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A QUALITY COMPANY TO AS/ISO9001

SP086 INDOOROOPILLY ROAD SEWAGE PUMP STATION SWITCHBOARD

OPERATION & MAINTENANCE MANUAL

JOB No A4229

HALMAC SERVICES IS A QUALITY COMPANY SERVING QUEENSLAND SINCE 1960
ELECTRICAL ENGINEERS & CONTRACTORS, DATA & COMMUNICATIONS, SERVICE AND MAINTENANCE, SWITCHBOARD MANUFACTURE, PLC, SCADA, TELEMETRY DESIGN & INSTALLATION
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SP086 INDOOROOPILLY ROAD SEWAGE PUMP STATION

OPERATION & MAINTENANCE MANUAL

JOB NO: A4229

1. Automatic Transfer Switch

Halmac Services (Qld) Pty. Ltd.
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AUTOMATIC TRANSFER SWITCH

1. ATyS 6 TECHNICAL DETAILS
2. ATyS TECHNICAL GUIDE
3. ATyS D10 & D20 OPERATING INSTRUCTIONS

Automatic transfer switch

ATyS

Technical guide

GB

SOCOMEC GROUP SWITCHING PROTECTION & UPS

SOCOMEC
Switching and Protection Systems

TECHNICAL GUIDE

Sommaire

You can download this documentation on www.socomec.com

Low voltage installation

The applications

INTRODUCTION

The word transfer is applied to any application requiring a switching operation from one power circuit to another.

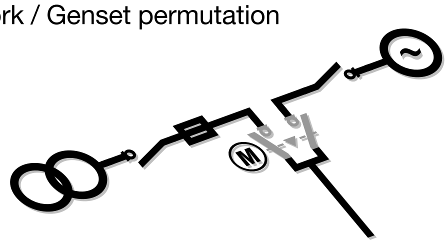
The transfer concept is mainly applied to two sources requiring changeover, one considered as a main supply and the other one as an emergency source or backup supply.

The expression 'normal/emergency' is used to name this function.

NORMAL/EMERGENCY APPLICATIONS

The most useful transfer application concerns installations requiring switching to another power supply in case of loss of a main's network.

• Network / Genset permutation



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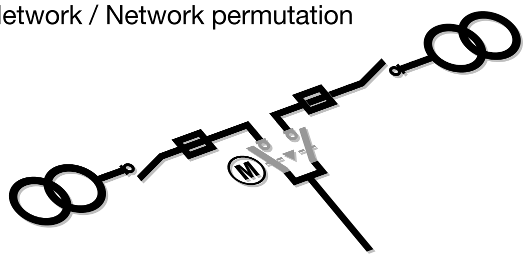
• Network / Network permutation



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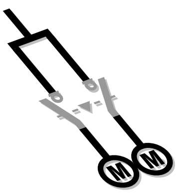
Transfer systems are dedicated to installations equipped with emergency power supplies to secure the supply of the loads.

This type of power supply is present on site to ensure life safety equipment is powered and to evacuate the installation in case of damage.

Security equipment can be lighting, alarm systems (fire..), smoke extraction systems, fire pumps, air compressors, sprinkler systems, lifts, …

OTHER APPLICATIONS

• Redundant loads to changeover on a unique source



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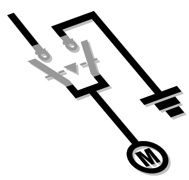
• Short circuit and earthing of a circuit to secure an installation and allow electrician's intervention



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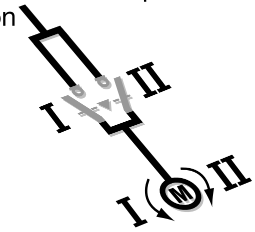
• Inverse two conductors of a three phases network to inverse phases rotation



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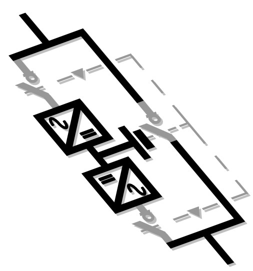
• Bypass applications



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Low voltage installation

Types of Transfer

Different transfer schemes can be selected to allow transfer from one source to another, depending on the requirements of the application.

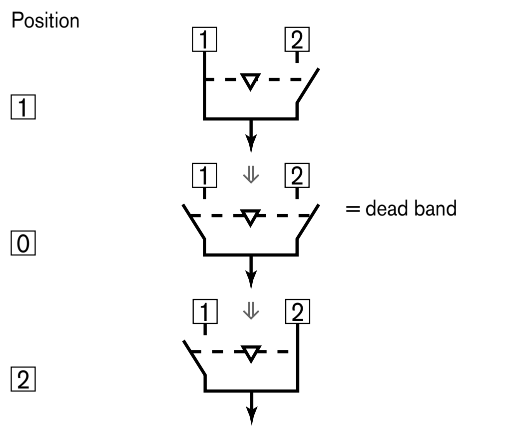
BREAK BEFORE MAKE (DEAD BAND)

The transfer from one source to a second source passes through a 0 position to avoid sources recovery.

A dead band time can be counted down to allow the load residual voltage to decrease under a non critical value before transferring.

Transferring the load too quickly to another source can induce important power transfers between the load and the supply. It can potentially damage some materials and cause protection equipment to trip, resulting in production losses.

The dead band time must be selected in accordance to the equipment.



SYNCHRONOUS TRANSFER

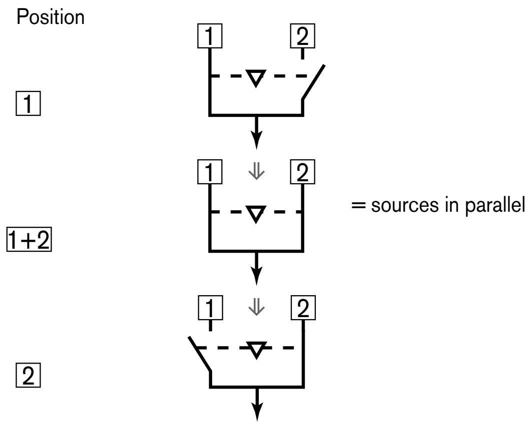
The main and the emergency sources can be running in parallel.

They must nevertheless be synchronous to allow the transfer:

• Their phases vectors are in phase,

• Their frequency and amplitudes are identical.

In this case, there won't be any dead band if both sources are present.

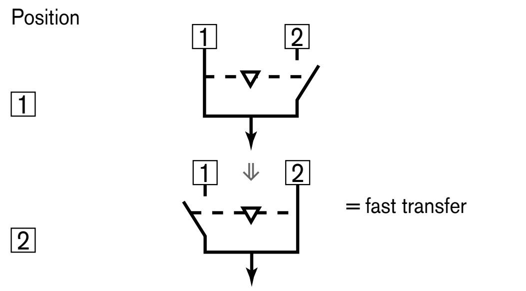


ASYNCHRONOUS TRANSFER

This type of transfer scheme is typically applicable to big asynchronous motors. Fast transfer is required to limit the motor's speed (frequency) and allow direct transfer without a stop condition.

The Transfer time normally does not exceed 0,2s.

Slip frequency and phase amplitudes must nevertheless be verified before transfer, to validate transfer conditions.



SOCOMEC ATyS systems are dedicated to break before make application representing most of the needs.

Emergency source is rarely always present and critical loads are normaly protected by UPS.

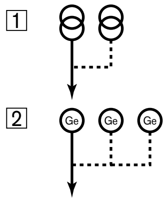
Low voltage installation

The sources

SOURCES DISTINCTION

The sources can be separated as follow:

- One source considered as priority (main): a power network (district) through one or several transformers in parallel.
- One emergency source: a power plant (generators, turbines, fuel cells, UPS, wind farms…)



GENSET SOURCES CATEGORIES

Emergency sources including generators are split in several categories depending on the time delay necessary to take back the load after a loss of main condition:

Category	Time delay	Genset Start	Comments
D	**not specified**	manual	Speed raise and power capacity depending on ambient and motor temperatures
C	**long shutdown ≤ 15 s**	after loss of mains	Constant Genset preheat operation to allow fast start sequence
B	**short shutdown ≤ 1 s**	permanent rotation	Generator connected to the Main as a motor without prime mover being started. Constant Genset preheat operation to allow fast start sequence. Motor started thanks to rotor inertia.
A	**without shutdown**	running In parallel with the mains	Immediate supply in case of loss of mains

Low voltage installation

The Loads

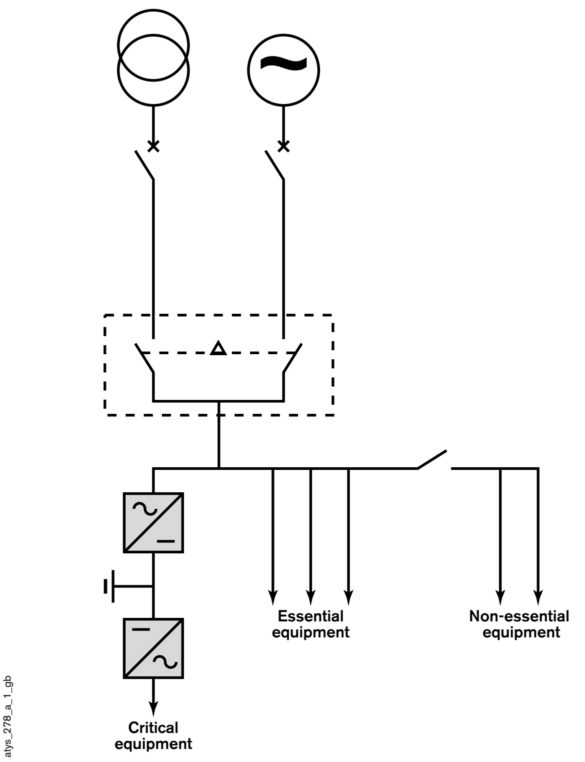
The transfer scheme and the type of emergency sources to instigate are linked to the loads available on the installation.

LOADS DISTINCTION

Some loads accept a power shutdown and others do not.

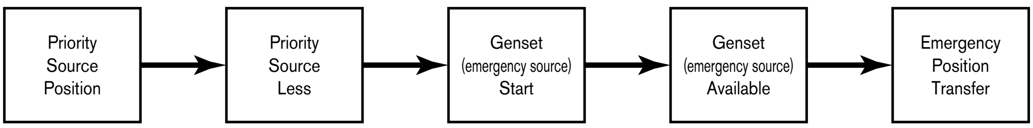
Several categories have been identified:

- Critical equipment: Fed through a UPS to guarantee service continuity in case of main's supply shutdown. Their power capacity is limited and depends on the load's consumption, batteries charge and maintenance
- Essential equipment: a fast feed back is required (from several seconds to several minutes)
- Non-essential equipment: only feed back after the main's return and transfer on the main's supply



SUPPLIES TRANSFER SEQUENCE

- Most of the applications require a short shutdown period after loss of a supply.
- Timers allow loss of source and source availability detection before transfer. The transfer timer is equal to the summation of these different timers.



ATyS Systems integrate genset control after loss of main source.

Automatic transfer

Sources Monitoring

The Normal/Emergency control system integrates the monitoring of the Mains and the backup sources to validate their availability.

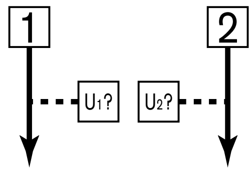
VOLTAGE MONITORING

The voltages must at least be verified to:

- Detect any failure of the source in service (long outage out of the pre-defined limits) and start the changeover process
- Validate the presence of the backup source to allow the transfer

> A complete voltage loss on one source indicates tripping of an upper protection system or the source shutdown (in case of genset). Single phase failure can be due to a single pole tripping operation of an upper protection system, or to an active conductor loss.

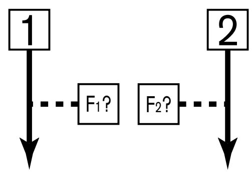
> A high or low voltage level, out of the pre-defined range can be due to reactive power overload (low power factor motors) or under load conditions (capacitive sources in excess) not compensated by voltage regulation system.



FREQUENCY MONITORING

In case of generator supplies sources, additional frequency detection allows better control of the source.

> Network frequency is linked to the generators rotation speed producing power on the source. A high or low frequency condition indicates active power underload or overload conditions. It can also be due to a speed regulation system failure.



NOTE

> These conditions should be considered for power plant applications (gensets).

> Protection systems must be programmed according to the application need. They have to operate before the changeover system detection in order to protect the installation.

> As a reminder, a transfer sequence is only initiated in case of Mains source failure, alternatively with an emergency source failure, with the Main source being available.

Automatic transfer

Sources Monitoring (cont.)

APPLICATION CLASSES

The power capacity of the source, its characteristic impedances, and the regulation systems will influence the transient behaviour of its voltage and frequency values.

Different classes have been identified to specify voltage and frequency limits in permanent and transient application. :

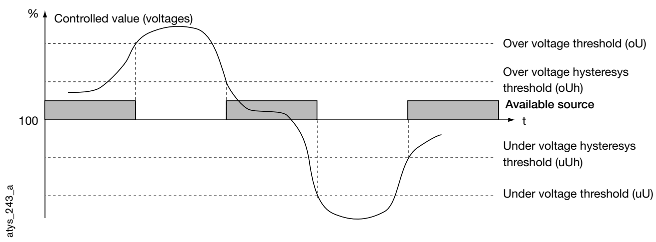
- Class G1 : low constraints (simple loads as such as lighting)
- Class G2 : temporary fluctuations accepted (grid)
- Class G3 : Severe requirements on the tolerances and the waveforms
- Class G4 : Specific severe requirements

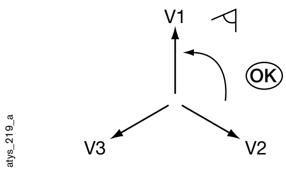
Parameters		Application class G1	G2	G3	G4
Frequency					Specific requirements
operation	permanent	+/- 2,5 %	+/- 1,5 %	+/- 0,5 %	
	transient	+/- 18 %	+/- 12 %	+/- 10 %	
Voltage					
operation	permanent	+/- 5 %	+/- 2,5 %	+/- 1%	
	transient	+ 35 % to - 25 %	+ 25 % to - 20 %	+ 20 % to - 15 %	

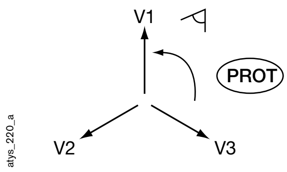
TRANSIENT BEHAVIOUR

The control circuit must be able to compensate for the difference between a stable condition and a transient condition, mainly due to loads application or loads rejection.

- High and low thresholds with time delay define the stable power supply range of the load. High and low hysteresis levels are generally associated with a new stable condition and avoid any triggering of the detection.
- A phase sequence detection is interesting in the case of 3 phase systems, detecting any reversing of the power cables during commissioning and always verifying the voltage vectors sequence of the power supply (important in case of rotating loads).







Automatic transfer

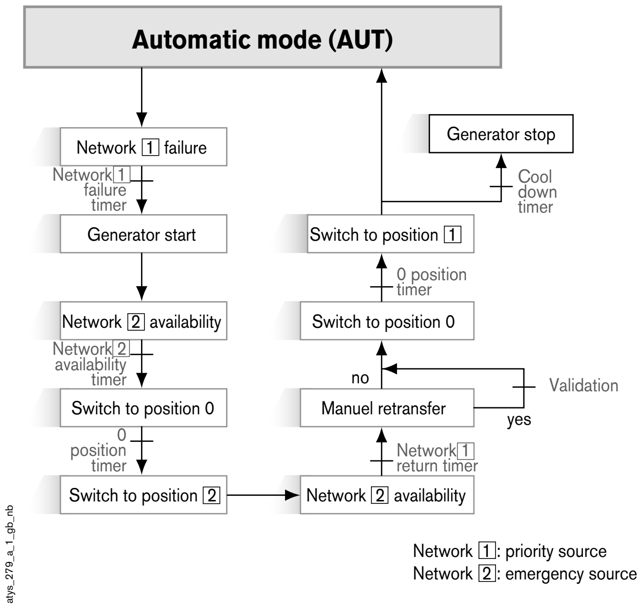
Transfer Cycles

LOSS OF MAIN SEQUENCE

- The sequence is started from a stable position considered as 'Normal' or having priority, and waits for a Mains source failure (threshold+ timer) to start a transfer sequence to the emergency or backup source.
- Once the loss is detected (loss of main source), a start contact dedicated to the emergency source is closed. This contact is used as a start signal in the case of a genset application but is not utilised for transformer applications.
- The emergency source detection (threshold + timer) validates its availability and initiates the transfer from the Normal to the Emergency position.
- The transfer can stop in the 0 position. The 0 stay timer can be modified according to the needs of the application (refer to break before make transfer).

RETURN SEQUENCE TO THE MAIN

- The transfer switch is in the emergency position and waits for the Mains supply availability to start a transfer back sequence.
- This sequence is similar to the loss of mains sequence. The genset start signal is kept closed until the end of the cool down period. This timer is started from transfer back to the Normal position and allows a complete cool down sequence for the genset (no load operation).
- Example : Network / Network application



Automatic transfer

Test cycles

It is a requirement to be able to guarantee the operation of the Automatic Transfer Switch to the end-user :

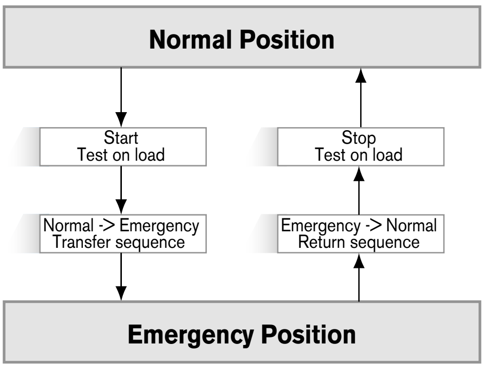
• transfer mechanism

• emergency source

The equipment has to be operational when required.

TEST ON LOAD

• A complete test of the transfer system can be initiated periodically or during preventive maintenance. This test called 'test on load' simulates a main's sequence and goes through the complete transfer cycle. The emergency source is started in case of power plant (genset) application and only stopped after cool down timer.



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TEST OFF LOAD

• It is also possible to test only the behaviour of the emergency source (genset) without transferring the load. This test called "test off load" allows verification of the genset remote start. The automatic transfer system is also able to stop the emergency source when required by the user.

Applicable standard

IEC 60 947-6-1 Standard

The transfer switch must be chosen according to the application, architecture of the installation, type of load to transfer and number of anticipated operations.

The product standard **IEC 60947-6-1** is dedicated to Automatic Transfer, type Normal / Emergency applications.

This standard is applicable to **Automatic Transfer and Connection Materials**, intended to be used in Emergency Transfer Systems with interruption of the load's supply during the transfer operation.

IEC 60 947-6-1 standard integrates specific requirements based on automatic transfer specifications.

Different classes of equipment and categories are defined. They have been created to reflect the different product needs of Normal / Emergency applications.

> Equipment Classes:

PC : Transfer systems without over current protection against short circuits

CB : Transfer systems including over current protection against short circuits

The PC class is required when the emergency source is located adjacent to the transfer panel and without any over current protection facility on the main incomer (already present above).

ATyS System complies with PC quipment type.

> Category of Use :

Different categories have been identified in the standard, specifying sequences of use for the equipment and based on the needs of the application.

> Operation Classes:

A and B : classes have been created in accordance to number of anticipated operations.

The IEC 60 947-6-1 standard also defines the complete transfer sequence including all timers and thresholds required to offer to the end user, a product with all facilities needed for his application.

A complete analysis of the application is always necessary to determine the type of equipment which suits the requirements. It is effectively unusual to directly transfer highly inductive loads or to realise repeated transfer operations on a standard Normal / Emergency Automatic System.

Specific applications

Networks or gensets applications

Normal / Emergency applications can require dedicated functions depending on the required transfer scheme.

PRIORITY SOURCE

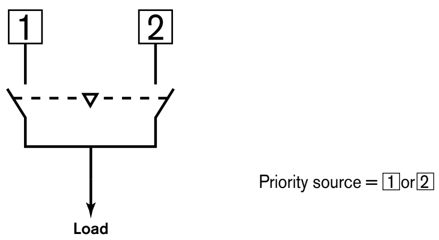
Transfer Applications between two power transformers might request to change periodically the source considered as having priority.

It is preferential in this case to try and preserve the same lifetime on both transformers and to determine the preferred source, based on the power consumption of the load together with the power capacity of the source.

This action can usually be achieved locally via an interface, remotely using an external contact or via communication.

Loss of Main and Main's return sequences remain the same. It is only the position considered as having priority that is modified.

The genset start signal is not utilised in this case (no genset).



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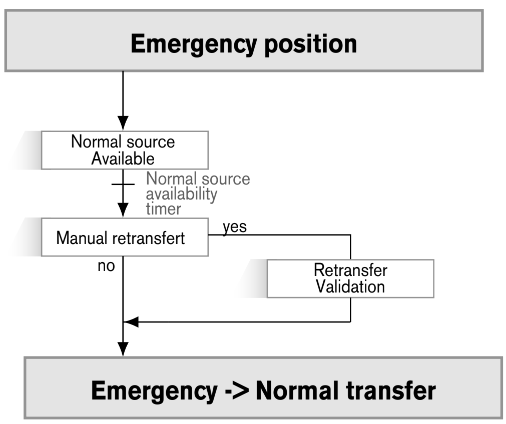
AUTOMATIC OR MANUAL RE-TRANSFER

Re-Transfer from Backup source to Main source can be achieved automatically or manually, depending on the requirement. It can be preferable to initiate the transfer back to the Main source during a specific planned and controlled period. The transfer back must be initiated by a voluntary action (pushbutton or closing of a contact).

In case of Re-transfer selection on the Automatic Transfer System, after validation of return, the re-transfer is blocked (on emergency supply), waiting for an external action to transfer.

The Automatic sequence always takes over, and initiates the transfer in case of loss of the emergency source.



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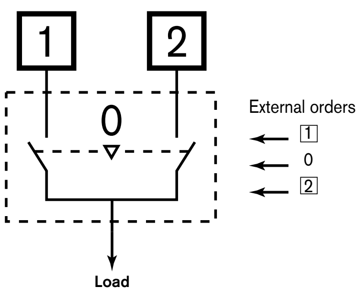
EXTERNAL CONTROL OF THE POSITIONS

The Transfer circuit allows remote operation of the system.

However it can be preferential in some applications to remotely activate the position of the switch (by another circuit or an operator…)

This specific mode of operation takes over the automatic control. It is important to restrict any automatic operation as soon as external control is active.



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Specific applications

Genset application

BACKUP SOURCE DETECTION

The Normal / Emergency system monitors both sources (Mains and backup). Voltage then frequency states are verified on each supply.

The emergency source, which is usually a generator (genset) can generate its own availability information based on its operational criteria (heating period, cycles of operation…)

This information can typically come from a dry contact and must be taken into account instead of the supply detection.

LOAD SHEDDING

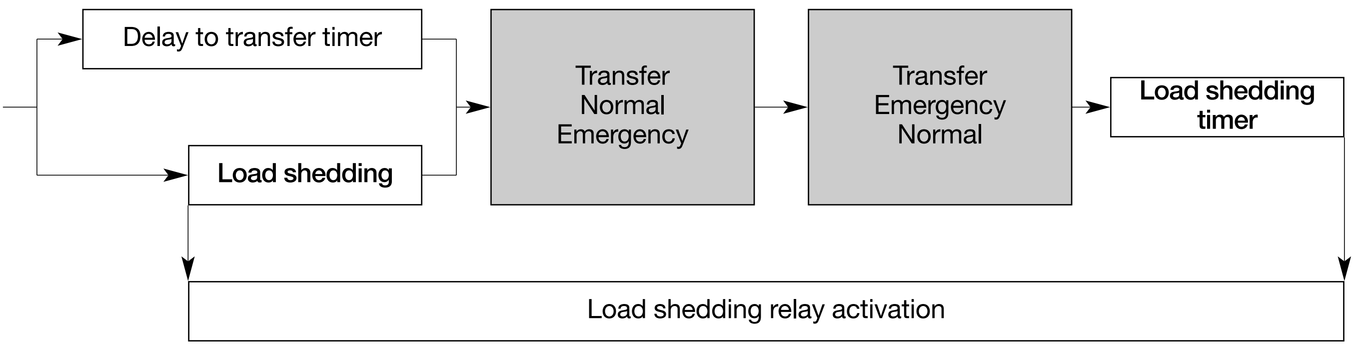
Normal and emergency supplies feeding the load are generally of a different type: Network (transformer) or Generator (genset).

Operation of the emergency source can result in load shedding. It is preferential to reduce the power capacity of the backup source.

A specific contact can be closed just before transferring the load to the emergency source. The time delay from contact closure to transfer (load shedding timer) can be modified.

This information can be used to open some circuits, and disconnect some loads.

This contact is opened after transfer back to the main supply and load shedder timer.



Specific applications

Genset application

CONTROLLED TRANSFER

Some applications equipped with several generators on the backup source might require a specific start up sequence including synchronisation before transferring the load.

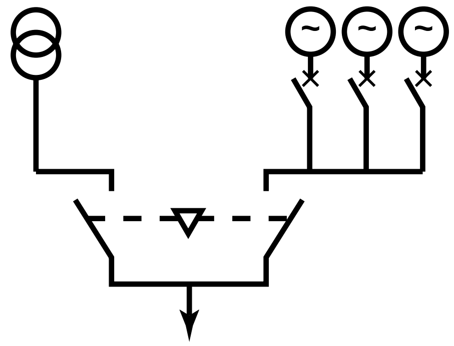
It is necessary in this case to wait for the complete power plant to be ready to start the transfer operation. It cannot be initiated from the first genset's availability (voltage presence on the bus bar).

The time required to build up the source might not be constant.

In order to allow the optimised control of the transfer, a specific contact is sent to the Automatic Transfer System when the source is available.

This mode of operation must be selected to allow the external order to be taken into account instead of the standard Delay To Transfer Timer.

If no information is received before the Timer count down, the transfer is forced.



Product Application and Specification Features

Automatic transfer system

1. GENERAL

- The ATS system must be proposed in 3 and 4 poles versions to optimise the size of the system based on the number of active wires to change over.
- The short circuit withstand of the changeover system and any associated protection must meet the potential short circuit level calculated for the application.
- The switching contacts must be maintainence free in many environments and of self cleaning to optimise the quality of the contacts during operation.
- Opening and closing operations of the contacts must be fast and independent from the automatic driving mechanism (Speed of contacts independent from the speed of the electrical and manual operations).
- System Positions and contacts must not be affected by vibrations or voltage variations of the power supplies (Stable position without power supply = no power consumption in stable position).

2. CHANGEOVER SYSTEM SECURITY

- The changeover system must integrate electrical and mechanical interlocking of the controls in order to avoid any recovery of the power sources.
- The changeover system must integrate a security disconnection function between upstream and downstream connections and between sources.
- It must be possible to manually operate the changeover system (in position 1, 0 or 2) to always allow changeover operations in case of electrical command failure or without any power source.
- An ‘Automatic Mode’ / ‘Manual Mode’ selector must restrict any automatic command in manual position. It must also be possible to equip the product with a key selector to allow secure access to the operational mode selection.
- Padlocking of the product in position 0 must be included, and padlocking of the changeover system in 3 positions must be possible on request.
- Access to manual operation must be prohibited in automatic or padlocked position. The system must avoid automatic mode access during manual operation (handle in place) or in padlocked position.

Product Application and Specification Features

Automatic transfer system

3. AUTOMATIC CONTROL

The changeover system must include automatic control for Normal / Emergency changeover sequences.

- The changeover system must integrate genset control (start and stop operation) to run on its own Transformer / Genset type of ATS application.
- A schematic diagram, showing source availability and changeover switch position must be included.
- The changeover system must be easily configurable via a dialogue interface. A security Password is required for programming access.
- It must be possible to choose locally or remotely the preferred source (having priority).
- A three phase sensing circuit on Mains and Backup sources must guarantee a secure detection.
- Voltage and frequency monitors must be displayed.
- Minimum and Maximum Voltages and frequencies thresholds, as well as associated hysteresis levels, must be programmable to avoid any triggering of the detection.
- Phase sequence detection must be included in the product to always correctly guarantee voltage vectors' sequence on both power supplies.
- Normal / Emergency sequences must integrate following timers:
  - > Loss of Mains Timer to validate Main source failure before starting loss of Main's sequence
  - > Delay to transfer Timer (Emergency Source Availability Timer) to validate emergency source stability before transferring
  - > O position Timer (Stay) during 1-2 or 2-1 changeover process. This timer must be adjusted in accordance to load's induced voltage decrease ramp
  - > Cool Down Timer in the case of a genset application. This allows a genset cooling down period after transferring back the load to the Main source
- It must be possible to block the re-transfer operation (from Emergency to Main source) via programming. When selected, the Transferring back operation to the Main source must be validated locally or remotely via keypad or external contact.
- Communication facility must be easily addable (RS485 Jbus/Modbus Protocol) to allow remote control and monitoring of the changeover system.

Product Application and Specification Features

Automatic transfer system

4. USE

- Test facilities must be included in the product to allow test sequence control, locally or remotely, via keypad or external contacts. Security Password access required.
- Electrical Control of the product position (1, 0, & 2) must be possible and controlled locally or remotely. Any automatic command must be inhibited during control operation (takeover).

5. INTEGRATION

> Choice 1 : Total Access

The whole command features (including manual/electrical and padlocking operation, product configuration, operating mode selection, tests control, metering and mimic display) must be accessible from front panel.

> Choice 2 : Controlled Access

Must only be accessible from front panel, product configuration, electrical control, test facilities, metering and mimic display.

6. MAINTENANCE

- Driving mechanism and control modules must be easily removable and replaced on site without disconnecting power elements and shutting down the power supply in less than 10 minutes.

7. APPROVALS

- Product must meet IEC 60 947-6-1 standard.

The product is similar to Socomec ATyS 6e changeover system, equipped or not, depending on integration needs, with its remote interface ATyS D20.

ATyS 6 Automatic Transfer Switches
125 to 1600 A

Functions
References
Characteristics
Accessories: see page A.142
Dimensions: see page A.148

ATyS 6m

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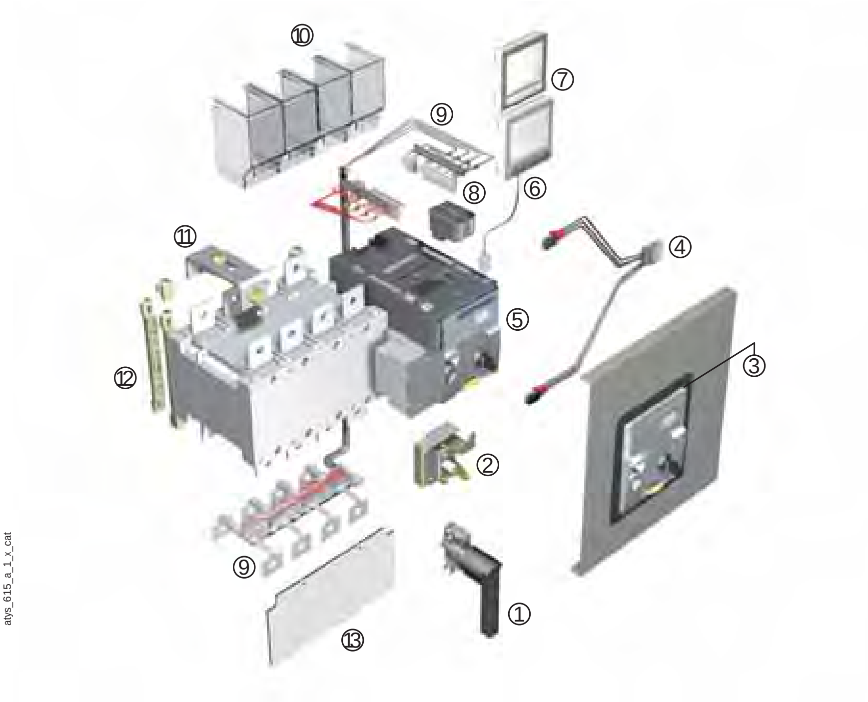

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Overview (for further details, please see the installation instructions supplied with each device).

1. Backup handle and support (included with device).
2. Handle key interlocking accessories.
3. Door protective surround.
4. Additional auxiliary contacts.
5. Standard device.
6. Connecting cable for off-set interfaces ATyS.
7. ATyS D10 or D20 interfaces.
8. Plug-in optional modules.
9. Voltage sensing and power supply kit.
10. Terminal shrouds.
11. Bridging bars.
12. Mounting spacers.
13. Terminal screens.

Functions

ATyS 6 products are motorised 3 or 4-pole **Automatic Transfer Switches**.

They are a combination of two electrical and mechanical interlocked superposed load-break switches mounted back to back.

They provide switching and automatic source inversion of two low voltage power circuits as well as safety isolation.

Conformity to standards

- IEC 60947-6-1
- IEC 60947-3
- NF EN 60947-6-1
- EN 60947-3
- BS EN 60947-3
- NBN EN 60947-3
- GB 14048

General characteristics

- Complete integration of the changeover logic for Normal/Backup applications between a transformer and a generator set or between two transformers.
- 3 stable positions (I, 0, II).
- AC-22 and AC-23 and AC-31 switching under load.
- Isolation with positive break indication.
- Electrical control by volt free dry contact.
- Manual emergency control.
- Padlocking in 0 (I and II optional).
- Available enclosed, see page "Automatic Transfer Switch ATyS 6 enclosed range", C.28.

ATyS	6e	6m
ATS*	X	X
3 U sensing 1+2	X	X
0, I, II control	X	X
Fault relay	X	X
Option COM + I/O	X	X
Metering (I, P, Q, S, PF)		X

atys_093_c_1_gb_cat

* ATS : Automatic Transfert Switch.

ATyS 6 Automatic Transfer Switches

References

atys_005_a_2_cat

atys_006_a_2_cat

Standard device - 230 VAC		125 A	160 A	250 A	400 A
ATyS 6e					
No. of poles		References	References	References	References
3 pole		1563 **3012**	1563 **3016**	1563 **3025**	1563 **3040**
4 pole		1563 **4012**	1563 **4016**	1563 **4025**	1563 **4040**
ATyS 6m					
3 pole		1573 **3012**	1573 **3016**	1573 **3025**	1573 **3040**
4 pole		1573 **4012**	1573 **4016**	1573 **4025**	1573 **4040**

Other voltages

12, 24 VDC	consult us	consult us	consult us	consult us

Accessories

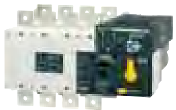
		125 A	160 A	250 A	400 A
Bridging bars					
1 pole		4109 **0019**	4109 **0019**	4109 **0025**	4109 **0039**
Voltage sensing and power supply kit					
3 pole		1559 **3012**	1559 **3012**	1559 **3025**	1559 **3040**
4 pole	Neutral on the right	1559 **4012**	1559 **4012**	1559 **4025**	1559 **4040**
4 pole	Neutral on the left	1559 **4013**	1559 **4013**	1559 **4026**	1559 **4041**
Plug-in optional modules					
COM RS485 (No. 1)		1599 **2000**	1599 **2000**	1599 **2000**	1599 **2000**
2 inputs/2 outputs (No. 2)		1599 **2001**	1599 **2001**	1599 **2001**	1599 **2001**
Remote control interface					
ATyS D10 interface		1599 **2010**	1599 **2010**	1599 **2010**	1599 **2010**
ATyS D20 interface		1599 **2020**	1599 **2020**	1599 **2020**	1599 **2020**
Terminal shrouds (1 set) (1)(2)					
3 pole	top / bottom / front (I) / rear (II)	2694 **3014**	2694 **3014**	2694 **3021**	2694 **3021**
4 pole	top / bottom / front (I) / rear (II)	2694 **4014**	2694 **4014**	2694 **4021**	2694 **4021**
Terminal screens (1 set top and bottom)					
3 pole		1509 **3012**	1509 **3012**	1509 **3025**	1509 **3025**
4 pole		1509 **4012**	1509 **4012**	1509 **4025**	1509 **4025**
Pre-breaking and signalling of position I and II auxiliary contacts					
2nd AC	NO/NC changeover	1599 **0002**	1599 **0002**	1599 **0012**	1599 **0012**
Control voltage transformer					
400/230 VAC		1599 **4063**	1599 **4063**	1599 **4063**	1599 **4063**
Padlocking (factory fitted)					
"Padlocking in the 3 positions I, 0 and II" option		1599 **0003**	1599 **0003**	1599 **0003**	1599 **0003**
Key handle interlocking system (factory fitted)					
Locking using RONIS EL11AP lock in padlocked position		1509 **1006**	1509 **1006**	1509 **1006**	1509 **1006**
Mounting spacers					
1 set of 2 spacers		1509 **0001**	1509 **0001**	1509 **0001**	1509 **0001**
Door protective surround					
		1539 **0012**	1539 **0012**	1539 **0012**	1539 **0012**

(1) To shroud front switch top and bottom 2 references required.
(2) To fully shroud front and rear / top and bottom 4 references required.

ATyS 6 Automatic Transfer Switches
125 to 1600 A

Functions
References
Characteristics
Accessories: see page A.142
Dimensions: see page A.148

References

atys_007_a_3_cat

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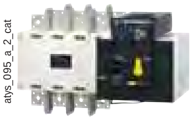
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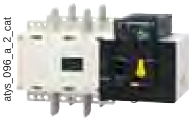


Standard device - 230 VAC	630 A	800 A	1000 A	1250 A	1600 A
ATyS 6e					
No. of poles	References	References	References	References	References
3 pole	1563 **3063**	1563 **3080**	1563 **3100**	1563 **3120**	1563 **3160**
4 pole	1563 **4063**	1563 **4080**	1563 **4100**	1563 **4120**	1563 **4160**
ATyS 6m					
3 pole	1573 **3063**	1573 **3080**	1573 **3100**	1573 **3120**	1573 **3160**
4 pole	1573 **4063**	1573 **4080**	1573 **4100**	1573 **4120**	1573 **4160**

Other voltages

12, 24 VDC	consult us	consult us	consult us	consult us	consult us

Accessories

Bridging bars					
1 pole	4109 **0063**	4109 **0080**	4109 **0080**	4109 **0120**	4109 **0160**
Voltage sensing and power supply kit					
3 pole	1559 **3063**	1559 **3080**	1559 **3080**	1559 **3120**	1559 **3160**
4 pole Neutral on the right	1559 **4063**	1559 **4080**	1559 **4080**	1559 **4120**	1559 **4160**
4 pole Neutral on the left	1559 **4064**	1559 **4081**	1559 **4081**	1559 **4121**	1559 **4161**
Plug-in optional modules					
COM RS485 (No. 1)	1599 **2000**	1599 **2000**	1599 **2000**	1599 **2000**	1599 **2000**
2 inputs/2 outputs (No. 2)	1599 **2001**	1599 **2001**	1599 **2001**	1599 **2001**	1599 **2001**
Remote control interface					
ATyS D10 interface	1599 **2010**	1599 **2010**	1599 **2010**	1599 **2010**	1599 **2010**
ATyS D20 interface	1599 **2020**	1599 **2020**	1599 **2020**	1599 **2020**	1599 **2020**
Terminal shrouds (1 set) (1)(2)					
3 pole top / bottom / front (I) / rear (II)	2694 **3051**	-	-	-	-
4 pole top / bottom / front (I) / rear (II)	2694 **4051**	-	-	-	-
Terminal screens (1 set top and bottom)					
3 pole	1509 **3063**	1509 **3080**	1509 **3080**	1509 **3080**	1509 **3160**
4 pole	1509 **4063**	1509 **4080**	1509 **4080**	1509 **4080**	1509 **4160**
Pre-breaking and signalling of position I and II auxiliary contacts					
2nd AC NO/NC changeover	1599 **0022**	1599 **0032**	1599 **0032**	1599 **0032**	1599 **0032**
Control voltage transformer					
400/230 VAC	1599 **4063**	1599 **4120**	1599 **4120**	1599 **4120**	1599 **4120**
Padlocking (factory fitted)					
"Padlocking in the 3 positions I, 0 and II" option	1599 **0003**	1599 **0004**	1599 **0004**	1599 **0004**	1599 **0004**
Key handle interlocking system (factory fitted)					
Locking using RONIS EL11AP lock in padlocked position	1509 **1006**	1509 **1004**	1509 **1004**	1509 **1004**	1509 **1004**
Mounting spacers					
1 set of 2 spacers	1509 **0001**	-	-	-	-
Door protective surround					
	1539 **0012**	1539 **0080**	1539 **0080**	1539 **0080**	1539 **0080**

(1) To shroud front switch top and bottom 2 references required.
(2) To fully shroud front and rear / top and bottom 4 references required.

Characteristics (according to IEC 60947-6-1)

Thermal current I_{th} (40°C)		**125 A**	**160 A**	**250 A**	**400 A**	**630 A**	**800 A**	**1000 A**	**1250 A**	**1600 A**
Rated insulation voltage U_i (V)		800	800	800	800	1000	1000	1000	1000	1000
Rated impulse withstand voltage U_{imp} (kV)		8	8	8	8	12	12	12	12	12
Rated operational currents I_e (A)										
Rated voltage	Load duty category	B[1]	B[1]	B[1]	B[1]	B[1]	B[1]	B[1]	B[1]	B[1]
415 VAC	AC-31 B	125	160	250	400	630	800	1000	1250	1600
Fuse protected short-circuit withstand (kA rms prospective)										
Prospective short-circuit current (kA rms)		100	100	50	18	70	50	100	100	100
Associated fuse rating (A)		125	160	250	400	630	800	1000	1250	2 x 800
Peak current value: making and breaking (kA peak)		18	18	23	23	45	41	80	80	96
Overload capacity										
Rated short-time withstand current I_{cw} (kA rms)		10 / 30 ms	10 / 30 ms	10 / 30 ms	10 / 30 ms	12,6 / 60 ms	16 / 60 ms	20 / 60 ms	25 / 60 ms	32 / 60 ms
Rated peak withstand current (kA peak)		17	17	17	17	25.2	32	40	52.5	67
Operating class										
Material class		PC	PC	PC	PC	PC	PC	PC	PC	PC
Connection										
Minimum Cu cable section (mm^2)		35	50	95	185	2 x 150	2 x 185	2 x 240	-	-
Minimum Cu busbar section (mm^2)		-	-	-	-	2 x 30 x 5	2 x 40 x 5	2 x 50 x 5	2 x 60 x 5	2 x 80 x 5
Maximum Cu cable section (mm^2)		50	95	150	240	2 x 300	2 x 300	4 x 185	4 x 185	6 x 185
Maximum Cu busbar width (mm)		25	25	32	32	50	63	63	63	100
Min. tightening torque (Nm)		9	9	20	20	20	-	-	20	40
Switching time										
I - II or II - I (s)[2]		0.75	0.75	1.3	1.3	1.3	2.6	2.6	2.6	2.6
I - 0 or II - 0 (s)[2]		0.45	0.45	0.85	0.85	0.85	1.6	1.6	1.6	1.6
Duration of “electrical blackout” (s)		0.3	0.3	0.6	0.6	0.6	1.5	1.5	1.5	1.6
Power-supply tolerance										
Supply 230 VAC min / max (V)		184 / 276	184 / 276	184 / 276	184 / 276	184 / 276	184 / 276	184 / 276	184 / 276	184 / 276
Control supply power demand (during transfer)										
Supply 230 VAC inrush / nominal (VA)		420 / 80	420 / 80	400 / 100	400 / 100	420 / 110	450 / 120	450 / 120	450 / 120	450 / 120
Mechanical characteristics										
Endurance (number of operating cycles)		10 000	10 000	8 000	8 000	5 000	4 000	4 000	4 000	3 000
Weight of 3 p switch (kg)		4	4.1	4.5	5.5	6	20.4	23.9	25.4	36.9
Weight of 4 p switch (kg)		4.1	4.2	4.6	6	6.5	23.9	25.4	30.4	42.9

(1) B: Category with index B = infrequent operation.
(2) Between the order given and the arrival in position (under the nominal conditions).

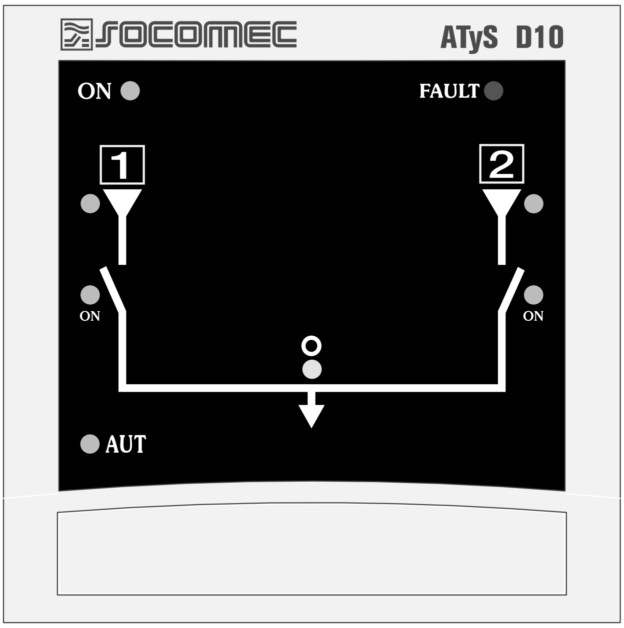
Characteristics (according to IEC 60947-3) see page A.136 “ATyS 3”

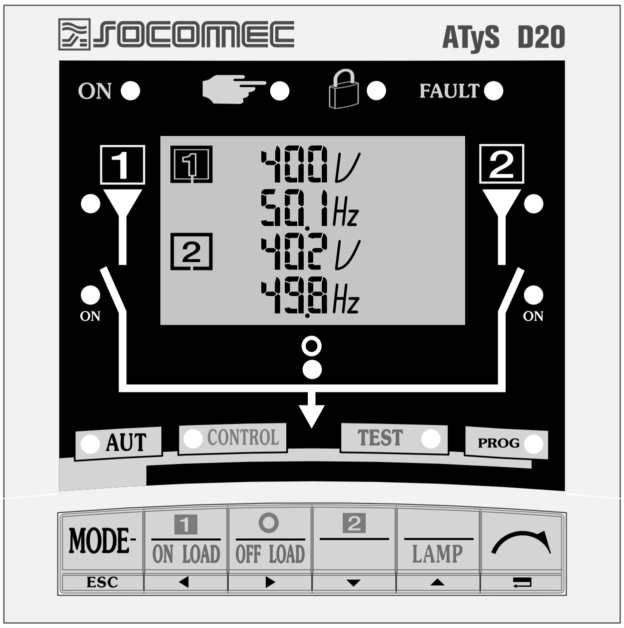
AFFICHEURS DÉPORTÉS - REMOTE INTERFACES

ATyS D10 & D20

Notice d'utilisation - Operating instructions

F GB MAKE YOUR BUSINESS SAFE





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Industrial Switching & Protection Systems

F

Sommaire

GB

Summary

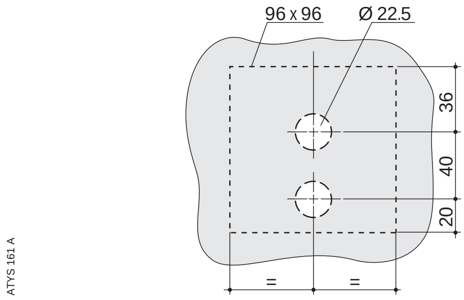
GENERAL PRESENTATION
ATyS D10 & D20

ATyS D10 and D20 models are remote interfaces designed for easy integration on front panels. They can be connected to ATyS 6e, 6m and C30 products to allow remote access to display or control features.

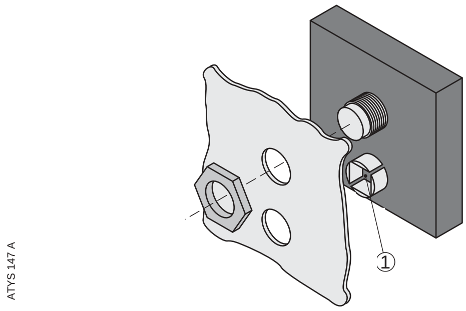
INSTALLATION
ATyS D10 & D20

Mounting

- Door fixing: 2 holes, diameter 22.5 mm
- Maximum thickness of the door: 20 mm



Door drilling



(1) RJ45 plug for ATyS connection

Connection

Connection only on AtyS 6e, 6m or C30 products.

> Cable

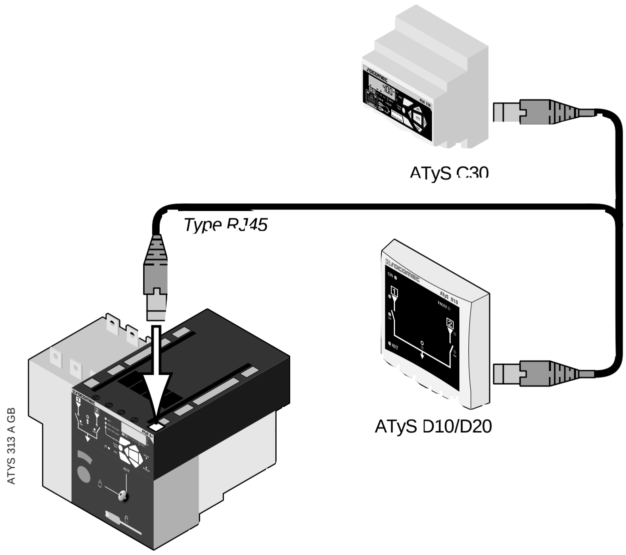
RJ45 type 8/8 not isolated

> Maximum cable length

3 m

> Tightning torque

4 N.m



Characteristics

> IP

IP21 standard
IP54 using gasket

> Operation

- Temperature: -10 to + 55 °C
- hygrometry: 80 % humidity at 55 °C
  95 % humidity at 40 °C

OPERATION
ATyS D10

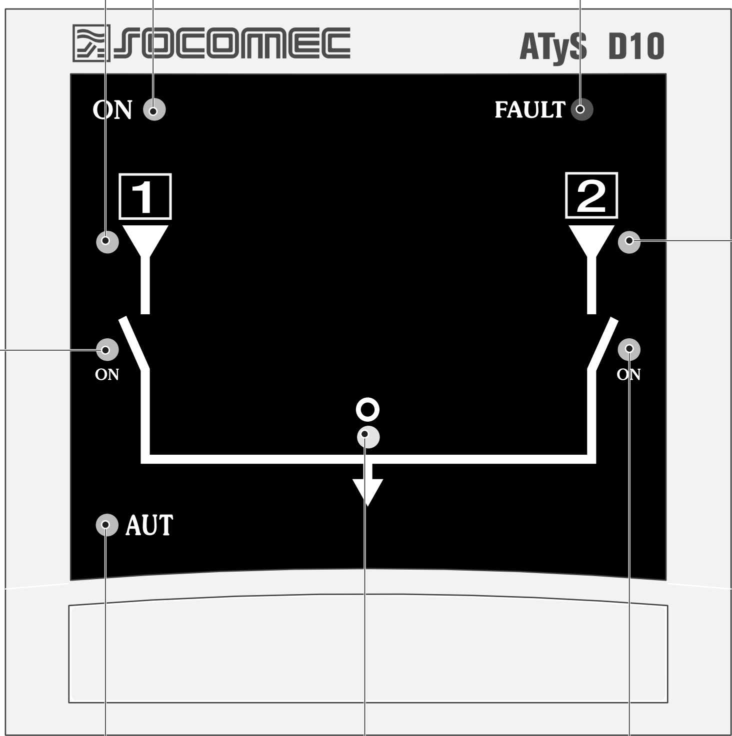
Display

ATyS D10 allows remote display of transfer system positions, sources availability and operational mode. Programming and operations remain available directly on master product (ATyS 6e, 6m or C30).

- ATyS Product faulty, transfer error
- Possible to reset after error disappearance the power supplies of the master product (ATyS 6e, 6m, C30) for 3 minutes

Source 1 available

Power On



Source 2 available

Transfer system in position 1

Transfer system in Automatic mode

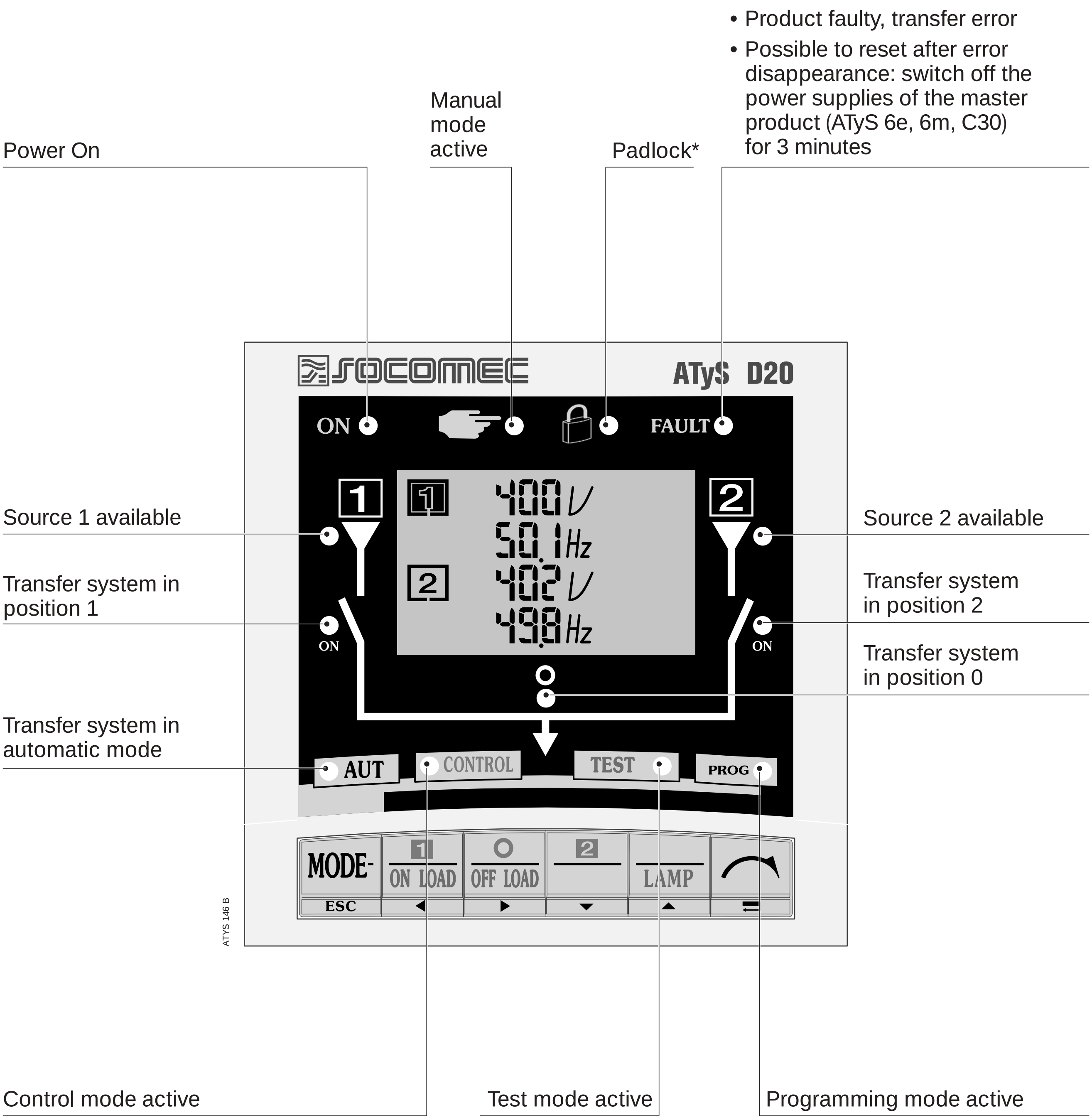
Transfer system in position 0

Transfer system in position 2

OPERATION
ATyS D20

Display

ATyS D20 allows remote display of transfer system positions, sources availability, operational mode and metering. Programming and operations (Test and Control) are also available. Master product (ATyS 6e, 6m or C30) display is deactivated as soon as the remote interface is connected.



* only on ATyS 6e and 6m

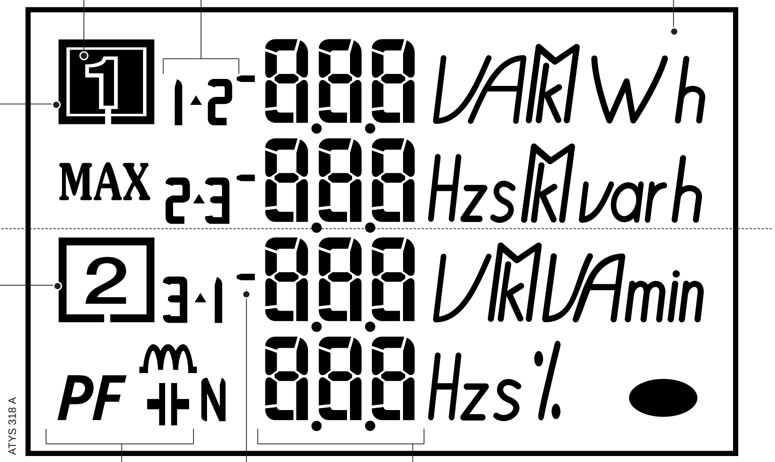
Display

Priority source

Phases (wires) displayed

Units

Informations
• source 1
• source 2
• sources 1 & 2
(split screen)

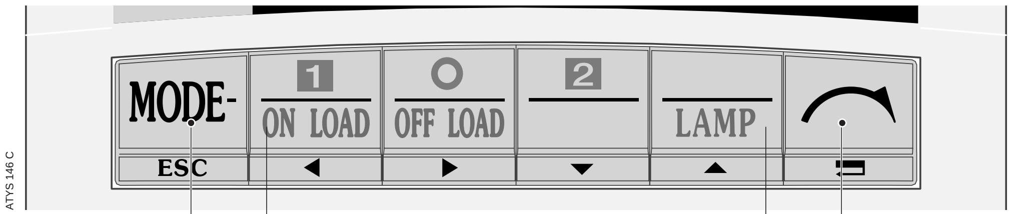


Power factor
Capacitive or inductive

Signed
values
(power)

Values

Keypad



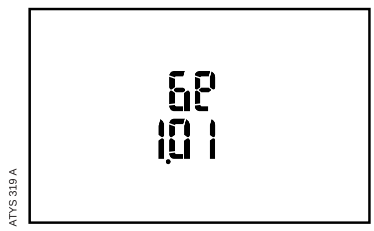
Access to AUT, Test, Control and Prog modes

Direct Access to Test and Control functionalities or navigation

Allows main menu access in visualisation mode or validation

Software version

Software version of the master product is displayed immediately after ATyS 6e, 6m or C30 power on.

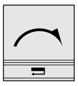


OPERATION
ATyS D20

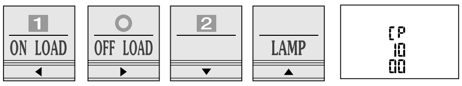
Programming

> Enter into programming mode

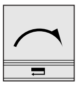
• **Step 1:** Press the “mode” push button until Prog led is blinking



• **Step 2:** Press “validation” push button. PROG led becomes fixed and access code is displayed



• **Step 3:** Enter access code (1000 factory default) using keypad “left”, “right”, “top” and “bottom”



• **Step 4:** Press “validation” push button to enter programming mode

> Programming mode exit

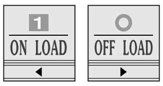
• **Step 1:** Press the “ESC” push button when not entering any value, to come back to main programming menu

• **Step 2:** Press again on “ESC” push button to exit programming

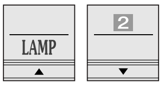
New Active mode (Automatic or Manual) depends on information from the master device (ATyS 6e, 6m ou C30)

Programming

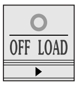
> Navigation in programming mode



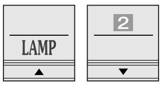
• Step 1: To access required menu, press navigation push buttons "left" and "right"



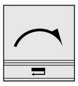
• Step 2: To access parameter to modify press navigation push buttons "top" and "bottom"



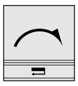
• Step 3: To modify the parameter, press push button "right" to make the required parameter blinking



• Step 4: Press push buttons "top" and "bottom" to increment or decrement the value of the parameter



• Step 5: Press "validation" push button to validate



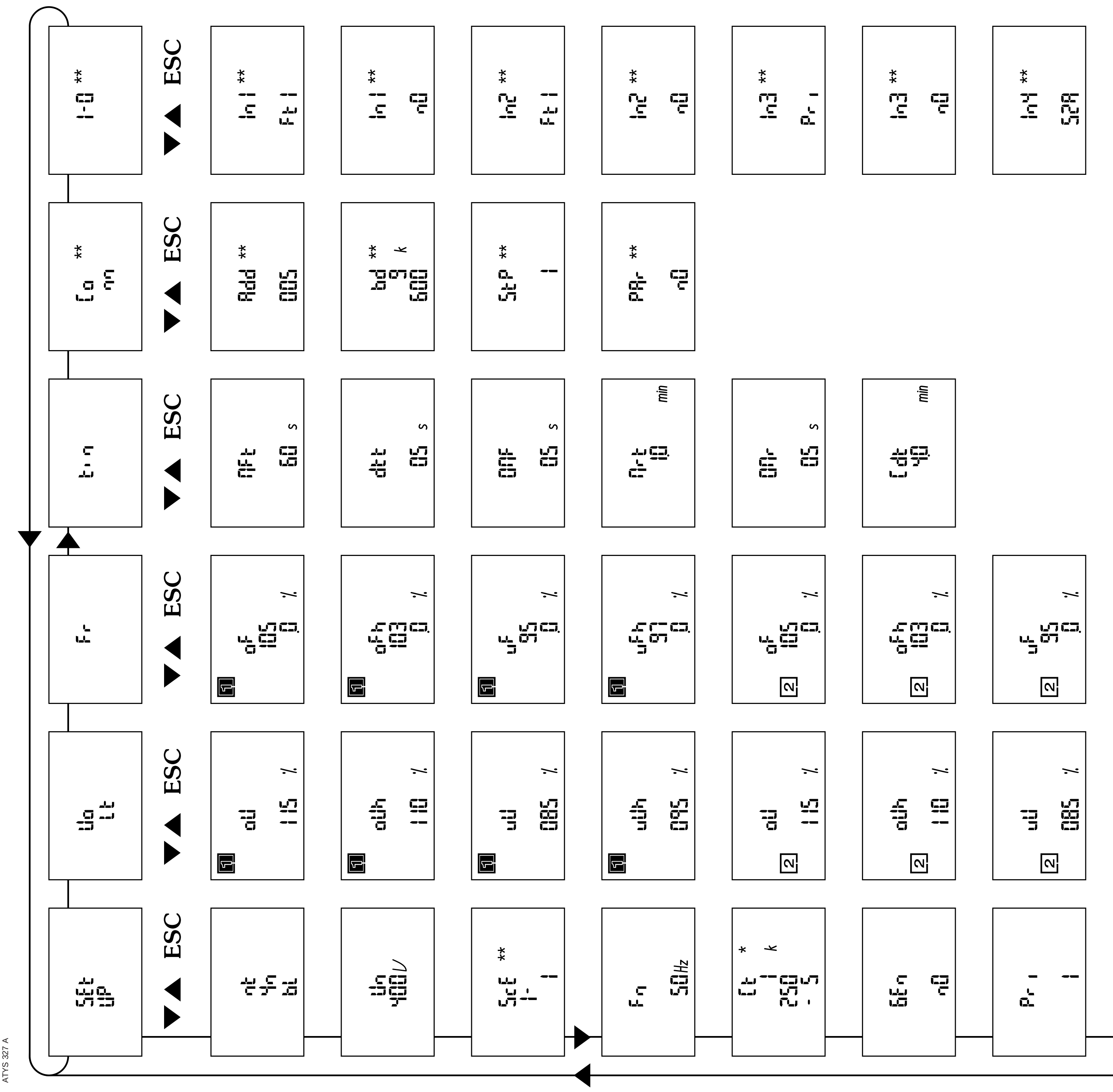
In case of parameter displayed on 2 lines, press "validation" push button after first line modification to access next one

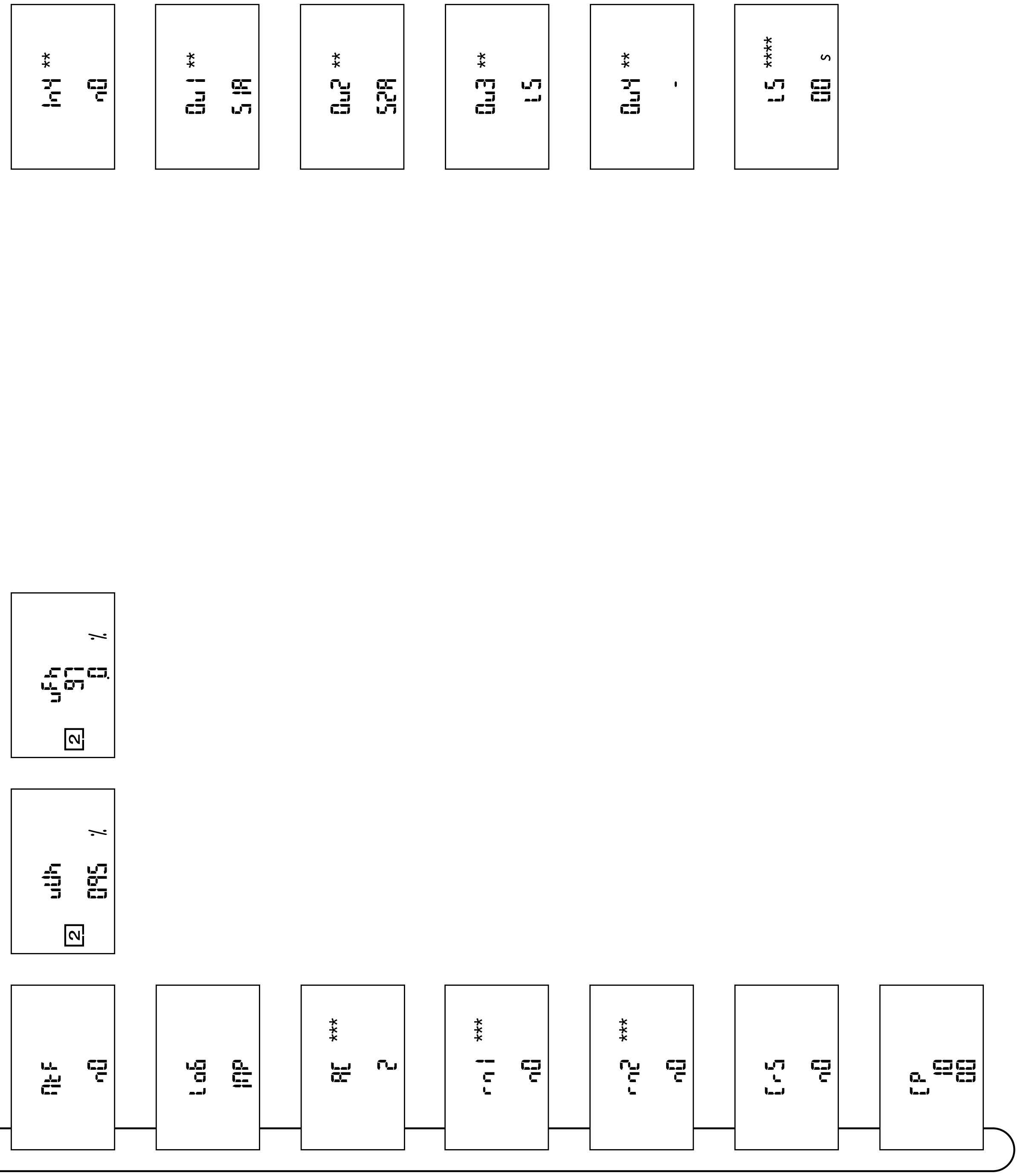
"ESC" push button allows to come back to main menu or to cancel the modification

OPERATION
ATyS D20

Programming

ARCHITECTURE OF THE PROGRAMMING MENU





*   only on Atys 6m
**   option on ATyS 6e & 6m
*** only on ATyS C30
**** visible if option LS selected and active

OPERATION
ATyS D20

Programming

VARIABLES CHARACTERISTICS

> Setup

LCD	Denomination	Setting range	Default values
nt	Type of network (cf. ATyS 6 or C30 instruction manual)	1BL, 2BL, 2NBL 3NBL, 4NBL, 41NBL, 42NBL	4NBL
Un	Network Nominal voltage Phase-Neutral voltage for 1BL & 41NBL Phase-Phase voltage for others	100 to 480 V	400 V
ScE**	Source 1 - Switch I or II configuration Source 1 (controlled and displayed) linked to switch I or II (depending on cabling)	I, II	I
Fn	Network nominal Frequency	50 or 60 Hz	50 Hz
Ct*	CTs primary current (5 A secondary CT)	50 to 5000 / 5 A	500 / 5 A
Gen	Genset start signal state Normally opened or closed	NO, NC	NO
Pri	Network priority selection Keypad selection (1 or 2) Also possible via external contact Using option	1, 2	1
Mtf	Manual Retransfer Activation of the feature	Yes, No	No
LoG	Type of control logic selection Impulse, contactor or breaker***	IMP, CON, brE***	IMP
AC***	Number of position auxiliary contacts used, depending on transfer device type (switch, contactor, breaker)	0, 2, 3	2
rn1	Allows 0 position command after loss of main source (source 1)	Yes, No	No
rn2	Allows 0 position command after loss of emergency source (source 2)	Yes, No	No
CrS	Number of permutation counter Reset	Yes, No	No
CP	Programming code modification Possible to change the code	0001 to 9999	1000

* only on AtyS 6m
** only on ATyS 6e & 6m
*** only on ATyS C30.

Programming

> Voltage thresholds

LCD	Denomination	Setting range	Default values
oU	Network 1 over voltage threshold	102 - 120 %	115 %
oUh	Network 1 over voltage threshold hysteresis	101 - 119 % (< oU)	110 %
uU	Network 1 under voltage threshold	80 - 98 %	85 %
uUh	Network 1 under voltage threshold hysteresis	81 - 99 % (> uU)	95 %
oU	Network 2 over voltage threshold	102 - 120 %	115 %
oUh	Network 2 over voltage threshold hysteresis	101 - 119 % (< oU)	110 %
uU	Network 2 under voltage threshold	80 - 98 %	85 %
uUh	Network 2 under voltage threshold hysteresis	81 - 99 % (> uO)	95 %

Values defined are % of nominal values.
Hysteresis thresholds must be programmed according to over and under voltage thresholds (respectively under & above).

> Frequency thresholds

LCD	Denomination	Setting range	Default values
oF	Network 1 over frequency threshold	101 to 120 %	105 %
oFh	Network 1 over frequency threshold hysteresis	100.5 - 119.5 % (< oF)	103 %
uF	Network 1 under frequency threshold	80 - 99 %	95 %
uFh	Network 1 under frequency threshold hysteresis	80.5 - 99.5 % (> uF)	97 %
oF	Network 2 over frequency threshold	101 - 120 %	105 %
oFh	Network 2 over frequency threshold hysteresis	100.5 - 119.5 % (< oF)	103 %
uF	Network 2 under frequency threshold	80 - 99 %	95 %
uFh	Network 2 under frequency threshold hysteresis	80.5 - 99.5 % (> uF)	97 %

Values defined are % of nominal values.
Hysteresis thresholds must be programmed according to over and under frequency thresholds (respectively under & above).

OPERATION
ATyS D20

Programming

> Timers

LCD	Denomination	Setting range	Default values
Mft	Main Failure Timer Delays priority network failure detection	From 0 to 60 s	5 s
dtt	Delay on transfer timer Emergency network stability validation before transfer	From 0 to 60 s	5 s
OMf	O Main Failure Timer Rest in O position when transferring from main network to emergency network	From 0 to 20 s	0 s
Mrt	Main Return Timer Main network stability validation before re-transfer	From 0 to 30 min	1 min
OMr	O Main Return Timer Rest in O position when re-transferring from emergency network to main network	From 0 to 20 s	5 s
Cdt	Cool Down Timer Allows generator cooling down period after load's retransfer from emergency source (generator) to Main source	From 0 to 10 min	4 min

> Communication

Only on ATyS 6e or 6m in case of optional communication module.

LCD	Denomination	Setting range	Default values
Add	Device address	1 to 247	5
bd	Communication speed	2400, 4800, 9600, 19200, 38400	9600
StoP	Stop bit	1, 2	1
PAr	Parity bit	No, Odd, Even	No

Programming

> Inputs / Outputs

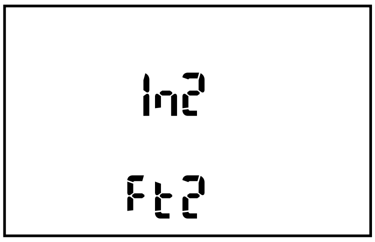
- 2 inputs (In1, In2) and 2 outputs (Ou1, Ou2) as standard on ATyS C30.
- Possibility to connect 2 modules 2 Inputs / 2 Outputs on ATyS 6e & 6m.

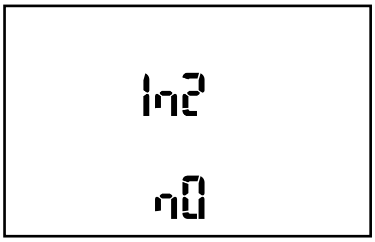
- First module: In1, In2, Ou1, Ou2
- Second module In3, In4, Ou3, Ou4.

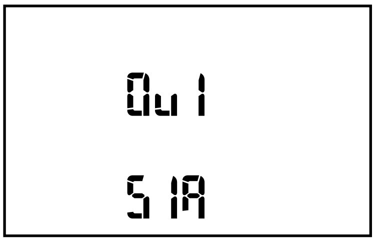
⚠ Refer to ATyS C30, 6e or 6m instruction manual for terminals identification.

Input / Output	Function	Relay State
I1 to I4	Ft1, Ft2, Ft3, Ft4, Pri, Mtf, S2A, Man, TOL, TFL, EJP, CTS	NO or NC
O1 to O4	S1A, S2A, LS, /	NO

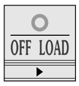
- Input (In2, Ft2) and output (Ou1, S1A) programming example:



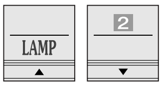




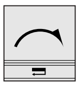
ATYS 328 A



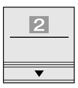
- Step 1: Press “right” push button to make first variable blinking (Ft2 ou S1A)



- Step 2: press “top” and “bottom” push buttons to modify the variable



- Step 3: press “validation”



- Step 4: press “bottom” push button to acces nO variable selection

OPERATION
ATyS D20

Programming

• Variables description
Inputs

Variable	Description
Ft1	Fault input 1. The fault led is blinking as soon as the input is active and Ft1 is displayed on LCD. Reset when the input is de-activated
Ft2	Fault input 2. The fault led is blinking as soon as the input is active and Ft2 is displayed on LCD. Reset when the input is de-activated
Ft3*	Fault input 3. The fault led is blinking as soon as the input is active and Ft3 is displayed on LCD. The transfer switch is immediately driven in 0 position. Keypad action (Esc) necessary to Reset the fault
Ft4*	Fault input 4. The fault led is blinking as soon as the input is active and Ft4 is displayed on LCD. The transfer switch is immediately driven in 0 position. Keypad action (Esc) necessary to Reset the fault
Pri	Priority network selection. Network 1 has priority when input is not activated. Network 2 has priority if input is active
Mtf	Remote manuel re-transfer. Feature identical to manual re transfert on keypad. Re-transfer from priority network to backup network is allowed from input activation (1 s front). The Mtf variable in the setup menu must be selected (Yes) to allow input recognition
S2A	Information source 2 available (Genset) used instead of voltage / frequency measurement from ATyS (inhibited when S2A is selected)
Man**	Information transfer system in manual mode. All automatic commands (+ test on load and control commands) are inhibited as soon as the input is activated
CTS**	Remote transfer control. Possible to initiate transfer from priority source to backup source before DTT ends. If DTT is set to its maximum value (60s), the transfer is initiated as soon as the input is activated (1 s front)
TOL**	Remote test on load. Started from input activation. Re-transfer is blocked until input de-activation
TFL	Remote test off load. Started from input activation (remote genset start / stop)
EJP	2 inputs one automatically affected to EJP • input 1 for EJP advice, to start generator • input 2 to transfer on emergency source Retransfer is activated when input 2 disapears

* only on ATyS C30, specific fault operation (Ft2 and Ft3)
** only as option on ATyS C30, standard features on ATyS 6e et 6m.

Outputs

Variable	Description
S1A	Source 1 available. Output activated as soon as source 1 is considered available (similar to front led source 1)
S2A	Source 2 available. Output activated as soon as source 2 is considered available (similar to front led source 2)
LS	Load shedding relay. LS timer corresponds to time available to disconnect the shed loads. The relay is activated before permutation on standby network according to LS timer. The relay is de-activated after retransfer on mains network and LS timer countdown

Programming

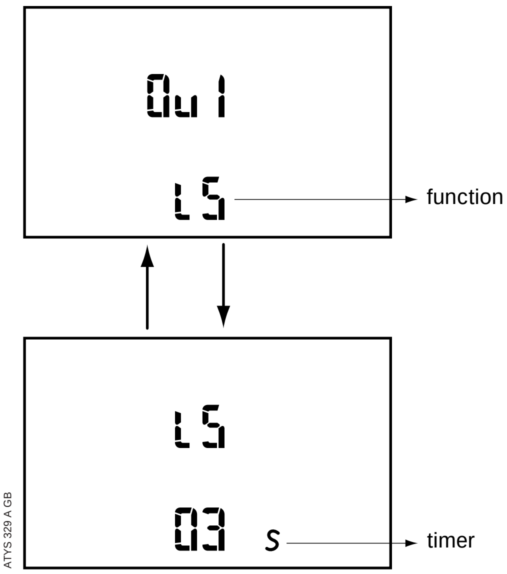
LOAD SHEDDING CONFIGURATION

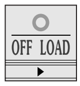
LS variable allows associated LS timer configuration.

Output	Associated funciton	Setting range	Default value
O1 to O4	LS	0 to 60 s (≤ DTT)*	2

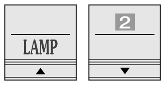
* In case of DTT variable configuration below LS, LS will be automatically set to to DTT value.

> Example: load shedding configuration

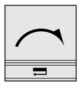




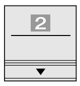
- Step 1: Press “right” push button to make first variable blinking (LS)



- Step 2: press push buttons “top” and “bottom” to modify the variable



- Step 3: Press “validation”



- Step 4: Press “bottom” push button to access timer value configuration

OPERATION
ATyS D20

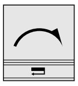
Control and Test modes

It is possible to start test sequences or to control electrically the changeover system from keypad.

NAVIGATION

> Enter Control or Test modes

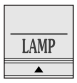
• Step 1: Press “mode” push button to make test or control led blinking


• Step 2: Press “validation” push button to make control or test led become fixed

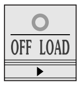
CONTROL MODE 

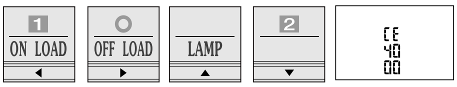
Access code is displayed directly

TEST MODE 

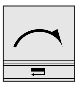
It is possible to test leds and LCD without entering any code by pressing directly 

Test on load or test off load access codes are displayed after pressing 

or 



Enter the code 4000 using “left”, “right”, “top” and “bottom” push buttons


Press “validation” push button to enter

Control and Test modes

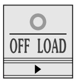
> Exit control or test modes

Press “ESC” push button

The new operational mode (automatic or manual) depends on information from master ATyS (6e, 6m ou C30)

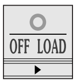
> Control or Test modes use

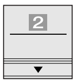
Direct access by pressing 

and 

To start a test (off load or on load) or to control the changeover switch electrically,

press 

, 

and 

push buttons

OPERATION
ATyS D20

Operational sequences

Refer to ATyS 6e, 6m or C30 manuals for more information on operational sequences and controls:
- sources control,
- tests cycles,
- loss of priority source sequence,
- priority source return sequence.

Visualisation

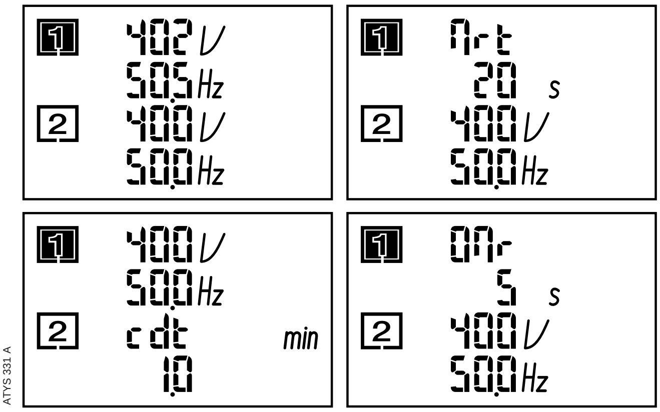
It is possible to display controlled parameters in both automatic and manual modes (but not during programming).
No code is required to perform visualisation.
Permutation cycles have priority over visualisation and display timer countdown during cycle operation.

Without keypad activation or any operational sequence during 5 minutes, the LCD comes back to default display mode and stops the backlight.

> If both sources are available:

- One visualisation screen is split into 2 parts and displays simultaneously voltage and frequency values on both networks.
- If a timer is active, on one of the source, its countdown is displayed instead of voltage and frequency values.

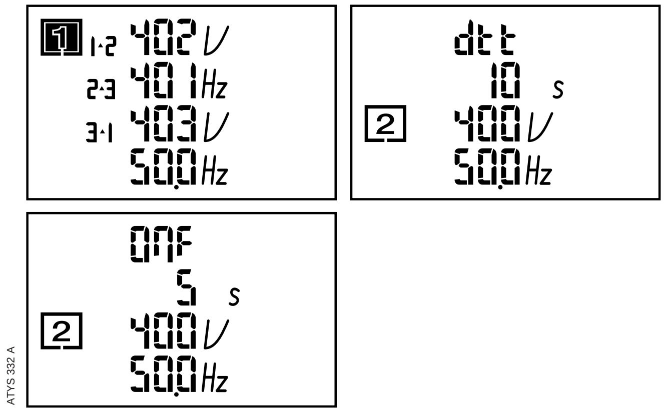
Examples:

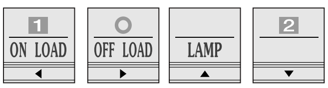


> If only one source is present:

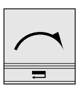
- During permutation cycle, voltage and frequency values of the available source (active) are displayed on 2 lines. The name of the active timer and its countdown are displayed on remaining 2 lines.
- Out of a permutation cycle, phase to phase voltages and frequency are displayed.

Examples:





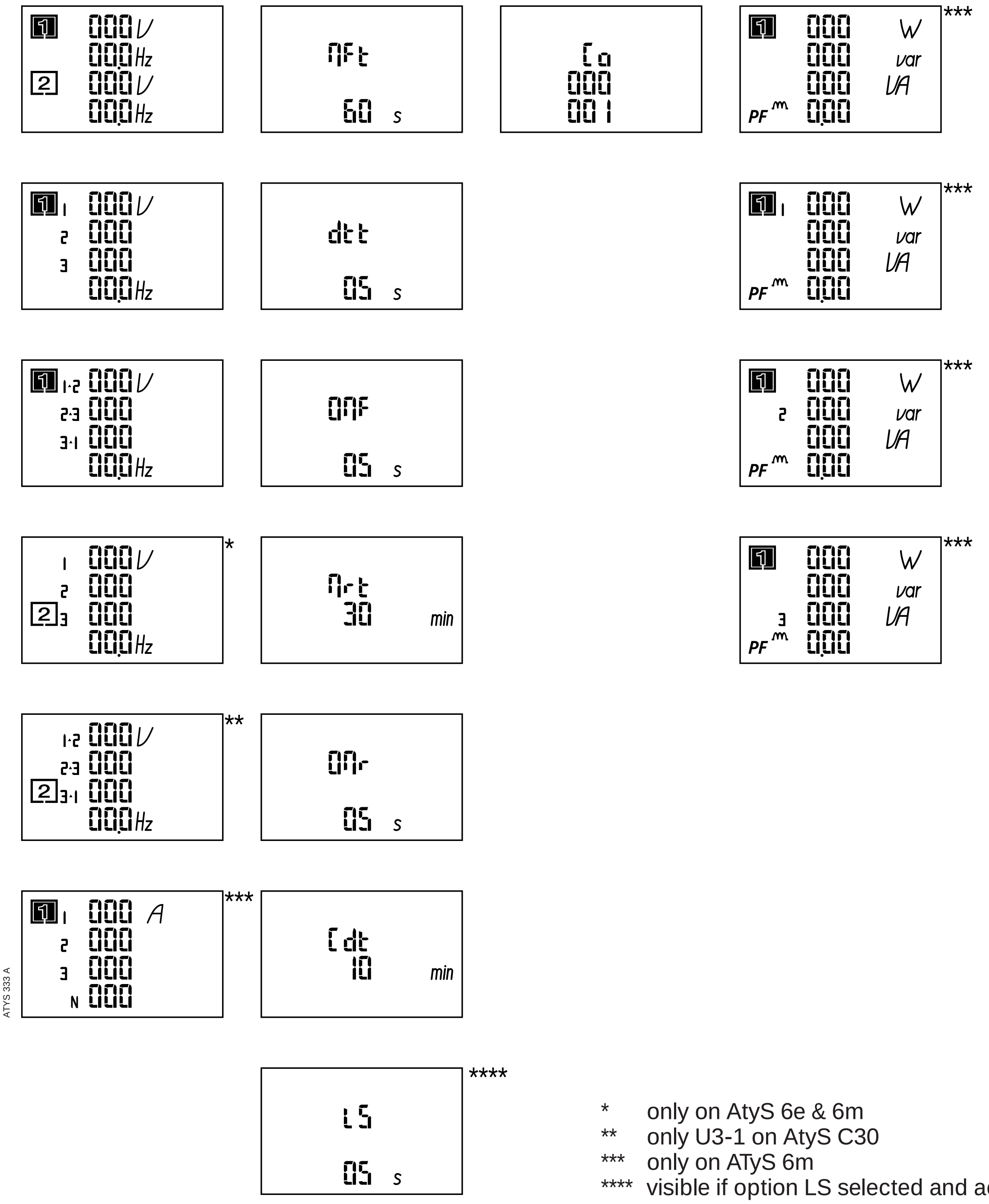
Press “left”, “right”, “top” & “bottom” push buttons to access available screens



Press “navigation” push button to navigate in visualisation, displaying all available screens

Visualisation

ARCHITECTURE OF VISUALISATION MENU



* only on AtyS 6e & 6m
** only U3-1 on AtyS C30
*** only on ATyS 6m
**** visible if option LS selected and active

HEAD OFFICE

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Systèmes de Coupure et de Protection
Industrial Switching & Protection Systems

2. Moulded Case Circuit Breaker

Halmac Services (Qld) Pty. Ltd.
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A.B.N. 40 741 712 113

MOULDED CASE CIRCUIT BREAKER

1. S630CE MCCB TECHNICAL DETAILS
2. S400GE MCCB TECHNICAL DETAILS
3. S125GJ MCCB TECHNICAL DETAILS
4. XS125 MCCB TECHNICAL DETAILS
5. MCCB ACCESSORIES

TERASAKI Innovators in Protection Technology — TemBreak2 **MCCB's**

NHP

Electronic type
S630CE

50kA

Current rating: **252 – 630A**

Approvals and Tests: AS/NZS 3947-2, IEC60947-2

Interrupting capacity:

	Voltage	Icu	Ics
AC use	380/415	50	50

Over Current Relay:

- Electronic, for general & selectivity applications
- 6 dial selectable characteristic curves suited for a variety of applications
- Base current *Ir* is adjustable from 40% - 100% of the nominal rated current *In*.
- STD setting 2.5 – 8 **(x I_R)** 2)
- INST setting 10 – 14 **(x I_R)** 2)

OCR Options:

- Ground Fault Trip (AG)
- Neutral Pole protection for 4 pole MCCBs ONLY(AN)
- Pre-Trip Alarm (AP)

Dimensions (mm)

Poles	3	4
H	260	260
W	140	185
D (less toggle)	103	103

Ampere ***Rating*** **NRC**	**I_R Adjust.** Min - Max.	**Cat. No.** 1)
630	252 - 630	**S630 CE _ 630**

Price Adder - if options are required, add the selected OCR option price below to the above MCCB price to calculate the total MCCB cost.

3 P OCR options:	PTA 3)	**S630 CE 3 AP 630**
	GF 3)	**S630 CE 3 AG 630**
	PTA + GF 3)	**S630 CE 3 APG 630**
4 P OCR options:	PTA 3)	**S630 CE 4 AP 630**
	AP 3)	**S630 CE 4 AN 630**
	PTA + NP 3)	**S630 CE 4 APN 630**
	GF + NP 3)	**S630 CE 4 AGN 630**
	PTA + GF + NP 3)	**S630 CE 4 APGN 630**

1) Add poles to complete MCCB catalogue number. Eg: 3 pole 630A: E630NE 3 630

2) The STD and Instantaneous pickup currents (I_{sd} & I_i) settings are not individually adjustable, however by selecting different curve types and different I_R settings the values will vary. Curve 1 & 2 I_{sd} = 2.5 x I_R, curve 3 I_{sd} = 5 x I_R, curve 4 - 6 I_{sd} = 8 x I_R . I_R dial setting 0.4 – 0.63 I_i = 14 x I_R and I_R dial setting 0.8 – 1.0 I_i = 10 x I_R. Refer curve examples & setting data on pages 18 to 30.

NRC **= Nominal rated current,** ***I_R*** **= Current adjustment dial setting,** ***STD*** **= Short Time Delay,** ***INST*** **= instantaneous**

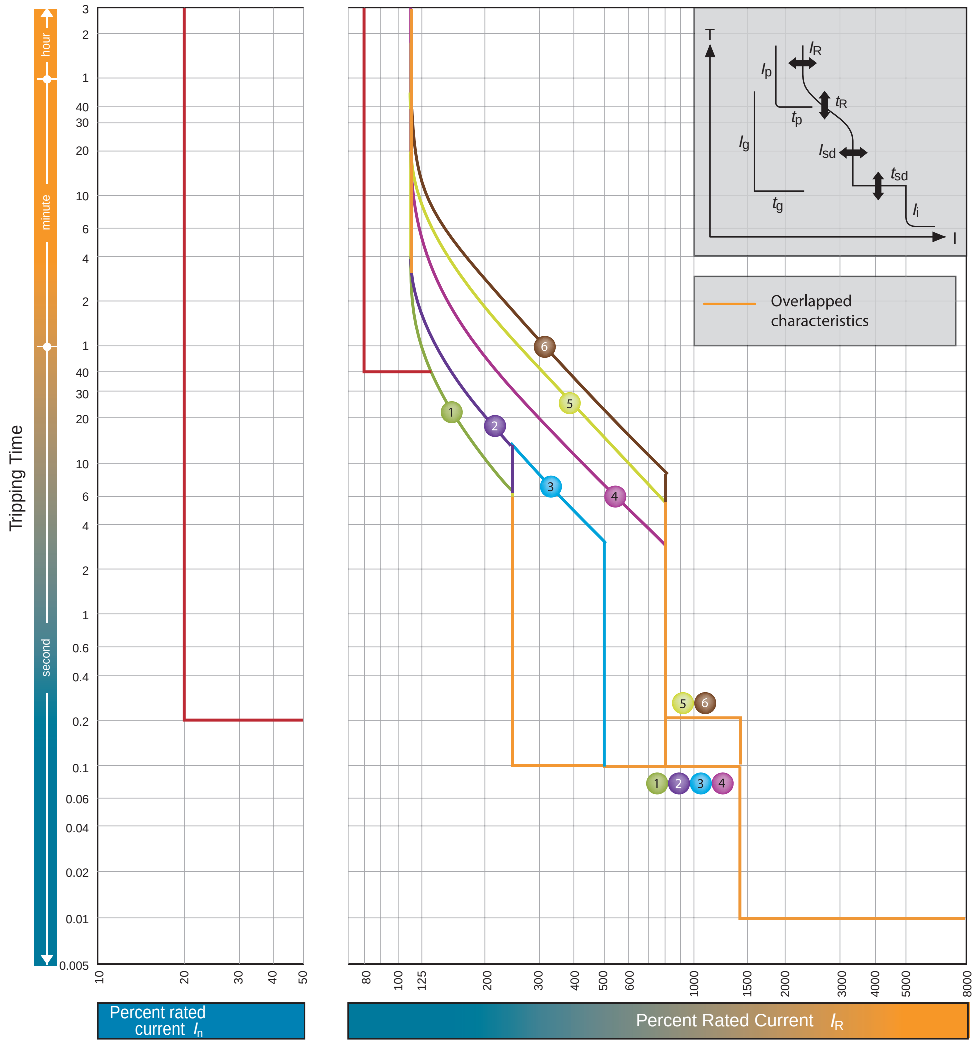
3) To order a MCCB with the above options insert the required option after the pole to make up the cat. number. Eg: S630CE 3 **AG** 630 is a S630CE 3 Pole 630A MCCB c/w Ground Fault protection.

Replaces: XS630SE, XS630NJ, *Note: check exact ratings or dimenions to suit your application requirement*

OPERATING CHARACTERISTICS

ELECTRONIC CHARACTERISTICS

E630-NE, S630-CE, S630-GE



In = 630A

I_R (A)									
LTD Pick-up current I_R	xI_n	0.4	0.5	0.63	0.8	0.85	0.9	0.95	1.0

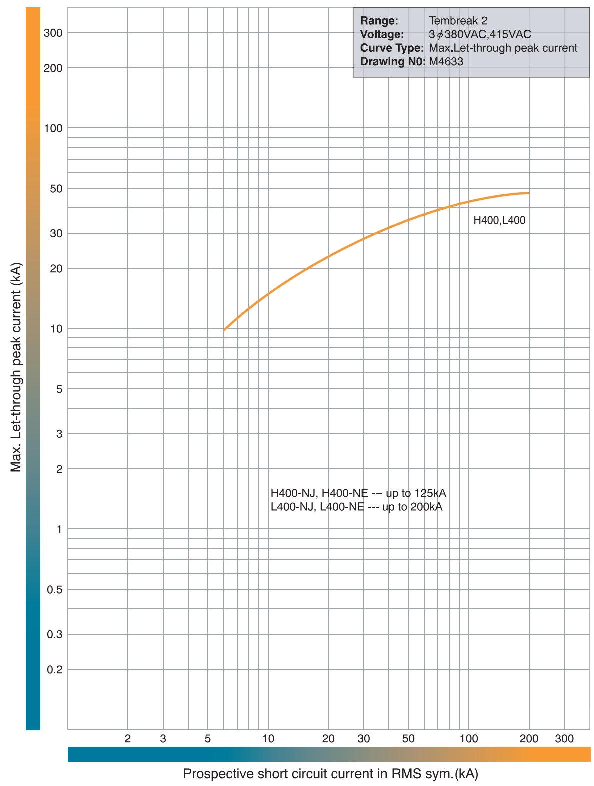
	Characteristics		No.	1	2	3	4	5	6
Standard	LTD	t_R	(s)	11	21	21	5	10	16
				at 200% x I_R			at 600% x I_R		
	STD	I_{sd}	xI_R	2.5		5	8		
		t_{sd}	(s)	0.1			0.2		
	INST	I_i	xI_R	14(Max: 10 x I_n) Note (1)					
Option	PTA	I_p	xI_R	0.8					
		t_p	(s)	40					
	GFT	I_g	xI_n	0.2					
		t_g	(s)	0.2					
	N	I_N	xI_n	1.0					
		t_N	(s)	t_N=t_R Note(2)					

Note
(1) I_i max. = 10 x I_n. (2) Standard setting of I_N is 100% of I_n. For any other setting please specify when ordering.

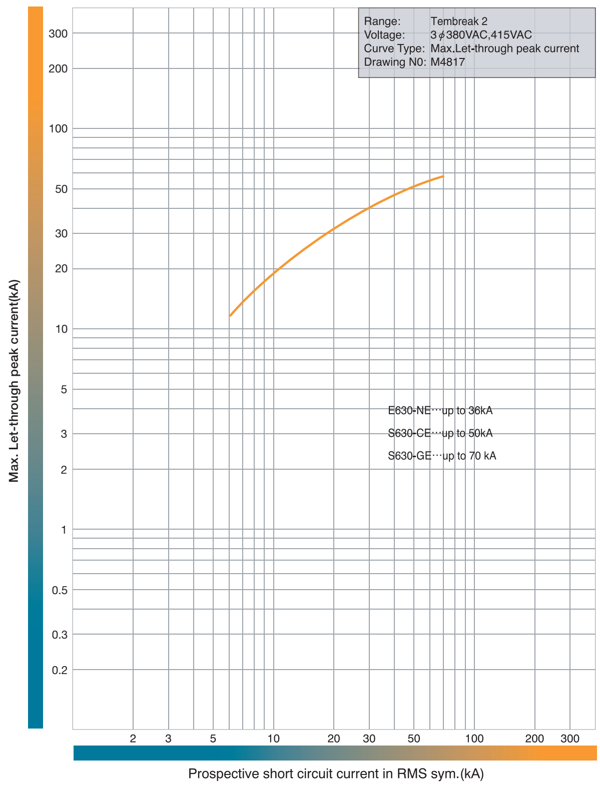
OPERATING CHARACTERISTICS

LET-THROUGH PEAK CURRENT CHARACTERISTICS

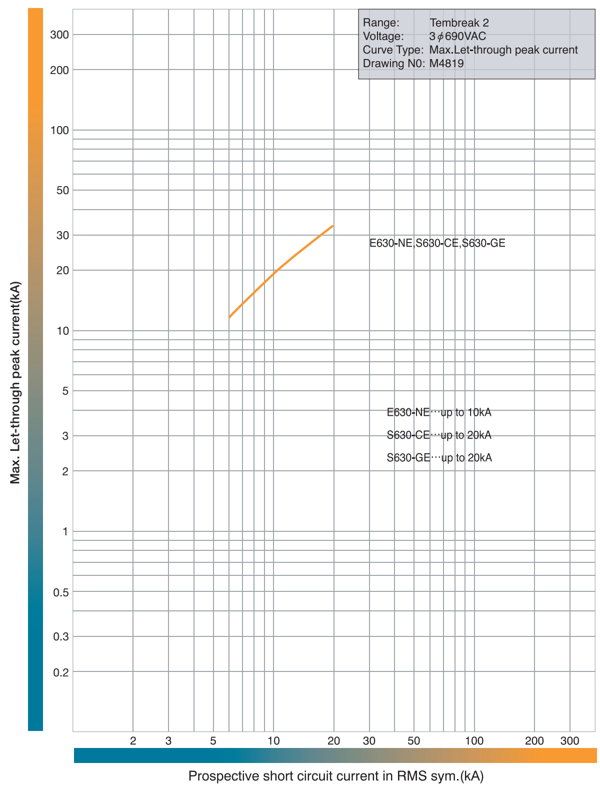
H400-NJ, H400-NE, L400-NJ, L400-NE. 415V AC.



E630-NE, S630-CE, S630-GE. 415V AC.



E630-NE, S630-CE, S630-GE. 690V AC.



APPLICATION DATA

SELECTIVITY TABLES

Selectivity & Cascade Tables @ 400 / 415 V

XX / YY Selectivity/ Cascade

Downstream MCCBs	Upstream MCCBs kA (RMS)	S250PE 70	H250NE 125	S400NE 50	S400GE 70	H400NE 125	L400NE 200	E630NE 36	S630CE 50	S630GE 70	TL630NE 125	XS800SE 50	XH800SE 65	TL800NE 125	XS1250SE 85	TL1250NE 125	XS1600SE 100	XS2000NE 85	XS2500NE 85
E125NJ	25	25/25	25/65	25/36	25/50	25/65	25/85	25/36	25/25	25/50	25/25	25/36	25/36	25/65	25/25	25/25	25/25	25/25	25/25
S125NJ	36	36/36	36/85	36/50	36/65	36/85	36/125	36/36	36/36	36/65	36/36	36/50	36/36	36/36	36/36	36/36	36/36	36/36	36/36
S125GJ	65	65/65	65/125	50/50	65/70	65/125	65/150	36/36	50/50	65/70	65/65	65/50	65/65	65/65	65/65	65/65	65/65	65/65	65/65
H125NJ	125	70/70	125/125	50/50	70/70	125/125	125/200	36/36	50/50	70/70	70/70	50/50	65/65	65/65	85/50	85/50	100/100	85/85	85/85
S160NJ	36			36/50	36/65	36/85	36/125	36/36	36/50	36/50	36/36	36/36	36/65	36/65	36/36	36/36	36/36	36/36	36/36
S160GJ	65			50/50	65/70	65/125	65/150	36/36	50/50	65/70	65/65	50/50	50/65	50/65	65/65	65/65	65/65	65/65	65/65
H160NJ	125					125/125	125/200	36/36	50/50	70/70	70/70	50/50	50/65	50/65	85/65	85/65	100/100	85/85	85/85
E250NJ	25					25/65	25/85	25/36	25/25	25/50	25/25	25/25	25/50	25/50	25/25	25/25	25/25	25/25	25/25
S250NJ	36					36/85	36/125	36/36	36/36	36/65	36/36	36/36	36/36	36/36	36/36	36/36	36/36	36/36	36/36
S250GJ	65					65/125	65/150	36/36	50/50	65/70	65/65	50/50	50/65	50/65	65/65	65/65	65/65	65/65	65/65
S250PE	70					40/125	70/150	36/36	50/50	70/70	70/70	50/50	50/65	50/65	70/70	70/70	70/70	70/70	70/70
H250NJ	125					125/125	125/200	36/36	50/50	70/70	70/70	50/50	50/65	50/65	85/85	85/85	100/100	85/85	85/85
H250PE	125					125/125	125/200	36/36	50/50	70/70	70/70	50/50	50/65	50/65	85/85	85/85	100/100	85/85	85/85
E400NJ	25							10/25	10/25	10/50	10/36	25/25	25/25	25/36	25/25	25/25	25/36	25/25	25/25
S400CJ	36							10/36	10/36	10/65	10/50	25/36	25/36	25/50	36/36	36/36	36/50	36/36	36/36
S400NE	50							10/36	10/50	10/50	10/50	25/50	25/50	25/50	50/50	50/50	50/50	50/50	50/50
S400NJ	50							10/36	10/36	10/70	10/65	25/50	25/50	25/65	50/50	50/50	50/65	50/50	50/50
S400GJ	70							10/36	10/50	10/70	10/70	25/50	25/50	25/65	70/36	70/36	70/85	70/70	70/70
H400NJ	125							10/36	10/50	10/70	10/70	25/50	25/65	25/65	125/85	125/85	125/100	125/85	125/85
H400NE	125							10/36	10/50	10/70	10/70	25/50	25/65	25/65	125/85	125/85	125/100	125/85	125/85
E630NE	36											25/36	25/36	25/36	36/36	36/36	36/36	36/36	36/36
E630CE	50											25/50	25/50	25/50	50/50	50/50	50/50	50/50	50/50
S630GE	70														70/70	70/70	70/70	70/70	70/70
XS630CJ	45														30/45	30/45	30/45	35/45	35/45
XS630NJ	65														30/65	30/65	30/65	35/65	36/65
XS630PJ	85														30/85	30/85	30/85	35/85	35/85
XS630SE	50														30/65	30/65	30/85	30/85	30/85
XH630SE	65														30/65	30/65	30/85	30/85	30/85
XH630PE	65														30/65	30/65	30/85	30/85	30/85
XS800NJ	65														15/65	15/65	20/65	35/65	35/65
XS800SE	50														15/50	15/50	20/50	35/50	35/50
XJ800PJ	85														15/85	15/85	20/85	35/85	35/85
XH800SE	65														15/65	15/65	20/65	35/65	35/65
XH800PE	65														15/65	15/65	20/65	35/65	35/65
XS1250SE	65																20/65	35/65	35/65
XS1600SE	85																	35/85	35/85

SECTION 4

APPLICATION DATA

CASCADE TABLES

CASCADE @ 380 – 415 V AC [1]) Downstream MCCBs	kA (RMS)	E125NJ	S125NJ	S125GJ	H125NJ	L125NJ	S160NJ	S160GJ	H160NJ	L160NJ	E250NJ	S250NJ	S250GJ	S250PE	H250NJ	H250NE	L250NJ
		25	36	65	125	200	36	65	125	200	25	36	65	70	125	125	200
E125NJ	25	–	36	36	65	85	36	36	65	85	–	36	36	–	65	65	85
S125NJ	36	–	–	50	85	125	–	50	85	125	–	–	–	–	85	85	125
S125GJ	65	–	–	–	125	150	–	–	125	150	–	–	65	–	125	125	150
H125NJ	125	–	–	–	–	200	–	–	-	200	–	–	65	–	–	–	200
S160NJ	36	–	–	65	–	–	–	65	85	125	–	–	65	65	85	85	125
S160GJ	65	–	–	–	–	–	–	–	125	150	–	–	–	70	125	125	150
H160NJ	125	–	–	–	–	–	–	–	–	200	–	–	–	-	–	–	200
S250NJ	36	–	–	–	–	–	–	65	–	–	–	–	–	65	85	85	125
S250GJ	65	–	–	–	–	–	–	–	–	–	–	–	–	70	125	125	150
S250PE	70	–	–	–	–	–	–	–	–	–	–	–	–	–	125	125	150
H250NJ	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200
E400NJ	25	–	–	–	–	–	–	–	–	–	–	–	–	36	65	65	–
S400CJ	36	–	–	–	–	–	–	–	–	–	–	–	–	50	70	70	–
S400NJ	50	–	–	–	–	–	–	–	–	–	–	–	50	65	85	85	–
S400GJ	70	–	–	–	–	–	–	–	–	–	–	–	50	–	125	125	–
H400NJ	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: [1]) Ratings have not been verified where a dash "–" is shown.

All pick-up and time delay settings are to be set at a maximum for upstream MCCB's

Upstream MCCBs

CASCADE @ 380 – 415 V AC [1]) Downstream MCCBs	kA (RMS)	S400CJ	S400NE S400NJ	S400GE S400GJ	H400NJ H400NE	L400NJ	L400NE	E630NE	S630CE	S630GE	TL630NE	XS800SE	XS800NJ	XH800SE	TL800NE	XS1250SE	XS1600SE
		36	50	70	125	200	200	36	50	70	125	65	65	65	200	65	85
E125NJ	25	36	36	50	65	85	85	36	-	50	–	36	36	36	–	–	–
S125NJ	36	–	50	65	85	125	125	–	-	65	–	50	50	–	–	–	–
S125GJ	65	–	–	70	125	150	150	–	50	70	–	–	–	65	–	–	–
H125NJ	125	–	–	–	–	200	200	–		-	–	–	–	65	–	50	–
S160NJ	36	–	50	65	85	125	125	–	50	50	–	–	65	65	–	–	–
S160GJ	65	–	–	70	125	150	150	–	–	70	–	–	–	–	–	–	–
H160NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	65	–	65	–
E250NJ	25	36	36	50	65	85	85	36	–	50	–	–	36	50	–	–	–
S250NJ	36	–	50	65	85	125	125	–	–	65	–	–	65	–	–	–	–
S250GJ	65	–	–	70	125	150	150	–	–	70	–	–	–	–	–	–	–
S250PE	70	–	–	–	125	150	150	–	–	–	–	–	–	–	–	–	–
H250NJ	125	–	–	–	–	200	200	–	–-	–	–	–	–	–	–	–	–
E400NJ	25	36	36	50	65	85	85	36	–	50	36	–	–	–	36	–	36
S400CJ	36	–	50	65	70	100	100	–	–	65	50	–	–	–	50	–	50
S400NJ	50	–	–	70	85	125	125	–	36	70	65	–	–	50	65	–	65
S400GJ	70	–	–	–	125	150	150	–	36	–	–	–	–	50	–	36	85
H400NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	–	–	–	–

Note: [1]) Ratings have not been verified where a dash "–" is shown.

All pick-up and time delay settings are to be set at a maximum for upstream MCCBs

APPLICATION DATA

SELECTIVITY AND CASCADE TEMBREAK 2 MCCBs AND DIN-T / SAFE-T MCBs

SELECTIVITY / CASCADE @ 415 V AC			Upstream MCCB							
			E125NJ	S125NJ	H125NJ S125GJ	S250NJ	S250GJ	S400CJ	S400GE S400GJ	H400NJ
Downstream MCB	Amp rating	kA (RMS)	25	36	65	36	65	36	70	125
DTCB6	2 – 20	6	18/18	25/25	35/35	35/35	35/35	–	–	–
	25 – 63	6	18/18	20/25	20/25	30/30	30/30	–	–	–
DTCB10	0.5 – 32	10	18/18	30/30	30/50	35/35	40/50	35/35	40/50	40/50
	40 – 63	10	18/18	20/25	25/25	30/30	30/30	30/30	30/30	30/30
DSRCBH /	0.5 – 32	10	18/18	30/30	30/50	35/35	40/50	35/35	40/50	40/50
DSRCD	40	10	18/18	20/25	25/25	30/30	30/30	30/30	30/30	30/30
Din-T10H	80 – 125	10	4/18	4/25	4/25	15/15	15/15	10/10	10/10	–
DTCH15	0.5 – 32	15	18/18	30	30/50	35/35	40/50	35/35	40/50	40/50
	40 – 63	15	18/18	20	25/25	30/30	30/30	30/30	30/30	30/30
Safe-T	16 – 20	6	3/10	3/10	3/10	–	–	–	–	–
SRCB	16 – 20	6	3/10	3/10	3/10	–	–	–	–	–

Guide

XX / YY

Selectivity Cascade

Notes: All figures stated are at 400/415 V AC.

SECTION 4

APPLICATION DATA

MOTOR STARTING TYPE 1 CO-ORDINATION TABLES

Short-Circuit Co-Ordination Motor Starting Table

Type '1'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 50/65 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 1 50/65 kA

		Terasaki Combinations		Terasaki Combinations		Sprecher + Schuh Combinations	
Motor Size (kW)	Approx. amps @ 400/415 V (A)	MCCB	Contactor	Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactor
0.37	1.1	XM30PB/1.4	CA7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1.0A	CA7-9
0.55	1.5	XM30PB/2	CA7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA7-9
0.75	1.8	XM30PB/2.6	CA7-9	CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA7-9
1.1	2.6	XM30PB/4.0	CA7-9	CT 7-24	2.4 - 4.0	KTA7-25S-2.5A	CA7-9
1.5	3.4	XM30PB/5	CA7-9	CT 7-24	2.4 - 4.0	KTA7-25S-4.0A	CA7-9
2.2	4.8	XM30PB/8	CA7-9	CT 7-24	4.0 - 6.0	KTA7-25S-6.3A	CA7-9
3	6.5	XM30PB/10	CA7-9	CT 7-24	6.0 - 10	KTA7-25S-6.3A	CA7-9
4	8.2	XM30PB/12	CA7-9	CT 7-24	6.0 - 10	KTA7-25S-10A	CA7-9
5.5	11	S125GJ/20	CA7-12	CT 7-24	10 - 16	KTA7-25H-16A	CA7-12
7.5	14	S125GJ/20	CA7-16	CT 7-24	10 - 16	KTA7-25H-16A	CA7-16
11	21	S125GJ/32	CA7-23	CT 7-24	16 - 24	KTA7-45H-20A	CA7-23
15	28	S125GJ/50	CA7-30	CT 7-45	18 - 30	KTA7-45H-32A	CA7-30
18.5	34	S125GJ/50	CA7-37	CT 7-45	30 - 45	KTA7-45H-45A	CA7-37
22	40	S125GJ/63	CA7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA7-43
30	55	S125GJ/100	CA7-60	CT 7-75	45 - 60	KTA3-100-63A	CA7-60
37	66	S125GJ/100	CA7-72	CT 7-75	60 - 75	KTA3-100-90A	CA7-72
45	80	S125GJ/125	CA7-85	CT 7-100	70 - 90	KTA3-100-90A	CA7-85
55	100	S125GJ/125	CA6-110	CEF 1-11/12	20 - 180	KTA3-160S-100A	CA6-110
5	130	S250PE/250	CA6-140	CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-140
0	155	S250PE/250	CA6-180	CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-180
10	200	S250PE/250	CA6-210	CEF 1-41/42	160 - 400	KTA3-250S-200A	CA6-210
32	225	S400GE/400	CA6-210	CEF 1-41/42	160 - 400	KTA3-250S-250A	CA6-250
60	270	S400GE/400	CA6-300	CEF 1-41/42	160 - 400	KTA3-400S-320A	CA6-300
00	361	S400GE/400	CA6-420	CEF 1-41/42	160 - 400	KTA3-400S-400A	CA6-420

Notes:
- Thermal or electronic overload relays may be used.
- XM30PB MCCB's can be replaced with S125GJ/20 if required.
- Combinations based on the thermal overload relay tripping before the circuit. breaker at overload currents up to the motor locked rotor current.

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION TABLES

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 50/65 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2 50/65 kA

		Terasaki Combinations		Terasaki Combinations		Sprecher + Schuh Combinations	
Motor Size (kW)	**Approx. amps @ 400/415 V (A)**	**MCCB**	**Contactor**	**Overload Relay**	**Thermal Setting (A)**	**KT7 Circuit Breaker**	**Contactor**
0.37	1.1	XM30PB/1.4	CA7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA7-9
0.55	1.5	XM30PB/2	CA7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA7-9
0.75	1.8	XM30PB/2.6	CA7-9	CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA7-9
1.1	2.6	XM30PB/4.0	CA7-16	CT 7-24	2.4 - 4.0	KTA7-25S-2.5A	CA7-9
1.5	3.4	XM30PB/5	CA7-16	CT 7-24	2.4 - 4.0	KTA7-25S-4A	CA7-9
2.2	4.8	XM30PB/8	CA7-16	CT 7-24	4.0 - 6.0	KTA7-25S-6.3A	CA7-9
3	6.5	XM30PB/10	CA7-30	CT 7-24	6.0 - 10	KTA7-25S-6.3A	CA7-9
4	8.2	XM30PB/12	CA7-30	CT 7-24	6.0 - 10	KTA7-25S-10A	CA7-9
5.5	11	S125GJ/20	CA7-30	CT 7-24	10 - 16	KTA7-25H-16A	CA7-12
7.5	14	S125GJ/20	CA7-30	CT 7-24	10 - 16	KTA7-25H-16A	CA7-16
11	21	S125GJ/32	CA7-30	CT 7-24	16 - 24	KTA7-45H-20A	CA7-23
15	28	S125GJ/50	CA7-43	CT 7-45	18 - 30	KTA7-45H-32A	CA7-30
18.5	34	S125GJ/50	CA7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA7-37
22	40	S125GJ/63	CA7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA7-43
30	55	S125GJ/100	CA7-72	CT 7-75	45 - 60	KTA3-100-63A	CA7-60
37	66	S125GJ/100	CA7-72	CT 7-75	60 - 75	KTA3-100-90A	CA7-72
45	80	S125GJ/125	CA6-105	CT 7-100	70 - 90	KTA3-100-90A	CA7-85
55	100	S250PE/160	CA6-105	CEF 1-11/12	20 - 180	KTA3-160S-100A	CA6-110
75	130	S250PE/250	CA6-140	CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-140
90	155	S250PE/250	CA6-170	CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-180
110	200	S250PE/250	CA6-210	CEF 1-41/42	160 - 400	KTA3-250S-200A	CA6-210
132	225	S400PE/400	CA6-210	CEF 1-41/42	160 - 400	KTA3-250S-250A	CA6-250
160	270	S400PE/400	CA6-300	CEF 1-41/42	160 - 400	KTA3-400S-320A	CA6-300
200	361	S400PE/400	CA6-420	CEF 1-41/42	160 - 400	KTA3-400S-400A	CA6-420

Notes:
- Thermal or electronic overload relays may be used.
- XM30PB combinations can be replaced with S125GJ/20 and CA7-30 if required.
- Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

SECTION 4

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 85 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2 85 kA

SECTION 4

		Terasaki Combinations		Terasaki Combinations		Sprecher + Schuh Combinations	
Motor Size (kW)	Approx. amps @ 400/415 V (A)	MCCB	Contactor	Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactor
0.37	1.1	XM30PB/1.4	CA 7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA 7-9
0.55	1.5	XM30PB/2	CA 7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA 7-9
0.75	1.8	XM30PB/2.6	CA 7-9	CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA 7-9
1.1	2.6	XM30PB/4.0	CA 7-16	CT 7-24	2.4 - 4.0	KTA7-25H-2.5A	CA 7-9
1.5	3.4	XM30PB/5	CA 7-16	CT 7-24	2.4 - 4.0	KTA7-25H-4A	CA 7-9
2.2	4.8	XM30PB/8	CA 7-30	CT 7-24	4.0 - 6.0	KTA7-25H-6.3A	CA 7-9
3	6.5	XM30PB/10	CA 7-30	CT 7-24	6.0 - 10	KTA7-25H-6.3A	CA 7-9
4	8.2	XM30PB/12	CA 7-30	CT 7-24	6.0 - 10	KTA7-25H-10A	CA 7-9
5.5	11	H125NJ/20	CA 7-30	CT 7-24	10 - 16	KTA7-45H-16A	CA 7-12
7.5	14	H125NJ/20	CA 7-30	CT 7-24	10 - 16	KTA7-45H-16A	CA 7-16
11	21	H125NJ/32	CA 7-30	CT 7-24	16 - 24	KTA7-45H-20A	CA 7-23
15	28	H125NJ/50	CA 7-43	CT 7-45	18 - 30	KTA7-45H-32A	CA 7-30
18.5	34	H125NJ/50	CA 7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA 7-37
22	40	H125NJ/63	CA 7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA 7-43
30	55	H125NJ/100	CA 7-72	CT 7-75	45 - 60	KTA3-100-63A	CA7-60
37	66	H125NJ/100	CA 7-72	CT 7-75	60 - 75	KTA3-100-90A	CA7-72
45	80	H125NJ/160	CA 6-105	CT 7-100	70 - 90	KTA3-100-90A	CA7-85
55	100	H160NJ/160	CA 6-105	CEF 1-11/12	20 - 180	-	-
75	130	H250PE/250	CA 6-210	CEF 1-11/12	20 - 180	-	-
90	155	H250PE/250	CA 6-210	CEF 1-11/12	20 - 180	-	-
110	200	H250PE/250	CA 6-210	CEF 1-41/42	160 - 400	-	-
132	225	H400NE/400	CA 6-210	CEF 1-41/42	160 - 400	-	-
160	270	H400NE/400	CA 6-300	CEF 1-41/42	160 - 400	-	-
200	361	H400NE/400	CA 6-420	CEF 1-41/42	160 - 400	-	-

Notes:
- Thermal or electronic overload relays may be used.
- XM30PB combinations can be replaced with H125GJ/20 and CA7-30 if required.
- Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 100 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2 100 kA

		Terasaki Combinations					Sprecher + Schuh Combinations	
Motor Size (kW)	**Approx. amps @ 400/415 V (A)**	**MCCB**	**Contactor**	**Overload Relay**	**Thermal Setting (A)**		**KT7 Circuit Breaker**	**Contactor**
0.37	1.1	H125NJ/20	CA 7-30	CT 7-24	1.0 - 1.6		KTA7-25S-1A	CA 7-9
0.55	1.5	H125NJ/20	CA 7-30	CT 7-24	1.0 - 1.6		KTA7-25S-1.6A	CA 7-9
0.75	1.8	H125NJ/20	CA 7-30	CT 7-24	1.6 - 2.4		KTA7-25S-2.5A	CA 7-9
1.1	2.6	H125NJ/20	CA 7-30	CT 7-24	2.4 - 4.0		KTA7-25H-2.5A	CA 7-9
1.5	3.4	H125NJ/20	CA 7-30	CT 7-24	2.4 - 4.0		KTA7-25H-4A	CA 7-9
2.2	4.8	H125NJ/20	CA 7-30	CT 7-24	4.0 - 6.0		KTA7-25H-6.3A	CA 7-9
3	6.5	H125NJ/20	CA 7-30	CT 7-24	6.0 - 10		KTA7-25H-6.3A	CA 7-9
4	8.2	H125NJ/20	CA 7-30	CT 7-24	6.0 - 10		KTA7-25H-10A	CA 7-9
5.5	11	H125NJ/20	CA 7-30	CT 7-24	10 - 16		KTA7-45H-16A	CA 7-12
7.5	14	H125NJ/20	CA 7-30	CT 7-24	10 - 16		KTA7-45H-16A	CA 7-16
11	21	H125NJ/32	CA 7-30	CT 7-24	16 - 24		KTA7-45H-20A	CA 7-23
15	28	H125NJ/50	CA 7-43	CT 7-45	18 - 30		KTA7-45H-32A	CA 7-30
18.5	34	H125NJ/50	CA 7-43	CT 7-45	30 - 45		KTA7-45H-45A	CA 7-37
22	40	H125NJ/63	CA 7-43	CT 7-45	30 - 45		KTA7-45H-45A	CA 7-43
30	55	H125-NJ/100	CA 7-60	CT 7-75	45 - 60		-	-
37	66	H125-NJ/100	CA 7-72	CT 7-75	60 - 75		-	-
45	80	H125-NJ/125	CA 7-85	CT 7-100	70 - 90		-	-
55	100	H250-NE/160	CA 6-95	CEF 1-11/12	20 - 180		-	-
75	130	H250-NE/250	CA 6-140	CEF 1-11/12	20 - 180		-	-
90	155	H250-NE/250	CA 6-140	CEF 1-11/12	20 - 180		-	-
110	200	H250-NE/250	CA 6-180	CEF 1-41/42	160 - 400		-	-
132	225	H400-NE/400	CA 6-420	CEF 1-41/42	160 - 400		-	-
160	270	H400-NE/400	CA 6-420	CEF 1-41/42	160 - 400		-	-
200	361	H400-NE/400	CA 6-420	CEF 1-41/42	160 - 400		-	-

Notes:
- Thermal or electronic overload relays may be used.
- Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

SECTION 4

INSTALLATION

INSULATION DISTANCE IN mm (AT 440V AC MAXIMUM)

Model	Type	A	B1	B2	C	D	E
E125	NJ	50	10	10	0	25	*(1)
S125	NF	50	10	10	0	25	*(1)
S125	NJ	50	10	10	0	25	*(1)
S125	GJ	75	45	25	0	25	*(1)
H125	NJ	100	80	60	0	50	*(1)
L125	NJ	100	80	60	0	50	*(1)
S160	NF	50	40	30	0	25	*(1)
S160	NJ	50	40	30	0	25	*(1)
S160	GJ	100	80	60	0	50	*(1)
H160	NJ	100	80	60	0	50	*(1)
L160	NJ	100	80	60	0	50	*(1)
E250	NJ	50	40	30	0	25	*(1)
S250	NJ	50	40	30	0	25	*(1)
S250	GJ	100	80	30	0	25	*(1)
S250	PE	100	80	60	0	50	*(1)
H250	NJ	100	80	60	0	50	*(1)
H250	NE	100	80	60	0	50	*(1)
L250	NJ	100	80	60	0	50	*(1)
E400	NJ	100	80	40	0	30	*(1)
S400	CJ	100	80	40	0	30	*(1)
S400	NJ	100	80	40	0	30	*(1)
S400	GJ	100	80	40	0	30	*(1)
S400	GE	100	80	40	0	30	*(1)
H400	NJ	120	120	80	0	80	*(1)
H400	NE	120	120	80	0	80	*(1)
L400	NJ	120	120	80	0	80	*(1)
L400	NE	120	120	80	0	80	*(1)
E630	NE	120	100	80	0	80	*(1)
S630	CE	120	100	80	0	80	*(1)
S630	GE	120	100	80	0	80	*(1)

***Note:** (1) Insulate the exposed conductor until it overlaps the moulded case at the terminal, or the terminal cover.

SECTION 6

INSTALLATION

TEMPERATURE RATINGS & DERATINGS

Calibration Temperature: 45°C

MCCB Type	Connection Type	Rating at calibration temperature (50°C)	Rated Current (A)			
			50°C	55°C	60°C	65°C
E125-NJ	Front	20A	19	18.5	18	17.5
S125-NJ	Rear	32A	31	30.5	30	29
S125-GJ	Plug-in	50A	48	45	43	41
		63A	60	57	55	52
		100A	97	94	90	87
		125A	121	117	113	109
H125-NJ	Front	20A	19	18.5	18	17.5
L125-NJ	Rear	32A	31	30	29	28
	Plug-in	50A	48	47	45	44
		63A	61	59	57	55
		100A	97	95	92	89
		125A	121	118	114	111
S160-NJ	Front	20A	19	18.5	18	17.5
S160-GJ	Rear	32A	31	30	29	28
	Plug-in	50A	48	46	44	42
		63A	61	59	57	55
		100A	97	94	91	88
		125A	121	117	113	109
		160A	156	151	146	141
H160-NJ L160-NJ	Front Rear Plug-in	160A	156	151	147	143
E250-NJ	Front	20A	19	18.5	18	17.5
	Rear	32A	31	30	29	28
	Plug-in	50A	48	46	44	42
		63A	61	59	57	55
		100A	97	94	91	88
		125A	121	117	113	109
E250-NJ	Front	160A	156	151	146	141
S250-NJ	Rear	250A	243	235	227	219
S250-GJ	Plug-in					
H250-NJ L250-NJ	Front Rear Plug-in	160A	156	151	147	143
	Front Rear	250A	244	237	230	223
E400-NJ	Front	250A	244	237	230	223
S400-CJ	Rear	400A	390	380	369	358
S400-NJ	Plug-in					
S400-GJ						
H400-NJ	Front	250A	243	237	230	223
L400-NJ	Rear	400A	390	381	371	361
	Plug-in	250A	243	237	231	224
		400A	392	384	376	368

Calibration Temperature: 30°C

MCCB Type	Connection Type	Rating at calibration temperature (30°C)	Rated Current (A)						
			35°C	40°C	45°C	50°C	55°C	60°C	65°C
H250-NJ L250-NJ	Plug-in Conn.	250A	244	236	225	219	209	200	190

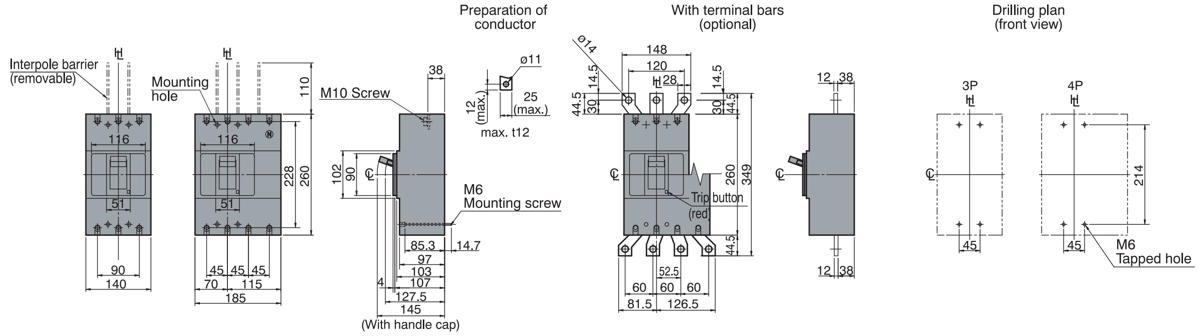
MCCB Type	Connection Type	Rating	Rated Current (A)							
			30°C	35°C	40°C	45°C	50°C	55°C	60°C	65°C
S250-PE H250-NE	Front Rear	250A	250	250	250	250	237.5	225	200	200
	Plug-in	250A	250	237.5	225	225	200	200	157.5	157.5
S400-NE	Front	250A	250	250	250	250	250	250	225	200
S400-GE	Rear Plug-in	400A	400	400	400	400	400	380	360	320
H400-NE	Front	250A	250	250	250	250	250	250	225	200
L400-NE	Rear	400A	400	400	400	400	400	380	360	320
	Plug-in	250A	250	250	250	250	250	250	225	200
		400A	400	400	400	400	400	380	360	320
E630-NE S630-CE S630-GE	Front Rear*	630A	630	630	630	630	598.5	598.5	567	504

DIMENSIONS

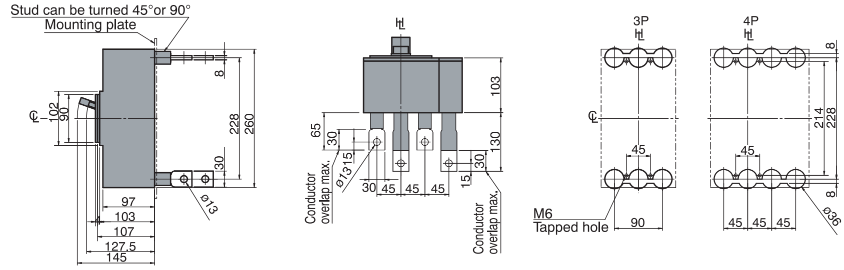
E630-NE, S630-CE, S630-GE

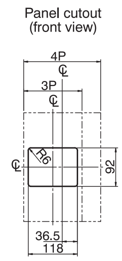
ASL: Arrangement Standard Line
HL : Handle Frame Centre Line

Front connected



Rear connected





Panel cutout dimensions shown give an allowance of 1.0mm around the handle escutcheon.

SECTION 7

OPERATING CHARACTERISTICS

ELECTRONIC PROTECTION

Optional Functions

Three optional functions are available:

Ground Fault Trip (G)

This function trips the MCCB after time delay, t_g, if the ground fault current exceeds the preset threshold, I_g. Ground fault protection can be enabled and disabled by operating a DIP switch on the electronic protection unit. An external current transformer is available if the ground fault trip function is required on a 3 pole MCCB.

Neutral Protection (N)

Neutral protection trips the MCCB after time delay, t_N, if current in the neutral conductor exceeds the rated current, I_n, of the MCCB. The time delay characteristic is identical to that of the overload characteristic (L).

Preferential Trip Alarm (P)

An LED and volt-free output contact are activated after a time delay, t_p, if the load current exceeds the preset threshold, I_p.

How to Specify Optional Functions

Optional functions must be specified at the time of order. Descriptions for electronic MCCBs include a 1-4 digit alphabetic code after the type designation which details the combination of optional functions. For example:

S400-GE **APG** 3P 400A FC - includes preferential trip and ground fault trip.

The table below lists codes for all the optional functions currently available:

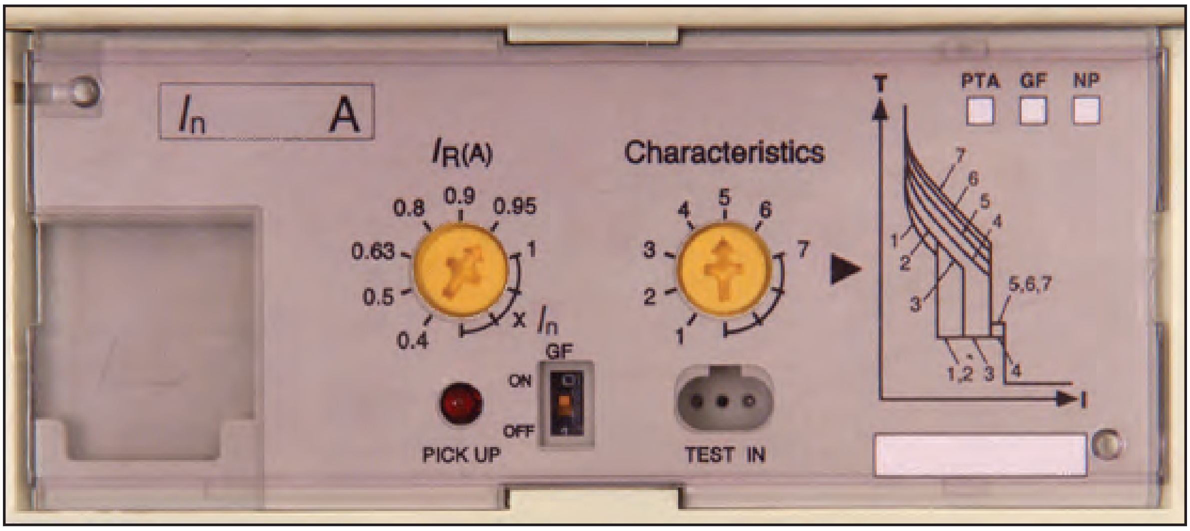
			Optional Function		
In	Poles	Code	Ground Fault (G)	Neutral Protection (N)	Preferential Trip Alarm (P)
250	3	AP	-	-	■
	4	AP	-	-	■
		AN	-	■	-
		APN	-	■	■
400	3	AP	-	-	■
		AG	■	-	-
		APG	■	-	■
	4	AP	-	-	■
		AN	-	■	-
		APN	-	■	■
		AGN	■	■	-
		APGN	■	■	■
630	3	AP	-	-	■
		AG	■	-	-
		APG	■	-	■
	4	AP	-	-	■
		AN	-	■	-
		APN	-	■	■
		AGN	■	■	-
		APGN	■	■	■

■ Available - Not Available

OPERATING CHARACTERISTICS

ELECTRONIC PROTECTION

Adjustment Dials



The left adjustment dial sets the rated current to match the conductor rating. The right adjustment dials select one of six on 630A models preset characteristics. The effects of the left adjustment dial (labelled I_R(A)), and the right adjustment dial (labelled Characteristics) are detailed in the tables shown underneath each time/current graph.

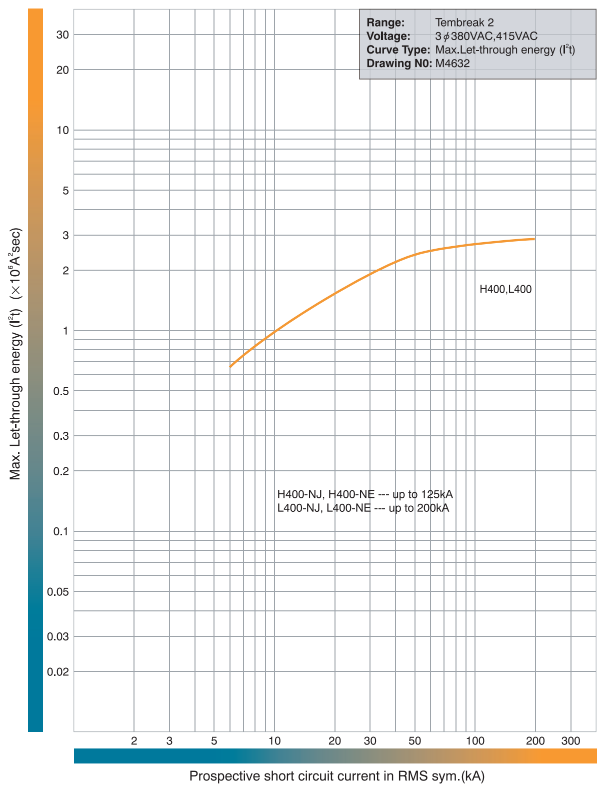
Tolerances of Characteristics

Characteristics		Tolerance
Long Time Delay	t_R	+/- 20%
Short Time Delay	I_{sd}	+/- 15%
	t_{sd}	Total clearing time +50ms, resettable time -20ms
Instantaneous	I_i	+/- 20%
Preferential trip Alarm	I_p	+/- 10%
	t_p	+/- 10%
Ground Fault Trip	I_g	+/- 15%
	t_g	Total clearing time +50ms, resettable time -20ms
Neutral Protection	I_N	+/- 15%

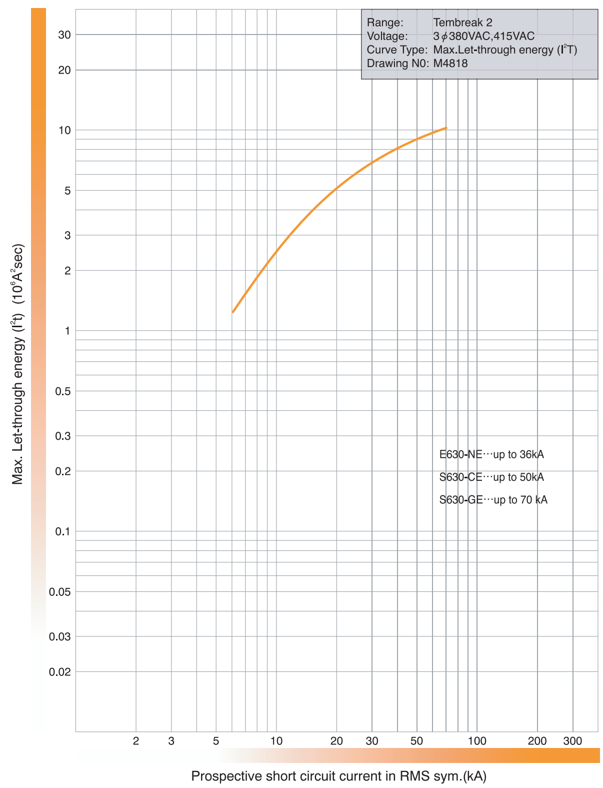
OPERATING CHARACTERISTICS

LET-THROUGH ENERGY CHARACTERISTICS

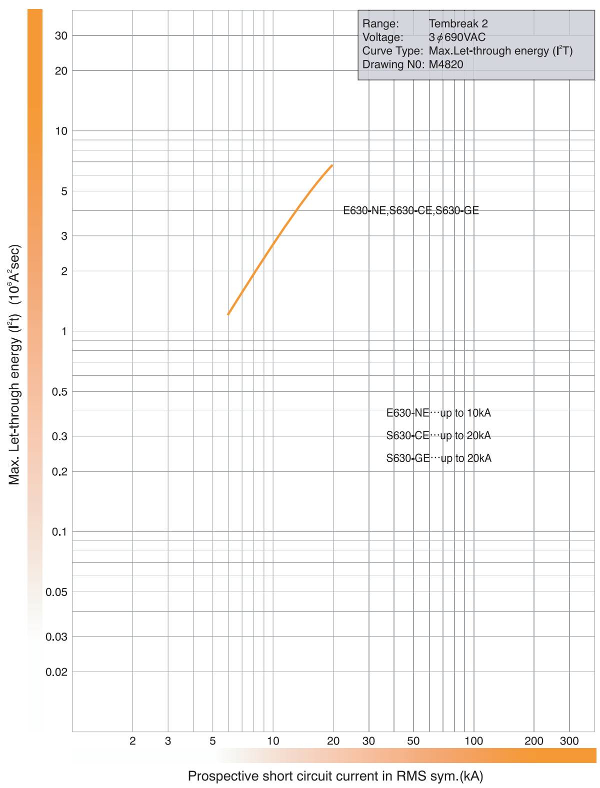
H400-NJ, H400-NE, L400-NJ, L400-NE. 415V AC.



E630-NE, S630-CE, S630-GE. 415V AC.



E630-NE, S630-CE, S630-GE. 690V AC.



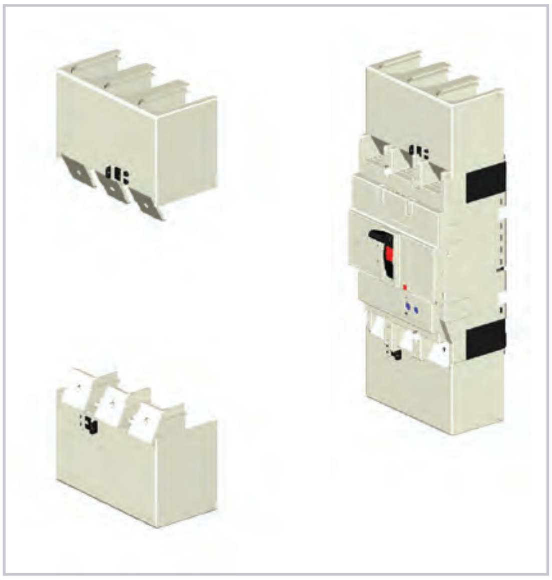
SECTION 3

ACCESSORIES

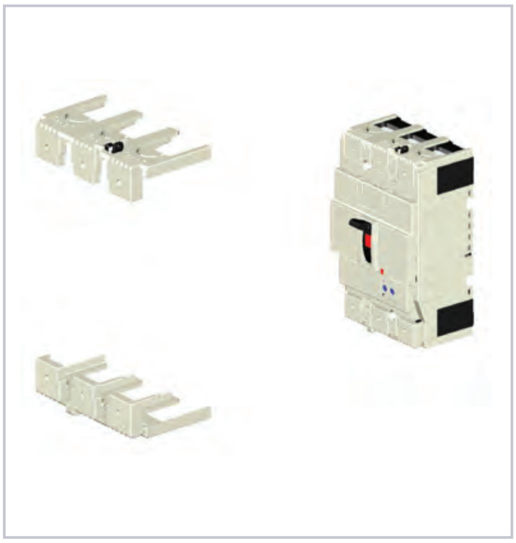
INSULATION ACCESSORIES

Terminal Covers for Front Connection (CF)

Terminal covers for front connection are suitable for covering the exposed live parts of conductors terminated on the MCCB.



Terminal Covers for Front Connection



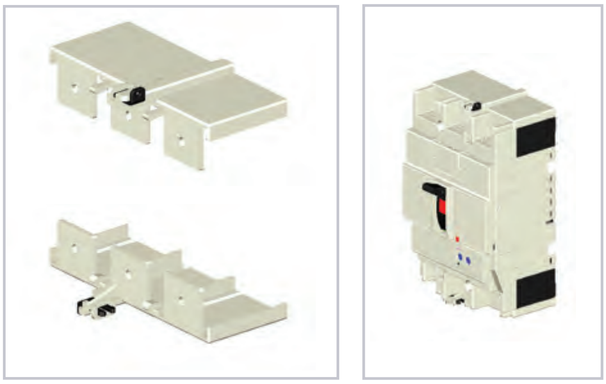
Flush Terminal Covers

Flush Terminal Covers (CS)

Flush terminal covers are useful for increasing the ingress protection rating at the terminals without increasing the overall length. They can be used with busbar and for direct entry of stranded cable (with solderless cable clamp terminals (FW), refer to Section 6, Installation).
Flush terminal covers are identical to rear terminal covers for 400A and 630A frame models.
The user can remove a section of the rear terminal cover using a tool to allow entry of the conductor.

Terminal covers for Rear Connection (CR)

Terminal covers for rear connection may be used on MCCBs fitted with rear connections (RP) or plug-in connections (PM). They prevent access to the terminals from the front and top.



