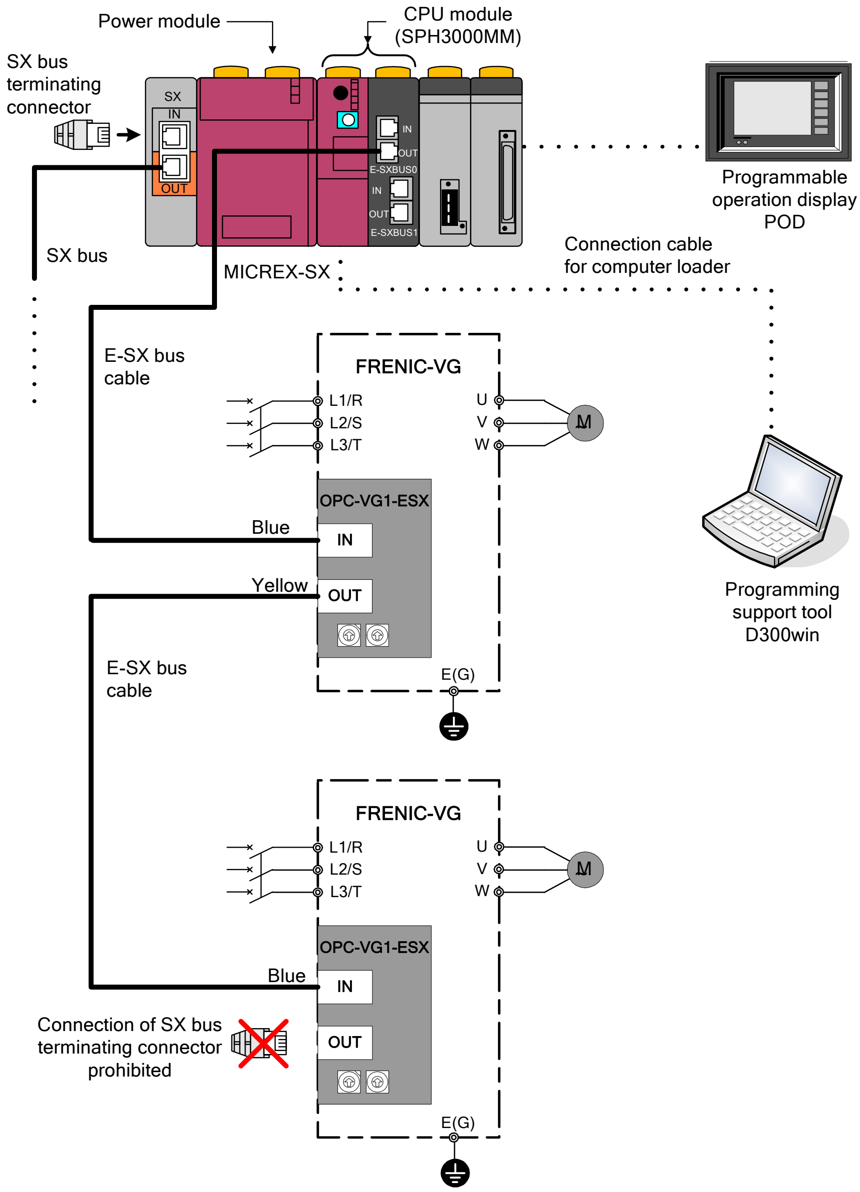


Figure 6.15.4 Example of Basic Connections

6.15.5 Related function codes

⚠WARNING

・ Incorrect function code data may create a hazardous condition. After setting and writing data, recheck the data.

Risk of an accident

Inverter function codes related to the E-SX bus interface card are described below.

Table 6.15.4 Related Function Codes

No.	Function code name		Setting range	Description
	Name	Keypad display		
H30	Link function	Link function	0 to 3	3: Set run command / command data enable via E-SX.
o30 *1	Action when transmission error occurs	Link mode	0	Immediate forcible stop when communication error occurs (light alarm) (Er-4 alarm: coast to stop)
			1	Continue operation for timer time after a communication error (light alarm) occurs (in a communication error state, the previous run command from communication is held) Forcible stop after timer time (Er-4 alarm: coast to stop) If communication recovers within timer time, operates according to the communication command. If after timer time, forcible stop.
			2	Continue operation for timer time after a communication error (light alarm) occurs (in a communication error state, the previous run command from communication is held). If communication error recovery does not take place within timer time, forcible stop. If communication recovers within timer time, operates normally according to the communication command.
			3	No alarm (Er-4) when a communication error (light alarm) occurs. In a communication error state, the previous communication command is held When communication recovers, operates normally according to the communication command.
o31 (*1)	Action time when transmission error occurs	Link timer	0.01 to 20.00s	Operation timer value [s] when communication error (light alarm) occurs. Enabled when o30 = 1 or 2
U11	E-SX transmission format selection	USER P11	3	Standard format: 2 Number of words occupied: 16 words (8W+8W)
			Other than above	Reserved (do not set)
F26	Carrier frequency	Carrier Hz	2 to 15	Set the carrier frequency (= inverter control cycle). The SPH3000MM tact cycle and inverter control cycle are only synchronized when F26 = 4 or 8.
H107	Light alarm definition 2	Light alarm 2	0000 to 1111	Select the alarm action when an E-SX bus error (Er-4) or toggle error (Ar-F) occurs. The Er-4 digit is 100, and Ar-F digit is 1. Set applicable digit to 0: alarm occurs or 1: light alarm (L-AL)
H108	Light alarm definition 3	Light alarm 3	0000 to 1111	Select the alarm action when an E-SX bus tact synchronization error (Ar-E) occurs. Set the "1" digit to 0: Ar-E alarm occurs or 1: light alarm (L-AL)
E10 | E13	X11 to X14 function selection	X11 to X14 functions	*2	Select the command when each X11 to X14 bit = 1. To perform toggle monitoring by X terminal bit, set TGL1, TGL2 in either of the two terminals.
E15 | E27	Y function selection	Y function	*2	Select the Y1 to Y5 and Y11 to Y18 functions. To check the E-SX tact synchronization status, set C-Do10 in any one of the terminals.*3
o160	Function code monitor (1) setting	Lead code 1	0000h to FFFFh	Only valid when standard format 2 is used. Use 485No to set the function code to be constantly monitored by function code monitor (1).
o161	Function code monitor (2) setting	Lead code 2	0000h to FFFFh	Only valid when standard format 2 is used. Use 485No to set the function code to be constantly monitored by function code monitor (2).

*1 For details on o30 and o31, refer to "6.15.6.1 (2) Action when a light alarm occurs (o30, o31)".

*2 For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

*3 For E-SX tact synchronization, refer to Section 6.15.10 "Synchronization of E-SX bus tact cycle and inverter control cycle".

6.15.6 Protective operations

6.15.6.1 Light alarms and heavy alarms in E-SX bus communication (Er-4)

(1) Causes of light alarms and heavy alarms (Er-4)

Light alarms and heavy alarms are generated on the E-SX bus interface card depending on the alarm level.

When an alarm occurs, the inverter outputs an Er-4 "network error" and the motor coasts to stop.*1

*1 Inverter function code H107 can be set to display L-AL and continue operation when an alarm occurs. Refer to the explanation of H107 in Chapter 4, Section 4.3 "Details of Function Codes."

Table 6.15.5 Causes of Light Alarms and Heavy Alarms (Er-4)

Item	Light alarm	Heavy alarm 1	Heavy alarm 2
Card LED state	ERR ■ (lit) RUN ■ (lit)	ERR ■ (lit) RUN ■ (lit)	Undefined
Cause *2	• Normal reception failed 3 times in succession due to noise on communication line or other cause.	• All masters down (Cable break, PLC power interrupted)	• Card hardware failure • Improper card installation
Reset method	Clear alarm cause (auto clear by communication reset) or set H30 = 0, 1 or [LE] = OFF and issue reset command.*3		After clearing the alarm cause, cycle the inverter power off/on (clearing is not possible until the power is turned off).
Control of alarm state	Alarms can be controlled by function codes o30, o31.	When a heavy alarm occurs, an Er-4 alarm is generated immediately.	
Communication error code displayed on keypad*4	1	2	3
Alarm sub-code *5	01(hex)	02(hex)	04(hex)

*2 When a light alarm cause occurs and command via E-SX is enabled (H30 = 2, 3 and LE = ON; for details, refer to the explanation of H30 in Chapter 4, Section 4.3 "Details of Function Codes"), Er-4 is generated. With heavy alarm 1, when run command via E-SX is ON, Er-4 is generated. With heavy alarm 2, Er-4 is generated regardless of the settings when the cause occurs.

*3 "Issue a reset command" at light alarm and heavy alarm 1 refers to inverter reset input by any of the following methods.

* Keypad (RESET) key input
* Assign error reset [RST] by X function selection and input digitally.
* RST bit = 1 in Q area from E-SX communication

Depending on the MICREX-SX CPU state, the CPU may need to be reset as well when heavy alarm 1 occurs.

*4 The communication error code for a light alarm or heavy alarm can be checked in the communication status screen of the maintenance information on the keypad. Press the (PRG) key in the operation mode screen of the communication status screen to change to the menu screen, move the arrow on the left side of the screen to "5. Maintenance" with the (∧)/(∨) key, and press the (FUNC/DATA) key. Press the (∨) key 3 times to display the screen below. This error code indicates the first factor that caused Er-4 to occur. A light alarm always occurs before heavy alarm 1 occurs, and thus when o30 = 0, this code shows the light alarm code even when the state is heavy alarm 1.

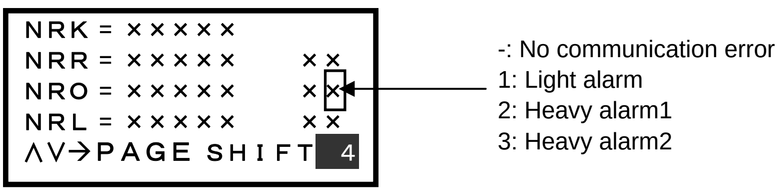


Figure 6.15.5 Communication Error (Er-4) Code Screen

*5 The alarm sub-code of Er-4 can be checked in alarm history selection in the alarm information of the keypad. The alarm sub-code screen can be displayed as follows: Press the PRG key in the operation mode screen to change to the menu screen. Move the arrow at the left side of the screen to "7. Alarm Information" with the ∧/∨ key and press the FUNC/DATA key. Select the alarm you want to view in the alarm information selection screen that shows the most recent alarm and the previous 3 alarms, and press the FUNC/DATA key. Press the ∧ key once. The screen below appears. This alarm sub-code indicates the first factor that caused Er-4 to occur. A light alarm always occurs before heavy alarm 1 occurs, and thus when o30 = 0, this code shows the light alarm code even when the state is heavy alarm 1.

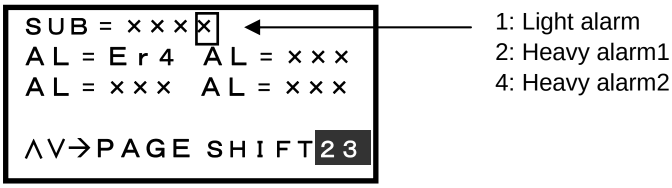


Figure. 6.15.6 Alarm Sub-Code Screen

(2) Action when light alarm occurs (o30, o31)

This section explains the control methods for Er-4 alarms by inverter function codes o30, o31 when a communication error (light alarm state) occurs while a run command is issued from the MICREX-SX via the E-SX bus.

1) Function code o30 = 0 (immediate coast to stop when communication error (light alarm) occurs)

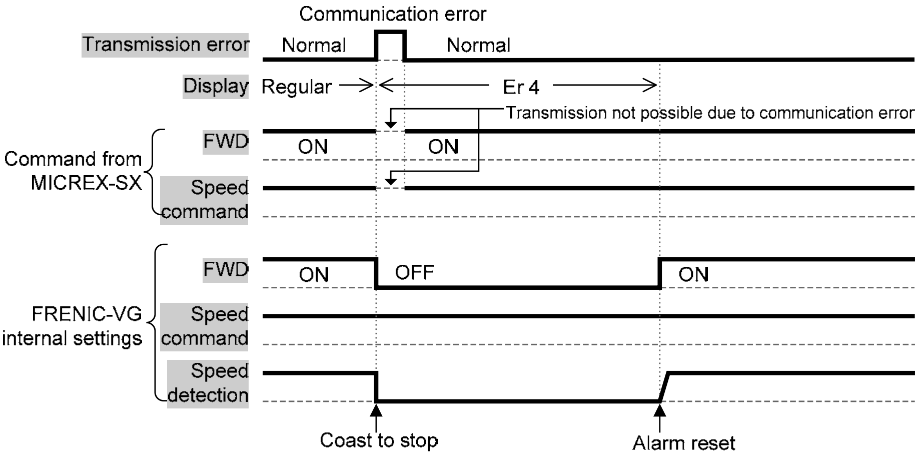


Figure 6.15.7

2) Function code o30 = 1, o31 = 5.0 (coast to stop after 5 seconds when communication error (light alarm) occurs)

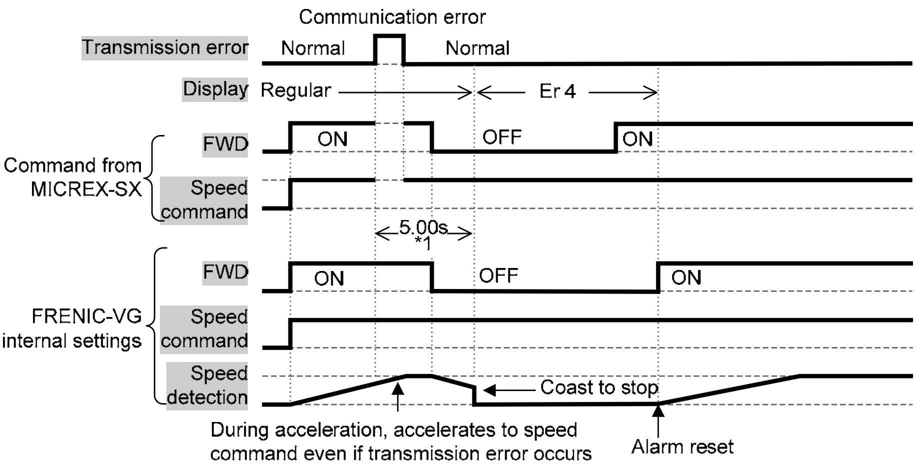


Figure 6.15.8

3) Function code o30 = 2, o31 = 5.0
(Er-4 alarm occurs if communication does not recover within 5 seconds after communication error (light alarm) occurs)

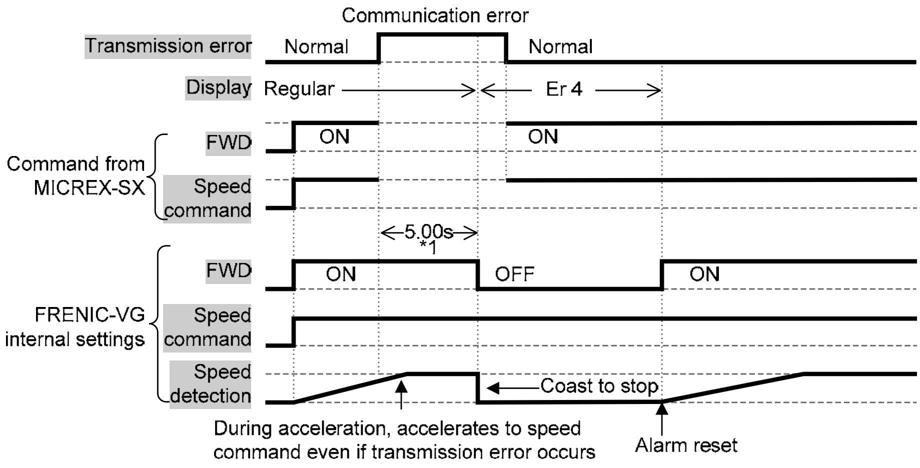


Figure 6.15.9

4) Function code o30 = 2, o31 = 5.0 (communication recovers within 5 seconds after communication error (light alarm) occurs)

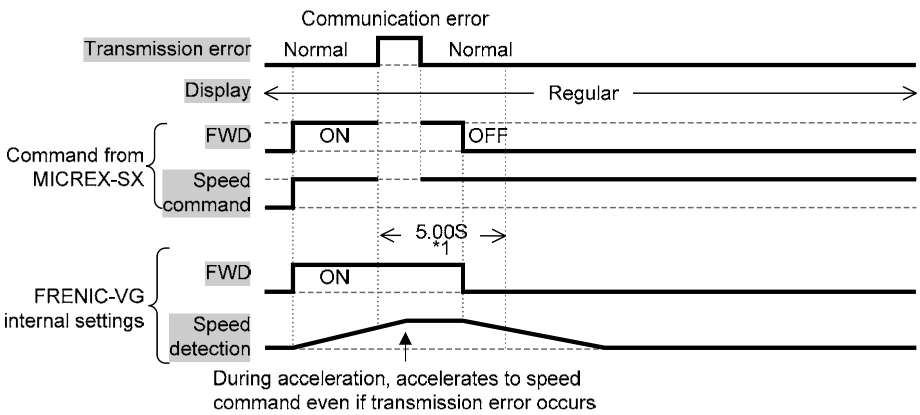


Figure 6.15.10

5) Function code o30 = 3 (operation continues)

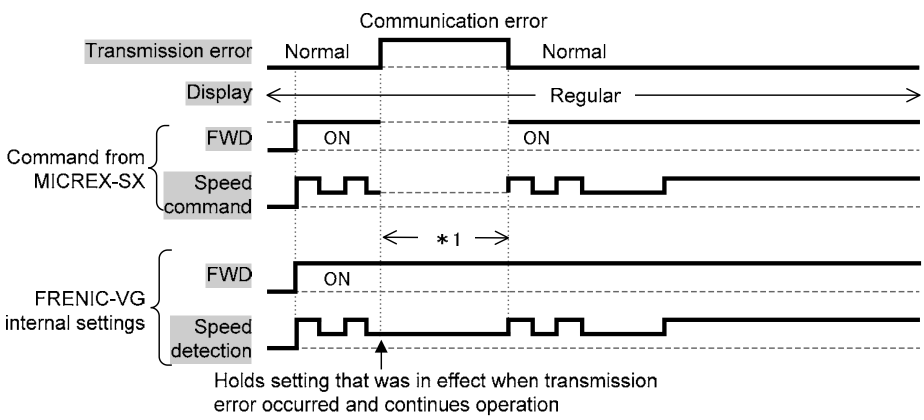


Figure 6.15.11

*1 During this period, if communication does not recover and a new command and setting are not sent, the command (run command, speed command, or both) from communication before the communication error occurred is held.

6.15.6.2 E-SX related alarms (Ar-E, Ar-F)

The causes of E-SX related alarms Ar-E and Ar-F are shown in Tables 6.15.6 and 6.15.7.

Table 6.15.6 Ar-E Alarm Causes

Item	E-SX bus tact synchronization error
Card LED state	ERR ■ (lit) RUN ■ (lit)
Cause	Synchronization of tact cycle and inverter control cycle lost due to noise or other cause.
Reset method	After clearing the cause of the alarm, issue a reset command. After the alarm is reset, the ERR LED turns off.
Communication error code displayed on keypad	-
Alarm sub-code *1	01(hex)

Table 6.15.7 Ar-F Alarm Causes

Item	Toggle error
Card LED state	ERR ■ (lit) RUN ■ (lit)
Cause	Normal toggle signal pattern of TGL1 and TGL2 signals not received within time set by inverter function code H144.
Reset method	After clearing the cause of the alarm, issue a reset command. After the alarm is reset, the ERR LED turns off.
Communication error code displayed on keypad	-
Alarm sub-code *1	04(hex)

*1 Alarm sub-codes can be checked as explained in *5 of "6.15.6.1 Light alarms and heavy alarms in E-SX bus communication".

6.15.6.3 Other inverter alarms

The card treats inverter alarms other than the above as light alarms. The actions indicated in Table 6.15.8 take place.

Table 6.15.8 Actions When Other Alarms Occur

<table>
<tr><th>Item</th><th>Inverter alarm other than an E-SX related alarm</th></tr>
<tr><td>Card LED state</td><td>ERR ■ (lit)
RUN ■ (lit)</td></tr>
<tr><td>Reset method</td><td>After clearing the cause of the alarm, issue a reset command.
After the alarm is reset, the ERR LED turns off.</td></tr>
<tr><td>Others</td><td>Inverter alarm codes (other than Er-4) can be checked on the E-SX bus light alarm information tab of alarm diagnosis in the Expert (D300win) support tool. Hexadecimal values are shown in the following format in Expert (D300win).
<table>
<tr><td>b8</td><td>b7</td><td>b6</td><td>b5</td><td>b4</td><td>b3</td><td>b2</td><td>b1</td><td>b0</td></tr>
<tr><td>1</td><td>1</td><td colspan="7">Alarm code (M16) (*1)</td></tr>
</table>
</td></tr>
</table>

*1 For details on alarm codes, refer to Chapter 4, Section 4.2.4 "Data Format List."

6.15.7 Data addresses (IQ area)

6.15.7.1 Supported formats

Function code U11 "SX bus transmission format selection" can be set to 3 to support the transmission format below.

(1) Standard format 2 (U11 = 3)

Basic format that allows reading/writing of the motor speed, operation status monitor, and two function codes each (specified in 485No).

6.15.7.2 Input/output data address assignments

(1) Standard format 2

<table>
<tr><th>(*1)</th><th colspan="8">bit 15</th><th colspan="8">bit 0</th></tr>
<tr><td>%IWx.x.*.0</td><td colspan="16">Polling function code 485No (1)</td></tr>
<tr><td>%IWx.x.*.1</td><td colspan="16">Polling function code 485No (2)</td></tr>
<tr><td>%IWx.x.*.2</td><td colspan="16">Data of polling function code (1)</td></tr>
<tr><td>%IWx.x.*.3</td><td colspan="16">Data of polling function code (2)</td></tr>
<tr><td>%IWx.x.*.4</td><td colspan="16">Function code monitor (1)</td></tr>
<tr><td>%IWx.x.*.5</td><td colspan="16">Function code monitor (2)</td></tr>
<tr><td>%IWx.x.*.6</td><td colspan="16">Motor speed</td></tr>
<tr><td>%IWx.x.*.7</td><td>BUSY</td><td>ERR</td><td>-</td><td>RL</td><td>ALM</td><td>DEC</td><td>ACC</td><td>IL</td><td>-</td><td>TL</td><td>NUV</td><td>BRK</td><td>INT</td><td>EXT</td><td>REV</td><td>FWD</td></tr>
<tr><td>%QWx.x.*.8</td><td colspan="16">Selecting function code 485No (1)</td></tr>
<tr><td>%QWx.x.*.9</td><td colspan="16">Selecting function code 485No (2)</td></tr>
<tr><td>%QWx.x.*.10</td><td colspan="16">Data of selecting function code (1)</td></tr>
<tr><td>%QWx.x.*.11</td><td colspan="16">Data of selecting function code (2)</td></tr>
<tr><td>%QWx.x.*.12</td><td colspan="16">Speed command</td></tr>
<tr><td>%QWx.x.*.13</td><td>RST</td><td>X14</td><td>X13</td><td>X12</td><td>X11</td><td>X9</td><td>X8</td><td>X7</td><td>X6</td><td>X5</td><td>X4</td><td>X3</td><td>X2</td><td>X1</td><td>REV</td><td>FWD</td></tr>
<tr><td>%QWx.x.*.14</td><td colspan="16">Polling function code 485No (1)</td></tr>
<tr><td>%QWx.x.*.15</td><td colspan="16">Polling function code 485No (2)</td></tr>
</table>

Figure 6.15.12 Standard Format 2

*1 The address structure is as follows.

Prefix (%IW, %QW)	.	SX bus station address of PLC (254-247)	.	E-SX bus number (0, 1)	.	Inverter station address (1-238)	.	Word number (0-9)

For address details, refer to the MICREX-SX SPH User's Manual, SPH3000MM (FH302).

6.15.8 Format details

6.15.8.1 I area (MICREX-SX ← FRENIC-VG)

(1) Standard format 2 (U11 = 3)

① Polling function code address, polling function code data

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Polling function code 485No (1)															
Polling function code 485No (2)															
Data of polling function code (1)															
Data of polling function code (2)															

The 485No corresponding to the function code in the polling request from the MICREX-SX is stored in "Polling function code 485No (1), (2)" (16 bits). The data are respectively stored in "Data of polling function code (1), (2)".

② Function code monitor

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Function code monitor (1)															
Function code monitor (2)															

"Function code monitor (1), (2)" are constant monitors of function codes. Set the 485Nos. of the function codes to be monitored in function code o160 for "Function code monitor (1)" and o161 for "Function code monitor (2)".

③ Motor speed

(MSB) (LSB)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Motor speed (decimal) x 20000 ÷ maximum speed 16 bit data															

The maximum speed is the speed set in inverter function code F03. To use r/min units, calculate the above equation in reverse. When the data is negative (2's complement), the command becomes a reverse speed command.

④ Operation status (1 when all are ON)

(MSB) 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	(LSB) 0
BUSY	ERR	-	RL	ALM	DEC	ACC	IL	-	TL	NUV	BRK	INT	EXT	REV	FWD

FWD : Running forward
REV : Running in reverse
EXT : DC braking / pre-excitation
INT : Inverter shutdown
BRK : Braking
NUV : DC link voltage established

TL : Torque limiting
IL : Current limiting
ACC : Accelerating
DEC : Decelerating
ALM : Alarm relay

RL : Communication selection (1: H30 = 2 or 3)
- (FRENIC-VG is always 0)
ERR : Function code access error
BUSY : Writing function code

- ERR is "0" when function code selecting (writing) and polling (reading) all took place normally. If a selecting or polling operation was abnormal, ERR becomes "1"*1. The cause of the error can be checked in function code M26 (the table below). When this bit is "1", remove the cause of the error as indicated in M26 and perform selecting/polling. If all finish normally at this time, ERR and M26 automatically change to "0".

Value of M26	Write/read error
78	Accessed unused function code
79	Write to read-only function code
	Write while running to function code that cannot be changed while running
	Write to function code that cannot be changed when FWD/REV is ON
80	Out of range data write

*1 If multiple errors occur simultaneously, the M26 error cause will be shown in the following order of priority:
Selecting (2) > Selecting (1) > Polling (2) > Polling (1).
(For example, if both selecting (2) and polling (1) are errors, the cause of the selecting (2) error will be stored in M26.)

- BUSY is "1" during data writing (processing). To successively write data, wait until this bit is "0" before writing the next data. Data written while this bit is "1" will be disregarded.

Chap. 6 CONTROL OPTIONS

6.15.8.2 Q area (MICREX-SX → FRENIC-VG)

(1) Standard format 2 (U11 = 3)

① Selecting function code 485No, selecting function code data

(MSB) 15 14 ... 1 0 (LSB)

Selecting function code 485No (1)
Selecting function code 485No (2)
Data of selecting function code (1)
Data of selecting function code (2)

The 485No corresponding to the function code for selecting from the MICREX-SX is written to "Selecting function code 485No (1), (2)" (16 bits). At the same time, write the data respectively to "Data of selecting function code (1), (2)".

Note 1: When selecting, write the 485No. and data at the same time.

Note 2: Writing to function code F00 (485No. = 0000h) is not possible in this format. If writing is attempted, a "Write to read-only function code error" will occur and 79 will be written to M26.

Note 3: If the same function code is set in selecting function code (1) and (2), the specification by selecting function code (2) is given priority.

② Speed command (S01)

15 (MSB)	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0 (LSB)
Motor speed (decimal) x 20000 ÷ maximum speed ⇒ 16 bit data															

The maximum speed is the speed set in inverter function code F03. To use r/min units, calculate the above equation in reverse. When the data is negative (2's complement), the command becomes a reverse speed command.

③ Run command / Di / RESET input (S06)

15 (MSB)	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0 (LSB)
RST	X14	X13	X12	X11	X9	X8	X7	X6	X5	X4	X3	X2	X1	REV	FWD

FWD : Run forward command X1-X14 : Terminal input (Di)
REV : Run reverse command RST : Reset alarm

If a link command is allowed, FWD and REV are valid. X1 to X14 and RST are always valid. For link commands, refer to Section 6.4.9 "Link function."

④ Polling function code 485No

(MSB) 15 14 ... 1 0 (LSB)

Polling function code 485No (1)
Polling function code 485No (2)

Specify the 485No corresponding to the polling request function code in "Polling function code 485No (1), (2)" (16 bits).

6.15.9 Data transmission examples

Examples of data transmission using standard format 2 are described below.

Conditions

Function code U11 "SX transmission format selection" = 3, H30 "Link Operation" = 3, maximum speed: 1500 r/min,

E-SX bus station address: 10, E-SX master station address: 254, E-SX bus used

(1) Speed setting / run command

Issuing run forward (FWD) and 750 r/min speed commands from the MICREX-SX

%QW254.0.10.12	2	7	1	0	750 ÷ 1500 × 20000 = 10000 = 2710(hex)
%QW254.0.10.13	0	0	0	1	FWD = 1

(2) Method of using function code monitor

Constant monitoring from the MICREX-SX of the calculated torque value M07 and the effective output current value M11.

Set o160 = 0807 (hex) and o161 = 080B (hex) in advance.

(485No. of M07 is 0807 (hex), 485No. of M11 is 080B (hex))

↓

%IW254.0.10.4	0	7	0	A	M07 = 1388 (hex) = 5000 ⇒ 50.00%
%IW254.0.10.5	0	5	B	4	M11 = 05B4 (hex) = 1460 ⇒ 146.0A

(3) Function code data settings

Setting 30.5 s in function code S08 "acceleration time" from the MICREX-SX.

%QW254.0.10.8	0	7	0	8	Selecting of function code S08 (485No. 0708h)
%QW254.0.10.9	0	0	0	0	
%QW254.0.10.10	0	1	3	1	30.5 = 305 × 0.1s = 305 = 0131 (hex)
%QW254.0.10.11	0	0	0	0	
%QW254.0.10.12	0	0	0	0	
%QW254.0.10.13	0	0	0	0	
%QW254.0.10.14	0	7	0	8	Polling of function code S08 to confirm completion of setting

↓ After write is completed

%IW254.0.10.0	0	8	0	7	Polling response of function code S08
%IW254.0.10.1	0	0	0	0	
%IW254.0.10.2	0	1	3	1	131 (hex) = 305 × 0.1 s = 30.5 s (Indicates that data was set normally.)
%IW254.0.10.3	0	0	0	0	

Chap. 6 CONTROL OPTIONS

(4) Toggle monitor

Performing data toggle monitor between the MICREX-SX and inverter. This example describes how to set the X12 terminal to TGL1 and the X13 terminal to TGL2.*1

Set E11 = 72 (TGL1), E12 = 73 (TGL2), H30 = 3, and H144 = 0.10 (100 ms) in advance.

As a result,
Transmission toggle (MICREX-SX→VG1): %QW254.0.10.13 bit 11 = TGL1, bit 12 = TGL2

The inverter monitors the toggle pattern sent from the MICREX-SX while the run command is ON, and if the correct toggle signal is not received within the time set in H144, generates toggle error Ar-F.

*1 For details on toggling, refer to the E01 to E13 toggle signal section in Chapter 4, Section 4.3 "Details of Function Codes."

Inverter function code H107 can be set to display L-AL and continue operation when an alarm occurs. Refer to the explanation of H107 in Chapter 4, Section 4.3 "Details of Function Codes."

When F26 "Carrier frequency" is set to a value other than 4 or 8, set the tact cycle of the application that sends the MICREX-SX transmission toggle to 0.5 ms or higher.

%QW254.0.10.13	*	0	0	0	0 → 1 → 2 → 3 → 0... is sent to * (toggle pattern transmission)
					↓ After toggle transmission
%QW254.0.10.13	*	0	0	1	Run command (FWD) = ON

Note: If an Er-4 E-SX bus communication error (light alarm, heavy alarm 1) occurs during toggle transmission and toggle transmission is continued, an Ar-F toggle error may occur immediately after communication recovers normally. To avoid an Ar-F toggle error, stop toggle transmission when an Er-4 E-SX bus communication error occurs.

6.15.10 Synchronization of E-SX bus tact cycle and inverter control cycle

6.15.10.1 Conditions required for tact synchronization

Connecting the card to the E-SX bus makes it possible to synchronize the E-SX bus tact cycle and the inverter control cycle. By doing this, the control timing of multiple inverters can be synchronized, making it easy to implement control that requires high-accuracy timing.

However, the processing that synchronizes the inverter control cycle and the E-SX bus tact cycle requires that the following conditions (1) and (2) both be satisfied. If either condition is not satisfied, the tact cycle and inverter control cycle will operate asynchronously. When the conditions are both satisfied, synchronization is performed automatically after E-SX bus communication is established.

Table 6.15.9 Tact Synchronization Conditions

	Synchronization condition
Condition (1)	The E-SX bus tact cycle is one of the following (recommended tact cycles are underlined).*1 0.25 ms, 0.5 ms, 0.75 ms, 1 ms, 1.25 ms, 1.5 ms, 1.75 ms 2 ms, 2.5 ms, 3 ms, 3.5 ms, 4 ms, 4.5 ms, 5 ms, 5.5 ms, 6 ms 6.5 ms, 7 ms, 7.5 ms, 8 ms, 8.5 ms, 9 ms, 9.5 ms, 10 ms
Condition (2)	Inverter function code F26 "Carrier Frequency" is set to either of the following frequencies.*2 4 kHz, 8 kHz

*1 If the tact cycle is other than a recommended cycle, the control cycle timing will not be the same for multiple inverters.

*2 When F26 "Carrier Frequency" is set to other than 4 kHz or 8 kHz, set the bus tact cycle to 0.5 ms or more.

6.15.10.2 Checking the tact synchronization status

The tact synchronization status can be checked by the methods indicated in Table 6.15.10.

Table 6.15.10 Tact Synchronization Status

Method	Operation
Function of Y terminal C-Do10	Tact synchronizing: C-Do10 = ON *1
Function code M142	Tact synchronizing: M142 bit 0 = 1*2

*1 To assign C-Do10 to the Y terminal, refer to E15 to E27, Y function selection in Chapter 4, Section 4.3 "Details of Function Codes."

*2 Can be checked in the data confirmation screen of the keypad even if C-Do10 is not assigned to the Y terminal.

6.15.10.3 Action when synchronization is lost (Ar-E)

If synchronization is lost due to noise or other cause after the E-SX bus tact cycle and inverter control cycle are synchronized, the inverter operates as described below.

Table 6.15.11 Action When Synchronization is Lost

Error	Operation
Synchronization is lost	"Ar-E" (alarm sub-code 1) occurs as an E-SX bus tact synchronization error.*1 Resynchronization is performed automatically, and "are" reset can take place when resynchronization is completed.

*1 If the tact cycle or inverter function code F26 is changed during synchronization so that the synchronization conditions are no longer met, synchronization will be lost; however, Ar-E will not occur in this case.

Note: Inverter function code H108 can be set to display L-AL and continue operation when an alarm occurs. Refer to the explanation of H108 in Chapter 4, Section 4.3 "Details of Function Codes."

6.15.11 Support tool interface

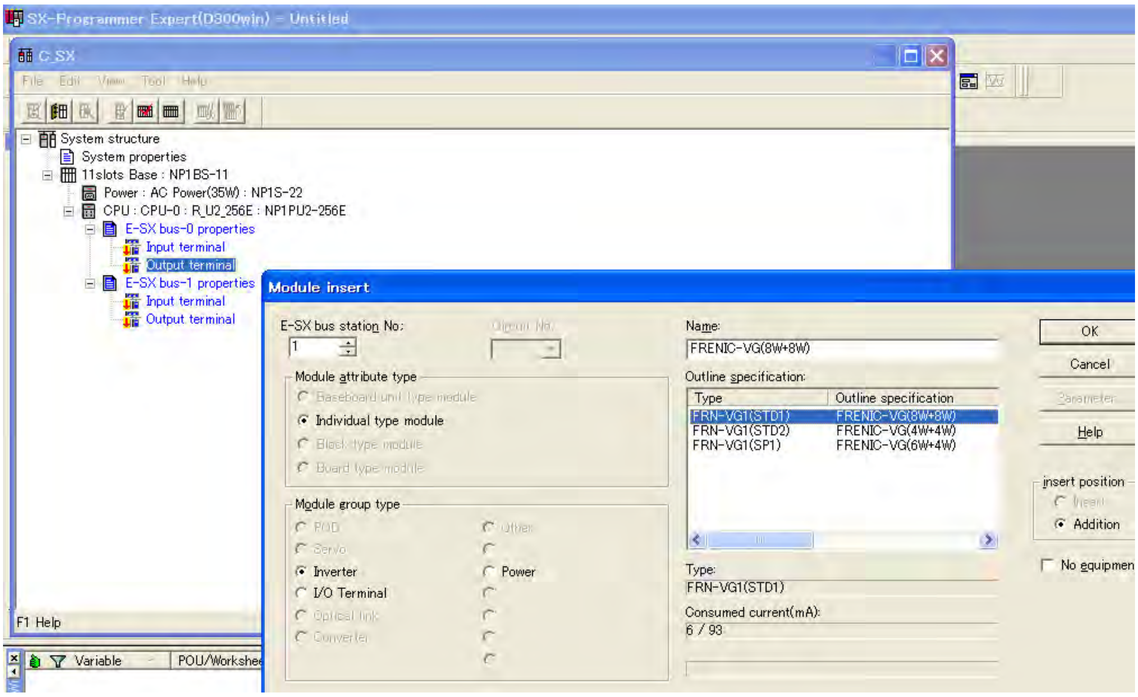
6.15.11.1 Configuration definition method

The configuration definition method in the "Expert (D300win)" support tool for the inverter is explained below.

① In "E-SX bus" under "CPU" below, select the IN terminal or OUT terminal that connects the inverter, and right-click to perform "Insert".

② In the "Module insert" window, select the individual module in "Module attribute type", select the inverter in "Module group type", and select model "FRN-VG1 (STD1)" in "Outline specification".

③ Parameter settings are not necessary (parameters cannot be set). Press OK.



6.15.11.2 Compatible versions of the SPH3000MM and support tool

(1) Compatible versions of the inverter support tool are as follows.

- Expert (D300win) : V3.5.2.36 or later
- Standard : V3.0.3.34 or later

(2) Compatible versions of the inverter SPH3000MM are as follows.

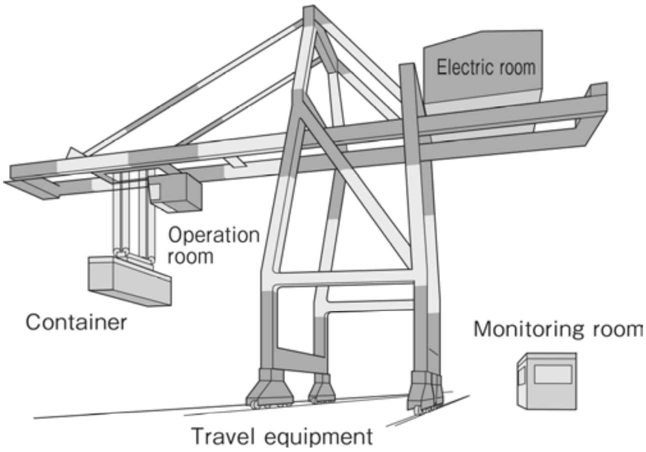
- Hardware : V20 or later
- Firmware : V02 or later

Chapter 7
APPLICATION EXAMPLES

This chapter gives application examples of the FRENIC-VG series of inverters.

Contents

7.1 Large Crane and Overhead Crane



High reliability

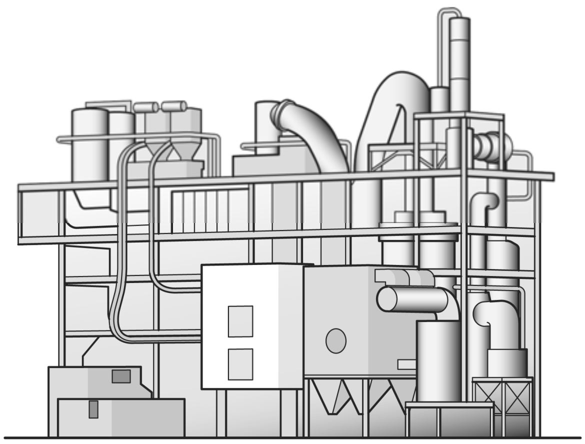
VG supports your facility with long life service and high reliability.

The trace back function allows easy fault diagnosis.

System support

The bus system is supported to allow centralized control of elevation, traverse, and trolley, as well as centralized monitoring of running conditions.

7.2 Application to Plants



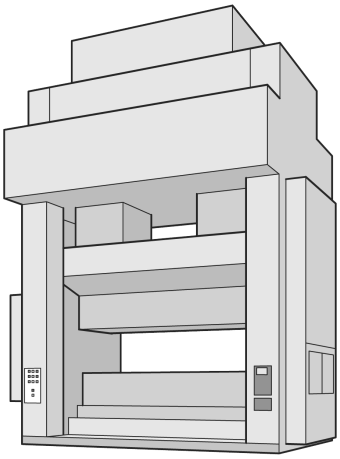
Control with high speed and high accuracy

In addition to high speed and high accuracy, VG contributes to stable facility operation with high reliability and long service life. The trace back function makes diagnosing the cause of problems easy when an abnormality arises.

System support

Centralized control and monitoring are achieved by supporting various fieldbuses.

7.3 Servo Press: Large Size for Automobiles, Small Size for Machines such as Crimping Terminal Processing Machines



Position control

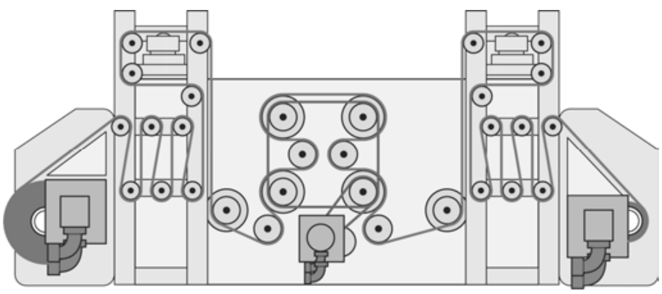
The press position is controlled based on an instantaneous position command given by the CNC of the high order.

Control with high responsibility contributes to shortening of the operation cycle.

Precision synchronization control

Large machines are driven with several motors to increase thrust. Precision synchronization control of several inverters and motors using the high-speed bus system can be applied.

7.4 Winding Equipment (Paper and Metal)



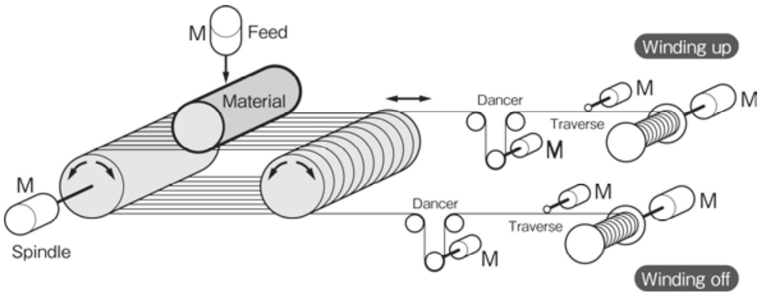
Tension control

Tension-type winding control capability with high accuracy torque control has been improved. Dancer-type winding control capability by the speed control with high speed response has been improved.

System support

The controller that calculates winding diameter achieves constant tension control.

7.5 Feeding Part of Semiconductor Manufacturing Device, Wire Saw



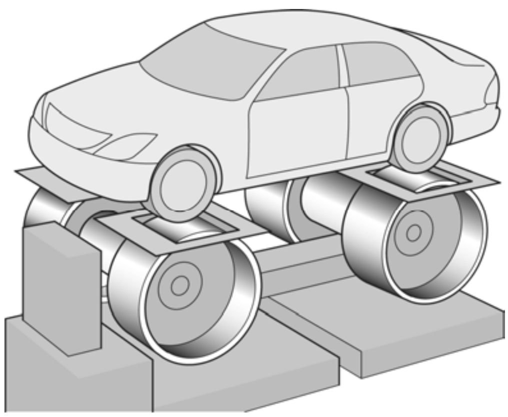
Smooth torque characteristic

The smooth drive characteristic in which torque ripple is suppressed contributes to machining quality.

System support

The system has been made simple and highly efficient by connecting and controlling the spindle that drives wires and the small-capacity servo that drives the traverse axis and winding up and off axes in the same bus system.

7.6 Test Equipment for Automobiles



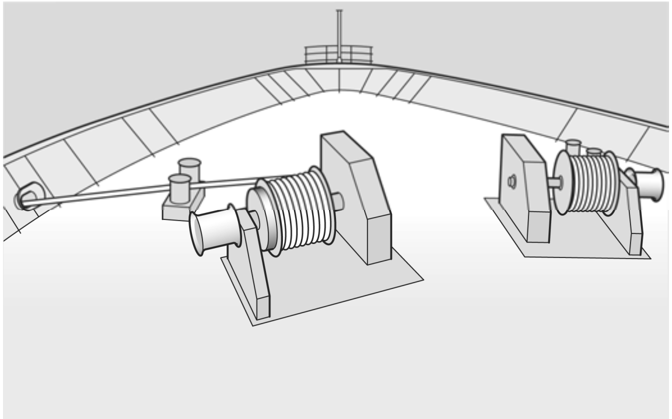
High-speed response control

High-speed rotation and torque control with high response are available for engine and transmission tests.

System support

The system can be supported in cases such as the vehicle body inertia simulation function for a brake test apparatus by combining with the controller.

7.7 Shipboard Winch

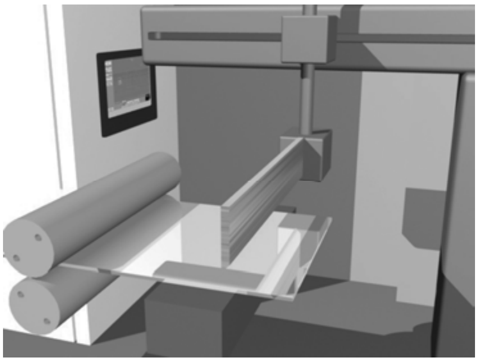


High reliability and tension control

Torque is controlled up to extra low speed using the sensorless feature.

Stable drive is maintained against load variation caused by waves.

7.8 Flying Shear



Position control

Position control is performed according to the position command given by the high-order CNC. The machine cuts the blank while moving at the same speed as the blank.

System support

The system is configured by a controller that calculates synchronous operation among the blank feed axis, cutter feed axis and cut axis.

FRENIC-VG

8

Chapter 8
SELECTING PERIPHERAL EQUIPMENT

This chapter describes how to use a range of peripheral equipment and options, FRENIC-VG's configuration with them, and requirements and precautions for selecting wires and crimp terminals.

Contents

8.1 Configuring the FRENIC-VG

This section lists the names and features of peripheral equipment and options for the FRENIC-VG series of inverters and includes a configuration example for reference.

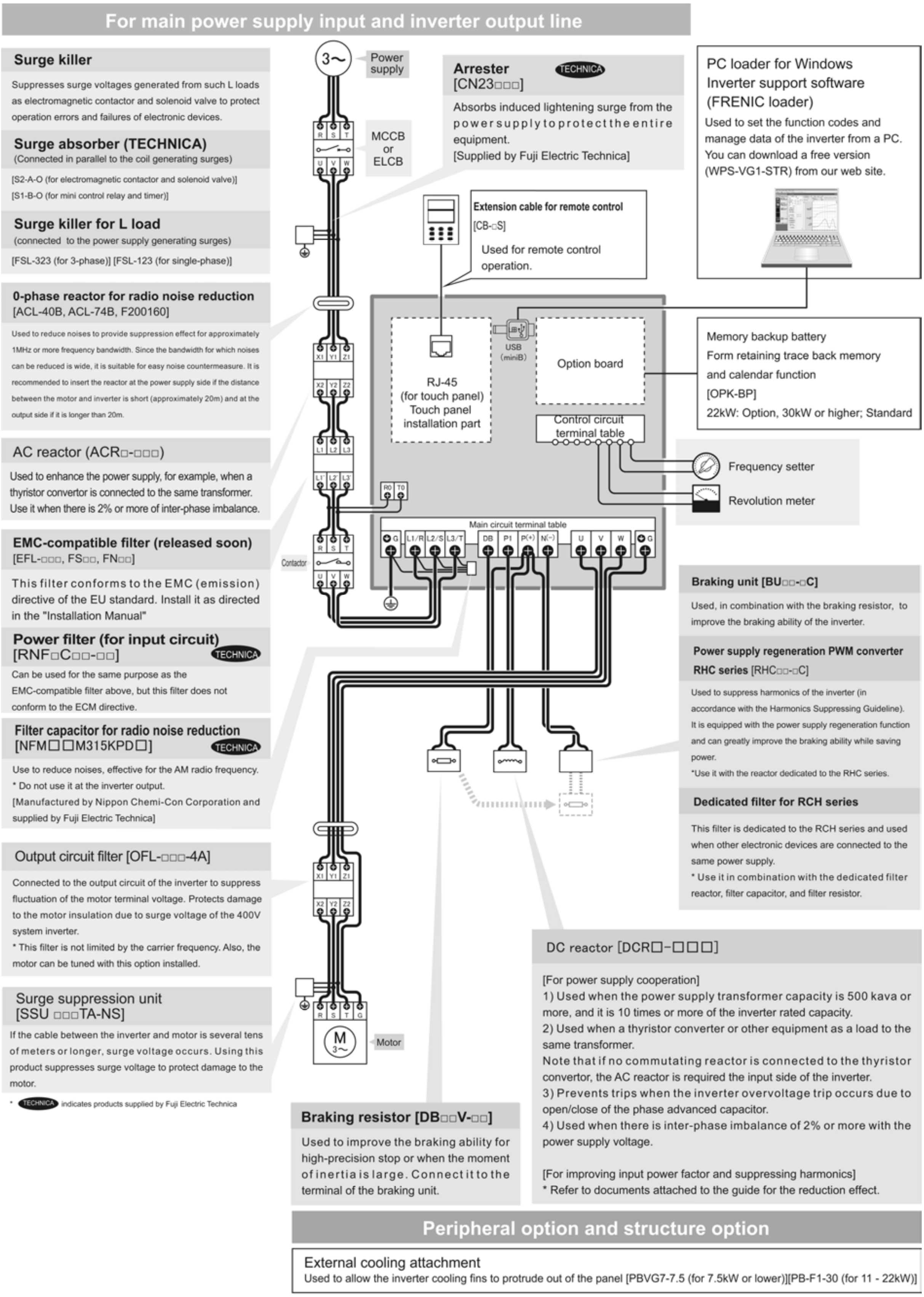


Figure 8.1 Quick Overview of Options

8.2 Selecting Wires and Crimp Terminals

This section contains information needed to select wires for connecting the inverter to commercial power lines, motor or any of the optional/peripheral equipment. The level of electric noise issued from the inverter or received by the inverter from external sources may vary depending upon wiring and routing. For more information about wiring and noise, refer to Appendix A "Advantageous Use of Inverters (Notes on electrical noise)" and the Fuji Electric technical information "Engineering Design of Panels."

Select wires that satisfy the following requirements:

- Sufficient capacity to flow the rated average current (allowable current capacity).
- Protective coordination with an MCCB or RCD/ELCB with overcurrent protection in the overcurrent zone.
- Voltage loss due to the wiring length is within the allowable range.
- Suitable for the type and size of terminals of the optional equipment to be used.

Recommended wires are listed below. Use these wires unless otherwise specified.

■ 600 V class of vinyl-insulated wires (IV wires)

Use this class of wire for the power circuits. This class of wire is hard to twist, so using it for the control signal circuits is not recommended. Maximum surrounding temperature for this wire is 60°C.

■ 600 V grade heat-resistant PVC insulated wires or 600 V polyethylene insulated wires (HIV wires)

As wires in this class are smaller in diameter and more flexible than IV wires and can be used at a higher surrounding temperature (75°C), they can be used for both of the main power and control signal circuits. To use this class of wire for the control circuits, you need to correctly twist the wires and keep the wiring length for equipment being connected as short as possible.

■ 600 V cross-linked polyethylene-insulated wires

Use this class of wire mainly for power and grounding circuits. These wires are smaller in diameter and more flexible than those of the IV and HIV classes of wires, meaning that these wires can be used to save on space and increase operation efficiency of your power system, even in high temperature environments. Maximum surrounding temperature for this wire is 90°C. The (Boardlex) wire range available from Furukawa Electric Co., Ltd. satisfies these requirements.

■ Shielded-Twisted cables for internal wiring of electronic/electric equipment

Use this category of cables for the control circuits of the inverter so as to prevent the signal lines from being affected by noise from external sources, including the power input/output lines of the inverter themselves. Even if the signal lines are inside the power control panel, always use this category of cables when the length of wiring is longer than normal. Cables satisfying these requirements are the Furukawa's BEAMEX S shielded cables of the XEBV and XEWV ranges.

Currents Flowing through Inverter Terminals

Table 8.1 summarizes average (effective) electric currents flowing across the terminals of each inverter model for ease of reference when selecting peripheral equipment, options and electric wires for each inverter--including supplied power voltage and applicable motor rating.

Table 8.1 Currents Flowing through Inverter

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	50 Hz, 200 V			60 Hz, 220 V		
				Input RMS current (A) DC reactor (DCR)		DC link bus current (A)	Input RMS current (A) DC reactor (DCR)		DC link bus current (A)
				w/ DCR	w/o DCR		w/ DCR	w/o DCR	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	3.2	5.3	4	3	4.9	3.7
	1.5	FRN1.5VG1□-2J		6.1	9.5	7.5	5.6	8.7	6.9
	2.2	FRN2.2VG1□-2J		8.9	13.2	11	8.1	12	10
	3.7	FRN3.7VG1□-2J		15	22.2	18.4	13.6	20	16.7
	5.5	FRN5.5VG1□-2J		21.1	31.5	25.9	19	28.4	23.3
	7.5	FRN7.5VG1□-2J		28.8	42.7	35.3	26	38.5	31.9
	11	FRN11VG1□-2J		42.2	60.7	51.7	38	54.7	46.6
	15	FRN15VG1□-2J		57.6	80.1	70.6	52	72.2	63.7
	18.5	FRN18.5VG1□-2J		71	97	87	64	87.4	78.4
	22	FRN22VG1□-2J		84.4	112	103	76	101	93.1
	30	FRN30VG1□-2J	HD	114	151	140	103	136	126
	37		LD	138	185	169	124	167	152
		FRN37VG1□-2J	HD	138	185	169	124	167	152
	45		LD	167	225	205	150	203	184
		FRN45VG1□-2J	HD	167	225	205	150	203	184
	55		LD	203	270	249	183	243	224
		FRN55VG1□-2J	HD	203	270	249	183	243	224
	75		LD	282		345	254		311
		FRN75VG1□-2J	HD	282		345	254		311
	90		LD	334	-	409	301	-	368
		FRN90VG1□-2J	HD	334		409	301		368
	110		LD	410		502	369		452

Note: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square (RMS) current is calculated according to the following conditions:

  [22 kW or below] Power supply capacity 500 kVA, Power supply impedance 5%

  [30 kW or above] Power supply capacity and power supply impedance which are calculated using values matching the inverter capacity recommended by Fuji Electric.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 230 VAC.

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Table 8.1 Currents Flowing through Inverter (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	50 Hz, 400 V			60 Hz, 440 V		
				Input RMS current (A) DC reactor (DCR)		DC link bus current (A)	Input RMS current (A) DC reactor (DCR)		DC link bus current (A)
				w/ DCR	w/o DCR		w/ DCR	w/o DCR	
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	7.5	13	9.2	6.9	11.8	8.5
	5.5	FRN5.5VG1□-4J	HD	10.6	17.3	13	9.6	15.7	11.8
	7.5	FRN7.5VG1□-4J	HD	14.4	23.2	17.7	13	21	16
	11	FRN11VG1□-4J	HD	21.1	33	25.9	19	29.8	23.3
	15	FRN15VG1□-4J	HD	28.8	43.8	35.3	26	39.5	31.9
	18.5	FRN18.5VG1□-4J	HD	35.5	52.3	43.5	32	47.1	39.2
	22	FRN22VG1□-4J	HD	42.2	60.6	51.7	38	54.6	46.6
	30	FRN30VG1□-4J	HD	57	77.9	69.9	51.4	70.2	63
	37	FRN30VG1□-4J	LD	68.5	94.3	83.9	61.8	85	75.7
	37	FRN37VG1□-4J	HD	68.5	94.3	83.9	61.8	85	75.7
	45	FRN37VG1□-4J	LD	83.2	114	102	75	103	91.9
	45	FRN45VG1□-4J	HD	83.2	114	102	75	103	91.9
	55	FRN45VG1□-4J	LD	102	140	125	91.9	126	113
	55	FRN55VG1□-4J	HD	102	140	125	91.9	126	113
	75	FRN55VG1□-4J	LD	138	-	169	124	-	152
	75	FRN75VG1□-4J	HD	138	-	169	124	-	152
	90	FRN75VG1□-4J	LD	164	-	201	148	-	181
	90	FRN90VG1□-4J	HD	164	-	201	148	-	181
	110	FRN90VG1□-4J	MD/LD	201	-	246	181	-	222
	110	FRN110VG1□-4J	HD	201	-	246	181	-	222
	132	FRN110VG1□-4J	MD/LD	238	-	292	214	-	263
	132	FRN132VG1□-4J	HD	238	-	292	214	-	263
	160	FRN132VG1□-4J	MD/LD	286	-	350	258	-	315
	160	FRN160VG1□-4J	HD	286	-	350	258	-	315
	200	FRN160VG1□-4J	MD/LD	357	-	437	321	-	394
	200	FRN200VG1□-4J	HD	357	-	437	321	-	394
	220	FRN200VG1□-4J	MD/LD	390	-	478	351	-	430
	220	FRN220VG1□-4J	HD	390	-	478	351	-	430
	250	FRN220VG1□-4J	MD	443	-	543	399	-	489
	280	FRN220VG1□-4J	LD	500	-	613	450	-	552
	280	FRN280VG1□-4J	HD	500	-	613	450	-	552
	315	FRN280VG1□-4J	MD	559	-	685	503	-	617
	355	FRN280VG1□-4J	LD	628	-	770	565	-	693

Note: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square (RMS) current is calculated according to the following conditions:

  [22 kW or below] Power supply capacity 500 kVA, Power supply impedance 5%

  [30 kW or above] Power supply capacity and power supply impedance which are calculated using values matching the inverter capacity recommended by Fuji Electric.

- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 380 VAC.

Table 8.1 Currents Flowing through Inverter (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	50 Hz, 400 V Input RMS current (A) DC reactor (DCR) w/ DCR	50 Hz, 400 V Input RMS current (A) DC reactor (DCR) w/o DCR	50 Hz, 400 V DC link bus current (A)	60 Hz, 440 V Input RMS current (A) DC reactor (DCR) w/ DCR	60 Hz, 440 V Input RMS current (A) DC reactor (DCR) w/o DCR	60 Hz, 440 V DC link bus current (A)
Three-phase 400 V	315	FRN315VG1□-4J	HD	559	-	685	503	-	617
	355		MD	628		770	565		693
	400		LD	705		864	635		778
	355	FRN355VG1□-4J	HD	628		770	565		693
	400		MD	705		864	635		778
	450		LD	789		967	710		870
	400	FRN400VG1□-4J	HD	705		864	635		778
	450		MD	789		967	710		870
	500		LD	881		1080	793		972
		FRN500VG1□-4J	HD	881		1080	793		972
	630		LD	1115		1367	1004		1230
		FRN630VG1□-4J	HD	1115		1367	1004		1230
	710		LD	1256		1539	1130		1385

Note: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square (RMS) current is calculated according to the following conditions:

  [22 kW or below] Power supply capacity 500 kVA, Power supply impedance 5%

  [30 kW or above] Power supply capacity and power supply impedance which are calculated using values matching the inverter capacity recommended by Fuji Electric.

- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 380 VAC.

8.3 Recommended Wires

The following tables list the recommended wires according to the internal temperature of your power control panel.

■If the internal temperature of your power control panel is 50°C or below

Table 8.2 Wire Size (for main circuit power input and inverter output)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires																			
				Main circuit power inputs L1/R, L2/S, L3/T								Inverter output U ,V, W											
				w/ DC reactor (DCR)				w/o DC reactor (DCR)				HD				MD				LD			
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)
				60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	3.2	2.0	2.0	2.0	5.3	2.0	2.0	2.0	5	-	-	-	-	-	-	-	-
	1.5	FRN1.5VG1□-2J		2.0	2.0	2.0	6.1	2.0	2.0	2.0	9.5	2.0	2.0	2.0	8	-	-	-	-	-	-	-	-
	2.2	FRN2.2VG1□-2J		2.0	2.0	2.0	8.9	2.0	2.0	2.0	13.2	2.0	2.0	2.0	11	-	-	-	-	-	-	-	-
	3.7	FRN3.7VG1□-2J		2.0	2.0	2.0	15.0	5.5	2.0	2.0	22.2	3.5	2.0	2.0	18	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-2J		5.5	2.0	2.0	21.1	8.0	3.5	3.5	31.5	5.5	3.5	2.0	27	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-2J		8.0	3.5	2.0	28.8	14	5.5	5.5	42.7	14	5.5	3.5	37	-	-	-	-	-	-	-	-
	11	FRN11VG1□-2J		14	5.5	5.5	42.2	22	14	8.0 *3)	60.7	14	8.0 *3)	5.5	49	-	-	-	-	-	-	-	-
	15	FRN15VG1□-2J		22	14	8.0 *3)	57.6	38	22	14	80.1	22	14	8.0 *3)	63	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-2J		38 *1)	14	14	71.1	60 *2)	22	14	97.0	38 *1)	14	14	76	-	-	-	-	-	-	-	-
	22	FRN22VG1□-2J		38 *1)	22	14	84.4	60 *2)	38 *1)	22	112	38 *1)	22	14	90	-	-	-	-	-	-	-	-
	30	FRN30VG1□-2J	HD	60	38	22	114	-	60	38	151	60	38	22	119	-	-	-	-	-	-	-	-
	37		LD	-	38	38	138	-	60	38	185	-	-	-	-	-	-	-	-	-	38	38	146
		FRN37VG1□-2J	HD	100								100	38	38	146					-	-	-	-
	45		LD	100	60	38	167	-	100	60	225	-	-	-	-	-	-	-	-	-	60	38	180
		FRN45VG1□-2J	HD									-	60	38	180					-	-	-	-
	55		LD	-	100	60	203	-	100	100	270	-	-	-	-	-	-	-	-	-	100	60	215
		FRN55VG1□-2J	HD									-	100	60	215					-	-	-	-
	75		LD	-	150 *4)	100	282	-	-	-	-	-	-	-	-	-	-	-	-	-	150 *4)	100	283
		FRN75VG1□-2J	HD		150							-	150	100	283					-	-	-	-
	90		LD	-	150	100	334	-	-	-	-	-	-	-	-	-	-	-	-	-	150	150	346
		FRN90VG1□-2J	HD									-	150	150	346					-	-	-	-
	110		LD	-	200	150	410	-	-	-	-	-	-	-	-	-	-	-	-	-	200	150	415

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2:□ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 38-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*2 Use the crimp terminal model No. 60-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*3 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*4 Use CB150-10 crimp terminals designed for low voltage appliances in JEM1399.

Table 8.2 Wire Size (for main circuit power input and inverter output) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires																			
				Main circuit power input L1/R, L2/S, L3/T								Inverter output U, V, W											
				w/ DC reactor (DCR)				w/o DC reactor (DCR)				HD				MD				LD			
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)
				60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	7.5	2.0	2.0	2.0	13.0	2.0	2.0	2.0	9	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	10.6	3.5	2.0	2.0	17.3	2.0	2.0	2.0	13.5	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-4J	HD	2.0	2.0	2.0	14.4	5.5	2.0	2.0	23.2	3.5	2.0	2.0	18.5	-	-	-	-	-	-	-	-
	11	FRN11VG1□-4J	HD	5.5	2.0	2.0	21.1	8.0 *1)	3.5	3.5	33	5.5	3.5	2.0	24.5	-	-	-	-	-	-	-	-
	15	FRN15VG1□-4J	HD	8.0 *1)	3.5	2.0	28.8	14	5.5	5.5	43.8	8.0 *1)	3.5	3.5	32	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-4J	HD	14	5.5	3.5	35.5	22	8.0 *1)	5.5	52.3	14	5.5	3.5	39	-	-	-	-	-	-	-	-
	22	FRN22VG1□-4J	HD	14	5.5	5.5	42.2	22	14	8.0 *1)	60.6	14	8.0 *1)	5.5	45	-	-	-	-	-	-	-	-
	30	FRN30VG1□-4J	HD	22	14	8.0	57.0	38	14	14	77.9	22	14	8.0	60	-	-	-	-	-	-	-	-
	37		LD	38	14	8.0	68.5	60	22	14	94.3	-	-	-	-	-	-	-	-	38	14	14	75
		FRN37VG1□-4J	HD									38	14	14	75					-	-	-	-
	45		LD	38	22	14	83.2	60	38	22	114	-	-	-	-	-	-	-	-	38	22	14	91
		FRN45VG1□-4J	HD									38	22	14	91					-	-	-	-
	55		LD	60	22	22	102	-	38	38	140	-	-	-	-	-	-	-	-	60	38	22	112
		FRN55VG1□-4J	HD									60	38	22	112					-	-	-	-
	75		LD	-	38	38	138	-	-	-	-	-	-	-	-	-	-	-	-	-	60	38	150
		FRN75VG1□-4J	HD	100								100	60	38	150					-	-	-	-
	90		LD	100	60	38	164	-	-	-	-	-	-	-	-	-	-	-	-	-	60	38	176
		FRN90VG1□-4J	HD									-	60	38	176					-	-	-	-
	110		MD/LD	-	100	60	201	-	-	-	-	-	-	-	-	-	100	60	210	-	100	60	210
		FRN110VG1□-4J	HD									-	100	60	210	-	-	-	-	-	-	-	-
	132		MD/LD	-	100	60	238	-	-	-	-	-	-	-	-	-	100	100	253	-	100	100	253
		FRN132VG1□-4J	HD									-	100	100	253	-	-	-	-	-	-	-	-
	160		MD/LD	-	150	100	286	-	-	-	-	-	-	-	-	-	150	100	304	-	150	100	304
		FRN160VG1□-4J	HD									-	150	100	304	-	-	-	-	-	-	-	-
	200		MD/LD	-	150	150	357	-	-	-	-	-	-	-	-	-	200	150	377	-	200	150	377
		FRN200VG1□-4J	HD									-	200	150	377	-	-	-	-	-	-	-	-
	220		MD/LD	-	200	150	390	-	-	-	-	-	-	-	-	-	200	150	415	-	200	150	415
		FRN220VG1□-4J	HD									-	200	150	415	-	-	-	-	-	-	-	-
	250		MD	-	250	150	443	-	-	-	-	-	-	-	-	-	250	200	468	-	-	-	-
	280		LD	-	250	200	500	-	-	-	-	-	-	-	-	-	-	-	-	-	325	200	520
		FRN280VG1□-4J	HD									-	325	200	520					-	-	-	-
	315		MD	-	2x150	250	559	-	-	-	-	-	-	-	-	-	325	250	585	-	-	-	-
	355		LD	-	2x200	250	628	-	-	-	-	-	-	-	-	-	-	-	-	-	2x200	325	650
	315	FRN315VG1□-4J	HD	-	2x150	250	559	-	-	-	-	-	325	250	585	-	-	-	-	-	-	-	-
	355		MD	-	2x200	250	628	-	-	-	-	-	-	-	-	-	2x200	325	650	-	-	-	-
	400		LD	-	2x200	325	705	-	-	-	-	-	-	-	-	-	-	-	-	-	2x250	325	740
	355	FRN355VG1□-4J	HD	-	2x200	250	628	-	-	-	-	-	2x200	325	650	-	-	-	-	-	-	-	-
	400		MD	-	2x200	325	705	-	-	-	-	-	-	-	-	-	2x250	325	740	-	-	-	-
	450		LD		2x250	2x200	789	-	-	-	-	-	-	-	-	-	-	-	-	-	2x250	2x200	840
	400	FRN400VG1□-4J	HD	-	2x200	325	705	-	-	-	-	-	2x250	325	740	-	-	-	-	-	-	-	-
	450		MD		2x250	2x200	789	-	-	-	-	-	-	-	-	-	2x250	2x200	840	-	-	-	-
	500		LD	-	2x325	2x200	881	-	-	-	-	-	-	-	-	-	-	-	-	-	2x325	2x250	960
		FRN500VG1□-4J	HD									-	2x325	2x250	960					-	-	-	-
	630		LD	-	3x325	2x325	1115	-	-	-	-	-	-	-	-	-	-	-	-	-	3x325	2x325	1170
		FRN630VG1□-4J	HD									-	3x325	2x325	1170					`	-	-	-
	710		LD	-	4x250	2x325	1256	-	-	-	-	-	-	-	-	-	-	-	-	-	4x325	3x325	1370

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2:□ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Table 8.2 Wire Size (for DC reactor, control circuit, and inverter grounding) (continued)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm²): For DC reactor connection [P1,P(+)] Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	For control circuit, Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary power input for the control circuit [R0, T0], Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary input for fan power supply [R1,T1], Maximum temperature (Note 1) 60°C / 75°C / 90°C	For inverter grounding [⏚ G], Maximum temperature (Note 1) 60°C / 75°C / 90°C
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	4.0	1.25	2.0	-	2.0
	1.5	FRN1.5VG1□-2J	HD	2.0	2.0	2.0	7.5	1.25	2.0	-	2.0
	2.2	FRN2.2VG1□-2J	HD	2.0	2.0	2.0	11.0	1.25	2.0	-	2.0
	3.7	FRN3.7VG1□-2J	HD	3.5	2.0	2.0	18.4	1.25	2.0	-	2.0
	5.5	FRN5.5VG1□-2J	HD	5.5	3.5	2.0	25.9	1.25	2.0	-	3.5
	7.5	FRN7.5VG1□-2J	HD	14	5.5	3.5	35.3	1.25	2.0	-	5.5
	11	FRN11VG1□-2J	HD	22	8.0 *3)	5.5	51.7	1.25	2.0	-	5.5
	15	FRN15VG1□-2J	HD	38 *1)	14	14	70.6	1.25	2.0	-	8.0
	18.5	FRN18.5VG1□-2J	HD	38 *1)	22	14	87.0	1.25	2.0	-	8.0
	22	FRN22VG1□-2J	HD	60 *2)	22	22	103	1.25	2.0	-	14
	30	FRN30VG1□-2J	HD	-	38	38	140	1.25	2.0	-	14
	37	FRN30VG1□-2J	LD	-	60	38	169	1.25	2.0	-	22
	37	FRN37VG1□-2J	HD	100	60	38	169	1.25	2.0	2.0 (37 kW or above)	22
	45	FRN37VG1□-2J	LD	-	100	60	205	1.25	2.0	2.0 (37 kW or above)	22
	45	FRN45VG1□-2J	HD	-	100	60	205	1.25	2.0	2.0 (37 kW or above)	22
	55	FRN45VG1□-2J	LD	-	100	60	249	1.25	2.0	2.0 (37 kW or above)	22
	55	FRN55VG1□-2J	HD	-	100	60	249	1.25	2.0	2.0 (37 kW or above)	22
	75	FRN55VG1□-2J	LD	-	150 *4)	150 *4)	345	1.25	2.0	2.0 (37 kW or above)	22
	75	FRN75VG1□-2J	HD	-	150	150	345	1.25	2.0	2.0 (37 kW or above)	22
	90	FRN75VG1□-2J	LD	-	200	150	409	1.25	2.0	2.0 (37 kW or above)	22
	90	FRN90VG1□-2J	HD	-	200	150	409	1.25	2.0	2.0 (37 kW or above)	22
	110	FRN90VG1□-2J	LD	-	250	200	502	1.25	2.0	2.0 (37 kW or above)	38

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2:□ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 38-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*2 Use the crimp terminal model No. 60-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*3 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*4 Use CB150-10 crimp terminals designed for low voltage appliances in JEM1399.

Table 8.2 Wire Size (for DC reactor, control circuit, and inverter grounding) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm^2)																		
				For DC reactor connection 〔P1,P(+)〕				For control circuit			Auxiliary power input for the control circuit 〔R0, T0〕			Auxiliary input for fan power supply 〔R1,T1〕			For inverter grounding 〔⏚ G〕		
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Maximum temperature (Note 1)			Maximum temperature (Note 1)			Maximum temperature (Note 1)		
				60°C	75°C	90°C		60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	9.2	1.25			2.0			-			2.0		
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	13.0												
	7.5	FRN7.5VG1□-4J	HD	3.5	2.0	2.0	17.7										3.5		
	11	FRN11VG1□-4J	HD	5.5	3.5	2.0	25.9												
	15	FRN15VG1□-4J	HD	14	5.5	3.5	35.3										5.5		
	18.5	FRN18.5VG1□-4J	HD	14	5.5	5.5	43.5												
	22	FRN22VG1□-4J	HD	22	8.0 *1)	5.5	51.7												
	30	FRN30VG1□-4J	HD	38	14	8.0	69.9										8.0		
	37		LD	38	22	14	83.9												
		FRN37VG1□-4J	HD																
	45		LD	60	22	22	102												
		FRN45VG1□-4J	HD																
	55		LD	60	38	22	125												
		FRN55VG1□-4J	HD														14		
	75		LD	-	60	38	169												
		FRN75VG1□-4J	HD	100										2.0 (75 kW or above)					
	90		LD	-	100	60	201												
		FRN90VG1□-4J	HD																
	110		MD/LD	-	100	60	246										22		
		FRN110VG1□-4J	HD																
	132		MD/LD	-	150	100	292												
		FRN132VG1□-4J	HD																
	160		MD/LD	-	150	150	350												
		FRN160VG1□-4J	HD																
	200		MD/LD	-	250	150	437										38		
		FRN200VG1□-4J	HD																
	220		MD/LD	-	250	200	478												
		FRN220VG1□-4J	HD																
	250		MD	-	325	250	543												
	280		LD	-	2x200	250	612												
		FRN280VG1□-4J	HD																
	315		MD	-	2x200	325	685										60		
	355		LD	-	2x250	2x200	769												
	315	FRN315VG1□-4J	HD	-	2x200	325	685												
	355		MD	-	2x250	2x200	769												
	400		LD	-	2x325	2x200	864												
	355	FRN355VG1□-4J	HD	-	2x250	2x200	769												
	400		MD	-	2x325	2x200	864												
	450		LD	-	2x325	2x250	966												
	400	FRN400VG1□-4J	HD	-	2x325	2x200	864												
	450		MD	-	2x325	2x250	966												
	500		LD	-	3x325	2x325	1079										100		
		FRN500VG1□-4J	HD																
	630		LD	-	3x325	3x325	1366												
		FRN630VG1□-4J	HD																
	710		LD	-	4x325	3x325	1538												

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

■ If the internal temperature of your power control panel is 40°C or below

Table 8.3 Wire Size (for main circuit power input and inverter output)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm²)																			
				Main circuit power input [L1/R, L2/S, L3/T]								Inverter output [U, V, W]											
				w/ DC reactor (DCR)				w/o DC reactor (DCR)				HD				MD				LD			
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)
				60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	3.2	2.0	2.0	2.0	5.3	2.0	2.0	2.0	5	-	-	-	-	-	-	-	-
	1.5	FRN1.5VG1□-2J		2.0	2.0	2.0	6.1	2.0	2.0	2.0	9.5	2.0	2.0	2.0	8	-	-	-	-	-	-	-	-
	2.2	FRN2.2VG1□-2J		2.0	2.0	2.0	8.9	2.0	2.0	2.0	13.2	2.0	2.0	2.0	11	-	-	-	-	-	-	-	-
	3.7	FRN3.7VG1□-2J		2.0	2.0	2.0	15	3.5	2.0	2.0	22.2	2.0	2.0	2.0	18	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-2J	HD	2.0	2.0	2.0	21.1	5.5	3.5	2.0	31.5	3.5	2.0	2.0	27	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-2J	HD	3.5	2.0	2.0	28.8	8.0	5.5	3.5	42.7	5.5	3.5	3.5	37	-	-	-	-	-	-	-	-
	11	FRN11VG1□-2J	HD	8.0 *2)	5.5	3.5	42.2	14	8.0 *2)	5.5	60.7	8.0 *2)	5.5	5.5	49	-	-	-	-	-	-	-	-
	15	FRN15VG1□-2J	HD	14	8.0 *2)	5.5	57.6	22	14	14	80.1	14	8.0 *2)	5.5	63	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-2J	HD	14	14	8.0 *2)	71	38 *1)	22	14	97.0	22	14	8.0 *2)	76	-	-	-	-	-	-	-	-
	22	FRN22VG1□-2J	HD	22	14	14	84.4	38 *1)	22	14	112	22	14	14	90	-	-	-	-	-	-	-	-
	30	FRN30VG1□-2J	HD	38	22	22	114	60	38	38	151	38	22	22	119	-	-	-	-	-	-	-	-
	37		LD	60	38	22	138	-	60	38	185	-	-	-	-	-	-	-	-	60	38	22	146
		FRN37VG1□-2J	HD					100				60	38	22	146					-	-	-	-
	45		LD	60	38	38	167	100	60	60	225	-	-	-	-	-	-	-	-	100	60	38	180
		FRN45VG1□-2J	HD									100	60	38	180					-	-	-	-
	55		LD	100	60	38	203	-	100	60	270	-	-	-	-	-	-	-	-	100	60	60	215
		FRN55VG1□-2J	HD									100	60	60	215					-	-	-	-
	75		LD	-	100	100	282	-	-	-	-	-	-	-	-	-	-	-	-	-	100	100	283
		FRN75VG1□-2J	HD	150 *3)								150	100	100	283					-	-	-	-
	90		LD	-	150	100	334	-	-	-	-	-	-	-	-	-	-	-	-	200	150	100	346
		FRN90VG1□-2J	HD									200	150	100	346					-	-	-	-
	110		LD	-	150	150	410	-	-	-	-	-	-	-	-	-	-	-	-	250	150	150	415

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 38-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*2 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*3 Use CB150-10 crimp terminals designed for low voltage appliances in JEM1399.

Table 8.3 Wire Size (for main circuit power input and inverter output) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm²)																			
				Main circuit power input 〔L1/R, L2/S, L3/T〕								Inverter output 〔U, V, W〕											
				w/ DC reactor (DCR)				w/o DC reactor (DCR)				HD				MD				LD			
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)
				60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	7.5	2.0	2.0	2.0	13.0	2.0	2.0	2.0	9	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	10.6	2.0	2.0	2.0	17.3	2.0	2.0	2.0	13.5	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-4J	HD	2.0	2.0	2.0	14.4	3.5	2.0	2.0	23.2	2.0	2.0	2.0	18.5	-	-	-	-	-	-	-	-
	11	FRN11VG1□-4J	HD	2.0	2.0	2.0	21.1	5.5	3.5	2.0	33	3.5	2.0	2.0	24.5	-	-	-	-	-	-	-	-
	15	FRN15VG1□-4J	HD	3.5	2.0	2.0	28.8	8.0 *1)	5.5	3.5	43.8	5.5	3.5	2.0	32	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-4J	HD	5.5	3.5	3.5	35.5	14	8.0 *1)	5.5	52.3	5.5	3.5	3.5	39	-	-	-	-	-	-	-	-
	22	FRN22VG1□-4J	HD	8.0 *1)	5.5	3.5	42.2	14	8.0 *1)	5.5	60.6	8.0 *1)	5.5	3.5	45	-	-	-	-	-	-	-	-
	30	FRN30VG1□-4J	HD	14	8.0	5.5	57.0	22	14	8.0	77.9	14	8.0	5.5	60	-	-	-	-	-	-	-	-
	37	FRN30VG1□-4J	LD	14	14	8.0	68.5	38	14	14	94.3	-	-	-	-	-	-	-	-	22	14	8.0	75
		FRN37VG1□-4J	HD									22	14	8.0	75					-	-	-	-
	45	FRN37VG1□-4J	LD	22	14	14	83.2	38	22	22	114	-	-	-	-	-	-	-	-	22	14	14	91
		FRN45VG1□-4J	HD									22	14	14	91					-	-	-	-
	55	FRN45VG1□-4J	LD	38	22	14	102	60	38	22	140	-	-	-	-	-	-	-	-	38	22	14	112
		FRN55VG1□-4J	HD									38	22	14	112					-	-	-	-
	75	FRN55VG1□-4J	LD	60	38	22	138	-	-	-	-	-	-	-	-	-	-	-	-	60	38	38	150
		FRN75VG1□-4J	HD									60	38	38	150					-	-	-	-
	90	FRN75VG1□-4J	LD	60	38	38	164	-	-	-	-	-	-	-	-	-	-	-	-	60	60	38	176
		FRN90VG1□-4J	HD									60	60	38	176					-	-	-	-
	110	FRN90VG1□-4J	MD/LD	100	60	38	201	-	-	-	-	-	-	-	-	100	60	60	210	100	60	60	210
		FRN110VG1□-4J	HD									100	60	60	210	-	-	-	-	-	-	-	-
	132	FRN110VG1□-4J	MD/LD	100	100	60	238	-	-	-	-	-	-	-	-	150	100	60	253	150	100	60	253
		FRN132VG1□-4J	HD									150	100	60	253	-	-	-	-	-	-	-	-
	160	FRN132VG1□-4J	MD/LD	150	100	100	286	-	-	-	-	-	-	-	-	150	100	100	304	150	100	100	304
		FRN160VG1□-4J	HD									150	100	100	304	-	-	-	-	-	-	-	-
	200	FRN160VG1□-4J	MD/LD	200	150	100	357	-	-	-	-	-	-	-	-	200	150	100	377	200	150	100	377
		FRN200VG1□-4J	HD									200	150	100	377	-	-	-	-	-	-	-	-
	220	FRN200VG1□-4J	MD/LD	250	150	150	390	-	-	-	-	-	-	-	-	250	150	150	415	250	150	150	415
		FRN220VG1□-4J	HD									250	150	150	415	-	-	-	-	-	-	-	-
	250	FRN220VG1□-4J	MD	250	200	150	443	-	-	-	-	-	-	-	-	325	200	150	468	-	-	-	-
	280	FRN220VG1□-4J	LD	325	200	150	500	-	-	-	-	-	-	-	-	-	-	-	-	325	250	200	520
		FRN280VG1□-4J	HD									325	250	200	520					-	-	-	-
	315	FRN280VG1□-4J	MD	-	250	200	559	-	-	-	-	-	-	-	-	-	250	200	585	-	-	-	-
	355	FRN280VG1□-4J	LD	-	325	250	628	-	-	-	-	-	-	-	-	-	-	-	-	-	325	250	650
	315	FRN315VG1□-4J	HD	-	250	200	559	-	-	-	-	-	250	200	585	-	-	-	-	-	-	-	-
	355	FRN315VG1□-4J	MD	-	325	250	628	-	-	-	-	-	-	-	-	-	325	250	650	-	-	-	-
	400	FRN315VG1□-4J	LD	-	2x150	250	705	-	-	-	-	-	-	-	-	-	-	-	-	-	2x200	325	740
	355	FRN355VG1□-4J	HD	-	325	250	628	-	-	-	-	-	325	250	650	-	-	-	-	-	-	-	-
	400	FRN355VG1□-4J	MD	-	2x150	250	705	-	-	-	-	-	-	-	-	-	2x200	325	740	-	-	-	-
	450	FRN355VG1□-4J	LD	-	2x200	325	789	-	-	-	-	-	-	-	-	-	-	-	-	-	2x200	2x150	840
	400	FRN400VG1□-4J	HD	-	2x150	250	705	-	-	-	-	-	2x200	325	740	-	-	-	-	-	-	-	-
	450	FRN400VG1□-4J	MD	-	2x200	325	789	-	-	-	-	-	-	-	-	-	2x200	2x150	840	-	-	-	-
	500	FRN400VG1□-4J	LD	-	2x250	2x200	881	-	-	-	-	-	-	-	-	-	-	-	-	-	2x250	2x200	960
		FRN500VG1□-4J	HD									-	2x250	2x200	960					-	-	-	-
	630	FRN500VG1□-4J	LD	-	2x325	2x250	1115	-	-	-	-	-	-	-	-	-	-	-	-	-	3x250	2x250	1170
		FRN630VG1□-4J	HD									-	3x250	2x250	1170					-	-	-	-
	710	FRN630VG1□-4J	LD	-	3x250	2x325	1256	-	-	-	-	-	-	-	-	-	-	-	-	-	3x325	2x325	1370

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□ └─ S (Basic type)

*1 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

Table 8.3 Wire Size (for DC reactor, control circuit, and inverter grounding) (continued)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm²): For DC reactor connection 〔P1,P(+)〕 Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	For braking resistor connection 〔P(+),DB〕 HD: Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	MD: Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	LD: Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	For control circuit, Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary power input for the control circuit 〔R0, T0〕, Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary input for fan power supply 〔R1,T1〕, Maximum temperature (Note 1) 60°C / 75°C / 90°C	For inverter grounding 〔⏚ G〕, Maximum temperature (Note 1) 60°C / 75°C / 90°C
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	4.0	2.0	2.0	2.0	1.6	-	-	-	-	-	-	-	-	1.25	2.0	-	2.0
	1.5	FRN1.5VG1□-2J	HD	2.0	2.0	2.0	7.5	2.0	2.0	2.0	3.6	-	-	-	-	-	-	-	-				
	2.2	FRN2.2VG1□-2J	HD	2.0	2.0	2.0	11.0	2.0	2.0	2.0	3.5	-	-	-	-	-	-	-	-				
	3.7	FRN3.7VG1□-2J	HD	2.0	2.0	2.0	18.4	2.0	2.0	2.0	4.1	-	-	-	-	-	-	-	-				
	5.5	FRN5.5VG1□-2J	HD	3.5	2.0	2.0	25.9	2.0	2.0	2.0	6.4	-	-	-	-	-	-	-	-				3.5
	7.5	FRN7.5VG1□-2J	HD	5.5	3.5	3.5	35.3	2.0	2.0	2.0	6.1	-	-	-	-	-	-	-	-				5.5
	11	FRN11VG1□-2J	HD	14	5.5	5.5	51.7	2.0	2.0	2.0	9.1	-	-	-	-	-	-	-	-				
	15	FRN15VG1□-2J	HD	14	14	8.0 *2)	70.6	2.0	2.0	2.0	11	-	-	-	-	-	-	-	-				8.0
	18.5	FRN18.5VG1□-2J	HD	22	14	14	87.0	2.0	2.0	2.0	14	-	-	-	-	-	-	-	-				
	22	FRN22VG1□-2J	HD	38 *1)	22	14	103	2.0	2.0	2.0	15	-	-	-	-	-	-	-	-				14
	30	FRN30VG1□-2J	HD	60	38	22	140	2.0	2.0	2.0	19	-	-	-	-	-	-	-	-				
	37	FRN30VG1□-2J	LD	60	38	38	169	-	-	-	-	-	-	-	-	2.0	2.0	2.0	19				22
		FRN37VG1□-2J	HD					3.5	2.0	2.0	25					-	-	-	-			2.0 (37kW or above)	
	45	FRN37VG1□-2J	LD	100	60	38	205	-	-	-	-	-	-	-	-	3.5	2.0	2.0	25				
		FRN45VG1□-2J	HD					3.5	3.5	2.0	30					-	-	-	-				
	55	FRN45VG1□-2J	LD	150 *3)	100	60	249	-	-	-	-	-	-	-	-	3.5	3.5	2.0	30				
		FRN55VG1□-2J	HD					5.5	3.5	3.5	37					-	-	-	-				
	75	FRN55VG1□-2J	LD	-	150 *3)	100	345	-	-	-	-	-	-	-	-	5.5	3.5	3.5	37				
		FRN75VG1□-2J	HD		150			8.0	5.5	5.5	48					-	-	-	-				
	90	FRN75VG1□-2J	LD	-	150	150	409	-	-	-	-	-	-	-	-	8.0	5.5	5.5	48				
		FRN90VG1□-2J	HD					14.0	8.0	5.5	61					-	-	-	-				
	110	FRN90VG1□-2J	LD	-	200	150	502	-	-	-	-	-	-	-	-	14	8.0	5.5	61				38

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2:□ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*2 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*3 Use CB150-10 crimp terminals designed for low voltage appliances in JEM1399.

