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BRISBANE CITY COUNCIL

CONTRACT BW70103~017

PUMP STATION SWITCHBOARD REPLACEMENT

SP 168 DURANTA STREET

OPERATION AND MAINTENANCE MANUALS

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Ref: z:\office\2009\word\090713.doc

13 July 2009

Brisbane City Council – Water Distribution
P.O. Box 745,
FORTITUDE VALLEY QLD 4006

ATTENTION: Wendy Wong

Dear Wendy,

RE: <u>CONTRACT NO. BW70103-017</u>
<u>PUMP STATION SWITCHBOARD REPLACEMENT</u>
<u>SP168 DURANTA STREET</u>

Please find attached 2 x copies of the operation and maintenance manuals together with 1 x electronic copy for the above contract.

If you have any queries please contact me.

Yours faithfully,

Shayne Farrelly
WHELAN ELECTRICAL SERVICES
<u>1 HARVEST STREET, YANDINA QLD 4561</u>

QUALITY ASSURED SUPPLIER
QLD GOVERNMENT
CERT. NO. 1052

Water & Sewerage Pumping Specialists Electrical Contractors Switchboard Manufacturing Engineering Contractors

BRISBANE CITY COUNCIL

CONTRACT BW70103-017
PUMP STATION SWITCHBOARD REPLACEMENT
SP168 DURANTA STREET

Supply and Installation of Switchboard

Our Job No. 0908

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2. **GRAPHIC DISPLAY**
3. **RADIO**
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By - Whelan Electrical Services Pty Ltd
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Ref:MANUAL.0908

Emotron MSF 2.0
Serial Communication Option

Instruction manual
English

emotron
DEDICATED DRIVE

Valid for the following models:
EMOTRON Modbus RTU

Serial Communication Option

Instruction Manual - English

Document number: 01-3853-01
Edition: r1
Date of release: 2007-09-15

Safety

Instruction manual

It is important to be familiar with the softstarter to fully understand this instruction manual.

Technically qualified personnel

Installation, commissioning, demounting, making measurements, etc. of or on the Emotron products may only be carried out by personnel technically qualified for the task.

Installation

The installation must be made by authorised personnel and must be made according to the local standards.

Opening the softstarter

DANGER! ALWAYS SWITCH OFF THE MAINS VOLTAGE BEFORE OPENING THE UNIT.

Always take adequate precautions before opening the softstarter. Although the connections for the control signals and the jumpers are isolated from the mains voltage. Always take adequate precautions before opening the softstarter.

EMC Regulations

EMC regulations must be followed to fulfil the EMC standards.

Contents

1. General information

1.1 Introduction

The MODBUS RTU optional card is an asynchronous serial interface for the softstarters of the MSF 2.0 series to exchange data asynchronously with external equipment.

The protocol used for data exchange is based on the Modbus RTU protocol, originally developed by Modicon.

Physical connection can be either RS232 or RS485.

It acts as a slave with address 1 - 247 in a master-slave configuration. The communication is half duplex. It has a standard non return to zero (NRZ) format.

Baudrate is possible from 2400 up to 38400 bits per sec.

The character frame format (always 11 bits) has:

- one start bit
- eight data bits
- one or two stop bits
- even or no parity bit

A Cyclic Redundancy Check is included.

1.2 Description.

This instruction manual describes the installation and operation of the MODBUS RTU option card, which can be built into the MSF 2.0 softstarters:

MSF-017 - MSF-1400

1.3 Users

This instruction manual is intended for:

- installation engineers
- designers
- maintenance engineers
- service engineers

1.4 Safety

Because this option is a supplementary part of the sofstarter, the user must be familiar with the original instruction manual of the MSF 2.0 sofstarter. All safety instructions, warnings etc. as mentioned in these instruction manuals are to be known to the user.

The following indications can appear in this manual. Always read these first and be aware of their content before continuing.

NOTE: Additional information as an aid to avoiding problems.

CAUTION: Failure to follow these instructions can result in malfunction or damage to the softstarter.

WARNING: Failure to follow these instructions can result in serious injury to the user in addition to serious damage to the softstarter.

1.5 Delivery and unpacking.

Check for any visible signs of damage. Inform your supplier immediately of any damage found. Do not install the option card if damage is found.

If the option card is moved from a cold storage room to the room where it is to be installed, condensation can form on it. Allow the option card to become fully acclimatised and wait until any visible condensation has evaporated before installing it in the softstarter.

2. Modbus RTU

2.1 General

Devices communicate using a master-slave technique, in which only one device (the master) can initiate transactions (called 'queries'). The other devices (the slaves) respond by supplying the requested data to the master, or by taking the action requested in the query. Typical master devices include host processors and programming panels. Typical slaves include programmable controllers, motor controllers, load monitors etc, see Fig. 1.

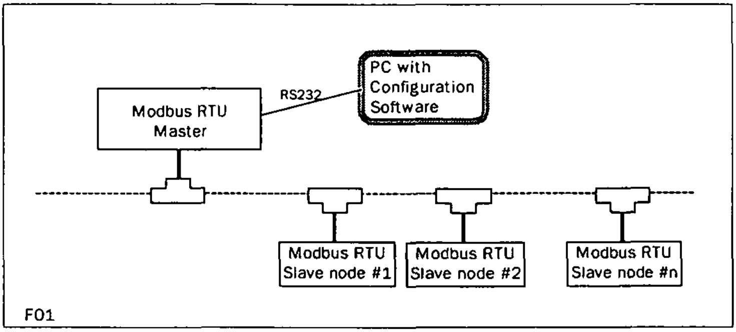

Fig. 1 Network configuration.

The master can address individual slaves. Slaves return a message (called a 'response') to queries that are addressed to them individually.

The Modbus protocol establishes the format for the master's query by placing into it the device address, a function code defining the requested action, any data to be sent, and an error checking field. The slave's response message is also constructed using Modbus protocol. It contains fields confirming the action taken, any data to be returned and an error-checking field. If an error occurred in receiving the message, or if the slave is unable to perform the requested action, the slave will construct an error message and send this as its response, see Fig. 2.

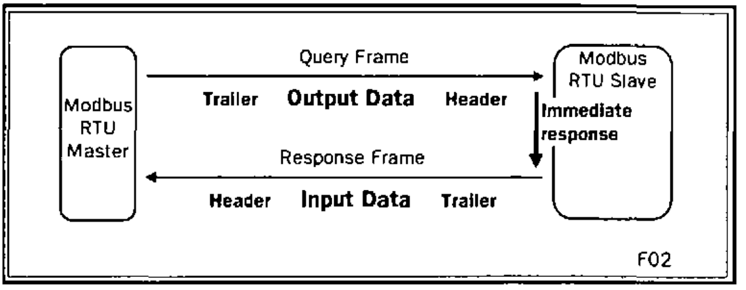

Fig. 2 Shows the MODBUS RTU data exchange.

Modbus RTU uses a binary transmission protocol.

If even parity is used, each character (8 bit data) is sent as:

Table 1

1	Start bit.
8	Data bits, hexadecimal 0-9,A-F, least significant bit sent first.
1	Even parity bit.
1	Stop bit.

If no parity is used each character (8 bit data) is sent as:

Table 2

1	Start bit.
8	Data bits, hexadecimal 0-9,A-F, least significant bit sent first.
2	Stop bit.

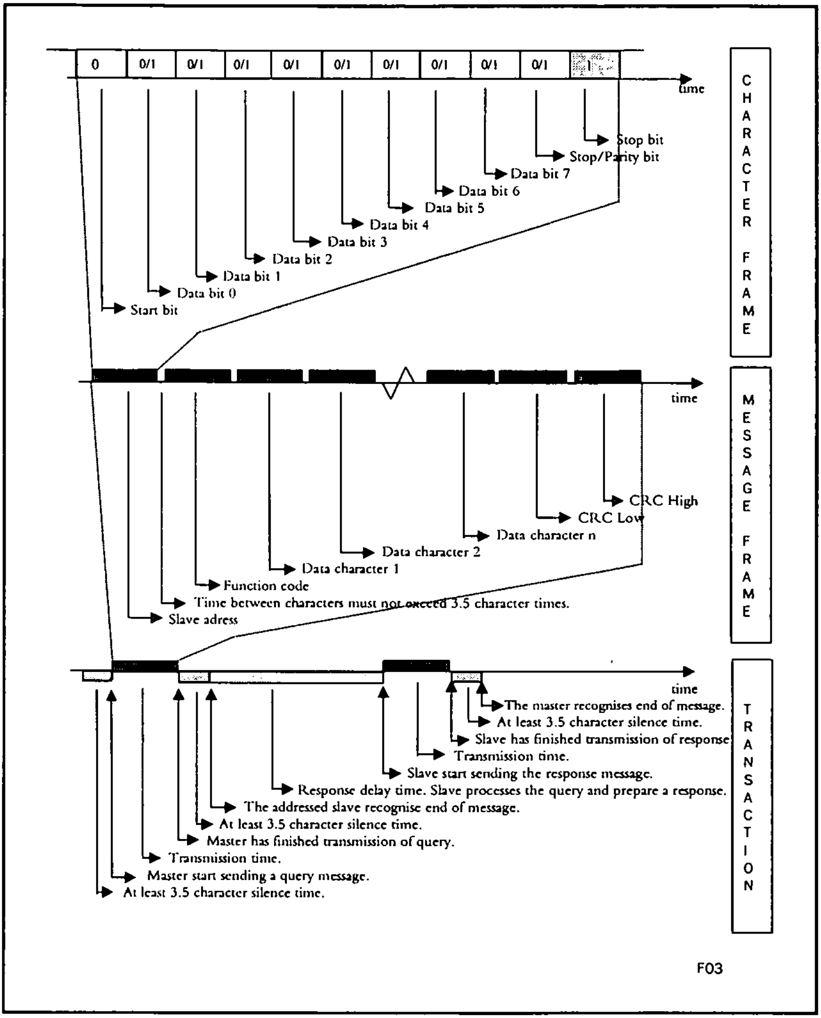

Fig. 3 *Timing diagram for a transaction (query and response messages) (bottom in figure), a message frame (middle in figure) and a character frame (top in figure).*

2.2 Framing

Messages start with a silent interval of at least 3.5 character times. This is easily implemented as a multiple of character times at the baud rate used on the network (shown as T1-T2-T3-T4 in the table below). The first field then transmitted is the device address.

The allowed characters transmitted for all fields are hexadecimal 0-9,A-F. Network devices monitor the network bus continuously, including during the 'silent' intervals. When the first field (the address field) is received, each device decodes it to find out if it is the addressed device.

Following the last transmitted character, a similar interval of at least 3.5 character times marks the end of the message. A new message can begin after this interval.

The entire message frame must be transmitted as a continuous stream. If a silent interval of more than 3.5 character times occurs before completion of the frame, the receiving device flushes the incomplete message and assumes that the next byte will be the address field of a new message.

Similarly, if a new message begins earlier than 3.5 character times following a previous message, the receiving device will consider it a continuation of the previous message. This will set an error, as the value in the final CRC field will not be valid for the combined messages. A typical message frame is shown below.

Table 3

Header	START	T1-T2-T3-T4
	ADDRESS	8 bits
	FUNCTION	8 bits
Data	DATA	n x 8 bits
Trailer	CRC CHECK	16 bits
	END	T1-T2-T3-T4

2.2.1 Address field

The address field of a message frame contains eight bits. The individual slave devices are assigned addresses in the range of 1 - 247. A master addresses a slave by placing the slave address in the address field of the message.

When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding.

2.2.2 Function field

The function code field of a message frame contains eight bits. Valid codes are in the range of 1 - 6, 15, 16 and 23. See section 2.2, page 8.

When a message is sent from a master to a slave device, the function code field tells the slave what kind of action to perform.

Examples are:

- to read the ON/OFF states of a group of inputs;
- to read the data contents of a group of parameters;
- to read the diagnostic status of the slave;
- to write to designated coils or registers within the slave.

When the slave responds to the master, it uses the function code field to indicate either a normal (error-free) response or that some kind of error occurred (called an exception response). For a normal response, the slave simply echoes the original function code. For an exception response, the slave returns a code that is equivalent to the original function code with its most significant bit set to a logic 1.

In addition to its modification of the function code for an exception response, the slave places an unique code into the data field of the response message. This tells the master what kind of error occurred, or the reason for the exception, see section 2.4.2, page 22.

The master device's application program has the responsibility of handling exception responses. Typical processes are to post subsequent retries of the message, to try diagnostic messages to the slave and to notify operators.

Additional information about function codes and exceptions comes later in this chapter.

2.2.3 Data field

The data field is constructed using sets of two hexadecimal digits (8 bits), in the range of 00 to FF hexadecimal.

The data field of messages sent from a master to slave devices contains additional information which the slave must use to take the action defined by the function code. This can include items like discrete and register addresses, the quantity of items to be handled and the count of actual data bytes in the field.

For example, if the master requests a slave to read a group of holding registers (function code 03), the data field specifies the starting register and how many registers are to be read. If the master writes to a group of registers in the slave (function code 10 hexadecimal), the data field specifies the starting register, how many registers to write, the count of data bytes to follow in the data field, and the data to be written into the registers.

If no error occurs, the data field of a response from a slave to a master contains the data requested. If an error occurs, the field contains an exception code that the master application can use to determine the next action to be taken.

2.2.4 CRC Error checking field

The error checking field contains a 16 bit value implemented as 2 bytes. The error check value is the result of a Cyclical Redundancy Check (CRC) calculation performed on the message contents.

The CRC field is appended to the message as the last field in the message. When this is done, the low-order byte of the field is appended first, followed by the high-order byte. The CRC high-order byte is the last byte to be sent in the message.

Additional information about CRC calculation, see chapter 5. page 49.

2.3 Functions

Emotron supports the following MODBUS function codes.

Function name	Function code
Read Coil Status	1 (01h)
Read Input Status	2 (02h)
Read Holding Registers	3 (03h)
Read Input Registers	4 (04h)
Force Single Coil	5 (05h)
Force Single Register	6 (06h)
Force Multiple Coils	15 (0Fh)
Force Multiple Registers	16 (10h)
Force/Read Multiple Holding Registers	23 (17h)

2.3.1 Read Coil Status

Read the status of digital changeable parameters.

Example

Requesting the motor PTC input ON/OFF-state. It is ON.

PTC input: Modbus no = 29 (1Dh)

On: Yes = 1 coil = 0001

1 byte of data: Byte count=01

Request message.

Field name	Hex value
Slave address	01
Function	01
Start address HI	00
Start address LO	1D
Number of Coils HI	00
Number of Coils LO	01
CRC LO	6D
CRC HI	CC

Response message.

Field name	Hex value
Slave address	01
Function	01
Byte count	01
Coil no.29 (1Dh) status	01
CRC LO	90
CRC HI	48

See section 4.4, page 37 for all parameters readable with this function code.

2.3.2 Read Input Status

Read the status of digital read-only information.

EXAMPLE

Request the Pre-alarm status. It is no Pre-alarm. Pre-alarm status: Modbus no= 2.

Request message.

Field name	Hex value
Slave address	01
Function	02
Start address HI	00
Start address LO	02
Number of Inputs HI	00
Number of Inputs LO	01
CRC LO	18
CRC HI	0A

Response message.

Field name	Hex value
Slave address	01
Function	02
Byte count	01
Input no.2 (02h)status	00
CRC LO	A1
CRC HI	88

See section 4.5, page 38 for all digital status readable with this function code.

2.3.3 Read Holding Registers

Read the value of analogue changeable information.

Example, requesting the Nominal Motor Voltage, Nominal Motor Frequency and the Nominal Motor Current. Their values are 400.0 V, 60 Hz and 15.5 A.

400.0V, unit 0.1V - 4000 (0FA0h)

60Hz unit 1Hz - 60 (003Ch)

15.5A, unit 0.1A - 155 (009Bh)

Request message.

Field name	Hex value
Slave address	01
Function	03
Start address HI	00
Start address LO	00
Number of Registers HI	00
Number of Registers LO	03
CRC LO	05
CRC HI	CB

Response message.

Field name	Hex value
Slave address	01
Function	03
Byte count	06
Reg no. 0, (0h) data HI	0F
Reg no. 0, (0h) data LO	A0
Reg no. 1, (1h) data HI	00
Reg no. 1, (1h) data LO	3C
Reg no. 2, (2h) data HI	00
Reg no. 2, (2h) data LO	9B
CRC LO	20
CRC HI	34

See section 4.7, page 42 for all analogue changeable parameters readable with this function code.

2.3.4 Read Input Registers

Read the contents of analogue read-only information.

EXAMPLE

Request the Shaft Torque. It is 452.0 Nm. It has a long representation, 2 registers are used.

452.0 Nm, unit 0.1 Nm - 4520 (000011A8h).

Request message.

Field name	Hex value
Slave address	01
Function	04
Start address HI	00
Start address LO	0A
Number of Registers HI	00
Number of Registers LO	02
CRC LO	51
CRC HI	C9

Response message.

Field name	Hex value
Slave address	01
Function	04
Byte count	04
Reg no. 10 (0Ah) data HI	00
Reg no. 10 (0Ah) data LO	00
Reg no. 11 (0Bh) data HI	11
Reg no. 11 (0Bh) data LO	A8
CRC LO	F6
CRC HI	6A

See section 4.6, page 38 and § 4.9, page 68 for all analogue read-only information readable with this function code.

2.3.5 Force Single Coil

Set the status of one changeable digital parameter.

EXAMPLE

Set the Start Command to ON. This will cause the motor to start.

Modbus no = 1 - address LO 1 (01h)

Run = 1 - 0 Data HI 255 (0FFh), Data LO 00 (00h)

Request message.

Field name	Hex value
Slave address	01
Function	05
Start address HI	00
Start address LO	01
Data HI	FF
Data LO	00
CRC LO	DD
CRC HI	FA

Response message.

Field name	Hex value
Slave address	01
Function	05
Start address HI	00
Start address LO	01
Data HI	FF
Data LO	00
CRC LO	DD
CRC HI	FA

See section 4.4, page 37 for all parameters changeable with this function code.

2.3.6 Force Single Register

Set the value of one analogue changeable parameter.

EXAMPLE

Set the Response Delay Max Alarm to 12.5 sec.

Modbus no 13 -> address LO (0Dh)

12.5s, unit 0.1s - 125 (7Dh)

Request message.

Field name	Hex value
Slave address	01
Function	06
Start address HI	00
Start address LO	0D
Data HI	00
Data LO	7D
CRC LO	D8
CRC HI	28

Response message.

Field name	Hex value
Slave address	01
Function	06
Start address HI	00
Start address LO	0D
Data HI	00
Data LO	7D
CRC LO	D8
CRC HI	28

See section 4.7, page 42 for all parameters changeable with this function code.

2.3.7 Force Multiple Coil

Set the status of multiple digital changeable parameters.

Example

Set the Alarm Reset ON and Start Command to ON. This will cause an alarm reset before the motor starts.

Coil no. = 0-1 Reset -> 1
Run = 1
->- 00000011 (03h)

Request message.

Field name	Hex value
Slave address	01
Function	0F
Start address HI	00
Start address LO	00
Number of Coils HI	00
Number of Coils LO	02
Byte count	01
Coil no. 0-1 status (0000 0011B)	03
CRC LO	9E
CRC HI	96

Response message.

Field name	Hex value
Slave address	01
Function	0F
Start address HI	00
Start address LO	00
Number of Coils HI	00
Number of Coils LO	02
CRC LO	D4
CRC HI	0A

See section 4.4, page 37 for all parameters changeable with this function code.

2.3.8 Force Multiple Register

Set the contents of multiple changeable analogue parameters.

Example

Set the min power alarm response delay to 25.0 sec and the min alarm margin to 55%.

25.0 sec, unit 0.1 sec -> - 250 (00FAh)

55%, unit 1% -> 55 (0037h)

Request message.

Field name	Hex value
Slave address	01
Function	10
Start address HI	00
Start address LO	11
Number of Registers HI	00
Number of Registers LO	02
Byte count	04
Data HI reg 17 (11h)	00
Data LO reg 17 (11h)	FA
Data HI reg 18 (12h)	00
Data LO reg 18 (12h)	37
CRC LO	52
CRC HI	88

Response message.

Field name	Hex value
Slave address	01
Function	10
Start address HI	00
Start address LO	11
Number of Registers HI	00
Number of Registers LO	02
CRC LO	11
CRC HI	CD

See section 4.7, page 42 for all parameters changeable with this function code.

2.3.9 Force/Read Multiple Register

Set and read the contents of multiple analogue changeable parameters in the same message.

Example

Set the Parameter Set parameter to 2 and Relay 1 function to 1 and read the Nominal Motor Speed and the Nominal Motor Power. They are 1450 rpm and 17000 W.

1450 rpm, unit 1 rpm → 1450 (05AAh)

17000 W, unit 1 W → 17000 (4268h)

Request message.

Field name	Hex value
Slave address	01
Function	17
Start read address HI	00
Start read address LO	03
Number of read Regs HI	00
Number of read Regs LO	02
Start write address HI	00
Start write address LO	15
Number of write Regs HI	00
Number of write Regs LO	02
Byte count	04
Data HI Reg 21 (15h)	00
Data LO Reg 21 (15h)	02
Data HI Reg 22 (16h)	00
Data LO Reg 22 (16h)	01
CRC LO	62
CRC HI	77

Response message.

Field name	Hex value
Slave address	01
Function	17
Byte count	04
Reg no. 3, (3h) data HI	05
Reg no. 3, (3h) data LO	AA
Reg no. 4, (4h) data HI	42
Reg no. 4, (4h) data LO	68
CRC LO	E8
CRC HI	85

See section 4.7, page 42 for all parameters change-able with this function code.

2.4 Errors, exception codes

Two kinds of errors are possible:

- Transmission errors.
- Operation errors.

2.4.1 Transmission errors

Transmission errors are:

- Frame error (stop bit error).
- Parity error (if parity is used).
- CRC error.
- No message at all.

These errors are caused by i.e. electrical interference from machinery or damage to the communication channel (cables, contact, I/O ports etc.). This unit will not act on or answer the master when a transmission error occurs. (Same result as if a non-existing slave is addressed). The master will eventually cause a time-out condition.

2.4.2 Operation errors

If no transmission error is detected in the master query, the message is examined. If an illegal function code, data address or data value is detected, the message is not acted upon but an answer with an exception code is sent back to the master. This unit can also send back an exception code when a set (force) function message is received during some busy operation states.

Bit 8 (most significant bit) in the function code byte is set to a '1' in the exception response message. Example with an illegal data address when reading an input register.

Exception response message.

Field name	Hex value
Slave address	01
Function	84
Exception code	02
CRC LO	C2
CRC HI	C1

Table 4 Exception codes.

Exc. code	Name	Description
01	Illegal function	This unit doesn't support the function code.
02	Illegal data address	The data address is not within its boundaries.
03	Illegal data value	The data value is not within it's boundaries.
06	Busy	The unit is unable to perform the request at this time. Retry later.
07	Read only	The data is not available for write access.

3. Installation

3.1 Installation on MSF-017 to MSF-145

Fig. 4 shows the parts of the MODBUS RTU option.

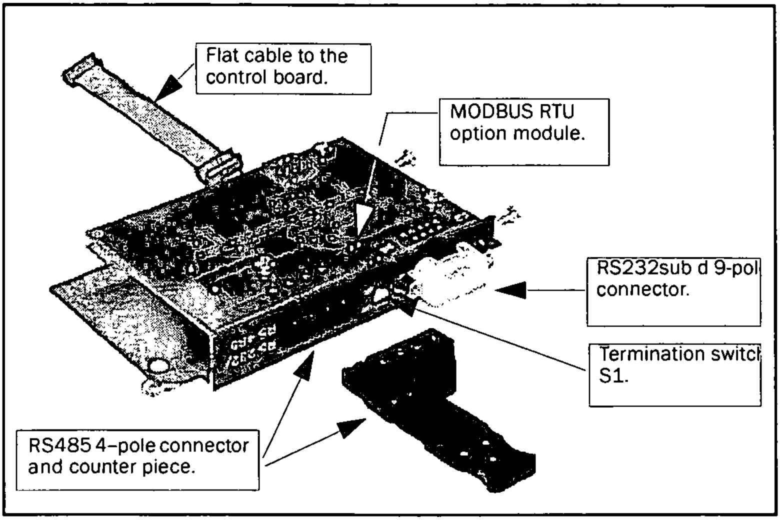

Fig. 4 MODBUS RTU option card.

WARNING: Opening the softstarter. Always switch off the mains voltage before opening the softstarter.

Remove first the lid on the top side of the softstarter. Mount the option card according to the sequence in Fig. 5.

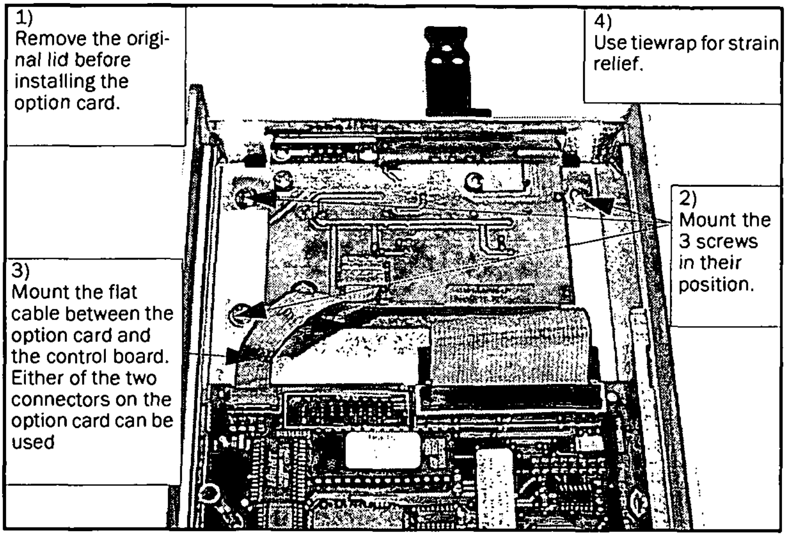

Fig. 5 Installation of the option board.

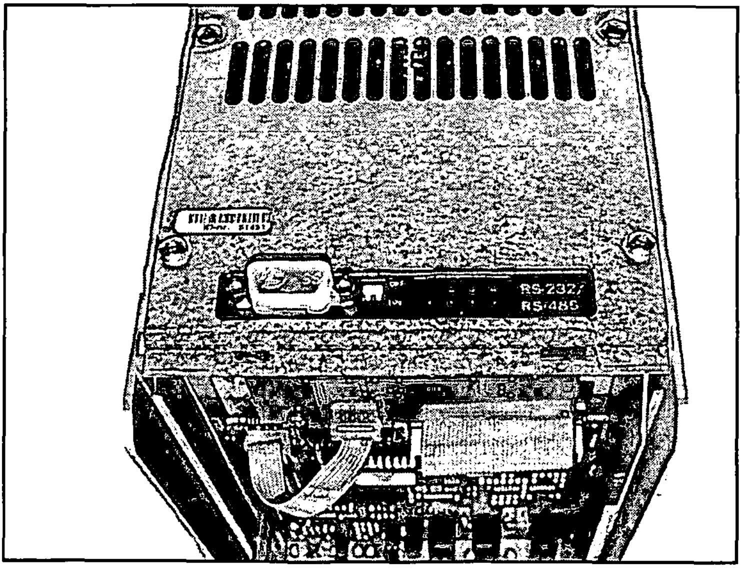

Fig. 6 Mounting of the option card seen from the top.

3.2 Installation of MSF-170 to MSF-1400

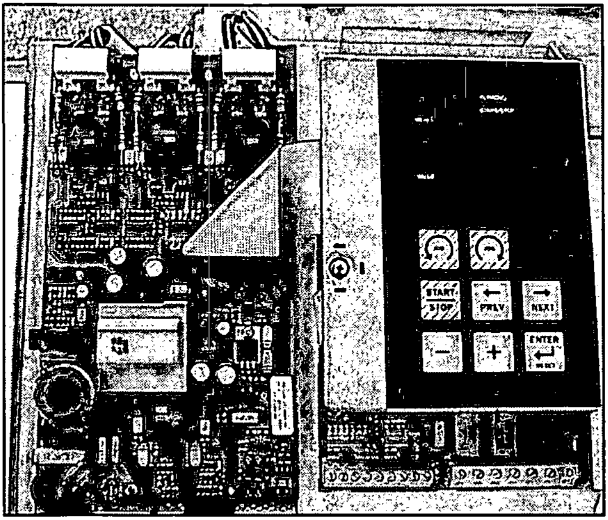

Fig. 7

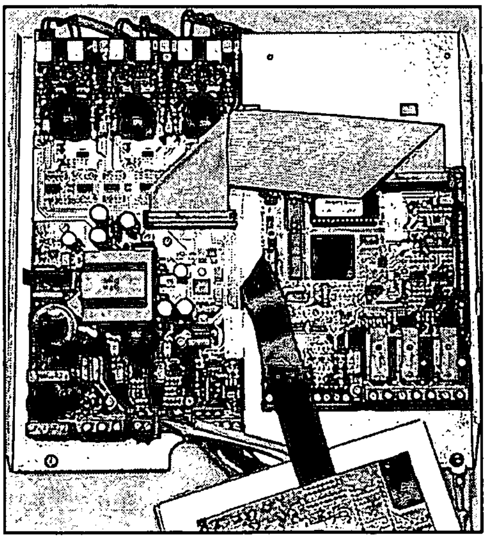

Fig. 8

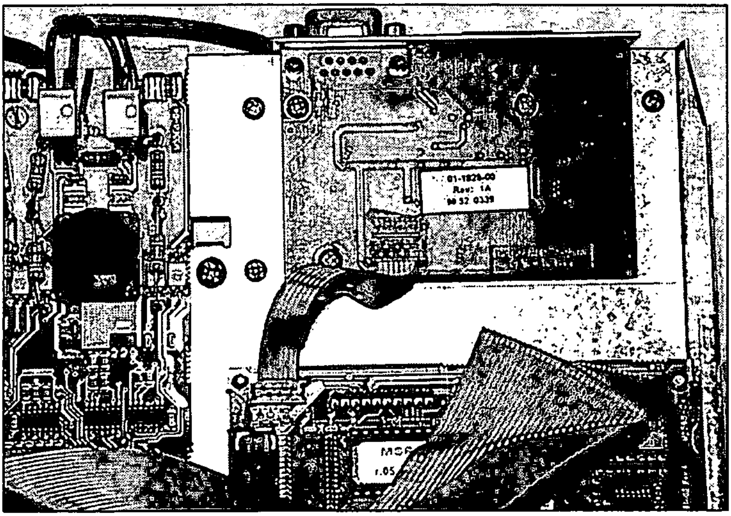

Fig. 9 Installation of the option board

3.3 RS485 Multipoint network

The RS485 port (see Fig. 4) is used for multi point communication. A host computer (PC/PLC) can address (master) maximum 247 slave stations (nodes). See Fig. 10.

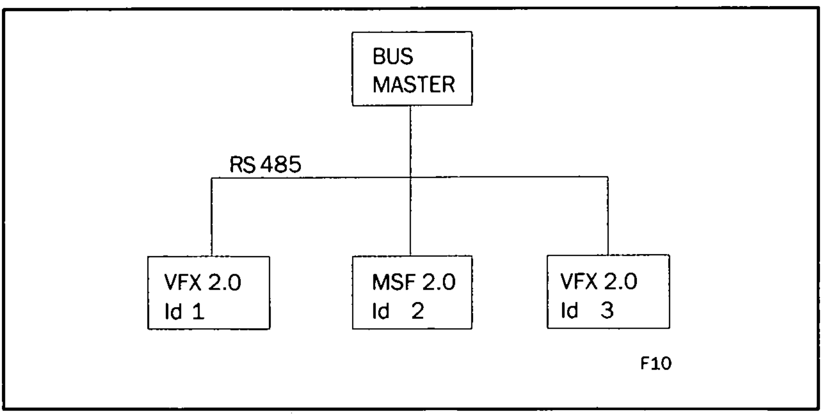

Fig. 10 RS 485 mulitpoint network

3.3.1 RS485 connection

Table 5

RS485 pin	Function
1	Ground
2	A-line
3	B-line
4	PE

The connector is a 4-pole male connector. The wiring should be done according to Fig. 11.

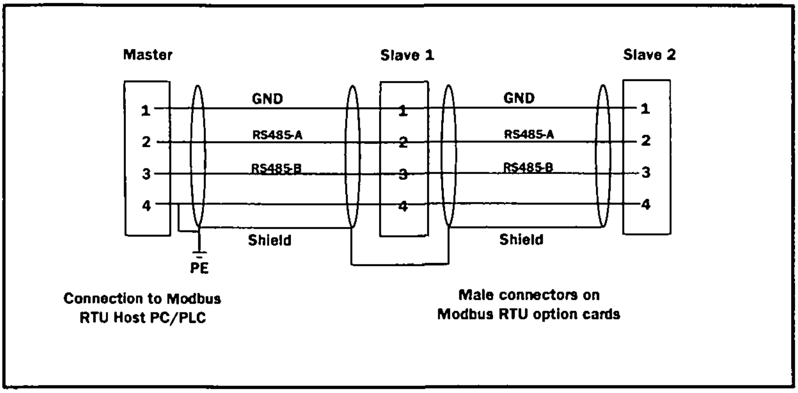

Fig. 11 RS485 wiring

3.3.2 RS485 termination

The RS485 network must always be terminated, to avoid transmission problem. The termination must take place at the end of the network. In Fig. 11 this means that the termination must take place at the slave 2 unit.

Switch S1 (see Fig. 4) sets the termination ON or OFF as indicated in the Fig. 12 and Fig. 13.

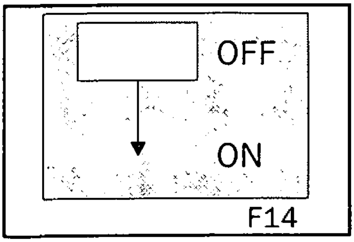

Fig. 12 Termination is OFF.

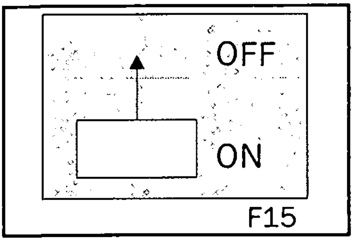

Fig. 13 Termination is ON.

NOTE: Physical connection can be either RS232 or RS485, not both on the same time.

3.4 RS232 point to point network

The RS232 port is used for point to point communication as a master slave. See fig Fig. 14.

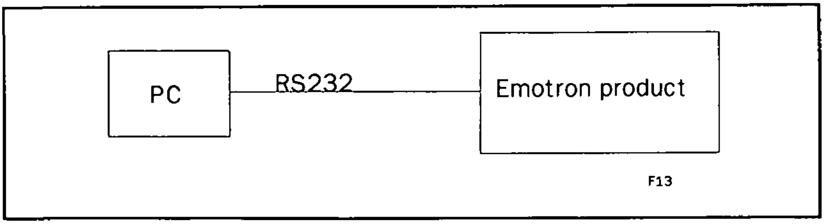

Fig. 14 RS232 point to point network

3.4.1 RS232 connection

Table 6

RS232 pin	Function
2	TX from module
3	RX to module
5	Ground

3.4.2 RS232 wiring

The RS232 port consists of a sub-D 9 pole female connector. The wiring should be done according to Fig. 14.

NOTE: Use an 1:1 cable WITHOUT a pin 2-3 crossing.

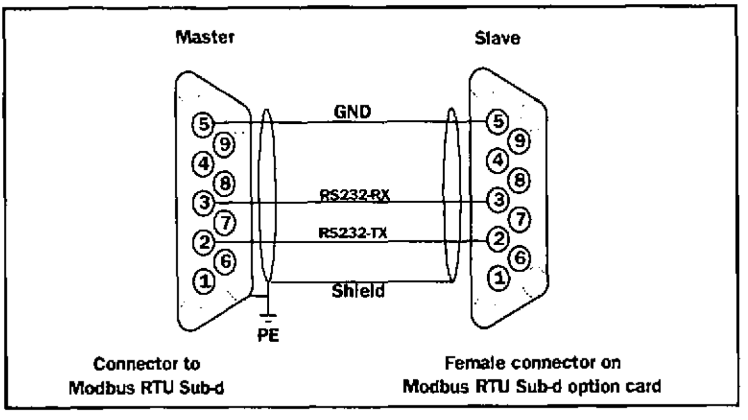

Fig. 15 RS232 wiring.

NOTE: Physical connection can be either RS232 or RS485, not both on the same time.

4. Communication parameters

4.1 Set-up Communication Parameters

The following parameters have to be set-up:

- Unit address.
- Baud rate.
- Parity
- Behaviour when contact broken.

Setting up the communication parameter must be made in local 'Control panel' mode. See section 4.2.1, page 36.

Serial comm. unit address [270].

270 Setting

Serial comm. unit address

1

Default:	1
Range:	1-247
1-247	Unit address.

Serial comm. baudrate [271]

271 Setting

Serial comm. baudrate

9.6

Default:	9.6 kBaud
Range:	2.4 - 38.4 kBaud
2.4-38.4	Baudrate.

Serial comm. parity [272]

272	Setting
0	**Serial comm. parity**
Default:	0
Range:	0, 1
0	No parity
1	Even parity.

Serial comm. broken alarm [273]

If the softstarter is configured for control via serial communications (menu [200] = 3) and the serial communication contact is broken during operation, an F15 alarm can be configured to occur. In this menu the alarm can be enabled and an action to be performed can be chosen. The following options are available:

OFF

Serial communication contact broken alarm is disabled.

WARNING

Alarm message F15 is shown in the display and relay K3 is activated (for default configuration of the relays). However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset when the fault disappears. The alarm may also be reset manually from the control panel.

COAST

Alarm message F15 is shown in the display and relay K3 is activated (for default configuration of the relays). The motor voltage is automatically switched off. The motor freewheels until it stops.

STOP

Alarm message F15 is shown in the display and relay K3 is activated (for default configuration of the relays). The motor is stopped according to the stop settings in menu [320] - [325].

BRAKE

Alarm message F15 is shown in the display and relay K3 is activated (for default configuration of the relays). The brake function is activated according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menu [326] - [327] (braking strength and braking time).

A serial communication broken alarm is automatically reset when a new start signal is given. The start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu 200. Regardless of the chosen control source, it is always possible to initiate a reset via control panel.

273	Setting
oFF	**Serial comm. contact broken (alarm code F15)**
Default:	2
Range:	oFF, 1, 2, 3, 4
oFF	Serial comm. contact broken disabled
1	Warning
2	Coast
3	Stop
4	Brake

4.2 Serial communication as control source

The source from where operation and parameter settings are made is selected in the Control Source parameter menu 200.

When serial communication control source (3) is selected, it is possible to:

- Operate the soft starter only via serial comm.
- Set up parameters only via serial comm. Exceptions for the serial comm. parameters described above.
- Readout all view information and all parameters.
- Set up the control source parameter from local MSF control panel.
- Inspect all parameters from local MSF control panel.

4.2.1 Selection of control sources

Setting up the control source has to be done from the local MSF 2.0 control panel.

200	Setting
2	**Control source**
Default:	2 (remote control)
Range:	1, 2, 3
1	Control panel.
2	Remote control.
3	Serial communication control.

Independent of the chosen control source it is always possible to read out all the information in the softstarter via serial communication, both parameters and view information.

NOTE: When Reset to factory settings is made via serial comm., the control source will remain in serial comm. control.

4.3 Parameter List

The product MSF menu column show the menu number on the control panel for the parameter.

For more information on any parameter/function, see Instruction Manual MSF 2.0 Softstarter.

4.4 Coil status list

Table 7

Modbus no	Function/Name	Range	Comment	Menu no.
0	Reset alarm	0, 1	0->1=Reset	
1	Start/Stop	0, 1	Stop=0, Run=1	
2	Jog forward	0, 1	0=No Jog, 1=Jog	
3	Jog reverse	0, 1	0=No Jog, 1=Jog	
4	Autoset	0, 1	0->1=Auto-set	411
5	Reset power consumption	0, 1	0->1=Reset	732
20	Control panel locked for settings	0, 1	0=Unlocked. 1=Locked	201
24	Enable US-units	0, 1	0=Off, 1=On	202
25	Preset pump control parameters	0, 1	0=No, 1=Yes	300
27	Bypass	0, 1	Off, on; off=0, on=1	340
28	Power Factor Control PFC	0, 1	Off, on; off=0, on=1	341
29	PTC input	0, 1	No, yes; no=0, yes=1	221
32	Jog forward enable	0, 1	No, yes; no=0, yes=1	334
33	Jog reverse enable	0, 1	No, yes; no=0, yes=1	335
36	Fan continuously on	0, 1	Off, on; off=0, on=1	342

4.5 Input status list

Table 8 Input status list

Modbus no	Function/Name	Range	Range/Unit
2	Pre-alarm	0, 1	0=No alarm, 1=Alarm
3	Pre-alarm max	0, 1	0=No alarm, 1=Alarm
4	Pre-alarm min	0, 1	0=No alarm, 1=Alarm

4.6 Input register list

Table 9

Modbus no	Function/Name	Range/Unit	Comments	Product MSF menu
0	Power consumption high word	0-2E9 Wh	1 Wh<->1	731
1	Power consumption low word			
2	Electrical power high word	-2E9-2E9 W	1 Wh<->1	
3	Electrical power low word			
4	Output shaft power high word	-2E9-2E9 kW	0.1 kW<->1	703
5	Output shaft power low word			
6	Operation time high word	0-9999999 h		730
7	Operation time low word			
10	Shaft torque high word	-2E9-2E9 Nm	0.1Nm <-> 1	705
11	Shaft torque low word			
16	Software version text		r23 -> HB = 0, LB = 23	902
17	Software variant text		v001 -> HB = 0, LB = 01	901
18	Current	0.0-6553.5 A	0.1A<->1	100/ 700
19	Current phase L1	0.0-6553.5 A	0.1A<->1	708
20	Current phase L2	0.0-6553.5 A	0.1A<->1	709
21	Current phase L3	0.0-6553.5 A	0.1A<->1	710
22	Shaft torque in percentage units	0 - 250% Tn		706

Table 9

Modbus no	Function/Name	Range/Unit	Comments	Product MSF menu
23	Line main voltage	0.0-720.0 V	0.1V<->1	701
24	Line main voltage L1-L2	0.0-720.0 V	0.1V<->1	711
25	Line main voltage L1-L3	0.0-720.0 V	0.1V<->1	712
26	Line main voltage L2-L3	0.0-720.0 V	0.1V<->1	713
27	Softstarter type	1-19	See description in 4.8.1.	900
29	Analogue output value	0-100%		725
30	Serial comm. unit address	1-247		270
31	Serial comm. baudrate	2.4–38.4 kBaud	0.1 kBaud <-> 1	271
32	Serial comm. parity	0=No parity 1=Even parity		272
34	Actual parameter set	1, 2, 3, 4		241
35	Output Shaft power %	0% -200% P_n		413/ 704
36	Softstarter temperature	29.0-96.0 °C 84.0-204.0 °F	0.1 deg <-> 1	707
37	Time to next allowed start	0-60 min		227
40	Mode	1-8	See description in § 4.8.3.	
41	Softstarter status	1-12		720
42	Digital input status	0000-1111	L<->0, H<->1	721
43	Analogue/digital input value	0-100%		723
44	Analogue/digital input status	0,1	L<->0, H<->1	722
45	Relay status	000-111	L<->0, H<->1	724
46	Used thermal capacity	0-150%		223/ 715
47	Power factor	0.00-1.00	1.00 <-> 100	702
50	Phase sequence	0, 1, 2	0 = None, 1 = RTS, 2 = RST	439/ 714
51	Emotron product	2	2=MSF	

Table 9

Modbus no	Function/Name	Range/Unit	Comments	Product MSF menu
100	Alarm list, latest error, time stamp high word	0-9999999 h	1 h<->1	
101	Alarm list, latest error, time stamp low word			
102	Alarm list, latest error	0- 17		800
103	Alarm list, error 14, time stamp high word	0-9999999 h	1 h<->1	
104	Alarm list, error 14, time stamp low word			
105	Alarm list, error 14	0- 17		801
106	Alarm list, error 13, time stamp high word	0-9999999 h	1 h<->1	
107	Alarm list, error 13, time stamp low word			
108	Alarm list, error 13	0- 17		802
109	Alarm list, error 12, time stamp high word	0-9999999 h	1 h<->1	
110	Alarm list, error 12, time stamp low word			
111	Alarm list, error 12	0- 17		803
112	Alarm list, error 11, time stamp high word	0-9999999 h	1 h<->1	
113	Alarm list, error 11, time stamp low word			
114	Alarm list, error 11	0- 17		804
115	Alarm list, error 10, time stamp high word	0-9999999 h	1 h<->1	
116	Alarm list, error 10, time stamp low word			
117	Alarm list, error 10	0- 17		805
118	Alarm list, error 9, time stamp high word	0-9999999 h	1 h<->1	
119	Alarm list, error 9, time stamp low word			

Table 9

Modbus no	Function/Name	Range/Unit	Comments	Product MSF menu
120	Alarm list, error 9	0- 17		806
121	Alarm list, error 8, time stamp high word	0-9999999 h	1 h<->1	
122	Alarm list, error 8, time stamp low word			
123	Alarm list, error 8	0- 17		807
124	Alarm list, error 7, time stamp high word	0-9999999 h	1 h<->1	
125	Alarm list, error 7, time stamp low word			
126	Alarm list, error 7	0- 17		808
127	Alarm list, error 6, time stamp high word	0-9999999 h	1 h<->1	
128	Alarm list, error 6, time stamp low word			
129	Alarm list, error 6	0- 17		809
130	Alarm list, error 5, time stamp high word	0-9999999 h	1 h<->1	
131	Alarm list, error 5, time stamp low word			
132	Alarm list, error 5	0- 17		810
133	Alarm list, error 4, time stamp high word	0-9999999 h	1 h<->1	
134	Alarm list, error 4, time stamp low word			
135	Alarm list, error 4	0- 17		811
136	Alarm list, error 3, time stamp high word	0-9999999 h	1 h<->1	
137	Alarm list, error 3, time stamp low word			
138	Alarm list, error 3	0- 17		812
139	Alarm list, error 2, time stamp high word	0-9999999 h	1 h<->1	

Table 9

Modbus no	Function/Name	Range/Unit	Comments	Product MSF menu
140	Alarm list, error 2, time stamp low word			
141	Alarm list, error 2	0- 17		813
142	Alarm list, error 1, time stamp high word	0-9999999 h	1 h<->1	
143	Alarm list, error 1, time stamp low word			
144	Alarm list, error 1	0- 17		814

4.7 Holding register list

Table 10

Modbus no	Function/Name	Range/Unit	Comment	Product MSF menu
0	Nominal motor voltage	200.0-700.0V	0.1 V<->1	210
1	Nominal frequency	50-60Hz	1 Hz<->1	215
2	Nominal motor current	25-200% Insoft in A	0.1 A<->1	211
3	Nominal motor speed	500 - 3600 rpm		213
4	Nominal motor power	25 - 400% Pnsoft in kW	Bit15=0 1 W<->1, 0.001 hp<->1 Bit15=1 0.1 kW<->1, 0.1 hp<->1	212
5	Nominal motor power factor	0.50-1.00	1.00 <-> 100	214
6	Analogue start-stop on-value	0-100%		502
7	Analogue star-stop off-value	0-100%		503
8	Analogue start-stop delay time	1-999 s		504
9	Automatic return menu	0.1-159	Off <-> 0, Menu 100 <-> 1, Menu 101 <-> 2, ..	101

Table 10

Modbus no	Function/Name	Range/Unit	Comment	Product MSF menu
10	Control source	1,2,3		200
11	Normal load	0-200% P_n		412
12	Start delay power alarms	1-999 s		402
13	Max power alarm response delay	0.1-90.0 s	0.1s->1	404
14	Max power alarm margin	0-100% P_{normal} 1		403
15	Max power pre-alarm response delay	0.1-90.0 s	0.1s->1	406
16	Max power pre-alarm margin	0-100% P_{normal}		405
17	Min power alarm response delay	0.1-90.0 s	0.1s->1	410
18	Min power alarm margin	0-100% P_{normal}		409
19	Min power pre-alarm response delay	0.1-90.0 s	0.1s->1	408
20	Min power pre-alarm margin	0-100% P_{normal}		407
21	Select parameter set	0, 1, 2, 3, 4		240
22	Relay K1	0, 1-19		530
23	Relay K2	0, 1-19		531
24	Relay K3	0, 1-19		532
25	Digital input 1 function	1, 2, 3, 4, 5, 6, 7		510
26	Digital input 2 function	1, 2, 3, 4, 5, 6, 7		511
28	Digital input 3 function	1, 2, 3, 4, 5, 6, 7		512
29	Digital input 4 function	1, 2, 3, 4, 5, 6, 7		513
30	K1 contact function	1, 2		533
31	K2 contact function	1, 2		534
32	Copy parameter set	0-12	Off<->0, 1-2 <-> 1, 1-3 <-> 2,	242
33	Stop method	1, 2, 3, 4, 5		320
34	Alarm braking time	1-120 s	1 s<->1	327
35	Alarm braking strength	0, 150-500%	Off<->0	326

Table 10

Modbus no	Function/Name	Range/Unit	Comment	Product MSF menu
36	Analogue output value	1, 2, 3, 4		521
37	Analogue output	0, 1, 2, 3, 4		520
38	Scaling analogue output, min	0-500%		522
40	Scaling analogue output, max	0-500%		523
2000	Initial voltage at start	25-90% U		313
2001	Start time	1-60 s	1 s<->1	315
2002	Step down voltage at stop	100-40% U		322
2003	Stop time	1-120 s	1 s<->1	325
2008	Initial torque at start	0-250% T_n		311
2009	End torque at start	25-250% T_n,		312
2010	Start method	1, 2, 3, 4		310
2012	Current limit at start	0, 150-500% I_n	Off <-> 0	314
2013	Braking strength	150-500%		324
2015	Torque boost current limit	0, 300-700% I_n	Off <-> 0	316
2016	Torque boost active time	0.1-2.0 s	0.1 s<->1	317
2017	Digital input pulses	1-100		501
2018	Slow speed strength	10-100		330
2019	Slow speed time at start	0, 1-60 s	Off <-> 0	331
2020	Slow speed time at stop	0, 1-60 s	Off <-> 0	332
2021	DC-brake at slow speed	0, 1-60 s	Off <-> 0	333
2022	Internal protection class	0, 2-40 s	1 s<->1	222
2023	Number of starts per hour	0, 1-99		225
2024	Locked rotor alarm	1.0-10.0	1.0 s<->10	229
2025	Unbalance voltage level	2-25% U_n		431
2026	Response delay voltage unbalance alarm	1-90 s	1 s<->1	432
2027	Over voltage level	100-150% U_n		434
2028	Response delay over voltage alarm	1-90 s	1 s<->1	435

Table 10

Modbus no	Function/Name	Range/Unit	Comment	Product MSF menu
2029	Under voltage level	75-100% U_n		437
2030	Response delay under voltage alarm	1-90 s	1 s<->1	438
2031	Reset to factory settings	0, 1		243
2033	End torque at stop	0-100% of T_n		321
2034	Braking method	1=dynamic brake; 2=reverse brake		323
2035	Analogue/digital input	0, 1, 2, 3, 4, 5, 6, 7		500
2036	Min. time between starts	0, 1-60 min	1 min<->1	226
2037	Thermal motor protection	0, 1, 2, 3, 4		220
2038	Start limitation	0, 1, 2		224
2039	Locked rotor alarm	0, 1, 2,		228
2040	Single phase input failure	1, 2		230
2041	Current limit start time expired	0, 1, 2, 3, 4		231
2042	Serial comm. contact broken	0, 1, 2, 3, 4		273
2043	Max power alarm	0, 1, 2, 3, 4		400
2044	Min power alarm	0, 1, 2, 3, 4		401
2045	External alarm	0, 1, 2, 3, 4, 5		420
2046	Voltage unbalance alarm	0, 1, 2, 3, 4		430
2047	Over voltage alarm	0, 1, 2, 3, 4		433
2048	Under voltage alarm	0, 1, 2, 3, 4		436
2049	Phase reversal alarm	0, 1, 2		440
2050	Autoreset attempts	0-10	Off <-> 0	250
2051	Thermal motor protection autoreset	0, 1-3600 s	Off<->0, 1 s<->1	251
2052	Start limitation autoreset	0, 1-3600 s	Off<->0, 1 s<->1	252
2053	Locked rotor alarm autoreset	0, 1-3600 s	Off<->0, 1 s<->1	253
2054	Current limit start time expired autoreset	0, 1-3600 s	Off<->0, 1 s<->1	254

Table 10

Modbus no	Function/Name	Range/Unit	Comment	Product MSF menu
2055	Max power alarm autoreset	0, 1-3600 s	Off<->0, 1 s<->1	255
2056	Min power alarm autoreset	0, 1-3600 s	Off<->0, 1 s<->1	256
2057	External alarm autoreset	0, 1-3600 s	Off<->0, 1 s<->1	257
2058	Phase input failure autoreset	0, 1-3600 s	Off<->0, 1 s<->1	258
2059	Voltage unbalance alarm autoreset	0, 1-3600 s	Off<->0, 1 s<->1	259
2060	Over voltage alarm autoreset	0, 1-3600 s	Off<->0, 1 s<->1	260
2061	Under voltage alarm autoreset	0, 1-3600 s	Off<->0, 1 s<->1	261
2062	Serial communication autoreset	0, 1-3600 s	Off<->0, 1 s<->1	262
2063	Softstarter overheated autoreset	0, 1-3600 s	Off<->0, 1 s<->1	263

4.8 Parameter description

For more information on any parameter/function, see MSF 2.0 Softstarter Instruction manual.

4.8.1 Softstarter type (Input register 27)

Table 11 Softstarter type

1 MSF-017	2 MSF-030	3 MSF-045	4 MSF-060	5 MSF-075	6 MSF-085
7 MSF-110	8 MSF-145	9 MSF-170	10 MSF-210	11 MSF-250	12 MSF-310
13 MSF-370	14 MSF-450	15 MSF-570	16 MSF-710	17 MSF-835	18 MSF-1000
19 MSF-1400					

4.8.2 Serial comm. contact broken (Holding register 2042)

Communication is considered lost if no request is made to this unit within 15 sec. See section 4.1, page 33

4.8.3 Operation mode (Input register 40)

1	Voltage control
2	Torque control
3	Current limit
4	Voltage control with current limit
7	Direct On Line start
5	Torque control with current limit

4.8.4 Reset to factory settings (Holding register 2031)

Reset to factory settings from serial communication will have the same effect as if it was done from the control panel, except for one parameter. The control source parameter (menu 200) will remain in 3 (serial comm. control) instead of being set to the default value 2 (remote control).

4.9 Performance

It is important to configure the communication master according to the slave performance/restrictions. The total message size must not exceed 64 bytes.

Max number of registers at a time is limited to 25 (both for read and write).

Max 2 requests per sec. to reduce system disturbance.

Min 1 request per 15 sec. to avoid serial comm. contact broken alarm.

4.9.1 MSF response delay

The read function codes (1 - 4), will have a maximum delay of 250 ms.

Table 12 Response delay table for setting (forcing) registers

Holding register modbus no.	Parameter	Response delay/ recommended time out
0-5	Nominal motor data	500 ms/data
2031	Reset to factory settings	3.5 sec
	Other registers	250 ms

5. CRC Generation

The CRC is started by first pre-loading a 16-bit register to all 1's. Then a process begins of applying successive eight-bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit, do not apply to the CRC.

During generation of the CRC, each eight-bit character is exclusive OR-ed with the register contents. The result is shifted in the direction of the least significant bit (lsb), with a zero filled into the most significant bit (msb) position. The lsb is extracted and examined. If the lsb was a 1, the register is then exclusive OR-ed with a preset, fixed value. If the lsb was a 0, no exclusive OR takes place.

This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next eight-bit character is exclusive OR-ed with the register's current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the characters of the message have been applied, is the CRC value.

5.1 Generation in steps:

- Step 1 Load a 16-bit register with 0xFFFF (all 1's). Call this the CRC register.
- Step 2 Exclusive OR the first eight-bit byte of the message with the low order byte of the 16-bit CRC register, putting the result in the CRC register.
- Step 3 Shift the CRC register one bit to the right (toward the lsb), zero-filling the msb. Extract and examine the lsb.
- Step 4 If the lsb is 0, repeat Step 3 (another shift). If the lsb is 1, Exclusive OR the CRC register with the polynomial value 0xA001 (1010 0000 0000 0001).
- Step 5 Repeat Steps 3 and 4 until eight shifts have been performed. When this is done, a complete eight-bit byte will have been processed.
- Step 6 Repeat Steps 2 ... 5 for the next eight-bit byte of the message. Continue doing this until all bytes have been processed.
- Result The final contents of the CRC register is the CRC value.

- Step 7 When the CRC is placed into the message, its upper and lower bytes must be swapped as described below.
- Placing the CRC into the Message
- When the 16-bit CRC (two eight-bit bytes) is transmitted in the message, the low order byte will be transmitted first, followed by the high order byte - e.g., if the CRC value is 0x1241.

Table 13

Message	
CRC LO	41
CRC HI	12

Example of CRC Generation Function

An example of a C language function performing CRC generation is shown on this page.

The function takes two arguments:

- Unsigned char *puchMsg; A pointer to the message buffer containing binary data to be used for generating the CRC.
- Unsigned int usDataLen; The quantity of bytes in the message buffer.

The function returns the CRC as a type unsigned int.

- Unsigned int CRC16 (unsigned int usDataLen, unsigned char *puchMsg)

```
#define CRC_POLYNOMIAL    0xA001
  unsigned int crc_reg;
  unsigned char i,k;
  crc_reg = 0xFFFF;
  for (i=0 ; i<usDataLen ; i++)
  {
    crc_reg ^= *puchMsg++;
    for (k=0 ; k<8 ; k++)
    {
      if (crc_reg & 0x0001)
      {
        crc_reg >>= 1;
        crc_reg ^= CRC_POLYNOMIAL;
      }
```

Fig. 16 CRC example.

emotron
DEDICATED DRIVE

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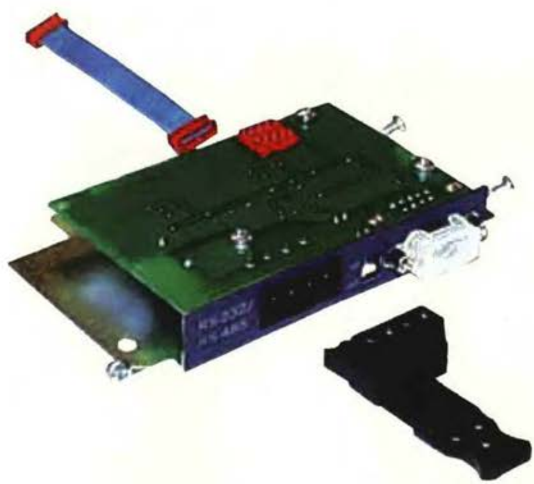
Emotron AB 01-3853-01r1 2007-09-15

emotron

DEDICATED DRIVE



SERIAL COMMUNICATION OPTION

INSTRUCTION MANUAL - ENGLISH

Valid for the following models:
EMOTRON Modbus RTU

Document number: 01-1989-01
Edition: r1
Date of release: 1999-10-07

SAFETY INSTRUCTIONS

Instruction manual

It is important to be familiar with the main product (softstarter/ inverter) to fully understand this instruction manual.

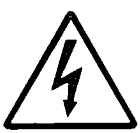
Technically qualified personnel

Installation, commissioning, demounting, making measurements, etc. of or on the Emotron products may only be carried out by personnel technically qualified for the task.

Installation

The installation must be made by authorised personnel and must be made according to the local standards.

Opening the frequency inverter or softstarter



DANGER! ALWAYS SWITCH OFF THE MAINS VOLTAGE BEFORE OPENING THE UNIT AND WAIT AT LEAST 5 MINUTES TO ALLOW THE BUFFER CAPACITORS TO DISCHARGE.

Always take adequate precautions before opening the frequency inverter or softstarter. Although the connections for the control signals and the jumpers are isolated from the main voltage. Always take adequate precautions before opening the inverter or softstarter.

EMC Regulations

EMC regulations must be followed to fulfill the EMC standards.

CONTENT

List of tables

List of figures

1. GENERAL INFORMATION

1.1 Introduction

The MODBUS RTU optional card is an asynchronous serial interface for the frequency inverters of the VFB/VFX series and the softstarters of the MSF series to exchange data asynchronously with external equipment.

The protocol used for data exchange is based on the Modbus RTU protocol, originally developed by Modicon.

Physical connection can be either RS232 or RS485.
It acts as a slave with address 1 - 247 in a master-slave configuration. The communication is half duplex. It has a standard non return to zero (NRZ) format.
Baudrates are possible from 2400 up to 38400 bits per sec.
The character frame format (always 11 bits) has:

one start bit
eight data bits
one or two stop bits
even or no parity bit

(The frequency inverters VFB/VFX have no parity).
A Cyclic Redundancy Check is included.

1.2 Description.

This instruction manual describes the installation and operation of the MODBUS RTU option card, which can be built into the following products.:

- VFB/VFX Frequency inverters:
  VFB40-004 to VFB40-046
  VFB40-018 to VFX40-1k2
  VFX50-018 to VFX50-1k2

specific information about the frequency inverters is in chapter 4. page 53.

-MSF softstarters:
  MSF-017 - MSF-1400

specific information about the sofstarters is in chapter 3. page 29.

1.3 Users

This instruction manual is intended for:
- installation engineers
- designers
- maintenance engineers
- service engineers

1.4 Safety

Because this option is a supplementary part of the frequency inverter or sofstarter, the user must be aquainted with the original instruction manual of the VFB/VFX frequency inverter and the MSF sofstarter. All safety instructions, warnings etc. as mentioned in these instruction manuals are to be known to the user. The following indications can appear in this manual. Always read these first and be aware of their content before continuing.

NOTE! Additional information as an aid to avoiding problems.

CAUTION	**Failure to follow these instructions can result in malfunction or damage to the softstarter or the frequency inverter.**
WARNING	**Failure to follow these instructions can result in serious injury to the user in addition to serious damage to the soft-starter or the frequency inverter.**
DANGER	**The life of the user is in danger.**

1.5 Delivery and unpacking.

Check for any visible signs of damage. Inform your supplier immediately of any damage found. Do not install the option card if damage is found.

If the option card is moved from a cold storage room to the room where it is to be installed, condensation can form on it. Allow the option card to become fully acclimatised and wait until any visible condensation has evaporated before installing it in the inverter or softstarter.

2. MODBUS RTU

2.1 General

Devices communicate using a master-slave technique, in which only one device (the master) can initiate transactions (called 'queries'). The other devices (the slaves) respond by supplying the requested data to the master, or by taking the action requested in the query. Typical master devices include host processors and programming panels. Typical slaves include programmable controllers, motor controllers, load monitors etc, see Fig. 1.

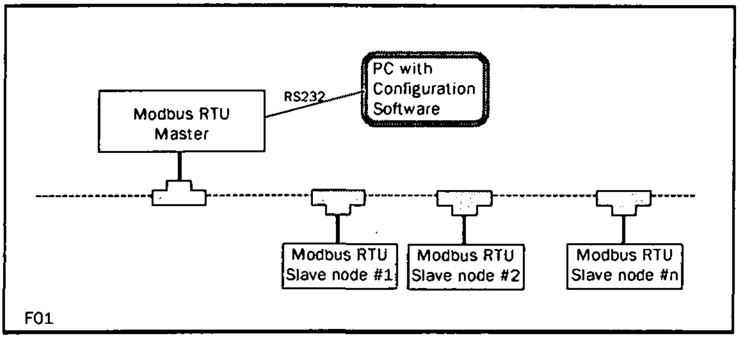


Fig. 1 Network configuration.

The master can address individual slaves. Slaves return a message (called a 'response') to queries that are addressed to them individually.

The Modbus protocol establishes the format for the master's query by placing into it the device address, a function code defining the requested action, any data to be sent, and an error checking field. The slave's response message is also constructed using Modbus protocol. It contains fields confirming the action taken, any data to be returned and an error-checking field. If an error occurred in receiving the message, or if the slave is unable to perform the requested action, the slave will construct an error message and send this as its response, see Fig. 2.

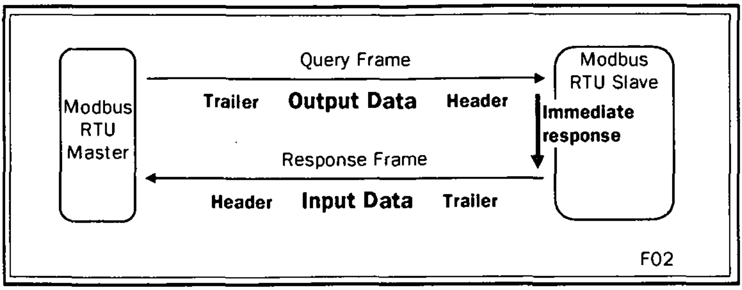


Fig. 2 Shows the MODBUS RTU data exchange.

Modbus RTU uses a binary transmission protocol.
If even parity is used, each character (8 bit data) is sent as:

Table 22 Character frame with no parity.

1	Start bit.
8	Data bits, hexadecimal 0-9,A-F, least significant bit sent first.
1	Even parity bit.
1	Stop bit.

If no parity is used each character (8 bit data) is sent as:

Table 23 Character frame with parity.

1	Start bit.
8	Data bits, hexadecimal 0-9,A-F, least significant bit sent first.
2	Stop bit.

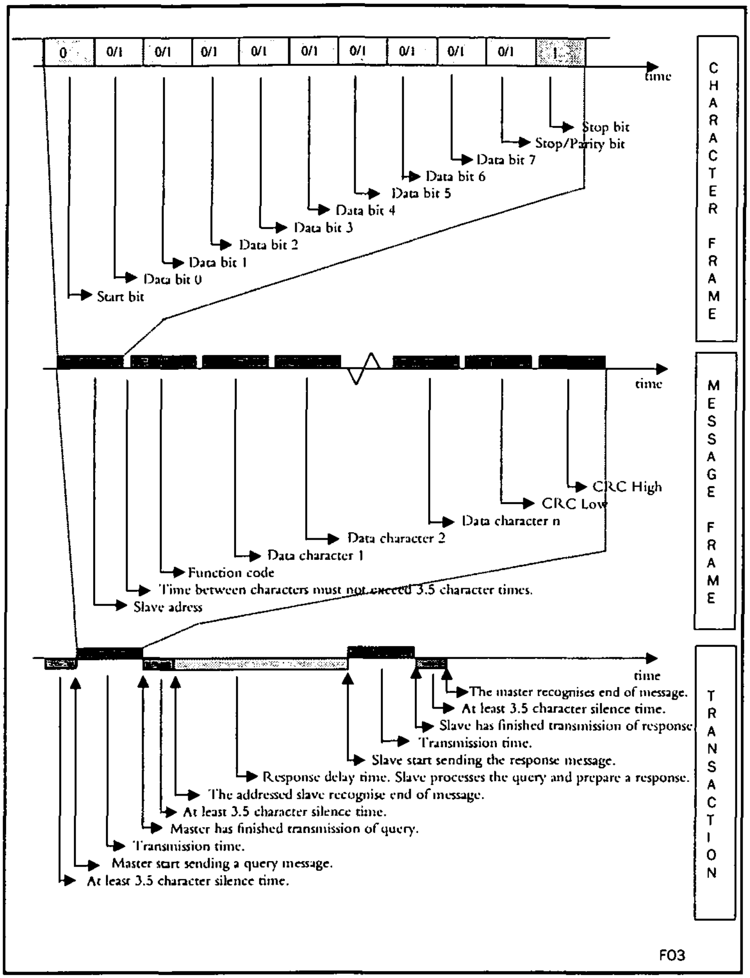


Fig. 3 Timing diagram for a transaction (query and response messages) (bottom in figure), a message frame (middle in figure) and a character frame (top in figure).

2.2 Framing

Messages start with a silent interval of at least 3.5 character times. This is easily implemented as a multiple of character times at the baud rate used on the network (shown as T1-T2-T3-T4 in the table below). The first field then transmitted is the device address.

The allowed characters transmitted for all fields are hexadecimal 0-9,A-F. Network devices monitor the network bus continuously, including during the 'silent' intervals. When the first field (the address field) is received, each device decodes it to find out if it is the addressed device.

Following the last transmitted character, a similar interval of at least 3.5 character times marks the end of the message. A new message can begin after this interval.

The entire message frame must be transmitted as a continuous stream. If a silent interval of more than 3.5 character times occurs before completion of the frame, the receiving device flushes the incomplete message and assumes that the next byte will be the address field of a new message.

Similarly, if a new message begins earlier than 3.5 character times following a previous message, the receiving device will consider it a continuation of the previous message. This will set an error, as the value in the final CRC field will not be valid for the combined messages. A typical message frame is shown below.

Header	**START**	T1-T2-T3-T4
	ADDRESS	8 bits
	FUNCTION	8 bits
Data	**DATA**	n x 8 bits
Trailer	**CRC CHECK**	16 bits
	END	T1-T2-T3-T4

2.2.1 Address field

The address field of a message frame contains eight bits. The individual slave devices are assigned addresses in the range of 1 - 247. A master addresses a slave by placing the slave address in the address field of the message.

When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding.

2.2.2 Function field

The function code field of a message frame contains eight bits. Valid codes are in the range of 1 - 6, 15, 16 and 23. See 2.2, page 13.

When a message is sent from a master to a slave device, the function code field tells the slave what kind of action to perform.

Examples are:
- to read the ON/OFF states of a group of inputs;
- to read the data contents of a group of parameters;
- to read the diagnostic status of the slave;
- to write to designated coils or registers within the slave.

When the slave responds to the master, it uses the function code field to indicate either a normal (error-free) response or that some kind of error occurred (called an exception response). For a normal response, the slave simply echoes the original function code. For an exception response, the slave returns a code that is equivalent to the original function code with its most significant bit set to a logic 1.

In addition to its modification of the function code for an exception response, the slave places an unique code into the data field of the response message. This tells the master what kind of error occurred, or the reason for the exception, see 2.4.2, page 28.

The master device's application program has the responsibility of handling exception responses. Typical processes are to post subsequent retries of the message, to try diagnostic messages to the slave and to notify operators.

Additional information about function codes and exceptions comes later in this chapter.

2.2.3 Data field

The data field is constructed using sets of two hexadecimal digits (8 bits), in the range of 00 to FF hexadecimal.

The data field of messages sent from a master to slave devices contains additional information which the slave must use to take the action defined by the function code. This can include items like discrete and register addresses, the quantity of items to be handled and the count of actual data bytes in the field.

For example, if the master requests a slave to read a group of holding registers (function code 03), the data field specifies the starting register and how many registers are to be read. If the master writes to a group of registers in the slave (function code 10 hexadecimal), the data field specifies the starting register, how many registers to write, the count of data bytes to follow in the data field, and the data to be written into the registers.

If no error occurs, the data field of a response from a slave to a master contains the data requested. If an error occurs, the field contains an exception code that the master application can use to determine the next action to be taken.

2.2.4 CRC Error checking field

The error checking field contains a 16 bit value implemented as 2 bytes. The error check value is the result of a Cyclical Redundancy Check (CRC) calculation performed on the message contents.

The CRC field is appended to the message as the last field in the message. When this is done, the low-order byte of the field is appended first, followed by the high-order byte. The CRC high-order byte is the last byte to be sent in the message.

Additional information about CRC calculation, see chapter 5. page 78.

2.3 Functions

Emotron supports the following MODBUS function codes.

Function name	Function code
Read Coil Status	1 (01h)
Read Input Status	2 (02h)
Read Holding Registers	3 (03h)
Read Input Registers	4 (04h)
Force Single Coil	5 (05h)
Force Single Register	6 (06h)
Force Multiple Coils	15 (0Fh)
Force Multiple Registers	16 (10h)
Force/Read Multiple Holding Registers	23 (17h)

2.3.1 Read Coil Status

Read the status of digital changeable parameters.

EXAMPLE

Requesting the motor PTC input ON/OFF-state. It is ON.

PTC input: Modbus no = 29 (1Dh)
On: Yes = 1 coil = 0001
1 byte of data: Byte count=01

Request message.

Field name	Hex value
Slave address	01
Function	01
Start address HI	00
Start address LO	1D
Number of Coils HI	00
Number of Coils LO	01
CRC LO	6D
CRC HI	CC

Response message.

Field name	Hex value
Slave address	01
Function	01
Byte count	01
Coil no.29 (1Dh) status	01
CRC LO	90
CRC HI	48

See 3.8, page 40 and 4.8, page 61 for all parameters readable with this function code.

2.3.2 Read Input Status

Read the status of digital read-only information.

EXAMPLE

Request the Pre-alarm status. It is no Pre-alarm. Pre-alarm status: Modbus no= 2.

Request message.

Field name	Hex value
Slave address	01
Function	02
Start address HI	00
Start address LO	02
Number of Inputs HI	00
Number of Inputs LO	01
CRC LO	18
CRC HI	0A

Response message.

Field name	Hex value
Slave address	01
Function	02
Byte count	01
Input no.2 (02h)status	00
CRC LO	A1
CRC HI	88

See 3.9, page 41 for all digital status readable with this function code.

2.3.3 Read Holding Registers

Read the value of analogue changeable information.
Example, requesting the Nominal Motor Voltage, Nominal Motor Frequency and the Nominal Motor Current. Their values are 400.0 V, 60 Hz and 15.5 A.

400.0V, unit 0.1V - 4000 (0FA0h)
60Hz unit 1Hz - 60 (003Ch)
15.5A, unit 0.1A - 155 (009Bh)

Request message.

Field name	Hex value
Slave address	01
Function	03
Start address HI	00
Start address LO	00
Number of Registers HI	00
Number of Registers LO	03
CRC LO	05
CRC HI	CB

Response message.

Field name	Hex value
Slave address	01
Function	03
Byte count	06
Reg no. 0, (0h) data HI	0F
Reg no. 0, (0h) data LO	A0
Reg no. 1, (1h) data HI	00
Reg no. 1, (1h) data LO	3C
Reg no. 2, (2h) data HI	00
Reg no. 2, (2h) data LO	9B
CRC LO	20
CRC HI	34

See 3.11, page 45 and 4.10, page 65 for all analogue changeable parameters readable with this function code.

2.3.4 Read Input Registers

Read the contents of analogue read-only information.

EXAMPLE

Request the Shaft Torque. It is 452.0 Nm. It has a long representation, 2 registers are used.

452.0 Nm, unit 0.1 Nm - 4520 (000011A8h).

Request message.

Field name	Hex value
Slave address	01
Function	04
Start address HI	00
Start address LO	0A
Number of Registers HI	00
Number of Registers LO	02
CRC LO	51
CRC HI	C9

Response message.

Field name	Hex value
Slave address	01
Function	04
Byte count	04
Reg no. 10 (0Ah) data HI	00
Reg no. 10 (0Ah) data LO	00
Reg no. 11 (0Bh) data HI	11
Reg no. 11 (0Bh) data LO	A8
CRC LO	F6
CRC HI	6A

See 3.10, page 42 and 4.9, page 62 for all analogue read-only information readable with this function code.

2.3.5 Force Single Coil

Set the status of one changeable digital parameter.

EXAMPLE

Set the Start Command to ON. This will cause the motor to start.

Modbus no = 1 - adress LO 1 (01h)
Run = 1 - 0 Data HI 255 (0FFh), Data LO 00 (00h)

Request message.

Field name	Hex value
Slave address	01
Function	05
Start address HI	00
Start address LO	01
Data HI	FF
Data LO	00
CRC LO	DD
CRC HI	FA

Response message.

Field name	Hex value
Slave address	01
Function	05
Start address HI	00
Start address LO	01
Data HI	FF
Data LO	00
CRC LO	DD
CRC HI	FA

See 3.8, page 40 and 4.8, page 61 for all parameters changeable with this function code.

2.3.6 Force Single Register

Set the value of one analogue changeable parameter.

EXAMPLE

Set the Response Delay Max Alarm to 12.5 sec.

Modbus no 13 -> address LO (0Dh)
12.5s, unit 0.1s - 125 (7Dh)

Request message.

Field name	Hex value
Slave address	01
Function	06
Start address HI	00
Start address LO	0D
Data HI	00
Data LO	7D
CRC LO	D8
CRC HI	28

Response message.

Field name	Hex value
Slave address	01
Function	06
Start address HI	00
Start address LO	0D
Data HI	00
Data LO	7D
CRC LO	D8
CRC HI	28

See 3.11, page 45 and 4.10, page 65 for all parameters changeable with this function code.

2.3.7 Force Multiple Coil

Set the status of multiple digital changeable parameters.

EXAMPLE

Set the Alarm Reset ON and Start Command to ON. This will cause an alarm reset before the motor starts.

Coil no. = 0-1 Reset -> 1
Run = 1
->- 00000011 (03h)

Request message.

Field name	Hex value
Slave address	01
Function	0F
Start address HI	00
Start address LO	00
Number of Coils HI	00
Number of Coils LO	02
Byte count	01
Coil no. 0-1 status (0000 0011B)	03
CRC LO	9E
CRC HI	96

Response message.

Field name	Hex value
Slave address	01
Function	0F
Start address HI	00
Start address LO	00
Number of Coils HI	00
Number of Coils LO	02
CRC LO	D4
CRC HI	0A

See 3.8, page 40 and 4.8, page 61 for all parameters changeable with this function code.

2.3.8 Force Multiple Register

Set the contents of multiple changeable analogue parameters.

EXAMPLE

Set the Response Delay Min Alarm to 25.0 sec and the Min Alarm Level to 55%.

25.0 sec, unit 0.1 sec -> - 250 (00FAh)
55%, unit 1% -> 55 (0037h)

Request message.

Field name	Hex value
Slave address	01
Function	10
Start address HI	00
Start address LO	11
Number of Registers HI	00
Number of Registers LO	02
Byte count	04
Data HI reg 17 (11h)	00
Data LO reg 17 (11h)	FA
Data HI reg 18 (12h)	00
Data LO reg 18 (12h)	37
CRC LO	52
CRC HI	88

Response message.

Field name	Hex value
Slave address	01
Function	10
Start address HI	00
Start address LO	11
Number of Registers HI	00
Number of Registers LO	02
CRC LO	11
CRC HI	CD

See 3.11, page 45 and 4.10, page 65 for all parameters changeable with this function code.

2.3.9 Force/Read Multiple Register

Set and read the contents of multiple analogue changeable parameters in the same message.

EXAMPLE

Set the Parameter Set parameter to 2 and Relay 1 function to 1 and read the Nominal Motor Speed and the Nominal Motor Power. They are 1450 rpm and 17000 W.

1450 rpm, unit 1 rpm -> 1450 (05AAh)
17000 W, unit 1 W -> 17000 (4268h)

Request message.

Field name	Hex value
Slave address	01
Function	17
Start read address HI	00
Start read address LO	03
Number of read Regs HI	00
Number of read Regs LO	02
Start write address HI	00
Start write address LO	15
Number of write Regs HI	00
Number of write Regs LO	02
Byte count	04
Data HI Reg 21 (15h)	00
Data LO Reg 21 (15h)	02
Data HI Reg 22 (16h)	00
Data LO Reg 22 (16h)	01
CRC LO	62
CRC HI	77

Response message.

Field name	Hex value
Slave address	01
Function	17
Byte count	04
Reg no. 3, (3h) data HI	05
Reg no. 3, (3h) data LO	AA
Reg no. 4, (4h) data HI	42
Reg no. 4, (4h) data LO	68
CRC LO	E8
CRC HI	85

See 3.11, page 45 and 4.10, page 65 for all parameters changeable with this function code.

2.4 Errors, exception codes

Two kinds of errors are possible:
- Transmission errors.
- Operation errors.

2.4.1 Transmission errors

Transmission errors are:
- Frame error (stop bit error).
- Parity error (if parity is used).
- CRC error.
- No message at all.

These errors are caused by i.e. electrical interference from machinery or damage to the communication channel (cables, contact, I/O ports etc.). This unit will not act on or answer the master when a transmission error occurs. (Same result as if a non-existing slave is addressed). The master will eventually cause a time-out condition.

2.4.2 Operation errors

If no transmission error is detected in the master query, the message is examined. If an illegal function code, data address or data value is detected, the message is not acted upon but an answer with an exception code is sent back to the master. This unit can also send back an exception code when a set (force) function message is received during some busy operation states.

Bit 8 (most significant bit) in the function code byte is set to a '1' in the exception response message. Example with an illegal data address when reading an input register.

Exception response message.

Field name	Hex value
Slave address	01
Function	84
Exception code	02
CRC LO	C2
CRC HI	C1

Table 24 Exception codes.

Exc. code	Name	Description
01	Illegal function	This unit doesn't support the function code.
02	Illegal data address	The data address is not within its boundaries.
03	Illegal data value	The data value is not within it's boundaries.
06	Busy	The unit is unable to perform the request at this time. Retry later.

3. SOFTSTARTER MSF DATA

3.1 Installation bookshelf types

Fig. 4 shows the parts of the MODBUS RTU option.