Terminal Covers for Rear Connection

INSTALLATION

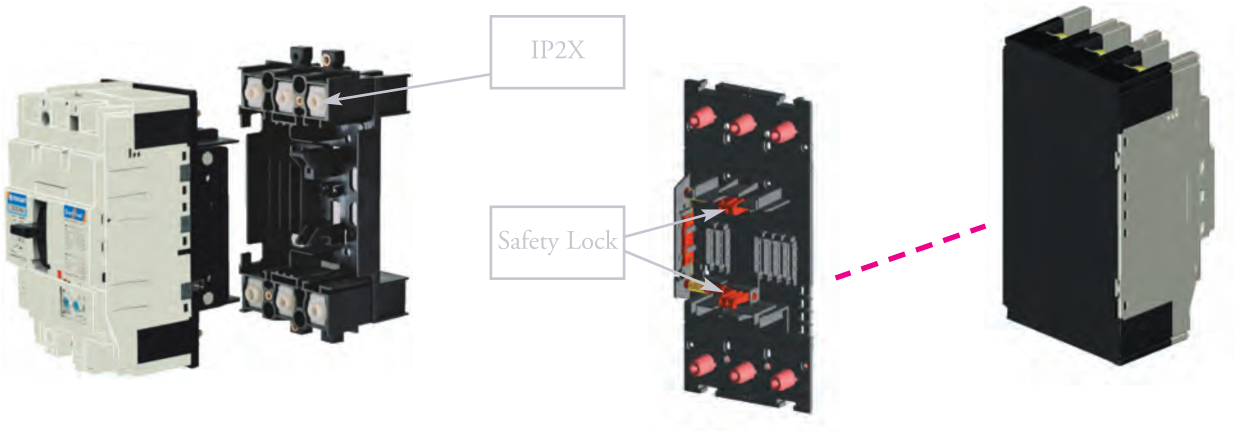
CONNECTION AND MOUNTING OPTIONS AND ACCESSORIES

Plug-in Mounting

The plug in mounting system allows fast replacement of the MCCB body without the need to disturb the terminations. Solid conductors or cables terminated with compression terminals can be used.

Plug-In Safety Lock

The plug-in MCCB body is **automatically locked to the base** when the contacts are closed (toggle ON). It cannot be removed unless the contacts are in the isolated position (toggle OFF or TRIPPED). This system ensures safe removal of the MCCB from the base.



Plug-in MCCB and base

Plug-in connections and safety lock are fitted to the back of the MCCB

The connection bars for plug-in bases are optional and can be configured in the field either for front or rear access. The illustrations below show possible mounting and connection options for plug in bases.

1. Mounted on base plate with connection bars mounted for front access. Insulation plates are supplied as standard and must be fitted.
2. Terminations in separate compartment. Connection bars are mounted for top access at the top and rear access at the bottom.
3. Mounted on angle bars. Connection bars are mounted for rear access.

ACCESSORIES

INSULATION ACCESSORIES

Interpole Barriers (BA)

Interpole barriers provide maximum insulation between phases at the terminals of the MCCB. They cannot be fitted at the same time as any of the terminal covers. Interpole barriers for use on one end of the MCCB are supplied as standard. Additional interpole barriers can be ordered individually. All interpole barriers can easily be fitted to either end of an MCCB.

MCCB moulds have been designed to accept an additional interpole barrier between two adjacent MCCBs.

MCCB Fitted with Interpole Barriers on Both Ends

Interpole Barriers between Adjacent MCCBs

TERASAKI Innovators in Protection Technology

TemBreak **MCCB's**

NHP

Electronic type

S400GE

70kA

Current rating: **100 – 400A**

Approvals and Tests:
Standards AS/NZS 3947-2, and IEC60947-2

Interrupting capacity:

	Voltage	Icu	Ics
AC use	380/415	70	50

Over Current Relay:

- Electronic, for general & selectivity applications
- 7 dial selectable characteristic curves suited for a variety of applications
- Base current *Ir* is adjustable from 40% - 100% of the nominal rated current *In*.
- STD setting 2.5 – 10 **(x I_R)** 2)
- INST setting 13 – 14 **(x I_R)** 2)

OCR Options:

- Ground Fault Trip (AG)
- Neutral Pole protection for 4 pole MCCBs **ONLY** (AN)
- Pre-Trip Alarm (AP)

Dimensions (mm)

Poles	3	4
H	260	260
W	140	185
D (less toggle)	103	103

Ampere ***Rating*** **NRC**	**I_R Adjustment** Min - Max.	**Cat. No.** 1)
250	100 - 250	**S400 GE _ 250**
400	160 - 400	**S400 GE _ 400**

Price Adder - if options are required, add the selected OCR option price below to the above MCCB price to calculate the total MCCB cost.

3 P OCR options:	PTA 3)	**S400 GE 3 AP #**
	GF 3)	**S400 GE 3 AG #**
	PTA + GF 3)	**S400 GE 3 APG #**
4 P OCR options:	PTA 3)	**S400 GE 4 AP #**
	AP 3)	**S400 GE 4 AN #**
	PTA + NP 3)	**S400 GE 4 APN #**
	GF + NP 3)	**S400 GE 4 AGN #**
	PTA + GF + NP 3)	**S400 GE 4 APGN #**

1) Add poles to complete MCCB catalogue number. Eg: 3 pole 250A: S400GE 3 250. "#" add OCR trip unit rating where shown.

2) The STD and Instantaneous pickup currents (I_{sd} & I_i) settings are not individually adjustable, however by selecting different curve types and different I_R settings the values will vary. Curve 1 & 2 I_{sd} = 2.5 x I_R, curve 3 I_{sd} = 5 x I_R, curve 4 - 7 I_{sd} = 10 x I_R . I_R dial setting 0.4 – 0.9 I_i = 14 x I_R and I_R dial setting 0.95 – 1.0 I_i = 13 x I_R. Refer curve examples & setting data on pages 18 to 30.

NRC **= Nominal rated current,** ***I_R*** **= Current adjustment dial setting,** ***STD*** **= Short Time Delay,** ***INST*** **= instantaneous**

3) To order a MCCB with the above options insert the required option after the pole to make up the cat. number. Eg: S400GE 4 **APGN** 250 is a S400GE 4 Pole 250A MCCB c/w Pre-trip Alarm, Neutral Protection and Ground Fault protection.

Replaces: XH400SE, XH400PE, TL400NE, Note: check exact ratings or dimenions to suit your application requirement

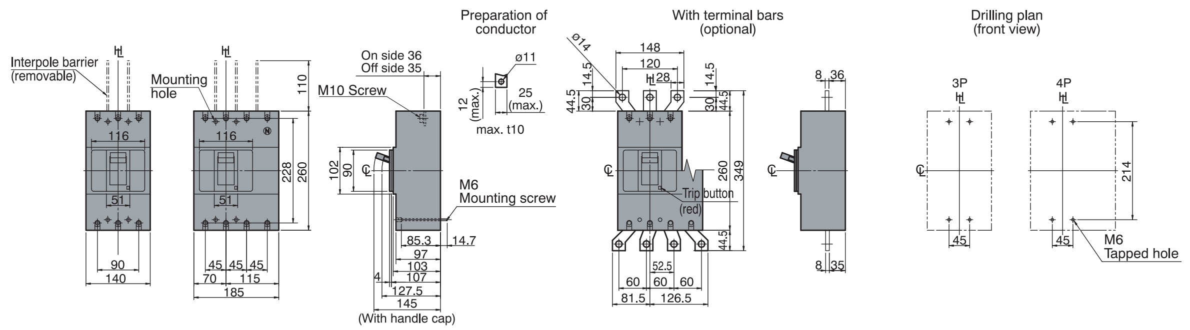
Price Schedule T2

DIMENSIONS

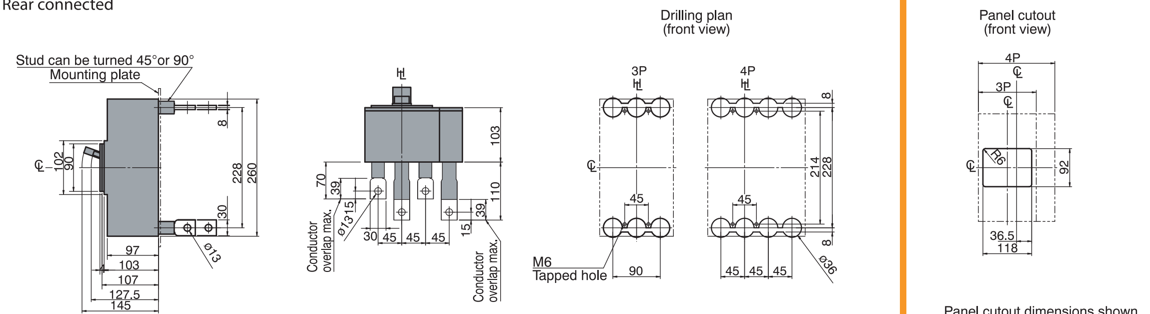
E400-NJ, S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE

ASL: Arrangement Standard Line
HFCL: Handle Frame Centre Line

Front connected

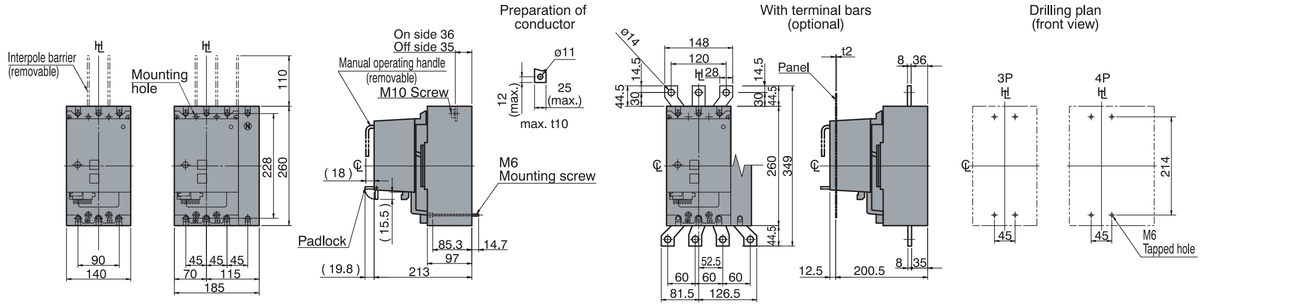


Rear connected

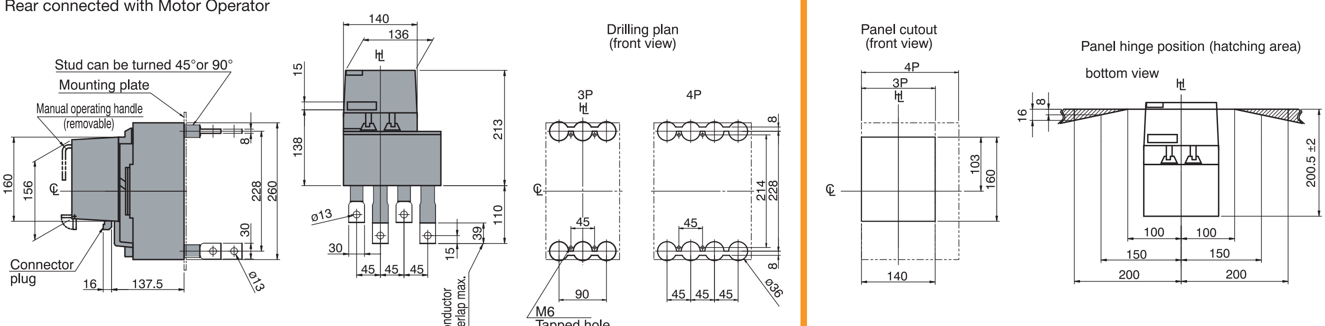


Panel cutout dimensions shown give an allowance of 1.0mm around the handle escutcheon.

Front connected with Motor Operator



Rear connected with Motor Operator



Panel cutout dimensions shown give an allowance of 1.5mm around motor operator

INSTALLATION

INSULATION DISTANCE IN mm (AT 440V AC MAXIMUM)

Model	Type	A	B1	B2	C	D	E
E125	NJ	50	10	10	0	25	*(1)
S125	NF	50	10	10	0	25	*(1)
S125	NJ	50	10	10	0	25	*(1)
S125	GJ	75	45	25	0	25	*(1)
H125	NJ	100	80	60	0	50	*(1)
L125	NJ	100	80	60	0	50	*(1)
S160	NF	50	40	30	0	25	*(1)
S160	NJ	50	40	30	0	25	*(1)
S160	GJ	100	80	60	0	50	*(1)
H160	NJ	100	80	60	0	50	*(1)
L160	NJ	100	80	60	0	50	*(1)
E250	NJ	50	40	30	0	25	*(1)
S250	NJ	50	40	30	0	25	*(1)
S250	GJ	100	80	30	0	25	*(1)
S250	PE	100	80	60	0	50	*(1)
H250	NJ	100	80	60	0	50	*(1)
H250	NE	100	80	60	0	50	*(1)
L250	NJ	100	80	60	0	50	*(1)
E400	NJ	100	80	40	0	30	*(1)
S400	CJ	100	80	40	0	30	*(1)
S400	NJ	100	80	40	0	30	*(1)
S400	GJ	100	80	40	0	30	*(1)
S400	GE	100	80	40	0	30	*(1)
H400	NJ	120	120	80	0	80	*(1)
H400	NE	120	120	80	0	80	*(1)
L400	NJ	120	120	80	0	80	*(1)
L400	NE	120	120	80	0	80	*(1)
E630	NE	120	100	80	0	80	*(1)
S630	CE	120	100	80	0	80	*(1)
S630	GE	120	100	80	0	80	*(1)

***Note:** (1) Insulate the exposed conductor until it overlaps the moulded case at the terminal, or the terminal cover.

SECTION 6

INSTALLATION

TEMPERATURE RATINGS & DERATINGS

Calibration Temperature: 45°C

MCCB Type	Connection Type	Rating at calibration temperature (50°C)	Rated Current (A)			
			50°C	55°C	60°C	65°C
E125-NJ S125-NJ S125-GJ	Front Rear Plug-in	20A	19	18.5	18	17.5
		32A	31	30.5	30	29
		50A	48	45	43	41
		63A	60	57	55	52
		100A	97	94	90	87
		125A	121	117	113	109
H125-NJ L125-NJ	Front Rear Plug-in	20A	19	18.5	18	17.5
		32A	31	30	29	28
		50A	48	47	45	44
		63A	61	59	57	55
		100A	97	95	92	89
		125A	121	118	114	111
S160-NJ S160-GJ	Front Rear Plug-in	20A	19	18.5	18	17.5
		32A	31	30	29	28
		50A	48	46	44	42
		63A	61	59	57	55
		100A	97	94	91	88
		125A	121	117	113	109
		160A	156	151	146	141
H160-NJ L160-NJ	Front Rear Plug-in	160A	156	151	147	143
E250-NJ	Front Rear Plug-in	20A	19	18.5	18	17.5
		32A	31	30	29	28
		50A	48	46	44	42
		63A	61	59	57	55
		100A	97	94	91	88
		125A	121	117	113	109
E250-NJ S250-NJ S250-GJ	Front Rear Plug-in	160A	156	151	146	141
		250A	243	235	227	219
H250-NJ L250-NJ	Front Rear Plug-in	160A	156	151	147	143
	Front Rear	250A	244	237	230	223
E400-NJ S400-CJ S400-NJ S400-GJ	Front Rear Plug-in	250A	244	237	230	223
		400A	390	380	369	358
H400-NJ L400-NJ	Front Rear	250A	243	237	230	223
		400A	390	381	371	361
	Plug-in	250A	243	237	231	224
		400A	392	384	376	368

Calibration Temperature: 30°C

MCCB Type	Connection Type	Rating at calibration temperature (30°C)	Rated Current (A)						
			35°C	40°C	45°C	50°C	55°C	60°C	65°C
H250-NJ L250-NJ	Plug-in Conn.	250A	244	236	225	219	209	200	190

MCCB Type	Connection Type	Rating	Rated Current (A)							
			30°C	35°C	40°C	45°C	50°C	55°C	60°C	65°C
S250-PE H250-NE	Front Rear	250A	250	250	250	250	237.5	225	200	200
	Plug-in	250A	250	237.5	225	225	200	200	157.5	157.5
S400-NE S400-GE	Front Rear Plug-in	250A	250	250	250	250	250	250	225	200
		400A	400	400	400	400	400	380	360	320
H400-NE L400-NE	Front Rear	250A	250	250	250	250	250	250	225	200
		400A	400	400	400	400	400	380	360	320
	Plug-in	250A	250	250	250	250	250	250	225	200
		400A	400	400	400	400	400	380	360	320
E630-NE S630-CE S630-GE	Front Rear*	630A	630	630	630	630	598.5	598.5	567	504

APPLICATION DATA

SELECTIVITY TABLES

Selectivity & Cascade Tables @ 400 / 415 V

XX / YY Selectivity/ Cascade

Downstream MCCBs	Upstream MCCBs kA (RMS)	S250PE 70	H250NE 125	S400NE 50	S400GE 70	H400NE 125	L400NE 200	E630NE 36	S630CE 50
E125NJ	25	25/25	25/65	25/36	25/50	25/65	25/85	25/36	25/25
S125NJ	36	36/36	36/85	36/50	36/65	36/85	36/125	36/36	36/36
S125GJ	65	65/65	65/125	50/50	65/70	65/125	65/150	36/36	50/50
H125NJ	125	70/70	125/125	50/50	70/70	125/125	125/200	36/36	50/50
S160NJ	36			36/50	36/65	36/85	36/125	36/36	36/50
S160GJ	65			50/50	65/70	65/125	65/150	36/36	50/50
H160NJ	125					125/125	125/200	36/36	50/50
E250NJ	25					25/65	25/85	25/36	25/25
S250NJ	36					36/85	36/125	36/36	36/36
S250GJ	65					65/125	65/150	36/36	50/50
S250PE	70					40/125	70/150	36/36	50/50
H250NJ	125					125/125	125/200	36/36	50/50
H250PE	125					125/125	125/200	36/36	50/50
E400NJ	25							10/25	10/25
S400CJ	36							10/36	10/36
S400NE	50							10/36	10/50
S400NJ	50							10/36	10/36
S400GJ	70							10/36	10/50
H400NJ	125							10/36	10/50
H400NE	125							10/36	10/50
E630NE	36								
E630CE	50								
S630GE	70								
XS630CJ	45								
XS630NJ	65								
XS630PJ	85								
XS630SE	50								
XH630SE	65								
XH630PE	65								
XS800NJ	65								
XS800SE	50								
XJ800PJ	85								
XH800SE	65								
XH800PE	65								
XS1250SE	65								
XS1600SE	85								

Downstream MCCBs	Upstream MCCBs kA (RMS)	S630GE 70	TL630NE 125	XS800SE 50	XH800SE 65	TL800NE 125	XS1250SE 85	TL1250NE 125	XS1600SE 100	XS2000NE 85	XS2500NE 85
E125NJ	25	25/50	25/25	25/36	25/36	25/65	25/25	25/25	25/25	25/25	25/25
S125NJ	36	36/65	36/36	36/50	36/36	36/36	36/36	36/36	36/36	36/36	36/36
S125GJ	65	65/70	65/65	65/50	65/65	65/65	65/65	65/65	65/65	65/65	65/65
H125NJ	125	70/70	70/70	50/50	65/65	65/65	85/50	85/50	100/100	85/85	85/85
S160NJ	36	36/50	36/36	36/36	36/65	36/65	36/36	36/36	36/36	36/36	36/36
S160GJ	65	65/70	65/65	50/50	50/65	50/65	65/65	65/65	65/65	65/65	65/65
H160NJ	125	70/70	70/70	50/50	50/65	50/65	85/65	85/65	100/100	85/85	85/85
E250NJ	25	25/50	25/25	25/25	25/50	25/50	25/25	25/25	25/25	25/25	25/25
S250NJ	36	36/65	36/36	36/36	36/36	36/36	36/36	36/36	36/36	36/36	36/36
S250GJ	65	65/70	65/65	50/50	50/65	50/65	65/65	65/65	65/65	65/65	65/65
S250PE	70	70/70	70/70	50/50	50/65	50/65	70/70	70/70	70/70	70/70	70/70
H250NJ	125	70/70	70/70	50/50	50/65	50/65	85/85	85/85	100/100	85/85	85/85
H250PE	125	70/70	70/70	50/50	50/65	50/65	85/85	85/85	100/100	85/85	85/85
E400NJ	25	10/50	10/36	25/25	25/25	25/36	25/25	25/25	25/36	25/25	25/25
S400CJ	36	10/65	10/50	25/36	25/36	25/50	36/36	36/36	36/50	36/36	36/36
S400NE	50	10/50	10/50	25/50	25/50	25/50	50/50	50/50	50/50	50/50	50/50
S400NJ	50	10/70	10/65	25/50	25/50	25/65	50/50	50/50	50/65	50/50	50/50
S400GJ	70	10/70	10/70	25/50	25/50	25/65	70/36	70/36	70/85	70/70	70/70
H400NJ	125	10/70	10/70	25/50	25/65	25/65	125/85	125/85	125/100	125/85	125/85
H400NE	125	10/70	10/70	25/50	25/65	25/65	125/85	125/85	125/100	125/85	125/85
E630NE	36			25/36	25/36	25/36	36/36	36/36	36/36	36/36	36/36
E630CE	50			25/50	25/50	25/50	50/50	50/50	50/50	50/50	50/50
S630GE	70						70/70	70/70	70/70	70/70	70/70
XS630CJ	45						30/45	30/45	30/45	35/45	35/45
XS630NJ	65						30/65	30/65	30/65	35/65	36/65
XS630PJ	85						30/85	30/85	30/85	35/85	35/85
XS630SE	50						30/65	30/65	30/85	30/85	30/85
XH630SE	65						30/65	30/65	30/85	30/85	30/85
XH630PE	65						30/65	30/65	30/85	30/85	30/85
XS800NJ	65						15/65	15/65	20/65	35/65	35/65
XS800SE	50						15/50	15/50	20/50	35/50	35/50
XJ800PJ	85						15/85	15/85	20/85	35/85	35/85
XH800SE	65						15/65	15/65	20/65	35/65	35/65
XH800PE	65						15/65	15/65	20/65	35/65	35/65
XS1250SE	65								20/65	35/65	35/65
XS1600SE	85									35/85	35/85

APPLICATION DATA

CASCADE TABLES

CASCADE @ 380 – 415 V AC ¹) Downstream MCCBs	kA (RMS)	E125NJ	S125NJ	S125GJ	H125NJ	L125NJ	S160NJ	S160GJ	H160NJ	L160NJ	E250NJ	S250NJ	S250GJ	S250PE	H250NJ	H250NE	L250NJ
		25	36	65	125	200	36	65	125	200	25	36	65	70	125	125	200
E125NJ	25	–	36	36	65	85	36	36	65	85	–	36	36	–	65	65	85
S125NJ	36	–	–	50	85	125	–	50	85	125	–	–	–	–	85	85	125
S125GJ	65	–	–	–	125	150	–	–	125	150	–	–	65	–	125	125	150
H125NJ	125	–	–	–	–	200	–	–	-	200	–	–	65	–	–	–	200
S160NJ	36	–	–	65	–	–	–	65	85	125	–	–	65	65	85	85	125
S160GJ	65	–	–	–	–	–	–	–	125	150	–	–	–	70	125	125	150
H160NJ	125	–	–	–	–	–	–	–	–	200	–	–	–	-	–	–	200
S250NJ	36	–	–	–	–	–	–	65	–	–	–	–	–	65	85	85	125
S250GJ	65	–	–	–	–	–	–	–	–	–	–	–	–	70	125	125	150
S250PE	70	–	–	–	–	–	–	–	–	–	–	–	–	–	125	125	150
H250NJ	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200
E400NJ	25	–	–	–	–	–	–	–	–	–	–	–	–	36	65	65	–
S400CJ	36	–	–	–	–	–	–	–	–	–	–	–	–	50	70	70	–
S400NJ	50	–	–	–	–	–	–	–	–	–	–	–	50	65	85	85	–
S400GJ	70	–	–	–	–	–	–	–	–	–	–	–	50	–	125	125	–
H400NJ	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: ¹**)** Ratings have not been verified where a dash "–" is shown.

All pick-up and time delay settings are to be set at a maximum for upstream MCCB's

Upstream MCCBs

CASCADE @ 380 – 415 V AC ¹) Downstream MCCBs	kA (RMS)	S400CJ	S400NE S400NJ	S400GE S400GJ	H400NJ H400NE	L400NJ	L400NE	E630NE	S630CE	S630GE	TL630NE	XS800SE	XS800NJ	XH800SE	TL800NE	XS1250SE	XS1600SE
		36	50	70	125	200	200	36	50	70	125	65	65	65	200	65	85
E125NJ	25	36	36	50	65	85	85	36	-	50	–	36	36	36	–	–	–
S125NJ	36	–	50	65	85	125	125	–	-	65	–	50	50	–	–	–	–
S125GJ	65	–	–	70	125	150	150	–	50	70	–	–	–	65	–	–	–
H125NJ	125	–	–	–	–	200	200	–		-	–	–	–	65	–	50	–
S160NJ	36	–	50	65	85	125	125	–	50	50	–	–	65	65	–	–	–
S160GJ	65	–	–	70	125	150	150	–	–	70	–	–	–	–	–	–	–
H160NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	65	–	65	–
E250NJ	25	36	36	50	65	85	85	36	–	50	–	–	36	50	–	–	–
S250NJ	36	–	50	65	85	125	125	–	–	65	–	–	65	–	–	–	–
S250GJ	65	–	–	70	125	150	150	–	–	70	–	–	–	–	–	–	–
S250PE	70	–	–	–	125	150	150	–	–	–	–	–	–	–	–	–	–
H250NJ	125	–	–	–	–	200	200	–	–-	–	–	–	–	–	–	–	–
E400NJ	25	36	36	50	65	85	85	36	–	50	36	–	–	–	36	–	36
S400CJ	36	–	50	65	70	100	100	–	–	65	50	–	–	–	50	–	50
S400NJ	50	–	–	70	85	125	125	–	36	70	65	–	–	50	65	–	65
S400GJ	70	–	–	–	125	150	150	–	36	–	–	–	–	50	–	36	85
H400NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	–	–	–	–

Note: ¹**)** Ratings have not been verified where a dash "–" is shown.

All pick-up and time delay settings are to be set at a maximum for upstream MCCBs

SECTION 4

APPLICATION DATA

SELECTIVITY AND CASCADE TEMBREAK 2 MCCBs AND DIN-T / SAFE-T MCBs

SELECTIVITY / CASCADE @ 415 V AC			Upstream MCCB							
			E125NJ	S125NJ	H125NJ S125GJ	S250NJ	S250GJ	S400CJ	S400GE S400GJ	H400NJ
Downstream MCB	Amp rating	kA (RMS)	25	36	65	36	65	36	70	125
DTCB6	2 – 20	6	18/18	25/25	35/35	35/35	35/35	–	–	–
	25 – 63	6	18/18	20/25	20/25	30/30	30/30	–	–	–
DTCB10	0.5 – 32	10	18/18	30/30	30/50	35/35	40/50	35/35	40/50	40/50
	40 – 63	10	18/18	20/25	25/25	30/30	30/30	30/30	30/30	30/30
DSRCBH /	0.5 – 32	10	18/18	30/30	30/50	35/35	40/50	35/35	40/50	40/50
DSRCD	40	10	18/18	20/25	25/25	30/30	30/30	30/30	30/30	30/30
Din-T10H	80 – 125	10	4/18	4/25	4/25	15/15	15/15	10/10	10/10	–
DTCH15	0.5 – 32	15	18/18	30	30/50	35/35	40/50	35/35	40/50	40/50
	40 – 63	15	18/18	20	25/25	30/30	30/30	30/30	30/30	30/30
Safe-T	16 – 20	6	3/10	3/10	3/10	–	–	–	–	–
SRCB	16 – 20	6	3/10	3/10	3/10	–	–	–	–	–

Guide

X X / Y Y

Selectivity Cascade

Notes: All figures stated are at 400/415 V AC.

SECTION 4

APPLICATION DATA

MOTOR STARTING TYPE 1 CO-ORDINATION TABLES

Short-Circuit Co-Ordination Motor Starting Table

Type '1'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 50/65 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 1 50/65 kA

		Terasaki Combinations		Terasaki Combinations		Sprecher + Schuh Combinations	
Motor Size (kW)	Approx. amps @ 400/415 V (A)	MCCB	Contactor	Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactor
0.37	1.1	XM30PB/1.4	CA7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1.0A	CA7-9
0.55	1.5	XM30PB/2	CA7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA7-9
0.75	1.8	XM30PB/2.6	CA7-9	CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA7-9
1.1	2.6	XM30PB/4.0	CA7-9	CT 7-24	2.4 - 4.0	KTA7-25S-2.5A	CA7-9
1.5	3.4	XM30PB/5	CA7-9	CT 7-24	2.4 - 4.0	KTA7-25S-4.0A	CA7-9
2.2	4.8	XM30PB/8	CA7-9	CT 7-24	4.0 - 6.0	KTA7-25S-6.3A	CA7-9
3	6.5	XM30PB/10	CA7-9	CT 7-24	6.0 - 10	KTA7-25S-6.3A	CA7-9
4	8.2	XM30PB/12	CA7-9	CT 7-24	6.0 - 10	KTA7-25S-10A	CA7-9
5.5	11	S125GJ/20	CA7-12	CT 7-24	10 - 16	KTA7-25H-16A	CA7-12
7.5	14	S125GJ/20	CA7-16	CT 7-24	10 - 16	KTA7-25H-16A	CA7-16
11	21	S125GJ/32	CA7-23	CT 7-24	16 - 24	KTA7-45H-20A	CA7-23
15	28	S125GJ/50	CA7-30	CT 7-45	18 - 30	KTA7-45H-32A	CA7-30
18.5	34	S125GJ/50	CA7-37	CT 7-45	30 - 45	KTA7-45H-45A	CA7-37
22	40	S125GJ/63	CA7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA7-43
30	55	S125GJ/100	CA7-60	CT 7-75	45 - 60	KTA3-100-63A	CA7-60
37	66	S125GJ/100	CA7-72	CT 7-75	60 - 75	KTA3-100-90A	CA7-72
45	80	S125GJ/125	CA7-85	CT 7-100	70 - 90	KTA3-100-90A	CA7-85
55	100	S125GJ/125	CA6-110	CEF 1-11/12	20 - 180	KTA3-160S-100A	CA6-110
5	130	S250PE/250	CA6-140	CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-140
0	155	S250PE/250	CA6-180	CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-180
10	200	S250PE/250	CA6-210	CEF 1-41/42	160 - 400	KTA3-250S-200A	CA6-210
32	225	S400GE/400	CA6-210	CEF 1-41/42	160 - 400	KTA3-250S-250A	CA6-250
60	270	S400GE/400	CA6-300	CEF 1-41/42	160 - 400	KTA3-400S-320A	CA6-300
00	361	S400GE/400	CA6-420	CEF 1-41/42	160 - 400	KTA3-400S-400A	CA6-420

Notes:
- Thermal or electronic overload relays may be used.
- XM30PB MCCB's can be replaced with S125GJ/20 if required.
- Combinations based on the thermal overload relay tripping before the circuit. breaker at overload currents up to the motor locked rotor current.

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION TABLES

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 50/65 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2 50/65 kA

		Terasaki Combinations	
Motor Size (kW)	**Approx. amps @ 400/415 V (A)**	**MCCB**	**Contactor**
0.37	1.1	XM30PB/1.4	CA7-9
0.55	1.5	XM30PB/2	CA7-9
0.75	1.8	XM30PB/2.6	CA7-9
1.1	2.6	XM30PB/4.0	CA7-16
1.5	3.4	XM30PB/5	CA7-16
2.2	4.8	XM30PB/8	CA7-16
3	6.5	XM30PB/10	CA7-30
4	8.2	XM30PB/12	CA7-30
5.5	11	S125GJ/20	CA7-30
7.5	14	S125GJ/20	CA7-30
11	21	S125GJ/32	CA7-30
15	28	S125GJ/50	CA7-43
18.5	34	S125GJ/50	CA7-43
22	40	S125GJ/63	CA7-43
30	55	S125GJ/100	CA7-72
37	66	S125GJ/100	CA7-72
45	80	S125GJ/125	CA6-105
55	100	S250PE/160	CA6-105
75	130	S250PE/250	CA6-140
90	155	S250PE/250	CA6-170
110	200	S250PE/250	CA6-210
132	225	S400PE/400	CA6-210
160	270	S400PE/400	CA6-300
200	361	S400PE/400	CA6-420

Terasaki Combinations		Sprecher + Schuh Combinations	
Overload Relay	**Thermal Setting (A)**	**KT7 Circuit Breaker**	**Contactor**
CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA7-9
CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA7-9
CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-4A	CA7-9
CT 7-24	4.0 - 6.0	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-10A	CA7-9
CT 7-24	10 - 16	KTA7-25H-16A	CA7-12
CT 7-24	10 - 16	KTA7-25H-16A	CA7-16
CT 7-24	16 - 24	KTA7-45H-20A	CA7-23
CT 7-45	18 - 30	KTA7-45H-32A	CA7-30
CT 7-45	30 - 45	KTA7-45H-45A	CA7-37
CT 7-45	30 - 45	KTA7-45H-45A	CA7-43
CT 7-75	45 - 60	KTA3-100-63A	CA7-60
CT 7-75	60 - 75	KTA3-100-90A	CA7-72
CT 7-100	70 - 90	KTA3-100-90A	CA7-85
CEF 1-11/12	20 - 180	KTA3-160S-100A	CA6-110
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-140
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-180
CEF 1-41/42	160 - 400	KTA3-250S-200A	CA6-210
CEF 1-41/42	160 - 400	KTA3-250S-250A	CA6-250
CEF 1-41/42	160 - 400	KTA3-400S-320A	CA6-300
CEF 1-41/42	160 - 400	KTA3-400S-400A	CA6-420

Notes:
- Thermal or electronic overload relays may be used.
- XM30PB combinations can be replaced with S125GJ/20 and CA7-30 if required.
- Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

SECTION 4

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 85 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2 85 kA

		Terasaki Combinations		Terasaki Combinations		Sprecher + Schuh Combinations	
Motor Size (kW)	Approx. amps @ 400/415 V (A)	MCCB	Contactor	Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactor
0.37	1.1	XM30PB/1.4	CA 7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA 7-9
0.55	1.5	XM30PB/2	CA 7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA 7-9
0.75	1.8	XM30PB/2.6	CA 7-9	CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA 7-9
1.1	2.6	XM30PB/4.0	CA 7-16	CT 7-24	2.4 - 4.0	KTA7-25H-2.5A	CA 7-9
1.5	3.4	XM30PB/5	CA 7-16	CT 7-24	2.4 - 4.0	KTA7-25H-4A	CA 7-9
2.2	4.8	XM30PB/8	CA 7-30	CT 7-24	4.0 - 6.0	KTA7-25H-6.3A	CA 7-9
3	6.5	XM30PB/10	CA 7-30	CT 7-24	6.0 - 10	KTA7-25H-6.3A	CA 7-9
4	8.2	XM30PB/12	CA 7-30	CT 7-24	6.0 - 10	KTA7-25H-10A	CA 7-9
5.5	11	H125NJ/20	CA 7-30	CT 7-24	10 - 16	KTA7-45H-16A	CA 7-12
7.5	14	H125NJ/20	CA 7-30	CT 7-24	10 - 16	KTA7-45H-16A	CA 7-16
11	21	H125NJ/32	CA 7-30	CT 7-24	16 - 24	KTA7-45H-20A	CA 7-23
15	28	H125NJ/50	CA 7-43	CT 7-45	18 - 30	KTA7-45H-32A	CA 7-30
18.5	34	H125NJ/50	CA 7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA 7-37
22	40	H125NJ/63	CA 7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA 7-43
30	55	H125NJ/100	CA 7-72	CT 7-75	45 - 60	KTA3-100-63A	CA7-60
37	66	H125NJ/100	CA 7-72	CT 7-75	60 - 75	KTA3-100-90A	CA7-72
45	80	H125NJ/160	CA 6-105	CT 7-100	70 - 90	KTA3-100-90A	CA7-85
55	100	H160NJ/160	CA 6-105	CEF 1-11/12	20 - 180	-	-
75	130	H250PE/250	CA 6-210	CEF 1-11/12	20 - 180	-	-
90	155	H250PE/250	CA 6-210	CEF 1-11/12	20 - 180	-	-
110	200	H250PE/250	CA 6-210	CEF 1-41/42	160 - 400	-	-
132	225	H400NE/400	CA 6-210	CEF 1-41/42	160 - 400	-	-
160	270	H400NE/400	CA 6-300	CEF 1-41/42	160 - 400	-	-
200	361	H400NE/400	CA 6-420	CEF 1-41/42	160 - 400	-	-

Notes:
- Thermal or electronic overload relays may be used.
- XM30PB combinations can be replaced with H125GJ/20 and CA7-30 if required.
- Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 100 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2 100 kA

		Terasaki Combinations		Terasaki Combinations		Sprecher + Schuh Combinations	
Motor Size (kW)	**Approx. amps @ 400/415 V (A)**	**MCCB**	**Contactor**	**Overload Relay**	**Thermal Setting (A)**	**KT7 Circuit Breaker**	**Contactor**
0.37	1.1	H125NJ/20	CA 7-30	CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA 7-9
0.55	1.5	H125NJ/20	CA 7-30	CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA 7-9
0.75	1.8	H125NJ/20	CA 7-30	CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA 7-9
1.1	2.6	H125NJ/20	CA 7-30	CT 7-24	2.4 - 4.0	KTA7-25H-2.5A	CA 7-9
1.5	3.4	H125NJ/20	CA 7-30	CT 7-24	2.4 - 4.0	KTA7-25H-4A	CA 7-9
2.2	4.8	H125NJ/20	CA 7-30	CT 7-24	4.0 - 6.0	KTA7-25H-6.3A	CA 7-9
3	6.5	H125NJ/20	CA 7-30	CT 7-24	6.0 - 10	KTA7-25H-6.3A	CA 7-9
4	8.2	H125NJ/20	CA 7-30	CT 7-24	6.0 - 10	KTA7-25H-10A	CA 7-9
5.5	11	H125NJ/20	CA 7-30	CT 7-24	10 - 16	KTA7-45H-16A	CA 7-12
7.5	14	H125NJ/20	CA 7-30	CT 7-24	10 - 16	KTA7-45H-16A	CA 7-16
11	21	H125NJ/32	CA 7-30	CT 7-24	16 - 24	KTA7-45H-20A	CA 7-23
15	28	H125NJ/50	CA 7-43	CT 7-45	18 - 30	KTA7-45H-32A	CA 7-30
18.5	34	H125NJ/50	CA 7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA 7-37
22	40	H125NJ/63	CA 7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA 7-43
30	55	H125-NJ/100	CA 7-60	CT 7-75	45 - 60	-	-
37	66	H125-NJ/100	CA 7-72	CT 7-75	60 - 75	-	-
45	80	H125-NJ/125	CA 7-85	CT 7-100	70 - 90	-	-
55	100	H250-NE/160	CA 6-95	CEF 1-11/12	20 - 180	-	-
75	130	H250-NE/250	CA 6-140	CEF 1-11/12	20 - 180	-	-
90	155	H250-NE/250	CA 6-140	CEF 1-11/12	20 - 180	-	-
110	200	H250-NE/250	CA 6-180	CEF 1-41/42	160 - 400	-	-
132	225	H400-NE/400	CA 6-420	CEF 1-41/42	160 - 400	-	-
160	270	H400-NE/400	CA 6-420	CEF 1-41/42	160 - 400	-	-
200	361	H400-NE/400	CA 6-420	CEF 1-41/42	160 - 400	-	-

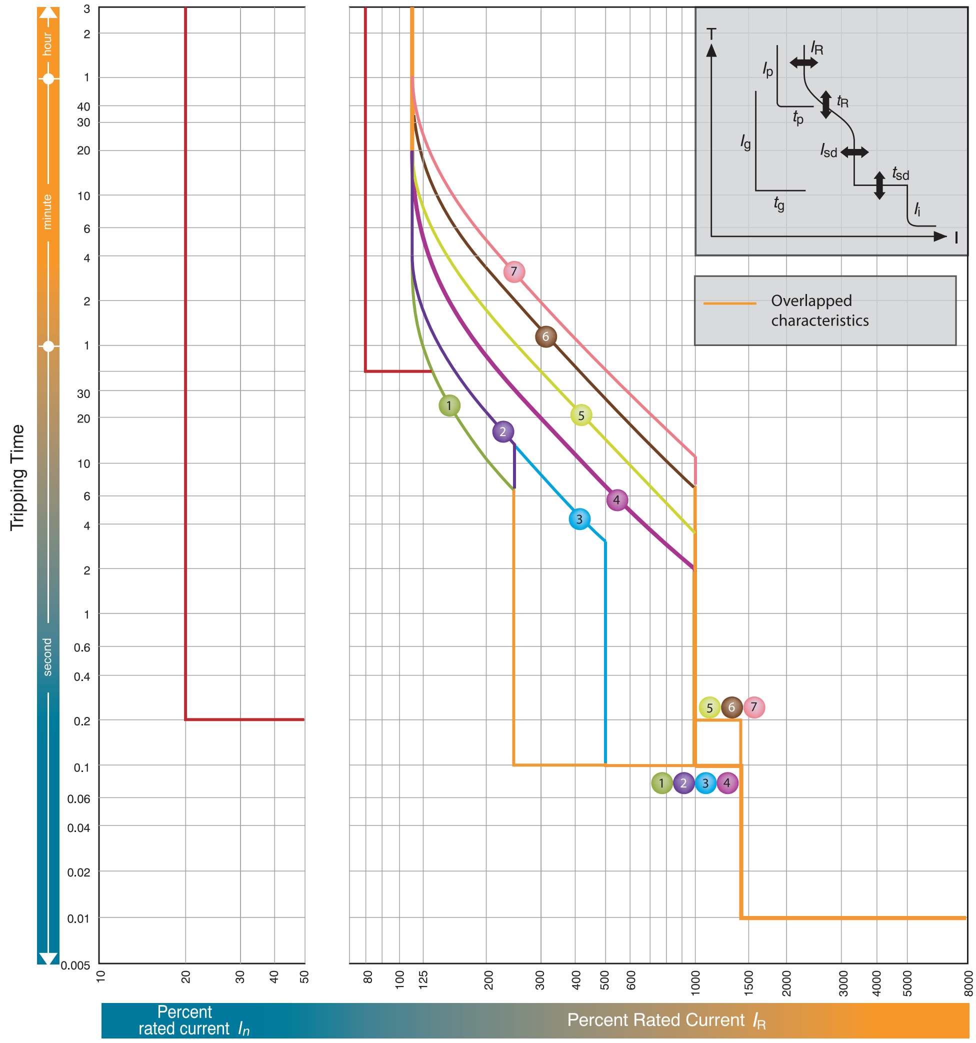
Notes:
- Thermal or electronic overload relays may be used.
- Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

SECTION 4

OPERATING CHARACTERISTICS

ELECTRONIC CHARACTERISTICS

S400-NE, S400-GE, H400-NE, L400-NE



In = 400A; 250A

I_R (A)									
LTD Pick-up current	I_R	xI_n	0.4	0.5	0.63	0.8	0.9	0.95	1.0

	Characteristics		No.	1	2	3	4	5	6	7
Standard	LTD	t_R	(s)	11	21	21	5	10	19	29
				at 200% x I_R			at 600% x I_R			
	STD	I_{sd}	xI_R	2.5		5	10			
		t_{sd}	(s)	0.1				0.2		
	INST	I_i	xI_R	14(Max: 13 x I_n) Note (1)						
Option	PTA	I_p	xI_R	0.8						
		t_p	(s)	40						
	GFT	I_g	xI_n	0.2						
		t_g	(s)	0.2						
	N	I_N	xI_n	1.0						
		t_N	(s)	t_N=t_R Note(2)						

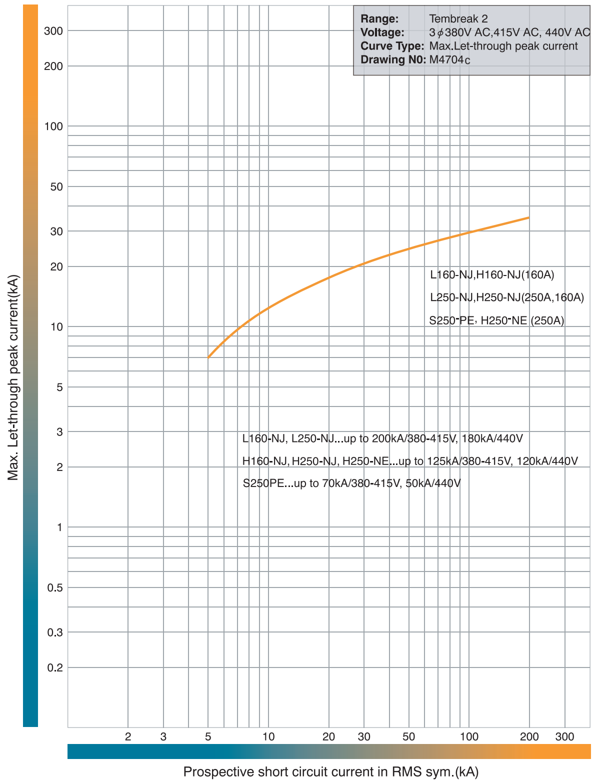
Note
(1) I_i max. = 13 x I_n. (2) Standard setting of I_N is 100% of I_n. For any other setting please specify when ordering.

SECTION 3

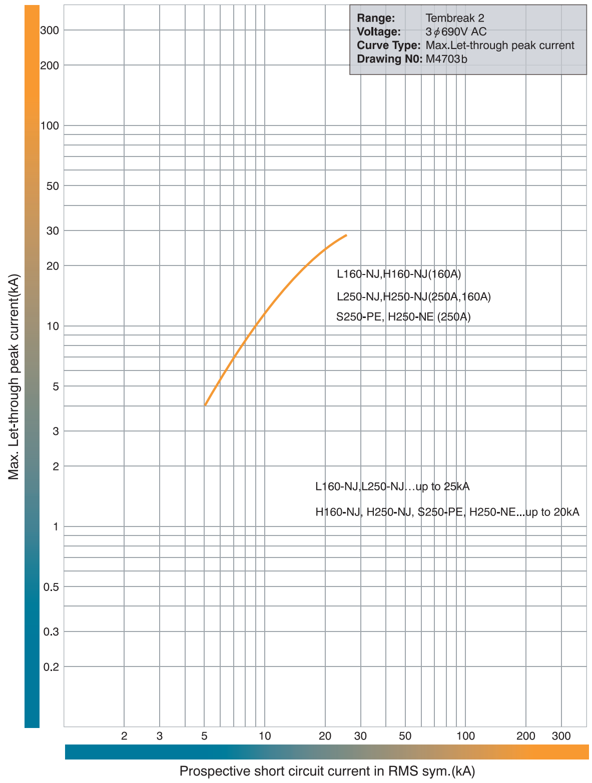
OPERATING CHARACTERISTICS

LET-THROUGH PEAK CURRENT CHARACTERISTICS

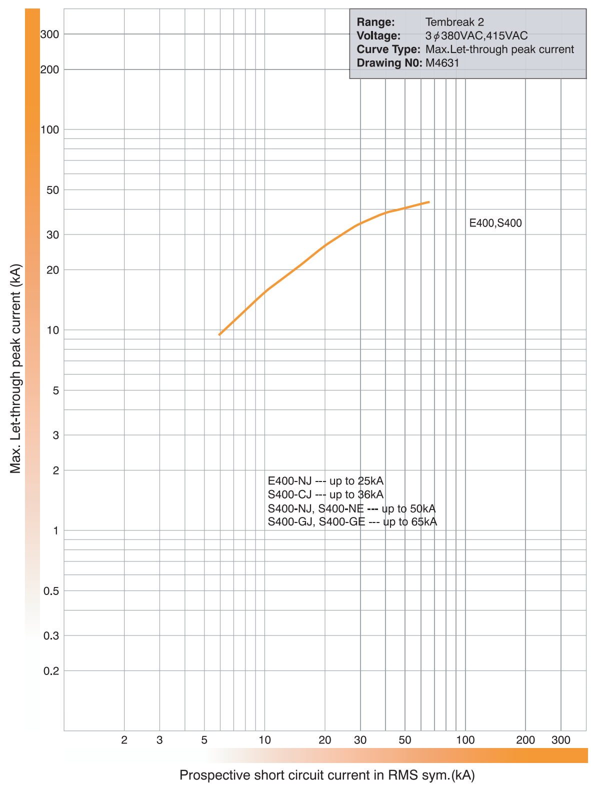
H160-NJ, L160-NJ, S250-PE, H250-NJ, H250-NE, L250-NJ. 440V AC.



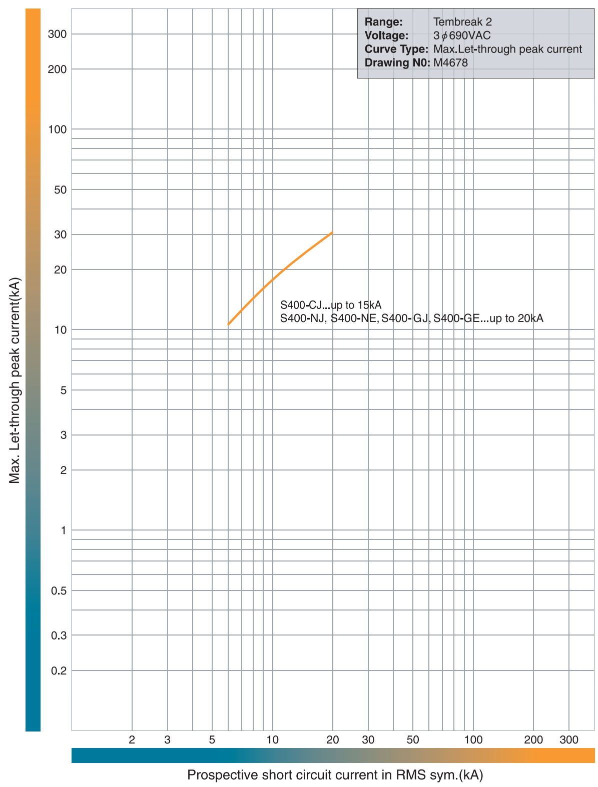
H160-NJ, L160-NJ, S250-PE, H250-NJ, H250-NE, L250-NJ. 690V AC.



E400-NJ, S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE, 415V AC.



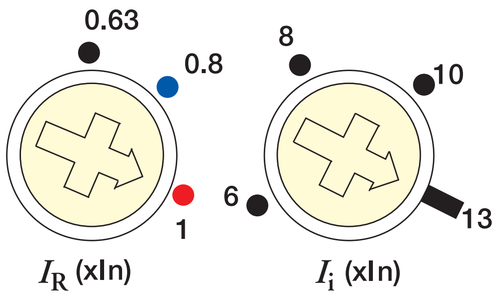
S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE, 690V AC.

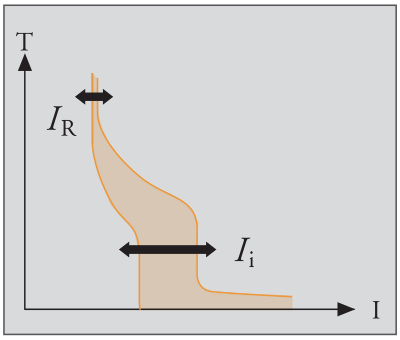


OPERATING CHARACTERISTICS

THERMAL MAGNETIC PROTECTION

Adjustment Dials





1. I_R is the thermal element adjustment dial and is used to set the rated current to match the conductor rating.

   I_R can be set between 0.63 and 1.0 times I_n.

2. I_i is the magnetic element adjustment dial and is used to set the short circuit tripping threshold to suit the application.

   I_i can be set between 6 and 12 times I_n on 125A and 400A frame models.

   I_i can be set between 6 and 13 times I_n on 250A frame models with ratings of 160A, 200A and 250A.

   I_i can be set between 6 and 12 times I_n on 250A frame models with ratings of 125A and less.

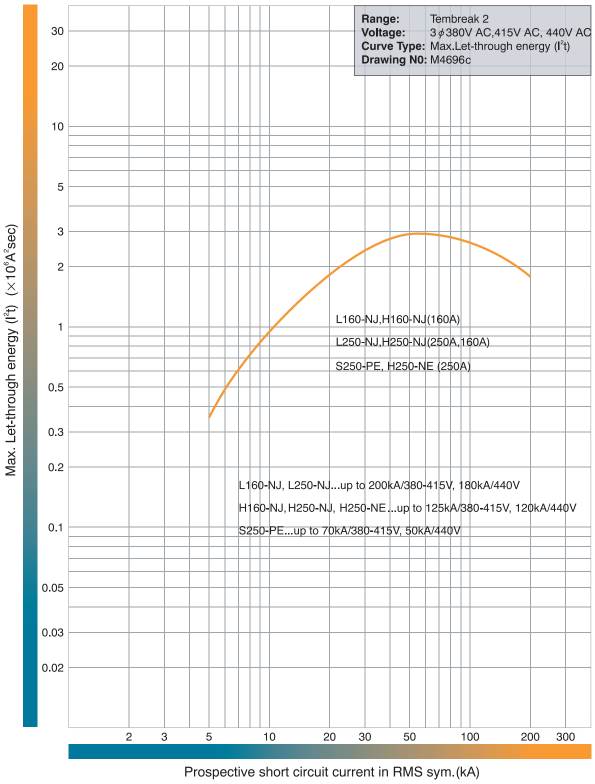
Models, Types and Rated Currents of Thermal Elements

Model	Type	Current Rating In (A)
S125	-NF	16, 20, 25, 32, 40, 50, 63, 80, 100, 125
E125	-NJ	20, 32, 50, 63, 100, 125
S125	-NJ	20, 32, 50, 63, 100, 125
S125	-GJ	20, 32, 50, 63, 100, 125
H125	-NJ	20, 32, 50, 63, 100, 125
L125	-NJ	20, 32, 50, 63, 100, 125
S160	-NF	16, 20, 25, 32, 40, 50, 63, 80, 100, 125, 160
S160	-NJ	20, 32, 50, 63, 100, 125, 160
S160	-GJ	50, 63, 100, 125, 160
H160	-NJ	160
L160	-NJ	160
E250	-NJ	20, 32, 50, 63, 100, 125, 160, 200, 250
S250	-NJ	160, 200, 250
S250	-GJ	160, 200, 250
H250	-NJ	160, 250
L250	-NJ	160, 250
E400	-NJ	250, 400
S400	-CJ	250, 400
S400	-NJ	250, 400
S400	-GJ	250, 400
H400	-NJ	250, 400
L400	-NJ	250, 400

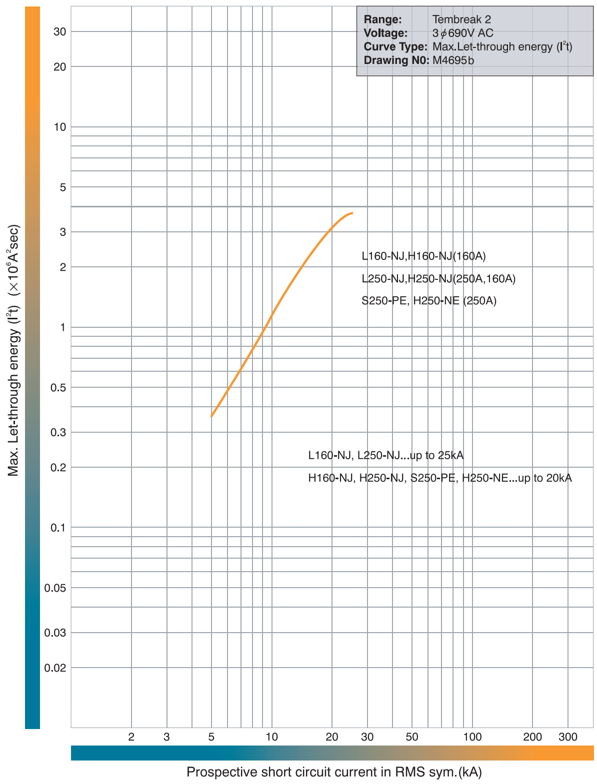
OPERATING CHARACTERISTICS

LET-THROUGH ENERGY CHARACTERISTICS

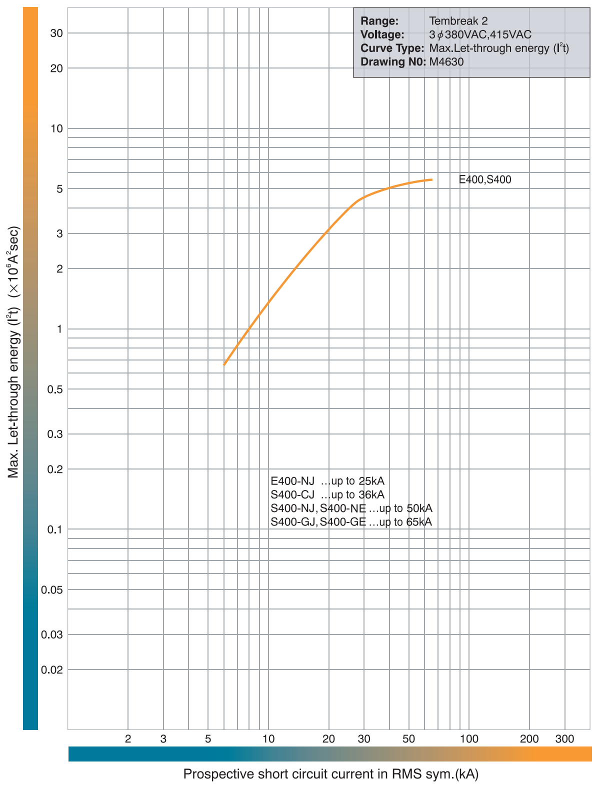
H160-NJ, L160-NJ, S250-PE, H250-NE, H250-NJ, L250-NJ. 440V AC.



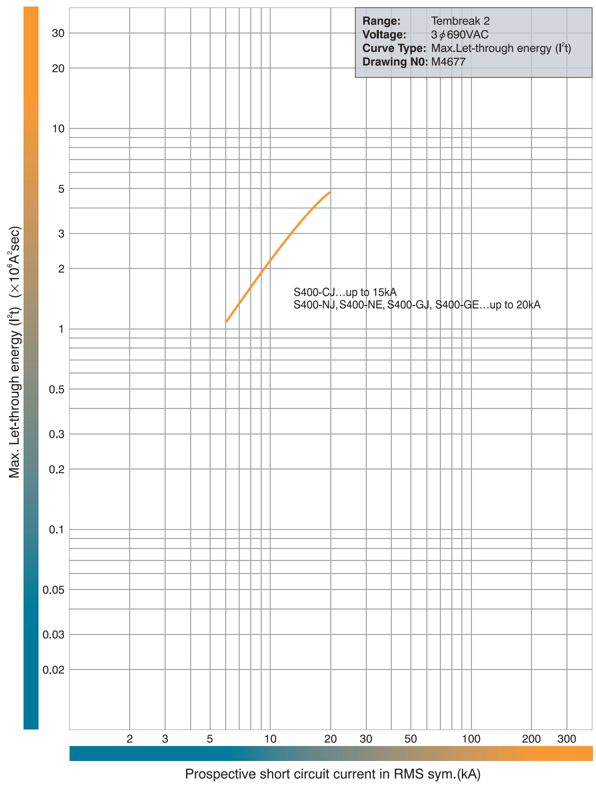
H160-NJ, L160-NJ, S250-PE, H250-NE, H250-NJ, L250-NJ. 690V AC.



E400-NJ, S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE. 415V AC.



S400-CJ, S400-NJ, S400-NE, S400-GJ, S400-GE. 690V AC.

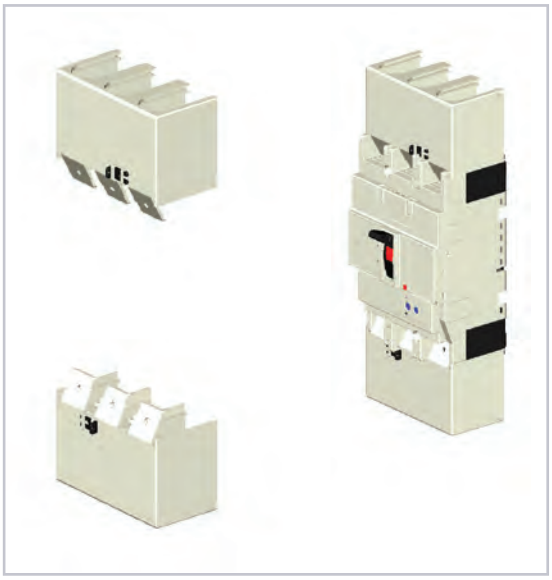


ACCESSORIES

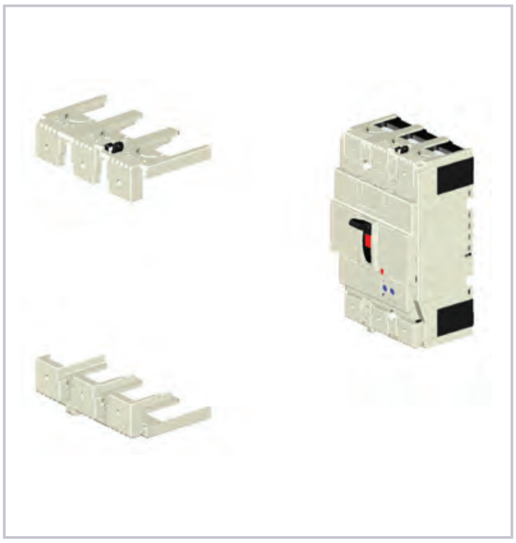
INSULATION ACCESSORIES

Terminal Covers for Front Connection (CF)

Terminal covers for front connection are suitable for covering the exposed live parts of conductors terminated on the MCCB.



Terminal Covers for Front Connection



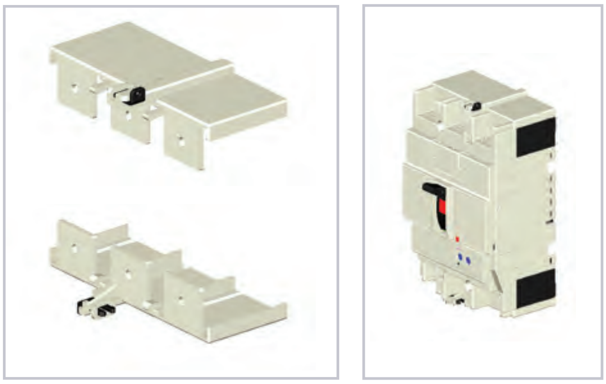
Flush Terminal Covers

Flush Terminal Covers (CS)

Flush terminal covers are useful for increasing the ingress protection rating at the terminals without increasing the overall length. They can be used with busbar and for direct entry of stranded cable (with solderless cable clamp terminals (FW), refer to Section 6, Installation).
Flush terminal covers are identical to rear terminal covers for 400A and 630A frame models.
The user can remove a section of the rear terminal cover using a tool to allow entry of the conductor.

Terminal covers for Rear Connection (CR)

Terminal covers for rear connection may be used on MCCBs fitted with rear connections (RP) or plug-in connections (PM). They prevent access to the terminals from the front and top.



Terminal Covers for Rear Connection

INSTALLATION

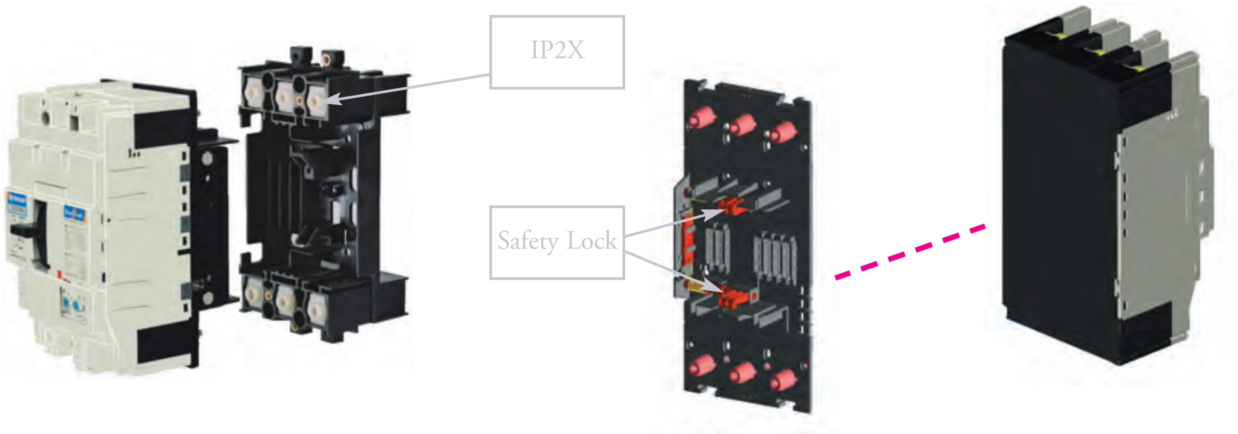
CONNECTION AND MOUNTING OPTIONS AND ACCESSORIES

Plug-in Mounting

The plug in mounting system allows fast replacement of the MCCB body without the need to disturb the terminations. Solid conductors or cables terminated with compression terminals can be used.

Plug-In Safety Lock

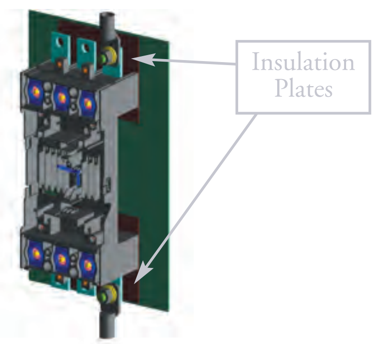
The plug-in MCCB body is **automatically locked to the base** when the contacts are closed (toggle ON). It cannot be removed unless the contacts are in the isolated position (toggle OFF or TRIPPED). This system ensures safe removal of the MCCB from the base.

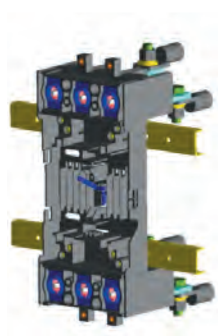


Plug-in MCCB and base

Plug-in connections and safety lock are fitted to the back of the MCCB

The connection bars for plug-in bases are optional and can be configured in the field either for front or rear access. The illustrations below show possible mounting and connection options for plug in bases.





1. Mounted on base plate with connection bars mounted for front access.
   Insulation plates are supplied as standard and must be fitted.
2. Terminations in separate compartment. Connection bars are mounted for top access at the top and rear access at the bottom.
3. Mounted on angle bars. Connection bars are mounted for rear access.

SECTION 6

TERASAKI Innovators in Protection Technology TemBreak2 **MCCB's**

NHP

Thermal magnetic type

S125GJ

65kA

Current rating: **12.5 – 125A**

Approvals and Tests:
Standards AS/NZS 3947-2, and IEC60947-2

Interrupting capacity:

	Voltage	Icu	Ics
AC use	380/400	65	36
DC use	250V	40	40

Trip unit:
Adjustable thermal (0.63 *Ir* to 100% *Ir*) and adjustable magnetic (6 *Im* to 12 *Im*)

Dimensions (mm)

Poles	3	4
H	155	155
W	90	120
D (less toggle)	68	68
Toggle cut-out		Standard DIN

Ampere Rating NRC	**Adj. *Ir*** 1) Min - Max.	**Adj. *Im*** 1) Min - Max.	**Cat. No.**
20	12.5 - 20	120 - 240	**S125 GJ 3 20** **S125 GJ 4 20**
32	20 - 32	192 - 384	**S125 GJ 3 32** **S125 GJ 4 32**
50	32 - 50	300 - 600	**S125 GJ 3 50** **S125 GJ 4 50**
63	40 - 63	378 - 756	**S125 GJ 3 63** **S125 GJ 4 63**
100	63 - 100	600 - 1200	**S125 GJ 3 100** **S125 GJ 4 100**
125	80 - 125	750 - 1500	**S125 GJ 3 125** **S125 GJ 4 125**

1) NRC: Nominal rated current
Adj. *Ir*: Adjustable thermal setting
Adj. *Im*: Adjustable magnetic setting

Replaces: XH125NJ, TL100NJ, Note: check exact ratings or dimenions to suit your application requirement

DIMENSIONS

E125-NJ, S125-NJ, S125-GJ

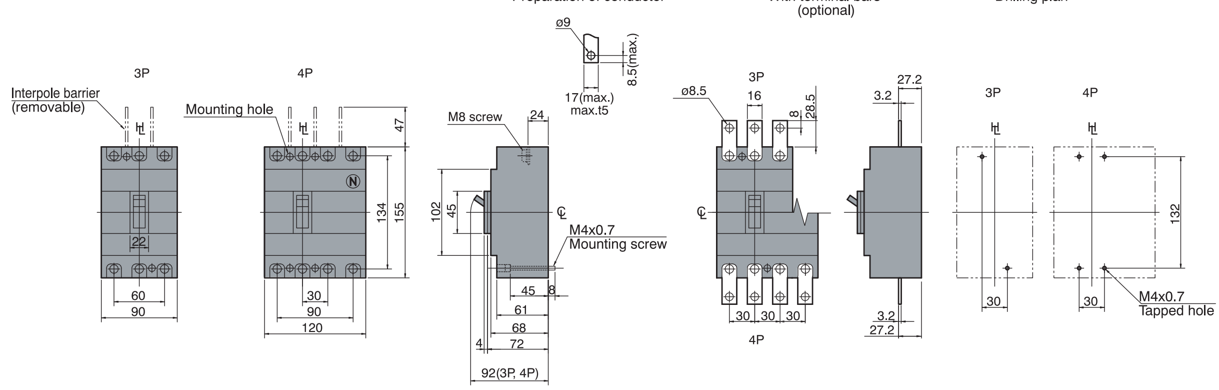
ASL: Arrangement Standard Line
H̶L : Handle Frame Centre Line

Front connected

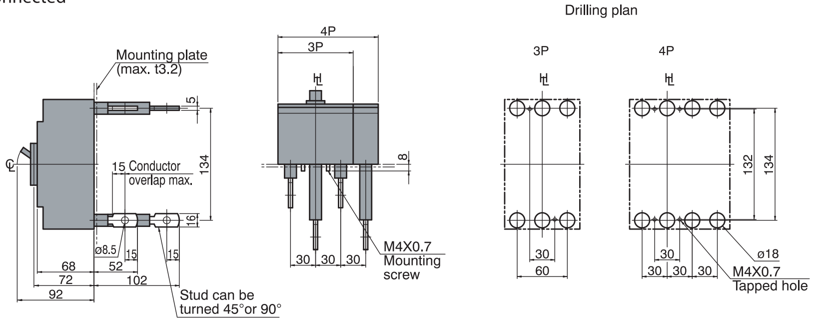
Preparation of conductor

With terminal bars
(optional)

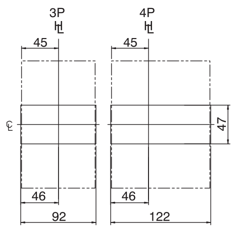
Drilling plan



Rear connected

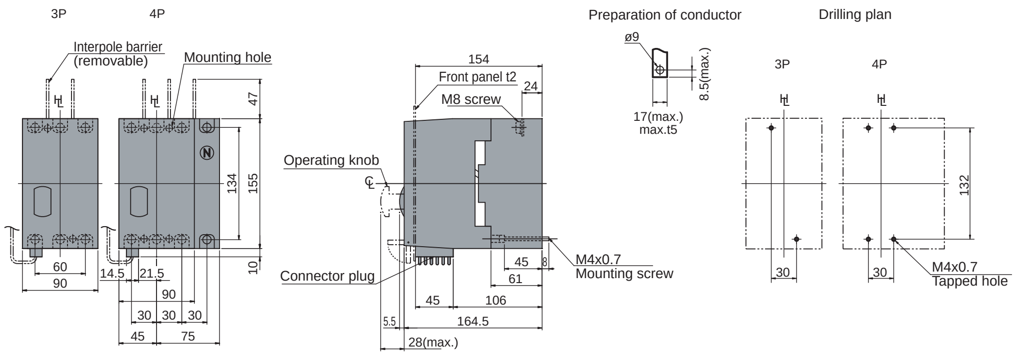


Panel cutout
(Front view)

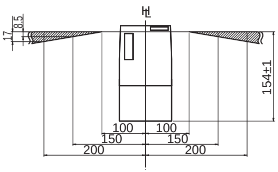


Panel cutout dimensions shown give an allowance of 1.0mm around the handle escutcheon.

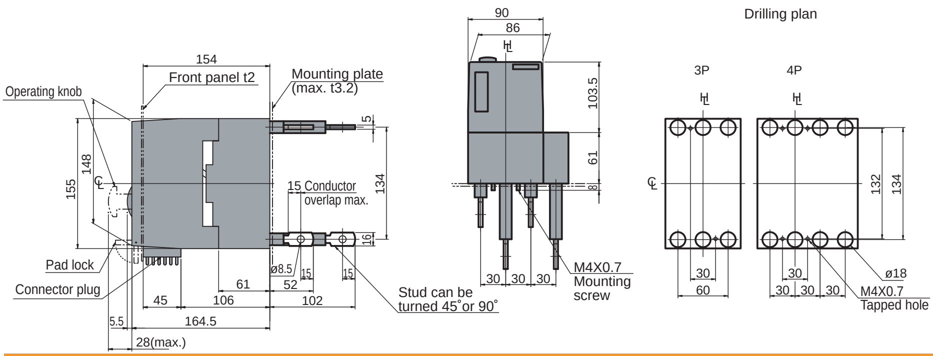
Front connected with Motor Operator



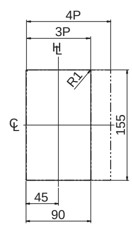
Panel hinge position (hatching area)
bottom view



Rear connected with Motor Operator



Panel cutout
(Front view)



Panel cutout dimensions shown give an allowance of 1.5mm around the handle escutcheon.

SECTION 7

INSTALLATION

INSULATION DISTANCE IN mm (AT 440V AC MAXIMUM)

Model	Type	A	B1	B2	C	D	E
E125	NJ	50	10	10	0	25	*(1)
S125	NF	50	10	10	0	25	*(1)
S125	NJ	50	10	10	0	25	*(1)
S125	GJ	75	45	25	0	25	*(1)
H125	NJ	100	80	60	0	50	*(1)
L125	NJ	100	80	60	0	50	*(1)
S160	NF	50	40	30	0	25	*(1)
S160	NJ	50	40	30	0	25	*(1)
S160	GJ	100	80	60	0	50	*(1)
H160	NJ	100	80	60	0	50	*(1)
L160	NJ	100	80	60	0	50	*(1)
E250	NJ	50	40	30	0	25	*(1)
S250	NJ	50	40	30	0	25	*(1)
S250	GJ	100	80	30	0	25	*(1)
S250	PE	100	80	60	0	50	*(1)
H250	NJ	100	80	60	0	50	*(1)
H250	NE	100	80	60	0	50	*(1)
L250	NJ	100	80	60	0	50	*(1)
E400	NJ	100	80	40	0	30	*(1)
S400	CJ	100	80	40	0	30	*(1)
S400	NJ	100	80	40	0	30	*(1)
S400	GJ	100	80	40	0	30	*(1)
S400	GE	100	80	40	0	30	*(1)
H400	NJ	120	120	80	0	80	*(1)
H400	NE	120	120	80	0	80	*(1)
L400	NJ	120	120	80	0	80	*(1)
L400	NE	120	120	80	0	80	*(1)
E630	NE	120	100	80	0	80	*(1)
S630	CE	120	100	80	0	80	*(1)
S630	GE	120	100	80	0	80	*(1)

***Note:** (1) Insulate the exposed conductor until it overlaps the moulded case at the terminal, or the terminal cover.

SECTION 6

APPLICATION DATA

SELECTIVITY (DISCRIMINATION) AND CASCADE

SECTION 4

Selectivity

The principle of Selectivity (Discrimination) is based upon an analysis of several circuit breaker characteristics. These include time-current (tripping) curves, peak-let-through current (I_{peak}) and energy let-through (I^2t).

The figures stated give the maximum selectivity level with the two nominated breakers in series under short-circuit conditions. For an indication on selectivity under overloads refer to the circuit breaker tripping/characteristic curves, or use the NHP TemCurve selectivity analysis software package.

Selectivity can be enhanced beyond the breaking capacity of the downstream breaker provided it is backed up by an appropriately selected upstream breaker, which should not trip (unlatch) under the stated short circuit current.

Cascade

Cascading is achieved by using an upstream device to assist (back-up) a downstream device in clearing a fault current. This principal is necessary should the downstream device be required to clear a prospective short circuit current greater than the devices' breaking capacity.

In most cascading applications it is generally necessary for the upstream breaker to trip (unlatch), as well as the downstream breaker to give adequate back-up protection. As such, cascade is commonly used in feeding and protecting non-essential loads, such as basic lighting.

For more information on selectivity and cascading please refer to the latest NHP Part C catalogue.

TERASAKI
Innovators in Protection Technology

NHP

APPLICATION DATA

SELECTIVITY TABLES

Selectivity & Cascade Tables @ 400 / 415 V

XX / YY
Selectivity/ Cascade

Downstream MCCBs	kA (RMS)	S250PE 70	H250NE 125	S400NE 50	S400GE 70	H400NE 125	L400NE 200	E630NE 36	S630CE 50
E125NJ	25	25/25	25/65	25/36	25/50	25/65	25/85	25/36	25/25
S125NJ	36	36/36	36/85	36/50	36/65	36/85	36/125	36/36	36/36
S125GJ	65	65/65	65/125	50/50	65/70	65/125	65/150	36/36	50/50
H125NJ	125	70/70	125/125	50/50	70/70	125/125	125/200	36/36	50/50
S160NJ	36			36/50	36/65	36/85	36/125	36/36	36/50
S160GJ	65			50/50	65/70	65/125	65/150	36/36	50/50
H160NJ	125					125/125	125/200	36/36	50/50
E250NJ	25					25/65	25/85	25/36	25/25
S250NJ	36					36/85	36/125	36/36	36/36
S250GJ	65					65/125	65/150	36/36	50/50
S250PE	70					40/125	70/150	36/36	50/50
H250NJ	125					125/125	125/200	36/36	50/50
H250PE	125					125/125	125/200	36/36	50/50
E400NJ	25							10/25	10/25
S400CJ	36							10/36	10/36
S400NE	50							10/36	10/50
S400NJ	50							10/36	10/36
S400GJ	70							10/36	10/50
H400NJ	125							10/36	10/50
H400NE	125							10/36	10/50
E630NE	36								
E630CE	50								
S630GE	70								
XS630CJ	45								
XS630NJ	65								
XS630PJ	85								
XS630SE	50								
XH630SE	65								
XH630PE	65								
XS800NJ	65								
XS800SE	50								
XJ800PJ	85								
XH800SE	65								
XH800PE	65								
XS1250SE	65								
XS1600SE	85								

Downstream MCCBs	kA (RMS)	S630GE 70	TL630NE 125	XS800SE 50	XH800SE 65	TL800NE 125	XS1250SE 85	TL1250NE 125	XS1600SE 100	XS2000NE 85	XS2500NE 85
E125NJ	25	25/50	25/25	25/36	25/36	25/65	25/25	25/25	25/25	25/25	25/25
S125NJ	36	36/65	36/36	36/50	36/36	36/36	36/36	36/36	36/36	36/36	36/36
S125GJ	65	65/70	65/65	65/50	65/65	65/65	65/65	65/65	65/65	65/65	65/65
H125NJ	125	70/70	70/70	50/50	65/65	65/65	85/50	85/50	100/100	85/85	85/85
S160NJ	36	36/50	36/36	36/36	36/65	36/65	36/36	36/36	36/36	36/36	36/36
S160GJ	65	65/70	65/65	50/50	50/65	50/65	65/65	65/65	65/65	65/65	65/65
H160NJ	125	70/70	70/70	50/50	50/65	50/65	85/65	85/65	100/100	85/85	85/85
E250NJ	25	25/50	25/25	25/25	25/50	25/50	25/25	25/25	25/25	25/25	25/25
S250NJ	36	36/65	36/36	36/36	36/36	36/36	36/36	36/36	36/36	36/36	36/36
S250GJ	65	65/70	65/65	50/50	50/65	50/65	65/65	65/65	65/65	65/65	65/65
S250PE	70	70/70	70/70	50/50	50/65	50/65	70/70	70/70	70/70	70/70	70/70
H250NJ	125	70/70	70/70	50/50	50/65	50/65	85/85	85/85	100/100	85/85	85/85
H250PE	125	70/70	70/70	50/50	50/65	50/65	85/85	85/85	100/100	85/85	85/85
E400NJ	25	10/50	10/36	25/25	25/25	25/36	25/25	25/25	25/36	25/25	25/25
S400CJ	36	10/65	10/50	25/36	25/36	25/50	36/36	36/36	36/50	36/36	36/36
S400NE	50	10/50	10/50	25/50	25/50	25/50	50/50	50/50	50/50	50/50	50/50
S400NJ	50	10/70	10/65	25/50	25/50	25/65	50/50	50/50	50/65	50/50	50/50
S400GJ	70	10/70	10/70	25/50	25/50	25/65	70/36	70/36	70/85	70/70	70/70
H400NJ	125	10/70	10/70	25/50	25/65	25/65	125/85	125/85	125/100	125/85	125/85
H400NE	125	10/70	10/70	25/50	25/65	25/65	125/85	125/85	125/100	125/85	125/85
E630NE	36			25/36	25/36	25/36	36/36	36/36	36/36	36/36	36/36
E630CE	50			25/50	25/50	25/50	50/50	50/50	50/50	50/50	50/50
S630GE	70						70/70	70/70	70/70	70/70	70/70
XS630CJ	45						30/45	30/45	30/45	35/45	35/45
XS630NJ	65						30/65	30/65	30/65	35/65	36/65
XS630PJ	85						30/85	30/85	30/85	35/85	35/85
XS630SE	50						30/65	30/65	30/85	30/85	30/85
XH630SE	65						30/65	30/65	30/85	30/85	30/85
XH630PE	65						30/65	30/65	30/85	30/85	30/85
XS800NJ	65						15/65	15/65	20/65	35/65	35/65
XS800SE	50						15/50	15/50	20/50	35/50	35/50
XJ800PJ	85						15/85	15/85	20/85	35/85	35/85
XH800SE	65						15/65	15/65	20/65	35/65	35/65
XH800PE	65						15/65	15/65	20/65	35/65	35/65
XS1250SE	65								20/65	35/65	35/65
XS1600SE	85									35/85	35/85

APPLICATION DATA

CASCADE TABLES

CASCADE @ 380 – 415 V AC [1]) Downstream MCCBs	kA (RMS)	E125NJ	S125NJ	S125GJ	H125NJ	L125NJ	S160NJ	S160GJ	H160NJ	L160NJ	E250NJ	S250NJ	S250GJ	S250PE	H250NJ	H250NE	L250NJ
		25	36	65	125	200	36	65	125	200	25	36	65	70	125	125	200
E125NJ	25	–	36	36	65	85	36	36	65	85	–	36	36	–	65	65	85
S125NJ	36	–	–	50	85	125	–	50	85	125	–	–	–	–	85	85	125
S125GJ	65	–	–	–	125	150	–	–	125	150	–	–	65	–	125	125	150
H125NJ	125	–	–	–	–	200	–	–	-	200	–	–	65	–	–	–	200
S160NJ	36	–	–	65	–	–	–	65	85	125	–	–	65	65	85	85	125
S160GJ	65	–	–	–	–	–	–	–	125	150	–	–	–	70	125	125	150
H160NJ	125	–	–	–	–	–	–	–	–	200	–	–	–	-	–	–	200
S250NJ	36	–	–	–	–	–	–	65	–	–	–	–	–	65	85	85	125
S250GJ	65	–	–	–	–	–	–	–	–	–	–	–	–	70	125	125	150
S250PE	70	–	–	–	–	–	–	–	–	–	–	–	–	–	125	125	150
H250NJ	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	200
E400NJ	25	–	–	–	–	–	–	–	–	–	–	–	–	36	65	65	–
S400CJ	36	–	–	–	–	–	–	–	–	–	–	–	–	50	70	70	–
S400NJ	50	–	–	–	–	–	–	–	–	–	–	–	50	65	85	85	–
S400GJ	70	–	–	–	–	–	–	–	–	–	–	–	50	–	125	125	–
H400NJ	125	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Note: [1]) Ratings have not been verified where a dash "–" is shown.

All pick-up and time delay settings are to be set at a maximum for upstream MCCB's

Upstream MCCBs

CASCADE @ 380 – 415 V AC [1]) Downstream MCCBs	kA (RMS)	S400CJ	S400NE S400NJ	S400GE S400GJ	H400NJ H400NE	L400NJ	L400NE	E630NE	S630CE	S630GE	TL630NE	XS800SE	XS800NJ	XH800SE	TL800NE	XS1250SE	XS1600SE
		36	50	70	125	200	200	36	50	70	125	65	65	65	200	65	85
E125NJ	25	36	36	50	65	85	85	36	-	50	–	36	36	36	–	–	–
S125NJ	36	–	50	65	85	125	125	–	-	65	–	50	50	–	–	–	–
S125GJ	65	–	–	70	125	150	150	–	50	70	–	–	–	65	–	–	–
H125NJ	125	–	–	–	–	200	200	–		-	–	–	–	65	–	50	–
S160NJ	36	–	50	65	85	125	125	–	50	50	–	–	65	65	–	–	–
S160GJ	65	–	–	70	125	150	150	–	–	70	–	–	–	–	–	–	–
H160NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	65	–	65	–
E250NJ	25	36	36	50	65	85	85	36	–	50	–	–	36	50	–	–	–
S250NJ	36	–	50	65	85	125	125	–	–	65	–	–	65	–	–	–	–
S250GJ	65	–	–	70	125	150	150	–	–	70	–	–	–	–	–	–	–
S250PE	70	–	–	–	125	150	150	–	–	–	–	–	–	–	–	–	–
H250NJ	125	–	–	–	–	200	200	–	–-	–	–	–	–	–	–	–	–
E400NJ	25	36	36	50	65	85	85	36	–	50	36	–	–	–	36	–	36
S400CJ	36	–	50	65	70	100	100	–	–	65	50	–	–	–	50	–	50
S400NJ	50	–	–	70	85	125	125	–	36	70	65	–	–	50	65	–	65
S400GJ	70	–	–	–	125	150	150	–	36	–	–	–	–	50	–	36	85
H400NJ	125	–	–	–	–	200	200	–	–	–	–	–	–	–	–	–	–

Note: [1]) Ratings have not been verified where a dash "–" is shown.

All pick-up and time delay settings are to be set at a maximum for upstream MCCBs

APPLICATION DATA

SELECTIVITY AND CASCADE TEMBREAK 2 MCCBs AND DIN-T / SAFE-T MCBs

SELECTIVITY / CASCADE @ 415 V AC			Upstream MCCB							
			E125NJ	S125NJ	H125NJ S125GJ	S250NJ	S250GJ	S400CJ	S400GE S400GJ	H400NJ
Downstream MCB	Amp rating	kA (RMS)	25	36	65	36	65	36	70	125
DTCB6	2 – 20	6	18/18	25/25	35/35	35/35	35/35	–	–	–
	25 – 63	6	18/18	20/25	20/25	30/30	30/30	–	–	–
DTCB10	0.5 – 32	10	18/18	30/30	30/50	35/35	40/50	35/35	40/50	40/50
	40 – 63	10	18/18	20/25	25/25	30/30	30/30	30/30	30/30	30/30
DSRCBH /	0.5 – 32	10	18/18	30/30	30/50	35/35	40/50	35/35	40/50	40/50
DSRCD	40	10	18/18	20/25	25/25	30/30	30/30	30/30	30/30	30/30
Din-T10H	80 – 125	10	4/18	4/25	4/25	15/15	15/15	10/10	10/10	–
DTCH15	0.5 – 32	15	18/18	30	30/50	35/35	40/50	35/35	40/50	40/50
	40 – 63	15	18/18	20	25/25	30/30	30/30	30/30	30/30	30/30
Safe-T	16 – 20	6	3/10	3/10	3/10	–	–	–	–	–
SRCB	16 – 20	6	3/10	3/10	3/10	–	–	–	–	–

Guide

XX / YY

Selectivity Cascade

Notes: All figures stated are at 400/415 V AC.

SECTION 4

APPLICATION DATA

MOTOR STARTING TYPE 1 CO-ORDINATION TABLES

Short-Circuit Co-Ordination Motor Starting Table

Type '1'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 50/65 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 1 50/65 kA

		Terasaki Combinations		Terasaki Combinations		Sprecher + Schuh Combinations	
Motor Size (kW)	Approx. amps @ 400/415 V (A)	MCCB	Contactor	Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactor
0.37	1.1	XM30PB/1.4	CA7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1.0A	CA7-9
0.55	1.5	XM30PB/2	CA7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA7-9
0.75	1.8	XM30PB/2.6	CA7-9	CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA7-9
1.1	2.6	XM30PB/4.0	CA7-9	CT 7-24	2.4 - 4.0	KTA7-25S-2.5A	CA7-9
1.5	3.4	XM30PB/5	CA7-9	CT 7-24	2.4 - 4.0	KTA7-25S-4.0A	CA7-9
2.2	4.8	XM30PB/8	CA7-9	CT 7-24	4.0 - 6.0	KTA7-25S-6.3A	CA7-9
3	6.5	XM30PB/10	CA7-9	CT 7-24	6.0 - 10	KTA7-25S-6.3A	CA7-9
4	8.2	XM30PB/12	CA7-9	CT 7-24	6.0 - 10	KTA7-25S-10A	CA7-9
5.5	11	S125GJ/20	CA7-12	CT 7-24	10 - 16	KTA7-25H-16A	CA7-12
7.5	14	S125GJ/20	CA7-16	CT 7-24	10 - 16	KTA7-25H-16A	CA7-16
11	21	S125GJ/32	CA7-23	CT 7-24	16 - 24	KTA7-45H-20A	CA7-23
15	28	S125GJ/50	CA7-30	CT 7-45	18 - 30	KTA7-45H-32A	CA7-30
18.5	34	S125GJ/50	CA7-37	CT 7-45	30 - 45	KTA7-45H-45A	CA7-37
22	40	S125GJ/63	CA7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA7-43
30	55	S125GJ/100	CA7-60	CT 7-75	45 - 60	KTA3-100-63A	CA7-60
37	66	S125GJ/100	CA7-72	CT 7-75	60 - 75	KTA3-100-90A	CA7-72
45	80	S125GJ/125	CA7-85	CT 7-100	70 - 90	KTA3-100-90A	CA7-85
55	100	S125GJ/125	CA6-110	CEF 1-11/12	20 - 180	KTA3-160S-100A	CA6-110
5	130	S250PE/250	CA6-140	CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-140
0	155	S250PE/250	CA6-180	CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-180
10	200	S250PE/250	CA6-210	CEF 1-41/42	160 - 400	KTA3-250S-200A	CA6-210
32	225	S400GE/400	CA6-210	CEF 1-41/42	160 - 400	KTA3-250S-250A	CA6-250
60	270	S400GE/400	CA6-300	CEF 1-41/42	160 - 400	KTA3-400S-320A	CA6-300
00	361	S400GE/400	CA6-420	CEF 1-41/42	160 - 400	KTA3-400S-400A	CA6-420

Notes:
- Thermal or electronic overload relays may be used.
- XM30PB MCCB's can be replaced with S125GJ/20 if required.
- Combinations based on the thermal overload relay tripping before the circuit. breaker at overload currents up to the motor locked rotor current.

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION TABLES

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 50/65 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2 50/65 kA

		Terasaki Combinations	
Motor Size (kW)	**Approx. amps @ 400/415 V (A)**	**MCCB**	**Contactor**
0.37	1.1	XM30PB/1.4	CA7-9
0.55	1.5	XM30PB/2	CA7-9
0.75	1.8	XM30PB/2.6	CA7-9
1.1	2.6	XM30PB/4.0	CA7-16
1.5	3.4	XM30PB/5	CA7-16
2.2	4.8	XM30PB/8	CA7-16
3	6.5	XM30PB/10	CA7-30
4	8.2	XM30PB/12	CA7-30
5.5	11	S125GJ/20	CA7-30
7.5	14	S125GJ/20	CA7-30
11	21	S125GJ/32	CA7-30
15	28	S125GJ/50	CA7-43
18.5	34	S125GJ/50	CA7-43
22	40	S125GJ/63	CA7-43
30	55	S125GJ/100	CA7-72
37	66	S125GJ/100	CA7-72
45	80	S125GJ/125	CA6-105
55	100	S250PE/160	CA6-105
75	130	S250PE/250	CA6-140
90	155	S250PE/250	CA6-170
110	200	S250PE/250	CA6-210
132	225	S400PE/400	CA6-210
160	270	S400PE/400	CA6-300
200	361	S400PE/400	CA6-420

Terasaki Combinations		Sprecher + Schuh Combinations	
Overload Relay	**Thermal Setting (A)**	**KT7 Circuit Breaker**	**Contactor**
CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA7-9
CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA7-9
CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-2.5A	CA7-9
CT 7-24	2.4 - 4.0	KTA7-25S-4A	CA7-9
CT 7-24	4.0 - 6.0	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-6.3A	CA7-9
CT 7-24	6.0 - 10	KTA7-25S-10A	CA7-9
CT 7-24	10 - 16	KTA7-25H-16A	CA7-12
CT 7-24	10 - 16	KTA7-25H-16A	CA7-16
CT 7-24	16 - 24	KTA7-45H-20A	CA7-23
CT 7-45	18 - 30	KTA7-45H-32A	CA7-30
CT 7-45	30 - 45	KTA7-45H-45A	CA7-37
CT 7-45	30 - 45	KTA7-45H-45A	CA7-43
CT 7-75	45 - 60	KTA3-100-63A	CA7-60
CT 7-75	60 - 75	KTA3-100-90A	CA7-72
CT 7-100	70 - 90	KTA3-100-90A	CA7-85
CEF 1-11/12	20 - 180	KTA3-160S-100A	CA6-110
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-140
CEF 1-11/12	20 - 180	KTA3-160S-160A	CA6-180
CEF 1-41/42	160 - 400	KTA3-250S-200A	CA6-210
CEF 1-41/42	160 - 400	KTA3-250S-250A	CA6-250
CEF 1-41/42	160 - 400	KTA3-400S-320A	CA6-300
CEF 1-41/42	160 - 400	KTA3-400S-400A	CA6-420

Notes:
- Thermal or electronic overload relays may be used.
- XM30PB combinations can be replaced with S125GJ/20 and CA7-30 if required.
- Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

SECTION 4

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 85 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2 85 kA

		Terasaki Combinations		Terasaki Combinations		Sprecher + Schuh Combinations	
Motor Size (kW)	Approx. amps @ 400/415 V (A)	MCCB	Contactor	Overload Relay	Thermal Setting (A)	KT7 Circuit Breaker	Contactor
0.37	1.1	XM30PB/1.4	CA 7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA 7-9
0.55	1.5	XM30PB/2	CA 7-9	CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA 7-9
0.75	1.8	XM30PB/2.6	CA 7-9	CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA 7-9
1.1	2.6	XM30PB/4.0	CA 7-16	CT 7-24	2.4 - 4.0	KTA7-25H-2.5A	CA 7-9
1.5	3.4	XM30PB/5	CA 7-16	CT 7-24	2.4 - 4.0	KTA7-25H-4A	CA 7-9
2.2	4.8	XM30PB/8	CA 7-30	CT 7-24	4.0 - 6.0	KTA7-25H-6.3A	CA 7-9
3	6.5	XM30PB/10	CA 7-30	CT 7-24	6.0 - 10	KTA7-25H-6.3A	CA 7-9
4	8.2	XM30PB/12	CA 7-30	CT 7-24	6.0 - 10	KTA7-25H-10A	CA 7-9
5.5	11	H125NJ/20	CA 7-30	CT 7-24	10 - 16	KTA7-45H-16A	CA 7-12
7.5	14	H125NJ/20	CA 7-30	CT 7-24	10 - 16	KTA7-45H-16A	CA 7-16
11	21	H125NJ/32	CA 7-30	CT 7-24	16 - 24	KTA7-45H-20A	CA 7-23
15	28	H125NJ/50	CA 7-43	CT 7-45	18 - 30	KTA7-45H-32A	CA 7-30
18.5	34	H125NJ/50	CA 7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA 7-37
22	40	H125NJ/63	CA 7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA 7-43
30	55	H125NJ/100	CA 7-72	CT 7-75	45 - 60	KTA3-100-63A	CA7-60
37	66	H125NJ/100	CA 7-72	CT 7-75	60 - 75	KTA3-100-90A	CA7-72
45	80	H125NJ/160	CA 6-105	CT 7-100	70 - 90	KTA3-100-90A	CA7-85
55	100	H160NJ/160	CA 6-105	CEF 1-11/12	20 - 180	-	-
75	130	H250PE/250	CA 6-210	CEF 1-11/12	20 - 180	-	-
90	155	H250PE/250	CA 6-210	CEF 1-11/12	20 - 180	-	-
110	200	H250PE/250	CA 6-210	CEF 1-41/42	160 - 400	-	-
132	225	H400NE/400	CA 6-210	CEF 1-41/42	160 - 400	-	-
160	270	H400NE/400	CA 6-300	CEF 1-41/42	160 - 400	-	-
200	361	H400NE/400	CA 6-420	CEF 1-41/42	160 - 400	-	-

Notes:
- Thermal or electronic overload relays may be used.
- XM30PB combinations can be replaced with H125GJ/20 and CA7-30 if required.
- Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

APPLICATION DATA

MOTOR STARTING TYPE 2 CO-ORDINATION

Short-Circuit Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's & Sprecher + Schuh KT7's
DOL starting 100 kA @ 400/415 V to AS/NZS 60947.4.1

TYPE 2
100 kA

		Terasaki Combinations		Terasaki Combinations		Sprecher + Schuh Combinations	
Motor Size (kW)	**Approx. amps @ 400/415 V (A)**	**MCCB**	**Contactor**	**Overload Relay**	**Thermal Setting (A)**	**KT7 Circuit Breaker**	**Contactor**
0.37	1.1	H125NJ/20	CA 7-30	CT 7-24	1.0 - 1.6	KTA7-25S-1A	CA 7-9
0.55	1.5	H125NJ/20	CA 7-30	CT 7-24	1.0 - 1.6	KTA7-25S-1.6A	CA 7-9
0.75	1.8	H125NJ/20	CA 7-30	CT 7-24	1.6 - 2.4	KTA7-25S-2.5A	CA 7-9
1.1	2.6	H125NJ/20	CA 7-30	CT 7-24	2.4 - 4.0	KTA7-25H-2.5A	CA 7-9
1.5	3.4	H125NJ/20	CA 7-30	CT 7-24	2.4 - 4.0	KTA7-25H-4A	CA 7-9
2.2	4.8	H125NJ/20	CA 7-30	CT 7-24	4.0 - 6.0	KTA7-25H-6.3A	CA 7-9
3	6.5	H125NJ/20	CA 7-30	CT 7-24	6.0 - 10	KTA7-25H-6.3A	CA 7-9
4	8.2	H125NJ/20	CA 7-30	CT 7-24	6.0 - 10	KTA7-25H-10A	CA 7-9
5.5	11	H125NJ/20	CA 7-30	CT 7-24	10 - 16	KTA7-45H-16A	CA 7-12
7.5	14	H125NJ/20	CA 7-30	CT 7-24	10 - 16	KTA7-45H-16A	CA 7-16
11	21	H125NJ/32	CA 7-30	CT 7-24	16 - 24	KTA7-45H-20A	CA 7-23
15	28	H125NJ/50	CA 7-43	CT 7-45	18 - 30	KTA7-45H-32A	CA 7-30
18.5	34	H125NJ/50	CA 7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA 7-37
22	40	H125NJ/63	CA 7-43	CT 7-45	30 - 45	KTA7-45H-45A	CA 7-43
30	55	H125-NJ/100	CA 7-60	CT 7-75	45 - 60	-	-
37	66	H125-NJ/100	CA 7-72	CT 7-75	60 - 75	-	-
45	80	H125-NJ/125	CA 7-85	CT 7-100	70 - 90	-	-
55	100	H250-NE/160	CA 6-95	CEF 1-11/12	20 - 180	-	-
75	130	H250-NE/250	CA 6-140	CEF 1-11/12	20 - 180	-	-
90	155	H250-NE/250	CA 6-140	CEF 1-11/12	20 - 180	-	-
110	200	H250-NE/250	CA 6-180	CEF 1-41/42	160 - 400	-	-
132	225	H400-NE/400	CA 6-420	CEF 1-41/42	160 - 400	-	-
160	270	H400-NE/400	CA 6-420	CEF 1-41/42	160 - 400	-	-
200	361	H400-NE/400	CA 6-420	CEF 1-41/42	160 - 400	-	-

Notes:
- Thermal or electronic overload relays may be used.
- Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

SECTION 4

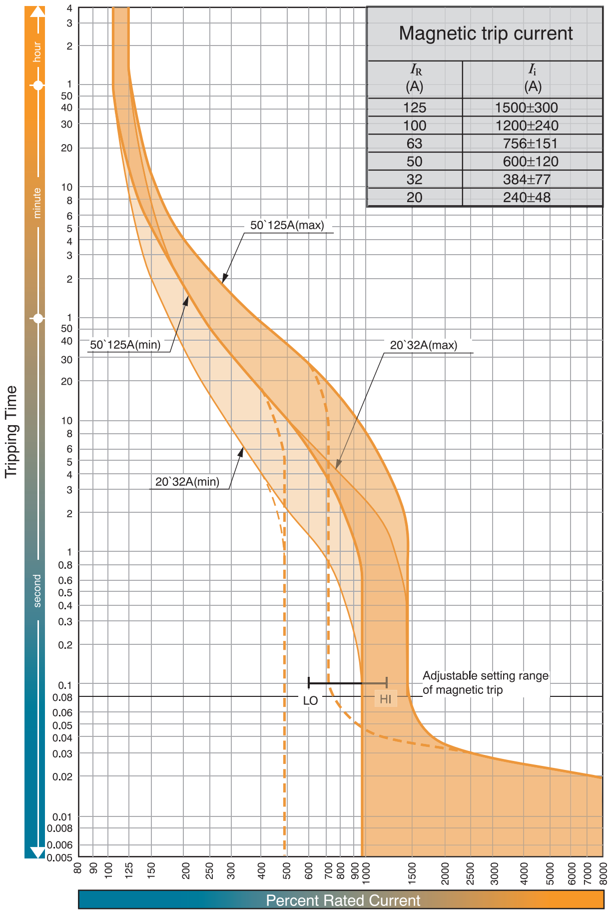
OPERATING CHARACTERISTICS

THERMAL MAGNETIC CHARACTERISTICS

125A Frame MCCBs

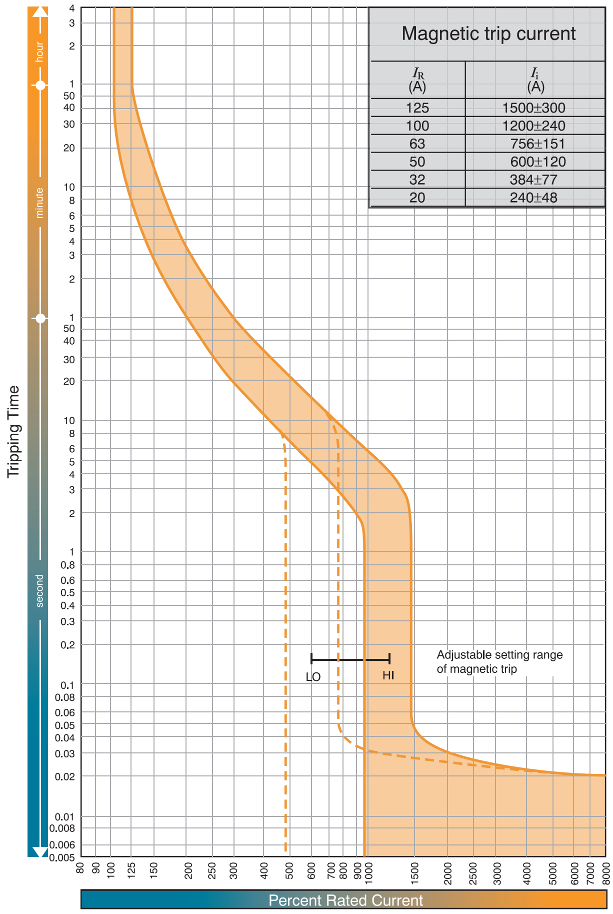
Time/current characteristic curves

E125-NJ, S125-NJ, S125-GJ



Time/current characteristic curves

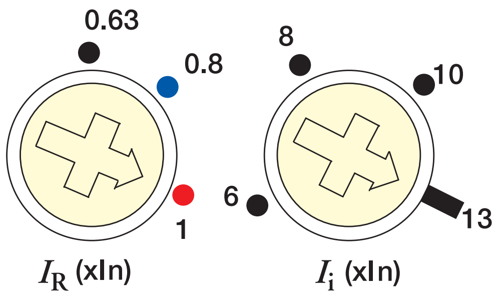
H125-NJ, L125-NJ

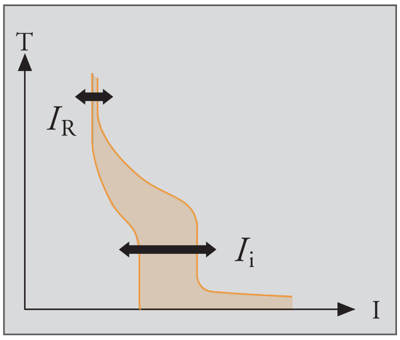


OPERATING CHARACTERISTICS

THERMAL MAGNETIC PROTECTION

Adjustment Dials





1. I_R is the thermal element adjustment dial and is used to set the rated current to match the conductor rating.

   I_R can be set between 0.63 and 1.0 times I_n.

2. I_i is the magnetic element adjustment dial and is used to set the short circuit tripping threshold to suit the application.

   I_i can be set between 6 and 12 times I_n on 125A and 400A frame models.

   I_i can be set between 6 and 13 times I_n on 250A frame models with ratings of 160A, 200A and 250A.

   I_i can be set between 6 and 12 times I_n on 250A frame models with ratings of 125A and less.

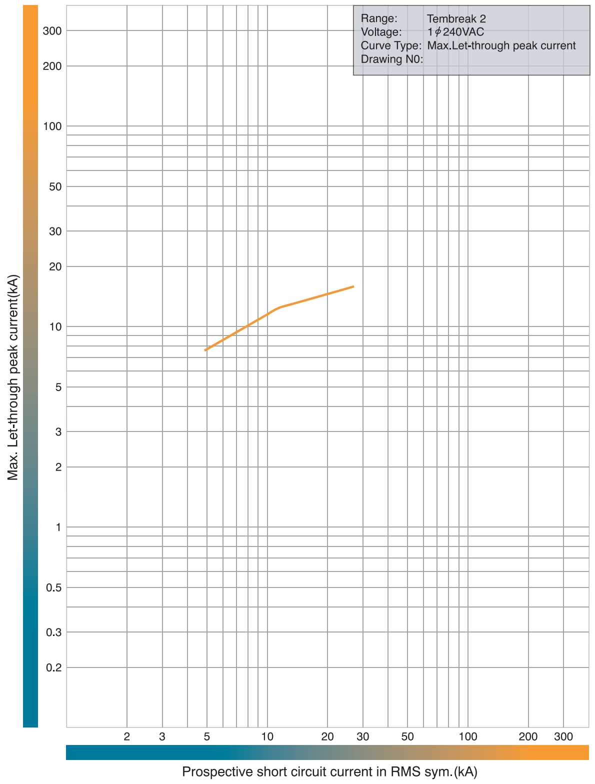
Models, Types and Rated Currents of Thermal Elements

Model	Type	Current Rating In (A)
S125	-NF	16, 20, 25, 32, 40, 50, 63, 80, 100, 125
E125	-NJ	20, 32, 50, 63, 100, 125
S125	-NJ	20, 32, 50, 63, 100, 125
S125	-GJ	20, 32, 50, 63, 100, 125
H125	-NJ	20, 32, 50, 63, 100, 125
L125	-NJ	20, 32, 50, 63, 100, 125
S160	-NF	16, 20, 25, 32, 40, 50, 63, 80, 100, 125, 160
S160	-NJ	20, 32, 50, 63, 100, 125, 160
S160	-GJ	50, 63, 100, 125, 160
H160	-NJ	160
L160	-NJ	160
E250	-NJ	20, 32, 50, 63, 100, 125, 160, 200, 250
S250	-NJ	160, 200, 250
S250	-GJ	160, 200, 250
H250	-NJ	160, 250
L250	-NJ	160, 250
E400	-NJ	250, 400
S400	-CJ	250, 400
S400	-NJ	250, 400
S400	-GJ	250, 400
H400	-NJ	250, 400
L400	-NJ	250, 400

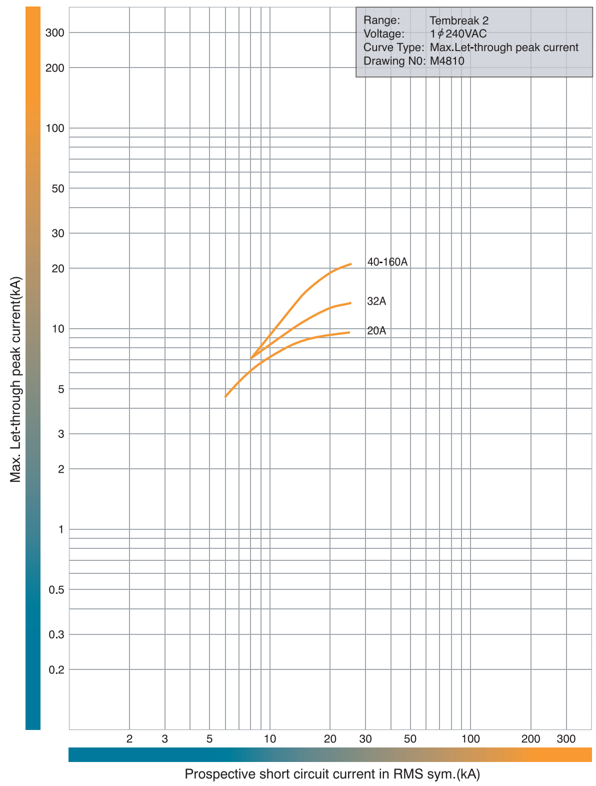
OPERATING CHARACTERISTICS

LET-THROUGH PEAK CURRENT CHARACTERISTICS

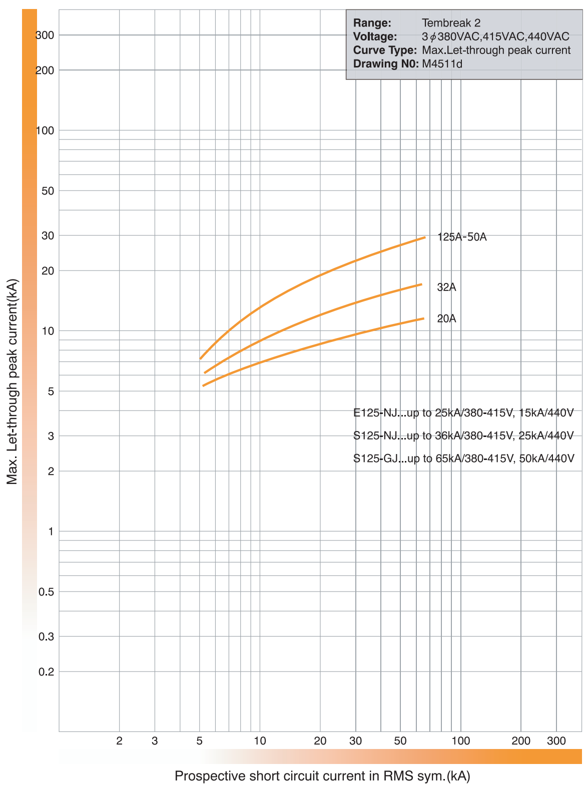
S125-NF. 240V AC



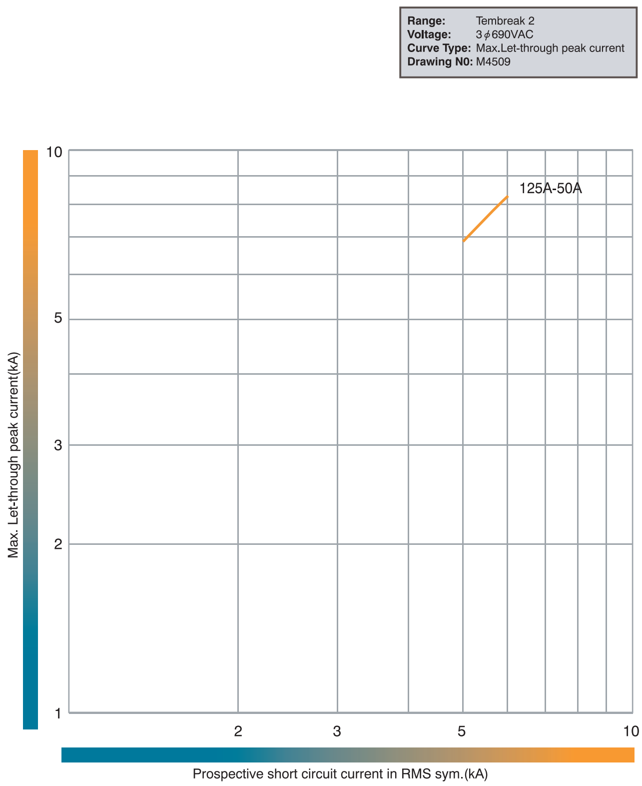
S160-NF. 240V AC.



E125-NJ, S125-NJ, S125-GJ. 440V AC.



S125-NJ, S125-GJ. 690V AC.

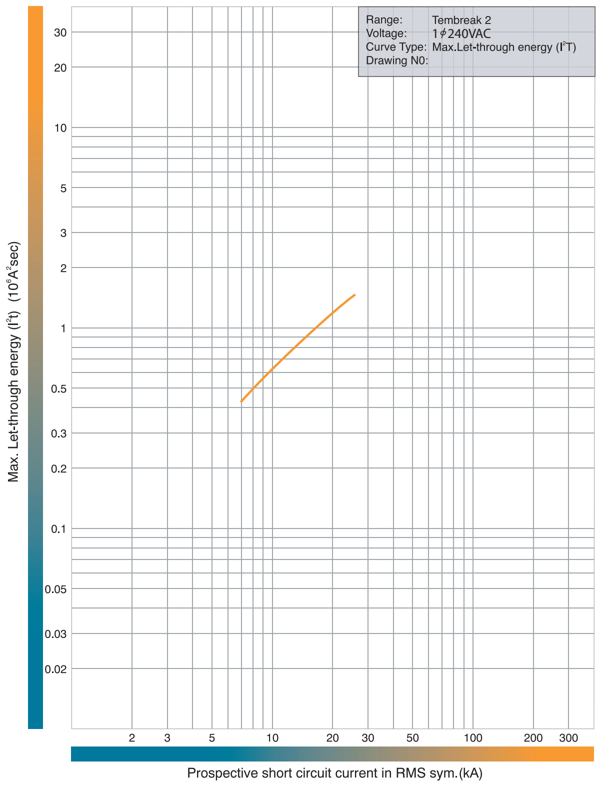


SECTION 3

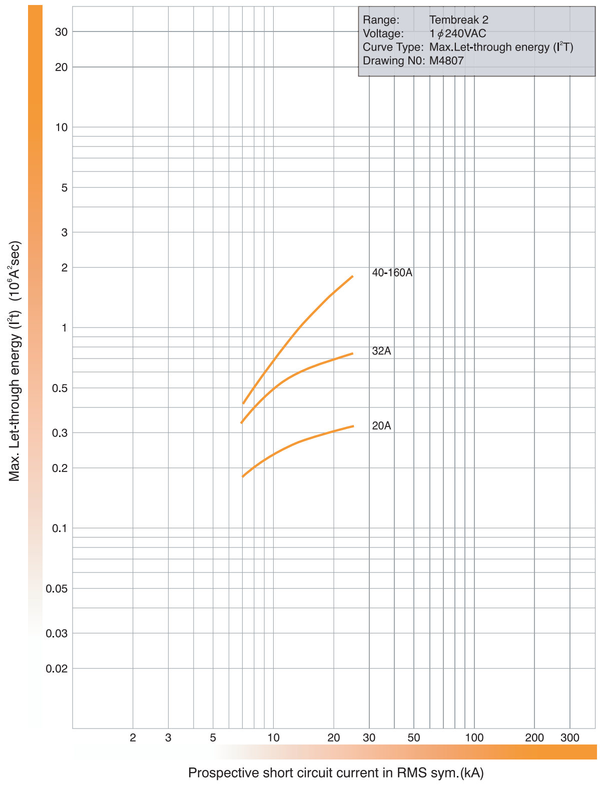
OPERATING CHARACTERISTICS

LET-THROUGH ENERGY CHARACTERISTICS

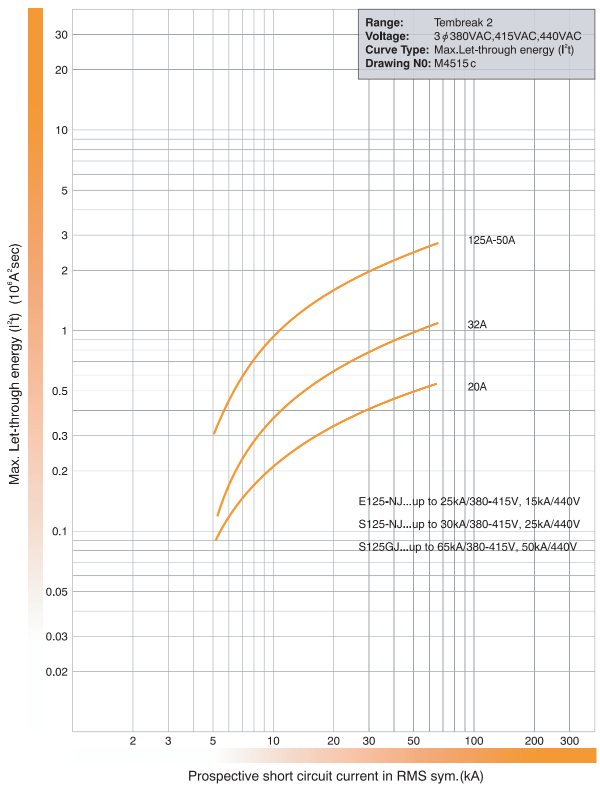
S125-NF. 240V AC



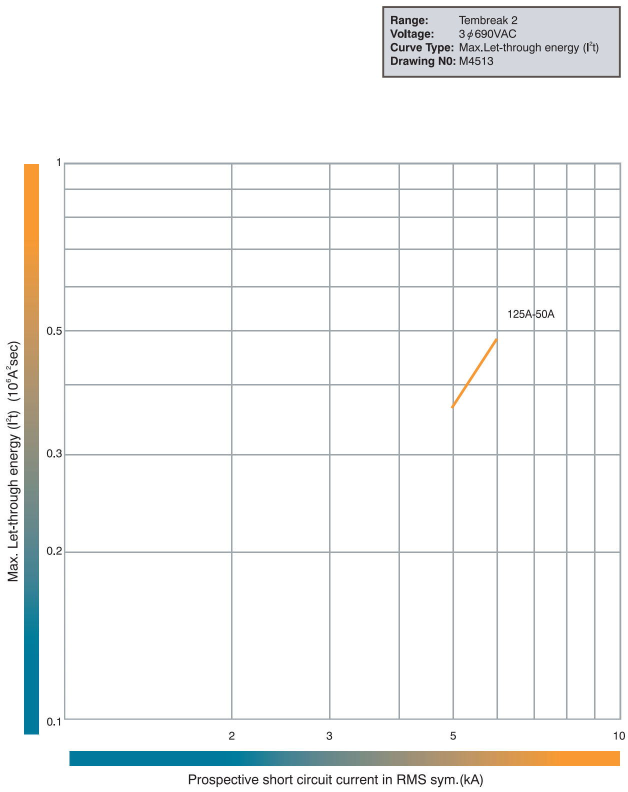
S160-NF. 240V AC



E125-NJ, S125-NJ, S125-GJ. 440V AC.



S125-NJ, S125-GJ. 690V AC.



XS125 series

- Adjustment range 63 - 100% of nominal current rating.
- Standards AS 2184/AS 3947-2.
- Adjustable thermal and fixed magnetic trip.
- Max. voltage (INSUL) 690V.

XS125CJ (18kA) 3 pole

Ampere rating	Min	Max	Cat. No.
20	12.5	20	**XS125CJ 20 3**
32	20	32	**XS125CJ 32 3**
50	32	50	**XS125CJ 50 3**
63	40	63	**XS125CJ 63 3**
100	63	100	**XS125CJ 100 3**
125	80	125	**XS125CJ 125 3**
125	Non-Auto (1.8kA for 1sec)		**XS125NN 3 [2]) [4])**

XS125NJ (30kA) 2 pole

Ampere rating	Min	Max	Cat. No.
20	12.5	20	**XS125NJ 20 2**
32	20	32	**XS125NJ 32 2**
50	32	50	**XS125NJ 50 2**
63	40	63	**XS125NJ 63 2**
100	63	100	**XS125NJ 100 2**
125	80	125	**XS125NJ 125 2**

XS125NJ (30kA) 3 pole

20	12.5	20	**XS125NJ 20 3**
32	20	32	**XS125NJ 32 3**
50	32	50	**XS125NJ 50 3**
63	40	63	**XS125NJ 63 3**
100	63	100	**XS125NJ 100 3**
125	80	125	**XS125NJ 125 3**

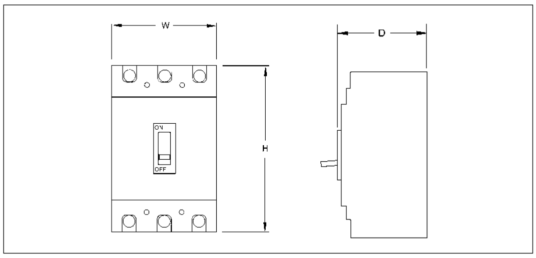
XS125NJ (30kA) 4 pole

20	12.5	20	**XS125NJ 20 4**
32	20	32	**XS125NJ 32 4**
50	32	50	**XS125NJ 50 4**
63	40	63	**XS125NJ 63 4**
100	63	100	**XS125NJ 100 4**
125	80	125	**XS125NJ 125 4**

Notes: [1]) MCCB's only.
[2]) Load-break isolating switch only–no overload or short circuit protection.
[3]) Poles in series.
[4]) Short time rating. Refer rating chart for technical details.
2 pole models use a 3 pole body with centre pole disabled.
Special generator protection MCCB's available – low instantaneous magnetic setting.

Dimensions (mm)

Description		Height	Width	Depth	kg
XS125CJ	3 pole	155	90	86	1.3
XS125NJ	2 pole	155	90	86	1.3
XS125NJ	3 pole	155	90	86	1.3
XS125NJ	4 pole	155	120	86	1.58



Short circuit capacity

Model	I/C	Voltage
XS125CJ	18 kA (AS2184)	415V 50Hz
XS125NJ	30 kA (AS2184)	415V 50Hz

DC use	I/C [3])	Voltage
XS125CJ	10 kA	250V DC
XS125NJ	15 kA	250V DC

Refer this section for ratings to AS 3947-2 and AS 2184, and Ics/Icu.

Product extensions

Chassis (TemWay, MHC, UHC)
Panelboards (TPX)
TemCurve

Base standards	Approvals
IEC 947-2	ASTA/UK, Aust. standards
BS EN 60947 Part 2	**Marine**
VDE 0660 Part 1	NK/JAPAN
AS 3947-2/Australia	LR/UK
AS 2184-1990/Australia [1])	AB/USA
NEMA USA	GL/GERMANY
ANSI C37. 13/USA	BV/FRANCE
JIS C 8372/JAPAN	DNV NORWAY
JEC 160/JAPAN	

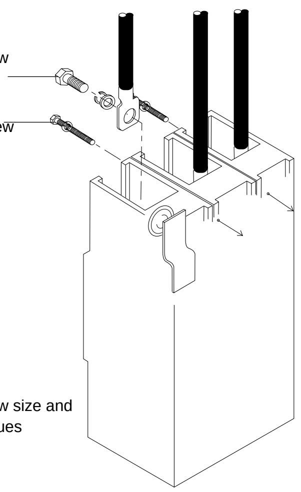
MCCB Technical data

Connections and mountings

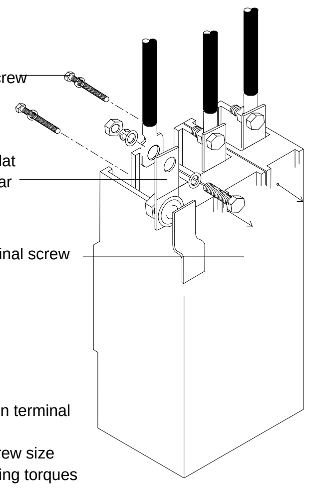
MCCB accessories

Front-connection type (FC)

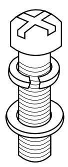
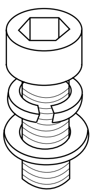
Compression terminals



Attached flat bar



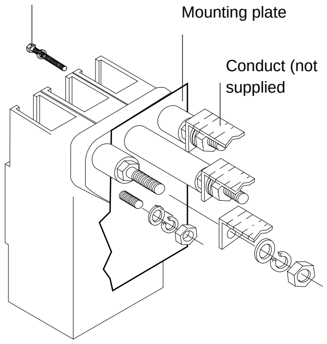
Types of terminal screws (Compression terminal and bar)

	Breakers and screw size							
	XE series (Economical)		XS series (Standard)		XH series (High-fault level)		XM series (Motor protection)	
Pan headed screw								
			XS125CJ	M8	XH125NJ	M8	XM30PB	M5
			XS125NJ	M8	XH125PJ	M8		
Hex socket head bolt								
	XE225NC	M8	XS250NJ	M8	XH250NJ	M8		
					XH160PJ	M8		
			XS400	M10	TL250NJ	M10		
			XH400	M10	TL400NJ	M10		
			XV400	M10	XH250PJ	M10		

Connections and mountings

Rear-connection type (RC)

Bolt stud



Applicable breakers

- **XS series**
  XS125CJ, XS125NJ
- **XH series**
  XH125NJ, XH125PJ

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MCCB Technical data

NHP

TemBreak XS125CS, CJ, NS, NJ, XH125NJ, TL30F MCCBs

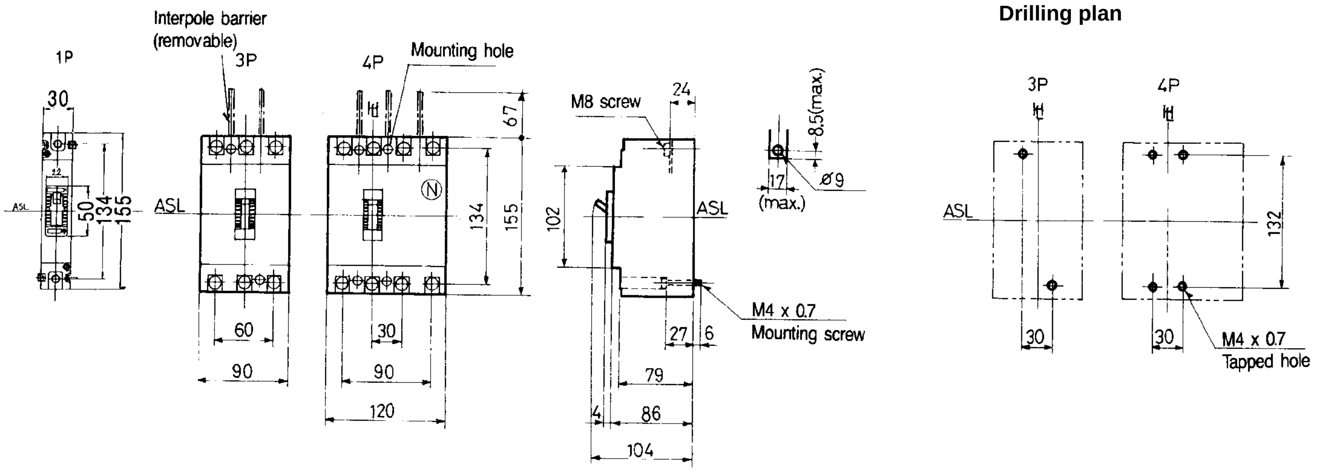
ASL: Arrangement Standard Line
ℍ: Handle frame centre line

Outline dimensions (mm)

Front connected (standard)

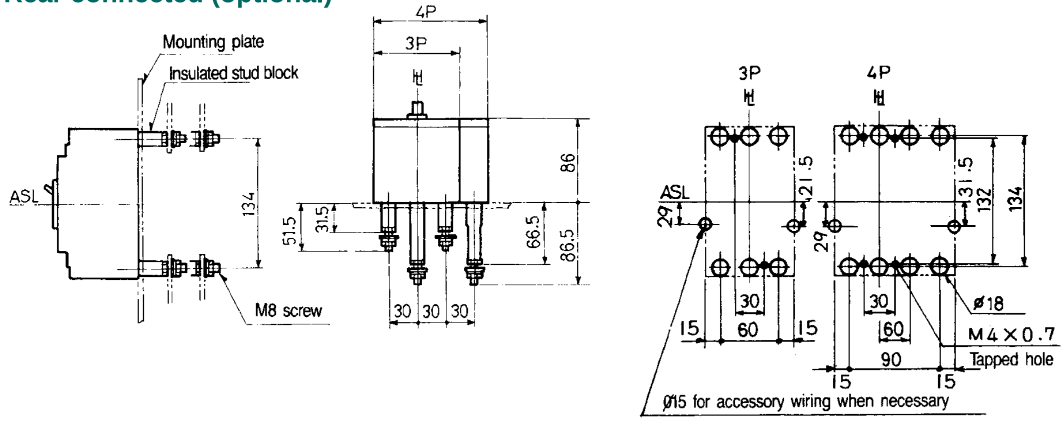
Note: XS125NS 1 pole only

Drilling plan

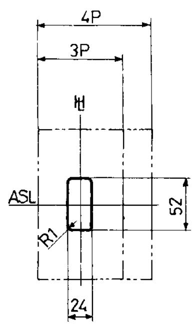


Rear connected (optional)

Drilling plan



Panel mount

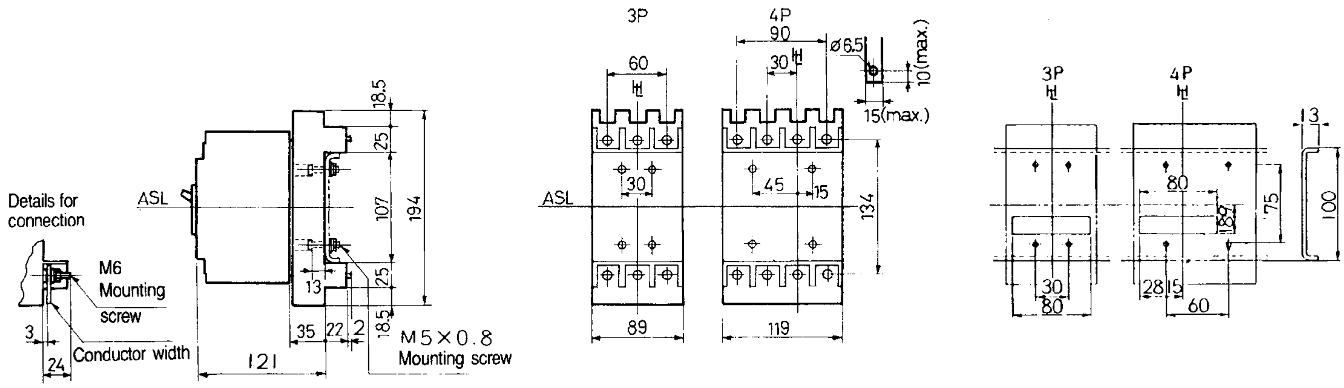


Panel cut out dimensions shown give an allowance of 1.0mm around the handle escutcheon.

Plug-in (optional)

Mounting block

Drilling plan



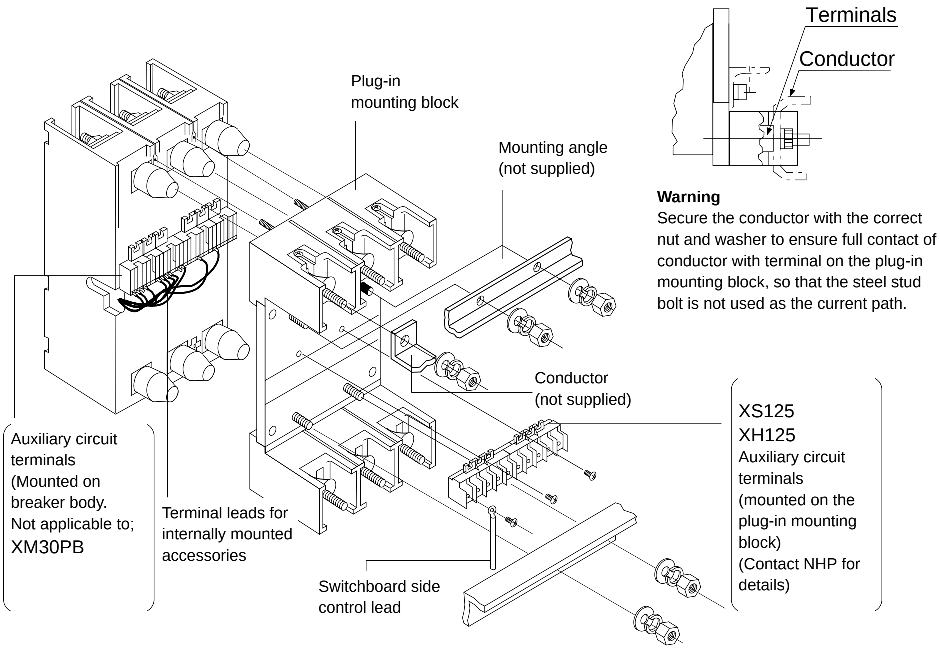
MCCB Technical data

Types of connections and mountings

MCCB accessories

Plug-in Type

Switchboard use



Warning
Secure the conductor with the correct nut and washer to ensure full contact of conductor with terminal on the plug-in mounting block, so that the steel stud bolt is not used as the current path.

Types of plug-in mounting blocks for switchboard use

Series	Breaker	Pole	Type
XS	XS125CJ	2, 3, [i]4	XDM2
	XS125NJ		
	XE225NC	3, [i]4	XDM3
	XS250NJ		
	XS400	3, [i]4	XDM4
	XS630	3, [i]4	XDM6
	XS800	3, [i]4	XDM6
	XS1250	3, [i]4	[i] XDM8
XH	XH125	3, [i]4	XDM2
	XH160PJ	3, [i]4	XDM3
	XH250PJ	3, [i]4	XDM4
	XH250NJ	3, [i]4	XDM4
	XH400	3, [i]4	[i] XDM6
	XH630	3, 4	[i] XDM6
	XH800	3	[i] TDM-1DR
XM	XM30PB		

IP 20 degree of protection and safety trip [1]) are available for plug-in type breakers, for switchboard and distribution board use.

Plug-in type

Degree of protection [i]

The degree of protection provided by the mounting blocks for plug in type TemBreak is IP 20 as defined in IEC Pub 529

Standard Safety Trip (Trip first plug-in mechanism) indent.

- The breaker will trip automatically if it is withdrawn while still in the "ON" position. It is not possible to "plug-in' the breaker when it is in the "ON" position.

Application table (up to 100A frame)

Breaker	IP cover code	Pole	Qty Req.
XS125	IP 20	2, 3P	1=2
XH125			

Note: [i][1]) Available on indent only.

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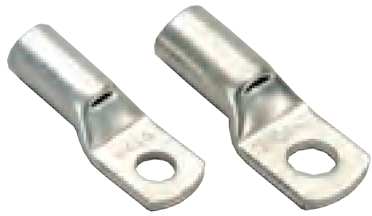
MCCB Technical data

NHP

Crimp lugs (compression type)

Frame (A)	Breaker	Nominal wire size (mm^2) 1.5	2.5	4	6	10	16	25
XM30	XM30PB	CAL1.5–5	CAL2.5–5	CAL4–5	CAL6–5	CAL10–5	CAL16–6	
		MT2.5 – M5	MT2.5 – M5	MT4– M5	MT6– M5	MT10– M5	MT16– M5	
125	XS125CJ	-	CAL2.5 – 8	CAL4–8	CAL6–8	CAL10–8	CAL16 – 8	CAL25–8
	XS125NJ	MT2.5 – M8	MT2.5 – M8	MT4– M8	MT6– M8	MT10– M8	MT16– M8	MT25– M8
	XH125NJ							
	XH125PJ							
	TL100NJ							
	TL30F							



Frame (A)	Breaker	Nominal wire size (mm^2) 35	50	70	95	120	150	185	240	300
160	XE225NC	CAL35–8	CAL50–8	CAL70–8	CALB95–8	CALB120–8	CALB150–8			
225	XS250NJ	MT35 – M8	MT50 – M8	MT70 – M8	-	-	-			
250	XH250NJ									
	XH160PJ									
400	XS400CJ	CAL35–10	CAL50–10	CAL70–10	CAL95–10	CALB120–10	CALB150–10			
	XS400NJ	MT35 – M10	MT50 – M10	MT70 – M10	MT95 – M10	-	-			
	XS400NE									
	XH400NE									
	XV400NE									
	XS400SE									
	XH400SE									
	XH250PJ									
	TL250NJ									
	TL400NJ									
	XH400PJ									
	XH400PE									
630	XS630CJ/NJ	CAL35–12	CAL50–12	CAL70–12	CAL95–12	CAL120–12	CAL150–12	CAL185–12	CAL240–12	CAL300–12
800	XH630NE/SE	MT35 – M12	MT50 – M12	MT70 – M12	MT95 – M12	MT120 – M12	MT150 – M12	MT185 – M12	MT240 – M12	-
	XS630NE/SE									
	XS800NJ/PJ									
	XS800NE/SE									
	XH800NE/SE									
	XH800PE									
1250	XS1250NE			CAL70–12	CAL95–12	CAL120–12	CAL150–12	CAL185–12	CAL240–12	CAL300–12
	XV1250NE			MT70 – M12	MT95 – M12	MT120 – M12	MT150 – M12	MT185 – M12	MT240 – M12	-

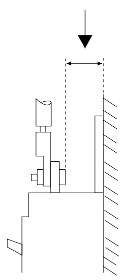
Commercially available compression terminals available from CABAC – Cable Accessories and JST Australia.

Key: CAL = CABAC lugs

MT = JST lugs

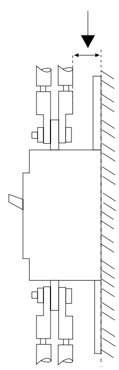
Connection (one electric cable)

If low clearance occurs use a recommended tape or insulation.



Connection (two electric cables)

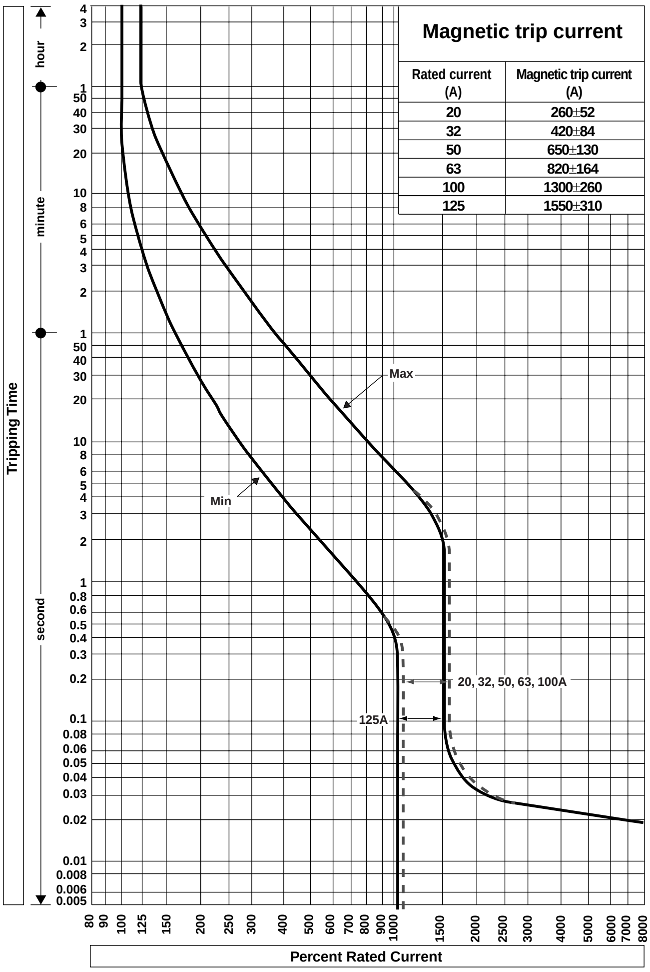
If low clearance occurs use a recommended tape or insulation.