Table 8.3 Wire Size (for DC reactor, control circuit, and inverter grounding) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm²): For DC reactor connection 〔P1,P(+)〕 Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	For control circuit, Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary power input for the control circuit 〔R0, T0〕, Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary input for fan power supply 〔R1,T1〕, Maximum temperature (Note 1) 60°C / 75°C / 90°C	For inverter grounding 〔⏚ G〕, Maximum temperature (Note 1) 60°C / 75°C / 90°C
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	9.2	1.25	2.0	-	2.0
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	13.0				
	7.5	FRN7.5VG1□-4J	HD	2.0	2.0	2.0	17.7				3.5
	11	FRN11VG1□-4J	HD	3.5	2.0	2.0	25.9				
	15	FRN15VG1□-4J	HD	5.5	3.5	3.5	35.3				5.5
	18.5	FRN18.5VG1□-4J	HD	8.0 *1)	5.5	3.5	43.5				
	22	FRN22VG1□-4J	HD	14	5.5	5.5	51.7				
	30	FRN30VG1□-4J	HD	14	14	8.0	69.9				8.0
	37		LD	22	14	14	83.9				
		FRN37VG1□-4J	HD								
	45		LD	38	22	14	102				
		FRN45VG1□-4J	HD								
	55		LD	38	38	22	125				14
		FRN55VG1□-4J	HD								
	75		LD	60	38	38	169				
		FRN75VG1□-4J	HD							2.0 (75 kW or above)	
	90		LD	100	60	38	201				
		FRN90VG1□-4J	HD								
	110		MD/ LD	150	100	60	246				22
		FRN110VG1□-4J	HD								
	132		MD/ LD	150	100	100	292				
		FRN132VG1□-4J	HD								
	160		MD/ LD	200	150	100	350				
		FRN160VG1□-4J	HD								
	200		MD/ LD	250	200	150	437				38
		FRN200VG1□-4J	HD								
	220		MD/ LD	325	200	150	478				
		FRN220VG1□-4J	HD								
	250		MD	-	250	200	543				
	280		LD	-	325	250	612				
		FRN280VG1□-4J	HD								
	315		MD	-	2x150	250	685				60
	355		LD	-	2x200	325	769				
	315	FRN315VG1□-4J	HD	-	2x150	250	685				
	355		MD	-	2x200	325	769				
	400		LD	-	2x250	2x200	864				
	355	FRN355VG1□-4J	HD	-	2x200	325	769				
	400		MD	-	2x250	2x200	864				
	450		LD	-	2x250	2x200	966				
	400	FRN400VG1□-4J	HD	-	2x250	2x200	864				
	450		MD	-	2x250	2x200	966				
	500		LD	-	2x325	2x250	1079				100
		FRN500VG1□-4J	HD								
	630		LD	-	3x325	2x325	1366				
		FRN630VG1□-4J	HD								
	710		LD	-	4x325	3x325	1538				

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

< Wire Size (for DC reactor, braking resistor >

■ If the internal temperature of your power control panel is 50°C or below

Table 8.4 Wire Size (for braking resistor)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	10% ED product												20% ED product											
				For braking resistor connection 〔P(+),DB〕												For braking resistor connection 〔P(+),DB〕											
				HD				MD				LD				HD				MD				LD			
				Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)
				60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	1.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	1.9	-	-	-	-	-	-	-	-
	1.5	FRN1.5VG1□-2J	HD	2.0	2.0	2.0	1.9	-	-	-	-	-	-	-	-	2.0	2.0	2.0	2.7	-	-	-	-	-	-	-	-
	2.2	FRN2.2VG1□-2J	HD	2.0	2.0	2.0	2.3	-	-	-	-	-	-	-	-	2.0	2.0	2.0	3.3	-	-	-	-	-	-	-	-
	3.7	FRN3.7VG1□-2J	HD	2.0	2.0	2.0	3.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	4.8	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-2J	HD	2.0	2.0	2.0	5.1	-	-	-	-	-	-	-	-	2.0	2.0	2.0	7.2	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-2J	HD	2.0	2.0	2.0	6.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	9.7	-	-	-	-	-	-	-	-
	11	FRN11VG1□-2J	HD	2.0	2.0	2.0	10.2	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.4	-	-	-	-	-	-	-	-
	15	FRN15VG1□-2J	HD	2.0	2.0	2.0	13.7	-	-	-	-	-	-	-	-	3.5	2.0	2.0	19.4	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-2J	HD	3.5	2.0	2.0	17.6	-	-	-	-	-	-	-	-	5.5	3.5	2.0	24.8	-	-	-	-	-	-	-	-
	22	FRN22VG1□-2J	HD	3.5	2.0	2.0	20.3	-	-	-	-	-	-	-	-	8.0	3.5	2.0	28.7	-	-	-	-	-	-	-	-
	30	FRN30VG1□-2J	HD	8.0	3.5	2.0	30.0	-	-	-	-	-	-	-	-	14	5.5	3.5	38.7	-	-	-	-	-	-	-	-
	37		LD	-	-	-	-	-	-	-	-	8.0	3.5	2.0	29.8	-	-	-	-	-	-	-	-	14	5.5	3.5	38.5
		FRN37VG1□-2J	HD	14	5.5	3.5	35.1					-	-	-	-	14	8.0	5.5	48.1					-	-	-	-
	45		LD	-	-	-	-	-	-	-	-	8.0	5.5	3.5	34.6	-	-	-	-	-	-	-	-	14	8.0	5.5	47.4
		FRN45VG1□-2J	HD	14	5.5	3.5	41.1					-	-	-	-	22	14	8.0	58.1					-	-	-	-
	55		LD	-	-	-	-	-	-	-	-	14	5.5	3.5	40.6	-	-	-	-	-	-	-	-	22	14	8.0	57.4
		FRN55VG1□-2J	HD	14	8.0	5.5	50.8					-	-	-	-	38	14	14	71.8					-	-	-	-
	75		LD	-	-	-	-	-	-	-	-	22	8.0	5.5	53.0	-	-	-	-	-	-	-	-	38	14	14	75.0
		FRN75VG1□-2J	HD	38	14	8.0	68.5					-	-	-	-	60	22	14	96.8					-	-	-	-
	90		LD	-	-	-	-	-	-	-	-	38	14	8.0	67.1	-	-	-	-	-	-	-	-	60	22	14	94.9
		FRN90VG1□-2J	HD	38	22	14	82.2					-	-	-	-	60	38	22	116					-	-	-	-
	110		LD	-	-	-	-	-	-	-	-	38	22	14	81.2	-	-	-	-	-	-	-	-	60	38	22	115

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2:□ in the inverter model represents an alphabet.

□
└── S (Basic type)

Table 8.4 Wire Size (for braking resistor) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	10% ED product												20% ED product											
				For braking resistor connection 〔P(+),DB〕												For braking resistor connection 〔P(+),DB〕											
				HD				MD				LD				HD				MD				LD			
				Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)
				60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	1.7	-	-	-	-	-	-	-	-	2.0	2.0	2.0	2.4	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	2.5	-	-	-	-	-	-	-	-	2.0	2.0	2.0	3.6	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-4J	HD	2.0	2.0	2.0	3.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	4.8	-	-	-	-	-	-	-	-
	11	FRN11VG1□-4J	HD	2.0	2.0	2.0	5.1	-	-	-	-	-	-	-	-	2.0	2.0	2.0	7.2	-	-	-	-	-	-	-	-
	15	FRN15VG1□-4J	HD	2.0	2.0	2.0	6.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	9.7	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-4J	HD	2.0	2.0	2.0	8.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	12.4	-	-	-	-	-	-	-	-
	22	FRN22VG1□-4J	HD	2.0	2.0	2.0	10.2	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.4	-	-	-	-	-	-	-	-
	30	FRN30VG1□-4J	HD	2.0	2.0	2.0	15.0	-	-	-	-	-	-	-	-	3.5	2.0	2.0	19.4	-	-	-	-	-	-	-	-
	37		LD	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.9	-	-	-	-	-	-	-	-	3.5	2.0	2.0	19.2
	37	FRN37VG1□-4J	HD	3.5	2.0	2.0	17.6					-	-	-	-	5.5	3.5	2.0	24.8					-	-	-	-
	45		LD	-	-	-	-	-	-	-	-	3.5	2.0	2.0	17.3	-	-	-	-	-	-	-	-	5.5	3.5	2.0	24.5
	45	FRN45VG1□-4J	HD	3.5	2.0	2.0	20.5					-	-	-	-	8.0	3.5	2.0	29.0					-	-	-	-
	55		LD	-	-	-	-	-	-	-	-	3.5	2.0	2.0	20.3	-	-	-	-	-	-	-	-	8.0	3.5	2.0	28.7
	55	FRN55VG1□-4J	HD	5.5	3.5	2.0	25.2					-	-	-	-	14	5.5	3.5	35.6					-	-	-	-
	75		LD	-	-	-	-	-	-	-	-	5.5	3.5	2.0	26.3	-	-	-	-	-	-	-	-	14	5.5	3.5	37.2
	75	FRN75VG1□-4J	HD	8.0	5.5	3.5	34.6					-	-	-	-	14	8.0	5.5	48.9					-	-	-	-
	90		LD	-	-	-	-	-	-	-	-	8.0	5.5	3.5	33.9	-	-	-	-	-	-	-	-	14	8.0	5.5	47.9
	90	FRN90VG1□-4J	HD	14	5.5	3.5	41.6					-	-	-	-	22	14	8.0	58.8					-	-	-	-
	110		MD	-	-	-	-	14	8.0	5.5	50.8									38	14	14	71.8				
	110		LD					-	-	-	-	14	5.5	3.5	41.1	-	-	-	-	-	-	-	-	22	14	8.0	58.2
	110	FRN110VG1□-4J	HD	14	8.0	5.5	50.8					-	-	-	-	38	14	14	71.8					-	-	-	-
	132		MD	-	-	-	-	22	14	8.0	61.7									38	22	14	87.3				
	132		LD					-	-	-	-	14	8.0	5.5	49.7	-	-	-	-	-	-	-	-	38	14	14	70.4
	132	FRN132VG1□-4J	HD	22	14	8.0	61.7					-	-	-	-	38	22	14	87.3					-	-	-	-
	160		MD	-	-	-	-	38	14	14	73.9									60	38	22	104				
	160		LD					-	-	-	-	22	14	8.0	60.8	-	-	-	-	-	-	-	-	38	22	14	85.9
	160	FRN160VG1□-4J	HD	38	14	14	73.9					-	-	-	-	60	38	22	104					-	-	-	-
	200		MD	-	-	-	-	38	22	14	92.6									100	38	22	131				
	200		LD					-	-	-	-	38	14	14	73.9	-	-	-	-	-	-	-	-	60	38	22	104
	200	FRN200VG1□-4J	HD	38	22	14	92.6					-	-	-	-	100	38	22	131					-	-	-	-
	220		MD	-	-	-	-	60	22	22	102									100	38	38	144				
	220		LD					-	-	-	-	38	22	14	86.8	-	-	-	-	-	-	-	-	60	38	22	123
	220	FRN220VG1□-4J	HD	60	22	22	102					-	-	-	-	100	38	38	144					-	-	-	-
	250		MD	-	-	-	-	60	38	22	120					-	-	-	-	100	60	38	170				
	280		LD					-	-	-	-	60	22	22	102					-	-	-	-	100	38	38	145
	280	FRN280VG1□-4J	HD	100	38	38	138					-	-	-	-	150	60	60	195					-	-	-	-
	315		MD	-	-	-	-	100	38	38	147					-	-	-	-	150	100	60	207				
	355		LD					-	-	-	-	100	38	38	139					-	-	-	-	150	60	60	197
	315	FRN315VG1□-4J	HD	100	38	38	147					-	-	-	-	150	100	60	207					-	-	-	-
	355		MD	-	-	-	-	150	60	38	175					-	-	-	-	200	100	60	248				
	400		LD					-	-	-	-	100	60	38	148					-	-	-	-	200	100	60	235
	355	FRN355VG1□-4J	HD	150	60	38	175					-	-	-	-	200	100	60	248					-	-	-	-
	400		MD	-	-	-	-	150	60	60	186					-	-	-	-	200	100	100	263				
	450		LD					-	-	-	-	150	60	38	177					-	-	-	-	200	100	100	250
	400	FRN400VG1□-4J	HD	150	60	60	186					-	-	-	-	200	100	100	263					-	-	-	-
	450		MD	-	-	-	-	150	100	60	228					-	-	-	-	325	150	100	322				
	500		LD					-	-	-	-	150	60	60	186					-	-	-	-	200	100	100	263
	500	FRN500VG1□-4J	HD	200	100	60	240					-	-	-	-	325	150	100	340					-	-	-	-
	630		LD	-	-	-	-	-	-	-	-	200	100	60	241	-	-	-	-	-	-	-	-	325	150	100	341
	630	FRN630VG1□-4J	HD	250	150	100	293					-	-	-	-	2x200	200	150	381					-	-	-	-
	710		LD	-	-	-	-	-	-	-	-	250	150	100	278	-	-	-	-	-	-	-	-	2x200	200.0	150	394

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2:□ in the inverter model represents an alphabet.

□
└── S (Basic type)

■ If the internal temperature of your power control panel is 40°C or below

Table 8.4 Wire Size (for braking resistor) (continued)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	10% ED product												20% ED product											
				For braking resistor connection 〔P(+),DB〕												For braking resistor connection 〔P(+),DB〕											
				HD				MD				LD				HD				MD				LD			
				Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)
				60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	1.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	1.9	-	-	-	-	-	-	-	-
	1.5	FRN1.5VG1□-2J	HD	2.0	2.0	2.0	1.9	-	-	-	-	-	-	-	-	2.0	2.0	2.0	2.7	-	-	-	-	-	-	-	-
	2.2	FRN2.2VG1□-2J	HD	2.0	2.0	2.0	2.3	-	-	-	-	-	-	-	-	2.0	2.0	2.0	3.3	-	-	-	-	-	-	-	-
	3.7	FRN3.7VG1□-2J	HD	2.0	2.0	2.0	3.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	4.8	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-2J	HD	2.0	2.0	2.0	5.1	-	-	-	-	-	-	-	-	2.0	2.0	2.0	7.2	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-2J	HD	2.0	2.0	2.0	6.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	9.7	-	-	-	-	-	-	-	-
	11	FRN11VG1□-2J	HD	2.0	2.0	2.0	10.2	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.4	-	-	-	-	-	-	-	-
	15	FRN15VG1□-2J	HD	2.0	2.0	2.0	13.7	-	-	-	-	-	-	-	-	2.0	2.0	2.0	19.4	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-2J	HD	2.0	2.0	2.0	17.6	-	-	-	-	-	-	-	-	3.5	2.0	2.0	24.8	-	-	-	-	-	-	-	-
	22	FRN22VG1□-2J	HD	2.0	2.0	2.0	20.3	-	-	-	-	-	-	-	-	3.5	2.0	2.0	28.7	-	-	-	-	-	-	-	-
	30	FRN30VG1□-2J	HD	3.5	3.5	2.0	30.0	-	-	-	-	-	-	-	-	5.5	3.5	3.5	38.7	-	-	-	-	-	-	-	-
	37		LD	-	-	-	-	-	-	-	-	3.5	3.5	2.0	29.8	-	-	-	-	-	-	-	-	5.5	3.5	3.5	38.5
	37	FRN37VG1□-2J	HD	5.5	3.5	3.5	35.1					-	-	-	-	8.0	5.5	5.5	48.1					-	-	-	-
	45		LD	-	-	-	-	-	-	-	-	5.5	3.5	3.5	34.6	-	-	-	-	-	-	-	-	8.0	5.5	5.5	47.4
	45	FRN45VG1□-2J	HD	8.0	5.5	3.5	41.1					-	-	-	-	14	8.0	5.5	58.1					-	-	-	-
	55		LD	-	-	-	-	-	-	-	-	8.0	5.5	3.5	40.6	-	-	-	-	-	-	-	-	14	8.0	5.5	57.4
	55	FRN55VG1□-2J	HD	14	5.5	5.5	50.8					-	-	-	-	14	14	8.0	71.8					-	-	-	-
	75		LD	-	-	-	-	-	-	-	-	14	8.0	5.5	53.0	-	-	-	-	-	-	-	-	22	14	8.0	75.0
	75	FRN75VG1□-2J	HD	14	14	8.0	68.5					-	-	-	-	38	22	14	96.8					-	-	-	-
	90		LD	-	-	-	-	-	-	-	-	14	14	8.0	67.1	-	-	-	-	-	-	-	-	38	14	14	94.9
	90	FRN90VG1□-2J	HD	22	14	14	82.2					-	-	-	-	38	22	22	116					-	-	-	-
	110		LD	-	-	-	-	-	-	-	-	22	14	14	81.2	-	-	-	-	-	-	-	-	38	22	22	115

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2:□ in the inverter model represents an alphabet.

□
└── S (Basic type)

Table 8.4 Wire Size (for braking resistor) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	10% ED product, For braking resistor connection 〔P(+),DB〕, HD, Maximum temperature (Note 1)				MD, Maximum temperature (Note 1)				LD, Maximum temperature (Note 1)				20% ED product, For braking resistor connection 〔P(+),DB〕, HD, Maximum temperature (Note 1)				MD, Maximum temperature (Note 1)				LD, Maximum temperature (Note 1)			
				60°C	75°C	90°C	Current (A)	60°C	75°C	90°C	Current (A)	60°C	75°C	90°C	Current (A)	60°C	75°C	90°C	Current (A)	60°C	75°C	90°C	Current (A)	60°C	75°C	90°C	Current (A)
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	1.7	-	-	-	-	-	-	-	-	2.0	2.0	2.0	2.4	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	2.5	-	-	-	-	-	-	-	-	2.0	2.0	2.0	3.6	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-4J	HD	2.0	2.0	2.0	3.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	4.8	-	-	-	-	-	-	-	-
	11	FRN11VG1□-4J	HD	2.0	2.0	2.0	5.1	-	-	-	-	-	-	-	-	2.0	2.0	2.0	7.2	-	-	-	-	-	-	-	-
	15	FRN15VG1□-4J	HD	2.0	2.0	2.0	6.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	9.7	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-4J	HD	2.0	2.0	2.0	8.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	12.4	-	-	-	-	-	-	-	-
	22	FRN22VG1□-4J	HD	2.0	2.0	2.0	10.2	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.4	-	-	-	-	-	-	-	-
	30	FRN30VG1□-4J	HD	2.0	2.0	2.0	15.0	-	-	-	-	-	-	-	-	2.0	2.0	2.0	19.4	-	-	-	-	-	-	-	-
	37		LD	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.9	-	-	-	-	-	-	-	-	2.0	2.0	2.0	19.2
	37	FRN37VG1□-4J	HD	2.0	2.0	2.0	17.6					-	-	-	-	3.5	2.0	2.0	24.8					-	-	-	-
	45		LD	-	-	-	-	-	-	-	-	2.0	2.0	2.0	17.3	-	-	-	-	-	-	-	-	3.5	2.0	2.0	24.5
	45	FRN45VG1□-4J	HD	2.0	2.0	2.0	20.5					-	-	-	-	3.5	3.5	2.0	29.0					-	-	-	-
	55		LD	-	-	-	-	-	-	-	-	2.0	2.0	2.0	20.3	-	-	-	-	-	-	-	-	3.5	2.0	2.0	28.7
	55	FRN55VG1□-4J	HD	3.5	2.0	2.0	25.2					-	-	-	-	5.5	3.5	3.5	35.6					-	-	-	-
	75		LD	-	-	-	-	-	-	-	-	3.5	2.0	2.0	26.3	-	-	-	-	-	-	-	-	5.5	3.5	3.5	37.2
	75	FRN75VG1□-4J	HD	5.5	3.5	3.5	34.6					-	-	-	-	8.0	5.5	5.5	48.9					-	-	-	-
	90		LD	-	-	-	-	-	-	-	-	5.5	3.5	2.0	33.9	-	-	-	-	-	-	-	-	8.0	5.5	5.5	47.9
	90	FRN90VG1□-4J	HD	8.0	5.5	3.5	41.6					-	-	-	-	14	8.0	5.5	58.8					-	-	-	-
	110		MD	-	-	-	-	14	5.5	5.5	50.8					-	-	-	-	14	14	8.0	71.8				
	110		LD					-	-	-	-	8.0	5.5	3.5	41.1					-	-	-	-	14	8.0	5.5	58.2
	110	FRN110VG1□-4J	HD	14	5.5	5.5	50.8					-	-	-	-	14	14	8.0	71.8					-	-	-	-
	132		MD	-	-	-	-	14	8.0	5.5	61.7					-	-	-	-	22	14	14	87.3				
	132		LD					-	-	-	-	8.0	5.5	5.5	49.7					-	-	-	-	14	14	8.0	70.4
	132	FRN132VG1□-4J	HD	14	8.0	5.5	61.7					-	-	-	-	22	14	14	87.3					-	-	-	-
	160		MD	-	-	-	-	22	14	8.0	73.9					-	-	-	-	38	22	14	104				
	160		LD					-	-	-	-	14	8.0	5.5	60.8					-	-	-	-	22	14	14	85.9
	160	FRN160VG1□-4J	HD	22	14	8.0	73.9					-	-	-	-	38	22	14	104					-	-	-	-
	200		MD	-	-	-	-	22	14	14	92.6					-	-	-	-	38	38	22	131				
	200		LD					-	-	-	-	22	14	8.0	73.9					-	-	-	-	38	22	14	104
	200	FRN200VG1□-4J	HD	22	14	14	92.6					-	-	-	-	38	38	22	131					-	-	-	-
	220		MD	-	-	-	-	38	22	14	102					-	-	-	-	60	38	22	144				
	220		LD					-	-	-	-	22	14	14	86.8					-	-	-	-	38	22	22	123
	220	FRN220VG1□-4J	HD	38	22	14	102					-	-	-	-	60	38	22	144					-	-	-	-
	250		MD	-	-	-	-	38	22	22	120					-	-	-	-	60	38	38	170				
	280		LD					-	-	-	-	38	22	14	102					-	-	-	-	60	38	22	145
	280	FRN280VG1□-4J	HD	60	38	22	138					-	-	-	-	100	60	38	195					-	-	-	-
	315		MD	-	-	-	-	60	38	22	147					-	-	-	-	100	60	38	207				
	355		LD					-	-	-	-	60	38	22	139					-	-	-	-	100	60	38	197
	315	FRN315VG1□-4J	HD	60	38	22	147					-	-	-	-	100	60	38	207					-	-	-	-
	355		MD	-	-	-	-	60	60	38	175					-	-	-	-	150	100	60	248				
	400		LD					-	-	-	-	60	38	22	148					-	-	-	-	100	100	60	235
	355	FRN355VG1□-4J	HD	60	60	38	175					-	-	-	-	150	100	60	248					-	-	-	-
	400		MD	-	-	-	-	100	60	38	186					-	-	-	-	150	100	60	263				
	450		LD					-	-	-	-	60	60	38	177					-	-	-	-	150	100	60	250
	400	FRN400VG1□-4J	HD	100	60	38	186	-	-	-	-	-	-	-	-	150	100	60	263					-	-	-	-
	450		MD	-	-	-	-	100	60	60	228					-	-	-	-	150	150	100	322				
	500		LD	-	-	-	-	-	-	-	-	100	60	38	186					-	-	-	-	150	100	60	263
	500	FRN500VG1□-4J	HD	100	100	60	240					-	-	-	-	200	150	100	340					-	-	-	-
	630		LD	-	-	-	-	-	-	-	-	100	100	60	241	-	-	-	-	-	-	-	-	200	150	100	341
	630	FRN630VG1□-4J	HD	150	100	100	293					-	-	-	-	200	150	100	381					-	-	-	-
	710		LD	-	-	-	-	-	-	-	-	150	100	60	278	-	-	-	-	-	-	-	-	250	150	150	394

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2:□ in the inverter model represents an alphabet.

□
└── S (Basic type)

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

8.4 Peripheral Equipment

8.4.1 Molded case circuit breaker or residual-current-operated protective device/earth leakage circuit breaker/magnetic contactor

8.4.1.1 Functional overview

■ **MCCBs and RCDs/ELCBs*** * With overcurrent protection

Molded Case Circuit Breakers (MCCBs) are designed to protect the power circuits between the power supply and inverter's main circuit terminals ([L1/R], [L2/S] and [L3/T]) from overload or short-circuit, which in turn prevents secondary accidents caused by the broken inverter.

Residual-Current-Operated Protective Devices (RCDs)/Earth Leakage Circuit Breakers (ELCBs) function in the same way as MCCBs.

Built-in overcurrent/overload protective functions protect the inverter itself from failures related to its input/output lines.

■ **MCs**

An MC can be used at both the power input and output sides of the inverter. At each side, the MC works as described below. Use as needed. When inserted in the output circuit of the inverter, the MC can also switch the motor drive power supply between the inverter output and commercial power lines.

<u>At the power supply side</u>

Insert an MC in the power supply side of the inverter in order to:

(1) Forcibly cut off the inverter from the power supply (generally, commercial/factory power lines) with the protective function built into the inverter, or with the external signal input.

(2) Stop the inverter operation in an emergency when the inverter cannot interpret the stop command due to internal/external circuit failures.

(3) Cut off the inverter from the power supply when the MCCB inserted in the power supply side cannot cut it off for maintenance or inspection purpose. For the purpose only, it is recommended that you use an MC capable of turning the MC ON/OFF manually.

Note Avoid frequent ON/OFF operation of the magnetic contactor (MC) in the input circuit; otherwise, the inverter failure may result.

The frequency of the MC's ON/OFF should not be more than once per 30 minutes. To assure 10-year or longer service life of the inverter, it should not be more than once per hour.

If frequent start/stop of the motor is required, use FWD/REV terminal signals or the FWD / REV / STOP keys on the inverter's keypad.

At the output side

Insert an MC in the power output side of the inverter in order to:

(1) Prevent externally turned-around current from being applied to the inverter power output terminals ([U], [V], and [W]) unexpectedly. An MC should be used, for example, when a circuit that switches the motor driving power supply between the inverter output and commercial power lines is connected to the inverter.

Tip If a magnetic contactor (MC) is inserted in the inverter's output (secondary) circuit for switching the motor to a commercial power or for any other purposes, it should be switched on and off when both the inverter and motor are completely stopped. This prevents the contact point from getting rough due to a switching arc of the MC. The MC should not be equipped with any main circuit surge killer (Fuji SZ-ZM□, etc.).

Applying a commercial power to the inverter's output circuit breaks the inverter. To avoid it, interlock the MC on the motor's commercial power line with the one in the inverter output circuit so that they are not switched ON at the same time.

(2) Drive more than one motor selectively by a single inverter.

(3) Selectively cut off the motor whose thermal overload relay or equivalent devices have been activated.

Driving the motor using commercial power lines

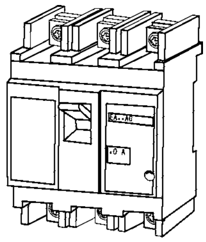
MCs can also be used to switch the power supply of the motor driven by the inverter to a commercial power supply.

Select the MC so as to satisfy the rated currents listed in Table 8.1, which are the most critical RMS currents for using the inverter. (Refer to Table 8.4) For switching the motor drive source between the inverter output and commercial power lines, use the MC of class AC3 specified by JIS C8325 in the commercial line side.

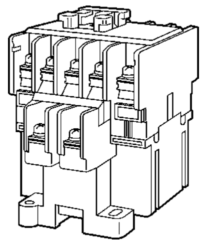
8.4.1.2 Connection example and criteria for selection of circuit breakers

Figure 8.2 shows a connection example for MCCB or RCD/ELCB (with overcurrent protection) and MC in the inverter input circuit. Table 8.5 lists the rated current for the MCCB and corresponding inverter models. Table 8.6 lists the applicable grades of RCD/ELCB sensitivity.

⚠WARNING
Insert an MCCB or RCD/ELCB (with overcurrent protection) recommended for each inverter for its input circuits. Do not use an MCCB or RCD/ELCB of a higher rating than that recommended. **Doing so could result in a fire.**



Molded case circuit breaker
or residual-current-operated protective device/
earth leakage circuit breaker



Magnetic contactor

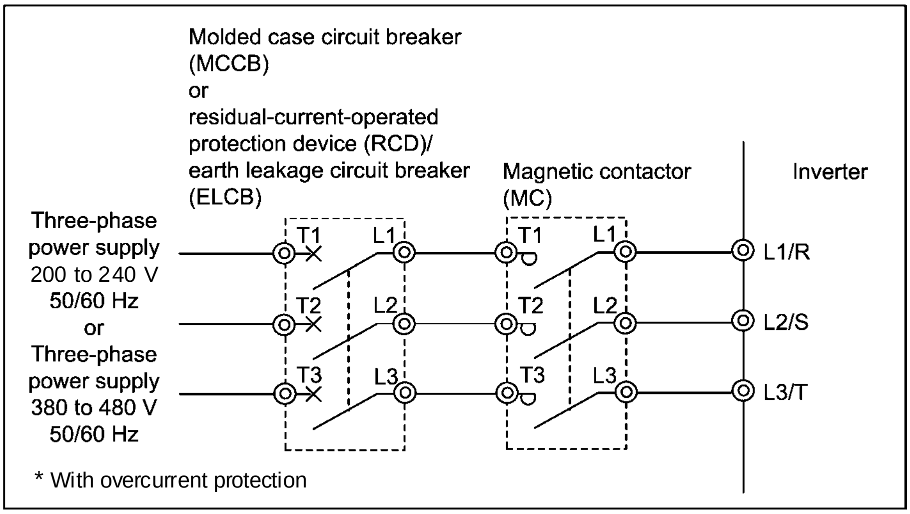


Figure 8.2 External Views of MCCB or RCD/ELCB and MC and Connection Example

Table 8.5 Rated Current of Molded Case Circuit Breaker (MCCB), Residual-Current-Operated Protective Device (RCD)/ Earth Leakage Circuit Breaker (ELCB) and Magnetic Contactor (MC)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	MCCB, ELCB Rated current(A) DC reactor (DCR) w/ DCR	MCCB, ELCB Rated current(A) DC reactor (DCR) w/o DCR	Magnetic contactor (MC) For input circuit DC reactor (DCR) w/ DCR	Magnetic contactor (MC) For input circuit DC reactor (DCR) w/o DCR	Magnetic contactor (MC) For output circuit HD	Magnetic contactor (MC) For output circuit LD
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	5	10	SC-05	SC-05	SC-05	-
	1.5	FRN1.5VG1□-2J	HD	10	15	SC-05	SC-05	SC-05	-
	2.2	FRN2.2VG1□-2J	HD	10	20	SC-05	SC-05	SC-05	-
	3.7	FRN3.7VG1□-2J	HD	20	30	SC-05	SC-5-1	SC-05	-
	5.5	FRN5.5VG1□-2J	HD	30	50	SC-05	SC-N1	SC-4-0	-
	7.5	FRN7.5VG1□-2J	HD	40	75	SC-5-1	SC-N2	SC-N1	-
	11	FRN11VG1□-2J	HD	50	100	SC-N1	SC-N2S	SC-N1	-
	15	FRN15VG1□-2J	HD	75	125	SC-N2	SC-N3	SC-N2	-
	18.5	FRN18.5VG1□-2J	HD	100	150	SC-N2S	SC-N4	SC-N2S	-
	22	FRN22VG1□-2J	HD	100	175	SC-N2S	SC-N5	SC-N3	-
	30	FRN30VG1□-2J	HD	150	200	SC-N4	SC-N7	SC-N4	-
	37	FRN30VG1□-2J	LD	175	250	SC-N5	SC-N8	-	SC-N5
	37	FRN37VG1□-2J	HD	175	250	SC-N5	SC-N8	SC-N5	-
	45	FRN37VG1□-2J	LD	200	300	SC-N7	SC-N8	-	SC-N7
	45	FRN45VG1□-2J	HD	200	300	SC-N7	SC-N8	SC-N7	-
	55	FRN45VG1□-2J	LD	250	350	SC-N8	SC-N11	-	SC-N8
	55	FRN55VG1□-2J	HD	250	350	SC-N8	SC-N11	SC-N8	-
	75	FRN55VG1□-2J	LD	350	-	SC-N11	-	-	SC-N10
	75	FRN75VG1□-2J	HD	350	-	SC-N11	-	SC-N11	-
	90	FRN75VG1□-2J	LD	400	-	SC-N11	-	-	SC-N11
	90	FRN90VG1□-2J	HD	400	-	SC-N11	-	SC-N11	-
	110	FRN90VG1□-2J	LD	500	-	SC-N12	-	-	SC-N12

Note: □ in the inverter model represents an alphabet.

□ └ S (Basic type)

- Install the MCCB or RCD/ELCB at the input side of the inverter. They cannot be installed at the output side of the inverter.
- The above table lists the rated current of MCCBs and RCD/ELCBs to be used in the power control panel with an internal temperature of lower than 50°C. The rated current is factored by a correction coefficient of 0.85 as the RCDs'/MCCBs' and ELCBs' original rated current is specified when using them in a surrounding temperature of 40°C or lower. Select an MCCB and/or RCD/ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.
- For the selection of the MC type, it is assumed that the 600 V HIV (allowable surrounding temperature: 75°C) wires for the power input/output of the inverter are used. If an MC type for another class of wires is selected, the wire size suitable for the terminal size of both the inverter and the MC type should be taken into account.
- Use ELCBs with overcurrent protection.
- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or RCD/ELCB with the rated current listed in the above table. Do not use an MCCB or RCD/ELCB with a rating higher than that listed.

Table 8.5 Rated Current of Molded Case Circuit Breaker (MCCB), Residual-Current-Operated Protective Device (RCD)/ Earth Leakage Circuit Breaker (ELCB) and Magnetic Contactor (MC) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	MCCB, ELCB Rated current(A) DC reactor (DCR) w/ DCR	MCCB, ELCB Rated current(A) DC reactor (DCR) w/o DCR	Magnetic contactor (MC) For input circuit DC reactor (DCR) w/ DCR	Magnetic contactor (MC) For input circuit DC reactor (DCR) w/o DCR	Magnetic contactor (MC) For output circuit HD	Magnetic contactor (MC) For output circuit MD	Magnetic contactor (MC) For output circuit LD
Three-phase 400V	3.7	FRN3.7VG1□-4	HD	10	20	SC-05	SC-05	SC-05	-	-
	5.5	FRN5.5VG1□-4		15	30		SC-4-0			
	7.5	FRN7.5VG1□-4		20	40		SC-5-1	SC-05		-
	11	FRN11VG1□-4		30	50		SC-N1	SC-4-0		-
	15	FRN15VG1□-4		40	60	SC-5-1		SC-5-1		-
	18.5	FRN18.5VG1□-4			75	SC-N1	SC-N2	SC-N1		-
	22	FRN22VG1□-4		50	100		SC-N2S	SC-N1		-
	30	FRN30VG1□-4		75	125	SC-N2	SC-N3	SC-N2		-
	37		LD	100		SC-N2S	SC-N4	-		SC-N2S
		FRN37VG1□-4	HD					SC-N2S		-
	45		LD		150	SC-N3		-		SC-N3
		FRN45VG1□-4	HD					SC-N3		-
	55		LD	125	200		SC-N5	-		SC-N4
		FRN55VG1□-4	HD					SC-N4		-
	75		LD	175	-	SC-N4	-	-		SC-N5
		FRN75VG1□-4	HD					SC-N5		-
	90		LD	200		SC-N7		-		SC-N7
		FRN90VG1□-4	HD					SC-N7		-
	110		MD/LD	250		SC-N8		-	SC-N8	SC-N8
		FRN110VG1□-4	HD					SC-N8	-	-
	132		MD/LD	300				-	SC-N8	SC-N8
		FRN132VG1□-4	HD					SC-N8	-	-
	160		MD/LD	350		SC-N11		-	SC-N11	SC-N11
		FRN160VG1□-4	HD					SC-N11	-	-
	200		MD/LD	500		SC-N12		-	SC-N12	SC-N12
		FRN200VG1□-4	HD					SC-N12	-	-
	220		MD/LD					-	SC-N12	SC-N12
		FRN220VG1□-4	HD					SC-N12	-	-
	250		MD	600				-	SC-N14	
	280		LD			SC-N14			-	SC-N14
		FRN280VG1□-4	HD					SC-N14		-
	315		MD	800				-	SC-N14	
	355		LD						-	SC-N14
	315	FRN315VG1□-4	HD					SC-N14		-
	355		MD					-	SC-N14	
	400		LD	1200		SC-N16			-	SC-N16
	355	FRN355VG1□-4	HD	800		SC-N14		SC-N14		-
	400		MD	1200		SC-N16		-	SC-N16	
	450		LD						-	610CM*
	400	FRN400VG1□-4	HD					SC-N16		-
	450		MD					-	610CM*	
	500		LD			610CM*			-	610CM*
		FRN500VG1□-4	HD					610CM*		-
	630		LD	1400		612CM*		-		612CM*
		FRN630VG1□-4	HD					612CM*		-
	710		LD	1600		616CM*		-		616CM*

* 610CM, 612CM and 616CM: Manufactured by Aichi Electric Works Co., Ltd.

Note: □ in the inverter model represents an alphabet.

□ └ S (Basic type)

- Install the MCCB or RCD/ELCB at the input side of the inverter. They cannot be installed at the output side of the inverter.
- The above table lists the rated current of MCCBs and RCD/ELCBs to be used in the power control panel with an internal temperature of lower than 50°C. The rated current is factored by a correction coefficient of 0.85 as the RCDs'/MCCBs' and ELCBs' original rated current is specified when using them in a surrounding temperature of 40°C or lower. Select an MCCB and/or RCD/ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.

- For the selection of the MC type, it is assumed that the 600 V HIV (allowable surrounding temperature: 75°C) wires for the power input/output of the inverter are used. If an MC type for another class of wires is selected, the wire size suitable for the terminal size of both the inverter and the MC type should be taken into account.
- Use ELCBs with overcurrent protection.
- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or RCD/ELCB with the rated current listed in the above table. Do not use an MCCB or RCD/ELCB with a rating higher than that listed.

Table 8.6 lists the relationship between the rated leakage current sensitivity of RCDs/ELCBs (with overcurrent protection) and wiring length of the inverter output circuits. Note that the sensitivity levels listed in the table are estimated values based on the results obtained by the test setup in the Fuji laboratory where each inverter drives a single motor.

Table 8.6 Rated Current Sensitivity of Residual-Current-Operated Protective Devices (RCDs)/Earth Leakage Circuit Breakers (ELCBs)

Power supply voltage	Standard application motor (kW)	Wire distance/current sensitivity					
		10 m	30 m	50 m	100 m	200 m	300 m
Three-phase 200V	0.75						
	1.5						
	2.2		30mA				
	3.7						
	5.5						
	7.5				100 mA		
	11						
	15						
	18.5					200 mA	
	22						
	30						
	37						
	45						
	55						
	75						500 mA
	90						
	110						
Three-phase 400V	3.7						
	5.5						
	7.5	30 mA					
	11			100 mA			
	15						
	18.5						
	22				200 mA		
	30						
	37						
	45					500 mA	
	55						
	75						
	90						
	110						
	132						1000 mA
	160						(Special)
	200						
	220						
	250						
	280						
	315						
	355						3000 mA
	400						(Special)
	450						
	500						
	630						
	710						

- Values listed above were obtained using Fuji ELCB EG or SG series applied to the test setup.
- The rated current of applicable motor rating indicates values for Fuji standard motor (4 poles, 50 Hz and 200 V three-phase).
- The leakage current is calculated based on grounding of the single wire for 200 V class delta connection and neutral grounding for 400 V class Y-connection power lines.
- Values listed above are calculated based on the static capacitance to the earth when the 600 V class of vinyl-insulated IV wires are used in a wiring through metal conduit pipes.
- Wiring length is the total length of wiring between the inverter and motor. If more than one motor is to be connected to a single inverter, the wiring length should be the total length of wiring between the inverter and motors.

8.4.2 Surge killer for L-load

A surge killer absorbs surge voltage induced by L-load of an electro magnetic switch or solenoid valve. Use of a surge killer is effective in preventing the electronic equipment, including inverters, from damage or malfunctioning caused by such surges.

Install a surge killer near the power coil of the surge source. Connected to the inverter's power source side, as shown in Figure 8.3, a surge killer absorbs the surge voltage, preventing the electronic equipment, from damage or malfunctioning. (The maximum capacity is 3.7 kW.)

Refer to the catalog "Fuji Surge Killers/Absorbers (HS118: Japanese edition only)" for details. These products are available from Fuji Electric Technica Co., Ltd.

Note: Do not use the capacitor in the inverter secondary (output) line.

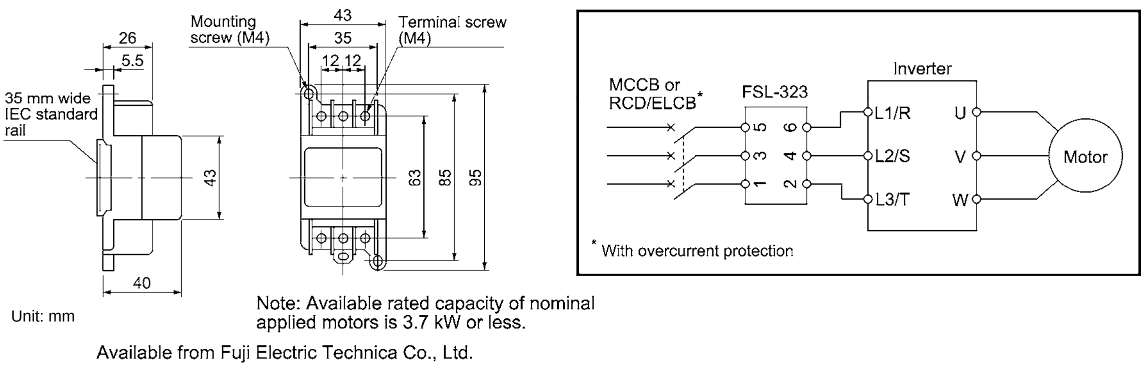


Figure 8.3 Dimensions of Surge Killer and Connection Example

8.4.3 Arrester

An arrester suppresses surge currents induced by lightning invaded from the power supply lines. Common use of the grounding wire that is used for electric equipment in the panel, with the arrester, is effective in preventing electronic equipment from damage or malfunctioning caused by such surges.

Applicable arrester models are CN23232 for three-phase 200 V class series, and CN2324E and CN2324L for three-phase 400 V class series. (CN233 series with 20 kA of discharging capability is also available.) Figure 8.4 shows their external dimensions and connection examples. Refer to the catalog "Fuji Surge Killers/Absorbers (HS118: Japanese edition only)" for details. These products are available from Fuji Electric Technica Co., Ltd.

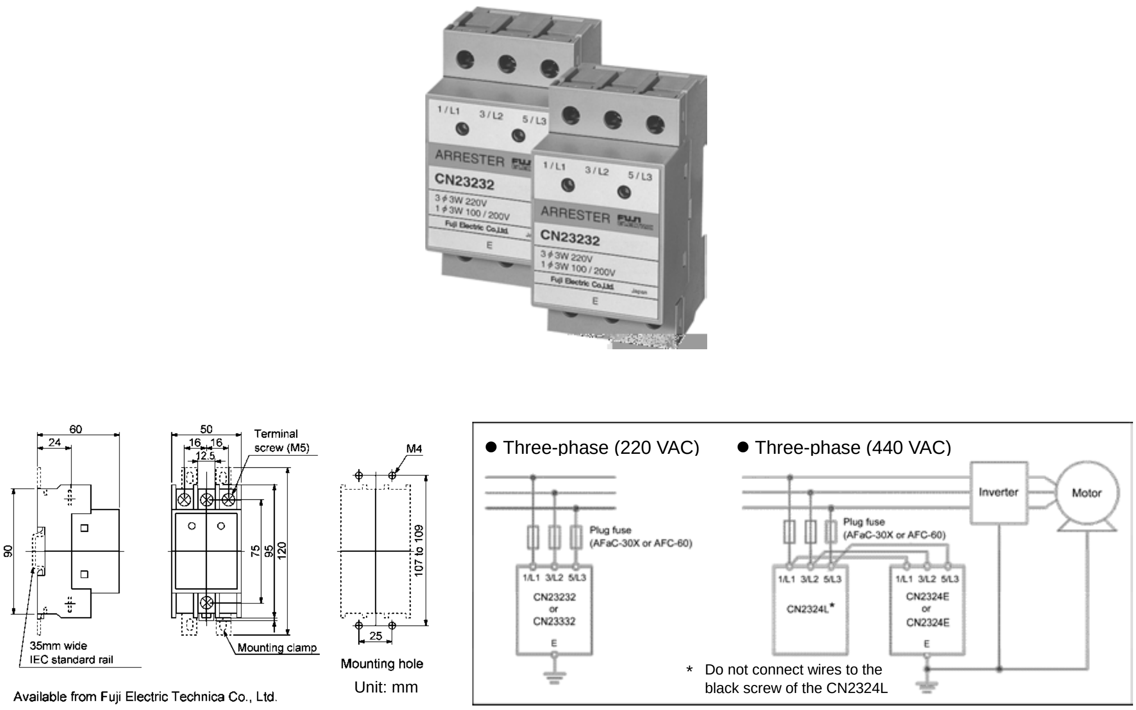


Figure 8.4 Arrester Dimensions and Connection Examples

8.4.4 Surge absorber

A surge absorber absorbs surges or noises generated by a magnetic contactor (MC) or solenoid valve in the power system to effectively protect electronic equipment in the panel from malfunctions or breakdown. Installed parallel to a coil of an MC, solenoid valve, or L load, a surge absorber absorbs a surge voltage.

The type of surge absorber is S2-A-O and S1-B-O. Figure 8.5 shows their external dimensions.

The surge absorbers are available from Fuji Electric Technica Co., Ltd.

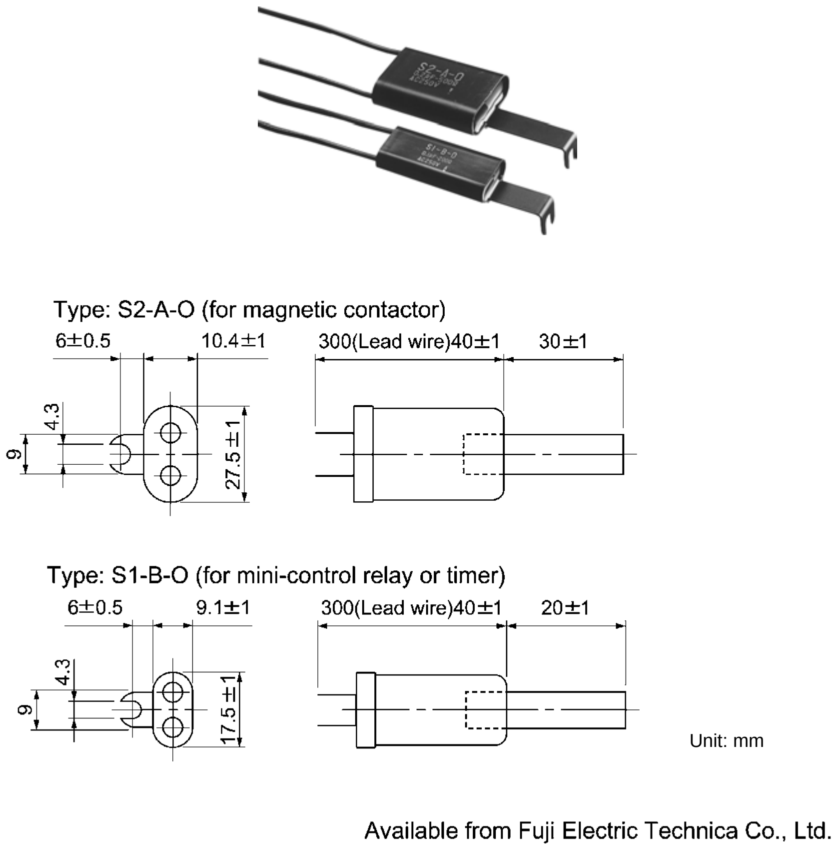


Figure 8.5 Surge Absorber Dimensions

8.4.5 Filter capacitor for radio noise reduction

These capacitors are effective to suppress AM radio band (less than 1 MHz) noises. Using them with Zero-phase reactors upgrades capability.

Applicable models are NFM25M315KPD1 for 200 V class series inverters and NFM60M315KPD for 400 V class. Use one of them no matter what the inverter capacity. Figure 8.6 shows their external dimensions. The surge absorbers are available from Fuji Electric Technica Co., Ltd.

Note: Do not use the capacitor in the inverter secondary (output) line.

NFM25M315KPD1 NFM60M315KPD

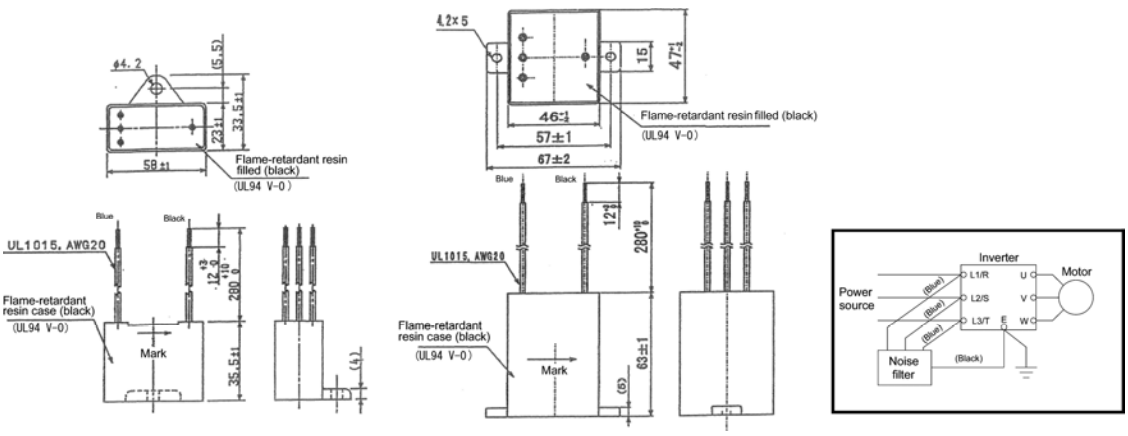


Figure 8.6 Filtering Capacitors Dimensions

8.5 Peripheral Equipment Options

8.5.1 Braking resistors (DBRs) and braking units

8.5.1.1 Braking resistors (DBRs)

A braking resistor converts regenerative energy generated from deceleration of the motor to heat for consumption. Use of a braking resistor results in improved deceleration performance of the inverter. FRENIC-VG provides 2 types: Standard 10% ED product and 20% ED product.

📖 Refer to Chapter 9, Section 9.2 "Selecting a Braking Resistor."

(1) 10% ED product, 20% ED product

The standard model of a braking resistor integrates a facility that detects the temperature on the heat sink of the resistor and outputs a digital ON/OFF signal if the temperature exceeds the specified level (as an overheating warning signal). To ensure that the signal is recognized at one of the digital input terminals of the FRENIC-VG, assign the external alarm THR to any of terminals [X1] to [X9]. Connect the assigned terminals to terminals [1] and [2] of the braking resistor. Upon detection of the warning signal, the inverter simultaneously transfers to Alarm mode, displays alarm 0h2 on the LED monitor and shuts down its power output.

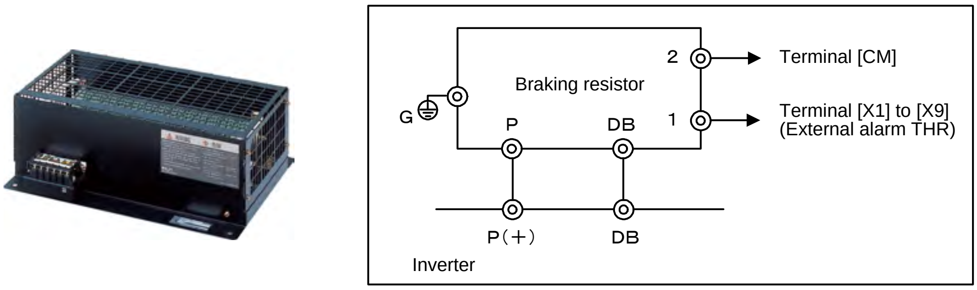


Figure 8.7 Braking Resistor (Standard Model) and Connection Example

📖 For the specifications and external dimensions of the braking units, refer to [3] and [4] in this Section.

8.5.1.2 Braking units

Add a braking unit to the braking resistor to upgrade the braking capability of inverters with the followings.

HD mode: 75 kW or above (200V series), 200 kW or above (400V series)
LD mode: 75 kW or above (200V series), 200 kW or above (400V series)
MD mode: 200 kW or above (400V series)

Inverters other than above have built-in IGBTs for the braking resistor.

Figure 8.8 Braking Unit

📖 For the specifications and external dimensions of the braking units, refer to [3] and [4] in this Section.

8.5.1.3 Specifications and connection example

Table 8.7 Generated Loss in Braking Unit

Model	Generated loss (W)	
	Standard model	With fan unit
BU55-2C	50	150
BU90-2C	60	180
BU220-4C	80	240

■HD-mode Inverters

Table 8.8(a) Braking Unit/Braking Resistor (Standard ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options					Maximum braking torque (%)			Continuous braking (converted to 150% torque value)		Repetitive braking (at 100s interval or less)	
				Braking unit		Braking resistor				Torque (N・m)					
				Model	Qty. (units)	Model	Qty. (units)	Resistance value (Ω)		50Hz	60Hz	Braking time (s)	Discharging capability (kWs)	Duty cycle (%ED)	Average loss (kW)
Three-phase 200V	0.75	FRN0.75VG1S-2J	A			DB2.2V-21B	1	30	150	7.16	5.97	10	16.5	10	0.165
	1.5	FRN1.5VG1S-2J				DB2.2V-21B	1	30	150	14.3	11.9	10	16.5	10	0.165
	2.2	FRN2.2VG1S-2J				DB2.2V-21B	1	30	150	21.0	17.5	10	16.5	10	0.165
	3.7	FRN3.7VG1S-2J				DB3.7V-21B	1	24	150	35.3	29.4	10	27.8	10	0.278
	5.5	FRN5.5VG1S-2J				DB5.5V-21B	1	16	150	52.5	43.8	10	41.3	10	0.413
	7.5	FRN7.5VG1S-2J				DB7.5V-21B	1	12	150	71.6	59.7	10	56.3	10	0.563
	11	FRN11VG1S-2J		–	–	DB11V-21B	1	8.0	150	105	87.5	10	82.5	10	0.825
	15	FRN15VG1S-2J				DB15V-21B	1	6.0	150	143	119	10	113	10	1.13
	18.5	FRN18.5VG1S-2J				DB18.5V-21B	1	4.5	150	177	147	10	139	10	1.39
	22	FRN22VG1S-2J				DB22V-21B	1	4.0	150	210	175	10	165	10	1.65
	30	FRN30VG1S-2J				DB30V-21B	1	2.5	150	286	239	10	225	10	2.25
	37	FRN37VG1S-2J				DB37V-21B	1	2.25	150	353	294	10	278	10	2.78
	45	FRN45VG1S-2J				DB45V-21B	1	2.0	150	430	358	10	338	10	3.38
	55	FRN55VG1S-2J				DB55V-21C	1	1.6	150	525	438	10	413	10	4.13
	75	FRN75VG1S-2J	B	BU55-2C	2	DB75V-21C	1	2.4/2	150	716	597	10	563	10	5.63
	90	FRN90VG1S-2J		BU90-2C	2	DB90V-21C	1	2.0/2	150	859	716	10	675	10	6.75
Three-phase 400V	3.7	FRN3.7VG1S-4J	A			DB3.7V-41B	1	96	150	35.3	29.4	10	27.8	10	0.278
	5.5	FRN5.5VG1S-4J				DB5.5V-41B	1	64	150	52.5	43.8	10	41.3	10	0.413
	7.5	FRN7.5VG1S-4J				DB7.5V-41B	1	48	150	71.6	59.7	10	56.3	10	0.563
	11	FRN11VG1S-4J				DB11V-41B	1	32	150	105	87.5	10	82.5	10	0.825
	15	FRN15VG1S-4J				DB15V-41B	1	24	150	143	119	10	113	10	1.13
	18.5	FRN18.5VG1S-4J				DB18.5V-41B	1	18	150	177	147	10	139	10	1.39
	22	FRN22VG1S-4J				DB22V-41B	1	16	150	210	175	10	165	10	1.65
	30	FRN30VG1S-4J		–	–	DB30V-41B	1	10	150	286	239	10	225	10	2.25
	37	FRN37VG1S-4J				DB37V-41B	1	9.0	150	353	294	10	278	10	2.78
	45	FRN45VG1S-4J				DB45V-41B	1	8.0	150	430	358	10	338	10	3.38
	55	FRN55VG1S-4J				DB55V-41C	1	6.5	150	525	438	10	413	10	4.13
	75	FRN75VG1S-4J				DB75V-41C	1	4.7	150	716	597	10	563	10	5.63
	90	FRN90VG1S-4J				DB90V-41C	1	3.9	150	859	716	10	675	10	6.75
	110	FRN110VG1S-4J				DB110V-41C	1	3.2	150	1050	875	10	825	10	8.25
	132	FRN132VG1S-4J				DB132V-41C	1	2.6	150	1261	1050	10	990	10	9.90
	160	FRN160VG1S-4J	C			DB160V-41C	1	2.2	150	1528	1273	10	1200	10	12.0
	200	FRN200VG1S-4J	D	BU220-4C	2	DB200V-41C	1	3.5/2	150	1910	1592	10	1500	10	15.0
	220	FRN220VG1S-4J		BU220-4C	2	DB220V-41C	1	3.2/2	150	2101	1751	10	1650	10	16.5
	280	FRN280VG1S-4J	E	BU220-4C	2	DB160V-41C	2	2.2/2	150	2674	2228	10	2100	10	21.0
	315	FRN315VG1S-4J		BU220-4C	2	DB160V-41C	2	2.2/2	150	3008	2507	10	2363	10	23.6
	355	FRN355VG1S-4J	F	BU220-4C	3	DB132V-41C	3	2.6/3	150	3390	2825	10	2663	10	26.6
	400	FRN400VG1S-4J		BU220-4C	3	DB132V-41C	3	2.6/3	150	3820	3183	10	3000	10	30.0
	500	FRN500VG1S-4J	G	BU220-4C	4	DB132V-41C	4	2.6/4	150	4775	3979	10	3750	10	37.5
	630	FRN630VG1S-4J	H	BU220-4C	4	DB160V-41C	4	2.2/4	150	6016	5013	10	4725	10	47.3

Note: • Refer to notes on and procedure of selection.

For DB160V-41C - DB220V-41C, two braking resistors are used per one unit.

Example) For the model: DB160V-41C, quantity: 2, four braking resistors are used.

■MD-mode Inverters

Table 8.8(b) Braking Unit/Braking Resistor (Standard 10%ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options: Braking unit Model	Braking unit Qty. (units)	Braking resistor Model	Braking resistor Qty. (units)	Resistance value (Ω)	Maximum braking torque (%)	Torque (N·m) 50Hz	Torque (N·m) 60Hz	Continuous braking (converted to 150% torque value): Braking time (s)	Discharging capacity (kWs)	Repetitive braking (at 100s interval or less): Duty cycle (%ED)	Average loss (kW)
Three-phase 400V	110	FRN90VG1S-4J	A	-	-	DB110V-41C	1	3.2	150	1050	875	10	825	10	8.25
	132	FRN110VG1S-4J				DB132V-41C	1	2.6	150	1261	1050	10	990	10	9.90
	160	FRN132VG1S-4J	C			DB160V-41C	1	2.2	150	1528	1273	10	1200	10	12.0
	200	FRN160VG1S-4J				DB200V-41C	1	3.5/2	150	1910	1592	10	1500	10	15.0
	220	FRN200VG1S-4J	D	BU220-4C	2	DB220V-41C	1	3.2/2	150	2101	1751	10	1650	10	16.5
	250	FRN220VG1S-4J	I	BU220-4C	2	DB132V-41C	2	2.6/2	150	2388	1990	10	1875	10	18.8
	315	FRN280VG1S-4J	E	BU220-4C	2	DB160V-41C	2	2.2/2	150	3008	2507	10	2363	10	23.6
	355	FRN315VG1S-4J	F	BU220-4C	3	DB132V-41C	3	2.6/3	150	3390	2825	10	2663	10	26.6
	400	FRN355VG1S-4J		BU220-4C	3	DB132V-41C	3	2.6/3	150	3820	3183	10	3000	10	30.0
	450	FRN400VG1S-4J	G	BU220-4C	4	DB132V-41C	4	2.6/4	150	4297	3581	10	3375	10	33.8

Note: • Refer to notes on and procedure of selection.
For DB160V-41C - DB220V-41C, two braking resistors are used per one unit.
Example) For the model: DB160V-41C, quantity: 2, four braking resistors are used.

■LD-mode Inverters

Table 8.8(c) Braking Unit/Braking Resistor (Standard 10%ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options: Braking unit Model	Braking unit Qty. (units)	Braking resistor Model	Braking resistor Qty. (units)	Resistance value (Ω)	Maximum braking torque (%)	Torque (N·m) 50Hz	Torque (N·m) 60Hz	Continuous braking (converted to 150% torque value): Braking time (s)	Discharging capacity (kWs)	Repetitive braking (at 100s interval or less): Duty cycle (%ED)	Average loss (kW)
Three-phase 200V	37	FRN30VG1S-2J	A	-	-	DB30V-21B	1	2.5	110	259	216	10	204	10	2.25
	45	FRN37VG1S-2J				DB37V-21B	1	2.25	110	315	263	10	248	10	2.78
	55	FRN45VG1S-2J				DB45V-21B	1	2.0	110	385	321	10	303	10	3.38
	75	FRN55VG1S-2J				DB55V-21C	1	1.6	110	525	438	10	413	10	4.13
	90	FRN75VG1S-2J	B	BU55-2C	2	DB75V-21C	1	2.4/2	110	630	525	10	495	10	5.63
	110	FRN90VG1S-2J		BU90-2C	2	DB90V-21C	1	2.0/2	110	770	642	10	605	10	6.75
Three-phase 400V	37	FRN30VG1S-4J	A	-	-	DB30V-41B	1	10	110	259	216	10	204	10	2.25
	45	FRN37VG1S-4J				DB37V-41B	1	9.0	110	315	263	10	248	10	2.78
	55	FRN45VG1S-4J				DB45V-41B	1	8.0	110	385	321	10	303	10	3.38
	75	FRN55VG1S-4J				DB55V-41C	1	6.5	110	525	438	10	413	10	4.13
	90	FRN75VG1S-4J				DB75V-41C	1	4.7	110	630	525	10	495	10	5.63
	110	FRN90VG1S-4J				DB90V-41C	1	3.9	110	770	642	10	605	10	6.75
	132	FRN110VG1S-4J				DB110V-41C	1	3.2	110	924	770	10	726	10	8.25
	160	FRN132VG1S-4J				DB132V-41C	1	2.6	110	1120	934	10	880	10	9.9
	200	FRN160VG1S-4J	C			DB160V-41C	1	2.2	110	1401	1167	10	1100	10	12.0
	220	FRN200VG1S-4J	D	BU220-4C	2	DB200V-41C	1	3.5/2	110	1541	1284	10	1210	10	15.0
	280	FRN220VG1S-4J		BU220-4C	2	DB220V-41C	1	3.2/2	110	1961	1634	10	1540	10	16.5
	355	FRN280VG1S-4J	E	BU220-4C	2	DB160V-41C	2	2.2/2	110	2486	2072	10	1953	10	21.0
	400	FRN315VG1S-4J		BU220-4C	2	DB160V-41C	2	2.2/2	110	2801	2334	10	2200	10	23.6
	450	FRN355VG1S-4J	F	BU220-4C	3	DB132V-41C	3	2.6/3	110	3151	2626	10	2475	10	26.6
	500	FRN400VG1S-4J		BU220-4C	3	DB132V-41C	3	2.6/3	110	3501	2918	10	2750	10	30.0
	630	FRN500VG1S-4J	G	BU220-4C	4	DB132V-41C	4	2.6/4	110	4412	3677	10	3465	10	37.5
	710	FRN630VG1S-4J	H	BU220-4C	4	DB160V-41C	4	2.2/4	110	4972	4143	10	3905	10	47.3

Note: • Refer to notes on and procedure of selection.
For DB160V-41C - DB220V-41C, two braking resistors are used per one unit.
Example) For the model: DB160V-41C, quantity: 2, four braking resistors are used.

■HD-mode Inverters

Table 8.9(a) Braking Unit/Braking Resistor (20%ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options: Braking unit Model	Braking unit Qty. (units)	Braking resistor Model	Braking resistor Qty.(units)	Resistance value(Ω)	Maximum braking torque (%)	Torque (N·m) 50Hz	Torque (N·m) 60Hz	Continuous braking (converted to 150% torque value): Braking time(s)	Discharging capability (kWs)	Repetitive braking (at 100s interval or less): Duty cycle (%ED)	Average loss (kW)
	0.75	FRN0.75VG1S-2J	A			DB2.2V-22B	1	30	150	7.16	5.97	20	33.0	20	0.330
	1.5	FRN1.5VG1S-2J				DB2.2V-22B	1	30	150	14.3	11.9	20	33.0	20	0.330
	2.2	FRN2.2VG1S-2J				DB2.2V-22B	1	30	150	21.0	17.5	20	33.0	20	0.330
	3.7	FRN3.7VG1S-2J				DB3.7V-22B	1	24	150	35.3	29.4	20	55.5	20	0.555
	5.5	FRN5.5VG1S-2J				DB5.5V-22B	1	16	150	52.5	43.8	20	82.5	20	0.825
	7.5	FRN7.5VG1S-2J				DB7.5V-22B	1	12	150	71.6	59.7	20	113	20	1.13
	11	FRN11VG1S-2J				DB11V-22B	1	8.0	150	105	87.5	20	165	20	1.65
Three-phase 200V	15	FRN15VG1S-2J		–	–	DB15V-22B	1	6.0	150	143	119	20	225	20	2.25
	18.5	FRN18.5VG1S-2J				DB18.5V-22B	1	4.5	150	177	147	20	278	20	2.78
	22	FRN22VG1S-2J				DB22V-22B	1	4.0	150	210	175	20	330	20	3.30
	30	FRN30VG1S-2J				DB30V-22C	1	3.0	150	286	239	20	450	20	4.50
	37	FRN37VG1S-2J				DB37V-22C	1	2.4	150	353	294	20	555	20	5.55
	45	FRN45VG1S-2J				DB45V-22C	1	2.0	150	430	358	20	675	20	6.75
	55	FRN55VG1S-2J				DB55V-22C	1	1.6	150	525	438	20	825	20	8.25
	75	FRN75VG1S-2J	B	BU55-2C	2	DB37V-22C	2	2.4/2	150	716	597	20	1125	20	11.3
	90	FRN90VG1S-2J		BU90-2C	2	DB45V-22C	2	2.0/2	150	859	716	20	1350	20	13.5
	3.7	FRN3.7VG1S-4J	A			DB3.7V-42B	1	96	150	35.3	29.4	20	55.5	20	0.555
	5.5	FRN5.5VG1S-4J				DB5.5V-42B	1	64	150	52.5	43.8	20	82.5	20	0.825
	7.5	FRN7.5VG1S-4J				DB7.5V-42B	1	48	150	71.6	59.7	20	113	20	1.13
	11	FRN11VG1S-4J				DB11V-42B	1	32	150	105	87.5	20	165	20	1.65
	15	FRN15VG1S-4J				DB15V-42B	1	24	150	143	119	20	225	20	2.25
	18.5	FRN18.5VG1S-4J				DB18.5V-42B	1	18	150	177	147	20	278	20	2.78
	22	FRN22VG1S-4J				DB22V-42B	1	16	150	210	175	20	330	20	3.30
	30	FRN30VG1S-4J		–	–	DB30V-42C	1	12	150	286	239	20	450	20	4.50
	37	FRN37VG1S-4J				DB37V-42C	1	9.0	150	353	294	20	555	20	5.55
	45	FRN45VG1S-4J				DB45V-42C	1	8.0	150	430	358	20	675	20	6.75
	55	FRN55VG1S-4J				DB55V-42C	1	6.5	150	525	438	20	825	20	8.25
Three-phase 400V	75	FRN75VG1S-4J				DB75V-42C	1	4.7	150	716	597	20	1125	20	11.3
	90	FRN90VG1S-4J				DB90V-42C	1	3.9	150	859	716	20	1350	20	13.5
	110	FRN110VG1S-4J				DB110V-42C	1	3.2	150	1050	875	20	1650	20	16.5
	132	FRN132VG1S-4J				DB132V-42C	1	2.6	150	1261	1050	20	1980	20	19.8
	160	FRN160VG1S-4J				DB160V-42C	1	2.2	150	1528	1273	20	2400	20	24.0
	200	FRN200VG1S-4J	D	BU220-4C	2	DB200V-42C	1	3.5/2	150	1910	1592	20	3000	20	30.0
	220	FRN220VG1S-4J		BU220-4C	2	DB220V-42C	1	3.2/2	150	2101	1751	20	3300	20	33.0
	280	FRN280VG1S-4J	I	BU220-4C	2	DB160V-42C	2	2.2/2	150	2674	2228	20	4200	20	42.0
	315	FRN315VG1S-4J		BU220-4C	2	DB160V-42C	2	2.2/2	150	3008	2507	20	4725	20	47.3
	355	FRN355VG1S-4J	F	BU220-4C	3	DB132V-42C	3	2.6/3	150	3390	2825	20	5325	20	53.3
	400	FRN400VG1S-4J		BU220-4C	3	DB132V-42C	3	2.6/3	150	3820	3183	20	6000	20	60.0
	500	FRN500VG1S-4J	G	BU220-4C	4	DB132V-42C	4	2.6/4	150	4775	3979	20	7500	20	75.0
	630	FRN630VG1S-4J		BU220-4C	4	DB160V-42C	4	2.2/4	150	6016	5013	20	9450	20	94.6

Note) • This option is built to order.
• The braking unit requires the fan unit (BU-F).
For DB200V-42C and DB220V-42C, two braking resistors are used per one unit.
Example) For the model: DB200V-42C, quantity: 1, two braking resistors are used.

■MD-mode Inverters

Table 8.9(b) Braking Unit/Braking Resistor (20%ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options: Braking unit Model	Braking unit Qty. (units)	Braking resistor Model	Braking resistor Qty. (units)	Resistance value(Ω)	Maximum braking torque (%)	Torque (N·m) 50Hz	Torque (N·m) 60Hz	Continuous braking (converted to 150% torque value): Braking time (s)	Discharging capability (kWs)	Repetitive braking (at 100s interval or less): Duty cycle (%ED)	Average loss (kW)
Three-phase 400V	110	FRN90VG1S-4J	A			DB110V-42C	1	3.2	150	1050	875	20	1650	20	16.5
	132	FRN110VG1S-4J		-	-	DB132V-42C	1	2.6	150	1261	1050	20	1980	20	19.8
	160	FRN132VG1S-4J				DB160V-42C	1	2.2	150	1528	1273	20	2400	20	24.0
	200	FRN160VG1S-4J	C			DB200V-42C	1	3.5/2	150	1910	1592	20	3000	20	30.0
	220	FRN200VG1S-4J	D	BU220-4C	2	DB220V-42C	1	3.2/2	150	2101	1751	20	3300	20	33.0
	250	FRN220VG1S-4J	I	BU220-4C	2	DB132V-42C	2	2.6/2	150	2388	1990	20	3750	20	37.5
	315	FRN280VG1S-4J		BU220-4C	2	DB160V-42C	2	2.2/2	150	3008	2507	20	4725	20	47.3
	355	FRN315VG1S-4J	F	BU220-4C	3	DB132V-42C	3	2.6/3	150	3390	2825	20	5325	20	53.3
	400	FRN355VG1S-4J		BU220-4C	3	DB132V-42C	3	2.6/3	150	3820	3183	20	6000	20	60.0
	450	FRN400VG1S-4J	G	BU220-4C	4	DB132V-42C	4	2.6/4	150	4297	3581	20	6750	20	67.5

■LD-mode Inverters

Table 8.9(c) Braking Unit/Braking Resistor (20%ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options: Braking unit Model	Braking unit Qty. (units)	Braking resistor Model	Braking resistor Qty. (units)	Resistance value (Ω)	Maximum braking torque(%)	Torque (N·m) 50Hz	Torque (N·m) 60Hz	Continuous braking (converted to 150% torque value): Braking time (s)	Discharging capability (kWs)	Repetitive braking (at 100s interval or less): Duty cycle (%ED)	Average loss (kW)
Three-phase 200V	37	FRN30VG1S-2J	A			DB30V-22C	1	3.0	110	259	216	20	407	20	4.50
	45	FRN37VG1S-2J		-	-	DB37V-22C	1	2.4	110	315	263	20	495	20	5.55
	55	FRN45VG1S-2J				DB45V-22C	1	2.0	110	385	321	20	605	20	6.75
	75	FRN55VG1S-2J				DB55V-22C	1	1.6	110	525	438	20	825	20	8.25
	90	FRN75VG1S-2J	B	BU55-2C	2	DB37V-22C	2	2.4/2	110	630	525	20	990	20	11.3
	110	FRN90VG1S-2J		BU90-2C	2	DB45V-22C	2	2.0/2	110	770	642	20	1210	20	13.5
Three-phase 400V	37	FRN30VG1S-4J	A			DB30V-42C	1	12	110	259	216	20	407	20	4.50
	45	FRN37VG1S-4J				DB37V-42C	1	9.0	110	315	263	20	495	20	5.55
	55	FRN45VG1S-4J				DB45V-42C	1	8.0	110	385	321	20	605	20	6.75
	75	FRN55VG1S-4J				DB55V-42C	1	6.5	110	525	438	20	825	20	8.25
	90	FRN75VG1S-4J		-	-	DB75V-42C	1	4.7	110	630	525	20	990	20	11.3
	110	FRN90VG1S-4J				DB90V-42C	1	3.9	110	770	642	20	1210	20	13.5
	132	FRN110VG1S-4J				DB110V-42C	1	3.2	110	924	770	20	1452	20	16.5
	160	FRN132VG1S-4J				DB132V-42C	1	2.6	110	1120	934	20	1760	20	19.8
	200	FRN160VG1S-4J				DB160V-42C	1	2.2	110	1401	1167	20	2200	20	24.0
	220	FRN200VG1S-4J	D	BU220-4C	2	DB200V-42C	1	3.5/2	110	1541	1284	20	2420	20	30.0
	280	FRN220VG1S-4J		BU220-4C	2	DB220V-42C	1	3.2/2	110	1961	1634	20	3080	20	33.0
	355	FRN280VG1S-4J	I	BU220-4C	2	DB160V-42C	2	2.2/2	110	2486	2072	20	3905	20	47.3
	400	FRN315VG1S-4J	F	BU220-4C	3	DB132V-42C	3	2.6/3	110	2801	2334	20	4400	20	53.3
	450	FRN355VG1S-4J		BU220-4C	3	DB132V-42C	3	2.6/3	110	3151	2626	20	4950	20	53.3
	500	FRN400VG1S-4J		BU220-4C	3	DB132V-42C	3	2.6/3	110	3501	2918	20	5500	20	60.0
	630	FRN500VG1S-4J	G	BU220-4C	4	DB132V-42C	4	2.6/4	110	4412	3677	20	6930	20	75.0
	710	FRN630VG1S-4J		BU220-4C	4	DB160V-42C	4	2.2/4	110	4972	4143	20	7810	20	94.6

Note) • This option is built to order.

• The braking unit requires the fan unit (BU-F).

For DB200V-42C and DB220V-42C, two braking resistors are used per one unit.

Example) For the model: DB200V-42C, quantity: 1, two braking resistors are used.

<Connection example>

Figure A

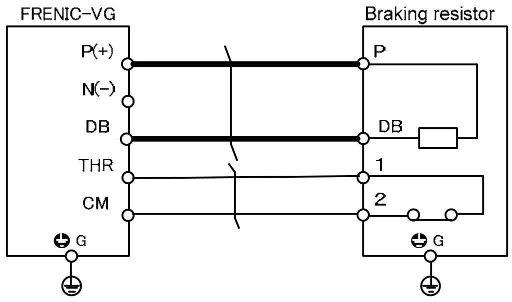
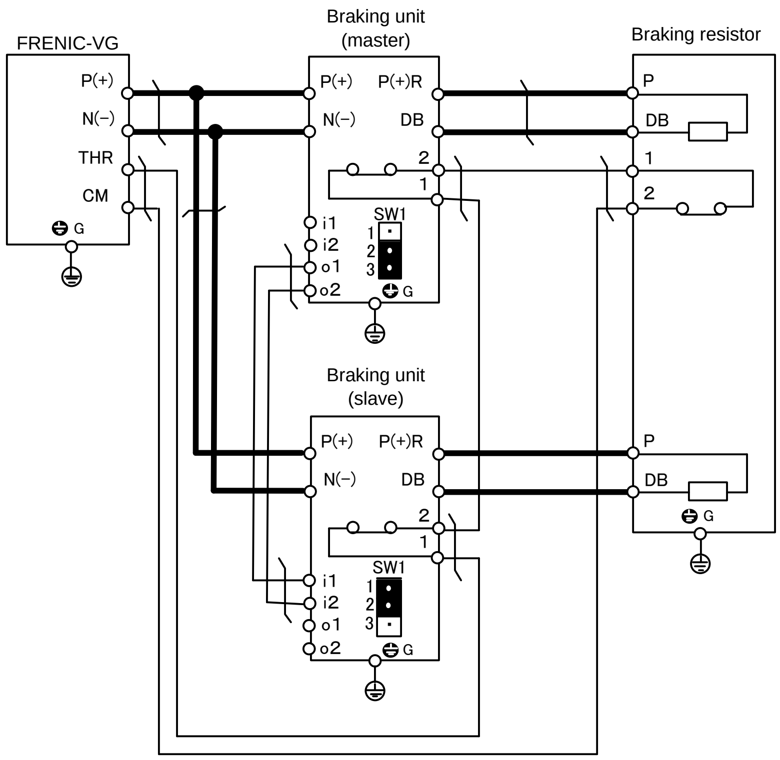
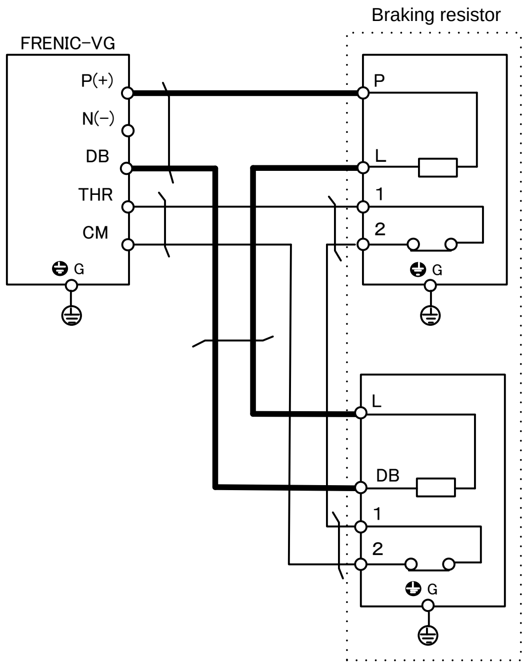


Figure B



Note 1: When using the 20%ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

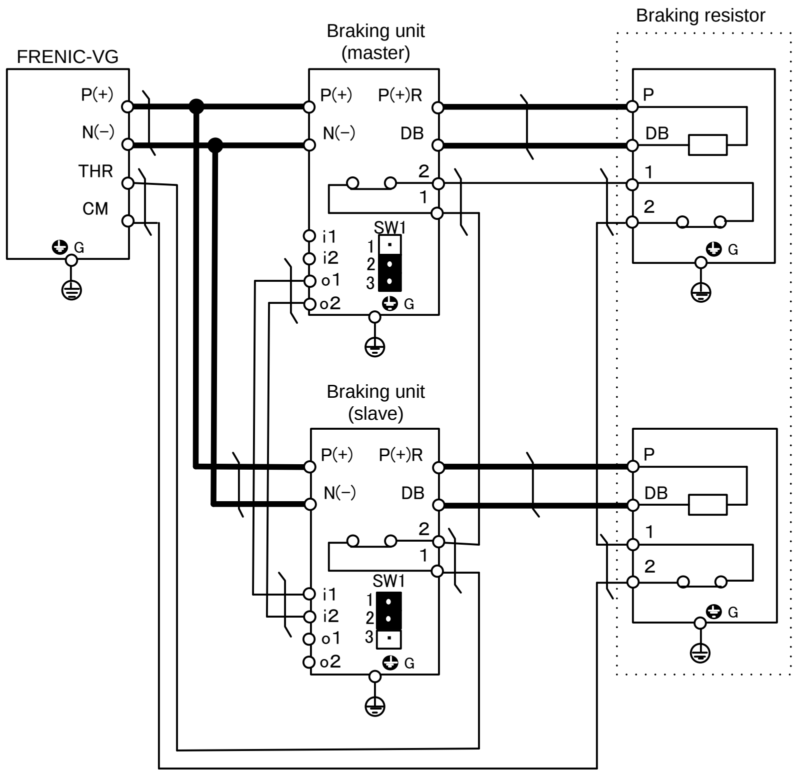
Figure C



Note 1: For DB160V-41C and DB200V-42C, two braking resistors are used per one unit.

Note 2: When using the 20%ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

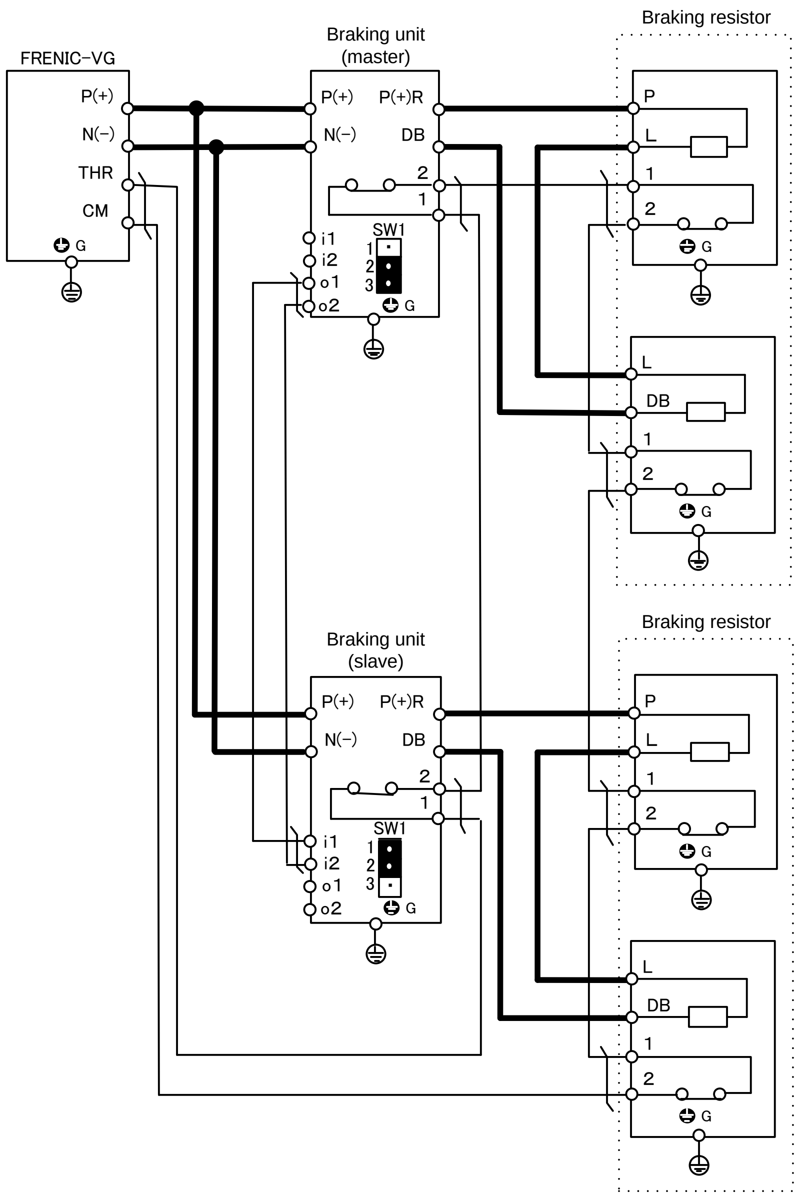
Figure D



Note 1: For DB200V-41C, DV220V-41C, DB200V-42C and DB220-42C, two braking resistors are used per one unit.

Note 2: When using the 20% ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

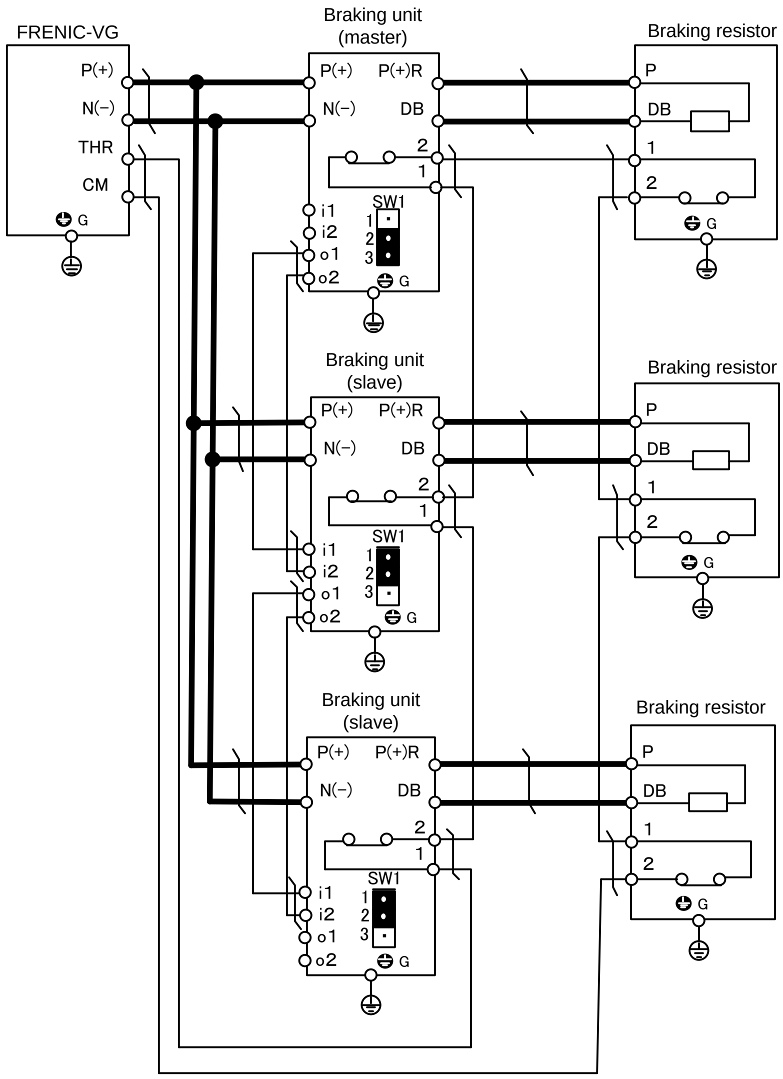
Figure E



Note 1: For DB160V-41C, two braking resistors are used per one unit.
Example) For the model: DB160V-41C, quantity: 2, four braking resistors are used.