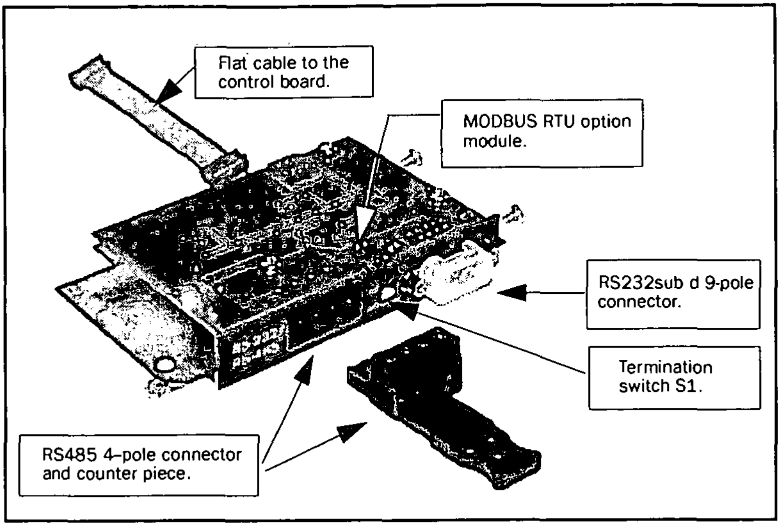
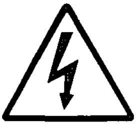


Fig. 4 MODBUS RTU option card.



WARNING! Opening the softstarter. Always switch off the mains voltage before opening the softstarter and wait at least 5 minutes to allow the buffer capacitors to discharge.

Remove first the lid on the top side of the softstarter. Mount the option card according to the sequence in Fig. 4.

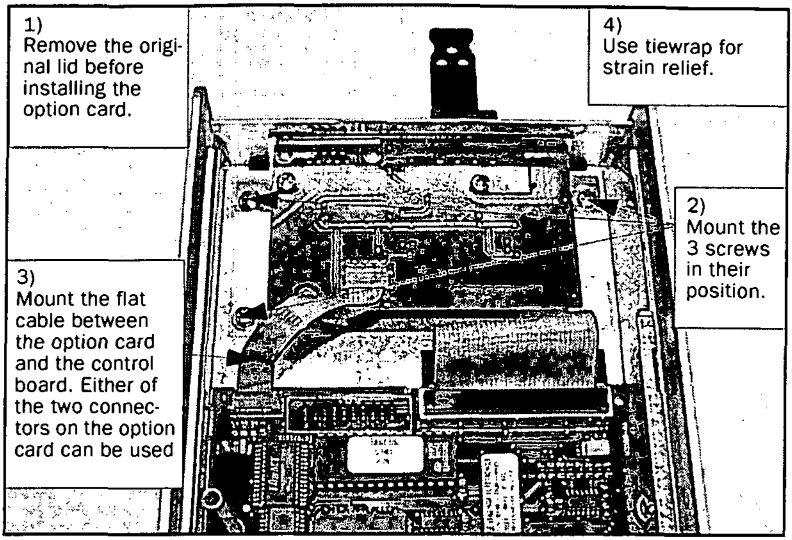


Fig. 5 Installation of the option card.

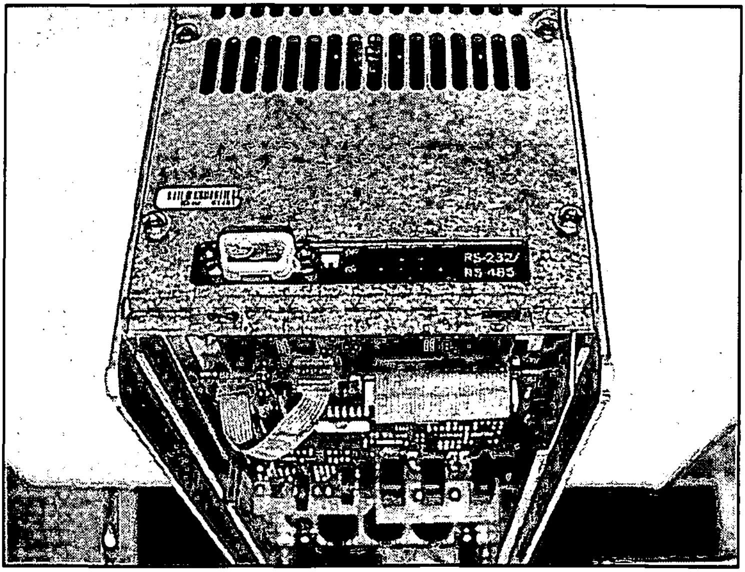


Fig. 6 Mounting of the option card seen from the top.

3.2 Installation of MSF-170 to MSF-1400

NOTE! Under construction, to be defined.

3.3 RS485 Multipoint network

The RS485 port (see Fig. 4) is used for multi point communication. A host computer (PC/PLC) can address (master) maximum 247 slave stations (nodes). See Fig. 7.

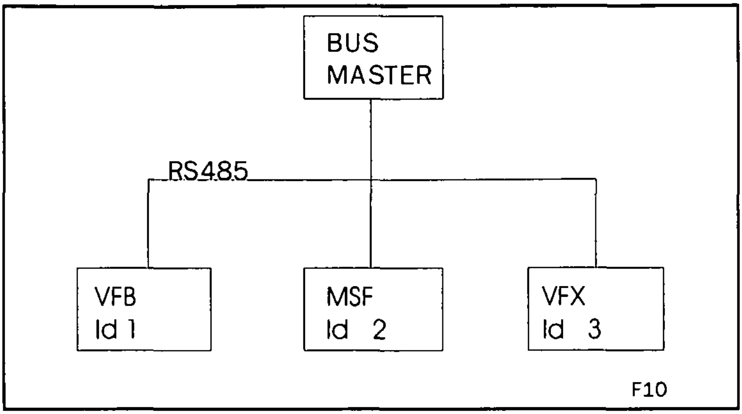


Fig. 7 RS 485 mulitpoint network

3.3.1 RS485 connection

Table 25 RS485 pinning

RS485 pin	Function
1	Ground
2	A-line
3	B-line
4	PE

The connector is a 4-pole male connector. The wiring should be done according to Fig. 8.

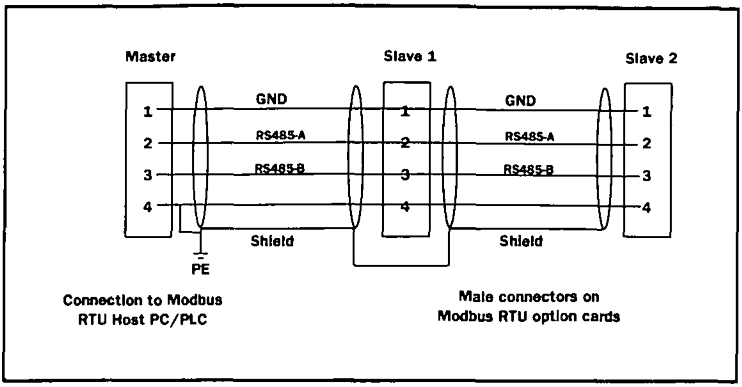


Fig. 8 RS485 wiring

3.3.2 RS485 termination.

The RS485 network must always be terminated, to avoid transmission problem. The termination must take place at the end of the network. In Fig. 8 this means that the termination must take place at the slave 2 unit.

Switch S1 (see Fig. 4) sets the termination ON or OFF as indicated in the Fig. 9 and Fig. 10.

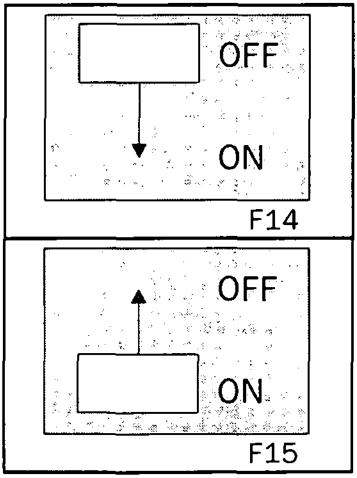


Fig. 9 Termination is OFF.

Fig. 10 Termination is ON.

NOTE! Physical connection can be either RS232 or RS485, not both on the same time.

3.4 RS232 point to point network

The RS232 port is used for point to point communication as a master slave. See fig Fig. 11.

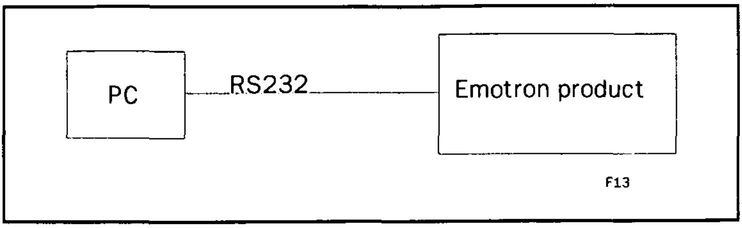


Fig. 11 RS232 point to point network

3.4.1 RS232 connection

Table 26 RS232 pinning

RS232 pin	Function
2	TX from module
3	RX to module
5	Ground

3.4.2 RS232 wiring

The RS232 port consists of a sub-D 9 pole female connector. The wiring should be done according to Fig. 11.

NOTE! Use an 1:1 cable WITHOUT a pin 2-3 crossing.

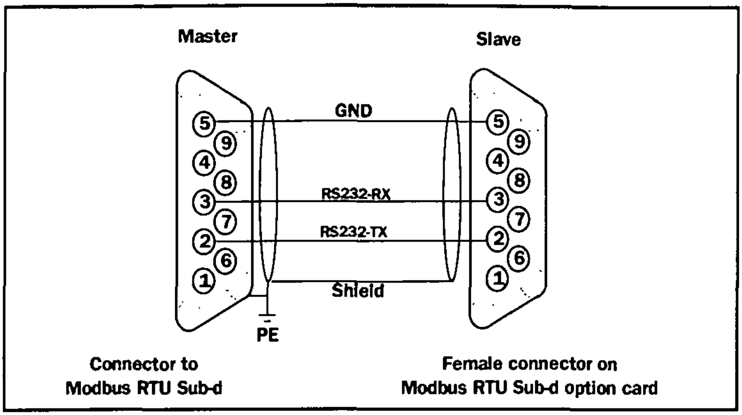


Fig. 12 RS232 wiring.

NOTE! Physical connection can be either RS232 or RS485, not both on the same time.

3.5 Set-up Communication Parameters for Softstarter MSF

The following parameters have to be set-up:
- Unit address.
- Baud rate.
- Parity
- Behaviour when contact broken.

Setting up the communication parameter must be made in local 'Keyboard control' mode. See 3.6.1, page 38.

Serial comm. unit address[111]

111	
1	**Serial comm unit address**
Default:	1
Range:	1-247
This parameter will select the unit address.	

Serial comm. baudrate[112]

112	
9.6	**Serial comm baudrate**
Default:	9.6
Range:	2.4, 4.8, 9.6, 19.2, 38.4 kBaud
This parameter will select the baudrate.	

Serial comm. parity[113]

113	
0	**Serial comm parity**
Default:	0
Range:	0.1
This parameter will select the parity. 0 No parity. 1 Even parity.	

Serial comm. broken alarm[114]

If control mode is 'Serial comm. control' and no contact is established or contact is broken the Soft starter consider the contact to be broken after 15 sec, the softstarter can act in three different ways:

1 Continue without any action at all.
2 Stop and alarm after 15 sec.
3 Continue and alarm after 15 sec.

If an alarm occurs, it is automatically reset if the communication is re-established. It is also possible to reset the alarm from the soft starter keyboard.

114	
1	**Serial comm. contact interrupted**
Default:	1
Range:	oFF, 1, 2
This parameter will control the behaviour in the soft starter when the serial comm. is interrupted. oFF No alarm and continue operation. 1 Alarm and stop operation. 2 Alarm and continue operation.	

3.6 Softstarter MSF in serial comm. control mode

The source from where operation and parameter settings are made is selected in the Control Mode para-meter menu 006. When serial communication control mode (3) is selected, it is possible to:

- Operate the soft starter only via serial comm.
- Set up parameters only via serial comm. Exceptions for the serial comm. parameters described above.
- Readout all view information and all parameters.
- Set up the control mode parameter from local MSF keyboard, but not via serial comm.
- Inspect all parameters and open the menu expansions from local MSF keyboard.

3.6.1 Selection of control mode [006]

Setting up the control mode has to be done from the local MSF keyboard.

006	**Selection of control mode**
2	
Default:	2
Range:	1, 2, 3
This parameter will select the control mode (source). 1 Keyboard control. 2 Remote input control. 3 Serial communication control.	

In all control modes it is possible to read out all the information in the soft starter via serial communication, both parameters and view information.

NOTE! When Reset to factory settings is made via serial comm., the control mode will remain in serial comm. control.

See also 6.1.7 'Overview of soft starter operation and parameter set-up' in MSF instruction manual.

3.7 Parameter List

Logical number is often used to give a parameter a unique number. But it is not the logical number inside the actual MODBUS message.

The following table explains the relations between logical numbers and actual numbers inside MODBUS messages.

Table 27 Parameter types

Parameter type	Modbus logical numbers	Modbus actual numbers
Coil Status	1 - 10000	0 - 9999 (Logical-1)
Input Status	10001 - 20000	0 - 9999 (Logical-10001)
Input Registers	30001 - 40000	0 - 9999 (Logical-30001)
Holding Registers	40001 - 50000	0 - 9999 (Logical-40001)

The product MSF menu column show the menu number on the PPU (Parameter Presentation Unit) for the parameter.

For more information on any parameter/function, see Instruction Manual MasterStart MSF Softstarter.

3.8 Coil status list

Table 28 Coil status list

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product MSF menu
1	0	Alarm reset	0->1 = Reset	
2	1	Run /-Stop	Stop=0, Run=1	
5	4	Auto-set monitor	0->1 = Auto-set	089
6	5	Reset power consumption	0->1 = Reset	206
26	25	Pump control	Off, on; off=0, on=1	022
27	26	Full voltage start D.O.L.	Off, on; off=0, on=1	024
28	27	By pass	Off, on; off=0, on=1	032
29	28	Power factor control PFC	Off, on; off=0, on=1	033
30	29	Motor PTC input	No, yes; no=0, yes=1	071
31	30	Run at single phase input failure	No, yes; no=0, yes=1	101
32	31	Run at current limit time-out	No, yes; no=0, yes=1	102
33	32	Jog forward from keyb. enable	No, yes; no=0, yes=1	103
34	33	Jog reverse from keyb. enable	No, yes; no=0, yes=1	104
35	34	Phase reversal alarm	Off, on; off=0, on=1	088

3.9 Input status list

Table 29 Input status list

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product MSF menu
10001	0	Locked keyboard info	0=Unlocked, 1=Locked	221
10002	1	Extended start ramp time	No, yes; no=0, yes=1	S05
10003	2	Pre-Alarm status	0=No Pre-Alarm, 1=Pre-Alarm	
10004	3	Max Pre-Alarm status	0=No Pre-Alarm, 1=Pre-Alarm	
10005	4	Min Pre-Alarm status	0=No Pre-Alarm, 1=Pre-alarm	

3.10 Input register list

Table 30 Input register list

Modbus logial no	Modbus no	Function/Name	Range/Unit	Product MSF menu
30001	0	Power consumption high word	0-2E9 Wh,1Wh<->1	205
30002	1	Power consumption low word		205
30003	2	Electrical power high word	0-+-2E9 W,1 W<->1	S51
30004	3	Electrical power low word		S51
30005	4	Output shaft power high word	0-+-2E9 W,1 W<->1	203
30006	5	Output shaft power low word		203
30007	6	Operation time high word	0.1 days <->1	208
30008	7	Operation time low word	0.1 days <->1	208
30011	10	Shaft torque high word	0- +-2E8 Nm, 0.1Nm <-> 1	207
30012	11	Shaft torque low word	"	207
30017	16	Software version	r23 -> r = release, Bit 15-14 = 0,0 LB =23	
30018	17	Software variant	v001 -> HB=0, LB=01	
30019	18	Current	0-6553.5A, 0.1A<->1	005
30020	19	Phase 1 current	"	211
30021	20	Phase 2 current	"	212
30022	21	Phase 3 current	"	213
30024	23	Line main voltage	"	202
30025	24	Line main voltage 1	"	214
30026	25	Line main voltage 2	"	215
30027	26	Line main voltage 3	"	216
30028	27	Product type number	1-19 See description in 3.12.1.	
30029	28	Control start by / Control mode	1= Keyboard 2= Remote 3= Serial comm.	006
30031	30	Serial comm. unit address	1-247	111

Table 30 Input register list (continuing)

Modbus logial no	Modbus no	Function/Name	Range/Unit	Product MSF menu
30032	31	Serial comm. baudrate	2400–38400 Baud, 100 Baud <-> 1	112
30033	32	Serial comm. parity	0=No parity 1=Even parity	113
30034	33	Serial comm. contact broken	0-2 See description in 3.12.2.	114
30035	34	Actual parameter set	1-4	
30036	35	Shaft power %	-200% -+200% 1%<-> 1	090
30037	36	Cooler temperature	30.0 - 100.0°C 0.1°C <-> 1	
30041	40	Operation mode	1-7 See description in 3.12.3.	
30042	41	Operation status	1-11 See description in 3.12.4.	
30047	46	Used thermal capacity	0-150 %, 1%<->1	073
30048	47	Power factor	0.00-1.00,0.01<->1	204
30049	48	Current ratio	80 -150%, 1%<->1	
30050	49	Voltage ratio	50 -150%, 1%<->1	F12
30051	50	Phase sequence	0-2 0 = None, 1 = RST, 2 = RTS	087
30052	51	Emotron product	1=VFB/VFX, 2=MSF	
30103	102	Trip message 1	0- 16 See description in 3.12.5.	901
30106	105	Trip message 2	See trip message 1.	902
30109	108	Trip message 3	See trip message 1.	903
30112	111	Trip message 4	See trip message 1.	904

Table 30 Input register list (continuing)

Modbus logial no	Modbus no	Function/Name	Range/Unit	Product MSF menu
30115	114	Trip message 5	See trip message 1.	905
30118	117	Trip message 6	See trip message 1.	906
30121	120	Trip message 7	See trip message 1.	907
30124	123	Trip message 8	See trip message 1.	908
30127	126	Trip message 9	See trip message 1.	909
30130	129	Trip message 10	See trip message 1.	910

3.11 Holding register list

Table 31 Holding register list

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product MSF menu
40001	0	Nominal motor voltage	200.0-700.0V 0.1V<->1	041
40002	1	Nominal motor frequency	50-60Hz 1Hz<->1	046
40003	2	Nominal motor current	25 %- 150% Insoft in Amp.0.1A<->1	042
40004	3	Nominal motor speed	500 - 3600 Rpm Bit15=0->1rpm<->1	044
40005	4	Nominal motor power	25% -150% Pnsoft in W; Bit15=0->1W<->1 Bit15=1->100W<->1	043
40006	5	Nominal motor cos phi	50-100, Cos phi = 1.00 <-> 100	045
40013	12	Start delay monitor	1-250sec,1sec<->1	091
40014	13	Max alarm response delay	0.1-25.0sec 0.1s->1	093
40015	14	Max alarm limit	5-200% Pn 1%<->1	092
40017	16	Max pre-alarm	5-200% Pn 1%<->1	094
40018	17	Min alarm response delay	0.1-25.0sec 0.1s<->1	099
40019	18	Min alarm limit	5-200% Pn 1%<->1	098
40020	19	Min pre-alarm response delay	0.1-25.0sec 0.1s<->1	097
40021	20	Min pre-alarm	5-200% Pn 1%<->1	096
40022	21	Parameter set	0 = External input selection 1-4 = Par. set 1-4.	061
40023	22	Relay 1	1-3 See description in 3.12.6.	051
40024	23	Relay 2	1-4 See description in 3.12.7.	052
40028	27	AnIn 1, setup	0= OFF, No remote analogue control. 1= 0-10V/0-20mA 2= 2-10V/4-20mA	023

Table 31 Holding register list (continuing)

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product MSF menu
40037	36	AnOut 1, function	1 - 3 See description in 3.12.8.	055
40038	37	AnOut 1, setup	0= OFF, No analogue output. 1= 0-10V/0-20mA 2= 2-10V/4-20mA	054
40040	39	AnOut 1, scaling	5 - 150% 1% <-> 1	056
42001	2000	Initial voltage at start	25-90% U, 1% Un<->1	001
42002	2001	Start time ramp 1	1-60sec, 1 sec<->1	002
42003	2002	Step down voltage at stop	100-40% U,1% Un<->1	003
42004	2003	Stop time ramp 1	Off,1-120sec, 1s<->1	004
42005	2004	Initial voltage start ramp 2	30-90% U, 1% Un<->1	011
42006	2005	Start time ramp 2	Off,1-60sec, 1sec<->1	012
42007	2006	Step down voltage stop ramp 2	100-40% U, 1% Un<->1	013
42008	2007	Stop time ramp 2	Off,1-120sec, 1s<->1	014
42009	2008	Initial torque at start	0-200% Tn,1% Tn<->1	016
42010	2009	End torque at start	50-200% Tn, 1% Tn<->1	017
42011	2010	Torque control	Off = Torque control OFF 1 = Linear characteristic. 2 = Square characteristic.	025
42012	2011	Voltage ramp with current limit	Off, 150-500% In 1% In<->1	020
42013	2012	Current limit at start	Off, 150-500% In 1% In<->1	021
42014	2013	DC-Brake current limit	100-300% In 1% In<->1	035
42015	2014	DC-Brake active time	Off, 1-120sec, 1s<->1	034
42016	2015	Torque boost current limit	300-500% In 1% In<->1	031
42017	2016	Torque boost active time	Off, 0.1-2.0sec 0.1sec<->1	030

Table 31 Holding register list (continuing)

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product MSF menu
42018	2017	Slow speed digital input	Off, 1-100 edges, 1 edge<->1	036
42019	2018	Slow speed torque	10-100, 10 <->10	037
42020	2019	Slow speed time at start	Off, 1-60sec, 1s<->1	038
42021	2020	Slow speed time at stop	Off, 1-60sec, 1s<->1	039
42022	2021	Slow speed DC-Brake time	Off, 1-60sec, 1s<->1	040
42023	2022	Motor thermal protection class	Off, 2-40sec, 1s<->1	072
42024	2023	Starts per hour limitation	Off, 1-90/hour, 1<->1	074
42025	2024	Locked rotor alarm	Off, 0.1-10.0sec 0.1 sec<->1	075
42026	2025	Voltage unbalance alarm	5-25% Un, 1% Un<->1	081
42027	2026	Response delay voltage unbal.	Off,1-60sec, 1sec<->1	082
42028	2027	Over voltage alarm	100-150% Un 1% Un<->1	083
42029	2028	Response delay over voltage	Off, 1-60sec, 1s<->1	084
42030	2029	Under voltage alarm	75-100% Un 1% Un<->1	085
42031	2030	Response delay under voltage	Off, 1-60sec, 1sec<->1	086
42032	2031	Reset to factory settings	No, yes; no=0, yes=1	199

3.12 Parameter description MSF

The MODBUS logical number inside brackets.

For more information on any parameter/function, see Instruction Manual MasterStart MSF Softstarter.

3.12.1 Softstarter type (30028).

Table 32 Softstarter type

1 MSF-017	2 MSF-030	3 MSF-045	4 MSF-060	5 MSF-075	6 MSF-085
7 MSF-110	8 MSF-145	9 MSF-170	10 MSF-210	11 MSF-250	12 MSF-310
13 MSF-370	14 MSF-450	15 MSF-570	16 MSF-710	17 MSF-835	18 MSF-1000
19 MSF-1400					

3.12.2 Serial comm. contact broken (30034).

Table 33 Serial comm. contact broken

0	No action when communication is lost.
1	Stop and alarm after 15 sec. when communication is lost.
2	Continue and alarm after 15 sec. when communication is lost.

Communication is considered lost if no request is made to this unit within 15 sec.

3.12.3 Operation mode (30041).

1	Voltage control.
2	Torque control.
3	Current limit control.
4	Ramp with current limit control.
5	Pump application.
6	Analogue input voltage control.
7	Direct On Line start.

3.12.4 Operation status (30042).

1	Stopped.
2	Stopped with alarm condition.
3	Run with alarm condition.
4	Run acceleration.
5	Run full voltage.
6	Run deceleration.
7	Run by passed.
8	Run power factor control.
9	Run DC brake.
10	Run at slow speed forward.
11	Run at slow speed reverse.

3.12.5 Alarm (30103).

1	Phase input failure	F1
2	Motor protection, overload	F2
3	Soft start overheated	F3
4	Current limit timeout	F4
5	Locked rotor	F5
6	Above max power limit	F6
7	Below min power limit	F7
8	Voltage unbalance	F8
9	Over voltage	F9
10	Under voltage	F10
11	Starts/hour exceeded	F11
12	Shorted thyristor	F12
13	Open thyristor	F13
14	Motor terminal open	F14
15	Serial comm. broken	F15
16	Phase reversal alarm	F16

3.12.6 Relay indication K1 (40023).

1	Indicates 'Operation'.
2	Indicates 'Full voltage'.
3	Indicates 'Pre alarm'.

3.12.7 Relay indication K2 (40024).

1	Indicates 'Operation'.
2	Indicates 'Full voltage'.
3	Indicates 'Pre alarm'.
4	Indicates 'DC-brake function is chosen'.

3.12.8 Analogue output value (40037).

1	RMS current (range 0 - 5(In).
2	Main input RMS voltage (range 0 - 532V).
3	Output shaft power (range 0 - 2(Pn).

3.12.9 Reset to factory setings (42032)

Reset to factory settings from serial communication will have the same effect as if it was done from the PPU keyboard, except for one parameter. The control mode (menu 006) will remain in 3 (serial comm. control) instead of being set to the default value 2 (remote control).

3.13 Performance

It is important to configure the communication master according to the slave performance/restrictions. The total message size must not exceed 64 bytes.
Max number of registers at a time is limited to 25 (both for read and write).

Max 2 requests per sec. to reduce system disturbance.

Min 1 request per 15 sec. to avoid serial comm. contact broken alarm.

3.13.1 MSF response delay

The read function codes (1 - 4), will have a maximum delay of 250 ms.

Table 34 Response delay table for setting (forcing) registers

Modbus logical nr	Parameter	Response delay/ recommended time out
40001-40006	Nominal motor data	500 ms/data
42032	Reset to factory settings	3.5 sec
	Other registers	250 ms

4. INVERTER VFB/VFX DATA

4.1 Installation bookshelf types

Fig. 13 shows the parts of the MODBUS RTU option.

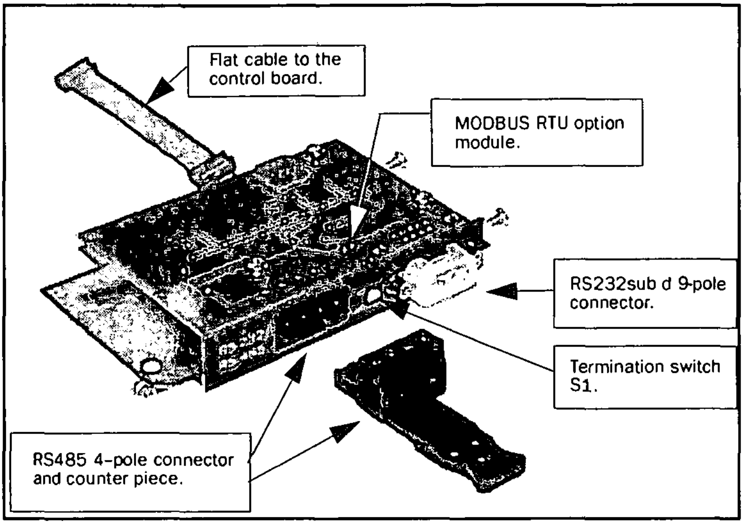


Fig. 13 MODBUS RTU option card.

WARNING! Opening the Inverter. Always switch off the mains voltage before opening the inverter and wait at least 5 minutes to allow the buffer capacitors to discharge.

Remove first the lid on the top side of the inverter. Mount the option card according to the sequence in Fig. 14.

4.1.1 Mounting option card

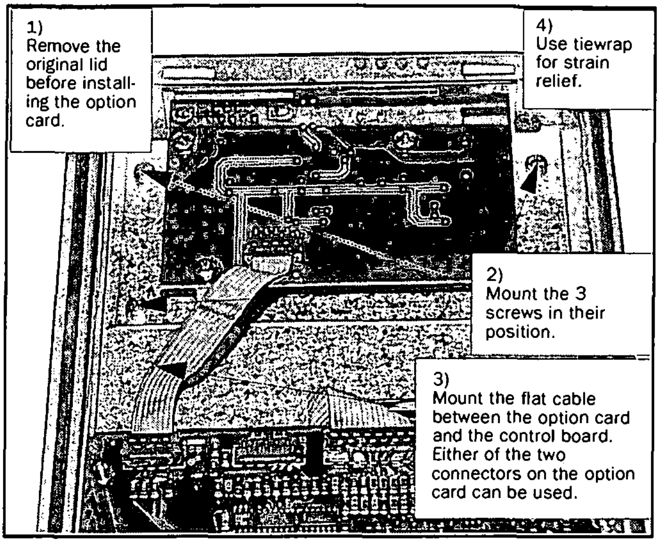


Fig. 14 Installation of the option card in VFB.

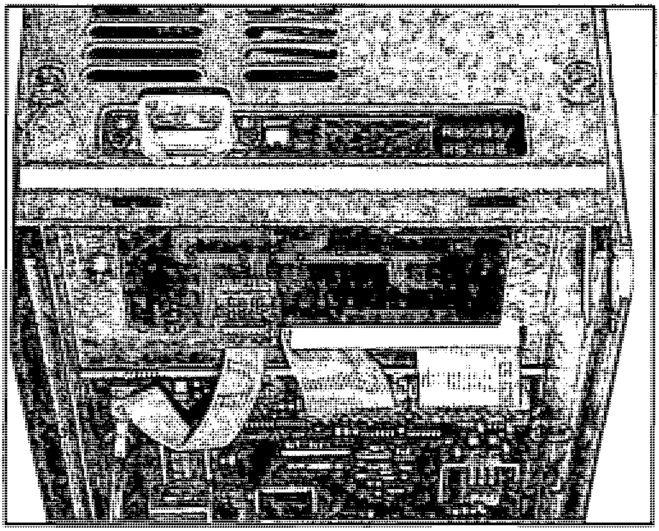


Fig. 15 Mounting of option card from above in VFB.

4.2 Installation of VFX types

NOTE! Pictures are under construction, to be defined.

4.3 RS485 Multipoint network

The RS485 port (see Fig. 13) is used for multi point communication. A host computer (PC/PLC) can address (master) maximum 247 slave stations (nodes). See Fig. 16.

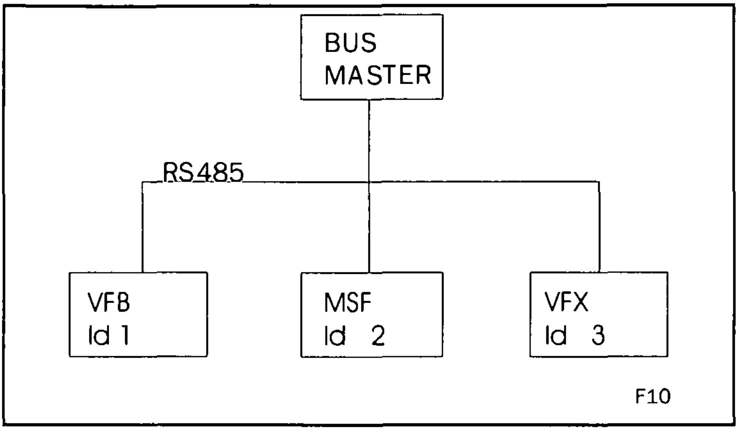


Fig. 16 RS 485 multipoint network

4.3.1 RS485 connection

Table 35 RS485 pinning

RS485 pin	Function
1	Ground
2	A-line
3	B-line
4	PE

The connector is a 4-pole male connector. The wiring should be done according to Fig. 17.

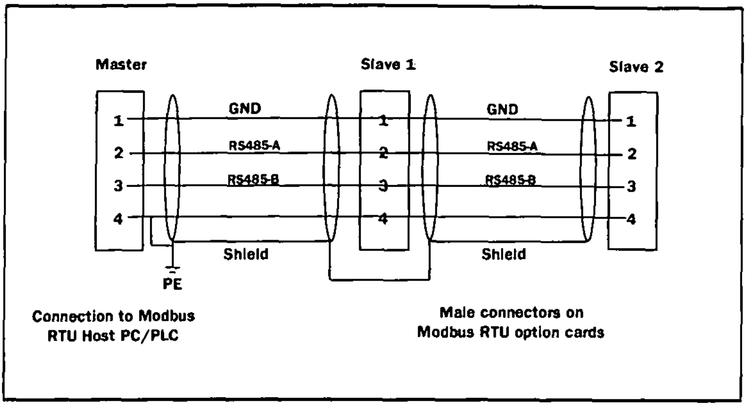


Fig. 17 RS485 wiring

4.3.2 RS485 termination.

The RS485 network must always be terminated, to avoid transmission problem. The termination must take place at the end of the network. In finure 5 this means that the termination must take place at the slave 2 unit.

Switch S1 (see Fig. 4) sets the termination ON or OFF as indicated in the Fig. 18 and Fig. 19.

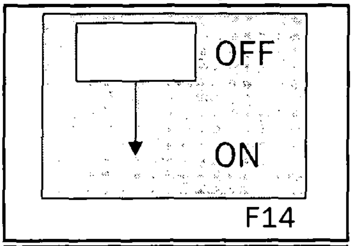


Fig. 18 Termination is OFF

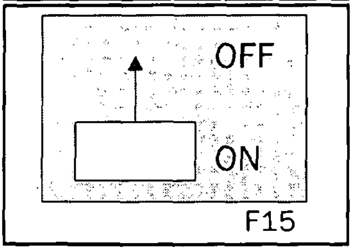


Fig. 19 Termination is ON

NOTE! Physical connection can be either RS232 or RS485, not both on the same time.

4.4 RS232 point to point network

The RS232 port is used for point to point communication as a master slave. See fig Fig. 20.

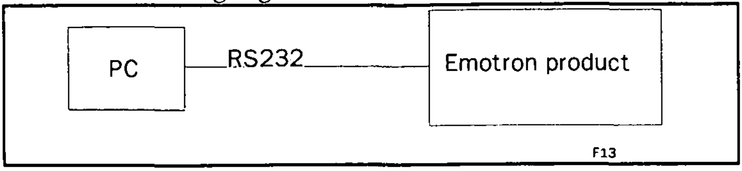


Fig. 20 RS232 point to point network

4.4.1 RS232 connection

Table 36 RS232 pinning

RS232 pin	Function
2	TX from module
3	RX to module
5	Ground

4.4.2 RS232 wiring

The RS232 port consists of a sub-D 9 pole female connector. The wiring should be done acc. to Fig. 20.

NOTE! Use an 1:1 cable WITHOUT a pin 2-3 crossing.

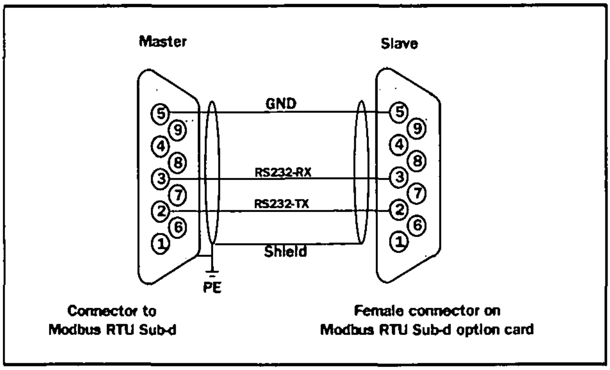


Fig. 21 RS232 wiring

NOTE! Physical connection can be either RS232 or RS485, not both on the same time.

4.5 Set-up Communication Parameters for frequency inverter VFB/VFX

The following parameters have to be set-up:

- Unit address.
- Baud rate.

Serial comm. unit address[262]

	262 Address Stp 1
Default:	1
Range	1-247
This parameter will select the unit address.	

Serial comm. baud rate[261]

	261 Baudrate Stp 9600
Default:	9600
Range	2400, 4800, 9600, 19200, 38400
This parameter will select the baudrate.	

4.6 Frequency inverter VFB/VFX in serial comm Control Mode

The serial comm link will have access to all parameters in the VFB/VFX inverter. If a valid setting for a parameter is received over the serial link that parameter will be accepted and changed. This means that the control panel and serial comm can be used in parallel. There are some limitations of writing data when the inverter is started, see manual for further information. The only parameters that can't be used in parallell is start/stop and reference values, see 4.5.

Ref control

To be able to use the serial comm as a source for the speed or torque reference menu 212 has to be set to Comm or Comm/DigIn1. See Instruction Manual VFB/VFX for further description.

	212 Ref Control Stp Comm
Default:	Remote
Range	Remote, keyboard, Comm, Rem/ DigIn1,or Comm/DigIn1
This parameter will select reference source	

Run/Stp ctrl

To be able to use the serial comm as a source for starting and stopping the inverter menu 213 has to be set to Comm or Comm/DigIn1. See Instruction Manual VFB/VFX for further description.

	213 Run/Stp Ctrl Stp Comm
Default:	Remote
Range	Remote, keyboard, Comm, Rem/ DigIn1, or Comm/DigIn1
This parameter will select run/stop source	

4.7 Parameter List

Logical number is often used to give a parameter a unique number. But it is not the logical number inside the actual MODBUS message.

The following table explains the relations between logical numbers and actual numbers inside MODBUS messages.

Table 37 Parameter type

Parameter type	Modbus logical numbers	Modbus actual numbers
Coil Status	1 - 10000	0 - 9999 (Logical-1)
Input Registers	30001 - 40000	0 - 9999 (Logical-30001)
Holding Registers	40001 - 50000	0 - 9999 (Logical-40001)

The product VFB/VFX menu column show the menu number on the control panel for the parameters.

For more information on any parameter/function, see Instruction Manual VFB/VFX.

4.8 Coil status list

Table 38 Coil status list

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product VFB/VFX menu
1	0	Alarm reset	0->1 = Reset	
2	1	Run /-Stop	Stop=0, Run=1	
3	2	Run Right	1=Run R	
4	3	Run Left	1=Run L	
5	4	Auto-set monitor	0->1 = Auto-set	815
6	5	Reset power consumption	0->1 = Reset	6F1
7	6	Reset Run-Time	0->1 = Reset	6D1
8	7	Reset Trip Log	0->1 = Reset	7B0
10	9	Auto-restart, Overtemp trip	Off, on; off=0, on=1	242
11	10	Auto-restart, I^2t	Off, on; off=0, on=1	243
12	11	Auto-restart, Overvolt D	Off, on; off=0, on=1	244
13	12	Auto-restart, Overvolt G	Off, on; off=0, on=1	245
14	13	Auto-restart, Overvolt L	Off, on; off=0, on=1	246
15	14	Auto-restart, PTC	Off, on; off=0, on=1	247
16	15	Auto-restart, External trip	Off, on; off=0, on=1	248
17	16	Auto-restart, Phase loss motor	Off, on; off=0, on=1	249
18	17	Auto-restart, Alarm	Off, on; off=0, on=1	24A
19	18	Auto-restart, Locked rotor	Off, on; off=0, on=1	24B
20	19	Auto-restart, Power fault	Off, on; off=0, on=1	24C
30	29	Motor PTC input	no, yes; no=0, yes=1	271

4.9 Input register list

Table 39 Input register list

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product VFB/VFX menu
30001	0	Power consumption high word	0-2E9 Wh, 1 Wh<->1	6F0
30002	1	Power consumption low word		6F0
30003	2	Electrical power high word	0 -+ -2E9 W, 1 W<->1	640
30004	3	Electrical power low word		640
30005	4	Output shaft power high word	0 - + - 2E9 W, 1 W<->1	630
30006	5	Output shaft power low word		630
30007	6	Operation time high word	0 - 65535 h, 1 h<->1	6D0
30008	7	Operation time low word	0 - 59 Min, 1 min<->1	6D0
30009	8	Mains time hour	0 - 65535 h, 1 h<->1	6E0
30010	9	Mains time min	0 - 59 Min, 1 min<->1	6E0
30011	10	Shaft torque high word	0- +-2E8 Nm, 0.1Nm <->1	620
30012	11	Shaft torque low word	"	620
30013	12	Process speed high word	1 - + - 2E8 Rpm, 1 rpm<->1000	6G0
30014	13	Process speed low word	"	6G0
30015	14	Shaft speed high word	0-2E8 rpm,1 rpm<->1	610
30016	15	Shaft speed low word	"	610
30017	16	Software version	V1.23 -> Release Bit 15-14= 0,0 Bit 13-8=1, LB =23 See 4.11.	920
30018	17	Option/variant version	OPT V2.34 -> HB = 2, LB =34	920
30019	18	Current	0-6553.5 A, 0.1A <-> 1	650
30023	22	Output voltage	0-6553.5 V, 0.1V<->1	660
30028	27	Product type number	See description in 4.11.	910

Table 39 Input register list (continuing)

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product VFB/VFX menu
30029	28	Control start by / Control mode	0=Remote, 1=Keyboard, 2=Serial comm	
30030	29	Control ref by	0=Remote 1=Keyboard 2=Serial comm	
30031	30	Serial comm. unit address	1-247	262
30032	31	Serial comm. baudrate	1=2400, 4=19200, 2=4800 5=38400 3=9600,	261
30035	34	Actual parameter set	0-3; 0= A, 2=C, 1=B 3=D	3XX
30036	35	Shaft torque %	-400%-+400% 1%<->1	620
30037	36	Cooler temperature	-40.0-+100.0°C, 0.1°C<->1	690
30038	37	Frequency	0-2000.0Hz, 0.1Hz<->1	670
30039	38	DC-link voltage	0-1000V, 0.1V<->1	680
30040	39	Warning	0-31 See description in 4.11.3.	6H0
30043	42	Digital input status	See description in 4.11.6.	6B0
30044	43	Analog input status 1	-100 -+100%, 1%<->1	6C0
30045	44	Analog input status 2	-100 -+100%, 1%<->1	6C0
30046	45	Param_version	For internal use	
30052	51	Emotron product	1=VFB/VFX, 2=MSF	
30101	100	Trip time 1 h	0-65535 h, 1h<->1	710
30102	101	Trip time 1 min	0-59 Min, 1 min<->1	710
30103	102	Trip message 1	0-31 See description in 4.11.3.	710
30104	103	Trip time 2 h	0-65535 h, 1h<->1	720
30105	104	Trip time 2 min	0-59 Min, 1 min<->1	720

Table 39 Input register list (continuing)

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product VFB/VFX menu
30106	105	Trip message 2	See trip message 1.	720
30107	106	Trip time 3 h	0-65535 h, 1h<->1	730
30108	107	Trip time 3 min	0-59 Min, 1 min<->1	730
30109	108	Trip message 3	See trip message 1.	730
30110	109	Trip time 4 h	0-65535 h, 1h<->1	740
30111	110	Trip time 4 min	0-59 Min, 1 min<->1	740
30112	111	Trip message 4	See trip message 1.	740
30113	112	Trip time 5 h	0-65535 h, 1h<->1	750
30114	113	Trip time 5 min	0-59 Min, 1 min<->1	750
30115	114	Trip message 5	See trip message 1.	750
30116	115	Trip time 6 h	0-65535 h, 1h<->1	760
30117	116	Trip time 6 min	0-59 Min, 1 min<->1	760
30118	117	Trip message 6	See trip message 1.	760
30119	118	Trip time 7 h	0-65535 h, 1h<->1	770
30120	119	Trip time 7 min	0-59 Min, 1 min<->1	770
30121	120	Trip message 7	See trip message 1.	770
30122	121	Trip time 8 h	0-65535 h, 1h<->1	780
30123	122	Trip time 8 min	0-59 Min, 1 min<->1	780
30124	123	Trip message 8	See trip message 1.	780
30125	124	Trip time 9 h	0-65535 h, 1h<->1	790
30126	125	Trip time 9 min	0-59 Min, 1 min<->1	790
30127	126	Trip message 9	See trip message 1.	790
30128	127	Trip time 10 h	0-65535 h, 1h<->1	7A0
30129	128	Trip time 10 min	0-59 Min, 1 min<->1	7A0
30130	129	Trip message 10	See trip message 1.	7A0

4.10 Holding register list

Table 40 Holding register list

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product VFB/VFX menu
40001	0	Nominal motor voltage	100.0-700.0V	222
40002	1	Nominal motor frequency	50-300Hz	223
40003	2	Nominal motor current	25% I_nom-3200.0A	224
40004	3	Nominal motor speed	100-18000 rpm Bit15=0->1rpm<->1 Bit15=1->100rpm<->1	225
40005	4	Nominal motor power	1-3276700W Bit15=0->1W<->1 Bit15=1->100W<->1	221
40006	5	Nominal motor cos phi	50-100, cos phi =1.00<->100	226
40007	6	Motor ventilation	0=Off, 1=Self, 2=Forced	227
40008	7	Remote input level edge	0=Level, 1=Edge	215
40009	8	Encoder pulses	5-32767 pulses/rev	252
40010	9	Encoder enable	0=Off 1=On	251
40011	10	Aarm select	0=Off, 1=Max, 2=Min, 3=Min+max	811
40012	11	Ramp enable	0=Off, 1=On	812
40013	12	Start delay monitor	0-3600sec	813
40014	13	Max alarm response delay	0.1- 90.0sec	814
40015	14	Max alarm limit	0-400% Tn	816
40017	16	Max pre-alarm	0-400% Tn	817
40018	17	Min alarm response delay	40014 is used for all delays	
40019	18	Min alarm limit	0-400% Tn	818
40020	19	Min pre-alarm response delay	40014 is used for all delays	
40021	20	Min pre-alarm	0-400% Tn	819

Table 40 Holding register list (continuing)

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product VFB/VFX menu
40022	21	Parameter set	0=A, 4=DI3, 1=B, 5=DI3+4, 2=C, 6=Comm 3=D,	234
40023	22	Relay 1	0-21 See description in 4.11.4.	451
40024	23	Relay 2	0-21 See description in 4.11.4.	452
40025	24	Relay 3	Not defined yet.	
40026	25	Relay 4	Not defined yet.	
40027	26	AnIn 1, function	0=Off, 1=Speed, 2=Torque	411
40028	27	AnIn 1, setup	0=0-10V/0-20mA 1=2-10V/4-20mA 2=User defined	412
40029	28	AnIn 1, offset	-100% - +100% 1% <-> 1	413
40030	29	AnIn 1, gain	-4.00 - +4.00, 0.01 <-> 1	414
40031	30	AnIn 1, bipolar	0=Off, 1=On	415
40032	31	AnIn 2, function	0=Off, 1=Speed, 2=Torque	416
40033	32	AnIn 2, setup	0=0-10V/0-20mA, 1=2-10V/4-20mA, 2=User defined	417
40034	33	AnIn 2, offset	-100% - +100% 1% <-> 1	418
40036	35	AnIn 2, bipolar	0=Off, 1=On	41A
40037	36	AnOut 1, function	0=Torque, 1=Speed, 4=Current, 2=Shaft power, 5=El.power, 3=Frequency, 6=Outp.voltage	431
40038	37	AnOut 1, setup	0=0-10V/0-20mA 1=2-10V/4-20mA 2=User defined	432
40039	38	AnOut 1, offset	-100% - +100% 1% <-> 1	433
40040	39	AnOut 1, gain	-4.00 - +4.00 0.01 <-> 1	434

Table 40 Holding register list (continuing)

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product VFB/VFX menu
40041	40	AnOut 1, bipolar	0=Off, 1=On	435
40042	41	AnOut 2, function	0=Torque, 1=Speed, 2=Shaft power, 3=Frequency, 4=Current, 5=El.power, 6=Outp. voltage	436
40043	42	AnOut 2, setup	0=0-10V/0-20mA, 1=2-10V/4-20mA, 2=User defined	437
40044	43	AnOut 2, offset	-100% - +100% 1% <-> 1	438
40045	44	AnOut 2, gain	-4.00 - +4.00, 0.01 <-> 1	439
40046	45	AnOut 2, bipolar	0=Off, 1=On	43A
40047	46	AnOut 3, function	0=Torque, 1=Speed, 2=Shaft power, 3=Frequency, 4=Current, 5=El.power, 6=Outp voltage	
40048	47	AnOut 3, setup	0=0-10V/0-20mA, 1=2-10V/4-20mA, 2=User defined	
40049	48	AnOut 3,offset	-100% - +100% 1% <-> 1	
40050	49	AnOut 3, gain	-4.00 - +4.00, 0.01 <-> 1	
40051	50	AnOut 3, bipolar	0=Off, 1=On	
40052	51	AnOut 4, function	0=Torque, 1=Speed, 2=Shaft power, 3=Frequency, 4=Current, 5=El.power, 6=Outp voltage	
40053	52	AnOut 4, setup	0=0-10V/0-20mA, 1=2-10V/4-20mA, 2=User defined	
40054	53	AnOut 4, offset	-100% - +100% 1% <-> 1	
40055	54	AnOut 4, gain	-4.00 - +4.00, 0.01 <-> 1	
40057	56	AnOut 5, function	0=Torque, 1=Speed, 2=Shaft power, 3=Frequency, 4=Current, 5=El.power, 6=Outp voltage	
40058	57	AnOut 5, setup	0=0-10V/0-20mA, 1=2-10V/4-20mA, 2=User defined	

Table 40 Holding register list (continuing)

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product VFB/VFX menu
40059	58	AnOut 5, offset	-100% - +100% 1% <-> 1	
40060	59	AnOut 5, gain	-4.00 - +4.00, 0.01 <-> 1	
40061	60	AnOut 5, bipolar	0=Off, 1=On	
41001	1000	Comm, ref	100% <-> 0x2000	
41002	1001	Operation.drive mode	0=Speed, 1=Torque, 2=V/Hz	211
41003	1002	Operation.ref ctrl	0=Remote, 1=Keyboard, 2=Comm	212
41004	1003	Operation.run stop ctrl	0=Remote, 3=Rem/digin1, 1=Keyboard, 4=Comm/digin1 2=Comm,	213
41005	1004	Operation.rotation	0=R+L, 1=R, 2=L	214
41006	1005	Utility.auto restart mask	16-bit mask	
41007	1006	Utility.auto restart	0-10	241
41008	1007	DigIn 1	0-11 See description in 4.11.6.	421
41009	1008	DigIn 2	0-11 See description in 4.11.6.	422
41010	1009	DigIn 3	0-11 See description in 4.11.6.	423
41011	1010	DigIn 4	0-11 See description in 4.11.6.	424
41014	1013	DigOut 1	0-21 See description in 4.11.4.	441
41015	1014	DigOut 2	0-21 See description in 4.11.4.	442
41018	1017	Crio enable	0=Off, 1=On	281
41019	1018	Crio control	0=4-Speed, 1=3-pos, 2=Analogue	282

Table 40 Holding register list (continuing)

Modbus logical no	Modbus no	Function/Name	Range/Unit	Product VFB/VFX menu
41020	1019	Crio relay 1	0-21 See description in 4.11.4.	283
41021	1020	Crio relay 2	0-21 See description in 4.11.4.	284
41022	1021	Process unit	0=None, 3=m/s, 1=rpm, 4=/min, 2=%, 5=/hr	6G1
41023	1022	Process scale	0-10.000, 0.0001 <=> 1	6G2
41024	1023	Multiple display 1	0=Speed, 6=Frequency, 1=Torque, 7=DC voltage, 2=Shaft power,8=Temp, 3=El power, 9=Drive status, 4=Current, 10=Process speed 5=Voltage,	110
41025	1024	Multiple display 2	See 41024	120
41026	1025	Utility language	0=English, 3=Dutch, 1=German, 4=French 2=Swedish,	231
41027	1026	Utility keyboard locked	0=Unlocked, 1=Locked	232
41028	1027	Serial com. address	1-247	262
41029	1028	Serial com. Baud-rate	1=2400, 4=19200, 2=4800 5=38400 3=9600,	261
41030	1029	Serial com. parity	0=None	
41032	1031	MVB card on/off	0=Off, 1=On	291

Table 41 Parameter set A

***	***	VFB/VFX Parameter set A	***	***
41101	1100	Acceleration time	0.00-3600.00 See description in 4.11.7	311
41102	1101	Deceleration time	0.00-3600.00 See description in 4.11.7	313
41103	1102	Q-stop time	0.00-3600.00 See description in 4.11.7	31B
41104	1103	Acceleration shape	0=Linear, 1=S-curve	312
41105	1104	Deceleration shape	0=Linear, 1=S-curve	314
41106	1105	Q-stop shape	0=Linear	
41111	1110	Wait before brake time	0.00-3.00, 0.01s<->1	319
41112	1111	Vector brake	0=Off, 1=On	31A
41113	1112	Spinstart	0=Off, 1=On	31C
41114	1113	Motor pot function	0=Volatile, 1=Non-volatile	325
41115	1114	Minspeed mode	0=Scale, 1=Limit, 2=Stop	323
41116	1115	Minimum speed	0- Maximum speed, see description in 4.11.7	321
41117	1116	Maximum speed	Minimum speed-2*motor sync speed, see description in 4.11.7	322
41118	1117	Preset speed 1	0-2*Motor sync speed, see description in 4.11.7	326
41119	1118	Preset speed 2	0-2*Motor sync speed, see description in 4.11.7	327
41120	1119	Preset speed 3	0-2*Motor sync speed, see description in 4.11.7	328
41121	1120	Preset speed 4	0-2*Motor sync speed, see description in 4.11.7	329
41122	1121	Preset speed 5	0-2*Motor sync speed, see description in 4.11.7	32A
41123	1122	Preset speed 6	0-2*Motor sync speed, see description in 4.11.7	32B
41124	1123	Preset speed 7	0-2*Motor sync speed, see description in 4.11.7	32C

Table 41 Parameter set A (continuing)

***	***	VFB/VFX Parameter set A	***	***
41125	1124	Skip speed 1 Low	0-2*Motor sync speed, see description in 4.11.7	32D
41126	1125	Skip speed 1 High	0-2*Motor sync speed, see description in 4.11.7	32E
41127	1126	Skip speed 2 Low	0-2*Motor sync speed, see description in 4.11.7	32F
41128	1127	Skip speed 2 High	0-2*Motor sync speed, see description in 4.11.7	32G
41129	1128	Jog speed	0-±2*Motor sync speed, see description in 4.11.7	32F
41130	1129	Maximum torque	0-400%, 1%<-> 1 or I_max/motor In	331
41131	1130	Speed P gain	0.1-30.0, 0.1<->1	342
41132	1131	Speed I time	0.01-10.00s, 0.01s<->1	343
41133	1132	Flux optimization	0=Off, 1=On	344
41134	1133	PID-controller	0=Off, 1=On, 2=Invert	345
41135	1134	PID-controller P gain	0.1-30.0, 0.1<->1	346
41136	1135	PID-controller I time	0.01-300.00s, 0.01s<->1	347
41137	1136	PID-controller D time	0.01-30.00s, 0.01s<->1	348
41138	1137	Low voltage overr-ride	0=Off, 1=On	351
41139	1138	Rotor locked	0=Off, 1=On	352
41140	1139	Motor lost	0=Off, 1=Resume, 2=Trip	353
41141	1140	Motor I2t type	0=Off, 1=Trip, 2=Limit	354
41142	1141	Motor I2t current	0-150% inverter i_nom, 0.1A<->1	355
41143	1142	Speed direction	0=R, 1=L, 2=R+L	324
41144	1143	Start speed	0 - + -2*Motor sync speed, see description i 4.11.7, page 76.	321

Table 42 Parameter set B, C and D

***	***	**VFB/VFX Parameter set B**	***	***
41201- 41299	1200-1298	/* Parameter set B */		
***	***	**VFB/VFX Parameter set C**	***	***
41301- 41399	1300-1398	/* Parameter set C */		
***	***	**VFB/VFX Parameter set D**	***	***
41401- 41499	1400-1498	/* Parameter set D */		

4.11 Parameter description VFB/VFX

The MODBUS logical number inside brackets.

For more information on any parameter/function, see Instruction Manual Vectorflux VFB/VFX.

4.11.1 Inverter software version (30017).

MSB	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0	LSB

Bit F,E	**Release Type:**	00	Release (V)
		01	Pre release (P)
		10	Beta (B)
		11	Alpha (A)
Bit D-8	**Major version**	000000	0
		000001	1
		111110	62
		111111	63
Bit 7-0	**Minor version**	00000000	0
		00000001	1
		11111110	254
		11111111	255
		3508h ->	
(5.08			

4.11.2 Inverter type (30028).

MSB	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0	LSB

Bit F,E,D,C,B	**Reserved for future use**		
Bit A	**Option:**	0	w/o Brake chopper
		1	with Brake chopper
Bit 9,8	**Type:**	10	FDB
		11	FDX
Bit 7,6,5	**Size:**	000	Reserved
		001	Size 1
		010	Size 2
		011	Size 3
		100	Size 4 and 8
		101	Size 5 and 10
		110	Reserved
		111	Size 15 and 20
Bit 4,3,2	**Power:**	000	Reserved
		001	1st Power in size
		010	2nd Power in size
		011	3rd Power in size
		100	4th Power in size
		101	5th Power in size
		110	6th Power in size
		111	7th Power in size
Bit 1,0	**Voltage class:**	00	230V
		01	400V
		10	500V
		11	690V

4.11.3 Warning, Tripmessage 1-10 (30040, 30103, 30106, 30109, 30112, 30115, 30118, 30121, 30124, 30127,30130).

0=No warning	1=Overtemp	2=Overcurrent	3=Overvolt D
4=Overvolt G	5=Overvolt L	6=Motor Temp	7=Ext Trip
8=Spare	9=Max Alarm	10=Locked Rotor	11=Power Fault
12=Int Error	13=Spare	14=Spare	15=Spare
16=Overvoltage	17=Low Voltage	18=Overtemp	19=Motor lost
20=Max Pre-Alrm	21=Min Pre-Alrm	22=Overcurrent	23=Spare
24=Spare	25=Spare	26=Spare	27=Overvolt L
28=Min Alarm	29=Spare	30=Spare	31=Spare

4.11.4 Relay, Digout and CRIO relay (40023,40024,41014,41015,41020, 41021).

0=Run	1=Stop	2=Acc/Dec	3=At speed
4=At max speed	5=No Trip	6=Trip	7=Autorst Trip
8=Limit	9=Warning	10=Ready	11=T=Tlim
12=I>Inom	13=Brake	14=Sgnl<Offset	15=Alarm
16=Pre Alarm	17=Max Alarm	18=Max Pre-Alrm	19=Min Alrm
20=Min Pre-Alrm	21=Deviation		

4.11.5 5.x.x Auto restart mask (41006)

MSB	F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0	LSB

Bit 12-15	Spare	
Bit 11	INT_ERROR	0x0800
Bit 10	POWER_FAULT	0x0400
Bit 9	LOCKED_ROTOR	0x0200
Bit 8	MON_ALARM	0x0100
Bit 7	MOTOR_LOST	0x0080
Bit 6	EXT_TRIP	0x0040
Bit 5	MOTOR_TEMP	0x0020
Bit 4	OVER_VOLT_L	0x0010
Bit 3	OVER_VOLT_G	0x0008
Bit 2	OVER_VOLT_D	0x0004
Bit 1	IIT	0x0002
Bit 0	OVER_TEMP	0x0001

The corresponding bits should be set to activate the autoreset function. To enable auto reset for Int error (bit 11) and locked rotor (Bit 9) the value 0x0A00 should be written to the register.

If the value 0x0123 was read, it indicates that MON_ALARM, MOTOR_TEMP, IIT and OVER_TEMP are in auto reset mode and all other functions are swithced off.

4.11.6 DigIn (41008,41009).

0=Off	1=Lim Switch+	2=Lim Switch -	3=Ext. Trip
4=AnIn Select	5=Preset Ref 1	6=Preset Ref 2	7=Preset Ref 4
8=Quick Stop	9=Jog	10=MotPot Up	11=MotPot Down
12=PS selected!			

4.11.7 Representation of speed.

Bit15=0<->1rpm<->1

Bit15=1<->100rpm<->1

4.12 Performance

It is important to configure the communication master according to the slave performance/restrictions.

The total message size must not exceed 64 bytes.
Max number of registers at a time is limited to 25 (both for read and write).

4.12.1 VFB/VFX response delay

The response delay for the VFB/VFX will be maximum 8 ms.

5. CRC GENERATION

The CRC is started by first pre-loading a 16-bit register to all 1's. Then a process begins of applying successive eight-bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit, do not apply to the CRC.

During generation of the CRC, each eight-bit character is exclusive ORed with the register contents. The result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB was a 1, the register is then exclusive OR-ed with a preset, fixed value. If the LSB was a 0, no exclusive OR takes place.

This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next eight-bit character is exclusive OR-ed with the register's current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the characters of the message have been applied, is the CRC value.

Generation in steps:

- **Step 1** Load a 16-bit register with 0xFFFF (all 1's). Call this the CRC register.
- **Step 2** Exclusive OR the first eight-bit byte of the message with the low order byte of the 16-bit CRC register, putting the result in the CRC register.
- **Step 3** Shift the CRC register one bit to the right (toward the LSB), zero-filling the MSB. Extract and examine the LSB.
- **Step 4** If the LSB is 0, repeat Step 3 (another shift). If the LSB is 1, Exclusive OR the CRC register with the polynomial value 0xA001 (1010 0000 0000 0001) .
- **Step 5** Repeat Steps 3 and 4 until eight shifts have been performed. When this is done, a complete eight-bit byte will have been processed.

- **Step 6** Repeat Steps 2 ... 5 for the next eight-bit byte of the message. Continue doing this until all bytes have been processed.
  Result The final contents of the CRC register is the CRC value.
- **Step 7** When the CRC is placed into the message, its upper and lower bytes must be swapped as described below.
- Placing the CRC into the Message
  When the 16-bit CRC (two eight-bit bytes) is transmitted in the message, the low order byte will be transmitted first, followed by the high order byte - e.g., if the CRC value is 0x1241.

Message	
CRC LO	41
CRC HI	12

Example of CRC Generation Function

An example of a C language function performing CRC generation is shown on this page.
The function takes two arguments:

- Unsigned char *puchMsg; A pointer to the message buffer containing binary data to be used for generating the CRC.
- Unsigned int usDataLen; The quantity of bytes in the message buffer.

The function returns the CRC as a type unsigned int.

- Unsigned int CRC16 (unsigned int usDataLen, unsigned char *puchMsg)

```
#define CRC_POLYNOMIAL    0xA001
  unsigned int crc_reg;
  unsigned char i,k;
  crc_reg = 0xFFFF;
  for (i=0 ; i<usDataLen ; i++)
  {
    crc_reg ^= *puchMsg++;
    for (k=0 ; k<8 ; k++)
    {
      if (crc_reg & 0x0001)
      {
        crc_reg >>= 1;
        crc_reg ^= CRC_POLYNOMIAL;
      }
      else
        crc_reg >>= 1;
    }
  }
  return crc_reg;
```

Fig. 22 CRC example.

emotron

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Emotron MSF 2.0 Softstarter

Instruction manual

English

emotron

DEDICATED DRIVE

Valid for the following softstarter models:
MSF 2.0

MSF 2.0

SOFTSTARTER

Instruction manual

Document number: 01-4135-01
Edition: r1
Date of release: 25-07-2007

Safety instructions

Safety

The softstarter should be installed in a cabinet or in an electrical control room.

- The device must be installed by trained personnel.
- Disconnect all power sources before servicing.
- Always use standard commercial fuses, slow blow e.g. gl, gG types, to protect the wiring and prevent short circuiting. To protect the thyristors against short-circuit currents, superfast semiconductor fuses can be used if preferred. The normal guarantee is valid even if superfast semiconductor fuses are not used.

Operating and maintenance personnel

1. Read the whole Instruction Manual before installing and putting the equipment into operation.
2. During all work (operation, maintenance, repairs, etc.) observe the switch-off procedures given in this instruction as well as any other operating instruction for the driven machine or system. See Emergency below.
3. The operator must avoid any working methods which reduce the safety of the device.
4. The operator must do what he can to ensure that no unauthorised person is working on the device.
5. The operator must immediately report any changes to the device which reduce its safety to the user.
6. The user must undertake all necessary measures to operate the device in perfect condition only.

Installation of spare parts

We expressly point out that any spare parts and accessories not supplied by us have also not been tested or approved by us.

Installing and/or using such products can have a negative effect on the characteristics designed for your device. The manufacturer is not liable for damage arising as a result of using non-original parts and accessories.

Emergency

You can switch the device off at any time with the mains switch connected before the softstarter (both motor and control supply voltage must be switched off).

Dismantling and scrapping

The enclosure of the softstarter is made of recyclable material such as aluminium, iron and plastic. Legal requirements for disposal and recycling of these materials must be complied with.

The softstarter contains a number of components demanding special treatment, such as thyristors for example. The circuit boards contain small amounts of tin and lead. Legal requirements for the disposal and recycling of these materials must be complied with.

General warnings

WARNING! Make sure that all safety measures have been taken before starting the motor in order to avoid personal injury.

WARNING! Never operate the softstarter with the front cover removed.

WARNING! Make sure that all safety measures have been taken before switching on the power supply.

Contents

1. General information

This manual describes the Emotron Softstarter MSF 2.0.

1.1 How to use the Instruction Manual

This instruction manual tells you how to install and operate the softstarter MSF 2.0. Read the whole Instruction Manual before installing and putting the unit into operation.

Once you are familiar with the softstarter, you can operate it from the control panel by referring to chapter 5. page 27. This chapter describes all the functions and possible settings.

1.2 Integrated safety systems

The device is equipped with a protection system which reacts to:

- Over temperature
- Voltage unbalance
- Over- and under voltage
- Phase reversal
- Phase loss
- Motor overload protection thermal and PTC.
- Motor load monitor, protecting machine or process maximum or minimum alarm
- Starts per hour limitation

The softstarter is equipped with a connection for protective earth ⏚ (PE).

All MSF 2.0 softstarters are IP 20 enclosed types, except MSF-1000 and MSF-1400 which are delivered as open chassis IP00.

1.3 Safety measures

These instructions are a constituent part of the device and must be:

- Available to competent personnel at all times.
- Read prior to installation of the device.
- Observed with regard to safety, warnings and information given.

The tasks in these instructions are described so that they can be understood by people trained in electrical engineering. Such personnel must have appropriate tools and testing instruments available. Such personnel must have been trained in safe working methods.

The safety measures laid down in DIN standard VDE 0100 must be guaranteed.

The user must obtain any general and local operating permits and meet any requirements regarding:

- Personnel safety
- Product disposal
- Environmental protection

NOTE! The safety measures must remain in force at all times. Should questions or uncertainties arise, please contact your local sales outlet.

1.4 Notes to the Instruction Manual

NOTE: Additional information as an aid to avoiding problems.

CAUTION: Failure to follow these instructions can result in malfunction or damage to the softstarter.

WARNING: Failure to follow these instructions can result in serious injury to the user in addition to serious damage to the softstarter.

Important

For all enquiries and spare parts orders, please quote the correct name of the device and serial number to ensure that your inquiry or order is dealt with correctly and swiftly.

1.5 Type number

Fig. 1, page 5 gives an example of the type code number used for an Emotron MSF Softstarter. With this code number the exact type of the softstarter can be determined. This identification will be required for type specific information when mounting and installing. The code number is located on the product label, on the front of the unit.

MSF	-017	525	2	C	V	N
1	2	3	4	5	6	7

Fig. 1 Type number.

Table 1

Position	Configuration parameter	Description
1	Softstarter type	MSF 2.0 type, Fixed
2	Motor current	017-1400 A
3	Mains supply voltage	525 V 690 V
4	Control supply voltage	2=100-240 V 5=380-500 V
5	Control panel option	C=Standard, no external control panel H=External control panel
6	Coated boards option	-=No coated boards V=Coated boards
7	Communication option	N=No COM included S=RS232/485 included D=DeviceNet included P=Profibus included

1.6 Standards

The device is manufactured in accordance with these regulations:

- IEC 60947-4-2
- EN 60204-1, Safety of Machinery, Electrical equipment of machines, part 1, General requirements and VDE 0113.
- EN 61000-6-4, EMC, Emission standard for industrial environments
- EN 61000-6-3, EMC, Emission standard for residential, commercial and light-industrial environments
- EN 61000-6-2, EMC, Immunity for industrial environments
- GOST
- UL 508

1.7 Tests in accordance with norm EN 60204 standard

Before leaving the factory, the device was subjected to the following tests:

- Through connection of earthing system:
  a) visual inspection.
  b) check that earthing wire is firmly connected.
- Insulation
- Voltage
- Function

1.8 Transport and packing

The device is packed in a carton or plywood box for delivery. The outer packaging can be recycled. The devices are carefully checked and packed before dispatch, but transport damage cannot be ruled out.

Check on receipt

Check that the goods are complete as listed on the delivery note, see type no. etc. on the rating plate.

Is the packaging damaged?

Check the goods for damage (visual check).

If you have cause for complaint

If the goods have been damaged during transport:

- Contact the transport company or the supplier immediately.
- Keep the packaging (for inspection by the transport company or for returning the device).

Packaging for returning the device

Pack the device so that it will resist shock and impact.

Intermediate storage

After delivery or after it has been dismounted, the device can be stored before further use in a dry room.

1.9 Unpacking MSF-310 and larger types

The MSF 2.0 softstarter is attached to the plywood box/ loading stool by screws, and the softstarter must be unpacked as follows:

1. Open only the securing plates at the bottom of the box (bend downwards). Then lift up the box from the loading stool, both top and sides in one piece.
2. Loosen the three (3) screws on the front cover of the softstarter unit, down by the lower logo.
3. Push up the front cover about 20 mm so that the front cover can be removed.
4. Remove the two (2) mounting screws at the bottom of the softstarter.
5. Lift up the softstarter unit at the bottom about 10 mm and then push backwards about 20 mm so that the softstarter can be removed from the mounting hooks* at the top. The hooks are placed under the bottom plate and cannot be removed until the softstarter is pulled out.
6. Loosen the two screws (2) for the mounting hooks and remove the hooks.
7. The hooks are used as an upper support for mounting the sofrstarter.

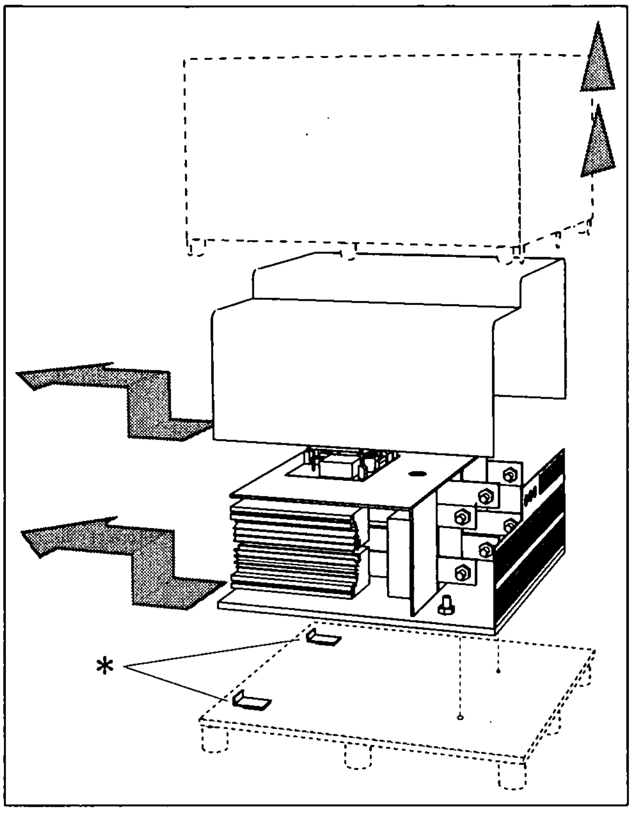


Fig. 2 Unpacking MSF-310 and larger models.

1.10 Glossary

1.10.1 Abbreviations

In this manual the following abbreviations are used:

Table 2 Abbreviations

Abbreviation	Description
FLC	Full load current
DOL	Direct on-line

1.10.2 Definitions

In this manual the following definitions for current, voltage, power, torque and speed are used:

Table 3 Definitions

Name	Description	Unit
I_{nsoft}	Nominal softstarter current	A
P_{nsoft}	Nominal softstarter power	kW, HP
N_{nsoft}	Nominal softstarter speed	rpm
T_n	Nominal motor torque	Nm, lbft
U_n	Nominal motor voltage	V
I_n	Nominal motor current	A
P_n	Nominal motor power	kw, HP
P_{normal}	Normal load	% of P_n

2. Description

In this chapter different starting methods for induction motors are explained and compared. The functionality of softstarters with torque control and their advantages and limitations compared to other starting methods are explained.

First a brief account of the background theory of starting induction motors will be given in section 2.1. Thereafter the different starting methods based on the usage of reduced voltage will be described and compared. This chapter will also cover softstarters with torque control. In section 2.3 some common starting methods based on other physical principles are explained. With this information some limitations of the reduced voltage starters will become clear. In section 2.4 there is a brief analysis of which applications may benefit from using a softstarter.

2.1 Background theory

The following two sections deal with motors with squirrel-cage rotors. In contrast to a wound rotor, the squirrel-cage rotor consists of straight conductors, which are short-circuited together at both ends.

When such a motor is connected directly to the line voltage it will typically draw a starting current of about 5 to 8 times its nominal current while the resulting starting torque will be about 0.5 to 1.5 times its nominal torque. In the following picture a typical starting characteristic is shown. The x-axis represents the speed relative to the nominal speed while the y-axis shows the torque and the current respectively, even those normalized to their nominal values. The dashed line indicates the nominal values.

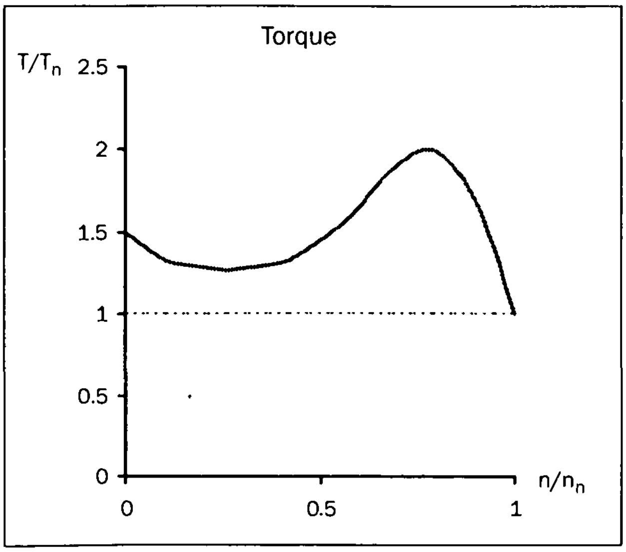


Fig. 3 Typical torque characteristics for the DOL start

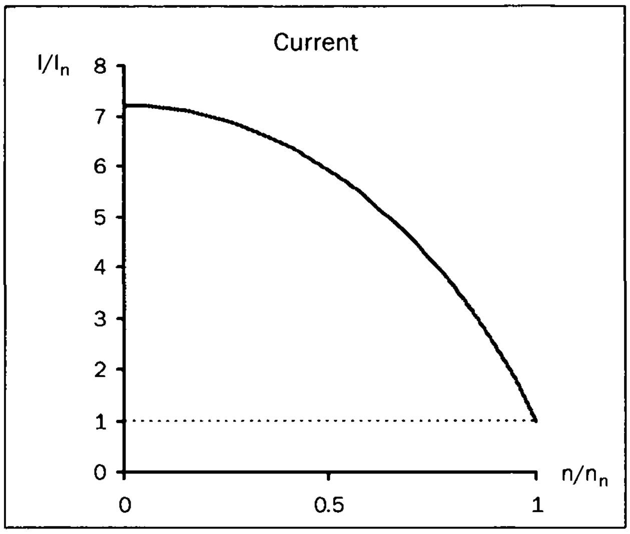


Fig. 4 Typical current characteristics for the DOL start

For many industrial applications direct on-line starting is not convenient, as the supply in this case has to be dimensioned to deliver the unnecessarily high starting current. Moreover, most applications do not gain anything from the high starting torque. Instead there is a risk of mechanical wear or even damage because of the resulting jerk at speedup.

The acceleration torque is determined by the difference between motor and load torque. The figure below shows some typical torque characteristics for constant speed applications. For comparative purposes, the inducion motors' torque characteristic is added to the diagram.

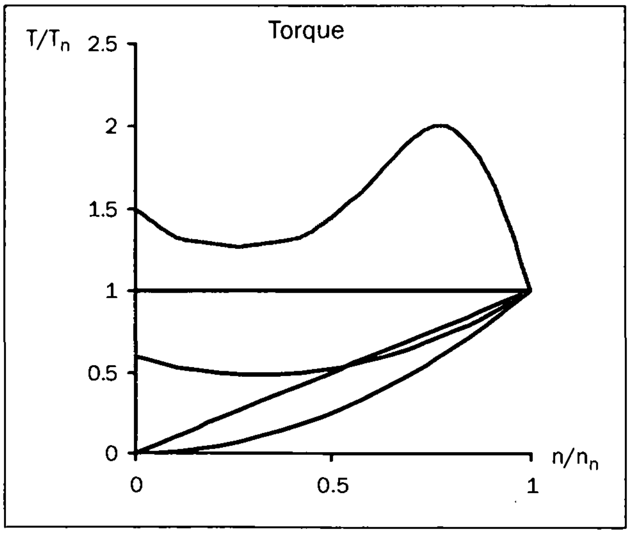


Fig. 5 Typical load torque characteristics

Typical applications with constant load are elevators, cranes and conveyors. Linear load characteristics are found for calendar rollers and smoothing machines; quadratic correlation between speed and torque is typical for pumps and fans.

Some applications like conveyors or screws may need an initial torque boost. However, for many applications it can be seen that the torque needed is much lower than the torque delivered by the induction motor in a DOL start.

A common method to reduce both starting torque and current is to decrease the motor voltage during starting. The following figure shows how the motor's torque and current characteristics are changed when the supply voltage is reduced.

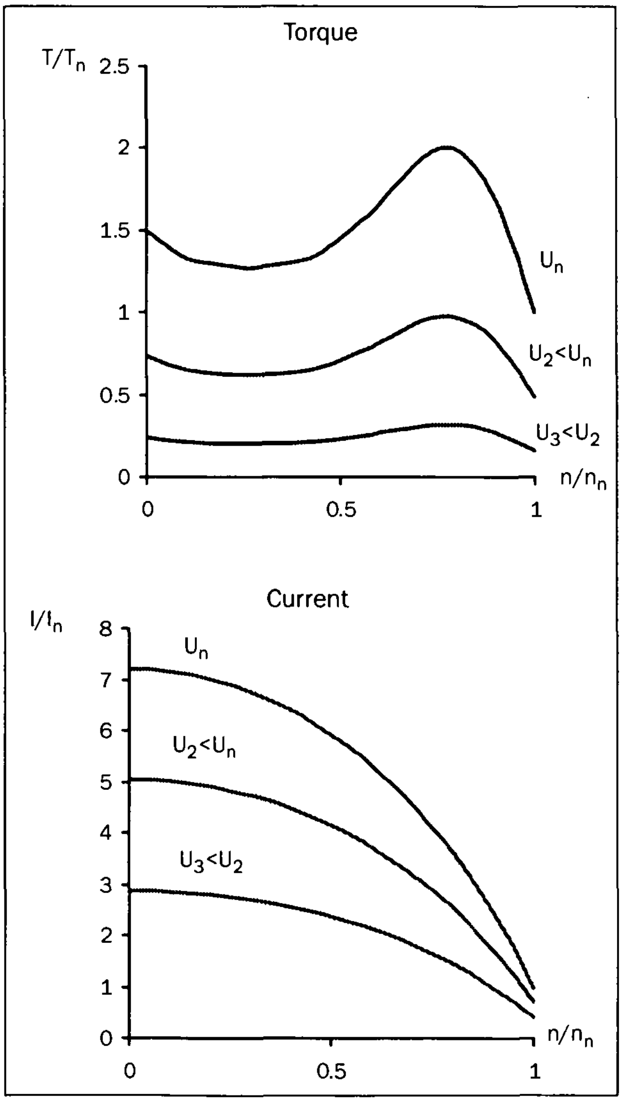


Fig. 6 Reduced voltage start

A general rule of thumb is that the torque at each operating point is roughly proportional to the square of the current. This means when the motor current is decreased by a factor of two by means of reducing the supply voltage, the torque delivered by the motor will be decreased by a factor of four (approximately).

$$T \sim I^2$$
$$I_{LV} = 1/2\ I_{DOL} \rightarrow T_{LV} \approx 1/4\ T_{DOL}$$
$$I_{LV} = 1/3\ I_{DOL} \rightarrow T_{LV} \approx 1/9\ T_{DOL}$$

LV=low voltage
DOL=Direct on line

This relationship is the base for any starting method using reduced voltage. It can be seen that the possibility of reducing the starting current depends on the correlation between the motor's and the load's torque characteristic. For the combination of an application with very low starting load and a motor with very high starting torque, the starting current may be reduced significantly by means of decreasing the voltage during start. However, for applications with high starting load it may – depending on the actual motor – not be possible to reduce the starting current at all.

2.2 Reduced voltage starting

This section describes different starting methods which are based on the reduced-voltage principle explained above. A pump and its quadratic torque characteristic are used as an example.

The star-delta starter is the simplest example of a reduced voltage starter. The motor phases are first star connected; at about 75% of nominal speed the phase connection is then changed to delta. To enable star-delta start, both ends of all three motor windings have to be available for connection. Moreover, the motor has to be dimensioned for the (higher) voltage in the delta connection. The following figure shows the resulting torque and current characteristics.