MCCB Technical data

XS125CJ, XS125NJ, XH125NJ, XH125NJ

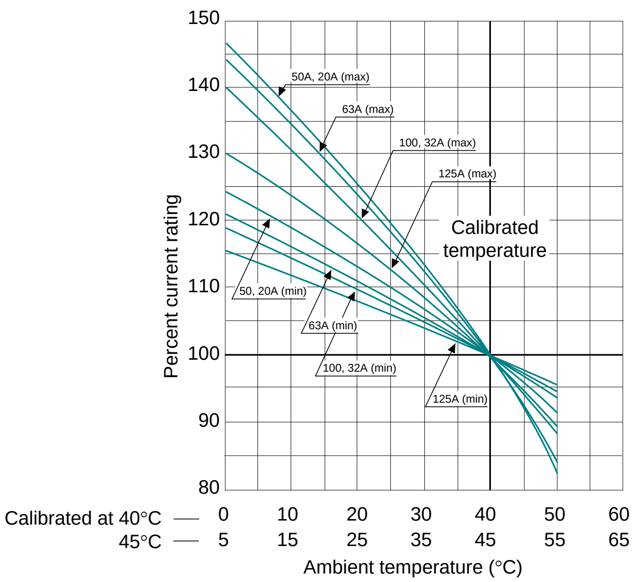
Time/current characteristic curves



Magnetic trip current

Rated current (A)	Magnetic trip current (A)
20	260±52
32	420±84
50	650±130
63	820±164
100	1300±260
125	1550±310

Ambient compensating curves



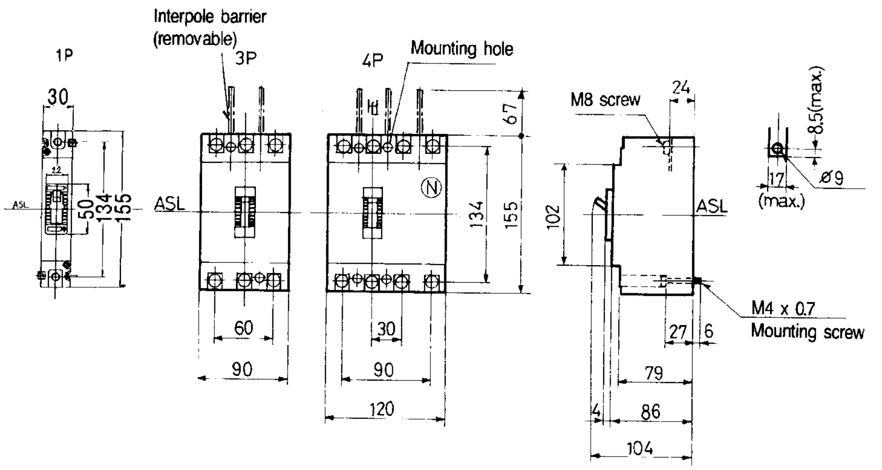
TemBreak XS125CS, CJ, NS, NJ, XH125NJ, PJ and TL30F MCCBs

ASL: Arrangement Standard Line
H: Handle frame centre line

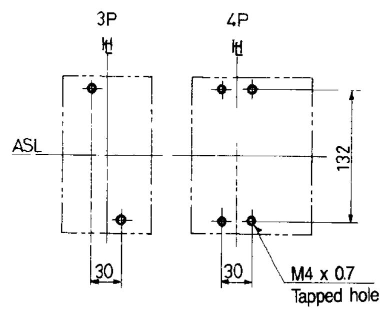
Outline dimensions (mm)

Front connected (standard)

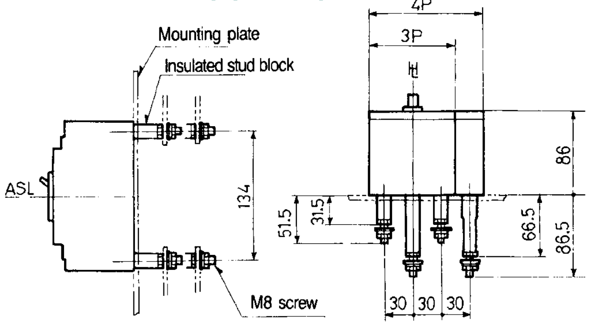
Note: XS125NS 1 pole only



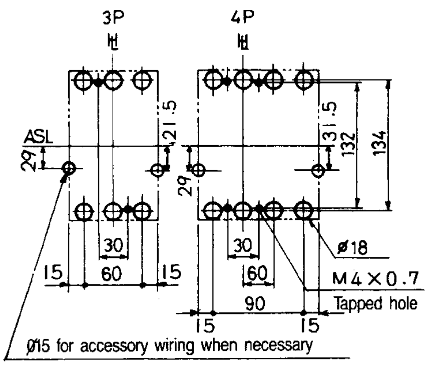
Drilling plan



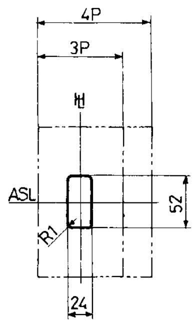
Rear connected (optional)



Drilling plan

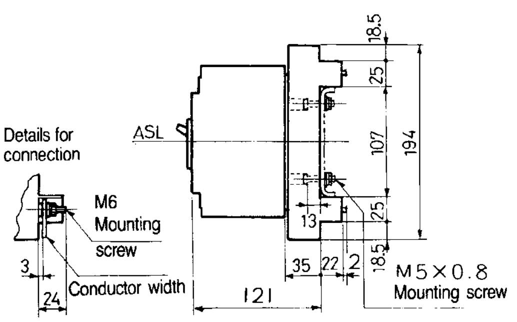


Panel mount

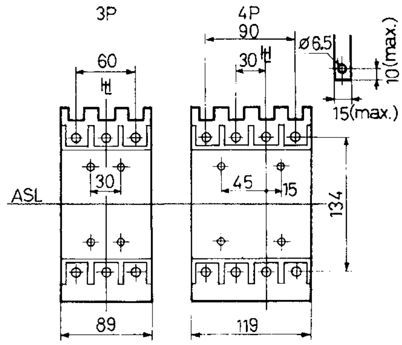


Panel cut out dimensions shown give an allowance of 1.0mm around the handle escutcheon.

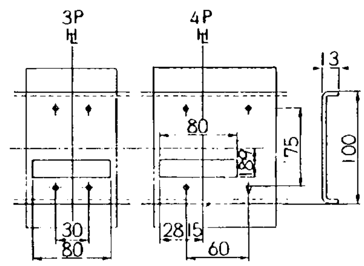
Plug-in (optional)



Mounting block



Drilling plan



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MCCB Technical data

NHP

Motor operators for XS125

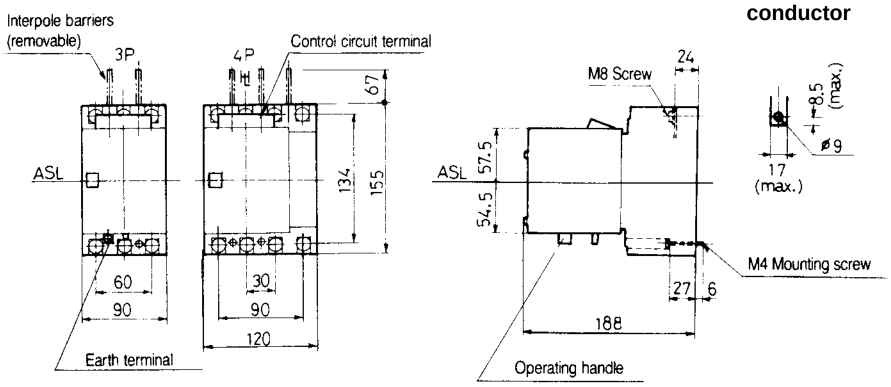
MCCB accessories

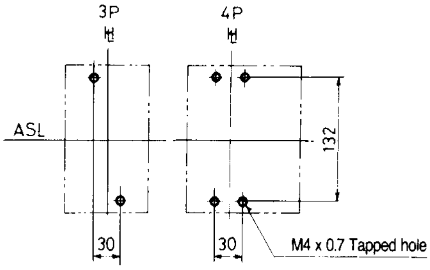
Outline dimensions (mm)

Front connected (standard)

Preparation of conductor

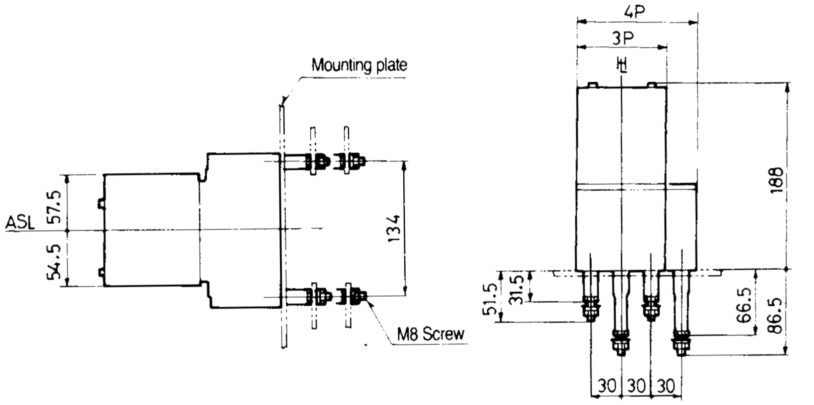
Drilling plan

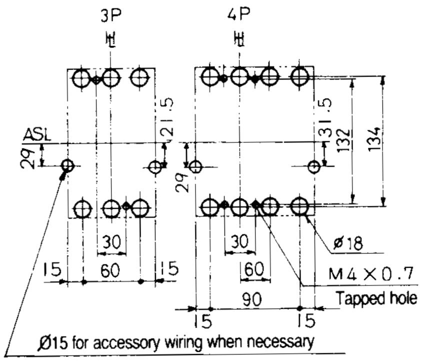




Rear connected (optional)

Drilling plan



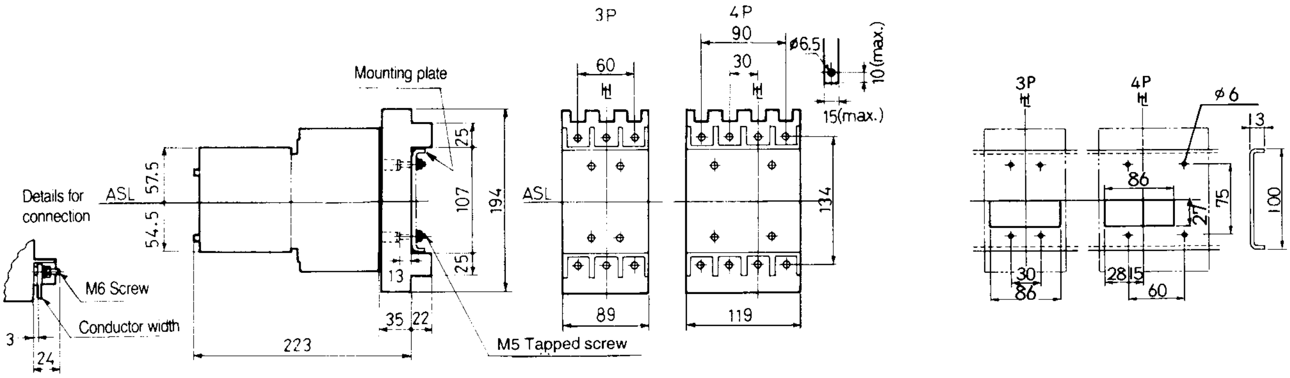


Plug-in (optional)

Mounting block

Preparation of conductor

Drilling plan



ASL: Arrangement Standard Line
Ħ: Handle frame centre line

Notes: [1]Above outline dimensions are for AC motors. Contact NHP for details for DC motors.

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Application data

NHP

Miniature circuit breakers and fuse fault current limiters co-ordination chart

For fault current levels up to 50kA at 415V

Circuit breaker Type	Rating amps	Min. fuse amps ¹)	Maximum fuse – amp BS 88	Maximum fuse – amp DIN
Safe-T	6-10	50	160 ²)	160
	16-25	63	200 ²)	200
	32	80	200 ²)	200
	40-50	100	200 ²)	200
	63-100	160	200 ²)	200
SRCB	10	50	160	160
	16-20	63	200	200
Din-T6	2-25	20-63	160	160
	32-63	100	160	160
Din-T10 &	0.5-6	20	200	200
Din-T15	10	25	200	200
	16	35	200	200
	20-32	63	200	200
	40-63	100	200	200
DRCBH	10	25	200	200
(10kA)	16	35	200	200
	20-32	63	200	200
Din-T10H	80	160	200	200
	100	200	200	200
	125	250	250	250
Tembreak MCCB's				
XS125NJ/CJ	16-125	250	400	400

Notes: ¹) Minimum fuse size is based on grading under overload of one MCB with one set of fuses. Where a single set of fuses protects more than one MCB, the minimum fuse size shall be increased to allow for load biasing effects.
²) Maximum fuse size based on testing to AS 3439.1 clause 8.2.3.

Tables based on the following maximum pre-arching I^2t for both BS 88 and DIN fuses:
160A – 0.62 x 10^5, 200A – 1.2 x 10^5, 250A – 2.1 x 10^5.
Suitable fuses include NHP, GEC, Siemens and Bovara-Crady.

Fuses with higher current ratings may be used providing I^2t values are equal to, or less than the levels above. Semi-conductor fuses have very low I^2t values and may suit some applications.

Attention is also drawn to AS 3000 clause 7.10.4.4 regarding the use of fault current limiters in installations containing fire and smoke control equipment, evacuation equipment and lifts.

Selectivity and Cascading Applications

A higher reliance on electrical supply and safety in commerce and industry has increased awareness in circuit breaker technology and applications. Additionally, while maximising system safety and reliability, efficient economy of overall costs is also of great importance.
The combination of these factors has given rise to more precise methods of circuit breaker application.

Two common terminologies relating to general power back-up and system protection are: Selectivity (Discrimination) and Cascading (Back-up). In general terms, Selectivity is used to improve system reliability and to ensure a continuous supply of power to as high a degree as possible. Cascading on the other hand is where an upstream breaker is used to "back-up" a lower specification breaker installed downstream to clear a fault current, and is generally used where economics plays a significant part in system design.

Selectivity (Discrimination)

Previously known as "Discrimination", the most basic form of Selectivity is where two circuit breakers are connected in series. A higher amperage breaker is installed upstream, and a lower amperage breaker downstream. Should an overload or short circuit occur downstream, the downstream breaker will trip, but the upstream breaker will not, hence feeding parts of the system which are fault-free. This is the concept of Selectivity.

Selectivity is generally used, for example in critical applications, feeding essential loads. It is important to ensure total installation power is not lost due to a small or minor fault in a sub part of the overall electrical system, for example in a local distribution board. Total power loss could affect vital systems such as in Hospitals or Computer Centres etc.

The principle of Selectivity (Discrimination) is based upon an analysis of several types of circuit breaker characteristics. These include tripping characteristics (time-current curves), Peak Let Through Current (I_{peak}) and Energy Let Through (I^2T).

Selectivity can be "enhanced" beyond the breaking capacity of the downstream device provided it is backed up by an appropriately selected upstream device, which should not trip (unlatch) under stated conditions.

Cascading (Back-up)

Cascading is achieved by using an upstream device to assist (back-up) a downstream device in clearing a fault current that happens to be greater than the breaking capacity of the downstream device.

In Cascading applications, the upstream device may have to trip (unlatch) in order to give sufficient protection to the downstream device, thus interrupting supply of power to all devices downstream. Therefore, Cascading is generally used in applications involving the supply of non-essential loads, such as basic lighting. The main benefit of Cascading is that in certain circumstances circuit breakers with breaking capacities lower than the prospective fault level, and hence lower in cost, can be safely used downstream provided it is backed-up by the relevant upstream breaker.

Cascade / Selectivity Tables

The Selectivity and Cascade tables shown in the following pages are structured as follows.

25 / 50

Selectivity   Cascade

Selectivity: The Selectivity or Enhanced Selectivity limit of the two nominated devices in series. Up to this level of fault current the downstream device will trip (unlatch) before the upstream device. Above this level, the upstream may also trip.

Cascade: The enhanced or maximum downstream fault current that can be safely interrupted when both breakers are installed in series. Both breakers may trip (unlatch).

The Selectivity and Cascade levels stated by NHP are fully compliant with the requirements of the applicable standards. Selection of breakers should be in accordance with the selection tables.

The figures stated in NHP tables are for nominated Terasaki devices only, and should not be used as guidance for using alternative brands of circuit breakers.

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Application data

NHP

TemBreak MCCB's and Safe-T/Din-T MCB's - Selectivity and Cascade tables at 415V

Guide

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Selectivity Cascade

Downstream MCB	kA (rms)	Upstream MCCB XS125CJ 18	XS125NJ 30	XH125NJ 50	XS250NJ 35	XH250NJ 50	XS400CJ 35	XS400SE XS400NJ 50
Din-T6 (2-25A)	6	18/18	25/25	25/25	25/25	25/25	-	-
Din-T6 (32-63A)	6	18/18	20/25	20/25	25/25	25/25	-	-
Din-T10 (0.5-25A)	10	18/18	25/30	30/50	35/35	35/50	35/35	35/50
Din-T10 (32-63A)	10	18/18	20/25	20/25	25/25	25/25	25/25	25/25
DRCBH (10-25A)	10	18/18	25/30	30/50	35/35	35/50	35/35	35/50
DRCBH (32A)	10	18/18	20/25	20/25	25/25	25/25	25/25	25/25
Din-T10H (80-125A)	10	4/18	4/25	4/25	15/15	15/15	10/10	10/10
Din-T15 (6-16A)	25	18/25	25/30	30/50	35/35	35/50	35/35	35/50
Din-T15 (20A)	20-25 [1])	18/20	25/30	30/50	35/35	35/50	35/35	35/50
Din-T15 (32A)	15-25 [1])	18/18	25/30	30/50	35/35	35/50	35/35	35/50
Din-T15 (40-63A)	10-12.5 [1])	18/18	20/25	20/25	25/25	25/25	25/25	25/25
Safe-T (16-63A)	6	3/10	3/10	3/10	-	-	-	-
SRCB (16-20A)	6	3/10	3/10	3/10	-	-	-	-

Note: [1]) Dependant on the number of poles. Refer to NHP.

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Application data

NHP

TemBreak *Plus* MCCB's - Selectivity and Cascade tables at 415V

Guide

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Selectivity Cascade

Downstream MCCB	kA (rms)	Upstream MCCB XS400SE 50	XH400SE 65	XS630SE 50	XH630SE 65	XS800SE 50	XH800SE 65	XS1250SE 65	XS1600SE 85
XS125CJ	18	15/50	15/50	18/30	18/30	18/30	18/30	18/18	18/18
XS125NJ	30	25/50	25/50	30/30	30/30	30/30	30/30	30/30	30/30
XH125NJ	50	35/50	35/65	50/50	50/65	50/50	50/65	50/50	50/50
XH125PJ	50	35/50	35/65	50/50	50/65	50/50	50/65	50/50	50/50
XH160PJ	50	25/50	25/65	50/50	50/65	50/50	50/65	50/50	50/50
XE225NC	18	15/30	15/30	18/30	18/30	18/30	18/30	18/18	18/18
XS250NJ	35	15/50	15/65	35/50	35/65	35/50	35/65	35/35	35/35
XH250NJ	50	25/50	25/65	50/50	50/65	50/50	50/65	50/50	50/50
XH250PJ	65	-	-	10/50	10/65	25/50	25/65	50/65	50/65
XS400CJ	35	-/50	-/50	10/50	10/65	25/50	25/65	35/42	35/42
XS400NJ	50	-	-/65	10/50	10/50	25/50	25/65	50/65	50/65
XS400SE	50	-	-/65	10/50	10/65	25/50	25/65	50/65	50/65
XH400PJ	65	-	-	10/50	10/65	25/50	25/65	50/65	50/65
XH400SE	65	-	-	10/50	10/65	25/50	25/65	50/65	50/65
XH400PE	65	-	-	10/50	10/65	25/50	25/65	50/65	50/65
XS630CJ	45	-	-	-	-/50	7/50	7/50	30/45	30/45
XS630NJ	65	-	-	-	-	7/50	7/65	30/65	30/85
XS630SE	50	-	-	-	-/65	-	-	30/65	30/85
XH630PJ	85	-	-	-	-	-	-	30/65	30/85
XH630SE	65	-	-	-	-	-	-	30/65	30/85
XH630PE	65	-	-	-	-	-	-	30/65	30/85
XS800NJ	65	-	-	-	-	-	-	15/65	20/85
XS800SE	50	-	-	-	-	-	-/65	15/65	20/85
XH800PJ	85	-	-	-	-	-	-	15/65	20/85
XH800SE	65	-	-	-	-	-	-	15/65	20/85
XH800PE	65	-	-	-	-	-	-	15/65	20/85
XS1250SE	65	-	-	-	-	-	-	-	20/65

Standard TemBreak MCCB's - Selectivity and Cascade tables at 415V

Guide

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Selectivity Cascade

Downstream MCCB	kA (rms)	Upstream MCCB XH125NJ 50	XS250NJ 35	XH250NJ 50	XS400CJ 35	XS400NJ 50	XS400NE 50	XH400NE 65
XS125CJ	18	-/50	3/30	3/50	4/35	4/50	6/50	6/50
XS125NJ	30	-/50	3/30	3/50	4/35	4/50	6/50	6/50
XH125NJ	50	-	-	-	-	-	6/50	6/65
XE225NC	18	-	-/30	-/30	-/30	-/30	6/30	6/30
XS250NJ	35	-	-	-	-	4/50	6/50	6/65
XH250NJ	50	-	-	-	-	4/50	6/50	6/65
XS400CJ	35	-	-	-	-	-/50	-/50	-/50
XS400NJ	50	-	-	-	-	-	-	-/65
XS400NE	50	-	-	-	-	-	-	-/65
XH400NE	65	-	-	-	-	-	-	-
XS630CJ	45	-	-	-	-	-	-	-
XS630NJ	65	-	-	-	-	-	-	-
XS630NE	50	-	-	-	-	-	-	-
XH630NE	65	-	-	-	-	-	-	-
XS800NJ	65	-	-	-	-	-	-	-
XS800NE	50	-	-	-	-	-	-	-
XS1250NE	65	-	-	-	-	-	-	-
XS1600NE	100	-	-	-	-	-	-	-

Downstream MCCB	kA (rms)	Upstream MCCB XS630CJ 45	XS630NJ 65	XS630NE 50	XH630NE 65	XS800NJ 65	XS800NE 50	XH800NE 65
XS125CJ	18	6/30	6/30	14/30	18/30	10/30	14/30	14/30
XS125NJ	30	6/30	6/30	18/30	18/30	10/30	18/30	18/30
XH125NJ	50	-	-	-	-	12/65	30/50	-
XE225NC	18	6/25	6/30	10/30	10/30	8/30	12/30	12/30
XS250NJ	35	6/45	6/50	10/50	10/65	8/50	12/50	12/65
XH250NJ	50	-	-	10/50	-	10/65	22/50	-
XS400CJ	35	6/35	6/50	7.5/50	7.5/65	6/50	10/50	10/65
XS400NJ	50	-	-	7.5/50	7.5/65	6/50	10/50	10/65
XS400NE	50	-	-	10/50	10/65	6/50	10/50	10/65
XH400NE	65	-	-	-	-	-	-	10/65
XS630CJ	45	-	-	-	-	-	-	-
XS630NJ	65	-	-	-	-	-	-	-
XS630NE	50	-	-	-	-	-	-	-
XH630NE	65	-	-	-	-	-	-	-
XS800NJ	65	-	-	-	-	-	-	-
XS800NE	50	-	-	-	-	-	-	-
XS1250NE	65	-	-	-	-	-	-	-
XS1600NE	100	-	-	-	-	-	-	-

Standard TemBreak MCCB's - Selectivity and Cascade tables at 415V

Guide **XX / YY**

Selectivity Cascade

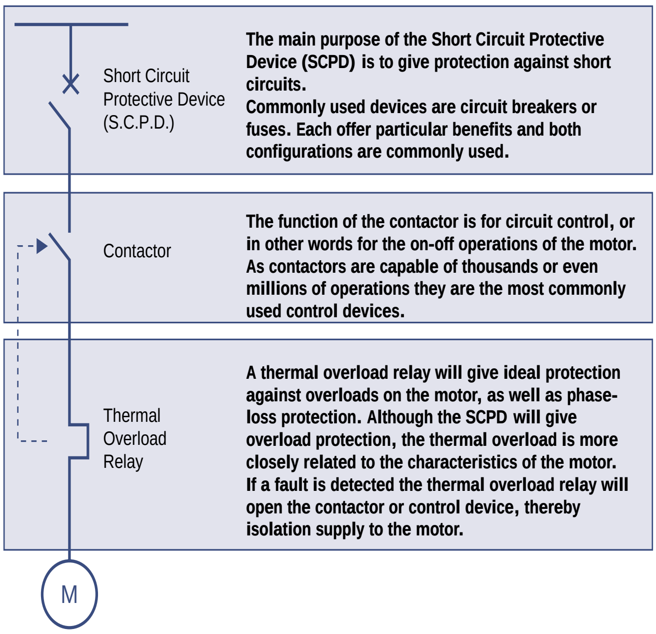
Downstream MCCB	kA (rms)	Upstream MCCB XH800PJ 85	XS1250NE 65	XS1600NE 100	XS2000NE 100	XS2500NE 100
XS125CJ	18	10/30	18/18	18/18	18/18	18/18
XS125NJ	30	10/30	30/30	30/30	30/30	30/30
XH125NJ	50	12/65	50/50	50/50	50/50	50/50
XE225NC	18	8/30	18/18	18/18	18/18	18/18
XS250NJ	35	8/65	25/35	35/35	35/35	35/35
XH250NJ	50	10/65	35/50	50/50	50/50	50/50
XS400CJ	35	6/65	20/42	35/42	35/42	35/42
XS400NJ	50	6/65	20/65	35/65	35/65	50/65
XS400NE	50	6/65	20/65	35/65	35/65	50/65
XH400NE	65	-	20/65	35/65	35/65	50/65
XS630CJ	45	-/50	15/45	20/45	35/45	35/45
XS630NJ	65	-/85	15/65	20/85	35/85	35/85
XS630NE	50	-/85	15/65	20/85	35/85	35/85
XH630NE	65	-/85	15/65	20/85	35/85	35/85
XS800NJ	65	-/85	15/65	20/85	35/85	35/85
XS800NE	50	-/85	15/65	20/85	35/85	35/85
XS1250NE	65	-	-	20/65	35/65	35/65
XS1600NE	100	-	-	-	-	35/65

Motor Starting – Introduction

Generally, an item of switchgear is selected on the basis of one or more performance criteria, be it current/power carrying or interrupting capabilities.

Additional consideration is often necessary when several different pieces of switchgear are connected in series, none more so than in motor starting applications. As motors play a significant part in most modern day electrical systems it is important to ensure that the components of switchgear controlling and protecting the motor will interact with each other, or in other words, they are “co-ordinated”.

In order to protect and operate a motor several components may be used, each with a different function. A typical set-up is as follows:



What problems can occur?

At the instant the motor is supplied with power it draws an “in-rush current” to its terminals, before gradually decaying to a normal operating current.

Should the in-rush current be high, it could be detected by the SCPD and classed as a fault current. If a high in-rush current should occur or even after repeated stop-start (inching) operations of the motor the SCPD may trip, albeit without a fault in the system. This is commonly known as “nuisance tripping” of the SCPD.

Special care must be taken when selecting a SCPD for motor-starting applications to prevent nuisance tripping, and at the same time ensuring adequate protection to the motor and associated cabling.

Another function of the SCPD is to protect the control device (e.g. contactor) from high-current, high-energy faults. Therefore, attention must also be paid when selecting an SCPD-Starter (contactor + thermal overload relay) combination.

When clearing a fault every SCPD has a finite opening time, which will result in an amount of fault current and energy being “let-through” to the downstream system and other devices. At the same time, a control device, such as a contactor can only withstand a finite level of fault current and energy, otherwise internal damage could occur.

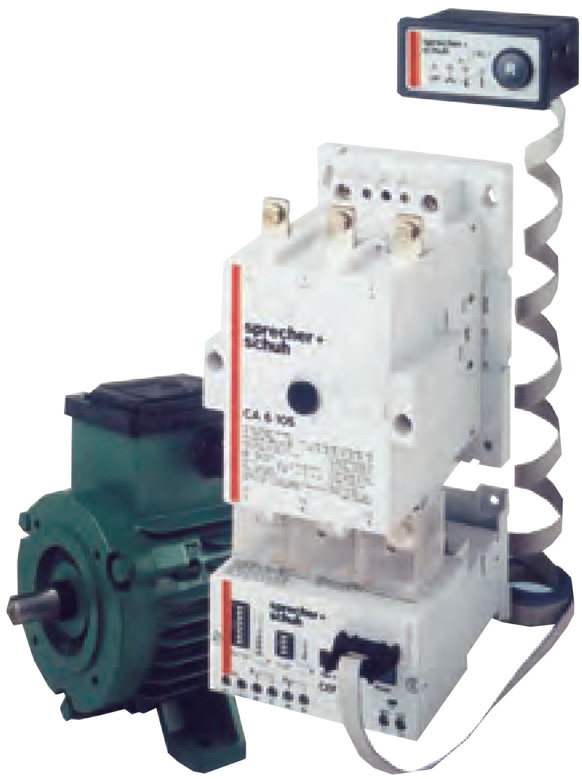
Even at relatively low fault levels the electromagnetic forces created by the fault current can cause the contacts of a contactor to lift. This can cause heating or even mild arcing which in turn can damage or weld the contacts of the contactor.

Furthermore, the let-through current of the SCPD can distort the bi-metal strip in the overload relay. This can prevent the restoration of the bi-metal strip to its original configuration on cooling, altering the relay’s protection characteristics and resulting in under or over protection of the motor.

What solutions are available to me?

Good component design in association with correct component co-ordination is the only way to ensure reliable protection and operation under abnormal condition.

Terasaki circuit breakers and Sprecher + Schuh starter combinations are tested to provide full and safe co-ordination for most motor starting applications.



Application data

Motor Starting
What is co-ordination

The motor starter consists of a combination of contactor, overload relay and Short Circuit Protection Device (SCPD) being either fuses or circuit breakers.

During motor starting and at normal loading, the overload relay protects both the motor and cables by tripping the contactor in a time inversely proportional to the current. However, under short circuit conditions, the response time would be too long and the fuses or circuit breakers must takeover to interrupt the fault current therefore limiting energy passed through the starter components. When this is successfully achieved, the combination is said to be co-ordinated.

It is a requirement of the Australian Standard AS 3947.4.1 that combination motor starters are capable of withstanding the effects of load side short circuits. Some damage to the combination is permitted, but this must be confined and not present a risk to the operator, or damage equipment adjacent to the starter.

Contactors and thermal overload relays only have limited ability to withstand the high current associated with a fault such as an internal motor short. Their design is optimised for performance at much lower currents and to design in the ability to control or withstand high fault levels would add to costs and possibly reduce its performance at normal levels.

The standards

The requirements of several standards can be applied to these combination units. The Wiring Rules, AS 3000, are concerned mainly with setting standards for the fixed wiring. In this regard the concern is the wiring between the protection device and the motor.

As motors can experience short term overloading the current rating of a fuse can be up 4 times and a circuit breaker 2.5 times the full load rating of the motor. The Wiring Rules allow the overload protection and the short circuit protection to be provided by different devices. This allows magnetic only circuit breakers, or back-up type fuses, to be used in conjunction with a contactor/thermal overload relay configuration.

Isolating switches must also be provided in the motor or control circuit. These are to be in clear view of any person working on the motor, or provided with a locking device.

AS 3947.4.1 specifies testing requirements for the combination of components required to perform the motor control and protection functions. If the equipment has been mounted in a switchboard it is possible to meet the testing requirements of AS 3947.2 short circuit withstand of the outgoing circuit at the same time as the tests to AS 3947.4.1 are performed.

Both standards look at the performance of the equipment when a fault occurs on the outgoing circuit. It is accepted in these standards that some damage may be sustained by the components of the starter when subjected to short circuit conditions.

AS 3947.2 requires that during the tests the equipment installed in the switchboard performs in accordance to its own standard. A selection by the customer of the performance required needs to be made, as AS 3947.4.1 allows for Type '1' and Type '2' performance.

Type '1'

Under short circuit conditions the starter shall not cause danger to persons or the installation. The starter itself may need repair.

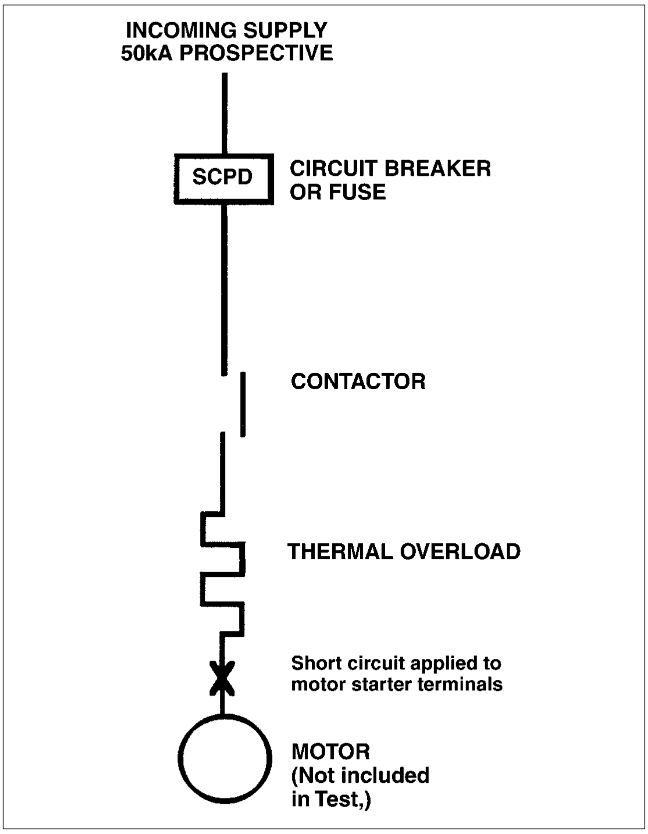
Type '2'

After a short circuit the starter is suitable for further service. A contact weld is permitted, but it must be easily separated - for example, by a screwdriver, without significant deformation.

Type '2' co-ordination does not mean the starter is suitable for normal operation without inspection/repair of the contacts. So, in both cases it is important that the condition of the starter is checked, to ensure that the SCPD has operated and that no damage has taken place.

Notes: IEC Standards are the basis of many Australian Standards. AS 3947.4.1 is equivalent to IEC 947.4.1 and AS 3947.2 is equivalent to IEC 947.2.
Both Australian standards list some amendments to the IEC versions.

Typical arrangement for co-ordination test



Application data

Motor Starting
Protective devices selection

In most cases very little difference will be noticed in the service performance of a system using fuses as against circuit breakers.

The circuit breaker is easier when it comes to restoring power, but as tripping should only be the result of a system fault it is unwise to reclose the circuit breaker without finding the cause. In this regard it is normal for only a “skilled person” to attend to fuse replacement and they are more likely to check for other problems.

As the circuit breaker or fuse is operating in conjunction with separate motor overload protection, it is the contactor which responds to overload problems. This is different to a protective device on a distribution circuit. For this application the advantages of the circuit breakers easy return to service has caused a general trend towards using circuit breakers.

Consideration should be given to preventing unskilled people from reclosing a tripped circuit breaker in a motor control application. This can be done by making the switchboard only accessible to the correct people, or by requiring the switchboard to be opened to reset the circuit breaker.

It must be assumed with both Type ‘1’ and Type ‘2’ co-ordination that if the short circuit protective device has operated there is a fault in the motor, or wiring to it and that the starter itself needs attention.

It is the let-through energy of the protective device which determines the damage to the starter. As this varies greatly between different models, it is essential that only proven combinations are used.

NHP, Sprecher + Schuh and Terasaki have now conducted many tests on different combinations and these are detailed in the co-ordination tables.

Terasaki circuit breakers for short circuit protection

Terasaki circuit breakers have been tested in combination with Sprecher + Schuh contactors and overloads and can be used for Type ‘1’ and Type ‘2’ co-ordination requirements. (Refer to following tables for actual combinations).

TemBreak
A new generation of MCCB’s offering a choice of 3 series (economical, standard and high fault) and two types, ie, adjustable thermal magnetic or microprocessor based solid state OCR are available from Terasaki. Both types have common construction features and interchangeable plug-in accessories. TemBreak thermal-magnetic MCCB’s offer a wide adjustment range, with 63% to 100% of rated current. Each MCCB is individually calibrated to ensure precision tripping on overcurrent.

TemBreak electronic type
The rated current of the electronic type TemBreak is adjustable in 15 steps from 50% to 100% of the nominal rated current, using the base current (Io) select switch and the pickup current (I1) setting dial.

This is one of the essential features for precise protection co-ordination and for low voltage distribution systems.

TemBreak motor protection circuit breaker

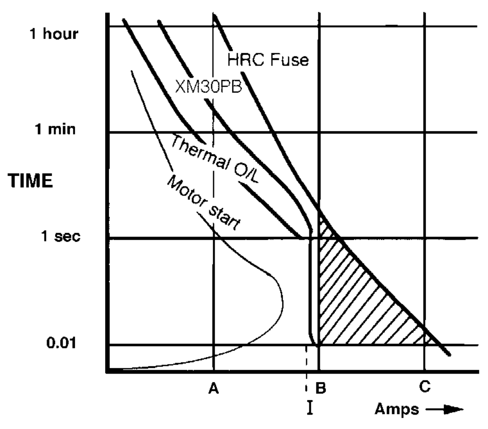
The XM30PB circuit breaker will protect contactor starters with direct connected overcurrent relays with ratings 1 amp to 12 amp in systems with up to 50kA rms prospective short circuit. The protection is due to the special current limiting effect of the XM30PB.

Motor starter protection
The XM30PB circuit breaker has been developed for motor starter protection and is suitable as the Short Circuit Protection Device (SCPD) for motor starters equipped with either direct connected or CT connected overcurrent relays.

XM30PB compared to HRC fuse
The circuit breaker tripping characteristic is more suitable for protection of starters than the HRC fuse. Unlike the HRC fuse, the breaker can be selected to trip instantaneously at a predetermined current level just lower than the maximum breaking current of the starter contactor, thus always protecting the contactor against opening fault currents higher than its capability. This can be seen from the typical breaker and fuse tripping characteristics compared to the contactor breaking capacity in
figure 1.

No protection is provided by the fuse when the overcurrent is of value B to C amps should the contactor open by earth fault relay. If the breaker is used as a SCPD then protection is provided for all currents in excess of the instantaneous trip current of the breaker. Also, the circuit breaker can be tripped by earth fault relay and so prevent the risk of contactor damage due to the long delay of the HRC fuse interruption if the fault current is of a value between
B and C.

Fig 1.



A - Normal CA 3 rating of contactor
B - Maximum breaking current of contactor
C - Cut-off current of fuse
I - Instantaneous tripping current of breaker

Type '1' short circuit co-ordination
Motor starter co-ordination table for DOL starting
50kA at 415V to AS 3947-41

TYPE 1 50kA

Motor size kW	Approx. amps	Terasaki circuit breaker	Sprecher + Schuh contactor type	Sprecher + Schuh thermal overload relay type [2])	Settings range amps
0.37	1.1	XM30PB/1.4	CA 7-9	CT 7-24	0.16-10
0.55	1.5	XM30PB/2	CA 7-9	CT 7-24	0.16-10
0.75	1.8	XM30PB/2.6	CA 7-9	CT 7-24	0.16-10
1.1	2.6	XM30PB/4.0	CA 7-9	CT 7-24	0.16-10
1.5	3.4	XM30PB/5	CA 7-9	CT 7-24	0.16-10
2.2	4.8	XM30PB/8	CA 7-9	CT 7-24	0.16-10
3.0	6.5	XM30PB/10	CA 7-9	CT 7-24	0.16-10
4.0	8.2	XM30PB/12	CA 7-9	CT 7-24	0.16-10
5.5	11	XH125NJ/20	CA 7-12	CT 7-24	0.16-16
7.5	14	XH125NJ/20	CA 7-16	CT 7-24	0.16-16
10	19	XH125NJ/32	CA 7-23	CT 7-24	0.16-24
11	21	XH125NJ/32	CA 7-23	CT 7-24	0.16-24
15	28	XH125NJ/50	CA 7-30	CT 7-45	18-30
18.5	34	XH125NJ/50	CA 7-37	CT 7-45	30-45
22	40	XH125NJ/63	CA 7-43	CT 7-45	30-45
30	55	XH125NJ/100	CA 7-60	CT 7-75	18-60
37	66	XH125NJ/100	CA 7-72	CT 7-75	18-75
45	80	XH125NJ/125 [1])	CA 7-85	CT 7-100	70-90
55	100	XH125NJ/125 [1])	CA 6-105-(EI)	CT 6-110	85-110
75	130	XH250NJ/250	CA 6-140-(EI)	CT 6-150	105-150
90	155	XH250NJ/250 [1])	CA 6-170-EI	CT 6-200	140-200
110	200	XH250NJ/250 [1])	CA 6-210-EI	CEF 1-41/42	160-400
132	225	XS400SE/400	CA 6-250-EI	CEF 1-41/42	160-400
160	270	XS400SE/400	CA 6-300-EI	CEF 1-41/42	160-400
200	361	XS400SE/400	CA 6-420-EI/ CA 5-450	CEF 1-41/42	160-400
250	425	XS630SE/630	CA 6-420-EI/ CA 5-450	CEF 1-52	160-630
315	530	XS630SE/630	CA 5-550	CEF 1-52	160-630

Notes: [1]) Use 'magnetic only' breaker. Refer NHP for details.
[2]) Thermal or electronic overload relays may be used.
Some combinations also achieve Type '2' performance.
CA 7 contactor can be replaced with equivalent CA 3 size.

Type ‘2’ short circuit co-ordination Terasaki Din-T at 50kA

TYPE 2 50kA

The 10kA Din-T miniature circuit breaker gives an amazing 50kA performance when used in the combinations shown in the co-ordination tables. For the low current ratings, the resistance of the thermal overloads assists in reducing the current to a level that the Din-T can handle with ease. For the higher ratings a Sprecher + Schuh limiter block lifts the combined performance to the 50kA level.

All the listed Din-T combinations include a rotary isolator which allows external control. To reset the starter after a short circuit, access to the breaker is required. This can be used to prevent unskilled operators from reclosing the motor starter after a fault.

It should also be remembered that whenever the circuit breaker trips under high fault currents, the contactor must be checked for welded contacts.

KTA 3 Motor starter combination

Type ‘2’ co-ordination table for Din-T circuit breakers with rotary isolator DOL starting 50kA @ 415V to AS 3947.4.1

Motor size kW	Approx. amps @ 415V	Sprecher + Schuh isolator	Terasaki circuit breaker	Sprecher + Schuh current limiter	Sprecher + Schuh contactor	Sprecher + Schuh thermal overload relay	Thermal overload range
0.37	1.1	LA 3-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1-1.6
0.55	1.5	LA 3-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1-1.6
0.75	1.8	LA 3-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1.6-2.4
1.1	2.6	LA 3-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4-4
1.5	3.4	LA 3-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4-4
2.2	4.8	LA 3-80	Din-T 10 / 10	KTL 3-65	CA 7-23	CT 7-24	4-6
3.0	6.5	LA 3-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6-10
4.0	8.2	LA 3-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6-10
5.5	11.0	LA 3-80	Din-T 10 / 20	KTL 3-65	CA 7-23	CT 7-24	10-16
7.5	14.0	LA 3-80	Din-T 10 / 32	KTL 3-65	CA 7-30	CT 7-45	10-16
11.0	21.0	LA 3-80	Din-T 10 / 40	KTL 3-65	CA 7-30	CT 7-45	16-24
15.0	28.0	LA 3-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	18-30
18.5	34.0	LA 3-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	30-45

Note: Isolator provides rotary operation for external control. May be deleted if not required.

Type ‘2’ short circuit co-ordination Motor starter co-ordination table for DOL starting 50kA at 415V to AS 3947-4-1

TYPE 2 50kA

Motor size kW	Approx. amps	Terasaki circuit breaker	Sprecher + Schuh contactor type	Sprecher + Schuh thermal overload relay type 3)	Settings range amps
0.37	1.1	XM30PB/1.4	CA 7-9	CT 7-24-1.6	1-1.6
0.55	1.5	XM30PB/2	CA 7-9	CT 7-24-1.6	1-1.6
0.75	1.8	XM30PB/2.6	CA 7-9	CT 7-24-2.4	1.6-2.4
1.1	2.6	XM30PB/4.0	CA 7-16	CT 7-24-4	2.4-4
1.5	3.4	XM30PB/5	CA 7-16	CT 7-24-4	2.4-4
2.2	4.8	XM30PB/8	CA 7-16	CT 7-24-6	4-6
3	6.5	XM30PB/10	CA 7-30	CT 7-24-10	6-10
4	8.2	XM30PB/12	CA 7-30	CT 7-24-10	6-10
5.5	11	XH125NJ/20	CA 7-30	CT 7-24-16	10-16
7.5	14	XH125NJ/20	CA 7-30	CT 7-24-16	10-16
11	21	XH125NJ/32	CA 7-30	CT 7-24-24	16-24
15	28	XH125NJ/50	CA 7-43	CT 7-45-30	18-30
18.5	34	XH125NJ/50	CA 7-43	CT 7-45-45	30-45
22	40	XH125NJ/63	CA 7-43	CT 7-45-45	30-45
30	55	XH125NJ/100	CA 7-85	CT 7-75 2)	45-60
37	66	XH125NJ/100	CA 7-85	CT 7-75 2)	60-75
45	80	XH125NJ/125	CA 6-105-(EI)	CT 6-90	70-90
55	100	XH125NJ/125 1)	CA 6-105-(EI)	CT 6-110	85-110
75	130	XH250NJ/250	CA 6-140-(EI)	CT 6-150	105-150
90	155	XH250NJ/250	CA 6-170-EI	CT 6-200	140-200
110	200	XH250NJ/250 1)	CA 6-210-EI	CEF 1-41/42	160-400
132	225	XS400SE/400	CA 6-210-EI	CEF 1-41/42	160-400
160	270	XS400SE/400	CA 6-300-EI	CEF 1-41/42	160-400
200	361	XS400SE/400	CA 6-420-EI	CEF 1-41/42	160-400
200	361	XS400SE/400	CA 5-450	CEF 1- 22 2)	160-400
250	425	XS630SE/630	CA 5-700	CEF 1- 52 2)	160-630
320	538	XS630SE/630	CA 5-700	CEF 1- 52 2)	160-630

Notes:
1) Use ‘magnetic only’ breaker or next higher circuit breaker/contactor combination. Refer NHP.
2) Use with separate mounting bracket.
3) Thermal or electronic overload relays may be used.
Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

Type '2' short circuit co-ordination
Motor starter co-ordination table for DOL starting
65kA, 415V to AS 3947-4-1

TYPE 2
65kA

Motor size kW	Approx. amps	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh overload relay [1])	Settings range amps
0.37	1.1	XM30PB/1.4	CA 7-9	CEP 7	1.0-2.9
0.55	1.5	XM30PB/2	CA 7-9	CEP 7	1.0-2.9
0.75	1.8	XM30PB/2.6	CA 7-9	CEP 7	1.0-2.9
1.1	2.6	XM30PB/4.0	CA 7-16	CEP 7	1.6-5
1.5	3.4	XM30PB/5	CA 7-16	CEP 7	1.6-5
2.2	4.8	XM30PB/8	CA 7-16	CEP 7	3.7-12
3	6.5	XM30PB/10	CA 7-30	CEP 7	3.7-12
4	8.2	XM30PB/12	CA 7-30	CEP 7	3.7-12
5.5	11	TL30F/20A	CA 7-30	CEP 7	3.7-12
7.5	14	TL30F/30A	CA 7-30	CEP 7	12-32
11	21	TL30F/30A	CA 7-30	CEP 7	12-32
15	28	TL100NJ/50A	CA 7-43	CEP 7	12-32
18.5	34	TL100NJ/50A	CA 7-43	CEP 7	12-37
22	40	TL100NJ/63A	CA 7-43	CEP 7	14-45
30	55	TL100NJ/100A	CA 7-72	CEP 7	26-85
37	66	TL100NJ/100A	CA 7-72	CEP 7	26-85
45	80	TL100NJ/100A	CA 6-105-(EI)	CT 6-90	70-90
55	100	XH400SE/250	CA 6-105-(EI)	CT 6-110	85-110
75	130	XH400SE/250	CA 6-140-(EI)	CT 6-150	105-150
90	155	XH400SE/250	CA 6-170-EI	CT 6-200	140-200
110	200	XH400SE/250	CA 6-210-EI	CEF 1-41/42	160-400
132	225	XH400SE/400	CA 6-210-EI	CEF 1-41/42	160-400
150	250	XH400SE/400	CA 6-250-EI	CEF 1-41/42	160-400
160	270	XH400SE/400	CA 6-300-EI	CEF 1-41/42	160-400
200	361	XH400SE/400	CA 6-420-EI	CEF 1-41/42	160-400
200	361	XH400SE/400	CA 5-450	CEF 1- 22 [2])	160-400
250	425	XH630SE/630	CA 5-700	CEF 1- 52 [2])	160-630
320	538	XH630SE/630	CA 5-700	CEF 1- 52 [2])	160-630

Notes: [1]) Thermal or electronic overload relays may be used.
[2]) Use with separate mounting bracket.
Combinations based on the overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

TERASAKI

Application data

NHP

NEW

TYPE 2
85kA

Type '2' short circuit co-ordination
Motor starter co-ordination table for DOL starting
85kA, 415V to AS 3947-4-1

Motor size kW	Approx. FLC at 415V amps	Terasaki circuit breaker	Sprecher + Schuh contactor type	Sprecher + Schuh thermal overload type [1])	Settings range amps
0.37	1.1	XM30PB/1.4	CA 7-9	CEP 7-M32-2.9-10	1.0-2.9
0.55	1.5	XM30PB/2	CA 7-9	CEP 7-M32-2.9-10	1.0-2.9
0.75	1.8	XM30PB/2.6	CA 7-9	CEP 7-M32-2.9-10	1.0-2.9
1.1	2.6	XM30PB/4	CA 7-16	CEP 7-M32-2.9-10	1.0-2.9
1.5	3.4	XM30PB/5	CA 7-16	CEP 7-M32-5-10	1.6-5
2.2	4.8	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7-12
3	6.5	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7-12
4	8.2	XM30PB/10	CA 7-30	CEP 7-M32-12-10	3.7-12
5.5	11	TL100NJ/20	CA 7-30	CEP 7-M32-12-10	3.7-12
7.5	14	TL100NJ/20	CA 7-30	CEP 7-M32-32-10	12-32
9	17	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12-32
10	19	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12-32
11	21	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12-32
15	28	TL100NJ/50	CA 7-43	CEP 7-M32-32-10	12-32
18.5	34	TL100NJ/50	CA 7-43	CEP 7-M37-37-10	12-37
22	40	TL100NJ/63	CA 7-43	CEP 7-M45-45-10	14-45
30	55	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26-85
37	66	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26-85
45	80	TL250NJ/160	CA 6-105	CEP 7-M85-85-10	26-85
55	100	TL250NJ/160	CA 6-105	CEF 1-11/12	0.5-180
75	135	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5-180
90	160	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5-180
110	200	TL250NJ/250	CA 6-210-EI	CEF 1-41/42/52	160-630
132	230	TL400NE/400	CA 6-210-EI	CEF 1-41/42/52	160-630
160	270	TL400NE/400	CA 6-300-EI	CEF 1-41/42/52	160-630
200	361	TL400NE/400	CA 6-420-EI	CEF 1-41/42/52	160-630

Notes: [1]) Thermal or electronic overload relays may be used.
Combinations based on the overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

Motor circuit application table for DOL starting
General applications

High fault range

Motor rating (kW)	Approx. FLC (amps)	Din-T C & D Curve	Safe-T	XS125CJ XS125NJ XH125NJ	XE225NC	XS250NJ XH250NJ	XS400SE XH400SE XS400CJ XS400NJ	XH630SE XS630SE XS630CJ XS630NJ	XS800NJ XH800SE XS800SE	XS1250SE/ 1000
0.37	1.1	4	6							
0.55	1.5	4	6	20						
0.75	1.8	6	6	20						
1.1	2.6	10	6	20						
1.5	3.4	10	10	20						
2.2	4.8	16	16	20						
3.0	6.5	20	16	20						
4	8.2	25	20	20						
4.5	9	32	25	20						
5.5	11	32	32	32						
7.5	14	40	40	32						
10	19	50	50	50						
11	21	50	50	50						
15	28	63	63	63						
18.5	34	100 [1])	80	100						
22	40	125 [1])	100	100						
25	46	125 [1])	100	100						
30	55			125		160				
37	66			125 [3])	125	160				
45	80			125 [3])	125	160				
55	100				175	160	250			
75	130				225	250	250			
90	155					250	250			
110	200						400	400		
132	225						400	400		
160	270						400	400		
185	320						400 [2])	630		
200	361						400 [2])	630		
220	380							630	800 [2])	
250	430							630	800	
280	480							630 [2])	800	
300	510							630 [2])	800	
375	650								800 [2])	
450	750									1000

Notes: These motor circuit application tables are to be used as a selection guide for average 3 phase, 4 pole 415V motors for standard applications only. The table is based on holding 125% of full load current (FLC) continuously and 600% of FLC for at least 10 seconds. Lower circuit breaker ratings are possible in some applications. Refer NHP.

[1]) 80, 100 and 125 amp refers to Din-T10H type.
[2]) Type 'SE' TemBreak MCCB only.
[3]) Use magnetic-only TemBreak MCCB. Refer NHP.

Adjustable magnetic trips set to high. Thermal magnetic TemBreak adjustable 63% – 100% of NRC (nominal rated current).
Din-T MCB's are calibrated to IEC 898 Curve 'C' & 'D'. Selected sizes of 'D' Curve are available from stock. Refer NHP.

Motor circuit application table for reduced voltage starting General applications

Breaker type and current rating, star delta, auto transformer resistor or reactance starting

Motor rating (kW)	Approx. FLC (amps)	Din-T C & D Curve	Safe-T	XS125CJ XS125NJ XH125NJ TL100NJ 3)	XE225NC	XS250NJ XH250NJ	XS400SE XH400SE XS400CJ XS400NJ	XH630SE XS630SE XS630CJ XS630NJ	XS800NJ XH800SE XS800SE	XS1250SE 1000
0.37	1.1	4	6							
0.55	1.5	4	6	20						
0.75	1.8	4	6	20						
1.1	2.6	6	6	20						
1.5	3.4	10	6	20						
2.2	4.8	10	10	20						
3.0	6.5	16	16	20						
4	8.2	20	16	20						
4.5	9	20	16	20						
5.5	11	25	20	20						
7.5	14	32	25	20						
10	19	40	40	32						
11	21	50	40	32						
15	28	50	50	50						
18.5	34	63	63	50						
22	40	80 1)	63	63						
25	46	100 1)	80	100						
30	55	125 1)	100	100		160				
37	66	125 1)		100	125	160				
45	80			125	125	160	250			
55	100				150	160	250			
75	130				175	250	250			
90	155				225	250	250			
110	200					250	250	400		
132	225						400	400		
160	270						400	400		
185	320						400	400	800 2)	
200	361						400 2)	630	800 2)	
220	380							630	800	
250	430							630	800	
280	480							630	800	
300	510							630	800	
375	650								800 2)	1000

Notes: These motor circuit application tables are to be used as a selection guide for average 3 phase, 4 pole 415V motors for standard applications only. The table is based on holding 125% FLC continuously and 350% FLC for at least 20 seconds.
1) 80, 100 and 125 amp refers to Din-T10H type.
2) Type 'SE' TemBreak MCCB only.
3) TL100NJ up to 100A only.

If co-ordination to IEC 947-4-1 is required refer to Type 1 and 2 co-ordination tables, contact NHP.

Din-T MCB's are calibrated to IEC 898 Curve 'C' & 'D'. Selected sizes of 'D' Curve are available from stock. Refer NHP.

TERASAKI

Application data

NHP

Motor circuit application table for *DOL FIRE PUMP* starting duty

Breaker type and current rating (A)

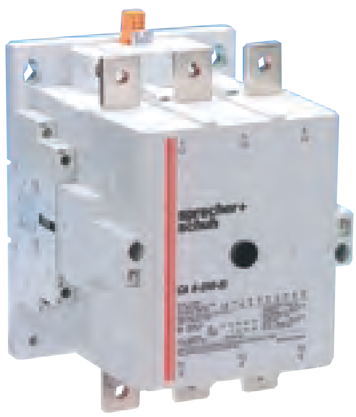
Motor rating (kW)	Approx. FLC (amps)	Din-T C & D Curve	Safe-T	XM30PB	XS125CJ XS125NJ XH125NJ TL100NJ [3])	TL100F TL100C	XE225NC	XS250NJ XH250NJ	XS400SE XH400SE XS400CJ XS400NJ	XH630SE XS630SE XS630CJ XS630NJ	XS800NJ XH800SE XS800SE	XS1250SE 1000
0.37	1.1	4	6	3.6								
0.55	1.5	6	6	3.6								
0.75	1.8	6	6	5	20	15						
1.1	2.6	10	6	7.4	20	15						
1.5	3.4	16	10	10	20	15						
2.2	4.8	20	16	12	20	15						
3	6.5	25	20		20	20						
4	8.2	32	25		32	30						
4.5	9	32	32		32	30						
5.5	11	40	40		32	30						
7.5	14	50	50		50	40						
10	19	63	50		50	50						
11	21	63	63		63	60						
15	28	100 [1])	80		100	75						
18.5	34	125 [1])	100		100	75						
22	40				125	75						
25	46				125	100						
30	55					100	125	160				
37	66						150	160				
45	80						175	250	250			
55	100						225	250	250			
75	130								400			
90	155								400			
110	200								400	630		
132	225								400	630		
160	270								400	630		
185	320								400 [2])	630		
200	361									630	800	
220	380									630	800	
250	430									630	800	
280	480										800	
300	510										800	
375	650										800 [2])	1000
450	750											1000

Notes: These motor circuit application tables are to be used as a selection guide for average 3 phase, 4 pole 415V motors for standard applications only. The table is based on holding 125% FLC continuously and 600% FLC for at least 20 seconds.
[1]) 80, 100 and 125 amp refers to Din-T10H type.
[2]) Type 'SE' TemBreak MCCB only.
[3]) TL100NJ up to 100A only.
Din-T MCB's are calibrated to IEC 898 Curve 'C' & 'D'. Selected sizes of 'D' Curve are available from stock refer NHP.

Motor starting table for DOL starting at 1000V AC 50 Hz

Motor size kW	Full load current amperes	MCCB	Voltage
0.37-10	0.4-7.5	**TL100EM/15**	1000V
11.0	9.0	**TL100EM/20**	1000V
15-18.5	12-14.5	**TL100EM/30**	1000V
22-33	17-23	**TL100EM/40**	1000V
37-50	28-38	**TL100EM/50**	1000V
55-80	40-57	**TL100EM/75**	1000V
90-110	65-78	**TL100EM/100**	1000V
150	102	**XV400NE/160**	1000V
185-220	138-160	**XV400NE/250**	1000V
220-500	160-350	**XV400NE/400**	1000V

TemBreak XV400NE mining breaker



Sprecher + Schuh 1000V CA 6 contactor

(Refer Part A for more information)

Note: This table should be used as a selection guide for standard applications only.

MCCB's for protection of Power Factor Correction (PFC) units

In circuits containing capacitor banks for Power Factor Correction (PFC) two conditions that the circuit breaker must overcome are as follows:

1. Voltage surges during MCCB opening.
2. Nuisance tripping due to in-rush current.

1. Voltage surges during MCCB opening

At the instant where the MCCB has to open, the voltage developed across its contacts can be up to twice the supply voltage, which can have damaging consequences should the breaker be slow to operate. If this worse case scenario actually occurs a potential re-arcing can take place across the contacts of the MCCB, until the breaker has fully opened and the distance between the contacts is at a maximum.

Re-arcing at each instant can be:

1st re-arcing – 3 x supply voltage

2nd re-arcing – 5 x supply voltage

3rd re-arcing – 7 x supply voltage

Internal capacitor damage will occur if the voltage level is greater than the capacitor's Dielectric Strength. With modern-day protection devices, (for example the Terasaki TemBreak MCCB's) this problem will not occur.

The numerous cases of re-arcing are mainly a result of older style "dependant manual closing" devices, which rely on the operator speed for opening or closing.

All Terasaki MCCB's are of the "manually independent closing" type, with high speed opening to prevent re-arcing between the contacts.

2. Nuisance tripping due to in-rush current

When feeding a circuit containing a PFC unit the circuit breaker and the PFC unit can be exposed to a large in-rush current, equal to the instantaneous value of the power source. The end result of this is a large in-rush current, which could cause the circuit breaker to operate instantaneously due to its short-circuit protection. (The value of in-rush current will depend on the source voltage, the inductance and reactance in the circuit).

Special care should be taken to ensure that the MCCB selected will not nuisance trip due to high in-rush currents.

The table below shows typical MCCB selections for varying capacitor ratings, and the breaker selection is by a rule-of-thumb.

$$\text{Capacitor Rated Current} = \frac{\text{kVAR} \times 1000}{\sqrt{3} \times V} \ (A)$$

kVAR: Capacitor Rating

V: Source Voltage

MCCB Rating = Capacitor Rated Current x 1.5 (A)

Once the MCCB rating has been determined, the MCCB type should be selected according to the short circuit fault level of the system.

MCCB's selection for power factor capacitor application

Voltage 415V (3∅) Capacitor rating (kVAR)	Capacitor rated current (A)	Recommended MCCB's [1] [2] Type/Rating (A)				
5	7			XS125CJ/20	XS125NJ/20	XH125NJ/20
10	13.9			XS125CJ/32	XS125NJ/32	XH125NJ/32
15	20.9			XS125CJ/50	XS125NJ/50	XH125NJ/50
20	27.8			XS125CJ/50	XS125NJ/50	XH125NJ/50
25	34.8			XS125CJ/63	XS125NJ/63	XH125NJ/63
30	41.7			XS125CJ/100	XS125NJ/100	XH125NJ/100
40	55.6			XS125CJ/100	XS125NJ/100	XH125NJ/100
50	69.6			XS125CJ/125	XS125NJ/125	XS125NJ/125
75	104	XE225NC/150	XS250NJ/160	XH250NJ/160		
100	139	XE225NC/225	XS250NJ/250	XH250NJ/250	XS400SE/250	XH400SE/250
150	209		XS400CJ/400	XS400NJ/400	XS400SE/400	XH400SE/400
200	278		XS400CJ/400	XS400NJ/400	XS400SE/400	XH400SE/400
300	417		XS630CJ/630	XS630NJ/630	XS630SE/630	XH630SE/630
400	556	XS800NJ/800	XS800SE/800	XH800SE/800		
500	696	XS1250SE/1250				
600	835	XS1250SE/1250				
800	1113	XS1600SE/1600				
1000	1391	XS2000SE/2000				

Note: [1]) Select applicable short circuit rating required by system specifications.
[2]) TemBreak *Plus* MCCBs can also be used.

MCCB use in high frequency (400Hz) applications

General

Terasaki TemBreak MCCB's are designed to operate primarily in 50 or 60Hz systems. However, it is possible to use the same MCCB's in high frequency (400Hz) applications provided consideration is taken to the effects high frequencies will have on the breaker.

A consequence of high frequencies is an increase in Eddy currents in conductors, including those internal to the breakers. This generally causes an increase of temperature in and around the breaker. As such, some derating allowances must be made when selecting a breaker in these 400Hz systems.

Thermal Magnetic MCCB's

In low overload (thermal) regions the current required to trip the MCCB is reduced as a result of the heat generated due to the higher Eddy currents. As a result the thermal protection must be derated to take the heating effect into account.

In short-circuit (magnetic) regions, the demagnetising effects of the Eddy currents mean that a larger fault will be required to trip the breaker. The rule of thumb generally used is that the Magnetic/Instantaneous Trip setting will be approximately twice that at normal 50/60 Hz operation.

Electronic MCCB's

Electronic MCCB's offer better performance at higher frequencies, although some consideration must be taken with regards to the heating effects caused by the Eddy currents. The figures in the table give the maximum Over Current Relay (OCR) rated current setting (I_0 x I_1) that should be used when in high frequency applications.

MCCB Model	MCCB Type	Rating at 50/60Hz (A)	Cable size in mm^2 as specified IEC 947-1	MCCB rating at 400Hz (A)
XS125CJ	Th/Mag	20	2.5	18
XS125NJ		32	6	30
		50	10	45
		63	16	58
		100	35	89
		125	50	110
XH160PJ	Th/Mag	160	70	147
XE225NC	Th/Mag	125	50	116
		150	50	135
		175	70	155
		200	95	185
		225	95	195
XS250NJ	Th/Mag	160	70	147
		250	120	210
XH250NJ	Th/Mag	160	70	147
		250	120	210
XH250PJ	Th/Mag	250	120	240
XS400NJ	Th/Mag	250	120	240
XH400PJ		400	240	330
XS630CJ	Th/Mag	400	240	320
XS630NJ		630	2 x 185	475
XS800NJ	Th/Mag	800	2 x 240	600
XS400SE	Electronic	250	120	238
XH400NE/SE/PE	Electronic	400	240	360
XS630SE	Electronic	630	2 x 185	600
XH630NE/SE/PE				
XS800SE	Electronic	800	2 x 240	640
XH800NE/SE/PE				
XS1250SE	Electronic	1250	2 x (80 x 5t)	800
XS1600SE	Electronic	1600	2 x (100 x 5t)	900

Note: When used at 400Hz, the rated current setting of the OCR must not exceed the values shown in Column 4.

TERASAKI

Application data

NHP

Circuit breaker selection for DC applications

The characteristics of an MCB or MCCB for DC applications are different from AC. The main differences are as follows:

1. Maximum permissible voltage is reduced in value (refer table).
2. Number of electrical operations is reduced (refer table).
3. Magnetic trip current increases by 40%.

Selecting the circuit breaker

When selecting the MCB most suitable for the protection of DC circuits the following criteria must be considered:

- Rated current.
- Rated voltage which determines the number of poles required to be involved in the interruption of the circuit.
- The type of DC system used.
- Maximum short circuit current to determine the breaking capacity.

As a general rule the Isc (short circuit current at the battery terminals) can be calculated as follows:

$$Isc = \frac{Vb}{Ri}$$

Where Vb – maximum discharge battery voltage

Where Ri – internal resistance (sum of all calls resistance) generally expressed in Ampere/hour capacity of the battery.

Terasaki MCB use in DC systems

MCB type	Breaking capacity kA [1])	No. of poles connected in series 24/48V	110V DC	125V DC	250V DC	No. of operations at In	Magnetic trip increase
Din-T6	6	1 pole	2 pole	-	-	4000	40%
Din-T10	10	1 pole	2 pole	-	-	4000	40%
Din-T10H	10	1 pole	2 pole	-	4 pole	4000	40%
Din-T15	10	1 pole	2 pole	-	-	4000	40%
Safe-T	5	-	-	2 pole	-	-	40%

Example: For a Din-T10 to break 10kA at 110V DC it must have 2 poles connected in series.

Breaking capacities of TemBreak MCCB in DC systems

MCCB type	24/48/60V	125V	250V	350V	500V	600V
XS125NJ	25	20	15	10	7.5 [2])	5 [2])
XH125NJ	50	40	40	10	7.5 [2])	5 [2])
XS250NJ	25	40	40	10	7.5	5
XH250NJ	50	40	40	20	15	10
XS400NJ	50	40	40	20	15	15
XS630NJ	50	40	40	30	20	20
XS800NJ	50	40	40	30	20	20
XS1000ND [3])	-	40	40	30	20	20
XS1250ND [3])	-	40	40	30	20	20
XS1600ND [3])	-	40	40	30	20	20
XS2000ND [3])	-	40	40	30	20	20
XS2500ND [3])	-	40	40	30	20	20

Notes:

[1]) Time constant (L/R) <= 15ms; excludes 50/63A where the time constant (L/R) <= 4ms.

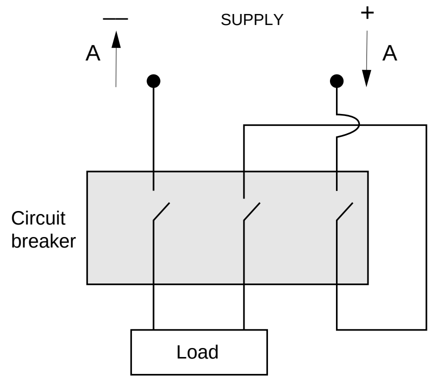
[2]) Special version of the standard AC circuit breaker. Standard circuit breakers cannot be used at these ratings. Please specify for use on 500 or 600V DC on application. **Indent only.**

[3]) Magnetic trip only, without overload protection. **Indent only.**

For voltage levels up to and including 250V DC standard 2-pole breakers maybe be used, with both poles connected in series.
For voltage levels greater than 250V DC 3-pole breakers must be used, with all three poles connected in series as shown.
The time constant (L/R) of the circuit should be:

less than 2ms at rated current.
less than 2.5ms for overload (2.5 x in).
less than 7ms for short circuit ≤ 10kA.
less than 15ms for short circuit > 10kA.

The following connection diagram should be applied to TemBreak circuit breakers when the voltage is greater than 250V DC.



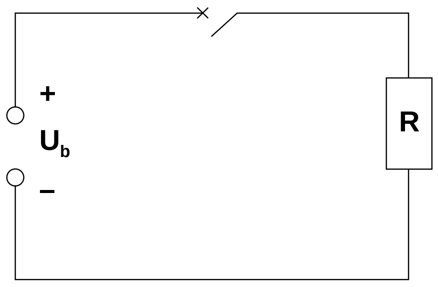
Application data

Circuit breaker selection for DC application (cont.)

Arrangement of breaking poles according to type of system.

Both poles insulated from earth

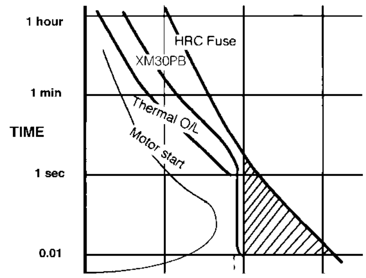
Protection only



The poles required to interrupt the fault can be divided between the (+) and (-) polarities. The total number of poles connected in series should be capable of breaking the short circuit current at a voltage level of U_b.

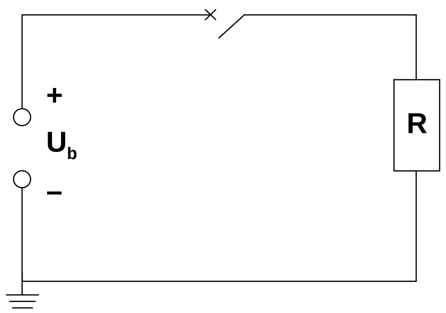
Sharing the circuit breaker interrupting poles between both polarities also ensures isolation as well as protection of the system.

Protection and Isolation



One polarity of the DC supply is earthed

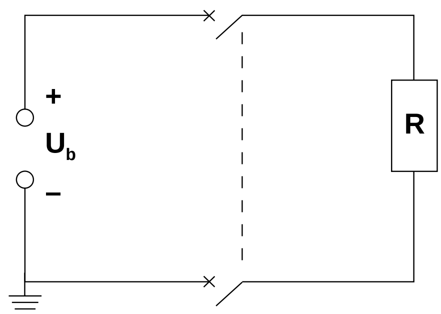
Protection only



Full protection is assured if the total number of poles in series on the side **not** connected to earth are capable of breaking the short circuit current at a voltage level of U_b.

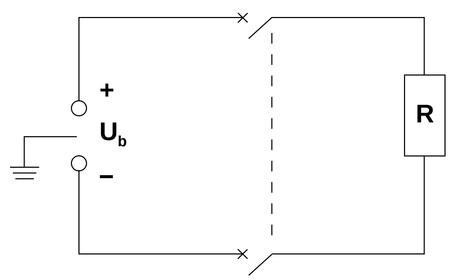
If full isolation is required then at least one interrupting pole is also required on the earthed polarity side.

Protection and Isolation



Protection and Isolation

The centre point of the DC supply is earthed



To ensure full protection the number of poles connected in series on each polarity must be capable of breaking the maximum short circuit current, but at a reduced voltage level of $U_b/2$.

Having circuit breaker interrupting poles breaking both polarities ensures isolation as well as protection of the system.

Selection of MCCB's for use in welder circuits

1. Definitions

P = Rated capacity of welder in kVA.

V = Welder rated voltage.

I1 = Maximum primary current (P/V).

T_1 = Current 'ON' period.

T_2 = Current 'OFF' period.

$T_1 + T_2$ = One welding cycle time.

B = Duty ratio, current 'ON' period divided by one welding cycle.

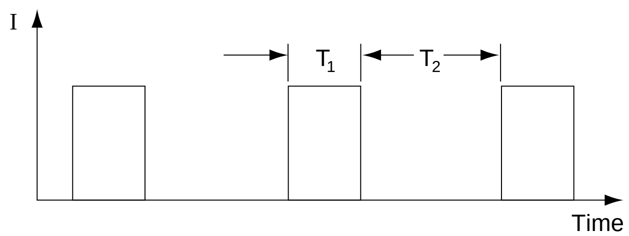
Ie = Thermally equivalent continuous current.

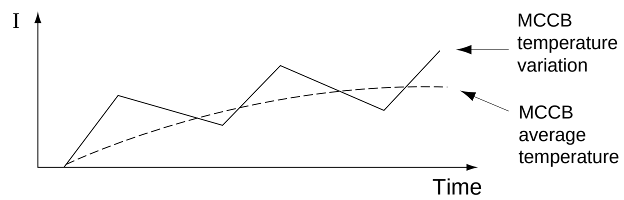
2. MCCB selection

a) Current rating

It can be seen from the diagrams below that the welder only draws current intermittently. MCCB selection should be based on the thermally equivalent continuous current, i.e. the current which would produce the MCCB average temperature shown in the diagram below.

It can further be seen that the MCCB temperature will not be constant but will vary as the load varies.



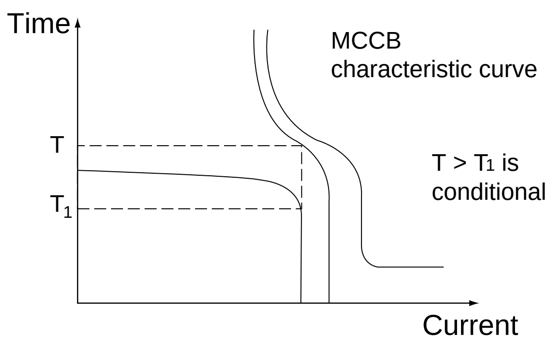


The thermally equivalent continuous current, Ie, may be calculated from:

$$Ie = \frac{P \times 1000}{V} \times \sqrt{B} \qquad \left(B = \frac{T_1}{T_1 + T_2}\right)$$

Note: The rated capacity of a spot welder is normally expressed in terms of its 50% duty ratio, ie. B = 0.5.

Once an MCCB has been selected, it is necessary, to compare the maximum primary current I_1 and the current 'ON' period, T_1 with the MCCB characteristic curve to ensure that it will not trip.



Note: A tolerance of 10 to 15% should be included to allow for variations in the supply voltage and equipment.

General guide lines for MCCB selection

Selection factor	MCCB rating
Resistance welders	3.00 max
Transformer arc welders	2.00 max

SAA wiring rules states that a circuit breaker protecting a circuit from which one or more welders are supplied may be greater than the rating of the protected conductor calculated as follows:

The maximum demand of the circuit excluding that of the largest welding machine plus

i) Three times the primary current of the largest resistance welding.

ii) Two times the primary ratings of the largest transformer arc welders.

Selection of MCCB's for use in welder circuits

b) Instantaneous setting

The MCCB's instantaneous trip setting should be high enough to avoid nuisance tripping due to the welding transformers excitation inrush current. When voltage is supplied to the transformers primary side, the iron core is saturated. This results in the flow of a large inrush current caused by a combination of the DC component of the voltage at the instant of closing and the residual magnetic flux of the transformer. The transformer input current value when the welder secondary is completely short-circuited is about 30% higher than the value calculated from the nominal maximum power input of the welder. So the maximum welder input current, Im, at the start of welding is given by:

$$I_m = \frac{P_m \times 1000}{V} \times 1.3 \times K$$

The value of K varies depending on the type of welder control employed. (Some form of synchronous closing is nearly always employed in order to stabilise the welding work and to prevent nuisance tripping of the MCCB).

K = 1 to 1.5 for synchronous type with peak control.

K = 1.4 to 3 for synchronous type without peak control.

K = 2 to 6 for non-synchronous soft start type.

If the protection of the thyristor stack is also required, the instantaneous trip setting must be greater than I_m, but less than the surge on-state current rating of the thyristor stack:

$$I_m < I_{INST} < \frac{I_s}{1.1}$$

where:

Is = surge on-state current rating of thyristor stack, in A

Im = maximum welder input current at start of welding, in A

I_{INST} = MCCB Instantaneous trip setting, in A

1.1 = Factor to allow for ± 10% tolerance on the instantaneous setting

c) MCCB breaking capacity

The MCCB breaking capacity should be higher than the estimated short-circuit fault level of the system.

Application data

Primary LV/LV transformer protection

When selecting an MCCB to protect the primary of an LV/LV transformer, the inrush current during initial energisation must be taken into account.

The magnitude of inrush current for any transformer is governed by several variables:

1. The primary winding resistance.
2. The supply impedance.
3. The excitation current.

The excitation current is, in theory at a maximum when the voltage is at a minimum, and vice versa.

Usually the level does not exceed 30 times the normal operating current.

If the inrush current is not known then a rule of thumb is that it is approximately 15 x the Primary Current.

	1 phase 240V			3 phase 415V		
Transformer (kVA)	**MCCB type**	**MCCB rating**	**BC (kA) at 240V**	**MCCB type**	**MCCB rating**	**BC (kA) at 415V**
5	XS125NS	50	25	XS125NJ	20	30
7.5	XS125NS	63	25	XS125NJ	32	30
10	XS125NS	100	25	XS125NJ	32	30
15	XE225NC	125	25	XS125NJ	50	30
	XS250NJ	160	50			
	XH250NJ	160	85			
20	XS250NJ	160	50	XS125NJ	63	30
	XH250NJ	160	85			
30				XS125NJ	100	30
50				XS125NJ	125	30
75				XE225NC	225	18
				XS250NJ	250	35
100				XS400SE	250	50
150				XS400SE	250	50
200				XS400SE	400	50
300				XS630SE	630	50

The above breaker selections are based upon inrush currents calculated using the table below

	Single-phase transformer		Three-phase transformer	
(kVA)	**First peak multiplier**	**Decay time constant**	**First peak multiplier**	**Decay time constant**
5 - 10	34	3 - 6	32	3 - 6
15 - 20	33	3 - 6	30	3 - 6
30	-	-	26	3 - 6
50	-	-	24	4 - 7
75	-	-	20	4 - 7
100	-	-	18	6 - 10
150	-	-	16	6 - 10
200	-	-	14	6 - 10
300	-	-	12	6 - 10

Notes: First peak multiplier is the first peak current as a multiple of the transformer rated current.
The above table/multipliers are in general larger than the practical current levels, as the current limiting by the circuit impedance is not taken into account.

MCB selection for high pressure sodium lamps

Assumption

1. The maximum inrush current which the circuit will pass is a feature of the current limiting ballast and not the lamp.
   Assuming these ballasts comply with the relevant IEC specification the circuit will pass currents not exceeding twice the appropriate lamp nominal current.
2. Run up time 10 minutes with the current decaying exponentially.
3. Based on 415/240V 3 phase or 240V single phase systems.

This table provides details for Din-T type 'C' MCB's

Power	Number of fittings per phase									
50W	2	4	7	9	12	24	36	48	60	76	108
70W	1	3	5	6	8	17	25	34	42	54	77
150W	-	1	2	3	4	8	12	16	20	25	36
250W	-	-	1	1	2	4	0.7	9	12	15	21
400W	-	-	-	1	1	3	4	6	7	9	13
700W	-	-	-	-	-	1	2	3	4	5	7
MCB (Amps)	**1**	**2**	**4**	**4**	**6**	**10**	**16**	**20**	**25**	**32**	**50**

Example

Given 42 lamps each 250W installed on a 415V 3 phase system.

Which MCB must be selected?

Number of tubes per phase = $\frac{42}{3}$ =14

Therefore from the table above a 32A MCB should be selected.

A short circuit rating as appropriate must be selected.

Notes: Observe the requirements of AS 3000 for No. of lighting points on a final sub-circuit.

MCB selection for fluorescent lighting loads

Assumptions

1. The power rating of the ballast is 25% of power of the tubes.
2. Power factor - 0.6 for non compensated fittings 0.86 for compensated fittings.
3. MCB's are installed in an enclosure with external ambient of 25°C.
4. Based on 415/240V 3 phase or 240V single phase systems.
5. MCB is used for circuit protection only, not switching.

   For switching duties of Din-T MCBs refer NHP.

This table provides details for Din-T type 'C' MCB's

Type of fitting	Power (W)	Number of fittings per phase					
Single non compensated	20	45	66	79	100	116	150
	40	22	33	39	50	57	75
	65	14	20	24	30	36	50
	80	11	16	20	25	29	40
Single compensated	20	64	94	113	143	166	200
	40	32	47	57	72	83	110
	65	20	29	35	44	51	70
	80	16	23	28	36	41	55
Twin compensated	2 x 20	32	47	57	72	83	110
	2 x 40	16	23	28	36	41	55
	2 x 65	10	14	17	22	25	35
	2 x 80	8	11	14	17	20	30
Recommended MCB rating	Amps	**10**	**16**	**20**	**25**	**32**	**50**

MCB selection for incandescent lighting loads

Assumptions

1) Tungsten lamps have theoretical inrush current of 14 times normal current, when switched from cold.
2) The circuit impedance typically limits the inrush to 10 times normal running current, the inrush current peaking at 0.0007 seconds falling exponentially to normal running current within 0.1 seconds.
3) Consider the worst case, if all lamps are switched on simultaneously, then nuisance tripping of MCB may result.
4) Above is based on 415/240V 3 phase and neutral or 240V single phase system and 240V lamps.
5) MCB is used for circuit protection only, not switching. For switching duties of Din-T MCB's refer NHP.

Method

In order to cope with this inrush the following formula should be used to calculate breaker size:

$$\text{Breaker rating} = \frac{W \times 10}{P \times 240 \times I\ inst}$$

Where W = total wattage
Where P = Number of phases
I inst = Minimum instantaneous tripping co-efficient.
C curve = 5
D curve = 10

Notes: Observe the requirements of AS 3000 for No. of lighting points on a final sub-circuit.

TemBreak MCCB clearance requirements at 380/415V

Clearance requirements for MCCB's (phase to phase and earth).

When MCCB's are called upon to interrupt large short circuits ionised gas and arcing material is expelled from the vents, usually at the top of the MCCB.

This ionised gas is highly conductive and is also at an elevated temperature when it exits the MCCB via the arc vents. Care must be taken therefore to avoid an arcing fault occurring due to the presence of the ionised gas.

Therefore, incoming conductors must be insulated right up to the terminal opening of the MCCB. This also applies to the attached busbars supplied as a proprietory part with the MCCB.

Proprietary type interpole barriers may be used to achieve creepage and clearance requirements.

Conductors must not impede the flow of ionised gas.

Insulating distance from Line-End for 380/415V

When earth metal is installed within the proximity of the breakers the correct insulating distance must be maintained.

WARNING:
EXPOSED CONDUCTORS INCLUDING TERMINALS AT ATTACHED BUSBARS MUST BE INSULATED TO AVOID POSSIBLE SHORT CIRCUITING OR EARTHING DUE TO FOREIGN MATTER COMING INTO CONTACT WITH THE CONDUCTORS.

Notes: When using the terminal bar (optional), the specified insulating distance must be maintained.
All dimensions in mm.

When earthed metal is installed within the proximity of the breakers the correct insulating distance must be maintained (refer to Table 1). This distance is necessary to allow the exhausted arc gases to disperse.

This distance is necessary to allow the exhausted arc gases to disperse.

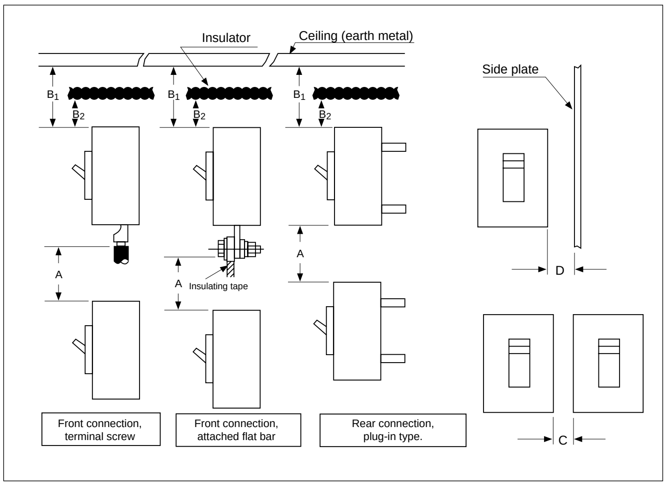


Table 1 below illustrates the min clearance that must be maintained

A Distance from lower breaker to open charging part of terminal on upper breaker (front connection) or the distance from lower breaker to upper breaker end (rear connection and plug-in type)

B1 Distance from breaker end to ceiling (earthed metal)

B2 Distance from breaker end to insulator

C Clearance between breakers

D Distance from breaker side to side plate (earthed metal)

Table 1
This table is valid for 380/415V

MCCB type	A	B1	B2	C	D
XM30PB	30	10	10	0	25
XS125CJ, XS125NJ, XH125NJ, XH125PJ	75	45	25	0	25
XE225NC	50	40	40	0	50
XS250NJ	80	60	30	0	25
XH160PJ, XH250NJ	100	60	30	0	25
XH250PJ, XS400CJ, XS400NJ, XS400SE	100	70	40	0	30
XH400SE, XS630CJ, XS630NJ, XS630SE, XS800NJ, XS800SE	120	70	40	0	30
XH630SE, XH800SE, XH800PE	150	80	50	0	40
XS1250SE	150	70	40	0	30
XH630PJ, XH800PJ, XS1600NE, XS2000NE, XS2500NE	150	150	100	0	100

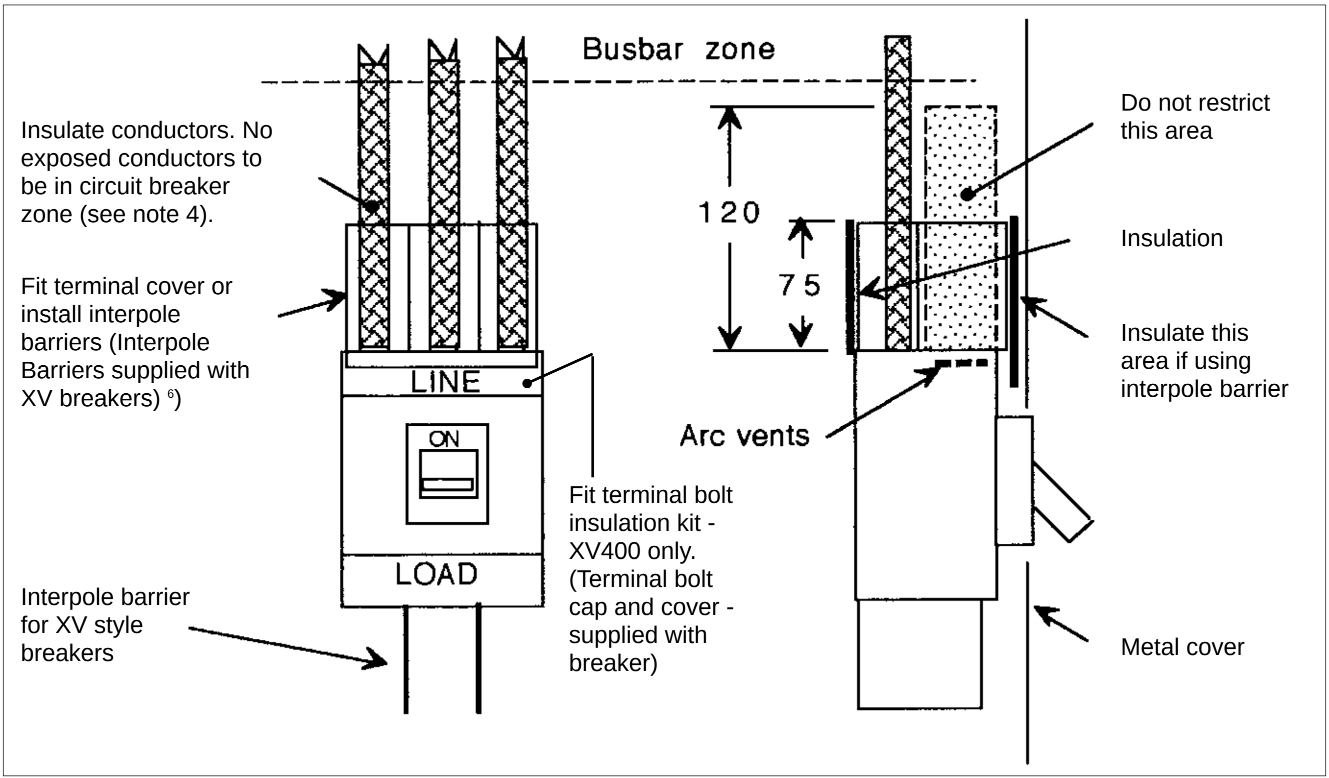
Clearance for mining MCCB's (1100 V) and incoming connections

The arc chamber in Terasaki TemBreak circuit breakers is located adjacent to the LINE side terminals. The chamber is vented through holes located just above each line terminal. The holes are covered by a flap which deflects when arc gases are being expelled. Even at low fault levels the arc gases that are released are very hot and reduce the dielectric strength of the air in the vicinity of the terminals. If care is not taken when installing the TemBreak this gas can cause arcing faults on the incoming bars or cables.

Significant voltage transients may also be produced as inductive circuits are switched and contribute to an arcing fault.

These problems affect all circuit breaker installations to varying degrees.

To ensure that problems are not created by the installation please observe the following recommendations.



Notes:

1: Always observe LINE/LOAD marking.

2: Ensure insulation on incoming conductors is adequate. Do not use low grade heat shrink (some grades split at operating temperatures).

3: Minimum clearance to earth metal,
Above and below breaker - 120mm (XV1250NE - 150mm)
To sides of breaker - 40mm.

4: Switchboard construction to be a minimum form 2 to AS 3439.1 with IP3x protection between busbar and circuit break zones.

5: Actual construction can vary to the above but in all cases it is the responsibility of the switchboard manufacturer to ensure compliance to the relevant standard ie. AS 3439.1.

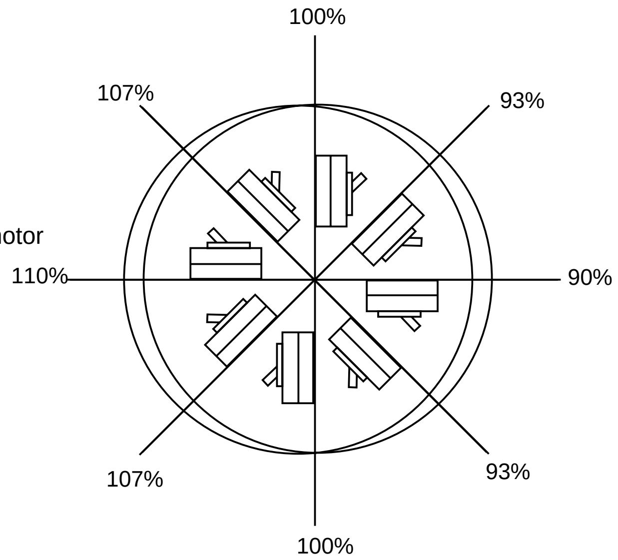
[6]) TL100EM MCCB's must use a TL100EMTLC lineside terminal cover. XV400 can use either a terminal cover or Interpole Barriers.

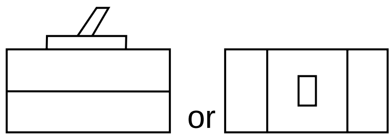
MCCB mounting angles

The overcurrent tripping characteristics of TemBreak are not influenced by the mounting angles for electronic and thermal magnetic types.

The XM30PB motor circuit protectors however, use an oil filled dashpot style trip mechanism, which can be affected. Refer to the diagram below.

Diagram at right is only applicable to XM30PB motor circuit protectors.





Note:
1: The above diagram applies to an XM30 MCCB mounted either way

Calculation of circuit fault level

NHP Nomogram

Fault calculation

The NHP Nomogram is a simple and easy to use aid. Developed by NHP to enable convenient and accurate calculation of circuit fault current.

When selecting circuit breakers for the use in modern distribution systems, it is important to calculate the fault level and then choose an MCCB with breaking capacity that is either higher or at least equal to the circuit fault current.

How to use the Nomogram

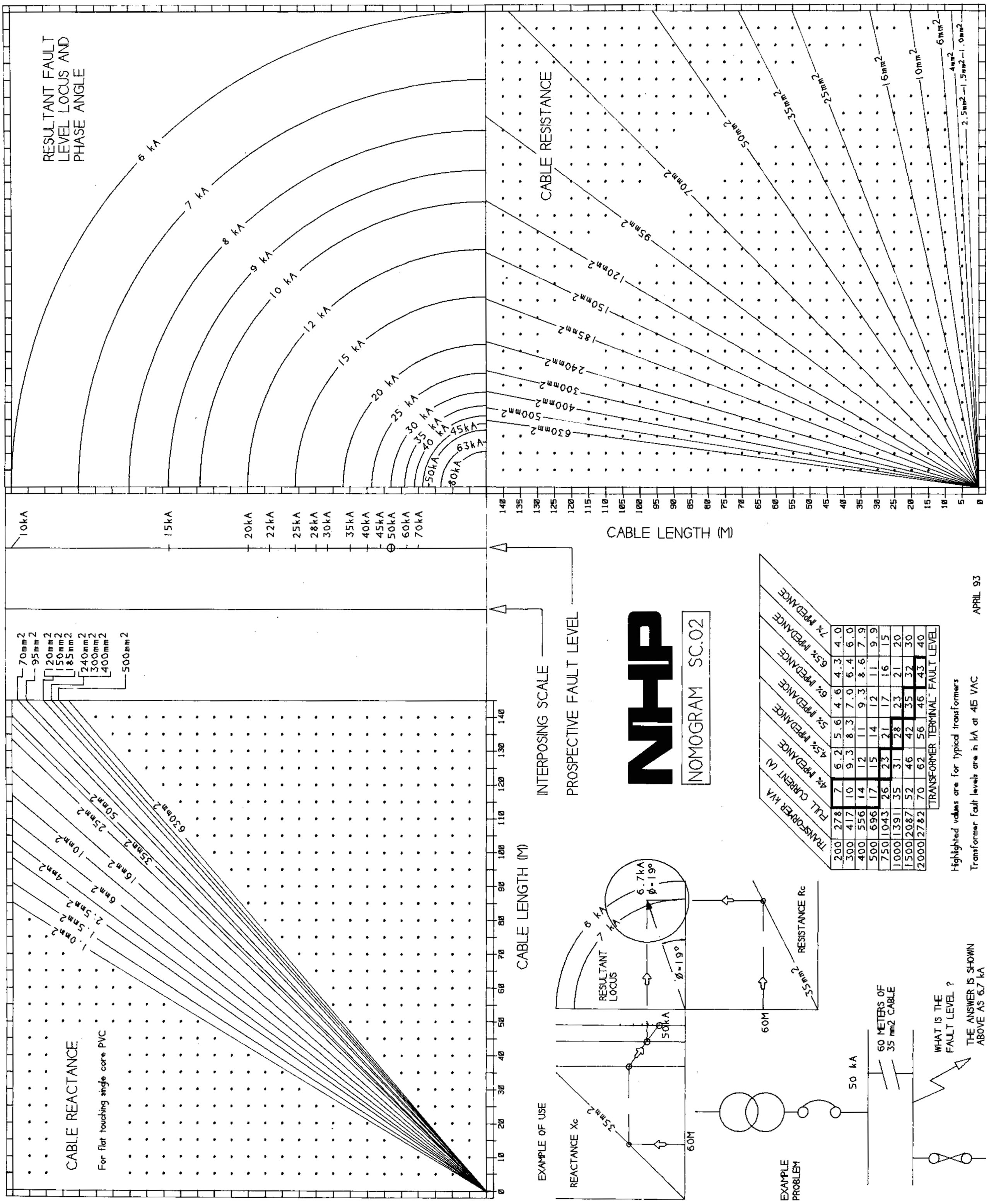
In the nomogram all you need to know is the size and length of the cable or cables and the size of the Transformer in kVA. The fault level at the terminals of the transformer is very dependant upon the Transformer internal impedance eg. the Australian Standard for a 2000kVA transformer is 6.5% – 7% impedance. This results in a fault level of 40-43kA.

However, many Supply Authorities are now installing low impedance transformer eg. 5% or less. Thus if the impedance is 5% then the fault level will be 56kA. If the impedance is unknown on the side of caution choose Z = 5% in your calculations.

eg. From the table, the maximum fault level of a 2000kVA transformer, with Z = 5% is 56kA. Proceed then to calculate the resultant fault level by applying the cable size and length in metres to the Transformer secondary fault level and calculate the resultant. By following the example shown it can be seen that the fault level is reduced from 50kA to 6.7kA.

Short circuit calculation nomogram

Please refer to previous page for instructions on use.

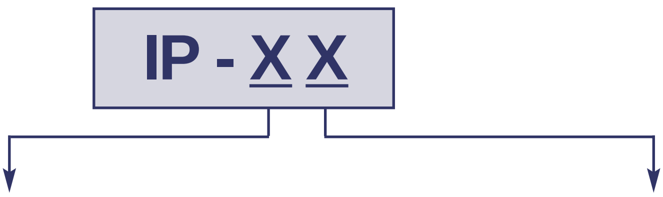


Application notes

A series of application notes are available on Terasaki breakers from your nearest NHP branch. The notes cover the following subjects.

Ref No.	Description
5006	Specification for corrosive proofing of MCCB's
5025	De-rated current of ACB's when enclosed
5093	De-rated current of MCCB's when enclosed
5088	De-rating of TemBreak electronic MCCB's when enclosed
5067	DC applications of ACB's
5065	Reverse connection
5074	Thyristor protection with MCCB's
5078	ELCB's at high frequency
5087	ACB's and MCCB's at high altitude
5083	Circuit breaker life mechanical and electrical
5086	TemBreak UVT: transient response time
5195	Inspection and maintenance of earth leakage and moulded case circuit breakers.

IP rating protection against ingress of dust and liquids



IP	1st digit Degree of protection against contact and ingress of foreign bodies	IP	2nd digit Degree of protection against ingress of liquids
0	No protection	0	No protection
1	Protection against ingress of solid foreign bodies with diameters greater than 50mm	1	Protection against vertically falling water drops
2	Protection against contact with the fingers, protection against ingress of solid foreign bodies with diameter greater than 12mm	2	Protection against obliquely falling water, up to an angle of 15°
3	Protection against contact with wires etc., with diameters greater than 2.5mm, or ingress of solid foreign bodies with diameters greater than 2.5mm	3	Protection against obliquely sprayed water, up to an angle of 60° from the vertical
4	Protection against contact with wires etc., with diameter greater than 1mm, or ingress of solid foreign bodies with diameters greater than 1mm	4	Protection against sprayed low pressure water from any direction
5	Complete protection against contact with live parts, protection against harmful deposits of dust	5	Protection against water-jets from any direction - limited ingress permitted
6	Complete protection against contact with live parts, protection against ingress of dust	6	Protection against strong jets of water eg. ship decks
		7	Protection against temporary immersion in water
		8	Protection against indefinite immersion in water - under pressure

TERASAKI Innovators in Protection Technology TemBreak 2 **MCCB's**

NHP

Accessories to suit 125 - 630AF MCCBs

External accessories — Cat. No.

Door interlocking, variable depth **Suits MCCB types**

E125, S125

IP54 rated	
Grey/black	T2HP12R5BNA4
Grey/black c/w key lock	T2HP12R5BKA4
Red/yellow	T2HP12R5RNA4
Red/yellow c/w key lock	T2HP12R5RKA4
IP65 rated	
Grey/black	T2HP12R6BNA4
Grey/black c/w key lock	T2HP12R6BKA4
Red/yellow	T2HP12R6RNA4
Red/yellow c/w key lock	T2HP12R6RKA4

H125, L125, S160, H160, L160, E250, S250, H250, L250

IP54 rated	
Grey/black	T2HP25R5BNA4
Grey/black c/w key lock	T2HP25R5BKA4
Red/yellow	T2HP25R5RNA4
Red/yellow c/w key lock	T2HP25R5RKA4
IP65 rated	
Grey/black	T2HP25R6BNA4
Grey/black c/w key lock	T2HP25R6BKA4
Red/yellow	T2HP25R6RNA4
Red/yellow c/w key lock	T2HP25R6RKA4

Note: Handles supplied with shaft

ACCESSORIES

OPERATING HANDLES & LOCKING DEVICES

TemBreak 2 handles are extremely reliable, having been designed to endure the same switching duty as the host MCCB.

It is easy to fit the operating unit to the MCCB. Fitting involves three easy steps:

1. Align breaker toggle with operating mechanism
2. Push handle into position (the handle's round pegs locate securely in the breaker's round holes and the handle's* square pegs in the breaker's square holes).
3. Twist locking screws through 45 degrees.*

Safety Features

- Door interlock mechanism with override facility included as standard
- IP54 (door mounted version), IP 54 as standard (breaker mounted version)
- IP65 (door mounted version), IP 65 optional (breaker mounted version)
- Locks OFF with up to 3 padlocks (8mm hasps)
- Optional keylock in OFF position
- Available in black or red and yellow
- A trip test can be performed with the handle fitted to the MCCB

Orientation

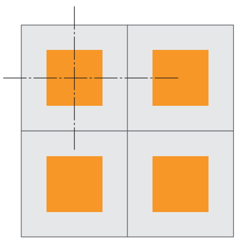
To switch the breaker from OFF to ON the handle is rotated through 90 degrees in a clockwise direction.

The ON (I) and OFF (O) indication of the handle can be re-oriented in steps of 90 degrees with respect to the operating mechanism. This allows the indication position to remain the same whether the breaker is mounted vertically (right side up or upside down) or horizontally (on its left side or on its right side). The hole cut-out dimensions for a panel or door will remain unchanged if the handle is re-oriented. The handle's axis of rotation is on the intersection of the centre lines of a 3P MCCB. This means that the positioning of the door cutouts is symmetrical for breakers mounted horizontally on either side of a vertical busbar system.

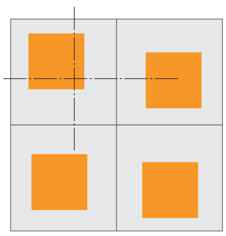
MCCB ON

MCCB ON

Cubicle Door Cutouts



Using TemBreak 2 Operating Handles



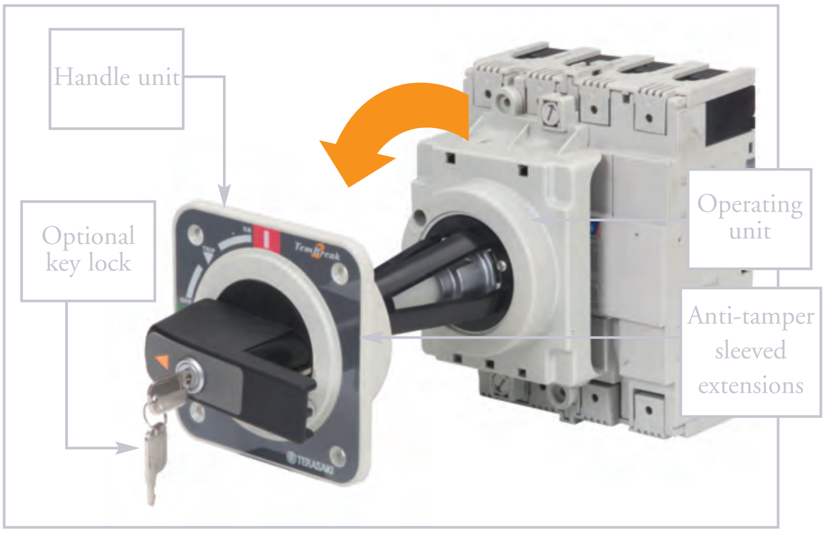
Using other MCCB Operating Handles

*handles for 400A and 630A Frame models are secured with four screws.

ACCESSORIES

OPERATING HANDLES & LOCKING DEVICES

Door Mounted Handle (HP)



Door Mounted Handle with Optional Keylock

The door mounted operating handle is used to operate a circuit breaker mounted inside a cubicle from outside the door. It consists of an operating mechanism that is mounted on the breaker, an operating handle that is mounted on the door, and a shaft that transmits the turning force from the handle to the operating unit. The shaft can be cut to the required length.

Breaker Mounted Handle (HB)

Breaker Mounted Handle Padlocked in the OFF Position

This handle is used to operate a circuit breaker mounted just behind a compartment door with the door closed. The operating unit and the handle itself are mounted directly onto the circuit breaker. The handle protrudes through a cutout in the door. A moulded door flange is supplied with the handle which covers the cutout from the front.

Padlocking and keylocking is possible in the OFF position or both the ON and OFF position depending on the mounting direction.

Locking Devices

Toggle locking devices allow MCCBs to be locked ON or OFF using up to three padlocks. Locking devices for 125A, 160A and 250A frame models accept padlocks with 5mm hasp diameter. Locking devices for 400A and 630A frame models accept padlocks with 8mm hasp diameter.

S250 Locked OFF

S400 Locked OFF

Fittings for Castell and Fortress locks are available. They are suitable for use on toggle-operated MCCBs, or on door mounted handles (HP) for MCCBs.

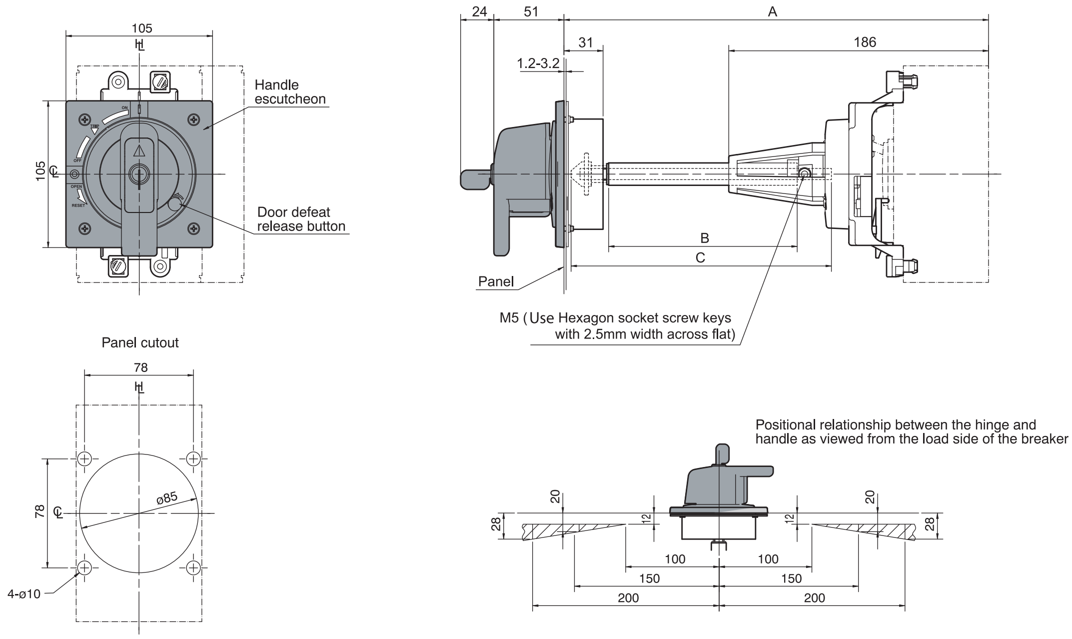
SECTION 5

DIMENSIONS

Door Mounted Handle

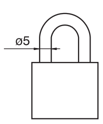
Applicable MCCB	A ⁎1	B	C	Shaft support
E125 S125	540 max.	370	421	With +

⁎1: Max. means the maximum length for A without cutting the shaft.
+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.



ASL: Arrangement Standard Line
H℄ : Handle Frame Centre Line
C℄ : Handle Centre Line

Padlock dimensions (mm)

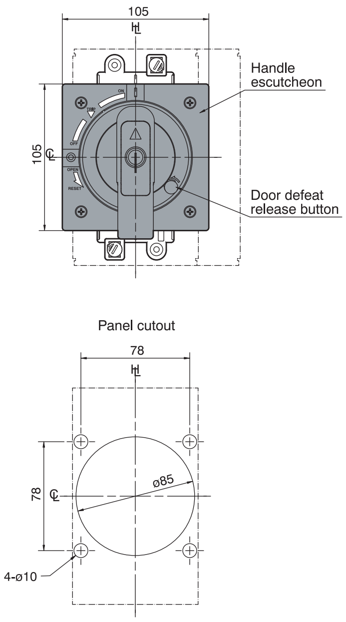


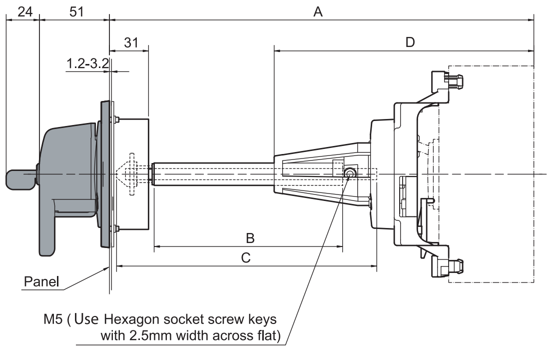
DIMENSIONS

Door Mounted Handle

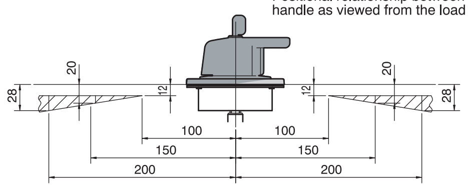
Applicable MCCB	A ⁎1	B	C	D	Shaft support
E250 S250 (except S250-PE)	540 max.	370	421	186	With +
S250-PE H125 L125 H160 L160 H250 L250	575 max.	370	421	221	With +

⁎1: Max. means the maximum length for A without cutting the shaft.
+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.



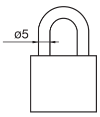


Positional relationship between the hinge and handle as viewed from the load side of the breaker



ASL: Arrangement Standard Line
HL: Handle Frame Centre Line
CL: Handle Centre Line

Padlock dimensions (mm)



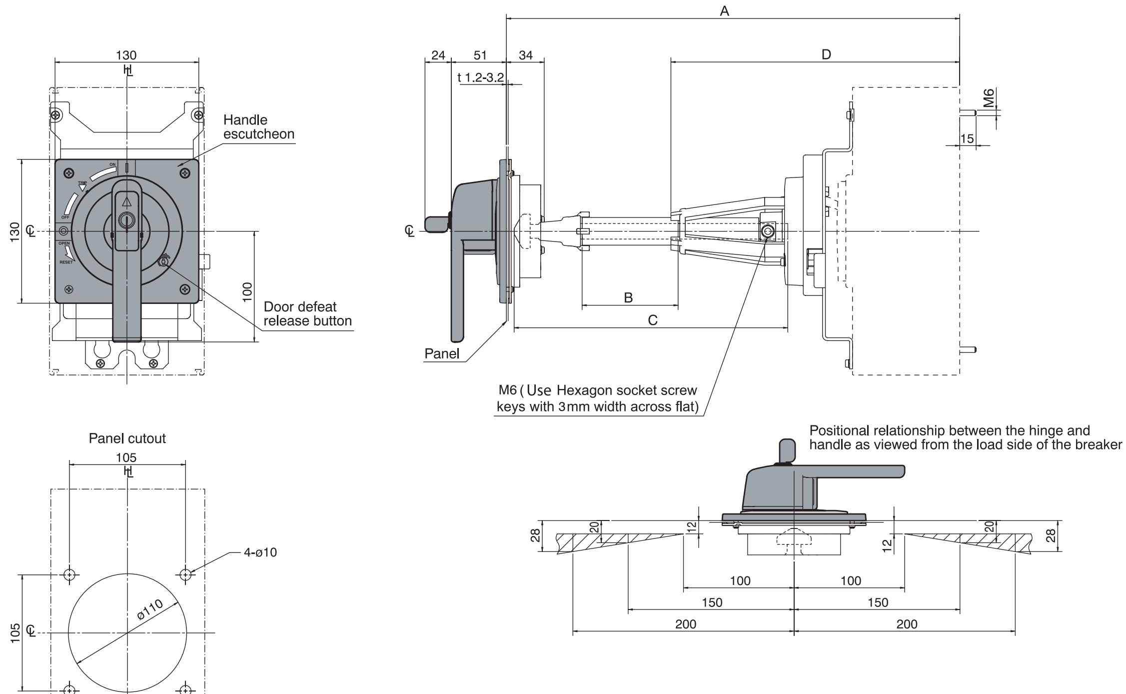
SECTION 7

DIMENSIONS

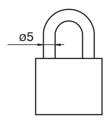
Door Mounted Handle

Applicable MCCB	A ✱1	B	C	D	Shaft support
E400 E630	270 min.	12	107.5	—	Without
S400 S630	610 max.	280	447.5	261	With +
H400	307 min.	12	107.5	—	Without
L400	647 max.	280	447.5	298	With +

✱1: Min. means the minimum length for A by cutting the shaft.
Max. means the maximum length for A without cutting the shaft.
+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.



ASL: Arrangement Standard Line
HL: Handle Frame Centre Line
CL: Handle Centre Line



SECTION 7

Accessories to suit 125 - 630AF MCCBs

External accessories — Cat. No.

Door interlocking, variable depth **Suits MCCB types**

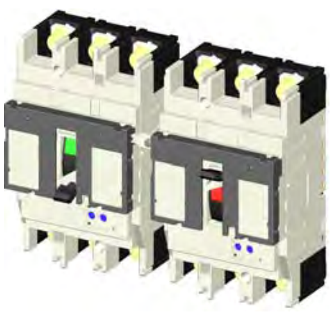
E400, S400, H400, L400, E630, S630

IP54 rated	
Grey/black	**T2HP40R5BNA4**
Grey/black c/w key lock	**T2HP40R5BKA4**
Red/yellow	**T2HP40R5RNA4**
Red/yellow c/w key lock	**T2HP40R5RKA4**
IP65 rated	
Grey/black	**T2HP40R6BNA4**
Grey/black c/w key lock	**T2HP40R6BKA4**
Red/yellow	**T2HP40R6RNA4**
Red/yellow c/w key lock	**T2HP40R6RKA4**

Note: Handles supplied with shaft

Mechanical Interlocks

Link Interlock – suitable for manual or motorised operation. Will accept handles. Suitable for front or rear connection



E125, S125

With trip interlock function	
3 or 4 pole right side section	**T2ML12RA**
3 pole left side section	**T2ML12L3A**
4 pole left side section	**T2ML12L4A**

H125, L125, S160, H160, L160, E250, S250, H250, L250

With trip interlock function	
3 or 4 pole right side section	**T2ML25RA**
3 pole left side section	**T2ML25L3A**
4 pole left side section	**T2ML25L4A**

E400, S400, H400, L400, E630, S630

With trip interlock function	
3 or 4 pole right side section	**T2ML40RA**
3 pole left side section	**T2ML40L3A**
4 pole left side section	**T2ML40L4A**

Refer page 53 if MCCB labels are required or refer to NHP.

ACCESSORIES

OPERATING HANDLES & LOCKING DEVICES

TemBreak 2 handles are extremely reliable, having been designed to endure the same switching duty as the host MCCB.

It is easy to fit the operating unit to the MCCB. Fitting involves three easy steps:

1. Align breaker toggle with operating mechanism
2. Push handle into position (the handle's round pegs locate securely in the breaker's round holes and the handle's* square pegs in the breaker's square holes).
3. Twist locking screws through 45 degrees.*

Safety Features

- Door interlock mechanism with override facility included as standard
- IP54 (door mounted version), IP 54 as standard (breaker mounted version)
- IP65 (door mounted version), IP 65 optional (breaker mounted version)
- Locks OFF with up to 3 padlocks (8mm hasps)
- Optional keylock in OFF position
- Available in black or red and yellow
- A trip test can be performed with the handle fitted to the MCCB

Orientation

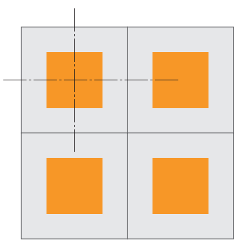
To switch the breaker from OFF to ON the handle is rotated through 90 degrees in a clockwise direction.

The ON (I) and OFF (O) indication of the handle can be re-oriented in steps of 90 degrees with respect to the operating mechanism. This allows the indication position to remain the same whether the breaker is mounted vertically (right side up or upside down) or horizontally (on its left side or on its right side). The hole cut-out dimensions for a panel or door will remain unchanged if the handle is re-oriented. The handle's axis of rotation is on the intersection of the centre lines of a 3P MCCB. This means that the positioning of the door cutouts is symmetrical for breakers mounted horizontally on either side of a vertical busbar system.

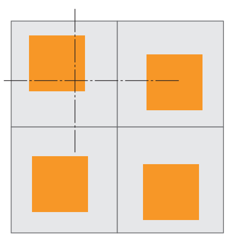
MCCB ON

MCCB ON

Cubicle Door Cutouts



Using TemBreak 2 Operating Handles



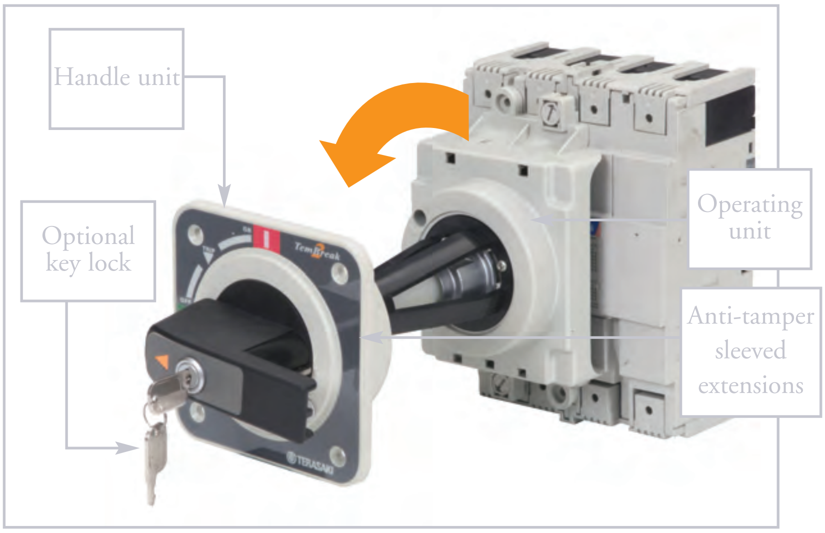
Using other MCCB Operating Handles

*handles for 400A and 630A Frame models are secured with four screws.

ACCESSORIES

OPERATING HANDLES & LOCKING DEVICES

Door Mounted Handle (HP)



Door Mounted Handle with Optional Keylock

The door mounted operating handle is used to operate a circuit breaker mounted inside a cubicle from outside the door. It consists of an operating mechanism that is mounted on the breaker, an operating handle that is mounted on the door, and a shaft that transmits the turning force from the handle to the operating unit. The shaft can be cut to the required length.

Breaker Mounted Handle (HB)

Breaker Mounted Handle Padlocked in the OFF Position

This handle is used to operate a circuit breaker mounted just behind a compartment door with the door closed. The operating unit and the handle itself are mounted directly onto the circuit breaker. The handle protrudes through a cutout in the door. A moulded door flange is supplied with the handle which covers the cutout from the front.

Padlocking and keylocking is possible in the OFF position or both the ON and OFF position depending on the mounting direction.

Locking Devices

Toggle locking devices allow MCCBs to be locked ON or OFF using up to three padlocks. Locking devices for 125A, 160A and 250A frame models accept padlocks with 5mm hasp diameter. Locking devices for 400A and 630A frame models accept padlocks with 8mm hasp diameter.

S250 Locked OFF

S400 Locked OFF

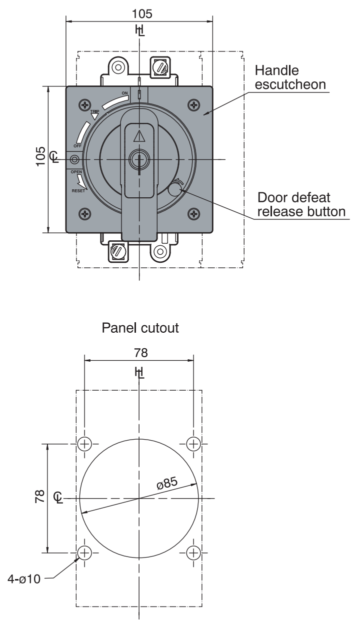
Fittings for Castell and Fortress locks are available. They are suitable for use on toggle-operated MCCBs, or on door mounted handles (HP) for MCCBs.

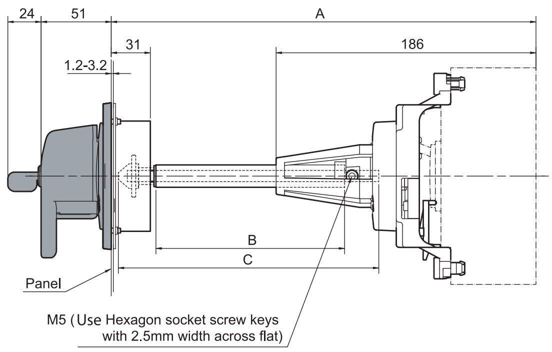
DIMENSIONS

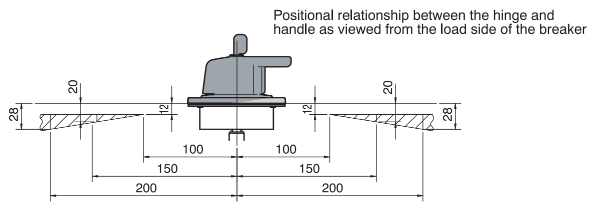
Door Mounted Handle

Applicable MCCB	A ⁎1	B	C	Shaft support
E125 S125	540 max.	370	421	With +

⁎1: Max. means the maximum length for A without cutting the shaft.
+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.

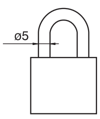






ASL: Arrangement Standard Line
HL : Handle Frame Centre Line
CL : Handle Centre Line

Padlock dimensions (mm)

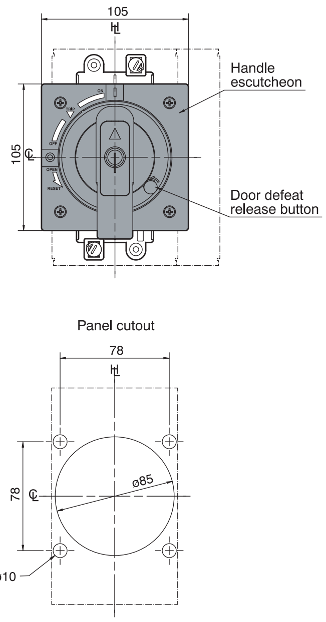


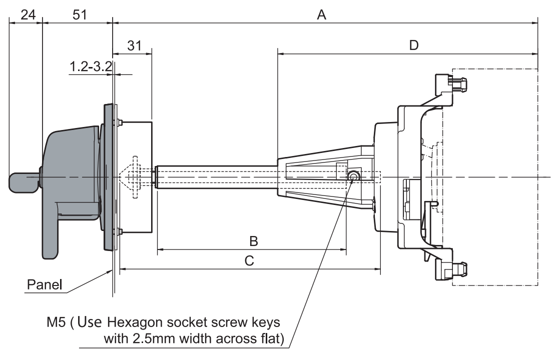
DIMENSIONS

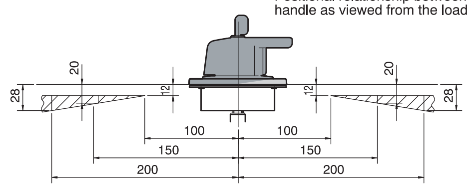
Door Mounted Handle

Applicable MCCB	A ⁎1	B	C	D	Shaft support
E250 S250 (except S250-PE)	540 max.	370	421	186	With +
S250-PE H125 L125 H160 L160 H250 L250	575 max.	370	421	221	With +

⁎1: Max. means the maximum length for A without cutting the shaft.
+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.

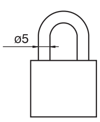






ASL: Arrangement Standard Line
H℄: Handle Frame Centre Line
℄: Handle Centre Line

Padlock dimensions (mm)

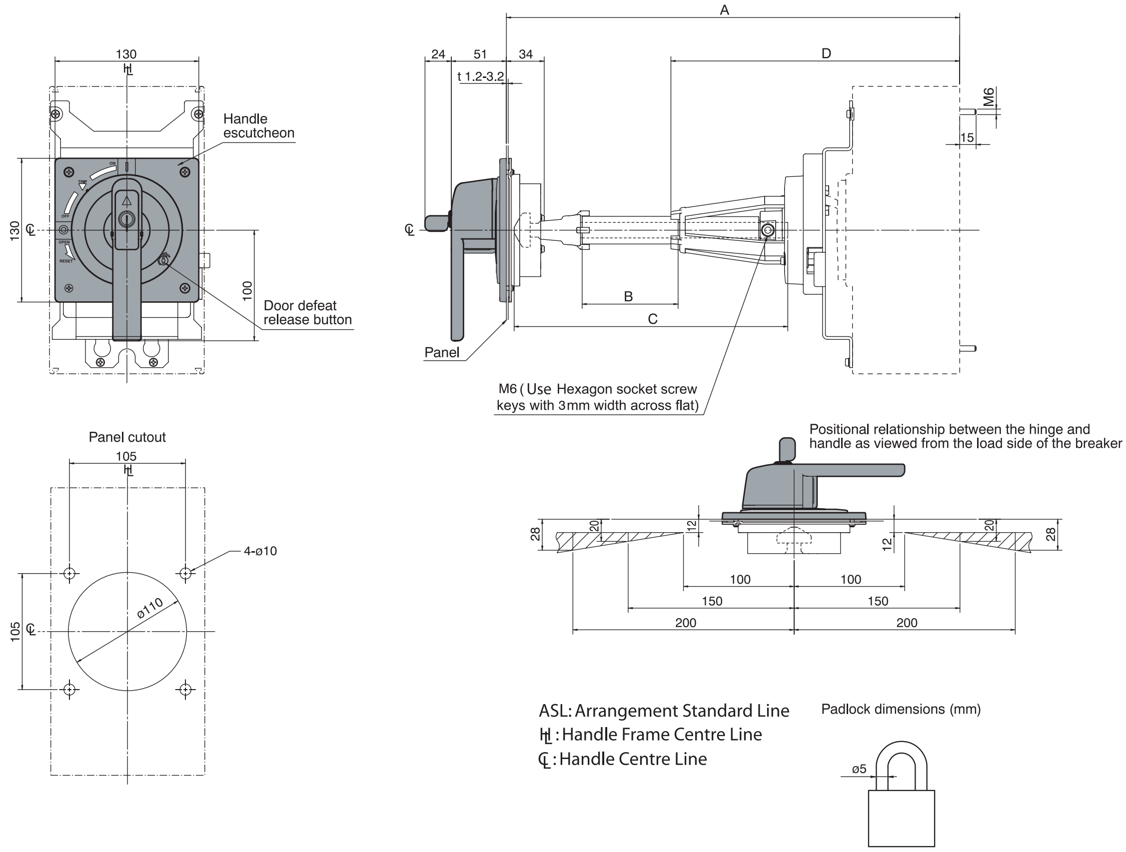


DIMENSIONS

Door Mounted Handle

Applicable MCCB	A ✱1	B	C	D	Shaft support
E400 E630	270 min.	12	107.5	—	Without
S400 S630	610 max.	280	447.5	261	With +
H400	307 min.	12	107.5	—	Without
L400	647 max.	280	447.5	298	With +

✱1: Min. means the minimum length for A by cutting the shaft.
Max. means the maximum length for A without cutting the shaft.
+ The shaft can be cut to the required length. If it is necessary to cut the shaft so short that it does not protrude beyond the shaft support, the shaft support may be removed.



SECTION 7

3. Miniature Circuit Breaker

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

MINIATURE CIRCUIT BREAKER

1 NHP

Miniature circuit breakers

Din-T6 series 6 kA MCB

DTCB6
1 pole

- Standards AS/NZS 4898
- Approval No. N17481
- Current range 2-63 Amps 1, 2 and 3 pole
- Sealable and lockable handle
- Available in curve type C and D
- Mounts on CD chassis (250 A and 355 A)

1 pole 1 module

In (A)	C – Curve 5-10 In
2	DTCB6102C
4	DTCB6104C
6	DTCB6106C
10	DTCB6110C
13	DTCB6113C
16	DTCB6116C
20	DTCB6120C
25	DTCB6125C
32	DTCB6132C
40	DTCB6140C
50	DTCB6150C
63	DTCB6163C

2 pole 2 modules

2	DTCB6202C
4	DTCB6204C
6	DTCB6206C
10	DTCB6210C
13	i DTCB6213C
16	DTCB6216C
20	DTCB6220C
25	DTCB6225C
32	DTCB6232C
40	DTCB6240C
50	DTCB6250C
63	DTCB6263C

3 pole 3 modules

2	DTCB6302C
4	DTCB6304C
6	DTCB6306C
10	DTCB6310C
13	i DTCB6313C
16	DTCB6316C
20	DTCB6320C
25	DTCB6325C
32	DTCB6332C
40	DTCB6340C
50	DTCB6350C
63	DTCB6363C

Short circuit capacity 6 kA

In (A)	2 - 63
1 P	240 V AC
2 P	240 - 415 V AC
3 P	240 - 415 V AC

DC use

	1 P	2 P [1])
Short circuit	20 kA	25 kA
Max.voltage (DC)	48 V	110 V

Use at DC

When using Din-T6 in a DC application the magnetic tripping current is approximately 40 % higher than in AC 50/60 Hz.

Shock resistance (In X, Y, Z directions).

20 g with shock duration 10 ms (minimum 18 shocks).
40 g with shock duration 5 ms (minimum 18 shocks).

Vibration resistance (In X, Y, Z directions).

3 g in frequency range 10 to 55 Hz
(operating time at least 30 min).
According to IEC 60068-2-6.

Storage temperature

From -55 °C to +55 °C, according to IEC 88 part 2 - 1 (duration 96 hours).

Operating temperature

From -25 °C to +55 °C, according to VDE 0664 parts 1 and 2.

Use at 400 Hz

At 400 Hz the magnetic trip current is approximately 50 % higher than in AC 50/60 Hz.

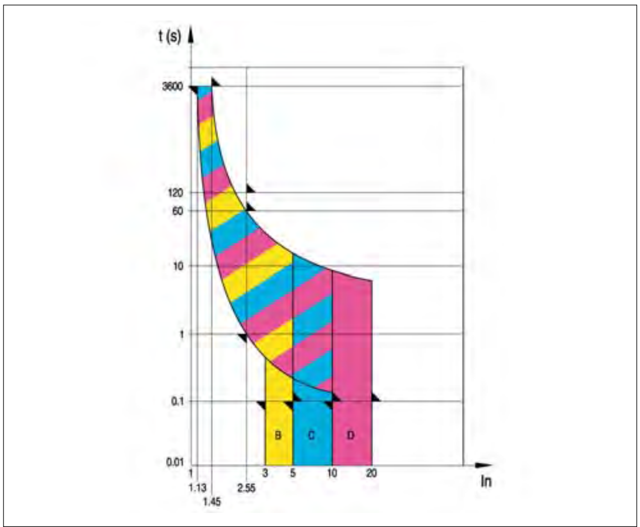
Notes: [1]) 2 pole MCB connected in series.
The line side is the "OFF" (bottom) side of the MCB, and connects to CD chassis tee-offs.
i Available on indent only.

Din-T MCBs Technical data

Characteristics according to BS EN 60898

Miniature Circuit Breakers are intended for the protection of wiring installations against both overloads and short-circuits in **domestic** or **commercial** wiring installations where operation is possible by **uninstructed** people

Tripping characteristic curves



Magnetic release

An electromagnet with plunger ensures instantaneous tripping in the event of short-circuit. The NHP Din-T range has 3 different types, following the current for instantaneous release: types B, C and D curve.

Icn (A)	Test current	Tripping time	Applications
B	3 x In 5 x In	0.1<t<45 s (In≤32 A) 0.1<t<90 s (In>32 A) t<0.1 s	Only for resistive loads eg: • electrical heating • water heater • stoves.
C	5 x In 10 x In	0.1<t<15 s (In≤32 A) 0.1<t<30 s (In>32 A) t<0.1 s	Usual loads such as: • lighting • socket outlets • small motors
D	10 x In 20 x In	0.1<t<4 s(**) (In≤32 A) 0.1<t<8 s (In>32 A) t<0.1 s	Control and protection of circuits having important transient inrush currents (large motors)

Thermal release

The release is initiated by a bimetal strip in the event of overload. The standard defines the range of releases for specific overload values. Reference ambient temperature is 30 °C.

Test current	Tripping time
1.13 x In	t ≥ 1 h (In ≤ 63 A) t ≥ 2 h (In > 63 A)
1.45 x In	t < 1 h (In ≤ 63 A) t < 2 h (In > 63 A)
2.55 x In	1 s < t < 60 s (In ≤ 32 A) 1 s < t < 120 s (In >32 A)

Rated short-circuit breaking capacity (Icn)

Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO.

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of 900 V. Moreover, the MCB shall be capable of tripping when loaded with 2.8 In within the time corresponding to 2.55 In but greater than 0.1s.

Service short-circuit breaking capacity (Ics)

Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO-t-CO.

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of 1500 V. Moreover, the MCB shall not trip at a current of 0.96 In. The MCB shall trip within 1h when current is 1.6 In.

O - Represents an opening operation

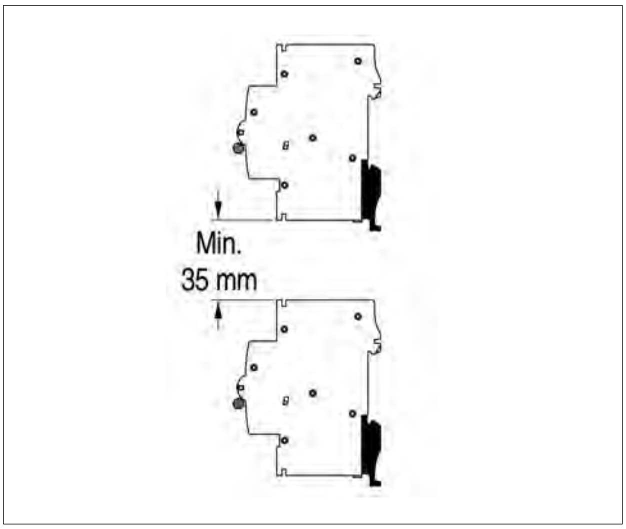
C - Represents a closing operation followed by an automatic opening.

t - Represents the time interval between two successive short-circuit operations: 3 minutes.

The relation between the rated short-circuit capacity (Icn) and the rated service short-circuit breaking capacity (Ics) shall be as follows:

Icn (A)	Ics (A)
≤ 6000	6000
> 6000 ≤ 10000	0.75 Icn min. 6000
> 10000	0.75 Icn min. 7500

In both sequences all MCBs are tested for emission of ionized gases during short-circuit (grid distance), in a safety distance between two MCBs of 35 mm when devices are installed in two different rows in the enclosure. This performance allows the use of any NHP/Terasaki enclosure.



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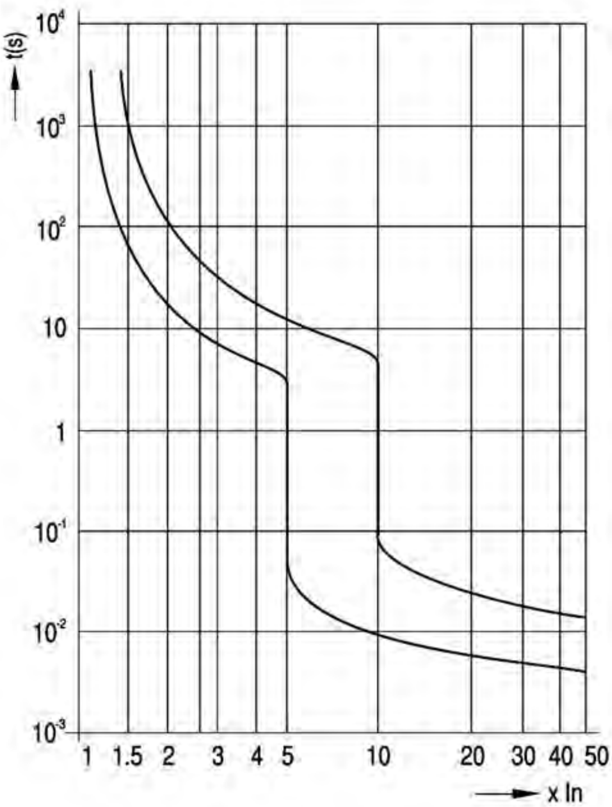
Din-T MCBs Technical data

Tripping curves according to EN 60898

The following tables show the average tripping curves of the Terasaki Din-T MCBs based on the thermal and magnetic characteristics.

Curve C



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Din-T MCBs Technical data

Influence of ambient air temperature on the rated current

The maximum value of the current which can flow through an MCB depends on the nominal current of the MCB, the conductor cross-section and the ambient air temperature.

The values shown in the table below are for devices in free air. For devices installed with other modular devices in the same switchboard, a correction factor (K) shall be applied relative to the mounting situation of the MCB, the ambient temperature and the number of main circuits in the installation.

No of devices	K [1])
2 or 3	0.9
4 or 5	0.8
6 or 9	0.7
> 10	0.6

Calculation example

Within a distribution board consisting of eight 2 Pole, 16 A, 'C' curve type MCBs, with an operating ambient temperature of 45 °C, which is the highest temperature the MCB can operate at without unwanted tripping?

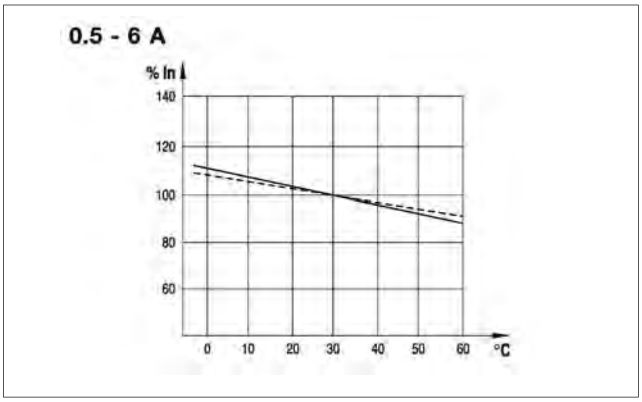
Calculation

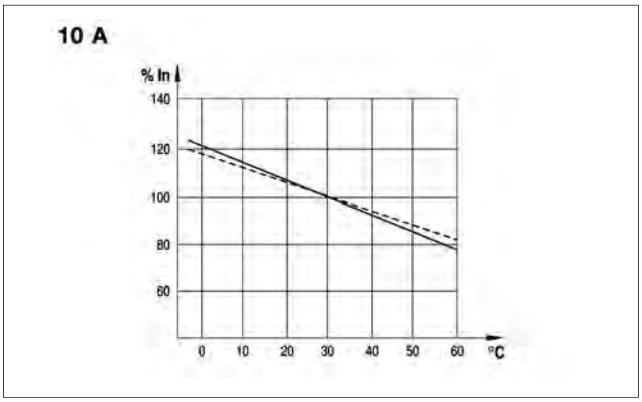
The correction factor K = 0.7, for use in an eight circuit installation: 16 A x 0.7 = 11.2 A

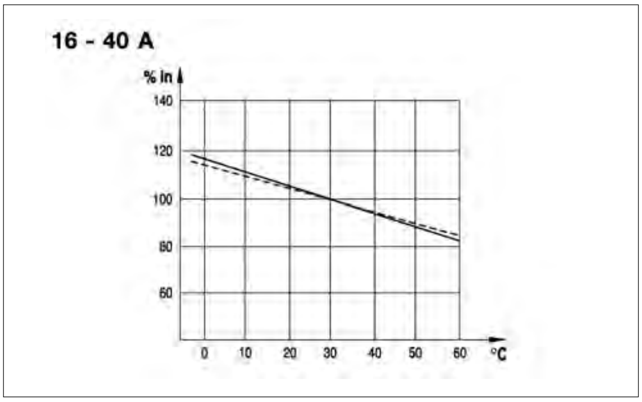
As the MCB is working at 45 °C it shall be given another factor (90 % = 0.9):
In at 45 °C = In at 30 °C x 0.9 = 11.2 A x 0.9 = 10.1 A.

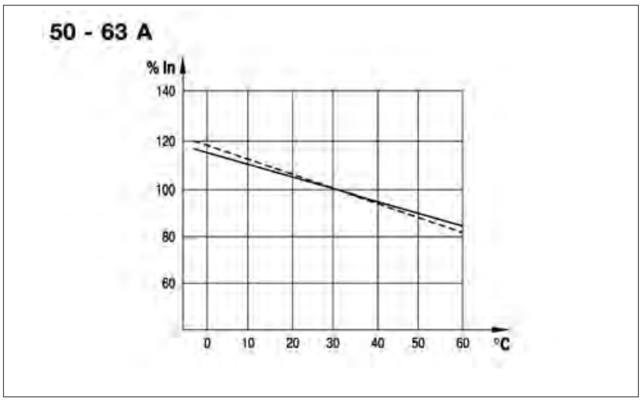
Note: [1]) Applicable for MCBs working at maximum rated currents.

The thermal calibration of the MCBs was carried out at an ambient temperature of 30 °C. Ambient temperatures different from 30 °C influence the bimetal and this results in earlier or later thermal tripping.









———— : 1P (single pole)

-------- : mP (multi-pole)

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Din-T MCBs Technical data

Effects of frequency on the tripping characteristic

All the MCBs are designed to work at frequencies of 50-60 Hz, therefore to work at different values, consideration must be given to the variation of the tripping characteristics. The thermal tripping does not change with variation of the frequency but the magnetic tripping values can be up to 50 % higher than the ones at 50-60 Hz.

Tripping current variation

60 Hz	100 Hz	200 Hz	300 Hz	400 Hz
1	1.1	1.2	1.4	1.5

Power losses

The power losses are calculated by measuring the voltage drop between the incoming and the outgoing terminals of the device at rated current.

Power loss per pole

In (A)	Voltage drop (V)	Energy loss (W)	Resistance (mOhm)
0.5	2.230	1.115	4458.00
1	1.270	1.272	1272.00
2	0.620	1.240	310.00
3	0.520	1.557	173.00
4	0.370	1.488	93.00
6	0.260	1.570	43.60
8	0.160	1.242	19.40
10	0.160	1.560	15.60
13	0.155	2.011	11.90
16	0.162	2.586	10.10
20	0.138	2.760	6.90
25	0.128	3.188	5.10
32	0.096	3.072	3.00
40	0.100	4.000	2.50
50	0.090	4.500	1.80
63	0.082	5.160	1.30
80	0.075	6.000	0.90
100	0.075	7.500	0.75
125	0.076	9.500	0.60

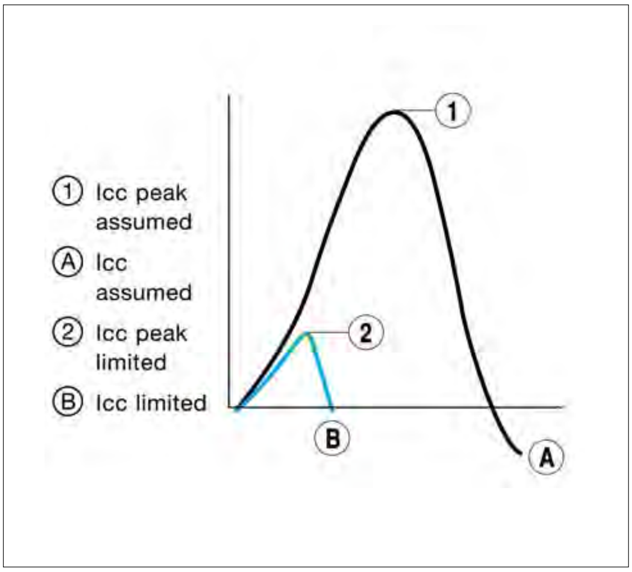
Limitation curves

Let-through energy I^2t

The limitation capacity of an MCB in short-circuit conditions, is its capacity to reduce the value of the let-through energy that the short-circuit would be generating.

Peak current Ip

Is the value of the maximum peak of the short-circuit current limited by the MCB.