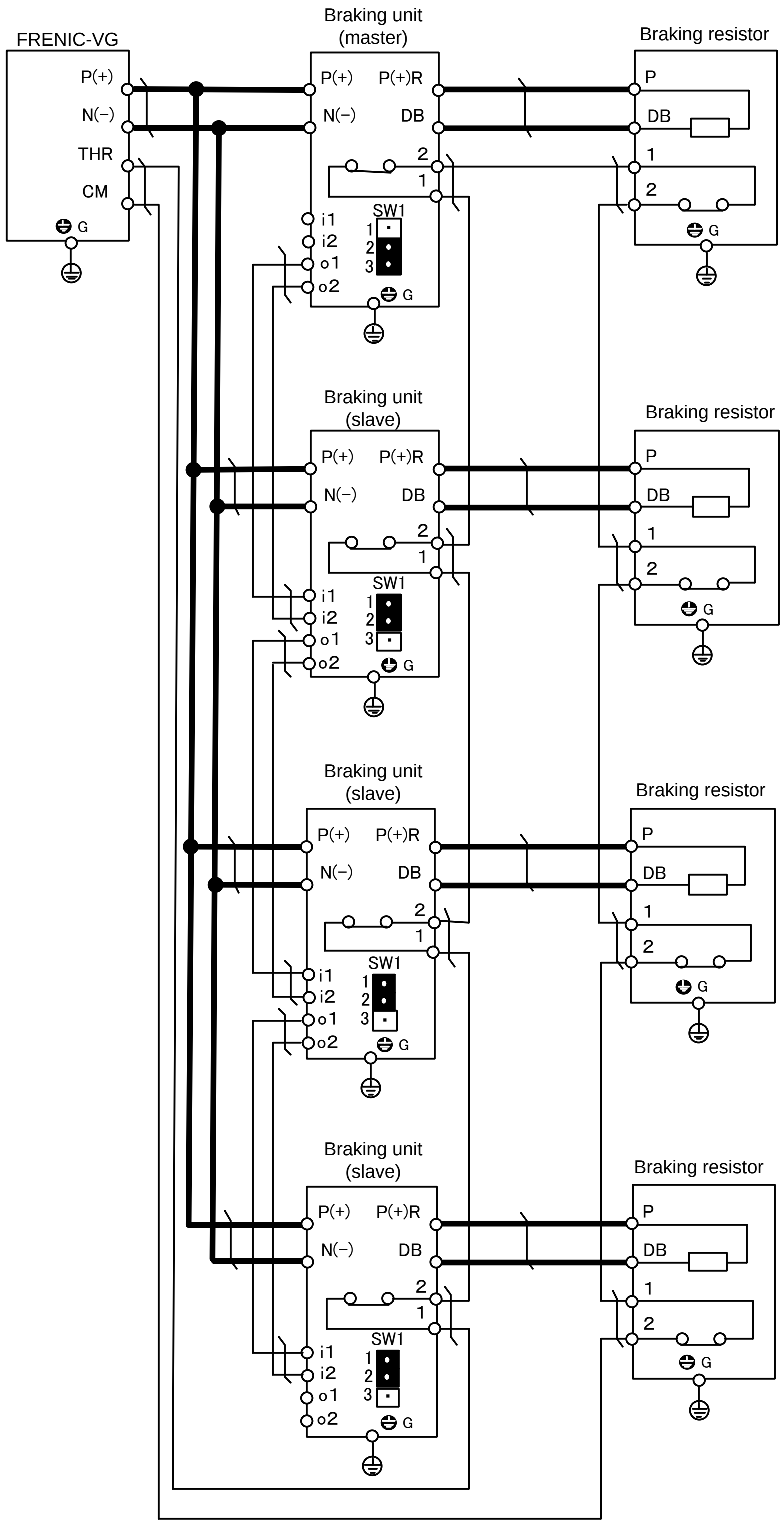
Note 2: When using the 20% ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

Figure F



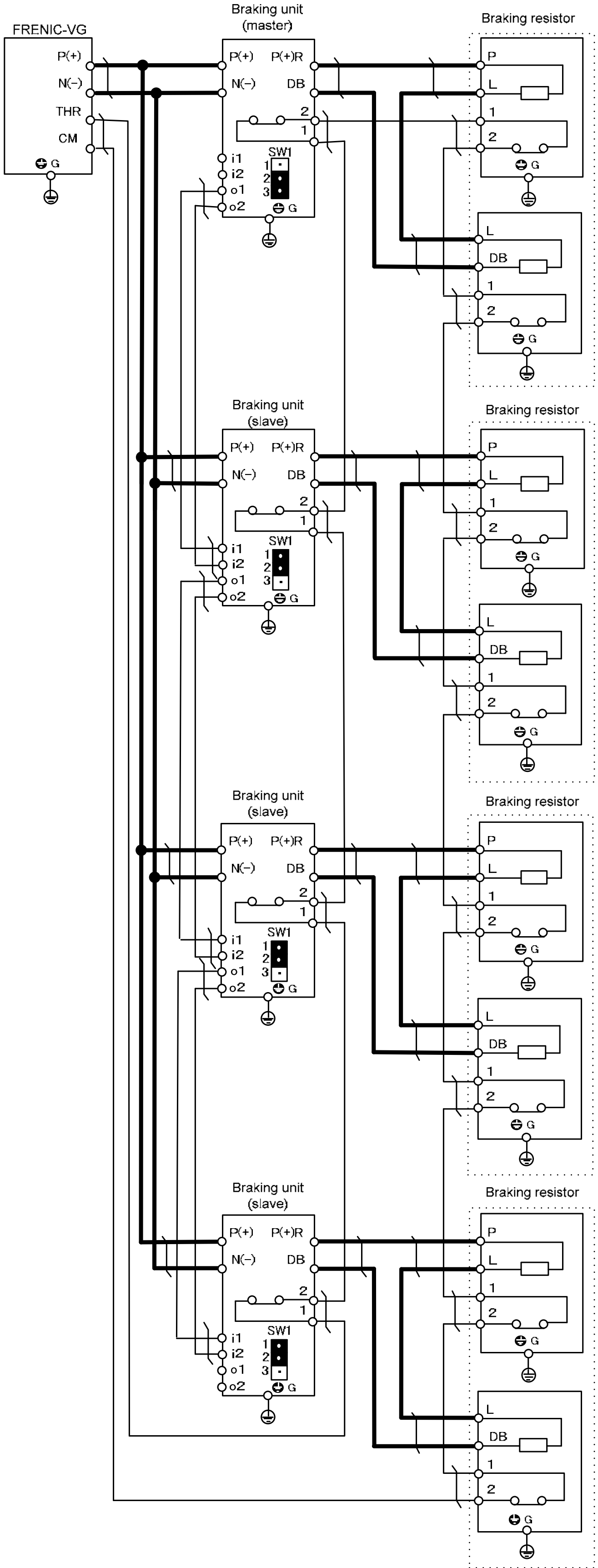
Note 1: When using the 20% ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

Figure G



Note 1: When using the 20% ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

Figure H

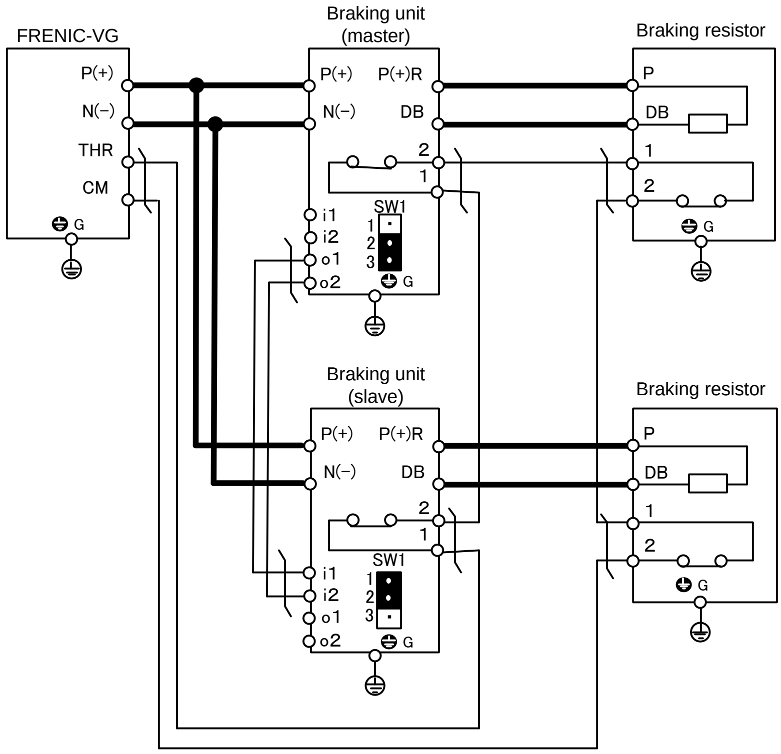


Note 1: For DB160V-41C, two braking resistors are used per one unit.

Example) For the model: DB160V-41C, quantity: 4, eight braking resistors are used.

Note 2: When using the 20% ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

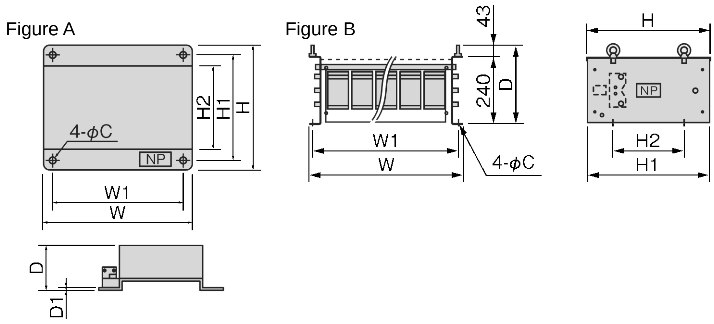
Figure I



Note 1: When using the 20% ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

8.5.1.4 External dimensions

Braking resistors, 10% ED models



200V series (10% ED product)

Model	Fig	Dimensions (mm)								Approx. weight (kg)
		W	W1	H	H1	H2	D	D1	C	
DB2.2V-21B	A	330	298	242	210	165	140	1.6	8	4
DB3.7V-21B		400	368	280	248	203	140	1.6	8	5
DB5.5V-21B		400	368	280	248	203	140	1.6	8	5
DB7.5V-21B		400	368	480	448	377	140	1.6	10	6
DB11V-21B		400	368	480	448	377	140	1.6	10	7
DB15V-21B		400	368	660	628	557	140	1.6	10	10
DB18.5V-21B		400	368	660	628	557	140	1.6	10	10
DB22V-21B		400	368	660	628	557	240	1.6	10	13
DB30V-21B		400	368	660	628	557	240	1.6	10	18
DB37V-21B		405	368	750	718	647	240	1.6	10	22
DB45V-21B		405	368	750	718	647	340	1.6	10	26
DB55V-21C	B	450	420	440	430	250	283	-	12	35
DB75V-21C		600	570	440	430	250	283	-	12	33
DB90V-21C		700	670	440	430	250	293	-	12	43

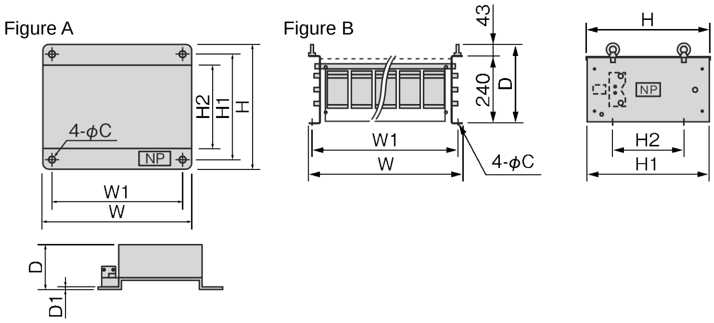
400V series (10% ED product)

Model	Fig	Dimensions (mm)								Approx. weight (kg)
		W	W1	H	H1	H2	D	D1	C	
DB3.7V-41B	A	420	388	280	248	203	140	1.6	8	5
DB5.5V-41B		420	388	480	448	377	140	1.6	10	7
DB7.5V-41B		420	388	480	448	377	140	1.6	10	7
DB11V-41B		420	388	480	448	377	140	1.6	10	8
DB15V-41B		420	388	660	628	557	140	1.6	10	11
DB18.5V-41B		420	388	660	628	557	140	1.6	10	11
DB22V-41B		420	388	660	628	557	240	1.6	10	14
DB30V-41B		420	388	660	628	557	240	1.6	10	19
DB37V-41B		425	388	750	718	647	240	1.6	10	21
DB45V-41B		425	388	750	718	647	340	1.6	10	26
DB55V-41C	B	550	520	440	430	250	283	-	12	26
DB75V-41C		550	520	440	430	250	283	-	12	30
DB90V-41C		650	620	440	430	250	283	-	12	41
DB110V-41C		750	720	440	430	250	283	-	12	57
DB132V-41C		750	720	440	430	250	283	-	12	43
*DB160V-41C		600	570	440	430	250	283	-	12	74
*DB200V-41C		725	695	440	430	250	283	-	12	50(x2)
*DB220V-41C		725	695	440	430	250	283	-	12	51(x2)

* For DB160V-41C - DB220V-41C, two resistors of the same shape are used in a pair, and enough space for them should be considered.

When this model is ordered, a set of two resistors will be shipped.

Braking resistor　20% ED product



200 V series (20% ED product)

Model	Fig	Dimension (mm)								Approx. weight (kg)
		W	W1	H	H1	H2	D	D1	C	
DB2.2V-22B	A	400	368	280	248	203	140	1.6	8	5
DB3.7V-22B		400	368	480	448	377	140	1.6	10	6
DB5.5V-22B		400	368	480	448	377	140	1.6	10	7
DB7.5V-22B		400	368	660	628	557	140	1.6	10	10
DB11V-22B		400	368	660	628	557	240	1.6	10	13
DB15V-22B		405	368	750	718	647	240	1.6	10	22
DB18.5V-22B		405	368	750	718	647	240	1.6	10	22
DB22V-22B		405	368	750	718	647	340	1.6	10	26
DB30V-22C	B	450	420	440	430	250	283	-	12	26
DB37V-22C		550	520	440	430	250	283	-	12	41
DB45V-22C		650	620	440	430	250	283	-	12	36
DB55V-22C		700	670	440	430	250	283	-	12	43

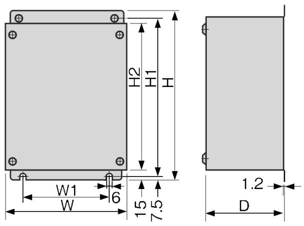
400 V series (20% ED product)

Model	Fig	Dimensions(mm)								Approx. weight (kg)
		W	W1	H	H1	H2	D	D1	C	
DB3.7V-42B	A	420	388	480	448	377	140	1.6	10	8
DB5.5V-42B		420	388	660	628	557	140	1.6	10	11
DB7.5V-42B		420	388	660	628	557	140	1.6	10	11
DB11V-42B		420	388	660	628	557	240	1.6	10	14
DB15V-42B		420	388	750	718	647	240	1.6	10	21
DB18.5V-42B		420	388	750	718	647	240	1.6	10	21
DB22V-42B		420	388	750	718	647	340	1.6	10	26
DB30V-42C	B	600	570	440	430	250	283	-	12	24
DB37V-42C		700	670	440	430	250	283	-	12	32
DB45V-42C		700	670	440	430	250	283	-	12	34
DB55V-42C		750	720	440	430	250	283	-	12	45
DB75V-42C		550	520	440	430	250	483	-	12	68
DB90V-42C		650	620	440	430	250	483	-	12	65
DB110V-42C		700	670	440	430	250	483	-	12	82
DB132V-42C		700	670	440	430	250	483	-	12	86
DB160V-42C		700	670	440	430	250	483	-	12	100
*DB200V-42C		700	670	440	430	250	483	-	12	85(x2)
*DB220V-42C		700	670	440	430	250	483	-	12	83(x2)

* For DB200V-42C and DB220V-42, two resistors of the same shape are used in a pair, and enough space for them should be considered.

When this model is ordered, a set of two resistors will be shipped.

Braking unit

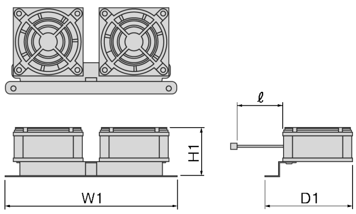


Voltage	Model	Dimensions (mm)						Approx. weight (kg)
		W	W1	H	H1	H2	D	
200V series	BU55-2C	230	130	240	225	210	160	6
	BU90-2C	250	150	370	355	340		9
400V series	BU220-4C	250	150	450	435	420	160	13

Fan units for braking units

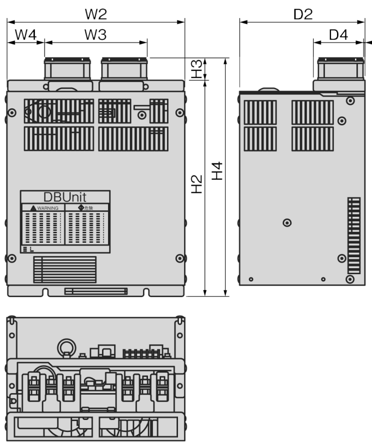
Using this option improves the duty cycle [%ED] of a model using the external braking unit from 10%ED to 30%ED.

■ Fan unit



Model	Dimensions(mm)			
	W1	H1	D1	ℓ (fan power supply line)
BU-F	149	44	76	320

■ Braking unit + fan unit



Voltage	Model	Dimensions(mm)								
		W2	W3	W4	H2	H3	H4	D2	D3	D4
200V series	BU55-2C+BU-F	230	135	47.5	240	30	270	160	1.2	64
	BU90-2C+BU-F	250		57.5	370		400			
400V series	BU220-4C+BU-F	250	135	57.5	450	30	480	160	1.2	64

8.5.2 Power regenerative PWM converters (RHC series)

8.5.2.1 Features

■ Conforms to harmonics suppressing guideline

Since this product converts the power supply current into sine waves by PWM control to greatly reduce the harmonics current, the conversion coefficient defined in the "Guideline of Harmonics Reduction for Consumers who has High or Ultra-High Voltage Power Receiving Facilities" can be reduced to "0" (i.e., no harmonics occur) when used in combination with inverters.

■ Can reduce power supply facilities capacity

By flowing current with the same phase as the power supply phase voltage by power factor control, operation with the power factor of approximately 1 can be achieved. This results in smaller power supply transformer capacity and equipment size, compared with the standard inverter.

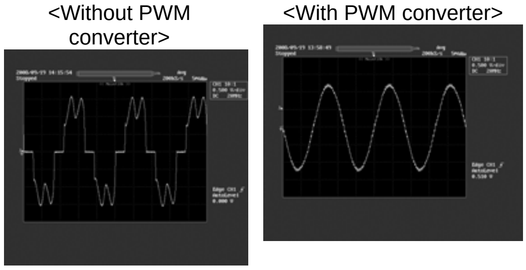
■ Greatly improves braking ability

In highly frequent acceleration/deceleration operation and elevator operation, regenerated energy is all returned to the power supply to save power in regeneration.
Also, there will be no trouble with the power supply system because the current waveform in regeneration is sine wave.

Continuous regeneration rating 100%
1-minute regeneration rating
150% (CT specification)
120% (VT specification)

Comparison of input current waveform

<Without PWM converter> <With PWM converter>

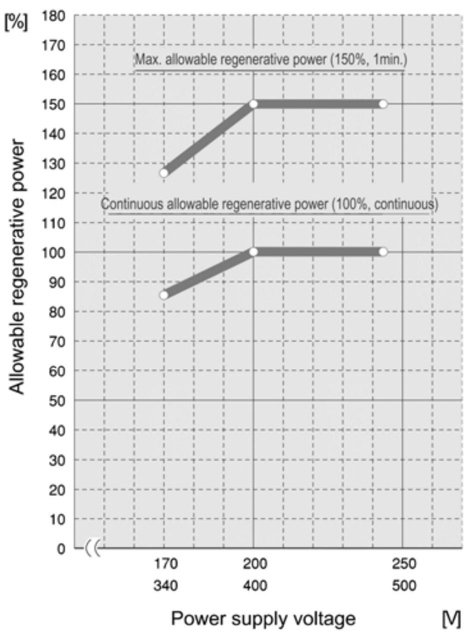


■ Rich protective and maintenance functionality

- Troubleshooting is made easier by the trace bag (option).

  Past alarm details (for the last 10 alarms) by the segment LEDs can be retrieved. This allows for easy alarm cause analysis and measure planning.
  Upon a momentary power failure, the gate is shut down to ensure quick restart after the power comes back.
  Predictive signals for overload, fin over temperature, and life, alarms can be generated before the converter slips.

Allowable characteristics of the RHC unit



■ Networking capability

- MICREX-SX, F series, and CC-Link master devices can be (optionally) connected. RS-485 is equipped by standard.

8.5.2.2 Specifications

(1) Standard specifications

■ 200 V series

Item			Standard specifications										
Model RHC□□□-2C			200 V series										
			7.5	11	15	18.5	22	30	37	45	55	75	90
CT application	Applicable inverter capacity (kW)		7.5	11	15	18.5	22	30	37	45	55	75	90
	Output	Continuous capacity (kW)	8.8	13	18	22	26	36	44	53	65	88	103
		Overload rating	150% of continuous rating for 1 minute										
		Voltage 200V	DC320-355V (variable according to input power supply voltage) (*3)										
	Required power supply capacity (kVA)		9.5	14	19	24	29	38	47	57	70	93	111
	Carrier frequency		Standard 15kHz									Standard 10kHz	
VT application	Applicable inverter capacity(kW)		11	15	18.5	22	30	37	45	55	75	90	110
	Output	Continuous capacity (kW)	13	18	22	26	36	44	53	65	88	103	126
		Overload rating	120% of continuous rating for 1 minute										
		Voltage200V	DC320-355V (variable according to input power supply voltage) (*3)										
	Required power supply capacity (kVA)		14	19	24	29	38	47	57	70	93	111	136
	Carrier frequency		Standard 10kHz									Standard 6kHz	
Input power supply	Number of phases, voltage, and frequency		3-phase 3-wire, 200-220V 50Hz, 220-230V 50Hz(*1), 200-230V 60Hz										
	Voltage and frequency fluctuation		Voltage: -15 to +10%, frequency: ±5%, Voltage imbalance: within 2% (*4)										

■ 400 V series

Item			Standard specifications																					
Model RHC□□□-4C			400V series																					
			7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
CT application	Applicable inverter capacity(kW)		7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
	Output	Continuous capacity (kW)	8.8	13	18	22	26	36	44	53	65	88	103	126	150	182	227	247	314	353	400	448	560	705
		Overload rating	150% of continuous rating for 1 minute																					
		Voltage400V	DC640-710V (variable according to input power supply voltage) (*3)																					
	Required power supply capacity (kVA)		9.5	14	19	24	29	38	47	57	70	93	111	136	161	196	244	267	341	383	433	488	610	762
	Carrier frequency		Standard 15kHz									Standard 10kHz											Standard 6kHz	
VT application	Applicable inverter capacity(kW)		11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500		
	Output	Continuous capacity (kW)	13	18	22	26	36	44	53	65	88	103	126	150	182	227	247	314	353	400	448	560		
		Overload rating	120% of continuous rating for 1 minute																					
		Voltage400V	DC640-710V (variable according to input power supply voltage) (*3)																					
	Required power supply capacity (kVA)		14	19	24	29	38	47	57	70	93	111	136	161	196	244	267	341	383	433	488	610		
	Carrier frequency		Standard 10kHz									Standard 6kHz												
Input power supply	Number of phases, voltage, and frequency		3-phase 3-wire, , 380-440V 50Hz, 380-460V 60Hz(*2)																					
	Voltage and frequency fluctuation		Voltage: -15 to +10%, frequency: ±5%, Voltage imbalance: within 2% (*4)																					

(*1) 220-230V/50Hz model can be manufactured for a separate order.

(*2) When the power supply voltage is 380-398V/50Hz or 380-430V/60Hz, tap switching is required inside the converter. If the power supply voltage is lower than 400V, the capacity must be reduced.

(*3) The output voltage is approximately DC320/640V for the power supply voltage of 200/400V, DC343/686V for 220/440V, and DC355/710V for 230/460V.

(*4) Inter-phase voltage imbalance ratio [%] = (Maximum voltage [V] - minimum voltage [V]) / 3-phase average voltage * 67

(2) Common specifications

Item		Specifications
Control	Control method	AVR constant control with DC ACR minor
	Running/Stopping	Starts rectification when the converter is powered ON after connection. Starts boosting when it receives a run signal (terminals [RUN] and [CM] short-circuited or a run command via the communications link). After that, the converter is ready to run.
	Running status signal	Running, power running, regenerative operation, ready-to-run, alarm output (for any alarm), etc.
	CT/VT switching	CT: 150% of overload rating for 1 min VT: 120% of overload rating for 1 min (CT model only: 500 kW or above)
	Carrier frequency	Fixed to high carrier frequency
	Input power factor	0.99 or above (at full load) (*1)
	Input harmonics current	Conversion coefficient can be Ki=0 according to the harmonics suppressing guideline by METI.
	Restart after momentary power failure	Shields the gate when the voltage level reaches the undervoltage level if a momentary power failure occurs, and the converter can automatically restart after the power recovers.
	Power limiting control	Controls the power not to exceed the preset limit value.
Indication	Alarm display (Protective functions)	AC fuse blown, AC overvoltage, AC undervoltage, AC overcurrent, AC input current error, input phase loss, synchronous power supply frequency error, DC fuse blown, DC overvoltage, DC undervoltage, charge circuit fault, heat sink overheat, external alarm, converter internal overheat, overload, memory error, keypad communications error, CPU error, network device error, operation procedure error, A/D converter error, optical network error, IPM error
	Alarm history	Saves and displays the most recent 10 alarms. Saves and displays the detailed information of the trip cause for the previous alarm.
	Monitor	Displays input power, input current in RMS, input voltage in RMS, DC link bus voltage and power supply frequency.
	Load factor	Allows the user to measure the load factor with the keypad.
	Language	Allows the user to specify or refer to function codes in any of the three languages--Japanese, English or Chinese.
	Charging lamp	Lights when the DC link bus capacitor is charged.

(*1) When the power supply voltage is 420V(210V) or higher and the operating load is 50% or higher, the power supply's power factor is reduced to approximately 0.095 (during regenerative operation only).

8.5.2.3 Function specifications

(1) Terminal functions

Classi-fication	Symbol	Name	Specifications
Main circuit	L1/R, L2/S, L3/T	Main circuit power inputs	Connects with the three-phase input power lines through a dedicated reactor.
	P(+), N( )	Converter outputs	Connects with the power input terminals P(+) and N(-) on an inverter.
	E(G)	Grounding	Grounding terminal for the converter's chassis (or casing).
	R0, T0	Auxiliary power input for the control circuit	For a backup of the control circuit power supply, connect the power lines same as that of the main power input.
Voltage detection	R1, S1, T1	Synchronous power input for voltage detection	Voltage detection terminals for the internal control of the converter. Connect with the power supply side of the dedicated reactor or filter.
	R2, T2	Inputs for control monitoring	Detection terminal for AC fuse blown.
Input signal	RUN	Run command	Short-circuiting terminals [RUN] and [CM] runs the converter; opening them stops the converter.
	RST	Reset alarm command	When the converter stops due to an alarm, removing the alarm factor and short-circuiting the terminals [RST] and [CM] cancels the protective function, restarting the converter.
	X1	General-purpose transistor input	0: Enable external alarm trip THR 1: Cancel current limiter LMT-CCL 2: 73 answerback 73ANS 3: Switch current limiter I-LIM4: Option D IOPT-DI
	CM	Digital input common	Common terminal for digital input signals.
	PLC	PLC signal power	Connects to PLC output signal power supply. (Rated voltage: 24 VDC (22 to 27 VDC)
Output signal	30A, 30B, 30C	Batch output alarm	Outputs a signal when the converter protective function acts and the converter stops in an alarm state. (Contact: 1C, on error, 30A-30C: ON) (Contact capacity: AC250V 50mAmax)
	Y1, Y2, Y3, Y11-Y18	General-purpose transistor output	0: Converter running RUN 1: Converter ready to run RDY 2: Power supply current limiting IL 3: Lifetime alarm LIFE 4: Heat sink overheat early warning PRE-OH 5: Overload early warning PRE-OL 6: Power running DRV 7: Regenerating REG 8: Current limiting early warning CUR 9: Restarting after momentary power failure U-RES 10: Synchronizing power supply frequency SY-HZ 11: Alarm content 1 AL1 12: Alarm content 2 AL2 13: Alarm content 4 AL4 14: Option DO OPT-DO * Mounting the OPC-VG7-DIOA option makes 8 points of DO extended functions available. (DI functions are not available.)
	CME	Digital output common	
	Y5A, Y5C	Relay output	
	A01, A04, A05	General-purpose analog output	0: Input power PWR 1: Input current in RMS I-AC 2: Input voltage in RMS V-AC 3: DC link bus voltage V-DC 4: Power supply frequency FREQ 5: +10 V test P106: -10 V test N10 * Mounting the OPC-VG7-DIOA option makes 2 points of DO extended functions available. (DI functions are not available.)
	M	Analog output common	Common terminal for analog output signal.
	73A, 73C	Charging resistor input relay outputs	Control output for the input relay of the external charging resistor (73).

(2) Communications specifications

Item			Specifications
Communications specifications	General communication specifications		Monitoring the running information, running status and function code data, and controlling (selecting) the terminals [RUN], [RST] and [X1]. * Writing to function codes is not possible.
	RS-485 (standard)		Communicating with a PC or PLC. (The converter supports the Fuji general-purpose inverter protocol and Modbus RTU protocol.)
	T-Link (option)		Mounting the OPC-VG7-TL option enables communication with a T-Link module of MICREX-F or MICREX-SX via a T-Link network.
	SX-bus (option)		Mounting the OPC-VG7-SX option enables communication with a MICREX-SX via an SX bus network.
	CC-Link (option)		Mounting the OPC-VG7-CCL option enables communication with a CC-Link master.
	Traceback (option)	Hardware	Mounting the OPC-RHC-TR option enables tracing back of the running status data of the converter. WPS-LD-TR software is required.
		Software	Installing the WPS-RHC-TR software enables collecting of traceback data on the PC.
	Optical communication (option)		The OPC-VG7-SI allows for load balancing control of a concurrent multi-processing system. This supports capacity of up to 2400kW.

(3) Function settings

Function code	Name
F00	Data protection
F01	High frequency filter selection
F02	Restart upon momentary power failure (operation selection)
F03	Current rating switching
F04	LED monitor, item selection
F05	LCD monitor, item selection
F06	LCD monitor, language selection
F07	LCD monitor, contrast control
F08	Carrier frequency
E01	Terminal [X1] function
E02-13	Terminal [Y1], [Y2], [Y3,], [Y5], [Y11] to [Y18] function
E14	I/O function normal open/closed
E15	RHC overload early warning level
E16	Cooling fan ON/OFF control
E17	Under current limiting (Hysteresis width)
E18-20	A01, A04 and A05, function selection
E21-23	A01, A04 and A05, gain setting
E24-26	A01, A04 and A05, bias setting
E27	A01, A04 and A05, filter setting
H01	Station address
H02	Communications error processing
H03	Timer
H04	Baud rate
H05	Data length
H06	Parity bits
H07	Stop bits
H08	No-response error detection time
H09	Response interval
H10	Protocol selection
H11	TL transmission format
H12	Parallel system
H13	Number of slave stations in parallel system
H14	Clear alarm data
H15,16	Power supply current limiter (driving 1/2)
H17,18	Power supply current limiter (braking 1/2)
H19,20	Current limiting early warning (level/timer)
S01	Operation method
S02,03	Power supply current limiting (driving/braking)
M09	Power supply frequency
M10	Input power
M11	Input current in RMS
M12	Input voltage in RMS
M13	Run command
M14	Running status
M15	Output terminals [Y1] to [Y18]

(4) Protective functions

Item	Indication	Protective specifications	Remarks
AC fuse blown	ACF	Stops the converter output if the AC fuse (R-/T-phase only) is blown.	
AC overvoltage	AOV	Stops the converter output upon detection of an AC overvoltage condition.	
AC undervoltage	ALV	Stops the converter output upon detection of an AC undervoltage condition.	
AC overcurrent	AOC	Stops the converter output if the peak value of the input current exceeds the overcurrent level.	
AC input current error	ACE	Stops the converter output upon detection of the excessive deviation of the AC reactor from the AC input.	
Input phase loss	LPV	Stops the converter output upon detection of an input phase loss.	
Synchronous power frequency error	FrE	After the MC for charging circuit (73) is turned on, the converter checks the power frequency. If it detects a power frequency error, this function stops the converter output. An error during converter running (e.g., momentary power failure) triggers no alarm.	
DC fuse blown	dCF	Stops the converter output if the DC fuse (P side) is blown.	18.5 kW or above
DC overvoltage	dOV	Stops the converter output upon detection of a DC overvoltage condition. If a power failure continues for a long time and the control power source is shut down, this alarm is automatically reset.	200 V class series: 400 V ±3 V 400 V class series: 800 V ±5 V
DC undervoltage	dLV	Stops the converter output upon detection of a DC undervoltage condition. If a power failure continues for a long time and the control power source is shut down, this alarm is automatically reset.	200 V class series: Stops at 185 V, restarts at 208 V. 400V class series: Stops at 371V, restarts at 417V.
Charging circuit fault	PbF	Stops the converter output upon detection of a heat sink overheat.	Condition: 73ANS (Answerback from 73) is assigned to terminal [X1].
Heat sink overheat	OH1	Stops the converter output upon receipt of an external signal THR.	
External alarm	OH2	Stops the converter output upon detection of an internal overheat of the converter.	THR (Enable external alarm trip) is assigned to terminal [X1].
Converter internal overheat	OH3	Stops the converter output with the inverse-time characteristics due to the input current.	
Converter overload	OLU	Stops the converter output upon detection of a heat sink overheat.	Activate at 105%, 150% for 1 min
Memory error	Er1	Stops the converter output if a data writing error or any other memory error occurs (when the checksums of the EEPROM and RAM do not match).	
Keypad communications error	Er2	Displays "*er2* " upon detection of a wire break in initial communication with the keypad. This does not affect the converter operation.	
CPU error	Er3	Activated if a CPU error occurs.	
Network device error	Er4	Stops the converter output if a fatal error (including no power supply connection) occurs in the master unit in the network.	Applies to T-Link, SX-bus, and CC-Link devices.
Operation procedure error	Er6	Stops the converter output upon detection of an error in the operation procedure.	
A/D converter error	Er8	Stops the converter output upon detection of a failure in the A/D converter circuit.	
Optical network error	Erb	Stops the converter output upon detection of an optical cable break or a fatal error in the optical option.	
IPM error	IPE	Activated when the IPM's self-diagnosis function works due to an overcurrent or overheat.	15 kW or below

(5) Required structure and environment

Item		Required structure, environment and standards	Remarks
Structure	Structure	Mounting in a panel or mounting for external cooling	
	Enclosure	IP00	
	Cooling system	Forced air cooling	
	Installation	Vertical installation	
	Coating color	Munsell 5Y3/0.5, eggshell	
	Maintainability	Structure designed for easy parts replacement	
Environment	Site location	Shall be free from corrosive gases, flammable gases, dusts, and direct sunlight.	
	Surrounding temperature	-10 to 500°C	
	Relative humidity	5 to 95% RH (No condensation)	
	Altitude	3,000 m max. (For use in an altitude between 1,001 m to 3,000 m, the output current should be derated.)	
	Vibration	2 to 9 Hz: Amplitude = 3 mm, 9 to 20 Hz: 9.8 m/s^2, 20 to 55 Hz: 2 m/s^2 (9 to 55 Hz: 2 m/s^2 for 90 kW or above), 55 to 200 Hz: 1 m/s^2	
	Storage temperature	-20 to 55°C	
	Storage humidity	5 to 95%RH	

8.5.2.4 Converter configuration

(1) CT mode

Power supply voltage	Applicable motor [kW]	PWM converter type	Charging circuit contactor		Power supply contactor		Charging circuit box		Charger resistor		Fuse		Boosting reactor		Filtering resistor		Filtering reactor		Filtering capacitor		Filter circuit contactor	
			(73)	Qty.	(52)	Qty.	(CU)	Qty.	(R0)	Qty.	(F)	Qty.	(Lr)	Qty.	(Lf)	Qty.	(Lf)	Qty.	(Cf)	Qty.	(6F)	Qty.
200V series	7.5	RHC7.5-2C	SC-5-1	1			CU7.5-2C	1	(80W 7.5Ω) (HF5C5504)	(3)	(CR2LS-50/UL)	(2)	LR2-7.5C	1	GRZG80 0.42Ω	3	LFC2-7.5C	1	CF2-7.5C	1		
	11	RHC11-2C	SC-N1	1			CU11-2C	1			(CR2LS-75/UL)	(2)	LR2-15C	1	GRZG150 0.2Ω	3	LFC2-15C	1	CF2-15C	1		
	15	RHC15-2C	SC-N2	1			CU15-2C	1			(CR2LS-100/UL)	(2)										
	18.5	RHC18.5-2C	SC-N3	1			CU18.5-2C	1	(GRZG120 2Ω)	(3)			LR2-22C	1	GRZG200 0.13Ω	3	LFC2-22C	1	CF2-22C	1		
	22	RHC22-2C					CU22-2C	1			(CR2L-150/UL)	(2)										
	30	RHC30-2C	SC-N4	1	-	-	CU30-2C	1			(CR2L-200/UL)	(2)	LR2-37C	1	GRZG400 0.1Ω	3	LFC2-37C	1	CF2-37C	1		
	37	RHC37-2C	SC-N5	1			CU45-2C	1			(CR2L-260/UL)	(2)										
	45	RHC45-2C	SC-N7	1									LR2-55C	1			LFC2-55C	1	CF2-55C	1		
	55	RHC55-2C	SC-N8	1			CU55-2C	1			(CR2L-400/UL)	(2)										
	75	RHC75-2C	SC-N11	1			CU75-2C	1					LR2-75C	1			LFC2-75C	1	CF2-75C	1		
	90	RHC90-2C					CU90-2C	1	(GRZG400 1Ω)	(3)	(A50P600-4)	(2)	LR2-110C	1	GRZG400 0.12Ω [2 parallel]	6	LFC2-110C	1	CF2-110C	1		
400V series	7.5	RHC7.5-4C	SC-05	1			CU7.5-4C	1	(TK50B 30ΩJ) (HF5B0416)	(3)	(CR6L-30/UL)	(2)	LR4-7.5C	1	GRZG80 1.74Ω	3	LFC4-7.5C	1	CF4-7.5C	1		
	11	RHC11-4C	SC-4-0	1			CU15-4C	1			(CR6L-50/UL)	(2)	LR4-15C	1	GRZG150 0.79Ω	3	LFC4-15C	1	CF4-15C	1		
	15	RHC15-4C	SC-5-1	1																		
	18.5	RHC18.5-4C	SC-N1	1			CU18.5-4C	1	(80W 7.5Ω) (HF5C5504)	(3)			LR4-22C	1	GRZG200 0.53Ω	3	LFC4-22C	1	CF4-22C	1		
	22	RHC22-4C					CU22-4C	1			(CR6L-75/UL)	(2)										
	30	RHC30-4C	SC-N2	1			CU30-4C	1			(CR6L-100/UL)	(2)	LR4-37C	1	GRZG400 0.38Ω	3	LFC4-37C	1	CF4-37C	1		
	37	RHC37-4C	SC-N2S	1			CU45-4C	1			(CR6L-150/UL)	(2)										
	45	RHC45-4C	SC-N3	1	-	-							LR4-55C	1	GRZG400 0.26Ω	3	LFC4-55C	1	CF4-55C	1		
	55	RHC55-4C	SC-N4	1			CU55-4C	1			(CR6L-200/UL)	(2)										
	75	RHC75-4C	SC-N5	1			CU75-4C	1					LR4-75C	1	GRZG400 0.38Ω	3	LFC4-75C	1	CF4-75C	1		
	90	RHC90-4C	SC-N7	1			CU90-4C	1			(CR6L-300/UL)	(2)	LR4-110C	1	GRZG400 0.53Ω [2 parallel]	6	LFC4-110C	1	CF4-110C	1		
	110	RHC110-4C	SC-N8	1			CU110-4C	1	(GRZG120 2Ω)	(3)												
	132	RHC132-4C					CU132-4C	1			(A50P400-4)	(2)	LR4-160C	1	RF4-160C	1	LFC4-160C	1	CF4-160C	1		
	160	RHC160-4C	SC-N11	1			CU160-4C	1			(A50P600-4)	(2)										
	200	RHC200-4C	SC-N12	1			CU200-4C	1	(GRZG400 1Ω)	(3)			LR4-220C	1	RF4-220C	1	LFC4-220C	1	CF4-220C	1		
	220	RHC220-4C		1			CU220-4C	1			(A70QS800-4)	(2)										
	280	RHC280-4C	SC-N3	1	SC-N14	1			GRZG400 1Ω [2 parallel]	6	A70QS800-4	2	LR4-280C	1	RF4-280C	1	LFC4-280C	1	CF4-280C	1	SC-N4	1
	315	RHC315-4C									A70P1600-4TA	2	LR4-315C	1	RR4-315C	1	LFC4-315C	1	CF4-315C	1		
	355	RHC355-4C											LR4-355C	1	RR4-355C	1	LFC4-355C	1	CF4-355C	1		
	400	RHC400-4C			SC-N16	1							LR4-400C	1	RR4-400C	1	LFC4-400C	1	CF4-400C	1		
	500	RHC500-4C			SC-N11	3							LR4-500C	1	RR4-500C	1	LFC4-500C	1	CF4-500C	1(*2)		
	630	RHC630-4C			SC-N12	3					A70P2000-4T	2	LR4-630C	1	RR4-630C	1	LFC4-630C	1	CF4-630C	1(*2)	SC-N7	1

(*1) The charging box (CU) contains a combination of a charging resistor (R0) and a fuse (F). If no CU is used, it is necessary to prepare the charging resistor (R0) and fuse (F) at your end.

(*2) The filtering capacitor consists of two pieces of capacitors. For an order of quantity "1," two pieces of capacitors are to be delivered.

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

(2) VT mode

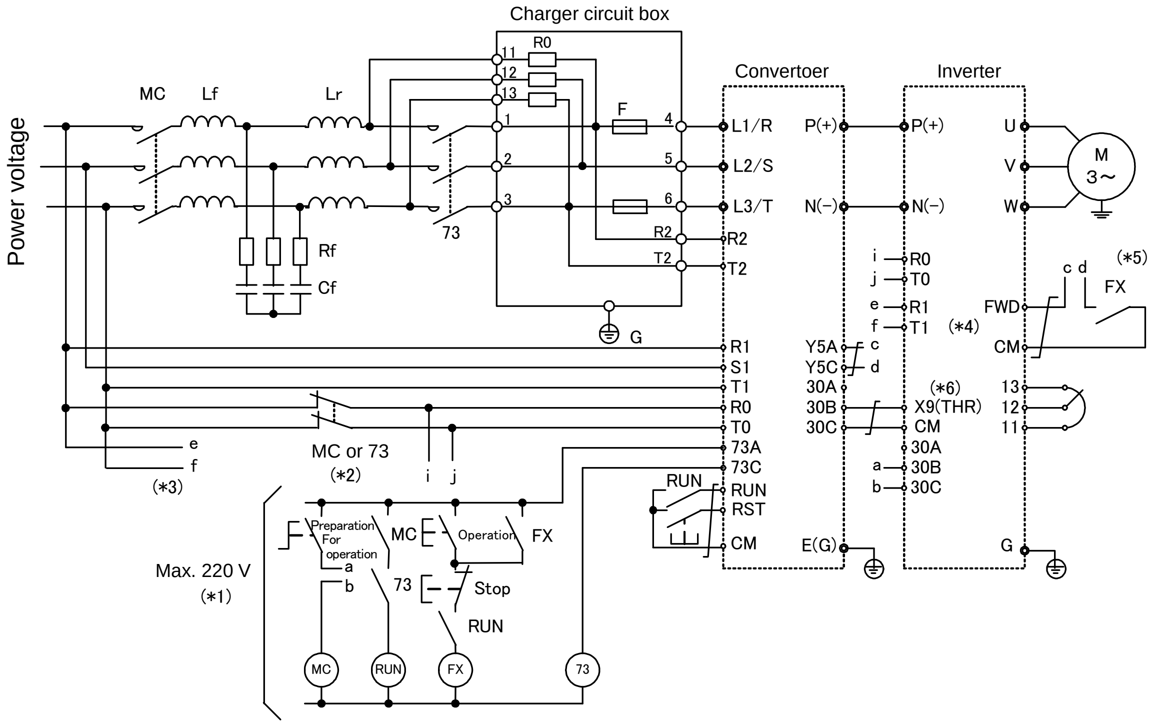
Power supply voltage	Applicable motor [kW]	PWM converter type	Charging circuit contactor (73)	Qty.	Power supply contactor (52)	Qty.	Charging circuit box (*1) (CU)	Qty.	Charger resistor (R0)	Qty.	Fuse (F)	Qty.	Boosting reactor (Lr)	Qty.	Filtering resistor (Lf)	Qty.	Filtering reactor (Lf)	Qty.	Filtering capacitor (Cf)	Qty.	Filter circuit contactor (6F)	Qty.
200V series	11	RHC7.5-2C	SC-N1	1			CU7.5-2C	1	(80W 7.5Ω) (HF5C5504)	(3)	(CR2LS-50/UL)	(2)	LR2-15C	1	GRZG150 0.2Ω	3	LFC2-15C	1	CF2-15C	1		
	15	RHC11-2C	SC-N2	1			CU11-2C	1			(CR2LS-75/UL)	(2)										
	18.5	RHC15-2C	SC-N3	1			CU15-2C	1			(CR2LS-100/UL)	(2)	LR2-22C	1	GRZG200 0.13Ω	3	LFC2-22C	1	CF2-22C	1		
	22	RHC18.5-2C					CU18.5-2C	1	(GRZG120 2Ω)	(3)												
	30	RHC22-2C	SC-N4	1			CU22-2C	1			(CR2L-150/UL)	(2)	LR2-37C	1	GRZG400 0.1Ω	3	LFC2-37C	1	CF2-37C	1		
	37	RHC30-2C	SC-N5	1	-	-	CU30-2C	1			(CR2L-200/UL)	(2)										
	45	RHC37-2C	SC-N7	1			CU45-2C	1			(CR2L-260/UL)	(2)	LR2-55C	1			LFC2-55C	1	CF2-55C	1		
	55	RHC45-2C	SC-N8	1																		
	75	RHC55-2C	SC-N11	1			CU55-2C	1			(CR2L-400/UL)	(2)	LR2-75C	1			LFC2-75C	1	CF2-75C	1		
	90	RHC75-2C					CU75-2C	1					LR2-110C	1	GRZG400 0.12Ω [2 parallel]	6	LFC2-110C	1	CF2-110C	1		
	110	RHC90-2C	SC-N12	1			CU90-2C	1	(GRZG400 1Ω)	(3)	(A50P600-4)	(2)										
400V series	11	RHC7.5-4C	SC-4-0	1			CU7.5-4C	1	(TK50B 30ΩJ) (HF5B0416)	(3)	(CR6L-30/UL)	(2)	LR4-15C	1	GRZG150 0.79Ω	3	LFC4-15C	1	CF4-15C	1		
	15	RHC11-4C	SC-5-1	1			CU15-4C	1			(CR6L-50/UL)	(2)										
	18.5	RHC15-4C	SC-N1	1									LR4-22C	1	GRZG200 0.53Ω	3	LFC4-22C	1	CF4-22C	1		
	22	RHC18.5-4C					CU18.5-4C	1	(80W 7.5Ω) (HF5C5504)	(3)												
	30	RHC22-4C	SC-N2	1			CU22-4C	1			(CR6L-75/UL)	(2)	LR4-37C	1	GRZG400 0.38Ω	3	LFC4-37C	1	CF4-37C	1		
	37	RHC30-4C	SC-N2S	1			CU30-4C	1			(CR6L-100/UL)	(2)										
	45	RHC37-4C	SC-N3	1			CU45-4C	1			(CR6L-150/UL)	(2)	LR4-55C	1	GRZG400 0.26Ω	3	LFC4-55C	1	CF4-55C	1		
	55	RHC45-4C	SC-N4	1																		
	75	RHC55-4C	SC-N5	1	-	-	CU55-4C	1			(CR6L-200/UL)	(2)	LR4-75C	1	GRZG400 0.38Ω	3	LFC4-75C	1	CF4-75C	1		
	90	RHC75-4C	SC-N7	1			CU75-4C	1					LR4-110C	1	GRZG400 0.53Ω [2 parallel]	6	LFC4-110C	1	CF4-110C	1		
	110	RHC90-4C	SC-N8	1			CU90-4C	1			(CR6L-300/UL)	(2)										
	132	RHC110-4C					CU110-4C	1	(GRZG120 2Ω)	(3)			LR4-160C	1	RF4-160C	1	LFC4-160C	1	CF4-160C	1		
	160	RHC132-4C	SC-N11	1			CU132-4C	1			(A50P400-4)	(2)										
	200	RHC160-4C	SC-N12	1			CU160-4C	1			(A50P600-4)	(2)	LR4-220C	1	RF4-220C	1	LFC4-220C	1	CF4-220C	1		
	220	RHC200-4C					CU200-4C	1	(GRZG400 1Ω)	(3)												
	280	RHC220-4C	SC-N14	1			CU220-4C	1			(A70QS800-4)	(2)	LR4-280C	1	RF4-280C	1	LFC4-280C	1	CF4-280C	1		
	315	RHC280-4C	SC-N3	1	SC-N14	1			GRZG400 1Ω [2 parallel]	6	A70QS800-4	2	LR4-315C	1	RR4-315C	1	LFC4-315C	1	CF4-315C	1	SC-N4	1
	355	RHC315-4C									A70P1600-4TA	2	LR4-355C	1	RR4-355C	1	LFC4-355C	1	CF4-355C	1		
	400	RHC355-4C			SC-N16	1							LR4-400C	1	RR4-400C	1	LFC4-400C	1	CF4-400C	1		
	500	RHC400-4C			SC-N11	3							LR4-500C	1	RR4-400C	1	LFC4-500C	1	CF4-500C	1(*2)		

(*1) The charging box (CU) contains a combination of a charging resistor (R0) and a fuse (F). If no CU is used, it is necessary to prepare the charging resistor (R0) and fuse (F) at your end.

(*2) The filtering capacitor consists of two pieces of capacitors. For an order of quantity "1," two pieces of capacitors are to be delivered.

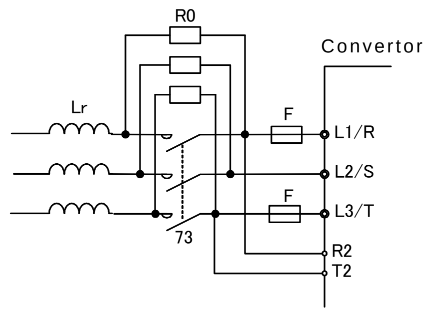
8.5.2.5 Basic connection diagrams

■RHC7.5-2C to RHC90-2C (Applicable inverters: FRN0.75VG1S-2J to FRN90VG1S-2J)
■RHC7.5-4C to RHC220-4C (Applicable inverters: FRN3.7VG1S-4J to FRN220VG1S-4J)



Symbol	Part name
Lr	Boosting reactor
Lf	Filtering reactor
Cf	Filtering capacitor
Rf	Filtering resistor
R0	Charger resistor
F	AC fuse
73	Magnetic contactor for charging circuit

When charger circuit box is not used



(*1) For the 400 V class power supply, connect a stepdown transformer to limit the voltage of the sequence circuit to 220 V or below.
Be sure to connect the auxiliary power input terminals R0 and T0 of the PWM converter to the main power input lines via B contacts of magnetic contactors of the charging circuit (73 or MC). Note that when applied to an ungrounded power supply, an insulated transformer is required. For the details, refer to the "PWM Converter Instruction Manual" (INR-HF51746□).

(*2) For FRN37VG1S-2J or FRN75VG1S-2J, be sure to connect the fan power input terminals R1 and T1 of the inverter to the main power input lines without going through the MC's B contacts or 73.

(*3) For the fan power supply switching connectors, change "CN R" to the NC side and "CN W" to the FAN side.

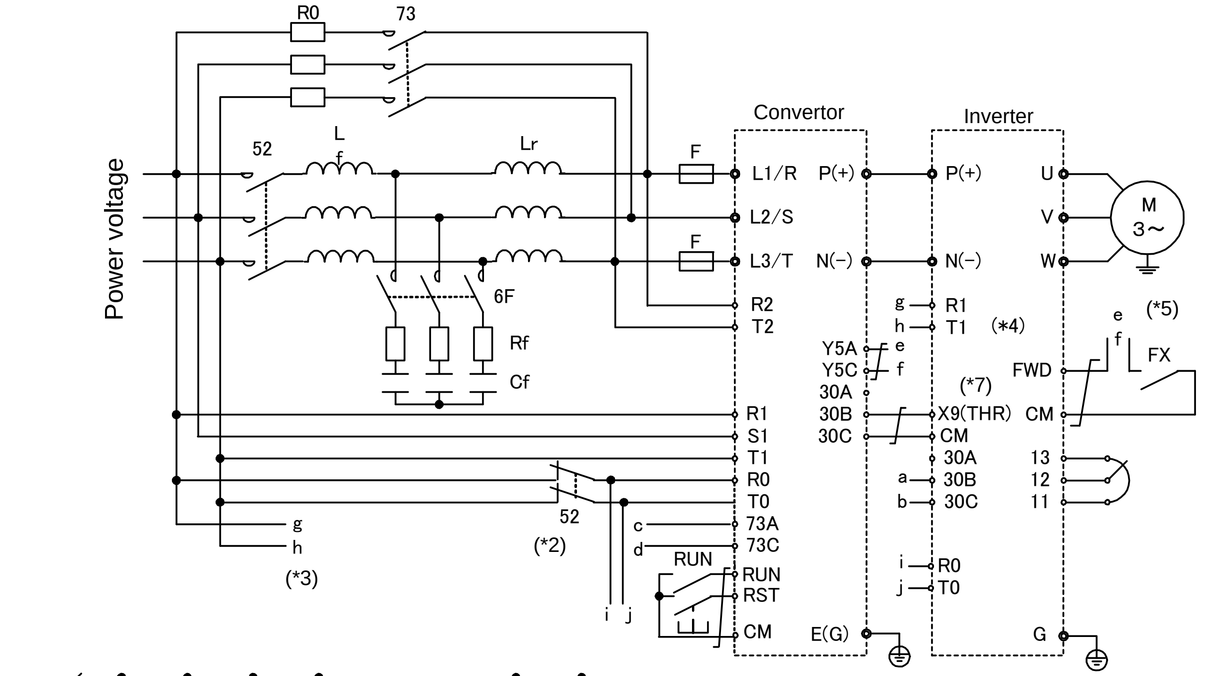
(*4) Construct a sequence in which a run command is given to the inverter after the PWM converter becomes ready to run.

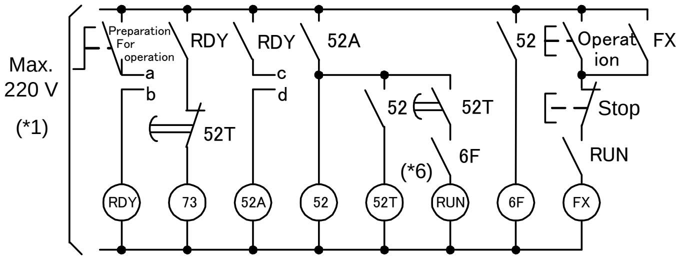
(*5) Assign the external alarm THR to any of terminals [X1] to [X9] on the inverter.

(*6) Wiring for terminals L1/R, L2/S, L3/T, R2, T2, R1, S1, and T1 should match with the phase sequence.

(*7) Remove the short-circuit bar or DC reactor connected to the P1, P(+) terminal of the inverter unit.

■RHC280-4C to RHC400-4C (Applicable inverters: FRN280VG1S-4J to FRN630VG1S-4J)





Symbol	Part name
Lr	Boosting reactor
Lf	Filtering reactor
Cf	Filtering capacitor
Rf	Filtering resistor
R0	Charger resistor
F	AC fuse
73	Magnetic contactor for charging circuit
52	Magnetic contactor for power supply
6F	Magnetic contactor for filtering circuit

(*1) Connect a stepdown transformer to limit the voltage of the sequence circuit to 220 V or below.

(*2) Be sure to connect the auxiliary power input terminals R0 and T0 of the PWM converter to the main power input lines via B contacts of magnetic contactors of the power supply circuit (52). Note that when applied to an ungrounded power supply, an insulated transformer is required. For the details, refer to the "PWM Converter Instruction Manual" (INR-HF51746□).

(*3) Be sure to connect the fan power input terminals R1 and T1 of the inverter to the main power input lines without going through the MC's B contacts or 73.

(*4) For the fan power supply switching connectors, change "CN R" to the NC side and "CN W" to the FAN side.

(*5) Construct a sequence in which a run command is given to the inverter after the PWM converter becomes ready to run.

(*6) Set the timer 52T at 1 sec.

(*7) Assign the external alarm THR to any of terminals [X1] to [X9] on the inverter.

(*8) Wiring for terminals L1/R, L2/S, L3/T, R2, T2, R1, S1, and T1 should match with the phase sequence.

(*9) Remove the short-circuit bar or DC reactor connected to the P1, P(+) terminal of the inverter unit.

8.5.2.6 External dimensions

<PWM converter>

Figure A

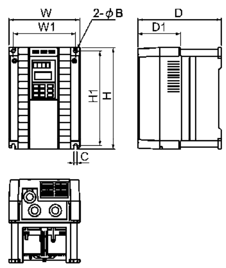


Figure B

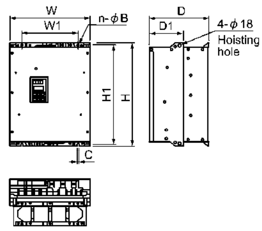


Figure C

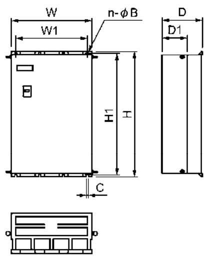
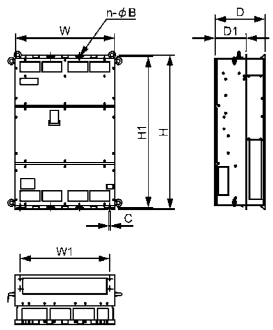


Figure D



PWM converter type		Fig	Dimensions(mm)									Approx. weight (kg)
			W	W1	H	H1	D	D1	n	B	C	
200V series	RHC7.5-2C	A	250	226	380	358	245	125	2	10	10	12.5
	RHC11-2C											
	RHC15-2C											
	RHC18.5-2C	B	340	240	480	460	255	145	2	10	10	24
	RHC22-2C											
	RHC30-2C	B	340	240	550	530	255	145	2	10	10	29
	RHC37-2C	B	375	275	615	595	270	145	2	10	10	36
	RHC45-2C	B	375	275	740	720	270	145	2	10	10	42
	RHC55-2C	B	375	275	740	720	270	145	2	10	10	44
	RHC75-2C	C	530	430	750	720	285	145	2	15	15	70
	RHC90-2C	C	680	580	880	850	360	220	3	15	15	115
400V series	RHC7.5-4C	A	250	226	380	358	245	125	2	10	10	12.5
	RHC11-4C											
	RHC15-4C											
	RHC18.5-4C	B	340	240	480	460	255	145	2	10	10	24
	RHC22-4C											
	RHC30-4C	B	340	240	550	530	255	145	2	10	10	29
	RHC37-4C	B	375	275	550	530	270	145	2	10	10	34
	RHC45-4C	B	375	275	675	655	270	145	2	10	10	38
	RHC55-4C	B	375	275	675	655	270	145	2	10	10	39
	RHC75-4C	B	375	275	740	720	270	145	2	10	10	48
	RHC90-4C	C	530	430	740	710	315	175	2	15	15	70
	RHC110-4C											
	RHC132-4C	C	530	430	1000	970	360	220	2	15	15	100
	RHC160-4C											
	RHC200-4C	C	680	580	1000	970	360	220	3	15	15	140
	RHC220-4C											
	RHC280-4C	C	680	580	1400	1370	450	285	3	15	15	320
	RHC315-4C											
	RHC355-4C	C	880	780	1400	1370	450	285	4	15	15	410
	RHC400-4C											
	RHC500-4C	D	999	900	1550	1520	500	313.2	4	15	15	525
	RHC630-4C											

< Boosting reactor >

Figure A

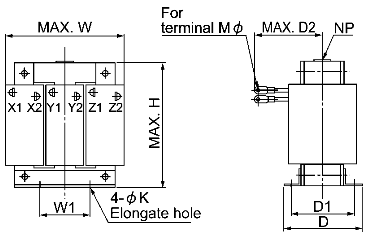


Figure B

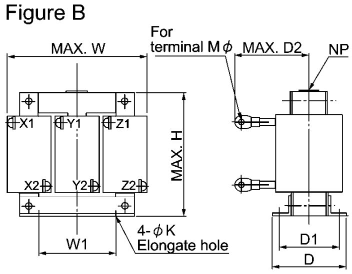


Figure C

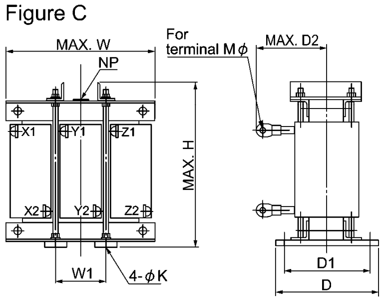
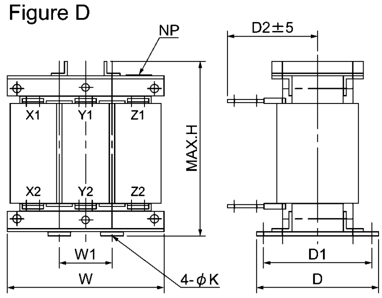


Figure D



Boosting reactor model		Fig	Dimensions(mm)								Approx. weight (kg)
			W	W1	H	D	D1	D2	K	M	
200 V Series	LR2-7.5C	A	180	75	205	105	85	95	7	M5	12
	LR2-15C	B	195	75	215	131	110	130	7	M8	18
	LR2-22C	C	240	80	340	215	180	145	10	M8	33
	LR2-37C	C	285	95	420	240	205	150	12	M10	50
	LR2-55C	C	285	95	420	250	215	160	12	M12	58
	LR2-75C	C	330	110	440	255	220	165	12	M12	70
	LR2-110C	C	345	115	500	280	245	185	12	M12	100
400 V Series	LR4-7.5C	B	180	75	205	105	85	90	7	M4	12
	LR4-15C	A	195	75	215	131	110	120	7	M5	18
	LR4-22C	C	240	80	340	215	180	120	10	M6	33
	LR4-37C	C	285	95	405	240	205	130	12	M8	50
	LR4-55C	C	285	95	415	250	215	145	12	M10	58
	LR4-75C	C	330	110	440	255	220	150	12	M10	70
	LR4-110C	C	345	115	490	280	245	170	12	M12	100
	LR4-160C	C	380	125	550	300	260	185	15	M12	140
	LR4-220C	C	450	150	620	330	290	230	15	M12	200
	LR4-280C	C	480	160	740	330	290	240	15	M16	250
	LR4-315C	C	480	160	760	340	300	250	15	M16	270
	LR4-355C	C	480	160	830	355	315	255	15	M16	310
	LR4-400C	C	480	160	890	380	330	260	19	M16	340
	LR4-500C	C	525	175	960	410	360	290	19	M16	420
	LR4-630C	D	600	200	64	440	390	290	19	4×M12	450

Note 1: CF4-500C to CF4-630C require two capacitors. (Figures above are for one capacitor.)

< Filtering reactor >

Figure A

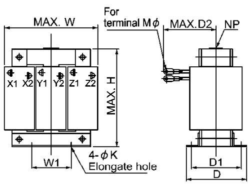


Figure B

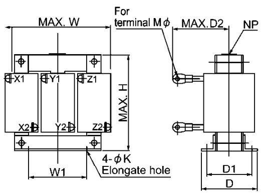


Figure C

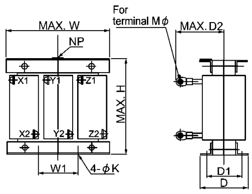


Figure D

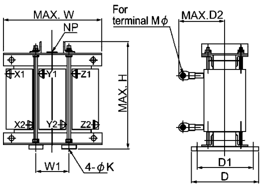
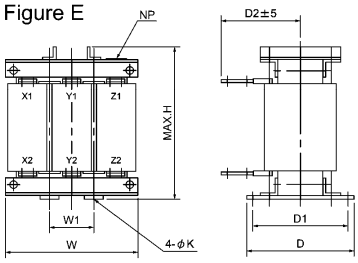


Figure E



Filtering reactor model		Fig	Dimensions(mm)								Approx. weight (kg)
			W	W1	H	D	D1	D2	K	M	
200V series	LFC2-7.5C	B	125	40	100	85	67	85	6	M5	2.2
	LFC2-15C	B	125	40	100	93	75	90	6	M8	2.5
	LFC2-22C	B	125	40	100	93	75	105	6	M8	3.0
	LFC2-37C	B	150	60	115	103	85	125	6	M10	5.0
	LFC2-55C	B	175	60	145	110	90	140	6	M12	8.0
	LFC2-75C	B	195	80	200	120	100	150	7	M12	13
	LFC2-110C	C	255	85	230	118	95	165	7	M12	20
400V series	LFC4-7.5C	A	125	40	100	85	67	75	6	M4	2.2
	LFC4-15C	A	125	40	100	93	75	90	6	M5	2.5
	LFC4-22C	A	125	40	100	93	75	95	6	M6	3.0
	LFC4-37C	B	150	60	115	108	90	110	6	M8	5.0
	LFC4-55C	B	175	60	145	110	90	120	6	M10	8.0
	LFC4-75C	B	195	80	200	113	93	130	7	M10	12
	LFC4-110C	C	255	85	220	113	90	145	7	M12	19
	LFC4-160C	C	255	85	245	137	110	150	7	M12	22
	LFC4-220C	D	300	100	320	210	180	170	10	M12	35
	LFC4-280C	D	330	110	320	230	195	195	12	M16	43
	LFC4-315C	D	315	105	365	230	195	200	12	M16	48
	LFC4-355C	D	315	105	395	235	200	210	12	M16	53
	LFC4-400C	D	345	115	420	235	200	235	12	M16	60
	LFC4-500C	D	345	115	480	240	205	240	12	M16	72
	LFC4-630C	E	435	145	550	295	255	205	15	4×M12	175

<Filtering capacitor>

Figure A

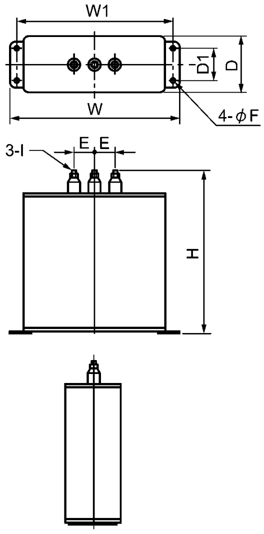
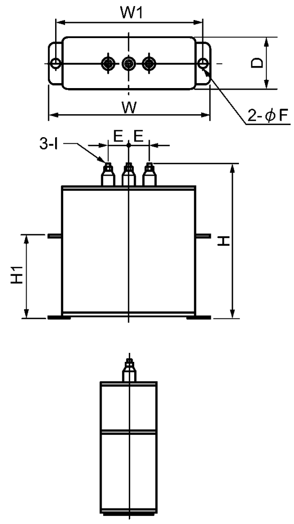


Figure B



Filtering capacitor model		Fig	Dimensions(mm)									Approx. weight (kg)
			W	W1	H	H1	D	D1	E	F	J	
200V series	CF2-7.5C	A	165	150	185	-	70	40	30	7	M5	1.9
	CF2-15C	A	205	190	245	-	70	40	30	7	M5	3.5
	CF2-22C	A	280	265	215	-	90	55	30	7	M5	5.5
	CF2-37C	A	280	265	235	-	90	55	30	7	M5	6.0
	CF2-55C	A	280	265	340	-	90	55	80	7	M6	8.5
	CF2-75C	A	280	265	235	-	90	55	30	7	M5	6.0
	CF2-110C	A	280	265	340	-	90	55	80	7	M8	8.5
400V series	CF4-7.5C	A	165	150	135	-	70	40	30	7	M5	1.3
	CF4-15C	A	165	150	215	-	70	40	30	7	M5	2.3
	CF4-22C	A	205	190	185	-	70	40	30	7	M5	2.5
	CF4-37C	A	205	190	205	-	70	40	30	7	M5	2.9
	CF4-55C	A	205	190	245	-	70	40	30	7	M5	3.5
	CF4-75C	A	205	190	205	-	70	40	30	7	M5	2.9
	CF4-110C	A	205	190	245	-	70	40	30	7	M5	3.5
	CF4-160C	A	280	265	260	-	90	55	80	7	M6	6.0
	CF4-220C	B	435	400	310	125	100	-	80	15x20 length hole	M12	13.0
	CF4-280C	B	435	400	350	165	100	-	80	15x20 length hole	M12	15.0
	CF4-315C	B	435	400	460	275	100	-	80	15x20 length hole	M12	20.0
	CF4-355C	B	435	400	520	335	100	-	80	15x20 length hole	M12	23.0
	CF4-400C	B	435	400	610	425	100	-	80	15x20 length hole	M12	27.0
	CF4-500C	B	435	400	310	125	100	-	80	15x20 length hole	M12	13.0
	CF4-630C	B	435	400	460	275	100	-	80	15x20 length hole	M12	20.0

< Filtering resistor >

Figure A

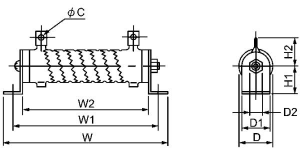


Figure B

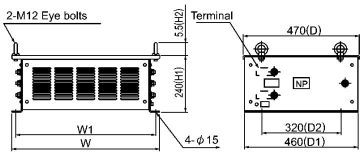
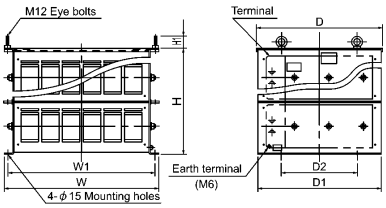


Figure C



Filtering resistor model		Fig	Dimensions(mm)									Approx. weight (kg)
			W	W1	W2	H1	H2	D	D1	D2	C	
200V series	GRZG80 0.42Ω	A	167	148	115	22	32	33	26	6	5.5	0.19
	GRZG150 0.2Ω	A	247	228	195	22	40	33	26	6	8.2	0.30
	GRZG200 0.13Ω	A	306	287	254	22	40	33	26	6	8.2	0.35
	GRZG400 0.1Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	GRZG400 0.12Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
400V series	GRZG80 1.74Ω	A	167	148	115	22	32	33	26	6	5.5	0.19
	GRZG150 0.79Ω	A	247	228	195	22	32	33	26	6	5.5	0.3
	GRZG200 0.53Ω	A	306	287	254	22	32	33	26	6	5.5	0.35
	GRZG400 0.38Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	GRZG400 0.26Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	GRZG400 0.53Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	RF4-160C	B	400	370	-	240	55	470	460	320	-	22
	RF4-220C											25
	RF4-280C	C	655	625	-	240	55	470	460	320	-	31
	RF4-315C											35
	RF4-355C											36
	RF4-400C											38
	RF4-500C											41
	RF4-630C	C	655	625	-	440	55	530	520	320	-	70

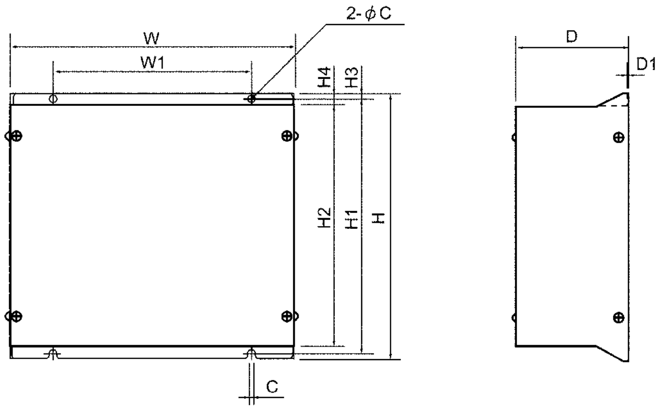
< Charging box >

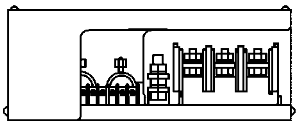
The charging box contains a combination of a charging resistor and a fuse, which is essential in the configuration of the RHC-C series of PWM converters. Using this charging box eases mounting and wiring jobs.

■ Capacity range

200 V series: 7.5 kW to 90 kW in 10 types, 400 V series:7.5 kW to 220 kW in 14 types, Total 24 types

As for 400 V class series with a capacity of 280 to 400 kW, the charging resistor and the fuse are separately provided as before.





Fuse model		Dimensions(mm)										Mounting bolt	Approx. weight (kg)
		W	W1	H	H1	H2	H3	4	D	D1	C		
200V series	CU7.5-2C	270	170	300	285	270	7.5	15	100	2.4	6	M5	6
	CU11-2C												
	CU15-2C												
	CU18.5-2C												
	CU22-2C												
	CU30-2C	300	200	310	295	280	7.5	15	110	2.4	6	M5	7
	CU45-2C	330	230	310	295	280	7.5	15	130	2.4	6	M5	8
	CU55-2C												
	CU75-2C	430	330	560	536	510	12	25	150	3.2	10	M8	17
	CU90-2C												20
400V series	CU7.5-4C	270	170	300	285	270	7.5	15	100	2.4	6	M5	5.5
	CU15-4C												
	CU18.5-4C												6
	CU22-4C												
	CU30-4C	300	200	310	295	280	7.5	15	110	2.4	6	M5	7
	CU45-4C												
	CU55-4C												
	CU75-4C	330	230	310	295	280	7.5	15	130	2.4	6	M5	8
	CU90-4C												
	CU110-4C												
	CU132-4C	430	330	560	536	510	12	25	150	3.2	10	M8	18
	CU160-4C												
	CU200-4C												20
	CU220-4C												

<Charger resistor>

Figure A

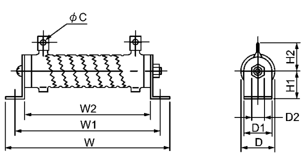


Figure B

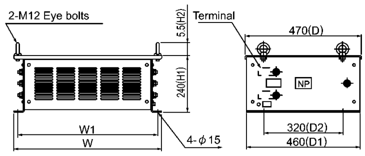
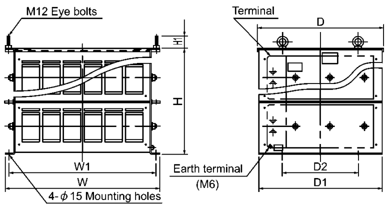


Figure C



Charger resistor model	Fig	Dimensions(mm)									Approx. weight (kg)
		W	W1	W2	H1	H2	D	D1	D2	C	
GRZG120 2Ω	A	217	198	165	22	32	33	22	6	5.5	0.25
GRZG400 1Ω	A	411	385	330	40	39	47	40	9.5	5.5	0.85
TK50B 30ΩJ (HF5B0416)	B	-	-	-	-	-	-	-	-	-	0.15
80W 7.5Ω (HF5C5504)	C	-	-	-	-	-	-	-	-	-	0.19

<fuse>

Figure A

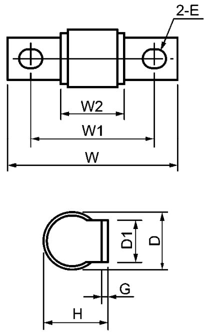


Figure B

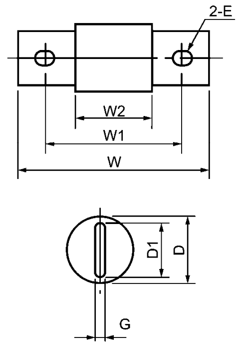
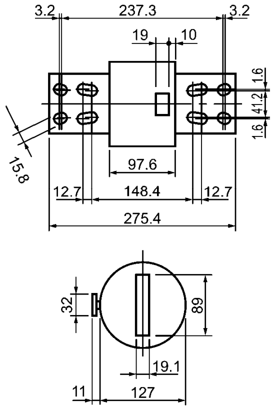
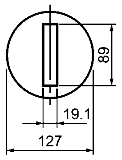


Figure C



Side view of A70P1600-4TA



Side view of A70P2000-4

Fuse model		Fig	Dimensions(mm)								Approx. weight (kg)
			W	W1	W2	H	D	D1	G	E	
200V series	CR2LS-50/UL	A	56	42	26	18.5	17.5	12	2	6.5x8.5	0.03
	CR2LS-75/UL										
	CR2LS-100/UL										
	CR2L-150/UL	A	80	58	29.5	30.5	27	20	3	9x11	0.10
	CR2L-200/UL	A	85	60	30	33.5	30	25	3.2	11x13	0.13
	CR2L-260/UL										
	CR2L-400/UL	A	95	70	31	42	37	30	4	11x13	0.22
	A50P600-4	B	113.5	81.75	56.4	-	50.8	38.1	6.4	10.3x18.2	0.60
400V series	CR6L-30/UL	A	76	62	47	18.5	17.5	12	2	6.5x8.5	0.04
	CR6L-50/UL										
	CR6L-75/UL	A	95	70	40	34	30	25	3.2	11x13	0.15
	CR6L-100/U										
	CR6L-150/UL										
	CR6L-200/UL	A	107	82	43	42	37	30	4	11x13	0.25
	CR6L-300/UL										
	A50P400-4	B	110	78.6	53.1	-	38.1	25.4	6.4	10.3x18.4	0.30
	A50P600-4	B	113.5	81.75	56.4	-	50.8	38.1	6.4	10.3x18.2	0.60
	A70QS800-4	B	180.2	129.4	72.2	-	63.5	50.8	9.5	13.5x18.3	1.1
	A70P1600-4T	C	-	-	-	-	-	-	-	-	8.0
	A70P2000-4	C	-	-	-	-	-	-	-	-	8.0

8.5.2.7 Generated loss

(1) In CT mode

Main unit		Boosting reactor		Filtering reactor		< Filtering resistor >		
Model	**Generated loss (W)**	**Model**	**Generated loss (W)**	**Model**	**Generated loss (W)**	**Model**	**Qty.**	**Generated loss (W)**
RHC7.5-2C	400	LR2-7.5C	95	LFC2-7.5C	10	GRZG80 0.42Ω	3	16
RHC11-2C	500	LR2-15C	150	LFC2-15C	19	GRZG150 0.2Ω	3	48
RHC15-2C	650							
RHC18.5-2C	700	LR2-22C	230	LFC2-22C	26	GRZG200 0.13Ω	3	68
RHC22-2C	800							
RHC30-2C	1000	LR2-37C	330	LFC2-37C	32	GRZG400 0.1Ω	3	107
RHC37-2C	1350							
RHC45-2C	1500	LR2-55C	450	LFC2-55C	43	GRZG400 0.1Ω	3	240
RHC55-2C	1750							
RHC75-2C	2050	LR2-75C	520	LFC2-75C	74	GRZG400 0.1Ω	3	137
RHC90-2C	2450	LR2-110C	720	LFC2-110C	115	GRZG400 0.12Ω (2 parallel)	6	374
RHC7.5-4C	400	LR4-7.5C	90	LFC4-7.5C	9	GRZG80 1.74Ω	3	15
RHC11-4C	500	LR4-15C	160	LFC4-15C	20	GRZG150 0.79Ω	3	48
RHC15-4C	600							
RHC18.5-4C	650	LR4-22C	230	LFC4-22C	22	GRZG200 0.53Ω	3	70
RHC22-4C	900							
RHC30-4C	1200	LR4-37C	350	LFC4-37C	36	GRZG400 0.38Ω	3	86
RHC37-4C	1550							
RHC45-4C	1800	LR4-55C	490	LFC4-55C	43	GRZG400 0.26Ω	3	130
RHC55-4C	2050							
RHC75-4C	2150	LR4-75C	520	LFC4-75C	78	GRZG400 0.38Ω	3	112
RHC90-4C	2600	LR4-110C	710	LFC4-110C	90	GRZG400 0.53Ω (2 parallel)	6	405
RHC110-4C	3050							
RHC132-4C	3500	LR4-160C	1000	LFC4-160C	160	RF4-160C	1	568
RHC160-4C	4150							
RHC200-4C	5100	LR4-220C	1240	LFC4-220C	200	RF4-220C	1	751
RHC220-4C	5600							
RHC280-4C	7100	LR4-280C	1430	LFC4-280C	220	RF4-280C	1	1027
RHC315-4C	8000	LR4-315C	1660	LFC4-315C	260	RF4-315C	1	1154
RHC355-4C	8900	LR4-355C	1910	LFC4-355C	300	RF4-355C	1	1286
RHC400-4C	10100	LR4-400C	2160	LFC4-400C	350	RF4-400C	1	1454
RHC500-4C	10000	LR4-500C	2470	LFC4-500C	450	RF4-500C	1	5463
RHC630-4C	12400	LR4-630C	2300	LFC4-630C	510	RF4-630C	1	4722

(2) In VT mode

Main unit		Boosting reactor		Filtering reactor		< Filtering resistor >		
Model	**Generated loss (W)**	**Model**	**Generated loss (W)**	**Model**	**Generated loss (W)**	**Model**	**Qty.**	**Generated loss (W)**
RHC7.5-2C	450	LR2-15C	150	LFC2-15C	19	GRZG150 0.2Ω	3	48
RHC11-2C	550							
RHC15-2C	650	LR2-22C	230	LFC2-22C	26	GRZG200 0.13Ω	3	68
RHC18.5-2C	750							
RHC22-2C	850	LR2-37C	330	LFC2-37C	32	GRZG400 0.1Ω	3	107
RHC30-2C	1200							
RHC37-2C	1500	LR2-55C	450	LFC2-55C	43	GRZG400 0.1Ω	3	240
RHC45-2C	1600							
RHC55-2C	2100	LR2-75C	520	LFC2-75C	74	GRZG400 0.1Ω	3	137
RHC75-2C	2300	LR2-110C	720	LFC2-110C	115	GRZG400 0.12Ω (2 parallel)	6	374
RHC90-2C	2650							
RHC7.5-4C	400	LR4-15C	160	LFC4-15C	20	GRZG150 0.79Ω	3	48
RHC11-4C	500							
RHC15-4C	600	LR4-22C	230	LFC4-22C	22	GRZG200 0.53Ω	3	70
RHC18.5-4C	600							
RHC22-4C	950	LR4-37C	350	LFC4-37C	36	GRZG400 0.38Ω	3	86
RHC30-4C	1200							
RHC37-4C	1450	LR4-55C	490	LFC4-55C	43	GRZG400 0.26Ω	3	130
RHC45-4C	1750							
RHC55-4C	2250	LR4-75C	520	LFC4-75C	78	GRZG400 0.38Ω	3	112
RHC75-4C	1950	LR4-110C	710	LFC4-110C	90	GRZG400 0.53Ω (2 parallel)	6	405
RHC90-4C	2400							
RHC110-4C	2900	LR4-160C	1000	LFC4-160C	160	RF4-160C	1	568
RHC132-4C	3250							
RHC160-4C	4100	LR4-220C	1240	LFC4-220C	200	RF4-220C	1	751
RHC200-4C	4400							
RHC220-4C	5600	LR4-280C	1430	LFC4-280C	220	RF4-280C	1	1027
RHC280-4C	6250	LR4-315C	1660	LFC4-315C	260	RF4-315C	1	1154
RHC315-4C	7000	LR4-355C	1910	LFC4-355C	300	RF4-355C	1	1286
RHC355-4C	8050	LR4-400C	2160	LFC4-400C	350	RF4-400C	1	1454
RHC400-4C	8950	LR4-500C	2470	LFC4-500C	450	RF4-500C	1	1821

* The generated loss for the filtering resistor above represent the value for all quantities.

8.5.3 DC reactor (DCR)

A DCR is mainly used for power supply matching and for input power factor correction (for reducing harmonic components).

For power supply matching

- Use a DCR when the capacity of a power supply transformer exceeds 500 kVA and is 10 times or more the rated inverter capacity. In this case, the percent reactance of the power supply decreases, and harmonic components and their peak value increase. These factors may break rectifiers or capacitors in the converter section of inverter, or decrease the capacitance of the capacitor (which can shorten the inverter's service life).
- Also use a DCR when there are thyristor-driven loads or when phase-advancing capacitors are being turned ON/OFF.
- Use a DCR when the interphase voltage unbalance ratio of the inverter power supply exceeds 2%.

$$\text{Interphase voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$$

For input power factor correction (for suppressing harmonics)

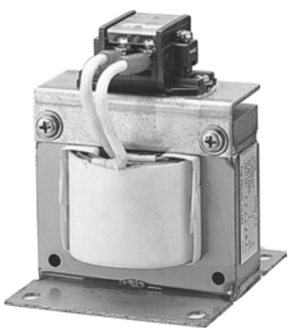
Generally a capacitor is used to improve the power factor of the load, however, it cannot be used in a system that includes an inverter. Using a DCR increases the reactance of inverter's power supply so as to decrease harmonic components on the power supply lines and improve the power factor of inverter. Using a DCR improves the input power factor to approximately 86% to 95%.

Note <HD class product: 55 kW or lower, LD class product: 45 kW or lower>

- At the time of shipping, a jumper bar is connected across terminals P1 and P (+) on the terminal block. Remove the jumper bar when connecting a DCR.
- If a DCR is not going to be used, do not remove the jumper bar.

<HD class product: 75 kW or higher, LD class product: 55 kW or higher, MD class product >

- At the time of shipping, a jumper bar is not connected across terminals P1 and P (+) on the terminal block. Be sure to connect the (supplied) DC reactor.



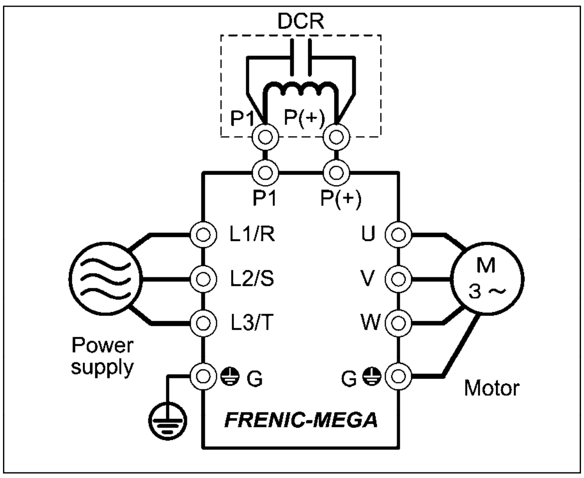


Figure 8.9 External View of a DC Reactor (DCR) and Connection Example

Table 8.10 DC reactor (DCR)

Power supply voltage	Nominal applicable motor (kW)	Inverter type	Specifi-cations	Reactor model	Rated current (A)	Inductance (mH)	Generated loss (W)
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	DCR2-0.75	5	7	2.8
	1.5	FRN1.5VG1□-2J		DCR2-1.5	8	4	4.6
	2.2	FRN2.2VG1□-2J		DCR2-2.2	11	3	6.7
	3.7	FRN3.7VG1□-2J		DCR2-3.7	18	1.7	8.8
	5.5	FRN5.5VG1□-2J		DCR2-5.5	25	1.2	14
	7.5	FRN7.5VG1□-2J		DCR2-7.5	34	0.8	16
	11	FRN11VG1□-2J		DCR2-11	50	0.6	27
	15	FRN15VG1□-2J		DCR2-15	67	0.4	27
	18.5	FRN18.5VG1□-2J		DCR2-18.5	81	0.35	29
	22	FRN22VG1□-2J		DCR2-22A	98	0.3	38
	30	FRN30VG1□-2J	HD	DCR2-30B	136	0.23	37
	37		LD	DCR2-37B	167	0.19	47
				DCR2-37C	175	0.119	63
		FRN37VG1□-2J	HD	DCR2-37B	167	0.19	47
				DCR2-37C	175	0.119	63
	45		LD	DCR2-45B	203	0.16	52
				DCR2-45C	213	0.1	68
		FRN45VG1□-2J	HD	DCR2-45B	203	0.16	52
				DCR2-45C	213	0.1	68
	55		LD	DCR2-55B	244	0.13	55
				DCR2-55C	256	0.08	75
		FRN55VG1□-2J	HD	DCR2-55B	244	0.13	55
				DCR2-55C	256	0.08	75
	75		LD	DCR2-75C	358	0.05	96
		FRN75VG1□-2J	HD				
	90		LD	DCR2-90C	431	0.042	100
		FRN90VG1□-2J	HD				
	110		LD	DCR2-110C	552	0.034	126

Note 1: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).
- An AC reactor (ACR) is not connected.