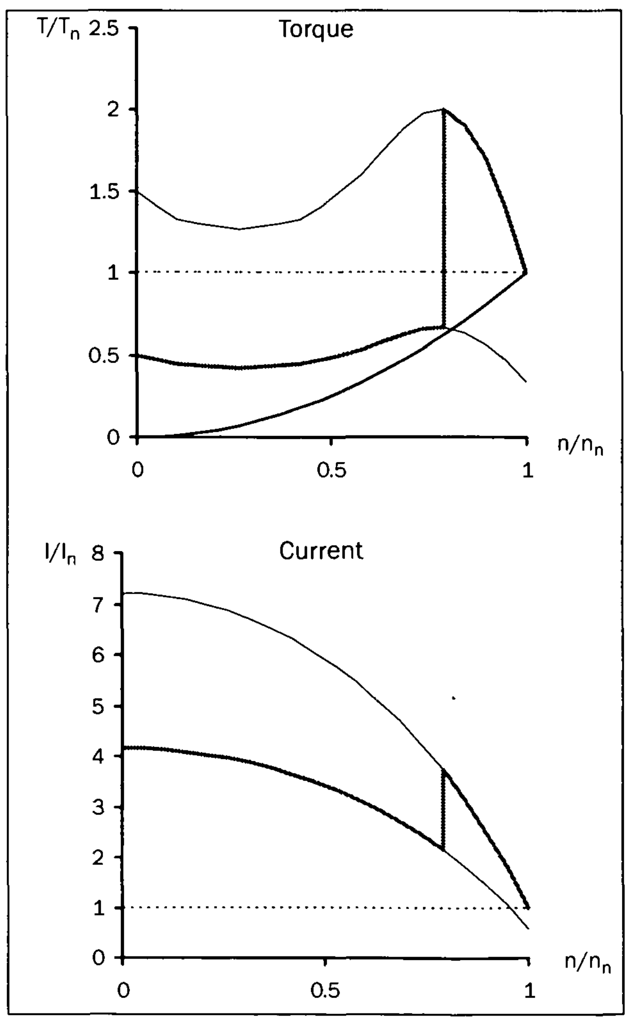


Fig. 7 Star-delta start

The disadvantage of the star-delta start is that it cannot be adapted to a special application. Both the voltage in star and in delta connection are defined by the supply, the resulting starting performance depends on the motor's DOL characteristic. For some applications the star-delta starter cannot be used as the resulting torque in star connection is too low to start rotating the load. On the other hand for low load applications further savings of starting current are impossible even though a big torque reserve is available. Moreover, the resulting abrupt rise of torque first at start and later when changing from star to delta connection may contribute to mechanical wear. The high transient currents during start-delta transition create unnecessary excess heat in the motor.

Better performance is achieved with a voltage ramp start, which a simple electronic softstarter can provide. The voltage is increased linearly from an initial value to the full supply voltage by means of phase angle control. The resulting torque and current characteristics are shown in the following figure.

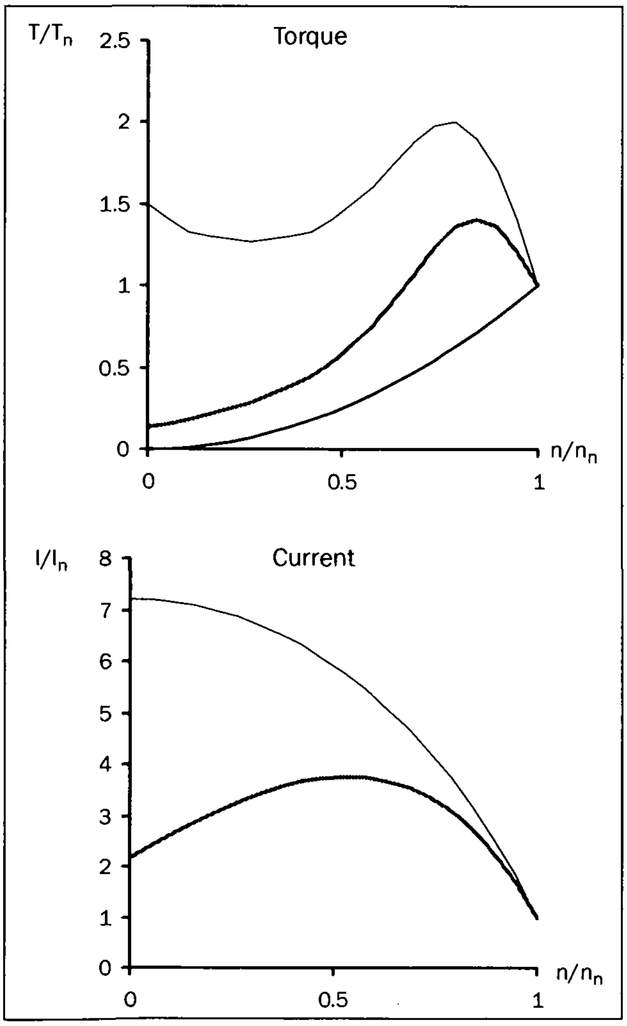


Fig. 8 Soft starting – voltage ramp

Obviously a much smoother start is realized compared to the star-delta start and the starting current is decreased.

A softstarter i often used to keep the starting current below a desired level. For the example above, setting a current limit of three times the nominal current may be desirable. The following figure shows the resulting torque and current characteristics.

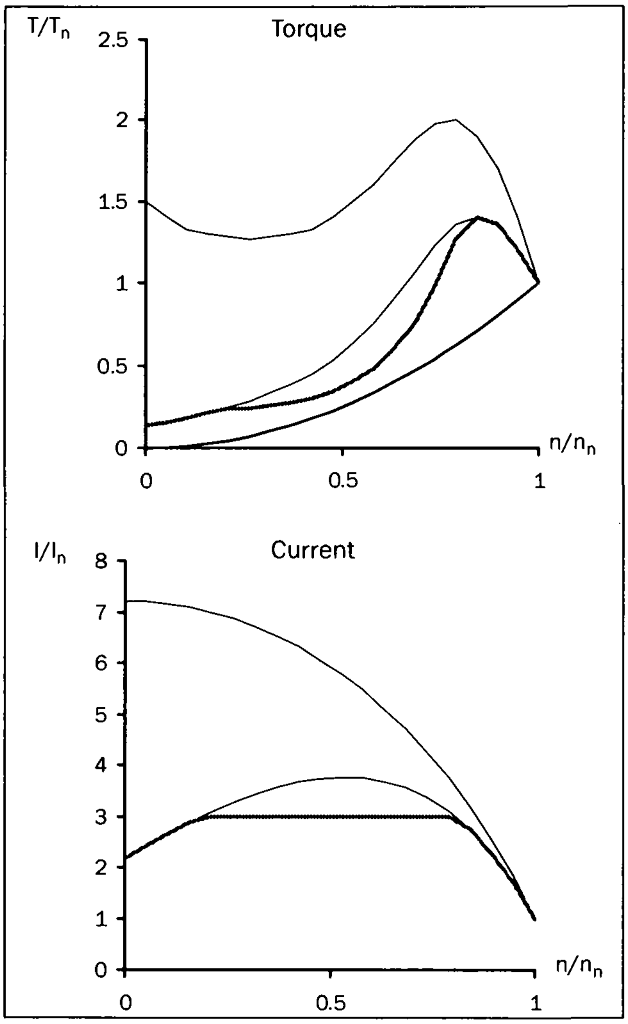


Fig. 9 Soft starting – voltage ramp with current limit

Once again the figure illustrates that the resulting performance depends on the combination of motor and load characteristics. In the example above the motor torque is close to the load torque at about half speed. This means for some other applications with different load characteristics (for example a linear torque-speed correlation) this particular motor would need more than three times the nominal current to start.

The most sophisticated electronic softstarters use torque control, which results in an almost constant acceleration during the start. A low starting current is also achieved. However, even this start method uses reduced motor voltage and the quadratic correlation between current and torque described in the first section of this chapter is still valid. This means, the lowest possible starting current is determined by the combination of motor and load characteristics.

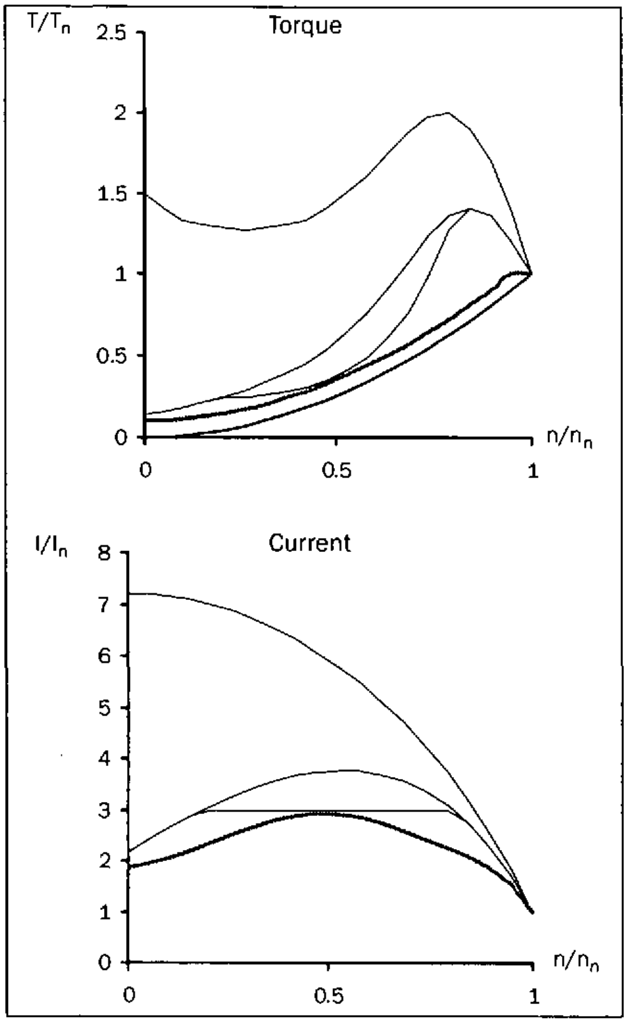


Fig. 10 Soft starting – torque control

For optimal starting performance, correct setting of the soft-starter's parameters such as initial torque and end torque at start and start time is important. The choice of parameters is explained in detail in section 8.7, page 55.

2.3 Other starting methods

In contrast to the preceding sections of this chapter, which focused on squirrel-cage motors, slip-ring motors are dealt with later on. A slip-ring motor is equipped with a wound rotor; one end of each rotor winding is available for external connection via slip-rings. These motors are often optimized for rotor resistance starting, e.g. with short-circuited rotor windings they develop a very low torque at an extremely high current. For starting external resistances are connected to the rotor windings. During the start, the resistance value is decreased in several steps until the rotor windings are short-circuited at nominal speed. The following figure shows typical torque and current characteristics for a slip-ring motor during the start with an external rotor-resistance starter.

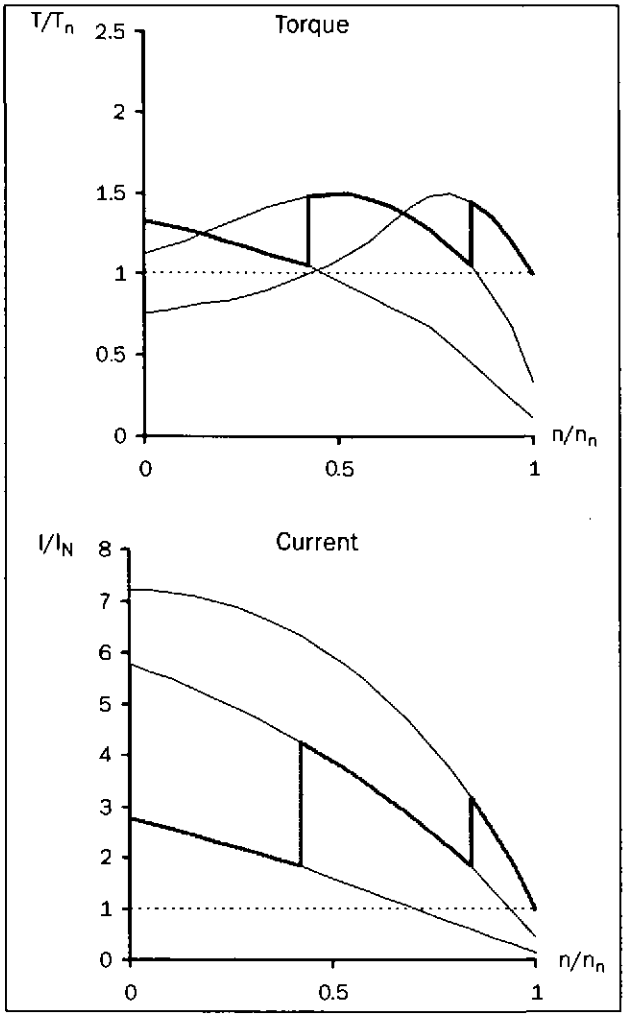


Fig. 11 Rotor-resistance starting

Because of the low starting torque it is often not possible to short-circuit the rotor windings and replace the rotor-resistance starter with a softstarter. However, it is always possible to use a frequency inverter instead. The following illustration shows how the torque and current characteristics are affected when the stator frequency is changed.

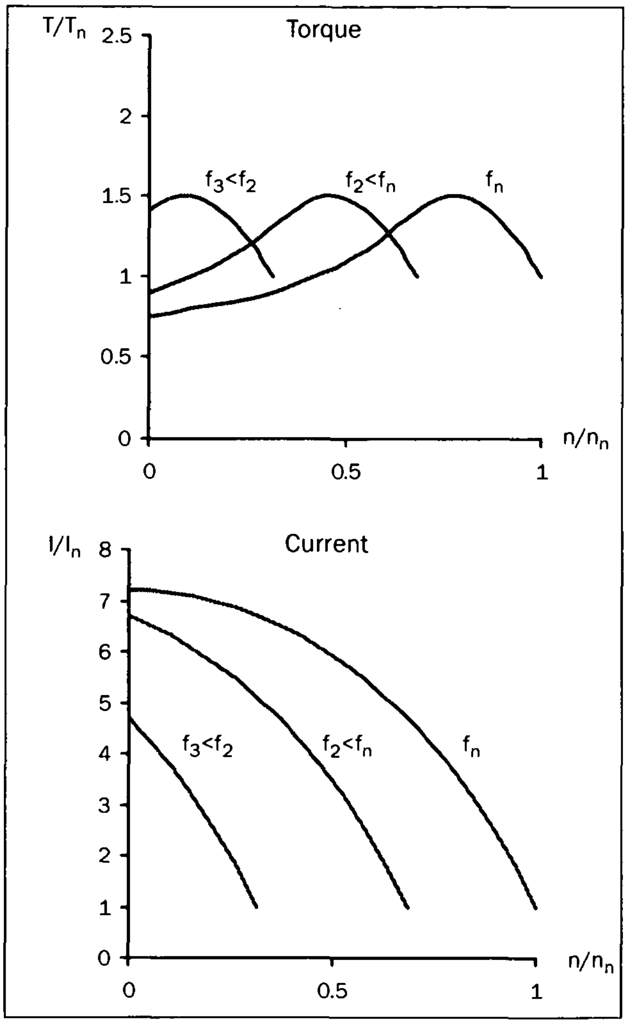


Fig. 12 Voltage/frequency regulation

Thus, such a motor can be started with a quite simple frequency inverter with voltage-frequency regulation. This solution is even valid for all other applications, which for some reason (high load torque compared to motor torque etc.) cannot be started by a softstarter.

2.4 Use of softstarters with torque control

To determine if a specific application benefits from using a softstarter at all, the correlation between the motor's torque characteristic during the start and the load's requirements has to be evaluated. As it can be seen from the examples above, the application will only benefit from using a softstarter if the load torque during the start is clearly below the motor's starting capacity. However, even loads with a high initial release torque may profit from a softstarter. In this case an initial torque boost can be used, thereafter the start ramp is continued reducing the starting current considerably.

The profit can be maximized when using a softstarter with torque control. To be able to configure the torque control parameters for optimal performance, the load characteristics (linear, square or constant load, need of initial release torque) must be known. In this case a proper torque control method (linear or square) can be chosen and torque boost can be enabled if needed. A description of the load characteristics of several common applications and guidelines for proper settings are found in chapter 6. page 31, Applications and Functions Selection. Optimization of the torque control parameter is explained in detail in section 8.7, page 55.

3. Mounting

This chapter describes how to mount the MSF 2.0 softstarter. Before mounting it is recommended that the installation be planned out first:

- Be sure that the softstarter suits the mounting location.
- The mounting site must support the weight of the softstarter.
- Will the softstarter continuously withstand vibrations and/or shocks?
- Consider using a vibration damper.
- Check ambient conditions, ratings, required cooling air flow, compatibility of the motor, etc.
- Do you know how the softstarter will be lifted and transported?

Make sure that the installation is performed in accordance with the local safety regulations of the electricity supply company. And in accordance with DIN VDE 0100 for setting up heavy current plants.

Care must be taken to ensure that personnel do not come into contact with live circuit components.

WARNING! Never operate the softstarter with the front cover removed.

3.1 Installation of the softstarter in a cabinet

When installing the softstarter:

- Ensure that the cabinet will be sufficiently ventilated after the installation.
- Keep the minimum free space, see the tables on page 15.
- Ensure that air can flow freely from the bottom to the top.

NOTE: When installing the softstarter, make sure it does not come into contact with live components. The heat generated must be dispersed via the cooling fins to prevent damage to the thyristors (free circulation of air).

MSF-017 to MSF-835 are all delivered as enclosed versions with front opening. The units have bottom entry for cables etc. see Fig. 20 on page 21 and Fig. 22 on page 23. MSF-1000 and MSF-1400 are delivered as open chassis.

3.1.1 Cooling

MSF-017 to MSF-250

Table 4 MSF-017 to MSF-250

MSF model	Minimum free space (mm):		
	above 1)	below	at side
-017, -030, -045	100	100	0
-060, -075, -085	100	100	0
-110, -145	100	100	0
-170, -210, -250	100	100	0
1) Above: wall-softstarter or softstarter-softstarter			

MSF-310 to MSF-1400

Table 5 MSF-310 to MSF-1400.

MSF model	Minimum free space (mm):		
	above 1)	below	at side
-310, -370, -450	100	100	0
-570, -710, -835	100	100	0
-1000, -1400	100	100	100
1) Above: Wall-softstarter or softstarter-softstarter			

3.1.2 Mounting schemes

MSF-017 to MSF-250

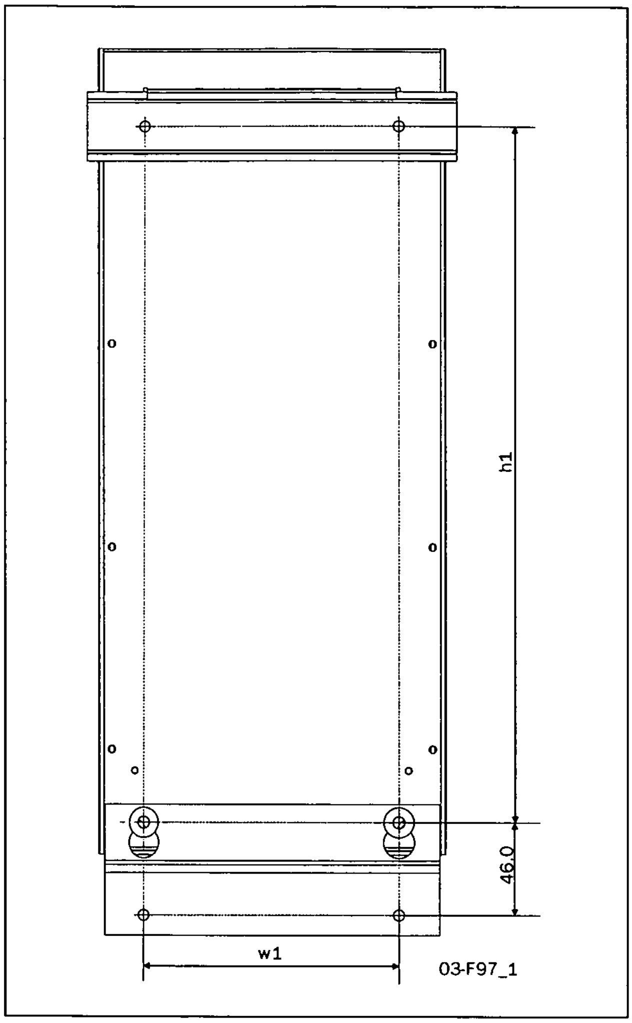


Fig. 13 Hole pattern for MSF-017 to MSF-250 (backside view).

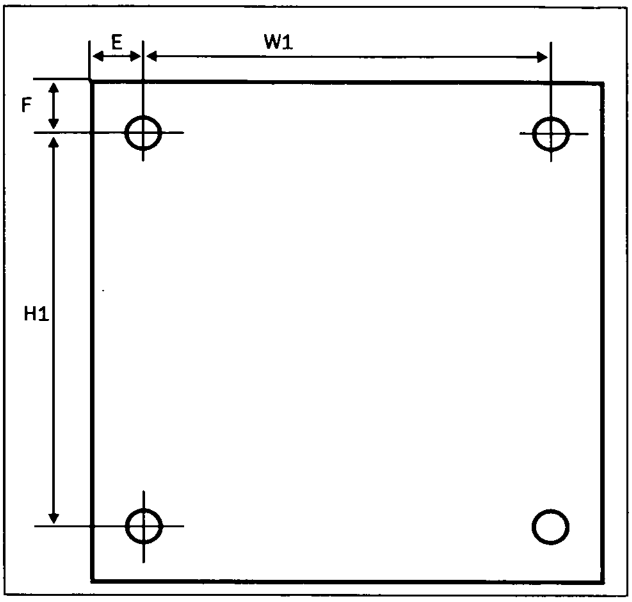


Fig. 14 Hole pattern for screw attachment, MSF-310 to MSF-835. Hole distance (mm).

Table 6

MSF Model	Hole distance w1 [mm]	Hole distance H1 [mm]	Hole distance E	Hole distance F	Diam./ screw	Tightening torque for bolt [mm]		
						Cable	PE cable	Supply and PE
-017, -030, -045	78.5	265			5.5/M5	8	8	0.6
-060, -075, -085	78.5	265			5.5/M5	12	8	0.6
-110, -145	128.5	345			5.5/M5	20	12	0.6
-170, -210, -250	208.5	445			5.5/M5	20	12	0.6
-310, -370, -450	460	450	44	39	8.5/M8	50	12	0.6
-570, -710, -835	550	600	45.5	39	8.5/M8	50	12	0.6
-1000, -1400					8.5/M8	50	12	0.6

Observe that the two mounting hooks supplied (see section 1.9, page 6 and Fig. 2 on page 7) must be used for mounting the softstarter as upper support (only MSF-310 to MSF-835).

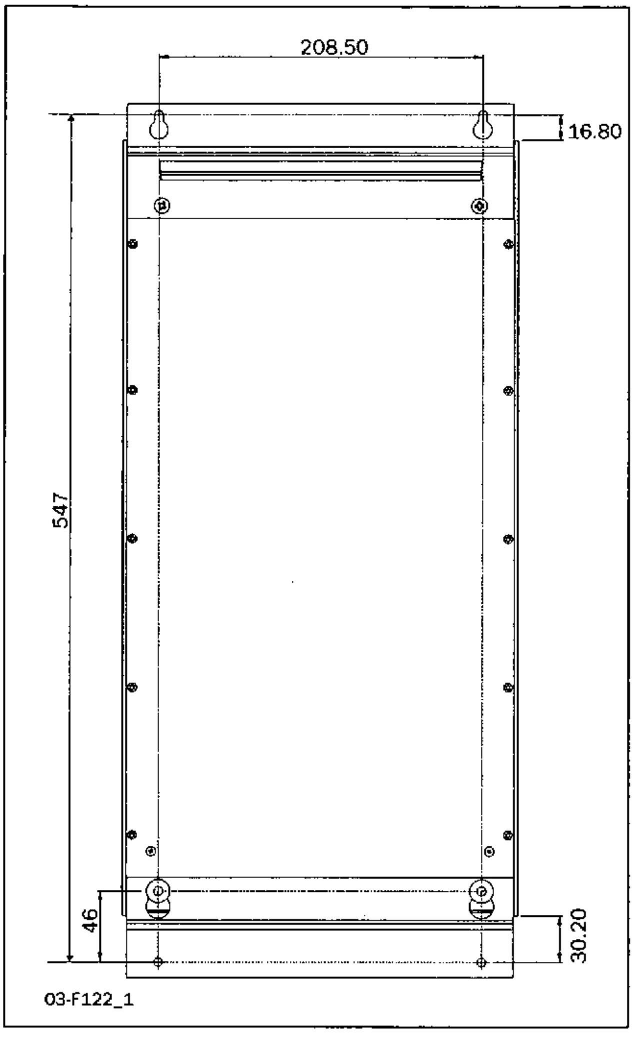


Fig. 15 Hole pattern for MSF-170 to MSF-250 with upper mounting bracket instead of DIN rail.

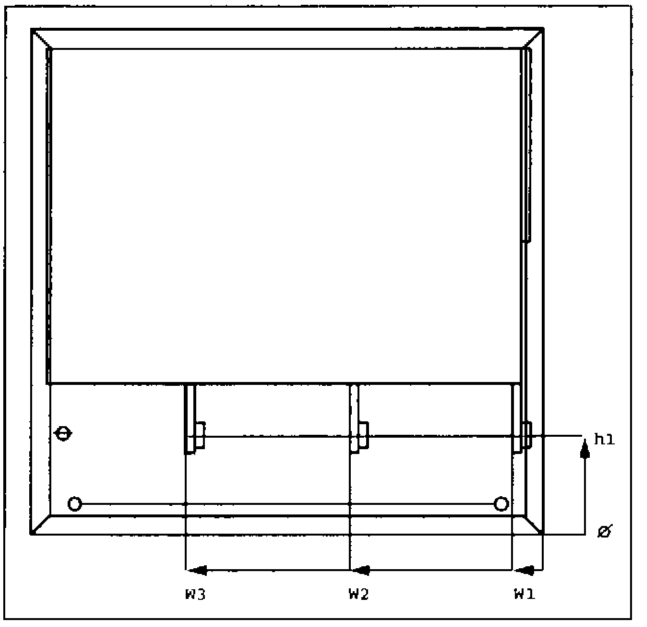


Fig. 16 Busbar distances MSF-310 to MSF-835.

Table 7 Busbar distances

MSF model	Dist. h1 (mm)	Dist. W1 (mm)	Dist.W2 (mm)	Dist.W3 (mm)
-310 to -450	104	33	206	379
-570 to -835	129	35	239.5	444
-1000 -1400		55	322.5	590.5

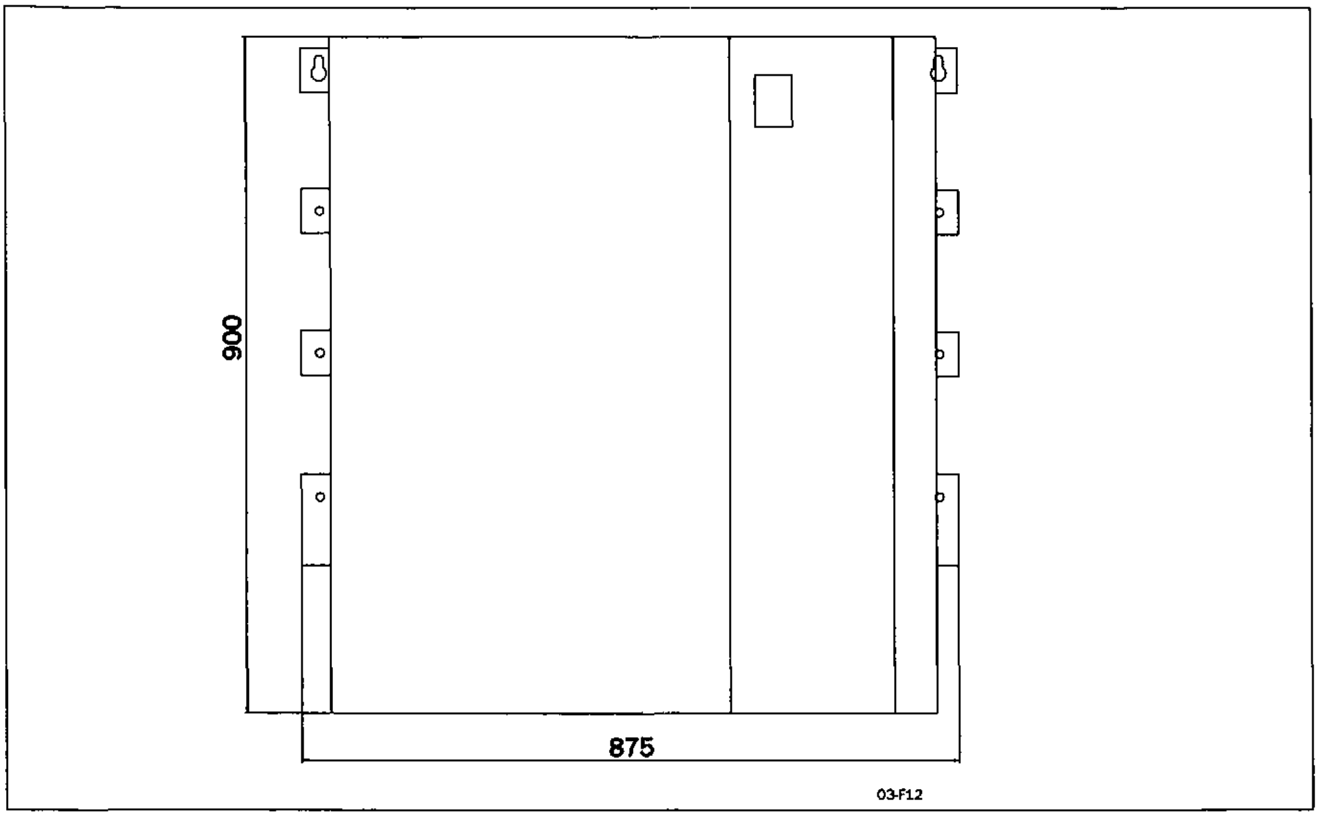


Fig. 17 MSF-1000 to MSF-1400

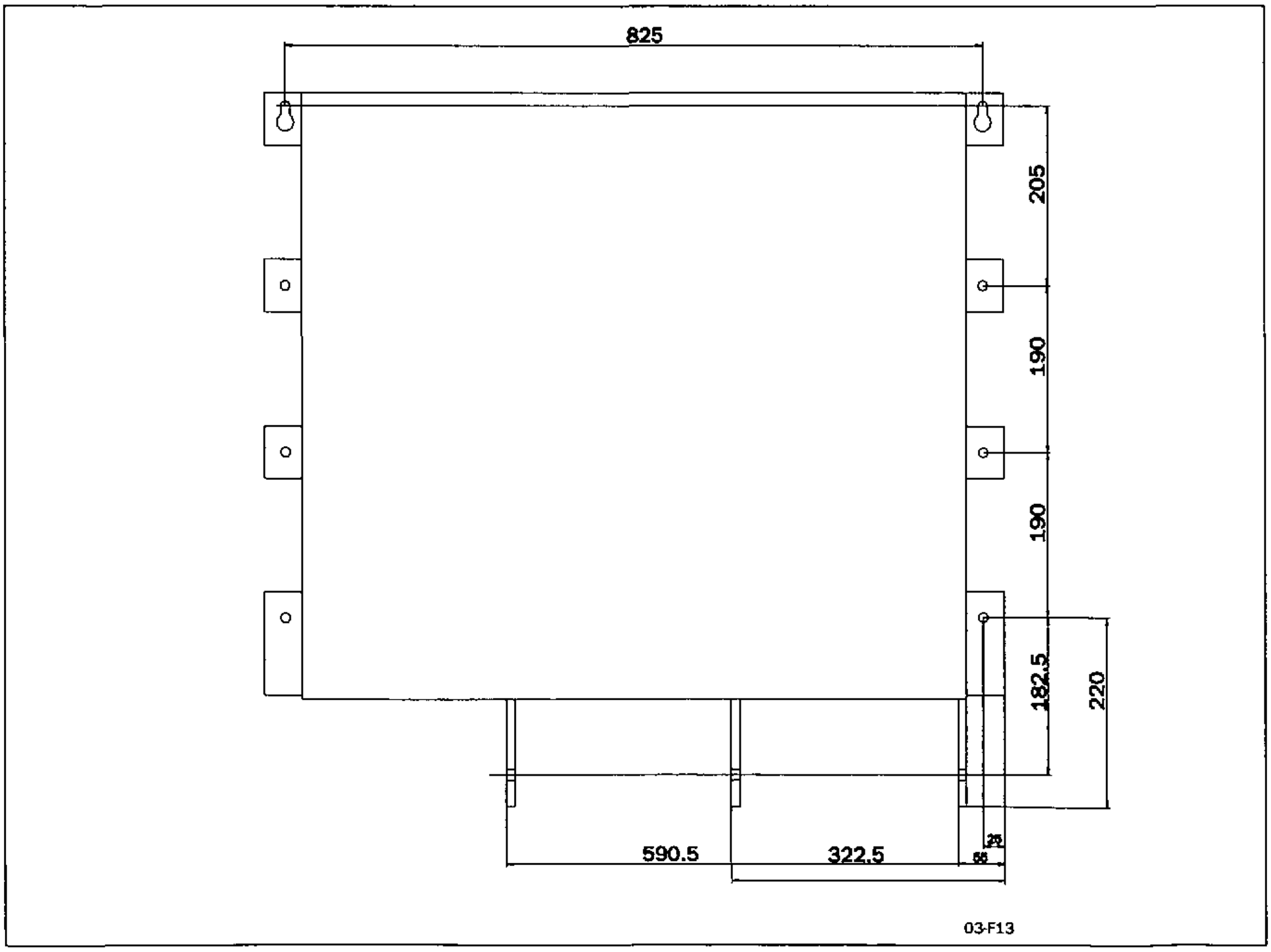


Fig. 18 Hole pattern busbar MSF-1000 to MSF-1400.

4. Connections

The description of installation in this chapter follows the EMC standards and the Machinery Directive.

If the softstarter is temporarily stored before being connected, please check the technical data for environmental conditions. If the softstarter is moved from a cold storage room to the room where it is to be installed, condensation can form on it. Allow the softstarter to become fully acclimatised and wait until any visible condensation has evaporated before connecting the mains voltage.

NOTE: The softstarter must be wired with shielded control cable to fulfil EMC regulations according to section 1.6, page 6.

NOTE: For UL-approval use 75°C Copper wire only.

4.1 Connecting mains and motor cables

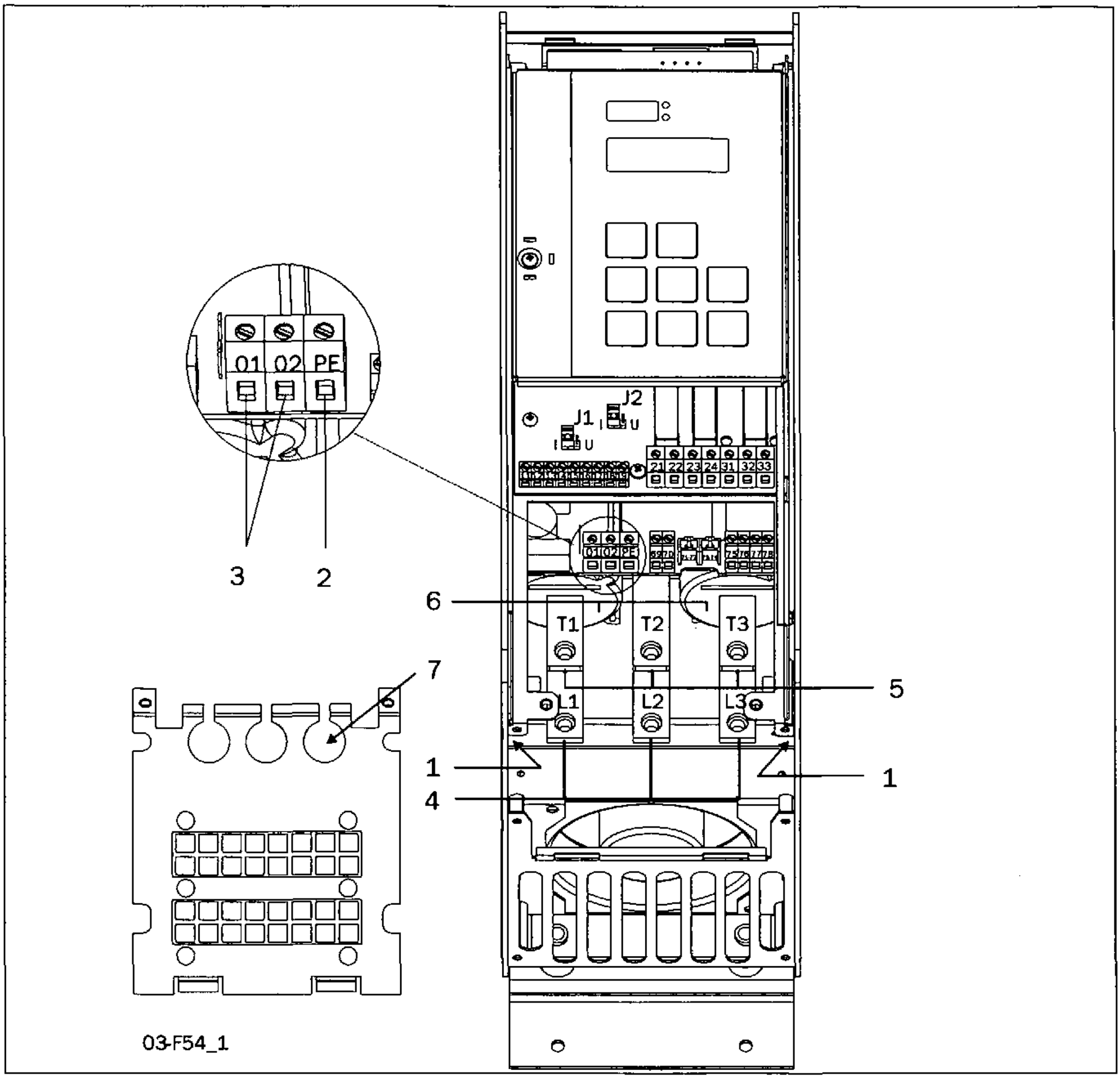


Fig. 19 Connection of MSF-017 to MSF-085.

Connection of MSF-017 to MSF-085

Device connections

1. Protective earth, ⏚ (PE), mains supply, motor (on the right and left inside of the cabinet)
2. Protective earth, ⏚ (PE), control supply voltage
3. Control supply voltage connection **01, 02**
4. Mains supply **L1, L2, L3**
5. Motor power supply **T1, T2, T3**
6. Current transformers (can be mounted outside for bypass see section 8.7.5, page 67)
7. Mounting of EMC gland for control cables

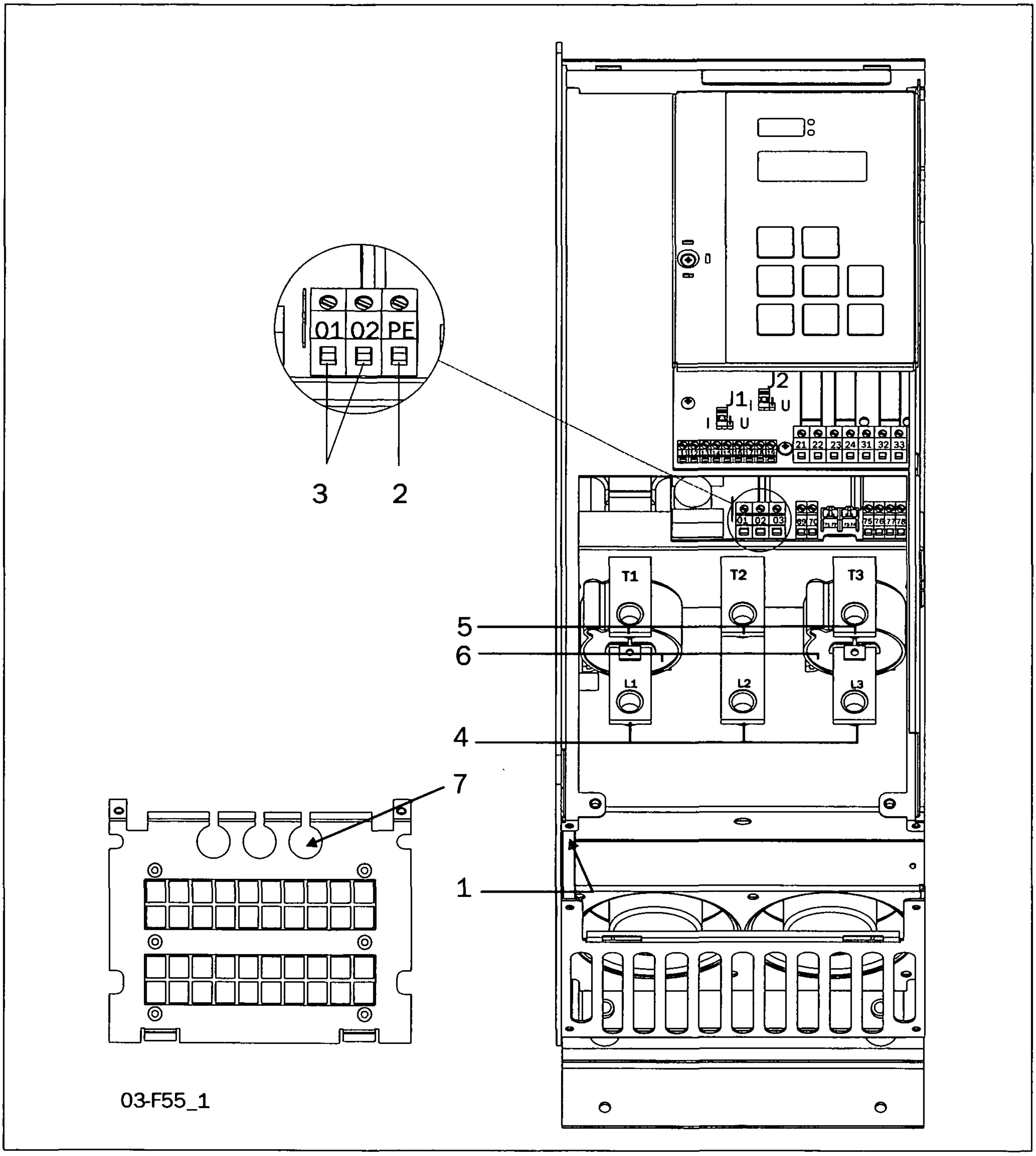


Fig. 20 Connection of MSF-110 to MSF-145.

Connection of MSF-110 to MSF-145

Device connections

1. Protective earth, ⏚ (**PE**), mains supply, motor (on the left inside of the cabinet)
2. Protective earth ⏚ (**PE**), control supply voltage
3. Control supply voltage connection **01**, **02**
4. Mains supply **L1**, **L2**, **L3**
5. Motor power supply **T1**, **T2**, **T3**
6. Current transformers (can be mounted outside for bypass see section 8.7.5, page 67)
7. Mounting of EMC gland for control cables

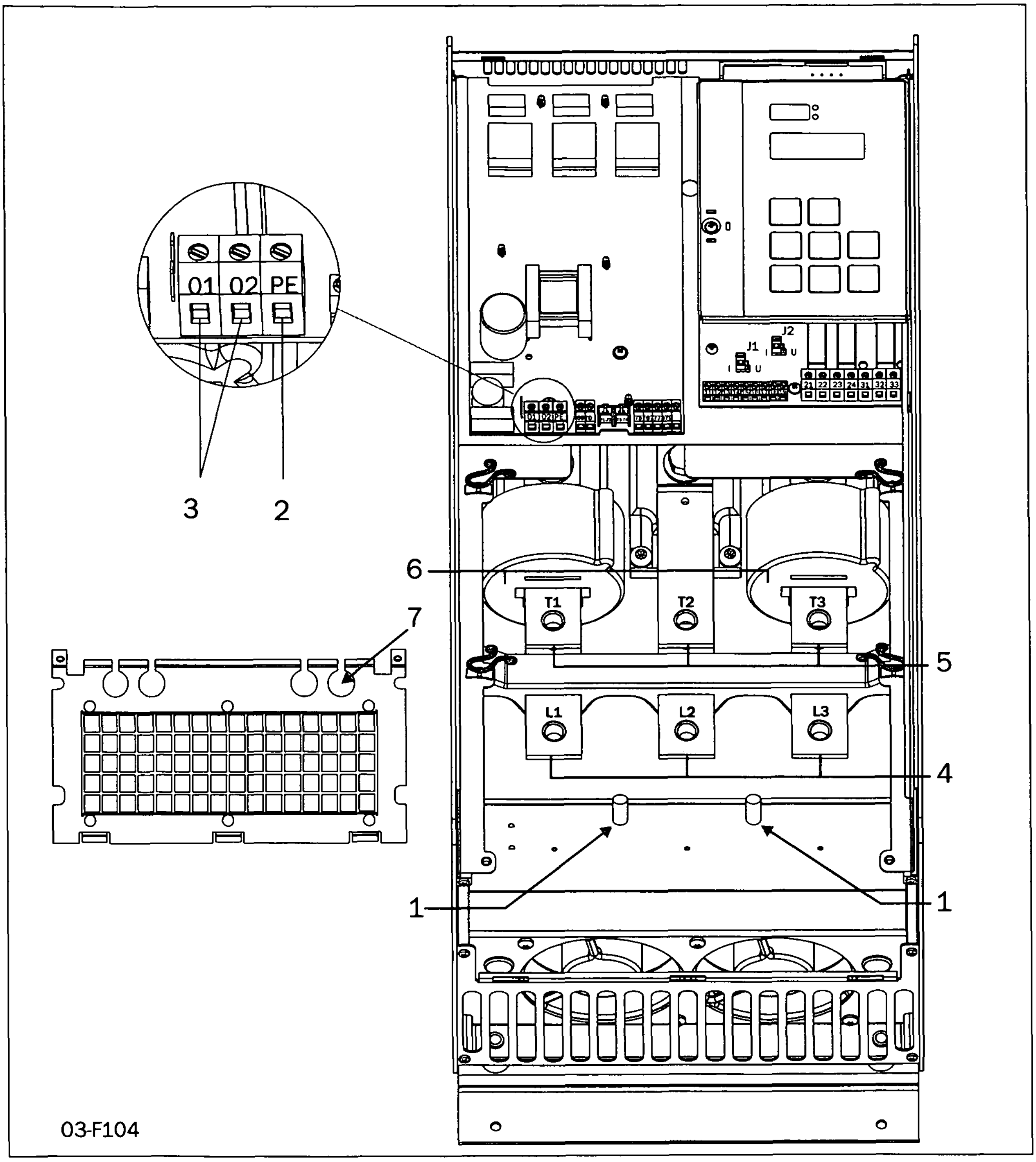


Fig. 21 Connection of MSF-170 to MSF-250.

Connection of MSF-170 to MSF-250

Device connections

1. Protective earth, ⏚ (PE), mains supply, motor (on the left inside of the cabinet)
2. Protective earth ⏚ (PE), control supply voltage
3. Control supply voltage connection **01, 02**
4. Mains supply **L1, L2, L3**
5. Motor power supply **T1, T2, T3**
6. Current transformers (can be mounted outside for bypass see section 8.7.5, page 67)
7. Mounting of EMC gland for control cables

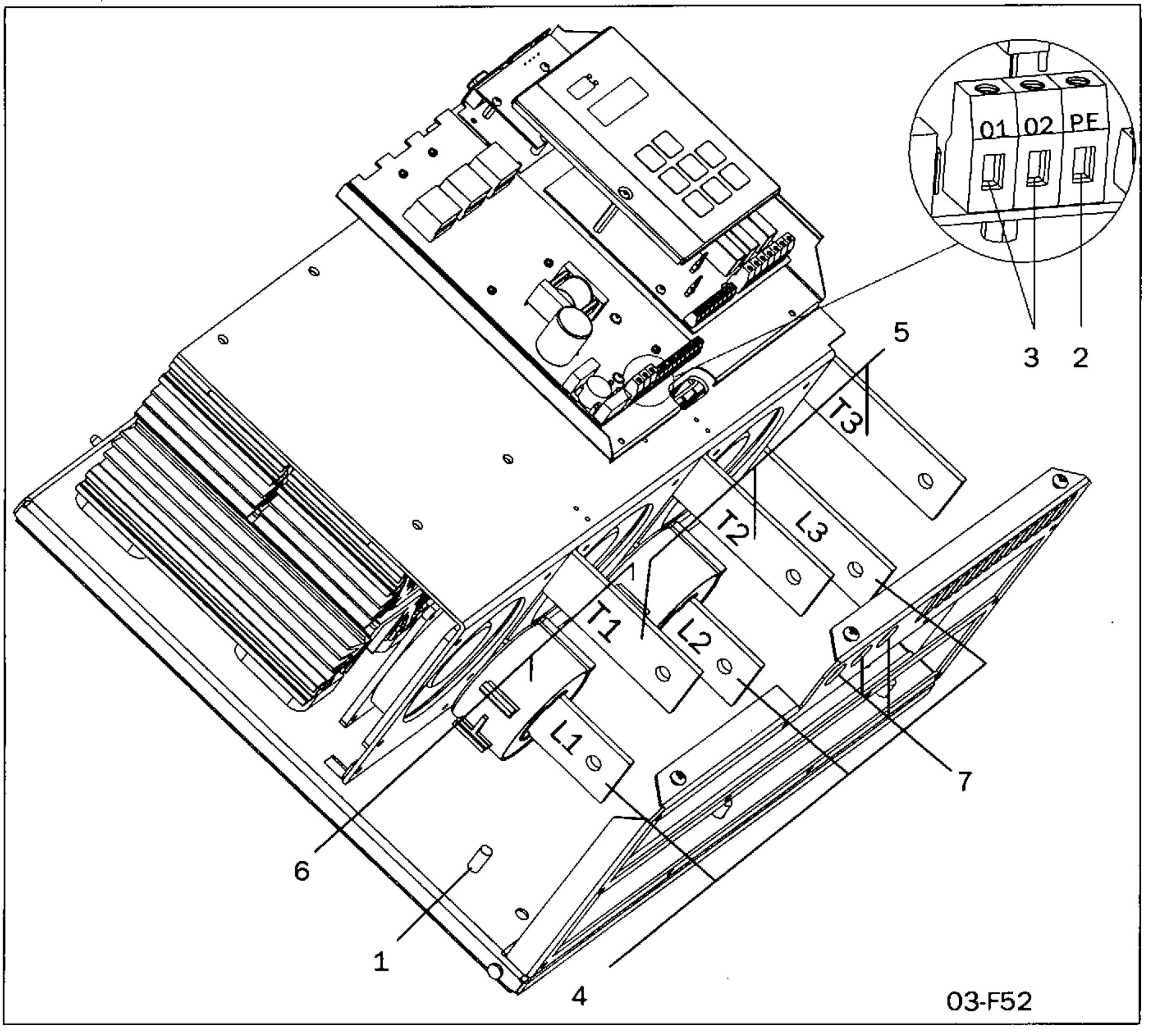


Fig. 22 Connection of MSF-310 to MSF-1400.

Connection of MSF-310 to MSF-1400

Device connections

1. Protective earth, ⏚ (PE), mains supply and motor
2. Protective earth, ⏚ (PE), control supply voltage
3. Control supply voltage connection **01, 02**
4. Mains supply **L1, L2, L3**
5. Motor power supply **T1, T2, T3**
6. Current transformers (possible to mount outside for bypass see section 8.7.5, page 67)
7. Mounting of EMC gland for control cables

4.2 Control Connection

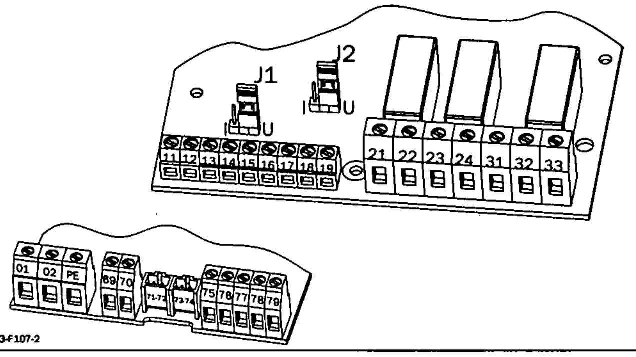


Fig. 23 PCB (control board) connections.

Table 8 PCB Terminals

Terminal	Function	Electrical characteristics
01	Control supply voltage	100-240 VAC ±10% alternative 380-500 VAC ±10% see rating plate
02		
PE	Protective Earth	⏚
11	Digital input 1	0-3 V –> 0; 8-27 V–> 1. Max. 37 V for 10 sec. Impedance to 0 VDC: 2.2 kΩ.
12	Digital input 2	
13	Control signal supply voltage to PCB terminal 11 and 12, 10 kΩ potentiometer, etc.	+12 VDC ±5%. Max. current from +12 VDC: 50 mA. Short circuit-proof but not overload-roof.
14	Analogue input, 0-10 V, 2-10 V, 0-20 mA and 4-20 mA/digital input.	Impedance to terminal 15 (0 VDC) voltage signal: 125 kΩ, current signal: 100 Ω.
15	GND (common)	0 VDC
16	Digital input 3	0-3 V –> 0; 8-27 V–> 1. Max. 37 V for 10 sec. Impedance to 0 VDC: 2.2 kΩ.
17	Digital input 4	
18	Control signal supply voltage to PCB terminal 16 and 17, 10 kΩ potentiometer, etc.	+12 VDC ±5%. Max. current from +12 VDC = 50 mA. Short circuit-proof but not overload-proof.
19	Analogue output	Analogue output contact: 0-10 V, 2-10 V; min load impedance 700Ω 0-20 mA and 4-20 mA; max load impedance 750Ω
21	Programmable relay K1. Factory setting is "Operation" with indication by closing terminal 21 to 22.	1-pole closing contact, 250 VAC 8 A or 24 VDC 8 A resistive, 250 VAC, 3 A inductive.
22		
23	Programmable relay K2. Factory setting is "Full voltage" with indication by closing terminals 23 to 24.	1-pole closing contact, 250 VAC 8 A or 24 VDC 8 A resistive, 250 VAC, 3 A inductive.
24		
31	Programmable relay K3. Factory setting is "All alarms". Indication by closing terminals 31 to 33 and opening terminals 32 to 33.	1-pole change-over contact, 250 VAC 8A or 24 VDC 8A resistive, 250 VAC, 3A inductive.
32		
33		
69-70	PTC Thermistor input	Alarm level 2.4 kΩ. Switch back level 2.2 kΩ.
71-72*	Clickson thermistor	Controlling softstarter cooling fan temperature MSF-310 - MSF-1400
73-74*	NTC thermistor	Temperature measuring of softstarter cooling fin
75	Current transformer input, cable S1 (blue)	Connection of L1 or T1 phase current transformer
76	Current transformer input, cable S1 (blue)	Connection of L3, T3 phase (MSF 017 to MSF 250) or L2, T2 phase (MSF 310 to MSF 1400)
77	Current transformer input, cable S2 (brown)	Common connection for terminals 75 and 76
78*	Fan connection	24 VDC
79*	Fan connection	0 VDC

*Internal connection, no customer use.

4.3 Minimum wiring

The figure below shows the "minimum wiring". See section 3.1.2, page 16, for tightening torque for bolts etc.

1. Connect Protective Earth (PE) to earth screw marked ⏚ (PE).
2. Connect the softstarter between the 3-phase mains supply and the motor. On the softstarter the mains side is marked L1, L2 and L3 and the motor side T1, T2 and T3.
3. Connect the control supply voltage (100-240 VAC) for the control card at terminals 01 and 02.
4. Connect PCB terminals 12 and 13 (PCB terminals 11 and 12 must be linked) e.g. to a 2-position switch (on/oFF) or a PLC, etc., to obtain control of soft start/stop (for factory configuration of the digital inputs).
5. Ensure the installation complies with the appropriate local regulations.

NOTE! The softstarter should be wired with a shielded control cable to fulfil the EMC regulations outlined in section 1.6, page 6.

NOTE! If local regulations say that a mains contactor should be used, relay K1 can control it. Always use standard commercial, slow blow fuses, e.g. gl or gG types, to protect the wiring and prevent short circuiting. To protect the thyristors against short-circuit currents, superfast semiconductor fuses can be used if preferred. The normal guarantee is valid even if superfast semiconductor fuses are not used. All signal inputs and outputs are galvanically insulated from the mains supply.

4.4 Wiring examples

Fig. 55 on page 79 gives an wiring example with the following functions:

- Analogue start/stop, see description on page 79.
- External control of parameter set, see section 8.9.6, page 90
- Analogue output, see "Analogue output" on page 82
- PTC input, see description of Thermal motor protection in section 8.3.1, page 46.

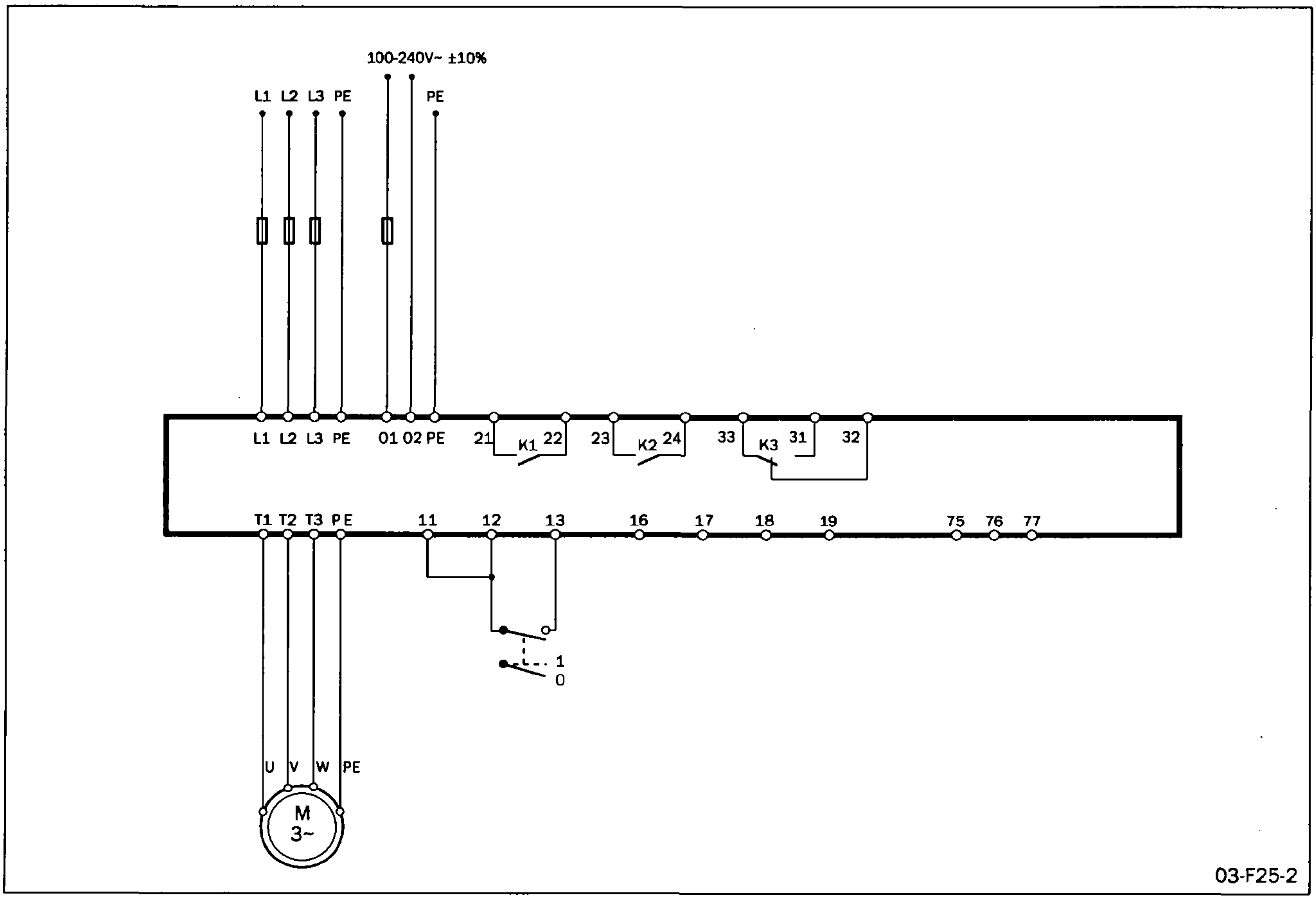


Fig. 24 Wiring circuit, "minimum wiring".

5. How to get started

This chapter briefly describes the set-up for basic soft start and soft stop using the default "Torque control" function.

WARNING! Mounting, wiring and setting the device into operation must be carried out by properly trained personnel.

5.1 Checklist

- Mount the softstarter as set out in chapter 3. page 15.
- Consider the power loss at rated current when dimensioning a cabinet, max. ambient temperature is 40°C.
- Check that the motor and supply voltage corresponds to the values on the softstarter's rating plate.
- Connect the protective earth.
- Connect the motor circuit according to Fig. 25.
- Connect the control supply to terminals 01 and 02. The control supply voltage range is 100-240 VAC or 380-500 VAC, see rating plate.
- Connect relay K1 (terminals 21 and 22 on the softstarter) to the contactor – the softstarter then controls the contactor (for factory configuration of K1).
- Connect terminals 12 and 13 to, e.g., a 2-way switch (closing non-return) or a PLC and a jumper between 11 and 12, etc., to obtain control of soft start/soft stop. (For factory configuration of digital inputs 1 and 2.)
- Ensure the installation complies with the appropriate local regulations.

5.2 Applications

WARNING! Make sure that all safety measures have been taken before switching on the power supply.

Switch on the control supply voltage (normally 1 x 230 V); all segments in the display and the two LEDs will be illuminated for a few seconds. Then the display will show menu [100]. An illuminated display indicates there is control supply voltage to the softstarter unit. Check that you have mains supply voltage to the mains contactor or to the thyristors. The settings are carried out according as follows:

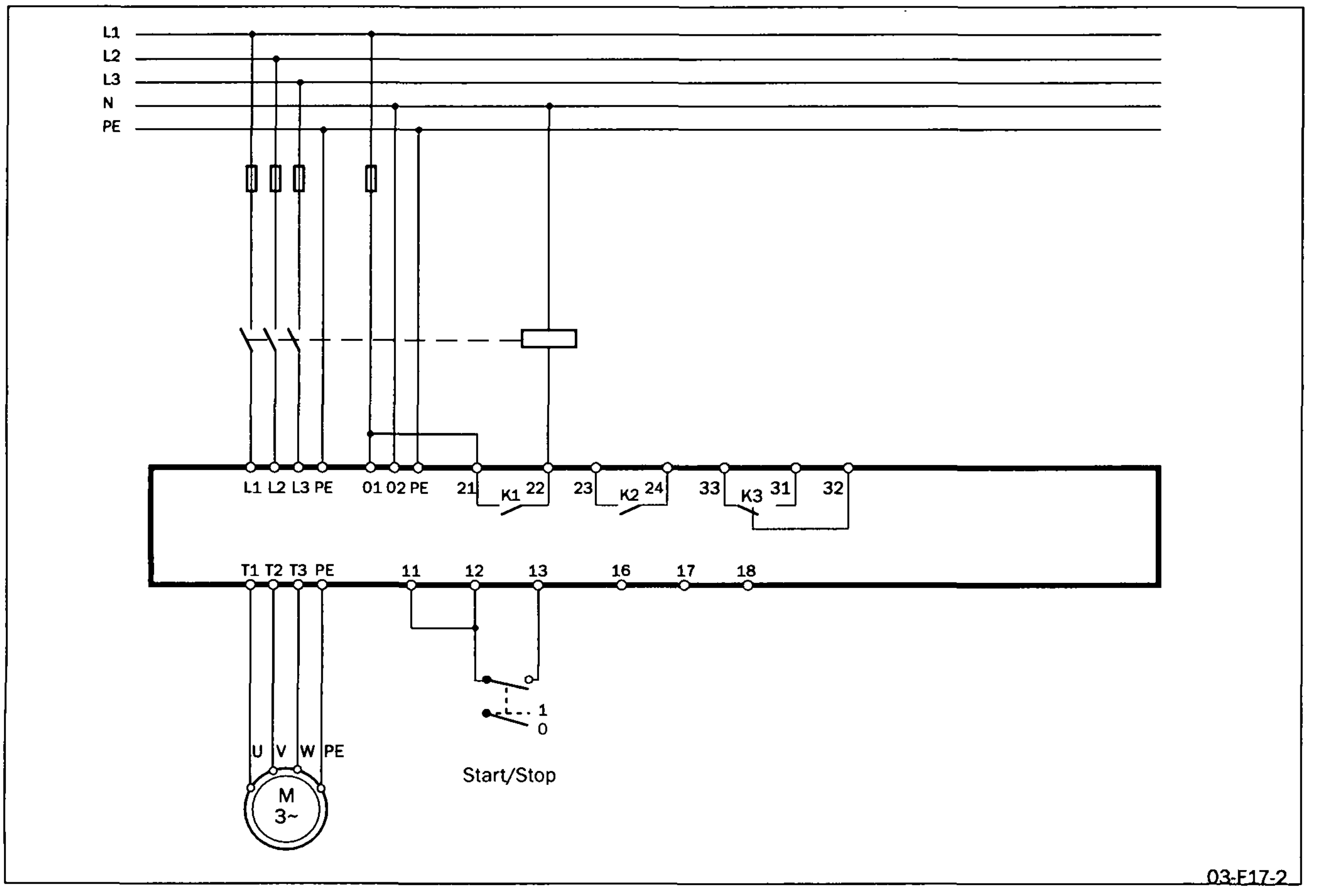


Fig. 25 Standard wiring.

5.3 Motor data

Set the data, according to the motor type plate, to obtain optimal settings for start, stop and motor protection.

NOTE! The default settings are for a standard 4-pole motor according to the nominal power of the softstarter. The softstarter will run even if no specific motor data is selected, but the performance will not be optimal.

210 — Setting

Nominal motor voltage

400

Default:	400 V
Range:	200-700 V
200-700	Nominal motor voltage.

211 — Setting

Nominal motor current

17

Default:	I_{nsoft} in A
Range:	25-200% of I_{nsoft} in A
25-200	Nominal motor current.

212 — Setting

Nominal motor power

7.5

Default:	P_{nsoft} in kW
Range:	25-400% of P_{nsoft} in kW or HP.
25-400	Nominal motor power.

213 — Setting

Nominal motor speed

1450

Default:	N_{nsoft} in rpm
Range:	500-3600 rpm
500-3600	Nominal motor speed.

214 — Setting

Nominal power factor

0.86

Default:	0.86
Range:	0.50-1.00
0.50-1.00	Nominal motor power factor.

215 — Setting

Nominal frequency

50

Default:	50 Hz
Range:	50 Hz, 60 Hz
50, 60	Nominal frequency.

5.4 Start and stop

315 — Setting

Start time

10

Default:	10 s
Range:	1-60 s
1-60	Start time.

320 — Setting

Stop method

4

Default:	4 (Coast)
Range:	1, 2, 3, 4, 5
1	Linear torque control
2	Square torque control
3	Voltage control
4	Coast
5	Brake

Default "Stop method" is Coast (freewheeling).

5.5 Setting the start command

As default the softstarter is set up for remote operation via terminals 11, 12 and 13. For easy commissioning it is possible to give start and stop signals via the control panel.

200	Setting **Control source** 2
Default:	2 (Remote control)
Range:	1, 2, 3
1	Control panel.
2	Remote control.
3	Serial communication control.

Menu [200] must be set to 1 to be able to operate from control panel.

NOTE! Factory default setting is remote control (2).

To start and stop from the control panel, the "START/ STOP" key is used.

To reset from the control panel, the "ENTER ↵ /RESET" key is used. A reset can be done both when the motor is running and when the motor is stopped. A reset by the control panel will not start or stop the motor.

5.6 Viewing the motor current

Set the display to menu [100]. Now the motor current can be viewed on the display.

100	Read-out **Current** 0.0
Range:	0.0-9999 A

5.7 Starting

Start the motor by pressing the "START/STOP" key on the control panel or through the remote control, PCB terminals 11, 12 and 13. When the start command is given, the mains contactor will be activated by relay K1 (softstarter terminals 21 and 22), and the motor then starts softly.

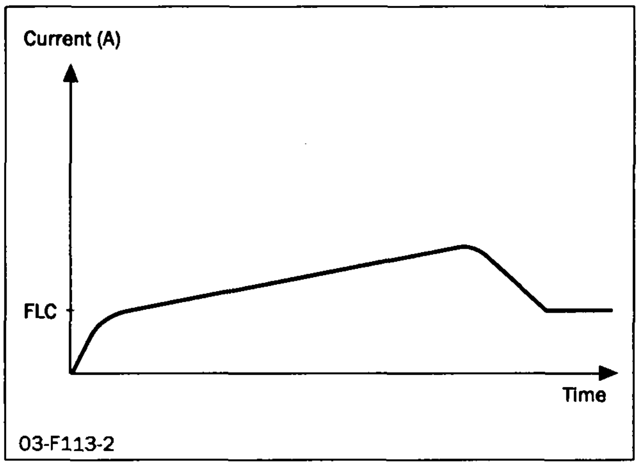


Fig. 26 Example of start current when the default torque control is used.

6. Applications and functions selection

This chapter is a guide to selecting the correct softstarter rating and softstarter functionality for different applications.

To make the right choice the following tools are used:

The norms AC53a and AC53b

These norms help select the softstarter rating with regard to duty cycle, starts per hour and maximum starting current.

The Applications Rating List

With this list the softstarter rating can be selected depending on the kind of application used. The list uses two levels, see Table 9, page 33.

The Applications Function List

This table gives an overview of the most common applications and their challenges. For each application MSF 2.0 solutions are proposed and a reference to the MSF 2.0 menus, which can be used, is given. See Table 10, page 34.

6.1 Softstarter rating according to AC53a

The IEC 60947-4-2 standard for electronic softstarters defines AC53a as a norm for dimensioning of softstarters for continuous running without bypass.

The MSF 2.0 softstarter is designed to run continuously.

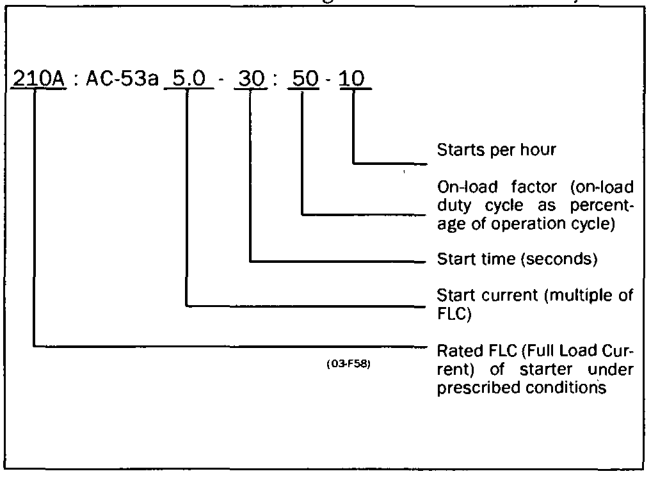


Fig. 27 AC53a rating example.

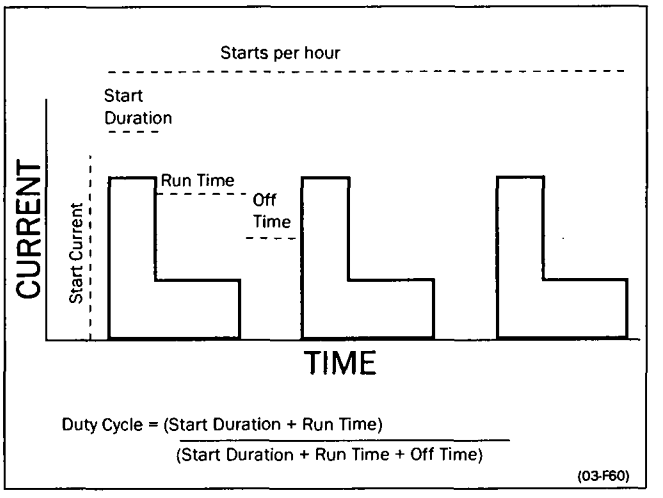


Fig. 28 Duty cycle, non-bypass.

The above example indicates a current rating of 210 Amps with a start current ratio of 5.0 x FLC (1050 A) for 30 seconds with a 50% duty cycle and 10 starts per hour.

NOTE! If more than 10 starts/hour or other duty cycles are needed, please contact your supplier.

In the Applications Rating List two commonly used levels of AC53a are specified. These are also given in the technical data tables (see chapter 13. on page 109).

6.2 Softstarter rating according to AC53b

This norm is made for bypass operation. The MSF 2.0 softstarter is designed to run continuously. In the event of high ambient temperature or for other reasons, an external bypass contactor can be used to minimize the power loss at nominal speed. In the Application Rating List, one level of AC53b is specified, normal with bypass.

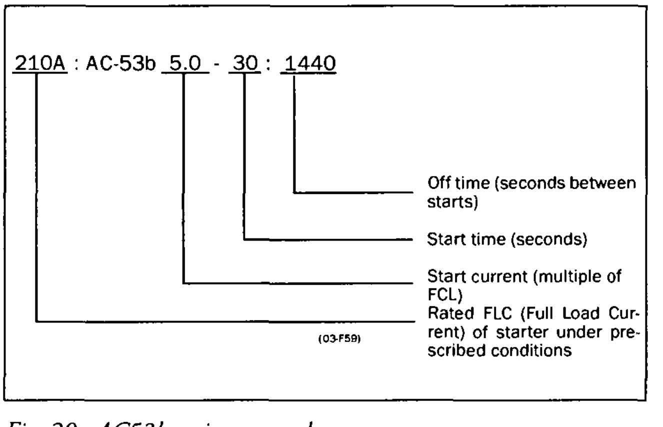


Fig. 29 AC53b rating example.

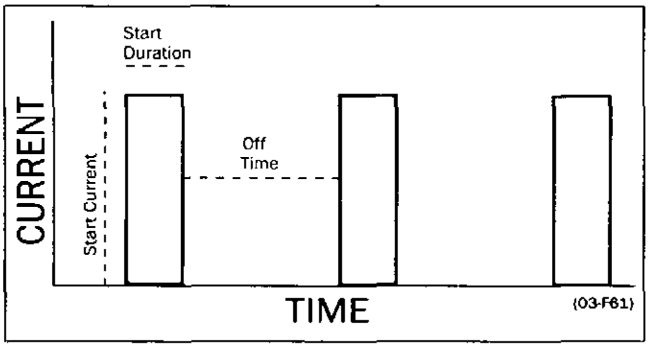


Fig. 30 Duty cycle, bypassed

The above example indicates a current rating of 210 Amps with a start current ratio of 5.0 x FLC (1050 A) for 30 seconds with a 24-minute interval between starts.

6.3 The Applications Rating List

According to the norms AC53a and AC53b a softstarter can have many current ratings.

With help of the Applications Rating List the correct rating can be chosen for most applications.

The Applications Rating List uses two levels for the AC53a norm and one level for the AC53b norm:

AC53a 5.0-30:50-10 (heavy)

This level will be able to start almost all applications and follows directly the type number of the softstarter.

Example: MSF-370 is designed for 370 A full load current (FLC) and 5 times this current for a starting time of 30 seconds.

AC 53a 3.0-30:50-10 (normal)

This level is for lighter applications and here the MSF 2.0 can manage a higher FLC.

Example: MSF-370 can be used for an application with 450 A FLC if the starting current is not more than 3 times this current for a starting time of 30 seconds.

AC53b 3.0-30:330 (normal with bypass)

This level is for lighter applications when a bypass contactor is used. The MSF 2.0 can in this case be used for applications with an even higher nominal current.

Example

An MSF-370 can be used for an application with a full load current of 555 A if the starting current is no more than three times this value and a bypass contactor is used.

NOTE! To compare softstarters it is important to ensure that not only FLC (Full Load Current) is compared but also the starting performance.

The Applications Rating List

The first column in the Applications Rating List, see Table 9, page 33 gives various applications. If the machine or application is not in this list, try to identify a similar machine or application. If in doubt please contact your supplier. The second and third columns gives typical ratings for the machine or application. The ratings are divided in Normal/Normal with by-pass and Heavy duty.

Example

The application is a Roller Mill. From the Applications Rating List a Roller Mill is rated as a Heavy duty application due to high starting current. The proper size of MSF 2.0 has to be selected from the Heavy rating column, see Technical data.

Table 9 Applications Rating List

Applications	Normal AC53a 3.0-30:50-10 and Normal with bypass AC53b 3.0-30:300	Heavy AC 53a 5.0-30:50-10
General & Water		
Centrifugal Pump	x	
Submersible Pump	x	
Conveyor		x
Compressor, Screw	x	
Compressor, Reciprocating	x	
Fan	x	
Blower	x	
Mixer		x
Agitator		x
Metals & Mining		
Belt Conveyor		x
Dust Collector	x	
Grinder	x	
Hammer Mill		x
Rock Crusher		x
Roller Conveyor		x
Roller Mill		x
Tumbler		x
Wire Draw Machine		x
Food Processing		
Bottle Washer	x	
Centrifuge		x
Dryer		x
Mill		x
Palletiser		x
Separator		x
Slicer	x	
Pulp and Paper		
Repulper		x
Shredder		x
Trolley		x
Petrochemical		
Ball Mill		x
Centrifuge		x
Extruder		x
Screw Conveyor		x
Transport & Machine Tool		
Ball Mill		x
Grinder		x
Material Conveyor		x
Palletiser		x
Press		x
Roller Mill		x
Rotary Table		x
Trolley		x
Escalator		x

Table 9 Applications Rating List

Applications	Normal AC53a 3.0-30:50-10 and Normal with bypass AC53b 3.0-30:300	Heavy AC 53a 5.0-30:50-10
Lumber & Wood Products		
Bandsaw		x
Chipper		x
Circular Saw		x
Debarker		x
Planer		x
Sander		x

6.4 The Application Functions List

This list gives an overview of many different applications with their challenges and a possible solution with one of the many MSF 2.0 functions.

Description and use of the table:

Application

This column gives the various applications. If the machine or application is not on this list, try to identify a similar machine or application. If in doubt please contact your supplier.

Challenge

This column describes possible challenges that are familiar for this kind of application.

MSF 2.0 Solution

Gives the possible solution for the challenge using one of the MSF 2.0 functions.

Menus

Gives the menu numbers and selection for the MSF 2.0 function.

"200;=1", means: program selection 1 in menu [200].

"323;=1 / 320, 324", means: program selection 1 in menu [323], menus [320] and [324] are related to this function.

Table 10 Application Functions List

Application	Challenge	MSF Solution	Menus
PUMP	Too fast starts and stops	Pre-setting for pump application	300
	Non-linear ramps	Square torque control for square loads.	310;=2, 320;=2
	Water hammer	Square torque control	320;=2
	High current and peaks during starts	Square torque control	310;=2
	Pump is going in wrong direction	Phase reversal alarm	440
	Dry running	Shaft power underload	401
	High load due to dirt in pump	Shaft power overload	400
COMPRESSOR	Mechanical shock for compressor, motor and transmissions	Linear Torque control	310;=1
	Small fuses and low current available.	Linear torque control and current limit at start.	310;=1, 314
	Screw compressor going in wrong direction	Phase sequence alarm	440
	Damaged compressor if liquid ammonia enters the compressor screw.	Shaft power overload	400
	Energy consumption due to compressor running unloaded	Shaft power underload	401
BLOWER	Mechanical shock for blower, motor and transmissions. High start current requires large cables and fuses.	Torque control ensures smooth starts that minimize mechanical stress. Start current is minimized by torque-controlled start.	310;=1

Table 10 Application Functions List

Application	Challenge	MSF Solution	Menus
CONVEYOR	Mechanical shocks for transmissions and transported goods.	Linear torque control	310;=1
	Loading or unloading conveyors	Slow speed and accurate position control.	330-333, 500,501
	Conveyor jammed	Shaft power overload	400
	Conveyor belt or chain is off but the motor is still running	Shaft power underload	401
	Starting after screw conveyor has stopped due to overload.	Jogging in reverse direction and then starting in forward.	335, 500
	Conveyor blocked when starting	Locked rotor function	228, 229
FAN	High starting current in end of ramps	Square torque control for square load characteristics	310;=2
	Slivering belts.		
	Fan is going in wrong direction when starting.	Catching the motor and going easy to zero speed and then starting in right direction.	310;=2
	Belt or coupling broken	Shaft power underload	401
	Blocked filter or closed damper.		
PLANER	High inertia load with high demands on torque and current control.	Linear torque control gives linear acceleration and low starting current.	310;=1
	Need to stop quickly both for emergency and production efficiency reasons.	Dynamic vector brake without contactor for medium loads.	320;=5 323;=1,324
		Reverse current brake with external contactor for heavy loads.	320;=5 323;=2,324
	High speed lines	Conveyor speed set from planer shaft power analogue output.	520-523
	Worn out tool	Shaft power overload	400
	Broken coupling	Shaft power underload	401
ROCK CRUSHER	High inertia	Linear torque control gives linear acceleration and low starting current.	310;=1
	Heavy load when starting with material	Torque boost	316,317
	Low power if a diesel powered generator is used.	Current limit at start	314
	Wrong material in crusher	Shaft power overload	400
	Vibrations during stop	Dynamic vector brake without contactor	320;=5 323;=1,324
BANDSAW	High inertia load with high demands on torque and current control.	Linear torque ramp gives linear acceleration and low starting current.	310;=1
	Need to stop quickly.	Dynamic vector brake without contactor for medium loads.	320;=5 323;=1,324
		Reverse current brake with external contactor for heavy loads.	320;=5 323;=2,324
	High speed lines	Conveyor speed set from bandsaw shaft power analogue output.	520-523
	Worn out saw blade	Shaft power overload	400
	Broken coupling, saw blade or belt	Shaft power underload	401
CENTRIFUGE	High inertia load	Linear torque control gives linear acceleration and low starting current.	310;=1
	Too high load or unbalanced centrifuge	Shaft power overload	400
	Controlled stop	Dynamic vector brake without contactor for medium loads.	320;=5 323;=1,324
		Reverse current brake with external contactor for heavy loads.	320;=5 323;=2,324
	Need to open centrifuge in a certain position.	Braking down to slow speed and then positioning control.	330-333, 500,501

Table 10 Application Functions List

Application	Challenge	MSF Solution	Menus
MIXER	Different materials	Linear torque control gives linear acceleration and low starting current.	310;=1
	Need to control material viscosity	Shaft power analogue output	520-523
	Broken or damaged blades	Shaft power overload	400
		Shaft power underload	401
HAMMER MILL	Heavy load with high breakaway torque	Linear torque control gives linear acceleration and low starting current.	310;=1
		Torque boost in beginning of ramp.	316,317
	Jamming	Shaft power overload	400
	Fast stop	Reverse current brake with reversing contactor for heavy loads.	320;=5 323;=2,324
	Motor blocked	Locked rotor function	228

Example

Hammer Mill:

- Linear Torque control (menu 310=1) will give the best results.
- Torque boost to overcome high breakaway torque (menus [316] and [317])
- Overload alarm function for jamming protection (menu [400])
- Stop function reverse current brake (menu [323], selection 2) can be used. Menus 324 and [325] to set the brake time and strength.