See following pages

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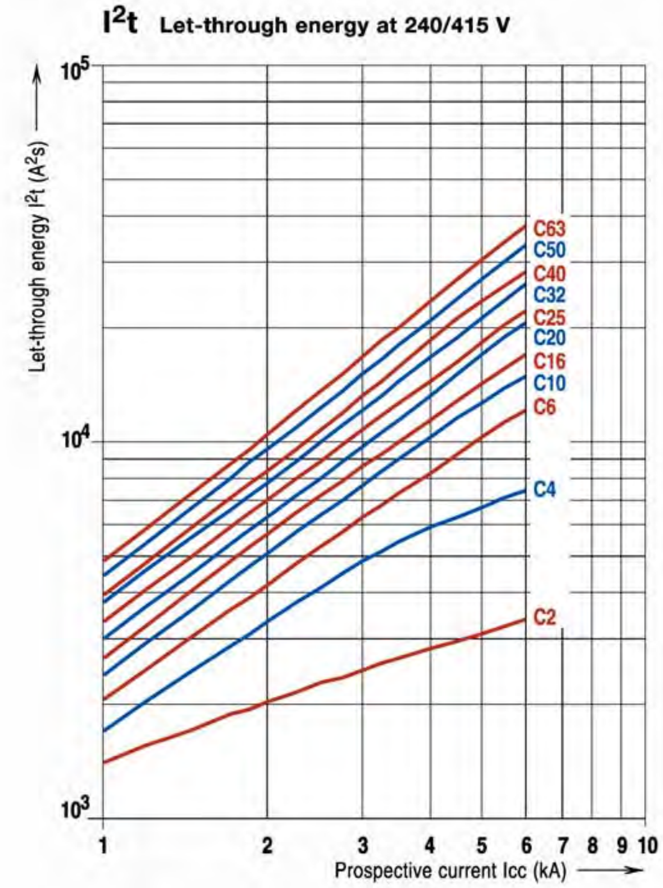
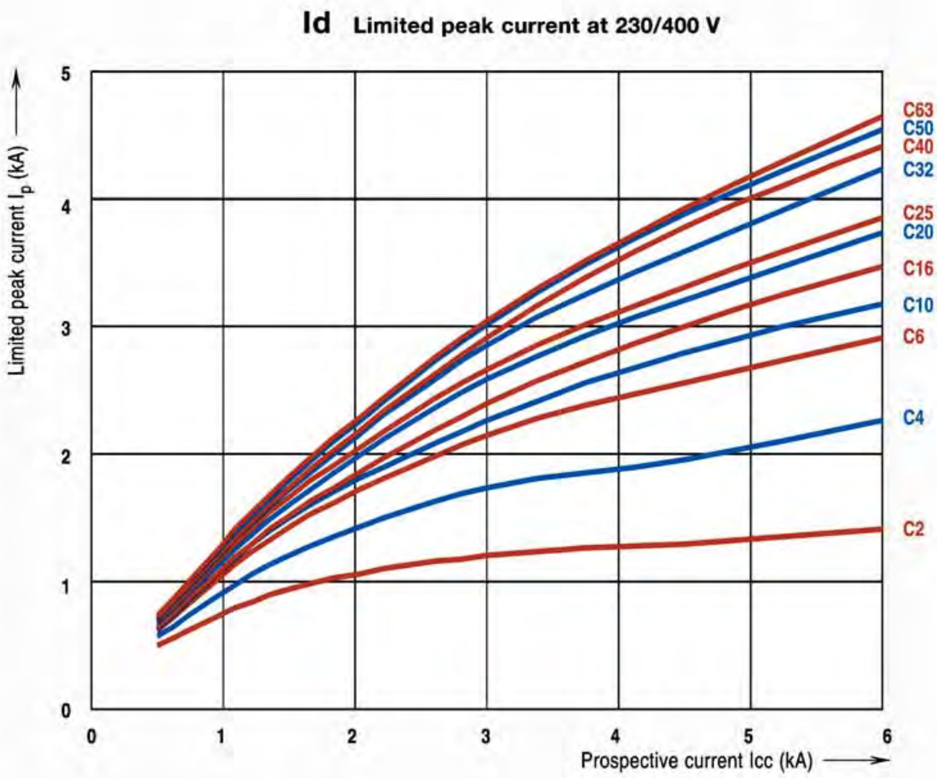
Din-T MCBs Technical data

Din-T 6

6 kA

C curve





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Din-T MCBs Technical data

3

Use of standard MCB for DC use

For MCBs designed to be used in alternating current but used in installations in direct current, the following should be taken into consideration:

- For protection against overloads it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is similar to alternating current.
- For protection against short-circuits it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is 40% higher than the one in alternating current.

Use in DC selection table

Series	Rated current (A)	48 V 1 pole Icu (kA)	110 V 2 poles in series Icu (kA)	250 V 1 pole Icu (kA)	440 V 2 poles in series Icu (kA)
Din-T 6	0.5....63 A	20	25	-	-

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Din-T MCBs Technical data

Text for specifiers

MCB Series Din-T 6

- According to EN 60898 standard
- For DIN rail mounting according to DIN EN 50022; EN 50022; future EN 60715; IEC 60715 (top hat rail 35 mm)
- Grid distance 35 mm
- Working ambient temperature from -25 °C up to +50 °C
- Approved by CEBEC, VDE, KEMA, IMQ.
- 1 pole is a module of 18 mm wide
- Nominal rated currents are: 0.5/1/2/3/4/6/10/13/16/20/25/32/40/50/63 A
- Tripping characteristics: B,C,D (B curve Din-T 10 only).
- Number of poles: 1 P, 1 P+N, 2 P, 3 P, 3 P+N, 4 P
- The short-circuit breaking capacity is: 6/10k A, energy limiting class 3
- Terminal capacity from 1 up to 35 mm² rigid wire or 1.5 up to 25 mm² flexible wire.
- Screw head suitable for flat or Pozidrive screwdriver
- Can be connected by means of both pin or fork busbars
- The toggle can be sealed in the ON or OFF position
- Rapid closing
- Both incoming and outgoing terminals have a protection degree of IP 20 and they are sealable
- Isolator function thanks to Red/Green printing on the toggle.
- Maximum voltage between two phases; 440 V~
- Maximum voltage for utilisation in DC current: 48 V 1 P and 110 V 2 P
- Two position rail clip
- Mechanical shock resistance 40 g (direction x, y, z) minimum 18 shocks 5 ms half-sinusoidal acc. to IEC 60068-2-27
- Vibration resistance: 3 g (direction x, y, z) minimum 30 min. according to IEC 60068-2-6
- Extensions can be added on both left or right hand side
  - Auxiliary contact
  - Shunt trip
  - Undervoltage release
  - Motor operator
  - Panelboard switch
- Add-on RCD can be coupled.

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Din-T MCBs Technical data

Series			Din-T6 AS/NZS 4898
Standards (Aust / NZ / International)			IEC 60898
Tripping characteristics			C, D
Nominal current		A	C/D(0.5-63)
Calibration temperature		°C	30
Number of poles (# mod)			1/2/3/4
Neutral pole protected			yes
Nominal voltage Un	AC 1 P	V	240/415
	3 P/4 P	V	415
	DC 1 P [1])	V DC	48
	2 P (in series) [1])	V DC	110
Frequency		Hz	50/60
		Hz	DC: magn.trip +40%
		Hz	400: magn.trip +50%
Maximum service voltage Ubmax between two wires		V	250/440; 53/120
Minimum service voltage Ubmin		V	12; 12
Selectivity class (IEC 60898)			3
Isolator application	IEC 60947-2		yes
Rated insulation voltage	Pollution degree 2	V	500
	Pollution degree 3	V	440
Impulse withstand test voltage		kV	6
Insulation resistance		mOhm	10,000
Dielectric rigidity		kV	2.5
Vibration resistance (in x, y, z direction) (IEC 77/16.3)			3 g
Endurance	Electrical at Un, In		10,000
	mechanical		20,000
Utilisation category (IEC 60947-2)			A
Protection degree (outside / inside, in enclosure with door)			IP 20/IP 40
Self-extinguish degree (according to UL94)			V2
Tropicalisation (according to IEC 60068-2 / DIN 40046)		°C/RH	+55 °C/95 % RH
Operating temperature		°C	-25/+55
Storage temperature		°C	-55/+55
Terminal capacity	Rigid cable min/max (top)	mm^2	1/35
	Flexible cable min*/max (top)	mm^2	0.75/25
	Rigid cable min/max (bottom)	mm^2	1/35
	Flexible cable min*/max (bottom)	mm^2	0.75/25
	(* Flexible cable 0.75/1/1.5 mm^2 with cable lug)		
	Torque	Nm	4.5
Add-on devices (side add-on)	Auxiliary contacts		yes
	UVT		yes
	Shunt trip		yes
	Motor operator		yes
	Panelboard switch		yes
Busbar systems	Pin (top/bottom)		yes/yes
	Fork (top/bottom)		-/yes
Accessories			yes
Dimensions, weights, packaging			
	(HxDxW) 86x68xW	mm/mod·	18
	Weight/mod.	g	120
	Package	mod.	12

Short-circuit capacity AC (kA)				AS/NZS 4898
IEC 60898	Icn	1 P	230/400 V	6
		2 P	230/400 V	6
		3 P/4 P	230/400 V	6
	Ics (service)			100 % Icn
IEC 60947-2	Icu (ultimate)	1 P	127 V	20
			240 V	10
			415 V	3
		2 P	127 V	-
			240 V	15
			415 V	10
		3 P, 4 P	240 V	15
			415 V	10
			440 V	6
	Ics (service)			75 % Icu
	NEMA AB1 (120/240V)			20
Short-circuit capacity DC (kA)				
IEC 60947-2	Icu (ultimate)	1 P	≤60 V	20
			≤220 V	-
		2 P	≤125 V	25
			≤440 V	-
	Ics (service)			100 % Icu

Notes Refer pages 3 - 23, 24 for information on SAFE-T MCBs.
[1]) Preferred values of rated control supply voltage (IEC 60947 - 2): 24 V, 48 V, 110 V, 125 V, 250 V
[2]) 0.5-4 A/6-25 A/32-40 A/50-63 A
[3]) 10 (125 V DC)
[4]) 10 (250 V DC)
[5]) On request.

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Din-T MCBs Technical data

Miniature circuit breakers - Din-T 6

Dimensions in mm.

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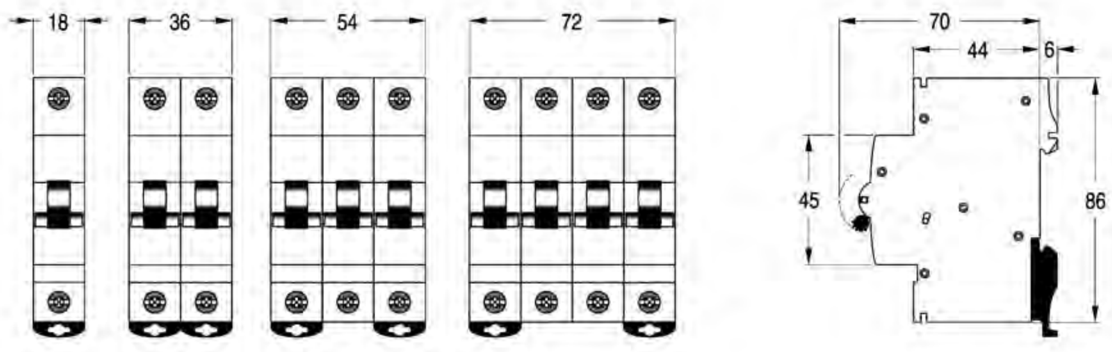

Miniature circuit breakers

Din-T15 series 15 kA, 20 kA, 25 kA MCBs

- Standards AS/NZS 3947-2
- Current range 6-63 Amp 1, 2, 3 and 4 pole
- Sealable and lockable handle
- Modular design
- Mounts on CD chassis (250 A and 355 A)
- Industrial applications

DTCB15
1 pole

1 pole 1 module [3])

In (A)	Icu (kA)	C - Curve 5 - 10 In
6	25	DTCB15106C
10	25	DTCB15110C
13	25	[i] DTCB15113C
16	25	DTCB15116C
20	25	DTCB15120C
25	25	DTCB15125C
32	20	DTCB15132C
40	20	DTCB15140C
50	15	DTCB15150C
63	15	DTCB15163C

2 pole 2 modules [3])

In (A)	Icu (kA)	C - Curve 5 - 10 In
6	25	[i] DTCB15206C
10	25	[i] DTCB15210C
13	25	[i] DTCB15213C
16	25	[i] DTCB15216C
20	25	[i] DTCB15220C
25	25	[i] DTCB15225C
32	20	[i] DTCB15232C
40	20	[i] DTCB15240C
50	15	[i] DTCB15250C
63	15	[i] DTCB15263C

3 pole 3 modules [3])

6	25	DTCB15306C
10	25	DTCB15310C
13	25	[i] DTCB15313C
16	25	DTCB15316C
20	25	DTCB15320C
25	25	DTCB15325C
32	20	DTCB15332C
40	20	DTCB15340C
50	15	DTCB15350C
63	15	DTCB15363C

4 pole 4 modules [2]) [3])

6	25	[i] DTCB15406C
10	25	[i] DTCB15410C
13	25	[i] DTCB15413C
16	25	[i] DTCB15416C
20	25	[i] DTCB15420C
25	25	[i] DTCB15425C
32	20	[i] DTCB15432C
40	20	[i] DTCB15440C
50	15	[i] DTCB15450C
63	15	[i] DTCB15463C

In (A)	6 - 63
1 P	240 V AC
2 P	240/415 V AC
3 P	240/415 V AC
4 P	240/415 V AC

Shock resistance (in x, y, z direction)

20 g with shock duration of 10 ms (minimum 18 shocks)
40 g with shock duration of 5 ms (minimum 18 shocks)

Vibration resistance (in x, y, z direction)

3 g in frequency range 10 to 55 Hz (operating time at least 30 mins) according to IEC 60068-2-6

Storage temperature

from -55 °C to +55 °C according to VDE 0664 parts 1 and 2

Operating temperature

from -25 °C to +55 °C according to VDE 0664 Parts 1 and 2.

Use at 400 Hz

At 400 Hz the magnetic tripping current is approximately 50 % higher than at AC 50/60 Hz

DTCB15
2 pole

DTCB15
3 pole

Notes: [1]) 2 P MCB connected in series.
The LINE-side is the OFF or bottom of the MCB and connects to CD chassis tee-offs.
[2]) All poles include overcurrent and short circuit protection.
[3]) Refer Section 3 for kA ratings at 240/415 V. The above ratings are at 415 V AC.
[i] Available on indent only.

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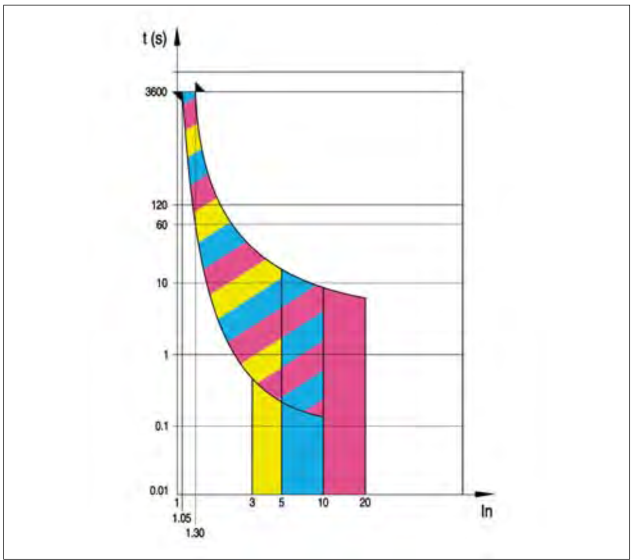
Din-T MCBs Technical data

Characteristics according to EN 60947-2

Miniature Circuit Breakers are intended for the protection of the lines against both overloads and short-circuits in **industrial** wiring installations where normal operation is done by **instructed** people

Tripping characteristic curves



Magnetic release

An electromagnet with plunger ensures instantaneous tripping in the event of short-circuit. The standard leaves the calibration of magnetic release to the manufacturers discretion.

NHP offers instantaneous tripping ranges:

- release between 5 and 10 In
- release between 10 and 20 In

Thermal release

The release is initiated by a bimetal strip in the event of overload. The standard defines the range of release for two special overload values. Reference ambient temperature is 40 °C.

Test current	Tripping time
1.05 x In	$t \geq 1$ h (In ≤ 63 A) $t \geq 2$ h (In > 63 A)
1.30 x In	$t < 1$ h (In ≤ 63 A) $t < 2$ h (In > 63 A)

Rated ultimate short-circuit breaking capacity (Icu)

Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO.

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of 1000 V. Moreover the MCB shall be capable of tripping when loaded with 2.5 In within the time corresponding to 2 In but greater than 0.1 s.

Rated service short-circuit breaking capacity (Ics)

Is the value of the short-circuit that the MCB is capable of withstanding in the following test of sequence of operations: O-t-CO-t-CO.

After the test the MCB is capable, without maintenance, to withstand a dielectric strength test at a test voltage of twice its rated insulation voltage with a minimum of 1000 V.
A verification of the overload releases on In and moreover the MCB shall trip within 1 h when current is 1.45 In (for In<63 A) and 2 h (for In>63 A).

O - Represents an opening operation

C - Represents a closing operation followed by an automatic opening.

t - Represents the time interval between two successive short-circuit operations: 3 minutes.

Category A: Without a short-time withstand current rating.

Utilization category	Application with respect to selectivity
A	Circuit breakers not specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. without an intentional short-time delay provided for selectivity under short-circuit conditions, and therefore without a short-time withstand current rating according to 4.3.5.4
B	Circuit breakers specifically intended for selectivity under short-circuit conditions with respect to other short-circuit protective devices in series on the load side, i.e. without an intentional short-time delay (which may be adjustable), provided for selectivity under short-circuit conditions. Such circuit-breakers have a short-time withstand current rating according to 4.3.5.4

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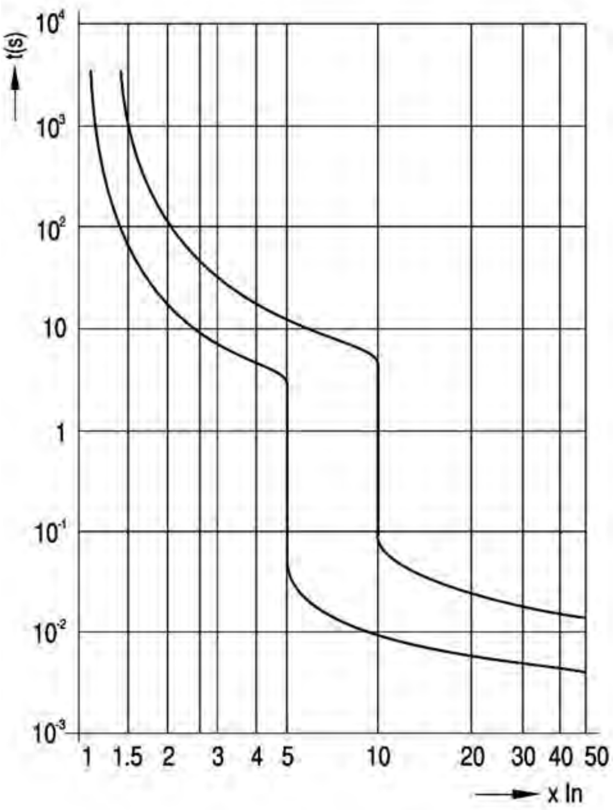
Din-T MCBs Technical data

Tripping curves according to EN 60898

The following tables show the average tripping curves of the Terasaki Din-T MCBs based on the thermal and magnetic characteristics.

Curve C



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Din-T MCBs Technical data

Definitions related to circuit breakers

MCB = Miniature Circuit Breaker

Short-circuit (making and breaking) capacity

Alternating component of the prospective current, expressed by its RMS value, which the circuit breaker is designed to make, to carry for its opening time and to break under specified conditions.

Ultimate or rated short-circuit breaking capacity (Icn - EN 60898)

A breaking capacity for which the prescribed conditions, according to a specified test sequence, do not include the capability of the MCB to carry 0.96 times its rated current for the conventional time.

Ultimate short-circuit breaking capacity (Icu - EN 60947-2)

A breaking capacity for which the prescribed conditions, according to a specified test sequence, do not include the capability of the MCB to carry its rated current for the conventional time.

Service short-circuit breaking capacity (Ics - EN 60898)

A breaking capacity for which the prescribed conditions, according to a specified test sequence, include the capability of the MCB to carry 0.96 times its rated current for the conventional time.

Prospective current

The current that would flow in the circuit, if each main current path of the MCB were replaced by a conductor of negligible impedance.

Conventional non-tripping current (Int)

A specified value of current which the circuit breaker is capable of carrying for a specified time without tripping.

Open position

The position in which the predetermined clearance between open contacts in the main circuit of the MCB is secured.

Closed position

The position in which the predetermined continuity of the main circuit of the MCB is secured.

Maximum prospective peak current (Ip)

The prospective peak current when the initiation of the current takes place at the instant which leads to the highest possible value.

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Din-T MCBs Technical data

Influence of ambient air temperature on the rated current

The maximum value of the current which can flow through an MCB depends on the nominal current of the MCB, the conductor cross-section and the ambient air temperature.

The values shown in the table below are for devices in free air. For devices installed with other modular devices in the same switchboard, a correction factor (K) shall be applied relative to the mounting situation of the MCB, the ambient temperature and the number of main circuits in the installation.

No of devices	K [1])
2 or 3	0.9
4 or 5	0.8
6 or 9	0.7
> 10	0.6

Calculation example

Within a distribution board consisting of eight 2 Pole, 16 A, 'C' curve type MCBs, with an operating ambient temperature of 45 °C, which is the highest temperature the MCB can operate at without unwanted tripping?

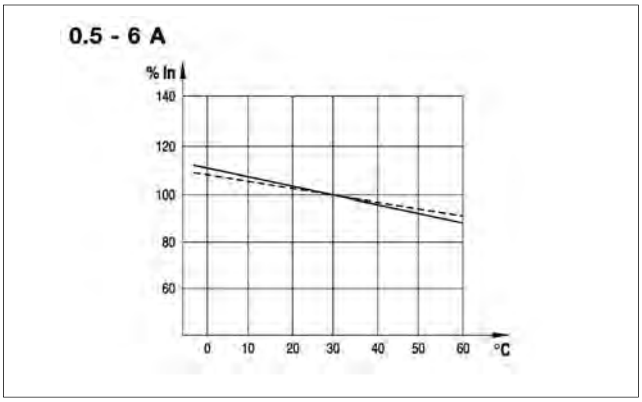
Calculation

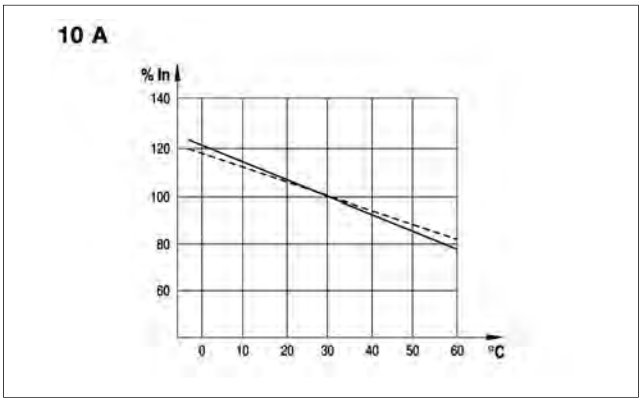
The correction factor K = 0.7, for use in an eight circuit installation: 16 A x 0.7 = 11.2 A

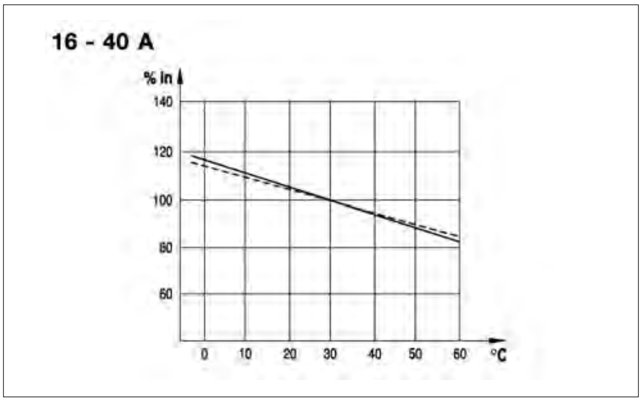
As the MCB is working at 45 °C it shall be given another factor (90 % = 0.9):
In at 45 °C = In at 30 °C x 0.9 = 11.2 A x 0.9 = 10.1 A.

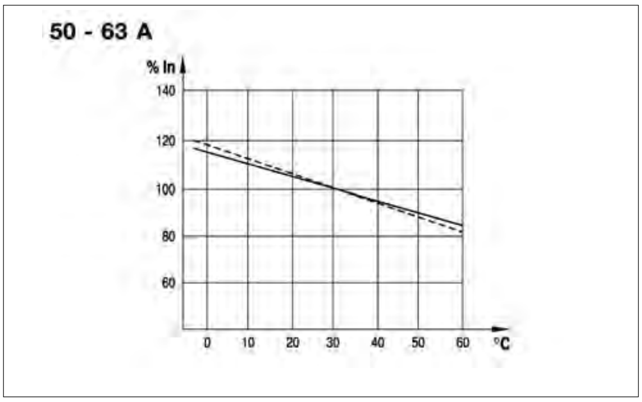
Note: [1]) Applicable for MCBs working at maximum rated currents.

The thermal calibration of the MCBs was carried out at an ambient temperature of 30 °C. Ambient temperatures different from 30 °C influence the bimetal and this results in earlier or later thermal tripping.









———— : 1P (single pole)

-------- : mP (multi-pole)

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Din-T MCBs Technical data

Effects of frequency on the tripping characteristic

All the MCBs are designed to work at frequencies of 50-60 Hz, therefore to work at different values, consideration must be given to the variation of the tripping characteristics. The thermal tripping does not change with variation of the frequency but the magnetic tripping values can be up to 50 % higher than the ones at 50-60 Hz.

Tripping current variation

60 Hz	100 Hz	200 Hz	300 Hz	400 Hz
1	1.1	1.2	1.4	1.5

Power losses

The power losses are calculated by measuring the voltage drop between the incoming and the outgoing terminals of the device at rated current.

Power loss per pole

In (A)	Voltage drop (V)	Energy loss (W)	Resistance (mOhm)
0.5	2.230	1.115	4458.00
1	1.270	1.272	1272.00
2	0.620	1.240	310.00
3	0.520	1.557	173.00
4	0.370	1.488	93.00
6	0.260	1.570	43.60
8	0.160	1.242	19.40
10	0.160	1.560	15.60
13	0.155	2.011	11.90
16	0.162	2.586	10.10
20	0.138	2.760	6.90
25	0.128	3.188	5.10
32	0.096	3.072	3.00
40	0.100	4.000	2.50
50	0.090	4.500	1.80
63	0.082	5.160	1.30

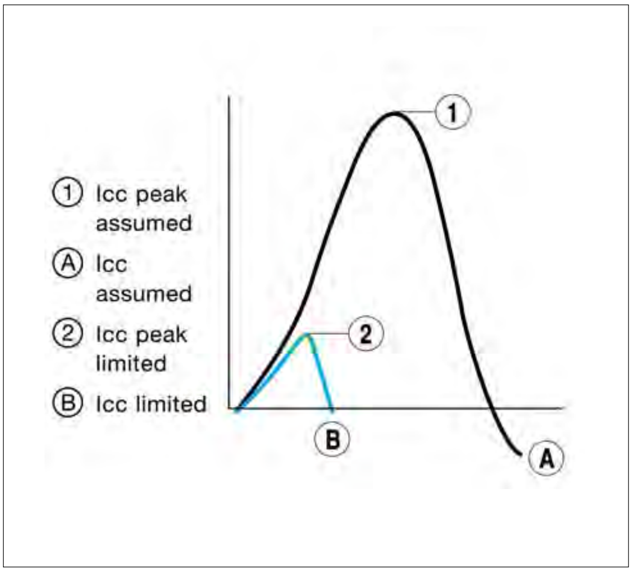
Limitation curves

Let-through energy I^2t

The limitation capacity of an MCB in short-circuit conditions, is its capacity to reduce the value of the let-through energy that the short-circuit would be generating.

Peak current Ip

Is the value of the maximum peak of the short-circuit current limited by the MCB.



See following pages

3

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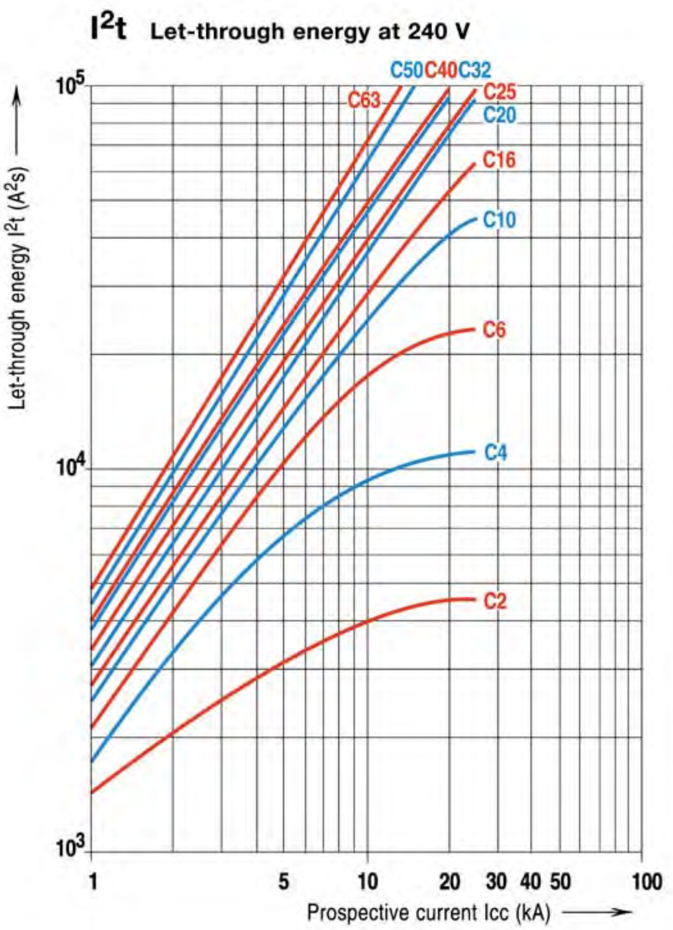
Din-T MCBs Technical data

Din-T 15

15 kA

C curve



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Din-T MCBs Technical data

Use of standard MCB for DC use

For MCBs designed to be used in alternating current but used in installations in direct current, the following should be taken into consideration:

- For protection against overloads it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is similar to alternating current.
- For protection against short-circuits it is necessary to connect the two poles to the MCB. In these conditions the tripping characteristic of the MCB in direct current is 40% higher than the one in alternating current.

Use in DC selection table

Series	Rated current (A)	48 V 1 pole Icu (kA)	110 V 2 poles in series Icu (kA)	250 V 1 pole Icu (kA)	440 V 2 poles in series Icu (kA)
Din-T 15	6....25 A	10	10	-	-

Installation of Din-T DC MCBs in direct current

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Din-T MCBs + RCDs Technical data

Text for specifiers

MCB Series Din-T 15

- According to EN 60947.2 standard
- For DIN rail mounting according to DIN EN 50022; EN 50022; future EN 60715; IEC 60715 (top hat rail 35 mm)
- Working ambient temperature from -25 °C up to +50 °C
- 1 pole is a module of 18 mm wide
- Nominal rated currents are: 6/10/13/16/20/25/32/40/50/63 A
- Tripping characteristic: C
- Number of poles: 1 P, 2 P, 3 P, 4 P
- Short-circuit capacity is: 15 kA
- Terminal capacity from 1 up to 35 mm^2 rigid wire or 1.5 up to 25 mm^2 flexible wire
- Screw head suitable for flat or Pozidrive screwdriver
- Can be connected by means of both pin or fork busbars
- The toggle can be sealed in the ON or OFF position
- Rapid closing
- Both incoming and outgoing terminals have a protection degree of IP 20 and they are sealable
- Isolator function thanks to Red/Green printing on the toggle.
- Maximum voltage between two phases; 440 V~
- Maximum voltage for utilisation in DC current: 48 V 1 P and 110 V 2 P
- Two position rail clip
- Mechanical shock resistance 40 g (direction x, y, z) minimum 18 shocks 5 ms half-sinusoidal acc. to IEC 60068-2-27
- Vibration resistance: 3 g (direction x, y, z) minimum 30 min. according to IEC 60068-2-6
- Extensions can be added on both left or right hand side
  - Auxiliary contact
  - Shunt trip
  - Undervoltage release
  - Motor operator
  - Panelboard switch

- Add-on RCD can be coupled.

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Din-T MCBs Technical data

Series				Din-T15 AS/NZS 3947-2
Standards (Aust / NZ / International)				IEC 60947-2
Tripping characteristics				C
Nominal current			A	0.5-63
Calibration temperature			°C	40
Number of poles (# mod)				1/2/3/4
Neutral pole protected				-
Nominal voltage Un	AC	1 P	V	240/415
		3 P/4 P	V	415
	DC	1 P [1])	V DC	48
		2 P (in series) [1])	V DC	110
Frequency			Hz	50/60
			Hz	DC: magn.trip +40%
			Hz	400: magn.trip +50%
Maximum service voltage Ubmax between two wires			V	250/440; 53/120
Minimum service voltage Ubmin			V	12; 12
Selectivity class (IEC 60898)				3
Isolator application	IEC 60947-2			yes
Rated insulation voltage	Pollution degree 2		V	500
	Pollution degree 3		V	440
Impulse withstand test voltage			kV	6
Insulation resistance			mOhm	10,000
Dielectric rigidity			kV	2.5
Vibration resistance (in x, y, z direction) (IEC 77/16.3)				3 g
Endurance	Electrical at Un, In			4000
	mechanical			20,000
Utilisation category (IEC 60947-2)				A
Protection degree (outside / inside, in enclosure with door)				IP 20/IP 40
Self-extinguish degree (according to UL94)				V2
Tropicalisation (according to IEC 60068-2 / DIN 40046)			°C/RH	+55 °C/95 % RH
Operating temperature			°C	-25/+55
Storage temperature			°C	-55/+55
Terminal capacity	Rigid cable min/max (top)		mm^2	1/35
	Flexible cable min*/max (top)		mm^2	0.75/25
	Rigid cable min/max (bottom)		mm^2	1/35
	Flexible cable min*/max (bottom)		mm^2	0.75/25
	(* Flexible cable 0.75/1/1.5 mm^2 with cable lug)			
	Torque		Nm	4.5
Add-on devices (side add-on)	Auxiliary contacts			yes
	UVT			yes
	Shunt trip			yes
	Motor operator			yes
	Panelboard switch			yes
Busbar systems	Pin (top/bottom)			yes/yes
	Fork (top/bottom)			-/yes
Accessories				yes
Dimensions, weights, packaging				
	(HxDxW) 86x68xW		mm/mod.	18
	Weight/mod.		g	120
	Package		mod.	12

Short-circuit capacity AC (kA)				AS/NZS 3947-2
IEC 60898	Icn	1 P	230/400 V	-
		2 P	230/400 V	-
		3 P/4 P	230/400 V	-
	Ics (service)			-
IEC 60947-2	Icu (ultimate)	1 P	127 V	50
			240 V	50/25/20/15 [2])
			415 V	-
		2 P	127 V	-
			240 V	50/50/40/30 [2])
			415 V	50/25/20/15 [2])
		3 P, 4 P	240 V	50/50/40/30 [2])
			415 V	50/25/20/15 [2])
			440 V	50/20/15/10 [2])
	Ics (service)			75 % Icu
	NEMA AB1 (120/240V)			-
Short-circuit capacity DC (kA)				
IEC 60947-2	Icu (ultimate)	1 P	≤60 V	25
			≤220 V	-
		2 P	≤125 V	30
			≤440 V	-
	Ics (service)			100 % Icu

Notes Refer pages 3 - 23, 24 for information on SAFE-T MCBs.
[1]) Preferred values of rated control supply voltage (IEC 60947 - 2): 24 V, 48 V, 110 V, 125 V, 250 V
[2]) 0.5-4 A/6-25 A/32-40 A/50-63 A
[3]) 10 (125 V DC)
[4]) 10 (250 V DC)
[5]) On request.

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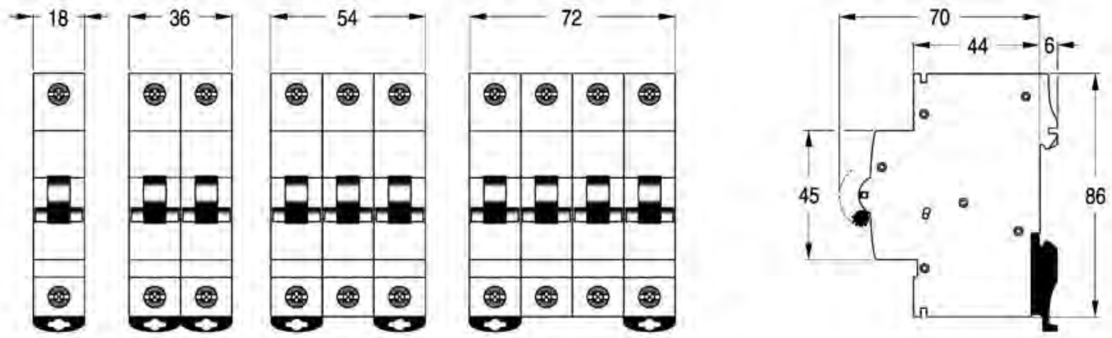
Din-T MCBs + RCDs Technical data

Miniature circuit breakers - Din-T 15

Dimensions in mm.



Miniature circuit breakers

Din-Safe single pole width residual current circuit breaker (RCBO)

- Standards AS/NZS 61009
- Approval N17482
- One module wide (18 mm)
- Short circuit, overcurrent and earth leakage protection
- Short circuit protection 10 kA
- Sensitivity 10 and 30 mA
- Din rail mount
- Suits CD chassis
- Type “A” residual current device (AC/DC)

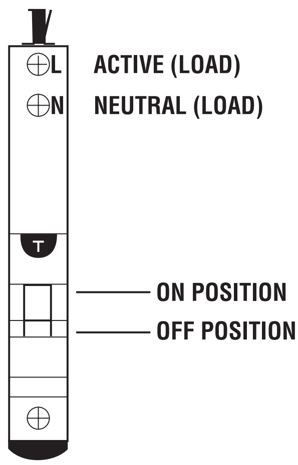
Amp rating (A)	Modules (18mm)	Voltage (AC)	Short circuit (kA)	Trip Sensitivity (mA)	Cat. No [1]) [2])
6	1	240	10	30	DSRCBH0630A
10	1	240	10	30	DSRCBH1030A
16	1	240	10	30	DSRCBH1630A
20	1	240	10	30	DSRCBH2030A
25	1	240	10	30	DSRCBH2530A
32	1	240	10	30	DSRCBH3230A
40	1	240	10	30	DSRCBH4030A
6	1	240	10	10	[i] DSRCBH0610A
10	1	240	10	10	DSRCBH1010A
16	1	240	10	10	DSRCBH1610A
20	1	240	10	10	DSRCBH2010A
25	1	240	10	10	[i] DSRCBH2510A
32	1	240	10	10	[i] DSRCBH3210A
40	1	240	10	10	[i] DSRCBH4010A

Note: [1]) Neutral not switched.
[2]) Will not accept side mounting accessories.
[i] Available on indent only.

Application

The Din-Safe single pole width residual current circuit breaker will fit the standard Din-T chassis for use in NHP panelboards. The design makes it possible to provide an MCB complete with earth leakage protection in an 18 mm wide module, which allows a greater number of devices to be fitted into a distribution board.

Connection diagram



Note: **Nuisance tripping may be experienced in VFD and motor starting applications refer NHP.**

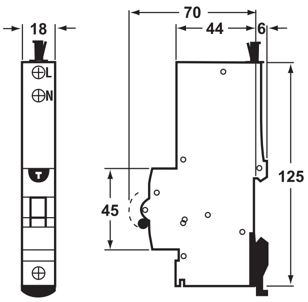
Operation

This unit combines the overload and short circuit protection of an MCB with earth leakage protection of an RCD. The unit occupies one, sub- circuit (one pole) of the distribution board and provides single phase protection against overload, short circuit and earth leakage current.

- The MCB element provides thermal and magnetic tripping protection which is rated to 10 kA prospective fault current.
- The RCD element of the device provides core-balance detection of the difference between the active and neutral currents and amplification to provide high sensitivity. The rated residual operating current (IΔn) is 10 mA or 30 mA.
- The green/yellow earth reference cable, in case of loss of supply neutral, ensures the device will continue to provide earth leakage protection and will operate normally upon detection of an earth leakage current.

Dimensions (mm)

Note: A 1.2 m long pigtail lead is included as standard.



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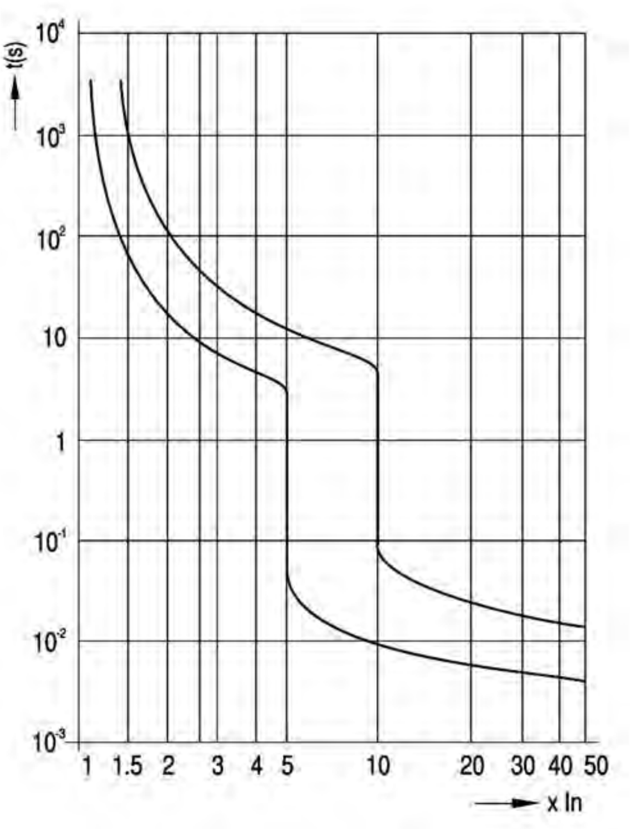
Din-T MCBs + RCDs Technical data

Tripping curves according to EN 60898

The following tables show the average tripping curves of the Terasaki Din-T MCBs based on the thermal and magnetic characteristics.

Curve C



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Din-T MCBs + RCDs Technical data

What is an RCD?

The RCD (Residual Current Device) is a device intended to protect people against indirect contact, the exposed conductive parts of the installation being connected to an appropriate earth electrode. It may be used to provide protection against fire hazards due to a persistent earth fault current, without operation of the overcurrent protective device.

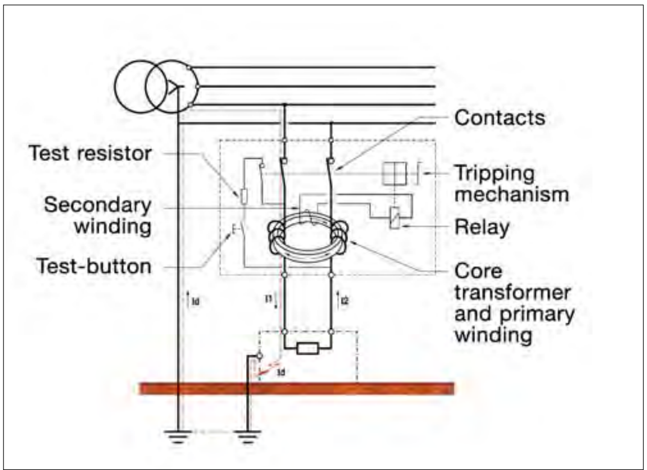
RCDs having a rated residual operating current not exceeding 30 mA are also used as a means for additional protection in case of failure of the protective means against electric shock (direct contact).

Working Principle

The main components of an RCD are the following:

- The core transformer: which detects the earth fault current.
- The relay: when an earth fault current is detected, the relay reacts by tripping and opening the contacts.
- The mechanism: element to open and close the contacts either manually or automatically.
- The contacts: to open or close the main circuit.

The RCD constantly monitors the vectorial sum of the current passing through all the conductors. In normal conditions the vectorial sum is zero (I1+I2=0) but in case of an earth fault, the vectorial sum differs from zero (I1+I2=Id), this causes the actuation of the relay and therefore the release of the main contacts.



Definitions related to RCDs

RCCB = Residual Current Circuit Breaker without overcurrent protection.

RCBO = Residual Current Circuit Breaker with overcurrent protection.

Breaking capacity

A value of AC component of a prospective current that an RCCB is capable of breaking at a stated voltage under prescribed conditions of use and behaviour.

Residual making and breaking capacity (IΔm)

A value of the AC component of a residual prospective current which an RCCB can make, carry for its opening time and break under specified conditions of use and behaviour.

Conditional residual short-circuit current (IΔc)

A value of the AC component of a prospective current which an RCCB protected by a suitable SCPD (short-circuit protective device) in series, can withstand, under specific conditions of use and behaviour.

Conditional short-circuit current (Inc)

A value of the AC component of a residual prospective current which an RCCB protected by a suitable SCPD in series, can withstand, under specific conditions of use and behaviour.

Residual short-circuit withstand current

Maximum value of the residual current for which the operation of the RCCB is ensured under specified conditions, and above which the device can undergo irreversible alterations.

Prospective current

The current that would flow in the circuit, if each main current path of the RCCB and the overcurrent protective device (if any) were replaced by a conductor of negligible impedance.

Making capacity

A value of AC component of a prospective current that an RCCB is capable to make at a stated voltage under prescribed conditions of use and behaviour.

Open position

The position in which the predetermined clearance between open contacts in the main circuit of the RCCB is secured.

Closed position

The position in which the predetermined continuity of the main circuit of the RCCB is secured.

Tripping time

The time which elapses between the instant when the residual operating current is suddenly attained and the instant of arc extinction in all poles.

Residual current (IΔn)

Vector sum of the instantaneous values of the current flowing in the main circuit of the RCCB.

Residual operating current

Value of residual current which causes the RCCB to operate under specified conditions.

Rated short-circuit capacity (Icn)

Is the value of the ultimate short-circuit breaking capacity assigned to the circuit breaker. (Only applicable to RCBO)

Conventional non-tripping current (Int)

A specified value of current which the circuit breaker is capable of carrying for a specified time without tripping. (Only applicable to RCBO)

Conventional tripping current (It)

A specified value of current which causes the circuit breaker to trip within a specified time.
(Only applicable to RCBO)

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Din-T MCBs + RCDs Technical data

RCDs classification according to EN 61008/61009

RCDs may be classified according to:

The behaviour in the presence of DC current (types for general use).

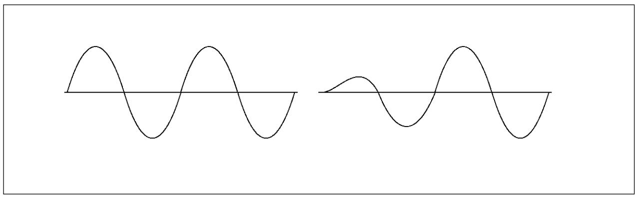
- Type AC
- Type A

The time-delay (in the presence of residual current)

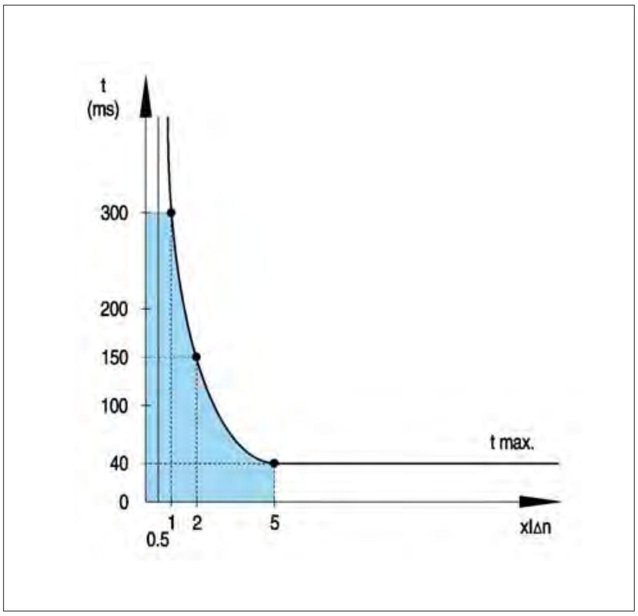
- RCDs without time delay: type for general use
- RCDs with time delay: type S for selectivity

Type AC [1]) [2])

The type AC RCDs are designed to release with sinusoidal residual currents which occur suddenly or slowly rise in magnitude.



Residual current	Tripping time
0.5 x IΔn	t = ∞
1 x IΔn	t = <300 ms
2 x IΔn	t = <150 ms
5 x IΔn	t = ≤40 ms



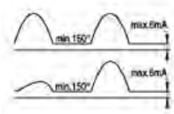
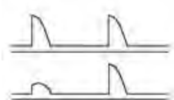
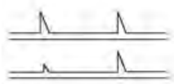
Tripping curve type AC
[1]) Standard in Australia
[2]) Type A acceptable in Australia

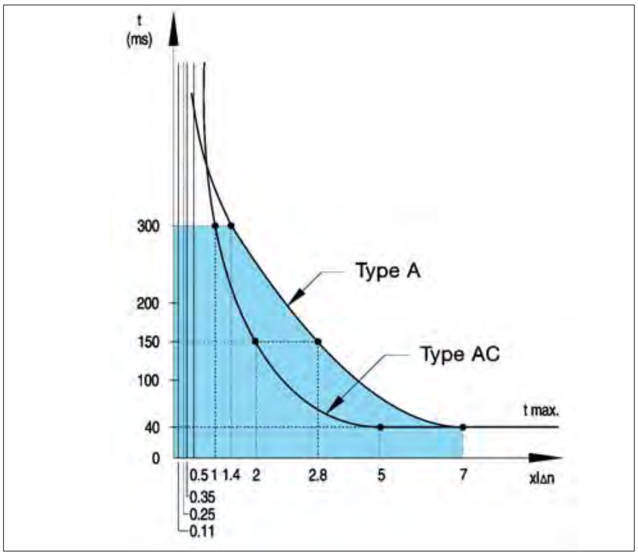
Type A [3]) [4])

Certain devices during faults can be the source of non-sinusoidal earth leakage currents (DC components) due to the electronic components e.g. diodes, thyristors etc.

Type A RCDs are designed to ensure that under these conditions the residual current devices operate on sinusoidal residual current and also with pulsating direct current(*) which occur suddenly or slowly rise in magnitude.

(*) Pulsating direct current: current of pulsating wave form which assumes, in each period of the rated power frequency, the value 0 or a value not exceeding 0.006 A DC during one single interval of time, expressed in angular measure of at least 150°.

	Residual current	Tripping time
1. For sinusoidal residual current		
	0.5 x IΔn	t = ∞
	1 x IΔn	t = <300 ms
	2 x IΔn	t = <150 ms
	5 x IΔn	t = ≤40 ms
2. For residual pulsating direct current		
	At point of wave 0°	
	0.35 x IΔn	t = ∞
	1.4 x IΔn	t = <300 ms
	2.8 x IΔn	t = <150 ms
	7 x IΔn	t = ≤40 ms
	At point of wave 90°	
	0.25 x IΔn	t = ∞
	1.4 x IΔn	t = <300 ms
	2.8 x IΔn	t = <150 ms
	7 x IΔn	t = ≤40 ms
	At point of wave 135°	
	0.11 x IΔn	t = ∞
	1.4 x IΔn	t = <300 ms
	2.8 x IΔn	t = <150 ms
	7 x IΔn	t = ≤40 ms



Tripping curve type A
[3]) Standard in New Zealand
[4]) DSRCBH is type A.

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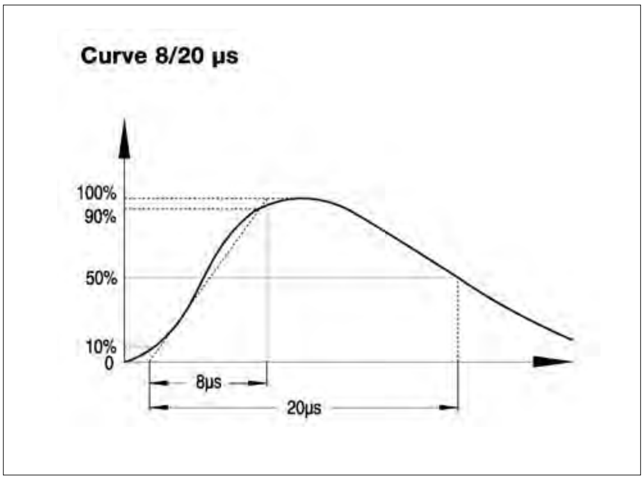
Din-T MCBs + RCDs Technical data

Nuisance tripping

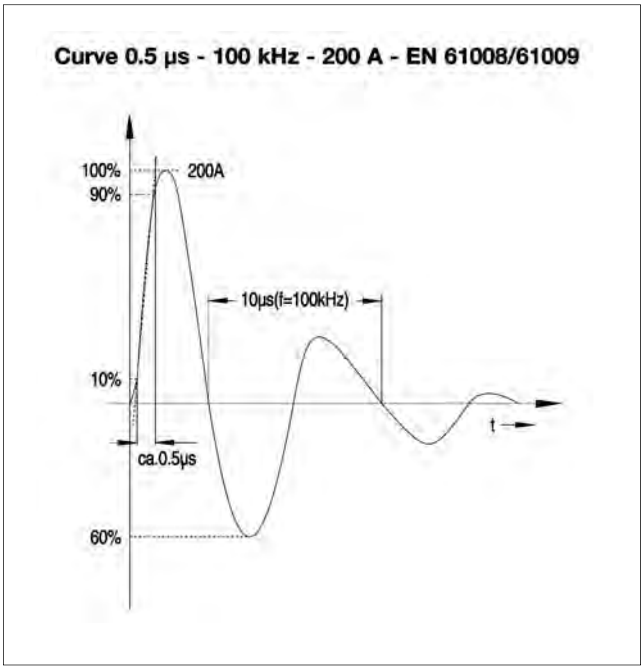
All DinSafe RCDs have a high level of immunity to transient currents, against current impulses of 8/20 µs according to EN 61008/61009 and VDE 0664.T1.

Type A, AC...................................250 A 8/20 µs

Type S.......................................3000 A 8/20 µs

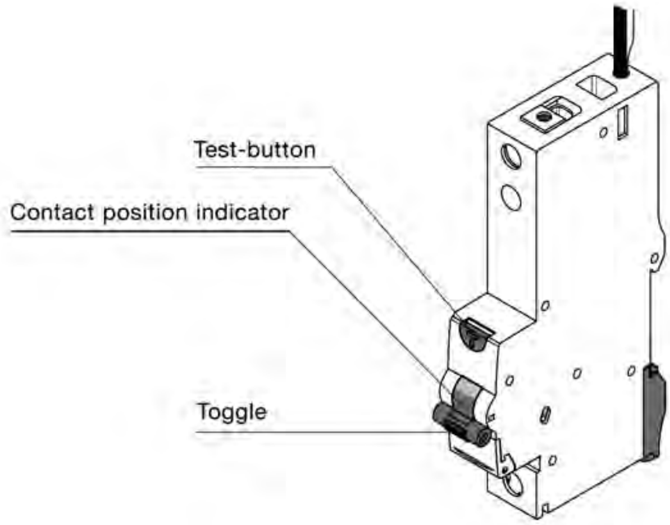


RCDs have a high level of immunity against alternating currents of high frequency according to EN 61008/61009.

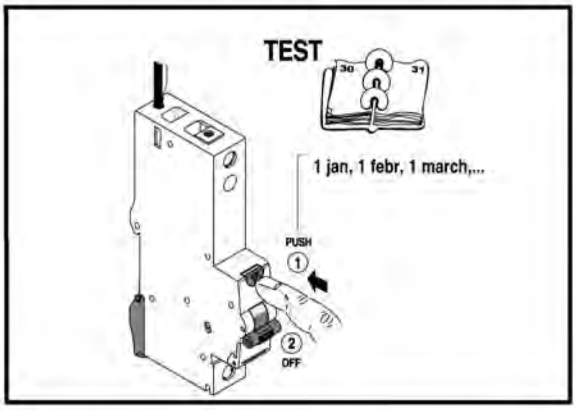


Din-T MCBs + RCDs Technical data

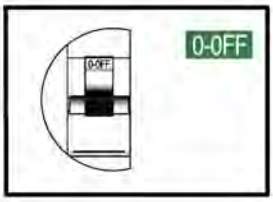
Use of an RCBO (DSRCBH)



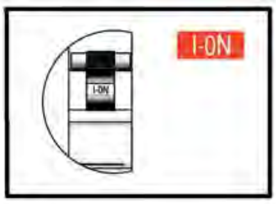
TEST-BUTTON
To ensure the correct functioning of the RCBO, the test-button T shall be pressed frequently. The device must trip when the test-button is pressed.



CONTACT POSITION INDICATOR
Printing on the toggle to provide information of the real contact position.



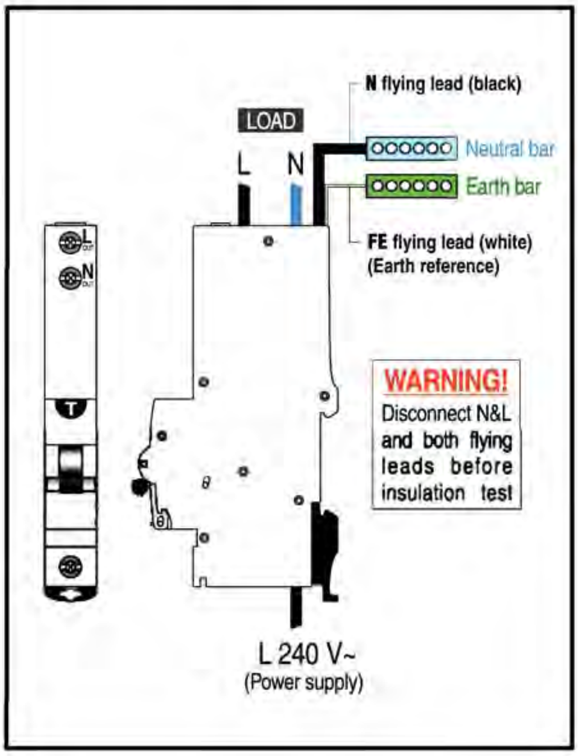
O-OFF
Contacts in open position. Ensure a distance between contacts > 4 mm.



I-ON
Contacts in closed position. Ensure continuity in the main circuit.

TOGGLE
To manually switch the RCBO ON or OFF

CABLE CONNECTION
The power supply (L) must be done at the bottom terminal, and the supply neutral flying cable (black) shall be connected to the neutral bar.
Load connection shall be done in both terminals at the top side (L out / N out).
The earth reference cable (FE white) ensures protection against earth leakage in case of loss of supply neutral.



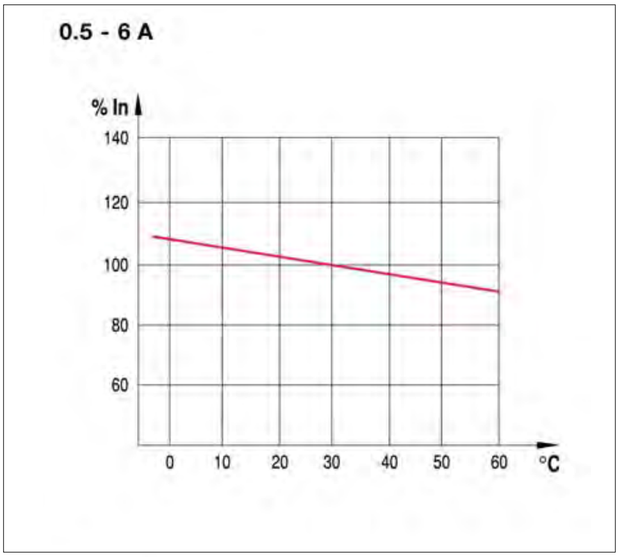
Din-T MCBs + RCDs Technical data

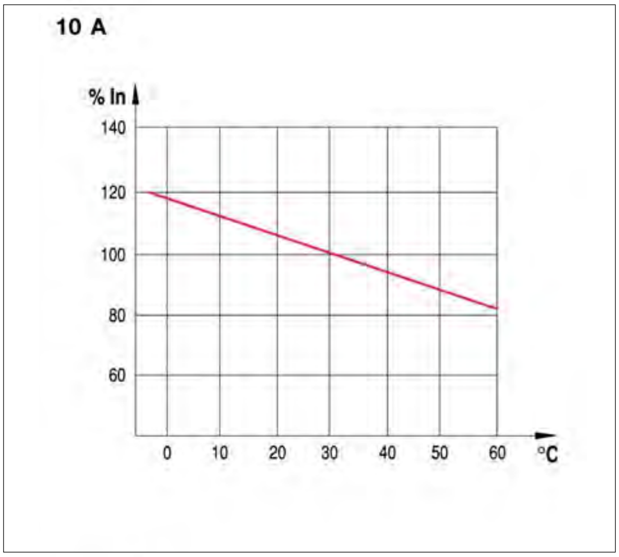
Product related information

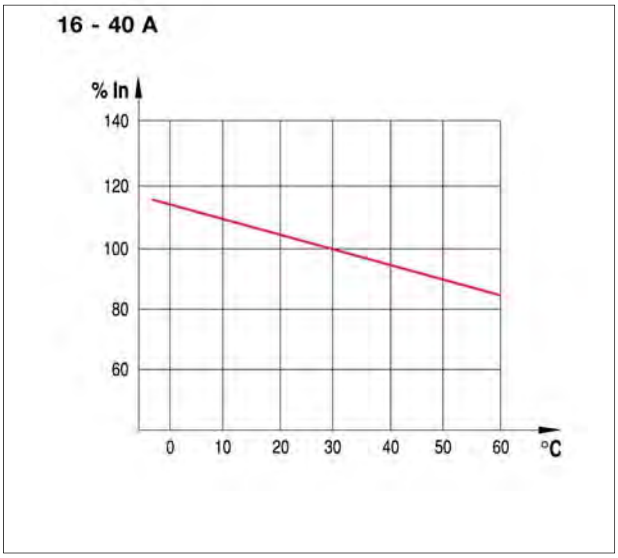
3

Influence of temperature on RCBOs (DinSafe DSRCB)

The thermal calibration of the RCBO was carried out at an ambient temperature of 30 °C. Ambient temperatures different from 30 °C influence the bimetal and this results in earlier or later thermal tripping.







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Din-T MCBs + RCDs Technical data

Tripping current as a function of the frequency

All RCDs are designed to work at frequencies of 50-60 Hz, therefore to work at different values, we must consider the variation of the tripping sensitivity according to the tables below. It should be taken into consideration that there is a no tripping risk when pushing the test-button, due to the fact that such action is made by means of an internal resistor with a fixed value.

RCBO DSRCBH [3])

Type AC [1])	10 Hz	30 Hz	50 Hz	100 Hz	200 Hz	300 Hz	400 Hz
30 mA	0.62	0.65	0.80	0.91	1.24	1.55	1.88
100 mA	0.74	0.71	0.80	0.95	1.16	1.38	1.59
300 mA	0.80	0.74	0.80	0.97	1.19	1.44	1.64
500 mA	1.10	0.81	0.80	0.89	1.18	1.38	1.68
Type A [2])							
30 mA	8.17	3.13	0.75	1.70	3.10	3.52	3.67
100 mA	6.81	2.71	0.75	1.43	2.35	2.58	2.71
300 mA	6.20	2.16	0.75	0.49	0.87	0.74	0.95
500 mA	4.34	1.53	0.75	0.39	0.59	0.62	0.64

Notes: [1]) The standard NHP/Terasaki type is the “type AC” in Australia, Type “A” in New Zealand.
[2]) The standard NHP/Terasaki DSRCBH single pole RCBO is “type A” in Australia and New Zealand.
[3]) The numbers in the table above are multipliers, e.g. A “DSRCD” at 50 hz has an 0.8 multiplier.
Therefore a 30 mA, “type AC” RCD will trip at (0.8 x 30 mA) 24 mA.

Power losses

The power losses are calculated by means of measuring the voltage drop between the incoming and the outgoing terminal of the device at rated current. Power loss per pole:

RCBO-Single pole DSRCBH

In (A)	6	10	13	16	20	25	32	40	50	63
Z (mOhm)	45.8	16.4	12.5	10.6	7.3	5.4	3.2	2.6	1.9	1.4
Pw (W)	1.65	1.7	2.1	2.7	2.9	3.3	3.4	4.2	4.8	5.6

3

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Din-T MCBs + RCDs Technical data

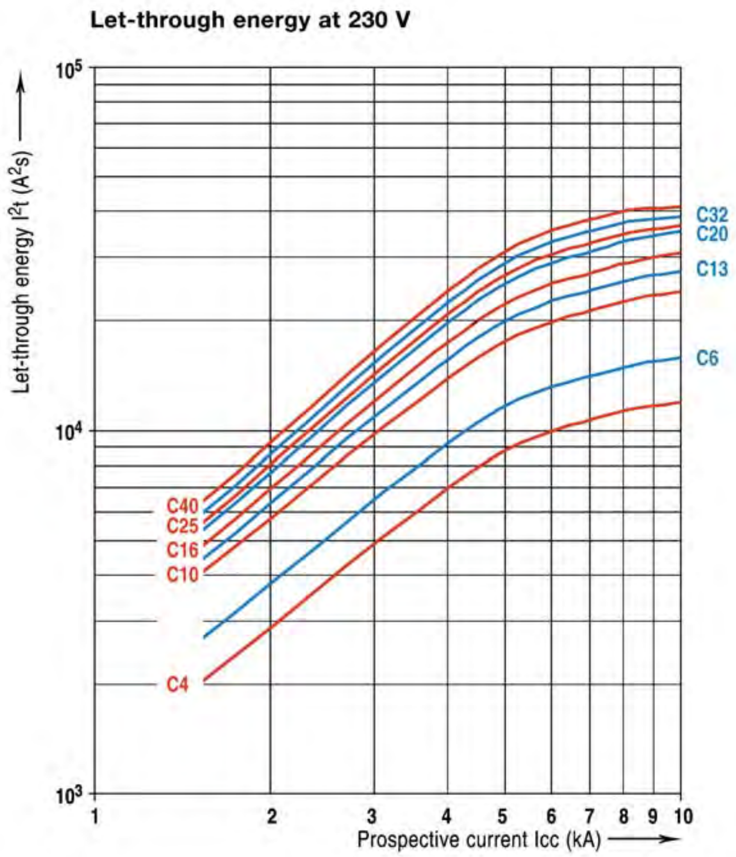
RCBO (DSRCB) let-through energy I^2t

The benefit of an RCBO in short-circuit conditions, is its ability to reduce the value of the let-through energy that the short-circuit would be generating.

Din-T single pole width RCD (DSRCBH)

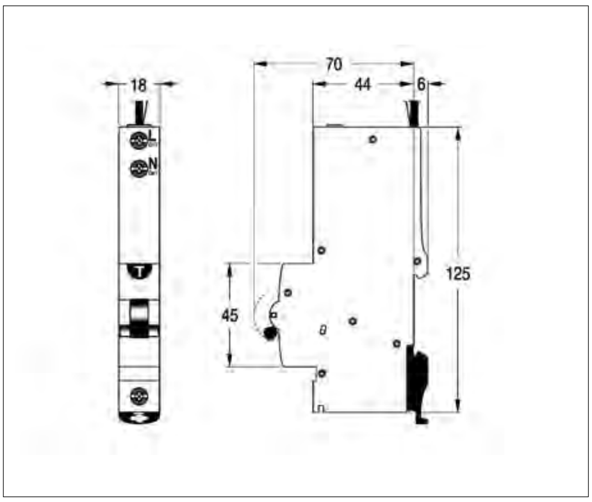
3

Curve C



RCCB - Din-Safe safety switch (DSRCD)

RCBO - Din-Safe (DSRCBH)



Dimensions in mm

Din-T MCBs + RCDs Technical data

Overview Din-Safe RCDs

RCBO

Device type definition

Rating/description		Cat. No.	DSRCBH
Standards			IEC 61009-1
Magnetic tripping characteristics			C
Residual tripping characteristic [1]			A
Tripping time at IΔn	Instantaneous	ms	<300
	Selective	ms	-
Rated current		A	6, 10, 16, 20, 25, 32, 40
Rated residual current IΔn		mA	10, 30
Calibration temperature		°C	30
Number of poles versus modules			1
Rated voltage Un	2 P AC	V	240 (1 P+N)
	3 P AC	V	-
	4 P AC	V	-
Frequency		Hz	50/60
Maximum service voltage Ubmax		V	255
Minimum service voltage Ubmin		V	100
Power supply			Bottom
Selectivity class			3
Rated making and breaking capacity (Im)		A	10xIn
Residual making and breaking capacity (IΔm)		A	10000
Conditional short-circuit capacity (Inc)		A	-
Conditional residual short-circuit capacity (IΔc)		A	-
Short-circuit capacity (Icn)		A	10000
Grid distance (safety distance between two devices)		mm	-
Isolator application			yes
Insulation degree	Insulation voltage	V (DC)	500 [2]
	Shock voltage (1.2/50 ms)	kV	6 [2]
	Insulation resistance	(mOhm)	1000 [2]
	Dielectric strength	V	2500 [2]
Shock resistance (in x, y, z direction)(IEC 60077/16.3)			40 g, 18 shocks 5 ms
Vibration resistance (in x, y, z direction; IEC 60068-2-6)			2 g, 30 min, 0...80 Hz
Endurance	electrical at Un, In		10000
	mechanical at Un, In		20000
Protection degree (outside/inside electrical enclosure)			IP 20 / IP 40
Self extinguish degree (according to UL 94)			V2
Tropicalisation (according to IEC 60068-2, DIN 40046)		°C/RH	+55/95 %
Pollution degree (acc. IEC 60947-1)			3
Operating temperature		°C	-5..+60
Storage temperature		°C	-25..+70
Terminals capacity	Rigid cable min/max (Top)	mm^2	1/25
	Flexible cable min*/max (Top)	mm^2	1/16
	Rigid cable min/max (bottom)	mm^2	1/35
	Flexible cable min*/max (bottom)	mm^2	1/25
	(*Flexible cable 0.75/1/1.5 mm^2 with cable lug)		
Torque	Top/Bottom	Nm	3
Add-on devices (side add-on)	Auxiliary contacts		-
	UVT		-
	Shunt trip		-
	Motor operator		-
	Panelboard switch		Bottom
Busbars systems	Pin		Bottom
	Fork		yes
Accessories			
Dimensions, weights, packaging		# Poles	1+N
	(HxDxW) 86x68xW	mm	18
	Weight/unit	g	350
	Package/unit		1

Note: [1]) Refer catalogue section for types.

[2]) Making sure that N-L and both flying leads are disconnected.

4. Contactor & Thermal Overload

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

CONTACTOR AND THERMAL OVERLOAD

1. CA6 CONTACTOR TECHNICAL DETAILS
2. CA7 CONTACTOR TECHNICAL DETAILS
3. CT7 SERIES THERMAL OVERLOAD TECHNICAL DETAILS

sprecher+ schuh

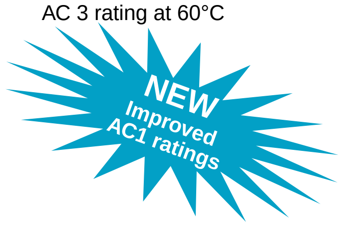
AC contactors

3 pole open type with AC coil

NHP

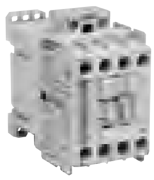
Refer catalogue CA 6, 2212, SACS

AC 3 rating at 60°C

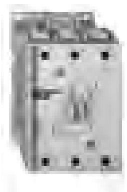


Ratings to IEC 947 and AS 3497 400/415 V

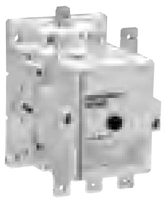
- For CA 7 contactors with coil terminals on line side, add …V AC to Catalogue No. Eg - CA 7-9-10-240 V AC [3])
- For CA 7 contactors with coil terminals on load side, add …V AC-U to Catalogue No. Eg - CA 7-9-10-240 V AC-U



Contactor CA 7-9

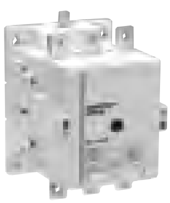


Contactor CA 7-72

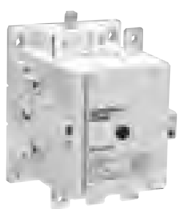


Contactor CA 6-105-EI

Contactor CA 6-170-EI



Contactor CA 6-250-EI



Contactor CA 6-420-EI

AC 3 400/415 V kW [1])	AC 3 400/415 V Amps [1])	AC 1 [6]) Amps 40 ˚C	AC 1 [6]) Amps 60 ˚C	Auxiliary contacts standard N/O	N/C	Max.	Cat. No. [2])
4	9	32	32	1	0	9	CA 7-9-10…V AC
				0	1	9	CA 7-9-01…V AC
5.5	12	32	32	1	0	9	CA 7-12-10…V AC
				0	1	9	CA 7-12-01…V AC
7.5	16	32	32	1	0	9	CA 7-16-10…V AC
				0	1	9	CA 7-16-01…V AC
11	23	32	32	1	0	9	CA 7-23-10…V AC
				0	1	9	CA 7-23-01…V AC
15	30	50	45	0	0	8	CA 7-30-00…V AC
18.5	37	50	45	0	0	8	CA 7-37-00…V AC
22	43	85	63	0	0	8	CA 7-43-00…V AC
30	60	100	100	0	0	8	CA 7-60-00…V AC
37	72	100	100	0	0	8	CA 7-72-00…V AC
45	85	100	100	0	0	8	CA 7-85-00…V AC
55 (45)	95 (33)	160	135	1	1	8	CA 6-85-11…V AC
75 (55)	130 (40)	160	135	1	1	8	CA 6-105-11…V AC
90 (75)	155 (55)	250	210	1	1	8	CA 6-140-11…V AC
75 (55)	130 (40)	160	135	1	1	8	CA 6-105-EI-11…V AC[4])
90 (75)	155 (55)	250	210	1	1	8	CA 6-140-EI-11…V AC[4])
100 (90)	170 (65)	250	210	1	1	8	CA 6-170-EI-11…V AC[4])
132 (111)	225 (80)	350	300	1	1	8	CA 6-210-EI-11…V AC[4])
150 (133)	258 (95)	350	300	1	1	8	CA 6-250-EI-11…V AC[4])
185 (163)	320 (115)	450	380	1	1	8	CA 6-300-EI-11…V AC[4])
250 (225)	425 (160)	500	425	1	1	8	CA 6-420-EI-11…V AC[4])
220 (220)	370 (155)	500	420	2	2	8	CA 5-370…V AC[5])
265 (280)	450 (200)	600	510	2	2	8	CA 5-450…V AC[5])
325 (355)	550 (250)	780	645	2	2	8	CA 5-550…V AC[5])
430 (500)	700 (340)	1000	850	2	2	8	CA 5-700…V AC[5])
520 (550)	860 (380)	1100	930	2	2	8	CA 5-860…V AC[5])
600	1000	1200	1020	1	1	8	CA 5-1000…V AC[5])
700	1150	1350	1150	1	1	8	CA 5-1200…V AC[5])

Notes:
1) 1000 volt ratings ( ).
2) Add control voltage to Cat. No. when ordering: 24, 32, 110, 240, 415, 440V 50 Hz.
Standard voltages for CA 6-105-EI…250-EI are 24, 48, 110, 240 and 415 V AC.
Standard voltages for CA 6-300-EI…420-EI 48, 110, 240 and 415 V AC.
Standard voltages for CA 5-370…1200, 110, 240 and 415 V AC.
3) All CA 7 coils can be reversed for line or load side coil terminals as required. Both versions are held in NHP stock for convenience.
4) Electronically controlled mechanism (ECM) with interface suffix (EI).
5) 55 ˚C enclosed.
6) Contact NHP for recommended cable size.

240/415 V rated coils are suitable for use on 230/400 V in accordance with AS 60038 : 2000.

Refer catalogue CA 6, 2212

CA 6 1000 volt contactor system

The latest in switching technology up to 1000 volts

The CA 6 contactors offer the latest in switching technology up to 1000 volts, from Sprecher + Schuh.

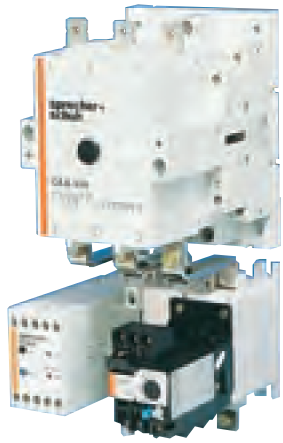
The development of the CA 6 range now covers the CA 6-85 to the CA 6-420, the complete range covering 1000 volt, AC 3 ratings up to 225 kW with 400/415 volt ratings up to 250 kW. Special design features of these contactors include a unique electronically controlled mechanism (ECM) which is standard on all sizes except the CA 6-85-11.

A choice of motor protection

Thermal overload relays CT 6 as well as the CEF 1 and CET 4 electronic motor protection relays are also rated at 1000 volts. They are ideally suited for combining with the CA 6 and CA 5 contactors providing a choice of quality motor protection solutions. For contactors CA 6-210 and above the standard protection can be CEF or CET 4 electronic motor protection.

Compact 90 kW 1000 volt starter with CEF 1 electronic motor protection.

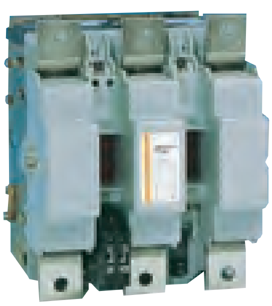
The CET 4 electronic motor protection relay can be combined with S+S 1000 volt contactors.



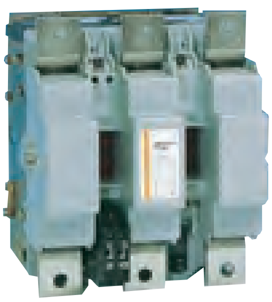
CA 6 with CT 6 thermal overload Here, the CT 6 displays innovative design concepts, with the direct mounting of the S+S RT 3 thermistor protection relay.

High current contactors CA 5

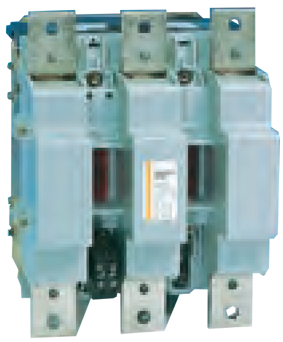
The CA 5-370 … CA 5-860 high current contactors combine high switching currents up to 1000 volts together with low coil power consumption due to a specially designed coil and magnet system. These rugged and reliable contactors extend the 1000 volt switching capacities of Sprecher + Schuh contactors up to 550 kW as well as being suitable for AC 3 400/415 volt applications up to 500 kW.



1000 V contactor CA 5-370



1000 V contactor CA 5-550



1000 V contactor CA 5-860

CA 6 contactors
45 - 250kW up to 1000 volts

Refer catalogue CA 6

Contactors with electronically controlled mechanism (ECM)
tested to IEC 947

CA 6 - A complete range

The CA 6 range of 1000 volt contactors is now available through to 420 amp. The range now incorporates eight sizes from 45 to 250 kW @ 400/415 volts and 225 kW at 1000 volts.

Electronically controlled mechanism (ECM)

The electronically controlled mechanism has, with the release of the larger CA 6 contactors, been further improved. As well as providing the unique advantages of electronic coil control, the ECM version now includes a built in PLC interface. These are identified with the suffix EI on the Cat. No.

What is "ECM"

ECM stands for "Electronically Controlled Mechanism". With the version EI, an electronic circuit regulates the voltage to the contactor coil. This is achieved using an ASIC (application specific integrated circuit) which precisely controls the pick-up and drop-out levels of the contactor. This provides decisive advantages for the user.

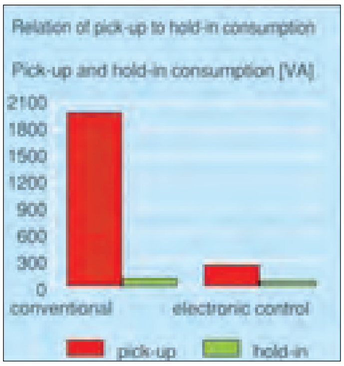
- Very low pick-up and hold coil consumption (constant VA)
- No contact chatter because of defined pick-up and drop-out voltages
- High contact reliability due to minimised tendency to contact bounce
- Built-in suppression circuits
- Built-in PLC interface
- Wide voltage tolerance of coils suitable for 50/60 Hz (DC versions also available)
- EMC compatibility:

(Note EMC is not to be confused with ECM. EMC means that the contactors also conform to Electromagnetic compatibility standards for noise

CA 6

Cat. No.	400/415 V AC 3 kW	1000 V AC 3 kW
CA 6-85	55	45
CA 6-105-(EI)	75	55
CA 6-140-EI	90	75
CA 6-170-EI	100	90
CA 6-210-EI	132	111
CA 6-250-EI	150	133
CA 6-300-EI	185	163
CA 6-420-EI	250	225

Relation of pick-up to hold-in consumption



Extremely low pick-up and hold-in coil consumption compared with conventional contactors.

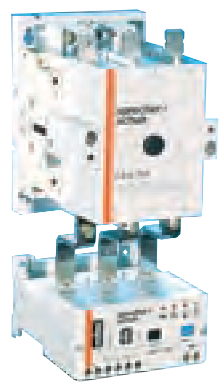
CA 6-170-EI is a 90 kW contactor with ECM

Robust and versatile

- Rated up to 1000 volts
- Type 2 co-ordination with fuses or circuit breakers
- High thermal capacity
- High switching capacity
- Mechanical interlock does not increase overall width
- Up to 8 auxiliary contacts
- Flexible busbars and mounting plates available for quick assembly of starter combinations
- Choice of electronic motor protection or CT 6 thermal overloads
- Plug-in voltage suppressors

Safety first

- Arc chamber cannot be removed with the contactor energised
- Contactor cannot be energised unless arc chambers are locked into place
- Switch position indicator (manual operation of contactor not possible)
- Closed arc chambers prevent hot gases escaping. Safety distance in front of contactor not necessary
- Touch proof design using special insulated terminal blocks and terminal covers
- No cadmium or asbestos (environmentally safe)



CA 6 contactor fitted with CEF 1-12 electronic protection provides the ideal starter.

sprecher+schuh

TERASAKI
Ensuring Service, Maintaining Quality

Short circuit co-ordination
Type ‘1’ with circuit breakers or fuses

NHP

Refer Catalogue C-CO

MCCB or fuse DOL starting
50/65 kA @ 400/415 V to AS 3947.4.1

TemBreak Moulded Case Circuit Breaker or fuse

Motor size kW	Approx. amps	Terasaki circuit breaker	or NHP HRC fuse to BS88	Sprecher + Schuh contactor type	Sprecher + Schuh thermal O/L relay type	Setting range amps
0.37	1.1	XM30PB/1.4	NTIA-6	CA 7-9	CT 7-24	1 - 1.6
0.55	1.5	XM30PB/2	NTIA-6	CA 7-9	CT 7-24	1 - 1.6
0.75	1.8	XM30PB/2.6	NTIA-10	CA 7-9	CT 7-24	1.6 - 2.4
1.1	2.6	XM30PB/4.0	NTIA-10	CA 7-9	CT 7-24	2.4 - 4
1.5	3.4	XM30PB/5	NTIA-10	CA 7-9	CT 7-24	2.4 - 4
2.2	4.8	XM30PB/8	NTIA-16	CA 7-9	CT 7-24	4 - 6
3.0	6.5	XM30PB/10	NTIA-16	CA 7-9	CT 7-24	6 - 10
4.0	8.2	XM30PB/12	NTIA-25	CA 7-9	CT 7-24	6 - 10
5.5	11	XH125NJ/20	NTIA-32	CA 7-12	CT 7-24	10 - 16
7.5	14	XH125NJ/20	NTIS-40	CA 7-16	CT 7-24	10 - 16
11	21	XH125NJ/32	NTIS-50	CA 7-23	CT 7-24	16 - 24
15	28	XH125NJ/50	NTIS-63	CA 7-30	CT 7-45	18 - 30
18.5	34	XH125NJ/50	NTCP-80	CA 7-37	CT 7-45	30 - 45
22	40	XH125NJ/63	NTCP-80	CA 7-43	CT 7-45	30 - 45
30	55	XH125NJ/100	NTCP-100	CA 7-60	CT 7-75	45 - 60
37	66	XH125NJ/100	NTF-160	CA 7-72	CT 7-75	60 - 75
45	80	XH125NJ/125 [1])	NTF-160	CA 6-85	CT 7-100	70 - 90
55	100	XH125NJ/125 [1])	NTF-200	CA 6-105-EI	CT 6-110	85 - 110
75	130	XH250NJ/250	NTKF-250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH250NJ/250 [1])	NTKF-250	CA 6-170-EI	CT 6-200	140 - 200
110	200	XH250NJ/250 [1])	NTKF-315	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XH400NE/400	NTMF-355	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XH400NE/400	NTMF-355	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XH400NE/400	NTMF-400	CA 6-300-EI	CEF 1-41/42	160 - 400
185	310	XH400NE/400	NTTF-450	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XH400NE/400	NTTM-500	CA 6-420-EI/CA 5-450	CEF 1-41/42	160 - 400
250	425	XH630NE/630	NTTM-630	CA 6-420-EI/CA 5-450	CEF 1-52	160 - 630
315	530	XH630NE/630	NTLM-710	CA 5-550	CEF 1-52	160 - 630

Notes: Fuses 65 kA. XH125NJ circuit breaker combinations limited to 50 kA, others 65 kA.
Overloads may be changed to different types eg. thermal style to electronic.
Some combinations also gives Type ‘2’ performance.
[1]) Use ‘magnetic only’ breaker - Refer NHP.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

sprecher+ schuh

TERASAKI
Ensuring Service, Maintaining Quality

Short circuit co-ordination
Type ‘2’ with NHP fuses

NHP

Refer Catalogue C-CO

Fuse protection DOL starting [1]) 50/65 kA @ 400/415 V to AS 3947.4.1

Fuse

Motor size kW	Approx. amps @ 400/415 V	NHP HRC fuse to BS88	Sprecher + Schuh contactor	Sprecher + Schuh overload relay [2]) [3])	Setting range amps
0.37	1.1	NTIA-4	CA 7-9	CEP 7	1.0 - 2.9
0.75	1.8	NTIA-6	CA 7-9	CEP 7	1.0 - 2.9
1.5	3.4	NTIA-10	CA 7-9	CEP 7	1.6 - 5
2.2	4.8	NTIA-16	CA 7-9	CEP 7	3.7 - 12
4.0	8.2	NTIA-20	CA 7-9	CEP 7	3.7 - 12
5.5	11	NTIA-25	CA 7-12	CEP 7	3.7 - 12
7.5	14	NTIA-32	CA 7-16	CEP 7	12 - 32
11	21	NTIS-50	CA 7-30	CEP 7	12 - 32
15	28	NTIS-63	CA 7-30	CEP 7	12 - 37
18.5	34	NTCP-80	CA 7-37	CEP 7	12 - 37
22	40	NTCP-80	CA 7-43	CEP 7	14- 45
30	55	NTCP-100	CA 7-60	CEP 7	26 - 85
37	66	NTF-125	CA 7-72	CEP 7	26 - 85
45	80	NTF-160	CA 7-85	CEP 7	26 - 85
55	100	NTF-200	CA 6-105-EI	CT 6-110	85 - 110
75	130	NTKF-250	CA 6-140-EI	CT 6-150	105 - 150
90	155	NTKF-250	CA 6-170-EI	CT 6-200	140 - 200
110	200	NTKF-315	CA 6-210-EI	CEF 1-41/42 [4])	160 - 400
132	225	NTMF-355	CA 6-210-EI	CEF 1-41/42 [4])	160 - 400
150	250	NTMF-355	CA 6-250-EI	CEF 1-41/42 [4])	160 - 400
185	320	NTTM-450	CA 6-300-EI	CEF 1-41/42 [4])	160 - 400
250	425	NTTM-560	CA 6-420-EI	CEF 1-52 [4])	160 - 630
320	538	NTLM-710	CA 5-550	CEF 1-52 [4])	160 - 630
380	650	NTLM-800	CA 5-700	CEF 1-11/12P [4])	300 - 1200

Notes:
[1]) Fuses with equal or lower let through energy may also be used.
[2]) Thermal overloads may be used instead of electronic CEP 7.
[3]) Above 37 kW overloads may also be electronic or thermal.
[4]) CET 4 may be used instead of CEF 1.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

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TERASAKI
Ensuring Service, Maintaining Quality

Short circuit co-ordination
Type '2' using Terasaki circuit breakers

NHP

Refer Catalogue C-CO

TemBreak circuit breakers DOL starting 50 kA @ 400/415 V to AS 3947.4.1

TemBreak MCCBs

Motor size kW	Approx. amps	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh overload relay	Setting range amps
0.37	1.1	XM30PB/1.4	CA 7-9	CT 7-24-1.6	1 - 1.6
0.55	1.5	XM30PB/2	CA 7-9	CT 7-24-1.6	1 - 1.6
0.75	1.8	XM30PB/2.6	CA 7-9	CT 7-24-2.4	1.6 - 2.4
1.1	2.6	XM30PB/4.0	CA 7-16	CT 7-24-4	2.4 - 4
1.5	3.4	XM30PB/5	CA 7-16	CT 7-24-4	2.4 - 4
2.2	4.8	XM30PB/8	CA 7-16	CT 7-24-6	4 - 6
3	6.5	XM30PB/10	CA 7-30	CT 7-24-10	6 - 10
4	8.2	XM30PB/12	CA 7-30	CT 7-24-10	6 - 10
5.5	11	XH125NJ/20	CA 7-30	CT 7-24-16	10 - 16
7.5	14	XH125NJ/20	CA 7-30	CT 7-24-16	10 - 16
11	21	XH125NJ/32	CA 7-30	CT 7-24-24	16 - 24
15	28	XH125NJ/50	CA 7-43	CT 7-45-30	18 - 30
18.5	34	XH125NJ/50	CA 7-43	CT 7-45-45	30 - 45
22	40	XH125NJ/63	CA 7-43	CT 7-45-45	30 - 45
30	55	XH125NJ/100	CA 6-85	CT 7-75 [2])	45 - 60
37	66	XH125NJ/100	CA 6-85	CT 7-75 [2])	60 - 75
45	80	XH125NJ/125	CA 6-105-EI	CT 6-90	70 - 90
55	100	XH125NJ/125 [1])	CA 6-105-EI	CT 6-110	85 - 110
75	130	XH250NJ/250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH250NJ/250	C A6-170-EI	CT 6-200	140 - 200
110	200	XH250NJ/250 [1])	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XS400SE/400	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XS400SE/400	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XS400SE/400	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XS400SE/400	CA 6-420-EI	CEF 1-41/42	160 - 400
200	361	XS400SE/400	CA 5-450	CEF 1-22 [2])	160 - 400
250	425	XS630SE/630	CA 5-700	CEF 1-52 [2])	160 - 630
320	538	XS630SE/630	CA 5-700	CEF 1-52 [2])	160 - 630

Notes: Overloads may be thermal or electronic.
Combinations based on the overload tripping before the circuit breaker at overload currents up to the motor locked rotor current.
[1]) Use 'magnetic only' breaker or next higher circuit breaker / contactor combination.
[2]) Use with separate mounting bracket.
Data for 65 kA co-ordination available refer Cat. C-CO.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

sprecher+ schuh

TERASAKI
Ensuring Service, Maintaining Quality

Short circuit co-ordination

Type '2' using Terasaki circuit breakers

NHP

Refer Catalogue C-CO

TemBreak circuit breakers DOL starting. 85 kA @ 400/415 V to AS 3947.4.1

MCCBs

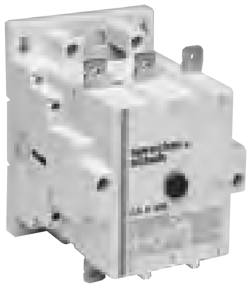
Motor size kW	Approx. FLC @ 400/415 V (A)	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L type	Setting range (A)
0.37	1.1	XM30PB/1.4	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.55	1.5	XM30PB/2.0	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.75	1.8	XM30PB/2.6	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
1.1	2.6	XM30PB/4	CA 7-16	CEP 7-M32-2.9-10	1.0 - 2.9
1.5	3.4	XM30PB/5	CA 7-16	CEP 7-M32-5-10	1.6 - 5
2.2	4.8	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
3	6.5	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
4	8.2	XM30PB/10	CA 7-30	CEP 7-M32-12-10	3.7 - 12
5.5	11	TL100NJ/20	CA 7-30	CEP 7-M32-12-10	3.7 - 12
7.5	14	TL100NJ/20	CA 7-30	CEP 7-M32-32-10	12 - 32
9	17	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
10	19	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
11	21	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
15	28	TL100NJ/50	CA 7-43	CEP 7-M32-32-10	12 - 32
18.5	34	TL100NJ/50	CA 7-43	CEP 7-M37-37-10	12 - 37
22	40	TL100NJ/63	CA 7-43	CEP 7-M45-45-10	14 - 45
30	55	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
37	66	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
45	80	TL250NJ/160	CA 6-105	CEP 7-M85-85-10	26 - 85
55	100	TL250NJ/160	CA 6-105	CEF 1-11/12	0.5 - 180
75	135	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
90	160	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
110	200	TL250NJ/250	CA 6-210-EI	CEF 1-41/42/52	160 - 630
132	230	TL400NE/400	CA 6-210-EI	CEF 1-41/42/52	160 - 630
160	270	TL400NE/400	CA 6-300-EI	CEF 1-41/42/52	160 - 630
200	361	TL400NE/400	CA 6-420-EI	CEF 1-41/42/52	160 - 630

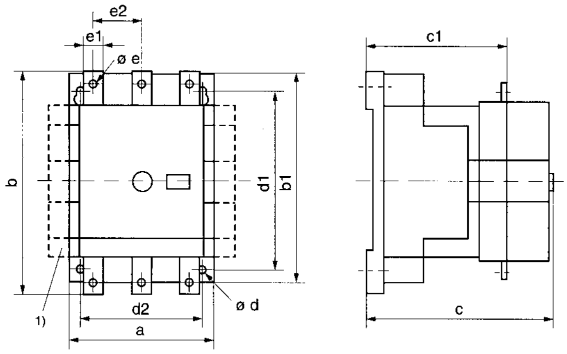
Contactors and overloads CA 6 + CT 6

Dimensions (mm)

Refer catalogue CA6

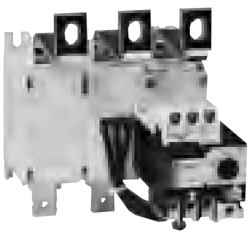
CA 6 Contactors

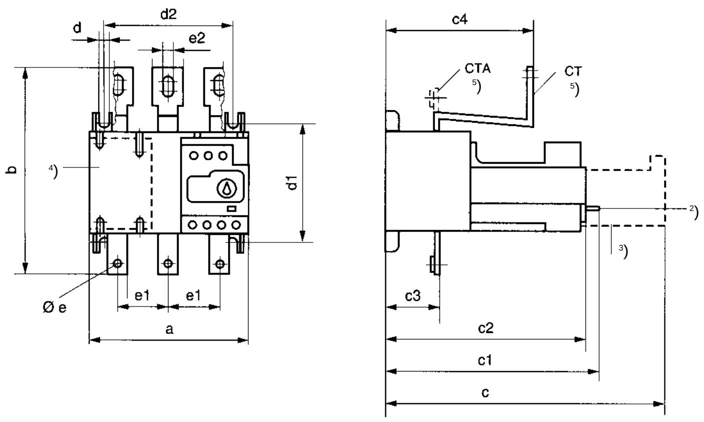




Type	a	b	b1	c	c1	ød	d1	d2	øe	e1	e2
CA 6-85/CA 6-105	120	182	170	156	110	5.2	145	100	M6	16	39
CA 6-105EI/CA 6-140/CA 6-170EI	120	182	170	156	110	5.2	145	100	M8	20	39
CA 6-210-EI…CA 6-420-EI	155	222	205	180	110	6.5	180	130	M10	25	48

CT 6 thermal overload





Type	a	b	c	c1	c2	c3	c4	d	d1	d2	øe	e1	e2
CT 6-90…CT 6-110	120	148	193	161	151.5	41	114	-	85	100	M6	39	8.5
CT 6-150…CT 6-200	120	170	193	161	151.5	45	114	-	85	100	M8	39	8.5
CTA 6-90… CTA 6-100	120	133	193	161	151.5	41	-	-	85	100	M6	39	M6
CTA 6-150…CTA 6-200	120	176	193	161	151.5	45	-	-	85	100	M8	39	M8

NEW

CEF 1-42 for contactors CA 6-210(EI) to CA 6-420EI.

Electronic motor protection for CA 6 contactor

In addition to standard current transformer operated thermal overloads for CA 6 contactors upto 200 amps, the CEF 1 electronic motor protection relay can also be utilised for the whole CA 6 range. For the contactors CA 6-210(EI)…CA 6-420EI the standard overload is the CEF 1-42. The CEF relay provides adjustable trip curves, phase failure protection and thermistor protection as standard.

Notes:
1) No increase in base dimension when fitted with P1, P2 aux. For auxiliary contact P3, P4 plus 13.5 mm.
2) Button travel - 3.5 mm for "reset". 6 mm for "test".
3) With reset magnet CMR.
4) Space for fitting CS 4 or CS 3 or RT 3 thermistor relay (M3.5 screws and nuts required).
5) CT = direct mounting on CA 6, CTA = for separate mounting.

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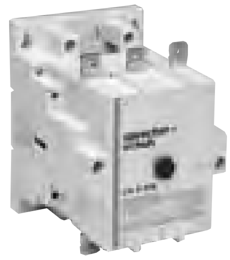
Starters CA 6

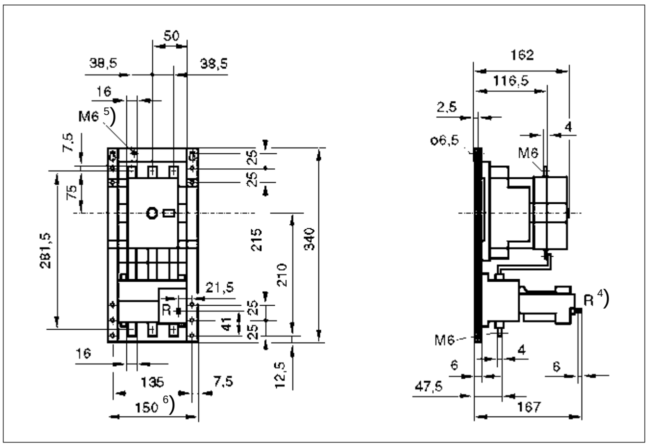
Dimensions (mm)

NHP

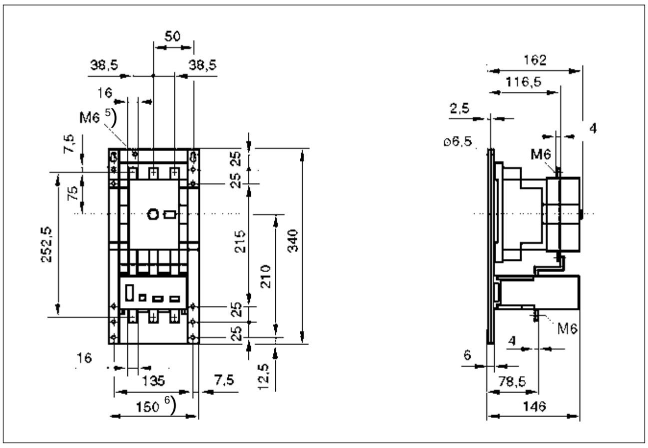
Refer catalogue CA6



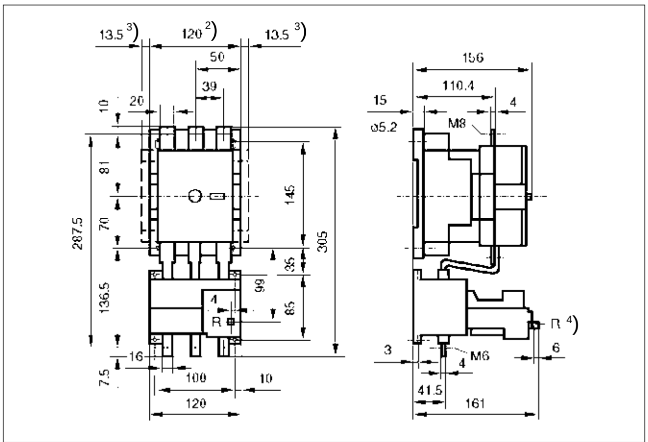
- Complete contactor range up to 425 amps
- 1000 volt rated
- Available with electronic motor protection CEF 1
- Option for electronic coil control (ECM)
- Built in safety features
- Tested to IEC 947



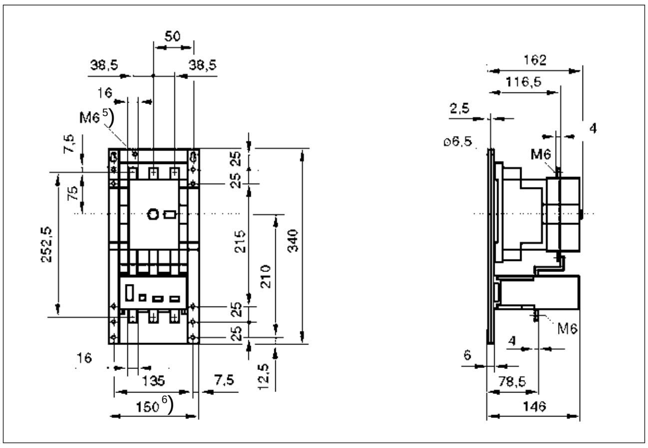
CA 6-85, CA 6-105 + CT 6-90, CT 6-110 ¹)



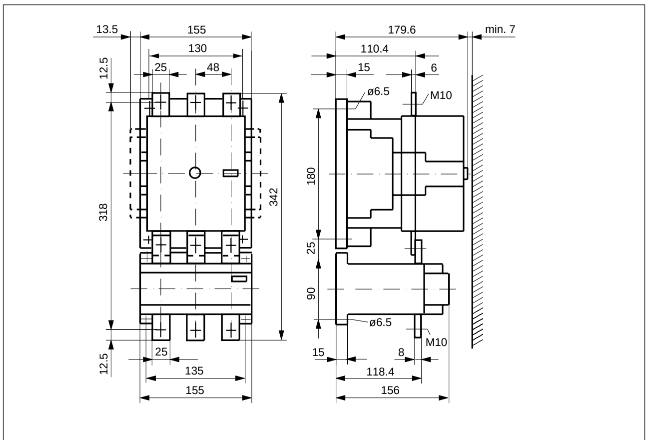
CA 6-85, CA 6-105 + CEF 1 ¹)



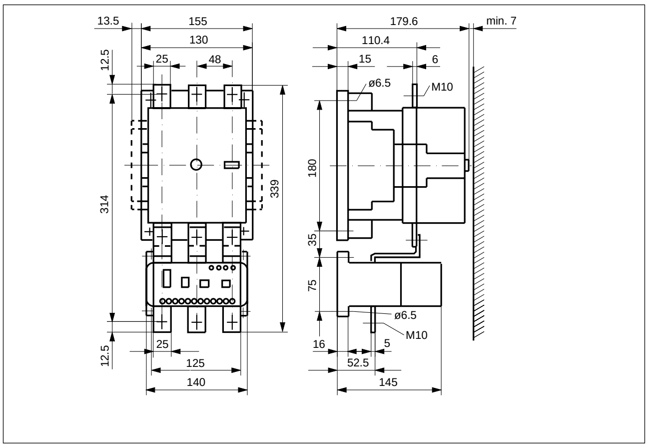
CA 6-105-EI, CA 6-140(EI), CA 6-170-EI + CT 6-150, CT 6-200



CA 6-105-EI, CA 6-140(EI), CA 6-170-EI + CEF 1



CA 6-210-EI…CA 6-420-EI + CWE 4-630



CA 6-210-EI…CA 6-420-EI + CEF 1-42

Notes:
1) Shown mounted on optional DOL mounting plate.
2) With one or two auxiliary contact blocks CA 6-P.
3) For third and fourth auxiliary contact blocks add 13.5 mm each.
4) R= Reset button: 3.5 mm travel = Reset , 6 mm travel = test.
5) Earthing terminal.
6) For 1...4 CA 6-P auxiliary contact blocks.

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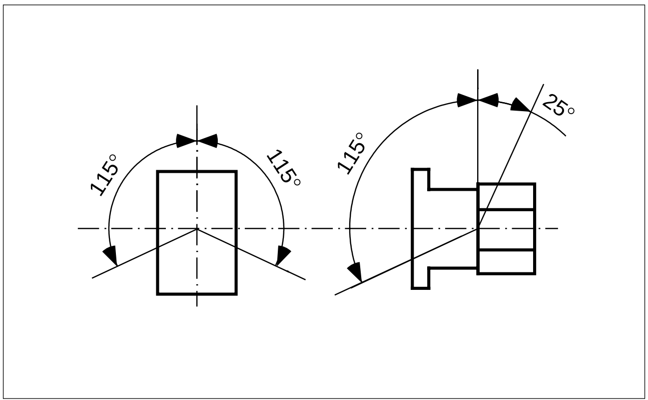
Contactors CA 6

Dimensions (mm)

Mounting positions CA 6



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AC contactors
3 pole open type with AC coil

NHP

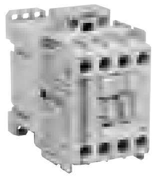
Refer catalogue CA 6, 2212, SACS

AC 3 rating at 60°C

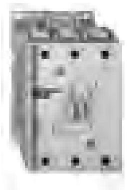
NEW Improved AC1 ratings

Ratings to IEC 947 and AS 3497 400/415 V

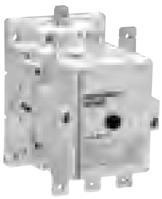
- **For CA 7 contactors with coil terminals on line side, add …V AC to Catalogue No. Eg - CA 7-9-10-240 V AC [3])**
- **For CA 7 contactors with coil terminals on load side, add …V AC-U to Catalogue No. Eg - CA 7-9-10-240 V AC-U**



Contactor CA 7-9

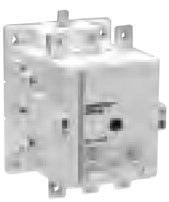


Contactor CA 7-72

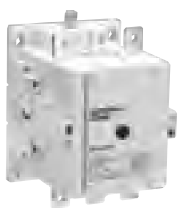


Contactor CA 6-105-EI

Contactor CA 6-170-EI



Contactor CA 6-250-EI



Contactor CA 6-420-EI

AC 3 400/415 V kW [1])	AC 3 400/415 V Amps [1])	AC 1 [6]) Amps 40 ˚C	AC 1 [6]) Amps 60 ˚C	Auxiliary contacts standard N/O	N/C	Max.	Cat. No. [2])
4	9	32	32	1	0	9	**CA 7-9-10…V AC**
				0	1	9	**CA 7-9-01…V AC**
5.5	12	32	32	1	0	9	**CA 7-12-10…V AC**
				0	1	9	**CA 7-12-01…V AC**
7.5	16	32	32	1	0	9	**CA 7-16-10…V AC**
				0	1	9	**CA 7-16-01…V AC**
11	23	32	32	1	0	9	**CA 7-23-10…V AC**
				0	1	9	**CA 7-23-01…V AC**
15	30	50	45	0	0	8	**CA 7-30-00…V AC**
18.5	37	50	45	0	0	8	**CA 7-37-00…V AC**
22	43	85	63	0	0	8	**CA 7-43-00…V AC**
30	60	100	100	0	0	8	**CA 7-60-00…V AC**
37	72	100	100	0	0	8	**CA 7-72-00…V AC**
45	85	100	100	0	0	8	**CA 7-85-00…V AC**
55 (45)	95 (33)	160	135	1	1	8	**CA 6-85-11…V AC**
75 (55)	130 (40)	160	135	1	1	8	**CA 6-105-11…V AC**
90 (75)	155 (55)	250	210	1	1	8	**CA 6-140-11…V AC**
75 (55)	130 (40)	160	135	1	1	8	**CA 6-105-EI-11…V AC[4])**
90 (75)	155 (55)	250	210	1	1	8	**CA 6-140-EI-11…V AC[4])**
100 (90)	170 (65)	250	210	1	1	8	**CA 6-170-EI-11…V AC[4])**
132 (111)	225 (80)	350	300	1	1	8	**CA 6-210-EI-11…V AC[4])**
150 (133)	258 (95)	350	300	1	1	8	**CA 6-250-EI-11…V AC[4])**
185 (163)	320 (115)	450	380	1	1	8	**CA 6-300-EI-11…V AC[4])**
250 (225)	425 (160)	500	425	1	1	8	**CA 6-420-EI-11…V AC[4])**
220 (220)	370 (155)	500	420	2	2	8	**CA 5-370…V AC[5])**
265 (280)	450 (200)	600	510	2	2	8	**CA 5-450…V AC[5])**
325 (355)	550 (250)	780	645	2	2	8	**CA 5-550…V AC[5])**
430 (500)	700 (340)	1000	850	2	2	8	**CA 5-700…V AC[5])**
520 (550)	860 (380)	1100	930	2	2	8	**CA 5-860…V AC[5])**
600	1000	1200	1020	1	1	8	**CA 5-1000…V AC[5])**
700	1150	1350	1150	1	1	8	**CA 5-1200…V AC[5])**

Notes:

[1]) 1000 volt ratings ( ).

[2]) Add control voltage to Cat. No. when ordering: 24, 32, 110, 240, 415, 440V 50 Hz.
Standard voltages for CA 6-105-EI…250-EI are 24, 48, 110, 240 and 415 V AC.
Standard voltages for CA 6-300-EI…420-EI 48, 110, 240 and 415 V AC.
Standard voltages for CA 5-370…1200, 110, 240 and 415 V AC.

[3]) All CA 7 coils can be reversed for line or load side coil terminals as required. Both versions are held in NHP stock for convenience.

[4]) Electronically controlled mechanism (ECM) with interface suffix (EI).

[5]) 55 ˚C enclosed.

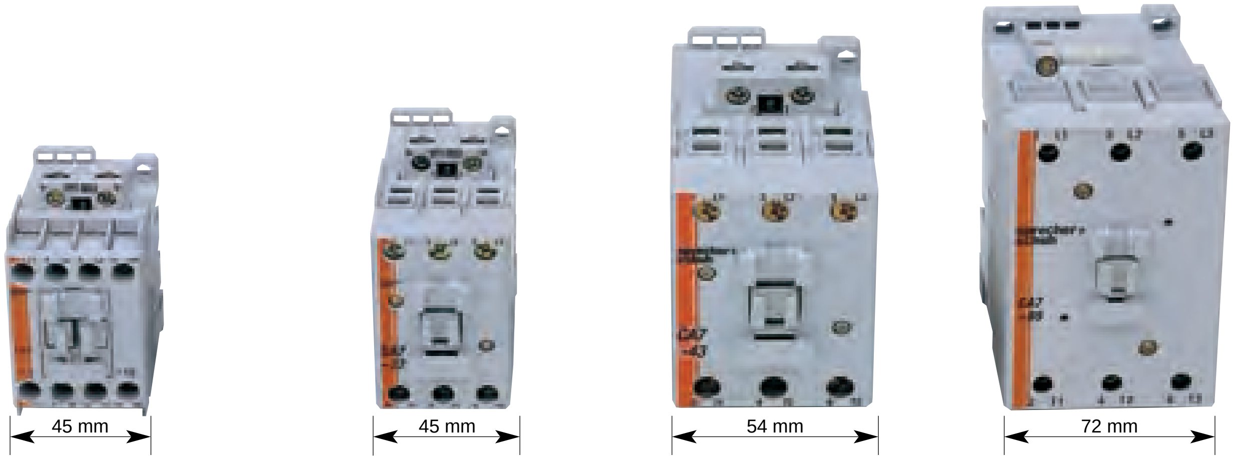
[6]) Contact NHP for recommended cable size.

240/415 V rated coils are suitable for use on 230/400 V in accordance with AS 60038 : 2000.

ACS contactors CA 7
4 – 45kW

Refer catalogue SACS

The highest switching capacity in the smallest space



Compact without compromise

Compact without compromise is the best way to describe the CA 7 range of contactors and motor protection relays from Sprecher + Schuh. In spite of the new compact dimensions, the CA 7 range features high breaking capacity and extraordinary flexibility. Up to 18.5 kW the contactors are only 45 mm wide and even the largest 45 kW frame is only 72 mm wide. The CA 7 contactors are the main component in the new Advanced Control System (ACS).

With CA 7 you have flexibility with auxiliary contacts

Common auxiliaries from 9 to 85 amps

Three fitting positions

- Front mounting
- Side mounting left
- Side mounting right

Alternatively you can choose to combine left, right and front mounting auxiliary contacts to fulfil your requirements.

Instead of the top mounted auxiliary contacts, on or off delay timing modules or mechanical latches can be fitted.

Motor switching rating AC 3 @ 400/415 V

CA 7-9	4 kW	45 mm	9 A
CA 7-12	5.5 kW		12 A
CA 7-16	7.5 kW		16 A
CA 7-23	11 kW		23 A
CA 7-30	15 kW	45 mm	30 A
CA 7-37	18.5 kW		37 A
CA 7-43	22 kW	54 mm	43 A
CA 7-60	30 kW	72 mm	60 A
CA 7-72	37 kW		72 A
CA 7-85	45 kW		85 A

With CA 7 you have more clip on accessories

Common accessories from 9 to 85 amps

- On and off delay pneumatic timers
- Coil mounted electronic timers on delay, off delay, star delta
- Coil mounted 24 V DC interface
- Coil mounted RC and varistor suppressor modules
- Mechanical latch
- Mechanical interlock
- Mechanical interlock with integrated N/C interlock contacts
- Moulded wire link sets for DOL, reversing and star delta starters
- Large choice of front and side mounting auxiliary contacts

ACS contactors CA 7
4 – 45kW

Refer catalogue SACS

Innovation and ease of use provide solutions for your control systems

Coil terminals are always in the correct position

The coil terminations on the CA 7 contactors can be supplied optionally at the top or the bottom of the contactor. It is also a simple task to change this on site should the requirements change.

When CA 7 contactors are used in combination with KTA 7 circuit motor circuit breakers the bottom coil terminations are used. For use with standard CT 7 thermal or CEP 7 electronic overloads the top coil termination should be selected.

Mechanical interlocks save space

Only 9mm wide, the CM 7 mechanical interlock snaps into place between any of the CA 7 contactors. It is allowed also to interlock different sizes of the CA 7 range with the same interlock.

The basic mechanical interlock is supplemented by a variation with built in N/C auxiliary contacts for electrical interlocking. This version is also only 9mm wide and further minimises space requirements.

CA 7 contactors provide improved wiring terminals

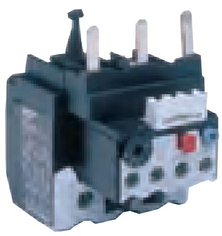
The main terminals of all CA 7 contactors are designed to accept at least two cables. At the same time they comply with safety standards regarding touch protection.

The larger contactors CA 7-30 and upwards employ a special cage terminal which allows the connection of two cables in separate chambers.

The ease of wiring with CA 7 contactors saves both time and money.

With Sprecher + Schuh you can choose the best protection for your motors.

High tech electronic protection type CEP 7 in trip class 10 or 20.



Standard thermal overloads type CT 7

ACS Short circuit co-ordination

Type '2' with KT 7 circuit breakers

Refer Catalogue C-CO

Automatic Type '2' co-ordination [1]) with no-oversizing of contactors

DOL starting
50/65 kA @ 400/415 V

NEW Automatic Type '2'

Motor size kW	Approx. amps @ 400/415 V	Sprecher + Schuh circuit breaker	Setting range amps	Magnetic amps	Sprecher + Schuh contactor	AC-3 amps
0.18	0.60	KT 7-25S	0.40 - 0.63	8.2	CA 7-9	9
0.25	0.80	KT 7-25S	0.63 - 1.00	13	CA 7-9	9
0.37	1.10	KT 7-25S	1.00 - 1.60	21	CA 7-9	9
0.55	1.50	KT 7-25S	1.00 - 1.60	21	CA 7-9	9
0.75	1.80	KT 7-25S	1.60 - 2.50	33	CA 7-9	9
1.10	2.60	KT 7-25S	2.50 - 4.00	52	CA 7-9	9
1.15	3.40	KT 7-25S	2.50 - 4.00	52	CA 7-9	9
2.20	4.80	KT 7-25S	4.00 - 6.30	80	CA 7-9	9
3.00	6.50	KT 7-25S	6.30 - 10.0	130	CA 7-9	9
4.00	8.20	KT 7-25S	6.30 - 10.0	130	CA 7-9	9
5.50	11.00	KT 7-25S	10.0 - 16.0	208	CA 7-12	12
7.50	14.00	KT 7-25S	10.0 - 16.0	208	CA 7-16	16
9.00	17.00	KT 7-25H	14.5 - 20.0	260	CA 7-23	23
11.00	21.00	KT 7-25H	18.0 - 25.0	325	CA 7-23	23
15.00	28.00	KT 7-45H	23.0 - 32.0	416	CA 7-30	30
18.50	34.00	KT 7-45H	32.0 - 45.0	585	CA 7-37	37
22.00	40.00	KT 7-45H	32.0 - 45.0	585	CA 7-43	43
30.00	55.00	KT 3-100	40.0 - 63.0	882	CA 7-60	60
37.00	66.00	KT 3-100	63.0 - 90.0	1260	CA 7-72	72
45.00	80.00	KT 3-100	63.0 - 90.0	1260	CA 7-85	85

Definition Type '2' co-ordination according to IEC 947-4-1:

- The contactor or the starter must not endanger persons or systems in the event of a short circuit
- The contactor or the starter must be suitable for further use
- No damage to the overload relay or other parts may occur with the exception of welding of the contactor or starter contacts provided that these can be easily separated without significant deformation (such as with a screwdriver)
- In the event of a short circuit, fast opening current limiting circuit breakers KT 7 make it possible to build economical, fully short circuit co-ordinated starter combinations in accordance with IEC 947-4-1, Type '2' co-ordination
- Type '2' co-ordination without oversizing of contactors means: Type '1' = Type '2'

Note: [1]) What is meant by Automatic Type '2' co-ordination?
The high speed operation of the new KT 7 motor protection circuit breakers means that contactors need not be oversized to achieve type '2' co-ordination. Simply select the normal AC 3 rated contactor and the corresponding KT 7 circuit breaker and type '2' co-ordination is assured.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

sprecher+schuh

TERASAKI
Ensuring Service, Maintaining Quality

Short circuit co-ordination
Type ‘1’ with circuit breakers or fuses

NHP

Refer Catalogue C-CO

MCCB or fuse DOL starting
50/65 kA @ 400/415 V to AS 3947.4.1

TemBreak Moulded Case Circuit Breaker or fuse

Motor size kW	Approx. amps	Terasaki circuit breaker	or NHP HRC fuse to BS88	Sprecher + Schuh contactor type	Sprecher + Schuh thermal O/L relay type	Setting range amps
0.37	1.1	XM30PB/1.4	NTIA-6	CA 7-9	CT 7-24	1 - 1.6
0.55	1.5	XM30PB/2	NTIA-6	CA 7-9	CT 7-24	1 - 1.6
0.75	1.8	XM30PB/2.6	NTIA-10	CA 7-9	CT 7-24	1.6 - 2.4
1.1	2.6	XM30PB/4.0	NTIA-10	CA 7-9	CT 7-24	2.4 - 4
1.5	3.4	XM30PB/5	NTIA-10	CA 7-9	CT 7-24	2.4 - 4
2.2	4.8	XM30PB/8	NTIA-16	CA 7-9	CT 7-24	4 - 6
3.0	6.5	XM30PB/10	NTIA-16	CA 7-9	CT 7-24	6 - 10
4.0	8.2	XM30PB/12	NTIA-25	CA 7-9	CT 7-24	6 - 10
5.5	11	XH125NJ/20	NTIA-32	CA 7-12	CT 7-24	10 - 16
7.5	14	XH125NJ/20	NTIS-40	CA 7-16	CT 7-24	10 - 16
11	21	XH125NJ/32	NTIS-50	CA 7-23	CT 7-24	16 - 24
15	28	XH125NJ/50	NTIS-63	CA 7-30	CT 7-45	18 - 30
18.5	34	XH125NJ/50	NTCP-80	CA 7-37	CT 7-45	30 - 45
22	40	XH125NJ/63	NTCP-80	CA 7-43	CT 7-45	30 - 45
30	55	XH125NJ/100	NTCP-100	CA 7-60	CT 7-75	45 - 60
37	66	XH125NJ/100	NTF-160	CA 7-72	CT 7-75	60 - 75
45	80	XH125NJ/125 [1])	NTF-160	CA 6-85	CT 7-100	70 - 90
55	100	XH125NJ/125 [1])	NTF-200	CA 6-105-EI	CT 6-110	85 - 110
75	130	XH250NJ/250	NTKF-250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH250NJ/250 [1])	NTKF-250	CA 6-170-EI	CT 6-200	140 - 200
110	200	XH250NJ/250 [1])	NTKF-315	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XH400NE/400	NTMF-355	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XH400NE/400	NTMF-355	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XH400NE/400	NTMF-400	CA 6-300-EI	CEF 1-41/42	160 - 400
185	310	XH400NE/400	NTTF-450	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XH400NE/400	NTTM-500	CA 6-420-EI/CA 5-450	CEF 1-41/42	160 - 400
250	425	XH630NE/630	NTTM-630	CA 6-420-EI/CA 5-450	CEF 1-52	160 - 630
315	530	XH630NE/630	NTLM-710	CA 5-550	CEF 1-52	160 - 630

Notes: Fuses 65 kA. XH125NJ circuit breaker combinations limited to 50 kA, others 65 kA.
Overloads may be changed to different types eg. thermal style to electronic.
Some combinations also gives Type ‘2’ performance.
[1]) Use ‘magnetic only’ breaker - Refer NHP.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

sprecher+schuh

TERASAKI
Ensuring Service, Maintaining Quality

Short circuit co-ordination
Type '2' with NHP fuses

NHP

Refer Catalogue C-CO

Fuse protection DOL starting [1]) 50/65 kA @ 400/415 V to AS 3947.4.1

Fuse

Motor size kW	Approx. amps @ 400/415 V	NHP HRC fuse to BS88	Sprecher + Schuh contactor	Sprecher + Schuh overload relay [2]) [3])	Setting range amps
0.37	1.1	NTIA-4	CA 7-9	CEP 7	1.0 - 2.9
0.75	1.8	NTIA-6	CA 7-9	CEP 7	1.0 - 2.9
1.5	3.4	NTIA-10	CA 7-9	CEP 7	1.6 - 5
2.2	4.8	NTIA-16	CA 7-9	CEP 7	3.7 - 12
4.0	8.2	NTIA-20	CA 7-9	CEP 7	3.7 - 12
5.5	11	NTIA-25	CA 7-12	CEP 7	3.7 - 12
7.5	14	NTIA-32	CA 7-16	CEP 7	12 - 32
11	21	NTIS-50	CA 7-30	CEP 7	12 - 32
15	28	NTIS-63	CA 7-30	CEP 7	12 - 37
18.5	34	NTCP-80	CA 7-37	CEP 7	12 - 37
22	40	NTCP-80	CA 7-43	CEP 7	14- 45
30	55	NTCP-100	CA 7-60	CEP 7	26 - 85
37	66	NTF-125	CA 7-72	CEP 7	26 - 85
45	80	NTF-160	CA 7-85	CEP 7	26 - 85
55	100	NTF-200	CA 6-105-EI	CT 6-110	85 - 110
75	130	NTKF-250	CA 6-140-EI	CT 6-150	105 - 150
90	155	NTKF-250	CA 6-170-EI	CT 6-200	140 - 200
110	200	NTKF-315	CA 6-210-EI	CEF 1-41/42 [4])	160 - 400
132	225	NTMF-355	CA 6-210-EI	CEF 1-41/42 [4])	160 - 400
150	250	NTMF-355	CA 6-250-EI	CEF 1-41/42 [4])	160 - 400
185	320	NTTM-450	CA 6-300-EI	CEF 1-41/42 [4])	160 - 400
250	425	NTTM-560	CA 6-420-EI	CEF 1-52 [4])	160 - 630
320	538	NTLM-710	CA 5-550	CEF 1-52 [4])	160 - 630
380	650	NTLM-800	CA 5-700	CEF 1-11/12P [4])	300 - 1200

Notes:
[1]) Fuses with equal or lower let through energy may also be used.
[2]) Thermal overloads may be used instead of electronic CEP 7.
[3]) Above 37 kW overloads may also be electronic or thermal.
[4]) CET 4 may be used instead of CEF 1.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

sprecher+schuh

TERASAKI
Ensuring Service, Maintaining Quality

Short circuit co-ordination
Type '2' using Terasaki circuit breakers

NHP

Refer Catalogue C-CO

TemBreak circuit breakers DOL starting
50 kA @ 400/415 V to AS 3947.4.1

TemBreak MCCBs

Motor size kW	Approx. amps	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh overload relay	Setting range amps
0.37	1.1	XM30PB/1.4	CA 7-9	CT 7-24-1.6	1 - 1.6
0.55	1.5	XM30PB/2	CA 7-9	CT 7-24-1.6	1 - 1.6
0.75	1.8	XM30PB/2.6	CA 7-9	CT 7-24-2.4	1.6 - 2.4
1.1	2.6	XM30PB/4.0	CA 7-16	CT 7-24-4	2.4 - 4
1.5	3.4	XM30PB/5	CA 7-16	CT 7-24-4	2.4 - 4
2.2	4.8	XM30PB/8	CA 7-16	CT 7-24-6	4 - 6
3	6.5	XM30PB/10	CA 7-30	CT 7-24-10	6 - 10
4	8.2	XM30PB/12	CA 7-30	CT 7-24-10	6 - 10
5.5	11	XH125NJ/20	CA 7-30	CT 7-24-16	10 - 16
7.5	14	XH125NJ/20	CA 7-30	CT 7-24-16	10 - 16
11	21	XH125NJ/32	CA 7-30	CT 7-24-24	16 - 24
15	28	XH125NJ/50	CA 7-43	CT 7-45-30	18 - 30
18.5	34	XH125NJ/50	CA 7-43	CT 7-45-45	30 - 45
22	40	XH125NJ/63	CA 7-43	CT 7-45-45	30 - 45
30	55	XH125NJ/100	CA 6-85	CT 7-75 [2])	45 - 60
37	66	XH125NJ/100	CA 6-85	CT 7-75 [2])	60 - 75
45	80	XH125NJ/125	CA 6-105-EI	CT 6-90	70 - 90
55	100	XH125NJ/125 [1])	CA 6-105-EI	CT 6-110	85 - 110
75	130	XH250NJ/250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH250NJ/250	C A6-170-EI	CT 6-200	140 - 200
110	200	XH250NJ/250 [1])	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XS400SE/400	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XS400SE/400	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XS400SE/400	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XS400SE/400	CA 6-420-EI	CEF 1-41/42	160 - 400
200	361	XS400SE/400	CA 5-450	CEF 1-22 [2])	160 - 400
250	425	XS630SE/630	CA 5-700	CEF 1-52 [2])	160 - 630
320	538	XS630SE/630	CA 5-700	CEF 1-52 [2])	160 - 630

Notes: Overloads may be thermal or electronic.
Combinations based on the overload tripping before the circuit breaker at overload currents up to the motor locked rotor current.
[1]) Use 'magnetic only' breaker or next higher circuit breaker / contactor combination.
[2]) Use with separate mounting bracket.
Data for 65 kA co-ordination available refer Cat. C-CO.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

sprecher+ schuh

TERASAKI Ensuring Service, Maintaining Quality

Short circuit co-ordination

Type ‘2’ using Terasaki circuit breakers

NHP

Refer Catalogue C-CO

TemBreak circuit breakers DOL starting. 85 kA @ 400/415 V to AS 3947.4.1

MCCBs

Motor size kW	Approx. FLC @ 400/415 V (A)	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L type	Setting range (A)
0.37	1.1	XM30PB/1.4	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.55	1.5	XM30PB/2.0	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.75	1.8	XM30PB/2.6	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
1.1	2.6	XM30PB/4	CA 7-16	CEP 7-M32-2.9-10	1.0 - 2.9
1.5	3.4	XM30PB/5	CA 7-16	CEP 7-M32-5-10	1.6 - 5
2.2	4.8	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
3	6.5	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
4	8.2	XM30PB/10	CA 7-30	CEP 7-M32-12-10	3.7 - 12
5.5	11	TL100NJ/20	CA 7-30	CEP 7-M32-12-10	3.7 - 12
7.5	14	TL100NJ/20	CA 7-30	CEP 7-M32-32-10	12 - 32
9	17	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
10	19	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
11	21	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
15	28	TL100NJ/50	CA 7-43	CEP 7-M32-32-10	12 - 32
18.5	34	TL100NJ/50	CA 7-43	CEP 7-M37-37-10	12 - 37
22	40	TL100NJ/63	CA 7-43	CEP 7-M45-45-10	14 - 45
30	55	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
37	66	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
45	80	TL250NJ/160	CA 6-105	CEP 7-M85-85-10	26 - 85
55	100	TL250NJ/160	CA 6-105	CEF 1-11/12	0.5 - 180
75	135	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
90	160	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
110	200	TL250NJ/250	CA 6-210-EI	CEF 1-41/42/52	160 - 630
132	230	TL400NE/400	CA 6-210-EI	CEF 1-41/42/52	160 - 630
160	270	TL400NE/400	CA 6-300-EI	CEF 1-41/42/52	160 - 630
200	361	TL400NE/400	CA 6-420-EI	CEF 1-41/42/52	160 - 630

Din-T circuit breakers with rotary isolator. DOL starting. 50 kA @ 400/415 V to AS 3947.4.1

Din-T MCBs

Motor size kW	Approx. amps @ 400/415 V	Sprecher + Schuh isolator	Terasaki circuit breaker	Sprecher + Schuh current limiter	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L relay	Thermal overload range
0.37	1.1	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	0.6 - 1.6
0.55	1.5	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1 - 1.6
0.75	1.8	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1.6 - 2.4
1.1	2.6	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
1.5	3.4	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
2.2	4.8	LA 7-80	Din-T 10 / 10	KTL 3-65	CA 7-23	CT 7-24	4 - 6
3	6.5	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
4	8.2	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
5.5	11	LA 7-80	Din-T 10 / 20	KTL 3-65	CA 7-23	CT 7-24	10 - 16
7.5	14	LA 7-80	Din-T 10 / 32	KTL 3-65	CA 7-30	CT 7-45	10 - 16
11	21	LA 7-80	Din-T 10 / 40	KTL 3-65	CA 7-30	CT 7-24	16 - 24
15	28	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	18 - 30
18.5	34	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	30 - 45

Note: **240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000**

ACS contactors CA 7

Technical data

Refer Catalogue C-CO

TemBreak circuit breakers DOL starting. 85 kA @ 400/415 V to AS 3947.4.1

MCCBs

Motor size kW	Approx. FLC @ 400/415 V (A)	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L type	Setting range (A)
0.37	1.1	XM30PB/1.4	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.55	1.5	XM30PB/2.0	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.75	1.8	XM30PB/2.6	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
1.1	2.6	XM30PB/4	CA 7-16	CEP 7-M32-2.9-10	1.0 - 2.9
1.5	3.4	XM30PB/5	CA 7-16	CEP 7-M32-5-10	1.6 - 5
2.2	4.8	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
3	6.5	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
4	8.2	XM30PB/10	CA 7-30	CEP 7-M32-12-10	3.7 - 12
5.5	11	TL100NJ/20	CA 7-30	CEP 7-M32-12-10	3.7 - 12
7.5	14	TL100NJ/20	CA 7-30	CEP 7-M32-32-10	12 - 32
9	17	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
10	19	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
11	21	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
15	28	TL100NJ/50	CA 7-43	CEP 7-M32-32-10	12 - 32
18.5	34	TL100NJ/50	CA 7-43	CEP 7-M37-37-10	12 - 37
22	40	TL100NJ/63	CA 7-43	CEP 7-M45-45-10	14 - 45
30	55	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
37	66	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
45	80	TL250NJ/160	CA 6-105	CEP 7-M85-85-10	26 - 85
55	100	TL250NJ/160	CA 6-105	CEF 1-11/12	0.5 - 180
75	135	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
90	160	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
110	200	TL250NJ/250	CA 6-210-EI	CEF 1-41/42/52	160 - 630
132	230	TL400NE/400	CA 6-210-EI	CEF 1-41/42/52	160 - 630
160	270	TL400NE/400	CA 6-300-EI	CEF 1-41/42/52	160 - 630
200	361	TL400NE/400	CA 6-420-EI	CEF 1-41/42/52	160 - 630

Din-T circuit breakers with rotary isolator. DOL starting. 50 kA @ 400/415 V to AS 3947.4.1

Din-T MCBs

Motor size kW	Approx. amps @ 400/415 V	Sprecher + Schuh isolator	Terasaki circuit breaker	Sprecher + Schuh current limiter	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L relay	Thermal overload range
0.37	1.1	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	0.6 - 1.6
0.55	1.5	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1 - 1.6
0.75	1.8	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1.6 - 2.4
1.1	2.6	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
1.5	3.4	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
2.2	4.8	LA 7-80	Din-T 10 / 10	KTL 3-65	CA 7-23	CT 7-24	4 - 6
3	6.5	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
4	8.2	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
5.5	11	LA 7-80	Din-T 10 / 20	KTL 3-65	CA 7-23	CT 7-24	10 - 16
7.5	14	LA 7-80	Din-T 10 / 32	KTL 3-65	CA 7-30	CT 7-45	10 - 16
11	21	LA 7-80	Din-T 10 / 40	KTL 3-65	CA 7-30	CT 7-24	16 - 24
15	28	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	18 - 30
18.5	34	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	30 - 45

Note: 240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

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ACS Advanced Control System

ACS contactors CA 7

Technical data

NHP

General data	CA 7-9…CA 7-85
Rated insulation voltage U_i	
IEC	690 V
UL, CSA	600 V
Rated impulse voltage withstand U_{imp}	8k V
Test voltage	
1 minute (to IEC 947-4)	2500 V
Rated voltage U_e	
AC	110, 240, 400/415, 500, 690 V
DC	24, 48, 110, 220, 440 V
Rated frequency of coil	50/60 Hz
Ambient temperature	
Storage	-55…+80 ˚C (-67…176 ˚F)
Operation at nominal current	-25…+60 ˚C (-13…140 ˚F)
Maximum with 15 % AC 1 current reduction > 60 °C	-25…+70 ˚C (-13…158 ˚F)
Climatic withstand	Cyclicly changing humid atmosphere to IEC 68-2-30 and DIN 50 016, 56
Maximum altitude	2000 m NN, to IEC 947-4
Protection class	
IP 2LX (IEC 529 and DIN 40050)	In connected condition
Protection against contact	Touch protection to VDE 0106, Part 100
Standards	IEC 947-1/4; VDE 0660, Part 100/104; UL 508; CSA 22.2. Part 14
Compliance	CE; UL; CSA

Short time withstand

I_{CW}, 60°	CA7-9	CA7-12	CA7-16	CA7-23	CA7-30	CA7-37	CA7-43	CA7-60	CA7-72	CA7-85
1 s (A)	210	210	290	380	480	525	650	1100	1150	1250
4 s (A)	140	150	220	280	360	390	480	820	860	910
10 s (A)	100	120	175	220	290	310	375	640	680	710
15 s (A)	90	100	150	200	250	270	325	560	600	620
60 s (A)	60	60	90	125	170	175	200	350	370	380
240 s (A)	40	40	50	60	100	100	120	190	190	200
900 s (A)	30	30	38	38	54	60	76	108	108	120
Minimum cooling time at zero current [Min]	20	20	20	20	20	20	20	20	20	20

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ACS Advanced Control System

ACS contactors CA 7

Technical data

NHP

Auxiliary contact data

		Built-in auxiliary contacts CA 7-9…23	Clip-on auxiliary contacts and accessories
Switching of AC current			
AC 1 I_{th} at 40 ˚C	[A]	25	10
at 60 ˚C	[A]	20	6
AC 15 at rated voltage	[V]	24 48 120 240 400 500 600 690	24 48 120 240 400 500 600 690
	[A]	16 16 14 10 5 2.5 1.8 1	6 6 6 3 2 1.5 1.2 0.7
Short circuit protection	Fuse gG		
Co-ordination type ‘2’	[A]	10	10
Rated impulse voltage withstand U_{imp}	[kV]	8	6
Isolation between control and load circuits to DIN, VDE 0106, parts	[V]	400	Between auxiliary circuit 250 V, between load & auxiliary circuit 690 V
Contact reliability to DIN 19240 without soiling, normal industry atmosphere		17 V, 5 mA, >10^8 switchings per failure	17 V, 5 mA, >10^8 switchings per failure
Terminals for auxiliary contacts			
Terminal size to IEC 947-1		2 x A4	2 x A4
Flexible wire with sleeve	1 wire [mm²]	1…4	0.5…2.5
	2 wire [mm²]	1…4	0.75…2.5
Stranded/solid core	1 wire [mm²]	1.5…6	0.5…2.5
	2 wire [mm²]	1.5…6	0.75…2.5
Tightening torque	[Nm]	1…2.5	1…1.5

		Built-in auxiliary contacts CA 7-9…85	Clip-on auxiliary contacts Front mount	Clip-on auxiliary contacts Side mount
Switching DC loads				
L/R<1 ms, resistive loads at:	[V]	24 48 110 220 440	24 48 110 220 440	24 48 110 220 440
	[A]	12 9 3.5 0.55 0.2	12 9 3.5 0.55 0.2	6 3.2 0.45 0.18 0.1
L/R<15 ms, inductive loads with economy resistor in series at:	[V]	24 48 110 220 440	24 48 110 220 440	24 48 110 220 440
	[A]	9 5 2 0.4 0.16	9 5 2 0.4 0.16	2 1.6 0.3 0.12 0.05
DC-13, switching electro magnets at:	[V]	24 48 110 220 440	24 48 110 220 440	24 48 110 220 440
	[A]	5 2 0.7 0.25 0.12	5 2 0.7 0.25 0.12	3 1.5 0.6 0.3 0.2

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ACS Advanced Control System

ACS contactors CA 7

Technical data

NHP

Additional rating data - contactors to IEC 947

Contactor		CA 7-9	CA 7-12	CA 7-16	CA 7-23	CA 7-30	CA 7-37	CA 7-43	CA 7-60	CA 7-72	CA 7-85
AC 1 resistive load switching 3~											
Ambient temperature 40 ˚C											
I_e [1])	[A]	32	32	32	32	50	50	85	100	100	100
230/240 V	[kW]	10	10	13	13	18	20	25	36	36	40
400/415 V	[kW]	18	18	23	23	32	36	45	64	64	71
690 V	[kW]	30	30	38	38	54	60	75	108	108	120
Ambient temperature 60 ˚C											
I_e [1])	[A]	32	32	32	32	45	45	63	100	100	100
230/240 V	[kW]	8	8	10	10	14	16	20	29	29	34
400/415 V	[kW]	14	14	17	17	26	28	36	51	51	61
690 V	[kW]	24	24	29	29	44	48	60	86	86	102
AC motor switching AC 2, AC 3, AC 4											
230/240 V	[A]	11.5	14.5	20	26.5	34	37	42	62	70	85
400/415 V	[A]	9	12	16	23	30	37	43	60	72	85
690 V	[A]	5	7	9.3	12	17	20	25	34	42	49
230/240 V	[kW]	3	4	5.5	7.5	10	11	13	18.5	22	25
400/415 V	[kW]	4	5.5	7.5	11	15	18.5	22	30	37	45
690 V	[kW]	4	5.5	7.5	10	15	18.5	22	30	37	45
Rated making capacity											
I_e AC 4, 50 Hz	max. 690 V [A]	135	180	240	345	450	555	645	900	1080	1275
Rated breaking capacity											
I_e AC 4	max. 460 V [A]	135	180	240	345	450	555	645	900	1080	1275
	max. 690 V [A]	75	105	140	140	255	300	375	510	630	735
Short circuit protection without protection relay fuse gG to IEC 947-4-1											
co-ordination type ‘1’	[A]	50	50	50	63	100	125	160	200	250	250
co-ordination type ‘2’	[A]	20	25	25	35	50	80	100	100	125	160
Main current circuit resistance	[mΩ]	2.7	2.7	2.7	2	2	2	1.5	0.9	0.9	0.9
Power dissipated by all circuits at Ie AC 3	[w]	0.7	1.2	2.1	3.2	5.4	8.2	8.3	9.7	14	19.5
Total power dissipation at Ie AC 3	AC control [w]	3.3	3.8	4.7	6.2	8.4	11.2	11.5	14.2	18.5	–
	DC control [w]	6.7	7.2	8.1	12.4	14.6	17.4	18.4	14.6	18.9	–
Life span in millions of operations											
Mechanical	AC control	13	13	13	13	13	13	12	10	10	10
	DC control	13	13	13	13	13	13	13	10	10	10
Operating times (DC)											
	Make (mS)	40…70	40…70	40…70	40…70	50…80	50…80	50…80	20…40	20…40	20…40
	Break (mS)	7…15	7…15	7…15	7…15	7…15	7…15	–	–	–	–

Note: [1]) Contact NHP for recommended cable size.