Note 2: □ in the inverter model represents an alphabet. 。

□
└── S (Basic type)

Table 8.10 DC reactor (DCR) (continued)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Reactor model	Rated current (A)	Inductance (mH)	Generated loss (W)
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	DCR4-3.7	9	7	8.1
	5.5	FRN5.5VG1□-4J		DCR4-5.5	13	4	10
	7.5	FRN7.5VG1□-4J		DCR4-7.5	18	3.5	15
	11	FRN11VG1□-4J		DCR4-11	25	2.2	21
	15	FRN15VG1□-4J		DCR4-15	34	1.8	28
	18.5	FRN18.5VG1□-4J		DCR4-18.5	41	1.4	29
	22	FRN22VG1□-4J		DCR4-22A	49	1.2	35
	30	FRN30VG1□-4J		DCR4-30B	71	0.86	35
	37		LD	DCR4-37B	88	0.70	40
				DCR4-37C	88	0.483	63
		FRN37VG1□-4J	HD	DCR4-37B	88	0.70	40
				DCR4-37C	88	0.483	63
	45		LD	DCR4-45B	107	0.58	44
				DCR4-45C	107	0.4	69
		FRN45VG1□-4J	HD	DCR4-45B	107	0.58	44
				DCR4-45C	107	0.4	69
	55		LD	DCR4-55B	131	0.47	55
				DCR4-55C	131	0.324	78
		FRN55VG1□-4J	HD	DCR4-55B	131	0.47	55
				DCR4-55C	131	0.324	78
	75		LD	DCR4-75C	178	0.23	97
		FRN75VG1□-4J	HD	DCR4-75C	178	0.23	97
	90		LD	DCR4-90C	214	0.2	111
		FRN90VG1□-4J	HD				
	110		MD/LD	DCR4-110C	261	0.166	122
		FRN110VG1□-4J	HD				
	132		MD/LD	DCR4-132C	313	0.148	159
		FRN132VG1□-4J	HD				
	160		MD/LD	DCR4-160C	380	0.122	185
		FRN160VG1□-4J	HD				
	200		MD/LD	DCR4-200C	475	0.098	218
		FRN200VG1□-4J	HD				
	220		MD/LD	DCR4-220C	524	0.087	231
		FRN220VG1□-4J	HD				
	250		MD	DCR4-250C	589	0.077	249
	280		LD	DCR4-280C	649	0.069	270
		FRN280VG1□-4J	HD				
	315		MD	DCR4-315C	739	0.061	285
	355		LD	DCR4-355C	833	0.054	308
	315	FRN315VG1□-4J	HD	DCR4-315C	739	0.061	285
	355		MD	DCR4-355C	833	0.054	308
	400		LD	DCR4-400C	938	0.048	323
	355	FRN355VG1□-4J	HD	DCR4-355C	833	0.054	308
	400		MD	DCR4-400C	938	0.048	323
	450		LD	DCR4-450C	1056	0.043	338
	400	FRN400VG1□-4J	HD	DCR4-400C	938	0.048	323
	450		MD	DCR4-450C	1056	0.043	338
	500		LD	DCR4-500C	1173	0.039	384
		FRN500VG1□-4J	HD				
	630		LD	DCR-630C	1477	0.031	620
		FRN630VG1□-4J	HD				
	710		LD	DCR-710C	1666	0.028	600

Note 1: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

Note 2: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).
- An AC reactor (ACR) is not connected.

Figure A

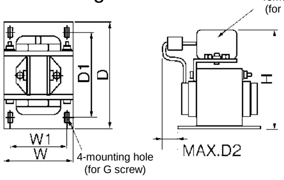


Figure B

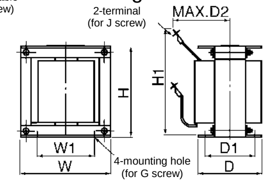


Figure C

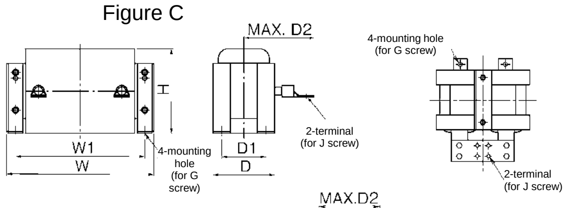


Figure D

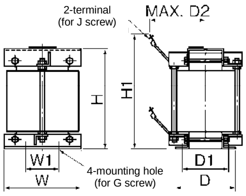


Figure E

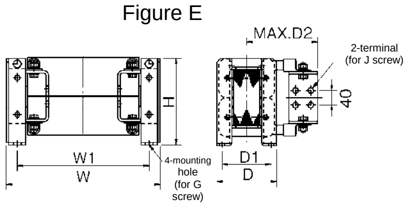


Figure F

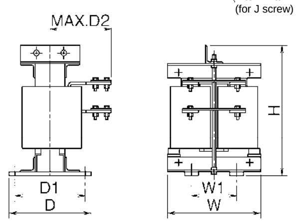


Table 8.11 DC Reactors (DCRs) External Dimensions

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Reactor model	Dimensions										Approx. weight (kg)
					Fig	W	W1	D	D1	D2	G	H	H1	J	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	DCR2-0.75	A	66	56	90	72	20	M4(5.2×8)	94	-	M4	1.4
	1.5	FRN1.5VG1□-2J		DCR2-1.5		66	56	90	72	20	M4(5.2×8)	94	-	M4	1.6
	2.2	FRN2.2VG1□-2J		DCR2-2.2		86	71	100	80	10	M5(6×9)	110	-	M4	1.8
	3.7	FRN3.7VG1□-2J		DCR2-3.7		86	71	100	80	20	M5(6×9)	110	-	M4	2.6
	5.5	FRN5.5VG1□-2J		DCR2-5.5		111	95	100	80	20	M6(7×11)	130	-	M5	3.6
	7.5	FRN7.5VG1□-2J		DCR2-7.5		111	95	100	80	23	M6(7×11)	130	-	M5	3.8
	11	FRN11VG1□-2J		DCR2-11		111	95	100	80	24	M6(7×11)	137	-	M6	4.3
	15	FRN15VG1□-2J		DCR2-15		146	124	120	96	15	M6(7×11)	180	-	M8	5.9
	18.5	FRN18.5VG1□-2J		DCR2-18.5		146	124	120	96	25	M6(7×11)	180	-	M8	7.4
	22	FRN22VG1□-2J		DCR2-22A		146	124	120	96	25	M6(7×11)	180	-	M8	7.5
	30	FRN30VG1□-2J	HD	DCR2-30B	B	152	90	156	116	115	M6(Φ8)	130	190	M10	12
	37		LD	DCR2-37B		171	110	151	110	115	M6(Φ8)	150	200	M10	14
				DCR2-37C	C	210	185	101	81	125	M6(7×13)	125	-	M10	7.4
		FRN37VG1□-2J	HD	DCR2-37B	B	171	110	151	110	115	M6(Φ8)	150	200	M10	14
				DCR2-37C	C	210	185	101	81	125	M6(7×13)	125	-	M10	7.4
	45		LD	DCR2-45B	B	171	110	166	125	120	M6(Φ8)	150	200	M10	16
				DCR2-45C	C	210	185	106	86	135	M6(7×13)	125	-	M12	8.4
		FRN45VG1□-2J	HD	DCR2-45B	B	171	110	166	125	120	M6(Φ8)	150	200	M10	16
				DCR2-45C	C	210	185	106	86	135	M6(7×13)	125	-	M12	8.4
	55		LD	DCR2-55B	D	190	160	131	90	100	M6(Φ8)	210	250	M12	16
				DCR2-55C	C	255	225	96	76	140	M6(7×13)	145	-	M12	11
		FRN55VG1□-2J	HD	DCR2-55B	D	190	160	131	90	100	M6(Φ8)	210	250	M12	16
				DCR2-55C	C	255	225	96	76	140	M6(7×13)	145	-	M12	11
	75		LD	DCR2-75C		255	225	106	86	145	M6(7×13)	145	-	M12	12
		FRN75VG1□-2J	HD												
	90		LD	DCR2-90C		255	225	116	96	155	M6(7×13)	145	-	M12	14
		FRN90VG1□-2J	HD												
	110		LD	DCR2-110C		300	265	116	90	185	M8(10×18)	160	-	M12	17

Note : □ in the inverter model represents an alphabet.

S (Basic type)

Table 8.11 DC Reactors (DCRs) External Dimensions (continued)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Reactor model	Dimensions										Approx. weight (kg)
					Fig	W	W1	D	D1	D2	G	H	H1	J	
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	DCR4-3.7	A	86	71	100	80	20	M5(6×9)	110	-	M4	2.6
	5.5	FRN5.5VG1□-4J		DCR4-5.5		86	71	100	80	20	M5(6×9)	110	-	M4	2.6
	7.5	FRN7.5VG1□-4J		DCR4-7.5		111	95	100	80	24	M6(7×11)	130	-	M5	4.2
	11	FRN11VG1□-4J		DCR4-11		111	95	100	80	24	M6(7×11)	130	-	M5	4.3
	15	FRN15VG1□-4J		DCR4-15		146	124	120	96	15	M6(7×11)	168	-	M5	5.9
	18.5	FRN18.5VG1□-4J		DCR4-18.5		146	124	120	96	25	M6(7×11)	171	-	M6	7.2
	22	FRN22VG1□-4J		DCR4-22A		146	124	120	96	25	M6(7×11)	171	-	M6	7.2
	30	FRN30VG1□-4J		DCR4-30B		152	90	157	115	100	M6(Φ8)	130	190	M8	13
	37		LD	DCR4-37B	B	171	110	150	110	100	M6(Φ8)	150	200	M8	15
				DCR4-37C	C	210	185	101	81	105	M6(7×13)	125	-	M8	7.4
		FRN37VG1□-4J	HD	DCR4-37B	B	171	110	150	110	100	M6(Φ8)	150	200	M8	15
				DCR4-37C	C	210	185	101	81	105	M6(7×13)	125	-	M8	7.4
	45		LD	DCR4-45B	B	171	110	165	125	110	M6(Φ8)	150	210	M8	18
				DCR4-45C	C	210	185	106	86	120	M6(7×13)	125	-	M8	8.4
		FRN45VG1□-4J	HD	DCR4-45B	B	171	110	165	125	110	M6(Φ8)	150	210	M8	18
				DCR4-45C	C	210	185	106	86	120	M6(7×13)	125	-	M8	8.4
	55		LD	DCR4-55B	B	171	110	170	130	110	M6(Φ8)	150	210	M8	20
				DCR4-55C	C	255	225	96	76	120	M6(7×13)	145	-	M10	11
		FRN55VG1□-4J	HD	DCR4-55B	B	171	110	170	130	110	M6(Φ8)	150	210	M8	20
				DCR4-55C	C	255	225	96	76	120	M6(7×13)	145	-	M10	11
	75		LD	DCR4-75C		255	225	106	86	125	M6(7×13)	145	-	M10	13
		FRN75VG1□-4J	HD	DCR4-75C		255	225	106	86	125	M6(7×13)	145	-	M10	13
	90		LD	DCR4-90C		255	225	116	96	140	M6(7×13)	145	-	M12	15
		FRN90VG1□-4J	HD												
	110		MD/LD	DCR4-110C		300	265	116	90	175	M8(10×18)	155	-	M12	19
		FRN110VG1□-4J	HD												
	132		MD/LD	DCR4-132C		300	265	126	100	180	M8(10×18)	160	-	M12	22
		FRN132VG1□-4J	HD												
	160		MD/LD	DCR4-160C		350	310	131	103	180	M10(12×22)	190	-	M12	26
		FRN160VG1□-4J	HD												
	200		MD/LD	DCR4-200C		350	310	141	113	185	M10(12×22)	190	-	M12	30
		FRN200VG1□-4J	HD												
	220		MD/LD	DCR4-220C		350	310	146	118	200	M10(12×22)	190	-	M12	33
		FRN220VG1□-4J	HD												
	250		MD	DCR4-250C		350	310	161	133	210	M10(12×22)	190	-	M12	35
	280		LD	DCR4-280C		350	310	161	133	210	M10(12×22)	190	-	M16	37
		FRN280VG1□-4J	HD												
	315		MD	DCR4-315C		400	345	146	118	200	M10(12×22)	225	-	M16	40
	355		LD	DCR4-355C	E	400	345	156	128	200	M10(12×22)	225	-	4×M12	49
	315	FRN315VG1□-4J	HD	DCR4-315C	C	400	345	146	118	200	M10(12×22)	225	-	M16	40
	355		MD	DCR4-355C	E	400	345	156	128	200	M10(12×22)	225	-	4×M12	49
	400		LD	DCR4-400C		445	385	145	117	213	M10(12×22)	245	-	4×M12	52
	355	FRN355VG1□-4J	HD	DCR4-355C		400	345	156	128	200	M10(12×22)	225	-	4×M12	49
	400		MD	DCR4-400C		445	385	145	117	213	M10(12×22)	245	-	4×M12	52
	450		LD	DCR4-450C		440	385	150	122	215	M10(12×22)	245	-	4×M12	62
	400	FRN400VG1□-4J	HD	DCR4-400C		445	385	145	117	213	M10(12×22)	245	-	4×M12	52
	450		MD	DCR4-450C		440	385	150	122	215	M10(12×22)	245	-	4×M12	62
	500		LD	DCR4-500C		445	390	165	137	220	M10(12×22)	245	-	4×M12	72
		FRN500VG1□-4J	HD												
	630		LD	DCR-630C	F	285	145	203	170	195	M12(14×20)	480	-	2×M12	75
		FRN630VG1□-4J	HD												
	710		LD	DCR-710C		340	160	295	255	225	M12(Φ15)	480	-	4×M12	95

Note: □ in the inverter model represents an alphabet.

□ └ S (Basic type)

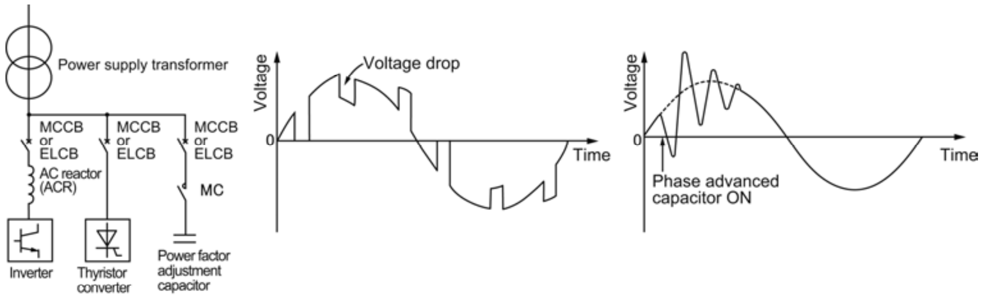
Chap. 8 SELECTING PERIPHERAL EQUIPMENT

8.5.4 AC reactor (ACR)

Use an ACR when the converter part of the inverter should supply very stable DC power, for example, in DC link bus operation (shared PN operation). Generally, ACRs are used for correction of voltage waveform and power factor or for power supply matching, but not for suppressing harmonic components in the power lines. For suppressing harmonic components, use a DCR.

■For power supply matching

- Also use a DCR when there are thyristor-driven loads or when phase-advancing capacitors are being turned ON/OFF.

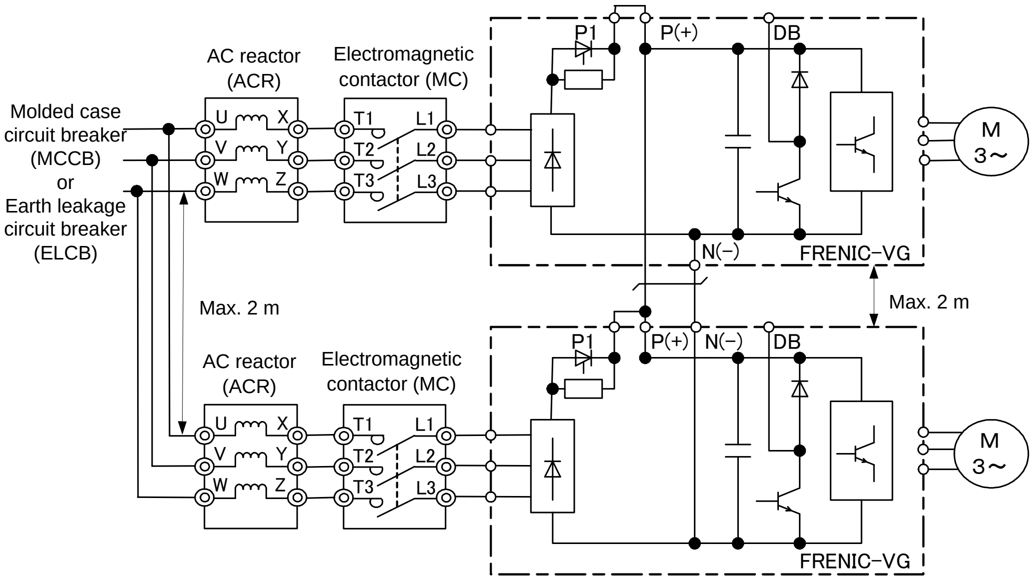


(a) Connection example (b) Voltage depression example with thyristor converter (c) Voltage fluctuation example with phase advanced capacitor

- Use a DCR when the interphase voltage unbalance ratio of the inverter power supply exceeds 2%.

$$\text{Interphase voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$$

- When connecting multiple inverters to DC mother line



Note 1) Be sure to connect the AC rector when connecting to the DC mother line.

Note 2) When connecting to the DC mother line, use inverters of the same model and capacity.

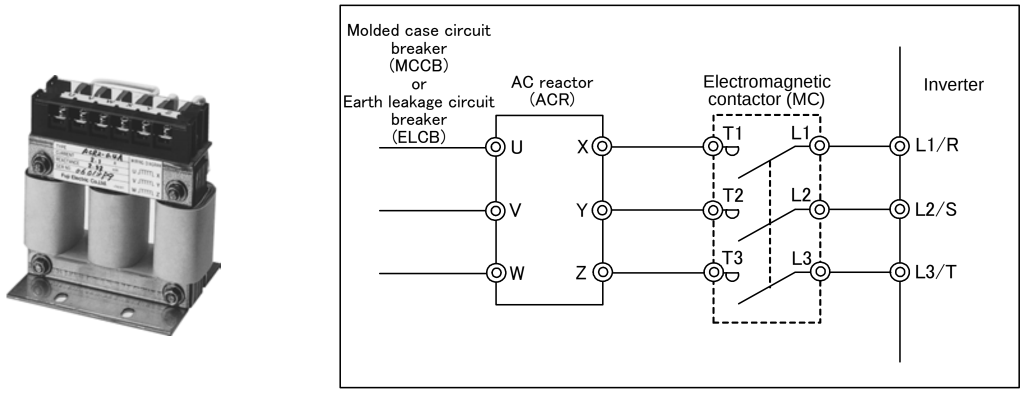


Figure 8.10 External View of AC Reactor (ACR) and Connection Example

Table 8.12 AC Reactor (ACR)

<table>
<tr><th rowspan="2">Power supply voltage</th><th rowspan="2">Nominal applied motor (kW)</th><th rowspan="2">Inverter type</th><th rowspan="2">Specifi-cations</th><th rowspan="2">Reactor model</th><th rowspan="2">Rated current (A)</th><th colspan="2">Reactance (mΩ/phase)</th><th rowspan="2">Winding resistor (mΩ)</th><th rowspan="2">Generated loss (W)</th></tr>
<tr><th>50Hz</th><th>60Hz</th></tr>
<tr><td rowspan="22">Three-phase 200V</td><td>0.75</td><td>FRN0.75VG1□-2J</td><td rowspan="10">HD</td><td>ACR2-0.75A</td><td>5</td><td>493</td><td>592</td><td>-</td><td>12</td></tr>
<tr><td>1.5</td><td>FRN1.5VG1□-2J</td><td>ACR2-1.5A</td><td>8</td><td>295</td><td>354</td><td>-</td><td>14</td></tr>
<tr><td>2.2</td><td>FRN2.2VG1□-2J</td><td>ACR2-2.2A</td><td>11</td><td>213</td><td>256</td><td>-</td><td>16</td></tr>
<tr><td>3.7</td><td>FRN3.7VG1□-2J</td><td>ACR2-3.7A</td><td>17</td><td>218</td><td>153</td><td>-</td><td>23</td></tr>
<tr><td>5.5</td><td>FRN5.5VG1□-2J</td><td>ACR2-5.5A</td><td>25</td><td>87.7</td><td>105</td><td>-</td><td>27</td></tr>
<tr><td>7.5</td><td>FRN7.5VG1□-2J</td><td>ACR2-7.5A</td><td>33</td><td>65</td><td>78</td><td>-</td><td>30</td></tr>
<tr><td>11</td><td>FRN11VG1□-2J</td><td>ACR2-11A</td><td>46</td><td>45.5</td><td>54.7</td><td>-</td><td>37</td></tr>
<tr><td>15</td><td>FRN15VG1□-2J</td><td>ACR2-15A</td><td>59</td><td>34.8</td><td>41.8</td><td>-</td><td>43</td></tr>
<tr><td>18.5</td><td>FRN18.5VG1□-2J</td><td>ACR2-18.5A</td><td>74</td><td>28.6</td><td>34.3</td><td>-</td><td>51</td></tr>
<tr><td>22</td><td>FRN22VG1□-2J</td><td>ACR2-22A</td><td>87</td><td>24</td><td>28.8</td><td>-</td><td>57</td></tr>
<tr><td>30</td><td rowspan="2">FRN30VG1□-2J</td><td>HD</td><td>ACR2-37</td><td>200</td><td>10.8</td><td>13</td><td>0.5</td><td>28.6</td></tr>
<tr><td rowspan="2">37</td><td>LD</td><td rowspan="2">ACR2-37</td><td rowspan="2">200</td><td rowspan="2">10.8</td><td rowspan="2">13</td><td rowspan="2">0.5</td><td rowspan="2">40.8</td></tr>
<tr><td rowspan="2">FRN37VG1□-2J</td><td>HD</td></tr>
<tr><td rowspan="2">45</td><td>LD</td><td rowspan="2">ACR2-55</td><td rowspan="2">270</td><td rowspan="2">7.5</td><td rowspan="2">9</td><td rowspan="2">0.375</td><td rowspan="2">47.1</td></tr>
<tr><td rowspan="2">FRN45VG1□-2J</td><td>HD</td></tr>
<tr><td rowspan="2">55</td><td>LD</td><td rowspan="2">ACR2-55</td><td rowspan="2">270</td><td rowspan="2">7.5</td><td rowspan="2">9</td><td rowspan="2">0.375</td><td rowspan="2">66.1</td></tr>
<tr><td rowspan="2">FRN55VG1□-2J</td><td>HD</td></tr>
<tr><td rowspan="2">75</td><td>LD</td><td rowspan="2">ACR2-75</td><td rowspan="2">390</td><td rowspan="2">5.45</td><td rowspan="2">6.54</td><td rowspan="2">0.25</td><td rowspan="2">55.1</td></tr>
<tr><td rowspan="2">FRN75VG1□-2J</td><td>HD</td></tr>
<tr><td rowspan="2">90</td><td>LD</td><td rowspan="2">ACR2-90</td><td rowspan="2">450</td><td rowspan="2">4.73</td><td rowspan="2">5.67</td><td rowspan="2">0.198</td><td rowspan="2">61.5</td></tr>
<tr><td rowspan="2">FRN90VG1□-2J</td><td>HD</td></tr>
<tr><td>110</td><td>LD</td><td>ACR2-110</td><td>500</td><td>4.25</td><td>5.1</td><td>0.18</td><td>83.4</td></tr>
</table>

Note 1: □ in the inverter model represents an alphabet.

□ └ S (Basic type)

Note 2: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Table 8.12 AC Reactor (ACR) (continued)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Reactor model	Rated current(A)	Reactance (mΩ/phase) 50 Hz	Reactance (mΩ/phase) 60 Hz	Winding resistor (mΩ)	Generated loss (W)
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	ACR4-3.7A	9	512	615	-	17
	5.5	FRN5.5VG1□-4J	HD	ACR4-5.5A	13	349	418	-	22
	7.5	FRN7.5VG1□-4J	HD	ACR4-7.5A	18	256	307	-	27
	11	FRN11VG1□-4J	HD	ACR4-11A	24	183	219	-	40
	15	FRN15VG1□-4J	HD	ACR4-15A	30	139	167	-	46
	18.5	FRN18.5VG1□-4J	HD	ACR4-18.5A	39	114	137	-	57
	22	FRN22VG1□-4J	HD	ACR4-22A	45	95.8	115	-	62
	30	FRN30VG1□-4J	HD	ACR4-37	100	41.7	50	2.73	38.9
	37	FRN30VG1□-4J	LD	ACR4-37	100	41.7	50	2.73	55.7
	37	FRN37VG1□-4J	HD	ACR4-37	100	41.7	50	2.73	55.7
	45	FRN37VG1□-4J	LD	ACR4-55	135	30.8	37	1.61	50.2
	45	FRN45VG1□-4J	HD	ACR4-55	135	30.8	37	1.61	50.2
	55	FRN45VG1□-4J	LD	ACR4-55	135	30.8	37	1.61	70.7
	55	FRN55VG1□-4J	HD	ACR4-55	135	30.8	37	1.61	70.7
	75	FRN55VG1□-4J	LD	ACR4-75 *	160	25.8	31	1.16	65.3
	75	FRN75VG1□-4J	HD	ACR4-75 *	160	25.8	31	1.16	65.3
	90	FRN75VG1□-4J	LD	ACR4-110	250	16.7	20	0.523	42.2
	90	FRN90VG1□-4J	HD	ACR4-110	250	16.7	20	0.523	42.2
	110	FRN90VG1□-4J	MD/LD	ACR4-110	250	16.7	20	0.523	60.3
	110	FRN110VG1□-4J	HD	ACR4-110	250	16.7	20	0.523	60.3
	132	FRN110VG1□-4J	MD/LD	ACR4-132 *	270	20.8	25	0.741	119
	132	FRN132VG1□-4J	HD	ACR4-132 *	270	20.8	25	0.741	119
	160	FRN132VG1□-4J	MD/LD	ACR4-220	561	10	12	0.236	56.4
	160	FRN160VG1□-4J	HD	ACR4-220	561	10	12	0.236	56.4
	200	FRN160VG1□-4J	MD/LD	ACR4-220	561	10	12	0.236	90.4
	200	FRN200VG1□-4J	HD	ACR4-220	561	10	12	0.236	90.4
	220	FRN200VG1□-4J	MD/LD	ACR4-220	561	10	12	0.236	107
	220	FRN220VG1□-4J	HD	ACR4-220	561	10	12	0.236	107
	250	FRN220VG1□-4J	MD	ACR4-280	825	6.67	8	0.144	96.4
	280	FRN220VG1□-4J	LD	ACR4-280	825	6.67	8	0.144	108
	280	FRN280VG1□-4J	HD	ACR4-280	825	6.67	8	0.144	108
	315	FRN280VG1□-4J	MD	ACR4-355	825	6.67	8	0.144	194
	355	FRN280VG1□-4J	LD	ACR4-355	825	6.67	8	0.144	245
	315	FRN315VG1□-4J	HD	ACR4-355	825	6.67	8	0.144	194
	355	FRN315VG1□-4J	MD	ACR4-355	825	6.67	8	0.144	245
	400	FRN315VG1□-4J	LD	ACR4-450	950	6.67	8	0.136	380
	355	FRN355VG1□-4J	HD	ACR4-355 *	825	6.67	8	0.144	245
	400	FRN355VG1□-4J	MD	ACR4-450	950	6.67	8	0.136	380
	450	FRN355VG1□-4J	LD	ACR4-450	950	6.67	8	0.136	473
	400	FRN400VG1□-4J	HD	ACR4-450	950	6.67	8	0.136	380
	450	FRN400VG1□-4J	MD	ACR4-450	950	6.67	8	0.136	473
	500	FRN400VG1□-4J	LD	ACR4-530	1100	5.75	6.9	0.0824	340
	500	FRN500VG1□-4J	HD	ACR4-530	1100	5.75	6.9	0.0824	340
	630	FRN500VG1□-4J	LD	ACR4-630	1300	4.87	5.84	0.0713	422
	630	FRN630VG1□-4J	HD	ACR4-630	1300	4.87	5.84	0.0713	422
	710	FRN630VG1□-4J	LD	-	-	-	-	-	-

* Cool the fan (for 3m/s or more).

Note 1: □ in the inverter model represents an alphabet. 。

□
└── S (Basic type)

Note 2: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).

Figure A

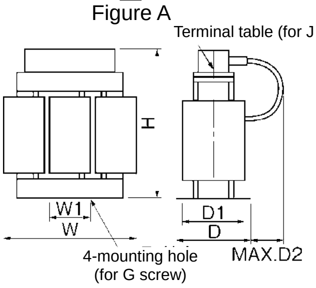


Figure B

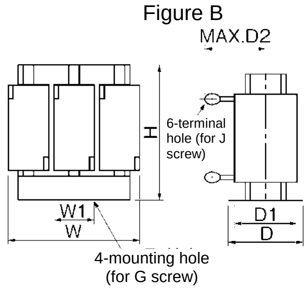


Figure C

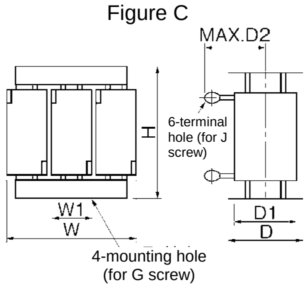


Figure D

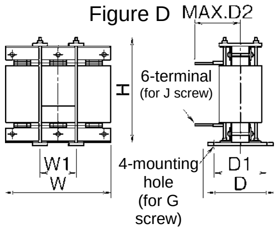


Figure E

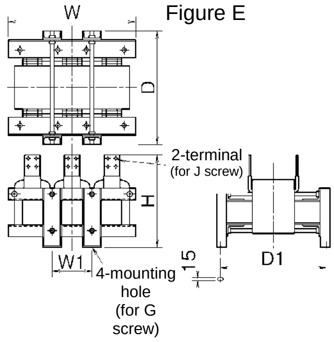


Table 8.13 AC Reactors (ACRs) External Dimensions

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Reactor model	Dimensions(mm) Fig	W	W1	D	D1	D2	G	H	J	Approx. weight (kg)
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	ACR2-0.75A	A	120	40	100	75	20	M5(6×10)	115	M4	1.9
	1.5	FRN1.5VG1□-2J		ACR2-1.5A		120	40	100	75	20	M5(6×10)	115	M4	2.0
	2.2	FRN2.2VG1□-2J		ACR2-2.2A		120	40	100	75	20	M5(6×10)	115	M4	2.0
	3.7	FRN3.7VG1□-2J		ACR2-3.7A		125	40	100	75	25	M5(6×10)	125	M4	2.4
	5.5	FRN5.5VG1□-2J		ACR2-5.5A		125	40	115	90	25	M5(6×10)	125	M4	3.1
	7.5	FRN7.5VG1□-2J		ACR2-7.5A	B	125	40	115	90	106	M5(6×10)	95	M5	3.1
	11	FRN11VG1□-2J		ACR2-11A		125	40	125	100	106	M5(6×10)	95	M6	3.7
	15	FRN15VG1□-2J		ACR2-15A		180	60	110	85	106	M6(7×11)	115	M6	4.8
	18.5	FRN18.5VG1□-2J		ACR2-18.5A		180	60	110	85	109	M6(7×11)	115	M6	5.1
	22	FRN22VG1□-2J		ACR2-22A		180	60	110	85	109	M6(7×11)	115	M6	5.1
	30	FRN30VG1□-2J	HD	ACR2-37		190	60	120	90	172	M6(7×11)	190	M8	11
	37		LD	ACR2-37		190	60	120	90	172	M6(7×11)	190	M8	11
		FRN37VG1□-2J	HD											
	45		LD	ACR2-55	C	190	60	120	90	200	M6(7×11)	190	M12	13
		FRN45VG1□-2J	HD											
	55		LD	ACR2-55		190	60	120	90	200	M6(7×11)	190	M12	13
		FRN55VG1□-2J	HD											
	75		LD	ACR2-75		250	100	120	90	200	M8(9×14)	250	M12	25
		FRN75VG1□-2J	HD											
	90		LD	ACR2-90		285	190	158	120	190	M10(12×20)	210	M12	26
		FRN90VG1□-2J	HD											
	110		LD	ACR2-110		280	150	138	110	200	M8(10×20)	270	M12	30

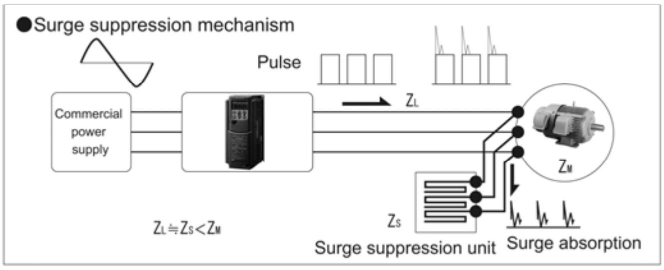
Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Table 8.13 AC Reactors (ACRs) External Dimensions (continued)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Reactor model	Dimensions(mm)									Approx. weight (kg)
					Fig	W	W1	D	D1	D2	G	H	J	
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	ACR4-3.7A	B	125	40	100	75	106	M5(6×10)	95	M4	2.4
	5.5	FRN5.5VG1□-4J		ACR4-5.5A		125	40	115	90	106	M5(6×10)	95	M5	3.1
	7.5	FRN7.5VG1□-4J		ACR4-7.5A		125	40	115	90	106	M5(6×10)	95	M5	3.7
	11	FRN11VG1□-4J		ACR4-11A		180	60	110	85	106	M6(7×11)	115	M6	4.3
	15	FRN15VG1□-4J		ACR4-15A		180	60	110	85	106	M6(7×11)	137	M6	5.4
	18.5	FRN18.5VG1□-4J		ACR4-18.5A		180	60	110	85	106	M6(7×11)	137	M6	5.7
	22	FRN22VG1□-4J		ACR4-22A		180	60	110	85	106	M6(7×11)	137	M6	5.9
	30	FRN30VG1□-4J	HD	ACR4-37		190	60	120	90	172	M6(7×11)	190	M8	12
	37		LD											
		FRN37VG1□-4J	HD											
	45		LD	ACR4-55	C	190	60	120	90	200	M6(7×11)	190	M10	14
		FRN45VG1□-4J	HD											
	55		LD	ACR4-55		190	60	120	90	200	M6(7×11)	190	M10	14
		FRN55VG1□-4J	HD											
	75		LD	ACR4-75		190	60	126	90	157	M6(7×10)	190	M10	16
		FRN75VG1□-4J	HD											
	90		LD	ACR4-110		250	100	136	105	202	M8(9.5×18)	245	M12	24
		FRN90VG1□-4J	HD											
	110		MD/LD	ACR4-110		250	100	136	105	202	M8(9.5×18)	245	M12	24
		FRN110VG1□-4J	HD											
	132		MD/LD	ACR4-132		250	100	146	115	207	M8(10x16)	250	M12	32
		FRN132VG1□-4J	HD											
	160		MD/LD	ACR4-220		320	120	150	110	240	M10(12×20)	300	M12	40
		FRN160VG1□-4J	HD											
	200		MD/LD	ACR4-220		320	120	150	110	240	M10(12×20)	300	M12	40
		FRN200VG1□-4J	HD											
	220		MD/LD	ACR4-220		320	120	150	110	240	M10(12×20)	300	M12	40
		FRN220VG1□-4J	HD											
	250		MD	ACR4-280		380	130	150	110	260	M10(12×20)	300	M12	52
	280		LD											
		FRN280VG1□-4J	HD											
	315		MD	ACR4-355		380	130	150	110	260	M10(12×20)	300	M12	52
	355		LD											
	315	FRN315VG1□-4J	HD	ACR4-355		380	130	150	110	260	M10(12×20)	300	M12	52
	355		MD											
	400		LD	ACR4-450	D	460	155	290	230	200	M12(Φ15)	490	4×M12	95
	355	FRN355VG1□-4J	HD	ACR4-355	C	380	130	150	110	260	M10(12×20)	300	M12	52
	400		MD	ACR4-450	D	460	155	290	230	200	M12(Φ15)	490	4×M12	95
	450		LD											
	400	FRN400VG1□-4J	HD	ACR4-450		460	155	290	230	200	M12(Φ15)	490	4×M12	95
	450		MD											
	500		LD	ACR4-530	E	480	155	420	370	-	M12(15×25)	380	4×M12	100
		FRN500VG1□-4J	HD											
	630		LD	ACR4-630		510	170	420	370	-	M12(15×25)	390	4×M12	110
		FRN630VG1□-4J	HD											
	710		LD	-	-	-	-	-	-	-	-	-	-	-

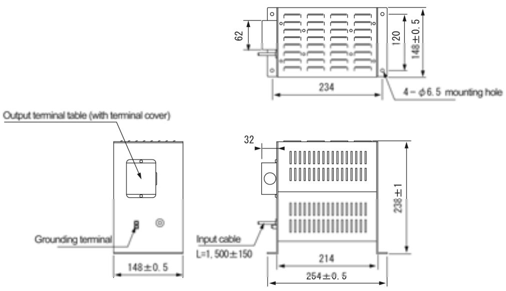
8.5.5 Surge suppression unit (SSU)

If the drive wire for the motor is long, an extremely low surge voltage (micro surge) occurs at the wire end connected to the motor. Surge voltage causes motor degradation, insulation breakdown, or increased noises. The surge suppression unit (SSU) suppresses the surge voltage. It features the connectivity for all motor capacities and easy wiring work.

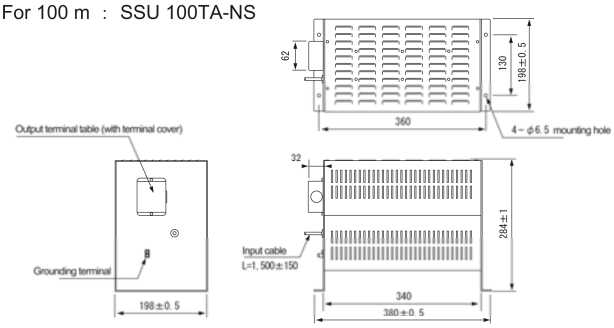


■External dimensions

・For 50 m : SSU 50TA-NS

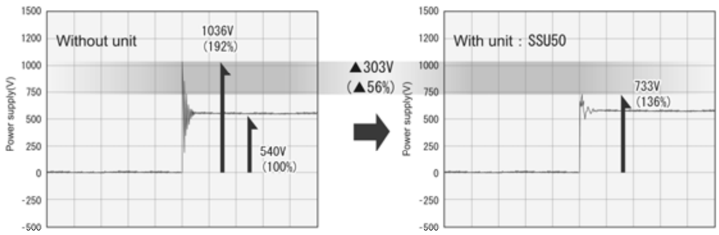


・For 100 m : SSU 100TA-NS

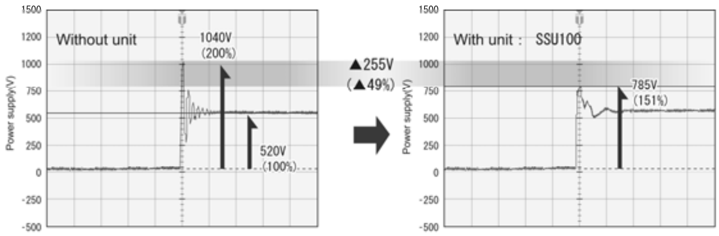


■Effect of surge suppression unit (voltage waveform between motor wires)

・Motor/inverter capacity: 3.7 kW
・Operation status: No load
・Wire length: 50 m
・Power supply voltage: 3-phase 400 V



・Motor/inverter capacity: 75 kW
・Operation status: No load
・Wire length: 100 m
・Power supply voltage: 3-phase 400 V



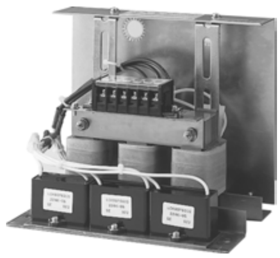
■Basic specifications

Item	Specifications	
Model	SSU 50TA-NS	SSU 100TA-NS
Applicable wire length	Up to 50 m	Up to 100 m
Power supply voltage	200V system, 400V system, PWM converter are applicable.	
Inverter capacity	Up to 75 kW	
Output frequency	Up to 400 Hz	
Carrier frequency	Up to 15 kHz (not available for 16 kHz)	
Protective structure	IP20	
Installation environment	Ambient temperature: -20 to 40℃, ambient humidity: 85%RH or lower, vibration: 0.7G or less, installation site: level	
Insulation voltage	2500 V AC, 1 min	

8.5.6 Output circuit filter (OFL)

Insert an OFL in the inverter power output circuit to:

- Suppress the surge voltage at motor terminal
  This protects the motor from insulation damage caused by the application of high voltage surge currents from the 400 V class series of inverters.
- Suppress leakage current (due to higher harmonic components) from the inverter output lines
  This reduces the leakage current when the motor is connected by long power feed lines. (Keep the length of the power feed line less than 400 m.)
- Minimize radiation and/or induction noise issued from the inverter output lines
  An OFL is an effective noise suppression device for long wiring applications at plants.



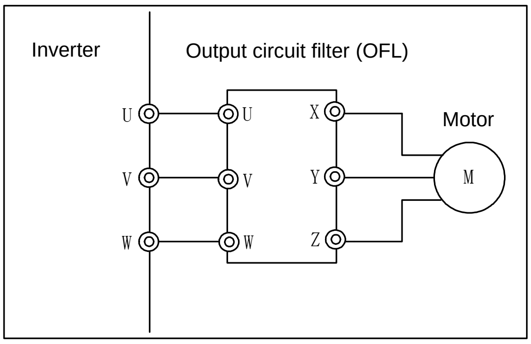


Figure 8.11 External View of Output Circuit Filter (OFL) and Connection

Table 8.14 Output Circuit Filter (OFL)

OFL-□□□-4A

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Filter model	Rated current (A)	Overload resistance	Inverter input power supply voltage	Carrier frequency tolerance (kHz)	Maximum output frequency (Hz)	Generated loss (W)
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	OFL-3.7-4A	9	HD model 150%-1min 200%-3s MD model 150%-1min LD model 120%-1min	Three-phase 380-480V 50/60Hz	2-15kHz	400Hz	210
	5.5	FRN5.5VG1□-4J	HD	OFL-7.5-4A	18			2-15kHz	400Hz	190
	7.5	FRN7.5VG1□-4J	HD	OFL-7.5-4A	18			2-15kHz	400Hz	190
	11	FRN11VG1□-4J	HD	OFL-15-4A	30			2-15kHz	400Hz	320
	15	FRN15VG1□-4J	HD	OFL-15-4A	30			2-15kHz	400Hz	320
	18.5	FRN18.5VG1□-4J	HD	OFL-22-4A	45			2-15kHz	400Hz	350
	22	FRN22VG1□-4J	HD	OFL-22-4A	45			2-15kHz	400Hz	350
	30	FRN30VG1□-4J	HD	OFL-30-4A	60			2-15kHz	400Hz	570
	37	FRN30VG1□-4J	LD	OFL-37-4A	75			2-15kHz	400Hz	610
	37	FRN37VG1□-4J	HD	OFL-37-4A	75			2-15kHz	400Hz	610
	45	FRN37VG1□-4J	LD	OFL-45-4A	91			2-15kHz	400Hz	810
	45	FRN45VG1□-4J	HD	OFL-45-4A	91			2-15kHz	400Hz	810
	55	FRN45VG1□-4J	LD	OFL-55-4A	112			2-15kHz	400Hz	910
	55	FRN55VG1□-4J	HD	OFL-55-4A	112			2-15kHz	400Hz	910
	75	FRN55VG1□-4J	LD	OFL-75-4A	150			2-10kHz	400Hz	1200
	75	FRN75VG1□-4J	HD	OFL-75-4A	150			2-10kHz	400Hz	1200
	90	FRN75VG1□-4J	LD	OFL-90-4A	176			2-10kHz	400Hz	1360
	90	FRN90VG1□-4J	HD	OFL-90-4A	176			2-10kHz	400Hz	1360
	110	FRN90VG1□-4J	MD/LD	OFL-110-4A	210			2-10kHz	400Hz	1410
	110	FRN110VG1□-4J	HD	OFL-110-4A	210			2-10kHz	400Hz	1410
	132	FRN110VG1□-4J	MD/LD	OFL-132-4A	253			2-10kHz	400Hz	1800
	132	FRN132VG1□-4J	HD	OFL-132-4A	253			2-10kHz	400Hz	1800
	160	FRN132VG1□-4J	MD/LD	OFL-160-4A	304			2-10kHz	400Hz	2210
	160	FRN160VG1□-4J	HD	OFL-160-4A	304			2-10kHz	400Hz	2210
	200	FRN160VG1□-4J	MD/LD	OFL-200-4A	377			2-10kHz	400Hz	2520
	200	FRN200VG1□-4J	HD	OFL-200-4A	377			2-10kHz	400Hz	2520
	220	FRN200VG1□-4J	MD/LD	OFL-220-4A	415			2-10kHz	400Hz	2590
	220	FRN220VG1□-4J	HD	OFL-220-4A	415			2-10kHz	400Hz	2590
	250	FRN220VG1□-4J	MD	OFL-280-4A	520			2-10kHz	400Hz	3570
	280	FRN220VG1□-4J	LD	OFL-280-4A	520			2-10kHz	400Hz	3570
	280	FRN280VG1□-4J	HD	OFL-280-4A	520			2-10kHz	400Hz	3570
	315	FRN280VG1□-4J	MD	OFL-315-4A	585			2-10kHz	400Hz	3290
	355	FRN280VG1□-4J	LD	OFL-355-4A	650			2-10kHz	400Hz	3320
	315	FRN315VG1□-4J	HD	OFL-315-4A	585			2-10kHz	400Hz	3290
	355	FRN315VG1□-4J	MD	OFL-355-4A	650			2-10kHz	400Hz	3320
	400	FRN315VG1□-4J	LD	OFL-400-4A	740			2-10kHz	400Hz	3390
	355	FRN355VG1□-4J	HD	OFL-355-4A	650			2-10kHz	400Hz	3320
	400	FRN355VG1□-4J	MD	OFL-400-4A	740			2-10kHz	400Hz	3390
	450	FRN355VG1□-4J	LD	OFL-450-4A	840			2-10kHz	400Hz	3390
	400	FRN400VG1□-4J	HD	OFL-400-4A	740			2-10kHz	400Hz	3390
	450	FRN400VG1□-4J	MD	OFL-450-4A	840			2-10kHz	400Hz	3390
	500	FRN400VG1□-4J	LD	OFL-500-4A	960			2-6kHz	400Hz	4250
	500	FRN500VG1□-4J	HD	OFL-500-4A	960			2-6kHz	400Hz	4250
	630	FRN500VG1□-4J	LD	OFL-630-4A	1170			2-6kHz	120Hz	4700
	630	FRN630VG1□-4J	HD	OFL-630-4A	1170			2-6kHz	120Hz	4700

Note : □ in the inverter model represents an alphabet. 。

□
└── S (Basic type)

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Table 8.15 Output Circuit Filter (OFL) Dimensions

OFL-□□□-4A

■ Filter (for 22 kW or below)

Figure A

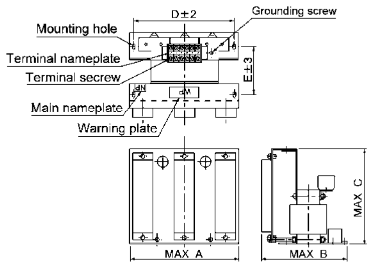
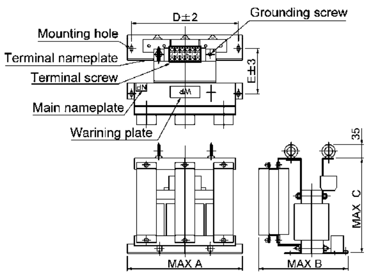


Figure B



■ Reactor (for 30 kW or above)

Figure C

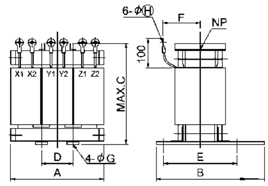


Figure D

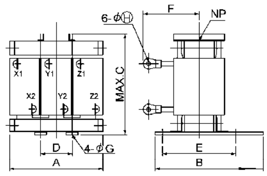
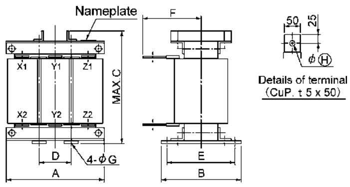


Figure E



■ Resistor and Capacitor (for 30 kW or above)

Figure F

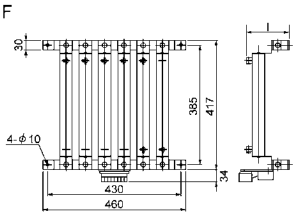
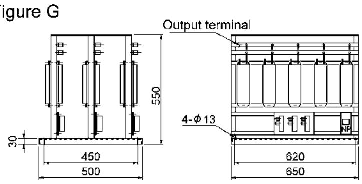


Figure G



Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Filter type	Fig	Dimensions(mm) A	B	C	D	E	F	G	Grounding screw H	Terminal screw J	Mounting screw K	Approx. weight (kg)
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	OFL-3.7-4A	A	220	225	220	200	115	-	-	M4	M4	M5	14
	5.5	FRN5.5VG1□-4J	HD	OFL-7.5-4A	B	290	290	230	260	160	-	-	M5	M5	M6	22
	7.5	FRN7.5VG1□-4J	HD	OFL-7.5-4A	B	290	290	230	260	160	-	-	M5	M5	M6	22
	11	FRN11VG1□-4J	HD	OFL-15-4A	B	330	275	310	300	145	-	-	M6	M6	M8	35
	15	FRN15VG1□-4J	HD	OFL-15-4A	B	330	275	310	300	145	-	-	M6	M6	M8	35
	18.5	FRN18.5VG1□-4J	HD	OFL-22-4A	B	330	300	330	300	170	-	-	M6	M6	M8	45
	22	FRN22VG1□-4J	HD	OFL-22-4A	B	330	300	330	300	170	-	-	M6	M6	M8	45
	30	FRN30VG1□-4J	HD	OFL-30-4A	C/F	210	175	210	70	140	90	160	-	M5	M6	12
	37	FRN30VG1□-4J	LD	OFL-37-4A	C/F	220	190	220	75	150	95	160	-	M5	M6	15
	37	FRN37VG1□-4J	HD	OFL-37-4A	C/F	220	190	220	75	150	95	160	-	M5	M6	15
	45	FRN37VG1□-4J	LD	OFL-45-4A	D/F	220	195	265	70	155	140	160	-	M6	M8	17
	45	FRN45VG1□-4J	HD	OFL-45-4A	D/F	220	195	265	70	155	140	160	-	M6	M8	17
	55	FRN45VG1□-4J	LD	OFL-55-4A	D/F	260	200	275	85	160	150	160	-	M6	M8	22
	55	FRN55VG1□-4J	HD	OFL-55-4A	D/F	260	200	275	85	160	150	160	-	M6	M8	22
	75	FRN55VG1□-4J	LD	OFL-75-4A	D/F	260	210	290	85	170	150	233	-	M8	M10	25
	75	FRN75VG1□-4J	HD	OFL-75-4A	D/F	260	210	290	85	170	150	233	-	M8	M10	25
	90	FRN75VG1□-4J	LD	OFL-90-4A	D/F	260	210	290	85	170	155	233	-	M8	M10	28
	90	FRN90VG1□-4J	HD	OFL-90-4A	D/F	260	210	290	85	170	155	233	-	M8	M10	28
	110	FRN90VG1□-4J	MD/LD	OFL-110-4A	D/F	300	230	330	100	190	170	233	-	M8	M10	38
	110	FRN110VG1□-4J	HD	OFL-110-4A	D/F	300	230	330	100	190	170	233	-	M8	M10	38
	132	FRN110VG1□-4J	MD/LD	OFL-132-4A	D/F	300	240	340	100	200	170	233	-	M10	M10	42
	132	FRN132VG1□-4J	HD	OFL-132-4A	D/F	300	240	340	100	200	170	233	-	M10	M10	42
	160	FRN132VG1□-4J	MD/LD	OFL-160-4A	D/F	300	240	340	100	200	180	233	-	M10	M10	48
	160	FRN160VG1□-4J	HD	OFL-160-4A	D/F	300	240	340	100	200	180	233	-	M10	M10	48
	200	FRN160VG1□-4J	MD/LD	OFL-200-4A	D/F	320	270	350	105	220	190	333	-	M10	M12	60
	200	FRN200VG1□-4J	HD	OFL-200-4A	D/F	320	270	350	105	220	190	333	-	M10	M12	60
	220	FRN200VG1□-4J	MD/LD	OFL-220-4A	D/F	340	300	390	115	250	190	333	-	M10	M12	70
	220	FRN220VG1□-4J	HD	OFL-220-4A	D/F	340	300	390	115	250	190	333	-	M10	M12	70
	250	FRN220VG1□-4J	MD	OFL-280-4A	D/F	350	300	430	115	250	200	333	-	M10	M12	78
	280	FRN220VG1□-4J	LD	OFL-280-4A	D/F	350	300	430	115	250	200	333	-	M10	M12	78
	280	FRN280VG1□-4J	HD	OFL-280-4A	D/F	350	300	430	115	250	200	333	-	M10	M12	78
	315	FRN280VG1□-4J	MD	OFL-315-4A	E/G	440	275	450	150	230	170	-	-	M12	M12	90
	355	FRN280VG1□-4J	LD	OFL-355-4A	E/G	440	290	480	150	245	175	-	-	M12	M12	100
	315	FRN315VG1□-4J	HD	OFL-315-4A	E/G	440	275	450	150	230	170	-	-	M12	M12	90
	355	FRN315VG1□-4J	MD	OFL-355-4A	E/G	440	290	480	150	245	175	-	-	M12	M12	100
	400	FRN315VG1□-4J	LD	OFL-400-4A	E/G	440	295	510	150	240	175	-	-	M12	M12	110
	355	FRN355VG1□-4J	HD	OFL-355-4A	E/G	440	290	480	150	245	175	-	-	M12	M12	100
	400	FRN355VG1□-4J	MD	OFL-400-4A	E/G	440	295	510	150	240	175	-	-	M12	M12	110
	450	FRN355VG1□-4J	LD	OFL-450-4A	E/G	440	325	470	150	270	195	-	-	M12	M12	125
	400	FRN400VG1□-4J	HD	OFL-400-4A	E/G	440	295	510	150	240	175	-	-	M12	M12	110
	450	FRN400VG1□-4J	MD	OFL-450-4A	E/G	440	325	470	150	270	195	-	-	M12	M12	125
	500	FRN400VG1□-4J	LD	OFL-500-4A	E/G	440	335	500	150	280	210	-	-	M12	M12	145
	500	FRN500VG1□-4J	HD	OFL-500-4A	E/G	440	335	500	150	280	210	-	-	M12	M12	145
	630	FRN500VG1□-4J	LD	OFL-630-4A	E/G	480	355	560	150	280	245	-	-	M12	M12	170
	630	FRN630VG1□-4J	HD	OFL-630-4A	E/G	480	355	560	150	280	245	-	-	M12	M12	170

Note that the OFL-***-4A models have no restrictions on carrier frequency.

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

8.5.7 Radio noise reducing zero phase reactor (ACL)

An ACL is used to reduce radio frequency noise emitted by the inverter.

An ACL suppresses the outflow of high frequency harmonics caused by switching operation for the power supply lines inside the inverter. Pass the power supply lines together through the ACL.

If wiring length between the inverter and motor is less than 20 m, insert an ACL to the power supply lines; if it is more than 20 m, insert it to the power output lines of the inverter.

Wire size is determined depending upon the ACL size (I.D.) and installation requirements.

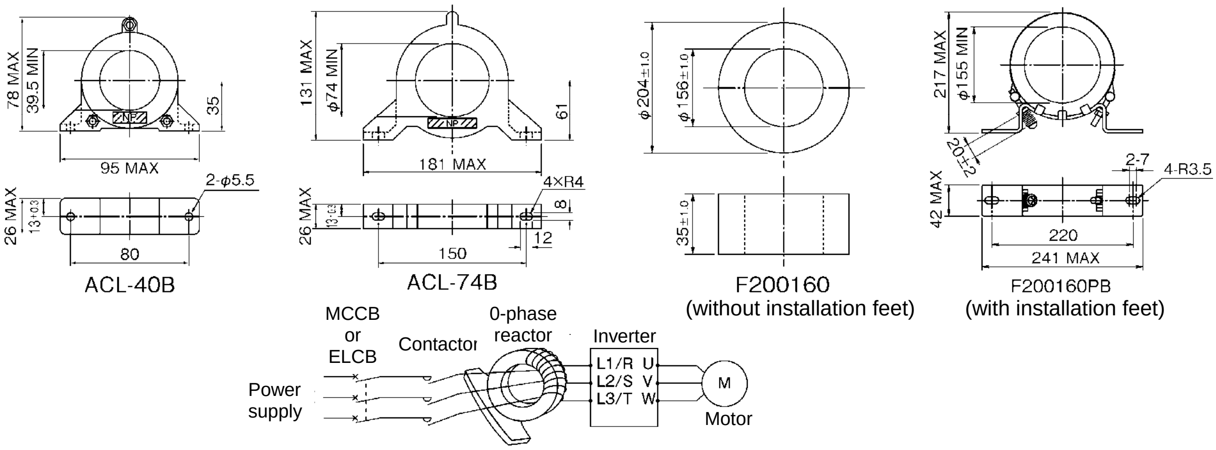


Figure 8.12 Dimensions of Zero-phase Reactor for Reducing Radio Noise (ACL) and Connection Example

Table 8.16 Zero-phase Reactors for Reducing Radio Noise (ACL)

Zero-phase reactor type	Installation requirements		Wire size (mm^2)
	Qty.	Number of turns	
ACL-40B	1	4	2.0, 3.5, 5.5
	2	2	8, 14
ACL-74B	1	4	8, 14
	2	2	22, 38, 60, 5.5×2, 8×2, 14×2, 22×2
	4	1	100, 150, 200, 250, 325, 38×2, 60×2, 100×2, 150×2
F200160	4	1	200×2, 250×2, 325×2, 325×3
F200160PB	4	1	200×2, 250×2, 325×2, 325×3

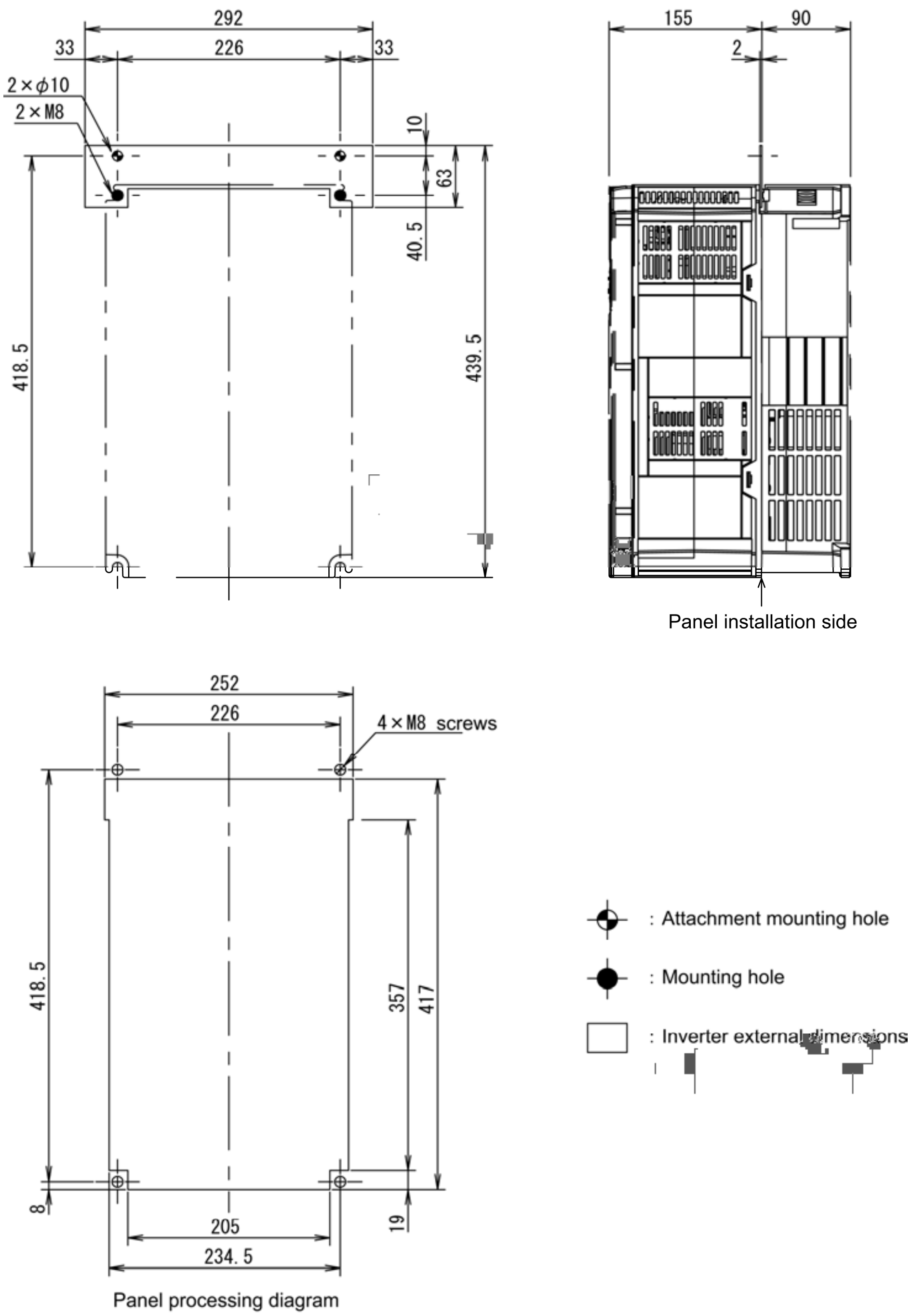
The selected wires are for use with 3-phase input/output lines (3 wires).

Note: Use the insulated wire of 75°C, 600 V, HIV-insulated.

8.5.8 External cooling attachment

This attachment is used to allow the inverter cooling fins to protrude out of the panel.

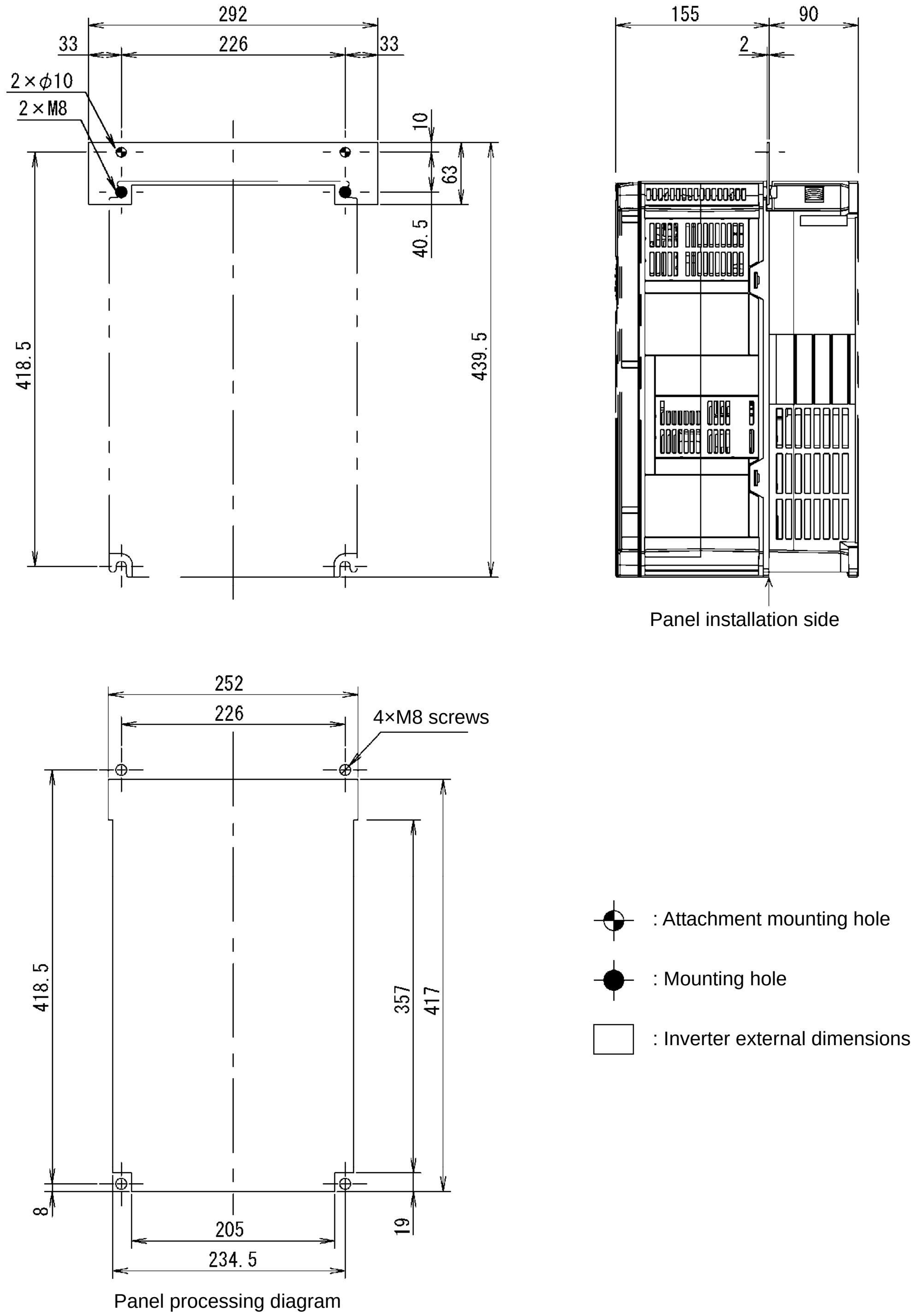
■PBVG7-7.5(FRN0.75VG1S-2J to FRN7.5VG1S-2J,FRN3.7VG1S-4J to FRN7.5VG1S-4J)



Unit：[mm]

Figure 8.13 External Cooling Attachment External Dimensions

■PB-F1-30(FRN11VG1S-2J to FRN22VG1S-2J,FRN11VG1S-4J to FRN22VG1S-4J)



Unit：mm

Figure 8.13 External Cooling Attachment External Dimensions (continued)

8.6 Battery

8.6.1 Overview of battery

Used to retain the trace back memory and calendar when the inverter is not powered.

- 22kW or lower: Option
- 30kW or higher: Standard

Model	**OPK-BP**
Voltage/capacity	3.6 V/1100 mAh
Type	Lithium Thionyl Chloride(Li-SOCl2) battery
Life	5 years (with ambient temperature of 60°C and inverter powered off)

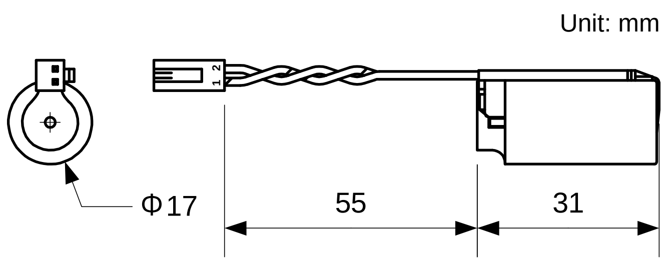


Figure 8.14 Overview of battery

⚠WARNING

Safety Precautions

This battery contains lithium (dangerous substance) and thionyl chloride (very dangerous substance) to provide high energy. If you use it in a wrong way, the battery may be deformed, liquid inside the battery may leak, or heat generation, explosion, fire, and/or stimulative/corrosive gas generation may occur, resulting in a injury or device failure. Be sure to observe the following precautions:

- Do not swallow the battery.
- Do not apply excessive force to the positive terminal.
- Do not drop the battery.
- Do not short-circuit the battery.
- Do not charge the battery.
- Do not force the battery to discharge.
- Do not heat the battery.
- Do not throw the battery into fire.
- Do not disassemble the battery.
- Do not deform the battery.
- Insert the battery into the inverter in the correct direction.
- Do not allow liquid from the battery to touch your skin.
- Do not leave a damaged battery in the inverter.

⚠CAUTION

Keep the battery where it is not exposed to the direct sunlight, high temperature/humidity, and/or rain drop.

This battery belongs to the "primary battery class", which must be discarded in accordance with the defined method (law).

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

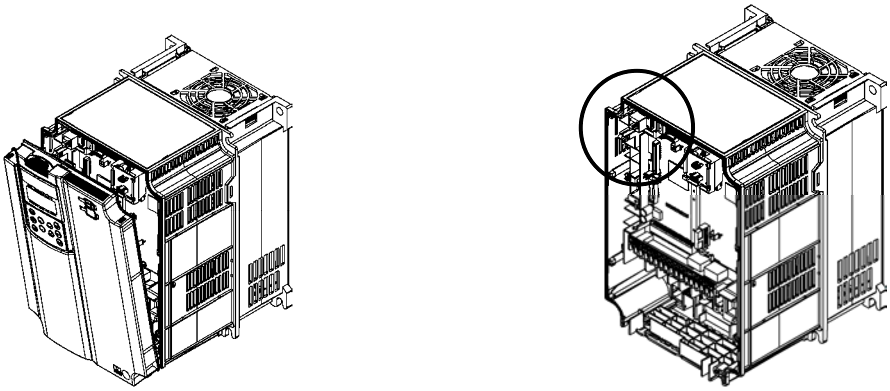
8.6.2 Installing battery

⚠CAUTION
Be sure to operate the inverter with the battery installed. **Afire or an accident might occur.**

Refer to "3.4.4.12 Setting Date/Time" for how to adjust the clock.

8.6.2.1 Installing battery (for 22 kW or lower)

① Remove the outer cover.



② Install the battery as shown in the figure.

③ Connect the battery cable to the connector CN7 on the control printed board.

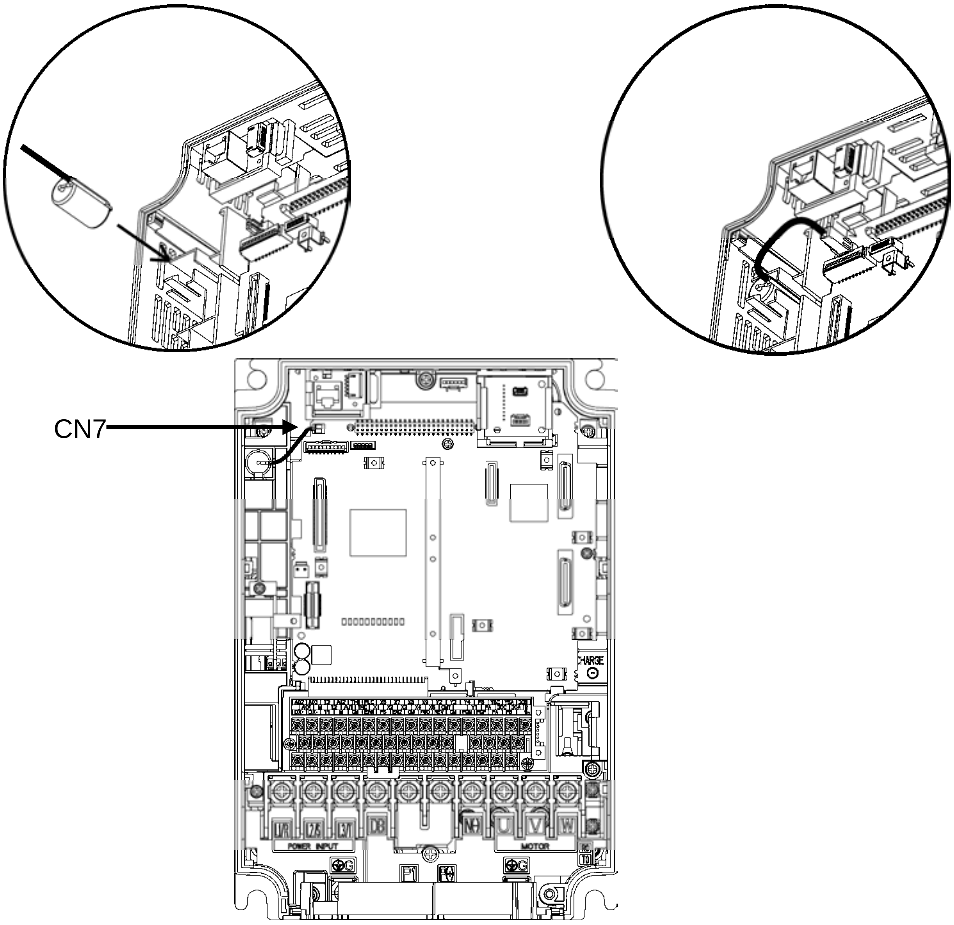
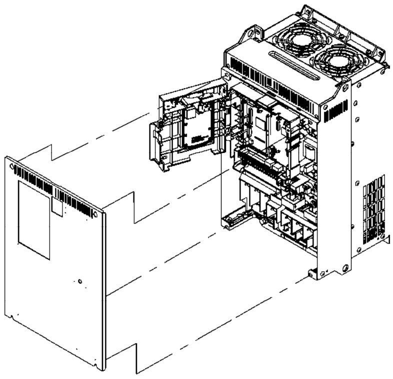


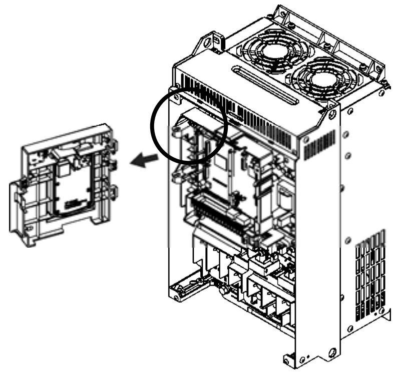
Figure 8.15 Battery Installed (22kW or lower)

8.6.2.2 Installing battery (for 30 kW or higher)

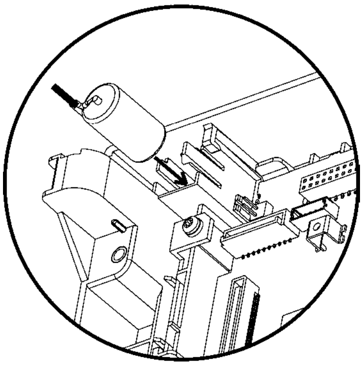
① Remove the front cover.
Open the touch panel case and disconnect the connectors CN5 and CN8 from the control printed board.



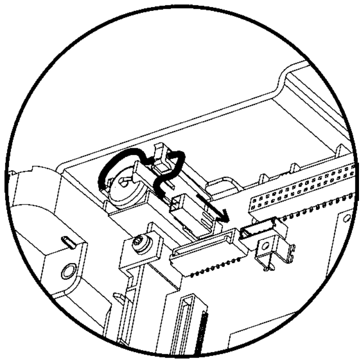
② Remove the touch panel case.



③ Install the battery as shown in the figure.



④ Connect the battery cable to the connector CN7 on the control printed board.



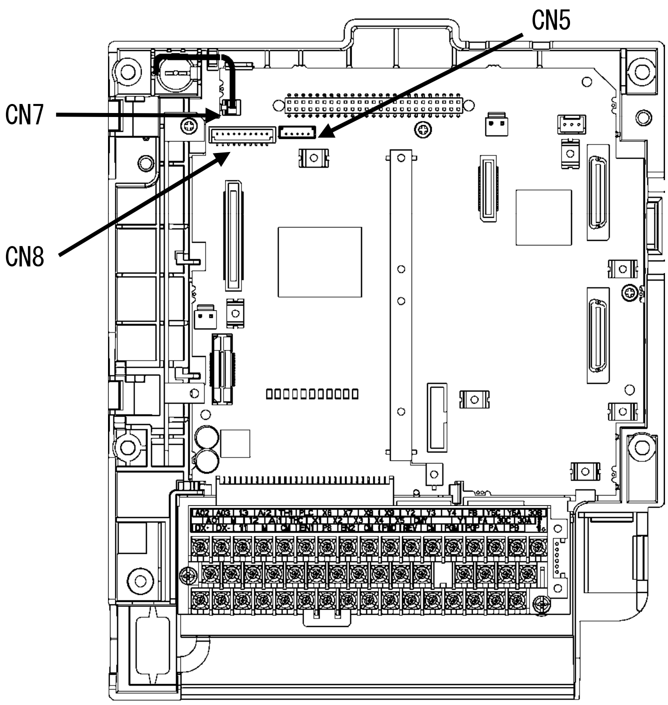


Figure 8.16 Battery Installed (30kW or higher)

8.6.3 Replacing battery

Reverse the installation procedure to remove the battery, and then install the new battery.

⚠CAUTION
Be sure to operate the inverter with the battery installed. **Afire or an accident might occur.**

Refer to "3.4.4.12 Setting Date/Time" for how to adjust the clock.

8.6.4 Sending battery via air transport

The International Air Transport Association (IATA) issued the new revision (Edition 44) of handling manual for dangerous substance and "Rules for Lithium and Lithium-Ion Batteries" was revised. This battery belongs to the category of non-dangerous substances (with lithium contents 1.0G or less, non-Class 9), and sending it via air transport is permitted up to 24 batteries in a single package. When sending more than 24 batteries, a package specified by the rule is required. Contact us or our distributor for the details. (As of 2011 April)

Chapter 9
SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

This chapter provides you with information about the inverter output torque characteristics, selection procedure, and equations for calculating capacities to help you select optimal motor and inverter models. It also helps you select braking resistors and inverter mode (HD, MD, or LD).

Contents

9.1 Selecting Motor and Inverter Capacities

First select a motor and then inverter as follows:

(1) Key point for selecting a motor: Determine what kind of load machine is to be used, calculate its moment of inertia, and then select the appropriate motor capacity.

(2) Key point for selecting an inverter: Taking into account the operation requirements (e.g., acceleration time, deceleration time, and frequency in operation) of the load machine to be driven by the motor selected in (1) above, calculate the acceleration/deceleration/braking torque.

This section describes the selection procedure for (1) and (2) above. First, it explains the output torque characteristics obtained by using the motor driven by the FRENIC-VG.

9.1.1 Motor output torque characteristics

Figure 9.1 shows the output torque characteristics of motors exclusive to the FRENIC-VG. The output torque is classified into the following quadrants by speed and torque-applied direction.

	(Speed)	(Torque)	
• First quadrant:	+	+	.... Driving in forward rotation
• Second quadrant:	−	+	..... Braking in reverse rotation
• Third quadrant:	−	−	..... Driving in reverse rotation
• Fourth quadrant:	+	−	..... Braking in forward rotation

In the figure below, the speed rate (%) is expressed assuming the base speed as 100%, and the torque rate (%), assuming the continuous rated torque as 100%.

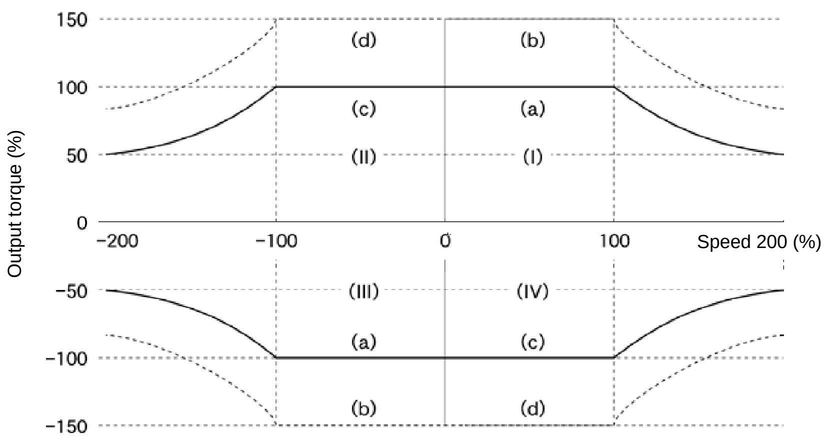


Figure 9.1 Output Torque Characteristics (HD mode)

(1) Allowable continuous driving torque (Curve (a) in the 1st and 3rd quadrants)

Curve (a) shows the output torque available continuously in the driving mode. In the domain below the base speed (100%) in the speed control range (0 to 200%), the rated output torque (100%) is obtained. In the domain above the base speed (100%), the constant output is obtained so that the output torque is in inverse proportion to the speed.

In particular, at very low speeds below the speed control range, due to the restriction on the inverter internal temperature rise, the allowable torque drops to 80% for the converted inverter output frequency of less than 0.1 Hz. When driving an induction motor (IM) with the frequency of less than 0.1 Hz, the inverter can drive the motor continuously, taking into account the motor slip in practice. However, when driving a permanent magnet synchronous motor (PMSM) with less than 0.1 Hz, the synchronous speed applies so that it is necessary to take the torque loss into account.

(2) Maximum driving torque in a short time (Curve (b) in the 1st and 3rd quadrants)

Curve (b) shows the output torque allowed for a short time (60 seconds) in the driving mode. In general, this torque applies to acceleration and deceleration. The torque is 150% of the rated continuous torque.

In particular, at very low speeds below the speed control range, due to the restriction on the inverter internal temperature rise, the allowable torque drops to 100% for the converted inverter output frequency of less than 0.1 Hz.

(3) Starting torque (Around speed zero (0) in the 1st and 3rd quadrants)

The torque at around the speed zero (0) applies as starting torque. Although the continuous output torque is 80%, the starting torque becomes as high as 150% because the curve passes the very low speed range in a short period (30 seconds or less).

(4) Braking torque (2nd and 4th quadrants)

The 2nd and 4th quadrants are the braking mode range. Curve (c) shows the braking torque available in the rated continuous current range of the inverter; curve (d) is the braking torque available for 60-second rated current. In the very low speed range, the torque drops to 80% just as in the driving mode.

The time rating of the braking torque is dominantly determined by another condition--the energy processing time rating of an optional braking resistor or braking unit since the kinetic energy of mechanical load is regenerated in the braking mode.

For the time rating of the braking resistor, this manual and the associated catalogs list the allowable values (kW) in terms of the average discharging loss and the allowable values (kWs) in terms of the discharging capability that can be discharged at one time.

For braking-related values to be applied to the standard combination of the inverter and braking resistor or braking unit, refer to Chapter 8, Section 8.5.1.1 "Braking resistors (DBRs) and braking units."

9.1.2 Selection procedure

Figure 9.2 shows the general selection procedure for optimal inverters. Items numbered (1) through (5) are described on the following pages.

You may easily select inverter capacity if there are no restrictions on acceleration and deceleration times. If "there are any restrictions on acceleration or deceleration time" or "acceleration and deceleration are frequent," then the selection procedure is more complex.

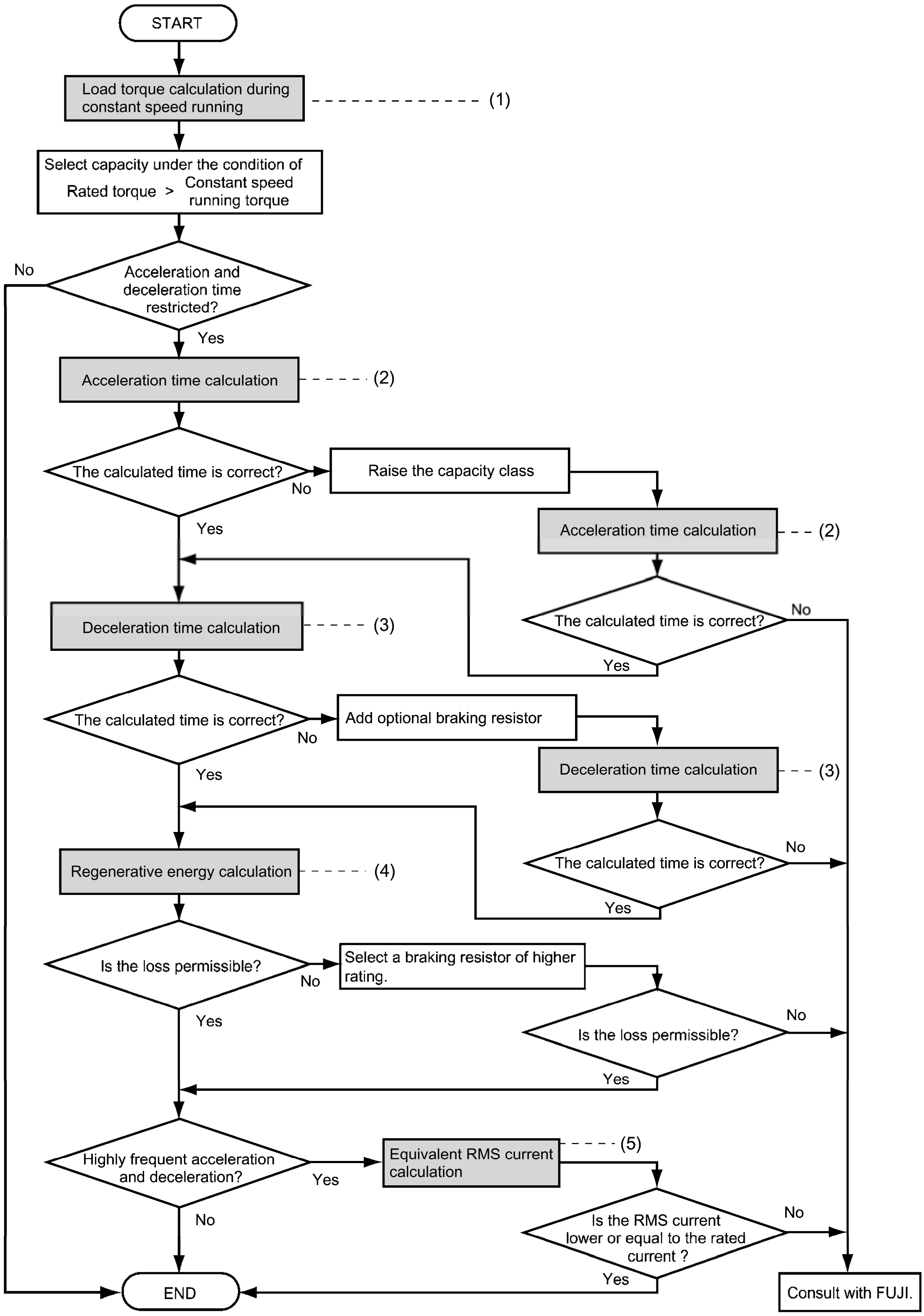


Figure 9.2 Selection Procedure

(1) Calculating the load torque during constant speed running (For detailed calculation, refer to Section 9.1.3.1)

The "load torque during constant speed running" refers to the torque required for rotating the load at the constant speed and converted to motor shaft. It can be calculated in consideration of the reducer rate (η_G).

Driving mode

"Load torque during constant speed running" = Actual load torque (τ_L) ÷ Reducer rate (η_G)

Braking mode

"Load torque during constant speed running" = Actual load torque (τ_L) x Reducer rate (η_G)

The above calculation is requisite for selecting capacities for all loads.