6.5 Special conditions

6.5.1 Small motor or low load

The minimum load current for the MSF 2.0 softstarter is 10% of the rated current of the softstarter, except for the MSF-017 where the min. current is 2 A. Example: MSF-210, rated current = 210 A. Min. Current 21 A. Please note that this is "minimum load current" and not minimum rated motor current.

6.5.2 Ambient temperature below 0°C

For ambient temperatures below 0°C an electric heater or similar must be installed in the cabinet. The softstarter can also be mounted somewhere else since the distance between the motor and the softstarter is not critical.

6.5.3 Phase compensation capacitor

If a phase compensation capacitor is to be used, it must be connected at the inlet of the softstarter, not between the motor and the softstarter.

6.5.4 Shielded motor cable

It is not necessary to use shielded wires together with softstarters. This is due to the very low radiated emissions.

NOTE! The softstarter should be wired with a shielded control cable to fulfil the EMC regulations outlined section 1.6, page 6.

6.5.5 Pump control with softstarter and frequency inverter together

It is possible, e.g. in a pump station with two or more pumps, to use one frequency inverter on one pump and softstarters on each of the other pumps. The flow of the pumps can then be controlled by one common control unit.

6.5.6 Starting with counter-clockwise rotating loads

It is possible to start a motor clockwise, even if the load and motor are rotating counterclockwise e.g. fans. Depending on the speed and the load "in the wrong direction" the current can be very high.

6.5.7 Running motors connected in parallel

When starting and running motors connected in parallel, the total amount of the motor current must be equal or lower than the rating of the connected softstarter. Please note that it is not possible to have individual settings for each motor or to use the internal thermal motor protection. The start ramp can only be set for an average starting ramp for all the connected motors. This means that the start time may differ from motor to motor.

For motors connected in parallel, torque control is not recommended because of the risk of oscillation between the motors. Voltage control with or without current limit is preferred instead. The use of the braking functionality is not recommended for motors connected in parallel.

6.5.8 Running motors linked together

When starting and running motors mechanically linked together but with one softstarter connected to each motor, there are two kinds of operation available. The first is to start the motors at the same time using voltage control with or without current limit. The second is to start one motor first with torque or voltage control and after the motor has reached full speed, the voltage to the other motors is ramped up using voltage control.

6.5.9 Step-up transformer for high voltage motor

A step-up transformer can be used between the MSF and the motor for controlling a motor rated at high voltage (e.g. higher than 690 V). Torque control can be used for starting and stopping. To compensate for the step-up transformer magnetization current at start, the initial torque should be set a little higher than normal. The motor data must be recalculated for the lower voltage side of the transformer.

6.5.10 How to calculate heat dissipation in cabinets

See chapter 13. on page 109 "Technical Data", "Power loss at rated motor load", "Power consumption control card" and "Power consumption fan". For further calculations please contact your local supplier of cabinets, e.g. Rittal.

6.5.11 Insulation test on motor

When testing the motor with high voltage e.g. insulation test, the softstarter must be disconnected from the motor. This is due to the fact that the softstarter will be seriously damaged by the high peak voltage.

6.5.12 Operation above 1000 m

All ratings are stated at 1000 m over sea level.

If an MSF 2.0 is placed at 3000 m for example, it must be derated.

To get information about motors and drives at higher altitudes please contact your supplier to get technical information no 151.

7. Operation of the softstarter

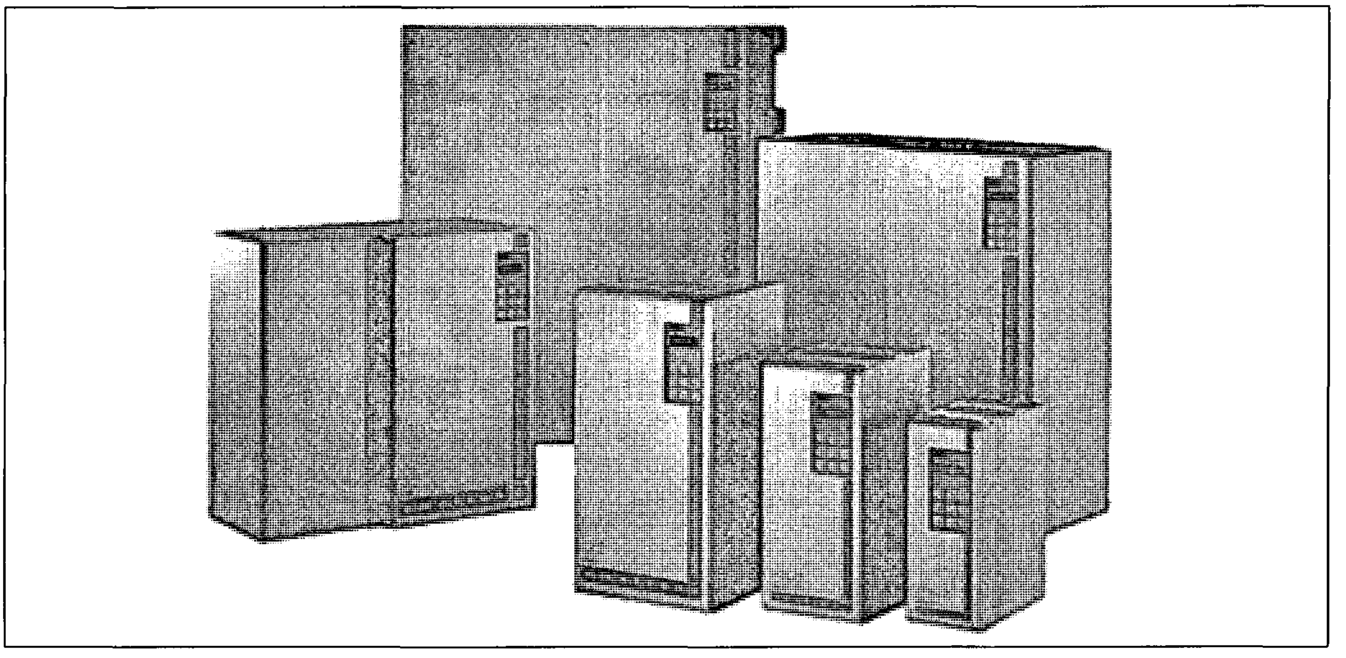


Fig. 31 MSF softstarter models MSF-017 to MSF-1400.

7.1 General description of user interface

WARNING! Never operate the softstarter with the front cover removed.

To obtain the required operation, a number of parameters must be set in the softstarter.

Configuration is carried out either from the control panel or by a computer/control system through the serial communication interface (option). Controlling the motor i.e. start/ stop, selection of parameter set, is done either from the control panel, through the remote control inputs or through the serial communication interface (option).

Setting

WARNING! Make sure that all safety measures have been taken before switching on the power supply.

Switch on the control supply (normally 1*230 V); all segments in the display will be illuminated for a few seconds. Then the display will show menu [100]. An illuminated display indicates that there is control supply voltage to the softstarter.

Check that you have voltage on the mains contactor or on the thyristors. Set the motor data, menus [210] to [215], to achieve correct functionality and optimized performance of the build-in functions such as torque control, motor protection, shaft power monitor etc.

7.2 Control panel

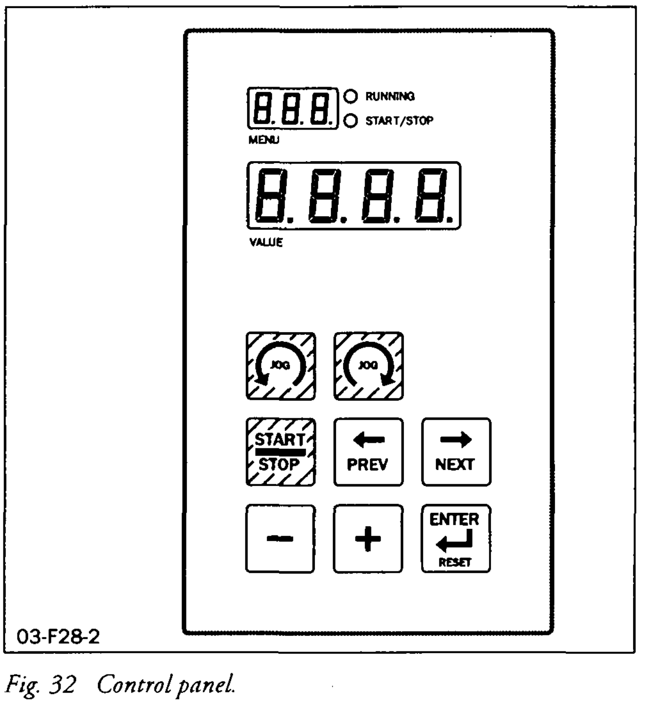


Fig. 32 Control panel.

The control panel is used for selection, programming and presentation. It consists of:

- 2 light emitting diodes (LEDs).
- 1 display with three 7-segment digits showing the actual menu number.
- 1 display with four 7-segment digits showing the actual value.
- Keyboard with eight keys.

7.3 LED indication

The two light emitting diodes indicate start/stop and running motor/machine.

When a start command is given either from the control panel, through the serial communication interface (option) or through the remote control inputs, the start/stop LED will be illuminated. At a stop command the start/stop LED will switch off. The start/stop LED flashes when the softstarter is in standby operation waiting for a start caused by autoreset or analogue start/stop.

When the motor is running, the running LED flashes during ramp up and down and is illuminated continuously at full motor voltage.

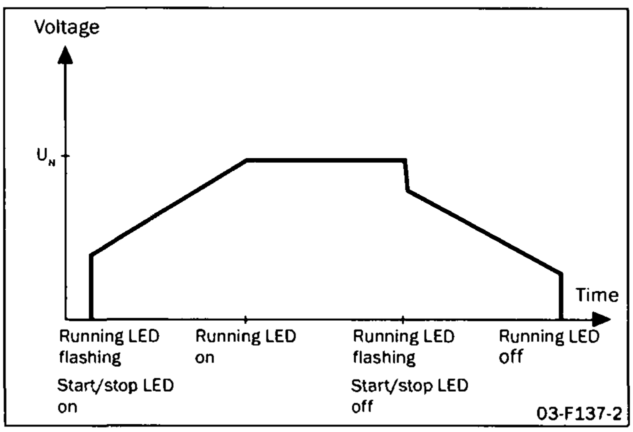


Fig. 33 LED indication at different operation situations.

7.4 The menu structure

The menus in MSF 2.0 are organized in a 1-level structure and they are divided into the groups set out in table 8.

For easier commissioning the menus are divided into three groups, Read-out, Setting and Multi Setting. Read-out menus are only for reading; Setting menus are for setting one parameter and Multi Setting menus are for setting several parameters which cannot be undone. The menus are selected by navigating backwards and forwards through the menu system. Sub-menus simplify setting but are not available when the corresponding main function is not activated.

Table 11 Menu structure of MSF 2.0.

Function	Menu number
General settings	100-101, 200-202
Motor data	210-215
Motor protection	220-231
Parameter set handling	240-243
Auto reset	250-263
Serial communication	270-273
Operation settings	300-342
Process protection	400-440
I/O settings	500-534
View operation	700-732
Alarm list	800-814
Softstarter data	900-902

7.5 The keys

The function of the control panel is based on a few simple rules.

1. At power up menu [100] is shown automatically.
2. Use the "NEXT → " and "PREV ← " keys to move between menus. To scroll through menu numbers, press and hold either the "NEXT → " or the "PREV ← " key.
3. The "+" and "–" keys are used to increase respectively decrease the value of setting. The value is flashing during setting.
4. The "ENTER ↵ " key confirms the setting just made, and the value will go from flashing to stable.
5. The "START/STOP" key is only used to start and stop the motor/machine.
6. The and keys are only used for JOG from the control panel. The Jog function must be enabled in menu [334] or [335].

Table 12 The keys

Start/stop motor operation.	START / STOP
Display previous menu.	← PREV
Display next menu.	→ NEXT
Decrease value of setting.	−
Increase value of setting.	+
Confirm setting just made. Alarm reset.	ENTER ↵ RESET
JOG Reverse	JOG
JOG Forward	JOG

7.6 Control panel lock

The control panel can be locked to prevent parameter being set by unauthorised personnel.

- Lock control panel by simultaneously pressing both "NEXT → " and "ENTER ↵ " for at least 2 sec. The message '- Loc' will be displayed for 2 seconds when locked.
- To unlock control panel, simultaneously press the same 2 keys "NEXT → " and "ENTER ↵ " for at least 2 sec. The message 'unlo' will be displayed for 2 seconds when unlocked.

In locked mode it is possible to operate the softstarter from the conrrol panel and to view all parameters and read-outs, but it is not possible to change any parameters.

7.7 Overview of softstarter operation and parameter set-up

Table showing how parameters can be set and operation carried out.

Table 13 Control sources

Control source	Control panel lock	Operation		Setting of parameters
		Start/Stop	Alarm reset	
Control panel Menu [200]=1	**Unlocked control panel**	Control panel	Control panel	Control panel
	Locked control panel	Control panel	Control panel	———
Remote Menu [200]=2	**Unlocked control panel**	Remote	Remote and control panel	Control panel
	Locked control panel	Remote	Remote and control panel	———
Serial comm. Menu [200]=3	**Unlocked control panel**	Serial comm.	Serial comm. and control panel	Serial comm.
	Locked control panel	Serial comm.	Serial comm. and control panel	Serial comm.

NOTE: If external control of parameter set is chosen in menu [240] no parameters except for parameter set [249] and control source [200] can be changed.

8. Functional description

This functional description for Softstarter MSF 2.0 describes the menus and parameters in the softstarter unit. You will find a short description of each function, their aims and settings.

The MSF 2.0 provides extensive setting possibilities via menus on the control panel, remote control or serial communication. The menus are numbered according to the menu overview in Table 10.

Table 14 Menu overview

Function	Menu number	Description	See section
General settings	100-101 200-202	General basic settings.	8.1
Motor data	210-215	For insertion of technical data for the actual motor.	8.2
Motor protection	220-231	Protection associated with the motor in the application.	8.3
Parameter set handling	240-243	Selection and programming of parameter sets.	8.4
Auto reset	250-263	Automatic reset of active alarm and restart of MSF 2.0.	8.5
Serial communication	270-273	Serial communication settings for the data transfer.	8.6
Operation settings	300-342	Settings associated with the operation, for example the start- and stop procedures.	8.7
Process protection	400-440	Protection associated with the process.	8.8
I/O settings	500-534	In- and output settings for control and monitoring.	8.9
View operation	700-732	For read-out of measured values.	8.10
Alarm list	800-814	Latest error. Available alarms.	8.11
Softstarter data	900-902	Displays softstarter type, software variant and version.	8.12

8.1 General settings

General settings for MSF 2.0 contains the following menus:

[100] Current

[101] Automatic return menu

[200] Control source

[201] Control panel locked for settings

[202] Enable US units

8.1.1 Current [100]

This read-out menu shows the actual current to the motor.

100 Read-out

Current

0.0

Range:	0.0-9999A

NOTE! This is the same read-out as menu [700].

8.1.2 Automatic return menu [101]

When the MSF 2.0 is powered up, menu [100] (Current read-out) is shown as default. When another menu has been selected by the user (moving through the menu list with the "NEXT" or "PREV" keys) this menu will remain active. Alternatively a specific menu can be chosen as automatic return menu. The chosen menu will be shown automatically after 60 seconds without any control panel activity.

101 Setting

Automatic return menu

oFF

Default:	oFF
Range:	oFF, 1-999
oFF	Automatic return menu is disabled.
1-999	Automatic return menu.

8.1.3 Control source [200]

The softstarter can be controlled either via the control panel, remote control or the serial communication interface. Remote control via terminals 11,12 and 13 is the default setting.

NOTE: Depending on the setting in this menu, the softstarter may be configured via control panel or via serial communication. See Table 13, page 42 for more information.

NOTE: If control panel (1) or remote control (2) is configured, the setting can only be changed via control panel to serial communication control (3). However, if serial communication control (3) is configured, the setting can be changed either via serial communication or via control panel.

200 Setting

Control source

2

Default:	2 (remote control)
Range:	1, 2, 3
1	Control panel.
2	Remote control.
3	Serial communication control.

8.1.4 Control panel lock [201]

The MSF 2.0 Control panel can be locked to prevent parameter being set by unauthorised personnel.

- Lock control panel by simultaneously pressing both keys "NEXT →" and "ENTER ↵" for at least 2 seconds. The message "- Loc" will be displayed for 2 seconds.
- To unlock control panel, simultaneously press the same two keys "NEXT →" and "ENTER ↵" for at least 2 seconds. The message "unlo" will be displayed for 2 seconds.

In locked mode, all parameters and read-outs (menus) can be displayed, but it is forbidden to change any parameters via the control panel.

The message '-Loc' will be displayed if someone tries to set a parameter in locked mode.

The key lock status can be read out in menu [201].

NOTE: If menu [200] is configured for serial communication control, the softstarter may still be configured via serial communication, regardless of the control panel lock status.

201 Read-out

Control panel locked for settings

no

Default:	no
Range:	no, YES
no	Control panel is not locked
YES	Control panel is locked

8.1.5 Enable US units [202]

By default all read-out and configuration values are given in SI units. If preferred, US customary units can be chosen instead. in this case the following units are used:

- Powers are set and shown in HP, menus [212] and [703]
- Power consumption is shown in MHph, menu [731]
- Shaft torque is shown in lbft, menu [705]
- Temperature is shown in degrees Fahrenheit, menu [707]

NOTE: When the setting for US units is changed, the motor data in menus [210-215] is reset to the default values for the chosen units (SI or US customary units) in all parameter sets.

[210] Nominal motor voltage – new default value (460 V, for US units enabled)

[211] Nominal motor current – new default value depending on softsrarter size.

[212] Nominal motor power – new default value depending on softstarter size

[213] Nominal motor speed – new default value depending on softstarter size

[215] Nominal frequency – new default value (60 Hz, for US units enabled)

If the setting is changed and confirmed with "ENTER", "SEt" is displayed for 2 seconds to indicate successful selection.

202 Setting

Enable US units

oFF

Default:	oFF
Range:	oFF, on
oFF	Values are presented in kW, Nm etc.
on	Values are presented in HP, lbft etc.

8.2 Motor data

For optimal performance the MSF 2.0 softstarter should be configured according to the motor's rating plate:

[210] to [215] Nominal motor data

NOTE: The default factory settings are for a standard 4-pole motor according to the nominal current and power of the softstarter. The softstarter will run even if no specific motor data is selected, but the performance will not be optimal.

Nominal motor voltage.

210 Setting

Nominal motor voltage

400

Default:	400 V
Range:	200-700 V
200-700	Nominal motor voltage.

NOTE: Make sure the softstarter's maximum voltage rating is suitable for selected motor voltage.

Nominal motor current. The current range is related to the size of the softstarter.

211 Setting

Nominal motor current

17

Default:	I_{nsoft} in A
Range:	25-200% of I_{nsoft} in A
25-200	Nominal motor current

Nominal motor power in kW or HP. The power range is related to the size of the softstarter.

212 Setting

Nominal motor power

7.5

Default:	P_{nsoft} in kW
Range:	25-400% of P_{nsoft} in kW or HP.
25-400	Nominal motor power.

Nominal motor speed.

213 Setting

Nominal motor speed

1450

Default:	N_{nsoft} in rpm
Range:	500-3600 rpm
500-3600	Nominal motor speed.

Nominal motor power factor.

214 Setting

Nominal power factor

0.86

Default:	0.86
Range:	0.50-1.00
0.50-1.00	Nominal motor power factor.

Nominal motor frequency

215 Setting

Nominal frequency

50

Default:	50 Hz
Range:	50 Hz, 60 Hz
50, 60	Nominal frequency.

8.3 Motor protection

The MSF 2.0 softstarter is equipped with different motor protection functions. The following menus are available to configure these protection methods:

[220]-[223] Thermal motor protection

[224]-[227] Start limitation

[228]-[229] Locked rotor

[230] Single phase input failure

[231] Current limit start time expired

For these protection methods the following options are available (all options may not be available for all protection methods – check the description of the relevant menu for details):

Off

The protection method is disabled.

Warning

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset wen the fault disappears. The alarm may also be reset manually.

Coast

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). The motor voltage is automatically switched off. The motor freewheels until it stops.

Stop

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). The motor is stopped according to the stop settings in menus [320] to [325].

Brake

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). The brake function is activated according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menus [326] to [327] (braking strength and braking time).

8.3.1 Thermal motor protection

With MSF 2.0 an internal thermal model of the motor or an external signal from a PTC can be used for thermal motor protection. It is also possible to combine both protection methods. Slight overload for a long time and several overloads of short duration will be detected with both methods.

Thermal motor protection [220]

Thermal motor protection is activated by choosing an alarm action in menu [220]. After that menus [221] to [223] will be available so that the type of the protection (internal and/or PTC) can be chosen. If the operation has been interrupted due to a thermal motor protection alarm, a manual reset and a new start signal is needed to restart the motor. The reset and the start signal can be given via control panel, remote or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via the control panel.

NOTE: A reset via the control panel will never start the motor.

220	Setting
2	**Thermal motor protection (Alarm code F2)**
Default:	2 (Coast)
Range:	oFF, 1, 2, 3, 4
oFF	Thermal motor protection is disabled.
1	Warning
2	Coast
3	Stop
4	Brake

PTC input [221]

This menu is available if thermal motor protection is enabled in menu [220]. To use the PTC functionality, connect the PTC to terminals 69 and 70. See fig. 53. If the motor gets too warm (PTC resistance above 2.4 kOhm), an F2 alarm will occur. The alarm will remain active until the motor has cooled down (PTC resistance below 2.2 kOhm).

221	Setting
oFF	**PTC Input**
Default:	oFF
Range:	oFF, on
oFF	Motor PTC input is disabled.
on	Motor PTC input is enabled.

NOTE: Open terminals will give an F2 alarm immediately. Make sure the PTC is always connected or the terminals are shorted.

Internal protection class [222]

This menu is available if thermal motor protection is enabled in menu [220]. In this menu an internal protection class can be chosen, which enables internal thermal motor protection. With this setting a thermal curve as set out in Fig. 34 is configured. The motor's thermal capacity is calculated continuously based on the chosen curve. If the thermal capacity exceeds 100% an F2 alarm occurs and the action chosen in menu [220] is performed. The alarm remains active until the motor model cools down to 95% of its thermal capacity. The used thermal capacity is shown in menu [223].

222	Setting
10	**Internal protection class**
Default:	10 s
Range:	oFF, 2-40 s
oFF	Internal protection class is disabled.
2-40	Selection of the thermal curve as set out in Fig. 34.

NOTE: Check that the motor current is configured properly in menu [211].

NOTE! If an external bypass contactor is used, check that the current transformers are placed and connected correctly.

CAUTION! Used thermal capacity is set to 0 if the control board loses its supply (terminal 01 and 02). This means that the internal thermal model starts with a "cold" motor, which perhaps in reality is not the case. This means that the motor can be overheated.

Used thermal capacity [223]

This menu is available if thermal motor protection is activated in menu [220] and an internal protection class is chosen in menu [222]. The menu shows the thermal capacity of the motor according to the thermal curve chosen in menu [222].

223	Read-out
0	**Used thermal capacity**
Range:	0-150%

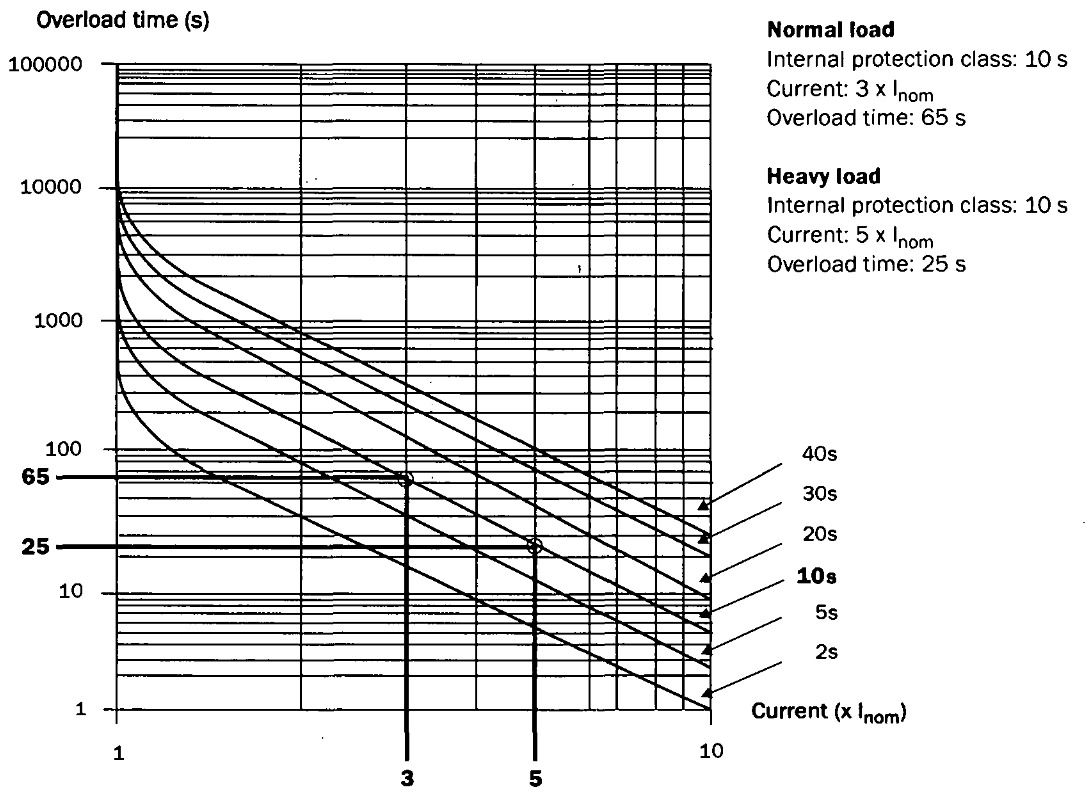


Fig. 34 The thermal curve

8.3.2 Start limitation

Start limitation is used to protect the motor by limiting the numbers of starts per hour or securing a minimum time delay between starts. Both protection methods can be used separately or in combination.

Start limitation [224]

Start limitation is enabled in this menu by choosing a proper alarm action. The available options are:

Off

The protection method is disabled.

Warning

Alarm message F11 is shown in the display and relay K3 is activated (for default configuration of the relays). However, the start will be allowed.

Coast

Alarm message F11 is shown in the display and relay K3 is activated (for default configuration of the relays). The start will not be allowed.

A Start limitation alarm is automatically reset when a new start signal is given. The start signal can be given via control panel, remote or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via the control panel.

NOTE: A reset via the control panel will never start the motor.

224	Setting
oFF	**Start limitation (Alarm code F11)**
Default:	oFF
Range:	oFF, 1, 2
oFF	Start limitation is disabled.
1	Warning
2	Coast

Number of starts per hour [225]

This menu is available if start limitation is enabled in menu [224]. In this menu the allowed number of starts per hour is configured. If this number is exceeded, an F11 alarm occurs and the action chosen in menu [224] is performed. The alarm is active until the hour has expired and a new start can be allowed.

225	Setting
oFF	Number of starts per hour
Default:	oFF
Range:	oFF, 1-99
oFF	Starts per hour protection is disabled
1-99	Number of starts per hour.

Min. time between starts [226]

This menu is available if start limitation is enabled in menu [224]. In this menu a minimum time between consecutive starts can be configured. If a new start attempt is made before the configured minimum time is expired an F11 alarm will occur and the action chosen in menu [224] is performed. The alarm remains active until the chosen minimum time has expired and a new start can be allowed.

226	Setting
oFF	Min. time between starts
Default:	oFF
Range:	oFF, 1-60 min
oFF	Min. time between starts protection is disabled.
1-60	Min. time between starts.

Time to next allowed start [227]

This menu is available if start limitation is enabled in menu [224] and at least one of the protection methods described above is configured (number of starts per hour or minimum time between starts). In this menu the remaining time to the next allowed start is shown. If both protection methods mentioned above are activated, the shown time is the total time delay to the next start, which is allowed by both methods.

227	Read-out
0	Time to next allowed start
Range:	0- 60 min

8.3.3 Locked rotor

This alarm is used to avoid high motor current due to a mechanically locked rotor. If the operation has been interrupted due to a locked rotor alarm, a manual reset and a new start signal is needed to restart the motor. The reset and the start signal can be given via control panel, remote or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via the control panel.

NOTE: A reset via the control panel will never start the motor.

Locked rotor [228]

Locked rotor alarm is activated in this menu by choosing a proper alarm action.

228	Setting
oFF	Locked rotor alarm (Alarm code F5)
Default:	oFF
Range:	oFF, 1, 2
oFF	Locked rotor alarm is disabled.
1	Warning
2	Coast

Locked rotor time [229]

This menu is available if Locked rotor alarm is enabled in menu [228]. In this menu the time delay for detection of a locked rotor is configured. If a high motor current (4.8 times the nominal motor current) is floating for a time exceeding the chosen value, an F5 alarm will occur and the action chosen in menu [228] will be performed.

229	Setting
5.0	Locked rotor time
Default:	5.0 s
Range:	1.0-10.0 s
1.0-10.0	Locked rotor time.

NOTE: Check that the motor current is configured properly in menu [211].

8.3.4 Phase input failure

All phase input failures shorter than 100 ms are ignored.

Multiple phase input failure

If the failure duration time is above 100 ms, operation is temporary stopped and a new soft start is made if the failure disappears within 2 s. If the failure duration time is longer than 2 s an F1 alarm occurs and the voltage to the motor remains off. During deceleration, regardless of the failure duration time, the motor voltage is automatically switched off and the motor freewheels until it stops.

Single phase input failure

During acceleration and deceleration the behaviour is the same as described above for multiple phase input failure. When running with full voltage, the softstarter can be configured for different actions in the event of a single phase input failure (menu [230]).

A phase input failure alarm is automatically reset when a new start signal is given. The start signal can be given via control panel, remote or via serial communication depending on the control source chosen in menu 200. Regardless of the chosen control source, it is always possible to initiate a reset via the control panel.

NOTE: A reset via the control panel will never start the motor.

Single phase input failure [230]

The softstarter's action on a single phase input failure occurring during full voltage running can be configured in this menu. In the event of a single phase input failure, alarm F1 is activated after 2 s (see description above) and the chosen action is performed. The alarm remains active until the failure disappears.

230	Setting
2	**Single phase input failure (alarm code F1)**
Default:	2
Range:	1, 2
1	Warning
2	Coast

8.3.5 Current limit start time expired

If current limit at start is activated in menu [314], an F4 alarm can be activated if the operation is still at current limit when the configured start time has expired. A current limit start time expired alarm is automatically reset when a new start signal is given. The start signal can be given via control panel, remote or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via control panel.

NOTE: A reset via the control panel will never start the motor.

Current limit start time expired [231]

In this menu the alarm for current limit start time expired can be enabled and a proper action can be selected.

231	Setting
2	**Current limit start time expired (alarm code F4)**
Default:	2
Range:	oFF, 1, 2, 3, 4
oFF	Current limit start time expired protection is disabled.
1	Warning
2	Coast
3	Stop
4	Brake

NOTE: If the action for current limit start time expired is configured as Warning or the protection is not activated at all, the softstarter will ramp up to full voltage with a ramp time of 6 s if the start time has expired in current limit mode. The current is then no longer controlled.

8.4 Parameter set handling

The use of different parameter sets can be helpful when using one softstarter to start different motors or when working under various load conditions. There are four parameter sets available in MSF 2.0. Parameter set handling is controlled by the following menus:

[240] Select parameter set

[241] Actual parameter set

[242] Copy parameter set

[243] Reset to factory setting

8.4.1 Select parameter set [240]

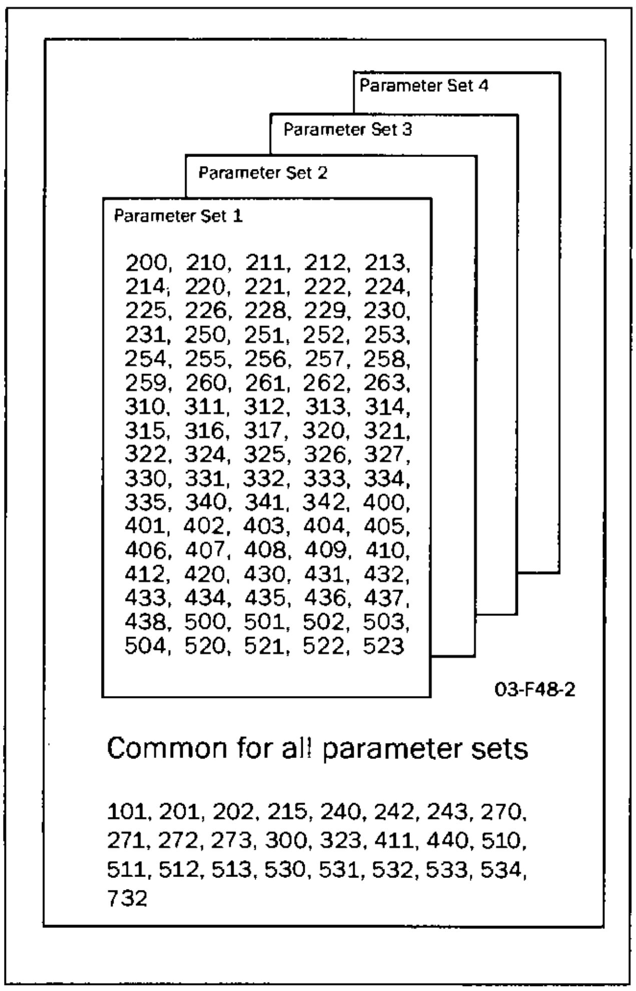


Fig. 35 Parameter overview

Select parameter set [240]

In this menu one of the parameter sets 1-4 can be selected directly or external control of parameter sets via digital inputs can be chosen. If external control of parameter sets is chosen, the digital inputs have to be configured properly (see description of menus [510] to [513]). By default digital inputs 3 and 4 (terminals 16 and 17) are configured for external control of parameter sets.

240 — Setting

Select parameter set

1

Default:	1
Range:	0, 1, 2, 3, 4
0	External control of parameter sets.
1, 2, 3, 4	Selection of parameter sets 1-4.

Actual parameter set [241]

This menu is available when external control of parameter sets is chosen in menu [240]. This menu shows which parameter set is actually selected via the digital inputs.

241 — Read-out

Actual parameter set

1

Range:	1, 2, 3, 4

8.4.2 Copy parameter set [242]

When programming a new parameter set, this function will simplify the procedure. It is possible to copy an already programmed parameter set into another set as follows:

- Select a copy alternative in this menu, for example P1-2. Press Enter. "CoPY" is displayed for 2 seconds to indicate successful copy process. After that, "no" is displayed.
- Go to menu [240] and select parameter set 2.
- Make the required new settings in corresponding menus for parameter set 2.

242 — Multi Setting

Copy parameter set

no

Default:	no
Range:	no, P1-2, P1-3, P1-4, P2-1, P2-3, P2-4, P3-1, P3-2, P3-4, P4-1, P4-2, P4-3
no	No action
P1-2 etc.	Copy parameter set 1 to parameter set 2 etc.

NOTE: Copying parameter sets is only allowed when the softstarter is not running.

8.4.3 Reset to factory setting [243]

This menu enables all parameters to be reset to the default values. This includes all four parameter sets and the common parameters except for parameter [202] (enable US units). As Enable US units is not reset to default, the values loaded for the normal motor data in menus [210] to [215] correspond to the chosen units (SI or US customary), see description of menu [202] on page 45 for more information. The alarm list, the power consumption and the operation time will not be affected by resetting the parameters. When the reset of all parameters to the factory default values has been executed successfully, menu [100] is shown on the display.

243 | Multi Setting

Reset to factory settings

no

Default:	no
Range:	no, YES
no	No action
YES	Reset all parameters to the factory default values.

NOTE! Reset to factory settings is not allowed when the softstarter is running.

8.5 Autoreset

For several non-critical application-related failure conditions, it is possible to automatically generate a reset and initiate a restart to overcome the fault condition. Autoreset functionality is configured using the following menus:

[250] Autoreset attempts.

[251] to [263] Autoreset items.

In menu [250] the maximum number of automatically generated restarts allowed can be set. When this number is exceeded and a new fault occurs, the softstarter will stay in fault condition because external assistance is required. In menus [251] to [263], autoreset is enabled for the different protection types by choosing a delay time. If a fault occurs for which autoreset is enabled, the motor is stopped according to the action chosen for the relevant protection method (see menus [220] to [231] and [400] to [440] for description of protection methods and configuration of actions on failures). When the fault has disappeared, and the configured delay time has elapsed, the motor is restarted.

Example:

The motor is protected by internal thermal protection. When a thermal protection alarm occurs, the softstarter should wait until the motor is cooled down enough before resuming normal operation. When this problem occurs several times in a short period of time, external assistance is required.

The following settings should be applied:

- Activate thermal motor protection, e.g. set menu [220] to 2 (Coast).
- Activate internal thermal motor protection, e.g. set menu [222] to 10 (thermal curve for 10 s).
- Insert maximum number of restarts: e.g. set menu [250] to 3.
- Activate thermal motor protection to be automatically reset: e.g. set menu [251] to 100.
- Configure one of the relays to give an alarm when external assistance is required: e.g. set menu [532] to 19 (all alarms which need manual reset).

The autoreset functionality is not available if control panel is chosen as control source in menu [220].

WARNING: A flashing start/stop LED indicates standby mode e.g. waiting for autoreset. The motor may be started automatically at a moment's notice.

NOTE: The autoreset cycle will be interrupted when a stop signal is given (remote or via serial communication) or if the control source is changed to control panel in menu [200].

8.5.1 Autoreset attempts [250]

In this menu the maximum allowed number of automatically generated restart attempts is set. If any number of autoreset attempts is selected in this menu the Autoreset functionality is activated and menus [251] to [263], will become available. If an alarm occurs for which autoreset is enabled (in menus [251] to [263]), the motor will automatically be restarted when the fault has disappeared and the delay time has expired. For each automatically generated restart, the internal autoreset counter (not visible) will go up one place. If no alarm occurs for more than 10 minutes, the autoreset counter will be decreased by one. When the maximum number of autoreset attempts is reached, no further restart will be allowed and the softstarter will remain in fault condition. In this case a manual reset (either via control panel, remote or serial communication, see description on page 39) is needed.

Example:

- Autoreset attempts (menu [250]=5)
- Within 10 minutes 6 alarms occur.
- At the 6th trip there is no autoreset, because the autoreset counter contains already 5 autoreset attempts.
- To reset, apply a normal reset. This will also reset the autoreset counter.

NOTE: The internal autoreset counter is reset to zero if a stop signal is given. After each new start signal (via remote or serial communication) the maximum number of restart attempts will be allowed as configured in menu [250].

250	Setting
oFF	**Autoreset attempts**
Default:	oFF
Range:	oFF, 1-10
oFF	Autoreset disabled.
1-10	Number of Autoreset attempts.

8.5.2 Autoreset items [251]-[263]

Menus [251] to [263] are available if autoreset is enabled in menu [250]. With these menus the delay time for autoreset is configured. The delay time starts counting when the fault is gone. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

NOTE: Enabling autoreset for an alarm has no effect if the alarm action for the respective alarm is set to oFF or Warning (1).

Thermal motor protection autoreset [251]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for thermal motor protection autoreset is configured. The delay time starts counting when the fault is gone. This means the internal thermal motor model has to cool down to a thermal capacity of 95% (if internal thermal motor protection is enabled) and the PTC resistance has to go down to 2.2 kOhm (if PTC is enabled), which indicates that the motor has cooled down. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

251	Setting
oFF	**Thermal motor protection autoreset**
Default	oFF
Range:	oFF, 1-3600 s
oFF	Thermal motor protection autoreset is disabled
1-3600	Delay time for thermal motor protection autoreset

Start limitation autoreset [252]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for an autoreset after a start limitation alarm (alarm code F11) is configured. The delay time starts counting when the fault is gone. This means the minimum time between starts has to be expired (if Minimum time between starts protection is enabled) and a start has to be allowed for the actual hour (if starts per hour protection is enabled). When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

Locked rotor alarm autoreset [253]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for an autoreset after a locked rotor alarm (alarm code F5) is configured. As a locked rotor cannot be detected in stopped state, the delay time starts counting immediately after the alarm action has been executed. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

Current limit start time expired autoreset [254]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for an autoreset after a current limit start time expired alarm (alarm code F4) is configured. As a current limit start time expired fault condition cannot be detected in stopped state, the delay time starts counting immediately after the alarm action has been executed. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

Max power alarm autoreset [255]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for an autoreset after a max power alarm (alarm code F6) is configured. As a max power fault condition cannot be detected in stopped state, the delay time starts counting immediately after the alarm action has been executed. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

Min power alarm autoreset [256]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for an autoreset after a min power alarm (alarm code F7) is configured. As a min power fault condition cannot be detected in stopped state, the delay time starts counting immediately after the alarm action has been executed. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

External alarm autoreset [257]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for an autoreset after a external alarm (alarm code F17) is configured. The delay time starts counting when the fault is gone. This means the external alarm signal input has to be closed. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

Phase input failure autoreset [258]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for an autoreset after a phase input failure (alarm code F1) is configured. As a phase input failure cannot be detected in stopped state, the delay time starts counting immediately after the alarm action has been executed. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

Voltage unbalance alarm autoreset [259]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for an autoreset after a voltage unbalance alarm (alarm code F8) is configured. The delay time starts counting when the fault is gone. Usually, the mains voltage will not be available to the softstarter in stopped state as the mains contactor is deactivated. In this case a voltage unbalance failure cannot be detected in stopped state and the delay time starts counting immediately after the alarm action has been executed. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

Over voltage alarm autoreset [260]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for an autoreset after an over voltage alarm (alarm code F9) is configured. The delay time starts counting when the fault is gone. Usually, the mains voltage will not be available to the softstarter in stopped state as the mains contactor is deactivated. In this case an over voltage failure cannot be detected in stopped state and the delay time starts counting immediately after the alarm action has been executed. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

Under voltage alarm autoreset [261]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for an autoreset after an under voltage alarm (alarm code F10) is configured. The delay time starts counting when the fault is gone. Usually, the mains voltage will not be available to the softstarter in stopped state as the mains contactor is deactivated. In this case an under voltage failure cannot be detected in stopped state and the delay time starts counting immediately after the alarm action has been executed. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

Serial communication autoreset [262]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for autoreset after a serial communication broken alarm (alarm code F15) is configured. The delay time starts counting when the fault is gone. This means serial communication has to be re-established. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

Softstarter overheated autoreset [263]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for autoreset after a softstarter overheated alarm (alarm code F3) is configured. The delay time starts counting when the fault is gone. This means the softstarter has to be cooled down. When the delay time has elapsed, the alarm will he reset and a restart attempt will automatically be made.

8.6 Serial communication

There are several serial communication options available for MSF 2.0 (see page 107 for more information). The softstarter can he configured and controlled via serial communication if this is configured in menu [200] (see page 44). The following parameters are available to configure serial communication:

[270] Serial comm. unit address

[271] Serial comm. baudrate

[272] Serial comm. parity

[273] Serial comm. contact broken

NOTE: The communication parameters [270] to [272] must be set up via the control panel. To enable configuration via the control panel, menu [200] must be set to 1 (control panel) or 2 (remote control).

Serial comm. unit address [270]

Serial communication unit address.

270	Setting
1	**Serial comm. unit address**
Default:	1
Range:	1-247
1-247	Unit address.

Serial comm. baudrate [271]

Serial communication baudrate.

271	Setting
9.6	**Serial comm. baudrate**
Default:	9.6 kBaud
Range:	2.4 - 38.4 kBaud
2.4-38.4	Baudrate.

Serial comm. parity [272]

Serial communication parity.

272	Setting
0	**Serial comm. parity**
Default:	0
Range:	0, 1
0	No parity
1	Even parity.

Serial comm. contact broken [273]

If the softstarter is configured for control via serial communications (menu [200] = 3) and the serial communication contact is broken during operation, an F15 alarm can be configured to occur. In this menu the alarm can be enabled and an action to be performed can be chosen. The following options are available:

Off

Serial communication contact broken alarm is disabled.

Warning

Alarm message F15 is shown in the display and relay K3 is activated (for default configuration of the relays). However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset when the fault disappears. The alarm may also be reset manually from the control panel.

Coast

Alarm message F15 is shown in the display and relay K3 is activated (for default configuration of the relays). The motor voltage is automatically switched off. The motor freewheels until it stops.

Stop

Alarm message F15 is shown in the display and relay K3 is activated (for default configuration of the relays). The motor is stopped according to the stop settings in menus [320] to [325].

Brake

Alarm message F15 is shown in the display and relay K3 is activated (for default configuration of the relays). The brake function is activated according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menus [326] to [327] (braking strength and braking time).

A serial communication broken alarm is automatically reset when a new start signal is given. The start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu 200. Regardless of the chosen control source, it is always possible to initiate a reset via control panel.

NOTE: A reset via control panel will never start the motor.

273	Setting
oFF	**Serial comm. contact broken (alarm code F15)**
Default:	2
Range:	oFF, 1, 2, 3, 4
oFF	Serial comm. contact broken disabled
1	Warning
2	Coast
3	Stop
4	Brake

8.7 Operation settings

Operation settings include parameters for configuration of starting and stopping, some of these can be pre-configured for pump applications. Furthermore, some special settings for stop behaviour at alarm, parameters for slow speed and jog and additional settings such as bypass operation, power factor control and control of the internal fan are included in this section.

[300] Preset pump control parameters

[310]-[317] Start

[320]-[327] Stop including stop at alarm

[330]-[335] Slow speed/JOG

[340]-[342] Additional settings

The MSF Softstarter controls all three phases supplied to the motor. In contrast to a simple softstarter controlling only one or two phases, the three-phase control enables different starting methods, voltage, current and torque control. A current limit can even be used in combination with either voltage or torque control.

With voltage control the output voltage to the motor is linearly increased to full line voltage during the set start time. The softstarter gives a smooth start but does not get any feedback on current or torque. The typical settings to optimize a voltage controlled start are the initial voltage and the start time.

With current control the output voltage to the motor is regulated so the set current limit is not exceeded during the start. Even with this starting method the starter does not get any feedback on the motor torque. However, current control can be combined with both voltage and torque control. The typical settings to optimize a current controlled start are the current limit and the maximum starting time.

Torque control is the most sophisticated way of starting motors. The softstarter continually monitors the motor torque and controls the output voltage to the motor so the torque follows the set ramp. Both linear- and square torque ramps can be chosen according to the application requirments. In this way constant acceleration can be accomplished during start which is very important in many applications. Torque control can also be used for stopping with constant deceleration. For pumps constant deceleration is important for avoiding water hammer.

8.7.1 Preset pump control [300]

With this multi-setting parameter the MSF 2.0 softstarter can easily be configured for pump applications. The following parameters are set if preset pump control parameters are chosen.

[310] Start method is set to square torque control (2)

[312] Initial torque at start is set to 10%

[313] End torque at start is set to 125%

[315] Start time is set to 10 seconds

[314] and [316] Current limit at start and torque boost are deactivated.

[320] Stop method is set to square torque control (2)

[321] End torque at stop is set to 10%

[325] Stop time is set to 15 seconds.

These settings will lead to a smooth start with linear acceleration and a linear stop without water hammer for most pump applications. However, if the pre-set parameters need to be adapted for a specific application, the values in the relevant menus can be adapted.

The following figure shows typical current characteristics at start and speed curve at stop.

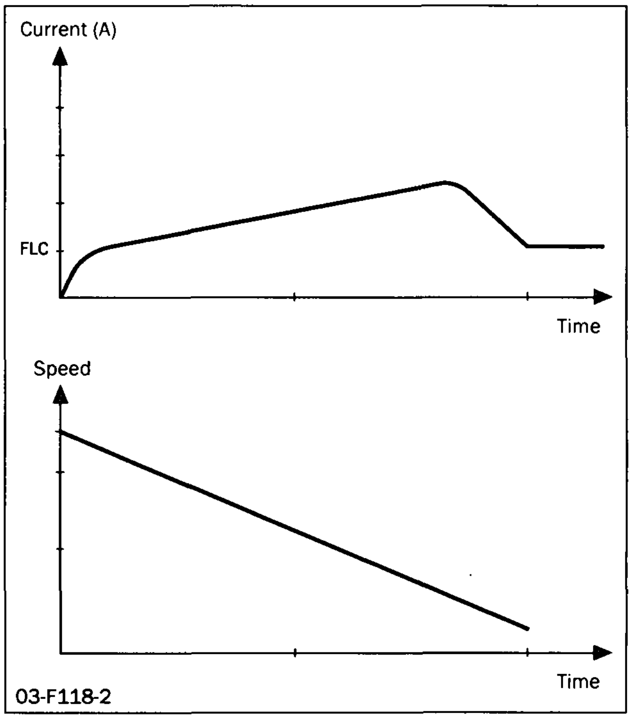


Fig. 36 Pump control. Current at start and speed at stop.

When the pre-setting of the parameters for pump control has been executed successfully, "SEt" is shown in the display for two seconds. After that "no" will be shown again.

Note: Pre-setting of parameters for pump control is not allowed when the softstarter is running.

300 — Multi Setting

Preset pump control parameters

Display: no

Default:	no
Range:	no, YES
no	No action
YES	Preset parameters for pump control

8.7.2 Start

With MSF 2.0, torque control, voltage control and direct on-line are available as start methods. Torque control is available both for loads with a linear torque characteristic like conveyors and planers and with square torque characteristics for pumps and fans. In general torque control is recommended as a starting method; voltage control may be used when for some special reasons a linear voltage ramp is desired. With Direct on-line (DOL) as a start method, neither the current nor the voltage will be controlled; full voltage is applied to the motor immediately. DOL can be used to start the motor if the softstarter has been damaged and the thyristors are short-circuited.

All start methods can be combined with a current limit. However, only a properly configured torque-controlled start will lead to constant acceleration. For this reason it is not recommended to set a current limit for pump applications. With a proper set-up of the torque control parameters, the starting current will be very low. For applications with variable load characteristics from start to start, the current limit functionality may be useful to avoid overloading the mains fuses. However, as the motor torque is proportional to the square of the current, setting a low current limit will limit the motor torque considerably. If the current limit is set too low in relation to the application's requirements, the motor will not be able to accelerate the load.

Start method [310]

In this menu the start method is chosen. The menus necessary for configuration of the start will be available depending on the chosen start method.

310 Setting

Start method

1

Default:	1
Range:	1, 2, 3, 4
1	Linear torque control
2	Square torque control
3	Voltage control
4	Direct on-line, DOL

Torque control

The default settings for initial torque at start is 10% and for end torque at start it is 150%. In Fig. 37 the resulting torque curve is shown versus time for linear and square torque characteristics.

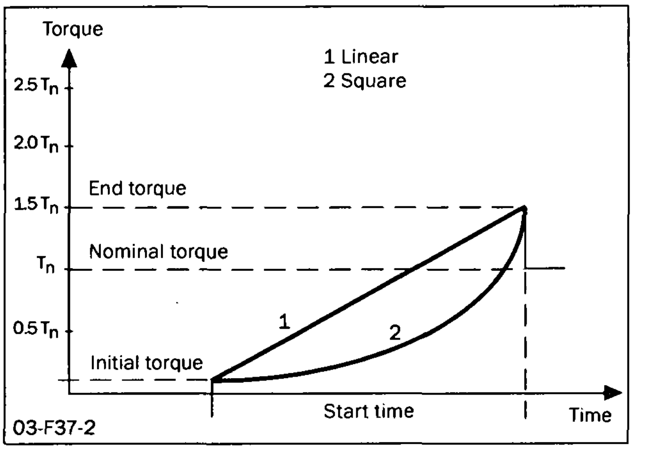


Fig. 37 Torque control at start

A Properly configured torque-controlled start will lead to a linear speed increase and low starting current without current peaks.

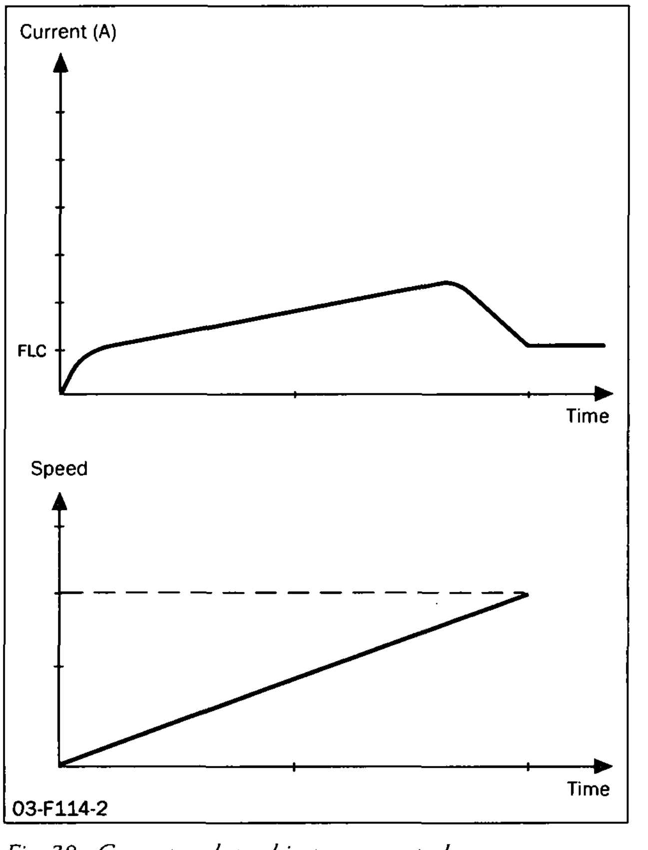


Fig. 38 Current and speed in torque control

To optimize the start, use the setting for initial torque at start, menu [311] and end torque at start, menu [312].

When the start command is given, the motor should immediately start to rotate to avoid unnecessary heat development in the motor. If required, increase the initial torque at start.

The end torque at start should be adjusted so that the time for the motor to come up to nominal speed approximately matches the start time set in menu [315]. If the actual start time is much shorter than the set start time in menu [315], the End torque at stop can be decreased. If the motor does not reach full speed before the start time set in menu [315] has expired, the end torque at stop has to be increased to avoid current peaks and jerking at the end of the ramp. This may be needed for high inertia loads such as planers, saws and centrifuges.

The read-out of shaft torque in percentage of T_n in menu [706] may be useful for fine-tuning the start ramp.

Initial torque at start [311]

This menu is available if torque control is selected in menu [310]. In this menu the initial torque at start is set.

311 Setting

Initial torque at start

10

Default:	10%
Range:	0-250% T_n
0-250	Initial torque at start.

End torque at start [312]

This menu is available if torque control is selected in menu [310]. In this menu the end torque at start is set.

312 Setting

End torque at start

150

Default:	150%
Range:	25-250% T_n
25-250	End torque at start.

Voltage control

Voltage control can be used when a linear voltage ramp is desired. The voltage to the motor will be ramped up linearly, from initial voltage up to full mains voltage.

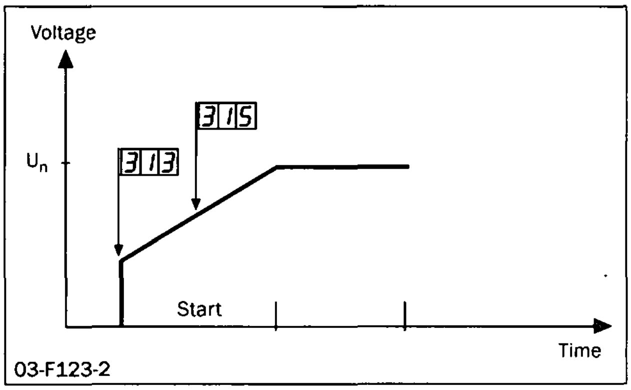


Fig. 39 Menu numbers for initial voltage and start time.

Initial voltage at start [313]

This menu is available if voltage control is chosen as start method in menu [310]. In this menu the initial voltage at start is set.

313 Setting

Initial voltage at start

30

Default:	30%
Range:	25-90% U
25-90	Sets initial voltage at start.

Direct on-line, DOL

If this alternative is selected in menu [310], the motor can be accelerated as if it was connected directly to the mains.

For this type of operation:

Check whether the motor can accelerate the required load (DOL start). This function can be used even with shorted thyristors.

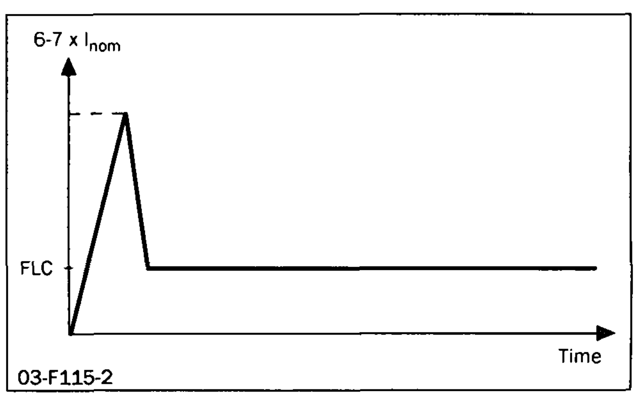


Fig. 40 DOL-start.

Current limit

Current limit at start can be used together with all start methods to limit the current to a defined max level when starting (150-500% of In). However, only a properly configured torque-controlled start will lead to linear acceleration. For this reason it is not recommended to set a current limit for pump applications. Moreover, as the motor torque is proportional to the square of the current, setting a low current limit will limit the motor torque considerably. If the current limit is set too low in relation to the application's requirements, the motor will not be able to accelerate the load.

The combination DOL start and current limit at start gives a start ramp with constant current. The softstarter will control the current up to the set current limit immediately at start, and keep it there until the start is completed or the set start-up time expires.

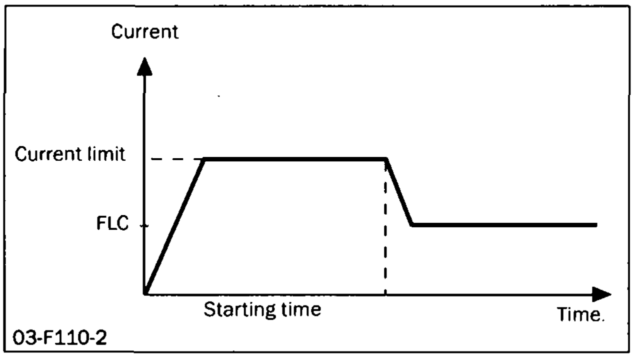


Fig. 41 Direct on-line start in combination with current limit at start.

Current limit at start [314]

In this menu the current limit at start is set.

314 — Setting

Current limit at start

oFF

Default:	oFF
Range:	oFF, 150-500% of I_n
oFF	Current limit disabled.
150-500	Current limit at start.

NOTE: Even though the current limit can be set as low as 150% of the nominal motor current value, this minimum value cannot be used generally. If the current limit is set too low in relation to the application's requirements, the motor will not be able to accelerate the load.

NOTE: Check that the nominal motor current is configured properly in menu [211] if the current limit functionality is used.

If the starting time is exceeded and the softstarter is still operating at current limit, an alarm will be activated according to "Current limit start time expired" settings for motor protection, menu [231]. Operation may be stopped or continued with a pre-defined voltage ramp. Note that the current will rise unchecked if the operation continues.

Start time [315]

In this menu the desired start time is set. This menu is not available if DOL is chosen as a start method and no current limit is configured.

315 — Setting

Start time

10

Default:	10 s
Range:	1-60 s
1-60	Start time.

Torque boost

In specific applications torque boost is required for the start. The torque boost parameter enables a high torque to be obtained by providing a high current for 0.1-2 seconds at start. This enables a soft start of the motor even if the break away torque is high at start. For example in crushing mills applications etc.

When the torque boost function has finished, starting continues according to the selected start method.

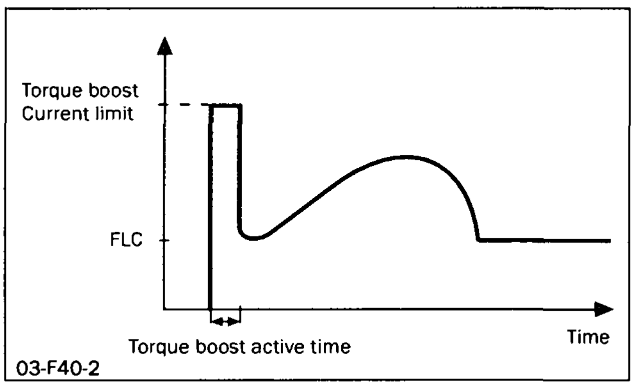


Fig. 42 The principle of the torque boost when starting the motor.

Torque boost current limit [316]

In this menu torque boost is enabled and the current limit for torque boost is configured.

316 Setting

Torque boost current limit

300

Default:	oFF
Range:	oFF, 300-700% of I_n
oFF	Torque boost disabled
300-700	Torque boost current limit.

Torque boost active time [317]

This menu is available if torque boost is enabled in menu [316]. In this menu the time for the torque boost to be active is selected.

317 Setting

Torque boost active time

oFF

Default:	1.0 s
Range:	0.1-2.0 s
0.1-2.0	Torque boost active time.

NOTE! Check whether the motor can accelerate the load with "Torque boost" without any harmful mechanical stress.

NOTE: Check that the nominal motor current is configured properly in menu [221].

8.7.3 Stop

With MSF 2.0, four stop methods are available: torque control, voltage control, coast and braking. Torque control is available for loads with linear or square torque characteristic. A torque or voltage-controlled stop is used for applications where the motor stopping suddenly could harm the application, e.g. water hammer in pump applications. In general a torque-controlled stop is recommended for these applications. The voltage-controlled stop can be used if a linear voltage ramp is desired. When coast is selected as a stop method, the voltage to the motor will be switched off and the motor will be left freewheeling. Braking may be used in applications where the motor needs to be stopped quickly, e.g for planers and bandsaws.

Any start method except for direct on-line (DOL) can be combined with any stop method, e.g. torque control can be used at start and brake for stop. The DOL start method can only be combined with coast or brake stop methods.

Stop method [320]

In this menu the stop method is chosen. The menus necessary for configuring the stop will be available depending on the chosen stop method.

320 Setting

Stop method

4

Default:	4
Range:	1, 2, 3, 4, 5
1	Linear torque control
2	Square torque control
3	Voltage control
4	Coast
5	Brake

Torque control

With torque control at stop, the torque to the motor will be controlled from the nominal torque down to the chosen end torque at stop (menu [321]). Examples for the torque ramps for linear and square torque control are shown in Fig. 43. The default value for end torque at stop is 0; this value may be increased if the motor is standing still before the stop is finished to avoid unnecessary heat development in the motor. With the end torque at stop set properly, the motor speed will decrease linearly down to standstill.

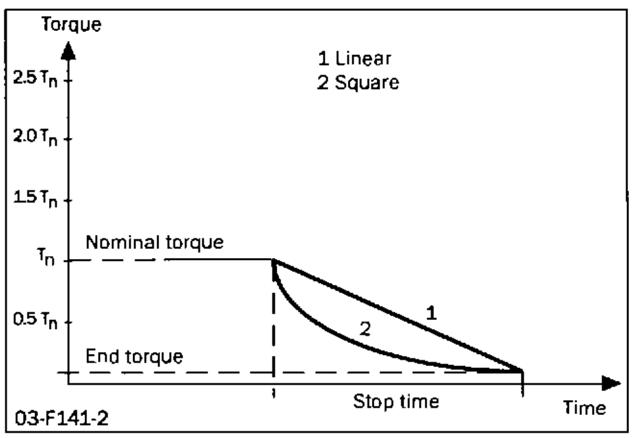


Fig. 43 Torque control at stop

End torque at stop [321]

This menu will be available if torque control is chosen as stop method in menu [320] (alternative 1 or 2). In this menu the end torque at stop is configured.

321	Setting
0	**End torque at stop**
Default:	0%
Range:	0-100% of T_n
0-100	End torque at stop.

Voltage control

With voltage control at stop, the voltage to the motor will be decreased to the chosen step down voltage at stop immediately after a stop signal. Then the voltage to the motor will follow a linear ramp down to the minimum voltage of 25% of the nominal voltage. An example of this voltage ramp is shown in Fig. 44.

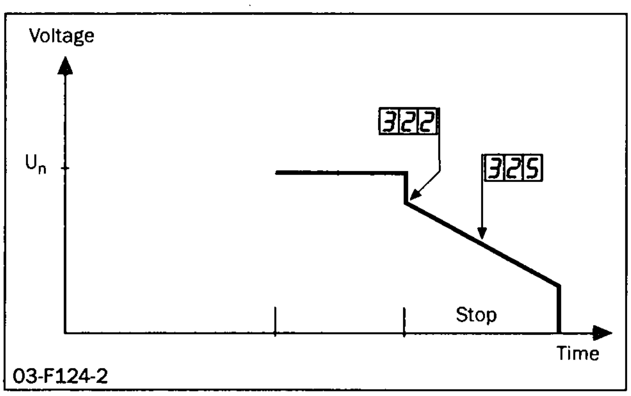


Fig. 44 Menu numbers for step down voltage at stop and stop time.

Step down voltage at stop [322]

This menu is available if voltage control is chosen as stop method in menu [320] (alternative 3). In this menu the step down voltage at stop is chosen in percentage of the nominal motor voltage.

322	Setting
100	**Step down voltage at stop**
Default:	100%
Range:	100-40% of U
100-40	Step down voltage at stop.

Braking

Braking can be used in applications where there is a need for a quick stop.

There are two built-in braking methods: dynamic vector brake for normal loads and reverse current brake for heavy loads with high inertia. In both braking methods the MSF 2.0 continuously detects the motor speed. At low speed the DC brake mode is activated until the motor is standing still. The MSF 2.0 will automatically turn off the output voltage when the motor has stopped or when the stop time has expired. Optionally an external rotation senaor can be connected via digital input, see description for menu [500] on page 77 for more information.

Dynamic vector brake

With dynamic vector brake, the braking torque applied to the motor will increase with decreasing speed. Dynamic vector brake can be used for all loads which are not rotating too close to synchronous speed when the motor voltage is switched off. This is valid for most applications as the load speed usually decreases because of frictional losses in gears or belt drives as soon as the motor voltage is switched off. However, loads with very high inertia may remain at high speed even though the motor is not supplying any torque. For these applications the reverse current brake can be used instead.

When the dynamic vector brake is used, no additional connections or contactors are needed.

Reverse current brake

With reverse current brake, a very high braking torque can be applied to the motor even close to synchronous speed. All kind of loads can be stopped quickly using reverse current brake, including loads with very high inertia. If high braking torques are needed, it should be checked carefully whether the motor, the gear or belt drive and the load can withstand the high mechanical forces. To avoid harmful vibrations, it is generally recommended to select as low a braking torque as possible which also fulfils the demands for a short braking time.

For reverse current brake, two mains contactors are needed. The connection is shown in Fig. 45. The contactors have to be controlled by the MSF's relay outputs. During start and full voltage operation contactor K1 will be closed, for braking K1 will be opened and after a time delay K2 will be closed to change the phase sequence.

NOTE: For several start/stops it is recommend that the motor temperature be monitored using the PTC input.

WARNING: When reverse current brake is selected, the relays K1 and K2 are automatically programmed for reverse current brake functionality. The relay setting remains even if reverse current brake is deactivated. Therefore it may be necessary to adapt the relay functions manually.

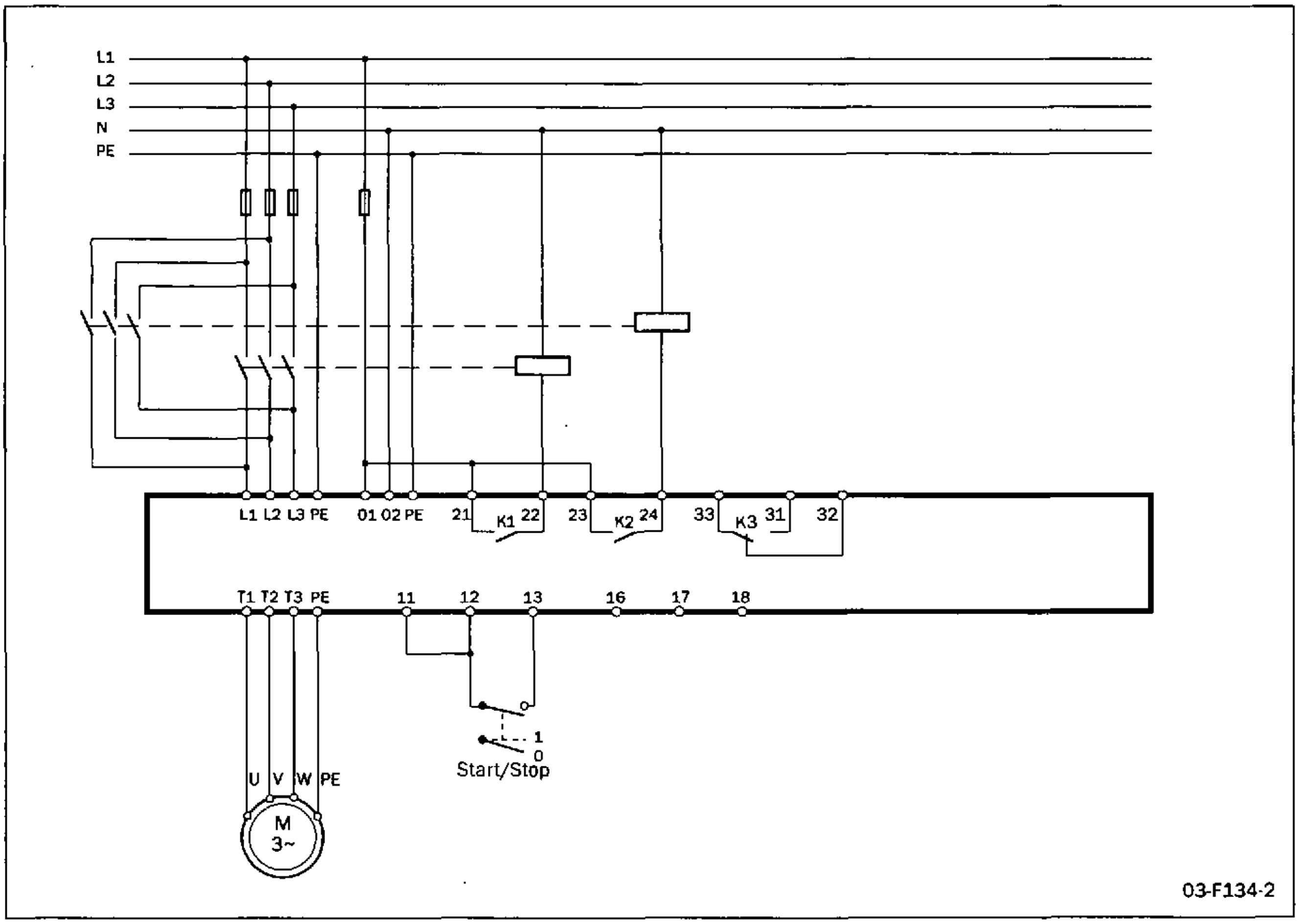


Fig. 45 Reverse current brake wiring example.

Braking method [323]

This menu is available if brake is selected as stop method in menu [320] (alternative 5) or if alarm brake is activated in menu [326] (see description of menus [326] to [327] for more information). In this menu the brake method is selected.

323 Setting

Braking method

1

Default:	1
Range:	1, 2
1	Dynamic vector brake
2	Reverse current brake

Braking strength [324]

This menu is available if brake is selected as stop method in menu [320] (alternative 5). In this menu the braking strength is selected. To avoid unnecessary heat development in the motor and high mechanical stress it is generally recommended to select as low a braking strength as possible which still fulfils the demands for a short braking time.

324 Setting

Braking strength

150

Default:	150%
Range:	150-500%
150-500	Braking strength.

Stop time [325]

This menu is available if any stop method except coast is selected in menu [320] (alternative 1, 2, 3 or 5). In this method the desired stop time is selected.

325	Setting
10	**Stop time**
Default:	10 s
Range:	1-120 s
1-120	Stop time.

Alarm braking

For most alarms it is possible to configure them so that when they are triggered either operation continues or the motor stops (see chapter 9. page 95 for more information). Brake is one of the actions available. If this option is chosen, the braking functionality is activated according to the brake method selected in menu [323] (see description of the braking functionality above for more information). While the braking strength and stop time chosen in menus [324] and [325] are used for braking on a stop signal, different braking strengths and times can be configured in menus [326] and [327] if braking is activated by an alarm. This function may mainly be used in combination with an external alarm (see description on page 73), where an external signal is used to initiate a quick stop with a higher braking strength and a shorter braking time compared to normal operation.

If alarm braking is disabled in menu [326] and brake is chosen as an alarm action, the voltage to the motor will be switched off and the motor will freewheel if the specific alarm occurrs.

Alarm braking strength [326]

In this menu braking as an alarm action is enabled and the alarm braking strength is selected. If alarm braking is not activated, the motor will be left freewheeling if an alarm occurs for which brake is configured as alarm action.

326	Setting
oFF	**Alarm braking strength**
Default:	oFF
Range:	oFF, 150-500%
oFF	Coast - motor voltage is switched off.
150-500	Alarm braking strength.

NOTE: If alarm brake is enabled, the braking method chosen in menu [323] is used.

Alarm braking time [327]

This menu is available if alarm brake is enabled in menu 327. In this menu the braking time to be used in the event of braking as an alarm action is configured.

327	Setting
10	**Alarm braking time**
Default:	10 s
Range:	1-120 s
1-120	Alarm braking time.

8.7.4 Slow speed and JOG functions

MSF 2.0 is able to run the motor at a fixed slow speed for a limited period of time. The slow speed will be about 14% of the full speed in the forward direction and 9% in the reverse direction.

NOTE: As the motor torque during slow speed is limited to about 30% of the nominal torque, slow speed can not be used in applications which need a high brake-away torque to start rotating.

The following functions are possible:

Slow speed during a selected time period

Slow speed will be active for a selected time period before a start is initiated or after a stop is performed.

Slow speed controlled by an external signal

The time period during which slow speed is active before a start is initiated or after a stop is performed is controlled by an external signal via the analogue/digital input. Slow speed will be active until a selected number of pulses has been detected on the input.

Slow speed using the JOG commands

Slow speed can be activated independently from a start or stop via the control panel using the jog keys, via remote control using the analogue/digital input or via serial communication depending on the control source chosen in menu [200].

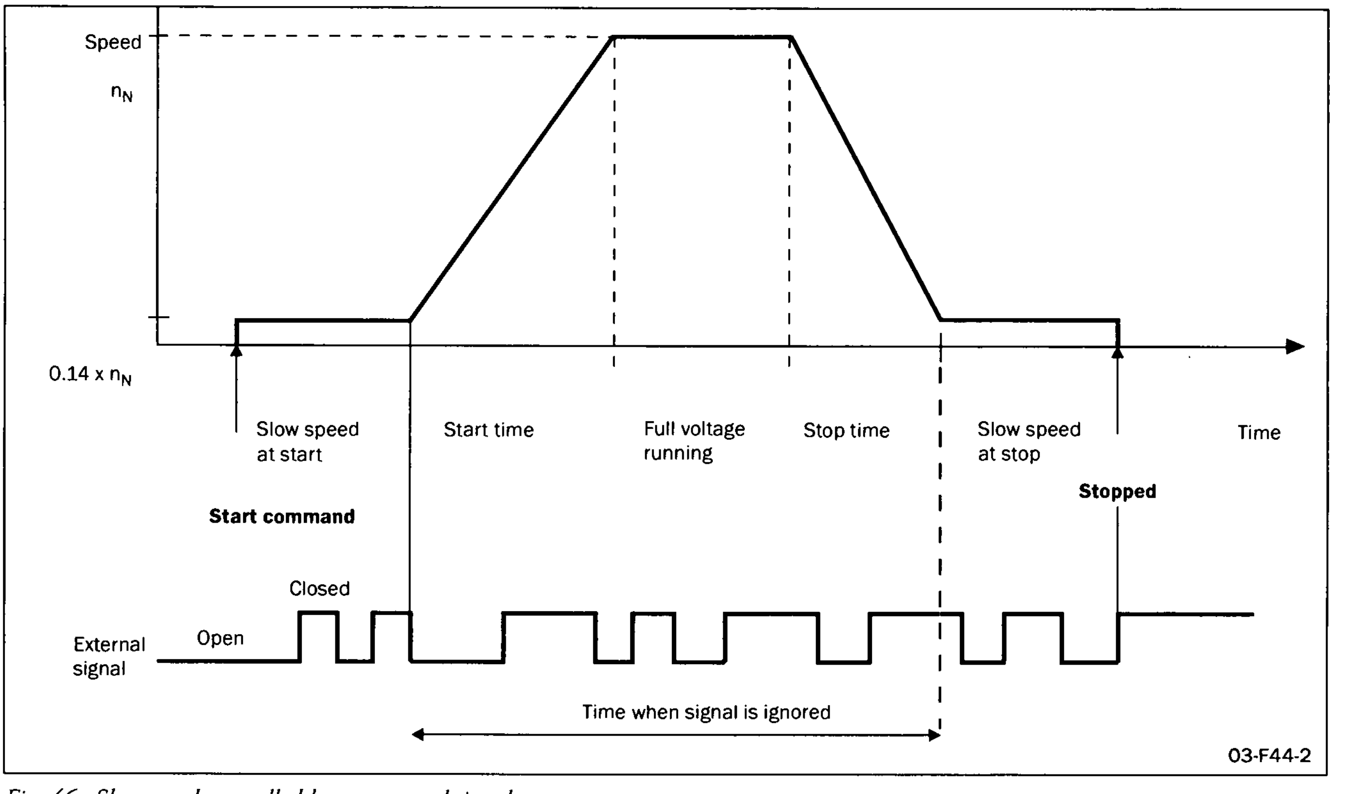


Fig. 46 Slow speed controlled by an external signal.

Slow speed for a selected time

Slow speed in forward direction can be activated before a start and/or after a stop. The resulting speed curve is shown in Fig. 47 overleaf. Slow speed will be active for the time period selected in menus [331] and [332]. Slow speed can be combined with any start and stop method. However, when slow speed at stop is used, it should be ensecured that the motor speed is decreased to a low value when slow speed is activated. If necessary, brake can be activated as stop method in menu [320].

The slow speed strength can be adapted to the application's requirements in menu [330]. Maximum available slow speed strength corresponds to about 30% of nominal motor torque.

If so desired, the DC brake can be activated after slow speed at stop. If activated, the DC brake will be active for the time period chosen in menu [333].

Slow speed during a selected time is configured using the following menus:

[330] Slow speed strength

[331] Slow speed time at start

[332] Slow speed time at stop

[333] DC-brake at slow speed

[324] Braking strength

Slow speed controlled by an external signal

Slow speed controlled by an external signal is basically the same functionality as slow speed during a selected time described above. An external signal connected to the analogue/digital input is also used to deactivate slow speed before the set time period has expired.

When slow speed at start is configured and the analogue/digital input (menu [500]) is configured for slow speed, the motor will start rotating at slow speed in a forward direction after a start signal. When the number of edges set in menu [501] is detected on the analogue/digital input, slow speed is deactivated and a start is performed according to the start settings (menu [310] Off).

When slow speed at stop is configured and the analogue/digital input (menu [500]) is configured for slow speed, the motor will start rotating with slow speed in forward direction after a stop has performed. When the number of pulses set in menu [501] is detected on the analogue/digital input, slow speed is deactivated and the DC brake is activated if configured in menu [333].

Slow speed controlled by an external signal is configured using the following menus:

[500] Digital/analogue input

[501] Digital input pulses

[330] Slow speed strength

[331] Slow speed time at start

[332] Slow speed time at stop

[333] DC-brake at slow speed

[324] Braking strength

Slow speed strength [330]

In this menu the slow speed strength is selected. The chosen setting applies for both slow speed during a selected time period, slow speed controlled by an external signal and slow speed using the JOG commands. The maximum setting (100) for the slow speed strength corresponds to about 30% of the nominal motor torque.

330 Setting

Slow speed strength

10

Default:	10
Range:	10-100
10-100	Slow speed strength.

Slow speed time at start [331]

In this menu slow speed at start is activated and the time is set for which slow speed is active before a start. If slow speed at start is controlled by an external signal via the analogue/ digital input, the set time becomes the maximum time for which slow speed is activated before a start is performed – if the number of edges set in menu [501] is not detected during the slow speed period.