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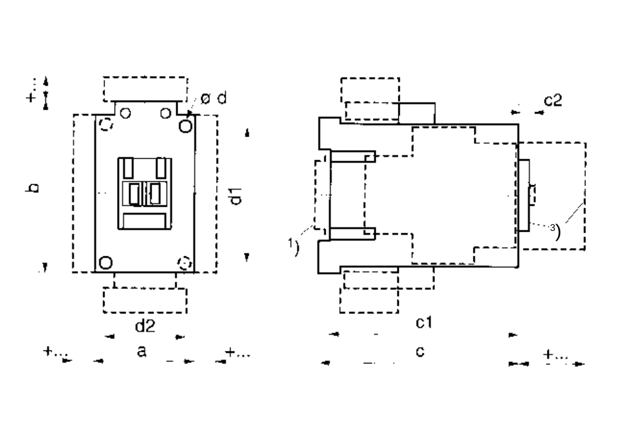
ACS Advanced Control System

ACS contactors CA 7

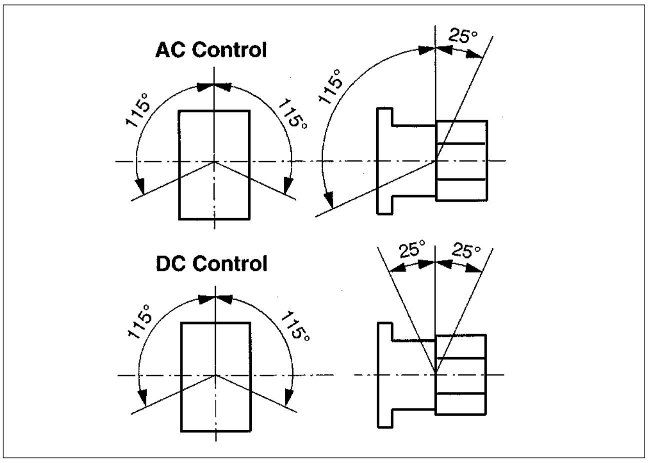
Dimensions

NHP

Dimensions in (mm)



Mounting position



Contactor (AC control)

Type	a	b	c	c1	c2	ød	d1	d2¹)
CA 7-9…CA 7-23 ²)	45	81	80.5	75.5	6	4.5	60	35
CA 7-30…CA 7-37	45	81	97.5	92.6	6.5	4.5	60	35
CA 7-43	54	81	100.5	95.6	6.5	4.5	60	45
CA 7-60…CA 7-85	72	122	117	111.5	8.5	5.4	100	55

(DC control)

Type	a	b	c	c1	c2	ød	d1	d2¹)
CA 7-9C…CA 7-16C	45	81	106.5	101.5	6	4.5	60	35
CA 7-23C	45	81	123.5	119	6	4.5	60	35
CA 7-30C…CA 7-37C	45	81	141.5	136.5	6.5	4.5	60	35
CA 7-43C	54	81	144.5	140	6.5	4.5	60	45
CA 7-60C…CA 7-85C	72	122	117	111.5	8.5	5.4	100	55

Accessories

Contactor with		(AC control) (mm)	(DC control) (mm)
Front mounting auxiliary contact	2 or 4 pole	c/c1 + 39	c/c1 + 39
Side mounting auxiliary contact	1 or 2 pole	a + 9	a + 9
Pneumatic timing module		c/c1 + 58	–
Electronic timing module	coil mounting	b + 24	b + 24
Mechanical interlock	mounts between contactors	a + 9	a + 9
Mechanical latch		c/c1 + 61	–
Interface	coil mounting	b + 9	–
Suppressor	coil mounting	b + 3	b + 3
With inscriptions ³)	labels	+0	+0
	label support system V4/V5	+5.5	+5.5

Notes: ¹) DIN Rail mounting 35 mm to EN 50 022.
²) Dimensions for 4 pole contactors same as 3 pole with auxiliary.
³) Dimensions with inscriptions.

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ACS Advanced Control System

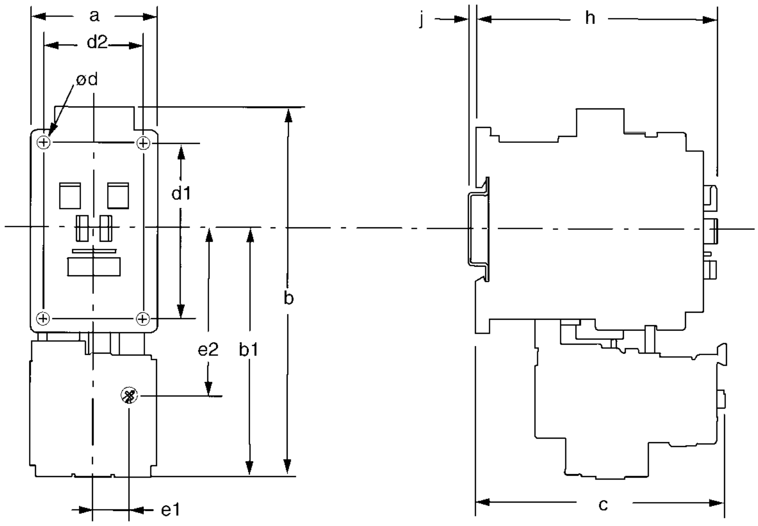
ACS electronic overloads CEP 7

Dimensions with and without contactors

NHP

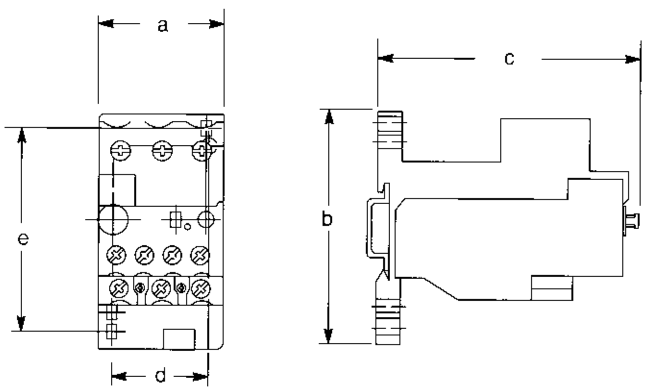
Dimensions in (mm)

CEP 7, CEP 7s and CEP 7-B mounted on CA 7 contactors



Cat. No.	a	b	b1	c	e1	e2	d1	d2	h	j	ød
CA 7-9/12/16/23 with CEP 7 or CEP 7S	45	131	86	88.5	16.5	69	60	35	86.5	2	4.2
CA 7-9/12/16/23 with CEP 7-B	54	137	97	90.7	5.1	59	60	35	85.1	2	4.2
CA 7-30/37 with CEP 7 or CEP 7S	45	136.5	91.5	92	16.5	69	60	35	104	2	4.2
CA 7-30/37 with CEP 7-B	54	137	97	92.1	5.2	59	60	35	104.7	2	4.2
CA 7-43 with CEP 7, CEP 7S or CEP 7-B	54	136.5	91.5	93	22	69	60	45	107	2	4.2
CA 7-60/72/85 with CEP 7, CEP 7S or CEP 7-B	72	188.5	120	120	18	84.5	100	55	125.5	2	5.5

CEP 7 with separate mounting bracket



Type	a	b	c	d	e
CEP 7-37-P-A	45	90	75	30	75
CEP 7-45-P-A	55	90	96.5	40	75
CEP 7-85-P-A	70	115	110	55	105

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ACS thermal overloads CT 7

Technical data

NHP

General		CT 7-24	CT 7-45	CT 7-75	CT 7-100
Weight	[kg]	0.13	0.21	0.21	1.3
Standards		IEC 947, EN 60 947, DIN VDE 0660, UL, LRS, GUS, CSA			
Climatic		damp/heat, constant, to DIN, IEC 68, Part 2 - 3			
		damp/heat, cyclic, to DIN, IEC 68, Part 2 - 30			
Ambient temperature	open	-25...+60 ˚C			
	enclosed	-25...+50 ˚C			
Temperature compensation		continuous temperature range –5...+40 ˚C to IEC 947, EN 60947; PTB: –5...+50 ˚C			
Shock resistance (sinusoidal 10 ms)	[G]	10			
Protection		IP 00 IP 2LX			
Protection		touch proof (VDE 0106, Part 100)			

Contactor, timer and overload selection chart for auto transformer starters

ATS kW	Line contactor	Trans contactor	Star contactor	Timer	Overload
11	CA 7-23-10	CA 7-16-10	CA 7-9-10	RZ7 FSY2D	CEP 7-M32-32-10
15	CA 7-30-00	CA 723-10	CA 7-12-10	RZ7 FSY2D	CEP 7-M37-37-10
18.5	CA 7-37-00	CA 7-30-00	CA 7-16-10	RZ7 FSY2D	CEP 7-M37-37-10
22	CA 7-43-00	CA 7-30-00	CA 7-23-10	RZ7 FSY2D	CEP 7-M45-45-10
30	CA 7-60-00	CA 7-37-00	CA 7-30-00	RZ7 FSY2D	CEP 7-M85-85-10
37	CA 7-72-00	CA 7-43-00	CA 7-30-00	RZ7 FSY2D	CEP 7-M85-85-10
45	CA 7-85-00	CA 7-60-00	CA 7-37-00	RZ7 FSY2D	CEP 7-M85-85-10
55	CA 6-85-11	CA 7-60-00	CA 7-43-00	RZ7 FSY2D	CT 6-110
75	CA 6-105-11	CA 7-85-00	CA 7-60-00	RZ7 FSY2D	CT 6-150
90	CA 6-140EI-11	CA 6-85-11	CA 7-72-00	RZ7 FSY2D	CT 6-200
110	CA 6-170EI-11	CA 6-105-11	CA 7-85-00	RZ7 FSY2D	CEF 1-41
132	CA 6-210EI-11	CA 6-140EI-11	CA 6-105-11	RZ7 FSY2D	CEF 1-41
150	CA 6-250EI-11	CA 6-140EI-11	CA 6-105-11	RZ7 FSY2D	CEF 1-41
185	CA 6-300EI-11	CA 6-210EI-11	CA 6-140EI-11	RZ7 FSY2D	CEF 1-41
220	CA 6-420EI-11	CA 6-210EI-11	CA 6-140-EI-11	RZ7 FSY2D	CEF 1-41

Contactor, timer and overload selection chart for star delta starters

SDS kW	Line contactor	Delta contactor	Star contactor	Timer	Overload
7.5	CA 7-9-10	CA 7-9-01	CA 7-9-01	RZ7 FSY2D	CEP 7-M32-12-10
11	CA 7-12-10	CA 7-12-01	CA 7-9-01	RZ7 FSY2D	CEP 7-M32-32-10
15	CA 7-16-10	CA 7-16-01	CA 7-9-01	RZ7 FSY2D	CEP 7-M32-32-10
18.5	CA 7-23-10	CA 7-23-01	CA 7-12-01	RZ7 FSY2D	CEP 7-M32-32-10
22	CA 7-23-10	CA 7-23-01	CA 7-16-01	RZ7 FSY2D	CEP 7-M32-32-10
30-37	CA 7-37-00	CA 7-37-00	CA 7-23-01	RZ7 FSY2D	CEP 7-M45-45-10
45	CA 7-60-11	CA 7-60-11	CA 7-30-00	RZ7 FSY2D	CEP 7-M85-85-10
55	CA 7-60-11	CA 7-60-11	CA 7-37-00	RZ7 FSY2D	CEP 7-M85-85-10
75	CA 7-85-00	CA 7-85-00	CA 7-43-00	RZ7 FSY2D	CEP 7-M85-85-10
90	CA 6-85-11	CA 6-85-11	CA 7-60-00	RZ7 FSY2D	CT 6-90
110	CA 6-105-11	CA 6-105-11	CA 7-72-00	RZ7 FSY2D	CT 6-110
132	CA 6-140EI-11	CA 6-140EI-11	CA 7-85-00	RZ7 FSY2D	CT 6-150
150	CA 6-170EI-11	CA 6-170EI-11	CA 6-85-00	RZ7 FSY2D	CTA 6-200
185	CA 6-210EI-11	CA 6-210EI-11	CA 6-105-11	RZ7 FSY2D	CEF 1-41
220	CA 6-210-EI-11	CA 6-210-EI-11	CA 6-140-EI-11	RZ7 FSY2D	CEF 1-41

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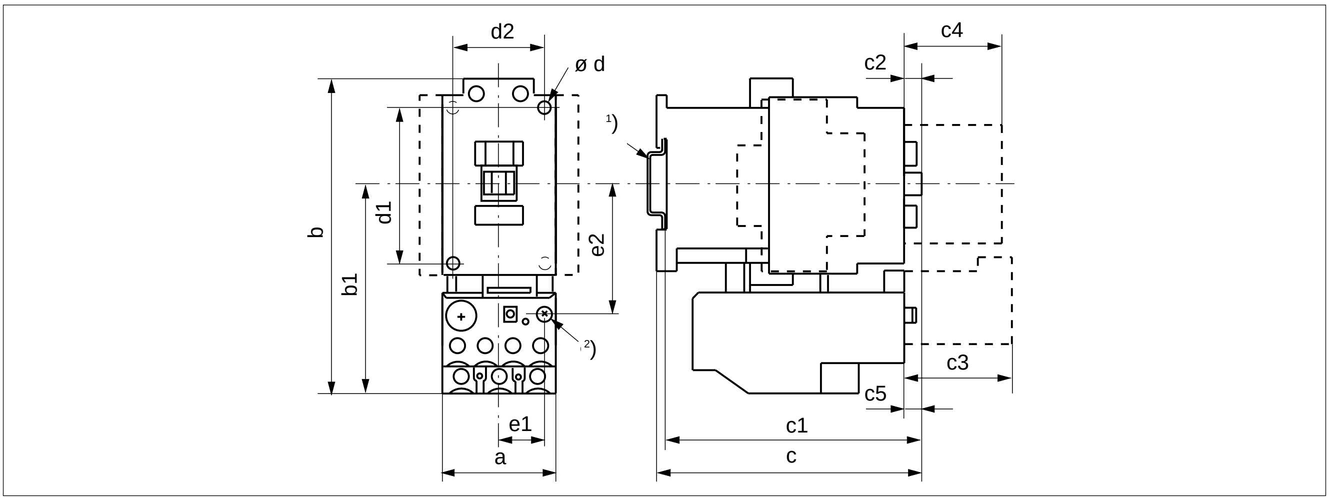
ACS thermal overloads CT 7

Dimensions with and without contactors

NHP

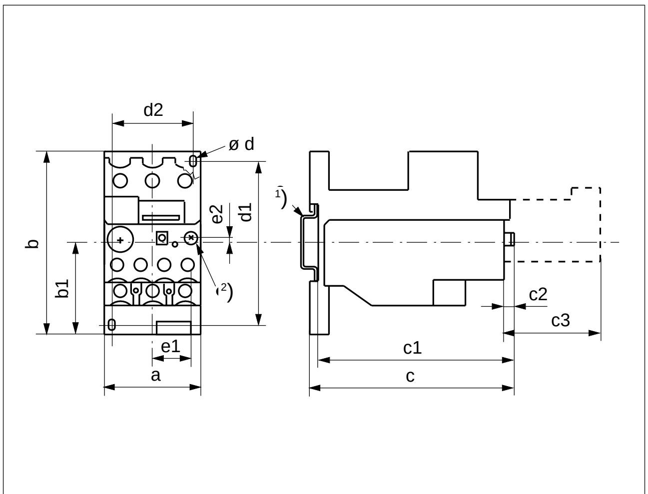
Mounted on CA 7 contactors



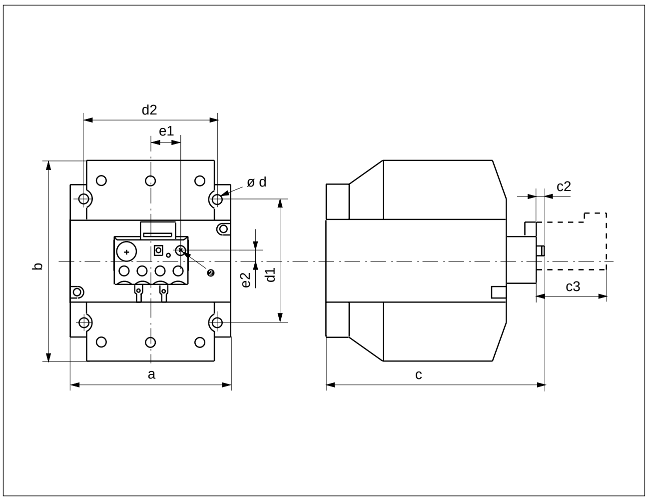
CT 7-24, CT 7-45, CT 7-75

Type	For contactor	a	b	b1	c	c1	c2	c3	c4	c5	ød	d1	d2	e1	e2
CT 7-24	CA 7-9…23	45	127	83	96	91	15	51	39	5	4.5	60	35 1)	16.5	51
	CA 7-30…37	45	127	83	105	99	6.5	51	39	9.5	4.5	60	35 1)	16.5	51
CT 7-45	CA 7-30…37	60	140	97	105	99	6.5	51	39	6.5	4.5	60	35 1)	16.5	57
	CA 7-43	60	140	97	107	103	6.5	51	39	8.5	4.5	60	45 1)	16.5	57
CT 7-75	CA 7-60…85	72	185	120	125	120	8.5	51	39	28.5	5.4	100	55 1)	16.5	82

Separate mounting with bracket



Separate mounting



Type	a	b	b1	c	c1	c2	c3	ød	d1	d2	e1	e2
CT 7-24	45	85	44	95	70.5	5	51	4.5	60...74	35 1)	16	3
CT 7-75	60	90	44	117	112	15	51	5.4	74	50 1)	16	0
CT 7-90	100	120	-	135	-	5	51	6.2	74	80 1)	16	7

Notes: 1) Standard DIN rail to EN 50 022-35.
2) With reset rod, maintain 9 mm maximum operating radius from centre of reset button.
c3 Reset magnet.
c4 Auxiliary contact block.

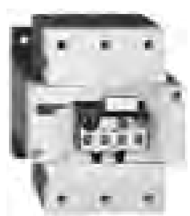
ACS thermal overload relays
Type CT 7

Refer catalogue SACS

Cat. No. CT 7-24

Cat. No. CT 7-45

Cat. No. CT 7-75



Cat. No. CT 7-100

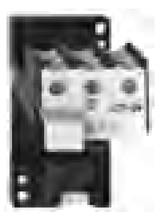
Thermal overload relays to IEC 947 and AS 3947

- Tripping class 10 A
- Single phasing sensitivity to IEC 947
- Separate N/O and N/C contacts
- Reset Auto/Man and test facility
- Easy access to control terminals
- Trip indicator

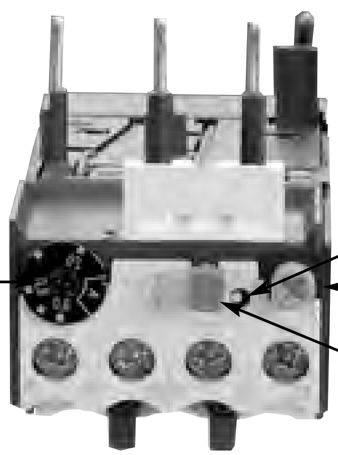
Standard motor kW	Approx kW range @ 400/415 V	Current range A	Suit CA 7	Cat. No.
-	-	0.1…0.16	CA 7-9…37	**CT 7-24-0.16**
-	-	0.16…0.24	CA 7-9…37	**CT 7-24-0.24**
-	-	0.24…0.4	CA 7-9…37	**CT 7-24-0.4**
-	0.1…0.17	0.4…0.6	CA 7-9…37	**CT 7-24-0.6**
-	0.17…0.34	0.6…1.0	CA 7-9…37	**CT 7-24-1**
-	0.34…0.6	1.0…1.6	CA 7-9…37	**CT 7-24-1.6**
1.0	0.6…1.0	1.6…2.4	CA 7-9…37	**CT 7-24-2.4**
1.5	1.0…1.8	2.4…4	CA 7-9…37	**CT 7-24-4**
2.2	1.8…2.7	4…6	CA 7-9…37	**CT 7-24-6**
4	2.7…5.0	6…10	CA 7-9…37	**CT 7-24-10**
5.5/7.5	5.0…8.0	10…16	CA 7-12…37	**CT 7-24-16**
11	8.0…12.5	16…24	CA 7-23…37	**CT 7-24-24**
11/15	9…16	18…30	CA 7-30…43	**CT 7-45-30 [2])**
18.5/22	16…24	30…45	CA 7-37…43	**CT 7-45-45 [2])**
11/15	9…16	18…30	CA 7-60…85	**CT 7-75-30**
18.5/22	16…24	30…45	CA 7-60…85	**CT 7-75-45**
30	24…33	45…60	CA 7-60…85	**CT 7-75-60**
37	33…41	60…75	CA 7-72…85	**CT 7-75-75**
45	40…45	70…90	Separate mount	**CT 7-100-90**

Notes: [2]) CT 7-45 cannot be separately mounted, use CT 7-75 with equivalent current rating.

CT 7 thermal overload



Cat. No. CT 7-24-P-A



sprecher+ schuh

TERASAKI Ensuring Service, Maintaining Quality

Short circuit co-ordination

Type '1' with circuit breakers or fuses

NHP

Refer Catalogue C-CO

MCCB or fuse DOL starting
50/65 kA @ 400/415 V to AS 3947.4.1

TemBreak Moulded Case Circuit Breaker or fuse

Motor size kW	Approx. amps	Terasaki circuit breaker	or	NHP HRC fuse to BS88	Sprecher + Schuh contactor type	Sprecher + Schuh thermal O/L relay type	Setting range amps
0.37	1.1	XM30PB/1.4		NTIA-6	CA 7-9	CT 7-24	1 - 1.6
0.55	1.5	XM30PB/2		NTIA-6	CA 7-9	CT 7-24	1 - 1.6
0.75	1.8	XM30PB/2.6		NTIA-10	CA 7-9	CT 7-24	1.6 - 2.4
1.1	2.6	XM30PB/4.0		NTIA-10	CA 7-9	CT 7-24	2.4 - 4
1.5	3.4	XM30PB/5		NTIA-10	CA 7-9	CT 7-24	2.4 - 4
2.2	4.8	XM30PB/8		NTIA-16	CA 7-9	CT 7-24	4 - 6
3.0	6.5	XM30PB/10		NTIA-16	CA 7-9	CT 7-24	6 - 10
4.0	8.2	XM30PB/12		NTIA-25	CA 7-9	CT 7-24	6 - 10
5.5	11	XH125NJ/20		NTIA-32	CA 7-12	CT 7-24	10 - 16
7.5	14	XH125NJ/20		NTIS-40	CA 7-16	CT 7-24	10 - 16
11	21	XH125NJ/32		NTIS-50	CA 7-23	CT 7-24	16 - 24
15	28	XH125NJ/50		NTIS-63	CA 7-30	CT 7-45	18 - 30
18.5	34	XH125NJ/50		NTCP-80	CA 7-37	CT 7-45	30 - 45
22	40	XH125NJ/63		NTCP-80	CA 7-43	CT 7-45	30 - 45
30	55	XH125NJ/100		NTCP-100	CA 7-60	CT 7-75	45 - 60
37	66	XH125NJ/100		NTF-160	CA 7-72	CT 7-75	60 - 75
45	80	XH125NJ/125 [1])		NTF-160	CA 6-85	CT 7-100	70 - 90
55	100	XH125NJ/125 [1])		NTF-200	CA 6-105-EI	CT 6-110	85 - 110
75	130	XH250NJ/250		NTKF-250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH250NJ/250 [1])		NTKF-250	CA 6-170-EI	CT 6-200	140 - 200
110	200	XH250NJ/250 [1])		NTKF-315	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XH400NE/400		NTMF-355	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XH400NE/400		NTMF-355	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XH400NE/400		NTMF-400	CA 6-300-EI	CEF 1-41/42	160 - 400
185	310	XH400NE/400		NTTF-450	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XH400NE/400		NTTM-500	CA 6-420-EI/CA 5-450	CEF 1-41/42	160 - 400
250	425	XH630NE/630		NTTM-630	CA 6-420-EI/CA 5-450	CEF 1-52	160 - 630
315	530	XH630NE/630		NTLM-710	CA 5-550	CEF 1-52	160 - 630

Notes: Fuses 65 kA. XH125NJ circuit breaker combinations limited to 50 kA, others 65 kA.
Overloads may be changed to different types eg. thermal style to electronic.
Some combinations also gives Type '2' performance.
[1]) Use 'magnetic only' breaker - Refer NHP.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

sprecher+ schuh

TERASAKI Ensuring Service, Maintaining Quality

Short circuit co-ordination
Type ‘2’ using Terasaki circuit breakers

NHP

Refer Catalogue C-CO

TemBreak circuit breakers DOL starting 50 kA @ 400/415 V to AS 3947.4.1

TemBreak MCCBs

Motor size kW	Approx. amps	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh overload relay	Setting range amps
0.37	1.1	XM30PB/1.4	CA 7-9	CT 7-24-1.6	1 - 1.6
0.55	1.5	XM30PB/2	CA 7-9	CT 7-24-1.6	1 - 1.6
0.75	1.8	XM30PB/2.6	CA 7-9	CT 7-24-2.4	1.6 - 2.4
1.1	2.6	XM30PB/4.0	CA 7-16	CT 7-24-4	2.4 - 4
1.5	3.4	XM30PB/5	CA 7-16	CT 7-24-4	2.4 - 4
2.2	4.8	XM30PB/8	CA 7-16	CT 7-24-6	4 - 6
3	6.5	XM30PB/10	CA 7-30	CT 7-24-10	6 - 10
4	8.2	XM30PB/12	CA 7-30	CT 7-24-10	6 - 10
5.5	11	XH125NJ/20	CA 7-30	CT 7-24-16	10 - 16
7.5	14	XH125NJ/20	CA 7-30	CT 7-24-16	10 - 16
11	21	XH125NJ/32	CA 7-30	CT 7-24-24	16 - 24
15	28	XH125NJ/50	CA 7-43	CT 7-45-30	18 - 30
18.5	34	XH125NJ/50	CA 7-43	CT 7-45-45	30 - 45
22	40	XH125NJ/63	CA 7-43	CT 7-45-45	30 - 45
30	55	XH125NJ/100	CA 6-85	CT 7-75 [2])	45 - 60
37	66	XH125NJ/100	CA 6-85	CT 7-75 [2])	60 - 75
45	80	XH125NJ/125	CA 6-105-EI	CT 6-90	70 - 90
55	100	XH125NJ/125 [1])	CA 6-105-EI	CT 6-110	85 - 110
75	130	XH250NJ/250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH250NJ/250	C A6-170-EI	CT 6-200	140 - 200
110	200	XH250NJ/250 [1])	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XS400SE/400	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XS400SE/400	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XS400SE/400	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XS400SE/400	CA 6-420-EI	CEF 1-41/42	160 - 400
200	361	XS400SE/400	CA 5-450	CEF 1-22 [2])	160 - 400
250	425	XS630SE/630	CA 5-700	CEF 1-52 [2])	160 - 630
320	538	XS630SE/630	CA 5-700	CEF 1-52 [2])	160 - 630

Notes: Overloads may be thermal or electronic.
Combinations based on the overload tripping before the circuit breaker at overload currents up to the motor locked rotor current.
[1]) Use ‘magnetic only’ breaker or next higher circuit breaker / contactor combination.
[2]) Use with separate mounting bracket.
Data for 65 kA co-ordination available refer Cat. C-CO.

240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000

sprecher+ schuh

TERASAKI Ensuring Service, Maintaining Quality

Short circuit co-ordination

Type '2' using Terasaki circuit breakers

NHP

Refer Catalogue C-CO

TemBreak circuit breakers DOL starting. 85 kA @ 400/415 V to AS 3947.4.1

MCCBs

Motor size kW	Approx. FLC @ 400/415 V (A)	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L type	Setting range (A)
0.37	1.1	XM30PB/1.4	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.55	1.5	XM30PB/2.0	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
0.75	1.8	XM30PB/2.6	CA 7-9	CEP 7-M32-2.9-10	1.0 - 2.9
1.1	2.6	XM30PB/4	CA 7-16	CEP 7-M32-2.9-10	1.0 - 2.9
1.5	3.4	XM30PB/5	CA 7-16	CEP 7-M32-5-10	1.6 - 5
2.2	4.8	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
3	6.5	XM30PB/8	CA 7-30	CEP 7-M32-12-10	3.7 - 12
4	8.2	XM30PB/10	CA 7-30	CEP 7-M32-12-10	3.7 - 12
5.5	11	TL100NJ/20	CA 7-30	CEP 7-M32-12-10	3.7 - 12
7.5	14	TL100NJ/20	CA 7-30	CEP 7-M32-32-10	12 - 32
9	17	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
10	19	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
11	21	TL100NJ/32	CA 7-30	CEP 7-M32-32-10	12 - 32
15	28	TL100NJ/50	CA 7-43	CEP 7-M32-32-10	12 - 32
18.5	34	TL100NJ/50	CA 7-43	CEP 7-M37-37-10	12 - 37
22	40	TL100NJ/63	CA 7-43	CEP 7-M45-45-10	14 - 45
30	55	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
37	66	TL100NJ/100	CA 7-72	CEP 7-M85-85-10	26 - 85
45	80	TL250NJ/160	CA 6-105	CEP 7-M85-85-10	26 - 85
55	100	TL250NJ/160	CA 6-105	CEF 1-11/12	0.5 - 180
75	135	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
90	160	TL250NJ/250	CA 6-210-EI	CEF 1-11/12	0.5 - 180
110	200	TL250NJ/250	CA 6-210-EI	CEF 1-41/42/52	160 - 630
132	230	TL400NE/400	CA 6-210-EI	CEF 1-41/42/52	160 - 630
160	270	TL400NE/400	CA 6-300-EI	CEF 1-41/42/52	160 - 630
200	361	TL400NE/400	CA 6-420-EI	CEF 1-41/42/52	160 - 630

Din-T circuit breakers with rotary isolator. DOL starting. 50 kA @ 400/415 V to AS 3947.4.1

Din-T MCBs

Motor size kW	Approx. amps @ 400/415 V	Sprecher + Schuh isolator	Terasaki circuit breaker	Sprecher + Schuh current limiter	Sprecher + Schuh contactor	Sprecher + Schuh thermal O/L relay	Thermal overload range
0.37	1.1	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	0.6 - 1.6
0.55	1.5	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1 - 1.6
0.75	1.8	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1.6 - 2.4
1.1	2.6	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
1.5	3.4	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
2.2	4.8	LA 7-80	Din-T 10 / 10	KTL 3-65	CA 7-23	CT 7-24	4 - 6
3	6.5	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
4	8.2	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
5.5	11	LA 7-80	Din-T 10 / 20	KTL 3-65	CA 7-23	CT 7-24	10 - 16
7.5	14	LA 7-80	Din-T 10 / 32	KTL 3-65	CA 7-30	CT 7-45	10 - 16
11	21	LA 7-80	Din-T 10 / 40	KTL 3-65	CA 7-30	CT 7-24	16 - 24
15	28	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	18 - 30
18.5	34	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	30 - 45

Note: **240/415 V rating suitable for use on 230/400 V in accordance with AS 60038 : 2000**

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ACS thermal overloads CT 7

Technical data

Main current circuit		CT 7-24	CT 7-45	CT 7-75	CT 7-100
Rated insulation voltage U_i	[V]	690	690	690	1000
Rated impulse withstand voltage U_{imp}	[V]	6000	6000	6000	8000
Rated operating voltage U_e	[V]	690	690	690	1000
Pollution		III/3	III/3	III/3	III/3
Isolation voltage between main current path and control circuit to DIN, VDE 106, Part 101 and Part 101 A1	[V]	440	440	440	440
Current range		0.1…24	18…45	18…60(75)	70…90
Heat dissipation (for 3 phase)					
lower value of adjustment	[W]	2.5	3	3 (7)	<16
upper value of adjustment	[W]	6	7.5	7.5 (10)	<28
Connections		M4	M6	M6	M8
Flexible wire with sleeve	[mm²]	2 x (1…4)	1 x 25 / 2 x (1…10)	1 x 25 / 2 x (1…10)	50 16
Stranded/solid core	[mm²]	2 x (1…6)	2 x (1…16)	2 x (1…16)	50
Tightening torque	[Nm]	1.8	3.5	3.5	6

Control circuit		CT 7-24	CT 7-45	CT 7-75	CT 7-100
Rated insulation voltage U_i	[V]	500	500	500	500
Rated impulse withstand voltage U_{imp}	[V]	6000	6000	6000	6000
Rated operating voltage U_e	[V]	500	500	500	500
Pollution		III/3	III/3	III/3	III/3
Rated operating current I_e		N/O / N/C	N/O / N/C	N/O / N/C	N/O / N/C
AC 15 220...240 V	[A]	1.5/1.5	1.5/1.5	1.5/1.5	1.5/1.5
400...415 V	[A]	0.5/0.9	0.5/0.9	0.5/0.9	0.5/0.9
500 V	[A]	0.5/0.8	0.5/0.8	0.5/0.8	0.5/0.8
DC 13 24 V	[A]	0.9/0.9	0.9/0.9	0.9/0.9	0.9/0.9
60 V	[A]	0.75/0.75	0.75/0.75	0.75/0.75	0.75/0.75
110 V	[A]	0.4/0.4	0.4/0.4	0.4/0.4	0.4/0.4
220 V	[A]	0.2/0.2	0.2/0.2	0.2/0.2	0.2/0.2
Isolation voltage between main current path and control circuit to DIN, VDE 106, Part 101 and Part 101 A1	[V]	240	240	240	240
Conventional thermal current	[A]	6	6	6	6
Short circuit protection fuse	gL [A]	6	6	6	6
Connections		M3.5	M3.5	M3.5	M3.5
Flexible wire with sleeve	[mm²]	2 x (0.75…2.5)	2 x (0.75…2.5)	2 x (0.75…2.5)	2 x (0.75…2.5)
Stranded/solid core	[mm²]	2 x (0.75…4)	2 x (0.75…4)	2 x (0.75…4)	2 x (0.75…4)
Tightening torque	[Nm]	1.2	1.2	1.2	1.2

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ACS thermal overloads CT 7
Technical data

NHP

General		CT 7-24	CT 7-45	CT 7-75	CT 7-100
Weight	[kg]	0.13	0.21	0.21	1.3
Standards		IEC 947, EN 60 947, DIN VDE 0660, UL, LRS, GUS, CSA			
Climatic		damp/heat, constant, to DIN, IEC 68, Part 2 - 3 damp/heat, cyclic, to DIN, IEC 68, Part 2 - 30			
Ambient temperature	open	-25...+60 ˚C			
	enclosed	-25...+50 ˚C			
Temperature compensation		continuous temperature range –5...+40 ˚C to IEC 947, EN 60947; PTB: –5...+50 ˚C			
Shock resistance (sinusoidal 10 ms)	[G]	10			
Protection		IP 00 IP 2LX			
Protection		touch proof (VDE 0106, Part 100)			

Contactor, timer and overload selection chart for auto transformer starters

ATS kW	Line contactor	Trans contactor	Star contactor	Timer	Overload
11	CA 7-23-10	CA 7-16-10	CA 7-9-10	RZ7 FSY2D	CEP 7-M32-32-10
15	CA 7-30-00	CA 723-10	CA 7-12-10	RZ7 FSY2D	CEP 7-M37-37-10
18.5	CA 7-37-00	CA 7-30-00	CA 7-16-10	RZ7 FSY2D	CEP 7-M37-37-10
22	CA 7-43-00	CA 7-30-00	CA 7-23-10	RZ7 FSY2D	CEP 7-M45-45-10
30	CA 7-60-00	CA 7-37-00	CA 7-30-00	RZ7 FSY2D	CEP 7-M85-85-10
37	CA 7-72-00	CA 7-43-00	CA 7-30-00	RZ7 FSY2D	CEP 7-M85-85-10
45	CA 7-85-00	CA 7-60-00	CA 7-37-00	RZ7 FSY2D	CEP 7-M85-85-10
55	CA 6-85-11	CA 7-60-00	CA 7-43-00	RZ7 FSY2D	CT 6-110
75	CA 6-105-11	CA 7-85-00	CA 7-60-00	RZ7 FSY2D	CT 6-150
90	CA 6-140EI-11	CA 6-85-11	CA 7-72-00	RZ7 FSY2D	CT 6-200
110	CA 6-170EI-11	CA 6-105-11	CA 7-85-00	RZ7 FSY2D	CEF 1-41
132	CA 6-210EI-11	CA 6-140EI-11	CA 6-105-11	RZ7 FSY2D	CEF 1-41
150	CA 6-250EI-11	CA 6-140EI-11	CA 6-105-11	RZ7 FSY2D	CEF 1-41
185	CA 6-300EI-11	CA 6-210EI-11	CA 6-140EI-11	RZ7 FSY2D	CEF 1-41
220	CA 6-420EI-11	CA 6-210EI-11	CA 6-140-EI-11	RZ7 FSY2D	CEF 1-41

Contactor, timer and overload selection chart for star delta starters

SDS kW	Line contactor	Delta contactor	Star contactor	Timer	Overload
7.5	CA 7-9-10	CA 7-9-01	CA 7-9-01	RZ7 FSY2D	CEP 7-M32-12-10
11	CA 7-12-10	CA 7-12-01	CA 7-9-01	RZ7 FSY2D	CEP 7-M32-32-10
15	CA 7-16-10	CA 7-16-01	CA 7-9-01	RZ7 FSY2D	CEP 7-M32-32-10
18.5	CA 7-23-10	CA 7-23-01	CA 7-12-01	RZ7 FSY2D	CEP 7-M32-32-10
22	CA 7-23-10	CA 7-23-01	CA 7-16-01	RZ7 FSY2D	CEP 7-M32-32-10
30-37	CA 7-37-00	CA 7-37-00	CA 7-23-01	RZ7 FSY2D	CEP 7-M45-45-10
45	CA 7-60-11	CA 7-60-11	CA 7-30-00	RZ7 FSY2D	CEP 7-M85-85-10
55	CA 7-60-11	CA 7-60-11	CA 7-37-00	RZ7 FSY2D	CEP 7-M85-85-10
75	CA 7-85-00	CA 7-85-00	CA 7-43-00	RZ7 FSY2D	CEP 7-M85-85-10
90	CA 6-85-11	CA 6-85-11	CA 7-60-00	RZ7 FSY2D	CT 6-90
110	CA 6-105-11	CA 6-105-11	CA 7-72-00	RZ7 FSY2D	CT 6-110
132	CA 6-140EI-11	CA 6-140EI-11	CA 7-85-00	RZ7 FSY2D	CT 6-150
150	CA 6-170EI-11	CA 6-170EI-11	CA 6-85-00	RZ7 FSY2D	CTA 6-200
185	CA 6-210EI-11	CA 6-210EI-11	CA 6-105-11	RZ7 FSY2D	CEF 1-41
220	CA 6-210-EI-11	CA 6-210-EI-11	CA 6-140-EI-11	RZ7 FSY2D	CEF 1-41

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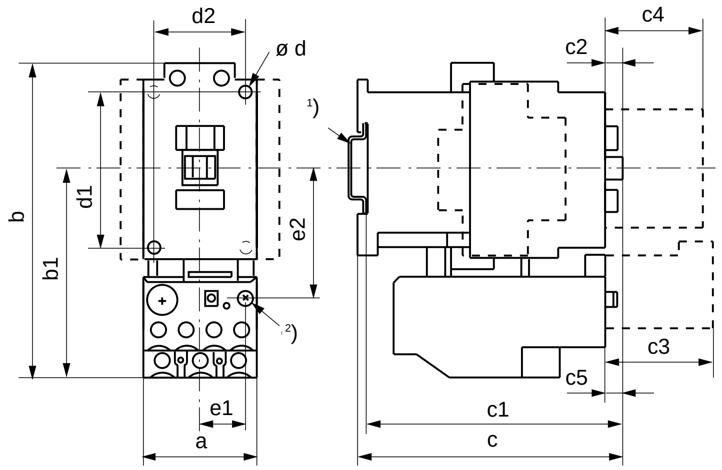
ACS Advanced Control System

ACS thermal overloads CT 7

Dimensions with and without contactors

NHP

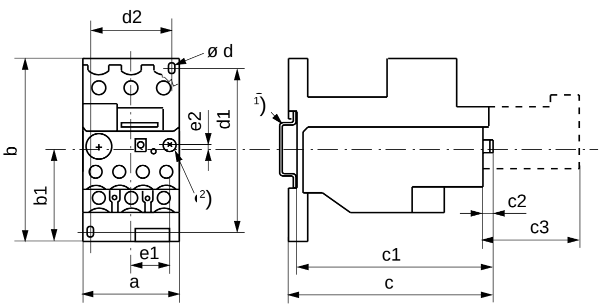
Mounted on CA 7 contactors



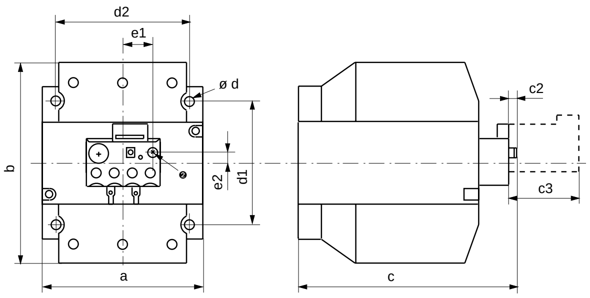
CT 7-24, CT 7-45, CT 7-75

Type	For contactor	a	b	b1	c	c1	c2	c3	c4	c5	ød	d1	d2	e1	e2
CT 7-24	CA 7-9…23	45	127	83	96	91	15	51	39	5	4.5	60	35 [1])	16.5	51
	CA 7-30…37	45	127	83	105	99	6.5	51	39	9.5	4.5	60	35 [1])	16.5	51
CT 7-45	CA 7-30…37	60	140	97	105	99	6.5	51	39	6.5	4.5	60	35 [1])	16.5	57
	CA 7-43	60	140	97	107	103	6.5	51	39	8.5	4.5	60	45 [1])	16.5	57
CT 7-75	CA 7-60…85	72	185	120	125	120	8.5	51	39	28.5	5.4	100	55 [1])	16.5	82

Separate mounting with bracket



Separate mounting



Type	a	b	b1	c	c1	c2	c3	ød	d1	d2	e1	e2
CT 7-24	45	85	44	95	70.5	5	51	4.5	60...74	35 [1])	16	3
CT 7-75	60	90	44	117	112	15	51	5.4	74	50 [1])	16	0
CT 7-90	100	120	-	135	-	5	51	6.2	74	80 [1])	16	7

Notes: [1]) Standard DIN rail to EN 50 022-35.
[2]) With reset rod, maintain 9 mm maximum operating radius from centre of reset button.
c3 Reset magnet.
c4 Auxiliary contact block.

sprecher+ schuh

ACS Advanced Control System

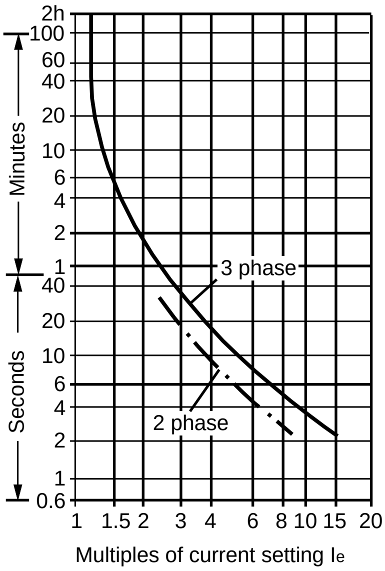
ACS thermal overloads CT 7

Tripping curves - connections

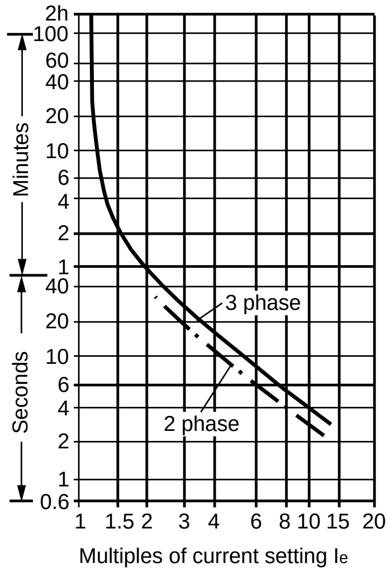
NHP

Tripping characteristics

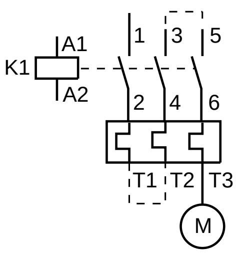
These tripping characteristics comply with IEC 947 and are the mean values of the bands at 20 °C ambient temperature starting from the cold state. Tripping time as a function of operating current. When the motor reaches operating temperature, the tripping time of the motor protection relay falls to approximately 1/4 of the set value (hot state).



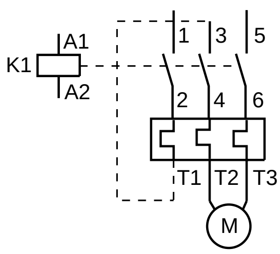
CT 7-24..., CT 7-45..., CT 7-75...



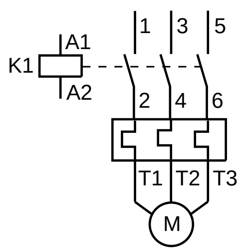
CT 7-100-90



Single phase
1 pole switching



Single phase
2 pole switching



Three phase
3 pole switching

5. Control Relay & Phase Failure Relay

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

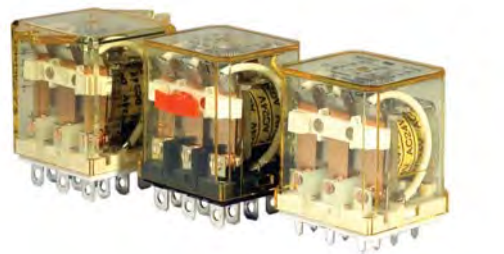
CONTROL RELAY & PHASE FAILURE RELAY

1. IDEC CONTROL RELAY TECHNICAL DETAILS
2. PHASE FAILURE RELAY TECHNICAL DETAILS

RH Series Compact Power Relays

SPDT through 4PDT, 10A contacts
Compact power type relays

The RH series are miniature power relays with a large capacity. The RH relays feature 10A contact capacity as large as the RR series but in a miniature package. The compact size saves space.



Part Number Selection

Contact	Model	Part Number: Blade Terminal	Part Number: PCB Terminal	Coil Voltage Code (Standard Stock in bold)
SPDT 	Basic	RH1B-U	RH1V2-U	AC6V, AC12V, **AC24V**, AC110V, **AC120V**, AC220V, **AC240V** DC6V, **DC12V**, **DC24V**, DC48V, DC110V
	With Indicator	RH1B-UL	—	
	With Check Button	RH1B-UC	—	
	With Indicator and Check Button	RH1B-ULC	—	
	Top Bracket Mounting	RH1B-UT	—	
	With Diode (DC coil only)	RH1B-UD	RH1V2-UD	DC6V, **DC12V**, **DC24V**, DC48V, DC110V
	With Indicator and Diode (DC coil only)	RH1B-ULD	—	**DC12V**, **DC24V**, DC48V, DC110V
DPDT 	Basic	RH2B-U	RH2V2-U	AC6V, AC12V, **AC24V**, **AC110-120V**, **AC220-240V** DC6V, **DC12V**, **DC24V**, DC48V, DC100-110V
	With Indicator	RH2B-UL	RH2V2-UL	
	With Check Button	RH2B-UC	—	
	With Indicator and Check Button	RH2B-ULC	—	
	Top Bracket Mounting	RH2B-UT	—	
	With Diode (DC coil only)	RH2B-UD	RH2V2-UD	DC6V, **DC12V**, **DC24V**, DC48V, DC100-110V
	With Indicator and Diode (DC coil only)	RH2B-ULD	—	
3PDT 	Basic	RH3B-U	RH3V2-U	AC6V, AC12V, **AC24V**, AC110V, **AC120V**, AC220V, **AC240V** DC6V, **DC12V**, **DC24V**, DC48V, DC110V
	With Indicator	RH3B-UL	RH3V2-UL	
	With Check Button	RH3B-UC	—	
	With Indicator and Check Button	RH3B-ULC	—	
	Top Bracket Mounting	RH3B-UT	—	
	With Diode (DC coil only)	RH3B-D*	RH3V2-D*	DC6V, DC12V, DC24V, DC48V, DC110V
	With Indicator and Diode (DC coil only)	RH3B-LD*	—	
4PDT 	Basic	RH4B-U	RH4V2-U	AC6V, AC12V, **AC24V**, AC110V, **AC120V**, AC220V, **AC240V** DC6V, **DC12V**, **DC24V**, DC48V, DC110V
	With Indicator	RH4B-UL	RH4V2-UL	
	With Check Button	RH4B-UC	—	
	With Indicator and Check Button	RH4B-ULC	—	
	Top Bracket Mounting	RH4B-UT	—	
	With Diode (DC coil only)	RH4B-UD	RH4V2-UD	DC6V, DC12V, DC24V, DC48V, DC110V
	With Indicator and Diode (DC coil only)	RH4B-LD*	—	

1. *Carries no UL recognition mark.
2. PCB terminal relays are designed to mount directly to a circuit board without any socket.

Ordering Information

When ordering, specify the Part No. and coil voltage code:

(example) **RH3B-U** $\boxed{\textbf{AC120V}}$

Part No. — Coil Voltage Code

Sockets (for Blade Terminal Models)

Relays	Standard DIN Rail Mount [1]	Finger-safe DIN Rail Mount [1]	Through Panel Mount	PCB Mount
RH1B	SH1B-05	SH1B-05C	SH1B-51	SH1B-62
RH2B	SH2B-05	SH2B-05C	SH2B-51	SH2B-62
RH3B	SH3B-05	SH3B-05C	SH3B-51	SH3B-62
RH4B	SH4B-05	SH4B-05C	SH4B-51	SH4B-62
				

1. DIN Rail mount socket comes with two horseshoe clips. Do not use unless you plan to insert pullover wire spring. Replacement horseshoe clip part number is Y778-011.

Hold Down Springs & Clips

Appearance	Description	Relay	For DIN Mount Socket	For Through Panel & PCB Mount Socket	Min Order Qty
	Pullover Wire Spring	RH1B	SY2S-02F1 [2]	SY4S-51F1	10
		RH2B	SY4S-02F1 [2]		
		RH3B	SH3B-05F1 [2]		
		RH4B	SH4B-02F1 [2]		
	Leaf Spring (side latch)	RH1B, RH2B, RH3B, RH4B	SFA-202 [3]	SFA-302 [3]	20
	Leaf Spring (top latch)	RH1B, RH2B, RH3B, RH4B	SFA-101 [3]	SFA-301 [3]	

2. Must use horseshoe clip when mounting in DIN mount socket. Replacement horseshoe clip part number is Y778-011.
3. Two required per relay.

AC Coil Ratings

Voltage (V)	Rated Current (mA) ±15% at 20°C								Coil Resistance (Ω) ±10% at 20°C				Operation Characteristics (against rated values at 20°C)		
	AC 50Hz				AC 60Hz										
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	Max. Continuous Applied Voltage	Pickup Voltage	Dropout Voltage
6	170	240	330	387	150	200	280	330	330	9.4	6.4	5.4	110%	80% maximum	30% minimum
12	86	121	165	196	75	100	140	165	165	39.3	25.3	21.2			
24	42	60.5	81	98	37	50	70	83	83	153	103	84.5			
110	9.6	—	18.1	21.6	8.4	—	15.5	18.2	18.2	—	2,200	1,800			
110-120	—	9.4-10.8	—	—	—	8.0-9.2	—	—	—	—	—	—			
120	8.6	—	16.4	19.5	7.5	—	14.2	16.5	16.5	—	10,800	7,360			
220	4.7	—	8.8	10.7	4.1	—	7.7	9.1	9.1	—	10,800	7,360			
220-240	—	4.7-5.4	—	—	—	4.0-4.6	—		—	18,820	—	—			
240	4.9	—	8.2	9.8	4.3	—	7.1	8.3	8.3	—	12,100	9,120			

DC Coil Ratings

Voltage (V)	Rated Current (mA) ±15% at 20°C				Coil Resistance (Ω) ±10% at 20°C				Operation Characteristics (against rated values at 20°C)		
	SPDT	DPDT	3PDT	4PDT	SPDT	DPDT	3PDT	4PDT	Max. Continuous Applied Voltage	Pickup Voltage	Dropout Voltage
6	128	150	240	250	47	40	25	24	110%	80% maximum	10% minimum
12	64	75	120	125	188	160	100	96			
24	32	36.9	60	62	750	650	400	388			
48	18	18.5	30	31	2,660	2,600	1,600	1,550			
100-110	—	8.2-9.0	—	—	—	12,250	—	—			
110	8	—	12.8	15	13,800	—	8,600	7,340			

Standard coil voltages are in **BOLD**.

Contact Ratings

Maximum Contact Capacity						
Model	Continuous Current	Allowable Contact Power		Rated Load		
		Resistive Load	Inductive Load	Voltage (V)	Res. Load	Ind. Load
SPDT	10A	1540VA 300W	990VA 210W	110 AC	10A	7A
				220 AC	7A	4.5A
				30 DC	10A	7A
DPDT 3PDT 4PDT	10A	1650VA 300W	1100VA 225W	110 AC	10A	7.5A
				220 AC	7.5A	5A
				30 DC	10A	7.5A

Note: Inductive load for the rated load — cos ø = 0.3, L/R = 7 ms

TÜV Ratings

Voltage	RH1	RH2	RH3	RH4
240V AC	10A	10A	7.5A	7.5A
30V DC	10A	10A	10A	10A

AC: cos ø = 1.0, DC: L/R = 0 ms

UL Ratings

Voltage	Resistive			General Use			Horse Power Rating		
	RH1 RH2	RH3	RH4	RH1 RH2	RH3	RH4	RH1 RH2	RH3	RH4
240V AC	10A	7.5A	7.5A	7A	6.5A	5A	1/3 HP	1/3 HP	—
120V AC	—	10A	10A	—	7.5A	7.5A	1/6 HP	1/6 HP	—
30V DC	10A	10A	—	7A	—	—	—	—	—
28V DC	—	—	10A	—	—	—	—	—	—

CSA Ratings

Voltage	Resistive				General Use				Horse Power Rating
	RH1	RH2	RH3	RH4	RH1	RH2	RH3	RH4	RH1, 2, 3
240V AC	10A	10A	—	7.5A	7A	7A	7A	5A	1/3 HP
120V AC	10A	10A	10A	10A	7.5A	7.5A	—	7.5A	1/6 HP
30V DC	10A	10A	10A	10A	7A	7.5A	—	—	—

Socket Specifications

	Sockets	Terminal	Electrical Rating	Wire Size	Torque
DIN Rail Mount Sockets	SH1B-05	(Coil) M3 screws (contact) M3.5 screws with captive wire clamp	250V, 10A	Maximum up to 2–#12AWG	5.5 - 9 in•lbs 9 - 11.5 in•lbs
	SH2B-05 SH3B-05 SH4B-05	M3.5 screws with captive wire clamp	300V, 10A	Maximum up to 2–#12AWG	9 - 11.5 in•lbs
Finger-safe DIN Rail Mount	SH1B-05C	(coil) M3 screws (contact) M3.5 screws with captive wire clamp, fingersafe	250V, 10A	Maximum up to 2–#12AWG	5.5 - 9 in•lbs 9 - 11.5 in•lbs
	SH2B-05C SH3B-05C SH4B-05C	M3.5 screws with captive wire clamp, fingersafe	300V, 10A	Maximum up to 2–#12AWG	9 - 11.5 in•lbs
Through Panel Mount Socket	SH1B-51 SH2B-51 SH3B-51 SH4B-51	Solder	300V, 10A	—	—
PCB Mount Socket	SH1B-62	PCB mount	250V, 10A	—	—
	SH2B-62 SH3B-62 SH4B-62	PCB mount	300V, 10A	—	—

Accessories

Description	Appearance	Use with	Part No.	Remarks
Aluminum DIN Rail (1 meter length)		All DIN rail sockets	BNDN1000	IDEC offers a low-profile DIN rail (BNDN1000). The BNDN1000 is designed to accommodate DIN mount sockets. Made of durable extruded aluminum, the BNDN1000 measures 0.413 (10.5mm) in height and 1.37 (35mm) in width (DIN standard). Standard length is 39" (1,000mm).
DIN Rail End Stop		DIN rail	BNL5	9.1 mm wide.
Replacement Hold-Down Spring Anchor		DIN mount sockets and hold down springs.	Y778-011	For use on DIN rail mount socket when using pullover wire hold down spring. 2 pieces included with each socket.

Specifications

Contact Material		Silver cadmium oxide
Contact Resistance [1]		50mΩ maximum
Minimum Applicable Load		24V DC, 30 mA; 5V DC, 100 mA (reference value)
Operate Time [2]	SPDT DPDT	20ms maximum
	3PDT 4PDT	25ms maximum
Release Time [2]	SPDT DPDT	20ms maximum
	3PDT 4PDT	25ms maximum
Power Consumption (approx.)	SPDT	AC: 1.1VA (50Hz), 1VA (60Hz) DC: 0.8W
	DPDT	AC: 1.4VA (50Hz), 1.2VA (60Hz) DC: 0.9W
	3PDT	AC: 2VA (50Hz), 1.7VA (60Hz) DC: 1.5W
	4PDT	AC: 2.5VA (50Hz), 2VA (60Hz) DC: 1.5W
Insulation Resistance		100MΩ minimum (500V DC megger)
Dielectric Strength [3]	SPDT	Between live and dead parts: 2,000V AC, 1 minute Between contact and coil: 2,000V AC, 1 minute Between contacts of the same pole: 1,000V AC, 1 minute
	DPDT 3PDT 4PDT	Between live and dead parts: 2,000V AC, 1 minute Between contact and coil: 2,000V AC, 1 minute Between contacts of different poles: 2,000V AC, 1 minute Between contacts of the same pole: 1,000V AC, 1 minute
Operating Frequency		Electrical: 1,800 operations/hour maximum Mechanical: 18,000 operations/hour maximum
Vibration Resistance		Damage limits: 10 to 55Hz, amplitude 0.5 mm Operating extremes: 10 to 55Hz, amplitude 0.5 mm
Shock Resistance		Damage limits: 1,000m/s² (100G) Operating extremes: 200m/s² (20G - SPDT, DPDT) 100m/s² (10G - 3PDT, 4PDT)
Mechanical Life		50,000,000 operations minimum
Electrical Life	DPDT	500,000 operations minimum (120V AC, 10A)
	SPDT 3PDT 4PDT	200,000 operations minimum (120V AC, 10A)
Operating Temperature [4]	SPDT	–25 to +50°C (no freezing)
	DPDT 3PDT 4PDT	–25 to +40°C (no freezing)
Operating Humidity		45 to 85% RH (no condensation)
Weight (approx.)		SPDT: 24g, DPDT: 37g, 3PDT: 50g, 4PDT: 74g

Note: Above values are initial values.

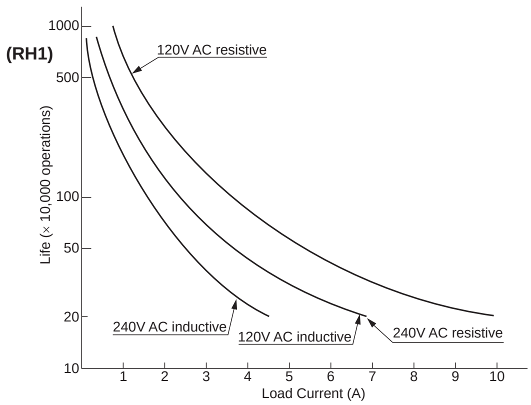
1. Measured using 5V DC, 1A voltage drop method
2. Measured at the rated voltage (at 20°C), excluding contact bouncing
   Release time of relays with diode: 40 ms maximum
3. Relays with indicator or diode: 1000V AC, 1 minute
4. For use under different temperature conditions, refer to Continuous Load Current vs. Operating Temperature Curve. The operating temperature range of relays with indicator or diode is –25 to +40°C.

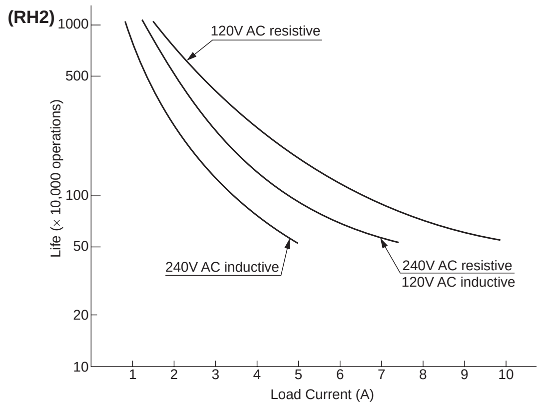
Switches & Pilot Lights
Display Lights
Relays & Sockets
Timers
Terminal Blocks
Circuit Breakers

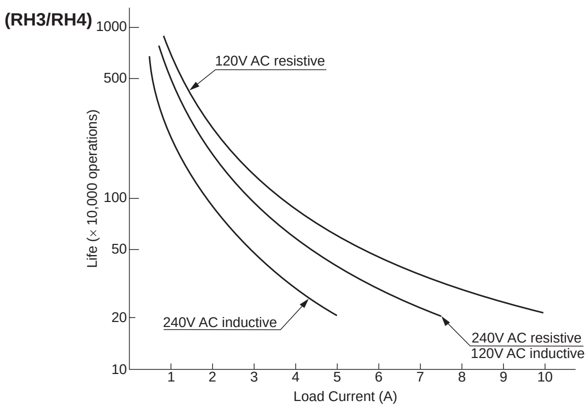
Characteristics (Reference Data)

Electrical Life Curves

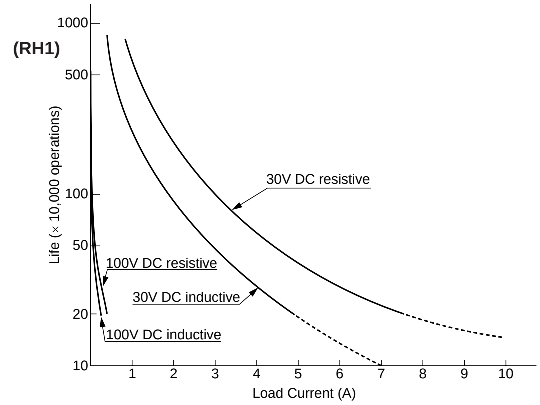
AC Load

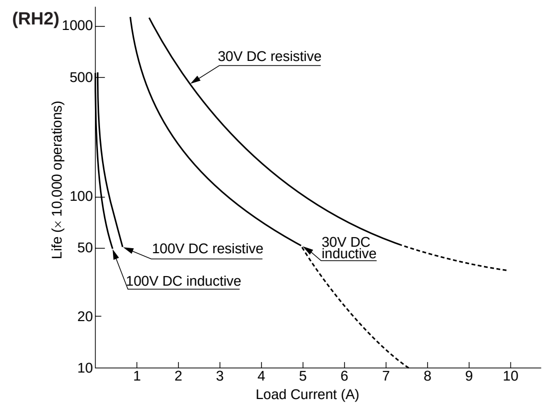


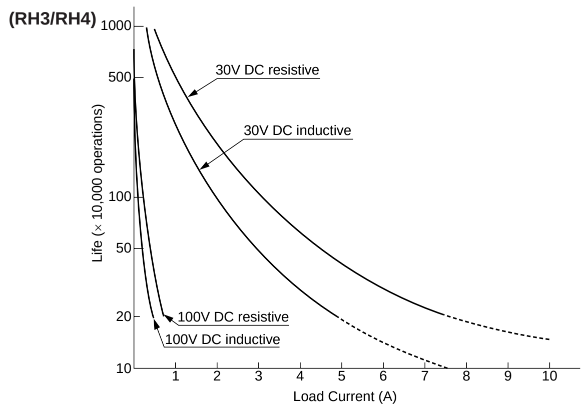




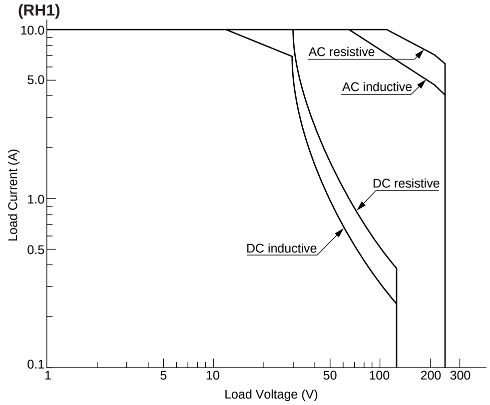
DC Load

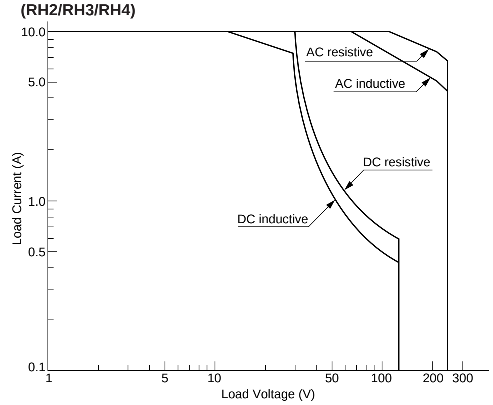




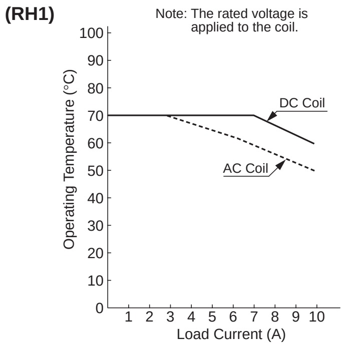


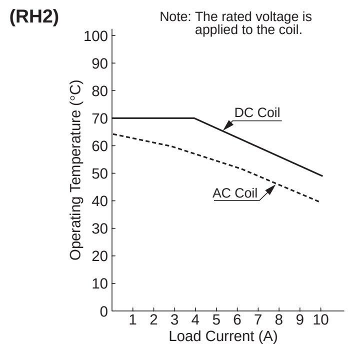
Maximum Switching Capacity

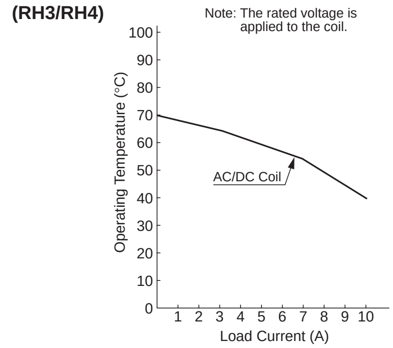




Continuous Load Current vs. Operating Temperature Curve (Basic Type, With Check Button, and Top Bracket Mounting Type)



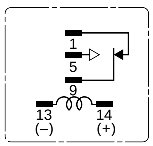




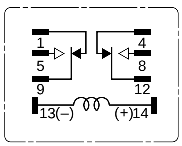
Internal Connection (View from Bottom)

Basic Type

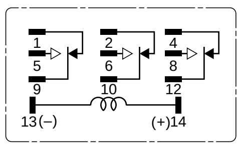
SPDT



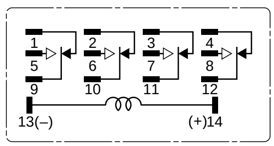
DPDT



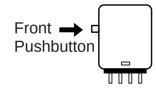
3PDT



4PDT



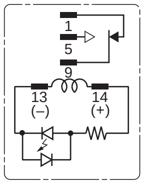
With Check Button

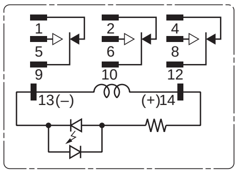


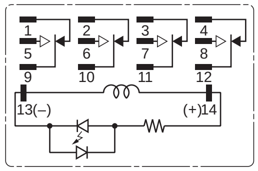
Contacts can be operated by pressing the check button.

With Indicator (-L type)

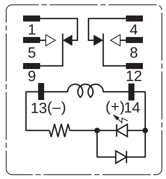
SPDT / 3PDT / 4PDT — Below 100V AC/DC



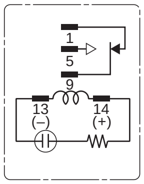


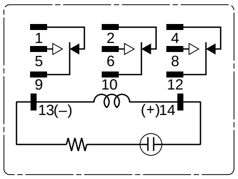


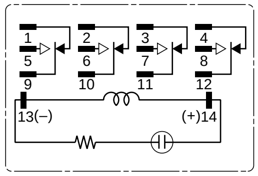
DPDT — Below 24V AC/DC



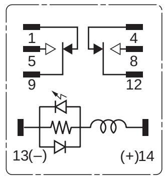
SPDT / 3PDT / 4PDT — 100V AC/DC and over







DPDT — 24V AC/DC and over

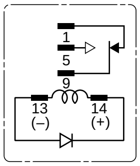


When the relay is energized, the indicator goes on.

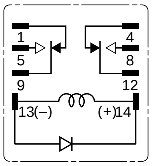
- Relay coils less than 100V DC do not contain a protection diode (except DPDT).
- Relay coils below 100V use LED indicator, coils above 100V use neon lamp indicator.

With Diode (-D type)

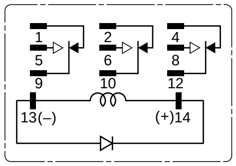
SPDT



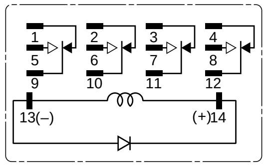
DPDT



3PDT



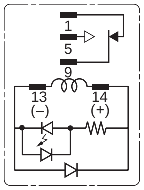
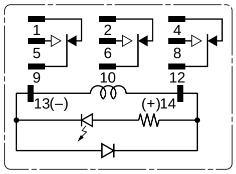
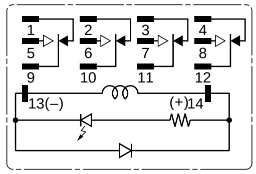
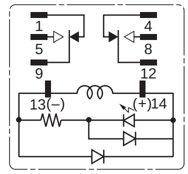
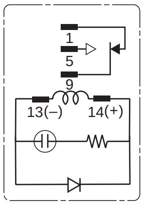
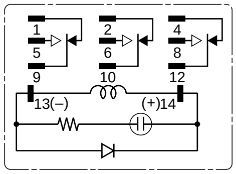
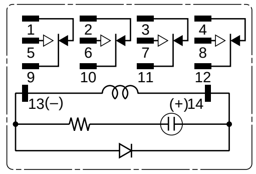
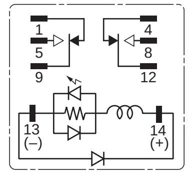
4PDT



Contains a diode to absorb the back emf generated when the coil is de-energized. The release time is slightly longer. Available for DC coil only.

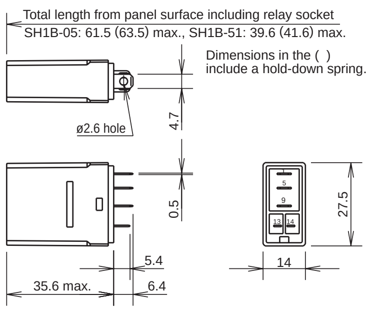
- Diode Characteristics
  Reverse withstand voltage: 1,000V
  Forward current: 1A

With Indicator LED & Diode (-LD type)

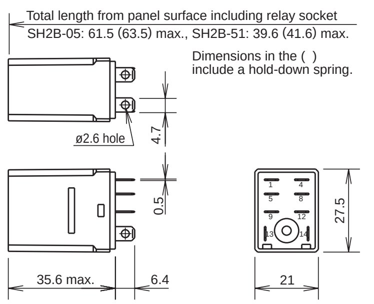
	SPDT	3PDT	4PDT		DPDT	
Below 100V DC				Below 24V AC/DC		Contains an LED indicator and a surge absorber, and has the same height as the basic type.
100V DC and over				24V AC/DC and over		

Dimensions (mm)

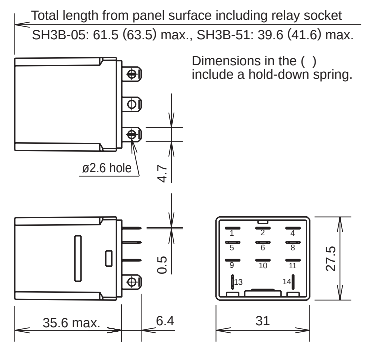
RH1B-U/RH1B-UL/RH1B-UD/RH1B-ULD



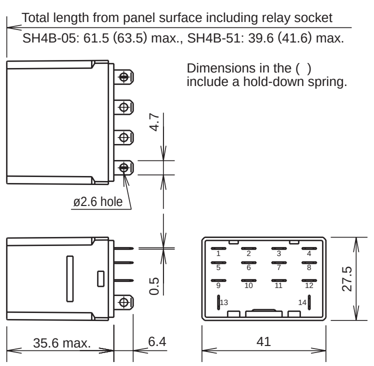
RH2B-U/RH2B-UL/RH2B-UD/RH2B-ULD



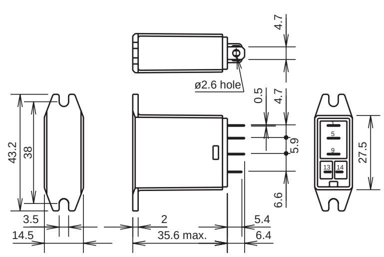
RH3B-U/RH3B-UL/RH3B-D/RH3B-LD



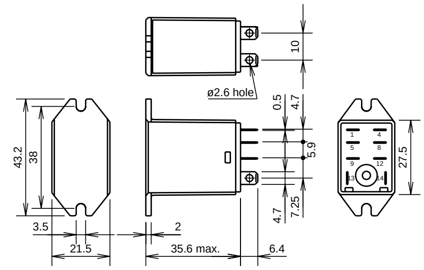
RH4B-U/RH4B-UL/RH4B-UD/RH4B-LD



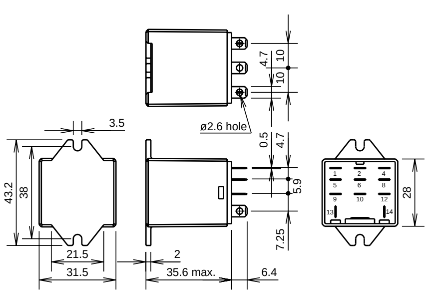
RH1B-UT



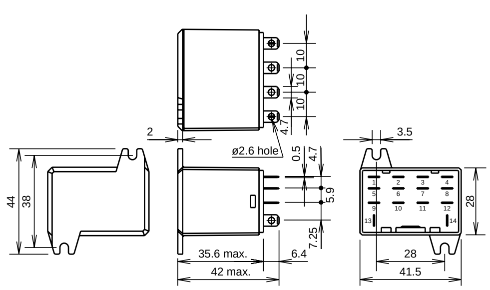
RH2B-UT



RH3B-UT

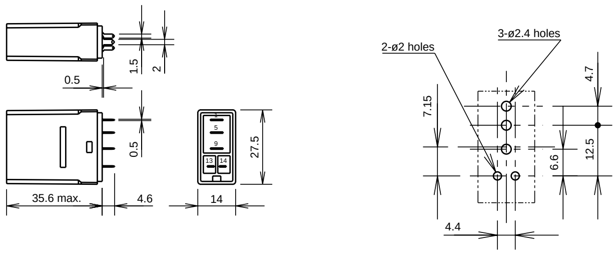


RH4B-UT

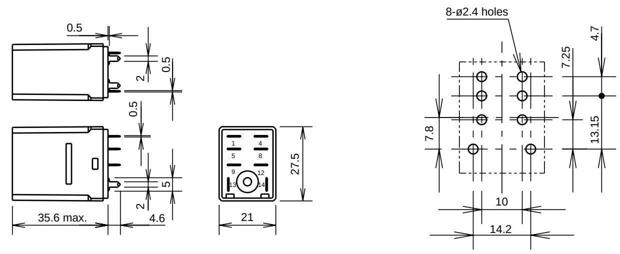


Dimensions con't (mm)

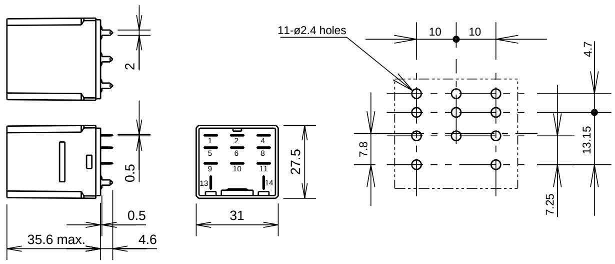
RH1V2-U/RH1V2-UD



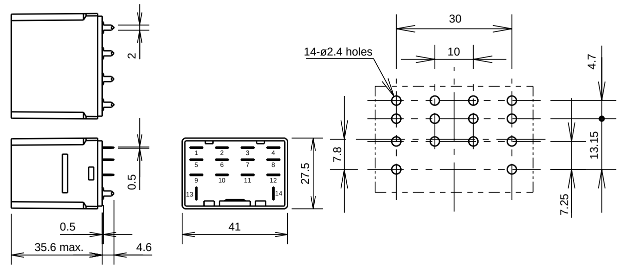
RH2V2-U/RH2V2-UL/RH2V2-UD



RH3V2-U/RH3V2-UL/RH3V2-D

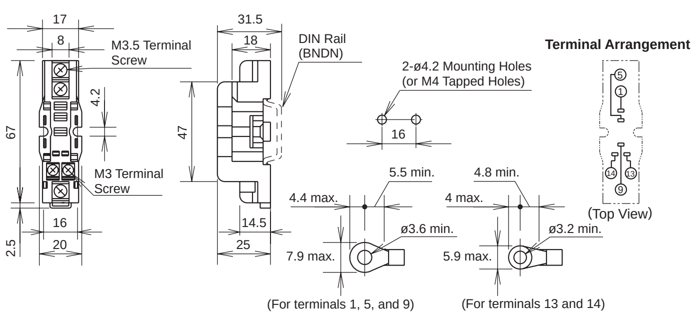


RH4V2-U/RH4V2-UL/RH4V2-UD

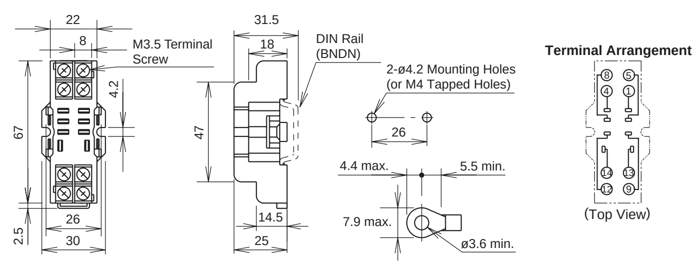


Standard DIN Rail Mount Sockets

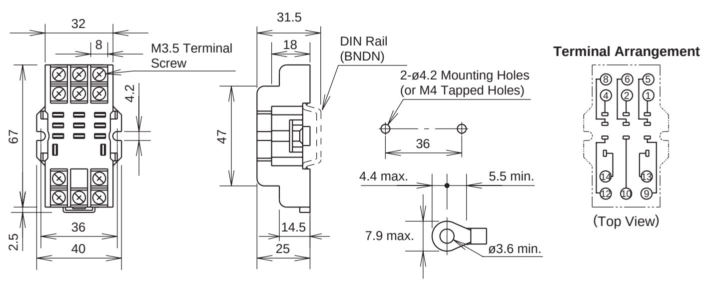
SH1B-05



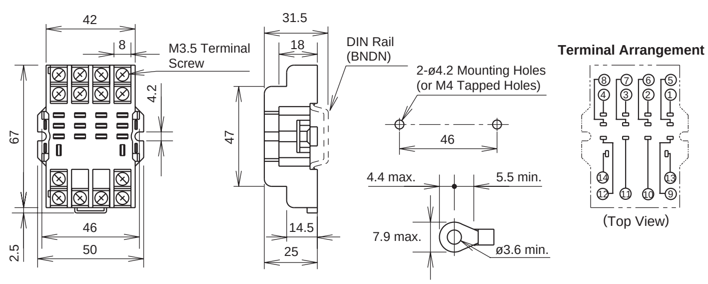
SH2B-05



SH3B-05



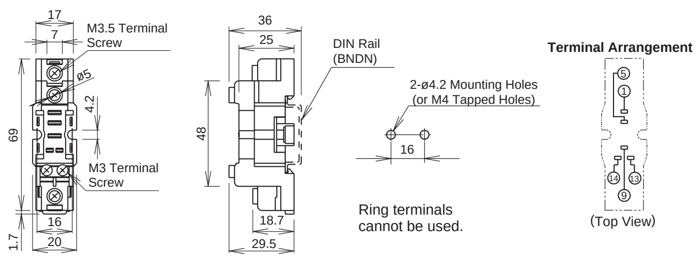
SH4B-05



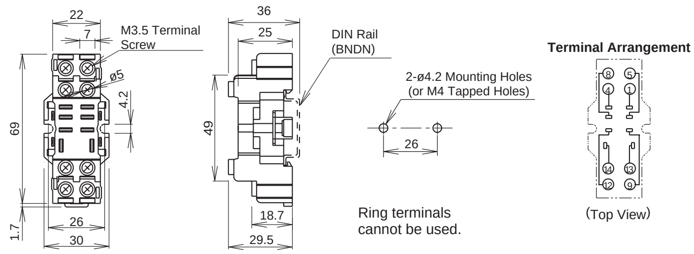
Dimensions con't (mm)

Finger-safe DIN Rail Mount Sockets

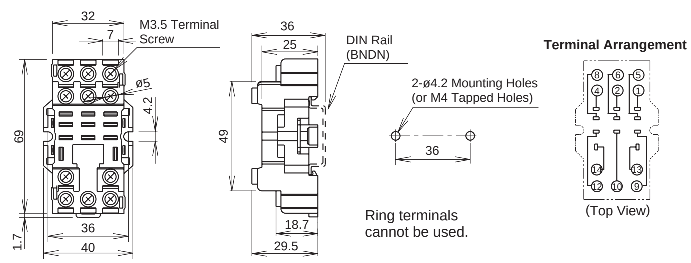
SH1B-05C



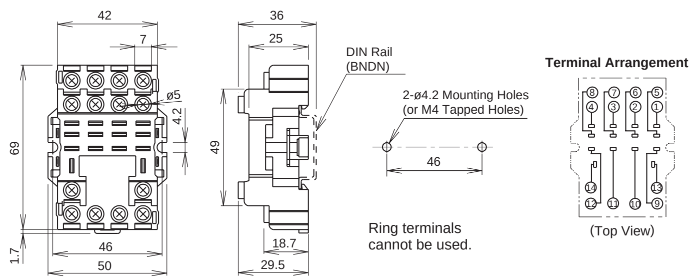
SH2B-05C



SH3B-05C

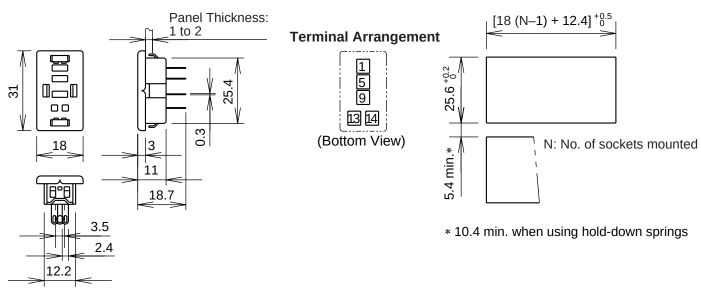


SH4B-05C

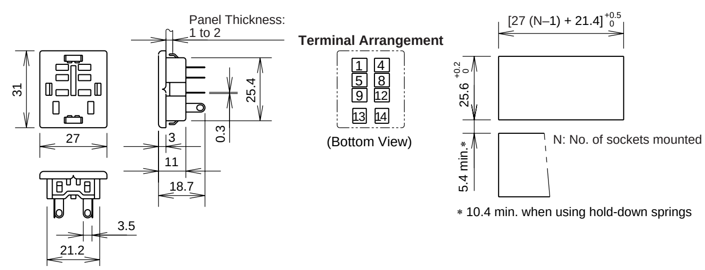


Through Panel Mount Socket

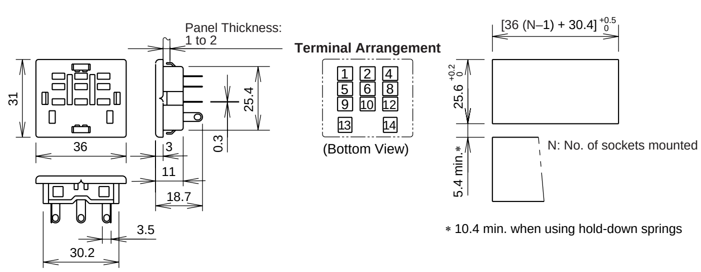
SH1B-51



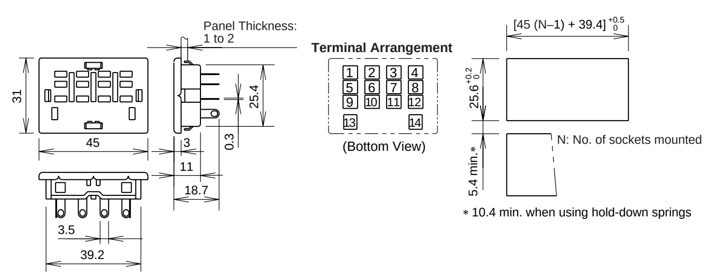
SH2B-51



SH3B-51



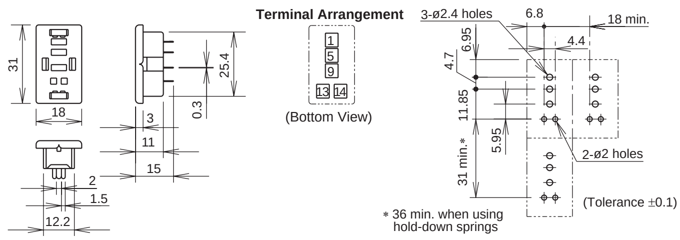
SH4B-51



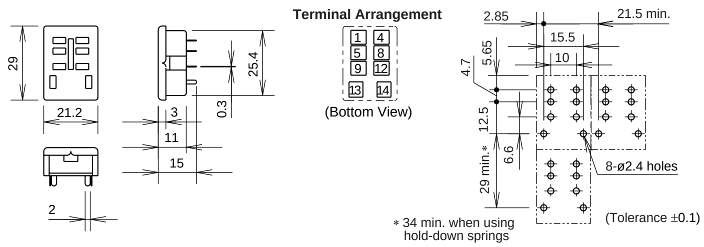
Dimensions con't (mm)

PCB Mount Sockets

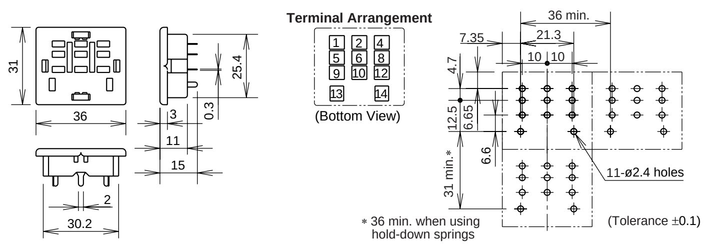
SH1B-62



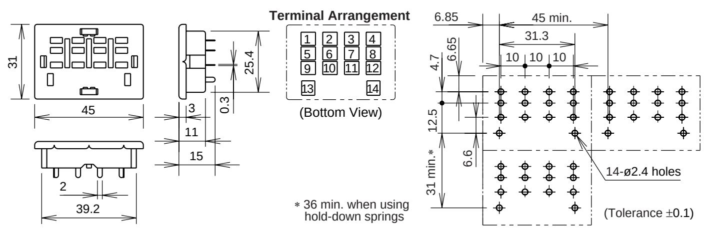
SH2B-62



SH3B-62



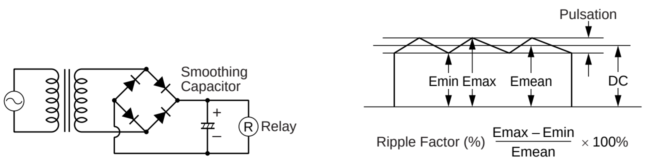
SH4B-62



Operating Instructions

Driving Circuit for Relays

1. To ensure correct relay operation, apply rated voltage to the relay coil.
2. Input voltage for the DC coil:
   A complete DC voltage is best for the coil power to make sure of stable relay operation. When using a power supply containing a ripple voltage, suppress the ripple factor within 5%. When power is supplied through a rectification circuit, the relay operating characteristics, such as pickup voltage and dropout voltage, depend on the ripple factor. Connect a smoothing capacitor for better operating characteristics as shown below.

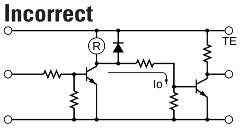


Ripple Factor (%) $\frac{\text{Emax} - \text{Emin}}{\text{Emean}} \times 100\%$

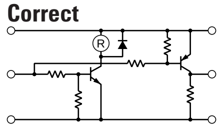
Emax = Maximum of pulsating current
Emin = Minimum of pulsating current
Emean = DC mean value

3. Leakage current while relay is off:
   When driving an element at the same time as the relay operation, special consideration is needed for the circuit design. As shown in the incorrect circuit below, leakage current (Io) flows through the relay coil while the relay is off. Leakage current causes coil release failure or adversely affects the vibration resistance and shock resistance. Design a circuit as shown in the correct example.

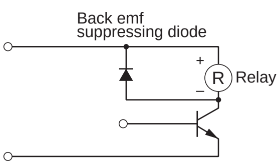
Incorrect



Correct

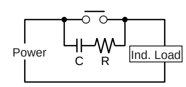
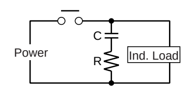
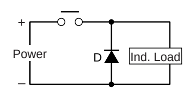
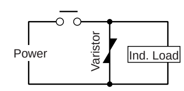


4. Surge suppression for transistor driving circuits:
   When the relay coil is turned off, a high-voltage pulse is generated, causing a transistor to deteriorate and sometimes to break. Be sure to connect a diode to suppress the back electromotive force. Then, the coil release time becomes slightly longer. To shorten the coil release time, connect a Zener diode between the collector and emitter of the transistor. Select a Zener diode with a Zener voltage slightly higher than the power voltage.

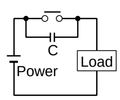
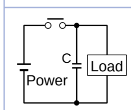


Protection for Relay Contacts

1. The contact ratings show maximum values. Make sure that these values are not exceeded. When an inrush current flows through the load, the contact may become welded. If this is the case, connect a contact protection circuit, such as a current limiting resistor.
2. Contact protection circuit:
   When switching an inductive load, arcing causes carbides to form on the contacts, resulting in increased contact resistance. In consideration of contact reliability, contact life, and noise suppression, use of a surge absorbing circuit is recommended. Note that the release time of the load becomes slightly longer. Check the operation using the actual load. Incorrect use of a contact protection circuit will adversely affect switching characteristics. Four typical examples of contact protection circuits are shown in the following table:

RC		This protection circuit can be used when the load impedance is smaller than the RC impedance in an AC load power circuit. • R: Resistor of approximately the same resistance value as the load • C:0.1 to 1 µF
		This protection circuit can be used for both AC and DC load power circuits. R: Resistor of approximately the same resistance value as the load C: 0.1 to 1 µF
Diode		This protection circuit can be used for DC load power circuits. Use a diode with the following ratings. Reverse withstand voltage: Power voltage of the load circuit x 10 Forward current: More than the load current
Varistor		This protection circuit can be used for both AC and DC load power circuits. For a best result, when using a power voltage of 24 to 48V AC/DC, connect a varistor across the load. When using a power voltage of 100 to 240V AC/DC, connect a varistor across the contacts.

3. Do not use a contact protection circuit as shown below:

	This protection circuit is very effective in arc suppression when opening the contacts. But, the capacitor is charged while the contacts are opened. When the contacts are closed, the capacitor is discharged through the contacts, increasing the possibility of contact welding.
	This protection circuit is very effective in arc suppression when opening the contacts. But, when the contacts are closed, a current flows to charge the capacitor, causing contact welding.

Generally, switching a DC inductive load is more difficult than switching a DC resistive load. Using an appropriate arc suppressor, however, will improve the switching characteristics of a DC inductive load.

Soldering

1. When soldering the relay terminals, use a soldering iron of 30 to 60W, and quickly complete soldering (within approximately 3 seconds).
2. Use a non-corrosive rosin flux.

Operating Instructions con't

Other Precautions

1. General notice:
   To maintain the initial characteristics, do not drop or shock the relay.

   The relay cover cannot be removed from the base during normal operation. To maintain the initial characteristics, do not remove the relay cover.

   Use the relay in environments free from condensation, dust, sulfur dioxide (SO_2), and hydrogen sulfide (H_2S).

   Make sure that the coil voltage does not exceed applicable coil voltage range.
2. UL and CSA ratings may differ from product rated values determined by IDEC.
3. Do not use relays in the vicinity of strong magnetic field, as this may affect relay operation.

Safety Precautions

- Turn off the power to the relay before starting installation, removal, wiring, maintenance, and inspection of the relays. Failure to turn power off may cause electrical shock or fire hazard.
- Observe specifications and rated values, otherwise electrical shock or fire hazard may be caused.
- Use wires of the proper size to meet voltage and current requirements. Tighten the terminal screws on the relay socket to the proper tightening torque.
- Surge absorbing elements on AC relays with RC or DC relays with diode are provided to absorb the back electromotive force generated by the coil. When the relay is subject to an excessive external surge voltage, the surge absorbing element may be damaged. Add another surge absorbing provision to the relay to prevent damage.

Precautions for the RU Relays

- Before operating the latching lever of the RU relay, turn off the power to the RU relay. After checking the circuit, return the latching lever to the original position.
- Do not use the latching lever as a switch. The durability of the latching lever is a minimum of 100 operations.
- When using DC loads on 4PDT relays, apply a positive voltage to terminals of neighboring poles and a negative voltage to the other terminals of neighboring poles to prevent the possibility of short circuits.
- DC relays with a diode have a polarity in the coil terminals. Apply the DC voltage to the correct terminals.

250 Series DIN-rail and Wall Mounted Relays

Phase Balance

The 250 series phase balance protector module provides continuous surveillance of a three-phase, three- or four-wire system and monitors the correct phase rotation or sequence of three-phase supply systems. The module protects against phase loss, reversal or sequence, phase unbalance and system under-voltage.

Operation

Rotating machines are particularly vulnerable to incorrect phase sequence. Three-phase motors can rotate in the wrong direction, potentially leading to physical damage or the risk of injury to personnel, yet voltage and current readings may appear normal. If one phase is lost because of a blown fuse, electric motors can continue to operate (single-phasing) which can result in severe electrical or mechanical damage. This relay has the added advantage that it will detect the phantom or regenerated phase that can be caused by a single-phase failure on some equipment or when running motors at low load levels.

An unbalanced supply voltage can lead to temperature rises in motors. An unbalanced voltage as little as 10% can increase operating temperature to 150% of normal. For permanent installations, this relay should be used to monitor the incoming supply, protecting all equipment against incorrect connection at initial installation or after maintenance work. Rotating machines that cannot tolerate reverse rotation or pose significant risk to personnel under this condition should be individually protected with this relay. The possibility of incorrect supply connection is much more likely in portable equipment or marine applications.

The protector continuously monitors the three-phase supply. With the correct phase sequence applied and all three voltages balanced within the required limits, the front panel LED will illuminate and the output relay will be energised. An incorrect sequence, missing phase, out of balance or under-voltage condition will de-energise the relay and the LED will be extinguished.

The set point control allows adjustment of the voltage matching between 5% and 15%. The time delay function operates only for the voltage unbalance condition. The delay can be used to prevent nuisance tripping due to short term unbalance situations. Incorrect phase rotation, a missing phase or an under-voltage condition trip the relay immediately.

Product Codes

Relay	Protection	ANSI no.	Cat. no.
3-phase 3- or 4-wire	Phase loss and unbalance 5-15%	47	252-PSF
3-phase 3- or 4-wire	Phase loss, unbalance and under-voltage 5-15%	47/27	252-PSG

Please specify system voltage, frequency and required options at time of ordering.

Features

- Three-phase, three or four-wire
- Adjustable set point
- Adjustable time delay
- Internal differential
- LED trip indication
- Double-pole relay contacts
- Automatic reset

Benefits

- Monitoring of correct phase rotation
- Protects against phantom or regenerated phase voltage
- Protection against phase loss, reversal or sequence
- Under-voltage and unbalanced voltage monitoring
- Prevents reverse rotation of motor driven equipment
- Ensures correct engine rotation
- Protects portable electrical equipment
- Nuisance tripping avoidance

Applications

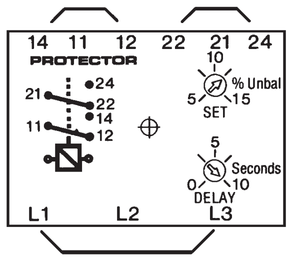
- Marine panels
- Switchgear
- Distribution systems
- Generator sets
- Control panels
- Process control
- Motor protection
- Transformers
- Overload protection

Specification – Phase Balance

Nominal voltage	110V, 120V, 208V, 220V, 230V, 240V, 277V, 380V, 400V, 415V, 440V or 480V
System frequency	50 or 60Hz
Voltage burden	3VA approx.
Overload	1.2 x rating continuously, 1.5 x rating for 10 x seconds
Set point repeatability	>0.5% of full span
Under-voltage set point	Pre-set at 15% of nominal voltage. Other values 10 to 30% to order (model 252-PSG only)
Trip level adjustment	Phase unbalance adjustable 5 to 15%
Time delay	10 seconds as standard. Up to 30 seconds available
Auxiliary voltage burden	4VA (max)
Output relay	2-pole change over
Relay contact rating	AC: 240V 5A, non inductive DC: 24V 5A resistive
Relay mechanical life	0.2 million operations at rated loads
Relay reset	Automatic
Operating temperature	0°C to +60°C (0°C to +40°C for UL models)
Storage temperature	–20°C to +70°C
Temperature co-efficient	0.05% per °C
Interference immunity	Electrical stress surge withstand and non-function to ANSI/IEEE C37 90a
Enclosure style	DIN-rail with wall mounting facility
Material	Flame retardant polycarbonate/ABS
Enclosure integrity	IP50
Model 252 dimensions	55mm (2.2") wide x 70mm (2.8") high x 112mm (4.4") deep
Weight	0.4Kg approx.

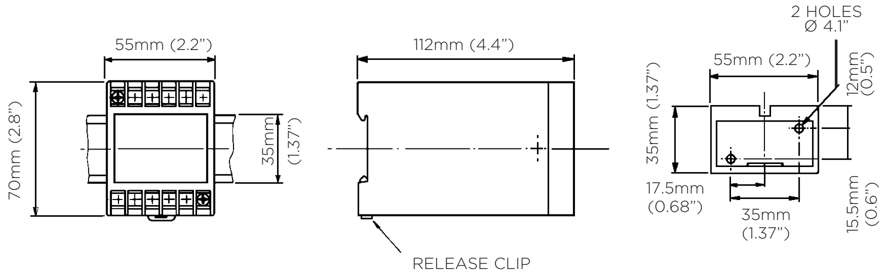
Connections

252-PSF
252-PSG



Note: Neutral connection not required.

Dimensions
Model 252



6. Chassis

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

CHASSIS

1. CD-2 CHASSIS TECHNICAL DETAILS

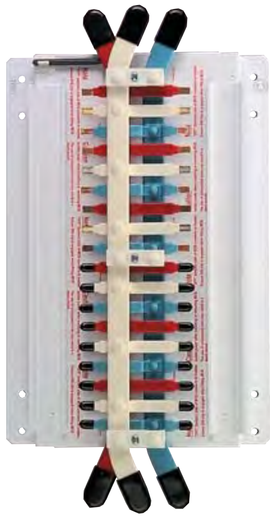
NHP

Panelboards, loadcentres and accessories

2

CONCEPT • PLUS and Premier busbar chassis – Din-T

- Standards AS/NZS 3439
- Current rating 250 A
- Withstand rating 250 A/20 kA for 0.2 sec
- Splayed busbar to suit 160 A & 250 A switch
- Top and bottom feed – splayed top & bottom
- Tee-offs stripped and 50% capped
- Top power feed stripped and capped
- Full 35 mm DIN rail, improved MCB mounting security
- Improved insulation coating



3 pole CD chassis to suit Din-T MCBs

Concept Din-T – 250 to suit Din-T MCBs (18 mm pole pitch) [3])

Pole capacity	250 A Cat. No. [1])
12	**CD-2-12/18-3U**
18	**CD-2-18/18-3U**
24	**CD-2-24/18-3U**
30	**CD-2-30/18-3U**
36	**CD-2-36/18-3U**
42	**CD-2-42/18-3U**
48	**CD-2-48/18-3U**
54	**CD-2-54/18-3U**
60	**CD-2-60/18-3U**
72	**CD-2-72/18-3U**
78	**CD-2-78/18-3U**
84	**CD-2-84/18-3U**
96	**CD-2-96/18-3U**

Notes: [1]) 4 pole and other special configurations available to special order refer NHP.
'OFF' (line) side of MCB connects to chassis tee-off.
MCB DIN clips may be disengaged or removed when mounting onto "CD" chassis.
If applicable use insulated tool provided to disengage DIN clip when removing MCB from chassis.

[3]) Not suitable for CONCEPT economy Panelboards. Contact NHP for availability. Available on indent only.

i

Accessories

Description	Cat. No.
Split tariff kit 250/355 A (supplied loose)	**STKCD**
Split tariff kit (fitted)	**REFER NHP**
Plastic tee-off cap 250 / 355 A	**CD250TOPC**

Technical data – CD/CT busbar chassis

Description		CD-250 A
Busbar rating	(Amp)	250
Voltage rating	(V)	415
Short circuit rating	(kA)	20
Short circuit time	(sec)	0.2
Insulation material		Polyolefin PPA-441

Catalogue number structure – CD/CT busbar chassis

XX - X - XX / XX - X

Type	
CD	Din-T
CDH	Din-T10H
CT	Safe-T

Current rating	
2	250 A
3	355 A
	Etc.

No. of ways
12
18
24
30
36 etc.
27 mm/18 mm
6/24
12/60

Pole pitch (mm)	
18	Din-T
27	Din-T10H
27/18	Hybrid Din-T10H/Din-T
25	Safe-T

No. of phases	
2	1 P + N (red, black)
3	3 P (red, white, blue)
4	3 P + N (red, white, blue, black)

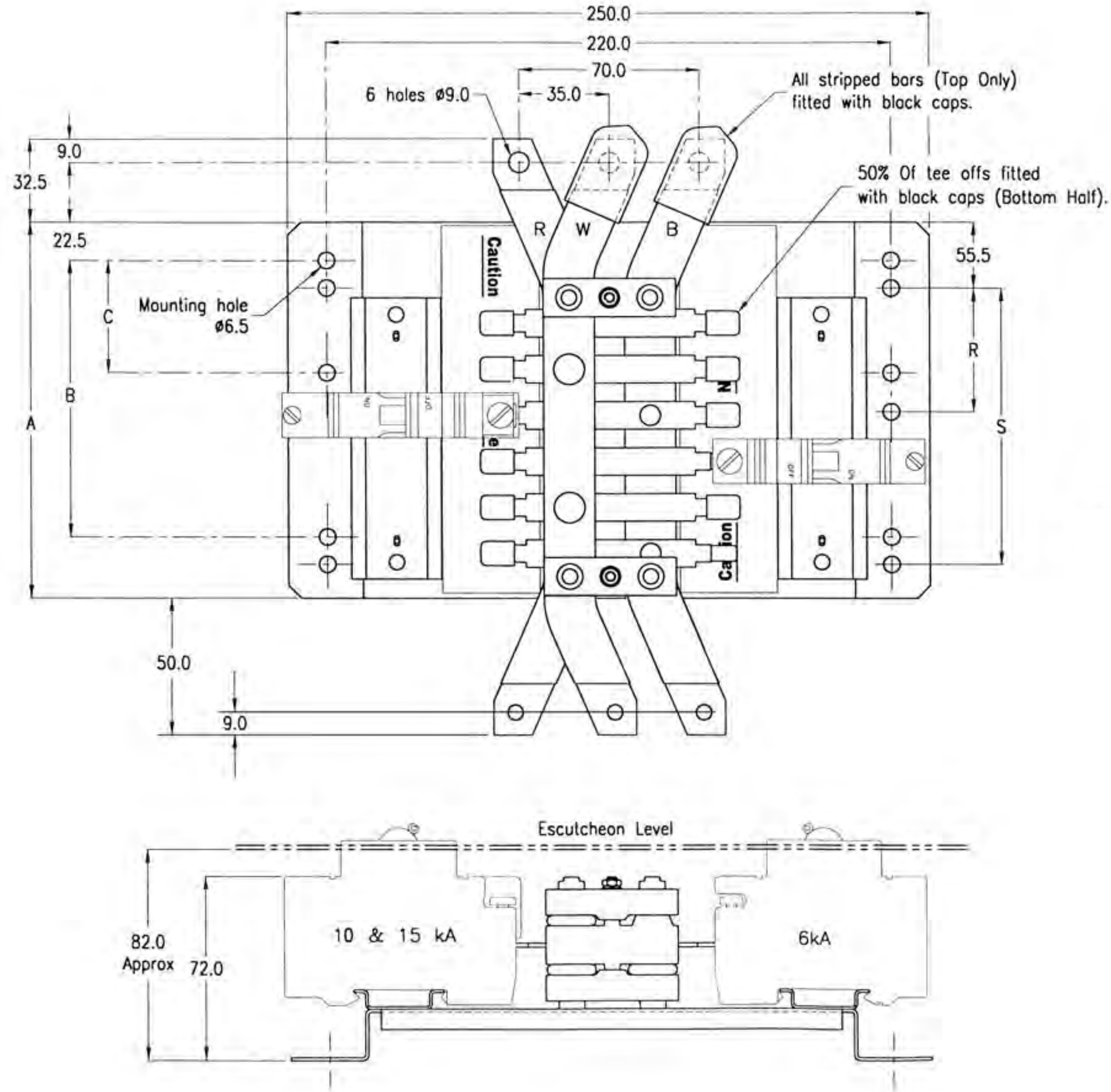
NHP

Panelboards, loadcentres and accessories

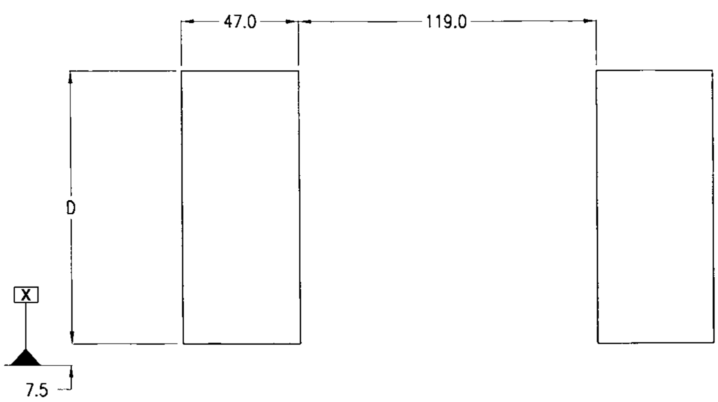
Dimensions (mm)

2

CD chassis 250 to suit Din-T6, 10 and 15



Escutcheon cut-out details



Dimensions (mm)

Chassis size [1])	A	B	C	D	R	S
CD-X-12/18-3U	152	100	–	110	–	100
CD-X-18/18-3U	206	100	–	164	–	100
CD-X-24/18-3U	260	100	–	218	–	100
CD-X-30/18-3U	314	200	–	272	–	200
CD-X-36/18-3U	368	300	–	326	–	300
CD-X-42/18-3U	422	300	–	280	–	300
CD-X-48/18-3U	476	400	–	434	–	400
CD-X-54/18-3U	530	400	–	488	–	400
CD-X-60/18-3U	584	500	–	542	–	500
CD-X-72/18-3U	692	600	–	650	–	600
CD-X-78/18-3U	745	700	300	704	300	700
CD-X-84/18-3U	800	700	300	758	300	700
CD-X-96/18-3U	908	800	400	866	400	800

Notes: [1]) "X" insert **2** = 250 A or **3** = 355 A, current rating does not effect above dims.
Maximum current rating of tee-off = 100 A.
'OFF' (line) side of MCB connects to chassis tee-off.
MCB DIN clips may be disengaged or removed when mounting onto "CD" chassis.
Use insulated tool provided to disengage DIN clip when removing MCB from chassis.

7. Fuse & Fuse Holder

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

FUSE & FUSE HOLDER

1. FUSE LINKS TECHNICAL DETAILS
2. FUSE HOLDER TECHNICAL DETAILS

BS compact fuse links

- Complies with BS 88
- Reduced dimensions
- Low watts loss

Refer catalogue NF

FUSES PROVIDE SUPERIOR SHORT CIRCUIT PROTECTION

NNS 2

NES 20

NNIT 16

NTIA 16

Clip-in offset tags

Rating (A)	BS 88 ref.	Overall length (mm)	Overall Dia. (mm)	Cat. No. [1])
2	F1	60	14	NNS 2
4				NNS 4
6				NNS 6
10				NNS 10
16				NNS 16
20				NNS 20
25				NNS 25
32				NNS 32
20M25				NNS 20M25
20M32				NNS 20M32
20	F2	68	17	NES 20
25				NES 25
32				NES 32
40				NES 40
50				NES 50
63				NES 63

Bolted pattern offset tags

Rating (A)	BS 88 ref.	Fixing centres (mm)	Cat. No. [1])
2	A1	44.5	NNIT 2
4			NNIT 4
6			NNIT 6
10			NNIT 10
16			NNIT 16
20			NNIT 20
25			NNIT 25
32			NNIT 32
20M25			NNIT 20M25
20M32			NNIT 20M32
32M40			NNIT 32M40
32M50			NNIT 32M50
32M63			NNIT 32M63
2	A2	73	NTIA 2
4			NTIA 4
6			NTIA 6
10			NTIA 10
16			NTIA 16
20			NTIA 20
25			NTIA 25
32			NTIA 32
32M40			NTIA 32M40
32M50			NTIA 32M50
32M63			NTIA 32M63

Note: [1]) 'M' in catalogue No. denotes motor starting type.

DIN and BS fuse link selection chart

BS Fuses

Switch-fuses								Fuse type Cat. No.
800	630	400	315	250	200	160	125	Prefix
								NNS_
								NNIT_
						✔	✔	NTIA_
						✔	✔	NTIS_
						✔	✔	NOS_
						✔		NTCP_
								NTFP_
								NTSL00_
		✔	✔	✔	✔			NTBC_
		✔	✔	✔	✔			NTC_
		✔	✔	✔	✔			NTF_
		✔	✔	✔				NTKF_
								NTSL3_
		✔						NTMF_
✔	✔							NTM_
✔	✔							NTTM_
✔								NTLM_

Quick - Link fuse reference guide

NHP HRC fuse holders									Fuse type Cat. No. Prefix
NC (Bolt-in)						NV (Clip-in)			
315	200	100	63	32	20	63	32	20	
							✔	✔	NNS_
						✔			NES_
				✔	✔				NNIT_
	✔ 1)	✔	✔						NTIA_
	✔ 1)	✔	✔ 2)						NTIS_
	✔ 1)	✔							NOS_
	✔								NTCP_
	✔								NTFP_
✔									NTBC_
✔									NTC_
✔									NTF_
✔									NTKF_

DIN Fuses

Switch-fuses						Fuse type Cat. No.
800	630	400	250	160	125	Prefix
				✔	✔	N00_
			✔			N1_
		✔				N2_
✔	✔					N3_

Legend: ✔ Fuse links fit direct.
✔ 1) Fuses require 100MFLK adaptor, see page 11-107.
✔ 2) 'M' type (motor rated) NTIS not suitable for NC63_. Use NC100 fuse holder.

NHP COMPACT FUSES

Fuse-link terminology

NHP Compact fuses

HRC
High rupturing capacity (HRC) or High breaking capacity denotes the ability of a fuse-link to interrupt extremely high fault currents, usually up to 80kA.

Current limiting fuse-link
A fuse-link that limits the circuit current during it's operation to a value much lower than the peak value of the prospective current. In practice, the terms HRC and current limiting are synonymous.

Rated breaking capacity
The highest value of fault current that a fuse-link has been tested to interrupt eg. 80kA.

Rated voltage
The maximum system voltage that the fuse-link is designed to interrupt. Rated voltages may be in AC, DC, or both.

Current rating
The value of current that a fuse-link will carry continuously without deterioration under specified conditions.

Minimum fusing current
The minimum value of current that will cause melting of the fuse element.

Power dissipation
The power released in a fuse-link carrying rated current under a specified condition, usually expressed in watts.

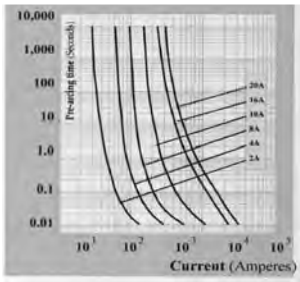
Time current characteristics (refer table 1)
A curve detailing the pre-arcing or operating time as a function of prospective current.

Let through characteristics (I^2t) (refer table 2)
A curve or chart showing values 'pre-arcing' and 'operating' let through energies as a function of prospective current, I^2t is proportional to energy in Amp^2 seconds.

Cut off characteristics (refer table 3)
A curve detailing the cut off current as a function of prospective current. Cut off current being the maximum instantaneous value of current let through by the fuse-link during operation.

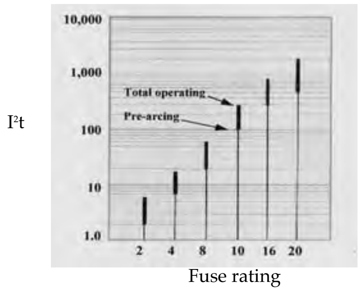
Discrimination (refer tables 4 and 5)
Discrimination is the ability of fuse-links to operate selectively and to disconnect only the parts of the circuit that are subject to faults. Discrimination can be checked by ensuring that the time current characteristics, including their tolerances, do not overlap at any point and that the total let through energy (I^2t) of the downstream (or minor) fuse-link does not exceed the pre-arcing energy (I^2t) of the upstream (or major) fuse-link at the applied system voltage. Discrimination is normally achieved with the ratio of 1.6 between upstream and downstream fuses.

Table 1



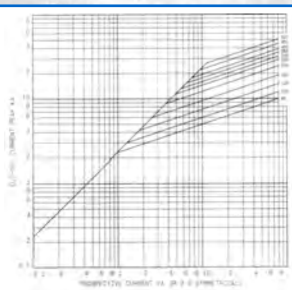
Typical time current curves

Table 2



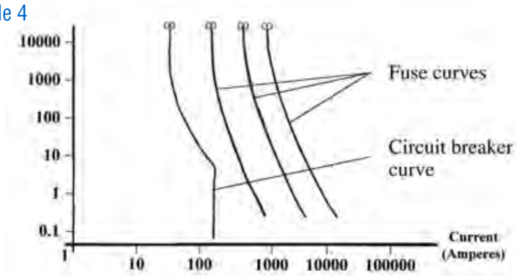
Operating and pre-arcing I^2t values

Table 3



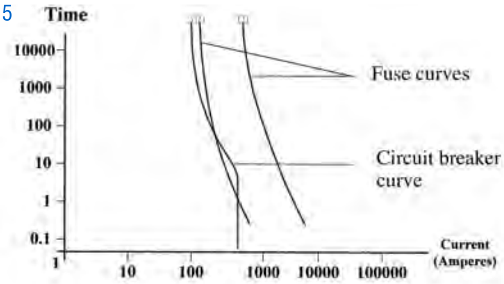
Cut off characteristics

Table 4



Discrimination achieved

Table 5



Discrimination NOT achieved

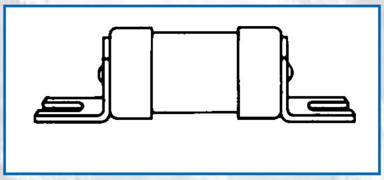
NHP COMPACT FUSES

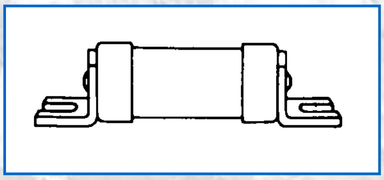
HRC cartridge fuse-links

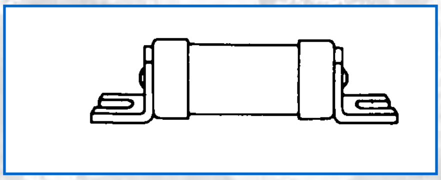
Dimensions

Dimensions (mm)

Fuse link type	A max. mm	B max. mm	D max. mm	E mm	F mm	G nom. mm	H mm	J mm
NNIT	36	14	55	11	0.8	44.5	4.8	-
NTIA, NTIS	56	21	86	9	1.2	73	5.5	7.5
NTIS(M)	58	26	90	13	1.6	73	5.5	-
NOS	58	27	90	13	1.6	73	5.5	-
NTCP	62	27	110	19	2.4	94	8.7	-
NTCP(M)	62	30	110	19	2.4	94	8.7	-
NTFP	77	30	110	19	2.4	94	8.7	10.3
NTFP(M)	77	40	110	19	2.4	94	8.7	10.3

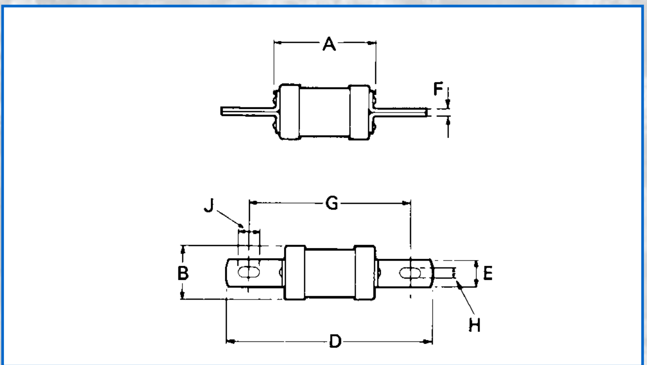


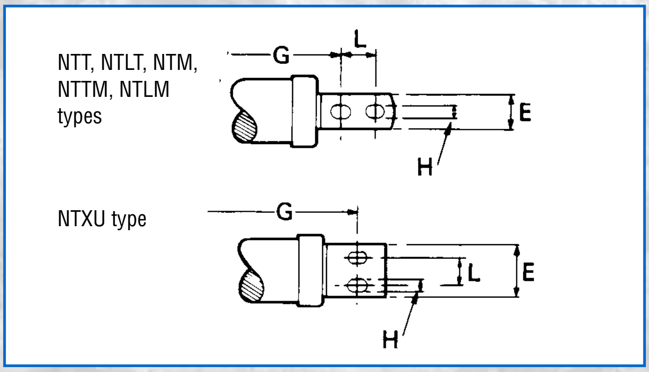




Dimensions (mm)

Fuse link type	A max. mm	B max. mm	D max. mm	E mm	F mm	G nom. mm	H mm	J mm	L mm
NTB	57	21	114	13	1.6	97	7.2	11	-
NTB...M...	57	26	116	13	1.6	97	7.2	11	-
NTBC	57	21	134	16	2.0	111	8.7	16	-
NTBC...M...	58	26	136	16	3.2	111	8.7	16	-
NTC	66	36	135	19	3.6	111	8.7	16	-
NTF	76	41	137	19	3.6	111	8.7	16	-
NTKF	76	51	137	26	4.0	111	8.7	16	-
NTMF	81	58	136	26	5.2	111	8.7	16	-
NTKM	76	51	158	26	4.0	133	8.7	16	-
NTM	81	58	210	26	5.2	133/184	10.3	16	25.4
NTTM	83	74	210	26	6.5	133/184	10.3	16	25.4
NTLM	84	82	210	26	10	133/184	10.3	16	25.4
NTT	83	74	267	38	6.5	165	10.3	16	32
NTLT	84	82	267	38	10	165	10.3	16	32
NTXU	83	100	198	63.5	9.5	149	14.3	19	32





NHP COMPACT FUSES

I^2t characteristics

BS fuses I^2t data

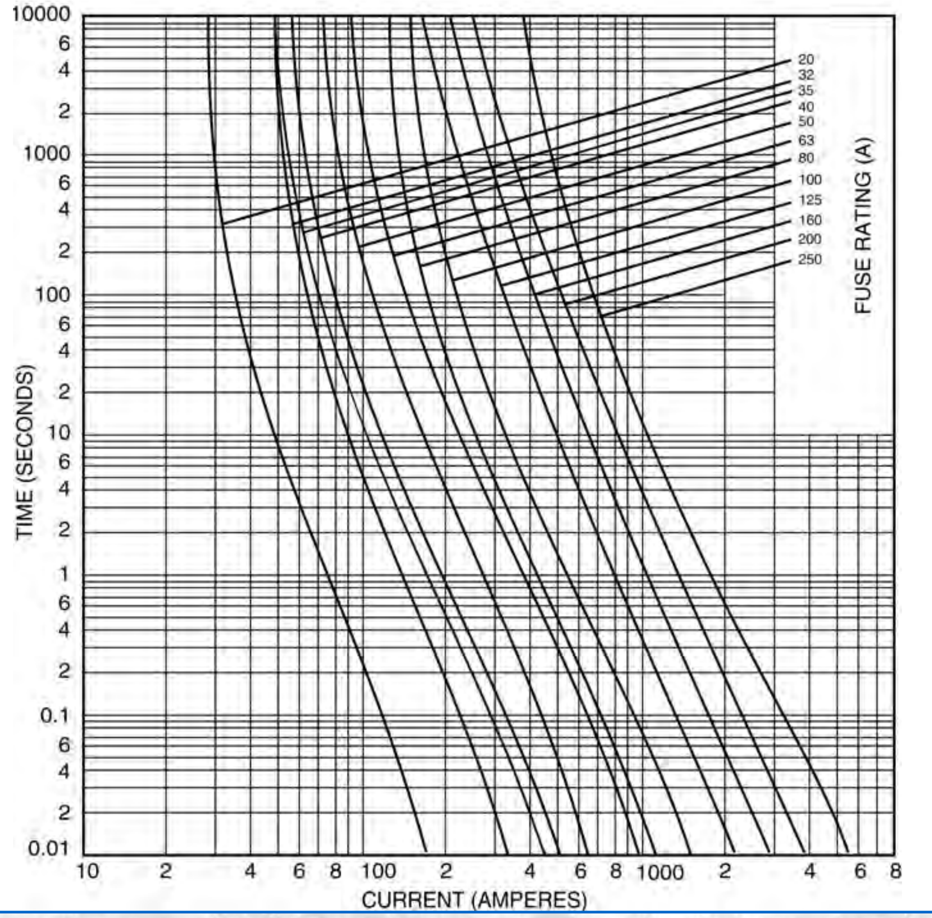
I^2t characteristics

Rating (amperes)	I^2t pre-arcing	I^2t total @ 240 volts	I^2t total @ 415 volts
2	2	2	4
4	10	15	21
6	34	52	74
10	188	289	408
16	92	211	412
20	155	355	690
20M25	574	1084	1809
20M32	574	1561	2605
25	826	1084	1809
32	826	1561	2605
35	1200	2400	4100
32M40	2482	4416	7019
32M50	3305	5879	9345
32M63	5875	10452	16612
40	2482	4416	7019
50	3305	5879	9345
63	5875	10452	16612
80 & 63M80	7800	15500	26000
100 & 63M100	14000	28000	46000
125 & 100M125	30000	51000	75500
160 & 100M160	58500	99000	145000
200 & 100M200	120000	205000	300000
250 & 200M250	210000	360000	530000
315 & 200M315	270000	460000	680000
355	365000	620000	915000
400 & 315M400	480000	820000	1200000
450	755000	1300000	1900000
500	1100000	1850000	2700000
560	1200000	2400000	4000000
630	1550000	3100000	5150000
710	1903565	2992861	4306813
800	3820349	6006505	8643534
1000	7000000	1500000	16000000
1250	12000000	20500000	30000000

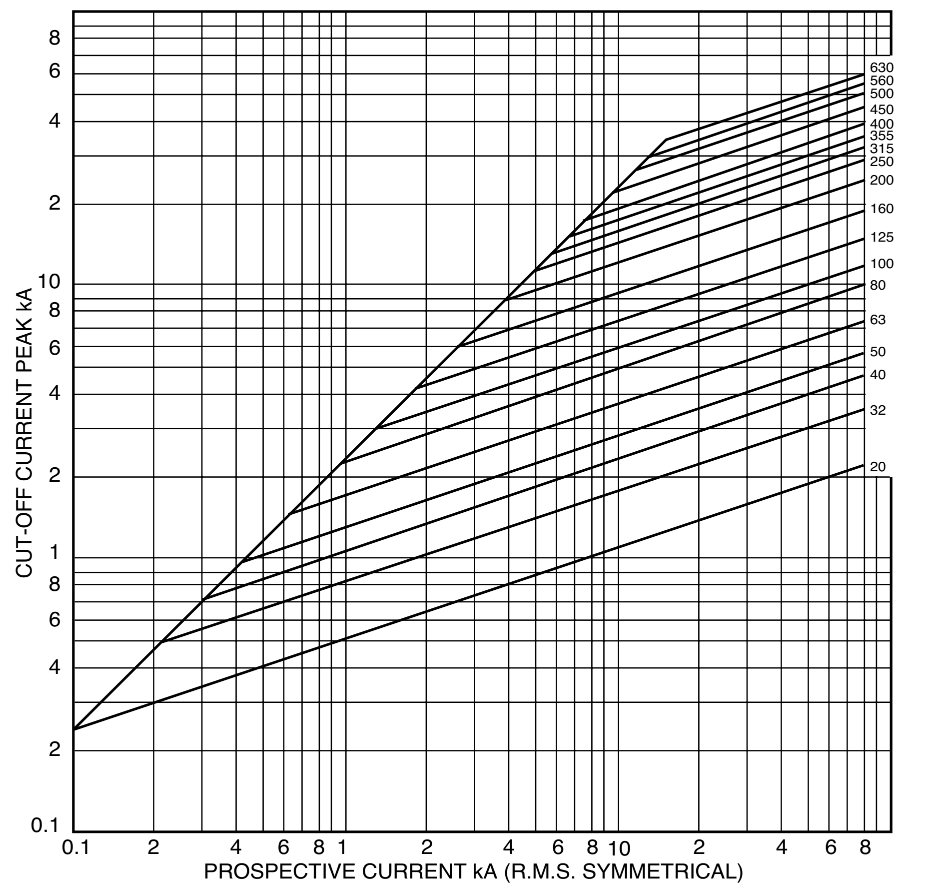
NHP COMPACT FUSES

Fuse curves

BS fuse curves



NHP Compact BS fuses from 20 to 250 amps



NHP Compact BS fuses cut-off current data from 20 to 630 amps

NHP COMPACT FUSES

BS fuse holders

FUSES PROVIDE SUPERIOR SHORT CIRCUIT PROTECTION

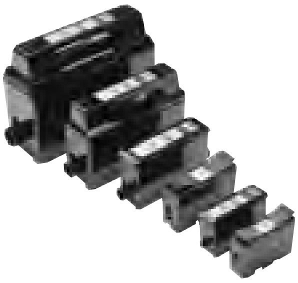
Refer Catalogue NF

Compact fuse holders (Bolt-in)

- New compact size
- Front (FW) or stud/front (SFW) versions
- Smaller dimensions
- Saves panel space

SAVE PANEL SPACE SAVE $$$ WITH NEW COMPACT FUSE HOLDERS

UP TO 30% SMALLER



Rating (A)	Fuse link to suit	Cat. No.
Front wired – bolt in		
32	NNIT	**NC32FW**
63	NTIA NTIS	**NC63FW**
100	NOS NTIA NTIS	**NC100FW**
200	NTIA 1) NTIS 1) NTFP NOS 1) NTCP	**NC200FW**
Back stud/front wired – bolt in		
32	NNIT	**NC32SFW**
63	NTIA NTIS	**NC63SFW**
100	NOS NTIA NTIS	**NC100SFW**
200	NTIA 1) NTIS 1) NTFP NOS 1) NTCP	**NC200SFW**

Note: 1) Fuses can be fitted using adaptor 100M FLK.

Dimensions (mm)

	H	W	D	Suggested Max. cable size
NC32_	87	27	50	10 mm²
NC63_	109	31	62	25 mm²
NC100_	118	35	72	50 mm²
NC200_	154	54	108	95 mm²

Standard fuse holders (Bolt-in)

- Ratings from 20 to 200 A
- Front (FW) or stud/front (SFW) versions
- Complies with BS88

OLD STYLE

N20FW

Rating (A)	Fuse link to suit	Cat. No.
Front wired – bolt in		
20	NNIT	**N20FW**
32	NTIA	**N32FW**
63	NTIA NTIS	**N63FW**
100	NTIA 1) NTIS 1) NOS 1) NTCP	**N100FW**
200	NTBC NTC NTF	**N200FW**
Back stud/front wired – bolt in		
20	NNIT	**N20SFW**
32	NTIA	**N32SFW**
63	NTIA NTIS	**N63SFW**
100	NTIA 1) NTIS 1) NOS 1) NTCP	**N100SFW**
200	NTBC NTC NTF	**N200SFW**

Dimensions (mm)

	H	W	D	Suggested Max. cable size
N20_	87	27	50	10 mm²
N32_	109	31	62	10 mm²
N63_	118	35	72	50 mm²
N100_	154	54	108	70 mm²
N200_	193	70	149	150 mm²

Clip-in fuse holders - DIN rail mount

Fast, reliable fitting and removal of fuse links

NV20FW

NV32FW

NV63FW

Rating (A)	Fuse link to suit	Cat. No.
Front wired – clip-in – Black		
20	NSS	**NV20FW**
32	NSS	**NV32FW**
63	NES	**NV63FW**
Front wired – Clip-in – White		
32	NNS	**NV32FWW**
63	NES	**NV63FWW**

8. GSM Modem

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

GSM MODEM

1. FASTRACK SUPREME GSM MODEM TECHNICAL DETAILS
2. FASTRACK SUPREME GSM MODEM USER GUIDE

wavecom
Make it wireless

Fastrack Supreme User Guide
WA_DEV_Fastrk_UGD_001

Plug and Play Wireless CPU®

FASTRACK Supreme User Guide

Reference: WA_DEV_Fastrk_UGD_001
Revision: 001e
Date: 5 june, 2007

Supports Open AT® embedded ANSI C applications

Document History

Revision	Date	List of revisions	
001	9 February, 07	First Issue	
001a	23 February, 2007	Update DC cable GPIO mapping, add AutoShutDown	
001b	21 May, 07	Add detail of IES, RTC and serial port autoshutdown	
001c	1 Jun, 07	Change to Quad Band	
001d	4 Jun, 07	Update label/packaging photo	
001e	5 Jun, 07	Comment	

Overview

The FASTRACK Supreme 10 and FASTRACK Supreme 20 are discrete, rugged cellular Plug & Play Wireless CPU® offering state-of-the-art GSM/GPRS (and EGPRS for FASTRACK Supreme 20) connectivity for machine to machine applications.

Proven for reliable, stable performance on wireless networks worldwide, Wavecom's latest generation of FASTRACK Supreme continues to deliver rapid time to market and painless integration.

Having comparable size with the previous M1306B generation, and updated with new features, the FASTRACK Supreme offers an Internal Expansion Socket (IES) interface accessible for customer use. Expanding application features is easy without voiding the warrantee of the FASTRACK Supreme by simply plugging in of an Internal Expansion Socket Module (IESM) board.

Fully certified, the quad band 850/900/1800/1900 MHz FASTRACK Supreme 10 offers GPRS Class 10 capability and FASTRACK Supreme 20 offers GPRS/EGPRS Class 10 capability. Both support a powerful open software platform (Open AT®). Open AT® is the world's most comprehensive cellular development environment, which allows embedded standard ANSI C applications to be natively executed directly on the Wireless CPU®.

FASTRACK Supreme is controlled by firmware through a set of AT commands.

This document describes the FASTRACK Supreme and gives information on the following topics:

- general presentation,
- functional description,
- basic services available,
- technical characteristics,
- installing and using the FASTRACK Supreme,
- user-level troubleshooting.
- recommended accessories to be used with the product.

Note:

This document covers the FASTRACK Supreme Plug & Play alone and does not include

- The programmable capabilities provided via the use of Open AT® Software Suites.
- The development guide for IESM for expanding the application feature through the IES interface.

For detailed, please refer to the documents shown in the "Reference documents" section.

RoHS Directive

The FASTRACK Supreme is now compliant with RoHS Directive 2002/95/EC, which sets limits for the use of certain restricted hazardous substances. This directive states that "from 1st July 2006, new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), and polybrominated diphenyl ethers (PBDE)".

Plug & Plays which are compliant with this directive are identified by the RoHS logo on their label.

Disposing of the product

This electronic product is subject to the EU Directive 2002/96/EC for Waste Electrical and Electronic Equipment (WEEE). As such, this product must not be disposed off at a municipal waste collection point. Please refer to local regulations for directions on how to dispose off this product in an environmental friendly manner.

Cautions

Information furnished herein by WAVECOM is accurate and reliable. However, no responsibility is assumed for its use. Please read carefully the safety recommendations given in Section 9 for an application based on FASTRACK Supreme Plug & Play.

Trademarks

Copyright

Web Site Support

General information about Wavecom and its range of products:	www.wavecom.com
Specific support is available for the FASTRACK Supreme Plug & Play Wireless CPU®:	TBD
Open AT® Introduction:	www.wavecom.com/OpenAT
Developer community for software and hardware:	www.wavecom.com/forum

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1 References

1.1 Reference Documents

For more details, several reference documents may be consulted. The Wavecom reference documents are provided in the Wavecom documents package contrary to the general reference documents, which are not Wavecom owned.

1.1.1 Open AT® Software Documentation

[1] Getting started with Open AT® (Ref.WM_ASW_OAT_CTI_001)

[2] Open AT® Tutorial (Ref.WM_ASW_OAT_UGD_001)

[3] Tools Manual (Ref. WM_ASW_OAT_UGD_003)

[4] Open AT® Programming Guide (Ref. TBD)

[5] Open AT® Customer Release Note (Ref. WM_ASW_OAT_DVD_00062)

Remark: The document above is for Open AT3.12 and FASTRACK Supreme will use new release of Open AT4.21. Reference document not yet available and TBC.

1.1.2 AT Software Documentation

[6] AT commands interface Guide for X51 (Ref. WM_ASW_OAT_UGD_00016)

[7] Customer Release Note X51 (Ref. WM_ASW_OAT_DVD_00120)

Remark: The document above is for X51 and FASTRACK Supreme will use new release of FW6.63. Reference document not yet available and TBC.

1.1.3 Firmware Upgrade Documents

[8] Firmware upgrade procedure (Ref. WM_SW_GEN_UGD_001)

1.1.4 Delta between M1306B Documents

[9] Delta between M1306B and FASTRACK Supreme (Ref. WA_DEV_Fastrk_UGD_004)

1.1.5 IESM Related Documents

[10] IESM Product Technical Specification (Ref. WA_DEV_Fastrk_PTS_001)

[11] IESM-GPS+USB User Guide (Ref. WA_DEV_Fastrk_UGD_002)

[12] IESM-GPS+USB Installation Guide (Ref. WA_DEV_Fastrk_UGD_003)

[13] IESM-IO+USB Installation Guide (Ref. WA_DEV_Fastrk_UGD_005)

[14] IESM-IO+USB User Guide (Ref. WA_DEV_Fastrk_UGD_006)

Note:

New versions of software may be available. Wavecom recommends customers to check the web site for the latest documentation.

1.2 Abbreviations

Abbreviation	Definition
AC	**A**lternating **C**urrent
ACM	**A**ccumulated **C**all **M**eter
AMR	**A**daptive **M**ulti-**R**ate
AT	**AT**tention (prefix for Wireless CPU® commands)
CLK	**CL**oc**K**
CMOS	**C**omplementary **M**etal **O**xide **S**emiconductor
CS	**C**oding **S**cheme
CTS	**C**lear **T**o **S**end
dB	**Deci**be**l**
dBc	**Deci**b**el relative to the **C**arrier power
dBi	**Deci**b**el relative to an **I**sotropic radiator
dBm	**Deci**b**el relative to one **m**illiwatt
DC	**D**irect **C**urrent
DCD	**D**ata **C**arrier **D**etect
DCE	**D**ata **C**ommunication **E**quipment
DCS	**D**igital **C**ellular **S**ystem
DSR	**D**ata **S**et **R**eady
DTE	**D**ata **T**erminal **E**quipment
DTMF	**D**ual **T**one **M**ulti-**F**requency
DTR	**D**ata **T**erminal **R**eady
EEPROM	**E**lectrically **E**rasable **P**rogrammable **R**ead-**O**nly **M**emory
EFR	**E**nhanced **F**ull **R**ate
E-GSM	**E**xtended **GSM**
EMC	**E**lectro**M**agnetic **C**ompatibility
EMI	**E**lectro**M**agnetic **I**nterference
ESD	**E**lectro**S**tatic **D**ischarges
ETSI	**E**uropean **T**elecommunications **S**tandards **I**nstitute
FIT	**Series of connectors (micro-FIT)**
FR	**F**ull **R**ate

Abbreviation	Definition
FTA	**F**ull **T**ype **A**pproval
GCF	**G**lobal **C**ertification **F**orum
GND	**G**rou**ND**
GPIO	**G**eneral **P**urpose **I**nput **O**utput
GPRS	**G**eneral **P**acket **R**adio **S**ervice
GSM	**Gl**obal **S**ystem for **M**obile communications
HR	**H**alf **R**ate
I	**I**nput
IEC	**I**nternational **E**lectrotechnical **C**ommission
IES	**I**nternal **E**xpansion **S**ocket
IESM	**I**nternal **E**xpansion **S**ocket **M**odule
IMEI	**I**nternational **M**obile **E**quipment **I**dentification
I/O	**I**nput / **O**utput
LED	**L**ight **E**mitting **D**iode
MAX	**MAX**imum
ME	**M**obile **E**quipment
MIC	**MIC**rophone
Micro-Fit	**Family of connectors from Molex**
MIN	**MIN**imum
MNP	**M**icrocom **N**etworking **P**rotocol
MO	**M**obile **O**riginated
MS	**M**obile **S**tation
MT	**M**obile **T**erminated
NOM	**NOM**inal
O	**O**utput
Pa	**Pa**scal (for speaker sound pressure measurements)
PBCCH	**P**acket **B**roadcast **C**ontrol **CH**annel
PC	**P**ersonal **C**omputer
PCL	**P**ower **C**ontrol **L**evel
PDP	**P**acket **D**ata **P**rotocol
PIN	**P**ersonal **I**dentity **N**umber
PLMN	**P**ublic **L**and **M**obile **N**etwork
PUK	**P**ersonal **U**nblocking **K**ey
RF	**R**adio **F**requency

Abbreviation	Definition
RFI	**R**adio **F**requency **I**nterference
RI	**R**ing **I**ndicator
RMS	**R**oot **M**ean **S**quare
RTS	**R**equest **T**o **S**end
RX	**R**eceive
SIM	**S**ubscriber **I**dentification **M**odule
SMA	**S**ub**M**iniature version **A** RF connector
SMS	**S**hort **M**essage **S**ervice
SNR	**S**ignal-to-**N**oise **R**atio
SPL	**S**ound **P**ressure **L**evel
SPK	**Sp**ea**K**er
SRAM	**S**tatic **RAM**
TCP/IP	**T**ransmission **C**ontrol **P**rotocol / **I**nternet **P**rotocol
TDMA	**T**ime **D**ivision **M**ultiple **A**ccess
TU	**T**ypical **U**rban fading profile
TUHigh	**T**ypical **U**rban, **High** speed fading profile
TX	**T**ransmit
TYP	**TYP**ical
VSWR	**V**oltage **S**tationary **W**ave **R**atio

2 Packaging

2.1 Contents

The complete package content of the FASTRACK Supreme consists of (see):

- one packaging box (**A**),
- one FASTRACK Supreme (**B**),
- two holding bridles (**C**),
- one power supply cable with fuse integrated (**D**)
- a mini notice (**E**) with:
  - a summary of the main technical features,
  - safety recommendations,
  - EC declaration of conformity.

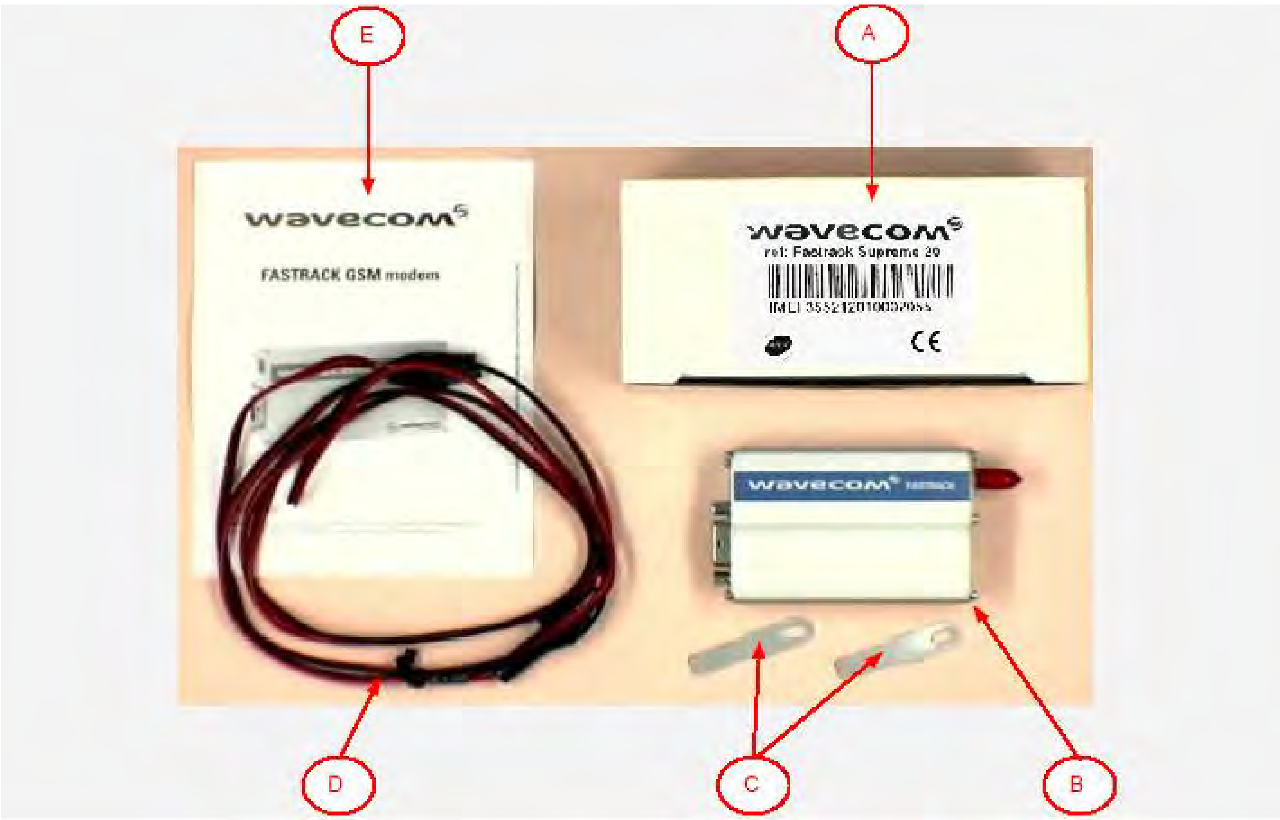


Figure 1: Complete package contents

2.2 Packaging Box

The packaging box is a carton box (see) with the following external dimensions:

- width: 54.5 mm,
- height: 68 mm,
- length: 108 mm.

A packaging label is slicked on the packaging box cover and supports the:

- WAVECOM logo,
- Product reference (Supreme),
- CE marking
- 15-digit IMEI code
- Open AT® Logo
- RoHS logo
- WEEE logo

Figure 2: Packaging box

The packaging label dimensions are:

- height: 40 mm,
- length: 65 mm.

2.3 Production Labelling

A production label (see Figure 3) located at the FASTRACK Supreme back side gives the following information:

- product reference (**FASTRACK Supreme 10** or **FASTRACK Supreme 20**),
- part number (WM19183),
- CE marking,
- 15-digit IMEI code,
- OpenAT® logo

Figure 3: Production Label

3 General Presentation

3.1 Description

The FASTRACK Supreme description is given in the Figure 4 below.