First calculate the load torque of the motor during constant speed running and then select a tentative capacity so that the continuous rated torque of the motor during constant speed running becomes higher than the load torque. To perform capacity selection efficiently, it is necessary to match the rated speeds (base speeds) of the motor and load each other. To do this, select an appropriate reducer (mechanical transmission) ratio and the number of motor poles.

If there is no restriction on acceleration or deceleration time and the load is not a lift load, the tentative capacity can apply as a defined capacity.

(2) Calculating the acceleration time (For detailed calculation, refer to Section 9.1.3.2)

When there are some specified requirements for the acceleration time, calculate it according to the following procedure:

1) Calculate the moment of inertia for the load and motor

   If the moment of inertia is large, the motor cannot accelerate easily, requiring longer acceleration time. Calculate the moment of inertia for the load, referring to Section 9.1.3.2, "Acceleration and deceleration time calculation." For the motor, refer to the related motor catalogs.

2) Calculate the minimum acceleration torque (See Figure 9.3)

   The acceleration torque is the difference between the "motor output torque allowed for one minute" explained in Section 9.1.1 (2) and the "load torque during constant speed running" calculated in the above (1). Calculate the minimum acceleration torque for the whole range of speed.

   At speeds higher than the motor rated speed, the output torque drops in inverse proportion to the speed.

3) Calculate the acceleration time

   Assign the value calculated above to the equation (9.15) in Section 9.1.3.2, "Acceleration and deceleration time calculation" to calculate the acceleration time. If the calculated acceleration time is longer than the expected time, select the inverter and motor having one class larger capacity and calculate it again.

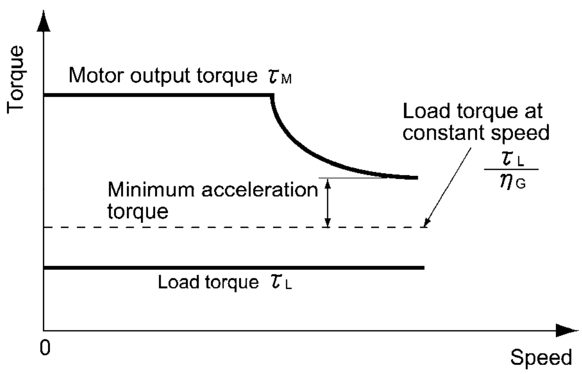


Figure 9.3 Example Study of Minimum Acceleration Torque

(3) Deceleration time (For detailed calculation, refer to Section 9.1.3.2)

To calculate the deceleration time, check the motor deceleration torque characteristics for the whole range of speed in the same way as for the acceleration time.

1) Calculate the moment of inertia for the load and motor

   Same as for the acceleration time. If the moment of inertia is large, the deceleration time increases.

2) Calculate the minimum deceleration torque (See Figures 9.4 and 9.5.)

   If the load torque is a positive value, Figure 9.4 applies.

   If the load is a braking load of a lift, etc. and the load torque is a negative value, Figure 9.5 applies. In this case, be careful with the minimum value of the braking torque that decreases due to energy regeneration.

3) Calculate the deceleration time

   Assign the value calculated above to the equation (9.16) to calculate the deceleration time in the same way as for the acceleration time. If the calculated deceleration time is longer than the requested time, select the inverter and motor having one class larger capacity and calculate it again.

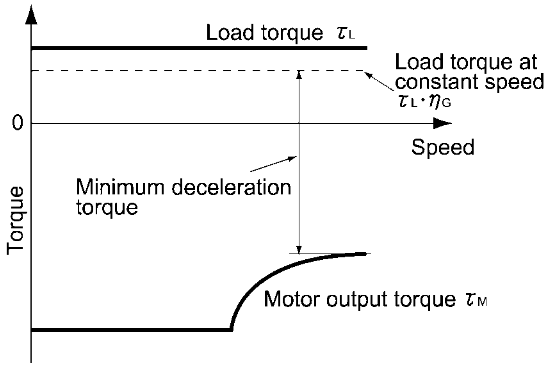


Figure 9.4 Example Study of Minimum Deceleration Torque (1)

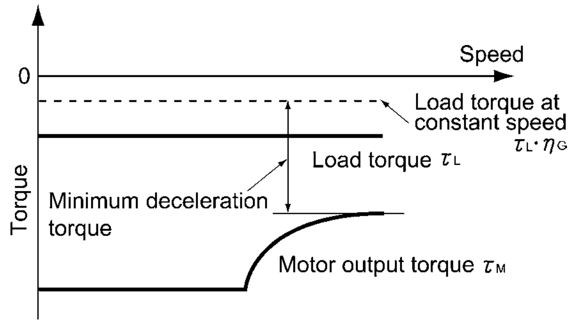


Figure 9.5 Example Study of Minimum Deceleration Torque (2)

(4) Braking resistor rating (For detailed calculation, refer to Section 9.1.3.3)

Braking resistor rating is classified into two types according to the braking periodic duty cycle.

1) When the periodic duty cycle is 100 sec or less:

   Calculate the average loss to determine rated values.

2) When the periodic duty cycle exceeds 100 sec:

   The allowable braking energy depends on the maximum regenerative braking capacity. The allowable values are listed in Chapter 8, Section 8.5.1.1 "Braking resistors (DBRs) and braking units."

(5) Motor RMS current (For detailed calculation, refer to Section 9.1.3.4)

In metal processing machine and materials handling machines requiring positioning control, highly frequent running for a short time is repeated. In this case, calculate the maximum equivalent RMS current value (effective value of current) not to exceed the allowable value (rated current) for the motor.

(6) Notes for examining inverter capacity

- When selecting an inverter for driving a FRENIC-VG dedicated motor, ensure that the root mean square of the motor torque is lower than 100% of the rated torque.
- When selecting a general-purpose motor, ensure that the root mean square of the motor current is lower than the motor rated current for effective motor cooling. In this case, select an inverter so that the root mean square of the current is lower than the inverter rated current.

9.1.3 Equations for selections

9.1.3.1 Load torque during constant speed running

[1] General equation

The frictional force acting on a horizontally moved load must be calculated. Calculation for driving a load along a straight line with the motor is shown below.

Where the force to move a load linearly at constant speed υ (m/s) is F (N) and the motor speed for driving this is N_M (r/min), the required motor output torque τ_M (N·m) is as follows:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot \frac{F}{\eta_G} \quad (N \cdot m) \qquad (9.1)$$

where, η_G is Reduction-gear efficiency.

When the inverter brakes the motor, efficiency works inversely, so the required motor torque should be calculated as follows:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot F \cdot \eta_G \quad (N \cdot m) \qquad (9.2)$$

$(60 \cdot \upsilon) / (2\pi \cdot N_M)$ in the above equation is an equivalent turning radius corresponding to speed υ (m/s) around the motor shaft.

The value F (N) in the above equations depends on the load type.

[2] Obtaining the required force F

■ Moving a load horizontally

A simplified mechanical configuration is assumed as shown in Figure 9.6. If the mass of the carrier table is W_0 (kg), the load is W (kg), and the friction coefficient of the ball screw is μ, then the friction force F (N) is expressed as follows, which is equal to a required force for driving the load:

$$F = (W_0 + W) \cdot g \cdot \mu \quad (N) \qquad (9.3)$$

where, g is the gravity acceleration ($\approx$ 9.8 (m/s^2)).

Then, the driving torque around the motor shaft is expressed as follows:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot \frac{(W_0 + W) \cdot g \cdot \mu}{\eta_G} \quad (N \cdot m) \qquad (9.4)$$

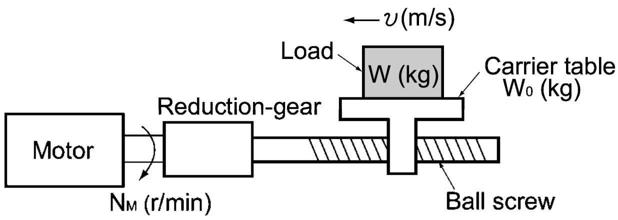


Figure 9.6 Moving a Load Horizontally

■ Vertical Lift Load

A simplified mechanical configuration is assumed as shown in Figure 9.7. If the mass of the cage is W_0 (kg), the load is W (kg), and the balance weight is W_B (kg), then the forces F (N) required for lifting the load up and down are expressed as follows:

$$F = (W_0 + W - W_B) \cdot g \text{ (N)} \qquad \text{(For lifting up)} \qquad (9.5)$$

$$F = (W_0 - W - W_B) \cdot g \text{ (N)} \qquad \text{(For lifting down)} \qquad (9.6)$$

Assuming the maximum load is W_{max}, the mass of the balance weight W_B (kg) is generally obtained with the expression $W_B = W_O + W_{max}/2$. Depending on the mass of load W (kg), the values of F (N) may be negative in both cases of lifting up and down, which means the lift is in braking mode. So, be careful in motor and inverter selection.

For calculation of the required output torque τ around the motor shaft, apply the expression (9.1) or (9.2) depending on the driving or braking mode of the lift, that is, apply the expression (9.1) if the value of F (N) is positive, and the (9.2) if negative.

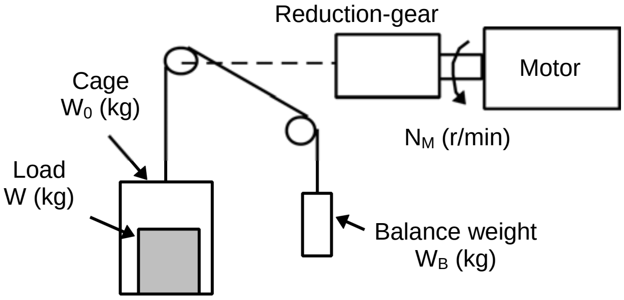


Figure 9.7 Vertical Lift Load

■ Inclined Lift Load

Although the mechanical configuration of an inclined lift load is similar to that of a vertical lift load, unignorable friction force in the inclined lift makes a difference; in an inclined lift load, there is a distinct difference between the expression to calculate the lift force F (N) for lifting up and that for lifting down.

If the incline angle is θ, and the friction coefficient is μ, as shown in the Figure 9.8, the driving force F (N) is expressed as follows:

$$F = ((W_0 + W)(\sin\theta + \mu \cdot \cos\theta) - W_B) \cdot g \text{ (N)} \qquad \text{(For lifting up)} \qquad (9.7)$$

$$F = ((W_B - (W_0 + W)(\sin\theta + \mu \cdot \cos\theta)) \cdot g \text{ (N)} \qquad \text{(For lifting down)} \qquad (9.8)$$

The braking mode applies to both lifting up and down as in the vertical lift load. And the calculation of the required output torque τ around the motor shaft is the same as in the vertical lift load; apply the expression (9.1) if the value of F (N) is positive, and the (9.2) if negative.

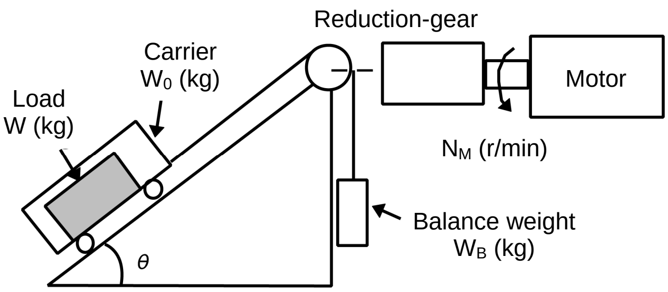


Figure 9.8 Inclined Lift Load

9.1.3.2 Acceleration and deceleration time calculation

When an object whose moment of inertia is J ($kg \cdot m^2$) rotates at the speed N (r/min), it has the following kinetic energy:

$$E = \frac{J}{2} \bullet \left(\frac{2\pi \bullet N}{60}\right)^2 \quad (J) \qquad (9.9)$$

To accelerate the above rotational object, the kinetic energy will be increased; to decelerate the object, the kinetic energy must be discharged. The torque required for acceleration and deceleration can be expressed as follows:

$$\tau = J \bullet \frac{2\pi}{60} \left(\frac{dN}{dt}\right) \quad (N \bullet m) \qquad (9.10)$$

This way, the mechanical moment of inertia is an important element in the acceleration and deceleration. First, calculation method of moment of inertia is described, then those for acceleration and deceleration time are explained.

[1] Calculation of moment of inertia

For an object that rotates around the shaft, virtually divide the object into small segments and square the distance from the shaft to each segment. Then, sum the squares of the distances and the masses of the segments to calculate the moment of inertia.

$$J = \sum (W_i \bullet r_i^2) \quad (kg \bullet m^2) \qquad (9.11)$$

The following describes equations to calculate moment of inertia having different shaped loads or load systems.

(1) Hollow cylinder and solid cylinder

The common shape of a rotating body is hollow cylinder. The moment of inertia J ($kg \cdot m^2$) around the hollow cylinder center axis can be calculated as follows, where the outer and inner diameters are D_1 and D_2 [m] and total mass is W [kg] in Figure 9.9.

$$J = \frac{W \bullet (D_1^2 + D_2^2)}{8} \quad (kg \bullet m^2) \qquad (9.12)$$

For a similar shape, a solid cylinder, calculate the moment of inertia as D_2 is 0.

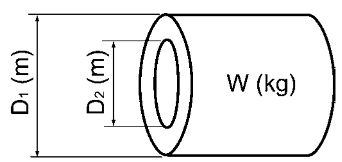


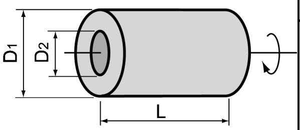
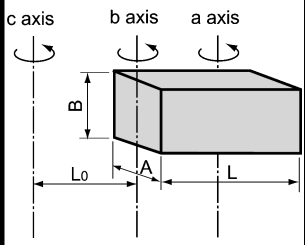
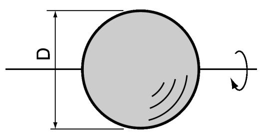
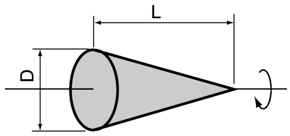
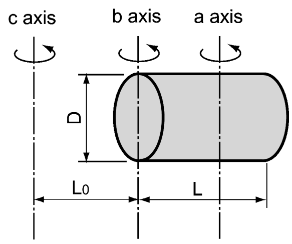
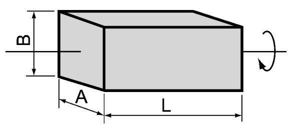
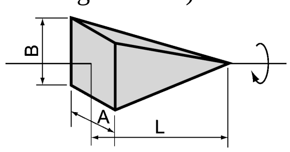
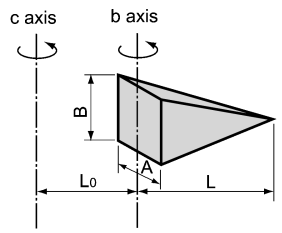
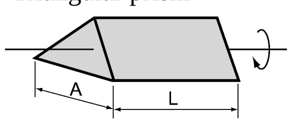
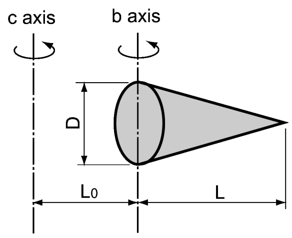
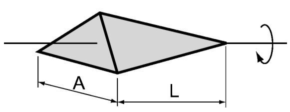
Figure 9.9 Hollow Cylinder

(2) For a general rotating body

Table 9.1 lists the calculation equations of moment of inertia of various rotating bodies including the above cylindrical rotating body.

Chap. 9 SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

Table 9.1 Moment of Inertia of Various Rotating Bodies

Shape	Mass: W (kg) / Moment of inertia: J ($kg \cdot m^2$)	Shape	Mass: W (kg) / Moment of inertia: J ($kg \cdot m^2$)
Hollow cylinder 	$W = \frac{\pi}{4} \bullet (D_1^2 - D_2^2) \bullet L \bullet \rho$ / $J = \frac{1}{8} \bullet W \bullet (D_1^2 + D_2^2)$		$W = A \bullet B \bullet L \bullet \rho$ / $J_a = \frac{1}{12} \bullet W \bullet (L^2 + A^2)$ $J_b = \frac{1}{12} \bullet W \bullet (L^2 + \frac{1}{4} \bullet A^2)$ $J_c \approx W \bullet (L_0^2 + L_0 \bullet L + \frac{1}{3} \bullet L^2)$
Sphere 	$W = \frac{\pi}{6} \bullet D^3 \bullet \rho$ / $J = \frac{1}{10} \bullet W \bullet D^2$		
Cone 	$W = \frac{\pi}{12} \bullet D^2 \bullet L \bullet \rho$ / $J = \frac{3}{40} \bullet W \bullet D^2$		$W = \frac{\pi}{4} \bullet D^2 \bullet L \bullet \rho$ / $J_a = \frac{1}{12} \bullet W \bullet (L^2 + \frac{3}{4} \bullet D^2)$ $J_b = \frac{1}{3} \bullet W \bullet (L^2 + \frac{3}{16} \bullet D^2)$ $J_c \approx W \bullet (L_0^2 + L_0 \bullet L + \frac{1}{3} \bullet L^2)$
Rectangular prism 	$W = A \bullet B \bullet L \bullet \rho$ / $J = \frac{1}{12} \bullet W \bullet (A^2 + B^2)$		
Square cone (Pyramid, rectangular base) 	$W = \frac{1}{3} \bullet A \bullet B \bullet L \bullet \rho$ / $J = \frac{1}{20} \bullet W \bullet (A^2 + B^2)$		$W = \frac{1}{3} \bullet A \bullet B \bullet L \bullet \rho$ / $J_b = \frac{1}{10} \bullet W \bullet (L^2 + \frac{1}{4} \bullet A^2)$ $J_c \approx W \bullet (L_0^2 + \frac{3}{2} \bullet L_0 \bullet L + \frac{3}{5} \bullet L^2)$
Triangular prism 	$W = \frac{\sqrt{3}}{4} \bullet A^2 \bullet L \bullet \rho$ / $J = \frac{1}{3} \bullet W \bullet A^2$		$W = \frac{\pi}{12} \bullet D^2 \bullet L \bullet \rho$ / $J_b = \frac{1}{10} \bullet W \bullet (L^2 + \frac{3}{8} \bullet D^2)$ $J_c \approx W \bullet (L_0^2 + \frac{3}{2} \bullet L_0 \bullet L + \frac{3}{5} \bullet L^2)$
Tetrahedron with an equilateral triangular base 	$W = \frac{\sqrt{3}}{12} \bullet A^2 \bullet L \bullet \rho$ / $J = \frac{1}{5} \bullet W \bullet A^2$		
Main metal density (at 20°C) $\rho (kg/m^3)$ Iron: 7860, Copper: 8940, Aluminum: 2700			

(3) For a load running horizontally

Assume a carrier table driven by a motor as shown in Figure 9.6. If the table speed is υ (m/s) when the motor speed is N_M (r/min), then an equivalent distance from the shaft is equal to $60 \cdot \upsilon / (2\pi \cdot N_M)$ (m). The moment of inertia of the table and load to the shaft is calculated as follows:

$$J = \left(\frac{60 \cdot \upsilon}{2\pi \cdot N_M}\right)^2 \cdot (W_0 + W) \quad (kg \cdot m^2) \tag{9.13}$$

(4) For a vertical or inclined lift load

The moment of inertia J ($kg \cdot m^2$) of the loads connected with a rope as shown in Figures 9.7 and 9.8 is calculated with the following equation using the mass of all moving objects, although the motion directions of those loads are different.

$$J = \left(\frac{60 \cdot \upsilon}{2\pi \cdot N_M}\right)^2 \cdot (W_0 + W + W_B) \quad (kg \cdot m^2) \tag{9.14}$$

[2] Calculation of the acceleration time

Figure 9.10 shows a general load model. Assume that a motor drives a load via a reduction-gear with efficiency η_G. The time required to accelerate this load in stop state to a speed of N_M (r/min) is calculated with the following equation:

$$t_{ACC} = \frac{J_1 + J_2/\eta_G}{\tau_M - \tau_L/\eta_G} \cdot \frac{2\pi \cdot (N_M - 0)}{60} \quad (s) \tag{9.15}$$

where,

J_1: Motor shaft moment of inertia ($kg \cdot m^2$)
J_2: Load shaft moment of inertia converted to motor shaft ($kg \cdot m^2$)
τ_M: Minimum motor output torque in driving motor (N·m)
τ_L: Maximum load torque converted to motor shaft (N·m)
η_G: Reduction-gear efficiency.

As clarified in the above equation, the equivalent moment of inertia becomes ($J_1 + J_2/\eta_G$) by considering the reduction-gear efficiency.

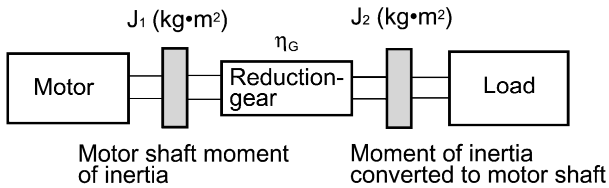


Figure 9.10 Load Model Including Reduction-gear

[3] Calculation of the deceleration time

In a load system shown in Figure 9.10, the time needed to stop the motor rotating at a speed of N_M (r/min) is calculated with the following equation:

$$t_{DEC} = \frac{J_1 + J_2 \bullet \eta_G}{\tau_M - \tau_L \bullet \eta_G} \bullet \frac{2\pi \bullet (0 - N_M)}{60} \quad \text{(s)} \qquad (9.16)$$

where,

J_1: Motor shaft moment of inertia (kg·m^2)
J_2: Load shaft moment of inertia converted to motor shaft (kg·m^2)
τ_M: Minimum motor output torque in braking (or decelerating) motor (N·m)
τ_L: Maximum load torque converted to motor shaft (N·m)
η_G: Reduction-gear efficiency

In the above equation, generally output torque τ_M is negative and load torque τ_L is positive. So, deceleration time becomes shorter. However, in the case of a lift load, τ_L may become a negative value in the braking mode so that the deceleration time becomes longer.

Tip: For lift applications, calculate the deceleration time using the negative value of τ_L (maximum load torque converted to motor shaft).

[4] Calculating non-linear acceleration/deceleration time

In applications requiring frequent acceleration/deceleration, the inverter can accelerate/decelerate the motor in the shortest time utilizing all torque margins. The inverter in a vector control mode can easily perform this type of operation.

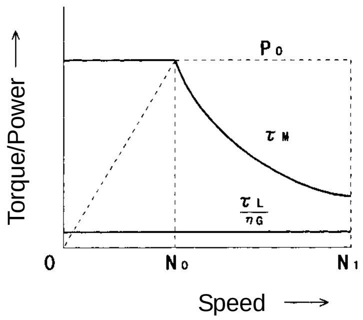


Figure 9.11 An Example of Driving Characteristics with a Constant Output Range

In this case, the acceleration/deceleration vs. speed curve will form a non-linear figure, and the acceleration/deceleration time cannot be calculated by a single expression.

Generally, the acceleration/deceleration time is obtained by calculating the acceleration/deceleration time of ΔN that is a difference of speed N broken into small parts, and then integrating it to obtain the total acceleration/deceleration time from start to end. Because the smaller ΔN provides higher accuracy, this numerical calculation needs an aid of a computer program.

The following is a guide for the numerical calculation method using a computer program.

Figure 9.11 illustrates an example of driving characteristics with a constant output range. In the figure, the range under N_0 is of constant torque characteristics, and the range between N_0 and N_1 is of a constant output with the non-linear acceleration/deceleration characteristics.

[4-1] Calculating non-linear acceleration time

The expression (9.17) gives an acceleration time Δt_{ACC} within a ΔN speed thread.

$$\Delta t_{ACC} = \frac{J_1 + J_2 / \eta_G}{\tau_M - \tau_L / \eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \quad (s) \qquad (9.17)$$

Before proceeding this calculation, obtain the motor shaft moment of inertia J_1, the load shaft moment of inertia converted to motor shaft J_2, maximum load torque converted to motor shaft τ_L, and the reduction-gear efficiency η_G. Apply the maximum motor output torque τ_M according to an actual speed thread ΔN as follows.

[τ_M in $N \leq N_0$] Constant output torque range

$$\tau_M = \frac{60 \cdot P_O}{2\pi \cdot N_0} \quad (N \cdot m) \qquad (9.18)$$

[τ_M in $N_0 \leq N \leq N_1$] Constant output power range
(The motor output torque is inversely proportional to the motor speed)

$$\tau_M = \frac{60 \cdot P_O}{2\pi \cdot N} \quad (N \cdot m) \qquad (9.19)$$

If the result obtained by the above calculation does not satisfy the target value, select an inverter with one rank higher capacity.

[4-2] Calculating non-linear deceleration time

Use the following expression to obtain the non-linear deceleration time as well as for the acceleration time shown in [4-1].

$$\Delta t_{DEC} = \frac{J_1 + J_2 \cdot \eta_G}{\tau_M - \tau_L \cdot \eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \quad (s) \qquad (9.20)$$

In this expression, both τ_M, and ΔN are generally negative values so that the load torque τ_L serves to assist the deceleration operation. For a lift load, however, the load torque τ_L is a negative value in some modes. In this case, the τ_M, and τ_L will take polarity opposite to each other and the τ_L will serve to prevent the deceleration operation of the lift.

9.1.3.3 Heat energy calculation of braking resistor

If the inverter brakes the motor, the kinetic energy of mechanical load is converted to electric energy to be regenerated into the inverter circuit. This regenerative energy is generally consumed in so-called braking resistors as heat. The following explains the braking resistor rating.

[1] Calculation of regenerative energy

In the inverter operation, the regenerative energy sources include the kinetic energy of a moving object and the potential energy of a lift.

(1) Kinetic energy of a moving object

When an object with moment of inertia J ($kg \cdot m^2$) rotates at a speed N_2 (r/min), its kinetic energy is as follows:

$$E = \frac{J}{2} \bullet \left(\frac{2\pi \bullet N_2}{60}\right)^2 \quad (J = Ws) \qquad (9.21)$$

$$\approx \frac{1}{182.4} \bullet J \bullet N_2^2 \quad (J) \qquad (9.21)'$$

When this object is decelerated to a speed N_1 (r/min), the output energy is as follows:

$$E = \frac{J}{2} \bullet \left[\left(\frac{2\pi \bullet N_2}{60}\right)^2 - \left(\frac{2\pi \bullet N_1}{60}\right)^2\right] \quad (J) \qquad (9.22)$$

$$\approx \frac{1}{182.4} \bullet J \bullet (N_2^2 - N_1^2) \quad (J) \qquad (9.22)'$$

The energy regenerated to the inverter as shown in Figure 9.11 is calculated from the reduction-gear efficiency η_G and motor efficiency η_M as follows:

$$E \approx \frac{1}{182.4} \bullet \left(J_1 + J_2 \bullet \eta_G\right) \bullet \eta_M \bullet \left(N_2^2 - N_1^2\right) \quad (J) \qquad (9.23)$$

(2) Potential energy of a lift

When an object whose mass is W (kg) falls from the height h_2 (m) to the height h_1 (m), the output energy is as follows:

$$E = W \bullet g \bullet (h_2 - h_1) \; (J=Ws) \qquad (9.24)$$

$$g \approx 9.8065 \; (m/s^2)$$

The energy regenerated to the inverter is calculated from the reduction-gear efficiency η_G and motor efficiency η_M as follows:

$$E = W \bullet g \bullet (h_2 - h_1) \bullet \eta_G \bullet \eta_M \; (J) \qquad (9.25)$$

9.1.3.4 Calculating the RMS rating of the motor

In the case of a load which is repeatedly and very frequently driven by a motor, the motor current fluctuates largely and enters the short-time rating range of the motor repeatedly. Therefore, you have to review the allowable thermal rating of the motor. The heat value is assumed to be approximately proportional to the square of the motor current. The temperature of the forced cooling fan type of FRENIC-VG dedicated motors rises in proportion to the heat value.

If an inverter drives a motor in duty cycles that are much shorter than the thermal time constant of the motor, calculate the "equivalent RMS current" as mentioned below, and select the motor so that this RMS current will not exceed the rated current of the motor.

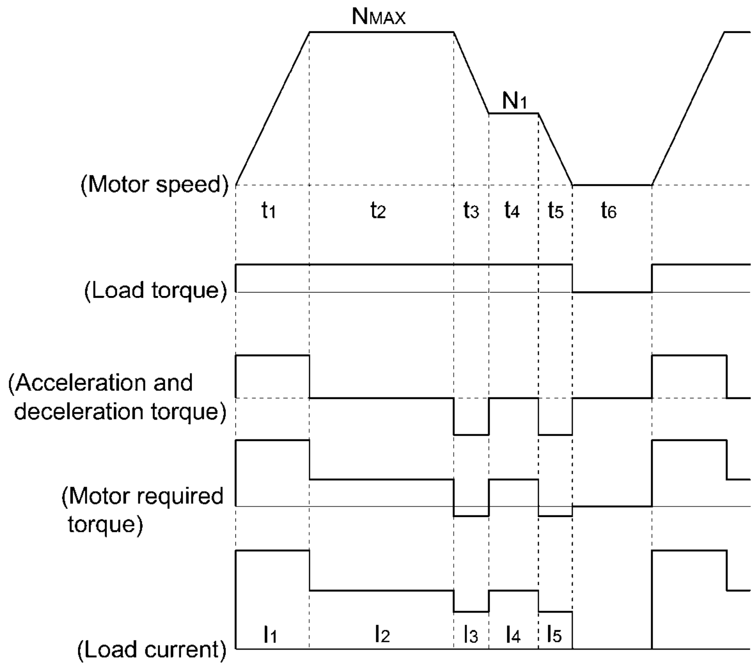


Figure 9.12 Sample of the Repetitive Operation

First, calculate the required torque of each part based on the speed pattern. Then using the torque-current curve of the motor, convert the torque to the motor current. The "equivalent RMS current, I_{eq}" can be finally calculated by the following equation:

$$I_{eq} = \sqrt{\frac{I_1^2 \cdot t_1 + I_2^2 \cdot t_2 + I_3^2 \cdot t_3 + I_4^2 \cdot t_4 + I_5^2 \cdot t_5}{t_1 + t_2 + t_3 + t_4 + t_5 + t_6}} \quad (A) \qquad (9.26)$$

The torque-current curve for the dedicated motor is not available for actual calculation. Therefore, calculate the motor current I from the load torque τ_1 using the following equation (9.27). Then, calculate the equivalent current I_{eq}:

$$I = \sqrt{\left(\frac{\tau 1}{100} \times I_{t100}\right)^2 + I_{m100}^2} \quad (A) \qquad (9.27)$$

Where, τ_1 is the load torque (%), I_{t100} is the torque current (P09; M1 torque current), and I_{m100} is exciting current (P08; M1 exciting current).

- For the function code data of P08 and P09, refer to Chapter 12 "Replacement Information."
- When using the 2nd motor, refer to the torque current and exciting current of A codes instead of those of P codes.

9.2 Selecting a Braking Resistor

9.2.1 Selection procedure

Depending on the cyclic period, the following requirements must be satisfied.

① If the cyclic period is 100 s or less: Requirements 1) and 3) below
② If the cyclic period exceeds 100 s: Requirements 1) and 2) below

1) The maximum braking torque should not exceed values listed in the tables given in Chapter 8, Section 8.5.1 "Braking resistors (DBRs) and braking units." To use the maximum braking torque exceeding values in those tables, select the braking resistor having one class larger capacity.
2) The discharge energy for a single braking action should not exceed the discharging capability (kWs) listed in the tables given in Chapter 8, Section 8.5.1 "Braking resistors (DBRs) and braking units." For detailed calculation, refer to Section 9.1.3.3 "Heat energy calculation of braking resistor."
3) The average loss that is calculated by dividing the discharge energy by the cyclic period must not exceed the average allowable loss (kW) listed in the tables given in Chapter 8, Section 8.5.1 "Braking resistors (DBRs) and braking units."

9.2.2 Notes on selection

The braking time T_1, cyclic period T_0, and duty cycle %ED are converted under deceleration braking conditions based on the rated torque as shown below. However, you do not need to consider these values when selecting the braking resistor capacity.

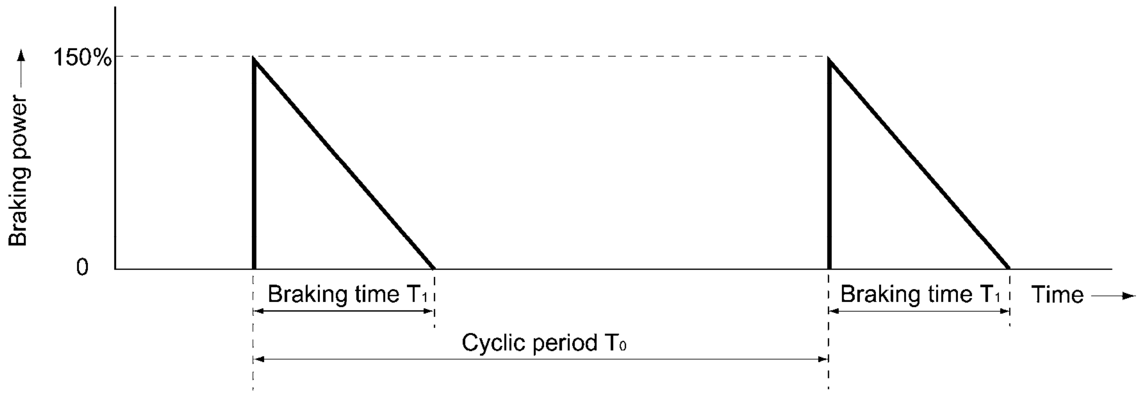


Figure 9.13 Duty Cycle

$$\text{Duty cycle \%ED} = \frac{T1}{T0} \times 100\ (\%)$$

9.3 Selecting an Inverter Drive Mode (HD/MD/LD)

9.3.1 Precaution in making the selection

The FRENIC-VG series of inverters is available in three different drive modes--HD (High Duty: for heavy duty load applications) , MD (Medium Duty: for medium duty load applications), and LD (Low Duty: for light duty load applications), which can be switched on site. The HD mode can drive a motor with the same capacity as the inverter; the MD mode, with one rank higher capacity than the inverter; the LD mode, with one or two ranks higher capacity than the inverter.

The LD mode is available in inverters of 30 kW or above, and the MD mode, in the 400 V class series of inverters of 90 to 400 kW.

Select the inverter drive mode appropriate to the user application, considering the motor capacity, overload characteristics, and HD/MD/LD mode referring to Section 9.3.2 "Guideline for selecting inverter drive mode and capacity."

HD mode designed for heavy duty load applications

Apply to general-purpose equipment where the inverter’s load current in normal operations is less than the rated current of the HD-mode inverter, and the load current in overcurrent operation is less than 150% of the rated current of the HD-mode inverter for 1 minute and 200% for 3 seconds.

The rated current of the HD mode inverter is based on a motor with the same capacity as the inverter. Inverter running with the intermittent load rating is also possible as described below.

Intermittent load rating in the HD mode

Satisfying the following conditions enables inverter running with overload torque 164 to 200% (depending upon the capacity) for 10 seconds or below.

1) The root-mean-square current in cycle operation is 80% or less of the inverter rated current.
2) The carrier frequency is 10 or 6 kHz (depending upon the capacity) or below.

MD mode designed for medium duty load applications

Apply to equipment where the inverter’s load current in normal operations is less than the rated current of the MD-mode inverter, and the load current in overcurrent operation is less than 150% of the rated current of the MD-mode inverter for 1 minute.

The rated current of the MD-mode inverter is based on a motor with one rank higher capacity than the inverter.

LD mode designed for light duty load applications

Apply to variable load equipment such as fans, pumps, and centrifugal machines where the inverter’s load current in normal operations is less than the rated current of the LD-mode inverter, and the load current in overcurrent operation is less than 120% of the rated current of the LD-mode inverter for 1 minute.

The rated current of the LD-mode inverter is based on a motor with one or two ranks higher capacity than the inverter.

Replacement information for replacing the FRENIC5000VG7S (HT mode) with the FRENIC-VG series

The FRENIC-VG does not support the HT mode. When replacing the HT-mode FRENIC5000VG7S with the FRENIC-VG, therefore, use the inverter with one rank higher capacity. Note that only when the 200 V class series of inverters of 7.5 to 22 kW or the 400 V class series of inverters of 18.5 to 22 kW runs with the carrier frequency of 10 kHz or below, the FRENIC5000VG7S can be replaced with the FRENIC-VG with the same capacity.

9.3.2 Guideline for selecting inverter drive mode and capacity

Table 9.2 lists the differences between HD, MD, and LD modes.

If MD-/LD-mode inverters of 30 kW or above satisfy the requirements of the overload capability and functionality in your application, you can select the inverter with one or two ranks lower capacity than that of the motor rating.

Table 9.2 Differences between HD, MD, and LD modes

<table>
<tr><th colspan="2">Function</th><th>HD mode</th><th>MD mode</th><th>LD mode</th><th>Remarks</th></tr>
<tr><td colspan="2">Application</td><td>Heavy duty load</td><td>Medium duty load</td><td>Light duty load</td><td>—</td></tr>
<tr><td rowspan="2">Capacity range</td><td>200 V</td><td>All capacities</td><td>Not available</td><td>30 to 90 kW
(corresponding to 37-110 kW motors)</td><td></td></tr>
<tr><td>400 V</td><td>All capacities</td><td>90 to 400 kW
(corresponding to 110 to 450 kW motors)</td><td>30 to 630 kW
(corresponding to 37 to 710 kW motors)</td><td></td></tr>
<tr><td colspan="2">Function code data setting
(Switching between HD, MD, and LD modes)</td><td>F80 = 0,
(Factory default)</td><td>F80 = 3</td><td>F80 = 1</td><td>—</td></tr>
<tr><td colspan="2">Continuous current rating level (inverter rated current level)</td><td>Rated current based on a motor with the <u>same</u> capacity as the inverter.</td><td>Rated current based on a motor with <u>one rank higher</u> capacity than the inverter.</td><td>Rated current based on a motor with <u>one or two ranks higher</u> capacity than the inverter.</td><td rowspan="2">The MD-/LD-mode inverter brings out the continuous current rating level which enables the inverter to drive a motor with one or two ranks higher capacity, but its overload capability (%) against the continuous current level decreases.
For the rated current level, refer to Chapter 2 "SPECIFICATIONS."</td></tr>
<tr><td colspan="2">Overload capability</td><td>150% for 1 min.
200% for 3 s,
relative to the rated current of HD-mode inverters</td><td>150% for 1 min.
relative to the rated current of MD-mode inverters</td><td>120% for 1 min.
relative to the rated current of LD-mode inverters</td></tr>
<tr><td colspan="2">Motor sound
(Carrier frequency)</td><td>Setting range:
2 to 15 kHz
(0.75 to 55 kW)
2 to 10 kHz
(75 to 400 kW)
2 to 5 kHz
(500, 630 kW)</td><td>Setting range:
2 to 4 kHz
(90 to 400 kW)</td><td>Setting range:
2 to 10 kHz
(30 to 55 kW)
2 to 5 kHz
(75 to 500 kW)
2 kHz
(630 kW)</td><td>In the MD/LD mode, a value out of the range, if specified, automatically changes to the maximum value allowable in the MD/LD mode.</td></tr>
</table>

The MD-/LD-mode inverters have no restrictions on the output frequency range.

The MD-/LD-mode inverters have no restrictions on the setting range of function codes whose data (e.g., DC braking level) is based on the rated current.

A DC reactor (DCR) is provided as standard for the FRENIC-VG of 75 kW or above. To use the inverter in the MD or LD mode, specify the MD-/LD-mode inverter when placing an order, and the FRENIC-VG comes with the DCR suitable for the motor capacity to be applied in the MD or LD mode. If the MD-/LD-mode inverter is not specified, the FRENIC-VG comes with the DCR suitable for the motor capacity to be applied in the HD mode. Applying the DCR to be applied in the HD mode to the MD-/LD-mode inverters may flow the current exceeding the DCR rated current.

If an order for the LD-mode inverter of 55 kW is placed, the inverter comes with the DCR suitable for 75 kW as standard.

Each rated current in the HD, MD and LD modes is used as a base for displaying or specifying the electric current data in percent (%) of the rated current with function codes or for outputting or displaying it by analog output or communications monitor.

Chapter 10
ABOUT MOTORS

This chapter details vector motors that can be connected to the FRENIC-VG series of inverters.

Contents

10.1 Vibration and Noise

For the specifications and the external dimensions of the dedicated motors, refer to Chapter 2, Section 2.4 "Dedicated Motor Specifications."

<table>
<tr><th rowspan="2">Dedicated applicable motor (kW)</th><th rowspan="2">No. of poles</th><th>Motor type</th><th colspan="2">Vibration level (μm)</th><th colspan="2">Noise level (dB (A)) *3</th></tr>
<tr><th>MVK__</th><th>Base speed 1500 r/min</th><th>Maximum speed *2 3600 r/min</th><th>Base speed 1500 r/min</th><th>Maximum speed 3600 r/min</th></tr>
<tr><td>0.75</td><td rowspan="27">4</td><td>8095A</td><td rowspan="12">Max. 5</td><td rowspan="10">Max. 7</td><td rowspan="3">56</td><td rowspan="3">60</td></tr>
<tr><td>1.5</td><td>8097A</td></tr>
<tr><td>2.2</td><td>8107A</td></tr>
<tr><td>3.7</td><td>8115A</td><td>58</td><td>62</td></tr>
<tr><td>5.5</td><td>8133A</td><td rowspan="2">60</td><td rowspan="2">64</td></tr>
<tr><td>7.5</td><td>8135A</td></tr>
<tr><td>11</td><td>8165A</td><td rowspan="2">68</td><td rowspan="2">72</td></tr>
<tr><td>15</td><td>8167A</td></tr>
<tr><td>18.5</td><td>8184A</td><td rowspan="4">71</td><td rowspan="2">73</td></tr>
<tr><td>22</td><td>8185A</td></tr>
<tr><td>30</td><td>8187A</td><td rowspan="2">Max. 7</td><td rowspan="2">73</td></tr>
<tr><td>37</td><td>8207A</td></tr>
<tr><td>45</td><td>8208A</td><td>Max. 5</td><td>Max. 7</td><td>71</td><td>73</td></tr>
<tr><td>55</td><td>9224A</td><td rowspan="14">*1</td><td rowspan="14">Max. 15</td><td rowspan="14">*1</td><td rowspan="14">*1</td></tr>
<tr><td>75</td><td>9254A</td></tr>
<tr><td>90</td><td>9256A</td></tr>
<tr><td>110</td><td>9284A</td></tr>
<tr><td>132</td><td>9286A</td></tr>
<tr><td>160</td><td>528KA</td></tr>
<tr><td>200</td><td>528LA</td></tr>
<tr><td>220</td><td>531FA</td></tr>
<tr><td>250</td><td>531GA</td></tr>
<tr><td>280</td><td>531HA</td></tr>
<tr><td>300</td><td>535GA</td></tr>
<tr><td>315</td><td>535GA</td></tr>
<tr><td>355</td><td>535HA</td></tr>
<tr><td>400</td><td>535JA</td></tr>
</table>

*1 Contact your Fuji Electric representative for individual values.

*2 3000 r/min for 30 to 45 kW, 2400 r/min for 55 to 75 kW, 2000 r/min for 90 to 220 kW

*3 Values measured 1 m away from the motor to the direction of the terminal box

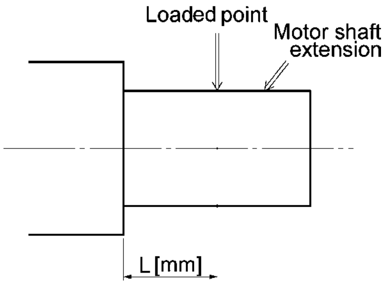
10.2 Acceleration Vibration Value

Dedicated applicable motor (kW)	No. of poles	Motor type MVK__	Acceleration vibration value, acceptable (m/s^2)
0.75	4	8095A	Max. 7
1.5		8097A	
2.2		8107A	
3.7		8115A	
5.5		8133A	
7.5		8135A	
11		8165A	
15		8167A	
18.5		8184A	
22		8185A	
30		8187A	
37		8207A	
45		8208A	
55		9224A	
75		9254A	
90		9256A	
110		9284A	
132		9286A	
160		528KA	
200		528LA	
220		531FA	
250		531GA	
280		531HA	
300		535GA	
315		535GA	
355		535HA	
400		535JA	

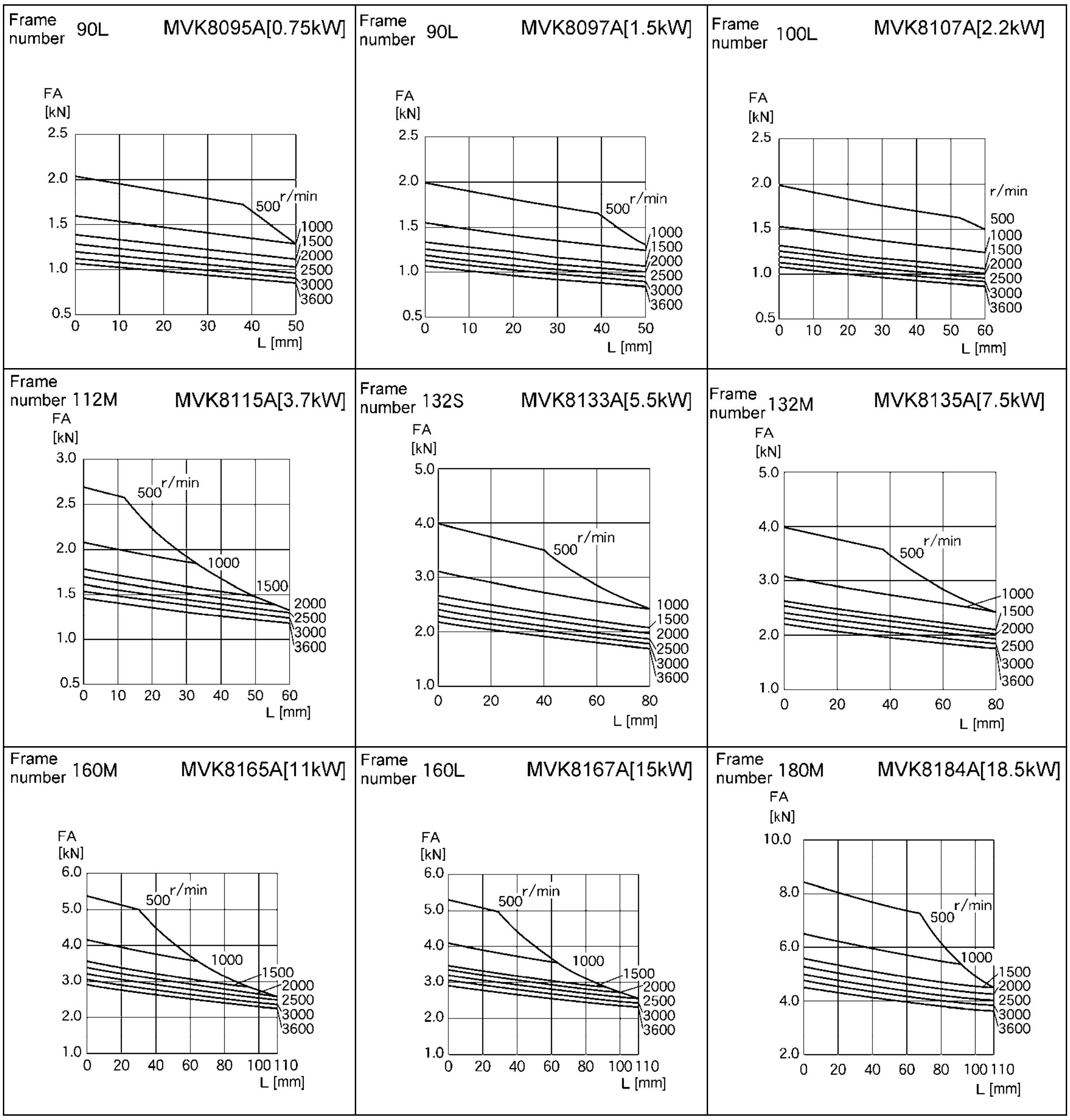
Note: If the actual vibration exceeds values listed above, any separate anti-vibration measure is required.

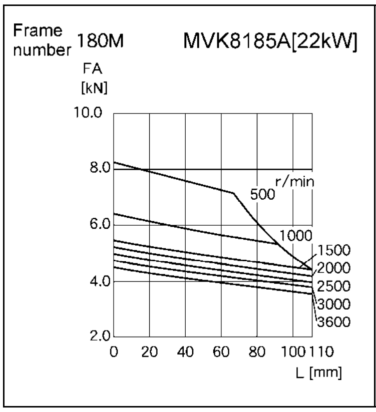
10.3 Allowable Radial Load at Motor Shaft Extension

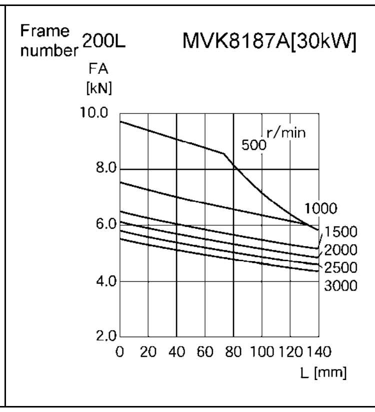
[Loaded point]

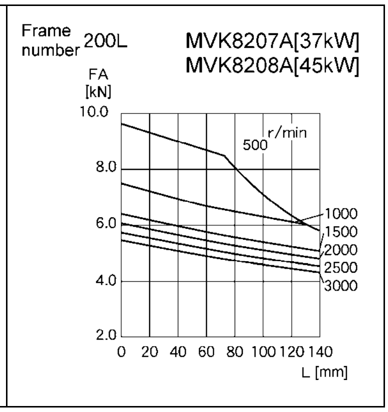


The maximum allowable value of radial load applied by the belt is shown in the figures below. The data is classified by the frame number and the rotation speed. If the point which is decided by the radial load FA (kN) acting on the motor shaft and the length L (mm) from the stepped joint at shaft end to the center of the pulley (the distance to the FA load points) is within a curve, the motor can be operated by that pulley. Refer to the technical leaflet of the induction motor for the details.





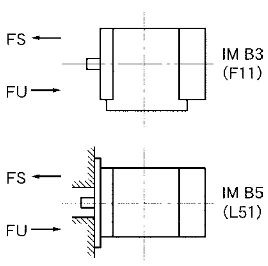
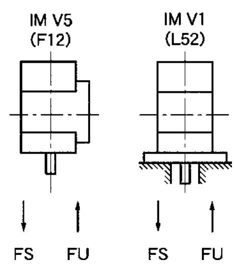
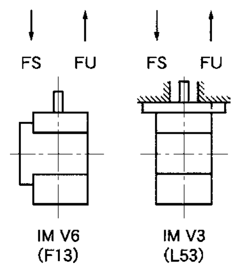




Note: Contact your Fuji Electric representative individually for motors whose frame number exceeds 200L (55 kW or above).

10.4 Allowable Thrust Load

Unit: kN (kgf)

Frame number	Type MVK__	Horizontal use IM B3(F11), IM B5(L51)						Vertical use IM V5(F12), IM V1(L52)						Vertical use IM V6(F13), IM V3(L53)					
		Direction of thrust: FS			Direction of thrust: FU			Direction of thrust: FS			Direction of thrust: FU			Direction of thrust: FS			Direction of thrust: FU		
		2 poles	4 poles	6 poles	2 poles	4 poles	6 poles	2 poles	4 poles	6 poles	2 poles	4 poles	6 poles	2 poles	4 poles	6 poles	2 poles	4 poles	6 poles
90L	8095A 8097A	0.3 (30)	0.45 (45)	0.55 (55)	0.4 (40)	0.6 (60)	0.7 (70)	0.25 (25)	0.4 (40)	0.5 (50)	0.45 (45)	0.65 (65)	0.75 (75)	0.4 (40)	0.55 (55)	0.65 (65)	0.3 (30)	0.5 (50)	0.6 (60)
100L	8107A	—	0.65 (65)	0.8 (80)	—	0.55 (55)	0.65 (65)	—	0.6 (60)	0.7 (70)	—	0.6 (60)	0.6 (60)	—	0.5 (50)	0.6 (60)	—	0.75 (75)	0.85 (85)
112M	8115A	0.65 (65)	0.9 (90)	1.1 (110)	0.6 (60)	0.75 (75)	0.95 (95)	0.6 (60)	0.8 (80)	1 (100)	0.65 (65)	0.85 (85)	1 (100)	0.55 (55)	0.7 (70)	0.85 (85)	0.75 (75)	1 (100)	1.2 (120)
132S	8133A	1 (100)	1.4 (140)	1.7 (170)	0.75 (75)	1 (100)	1.2 (120)	1 (100)	1.3 (130)	1.7 (170)	0.9 (90)	1.1 (110)	1.4 (140)	0.65 (65)	0.9 (90)	1.1 (110)	1.2 (120)	1.5 (150)	1.9 (190)
132M	8135A	—			—			—		1.6 (160)	—			—		1 (100)	—		
160M	8165A	1.3 (130)	1.8 (180)	2.2 (220)	1.2 (120)	1.5 (150)	1.9 (190)	1.1 (110)	1.6 (160)	2 (200)	1.5 (150)	1.8 (180)	2.2 (220)	1 (100)	1.4 (140)	1.7 (170)	1.6 (160)	2.1 (210)	2.5 (250)
160L	8167A		1.7 (170)	2.1 (210)			1.8 (180)		1.5 (150)	1.8 (180)					1.3 (130)	1.5 (150)			
180M	8184A 8185A	2 (200)	2.7 (280)	3.3 (340)	1.9 (190)	2.3 (230)	2.8 (290)	1.8 (180)	2.3 (230)	2.9 (300)	2.2 (220)	2.7 (280)	3.4 (350)	1.6 (160)	2 (200)	2.6 (270)	2.4 (240)	3.2 (330)	3.9 (400)
180L	8187A																		
200L	8207A	1.9 (190)	3.8 (390)	4.5 (460)	2 (200)	3.2 (330)	3.7 (380)	1.5 (150)	3.2 (330)	3.8 (390)	2.6 (270)	4 (410)	4.8 (490)		2.7 (280)	3 (310)	2.5 (250)	4.6 (470)	5.6 (570)
	8208A	1.2 (120)	5.4 (550)	6.5 (-)	1.2 (120)	5.4 (550)	6.5 (-)	0.4 (40)	4.4 (445)	5.3 (-)	2.3 (230)	6.9 (700)	8.2 (-)	0.4 (40)	4.4 (445)	5.3 (-)	2.3 (230)	6.9 (700)	8.2 (-)
225S	9224A	1.1 (110)	5.2 (535)	6.2 (630)	1.1 (110)	5.2 (535)	6.2 (630)	0.3 (30)	4.1 (415)	4.8 (490)				0.3 (30)	4.1 (415)	4.8 (490)			
250S	9254A	1 (100)	6.4 (650)	7.6 (770)	1 (100)	6.4 (650)	7.6 (770)	—	4.9 (500)	5.6 (570)	—	8.4 (860)	10.3 (1050)	—	4.9 (500)	5.6 (570)	—	8.4 (860)	10.3 (1050)
250M	9256A	0.9 (90)	6.2 (630)	7.3 (740)	0.9 (90)	6.2 (630)	7.3 (740)	—	4.5 (460)	5.1 (520)	—	8.5 (870)	10.4 (1060)	—	4.5 (460)	5.1 (520)	—	8.5 (870)	10.4 (1060)
280S	9284A	0.8 (80)	5.9 (600)	6.9 (700)	0.8 (80)	5.9 (600)	6.9 (700)	—	3.7 (380)	4.2 (430)	—	9.2 (940)	10.8 (1100)	—	3.7 (380)	4.2 (430)	—	9.2 (940)	10.8 (1100)
280M	9286A	0.7 (70)	5.7 (580)	6.7 (680)	0.7 (70)	5.7 (580)	6.7 (680)	—	3.1 (320)	3.8 (390)	—	9.3 (950)	10.9 (1110)	—	3.1 (320)	3.8 (390)	—	9.3 (950)	10.9 (1110)
—	528KA 528LA 531FA 531GA 531HA 535GA 535HA 535JA	*Contact Fuji individually						*Contact Fuji individually						*Contact Fuji individually					
Mounting method and the direction of thrust																			

Note 1: The above-mentioned figures whose frame number is 250S or above show the allowable thrust (axial) load of the motor for direct connection.

Note 2: The above-mentioned allowable thrust (axial) load is calculated on the assumption that the motor would bear the radial load through the normal sized half-coupling.

Chap. 10 ABOUT MOTORS

10.5 List of Special Combinations

10.5.1 Combination list of 380V series

Type		4-pole non-standard special motor			4-pole standard motor		
Base speed (r/min)		1500			Base speed: 1,500 (r/min), Max. speed: 1,500 (r/min)		
Max. load torque (%)		150			150		
Model and item		Model		Max. speed Nmax (r/min)	Model		Potential max. speed Nmax (r/min) *2
		Motor	Inverter		Motor	Inverter	
Output (kW)	3.7	MVK8115A	FRN3.7VG1S-4J	3600	MVK8115A	FRN3.7VG1S-4J	3300
	5.5	MVK8133A	FRN5.5VG1S-4J		MVK8133A	FRN5.5VG1S-4J	3400
	7.5	MVK8135A	FRN7.5VG1S-4J		MVK8135A	FRN7.5VG1S-4J	2150
	11	MVK8165A	FRN11VG1S-4J		MVK8165A	FRN11VG1S-4J	1600
	15	MVK8167A	FRN15VG1S-4J		MVK8167A	FRN15VG1S-4J	3200
	18.5	MVK8184A	FRN22VG1S-4J		MVK8184A	FRN18.5VG1S-4J	2750
	22	MVK8185A	FRN30VG1S-4J		MVK8185A	FRN22VG1S-4J	2000
	30	MVK8187A	FRN37VG1S-4J		MVK8187A	FRN30VG1S-4J	2200
	37	MVK8207A	FRN45VG1S-4J		MVK8207A	FRN37VG1S-4J	1600
	45	MVK8208A	FRN55VG1S-4J		MVK8208A	FRN45VG1S-4J	2100
	55	MVK9224A	FRN75VG1S-4J	2400	MVK9224A	FRN55VG1S-4J	1600
	75	MVK9254A	FRN90VG1S-4J		MVK9254A	FRN75VG1S-4J	2000
	90	MVK9256A	FRN110VG1S-4J	2000	MVK9256A	FRN90VG1S-4J	2000
	110	MVK9284A	FRN132VG1S-4J		MVK9284A	FRN110VG1S-4J	2000
	132	MVK9286A *1	FRN160VG1S-4J		MVK9286A	FRN132VG1S-4J	1500
	160	MVK528KA *1	FRN200VG1S-4J		MVK528KA	FRN160VG1S-4J	1500
	200	MVK528LA *1	FRN220VG1S-4J		MVK528LA	FRN200VG1S-4J	1500
	220	MVK531FA *1	FRN280VG1S-4J		MVK531FA	FRN220VG1S-4J	1500

*1 The electric characteristics of the motor are the same as those of the standard motor. The frame size of the inverter is one frame larger.

*2 The maximum speed at which the 150% overload rating torque is obtained with 380 V input is specified. If a 150% overload constant is necessary at a larger speed, select the inverter of a larger capacity.

10.5.2 Combination list of low base speed series

200V class

No. of poles, standard/ non-standard		6-pole non-standard special motor						4-pole standard motor	
Base speed		500 (r/min)	650 (r/min)	750 (r/min)	850 (r/min)	1,000 (r/min)		1,000 (r/min)	
Max. speed		2,000 (r/min)	2,000 (r/min)	1,800 (r/min)	1,700 (r/min)	2,000 (r/min)	2,400 (r/min)	3,000 (r/min)	3,600 (r/min)
Output (kW)	0.75	MVK8115A FRN1.5VG1S-2J		MVK8107A FRN1.5VG1S-2J			MVK8097A FRN0.75VG1S-2J		MVK8097A FRN1.5VG1S-2J
	1.5	MVK8133A FRN3.7VG1S-2J		MVK8115A FRN2.2VG1S-2J			MVK8107A FRN2.2VG1S-2J		MVK8107A FRN2.2VG1S-2J
	2.2	MVK8135A FRN3.7VG1S-2J		MVK8133A FRN3.7VG1S-2J			MVK8115A FRN3.7VG1S-2J		MVK8115A FRN3.7VG1S-2J
	3.7	MVK8165A FRN5.5VG1S-2J		MVK8135A FRN5.5VG1S-2J			MVK8133A FRN5.5VG1S-2J		MVK8133A FRN5.5VG1S-2J
	5.5	MVK8167A FRN7.5VG1S-2J		MVK8165A FRN7.5VG1S-2J			MVK8135A FRN7.5VG1S-2J		MVK8135A FRN7.5VG1S-2J
	7.5	MVK8185A FRN11VG1S-2J		MVK8167A FRN11VG1S-2J			MVK8165A FRN7.5VG1S-2J		MVK8165A FRN11VG1S-2J
	11	MVK8187A FRN15VG1S-2J		MVK8184A FRN15VG1S-2J			MVK8167A FRN15VG1S-2J		MVK8184A FRN18.5VG1S-2J
	15	MVK8207A FRN22VG1S-2J		MVK8185A FRN18.5VG1S-2J			MVK8184A FRN18.5VG1S-2J		MVK8185A FRN22VG1S-2J
	18.5	MVK9256A FRN30VG1S-2J	MVK9221A FRN30VG1S-2J	MVK8187A FRN22VG1S-2J			MVK81855A FRN22VG1S-2J		MVK8187A FRN30VG1S-2J
	22	MVK9284A FRN37VG1S-2J	MVK9250A FRN37VG1S-2J	MVK8207A FRN30VG1S-2J		MVK8187A FRN30VG1S-2J		MVK8207A FRN37VG1S-2J	
	30	MVK9284A FRN45VG1S-2J	MVK9256A FRN45VG1S-2J		MVK9221A FRN37VG1S-2J	MVK8207A FRN37VG1S-2J		MVK8208A FRN45VG1S-2J	
	37	MVK9286A FRN55VG1S-2J	MVK9284A FRN55VG1S-2J		MVK9224A FRN45VG1S-2J	MVK9221A FRN45VG1S-2J			
	45	MVK528KA FRN75VG1S-2J	MVK9284A FRN75VG1S-2J		MVK9250A FRN55VG1S-2J	MVK9224A FRN55VG1S-2J			
	55	MVK528LA FRN90VG1S-2J	MVK9286A FRN75VG1S-2J		MVK9256A FRN75VG1S-2J	MVK9250A FRN75VG1S-2J			
	75		MVK528LA FRN90VG1S-2J		MVK9284A FRN90VG1S-2J	MVK9256A FRN90VG1S-2J			

400V class

No. of poles, standard/ non-standard		6-pole non-standard special motor						4-pole standard motor	
Base speed		500 (r/min)	650 (r/min)	750 (r/min)	850 (r/min)	1,000 (r/min)		1,000 (r/min)	
Max. speed		2,000 (r/min)	2,000 (r/min)	1,800 (r/min)	1,700 (r/min)	2,000 (r/min)	2,400 (r/min)	3,000 (r/min)	3,600 (r/min)
Output(kW)	0.75	MVK8115A FRN3.7VG1S-4J		MVK8107A FRN3.7VG1S-4J			MVK8097A FRN3.7VG1S-4J		MVK8097A FRN1.5VG1S-4J
	1.5	MVK8133A FRN3.7VG1S-4J		MVK8115A FRN3.7VG1S-4J			MVK8107A FRN3.7VG1S-4J		MVK8107A FRN2.2VG1S-4J
	2.2	MVK8135A FRN3.7VG1S-4J		MVK8133A FRN3.7VG1S-4J			MVK8115A FRN3.7VG1S-4J		MVK8115A FRN3.7VG1S-4J
	3.7	MVK8165A FRN5.5VG1S-4J		MVK8135A FRN5.5VG1S-4J			MVK8133A FRN5.5VG1S-4J		MVK8133A FRN5.5VG1S-4J
	5.5	MVK8167A FRN7.5VG1S-4J		MVK8165A FRN7.5VG1S-4J			MVK8135A FRN7.5VG1S-4J		MVK8135A FRN7.5VG1S-4J
	7.5	MVK8185A FRN11VG1S-4J		MVK8167 FRN11VG1S-4J			MVK8165A FRN7.5VG1S-4J		MVK8165A FRN11VG1S-4J
	11	MVK8187A FRN15VG1S-4J		MVK8184 FRN15VG1S-4J			MVK8167A FRN11VG1S-4J		MVK8184A FRN18.5VG1S-4J
	15	MVK8207A FRN22VG1S-4J		MVK8185A FRN18.5VG1S-4J			MVK8184A FRN18.5VG1S-4J		MVK8185A FRN22VG1S-4J
	18.5	MVK9256A FRN30VG1S-4J	MVK9221A FRN30VG1S-4J	MVK8187A FRN22VG1S-4J			MVK8185A FRN22VG1S-4J		MVK8187A FRN30VG1S-4J
	22	MVK9284A FRN37VG1S-4J	MVK9250A FRN30VG1S-4J	MVK8207A FRN30VG1SJ		MVK8187A FRN30VG1S-4J		MVK8207A FRN37VG1S-4J	
	30	MVK9284A FRN45VG1S-4J	MVK9256A FRN37VG1S-4J		MVK9221A FRN37VG1S-4J	MVK8207A FRN37VG1S-4J		MVK8208A FRN45VG1S-4J	
	37	MVK9286A FRN55VG1S-4J	MVK9284A FRN45VG1S-4J		MVK9224A FRN45VG1S-4J	MVK9221A FRN45VG1S-4J			
	45	MVK528KA FRN75VG1S-4J	MVK9284A FRN55VG1S-4J		MVK9250A FRN55VG1S-4J	MVK9224A FRN55VG1S-4J			
	55	MVK528LA FRN75VG1S-4J	MVK9286A FRN75VG1S-4J		MVK9256A FRN75VG1S-4J	MVK9250A FRN75VG1S-4J			
	75	MVK531GA FRN110VG1S-4J	MVK528LA FRN90VG1S-4J		MVK9284A FRN90VG1S-4J	MVK9256A FRN90VG1S-4J			
	90	MVK531HA FR132VG1S-4J	MVK531GA FRN110VG1S-4J		MVK9286A FRN110VG1S-4J	MVK9284A FRN110VG1S-4J			
	110		MVK531HA FRN132VG1S-4J		MVK528KA FRN132VG1S-4J	MVK9286A FRN132VG1S-4J			
	132		MVK531HA FRN200VG1S-4J		MVK528LA FRN160VG1S-4J	MVK528KA FRN160VG1S-4J			
	160					MVK528LA FRN200VG1S-4J			
	200					*1			

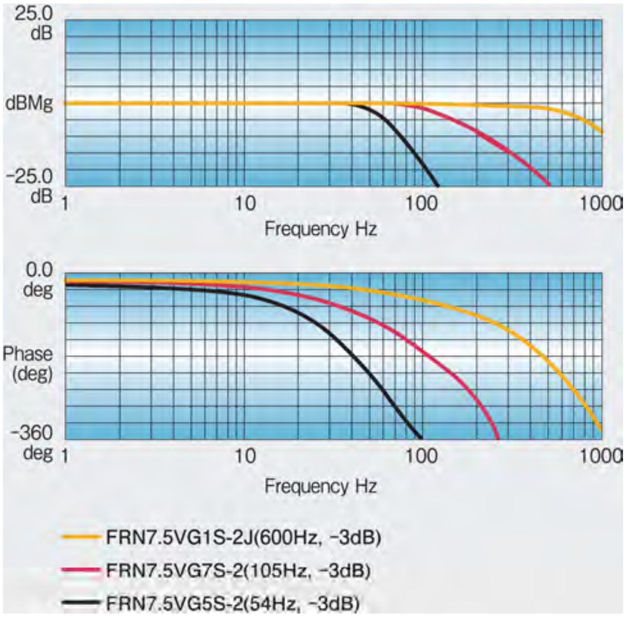
*1 Contact your Fuji Electric representative.

Chapter 11
OPERATION DATA

This chapter provides the characteristics data of the FRENIC-VG series of inverters running.

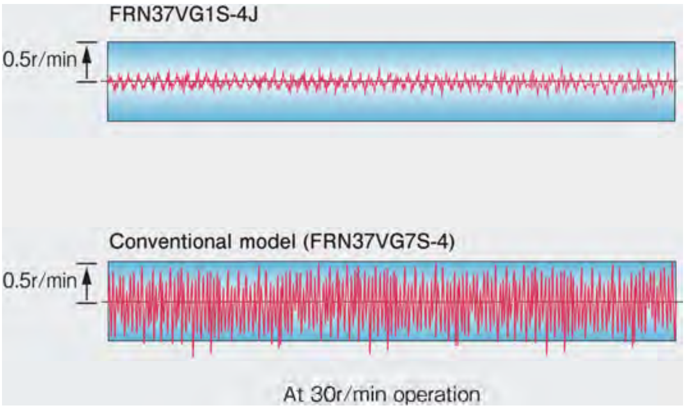
Contents

11.1 Frequency Response Characteristics



Inverter: FRN7.5VG1S-2J

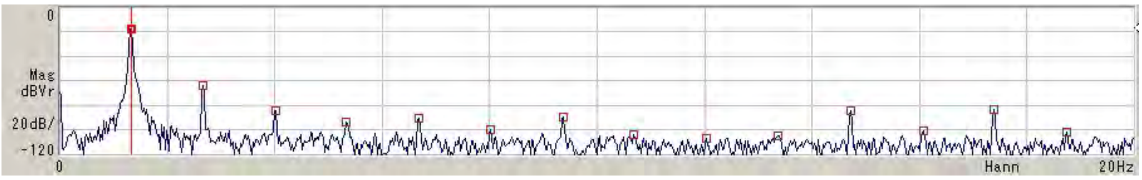
11.2 Rotational Fluctuation Measurement Sample



Inverter:	FRN37VG1S-4J
Motor:	MVK8207A, 37 kW, 1500/3000 r/min
Test condition:	Motor alone

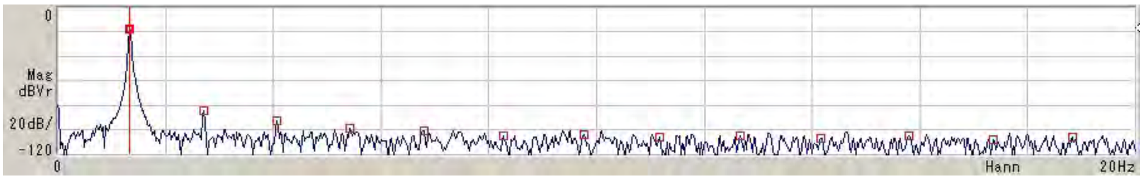
11.3 Current Distortion Characteristics

Conventional models (FRENIC5000VG7S)



f **f x 3 times** **f x 5 times** **f x 7 times** **f: Output frequency (Hz)**

FRENIC-VG



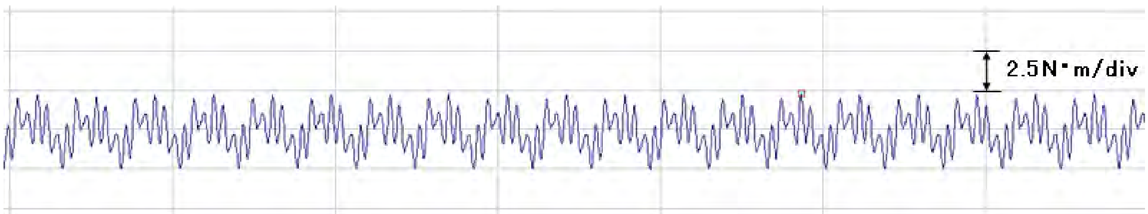
f **f x 3 times** **f x 5 times** **f x 7 times** **f: Output frequency (Hz)**

Inverter: FRN7.5VG1S-2J

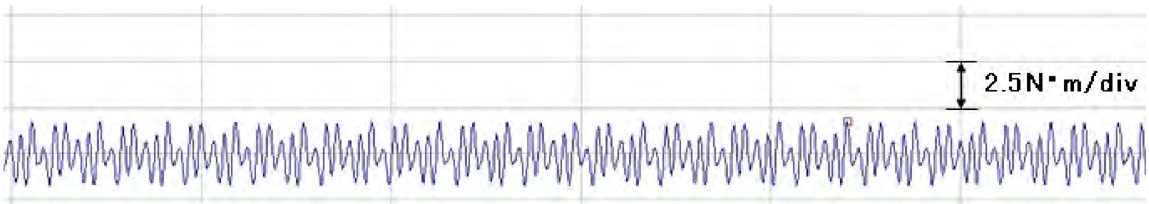
Test condition: Motor alone

11.4 Torque Ripple

Conventional models (FRENIC5000VG7S)



FRENIC-VG



Torque ripple components P-P 100%: Rated torque

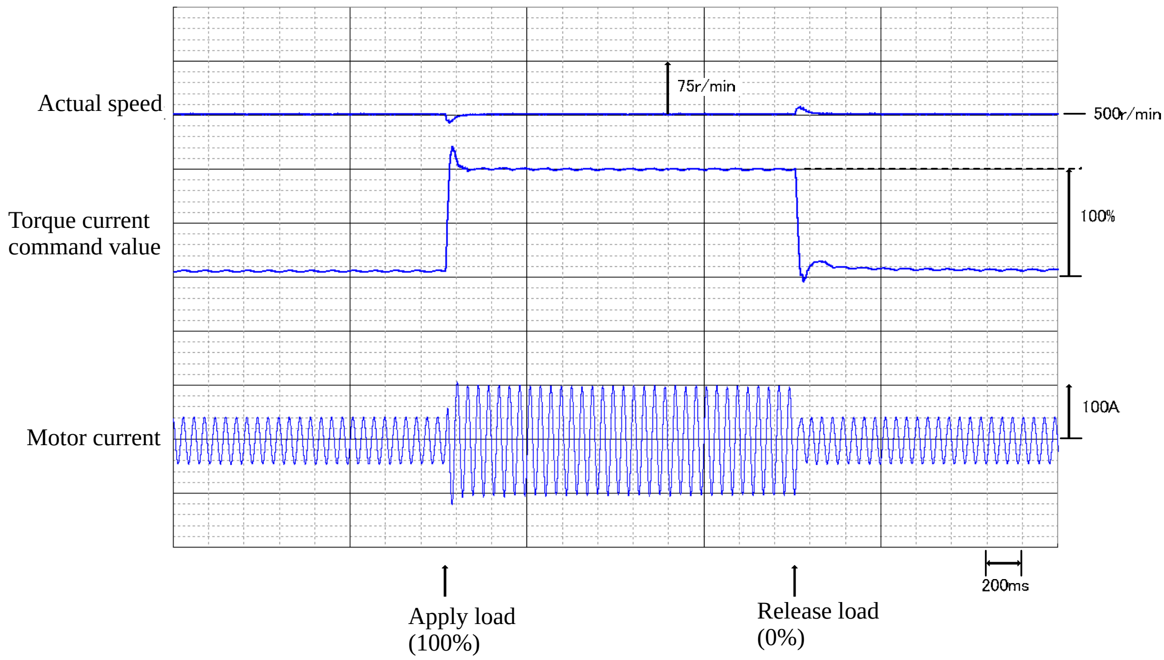
	1 time	2 times	6 times
FRENIC-VG	0.068%	0.307%	0.907%
Conventional models (FRENIC5000VG7S)	0.720%	0.364%	0.911%

Inverter: FRN37VG1S-2J

Motor: MVK6207A-C, 37 kW, 1500/3000 rpm

Test condition: Motor constraint

11.5 Impact Load Characteristics



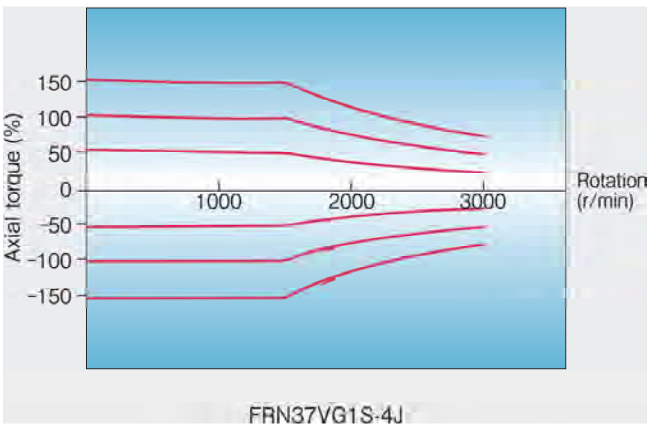
FRN37VG1S-4J running at 500 r/min

Inverter: FRN37VG1S-4J

Motor: MVK8207A, 37 kW, 1500/3000 r/min

Test condition: Running at 500 r/min

11.6 Speed-torque Characteristics (Vector control with speed sensor)

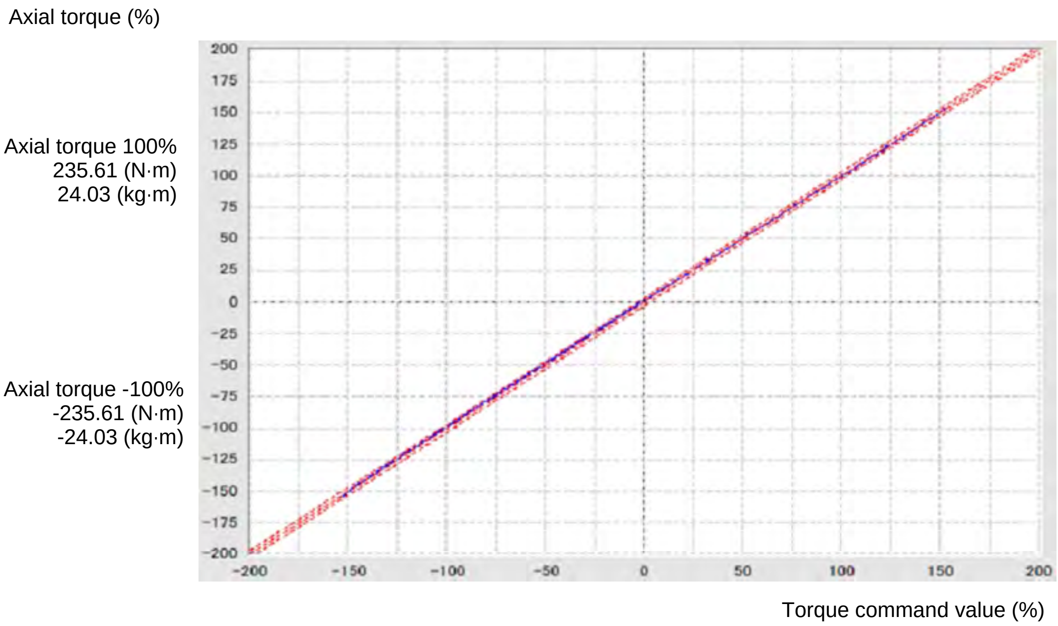


Inverter: FRN37VG1S-4J

Motor: MVK8207A, 37 kW, 1500/3000 r/min

Chap. 11 OPERATION DATA

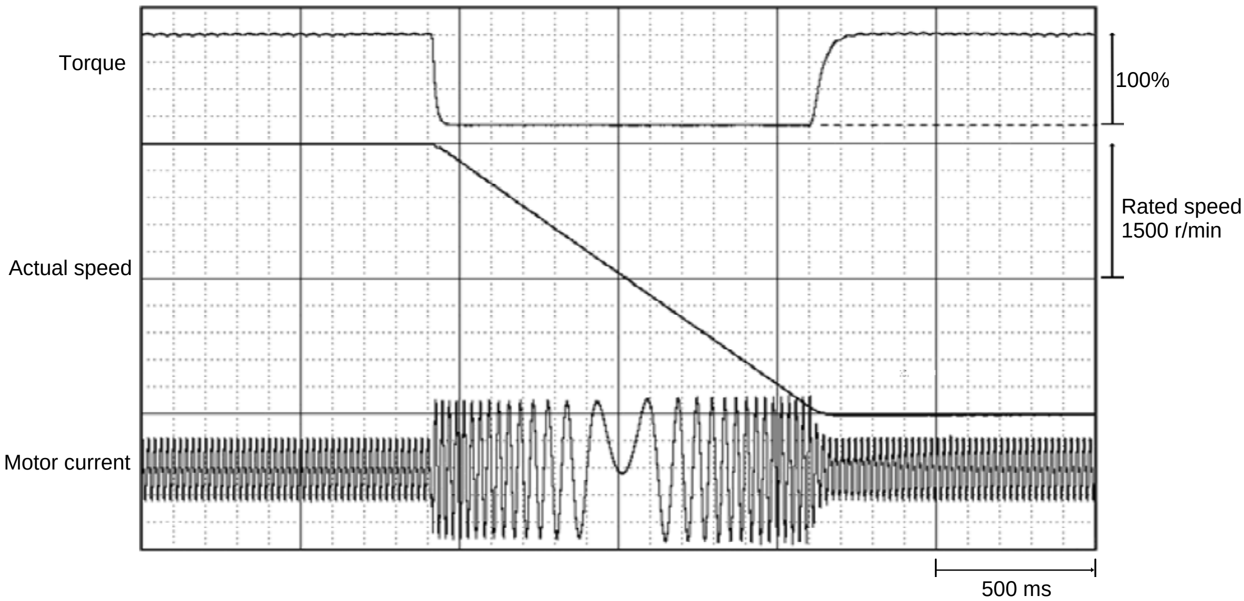
11.7 Torque Control Accuracy (Vector control with speed sensor)



Inverter: FRN37VG1S-4J

Motor: MVK8207A, 37 kW, 1500/3000 r/min

11.8 Deceleration/Acceleration via Zero Speed (Vector control with speed sensor)



Inverter: FRN37VG1S-4J

Motor: MVK8207A, 37 kW, 1500/3000 r/min

Chapter 12
REPLACEMENT DATA

When replacing the former inverters (VG, VG3, VG5) with FRENIC-VG, refer to this section.

Contents

12.1 Classification of Replacement

	Inverter	Motor	Possibility
A: Both inverter and motor are replaced.	VG3/VG3N ⇒ FRENIC-VG	VG3 ⇒ FRENIC-VG	Possible
	VG5S/VG5N ⇒ FRENIC-VG	VG5 ⇒ FRENIC-VG (Same product)	Possible
	VG7 ⇒ FRENIC-VG	VG7 ⇒ FRENIC-VG (Same product)	Possible
B: Only the inverter is replaced.	VG3/VG3N ⇒ FRENIC-VG	VG3	Possible (Note 1)
	VG5S/VG5N ⇒ FRENIC-VG	VG5	Possible
	VG7 ⇒ FRENIC-VG	VG7	Possible
C: Only the motor is replaced.	VG3	VG3 ⇒ FRENIC-VG	Impossible (Note 2)
	VG5	VG5 ⇒ FRENIC-VG (Same product)	Possible
	VG7	VG7 ⇒ FRENIC-VG	Possible

Note 1: The rated current of VG and VG3 is bigger than that of VG5, VG7. For this reason, the inverter in one-rank upper grade is required if only the inverter is changed from VG or VG3.

Note 2: For VG and VG3, the maximum output voltage, to which the stable current control is possible, is lower than that of VG5 and VG7. Therefore, if these inverters are combined with VG5 or VG7 motors, the characteristics (torque accuracy or motor wow) at around the base speed or at higher speed will deteriorate.

Note 3: When substituting from FRENIC5000VG (old model of VG3), contact us.

12.2 External Dimensions Comparison

12.2.1 Replacing VG7S

200V series

Capacity (kW)	FRENIC5000 VG7S External dimensions W (mm)	H (mm)	D (mm)	Installation dimensions W1 (mm)	H1 (mm)	Mounting method	Rough mass (kg)	FRENIC-VG External dimensions W (mm)	H (mm)	D (mm)	Installation dimensions W1 (mm)	H1 (mm)	Mounting method	Rough mass (kg)
0.75	205	300	245	181	278	Wall type	8	205	300	245	181	278	Wall type	6
1.5														
2.2														
3.7														
5.5														
7.5														
11	250	380		226	358		12.5	250	400		226	378		10
15														
18.5	340	480	255	240	460		25		400			378		
22				240	460									10.5
30		550	255	240	530		30	320	550	255	240	530		25
37	375	615	270	275	595		37	355	615	270	275	595		32
45		740			720		46		740			720		42
55							48							43
75	530	750	285	430			70	530	750	285	430			62
90	680	880	360	580	850		115	680	880	360	580	850		105

Larger than VG7

An adapter is required for replacement.

The control panel containing VG3 should be modified.

400V series

	FRENIC5000 VG7S							FRENIC-VG							
	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)
Capacity (kW)	W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)			W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)		
3.7	205	300	245	181	278	Wall type	8	205	300	245	181	278	Wall type	6
5.5														
7.5														
11	250	380		226	358		12.5	250	400		226	378		10
15														
18.5	340	480	255	240	460		25		400			378		
22														
30	340	550	255	240	530		30	320	550	255	240	530		25
37	375		270	275	530		35							26
45		675			655		40	355	615	270	275	595		31
55				275	655		41		675			655		33
75		740			720		50		740			720		42
90	530		315	430	710		72	530		315	430	710		62
110														64
132		1000	360		970		100		1000	360		970		94
160														98
200	680			580			140	680			580			129
220														140
250							150	-	-	-	-	-		-
280		1400	450		1370		320	680	1400	440	580	1370		245
315														
355	880			780			410	880			780			330
400														
500	1000	1550	500	900	1520		525	1000	1550	500	900	1520		555
630														

Larger than VG7

An adapter is required for replacement.

The control panel containing VG3 should be modified.

Chap. 12

REPLACEMENT DATA

12.2.2 Replacing VG5S

200V series

Capacity (kW)	FRENIC5000 VG5S External dimensions W (mm)	H (mm)	D (mm)	Installation dimensions W1 (mm)	H1 (mm)	Mounting method	Rough mass (kg)	FRENIC-VG External dimensions W (mm)	H (mm)	D (mm)	Installation dimensions W1 (mm)	H1 (mm)	Mounting method	Rough mass (kg)
0.75	205	350	245	183	328	Wall type	10	205	300	245	181	278	Wall type	6
1.5							10							
2.2							10							
3.7							10							
5.5							11							
7.5							11							
11	255	440	255	233	418		17	250	400		226	378		10
15	320	480		298	458		25							
18.5							25							
22							25							10.5
30	340	550	255	240	530		36	320	550	255	240	530		25
37	375	615		275	595		45	355	615	270	275	595		32
45		750		275	730		58		740			720		42
55	530		270	430	720		60							43
75			285	430	720		76	530	750	285	430			62
90	680	880	360	580	860	Floor type	141	680	880	360	580	850		105

400V series

Capacity (kW)	FRENIC5000 VG5S External dimensions W (mm)	H (mm)	D (mm)	Installation dimensions W1 (mm)	H1 (mm)	Mounting method	Rough mass (kg)	FRENIC-VG External dimensions W (mm)	H (mm)	D (mm)	Installation dimensions W1 (mm)	H1 (mm)	Mounting method	Rough mass (kg)
3.7	205	350	245	183	328	Wall type	10	205	300	245	181	278	Wall type	6
5.5							11							
7.5														
11	255	440	255	233	418		17	250	400		226	378		10
15														
18.5	320	480		298	458		25							
22														
30	340	550		240	530		35	320	550	255	240	530		25
37	375			275	530		36							26
45	375	675			655		43	355	615	270	275	595		31
55	530			430	645		53		675			655		33
75		740	270		710		60		740			720		42
90			315	430	710		86	530		315	430	710		62
110														64
132		1000	360		970		116		1000	360		970		94
160							121							98
200	680			580	980	Floor type	173	680			580			129
220							173							140

(light shading) Larger than VG5

(dark shading) An adapter is required for replacement.

(medium shading) The control panel containing VG3 should be modified.