331 Setting

Slow speed time at start

oFF

Default:	oFF
Range:	oFF, 1-60 s
oFF	Slow speed at start is disabled
1-60	Slow speed time at start.

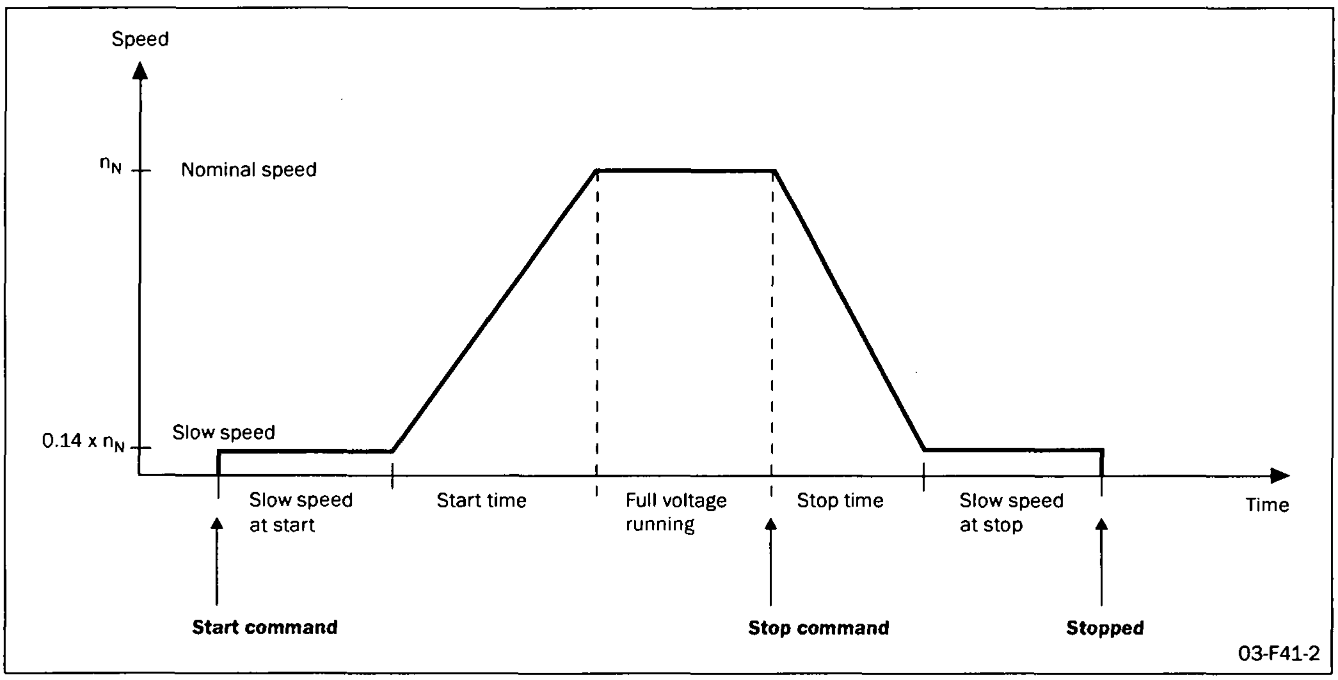


Fig. 47 Slow speed at start/stop during a selected time period.

Slow speed time at stop [332]

In this menu slow speed at stop is activated and the time is set for which slow speed is active after a stop. If slow speed at stop is controlled by an external signal via the analogue/digital input, the set time becomes the maximum time for which slow speed is activated after a stop – if the number of edges is set in menu [501] is not detected during the slow speed period.

332	Setting
oFF	**Slow speed time at stop**
Default:	oFF
Range:	oFF, 1-60 s
oFF	Slow speed at stop is disabled
1-60	Slow speed time at stop.

DC brake at slow speed [333]

In this menu the DC brake can be activated after slow speed at stop. This may be useful for loads with high interia or if an exact stop position is desired. The DC brake will be active during the time set in this menu.

NOTE: The brake strength used for DC brake after slow speed corresponds to the brake strength used for braking as stop method. The braking strength can be adjusted in menu [324].

333	Setting
oFF	**DC Brake at slow speed**
Default:	oFF
Range:	oFF, 1-60 s
oFF	DC brake at slow speed disabled.
1-60	DC brake duration time at slow speed.

Slow speed using the JOG commands

Slow speed in forward or reverse direction can be activated using the JOG commands. To use the JOG commands these have to be independently enabled for slow speed in forward or reverse direction in menus [334] and [335]. Depending on the control source chosen in menu [200], the JOG commands are accepted via control panel, remotely via analogue/digital input or via serial communications.

If the control panel is chosen as control source (menu [200]=1) and the JOG commands are enabled in menus [334] and [335], the JOG keys on the control panel can be used. Slow speed in forward or reverse direction will be active as long as the relevant button is pushed.

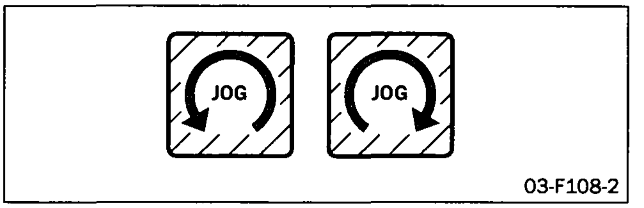


Fig. 48 Jog keys

If remote control is chosen (menu [200]=2) and the JOG commands are enabled in menus [334] and [335], the JOG commands can be given via analogue/digital input. The analogue/digital input can be configured either for jog forward or jog reverse (see description of menu [500] on page 77 for more information). Slow speed will be active as long as the signal on the analogue/digital input is active.

If serial communication control is chosen (menu [200]=3) and the JOG commands are enabled in menus [334] and [335], the JOG commands can be given via serial communication. (See separate instruction manual for serial communications options.)

JOG forward enable [334]

In this menu the command for JOG in forward direction is enabled. Depending on the control source chosen in menu [200], the JOG forward command may be accepted from the control panel, via remote control or serial communication.

NOTE! The enable functions are for all control sources.

334	Setting
oFF	**JOG forward enable**
Default:	oFF
Range:	oFF, on
oFF	JOG forward disabled
on	JOG forward enabled

JOG reverse enable [335]

In this menu the command for JOG in reverse direction is enabled. Depending on the control source chosen in menu [200,], the JOG reverse command may be accepted from the control panel, via remote control or serial communication.

335	Setting
oFF	**JOG reverse enable**
Default:	oFF
Range:	oFF, on
oFF	JOG reverse disabled
on	JOG reverse enabled

8.7.5 Additional settings [340]-[342]

In this section the bypass functionality, power factor control and the control of the internal fan are described.

Bypass [340]

As the MSF 2.0 is designed for continuous running, a by-pass contactor is not normally needed. However, where there is high ambient temperature or other special conditions, the use of a bypass contactor can be advantageous. In this case the by-pass contactor can be controlled by one of the relays. By default, relay K2 is configured to control a bypass contactor (for full voltage functionality, see description of menus [530]-[532] on page 85 for more information).

The use of a bypass contactor can be combined with any start and stop method without any connection changes being necessary. However, to use the motor protection functions, the load monitor and the viewing functions in bypassed state, the current transformers have to be moved outside the softstarter. For this purpose an optional extension cable is available, see chapter 12. page 107 (Options) for more information. Figures 49 - 51 below show a connection example.

If a bypass contactor is used, bypass operation must be enabled in menu [340] for the softstarter to work properly.

340	Setting
oFF	**Bypass**
Default:	oFF
Range:	oFF, on
oFF	Bypass disabled
on	Bypass enabled.

CAUTION: If the current transformers are not moved outside the softstarter, several alarm functions will not work properly.

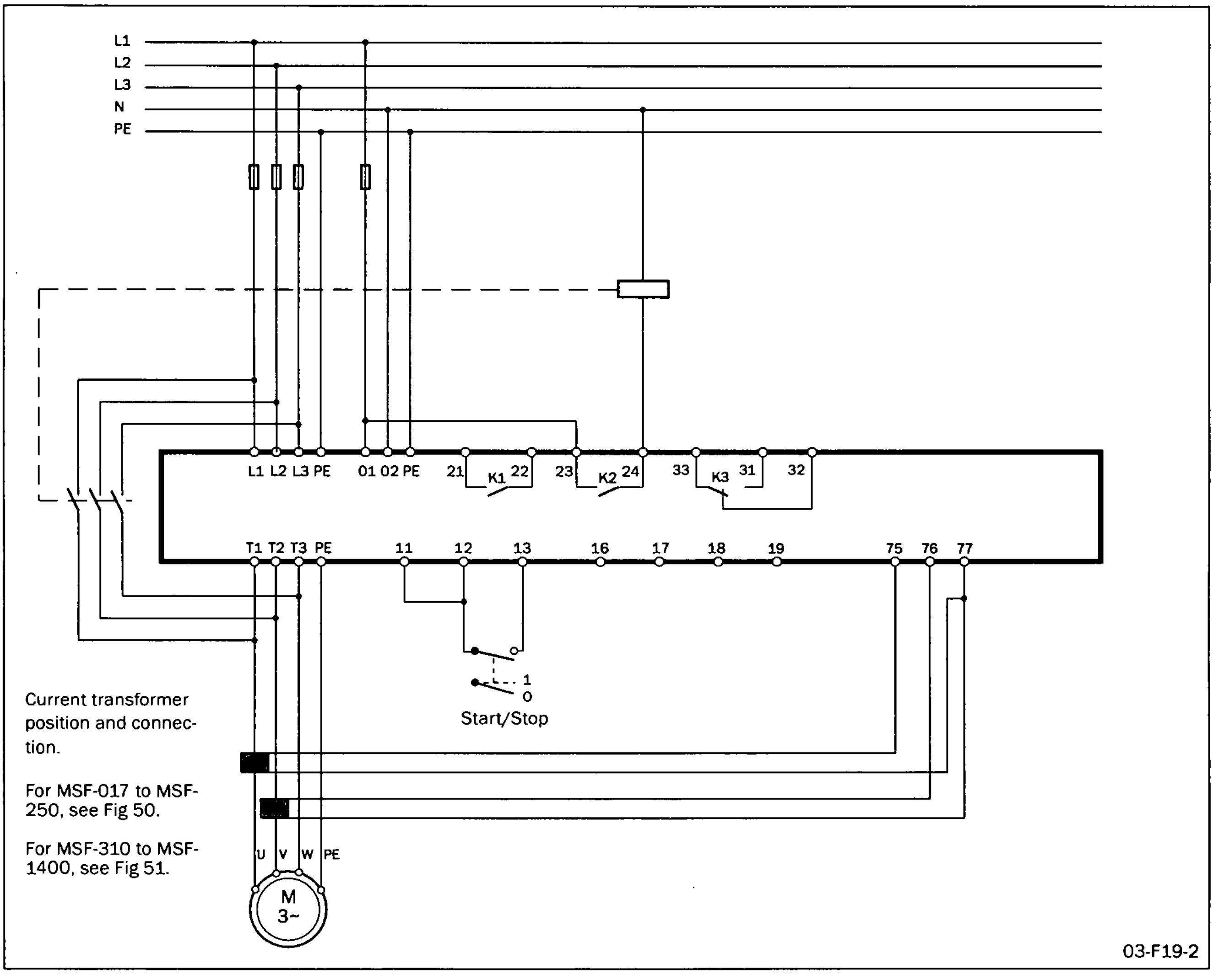


Fig. 49 Bypass wiring example MSF 310-1400.

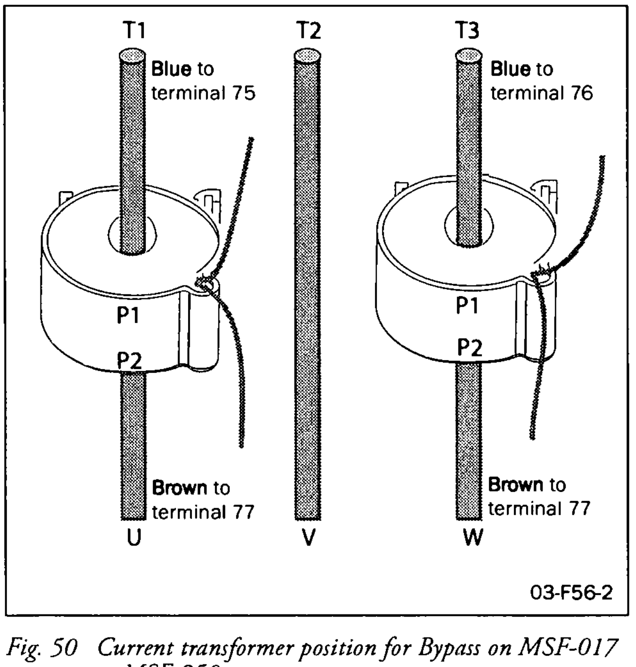


Fig. 50 Current transformer position for Bypass on MSF-017 to MSF-250.

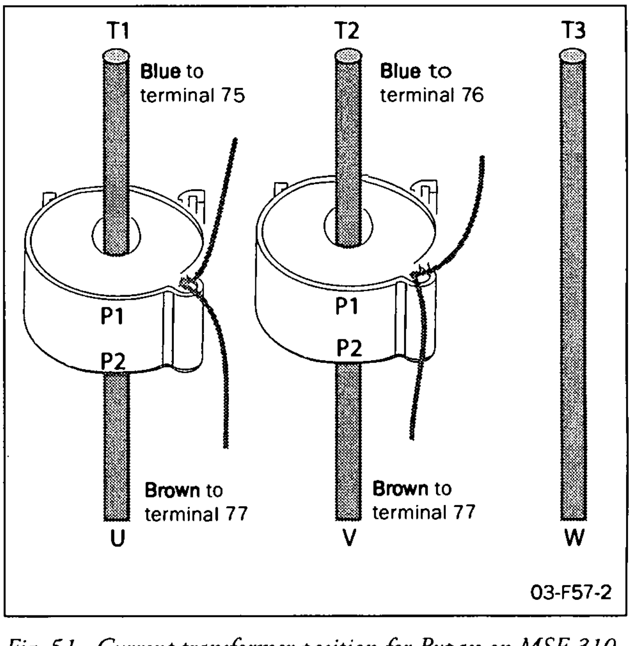


Fig. 51 Current transformer position for Bypass on MSF-310 to MSF-1400.

Power Factor Control PFC [341]

During operation, the softstarter continuously monitors the load of the motor. Particularly when idling or when only partially loaded, it is sometimes desirable to improve the power factor. If Power Factor Control (PFC) is selected, the softstarter reduces the motor voltage when the load is lower. Power consumption is reduced and the degree of efficiency improved.

341	Setting
oFF	**Power Factor Control PFC**
Default:	oFF
Range:	oFF, on
oFF	PFC disabled
on	PFC enabled.

CAUTION: If Power Factor Control is used, the EMC Directive will not be complied with. External measures will be necessary to meet the requirements of the EMC Directive.

Fan continuously on [342]

This menu enables the internal fan to be switched on continuously. the default setting is for the fan only to run when the softstarter heatsink is too warm. The lifetime of the fan is increased by only running it when needed.

342	Setting
oFF	**Fan continuously on**
Default:	oFF
Range:	oFF, on
oFF	Fan is controlled by the heatsink temperature
on	Fan is running continuously.

8.8 Process protection

The MSF 2.0 softstarter is equipped with different functions for process protection:

[400]-[413] Load monitor

[420] External alarm

[430]-[440] Mains protection

8.8.1 Load monitor

The MSF 2.0 has a built-in load monitor, which continuously supervises the motor shaft power. This means, the process can easily be protected both from overload and underload conditions. The load monitor functionality includes both alarms and pre-alarms for overload (max power) and underload (min power). While the max. and min power alarms can be configured to affect operation (OFF, Warning, Coast, Stop, Brake), the respective pre-alarms only give an indication that an over- or underload situation may be close. The pre-alarm status is available on one of the programmable relays K1 to K3 if so configured (see description of the relays, menus [530] to [532] on page 85 for more information)

All load monitor alarms and pre-alarms are configured using a delay time and an alarm margin. The alarm margin is chosen as a percentage of nominal motor load. A max power alarm will occur when the actual power exceeds the normal load plus the max power alarm margin and a min power alarm will occur when the actual load is lower than the normal load minus the min power margin. Normal load is the shaft power needed under normal operation conditions. The default normal load is considered to be 100% of the nominal motor power. Depending on the dimensioning of the motor with respect to the application, this value may need to be adapted. Normal load can easily be adapted by using the Autoset function in menu [411]. When an Autoset is performed the actual motor shaft power will be measured and stored to the Normal load.

A start delay can be configured to avoid faulty alarms due to initial over- or underload situations at start.

Fig. 52 illustrates the load monitor functionality with an example of a load curve.

If the operation has been interrupted due to a max or min power alarm, a manual reset and a new start signal is needed to continue operation. The reset and the start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via control panel.

NOTE: A reset via control panel will never start the motor.

NOTE! The load monitor alarms are disabled during deceleration.

NOTE: When using the load monitor, check that the nominal motor power is set properly in menu [212].

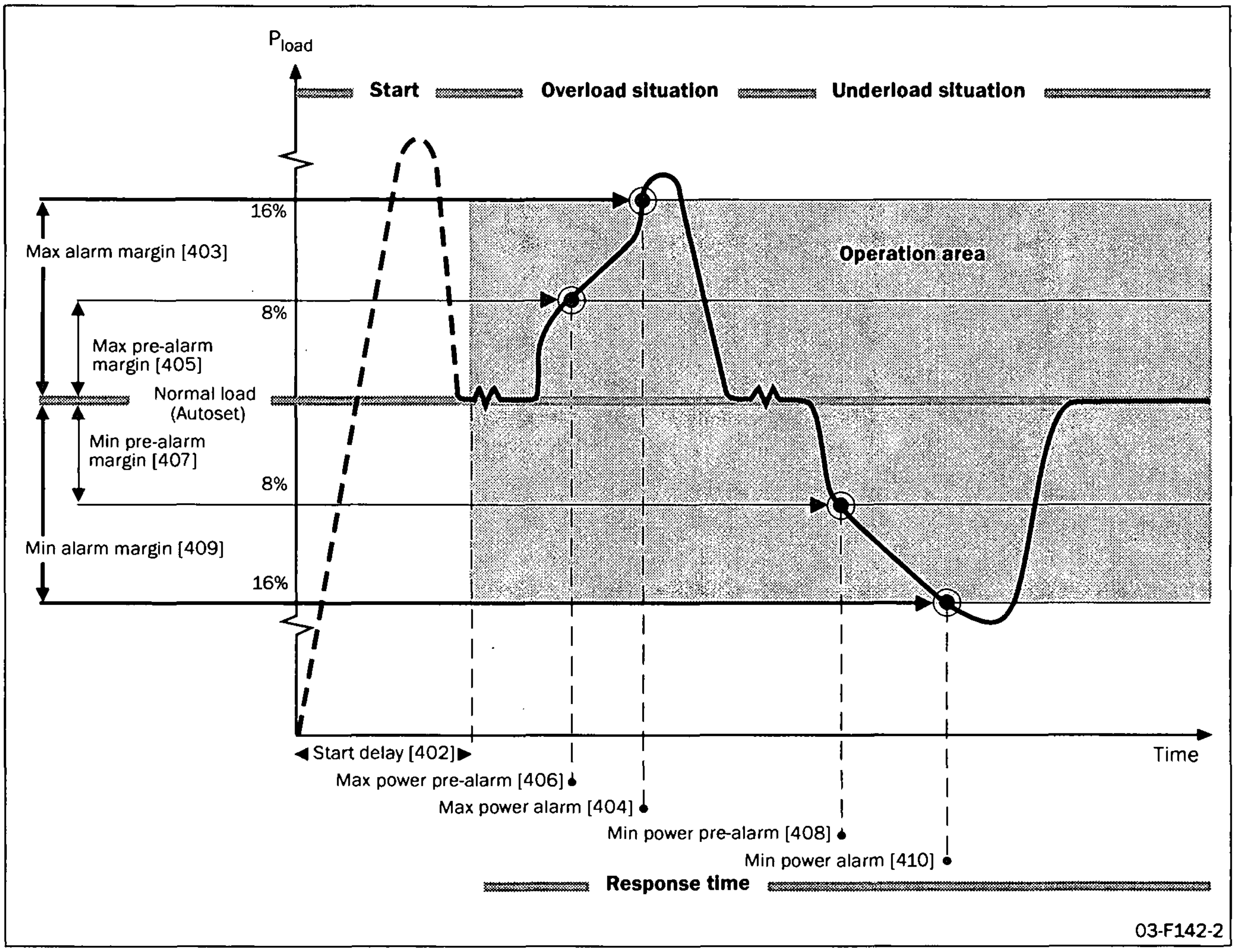


Fig. 52 Load monitor alarm functions

For max and min power alarms the following alarm actions are available:

Off

The protection method is deactivated.

Warning

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset when the fault disappears. The alarm may also be reset manually.

Coast

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). The motor voltage is automatically switched off. The motor freewheels until it stops.

Stop

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). The motor is stopped according to the stop settings in menus [320] to [325].

Brake

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). The brake function is activated according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menus [326] to [327] (braking strength and braking time).

If the operation has been interrupted due to a max or min power alarm, a reset signal and a new start signal are needed to restart the motor. The reset and the start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via control panel.

NOTE: A reset via control panel will never start the motor.

Max power alarm [400]

In this menu max power alarm is enabled and a proper alarm action is selected. The pre-alarm functionality for max power is automatically enabled together with the max power alarm.

400 Setting

oFF **Max power alarm (alarm code F6)**

Default:	oFF
Range:	oFF, 1, 2, 3, 4
oFF	Max power alarm is disabled.
1	Warning
2	Coast
3	Stop
4	Brake

Min power alarm [401]

In this menu min power alarm is enabled and a proper alarm action is selected. The pre-alarm functionality for min power is automatically enabled together with the min power alarm.

401 Setting

oFF **Min power alarm (alarm code F7)**

Default:	oFF
Range:	oFF, 1, 2, 3, 4
oFF	Min power alarm is disabled.
1	Warning
2	Coast
3	Stop
4	Brake

Start delay power alarms [402]

This menu is available if max or min power alarm is enabled in menu [400] or [401]. In this menu the start delay for the power alarms and pre-alarms is selected. A start delay is useful for avoiding faulty alarms due to initial over- or under-load situations. The start delay begins when a start of the motor is initiated.

402 Setting

10 **Start delay power alarms**

Default:	10 s
Range:	1-999 s
1-999	Start delay for power alarms and pre-alarms.

Max power alarm margin [403]

This menu is available if Max power alarm is enabled in menu [400]. In this menu the max power alarm margin is configured. The margin is selected as percentage of nominal motor power. A max power alarm will occur if the actual motor shaft power exceeds the normal load (menu [412]) plus the chosen max power alarm margin for a longer time period than the max power alarm response delay set in menu [404].

403 Setting

16 **Max power alarm margin**

Default:	16%
Range:	0-100% of P_n
0-100	Max power alarm margin

Max power alarm response delay [404]

This menu is available if max power alarm is enabled in menu [400]. In this menu the response delay for the max power alarm is configured. A max power alarm will occur if the actual motor shaft power exceeds the normal load (menu [412]) plus the max power alarm margin set in menu [403] for a longer time period than the chosen max power alarm response delay.

404 Setting

0.5 **Max power alarm response delay**

Default:	0.5 s
Range:	0.1-90.0 s
0.1-90.0	Response delay for max power alarm.

Max power pre-alarm margin [405]

This menu is available if max power alarm is enabled in menu [400]. In this menu the max power pre-alarm margin is configured. The margin is selected in percent of nominal motor power. A max power pre-alarm will occur if the actual motor shaft power exceeds the normal load (menu [412]) plus the chosen max power pre-alarm margin for a longer time period than the max power pre-alarm response delay set in menu [406]. The max power pre-alarm status is available on one of the programmable relays K1-K3 if so configured (see description of the relays, menus [530] to [532] for more information).

405 Setting

Max power pre-alarm margin

8

Default:	8%
Range:	0-100% of P_n
0-100	Max power pre-alarm margin.

Max power pre-alarm response delay [406]

This menu is available if max power alarm is enabled in menu [400]. In this menu the response delay for max power pre-alarm is configured. A max power pre-alarm will occur if the actual motor shaft power exceeds the normal load (menu [412]) plus the max power pre-alarm margin set in menu [405] for a longer time period than the chosen max power pre-alarm response delay.

406 Setting

Max power pre-alarm response delay

0.5

Default:	0.5 s
Range:	0.1-90.0 s
0.1-90.0	Response delay for Max power pre-alarm.

Min power pre-alarm margin [407]

This menu is available if min power alarm is enabled in menu [401]. In this menu the min power pre-alarm margin is configured. The margin is selected as a percentage of nominal motor power. A min power pre-alarm will occur if the actual motor load is below the nominal load (menu [412]) minus the chosen min power pre-alarm margin for a longer time period than the min power pre-alarm response delay set in menu [408]. The min power pre-alarm status is available on one of the programmable relays K2-K3 if so configured (see description of the relays, menus [530] to [532] for more information.

407 Setting

Min power pre-alarm margin

8

Default:	8%
Range:	0-100% of P_n
0-100	Min power pre-alarm margin.

Min power pre-alarm response delay [408]

This menu is available if min power alarm is enabled in menu [401]. In this menu the response delay for min power pre-alarm is configured. A min power pre-alarm will occur if the actual motor shaft power is below the normal load (menu [412]) minus the min power pre-alarm margin set in menu [407] for a longer time period than the chosen min power pre-alarm response delay.

408 Setting

Min power pre-alarm response delay

0.5

Default:	0.5 s
Range:	0.1-90.0 s
0.1-90.0	Response delay for Min power pre-alarm.

Min power alarm margin [409]

This menu is available if min power alarm is enabled in menu [401]. In this menu the min power alarm margin is configured. The margin is selected as a percentage of nominal motor power. A min power alarm will occur if the actual motor shaft power is below the normal load (menu [412]) minus the chosen min power alarm margin for a longer time period than the min power alarm response delay set in menu [410].

409 Setting

Min power alarm margin

16

Default:	16%
Range:	0-100% of P_n
0-100	Min power alarm margin.

Min power alarm response delay [410]

This menu is available if min power alarm is enabled in menu [401]. In this menu the response delay for min power alarm is configured. A min power alarm will occur if the actual motor shaft power is below the normal load (menu [412]) minus the min power alarm margin set in menu [409] for a longer time period than the chosen min power alarm response delay.

410	Setting **Min power alarm response delay**
	0.5
Default:	0.5 s
Range:	0.1-90.0 s
0.1-90.0	Response delay for Min power alarm.

Autoset [411]

This menu is available if max or min power alarm is enabled in menu [400] or [401]. The Autoset command performs a measurement of the actual motor load and automatically sets the normal load in menu [412].

To perform an Autoset, select YES, and press Enter during normal operation. If Autoset has been executed successfully, "SEt" is shown in the display for two seconds. After that "no" is shown again. An Autoset can also be initiated via the analogue/digital input, see description of menu [500] for more information.

NOTE: Autoset is only allowed during full voltage running.

411	Multi Setting **Autoset**
	no
Default:	no
Range:	no, YES
no	No action
YES	Autoset

Normal load [412]

This menu is available if Max or Min power alarm is enabled in menu [400] or [401]. Normal load is the shaft power needed under normal operation conditions. By default, Normal load is considered to be 100% of the nominal motor power. Depending on the dimensioning of the motor with respect to the application, this value may need to be adapted. Normal load can easily be adapted by using the Autoset function in menu [411]. Normal load is set as apercentage of nominal motor power.

NOTE: When using the load monitor, check that the nominal motor power is set properly in menu [212].

412	Setting **Normal load**
	100
Default:	100%
Range:	0-200% of P_n
0-200	Normal load

Output shaft power [413]

This menu is available if max or min power alarm is enabled in menu [400] or [401]. The menu provides a read-out of the actual shaft power. It can be used as input information when the normal load is set manually.

413	Read-out **Output shaft power**
	0
Range:	0-200% of P_n

8.8.2 External alarm [420]

The MSF 2.0 can generate an alarm according to the status of an external signal. For a detailed description of the external alarm functionality see section 8.9.5, page 89.

The following alternatives are available for external alarm:

Off

External alarm is deactivated.

Warning

Alarm message F17 is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm input is opened. However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset when the external alarm input is closed again. The alarm may also be reset manually.

Coast

Alarm message F17 is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm input is opened. The motor voltage is automatically switched off. The motor freewheels until it stops.

Stop

Alarm message F17 is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm input is opened. The moror is stopped according to the stop settings in menus [320] to [325].

Brake

Alarm message F17 is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm input is opened. The brake function is activated according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menus [326] to [327] (braking strength and braking time).

Spinbrake

The functionality for the spinbrake alternative is the same as described above for the brake alternative. However, if spinbrake is chosen, braking can even be initiated from an inactive state by opening the external alarm input. This means the softstarter can catch a freewheeling motor and brake it down to standstill. The spinbrake alternative is only available for external alarm.

If the operation has been interrupted due to an external alarm, a reset signal and a new start signal are needed to restart the motor. The reset and the start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via control panel..

NOTE: A reset via control panel will never start the motor.

420	Setting
oFF	**External alarm (alarm code F17)**
Default:	oFF
Range:	oFF, 1, 2, 3, 4, 5
oFF	External alarm is disabled.
1	Warning
2	Coast
3	Stop
4	Brake
5	Spinbrake

8.8.3 Mains protection

The MSF 2.0 continuously monitors the mains voltage. This means the motor can easily be protected from over- and undervoltages as well as from voltage unbalance conditions. A phase reversal alarm is also available.

For mains protection the following alternatives are available:

Off

The protection method is deactivated.

Warning

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset when the fault disappears. The alarm may also be reset manually.

Coast

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). The motor voltage is automatically switched off. The motor freewheels until it stops.

Stop

The appropriate alarm message is shown in the display and relay K3 is activared (for default configuration of the relays). The motor is stopped according to the stop settings in menus [320] to [325].

Brake

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). The brake function is activated according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menus [326] to [327] (braking strength and braking time).

An overvoltage, undervoltage or voltage unbalance alarm is automatically reset when a new start signal is given. If the operation has been interrupted due to a phase reversal alarm, a reset signal and a new start signal are needed to restart the motor. The reset and the start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via control panel.

NOTE: A reset via control panel will never start the motor.

Voltage unbalance alarm [430]

In this menu voltage unbalance alarm is enabled and a proper action is selected.

430	Setting
oFF	**Voltage unbalance alarm (alarm code F8)**
Default:	oFF
Range:	oFF, 1, 2, 3, 4
oFF	Voltage unbalance alarm is disabled.
1	Warning
2	Coast
3	Stop
4	Brake

Unbalance voltage level [431]

This menu is available if voltage unbalance alarm is enabled in menu [430]. In this menu the maximum allowed voltage unbalance level is selected. If the difference between any two line voltages exceeds the chosen level for the response delay time set in menu [432], a voltage unbalance alarm will occur and the action selected in menu [430] will be executed.

431	Setting
10	**Voltage unbalance level**
Default:	10%
Range:	2-25% of U_n
2-25	Voltage unbalance level.

Response delay voltage level unbalance alarm [432]

This menu is available if voltage unbalance alarm is enabled in menu [430]. In this menu the response delay for voltage unbalance alarm is selected. If the difference between any two line voltages exceeds the level set in menu [431] for the chosen response delay time, a voltage unbalance alarm will occur and the action selected in menu [430] will be executed.

432	Setting
1	**Response delay voltage unbalance alarm**
Default:	1 s
Range:	1-90 s
1-90	Response delay for voltage unbalance alarm.

Overvoltage alarm [433]

In this menu overvoltage alarm is enabled and a proper action is selected.

433	Setting
oFF	**Overvoltage alarm (alarm code F9)**
Default:	oFF
Range:	oFF, 1, 2, 3, 4
oFF	Overvoltage alarm is disabled.
1	Warning
2	Coast
3	Stop
4	Brake

Overvoltage level [434]

This menu is available if overvoltage alarm is enabled in menu [433]. In this menu the voltage level for an overvoltage alarm is selected. If any line voltage exceeds the chosen level for the response delay time set in menu [435], an overvoltage alarm will occur and the action selected in menu [433] will be executed.

434	Setting
115	**Overvoltage level**
Default:	115%
Range:	100-150% of U_n
100-150	Overvoltage level

Response delay overvoltage alarm [435]

This menu is available if overvoltage alarm is enabled in menu [433]. In this menu the response delay for overvoltage alarm is selected. If any line voltage exceeds the level set in menu [434] for the chosen response delay time, an overvoltage alarm will occur and the action selected in menu [433] will be executed.

435	Setting
1	**Response delay overvoltage alarm**
Default:	1 s
Range:	1-90 s
1-90	Response delay for overvoltage alarm.

Undervoltage alarm [436]

In this menu undervoltage alarm is enabled and a proper action is selected.

436	Setting
oFF	**Undervoltage alarm (alarm code F10)**
Default:	oFF
Range:	oFF, 1, 2, 3, 4
oFF	Undervoltage alarm is disabled.
1	Warning
2	Coast
3	Stop
4	Brake

Undervoltage level [437]

This menu is available if undervoltage alarm is enabled in menu [436]. In this menu the voltage level for an undervoltage alarm is selected. If any line voltage is below the chosen level for the response delay time set in menu [438], an undervoltage alarm will occur and the action selected in menu [436] will be executed.

437 Setting

85 **Undervoltage level**

Default:	85%
Range:	75-100% of U_n
75-100	Undervoltage level

Response delay undervoltage alarm [438]

This menu is available if undervoltage alarm is enabled in menu [436]. In this menu the response delay for undervoltage alarm is selected. If any line voltage is below the level set in menu [437] for the chosen response delay time, an undervoltage alarm will occur and the action selected in menu [436] will be executed.

438 Setting

1 **Response delay undervoltage alarm**

Default:	1 s
Range:	1-90 s
1-90	Response delay for undervoltage alarm

Phase sequence [439]

In this menu the actual phase sequence is shown.

NOTE! The actual phase sequence can only be shown with a motor connected.

439 Read-out

L- - - **Phase sequence**

Range:	L123, L321
L123	Phase sequence L1, L2, L3
L321	Phase sequence L3, L2, L1
L- - -	Phase sequence can not be detected

Phase reversal alarm [440]

In this menu phase reversal alarm is enabled and a proper action can be chosen. The softstarter will detect the phase sequence prior to each start attempt. If the actual phase sequence does not match the phase sequence stored during activation of phase reversal alarm, the action chosen in this menu will be executed. If alternative 2 (Coast) is chosen, no start will be performed if the wrong phase sequence is detected.

To activate phase reversal alarm, a motor has to be connected and the mains voltage has to be switched on. This means activation of phase reversal alarm can either be done in stopped state with the mains contactor switched on manually or during full voltage running.

440 Setting

oFF **Phase reversal alarm (alarm code F16)**

Default:	oFF
Range:	oFF, 1, 2
oFF	Phase reversal alarm is disabled.
1	Warning
2	Coast

NOTE! The actual phase sequence can be viewed in menu [439].

8.9 I/O settings

In this section the programmable inputs and outputs are described.

[500]-[513] Input signals

[520]-[534] Output signals

A connection example using most of the available in- and outputs is shown in Fig. 53.

This section includes also detailed descriptions of the following functions:

- Start/stop/reset command functionality
- Start right/left functionality
- External alarm functionality
- External control of parameter set

8.9.1 Input signals

The MSF 2.0 has one programmable analogue/digital input and four programmable digital inputs for remote control.

Analogue/digital input [500]

The analogue/digital input can either be programmed for analog or digital functionality. The following alternatives are available when using the input for digital signals:

Rotation sensor

An external rotation sensor can be used for the braking functions. If the analogue/digital input is configured for rotation sensor functionality in menu [500], braking will be deactivated if the number of edges chosen in menu [501] is detected on the input.

Slow speed

This alternative is used for slow speed controlled by an external signal (see the description of slow speed and jog functions in section 8.7.4, page 63 for more information). If the number of edges set in menu [501] is detected on the input, slow speed at start or stop will be finished.

Jog Forward

With this alternative, slow speed in forward direction can be activated via the analogue/digital input. Slow speed will be active as long as the input signal is high. See the description of slow speed and jog functions in section 8.7.4, page 63 for more information. Note that "JOG" forward has to be enabled in menu [334] to use this function.

Jog reverse

With this alternative, slow speed in reverse direction can be activated via the analogue/digital input. Slow speed will be active as long as the input signal is high. See the description of slow speed and jog functions in section 8.7.4, page 63 for more information. Note that "JOG" reverse has to be enabled in menu [335] to use this function.

Autoset

When the analogue/digital input is configured for Autoset, a rising edge on the input will initiate an Autoset. Note that an Autoset only can be performed during full voltage running. See description of load monitor functionality in section 8.8.1, page 69 for more information

The following alternatives are available when using the input for analogue signals:

Analogue start/stop: 0-10 V/0-20 mA or 2-10 V/4-20 mA:

The analogue/digital input is used for the reference signal which controls analogue start stop. Two signal ranges (0-10 V/0-20 mA or 2-10 V/4-20 mA) can be chosen. Analogue start/stop is activated if alternative 6 or 7 is chosen in menu [500]. See the description of Analogue start/stop on page 79 for more information.

500 Setting

Analogue/digital input

oFF

Default:	oFF
Range:	oFF, 1-7
oFF	Analogue/digital input disabled
1	Digital, Rotation sensor
2	Digital, Slow speed
3	Digital, Jog forward
4	Digital, Jog reverse
5	Digital, Autoset
6	Analogue start/stop: 0-10 V/0-20 mA
7	Analogue start/stop: 2-10 V/4-20 mA

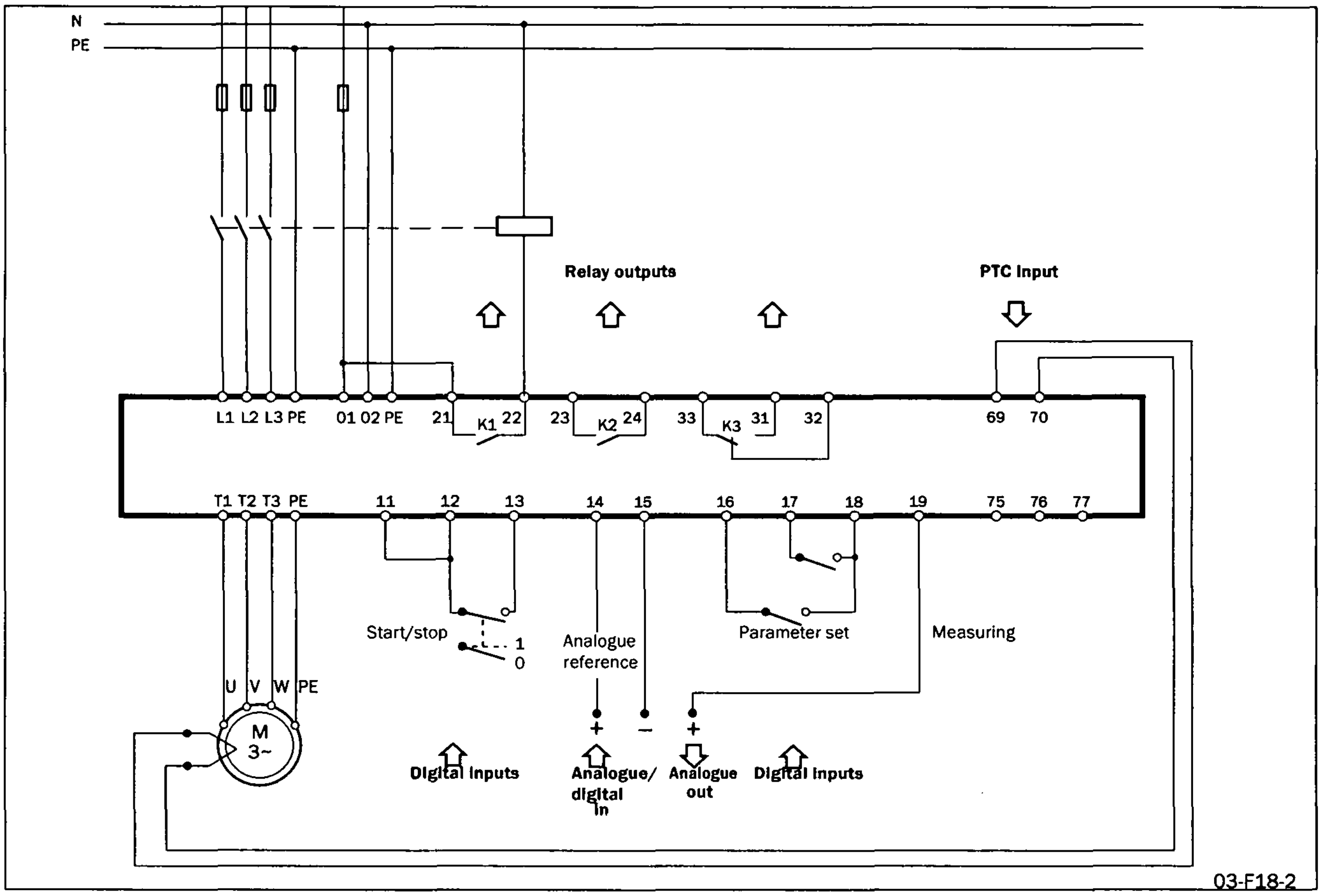


Fig. 53 Connection example when using the digital and analogue inputs and outputs

Digital input

The analogue/digital input is used as a digital input if one of alternatives 1-5 in menu [500] is selected. Jumper J1 has to be set for voltage control, which is the default setting.

The input signal is interpreted as 1 (high) when the input voltage exceeds 5 V. When the input voltage is below 5 V the input signal is interpreted as 0 (low). The input signal can be generated using the internal control supply voltage by connecting a switch between terminal 14 (analogue/digital input) and 18 (supply voltage to terminals 14, 16 and 17).

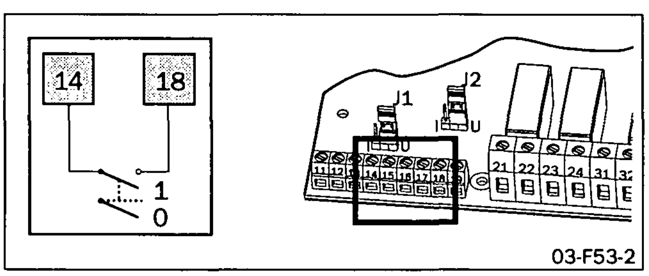


Fig. 54 Wiring for digital input signal.

Digital input pulses [501]

This menu is available if the analogue/digital input is programmed for digital input signals for rotation sensor (alternative 1) or for slow speed (alternative 2) in menu [500]. In this menu the number of edges is chosen to deactivate the braking function or the slow speed function respectively. .

NOTE: All edges, both positive and negative transitions, will be counted.

501	Setting
	Digital input pulses
	1
Default:	1
Range:	1-100
1-100	Number of edges

Analogue input

The analogue/digital input is used as an analogue input if one of alternatives 6-7 in menu [500] is selected. In this case, the input can be configured for voltage or current signal using jumper J1 (see Fig. 55). By default jumper J1 is set to voltage signal. According to the chosen alternative in menu [500], the signal will be interpreted as 0-10 V/ 0-20 mA or 2-10 V/4-20 mA (see Fig. 56).

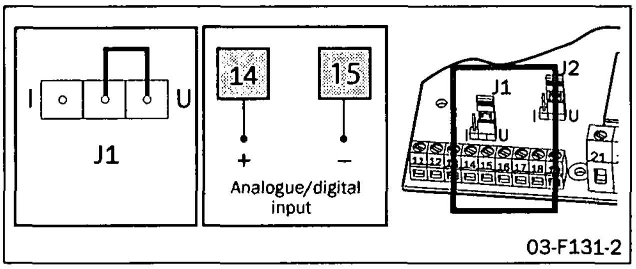


Fig. 55 Wiring for analogue/digital input and setting of J1 for analogue current or voltage control.

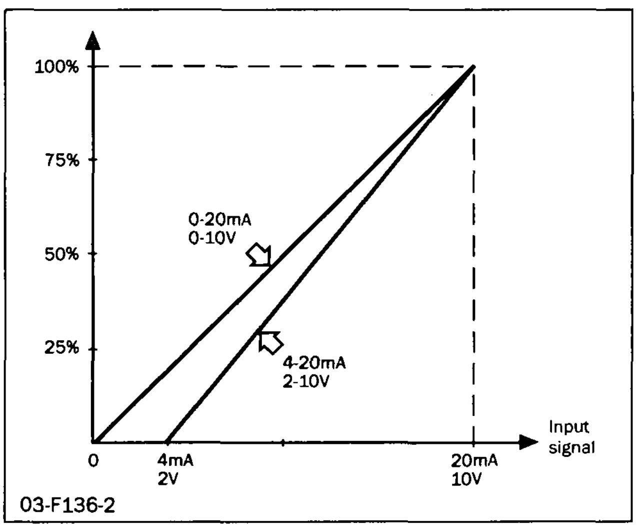


Fig. 56 Analogue input

Analogue start/stop

Starts and stops can be performed according to a process signal on the analogue/digital input. This means that e.g. the operation of a pump may be controlled according to a flow signal.

Analogue start/stop is available if remote control or serial communication control is chosen in menu [200] (alternatives 2 or 3).

NOTE: Analogue start/stop is not available if control panel is chosen as control source in menu [200] (alternative 1).

If a start signal is given via remote or serial communication (according to the setting in menu [200]), the softstarter will check the reference signal on the analogue/digital signal. A start will be performed if the level of the reference signal is below the analogue start/stop on-value chosen in menu [502] for a longer time than the analogue start/stop delay time set in menu [504]. A stop will be performed if the reference signal exceeds the analogue start/stop off-value chosen in menu [503] for a longer time than the analogue start/stop delay time set in menu [504].

NOTE: If the selected analogue start/stop on-value is bigger than or equal to the off-value, a level above the on-value at the analogue input will cause a start. A value below the off-value will in this case cause a stop.

The start/stop LED on the front of the MSF will be flashing if the softstarter is in standby mode waiting for an analogue start.

Warning: A flashing start/stop LED is indicating standby mode - e.g. waiting for an analogue start. The motor may be started automatically at a moment's notice

Analogue start/stop on-value [502]

This menu is available if analogue start/stop is activated in menu [500] (alternative 6 or 7). If the reference signal on the analogue/digital input is below the chosen on-level for a longer time than the analogue start/stop delay time chosen in menu [504], a start will be performed..

NOTE: If the selected analogue start/stop on-value is bigger than or equal to the off-value, a level above the on-value at the analogue/digital input will cause a start.

NOTE: An analogue start will only be performed if the softstarter has been set to standby mode by a valid start signal via remote control or serial communication.

The analogue start/stop on-value is chosen as a percentage of the input signal range. This means, if the analogue/digital input is configured for 0-10 VDC/0-20 mA (alternative 6 in menu [500]), 25% corresponds to 2.5 V or 5 mA. If the analogue/digital input is configured for 2-10 VDC/4-20 mA (alternative 7 in menu [500]), 25% corresponds to 4 V or 8 mA.

502 Setting

Analogue start/stop on-value

25

Default:	25%
Range:	0-100% of input signal range
0-100	Analogue start/stop on-value.

Analogue start/stop off-value [503]

This menu is available if analogue start/stop is activated in menu [500] (alternatives 6 or 7). If the reference signal on the analogue/digital input exceeds the chosen off-level for a longer time than the analogue start/stop delay time chosen in menu [504], a stop will be performed.

NOTE: If the selected analogue start/stop off-value is less than or equal to the on-value, a level below the off-value at the analogue/digital input will cause a stop.

NOTE: A stop will also be performed if the softstarter receives a stop signal via remote control or serial communication.

The analogue start/stop off-value is chosen as a percentage of the input signal range. This means if the analogue/digital input is configured for 0-10 V / 0-20 mA (alternative 6 in menu [500]), 25% corresponds to 2.5 V or 5 mA. If the analogue/digital input is configured for 2-10 V / 4-20 mA (alternative 7 in menu [500]), 25% corresponds to 4 V or 8 mA.

503 Setting

Analogue start/stop off-value

75

Default:	75%
Range:	0-100% of input signal range
0-100	Analogue start/stop off-value.

Analogue start/stop delay time [504]

This menu is available if analogue start/stop is activated in menu [500] (alternatives 6 or 7). In this menu the delay time for starts and stops caused by the analogue reference signal is set.

504 Setting

Analogue start/stop delay time

1 s

Default:	1 s
Range:	1-999 s
1-999	Delay time for analogue start/stop

Digital inputs

The MSF 2.0 has four programmable digital inputs. The four inputs and their corresponding control supply terminals are shown overleaf in Fig. 57.

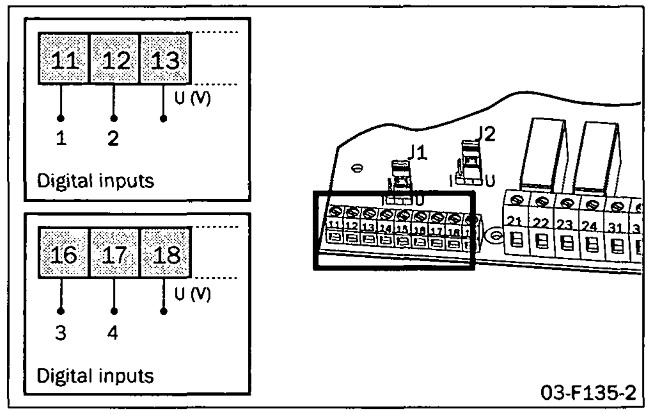


Fig. 57 Wiring for digital inputs 1-4.

The four digital inputs are electrically identical.The digital inputs can be used for remote control of start, stop and reset, for choice of parameter set and for external alarm.

Stop signal

If remote control is chosen in menu [200] (alternative 2), one digital input has to be programmed as stop signal.

NOTE: No starts will be allowed if the input set for stop signal is open or if no input is configured for stop signal.

If the motor is running a stop will be performed according to the stop settings in menus [320] to [325] as soon as the input configured for stop signal is opened. If more than one input is configured for stop signal, opening one of these will lead to a stop. Accordingly no starts will be allowed if any of these inputs is open.

Start and reset signal

The digital inputs can be configured for several different start signals (start, start R or start L signal). Closing any input, which is configured for start, will start the motor. Moreover, a rising edge on any input configured for start is interpreted as a reset signal.

NOTE: If more than one digital input is configured for any of the start signals (start, start R or start L), closing more than one of these inputs at the same time will lead to a stop. However, if several digital inputs are configured for the same start functionality, e.g. start R, closing any of these inputs will lead to a start.

Naturally the softstarter has no way of controlling the motor's running direction internally. However, if two mains contactors – one for each phase sequence – are used, these can be controlled by the softstarter using the programmable relays. The settings for the programmable relays in menus [530] to [532] correspond to the different start signals, which can be chosen for the digital inputs. In this way different running directions for the motor can be chosen.

Example

1. If only one running direction is used, digital input 1 can be configured for start signal and digital input 2 for stop signal (default setting). In this case relay K1 may be configured for operation (default setting) and can control the mains relay. When digital inputs 1 and 2 are closed, the mains contactor will be activated and the motor will start. When digital input 2 is opened the motor will stop. The mains contactor will be deactivated after the stop has been finished.
2. If two running directions are desired, digital input 1 can be configured for start R, digital input 2 for stop and digital input 3 for start L. Relay K1 controls the mains contactor for running in right direction and may be configured for Operation R. Relay K2 controls the mains contactor with the opposite phase sequence for running in left direction and may be configured for Operation L. In this case closing digital inputs 1 and 2 (start right command) will lead to activation of the mains contactor for running in right direction and the motor will start in right direction. Opening digital input 2 will lead to a stop; the mains contactor for running right will be deactivated after the stop has been finished. Closing digital inputs 2 and 3 (while digital input 1 is open) will lead to activation of the mains contactor for running in left direction and the motor will start in left direction.

For more information see the description of the start right/ left functionality in section 8.9.4, page 87.

External alarm

The digital inputs can be configured as external alarm inputs. If an input configured for external alarm is opened, the action chosen in menu [420] for external alarm is performed. See description of the external alarm functionality in section 8.9.5, page 89 for more information.

NOTE: If more than one digital input is configured for external alarm, opening any of these will lead to an external alarm.

Parameter set

This configuration enables choice of parameter set by an external signal. See description of external control of parameter set in section 8.9.6, page 90 for more information.

Digital input 1 function [510]

In this menu the function for digital input 1 (terminal 11) is selected.

510	Setting
1	**Digital input 1 function**
Default:	1
Range:	oFF, 1, 2, 3, 4, 5, 6, 7
oFF	Digital input 1 is disabled
1	Start signal
2	Stop signal
3	Parameter set, input 1
4	Parameter set, input 2
5	External alarm signal
6	Start R signal
7	Start L signal

Digital input 2 function [511]

In this menu the function for digital input 2 (terminal 12) is selected.

511	Setting
2	**Digital input 2 function**
Default:	2
Range:	Off, 1, 2, 3, 4, 5, 6, 7
oFF	Digital input 2 is disabled.
1	Start signal
2	Stop signal
3	Parameter set, input 1
4	Parameter set, input 2
5	External alarm signal
6	Start R signal
7	Start L signal

Digital input 3 function [512]

In this menu the function for digital input 3 (terminal 16) is selected.

512	Setting
3	**Digital input 3 function**
Default:	3
Range:	oFF, 1, 2, 3, 4, 5, 6, 7
oFF	Digital input 3 is disabled.
1	Start signal
2	Stop signal
3	Parameter set, input 1
4	Parameter set, input 2
5	External alarm signal
6	Start R signal
7	Start L signal

Digital input 4 function [513]

In this menu the function for digital input 4 (terminal 17) is selected.

513	Setting
4	**Digital input 4 function**
Default:	4
Range:	oFF, 1, 2, 3, 4, 5, 6, 7
oFF	Digital input 4 is disabled.
1	Start signal
2	Stop signal
3	Parameter set, input 1
4	Parameter set, input 2
5	External alarm signal
6	Start R signal
7	Start L signal

8.9.2 Output signals

The MSF 2.0 has one programmable analogue output and three programmable relays.

Analogue output

The analogue output can present current, voltage, shaft power and torque for connection to a recording instrument, PLC etc. The external device is connected to terminals 19 (+) and 15 (-) according to Fig. 58 below. The analogue output can be configured for voltage or current signal. The selection is made by jumper J2 on the control board. The default setting for J2 is voltage signal according to Fig. 58.

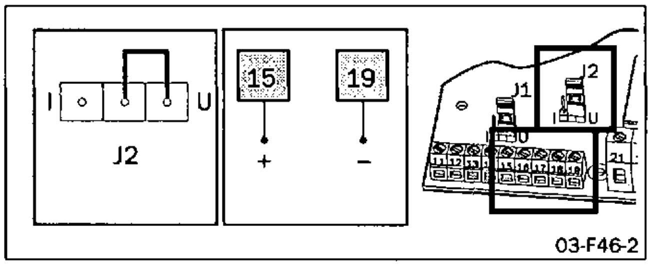


Fig. 58 Wiring for analogue output and setting of J2 for analogue current or voltage signal.

Analogue output [520]

In this menu the analogue output can be set to provide either one of the signal ranges shown in Fig. 59.

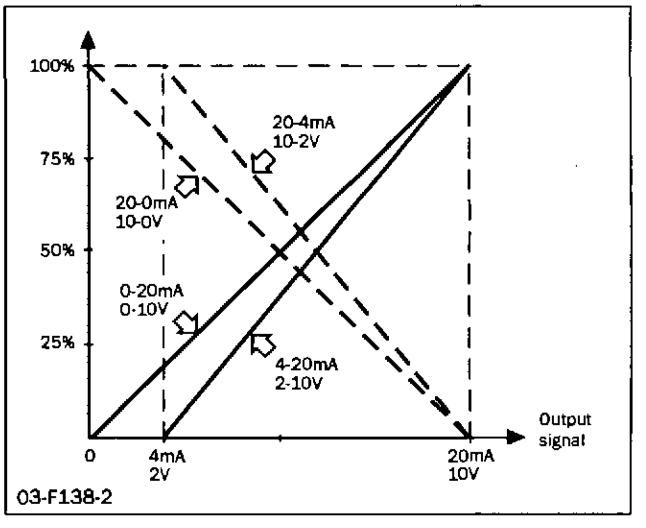


Fig. 59 Analogue output

520	Setting
oFF	**Analogue output**
Default:	oFF
Range:	oFF, 1, 2, 3, 4
oFF	Analogue output is disabled.
1	Analogue signal 0-10 V/0-20 mA
2	Analogue signal 2-10 V/4-20 mA
3	Analogue signal 10-0 V/20-0 mA
4	Analogue signal 10-2 V/20-4 mA

Analogue output function [521]

This menu is available if the analogue output is enabled in menu [520] (alternatives 1-4). In this menu the desired output function is chosen.

521	Setting
1	**Analogue output function**
Default:	1
Range:	1, 2, 3, 4
1	RMS current
2	Line voltage
3	Shaft power
4	Torque

The scaling of the analogue output is reset to the default values (0-100%) if a new output value is chosen in menu [521].

Analogue output scaling

By default the scaling of the analogue output corresponds to Fig. 60. In this case the signal range of the analogue output chosen in menu [520] corresponds to 0 to 100% of the nominal motor current I_n, the nominal motor voltage U_n, the nominal motor power P_n or the nominal motor torque T_n respectively.

Example

If 0-10 V / 0-20 mA is chosen in menu [520] (alternative 1) and RMS current is chosen as output value in menu [521] (alternative 1), a current of 100% of the nominal motor current gives 10 V or 20 mA at the analogue output. A current of 25% of the nominal motor current gives 2.5 V or 5 mA at the analogue output.

The scaling of the analogue output may be adapted for higher resolution or if values above the nominal values are to be monitored. The scaling is done by choosing a minimum scaling value in menu [522] and a maximum value in menu [523]. An example for a different scaling is shown in Fig. 60.

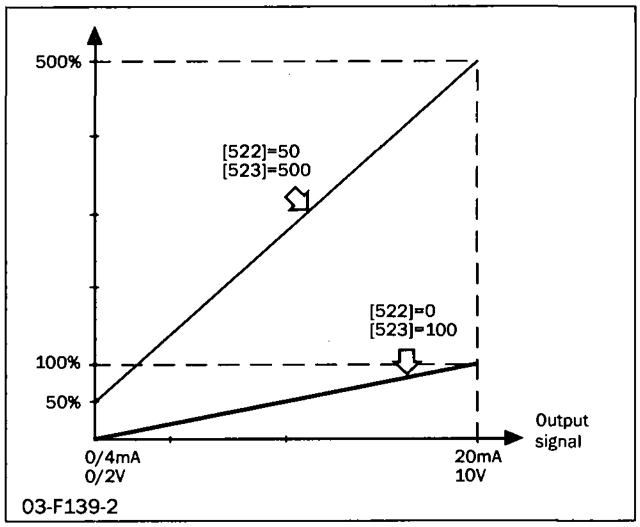


Fig. 60 Scaling of analogue output

With the scaling for wide range (menu [522]=50 and menu [523]=500) according to the example in Fig. 60 the following will apply.

If 0-10 V/0-20 mA is chosen in menu [520] (alternative 1) and RMS current is chosen as output value in menu [521] (alternative 1), a current of 100% of the nominal motor current gives approximately 1.1 V or 2.2 mA at the analogue output.

Scaling analogue output, min [522]

This menu is available if the analogue output is enabled in menu [520]. In this menu the minimum value to be shown at the analogue output is chosen. The value is chosen in percent of I_n, U_n, P_n or T_n according to the output value chosen in menu [521].

522	Setting
0	**Scaling analogue output, min**
Default:	0%
Range:	0-500%
0-500	Minimum output value

NOTE: The minimum value for scaling the analogue output is reset to the default value 0% if a new output value is chosen in menu [521].

Scaling analogue output, max [523]

This menu is available if the analogue output is enabled in menu [520]. In this menu the maximum value to be shown at the analogue output is chosen. The value is chosen as a percentage of I_n, U_n, P_n or T_n according to the output value chosen in menu [521].

523	Setting
100	**Scaling analogue output, max**
Default:	100%
Range:	0-500%
0-500	Maximum output value.

NOTE: The maximum value for scaling the analogue output is reset to the default value 100% if a new output value is chosen in menu [521].

Programmable relay outputs

The softstarter has three built-in relays, K1, K2 and K3. All three relays are programmable.

For relay K1 (terminals 21 and 22) and K2 (terminals 23 and 24) the contact function can be programmed in menus [533] and [534] respectively to be normally open (NO) or normally closed (NC). Relay K3 is a change-over relay with three terminals (31-33), the NO functionality is available between terminals 31 and 32, NC functionality between terminals 32 and 33.

The relays can be used to control mains contactors or a bypass contactor or to indicate alarm conditions. As illustrated in Fig. 61 overleaf, the Operation setting (alternative 1) should be chosen to activate the mains contactor both during start, full voltage operation and stop. If a by-pass contactor is used, this can be controlled by a relay with the setting Full voltage (2). The settings Run (5) and Brake (4) are used when reverse current brake is chosen as stop method. In this case one relay has to be configured for Run and will control the mains contactor during the start and during full voltage operation. Another relay has to be configured for Brake and will control the contactor with reversed phase sequence during braking. For security reasons the relay configured for Brake will not be activated until after a time delay of 500 ms after deactivation of the relay configured for Run.

The settings Run R, Run L, Operation R and Operation L are used for the start right/left functionality. Consult section 8.9.4, page 87 for more information.

Different alarms can also be indicated on the relay outputs. With the setting Power pre-alarms (alternative 3), both a Max power pre-alarm or a Min power pre-alarm occurring will activate the relay. When Power alarms (10) is chosen as a setting, both a Max power alarm or a Min power alarm will activate the relay. If so desired, the relays can instead be programmed to react only to one specific power alarm or pre-alarm (11 - 14).

With setting All alarms (15) the relay will be activated for any alarm. As the power pre-alarms are not considered to be real alarms, the relay will not react to those. With alternative 16 chosen, even the power alarms are excluded. When External alarm (17) is chosen, only an External alarm will activate the relay. With setting 18, Autoreset expired, the relay will be activated when an additional fault occurs after the maximum allowed number of autoreset attempts have been executed. This may indicate that external help is needed to rectify a re-occurring fault (see description of Autoreset in section 8.5, page 52 for detailed information). With alternative 19 the relay will indicate all alarms which need a manual reset. This includes all alarms which are not solved with an automatic Autoreset, e.g. all alarms for which Autoreset is not enabled and each alarm occurring after the maximum allowed number of autoreset attempts has been executed.

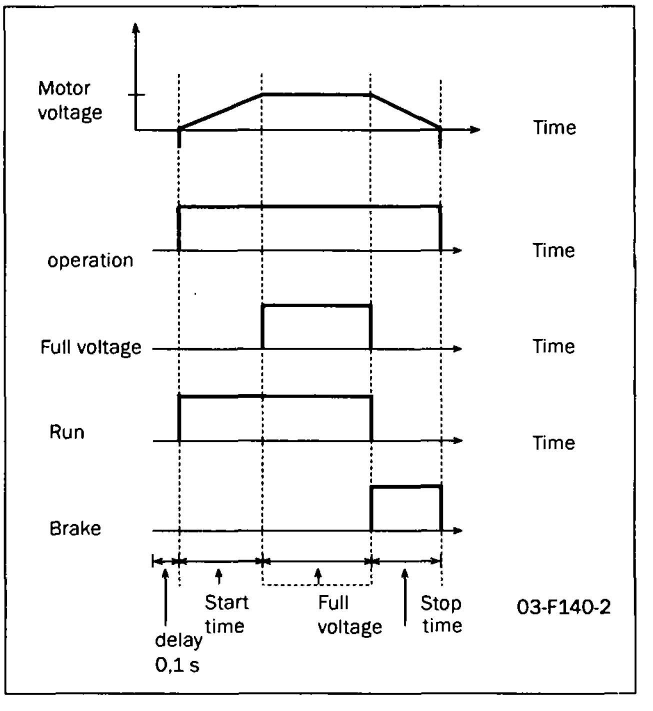


Fig. 61 The relay functions for operation, run and full voltage.

Relay K1 [530]

In this menu the function for relay K1 (terminals 21 and 22) is chosen.

530	Setting
1	**Relay K1**
Default:	1
Range:	oFF, 1 - 19
oFF	Relay inactive
1	Operation
2	Full voltage
3	Power pre-alarms
4	Brake
5	Run
6	Run R
7	Run L
8	Operation R
9	Operation L
10	Power alarms
11	Max power alarm
12	Max power pre-alarm
13	Min power alarm
14	Min power pre-alarm
15	All alarms (except power pre-alarms)
16	All alarms (except power alarms and pre-alarms)
17	External alarm
18	Autoreset expired
19	All alarms which need manual reset

NOTE: If relay K1 is chosen to be inactive (oFF), the relay state is determined by the contact function in menu [533].

WARNING: When reverse current brake is activated by changing the settings in menu [320] (stop method), [323] (braking method) or [326] (alarm brake strength), relay K1 is automatically set for Run (5). If a different setting is desired for the specific application, the relay setting has to be changed afterwards.

Relay K2 [531]

In this menu the function for relay K2 (terminals 23 and 24) is chosen.

531	Setting
2	**Relay K2**
Default:	2
Range:	oFF, 1-19
oFF	Relay inactive
1-19	See menu "Relay K1 [530]" for setting alternatives.

NOTE: If relay K2 is chosen to be inactive (oFF), the relay state is determined by the contact function in menu [534].

WARNING: When reverse current brake is activated by changing the settings in menu [320] (stop method), [323] (braking method) or [326] (alarm brake strength), relay K2 is automatically set for Brake (4). If a different setting is desired for the specific application, the relay setting has to be changed afterwards.

Relay K3 [532]

In this menu the function for relay K3 (terminals 31-33) is chosen.

532	Setting
15	**Relay K3**
Default:	15
Range:	oFF, 1-19
oFF	Relay inactive
1-19	See menu "Relay K1 [530]" for setting alternatives.

K1 contact function [533]

In this menu the contact function for relay K1 can be chosen. The available alternatives are Normally open (1=Closing on relay activation) and Normally closed (2=Opening on relay activation).

533 Setting

K1 contact function

1

Default:	1
Range:	1, 2
1	Normally open (N.O.)
2	Normally closed (N.C.)

K2 contact function [534]

In this menu the contact function for relay K2 can be chosen. The available alternatives are Normally open (1=Closing on relay activation) and Normally closed (2=Opening on relay activation).

534 Setting

K2 contact function

1

Default:	1
Range:	1, 2
1	Normally open (N.O.)
2	Normally closed (N.C.)

8.9.3 Start/stop/reset command functionality

Starting/stopping of the motor and alarm reset is done either from the control panel, through the remote control inputs or through the serial communication interface depending on the control source chosen in menu [200].

Control panel

To start and stop from the control panel, the "START/ STOP" key is used.

To reset from the control panel, the "ENTER ↵ /RESET" key is used.

Regardless of the chosen control source, it is always possible to initiate a reset via the control panel.

NOTE! A reset via the control panel will never start the motor.

Serial communication

For description of the start, stop and reset commands via serial communication see the operation instruction supplied with this option.

Remote control

When remote control is chosen in menu [200], the digital inputs are used to start and stop the motor and to reset upcoming alarms. In the following sections different possibilities for connecting the digital inputs are described. For the following explanations the following settings are assumed:

Menu	Description	Setting
510	Digital input 1 (terminal 11)	Start signal (1)
511	Digital input 2 (terminal 12)	Stop signal (2)

2-wire start/stop with automatic reset at start

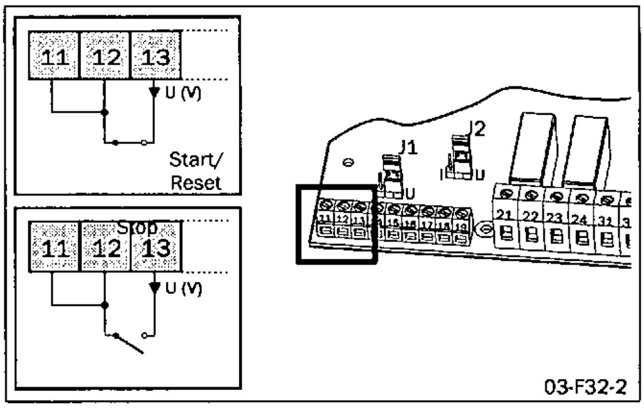


Fig. 62 2-wire connection of terminals for start/stop/automatic reset at start

An external switch is connected between terminals 12 and 13 and a jumper is connected between terminals 11 and 12.

Start

Closing terminal 12 to terminal 13 will give a start command. If terminal 12 is closed to terminal 13 at power up, a start command is given immediately (automatic start at power up).

Stop

Opening terminal 12 will give a stop command.

Reset

When a start command is given there will automatically be a reset.

2-wire start/stop with separate reset

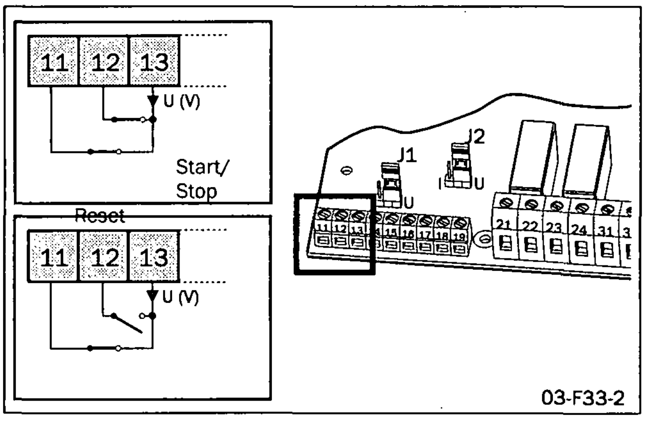


Fig. 63 2-wire connection of terminals for start/stop/separate reset

One external switch is connected between terminals 11 and 13 and a second switch is connected between terminals 12 and 13.

Start

Closing terminals 11 and 12 to terminal 13 will give a start command. If terminals 11 and 12 are closed at power up, a start command is given immediately (automatic start at power up).

Stop

Opening terminal 12 will give a stop command.

Reset

When terminal 11 is opened and closed again a reset is given. A reset can be given both when the motor is running and when it is stopped.

3-wire start/stop with automatic reset at start

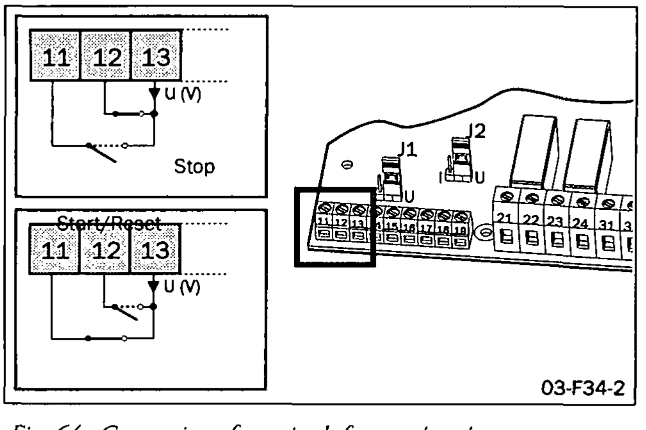


Fig. 64 Connection of terminals for start/stop/reset

An external switch is connected between terminals 11 and 13 and a second switch is connected between terminals 12 and 13.

The connection between terminal 11 and 13 is normally open and the connection between terminal 12 and 13 is normally closed.

Start

Closing terminal 11 momentarily to terminal 13, will give a start command. There will not be an automatic start at power up as long as terminal 11 is open.

Stop

To stop, terminal 12 is momentarily opened.

Reset

When a start command is given there will automatically be a reset.

8.9.4 Start right/left functionality

The digital inputs can be configured to enable starting a motor in two different directions in combination with the programmable relays K1 and K2. A connection example is shown in Fig. 65. For the following description of the start right/left functionality, the following settings for the digital inputs are assumed.

Menu	Description	Setting
510	Digital input 1 (terminal 11)	Start R signal (6)
511	Digital input 2 (terminal 12)	Stop signal (2)
512	Digital input 3 (terminal 16)	Start L signal (7)

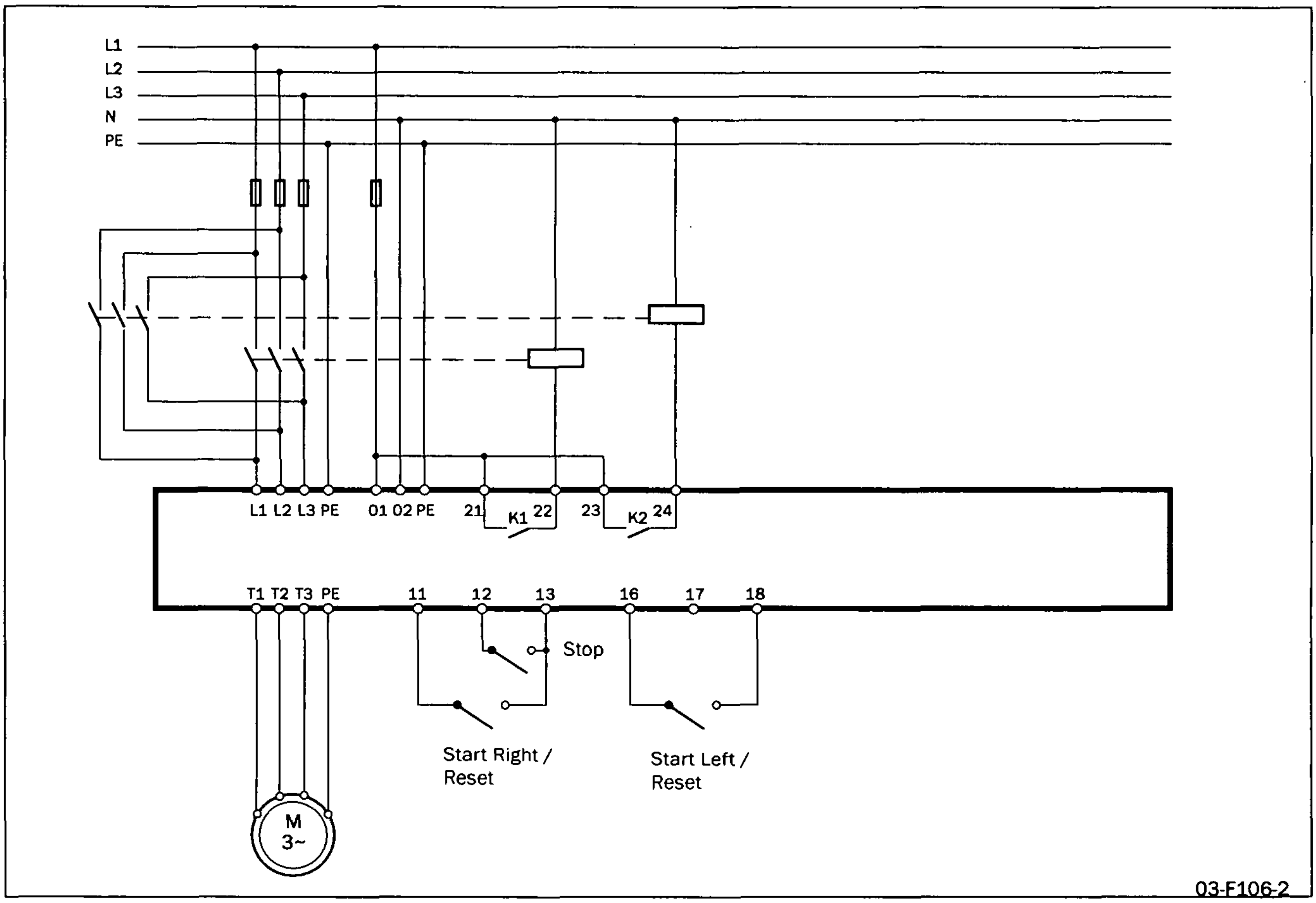


Fig. 65 Connection for start right/left

The configuration of the relays depends on the application's requirements. For applications which **do not** use the reverse current brake functionality, the following settings may be used.

Menu	Description	Setting
530	Relay K1 (terminals 21 and 22)	Operation R (8)
531	Relay K2 (terminals 23 and 24)	Operation L (9)

With these settings the functionality is as follows:

If terminals 11and 12 are closed to terminal 13 while terminal 16 is open, the mains contactor for running in right direction will be activated by relay K1 and the motor will start in right direction. If terminal 12 is opened, a stop according to the stop settings in menus [320] to [325] will be performed. When the stop is finished, the mains contactor for running right will be deactivated by relay K1.

If terminal 12 is closed to terminal 13 and terminal 16 is closed to terminal 18 while terminal 11 is open, the mains contactor for running in left direction will be activated by relay K2 and the motor will start in left direction. If terminal 12 is opened, a stop according to the stop settings in menus [320] to [325] will be performed. When the stop is finished, the mains contactor for running left will be deactivated by relay K2.

If both start terminals (11 and 16) are closed to their respective supply voltage at the same time, a stop is performed in the same way as described above. In this case no start will be allowed.

A motor can be reversed from right to left direction as follows: When the motor is running in right direction, terminal 11 is opened. Terminal 16 is then closed to terminal 18. In this case the voltage to the motor is switched off and the mains contactor for running right is deactivated by relay K1. After a time delay of 500 ms the mains contactor for running left will be activated by relay K2 and a start in left direction will be performed. The motor can be reversed from running left to running right in the same way by opening terminal 16 while running left and then closing terminal 11.

CAUTION: Very high currents can arise when the motor is reversed from running at full speed in one direction to running at full speed in the opposite direction.

WARNING: If configured according to the description above, relays K1 and K2 will never be activated at the same time. There is a time delay of 500 ms for the change-over between the relays. However, if the relays are not configured properly, they may be activated at the same time.

For applications which use the reverse current brake functionality, the following settings for the relays may be used.

Menu	Description	Setting
530	Relay K1 (terminals 21 and 22)	Run R (6)
531	Relay K2 (terminals 23 and 24)	Run L (7)

With these settings the functionality is as follows:

If terminals 11and 12 are closed to terminal 13 while terminal 16 is open, the mains contactor for running in right direction will be activated by relay K1 and the motor will start in right direction. If terminal 12 is opened the voltage to the motor is switched off and the mains contactor for running right is deactivated by relay K1. After a time delay of 500 ms the mains contactor for running left will be activated by relay K2 and the reverse current brake will brake the motor to standstill. When the stop is finished, the mains contactor for running left will be deactivated by relay K2.

If terminal 12 is closed to terminal 13 and terminal 16 is closed to terminal 18 while terminal 11 is open, the mains contactor for running in left direction will be activated by relay K2 and the motor will start in left direction. If terminal 12 is opened the voltage to the motor is switched off and the mains contactor for running left is deactivated by relay K2. After a time delay of 500 ms the mains contactor for running right will be activated by relay K1 and the reverse current brake will brake the motor to standstill. When the stop is finished, the mains contactor for running right will be deactivated by relay K1.

If both start terminals (11 and 16) are closed to their respective supply voltage at the same time, a stop is performed in the same way as described above. In this case no start will be allowed.

A motor can be reversed in the same way as described above for applications which do not use the reverse current brake functionality.

WARNING: If configured according to the description above, relays K1 and K2 will never be activated at the same time. There is a time delay of 500 ms for the change-over between the relays. However, if the relays are not configured properly, they may be activated at the same time.

NOTE: When reverse current brake is activated by changing the settings in menu [320] (stop method), [323] (braking method) or [326] (alarm brake strength), relay K1 is automatically set for Run (5) and relay K2 is automatically set for Brake (4). To use the start right/ left functionality in combination with reverse brake, the relay settings have to be adapted as described above once reverse current brake has been enabled.

8.9.5 External alarm functionality

The external alarm functionality is used to generate an alarm depending on the state of an external alarm signal. Each of the digital inputs can be configured for external alarm signal. Fig. 66 shows a connection example with digital input 3 (terminal 16) configured for external alarm signal.

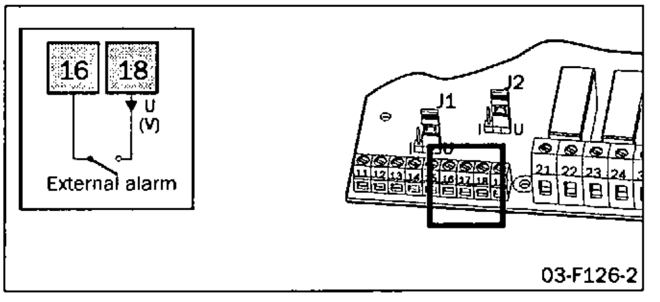


Fig. 66 Connection of terminals for external alarm

If any digital input is configured for external alarm signal, opening this input will cause an external alarm to occur if external alarm is enabled in menu [420].

NOTE: If more than one digital input is configured for external alarm signal, opening any of these inputs will generate an external alarm if external alarm is enabled in menu [420].

The following alarm actions are available for external alarm:

Off

External alarm is disabled.

Warning

An F17 alarm message is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm input is opened. However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset when the external alarm input is closed again. The alarm may also be reset manually.

Coast

An F17 alarm message is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm input is opened. The motor voltage is automatically switched off. The motor freewheels until it stops.

Stop

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm input is opened. The motor is stopped according to the stop settings in menus [320] to [325].

Brake

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm input is opened. The brake function is activated according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menu [326] - [327] (Braking strength and braking time).

Spinbrake

The functionality for the spinbrake alternative is the same as described above for the brake alternative. However, if spinbrake is chosen, braking can even be initiated from an inactive state by opening the external alarm input. This means the softstarter can catch a freewheeling motor and brake it down to standstill. The Spinbrake alternative is only available for external alarm.