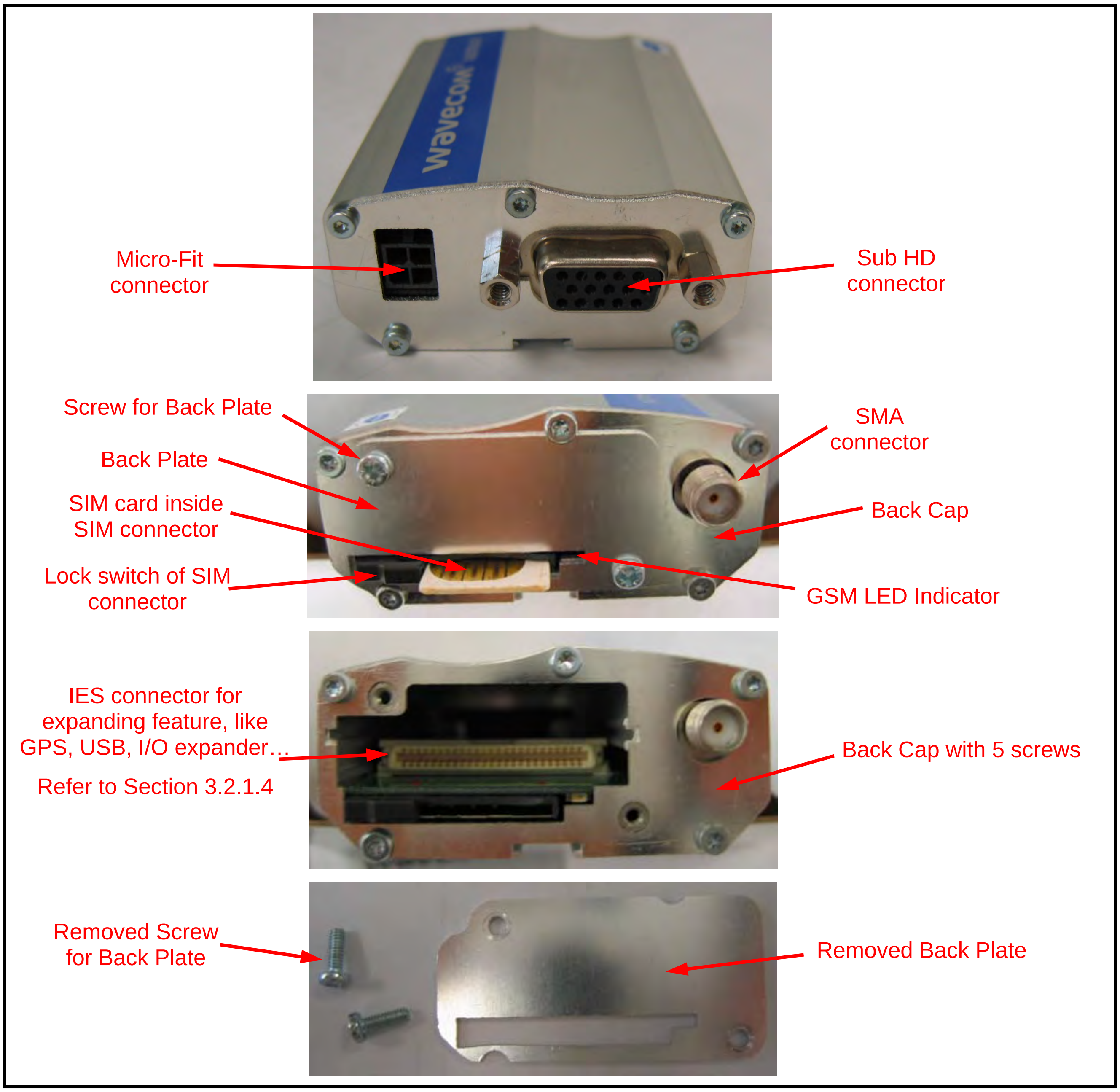


Figure 4: FASTRACK Supreme general description

CAUTION: Users are free to remove the back plate for IESM board plug in/unplug without voiding the warrantee of the FASTRACK Supreme. **However, the warrantee will be voided if unscrewing any screw of the back cap.**

In addition, two holding bridles are provided to tighten the FASTRACK Supreme on a support.

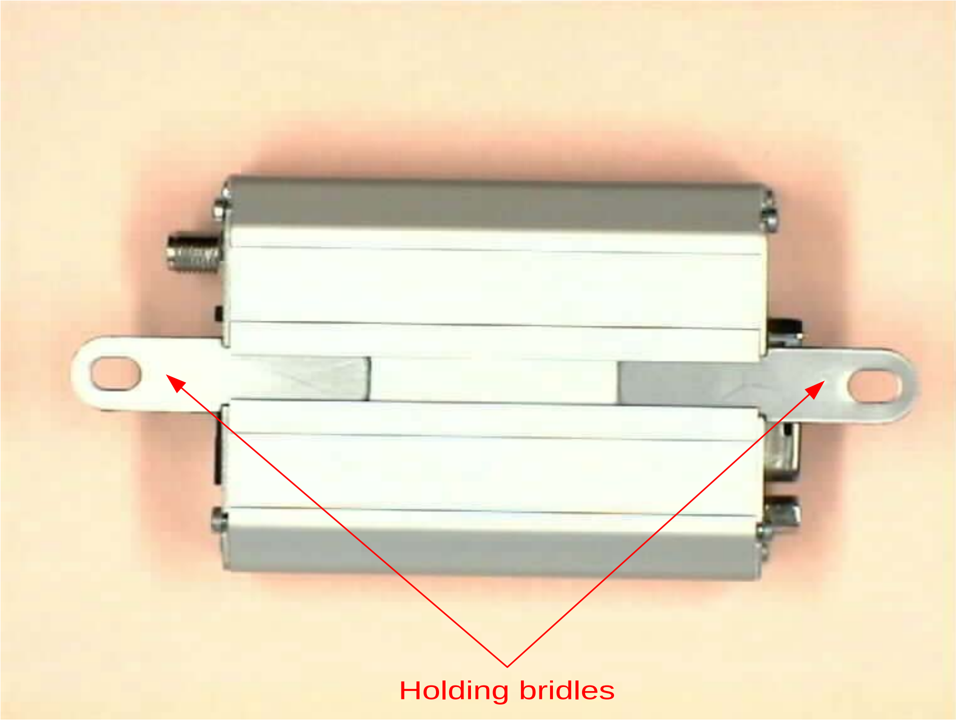


Figure 5: FASTRACK Supreme holding bridles

3.2 External Connections

3.2.1 Connectors

3.2.1.1 Antenna Connector

The antenna connector is a SMA type connector for a 50 Ω RF connection.

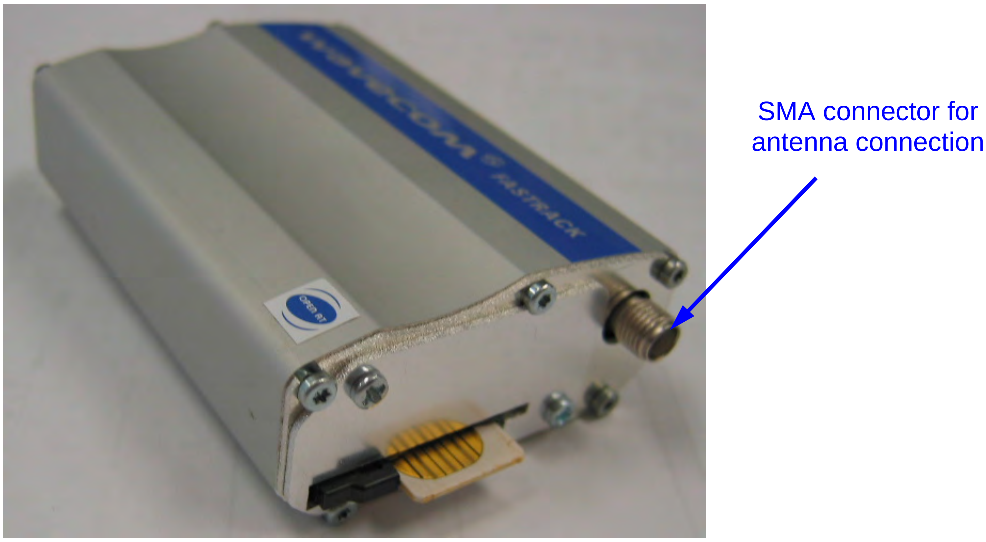


Figure 6: SMA connector for antenna connection

3.2.1.2 Power Supply Connector

The power supply connector is a 4-pin Micro FIT connector for:

- external DC Power Supply connection,
- GPIOs connection (two General Purpose Input/Output signals available).

Figure 7: Power supply connector

Table 1: Power supply connector pin description

Pin #	Signal	I/O	I/O type	Description	Reset State	Comment
1	V+BATTERY	I	Power supply	Battery voltage input: ▪ 5.5 V Min. ▪ 13.2 V Typ. ▪ 32 V Max.		High current
2	GND		Power supply	Ground		
3	GPIO21	I/O	2V8	General Purpose Input/output	Undefined	Not mux
4	GPIO25	I/O	2V8	General Purpose Input/output	Z	Multiplex with INT1

Warning:

Both pin 3 and pin 4 are used by GPIO interface. It is strictly prohibited to connect them to any power supply at the risk of damage to the FASTRACK Supreme.

3.2.1.3 Sub HD 15-pin Connector

The Sub D high density 15-pin connector is used for:

- RS232 serial link connection,
- Audio lines (microphone and speaker) connection,
- BOOT and RESET signal connection.

Figure 8: Sub HD 15-pin connector

Table 2: Sub HD 15-pin connector description

Pin #	Signal (CCITT / EIA)	I/O	I/O type	Description	Comment
1	CDCD/CT109	O	STANDARD RS232	RS232 Data Carrier Detect	
2	CTXD/CT103	I	STANDARD RS232	RS232 Transmit serial data	
3	BOOT	I	CMOS	Boot	This signal must not be connected. Its use is strictly reserved to Wavecom or competent retailers.
4	CMIC2P	I	Analog	Microphone positive line	
5	CMIC2N	I	Analog	Microphone negative line	
6	CRXD/CT104	O	STANDARD RS232	RS232 Receive serial data	
7	CDSR/CT107	O	STANDARD RS232	RS232 Data Set Ready	
8	CDTR/CT108-2	I	STANDARD RS232	RS232 Data Terminal Ready	
9	GND	-	GND	Ground	

Pin #	Signal (CCITT / EIA)	I/O	I/O type	Description	Comment
10	CSPK2P	O	Analog	Speaker positive line	
11	CCTS/CT106	O	STANDARD RS232	RS232 Clear To Send	
12	CRTS/CT105	I	STANDARD RS232	RS232 Request To Send	
13	CRI/CT125	O	STANDARD RS232	RS232 Ring Indicator	
14	RESET	I/O	Schmitt	Supreme Plug & Play reset	Active low
15	CSPK2N	O	Analog	Speaker negative line	

3.2.1.4 IES Connector

The IES connector is a 50 pins board-to-board connector for expanding application features like GPS, USB, I/O expander… Currently there are already 3 IESM boards available for customer to expand the FASTRACK Supreme features immediately. They are:

- IESM-GPS+USB+I/O
- IESM-GPS+USB
- IESM-USB+I/O

For detail, please refer to Document in Section 1.1.5.

For sales and support, please contact Wavecom sales/FAE or your distributor.

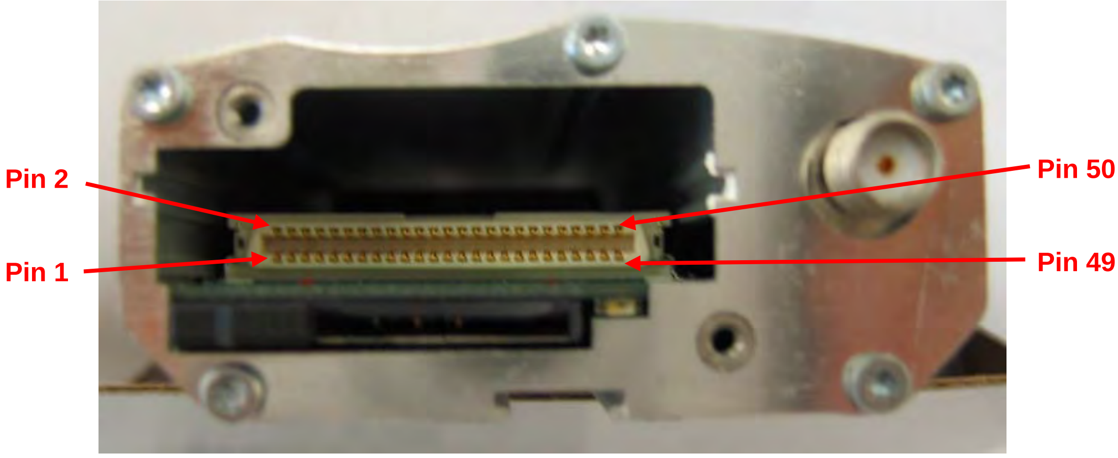


Figure 9: IES connector for feature expansion

Table 3: IES Connector Description

Pin Number	Signal Name		I/O type	Voltage	I/O*	Reset State	Description	Dealing with unused pins
	Nominal	Mux						
1	GND						Ground	
2	GND						Ground	
3	GPIO4	COL0	C8	GSM-1V8	I/O	Pull-up	Keypad column 0	NC
4	GPIO5	COL1	C8	GSM-1V8	I/O	Pull-up	Keypad column 1	NC
5	GPIO6	COL2	C8	GSM-1V8	I/O	Pull-up	Keypad column 2	NC
6	GPIO7	COL3	C8	GSM-1V8	I/O	Pull-up	Keypad column 3	NC
7	VPAD-USB			VPAD-USB	I		USB Power supply input	NC
8	USB-DP			VPAD-USB	I/O		USB Data	NC
9	USB-DM			VPAD-USB	I/O		USB Data	NC
10	GSM-1V8*			GSM-1V8	O		1.8V Supply Output (for GPIO pull-up only)	NC
11	GSM-2V8*			GSM-1V8	O		2.8V Supply Output (for GPIO pull-up only)	NC
12	BOOT			GSM-1V8	I		Not Used	Add a test point / a jumper/ a switch to VCC_1V8 (Pin 10) in case Download Specific mode is used (See product specification for details)
13	~RESET		C4	GSM-1V8	I/O		RESET Input	NC or add a test point
14	AUX-ADC		A2	Analog	I		Analog to Digital Input	Pull to GND
15	~SPI1-CS	GPIO31	C1	GSM-2V8	O	Z	SPI1 Chip Select	NC
16	SPI1-CLK	GPIO32	C1	GSM-2V8	O	Z	SPI1 Clock	NC
17	SPI1-I	GPIO30	C1	GSM-2V8	I	Z	SPI1 Data Input	NC
18	SPI1-IO	GPIO29	C1	GSM-2V8	I/O	Z	SPI1 Data Input / Output	NC
19	SPI2-CLK	GPIO32	C1	GSM-2V8	O	Z	SPI2 Clock	NC
20	SPI2-IO	GPIO33	C1	GSM-2V8	I/O	Z	SPI2 Data Input / Output	NC
21	~SPI2-CS	GPIO35	C1	GSM-2V8	O	Z	SPI2 Chip Select	NC
22	SPI2-I	GPIO34	C1	GSM-2V8	I	Z	SPI2 Data Input	NC
23	CT104-RXD2	GPIO15	C1	GSM-1V8	O	Z	Auxiliary RS232 Receive	Add a test point for firmware upgrade
24	CT103-TXD2	GPIO14	C1	GSM-1V8	I	Z	Auxiliary RS232 Transmit	(TXD2) Pull-up to VCC_1V8 with 100kΩ and add a test point for firmware update
25	~CT106-CTS2	GPIO16	C1	GSM-1V8	O	Z	Auxiliary RS232 Clear To Send	(CTS2) Add a test point for firmware update
26	~CT105-RTS2	GPIO17	C1	GSM-1V8	I	Z	Auxiliary RS232 Request To Send	(RTS2) Pull-up to VCC_1V8 with 100kΩ and add a test point for

Pin Number	Signal Name		I/O type	Voltage	I/O*	Reset State	Description	Dealing with unused pins
	Nominal	Mux						
								firmware update
27	GPIO8	COL4	C8	GSM-1V8	I/O	Pull-up	Keypad column 4	NC
28	GPIO26	SCL	A1	Open Drain	O	Z	I²C Clock	NC
29	GPIO19		C1	GSM-2V8	I/O	Z		NC
30	GPIO27	SDA	A1	Open Drain	I/O	Z	I²C Data	NC
31	GPIO20		C1	GSM-2V8	I/O	Undefined		NC
32	INT0	GPIO3	C1	GSM-1V8	I	Z	Interruption 0 Input	If INT0 is not used, it should be configured as GPIO
33	GPIO23	**	C1	GSM-2V8	I/O	Z		NC
34	GPIO22	**	C1	GSM-2V8	I/O	Z		NC
35	~CT108-2-DTR1	GPIO41	C1	GSM-2V8	I	Z	Main RS232 Data Terminal Ready	(DTR1) Pull-up to VCC_2V8 with 100kΩ
36	PCM-SYNC			GSM-1V8	O	Pull-down	PCM Frame Synchro	NC
37	PCM-IN		C5	GSM-1V8	I	Pull-up	PCM Data Input	NC
38	PCM-CLK			GSM-1V8	O	Pull-down	PCM Clock	NC
39	PCM-OUT			GSM-1V8	O	Pull-up	PCM Data Output	NC
40	AUX-DAC			Analog	O		Digital to Analog Output	NC
41	VCC-2V8			VCC_2V8	O		LDO 2.8V Supply Output	NC
42	GND						Ground	
43	DC-IN			DC-IN from 5.5V~32VDC	O		DC voltage input through Micro-Fit connector	NC
44	DC-IN			DC-IN from 5.5V~32VDC	O		DC voltage input through Micro-Fit connector	NC
45	GND						Ground	
46	4V			4V	O		4V DC/DC converter Output	NC
47	4V			4V	O		4V DC/DC converter Output	NC
48	GND						Ground	
49	GND						Ground	
50	GND						Ground	

3.2.2 Power supply cable

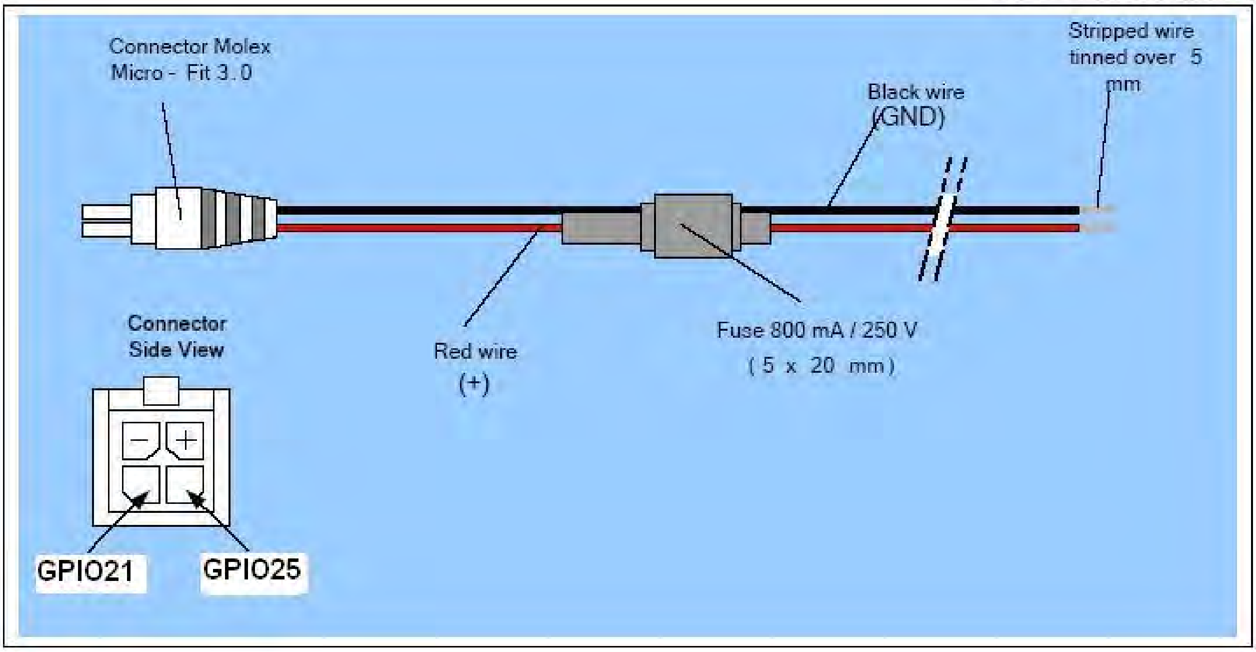


Figure 10: Power supply cable

Component	Characteristics
Micro-Fit connector 4-pin	Part number: MOLEX 43025-0400
Cable	Cable length: ~1.5 m
Wire	Core: tinned copper 24 x 0.2 mm
	Section: 0.75 mm^2

4 Features and Services

4.1 Basic Features and Services

Basic features of the FASTRACK Supreme and available services are summarized in the table below.

Table 4: Basic features of the FASTRACK Supreme

Features	GSM850 / GSM900	DCS1800 / PCS1900
Open AT®	Open AT® programmable: Native execution of embedded standard ANSI C applications, Custom AT command creation, Custom application library creation, Standalone operation.	
Standard	850MHz / 900 MHz. E-GSM compliant. Output power: class 4 (2W). Fully compliant with ETSI GSM phase 2 + small MS.	1800 MHz / 1900MHz Output power: class 1 (1W). Fully compliant with ETSI GSM phase 2 + small MS.
GPRS	Class 10. PBCCH support. Coding schemes: CS1 to CS4. Compliant with SMG31bis. Embedded TCP/IP stack.	
EGPRS **(for FASTRACK Supreme 20 only)**	Output power: 0.5W	Output power: 0.4W
	Class 10. PBCCH support. Coding schemes: MCS1 to MCS9. Compliant with SMG31bis. Embedded TCP/IP stack.	

Features	GSM850 / GSM900	DCS1800 / PCS1900
Interfaces	RS232 (V.24/V.28) Serial interface supporting: ▪ Baud rate (bits/s): 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800 and 921600. ▪ Autobauding (bits/s): from 1200 to 921600. 2 General Purpose Input/Output gates (GPIOs) available. 1.8 V / 3 V SIM interface. AT command set based on V.25ter and GSM 07.05 & 07.07. Open AT® interface for embedded application. Open AT® Plug-In Compatible.	
SMS	Text & PDU. Point to point (MT/MO). Cell broadcast.	
Data	Data circuit asynchronous. Transparent and Non Transparent modes. Up to 14.400 bits/s. MNP Class 2 error correction. V42.bis data compression.	
Fax	Automatic fax group 3 (class 1 and Class 2).	
Audio	Echo cancellation Noise reduction Telephony. Emergency calls. Full Rate, Enhanced Full Rate, Half Rate operation and Adaptive Multi-Rate (FR/EFR/HR/AMR). Dual Tone Multi Frequency function (DTMF).	

Features	GSM850 / GSM900	DCS1800 / PCS1900
GSM supplement services	Call forwarding. Call barring. Multiparty. Call waiting and call hold. Calling line identity. Advice of charge. USSD	
Other	DC power supply Real Time Clock with calendar Complete shielding	

For other detailed technical characteristics, refer to Section 8.

4.2 Additional NEW Features

4.2.1 Support Additional GSM850/PCS1900 Bands

Apart from GSM900/DCS1800, the FASTRACK Supreme Plug & Play now supports also the GSM850/PCS1900 bands. FASTRACK Supreme is fully compliant to PTCRB and FCC also.

4.2.2 IES Interface for Easy Expansion of Application Features

The FASTRACK Supreme Plug & Play offers a 50 pin Internal Expansion Socket (IES) Interface accessible for customer use. It is the additional interface which is easy for customers to expand their application features without voiding the warrantee of the FASTRACK Supreme, by simply plugging in an Internal Expansion Socket Module (IESM) board through the matting connector of the IES interface.

Thanks to the flexible IES interface, customers are ready to expand the application features by plugging in the corresponding Internal Expansion Socket Module (IESM) of GPS, I/O expander…, etc.

For brief description of the interface, please refer to Section 3.2.1.4.

For technical detail, please refer to Document [11] or contact your Wavecom distributor or Wavecom FAE.

4.2.3 Serial Port Auto Shut Down or Improving Power Consumption

In order to save power consumption when there is no data communication between the Plug & Play and the DTE, FASTRACK Supreme has now implement the Serial Port Auto Shut Down feature. User can activate or deactivate the Serial Port Auto Shut Down mode by simple AT-command.

For detail, please refer to Section 7.3.4.

4.2.4 Real Time Clock (RTC) for Saving Date and Time

The FASTRACK Supreme has now implemented the Real Time Clock for saving date and time when the Plug & Play is unplugged from the DC power supply through the DC power cable.

For detail, please refer to Section 7.8.

4.2.5 SIM Card Lock Feature

The FASTRACK Supreme has now implemented a SIM connector having a carrier with lock. This helps ensuring the user to have proper SIM card insertion and locked before proper use of GSM network.

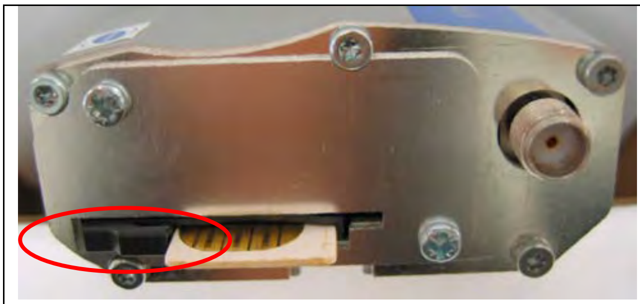
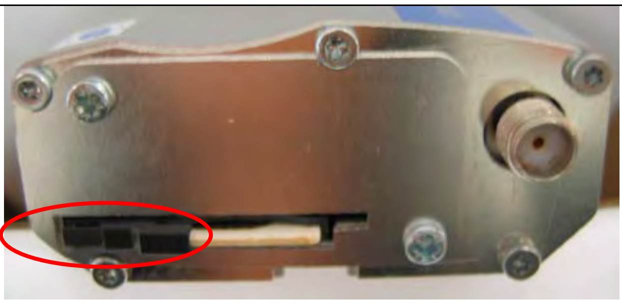
	
SIM card is inserted but not locked. GSM network is not ready for use. Only emergency call 112 is possible.	SIM card is inserted and being locked properly. GSM network is ready for use.

Figure 11: SIM card lock feature

5 Using the FASTRACK Supreme Plug & Play

5.1 Getting Started

5.1.1 Mount the FASTRACK Supreme

To mount the FASTRACK Supreme on its support, bind it using the holding bridles as shown in the Figure 12 below.

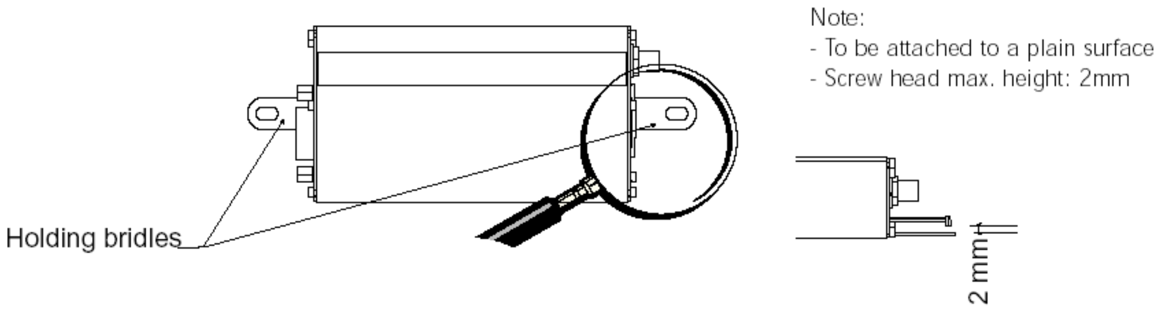


Figure 12: FASTRACK Supreme mounting

For the drill template, refer to Figure 18.

5.1.2 Set up the FASTRACK Supreme

To set up the FASTRACK Supreme, perform the following operations:

- Insert the SIM card into the SIM card holder of the FASTRACK Supreme.
- Lock the SIM card by sliding the lever towards the SIM card.
- Connect the antenna to the SMA connector.
- Connect both sides of the serial and control cable (15-pin Sub HD connector on the FASTRACK Supreme side).
- Connect the power supply cable to the external power supply source.

Note:

For automotive application, it is recommended to connect the V+BATTERY line of the FASTRACK Supreme directly to the battery positive terminal.

- Plug the power supply cable into the FASTRACK Supreme and switch on the external power supply source.
- The FASTRACK Supreme is ready to work. Refer to Section 5.10 for the description of AT commands used to configure the FASTRACK Supreme.

5.1.3 Check the communication with the FASTRACK Supreme

To check the communication with the FASTRACK Supreme, do the following operations:

- Connect the RS232 link between the DTE (port COM) and the FASTRACK Supreme (DCE).
- Configure the RS232 port of the DTE as follows:
  - Bits per second: **115.200 bps**,
  - Data bits: **8**,
  - Parity: **None**,
  - Stop bits: **1**,
  - Flow control: **hardware**.
- Using a communication software such as a HyperTerminal, enter the **AT↵** command. The response of the FASTRACK Supreme must be **OK** displayed in the HyperTerminal window.
- If the communication cannot be established with the FASTRACK Supreme, do the following:
  - Check the RS232 connection between the DTE and the FASTRACK Supreme (DCE),
  - Check the configuration of the port COM used on the DTE.
- Example of AT commands which can be used after getting started the FASTRACK Supreme:
  - **AT+CGMI**: FASTRACK Supreme answer is "WAVECOM MODEM" when serial link is OK.
  - **AT+CPIN=xxxx:** to enter a PIN code xxxx (if activated).
  - **AT+CSQ**: to verify the received signal strength.
  - **AT+CREG?**: to verify the registration of the FASTRACK Supreme Plug & Play on the network.
  - **ATD<phone number>;**: to initiate a voice call.
  - **ATH**: to hang up (end of call).

For further information on these AT commands and their associated parameters, refer to "AT Commands Interface Guide" [6].

5.1.4 Reset the FASTRACK Supreme

To reset the FASTRACK Supreme, a hardware reset signal is available on pin 14 of the Sub HD 15-pin connector (RESET).

The FASTRACK Supreme reset is carried out when this pin is low for at least 200 µs.

Warning This signal has to be considered as an emergency reset only. For further details on the FASTRACK Supreme reset, refer to Section 7.7.

5.2 Specific Recommendations when Using the FASTRACK Supreme on Trucks

Warning: The power supply connection of the FASTRACK Supreme must NEVER be directly connected to the truck battery.

5.2.1 Recommended Power Supply Connection on Trucks

All trucks have a circuit breaker on the exterior of the cabin. The circuit breaker is used for safety reasons: if a fire blazes in the trucks, (for example, on the wiring trunk) the driver may cut the current source to avoid any damage (explosion). The circuit breaker is connected to the truck ground, most often associated with the fuse box.

Most of truck circuit breakers do not cut the Positive Supply line of the battery, but cut the ground line of the later.

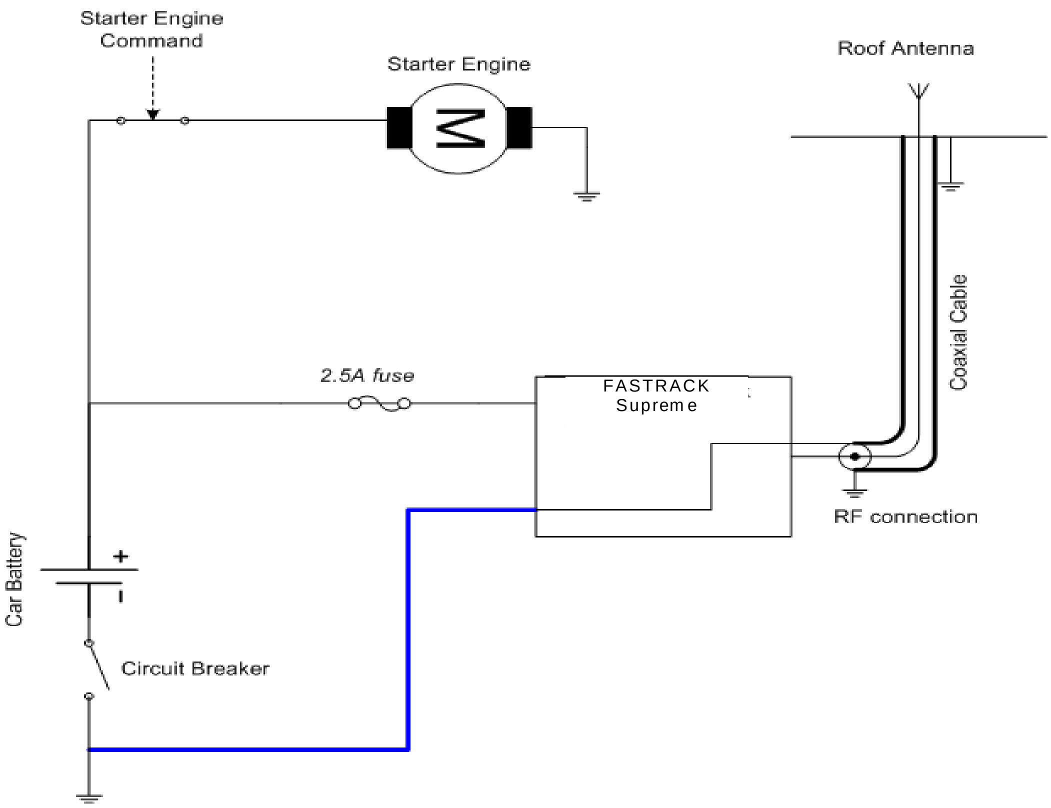


Figure 13: Recommended power supply connection on trucks

Figure 13 gives the recommended power supply connection where the ground connection of the FASTRACK Supreme is not directly connected to the battery but is connected after the Circuit Breaker (on the truck ground or the fuse box).

5.2.2 Technical Constraints on Trucks

It is highly not recommended to connect directly the power supply on the battery rather than on the circuit breaker. The FASTRACK Supreme may be damaged when starting the truck if the circuit breaker is switched OFF (in this case, the truck ground and the battery ground will be connected through the FASTRACK Supreme as shown in the figure below).

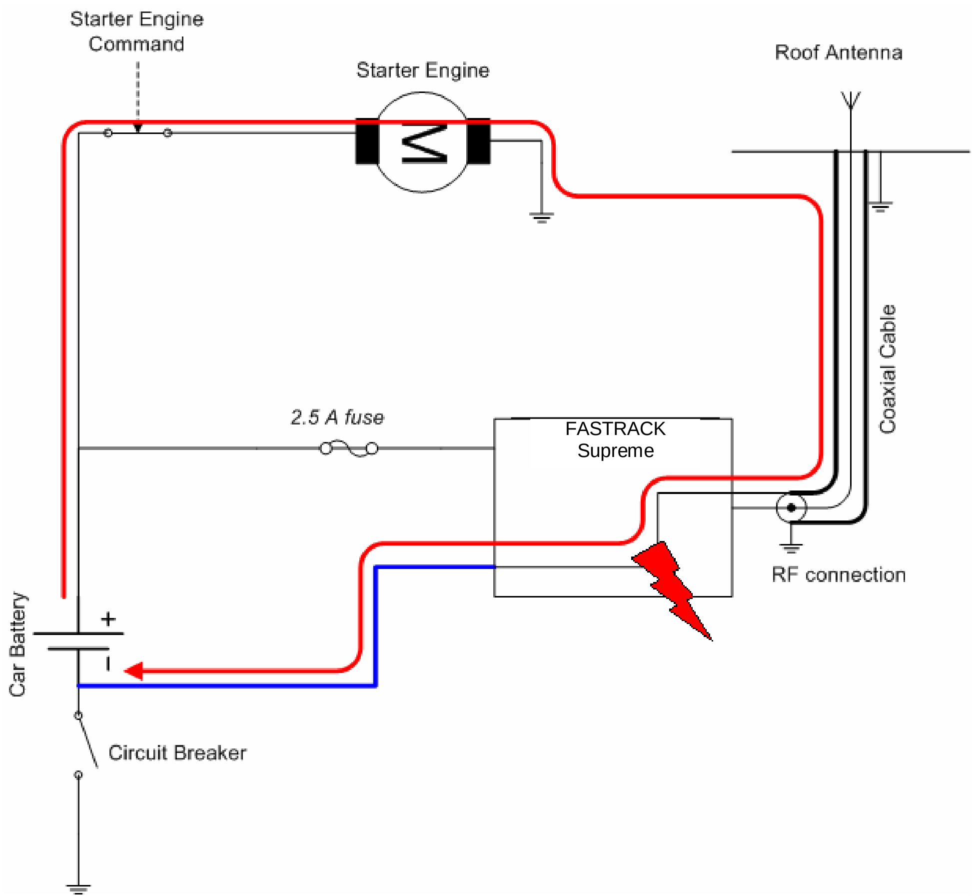


Figure 14: Example of electrical connection which may dramatically damage the FASTRACK Supreme

Figure 14 gives an example of electrical connection which may dramatically damage the FASTRACK Supreme when its ground connection is directly connected to the battery ground.

In this example, when the circuit breaker is switched OFF, the current flows through the FASTRACK Supreme and powers the electrical circuit of the truck (for example, dashboard).

Furthermore, when the Starter Engine command will be used, it will destroy the cables or the FASTRACK Supreme.

Since the internal tracks are not designed to support high current (up to 60 A when starting the truck), they will be destroyed.

5.3 FASTRACK Supreme Operational Status

The FASTRACK Supreme operational status is given by the red LED status located next to the SIM connector on the FASTRACK Supreme panel.

The Table 5 below gives the meaning of the various statuses available.

Table 5: FASTRACK Supreme operational status

LED Status	LED light activity	FASTRACK Supreme Plug & Play status
ON	LED ON permanent	FASTRACK Supreme is switched ON but not registered on the network
	LED Flashing slowly	FASTRACK Supreme is switched ON and registered on the network, but no communication is in progress (Idle mode)
	LED Flashing rapidly	FASTRACK Supreme is switched ON and registered on the network, and a communication is in progress
OFF	LED OFF	FASTRACK Supreme is switched OFF, or Flash LED is disabled* by the user.

* : Flash LED can be disabled by user when in Slow Standby mode in order to save power consumption. For detail, please refer to Section 7.9.

5.4 Echo Function Disabled

If no echo is displayed when entering an AT command, that means:

- The "local echo" parameter of your communication software (such as HyperTerminal) is disabled.
- The FASTRACK Supreme echo function is disabled.

To enable the FASTRACK Supreme echo function, enter the **ATE1**.

When sending AT commands to the FASTRACK Supreme by using a communication software, it is recommended:

- to disable the "local echo" parameter of your communication software (such as HyperTerminal),
- to enable the FASTRACK Supreme echo function (**ATE1** command).

In a Machine To Machine communication with the FASTRACK Supreme, it is recommended to disable the FASTRACK Supreme echo function (**ATE0** command) in order to avoid useless CPU processing.

For further information on **ATE0** and **ATE1** commands, refer to "AT Commands Interface Guide" [6].

5.5 Verify the Received Signal Strength

The FASTRACK Supreme establishes a call only if the received signal is sufficiently strong.

To verify the received signal strength, do the following operations:

- Using a communication software such as HyperTerminal, enter the AT command **AT+CSQ.**
  The response returned has the following format:
  +CSQ: <rssi>,<ber> with:
  - **<rssi>** = received signal strength indication,
  - **<ber>** = channel bit error rate.
- Verify the **<rssi>** value returned using the Table 6 below.

Table 6: Values of received signal strength

Value of received signal strength indication (<rssi>)	Interpretation of the received signal strength
0 - 10	Insufficient(*)
11 - 31	Sufficient(*)
32 - 98	Not defined
99	No measure available

(*) Based on general observations.

For further information on AT commands, refer to "AT Commands Interface Guide" [6].

5.6 Check the Pin Code Status

To check that the pin code has been entered, use a communication software such as a HyperTerminal, then enter **AT+CPIN?** command.

The table below gives the main responses returned:

Table 7: AT+CPIN Responses

AT+CPIN response (*)	Interpretation
+CPIN: READY	Code PIN has been entered
+CPIN: SIM PIN	Code PIN has not been entered

(*)For further information on the other possible responses and their meaning, refer to "AT Commands Interface Guide" [6].

5.7 Switch between EU/US Band(s)

To switch between EU/US band(s) for the FASTRACK Supreme, use a communication software such as a HyperTerminal, then enter **AT+WMBS=<band>[,<param>]** command.

The table below gives the commands for various band(s) selection:

Table 8: AT+WMBS Band Selection

AT+WMBS response (*)	Interpretation
AT+WMBS=0,x	Select mono band mode 850MHz.
AT+WMBS=1,x	Select mono band mode extended 900MHz
AT+WMBS=2,x	Select mono band mode 1800MHz
AT+WMBS=3,x	Select mono band mode 1900MHz
AT+WMBS=4,x	Select dual band mode 850/1900MHz
AT+WMBS=5,x	Select dual band mode extended 900MHz/1800MHz
AT+WMBS=6,x	Select dual band mode extended 900MHz/1900MHz

(*)For further information on the other possible responses and their meaning, refer to "AT Commands Interface Guide" [6].

Remark:
x=0 : The Plug & Play will have to be reset to start on specified band(s).
x=1 : The change is effective immediately. This mode is forbidden while in communication and during Plug & Play initialization.
Refer to "AT Commands Interface Guide" [6] for further information on AT commands.

5.8 Check the Band(s) Selection

To check the band selection for the FASTRACK Supreme, use a communication software such as a HyperTerminal, then enter **AT+WMBS?** command.

The table below gives the main responses returned:

Table 9: AT+WMBS Responses

AT+WMBS response (*)	Interpretation
+WMBS: 0,x	Mono band mode 850MHz is selected
+WMBS: 1,x	Mono band mode extended 900MHz is selected
+WMBS: 2,x	Mono band mode 1800MHz is selected
+WMBS: 3,x	Mono band mode 1900MHz is selected
+WMBS: 4,x	Dual band mode 850/1900MHz are selected
+WMBS: 5,x	Dual band mode extended 900MHz/1800MHz are selected
+WMBS: 6,x	Dual band mode extended 900MHz/1900MHz are selected

(*)For further information on the other possible responses and their meaning, refer to "AT Commands Interface Guide" [6].

5.9 Verify the FASTRACK Supreme Network Registration

1. Make sure a valid SIM card has been previously inserted and locked in the FASTRACK Supreme SIM card holder.

2. Using a communication software such as a HyperTerminal, enter the following AT commands:

   a. **`AT+CPIN=xxxx`** to enter PIN code xxxx.

   b. **`AT+WMBS?`** To check the current band setting in the Plug & Play

   c. **`AT+WMBS=<Band>[,<param>]`** To switch band/mode when needed

   d. **`AT+CREG?.`** To ascertain the registration status.

   The format of the returned response is as follows:

   `+CREG: <mode>,<stat>` with:

   - ***<mode>*** = unsolicited registration message configuration,
   - ***<stat>*** = registration state.

3. Verify the state of registration according the returned value given in the table below.

Table 10: Values of network registration

Returned Value (*) <mode>,<stat>	Network registration
+CREG: 0,0	No (not registered)
+CREG: 0,1	Yes (registered, home network)
+CREG: 0,5	Yes (registered, roaming)

(*)For further information on the other returned values and their meaning, refer to "AT Commands Interface Guide" [6].

If the FASTRACK Supreme is not registered, perform the following procedure:

- Check the connection between the FASTRACK Supreme and the antenna.
- Verify the signal strength to determine the received signal strength (refer to Section 5.5).

Note: For information on AT command relating to the network registration in GPRS mode, and in particular: CGREG, CGCLASS, CGATT, refer to "AT Commands Interface Guide" [6].

5.10 Main AT Commands for the Plug & Play

The table below lists the main AT commands required for starting the Plug & Play.

For other AT commands available or further information on the AT commands, refer to "AT Commands Interface Guide" [6].

Table 11: Main usual AT commands for the Plug & Play

Description	AT commands	FASTRACK Supreme Plug & Play response	Comment
Check for selected band(s)	AT+WMBS?	+WMBS:<Band>,<ResetFlag> OK	Current selected band mode is return
Band(s) switch	AT+WMBS=<Band>	OK	Band switch is accepted, Plug & Play has to be reset for change to be effective
	AT+WMBS=<Band>,0	OK	Band switch is accepted, Plug & Play has to be reset for change to be effective
	AT+WMBS=<Band>,1	OK	Band switch is accepted and GSMS stack restarted
	AT+WMBS=<Band>	+CME ERROR: 3	Band not allowed
Enter PIN Code	AT+CPIN=xxxx (xxxx = PIN code)	OK	PIN Code accepted.
		+CME ERROR: 16	Incorrect PIN Code (with +CMEE = 1 mode) (1*)
		+CME ERROR: 3	PIN code already entered (with +CMEE = 1 mode) (1*)
Network registration checking	AT+CREG?	+CREG: 0,1	FASTRACK Supreme Plug & Play registered on the network.
		+CREG: 0,2	FASTRACK Supreme Plug & Play not registered on the network, registration attempt.

Description	AT commands	FASTRACK Supreme Plug & Play response	Comment
		+CREG: 0,0	FASTRACK Supreme Plug & Play not registered on the network, no registration attempt.
Receiving an incoming call	ATA	OK	Answer the call.
Initiate a call	ATD<phone number>; (Don't forget the « ; » at the end for « voice » call)	OK	Communication established.
		+CME ERROR: 11	PIN code not entered (with +CMEE = 1 mode).
		+CME ERROR: 3	AOC credit exceeded or a communication is already established.
Initiate an emergency call	ATD112; (Don't forget the « ; » at the end for « voice » call)	OK	Communication established.
Communication loss		NO CARRIER	
Hang up	ATH	OK	
Store the parameters in EEPROM	AT&W	OK	The configuration settings are stored in EEPROM.

(1*) The command "AT+CMEE=1" switch to a mode enabling more complete error diagnostics.

5.11 Firmware Upgrade Procedure

The firmware upgrade procedure is used to update the firmware embedded into the FASTRACK Supreme.

That procedure consists in downloading the firmware into internal memories through the RS232 serial link available on the SUB-D 15-pin connector.

Refer to "Firmware upgrade procedure" [8] for a detailed description of this procedure.

6 Troubleshooting

This section of the document describes possible problems encountered when using the FASTRACK Supreme and their solutions.

To review other troubleshooting information, refer the 'FAQs' (Frequently Asked Questions) page at www.wavecom.com or use the following link: http://www.wavecom.com/support/faqs.php

6.1 No Communication with the FASTRACK Supreme through the Serial Link

If the FASTRACK Supreme does not answer to AT commands through the serial link, refer to the table below for possible causes and solutions.

Table 12: Solutions for no connection with FASTRACK Supreme through serial link

If the Supreme returns	then ask	Action
Nothing	Is the FASTRACK Supreme powered correctly?	Make sure the external power supply is connected to the FASTRACK Supreme and provides a voltage in the range of 5.5 V to 32 V.
	Is the serial cable connected at both sides?	Check the serial cable connection
	Does the serial cable follow correctly pin assignment shown in paragraph 3.2.1.2.	Connect the cable by following pin assignment given in paragraph 3.2.1.1.
Nothing or non-significant characters	Is the communication program properly configured on PC?	Ensure the setting of the communication program is fit to setting of FASTRACK Supreme. FASTRACK Supreme factory setting is: Data bits = 8 Parity = none Stop bits = 1 Baud = 115 200 bps. Flow control = hardware
	Is there another program interfering with the communication program (i.e. Conflict on communication port access)	Close the interfering program.

6.2 Receiving "ERROR" Message

The FASTRACK Supreme returns an "**ERROR"** message (in reply to an AT command) in the following cases:

- AT command syntax is incorrect: check the command syntax (refer to "AT Commands Interface Guide" [6]),
- AT command syntax is correct, but transmitted with wrong parameters:
- Enter the **AT+CMEE=1** command in order to change the error report method to the verbose method, which includes the error codes.
- Enter again the AT command which previously caused the reception of "ERROR" message in order to get the Mobile Equipment error code.

When the verbose error report method is enabled, the response of the FASTRACK Supreme in case of error is as follows:

- Either +CME ERROR: <error result code>,
- Or +CMS ERROR: <error result code>.

Refer to "AT Commands Interface Guide" [6] for error result code description and further details on the **AT +CMEE** command.

Note: It is strongly recommended to always enable the verbose error report method to get the Mobile Equipment error code (enter **AT +CMEE=1** command).

6.3 Receiving "NO CARRIER" Message

If the FASTRACK Supreme returns a **"NO CARRIER"** message upon an attempted call (voice or data), then refer to the table below for possible causes and solutions.

Table 13: Solutions for "NO CARRIER" message

If the Supreme returns…	Then ask…	Action…
"**NO CARRIER**"	Is the received signal strong enough?	Refer to section 5.5 to verify the strength of the received signal.
	Is the FASTRACK Supreme registered on the network?	Refer to section 5.9 to verify the registration.
	Is the antenna properly connected?	Refer to section 8.2.7.3 for antenna requirements.
	Is the band selection correction?	Refer to Section 7.2 for band switch
"**NO CARRIER**" (when trying to issue a voice communication)	Is the semicolon (;) entered immediately after the phone number in the AT command?	Ensure that the semicolon (;) is entered immediately after the phone number in the AT command. e.g. **ATD######;**
"**NO CARRIER**" (when trying to issue a data communication)	Is the SIM card configured for data / fax calls?	Configure the SIM card for data / fax calls (Ask your network provider if necessary).
	Is the selected bearer type supported by the called party?	Ensure that the selected bearer type is supported by the called party.
	Is the selected bearer type supported by the network?	Ensure that the selected bearer type is supported by the network. If no success, try bearer selection type by AT command: AT+CBST=0,0,3

If the FASTRACK Supreme returns a "**NO CARRIER"** message, you may have the **extended error code** by using AT command **AT+CEER**. Refer to the table below for interpretation of **extended error code**.

Table 14: Interpretation of extended error code

Error Code	Diagnostic	Hint
1	Unallocated phone number	
16	Normal call clearing	
17	User busy	
18	No user responding	
19	User alerting, no answer	
21	Call rejected	
22	Number changed	
31	Normal, unspecified	
50	Requested facility not subscribed	Check your subscription (data subscription available?).
68	ACM equal or greater than ACMmax	Credit of your pre-paid SIM card expired.
252	Call barring on outgoing calls	
253	Call barring on incoming calls	
3, 6, 8, 29, 34, 38, 41, 42, 43, 44, 47, 49, 57, 58, 63, 65, 69, 70, 79, 254	Network causes	See "AT Commands Interface Guide" [6] for further details or call network provider.

Note: For all other codes, and/or details, see AT commands documentation [6].

7 Functional Description

7.1 Architecture

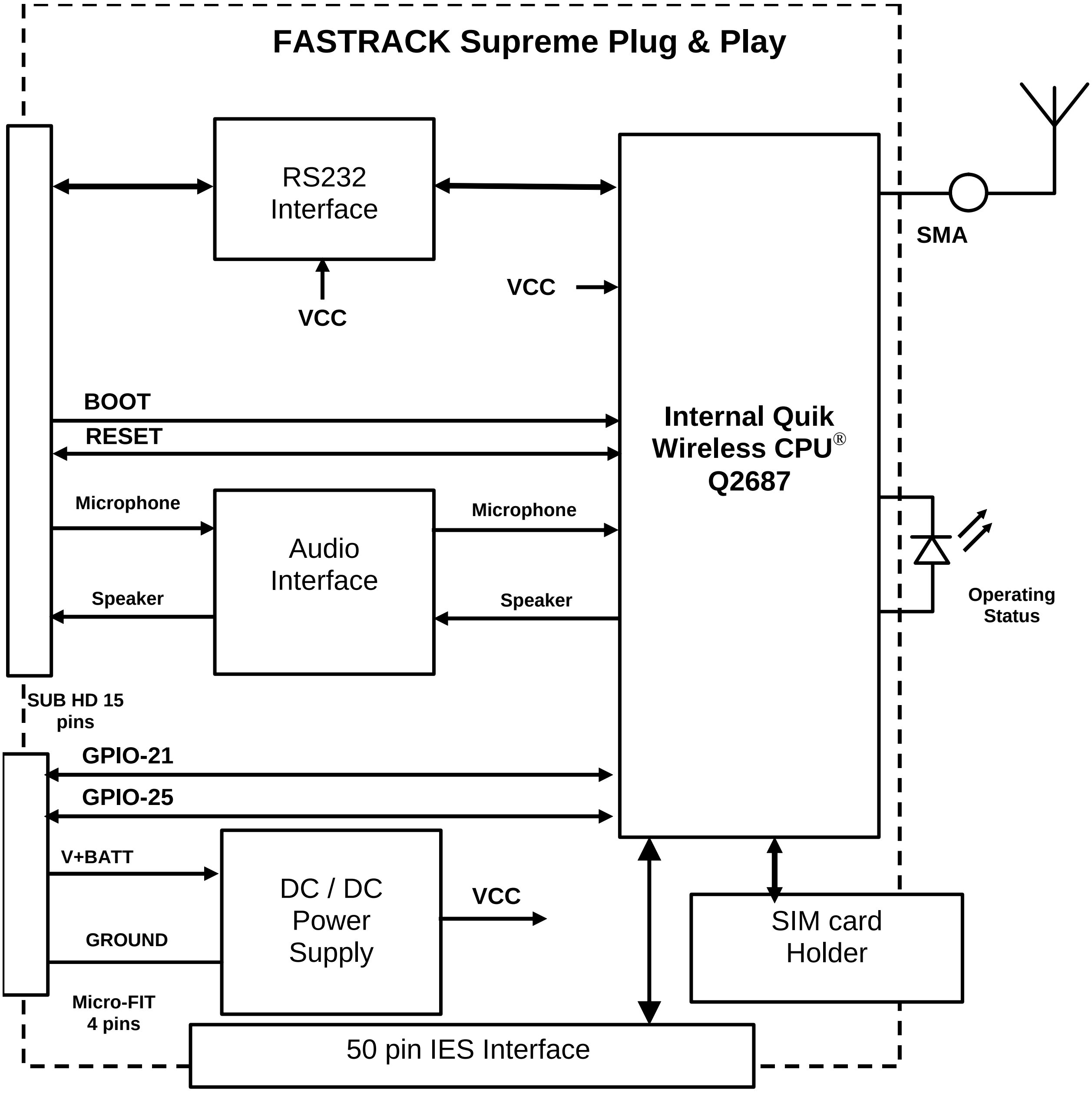


Figure 15: Functional architecture

7.2 EU and US Bands

7.2.1 General Presentation

The FASTRACK Supreme is a quad band Plug & Play. It supports either EU bands (EGSM900/DCS1800) or US bands (GSM850/ PCS1900), depending on the band setting within the Plug & Play. Users are free to switch between EU bands and US bands by simple AT commands when the selected bands are supported.

7.2.2 AT COMMAND for Bands Switch

EU/US band is easily switched/checked by AT command **AT+WMBS**.

For detail, please refer to Section 5.7 and 5.8.

7.3 Power Supply

7.3.1 General Presentation

The FASTRACK Supreme is supplied by an external DC voltage (V+BATTERY) from +5.5 V to +32 V at 2.2 A.

Main regulation is made with an internal DC/DC converter in order to supply all the internal functions with a DC voltage.

Correct operation of the FASTRACK Supreme in communication mode is not guaranteed if input voltage (V+BATTERY) falls below 5.5 V.

Note: The minimum input voltage specified here is at the FASTRACK Supreme input. Be careful of the input voltage decrease caused by the power cable. See paragraph 8.2.1 for more information.

7.3.2 Protections

The FASTRACK Supreme is protected by a 800 mA / 250 V fuse directly bonded on the power supply cable.

The FASTRACK Supreme is also protected against voltage over +32 V.

Filtering guarantees:

- EMI/RFI protection in input and output,
- Signal smoothing.

7.4 RS232 Serial Link

7.4.1 General Presentation

The RS232 interface performs the voltage level adaptation (V24/CMOS ⇔ V24/V28) between the internal FASTRACK Supreme Plug & Play (DCE) and the external world (DTE).

The RS232 interface is internally protected (by ESD protection) against electrostatic surges on the RS232 lines.

Filtering guarantees:

- EMI/RFI protection in input and output,
- Signal smoothing.

Signals available on the RS232 serial link are:

- TX data (CT103/TX),
- RX data (CT104/RX),
- Request To Send (CT105/RTS),
- Clear To Send (CT106/CTS),
- Data Terminal Ready (CT108-2/DTR),
- Data Set Ready (CT107/DSR),
- Data Carrier Detect (CT109/DCD),
- Ring Indicator (CT125/RI).

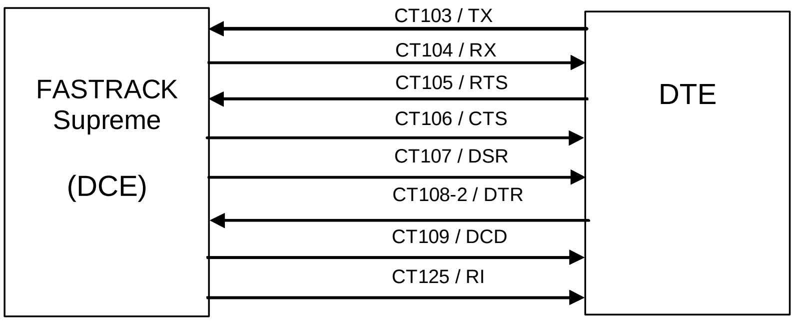


Figure 16: RS232 Serial Link signals

RS232 interface has been designed to allow flexibility in the use of the serial interface signals. However, the use of TX, RX, CTS and RTS signals is mandatory, which is not the case for DTR, DSR, DCD and RI signals which can be not used.

7.4.2 Autobauding Mode

The autobauding mode allows the FASTRACK Supreme to detect the baud rate used by the DTE connected to the RS232 serial link.

Autobauding mode is controlled by AT commands. See "AT Commands Interface Guide" [6] for details on this function.

7.4.3 Pin Description

Signal	Sub HD connector Pin number	I/O	I/O type RS232 STANDARD	Description
CTXD/CT103	2	I	TX	Transmit serial data
CRXD/CT104	6	O	RX	Receive serial data
CRTS/CT105	12	I	RTS	Request To Send
CCTS/CT106	11	O	CTS	Clear To Send
CDSR/CT107	7	O	DSR	Data Set Ready
CDTR/CT108-2	8	I	DTR	Data Terminal Ready
CDCD/CT109	1	O	DCD	Data Carrier Detect
CRI/CT125	13	O	RI	Ring Indicator
CT102/GND	9		GND	Ground

7.4.4 Serial Port Auto shut down Feature

The UART1 can be shut down when there is no activity between the DTE and the FASTRACK Supreme Plug & Play. This can help for improving power consumption performance.

Serial Port Auto shut down feature is easily controlled by AT command **AT+WASR**.

- **AT+WASR=1** for entering the serial port auto shut down mode
- **AT+WASR=0** for exiting the serial port auto shut down mode

Refer to "AT Commands Interface Guide" [6] for further information on AT commands.

CAUTION: GPIO24 is reserved for serial port auto shut down feature. It is prohibited for customer use. Improper access to GPIO24 by customer may lead to unexpected behavior on UART1 performance.

7.5 General Purpose Input/Output (GPIO)

The FASTRACK Supreme provides two General Purpose Input / Output lines available for external use: GPIO21 and GPIO25.

These GPIOs may be controlled by AT commands:

- **AT+WIOW** for a write access to the GPIO value, when the GPIO is used as an output,
- **AT+WIOR** for a read access to the GPIO value, when the GPIO is used as an input.

Refer to "AT Commands Interface Guide" [6] for further information on AT commands.

After reset, both GPIOs are configured as inputs. The **AT+WIOM** command has to be used to change this configuration (refer to "AT Commands Interface Guide" [6] for further details).

Pin description

Signal	Power Supply connector (4-pin Micro-Fit)	I/O	I/O Voltage	Reset state	Description	Mulitplex with
GPIO21	3	I/O	2V8	Undefined	General Purpose I/O	No mux
GPIO25	4	I/O	2V8	Z	General Purpose I/O	INT1

Notes:

- The power supply cable may need to be modified due to the GPIO signals (GPIO21 & GPIO25) available on the 4-pin Micro-FIT connector of the FASTRACK Supreme.
- The previous generation M1306B have GPIO4 and GPIO5 being replaced by GPIO21 and GPIO25 respectively, for which both are of LOW level at reset state.

7.6 BOOT

This signal must not be connected. Its use is strictly reserved to Wavecom or competent retailers.

Caution: Previous generation M1306B has BOOT signal of HIGH level at 2.8V. But the FASTRACK Supreme now of 1.8V BOOT instead.

7.7 RESET

7.7.1 General presentation

This signal is used to force a reset procedure by providing low level during at least 200 µs.

This signal must be considered as an emergency reset only. A reset procedure is automatically driven by an internal hardware during the power-up sequence.

This signal may also be used to provide a reset to an external device. It then behaves as an output. If no external reset is necessary, this input may be left open, if used (emergency reset), it has to be driven either by an open collector or an open drain output:

- RESET pin 14 = 0, for FASTRACK Supreme Reset,
- RESET pin 14 = 1, for normal mode.

Pin description

Signal	Sub HD 15-Pin connector Pin number	I/O	I/O type	Voltage	Description
RESET	14	I/O	Open Drain	1V8	FASTRACK Supreme Reset

Caution: Previous generation M1306B has RESET signal of HIGH level at 2.8V. But the FASTRACK Supreme now of 1.8V RESET instead.

Additional comments on RESET:

The RESET process is activated either by the external RESET signal or by an internal signal (coming from a RESET generator). This automatic reset is activated at Power-up.

The FASTRACK Supreme remains in RESET mode as long as the RESET signal is held low.

Caution: This signal should be used only for "emergency" reset.

A software reset is always preferred to a hardware reset.

Note: See "AT Commands Interface Guide" [6] for further information on software reset.

7.7.2 Reset Sequence

To activate the "emergency" reset sequence, the RESET signal has to be set to low for 200 µs minimum.

As soon as the reset is done, the AT interface answers "OK" to the application. For this, the application must send **AT↵.**

If the application manages hardware flow control, the AT command may be sent during the initialization phase. Another solution is to use the **AT+WIND** command to get an unsolicited status from the FASTRACK Supreme.

For further details, refer to AT commands "AT Commands Interface Guide" [6].

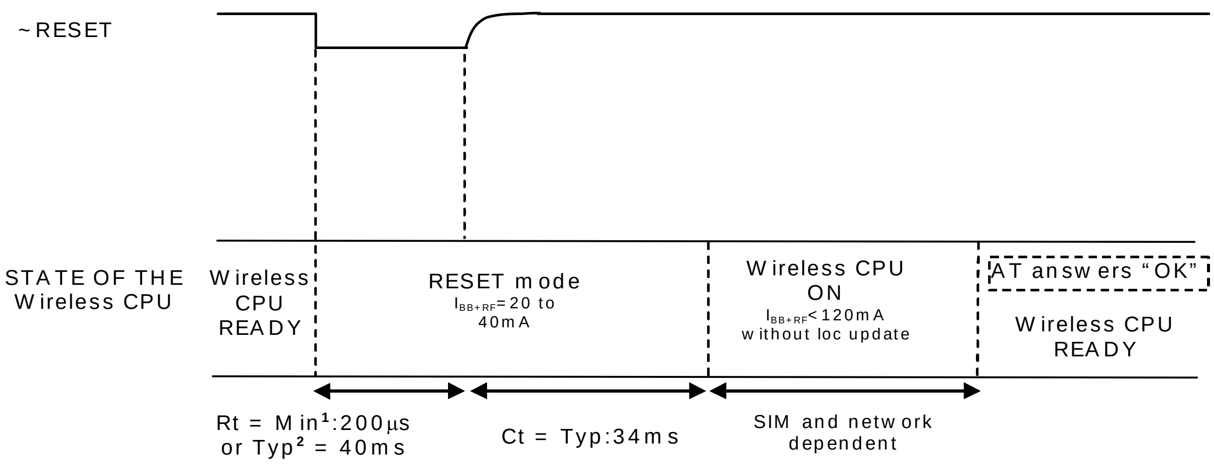


Figure 17: Reset sequence diagram

7.8 Audio

Audio interface is a standard one for connecting a phone handset.

Echo cancellation and noise reduction features are also available to improve the audio quality in case of hand-free application.

7.8.1 Microphone Inputs

The microphone inputs are differential ones in order to reject common mode noise and TDMA noise.

They already include the convenient biasing for an electret microphone (0.5 mA and 2 Volts) and are ESD protected.

This electret microphone may be directly connected to these inputs allowing an easy connection to a handset.

The microphone impedance must be around 2 kΩ.

AC coupling is already embedded in the Wireless CPU®.

The gain of the microphone inputs is internally adjusted and may be tuned from 30 dB to 51 dB using an **AT+VGT** command (refer to AT commands documentation [6]).

Pin description

Signal	Sub D 15-pin Pin #	I/O	I/O type	Description
CMIC2P	4	I	Analog	Microphone positive input
CMIC2N	5	I	Analog	Microphone negative input

7.8.2 Speaker Outputs

This connection is differential to reject common mode noise and TDMA noise.

Speaker outputs are connected to internal push-pull amplifiers and may be loaded down between 32 to 150 Ohms and up to 1 nF (see details in table *Speaker gain vs Max output voltage,* in "AT Commands Interface Guide" [6]). These outputs may be directly connected to a speaker.

The output power may be adjusted by step of 2 dB. The gain of the speaker outputs is internally adjusted and may be tuned using an **AT +VGR** command (refer to AT commands documentation [6]).

Pin description

Signal	Sub D 15-pin Pin #	I/O	I/O type	Description
CSPK2P	10	O	Analog	Speaker positive output
CSPK2N	15	O	Analog	Speaker negative output

7.9 Real Time Clock (RTC)

The FASTRACK Supreme has now implemented the Real Time Clock for saving date and time when the Plug & Play is unplugged from the DC power supply through the DC power cable.

Item		Min	Typical	Max
Charging Time start from fully discharged to fully charged			940 min	
RTC Time Period*	Guarantee		2475 min	
	Non-guarantee		5225 min	

Remark: The RTC time period is measured from the RTC battery is fully charged before being unplugged from the DC power source.

7.10 FLASH LED

The FASTRACK Supreme has a red LED indicator to show the status of the GSM network. For detail description of the various status, please refer to Section 5.3.

However, during operation mode of Slow Standby, there will be no network registration and so the red LED indicator will always be ON. It is possible for user to deactivate the LED indication during Slow Standby mode, in order to reduce power consumption.

The Flash LED can be deactivated by AT command *at+whcnf=1,0*
The Flash LED can be activated by AT command *at+whcnf=1,1*

However, the new setting will be taken into account only after a restart. For detail, please refer to Document[6].

8 Technical Characteristics

8.1 Mechanical Characteristics

Table 15: Mechanical characteristics

Dimensions	73 x 54.5 x 25.5 mm (excluding connectors)
Overall Dimension	88 x 54.5 x 25.5 mm
Weight	≈ 80 grams (FASTRACK Supreme only) < 120 grams (FASTRACK Supreme + bridles + power supply cable)
Volume	101.5 cm^3
Housing	Aluminum profiled

The next page gives the dimensioning diagram of the FASTRACK Supreme including the clearance areas to take into account for the FASTRACK Supreme installation.

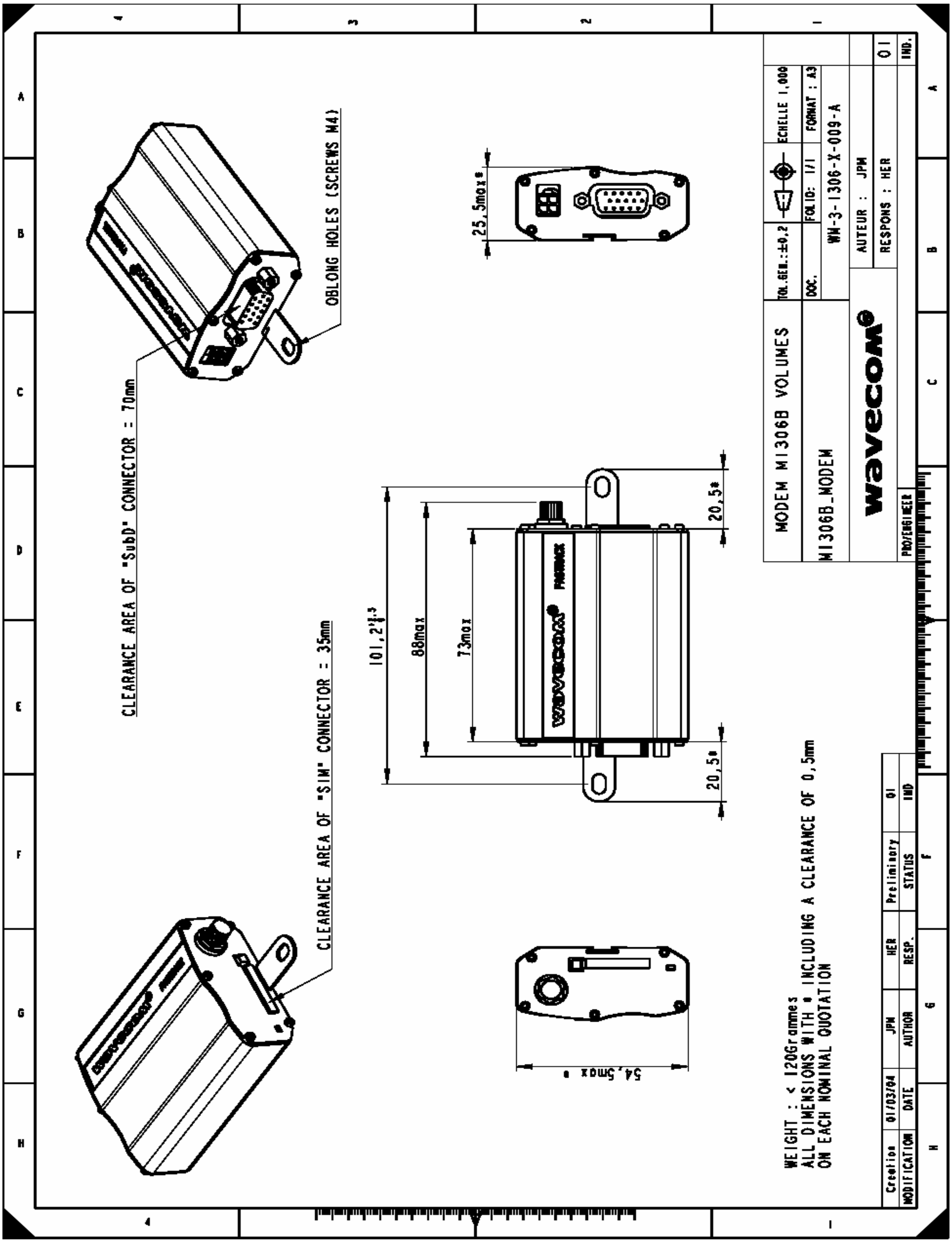


Figure 18: Dimensioning diagram

8.2 Electrical Characteristics

8.2.1 Power Supply

Table 16: Electrical characteristics

Operating Voltage ranges	5.5 V to 32 V DC.
Maximum current	480 mA Average at 5.5V. 2.1 A Peak at 5.5 V. (TBC)

Note:

The FASTRACK Supreme is permanently powered once the power supply is connected. The following table describes the consequences of over-voltage and under-voltage with the FASTRACK Supreme.

Warning:

All the input voltages specification described in this Section are at the FASTRACK Supreme input. While powering the FASTRACK Supreme, take into account the input drop caused by the power cable. With the delivered cable, this input drop is around 700 mV at 5.5 V and 220 mV at 32V.

Table 17: Effects of power supply defect

If the voltage	then
falls below 5.5 V,	the GSM communication is not guaranteed.
is over 32 V (Transient peaks),	the FASTRACK Supreme guarantees its own protection.
Is over 32 V (continuous overvoltage)	the protection of the FASTRACK Supreme is done by the fuse (the supply voltage is disconnected).

The fuse is a 800 mA / 250 V FAST-ACTING 5*20mm. See Section 10 for recommended references.

The following table provides information on power consumption of the FASTRACK Supreme, assuming an operating temperature of +25 °C and using a 3 V SIM card.

8.2.2 Power Consumption

The following table provides information on power consumption of the FASTRACK Supreme, assuming an operating temperature of +25 °C and using a 3 V SIM card.

Table 18: Power consumption (1*)

Power Consumption in E-GSM 900/DCS 1800 MHz - GPRS class 10				E-GSM 900	DCS 1800
GSM	I peak	**GSM900**: During **TX** bursts @ **PCL5** **DCS1800** : During **TX** bursts @ **PCL0**	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
	I avg	**GSM900 : Average @ PCL5** **DCS1800 : Average @ PCL0**	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
GPRS Class 2	I peak	**GSM900**: During **1TX** bursts @ **PCL5** **DCS1800** : During **1TX** bursts @ **PCL0**	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
	I avg	GSM900 : **Average 1TX/1RX @PCL5** DCS1800 : **Average 1TX/1RX @PCL0**	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
GPRS Class 10	I peak	**GSM900**: During 2**TX** bursts @ **PCL5 (Gamma 3)** **DCS1800** : During 2**TX** bursts @ **PCL0 (Gamma 2)**	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
	I avg	GSM900 : **Average 2TX/3RX @ PCL5 (Gamma 3)** DCS1800 : **Average 2TX/3RX @ PCL0 (Gamma 2)**	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
EGPRS Class 2	I peak	**GSM900**: During **1TX** bursts @ **PCL8 (Gamma 6)** **DCS1800** : During **1TX** bursts @ **PCL2 (Gamma 5)**	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
	I avg	GSM900 : **Average 1TX/1RX @ PCL8 (Gamma 6)** DCS1800 : **Average 1TX/1RX @ PCL2 (Gamma 5)**	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC

Power Consumption in E-GSM 900/DCS 1800 MHz - GPRS class 10				E-GSM 900	DCS 1800
EGPRS Class 10	I peak	**GSM900**: During **2TX** bursts @ **PCL8 (Gamma 6)** **DCS1800** : During 2**TX** bursts @ **PCL2 (Gamma 5)**	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
	I avg	GSM900 : **Average 2TX/3RX @ PCL8 (Gamma 6)** DCS1800 : **Average 2TX/3RX @ PCL2 (Gamma 5)**	@ 5.5V	TBC	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
I avg in Fast Idle mode Page 9 (2*)		Serial port auto shut down deactivated	@ 5.5V	33	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
		Serial port auto shut down activated	@ 5.5V	17	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
I avg in Slow Idle mode Page 9 (3*)		Serial port auto shut down deactivated	@ 5.5V	23	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
		Serial port auto shut down activated	@ 5.5V	5	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
I avg in Fast Standby mode (4*)		Serial port auto shut down deactivated	@ 5.5V	52	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC
		Serial port auto shut down activated	@ 5.5V	35	TBC
			@ 13.2V	TBC	TBC
			@ 32V	TBC	TBC

Power Consumption in E-GSM 900/DCS 1800 MHz - GPRS class 10			E-GSM 900	DCS 1800
I_{avg} in Slow Standby mode (with FLASH LED activated) (4*)	Serial port auto shut down deactivated	@ 5.5V	24	TBC
		@ 13.2V	TBC	TBC
		@ 32V	TBC	TBC
	Serial port auto shut down activated	@ 5.5V	8	TBC
		@ 13.2V	TBC	TBC
		@ 32V	TBC	TBC
I_{avg} in Slow Standby mode (with FLASH LED deactivated) (4*)	Serial port auto shut down deactivated	@ 5.5V	TBC	TBC
		@ 13.2V	TBC	TBC
		@ 32V	TBC	TBC
	Serial port auto shut down activated	@ 5.5V	4	TBC
		@ 13.2V	TBC	TBC
		@ 32V	TBC	TBC

(1*):The power consumption might vary by 5 % over the whole operating temperature range (-20 °C to +55 °C).
(2*): In this Mode, the RF function is active and the FASTRACK Supreme synchronized with the network, but there is no communication.
(3*): In this Mode, the RF function is disabled, but regularly activated to keep the synchronization with the network. This Mode works only when the DTE send AT command to shut down the serial link by software approach (DTE turns DTR in inactive state).
(4*): In this Mode, the RF function is disabled, and there is no synchronization with the network.

8.2.3 Audio Interface

The audio interface is available through the Sub HD 15-pin connector.

Table 19: Audio parameters caracteristics

Audio parameters	Min	Typ	Max	Unit	Comments
Microphone input current @2 V/2 kΩ		0.5		mA	
Absolute microphone input voltage			100	mVpp	AC voltage
Speaker output current 150 Ω //1 nF		16		mA	
Absolute speaker impedance	32	50		Ω	
Impedance of the speaker amplifier output in differential mode			1	Ω	+/-10 %

Table 20: Microphone inputs internal audio filter characteristics

Frequency	Gain
0-150 Hz	< -22 dB
150-180 Hz	< -11 dB
180-200 Hz	< -3 dB
200-3700 Hz	0 dB
>4000 Hz	< -60 dB

Table 21: Recommended characteristics for the microphone:

Feature	Value
Type	Electret 2 V / 0.5 mA
Impedance	Z = 2 kΩ
Sensitivity	-40 dB to –50 dB
SNR	> 50 dB
Frequency response	compatible with the GSM specifications

Table 22: Recommended characteristics for the speaker:

Feature	Value
Type	10 mW, electro-magnetic
Impedance	Z = 32 to 50 Ω
Sensitivity	110 dB SPL min. (0 dB = 20 µPa)
Frequency response	compatible with the GSM specifications

8.2.4 General Purpose Input/Output

Both GPIO21 and GPIO25 may be interfaced with a component that comply with 3 Volts CMOS levels.

Table 23: Operating conditions

Parameter	I/O type	Min	Typ	Max	Condition
V_{IL}	CMOS			0.84 V	
V_{IH}	CMOS	1.96 V			
V_{OL}	CMOS			0.4 V	I_{OL} = -4 mA
V_{OH}	CMOS	2.4 V			I_{OH} = 4 mA
I_{OH}				4mA	
I_{OL}				-4mA	

Clamping diodes are present on I/O pads.

8.2.5 SIM Interface

Table 24: SIM card characteristics

SIM card	1.8V / 3 V

8.2.6 RESET Signal

Table 25: Electrical characteristics

Parameter	Min	Typ	Max	Unit
Input Impedance (R)*		330K		kΩ
Input Impedance (C)		10n		nF

*Internal pull-up

Table 26: Operating conditions

Parameter	Minimum	Typ	Maximum	Unit
~RESET time (Rt) [1]	200			µs
~RESET time (Rt) [2] at power up only	20	40	100	ms
Cancellation time (Ct)		34		ms
V_H	0.57			V
V_{IL}	0		0.57	V
V_{IH}	1.33			V

* $V_{H:}$ Hysterisis Voltage

1 This reset time is the minimum to be carried out on the ~RESET signal when the power supply is already stabilized.

2 This reset time is internally carried out by the Wireless CPU power supply supervisor only when the Wireless CPU power supplies are powered ON.

8.2.7 RF Characteristics

8.2.7.1 Frequency Ranges

Table 27: Frequency ranges

Characteristic	GSM 850	E-GSM 900	DCS 1800	PCS 1900
Frequency TX	824 to 849 MHz	880 to 915 MHz	1710 to 1785 MHz	1850 to 1910 MHz
Frequency RX	869 to 894 MHz	925 to 960 MHz	1805 to 1880 MHz	1930 to 1990 MHz

8.2.7.2 RF Performances

RF performances are compliant with the ETSI recommendation GSM 05.05.

The RF performances for receiver and transmitter are given in the table below.

Table 28: Receiver and transmitter RF performances

Receiver	
E-GSM900/GSM850 Reference Sensitivity	-104 dBm Static & TUHigh
DCS1800/PCS1900 Reference Sensitivity	-102 dBm Static & TUHigh
Selectivity @ 200 kHz	> +9 dBc
Selectivity @ 400 kHz	> +41 dBc
Linear dynamic range	63 dB
Co-channel rejection	>= 9 dBc
Transmitter	
Maximum output power (E-GSM 900/GSM850) at ambient temperature	33 dBm +/- 2 dB
Maximum output power (DCS1800/PCS1900) at ambient temperature	30 dBm +/- 2 dB
Minimum output power (E-GSM 900/GSM850) at ambient temperature	5 dBm +/- 5 dB
Minimum output power (DCS1800/PCS1900) at ambient temperature	0 dBm +/- 5 dB

8.2.7.3 External Antenna

The external antenna is connected to the FASTRACK Supreme via the SMA connector.

The external antenna must fulfill the characteristics listed in the table below.

Table 29: External antenna characteristics

Antenna frequency range	Quad-band GSM 850/GSM900/DCS1800/PCS1900 MHz
Impedance	50 Ohms nominal
DC impedance	0 Ohm
Gain (antenna + cable)	0 dBi
VSWR (antenna + cable)	2

Note: Refer to Section 10 for recommended antenna.

8.3 Environmental Characteristics

The FASTRACK Supreme Plug & Play is compliant with the following operating class. To ensure the proper operation of the FASTRACK Supreme, the temperature of the environment must be within a specific range as described in the table below.

Table 30: Ranges of temperature

Conditions	Temperature range
Operating / Class A	-20 °C to +55°C
Operating / Class B	-30 °C to +85°C
Storage	-40 °C to +85°C

Function Status Classification:

Class A:

The FASTRACK Supreme remains fully functional, meeting GSM performance criteria in accordance with ETSI requirements, across the specified temperature range.

Class B:

The FASTRACK Supreme remains fully functional, across the specified temperature range. Some GSM parameters may occasionally deviate from the ETSI/PTCRB specified requirements and this deviation does not affect the ability of the FASTRACK Supreme to connect to the cellular network and function fully, as it does within the Class A range.

The detailed climatic and mechanics standard environmental constraints applicable to the FASTRACK Supreme are listed in the table below:

Table 31: Environmental standard constraints

Environmental Tests (IEC TR 60721-4)		**Environmental Classes (IEC 60721-3)**			
Tests	**Standards**	**Storage (IEC 60721-3-1) Class IE13**	**Transportation** (IEC 60721-3-2) Class IE23	**Operation** Stationary (IEC 60721-3-3) **Class IE35**	**Operation** Non-Stationary **(IEC 60721-3-7) Class IE73**
Cold	IEC 60068-2-1 : Ab/Ad	-25°C, 16 h	-40°C, 16 h	-5°C, 16 h	-5°C, 16 h
Dry heat	IEC 60068-2-2 : Bb/Bd	+70°C, 16 h	+70°C, 16 h	+55°C, 16 h	+55°C, 16 h
Change of temperature	IEC 60068-2-14 : Na/Nb	-33°C to ambient 2 cycles, t1=3 h 1 °C.min^{-1}	-40°C to ambient 5 cycles, t1=3 h t2<3 min	-5°C to ambient 2 cycles, t1=3 h 0,5 °C.min^{-1}	-5°C to ambient 5 cycles, t1=3 h t2<3 min
Damp heat	IEC 60068-2-56 : Cb	+30°C, 93% RH 96 h	+40°C, 93% RH 96 h minimum	+30°C, 93% RH, 96 h	+30°C, 93% RH, 96 h
Damp heat, cyclic	60068-2-30 : Db Variant 1 or 2	+40°C, 90% to 100% RH One cycle Variant 2	+55°C, 90% to 100% RH Two cycles Variant 2	+30°C, 90% to 100% RH Two cycles Variant 2	+40°C, 90% to 100% RH Two cycles Variant 1
Vibration (sinusoidal)	IEC 60068-2-6 : Fc	1-200 Hz 2 m.s^{-2} 0,75 mm 3 axes 10 sweep cycles	1-500 Hz 10 m.s^{-2} 3,5 mm 3 axes 10 sweep cycles	1-150 Hz 2 m.s^{-2} 0,75 mm 3 axes 5 sweep cycles	1-500 Hz 10 m.s^{-2} 3,5 mm 3 axes 10 sweep cycles
Vibration (random)	IEC 60068-2-64 : Fh	-	10-100 Hz / 1,0 m^2.s^{-3} 100-200 Hz / -3 dB.octave^{-1} 200-2000 Hz / 0,5 m^2.s^{-3} 3 axes 30 min	-	-
Shock (half-sine)	IEC 60068-2-27 : Ea	-	-	50 m.s^{-2} 6 ms 3 shocks 6 directions	150 m.s^{-2} 11 ms 3 shocks 6 directions
Bump	IEC 60068-2-29 : Eb	-	250 m.s^{-2} 6 ms 50 bumps vertical direction	-	-
Free fall	ISO 4180-2	-	Two falls in each specified attitude	-	2 falls in each specified attitude 0,025 m (<1kg)
Drop and topple	IEC 60068-2-31 : Ec	-	One drop on relevant corner One topple about each bottom edge	-	One drop on each relevant corner One topple on each of 4 bottom edges

Notes:

Short description of Class IE13 (*For more information see standard IEC 60721-3-1)*

"Locations without controlled temperature and humidity, where heating may be used to raise low temperatures, locations in buildings providing minimal protection against daily variations of external climate, prone to receiving rainfall from carrying wind".

Short description of Class IE23 (*For more information, see standard IEC 60721-3-2)*

"Transportation in unventilated compartments and in conditions without protection against bad weather, in all sorts of trucks and trailers in areas of well developed road network, in trains equipped with buffers specially designed to reduce shocks and by boat".

Short description of Class IE35 (*For more information see standard IEC 60721-3-3)*

"Locations with no control on heat or humidity where heating may be used to raise low temperatures, to places inside a building to avoid extremely high temperatures, to places such as hallways, building staircases, cellars, certain workshops, equipment stations without surveillance".

Short description of Class IE73 (*For more information see standard IEC 60721-3-7)*

"Transfer to places where neither temperature nor humidity are controlled but where heating may be used to raise low temperatures, to places exposed to water droplets, products can be subjected to ice formation, these conditions are found in hallways and building staircases, garages, certain workshops, factory building and places for industrial processes and hardware stations without surveillance".

Warning: The specification in the above table applies to the FASTRACK Supreme product only. Customers are advised to verify that the environmental specification of the SIM Card used is compliant with the FASTRACK Supreme environmental specifications. Any application must be qualified by the customer with the SIM Card in storage, transportation and operation.

The use of standard SIM cards may drastically reduce the environmental conditions in which the Product can be used. These cards are particularly sensible to humidity and temperature changes. These conditions may produce oxidation of the SIM card metallic layers and cause, in the long term, electrical discontinuities. This is particularly true in left alone applications, where no frequent extraction/insertion of the SIM card is performed.

In case of mobility when the application is moved through different environments with temperature variations, some condensation may appear. These events have a negative impact on the SIM and may favor oxidation.

If the use of standard SIM card, with exposition to the environmental conditions described above, can not be avoided, special care must be taken in the integration of the final application in order to minimize the impact of these conditions. The solutions that may be proposed are:

- Lubrication of the SIM card to protect the SIM Contact from oxidation.
- Putting the FASTRACK Supreme Plug & Play in a waterproof enclosure with desiccant bags.

Lubrication of the SIM card had been tested by Wavecom (using Tutela Fluid 43EM from MOLYDUVAL) and gives very good results.

If waterproof enclosure with a desiccant solution is used, check with your desiccant retailer the quantity that must be used according to the enclosure dimensions. Ensure humidity has been removed before sealing the enclosure.

Any solution selected must be qualified by the customer on the final application.

To minimize oxidation problem on the SIM card, its manipulation must be done with the greatest precautions. In particular, the metallic contacts of the card must never be touched with bare fingers or any matter which may contain polluted materials liable to produce oxidation (such as, e.g. substances including chlorine). In case a cleaning of the Card is necessary, a dry cloth must be used (never use any chemical substance).

8.4 Conformity

The complete product complies with the essential requirements of article 3 of R&TTE 1999/5/EC Directive and satisfied the following standards:

Domain	Applicable standard
Safety standard	EN 60950 (ed.1999)
Efficient use of the radio frequency spectrum	EN 301 419-(v 4.1.1) EN 301 511 (V 7.0.1)
EMC	EN 301 489–1 (edition 2002) EN 301 489-7 (edition 2002)
Global Certification Forum – Certification Criteria	GCF-CC V3.13.0
PTCRB	
FCC	
IC	

8.5 Protections

8.5.1 Power Supply

The FASTRACK Supreme is protected by a 800 mA / 250 V fuse directly bonded on the power supply cable.

The model of fuse used is: **FSD 800 mA / 250 V FAST-ACTING**.

8.5.2 Overvoltage

The FASTRACK Supreme is protected against voltage over +32 V.

When input voltages exceed +32 V, the supply voltage is disconnected in order to protect the internal electronic components from an overvoltage.

8.5.3 Electrostatic Discharge

The FASTRACK Supreme withstands ESD according to IEC 1000-4-2 requirements for all accessible parts of the FASTRACK Supreme except the RF part:

- 8 kV of air discharge,
- 4 kV of contact discharge.

8.5.4 Miscellaneous

Filtering guarantees:

- EMI/RFI protection in input and output,
- Signal smoothing.

9 Safety recommendations

9.1 General Safety

It is important to follow any special regulations regarding the use of radio equipment due in particular to the possibility of radio frequency (RF) interference. Please follow the safety advice given below carefully.

Switch OFF your Wireless CPU®:

- When in an aircraft. The use of cellular telephones in an aircraft may endanger the operation of the aircraft, disrupt the cellular network and is illegal. Failure to observe this instruction may lead to suspension or denial of cellular telephone services to the offender, or legal action or both,
- When at a refueling point,
- When in any area with a potentially explosive atmosphere which could cause an explosion or fire,
- In hospitals and any other place where medical equipment may be in use.

Respect restrictions on the use of radio equipment in:

- Fuel depots,
- Chemical plants,
- Places where blasting operations are in progress,
- Any other area where signalization reminds that the use of cellular telephone is forbidden or dangerous.
- Any other area where you would normally be advised to turn off your vehicle engine.

There may be a hazard associated with the operation of your FASTRACK Supreme Plug & Play close to inadequately protected personal medical devices such as hearing aids and pacemakers. Consult the manufacturers of the medical device to determine if it is adequately protected.

Operation of your FASTRACK Supreme Plug & Play close to other electronic equipment may also cause interference if the equipment is inadequately protected. Observe any warning signs and manufacturers' recommendations.

The FASTRACK Supreme Plug & Play is designed for and intended to be used in "***fixed***" and "***mobile***" applications:

- **"*Fixed*"** means that the device is physically secured at one location and is not able to be easily moved to another location.
- **"*Mobile*"** means that the device is designed to be used in other than fixed locations and generally in such a way that a separation distance of at least 20 cm (8 inches) is normally maintained between the transmitter's antenna and the body of the user or nearby persons.

The FASTRACK Supreme Plug & Play is not designed for and intended to be used in portable applications (within 20 cm or 8 inches of the body of the user) and such uses are strictly prohibited.

9.2 Vehicle Safety

Do not use your FASTRACK Supreme Plug & Play while driving, unless equipped with a correctly installed vehicle kit allowing 'Hands-Free' Operation.

Respect national regulations on the use of cellular telephones in vehicles. Road safety always comes first.

If incorrectly installed in a vehicle, the operation of FASTRACK Supreme Plug & Play telephone could interfere with the correct functioning of vehicle electronics. To avoid such problems, make sure that the installation has been performed by a qualified personnel. Verification of the protection of vehicle electronics should form part of the installation.

The use of an alert device to operate a vehicle’s lights or horn on public roads is not permitted.

9.3 Care and Maintenance

Your FASTRACK Supreme Plug & Play is the product of advanced engineering, design and craftsmanship and should be treated with care. The suggestion below will help you to enjoy this product for many years.

Do not expose the FASTRACK Supreme Plug & Play to any extreme environment where the temperature or humidity is high.

Do not use or store the FASTRACK Supreme Plug & Play in dusty or dirty areas. Its moving parts (SIM holder for example) can be damaged.

Do not attempt to disassemble the Wireless CPU®. There are no user serviceable parts inside.

Do not expose the FASTRACK Supreme Plug & Play to water, rain or spilt beverages. It is not waterproof.

Do not abuse your FASTRACK Supreme Plug & Play by dropping, knocking, or violently shaking it. Rough handling can damage it.

Do not place the FASTRACK Supreme Plug & Play alongside computer discs, credit or travel cards or other magnetic media. The information contained on discs or cards may be affected by the Wireless CPU®.

The use of third party equipment or accessories, not made or authorized by Wavecom may invalidate the warranty of the Wireless CPU®.

Do contact an authorized Service Center in the unlikely event of a fault in the Wireless CPU®.

9.4 Your Responsibility

This FASTRACK Supreme Plug & Play is under your responsibility. Please treat it with care respecting all local regulations. It is not a toy. Therefore, keep it in a safe place at all times and out of the reach of children.

Try to remember your Unlock and PIN codes. Become familiar with and use the security features to block unauthorized use and theft.

10 Recommended Accessories

Accessories recommended by Wavecom for the FASTRACK Supreme are given in the table below.

Table 32: List of recommended accessories

Designation	Part number	Supplier
Quad-band antenna	1140.26	ALLGON
	MA112VX00	MAT Equipement
	MCA1890 MH/PB/SMA m	HIRSCHMANN
SMA/FME Antenna adaptor		PROCOM
Power adaptor (Europe)	EGSTDW P2 EF9W3 24W Out:12 V - 2A In: 100 to 240 V – 50/60 Hz – 550 mA Mounted with micro-fit connector	EGSTDW (for power adaptor) MOLEX (for micro-fit connector)*
Fuse	F800L250V	Shanghai Fullness
IESM GPS + USB	M13SUE01	WAVECOM
IESM IO + USB	M13SUE02	WAVECOM
IESM IO + USB + GPS	M13SUE03	WAVECOM

* Information not available for this preliminary version.

11 Online Support

Wavecom provides an extensive range on online support which includes the following areas of Wavecom's wireless expertise:

- the latest version of this document
- new versions of our Operating System user guides
- comprehensive support for Open AT®
- regulatory certifications
- carrier certifications
- application notes

To gain access to this support, simply visit our web site at www.wavecom.com or click on the desire link in Page. Privileged access via user login is provided to Wavecom authorized distributors.

OPEN AT® SOFTWARE
WIRELESS CPU
SERVICES

Fastrack Supreme

GSM/GPRS/EDGE with unlimited expandability

Fastrack Supreme is a versatile Plug & Play Wireless CPU® that will carry your applications well into the future. It has been designed to accommodate any additional features you can imagine, thanks to a revolutionary, open standard Internal Expansion Socket which you can populate with an expansion card from Wavecom – or one of your own.

SECURE CELLULAR INTERNET

Prevent hacker attacks by using our Security software Plug-In to connect your sales terminal, meter, vehicle, asset tracking or monitoring product via GSM, GPRS or high speed EDGE to the cellular Internet highway.

POWERFUL CORE APPLICATION PROCESSING

Every Fastrack Supreme features a Wavecom Q26-family Wireless CPU®: a powerful central processing unit with an ARM9 32 bit, 26-104MHz core, programmable via any combination of AT commands, C and Lua.

FASTRACK = YOUR PRODUCT

By designing your product value as an expansion card you save time and money in cellular learning curve, certification, mechanical design and time to market. Fastrack can now become *your* product.

UNHEARD-OF EXPANDABILITY

Add additional IO connectivity or features like GPS, WiFi, Bluetooth, Zigbee and more. The open interface means you can develop your own expansion modules for your specific needs.

INTELLIGENT DEVICE SERVICES

Our Intelligent Device Services enable you to remotely monitor and securely upgrade the software of your product, in order to reduce post-deployment field maintenance costs.

PROFESSIONAL SERVICES

Accelerate your product design and ensure you capitalize on market opportunities!

wavecom

Smart wireless. Smart business.

Operating Systems | Plug-Ins | Integrated Development Environments | Wireless CPUs | Services

Fastrack Supreme

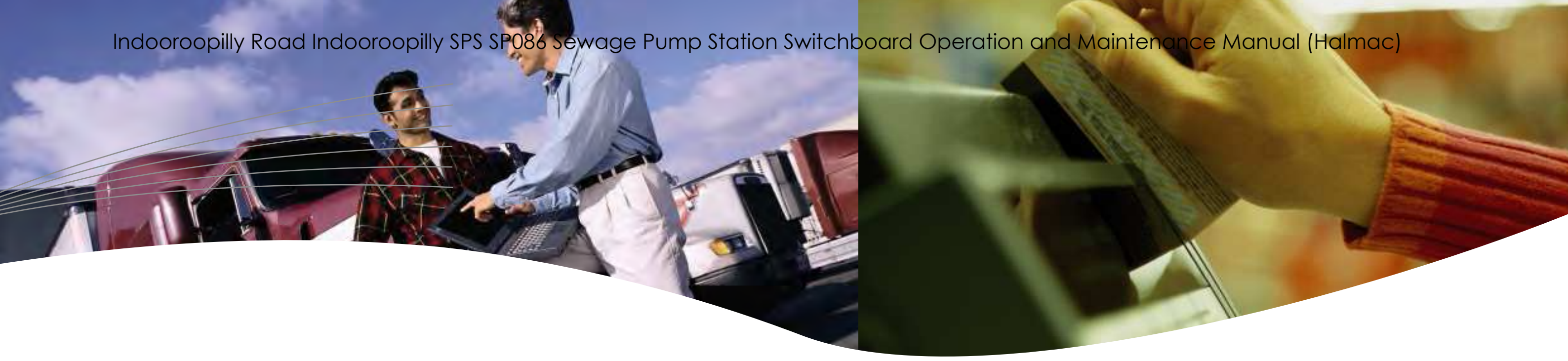
Plug and play with unlimited expandability

Evolve to the latest cellular technology and add functionality without sacrificing the form factor you have come to rely on. The Fastrack Supreme is the same size, has the same interfaces and is completely backward compatible with previous Fastrack products, and is packed with a host of new features.

Wavecom has developed an exciting new, open-standard Internal Expansion Socket (IES) interface for you to add additional IO connectivity or features like GPS, WiFi, Bluetooth, Zigbee and more. The open interface means you can develop your own expansion modules and customize the product for your specific requirements, or you can look to Wavecom for new expansion modules designed to address your most-pressing needs.

Features

	Wireless CPU		IESM			
	FASTRACK Supreme 10	FASTRACK Supreme 20	IESM GPS+USB	IESM IO+USB	IESM IO+USB+GPS	IESM Ethernet
Core CPU	ARM9, 32 bit with cache	ARM9, 32 bit with cache				MAC ethernet
Open AT® Software Suite	FW6.63/OS4.20	FW6.63/OS4.20				
VariSpeed	26/104MHz	26/104MHz				
MIPS	87 max.	87 max.				
DOTA	Type I & II	Type I & II				
External Interruption	<1ms	<1ms				
RTC Interruption	<1ms	<1ms				
GPIO	2	2		3+2	2	
Analogue Audio	2	2				
ADC/DAC/SPI/I2C				1/1/1/1	1/1/1/1	
RS232	1	1		1		
USB			1	1	1	1
SIM/RUIM	3V/1.8V SIM	3V/1.8V SIM				
Voltage/VDC (nom)	5.5 to 32	5.5 to 32	4		4	4
Current/A (max)	0.48 @ 5.5V	0.48 @ 5.5V	0.12 @ 5.5V		0.12 @ 5.5V	
MMCx			•		•	
SMA	•	•				
RJ45						•
Size/mm	73x54.5x25.5	73x54.5x25.5	58x35.7x10.01	58x35.7x10.01	58x35.7x10.01	58x35.7x10.01
Weight/g	89	89	<10	<10	<10	<10
SIM holder	•	•				
Operating t° range	-30°C+75°C	-30°C+75°C	-30°C+65°C	-30°C+65°C	-30°C+65°C	-30°C+65°C
GSM	•	•				
GPRS class	10	10				
EDGE class		10				
850/900/1800/1900	•	•				
Max Sensitivity (dBm)	-109 @ 900	-109 @ 900				
Codecs	FR/EFR/HR	FR/EFR/HR				
RIL	•	•				
TCP/IP & Internet	Plug-In	Plug-In				
Ethernet						Companion
Bluetooth	Plug-In	Plug-In				
Security	Plug-In	Plug-In				
GPS	Plug-In	Plug-In	Companion		Companion	



Open AT® Software Suite 2.0

Industrial software for industrial design demands

The Open AT® Software Suite allows you to develop, compile, test, debug, download and natively execute your applications written in standard ANSI C directly on the Fastrack Supreme, or indeed any other Wavecom Wireless CPU®. It is royalty free and comprises operating system, compiler and integrated development environments. There are no hidden costs - maintenance and qualification are provided for free by Wavecom.

- **Multitasked Pre-Emptive Event-Based Real-Time Operating System**
- **Integrated Development Environment built on Eclipse™**
- **Extensive Set of Plug-Ins (Internet Suite, C-GPS and more)**
- **GSM Release 99 compliant modem firmware**
- **Secure Intelligent Device Services (IDS) compatible**

REAL TIME OPERATING SYSTEM

Real-Time
Guarantied response time to interruption
(even during GSM/GPRS/EDGE activities, calls and transfer).

Wireless CPU® Resources Direct Access and IT Management

- Hardware and Software Timers
- DSP
- SPI
- ADC
- External Interrupt Pins
- GPIOs
- UARTS (coming in 2008)

Multitasking

Auto shut-down feature
Feature improving the overall consumption of the application by deactivating the RS232 interface.

Application dedicated Hardware Watchdog

- application dedicated for close monitoring
- tunable depending on the complexity of the processing (ex: Pulse count Vs RSA signature calculation...)

CROSS-PLATFORM INTEGRATED DEVELOPMENT ENVIRONMENT

For eased application debug it can be performed on PC:
for very fast and convenient application debugging through Remote Task Environment.

On target for final Integration and time-critical behavior management:

- Live through Traces
- Post mortem through BackTraces

On field:

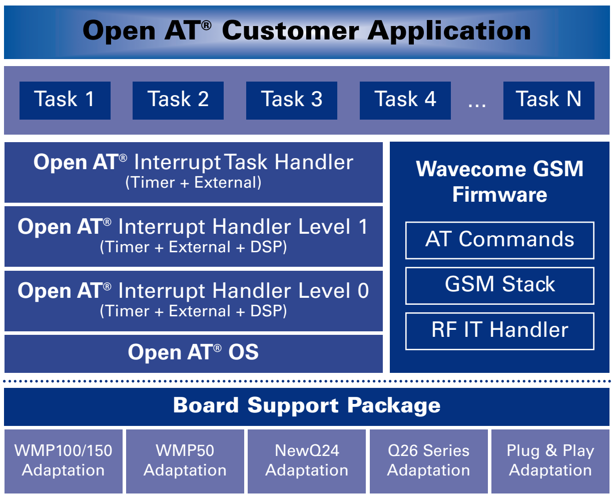
- for difficult error causing operating scenarios through IDS device monitoring services and BackTraces over the air retrieval.

SEAMLESSLY PLUG-IN ADDITIONAL FEATURES

Plug-Ins are an optional range of software feature packages that are selected when your order your Wireless CPU®. The standard range provides access to Internet clients & protocols, controller-less companion wireless peripherals such as Bluetooth & GPS. Of course, the powerful flexibility of Open AT® Software Suite means that you can also develop your own Plug-Ins and own custom AT commands.

Lua	*Internet*	*C-GPS*	*C-Bluetooth™*	*aqLink®*
Easy Scripting	Clients & Protocols	Companion	Companion	in-band modem

WAVECOM BSP-BASED EMBEDDED SOFTWARE ARCHITECTURE



Wavecom Services

The wireless products you are developing are most probably very complex, and they will stay in the field for many years. With this in mind, Wavecom has created a range of professional and operated services to make the development process easier and to help you protect your investment, enrich your products and services, and reduce the lifetime cost of your device network.

Professional services: Less pain, more gain

Wavecom Professional Services help you be faster, sleeker and more adaptable to the ever changing needs of your market, all along the typical product lifecycle timeline:

WAVECOM UNIVERSITY
- → **Open AT® Developer course**
- → **Open AT® Expert course**

PRODUCT BUILD
- → **IMEI implementation**
- → **Tailored Delivery (Express & Fast)**
- → **Tailored Product Configuration**

PRODUCT DESIGN
- → **Customer Design Review**
- → **Customer Product Certification**
- → **Open AT® Application Code Review**

AFTER SALES
- → **Reconfiguration for Wireless CPU®**
- → **Out Of Warranty repair for Wireless CPU®**
- → **Repair Equipment Wireless CPU®**

Intelligent Device Services: Investment protection

Wavecom has created the world's first cellular operated service portfolio to benefit from easy to use end-to-end Intelligent Device Services that enable to remotely monitor and securely upgrade the application software of your product in addition to the entire Wavecom embedded Open AT® Software:

WIRELESS DEVICE MANAGEMENT
- → **Simplify your device installation and protect your wireless investment while reducing your field service costs**

COMMUNICATION MANAGEMENT
- → **Analyze your traffic load and roaming usage, and adjust your tariff plans to your real usage**

APPLICATION MANAGEMENT
- → **Benefit from proactive maintenance services to diagnose issues and take action before a significant problem occurs**

See the Fastrack Supreme online:
www.wavecom.com/fastracksupreme

Join the Wavecom Developer community:
www.wavecom.com/forum

Smart wireless. Smart business.

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9. Human Machine Interface

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

HUMAN MACHINE INTERFACE

1. HUMAN MACHINE INTERFACE TECHNICAL DETAILS

red lion®
Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
www.redlion.net

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.

CompactFlash is a registered trademark of CompactFlash Association.

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/m^2
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.

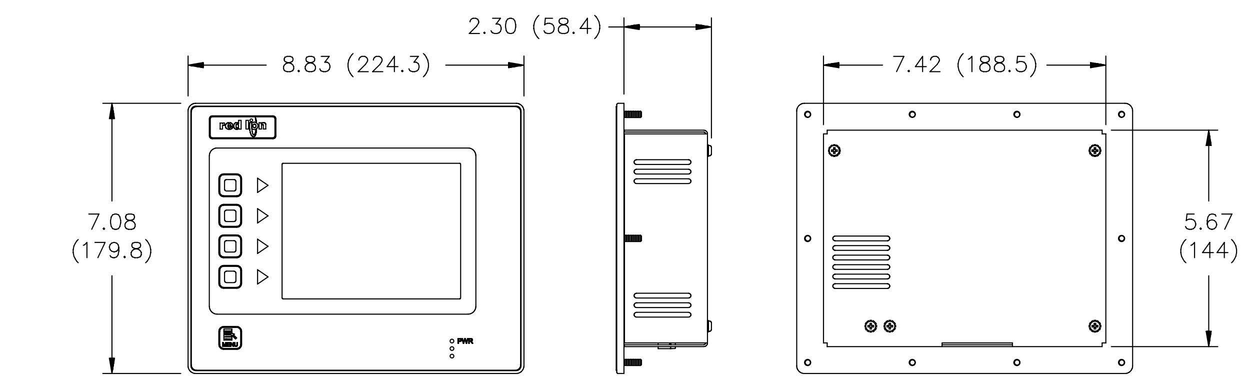
WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

   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)

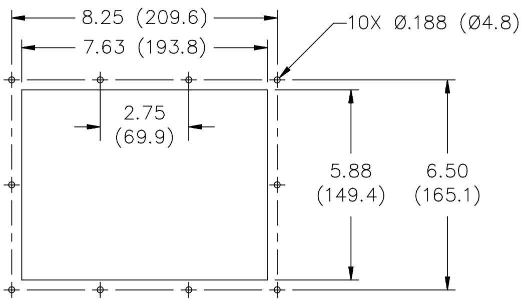


INSTALLING AND POWERING THE G306A

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.

RS232 PORTS

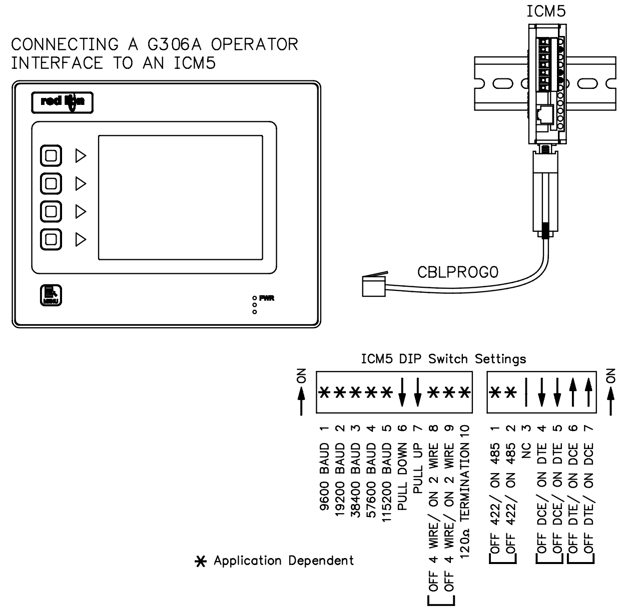
The G306A has two RS232 ports. There is the PGM port and the COMMS port. Although only one of these ports can be used for programming, both ports can be used for communications with a PLC.

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].

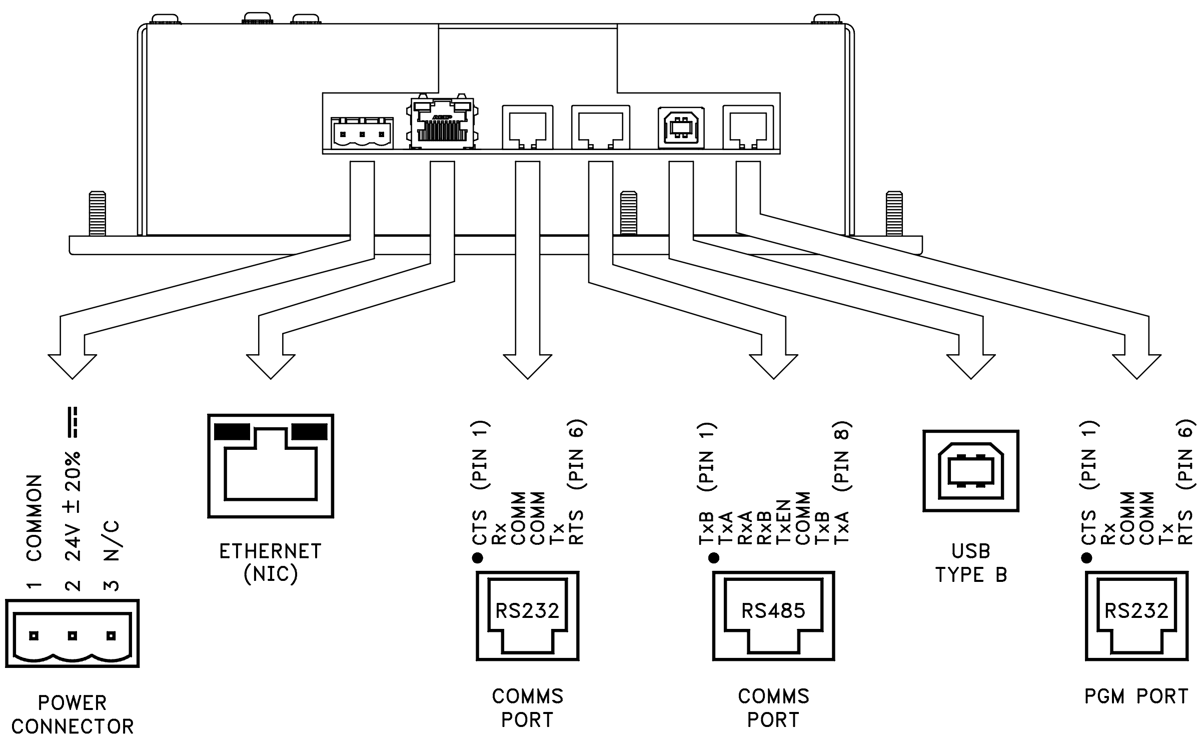
G3 RS232 to a PC

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



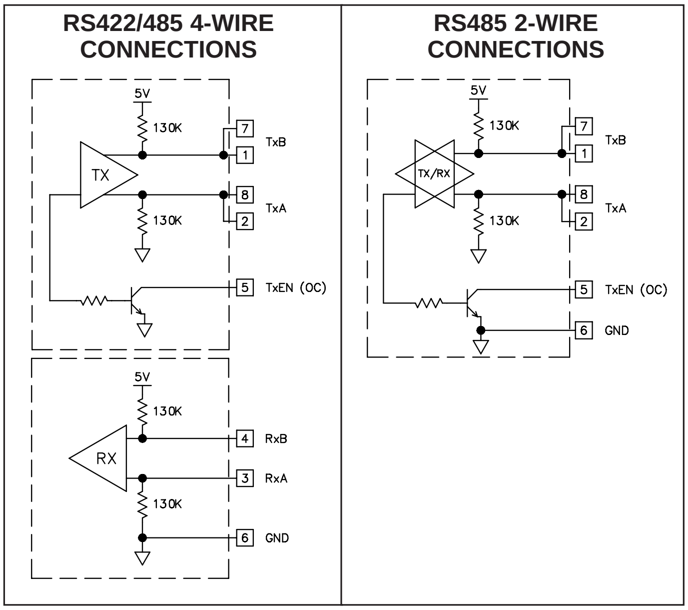
[1] CBLPROG0 can also be used to communicate with either a PC or an ICM5.
[2] DB9 adapter not included, 1 foot long.
[3] DB9 adapter not included, 10 feet long.

G306A PORT PIN OUTS



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.

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

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

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.

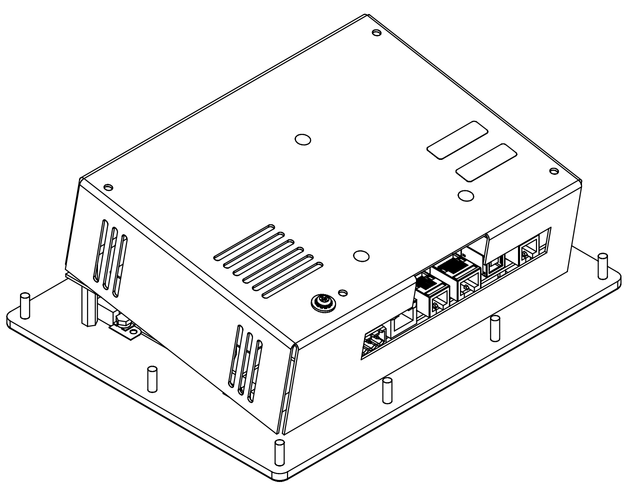
WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN DISCONNECTED AND THE AREA IS KNOWN TO BE NON-HAZARDOUS.

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.

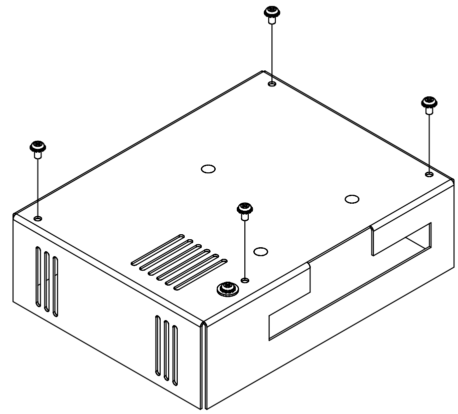
To change the battery of a G306A, remove power, cabling, and then the rear cover of the unit. To remove the cover, remove the four screws designated by the arrows on the rear of the unit. Then, by lifting the top side, hinge the cover, thus providing clearance for the connectors on the bottom side of the PCB as shown in the illustration below. Install in the reverse manner.

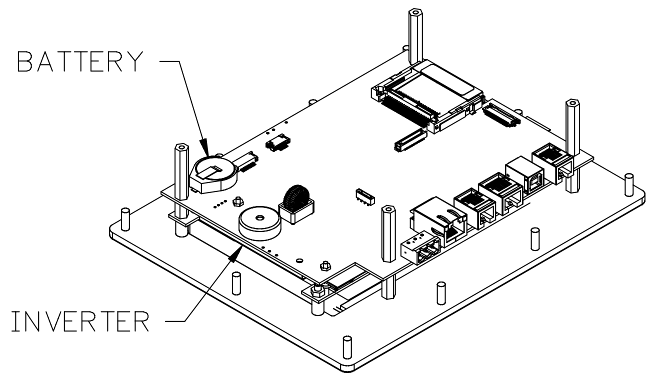


Remove the old battery* from the holder and replace with the new battery. Replace the rear cover, cables, and re-apply power. Using Crimson or the unit's keypad, enter the correct time and date.

** 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.





OPTIONAL FEATURES AND ACCESSORIES

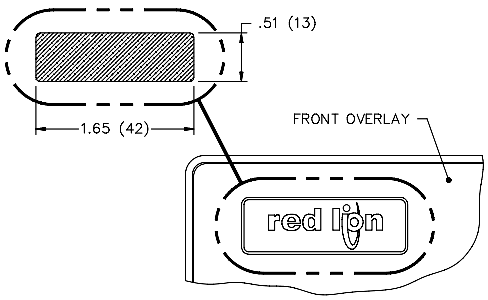
OPTIONAL COMMUNICATION CARD

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

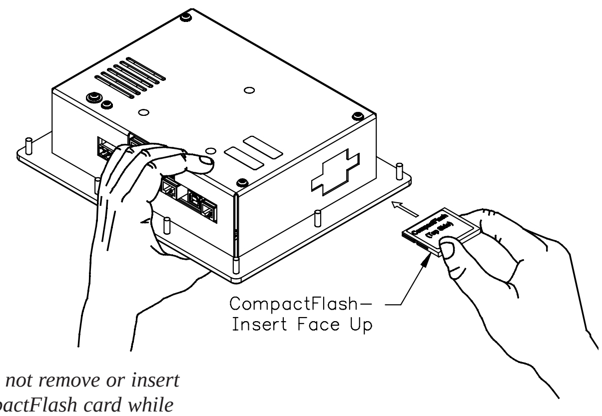
Each G3 operator interface has an embossed area containing the Red Lion logo. Red Lion can provide custom logos to apply to this area. Contact your distributor for additional information and pricing.



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.

Red Lion Controls
20 Willow Springs Circle
York PA 17406
Tel +1 (717) 767-6511
Fax +1 (717) 764-0839

Red Lion Controls BV
Printerweg 10
NL - 3821 AD Amersfoort
Tel +31 (0) 334 723 225
Fax +31 (0) 334 893 793

Red Lion Controls AP
Unit 101, XinAn Plaza
Building 13, No.99 Tianzhou Road
ShangHai, P.R. China 200223
Tel +86 21 6113-3688
Fax +86 21 6113-3683

10. Load Break Switch

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

LOAD BREAK SWITCH

1. SLB SERIES LOAD BREAK SWITCH TECHNICAL DETAILS

SLB Standard load-break switches

SIRCO 125 to 4000 A

New Range

SLB 125...630

The SIRCO range of load-break switches offer compact solutions for switching from 125 A to 4000 A. Base mounting is standard.

The SIRCO range are a proven, reliable design that more than suit harsh Australian conditions.

The switches come complete with extended shaft and door mountable pistol grip handle. Available in three and four pole versions with a large range of accessories to choose from.

Front operated surface mount

(Supplied with external handle and shaft)

	AC 21 400 V (A)	AC 23 400 V (A)	AC 23 400 V (kW)	No. of poles [1])	Cat. No.
125 A	125	125	63	3	SLB 125 3P
				4	SLB 125 4P
160 A	160	160	80	3	SLB 160 3P
				4	SLB 160 4P
200 A	200	200	100	3	SLB 200 3P
				4	SLB 200 4P
250 A	250	250	132	3	SLB 250 3P
				4	SLB 250 4P
315 A	315	315	160	3	SLB 315 3P
				4	SLB 315 4P
400 A	400	400	220	3	SLB 400 3P
				4	SLB 400 4P
500 A	500	400	280	3	SLB 500 3P
				4	SLB 500 4P
630 A	630	500	280	3	SLB 630 3P
				4	i SLB 630 4P
800 A	800	800	450	3	SLB 800 3P
				4	i SLB 800 4P

Notes: [1]) 6 and 8 pole switches available on indent. Refer NHP.
i Available on indent only.

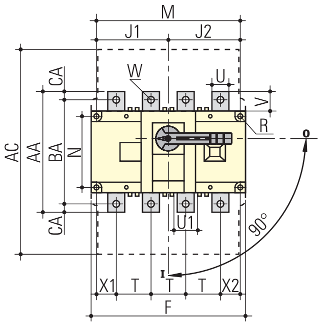
SLB 800...3150

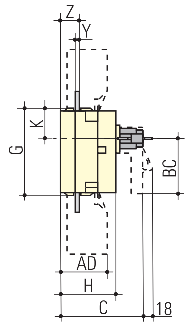
SOCOMEC NHP

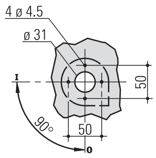
Technical data and dimensions (mm)

SIRCO SLB 125 to 2500 A

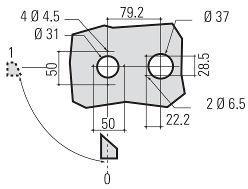
SIRCO 125 to 2500 A



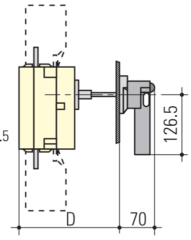




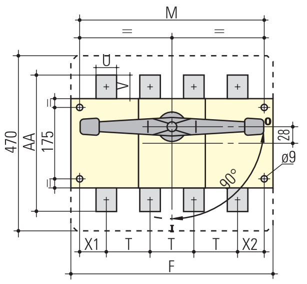
Door Drilling

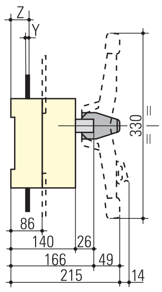


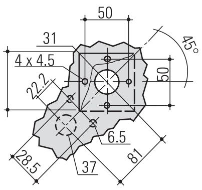
Castell drilling



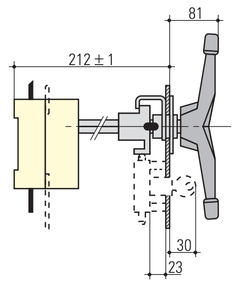
Rating A	Overall dimensions C	D	Terminal shrouds AC	AD	Switch body F 3p	F 4p	G	H	J1 3p	J1 4p	J2	K	BC	Switch mounting M 3p	M 4p	N	R	Connection terminals T	U	U1	V	W	X1 3p	X1 4p	X2	Y	Z	AA	BA	CA
125	120	124…354	235	50	140	170	93	65	45	75	75	31.5	80	120	150	65	5.5	36	20	20.5	25	9	28	22	20	3.5	20.5	135	115	10
160	120	124…354	235	50	140	170	93	65	45	75	75	31.5	80	120	150	65	5.5	36	20	20.5	25	9	28	22	20	3.5	20.5	135	115	10
200	130	135…365	290	60	180	230	108	75	55	105	105	34	115	160	210	80	5.5	50	25	25.5	30	11	33	33	27	3.5	22.5	160	130	15
250	130	135…365	290	60	180	230	108	75	55	105	105	34	115	160	210	80	5.5	50	25	25.5	30	11	33	33	27	3.5	22.5	160	130	15
315	165	167…397	401	89	230	290	170	110	75	135	135	55	115	210	270	140	7	65	32	45.5	37.5	11	42.5	37.5	37.5	5	36	235	205	15
400	165	167…397	401	89	230	290	170	110	75	135	135	55	115	210	270	140	7	65	32	45.5	37.5	11	42.5	37.5	37.5	5	36	235	205	15
500	165	167…397	401	89	230	290	170	110	75	135	135	55	115	210	270	140	7	65	32	45.5	37.5	13	42.5	37.5	37.5	5	36	235	205	15
630	165	167…397	400	89	230	290	170	110	75	135	135	55	115	210	270	140	7	65	45	45.5	50	13	42.5	37.5	37.5	5	36	260	220	20



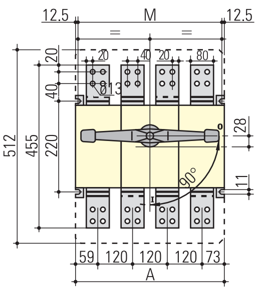


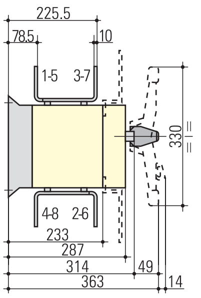


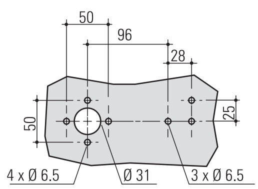
Castell Drilling



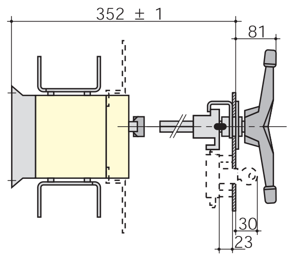
Rating A	Switch body F 3p	F 4p	Switch mounting M 3p	M 4p	Connection terminals T	U	V	Y	X1	X2	Z	AA
800	280	360	255	335	80	50	60.5	7	47.5	47.5	46.5	321
1000	280	360	255	335	80	50	60.5	7	47.5	47.5	46.5	321
1250	372	492	347	467	120	90	44	8	53.5	53.5	47.5	288
1600	372	492	347	467	120	90	44	8	53.5	53.5	47.5	288
1800	372	492	347	467	120	90	44	8	53.5	53.5	47.5	288







Castell Drilling



Rating A	Overall dimensions A 3p	A 4p	Switch mounting M 3p	M 4p
2000	372	492	347	467
2500	372	492	347	467

NHP SOCOMEC

Technical data and ratings chart

SIRCO SLB 125 to 630 A

Ratings to AS 3947-3 and IEC 60947-3

			125 A	160 A	200 A	250 A	315 A	400 A	500 A	630 A
Rated insulation voltage and rated operation voltage AC 20/DC 20		V	800	800	800	800	1000	1000	1000	1000
Rated impulse withstand voltage		kV	8	8	8	8	12	12	12	12
Rated operational current										
AC 21A	400 V	A	125	160	200	250	315	400	500	630
	500 V	A	125	160	200	250	315	400	500	630
	690 V	A	125	160	200	250	315	400	500	500
AC 22A	400 V	A	125	160	200	250	315	400	500	630
	500 V	A	125	125	200	250	315	400	500	500
	690 V	A	-	-	-	125	250	250	250	315
AC23A	400 V	A	125	160	200	250	315	400	500	500
	500 V	A	100	100	160	200	315	315	315	315
	690 V	A	-	-	-	100	160	160	160	160
Rated operational current										
DC 21A	400 V	A	125	160	160	250	315	400	400	630
	500 V	A	125	125	160	200	315	400	400	500
DC 22A	400 V	A	125	160	160	200	315	400	400	500
	500 V	A	125	125	160	200	315	315	315	500
DC 23A	400 V	A	125	125	160	200	315	400	400	500
	500 V	A	125	125	160	200	315	400	400	500
Operational power										
AC 23A	400 V	kW	63	80	100	132	160	220	280	280
	500 V	kW	63	63	110	140	220	220	220	220
	690 V	kW	55	55	75	90	150	150	150	150
Overload capacity										
Short time withstand current Icw (RMS 1s) 690 V		kA	7	7	9	9	13	13	13	13
Breaking capacity AC 23A	400 V	A	1000	1280	1600	2000	2520	3200	4000	4000
Fuse protected short circuit withstand. (kA RMS prospective)	400 V AC	kA	100	100	80	50	100	100	100	70
	Fuse	A	125	160	200	250	315	400	500	630
Rated capacitor power		kVAr	55	75	90	115	145	185	230	290
Mechanical endurance		Ops	10000	10000	10000	10000	5000	5000	5000	5000
Weight (3 pole)		Kg	1	1.5	2	2	3.5	3.5	3.5	3.5
Min. tightening torque		Nm	6.5	6.5	10	10	15.4	14.5	14.5	14.5
Connection cable size		mm^2	35/50	50/95	70/95	95/150	150/240	185/240	240/240	2 (150/300)

Note: 240/415 V ratings suitable for use on 230/400 V in accordance with AS 60038 : 2000.

11. Level Transmitter

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

LEVEL TRANSMITTER

1. LEVEL TRANSMITTER TECHNICAL DETAILS

Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Technical Information

Waterpilot FMX21

Hydrostatic level measurement
Reliable and robust level probe with ceramic measuring cell
Compact device for level measurement in fresh water, wastewater and saltwater, communication via HART

Application

The Waterpilot FMX21 is a pressure sensor for hydrostatic level measurement.
Endress+Hauser offers three different versions of the FMX21 sensor:

- FMX21 with a stainless steel housing, outer diameter of 22 mm (0.87 inch): Standard version suitable for drinking water applications and for use in bore holes and wells with small diameters.
- FMX21 with a stainless steel housing, outer diameter of 42 mm (1.66 inch): Heavy duty version, easy clean flush-mounted process diaphragm. Ideally suited for wastewater and sewage treatment plants.
- FMX21 with a coated housing, outer diameter of 29 mm (1.15 inch): Corrosion resistant version generally for use in saltwater, particularly for ship ballast water tanks.

Your benefits

- High resistance to overload and aggressive media
- High-precision, robust ceramic measuring cell with long-term stability
- Climate proofed sensor thanks to completely potted electronics and 2-filter pressure compensation system
- 4 to 20 mA with superimposed HART 6.0 output signal
- Simultaneous measurement of level and temperature with optionally integrated Pt100 temperature sensor
- Accuracy
  - Reference accuracy ±0.2 %
  - PLATINUM version ±0.1 %
- Automatic density compensation to increase accuracy
- Usage in drinking water: KTW, NSF, ACS
- Approvals: ATEX, FM, CSA
- Extensive range of accessories provides complete measuring point solutions

TI431P/00/EN/08.10
71118704

Endress+Hauser
People for Process Automation

Table of contents

Function and system design

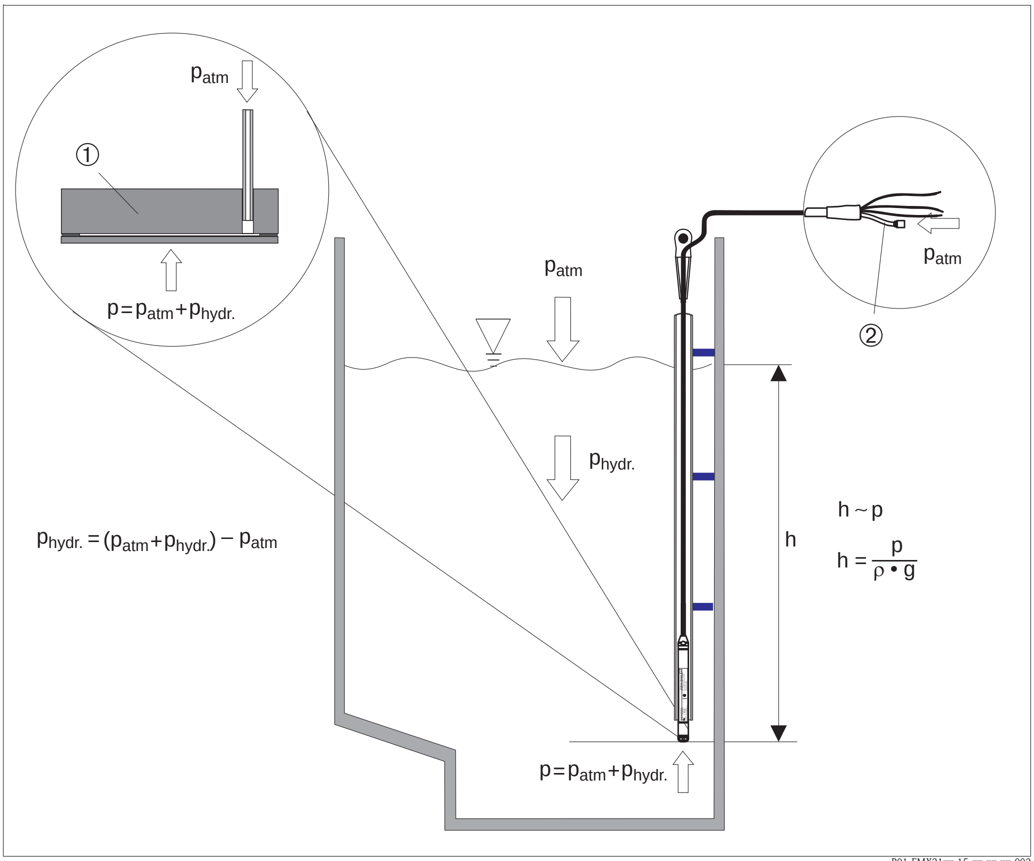
Device selection

Waterpilot FMX21	 P01-FMX21xxx-16-xx-xx-xx-002	 P01-FMX21xx-16-xx-xx-xx-003	 P01-FMX21xxx-16-xx-xx-xx-004
Field of application	Hydrostatic level measurement in deep wells e.g. drinking water	Hydrostatic level measurement in wastewater	Hydrostatic level measurement in saltwater
	Caution! The Waterpilot is not suitable for use in biogas plants since the gases can diffuse through the elastomers (seals, extension cable). For applications with biogas Endress+Hauser offers the level transmitter Deltapilot.		
Process connection	– Mounting clamp – Extension cable mounting screw with G1 ½ A or 1 ½ NPT thread		
Outer diameter	22 mm (0.87 in)	42 mm (1.65 in)	max. 29 mm (1.14 in)
Extension cable	– PE extension cable – PUR extension cable – FEP extension cable		
Seals	– FKM Viton – EPDM [1]	– FKM Viton	– FKM Viton – EPDM [1]
Measuring ranges	– Gauge pressure: from 0 to 0.1 bar to 0 to 20 bar (0 to 1.5 psi to 0 to 300 psi) – Absolute pressure: from 0 to 2 bar to 0 to 20 bar (0 to 30 psi to 0 to 300 psi)		– Gauge pressure: from 0 to 0.1 bar to 0 to 4 bar (0 to 1.5 psi bis 0 to60 psi) – Absolute pressure: from 0 to 2 bar to 0 to 4 bar (0 to 1.5 psi bis 0 to 60 psi)
	– Customer-specific measuring ranges; factory-calibrated – The following output units can be configured: %, mbar, bar, kPa, MPa, mmH_2O, mH_2O, inH_2O, ftH_2O, psi and numerous level units.		
Overload	Up to 40 bar (580 psi)		Up to 25 bar (362 psi)
Process temperature range	–10 to +70 °C (+14 to +158 °F)		0 to +50 °C (+32 to +122 °F)
Reference accuracy	– ±0.2 % of the set span – Optional: ±0.1 % of set span (PLATINUM version)		
Supply voltage	10.5 to 35 V DC, Ex: 10.5 to 30 V DC		
Output	4 to 20 mA (invertible) with superimposed digital communication protocol HART 6.0, 2-wire (invertible)		
Options	– Large selection of approvals, including ATEX, FM, CSA, Drinking water approval – Broad range of accessories – Integrated Pt100 temperature sensor and TMT182 temperature head transmitter (4 to 20 mA/HART)		
Specialties	– High-precision, robust ceramic measuring cell with long-term stability – Automatic density compensation – Customer specific cable marking – Absolute pressure cell		

1) Recommended for drinking water applications.

Measuring principle

The ceramic measuring cell is a dry measuring cell, i.e. pressure acts directly on the robust ceramic process isolating diaphragm of the Waterpilot FMX21.
Any changes in the air pressure are routed through the extension cable, via a pressure compensation tube, to the rear of the ceramic process isolating diaphragm and compensated for. A pressure-dependent change in capacitance caused by the movement of the process isolating diaphragm is measured at the electrodes of the ceramic carrier. The electronics then convert this into a signal which is proportional to the pressure and is linear to the level of the medium.



Measuring principle

1 Ceramic measuring cell
2 Pressure compensation tube
h Level height
p Total pressure = hydrostatic pressure + atmospheric pressure
ρ Density of the medium
g Gravitational acceleration
$p_{hydr.}$ Hydrostatic pressure
p_{atm} Atmospheric pressure

Temperature measurement with optional Pt100 [1)]

Endress+Hauser also offers the Waterpilot FMX21 with an optional 4-wire Pt100 resistance thermometer to measure level and temperature simultaneously. The Pt100 belongs to Accuracy Class B in accordance with DIN EN 60751, see also → 26 "Accessories".

Temperature measurement with optional Pt100 and TMT182 temperature head transmitter [1)]

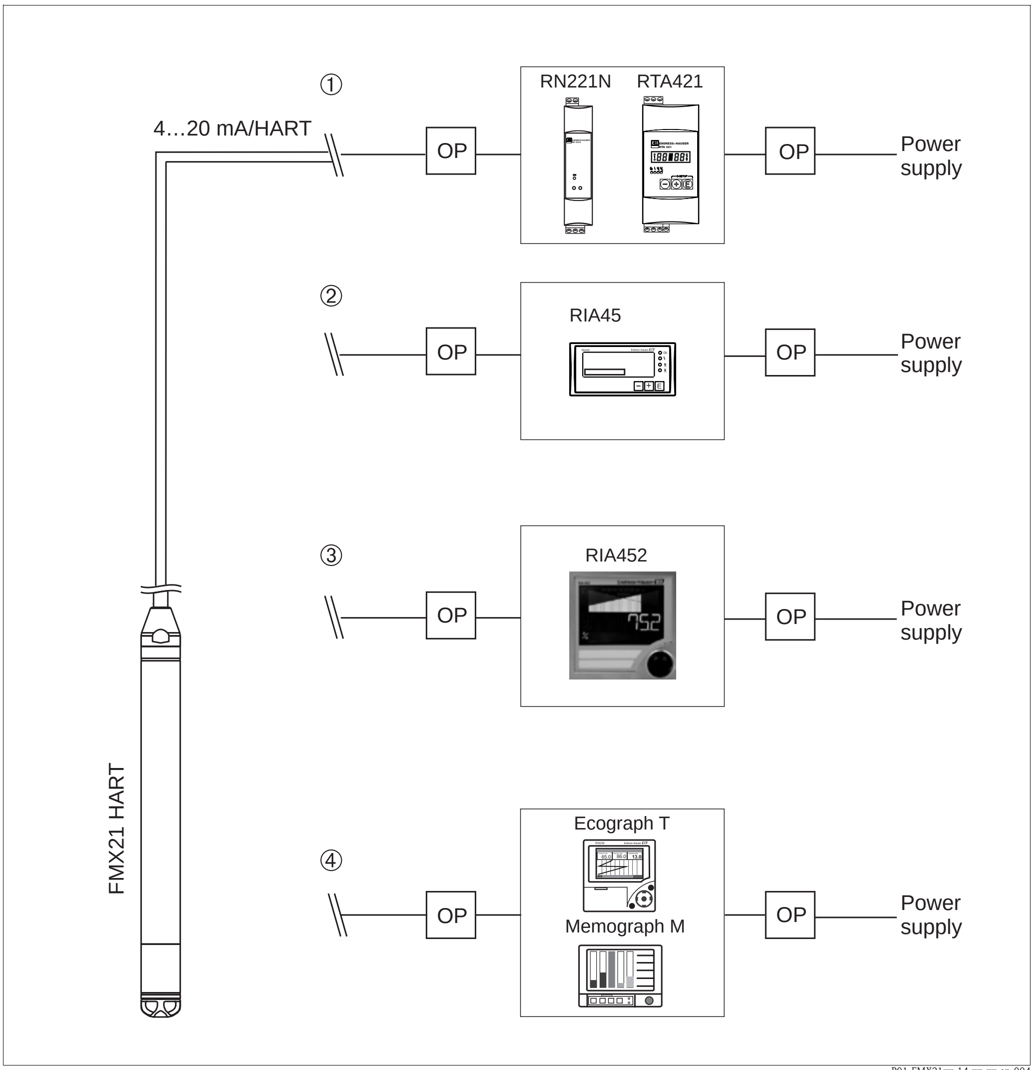
Endress+Hauser also offers the TMT182 temperature head transmitter with the HART protocol to convert the temperature signal to an analog, scalable 4 to 20 mA output signal superimposed with HART 6.0, see also → 7 "Density compensation with Pt100 temperature sensor" → 24 "Ordering information" → 26 Chap. "Accessories" and Technical Information TI078R.

1) Not for use in hazardous areas.

Measuring system

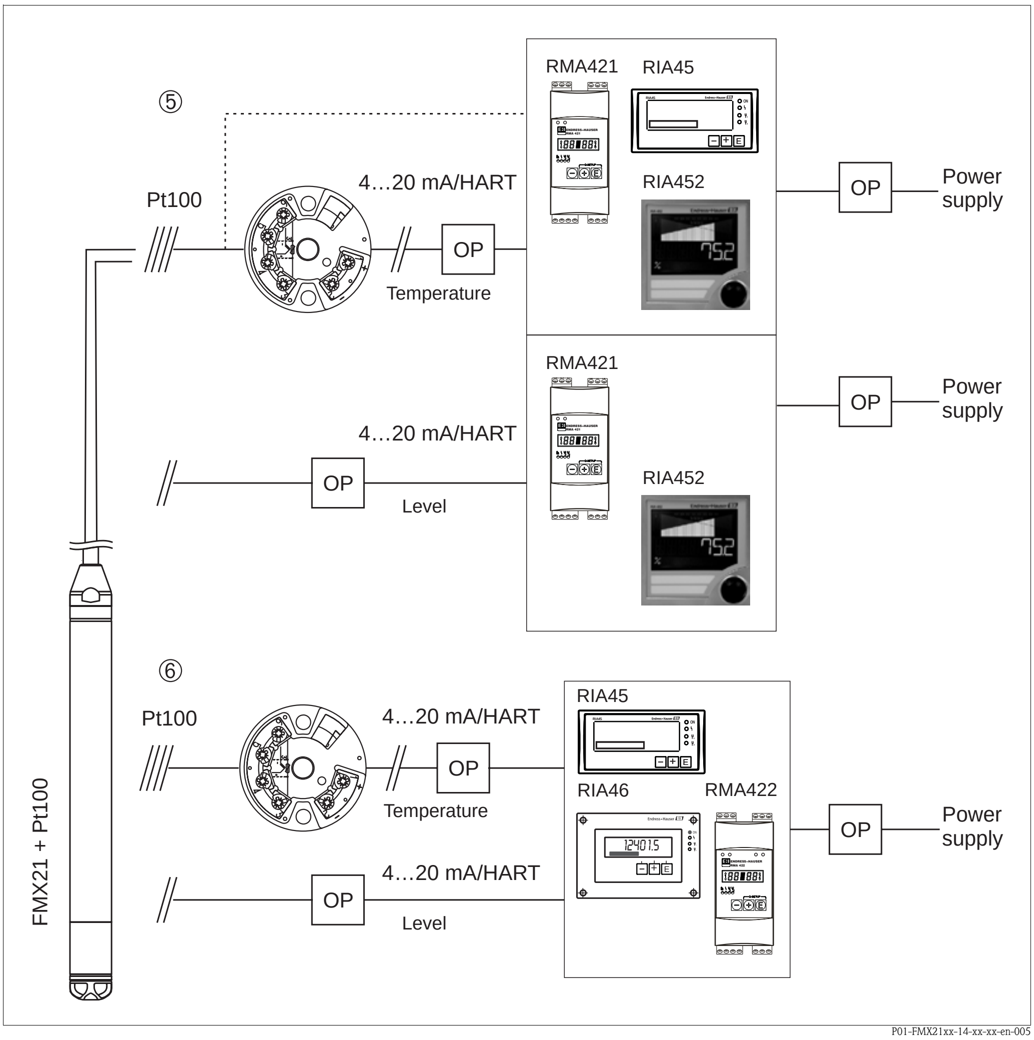
As standard, the complete measuring system consists of a Waterpilot FMX21 and a transmitter power supply unit with a supply voltage of 10.5 to 30 V DC (hazardous areas) or 10.5 to 35 V DC (non-hazardous areas).