12.2.3 Replacing VG3

200V series

	FRENIC5000 VG3							FRENIC-VG						
	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)
Capacity (kW)	W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)			W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)		
0.75	255	440	255	155	425	Wall type	14	205	300	245	181	278	Wall type	6
1.5														
2.2														
3.7														
5.5							16							
7.5	280	480		180	465		20							
11	320	480		220	460		24	250	400		226	378		10
15		520		220	500		27							
18.5	340	550		240	530		30							
22														10.5
30	375	615		275	596		40	320	550	255	240	530		25
37	390	800		290	775		53	355	615	270	275	595		32
45									740			720		42
55	540	750	270	440	720		70							43
75	850	880	-	750	855	Floor type	130	530	750	285	430			62
90	-	-	-	-	-	-	-	680	880	360	580	850		105

400V series

	FRENIC5000 VG3							FRENIC-VG						
	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)
Capacity (kW)	W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)			W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)		
3.7	280	440	255	180	425	Wall type	20	205	300	245	181	278	Wall type	6
5.5														
7.5		480			465		22							
11	320	520		220	500		27	250	400		226	378		10
15														
18.5														
22	340	550		240	530		30							
30	375	615		275	596		35	320	550	255	240	530		25
37		675			656		43							26
45								355	615	270	275	595		31
55	530	880	325	430	850		85		675			655		33
75									740			720		42
90							95	530		315	430	710		62
110		1050	340		1020		105							64
132	680		-	580	1025	Floor type	135		1000	360		970		94
160	850		-	750			170							98
200			-					680			580			129
220	-	-	-	-	-	-	-							140

Larger than VG3

An adapter is required for replacement.

The control panel containing VG3 should be modified.

12.3 Terminal Size

12.3.1 Replacing VG7S

Main circuit terminal (200V series)

<table>
<tr><th></th><th colspan="5">FRENIC5000 VG7S</th><th colspan="5">FRENIC-VG</th></tr>
<tr><th></th><th colspan="5">Terminal size and arrangement</th><th colspan="5">Terminal size and arrangement</th></tr>
<tr><th>Capacity (kW)</th><th>Input
LI/R, L2/S, L3/T</th><th>DC link
DB, P1, P(+), N(-))</th><th>Output
U, V, W</th><th>GRD*
G</th><th>APS*
R0, T0</th><th>Input
LI/R, L2/S, L3/T</th><th>DC link
DB, P1, P(+), N(-)</th><th>Output
U, V, W</th><th>GRD*
G</th><th>APS*
R0, T0</th></tr>
<tr><td>0.75</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="10">M4</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="10">M3.5</td></tr>
<tr><td>1.5</td></tr>
<tr><td>2.2</td></tr>
<tr><td>3.7</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td></tr>
<tr><td>5.5</td></tr>
<tr><td>7.5</td></tr>
<tr><td>11</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td></tr>
<tr><td>15</td></tr>
<tr><td>18.5</td></tr>
<tr><td>22</td></tr>
<tr><td></td><td>LI/R, L2/S, L3/T</td><td>P1, P(+), DB, N(-)</td><td>U, V, W</td><td>G</td><td>R0, T0</td><td>LI/R, L2/S, L3/T</td><td>DB, P1, P(+), N(-)</td><td>U, V, W</td><td>G</td><td>R0, T0</td></tr>
<tr><td>30</td><td>M8</td><td>M8</td><td>M8</td><td rowspan="4">M8</td><td rowspan="4">M4</td><td>M8</td><td>M8</td><td>M8</td><td rowspan="4">M8</td><td rowspan="4">M3.5</td></tr>
<tr><td>37</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td></tr>
<tr><td>45</td></tr>
<tr><td>55</td></tr>
<tr><td></td><td>LI/R, L2/S, L3/T</td><td>P1, P(+), N(-)</td><td>U, V, W</td><td>G</td><td>R0, T0</td><td>LI/R, L2/S, L3/T</td><td>P1, P(+), N(-)</td><td>U, V, W</td><td>G</td><td>R0, T0</td></tr>
<tr><td>75</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M10</td><td rowspan="2">M4</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M10</td><td rowspan="2">M3.5</td></tr>
<tr><td>90</td></tr>
</table>

*GRD: Ground
*APS: Auxiliary power supply
Replacing

Main circuit terminal (400V series)

	FRENIC5000 VG7S					FRENIC-VG				
	Terminal size and arrangement					Terminal size and arrangement				
Capacity (kW)	Input LI/R, L2/S, L3/T	DC link DB, P1, P(+), N(-))	Output U, V, W	GRD* G	APS* R0, T0	Input L1/R, L2/S, L3/T	DC link DB, P1, P(+), N(-)	Output U, V, W	GRD* G	APS* R0, T0
3.7	M5	M5	M5	M5	M4	M5	M5	M5	M5	M3.5
5.5										
7.5										
11	M6	M6	M6	M6		M6	M6	M6	M6	
15										
18.5										
22										
	R, S, T	P1, P(+), DB, N(-)	U, V, W	E(G)	R0, T0	L1/R, L2/S, L3/T	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
30	M8	M8	M8	M8	M4	M8	M8	M8	M8	M3.5
37										
45										
55										
75	M10	M10	M10	M10		M10	M10	M10	M8	M3.5
90										
110										
	LI/R, L2/S, L3/T	P1, P(+), N(-)	U, V, W	G	R0, T0	L1/R, L2/S, L3/T	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
132	M12	M12	M12	M10	M4	M12	M12	M12	M10	M3.5
160										
	LI/R, L2/S, L3/T	P1, P(+), N(-)	U, V, W	G	R0, T0	L1/R, L2/S, L3/T	P1, P(+), N(-)	U, V, W	G	R0, T0
200	M12	M12	M12	M10	M4	M12	M12	M12	M10	M3.5
220										
250						-	-	-	-	-
280						M12	M12	M12	M10	M3.5
315										
355										
400										
500										
630										

*GRD: Ground
*APS: Auxiliary power supply

12.3.2 Replacing VG5S

Main circuit terminal (200V series)

<table>
<tr><td></td><td colspan="5">FRENIC5000 VG5S</td><td colspan="5">FRENIC-VG</td></tr>
<tr><td rowspan="2">Capacity (kW)</td><td colspan="5">Terminal size and arrangement</td><td colspan="5">Terminal size and arrangement</td></tr>
<tr><td>Input
R, S, T</td><td>DC link
P1, P(+), DB, N(-)</td><td>Output
U, V, W</td><td>GRD*
E(G)</td><td>APS*
R0, T0</td><td>Input
LI/R, L2/S, L3/T</td><td>DC link
DB, P1, P(+), N(-))</td><td>Output
U, V, W</td><td>GRD*
G</td><td>APS*
R0, T0</td></tr>
<tr><td>0.75</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="10">M4</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="10">M3.5</td></tr>
<tr><td>1.5</td></tr>
<tr><td>2.2</td></tr>
<tr><td>3.7</td></tr>
<tr><td>5.5</td></tr>
<tr><td>7.5</td></tr>
<tr><td>11</td><td>M6</td><td>M6</td><td>M6</td><td>M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td></tr>
<tr><td>15</td><td rowspan="3">M8</td><td rowspan="3">M8</td><td rowspan="3">M8</td><td rowspan="3">M8</td></tr>
<tr><td>18.5</td></tr>
<tr><td>22</td></tr>
<tr><td></td><td>R, S, T</td><td>P1, P(+), DB, N(-)</td><td>U, V, W</td><td>E(G)</td><td>R0, T0</td><td>LI/R, L2/S, L3/T</td><td>DB, P1, P(+), N(-)</td><td>U, V, W</td><td>G</td><td>R0, T0</td></tr>
<tr><td>30</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="4">M8</td><td rowspan="4">M4</td><td>M8</td><td>M8</td><td>M8</td><td rowspan="4">M8</td><td rowspan="4">M3.5</td></tr>
<tr><td>37</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td></tr>
<tr><td>45</td><td rowspan="2">M10</td><td rowspan="2">M10</td><td rowspan="2">M10</td></tr>
<tr><td>55</td></tr>
<tr><td></td><td>R, S, T</td><td>P1, P(+), N(-)</td><td>U, V, W</td><td>E(G)</td><td>R0, T0</td><td>LI/R, L2/S, L3/T</td><td>P1, P(+), N(-)</td><td>U, V, W</td><td>G</td><td>R0, T0</td></tr>
<tr><td>75</td><td>M10</td><td>M10</td><td>M10</td><td>M8</td><td rowspan="2">M4</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M10</td><td rowspan="2">M3.5</td></tr>
<tr><td>90</td><td>M12</td><td>M12</td><td>M12</td><td>M10</td></tr>
</table>

*GRD: Ground

*APS: Auxiliary power supply

Main circuit terminal (400V series)

	FRENIC5000 VG5S					FRENIC-VG				
	Terminal size and arrangement					Terminal size and arrangement				
Capacity (kW)	Input R, S, T	DC link P1, P(+), DB, N(-)	Output U, V, W	GRD* E(G)	APS* R0, T0	Input L1/R, L2/S, L3/T	DC link DB, P1, P(+), N(-)	Output U, V, W	GRD* G	APS* R0, T0
3.7	M5	M5	M5	M5	M4	M5	M5	M5	M5	M3.5
5.5										
7.5										
11	M6	M6	M6	M6		M6	M6	M6	M6	
15										
18.5	M8	M8	M8	M8						
22										
	R, S, T	P1, P(+), DB, N(-)	U, V, W	E(G)	R0, T0	L1/R, L2/S, L3/T	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
30	M8	M8	M8	M8	M4	M8	M8	M8	M8	M3.5
37										
45										
55										
	R, S, T	DB, P1, P(+), N(-)	U, V, W	E(G)	R0, T0	L1/R, L2/S, L3/T	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
75	M10	M10	M10	M8	M4	M10	M10	M10	M8	M3.5
90		M10 (No DB terminal)								
110										
132										
160	M12	M12 (No DB terminal)	M12	M10		M12	M12	M12	M10	
	R, S, T	P1, P(+), N(-)	U, V, W	E(G)	R0, T0	L1/R, L2/S, L3/T	P1, P(+), N(-)	U, V, W	G	R0, T0
200	M12	M12	M12	M10	M4	M12	M12	M12	M10	M3.5
220										

*GRD: Ground

*APS: Auxiliary power supply

Control circuit terminal (Common to 200V series and 400V series)

FRENIC5000 VG5S	FRENIC-VG
Common to all capacities M3	Common to all capacities M3

12.3.3 Replacing VG3

Main circuit terminal (200V series）

<table>
<tr><td></td><td colspan="5">FRENIC5000 VG3</td><td colspan="5">FRENIC-VG</td></tr>
<tr><td rowspan="2">Capacity (kW)</td><td colspan="5">Terminal size and arrangement</td><td colspan="5">Terminal size and arrangement</td></tr>
<tr><td>Input
R, S, T</td><td>Output
U, V, W</td><td>DC link
DB, P</td><td>GRD*
E(G)</td><td>APS*
R0, T0</td><td>Input
L1/R, L2/S, L3/T</td><td>DC link
DB, P1, P(+), N(-)</td><td>Output
U, V, W</td><td>GRD*
G</td><td>APS*
R0, T0</td></tr>
<tr><td>0.75</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="9">M4</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="9">M3.5</td></tr>
<tr><td>1.5</td></tr>
<tr><td>2.2</td></tr>
<tr><td>3.7</td></tr>
<tr><td>5.5</td></tr>
<tr><td>7.5</td></tr>
<tr><td>11</td><td>M6</td><td>M6</td><td>M6</td><td rowspan="3">M6</td><td rowspan="3">M6</td><td rowspan="3">M6</td><td rowspan="3">M6</td><td rowspan="3">M6</td></tr>
<tr><td>15</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="2">M8</td></tr>
<tr><td>18.5</td></tr>
<tr><td rowspan="2">22</td><td>R, S, T</td><td>U, V, W</td><td>DB, P1, P</td><td>E(G)</td><td>R0, T0</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>M8</td><td>M8</td><td>M8</td><td>M6</td><td>M4</td><td>M6</td><td>M6</td><td>M6</td><td>M6</td><td>M3.5</td></tr>
<tr><td></td><td>R, S, T</td><td>U, V, W</td><td>DB, P1, P</td><td>E(G)</td><td>R0, T0</td><td>L1/R, L2/S, L3/T</td><td>DB, P1, P(+), N(-)</td><td>U, V, W</td><td>G</td><td>R0, T0</td></tr>
<tr><td>30</td><td>M8</td><td>M8</td><td>M8</td><td rowspan="4">M8</td><td rowspan="4">M4</td><td>M8</td><td>M8</td><td>M8</td><td rowspan="4">M8</td><td rowspan="4">M3.5</td></tr>
<tr><td>37</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td></tr>
<tr><td>45</td></tr>
<tr><td>55</td></tr>
<tr><td></td><td colspan="2">Input/Output
R, U, S, V, T, W</td><td>DC link
N, P1, P</td><td>GRD*
E(G)</td><td>APS*
R0, T0</td><td>Input
L1/R, L2/S, L3/T</td><td>DC link
P1, P(+), N(-)</td><td>Output
U, V, W</td><td>GRD*
G</td><td>APS*
R0, T0</td></tr>
<tr><td>75</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M10</td><td rowspan="2">M4</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M10</td><td rowspan="2">M3.5</td></tr>
<tr><td>90</td></tr>
</table>

*GRD: Ground

*APS: Auxiliary power supply

Main circuit terminal (400V series)

<table>
<tr><td></td><td colspan="5">FRENIC5000 VG3</td><td colspan="5">FRENIC-VG</td></tr>
<tr><td rowspan="2">Capacity (kW)</td><td colspan="5">Terminal size and arrangement</td><td colspan="5">Terminal size and arrangement</td></tr>
<tr><td>Input
R, S, T</td><td>Output
U, V, W</td><td>DC link
DB, P</td><td>GRD*
E(G)</td><td>APS*
R0, T0</td><td>Input
L1/R, L2/S, L3/T</td><td>DC link
DB, P1, P(+), N(-)</td><td>Output
U, V, W</td><td>GRD*
G</td><td>APS*
R0, T0</td></tr>
<tr><td>3.7</td><td rowspan="2">M4</td><td rowspan="2">M4</td><td rowspan="2">M4</td><td rowspan="2">M4</td><td rowspan="6">M4</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="6">M3.5</td></tr>
<tr><td>5.5</td></tr>
<tr><td>7.5</td><td rowspan="2">M5</td><td rowspan="2">M5</td><td rowspan="2">M5</td><td rowspan="2">M5</td></tr>
<tr><td>11</td><td rowspan="3">M6</td><td rowspan="3">M6</td><td rowspan="3">M6</td><td rowspan="3">M6</td></tr>
<tr><td>15</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td></tr>
<tr><td>18.5</td></tr>
<tr><td rowspan="2">22</td><td>R, S, T</td><td>U, V, W</td><td>DB, P1, P</td><td>E(G)</td><td>R0, T0</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>M6</td><td>M6</td><td>M6</td><td>M6</td><td>M4</td><td>M6</td><td>M6</td><td>M6</td><td>M6</td><td>M3.5</td></tr>
<tr><td></td><td>R, S, T</td><td>P1, P(+), DB, N(-)</td><td>U, V, W</td><td>E(G)</td><td>R0, T0</td><td>L1/R, L2/S, L3/T</td><td>DB, P1, P(+), N(-)</td><td>U, V, W</td><td>G</td><td>R0, T0</td></tr>
<tr><td>30</td><td rowspan="3">M8</td><td rowspan="3">M8</td><td rowspan="3">M8</td><td rowspan="7">M8</td><td rowspan="7">M4</td><td rowspan="4">M8</td><td rowspan="4">M8</td><td rowspan="4">M8</td><td rowspan="7">M8</td><td rowspan="7">M3.5</td></tr>
<tr><td>37</td></tr>
<tr><td>45</td></tr>
<tr><td>55</td><td rowspan="4">M10</td><td rowspan="4">M10</td><td rowspan="4">M10</td></tr>
<tr><td>75</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td></tr>
<tr><td>90</td></tr>
<tr><td>110</td></tr>
<tr><td></td><td colspan="2">Input/Output
R, U, S, V, T, W</td><td>DC link
N, P1, P</td><td>GRD*
E(G)</td><td>APS*
R0, T0</td><td>L1/R, L2/S, L3/T</td><td>DB, P1, P(+), N(-)</td><td>U, V, W</td><td>G</td><td>R0, T0</td></tr>
<tr><td>132</td><td colspan="2" rowspan="3">M12</td><td rowspan="3">M12</td><td rowspan="3">M10</td><td rowspan="3">M4</td><td rowspan="4">M12</td><td rowspan="2">M12</td><td rowspan="4">M12</td><td rowspan="4">M10</td><td rowspan="4">M3.5</td></tr>
<tr><td>160</td></tr>
<tr><td>200</td><td rowspan="2">M12
(No DB terminal)</td></tr>
<tr><td>220</td><td>-</td><td>-</td><td></td><td>-</td><td>-</td></tr>
</table>

*GRD: Ground

*APS: Auxiliary power supply

Control circuit terminal (Common to 200V series and 400V series)

FRENIC5000 VG3	FRENIC-VG
Common to all capacities M3	Common to all capacities M3

Chap. 12

REPLACEMENT DATA

12.4 Terminal Symbol

12.4.1 Replacing VG7S

Since the terminal symbols for FRENIC-VG are the same as those for VG7S (excepting for I/O of RS-485 communications), the same connections as the terminal connections of VG7S are available.

Category	FRENIC5000 VG7S		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
Communications	RX(+), RX(-), TX(+), TX(-), SD	I/O of RS-485 communications (Dedicated connector)	DX(+), DX(-)	I/O of RS-485 communications

12.4.2 Replacing VG5S

Category	FRENIC5000 VG5S		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
Main circuit	R, S, T	Power input	L1/R, L2/S, L3/T	Power input
	U, V, W	Inverter output	U, V, W	Inverter output
	P1, P(+)	Connects a DC REACTOR	P1, P(+)	Connects a DC REACTOR
	P(+), N(-)	Connects a braking unit	P(+), N(-)	Connects a braking unit
	P(+), DB	Connects an external braking resistor	P(+), DB	Connects an external braking resistor
	E(G)	To ground the inverter	G	To ground the inverter
	R0, T0	Auxiliary control power supply	R0, T0	Auxiliary control power supply
Analog input	13	Power supply for potentiometer	13	Power supply for potentiometer
	12	Voltage input for speed setting	12	Voltage input for speed setting
	11	Analog input common	11	Analog input common
	Ai1	Analog input 1	Ai1	Analog input 1
	Ai2	Analog input 2	Ai2	Analog input 2
	[AOFF]	Input signal off	[OFF]	Input signal off
	[AAS1]	Auxiliary speed setting 1	[AUX-N1]	Auxiliary speed setting 1
	[AAS2]	Auxiliary speed setting 2	[AUX-N2]	Auxiliary speed setting 2
	[ATL1]	Torque limiter (level 1)	[TL-REF1]	Torque limiter (level 1)
	[ATL2]	Torque limiter (level 2)	[TL-REF2]	Torque limiter (level 2)
	[ATBS]	Torque bias	[TB-REF]	Torque bias
	[ATS]	Torque command (before limit)	[T-REF]	Torque command (before limit)
	[ATCS]	Torque current command	[IT-REF]	Torque current command
	[AJSS1]	Creep speed 1	[CRP-N1]	Creep speed 1
	[AJSS2]	Creep speed 2	[CRP-N2]	Creep speed 2
	[AFLUX]	Magnetic-flux command	[MF-REF]	Magnetic-flux command
	[ASFB]	Speed feedback	[LINE-N]	Line speed detection
	[AMTMP]	Motor temperature	[M-TMP]	Motor temperature
	[ASOR]	Speed override	[N-OR]	Speed override
	M	Analog input common	M	Analog input common
Digital input	FWD	Forward operation · stop command	FWD	Forward operation · stop command
	REV	Reverse operation · stop command	REV	Reverse operation · stop command
	X1 X2 X3 X4 X5	Digital input 1 Digital input 2 Digital input 3 Digital input 4 Digital input 5	X1 X2 X3 X4 X5 X6 X7 X8 X9	Digital input 1 Digital input 2 Digital input 3 Digital input 4 Digital input 5 Digital input 6 Digital input 7 Digital input 8 Digital input 9
	[COPC]	Operation command switch over		
	[CSRM]	Speed setting value switch over	[N2/N1]	Speed setting N2/N1
	[CMCS]	Coast-to-stop command	[BX]	Coast-to-stop command
	[CPEX]	Pre-exciting command	[EXITE]	Pre-exciting command
	[CHLD]	Operation signal hold	[HLD]	Operation signal hold
	[CSR1]	Multistep speed selection 1	[SS1]	Multistep speed selection 1
	[CSR2]	Multistep speed selection 2	[SS2]	Multistep speed selection 2
	[CSR4]	Multistep speed selection 4	[SS4]	Multistep speed selection 4
	[CUP]	ACC command in UP/DOWN setter	[UP]	UP command in UP/DOWN setting
	[CDOWN]	DEC command in UP/DOWN setter	[DOWN]	DOWN command in UP/DOWN setting

Category	FRENIC5000 VG5S		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
	[CCLR]	Zero clear command in UP/DOWN setter	[CLR]	ACC/DEC zero clear command
	[CJSC]	Creep switch	[CRP-N2/N1]	Creep speed switching in UP/DOWN setting
	[CSUC]	ACC/DEC · UP/DOWN switch	[N2/N1]	Speed setting N2/N1
	[CSRL]	Speed reference limiter	[N-LIM]	Speed command cancel
	[CSTC]	Speed control/Torque limiter switch	[H41-CCL]	H41[torque command] cancel
	[CTL]	Torque limiter	[F40-CCl]	F40 [torque limiter mode] cancel
	[CADT]	ACC/DEC time selection	[RT1][RT2]	ASR, ACC/DEC selection
	[CADB]	ACC/DEC time bypass	[BPS]	Bypass
	[CTB1]	Torque bias command 1	[TB1]	Torque bias command 1
	[CTB2]	Torque bias command 2	[TB2]	Torque bias command 2
	[CDRP]	Droop function	[DROOP]	Droop selection
	[CPI]	ASR PI switch	[RT1][RT2]	ASR,ACC/DEC selection
	[CPPI]	ASR P/PI switch	[RT1][RT2]	ASR,ACC/DEC selection
	[CAI1Z]	Ai1-ACC/DEC zero hold	[ZH-Ai1]	Ai1 zero hold
	[CAI2Z]	Ai2-ACC/DEC zero hold	[ZH-Ai2]	Ai2 zero hold
	[CSAD]	Analog/Digital switch (speed)	[N2/N1]	Speed setting N2/N1
	[CTAD]	Analog/Digital switch (torque)	[H41-CCL]	H41[torque command]cancel
	[CDILS]	Di card input latch signal (speed)	[DIA]	DiA card input latch signal
	[CDILT]	Di card input latch signal (torque)	[DIB]	DiB card input latch signal
	[CTEN]	T-Link enable	[LE], [WE-LK]	Operation selection through link, Write enable command through link
	[CTDI]	DI command for transmission	[U-DI]	Universal DI
	[CREN]	RS485 enable	[LE], [WE-LK]	Operation selection through link, Write enable command through link
	RST	Alarm reset	[RST]	Alarm reset
	THR	External alarm	[THR]	External alarm
	–		PLC	PLC signal power supply
	CM	Digital input common	CM	Digital input common
Analog output	Ao1	Analog output 1	Ao1	Analog output 1
	Ao2	Analog output 2	Ao2	Analog output 2
	Ao3	Analog output 3	Ao3	Analog output 3
	[BSM1]	Speedometer (one-way deflection)	[N-FB1+]	Speed detection (Speedometer, one-way deflection)
	[BSM2]	Speedometer (two-way deflection)	[N-FB1±]	Speed detection (Speedometer, two-way deflection)
	[BSR0]	Speed setting 0	[N-REF2]	Speed setting2 (before ACC/DEC calculation)
	[BSR1]	Speed setting 1	[N-REF4]	Speed setting 4 (ASR input)
	[BSR2]	Speed setting 2	[N-REF4]	Speed setting 4 (ASR input)
	[BSR]	Speed setting	[N-REF4]	Speed setting 4 (ASR input)
	[BSFB]	Speed feedback	[N-FB2±]	Speed detection (ASR input)
	[BTC1]	Torque ammeter (two-way deflection)	[IT-REF±]	Torque current command (torque ammeter, two-way deflection)
	[BTC2]	Torque ammeter (one-way deflection)	[IT-REF+]	Torque current command (torque ammeter, one-way deflection)
	[BTM1]	Torque meter (two-way deflection)	[T-REF±]	Torque command (torque meter, two-way deflection)
	[BTM2]	Torque meter (one-way deflection)	[T-REF+]	Torque command (torque meter, one-way deflection)
	[BTR]	Torque command output	[T-REF±]	Torque command (torque meter, two-way deflection)
	] [BMC	Effective detected value of motor current	[I-AC]	Motor current

Category	FRENIC5000 VG5S Terminal symbol	FRENIC5000 VG5S Terminal name	FRENIC-VG Terminal symbol	FRENIC-VG Terminal name
	[BMV]	Effective detected value of motor voltage	[V-AC]	Motor voltage
	[BMTMP]	Motor temperature detected value	[TMP-M]	Motor temperature
	[BVDC]	Main circuit DC voltage	[V-DC]	DC link circuit voltage
	M	Analog output common	M	Analog output common
Transistor output	Y1	Digital output 1	Y1	Digital output 1
	Y2	Digital output 2	Y2	Digital output 2
	Y3	Digital output 3	Y3	Digital output 3
	–		Y4	Digital output 4
	[DVDC]	Establishment of main circuit DC voltage	[RDY]	Ready for operation
	[DRUN]	Running	[RUN]	Running
	[DACC]	Accelerating	[U-ACC]	Accelerating
	[DDEC]	Decelerating	[U-DEC]	Decelerating
	[DNZS]	Speed existence	[N-EX]	Speed existence
	[DSAR]	Arrival at the preset speed	[N-AR]	Arrival at the preset speed
	[DSAG]	Speed agreement	[N-AG1]	Speed agreement
	[DSD1]	Speed detection	[N-DT1]	Speed detection 1
	[DSD2]	Speed detection	[N-DT2]	Speed detection 2
	[DSD3]	Speed detection	[N-DT3]	Speed detection 3
	[DTLM]	Torque limiting	[TL]	Torque limiting
	[DTD]	Torque detection	[T-DT1]	Torque detection
	[DOL]	Inverter overload early warning	[INV-OL]	Inverter overload early warning
	[DMOH]	Motor temperature overheat early warning	[M-OH]	Motor temperature overheat early warning
	[DMOL]	Motor overload early warning	[M-OL]	Motor overload early warning
	[DBRS]	Brake release signal	[BRK]	Brake release signal
	[DBRK]	Braking	[B/D]	Torque polarity detection
	[DTDO]	DO for transmission	[U-DO]	Universal DO
	[DTER]	Transmission error	[LK-ERR]	Transmission error
	[DSYN]	Synchronizing	[SY-C]	Synchronization control completion
	CME	Digital output common	CME	Digital output common
Relay output	RYA, RYC	Relay output	Y5A, Y5C	Relay output
	30A, 30B, 30C	Alarm output for any fault	30A, 30B, 30C	Alarm output for any fault
Communi-cation	DXA,DXB	RS-485 communication input/output	DX(+),DX(-)	RS-485 communication input/output
Speed detection	PA, PB	Pulse generator 2-phase signal input	PA, PB	Pulse generator 2-phase signal input
	PGP, PGM	Pulse generator power supply	PGP, PGM	Pulse generator power supply
	FA, FB	Pulse generator output	FA, FB	Pulse generator output
	CM	Common to pulse generator output	CM	Common to pulse generator output
Temperature detection	TH1	Connects a motor thermistor	TH1	Connects a motor thermistor (Motor temperature can be detected with NTC, PTC thermistors)
	THC	Common to motor thermistor	THC	Common to motor thermistor
Option power supply	P24	Power supply to option (24V)	–	Please utilize the power supply on the market.
	M24	Common terminal to 24V	–	
	P15	Power supply for option (+15V)	–	
	(M)	Common terminal to ±15V	–	
	N15	Power supply to option (-15V)	–	

Chap. 12 REPLACEMENT DATA

12.4.3 Replacing VG3

Cat-ego-ry	FRENIC5000 VG3		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
Main circuit	R, S, T	Power input	L1/R, L2/S, L3/T	Power input
	U, V, W	Inverter output	U, V, W	Inverter output
	P, DB	Connects an external braking resistor	P(+), DB	Connects an external braking resistor
	P, N	Connects a braking unit	P(+), N(-)	Connects a braking unit
	P, P1	Connects a DC REACTOR	P(+), P1	Connects a DC REACTOR
	P, N1	Connects a backup condenser	P(+), N(-)	Connects a backup condenser
	E(G)	To ground the inverter	G	To ground the inverter
	R0, T0	Auxiliary control power supply	R0, T0	Auxiliary control power supply
Analog input	11	Common to analog input	11	Common to analog input
	13	Power supply for potentiometer	13	Power supply for potentiometer
	12	Speed setting voltage input	12	Speed setting voltage input
	M	Common to analog input	M	Common to analog input
	Ai1	Analog input 1	Ai1	Analog input 1
	Ai2	Analog input 2	Ai2	Analog input 2
	[AV2]	Auxiliary speed setting 2	[AUX-N1]	Auxiliary speed setting 1
	[AV3]	Auxiliary speed setting 3	[AUX-N2]	Auxiliary speed setting 2
	[ATL1]	Torque limiter value 1 / Torque bias command value 1	[TL-REF1]	Torque limiter (level 1)
	[ATL2]	Torque limiter value 2 / Torque bias command value 2	[TL-REF2]	Torque limiter (level 2)
	[ATL3]	Torque limiter value 3 / Torque bias command value 3	–	–
	[ATL4]	Torque limiter value 4	–	–
	[ATIN]	Torque command input	[T-REF]	Torque command (before limit)
	[ATR]	Torque command		
	[AFAI]	Magnetic-flux command input	[MF-REF]	Magnetic-flux command
	[ANFI]	Speed feedback input	[LINE-N]	Speed override
	[ANJF]	Creep setting value in UP/DOWN setter	[CRP-N1]	Creep speed 1
			[CRP-N2]	Creep speed 2
	[ATM]	Motor temperature input	[M-TMP]	Motor temperature
	V1	Voltage input for auxiliary speed setting	[AUX-N1]	Auxiliary speed setting 1
Digital input	CM	Digital input common	CM	Digital input common
	FWD	Forward operation · stop command	FWD	Forward operation · stop command
	REV	Reverse operation · stop command	REV	Reverse operation · stop command
	X1	Digital input 1	X1	Digital input 1
	X2	Digital input 2	X2	Digital input 2
	X3	Digital input 3	X3	Digital input 3
	X4	Digital input 4	X4	Digital input 4
	X5	Digital input 5	X5	Digital input 5
			X6	Digital input 6
			X7	Digital input 7
			X8	Digital input 8
			X9	Digital input 9
	[CNR1]	Multistep speed setting selection 1	[SS1]	Multistep speed setting selection 1
	[CNR2]	Multistep speed setting selection 2	[SS2]	Multistep speed setting selection 2
	[CNR4]	Multistep speed setting selection 4	[SS4]	Multistep speed setting selection 4
al	[CUP]	ACC command in UP/DOWN setter	[UP]	UP command in UP/DOWN setting

Category	FRENIC5000 VG3		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
	[CDWN]	DEC command in UP/DOWN setter	[DOWN]	DOWN command in UP/DOWN setting
	[CCLR]	Clear command in UP/DOWN setter	[CLR]	ACC/DEC zero clear command
	[CBSS]	Soft start · stop bypass	[BPS]	Bypass
	[CRT]	Soft start · stop time switch	[RT1]	ASR,ACC/DEC selection
	[CNL]	Reverse rotation lock command	H08	Reverse rotation lock
	[CPI]	ASR PI switch	[RT1][RT2]	ASR,ACC/DEC selection
	[CPPI]	ASR P/PI switch	[RT1][RT2]	ASR,ACC/DEC selection
	[CSTC]	Speed control/Torque control switch	[H41-CCL]	H41 [Torque command] cancel
	[CDRP]	Droop function	[DROOP]	Droop selection
	[CTL]	Torque limiter	[F40-CCL]	F40 (Torque limiter mode) cancel
	[CTB1]	Torque bias command 1	[TB1]	Torque bias command 1
	[CTB2]	Torque bias command 2	[TB2]	Torque bias command 2
	[CPOS]	Simplified position control command	–	–
	RST	Alarm reset	[RST]	Alarm reset
	THR	External alarm	[THR]	External alarm
	EXT	Pre-exciting command	[EXITE]	Pre-exciting command
	–		PLC	PLC signal power supply
Analog output	Ao	Analog output	Ao1	Analog output 1
			Ao2	Analog output 2
			Ao3	Analog output 3
	[BNF0]	Speed feedback output 0	[N-FB1+]	Speedometer one-way deflection
	[BNR0]	Speed setting 0	[N-REF2]	Speed setting 2
	[BNR1]	Speed setting 1	[N-REF4]	Speed setting 4
	[BNR2]	Speed setting 2	[N-REF4]	Speed setting 4
	[BT0]	Torque command output 0	[T-REF±]	Torque meter two-way deflection
	[BT1]	Torque command output 1	[T-REF±]	Torque meter two-way deflection
	[BIT]	Torque current command	[IT-REF±]	Torque ammeter two-way deflection
	[BNR]	Speed setting	[N-REF4]	Speed setting 4
	[BNA]	Speed feedback	[N-FB2±]	Speed detection
	[BNAB]	Speed feedback absolute value	[N-FB1+]	Speedometer one-way deflection
	[BTAB]	Torque command output absolute value	[T-REF+]	Torque meter one-way deflection
	[BITAB]	Torque current command output absolute value	[IT-REF+]	Torque ammeter one-way deflection
	[BIM]	Motor current detected value	[I-AC]	Motor current
	LM	For load meter	[IT-REF±]	Torque current command (torque ammeter two-way deflection)
			[IT-REF+]	Torque current command (torque ammeter one-way deflection)
			[T-REF±]	Torque command (torque meter two-way deflection)
			[T-REF+]	Torque command (torque meter one-way deflection)
	SM	For speedometer	[N-FB1+]	Speed detection (speedometer one-way deflection)
			[N-FB1±]	Speed detection (speedometer two-way deflection)
	M	Common to analog output	M	Common to analog output
Transistor output	Y1	Digital output 1	Y1	Digital output 1
	Y2	Digital output 2	Y2	Digital output 2
	Y3	Digital output 3	Y3	Digital output 3

Cat-ego-ry	FRENIC5000 VG3		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
	–		Y4	Digital output 4
	[DUV]	Establishment of link voltage (undervoltage)	[RDY]	Ready for operation
	[DZS]	Speed existence (zero speed)	[N-EX]	Speed existence
Transistor output	[DSAR]	Arrival at the preset speed	[N-AR]	Arrival at the preset speed
	[DSAG]	Speed agreement	[N-AG]	Speed agreement
	[DSDA]	Arbitrary speed (absolute value)	[N-DT1]	Speed detection 1
	[DSDP]	Arbitrary speed (with polarity)	[N-DT2]	Speed detection 2
	[DTLM]	Torque limiting	[TL]	Torque limiting
	[DTDT]	Torque detection	[T-DT1]	Torque detection 1
	[DAX]	Inverter running	[RUN]	Inverter running
	[DACC]	Accelerating	[U-ACC]	Accelerating
	[DDEC]	Decelerating	[U-DEC]	Decelerating
	[DOL]	Inverter overload early warning	[INV-OL]	Inverter overload early warning
	[DOLM]	Motor temperature overheat early warning	[M-OH]	Motor temperature overheat early warning
	[DTY4]	Transmission data Y4	[U-DO]	Universal DO
	[DTY5]	Transmission data Y5		
	[DTFT]	Transmission data error	[LK-ERR]	Transmission error
	CME	Digital output common	CME	Digital output common
Relay output	RYA, RYC	Relay output	Y5A, Y5C	Relay output
	30A, 30B, 30C	Alarm output for any fault	30A, 30B, 30C	Alarm output for any fault
	RYA, RYC	Relay output	Y5A, Y5C	Relay output
	30A, 30B, 30C	Alarm output for any fault	30A, 30B, 30C	Alarm output for any fault
Speed detection	PA, PB	Pulse generator 2-phase signal input	PA, PB	Pulse generator 2-phase signal input
	PGP, PGM	Pulse generator power supply	PGP, PGM	Pulse generator power supply
Temperature detection	THT	Connects motor thermistor	TH1	Connects motor thermistor (Motor temperature can be detected with the NTC and the PTC thermistors).
	THC	Common to motor thermistor	THC	Common to motor thermistor
Option power supply	P24	Power supply for option (+24V)	–	Please utilize the power supply on the market.
	M24	For +24V common	–	
	P15	Power supply for option (+15V)	–	
	(M)	For ±15V common	–	
	N15	Power supply for option (˜15V)	–	

12.5 Function Codes

12.5.1 Replacing VG7S

Since the function codes for FRENIC-VG are compatible with those for VG7S, settings for VG7S are available for the settings for the same function codes of FRENIC-VG.

Note that VG7S uses different function codes only for No. 3 parameters dedicated for V/f control, as shown below.

(For the settings for function codes, refer to Chapter 4.)

FRENIC5000 VG7S		FRENIC-VG	
Function Codes	Name	Function Codes	Name
-	-	A101	M3 control system (*1)
A35	M3 motor rated capacity	A102	M3 motor rated capacity
A36	M3 motor rated current	A103	M3 motor rated current
A37	M3 rated voltage	A104	M3 rated voltage
A38	M3 highest output voltage	A153	M3 highest output voltage
A39	M3 rated speed	A105	M3 rated speed
A40	M3 maximum speed	A106	M3 maximum speed
A41	M3 motor pole	A107	M3 motor pole
A42	M3 %R1	A108	M3 %R1
A43	M3 %X	A109	M3 %X
A44	M3 exciting current	A110	M3 exciting current
A45	M3 slip compensation amount	A154	M3 slip compensation amount
A46	M3 torque boost (*2)	A155	M3 torque boost (*2)
A47	M3 thermistor selection	A131	M3 thermistor selection
A48	M3 electronic thermal (operation selection)	A132	M3 electronic thermal (operation selection)
A49	M3 electronic thermal (operation level)	A133	M3 electronic thermal (operation level)
A50	M3 electronic thermal (thermal time constant)	A134	M3 electronic thermal (thermal time constant)

(*1) The V/f control is performed when the function code A101 is set to "5".

(*2) When the inverter capacity is 22 kW or less with the torque boos set to 2.0 to 20.0, make the settings according to the conversion table below.

■Torque boost conversion table

<table>
<tr><th>FRENIC5000 VG7S
A46</th><th>FRENIC-VG
P35, A55, A155</th><th>Remarks</th></tr>
<tr><td>2.0</td><td>2.0</td><td rowspan="10">Substitute according to the following calculation formula.
* Calculation formula
・ VG7 A46 = 2.0 to 20.0
VG1 setting = (100 X [A46 for VG7] + 200)÷200

The boost amount is calculated by the following formula.
・ VG7 boost amount [%]
Boost amount [%] = (10% ÷ (20.2 - 2.0)) X ([P35] - 2.0))
・ VG1 boost amount [V]
Boost amount [%] = (20% ÷ (20.2 - 2.0)) X ([P35] - 2.0))
*100% rated voltage</td></tr>
<tr><td>4.0</td><td>3.0</td></tr>
<tr><td>6.0</td><td>4.0</td></tr>
<tr><td>8.0</td><td>5.0</td></tr>
<tr><td>10.0</td><td>6.0</td></tr>
<tr><td>12.0</td><td>7.0</td></tr>
<tr><td>14.0</td><td>8.0</td></tr>
<tr><td>16.0</td><td>9.0</td></tr>
<tr><td>18.0</td><td>10.0</td></tr>
<tr><td>20.0
(Equivalent to 10% of rated voltage)</td><td>11.0
(Equivalent to 10% of rated voltage)</td></tr>
</table>

12.5.2 Replacing VG5S

FRENIC5000 VG5S		FRENIC-VG	
Function Codes	Name	Function Codes	Name
01	Speed setting	F01	Speed setting N1
02	Operation method	F02	Operation method
03	Max. speed	F03	M1 max. speed
04	Acceleration time 1	F07	Acceleration time 1
05	Deceleration time 1	F08	Deceleration time 1
06	S-curve acceleration/deceleration 1	F67 to F70	S-curve acceleration/deceleration 1
07	Multistep speed 1	C05	Multistep speed 1
08	Multistep speed 2	C06	Multistep speed 2
09	Multistep speed 3	C07	Multistep speed 3
10	Multistep speed 4	C08	Multistep speed 4
11	Multistep speed 5	C09	Multistep speed 5
12	Multistep speed 6 / Creep speed 1	C10/C18	Multistep speed 6 / Creep speed 1
13	Multistep speed 7 / Creep speed 2	C11/C19	Multistep speed 7 / Creep speed 2
14	ASR1 (P gain)	F61	ASR1-P(Gain)
15	(I gain)	F62	ASR1-I (Constant of integration)
16	Constant on filtering (Speed setting)	F64	ASR1 input filter
17	(Speed detection)	F65	ASR1 detection filter
18	Torque limiter (Method selection)	F40,41	Torque limiter mode
19	(Limiter value selection)	F42,43	Torque limiter value selection
20	Torque limiter (Level 1)	F44	Torque limiter (Level 1)
21	(Level 2)	F45	(Level 2)
22	Motor electronic thermal (Select)	F10	M1 motor electronic thermal (Select)
23	(Level)	F11	(Level)
24	Restart after momentary power failure	F14	Restart after momentary power failure (Operation selection)
25	DC brake (Time)	F22	DC brake (Braking time)
26	(Level)	F21	(Operation level)
27	Pre-excitation (Time)	F74	Pre-excitation time
30	Function block (31-44) selection	–	
31	Droop control	H28	Droop control
32	Filtering time constant (ASR output)	F66	ASR1 output filter
33	Acceleration time 2	C46	Acceleration time 2
34	Deceleration time 2	C47	Deceleration time 2
35	S-curve acceleration/deceleration 2	C48, C49	S-curve acceleration/deceleration 2
36	Ratio setting	F17	Gain (Speed setting signal 12)
37	ASR2 (P gain)	C40	ASR2-P (Gain)
38	(I gain)	C41	ASR2-I (Constant of integration)
39	ASR1, 2 switching characteristic	C70	ASR switching time
40	Torque bias (Level 1)	F47	Torque bias T1
41	(Level 2)	F48	Torque bias T2
42	Selection between torque control and torque current control (Select)	H41, H42	Torque command and torque current command selection
43	Magnetic-flux command (Select)	H43	Magnetic-flux command selection
44	Magnetic-flux command at light load	F73	Magnetic-flux level at light load
50	Function block (51-55) selection	–	
51	ASR tuning (Action selection)	H46	Observer type selection
52	(Operation selection)	H01	Tuning operation selection

FRENIC5000 VG5S		FRENIC-VG	
Function Codes	Name	Function Codes	Name
53	Observer data (Compensation gain)	H47, H48	Observer settings (Compensation gain)
54	(Integration time)	H49, H50	(Integration time)
55	(Load inertia)	H51, H52	(Load inertia)
60	Function block (61-74) selection	–	
61	Motor overheat protection (temp.)	E30	Motor overheat protection (temp.)
62	Motor overheat early warning (temp.)	E31	Motor overheat early warning (temp.)
63	Inverter overload early warning (Level)	E33	Inverter overload early warning
64	Motor overload early warning (Level)	E34	Motor overload early warning
65	Zero speed detection (Level)	F37	Stop speed
66	Speed detection (Level 1)	E39	Speed detection level 1
67	(Level 2)	E40	Speed detection level 2
68	(Level 3)	E41	Speed detection level 3
69	Speed detection method	E38	Speed detection method
70	Speed equivalence (Detection range)	E42	Speed equivalence (Detection range)
71	Speed agreement (Detection range)	E43	Speed agreement (Detection range)
72	(Off delay timer)	E44	(Off delay timer)
73	Torque detection (Level)	E46	Torque detection level 1
74	Timer for continuous operation	F39	Stop speed (Zero speed holding time)
80	Function block (81-101) selection	–	
81	Auto-restart (Times)	H04	Auto-restart (Times)
82	(Interval)	H05	(Interval)
83	Speed bias setting	F18	Bias (Speed setting signal 12)
84	Speed limiter (Method selection)	F76	Speed limiter (Method selection)
85	Speed limiter (Level 1)	F77	Speed limiter level 1
86	(Level 2)	F78	Speed limiter level 2
87	Creep selection (Setting selection)	C73	Creep speed switching (on UP/DOWN control)
88	Operation method changeover switch	–	Function selection Di [IVS]
89	Speed feedback (Signal selection)	H53	Line speed feedback selection
90	Suppressing function	H57	Overvoltage suppressing function
91	Operation method selection	H11	Automatic operation OFF function
92	Torque command monitor	F51	Torque command monitor (Polarity selection)
93	Language	F58	LCD monitor (Language selection)
94	LCD brightness adjustment	F59	LCD monitor (Contrast adjustment)
95	LED monitor selection	F55	LED monitor (Display selection)
96	Display of load speed (Coefficient 1)	F52	LED monitor (Display coefficient A)
97	(Coefficient 2)	F53	LED monitor (Display coefficient B)
98	LCD monitor selection	F57	LCD monitor (Display selection)
99	Motor sound selection	F26	Motor sound (Carrier freq.)
100	Data initialization	H03	Data initialization
101	All save	H02	All save
110	Function block (111-134) selection	–	
111	Selection of X1 to X5 functions (X1, X2)	E01, E02	Selection of X1 function, Selection of X2 function
112	(X3, X4)	E03, E04	Selection of X3 function, Selection of X4 function
113	(X5)	E05	X5 function selection
114	Timer for multistep speed reference agreement	C20	Timer for multistep speed reference agreement
115	Y1 to Y3, RY function selection (Y1, Y2)	E15, E16	Y1 function selection, Y2 function selection
116	(Y3, RY)	E17, E19	Y3 function selection, Y5 function selection

FRENIC5000 VG5S		FRENIC-VG	
Function Codes	Name	Function Codes	Name
117	Ai1, Ai2 function selection	E49, E50	Ai1 function selection, Ai2 function selection
118	Increment/decrement limiter (Ai1)	E65	Increment/decrement limiter (Ai1)
119	(Ai2)	E66	Increment/decrement limiter (Ai2)
120	Offset setting (12)	F18	Bias (Speed setting signal 12)
121	(Ai1)	E57	Ai1 bias setting
122	(Ai2)	E58	Ai2 bias setting
123	Gain setting (12)	F17	Gain (Speed setting signal 12)
124	(Ai1)	E53	Ai1 gain setting
125	(Ai2)	E54	Ai2 gain setting
126	AO1 to AO3 function selection	E69 to E71	AO1 function selection, AO2 function selection, AO3 function selection
127	Bias adjustment (AO1)	E79	AO1 bias setting
128	(AO2)	E80	AO2 bias setting
129	(AO3)	E81	AO3 bias setting
130	Gain adjustment (AO1)	E74	AO1 gain setting
131	(AO2)	E75	AO2 gain setting
132	(AO3)	E76	AO3 gain setting
133	Filter selection (AO1, AO2, AO3)	E84	AO1-5 filter setting
140	Function block (140-169) selection	–	
141	Operation command selection	H30	Serial link
142	Control input through transmission	S06	Operation method 1(through communication)
143	Speed command through transmission	S01	Speed command
144	Action on T-Link error (Mode)	o30	T-Link option setting (Action on transmission error)
145	(Action time)	o31	(Action time on transmission error)
146	Standard built-in RS-485 address	H31	RS-485 (Station address)
147	Action on RS-485 error (Mode)	H32	Action on RS-485 error Operation (Mode select on error)
148	(Action time)	H33	(Timer operating time)
149	(No response error detection time)	H38	(No response error detection time)
150	(Response interval)	H39	(Response interval)
151	X11 to X14 function selection (X11, X12)	E10, E11	X11 function selection, X12 function selection
152	(X13, X14)	E12, E13	X13 function selection, X14 function selection
153	Y11 to Y13 function selection (Y11, Y12)	E20, E21	Y11 function selection, Y12 function selection
154	(Y13)	E22	Y13 function selection
155	Function selection of OPCII-VG5-DI	o01, o02	DIA function selection, DIB function selection
156	BCD input speed	o03, o04	DIA BCD input setting, DIB BCD input setting
157	Command pulse correction 1	o14	Command pulse correction 1
158	Command pulse correction 2	o15	Command pulse correction 2
159	APR gain	o16	APR gain
160	F/F gain	o17	F/F gain
161	Deviation excess range	o18	Deviation excess range
162	Deviation zero range	o19	Deviation zero range
170	Function block (171-197) selection	–	
171	Motor selection (*1)	P02	M1 motor selection
172	PG pulse number	P28	M1-PG pulse number
173	NTC thermistor selection	P30	M1 thermistor selection

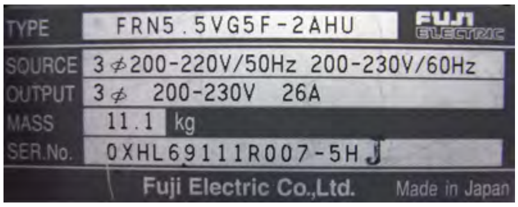
FRENIC5000 VG5S		FRENIC-VG	
Function Codes	Name	Function Codes	Name
174	Motor ratings (Capacity)	P03	M1 rated capacity
175	(Voltage)	F05	M1 rated voltage
176	(Current)	P04	M1 rated current
177	(Base speed)	F04	M1 rated speed
178	(No. of pole)	P05	M1 number of pole
179	Overload capability	–	
180	Auto-tuning of motor characteristic (Protection)	–	
181	(Operation)	H01	Tuning operation selection
182	Motor characteristic (%R1)	P06	M1-%R1
183	(%X)	P07	M1-%X
184	(Exciting current)	P08	M1 exciting current
185	(Torque current)	P09	M1 torque current
186	(Slip on driving)	P10	M1 slip on driving
187	(Slip on braking)	P11	M1 slip on braking
188	(Iron loss coefficient 1)	P12	M1 iron loss coefficient 1
189	(Iron loss coefficient 2)	P13	M1 iron loss coefficient 2
190	(Iron loss coefficient 3)	P14	M1 iron loss coefficient 3
191	(Magnetic saturation coefficient 1)	P15	M1 magnetic saturation coefficient 1
192	(Magnetic saturation coefficient 2)	P16	M1 magnetic saturation coefficient 2
193	(Magnetic saturation coefficient 3)	P17	M1 magnetic saturation coefficient 3
194	(Magnetic saturation coefficient 4)	P18	M1 magnetic saturation coefficient 4
195	(Magnetic saturation coefficient 5)	P19	M1 magnetic saturation coefficient 5
196	(Secondary time constant)	P20	M1 secondary time constant
197	(Induced voltage coefficient)	P21	M1 induced voltage coefficient
200	Data protection	F00	Data protection

(*1) If "other" is specified in VG5 motor selection [171], calculate with the following formula.

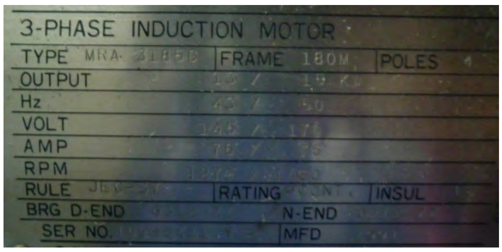
VG1 Function Codes	Name	Conversion formula
P06	M1-%R1	・ For 200V system [182]×135÷[175]×√3 ・ For 400V system [182]×270÷[175]×√3
P07	M1-%X	・ For 200V system [183]×135÷[175]×√3×fbase÷50 (fbase=[177]×[178]÷120) ・ For 400V system [183]×270÷[175]×√3×fbase÷50 (fbase=[177]×[178]÷120)
P08	M1 exciting current	[184]÷√2
P09	M1 torque current	[185]÷√2
P21	M1 inductive voltage	[197]×fbase÷50×√3÷√2 (fbase=[177]×[178]÷120)

Function codes for VG5 are put in brackets.

(*2) If the inverter is broken, and the motor constant cannot be confirmed, notify our sales office of the following contents.

<table>
<tr><th></th><th>Item</th><th>Details</th></tr>
<tr><td rowspan="3">Inverter</td><td>▪ TYPE
▪ SER. No.</td><td>Notify us of the descriptive contents of the name plate.

</td></tr>
<tr><td>ROM No</td><td>ROM seal are affixed to the CUP board of the control PCB.

</td></tr>
<tr><td>・ System code
(VG5□-□□□□-□□)
2 digits at the end = 00 (standard item)
01 to 99 (special item)</td><td>The system code seal is affixed to the back face of the control terminal block. (See the photo below)

</td></tr>
<tr><td rowspan="2">Motor</td><td>▪ Product model (TYPE)
▪ Number of poles (POLES)
▪ Capacity (OUTPUT)
▪ Frequency (Hz)
▪ Voltage (VOLT)
▪ Current (AMP)
▪ Number of revolutions (RPM)
▪ Production No. (SER No.)</td><td>Notify us of the descriptive contents of the name plate.

</td></tr>
<tr><td>Outline drawing</td><td></td></tr>
</table>

12.5.3 Replacing VG3

FRENIC5000 VG3		FRENIC-VG	
Function Codes	Name	Function Codes	Name
01	Motor rotating speed detection value display	–	LED MONITOR
02	Motor rotating speed setting value display	–	LED MONITOR
03	Load speed detection value display	–	LED MONITOR
04	Torque current reference value display	–	LED MONITOR
05	Torque reference value display	–	LED MONITOR
06	Motor output display	–	LED MONITOR
07	Inverter output current display	–	LED MONITOR
08	Motor temperature display	–	LED MONITOR
09	Input signal (1) display	–	LCD monitor
0A	Input signal (2) display	–	LCD monitor
0B	Output signal display	–	LCD monitor
0C	Operation mode display	–	LCD monitor
0D	Soft switch (1) display	–	LCD monitor
0E	Soft switch (2) display	–	LCD monitor
0F	Magnetic-flux quantity	–	LED MONITOR
10	Protection of setting data (11-3F)	–	
11	Acceleration time 1	F07	Acceleration time 1
12	Deceleration time 1	F08	Deceleration time 1
13	S-curve applied range	F67 F68 F69 F70	S-curve acceleration start side 1 S-curve acceleration end side 1 S-curve deceleration start side 1 S-curve deceleration end side 1
14	Multistep speed setting value 1	C05	Multistep speed 1
15	Multistep speed setting value 2	C06	Multistep speed 2
16	Multistep speed setting value 3	C07	Multistep speed 3
17	Multistep speed setting value 4	C08	Multistep speed 4
18	Multistep speed setting value 5	C09	Multistep speed 5
19	Acceleration time 2	C46	Acceleration time 2
1A	Deceleration time 2	C47	Deceleration time 2
1B	Speed reference input gain	F17	Gain (Speed setting signal 12)
20	ASR P (1)	F61	ASR1 P
21	ASR I (1)	F62	ASR1 I
22	Speed setting constant on filtering (1)	F64	ASR1 input filter
23	Speed detection constant on filtering (1)	F65	ASR1 detection filter
24	ASR P (2)	C40	ASR2 P
25	ASR I (2)	C41	ASR2 I
26	Speed setting constant on filtering (2)	C43	ASR2 input filter
27	Speed detection constant on filtering (2)	C44	ASR2 detection filter
28	Droop quantity	H28	Droop control
29	ASR time constant of P changeover switch	C70	ASR switching time
2A	Torque limiter value 1/Torque bias command value 1	F44	Torque limiter value (Level 1)
2B	Torque limiter value 2/Torque bias command value 2	F45	Torque limiter value (Level 2)
2C	Torque limiter value 3/Torque bias command value 3	–	
2D	Torque limiter value 4	–	
2E	Magnetic-flux command level	H44	Magnetic-flux command value
2F	Magnetic-flux command level at light load	F73	Magnetic-flux level at light load
30	Zero speed detection level	F37	Stop speed
31	Arbitrary speed detection level	E39	Speed detection level 1

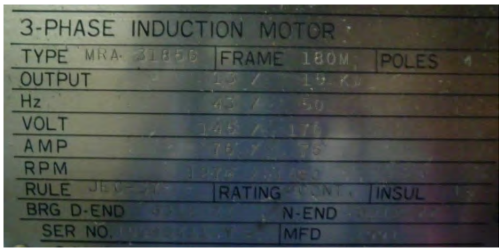
FRENIC5000 VG3		FRENIC-VG	
Function Codes	Name	Function Codes	Name
	(Absolute value)		
32	Arbitrary speed detection level (With polarity)	E40	Speed detection level 2
33	Speed equivalence detection level	E42	Speed equivalence
34	Speed agreement detection level	E43	Speed agreement
35	Torque detection level	E46	Torque detection level 1
36	Overload early warning detection level	E33	Inverter overload early warning
37	Motor overheat early warning detection level	E31	Motor overheat early warning
38	Output calibration coefficient of load meter	–	Adjustment is possible through E69 to 71, by allocating the torque meter into AO1 to 3.
39	Output calibration coefficient of speedometer	–	Adjustment is possible through E69 to 71, by allocating the speedometer into AO1 to 3.
3A	Stop position by the simplified position control	–	
40	First fault	–	LED MONITOR
41	Second fault	–	LED MONITOR
42	Fault condition	–	LCD MONITOR
43	Speed setting value at the occurrence of fault.	–	LCD MONITOR
44	Speed detection value at the occurrence of fault.	–	LCD MONITOR
45	Torque current reference value at the occurrence of fault.	–	LCD MONITOR
46	Motor current value (U-phase) at the occurrence of fault.	–	LCD MONITOR
47	Motor current value (W-phase) at the occurrence of fault.	–	LCD MONITOR
48	Operation mode (LED display) at the occurrence of fault.	–	LCD MONITOR
49	Operation mode (HEX display) at the occurrence of fault.	–	LCD MONITOR
4A	Soft switch 1 (LED display) at the occurrence of fault.	–	LCD MONITOR
4B	Soft switch 2 (LED display) at the occurrence of fault.	–	LCD MONITOR
4C	Soft switch (HEX display) at the occurrence of fault.	–	LCD MONITOR
4D	Last fault (First fault)	–	LCD MONITOR
4E	Fault before last (First fault)	–	LCD MONITOR
4F	Fault before and before last (First fault)	–	LCD MONITOR
50	Protection of setting data (51-8F)	–	
51	Max. speed of motor	F03	M1 max. speed
52	Base speed of motor	F04	M1 rated speed
53	DC brake using/not using.	F22	DC brake (Braking time)
54			
55	DC braking time	F22	DC brake (Braking time)
56			
57	Speed setting limiter value (Upper limit)	F77	Speed limiter level 1
58	Definition of the operation method (1)	–	
59	Definition of the operation method (2)	H11	Automatic operation OFF function
5A	Definition of the Speed setting method (1)	F01	Speed setting N1
5B	Definition of forward･reverse command	–	Possible through function selection DI [IVS].
5C	Calibration coefficient of load speed	F52,53	LED monitor (Display coefficient)

FRENIC5000 VG3		FRENIC-VG	
Function Codes	Name	Function Codes	Name
5D	Definition of the speed detection area	H53	Line speed feedback selection
5E	Definition of the Speed setting method (2)	C25	Speed setting N2
5F	Creep setting of U/D setter	C73	Creep speed switching
60	Definition of the torque limiter method	F40	Torque limiter mode
61	Definition of the torque limiter value 1/Torque bias reference value 1.	F42	Torque limiter value (Level 1) selection
62	Definition of the torque limiter value 2/Torque bias reference value 2.	F43	Torque limiter value (Level 2) selection
63	Definition of the torque limiter value 3/Torque bias reference value 3.	–	
64	Definition of the torque limiter value 4.	–	
65	In use/not in use of external Ai for the torque reference.	H41	Torque reference selection
66	Definition of the magnetic-flux reference value.	H43	Magnetic-flux command selection
70	LM terminal definition	–	Possible through function selection from AO1 to 3.
71	SM terminal definition	–	Possible through function selection from AO1 to 3.
72	DI definition (X1 to X4, X6, X7)	E01 to E04	X1 to X4 function selection
73	DI definition (X5)	E05	X5 function selection
74	DO definition (Y1 to Y5)	E15 to E18	Y1 to Y4 function selection
75	DO definition (RY)	E19	Y5 function selection
76	AI definition (Ai1)	E49	Ai1 function selection
77	AI definition (Ai2)	E50	Ai2 function selection
78	AO definition (AO1)	E69	AO1 function selection
79	AO definition (AO2, AO3)	E70, E71	A02, A03 function selection
7A	No. of motor poles, specification for the pulse generator	P28	No. of PG pulses
7B	V1 enabled/disabled	–	Possible through function selection Ai [OFF].
80	Calibration coefficient of BCD input for speed setting	o03, o04	DI BCD input setting.
81	Definition of the initial setting value of UP/DOWN setter.	F01, C25	Speed setting N1, N2
82	Enabled/disabled of transmission data	H30	Serial link
83	Transmission ID code	–	
84			
85	AO adjustment	–	Possible through AO function selection [P10], [N10].
86	AI1 filter	E61	Ai1 filter
87	AI2 filter	E62	Ai2 filter
88	12 offset adjustment value	–	
89	12 gain adjustment value	F17	Gain (Speed setting signal 12)
8A	V1 offset adjustment value	–	
8B	V1 gain adjustment value	–	
8C	AI1 offset adjustment value	E57	AI1 bias setting
8D	AI1 gain adjustment value	E53	AI1 gain setting
8E	AI2 offset adjustment value	E58	AI2 bias setting
8F	AI2 gain adjustment value	E54	AI2 gain setting
90	Display of the transmitted and written DI data	S06	Operation method 1
91	Transmission speed setting mode selection	H30	Serial link
92	Transmission speed setting	S01	Speed command

FRENIC5000 VG3		FRENIC-VG	
Function Codes	Name	Function Codes	Name
93	Transmission speed setting bias	–	
94	Transmission torque command mode selection	H41	Torque command selection
95	Transmission torque command	S02	Torque command
96	General purpose DO	S07	Universal DO
97	Trace data mode	–	
98, 99			
9A	Confirmation of data saving condition	–	
9B	ALL SAVE function	H02	All save
For manufacturer	Motor constant setting value (non-disclosure)	P01 to P30	Motor code (*1)

(*1) Using "Excepting V63 standard motor" requires the confirmation of the motor constant.

Notify our sales office of the following contents.

	Item	Details
Inverter	・ TYPE ・ SER. No.	Notify us of the descriptive contents of the name plate. 
	ROM No	ROM seal are affixed to the IC2 and IC3 of the control PCB. 
	・ System code (VG3□-□□□□-□□) 2 digits at the end = 00 (standard item) 01 to 99 (special item)	The system code seal is affixed to the back face of the control terminal block. (See the photo below) 
Motor	▪ Product model (TYPE) ▪ Number of poles (POLES) ▪ Capacity (OUTPUT) ▪ Frequency (Hz) ▪ Voltage (VOLT) ▪ Current (AMP) ▪ Number of revolutions (RPM) ▪ Production No. (SER No.)	Notify us of the descriptive contents of the name plate. 
	Outline drawing	

12.6 Motor Parameters

12.6.1 Replacing VG7S

200V series

Motor specification			VG7S code No. / FRENIC-VG code No.			Motor parameters																										
						F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	H51
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.)[r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	Iron loss co-ef*. 2 [%]	Iron loss co-ef*. 3 [%]	Magnetic saturation co-ef*. 1 [%]	Magnetic saturation co-ef*. 2 [%]	Magnetic saturation co-ef*. 3 [%]	Magnetic saturation co-ef*. 4 [%]	Magnetic saturation co-ef*. 5 [%]	Secondary time constant [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correctionco-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.	Load inertia
MVK6096 MVK6095A	0.75	4	1500/3600	188	4.3	1500	1500	188	0.75	4.3	4	4.34	9.07	3.21	2.92	1.320	1.185	7.60	7.60	10.00	93.0	85.8	72.6	60.0	47.6	0.108	149	1.360	1.480	1.000	0.000	0.009
MVK6097 MVK8097A	1.5	4	1500/3600	188	7.0	1500	1500	188	1.5	7.0	4	7.06	14.76	3.21	5.83	2.640	2.370	3.80	3.80	5.00	93.0	85.8	72.6	60.0	47.6	0.108	149	1.360	1.480	1.000	0.000	0.009
MVK6107 MVK8107A	2.2	4	1500/3600	188	11	1500	1500	188	2.2	11	4	8.27	12.95	3.81	9.75	2.622	3.059	3.00	4.00	1.00	85.2	73.7	59.1	47.6	37.4	0.051	140	2.530	1.133	1.000	0.000	0.009
MVK6115 MVK8115A	3.7	4	1500/3600	188	18	1500	1500	188	3.7	18	4	6.86	12.69	8.11	15.69	2.500	2.370	3.00	2.95	2.50	88.4	80.1	66.4	54.1	43.0	0.084	146	0.899	1.320	1.000	0.022	0.016
MVK6133 MVK8133A	5.5	4	1500/3600	188	30	1500	1500	188	5.5	30	4	6.05	13.44	12.98	21.92	1.490	1.440	3.00	2.50	3.00	88.3	79.5	66.0	54.1	43.0	0.090	149	1.925	1.985	1.000	0.026	0.030
MVK6135 MVK8135A	7.5	4	1500/3600	188	37	1500	1500	188	7.5	37	4	6.70	12.45	15.62	30.66	1.771	1.871	2.32	1.76	3.00	85.3	70.7	53.8	43.7	34.4	0.070	155	0.900	0.900	1.000	0.000	0.038
MVK6165 MVK8165A	11	4	1500/3600	188	50	1500	1500	188	11	50	4	4.26	11.64	24.79	40.30	0.988	0.824	4.53	1.88	0.22	84.9	75.0	61.6	50.0	39.4	0.087	175	0.900	2.343	1.000	0.000	0.085
MVK6167 MVK8167A	15	4	1500/3600	188	65	1500	1500	188	15	65	4	4.47	12.25	26.99	53.96	1.067	1.067	0.00	1.50	1.00	88.7	80.7	67.2	55.2	44.0	0.133	160	1.689	1.689	1.000	0.000	0.120
MVK6184 MVK8184A	18.5	4	1500/3600	188	74	1500	1500	188	18.5	74	4	3.22	10.68	30.58	72.83	0.934	0.931	3.50	0.50	0.50	90.7	83.2	69.5	56.8	44.4	0.240	160	1.465	1.803	1.000	0.097	0.210
MVK6185 MVK8185A	22	4	1500/3600	188	90	1500	1500	188	22	90	4	3.59	11.78	34.17	83.43	0.606	0.855	1.30	0.77	2.00	91.1	83.2	69.1	56.8	44.6	0.387	160	4.000	2.200	1.000	0.089	0.230
MVK6206	30	4	1500/3000	188	116	1500	1500	188	30	116	4	2.53	12.13	53.42	108.1	0.606	0.648	2.50	3.50	5.00	84.4	74.0	59.5	48.9	38.0	0.173	166	2.268	2.078	1.000	0.000	0.340
MVK8187A	30	4	1500/3000	188	116	1500	1500	188	30	116	4	2.43	12.32	39.95	106.0	0.915	1.015	3.00	0.00	0.00	88.2	81.9	70.1	58.4	46.7	0.385	166	1.818	1.737	1.000	0.000	0.340
MVK6207 MVK8207A	37	4	1500/3000	188	143	1500	1500	188	37	143	4	2.47	14.69	60.09	133.2	0.497	0.536	1.80	3.00	5.00	85.4	75.7	62.3	50.5	39.9	0.184	168	3.200	2.560	1.000	0.180	0.410
MVK6208 MVK8208A	45	4	1500/3000	188	170	1500	1500	188	45	170	4	2.73	15.26	56.71	169.7	0.947	0.901	1.00	0.00	0.15	89.2	81.6	67.6	56.2	43.4	0.295	164	1.229	1.813	1.000	0.178	0.470
MVK9250	55	4	1500/2400	185	216	1500	1500	185	55	216	4	2.08	12.36	66.22	197.9	0.621	0.595	3.00	0.83	0.21	91.5	83.8	70.6	57.8	45.6	0.413	168	1.615	1.753	1.000	0.000	0.800
MVK9224A	55	4	1500/2400	180	225	1500	1500	180	55	225	4	2.04	14.42	72.66	202.3	0.742	0.742	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.544	167	1.000	1.000	1.000	0.000	0.530
MVK9252	75	4	1500/2400	183	276	1500	1500	183	75	276	4	1.70	15.29	99.34	261.6	0.638	0.665	2.00	2.00	0.00	90.4	83.0	68.4	57.4	46.4	0.409	165	1.856	1.785	1.000	0.091	0.950
MVK9254A	75	4	1500/2400	183	299	1500	1500	183	75	299	4	2.00	16.41	89.26	272.1	0.597	0.647	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.555	163	1.849	1.784	1.000	0.000	0.880
MVK9280	90	4	1500/2000	183	345	1500	1500	183	90	345	4	2.28	20.12	89.3	332.3	0.669	0.546	0.00	5.00	0.00	91.1	85.1	70.9	59.2	48.7	0.490	181	1.331	1.428	1.000	0.000	1.370
MVK9256A	90	4	1500/2000	185	362	1500	1500	185	90	362	4	1.72	14.10	124.40	321.7	0.680	0.680	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.549	172	1.000	1.000	1.000	0.000	1.030

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

400 V series (1)

Motor specification			VG7S code No. / FRENIC-VG code No.			Motor parameters																										
						F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	H51
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.) [r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	Iron loss co-ef*. 2 [%]	Iron loss co-ef*. 3 [%]	Magnetic saturation co-ef*. 1 [%]	Magnetic saturation co-ef*. 2 [%]	Magnetic saturation co-ef*. 3 [%]	Magnetic saturation co-ef*. 4 [%]	Magnetic saturation co-ef*. 5 [%]	Secondary time constant [s]	Induced voltage co-ef*. [V]	Load inertia	R2 correctionco-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.	Load inertia
MVK6115 M8115A	3.7	4	1500/3600	376	9	1500	1500	376	3.7	9	4	6.86	13.94	3.93	7.78	2.510	2.340	2.35	2.55	1.20	90.5	82.4	68.7	57.0	45.3	0.104	294	0.880	1.440	1.000	0.028	0.016
MVK6133 MVK8133A	5.5	4	1500/3600	376	15	1500	1500	376	5.5	15	4	5.50	12.78	7.15	10.74	1.311	1.370	2.00	5.00	7.00	88.0	79.2	65.6	53.6	42.2	0.078	299	2.361	1.985	1.000	0.019	0.030
MVK6135 MVK8135A	7.5	4	1500/3600	376	18.5	1500	1500	376	7.5	18.5	4	4.37	13.72	7.81	15.33	1.465	1.686	7.61	2.00	1.00	85.9	76.9	63.4	51.6	40.5	0.064	310	1.607	1.427	1.000	0.000	0.037
MVK6165 MVK8165A	11	4	1500/3600	376	25.0	1500	1500	376	11	25	4	4.27	11.67	12.39	20.15	0.988	0.824	4.53	1.88	0.22	84.9	75.0	61.6	50.0	39.4	0.087	348	0.910	2.343	1.000	0.000	0.085
MVK6167 MVK8167A	15	4	1500/3600	376	31.7	1500	1500	376	15	31.7	4	4.48	13.69	14.47	28.63	1.290	1.269	1.00	0.50	1.00	88.7	81.7	67.2	55.2	44.0	0.133	306	1.090	1.318	1.000	0.027	0.110
MVK6184 MVK8184A	18.5	4	1500/3600	376	37	1500	1500	376	18.5	37	4	2.66	12.45	14.02	36.06	0.882	0.882	1.00	3.00	3.00	92.5	84.3	70.3	57.1	45.1	0.295	321	1.825	1.825	1.000	0.018	0.210
MVK6185 MVK8185A	22	4	1500/3600	376	45	1500	1500	376	22	45	4	3.61	14.06	16.81	41.72	0.903	0.891	1.50	1.50	3.00	91.1	83.2	69.1	56.5	44.6	0.387	320	1.357	1.673	1.000	0.037	0.230
MVK6206	30	4	1500/3000	376	58	1500	1500	376	30	58	4	2.55	12.16	25.74	52.52	0.666	0.648	2.50	3.50	9.50	84.4	74.0	59.5	48.9	38.0	0.173	331	2.268	2.078	1.000	0.070	0.340
MVK8187A	30	4	1500/3000	376	58	1500	1500	376	30	58	4	2.43	12.32	19.97	53.0	0.915	1.015	3.00	0.00	0.00	88.2	81.9	70.1	58.4	46.7	0.385	332	1.818	1.737	1.000	0.000	0.340
MVK6207 MVK8207A	37	4	1500/3000	376	71	1500	1500	376	37	71	4	2.49	14.11	30.07	65.54	0.497	0.498	1.79	1.80	5.00	85.4	75.7	62.3	50.5	39.9	0.184	336	3.200	3.064	1.000	0.095	0.410
MVK6208 MVK8208A	45	4	1500/3000	376	85	1500	1500	376	45	85	4	2.73	15.30	28.36	84.85	0.947	0.937	0.50	1.50	1.85	89.2	81.6	67.6	56.2	43.4	0.295	328	1.229	1.502	1.000	0.089	0.470
MVK9250	55	4	1500/2400	376	108	1500	1500	376	55	108	4	2.05	12.20	33.11	98.98	0.621	0.595	3.00	0.83	0.21	91.5	83.8	70.6	57.8	45.6	0.413	336	1.615	1.753	1.000	0.000	0.800
MVK9224A	55	4	1500/2400	365	111	1500	1500	365	55	111	4	1.99	13.96	37.76	99.0	0.721	0.721	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.531	339	1.000	1.000	1.000	0.000	0.530
MVK9252	75	4	1500/2400	365	138	1500	1500	365	75	138	4	1.71	15.39	49.67	130.8	0.638	0.665	2.00	2.00	0.00	90.4	83.0	68.4	57.4	46.4	0.409	330	1.856	1.785	1.000	0.091	0.950
MVK9254A	75	4	1500/2400	365	149	1500	1500	365	75	149	4	1.77	16.39	44.04	135.0	0.714	0.714	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.627	339	1.000	1.000	1.000	0.000	0.880
MVK9280	90	4	1500/2000	370	173	1500	1500	370	90	173	4	2.23	18.47	44.37	164.1	0.685	0.647	0.00	2.00	0.00	90.7	83.7	69.0	57.1	44.9	0.590	348	1.093	1.212	1.000	0.163	1.370
MVK9256A	90	4	1500/2000	370	179	1500	1500	370	90	179	4	1.51	13.93	62.28	159.2	0.600	0.600	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.621	345	1.000	1.000	1.000	0.000	1.030
MVK9282	110	4	1500/3000	375	206	1500	1500	375	110	206	4	2.14	16.83	53.03	195.8	0.557	0.606	0.44	0.00	0.00	90.1	82.6	67.7	56.3	44.2	0.577	350	1.488	1.172	1.000	0.090	1.600
MVK9284A	110	4	1500/2000	370	212	1500	1500	370	110	212	4	1.66	15.39	59.73	192.9	0.579	0.579	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.824	346	1.000	1.000	1.000	0.000	1.540
MVK9310	132	4	1500/3000	375	248	1500	1500	375	132	248	4	1.56	17.21	62.05	237.3	0.481	0.531	0.00	0.39	0.00	90.1	81.2	67.7	56.2	45.9	0.689	336	1.468	1.424	1.000	0.000	2.680
MVK9286A	132	4	1500/2000	375	247	1500	1500	375	132	247	4	1.57	15.65	68.05	237.4	0.592	0.592	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.876	351	1.000	1.000	1.000	0.000	1.770

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

400 V series (2)

Motor specification			VG7S code No. / FRENIC-VG code No.			Motor parameters																										
						F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	H51
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.) [r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	Iron loss co-ef*. 2 [%]	Iron loss co-ef*. 3 [%]	Magnetic saturation co-ef*. 1 [%]	Magnetic saturation co-ef*. 2 [%]	Magnetic saturation co-ef*. 3 [%]	Magnetic saturation co-ef*. 4 [%]	Magnetic saturation co-ef*. 5 [%]	Secondary time constant [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correctionco-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.	Load inertia
MVK9312	160	4	1500/2400	375	297	1500	1500	375	160	297	4	1.15	17.47	70.71	286.3	0.518	0.518	0.00	0.00	0.00	91.0	84.3	71.8	59.1	47.7	1.127	330	1.496	1.496	1.000	0.000	3.220
MVK931LA	160	4	1500/2000	375	297	1500	1500	375	160	297	4	1.36	16.71	76.07	287.2	0.594	0.594	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.948	351	1.000	1.000	1.000	0.000	2.970
MVK528JA	160	4	1500/2000	370	300	1500	1500	370	160	300	4	1.35	18.03	71.69	284.7	0.640	0.640	2.26	0.00	0.00	93.8	87.5	75.0	62.5	50.0	0.906	340	1.000	1.000	1.000	0.000	-
MVK9316	200	4	1500/2400	375	369	1500	1500	375	200	369	4	1.15	14.98	107.7	341.5	0.470	0.441	0.00	2.50	0.00	93.8	87.6	74.8	60.6	48.2	1.026	342	1.175	1.358	1.000	0.104	3.900
MVK931MA	200	4	1500/2000	375	376	1500	1500	375	200	376	4	1.17	13.73	121.00	357.0	0.492	0.492	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.894	353	1.000	1.000	1.000	0.000	3.290
MVK528LA	200	4	1500/2000	375	375	1500	1500	375	200	375	4	1.27	16.82	106.1	351.8	0.615	0.615	2.20	0.00	0.00	93.7	87.5	75.0	62.5	50.0	0.785	343	1.000	1.000	1.000	0.000	-
MVK9318	220	4	1500/2000	370	409	1500	1500	370	220	409	4	1.63	14.54	98.64	385.3	0.447	0.458	1.00	1.00	0.00	95.1	88.5	75.0	63.1	51.3	1.758	361	1.535	1.513	1.000	0.078	4.260
MVK931NA	220	4	1500/2000	380	409	1500	1500	380	220	409	4	1.05	13.27	130.40	388.2	0.473	0.473	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.935	359	1.000	1.000	1.000	0.000	3.660
MVK531FA	220	4	1500/2000	375	415	1500	1500	375	220	415	4	1.08	14.90	135.0	383.0	0.508	0.508	2.41	0.00	0.00	93.7	87.5	75.0	62.5	50.0	0.820	344	1.000	1.000	1.000	0.000	-

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

12.6.2 Replacing VG5S

200V series

Motor specification						Motor parameters												
			VG5S code No.			03	177	175	174	176	178	182	183	184	185	186	187	188
			FRENIC-VG code No.			F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.) [r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]
MVK6096	0.75	4	1500/3600	188	4.3	1500	1500	188	0.75	4.3	4	4.34	9.07	3.21	2.92	1.320	1.185	7.60
MVK6097	1.5	4	1500/3600	188	7.0	1500	1500	188	1.5	7.0	4	7.06	14.76	3.21	5.83	2.640	2.370	3.80
MVK6107	2.2	4	1500/3600	188	11	1500	1500	188	2.2	11	4	8.27	12.95	3.81	9.75	2.622	3.059	3.00
MVK6115	3.7	4	1500/3600	188	18	1500	1500	188	3.7	18	4	6.86	12.69	8.11	15.69	2.500	2.370	3.00
MVK6133	5.5	4	1500/3600	188	30	1500	1500	188	5.5	30	4	6.05	13.44	12.98	21.92	1.490	1.440	3.00
MVK6135	7.5	4	1500/3600	188	37	1500	1500	188	7.5	37	4	6.70	12.45	15.62	30.66	1.771	1.871	2.32
MVK6165	11	4	1500/3600	188	50	1500	1500	188	11	50	4	4.26	11.64	24.79	40.30	0.988	0.824	4.53
MVK6167	15	4	1500/3600	188	65	1500	1500	188	15	65	4	4.47	12.25	26.99	53.96	1.067	1.067	0.00
MVK6184	18.5	4	1500/3600	188	74	1500	1500	188	18.5	74	4	3.22	10.68	30.58	72.83	0.934	0.931	3.50
MVK6185	22	4	1500/3600	188	90	1500	1500	188	22	90	4	3.59	11.78	34.17	83.43	0.606	0.855	1.30
MVK6206	30	4	1500/3000	188	116	1500	1500	188	30	116	4	2.53	12.13	53.42	108.1	0.606	0.648	2.50
MVK6207	37	4	1500/3000	188	143	1500	1500	188	37	143	4	2.47	14.69	60.09	133.2	0.497	0.536	1.80
MVK6208	45	4	1500/3000	188	170	1500	1500	188	45	170	4	2.73	15.26	56.71	169.7	0.947	0.901	1.00
MVK9250	55	4	1500/2400	185	216	1500	1500	185	55	216	4	2.08	12.36	66.22	197.9	0.621	0.595	3.00
MVK9252	75	4	1500/2400	183	276	1500	1500	183	75	276	4	1.70	15.29	99.34	261.6	0.638	0.665	2.00
MVK9280	90	4	1500/2000	183	345	1500	1500	183	90	345	4	2.28	20.12	89.3	332.3	0.669	0.546	0.00

Motor specification	Motor parameters												
VG5S code No.	189	190	191	192	193	194	195	196	197	C03	C04	-	C14
FRENIC-VG code No.	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Iron loss co-ef*. 2 [%]	Iron loss co-ef*. 3 [%]	Magnetic saturation co-ef*. 1 [%]	Magnetic saturation co-ef*. 2 [%]	Magnetic saturation co-ef*. 3 [%]	Magnetic saturation co-ef*. 4 [%]	Magnetic saturation co-ef*. 5 [%]	Secondary time constant [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correctionco-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.
MVK6096	7.60	10.00	93.0	85.8	72.6	60.0	47.6	0.108	149	1.360	1.480	1.000	0.000
MVK6097	3.80	5.00	93.0	85.8	72.6	60.0	47.6	0.108	149	1.360	1.480	1.000	0.000
MVK6107	4.00	1.00	85.2	73.7	59.1	47.6	37.4	0.051	140	2.530	1.133	1.000	0.000
MVK6115	2.95	2.50	88.4	80.1	66.4	54.1	43.0	0.084	146	0.899	1.320	1.000	0.022
MVK6133	2.50	3.00	88.3	79.5	66.0	54.1	43.0	0.090	149	1.925	1.985	1.000	0.026
MVK6135	1.76	3.00	85.3	70.7	53.8	43.7	34.4	0.070	155	0.900	0.900	1.000	0.000
MVK6165	1.88	0.22	84.9	75.0	61.6	50.0	39.4	0.087	175	0.900	2.343	1.000	0.000
MVK6167	1.50	1.00	88.7	80.7	67.2	55.2	44.0	0.133	160	1.689	1.689	1.000	0.000
MVK6184	0.50	0.50	90.7	83.2	69.5	56.8	44.4	0.240	160	1.465	1.803	1.000	0.097
MVK6185	0.77	2.00	91.1	83.2	69.1	56.8	44.6	0.387	160	4.000	2.200	1.000	0.089
MVK6206	3.50	5.00	84.4	74.0	59.5	48.9	38.0	0.173	166	2.268	2.078	1.000	0.000
MVK6207	3.00	5.00	85.4	75.7	62.3	50.5	39.9	0.184	168	3.200	2.560	1.000	0.180
MVK6208	0.00	0.15	89.2	81.6	67.6	56.2	43.4	0.295	164	1.229	1.813	1.000	0.178
MVK9250	0.83	0.21	91.5	83.8	70.6	57.8	45.6	0.413	168	1.615	1.753	1.000	0.000
MVK9252	2.00	0.00	90.4	83.0	68.4	57.4	46.4	0.409	165	1.856	1.785	1.000	0.091
MVK9280	5.00	0.00	91.1	85.1	70.9	59.2	48.7	0.490	181	1.331	1.428	1.000	0.000

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

400 V series

Motor specification						Motor parameters																								
			VG5S code No.			03	177	175	174	176	178	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	C03	C04	-	C14
			FRENIC-VG code No.			F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.) [r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	Iron loss co-ef*. 2 [%]	Iron loss co-ef*. 3 [%]	Magnetic saturation co-ef*. 1 [%]	Magnetic saturation co-ef*. 2 [%]	Magnetic saturation co-ef*. 3 [%]	Magnetic saturation co-ef*. 4 [%]	Magnetic saturation co-ef*. 5 [%]	Secondary time constant [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correctionco-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.
MVK6115	3.7	4	1500/3600	376	9	1500	1500	376	3.7	9	4	6.86	13.94	3.93	7.78	2.510	2.340	2.35	2.55	1.20	90.5	82.4	68.7	57.0	45.3	0.104	294	0.880	1.440	1.000	0.028
MVK6133	5.5	4	1500/3600	376	15	1500	1500	376	5.5	15	4	5.50	12.78	7.15	10.74	1.311	1.370	2.00	5.00	7.00	88.0	79.2	65.6	53.6	42.2	0.078	299	2.361	1.985	1.000	0.019
MVK6135	7.5	4	1500/3600	376	18.5	1500	1500	376	7.5	18.5	4	4.37	13.72	7.81	15.33	1.465	1.686	7.61	2.00	1.00	85.9	76.9	63.4	51.6	40.5	0.064	310	1.607	1.427	1.000	0.000
MVK6165	11	4	1500/3600	376	25.0	1500	1500	376	11	25	4	4.27	11.67	12.39	20.15	0.988	0.824	4.53	1.88	0.22	84.9	75.0	61.6	50.0	39.4	0.087	348	0.910	2.343	1.000	0.000
MVK6167	15	4	1500/3600	376	31.7	1500	1500	376	15	31.7	4	4.48	13.69	14.47	28.63	1.290	1.269	1.00	0.50	1.00	88.7	81.7	67.2	55.2	44.0	0.133	306	1.090	1.318	1.000	0.027
MVK6184	18.5	4	1500/3600	376	37	1500	1500	376	18.5	37	4	2.66	12.45	14.02	36.06	0.882	0.882	1.00	3.00	3.00	92.5	84.3	70.3	57.1	45.1	0.295	321	1.825	1.825	1.000	0.018
MVK6185	22	4	1500/3600	376	45	1500	1500	376	22	45	4	3.61	14.06	16.81	41.72	0.903	0.891	1.50	1.50	3.00	91.1	83.2	69.1	56.5	44.6	0.387	320	1.357	1.673	1.000	0.037
MVK6206	30	4	1500/3000	376	58	1500	1500	376	30	58	4	2.55	12.16	25.74	52.52	0.666	0.648	2.50	3.50	9.50	84.4	74.0	59.5	48.9	38.0	0.173	331	2.268	2.078	1.000	0.070
MVK6207	37	4	1500/3000	376	71	1500	1500	376	37	71	4	2.49	14.11	30.07	65.54	0.497	0.498	1.79	1.80	5.00	85.4	75.7	62.3	50.5	39.9	0.184	336	3.200	3.064	1.000	0.095
MVK6208	45	4	1500/3000	376	85	1500	1500	376	45	85	4	2.73	15.30	28.36	84.85	0.947	0.937	0.50	1.50	1.85	89.2	81.6	67.6	56.2	43.4	0.295	328	1.229	1.502	1.000	0.089
MVK9250	55	4	1500/2400	376	108	1500	1500	376	55	108	4	2.05	12.20	33.11	98.98	0.621	0.595	3.00	0.83	0.21	91.5	83.8	70.6	57.8	45.6	0.413	336	1.615	1.753	1.000	0.000
MVK9252	75	4	1500/2400	365	138	1500	1500	365	75	138	4	1.71	15.39	49.67	130.8	0.638	0.665	2.00	2.00	0.00	90.4	83.0	68.4	57.4	46.4	0.409	330	1.856	1.785	1.000	0.091
MVK9280	90	4	1500/2000	370	173	1500	1500	370	90	173	4	2.23	18.47	44.37	164.1	0.685	0.647	0.00	2.00	0.00	90.7	83.7	69.0	57.1	44.9	0.590	348	1.093	1.212	1.000	0.163
MVK9282	110	4	1500/3000	375	206	1500	1500	375	110	206	4	2.14	16.83	53.03	195.8	0.557	0.606	0.44	0.00	0.00	90.1	82.6	67.7	56.3	44.2	0.577	350	1.488	1.172	1.000	0.090
MVK9310	132	4	1500/3000	375	248	1500	1500	375	132	248	4	1.56	17.21	62.05	237.3	0.481	0.531	0.00	0.39	0.00	90.1	81.2	67.7	56.2	45.9	0.689	336	1.468	1.424	1.000	0.000
MVK9312	160	4	1500/2400	375	297	1500	1500	375	160	297	4	1.15	17.47	70.71	286.3	0.518	0.518	0.00	0.00	0.00	91.0	84.3	71.8	59.1	47.7	1.127	330	1.496	1.496	1.000	0.000
MVK9316	200	4	1500/2400	375	369	1500	1500	375	200	369	4	1.15	14.98	107.7	341.5	0.470	0.441	0.00	2.50	0.00	93.8	87.6	74.8	60.6	48.2	1.026	342	1.175	1.358	1.000	0.104
MVK9318	220	4	1500/2000	370	409	1500	1500	370	220	409	4	1.63	14.54	98.64	385.3	0.447	0.458	1.00	1.00	0.00	95.1	88.5	75.0	63.1	51.3	1.758	361	1.535	1.513	1.000	0.078