External alarm can be used together with any setting for the control source chosen in menu [200].

If the operation has been interrupted due to an external alarm, a reset signal and a new start signal are needed to restart the motor. The reset and the start signal can be given via control panel, remote or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via control panel.

NOTE: A reset via control panel will never start the motor.

8.9.6 External control of parameter set

The parameter set can be chosen via the digital inputs if external control of parameter set is chosen in menu [240] (alternative 0). For this purpose any of the digital inputs can be configured for parameter set input 1 (PS1, alternative 3 in menus [510] to [513]) or parameter set input 2 (PS2, alternative 4 in menus [510] to [513]). Fig. 67 shows a connection example for external control of parameter set, in this example digital inputs 3 and 4 are configured for PS1 and PS2.

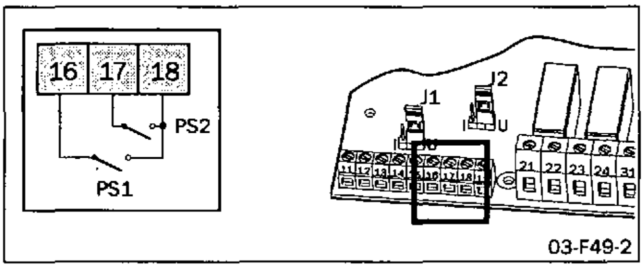


Fig. 67 Connection of external control inputs.

Table 15 How parameter set inputs are evaluated

Parameter Set	PS1 (16-18)	PS2 (17-18)
1	Open	Open
2	Closed	Open
3	Open	Closed
4	Closed	Closed

It is possible to use just one digital input to change between two parameter sets. According to the example above, digital input 3 is configured for PS1. If no digital input is configured for PS2, PS2 is considered to be open. In this case digital input 3 can be used to change between parameter set 1 and 2.

Changing the parameter set via external signal is only executed in stopped mode and at full voltage operation. If the input signals for PS1 and PS2 are changed during acceleration or deceleration, only the new parameters for the control source (menu [200]), the analogue/digital input (menu [500]), the digital input pulses (menu [501]), the analogue start/stop on- and off-value (menus [502] and [503]) and the analogue start/stop delay (menu [504]) are loaded immediately. All other parameters will not change until the softstarter is in stopped mode or at full voltage running. In this way a change of the control source will take effect immediately, which can be useful for changing from remote to manual operation for maintenance.

NOTE: No parameters, except for the control source in menu [200] and the parameter set in menu [240], may be changed if external control of parameter set is activated in menu [240] (alternative 0).

8.10 View operation

MSF 2.0 includes numerous viewing functions which eliminate the need for additional transducers and meters for monitoring the operation.

[700] to [716] Operation (current, voltage, power etc.)

[720] to [725] Status (softstart status, input/output status)

[730] to [732] Stored values (operation time etc.)

8.10.1 Operation

RMS current

700	Read-out
0.0	**Current**
Range:	0.0-9999 A

NOTE! This is the same read-out as menu [100].

Line main voltage

701	Read-out
0	**Line main voltage**
Range:	0-720 V

Power factor

702	Read-out
0.00	**Power factor**
Range:	0.00-1.00

Output shaftpower

The output shaft power is shown in kW or in HP depending on the setting for Enable US units in menu [202].

703	Read-out
0.0	**Output shaftpower**
Range:	-999-9999 kW or HP

Output shaftpower in percentage unit

704	Read-out
0	**Output shaftpower in percentage units**
Range:	0-200% of P_n

NOTE: This is the same read-out as menu [413].

Shaft torque

The shaft torque is shown in Nm or in lbft depending on the setting for Enable US units in menu [202].

705	Read-out
0.0	**Shaft torque**
Range:	-999-9999 Nm or lbft

Shaft torque in percentage unit

706	Read-out
0	**Shaft torque in percentage units**
Range:	0-250% of T_n

Softstarter temperature

The softstart temperature is shown in degrees Celsius or in degrees Fahrenheit depending on the setting for Enable US units in menu [202].

707	Read-out
Lo	**Softstarter temperature**
Range:	Low, 30-96°C or low, 85-204°F

Current phase I1

708	Read-out
0.0	**Current phase L1**
Range:	0.0-9999 A

Current phase L2

709	Read-out
0.0	**Current phase L2**
Range:	0.0-9999 A

Current phase L3

710	Read-out
0.0	**Current phase L3**
Range:	0.0-9999 A

Line main voltage L1-L2

711	Read-out
0	**Line main voltage L1-L2**
Range:	0-720 V

Line main voltage L1-L3

712	Read-out
0	**Line main voltage L1-L3**
Range:	0-720 V

Line main voltage L2-L3

713	Read-out
0	**Line main voltage L2-L3**
Range:	0-720 V

Phase sequence

714	Read-out
L - - -	**Phase sequence**
Range:	L--, L123, L321

Used thermal capacity

715	Read-out
0	**Used thermal capacity**
Range:	0-150%

Time to next allowed start

716	Read-out
0	**Time to next allowed start**
Range:	0-60 min

8.10.2 Status

Softstarter status

720	Read-out
0	**Softstarter status**
Range:	1-12
1	Stopped, no alarm
2	Stopped, alarm
3	Run with alarm
4	Acceleration
5	Full voltage
6	Deceleration
7	Bypassed
8	PFC
9	Braking
10	Slow speed forward
11	Slow speed reverse
12	Standby (waiting for Analogue start/stop or Autoreset)

Digital Input Status

Status of the digital inputs 1- 4 from left to right. L or H are displayed for input status low (open) or high (closed).

721	Read-out
L L L L	**Digital input status**
Range:	LLLL-HHHH

Analogue/digital Input status

Status of the analogue/digital input when it is used as digital input. L and H are displayed for input status low (open) and high (closed).

722	Read-out
L	**Analogue/digital input status**
Range:	L, H

Analogue/digital input value

Value on the analogue/digital input as a percentage of the input range. This read-out depends on the configuration of the analogue/digital input in menu [500], e.g. if the analogue/digital input is configured for analogue start/stop 0-10 V/0-20 mA (alternative 6), an input signal of 4 V or 8 mA will be shown as 40%. However, if the analogue/digital input is configured for analogue start/stop 2.10 V/4-20 mA (alternative 7), an input signal of 4 V or 8 mA will be shown as 25%.

723	Read-out
0	**Analogue/digital input value**
Range:	0-100%

Relay status

Status of the relays K1 to K3 from the left to the right. L or H are displayed for relay status low (opened) or high (closed). The status described for relay K3 corresponds to the status of terminal 3.

724	Read-out
L L L	**Relay status**
Range:	LLL-HHH

Analogue Output value

Value on the analogue output as a percentage of the output range. This read-out depends on the configuration of the analogue output in menu [520], e.g. if the analogue/digital input is configured for 0-10 V/0-20 mA (alternative 1) or for 10-0 V/20-0 mA (alternative 3), an output signal of 4 V or 8 mA will be shown as 40%. However, if the analogue output is configured for 2-10 V/4-20 mA (alternative 2) or 10-2 V/20-4 mA (alternative 4), an output signal of 4 V or 8 mA will be shown as 25%.

725	Read-out
0	**Analogue Output value**
Range:	0-100%

8.10.3 Stored values

Operation time. The operation time is the time during which the motor connected to the softstarter is running, not the time during which the supply power is on.

If the actual value for the operation time exceeds 9999 hours the display will alternate between the four lower digits and the higher digits.

Example

If the actual operation time is 12467, 1 will be shown for 1 s, then 2467 will be shown for 5 s and so on.

730	Read-out
0	**Operation time**
Range:	0-9 999 999 h

Energy consumption

731	Read-out
0.000	**Energy consumption**
Range:	0.000-2000 MWh

Reset energy consumption

In this menu the stored power consumption (menu [713]) can be reset to 0.

732	Multi Setting
no	**Reset energy consumption**
Default:	no
Range:	no, YES
no	No action
YES	Reset power consumption

8.11 Alarm list

The alarm list is generated automatically. It shows the latest 15 alarms (F1-F17). The alarm list can be useful for tracking failures in the softstarter or its control circuit. In the alarm list both the alarm message and the operation time is saved for each alarms that occurs. In menu [800] the latest alarm message and the corresponding operation time are shown alternately, in the same way, older alarms are shown in menus [801] to [814].

Example

- If the latest alarm was a phase input failure (F1), which occurred at operation time 524. F1 is shown for 4 s then 524 is shown for 2 s and so on.
- If the latest alarm was a thermal motor protection alarm (F2), which occurred at operation time 17852. F2 is shown for 3 s, after that 1 is shown for 1 s, then 7852 is shown for 2 s and so on.

Alarm list, latest error

800	Read-out
F1	**Alarm list, latest error**
Range:	F1-F17

Alarm list, error

801	Read-out
F1	**Alarm list, error 14**
Range:	F1-F17

Menu	Function
802	Alarm list, error 13
803	Alarm list, error 12
804	Alarm list, error 11
805	Alarm list, error 10
806	Alarm list, error 9
807	Alarm list, error 8
808	Alarm list, error 7
809	Alarm list, error 6
810	Alarm list, error 5
811	Alarm list, error 4
812	Alarm list, error 3
813	Alarm list, error 2
814	Alarm list, error 1

8.12 Softstarter data

In menus [900] to [902] the softstarter type is shown and the softstarter's software version is specified.

Softstarter type

900	Read-out
17	**Softstarter type**
Range:	17-1400 A

Software variant

901	Read-out
V220	**Software variant text**
Range:	Same as label

Software version

902	Read-out
R15	**Software version text**
Range:	Same as label

9. Protection and alarm

MSF 2.0 is equipped with functions for motor protection, process protection and protection of the softstarter itself.

9.1 Alarm codes

Different alarm codes are used for the different errors, see Table 16 for a description of the alarm codes used. When an alarm occurs, this is indicated with the appropriate alarm message flashing in the display. If more than one alarm is active at the same time, the alarm code for the last alarm is presented on the display. The alarm code for each occurring alarm is also saved in the alarm list in menus [800] to [814].

9.2 Alarm actions

For most protection methods a proper action can be chosen to be performed if the relevant alarm occurs. The following alternatives are available as alarm actions (all alternatives may not be available for all protection methods - check Table 16):

Off

The alarm is deactivated.

Warning

The appropriate alarm code is flashing in the display and relay K3 is activated (for default configuration of the relays) if an the alarm occurs. However, the motor is not stopped ans operation continues. The alarm message in the display will disappear and the relay will be reset when the alarm has disappeared. The alarm may also be reset manually. This setting alternative may be useful if it is desired to control operation in alarm state by an external control unit.

Coast

The appropriate alarm code is flashing in the display and relay K3 is activated (for default configuration of the relays) if an the alarm occurs. The motor voltage is automatically switched off. The motor is freewheels until it stops.

This setting alternative is useful if continuous running or active stopping could harm the process or the motor. This may be appplicable for applications with very high inertia that use braking as the normal stop method. In this case it may be a good idea to choose Coast as alarm action on thermal motor protection alarm, because continuous running or braking could harm the motor seriously when this alarm has occurred.

Stop

The appropriate alarm code is flashing in the display and relay K3 is activated (for default configuration of the relays) if an alarm occurs. The motor is stopped according to the stop settings in menus [320] to [325].

This setting is useful for applications where a correct stop is important. This may apply to most pump applications, as Coast as an alarm action could cause water hammer.

Brake

The appropriate alarm code is flashing in the display and relay K3 is activated (for default configuration of the relays) if an alarm occurs. The brake function is activated according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menus [326] to [327] (braking strength and braking time). If alarm braking is deactivated in menu [326] and Brake is chosen as an alarm action, the action will be the same as described above for Coast.

Brake as an alarm action may mainly be used in combination with External alarm, where an external signal is used to initiate a quick stop with a higher braking strength and a shorter braking time compared to normal operation.

Spinbrake

The functionality for the Spinbrake alternative is the same as described above for the Brake alternative. However, if Spinbrake is chosen, braking can even be initiated from an inactive state. This means the softstarter can catch a freewheeling motor and brake it down to standstill.

The Spinbrake alternative is only available for External alarm. It may be useful e.g. for test running of planers and bandsaws after tool exchange. It may be desirable to accelerate the tool up to a specific speed and then leave it coasting to check if there is any unbalance. In this case it is possible to activate braking immediately by opening the external input.

In Table 16 below the alarm actions available for each alarm type are specified in detail.

9.3 Reset

For the following explanations it is important to distinguish between Reset and Restart. Reset means that the alarm message on the display disappears and the alarm relay K3 (for default configuration of the relays) is deactivated. If the operation has been interrupted due to an alarm the softstarter is prepared for a Restart. However, giving a Reset signal without giving a new start signal will never lead to a start.

The Reset signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control method, it is always possible to give a Reset signal via control panel.

If an alarm occurs whose alarm action is configured for Warning (see description of alarm actions above), the alarm will automatically be reset as soon as the failure disappears. The alarm may also be reset manually by giving a Reset signal as described above.

If operation has been interrupted due to an alarm, a Reset signal and a new start signal may be needed to Restart the motor. However, some alarms are automatically reset when a new start signal is given. Table 16 covers all alarm types and whether they need a Reset signal (manual reset) or if they are reset automatically when a new start signal is given.

An alarm can always be reset by giving a Reset signal, even if the failure that caused the alarm has not disappeared yet. Giving a Reset will cause the alarm message on the display to disappear and the alarm relay K3 to be deactivated (for default configuration of the relays). However, if operation has been interrupted due to an alarm, a Restart will not be possible until the failure has disappeared. If a new start signal is given while the failure still is active, the alarm message will appear flashing in the display and the alarm relay K3 will be activated again (for default configuration of the relays).

MSF 2.0 is also provided with an Autoreset function. This functionality is described in detail in section 8.5, page 52.

9.4 Alarm overview

Table 16 Alarm overview

Alarm code	Alarm description	Alarm action	Protection system	Reset
F1	Phase input failure.	Warning Coast	Motor protection (menu [230])	Automatic Reset when new start signal is given.
F2	Thermal motor protection	Off Warning Coast Stop Brake	Motor protection (menu [220])	Separate Reset signal needed.
F3	Soft start overheated	Coast		Separate Reset signal needed.
F4	Current limit start time expired.	Off Warning Coast Stop Brake	Motor protection (menu [231])	Automatic Reset when new start signal is given.
F5	Locked rotor alarm.	Off Warning Coast	Motor protection (menu [228])	Separate Reset signal needed.
F6	Max power alarm.	Off Warning Coast Stop Brake	Process protection (menu [400])	Separate Reset signal needed.
F7	Min power alarm.	Off Warning Coast Stop Brake	Process protection (menu [401])	Separate Reset signal needed.
F8	Voltage unbalance alarm.	Off Warning Coast Stop Brake	Process protection (menu [430])	Automatic Reset when new start signal is given.
F9	Overvoltage alarm.	Off Warning Coast Stop Brake	Process protection (menu [433])	Automatic Reset when new start signal is given.
F10	Undervoltage alarm.	Off Warning Coast Stop Brake	Process protection (menu [436])	Automatic Reset when new start signal is given.

Table 16 Alarm overview

Alarm code	Alarm description	Alarm action	Protection system	Reset
F11	Start limitation.	Off Warning Coast	Motor protection (menu [224])	Automatic Reset when new start signal is given.
F12	Shorted thyristor.	Coast		Separate Reset signal needed.
F13	Open thyristor.	Coast		Separate Reset signal needed.
F14	Motor terminal open.	Coast		Separate Reset signal needed.
F15	Serial communication contact broken.	Off Warning Coast Stop Brake	Control source protection (menu [273])	Automatic Reset when new start signal is given.
F16	Phase reversal alarm.	Off Warning Coast	Process protection (menu [440])	Separate Reset signal needed.
F17	External alarm.	Off Warning Coast Stop Brake Spinbrake	Process protection (menu [420])	Separate Reset signal needed.

10. Troubleshooting

10.1 Fault, cause and solution

Observation	Fault indication	Cause	Solution
The display is not illuminated.	None	No control supply voltage.	Switch on the control supply voltage.
The motor does not run.	F1 (Phase input failure)	Fuse defective.	Renew the fuse.
		No mains supply.	Switch on the mains supply.
	F2 (Thermal motor protection)	PTC connection could be open. Incorrect nominal motor current could be entered in menu [211].	Check the PTC input if PTC protection is used. If internal thermal motor protection is used, perhaps an other internal thermal protection class could be used (menu [222]). Cool down the motor and restart.
	F3 (Softstarter overheated)	Ambient temperature too high. Softstarter duty cycle exceeded. Could be fan failure.	Check ventilation of cabinet. Check the size of the cabinet. Clean the cooling fins. If the fan(s) is (are) not working correctly, contact your local MSF sales outlet.
	F4 (Current limit start time expired)	Current limit parameters are perhaps not matched to the load and motor.	Increase the start time (menu [315]) and/or the current limit at start (menu [314]).
	F5 (Locked rotor)	Something stuck in the machine or perhaps motor bearing failure.	Check the machine and motor bearings. Perhaps the Locked rotor time can be set longer (menu [229]).
	F6 (Max power alarm)	Overload	Check the machine. Perhaps the Max power alarm response delay can be set longer menu [404].
	F7 (Mn power alarm)	Underload	Check the machine. Perhaps the Min power alarm response delay can be set longer menu [410].
	F8 (Voltage unbalance)	Mains supply voltage unbalance.	Check mains supply.
	F9 (Overvoltage)	Mains supply overvoltage.	Check mains supply.
	F10 (Undervoltage)	Mains supply undervoltage.	Check mains supply.
	F11 (Start limitation)	Number of starts per hour exceeded, min time between starts not kept.	Wait and start again. Perhaps the number of starts per hour could be increased in menu [225] or the min time between starts could be decreased (menu [226]).
	F13 (Open thyristor)	Perhaps a damaged thyristor.	Initiate a reset and a restart. If the same alarm appears immediately, contact your local MSF sales outlet.
	F14 (Motor terminal open)	Open motor contact, cable or motor winding.	If the fault is not found, reset the alarm and inspect the alarm list. If alarm F12 is found, a thyristor is probably shorted. Initiate a restart. If alarm F14 appears immediately, contact your local MSF sales outlet.

Observation	Fault indication	Cause	Solution
The motor does not run.	F15 (Serial communication contact broken)	Serial communication contact broken.	Initiate a reset and try to establish contact. Check contacts, cables and option board. Verify - Serial communication unit address [270]. - Baudrate menu [271]. - Parity menu [272]. If the fault is not found, run the motor from the control panel if urgent set menu [200] to 1. See also manual for serial communication.
	F16 (Phase reversal)	Incorrect phase sequence on main supply.	Switch L2 and L3 input phases.
	F17 (External alarm)	External alarm signal input open	Check the digital input configured for External alarm. Check the configuration of the digital inputs (menus [510] to [513]).
	- - - -	Start command comes perhaps from incorrect control source. (I.e. start from control panel when remote control is selected).	Give start command from correct control source menu [200].
The motor is running but an alarm is given.	F1 (Phase input failure)	Failure in one phase. Perhaps fuse is defective.	Check fuses and mains supply. Select a different alarm action for Single phase input failure in menu [230] if stop is desired at single phase loss.
	F4 (Current limit start time expired)	Current limit parameters are perhaps not matched to the load and motor.	Increase the start time (menu [315]) and/or the current limit at start (menu [314]). Select a different action for Current limit start time expired alarm in menu [231], if stop is desired at current limit time-out.
	F12 (Shorted thyristor)	Perhaps a damaged thyristor.	When stop command is given, a freewheel stop is made. Initiate a reset and a restart. If alarm F14 appears immediately, contact your local MSF sales outlet. If the motor must be started urgently, the softstarter can start the motor direct on-line (DOL). Set the start method to DOL in this case (menu [310]=4).
		Bypass contactor is used but menu [340] 'Bypass' is not set to "on".	Set menu [340] Bypass to on.
	F15 (Serial communication contact broken)	Serial communication contact broken.	Initiate a reset and try to establish contact. Check contacts, cables and option board. Verify - Serial communication unit address [270]. - Baudrate menu [271]. - Parity menu [272]. If the fault is not found, run the motor from the control panel if urgent, see also manual for serial communication.

Observation	Fault indication	Cause	Solution
The motor jerks etc.	When starting, motor reaches full speed but it jerks or vibrates.	If "Torque control" or "Pump control" is selected, it is necessary to input motor data into the system.	Input nominal motor data in menus [210]-[215]. Select the proper torque control alternative in menu [310] (linear or square) according to the load characteristic. Select a correct initial- and end torque at start in menus [311] and [312]. If 'Bypass' is selected, check that the current transformers are correctly connected.
		Start time too short.	Increase start time [315].
		If voltage control is used as start method, the initial voltage at start may be too low. Starting voltage incorrectly set.	Adjust initial voltage at start [311].
		Motor too small in relation to rated current of softstarter.	Use a smaller model of the softstarter.
		Motor too large in relation to load of softstarter.	Use larger model of softstarter.
		Starting voltage not set correctly.	Readjust the start ramp.
			Select the current limit function.
	Starting or stopping time too long.	Ramp times not set correctly.	Readjust the start and/or stop ramp time.
		Motor too large or too small in relation to load.	Change to another motor size.
The monitor function does not work.	No alarm or pre-alarm	It is necessary to input nominal motor data for this function. Incorrect alarm margins or normal load.	Input nominal motor data in menus [210]-[215]. Adjust alarm margins and normal load in menus [402] - [412]. Use Autoset [411] if needed. If a Bypass contactor is used, check that the current transformers are correctly connected.
Unexplainable alarm.	F5, F6, F7, F8, F9, F10	Alarm delay time is too short.	Adjust the response delay times for the alarms in menus [229], [404], [410], [432], [435] and [438].
The system seems locked in an alarm.	F2 (Thermal motor protection)	PTC input terminal could be open. Motor could still be too warm. If internal motor protection is used, the cooling in the internal model may take some time.	PTC input terminal should be short circuit if not used. Wait until motor PTC gives an OK (not overheated) signal. Wait until the internal cooling is done. Try to restart after a while.
	F3 (Softstarter overheated)	Ambient temperature to high. Perhaps fan failure.	Check that cables from power part are connected in terminals 71 to 74. MSF-017 to MSF-250 should have a jumper between terminals 71 and 72. Check also that the fan(s) is(are) rotating.

Observation	Fault indication	Cause	Solution
Parameter will not be accepted.		If menu 240, "Parameter set" is set to "0", the system is configured for external control of parameter set. Most parameters are not allowed to be changed in this mode.	Set the menu 240, "Parameter set" to a value between "1" - "4" and then any parameter can be changed.
		During start, stop and slow speed changing parameters is not permitted.	Set parameters during standstill or full voltage running.
		If control source is serial comm., it is impossible to change parameters from keyboard and vice versa.	Change parameters from the actual control source.
		Some menus include only read-out values and not parameters.	Read-out values cannot be altered. In Table 14, read-out menus have '—' in the factory setting column.
	-Loc	Control panel is locked for settings.	Unlock control panel by pressing the keys "NEXT" and "ENTER'"for at least 3 sec.

11. Maintenance

In general the softstarter is maintenance-free. There are however some things which should be checked regularly. In particular, if the surroundings are dusty the unit should be cleaned regularly.

WARNING! Do not touch parts inside the enclosure of the unit when the control supply voltage or the mains supply voltage is switched on.

11.1 Regular maintenance

- Check that nothing in the softstarter has been damaged by vibration (loose screws or connections).
- Check external wiring, connections and control signals. Tighten terminal screws and busbar bolts if necessary.
- Check that printed circuit boards, thyristors and cooling fins are free from dust. Clean with compressed air if necessary. Make sure the printed circuit boards and the thyristors are undamaged.
- Check for signs of overheating (changes in colour on printed circuit boards, oxidation of solder points etc.). Check that the temperature is within permissible limits.
- Check that the cooling fan(s) permit free air flow. Clean any external air filters if necessary.

12. Options

The following options are available. Please contact your supplier for more detailed information.

12.1 Serial communication

For serial communication the MODBUS RTU (RS232/ RS485) option board is available, order part number: 01-1733-00.

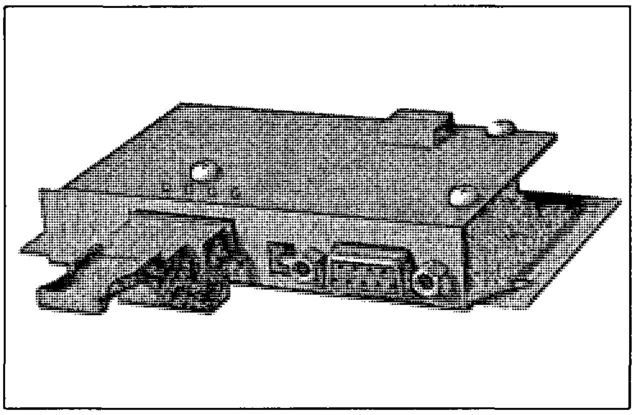


Fig. 68 Option RS232/485

12.2 Fieldbus systems

Various option boards are available for the following bus systems:

- PROFIBUS DP order part number: 01-1734-01
- Device NET, order part number: 01-1736-01

Each system has its own board. The option is delivered with an instruction manual containing all the details for the installation and set-up of the board and the protocol for programming.

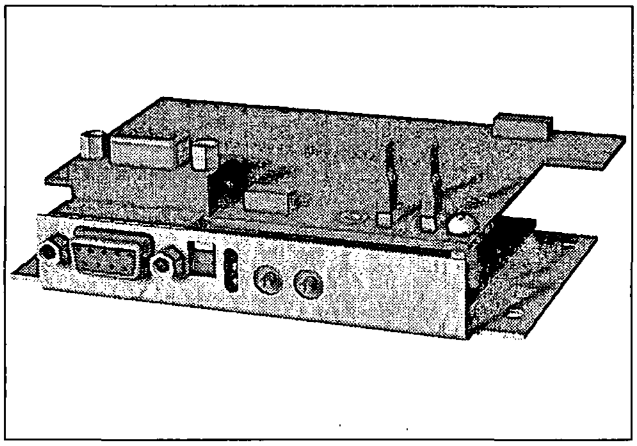


Fig. 69 Profibus Option

12.3 External control panel

The external control panel option is used to move the control panel from the softstarter to the front of a panel door or control cabinet.

The maximum distance between the softstarter and the external control panel is 3 m.

The part number to order for the external control panel is 01-2138-00. A separate data sheet for this option is available.

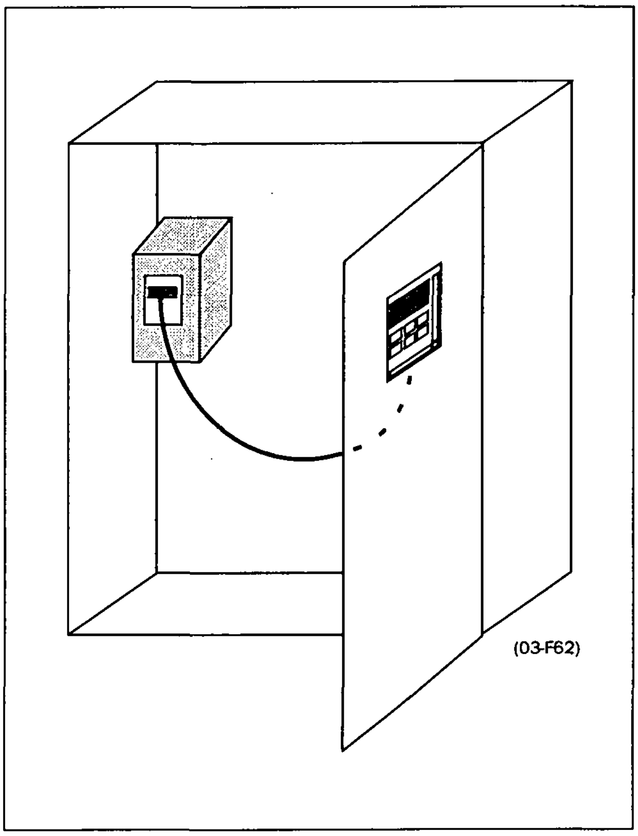


Fig. 70 Use of the external control panel.

12.3.1 Cable kit for external current transformers

This kit is used for the bypass function, to connect the current transformers externally. order part number: 01-2020-00.

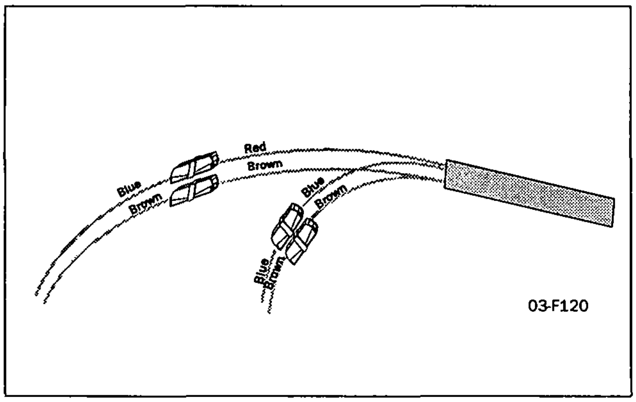


Fig. 71 Cable kit

12.4 Terminal clamp

Data: Single cables, Cu or Al

Cables	95-300 mm^2
MSF type Cu Cable	310
Bolt for connection to busbar	M10
Dimensions in mm	33x84x47 mm
Part no. single	9350
Data: Parallel cables, Cu or Al	
Cables	2x95-300 mm^2
MSF type and Cu Cable	310 to 835
Bolt for connection to busbar	M10
Dimensions in mm	35x87x65
Part no. parallel	9351

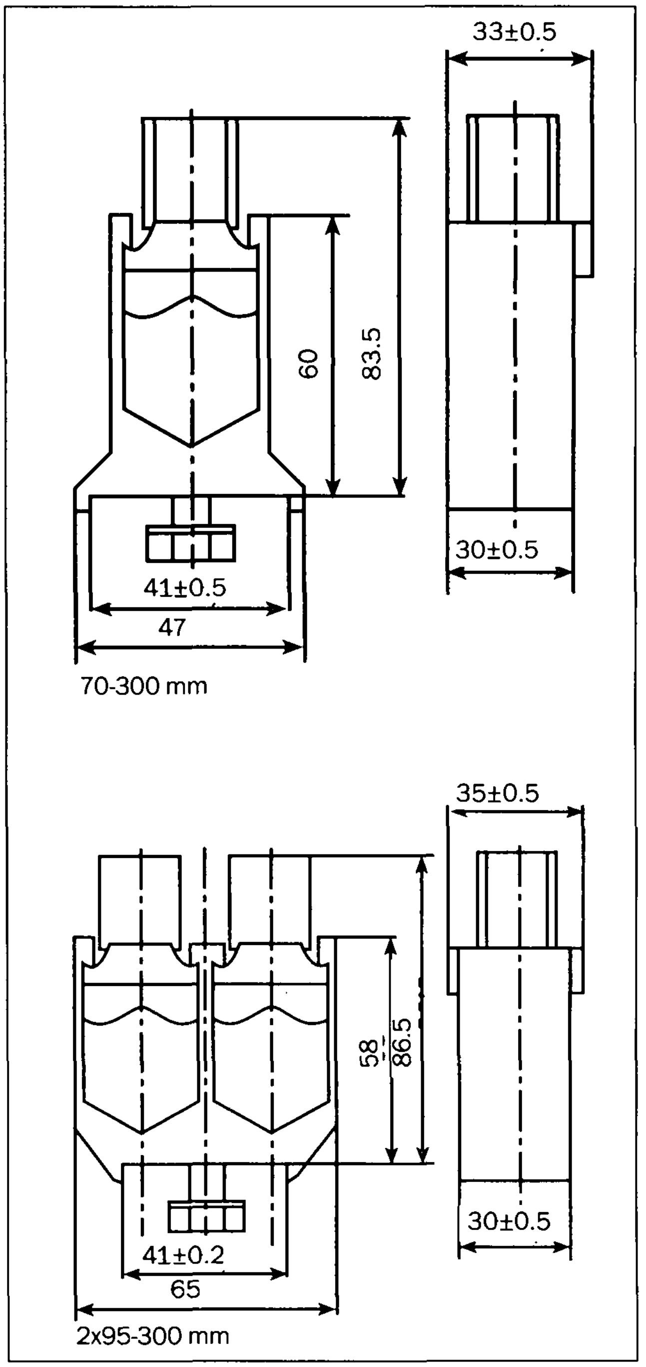


Fig. 72 The terminal clamp.

13. Technical data

13.1 Electrical specifications

Table 17 Typical motor power at mains voltage 400 V

MSF model	Heavy AC-53a 5.0-30:50-10		Normal AC-53a 3.0-30:50-10		Normal with bypass AC-53b 3.0-30:300	
	Power @400V [kW]	Rated current [A]	Power @400V [kW]	Rated current [A]	Power @400V [kW]	Rated current [A]
MSF-017	7.5	17	11	22	11	25
-030	15	30	18.5	37	22	45
-045	22	45	30	60	37	67
-060	30	60	37	72	45	85
-075	37	75	45	85	55	103
-085	45	85	45	96	55	120
-110	55	110	75	134	90	165
-145	75	145	75	156	110	210
-170	90	170	110	210	132	255
-210	110	210	132	250	160	300
-250	132	250	132	262	200	360
-310	160	310	200	370	250	450
-370	200	370	250	450	315	555
-450	250	450	315	549	355	675
-570	315	570	400	710	450	820
-710	400	710	450	835	500	945
-835	450	835	500	960	630	1125
-1000	560	1 000	630	1125	800	1400
-1400	800	1 400	900	1650	1000	1800

Table 18 Typical motor power at mains voltage 460 V

MSF model	Heavy AC-53a 5.0-30:50-10		Normal AC-53a 3.0-30:50-10		Normal with bypass AC-53b 3.0-30:300	
	Power @460V [hp]	Rated current [A]	Power @460V [hp]	Rated current [A]	Power @460V [hp]	Rated current [A]
MSF-017	10	17	15	22	20	25
-030	20	30	25	37	30	45
-045	30	45	40	60	50	68
-060	40	60	50	72	60	85
-075	60	75	60	85	75	103
-085	60	85	75	96	100	120
-110	75	110	100	134	125	165
-145	100	145	125	156	150	210
-170	125	170	150	210	200	255
-210	150	210	200	250	250	300
-250	200	250	200	262	300	360
-310	250	310	300	370	350	450
-370	300	370	350	450	450	555
-450	350	450	450	549	500	675
-570	500	570	600	710	650	820
-710	600	710	700	835	800	945
-835	700	835	800	960	900	1125
-1000	800	1 000	900	1125	1000	1400
-1400	1000	1 400	1250	1650	1500	1800

Table 19 Typical motor power at mains voltage 525 V

MSF model	Heavy AC-53a 5.0-30:50-10		Normal AC-53a 3.0-30:50-10		Normal with bypass AC-53b 3.0-30:300	
	Power @525V [kW]	**Rated current [A]**	**Power @525V [kW]**	**Rated current [A]**	**Power @525V [kW]**	**Rated current [A]**
MSF-017	11	17	15	22	15	25
-030	18,5	30	22	37	30	45
-045	30	45	37	60	45	68
-060	37	60	45	72	55	85
-075	45	75	55	85	75	103
-085	55	85	55	96	75	120
-110	75	110	90	134	110	165
-145	90	145	110	156	132	210
-170	110	170	132	210	160	255
-210	132	210	160	250	200	300
-250	160	250	160	262	250	360
-310	200	310	250	370	315	450
-370	250	370	315	450	355	555
-450	315	450	400	549	450	675
-570	400	570	500	710	560	820
-710	500	710	560	835	630	945
-835	560	835	710	960	800	1125
-1000	710	1 000	800	1125	1000	1400
-1400	1000	1 400	1250	1650	1400	1800

Table 20 Typical motor power at mains voltage 575 V

MSF model	Heavy AC-53a 5.0-30:50-10		Normal AC-53a 3.0-30:50-10		Normal with bypass AC-53b 3.0-30:300	
	Power @575V [hp]	**Rated current [A]**	**Power @575V [hp]**	**Rated current [A]**	**Power @575V [hp]**	**Rated current [A]**
MSF-017	15	17	20	22	25	25
-030	25	30	30	37	40	45
-045	40	45	50	60	60	68
-060	50	60	60	72	75	85
-075	75	75	75	85	100	103
-085	75	85	75	90	125	120
-110	100	110	125	134	150	165
-145	150	145	150	156	200	210
-170	150	170	200	210	250	255
-210	200	210	250	250	300	300
-250	250	250	250	262	350	360
-310	300	310	400	370	450	450
-370	400	370	500	450	600	555
-450	500	450	600	549	700	675
-570	600	570	700	640	800	820
-710	700	710	800	835	1000	945
-835	800	835	900	880	1250	1125
-1000	1000	1 000	1250	1125	1500	1400
-1400	1500	1 400	1500	1524	2000	1800

Table 21 Typical motor power at mains voltage 690 V

MSF model	Heavy AC-53a 5.0-30:50-10		Normal AC-53a 3.0-30:50-10		Normal with bypass AC-53b 3.0-30:300	
	Power @690V [kW]	**Rated current [A]**	**Power @690V [kW]**	**Rated current [A]**	**Power @690V [kW]**	**Rated current [A]**
MSF-017	15	17	18,5	22	22	25
-030	22	30	30	37	37	45
-045	37	45	55	60	55	68
-060	55	60	55	72	75	85
-075	55	75	75	85	90	103
-085	75	85	90	90	110	120
-110	90	110	110	134	160	165
-145	132	145	132	156	200	210
-170	160	170	200	210	250	255
-210	200	210	250	250	250	300
-250	250	250	250	262	355	360
-310	315	310	355	370	400	450
-370	355	370	400	450	500	555
-450	400	450	560	549	630	675
-570	560	570	630	640	800	820
-710	710	710	800	835	900	945
-835	800	835	900	880	1120	1125
-1000	1000	1 000	1120	1125	1400	1400
-1400	1400	1 400	1600	1524	1800	1800

13.2 General electrical specifications

Table 22 General electrical specifications

Parameter	Description
General	
Mains supply voltage	200-525 V ±10% 200-690 V +5%, -10%
Control supply voltage	100-240 V ±10% 380-500 V ±10%
Mains and Control supply frequency	50/60 Hz ±10%
Number of fully controlled phases	3
Recommended fuse for control supply	Max 10 A
Control signal inputs	
Digital input voltage	0-3 V→0, 8-27 V→1. Max 37 V for 10 sec.
Digital input impedance to GND (0 VDC)	2.2 kΩ
Analoueg input voltage/current	0-10 V, 2-10 V, 0-20 mA, 4-20 mA
Analoueg input impedance to GND (0 VDC)	Voltage signal 125 kΩ, current signal 100 Ω
Control signal outputs	
Output relays contact	8 A, 250 VAC or 24 VDC resistive load; 3 A, 250 VAC inductive load (PF 0.4)
Analogue output voltage/current	0-10 V, 2-10 V, 0-20 mA, 4-20 mA
Analogue output load impedance	Voltage signal min load 700Ω, current signal max load 750Ω
Control signal supply	
+12 VDC	+12 VDC ±5%. Max current 50 mA. Short circuit proof.

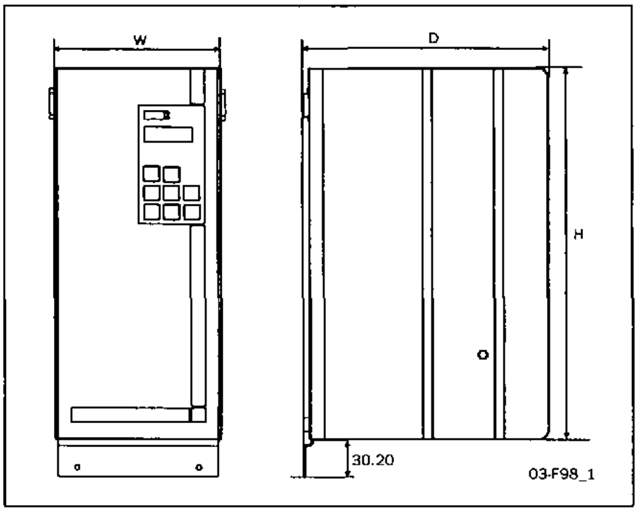
13.3 Fuses and power losses

Table 23 Fuses, power losses

Model	Recommended wiring fuses [A] First column Ramp start/second column Direct-on-line start		Power loss at rated motor load [W] No losses with bypass		Power consumption control card [VA]
	Heavy	Normal	Heavy	Normal	
MSF-017	25/50	32	50	70	20
-030	35/80	50	90	120	20
-045	50/125	80	140	180	25
-060	63/160	100	180	215	25
-075	80/200	100	230	260	25
-085	100/250	125	260	290	25
-110	125/315	180	330	400	25
-145	160/400	200	440	470	25
-170	200/400	200	510	630	35
-210	250/400	315	630	750	35
-250	250/500	315	750	750	35
-310	315/630	400	930	1100	35
-370	400/800	500	1100	1535	35
-450	500/1000	630	1400	1730	35
-570	630/1000	800	1700	2100	35
-710	800/1000	1000	2100	2500	35
-835	1000/1200	1000	2500	2875	35
-1000	1000/1400	1200	3000	3375	35
-1400	1400/1800	1800	4200	4950	35

13.4 Mechanical specifications including mechanical drawings

MSF Model	Dimensions H*W*D [mm]	Mounting position [Vertical/ Horizontal]	Weight [kg]	Connection busbars [mm]	PE screw	Cooling system	Protection class
-017, -030	320*126*260	Vertical	6.7	15*4, Cu (M6)	M6	Convection	IP20
-045, -060, -075, -085	320*126*260	Vert. or Horiz.	6.9	15*4, Cu (M6)	M6	Fan	IP20
-110, -145	400*176*260	Vert. or Horiz.	12	20*4, Cu (M10)	M8	Fan	IP20
-170, -210, -250	500*260*260	Vert. or Horiz.	20	30*4, Cu (M10)	M8	Fan	IP20
-310, -370, -450	532*547*278	Vert. or Horiz	46	40*8, Al (M12)	M8	Fan	IP20
-570, -710, -835	687*640*302	Vert. or Horiz	80	40*10, Al (M12)	M8	Fan	IP20
-1000, -1400	900*875*336	Vert. or Horiz	175	75*10, Al (M12)		Fan	IP00



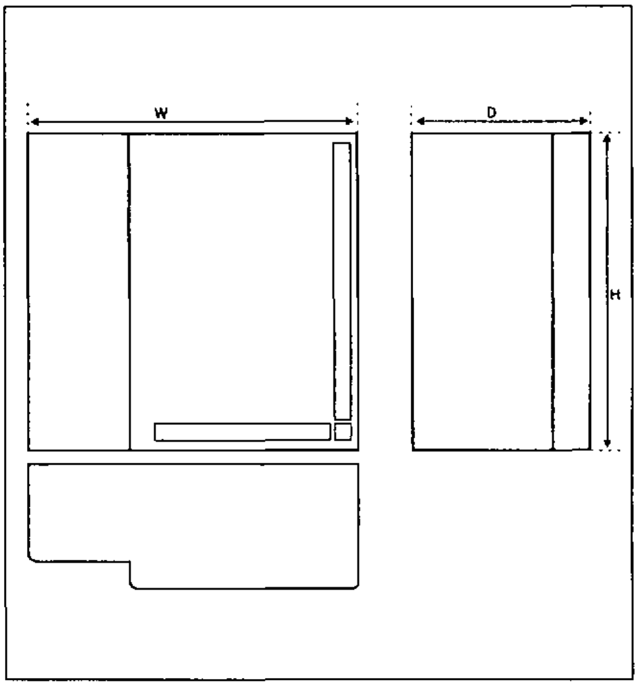


Fig. 73 MSF -310 to MSF -835.

13.5 Derating at higher temperature

By derating the current to 80% of nominal current, the MSF can be operated at an ambient temperature of up to 50 °C. E.g. a MSF-045 can operate a heavy load of 36 A (45 A*0.8).

13.6 Environmental conditions

Normal operation	
Temperature	0 - 40°C
Relative humidity	95%, non-condensing
Max altitude without derating	1000 m
Storage	
Temperature	-25 - +70°C
Relative humidity	95%, non-condensing

13.7 Standards

Market	Standard	Description
All	IEC 60947-1	Low-voltage switch gear and control gear. General part.
	IEC 60947-4-2	AC semiconductors motor controller and starters
	EN 60204-1	Safety of machinery – Electrical equipment of machines
European	Machinery Directive	89/392/ECC, Amendment 98/37/ECC
	EMC Directive	89/336/ECC, Amendment 91/263/ECC, 93/68/ECC
	Low Voltage Directive	73/23/ECC, Amendment 93/68/ECC
Russian	GOST R	Russia certificate of conformity
American	UL 508	Outline of investigation for power conversion equipment. Only models MSF-017 to MSF-250 up to 600 VAC

13.8 Power- and signal connectors.

Table 24 PCB Terminals

Terminal	Function	Electrical characteristics
01 02	Control supply voltage	100-240 VAC ±10% alternative 380-500 VAC ±10% see rating plate
PE	Protective Earth	⏚
11	Digital input 1	0-3 V –> 0; 8-27 V–> 1. Max. 37 V for 10 sec. Impedance to 0 VDC: 2.2 kΩ.
12	Digital input 2	
13	Control signal supply voltage to PCB terminal 11 and 12, 10 kΩ potentiometer, etc.	+12 VDC ±5%. Max. current from +12 VDC: 50 mA. Short circuit-proof but not overload-roof.
14	Analogue input, 0-10 V, 2-10 V, 0-20 mA and 4-20 mA/digital input.	Impedance to terminal 15 (0 VDC) voltage signal: 125 kΩ, current signal: 100 Ω.
15	GND (common)	0 VDC
16	Digital input 3	0-3 V –> 0; 8-27 V–> 1. Max. 37 V for 10 sec. Impedance to 0 VDC: 2.2 kΩ.
17	Digital input 4	
18	Control signal supply voltage to PCB terminal 16 and 17, 10 kΩ potentiometer, etc.	+12 VDC ±5%. Max. current from +12 VDC = 50 mA. Short circuit-proof but not overload-proof.
19	Analogue output	Analogue output contact: 0-10 V, 2-10 V; min load impedance 700Ω 0-20 mA and 4-20 mA; max load impedance 750Ω
21 22	Programmable relay K1. Factory setting is "Operation" with indication by closing terminal 21 to 22.	1-pole closing contact, 250 VAC 8 A or 24 VDC 8 A resistive, 250 VAC, 3 A inductive.
23 24	Programmable relay K2. Factory setting is "Full voltage" with indication by closing terminals 23 to 24.	1-pole closing contact, 250 VAC 8 A or 24 VDC 8 A resistive, 250 VAC, 3 A inductive.
31 32 33	Programmable relay K3. Factory setting is "All alarms". Indication by closing terminals 31 to 33 and opening terminals 32 to 33.	1-pole change-over contact, 250 VAC 8A or 24 VDC 8A resistive, 250 VAC, 3A inductive.
69-70	PTC Thermistor input	Alarm level 2.4 kΩ. Switch back level 2.2 kΩ.
71-72*	Clickson thermistor	Controlling softstarter cooling fan temperature MSF-310 - MSF-1400
73-74*	NTC thermistor	Temperature measuring of softstarter cooling fin
75	Current transformer input, cable S1 (blue)	Connection of L1 or T1 phase current transformer
76	Current transformer input, cable S1 (blue)	Connection of L3, T3 phase (MSF 017 to MSF 250) or L2, T2 phase (MSF 310 to MSF 1400)
77	Current transformer input, cable S2 (brown)	Common connection for terminals 75 and 76
78*	Fan connection	24 VDC
79*	Fan connection	0 VDC

*Internal connection, no customer use.

13.9 Semi-conductor fuses

Always use standard commercial fuses to protect the wiring and prevent short circuiting. To protect the thyristors against short-circuit currents, superfast semiconductor fuses can be used if preferred (e.g. Bussmann type FWP or similar, see table below).

The normal guarantee is valid even if superfast semiconductor fuses are not used.

Type	FWP Bussmann fuse	
	A	I^2t (fuse) x 1000
MSF-017	80	2.4
MSF-030	125	7.3
MSF-045	150	11.7
MSF-060	200	22
MSF-075	250	42.5
MSF-085	300	71.2
MSF-110	350	95.6
MSF-145	450	137
MSF-170	700	300
MSF-210	700	300
MSF-250	800	450

NOTE: Short circuit withstand MSF017-MSF060 5000 rms A when used with K5 or RK5 fuses.

NOTE: Short circuit withstand MSF075-MSF145 10000 rms A when used with K5 or RK5 fuses.

NOTE! Short circuit withstand MSF170-250 18000 rms A when used with K5 or RK5 fuses.

14. Set-up menu list

Menu	Function/Parameter	Range	Parameter alt. Alarm codes	Param. set	Factory setting	Value	Page
	General settings						
100	Current	0.0-9999 A		—	—		page 44
101	Automatic return menu	oFF, 1-999		—	oFF		page 44
200	Control source	1, 2, 3	1. Control panel 2. Remote control 3. Serial comm.	1-4	2		page 44
201	Control panel locked for settings	no, YES		—	—		page 44
202	Enable US units	oFF, on		—	oFF		page 45
	Motor data						
210	Nominal motor voltage	200-700 V		1-4	400		page 45
211	Nominal motor current	25-200% of I_{nsoft} in A		1-4	I_{nsoft}		page 45
212	Nominal motor power	25-400% of P_{nsoft} in kW resp. hp		1-4	P_{nsoft}		page 45
213	Nominal speed	500-3600 rpm		1-4	N_{nsoft}		page 45
214	Nominal power factor	0.50-1.00		1-4	0.86		page 45
215	Nominal frequency	50, 60 Hz		—	50		page 45
	Motor protection						
	THERMAL MOTOR PROTECTION						
220	Thermal motor protection	oFF, 1, 2, 3, 4	oFF 1. Warning 2. Coast 3. Stop 4. Brake	1-4	2		page 46
221	PTC input	oFF, on		1-4	oFF		page 47
222	Internal protection class	oFF, 2-40 s		1-4	10		page 47
223	Used thermal capacity	0-150%		—	—		page 47
	START LIMITATION						
224	Start limitation	oFF, 1, 2	oFF 1. Warning 2. Coast	1-4	oFF		page 48
225	Number of starts per hour	oFF, 1-99		1-4	oFF		page 49
226	Min time between starts	oFF, 1-60 min		1-4	oFF		page 49
227	Time to next allowed start	0-60 min		—	—		page 49
	LOCKED ROTOR						
228	Locked rotor alarm	oFF, 1, 2	oFF 1. Warning 2. Coast	1-4	oFF		page 49
229	Locked rotor time	1,0-10,0 s		1-4	5,0 s		page 49
	SINGLE PHASE INPUT FAILURE						
230	Single phase input failure	1, 2	1. Warning 2. Coast	1-4	2		page 50
	CURRENT LIMIT START TIME EXPIRED						

Menu	Function/Parameter	Range	Parameter alt. Alarm codes	Param. set	Factory setting	Value	Page
231	Current limit start time expired	oFF, 1, 2, 3, 4	oFF 1. Warning 2. Coast 3. Stop 4. Brake	1-4	2		page 50

	Parameter set handling						
240	Select parameter set	0, 1, 2, 3, 4	0 - External control of parameter set 1-4 - Parameter set 1-4	—	1		page 51
241	Actual parameter set	1, 2, 3, 4		—	—		page 51
242	Copy parameter set	no, P1-2, P1-3, P1-4, P2-1, P2-3, P2-4, P3-1, P3-2, P3-4, P4-1, P4-2, P4-3	no - no action P1-2 - Copy parameter set 1 to parameter set 2 etc.	—	no		page 51
243	Reset to factory settings	no, YES		—	no		page 52

	Autoreset						
250	Autoreset attempts	oFF, 0-10		1-4	oFF		page 52
251	Thermal motor protection autoreset	oFF, 0-3600 s		1-4	oFF		page 53
252	Start limitation autoreset	oFF, 0-3600 s		1-4	oFF		page 53
253	Locked rotor alarm autoreset	oFF, 0-3600 s		1-4	oFF		page 53
254	Current limit start time expired autoreset	oFF, 0-3600 s		1-4	oFF		page 53
255	Max power alarm autoreset	oFF, 0-3600 s		1-4	oFF		page 53
256	Min power alarm autoreset	oFF, 0-3600 s		1-4	oFF		page 53
257	External alarm autoreset	oFF, 0-3600 s		1-4	oFF		page 53
258	Phase input failure autoreset	oFF, 0-3600 s		1-4	oFF		page 53
259	Voltage unbalance alarm autoreset	oFF, 0-3600 s		1-4	oFF		page 53
260	Overvoltage alarm autoreset	oFF, 0-3600 s		1-4	oFF		page 53
261	Undervoltage alarm autoreset	oFF, 0-3600 s		1-4	oFF		page 53
262	Serial communication autoreset	oFF, 0-3600 s		1-4	oFF		page 53
263	Softstarter overheated autoreset	oFF, 0-3600 s		1-4	oFF		page 53

	Serial communication						
270	Serial comm. unit address	1-247		—	1		page 54
271	Serial comm. baudrate	2.4-38.4 kBaud		—	9.6		page 55
272	Serial comm. parity	0, 1	0. No parity 1. Even parity	—	0		page 55
273	Serial comm. contact broken	oFF, 1, 2, 3, 4	oFF 1. Warning 2. Coast 3. Stop 4. Brake	—	3		page 55

	Operation settings						
	PRE-SETTING						
300	Preset pump control parameters	no, yes		—	no		page 55
	START						

Menu	Function/Parameter	Range	Parameter alt. Alarm codes	Param. set	Factory setting	Value	Page
310	Start method	1, 2, 3, 4	1. Linear torque control 2. Square torque control 3. Voltage control 4. DOL	1-4	1		page 57
311	Initial torque at start	0-250% of T_n		1-4	10		page 58
312	End torque at start	25-250% of T_n		1-4	150		page 58
313	Initial voltage at start	25-80% of U		1-4	30		page 58
314	Current limit at start	off, 150-500% of I_n		1-4	oFF		page 59
315	Start time	1-60 s		1-4	10		page 59
316	Torque boost current limit	off, 300-700% of I_n		1-4	oFF		page 60
317	Torque boost active time	0.1-2.0 s		1-4	1.0		page 60
	STOP						
320	Stop method	1, 2, 3, 4, 5	1. Linear torque control 2. Square torque control 3. Voltage control 4. Coast 5. Brake	1-4	4		page 60
321	End torque at stop	0-100% of T_n		1-4	0		page 61
322	Step down voltage at stop	100-40% of U		1-4	100		page 61
323	Braking method	1, 2	1. Dynamic vector brake 2. Reverse current brake	—	1		page 62
324	Braking strength	150-500%		1-4	150		page 62
325	Stop time	1-120 s		1-4	10		page 63
326	Alarm braking strength	oFF, 150-500%		1-4	oFF		page 63
327	Alarm braking time	1-120 s		1-4	10		page 63
	SLOW SPEED / JOG						
330	Slow speed strength	10-100		1-4	10		page 65
331	Slow speed time at start	oFF, 1-60 s		1-4	oFF		page 65
332	Slow speed time at stop	oFF, 1-60 s		1-4	oFF		page 66
333	DC brake at slow speed	oFF, 1-60 s		1-4	oFF		page 66
334	Jog forward enable	oFF, on		1-4	oFF		page 66
335	Jog reverse enable	oFF, on		1-4	oFF		page 66
	ADDITIONAL SETTINGS						
340	Bypass	oFF, on		1-4	oFF		page 67
341	Power Factor Control (PFC)	oFF, on		1-4	oFF		page 69
342	Fan continuously on	oFF, on		1-4	oFF		page 69
	Process protection						
	LOAD MONITOR						
400	Max power alarm	oFF, 1, 2, 3, 4	oFF 1. Warning 2. Coast 3. Stop 4. Brake	1-4	oFF		page 71
401	Min power alarm	oFF, 1, 2, 3, 4	oFF 1. Warning 2. Coast 3. Stop 4. Brake	1-4	oFF		page 71
402	Start delay power alarms	1-999 s		1-4	10		page 71

Menu	Function/Parameter	Range	Parameter alt. Alarm codes	Param. set	Factory setting	Value	Page
403	Max power alarm margin	0-100% of P_n		1-4	16		page 71
404	Max power alarm response delay	0.1-90.0 s		1-4	0.5		page 71
405	Max power pre-alarm margin	0-100% of P_n		1-4	8		page 72
406	Max power pre-alarm response delay	0.1-90.0 s		1-4	0.5		page 72
407	Min power pre-alarm margin	0-100% of P_n		1-4	8		page 72
408	Min power pre-alarm response delay	0.1-90.0 s		1-4	0.5		page 72
409	Min power alarm margin	0-100% of P_n		1-4	16		page 72
410	Min power alarm response delay	0.1-90.0 s		1-4	0.5		page 73

411	Autoset power limits	no, YES		—	no		page 73
412	Normal load	0-200% of P_n		1 - 4	100		page 73
413	Output shaft power	0.0-200.0% of P_n		—	—		page 73
	EXTERNAL ALARM						
420	External alarm	oFF, 1, 2, 3, 4, 5	oFF 1. Warning 2. Coast 3. Stop 4. Brake 5. Spinbrake	1-4	oFF		page 73
	MAINS PROTECTION						
430	Voltage unbalance alarm	oFF, 1, 2, 3, 4	oFF 1. Warning 2. Coast 3. Stop 4. Brake	1-4	oFF		page 74
431	Voltage unbalance level	2-25% of U_n		1-4	10		page 75
432	Response delay voltage unbalance alarm	1-90 s		1-4	1		page 75
433	Overvoltage alarm	oFF, 1, 2, 3, 4	oFF 1. Warning 2. Coast 3. Stop 4. Brake	1-4	oFF		page 75
434	Overvoltage level	100-150% of U_n		1-4	115		page 75
435	Response delay overvoltage alarm	1-90 s		1-4	1		page 75
436	Undervoltage alarm	oFF, 1, 2, 3, 4	oFF 1. Warning 2. Coast 3. Stop 4. Brake	1-4	oFF		page 75
437	Undervoltage level	75-100% of U_n		1-4	85		page 76
438	Response delay undervoltage alarm	1-90 s		1-4	1		page 76
439	Phase sequence	L123, L321		—	—		page 76
440	Phase reversal alarm	oFF, 1, 2	oFF 1. Warning 2. Coast	—	oFF		page 76

	I/O settings						
	INPUT SIGNALS						

Menu	Function/Parameter	Range	Parameter alt. Alarm codes	Param. set	Factory setting	Value	Page
500	Digital/analogue input	oFF, 1, 2, 3, 4, 5, 6, 7	oFF 1. Digital, Rotation sen-sor 2. Digital, Slow speed 3. Digital, Jog fwd 4. Digital, Jog rev 5. Digital, Autoset 6. Analogue start-stop, 0-10V/0-20mA 7. Analogue start-stop, 2-10V/4-20 mA	1-4	oFF		page 77
501	Digital input pulses	1-100		1-4	1		page 78
502	Analogue start-stop on-value	0-100% of signal range		1-4	25		page 79
503	Analogue start-stop off-value	0-100% of signal range		1-4	75		page 80
504	Analogue start-stop delay time	1-999 s		1-4	1		page 80
510	Digital input 1 function	oFF, 1, 2, 3, 4, 5, 6, 7	oFF 1. Start signal 2. Stop signal 3. Parameter set input 1 4. Parameter set input 2 5. External alarm signal 6. Start R signal 7. Start L signal	—	1		page 81
511	Digital input 2 function	oFF, 1, 2, 3, 4, 5, 6, 7	See 510	—	2		page 81
512	Digital input 3 function	oFF, 1, 2, 3, 4, 5, 6, 7	See 510	—	3		page 82
513	Digital input 4 function	oFF, 1, 2, 3, 4, 5, 6, 7	See 510	—	4		page 82
	OUTPUT SIGNALS						
520	Analogue output	oFF, 1, 2, 3, 4	oFF 1. 0-10V/0-20mA 2. 2-10V/4-20mA 3. 10-0V/20-0mA 4. 10-2V/20-4mA	1-4	oFF		page 82
521	Analogue output function	1, 2, 3, 4	1. RMS current 2. Line voltage 3. Shaft power 4. Torque	1-4	1		page 82
522	Scaling analogue output, min	0-500% of value range		1-4	0		page 83
523	Scaling analogue output, max	0-500% of value range		1-4	100		page 84

Menu	Function/Parameter	Range	Parameter alt. Alarm codes	Param. set	Factory setting	Value	Page
530	Relay K1	off, 1-19	oFF 1. Operation 2. Full voltage 3. Power pre-alarms 4. Brake 5. Run 6. Run R 7. Run L 8. Operation R 9. Operation L 10. Power alarms 11. Max power alarm 12. Max power pre-alarm 13. Min power alarm 14. Min power pre-alarm 15. All alarms (except power pre-alarms) 16. All alarms (except power alarm and pre-alarms) 17. External alarm 18. Autoreset expired 19. All alarms which need manual reset	—	1		page 85
531	Relay K2	off, 1-19	Same as 530	—	2		page 85
532	Relay K3	off, 1-19	Same as 530	—	15		page 85
533	K1 contact function	1, 2	1. N.O. 2. N.C.	—	1		page 85
534	K2 contact function	1, 2	1. N.O. 2. N.C.	—	1		page 86

	View operation						
	OPERATION						
700	Current	0.0-9999 A		—	—		page 91
701	Line main voltage	0-720 V		—	—		page 91
702	Power factor	0.00-1.00		—	—		page 91
703	Output shaft power	-999-9999 kW		—	—		page 91
704	Output shaft power in percentage units	0-200% of P_n		—	—		page 91
705	Shaft torque	-999-9999 Nm		—	—		page 91
706	Shaft torque in percentage units	0-250% of T_n		—	—		page 91
707	Softstarter temperature	low, 30-96°C low, 85-204°F		—	—		page 92
708	Current phase L1	0.0-9999 A		—	—		page 92
709	Current phase L2	0.0-9999 A		—	—		page 92
710	Current phase L3	0.0-9999 A		—	—		page 92
711	Line main voltage L1-L2	0-720 V		—	—		page 92
712	Line main voltage L1-L3	0-720 V		—	—		page 92
713	Line main voltage L2-L3	0-720 V		—	—		page 92
714	Phase sequence	L—, L123, L321		—	—		page 92
715	Used thermal capacity	0-150%		—	—		page 92
716	Time to next allowed start	0-60 min		—	—		page 92

Menu	Function/Parameter	Range	Parameter alt. Alarm codes	Param. set	Factory setting	Value	Page
	STATUS						
720	Softstarter status	1-12	1. Stopped, no alarm 2. Stopped, alarm 3. Run with alarm 4. Acceleration 5. Full voltage 6. Deceleration 7. Bypassed 8. PFC 9. Braking 10. Slow speed forward 11. Slow speed reverse 12. Standby (waiting for analogue start/stop or autoreset)	—	—		page 93
721	Digital input status	LLLL-HHHH		—	—		page 93
722	Analogue/digital input status	L, H		—	—		page 93
723	Analogue/digital input value	0-100% of signal range		—	—		page 93
724	Relay status	LLL-HHH		—	—		page 93
725	Analogue output value	0-100% of signal range		—	—		page 93

	STORED VALUES						
730	Operation time	0-9 999 999 h		—	—		page 94
731	Energy consumption	0.000-2000 MWh		—	—		page 94
732	Reset energy consumption	no, YES		—	no		page 94

	Alarm list						
800	Alarm list, latest error	F1-F17, h		—	—		page 94
801	Alarm list, error 14	F1-F17, h		—	—		page 94
802	Alarm list, error 13	F1-F17, h		—	—		page 94
803	Alarm list, error 12	F1-F17, h		—	—		page 94
804	Alarm list, error 11	F1-F17, h		—	—		page 94
805	Alarm list, error 10	F1-F17, h		—	—		page 94
806	Alarm list, error 9	F1-F17, h		—	—		page 94
807	Alarm list, error 8	F1-F17, h		—	—		page 94
808	Alarm list, error 7	F1-F17, h		—	—		page 94
809	Alarm list, error 6	F1-F17, h		—	—		page 94
810	Alarm list, error 5	F1-F17, h		—	—		page 94
811	Alarm list, error 4	F1-F17, h		—	—		page 94
812	Alarm list, error 3	F1-F17, h		—	—		page 94
813	Alarm list, error 2	F1-F17, h		—	—		page 94
814	Alarm list, error 1	F1-F17, h		—	—		page 94

	Softstarter data						
900	Softstarter type	17-1400 A		—	17		page 95
901	Software variant text	Same as label		—	V220		page 95
902	Software version text	Same as label		—	R15		page 95

Explanation of units:

U	Input line voltage
U_n	Nominal motor voltage.
I_n	Nominal motor current.
P_n	Nominal motor power.
N_n	Nominal motor speed.
T_n	Nominal shaft torque.
I_{nsoft}	Nominal current softstarter.
P_{nsoft}	Nominal power softstarter.
N_{nsoft}	Nominal speed softstarter.

Calculation shaft torque

$$T_n = \frac{P_n}{\left(\frac{N_n}{60} x 2\pi\right)}$$

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DEDICATED DRIVE

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Emotron AB 01-4135-01r1 25-07-2007

red lion®

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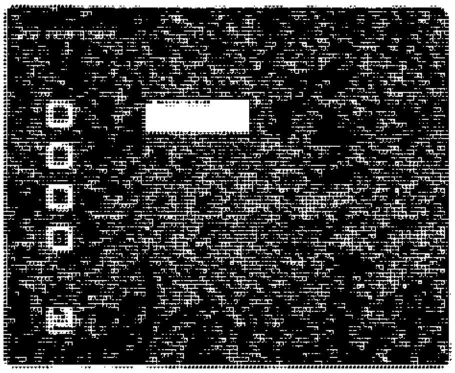
Bulletin No. G306A-B
Drawing No. LP0666
Released 4/08

MODEL G306A - GRAPHIC COLOR LCD OPERATOR INTERFACE TERMINAL WITH TFT QVGA DISPLAY AND TOUCHSCREEN



- *CONFIGURED USING CRIMSON® SOFTWARE (BUILD 424 OR NEWER)*
- *UP TO 5 RS-232/422/485 COMMUNICATIONS PORTS (2 RS-232 AND 1 RS-422/485 ON BOARD, 1 RS-232 AND 1 RS422/485 ON OPTIONAL COMMUNICATIONS CARD)*
- *10 BASE T/100 BASE-TX ETHERNET PORT TO NETWORK UNITS AND HOST WEB PAGES*
- *USB PORT TO DOWNLOAD THE UNIT'S CONFIGURATION FROM A PC OR FOR DATA TRANSFERS TO A PC*
- *UNIT'S CONFIGURATION IS STORED IN NON-VOLATILE MEMORY (8 MBYTE FLASH)*
- *COMPACTFLASH® SOCKET TO INCREASE MEMORY CAPACITY*
- *5.7-INCH TFT ACTIVE MATRIX 256 COLOR QVGA 320 X 240 PIXEL LCD*
- *5-BUTTON KEYPAD FOR ON-SCREEN MENUS*
- *THREE FRONT PANEL LED INDICATORS*
- *POWER UNIT FROM 24 VDC ±20% SUPPLY*
- *RESISTIVE ANALOG TOUCHSCREEN*

c UL us LISTED 63YN
LABORATORY EQUIPMENT

FOR USE IN HAZARDOUS LOCATIONS:
Class I, Division 2, Groups A, B, C, and D
Class II, Division 2, Groups F and G
Class III, Division 2

GENERAL DESCRIPTION

The G306A Operator Interface Terminal combines unique capabilities normally expected from high-end units with a very affordable price. It is built around a high performance core with integrated functionality. This core allows the G306A to perform many of the normal features of the Paradigm range of Operator Interfaces while improving and adding new features.

The G306A is able to communicate with many different types of hardware using high-speed RS232/422/485 communications ports and Ethernet 10 Base T/100 Base-TX communications. In addition, the G306A features USB for fast downloads of configuration files and access to trending and data logging. A CompactFlash socket is provided so that Flash cards can be used to collect your trending and data logging information as well as to store larger configuration files.

In addition to accessing and controlling of external resources, the G306A allows a user to easily view and enter information. Users can enter data through the touchscreen and/or front panel 5-button keypad.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the controller to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller.

The protective conductor terminal is bonded to conductive parts of the equipment for safety purposes and must be connected to an external protective earthing system.

WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2/CLASS II, DIVISION 2/CLASS III, DIVISION 2

CAUTION: Risk Of Danger. Read complete instructions prior to installation and operation of the unit.	CAUTION: Risk of electric shock.

CONTENTS OF PACKAGE

- G306A Operator Interface.
- Panel gasket.
- Template for panel cutout.
- Hardware packet for mounting unit into panel.
- Terminal block for connecting power.

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
G306A	Operator Interface for indoor applications, textured finish with embossed keys	G306A000
G3CF	64 MB CompactFlash Card [5]	G3CF064M
	256 MB CompactFlash Card [5]	G3CF256M
	512 MB CompactFlash Card [5]	G3CF512M
G3RS	RS232/485 Optional Communication Card	G3RS0000
G3CN	CANopen Optional Communication Card	G3CN0000
G3DN	DeviceNet option card for G3 operator interfaces lated high speed communications ports	G3DN0000
G3PBDP	Profibus DP Optional Communication Card	G3PBDP00
PSDR7	DIN Rail Power Supply	PSDR7000
SFCRM2	Crimson 2.0 [2]	SFCRM200
CBL	RS-232 Programming Cable	CBLPROG0
	USB Cable	CBLUSB00
	Communications Cables [1]	CBLxxxxx
DR	DIN Rail Mountable Adapter Products [3]	DRxxxxxx
	Replacement Battery [4]	BNL20000
G3FILM	Protective Films	G3FILM06

[1] Contact your Red Lion distributor or visit our website for complete selection.
[2] Use this part number to purchase the Crimson® software on CD with a printed manual, USB cable, and RS-232 cable. Otherwise, download for free from www.redlion.net.
[3] Red Lion offers RJ modular jack adapters. Refer to the DR literature for complete details.
[4] Battery type is lithium coin type CR2025.
[5] Industrial grade two million write cycles.

SPECIFICATIONS

1. **POWER REQUIREMENTS**:
   Must use Class 2 or SELV rated power supply.
   Power connection via removable three position terminal block.
   Supply Voltage: +24 VDC ±20%
   Typical Power[1]: 8 W
   Maximum Power[2]: 14 W
   Notes:
   1. *Typical power with +24 VDC, RS232/485 communications, Ethernet communications, CompactFlash card installed, and display at full brightness.*
   2. *Maximum power indicates the most power that can be drawn from the G306A. Refer to "Power Supply Requirements" under "Installing and Powering the G306A."*
   3. *The G306A's circuit common is not connected to the enclosure of the unit. See "Connecting to Earth Ground" in the section "Installing and Powering the G306A."*
   4. *Read "Power Supply Requirements" in the section "Installing and Powering the G306A" for additional power supply information.*
2. **BATTERY**: Lithium coin cell. Typical lifetime of 10 years.
3. **LCD DISPLAY**:

SIZE	5.7-inch
TYPE	TFT
COLORS	256
PIXELS	320 X 240
BRIGHTNESS	500 cd/m²
BACKLIGHT*	40,000 HR TYP.

*Lifetime at room temperature. Refer to "Display" in "Software/Unit Operation"

4. **5-KEY KEYPAD**: for on-screen menus.
5. **TOUCHSCREEN**: Resistive analog
6. **MEMORY**:
   On Board User Memory: 8 Mbyte of non-volatile Flash memory.
   Memory Card: CompactFlash Type II slot for Type I and Type II CompactFlash cards.
7. **COMMUNICATIONS**:
   USB Port: Adheres to USB specification 1.1. Device only using Type B connection.

> WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

   Serial Ports: Format and Baud Rates for each port are individually software programmable up to 115,200 baud.
   PGM Port: RS232 port via RJ12.
   COMMS Ports: RS422/485 port via RJ45, and RS232 port via RJ12.
   DH485 TXEN: Transmit enable; open collector, V_{OH} = 15 VDC.
   V_{OL} = 0.5 V @ 25 mA max.
   Note: For additional information on the communications or signal common and connections to earth ground please see the "Connecting to Earth Ground" in the section "Installing and Powering the G306A."
   Ethernet Port: 10 BASE-T / 100 BASE-TX
   RJ45 jack is wired as a NIC (Network Interface Card).
   Isolation from Ethernet network to G3 operator interface: 1500 Vrms
8. **ENVIRONMENTAL CONDITIONS**:
   Operating Temperature Range: 0 to 50°C
   Storage Temperature Range: -20 to 70°C
   Operating and Storage Humidity: 80% maximum relative humidity (non-condensing) from 0 to 50°C.
   Vibration according to IEC 68-2-6: Operational 5 to 8 Hz, 0.8" (p-p), 8 to 500 Hz, in X, Y, Z direction, duration: 1 hour, 3 g.
   Shock according to IEC 68-2-27: Operational 40 g, 9 msec in 3 directions.
   Altitude: Up to 2000 meters.
9. **CERTIFICATIONS AND COMPLIANCES**:
   SAFETY
   UL Recognized Component, File #E179259, UL61010-1, CSA 22.2 No.61010-1
   Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
   UL Listed, File #E211967, UL61010-1, UL1604, CSA 22.2 No. 61010.1, CSA 22.2 No. 213-M1987
   LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
   Type 4X Indoor Enclosure rating (Face only), UL50
   IECEE CB Scheme Test Certificate #US/12460/UL,
   CB Scheme Test Report #E179259-A1-CB-1
   Issued by Underwriters Laboratories Inc.
   IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
   IP66 Enclosure rating (Face only), IEC 529
   ELECTROMAGNETIC COMPATIBILITY
   Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.

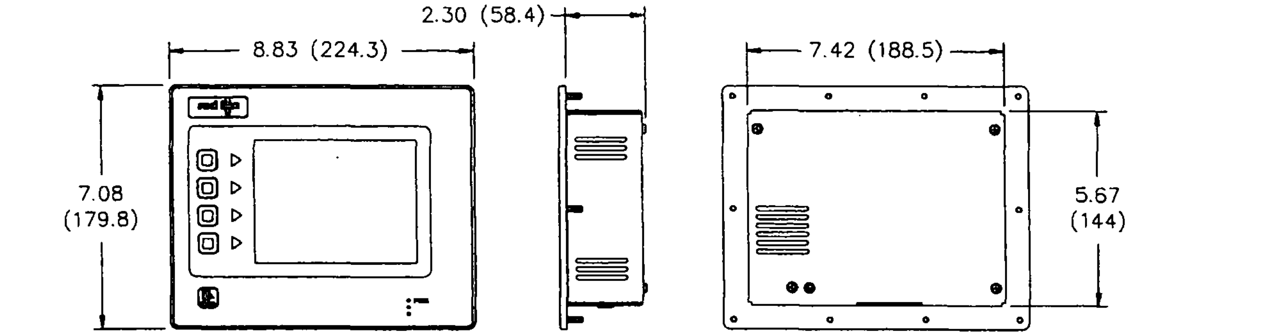
Immunity to Industrial Locations:

Electrostatic discharge	EN 61000-4-2	Criterion A 4 kV contact discharge 8 kV air discharge
Electromagnetic RF fields	EN 61000-4-3	Criterion A 10 V/m
Fast transients (burst)	EN 61000-4-4	Criterion A 2 kV power 1 kV signal
Surge	EN 61000-4-5	Criterion A 1 kV L-L, 2 kV L&N-E power
RF conducted interference	EN 61000-4-6	Criterion A 3 V/rms
Emissions:		
Emissions	EN 55011	Class A

Note:
1. *Criterion A: Normal operation within specified limits.*

10. **CONNECTIONS**: Compression cage-clamp terminal block.
    Wire Gage: 12-30 AWG copper wire
    Torque: 5-7 inch-pounds (56-79 N-cm)
11. **CONSTRUCTION**: Steel rear metal enclosure with NEMA 4X/IP66 aluminum front plate for indoor use only when correctly fitted with the gasket provided. Installation Category II, Pollution Degree 2.
12. **MOUNTING REQUIREMENTS**: Maximum panel thickness is 0.25" (6.3 mm). For NEMA 4X/IP66 sealing, a steel panel with a minimum thickness of 0.125" (3.17 mm) is recommended.
    Maximum Mounting Stud Torque: 17 inch-pounds (1.92 N-m)
13. **WEIGHT**: 3.0 lbs (1.36 Kg)

DIMENSIONS In inches (mm)

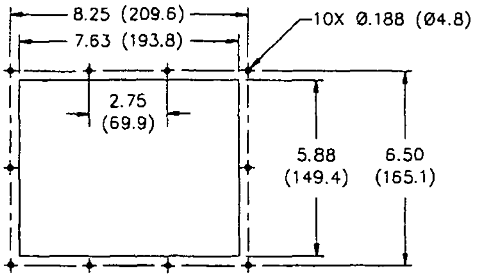


INSTALLING AND POWERING THE G306A

MOUNTING INSTRUCTIONS

This operator interface is designed for through-panel mounting. A panel cut-out diagram and a template are provided. Care should be taken to remove any loose material from the mounting cut-out to prevent that material from falling into the operator interface during installation. A gasket is provided to enable sealing to NEMA 4X/IP66 specification. Install the ten kep nuts provided and tighten evenly for uniform gasket compression.

Note: Tightening the kep nuts beyond a maximum of 17 inch-pounds (1.92 N-m) may cause damage to the front panel.



All tolerances ±0.010" (±0.25 mm).

> ALL NONINCENDIVE CIRCUITS MUST BE WIRED USING DIVISION 2 WIRING METHODS AS SPECIFIED IN ARTICLE 501-4 (b), 502-4 (b), AND 503-3 (b) OF THE NATIONAL ELECTRICAL CODE, NFPA 70 FOR INSTALLATION WITHIN THE UNITED STATES, OR AS SPECIFIED IN SECTION 19-152 OF CANADIAN ELECTRICAL CODE FOR INSTALLATION IN CANADA.

CONNECTING TO EARTH GROUND

The protective conductor terminal is bonded to conductive parts of the equipment for safety purposes and must be connected to an external protective earthing system.

Each G306A has a chassis ground terminal on the back of the unit. Your unit should be connected to earth ground (protective earth).

The chassis ground is not connected to signal common of the unit. Maintaining isolation between earth ground and signal common is not required to operate your unit. But, other equipment connected to this unit may require isolation between signal common and earth ground. *To maintain isolation between signal common and earth ground care must be taken when connections are made to the unit.* For example, a power supply with isolation between its signal common and earth ground must be used. Also, plugging in a USB cable may connect signal common and earth ground.[1]

[1] USB's shield may be connected to earth ground at the host. USB's shield in turn may also be connected to signal common.

POWER SUPPLY REQUIREMENTS

The G306A requires a 24 VDC power supply. Your unit may draw considerably less than the maximum rated power depending upon the options being used. As additional features are used your unit will draw increasing amounts of power. Items that could cause increases in current are additional communications, optional communications card, CompactFlash card, and other features programmed through Crimson.

In any case, it is very important that the power supply is mounted correctly if the unit is to operate reliably. Please take care to observe the following points:

- The power supply must be mounted close to the unit, with usually not more than 6 feet (1.8 m) of cable between the supply and the operator interface. Ideally, the shortest length possible should be used.
- The wire used to connect the operator interface's power supply should be at least 22-gage wire. If a longer cable run is used, a heavier gage wire should be used. The routing of the cable should be kept away from large contactors, inverters, and other devices which may generate significant electrical noise.
- A power supply with a Class 2 or SELV rating is to be used. A Class 2 or SELV power supply provides isolation to accessible circuits from hazardous voltage levels generated by a mains power supply due to single faults. SELV is an acronym for "safety extra-low voltage." Safety extra-low voltage circuits shall exhibit voltages safe to touch both under normal operating conditions and after a single fault, such as a breakdown of a layer of basic insulation or after the failure of a single component has occurred.

COMMUNICATING WITH THE G306A

CONFIGURING A G306A

The G306A is configured using Crimson® software. Crimson is available as a free download from Red Lion's website, or it can be purchased on CD. Updates to Crimson for new features and drivers are posted on the website as they become available. By configuring the G306A using the latest version of Crimson, you are assured that your unit has the most up to date feature set. Crimson® software can configure the G306A through the RS232 PGM port, USB port, or CompactFlash.

The USB port is connected using a standard USB cable with a Type B connector. The driver needed to use the USB port will be installed with Crimson.

The RS232 PGM port uses a programming cable made by Red Lion to connect to the DB9 COM port of your computer. If you choose to make your own cable, use the "G306A Port Pin Out Diagram" for wiring information.

The CompactFlash can be used to program a G3 by placing a configuration file and firmware on the CompactFlash card. The card is then inserted into the target G3 and powered. Refer to the Crimson literature for more information on the proper names and locations of the files.

USB, DATA TRANSFERS FROM THE COMPACTFLASH CARD

> WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

In order to transfer data from the CompactFlash card via the USB port, a driver must be installed on your computer. This driver is installed with Crimson and is located in the folder C:\Program Files\Red Lion Controls\Crimson 2.0\Device\ after Crimson is installed. This may have already been accomplished if your G306A was configured using the USB port.

Once the driver is installed, connect the G306A to your PC with a USB cable, and follow "Mounting the CompactFlash" instructions in the Crimson 2 user manual.

CABLES AND DRIVERS

Red Lion has a wide range of cables and drivers for use with many different communication types. A list of these drivers and cables along with pin outs is available from Red Lion's website. New cables and drivers are added on a regular basis. If making your own cable, refer to the "G306A Port Pin Outs" for wiring information.