Possible measuring point solutions with a transmitter and evaluation units from Endress+Hauser:



Sample applications with FMX21
OP = Overvoltage protection, e.g. HAW from Endress+Hauser (not for use in hazardous areas)
- OP on sensor side for field installation: HAW569/for top-hat/DIN rail: HAW562/intrinsically safe HAW562Z
- OP on power supply side for top-hat/DIN rail: HAW561 (115/230 V) and HAW561K (24/48 V AC/DC)
The overvoltage protection selected must be appropriate for the supply voltage.

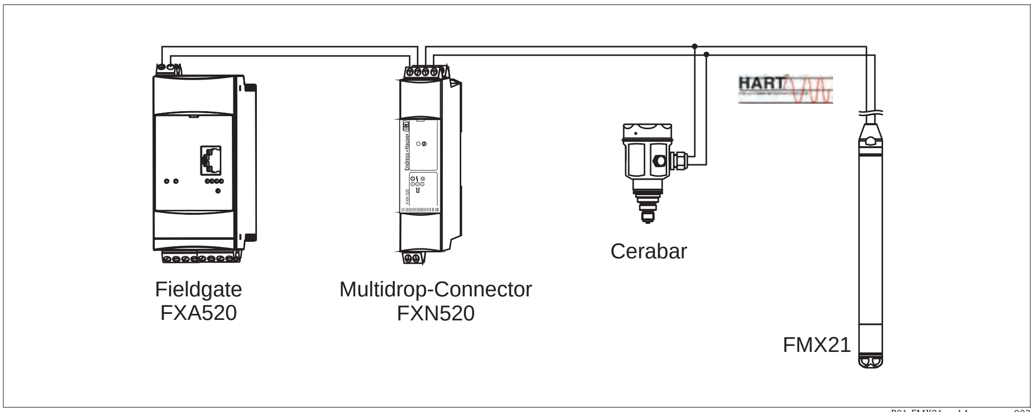
1. Easy and cost-effective measuring point solution: power supplied to the Waterpilot in hazardous and non-hazardous areas via the RN221N active barrier.
   Power supply and additional control of two appliances, such as pumps, by means of the RTA421 limit value switch with onsite display.
2. The RIA45 units (for panel mounting) offer power supply, an onsite display, two switch outputs and signal adjustment (turndown).
3. If several pumps are used, the pump service life can be prolonged by alternate switching. With alternating pump control, the pump which was out of service for the longest period of time is switched on. The evaluation unit RIA452 (for panel mounting) provide this option in additional to several other functions.
4. State-of-the-art recording technology with graphic display recorders from Endress+Hauser, such as Ecograph T, Memograph M for documenting, monitoring, visualizing and archiving purposes.



Sample applications with FMX21 with Pt100
OP = Overvoltage protection e.g. HAW from Endress+Hauser (not for use in hazardous areas)
- OP on sensor side for field installation: HAW569/for top-hat/DIN rail: HAW562/intrinsically safe HAW562Z
- OP on power supply side for top-hat/DIN rail: HAW561 (115/230 V) and HAW561K (24/48 V AC/DC)
The overvoltage protection selected must be appropriate for the supply voltage.

5. If you want to measure, display and evaluate the temperature as well as the level, e.g. to monitor temperature in fresh water to detect temperature limits for germ formation, you have the following options:
   The optional TMT182 temperature head transmitter can convert the Pt100 signal to a 4 to 20 mA HART signal and transfer it to any common evaluation unit. The RMA421, RIA45 and RIA452 evaluation units also offer a direct input for the Pt100 signal.
6. If you want to record and evaluate the level and temperature measured value with one device, use the RMA422, RIA45 and RIA46 evaluation unit with two inputs. It is even possible to mathematically link the input signals with this unit. These evaluation are not HART permeable.

Level measurement with absolute pressure probe and external pressure signal



P01-FMX21xx-14-xx-xx-xx-003

It is advisable to use an absolute pressure probe for applications in which condensation can occur. In the case of level measurement with an absolute pressure probe, the measured value is affected by fluctuations in the ambient air pressure. To correct the resulting measured error, you can connect an external absolute pressure sensor (e.g. Cerabar) to the HART signal cable, switch the waterpilot to the burst mode and the Cerabar to operate in mode "Electr. Delta P".

The external absolute pressure sensor then calculates the difference between the two pressure signals and can thus determine the level precisely.
Only one level measured value can be corrected in this way.

Caution!
If using intrinsically safe devices, strict compliance with the rules for interconnecting intrinsically safe circuits as stipulated in IEC60079-14 (proof of intrinsic safety) is mandatory.

Density compensation with Pt100 temperature sensor

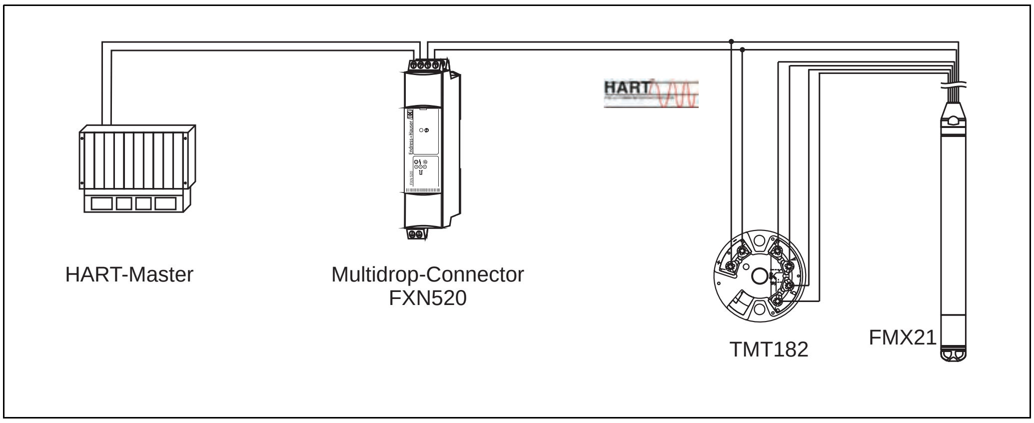
The Waterpilot FMX21 can correct measured errors that result from fluctuations in the density of the water caused by temperature. Users can choose from the following options:

Use the internally measured sensor temperature of the FMX21

The internally measured sensor temperature is calculated in the Waterpilot FMX21 for density compensation. The level signal is thus corrected according to the density characteristic line of the water.

Use the optional internal temperature sensor for density compensation in a suitable HART master (e.g. PLC)

The Waterpilot FMX21 is available with an optional Pt100 temperature sensor. Endress+Hauser additionally offers the TMT182 temperature head transmitter to convert the Pt100 signal to a 4 to 20 mA HART signal. The temperature and pressure signal is transmitted to the HART master (e.g. PLC) where a corrected level value can be generated using a stored linearization table or the density function (of a chosen medium).

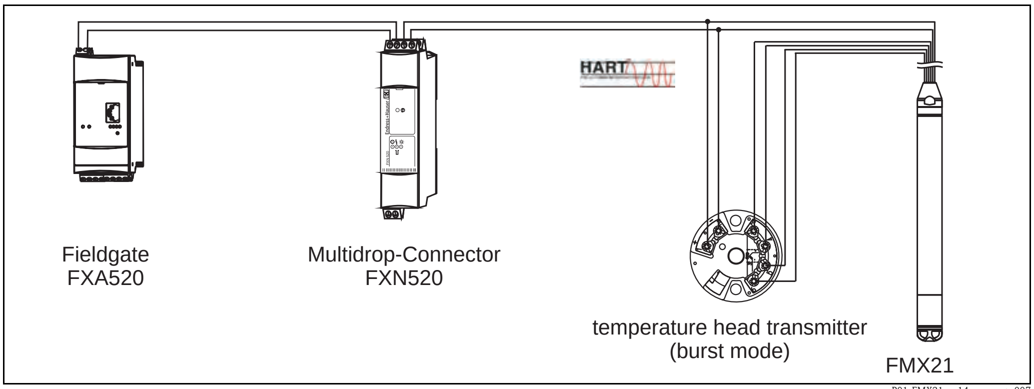


P01-FMX21xx-14-xx-xx-xx-002

Use an external temperature signal which is transmitted to the FMX21 via HART burst mode

The Waterpilot FMX21 is available with an optional Pt100 temperature sensor. In this case, the signal of the Pt100 is analyzed using a HART-compliant (at least HART 5.0) temperature transmitter that supports BURST mode. The temperature signal can thus be transmitted to the FMX21. The FMX21 uses this signal for the density correction of the level signal.

Note!
The TMT182 temperature head transmitter is not suitable for this configuration.



P01-FMX21xx-14-xx-xx-en-007

Without compensation additional errors of up to 4 % can occur at a temperature of 70 °C (158 °F) for example. With density compensation, this error can be decreased to 0.5% in the entire temperature range from 0 to 70 °C (32 to 158 °F).

Note!
For further information on the devices, please refer to the appropriate Technical Information:
- TI078R: TMT182 temperature head transmitter (4 to 20 mA/HART)
- TI369F: FXA520 Fieldgate
- TI400F: FXN520 multidrop connector

Communication protocol

4 to 20 mA HART with communication protocol

System integration

The device can be fitted with a tag name, see → 24 ff "Ordering information", feature 895 "Marking" version "Z1".

Input

Measured variable

FMX21 + Pt100 (optional)

- Hydrostatic pressure of a liquid
- Pt100: temperature

TMT182 temperature head transmitter (optional)

- Temperature

Measuring range

- Customer-specific measuring ranges; factory-calibrated
- Temperature measurement from –10 to +70 °C (+14 to +158 °F) with Pt100 (optional)
- A sensor measuring range turndown (TD) of up to 10:1 can be set at the factory or directly by the customer.

Sensor measuring range [bar (psi)]	Smallest span that can be calibrated [bar (psi)]	Maximum overload/ OPL 1) [bar (psi)]	Vacuum resistance [bar_{abs} (psi_{abs})]	Version in the order code2)
Gauge pressure				
0.1 (1.5)	0.01 (0.15)	5.0 (75.0)	0.3 (4.5)	1C
0.2 (3.0)	0.02 (0.3)	5.0 (75.0)	0.3 (4.5)	1D
0.4 (6.0)	0.04 (1.0)	6.0 (90.0)	0	1F
0.6 (9.0)	0.06 (1.0)	10.0 (150)	0	1G
1.0 (15.0)	0.1 (1.5)	10.0 (150)	0	1H
2.0 (30.0)	0.2 (3.0)	15.0 (225)	0	1K
4.0 (60.0)	0.4 (6.0)	25.0 (375)	0	1M
10.0 (150) 3)	1.0 (15)	40.0 (600)	0	1P
20.0 (300) 3)	2.0 (30)	40.0 (600)	0	1Q
Absolute pressure				
2.0 (30.0)	0.2 (3.0)	15.0 (225)	0	2K
4.0 (60.0)	0.4 (6.0)	25.0 (375)	0	2M
10.0 (150) 3)	1.0 (15)	40.0 (600)	0	2P
20.0 (300) 3)	2.0 (30)	40.0 (600)	0	2Q

1) OPL: overpressure limit, depending on the weakest element, in terms of pressure, of the selected components

2) See → 24 "Ordering information"

3) These measuring ranges are not offered for the probe version with a coated housing. outer diameter 29 mm (1.14 in) .

Input signal

FMX21 + Pt100 (optional)

- Change in capacitance
- Pt100: change in resistance

TMT182 temperature head transmitter (optional)

- Pt100 resistance signal, 4-wire

Output

Output signal

FMX21 + Pt100 (optional)

- 4 to 20 mA with overlying digital HART 6.0 communication protocol, 2-wire for hydrostatic pressure measured value
- Pt100: Temperature-dependent resistance values

TMT182 temperature head transmitter (optional)

- 4 to 20 mA with overlying digital HART 5.0 communication protocol for temperature measured value, 2-wire

Signal range

- 3.8 to 20.5 mA

Signal on alarm

FMX21 + Pt100 (optional)

- 4 to 20 mA/HART
  Options:
  – Max. alarm (factory setting 22mA): can be set from 21 to 23 mA
  – Hold measured value: last measured value is held
  – Min. alarm: 3.6 mA

TMT182 temperature head transmitter (optional)

Options:
- Max. alarm ≥ 21.0 mA
- Min. alarm ≤ 3.6 mA

Load

FMX21

$$R_{Lmax} \leq \frac{U - 10.5\ V}{23\ mA} - 2 \cdot 0.9\ \frac{\Omega}{m} \cdot l - R_{add}$$

P01-FMX21xx-16-xx-xx-en-000

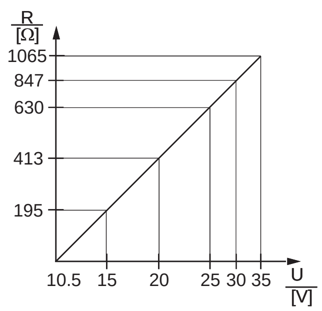
TMT182 temperature head transmitter (optional)

$$R_{tot} \leq \frac{U - 11.5\ V}{0.023\ A} - R_{add}$$

P01-FMX21xx-16-xx-xx-en-001

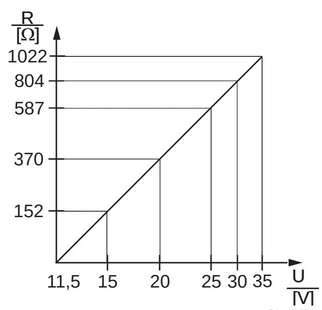
R_{Lmax} = Max. load resistance [Ω]
R_{add} = Additional resistances such as resistance of evaluation unit and/or display unit, cable resistance [Ω]
U = Supply voltage [V]
l = Simple length of extension cable [m] (cable resistance per wire ≤ 0.09 Ω/m)

Note!
When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions or Installation or Control Drawings.



P01-FMX21xxxx-05-xx-xx-xx-000

FMX21 load chart for estimating the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.



P01-FMXxxxx-05-xx-xx-xx-003

Temperature head transmitter load chart for estimating the load resistance. Additional resistances have to be subtracted from the value calculated as shown in the equation.

Hinweis!
When operating using a HART handheld terminal or a PC with an operating program, a minimum communication resistance of 250 Ω has to be taken into account.

Resolution

Current output: 1 µA

Read cycle

HART commands: 2 to 3 per second on average

Damping

- Continuously 0 to 999 s via HART handheld terminal or PC with operating program
- Factory setting: 2 s

Power supply

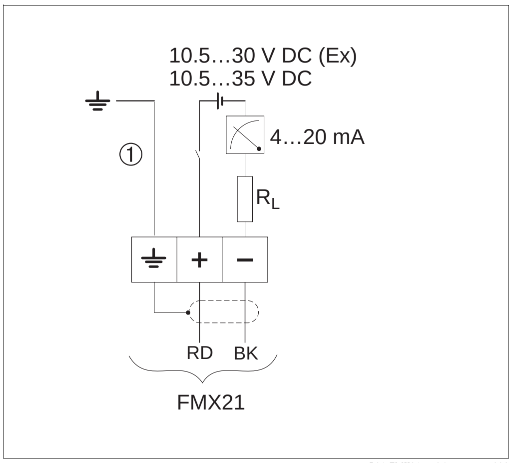
Measuring unit electrical connection

Note!

- When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) and the Installation or Control Drawings (ZDs). → 28 "Additional documentation", "Safety instructions" and "Installation/Control Drawings".
- Reverse polarity protection is integrated in the Waterpilot FMX21 and in the TMT182 temperature head transmitter. Changing the polarities will not damage the devices.
- The cable must end in a dry room or a suitable terminal box. The terminal box (IP66/IP67) with a GORE-TEX® filter from Endress+Hauser is suitable for outdoor installations. The terminal box can be ordered as an accessory using the order code for FMX21 → 24 version "PS" for feature 620.

The electrical connection is made with the corresponding wires of the probe cable and with the optional use of the terminal box (Commubox FXA) or an active barrier (e.g. RN221N).

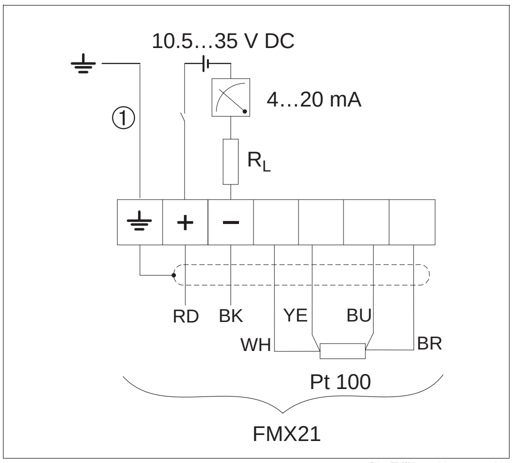
FMX21



P01-FMX21xx-04-xx-xx-xx-008

Electrical connection

FMX21 with Pt100 [1)]



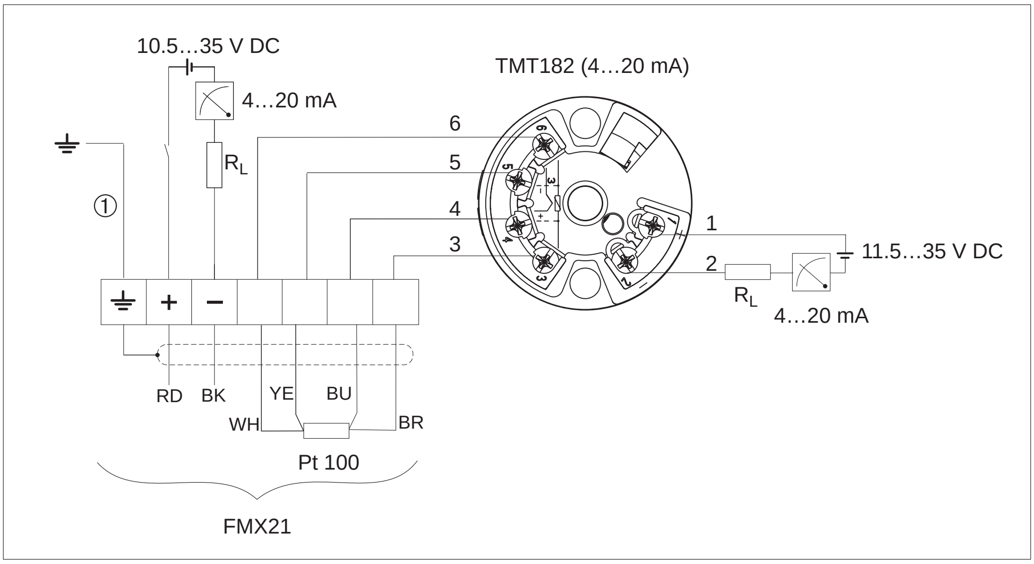
P01-FMX21xx-04-xx-xx-xx-006

Electrical connection
Version" NB" for feature 610 "Accessories" in the order code → 24 ff.

① Not for FMX21 with an outer diameter of 29 mm (1.14 in).

1) Not for use in hazardous areas.

Waterpilot FMX21 with Pt100 and TMT182 temperature head transmitter (4 to 20 mA/HART) 1)



FMX21 with Pt100 and TMT182 temperature head transmitter
versions "NB" and "PT" for the features 610 and 620 in the order code → 24 ff.

① *Not for FMX21 with an outer diameter of 29 mm (1.14 in).*

Wire colors: RD = red, BK = black, WH = white, YE = yellow, BU = blue, BR = brown

1) Not for use in hazardous areas.

Connection classification as per IEC 61010-1:

- Overvoltage category 1
- Pollution degree 1

Connection data in the hazardous area

4 to 20 mA	Ex ia IIC T4 to T6
Ui	30 V DC
Ii	133 mA
Pi	1.0 W
Ci	10.3 nF (sensor)/180 pF/m (cable)
Li	0 µH (sensor)/1 µH/m (cable)
Ta	–10 °C (+14 °F) ≤ Ta ≤ +70 °C (+158 °F) for T4; –10 °C (+14 °F) ≤ Ta ≤ +40 °C (+104 °F) for T6

Supply voltage

Note!
- When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) and the Installation or Control Drawings (ZDs). All explosion-protection data are given in a separate documentation which is available upon request. This documentation is provided with the devices as standard, see also → 28 "Additional documentation".

FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
■ 10.5 to 35 V (non-hazardous area) ■ 10.5 to 30 V (hazardous area)	■ 11.5 to 35 V DC

Cable specifications

FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
■ Commercially available shielded instrument cable ■ Terminal, terminal box: 0.08 to 2.5 mm² (28 to 14 AWG) ■ If the Pt100 signal is directly connected to a display and/or evaluation unit, Endress+Hauser recommends using a shielded cable.	■ Commercially available shielded instrument cable ■ Terminal, terminal box: 0.08 to 2.5 mm² (28 to 14 AWG) ■ Transmitter connection: max. 1.75 mm² (15 AWG)

Power consumption

FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
■ ≤ 0.805 W at 35 V DC (non-hazardous area) ■ ≤ 0.690 W at 30 V DC (hazardous area)	■ ≤ 0.805 W at 35 V DC

Current consumption

FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
■ Max. current consumption: ≤ 23 mA Min. current consumption: ≥ 3.6 mA ■ Pt100: ≤ 0.6 mA	■ Max. current consumption: ≤ 23 mA Min. current consumption: ≥ 3.5 mA ■ Pt100 via temperature head transmitter: ≤ 0.6 mA

Residual ripple

FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
■ No impact on 4 to 20 mA signal to ±5 % residual ripple within the permitted voltage range (according to HART Hardware Specification HCF_SPEC-54 (DIN IEC 60381-1)).	$U_{ss} \geq 3$ V at $U_b \geq 13$ V, $f_{max.} = 1$ kHz

Performance characteristics

	FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
Reference operating conditions	▪ As per IEC 60770 ▪ Ambient temperature T_A = constant, in range: +21 to +33 °C (+70 °F to +91 °F) ▪ Humidity φ = constant, in range: 20 to 80 % RH ▪ Ambient pressure p_A = constant, in range: 860 to 1060 mbar (12.47 to 15.37 psi) ▪ Position of the measuring cell = constant, in range: vertical: ±1° ▪ Supply voltage constant: 21 V DC to 27 V DC ▪ Load with HART: 250 Ω ▪ Pt100: DIN EN 60770 T_A = 25 °C (77 °F)	Calibration temperature 25 °C (77 °F) ±5 K
Reference accuracy	The reference accuracy comprises the non-linearity after limit point configuration, hysteresis and non-repeatability in accordance with IEC 60770. ▪ Setting ±0.2 % – to TD 5:1: < 0.2 % of the set span – from TD 5:1 to TD 10:1 ±(0.02 x TD+0.1) PLATINUM version: ▪ Setting ±0.1 % (optional) – to TD 5:1: < 0.1 % of the set span – from TD 5:1 to TD 10:1 ±(0.02 x TD) ▪ Class B to DIN EN 60751 – Pt100: max. ±1 K	▪ ±0.2 K ▪ With Pt100: max. ±0.9 K
Long-term stability	▪ ≤ 0.1 % of URL/year ▪ ≤ 0.25 % of URL/5 years	≤ 0.1 K per year

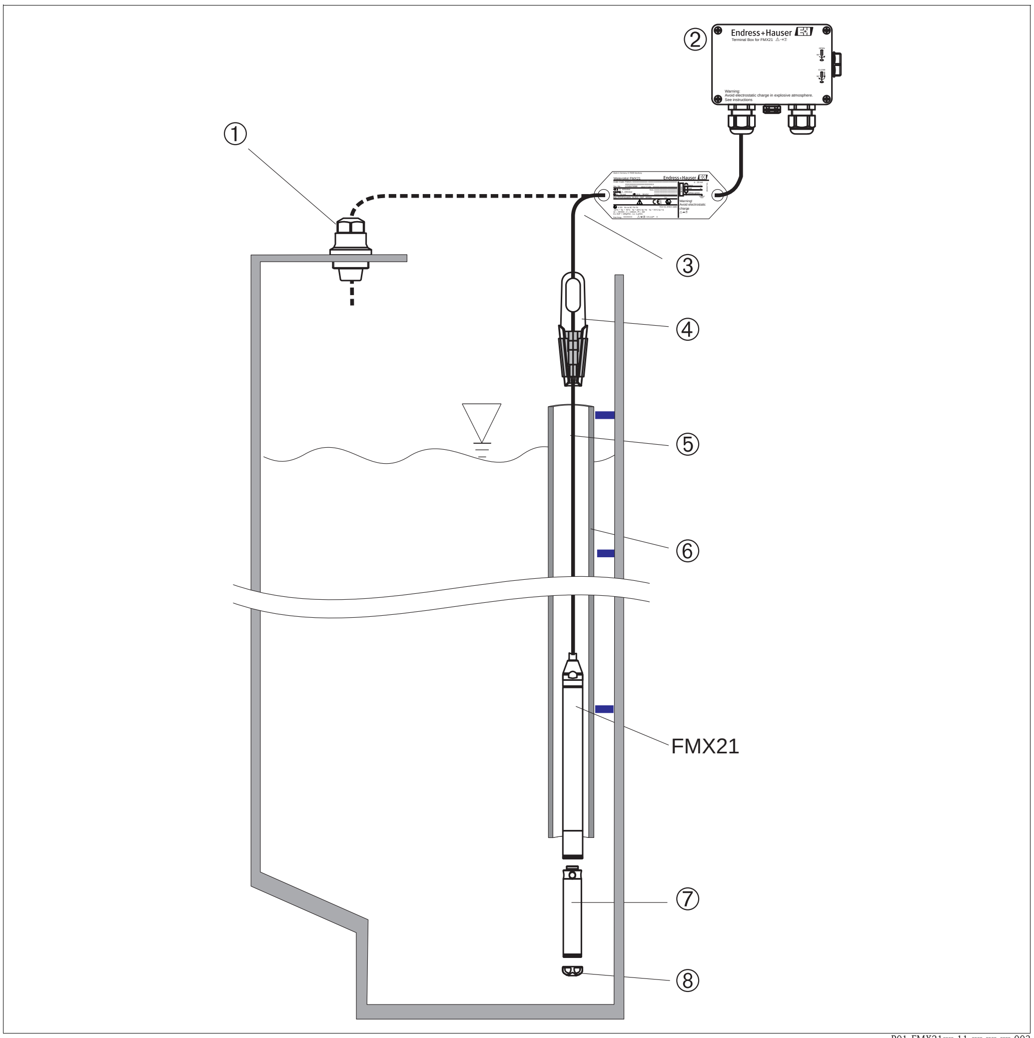
Influence of medium temperature

- Thermal change in the zero output and the output span
  0 to +30 °C (+32 to +86 °F): <(0.15 + 0.15 x TD)%
  –10 to +70 °C (+14 to +158 °F): <(0.4 + 0.4 x TD)%
- Temperature coefficient (T_K) of the zero output and output span
  –10 to +70 °C (+14 to +158 °F): 0.1 % / 10 K URL

	FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
Warm-up period	FMX21: < 6 s Pt100: 20 ms	4 s
Step response time	▪ FMX21: 400 ms (T90 time), 500 ms (T99 time) ▪ Pt100: 160 s (T90 time), 300 s (T99 time)	–

Installation

Installation instructions



P01-FMX21xx-11-xx-xx-xx-003

Installation examples, here illustrated with FMX21 with an outer diameter of 22 mm (0.87 in)

1 *Extension cable mounting screw can be ordered via order code or as an accessory → 🗎 24 ff*
2 *Terminal box can be ordered via order code or as an accessory → 🗎 24 ff*
3 *Extension cable bending radius > 120 mm (4.72 in)*
4 *Mounting clamp can be ordered via order code or as an accessory → 🗎 24 ff*
5 *Extension cable, length → 🗎 21*
6 *Guide pipe*
7 *Additional weight can be ordered as an accessory for FMX21 with an outer diameter of 22 mm (0.87 in) and 29 mm (1.14 in) → 🗎 26*
8 *Protection cap*

Note!

- Sideways movement of the level probe can result in measuring errors. For this reason, 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 FMX21.
- The cable must end in a dry room or a suitable terminal box. The terminal box from Endress+Hauser provides optimum humidity and climatic protection and is suitable for outdoor installation.
- Protection cap: The device is provided with a protection cap to prevent mechanical damage to the measuring cell. This cap should not be removed during the transportation and installation process.
- If the cable is shortened, the filter at the pressure compensation tube has to be reattached. Endress+Hauser offers a cable shortening kit for this purpose → 🗎 24 ff (SD552P/00/A6).
- Endress+Hauser recommends using twisted, shielded cables.

Ambient conditions

	FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
Ambient temperature range	▪ FMX21 with outer diameter of 22 mm (0.87 in) and 42 mm (1.65 in): –10 to +70 °C (+14 to +158 °F) (= medium temperature) ▪ FMX21 with outer diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to +122 °F) (= medium temperature) **Terminal box** ▪ –40 to +80 °C (–40 to +176 °F)	–40 to +85 °C (–40 to +185 °F)
Storage temperature range	▪ –40 to +80 °C (–40 to +176 °F) **Terminal box** ▪ –40 to +80 °C (–40 to +176 °F)	–40 to +100 °C (–40 to +212 °F)
Degree of protection	▪ IP68, permanently hermetically sealed at 40 bar (580 psi)(~400 m H_2O) **Terminal box (optional)** ▪ IP66/IP67	▪ IP00, condensation permitted
Electromagnetic compatibility (EMC)	▪ EMC in accordance with all the relevant requirements of the EN 61326 series. Details are provided in the Declaration of Conformity. ▪ Maximum deviation <0.5 % of the span.	▪ EMC in accordance with all the relevant requirements of the EN 61326 series. Details are provided in the Declaration of Conformity.
Overvoltage protection	Integrated overvoltage protection to EN 61000-4-5 (500 V symmetrical/1000 asymmetrical) Install overvoltage protection ≥1.0 kV, external if necessary	Install overvoltage protection, external if necessary.

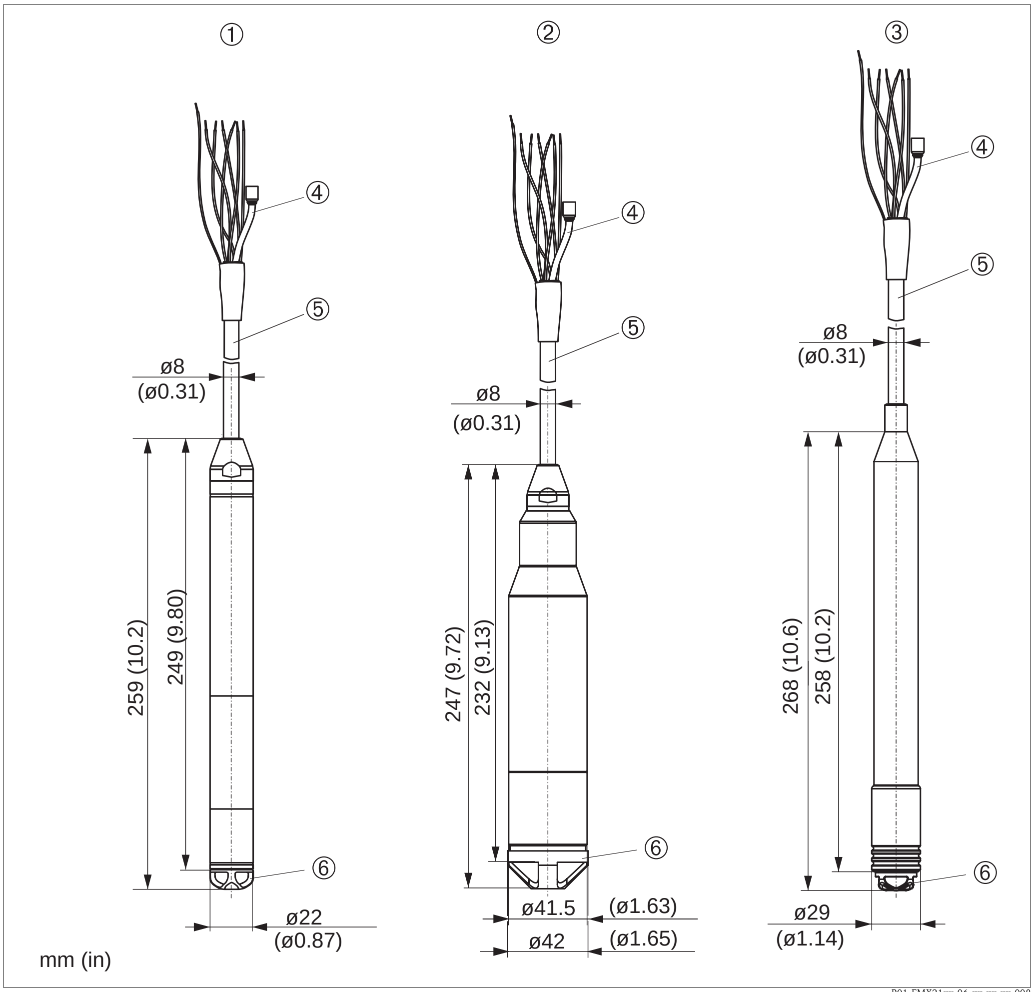
Process conditions

	FMX21 + Pt100 (optional)	TMT182 temperature head transmitter (optional)
Medium temperature range	▪ FMX21 with outer diameter of 22 mm (0.87 in) and 42 mm (1.65 in): –10 to +70 °C (+14 to +158 °F) ▪ FMX21 with outer diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to +122 °F)	–

	FMX21 + Pt100 (optional)	
Medium temperature limits	▪ FMX21 with outer diameter of 22 mm (0.87 in) and 42 mm (1.65 in): –20 to +70 °C (–4 to +158 °F) Note! In hazardous areas incl. CSA GP, the medium temperature limit is at –10 to +70 °C (+14 to +158 °F). ▪ FMX21 with outer diameter of 29 mm (1.14 in): 0 to +50 °C (+32 to +122 °F) (The FMX21 can be operated in this temperature range. The specification can then be exceeded, e.g. measuring accuracy.)	–

Mechanical construction

Dimensions of the level probe

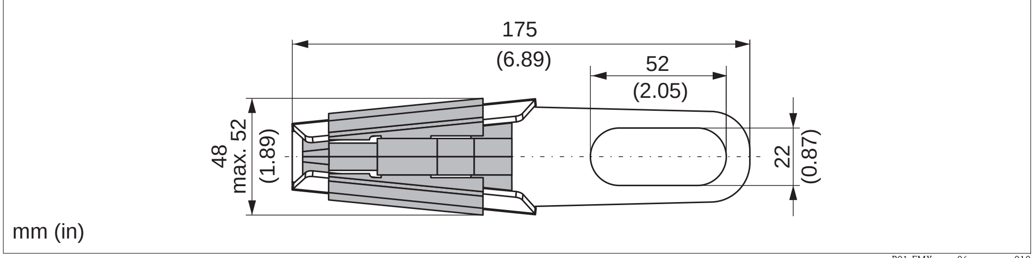


P01-FMX21xx-06-xx-xx-xx-008

Versions of the FMX21

1 *Version "1" for feature 45 "Probe tube" or "Accessories" in the order code → 🗎 24 ff*
2 *Version "2" for feature 45 "Probe tube" in the order code → 🗎 24 ff*
3 *Version "5" for feature 45 "Probe tube" in the order code → 🗎 24 ff*
4 *Pressure compensation tube*
5 *Extension cable*
6 *Protection cap*

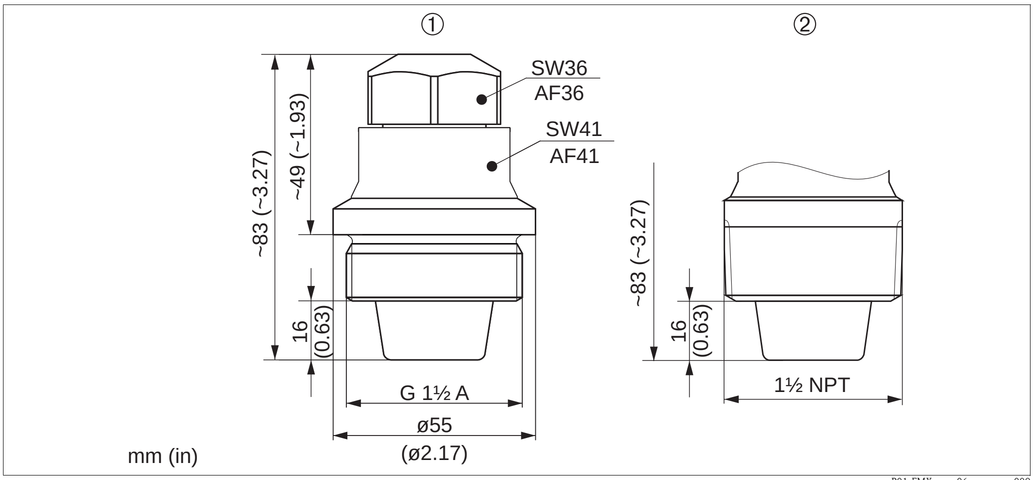
Dimensions of the mounting clamp



P01-FMXxxxx-06-xx-xx-xx-010

Mounting clamp, version "PO" for feature 620 "Accessories" in the order code → 🗎 24 ff

Dimensions of the extension cable mounting screws



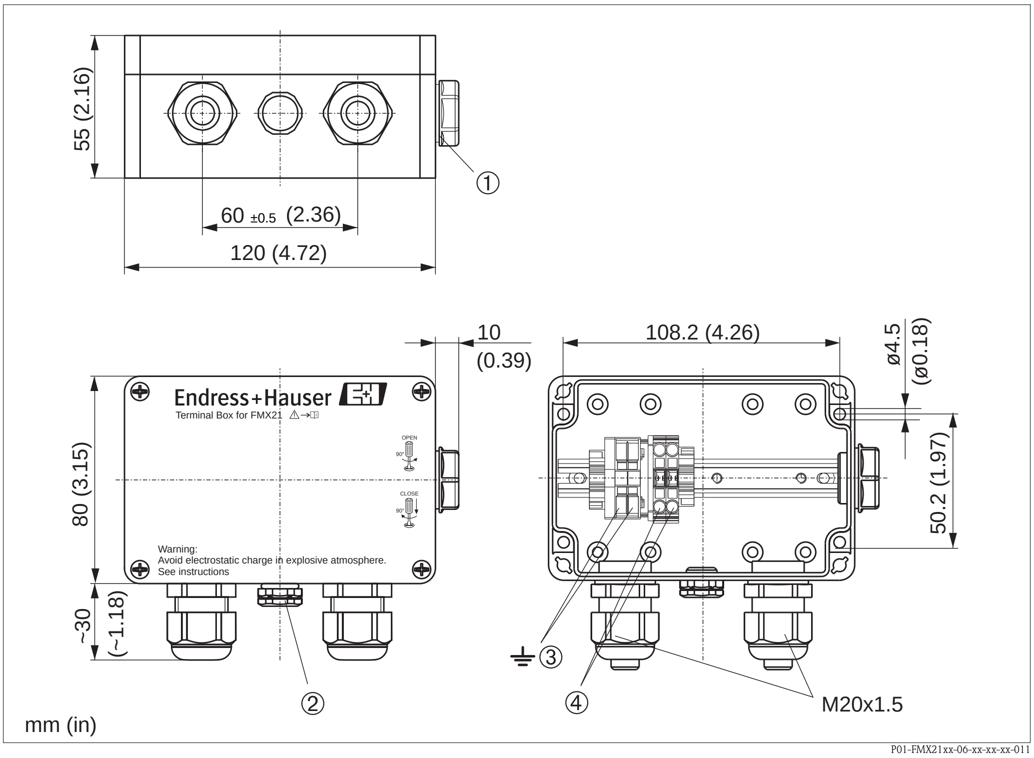
P01-FMXxxxx-06-xx-xx-xx-009

Extension cable mounting screws

1 *Extension cable mounting screw G 1 ½ A, version "PQ" for feature 620 "Accessories" in the order code → 24 ff*
2 *Extension cable mounting screw 1 ½ NPT, version "PR" for feature 620 "Accessories" in the order code → 24 ff*

Note!
Application in unpressurized containers only.

Dimensions of the IP66/IP67 terminal boxes with filters



P01-FMX21xx-06-xx-xx-xx-011

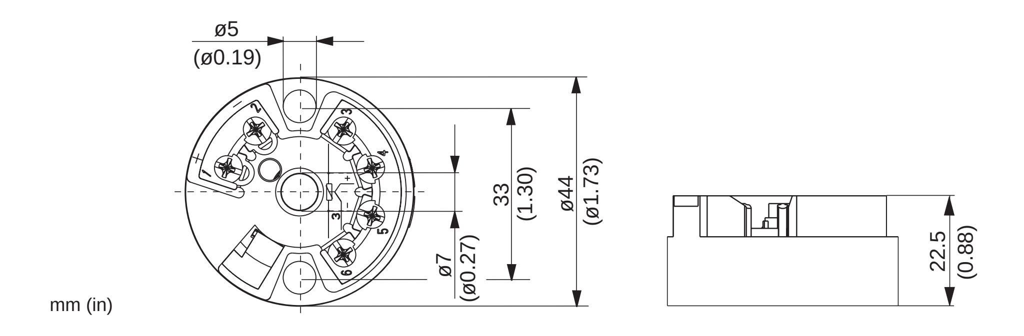
Terminal box / Version "PS" or "PT" for feature 620 "Accessories" in the order code → 24 ff

1 *Dummy plug M20x1.5*
2 *GORE-TEX® filter*
3 *Ground connection / terminals for 0.08 to 2.5 mm² (28 to 14 AWG)*
4 *4 to 20 mA / terminals for 0.08 to 2.5 mm² (28 to 14 AWG)*

If ordered together with FMX21 but without the optional TMT182 temperatur transmitter, the terminal box is incl. a 4-terminal strip.

Note!
The 4-terminal strip is not intended for use in hazardous areas incl. CSA GP.

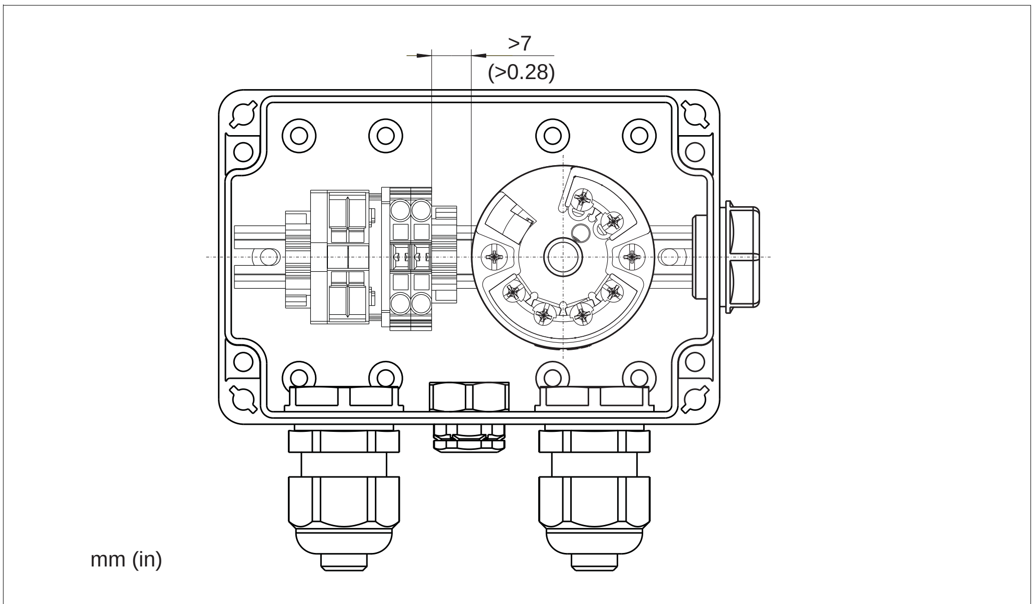
Dimensions of the TMT182 temperature head transmitter



P01-FMX21xxx-06-xx-xx-xx-012

TMT182 temperature head transmitter (4 to 20 mA/HART), version "PT" for feature 620 "Accessories" in the order code → 24 ff.

Terminal box with integrated TMT182 temperature head transmitter (4 to 20 mA/ HART)



P01-FMX21xxx-06-xx-xx-xx-022

Note!
A distance of >7 mm (>0.28 in mm) must be maintained between the terminal strip and the TMT182 temperature head transmitter.

Weight

- Level probe, outer diameter 22 mm (0.87 in): 344 g (12.133 oz)
- Level probe, outer diameter 29 mm (1.14 in): 394 g (13.896 oz)
- Level probe, outer diameter 42 mm (1.65 in): 1376 g (48.532 oz)
- PE extension cable: 52 g/m (0.33 lbs/1 ft)
- FEP extension cable: 108 g/m (0.072 lbs/1 ft)
- PUR extension cable: 60 g/m (0.039 lbs/1 ft)
- Mounting clamp: 170 g (5.996 oz)
- Extension cable mounting screw G1 ½ A: 770 g (27.158 oz)
- Extension cable mounting screw 1½ NPT: 724 g (25.535 oz)
- Terminal box: 235 g (8.288 oz)
- Temperature head transmitter: 40 g (1.411oz)
- Additional weight: 300 g (1.376 oz)
- Adapter weight: 39 g

Material

- Level probe, outer diameter 22 mm (0.87 in): 1.4435 (AISI 316L)
- Level probe, outer diameter 29 mm (1.14 in): 1.4435 (AISI 316L)
  – Sensor sleeve: PPS (polyphenylene sulfide); heat-shrink tube/cover: polyolefin. The materials used ensure that metal does not come in contact with the medium.
- Level probe, outer diameter 42 mm (1.65 in): 1.4435 (AISI 316L)
- Process ceramic: Al_2O_3 aluminum oxide ceramic
- Seal (internal): EPDM or Viton
- Protection cap: – PPO (polyphenylene oxide) for FMX21 with outer diameter 22 mm and 29 mm.
  – PFA (perfluoroalkoxy) for FMX21 with outer diameter 42 mm.
- Extension cable insulation: either PE-LD (low-density polyethylene), FEP (fluorinated ethylene propylene) or PUR (polyurethane), for further information, see → 🗎 21 "Extension cable".
- Mounting clamp: 1.4404 (AISI 316L) and fiberglass reinforced PA (polyamide)
- Extension cable mounting screw G1½ A: 1.4301 (AISI 304)
- Extension cable mounting screw 1½ NPT: 1.4301 (AISI 304)
- Terminal box: PC (polycarbonate)
- Temperature head transmitter: PC housing (polycarbonate)

Extension cable

PE extension cable
- Abrasion-resistant extension cable with Dynema strain-relief members; shielded with aluminum-coated film; insulated with polyethylene (PE), black; copper wires, twisted
- Pressure compensation tube with Teflon filter

PUR extension cable
- Abrasion-resistant extension cable with Dynema strain-relief members; shielded with aluminum-coated film; insulated with polyurethane (PUR), black; copper wires, twisted
- Pressure compensation tube with Teflon filter

FEP extension cable
- Abrasion-resistant extension cable; shielded with galvanized steel wire netting; insulated with fluorinated ethylene propylene (FEP), black; copper wires, twisted
- Pressure compensation tube with Teflon filter

Cross-section of PE/PUR/FEP extension cable
- Total outer diameter: 8.0 mm (0.31 in) ±0.25 mm (±0.01 in)
- FMX21: 3 x 0.227 mm^2 (3 x 26 AWG) + pressure compensation tube with Teflon filter
- FMX21 with Pt100 (optional): 7x 0.227 mm^2 (7x 26 AWG) + pressure compensation tube with Teflon filter
- Pressure compensation tube with Teflon filter: outer diameter 2.5 mm (0.1 in), internal diameter 1.5 mm (0.06 in)

Cable resistance of PE/PUR/FEP extension cable
- Cable resistance per wire: ≤ 0.09 Ω/m

Cable length of PE/PUR/FEP extension cable
- Please refer also to → 🗎 10, Chap. "Load".
- Cable length that can be ordered
  – Customer-specific length in meters or feet (→ 🗎 24, "Ordering information")
  – Limited cable length when performing installation with freely suspended device with extension cable mounting screw or mounting clamp, as well as for hazardous areas: max. 300 m (984 ft).
- When using the measuring device in hazardous areas, installation must comply with the applicable national standards and regulations and the Safety Instructions (XAs) or the Installation or Control Drawings (ZDs) "Additional documentation".

Further technical data for PE/PUR/FEP extension cable
- Minimum bending radius: 120 mm (4.72 in)
- Tensile strength: max. 950 N (213.56 lbf)
- Cable extraction force: typical ≥400 N (89.92 lbf) PE, FEP / typical ≥150 N (33.72 lbf) PUR (The extension cable could be extracted from the level probe with a appropriate tensile force.)
- Resistance to UV light
- PE: Approved for use with drinking water

Terminals

- Three terminals as standard in the terminal box
- 4-terminal strip can be ordered as an accessory, Order No: 52008938
  Conductor cross-section 0.08 to 2.5 mm^2 (28 to 14 AWG)

Note!
The 4-terminal strip is not intended for use in hazardous areas incl. CSA GP.

Human interface

Field Xpert SFX100

Field Xpert is an industrial PDA with integrated 3.5" touchscreen from Endress+Hauser based on Windows Mobile. It communicates via wireless with the optional VIATOR® Bluetooth® modem connected to a HART device point-to-point or wireless via WiFi and Endress+Hauser's Fieldgate FXA520. Field Xpert also works as a stand-alone device for asset management applications. For details refer to BA060S/00/EN.

Field Communicator 375, 475

The Field Communicator 375, 475 handheld terminal can be used to set all the parameter via menu operation.

FieldCare

FieldCare is Endress+Hauser's plant asset management tool based on FDT technology. You can use FieldCare to configure all Endress+Hauser devices as well as third-party devices which support the FDT standard.

FieldCare supports the following functions:
- Configuration of transmitters in offline and online mode
- Loading and saving device data (upload/download)
- Documentation of the measuring point

Connection options:
- Via Commubox FXA195 and the USB port of a computer
- Via Fieldgate FXA520

For further information and free download of FieldCare see → www.endress.com → Download → Search: FieldCare

Certificates and approvals

CE mark

The device meets the legal requirements of the applicable EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

Approvals, types of protection

- ATEX II 2 G Ex ia IIC T4/T6 [1) 2)]
- ATEX II 3 G Ex nA IIC T5/T6 [1) 3)]
- FM: IS Cl. I, Div. 1 Gp. A-D; AEx ia Cl. I Zone 1 IIC [1)]
- CSA C/US: IS Cl. I, Div. 1 Gp. A-D; Ex ia Cl. I Zone 1 IIC [1)]
- CSA: General Purpose
- IEC Ex ia IIC T6 Gb [1)]
- NEPSI Ex ia IIC T6

1) Only for Waterpilot FMX21 without Pt100 and TMT182
2) T4/T6:
Temperature class T4 at –10 °C (+14 °F) < Ta < +70 °C (+158 °F)
Temperature class T6 at –10 °C (+14 °F) < Ta < +40 °C (+104 °F)
3) T5/T6:
Temperature class T5 at –10 °C (+14 °F) < Ta < +70 °C (+158 °F)
Temperature class T6 at –10 °C (+14 °F) < Ta < +60 °C (+140 °F)

✎ Note!
- Waterpilot FMX21 is only available for use in hazardous areas with the FKM Viton seal.
- All explosion-protection data are given in a separate documentation which is available upon request. The Ex documentation is provided with all Ex-systems as standards, see also → 28 "Additional documentation", "Safety instructions" and "Installation/Control Drawings".

Drinking water approval (for FMX21 with outer diameter 22 mm (0.87 in))

- KTW certificate
- NSF 61 approval
- ACS approval (in preparation)

Standards and guidelines applied

The European standards and guidelines that have been applied are listed in the associated EC Declarations of Conformity. In addition, the following standards were also applied for the Waterpilot FMX21:

- DIN EN 60770 (IEC 60770):
  Transmitters for use in industrial process control systems
  Part 1: Methods for performance evaluation
- DIN 16086:
  Electrical pressure measuring instruments,
  pressure sensors, pressure transmitters,
  pressure measuring instruments, concepts, specifications on data sheets
- EN 61326:
  Electrical equipment for measurement, control and laboratory use – EMC requirements
- EN 61010-1 (IEC 61010-1):
  Safety requirements for electrical equipment for measurement, control and laboratory use
- EN 60529:
  Degrees of protection provided by enclosures

Ordering information

FMX21

You can enter the versions for the specific feature in the following table. The versions entered make up the complete order code. Options which are mutually exclusive are not marked.

10	**Approval:**	
	AA	Non-hazardous area
	BE	ATEX II 2 G Ex ia IIC T6
	BD	ATEX II 3 G Ex nA IIC T6
	FE	FM IS, Cl. I Division 1, Groups A – D, AEx ia, zone 1
	CE	CSA C/US IS Cl. I Division 1, Groups A – D, Ex ia, zone 1
	CD	CSA General Purpose
	IC	IEC Ex ia IIC T6 Gb
	NA	NEPSI Ex ia IIC T6

20	**Output:**	
	2	4-20 mA HART

45	**Probe tube:**	
	1	Outer diameter d = 22 mm, AISI 316L
	2	Outer diameter d = 42 mm, flush-mounted, AISI 316L
	5	Outer diameter d = 29 mm, AISI 316L, PPS/polyolefin for saltwater applications

70	**Sensor range:**	
	Measuring range	
	1C	100 mbar/10 kPa/1.5 psi gauge, $1mH_2O/3ftH_2O/40inH_2O$
	1D	200 mbar/20 kPa/3 psi gauge, $2mH_2O/6ftH_2O/80inH_2O$
	1F	400 mbar/40 kPa/6 psi gauge, $4mH_2O/13ftH_2O/160inH_2O$
	1G	600 mbar/60 kPa/9 psi gauge, $6mH_2O/20ftH_2O/240inH_2O$
	1H	1 bar/100 kPa/15 psi gauge, $10mH_2O/33ftH_2O/400inH_2O$
	1K	2 bar/200 kPa/30 psi gauge, $20mH_2O/67ftH_2O/800inH_2O$
	1M	4 bar/400 kPa/60 psi gauge, $40mH_2O/133ftH_2O/1600inH_2O$
	1P	10 bar/1 MPa/150 psi gauge, $100mH_2O/333ftH_2O/4000inH_2O$
	1Q	20 bar/2 MPa/300 psi gauge, $200mH_2O/667ftH_2O/8000inH_2O$
	2K	2 bar/200 kPa/30 psi absolute, $20mH_2O/67ftH_2O/800inH_2O$
	2M	4 bar/400 kPa/60 psi absolute, $40mH_2O/133ftH_2O/1600inH_2O$
	2P	10 bar/1 MPa/150 psi absolute, $100mH_2O/333ftH_2O/4000inH_2O$
	2Q	20 bar/2 MPa/300 psi absolute, $200mH_2O/667ftH_2O/8000inH_2O$

80	**Reference accuracy:**	
	D	Platinum
	G	Standard

90	**Calibration, unit:**	
	A	Sensor range; %
	B	Sensor range; mbar/bar
	C	Sensor range; kPa/MPa
	D	Sensor range; mm/mH_2O
	E	Sensor range; inH_2O/ftH_2O
	F	Sensor range; psi
	J	Customized pressure; see additional specification
	K	Customized level; see additional specification

FMX21-										Order code

→ Ordering information for FMX21 continued on next page.

FMX21 (continued)

100	Probe connection:	
	10	10 m cable, shortable, PE
	11	20 m cable, shortable, PE
	15	..... m cable, shortable, PE
	20	30 ft cable, shortable, PE
	21	60 ft cable, shortable, PE
	25	..... ft cable, shortable, PE
	30	10 m cable, shortable, FEP
	31	20 m cable, shortable, FEP
	35	..... m cable, shortable, FEP
	40	30 ft cable, shortable, FEP
	41	60 ft cable, shortable, FEP
	45	..... ft cable, shortable, FEP
	50	10 m cable, shortable, PUR
	51	20 m cable, shortable, PUR
	55	..... m cable, shortable, PUR
	60	30 ft cable, shortable, PUR
	61	60 ft cable, shortable, PUR
	65	..... ft cable, shortable, PUR
190	**Seal:**	
	A	FKM Viton
	H	EPDM
FMX21-		Order code

Additional ordering information (optional)

550	Calibration	
	F1	Works calib. certificate 5-point
570	**Service**	
	IA	Adjusted min alarm current
	IB	Adjusted HART Burst Mode PV
	IR	... m cable marking>installation
	IS	... ft cable marking>installation
	I9	Special version
590	**Additional approval**	
	LQ	KTW potable water approval
	LR	NSF potable water approval
	LS	ACS potable water approval (in preparation)
610	**Accessories mounted**	
	NB	Temperature sensor Pt100, 4-wire
620	**Accessories enclosed**	
	PO	Suspension clamp, 316L
	PQ	Cable mounting screw G1-1/2, 304
	PR	Cable mounting screw NPT1-1/2, 304
	PS	Terminal box IP66/67
	PT	Temperature head transmitter TMT182, 2-wire, 4-20 mA, –20 to 80 °C
	PU	Additional weight, 316L
	PV	Adapter, function test
	PW	Shortening kit, extension cable
895	**Marking**	
	Z1	Tagging (TAG)
FMX21-		Order code

Accessories

Mounting clamp

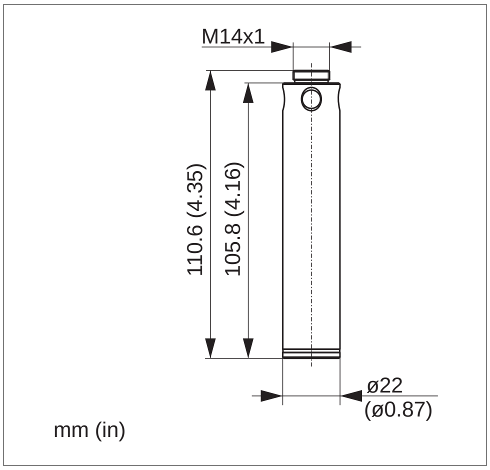
- Endress+Hauser offers a mounting clamp for easy FMX21 mounting → 18.
- Material: 1.4404 (AISI 316L) and fiberglass reinforced PA (polyamide)
- Order number 52006151, see also "Ordering information" → 24,

Terminal box

- IP66/IP67 terminal boxes with GORE-TEX® filter incl. 3 integrated terminals.
  The terminal box is also suitable for installing a TMT182 temperature head transmitter or for four additional terminals (Order No. 52008938) → 19.
- "Ordering information" → 24

Note!
The terminal box is not intended for the FMX21 with Ex nA explosion protection in the hazardous area.

Additional weight (for FMX21 with outer diameter of 22 mm (0.87 in) or 29 mm (1.14 in))



P01-FMXxxxxx-06-xx-xx-xx-014

- Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube.
  You can screw several weights together. The weights are then attached directly to the FMX21. For FMX21 with an outer diameter of 29 mm (1.14 in) a maximum of 5 weights may be attached. In combination with the Ex nA approval, for FMX21 with an outer diameter of 29 mm (1.14 in) a maximum of 1 additional weight may be attached.
- Material: 1.4435 (AISI 316L)
- Weight: 300 g (10.581 oz)
- Order number 52006153, see also "Ordering information" → 24

TMT182 temperature head transmitter (4 to 20 mA/ HART)

- 2-wire temperature head transmitter, configured for a measuring range from –20 to +80 °C (-4 to +158 °F). This setting offers a temperature range of 100 K which can be easily mapped. Please note that the Pt100 resistance thermometer is designed for a temperature range from –10 to +70 °C (–14 to +176 °F) → 20.
- "Ordering information"→ 24,

Note!
The TM182 temperature head transmitter is not intended for use in hazardous areas incl. CSA GP.

Extension cable mounting screw

- Endress+Hauser offers extension cable mounting screws to ease FMX21 mounting and to seal the measuring aperture → 19.
- Material: 1.4301 (AISI 304)
- order number 52008264 (G1½ A thread), order number 52009311 (NPT1½ thread), see also "Ordering information" → 24

Terminals

- Four terminals in strip for terminal box, suitable for wire cross-section: 0.08 to 2.5 mm^2 (28 to 14 AWG)
- Order number: 52008938

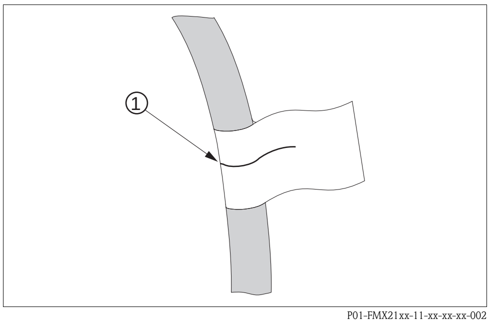
Note!
The 4-terminal strip is not intended for use in hazardous areas incl. CSA GP.

Cable shortening kit

- The cable shortening kit is used to easily and professionally shorten a cable.
- → 24, "Ordering information" and the documentation SD552P/00/A6.

Note!
The cable shortening kit is not intended for the FMX21 with FM/CSA approval.

Installation tool – indicating the customer-specific length on the cable

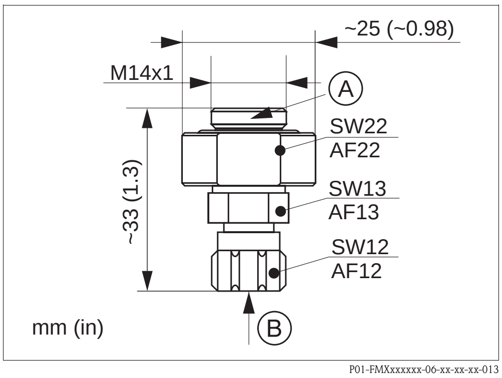


1 cable marking, distance to the lower end of the cable probe

- To make installation easier, Endress+Hauser offers a mark on the extension cable for a customer-specific length, see also → 24 "Ordering information".
- Mark tolerance: up to ±50 mm (1.97 in) (The mark tolerance corresponds to a measured error from up to ±50 mm (1.97 in).
- Material: PET
- Adhesive: acrylic
- Immunity to temperature change: –30 to +100 °C (–22 to +212 °F)

Note!
The mark is for installation purposes only.
The mark must be thoroughly removed without trace in the case of devices with drinking water approval. The extension cable must not be damaged in the process.

Testing adapter (for FMX21 with outer diameter of 22 mm (0.87 in) and 29 mm (1.14 in))



Testing adapter

A FMX21 level probe connection
B Compressed air hose connection, internal diameter of quick coupling piece 4 mm (0.16 in)

- Endress+Hauser offers a testing adapter to ease function-testing of the level probes.
- Observe the maximum pressure for the compressed air hose and the maximum overload for the level probe → 24.
- Maximum pressure of the quick coupling piece supplied: 10 bar (145 psi)
- Adapter material: 1.4301 (AISI 304)
- Quick coupling piece material: anodized aluminum
- Adapter weight: 39 g (1.376 oz)
- Order number 52011868, see also → 24 "Ordering information".

Additional documentation

Field of activities	▪ Pressure measurement: FA004P/00/EN ▪ Recording technology: FA014R/09/EN ▪ System components: FA016K/09/EN
Technical Information	▪ Technical Information Waterpilot FMX167 with 4 to 20 mA analog output: TI351P/00/EN ▪ Technical Information Deltapilot M: TI437P/00/EN ▪ Temperature head transmitter iTEMP HART TMT182: TI078R/09/EN
Operating Instructions	▪ Waterpilot FMX21: BA380P/00/EN ▪ Cable shortening kit: SD552P/00/A6 ▪ Field Xpert: BA060S/04/EN
Safety instructions	▪ ATEX II 2 G: XA454P/00/A3 ▪ ATEX II 3 G: XA485P/00/A3 ▪ IECEx Ex ia IIC: XA455P/00/EN ▪ NEPSI Ex ia IIC: XA456P/00/B2
Installation/ Control Drawings	▪ FM IS Cl. I, Div. 1, Gp. A – D / Cl. I Zone 1 IIC: ZD231P/00/EN ▪ CSA C/US IS Cl. I, Div. 1, Gp. A – D / Cl. I Zone 1, IIC: ZD232P/00/EN
Drinking water approval	▪ SD289P/00/A3 (NSF) ▪ SD319P/00/A3 (KTW) ▪ SD320P/00/A3 (ACS) (in preparation)

Configuration data sheet

Level

The following configuration data sheet has to be filled in and included with the order if the option "K: customized level" has been selected in feature "090: Calibration; unit" in the product structure.

Pressure engineering unit

☐ mbar	☐ mmH2O
☐ bar	☐ mH2O
	☐ ftH2O
☐ psi	☐ inH2O
☐ mmHg	☐ Pa
	☐ kPa
☐ kgf/cm2	☐ MPa

Output unit (Scaled unit)

☐ %	☐ m	☐ l	☐ gal	
	☐ dm	☐ hl	☐ Igal	
	☐ cm			
	☐ mm	☐ m3	☐ ft3	
			☐ in3	☐ kg
	☐ inch			☐ t
	☐ ft			☐ lb

Empty calibration (a)
(Empty) low pressure value ________________ (pres. eng. unit)

(Empty) low level value ________________ (scaled unit)

Full calibration (b)
(Full) high pressure value ________________ (pres. eng. unit)

(Full) high level value ________________ (scaled unit)

Damping

Damping: _____ sec

Pressure

The following configuration data sheet has to be filled in and included with the order if the option "J: customized pressure" has been selected in feature "090: Calibration; unit" in the product structure.

Pressure Engineerung Unit (a)

☐ mbar	☐ mmH2O	☐ mmHg	☐ Pa
☐ bar	☐ mH2O		☐ kPa
	☐ ftH2O		☐ MPa
☐ psi	☐ inH2O	☐ kgf/cm2	

Calibration Range / Output

LRV: ________________________ [pressure engineering unit)
URV: ________________________ [pressure engineering unit)

Damping

Damping _____ sec

Instruments International

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Endress+Hauser
People for Process Automation

TI431P/00/EN/08.10
71118704
CCS/FM+SGML 6.0

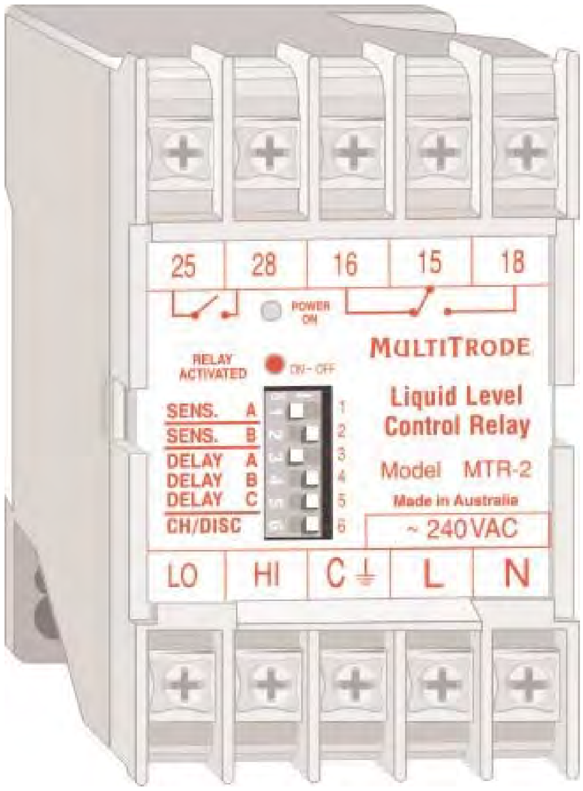
71118704

12. Multitrode Level Relay

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

MULTITRODE LEVEL RELAY

1. MTR LEVEL RELAY TECHNICAL DETAILS
2. MTR WIRING DETAILS
3. MTRA LEVEL RELAY TECHNICAL DETAILS
4. MTRA WIRING DETAILS
5. MTR/MTRA INSTALLATION & TROUBLESHOOTING DETAILS



After many years of field use, the simplicity and reliability of these units is unquestionable.

Controls either one pump, alarm or solenoid.

The MultiTrode MTR is a latching conductive liquid level relay. When connected to a MultiTrode probe, the MTR controls the activation and de-activation of pumps, alarms and other monitoring and control equipment.

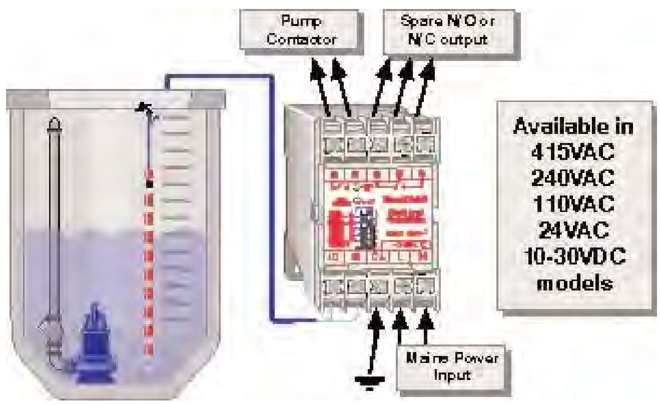
The relay senses the liquid via a safe extra-low voltage signal and latches. This state is maintained until the circuit is broken when the liquid passes the selected stop sensor. The relay then resets for the next operation. A single sensor may be used for alarms.

The MTR relay offers many features found in several discrete devices such as latching and time delay relays. Normally all of these devices must be installed individually. MultiTrode's MTR includes all of these features in one compact case, simplifying installation and reducing labour costs.

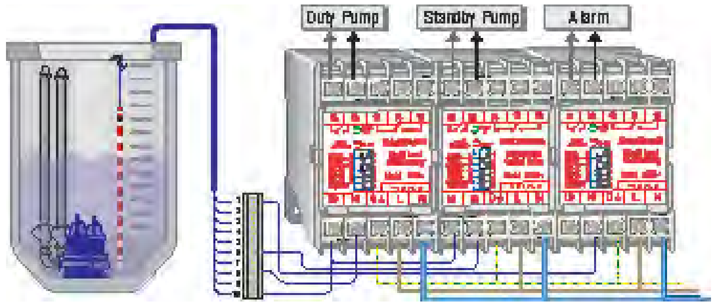
Use the MTR in any applications where level control is required, such as sumps, wells, bores, collection tanks, effluent pits, drainage ponds, pump stations, reservoirs, and sullage pits.

- Safe, extra-low, sensing voltage: Ensures safety for operators and maintenance personnel .
- Charge or discharge: The modes of operation are selectable to either fill or empty a tank.
- Dip Switch Programmable: All settings are easily selected from the front panel. Fixed settings ensure repetition and accuracy.
- 4 Sensitivities: Enable the relay to operate effectively in a wide range of conductive liquids.
- 8 Activation Delays. Used for staggering multiple pump starts or to overcome premature activation due to wave action or turbulence.
- LED Indication. Power On (green) and Relay Activation (red) via high intensity LED indicators.
- Battery Operation. As well as 24, 110, 240 and 415VAC, the MTR Relay is also available in 10-30 VDC.
- Proven Reliability. The proven design of the relay ensures long-term reliability of the MultiTrode system.
- I.S. application Perfect for I.S. application when used with MTISB.
- DIN rail or screw mounting
- Low installed cost

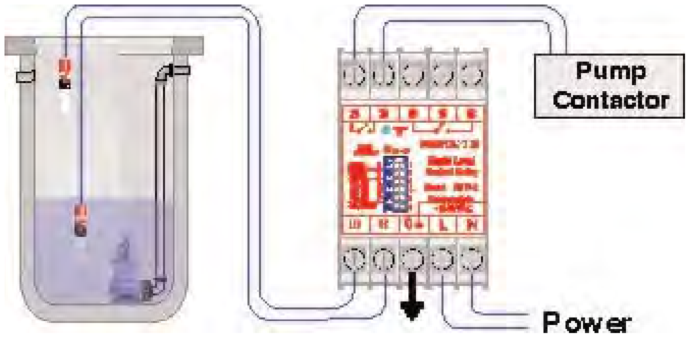
Sample MTR Application



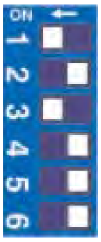
Sample MTR Application



Sample Application



Dip Switch Settings

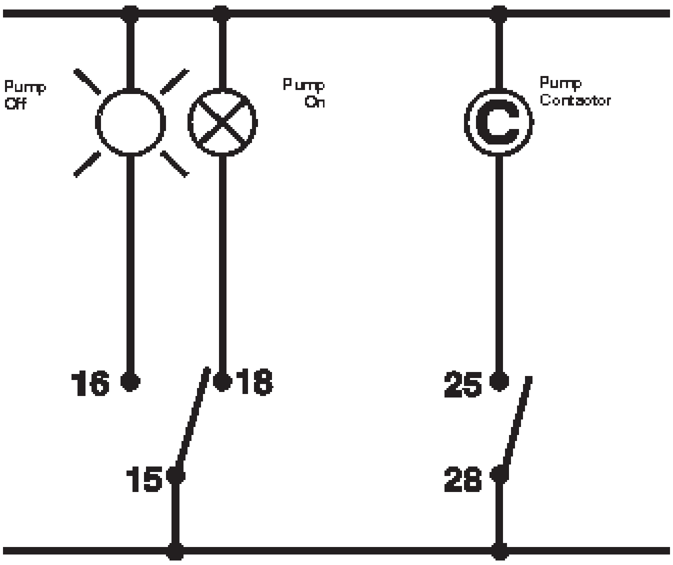


Sw 1&. 2 Sensitivity settings: 1k, 4k, 20k, 80k

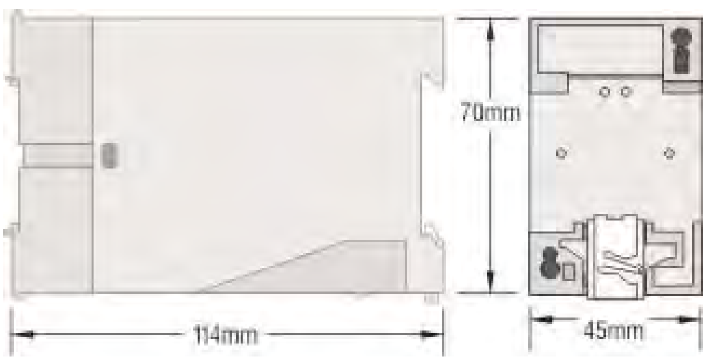
Sw 3, 4 & 5 Activation delays: 0, 2.5, 5, 10, 20, 40, 80, 160 sec

Sw 6 Mode settings: Charge & Discharge

Wiring Diagram



Physical Dimensions



Product Specifications

Mode of operation:

MTR	Charge/Discharge (Fill or Empty)

Probe Inputs:

Sensor inputs	MTR : 2 / MTRA : 3
Sensor voltage	10/12VAC Nominal
Sensor current	0.8mA max. (per sensor)
Sensitivity	1k, 4k, 20k, 80k

Relay Outputs:

MTR relay output	2 contact sets : 1 N/O & 1 C/O
MTR Output delay	0, 2.5, 5, 10, 20, 40, 80, 160 sec
Relay contact rating	250 VAC 5A Resistive, 2A Inductive
Relay contact life	10^5 Operations
Terminal size	2 x 2.5mm², #13

Display LEDs:

	Power On	Pump	Alarm
MTR	Green	Red	

Physical Product:

Dimensions (mm)	72H x 45W x 114D
Mounting	DIN Rail or 2 x M4 Screws #6
Enclosure	Makrolon (self extinguishing)

Power Supply:

Supply Voltage AC	24, 110, 240, 415VAC* - 50/60Hz
Power Consumption	3.5 Watts max *(MTR only)
Supply Voltage DC	12 or 24VDC,
Power Consumption	3 watts max

Environmental Range:

Centigrade	- 10° to +60°C
Fahrenheit	+14° to +140°F

N1653 US UL C LISTED 2P27

AVAILABLE MODELS

415VAC	MTR1	n/a
240VAC	MTR2	MTRA2
110VAC	MTR3	MTRA3
24VAC	MTR4	MTRA4
24VDC	MTR5	MTRA5
12VDC	MTR6	MTRA6

Ordering Information & Example

Model	Voltage
MTRA	2

This order code is for a 240VAC MTRA.

All MultiTrode Products carry a two year warranty

MultiTrode Pty Ltd Head Office
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6560 East Rogers Circle,
Boca Raton Fl 33487
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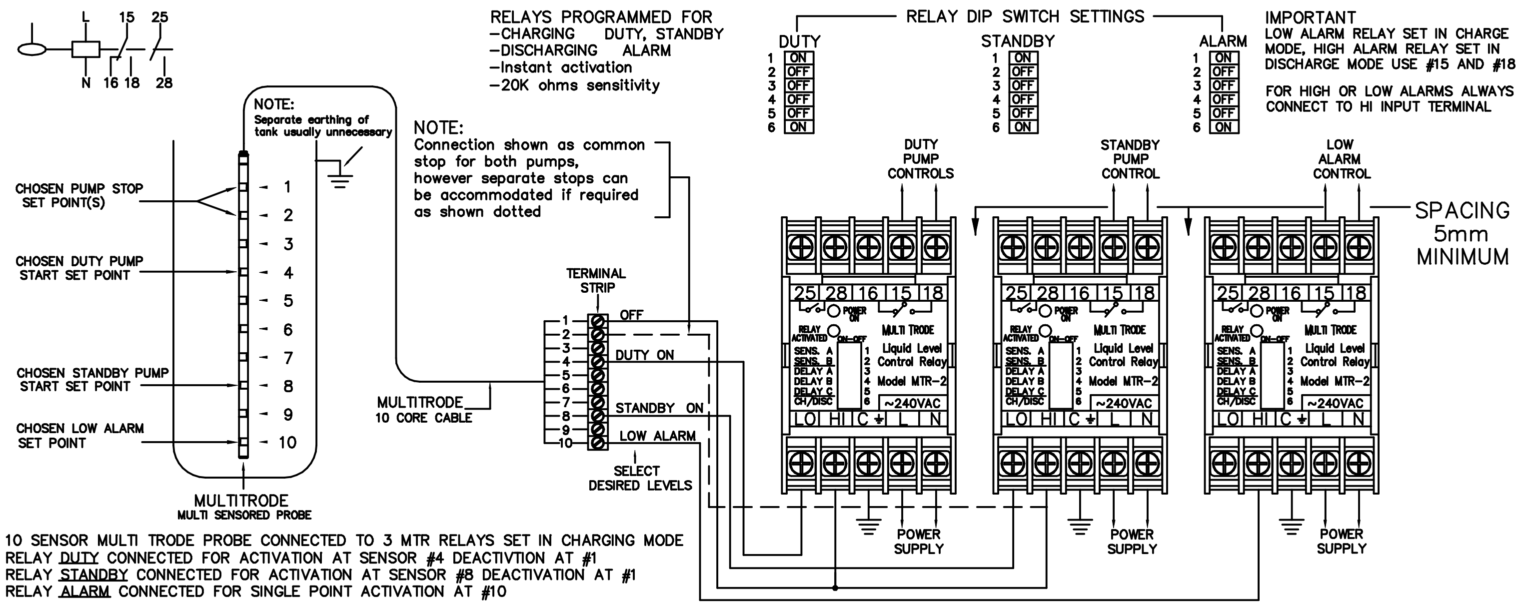
E-mail: sales@multitrode.net

MULTITRODE RELAY 240VAC (MTR 2) INSTALLATION SHEET. N01

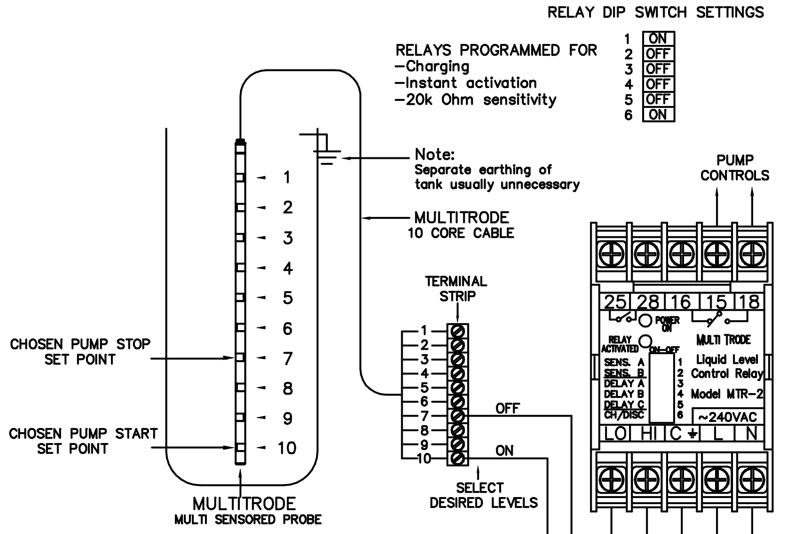
CONTROL OF THREE APPLIANCES IN A CHARGING SITUATION



FIGURE–4

WARNING: Always separate probe cables from power wiring

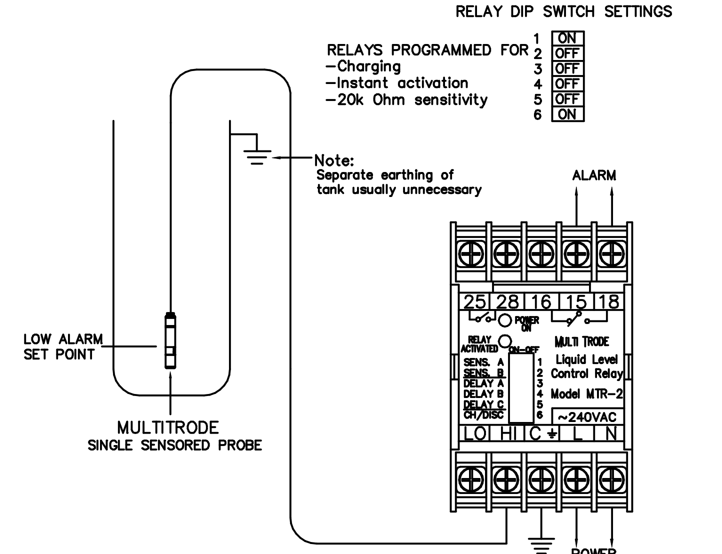
ON–OFF CONTROL IN A CHARGING SITUATION



10 SENSOR MULTI TRODE PROBE CONNECTED TO SINGLE MTR RELAY SET IN DISCHARGING MODE
RELAY CONNECTED FOR ACTIVATION AT SENSOR #10
DEACTIVATED AT SENSOR #7

FIGURE–5

SINGLE POINT OPERATION IN A CHARGING SITUATION



1 SINGLE SENSOR PROBE CONNECTED TO SINGLE MTR RELAY IN CHARGING MODE
ACTIVATION AND DEACTIVATION AT SAME POINT

FIGURE–6

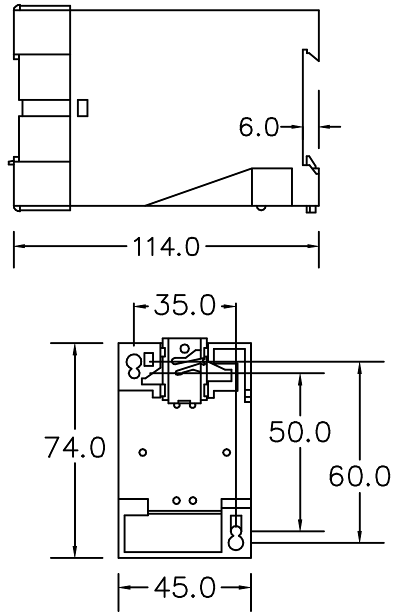
RELAY PROGRAM FUNCTIONS

SWITCH Nº SETTING 1	2	SENSITIVITY	
OFF	OFF	1k Ω	Concentrated Acids, Minerals, Alkalines
OFF	ON	4k Ω	Acids, Alkalines, Diluted brine, Sea water
ON	OFF	20k Ω	Sullage, Sewage effluent Town water
ON	ON	80k Ω	Low conductive liquids, Purified water

3	4	5	DELAY ON ACTIVATION
OFF	OFF	OFF	Zero Seconds
OFF	OFF	ON	2.5 Seconds
OFF	ON	OFF	5 Seconds
OFF	ON	ON	10 Seconds
ON	OFF	OFF	20 Seconds
ON	OFF	ON	40 Seconds
ON	ON	OFF	80 Seconds
ON	ON	ON	160 Seconds

6	MODE
OFF	Discharge
ON	Charge

MTR DIMENSIONS IN mm.



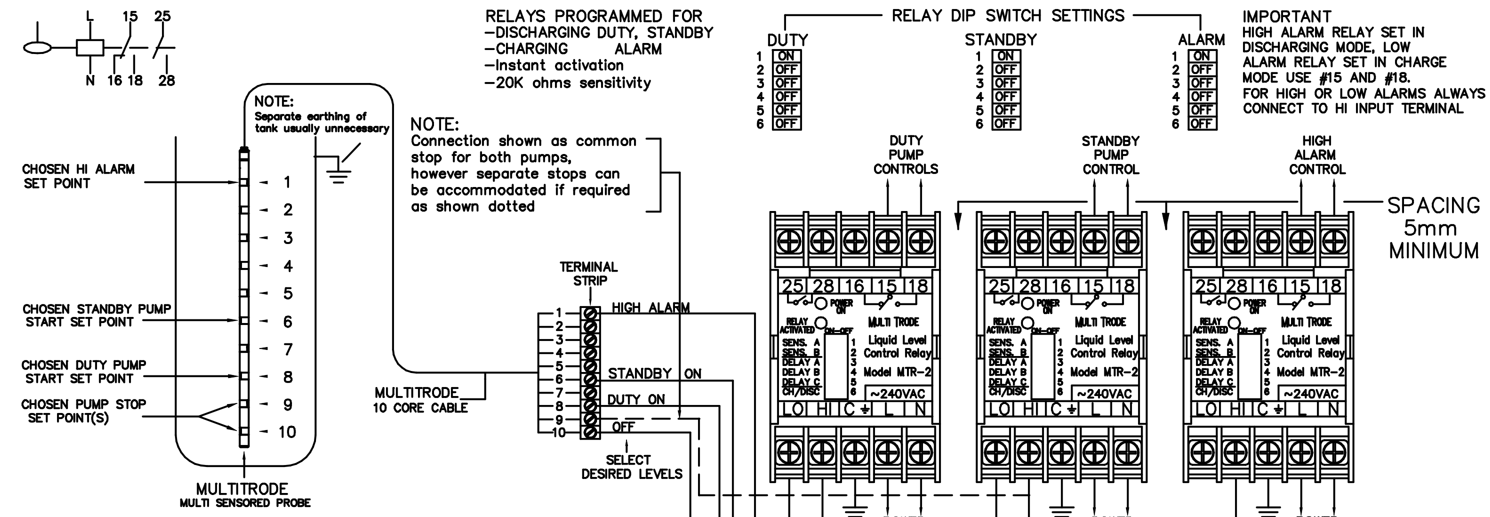
PHONE (07) 808–4011
FAX (07) 808–0011
MULTITRODE

FOR INSTALLATION SHEET – INCLUDED WITH PRODUCT		
TITLE MTR – WIRING DIAGRAMS		Pg.1 of 2
DESIGNED BY	REV.2.1	SCALE NO
CHECKED	DATE APRIL 2000	
DRAWN BY TRAVIS PARKINSON	DRAWING # 9956	

Designed & Manufactured by MULTITRODE Pty. Ltd. BRISBANE, AUSTRALIA

MULTITRODE RELAY 240VAC (MTR 2) INSTALLATION SHEET. NO2

CONTROL OF THREE APPLIANCES IN A DISCHARGING SITUATION

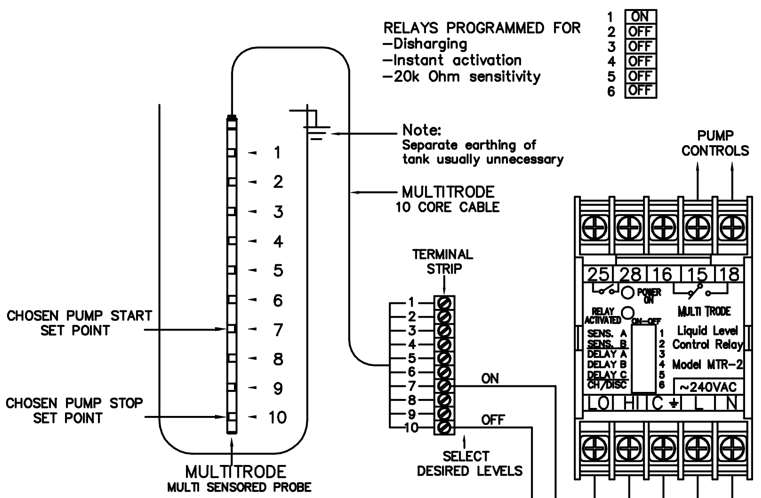


10 SENSOR MULTITRODE PROBE CONNECTED TO 3 MTR RELAYS SET IN DISCHARGING MODE
RELAY DUTY CONNECTED FOR ACTIVATION AT SENSOR #8 DEACTIVTION AT #10
RELAY STANDBY CONNECTED FOR ACTIVATION AT SENSOR #6 DEACTIVATION AT #10
RELAY ALARM CONNECTED FOR SINGLE POINT ACTIVATION AT #1

FIGURE-4

WARNING: Always separate probe cables from power wiring

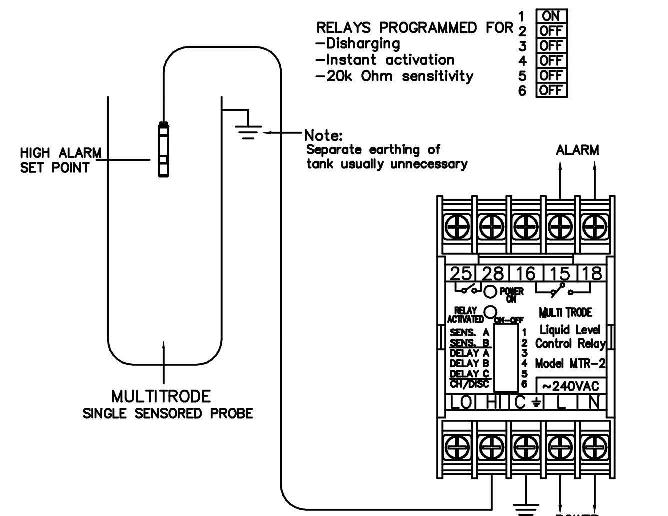
ON-OFF CONTROL IN A DISCHARGING SITUATION



10 SENSOR MULTI TRODE PROBE CONNECTED TO SINGLE
MTR RELAY SET IN DISCHARGING MODE
RELAY CONNECTED FOR ACTIVATION AT SENSOR #7
DEACTIVATED AT SENSOR #10

FIGURE-5

SINGLE POINT OPERATION FOR DISCHARGING



1 SINGLE SENSOR PROBE CONNECTED TO
SINGLE MTR RELAY IN CHARGING MODE
ACTIVATION AND DEACTIVATION AT SAME POINT

FIGURE-6

RELAY PROGRAM FUNCTIONS

SWITCH Nº SETTING 1 2	SENSITIVITY	
OFF OFF	1k Ω	Concentrated Acids, Minerals, Alkalines
OFF ON	4k Ω	Acids,Alkalines, Diluted brine,Sea water
ON OFF	20k Ω	Sullage,Sewage effluent Town water
ON ON	80k Ω	Low conductive liquids, Purified water
3 4 5	DELAY ON ACTIVATION	
OFF OFF OFF	Zero Seconds	
OFF OFF ON	2.5 Seconds	
OFF ON OFF	5 Seconds	
OFF ON ON	10 Seconds	
ON OFF OFF	20 Seconds	
ON OFF ON	40 Seconds	
ON ON OFF	80 Seconds	
ON ON ON	160 Seconds	
6	MODE	
OFF	Discharge	
ON	Charge	

SPECIFICATIONS

SENSOR VOLTAGE	12VAC NOMINAL
NO OF OUTPUTS	2 SETS, 1 NO & 1 CHANGEOVER
CONTACT RATING	5 AMP 250VAC RESISTIVE
CONTACT LIFE	10^5 OPERATIONS
SUPPLY VOLTAGE(+-10%)	240, 110, 240VAC, 50/60Hz 24, 12VDC
POWER CONSUMPTION	3.4VA (MAX)
DIMENSIONS mm (inches)	H74(2.78) X W45(1.77) X D114(4.5)
TERMINAL SIZE mm (in)	2 X $2.5mm^2$ (0.64^2 INCH)
DISPLAY LEDS	GREEN - POWER ON RED - ACTIVATION
MOUNTING ARRANGEMENT	DIN RAIL OR 2X4mm SCREWS (3/16")
SENSITIVITY (OHMS)	SELECTABLE VIA SWITCHES 1K, 4K, 20K, 80K
MODE	SELECTABLE VIA SWITCHES CHARGE/DISCHARGE
DELAYS (SECS)	SELECTABLE VIA SWITCHES 2.5, 5, 10, 20, 40, 80, 160
WORKING TEMP C(F)	MINUS 10° C (+14° F) PLUS 60° C (140° F)

PHONE (07) 808-4011 FAX (07) 808-0011	FOR INSTALLATION SHEET - INCLUDED WITH PRODUCT		
	TITLE MTR - WIRING DIAGRAMS		Pg.2 of 2
MULTITRODE	DESIGNED BY	REV.2	SCALE NO
	CHECKED	DATE JANUARY 1995	
	DRAWN BY JAN PARKINSON	DRAWING # 9957	

Designed & Manufactured by MULTITRODE Pty. Ltd. BRISBANE, AUSTRALIA

After many years of rigorous field use, reliability and simplicity of opperation of these units is unquestionable.

The MTRA relay offers many of the cost-effective features of the MTR relay, with the benefit of a built-in Hi level alarm.

Note: The MTRA is intended for discharge applications ONLY

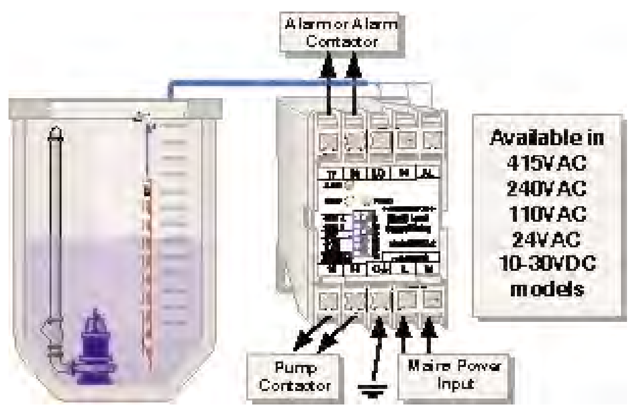
The MultiTrode MTRA Liquid Level Control Relay with alarm is a latching conductive liquid level control device. The pump is activated when the start point, "HI", is reached and deactivated when level falls below the stop point, "LO". The alarm activates once the level reaches the alarm point and deactivates once the level drops below the alarm point.

In 2 sensor mode the the pump start point "HI" will activate the alarm after after a preset time delay (0.5, 15 sec). This alarm can be set to flash or remain steady, as required.

Any application where level control plus high level alarm, such as sumps, wells, bores, collection tanks, effluent pits, drainage ponds, sullage pits etc, can benefit from use of the MultiTrode MTRA.

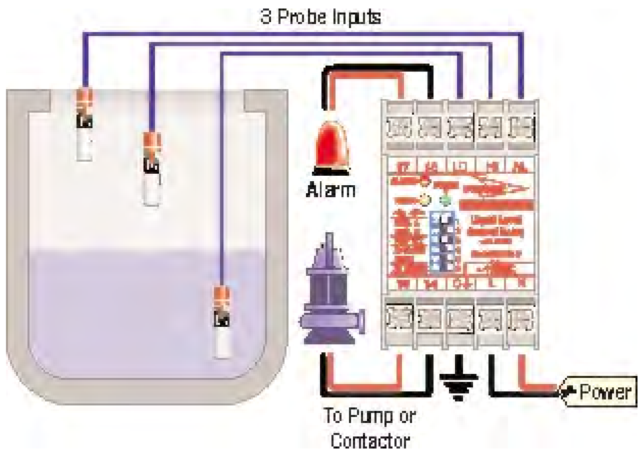
- Controls One Pump and One Alarm: The MTRA was designed specifically to control a pump and an alarm at a low installed-cost.
- Safe, extra-low, sensing voltage : Ensures safety for operators and maintenance personnel .
- 4 Sensitivities : Enables the relay to operate effectively in a wide range of conductive liquids.
- 2 Activation Delays : Each output can have a different time delay to overcome wave action and turbulence.
- LED Indication : High intensity LED indicators : Power On (green), Alarm on (red) and Pump on (yellow) via high intensity LED indicators.
- Dip Switch Programmable : All settings are easily selected from the front panel.
- Unique Two Sensor Operation : Enables pump and alarm to be controlled using 2 or 3 sensors. Two sensor operation is ideal for budget applications or where space is limited
- Proven Reliability : The proven design of the relay ensures long-term reliability of the MultiTrode system.
- I.S. application : Perfect for I.S. application when used with MTISB.
- DIN rail or screw mounting
- Low installed cost

Sample Application

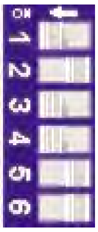


Note: The MTRA is intended for discharge applications ONLY

Sample Application



Dip Switch Settings

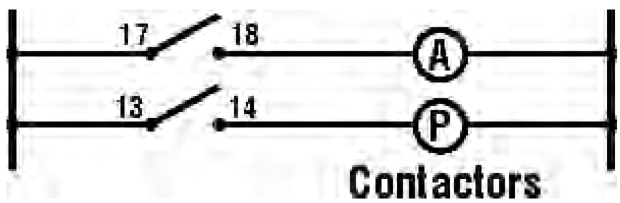


- Sw 1 & 2 Sensitivity settings: 1k, 4k, 20k, 80k
- Sw 3 . . . Pump activation delays: 0.5 & 10 sec
- Sw 4 . . . Alarm activation delays: 0.5 & 15 sec
- Sw 5 . . . Alarm: Steady or Flashing output
- Sw 6 . . . Input mode: 2 or 3 Sensor

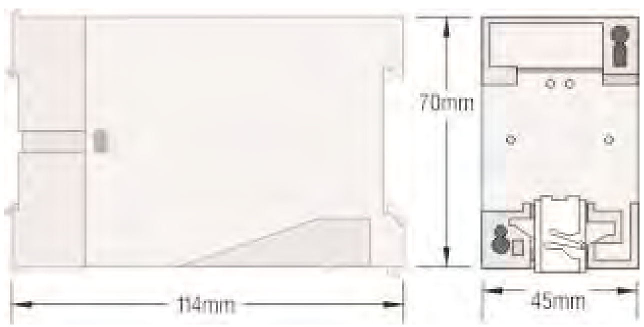
Available Sensitivity settings

1K	Concentrated Acids, Minerals, Alkalis.
20K	Alkali's, Diluted brine, Acids, Sea water.
40K	Sewerage effluentSullage, Town water.
80K	Industrial effluent and Processes, Purified water.

Wiring Diagram



Physical Dimensions



Product Specifications

Mode of operation:

MTRA	Discharge ONLY

Probe Inputs:

Sensor inputs	MTR : 2 / MTRA : 3
Sensor voltage	10/12VAC Nominal
Sensor current	0.8mA max. (per sensor)
Sensitivity	1k, 4k, 20k, 80k

Relay Outputs:

MTRA relay output	2 relays : both N/O
MTRA Output delay	Pump: 0.5, 10; Alarm: 0.5, 15 sec
Relay contact rating	250 VAC
	5A Resistive, 2A Inductive
Relay contact life	10^5 Operations
Terminal size	2 x 2.5mm², #13

Display LEDs:

	Power On	Pump	Alarm
MTRA	Green	Yellow	Red

Physical Product:

Dimensions (mm)	72H x 45W x 114D
Mounting	DIN Rail or 2 x M4 Screws #6
Enclosure	Makrolon (self extinguishing)

Power Supply:

Supply Voltage AC	24, 110, 240, 415VAC* - 50/60Hz
Power Consumption	3.5 Watts max *(MTR only)
Supply Voltage DC	12 or 24VDC,
Power Consumption	3 watts max

Environmental Range:

Centigrade	- 10° to +60°C
Fahrenheit	+14° to +140°F

N1653

AVAILABLE MODELS

MTRA 2	240VAC
MTRA 3	110VAC
MTRA 4	24VAC
MTRA 5	24VDC
MTRA 6	12VDC

Ordering Information & Example

Model	Voltage
MTRA	2

This order code is for a 240VAC MTRA.

All MultiTrode Products carry a full two year warranty

The MTRA Relay is designed for discharge operation only.

This product can also be ordered as part of a "MTSSP" Sump pack, this pack includes an MTRA and two single sensor level sensing probes (model: 0.2/1-10m) with 10m of cable.

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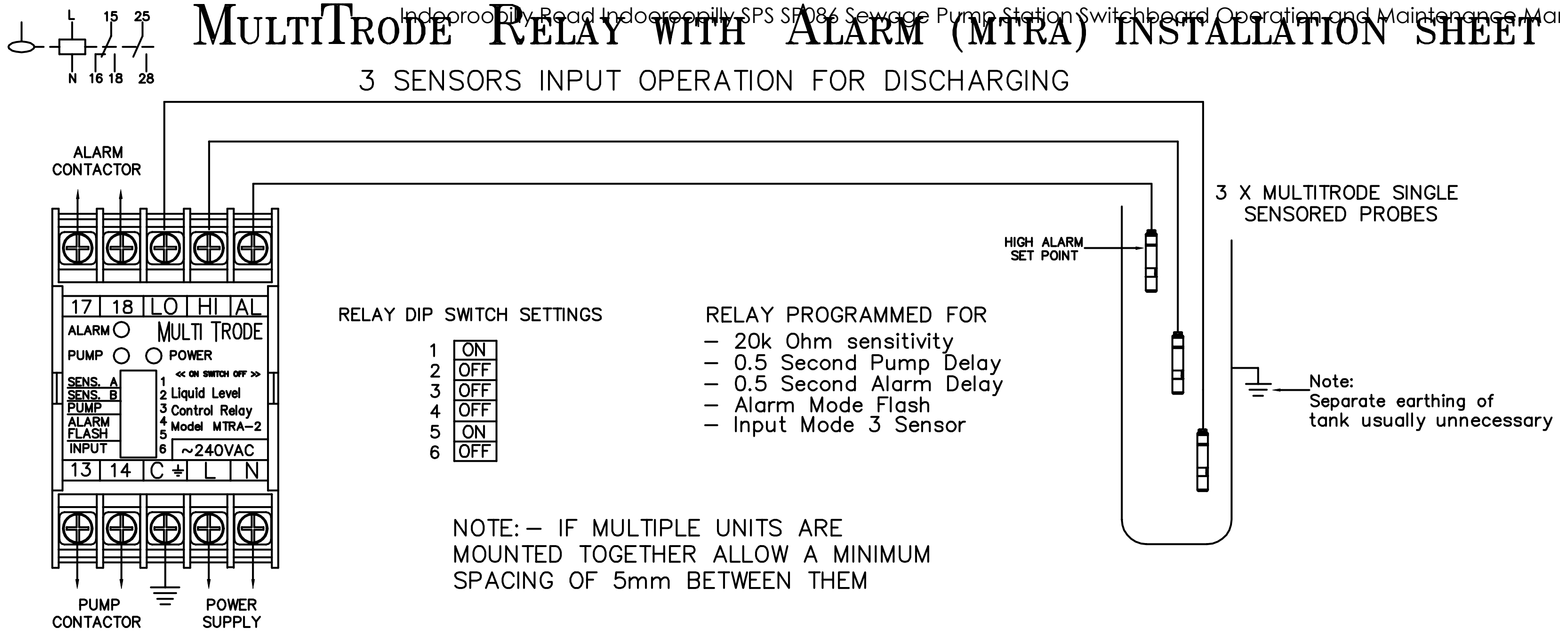
E-mail: sales@multitrode.net

MULTITRODE RELAY WITH ALARM (MTRA) INSTALLATION SHEET

3 SENSORS INPUT OPERATION FOR DISCHARGING



RELAY DIP SWITCH SETTINGS

1	ON
2	OFF
3	OFF
4	OFF
5	ON
6	OFF

RELAY PROGRAMMED FOR
- 20k Ohm sensitivity
- 0.5 Second Pump Delay
- 0.5 Second Alarm Delay
- Alarm Mode Flash
- Input Mode 3 Sensor

NOTE:- IF MULTIPLE UNITS ARE MOUNTED TOGETHER ALLOW A MINIMUM SPACING OF 5mm BETWEEN THEM

MTRA RELAY PROGRAM FUNCTIONS

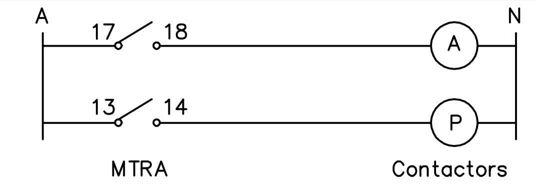
SWITCH No 1	SWITCH No 2	SENSITIVITY	
OFF	OFF	1K Ω	Concentrated Acids Minerals,Alkalines
OFF	ON	4K Ω	Acids,Alkalines,Diluted Brine,Sea Water
ON	OFF	20K Ω	Sullage,Sewerage Effluent Town Water
ON	ON	80K Ω	Industrial Effluent and Process,Purified Water

3	PUMP (Delay on Activation)
OFF	0.5 SECONDS
ON	10 SECONDS

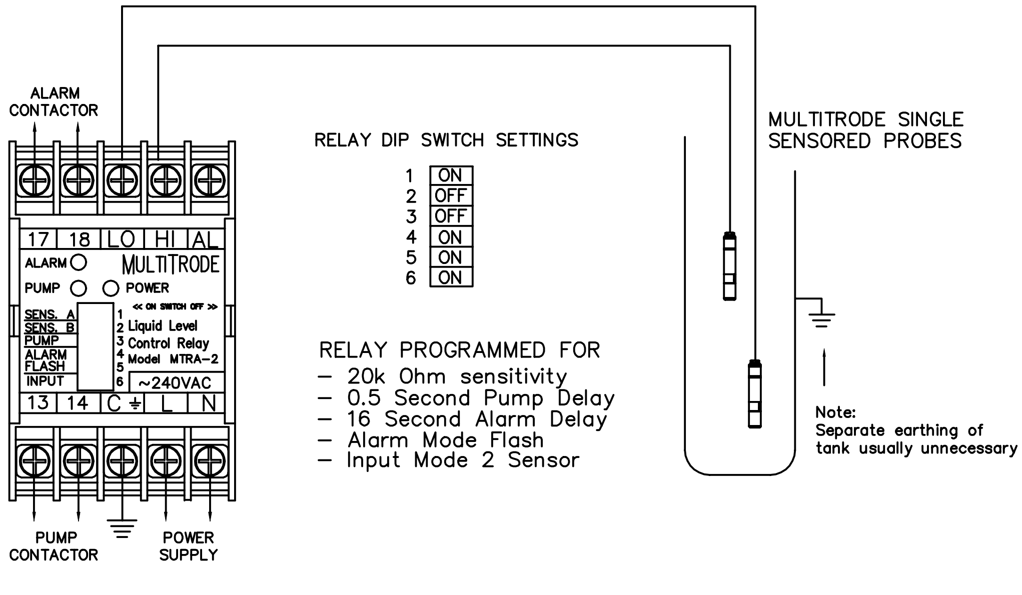
4	ALARM (Delay on Activation)
OFF	0.5 SECONDS
ON	16 SECONDS

5	ALARM MODE
OFF	STEADY
ON	FLASH

6	INPUT MODE
OFF	3 SENSOR
ON	2 SENSOR



2 SENSOR INPUT OPERATION FOR DISCHARGING

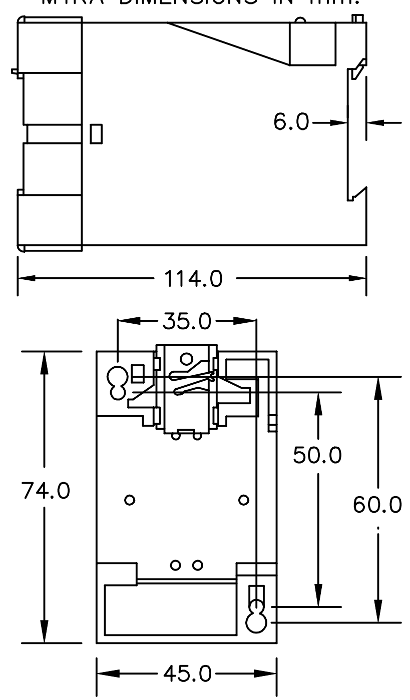


RELAY DIP SWITCH SETTINGS

1	ON
2	OFF
3	OFF
4	ON
5	ON
6	ON

RELAY PROGRAMMED FOR
- 20k Ohm sensitivity
- 0.5 Second Pump Delay
- 16 Second Alarm Delay
- Alarm Mode Flash
- Input Mode 2 Sensor

MTRA DIMENSIONS IN mm.



SPECIFICATIONS

SENSOR VOLTAGE	12VAC NOMINAL
NUMBER OF OUTPUTS	2 SETS NORMALLY OPEN
CONTACT RATING	5 AMP 250VAC RESISTIVE
CONTACT LIFE	10^5 OPERATIONS
SUPPLY VOLTAGE(+-10%)	24, 110, 240VAC, 50/60Hz
POWER CONSUMPTION	4.0VA (MAX)
DIMENSIONS mm	H74 X W45 X D114
TERMINAL SIZE mm	2 X $2.5mm^2$
DISPLAY LEDS	GREEN – POWER ON RED – ALARM ON YELLOW – PUMP ON
MOUNTING ARRANGEMENT	DIN RAIL OR 2X4mm SCREWS
SENSITIVITY (OHMS)	1K, 4K, 20K, 80K
INPUT MODE	2 SENSOR, 3 SENSOR
DELAYS (SECONDS)	PUMP – 0.5 OR 10 SEC. ALARM – 0.5 OR 16 SEC.
WORKING TEMPERATURE C	MINUS 10° C PLUS 60° C

THE MTRA RELAY IS DESIGNED FOR DISCHARGE MODE ONLY.
THE MTRA RELAY CAN BE PURCHASED AS A SUMP PACK: MTSSP.
A MTSSP PACK INCLUDES 1 X MTRA RELAY AND 2 X SINGLE SENSORED PROBES (MODEL: 0.2/1–10M) WITH 10M OF CABLE.

PH (07) 3808–4011 FAX (07) 3808–0011	FOR CUSTOMERS		
	TITLE MTRA WIRING DIAGRAM		
MULTITRODE	DESIGNED BY MULTITRODE	REV.2.1	SCALE N.T.S
	CHECKED CHRIS EATON	DATE 17–04–00	
	DRAWN BY TRAVIS PARKINSON	DRAWING # 3961	

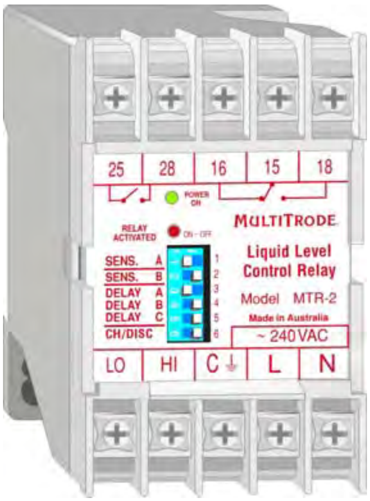
Designed & Manufactured by MULTITRODE Pty. Ltd. BRISBANE, AUSTRALIA

1 Introduction

The MultiTrode level control relay is a solid-state electronic module in a hi-impact plastic case with a DIN rail attachment on the back, making a snap-on-snap-off installation. Any number of relays can be easily added to the DIN metal rail then wired together to form a complex pumping system that other wise may have to be controlled and operated by a programmed PLC.

The relay is normally matched with the MultiTrode probe which works in conjunction with the relay and uses the conductivity of the liquid to complete an electrical circuit.

2 Electrical Overview



There are 10 screw terminals on the unit. Facing the relay as shown, we look at the bottom terminals (left to right):

- Lo – (Charge mode). This is the point when the probe is dry the relay will turn on.
- Lo – (Discharge mode). This is the point when the probe in the tank is dry the relay will turn off.
- Hi – (Charge mode). This is the point when the probe in the tank is wet a relay will turn off
- Hi – (Discharge mode). This is the point when the probe in the tank is wet a relay will turn on.
- C - is common earth. All earth bonding must be terminated here for correct operation.
- “ L “ is “live” (240V AC)
- “ N “ is “neutral” (240V AC)

If the tank is plastic, or if you are conducting tests in a plastic bucket, or the vessel has no earth point inside, you must install an earth rod within the tank, vessel or bucket and make sure that it is bonded back to C on the relay unit.

3 DIP Switches

3.1 DIP Switches

(See Wiring Diagram for full program functions.)

3.1.1 DIP 1 & 2

DIP 1 and 2 control the Sensitivity, in other words the cleaner the liquid the higher the sensitivity setting must be. Concentrated acids, minerals are by their own chemical composition highly conductive, so a low level of sensitivity is required, purified water is almost an insulator against electrical current flow so a higher sensitivity inside the relay is required.

3.1.2 DIP 3, 4 & 5

DIP switches 3, 4 and 5, control delay on activation. For example, in discharge mode with DIP switches 3, 4 and 5 set to 10 seconds, when the Hi point becomes wet it will activate the motor and it will take 10 seconds of continual coverage of the probe sensor to make the relay close and start the pump. This is invaluable when the probe is in a turbulent part of a well where fluid is splashing around touching the sensors momentarily, and false activation cannot be tolerated.

3.1.3 DIP 6

DIP switch 6 controls the charge/discharge function. Set “ON” for charge, and “OFF” for discharge

3.2 Relay Contacts & their Applications

3.2.1 Contacts 15, 16 & 18

Contacts 15, 16, and 18 are used for electronic or visual notification of a change in state at the pump itself. Contacts 15, 16, and 18 are used for more advanced applications because they are a changeover relay, their state may be the same as contacts 25, 28 or the opposite. Both sets of contactors are triggered simultaneously. An example is when in discharge mode, (see Figure 1).

You have a gravity flow coming in so the fluid reaches the lower sensor PB1, contacts 15 and 18 are open (15 being common to both contact 16 and 18) contacts 25 and 28 are also normally open but contacts 15 16 in this current situation are closed, whether PB1 is wet or dry is of no concern all will stay the same. The level now rises to PB2 and both relays change state, contacts 25 and 28 close to turn on the pump, contacts 15 and 16 are open, with 15 and 18 closed.

In advanced applications this state change may be fed into a logic device to indicate the pump is running or the pump has stopped and perhaps light an LED or incandescent light source for visual confirmation that a change has occurred in the relay.

3.2.2 Contacts 25 & 28

Contacts 25 and 28 are used to control pump states. Contacts 25 and 28 are mostly used for turning on motors via a starting relay or solenoid, so, these sets of contacts react to the rising or falling levels of the fluid inside the tank, they will operate to turn on a pump in discharge mode when the top sensor is wet and in charge mode turn on the pump when the bottom sensor is dry.

4 Practical Overview

4.1 Discharge Mode – DIP switch 6 set to "OFF"

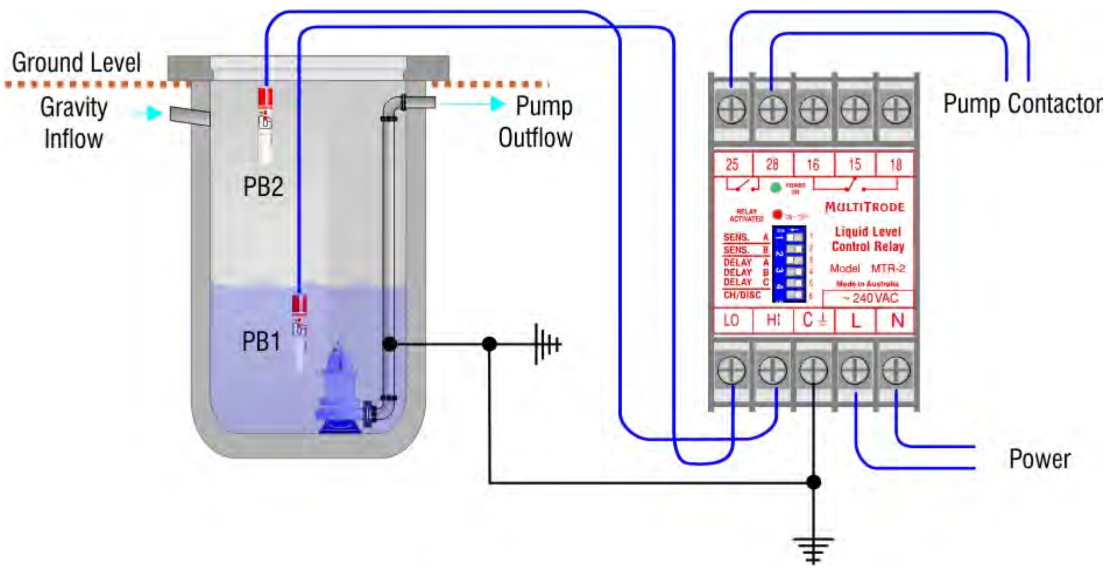
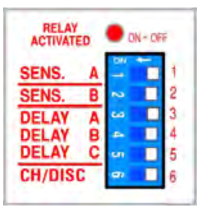


Figure 1 – Discharge Mode

Figure 1 shows two probes, (PB1 connected to Lo and PB2 connected to Hi). The pit is mostly underground and there is a gravity-fed inlet at the top left-hand side. The pit is empty with PB1 completely dry. Dipswitch 6 is set to "OFF."



The relay operation depends on the electrical conductivity of liquid in the pit, i.e. no liquid = no current flow. The level starts to rise and covers PB1.

This is a discharge operation so we do not want the relay to close and start a pump until the well is full so as the water rises it reaches PB2, the relay closes and the pump starts. The level now drops below PB2 but the pump still continues to run, the level continues to drop below PB1 the relay opens the pump stops.

4.2 Charge Mode – DIP switch 6 set to "On"

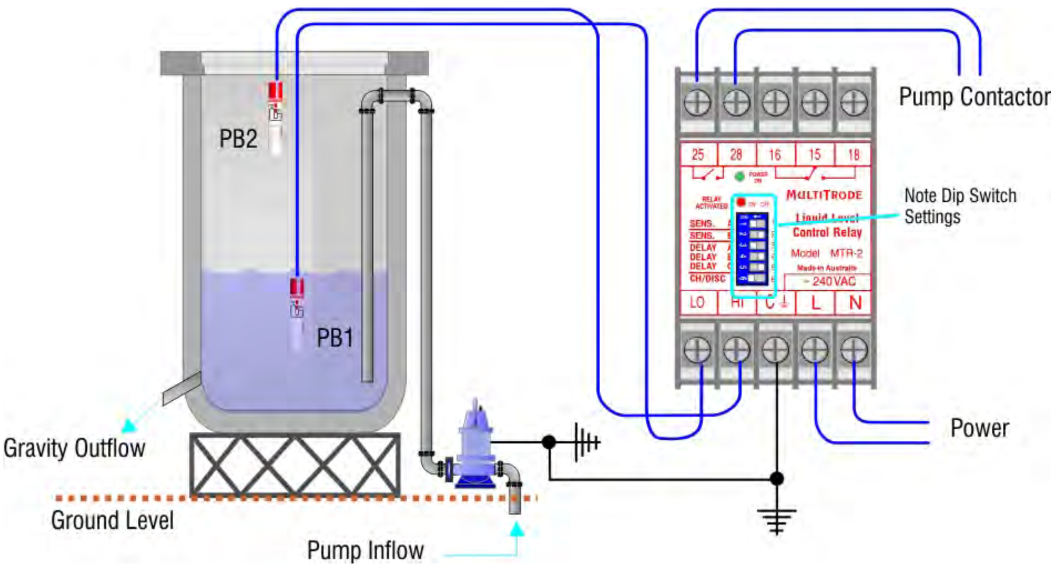


Figure 2 – Charge Mode

NOTE:
"C" is connected to common bonded earth. The unit will not operate correctly if not earthed.

Let's look at the same relay but in a tank that is charging (DIP 6 is now on). See Figure 3, where liquid is being pumped into a tank, and discharging through a gravity feed, the tank is on steel stands "x" metres above the ground.

With the tank full, PB1 and PB2 will be wet, the relay is off, and the pump has stopped. Water is slowly fed out from the bottom, and now as PB2 (HI) becomes dry nothing happens; the water now drops to below PB1 (Lo), and the pumps restarts to fill the tank.

The pump will continue to fill the tank until PB2 (HI), becomes wet again.

4.3 MTRA Relay with Alarm (Discharge Applications Only)

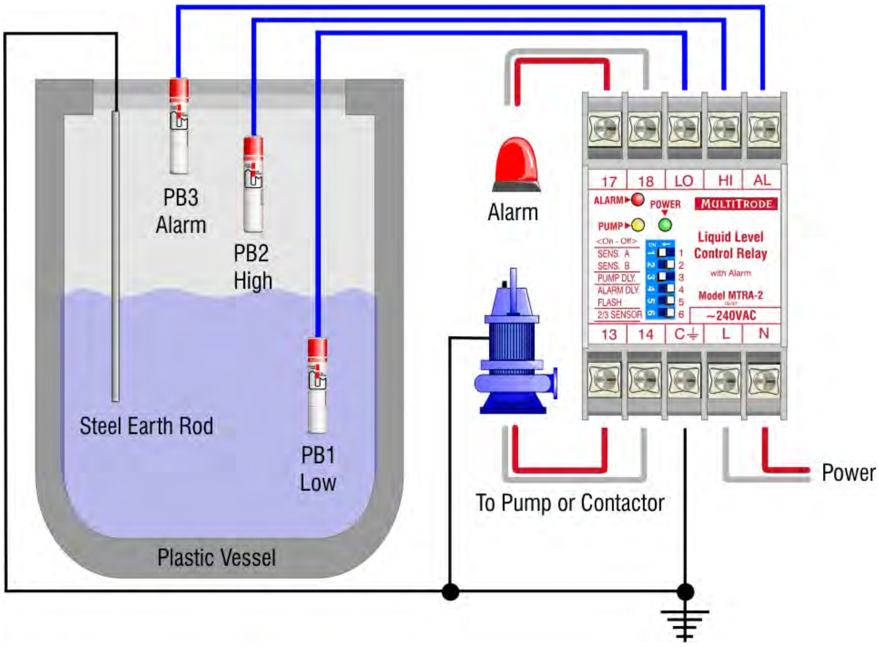


Figure 3 - MTRA Operation

The MTRA relay works in the same way as the MTR relay except the MTRA has a separate alarm output, and does not have a charge mode. The planned application is to close a contact to illuminate a warning alarm light. . Various other applications have included introducing a third probe to latch another relay.

In Figure 2 we see three probes in a pit that is plastic, note the steel rod in the tank. (In a plastic vessel a steel rod must be used to create an earth return in the liquid so probes can function.) PB1, PB2, and PB3 are dry, and the relay power LED is on. When water enters the pit and wets PB1, nothing happens, water now reaches PB2 causing contacts 13 and 14 to close, the pump LED to light, and the water to drop.

If, for example, the pump has its inlet partially blocked, the level continues to rise and wets PB3. This closes a separate relay that can activate a red flashing light, an audible fog horn or send a 5 volt pulse into another device with the common cause to warn human beings that a spill is due to occur. If the pumps become unclogged and PB3 becomes dry the alarm opens again and breaks the circuit that stops the light from flashing or the foghorn from sounding.

5 Most Common Installation Problems

The relay requires a path between the probes to earth through the liquid. If you are testing in a plastic bucket, have installed the probe in a plastic tank or have no good earthing in the vessel you will need to install a separate earth and make sure all earth bonding comes back to the C terminal. Most problems like these are traced back to a lack of or poor earthing, or open circuits in the probe wiring.

Now is the time to check the relay by using “the bridge testing line technique” remember you must simulate a fluid flow to correctly ascertain a good relay or a bad one. (All DIPswitch settings from 1 to 6 should be off.)

Cut two pieces of insulated flexible copper wire one black one red 250 mm long, strip both ends back 10 mm on both cables, and join one black end and one red end. Insert the joined ends into C on the relay box, observing all safe electrical practises. You should have one black wire and one red wire free.

Set your relay for discharge mode (DIP switch 6 is off) with no sensors connected to the unit, connect the red wire to Lo – nothing should happen (if it does return the relay for replacement or repair*). Now connect the black wire to the Hi terminal the relay activated LED should light instantly (if it does not, the relay should be returned for repair*).

6 Troubleshooting

I have checked all the DIPswitches and settings but in discharge mode as soon as the bottom sensor gets wet the pump turns on then turns off almost straight away.	• This is the most common problem encountered with relay set up and commissioning, the probe in the bottom of the tank is wired into the Hi terminal instead of the Lo terminal.
The installation went fine but now and again the pump will not turn on even though I am sure the probe is wet.	• Check the sensitivity level set on the relay, some times the level is set for foul water but due to changes in the flow the water becomes grey or clear, try changing the setting from 20KΩ to 80KΩ and monitor the results carefully.
All wiring is complete and all DIPswitches have been checked but the pump will not turn on at all.	• If you have completed the test schedule for the relay and it passed then check the wiring to the sensors – for this is now where the problem lies or in the earthing arrangements. If possible check the resistance between the sensor cable and the steel sensor on the probe to prove a solid connection.

*** Please contact your distributor or agent before returning any product for repair or warranty claim.**

multitrode WATER • WASTEWATER • PUMP STATION • TECHNOLOGY

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Visit www.multitrode.com for the latest information

13. Power Supply & Battery

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

POWER SUPPLY & BATTERY

1. 24VDC POWER SUPPLY TECHNICAL DETAILS
2. 24VDC/13VDC CONVERTER TECHNICAL DETAILS
3. BATTERY TECHNICAL DETAILS

PB251 Series

220-330 WATTS DC UPS

Features

- Ultra-low noise output
- Independent battery charging output
- DC output OK & battery OK alarms & LEDs
- Battery-LVD and alarm
- Over-temperature protection
- Battery fuse fail LED

Specifications

INPUT	
Voltage:	190 to 264 vac, or 190 to 400VDC
Line regulation:	0.2%typical
Current:	1.4A maximum
Inrush current:	10A maximum
Frequency:	45 to 65 Hz
OUTPUT	
Voltage	See table
Current	See table
Load regulation	0.5%typical
Current limit type - load cct	Constant current
Current limit type - batt. cct	Constant current
Short circuit protection	Indefi nite, auto-resetting
Over-voltage protection	17.5 to 20V latching (13.8Vdc output) 31.5 to 39V latching (27.6Vdc output)
Ripple & noise 100 MHz bandwidth	28mVp-p (13.8Vdc output) 55mVp-p (27.6Vdc output)
ENVIRONMENTAL	
Operating temperature	0 to 70°C ambient with derating, 5...90% relative humidity (non-condensing)
Over-temperature protection	Automatic & auto-resetting
Cooling requirement	Natural convection
Efficiency	80% minimum

STANDARDS & APPROVALS	
Safety	Complies with AS/NZS 60950, class 1, NSW Office of Fair Trading Approval N20602
EMC	Emissions comply with AS/NZS CISPR11, Group 1, Class B. Complies with ACA EMC Scheme, Safety & EMC Regulatory Compliance Marked
Isolation i/p-o/p i/p-ground o/p-ground	4242VDC for 1 minute 2121VDC for 1 minute 707VDC for 1 minute
ALARMS & BATTERY FUNCTIONS	
Converter ON/OK alarm	Indicated by voltage-free changeover relay contacts &
green LED	ON=PSU OK
Battery low (& fuse) alarm	10.2 to 12.6V for 12V battery, adjustable 20.4 to 25.2V for 24V battery, adjustable Indicated by voltage-free changeover relay contacts & green LED: ON=BATT OK
Low voltage disconnect	9.6 to 12V for 12V battery, adjustable 19.2 to 24V2 for 4V battery, adjustable
Charger over-load protection	Auto-resetting electronic circuit breaker
Reverse polarity protection	Internal battery fuse
Battery to load voltage drop	0.2 to. 0.25V typical
MECHANICAL	
Case size	264 L x 172 W x 67 H mm
Case size with heatsink	264 L x 186 W x 67 H mm
Rack size	232 D x 19" W x 2RU H
Weight	1.9 kg
Weight with heatsink	2.1 kg
Weight (rack mounted version)	5.5 kg

Selection Table

MODEL NUMBER	OUTPUT VDC	I_{LOAD}	I_{BATT}	OUTPUT POWER
PB251-12CM	13.8V	16A	2A	220W
PB251-12CM-H	13.8V	20A	2A	275W
PB251-24CM	27.6V	11A	2A	300W
PB251-24CM-H	27.6V	12A	2A	330W
PB251-12RML	13.8V	20A	4A	275W
PB251-12B	13.8V	20A	4A	275W
PB251-24RML	27.6V	12A	2A	330W

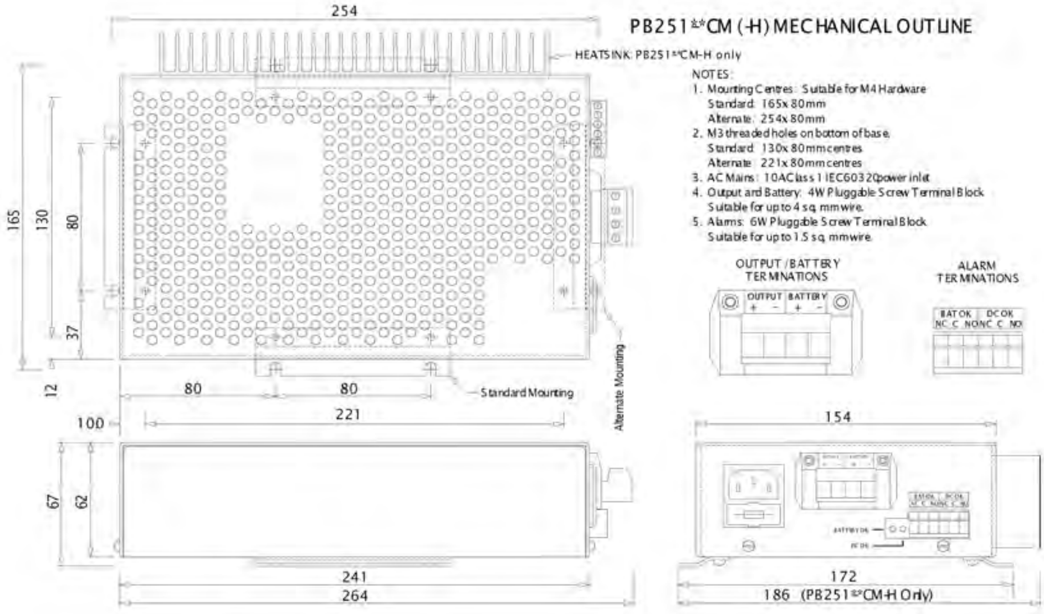
Note: Non standard battery charging current available on request. ie PB251-12CM-H-10 for 10A.

powerbox

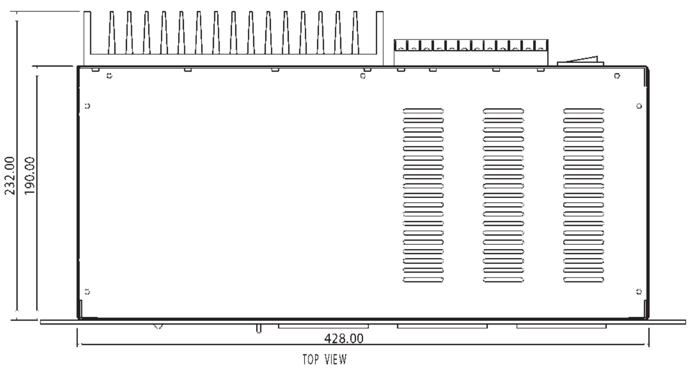
PB251 Series

275-330 WATTS DC UPS

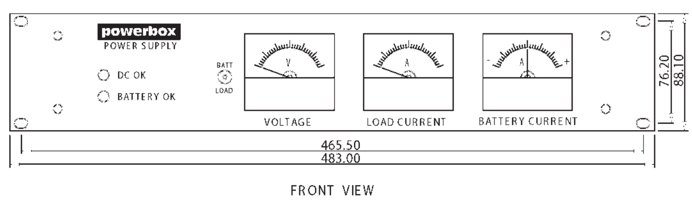
Technical Illustrations

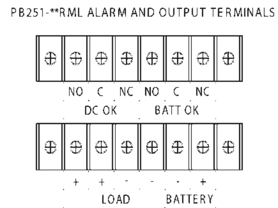


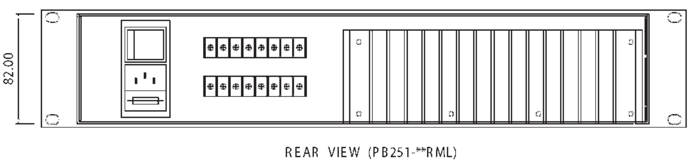
PB251-**RML & -12B MECHANICAL OUTLINE

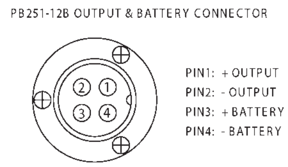


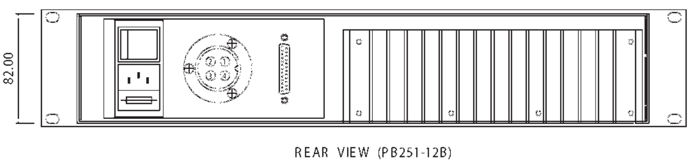
NOTES:
1. 2RU x 19" rack enclosure per IEC297
2. Mounting slots are suitable for M6 hardware.
3. Input connector is a 10A Class 1 IEC60320 inlet.
4. 2 meter IEC mains cord with Australian plug is supplied with unit.
5. PB251-12B alarm terminal is DB25 female.
6. PB251-12B output and battery connector is Hirose pn. HS28R-4A. Mating connector is Hirose pn. HS28P-4A (not supplied).
7. PB251-**RML alarm and output terminals are M3.5 screws suitable for ring or fork lugs up to 8 mm wide.

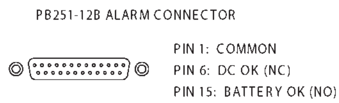












PBIH Series

15-150 WATTS DC/DC SINGLE OUTPUT

Features

- Wide selection of models
- 4 input voltage ranges
- High efficiency
- Low output ripple
- Proven reliability
- Good thermal margins

Specifications

INPUT

Input voltage	12VDC (9.2–16) 24VDC (19–32) 48VDC (38–63) 110VDC (85–140)
Inrush current	20A max. for 110V only

OUTPUT

Output voltage	See table
Voltage adjustment	±10%, ±5% for PBIH-F
Output current	See table
Ripple & noise	Output Volts x 1% + 50mV to -100mV pk-pk
Line regulation	0.8% over input range
Load regulation	0.9%, 0%–100% load
Temperature coefficient	0°C to 50°C, 0.03% per °C
Overvoltage protection	O.V. clamp, PBIH-F Output shutdown, PBIH-G, J, M, R – input must be switched off for at least 30S to reactivate
Overcurrent protection	Fold back – PBIH-F Current limiting, PBIH-G, J, M, R (PBIH-R series is adjustable); PBIH110xxR models are not adjustable
Drift	Output V x 0.5% + 15(mV) per 8 hrs after 1 hr warm-up
Rise Time	200mS max. – PBIH-F, M, R 100mS max. – PBIH-G, J (at 25°C)
Holdup time	10mS (only 110V input)
Remote sense	PBIH-R Series only

OPERATING

Efficiency	70%–89%
Safety isolation (1 minute)	Type – 12, 24, 48V input Input – Output: 1500VAC Input– Case: 1500VAC Output– Case: 500VAC Type– 110V input Input– Output: 2000VAC Input– Case: 2000VAC Output– Case: 500VAC
Insulation resistance	50M (500VDC) Input – Case
Parallel operation	Consult sales office for details
Remote control	PBIH-R Series: Open link: output normal Short link: output off

ENVIRONMENTAL

Operating temperature	0°C to 50°C full load
Cooling	Convection cooled
Storage temperature	-20°C to +85°C
Humidity	85%
Shock	30G, PBIH-F, G and J
Vibration	(5Hz–10Hz, 10mm), (10Hz–50Hz) 2G, PBIH-F, G and J

STANDARDS AND APPROVALS

Safety	Designed to UL1950
C-tick	AS/NZS CISPR11 Group 1, Class A

MECHANICAL

Weight	PBIH-F : 250g PBIH-G : 380g PBIH-J : 410g PBIH-M : 800g PBIH-R : 1.4kg

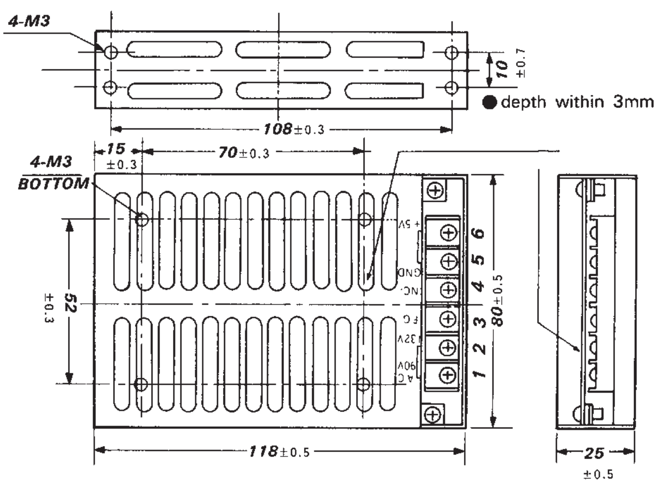
PBIH Series

15-150 WATTS DC/DC SINGLE OUTPUT

Selection Table

MODEL NUMBER	INPUT	OUTPUT		OUTPUT POWER
PBIH-1205F	9.2-16V	5V	3A	15W
PBIH-1212F	9.2-16V	12V	1.2A	15W
PBIH-1215F	9.2-16V	15V	1A	15W
PBIH-1224F	9.2-16V	24V	0.62A	15W
PBIH-2405F	19-32V	5V	3A	15W
PBIH-2412F	19-32V	12V	1.2A	15W
PBIH-2415F	19-32V	15V	1A	15W
PBIH-2424F	19-32V	24V	0.62A	15W
PBIH-4805F	38-63V	5V	3A	15W
PBIH-4812F	38-63V	12V	1.2A	15W
PBIH-4815F	38-63V	15V	1A	15W
PBIH-4824F	38-63V	24V	0.62A	15W
PBIH-11005F	85-140V	5V	3A	15W
PBIH-11012F	85-140V	12V	1.2A	15W
PBIH-11015F	85-140V	15V	1A	15W
PBIH-11024F	85-140V	24V	0.62A	15W
PBIH-1205G	9.2-16V	5V	5A	25W
PBIH-1212G	9.2-16V	12V	2.1A	25W
PBIH-1215G	9.2-16V	15V	1.7A	25W
PBIH-1224G	9.2-16V	24V	1.1A	25W
PBIH-1248G	9.2-16V	48V	0.5A	25W
PBIH-2405G	19-32V	5V	5A	25W
PBIH-2412G	19-32V	12V	2.1A	25W
PBIH-2415G	19-32V	15V	1.7A	25W
PBIH-2424G	19-32V	24V	1.1A	25W
PBIH-2448G	19-32V	48V	0.5A	25W
PBIH-4805G	38-63V	5V	5A	25W
PBIH-4812G	38-63V	12V	2.1A	25W
PBIH-4815G	38-63V	15V	1.7A	25W
PBIH-4824G	38-63V	24V	1.1A	25W
PBIH-4848G	38-63V	48V	0.5A	25W
PBIH-11005G	85-140V	5V	5A	25W
PBIH-11012G	85-140V	12V	2.1A	25W
PBIH-11015G	85-140V	15V	1.7A	25W
PBIH-11024G	85-140V	24V	1.1A	25W
PBIH-11048G	85-140V	48V	0.5A	25W
PBIH-1205J	9.2-16V	5V	8A	50W
PBIH-1212J	9.2-16V	12V	3.3A	50W
PBIH-1215J	9.2-16V	15V	2.7A	50W
PBIH-1224J	9.2-16V	24V	1.7A	50W
PBIH-1248J	9.2-16V	48V	0.8A	50W
PBIH-2405J	19-32V	5V	10A	50W
PBIH-2412J	19-32V	12V	4.3A	50W
PBIH-2415J	19-32V	15V	3.4A	50W
PBIH-2424J	19-32V	24V	2.5A	50W
PBIH-2448J	19-32V	48V	1A	50W
PBIH-4805J	38-63V	5V	10A	50W
PBIH-4812J	38-63V	12V	4.3A	50W
PBIH-4815J	38-63V	15V	3.4A	50W
PBIH-4824J	38-63V	24V	2.5A	50W
PBIH-4848J	38-63V	48V	1A	50W
PBIH-11005J	85-140V	5V	10A	50W
PBIH-11012J	85-140V	12V	4.3A	50W
PBIH-11015J	85-140V	15V	3.4A	50W
PBIH-11024J	85-140V	24V	2.5A	50W
PBIH-11048J	85-140V	48V	1A	50W
PBIH-1205M	9.2-16V	5V	18A	100W
PBIH-1212M	9.2-16V	12V	9A	100W
PBIH-1215M	9.2-16V	15V	7A	100W
PBIH-1224M	9.2-16V	24V	4.5A	100W
PBIH-1248M	9.2-16V	48V	2A	100W
PBIH-2405M	19-32V	5V	20A	100W
PBIH-2412M	19-32V	12V	9A	100W
PBIH-2415M	19-32V	15V	7A	100W
PBIH-2424M	19-32V	24V	5A	100W
PBIH-2448M	19-32V	48V	2A	100W
PBIH-4805M	38-63V	5V	20A	100W
PBIH-4812M	38-63V	12V	9A	100W
PBIH-4815M	38-63V	15V	7A	100W
PBIH-4824M	38-63V	24V	5A	100W
PBIH-4848M	38-63V	48V	2A	100W
PBIH-11005M	85-140V	5V	20A	100W
PBIH-11012M	85-140V	12V	9A	100W
PBIH-11015M	85-140V	15V	7A	100W
PBIH-11024M	85-140V	24V	5A	100W
PBIH-11048M	85-140V	48V	2A	100W
PBIH-1205R	9.2-16V	5V	27A	150W
PBIH-1212R	9.2-16V	12V	13A	150W
PBIH-1215R	9.2-16V	15V	10A	150W
PBIH-1224R	9.2-16V	24V	6.5A	150W
PBIH-1248R	9.2-16V	48V	3.3A	150W
PBIH-2405R	19-32V	5V	30A	150W
PBIH-2412R	19-32V	12V	14A	150W
PBIH-2415R	19-32V	15V	11A	150W
PBIH-2424R	19-32V	24V	7A	150W
PBIH-2448R	19-32V	48V	3.5A	150W
PBIH-4805R	38-63V	5V	30A	150W
PBIH-4812R	38-63V	12V	14A	150W
PBIH-4815R	38-63V	15V	11A	150W
PBIH-4824R	38-63V	24V	7A	150W
PBIH-4848R	38-63V	48V	3.5A	150W
PBIH-11005R	85-140V	5V	30A	150W
PBIH-11012R	85-140V	12V	14A	150W
PBIH-11015R	85-140V	15V	11A	150W
PBIH-11024R	85-140V	24V	7A	150W
PBIH-11048R	85-140V	48V	3.5A	150W

PBIH-F



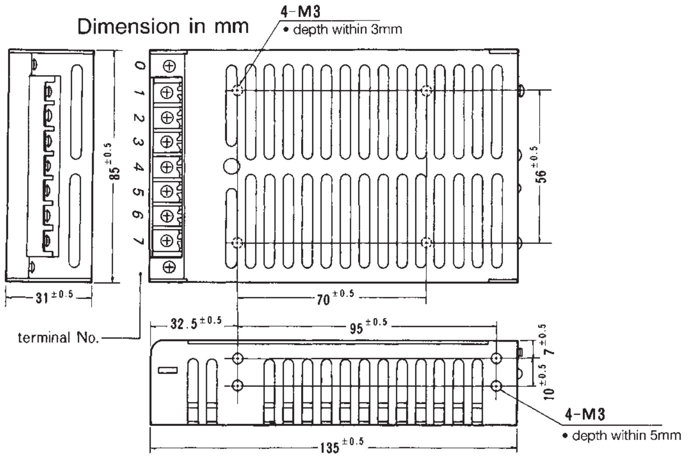
• Dimensions in mm

terminal No.	
1	0 V (DC in)
2	+V (DC in)
3	FG
4	NO Connection
5	−V out
6	+V out

PBIH Series

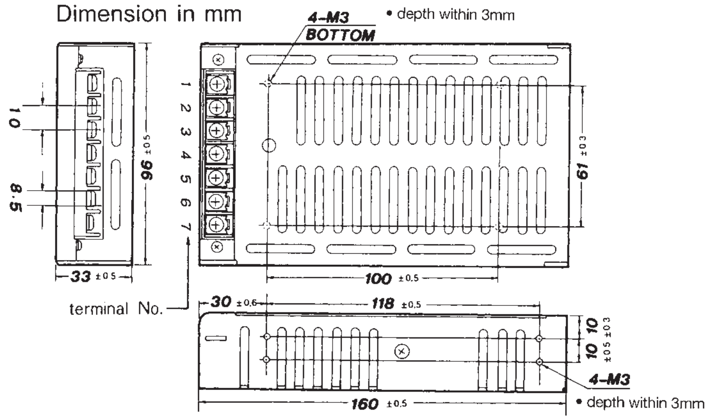
15-150 WATTS SINGLE OUTPUT

PBIH-G



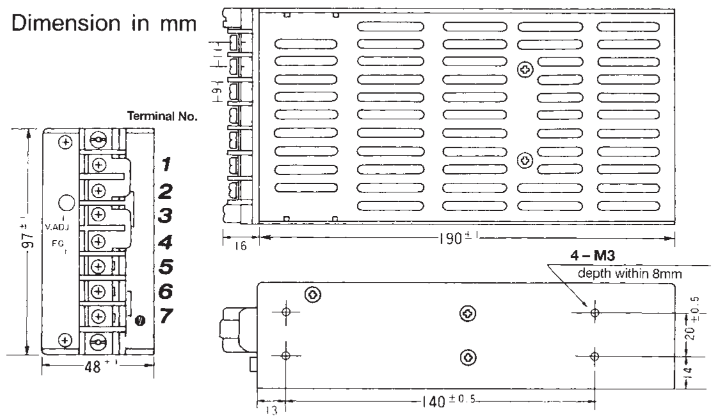
Terminal	Connection
0	FG
1	DC +V in
2	0V in
3	LFG
4	NO
5	NO
6	-V out
7	+V out

PBIH-J



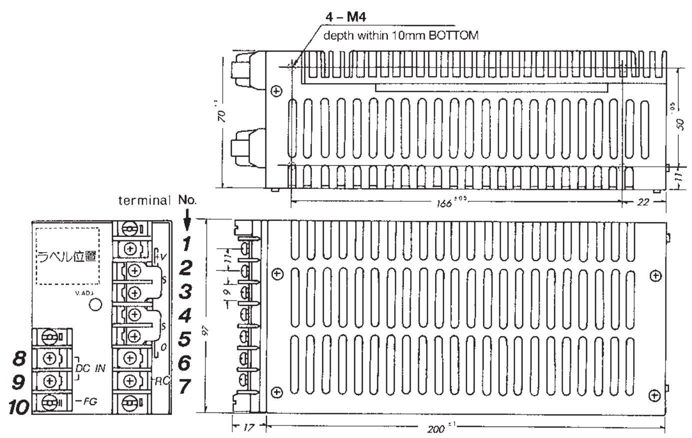
Terminal	Connection
1	FG
2	DC +V in
3	0V in
4	LFG
5	-V out
6	+V out
7	NC

PBIH-M



Terminal	Connection
1	+V out
2	+V out
3	-V out
4	-V out
5	FG
6	-V in
7	+V in

PBIH-R

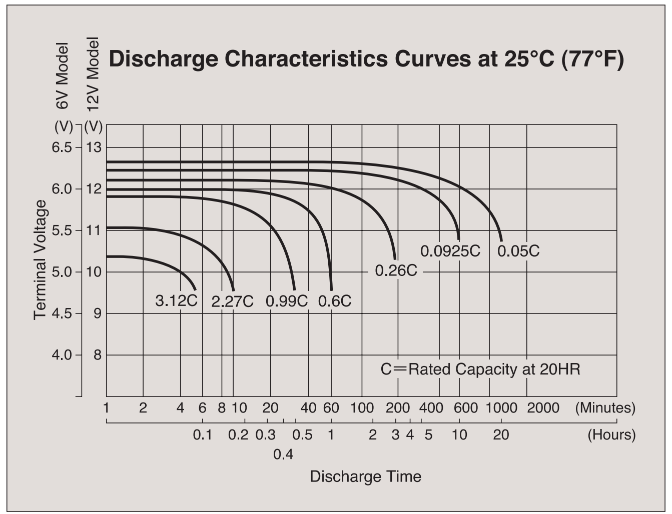


Terminal	Connection
1, 2	+V out
3	+S
4	-S
5, 6	-V out
7	Remote Control
8	DC +V in
9	DC 0V in
10	FG

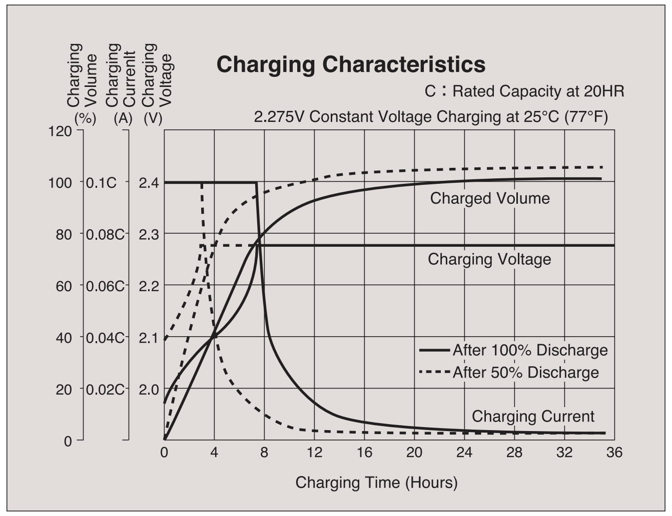
YUASA

General Characteristics

■DISCHARGE CHARACTERISTICS



■CHARGING CHARACTERISTICS



Peripheral Device

A life diagnosis device for valve regulated lead-acid batteries, "JUST FEEL ".
The battery monitor, JUST FEEL, diagnoses life of valve regulated lead-acid batteries. Battery life can be diagnosed without disconnecting a power supply as a result of measuring battery internal impedance during floating charge.