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

12.6.3 Replacing VG3

200 V series

Motor specification			FRENIC-VG code No.			Motor parameters																									
						F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.)[r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	Iron loss co-ef*. 2 [%]	Iron loss co-ef*. 3 [%]	Magnetic saturation co-ef*. 1 [%]	Magnetic saturation co-ef*. 2 [%]	Magnetic saturation co-ef*. 3 [%]	Magnetic saturation co-ef*. 4 [%]	Magnetic saturation co-ef*. 5 [%]	Secondary time constant [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correctionco-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.
MVK6096	0.75	4	1500/3600	160	4.0	1500	1500	160	0.75	5.4	4	4.62	9.16	2.65	4.55	2.360	2.560	2.30	1.90	0.10	94.1	87.8	74.9	62.7	50.2	0.152	96	1.000	1.000	1.000	0.000
MVK6097	1.5	4	1500/3600	160	8.0	1500	1500	160	1.5	9.8	4	8.36	16.59	2.65	9.09	4.700	5.100	2.30	1.90	0.10	94.1	87.8	74.9	62.7	50.2	0.152	96	1.000	1.000	1.000	0.000
MVK6107	2.2	4	1500/3600	160	12.5	1500	1500	160	2.2	12.2	4	7.82	13.73	4.15	11.00	3.340	3.600	4.80	0.00	0.10	93.7	87.1	74.1	60.8	47.8	0.096	116	1.000	1.000	1.000	0.000
MVK6115	3.7	4	1500/3600	160	20	1500	1500	160	3.7	19.9	4	7.06	14.40	7.25	18.60	2.540	3.440	0.00	0.00	0.10	89.4	80.4	66.7	54.5	42.7	0.172	115	1.000	1.000	1.000	0.000
MVK6133	5.5	4	1500/3600	160	31	1500	1500	160	5.5	30.2	4	4.88	13.44	14.93	26.10	1.680	2.200	0.00	0.00	0.00	87.1	77.6	63.5	51.8	40.8	0.200	122	1.000	1.000	1.000	0.000
MVK6135	7.5	4	1500/3600	160	41	1500	1500	160	7.5	41.8	4	4.96	13.75	18.90	37.30	1.960	2.000	0.00	0.00	0.00	82.8	72.3	58.6	48.0	38.3	0.220	120	1.000	1.000	1.000	0.000
MVK6165	11	4	1500/3600	160	58	1500	1500	160	11	54.7	4	3.80	13.99	24.00	49.10	1.320	1.500	0.00	0.00	0.00	77.6	79.6	65.9	53.7	43.1	0.320	130	1.000	1.000	1.000	0.000
MVK6167	15	4	1500/3600	160	74	1500	1500	160	15	70.5	4	3.17	13.21	28.20	64.60	1.320	1.520	0.00	0.00	0.00	91.0	83.1	69.0	56.9	45.1	0.336	135	1.000	1.000	1.000	0.000
MVK6185	18.5	4	1500/3600	160	90	1500	1500	160	18.5	89.6	4	2.63	13.94	36.80	81.70	0.820	0.940	0.00	0.00	0.00	89.4	80.0	62.7	50.2	40.0	0.364	131	1.000	1.000	1.000	0.000
MVK6187	22	4	1500/3600	160	106	1500	1500	160	22	104.3	4	2.49	13.21	45.70	93.80	0.780	1.000	0.00	0.00	0.00	89.4	81.2	67.5	50.2	43.9	0.384	136	1.000	1.000	1.000	0.000
MVK6205	30	4	1500/3000	160	142	1500	1500	160	30	140.6	4	2.59	15.06	51.20	130.9	0.800	0.940	0.00	0.00	0.00	89.8	80.4	65.9	53.7	42.4	0.568	133	1.000	1.000	1.000	0.000
MVK6206	37	4	1500/3000	160	177	1500	1500	160	37	164.5	4	2.46	14.03	51.10	156.3	0.720	0.940	0.00	0.00	0.00	90.6	80.4	65.9	54.1	43.1	0.484	137	1.000	1.000	1.000	0.000
MVK6207	45	4	1500/3000	160	203	1500	1500	160	45	195.6	4	2.50	16.36	54.40	187.9	0.960	1.100	0.00	0.00	0.00	91.4	82.7	69.0	57.3	45.5	0.732	138	1.000	1.000	1.000	0.000

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

400 V series

Motor specification			FRENIC-VG code No.			Motor parameters F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.)[r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]
MVK6115	3.7	4	1500/3600	320	10	1500	1500	320	3.7	10	4	7.07	14.40	3.62	9.30	2.540	3.280
MVK6133	5.5	4	1500/3600	320	15.5	1500	1500	320	5.5	15.1	4	4.89	13.44	7.50	13.10	1.680	1.880
MVK6135	7.5	4	1500/3600	320	20.5	1500	1500	320	7.5	20.3	4	4.84	13.35	9.30	18.00	1.960	2.000
MVK6165	11	4	1500/3600	320	29	1500	1500	320	11	27.4	4	3.79	14.03	12.00	24.60	1.320	1.420
MVK6167	15	4	1500/3600	320	37	1500	1500	320	15	35.3	4	3.17	13.24	14.10	32.30	1.200	1.400
MVK6185	18.5	4	1500/3600	320	45	1500	1500	320	18.5	44.5	4	2.60	13.86	18.10	39.00	0.940	0.960
MVK6187	22	4	1500/3600	320	53	1500	1500	320	22	53.2	4	2.52	13.46	19.90	47.60	0.960	1.000
MVK6205	30	4	1500/3000	320	71	1500	1500	320	30	70.3	4	2.57	15.08	25.60	65.50	0.800	0.940
MVK6206	37	4	1500/3000	320	89	1500	1500	320	37	78.4	4	2.35	13.38	25.20	74.30	0.740	0.860
MVK6207	45	4	1500/3000	320	102	1500	1500	320	45	97.8	4	2.49	16.38	27.20	94.00	0.840	1.100
MVK5256	75	4	1500/2400	320	170	1500	1500	320	75	170	4	1.73	14.88	47.38	162.8	0.840	0.960

Type	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
	Iron loss co-ef*. 1 [%]	Iron loss co-ef*. 2 [%]	Iron loss co-ef*. 3 [%]	Magnetic saturation co-ef*. 1 [%]	Magnetic saturation co-ef*. 2 [%]	Magnetic saturation co-ef*. 3 [%]	Magnetic saturation co-ef*. 4 [%]	Magnetic saturation co-ef*. 5 [%]	Secondary time constant [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correctionco-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.
MVK6115	0.00	0.00	0.00	89.4	80.4	66.7	54.5	42.7	0.172	230	1.000	1.000	1.000	0.000
MVK6133	0.00	0.00	0.00	87.1	77.6	63.5	51.8	40.8	0.200	242	1.000	1.000	1.000	0.000
MVK6135	0.00	0.00	0.00	86.7	76.1	60.8	49.4	38.4	0.224	241	1.000	1.000	1.000	0.000
MVK6165	0.00	0.00	0.00	88.6	79.6	65.9	53.7	43.1	0.320	258	1.000	1.000	1.000	0.000
MVK6167	0.00	0.00	0.00	91.0	83.1	69.0	56.9	45.1	0.336	268	1.000	1.000	1.000	0.000
MVK6185	1.10	3.10	1.70	91.4	83.1	68.6	56.1	45.9	0.412	274	1.000	1.000	1.000	0.000
MVK6187	2.20	1.60	0.70	92.9	85.1	71.4	58.8	46.7	0.412	267	1.000	1.000	1.000	0.000
MVK6205	0.00	0.00	0.00	89.8	80.4	65.9	53.7	42.4	0.568	265	1.000	1.000	1.000	0.000
MVK6206	0.00	0.00	0.00	90.6	80.8	67.5	52.5	40.8	0.460	288	1.000	1.000	1.000	0.000
MVK6207	0.00	0.00	0.00	91.4	82.7	69.0	57.3	45.5	0.732	277	1.000	1.000	1.000	0.000
MVK5256	0.00	0.00	0.00	92.6	85.2	72.3	60.5	48.4	0.576	266	1.000	1.000	1.000	0.000

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

12.7 Protective Functions

12.7.1 Replacing VG7S

FRENIC5000 VG7S		FRENIC-VG	
–		dbA	Braking transistor error
dbH	DB resistor overheat	dbH	Braking resistor overheat
dcF	DC fuse blown	dcF	DC fuse blown
dO	Excessive position deviation	dO	Excessive position deviation
EF	Ground fault	EF	Ground fault
–		EC	Encoder communications error
Er1	Memory error	Er1	Memory error
Er2	KEYPAD panel communication error	Er2	KEYPAD panel communication error
Er3	CPU error	Er3	CPU error
Er4	Network error	Er4	Network error
Er5	RS-485 communication error	Er5	RS-485 communication error
Er6	Operation procedure error	Er6	Operation procedure error
Er7	Output wiring error	Er7	Output wiring error
Er8	A/D converter error	Er8	A/D converter error
Er9	Speed disagreement	Er9	Speed disagreement
ErA	UPAC error	ErA	UPAC error
Erb	Inter-inverter communication error	Erb	Inter-inverter communication error
–		Err	Mock alarm
–		Et1	Encoder error
IPE	IPM error	–	
Lin	Input phase loss	Lin	Input phase loss
LU	Undervoltage	LU	Undervoltage
nrb	NTC thermistor disconnection	nrb	NTC thermistor disconnection
OC	Overcurrent	OC	Overcurrent
OH1	Overheating at heat sink	OH1	Overheating at heat sink
OH2	External alarm	OH2	External alarm
OH3	Inverter internal overheat	OH3	Inverter internal overheat
OH4	Motor overheat	OH4	Motor overheat
OL1	Motor 1 overload	OL1	Motor 1 overload
OL2	Motor 2 overload	OL2	Motor 2 overload
OL3	Motor 3 overload	OL3	Motor 3 overload
OLU	Inverter unit overload	OLU	Inverter unit overload
–		OPL	Output phase loss detection
OS	Overspeed	OS	Overspeed
OU	Overvoltage	OU	Overvoltage
PbF	Charging circuit error	PbF	Charging circuit error
–		ECF	Security circuit error
P9	PG disconnection	P9	PG disconnection
–		dFA	DC fan lock
–		ErH	Hardware error

12.7.2 Replacing VG5S

FRENIC5000 VG5S		FRENIC-VG	
–		dbA	Braking transistor error
–		dbH	Braking resistor overheat
dcF	DC fuse blown	dcF	DC fuse blown
–		dO	Excessive position deviation
EF	Ground fault	EF	Ground fault
–		EC	Encoder communications error
Er1	Memory error	Er1	Memory error
Er2	KEYPAD panel communication error	Er2	KEYPAD panel communication error
Er3	CPU error	Er3	CPU error
Er4	T-Link communication error	Er4	Network error
Er5	RS485 communication error	Er5	RS485 communication error
Er6	Operation procedure error	Er6	Operation procedure error
Er7	Output wiring error	Er7	Output wiring error
Er8	A/D converter error	Er8	A/D converter error
–		Er9	Speed disagreement
–		ErA	UPAC error
–		Erb	Inter-inverter communication error
–		Err	Mock alarm
–		Et1	Encoder error
–		–	
–		Lin	Input phase loss
LU	Undervoltage	LU	Undervoltage
nrb	NTC thermistor disconnection	nrb	NTC thermistor disconnection
OC	Overcurrent	OC	Overcurrent
OH1	Overheating at heat sink	OH1	Overheating at heat sink
OH2	External alarm	OH2	External alarm
OH3	Inverter internal overheat	OH3	Inverter internal overheat
OH4	Motor overheat	OH4	Motor overheat
OL	Motor overload	OL1	Motor 1 overload
–		OL2	Motor 2 overload
–		OL3	Motor 3 overload
OLU	Inverter unit overload	OLU	Inverter unit overload
–		OPL	Output phase loss detection
OS	Overspeed	OS	Overspeed
OU	Overvoltage	OU	Overvoltage
PbF	Charging circuit error	PbF	Charging circuit error
–		ECF	Security circuit error
P9	PG disconnection	P9	PG disconnection
–		dFA	DC fan lock
–		ErH	Hardware error

12.7.3 Replacing VG3

FRENIC5000 VG3		FRENIC-VG	
–		dbA	Braking transistor error
–		dbH	Braking resistor overheat
dCF	DC fuse blown	dcF	DC fuse blown
–		dO	Excessive position deviation
EF	Ground fault	EF	Ground fault
–		EC	Encoder communications error
Rf	Memory error	Er1	Memory error
–		Er2	KEYPAD panel communication error
–		Er3	CPU error
OPF	T-Link communication error	Er4	Network error
–		Er5	RS485 communication error
–		Er6	Operation procedure error
–		Er7	Output wiring error
CF	Current detection circuit error	–	
–		Er8	A/D converter error
–		Er9	Speed disagreement
–		ErA	UPAC error
–		Erb	Inter-inverter communication error
–		Err	Mock alarm
–		Et1	Encoder error
–		IPE	IPM error
–		Lin	Input phase loss
LU	Undervoltage	LU	Undervoltage
rb	NTC thermistor disconnection	nrb	NTC thermistor disconnection
OC	Overcurrent	OC	Overcurrent
OH1	Overheating at heat sink	OH1	Overheating at heat sink
OH3	External alarm	OH2	External alarm
–		OH3	Inverter internal overheat
OH2	Motor overheat	OH4	Motor overheat
–		OL1	Motor 1 overload
–		OL2	Motor 2 overload
–		OL3	Motor 3 overload
OL	Inverter overload	OLU	Inverter overload
–		OPL	Output phase loss detection
OS	Overspeed	OS	Overspeed
OU	Overvoltage	OU	Overvoltage
–		PbF	Charging circuit error
–		ECF	Security circuit error
–		P9	PG disconnection
–		dFA	DC fan lock
–		ErH	Hardware error

12.8 Options

12.8.1 Replacing VG7S

Name	FRENIC5000 VG7S option	Alternative FRENIC-VG option
Synchro. interface	OPC-VG7-SN	OPC-VG1-SN (Available soon)
F/V converter	OPC-VG7-FV	OPC-VG1-FV (Available soon)
Aio expansion card	OPC-VG7-AIO	OPC-VG1-AIO
Di interface card	OPC-VG7-DI	OPC-VG1-DI
DIO expansion card	OPC-VG7-DIO	OPC-VG1-DIO
RG interface expansion card	OPC-VG7-PG	OPC-VG1-PG
	OPC-VG7-PGo	OPC-VG1-PGo
T-Link interface card	OPC-VG7-TL	OPC-VG1-TL
Highspeed serial card	OPC-VG7-SI	OPC-VG1-TBSI
	OPC-VG7-SIU	OPC-VG1-SIU (Available soon)
RS485 expansion card	OPC-VG7-RS	Built-in.
CC-Link interface card	OPC-VG7-CCL	OPC-VG1-CCL
For synchronous motor driving PG card	OPC-VG7-PMPG	OPC-VG1-PMPG
	OPC-VG7-PMPGo	OPC-VG1-PMPGo
UPAC	OPC-VG7-UPAC	OPC-VG1-UPAC (Available soon)
SX bus interface card	OPC-VG7-SX	OPC-VG1-SX
PROFIBUS-DP	OPC-VG7-PDP	OPC-VG1-PDP (Available soon)
DeviceNet	OPC-VG7-DEV	OPC-VG1-DEV (Available soon)
Synchro. interface	MCA-VG7-SN	MCA-VG1-SN (Available soon)
F/V converter	MCA-VG7-FV	MCA-VG1-FV (Available soon)
Dancer controller	MCAII-PU	MCAII-PU (Available soon)
PG switcher	MCAII-VG7-CPG	MCAII-VG1-CPG (Available soon)
Braking unit	Depends on the capacity	Depends on the capacity (Built-in for 55 kW or less of 200V series, and for 160 kW or less of 400V series)
Braking resistor	Depends on the capacity	Depends on the capacity
AC reactor	Depends on the capacity	Depends on the capacity
DC REACTOR	Depends on the capacity	Depends on the capacity (Provided as standard for units of more than 75 kW)
Ferrite ring for reducing radio noise. Zero-phase reactor	ACL-40B, ACL-74B	
KEYPAD panel extension cable	CBIII-10R-2S CBIII-10R-1C CBIII-10R-2C	Extension cable for extension operation CB-ϒS

12.8.2 Replacing VG5S

Name	FRENIC5000 VG5S option	Alternative FRENIC-VG option
Adder	OPCII-VG3-AD	
I/V, V/I converter	OPCII-VG3-IV	
Comparator	OPCII-VG3-CP	
Isolation converter	OPCII-VG3-IA	
F/V converter	OPCII-VG3-FV	OPC-VG1-FV (Available soon)
Synchro. interface	OPCII-VG3-SN	OPC-VG1-SN (Available soon)
Di interface	OPCII-VG5-DIN	OPC-VG1-DI (DIA, DIB)
	OPCII-VG5-DIT	OPC-VG1-DI (DIA, DIB)
DIO expansion card	OPCII-VG5-DIO	OPC-VG1-DIO (DIOA)
T-Link interface card	OPCII-VG5-TL	OPC-VG1-TL
PG interface card	OPCII-VG5-PG1	Built-in.
	OPCII-VG5-PG2	OPC-VG1-PG
Pulse train interface card	OPCII-VG5-PTI	OPC-VG1-PG
Adder	MCAII-VG3-AD	
I/V, V/I converter	MCAII-VG3-IV	
Comparator	MCAII-VG3-CP	
Isolation converter	MCAII-VG3-IA	
F/V converter	MCAII-VG3-FV	MCA-VG1-FV (Available in the near future)
Synchro. interface	MCAII-VG5-SN	MCA-VG1-SN (Available in the near future)
Dancer controller	MCAII-PU	
Relay unit	MCAII-RY	
PG switcher	MCAII-VG5-CPG	MCA-VG1-CPG (Available in the near future)
Braking unit	Depends on the capacity	Depends on the capacity (Built-in for 55 kW or less of 200V series, and for 160 kW or less of 400V series)
Braking resistor	Depends on the capacity	Depends on the capacity
AC reactor	Depends on the capacity	Depends on the capacity
DC REACTOR	Depends on the capacity	Depends on the capacity (Provided as standard for units of more than 75 kW)
Ferrite ring for reducing radio noise. Zero-phase reactor	ACL-40B, ACL-74B	
KEYPAD panel extension cable	CBIII-10R-2S CBIII-10R-1C CBIII-10R-2C	Extension cable for extension operation CB-ϒS

Cahp. 12

REPLACEMENT DATA

12.8.3 Replacing VG3

Name	FRENIC5000 VG3 option	Alternative FRENIC-VG option
Adder	OPCII-VG3-AD	
I/V, V/I converter	OPCII-VG3-IV	
Comparator	OPCII-VG3-CP	
Isolation converter	OPCII-VG3-IA	
F/V converter	OPCII-VG3-FV	OPC-VG1-FV (Available in the near future)
Synchro. interface	OPCII-VG3-SN	OPC-VG1-SN (Available in the near future)
Di interface	OPCII-VG3-DI	OPC-VG1-DI(DIA, DIB)
AO interface	OPCII-VG3-AO	OPC-VG1-AIO
T-Link interface card	OPCII-VG3-T2 OPCII-VG3-TL	OPC-VG1-TL
Adder	MCAII-VG3-AD	
I/V, V/I converter	MCAII-VG3-IV	
Comparator	MCAII-VG3-CP	
Isolation converter	MCAII-VG3-IA	
F/V converter	MCAII-VG3-FV	MCA-VG1-FV (Available in the near future)
Synchro. interface	MCAII-VG5-SN	MCA-VG1-SN (Available in the near future)
Dancer controller	MCAII-PU	
Relay unit	MCAII-RY	
Ground fault detection unit	MCAII-GFD-1 MCAII-GFD-2	For the output circuit, the ground fault detection function is included as standard.
Braking unit	Depends on the capacity	Depends on the capacity (Built-in for 55 kW or less of 200V series, and for 160 kW or less of 400V series)
Braking resistor	Depends on the capacity	Depends on the capacity
AC reactor	Depends on the capacity	Depends on the capacity
DC REACTOR	Depends on the capacity	Depends on the capacity (Provided as standard for units of more than 75 kW)
Ferrite ring for reducing radio noise. Zero-phase reactor	ACL-10A	

Chapter 13
TROUBLESHOOTING

This chapter describes troubleshooting procedures to be followed when the inverter malfunctions or detects an alarm or a light alarm condition. In this chapter, first check whether any alarm code or the "light alarm" indication (L-AL) is displayed or not, and then proceed to the troubleshooting items.

Contents

13.1 Protective Functions

The FRENIC-VG series of inverters has various protective functions as listed below to prevent the system from going down and reduce system downtime. The protective functions marked with an asterisk (*) in the table are disabled by default. Enable them according to your needs.

The protective functions include, for example, the "heavy alarm" detection function which, upon detection of an abnormal state, displays the alarm code and causes the inverter to trip, the "light alarm" detection function which displays the alarm code but lets the inverter continue the current operation, and other warning signal output functions.

If any problem arises, understand the protective functions listed below and follow the procedures given in Section 13.2 and onwards for troubleshooting.

Protective function	Description
"Heavy alarm" detection	This function detects an abnormal state, displays the corresponding alarm code, and causes the inverter to trip. The "heavy alarm" codes are check-marked in the "Heavy alarm" object column in Table 13.1. For details of each alarm code, see the corresponding item in the troubleshooting. The inverter retains the latest and the last 10 alarm codes (see Section 3.4.4.9) and the latest and the last three pieces of alarm information (see Section 3.4.4.8). It can also display them.
"Light alarm" detection*	This function detects an abnormal state categorized as a "light alarm," displays L-AL and lets the inverter continue the current operation without tripping. It is possible to define which abnormal states should be categorized as a "light alarm" using function codes H81 and H82. The "light alarm" codes are check-marked in the "Light alarm" object column in Table 13.1. For instructions on how to check and release light alarms, see Section 3.4.3.5 "Monitoring light alarms, ■ How to remove the current light alarm."
Stall prevention	When the torque command exceeds the torque limiter level (F44, F45) during acceleration/ deceleration or constant speed running, this function limits the motor torque generated in order to avoid an overcurrent trip.
Automatic lowering of carrier frequency	Before the inverter trips due to an abnormal surrounding temperature or output current, this function automatically lowers the carrier frequency to avoid a trip.
Motor overload early warning*	When the inverter output current has exceeded the specified level, this function issues the "Motor overload early warning" signal ***OL*** before the thermal overload protection function causes the inverter to trip for motor protection.
Auto-reset*	When the inverter has stopped because of a trip, this function allows the inverter to automatically reset and restart itself. (The number of retries and the latency between stop and reset can be specified.)
Surge protection	This function protects the inverter from a surge voltage invaded between main circuit power lines and the ground.

13.2 Before Proceeding with Troubleshooting

⚠ WARNING ⚠

- If any of the protective functions has been activated, first remove the cause. Then, after checking that the all run commands are set to OFF, release the alarm. If the alarm is released while any run commands are set to ON, the inverter may supply the power to the motor, running the motor.

  Injury may occur.

- Even if the inverter has interrupted power to the motor, if the voltage is applied to the main circuit input terminals L1/R, L2/S and L3/T, voltage may be output to inverter output terminals U, V, and W.
- **Turn OFF the power and wait at least five minutes for inverters with a capacity of 22 kW or below, or at least ten minutes for inverters with a capacity of 30 kW or above.** Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P (+) and N (-) has dropped to the safe level (+25 VDC or below).

  Electric shock may occur.

Follow the procedure below to solve problems.

(1) First, check that the inverter is correctly wired, referring to Chapter 2, Section 2.3.1 "Wiring of main circuit terminals and grounding terminals."

(2) Check whether an alarm code or the "light alarm" indication (L-AL) is displayed on the LED monitor.

- If an alarm code appears on the LED monitor ——→ Go to Section 13.3.
- If the "light alarm" indication (L-AL) appears on the LED monitor ——→ Go to Section 13.4.
- If neither an alarm code nor "light alarm" indication (L-AL) appears on the LED monitor

Abnormal motor operation ——→ Go to Section 13.5.1.

[1] The motor does not rotate.
[2] The motor rotates, but the speed does not change.
[3] The motor runs in the opposite direction to the command.
[4] Speed fluctuation or current oscillation (e.g., hunting) occurs during running at constant speed.
[5] Grating sound is heard from the motor or the motor sound fluctuates.
[6] The motor does not accelerate or decelerate within the specified time.
[7] The motor does not restart even after the power recovers from a momentary power failure.
[8] The motor abnormally heats up.
[9] The motor does not run as expected.
[10] When the motor accelerates or decelerates, the speed is not stable.
[11] The motor stalls during acceleration.
[12] When the T-Link communications option is in use, neither a run command nor a speed command takes effect.
[13] When the SX-bus communications option is in use, neither a run command nor a speed command takes effect.
[14] When the CC-Link communications option is in use, neither a run command nor a speed command takes effect.
[15] _ _ _ _ (under bars) appears.

Problems with inverter settings ——→ Go to Section 13.5.2.

[1] Nothing appears on the monitors.
[2] The desired function code does not appear.
[3] Data of function codes cannot be changed from the keypad.
[4] Data of function codes cannot be changed via the communications link.

If any problems persist after the above recovery procedure, contact your Fuji Electric representative.

13.3 If an alarm code appears on the LED monitor

13.3.1 List of alarm codes

If the inverter detects an alarm, check whether any alarm code appears on the 7-segment LED monitor of the keypad.

As listed below, some alarm codes are followed by alarm sub codes that denote the detailed error causes. For alarm codes not followed by alarm sub codes, "--" is written in the table below.

* For the alarm sub code checking procedure, refer to Chapter 3, Section 3.4.4.8 "Reading alarm information--Menu #7 "ALM INF."
* For alarm codes followed by alarm sub codes listed as "For particular manufacturers," inform your Fuji Electric representative of the alarm sub code also when contacting or asking him/her to repair the inverter.

Table 13.1 Abnormal States Detectable ("Heavy Alarm" and "Light Alarm" Objects)

Alarm code	Error cause	"Heavy alarm" objects	"Light alarm" objects	Retry objects	Alarm sub code *	Detailed error cause *	Ref. page
dbA	Braking transistor broken	√	--	--	--	--	13-5
dbH	Braking resistor overheated	√	--	√	--	--	13-5
dCF	DC fuse blown	√	--	--	--	--	13-5
dFA	DC fan locked	√	√	--	--	--	13-6
dO	Excessive positioning deviation	√	--	--	--	--	13-6
EC	PG communication error	√	--	--	0001 to 2000	For particular manufacturers *	--
ECF	ENABLE circuit (safety stop circuit) failure	√	√	--	--	--	--
EF	Ground fault	√	--	--	--	--	13-6
Er1	Memory error	√	--	--	0001 to 0008	For particular manufacturers *	13-7
Er2	Keypad communications error	√	--	--	0001	Wire break detected	13-7
					0002	Wire break detected (during keypad operation)	
Er3	CPU error	√	--	--	0001 to 0008	For particular manufacturers *	13-8
Er4	Network error	√	√	--	0001 to 0004	See the related option manual.	13-8
Er5	RS-485 communications error	√	√	--	0001	Communications error (timeout)	13-9
					0002	Communications error (transmission error)	
Er6	Operation error	√	--	--	0001	Option mounting error	13-10
					0002	Auto-tuning failed	
					0008	For particular manufacturers *	
Er7	Output wiring fault	√	--	--	0001	Output wiring fault during tuning	13-11
					0002	Speed not arrived during tuning with the motor running	
					0004 to 0008	For particular manufacturers *	
Er8	A/D converter error	√	--	--	0001 to 0004	For particular manufacturers *	13-11
Er9	Speed not agreed	√	√	--	0001	Motor 1 speed not agreed	13-12
					0002	Motor 2 speed not agreed	
					0003	Motor 3 speed not agreed	
					0004	Machine runaway detected (by H149)	

Table 13.1 Abnormal States Detectable ("Heavy Alarm" and "Light Alarm" Objects) (Continued)

Code	Name	"Heavy alarm" objects	"Light alarm" objects	Retry objects	Alarm sub code *	Detailed error cause *	Ref. page
ErA	UPAC error	√	--	--	0001 to 0004	See the related option manual.	--
Erb	Inter-inverter communications link error	√	√	--	--	--	13-13
ErH	Hardware error	√	--	--	0001 to 1000	For particular manufacturers *	13-13
Err	Mock alarm	√	√	--	--	--	13-13
Et1	PG failure	√	--	--	--	--	--
Lin	Power supply phase loss	√	--	--	--	--	13-14
LoC	Start delay	√	√	--	--	--	13-14
LU	Undervoltage	√	--	--	--	--	13-15
nrb	NTC thermistor wire break error	√	√	--	--	--	13-16
OC	Overcurrent	√	--	√	0001 to 0004	For particular manufacturers *	13-16
					0100	Demagnetizing limit current for PMSM	
OH1	Heat sink overheat	√	--	√	0001 to 0008	Protection by thermistor	13-18
					0010 to 0200	For particular manufacturers *	
OH2	External alarm	√	√	--	0001	Protection by ***THR*** signal	13-18
OH3	Inverter internal overheat	√	--	√	0001 to 0008	Protection by thermistor	13-19
					0010	For particular manufacturers *	
OH4	Motor overheat	√	√	√	--	--	13-19
OL1	Motor 1 overload	√	√	√	--	--	13-20
OL2	Motor 2 overload	√	√	√	--	--	
OL3	Motor 3 overload	√	√	√	--	--	
OLU	Inverter overload	√	--	√	0001 to 0002	For particular manufacturers *	13-21
OPL	Output phase loss	√	--	--	0001	Loss of one or more phases	13-22
					0002	Loss of two or more phases	
OS	Overspeed	√	--	--	--	--	13-22
OU	Overvoltage	√	--	--	0001	For particular manufacturers *	13-23
PG	PG wire break	√	--	--	0001	Wire break detected (inverter unit, PA and PB)	13-24
					0002	Wire break detected (option)	
					0003	Power shutdown detected (inverter unit)	
PbF	Charger circuit fault	√	--	--	0001 to 0002	For particular manufacturers *	13-25

13.3.2 Possible causes of alarms, checks and measures

[1] dbA Braking transistor error

Problem A braking transistor error is detected.

Possible Causes	What to Check and Suggested Measures
(1) The braking transistor is broken.	Check whether resistance of the braking resistor is correct or there is a misconnection of the resistor. ➔ Ask your Fuji Electric representative to repair the inverter.

[2] dbH Braking resistor overheated

Problem The electronic thermal protection for the braking resistor has been activated.

Possible Causes	What to Check and Suggested Measures
(1) Braking load is too heavy.	Reconsider the relationship between the estimated braking load and the real one. ➔ Lower the real braking load. ➔ Review the selection of the braking resistor and increase the braking capability (Modification of related function code data (E35, E36, E37) is also required.)
(2) Specified deceleration time is too short.	Recalculate the deceleration torque and time needed for the load currently applied, based on a moment of inertia for the load and the deceleration time. ➔ Increase the deceleration time (F08, C36, C47, C57, C67). ➔ Review the selection of the braking resistor and increase the braking capability. (Modification of related function code data (E35, E36, E37) is also required.)
(3) Incorrect setting of function code data (E35, E36, E37).	Recheck the specifications of the braking resistor. ➔ Review data of function codes E35, E36 and E37, then modify them.

[3] dCF Fuse blown

Problem The fuse inside the inverter blew. (Applicable to the inverters of 75 kW or above (200 V class series) and those of 90 kW or above (400 V class series))

Note If the fuse has blown, the internal elements may be broken. NEVER turn the power ON to prevent the secondary damage. Contact your Fuji Electric representative.

Possible Causes	What to Check and Suggested Measures
(1) The fuse blew due to short-circuiting inside the inverter.	Check whether there has been any excess surge or noise coming from outside. ➔ Take measures against surges and noise. ➔ Ask your Fuji Electric representative to repair the inverter.
(2) The fuse blew due to ground faults that have occurred at the inverter output lines.	Disconnect the wiring from the output terminals [U], [V] and [W] and perform a Megger test for the inverter and the motor. ➔ Remove the grounded parts (including replacement of the wires, relay terminals and motor). ➔ Ask your Fuji Electric representative to repair the inverter or the motor.
(3) Miswiring of main circuit power lines and output lines.	Check the wiring. ➔ Ask your Fuji Electric representative to repair the inverter.

[4] dFA DC fan locked

Problem The DC fan has stopped. (Applicable to the inverters of 45 kW or above (200 V class series) and those of 75 kW or above (400 V class series))

Possible Causes	What to Check and Suggested Measures
(1) The service life of the DC fan has expired or the DC fan is defective.	The DC fan has stopped although the main power is ON. (Check the DC fan state with the cooling fan ON/OFF control disabled with H06 = 0.) ➔ Replace the DC fan. ➔ Disable the DC fan locked signal output (treat it as a light alarm) to keep the inverter running by setting "1" to the hundreds digit of H108 (Light alarm object definition) to "1" (H108 = □1□□). If the DC fan has stopped, replace the fan immediately and revert the data of H108 to the factory default. Leaving the DC fan stopped causes an inverter internal overheat trip or a local temperature rise that shortens the service life of electrolytic capacitors and other electronic devices on the printed circuit boards in the inverter unit, in the worst case, it results in a broken inverter unit.

[5] dO Excessive positioning deviation

Problem An excessive positioning deviation has occurred.

Possible Causes	What to Check and Suggested Measures
(1) Wrong wiring to the motor.	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively. It is also possible to use H75 (Phase sequence configuration of main circuit output wires).
(2) The motor cannot rotate mechanically.	➔ Check whether the brake is applied.
(3) Output torque too small.	➔ Increase the torque limiter value (F44, F45).
(4) Deviation override width too small.	➔ Review the deviation override width (o18).
(5) Insufficient gain in positioning control system.	➔ Readjust the positioning loop gain (o16).
(6) The acceleration/ deceleration by pulse train command is too rapid.	➔ Increase the acceleration/deceleration time.

[6] EF Ground fault

Problem A ground fault current flew from the output terminal of the inverter.

Possible Causes	What to Check and Suggested Measures
(1) Inverter output terminal(s) grounded (ground fault).	Disconnect the wiring from the output terminals [U], [V] and [W] and perform a Megger test for the inverter and the motor. ➔ Remove the grounded parts (including replacement of the wires, relay terminals and motor).
(2) The setting of the motor rated current (P04, A03, A103) is small relative to the inverter rated current.	Check whether an extremely small motor rated current is set relative to the inverter rated current. ➔ Check the setting of the motor rated current (P04, A03, A103). ➔ Disable the ground fault detection by setting "0" to the hundreds digit of H103 (Protection/maintenance function 1).

[7] Er1 Memory error

Problem Error occurred in writing data to the memory in the inverter.

Possible Causes	What to Check and Suggested Measures
(1) When writing data (especially initializing or copying data), the inverter was shut down so that the voltage to the control PCB has dropped.	Initialize the function code data by setting H03 to "1." After initialization, check if pressing the PRG/RESET key releases the alarm. ➔ Revert the initialized function code data to their previous customized settings (See Note below), then restart the operation.
(2) Inverter affected by strong electrical noise when writing data (especially initializing or copying data).	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires). Also, perform the same check as described in (1) above. ➔ Implement noise control measures. Revert the initialized function code data to their previous customized settings (See Note below), then restart the operation.
(3) Control circuit failure. [Sub code: 0001 to 0008]	Initialize the function code data by setting H03 to "1," then reset the alarm by pressing the PRG/RESET key and check that the alarm goes on. ➔ The control PCB (on which the CPU is mounted) is defective and needs to be replaced. Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.
(4) Highly-frequent rewriting to the non-volatile memory has reached the limit of the electronic device (approx. 1,000,000 times). [Sub code: 0001 to 0008]	Function code data has been frequently changed. ➔ The non-volatile memory needs to be replaced. Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed. ➔ Decrease the frequency of rewriting. Decrease the frequency of full save operations.

Note: Function code data can be easily reverted to the previously customized settings by using the backup data copied in the keypad memory with Menu #10 "DATA COPY" in Programming mode. (Refer to Chapter 3, Section 3.4.4.10 "Copying data")

[8] Er2 Keypad communications error

Problem A communications error occurred between the keypad and the inverter.

Possible Causes	What to Check and Suggested Measures
(1) Broken communications cable or poor contact. [Sub code: 0001]	Check continuity of the cable, contacts and connections. ➔ Re-insert the connector firmly. ➔ Replace the cable.
(2) Connecting many control wires hinders the front cover from being mounted, lifting the keypad. [Sub code: 0001]	Check the mounting condition of the front cover. ➔ Use wires of the recommended size (0.75 mm^2) for wiring. ➔ Change the wiring layout inside the unit so that the front cover can be mounted firmly.
(3) Inverter affected by strong electrical noise. [Sub code: 0002]	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of communication cables and main circuit wires). ➔ Implement noise control measures.
(4) A keypad failure occurred.	Replace the keypad with another one and check whether a keypad communications error (Er2) occurs. ➔ Replace the keypad.
(5) A keypad designed for any other series of inverters is connected.	Check whether the connected keypad is a multi-function keypad designed for FRENIC-Mini/-Eco/-Multi/-MEGA/-Lift. ➔ Replace the keypad with the one designed for the FRENIC-VG.

[9] Er3 CPU error

Problem A CPU error (e.g. erratic CPU operation) occurred.

Possible Causes	What to Check and Suggested Measures
(1) Inverter affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g. correct grounding and routing of signal wires, communications cables, and main circuit wires). ➔ Implement noise control measures.
(2) Short circuit on the printed circuit board(s). [Sub code: 0001 to 0008]	Check the printed circuit board(s) for short circuits, accumulation of dust or dirt. ➔ Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.

Note To remove the Er3 CPU error, turn the power to the inverter OFF and then ON. The error cannot be removed by pressing the PRG/RESET key.

[10] Er4 Network error

Problem The connected option card detected an error.

① For T-Link option

Possible Causes	What to Check and Suggested Measures
(1) The power to the MICREX IO terminal is OFF.	Check the power to the MICREX IO terminal. ➔ Turn ON the power to the MICREX IO terminal and reset the inverter alarm state.
(2) T-Link address double assigned.	Check the T-Link address. ➔ Set a new T-Link address.
(3) Wrong wiring.	Check that: • The T-Link network has a terminating resistor at each end. • The specified cable is used. • There is no wire break. • The wiring length is within the range of the specification. • The shielded wires are properly treated. • The SD terminal of the T-Link is not connected to a frame ground (FG). • A crimp terminal is used for connection. • The signal lines are not wired in parallel with the power lines. ➔ Correct the wiring.

② For SX-bus option

Possible Causes	What to Check and Suggested Measures
(1) The SX-bus power is shut down or the PLC's CPU module is down.	Check the power to the SX-bus and the status of the PLC's CPU module. ➔ Turn ON the power to the SX-bus, recover the PLC's CPU module, and reset the inverter alarm state.
(2) An error has occurred at any other station.	Check the detailed RAS information on the PLC's CPU module to find a faulty station. ➔ Recover the faulty station and reset the inverter alarm state.

Possible Causes	What to Check and Suggested Measures
(3) Wrong wiring.	Check that: • The SX-bus network has a terminating connector at each end. • A dedicated cable is used. • There is no wire break. • Connection to the IN and OUT connector is proper. • The signal lines are not wired in parallel with the power lines. • The total extension length of the SX bus cable does not exceed 25 m. The number of devices connected in succession does not exceed 10. • The SX bus cable is not bent with the bend radius of 50 mm or below. ➔ Correct wiring.

③ For CC-Link option

Possible Causes	What to Check and Suggested Measures
(1) The power to the PLC is shut down or the PLC's CPU module is down.	Check the power to the PLC and the status of the PLC's CPU module. ➔ Turn ON the power to the PLC, recover the PLC's CPU module, and reset the inverter alarm state.
(2) An error has occurred at any other station.	Check the detailed RAS information on the PLC's CPU module to find a faulty station. ➔ Recover the faulty station and reset the inverter alarm state.
(3) Wrong wiring.	Check that: • The CC-Link network has a terminating resistor at each end. • A dedicated cable is used. • There is no wire break. • Connection to the terminal block is proper. • The signal lines are not wired in parallel with the power lines. • The maximum cable length of the CC-link cable, inter-station cable length, and the number of devices connected are as specified. ➔ Correct wiring.

[11] Er-5 RS-485 communications error

Problem A communications error occurred during RS-485 communication.

Possible Causes	What to Check and Suggested Measures
(1) Communications conditions of the inverter do not match that of the host equipment. [Sub code: 0002]	Compare the settings of function codes H32 to H40 with those of the host equipment. ➔ Correct any settings that differ.
(2) Even though no-response error detection time (H38) has been set, communication is not performed within the specified cycle. [Sub code: 0001]	Check the host equipment. ➔ Change the settings of host equipment software or disable the no-response error detection (H38 = 0).
(3) The host equipment did not operate due to defective software, settings, or defective hardware. [Sub code: 0002]	Check the host equipment (e.g., PLCs and host computers). ➔ Remove the cause of the equipment error.

Possible Causes	What to Check and Suggested Measures
(4) The RS-485 converter did not operate due to incorrect connections and settings, or defective hardware.	Check the RS-485 converter (e.g., check for poor contact or incorrect connections). ➔ Change the various RS-485 converter settings, reconnect the wires, or replace hardware with recommended devices as appropriate.
(5) Broken communications cable or poor contact.	Check the continuity of the cables, contacts and connections. ➔ Replace the cable.
(6) Inverter affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of communications cables and main circuit wires). Check if decreasing the baud rate (H34) down to 2400 bps causes no alarm. ➔ Implement noise control measures. ➔ Implement noise reduction measures on the host side. ➔ Replace the RS-485 converter with a recommended insulated one. ➔ Keep the inverter running, using any proper communications error processing (H32).
(7) Terminating resistor not properly configured.	Check that the inverter serves as a terminating device in the network. ➔ Configure the terminating resistor switch (SW4) for RS-485 communication correctly. (To use the inverter as a terminating device, turn the switch to the ON position.)
(8) Response interval does not match the send/receive switching time of the RS-232C−RS-485 converter.	Check whether the specified response interval (H39) matches the specification of the actual converter. ➔ Match the response interval (H39) with the specification of the converter.

[12] Er6 Operation error

Problem An incorrect operation was attempted.

Possible Causes	What to Check and Suggested Measures
(1) Restrictions on mounting of option(s) not observed. [Sub code: 0001]	Check the model of option(s) mounted. ➔ Check the restrictions on mounting of the option(s). (This error cannot be shown as mounting status of control options on the OPTION pages of the LCD monitor in Menu #4 "I/O CHECK.") Check whether the configurations of the customizing switches (SW) on the two option boards are the same. ➔ Change the SW configuration.
(2) Auto-tuning not performed in accordance with correct procedure. [Sub code: 0002]	Check whether tuning started with digital input ***BX***, ***STOP1***, ***STOP2*** or ***STOP3*** being ON. ➔ With all of ***BX***, ***STOP1***, ***STOP2*** and ***STOP3*** being OFF, start tuning. Check whether tuning started with digital input ***EN1*** or ***EN2*** being opened. ➔ With each of ***EN1*** and ***EN2*** being short-circuited with ***PS***, start tuning. Check whether 20 seconds or more have elapsed after writing to H01 until the FWD key is pressed. ➔ Press the FWD key within 20 seconds after writing to H01. ➔ Before writing to H01, make sure that F02 = 0 and H30 = 0 or 1.
(3) PG detection circuit self-diagnosis function performed with the PG (SD)/PGo (SD) card being mounted.	Check whether the PG (SD)/PGo (SD) card is mounted. ➔ Remove the PG (SD)/PGo (SD) card, then perform the self-diagnosis function of the PG detection circuit (H74).

Possible Causes	What to Check and Suggested Measures
(4) The multiplex system station number of the optical link option (specified by o50) is greater than the setting of o34 (Number of slaves).	➔ Review the settings of o50 and o34.
(5) Motor drive control other than the vector control (e.g., V/f control) is selected with an optical link option being used.	➔ Change the motor drive control to the vector control.

[13] Er-7 Output wiring fault

Problem Auto-tuning failed.

Possible Causes	What to Check and Suggested Measures
(1) A phase was missing (There was a phase loss) in the connection between the inverter and the motor. [Sub code: 0001]	➔ Properly connect the motor to the inverter.
(2) A tuning operation involving motor rotation (H01 = 4) was attempted while the brake was applied to the motor. [Sub code: 0002]	Check that the brake can be released. ➔ Specify the tuning that does not involve the motor rotation (H01 = 2 or 3). ➔ Release the brake before tuning that involves the motor rotation (H01 = 4).

[14] Er-8 A/D converter error

Problem An error occurred in the A/D converter circuit.

Possible Causes	What to Check and Suggested Measures
(1) Inverter affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g. correct grounding and routing of signal wires, communications cables, and main circuit wires). ➔ Implement noise control measures.
(2) Short circuit on the printed circuit board(s). [Sub code: 0001 to 0004]	Check the printed circuit board(s) for short circuits, accumulation of dust or dirt. Check for dew condensation in the inverter unit. Check whether foreign materials have gotten into the inverter unit. ➔ Fix the printed circuit board(s). ➔ Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.

[15] Er-9 Speed mismatch

Problem An excessive deviation has occurred between the speed command and the detected speed.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of function code data. [Sub code: 0001 to 0003]	Check the data of the following function codes; P05, A07 and A107 (Motor, No. of poles), P28, A30 and A130 (Feedback encoder pulse count/rev), and P29, A51 and A151 (Feedback pulse correction factor 1). ➔ Specify motor parameters in accordance with the motor and PG. ➔ Review the data of the following function codes. • E43 (Speed agreement, Detection width) • E44 (Speed agreement, Off-delay timer) • E45 (Speed agreement, Alarm)
(2) Overload. [Sub code: 0001 to 0003]	Measure the inverter output current. ➔ Reduce the load. ➔ Increase the inverter capacity. Check whether any mechanical brake is working. ➔ Release the mechanical brake.
(3) Mismatch between function code settings and the motor characteristics. [Sub code: 0001 to 0003]	Check the motor parameters. ➔ Perform auto-tuning, using H01.
(4) Wrong wiring between the pulse generator (PG) and the inverter. [Sub code: 0001 to 0003]	Check the wiring between the PG and the inverter. ➔ Correct the wiring. (Refer to Chapter 3, Section 3.5.2 "Mounting direction of a pulse generator (PG) and PG signals.")
	Check that the relationships between the PG feedback signal and the run command are as follows: • For the FWD command: the B phase pulse is in the High level at rising edge of the A phase pulse • For the REV command: the B phase pulse is in the Low level at rising edge of the A phase pulse ➔ If the relationship is wrong, interchange the A and B phase wires. ➔ Note that if the digital input signal ***IVS*** ("Switch normal/inverse operation") is active, the above operation is reversed.
(5) Wrong wiring to the motor. [Sub code: 0001 to 0003]	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively. It is also possible to use H75 (Phase sequence configuration of main circuit output wires).
Under vector control with/without speed sensor (6) The motor speed does not rise due to the torque limiter operation. [Sub code: 0001 to 0003]	Check the setting of the torque limiter level (F44, F45). ➔ Change the F44 or F45 data to an appropriate value. If no torque limiter is required, disable the torque limiter (F40 = 0).
(7) During running of the motor (after the mechanical brake is released), the deviation between the speed command (Reference speed 4, ASR input) and the actual speed exceeds the setting of H149. [Sub code: 0008]	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively.

[16] Er-b Inter-inverter communications link error

Problem A communications link error occurred between optical link options.

Possible Causes	What to Check and Suggested Measures
(1) The optical cable is disconnected or inserted poorly into the connector.	➔ Connect the optical cable fully.
(2) The optical cable is bundled or bent with the bend radius of 35 mm or less.	➔ Increase the bend radius to more than 35 mm.
(3) The colors (gray and dark blue) of the connection plugs of the optical link cable do not match those of the connectors on the printed circuit board.	➔ Match the colors of the connection plugs with those of the connectors on the printed circuit board.
(4) The optical cable connection does not form an optical loop.	➔ Review the connection of the optical cable to form an optical loop.
(5) The same hardware station number is double assigned by o50.	➔ Review the setting of o50.
(6) The slave station is not sequentially numbered by o50 relative to the master station number.	➔ Review the setting of the slave stations (o50).
(7) A run command (***FWD***/***REV***) has entered before the establishment of the optical communications link.	➔ Do not enter a run command until the establishment of the optical communications link.
(8) The optical cable or connectors on the inverter were exposed to intense light (e.g., direct sunlight or strobe light).	➔ Do not expose the optical cable or the connectors to intense light.

[17] Er-H Hardware error

Problem The LSI on the power supply printed circuit board (PCB) malfunctions.

Possible Causes	What to Check and Suggested Measures
(1) The control circuit PCB or power supply PCB is defective.	The control circuit PCB or power supply PCB (including the gate PCB) needs to be replaced. ➔ Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.

[18] Er-r Mock alarm

Problem The LED displays Er-r.

Possible Causes	What to Check and Suggested Measures
(1) The STOP + FUNC/DATA keys were held down for more than 5 seconds.	➔ To escape from this alarm state, press the PRG/RESET key.

[19] Lin Power supply phase loss

Problem Input phase loss occurred, or interphase voltage unbalance rate was large.

Possible Causes	What to Check and Suggested Measures
(1) Breaks in wiring to the main power input terminals.	Measure the input voltage. ➔ Repair or replace the main circuit power input wires or input devices (MCCB, MC, etc.).
(2) The screws on the main power input terminals are loosely tightened.	Check if the screws on the main power input terminals have become loose. ➔ Tighten the terminal screws to the recommended torque.
(3) Interphase voltage unbalance between three phases was too large.	Measure the input voltage. ➔ Connect an AC reactor (ACR) to lower the voltage unbalance between input phases. ➔ Increase the inverter capacity.
(4) Overload cyclically occurred.	Correct the load. ➔ Increase the inverter capacity.
(5) Single-phase voltage was input to the three-phase input inverter.	➔ Connect the inverter to the three-phase voltage power supply. (The FRENIC-VG is a three-phase inverter.)

[20] LoC Start delay

Problem At the startup, an excessive deviation has occurred between the speed command and the detected speed.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of function code data.	Check the data of the following function codes; P05, A07 and A107 (Motor, No. of poles), P28, A30 and A130 (Feedback encoder pulse count/rev), and P29, A51 and A151 (Feedback pulse correction factor 1). ➔ Specify motor parameters in accordance with the motor and PG. ➔ Review the data of the following function codes. • H140 (Start delay, Detection level) • H141 (Start delay, Detection timer)
(2) Overload.	Measure the inverter output current. ➔ Reduce the load. ➔ Increase the inverter capacity. Check whether any mechanical brake is working. ➔ Release the mechanical brake.
(3) Mismatch between function code settings and the motor characteristics.	Check the motor parameters. ➔ Perform auto-tuning, using H01.
(4) Wrong wiring between the pulse generator (PG) and the inverter.	Check the wiring between the PG and the inverter. ➔ Correct the wiring. (Refer to Chapter 3, Section 3.5.2 "Mounting direction of a pulse generator (PG) and PG signals.")
	Check that the relationships between the PG feedback signal and the run command are as follows: • For the FWD command: the B phase pulse is in the High level at rising edge of the A phase pulse • For the REV command: the B phase pulse is in the Low level at rising edge of the A phase pulse ➔ If the relationship is wrong, interchange the A and B phase wires. ➔ Note that if the digital input signal ***IVS*** ("Switch normal/inverse operation") is active, the above operation is reversed.

Possible Causes	What to Check and Suggested Measures
(5) Wrong wiring to the motor.	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively. It is also possible to use H75 (Phase sequence configuration of main circuit output wires).
<u>Under vector control with/without speed sensor</u> (6) The motor speed does not rise due to the torque limiter operation.	Check the setting of the torque limiter level (F44, F45). ➔ Change the F44 or F45 data to an appropriate value. If no torque limiter is required, disable the torque limiter (F40 = 0).
(7) During running of the motor (after the mechanical brake is released), the reference torque current (F44, F45) exceeds the specified level (H140) and the actual speed drops below the specified stop speed (F37), and then the state is kept for the specified duration (H141).	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively.

[21] LU Undervoltage

Problem DC link bus voltage has dropped below the undervoltage detection level.

Possible Causes	What to Check and Suggested Measures
(1) A momentary power failure occurred.	➔ Release the alarm. ➔ To restart running the motor without treating this condition as an alarm, set F14 to "3," "4," or "5," depending on the load type.
(2) The power to the inverter was switched back to ON too soon (when F14 = 1).	Check if the power to the inverter was switched back to ON while the control power was still alive. (Check whether the LEDs on the keypad light.) ➔ Turn the power ON again after all LEDs on the keypad go off.
(3) The power supply voltage does not reach the inverter's specification range.	Measure the input voltage. ➔ Increase the voltage to within the specified range.
(4) Peripheral equipment for the power circuit malfunctioned, or the connection is incorrect.	Measure the input voltage to find which peripheral equipment malfunctioned or which connection is incorrect. ➔ Replace any faulty peripheral equipment, or correct any incorrect connections.
(5) Any other load(s) connected to the same power supply has required a large starting current, causing a temporary voltage drop.	Measure the input voltage and check the voltage fluctuation. ➔ Reconsider the power supply system configuration.
(6) Insufficient capacity of the power supply transformer increases load, causing a voltage drop.	Measure the output current. ➔ Reduce the load. ➔ Reconsider the capacity of the power supply transformer.

Possible Causes	What to Check and Suggested Measures
(7) No power is supplied to the auxiliary control power input terminals R0 and T0. Fan power supply switching connectors CN W and CN R are set as follows. CN W (white): [FAN] position CN R (red): [NC] position (Refer to Chapter 3, Section 3.3.3.7 "Switching connectors.")	Measure the input voltage of the auxiliary power supply. ➔ Insert various circuit breakers or magnetic contactor (MC). ➔ Check for voltage drop, connection failure, poor contact and other problems, then take measures against them.

[22] nrb NTC thermistor wire break error

Problem A wire break is found in the NTC thermistor detection circuit.

Note: A negative temperature coefficient (NTC) thermistor is used to protect the motor from overheat, and under vector control, to compensate for the temperature in the motor parameters.

A dedicated motor (VG motor) for Fuji vector control has a built-in NTC thermistor.

Possible Causes	What to Check and Suggested Measures
(1) The NTC thermistor cable is broken.	Check whether the motor cable is broken. ➔ Replace the motor cable.
(2) The temperature around the motor is extremely low (lower than -30°C).	Measure the temperature around the motor. ➔ Reconsider the use environment of the motor.
(3) The NTC thermistor is broken.	Measure the resistance of the NTC thermistor (including a spare thermistor). ➔ Connect a spare thermistor to the motor. ➔ If the spare thermistor is also broken, replace the motor.

[23] OC Overcurrent

Problem The inverter momentary output current exceeded the overcurrent level.

Possible Causes	What to Check and Suggested Measures
(1) The inverter output lines were short-circuited.	Disconnect the wiring from the inverter output terminals ([U], [V] and [W]) and measure the interphase resistance of the motor wiring. Check if the resistance is too low. ➔ Remove the short-circuited part (including replacement of the wires, relay terminals and motor).
(2) Ground faults have occurred at the inverter output lines.	Disconnect the wiring from the output terminals [U], [V] and [W] and perform a Megger test for the inverter and the motor. ➔ Remove the grounded parts (including replacement of the wires, relay terminals and motor).

Possible Causes	What to Check and Suggested Measures
(3) Overload.	Measure the motor current with a measuring device to trace the current trend. Then, use this data to judge if the trend is over the calculated load value for your system design. ➔ If the load is too heavy, reduce it or increase the inverter capacity. Trace the current trend and check if there are any sudden changes in the current. ➔ If there are any sudden changes, make the load fluctuation smaller or increase the inverter capacity. ➔ Under V/f control Enable overcurrent limiting (H58 = 1).
Under V/f control (4) Excessive torque boost specified (in the case of manual torque boost)	Check whether decreasing the torque boost (P35, A55, A155) decreases the output current but does not stall the motor. ➔ If no stall occurs, decrease the torque boost (P35, A55, A155).
Under V/f control (5) The acceleration/ deceleration time was too short.	Check that the motor generates enough torque required during acceleration/deceleration. That torque is calculated from the moment of inertia for the load and the acceleration/deceleration time. ➔ Increase the acceleration/deceleration time (F07, F08, C46, C47, C56, C57, C66, C67). ➔ Increase the inverter capacity. ➔ Review the braking method.
(6) Malfunction caused by noise.	Check if noise control measures are appropriate (e.g., correct grounding and routing of control and main circuit wires). ➔ Implement noise control measures. For details, refer to the FRENIC-VG User's Manual, "Appendix A." ➔ Enable the Auto-reset (H04). ➔ Connect a surge absorber to magnetic contactor's coils or other solenoids (if any) causing noise.
Under vector control with/without speed sensor (7) The carrier frequency is low.	Check the motor sound (carrier frequency) specified by F26. ➔ Increase the setting of F26. (Note that increasing the carrier frequency excessively may cause other devices to malfunction due to noise generated from the inverter.)
Under vector control with/without speed sensor (8) Exciting current was too small during auto-tuning.	Check whether it happens during auto-tuning. ➔ Increase the exciting current (P08, A10, A110) and then perform auto-tuning.
Under vector control with speed sensor (9) Mismatch between the PG's pulse resolution and the function code setting.	Check the function code setting (P28, A30, A130). ➔ Match the function code settings with the PG specifications.
Under vector control with speed sensor (10) Wrong wiring of the PG.	Check the wiring between the PG and the inverter for the phase sequence, wire breaks, shielding and twisting. ➔ Correct the wiring.
Under vector control with speed sensor (11) PG defective.	Check whether the inverter internal control circuit (PG input circuit) is faulty, using the self-diagnosis function of the PG detection circuit (H74). ➔ If the result is "Normal," replace the PG; if it is "Abnormal," contact your Fuji Electric representative. Check the PG waveform using an oscilloscope. ➔ Replace the PG.

[24] OH1 Heat sink overheat

Problem Temperature around heat sink has risen abnormally.

Possible Causes	What to Check and Suggested Measures
(1) The surrounding temperature exceeded the range of the inverter specification. [Sub code: 0001 to 0008]	Measure the temperature around the inverter. ➔ Lower the temperature around the inverter (e.g., ventilate the panel where the inverter is mounted).
(2) Ventilation path is blocked. [Sub code: 0001 to 0008]	Check if there is sufficient clearance around the inverter. ➔ Change the mounting place to ensure the clearance.
	Check if the heat sink is not clogged. ➔ Clean the heat sink. (For the cleaning procedure, contact your Fuji Electric representative.)
(3) Cooling fan's airflow volume decreased due to the service life expired or failure. [Sub code: 0001 to 0008] [Sub code: 0010 to 0200]	Check the cumulative run time of the cooling fan. Refer to Chapter 3, Section 3.4.4.6 "Reading maintenance information – Menu #5 MAINTENANCE." ➔ Replace the cooling fan. (Contact your Fuji Electric representative.)
	Visually check whether the cooling fan rotates normally. ➔ Replace the cooling fan. (Contact your Fuji Electric representative.)
(4) Overload. [Sub code: 0001 to 0008]	Measure the output current. ➔ Reduce the load (Use the heat sink overheat early warning ***INV-OH*** (E15 through E27) or the inverter overload early warning ***INV-OL*** (E15 through E27) to reduce the load before the overload protection is activated.). ➔ Decrease the data of F26 (Motor sound, Carrier frequency).

[25] OH2 External alarm

Problem External alarm was inputted (***THR***).
(when the "Enable external alarm trip" ***THR*** has been assigned to any of digital input terminals)

Possible Causes	What to Check and Suggested Measures
(1) An alarm function of external equipment was activated.	Check the operation of external equipment. ➔ Remove the cause of the alarm that occurred.
(2) Wrong connection or poor contact in external alarm signal wiring.	Check if the external alarm signal wiring is correctly connected to the terminal to which the "Enable external alarm trip" terminal command ***THR*** has been assigned (Any of E01 through E09 should be set to "9."). ➔ Connect the external alarm signal wire correctly.
(3) Incorrect setting of function code data.	Check whether the normal/negative logic of the external signal matches that of the ***THR*** command specified by E14. ➔ Ensure the matching of the normal/negative logic.
(4) The surrounding temperature exceeded the range of the braking resistor specification.	Measure the temperature around the braking resistor. ➔ Lower the temperature (e.g., ventilate the inverter).
(5) The capacity of the braking resistor is insufficient.	Reconsider the capacity and %ED of the braking resistor. ➔ Review the braking resistor.

[26] OH3 Inverter internal overheat

Problem Temperature inside the inverter has exceeded the allowable limit.

Possible Causes	What to Check and Suggested Measures
(1) The surrounding temperature exceeded the inverter's specification limit. [Sub code: 0001 to 0008]	Measure the surrounding temperature. ➔ Lower the temperature around the inverter (e.g., ventilate the panel where the inverter is mounted).
(2) Temperature detection circuit failure (Thermistor wire break). [Sub code: 0010]	➔ Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.

[27] OH4 Motor overheat (PTC/NTC thermistor)

Problem Temperature of the motor has risen abnormally.

Possible Causes	What to Check and Suggested Measures
(1) The temperature around the motor exceeded the range of the motor specification.	Measure the temperature around the motor. ➔ Lower the temperature.
(2) Cooling system for the motor defective.	Check if the cooling system of the motor is operating normally. ➔ Repair or replace the cooling system of the motor.
(3) Overload.	Measure the output current. ➔ Reduce the load. (e.g. Use the motor overload early warning (E34) to reduce the load before the overload protection is activated.) ➔ Lower the temperature around the motor.
(4) The activation level (E32) of the PTC thermistor for motor overheat protection was set inadequately.	Check the PTC thermistor specifications and recalculate the detection voltage. ➔ Modify the data of function code E32.
(5) The activation level (E30) of the NTC thermistor for motor overheat protection was set inadequately.	Check the data of function code E30 (Motor overheat protection, Temperature). ➔ When a motor exclusive to vector control is used, set E30 to 150°C (Factory default). ➔ When the motor temperature is entered via any of analog input terminals [Ai1] to [Ai4], set E30 to the protection level matching the motor specification.
(6) Settings for the PTC/NTC thermistor are improper.	Check the setting of the thermistor mode selection (function code P30, A31, A131). ➔ Change the data of P30, A31 or A131 in accordance with the thermistor used.
(7) NTC thermistor model (characteristics) improper.	Check the NTC thermistor model (characteristics). ➔ Use the NTC thermistor incorporated in a motor exclusive to vector control.
<u>Under V/f control</u> (8) Excessive torque boost specified. (P35, A55, A155)	Check whether decreasing the torque boost (function code P35, A55, A155) does not stall the motor. ➔ If no stall occurs, decrease the data of P35, A55 or A155.
<u>Under V/f control</u> (9) The V/f pattern did not match the motor.	Check whether the motor rated speed (F04, A05, A105) and the rated voltage (F05, A04, A104) match the values on the motor's nameplate. ➔ Match the function code data with the values on the motor's nameplate.

Possible Causes	What to Check and Suggested Measures
(10) Incorrect setting of function code data.	Although no PTC thermistor is used, the thermistor mode is enabled (function code P30, A31, A131). ➔ Set the data of P30, A31 or A131 to "0" (Disable).
(11) The input voltage of the motor cooling fan is out of the range of the specification.	Check the input voltage of the motor cooling fan. ➔ Review the power supply system.
(12) The air passage of the motor cooling fan is clogged.	Check the air passage of the motor cooling fan. ➔ Clear the clog. (For the cleaning procedure, contact your Fuji Electric representative.)
(13) Mismatch of motor parameters	For exclusive motors for the FRENIC-VG: Check whether the data of function code P02 matches the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.

[28] OLn Overload of motor 1 through 3

Problem Electronic thermal protection for motor 1, 2, or 3 activated.

OL1 Motor 1 overload
OL2 Motor 2 overload
OL3 Motor 3 overload

Possible Causes	What to Check and Suggested Measures
(1) The electronic thermal characteristics do not match the motor overload characteristics.	Check the motor characteristics. ➔ Reconsider the data of function codes F10, F12, A32, A34, A132 and A134. ➔ Use an external thermal relay.
(2) The activation level for the electronic thermal protection was not appropriate.	Check the continuous allowable current of the motor. ➔ Reconsider and change the data of function code F11, A33 or A133.
(3) The specified acceleration/ deceleration time was too short.	Recalculate the acceleration/deceleration torque and time needed for the load, based on the moment of inertia for the load and the acceleration/deceleration time. ➔ Increase the acceleration/ deceleration time (F07, F08, C46, C47, C56, C57, C66, C67).
(4) Overload.	Measure the output current. ➔ Reduce the load (e.g. Use the motor overload early warning (E34) to reduce the load before the overload protection is activated.).
Under V/f control (5) Excessive torque boost specified	Check whether decreasing the torque boost (P35, A55, A155) does not stall the motor. ➔ If no stall occurs, decrease the data of P35, A55 or A155.
Under vector control with/without speed sensor (6) The control constants of the automatic speed regulator (ASR) are inadequate.	Check whether the actual speed overshoots or undershoots the commanded one. ➔ Readjust the ASR (ASR gain, constant of integration, etc.).

[29] OLU Inverter overload

Problem Electronic thermal overload protection for inverter activated.

Possible Causes	What to Check and Suggested Measures
(1) The surrounding temperature exceeded the range of the inverter specification.	Measure the temperature around the inverter. ➔ Lower the temperature (e.g., ventilate the panel where the inverter is mounted).
(2) Excessive torque boost specified.	Check whether decreasing the torque boost (P35, A55, A155) does not stall the motor. ➔ If no stall occurs, decrease the torque boost (P35, A55, A155).
(3) The specified acceleration/ deceleration time was too short.	Recalculate the acceleration/deceleration torque and time needed for the load, based on the moment of inertia for the load and the acceleration/deceleration time. ➔ Increase the acceleration/deceleration time (F07, C35, C46, C56, C66).
(4) Overload.	Measure the load factor to see that it does not exceed 100%. (Refer to Chapter 3, Section 3.4.4.7 "Measuring load factor -- Menu #6 "LOAD FCTR." ➔ Reduce the load (e.g., Use the overload early warning (E33) and reduce the load before the overload protection is activated.). ➔ Decrease the motor sound (Carrier frequency) (F26).
(5) Ventilation paths are blocked.	Check if there is sufficient clearance around the inverter. ➔ Change the mounting place to ensure the clearance. (For details, refer to Chapter 3, Section 3.3.2 "Installing the Inverter." Check if the heat sink is not clogged. ➔ Clean the heat sink. (For the cleaning procedure, contact your Fuji Electric representative.)
(6) Cooling fan's airflow volume decreased due to the service life expired or failure.	Check the cumulative run time of the cooling fan. ➔ Replace the cooling fan. (Contact your Fuji Electric representative.) Visually check that the cooling fan rotates normally. ➔ Replace the cooling fan. (Contact your Fuji Electric representative.)
(7) The wires to the motor are too long, causing a large leakage current from them.	Measure the leakage current. ➔ Insert an output circuit filter (OFL).
<u>Under vector control with/without speed sensor</u> (8) Reference speed fluctuating	Check whether the reference speed is fluctuating. ➔ Increase the ASR input filter setting (F64, C43, C53, C63).
<u>Under vector control with/without speed sensor</u> (9) The control constants of the automatic speed regulator (ASR) are inadequate.	Check whether the actual speed overshoots or undershoots the commanded one. ➔ Readjust the ASR (ASR gain, constant of integration, etc.).
(10) Wrong wiring to the PG.	Check the wiring to the PG. ➔ Correct the wiring.
(11) Wrong wiring to the motor.	Check the wiring to the motor. ➔ Correct the wiring. It is also possible to use H75 (Phase sequence configuration of main circuit output wires).

Possible Causes	What to Check and Suggested Measures
(12) The magnetic pole position of the permanent magnet synchronous motor (PMSM) is out of place.	Check the magnetic pole position. ➔ Adjust the magnetic pole position (o10, A60, A160). (Refer to Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor and magnetic pole position sensor," ■ Adjusting the magnetic pole position.")

[30] OPL Output phase loss

Problem Output phase loss occurred.

Possible Causes	What to Check and Suggested Measures
(1) Inverter output wires are broken.	Measure the output current. ➔ Replace the output wires.
(2) The motor winding is broken.	Measure the output current. ➔ Replace the motor.
(3) The inverter output terminals or motor input terminals are weakly tightened.	Check if any screws on those terminals have become loose. ➔ Tighten the terminal screws to the recommended torque.
(4) A single-phase motor has been connected.	➔ Single-phase motors cannot be used. (The FRENIC-VG is a drive for three-phase motors.)

[31] OS Overspeed

Problem The motor rotates in an excessive speed (when Motor speed ≥ Maximum speed setting × H90÷100)

Possible Causes	What to Check and Suggested Measures
Under vector control with/without speed sensor (1) Incorrect setting of function code data.	Check the maximum speed setting (function code F03, A06, A106). ➔ Modify the data of F03, A06 or A106 in accordance with the machinery.
	Check the setting of the speed limiter (F76 to F78). ➔ Enable the speed limiter (F76 to F78).
Under vector control with/without speed sensor (2) Insufficient gain of the speed controller (ASR).	Check whether the actual speed overshoots the commanded one in higher speed operation. ➔ Increase the ASR gain (F61). (Depending on the situations, reconsider the setting of the filter constants or the integral time.)
Under vector control with/without speed sensor (3) The overspeed alarm detection level is not appropriate.	Check the setting of the overspeed alarm detection level (H90, Factory default 120%). ➔ Set the data of H90, taking into account the maximum allowable speed for the machinery.
Under vector control with speed sensor (4) Noises superimposed on the PG wire.	Check whether appropriate noise control measures have been implemented (e.g., correct grounding and routing of signal wires and main circuit wires). ➔ Implement noise control measures. For details, refer to the FRENIC-VG User's Manual, "Appendix A."
Under vector control with/without speed sensor (5) Droop gain too large.	Check whether the droop gain is appropriate. ➔ Decrease the droop gain (H28).

Possible Causes	What to Check and Suggested Measures
Under vector control with/without speed sensor (6) The motor parameters do not match the connected motor.	For motors exclusive to the FRENIC-VG: Check whether the setting of function code P02 matches the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.
Under vector control without speed sensor (7) Breaks in the inverter output circuit.	Check the inverter output circuit. ➔ Correct the wiring.
Under vector control with speed sensor (8) PG waveform abnormal.	Measure the PG waveform. ➔ Replace the PG.
Under vector control with speed sensor (9) Mismatch between the PG's pulse resolution and the function code setting.	Check the function code setting (P28, A30, A130). ➔ Match the function code settings with the PG specifications.
(10)The magnetic pole position of the permanent magnet synchronous motor (PMSM) is out of place.	Check the magnetic pole position. ➔ Adjust the magnetic pole position (o10, A60, A160). (Refer to Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor and magnetic pole position sensor," ■ Adjusting the magnetic pole position.")

[32] 0U Overvoltage

Problem The DC link bus voltage exceeded the overvoltage detection level.

Possible Causes	What to Check and Suggested Measures
(1) The power supply voltage exceeded the range of the inverter specification.	Measure the input voltage. ➔ Decrease the voltage to within the specified range.
(2) A surge current entered the input power supply.	In the same power line, if a phase-advancing capacitor is turned ON/OFF or a thyristor converter is activated, a surge (momentary large increase in the voltage or current) may be caused in the input power. ➔ Install a DC reactor.
(3) The deceleration time was too short for the moment of inertia of the load.	Recalculate the deceleration torque based on the moment of inertia of the load and the deceleration time. ➔ Increase the deceleration time (F08, C36, C47, C57, C67). ➔ Consider the use of a braking resistor or PWM converter (RHC-C). ➔ Decrease the moment of inertia of the load. ➔ Enable the overvoltage trip prevention (H57). ➔ Select the power limit function (F40 = 2). ➔ Under vector control with speed sensor Enable the torque limiter (F40 to F45).
(4) The acceleration time was too short.	Check if an overvoltage alarm occurs after rapid acceleration. ➔ Increase the acceleration time (F07, C35, C46, C56, C66). ➔ Select the S-curve acceleration/deceleration (F67 to F70). ➔ Consider the use of a braking resistor or PWM converter (RHC-C). ➔ Decrease the moment of inertia of the load.
(5) Braking load was too heavy.	Compare the braking torque of the load with that of the inverter. ➔ Consider the use of a braking resistor or PWM converter (RHC-C).

Possible Causes	What to Check and Suggested Measures
(6) Malfunction caused by noise.	Check if the DC link bus voltage was below the protective level when the overvoltage alarm occurred. ➔ Implement noise control measures. For details, refer to the FRENIC-VG User's Manual, "Appendix A." ➔ Enable the auto-reset (H04). ➔ Connect a surge absorber to magnetic contactor's coils or other solenoids (if any) causing noise.
(7) The inverter output lines were short-circuited.	Disconnect the wiring from the inverter output terminals ([U], [V] and [W]) and measure the interphase resistance of the motor wiring. Check if the resistance is too low. ➔ Remove the short-circuited part (including replacement of the wires, relay terminals and motor).
(8) Wrong connection of the braking resistor.	Check the connection. ➔ Correct the connection.
(9) Large, rapid decrease of the load.	Check whether the inverter runs at the time of rapid decrease of the load. ➔ Consider the use of a braking resistor or PWM converter (RHC-C).

[33] PG PG wire break

Problem The pulse generator (PG) wire has been broken somewhere in the circuit.

Possible Causes	What to Check and Suggested Measures
(1) Wire break between the pulse generator (PG) and the option.	Check whether the PG is correctly connected to the option or any wire is broken. ➔ Check whether the PG is connected correctly. Or, tighten up the related terminal screws. ➔ Check whether any joint or connecting part bites the wire sheath. ➔ Replace the wire.
(2) Connection failure of speed/magnetic pole position sensor.	Check the output wiring of the speed/magnetic pole position sensor for poor contact or the phase sequence of the AB phases and UVW phases. ➔ Connect the speed/magnetic pole position sensor to the feedback input card correctly.
(3) Motor rotation direction and sensor output not matched.	Check the motor wiring for poor contact or the phase sequence. ➔ Connect the inverter with the motor correctly.
(4) Connection failure of option card(s)	Check whether the connector of the option card engages with that of the inverter unit. ➔ Mount the option card on the inverter unit correctly.
(5) PG related circuit affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of signal wires, communication cables, and main circuit wires). ➔ Implement noise control measures. ➔ Separate the signal wires from the main power wires as far as possible.
(6) Motor drive control wrongly selected.	Check the motor drive control currently selected. ➔ If no PG is mounted, select the vector control without speed sensor.
(7) Mismatch between the PG power voltage (rated) and the output voltage setting of terminal [PGP].	Check the PG power voltage (rated) and the output voltage setting of terminal [PGP] (switchable with SW6). ➔ Set SW6 properly. For details, refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches."
(8) PG wires small in size.	Check whether the PG wires satisfy the recommended wire size. ➔ Replace the wires with the recommended one.

Possible Causes	What to Check and Suggested Measures
(9) PG waveform abnormal.	Check whether the inverter internal control circuit (PG input circuit) is faulty, using the self-diagnosis function of the PG detection circuit (H74). ➔ If the result is "Normal," replace the PG; if it is "Abnormal," contact your Fuji Electric representative. Check the PG waveform using an oscilloscope. ➔ Replace the PG.

[34] PbF Charger circuit fault

Problem The magnetic contactor for short-circuiting the charging resistor failed to work. (For 200 V class series of 37 kW or above and those of 75 kW or above)

Possible Causes	What to Check and Suggested Measures
(1) No control power was supplied to the magnetic contactor (MC) intended for short-circuiting the charging resistor.	Check that, in normal connection of the main circuit (not a connection via the DC link bus), the connector (CN R) on the power printed circuit board (power PCB) is not inserted to NC. ➔ Insert the connector (CN R) to FAN. For details, refer to Chapter 3, Section 3.3.3.6 "Switching connectors, ■ Fan power supply switching connectors."
(2) Breaks in wiring to the main power input terminals.	Measure the input voltage. ➔ Repair or replace the main circuit power input wires or input devices (MCCB, MC, etc.).

13.4 If the "Light Alarm" Indication (l-al) Appears on the LED Monitor

If the inverter detects a minor abnormal state "light alarm," it can continue the current operation without tripping while displaying the "light alarm" indication l-al on the LED monitor. In addition to the indication l-al, the inverter blinks the KEYPAD CONTROL LED and outputs the "light alarm" signal ***L-ALM*** to a general-purpose digital output terminal to alert the peripheral equipment to the occurrence of a light alarm. (To use the ***L-ALM***, it is necessary to assign the signal to any of the digital output terminals by setting any of function codes E15 through E19 to "57.")

Function codes H106 through H110 specify which alarms should be categorized as "light alarm." The available "light alarm" codes are check-marked in the "Light alarm" object column in Table 13.1.

For the "light alarm" factors and the alarm removal procedure, refer to Chapter 3, Section 3.4.3.5 "Monitoring light alarms."

13.5 If Neither an Alarm Code Nor "Light Alarm" Indication (L -AL) Appears on the LED Monitor

13.5.1 Abnormal motor operation

[1] The motor does not rotate.

Possible Causes	What to Check and Suggested Measures
(1) No power supplied to the inverter.	Check the input voltage and interphase voltage unbalance. ➔ Turn ON a molded case circuit breaker (MCCB), a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) or a magnetic contactor (MC). ➔ Check for voltage drop, phase loss, poor connections, or poor contacts, and fix them if necessary. ➔ If only the auxiliary control power input is supplied, also supply the main power to the inverter.
(2) No run forward/reverse command was inputted, or both the commands were inputted simultaneously (external signal operation).	Check the input status of the forward/reverse command with Menu #4 "I/O CHECK" using the keypad. ➔ Input a run command. ➔ Set either the forward or reverse operation command to off if both commands are being inputted. ➔ Correct the run command source. (Set the data of F02 to "1.") ➔ Connect the external circuit wires to control circuit terminals [FWD] and [REV] correctly. ➔ Make sure that the sink/source slide switch (SW1) on the control printed circuit board (control PCB) is properly configured. (Refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches.")
(3) A run command with higher priority than the one attempted was active, and the run command was stopped. Or, a speed command was active.	Referring to the run command block diagram given in the FRENIC-VG User's Manual, Chapter 4, check the higher priority run command using Menu #2 "DATA CHECK" and Menu #4 "I/O CHECK" with the keypad. ➔ Correct wrong setting of function code H30 (Communications link function, Mode selection) or cancel the higher priority run command.
(4) No analog speed command input.	Check whether the analog speed command is correctly inputted, using Menu #4 "I/O CHECK" on the keypad. ➔ Connect the external circuit wires to terminals [13], [12], [11], [Ai1] and [Ai2] correctly. ➔ Inspect the external speed command potentiometers, signal converters, switches and relay contacts. Replace any ones that are faulty.
Under V/f control (5) The reference speed was below the starting or stop speed.	Check that a speed command has been entered correctly, using Menu #4 "I/O CHECK" on the keypad. ➔ Set the reference speed at the same or higher than the starting speed (F23). ➔ Reconsider the starting speed (F23), and if necessary, change it to the lower value. ➔ Inspect the external speed command potentiometers, signal converters, switches and relay contacts. Replace any ones that are faulty. ➔ Connect the external circuit wires to terminals [13], [12], [11], [Ai1] and [Ai2] correctly.

Possible Causes	What to Check and Suggested Measures
(6) A run command with higher priority than the one attempted was active.	Referring to the run command block diagram given in the FRENIC-VG User's Manual, Chapter 4, check the higher priority run command using Menu #2 "DATA CHECK" and Menu #4 "I/O CHECK" with the keypad. ➔ Correct the wrong setting of function codes (e.g., cancel the higher priority run command). ➔ Correct wrong setting of function code H30 (Communications link function, Mode selection) or cancel the higher priority run command.
(7) The speed limiter settings were made incorrectly.	Check the data of function codes F76 (Speed limiter mode), F77 and F78 (Speed limiter levels 1 and 2). ➔ Correct the data of F76 through F78.
(8) The coast-to-stop command was effective.	Check the data of function codes E01 through E09 and the input signal status of X terminals, using Menu #4 "I/O CHECK" on the keypad. ➔ Release the coast-to-stop command setting. Check the input signal status of terminal [EN], using Menu #4 "I/O CHECK" on the keypad. ➔ Short-circuit the terminal [EN] with terminal [PS].
(9) No input on [EN1] or [EN2].	Check the input status of the EN terminal, using Menu #4 "I/O CHECK" on the keypad. ➔ Short-circuit each of [EN1] and [EN2] with [PS]. (Refer to Chapter 3, Section 3.3.3.8 "Detailed functions of control circuit terminals."
(10) Broken wires, incorrect connection or poor contact with the motor. Or the motor defective.	Check the wiring and the motor. (Measure the output current). ➔ Repair the wires to the motor, or replace them. ➔ Repair the motor or replace it.
(11) Overload	Measure the output current. ➔ Reduce the load (In winter, the load tends to increase.) ➔ Increase the inverter and motor capacities.
	Check whether any mechanical brake is activated. ➔ Release the mechanical brake, if any.
(12) Torque generated by the motor was insufficient.	Check that the motor switching signal (selecting motor 1, 2 or 3) is correct using Menu #4 "I/O CHECK" on the keypad and that the data of function codes matches each motor. ➔ Correct the motor switching signal. ➔ Modify the function code data to match the connected motor.
<u>Under V/f control</u> (13) Torque generated by the motor was insufficient.	Check whether the reference speed is below the slip-compensated speed of the motor (Function codes P10 and P11 for M1, A12 and A13 for M2, and A112 and A113 for M3). ➔ Change the reference speed so that it becomes higher than the slip-compensated speed of the motor. Check whether increasing the toque boost (Function code P35, A55, A155) starts rotating the motor. ➔ Increase the data of P35, A55 or A155. Check the data of function code F04, A05 or A105. ➔ Change the V/f pattern setting to match each motor.
(14) Wrong connection or poor contact of DC reactor (DCR)	Check the wiring between the main circuit terminals P1 and P(+). Inverters of 55 kW in LD mode and inverters of 75 kW or above come with a DCR as standard. Without connection of a DCR, these inverters cannot run. ➔ Connect a jumper bar or DCR correctly. Repair or replace wires to the DCR.

Possible Causes	What to Check and Suggested Measures
(15) No reference speed setting (keypad operation).	Check the reference speed setting made on the keypad. ➔ Modify the reference speed setting by pressing [↑] key.
(16) The inverter could not accept any run commands from the keypad since it was in Programming mode.	Check which operation mode the inverter is in, using the keypad. ➔ Shift the operation mode to Running mode and enter a run command.
Under vector control with speed sensor (17) Incorrect setting of the number of poles of the motor	Check whether the setting of function code P05, A07 or A107 (No. of poles) matches the number of poles of the actual motor. ➔ Set the data of P05, A07 or A107 to the correct number of poles.
Under vector control with speed sensor (18) Wrong wiring between the motor and pulse generator (PG).	Check the motor wiring (phase sequence) and the polarity of the PG. ➔ Correct the wiring.
Under vector control with/without speed sensor (19) Incorrect setting of the torque limiter level.	Check whether the torque limiter level (Function code F44, F45) is set to zero (0). ➔ Modify the data of F44 or F45 to the appropriate value.
Under vector control with/without speed sensor (20) Incorrect setting of the torque command.	Check whether the torque command of terminal [Ai1]/[Ai2] is zero (0) under torque control mode. ➔ Modify the torque command to the appropriate value.
Under vector control with speed sensor (21) Mismatch between the PG's pulse resolution and the function code setting.	Check whether the setting of function code P28, A30 or A130 matches the pulse resolution of the actual PG.. ➔ Modify the data of P28, A30 or A130 to the appropriate value. Check whether the voltage setting of terminal [PGP] (SW6) matches the voltage specification of the actual PG. ➔ Set SW6 to the appropriate position.
(22) The magnetic pole position of the permanent magnet synchronous motor (PMSM) is out of place.	Check the magnetic pole position. ➔ Adjust the magnetic pole position (o10, A60, A160). (Refer to Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor and magnetic pole position sensor," ■ Adjusting the magnetic pole position.")

[2] The motor rotates, but the speed does not change.

Possible Causes	What to Check and Suggested Measures
(1) The setting of the maximum speed was too low.	Check the data of function code F03, A06 or A106 (Maximum speed). ➔ Modify the data of F03, A06 or A106 to the appropriate value.
(2) The setting of the speed limiter was too low.	Check the setting of the speed limiter (F76 to F78). ➔ Modify the data of F76 to F78 to the appropriate value.
(3) The reference speed (analog setting) did not change.	Check whether the reference speed has been entered correctly, using Menu #4 "I/O CHECK" on the keypad. ➔ Increase the reference speed. ➔ Inspect the external speed command potentiometers, signal converters, switches, and relay contacts. Replace any ones that are faulty. ➔ Connect the external circuit wires to terminals [13], [12], [11], [Ai1] and [Ai2] correctly.