ETHERNET COMMUNICATIONS

Ethernet communications can be established at either 10 BASE-T or 100 BASE-TX. The G306A unit's RJ45 jack is wired as a NIC (Network Interface Card). For example, when wiring to a hub or switch use a straight-through cable, but when connecting to another NIC use a crossover cable.

The Ethernet connector contains two LEDs. A yellow LED in the upper right and a bi-color green/amber LED in the upper left. The LEDs represent the following statuses:

LED COLOR	DESCRIPTION
YELLOW solid	Link established.
YELLOW flashing	Data being transferred.
GREEN	10 BASE-T Communications
AMBER	100 BASE-TX Communications

On the rear of each unit is a unique 12-digit MAC address and a block for marking the unit with an IP address. Refer to the Crimson manual and Red Lion's website for additional information on Ethernet communications.

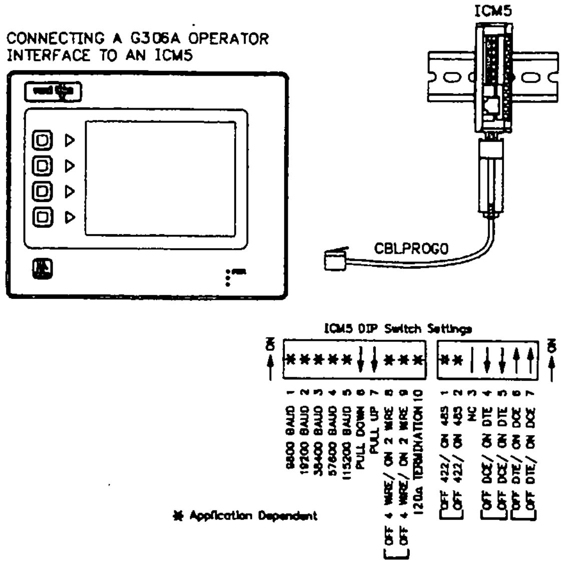
3

RS232 PORTS

The G306A has two RS232 ports. There is the PGM port and the COMMS port. Although only one of these ports can be used for programming, both ports can be used for communications with a PLC.

The RS232 ports can be used for either master or slave protocols with any G306A configuration.

Examples of RS232 communications could involve another Red Lion product or a PC. By using a cable with RJ12 ends on it, and a twist in the cable, RS232 communications with another G3 product or the Modular Controller can be established. Red Lion part numbers for cables with a twist in them are CBLPROG0 [1]. CBLRLC01 [2], or CBLRC02 [3].

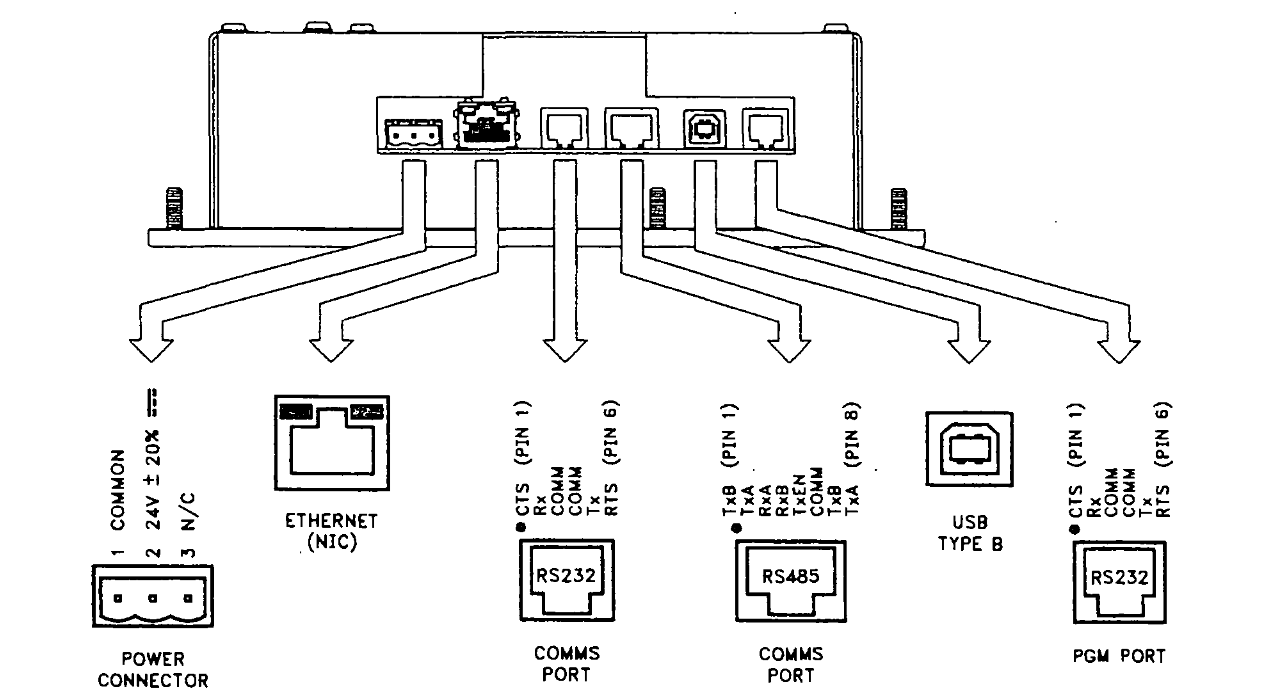


G3 RS232 to a PC

Connections			
G3: RJ12	Name	PC: DB9	Name
4	COMM	1	DCD
5	Tx	2	Rx
2	Rx	3	Tx
	N/C	4	DTR
3	COM	5	GND
	N/C	6	DSR
1	CTS	7	RTS
6	RTS	8	CTS
	N/C	9	RI

[1] CBLPROG0 can also be used to communicate with either a PC or an ICM5.
[2] DB9 adapter not included, 1 foot long.
[3] DB9 adapter not included, 10 feet long.

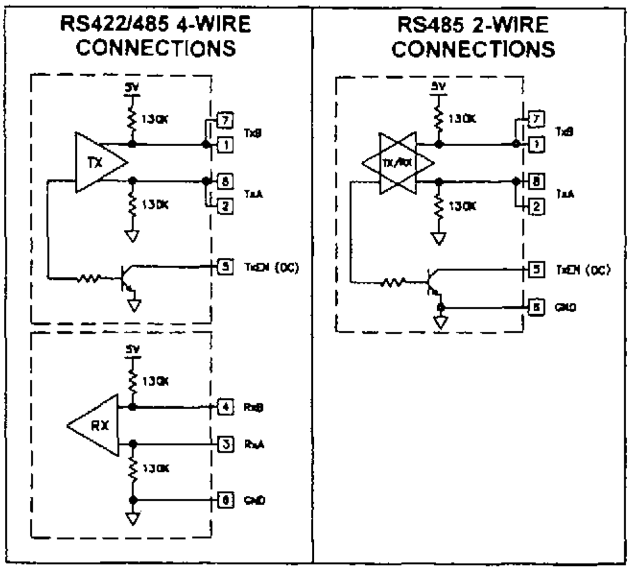
G306A PORT PIN OUTS



4

RS422/485 COMMS PORT

The G306A has one RS422/485 port. This port can be configured to act as either RS422 or RS485.



Note: All Red Lion devices connect A to A and B to B, except for Paradigm devices. Refer to www.redlion.net for additional information.

Examples of RS485 2-Wire Connections

**G3 to Red Lion RJ11 (CBLRLC00)
DLC, IAMS, ITMS, PAXCDC4C**

Connections			
G3: RJ45	Name	RLC: RJ11	Name
5	TxEN	2	TxEN
6	COM	3	COM
1	TxB	5	B-
2	TxA	4	A+

G3 to Modular Controller (CBLRLC05)

Connections			
G3	Name	Modular Controller	Name
1,4	TxB	1,4	TxB
4,1	RxB	4,1	RxB
2,3	TxA	2,3	TxA
3,2	RxA	3,2	RxA
5	TxEN	5	TxEN
6	COM	6	COM
7	TxB	7	TxB
8	TxA	8	TxA

DH485 COMMUNICATIONS

The G306A's RS422/485 COMMS port can also be used for Allen Bradley DH485 communications.

WARNING: DO NOT use a standard DH485 cable to connect this port to Allen Bradley equipment. A cable and wiring diagram are available from Red Lion.

G3 to AB SLC 500 (CBLAB003)

Connections			
RJ45: RLC	Name	RJ45: A-B	Name
1	TxB	1	A
2	TxA	2	B
3, 8	RxA	-	24V
4, 7	RxB	-	COMM
5	TxEN	5	TxEN
6	COMM	4	SHIELD
4, 7	TxB	-	COMM
3, 8	TxA	-	24V

SOFTWARE/UNIT OPERATION

CRIMSON® SOFTWARE

Crimson® software is available as a free download from Red Lion's website or it can be purchased on a CD, see "Ordering Information" for part number. The latest version of the software is always available from the website, and updating your copy is free.

DISPLAY

This operator interface uses a liquid crystal display (LCD) for displaying text and graphics. The display utilizes a cold cathode fluorescent tube (CCFL) for lighting the display. The CCFL tubes can be dimmed for low light conditions.

These CCFL tubes have a limited lifetime. Backlight lifetime is based upon the amount of time the display is turned on at full intensity. Turning the backlight off when the display is not in use can extend the lifetime of your backlight. This can be accomplished through the Crimson® software when configuring your unit.

FRONT PANEL LEDS

There are three front panel LEDs. Shown below is the default status of the LEDs.

LED	INDICATION
RED (TOP, LABELED PWR)	
FLASHING	Unit is in the boot loader, no valid configuration is loaded.[1]
STEADY	Unit is powered and running an application.
YELLOW (MIDDLE)	
OFF	No CompactFlash card is present.
STEADY	Valid CompactFlash card present.
FLASHING RAPIDLY	CompactFlash card being checked.
FLICKERING	Unit is writing to the CompactFlash, either because it is storing data, or because the PC connected via the USB port has locked the drive.[2]
FLASHING SLOWLY	Incorrectly formatted CompactFlash card present.
GREEN (BOTTOM)	
FLASHING	A tag is in an alarm state.
STEADY	Valid configuration is loaded and there are no alarms present.

[1] The operator interface is shipped without a configuration. After downloading a configuration, if the light remains in the flashing state continuously, try cycling power. If the LED still continues to flash, try downloading a configuration again.

[2] Do not turn off power to the unit while this light is flickering. The unit writes data in two minute intervals. Later Microsoft operating systems will not lock the drive unless they need to write data; Windows 98 may lock the drive any time it is mounted, thereby interfering with logging. Refer to "Mounting the CompactFlash" in the Crimson 2 User Manual.

TOUCHSCREEN

This operator interface utilizes a resistive analog touchscreen for user input. The unit will only produce an audible tone (beep) when a touch on an active touchscreen cell is sensed. The touchscreen is fully functional as soon as the operator interface is initialized, and can be operated with gloved hands.

KEYPAD

The G306A keypad consists of five keys that can be used for on-screen menus.

TROUBLESHOOTING YOUR G306A

If for any reason you have trouble operating, connecting, or simply have questions concerning your new G306A, contact Red Lion's technical support. For contact information, refer to the back page of this bulletin for phone and fax numbers.

EMAIL: techsupport@redlion.net
Web Site: http://www.redlion.net

BATTERY & TIME KEEPING

WARNING - EXPLOSION HAZARD - THE AREA MUST BE KNOWN TO BE NON-HAZARDOUS BEFORE SERVICING/ REPLACING THE UNIT AND BEFORE INSTALLING OR REMOVING I/O WIRING AND BATTERY.

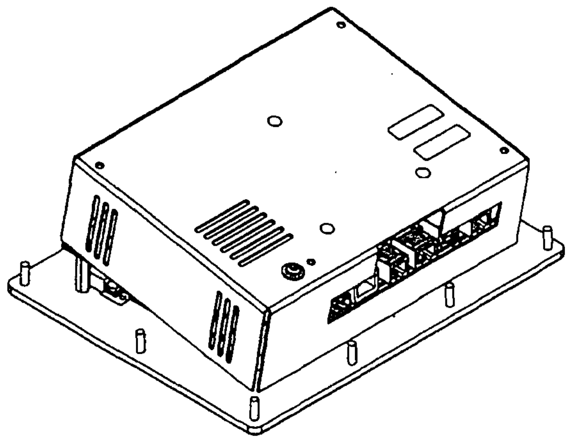
WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN DISCONNECTED AND THE AREA IS KNOWN TO BE NON-HAZARDOUS.

A battery is used to keep time when the unit is without power. Typical accuracy of the G306A time keeping is less than one minute per month drift. The battery of a G306A unit does not affect the unit's memory, all configurations and data is stored in non-volatile memory.

CAUTION: RISK OF ELECTRIC SHOCK
The inverter board, attached to the mounting plate, supplies the high voltage to operate the backlight. Touching the inverter board may result in injury to personnel.

CAUTION: The circuit board contains static sensitive components. Before handling the operator interface without the rear cover attached, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle the operator interface at a static controlled clean workstation. Also, do not touch the surface areas of the circuit board. Dirt, oil, or other contaminants may adversely affect circuit operation.

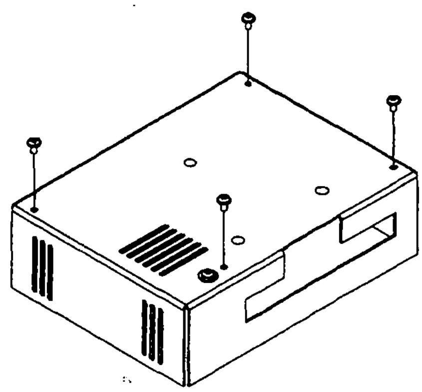
To change the battery of a G306A, remove power, cabling, and then the rear cover of the unit. To remove the cover, remove the four screws designated by the arrows on the rear of the unit. Then, by lifting the top side, hinge the cover, thus providing clearance for the connectors on the bottom side of the PCB as shown in the illustration below. Install in the reverse manner.

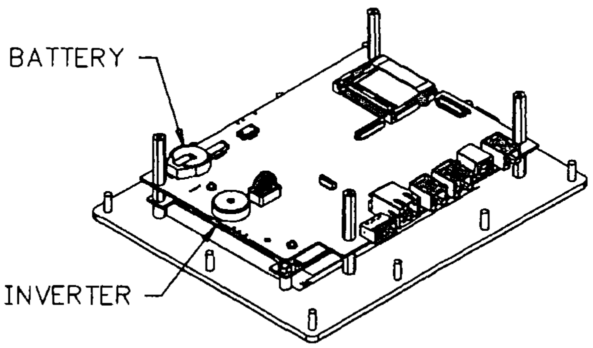


Remove the old battery* from the holder and replace with the new battery. Replace the rear cover, cables, and re-apply power. Using Crimson or the unit's keypad, enter the correct time and date.

** Please note that the old battery must be disposed of in a manner that complies with your local waste regulations. Also, the battery must not be disposed of in fire, or in a manner whereby it may be damaged and its contents come into contact with human skin.*

The battery used by the G306A is a lithium type CR2025.





7

OPTIONAL FEATURES AND ACCESSORIES

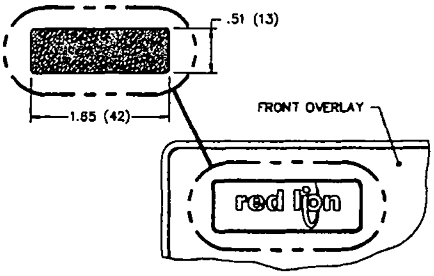
OPTIONAL COMMUNICATION CARD

Red Lion offers optional communication cards for fieldbus communications. These communication cards will allow your G306A to communicate with many of the popular fieldbus protocols.

Red Lion is also offering a communications card for additional RS232 and RS422/485 communications. Visit Red Lion's website for information and availability of these cards.

CUSTOM LOGO

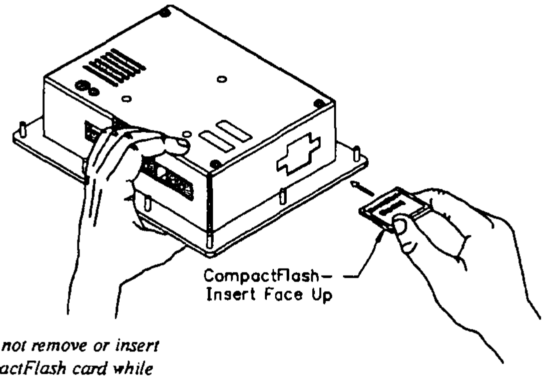
Each G3 operator interface has an embossed area containing the Red Lion logo. Red Lion can provide custom logos to apply to this area. Contact your distributor for additional information and pricing.



COMPACTFLASH SOCKET

CompactFlash socket is a Type II socket that can accept either Type I or II cards. Use cards with a minimum of 4 Mbytes and a maximum of 2 Gbytes with the G306A's CompactFlash socket. Cards are available at most computer and office supply retailers.

CompactFlash can be used for configuration transfers, larger configurations, data logging, and trending.



Note: Do not remove or insert the CompactFlash card while power is applied. Refer to "Front Panel LEDs."

Information stored on a CompactFlash card by a G306A can be read by a card reader attached to a PC. This information is stored in IBM (Windows®) PC compatible FAT16 file format.

NOTE

For reliable operation in all of our products, Red Lion recommends the use of SanDisk® and SimpleTech brands of CompactFlash cards.

Industrial grade versions that provide up to two million write/erase cycles minimum are available from Red Lion.

LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowledges the disclaimers and limitations contained herein and relies on no other warranties or affirmations.

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TRIO DATACOM

TC-900DR USER GUIDE

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GENERAL

The Trio DataCom TC-900DR is a full duplex 900 MHz Radio featuring a fully integrated 4800/9600 bps data radio modem and antenna diplexer. Configuration of the unit is fully programmable, with parameters held in non volatile memory (NVRAM). All configuration parameters are accessible using the TC-DRPROG installation package, consisting of a programming lead, manual and software which will run on a PC under Windows 95/98/NT. It is essential that each unit is programmed to suit individual requirements prior to operation. *For detailed information refer to the TC-900DR Handbook.*

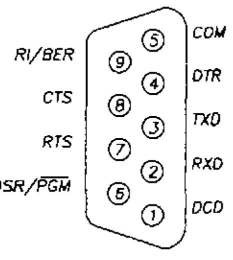
DATA CONNECTION

The data connection is via a DB9 connector labeled 'Port A' (shown below), which is wired as a DCE.

User Serial "Port A" Pin Assignment.

EXTERNAL VIEW OF '**PORT A**

NOTE: Pin 6 and pin 9 provide a dual function which depends on the mode that the TC-900DR is operating in.



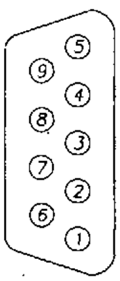
PIN NO. & FUNCTION

1. DATA CARRIER DETECT (DCD)
2. RECEIVE DATA OUTPUT (RXD)
3. TRANSMIT DATA IN (TXD)
4. DATA TERMINAL READY (DTR)
5. COMMON (COM)
6. PROGRAM PIN (PGM)
7. REQUEST TO SEND (RTS)
8. CLEAR TO SEND (CTS)
9. BIT ERROR RATE PIN (BER)

User Serial "Port B" Pin Assignment.

Port B can be used as a secondary data steam (independent of Port A) once configured by the programmer. Port B also has one connection that may be of use for installation. This connection (Pin 9) is Receive Signal Strength Indicator (RSSI) output. 0-5V where 1.5V typically indicates -110dBm and every 0.5V increase indicates an improvement of » 10dBm.

EXTERNAL VIEW OF '**PORT B**'



PIN NO. & FUNCTION

1. DATA CARRIER DETECT (DCD)
2. RECEIVE DATA O/P (RxD)
3. TRANSMIT DATA O/P (TxD)
4. UNUSED
5. COMMON
6. DATA SET RECEIVE (DSR)
7. UNUSED
8. UNUSED
9. RECEIVE SIGNAL STRENGTH

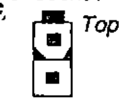
NOTE: Port B Pin 9 output has a high impedance of around 50K OHMS and loading will decrease accuracy of the RSSI measurement.

POWER CONNECTIONS

The power required is 13.8VDC nominal, at 600mA (Tx) nominal. If the POWER LED indicator is not illuminated once power is applied, check the internal 1Amp fuse fitted within the unit.

POWER CONNECTOR	PIN ASSIGNMENT
TOP PIN	***+VE SUPPLY (13.8vdc***
BOTTOM PIN	***GROUND***

Ext. view of socket

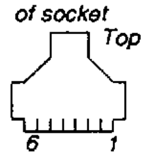


AUXILIARY CONNECTOR

The auxiliary connector is primarily for use with the optional audio handset. The connections to this auxiliary 6 pin RJ11 connector are as follows:

PIN NUMBER	FUNCTION
1	***8 VOLTS***
2	***AUDIO OUT***
3	***GROUND***
4	***MIC INPUT/SENSE***
5	***GROUND***
6	***MANUAL PTT***

External view of socket



The optional audio handset is recommended as an aid in checking installations for radio path viability. This audio handset will only function when fitted prior to applying power to the unit.

The modem upon power up will check the presence of the handset and will inhibit data being transmitted so that voice communications can be established.

Once the path tests have been conducted the audio handsets **MUST be REMOVED** and the unit powered up with the handset removed before data communication can commence.

USER INDICATIONS

The TC-900DR provides 4 LED's that show status information to the user - POWER, RXSIG, SYNC, and TXMIT indications.

The POWER is indicated by a green LED and simply signifies that power has been applied to the unit.

The RXSIG LED (yellow) indicates the level of RSSI signal from the radio IF strip, compared to a threshold level set in the configuration data programmed by the user. If the signal is above the threshold, then the LED indicator is turned on.

In all operation modes except "Programmer mode", the SYNC LED (yellow) indicates when the modem has detected a valid data stream. The SYNC LED is activated, when the modem detects a valid HDLC flag sequence, and remains active until an invalid sequence of seven or more consecutive "1" bits is detected.

The SYNC LED will not be turned on if the RSSI signal strength (as indicated by the RXSIG LED) is below the minimum threshold. This prevents false SYNC detection from noise.

The TXMIT LED (red) indicator is connected directly to the modem's PTT output transistor. Whenever the radio is transmitting, this TXMIT LED indicator will be on.

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SPECIAL MODES OF OPERATION

Part of the power-up/reset initialisation phase of the TC-900DR are tests to determine if the modem should enter one of 3 "special operation" modes. *In these modes the TC-900DR won't operate in its standard run mode.*

- Programmer mode.
- Bit error rate test mode.
- Handset mode.

These modes are only entered if the required setup conditions are present at power up. An error mode of operation can also be entered into, if during normal operation, an error condition occurs.

PROGRAMMER MODE

CABLE - Pins 2, 3, 4, 5 straight through with Pin 6 on the DB9 connector of Port A, connected to pin 5. When the modem is powered up with this fitted, the controller senses this and attempts to enter "Programmer mode" and the "SYNC" LED will flash approx. once per second. (Note, the TC-DRPROG programming software and lead has the required connections). Failure to supply the correct password in time, will cause the modem to abandon the "Programmer mode" attempt, and go on with it's normal power-up procedure.

BIT ERROR RATE TEST MODE

Pin 9 of the DB9 connector of Port A, is normally the Ring Indicate output line. However, if this pin is driven positive (connecting it to pin 6 [DSR] and pin 7 [RTS]), then the modem's data transmitter and receiver will enter the BER test mode. This will activate the RF transmitter, and generate a scrambled bit pattern which should be decoded at a receiver as a constant logic "1" level in the unscrambled data. Any errors in the decoded bitstream, will be "0", and the receiver portion of the modem in this mode, will activate the SYNC LED every time it sees a "0" bit.

Note: As the TC-900DR is full duplex this test can operate in both directions simultaneously.

Every error bit detected, will activate the SYNC LED. For error rates of 1 in 10^3 and above, the SYNC LED will be ON most of the time. A 1 in 10^4 error rate will show the SYNC LED active for approximately 10% of the time. This function provides a crude indication of Bit Error Rate for installation purposes. Note: Error count messages (ET:XXXX) for every 10,000 bits are presented to Port A for the user. If pin 9 ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts it's initialisation phase.

HANDSET MODE

The modem tests for the presence of a handset plugged into the handset auxiliary port at power up. If a handset is plugged in, the modem will not generate a data stream. However, it will continue to indicate received RF signal strength. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will not activate the TXMIT LED. It is essential to remove the handset from the unit and reapply power to the unit in order to return to normal operation.

ERROR INDICATION MODES

There are 3 error conditions that cause the RXSIG & SYNC LEDs to be used for error indications and not their normal purpose. Two are fatal conditions, that cause the modem to restart after the duration of the error indication phase.

TRANSMIT POWER LOW

While the modem activates the radio transmitter, it periodically checks the transmit power. If the power measurement is less than a threshold set in the non-volatile memory, then the RXSIG and SYNC LEDs are made to alternate, approximately 4 times per second. The TXMIT LED will also be on during this process. This indication condition will persist for the duration of the transmission. As soon as the transmission is discontinued, the error indication will cease, and the two LEDs revert to their normal function. Factory set to 100 milliWatts.

NVRAM READ ERROR

The DFM4-9DR modem accesses the non-volatile memory as part of it's initialisation phase, to read programming configuration data. If the communication protocol with the device is violated, or the non-volatile memory CRC checksum is found to be incorrect, then the modem indicates this by flashing the RXSIG and SYNC LEDs twice alternately. That is, one LED operates ON and OFF twice, then the other. A total of five cycles of this occurs, then the modem restarts initialisation.

SYNTHESISER LOCK DETECT ERROR

If at any time during normal operation, BER mode, or handset mode, the TBB206 frequency synthesiser indicates an out of lock condition, the modem enters an error indication mode for a short time before restarting.

One LED is turned ON (○), the LEDs are swapped, then both turned OFF (●). Then the latter LED ON again, swap LEDS, and then OFF. This will give the appearance of a sweeping motion between the LEDs. The following table shows all error condition displays.

Tx PWR Err		NVRAM Err		SYNTH Err	
RXSIG	SYNC	RXSIG	SYNC	RXSIG	SYNC
○	●	○	●	○	●
●	○	●	●	●	○
○	●	○	●	●	●
●	○	●	●	●	○
○	●	●	○	○	●
●	○	●	●	●	●
○	●	●	○		repeat
●	○	●	●		
continue			repeat		

MOUNTING AND ANTENNA CONNECTION

The TC-900DR should be mounted in a cool, dry, vibration free environment, whilst providing easy access to screws and connections. There are 4 mounting holes on the unit. The antenna should be an external yagi antenna but can be a ground independent dipole mounted via a feeder to the antenna connector (SMA type) for short range applications. However the whole radio modem should be clear of the associated data equipment to prevent mutual interference.

ASSEMBLY OF POWER LEAD

A small plastic bag containing a molex connector (M5557-2R) and two pins (M5556-TL) is provided in the packing box.

The pins are designed to take 18-24 (AWG) wire size with insulation range 1.3 - 3.10mm.

Please take care when crimping the pins. 09/03

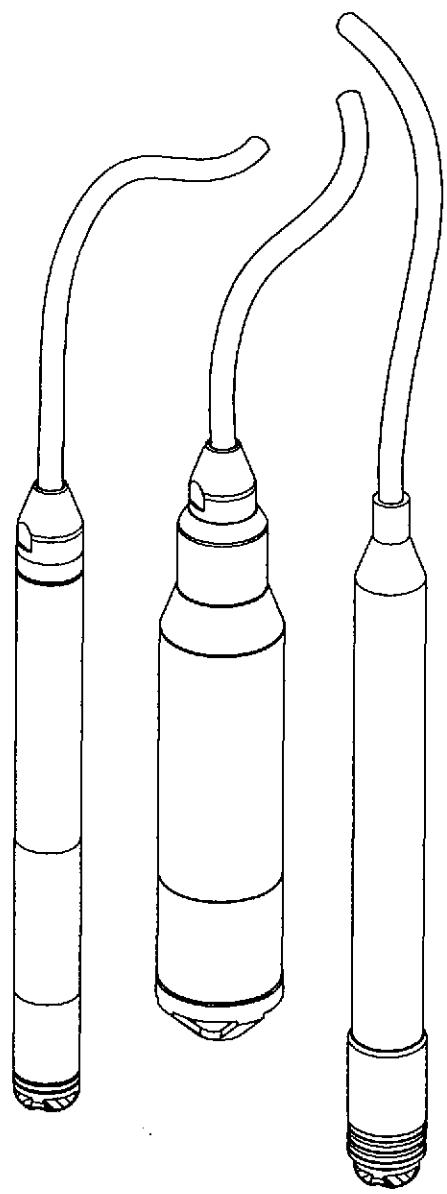
L:\Docs\Hbk- D and S Series\userguide\trio datacom 900dr user guide.fwp

Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Operating Instructions

Waterpilot FMX167

Level probe



BA231P/00/en/08.05
71003557

Endress+Hauser
People for Process Automation

Table of contents

1 Safety instructions

1.1 Designated use

The Waterpilot FMX167 is a hydrostatic pressure sensor for measuring the level of fresh water, wastewater and seawater. Versions with a Pt 100 resistance thermometer can detect temperature at the same time. The optional temperature transmitter converts the Pt 100 signal into a 4...20 mA signal.

The manufacturer shall not accept any liability for damage arising from improper use or if the device is used for purposes for which it was not intended.

1.2 Installation, commissioning and operation

The Waterpilot FMX167 and the temperature transmitter TMT181 (optional) are designed as fail-safe to the state of the art and comply with prevailing regulations and EC directives. If the devices are not used properly or for purposes for which they were not intended, they may become hazards arising from the particular application, e.g. product overflow through incorrect installation or adjustment. For these reasons, only trained personnel authorised by the plant operator may install, connect electrically, commission, operate and maintain the measuring system. Trained personnel must have read and understood these Operating Instructions and heed the instructions. Any changes and repairs to the devices may only be performed if the Operating Instructions expressly permit this.

1.3 Operational safety

1.3.1 Explosion hazardous area (optional)

Devices for use in hazardous areas are additionally identified on the nameplate (→ see Page 6). If the device is to be installed in an explosion hazardous area, then the specifications in the certificate as well as all national and local regulations must be observed. A separate Ex documentation is enclosed with the device and is an integral part of this documentation. The installation regulations, connection values and Safety Instructions listed in this document must be observed. The documentation number of the related Safety Instructions (XAs) is also indicated on the nameplate.

- Ensure that all personnel are suitably qualified.

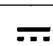
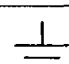
Versions in the order code (e.g. FMX167 - D ...)	Certificate	Protection
B	ATEX	ATEX II 2 G EEx ia IIC T6
C	ATEX	ATEX II 3 G EEx nA II T6
D	FM	IS, Class I, Division 1, Groups A–D
E	CSA	IS, Class I, Division 1, Groups A–D

1.4 Notes on safety conventions and icons

In order to highlight safety-relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding icon in the margin.

Symbol	Meaning
	**Warning!** A warning highlights actions or procedures which, if not performed correctly, will lead to personal injury, a safety hazard or destruction of the instrument.
	**Caution!** Caution highlights actions or procedures which, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument.
	**Note!** A note highlights actions or procedures which, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned.

	**Device certified for use in explosion hazardous area** If the device has this symbol embossed on its nameplate, it can be installed in an explosion hazardous area or a non-explosion hazardous area, according to the approval.
	**Explosion hazardous area** Symbol used in drawings to indicate explosion hazardous areas. – Devices used in hazardous areas must possess an appropriate type of protection.
	**Safe area (non-explosion hazardous area)** Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. – Devices used in hazardous areas must possess an appropriate type of protection. Lines used in hazardous areas must meet the necessary safety-related characteristic quantities.

	**Direct voltage** A terminal to which or from which a direct current or voltage may be applied or supplied.
~	**Alternating voltage** A terminal to which or from which an alternating (sine-wave) current or voltage may be applied or supplied.
	**Grounded terminal** A grounded terminal, which as far as the operator is concerned, is already grounded by means of an earth grounding system.
	**Protective grounding (earth) terminal** A terminal which must be connected to earth ground prior to making any other connection to the equipment.
	**Equipotential connection (earth bonding)** A connection made to the plant grounding system which may be of type e.g. neutral star or equipotential line according to national or company practice.

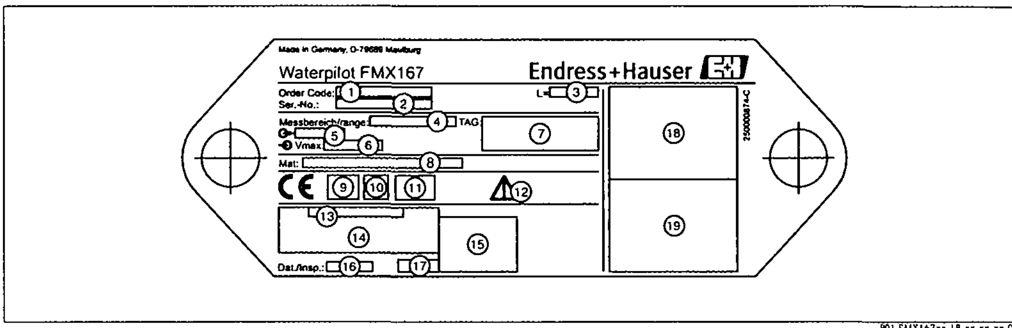
2 Identification

2.1 Device designation

- Waterpilot FMX167 for hydrostatic level measurement, refer to Section 2.1.1.
- Waterpilot FMX167 with optional Pt 100 resistance thermometer for simultaneous level and temperature measurement, refer to Section 2.1.1.
- Waterpilot FMX167 with optional Pt 100 resistance thermometer and optional temperature transmitter TMT181, refer to Sections 2.1.1 and 2.1.2.

2.1.1 Nameplate Waterpilot FMX167

The nameplate is fitted to the FMX167 extension cable.

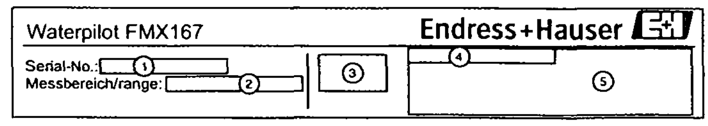


P01-FMX167xx-18-xx-xx-xx-003

Fig. 1: Nameplate for Waterpilot FMX167

1 Order code
See the specifications on the order confirmation for the meaning of the individual letters and digits.
2 Serial number
3 Length of extension cable
4 Nominal measuring range
5 Current output
6 Supply voltage
7 TAG
8 Wetted materials
9 Ex symbol (optional)
10 CSA symbol (optional)
11 FM symbol (optional)
12 Pay attention to the installation instructions in the Operating Instructions!
13 ID number of notified body with regard to ATEX (optional)
14 Text for approval (optional)
15 Approval symbol (optional)
16 Test date (optional)
17 Symbol: Observe Safety Instructions, indicating the documentation number, e.g. XA131P-C (optional)
18 Wiring diagram FMX167
19 Wiring diagram Pt 100 if Waterpilot was ordered with Pt 100.

The following information is also provided on the FMX167 with outer diameter = 22 mm (0.87 in) and 42 mm (1.66 in):

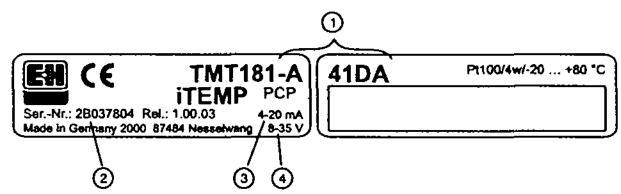


P01-FMX167xx-18-xx-xx-004

Fig. 2: FMX167 labeling

1 *Serial number*
2 *Nominal measuring range*
3 *CE symbol or approval symbol*
4 *ID number of notified body with regard to ATEX (optional)*
5 *Text for approval (optional)*

2.1.2 Nameplate of temperature transmitter TMT181



P01-FMX167xx-18-xx-xx-002

Fig. 3: Nameplate of temperature transmitter TMT181

1 *Order code of temperature transmitter TMT181-A41DA*
  A: Version for non-hazardous area
  4: 4-wire
  1: Sensor Pt 100
  D: Temperature transmitter with settings for –20...+80°C (–4...+174°F) range
  A: Label: Standard version
2 *Serial No.*
3 *Current output: 4...20 mA*
4 *Supply voltage: 8...35 V DC*

2.2 Scope of supply

The scope of delivery comprises:
- Waterpilot FMX167, optionally with integrated Pt 100 resistance thermometer
- Optional accessories (→ see also Chapter 7)

Documentation supplied:
- Operating Instructions BA231P (this document)
- Final inspection report
- Drinking water approval SD126P (optional)
- Devices which are suitable for use in hazardous areas:
  additional documentation such as Safety Instructions (XAs), Control or Installation Drawings (ZDs)

2.3 CE mark, declaration of conformity

The device is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The device complies with the applicable standards and regulations as listed in the EC declaration of conformity and thus complies with the statutory requirements of the EC Directives. Endress+Hauser confirms the successful testing of the device by affixing to it the CE mark.

3 Installation

3.1 Incoming acceptance and storage

3.1.1 Incoming acceptance

- Check the packaging and the contents for damage.
- Check the shipment, make sure nothing is missing and that the scope of supply matches your order.

3.1.2 Storage

The device must be stored in a dry, clean area and protected against damage from impact (EN 837-2).

Storage temperature range:
- FMX167: –40...+80°C (–40...+176°F)
- TMT181: –40...+100°C (–40...+212°F)

3.2 Installation conditions

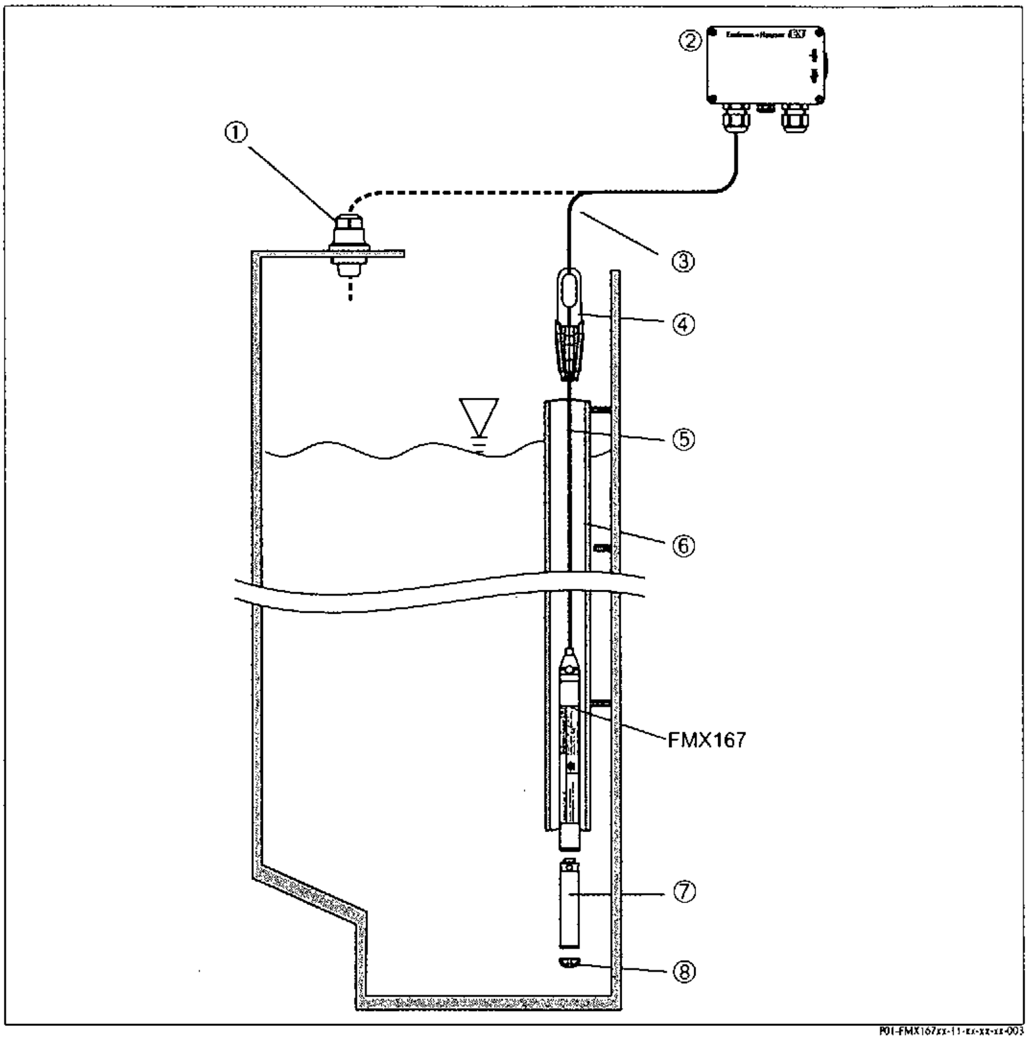


Fig. 4: Installation examples
For accessories see Page 18, Chapter 7.

1. *Extension cable mounting screw can be ordered via order code or as an accessory*
2. *Terminal housing can be ordered via order code or as an accessory*
3. *Extension cable bending radius > 120 mm (4.72 in)*
4. *Mounting clamp can be ordered via order code or as an accessory*
5. *Extension cable up to 300 m (384 ft)*
6. *Guide tube*
7. *Additional weight can be ordered as an accessory*
8. *Protection cap*

Note!
- A sideways movement of the level probe can lead to measuring errors. Therefore install the probe at a point free from flow and turbulence, or use a guide tube. The internal diameter of the guide tube should be at least 1 mm (0.04 in) bigger than the outer diameter of the selected FMX167.
- The cable must end in a dry room or in a proper terminal box. The terminal box from Endress+Hauser provides optimum humidity and climatic protection and is suitable for outdoor installation.
- Protective cap: to avoid mechanical damage to the measuring cell, the device is provided with a protective cap.
  You can order protective caps (5 pieces per set) as spare part directly from your Endress+Hauser Service Organisation using Order No.: 52008999.

3.2.1 Dimensions

→ For dimensions, please refer to the Technical Information for Waterpilot TI351P, "Mechanical construction" section (→ see also: www.endress.com → Download).

3.3 Installation instructions

3.3.1 Installing Waterpilot with a mounting clamp

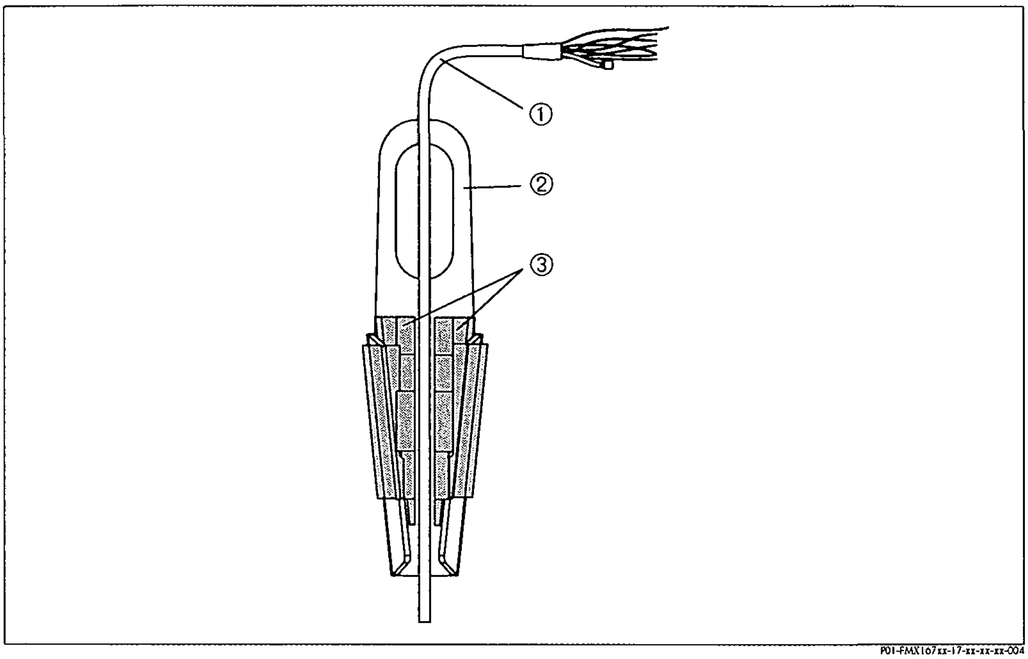


Fig. 5: Installing Waterpilot FMX167 with a mounting clamp

1 Extension cable
2 Mounting clamp
3 Clamping jaws

How to mount the mounting clamp:

1. Mount the mounting clamp (Pos. 2). When selecting the type of fixing, note the weight of the extension cable (Pos. 1) and the device.
2. Raise clamping jaws (Pos. 3). Place extension cable (Pos. 1) acc. to Figure 5 between clamping jaws.
3. Hold extension cable (Pos. 1) tight and push clamping jaws (Pos. 3) back down.
   Fix clamping jaws by tapping lightly.

3.3.2 Installing Waterpilot with cable mounting screw

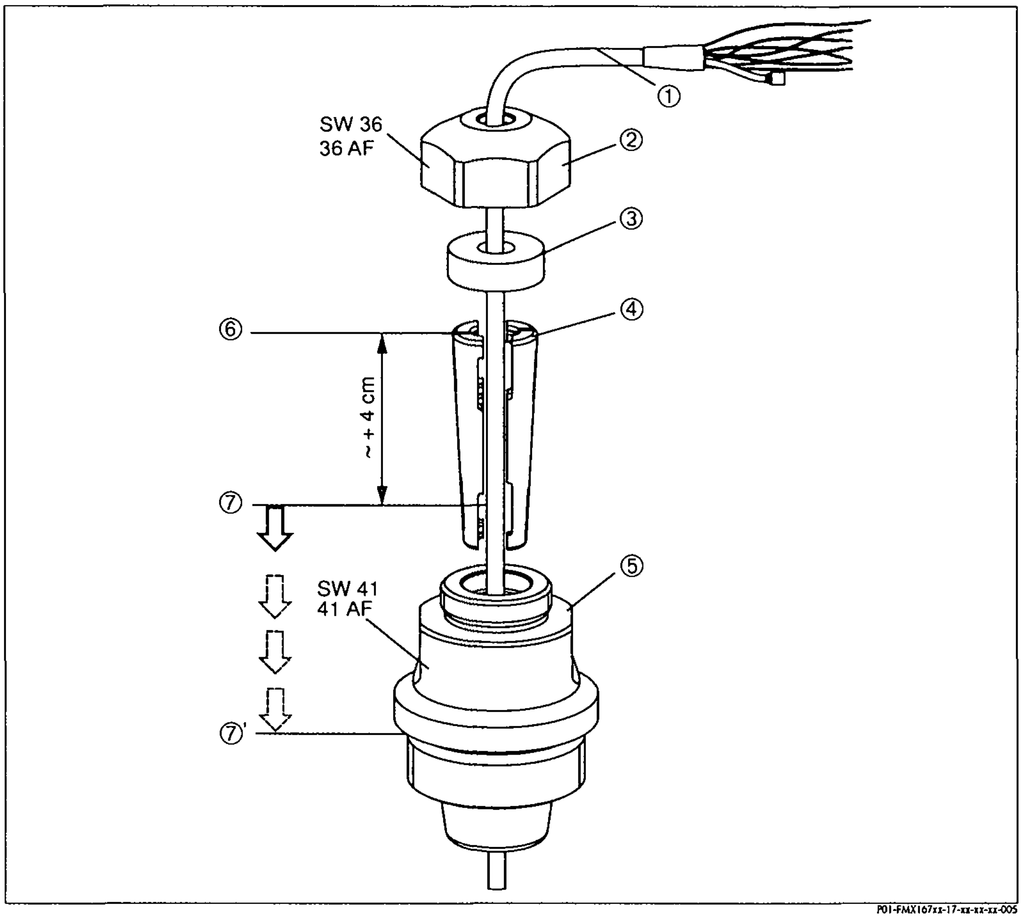


Fig. 6: Installing the Waterpilot FMX167 with cable mounting screw, here depicted with G 1 1/2 thread

1 *Extension cable*
2 *Mounting screw cap nut*
3 *Sealing ring*
4 *Clamping sleeve*
5 *Mounting screw adapter*
6 *Top edge of clamping sleeve*
7 *required length of extension cable and FMX167 probe before assembly*
7' *after assembly Pos. 7 is located next to the mounting screw with*
G 1 1/2 thread: sealing surface of mounting screw adapter
1 1/2 NPT thread run-out of mounting screw adapter

Note!
If you want to lower the level probe to a certain depth, place the top edge of the clamping sleeve 4 cm (1.57 in) higher than the required depth. Then push the extension cable and the clamping sleeve into the adapter as described in the following Section, Step 6.

How to mount the cable mounting screw with G 1 1/2 or NPT thread:

1. Mark required length of extension cable, refer to "Note" on this Page.
2. Insert probe through measuring opening and carefully lower on extension cable.
   Fix extension cable to prevent it from slipping.
3. Push adapter (Pos. 5) over extension cable and screw tightly in measuring opening.
4. Push sealing ring (Pos. 3) and cap (Pos. 2) from top onto cable. Press sealing ring into cap.
5. Place clamping sleeve (Pos. 4) around extension cable (Pos. 1) acc. to Figure 6.

6. Push extension cable and clamping sleeve (Pos. 4) into adapter (Pos. 5).
7. Push cap (Pos. 2) and sealing ring (Pos. 3) onto adapter (Pos. 5) and screw tightly to adapter.

Note!
Remove the cable mounting screw in the opposite sequence of operation to installation.

3.3.3 Mounting the terminal box

Mount the optional terminal box with four screws (M 4). → For dimensions of the terminal box, please refer to the Technical Information for Waterpilot TI351P, "Mechanical construction" section (→ see also: www.endress.com → Download).

3.3.4 Mounting the temperature transmitter TMT181

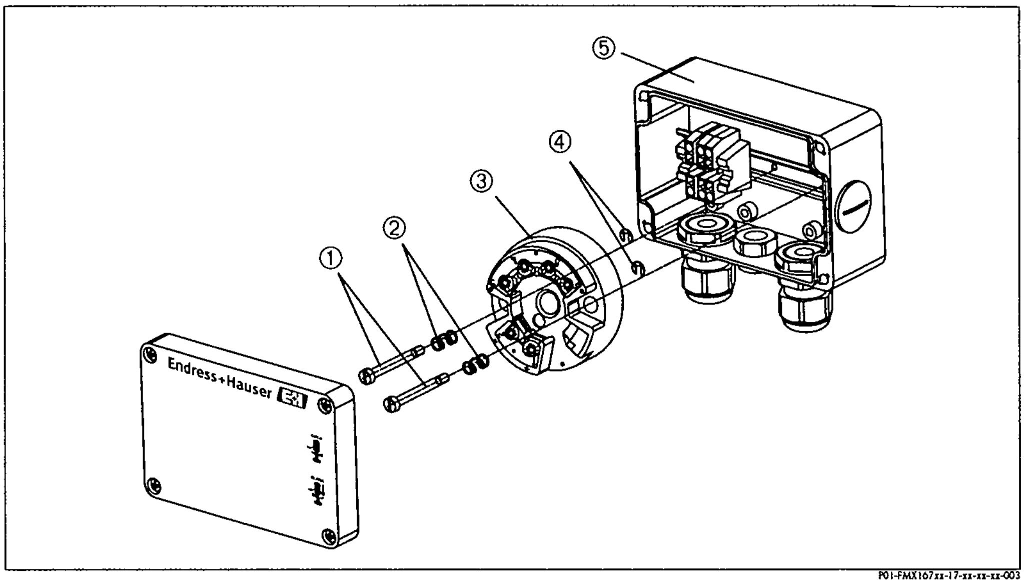


Fig. 7: Mounting the temperature transmitter, depicted here with terminal box
Only open terminal box with a screwdriver.

1 Mounting screws
2 Mounting springs
3 Temperature transmitter TMT181
4 Circlips
5 Terminal box

How to mount the temperature transmitter:

1. Insert the mounting screws (Pos. 1) with the mounting springs (Pos. 2) through the boring of the temperature transmitter (Pos. 3).
2. Fix the mounting screws with the circlips (Pos. 4).
   The circlips, mounting screws and springs are contained in the scope of supply of the temperature transmitter.
3. Screw the temperature transmitter tightly in the field housing. (thread tapper max. 6 mm (0.23 in))

Warning!
To prevent damage to the temperature transmitter, do not tighten the mounting screw too tightly.

3.4 Checking the installation

Check that all screws are seated firmly.

4 Wiring

4.1 Connecting the device

Note!
When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions (XAs) or Installation or Control Drawings (ZDs).

- The supply voltage must match the supply voltage on the nameplate. (→ See also Page 6 ff, Sections 2.1.1 and 2.1.2.)
- Switch off supply voltage before you connect the device.
- The cable must end in a dry room or in a proper terminal box. The terminal box with GORE-TEX® filter, IP 66/IP 67 from Endress+Hauser is suitable for outdoor installation.
- Connect device acc. to the following figures. A polarity protection is integrated in the Waterpilot FMX167 and the temperature transmitter TMT181. Changing the polarities will not destroy the devices.

Waterpilot FMX167, Standard

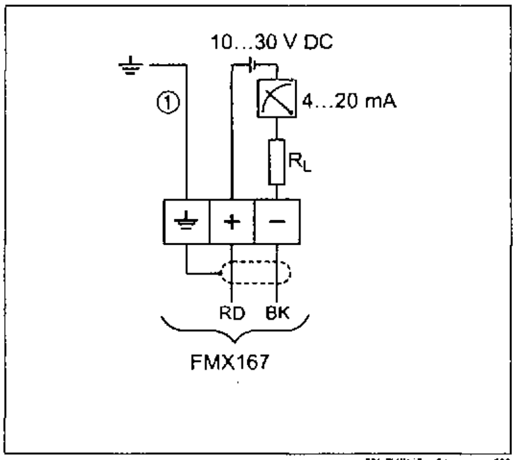


Fig. 8: FMX167 electrical connection, versions "7" or "3" for Feature 70 "Additional options" in the order code.

1 Not for FMX167 with outer diameter = 29 mm (1.15 in)

Waterpilot FMX167 with Pt 100

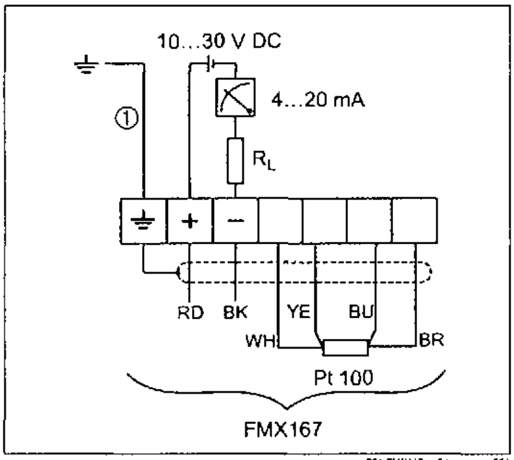


Fig. 9: FMX167 electrical connection with Pt 100, versions "1" or "4" for Feature 70 "Additional options" in the order code.

1 Not for FMX167 with outer diameter = 29 mm (1.15 in)

Wire colors: RD = red, BK = black, WH = white, YE = yellow, BU = blue, BR = brown

Waterpilot FMX167 with Pt 100 and temperature transmitter TMT181 (4...20 mA)

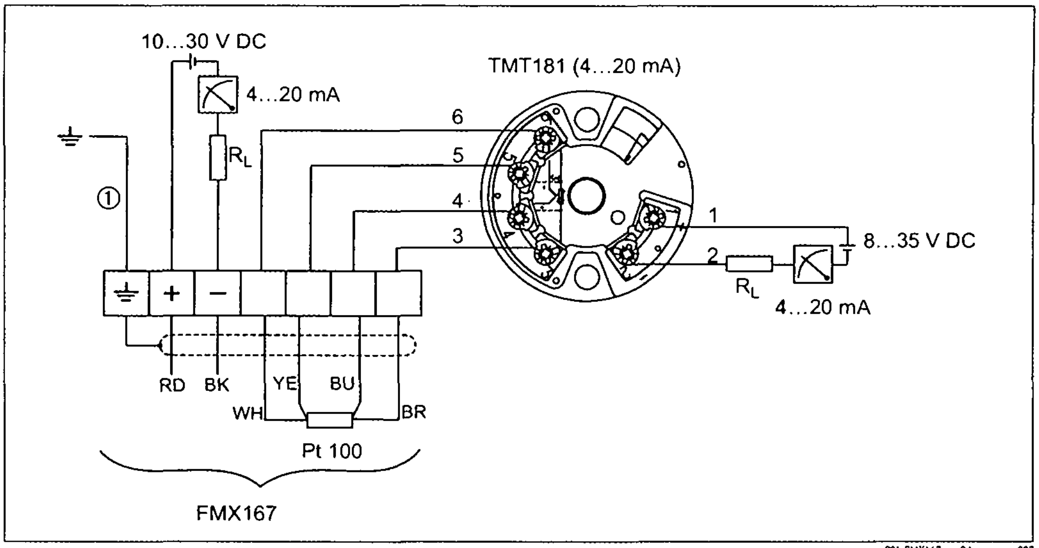


Fig. 10: FMX167 with Pt 100 and TMT181 temperature transmitter (4...20 mA), version "5" for Feature 70 in the order code

1 Not for FMX167 with outer diameter = 29 mm (1.15 in)

Wire colours: RD = red, BK = black, WH = white, YE = yellow, BU = blue, BR = brown

4.1.1 Supply voltage

Certificate	Supply voltage		
	FMX167	**FMX167 + Pt 100**	**Temperature transmitter TMT181**
Standard	10...30 V DC	10...30 V DC	8...35 V DC

4.1.2 Cable specification

- FMX167 with optional Pt 100
  - Commercially available installation cable
  - Terminals in terminal box FMX 167: 0.08...2.5 mm^2
- Temperature transmitter TMT181 (optional)
  - Commercially available installation cable
  - Terminals in terminal box FMX 167: 0.08...2.5 mm^2
  - Transmitter terminals: max. 1.75 mm^2

Note!
For versions with outer diameter = 22 mm (0.87 in) and 42 mm (1.66 in) the extension cables are shielded. In the following cases Endress+Hauser recommends use of a shielded cable for the cable extension:
- for large distances between extension cable end and display and/or evaluation unit,
- for large distances between extension cable end and temperature transmitter
- for directly connecting Pt 100 signals to the display and/or evaluation unit.

4.1.3 Power consumption/current drain

	FMX167	FMX167 + Pt 100	Temperature transmitter TMT181
Power consumption	≤ 0.675 W at 30 V DC	≤ 0.675 W at 30 V DC	≤ 0.875 W at 35 V DC
Current drain	max. ≤ 22.5 mA min. ≥ 3.5 mA	max. ≤ 22.5 mA min. ≥ 3.5 mA Pt 100: ≤ 0.6 mA	max. ≤ 25 mA min. ≥ 3.5 mA

4.1.4 Load

The maximum load resistance is dependent on the supply voltage (U_b) and must be determined for every current loop separately. Refer to the equations and diagrams for "FMX 167" and "Temperature transmitter".
The total resistance resulting from the resistances of the connected devices, the connecting cable and if necessary, the resistor of the extension cable may not exceed the load resistance.

FMX167

$$R_{tot} \leq \frac{U_b - 10\ V}{0.0225\ A} - 2 \cdot 0.09 \frac{\Omega}{m} \cdot l - R_{add}$$

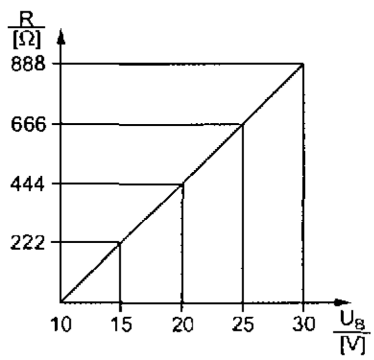
P01-FMX167xx-16-xx-xx-xx-000

Temperature transmitter

$$R_{tot} \leq \frac{U_b - 8\ V}{0.025\ A} - R_{add}$$

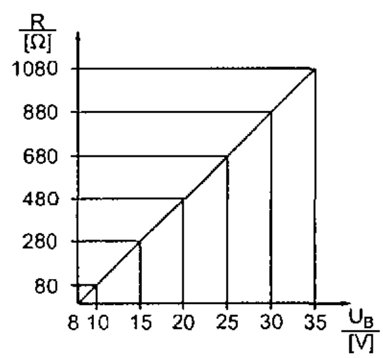
P01-FMX167xx-16-xx-xx-xx-001

R_{tot} = Max. load resistance [Ω]
R_{add} = additional resistances, e.g. resistance of evaluating device and/or the display instrument, line resistance [Ω]
U_b = Supply voltage [V]
l = Simple length of extension cable [m] (cable resistance per wire ≤ 0,09 Ω/m)



P01-FMX167xx-05-xx-xx-xx-001

Fig. 11: Load chart FMX167 for estimating load resistance. Subtract the additional resistances, e.g. resistance of extension cable, from the calculated value as shown in the equation.



P01-FMX167xx-05-xx-xx-xx-003

Fig. 12: Load chart temperature transmitter for estimating load resistance. Subtract the additional resistances from the calculated value as shown in the equation.

4.2 Wiring up the measuring unit

4.2.1 Overvoltage protection

Note!
- In order to protect the Waterpilot FMX167 and the temperature transmitter TMT181 from large transients, Endress+Hauser recommends the installation of an overvoltage protector upstream and downstream of the display and/or evaluation device as shown in the figure.
- The Waterpilot FMX 167 has an integrated overvoltage protection to EN 61000 of ≤ 1.2 kV as standard.

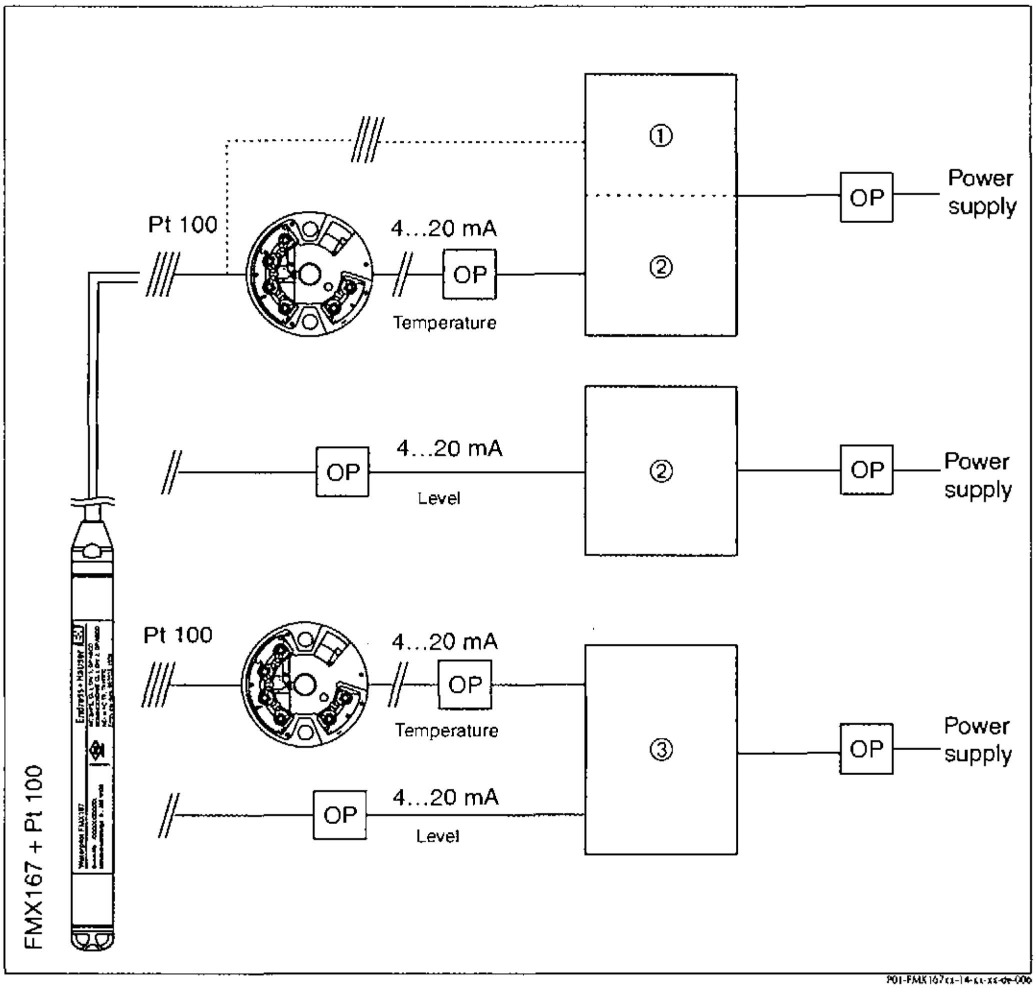


Fig. 13: Wiring up the measuring unit

1 Power supply, display and evaluation unit with one input for Pt 100
2 Power supply, display and evaluation unit with one input for 4...20 mA
3 Power supply, display and evaluation unit with two inputs for 4...20 mA
OP Overvoltage protection e.g. HAW from Endress+Hauser

4.3 Checking the wiring

Perform the following checks after completing electrical installation of the device:
- Does the supply voltage match the specifications on the nameplate?
- Is the device connected as per Section 4.1?
- Are all screws firmly tightened?
- Optional terminal box: are the cable glands tight?

5 Operation

Note!
Endress+Hauser offers extensive measuring point solutions with display and/or evaluation units for the Waterpilot FMX167 and the temperature transmitter TMT181. For more information, please contact your nearest Endress+Hauser Service Organisation. For contact addresses, please go to www.endress.com/worldwide.

6 Maintenance

No special maintenance work is required for the Waterpilot FMX167 or for the optional temperature transmitter TMT181.

6.1 Exterior cleaning

Please note the following points when cleaning the exterior of the device:
- Do not use a cleaning agent that is aggressive to the housing surface or the seal.
- Waterpilot FMX167: avoid any mechanical damage to the membrane or the extension cable.

7 Accessories

There are a number of accessories available for the Waterpilot FMX167. You can order them separately from Endress+Hauser.

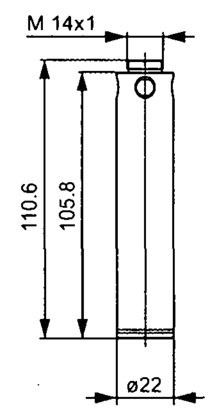
Mounting clamp

- Endress+Hauser offers a mounting clamp for simple FMX167 mounting. → See also Page 10, Section 3.3.1.
- Material: 1.4435 (AISI 316L) and glass fiber reinforced PA (polyamide)
- Order number: 52006151

Terminal box

- Terminal box IP 66/IP 67 with GORE-TEX® filter incl. 3 mounted terminals.
  The terminal box is also suitable for installing a temperature transmitter (Order No. 52008794) or for four additional terminals (Order No. 52008938). → See also Page 12, Section 3.3.4.
- Order number: 52006152

Additional weight for FMX167 with d_O=22 mm (0.87 in) and d_O=29 mm (1.15 in)



P01-FMX167xxx-00-xx-xx-xx-014

- To prevent sideways movement leading to measuring errors or to ensure that the device lowers into a guide tube, Endress+Hauser provides additional weights.
  You can screw several weights together. The weights are then attached directly to the FMX167. For FMX167 with outer diameter = 29 mm (1.15 in), a maximum of 5 weights may be screwed on to FMX167.
- Material: 1.4435 (AISI 316L)
- Weight: 300 g
- Order number: 52006153

Temperature transmitter TMT181 (4...20 mA)

- Temperature transmitter, 2-wire, preset for measuring range from –20...+80°C (–4...+176°F). This setting offers an easily displayable temperature range of 100 K. Note that the Pt 100 resistance thermometer is designed for a temperature range of –10...+70°C (+14...+158°F). → See also Page 12, Section 3.3.4.
- Order number: 52008794

Cabel mounting screw

- Endress+Hauser offers extension cable mounting screws to simplify the installation of the FMX167 and to close the measuring open. → See also Page 11, Section 3.3.2.
- Material: 1.4301 (AISI 304)
- Order number for extension cable mounting screw with G 1 1/2 A thread: 52008264
- Order number for extension cable mounting screw with 1 1/2 NPT thread: 52009311

Terminals

- Four terminals in strip for FMX167 terminal box, suitable for wire cross-section of 0.08...2.5 mm^2
- Order number: 52008939

Test adapter for FMX167 with d_O=22 mm (0.87 in) and d_O=29 mm (1.15 in)

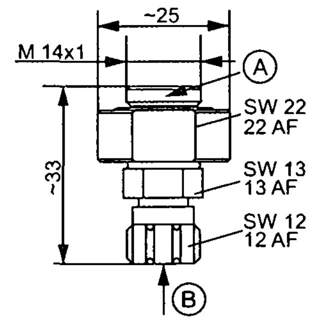


Abb. 14: Test adapter

A Connection suitable for level probe FMX167
B Connection compressed air hose, internal diameter, quick hose gland 4 mm (0.157 in)

- Endress+Hauser offers a test adapter to simplify the function test of level probes.
- Note the maximum pressure for the compressed air hose and the maximum level probe overload. (→ For the maximum level probe overload refer to Technical Information for Waterpilot TI351P or Internet: www.endress.com → Download)
- The maximum pressure for the supplied quick hose gland is 10 bar (145 psi).
- Adapter material: 1.4301 (AISI 304)
- Quick hose gland material: Anodized aluminum
- Adapter weight: 39 g
- Order number: 52011868

8 Trouble-shooting

8.1 Faults on Waterpilot FMX167 and Waterpilot FMX167 with optional Pt 100

Error description	Cause	Action
No measuring signal	Connection of 4...20 mA line incorrect	Connect device acc. to Section 4.1, Page 13.
	No supply voltage over 4...20 mA line	Check current loop.
	Supply voltage too low (min. 10 V DC)	– Check supply voltage. – Total resistance grater than max. load resistance, refer to Section 4.1, Page 15.
	Waterpilot defective	Replace Waterpilot.
Temperature measuring value inaccurate/incorrect (only with Waterpilot FMX167 with Pt 100)	Pt 100 connected to 2-wire circuit, line resistance not compensated	– Compensate line resistance. – Connect Pt 100 as 3-wire or 4-wire circuit.

8.2 Faults of temperature transmitter TMT181

Error description	Cause	Action
No measuring signal	Connection of 4...20 mA line incorrect	Connect device acc. to Section 4.1, Page 13.
	No supply voltage over 4...20 mA line	Check current loop.
	Supply voltage too low (min. 8 V DC)	– Check supply voltage. – Total resistance grater than max. load resistance, refer to Section 4.1, Page 13.
Error current ≤ 3,6 mA or ≥ 21 mA	Connection of Pt 100 incorrect	Connect device acc. to Section 4.1, Page 13.
	Connection of 4...20 mA line incorrect	Connect device acc. to Section 4.1, Page 13.
	Pt 100 resistance thermometer defective	Replace Waterpilot FMX167.
	Temperature transmitter defective	Replace temperature transmitter.
Measuring value inaccurate/incorrect	Pt 100 connected in 2-wire circuit, line resistance not compensated	– Compensate line resistance. – Connect Pt 100 as 3-wire or 4-wire circuit.

8.3 Spare Parts

Note!
You can order spare parts directly from your nearest Endress+Hauser Service Organisation.

Membrane protective cap
- 5 pieces in set
- Order No.: 52008999

Pressure compensation set
- 10 pieces in set, comprising Teflon filter and sleeve for extension cable
- Order No.: 52005578

9 Technical Data

For technical data, please refer to the Technical Information for Waterpilot TI351P (→ see also: www.endress.com → Download).

Index

Declaration of Contamination
Erklärung zur Kontamination

Endress+Hauser
People for Process Automation

Because of legal regulations and for the safety of our employees and operating equipment, we need the "declaration of contamination", with your signature, before your order can be handled. Please make absolutely sure to include it with the shipping documents, or - even better - attach it to the outside of the packaging.
Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination", bevor Ihr Auftrag bearbeitet werden kann. Legen Sie diese unbedingt den Versandpapieren bei oder bringen Sie sie idealerweise außen an der Verpackung an.

Type of instrument / sensor
Geräte-/Sensortyp ______________________

Serial number
Seriennummer ______________

Process data/ *Prozessdaten*

Temperature / *Temperatur* ________ [°C] Pressure / *Druck* ________ [Pa]

Conductivity / *Leitfähigkeit* ________ [S] Viscosity / *Viskosität* ________ [mm^2/s]

Medium and warnings
Warnhinweise zum Medium

	Medium /concentration *Medium /Konzentration*	Identification CAS No.	flammable *entzündlich*	toxic *giftig*	corrosive *ätzend*	harmful/ irritant *gesundheitsschädlich/ reizend*	other * *sonstiges**	harmless *unbedenklich*
Process medium *Medium im Prozess*								
Medium for process cleaning *Medium zur Prozessreinigung*								
Returned part cleaned with *Medium zur Endreinigung*								

* explosive; oxidising; dangerous for the environment; biological risk; radioactive
* *explosiv; brandfördernd; umweltgefährlich; biogefährlich; radioaktiv*

Please tick should one of the above be applicable, include security sheet and, if necessary, special handling instructions.
Zutreffendes ankreuzen; trifft einer der Warnhinweise zu, Sicherheitsdatenblatt und ggf. spezielle Handhabungsvorschriften beilegen.

Reason for return / *Grund zur Rücksendung* ______________________________

____

____

Company data / *Angaben zum Absender*

Company / *Firma* ______________________

____

Address / *Adresse*

____

____

Contact person / *Ansprechpartner* ______________

Department / *Abteilung* ______________

Phone number/ *Telefon* ______________

Fax / E-Mail ______________

Your order No. / *Ihre Auftragsnr.* ______________

We hereby certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free from any residues in dangerous quantities.
Hiermit bestätigen wir, dass die zurückgesandten Teile sorgfältig gereinigt wurden, und nach unserem Wissen frei von Rückständen in gefahrbringender Menge sind.

____
(place, date / *Ort, Datum*)

____
(Company stamp and legally binding signature)
(Firmenstempel und rechtsverbindliche Unterschrift)

P/SF/Konta VIII

www.endress.com/worldwide

Endress+Hauser

People for Process Automation

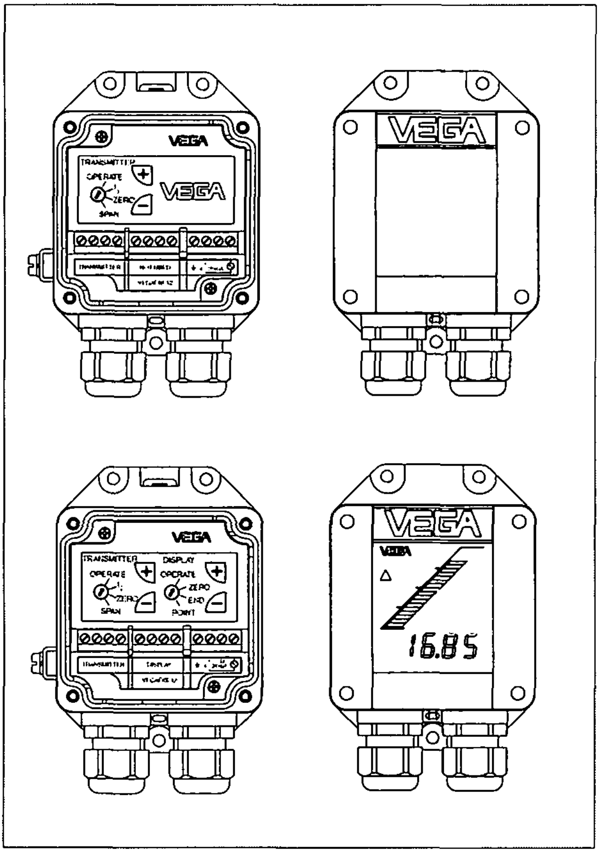
BA231P/00/en/08.05
71003557
CCS/FM+SGML6.0

71003557

OrderNo: 1245303_3

Operating Instructions

VEGADIS 12



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Safety information

Please read this manual carefully, and also take note of country-specific installation standards (e.g. the VDE regulations in Germany) as well as all prevailing safety regulations and accident prevention rules.

For safety and warranty reasons, any internal work on the instruments, apart from that involved in normal installation and electrical connection, must be carried out by qualified VEGA personnel.

Note Ex area

Please note the approval documents (yellow binder), and especially the included safety data sheet.

Contents

1 Product description

1.1 Function and configuration

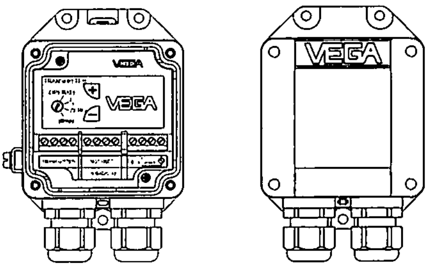
VEGADIS 12 is an external connection housing with integrated adjustment elements. It is connected via the VEGA special cable with breather capillaries or a three-wire standard cable to the hydrostatic pressure transmitter VEGAWELL 72 - 4 ... 20 mA/HART®, VEGABAR 74 or VEGABAR 75. VEGADIS 12 is connected to the supply and signal circuit of the pressure transmitter and does not require a separate external energy source.

VEGADIS 12 has the following functions:
- adjustment of zero, span and ti
- atmospheric pressure compensation for the pressure transmitter
- measured value display (optional).

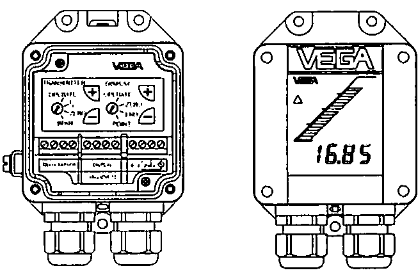
As a standard feature, VEGADIS 12 is equipped with an adjustment module for the pressure transmitter. The optional display is located in the housing cover and is equipped with a bar graph and a digital display indication. In this version, additional adjustment elements for indication scaling are integrated.

1.2 Types and versions

VEGADIS 12 without display



VEGADIS 12 with display



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1.3 Technical data

Standard data

Materials and weight

Housing	high-resistance plastic PBT (Polyester)
Ground terminal	stainless steel 1.4305
Display window	Lexan
Breather facility	PTFE filter element [1]
Weight	approx. 0.5 kg

Adjustment and indicating elements

Adjustment elements	2 keys, 1 rotary switch
Adjustment elements with display	2 x 2 keys, 2 x 1 rotary switch
Display (option)	LC multifunctional display with - bar graph (20 segments) - digital value (4 digits) - tendency indicator for rising or falling values

Connection

Cable entry	M20 x 1.5 (for cable ø 5 … 9 mm)
Screw terminals	for wire cross-section up to 2.5 mm²

Adjustment circuit

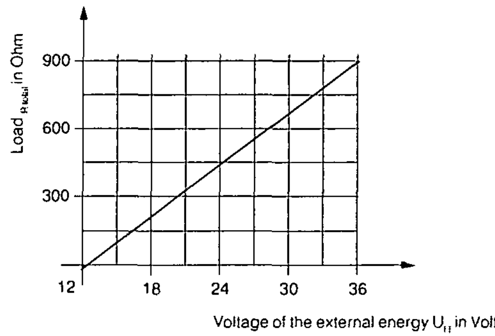
Connection to	VEGAWELL 72 - 4 … 20 mA/HART®, VEGABAR 74 or VEGABAR 75
connection cable	VEGA special cable with breather capillaries or 3-wire standard cable
Cable length	max. 200 m

[1] air permeable and humidity blocking

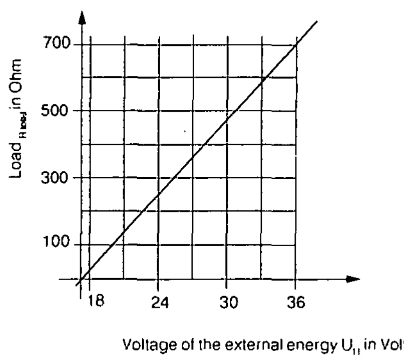
Supply and signal circuit (analogue transmission, 4 ... 20 mA)

Supply voltage via pressure transmitter in conjunction with VEGADIS 12	
- without display	12 ... 36 V DC
- with display	17 ... 36 V DC
Max. input current	150 mA
Range of the current signal	3.5 ... 22 mA
Max. permissible load	depending on the supply voltage (see load diagrams)

Load diagram without display



Load diagram with display



Protective measures

Housing	IP 65 [1]
Protection class	III
Overvoltage category	III

Ambient conditions

Ambient temperature	
- VEGADIS 12	-40°C ... +85°C
- VEGADIS 12 with display	-20°C ... +70°C
Storage and transport temperature	-40°C ... +85°C

[1] Maintaining the housing protection IP 65 requires the use of a seal in the cable entry fitting to the cable. If the supplied seal does not fit, the customer has to provide a suitable one.

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1.4 Approvals

If a pressure transmitter or the external housing is used in hazardous areas, approved versions should be used.

The respective official documents (test reports, test certificates and conformity certificates) must be noted for these applications. These are supplied with the respective instrument.

General approvals

VEGADIS 12	CENELEC EEx ia IIC

CE conformity CE

The external housings VEGADIS 12 or VEGADIS 12 Ex meet the protective regulations of EMC (89/336/EWG) and NSR (73/23/EWG). The conformity has been judged acc. to the following standards:

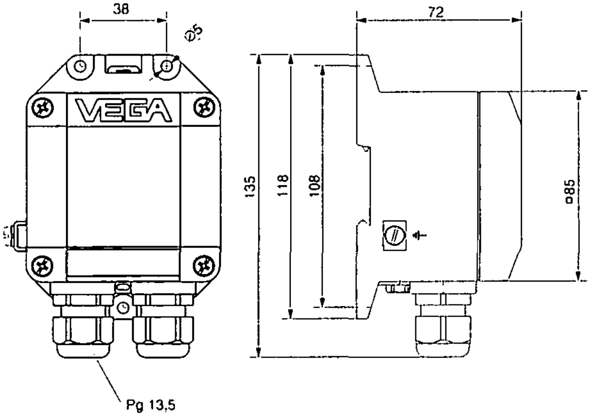
EMC	Emission	EN 50 081
	Susceptibility	EN 50 082
NSR		EN 61 010

NAMUR regulations

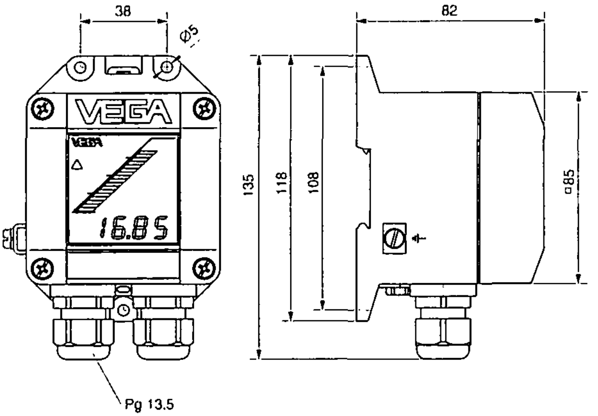
Full compliance with NAMUR regulations NE21, May 1993.

1.5 Dimensions

without display



with display



2 Mounting

VEGADIS 12 can be mounted in the following ways:
- on carrier rail 35 x 7.5 acc. to EN 50 022
- on mounting sheet or to the wall.

In case of vertical wall mounting, the cable entry must point downwards to avoid moisture ingress.

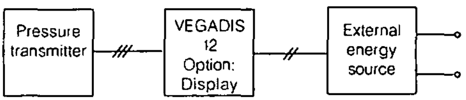
If VEGADIS 12 is additionally used for atmospheric pressure compensation for the pressure transmitter, the following must be noted:
- there must be the same atmospheric pressure on the breather facility as on the vessel
- the breather facility must not be clogged or dirty.

3 Electrical connection

3.1 Connection instructions

VEGADIS 12 is connected to the supply and signal circuit of the pressure transmitter and does not require a separate external energy source.

Block diagram



The electronics in the pressure transmitter is designed in two-wire technology and requires a supply voltage of 12 ... 36 V DC, with display 17 ... 36 V DC. Supply voltage and current signal are led via the same two-wire connection cable to the connection terminals. The third cable between pressure transmitter and VEGADIS 12 is used for transmission of the adjustment data.

The external energy is provided via a separate power supply unit:
- power supply unit, e.g. VEGASTAB 690
- processing unit with integrated DC current source (e.g. active DCS input)

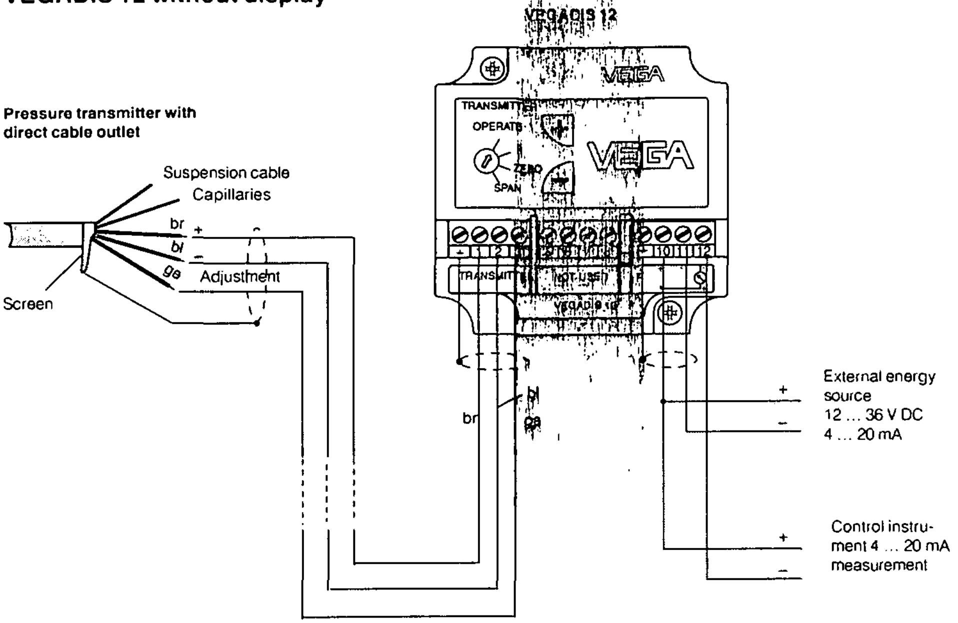
Make sure that the external energy source is reliably separated from the mains circuits acc. to DIN VDE 0106, part 101. The above mentioned VEGA instruments meet this requirement and protection class III is therefore ensured.

The external energy source must deliver a terminal voltage of at least 12 V or 17 V to the transmitter. The actual terminal voltage on the transmitter depends on the following factors:
- output voltage U_H of the external energy source under nominal load.
- load resistances of the instruments in the current circuit.

For electrical connection in general, the following points should be given attention:
- The connection must be made according to the national installation standards (e.g. in Germany acc. to the VDE regulations).
- To avoid damage of the electronics, the terminal voltage must not exceed 36 V.
- The connection elements have built-in protection against polarity reversal.
- The wiring between pressure transmitter and VEGADIS 12 or between VEGADIS 12 and the power supply can be made with standard three or two-wire cable.
- If strong electromagnetic interferences are expected, screened cable is recommended. The screening must be made on both ends. For use in Ex areas, the installation regulations must be noted.
- If overvoltages are expected, we recommend the installation of VEGA overvoltage arresters.
- A seal fitting the cable must be used in the cable entry.

3.2 Wiring plan

VEGADIS 12 without display



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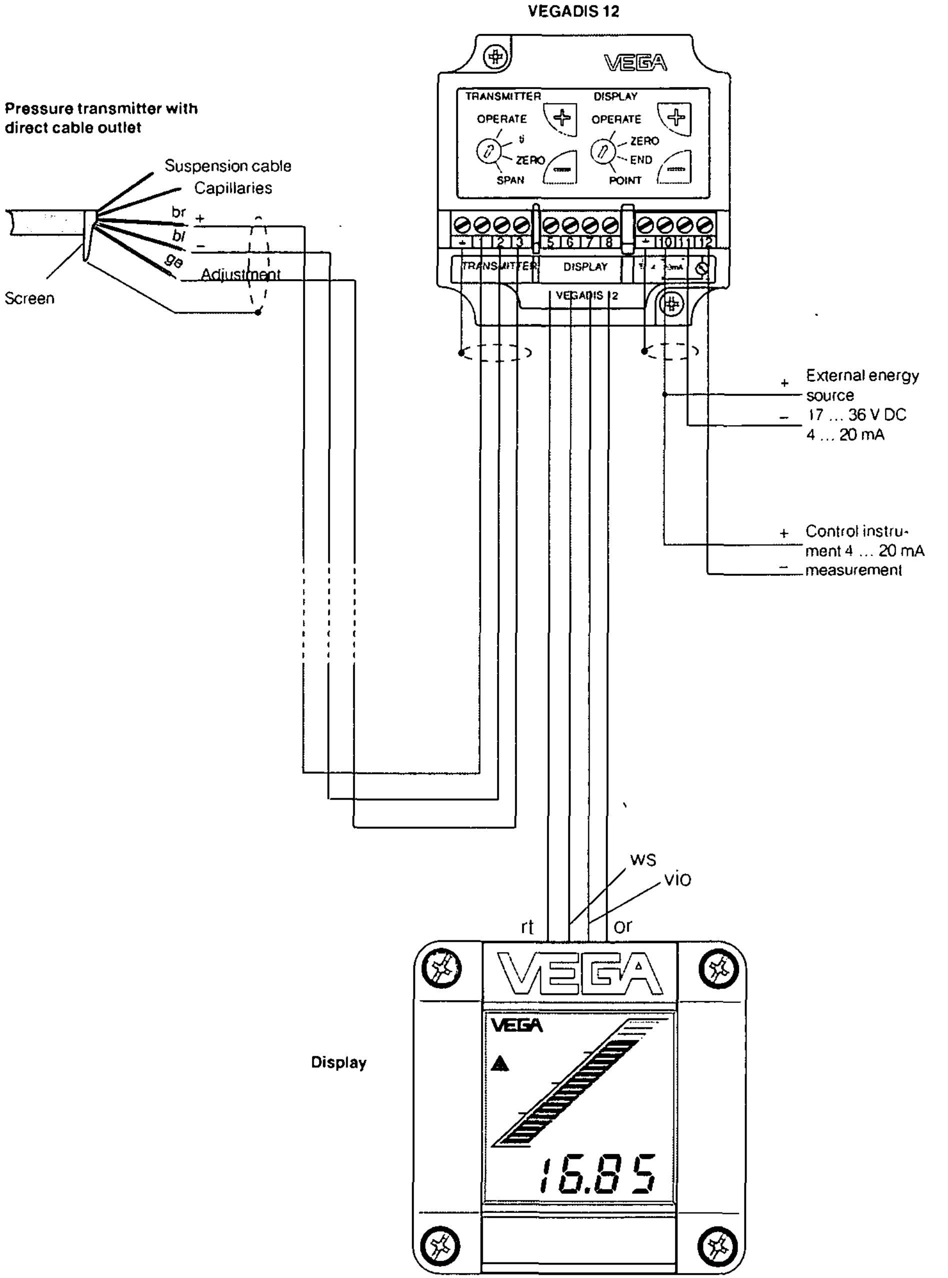
VEGADIS 12 with display



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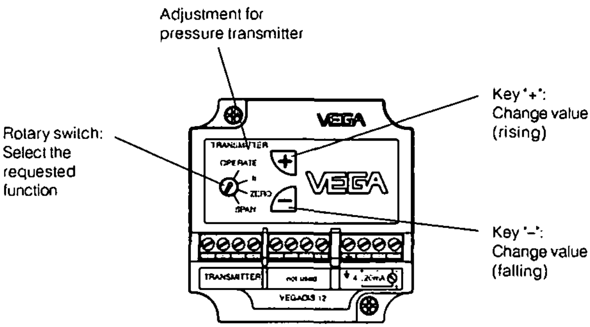
4 Setup

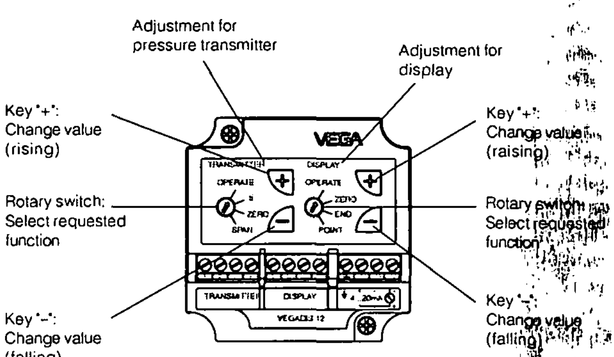
4.1 Adjustment elements



Adjustment system (transmitter)

- Choose the requested function with the rotary switch.
- With the "+" and "–" keys you modify the signal current to the requested values or set the suitable integration time.
- Set the rotary switch to position "OPERATE". The set values are transferred to the EEPROM memory and remain there even in case of voltage loss.

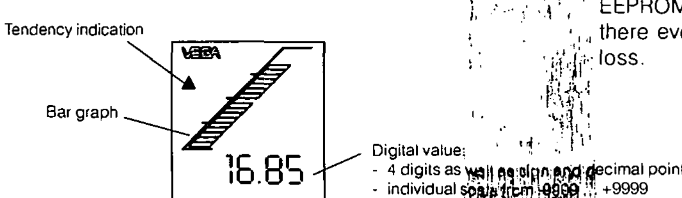
4.2 Adjustment and indicating elements (version with display)



Adjustment system (transmitter)
(see section 4.1)

Adjustment system (display)

- With the rotary switch you choose the requested function.
- With the "+" and "–" keys you change the display indication to the requested values or set the suitable decimal point.
- Then set the rotary switch to position "OPERATE". The set values are transferred to the EEPROM memory and remain there even in case of voltage loss.



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4.3 Adjustment of the transmitter

Adjustment

To adjust the beginning of the measuring range and end value of the measuring range, connect an ammeter to terminals 10 and 12. The measured value is identical to the output current.

1 Adjust zero
(vessel empty)
- Set the rotary switch to zero.
- Set a current of 4 mA by pushing the "+" and "–" key.

2 Adjust span
(max. vessel level)
- Set the rotary switch to span.
- Set a current of 20 mA by pushing the "+" and "–" key.

Adjustment range of the measuring range final value:
3.3 % ... 120 % of nominal range

Adjustment instructions:
- A modification of the beginning of the measuring range does not influence the adjusted span.
- It is also possible to adjust currents for partial fillings, e.g. 8 mA for 25 % and 16 mA for 75 %. The electronics then calculates automatically the current values for 0 % and 100 % (only possible with a delta ≥ 3 %).
- The current value first changes in steps of 6 µA steps, then after approx. 10 sec. of pressing, in steps of about 300 µA.
- If the current values react to the key pressing with a time delay, this can have two reasons:
  - the last adjustment was carried out with a level considerably deviating from the actual level.

Integration time

An integration time t_i of 0 ... 10 sec can be set for damping level fluctuations.

Procedure:
- Set rotary switch to t_i.
- By pushing the "-" key 10 times, make sure that the integration time is set to 0 sec.
- For every 1 sec requested integration time, push the "+" key once.

The integration time is the time required by the current output signal to reach 90 % of the actual level after a sudden level change.

4.4 Scaling of the indication

The display provides the current values 4 ... 20 mA as bar graph and as digital value.

Bar graph
At 4 mA no segment of the bar graph appears, at 20 mA all segments appear. This assignment is fixed.

Digital value
The digital value can be scaled individually between -9999 ... +9999 via the adjustment module.

1 Adjust zero
- Set the rotary switch to zero.
- Set the requested value, e.g. 0 by pushing the "+" and "–" key.

2 Adjust end
- Set the rotary switch to end.
- Set the requested value, e.g. 1000 by pushing the "+" and "–" key.

3 Adjust the decimal point (point)
- Set the rotary switch to point.
- Set the requested values, e.g. 8888 (no decimal point) by pushing the "+" and "–" key.

5 Diagnostics

5.1 Maintenance

VEGADIS 12 is maintenance-free.

5.2 Failure rectification

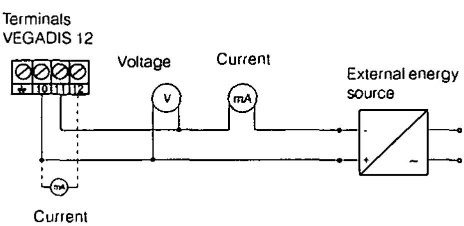
In case of an instrument failure, please check the following:
- the atmospheric pressure compensation
- the electrical connections and components.

Check atmospheric pressure compensation

First of all open the housing cover. The indicated measured value must not change. However, if the indicated value changes nevertheless, the compensation of the atmospheric pressure is not ensured. Please therefore check:
- the breather facility on the housing
- the capillaries in the special cable.

Note:
There must be always the same atmospheric pressure on the breather facility as on the open vessel.

Check electrical components



Instruction for Ex applications
Deviating from the previous assignment, the terminals 10 and 12 are here used for brief connection to a certified, active, floating (max. value: 470 mW) or to an individual passive, floating measuring instrument. For connection, the regulations for wiring of intrinsically safe circuits (measuring instrument, supply and signal circuit) must be noted.

Voltage

- Check the terminal voltage on VEGADIS 12 (must be at least 12 V DC or 17 V DC with display).

Current

Current value	Condition
3.8 … 20.5 mA	standard range for output current
0 mA	signal cable interrupted
< 3.6 mA	electronics or pressure sensor element defective
22 mA	electronics or pressure sensor element defective

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VEGA

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Fax (0 78 36) 50 - 201
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www.vega.com

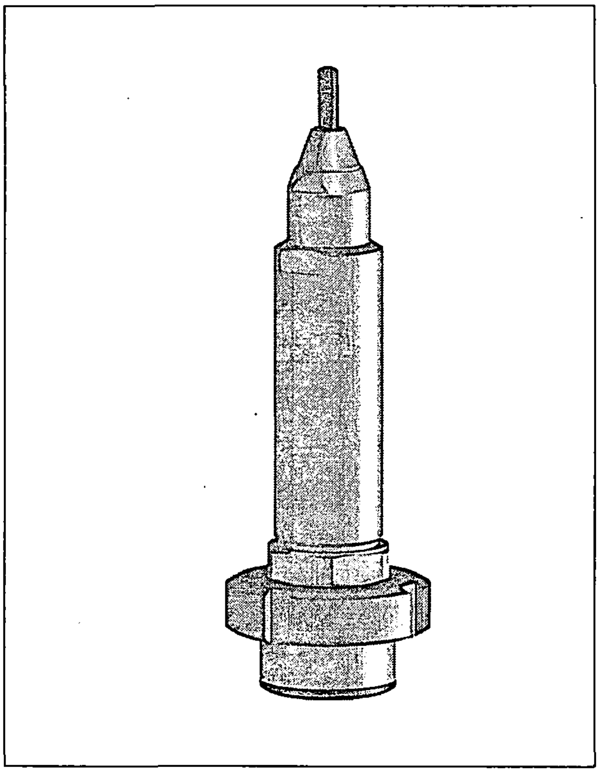
ISO 9001

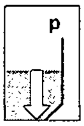
All statements concerning scope of delivery, application, practical use and operating conditions of the sensors and processing systems correspond to the latest information at the time of printing.

Technical data subject to alterations

VEGA

Operating Instructions
VEGABAR 74
4 … 20 mA/HART





Process pressure/
Hydrostatic

Contents

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Supplementary documentation

Information:
Depending on the ordered version, supplementary documentation belongs to the scope of delivery. You find this documentation in chapter "*Product description*".

Instructions manuals for accessories and replacement parts

Tip:
To ensure reliable setup and operation of your VEGABAR 74, we offer accessories and replacement parts. The associated documents are:

- Supplementary instructions manual 32036 "*Welded socket and seals*"
- Operating instructions manual 32798 "*Breather housing VEGABOX 02*"
- Operating instructions manual 20591 "*External indicating and adjustment unit VEGADIS 12*"

1 About this document

1.1 Function

This operating instructions manual provides all the information you need for mounting, connection and setup as well as important instructions for maintenance and fault rectification. Please read this information before putting the instrument into operation and keep this manual accessible in the immediate vicinity of the device.

1.2 Target group

This operating instructions manual is directed to trained personnel. The contents of this manual should be made available to these personnel and put into practice by them.

1.3 Symbolism used

Information, tip, note
This symbol indicates helpful additional information.

Caution: If this warning is ignored, faults or malfunctions can result.
Warning: If this warning is ignored, injury to persons and/or serious damage to the instrument can result.
Danger: If this warning is ignored, serious injury to persons and/or destruction of the instrument can result.

Ex applications
This symbol indicates special instructions for Ex applications.

• **List**
The dot set in front indicates a list with no implied sequence.

→ **Action**
This arrow indicates a single action.

1 **Sequence**
Numbers set in front indicate successive steps in a procedure.

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2 For your safety

2.1 Authorised personnel

All operations described in this operating instructions manual must be carried out only by trained specialist personnel authorised by the operator.

During work on and with the device the required personal protection equipment must always be worn.

2.2 Appropriate use

VEGABAR 74 is a pressure transmitter for measurement of gauge pressure, absolute pressure and vacuum.

You can find detailed information on the application range in chapter "*Product description*".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

Due to safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden.

2.3 Warning about misuse

Inappropriate or incorrect use of the instrument can give rise to application-specific hazards, e.g. vessel overfill or damage to system components through incorrect mounting or adjustment.

2.4 General safety instructions

This is a high-tech instrument requiring the strict observance of standard regulations and guidelines. The user must take note of the safety instructions in this operating instructions manual, the country-specific installation standards as well as all prevailing safety regulations and accident prevention rules.

The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for trouble-free operation of the instrument.

During the entire duration of use, the user is obliged to determine the compliance of the required occupational safety measures with the current valid rules and regulations and also take note of new regulations.

2.5 Safety approval markings and safety tips

The safety approval markings and safety tips on the device must be observed.

2.6 CE conformity

VEGABAR 74 is in CE conformity with EMC (89/336/EWG), fulfils NAMUR recommendation NE 21 and is in CE conformity with LVD (73/23/EWG).

Conformity has been judged according to the following standards:

- EMC:
  - Emission EN 61326: 2004 (class B)
  - Susceptibility EN 61326: 2004 including supplement A
- LVD: EN 61010-1: 2001

VEGABAR 74 is not subject to the pressure device guideline.[1]

2.7 Fulfilling NAMUR recommendations

VEGABAR 74 fulfills the following NAMUR recommendations:

- NE 21 (interference resistane and emitted interference)
- NE 43 (signal level for failure information)
- NE 53 (compatibility sensor and indicating/adjustment components)

VEGA instruments are generally upward and downward compatible:

- Sensor software to DTM VEGABAR 74 HART
- DTM VEGABAR 74 for adjustment software PACTware™

The parameter adjustment of the basic sensor functions is independent of the software version. The range of available functions depends on the respective software version of the individual components.

The software version of VEGABAR 74 HART can be read out via PACTware™.

[1] Due to the flush diaphragm, no own pressure compartment is formed.

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You can view all software histories on our website www.vega.com. Make use of this advantage and get registered for update information via e-mail.

2.8 Safety instructions for Ex areas

Please note the Ex-specific safety information for installation and operation in Ex areas. These safety instructions are part of the operating instructions manual and come with the Ex-approved instruments.

2.9 Environmental instructions

Protection of the environment is one of our most important duties. That is why we have introduced an environment management system with the goal of continuously improving company environmental protection. The environment management system is certified according to DIN EN ISO 14001.

Please help us fulfil this obligation by observing the environmental instructions in this manual:

- Chapter "*Packaging, transport and storage*"
- Chapter "*Disposal*"

3 Product description

3.1 Configuration

Scope of delivery

The scope of delivery encompasses:

- VEGABAR 74 pressure transmitter
- Documentation
  - this operating instructions manual
  - Test certificate for pressure transmitters
  - Ex-specific "*Safety instructions*" (with Ex-versions)
  - if necessary, further certificates

Components

VEGABAR 74 consists of the following components:

- Process fitting with measuring cell
- Housing with electronics
- Connection cable (direct cable outlet)

The components are available in different versions.

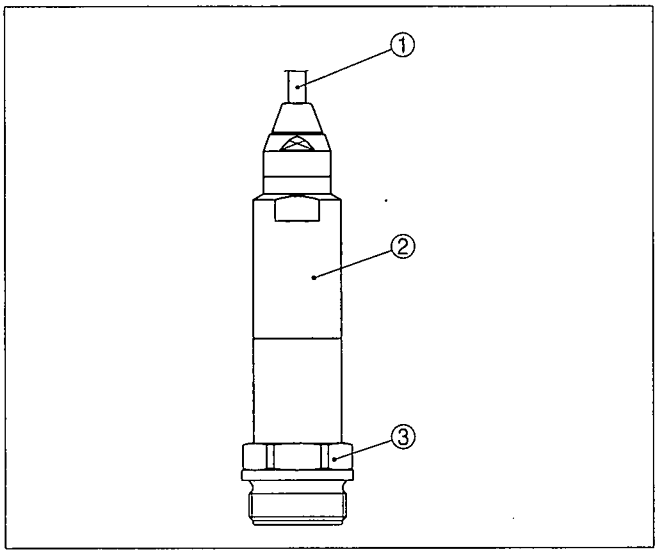

Fig. 1: Example of a VEGABAR 74 with process fitting G1½ A
1 Connection cable
2 Housing with electronics
3 Process fitting with measuring cell

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3.2 Principle of operation

Area of application

VEGABAR 74 is a pressure transmitter for use in the paper, food processing and pharmaceutical industry. Thanks to the high protection class IP 68/IP 69K it is particularly suitable for use in humid environment. Depending on the version, it is used for level, gauge pressure, absolute pressure or vacuum measurements. Measured products are gases, vapours and liquids, also with abrasive contents.

Functional principle

The sensor element is the CERTEC® measuring cell with flush, abrasion resistant ceramic diaphragm. The hydrostatic pressure of the medium or the process pressure causes a capacitance change in the measuring cell via the diaphragm. This change is converted into an appropriate output signal and outputted as measured value.

The CERTEC® measuring cell is also equipped with a temperature sensor. The temperature value can be processed via the signal output.

Supply

Two-wire electronics 4 … 20 mA/HART for power supply and measured value transmission over the same cable.

The supply voltage range can differ depending on the instrument version.

The data for power supply are stated in chapter "*Technical data*" in the "*Supplement*".

3.3 Operation

VEGABAR 74 4 … 20 mA/HART can be adjusted with different adjustment media:

- with external adjustment/indication VEGADIS 12
- an adjustment software according to FDT/DTM standard, e.g. PACTware™ and PC
- with a HART handheld

The kind of adjustment and the adjustment options depend on the selected adjustment component. The entered parameters are generally saved in the respecitive sensor, when adjusting with PACTware™ and PC optionally also in the PC.

3.4 Packaging, transport and storage

Packaging

Your instrument was protected by packaging during transport. Its capacity to handle normal loads during transport is assured by a test according to DIN EN 24180.

The packaging of standard instruments consists of environment-friendly, recyclable cardboard. For special versions, PE foam or PE foil is also used. Dispose of the packaging material via specialised recycling companies.

Transport

Transport must be carried out under consideration of the notes on the transport packaging. Nonobservance of these instructions can cause damage to the device.

Transport inspection

The delivery must be checked for completeness and possible transit damage immediately at receipt. Ascertained transit damage or concealed defects must be appropriately dealt with.

Storage

Up to the time of installation, the packages must be left closed and stored according to the orientation and storage markings on the outside.

Unless otherwise indicated, the packages must be stored only under the following conditions:

- Not in the open
- Dry and dust free
- Not exposed to corrosive media
- Protected against solar radiation
- Avoiding mechanical shock and vibration

Storage and transport temperature

- Storage and transport temperature see "*Supplement - Technical data - Ambient conditions*"
- Relative humidity 20 … 85 %

4 Mounting

4.1 General instructions

Materials, wetted parts

Make sure that the wetted parts of VEGABAR 74, especially the seal and process fitting, are suitable for the existing process conditions such as pressure, temperature etc. as well as the chemical properties of the medium.

You can find the specifications in chapter "*Technical data*" in the "*Supplement*".

Temperature limits

Higher process temperatures often mean also higher ambient temperatures. Make sure that the upper temperature limits stated in chapter "*Technical data*" for the environment of the electronics housing and connection cable are not exceeded.

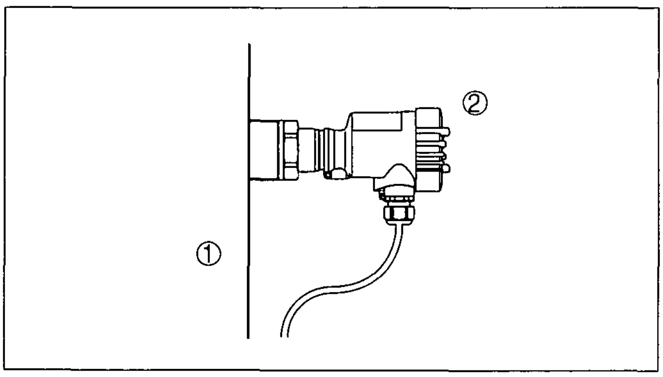

Fig. 2: Temperature ranges
1 Process temperature
2 Ambient temperature

Connection

- The connection cable has a capillary for atmospheric pressure compensation

→ Lead the cable end into a dry space or into a suitable terminal housing.

Information:
VEGA recommends the breather housing VEGABOX 02 or the indication/adjustment VEGADIS 12. Both contain terminals and a ventilation filter for pressure compensation. For mounting outdoors, a suitable protective cover is available.

4.2 Mounting steps

Sealing/Screwing in threaded versions

Seal the thread with teflon, hemp or a similar resistant seal material on the process fitting thread 1½ NPT.

→ Screw VEGABAR 74 into the welded socket. Tighten the hexagon on the process fitting with a suitable wrench. Wrench size, see chapter "*Dimensions*".

Sealing/Screwing in flange versions

Seal the flange connections according to DIN/ANSI with a suitable, resistant seal and mount VEGABAR 74 with suitable screws.

Sealing/Screwing in hygienic fittings

Use the seal suitable for the respective process fitting. You can find the components in the line of VEGA accessories in the supplementary instructions manual "*Welded socket and seals*".

5 Connecting to power supply

5.1 Preparing the connection

Note safety instructions

Always keep in mind the following safety instructions:

- Connect only in the complete absence of line voltage
- If overvoltage surges are expected, versions with integrated overvoltage arresters should be used or external overvoltage arresters should be installed

Tip:
We recommend the version of VEGABAR 74 with integrated overvoltage arrester or VEGA type ÜSB62-36G.X as external overvoltage arreaster.

Take note of safety instructions for Ex applications

In hazardous areas you should take note of the appropriate regulations, conformity and type approval certificates of the sensors and power supply units.

Select power supply

Power supply and current signal are carried on the same two-wire cable. The voltage supply range can differ depending on the instrument version.

The data for power supply are stated in chapter "*Technical data*" in the "*Supplement*".

Provide a reliable separation of the supply circuit from the mains circuits according to DIN VDE 0106 part 101.

VEGA power supply units VEGATRENN 149AEx, VEGASTAB 690, VEGADIS 371 as well as all VEGAMETs meet this requirement. When using one of these instruments, protection class III is ensured for VEGABAR 74.

Bear in mind the following factors regarding supply voltage:

- Output voltage of the power supply unit can be lower under nominal load (with a sensor current of 20.5 mA or 22 mA in case of fault message)
- Influence of additional instruments in the circuit (see load values in chapter "*Technical data*")

Selecting connection cable

VEGABAR 74 is connected with standard two-wire cable without screen. An outer cable diameter of 5 … 9 mm ensures the seal effect of the cable gland when connecting via VEGABOX 02 or VEGADIS 12. If electromagnetic interference is expected which is above the test values of EN 61326 for industrial areas, screened cable should be used. For HART multidrop operation we recommend as standard practice the use of screened cable.

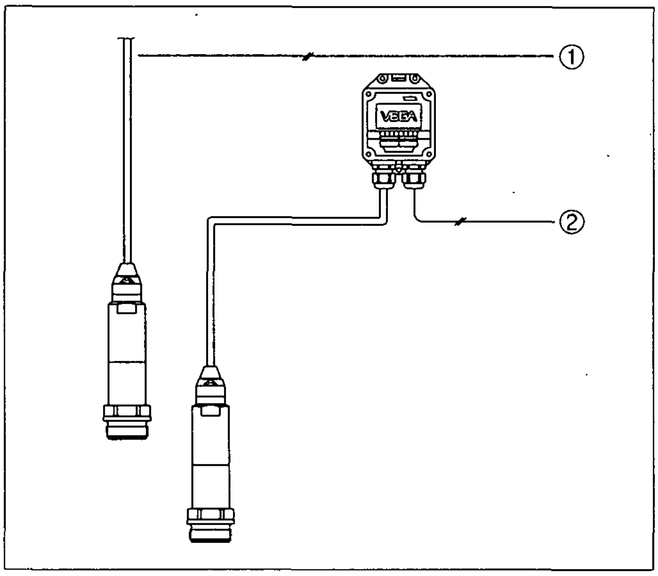

Fig. 3: Connection of VEGABAR 74
1 Direct connection
2 Connection via VEGABOX 02 or VEGADIS 12

Cable screening and grounding

If screened cable is necessary, connect the cable screen on both ends to ground potential. In the VEGABOX 02 or VEGADIS 12, the screen must be connected directly to the internal ground terminal. The ground terminal on the outside of the housing must be connected to the potential equalisation (low impedance).

If potential equalisation currents are expected, the connection on the processing side must be made via a ceramic capacitor (e.g. 1 nF, 1500 V). The low frequency potential equalisation currents are thus suppressed, but the protective effect against high frequency interference signals remains.

Select connection cable for Ex applications

Take note of the corresponding installation regulations for Ex applications. In particular, make sure that no potential equalisation currents flow over the cable screen. In case of grounding on both sides this can be achieved by the use of a capacitor or a separate potential equalisation.

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5.2 Connection procedure

Direct connection

Proceed as follows:

1 Wire the connection cable up to the connection compartment. The bending radius must be at least 25 mm.[2]

2 Connect the wire ends to the screw terminals according to the wiring plan

Via VEGABOX 01 or VEGADIS 12

Proceed as follows:

1 Snap connection housing onto the carrier rail or screw it to the mounting plate

2 Loosen the cover screws and remove the cover

3 Insert the cable through the cable entry into the connection housing housing

4 Loosen the screws with a screwdriver

5 Insert the wire ends into the open terminals according to the wiring plan

6 Tighten the screws with a screwdriver

7 Check the hold of the wires in the terminals by lightly pulling on them

8 Tighten the compression nut of the cable entry. The seal ring must completely encircle the cable

9 Connect the supply cable according to steps 3 to 8

10 Screw the housing cover back on

The electrical connection is finished.

[2] The connection cable is already preconfectioned. After shortening the cable, fasten the type plate with support again to the cable.

5.3 Wiring plan

Direct connection

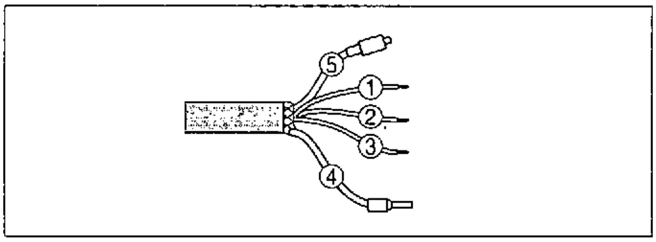

Fig. 4: Wire assignment, connection cable
1. *brown (+): to power supply or to the processing system*
2. *blue (-): to power supply or to the processing system*
3. *yellow: is only required with VEGADIS 12, otherwise connect to minus or with VEGABOX 01 to terminal 3*[3]
4. *Screen*
5. *Breather capillaries with filter element*

Connection via VEGABOX 02

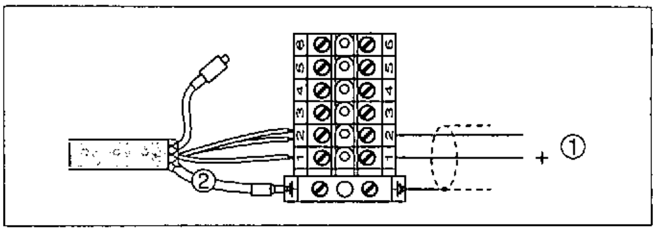

Fig. 5: Terminal assignment VEGABAR 74
1. *To power supply or the processing system*
2. *Screen*[4]

Wire number	Wire colour/Polarity	VEGABAR 74 terminal
1	brown (+)	1
2	blue (-)	2
3	Yellow	2
	Screen	Ground

[3] For customer-specific versions already connected with blue (-) when being shipped.

[4] Connect screen to ground terminal. Connect ground terminal on the outside of the housing as prescribed. The two terminals are galvanically connected.

Connection via VEGADIS 12

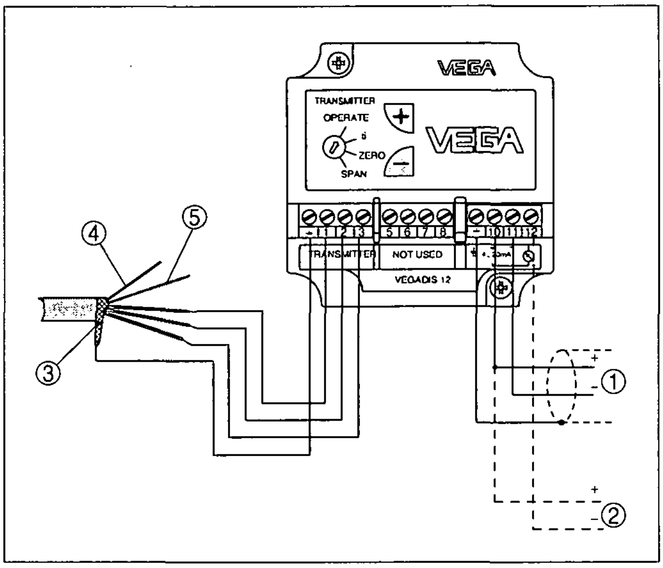

Fig. 6: Terminal assignment, VEGADIS 12
1 *To power supply or the processing system*
2 *Control instrument (4 … 20 mA measurement)*
3 *Screen[5]*
4 *Breather capillaries*
5 *Suspension cable*

Wire number	Wire colour/Polarity	Terminal VEGADIS 12
1	brown (+)	1
2	blue (-)	2
3	Yellow	3

[5] Connect screen to ground terminal. Connect ground terminal on the outside of the housing as prescribed. The two terminals are galvanically connected.

6 Set up

6.1 Setup steps without VEGADIS 12

After mounting and electrical connection, VEGABAR 74 is ready for operation.

→ Switch on voltage

The electronics now carries out a self-check for approx. 2 seconds. Then VEGABAR 74 delivers a current of 4 … 20 mA according to the actual level.

6.2 Setup steps with VEGADIS 12

Adjustment volume

- zero - measuring range begin
- span - measuring range end
- ti - Integration time

Adjustment system

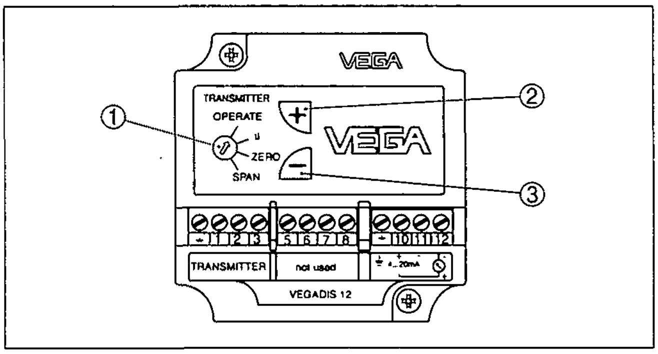

Fig. 7: Adjustment elements of VEGADIS 12
1 Rotary switch: choose the requested function
2 [+] key, change value (rising)
3 [-] key, change value (falling)

- With the rotary switch the requested function is selected
- With the *[+]* and *[-]* keys, the signal current or the integration time are adjusted
- Finally the rotary switch is set to position "*OPERATE*"

The set values are transmitted to the EEPROM memory and remain there even in case of voltage loss.

Adjustment steps, adjustment

Proceed as follows for adjustment with VEGADIS 12:

1 Open housing cover
2 Connect hand multimeter to terminals 10 and 12
3 Meas. range begin: Set rotary switch to "*zero*"

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4 Empty the vessel or reduce process pressure
5 Set a current of 4 mA with the *[+]* and *[-]* keys
6 Meas. range end: Set rotary switch to "*span*"
7 Fill the vessel or increase process pressure
8 Set a current of 20 mA with the *[+]* and *[-]* keys
9 Operation: Set rotary switch to "*OPERATE*"
10 Close housing cover

The adjustment data are effective, the output current 4 … 20 mA corresponds to the actual level.

Adjustment steps, integration time

Proceed as follows for the adjustment of the integration time with VEGADIS 12:

1 Open housing cover
2 Set rotary switch to "*ti*"
3 By pushing the *[-]* key 10-times, make sure that the integration time is set to 0 sec.
4 For every 1 sec. requested integration time, push the *[+]* key once.
5 The integration time is the time required by the output current signal to reach 90 % of the actual height after a sudden level change.
6 Set rotary switch to "*OPERATE*"
7 Close housing cover

Adjustment steps, scaling

The display outputs the current 4 … 20 mA as bar graph and digital value.

With 4 mA no segment of the bar graph appears, with 20 mA all segments appear. This assignment is fix.

You can scale the digital value to any value between -9999 … +9999 via the adjustment module.

Proceed as follows for scaling the indication of VEGADIS 12:

1 Open housing cover
2 Initial value: Set rotary switch to "*zero*"
3 Set the requested value, e.g. 0 with the *[+]* and *[-]* keys
4 Final value: Set the rotary switch to "*span*"
5 Set the requested value, e.g. 1000 with the *[+]* and *[-]* keys
6 Decimal point: Set the rotary switch to "*point*"
7 With the *[+]* and *[-]* keys you can adjust the requested value, e.g. 8888 (no decimal point)

8 Set rotary switch to "*OPERATE*"

9 Close housing cover

The adjustment data are effective, the output current 4 … 20 mA corresponds to the actual level.

7 Setup with PACTware™

7.1 Connect the PC with VEGACONNECT 3

Connecting the PC to the signal cable

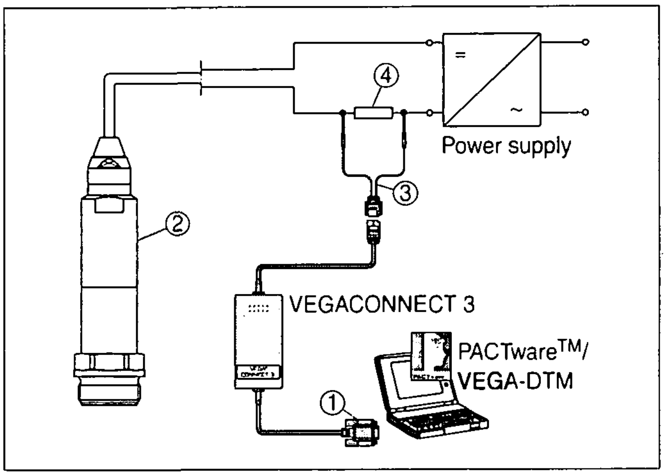

Fig. 8: Connecting the PC to the signal cable
1 RS232 connection (with VEGACONNECT 3) or USB connection (with VEGACONNECT 4)
2 VEGABAR 74
3 HART adapter cable
4 HART resistance 250 Ohm (optional depending on the processing)

Necessary components:

- VEGABAR 74
- PC with PACTware™ and suitable VEGA DTM
- VEGACONNECT 3 or 4 with HART adapter cable (art. no. 2.25397)
- HART resistance approx. 250 Ohm
- Power supply unit

Note:
With power supply units with integrated HART resistance (internal resistance approx. 250 Ohm), an additional external resistance is not necessary (e.g. VEGATRENN 149A, VEGADIS 371, VEGAMET 381/624/625, VEGASCAN 693). In such cases, VEGACONNECT 3 can be connected parallel to the 4 … 20 mA cable.

7.2 Connect the PC with VEGACONNECT 4

Connection via HART

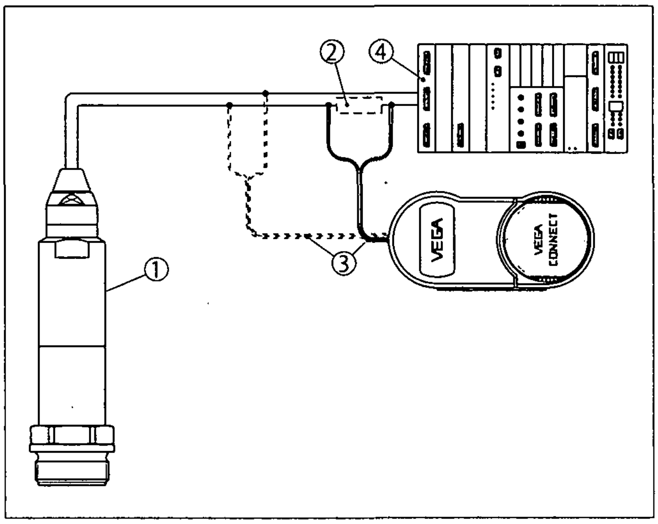

Fig. 9: Connecting the PC via HART to the signal cable
1 VEGABAR 74
2 HART resistance 250 Ohm (optional depending on the processing)
3 Connection cable with 2 mm pins and terminals
4 Processing system/PLC/Voltage supply

Necessary components:

- VEGABAR 74
- PC with PACTware™ and suitable VEGA DTM
- VEGACONNECT 4
- HART resistance 250 Ohm (optional depending on the processing)
- Power supply unit or processing system

Note:
With power supply units with integrated HART resistance (internal resistance approx. 250 Ohm), an additional external resistance is not necessary. This applies, e.g. to the VEGA instruments VEGATRENN 149A, VEGADIS 371, VEGAMET 381). Also usual Ex separators are most of the time equipped with a sufficient current limitation resistor. In such cases, VEGACONNECT 4 can be connected parallel to the 4 … 20 mA cable.

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7.3 Parameter adjustment with PACTware™

Further setup steps are described in the operating instructions manual "*DTM Collection/PACTware™*" attached to each CD and which can also be downloaded from our homepage. A detailed description is available in the online help of PACTware™ and the VEGA DTMs.

Note:
Keep in mind that for setup of VEGABAR 74, DTM-Collection in the actual version must be used.

All currently available VEGA DTMs are provided in the DTM Collection on CD and can be obtained from the responsible VEGA agency for a token fee. This CD includes also the up-to-date PACTware™ version. The basic version of this DTM Collection incl. PACTware™ is also available as a free-of-charge download from the Internet.

Go via www.vega.com and "*Downloads*" to the item "*Software*".

7.4 Parameter adjustment with AMS™ and PDM

For VEGA sensors, instrument descriptions for the adjustment programs AMS™ and PDM are available as DD or EDD. The instrument descriptions are already implemented in the current versions of AMS™ and PDM. For older versions of AMS™ and PDM, a free-of-charge download is available via Internet.

Go via www.vega.com and "*Downloads*" to the item "*Software*".

7.5 Saving the parameter adjustment data

It is recommended to document or save the parameter adjustment data. They are hence available for multiple use or service purposes.

The VEGA DTM Collection and PACTware™ in the licensed, professional version provide suitable tools for systematic project documentation and storage.

8 Maintenance and fault rectification

8.1 Maintenance

When used as directed in normal operation, VEGABAR 74 is completely maintenance free.

8.2 Fault clearance

Reaction in case of failures

The operator of the system is responsible for taken suitable measures to remove interferences.

Causes of malfunction

VEGABAR 74 offers maximum reliability. Nevertheless faults can occur during operation. These may be caused by the following, e.g.:

- Sensor
- Process
- Supply
- Signal processing

Fault rectification

The first measures to be taken are to check the output signals as well as to evaluate the error messages via the indicating and adjustment module. The procedure is described below. Further comprehensive diagnostics can be carried out on a PC with the software PACTware™ and the suitable DTM. In many cases, the causes can be determined in this way and faults can be rectified.

24 hour service hotline

However, if these measures are not successful, call the VEGA service hotline in urgent cases under the phone no. **+49 1805 858550**.

The hotline is available to you 7 days a week round-the-clock. Since we offer this service world-wide, the support is only available in the English language. The service is free of charge, only the standard telephone costs will be charged.

Checking the 4 … 20 mA signal

Connect a handheld multimeter in the suitable measuring range according to the wiring plan.

? 4 … 20 mA signal not stable

- Level fluctuations
  → Adjust integration time via PACTware™
- no atmospheric pressure compensation
  → Check the capillaries and cut them clean

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→ Check the pressure compensation in the housing and clean the filter element, if necessary

? 4 … 20 mA signal missing

- Wrong connection to power supply

→ Check connection according to chapter "*Connection steps*" and if necessary, correct according to chapter "*Wiring plan*"

- No voltage supply

→ Check cables for breaks; repair if necessary

- supply voltage too low or load resistance too high

→ Check, adapt if necessary

? Current signal 3.6 mA; 22 mA

- electronics module or measuring cell defective

→ Exchange instrument or return instrument for repair

In Ex applications, the regulations for the wiring of intrinsically safe circuits must be observed.

Reaction after fault rectification

Depending on the failure reason and measures taken, the steps described in chapter "*Set up*" must be carried out again, if necessary.

8.3 Instrument repair

If a repair is necessary, please proceed as follows:

You can download a return form (23 KB) from the Internet on our homepage www.vega.com under: "*Downloads - Forms and certificates - Repair form*".

By doing this you help us carry out the repair quickly and without having to call back for needed information.

- Print and fill out one form per instrument
- Clean the instrument and pack it damage-proof
- Attach the completed form and, if need be, also a safety data sheet outside on the packaging
- Please ask the agency serving you for the address of your return shipment. You can find the respective agency on our website www.vega.com under: "*Company - VEGA worldwide*"

9 Dismounting

9.1 Dismounting steps

Warning:
Before dismounting, be aware of dangerous process conditions such as e.g. pressure in the vessel, high temperatures, corrosive or toxic products etc.

Take note of chapters "*Mounting*" and "*Connecting to power supply*" and carry out the listed steps in reverse order.

9.2 Disposal

The instrument consists of materials which can be recycled by specialised recycling companies. We use recyclable materials and have designed the electronics to be easily separable.

WEEE directive 2002/96/EG
This instrument is not subject to the WEEE directive 2002/96/EG and the respective national laws (in Germany, e.g. ElektroG). Pass the instrument directly on to a specialised recycling company and do not use the municipal collecting points. These may be used only for privately used products according to the WEEE directive.

Correct disposal avoids negative effects to persons and environment and ensures recycling of useful raw materials.

Materials: see chapter "*Technical data*"

If you cannot dispose of the instrument properly, please contact us about disposal methods or return.

10 Supplement

10.1 Technical data

General data

Manufacturer	VEGA Grieshaber KG, D-77761 Schiltach
Type name	VEGABAR 74
Parameter, pressure	Gauge pressure, absolute pressure, vacuum
Measuring principle	Ceramic-capacitive, dry measuring cell
Communication interface	None

Materials and weights

Material 316L corresponds to 1.4404 or 1.4435

Materials, wetted parts	
– Process fitting	316L
– Diaphragm	sapphire ceramic® (99.9 % oxide ceramic)
– Seal	FKM (e.g. Viton), Kalrez 6375, EPDM, Chemraz 535
– Seal process fitting thread G½ A, G1½ A	Klingersil C-4400
Materials, non-wetted parts	
– Housing	316L
– Ground terminal	316Ti/316L
– Connection cable	PUR, FEP, PE
– type label support on cable	PE-HART
Weight	0.8 … 8 kg (1.8 … 17.6 lbs), depending on process fitting

Output variable

Output signal	4 … 20 mA/HART
Failure signal	22 mA (3.6 mA), adjustable
Max. output current	22.5 mA
Damping (63 % of the input variable)	0 … 10 s, adjustable
Step response or adjustment time	70 ms (ti: 0 s, 0 … 63 %)
Fulfilled NAMUR recommendations	NE 43

Additional output parameter - temperature

Processing is made via HART-Multidrop

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Range	-50 … +150 °C (-58 … +302 °F)
Resolution	1 °C (1.8 °F)
Accuracy	
– in the range of 0 … +100°C (+32 … +212 °F)	±3 K
– in the range of -50 … 0 °C (-58 … +32 °F) and +100 … +150 °C (+212 … +302 °F)	typ. ±4 K

Input variable

Adjustment

Zero adjustable	-20 … +95 % of the nominal measuring range
Span adjustable	3.3 … +120 % of the nominal measuring range
Recommended max. turn down	10:1

Nominal measuring ranges and overload resistance

Nominal range	Overload, max. pressure[6]	Overload, min. pressure
Gauge pressure		
0 … 0.1 bar/0 … 10 kPa	15 bar/1500 kPa	-0.2 bar/-20 kPa
0 … 0.2 bar/0 … 20 kPa	20 bar/2000 kPa	-0.4 bar/-40 kPa
0 … 0.4 bar/0 … 40 kPa	30 bar/3000 kPa	-0.8 bar/-80 kPa
0 … 1 bar/0 … 100 kPa	35 bar/3500 kPa	-1 bar/-100 kPa
0 … 2.5 bar/0 … 250 kPa	50 bar/5000 kPa	-1 bar/-100 kPa
0 … 5 bar/0 … 500 kPa	65 bar/6500 kPa	-1 bar/-100 kPa
0 … 10 bar/0 … 1000 kPa	90 bar/9000 kPa	-1 bar/-100 kPa
0 … 25 bar/0 … 2500 kPa	130 bar/13000 kPa	-1 bar/-100 kPa
0 … 60 bar/0 … 6000 kPa	200 bar/20000 kPa	-1 bar/-100 kPa
-1 … 0 bar/-100 … 0 kPa	35 bar/3500 kPa	-1 bar/-100 kPa
-1 … 1.5 bar/-100 … 150 kPa	50 bar/5000 kPa	-1 bar/-100 kPa
-1 … 5 bar/-100 … 500 kPa	65 bar/6500 kPa	-1 bar/-100 kPa
-1 … 10 bar/-100 … 1000 kPa	90 bar/9000 kPa	-1 bar/-100 kPa
-1 … 25 bar/-100 … 2500 kPa	130 bar/13000 kPa	-1 bar/-100 kPa
-1 … 60 bar/-100 … 6000 kPa	300 bar/30000 kPa	-1 bar/-100 kPa
-0.05 … 0.05 bar/-5 … 5 kPa	15 bar/1500 kPa	-0.2 bar/-20 kPa
-0.1 … 0.1 bar/-10 … 10 kPa	20 bar/2000 kPa	-0.4 bar/-40 kPa

[6] Limited to 200 bar according to the pressure device directive.

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Nominal range	Overload, max. pressure6)	Overload, min. pressure
-0.2 ... 0.2 bar/-20 ... 20 kPa	30 bar/3000 kPa	-0.8 bar/-80 kPa
-0.5 ... 0.5 bar/-50 ... 50 kPa	35 bar/3500 kPa	-1 bar/-100 kPa
Absolute pressure		
0 ... 0.1 bar/0 ... 10 kPa	15 bar/1500 kPa	
0 ... 1 bar/0 ... 100 kPa	35 bar/3500 kPa	
0 ... 2.5 bar/0 ... 250 kPa	50 bar/5000 kPa	
0 ... 5 bar/0 ... 500 kPa	65 bar/6500 kPa	
0 ... 10 bar/0 ... 1000 kPa	90 bar/9000 kPa	
0 ... 25 bar/0 ... 2500 kPa	130 bar/13000 kPa	
0 ... 60 bar/0 ... 6000 kPa	200 bar/20000 kPa	

Reference conditions and influencing variables (similar to DIN EN 60770-1)

Reference conditions according to DIN EN 61298-1

- Temperature — +15 ... +25 °C (+59 ... +77 °F)
- Relative humidity — 45 ... 75 %
- Air pressure — 860 ... 1060 mbar/86 ... 106 kPa (12.5 ... 15.4 psi)

Determination of characteristics — Limit point adjustment according to IEC 61298-2

Characteristics — linear

Reference installation position — upright, diaphragm points downward

Influence of the installation position — <0.2 mbar/20 Pa (0.003 psi)

Deviation determined according to the limit point method according to IEC 60770[7]

Applies to **digital** HART interface as well as to **analogue** current output 4 ... 20 mA. Specifications refer to the set span. Turn down (TD) = nominal measuring range/set span.

Deviation

- Turn down 1:1 up to 5:1 — <0.075 %
- Turn down up to 10:1 — <0.015 % x TD

Deviation with absolutely flush process fittings EV, FT

- Turn down 1:1 up to 5:1 — <0.05 %
- Turn down up to 10:1 — <0.01 % x TD

[7] Incl. non-linearity, hysteresis and non-repeatability.

Deviation with absolute pressure measuring range 0.1 bar

- Turn down 1:1 up to 5:1 <0.25 % x TD
- Turn down up to 10:1 <0.05 % x TD

Influence of the product or ambient temperature

Applies to **digital** HART interface as well as to **analogue** current output 4 … 20 mA. Specifications refer to the set span. Turn down (TD) = nominal measuring range/set span.

Average temperature coefficient of the zero signal

In the compensated temperature range of 0 … +100 °C (+212 °F), reference temperature 20 °C (68 °F):

Average temperature coefficient of the zero signal

- Turn down 1:1 <0.05 %/10 K
- Turn down 1:1 up to 5:1 <0.1 %/10 K
- Turn down up to 10:1 <0.15 %/10 K

Outside the compensated temperature range:

Average temperature coefficient of the zero signal

- Turn down 1:1 typ. <0.05 %/10 K

Thermal change of the current output

Applies also to the **analogue** 4 … 20 mA current output and refers to the set span.

Thermal change, current output <0.15 % at -40 … +80 °C (-40 … +176 °F)

Long-term stability (similar to DIN 16086, DINV 19259-1 and IEC 60770-1)

Applies to **digital** HART interface as well as to **analogue** current output 4 … 20 mA. Specifications refer to the set span. Turn down (TD) = nominal measuring range/set span.

Long-term drift of the zero signal <(0.1 % x TD)/1 year

Total deviation (similar to DIN 16086)

The total deviation (max. practical deviation) is the sum of basic accuracy and long-term stability:

$F_{total} = F_{perf} + F_{stab}$

$F_{perf} = \sqrt{((F_T)^2 + (F_{KI})^2)}$

With

- F_{total}: Total deviation
- F_{perf}: Basic accuracy
- F_{stab}: Long-term drift

- F_T: Temperature coefficient (influence of medium or ambient temperature)
- F_{Kl}: Deviation

Ambient conditions

Ambient, storage and transport temperature	
– Connection cable PE	-40 … +60 °C (-40 … +140 °F)
– Connection cable PUR, FEP	-40 … +85 °C (-40 … +185 °F)

Process conditions

The specifications of the pressure stage are used as an overview. The specifications on the type plate are applicable.

Pressure stage, process fitting	
– Thread 316L	PN 60
– Thread Alu	PN 25
– Hygienic fittings 316L	PN 10, PN 16, PN 25, PN 40
– Flange 316L, flange with extension 316L	PN 40 or 150 lbs, 300 lbs
Product temperature depending on the measuring cell seal	
– FKM (e.g. Viton)	-20 … +100 °C (-4 … +212 °F)
– EPDM	-40 … +100 °C (-40 … +212 °F), 1 h: 140 °C/ 284 °F cleaning temperature
– Kalrez 6375 (FFKM)	-10 … +100 °C (+14 … +212 °F)
– Chemraz 535	-30 … +100 °C (-22 … +212 °F)
Vibration resistance	mechanical vibrations with 4 g and 5 … 100 Hz[8]
Shock resistance	Acceleration 100 g/6 ms[9]

Electromechanical data

Connection cable	
– Configuration	four wires, one suspension cable, one breather capillary, screen braiding, metal foil, mantle
– Wire cross-section	0.5 mm² (AWG no. 20)
– wire resistance	<0.036 Ohm/m (0.011 Ohm/ft)
– Standard length	6 m (19.685 ft)
– max. length with VEGADIS 12	200 m (656.168 ft)

[8] Tested according to the regulations of German Lloyd, GL directive 2.
[9] Tested according to EN 60068-2-27.

– Min. bending radius at 25 °C/77 °F	25 mm (0.985 in)
– Diameter	approx. 8 mm (0.315 in)
– Colour - standard PE	Black
– Colour - standard PUR	Blue
– Colour - Ex-version	Blue

Voltage supply

Supply voltage	
– Non-Ex instrument	12 … 36 V DC
– EEx ia instrument	12 … 29 V DC
Permissible residual ripple	
– <100 Hz	U_{ss} <1 V
– 100 Hz … 10 kHz	U_{ss} <10 mV
Load	see diagram

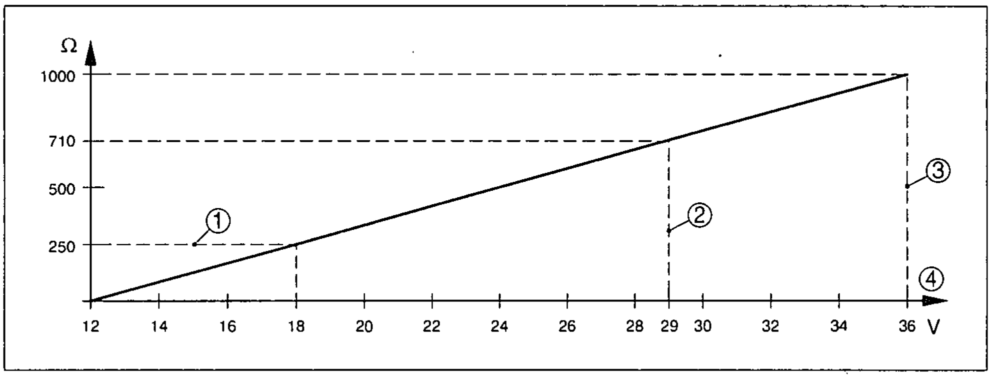

Fig. 10: Voltage diagram VEGABAR 74
1 HART load
2 Voltage limit Ex instrument
3 Voltage limit non-Ex instrument
4 Voltage supply

Load in conjunction with VEGADIS 12	see diagram

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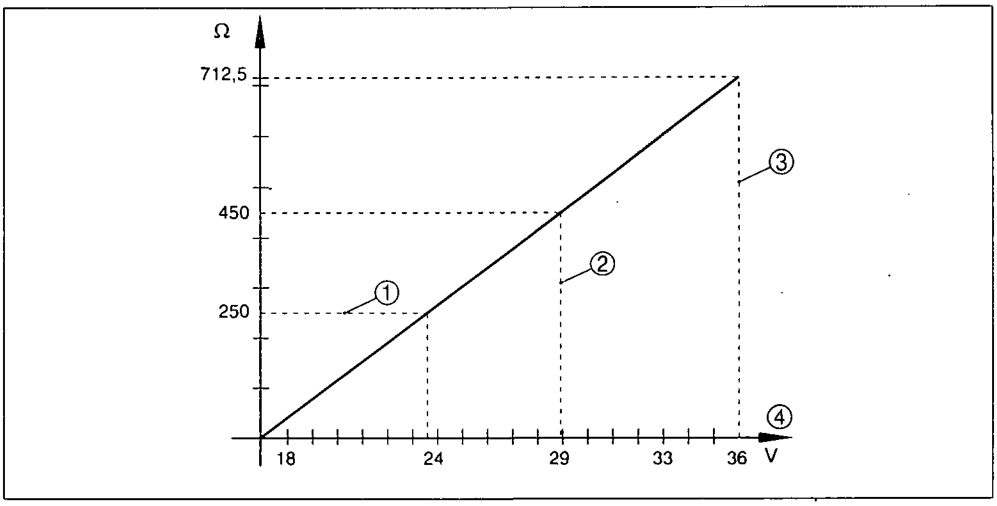

Fig. 11: Voltage diagram VEGABAR 74 with VEGADIS 12
1 *HART load*
2 *Voltage limit Ex instrument*
3 *Voltage limit non-Ex instrument*
4 *Voltage supply*

Integrated overvoltage protection	
Nominal leakage current (8/20 µs)	10 kA
Min. response time	<25 ns

Electrical protective measures	
Protection	IP 68 (25 bar)/IP 69K
Overvoltage category	III
Protection class	III

Approvals[10)]	
ATEX ia	ATEX II 1G EEx ia IIC T6; ATEX II 2G EEx ia IIC T6
Ship approvals	GL, LRS, ABS, CCS, RINA, DNV
Others	WHG

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10) Deviating data in Ex applications: see separate safety instructions.

10.2 Dimensions

VEGABAR 74 - threaded fitting

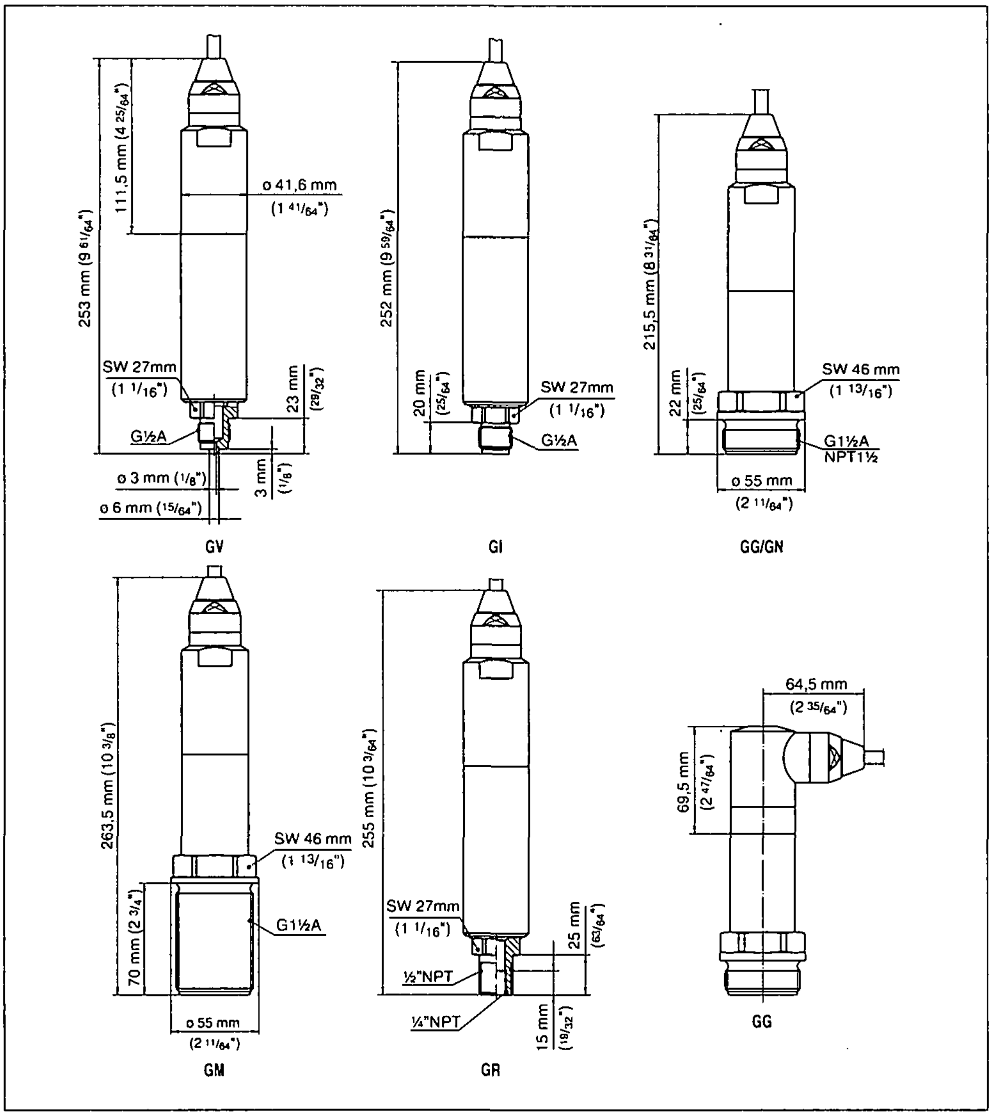

Fig. 12: VEGABAR 74 threaded fitting: GV = G½ A manometer connection EN 837, GI = G½ A inner G¼ A, GG = G1½ A, GN = 1½ NPT, GM = G1½ A 70 mm, GR = ½ NPT inner ¼ NPT

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VEGABAR 74 - hygienic fitting 1

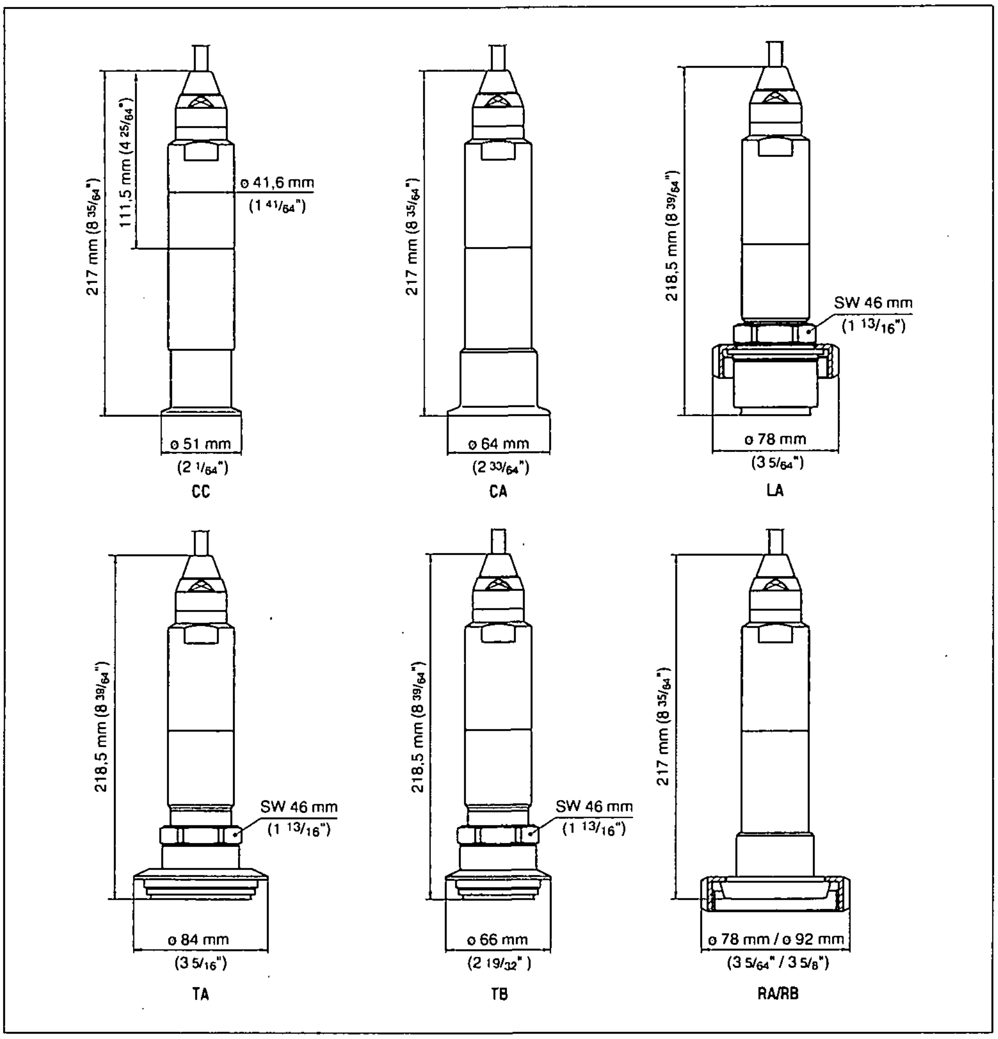

Fig. 13: VEGABAR 74 hygienic fitting: CC = Tri-Clamp 1½", CA = Tri-Clamp 2", LA = hygienic fitting with compression nut F40, TA = Tuchenhagen Varivent DN 32, TB = Tuchenhagen Varivent DN 25, RA/RB = bolting DN 40/DN 50 according to DIN 11851

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VEGABAR 74 - hygienic fitting 2

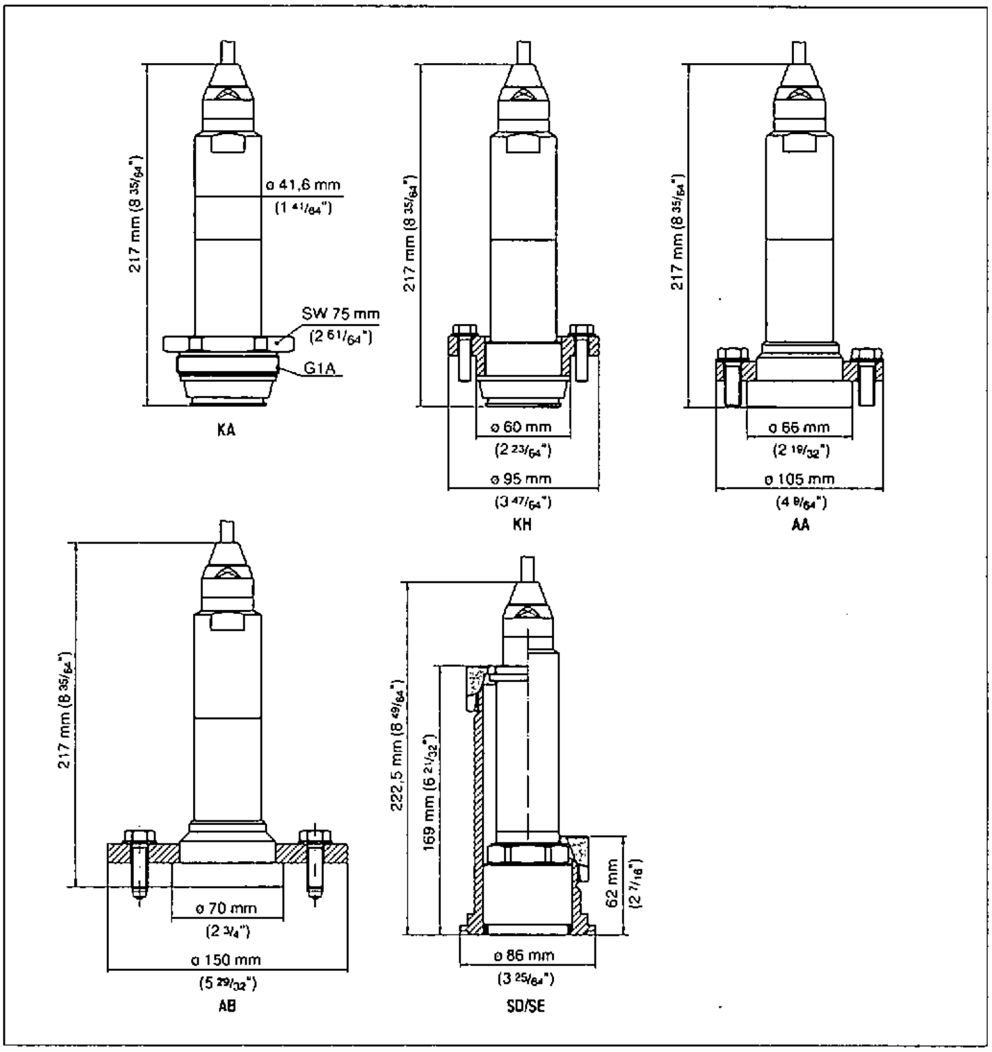
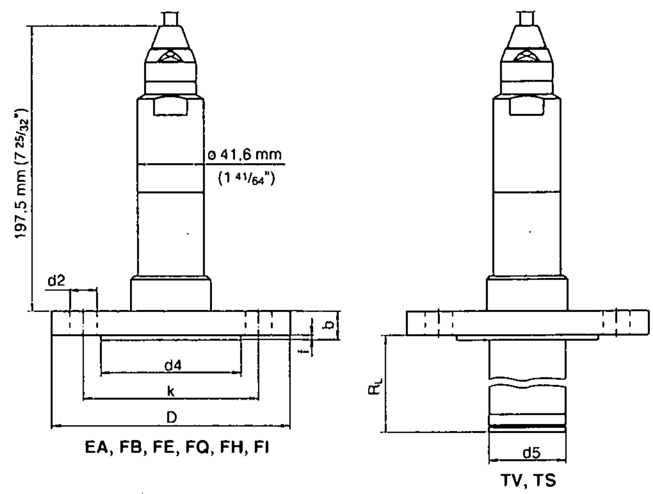


Fig. 14: VEGABAR 74 KA/KH = cone DN 40, AA = DRD, SD/SE = Anderson 3" long/short fitting

VEGABAR 74 - flange connection



①	DN	PN	D	b	k	d2	d4	f	RL	d5
EA	40	40	5 29/32"	45/64"	4 21/64"	4xø 45/64"	3 15/32"	1/8"	-	-
FB	50	40	6 1/2"	25/32"	4 59/64"	4xø 45/64"	4 1/64"	1/8"	-	-
FE	80	40	7 7/8"	15/16"	6 19/64"	8xø 45/64"	5 7/16"	1/8"	-	-

②	"	lbs	D	b	k	d2	d4	f	RL	d5
FQ	1 ½"	150	5"	11/16"	3 14/16"	4xø 5/8"	2 7/8"	1/8"	-	-
FH	2"	150	6"	3/4"	4 3/4"	4xø 5/8"	3 5/8"	1/8"	-	-
FI	3"	150	7 1/2"	3/4"	6	4xø 5/8"	6	1/8"	-	-

③	DN	PN	D	b	k	d2	d4	f	RL	d5
TV	50	40	6 1/2"	25/32"	4 59/64"	4xø 45/64"	4 1/64"	1/8"	④	1 1/2"
TS	80	40	7 7/8"	15/16"	6 19/64"	8xø 45/64"	5 7/16"	1/8"		1 1/2"

Fig. 15: VEGABAR 74 - flange connection
1 *Flange connection according to DIN 2501*
2 *Flange fitting according to ANSI B16.5*
3 *Flange with extension*
4 *Order-specific*

VEGABAR 74 - threaded fitting for paper industry

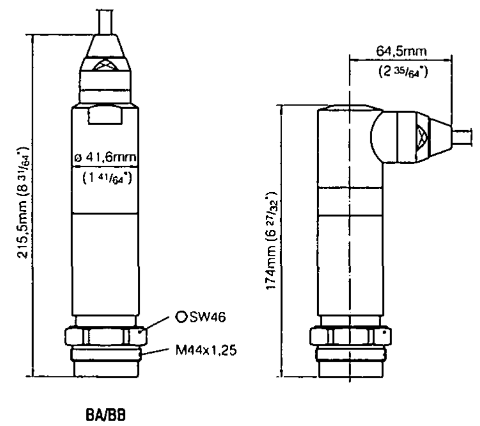


Fig. 16: VEGABAR 74 - connection for paper industry: BA/BB = M44x1.25

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VEGABAR 74 - extension fitting for paper industry

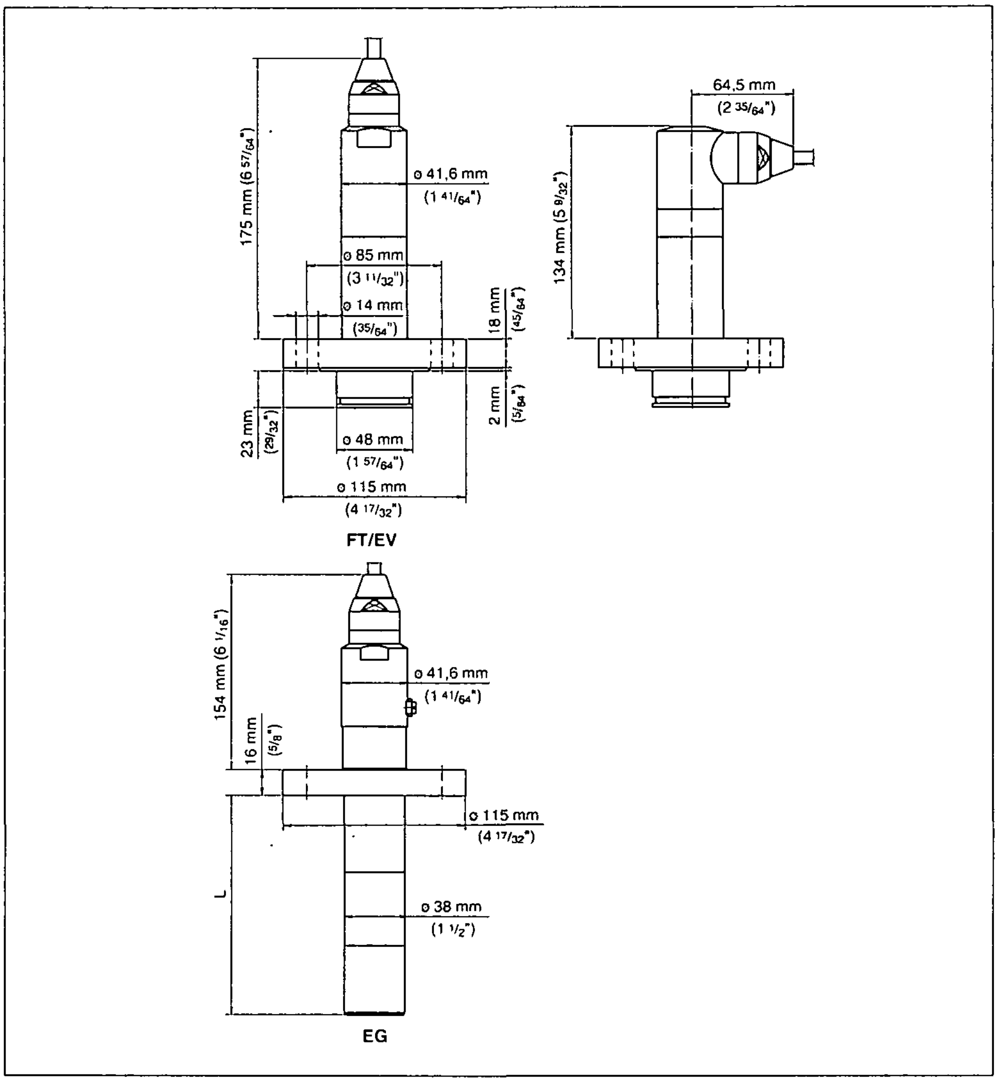

Fig. 17: VEGABAR 74 - extension fitting for paper industry: EV/FT = absolutely flush for pulper (EV 2-times flattened), EG = extension for ball valve fitting (L = order-specific)

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CERTIFICATE OF TEST

Project:- **SP 168 DURANTA STREET**

Client:- **BRISBANE CITY COUNCIL**

"Whelan Electrical Services Pty Ltd certify that the electrical installation, to the extent it is effected by the electrical work, has been tested to ensure it is electrically safe and is in accordance with the requirements of the wiring rules and any other standard applying to the electrical installation under the Electrical Safety Regulation 2002"

Signed:- ....[signature].......... Date:- ....13-07-09....

Shayne Farrelly

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