Possible Causes	What to Check and Suggested Measures
(4) The external circuit wiring to terminals [X1] to [X9] or signal assignment to those terminals is wrong.	Check whether the reference speed has been entered correctly, using Menu #4 "I/O CHECK" on the keypad. ➔ Connect the external circuit wires to terminals [X1] through [X9]. ➔ Correct the data of E01 to E14. ➔ Correct the data of C05 to C21 (Multistep speed settings).
(5) A reference speed (e.g., multistep speed or via communications link) with higher priority than the one attempted was active and the reference speed was too low.	Referring to the speed command block diagram given in the FRENIC-VG User's Manual, Chapter 4, check the data of the relevant function codes and what speed commands are being received, using Menu #2 "DATA CHECK" and Menu #4 "I/O CHECK" with the keypad. ➔ Correct any incorrect data of function codes (e.g. cancel the higher priority reference speed).
(6) The acceleration or deceleration time was too long or too short.	Check the settings of the acceleration time and deceleration time (function codes F07, F08, C35, C36, C46, C47, C56, C57, C66 and C67). ➔ Change the acceleration/deceleration time to match the load.
(7) Overload.	Measure the output current. ➔ Reduce the load. Check whether any mechanical brake is activated. ➔ Release the mechanical brake.
<u>Under V/f control</u> (8) Function code settings do not agree with the motor characteristics.	If auto-torque boost (Function code P35, A55, A155) is enabled, check whether the data of P03, P04, P06, P07 and P08 for M1, A02, A03, A08, A09 and A10 for M2, A102, A103, A108, A109 and A110 for M3 matches the parameters of the motor. ➔ Perform auto-tuning of the inverter for the motor to be used.
<u>Under V/f control</u> (9) The output frequency does not increase due to the current limiter operation.	Decrease the value of the torque boost (Function code P35, A55, A155), then run the motor again and check if the speed increases. ➔ Adjust the value of the torque boost (P35, A55, A155). Check the data of function codes F04, A05 and A105 to ensure that the V/f pattern setting is right. ➔ Match the V/f pattern setting with the motor ratings.
(10) The motor speed does not increase due to the torque limiter operation.	Check whether the data of torque limiter related function codes F40 through F45 is correctly configured and the ***TL2***/***TL1*** terminal command ("Select torque limiter level") is correct. ➔ Correct the data of F44 or F45 or enter the ***F40-CCL*** terminal command ("Cancel F40 (Torque limiter mode 1)").
(11) Incorrect settings of bias and gain for analog input.	Check the data of function codes F17, F18 and E53 to E60. ➔ Correct the bias and gain settings.
(12) The reference speed did not change. (Keypad operation)	Check whether modifying the reference speed setting from the keypad changes the reference speed. ➔ Modify the reference speed setting by pressing the [↑] and [↓] keys.
<u>Under vector control with speed sensor</u> (13) Wrong wiring of the PG.	Check the wiring between the PG and the inverter for the phase sequence, wire breaks, shielding and twisting. ➔ Correct the wiring.
<u>Under vector control with speed sensor</u> (14) Wrong wiring between the inverter and the motor.	Check the phase sequence (U, V, and W) of the main circuit wires between the inverter and the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively.

Possible Causes	What to Check and Suggested Measures
Under vector control with/without speed sensor (15) Function code settings do not agree with the motor characteristics.	For exclusive motors for the FRENIC-VG: Check whether the data of function code P02 matches the specification of the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.

[3] The motor runs in the opposite direction to the command.

Possible Causes	What to Check and Suggested Measures
Under V/f control Under vector control without speed sensor (1) Wrong wiring to the motor.	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively.
(2) The rotation direction specification of the motor is opposite to that of the inverter.	The rotation direction of IEC-compliant motors is opposite to that of incompliant motors. ➔ Switch the ***FWD***/***REV*** signal setting.
(3) Incorrect setting of speed command related function code data.	Check the data of the speed command related function codes, referring to the speed command block diagram given in the FRENIC-VG User's Manual, Chapter 4. ➔ Correct the data of the related function codes.
Under vector control with speed sensor (4) Wrong wiring of the PG.	Check the wiring to the motor. ➔ Correct the wiring. (Refer to Chapter 3, Section 3.5.2 "Mounting direction of a pulse generator (PG) and PG signals.")

[4] Speed fluctuation or current oscillation (e.g., hunting) occurs during running at constant speed.

Possible Causes	What to Check and Suggested Measures
(1) The analog speed command fluctuates.	Check the signal status for the speed command with Menu #4 "I/O CHECK" using the keypad. ➔ Increase the filter constants (F83, E61 to E64) for the speed command. ➔ Take measures to keep the speed command constant.
(2) An external potentiometer is used for speed setting.	Check that there is no noise on the control signal wires connecting to external sources. ➔ Isolate the control signal wires from the main circuit wires as far as possible. ➔ Use shielded or twisted wires for control signals. Check whether the external speed command potentiometer is malfunctioning due to noise from the inverter. ➔ Connect a capacitor to the output terminal of the potentiometer or set a ferrite core on the signal wire. (Refer to Chapter 2.)
(3) Speed switching or multistep speed command was enabled.	Check whether the relay signal for switching the speed command is chattering. ➔ If the relay contact is defective, replace the relay.
(4) The wiring length between the inverter and the motor is too long.	Check whether auto-torque boost is enabled (P35, A55, A155). ➔ Perform auto-tuning. ➔ Under V/f control, disable the automatic control system (select manual torque boost), then check that the motor vibration stops. ➔ Make the output wires as short as possible.

Possible Causes	What to Check and Suggested Measures
(5) The machinery is hunting due to vibration caused by low rigidity of the load. Or the current is irregularly oscillating due to special motor parameters.	Once disable all the automatic control systems (speed control, auto torque boost, current limiter, torque limiter and droop control), then check that the motor vibration comes to a stop. ➔ Under vector control with/without speed sensor, readjust the speed control system. (F61 through F66, C40 through C45, C50 through C55) ➔ Disable the automatic control system(s) causing the vibration.
(6) Function code settings do not agree with the motor characteristics.	For exclusive motors for the FRENIC-VG: Check whether the setting of function code P02 matches the specification of the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.
(7) Load is fluctuating.	Under vector control with/without speed sensor Check whether automatic speed regulator (ASR) is properly configured. (F61 through F66, C40 through C45, C50 through C55) ➔ Readjust the ASR setting.

[5] Grating sound is heard from the motor or the motor sound fluctuates.

Possible Causes	What to Check and Suggested Measures
(1) The specified carrier frequency is too low.	Check the data of function code F26 (Motor sound (Carrier frequency)). ➔ Increase the data of F26.
(2) The surrounding temperature of the inverter was too high.	Measure the temperature inside the panel where the inverter is mounted. ➔ If it is over 40°C, lower it by improving the ventilation. ➔ Lower the temperature of the inverter by reducing the load.
(3) Resonance with the load.	Check the machinery mounting accuracy or check whether there is resonance with the mounting base. ➔ Disconnect the motor from the machinery and run it alone to find where the resonance comes from. Upon locating the cause, improve the characteristics of the source of the resonance. ➔ Adjust the jump speed (C01 through C04) to avoid continuous running in the frequency range causing resonance. ➔ Specify the observer (H47 through H52, H125 through H127) to suppress vibration. (Depending on the characteristics of the load, this may take no effect.) ➔ Decrease the P gain of the auto speed regulator (ASR). (F61, C40, C50, C60)

[6] The motor does not accelerate or decelerate within the specified time.

Possible Causes	What to Check and Suggested Measures
(1) The inverter runs the motor with S-curve acceleration/ deceleration.	Check the data of function codes F67 through F70 (S-curve acceleration/ deceleration pattern). ➔ Select the linear pattern (F67 through F70 = 0). ➔ Decrease the acceleration/deceleration time (F07, F08, C46, C47, C56, C57, C66, C67).
Under V/f control (2) The current limiting operation prevented the output frequency from increasing (during acceleration).	Check whether the acceleration time and torque boost are properly specified. ➔ Increase the data of F07, C35, C46, C56 or C66 (acceleration time). ➔ Decrease the torque boost (P35, A55, A155) and restart the inverter to check that the speed increases.

Possible Causes	What to Check and Suggested Measures
(3) Overload.	Measure the output current. ➔ Reduce the load.
<u>Under V/f control</u> (4) Torque generated by the motor was insufficient.	Check that increasing the torque boost (P35, A55, A155) starts the motor. ➔ Increase the value of the torque boost (P35, A55, A155).
(5) An external potentiometer is used for frequency setting.	Check that there is no noise on the control signal wires connecting to external sources. ➔ Isolate the control signal wires from the main circuit wires as far as possible. ➔ Use shielded or twisted wires for control signals. Check whether the external speed command potentiometer is malfunctioning due to noise from the inverter. ➔ Connect a capacitor to the output terminal of the potentiometer or set a ferrite core on the signal wire. (Refer to Chapter 3, Section 3.3.3.8.)
(6) Motor torque generated is limited by the torque limiter.	Check whether data of torque limiter related function codes (F40 through F45) is correctly configured and the ***TL2***/***TL1*** terminal command ("Select torque limiter level 2/1") is correct. ➔ Correct the data of F40 through F45 or reset them to the factory defaults. Check whether the speed command potentiometer is malfunctioning due to noise from the inverter. ➔ Set the ***TL2***/***TL1*** correctly. ➔ Increase the acceleration/deceleration time (F07, F08, C35, C36, C46, C47, C56, C57, C66, C67).
(7) The specified acceleration or deceleration time was incorrect.	Check the terminal commands ***RT1*** and ***RT2*** for acceleration/deceleration times. ➔ Correct the ***RT1*** and ***RT2*** settings.

[7] The motor does not restart even after the power recovers from a momentary power failure.

Possible Causes	What to Check and Suggested Measures
(1) The data of function code F14 is either "0," "1," or "2."	Check if an undervoltage trip (LU) occurs. ➔ Change the data of F14 (Restart mode after momentary power failure, Mode selection) to "3," "4," or "5."
(2) The run command remains OFF even after the power has been restored.	Check the input signal with Menu #4 "I/O CHECK" using the keypad. ➔ Check the power recovery sequence with an external circuit. If necessary, consider the use of a relay that can keep the run command ON.
	In 3-wire operation, the power to the control printed circuit board (control PCB) has been shut down once because of a long momentary power failure time, or the ***HOLD*** signal ("Enable 3-wire operation") has been turned OFF once. ➔ Change the design or the setting so that a run command can be issued again within 2 seconds after the power has been restored.

[8] The motor abnormally heats up.

Possible Causes	What to Check and Suggested Measures
(1) Airflow volume of the motor's cooling fan decreased due to the service life expired or failure	Visually check whether the cooling fan rotates normally. ➔ Ask your Fuji Electric representative to repair the motor's cooling fan.
Under V/f control (2) Excessive torque boost specified.	Check whether decreasing the torque boost (P35, A55, A155) decreases the output current but does not stall the motor. ➔ If no stall occurs, decrease the torque boost (P35, A55, A155).
Under V/f control (3) Continuous running in extremely slow speed.	Check the running speed of the inverter. ➔ Change the speed setting or replace the motor with an exclusive motor for inverters (motor with separately powered cooling fan).
(4) Overload.	Measure the inverter output current. ➔ Reduce the load. ➔ Increase the inverter capacity and motor capacity.
Under vector control with/without speed sensor (5) Function code settings do not agree with the motor characteristics.	For exclusive motors for the FRENIC-VG: Check whether the setting of function code P02 matches the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.
(6) Motor defective.	Check whether the inverter output voltages (U, V and W) are well-balanced. ➔ Repair or replace the motor.

[9] The motor does not run as expected.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of function code data.	Check that function codes are correctly configured and no unnecessary configuration has been done. ➔ Configure all the function codes correctly.
	Make a note of function code data currently configured and then initialize all function code data using H03. ➔ After the above process, reconfigure function codes one by one, checking the running status of the motor.
(2) Under torque control, the inverter keeps output although the run command is OFF.	Check the setting of the automatic operation OFF function (H11). ➔ Set the data of H11 to "2" ("Coast to a stop when a run command is turned OFF") or "4" ("Coast to a stop when a run command is turned OFF" under torque control).

[10] When the motor accelerates or decelerates, the speed is not stable.

Possible Causes	What to Check and Suggested Measures
Under vector control with/without speed sensor (1) The control constants of the automatic speed regulator (ASR) are inadequate.	Check whether the automatic speed regulator (ASR) is properly adjusted under speed control. ➔ Readjust the ASR (F61 to F66, C40 to C45, C50 to C55).

[11] The motor stalls during acceleration.

Possible Causes	What to Check and Suggested Measures
Under vector control with/without speed sensor (1) Function code settings do not agree with the motor characteristics.	For exclusive motors for the FRENIC-VG: Check whether the setting of function code P02 matches the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.
Under V/f control (2) The specified acceleration time is too short.	Check the data of F07, C35, C46, C56 or C66 (acceleration time). ➔ Increase the acceleration time.
Under V/f control (3) The moment of inertia of the load is large.	Measure the inverter output current. ➔ Decrease the moment of inertia of the load. ➔ Increase the inverter capacity.
Under V/f control (4) Large voltage drop on wires.	Check the terminal voltage of the motor. ➔ Use larger size wires between the inverter and motor or make the wiring distance shorter.
Under V/f control (5) The torque of the load is large.	Measure the output current. ➔ Decrease the torque of the load. ➔ Increase the inverter capacity.
Under V/f control (6) Torque generated by the motor was insufficient.	Check that increasing the torque boost (P35, A55, A155) starts the motor. ➔ Increase the value of the torque boost (P35, A55, A155).

[12] When the T-Link communications option is in use, neither a run command nor a speed command takes effect.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of the communications link operation (H30).	Check whether the setting of the communications link operation is correct (H30). ➔ Correct the data of H30. ➔ Check the status of the X terminal to which the ***LE*** command ("Enable communications link") is assigned.
(2) Incorrect setting of the transmission format (o32).	Check whether the setting of the transmission format is correct (o32). ➔ Correct the data of o32 (4W + 4W or 8W + 8W).
(3) Incorrect setting of the link number.	Check the current setting of the link number (that should be configured in hexadecimal). ➔ Review the function code list.
(4) Data not written to the I/O relay area as assigned.	Check the data held in the I/O relay area, using the MICREX loader. ➔ Investigate writing into the I/O relay area.

[13] When the SX-bus communications option is in use, neither a run command nor a speed command takes effect.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of the communications link operation (H30).	Check whether the setting of the communications link operation is correct (H30). ➔ Correct the data of H30.
(2) Terminal command ***LE*** is assigned to an X terminal, but the terminal is OFF.	Check the status of the X terminal to which the ***LE*** command ("Enable communications link") is assigned. ➔ Turn the corresponding X terminal ON.
(3) Incorrect setting of the transmission format (U11).	Check whether the transmission format selected by U11 is identical with the one selected in the system configuration definition. ➔ Correct the setting of the transmission format.
(4) Incorrect setting of the link number.	Check the current setting of the link number (that should be configured in hexadecimal). ➔ Review the function code list.
(5) Data not written to the I/O relay area as assigned.	Check the data in application programs, using the SX loader. ➔ Investigate writing into the I/O memory area.

[14] When the CC-Link communications option is in use, neither a run command nor a speed command takes effect.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of the communications link operation (H30).	Check whether the setting of the communications link operation is correct (H30). ➔ Correct the data of H30.
(2) Terminal command ***LE*** is assigned to an X terminal, but the terminal is OFF.	Check the status of the X terminal to which the ***LE*** command ("Enable communications link") is assigned. ➔ Turn the corresponding X terminal ON.
(3) Incorrect setting of the transmission format (o32).	Check whether the transmission format selected by o32 is identical with the one selected in the system configuration definition. ➔ Correct the setting of the transmission format.
(4) Incorrect setting of the link number.	Check the current setting of the link number (that should be configured in hexadecimal). ➔ Review the function code list.
(5) Data not written to the I/O memory area as assigned.	Check the data in application programs, using the PLC loader. ➔ Investigate writing into the I/O memory area.

[15] _ _ _ _ (under bar) appears.

Problem Although you pressed the FWD or REV key or entered a run forward command ***FWD*** or a run reverse command ***REV***, the motor did not start and an under bar (_ _ _ _) appeared on the LED monitor.

Possible Causes	What to Check and Suggested Measures
(1) The DC link bus voltage was low.	Select Menu #5 "MAINTENANCE" in Programming mode on the keypad and check the DC link bus voltage which should be 200 VDC or below for three-phase 200 V class series, and 400 VDC or below for three-phase 400 V class series. ➔ Connect the inverter to a power supply that meets its input specifications.
(2) The main power is not ON, while the auxiliary input power to the control circuit is supplied.	Check whether the main power is turned ON. ➔ Turn the main power ON. Check whether the short bar is removed from terminals P1 and P(+) or check the short bar for poor contact. ➔ Mount a short bar or DC reactor (DCR) between terminals P1 and P(+). Or tighten the fixing screw further.
(3) Although power is supplied not via the commercial power line but via the DC link bus, the main power down detection is enabled (H76 = 1).	Check the connection to the main power and check if the H76 data is set to "1" (factory default). ➔ Correct the data of H76.
(4) Breaks in wiring to the main power input terminals.	Measure the input voltage. ➔ Repair or replace the main circuit power input wires or input devices (MCCB, MC, etc.).

13.5.2 Problems with inverter settings

[1] Nothing appears on the monitors.

Possible Causes	What to Check and Suggested Measures
(1) No power (neither main power nor auxiliary control power) supplied to the inverter.	Check the input voltage and interphase voltage unbalance. ➔ Turn ON a molded case circuit breaker (MCCB), a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) or a magnetic contactor (MC). ➔ Check for voltage drop, phase loss, poor connections, or poor contacts and fix them if necessary.
(2) The power for the control PCB did not reach a sufficiently high level.	Check if the jumper bar has been removed from terminals P1 and P(+) or if there is a poor contact between the jumper bar and those terminals. ➔ Mount a jumper bar or a DC reactor between terminals P1 and P(+). For poor contact, tighten up the screws.
(3) The keypad was not properly connected to the inverter.	Check whether the keypad is properly connected to the inverter. ➔ Remove the keypad, put it back, and see whether the problem recurs. ➔ Replace the keypad with another one and check whether the problem recurs.
	When running the inverter remotely, ensure that the extension cable is securely connected both to the keypad and to the inverter. ➔ Disconnect the cable, reconnect it, and see whether the problem recurs. ➔ Replace the keypad with another one and check whether the problem per recurs.

[2] The desired function code does not appear.

Possible Causes	Check and Measures
(1) The function code is not located in the current directory.	Check whether the function code is located in a different directory. ➔ Display the function codes in the directory, referring to Chapter 3, Section 3.4.4 "Programming Mode." If o codes do not appear, check whether an option board is mounted. ➔ Display the function codes in the directory, referring to Chapter 3, Section 3.4.4 "Programming Mode." **Note:** No o codes appear unless an option board is mounted.

[3] Data of function codes cannot be changed <u>from the keypad</u>.

Possible Causes	What to Check and Suggested Measures
(1) An attempt was made to change function code data that cannot be changed when the inverter is running.	Check if the inverter is running with Menu #3 "OPR MNTR" using the keypad and then confirm whether the data of the function codes can be changed when the motor is running, referring to the function code tables. ➔ Stop the motor and then change the data of the function codes.
(2) The data of the function codes is protected.	Check the data of function code F00 (Data Protection). ➔ Change the data of F00 from "Enable data protection" (F00 = 1) to "Disable data protection" (F00 = 0).
(3) The ***WE-KP*** terminal command ("Enable data change with keypad") is not entered, though it has been assigned to a digital input terminal.	Check the data of function codes E01 through E09 and the input signal status with Menu #4 "I/O CHECK" using the keypad. ➔ Input a ***WE-KP*** command through a digital input terminal.
(4) The FUNC/DATA key was not pressed.	Check whether you have pressed the FUNC/DATA key after changing the function code data. ➔ Press the FUNC/DATA key after changing the function code data. ➔ Check that "STORING…" is displayed on the LCD monitor.
(5) The data of function codes F02 and E01 through E09 cannot be changed.	Either one of the ***FWD*** and ***REV*** terminal commands is turned ON. ➔ Turn OFF both ***FWD*** and ***REV***.

[4] Data of function codes cannot be changed <u>via the communications link</u>.

Possible Causes	What to Check and Suggested Measures
(1) An attempt was made to change function code data that cannot be changed when the inverter is running.	Check if the inverter is running with Menu #3 "OPR MNTR" using the keypad and then confirm whether the data of the function codes can be changed when the motor is running, referring to the function code tables. ➔ Stop the motor and then change the data of the function codes.
(2) The data of the function codes is protected.	Check the data of function code F00 (Data Protection). ➔ Change the data of F00 from "Enable data protection" (F00 = 1) to "Disable data protection" (F00 = 0).
(3) The ***WE-LK*** terminal command ("Enable data change via communications link") is not entered, though it has been assigned to a digital input terminal.	Check the data of function codes E01 through E09 and the input signal status with Menu #4 "I/O CHECK" using the keypad. ➔ Input a ***WE-LK*** command through a digital input terminal.
(4) The "Full save function" (H02) was not executed.	Check that the "Full save function" was executed (H02 = 1). ➔ If data of function codes is changed via the communications link, execute the "Full save function"; otherwise, turning the power OFF loses the changed data.
(5) The data of function code F02 cannot be changed.	Either one of the ***FWD*** and ***REV*** terminal commands is turned ON. ➔ Turn OFF both ***FWD*** and ***REV***.

Appendices

Contents

App. A Advantageous Use of Inverters (Notes on electrical noise)

- *Disclaimer: This document provides you with a summary of the Technical Document of the Japan Electrical Manufacturers' Association (JEMA) (December 2008). It is intended to apply to the domestic market only. It is only for reference for the foreign market.* -

A.1 Effect of inverters on other devices

Inverters have been and are rapidly expanding its application fields. This paper describes the effect that inverters have on electronic devices already installed or on devices installed in the same system as inverters, as well as introducing noise prevention measures. (Refer to Section A.3 [3], "Noise prevention examples" for details.)

[1] Effect on AM radios

Phenomenon	If an inverter operates, AM radios may pick up noise radiated from the inverter. (An inverter has almost no effect on FM radios or television sets.)
Probable cause	Radios may receive noise radiated from the inverter.
Countermeasures	Inserting a noise filter on the power supply side of the inverter is effective.

[2] Effect on telephones

Phenomenon	If an inverter operates, nearby telephones may pick up noise radiated from the inverter in conversation so that it may be difficult to hear.
Probable cause	A high-frequency leakage current radiated from the inverter and motors enters shielded telephone cables, causing noise.
Countermeasures	It is effective to commonly connect the grounding terminals of the motors and return the common grounding line to the grounding terminal of the inverter.

[3] Effect on pressure sensors

Phenomenon	If an inverter operates, pressure sensors may malfunction.
Probable cause	Noise may penetrate through a grounding wire into the signal line.
Countermeasures	It is effective to install a noise filter on the power supply side of the inverter or to separate the control circuit wirings from the I/O wires and grounding wires.

[4] Effect on position detectors (pulse encoders)

Phenomenon	If an inverter operates, pulse encoders may cause a malfunction that shifts the stop position of a machine.
Probable cause	Erroneous pulses are liable to occur when the signal lines of the PG and power lines are bundled together.
Countermeasures	The influence of induction noise and radiation noise can be reduced by separating the PG signal lines and power lines. Providing noise filters at the input and output terminals is also an effective measure.

[5] Effect on proximity switches

Phenomenon	If an inverter operates, proximity switches (capacitance-type) may malfunction.
Probable cause	The capacitance-type proximity switches may provide inferior noise immunity.
Countermeasures	It is effective to connect a filter to the input terminals of the inverter or implement grounding wiring with a capacitor on the 0 V side of the proximity switches. The proximity switches can be replaced with superior noise immunity types such as magnetic types.

A.2 Noise

This section gives a summary of noises generated in inverters and their effects on devices subject to noise.

[1] Inverter noise

Figure A.1 shows an outline of the inverter configuration. The inverter converts AC to DC (rectification) in a converter unit, and converts DC to AC (inversion) with 3-phase variable voltage and variable frequency. The conversion (inversion) is performed by PWM implemented by switching six transistors (IGBT: Insulated Gate Bipolar Transistor, etc), and is used for variable speed motor control.

Switching noise is generated by high-speed on/off switching of the six transistors. At each high-speed on/off switching, noise current (i) flows to the ground through stray capacitance (C) of the inverter, I/O wire and motor. The amount of the noise current is expressed as follows:

$$i = C \cdot dv/dt$$

It is related to the stray capacitance (C) and dv/dt (switching speed of the transistors). Further, this noise current is related to the carrier frequency since the noise current flows each time the transistors are switched on or off.

In addition to the main circuit of the inverter, the DC-to-DC switching power regulator (DC/DC converter), which is the power source for the control circuit of the inverter, may be a noise source in the same principles as stated above.

The frequency band of this noise over the range of several tens of MHz may affect communications devices such as AM radios, plant radios, and telephones.

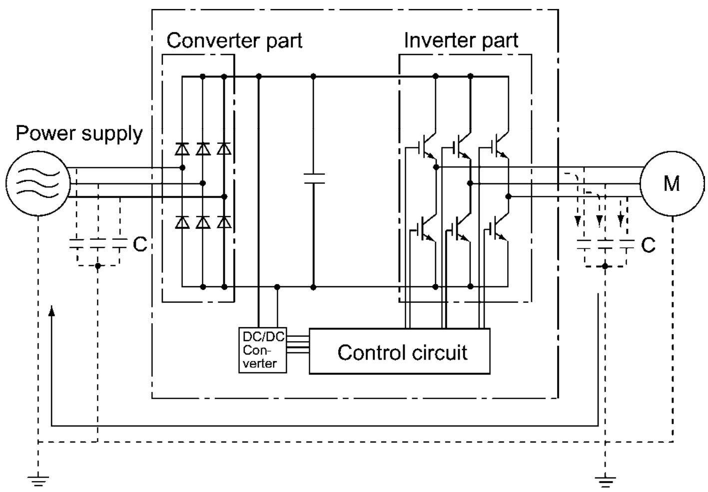


Figure A.1 Outline of Inverter Configuration

[2] Types of noise

Noise generated in an inverter is propagated through the main circuit wiring to the power supply and the motor so as to affect a wide range of applications from the power supply transformer to the motor. The various propagation routes are shown in Figure A.2. According to those routes, noises are roughly classified into three types--conduction noise, induction noise, and radiation noise.

Conduction noise propagates through routes 1) to 3), induction noise through route 4), and radiation noise through route 5). Details are described below.

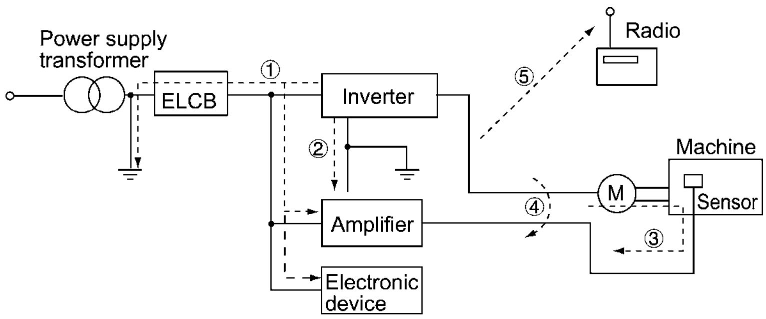


Figure A.2 Noise Propagation Routes

(1) Conduction noise

Noise generated in an inverter may propagate through the conductor and power supply so as to affect peripheral devices of the inverter (Figure A.3). This noise is called "conduction noise." Some conduction noises will propagate through the main circuit ①. If the ground wires are connected to a common ground, conduction noise will propagate through route ②. As shown in route ③, some conduction noises will propagate through signal lines or shielded wires.

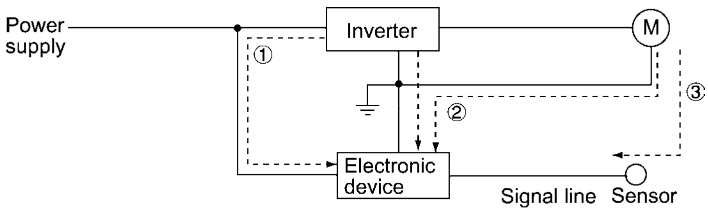


Figure A.3 Conduction Noise

(2) Induction noise

When wires or signal lines of peripheral devices are brought close to the wires on the input and output sides of the inverter through which noise current is flowing, noise will be induced into those wires and signal lines of the devices by electromagnetic induction (Figure A.4) or electrostatic induction (Figure A.5). This is called "induction noise" ④.

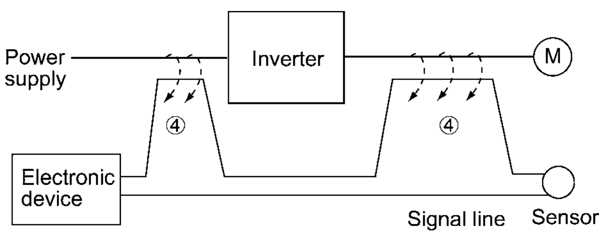


Figure A.4 Electromagnetic Induced Noise

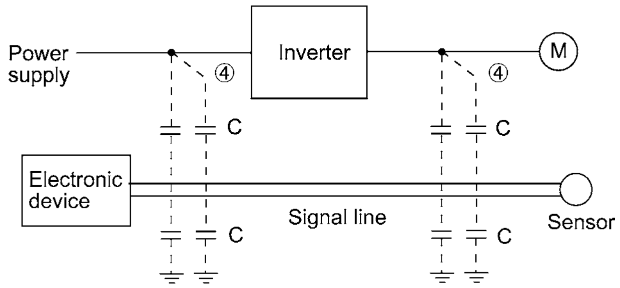


Figure A.5 Electrostatic Induced Noise

(3) Radiation noise

Noise generated in an inverter may be radiated through the air from main circuit wires or grounding wires (that act as antennas) at the input and output sides of the inverter so as to affect peripheral devices or broadcasting and radio-communications. This noise is called "radiation noise" ⑤ as shown below. Not only wires but motor frames or control system panels containing inverters may also act as antennas.

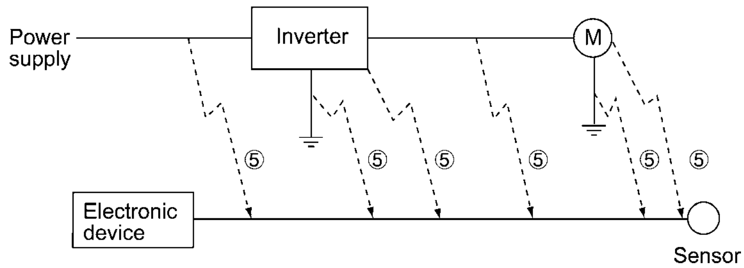


Figure A.6 Radiation Noise

A.3 Noise prevention

The more noise prevention is strengthened, the more effective. However, with the use of appropriate measures, noise problems may be resolved easily. It is necessary to implement economical noise prevention according to the noise level and the equipment conditions.

[1] Noise prevention prior to installation

Before installing an inverter in your control panel or installing an inverter panel, you need to consider noise prevention. Once noise problems occur, it will cost additional materials and time for solving them.

Noise prevention prior to installation includes:

1) Separating the wiring of main circuits and control circuits
2) Putting main circuit wiring into a metal conduit pipe
3) Using shielded wires or twisted shielded wires for control circuits.
4) Implementing appropriate grounding work and grounding wiring.

These noise prevention measures can avoid most noise problems.

[2] Implementation of noise prevention measures

There are two types of noise prevention measures--one for noise propagation routes and the other for noise receiving sides.

The basic measures for lessening the effect of noise at the receiving side include:

1) Separating the main circuit wiring from the control circuit wiring, avoiding noise effect.

The basic measures for lessening the effect of noise at the generating side include:

2) Inserting a noise filter that reduces the noise level.
3) Applying a metal conduit pipe or metal control panel that will confine noise, and
4) Applying an insulated transformer for the power supply that cuts off the noise propagation route.

Table A.1 lists the noise prevention measures, their purposes, and targeted propagation routes.

Table A.1 Noise Prevention Measures

Noise prevention method		Goal of noise prevention measures				Conduction route		
		Make it more difficult to receive noise	Cutoff noise conduc-tion	Confine noise	Reduce noise level	Conduc-tion noise	Induc-tion noise	Radia-tion noise
Wiring and installation	Separate main circuit from control circuit	Y					Y	
	Minimize wiring distance	Y			Y		Y	Y
	Avoid parallel and bundled wiring	Y					Y	
	Use appropriate grounding	Y			Y		Y	Y
	Use shielded wire and twisted shielded wire	Y					Y	Y
	Use shielded cable in main circuit			Y				Y
	Use metal conduit pipe			Y			Y	Y
Control panel	Appropriate arrangement of devices in panel	Y					Y	Y
	Metal control panel			Y			Y	Y
Anti-noise device	Line filter	Y			Y	Y		Y
	Insulation transformer		Y			Y		Y
Measures at noise receiving sides	Use a passive capacitor for control circuit	Y					Y	Y
	Use ferrite core for control circuit	Y					Y	Y
	Line filter	Y				Y		
Others	Separate power supply systems	Y	Y			Y		
	Lower the carrier frequency				Y	Y	Y	Y

Y: Effective, Blank: Not effective

App.

What follows is noise prevention measures for the inverter drive configuration.

(1) Wiring and grounding

As shown in Figure A.7, separate the main circuit wiring from control circuit wiring as far as possible regardless of being located inside or outside the system control panel containing an inverter. Use shielded wires and twisted shielded wires that will block out extraneous noises, and minimize the wiring distance. Also avoid bundled wiring of the main circuit and control circuit or parallel wiring.

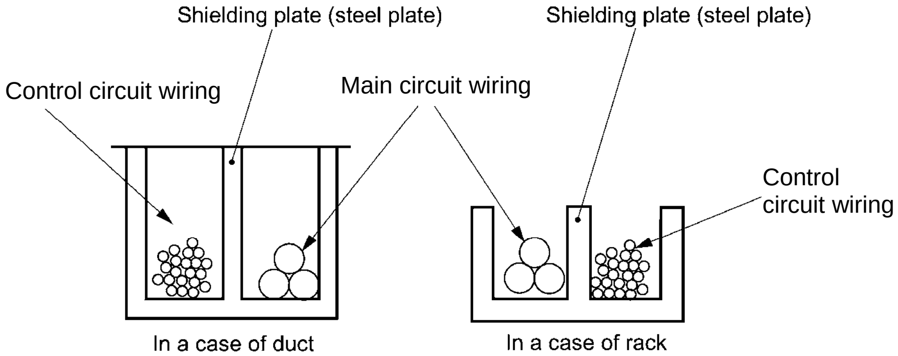


Figure A.7 Separate Wiring

For the main circuit wiring, use a metal conduit pipe and connect its wires to the ground to prevent noise propagation (refer to Figure A.8).

The shield (braided wire) of a shielded wire, in principle, should be connected to the base (common) side of the signal line at only one point to avoid the loop formation resulting from a multi-point connection (refer to Figure A.9).

The grounding is effective not only to reduce the risk of electrical shocks due to leakage current, but also to block noise penetration and radiation. Corresponding to the main circuit voltage, the grounding work should be Class C (300 to 600 VAC, grounding resistance: 10Ω or less) and Class D (300 VAC or less, grounding resistance: 100Ω or less). Each ground wire is to be provided with its own ground or separately wired to a grounding point.

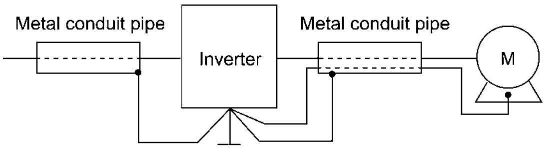


Figure A.8 Grounding of Metal Conduit Pipe

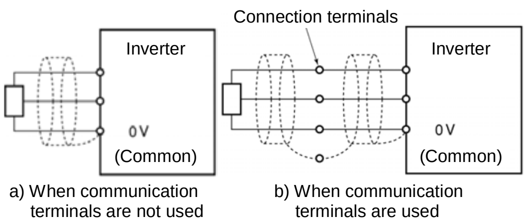


Figure A.9 Treatment of Braided Wire of Shielded Wire

(2) Control panel

The system control panel containing an inverter is generally made of metal, which can shield noise radiated from the inverter itself.

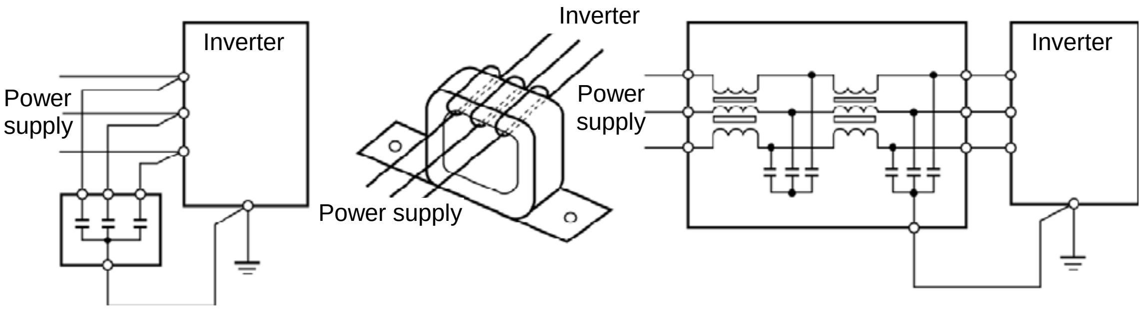
When installing other electronic devices such as a programmable logic controller in the same control panel, be careful with the layout of each device. If necessary, arrange shield plates between the inverter and peripheral devices.

(3) Anti-noise devices

To reduce the noise propagated through the electrical circuits and the noise radiated from the main circuit wiring to the air, a line filter and insulation transformer should be used (refer to Figure A.10).

Line filters are available in these types--the simplified type such as a capacitive filter to be connected in parallel to the power supply line and an inductive filter to be connected in series to the power supply line and the orthodox type such as an LC filter to meet noise regulations. Use them according to the targeted effect for reducing noise.

Insulation transformers include common insulated transformers, and shielded transformers. These transformers have different effectiveness in blocking noise propagation.



(a) Capacitive filter (b) Inductive filter (zero-phase reactor) (c) Input LC filter

Figure A.10 Various Filters and their Connection

(4) Noise prevention measures at the receiving side

It is important to strengthen the noise immunity of those electronic devices installed in the same control panel as the inverter or located near an inverter. Line filters, shielded or twisted shielded wires are used to block the penetration of noise in the control circuit wirings of these devices. The following treatments are also implemented.

1) Lower the circuit impedance by connecting capacitors or resistors to the input and output terminals of the signal circuit in parallel.
2) Increase the circuit impedance for noise by inserting choke coils in series in the signal circuit or passing signal lines through ferrite core beads. It is also effective to widen the signal base lines (0 V line) or grounding lines.

(5) Other

The level of generating/propagating noise will change with the carrier frequency of the inverter. The higher the carrier frequency, the higher the noise level.

In an inverter whose carrier frequency can be changed, lowering the carrier frequency can reduce the generation of electrical noise and result in a good balance with the audible noise of the motor under driving conditions.

[3] Noise prevention examples

Table A.2 lists examples of the measures to prevent noise generated by a running inverter.

Table A.2 Examples of Noise Prevention Measures

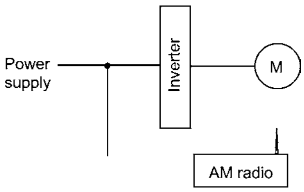
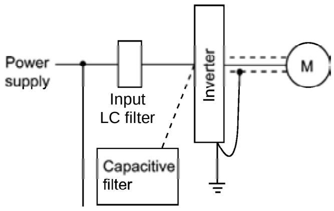
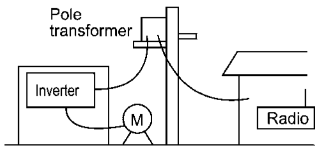
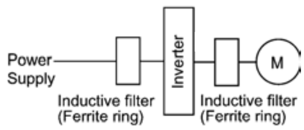
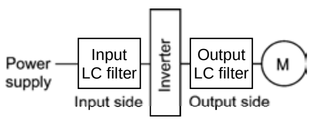
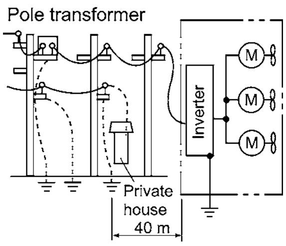
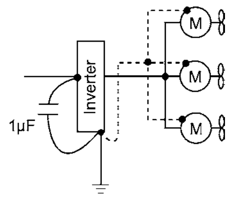
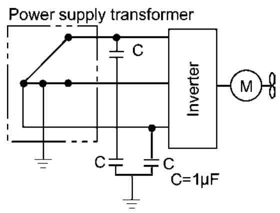
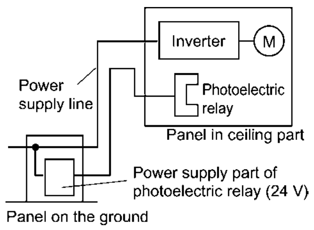
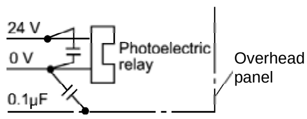
No.	Target device	Phenomena	Noise prevention measures	Notes
1	AM radio	When operating an inverter, noise enters into an AM radio broadcast (500 to 1500 kHz).  <Possible cause> The AM radio may receive noise radiated from wires at the power supply and output sides of the inverter.	1) Install an LC filter at the power supply side of the inverter. (In some cases, a capacitive filter may be used as a simple method.) 2) Install a metal conduit wiring between the motor and inverter.  Note: Minimize the distance between the input LC filter and inverter as short as possible (within 1 m).	1) The radiation noise of the wiring can be reduced. 2) The conduction noise to the power supply side can be reduced. Note: Sufficient improvement may not be expected in narrow regions such as between mountains.
2	AM radio	When operating an inverter, noise enters into an AM radio broadcast (500 to 1500 kHz).  <Possible cause> The AM radio may receive noise radiated from the power line at the power supply side of the inverter.	1) Install inductive filters at the input and output sides of the inverter.  The number of turns of the zero-phase reactor (or ferrite ring) should be as large as possible. In addition, wiring between the inverter and the zero-phase reactor (or ferrite ring) should be as short as possible. (within 1 m) 2) When further improvement is necessary, install LC filters. 	1) The radiation noise of the wiring can be reduced.

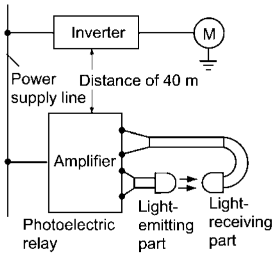
Table A.2 Continued

No.	Target device	Phenomena	Noise prevention measures	Notes
3	Tele-phone (in a common private residence at a distance of 40 m)	When driving a ventilation fan with an inverter, noise enters a telephone in a private residence at a distance of 40m.  <Possible cause> A high-frequency leakage current from the inverter and motor flowed to grounded part of the telephone cable shield. During the current's return trip, it flowed through a grounded pole transformer, and noise entered the telephone by electrostatic induction.	1) Connect the ground terminals of the motors in a common connection. Return to the inverter panel, and insert a 1 µF capacitor between the input terminal of the inverter and ground. 	1) The effect of the inductive filter and LC filter may not be expected because of sound frequency component. 2) In the case of a V-connection power supply transformer in a 200V system, it is necessary to connect capacitors as shown in the following figure, because of different potentials to ground. 
4	Photo-electric relay	A photoelectric relay malfunctioned when the inverter runs the motor. [The inverter and motor are installed in the same place (for overhead traveling)]  <Possible cause> It is considered that induction noise entered the photoelectric relay since the inverter's input power supply line and the photoelectric relay's wiring are in parallel separated by approximately 25 mm over a distance of 30 to 40 m. Due to conditions of the installation, these lines cannot be separated.	1) As a temporary measure, Insert a 0.1 µF capacitor between the 0 V terminal of the power supply circuit in the detection unit of the overhead photoelectric relay and the overhead frame.  2) As a permanent measure, move the 24 V power supply from the ground to the overhead unit so that signals are sent to the ground side with relay contacts in the ceiling part.	1) The wiring is separated by more than 30 cm. 2) When separation is impossible, signals can be received and sent with dry contacts etc. 3) Do not wire low-current signal lines and power lines in parallel.

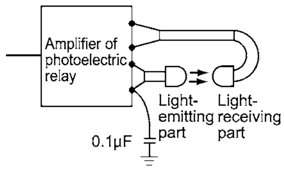
App.

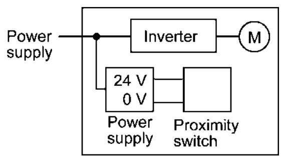
Table A.2   Continued

<table>
<tr><th>No.</th><th>Target device</th><th>Phenomena</th><th>Noise prevention measures</th><th>Notes</th></tr>
<tr><td>5</td><td>Photo-electric relay</td><td>A photoelectric relay malfunctioned when the inverter was operated.



<Possible cause>
Although the inverter and photoelectric relay are separated by a sufficient distance but the power supplies share a common connection, it is considered that conduction noise entered through the power supply line into the photoelectric relay.</td><td>1) Insert a 0.1 μF capacitor between the output common terminal of the amplifier of the photoelectric relay and the frame.


</td><td>1) If a low-current circuit at the malfunctioning side is observed, the measures may be simple and economical.</td></tr>
<tr><td>6</td><td>Prox-imity switch (capaci-tance type)</td><td>A proximity switch malfunctioned.



<Possible cause>
It is considered that the capacitance type proximity switch is susceptible to conduction and radiation noise because of its low noise immunity.</td><td>1) Install an LC filter at the output side of the inverter.
2) Install a capacitive filter at the input side of the inverter.
3) Ground the 0 V (common mode) line of the DC power supply of the proximity switch through a capacitor to the box body of the machine.

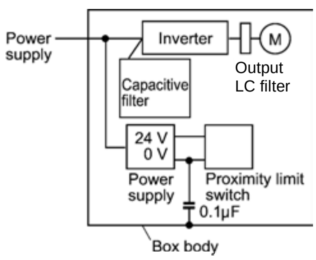
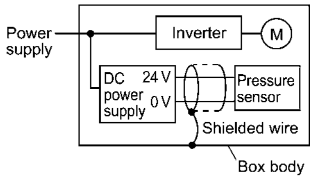
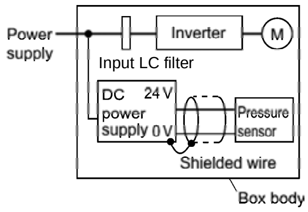
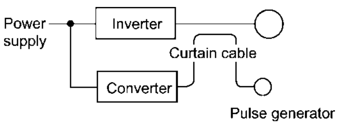
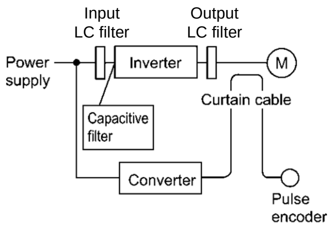
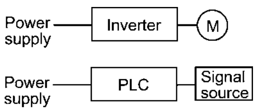
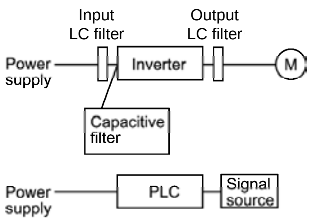

</td><td>1) Noise generated in the inverter can be reduced.
2) The switch is superseded by a proximity switch of superior noise immunity (such as a magnetic type).</td></tr>
</table>

Table A.2　Continued

No.	Target device	Phenomena	Noise prevention measures	Notes
7	Pressure sensor	A pressure sensor malfunctioned.  <Possible cause> The pressure sensor may malfunction due to noise that came from the box body through the shielded wire.	1) Install an LC filter on the input side of the inverter. 2) Connect the shield of the shielded wire of the pressure sensor to the 0 V line (common mode) of the pressure sensor, changing the original connection. 	1) The shielded parts of shield wires for sensor signals are connected to a common point in the system. 2) Conduction noise from the inverter can be reduced.
8	Position detector (pulse encoder)	Erroneous-pulse outputs from a pulse converter caused a shift in the stop position of a crane.  <Possible cause> Erroneous pulses may be outputted by induction noise since the power line of the motor and the signal line of the PG are bundled together.	1) Install an LC filter and a capacitive filter at the input side of the inverter. 2) Install an LC filter at the output side of the inverter. 	1) This is an example of a measure where the power line and signal line cannot be separated. 2) Induction noise and radiation noise at the output side of the inverter can be reduced.
9	Programmable logic controller (PLC)	The PLC program malfunctions.  <Possible cause> Since the power supply system is the same for the PLC (programmable logic controller) and inverter, it is considered that noise enters the PLC through the power supply.	1) Install a capacitive filter and an LC filter on the input side of the inverter. 2) Install an LC filter on the output side of the inverter. 3) Lower the carrier frequency of the inverter. 	1) Total conduction noise and induction noise in the electric line can be reduced.

App. B Japanese Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage

- Disclaimer: This document provides you with a translated summary of the Guideline of the Ministry of Economy, Trade and Industry. It is intended to apply to the domestic market only. It is only for reference for the foreign market. -

Agency of Natural Resource and Energy of Japan published the following two guidelines for suppressing harmonic noise in September 1994.

(1) Guideline for suppressing harmonics in home electric and general-purpose appliances

(2) Guideline for suppressing harmonics by customers receiving high voltage or special high voltage

Assuming that electronic devices generating high harmonics will be increasing, these guidelines are to establish regulations for preventing high frequency noise interference on devices sharing the power source. These guidelines should be applied to all devices that are used on the commercial power lines and generate harmonic current. This section gives a description limited to general-purpose inverters.

B.1 Application to general-purpose inverters

[1] Guideline for suppressing harmonics in home electric and general-purpose appliances

Our three-phase, 200 V class series inverters of 3.7 kW or less (FRENIC-MEGA series) were the products of which were restricted by the "Guideline for Suppressing Harmonics in Home Electric and General-purpose Appliances" (established in September 1994 and revised in October 1999) issued by the Ministry of Economy, Trade and Industry.

The above restriction, however, was lifted when the Guideline was revised in January 2004. Since then, the inverter makers have individually imposed voluntary restrictions on the harmonics of their products.

We, as before, recommend that you connect a reactor (for suppressing harmonics) to your inverter.

[2] Guideline for suppressing harmonics by customers receiving high voltage or special high voltage

Unlike other guidelines, this guideline is not applied to the equipment itself such as a general-purpose inverter, but is applied to each large-scale electric power consumer for total amount of harmonics. The consumer should calculate the harmonics generated from each piece of equipment currently used on the power source transformed and fed from the high or special high voltage source.

(1) Scope of regulation

In principle, the guideline applies to the customers that meet the following two conditions:

- The customer receives high voltage or special high voltage.
- The "equivalent capacity" of the converter load exceeds the standard value for the receiving voltage (50 kVA at a receiving voltage of 6.6 kV).

Appendix B.2 [1] "Calculation of equivalent capacity (Pi)" gives you some supplemental information with regard to estimation for the equivalent capacity of an inverter according to the guideline.

(2) Regulation

The level (calculated value) of the harmonic current that flows from the customer's receiving point out to the system is subjected to the regulation. The regulation value is proportional to the contract demand. The regulation values specified in the guideline are shown in Table B.1.

Appendix B.2 gives you some supplemental information with regard to estimation for the equivalent capacity of the inverter for compliance to "Japanese guideline for suppressing harmonics by customers receiving high voltage or special high voltage."

Table B.1 Upper Limits of Harmonic Outflow Current per kW of Contract Demand (mA/kW)

Receiving voltage	5th	7th	11th	13th	17th	19th	23rd	Over 25th
6.6 kV	3.5	2.5	1.6	1.3	1.0	0.90	0.76	0.70
22 kV	1.8	1.3	0.82	0.69	0.53	0.47	0.39	0.36

(3) When the regulation applied

The guideline has been applied. As the application, the estimation for "Voltage distortion factor" required as the indispensable conditions when entering into the consumer's contract of electric power is already expired.

B.2 Compliance to the harmonic suppression for customers receiving high voltage or special high voltage

When calculating the required matters related to inverters according to the guideline, follow the terms listed below. The following descriptions are based on "Technical document for suppressing harmonics" (JEAG 9702-1995) published by the Japan Electrical Manufacturer's Association (JEMA).

[1] Calculation of equivalent capacity (Pi)

The equivalent capacity (Pi) may be calculated using the equation of (input rated capacity) x (conversion factor). However, catalogs of conventional inverters do not contain input rated capacities, so a description of the input rated capacity is shown below:

(1) "Inverter rated capacity" corresponding to "Pi"

- In the guideline, the conversion factor of a 6-pulse converter is used as reference conversion factor 1. It is, therefore, necessary to express the rated input capacity of inverters in a value including harmonic component current equivalent to conversion factor 1.
- Calculate the input fundamental current I_1 from the kW rating and efficiency of the load motor, as well as the efficiency of the inverter. Then, calculate the input rated capacity as shown below:

$$\text{Input rated capacity} = \sqrt{3} \times (\text{power supply voltage}) \times I_1 \times 1.0228/1000 \text{ (kVA)}$$

where 1.0228 is the 6-pulse converter's value of (effective current)/(fundamental current).

- When a general-purpose motor or inverter motor is used, the appropriate value shown in Table B.2 can be used. Select a value based on the kW rating of the motor used, irrespective of the inverter type.

Note: The input rated capacity shown above is for the dedicated use in the equation to calculate capacity of the inverters, following the guideline. Note that the capacity cannot be applied to the reference for selection of the equipment or wires to be used in the inverter input circuits.

For selection of capacity for the peripheral equipment, refer to the catalogs or technical documents issued from their manufacturers.

Table B.2 "Input Rated Capacities" of General-purpose Inverters Determined by the Applicable Motor Ratings

Applicable motor rating (kW)		0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5
Pi (kVA)	200 V	0.57	0.97	1.95	2.81	4.61	6.77	9.07	13.1	17.6	21.8
	400 V	0.57	0.97	1.95	2.81	4.61	6.77	9.07	13.1	17.6	21.8

Applicable motor rating (kW)		22	30	37	45	55	75	90	110	132	160
Pi (kVA)	200 V	25.9	34.7	42.8	52.1	63.7	87.2	104	127		
	400 V	25.9	34.7	42.8	52.1	63.7	87.2	104	127	153	183

Applicable motor rating (kW)		200	220	250	280	315	355	400	450	500	630
Pi (kVA)	200 V										
	400 V	229	252	286	319	359	405	456	512	570	718

(2) Values of "Ki (conversion factor)"

Depending on whether an optional ACR (AC reactor) or DCR (DC reactor) is used, apply the appropriate conversion factor specified in the appendix to the guideline. The values of the conversion factor are listed in Table B.3.

Table B.3 "Conversion Factors Ki" for General-purpose Inverters Determined by Reactors

Circuit category	Circuit type		Conversion factor Ki	Main applications
3	3-phase bridge (capacitor smoothing)	w/o reactor	K31=3.4	• General-purpose inverters • Elevators • Refrigerators, air conditioning systems • Other general appliances
		w/- reactor (ACR)	K32=1.8	
		w/- reactor (DCR)	K33=1.8	
		w/- reactors (ACR and DCR)	K34=1.4	

Note: Some models are equipped with a reactor as a standard accessory.

[2] Calculation of Harmonic Current

(1) Value of "input fundamental current"

- When you calculate the amount of harmonics according to Table 2 in Appendix of the Guideline, you have to previously know the input fundamental current.
- Apply the appropriate value shown in Table B.4 based on the kW rating of the motor, irrespective of the inverter type or whether a reactor is used.

Note: If the input voltage is different, calculate the input fundamental current in inverse proportion to the voltage.

Table B.4 "Input Fundamental Currents" of General-purpose Inverters Determined by the Applicable Motor Ratings

Applicable motor rating (kW)		0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5
Input fundamental current (A)	200 V	1.62	2.74	5.50	7.92	13.0	19.1	25.6	36.9	49.8	61.4
	400 V	0.81	1.37	2.75	3.96	6.50	9.55	12.8	18.5	24.9	30.7
6.6 kV converted value (mA)		49	83	167	240	394	579	776	1121	1509	1860

Applicable motor rating (kW)		22	30	37	45	55	75	90	110	132	160
Input fundamental current (A)	200 V	73.1	98.0	121	147	180	245	293	357		
	400 V	36.6	49.0	60.4	73.5	89.9	123	147	179	216	258
6.6 kV converted value (mA)		2220	2970	73.5	4450	5450	7450	8910	10850	13090	15640

Applicable motor rating (kW)		200	220	250	280	315	355	400	450	500	630
Input fundamental current (A)	200 V										
	400 V	323	355	403	450	506	571	643	723	804	1013
6.6 kV converted value (mA)		19580	21500	24400	27300	30700	34600	39000	43800	48700	61400

(2) Calculation of harmonic current

Usually, calculate the harmonic current according to the Sub-table 3 "Three-phase bridge rectifier with the smoothing capacitor" in Table 2 of the Guideline's Appendix. Table B.5 lists the contents of the Sub-table 3.

Table B.5 Generated Harmonic Current (%), 3-phase Bridge Rectifier (Capacitor Smoothing)

Degree	5th	7th	11th	13th	17th	19th	23rd	25th
w/o a reactor	65	41	8.5	7.7	4.3	3.1	2.6	1.8
w/- a reactor (ACR)	38	14.5	7.4	3.4	3.2	1.9	1.7	1.3
w/- a reactor (DCR)	30	13	8.4	5.0	4.7	3.2	3.0	2.2
w/- reactors (ACR and DCR)	28	9.1	7.2	4.1	3.2	2.4	1.6	1.4

- ACR: 3%
- DCR: Accumulated energy equal to 0.08 to 0.15 ms (100% load conversion)
- Smoothing capacitor: Accumulated energy equal to 15 to 30 ms (100% load conversion)
- Load: 100%

Calculate the harmonic current of each degree using the following equation:

$$\text{nth harmonic current (A)} = \text{Fundamental current (A)} \times \frac{\text{Generated nth harmonic current (\%)}}{100}$$

(3) Maximum availability factor

- For a load for elevators, which provides intermittent operation, or a load with a sufficient designed motor rating, reduce the current by multiplying the equation by the "maximum availability factor" of the load.
- The "maximum availability factor of an appliance" means the ratio of the capacity of the harmonic generator in operation at which the availability reaches the maximum, to its total capacity, and the capacity of the generator in operation is an average for 30 minutes.
- In general, the maximum availability factor is calculated according to this definition, but the standard values shown in Table B.6 are recommended for inverters for building equipment.

Table B.6 Availability Factors of Inverters, etc. for Building Equipment (Standard Values)

Equipment type	Inverter capacity category	Single inverter availability
Air conditioning system	200 kW or less	0.55
	Over 200 kW	0.60
Sanitary pump	———	0.30
Elevator	———	0.25
Refrigerator, freezer	50 kW or less	0.60
UPS (6-pulse)	200 kVA	0.60

Correction coefficient according to contract demand level

Since the total availability factor decreases if the scale of a building increases, calculating reduced harmonics with the correction coefficient β defined in Table B.7 is permitted.

Table B.7 Correction Coefficient according to the Building Scale

Contract demand (kW)	Correction coefficient β
300	1.00
500	0.90
1000	0.85
2000	0.80

Note: If the contract demand is between two specified values listed in Table B.7, calculate the value by interpolation.

Note: The correction coefficient β is to be determined as a matter of consultation between the customer and electric power company for the customers receiving the electric power over 2000 kW or from the special high voltage lines.

(4) Degree of harmonics to be calculated

The higher the degree of harmonics, the lower the current flows. This is the property of harmonics generated by inverters so that the inverters are covered by "The case not causing a special hazard" of the term (3) in the above Appendix for the 9th or higher degrees of the harmonics.

Therefore, "It is sufficient that the 5th and 7th harmonic currents should be calculated."

[3] Examples of calculation

(1) Equivalent capacity

Example of loads	Input capacity and No. of inverters	Conversion factor	Equivalent capacity
[Example 1] 400 V, 3.7 kW, 10 units w/- AC reactor and DC reactor	4.61 kVA × 10 units	K32 = 1.4	4.61 × 10 × 1.4 = 64.54 kVA
[Example 2] 400 V, 1.5 kW, 15 units w/- AC reactor	2.93 kVA × 15 units	K34 = 1.8	2.93 × 15 × 1.8 = 79.11 kVA
	Refer to Table B.2.	Refer to Table B.3.	

(2) Harmonic current every degrees

[Example 1] 400 V, 3.7 kW 10 units, w/- AC reactor, and maximum availability: 0.55

Fundamental current onto 6.6 kV lines (mA)	Harmonic current onto 6.6 kV lines (mA)							
394 × 10 = 3940 3940 × 0.55 = 2167	5th (38%)	7th (14.5%)	11th (7.4%)	13th (3.4%)	17th (3.2%)	19th (1.9%)	23rd (1.7%)	25th (1.3%)
	823.5	314.2						
Refer to Tables B.4 and B.6.	Refer to Table B.5.							

[Example 2] 400 V, 3.7 kW, 15 units, w/- AC reactor and DC reactor, and maximum availability: 0.55

Fundamental current onto 6.6 kV lines (mA)	Harmonic current onto 6.6 kV lines (mA)							
394 × 15 = 5910 5910 × 0.55 = 3250.5	5th (28%)	7th (9.1%)	11th (7.2%)	13th (4.1%)	17th (3.2%)	19th (2.4%)	23rd (1.6%)	25th (1.4%)
	910.1	295.8						
Refer to Tables B.4 and B.6.	Refer to Table B.5.							

App. C Effect on Insulation of General-purpose Motors Driven with 400 V Class Inverters

- Disclaimer: This document provides you with a summary of the Technical Document of the Japan Electrical Manufacturers' Association (JEMA) (March, 1995). It is intended to apply to the domestic market only. It is only for reference for the foreign market. -

Preface

When an inverter drives a motor, surge voltages generated by switching the inverter elements are superimposed on the inverter output voltage and applied to the motor terminals. If the surge voltages are too high they may have an effect on the motor insulation and some cases have resulted in damage.

For preventing such cases this document describes the generating mechanism of the surge voltages and countermeasures against them.

📖 Refer to A.2 [1] "Inverter noise" for details of the principle of inverter operation.

C.1 Generating mechanism of surge voltages

As the inverter rectifies a commercial power source voltage and smoothes into a DC voltage, the magnitude E of the DC voltage becomes about $\sqrt{2}$ times that of the source voltage (about 620 V in case of an input voltage of 440 VAC). The peak value of the output voltage is usually close to this DC voltage value.

But, as there exists inductance (L) and stray capacitance (C) in wiring between the inverter and the motor, the voltage variation due to switching the inverter elements causes a surge voltage originating in LC resonance and results in the addition of high voltage to the motor terminals. (Refer to Figure C.1)

This voltage sometimes reaches up to about twice that of the inverter DC voltage (620 V x 2 = approximately 1,200 V) depending on a switching speed of the inverter elements and wiring conditions.

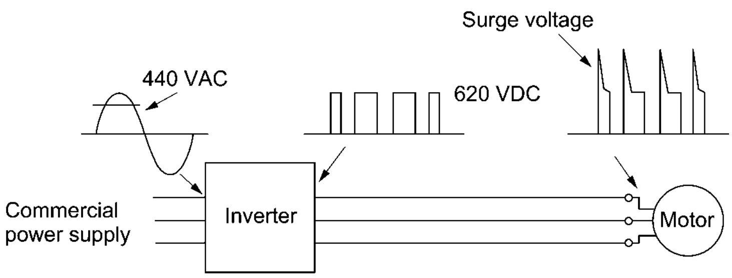
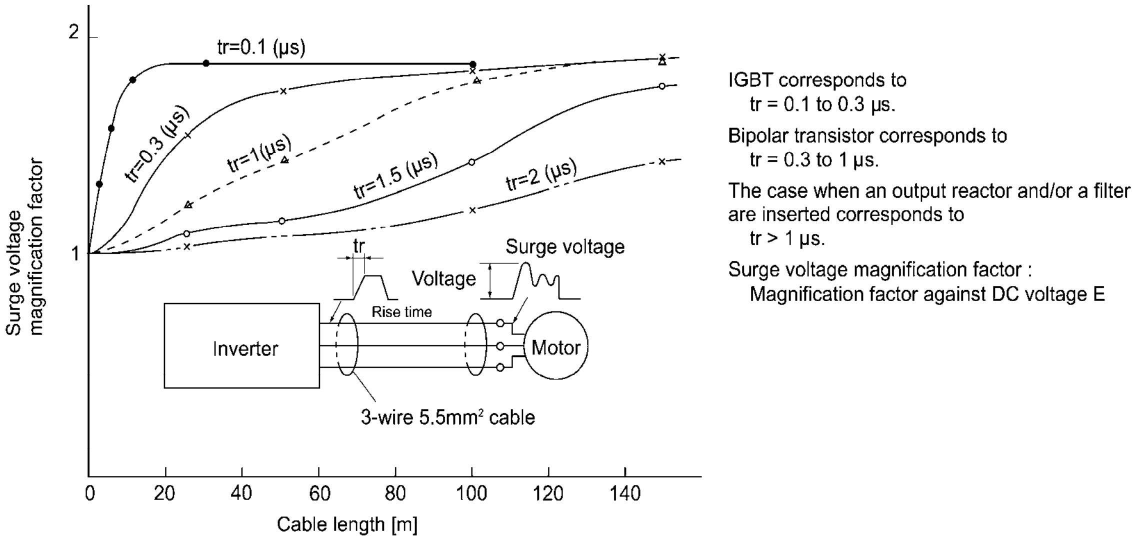


Figure C.1 Voltage Waveform of Individual Portions

A measured example in Figure C.2 illustrates the relation of a peak value of the motor terminal voltage with a wiring length between the inverter and the motor.

From this it can be confirmed that the peak value of the motor terminal voltage ascends as the wiring length increases and becomes saturated at about twice the inverter DC voltage.

The shorter a pulse rise time becomes, the higher the motor terminal voltage rises even in the case of a short wiring length.



Excerpt from [J. IEE Japan, Vol. 107, No. 7, 1987]

Figure C.2 Measured Example of Wiring Length and Peak Value of Motor Terminal Voltage

C.2 Effect of surge voltages

The surge voltages originating in LC resonance of wiring may be applied to the motor terminals and depending on their magnitude sometimes cause damage to the motor insulation.

When the motor is driven with a 200 V class inverter, the dielectric strength of the insulation is no problem since the peak value at the motor terminal voltage increases twice due to the surge voltages (the DC voltage is only about 300 V).

But in case of a 400 V class inverter, the DC voltage is approximately 600 V and depending on the wiring length, the surge voltages may greatly increase and sometimes result in damage to the insulation.

App.

C.3 Countermeasures against surge voltages

When driving a motor with a 400 V class inverter, the following are countermeasures against damage to the motor insulation by the surge voltages.

[1] Using a surge suppressor unit, SSU

The surge suppressor unit (SSU) is a newly structured unit using circuits based on the impedance-matching theory of a transmission line. Just connecting the SSU to the surge suppressor cable of the existing equipment can greatly reduce the surge voltage that results in a motor dielectric breakdown.

For 50 m of wiring length: SSU 50TA-NS

For 100 m of wiring length: SSU 100TA-NS

[2] Suppressing surge voltages

There are two ways for suppressing the surge voltages, one is to reduce the voltage rise time and another is to reduce the voltage peak value.

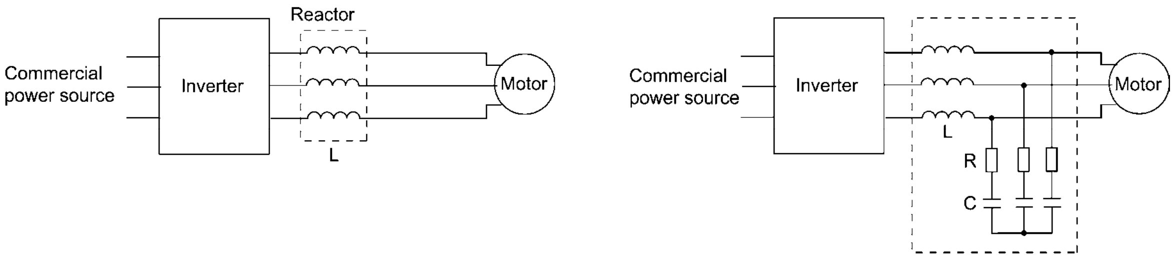
(1) Output reactor

If wiring length is relatively short, the surge voltages can be suppressed by reducing the voltage rise time (dv/dt) with the installation of an AC reactor on the output side of the inverter. (Refer to Figure C.3 (1).)

However, if the wiring length becomes long, suppressing the peak voltage due to surge voltage may be difficult.

(2) Output filter

Installing a filter on the output side of the inverter allows a peak value of the motor terminal voltage to be reduced. (Refer to Figure C.3 (2).)



(1) Output reactor   (2) Output filter

Figure C.3 Method to Suppress Surge Voltage

Tip: If the wiring length between the inverter and the motor is comparatively long, the crest value of the surge voltage can be suppressed by connecting a surge suppressor unit (SSU) to the motor terminal. For details, refer to Chapter 8, Section 8.5.1.4 "Surge suppression unit (SSU)."

[3] Using motors with enhanced insulation

Enhanced insulation of a motor winding allows its surge withstanding to be improved.

C.4 Regarding existing equipment

[1] In case of a motor being driven with 400 V class inverter

A survey over the last five years on motor insulation damage due to the surge voltages originating from switching of inverter elements shows that the damage incidence is 0.013% under the surge voltage condition of over 1,100 V and most of the damage occurs several months after commissioning the inverter. Therefore there seems to be little probability of occurrence of motor insulation damage after a lapse of several months of commissioning.

[2] In case of an existing motor driven using a newly installed 400 V class inverter

We recommend suppressing the surge voltages with the ways shown in Section C.3.

App. D Inverter Generating Loss

The table below lists the inverter generating loss.

●HD specification generating loss

Power supply voltage	Standard applicable motor capacity [kW]	Inverter type	Low carrier		Medium carrier (At time of F26 factory default setting)	High carrier	
			F26 [kHz]	Generating loss [W]	Generating loss [W]	F26 [kHz]	Generating loss [W]
Three-phase 200 V	0.75	FRN0.75VG1S-2J	2	70	95	15	100
	1.5	FRN1.5VG1S-2J	2	100	125	15	130
	2.2	FRN2.2VG1S-2J	2	130	165	15	170
	3.7	FRN3.7VG1S-2J	2	190	245	15	260
	5.5	FRN5.5VG1S-2J	2	240	295	15	310
	7.5	FRN7.5VG1S-2J	2	300	390	15	415
	11	FRN11VG1S-2J	2	450	580	15	620
	15	FRN15VG1S-2J	2	540	670	15	700
	18.5	FRN18.5VG1S-2J	2	660	825	15	860
	22	FRN22VG1S-2J	2	790	995	15	1040
	30	FRN30VG1S-2J	2	1300	1400	15	1450
	37	FRN37VG1S-2J	2	1300	1500	15	1550
	45	FRN45VG1S-2J	2	1450	1600	15	1600
	55	FRN55VG1S-2J	2	1750	1900	15	1900
	75	FRN75VG1S-2J	2	2300	2450	10	2550
	90	FRN90VG1S-2J	2	2750	2900	10	3050
Three-phase 400 V	3.7	FRN3.7VG1S-4J	2	150	215	15	230
	5.5	FRN5.5VG1S-4J	2	170	280	15	300
	7.5	FRN7.5VG1S-4J	2	230	375	15	400
	11	FRN11VG1S-4J	2	300	480	15	520
	15	FRN15VG1S-4J	2	360	560	15	610
	18.5	FRN18.5VG1S-4J	2	440	715	15	770
	22	FRN22VG1S-4J	2	510	835	15	900
	30	FRN30VG1S-4J	2	850	1100	15	1150
	37	FRN37VG1S-4J	2	1050	1400	15	1450
	45	FRN45VG1S-4J	2	1150	1500	15	1600
	55	FRN55VG1S-4J	2	1400	1850	15	1950
	75	FRN75VG1S-4J	2	1750	1950	10 *1	2150
	90	FRN90VG1S-4J	2	2000	2350	10 *1	2600
	110	FRN110VG1S-4J	2	2400	2750	10 *1	3050
	132	FRN132VG1S-4J	2	2650	3000	10 *1	3300
	160	FRN160VG1S-4J	2	3200	3650	10 *1	4000
	200	FRN200VG1S-4J	2	4000	4550	10 *1	5000
	220	FRN220VG1S-4J	2	4500	5100	10 *1	5600
	280	FRN280VG1S-4J	2	5500	6300	10 *1	6900
	315	FRN315VG1S-4J	2	6250	7100	10 *1	7800
	355	FRN355VG1S-4J	2	6750	7650	10 *1	8450
	400	FRN400VG1S-4J	2	7650	8750	10 *1	9650
	500	FRN500VG1S-4J	2	9950	10700	5 *1	10700
	630	FRN630VG1S-4J	2	12350	13300	5 *1	13300

(*1) If the generating loss set in F26 exceeds the value specified in this table, it is set to the same generating loss as that applied with the high carrier set regardless of the value in F26.

App.

●LD specification generating loss

Power supply voltage	Standard applicable motor capacity [kW]	Inverter type	Low carrier		Medium carrier (At time of F26 factory default setting)	High carrier	
			F26 [kHz]	Generating loss [W]	Generating loss [W]	F26 [kHz]	Generating loss [W]
Three-phase 200 V	37	FRN30VG1S-2J	2	1650	1650	10 *1	1750
	45	FRN37VG1S-2J	2	1650	1650	10 *1	1850
	55	FRN45VG1S-2J	2	1850	1850	10 *1	1950
	75	FRN55VG1S-2J	2	2250	2300	10 *1	2400
	90	FRN75VG1S-2J	2	2700	2800	5 *1	2800
	110	FRN90VG1S-2J	2	3250	3350	5 *1	3350
Three-phase 400 V	37	FRN30VG1S-4J	2	1050	1050	10 *1	1250
	45	FRN37VG1S-4J	2	1300	1300	10 *1	1550
	55	FRN45VG1S-4J	2	1400	1400	10 *1	1700
	75	FRN55VG1S-4J	2	2000	2400	5 *1	2400
	90	FRN75VG1S-4J	2	2100	2250	5 *1	2250
	110	FRN90VG1S-4J	2	2350	2250	5 *1	2250
	132	FRN110VG1S-4J	2	2850	3050	5 *1	3050
	160	FRN132VG1S-4J	2	3150	3400	5 *1	3400
	200	FRN160VG1S-4J	2	4050	4350	5 *1	4350
	220	FRN200VG1S-4J	2	4400	4750	5 *1	4750
	280	FRN220VG1S-4J	2	5850	6200	5 *1	6200
	355	FRN280VG1S-4J	2	6750	7300	5 *1	7300
	400	FRN315VG1S-4J	2	7800	8350	5 *1	8350
	450	FRN355VG1S-4J	2	8450	9100	5 *1	9100
	500	FRN400VG1S-4J	2	9600	10350	5 *1	10350
	630	FRN500VG1S-4J	2	12050	12950	5 *1	12950
	710	FRN630VG1S-4J	2	13500	13500	-	-

(*1) If the generating loss set in F26 exceeds the value specified in this table, it is set to the same generating loss as that applied with the high carrier set regardless of the value in F26.

●MD specification generating loss

Power supply voltage	Standard applicable motor capacity [kW]	Inverter type	Low carrier (At time of F26 factory default setting)	Medium carrier	
			Generating loss [W]	F26 [kHz]	Generating loss [W]
Three-phase 400 V	110	FRN90VG1S-4J	2250	-	-
	132	FRN110VG1S-4J	2700	-	-
	160	FRN132VG1S-4J	3050	-	-
	200	FRN160VG1S-4J	3900	-	-
	220	FRN200VG1S-4J	4250	-	-
	250	FRN220VG1S-4J	4850	-	-
	315	FRN280VG1S-4J	5850	-	-
	355	FRN315VG1S-4J	6650	-	-
	400	FRN355VG1S-4J	7250	-	-
	450	FRN400VG1S-4J	8250	-	-

App. E Conversion from SI Units

All expressions given in Chapter 3, "SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES" are based on SI units (The International System of Units). This section explains how to convert expressions to other units.

[1] Conversion of units

(1) Force

- 1 (kgf) ≈ 9.8 (N)
- 1 (N) ≈ 0.102 (kgf)

(2) Torque

- 1 (kgf·m) ≈ 9.8 (N·m)
- 1 (N·m) ≈ 0.102 (kgf·m)

(3) Work and energy

- 1 (kgf·m) ≈ 9.8 (N·m) = 9.8(J)
  = 9.8 (W·s)

(4) Power

- 1 (kgf·m/s) ≈ 9.8 (N·m/s) = 9.8 (J/s)
  = 9.8(W)
- 1 (N·m/s) ≈ 1 (J/s) = 1 (W)
  ≈ 0.102 (kgf·m/s)

(5) Rotation speed

- $1\,(\mathrm{r/min}) = \frac{2\pi}{60}\,(\mathrm{rad/s}) \approx 0.1047\,(\mathrm{rad/s})$
- $1\,(\mathrm{rad/s}) = \frac{60}{2\pi}\,(\mathrm{r/min}) \approx 9.549\,(\mathrm{r/min})$

(6) Inertia constant

J (kg·m^2) : moment of inertia
GD^2 (kg·m^2) : flywheel effect

- GD^2 = 4 J
- $J = \frac{GD^2}{4}$

(7) Pressure and stress

- 1 (mmAq) ≈ 9.8 (Pa) ≈ 9.8 (N/m^2)
- 1(Pa) ≈ 1(N/m^2) ≈ 0.102 (mmAq)
- 1 (bar) ≈ 100000 (Pa) ≈ 1.02 (kg·cm^2)
- 1 (kg·cm^2) ≈ 98000 (Pa) ≈ 980 (mbar)
- 1 atmospheric pressure = 1013 (mbar)
  = 760 (mmHg) = 101300 (Pa)
  ≈ 1.033 (kg/cm^2)

App.

[2] Calculation formula

(1) Torque, power, and rotation speed

- $P\ (\mathrm{W}) \approx \dfrac{2\pi}{60} \cdot N\ (\mathrm{r/min}) \cdot \tau\ (\mathrm{N \cdot m})$
- $P\ (\mathrm{W}) \approx 1.026 \cdot N\ (\mathrm{r/min}) \cdot T\ (\mathrm{kgf \cdot m})$
- $\tau\ (\mathrm{N \cdot m}) \approx 9.55 \cdot \dfrac{P\ (\mathrm{W})}{N\ (\mathrm{r/min})}$
- $T\ (\mathrm{kgf \cdot m}) \approx 0.974 \cdot \dfrac{P\ (\mathrm{W})}{N\ (\mathrm{r/min})}$

(2) Kinetic energy

- $E\ (\mathrm{J}) \approx \dfrac{1}{182.4} \cdot J\ (\mathrm{kg \cdot m^2}) \cdot N^2\ [(\mathrm{r/min})^2]$
- $E\ (\mathrm{J}) \approx \dfrac{1}{730} \cdot GD^2\ (\mathrm{kg \cdot m^2}) \cdot N^2\ [(\mathrm{r/min})^2]$

(3) Torque of linear moving load

<u>Driving mode</u>

- $\tau\ (\mathrm{N \cdot m}) \approx 0.159 \cdot \dfrac{V\ (\mathrm{m/min})}{N_M\ (\mathrm{r/min}) \cdot \eta_G} \cdot F\ (\mathrm{N})$
- $T\ (\mathrm{kgf \cdot m}) \approx 0.159 \cdot \dfrac{V\ (\mathrm{m/min})}{N_M\ (\mathrm{r/min}) \cdot \eta_G} \cdot F\ (\mathrm{kgf})$

<u>Braking mode</u>

- $\tau\ (\mathrm{N \cdot m}) \approx 0.159 \cdot \dfrac{V\ (\mathrm{m/min})}{N_M\ (\mathrm{r/min}) / \eta_G} \cdot F\ (\mathrm{N})$
- $T\ (\mathrm{kgf \cdot m}) \approx 0.159 \cdot \dfrac{V\ (\mathrm{m/min})}{N_M\ (\mathrm{r/min}) / \eta_G} \cdot F\ (\mathrm{kgf})$

(4) Acceleration torque

<u>Driving mode</u>

- $\tau\ (\mathrm{N \cdot m}) \approx \dfrac{J\ (\mathrm{kg \cdot m^2})}{9.55} \cdot \dfrac{\Delta N\ (\mathrm{r/min})}{\Delta t\ (\mathrm{s}) \cdot \eta_G}$
- $T\ (\mathrm{kgf \cdot m}) \approx \dfrac{GD^2\ (\mathrm{kg \cdot m^2})}{375} \cdot \dfrac{\Delta N\ (\mathrm{r/min})}{\Delta t\ (\mathrm{s}) \cdot \eta_G}$

<u>Braking mode</u>

- $\tau\ (\mathrm{N \cdot m}) \approx \dfrac{J\ (\mathrm{kg \cdot m^2})}{9.55} \cdot \dfrac{\Delta N\ (\mathrm{r/min}) \cdot \eta_G}{\Delta t\ (\mathrm{s})}$
- $T\ (\mathrm{kgf \cdot m}) \approx \dfrac{GD^2\ (\mathrm{kg \cdot m^2})}{375} \cdot \dfrac{\Delta N\ (\mathrm{r/min}) \cdot \eta_G}{\Delta t\ (\mathrm{s})}$

(5) Acceleration time

- $t_{ACC}\ (\mathrm{s}) \approx \dfrac{J_1 + J_2 / \eta_G\ (\mathrm{kg \cdot m^2})}{\tau_M - \tau_L / \eta_G\ (\mathrm{N \cdot m})} \cdot \dfrac{\Delta N\ (\mathrm{r/min})}{9.55}$
- $t_{ACC}\ (\mathrm{s}) \approx \dfrac{GD_1^2 + GD_2^2 / \eta_G\ (\mathrm{kg \cdot m^2})}{T_M - T_L / \eta_G\ (\mathrm{kgf \cdot m})} \cdot \dfrac{\Delta N\ (\mathrm{r/min})}{375}$

(6) Deceleration time

- $t_{DEC}\ (\mathrm{s}) \approx \dfrac{J_1 + J_2 \cdot \eta_G\ (\mathrm{kg \cdot m^2})}{\tau_M - \tau_L \cdot \eta_G\ (\mathrm{N \cdot m})} \cdot \dfrac{\Delta N\ (\mathrm{r/min})}{9.55}$
- $t_{DEC}\ (\mathrm{s}) \approx \dfrac{GD_1^2 + GD_2^2 \cdot \eta_G\ (\mathrm{kg \cdot m^2})}{T_M - T_L \cdot \eta_G\ (\mathrm{kgf \cdot m})} \cdot \dfrac{\Delta N\ (\mathrm{r/min})}{375}$

App. F Allowable Current of Insulated Wires

The tables below list the allowable current of IV wires, HIV wires, and 600 V cross-linked polyethylene insulated wires.

■ IV wires (Maximum allowable temperature: 60°C)

Table F.1 (a) Allowable Current of Insulated Wires

	Allowable current	Aerial wiring					Wiring in the duct (Max. 3 wires in one duct)			
Wire size	reference value	35°C	40°C	45°C	50°C	55°C	35°C	40°C	45°C	50°C
(mm^2)	(up to 30°C)	(Io×0.91)	(Io×0.82)	(Io×0.71)	(Io×0.58)	(Io×0.40)	(Io×0.63)	(Io×0.57)	(Io×0.49)	(Io×0.40)
	Io (A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
2.0	27	24	22	19	15	11	17	15	13	10
3.5	37	33	30	26	21	15	23	21	18	14
5.5	49	44	40	34	28	20	30	27	24	19
8.0	61	55	50	43	35	25	38	34	29	24
14	88	80	72	62	51	36	55	50	43	35
22	115	104	94	81	66	47	72	65	56	46
38	162	147	132	115	93	66	102	92	79	64
60	217	197	177	154	125	88	136	123	106	86
100	298	271	244	211	172	122	187	169	146	119
150	395	359	323	280	229	161	248	225	193	158
200	469	426	384	332	272	192	295	267	229	187
250	556	505	455	394	322	227	350	316	272	222
325	650	591	533	461	377	266	409	370	318	260
400	745	677	610	528	432	305	469	424	365	298
500	842	766	690	597	488	345	530	479	412	336
2 x 100	497	452	407	352	288	203	313	283	243	198
2 x 150	658	598	539	467	381	269	414	375	322	263
2 x 200	782	711	641	555	453	320	492	445	383	312
2 x 250	927	843	760	658	537	380	584	528	454	370
2 x 325	1083	985	888	768	628	444	682	617	530	433
2 x 400	1242	1130	1018	881	720	509	782	707	608	496
2 x 500	1403	1276	1150	996	813	575	883	799	687	561

■ HIV wires (Maximum allowable temperature: 75°C)

Table F.1 (b) Allowable Current of Insulated Wires

	Allowable current	Aerial wiring					Wiring in the duct (Max. 3 wires in one duct)			
Wire size	reference value	35°C	40°C	45°C	50°C	55°C	35°C	40°C	45°C	50°C
(mm^2)	(up to 30°C)	(Io×0.91)	(Io×0.82)	(Io×0.71)	(Io×0.58)	(Io×0.40)	(Io×0.63)	(Io×0.57)	(Io×0.49)	(Io×0.40)
	Io (A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)	(A)
2.0	32	31	29	27	24	22	21	20	18	17
3.5	45	42	39	37	33	30	29	27	25	23
5.5	59	56	52	49	44	40	39	36	34	30
8.0	74	70	65	61	55	50	48	45	42	38
14	107	101	95	88	80	72	70	66	61	55
22	140	132	124	115	104	94	92	86	80	72
38	197	186	174	162	147	132	129	121	113	102
60	264	249	234	217	197	177	173	162	151	136
100	363	342	321	298	271	244	238	223	208	187
150	481	454	426	395	359	323	316	296	276	248
200	572	539	506	469	426	384	375	351	328	295
250	678	639	600	556	505	455	444	417	389	350
325	793	747	702	650	591	533	520	487	455	409
400	908	856	804	745	677	610	596	558	521	469
500	1027	968	909	842	766	690	673	631	589	530
2 x 100	606	571	536	497	452	407	397	372	347	313
2 x 150	802	756	710	658	598	539	526	493	460	414
2 x 200	954	899	844	782	711	641	625	586	547	492
2 x 250	1130	1066	1001	927	843	760	741	695	648	584
2 x 325	1321	1245	1169	1083	985	888	866	812	758	682
2 x 400	1515	1428	1341	1242	1130	1018	993	931	869	782
2 x 500	1711	1613	1515	1403	1276	1150	1122	1052	982	883

■ 600 V Cross-linked Polyethylene Insulated wires (Maximum allowable temperature: 90°C)

Table F.1 (c) Allowable Current of Insulated Wires

Wire size (mm^2)	Allowable current reference value (up to 30°C) Io (A)	Aerial wiring					Wiring in the duct (Max. 3 wires in one duct)			
		35°C (Io×0.91) (A)	40°C (Io×0.82) (A)	45°C (Io×0.71) (A)	50°C (Io×0.58) (A)	55°C (Io×0.40) (A)	35°C (Io×0.63) (A)	40°C (Io×0.57) (A)	45°C (Io×0.49) (A)	50°C (Io×0.40) (A)
2.0	38	36	34	32	31	29	25	24	22	21
3.5	52	49	47	45	42	39	34	33	31	29
5.5	69	66	63	59	56	52	46	44	41	39
8.0	86	82	78	74	70	65	57	54	51	48
14	124	118	113	107	101	95	82	79	74	70
22	162	155	148	140	132	124	108	103	97	92
38	228	218	208	197	186	174	152	145	137	129
60	305	292	279	264	249	234	203	195	184	173
100	420	402	384	363	342	321	280	268	253	238
150	556	533	509	481	454	426	371	355	335	316
200	661	633	605	572	539	506	440	422	398	375
250	783	750	717	678	639	600	522	500	472	444
325	916	877	838	793	747	702	611	585	552	520
400	1050	1005	961	908	856	804	700	670	633	596
500	1187	1136	1086	1027	968	909	791	757	715	673
2 x 100	700	670	641	606	571	536	467	447	422	397
2 x 150	927	888	848	802	756	710	618	592	559	526
2 x 200	1102	1055	1008	954	899	844	735	703	664	625
2 x 250	1307	1251	1195	1130	1066	1001	871	834	787	741
2 x 325	1527	1462	1397	1321	1245	1169	1018	974	920	866
2 x 400	1751	1676	1602	1515	1428	1341	1167	1117	1055	993
2 x 500	1978	1894	1809	1711	1613	1515	1318	1262	1192	1122

High Performance, Vector Control Inverter

FRENIC-VG

User's Manual

First Edition, July 2012

Fuji Electric Co., Ltd.

The purpose of this manual is to provide accurate information in the handling, setting up and operating of the FRENIC-VG series of inverters. Please feel free to send your comments regarding any errors or omissions you may have found, or any suggestions you may have for generally improving the manual.