- Diagnoses battery life during floating charge.
- A compact, portable device.
- Can be used for a large variety of valve regulated lead-acid batteries.
- Mounted with comparator function.
- May be used for UPS batteries.(Some models may prohibit the use of this device. If you intend to use the device for UPS, please contact us for consultation.)

●Specifications subject to change without prior notice

Distributed by:
GS Yuasa International Ltd.
1-8-1, Nishi-Shimbashi, Minato-ku
Tokyo 105-0003
Japan
Tel +81-3-3597-2403
Fax +81-3-3597-2405

Cat.No. UXH-13 0505-10 (NMP) Printed in Japan

"Yuasa" Brand Maintenance-Free Valve Regulated Lead-Acid Stationary Batteries

UXH SERIES

UXH SERIES

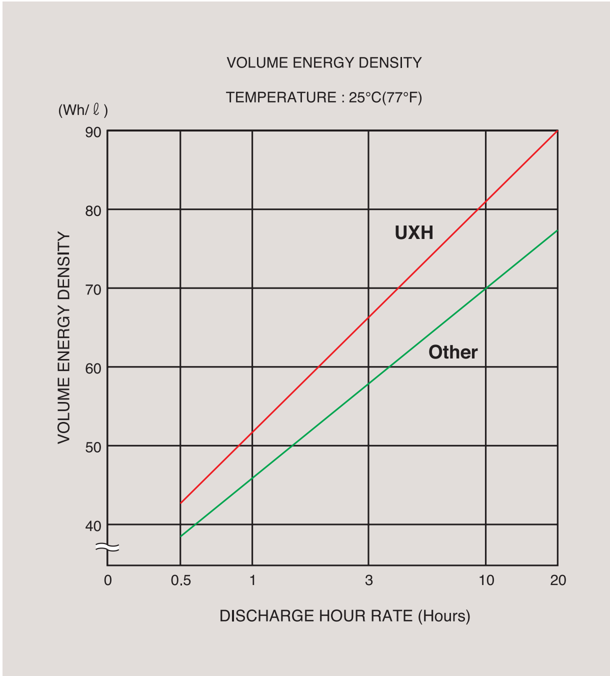
The latest in YUASA's state-of-the-art technology has brought about a new UXH series capable of yielding even greater capacity than comparable batteries.
YUASA UXH batteries are designed with unique valve regulating devices and acid free constructions, ensuring safety and suitability to the contemporary business environment.

Designed Life

10 years

Features

Up to 15% more capacity
Maintenance-free
Higher energy efficiency
Negligible gas emissions
Valve regulated
Systems compatible
Fitted with explosion proof filter
(Except UXH100-12N and UXH200-6N)
No equalizing charge required
(Option) Flame reterdant version available
No free Acid (Non-spillable Battery)



Applications

UPS
Telecommunications
Alarm systems
Fire & security systems
Emergency lighting
Engine starting
Solar powered systems
Utilities
Rail

Float charge voltage: 2.275V per cell
Permissible operating temperature: -15~45°C
Container material: ABS
Terminal: L terminal

General Specifications

Battery Model	Nominal Voltage(V)	20HR Rated Capacity(Ah) *1	Internal Resistance(mΩ) *2	Approx. Dimensions, mm(inch) Length	Width	Height	Overall Height	Approx. Weight kg(lbs.)	Explosion Proof Filter
UXH38-12	12	38	7.0	235 (9.3)	128 (5.0)	190 (7.5)	217 (8.5)	17 (37)	O
UXH50-12	12	50	6.0	299 (11.8)	128 (5.0)	190 (7.5)	217 (8.5)	21 (46)	O
UXH63-12	12	63	5.0	363 (14.3)	128 (5.0)	190 (7.5)	217 (8.5)	25 (55)	O
UXH75-6	6	75	2.2	217 (8.5)	128 (5.0)	190 (7.5)	217 (8.5)	16 (35)	O
UXH100-6	6	100	1.8	281 (11.1)	128 (5.0)	190 (7.5)	217 (8.5)	20 (44)	O
UXH125-6	6	125	1.5	345 (13.6)	128 (5.0)	190 (7.5)	217 (8.5)	24 (53)	O
UXH100-12N	12	100	4.0	407 (16.0)	172.5 (6.8)	210 (8.3)	240 (9.4)	39 (86)	×
UXH200-6N	6	200	1.3	398 (15.6)	176 (6.9)	216 (8.5)	250 (9.8)	39 (86)	×

*1 Final Voltage: 1.80V/cell, Temperature: 25°C(77°F)
*2 In a fully charged state and measured through a 1000Hz AC bridge.

Performance Data at 25°C(77°F)

(Amperes and Watts per cell)

Amperes to F.V.1.60 Volts Per Cell

Battery Model		1 min	5 min	10 min	15 min	20 min	25 min	30 min	35 min	40 min	45 min	1 h
UXH38-12	A	141.0	119.0	86.3	63.5	50.9	42.6	37.6	33.4	30.8	28.0	22.8
	W	229.0	199.0	154.0	116.0	94.2	79.4	71.1	63.5	58.5	53.6	43.7
UXH50-12	A	185.0	156.0	114.0	83.5	67.0	56.0	49.5	44.0	40.5	37.0	30.0
	W	302.0	262.0	203.0	153.0	124.0	105.0	93.5	83.5	77.0	70.5	57.5
UXH63-12	A	233.0	197.0	143.0	105.0	84.4	70.6	62.4	55.4	51.0	46.6	37.8
	W	380.0	330.0	255.0	193.0	156.0	132.0	118.0	105.0	97.0	88.8	72.5
UXH75-6	A	278.0	234.0	170.0	125.0	101.0	84.0	74.3	66.0	60.8	55.5	45.0
	W	452.0	393.0	304.0	230.0	186.0	157.0	140.0	125.0	116.0	106.0	86.3
UXH100-6	A	370.0	312.0	227.0	167.0	134.0	112.0	99.0	88.0	81.0	74.0	60.0
	W	603.0	524.0	405.0	306.0	248.0	209.0	187.0	167.0	154.0	141.0	115.0
UXH125-6	A	463.0	390.0	284.0	209.0	168.0	140.0	124.0	110.0	101.0	92.5	75.0
	W	754.0	655.0	506.0	383.0	310.0	261.0	234.0	209.0	193.0	176.0	144.0
UXH100-12N	A	370.0	312.0	227.0	167.0	134.0	112.0	99.0	88.0	81.0	74.0	60.0
	W	603.0	524.0	405.0	306.0	248.0	209.0	187.0	167.0	154.0	141.0	115.0
UXH200-6	A	740.0	624.0	452.0	334.0	268.0	224.0	198.0	176.0	162.0	148.0	120.0
	W	1204.0	1048.0	808.0	612.0	496.0	416.0	374.0	334.0	308.0	282.0	230.0

Amperes to F.V.1.70 Volts Per Cell

Battery Model		1 min	5 min	10 min	15 min	20 min	25 min	30 min	35 min	40 min	45 min	1 h	2 h	3 h
UXH38-12	A	123.0	106.0	73.7	57.4	47.9	41.4	36.5	32.3	29.3	27.0	22.0	13.7	9.9
	W	211.0	186.0	133.0	106.0	88.9	77.9	69.2	61.6	55.9	51.7	42.6	26.6	19.4
UXH50-12	A	162.0	139.0	97.0	75.5	63.0	54.5	48.0	42.5	38.5	35.5	29.0	18.0	13.0
	W	277.0	245.0	176.0	139.0	117.0	103.0	91.0	81.0	73.5	68.0	56.0	35.0	25.5
UXH63-12	A	204.0	175.0	122.0	95.1	79.4	68.7	60.5	53.6	48.5	44.7	36.5	22.7	16.4
	W	349.0	308.0	221.0	175.0	147.0	129.0	115.0	102.0	92.6	85.7	70.6	44.1	32.1
UXH75-6	A	243.0	209.0	146.0	113.0	94.5	81.8	72.0	63.8	57.8	53.3	43.5	27.0	19.5
	W	416.0	367.0	263.0	209.0	176.0	154.0	137.0	122.0	110.0	102.0	84.0	52.5	38.3
UXH100-6	A	324.0	278.0	194.0	151.0	126.0	109.0	96.0	85.0	77.0	71.0	58.0	36.0	26.0
	W	554.0	489.0	351.0	278.0	234.0	205.0	182.0	162.0	147.0	136.0	112.0	70.0	51.0
UXH125-6	A	405.0	348.0	243.0	189.0	158.0	136.0	120.0	106.0	96.3	88.8	72.5	45.0	32.5
	W	693.0	611.0	439.0	348.0	293.0	256.0	228.0	203.0	184.0	170.0	140.0	87.5	63.8
UXH100-12N	A	324.0	278.0	194.0	151.0	126.0	109.0	96.0	85.0	77.0	71.0	58.0	36.0	26.0
	W	554.0	489.0	351.0	278.0	234.0	205.0	182.0	162.0	147.0	136.0	112.0	70.0	51.0
UXH200-6	A	648.0	556.0	388.0	302.0	252.0	218.0	192.0	170.0	154.0	142.0	116.0	72.0	52.0
	W	1106.0	976.0	700.0	556.0	468.0	408.0	364.0	324.0	294.0	272.0	224.0	140.0	102.0

Amperes to F.V.1.80 Volts Per Cell

Battery Model		1 min	5 min	10 min	15 min	20 min	25 min	30 min	35 min	40 min	45 min	1 h	2 h	3 h	5 h	8 h	10 h	20 h
UXH38-12	A	99.2	86.3	63.8	52.8	44.8	38.8	35.0	31.2	28.1	26.2	21.3	12.9	9.5	6.1	4.2	3.5	1.90
	W	179.0	157.0	118.0	99.2	84.7	73.7	66.9	59.7	54.3	50.5	41.4	25.1	18.6	12.2	8.4	6.8	3.80
UXH50-12	A	131.0	114.0	84.0	69.5	59.0	51.0	46.0	41.0	37.0	34.5	28.0	17.0	12.5	8.0	5.5	4.6	2.50
	W	236.0	207.0	156.0	131.0	112.0	97.0	88.0	78.5	71.5	66.5	54.5	33.0	24.5	16.0	11.0	9.0	5.00
UXH63-12	A	164.0	143.0	106.0	87.6	74.3	64.3	58.0	51.7	46.6	43.5	35.3	21.4	15.8	10.1	6.9	5.8	3.15
	W	297.0	260.0	196.0	164.0	140.0	122.0	111.0	98.9	90.1	83.8	68.7	41.6	30.9	20.2	13.9	11.3	6.30
UXH75-6	A	196.0	170.0	126.0	104.0	88.5	76.5	69.0	61.5	55.5	51.8	42.0	25.5	18.8	12.0	8.3	6.9	3.75
	W	353.0	310.0	233.0	196.0	167.0	146.0	132.0	118.0	107.0	99.8	81.8	49.5	36.8	24.0	16.5	13.5	7.50
UXH100-6	A	261.0	227.0	168.0	139.0	118.0	102.0	92.0	82.0	74.0	69.0	56.0	34.0	25.0	16.0	11.0	9.3	5.00
	W	471.0	413.0	311.0	261.0	223.0	194.0	176.0	157.0	143.0	133.0	109.0	66.0	49.0	32.0	22.0	18.0	10.00
UXH125-6	A	326.0	284.0	210.0	174.0	148.0	128.0	115.0	103.0	92.5	86.3	70.0	42.5	31.3	20.0	13.8	11.6	6.25
	W	589.0	516.0	389.0	326.0	279.0	243.0	220.0	196.0	179.0	166.0	136.0	82.5	61.3	40.0	27.5	22.5	12.50
UXH100-12N	A	261.0	227.0	168.0	139.0	118.0	102.0	92.0	82.0	74.0	69.0	56.0	34.0	25.0	16.0	11.0	9.3	5.00
	W	471.0	413.0	311.0	261.0	223.0	194.0	176.0	157.0	143.0	133.0	109.0	66.0	49.0	32.0	22.0	18.0	10.00
UXH200-6	A	520.0	452.0	336.0	278.0	236.0	204.0	184.0	164.0	148.0	138.0	112.0	68.0	50.0	32.0	22.0	18.6	10.00
	W	940.0	824.0	620.0	520.0	444.0	388.0	352.0	314.0	286.0	266.0	218.0	132.0	98.0	64.0	44.0	36.0	20.00

14. Proximity Switch

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

PROXIMITY SWITCH

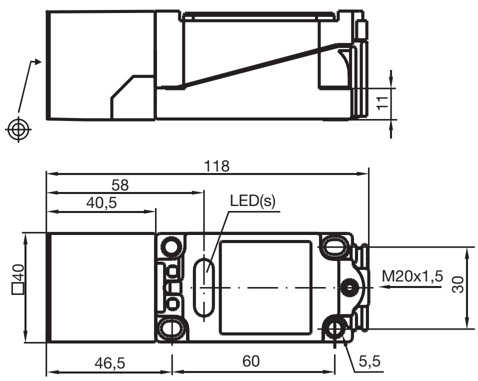
1. NJ20+U1+E2 PROXIMITY SWITCH TECHNICAL DETAILS

Inductive proximity switches

NJ20+U1+E2

Comfort series

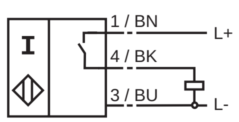
20 mm embeddable



Switching element function	PNP Make function
Rated operating distance s_n	20 mm
Installation	embeddable
Assured operating distance s_a	0 ... 16,2 mm
Reduction factor r_{Al}	0,35
Reduction factor r_{Cu}	0,35
Reduction factor r_{V2A}	0,8
Operating voltage U_B	10 ... 60 V
Switching frequency f	0 ... 150 Hz
Hysteresis H	1 ... 10 typ. 5 %
Reverse polarity protection	Protected against reverse polarity
Short circuit protection	pulsing
Voltage drop U_d	≤ 2,8 V
Operating current I_L	0 ... 200 mA
Off-state current I_r	0 ... 0,5 mA typ. 0,01 mA
No-load supply current I_0	≤ 10 mA
Operating voltage display	LED, green
Indication of the switching state	LED, yellow
Standards	EN 60947-5-2
Ambient temperature	-25 ... 70 °C (248 ... 343 K)
Storage temperature	-25 ... 85 °C (248 ... 358 K)
Connection type	terminal compartment
Core cross-section	up to 2.5 mm^2
Housing material	PBT
Sensing face	PBT
Protection degree	IP68

Connection_type:

E2



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2003-06-02

www.pepperl-fuchs.com

PEPPERL+FUCHS GmbH

15. Pushbutton & Indicator

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

PUSHBUTTON & INDICATORS

1. PUSH BUTTON TECHNICAL DETAILS
2. HOUR RUN METER TECHNICAL DETAILS

Economical Devices for High Performance Switching & Control Solutions

Series D7 Pilot Devices

22mm Design Saves Panel Space | **Heavy Duty Ratings** | **Modular Design Reduces Inventory** | **Order Assembled or by Component**

Sprecher + Schuh's rugged D7 pilot devices offer maximum flexibility and a wide choice for all applications. This 22mm line is aesthetically appealing and modularly designed to make assembly and interchangeability easy. The D7 operators are available in two different body styles to meet every industrial application need. Both operators exhibit a new lower profile stylish appearance while maintaining the rugged performance necessary for demanding environments.

Features

TWO OPERATOR TYPES
- Plastic operator with captive front bezel
- Metal operator with die-cast zinc housing and captive shiny metal bezel

LESS INVENTORY, MORE CHOICES
- Wide range of style choices
- Modular design for mix and match flexibility
- Endless configurations from core components

QUICK, EASY INSTALLATION
- Tool-less mounting latch for quick assembly
- Anti-rotation tab for one person installation
- Snap-on back panel components

LONG ELECTRICAL & MECHANICAL LIFE
- 10 million mechanical operations
- 10 million electrical cycles

ENVIRONMENTAL RATINGS
- UL Type 4/4X/13, IP66 Sealing
- Chemical resistant industrial grade thermoplastic body
- Corrosion and UV resistant

sprecher+schuh

Fast Mounting

Tool-less, snap-in design for fast assembly

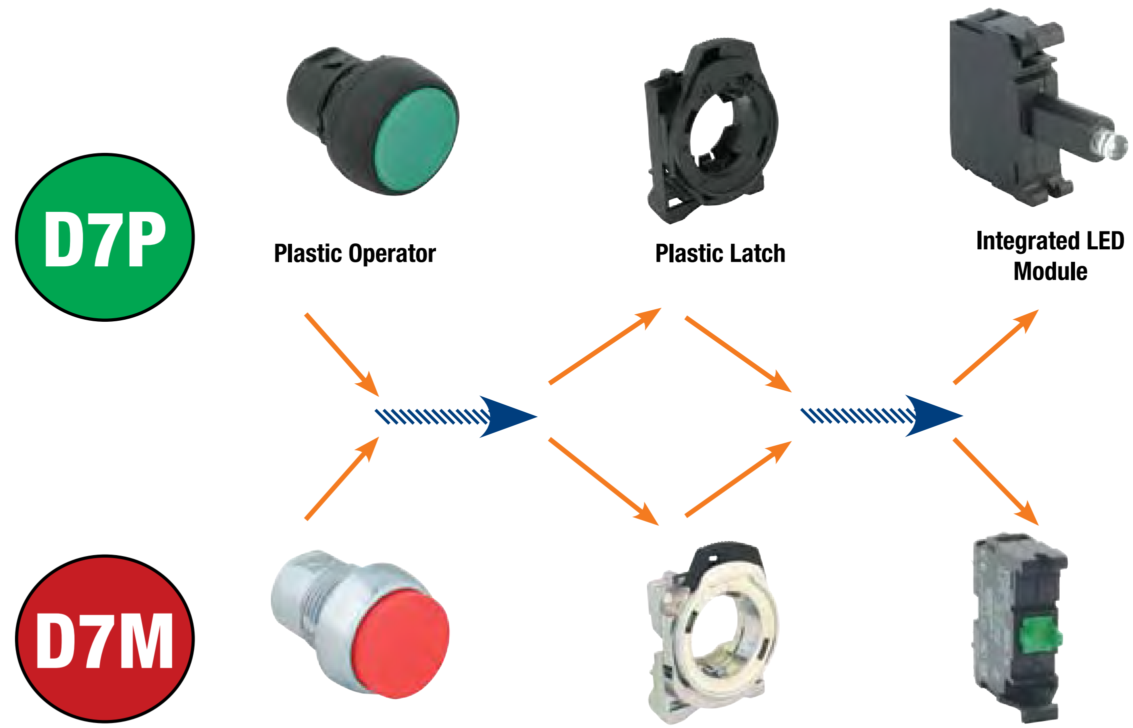
Snap down color coded contact blocks

Rotating collar for easy assembly and removal

Anti-rotation tab provides accurate alignment and eliminates operator and legend plate rotation. The tab is easily removed for use in panels without notches.

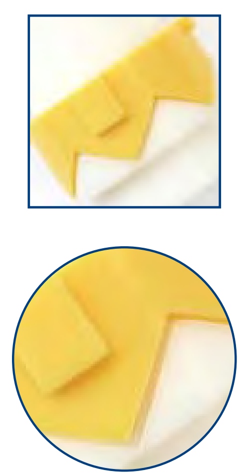
Easy one-person mounting and removal provide both time and cost savings.

Flexibility



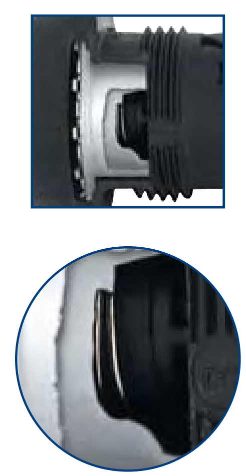
Complete Accessories

Superior Design



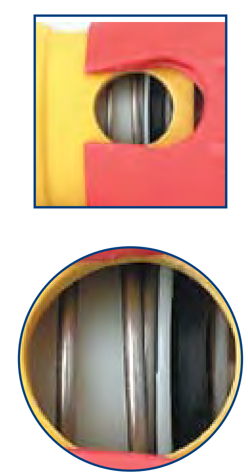
Selector Switch Safety

- *Positive Detent*
- *Constant Energy*



Diaphragm Seal

- *Flexes with operation*
- *Dependent on lubrication*



K-Seal

- *Dual wiping action*
- *Lubrication trapping extends sealing life*

Panel Gaskets

- *Seals both panel & mounting blades*

Push Buttons

Extended

*Flush Guarded**

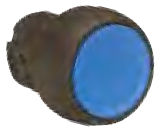
Illuminated

	Momentary, Extended		Momentary, Flush*		Maintained, Flush	
	Plastic	Metal	Plastic	Metal	Plastic	Metal
•	D7P-LE0	D7M-LE0	D7P-LF0	D7M-LF0	D7P-LFA0	D7M-LFA0
•	D7P-LE3	D7M-LE3	D7P-LF3	D7M-LF3	D7P-LFA3	D7M-LFA3
•	D7P-LE4	D7M-LE4	D7P-LF4	D7M-LF4	D7P-LFA4	D7M-LFA4
•	D7P-LE5	D7M-LE5	D7P-LF5	D7M-LF5	D7P-LFA5	D7M-LFA5
•	D7P-LE6	D7M-LE6	D7P-LF6	D7M-LF6	D7P-LFA6	D7M-LFA6
○	D7P-LE7	D7M-LE7	D7P-LF7	D7M-LF7	D7P-LFA7	D7M-LFA7
ø	D7P-LE9	D7M-LE9	D7P-LE9	D7M-LE9	D7P-LEA9	D7M-LEA9

ø Push Button without Cap

* Guarded available on Momentary Flush only

Extended



Flush

Non-Illuminated

	Momentary, Extended		Momentary, Flush*		Maintained, Flush	
	Plastic	Metal	Plastic	Metal	Plastic	Metal
•	D7P-E0	D7M-E0	D7P-F0	D7M-F0	D7P-FA0	D7M-FA0
○	D7P-E1	D7M-E1	D7P-F1	D7M-F1	D7P-FA1	D7M-FA1
•	D7P-E2	D7M-E2	D7P-F2	D7M-F2	D7P-FA2	D7M-FA2
•	D7P-E3	D7M-E3	D7P-F3	D7M-F3	D7P-FA3	D7M-FA3
•	D7P-E4	D7M-E4	D7P-F4	D7M-F4	D7P-FA4	D7M-FA4
•	D7P-E5	D7M-E5	D7P-F5	D7M-F5	D7P-FA5	D7M-FA5
•	D7P-E6	D7M-E6	D7P-F6	D7M-F6	D7P-FA6	D7M-FA6
ø	D7P-E9	D7M-E9	D7P-F9	D7M-F9	D7P-FA9	D7M-FA9

ø Push Button without Cap

* Guarded available on Momentary Flush only

Illuminated

40mm Mushroom, Momentary

	Plastic	Metal
•	D7P-LMM3	D7M-LMM3
•	D7P-LMM4	D7M-LMM4
•	D7P-LMM5	D7M-LMM5
•	D7P-LMM6	D7M-LMM6
○	D7P-LMM7	D7M-LMM7

Also available in 60mm Mushroom

Non-Illuminated

40mm Mushroom, Momentary

	Plastic	Metal
•	D7P-MM42	D7M-MM42
•	D7P-MM43	D7M-MM43
•	D7P-MM44	D7M-MM44
•	D7P-MM45	D7M-MM45
•	D7P-MM46	D7M-MM46

Emergency Stops

Illuminated

Twist-to-release, 40mm Mushroom

	Plastic	Metal
	D7P-LMT44	D7M-LMT44
	Complete Unit	
1NC:	D7P-LMT44PX01	D7M-LMT44PX01
1 Guardian:	D7P-LMT44PX01S	D7M-LMT44PX01S

Non-Illuminated

Twist-to-release, 30mm Mushroom

	Plastic	Metal
	D7P-MT34	D7M-MT34
	Complete Unit	
1NC:	D7P-MT34PX01	D7M-MT34PX01
1 Guardian:	D7P-MT34PX01S	D7M-MT34PX01S

Twist-to-release, 40mm Mushroom

	Plastic	Metal
	D7P-MT44	D7M-MT44
	Complete Unit	
1NC:	D7P-MT44PX01	D7M-MT44PX01
1 Guardian:	D7P-MT44PX01S	D7M-MT44PX01S

Twist-to-release, 60mm Mushroom

	Plastic	Metal
	D7P-MT64	D7M-MT64
	Complete Unit	
1NC:	D7P-MT64PX01	D7M-MT64PX01
1 Guardian:	D7P-MT64PX01S	D7M-MT64PX01S

Keyed

Twist-to-release, 40mm Mushroom

	Plastic	Metal
	D7P-MK44	D7M-MK44
	Complete Unit	
1NC:	D7P-MK44PX01	D7M-MK44PX01
1 Guardian:	D7P-MK44PX01S	D7M-MK44PX01S

Pilot Lights

	Plastic	Metal
•	D7P-P0	D7M-P0
•	D7P-P3	D7M-P3
•	D7P-P4	D7M-P4
•	D7P-P5	D7M-P5
•	D7P-P6	D7M-P6
○	D7P-P7	D7M-P7
ø	D7P-P9	D7M-P9

ø Pilot light without lens or diffuser

Push-Pull Operators

2 Position Illuminated

Push-Pull, 40mm Mushroom

	Plastic	Metal
•	D7P-LMP43	D7M-LMP43
•	D7P-LMP44	D7M-LMP44
•	D7P-LMP45	D7M-LMP45
	Complete Unit	
1NC:	D7P-LMP44PX01	D7M-LMP44PX01
1 Guardian:	D7P-LMP44PX01S	D7M-LMP44PX01S

Push-Pull, 30mm Mushroom

	Plastic	Metal
•	D7P-LMP33	D7M-LMP33
•	D7P-LMP34	D7M-LMP34
•	D7P-LMP35	D7M-LMP35

Push-Pull, 60mm Mushroom

	Plastic	Metal
•	D7P-LMP63	D7M-LMP63
•	D7P-LMP64	D7M-LMP64
•	D7P-LMP65	D7M-LMP65

2 Position Non-Illuminated

Push-Pull, 40mm Mushroom

	Plastic	Metal
•	D7P-MP42	D7M-MP42
•	D7P-MP44	D7M-MP44
	Complete Unit	
1NC:	D7P-MP44PX01	D7M-MP44PX01
1 Guardian:	D7P-MP44PX01S	D7M-MP44PX01S

3 Position Illuminated

Push-Pull, 40mm Mushroom

	Momentary	Maintained
•	D7M-LMM40-E3	D7M-LMP40-E3
•	D7M-LMM43-E3	D7M-LMP43-E3
•	D7M-LMM44-E3	D7M-LMP44-E3
•	D7M-LMM46-E3	D7M-LMP46-E3
•	D7M-LMM47-E3	D7M-LMP47-E3

3 Position Non-Illuminated

Push-Pull, 40mm Mushroom

	Momentary	Maintained
•	D7M-MM42-E3	D7M-MP42-E3
•	D7M-MM43-E3	D7M-MP43-E3
•	D7M-MM44-E3	D7M-MP44-E3

Reset Operators

Mechanical and/or Electrical Reset

	Plastic	Metal
○	D7P-R1	D7M-R1
•	D7P-R2	D7M-R2
•	D7P-R6	D7M-R6

PUSH buttons
MONOLITHIC
emergency STOP
SELECTOR switches
MULTIfunction push buttons
COMPONENTS
PILOT lights
PUSH-PULL operators
RESET operators
OTHERswitches

Monolithic

Indicator Light
Plastic

LED	Incandescent
D7D-P0N♣	D7D-P0D♣
D7D-P3N♣	D7D-P3D♣
D7D-P4N♣	D7D-P4D♣
D7D-P5N♣	D7D-P5D♣
D7D-P6N♣	D7D-P6D♣
D7D-P7N♣	D7D-P7D♣

♣ Select lamp voltage and terminal type

Push Button
Non-Illuminated, Plastic, Momentary

Flush Cap	Extended Cap
D7D-F1♣	D7D-E1♣
D7D-F2♣	D7D-E2♣
D7D-F3♣	D7D-E3♣
D7D-F4♣	D7D-E4♣
D7D-F5♣	D7D-E5♣
D7D-F6♣	D7D-E6♣

♣ Select cap text and contact configuration

E-STOP Push Button
Push-Pull and Twist-to-release, 40mm Mushroom, Plastic

D7D-MT44X01	1NC
D7D-MT44X11	1NO 1NC
D7D-MT44X02	2NC

Also available with spring return

Selector Switch
Non-Illuminated, Plastic

2 Position, Maintained

- D7D-SM22X10 1NO
- D7D-SM22X01 1NC
- D7D-SM22X20 2NO
- D7D-SM22X02 2NC
- D7D-SM22X11 1NO, 1NC

3 Position, Maintained

- D7D-SM32X20 2NO
- D7D-SM32X02 2NC
- D7D-SM32X11 1NO, 1NC

Selector Switches

Also available with spring return

Non-Illuminated

2 Position, Maintained

Plastic	Metal
D7P-SM22	D7M-SM22

3 Position, Maintained

Plastic	Metal
D7P-SM32	D7M-SM32

Illuminated

2 Position, Maintained

Plastic	Metal
D7P-LSM20	D7M-LSM20
D7P-LSM23	D7M-LSM23
D7P-LSM24	D7M-LSM24
D7P-LSM25	D7M-LSM25
D7P-LSM26	D7M-LSM26
D7P-LSM27	D7M-LSM27

3 Position, Maintained

Plastic	Metal
D7P-LSM30	D7M-LSM30
D7P-LSM33	D7M-LSM33
D7P-LSM34	D7M-LSM34
D7P-LSM35	D7M-LSM35
D7P-LSM36	D7M-LSM36
D7P-LSM37	D7M-LSM37

Multi-function

Illuminated

2 Function

Plastic	Metal
D7P-LU2X	D7M-LU2X

Non-Illuminated

2 Function

Plastic	Metal
D7P-U2X	D7M-U2X

3 Functions

Plastic	Metal
D7P-U3X	D7M-U3X

Other Switches

Toggle Switch
Metal

2 Position

D7M-JR2	Momentary
D7M-JM2	Maintained

4 Position

D7M-JR4	Momentary
D7M-JM4	Maintained

Potentiometer
Single Turn, Assembled

Plastic	Resistive Element
D7P-POT	None (Operator Only)
D7P-POT1	150 Ω
D7P-POT2	500 Ω
D7P-POT3	1000 Ω
D7P-POT4	2500 Ω
D7P-POT5	5000 Ω
D7P-POT6	10000 Ω

Also available with spring return

Key Selector Switches

2 Position, Maintained

Plastic	Metal
D7P-KM21	D7M-KM21
D7P-KM22	D7M-KM22
D7P-KM23	D7M-KM23

3 Position, Maintained

Plastic	Metal
D7P-KM31	D7M-KM31
D7P-KM33	D7M-KM33
D7P-KM34	D7M-KM34
D7P-KM35	D7M-KM35

Selector/Jog Operators

2 Position

Plastic	Metal
D7P-SJ22	D7M-SJ22
D7P-SJ23	D7M-SJ23

3 Position

Plastic	Metal
D7P-SJ32	D7M-SJ32
D7P-SJ33	D7M-SJ33

Components

Contact Blocks
(latch not included)

D7-X10	1NO
D7-X01	1NC
D7-X01B	1NC Early Break
D7-X10E	1NO Early Make
D7-X01L	1NC Late Break
D7-X10V(1mA)	1NO Low Voltage
D7-X01V(1mA)	1NC Low Voltage
D7-X01S	Guardian Block
D7-Q10	1NO Screwless
D7-Q01	1NC Screwless

Integrated LED Module
(latch not included)

Screw Type

D7-N3✱	24V AC/DC
D7-N5✱	120V AC
D7-N7✱	240V AC

Spring-Clamp

D7-Q3✱	24V AC/DC
D7-Q5✱	120V AC
D7-Q7✱	240V AC

✱ Add LED Color, R=red, G=green, Y=yellow, B=blue, W=white

Plastic Latch
D7-ALP

Metal Latch
D7-ALM

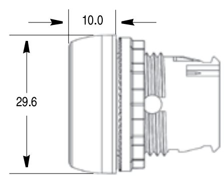
Incandescent Power Module
(bulb not included)

D7-DOC	6-240V AC/DC

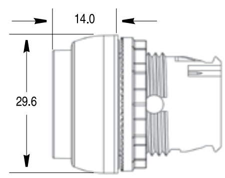
D7 Pilot Devices

Dimensions* *(Approximately in millimeters)*

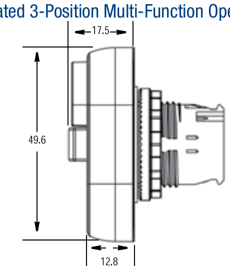
Non-Illuminated and Illuminated
Flush Push Button Operators (D7x-F)



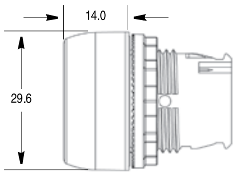
Illuminated and Non-Illuminated
Extended Push Button Operators



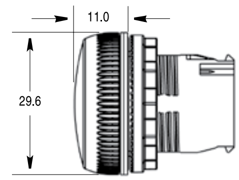
Non-Illuminated 3-Position Multi-Function Operators (D7x-U3)



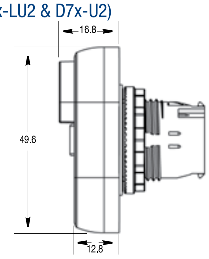
Non-Illuminated Guarded and Non-Illuminated
Maintained Push Button Operators (D7x-G and D7x-FA)



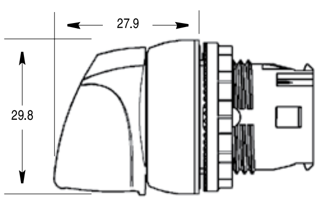
Pilot Light Operators (D7x-P)



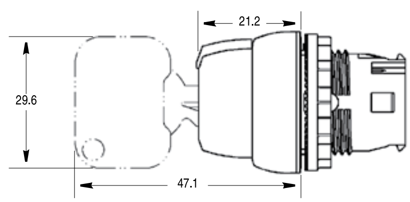
Illuminated and Non-Illuminated 2-Position Multi-Function
Operators (D7x-LU2 & D7x-U2)



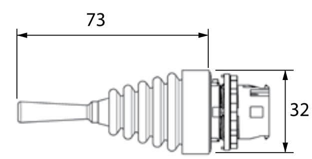
Illuminated and Non-Illuminated Knob Selector Switch
Operators (D7x-LS & D7x-S)



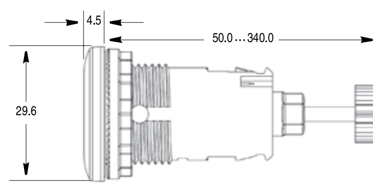
Key Selector Switch Operators (D7x-K)



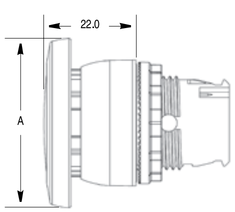
Toggle Switch Operators (D7M-JM)



Reset Operators (D7x-R)

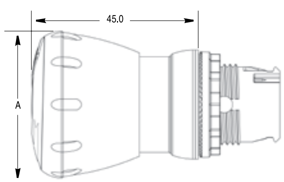


Illuminated and Non-Illuminated
Momentary Mushroom Operators
40mm and 60mm (D7x-LMM & D7x-MM)



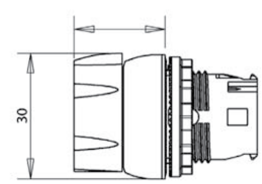
Operator	A
40mm	39.8
60mm	59.8

Illuminated and Non-Illuminated Twist-to-Release
Operators 30mm, 40mm, and 60mm (D7x-MT)

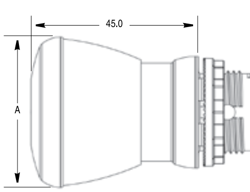


Operator	A
30mm	30
40mm	40
60mm	60

Selector Jog Operators (D7x-SJ)

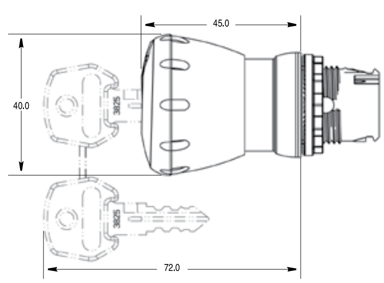


Illuminated and Non-Illuminated
Push-Pull Mushroom Operators 30mm, 40mm, and 60mm
(D7x-MP)

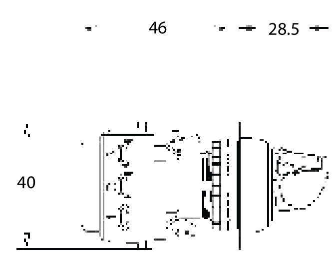


Operator	A
30mm	30
40mm	40
60mm	60

Mushroom Key Release Operator 40mm (D7x-MK)



Potentiometer with Resistive Element (D7P- POT)



* For Monolithic Devices see the D7D Monolithic Flyer

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Technical Information

Series D7 – Heavy Duty/Oil Tight

Pilot Devices

D7

Front-of-Panel (Operators) ❶

Mechanical Ratings

Description			Plastic (D7P)	Metal (D7M)
Vibration (assembled to panel)		[G]	Tested at 10 ...2000Hz, 1.52mm displacement (peak-to-peak) max./10G max. for 3hr duration, no damage	
Shock		[G]	Tested at 1/2 cycle sine wave for 11ms; no damage at 100G	
Degree of protection ❷			UL Type 3/3R/4/4X/12/13 (IP65/66)	UL Type 3/3R/4/12/13 (IP65/66)
Mechanical durablity per EN 60947-5-1 (Annex C)	10,000,000 Cycles		Momentary push buttons, momentary mushroom	
	1,000,000 Cycles		Multi-function, Selector Switch, Key Selector Switch, Selector Jog	
	500,000 Cycles		Non-illuminated Push-Pull E-Stop	
	300,000 Cycles		Twist-to-Release E-Stop, Illuminated Push-Pull E-Stop, Maintained Push Buttons, selector switches	
	100,000 Cycles		Potentiometer, Toggle Switch	
Operating forces (typical with one contact block)		[N]	Flush/extended = 5N E-stop = 36N Mushroom = 9N	
Operating torque (typical application with one contact block)		[N·m]	Selector switch = 0.25 N·m (2.2 lb-in.)	
Mounting torque		[N·m]	1.7 N•m (15 lb-in.)	4.4 N•m (40 lb-in.)

Environmental

Temperature range (operating) ❸	[ºC]	-25...+70ºC (-13...+158ºF)
Temperature range (short-term storage)	[ºC]	-40...+85ºC (-40...+185ºF)
Humidity	[%]	50...95% RH from 25...60ºC (77...140ºF) per: Procedure IV of MIL-STD-810C, Method 507.1 cycling test

Back-of-Panel Components ❶

Electrical Ratings

Standard contact block ratings			A600, Q600 600V AC AC15, DC 13 to EN 60947-5-1 and UL 508, 17V, 5mA min.		
Low voltage contact block ratings ❹			5V, 1mA DC min. C300, R150, AC 15, DC 13 to EN 60947-5-1 and UL 508		
LED Module Ratings	Nominal Voltage		Range	Current Draw	Frequency
	24V AC		10...29V AC	31 mA	50/60 Hz
	24V DC		10...30V DC	24 mA	DC
	120V AC		70...132V AC	25 mA	50/60 Hz
	240V AC		180...264V AC	22 mA	50/60 Hz
Thermal current		[A]	10 A max. enclosed (40ºC ambient) to UL 508, EN 60947-5-1		
Wire capacity	Screw terminal ❺	[AWG]	#18...12 AWG (0.75...2.5mm²) Max. (2) #14 AWG or (1) #12 AWG		
	Spring-clamp terminal	[AWG]	#18...14 AWG (0.75...1.5mm²)		
Recommended tightening torque on screw terminals		[N]	0.7...0.9 N • m (6...8 lb-in.)		
Insulation voltage		[U_i]	U_i = 690 V (screw terminal) U_i = 300 V (screwless terminal)		
Dielectric strength (minimum)		[V]	2500V for one minute		
External short circuit protection	Standard blocks		10 A type gL/gG cartridge fuse to EN 60269-2-1 or gN (Class J to UL 248-8 or Class C to UL 248-4)		
	Low voltage contact blocks		6 A type gL/gG cartridge fuse to EN 60269-2-1 or gN (Class J to UL 248-8 or Class C to UL 248-4)		
Electrical shock protection			Finger-safe conforming to IP2X		

Mechanical Ratings

Vibration (assembled to panel)		[G]	10...2000 Hz, 1.52mm displacement (peak-to-peak) max./10G max. 6hr
Shock		[G]	Tested at 1/2 cycle sine wave for 11ms and no damage at 100G max.
Contact durability per EN 60947-5-1 (Annex C)			10,000,000 cycles
Contact operation	NO		Slow double make and break
	NC		Slow double make and break - positive opening ⊖
	NOEM		Double break / double make / early make
	NCLB		Double break / double make, late break - positive opening ⊖
	NCEB		Double break / double make, early break - positive opening ⊖
Push button travel to change electrical state			N.C. and N.O.E. M. 1.5 mm (0.060 in.)
			N.O. and N.C.L.B. 2.5 mm (0.1 in.)
Operating forces (typical)		[N]	3.4 N: each single circuit contact block 5...6.5 N: each dual circuit contact block

❶ Performance data given in this publication is provided only as a guide for the user in determining suitability and do not constitute a performance warranty of any kind. Such data may represent the results of accelerated testing at elevated stress levels, and the user is responsible for correlating the data to actual application requirements. ALL WARRANTIES AS TO ACTUAL PERFORMANCE, WHETHER EXPRESS OR IMPLIED, ARE EXPRESSLY DISCLAIMED.
❷ Momentary mushroom operators are IP65, multi-function operators have no Type 13 rating. Plastic operators with keys have no Type 4X rating.
❸ Operating temperatures below 0ºC (32ºF) are based on the absence of freezing moisture and liquids, UL recognized to 55˚C (131˚F) - incandescent module, max 40˚C (104˚F).
❹ Low voltage contacts are recommended for applications below 17V, 5 mA.
❺ Wires less than #18 (0.75mm²) may not hold in terminal securely.

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Back-of-Panel Components ❶, continued

Illumination			
LED dominant wavelength	Green Red Yellow Blue White	[nm]	525 nm 629 nm 590 nm 470 nm —
LED luminous intensity	Green Red Yellow Blue White	[mcd]	890 mcd 890 mcd 690 mcd 193 mcd 412 mcd
Incandescent maximum wattage		[W]	2.6W
Materials			
Springs			Stainless steel and zinc coated music wire
Electrical contacts	Standard		Silver-nickel
	Low voltage		Gold-plated over silver
Terminals	Screw		Brass
	Screwless		Silver-plated brass

Environmental Approval Note: Front elements UL Recognized; Complete assemblies UL Approved.
See Table A2 for your application.

This table is extracted from Sprecher + Schuh's UL 508A file and can be used to determine which D7 Pilot Device is approved for a particular enclosure type.

TABLE A2 - Openings in Enclosure

Enclosure Type	Openings May Be Closed By Equipment Marked...
2	2, 3, 3R, 3S, 4, 4X, 6, 6P, 11, 12, 12K, 13
3	3, 3R, 3S, 4, 4X, 6, 6P
3R	3, 3R, 3S, 4, 4X, 6, 6P
3S	3, 3R, 3S, 4, 4X, 6, 6P
4	4, 4X, 6, 6P
4X	4X
6	6, 6P
6P	6P
11	11
12, 12K	12, 12K, 13
13	13

Product Certifications

Certifications	UL, UR, CSA, CCC, CE
Conformity of Standards - CE marked	NEMA ICS-5; UL 508, EN 418, EN 60947-1, EN 60947-5-1, EN 60947-5-5
Terminal identification	IEC 60947-1
Shipping approvals	RINA, LR, ABS
RoHS	✓

❶ Performance data given in this publication is provided only as a guide for the user in determining suitability and do not constitute a performance warranty of any kind. Such data may represent the results of accelerated testing at elevated stress levels, and the user is responsible for correlating the data to actual application requirements. ALL WARRANTIES AS TO ACTUAL PERFORMANCE, WHETHER EXPRESS OR IMPLIED, ARE EXPRESSLY DISCLAIMED.

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Technical Information

Series D7 – Heavy Duty/Oil Tight

Material Listing

Component	For Use with	Material Used
Panel gasket	All operators	Nitrile, TPE
Diaphragm seal	Illuminated push button, non-illuminated push button	Automotive industry acceptable silicone
K-seal	Selector switch, key selector switch, push/twist-to-release E-stop, key E-stop, push/pull mushroom	Nitrile
Diaphragm retainer, return spring I	Illuminated push button, non-illuminated push button, momentary mushroom	Stainless steel
Return spring II	Reset, selector switch, key selector switch, maintained action, push/twist-to-release E-stop, key E-stop, push/pull mushroom	Zinc coated music wire
Button cap/mushroom head	Non-illuminated push button, momentary mushroom, reset, push/twist-to-release E-stop, key E-stop, push/pull mushroom, multi-function	PBT/polycarbonate blend
2-color molded button cap	Non-illuminated push button	PBT/polycarbonate blend
Lens	Multi-function	Acetal
Lens, knob	Illuminated push button, illuminated momentary mushroom, illuminated selector switch	Polyamide
Knob	Non-illuminated selector switch	Glass-filled polyamide
Plastic bezel/bushing I	Non-illuminated push button, illuminated push button, momentary mushroom, selector switch, key selector switch, push/twist-to-release E-stop, key E-stop, push/pull mushroom, multi-function, reset	Glass-filled polyamide
Plastic bezel/bushing II, jam nut	Pilot light, reset jam nut, reset pusher	Glass-filled PBT
Metal bezel/bushing	All metal operators	Zinc
Diffuser	Illuminated push button, pilot light	Polycarbonate
Legend frames	—	Glass-filled polyamide
Plastic mounting ring	All plastic operators	Glass-filled polyamide
Metal mounting ring	All metal operators	Chromated zinc
Plastic latch	—	Glass-filled polyamide
Metal latch	—	Chromated zinc + stainless steel
Plastic enclosure	—	PBT/polycarbonate blend
Metal enclosure	—	Aluminum
Terminal screws	LED module, incandescent module, contact blocks	Zinc-plated steel with chromate
Terminals	LED module, incandescent module, contact blocks	Brass with silver-nickel contacts
Screwless	LED module, incandescent module, contact blocks	Stainless steel
Lamp socket	Incandescent module	Brass
Housing	Incandescent module, LED module	Glass-filled polyamide
Low voltage terminals	Contact blocks	Gold plated silver-nickel contacts
Low voltage spanner	Contact blocks	Gold-plated silver-nickel contacts
Spanner	Contact blocks	Brass with silver-nickel contacts
Boot	Toggle Switch, illuminated push button, non-illuminated push button, multi-function illuminated an non-illuminated	Automotive industry acceptable silicone

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Specifications

Mechanical Ratings

Vibration (assembled to panel)	Tested at 10...2000 Hz, 1.52 mm displacement (peak-to-peak) max./10 G max. for 3 hr duration, no damage	
Shock	Tested at 1/2 cycle sine wave for 11 ms; no damage at 100 G	
Degree of protection	IP 66 (Type 3/3R/4/4X/12/13)	
mechanical durability per EN 60947-5-1 (Annex C)	2,000,000 Cycles	Momentary Push Button
	300,000 Cycles	Selector Switch and E-Stop
Operating forces	Flush/Extended = 9 N, E-stop = 36 N	
Operating torque (typical application with one contact block)	Selector Switch = 0.25 N•m	
Contact operation	N.O.	Slow double make and break
	N.C.	Slow double make and break - positive opening ⊖
Push button travel to change electrical state	N.O.	2.5 mm (0.1 in.)
	N.C.	1.5 mm (0.060 in.)

⊖ Positive Opening per EN60947-5-1 (applies to all NC contact block styles)

Environmental

Temperature range (operating) ❶	-25...+60°C (-13...140°F)
Temperature range (short term storage)	-40...+85°C (-40...185°F)
Humidity	50...95% RH from 25...60°C (77...140°F)

Electrical Ratings

Standard contact block ratings	B300, R300; AC 15, DC 13; 300 VAC; EN/IEC 60947-5-1 and UL 508, 17V, 5 mA min.			
LED Module Ratings	Nominal Voltage	Range	Nominal Current Draw	Frequency
	24V AC	20...26V AC	32 mA	50/60 Hz
	24V DC	18...30V DC	24 mA	DC
	120V AC	102...132V AC	22 mA	50/60 Hz
	240V AC	204...264V AC	22 mA	50/60 Hz
Thermal current	5 A max. enclosed (40°C ambient) to UL508, EN/IEC 60947-5-1			
Insulation voltage (Ui)	300V			
Wire capacity (screw terminal)	#18...14 AWG (0.75...2.5 mm²), Max. (2) #14 AWG, uses same size wire only			
Recommendations for Ring Lug termination option ❷	6.35 mm (0.250 in.) Max. outer diameter with 3.8 mm (0.148 in.) hole diameter			
Recommened tightening torque on screw terminals	0.7...0.9 N•m (6...8 lb-in.)			
Dielectric strength (minimum)	2500V for one minute			
External short circuit protection	5 A type gL/gG cartridge fuse to EN 60269-2-1 or gN (Class J to UL 248-8 or Class CC to UL 248-4)			
Electrical shock protection	Finger-safe conforming to IP2X			

Illumination

LED Dominant Wavelength	Green	Red	Yellow	Blue	White
	525 nm	629 nm	590 nm	470 nm	
LED Luminous Wavelength	Green	Red	Yellow	Blue	White
	890 mcd	890 mcd	690 mcd	193 mcd	412 mcd
Incandescent maximum wattage	2.6 W				

Materials

Springs	Stainless steel and zinc coated music wire
Electrical contacts	Brass with silver-nickel contacts
Terminals	Brass and phosphor bronze
Panel gasket	nitrile and polyester-based TPE
Seal	Nitrile
Button cap/mushroom head	Polyester/polycarbonate blend
Lens (pilot light)	Acrylic
Knob (selector switch)	Glass-filled polyamide
Bezel/bushing, housing	Glass filled polyester
Legend frames	Glass filled polyamide
Mounting ring	Glass filled polyamide
Terminal screws	Zinc-plated steel with chromate
Lamp Socket	Brass and Phosphor bronze

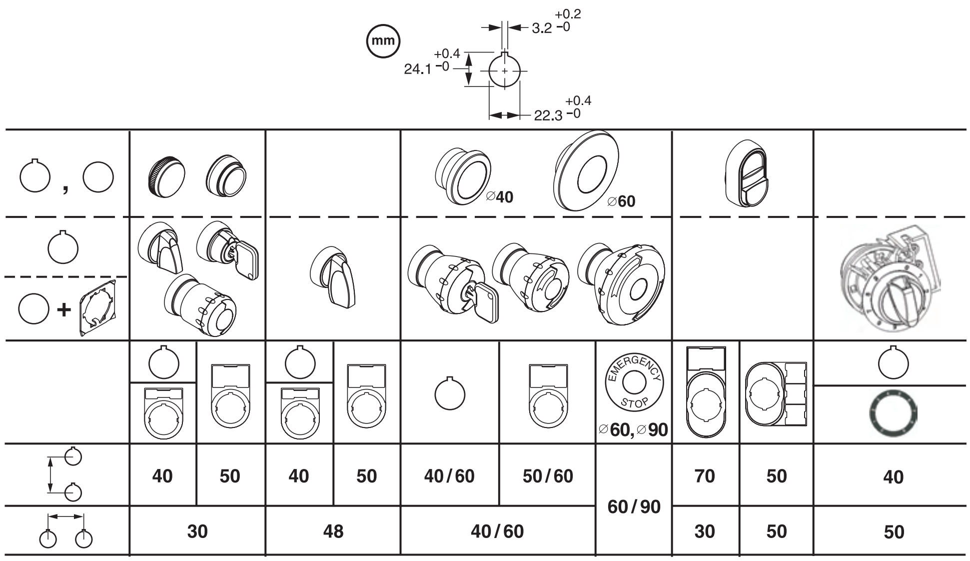
Product Certifications

Certifications	Ul, CSA, CCC, CE
Conformity to standards - CE marked	UL 508, EN 60947-1, EN 60947-5-1, EN 60947-5-5
Terminal Identification	EN/IEC 60947-1

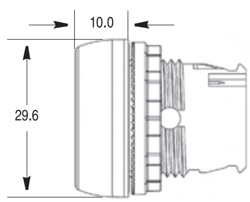
❶ Operating temperatures below 0ºC (32ºF) are based on the absence of freezing moisture and liquids.
❷ 3M MV018-R/S #(22…18 AWG) or 3M MVU14-6R/S (#16…14 AWG)

Approximate Dimensions – millimeters ❶

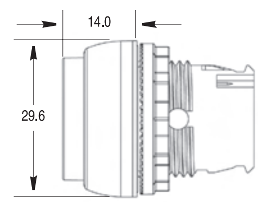
Panel Hole Spacing



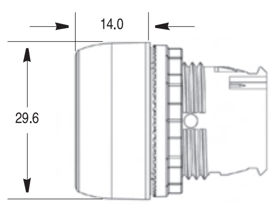
Non-illuminated and Illuminated Flush Push Button Operators **(D7x-F)**



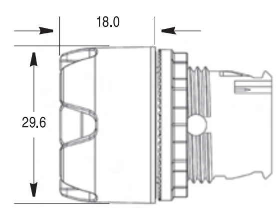
Illuminated and Non-illuminated Extended Push Button Operators **(D7x-LE & D7x-E)**



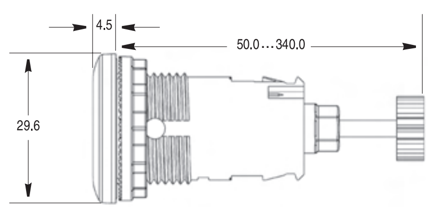
Non-illuminated Guarded and Non-illuminated Maintained Push Button Operators **(D7x-G and D7x-FA)**



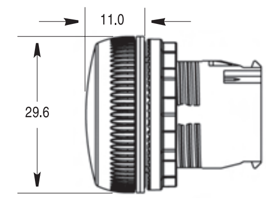
Illuminated Guarded Push Button Operators **(D7x-LG)**



Reset Operators **(D7x-R)**



Pilot Light Operators **(D7x-P)**



❶ Dimensions are not intended to be used for manufacturing purposes.

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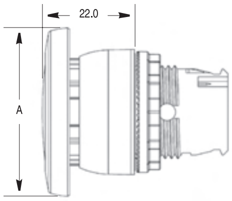
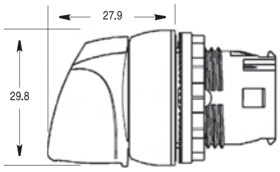
Approximate Dimensions – millimeters ❶

Illuminated and Non-illuminated Momentary Mushroom Operators 40mm and 60mm **(D7x-LMM & D7x-MM)**

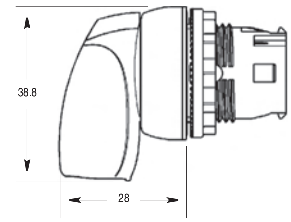


Operator	A
40mm	39.8
60mm	59.8

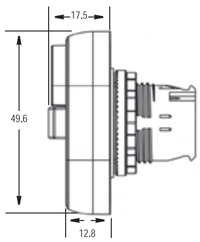
Illuminated and Non-illuminated Knob Selector Switch Operators **(D7x-LS & D7x-S)**



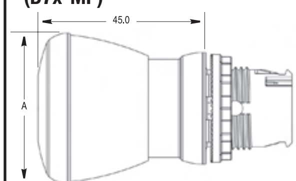
Non-illuminated Knob Lever Selector Switch Operators **(D7x-H)**



Non-illuminated 3-Position Multi-Function Operators **(D7x-U3)**

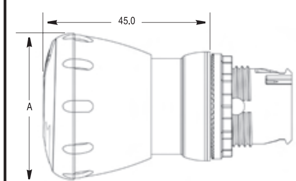


Illuminated and Non-illuminated Push-Pull Mushroom Operators 30mm, 40mm, and 60mm **(D7x-MP)**



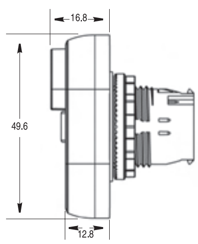
Operator	A
30mm	30
40mm	40
60mm	60

Illuminated and Non-illuminated Twist-to-Release Operators 30mm, 40mm, and 60mm **(D7x-MT)**

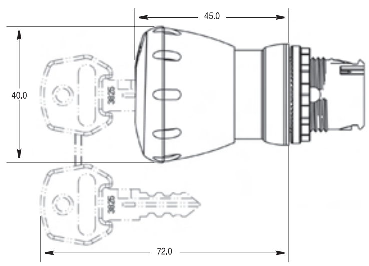


Operator	A
30mm	30
40mm	40
60mm	60

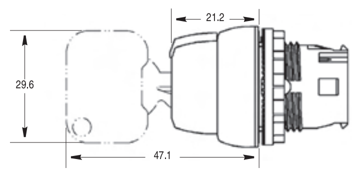
Illuminated and Non-illuminated 2-Position Multi-Function Operators **(D7x-LU2 & D7x-U2)**



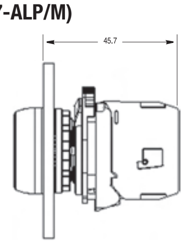
Mushroom Key Release Operator 40mm **(D7x-MK)**



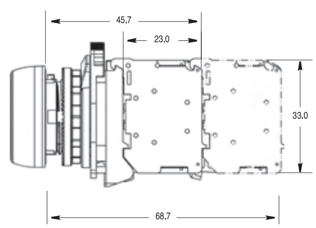
Key Selector Switch Operators **(D7x-K)**



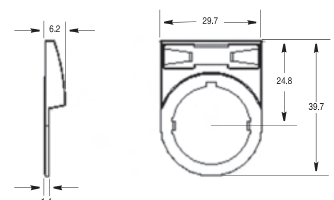
Back-of-Panel Components — Incandescent Module with Latch **(D7-DOC & D7-ALP/M)**



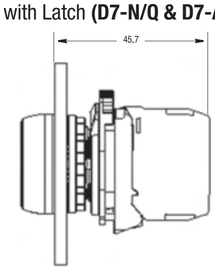
Back-of-Panel Components — Contact Cartridges with Latch **(D7-X/Q + D7-ALP/M)**



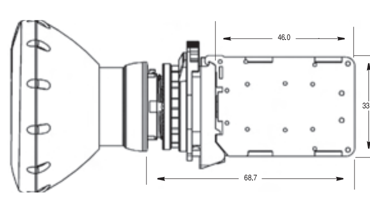
30 x 40mm Snap-in-Legend Plate **(D7-11)**



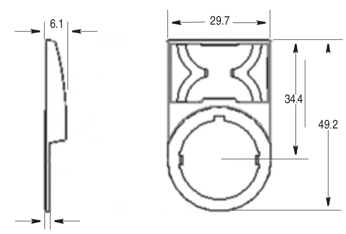
Back-of-Panel Components — LED Module with Latch **(D7-N/Q & D7-ALP/M)**



Back-of-Panel Components — Dual Circuit Contact Block (Max. of 1 Deep) **(D7x-X__D/D7-X01S)**



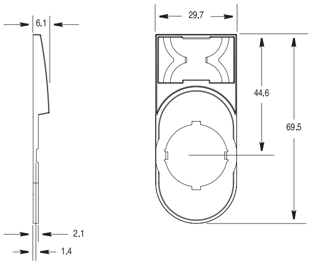
30 x 50mm Snap-in-Legend Plate **(D7-12)**



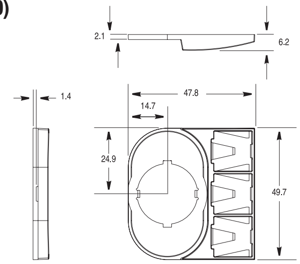
❶ Dimensions are not intended to be used for manufacturing purposes.

Approximate Dimensions – millimeters ❶❷

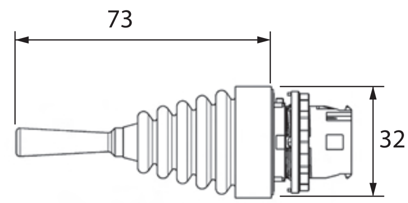
30 x 60mm Snap-in Legend Plate **(D7-20)**



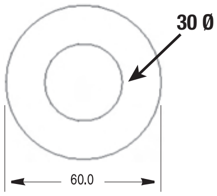
Special Multi-Function Snap-in Legend Plate **(D7-40)**



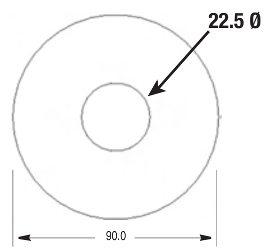
Toggle Switch Operators **(D7M-JM)**



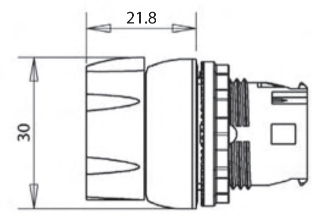
60mm Round Legend **(D7-15)**



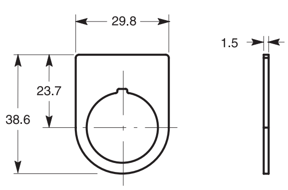
90mm Round Legend **(D7-16)**



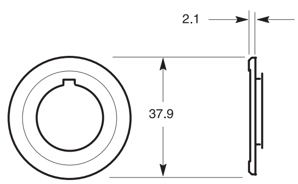
Selector Jog Operators **(D7x-SJ)**



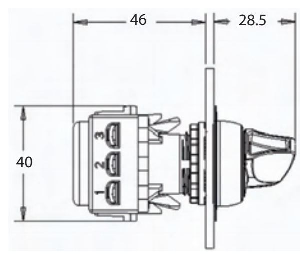
30 x 40mm One-Piece Legend Plate **(D7-34)**



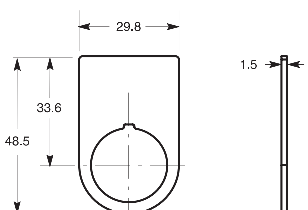
30mm to 22.5mm Hole Adapter **(D7-AHA1)**



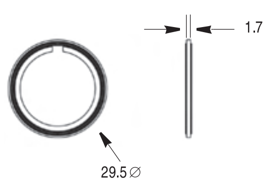
Potentiometer with Resistive Element **(D7P- POT)**



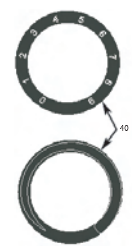
30 x 50mm One-Piece Legend Plate **(D7-35)**



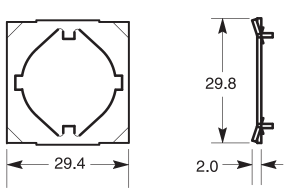
Trim Washer **(D7-ATW1)**



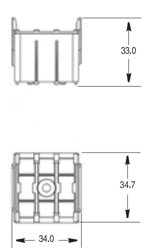
Potentiometer Legend Plate **(D7-30WN & D7-30WG)**



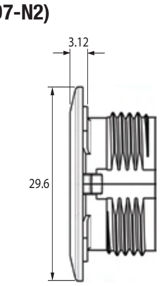
Anti-Rotation Washer **(D7-ALC1)**



Base Mount Adapter **(D7-A3BA)**



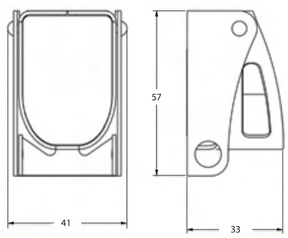
Hole Plug **(D7-N2)**



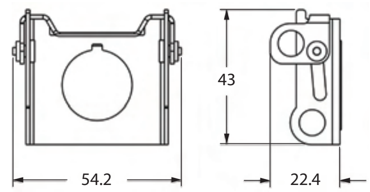
❶ Dimensions are not intended to be used for manufacturing purposes.
❷ Panel thickness range is 1.0...6.0 maximum. Panel thickness reduced to 4.5 when optional legend plates are used.

Approximate Dimensions – millimeters ❶

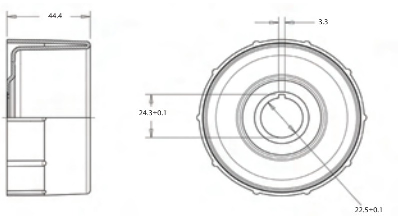
Locking Cover **(D7-ALØ1)**



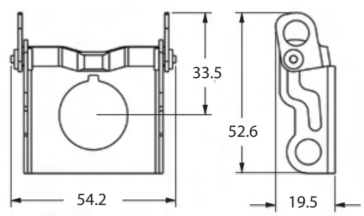
Extended Non-Illuminated Locking Attachment **(D7-AE1)**



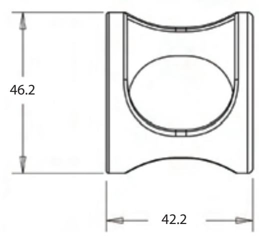
Plastic Guard **(D7-A6PR5)**



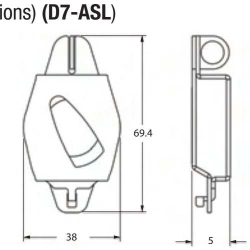
Flush Non-Illuminated Locking Attachment **(D7-AFL1)**



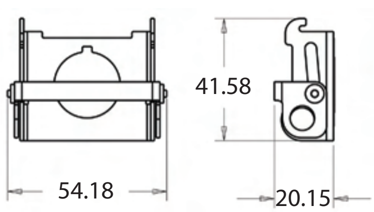
Protective Ring **(D7-AMRG)**



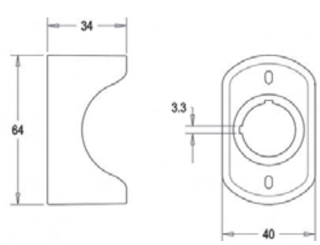
Selector Switch Locking Cover (Same for all Lock Positions) **(D7-ASL)**



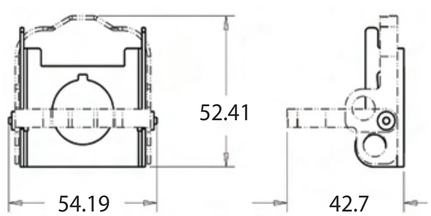
Momentary Mushroom Locking Attachment **(D7-AML1)**



Narrow Guard **(D7-AMEGY)**

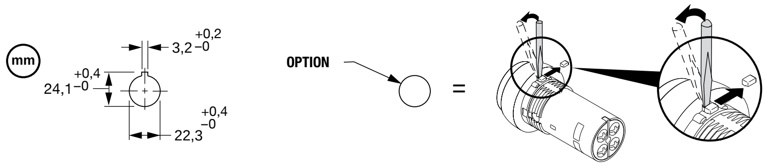


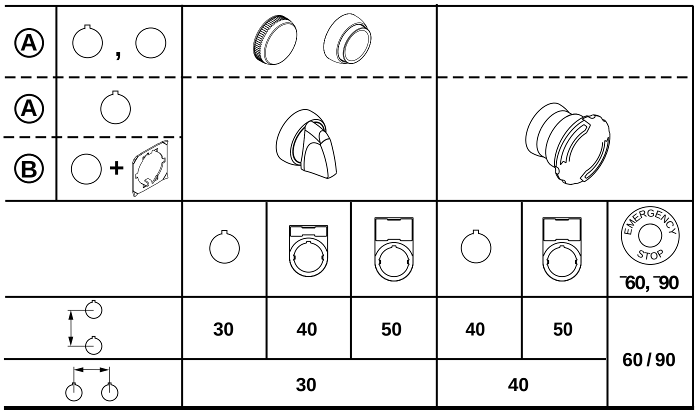
Maintained Mushroom Locking Attachment **(D7-AML2)**



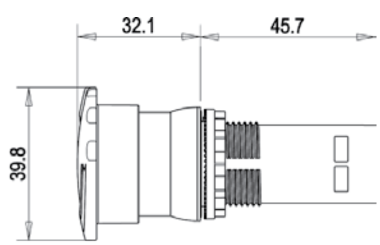
❶ Dimensions are not intended to be used for manufacturing purposes.

Approximate Dimensions – millimeters ❶

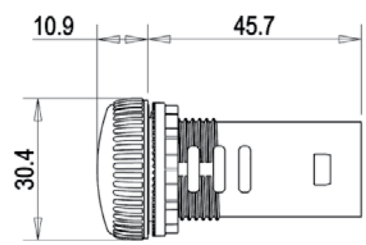




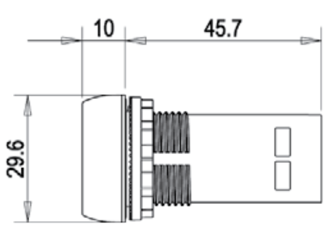
2-Position Push-Pull/Twist-to-Release Mushroom Devices **(D7D-MT)**



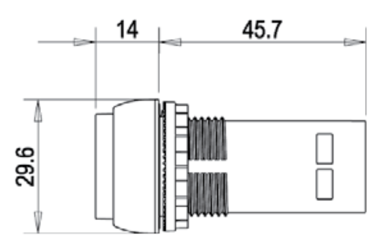
Pilot Light Devices **(D7D-P)**



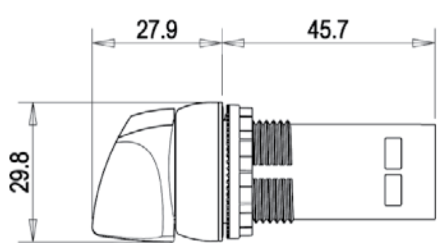
Momentary Pushbutton Device - Flush **(D7D-F)**



Momentary Pushbutton Device - Extended **(D7D-E)**



2 & 3 Position Selector Switch Devices **(D7D-S)**



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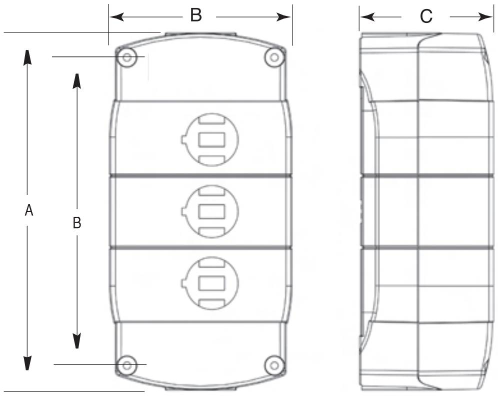
Pilot Devices

Series D7 – Heavy Duty/Oil Tight

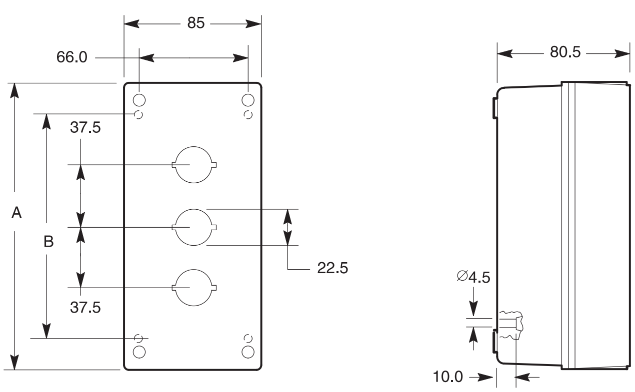
Approximate Dimensions – millimeters ❶

Plastic Enclosure



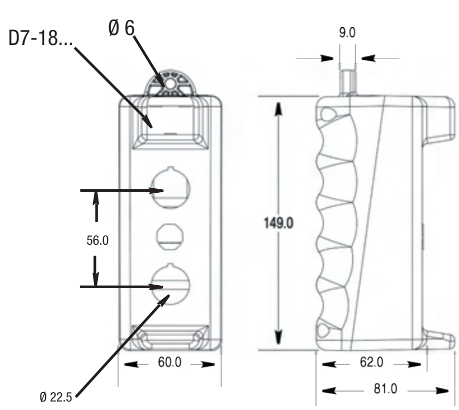
Type - 4/4X/13 (IP66) - Plastic Enclosures					
Cat. No.	**No. of Units (Holes)**	**A**	**B**	**C**	**Knockout/ Conduit Openings**
D7-1PP (1YP)	1	85 (3-11/32)	89 (3-1/2)	58 (2-9/32)	PG11 PG16
D7-2PP	2	124 (4-7/8)	79 (3-1/8)	58 (2-9/32)	PG11 PG16
D7-3PP	3	155 (6-3/32)	79 (3-1/8)	58 (2-9/32)	PG11 PG16
D7-4PP	4	186 (7-5/16)	79 (3-1/8)	58 (2-9/32)	PG11 PG16
D7-6PP	6	248 (9-3/4)	87 (3-7/16)	64 (2-17/32)	PG16

Metal Enclosure



Type 4/13 (IP66) - Metal Enclosures				
Cat. No.	**No. of Units (Holes)**	**A**	**B**	**Knockout/ Conduit Openings**
D7-1MP (1MY)	1	99 (3-9/32)	62 (2-7/16)	PG11 PG16
D7-2MP	2	137 (5-13/32)	100 (3-15/16)	PG11 PG16
D7-3MP	3	174 (6-27/32)	137 (5-13/32)	PG11 PG16
D7-5MP	5	249 (9-13/32)	212 (8-11/32)	PG16

Pendant Stations



❶ Dimensions are not intended to be used for manufacturing purposes.

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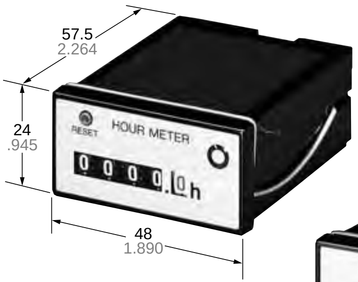
DIN HALF SIZE HOUR METER

TH63·TH64 Hour Meters



mm inch

TH64 series (with reset button)

TH63 series (without reset button)

RoHS Directive compatibility information
http://www.nais-e.com/

UL File No.: E42876
CSA File No.: LR39291

Features

1. Compact to save panel space
The 24 × 48 mm hour meters are just half the DIN 48 × 48 standard size. They help save the panel space.

2. Reset button
The hour meters can be reset to zero (TH64 series).

3. Wide-ranging measurement display
The measurement can be displayed from 0.1 hour up to 99999.9 hours (TH63 series). The dial size is the same as that of 48 × 48 DIN size hour meters (TH14 and TH24 series).

4. Easy to install
The flat terminals (#187) are used for easier wiring. There is no need to undo the lock spring.

5. High-performance sync motor with 50/60 Hz selector
The noise-resistant, accurately turning motor is employed to provide for longer period of measurement. The power frequency can be selected for 50 or 60 Hz.

6. Rotary indicator
The rotary indicator makes one turn every 72 seconds for monitoring.

7. Compliant with UL, CSA and CE.

Typical applications

Management of small generators and food processing machines; hour counting for leased equipment; maintenance management of various equipment, etc.

Specifications

Rated operating voltage		12 V AC, 24 V AC, 48 V AC, 100 V AC, 110 V AC, 115 to 120 V AC, 200 V AC, 220 V AC, 240 V AC
Allowable operating voltage range		85 to 115% of rated operating voltage
Rated frequency		50/60 Hz (selectable by switch)
Counting range		0 to 99999.9 hours (TH63 series) 0 to 9999.9 hours (TH64 series)
Minimum time display		0.1 hours (6 min)
Rated power consumption		Approx. 1.5 W
Insulation resistance (Initial value)		Min. 100 MΩ, Between live and dead metal parts (At 500 V DC)
Breakdown voltage (Initial value)		2,000 Vrms, Between live and dead metal parts
Max. temperature rise		55°C 131°F
Vibration resistance	Functional	10 to 55 Hz: 1 cycle/min double amplitude of 0.5 mm (10 min on 3 axes)
Shock resistance	Functional	Min 98 m/s^2 {10 G} (4 times on 3 axes)
	Destructive	Min 980 m/s^2 {100 G} (5 times on 3 axes)
Ambient temperature		–10 to +50°C +14 to +122°F
Ambient humidity		Max. 85% RH (non-condensing)
Weight		Approx. 80 g 2.82 oz

Product types

Type	Operating voltage	Part number	Operating voltage	Part number	Operating voltage	Part number
TH63 series (without reset button)	100V AC	TH631	24V AC	TH634	115 to 120V AC	TH637
	200V AC	TH632	48V AC	TH635	220V AC	TH638
	12V AC	TH633	110V AC	TH636	240V AC	TH639
TH64 series (with reset button)	100V AC	TH641	24V AC	TH644	115 to 120V AC	TH647
	200V AC	TH642	48V AC	TH645	220V AC	TH648
	12V AC	TH643	110V AC	TH646	240V AC	TH649

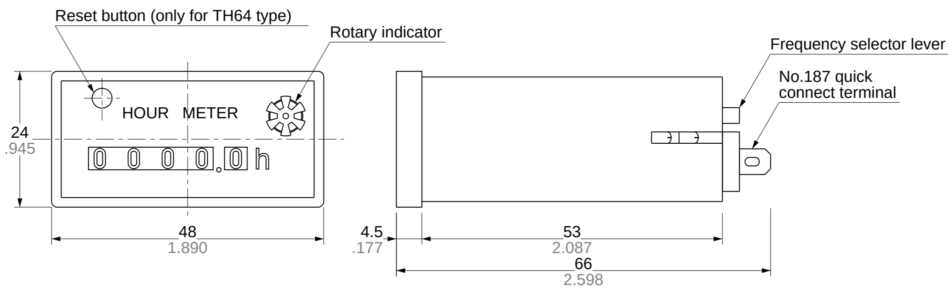
Notes) 1. Only the metallic-looking (silver) panel mounting type is available.
2. Standard products are UL-recognized as well as CSA-certified. There is no need to add “U” at the end of the part number. Just specify the standard part number when ordering.

Applicable standard

Safety standard	EN61010-1	Pollution Degree 2/Overvoltage Category II
EMC	(EMI)EN61000-6-4 Radiation interference electric field strength Noise terminal voltage (EMS)EN61000-6-2 Static discharge immunity RF electromagnetic field immunity EFT/B immunity Surge immunity Conductivity noise immunity Power frequency magnetic field immunity Voltage dip/Instantaneous stop/Voltage fluctuation immunity	 EN55011 Group1 ClassA EN55011 Group1 ClassA EN61000-4-2 4 kV contact 8 kV air EN61000-4-3 10 V/m AM modulation (80 MHz to 1 GHz) 10 V/m pulse modulation (895 MHz to 905 MHz) EN61000-4-4 2 kV (power supply line) EN61000-4-5 1 kV (power line) EN61000-4-6 10 V/m AM modulation (0.15 MHz to 80 MHz) EN61000-4-8 30 A/m (50 Hz) EN61000-4-11 10 ms, 30% (rated voltage) 100 ms, 60% (rated voltage) 1,000 ms, 60% (rated voltage) 5,000 ms, 95% (rated voltage)

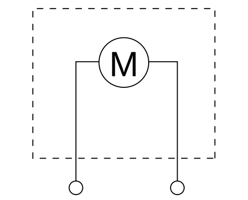
Dimensions

mm inch
General tolerance: ±0.5 ±.020

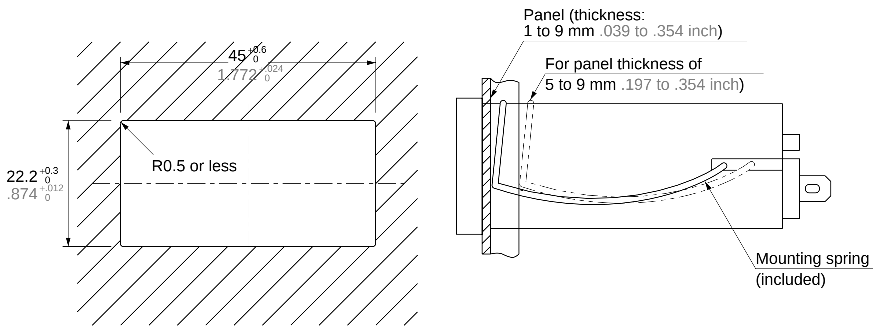


Wiring diagram

mm inch

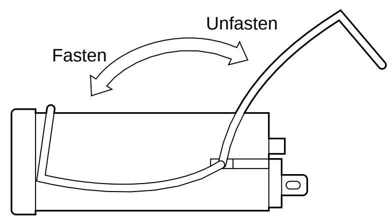


• Panel cutout dimensions



Mounting

1. Cut a $22.2^{+0.3}_{0}$ × $45^{+0.6}_{0}$ mm (.874$^{+.012}_{0}$ × 1.772$^{+.024}_{0}$ inch) opening in the panel.
2. Swing the mounting spring to the rear of the hour meter and fit the hour meter into the panel opening. (There is no need to detach the mounting spring from the hour meter.) If the panel is 5 to 9 mm .197 to .354 inch thick, move the mounting spring to the other hole toward the rear of the hour meter.
3. Swing the mounting spring to the front of the hour meter to secure the hour meter to the panel.
4. Wire the supplied quick connectors and connect to the hour meter. Be sure to use the supplied insulating sleeves to cover the connectors.

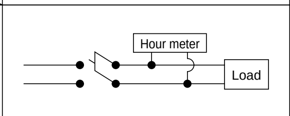
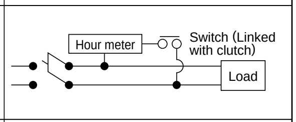
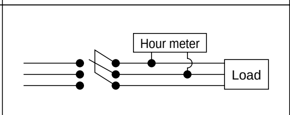
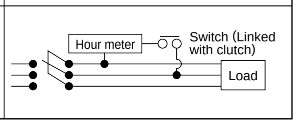


PRECAUTIONS IN USING THE HOUR METERS

1. Frequency setting
Frequency is specified for AC motor-driven hour meters. Before installing, be sure to check your local power frequency.

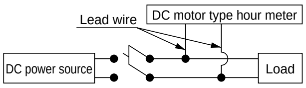
2. Connections

• TH13,23,14,24,40,50,63,64

	For measuring energized time of load	For measuring operation time of load
Single phase		
Three phases		

Note) Make the connection with the accompanying flat connector first and then with the hour meter's terminal (#187). In such case, be sure to cover the connection with the accompanying insulating sleeve.

• TH70, TH8



Note) Solder the lead wires in position.

3. Safety precautions
Do not use the hour meters in the following places.
• Where ambient temperature is below –10° or above +50°C
• In wet, dusty or gaseous environments
• Where exposed to vibrations and shocks
• Outdoors, or where exposed to rain or direct sunlight

4. Compliant with CE.
• LH2H
Ambient conditions:
Overvoltage category III, contamination factor 2, indoor use. Ambient temperature and humidity –10 and +55°C and 35% to 85%RH respectively.
• TH13, 23, 14, 24, 40, 50, 63, 64
Ambient conditions:
Overvoltage category II, contamination factor 2, indoor use. Ambient temperature and humidity –10 and +50°C and below 85%RH respectively.

5. Reset-type hour meter
• Precautions for use
If the number indications are off before use, press the reset button and confirm that all zeroes ("0") are displayed.
• Resetting caution
Exercise due caution as an insufficient amount of pressure on the reset button may result in abnormal readings.

6. Acquisition of CE marking
Please abide by the conditions below when using in applications that comply with EN 61010-1/IEC 61010-1
1) Ambient conditions
• Overvoltage category II, pollution level 2
• Indoor use
• Acceptable temperature and humidity range: -10 to +55°C, 35 to 85%RH (with no condensation at 20°C)
• Under 2000 m elevation
2) Use the main unit in a location that matches the following conditions.
• There is minimal dust and no corrosive gas.
• There is no combustible or explosive gas.
• There is no mechanical vibration or impacts.
• There is no exposure to direct sunlight.
• Located away from large-volume electromagnetic switches and power lines with large electrical currents.
3) Connect a breaker that conforms to EN60947-1 or EN60947-3 to the voltage input section.
4) Applied voltage should be protected with an overcurrent protection device (example: T 1A, 250 V AC time lag fuse) that conforms to the EN/IEC standards. (Free voltage input type)

16. Pressure Transmitter & Adjustment Unit

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

PRESSURE TRANSMITTER & ADJUSTMENT UNIT

1. VEGABAR74 PRESSURE TRANSMITTER TECHNICAL DETAILS

2. VEGADIS PRESSURE ADJUSTMENT UNIT TECHNICAL DETAILS

Process pressure/Hydrostatic

VEGABAR 74
VEGABAR 75

Product Information

VEGA

Content

Take note of safety instructions for Ex applications
Please note the Ex specific safety information which you can find on our homepage www.vega.com\services\downloads and which comes with every instrument. In hazardous areas you should take note of the appropriate regulations, conformity and type approval certificates of the sensors and power supply units. The sensors must only be operated on intrinsically safe circuits. The permissible electrical values are stated in the certificate.

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1 Description of the measuring principle

Measuring principle

VEGABAR 74 and 75 pressure transmitters are specially adapted to their respective application areas. That is why different sensor elements and measuring units are implemented.

VEGABAR 74

The sensor element of VEGABAR 74 is the dry ceramic-capacitive CERTEC® measuring cell. Base element and diaphragm consist of high purity sapphire-ceramic®.

The process pressure causes via the diaphragm a change in an electrical parameter of the measuring cell. This change is converted into an appropriate output signal.

The CERTEC® measuring cell is also equipped with a temperature sensor. The temperature value can be displayed via the indicating and adjustment module or processed via the signal output.

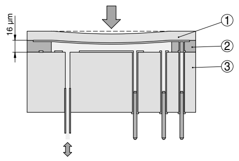

Fig. 1: Configuration of the CERTEC® measuring cell in VEGABAR 74

1 Diaphragm
2 Soldered glass bond
3 Base element

The advantages of the CERTEC® measuring cell are:
- Very high overload resistance
- No hysteresis
- Excellent long-term stability
- Completely front flush installation
- Good corrosion resistance
- Very high abrasion resistance

VEGABAR 75

The METEC® measuring cell is the measuring unit of VEGABAR 75. This unit consists of a CERTEC® measuring cell and a special isolating system with metallic process diaphragm. A special feature of this isolating system is the direct mechanical compensation of temperature influence.

The process pressure causes via the diaphragm a change in an electrical parameter of the measuring cell. This change is converted into an appropriate output signal.

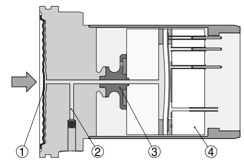

Fig. 2: Configuration of the METEC® measuring cell in VEGABAR 75

1 Diaphragm Hastelloy C276
2 Isolating liquid (approx. 0.3 cm³, FDA-listed)
3 FeNi adapter
4 CERTEC® measuring cell

The advantages of the METEC® measuring cell are:
- Completely welded, elastomer-free
- Very high overload resistance
- Full vacuum resistance (also with 0.1 bar measuring range)
- Good thermo-shock reaction
- Excellent long-term stability
- High degree of flushness

Wide application range

VEGABAR 74 and 75 transmitters are designed for front flush process pressure measurement of gases, vapours and liquids. Their application-optimised housings in IP 68 and high resistance materials ensure reliable use even in harsh environments and in extremely moist areas. Thanks to their compact configuration with completely integrated electronics, the instruments can be connected directly to the respective signal processing equipment.

VEGABAR 74 is best suited for use in abrasive media in the paper industry or in waste water treatment.

VEGABAR 75 with its hygienic fittings is particularly suitable for the food processing and pharmaceutical industries.

Information:
Continuative documentation such as operating instructions manuals:

- 28432 - VEGABAR 74
- 28433 - VEGABAR 75

2 Type overview

	VEGABAR 74	VEGABAR 75
		
Measuring cell:	CERTEC®	METEC®
Diaphragm:	Ceramic	Metal
Media:	gas, vapours and liquids, also abrasive	gases, vapours and liquids also with higher temperatures
Process fitting:	Thread from 1½", flanges from DN 40, fittings for the food processing and paper industry	Thread from 1½", flanges from DN 40, fittings for the food processing industry
Material:	316L	316L
Measuring range:	-1 … 60 bar (-14.5 … 870 psi)	-1 … 25 bar (-14.5 … 363 psi)
Smallest measuring range:	0.1 bar (1.45 psi)	0.1 bar (1.45 psi)
Process temperature:	-40 … +120 °C (-40 … +248 °F)	-12 … +200 °C (-40 … +392 °F)
Deviation in characteristics:	< 0.075 %	< 0.075 %
Signal output:	4 … 20 mA/HART	4 … 20 mA/HART
Remote adjustment/ indication:	VEGADIS 12	VEGADIS 12

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3 Mounting instructions

Installation position
VEGABAR functions in any installation position. Depending on the measuring system, the installation position can influence the measurement. This can be compensated by a position correction.

Information:
We recommend using parts from the line of VEGA mounting accessories.

4 Electrical connection

4.1 General prerequisites

The supply voltage range can differ depending on the instrument version. You can find exact specifications in chapter "*Technical data*".

The national installation standards as well as the valid safety regulations and accident prevention rules must be observed.

In hazardous areas you should take note of the appropriate regulations, conformity and type approval certificates of the sensors and power supply units.

4.2 Voltage supply

Supply voltage and current signal are carried on the same two-wire cable. The requirements on the power supply are specified in chapter "*Technical data*".

The VEGA power supply units VEGATRENN 149AEx, VEGASTAB 690, VEGADIS 371 as well as VEGAMET signal conditioning instruments are suitable for power supply. When one of these instruments is used, a reliable separation of the supply circuits from the mains circuits according to DIN VDE 0106 part 101 is ensured.

4.3 Connection cable

Generally
The sensors are connected with standard cable without screen. An outer cable diameter of 5 … 9 mm ensures the seal effect of the cable entry.

4 … 20 mA/HART two-wire and four-wire
If electromagnetic interference is expected which is above the test values of EN 61326 for industrial areas, screened cable should be used. In HART multidrop mode the use of screened cable is generally recommended.

In Ex applications, the corresponding installation regulations must be noted for the connection cable.

4.4 Cable screening and grounding

If screened cable is necessary, the cable screen must be connected on both ends to ground potential. If potential equalisation currents are expected, the connection on the evaluation side must be made via a ceramic capacitor (e.g. 1 nF, 1500 V).

4.5 Wiring plan VEGABAR 74, 75

Direct connection

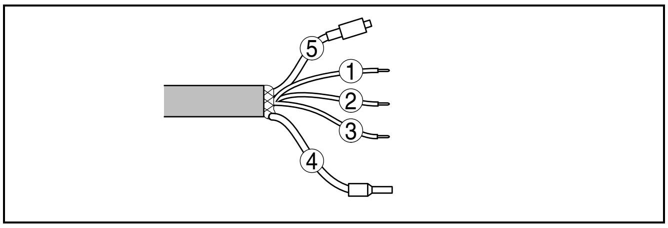

Fig. 3: Wire assignment, connection cable

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*
4 *Screen*
5 *Breather capillaries with filter element*

Connection via VEGABOX 02

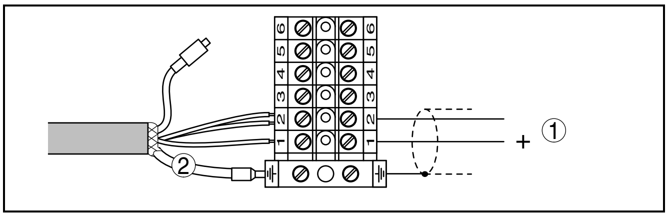

Fig. 4: Terminal assignment VEGABAR

1 *To power supply or the processing system*
2 *Screen*

Connection via VEGADIS 12

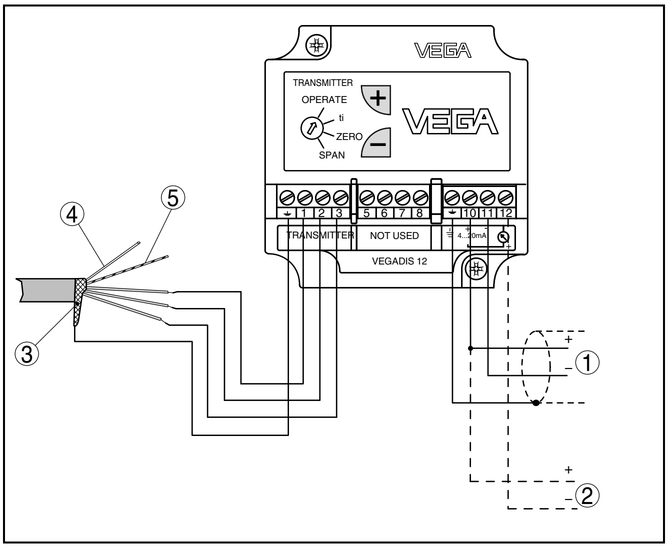

Fig. 5: Terminal assignment, VEGADIS 12

1 *To power supply or the processing system*
2 *Control instrument (4 … 20 mA measurement)*
3 *Screen*
4 *Breather capillaries*
5 *Suspension cable*

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5 Operation

5.1 Overview

VEGABAR 74 and 75 can be adjusted with the following adjustment media:
- Indication/Adjustment VEGADIS 12
- Adjustment software according to FDT/DTM standard, e.g. PACTware™ and PC
- HART handheld

5.2 Adjustment with VEGADIS 12

VEGADIS 12
VEGADIS 12 is connected directly to the connection or suspension cable of VEGABAR or VEGAWELL. It is looped into the supply and signal circuit and requires no separate external energy.

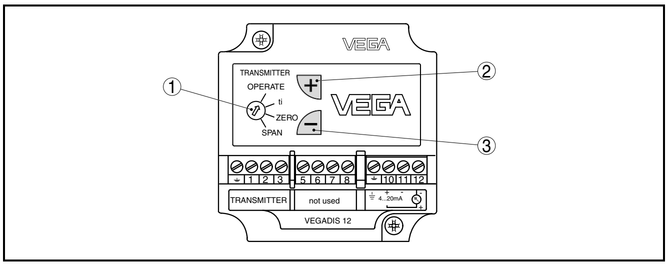

Fig. 6: Adjustment elements of VEGADIS 12

1 Rotary switch: choose the requested function
2 [+] key change value
3 [-] key change value

5.3 Adjustment with PACTware™

PACTware™/DTM
VEGABAR 74 and 75 sensors are adjusted via the signal cable by means of PACTware™.

An instrument driver for the respective VEGABAR is necessary for the adjustment with PACTware™.

All currently available VEGA DTMs are provided as DTM Collection with the current PACTware™ version on CD. They are available from the responsible VEGA agency for a token fee. The basic version of this DTM Collection incl. PACTware™ is available as a free-of charge download from the Internet.

To use the entire range of functions of a DTM, incl. project documentation, a DTM licence is required for that particular instrument family, e.g. VEGABAR. This licence can be bought from the VEGA agency serving you.

Connection of the PC via VEGACONNECT 3

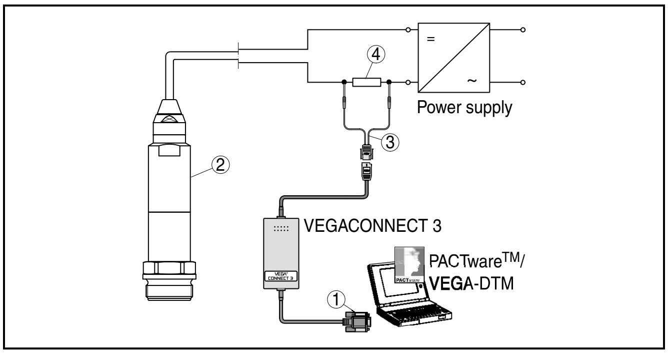

Fig. 7: Connecting the PC to the signal cable

1 RS232 connection (with VEGACONNECT 3) or USB connection (with VEGACONNECT 4)
2 VEGABAR
3 HART adapter cable
4 HART resistor 250 Ω

Connection of the PC via VEGACONNECT 4

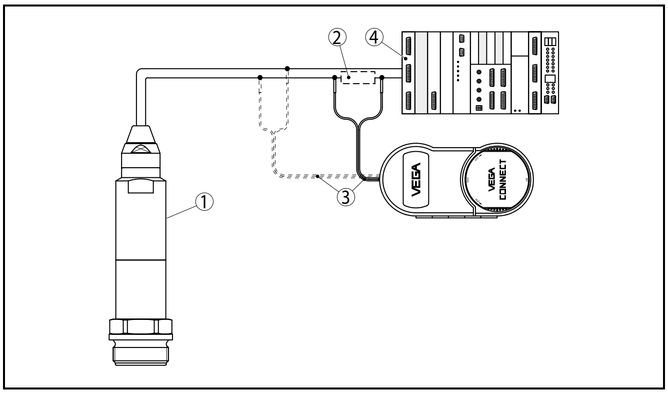

Fig. 8: Connecting the PC via HART to the signal cable

1 VEGABAR
2 HART resistor 250 Ω (optional depending on processing)
3 Connection cable with 2 mm pins and terminals
4 Processing system/PLC/Voltage supply

5.4 Adjustment with other adjustment programs

PDM
For VEGA PA sensors, instrument descriptions for the adjustment program PDM are available as EDD. The instrument descriptions are already implemented in the current version of PDM. For older versions of PDM, a free-of-charge download is available via Internet.

AMS
For VEGA FF sensors, instrument descriptions for the adjustment program AMS™ are available as DD. The instrument descriptions are already implemented in the current version of AMS™. For older versions of AMS™, a free-of-charge download is available via Internet.

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6 Technical data

General data

Material 316L corresponds to 1.4404 or 1.4435

VEGABAR 74

Materials, wetted parts	
– Process fitting	316L
– Diaphragm	sapphire ceramic® (99.9 % oxide ceramic)
– Seal	FKM (Viton), Kalrez 6375, EPDM, Chemraz 535
– Seal process fitting thread G½ A, G1½ A	Klingersil C-4400

VEGABAR 75

Materials, wetted parts	
– Process fitting	316L
– Process diaphragm	Hastelloy C276
Materials, non-wetted parts	
– Isolating liquid	med. white oil, FDA listed (silicone-free)

Common data

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 (1.764 … 17.64 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 variable - temperature (with VEGABAR 74)

Processing is made via HART-Multidrop

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

Parameter	Level
Measuring range	see product code
Turn down	
– recommended	1 : 10
– Max.	1 : 30

Reference conditions and actuating variables (similar to DIN EN 60770-1)

Reference conditions according to DIN EN 61298-1	
– Temperature	+18 … +30 °C (+64 … +86 °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 DIN 16086
Characteristics	linear
Calibration position	upright, diaphragm points downward

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Deviation determined according to the limit point method according to 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.

Deviation	
– Turn down 1 : 1 up to 5 : 1	< 0.075 %
– Turn down > 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 > 10 : 1	< 0.01 % x TD
Deviation with absolute pressure measuring range 0.1 bar	
– Turn down 1 : 1 up to 5 : 1	< 0.25 % x TD
– Turn down > 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 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, 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** interfaces (HART, Profibus PA, Foundation Fieldbus) as well as for the **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

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

VEGABAR 74

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)

VEGABAR 75

Medium temperature (temperature: p_{abs} > 1 bar (14.5 psi)/p_{abs} < 1 bar (14.5 psi)	
– Standard	-12 … +150 °C/-12 … +130 °C (+10 … +302 °F/+10 … +266 °F)
– with cooling element	-12 … +180 °C/-12 … +130 °C (+10 … +356 °F/+10 … +266 °F)
– with cooling element and screening sheet	-12 … +200 °C/-12 … +130 °C (+10 … +392 °F/+10 … +266 °F)

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[1] Incl. non-linearity, hysteresis and non-repeatability.

Common data

Vibration resistance	mechanical vibrations with 4 g and 5 … 100 Hz[2)]
Shock resistance	Acceleration 100 g/6 ms[3)]

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 Ω/m (0.011 Ω/ft)
– Standard length	6 m (19.69 ft)
– max. length with VEGADIS 12	200 m (656.2 ft)
– 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

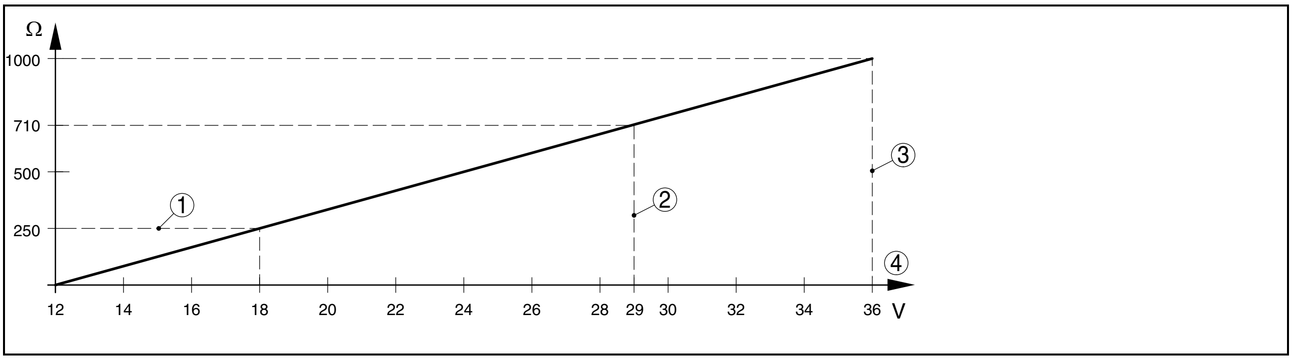

Fig. 9: Voltage diagram

1 *HART load*
2 *Voltage limit Ex instrument*
3 *Voltage limit non-Ex instrument*
4 *Supply voltage*

Load in conjunction with VEGADIS 12	see diagram

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2) Tested according to the regulations of German Lloyd, GL directive 2.
3) Tested according to EN 60068-2-27.

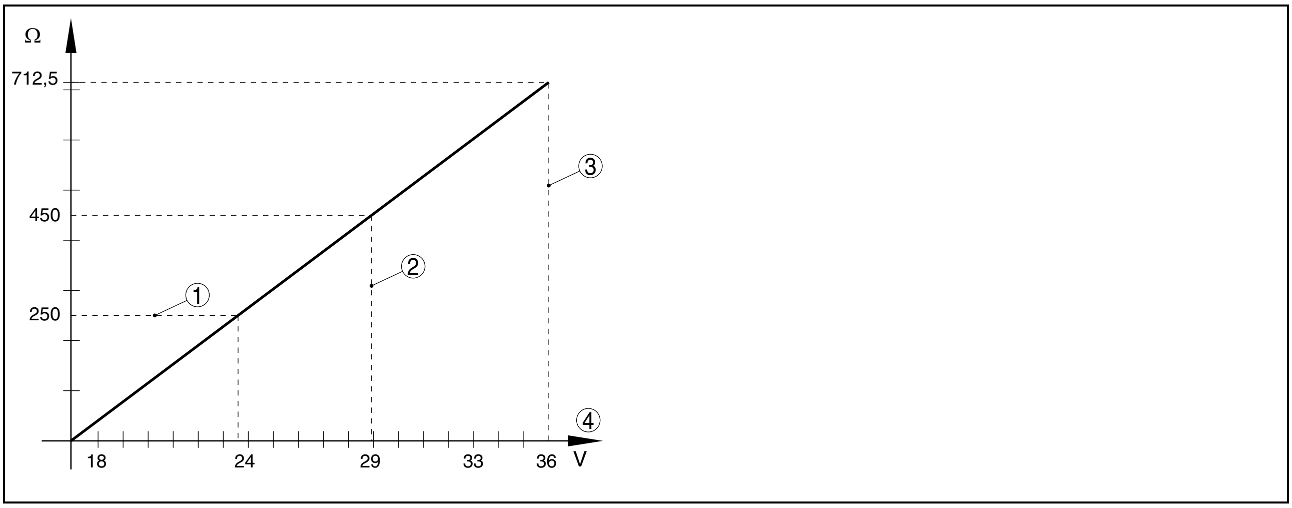

Fig. 10: Voltage diagram

1 HART load
2 Voltage limit Ex instrument
3 Voltage limit non-Ex instrument
4 Supply voltage

Electrical protective measures

Protection	IP 68 (25 bar)/IP 69K
Overvoltage category	III
Protection class	III

Approvals[4)5)]

ATEX ia	ATEX II 1G EEx ia IIC T6, ATEX II 2G EEx ia IIC T6
ATEX D	ATEX II 1/2D, 2D IP6X T
ATEX ia+D	ATEX II 1G EEx ia IIC T6, ATEX II 1/2D, 2D IP6X T
Ship approval	GL, LRS, ABS, CCS, RINA, DNV
Other approvals	WHG

CE conformity

EMC (89/336/EWG)	Emission EN 61326: 1997 (class B), susceptibility EN 61326: 1997/A1: 1998
LVD (73/23/EWG)	EN 61010-1: 2001

Environmental instructions

VEGA environment management system	certified according to DIN EN ISO 14001

You can find detailed information under www.vega.com.

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4) Deviating data in Ex applications: see separate safety instructions.
5) You can find detailed information under www.vega.com.

7 Dimensions

VEGABAR 74 - threaded fitting

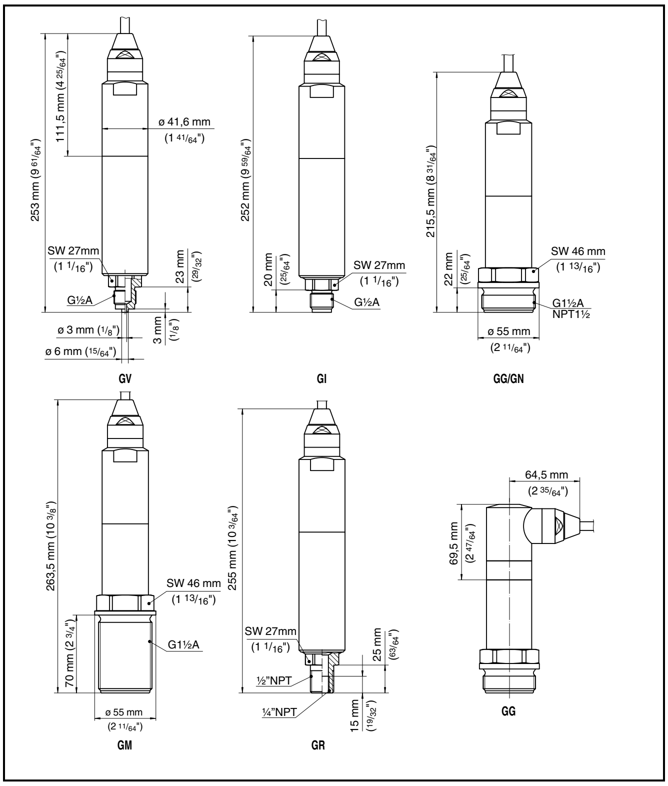


Fig. 11: VEGABAR 74 - threaded fitting: GV = G½ A manometer connection EN 837, GI = G½ A inner G¼ A, GG = G1½ A, GN = 1½ NPT, GM = G1½ A 70 mm

VEGABAR 74 - hygienic fitting 1

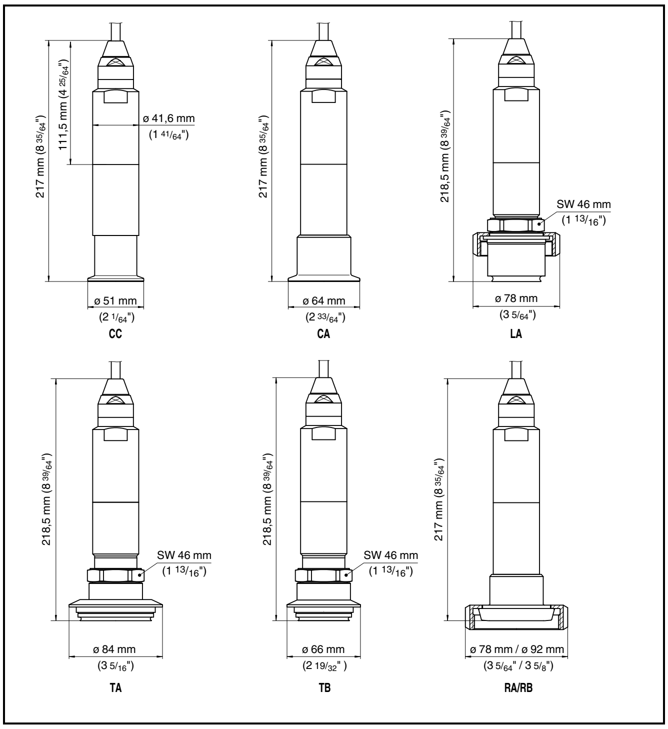


Fig. 12: VEGABAR 74 - hygienic fitting: CC = Tri-Clamp 1½", CA = Tri-Clamp 2", LA = hygienic fitting with compression nut F40, TA = Tuchenhagen Varivent DN 32, TB = Tuchenhagen Varivent DN 25, RA/RB = bolting DN 40/DN 50 according to DIN 11851, KA = conus DN 40

VEGABAR 74 - hygienic fitting 2

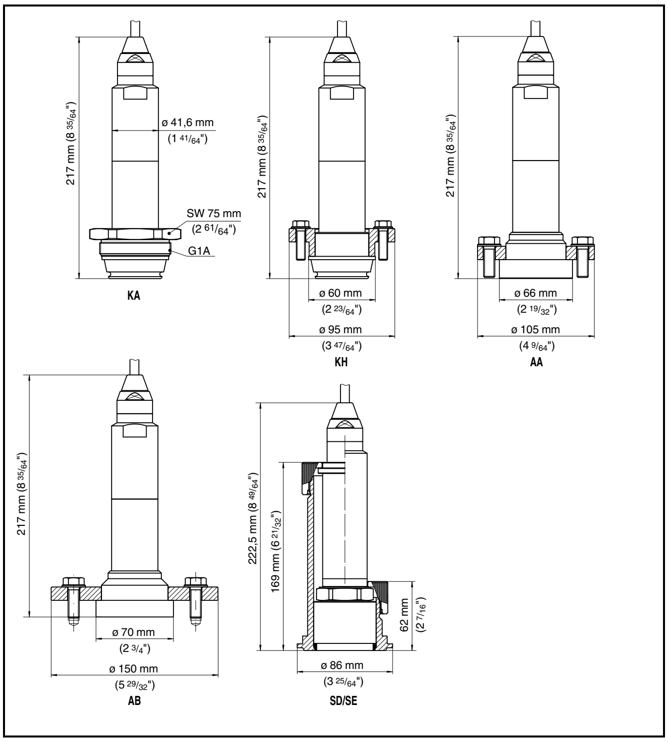
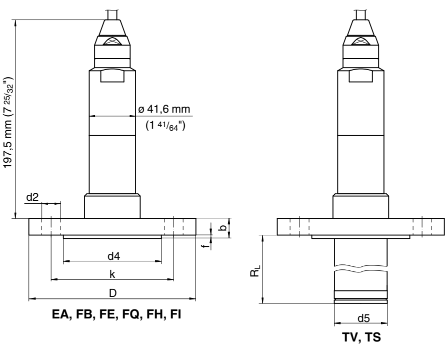


Fig. 13: VEGABAR 74 AA = DRD, KA = conus DN 40

VEGABAR 74 - flange fitting



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. 14: VEGABAR 74 - flange fitting

1. *Flange connection according to DIN 2501*
2. *Flange fitting according to ANSI B16.5*
3. *Flange with extension*
4. *Order-specific*

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VEGABAR 74 - threaded fitting for paper industry

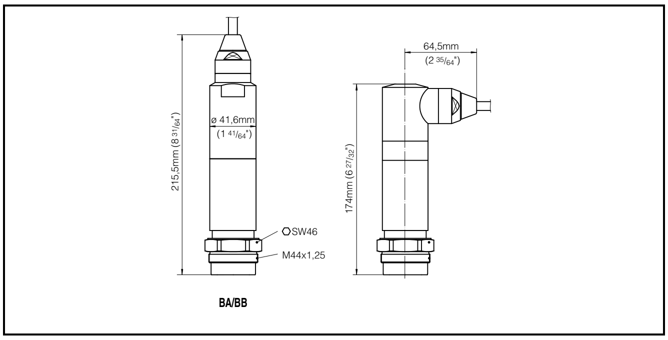

Fig. 15: VEGABAR - connection for paper industry: BA/BB = M44 x 1.25

VEGABAR 74 - extension fitting for paper industry

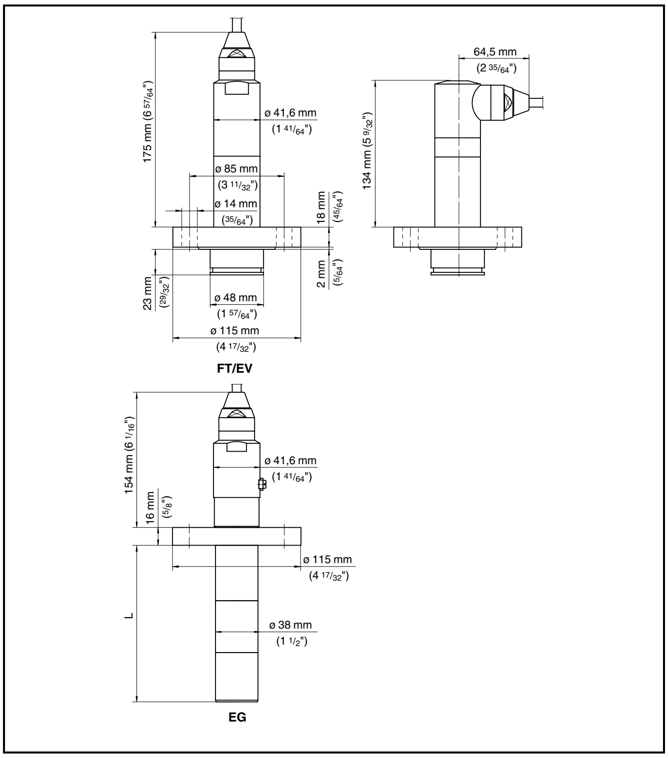

Fig. 16: VEGABAR - extension fitting for paper industry: EV/FT = absolutely flush for pulper (EV 2-times flattened), EG = extension for ball valve fitting (L = order-specific)

VEGABAR 75 - threaded fitting

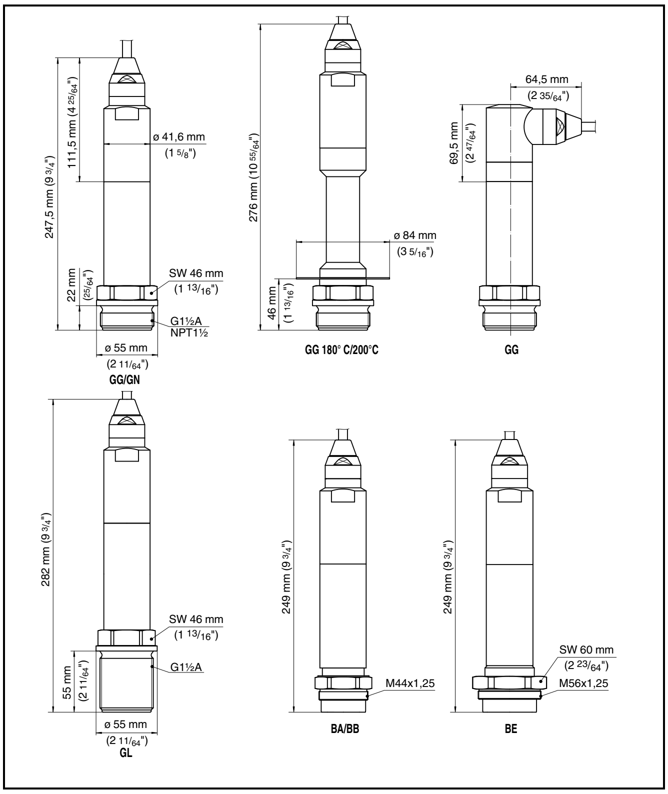

Fig. 17: VEGABAR - threaded fitting: GG = G1½ A, GN = 1½ NPT, GL = G1½ A thread length 55 mm, BB = M44 x 1.25, BE = M56 x 1.25

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VEGABAR 75 - hygienic fitting 1

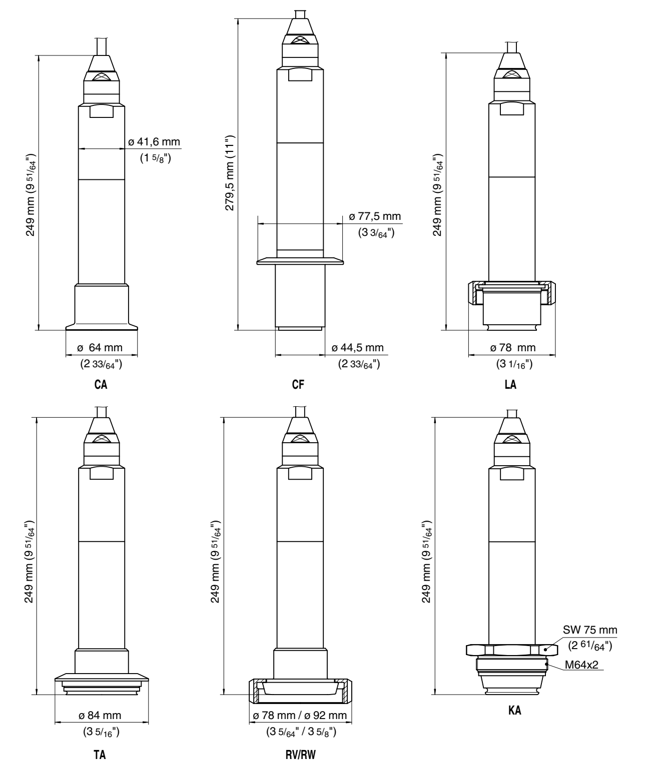


Fig. 18: VEGABAR 75 - hygienic fitting: CA/CF = Tri-Clamp 2"/Tri-Clamp 2½", LA = hygienic fitting with compression nut F40, TA = Tuchenhagen Varivent DN 32, RV/RW = bolting DN 40/DN 50 according to DIN 11851, KA = conus DN 40, AA = DRD

VEGABAR 75 - hygienic fitting 2

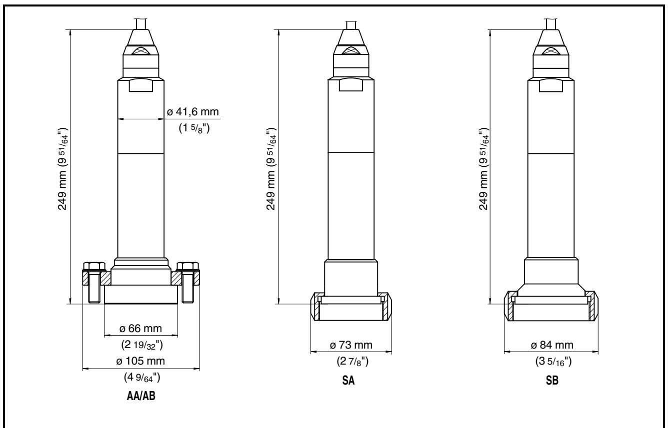
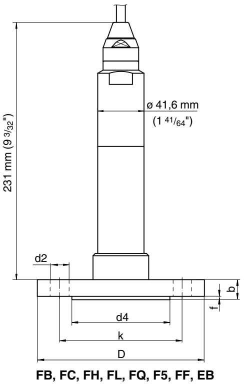


Fig. 19: VEGABAR 75 - hygienic fitting: SA = SMS DN 38, SB = SMS DN 51

VEGABAR 75 - flange fitting



FB, FC, FH, FL, FQ, F5, FF, EB

①

mm	DN	PN	D	b	k	d2	d4	f
FB	40	40	150	18	110	4xø18	88	3
FC	50	40	165	20	125	4xø18	102	3
FH	80	40	200	24	160	8xø18	138	3
FL	100	40	200	24	160	8xø18	138	3

inch	DN	PN	D	b	k	d2	d4	f
FB	40	40	5 29/32"	45/64"	4 21/64"	4xø 45/64"	3 15/32"	1/8"
FC	50	40	6 1/2"	25/32"	4 59/64"	4xø 45/64"	4 1/64"	1/8"
FH	80	40	7 7/8"	15/16"	6 19/64"	8xø 45/64"	5 7/16"	1/8"
FL	100	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
FQ	1½"	150	5"	11/16"	3 7/8"	4xø 5/8"	2 7/8"	1/8"
F5	2"	150	6"	3/4"	4 3/4"	4xø 3/4"	3 5/8"	1/8"
FT	3"	300	8 1/4"	1 1/8"	6 5/8"	8xø 7/8"	5“	1/8"
EB	4"	300	10"	1 1/4"	7 7/8"	8xø 7/8"	6 3/16"	1/8"

Fig. 20: VEGABAR - flange connection

1 *Flange connection according to DIN 2501*
2 *Flange fitting according to ANSI B16.5*

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8 Product code

VEGABAR 74

Approval
- **XX** without
- **XM** Ship approval
- **CX** ATEX II 1G EEx ia IIC T6
- **AX** ATEX II 2G EEx ia IIC T6
- **AM** ATEX II 2G EEx ia IIC T6 + Ship approval

Process fitting / Material
- **GI** G½A inner G¼A PN160 / 316L
- **GG** Thread G1½A PN60 / 316L
- **GN** Thread 1½NPT PN60 / 316L
- **CA** Tri-Clamp 2" PN16 / 316L
- **LA** Hyg.connection w. compression nut F40 PN40 / 316L
- **TA** Varivent N50-40 PN25 / 316L
- **RA** Bolting DN40PN40 DIN11851 / 316L
- **RB** Bolting DN50PN25 DIN11851 / 316L
- **AA** DRD PN40 / 316L
- **BA** M44x1.25 with pressure screw Alu PN25 / 316L
- **BB** M44x1.25; with pressure screw PN60 / 316L
- **EA** Flange DN40PN40 Form C, DIN2501 / 316L
- **FB** Flange DN50PN40 Form C, DIN2501 / 316L
- **FE** Flange DN80PN40 Form C, DIN2501 / 316L
- **FH** Flange 2" 150lb RF, ANSI B16.5 / 316L
- **FI** Flange 3" 150lb RF, ANSI B16.5 / 316L

Seal measuring cell
- **1** FKM (Viton)
- **2** Kalrez 6375
- **3** EPDM

Pressure / Measuring range
- **A** rel. / 0...0.1bar (0...10kPa)
- **B** rel. / 0...0.2bar (0...20kPa)
- **C** rel. / 0...0.4bar (0...40kPa)
- **D** rel. / 0...1.0bar (0...100kPa)
- **E** rel. / 0...2.5bar (0...250kPa)
- **F** rel. / 0...5.0bar (0...500kPa)
- **G** rel. / 0...10.0bar (0...1000kPa)
- **H** rel. / 0...25.0bar (0...2500kPa)
- **U** rel. / 0...60.0bar (0...6000kPa)
- **P** rel. / -1...0.0bar (-100...0kPa)
- **Q** rel. / -1...1.5bar (-100...150kPa)
- **R** rel. / -1...5.0bar (-100...500kPa)
- **S** rel. / -1...10.0bar (-100...1000kPa)
- **T** rel. / -1...25.0bar (-100...2500kPa)
- **W** rel. / -1...60.0bar (-100...6000kPa)
- **K** rel. / -0.05...0.05bar (-5...5kPa)
- **L** rel. / -0.1...0.1bar (-10...10kPa)
- **M** rel. / -0.2...0.2bar (-20...20kPa)
- **O** rel. / -0.5...0.5bar (-50...50kPa)
- **I** abs. / 0...0,1bar (0...10kPa) [1]
- **1** abs. / 0...1.0bar (0...100kPa)
- **2** abs. / 0...2.5bar (0...250kPa)
- **3** abs. / 0...5.0bar (0...500kPa)
- **4** abs. / 0...10.0bar (0...1000kPa)
- **5** abs. / 0...25.0bar (0...2500kPa)

Electronics
- **H** 4...20mA/HART®

Electrical connection / Protection
- **A** Direct cable outlet axial / IP68
- **S** Direct cable outlet lateral / IP68

Cable material / Length
- **1** PE / 6m
- **2** PE / Special length
- **3** PUR / Special length
- **4** FEP / Special length

Overvoltage arrester
- **X** without
- **B** with [2]

BR74.

[1] Deviation in characteristic 0.25%
[2] Only in conjunction with Approval 'XX' or 'AX'

VEGABAR 75

Approval
- **XX** without
- **XM** Ship approval
- **CX** ATEX II 1G EEx ia IIC T6
- **CK** ATEX II 1G EEx ia IIC T6 + ATEX II 1/2D,2D IP6X T
- **AX** ATEX II 2G EEx ia IIC T6
- **AM** ATEX II 2G EEx ia IIC T6 + Ship approval
- **GX** ATEX II 1/2D,2D IP6X T

Process fitting / Material
- **FB** Flange DN40PN40 Form C, DIN2501 / 316L
- **FC** Flange DN50PN40 Form C, DIN2501 / 316L
- **FH** Flange DN80PN40 Form C, DIN2501 / 316L
- **F5** Flange 2" 150lb RF, ANSI B16.5 / 316L
- **GG** Thread G1½A PN60 / 316L
- **GN** Thread 1½NPT PN60 / 316L
- **CA** Tri-Clamp 2" PN16 / 316L
- **LA** Hygienic connec. w. compression nut F40PN40 / 316L
- **TA** Varivent N50-40 PN25 / 316L
- **RV** Bolting DN40PN40, DIN11851 / 316L
- **RW** Bolting DN50PN40, DIN11851 / 316L
- **AA** DRD PN40 / 316L
- **BB** M44x1.25 with pressure screw 316L PN60 / 316L
- **SB** SMS DN51 PN6 / 316L

Isolating liquid / Temperature
- **M** Med.white oil,FDA appr.-12...150°C(Pabs<1bar-12..130°C)
- **S** Med.w.oil,cool.(FDA)/-12..180°C(Pabs <1bar -12..130°C)
- **R** Med.w.oil,cool.(FDA)/-12..200°C(Pabs <1bar -12..130°C)

Pressure / Measuring range
- **A** rel. / 0...0.1bar (0...10kPa)
- **B** rel. / 0...0.2bar (0...20kPa)
- **C** rel. / 0...0.4bar (0...40kPa)
- **D** rel. / 0...1.0bar (0...100kPa)
- **E** rel. / 0...2.5bar (0...250kPa)
- **F** rel. / 0...5.0bar (0...500kPa)
- **G** rel. / 0...10.0bar (0...1000kPa)
- **T** rel. / 0...25.0bar (0...2500kPa)
- **P** rel. / -1...0.0bar (-100...0kPa)
- **Q** rel. / -1...1.5bar (-100...150kPa)
- **R** rel. / -1...5.0bar (-100...500kPa)
- **S** rel. / -1...10.0bar (-100...1000kPa)
- **H** rel. / -1...25.0bar (-100...2500kPa)
- **K** rel. / -0.05...0.05bar (-5...5kPa)
- **L** rel. / -0.1...0.1bar (-10...10kPa)
- **M** rel. / -0.2...0.2bar (-20...20kPa)
- **O** rel. / -0.5...0.5bar (-50...50kPa)
- **1** abs. / 0...1.0bar (0...100kPa)
- **2** abs. / 0...2.5bar (0...250kPa)
- **3** abs. / 0...5.0bar (0...500kPa)
- **4** abs. / 0...10.0bar (0...1000kPa)
- **5** abs. / 0...25.0bar (0...2500kPa)

Electronics
- **H** 4...20mA/HART®

Electrical connection / Protection
- **A** Direct cable outlet axial / IP68
- **S** Direct cable outlet lateral / IP68

Cable material / Length
- **1** PE / 6m
- **2** PE / Special length
- **3** PUR / Special length
- **4** FEP / Special length

Overvoltage arrester
- **X** without
- **B** with [1]

BR75.

[1] Only in conjunction with Approval 'XX' or 'AX'

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Indicating and adjustment

VEGADIS 11
VEGADIS 12
VEGADIS 61
PLICSCOM
VEGADIS 175

Product Information

VEGA

Content

Take note of safety instructions for Ex applications

Please note the Ex specific safety information which you will find on our homepage www.vega.com\services\downloads and which come with the appropriate instrument with Ex approval. In hazardous areas you should take note of the appropriate regulations, conformity and type approval certificates of the sensors and power supply units. Each VEGADIS with Ex approval is an associated, intrinsically safe instrument and must not be installed in hazardous areas.

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1 Product description

In continuous measurement, the level in a vessel or the pressure in a pipeline, for example, is detected by a sensor. The measured value is converted into an analogue 4 … 20 mA output signal or a digital output signal, e.g. Profibus PA. The output signal is then further processed, e.g. in a PLCS or a control system.

On-site indication of the measured value or sensor adjustment is often desired. To fulfill this need, VEGA offers a wide range of indicating instruments. Indication, power supply and mounting differ depending on the model. This product information manual provides an overview and helps you select a suitable instrument.

VEGADIS 11
VEGADIS 11 is a universal, digital indicating instrument that operates without additional power. It is used for remote (i.e. at some distance from the measuring site) measured value indication. VEGADIS 11 can be connected at any point to the 4 … 20 mA signal cable. It is suitable for any VEGA sensor as well as sensors from other manufacturers, i.e. for active (four-wire) as well as passive (two-wire) sensors.

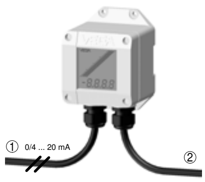

Fig. 1: Configuration VEGADIS 11

1 To the sensor
2 To the processing system

Advantages:
- Universal use for active or passive 4 … 20 mA sensors
- No separate external energy required
- mounting to the wall or on carrier rail

VEGADIS 12
VEGADIS 12 is a digital indicating instrument that operates without additional power. It is used for remote (i.e. at some distance from the measuring site) measured value indication and adjustment of VEGABAR 74, 75 and VEGAWELL 72 - 4 … 20 mA/HART hydrostatic pressure transmitters. VEGADIS 12 can be connected at any point to the 4 … 20 mA signal cable. It is provided with a breather facility for sensor ventilation via the capillary line in the special cable.

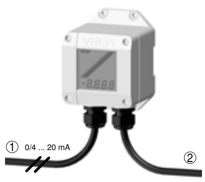

Fig. 2: Configuration VEGADIS 12

1 To the sensor
2 To the processing system

Advantages:
- No separate external energy required
- mounting to the wall or on carrier rail

VEGADIS 61
VEGADIS 61 is an external indicating and adjustment module that operates without additional power. It is used for remote (i.e. at some distance from the measuring site) measured value indication and adjustment of VEGA plics® sensors. The sensors can be 4 … 20 mA, Profibus PA or Foundation Fieldbus sensors. VEGADIS 61 is connected to the sensors with a standard four-wire screened cable up to 25 m long. Communication is carried out via this cable and, what is more, VEGADIS 61 is powered by the sensor. An additional power supply is not required.

PLICSCOM
The indicating and adjustment module PLICSCOM is used for measured value indication, adjustment and diagnosis of VEGA plics® sensors. It is mounted in the respective sensor housing or in the external indicating and adjustment module VEGADIS 61. After mounting, the sensor and PLICSCOM are splash-proof even without housing cover.

An integrated backlight enables reading even under unfavourable lighting conditions. As an option, the display can also be equipped with heating that ensures good readability at low temperatures down to -40 °C (-40 °F).

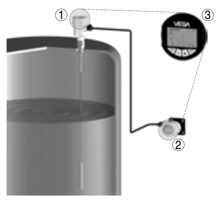

Fig. 3: Configuration VEGADIS 61 and PLICSCOM

1 Sensor
2 VEGADIS 61
3 PLICSCOM

Advantages:
- Universal use for all plics® sensors
- Splash-proof adjustment with open cover
- No separate external energy required
- mounting VEGADIS 61 to the wall, on carrier rail or tube

VEGADIS 175
VEGADIS 175 is a digital indicating instrument for front panel mounting. It can be connected at any point to the 4 … 20 mA signal cable and is suitable for active (four-wire) as well as passive (two-wire) sensors.

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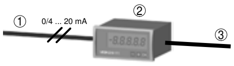

Fig. 4: Configuration VEGADIS 175

1 To the sensor
2 VEGADIS 175
3 To the processing system

Advantages:
- Universal use for passive or 4 … 20 mA sensors
- No separate external energy required

1.1 Application examples

Pump shaft

Fig. 5: Level measurement in a pump shaft with VEGAWELL 72, remote indication and adjustment with VEGADIS 12

For hydrostatic level measurement in a pump shaft, VEGADIS 12 together a VEGAWELL 72 is well suited for remote indication and adjustment. The min./max. adjustment is carried out on site and the actual measured value can be read out during operation.

Chip silo

Fig. 6: Level measurement in a chip silo with VEGAPULS 68, remote indication and adjustment with VEGADIS 61

In non-contact level measurement in a chip silo with VEGAPULS 68, the mounting location is not directly accessible. For that reason VEAGDIS 61 is an excellent solution for remote indication and adjustment. The min./max. adjustment can be carried out locally with or without filling.

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2 Type overview

	VEGADIS 11	**VEGADIS 12**	**VEGADIS 61**
			
Indication:	digital and quasi-analogue	digital and quasi-analogue	Dot-Matrix
Signal:	4 … 20 mA, 4 … 20 mA/HART	4 … 20 mA, 4 … 20 mA/HART	I^2C bus
Sensors:	4 … 20 mA passive or active	VEGABAR 74, 75; VEGAWELL 72 - 4 … 20 mA/HART	plics® sensors
Mounting:	Wall, rail mounting	Wall, rail mounting	Wall, rail, tube mounting
Ambient temperature:	-20 … +70 °C (-4 … +158 °F)	-20 … +70 °C (-4 … +158 °F)	-20 … +70 °C (-4 … +158 °F)

	PLICSCOM	**VEGADIS 175**
		
Indication:	Dot-Matrix	digital
Signal:	I^2C bus	4 … 20 mA, 4 … 20 mA/HART
Sensors:	plics® sensors	4 … 20 mA passive or active
Mounting:	in the sensor or in VEGADIS 61	Front panel
Ambient temperature:	-15 … +70 °C (+5 … +158 °F)	-10 … +60 °C (+14 … +140 °F)

3 Mounting instructions

VEGADIS 11 and VEGADIS 12

VEGADIS 11 and VEGADIS 12 are configured for the following installation and mounting options:

- Carrier rail 35 x 7.5 according to EN 50022
- Wall mounting

Carrier rail mounting

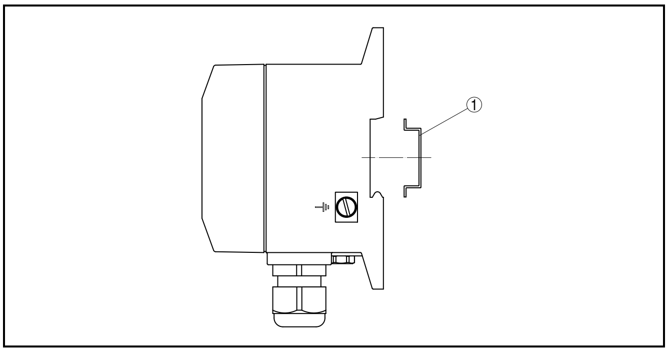

Fig. 7: VEGADIS 11 and VEGADIS 12 carrier rail mounting

1 Carrier rail

Wall mounting

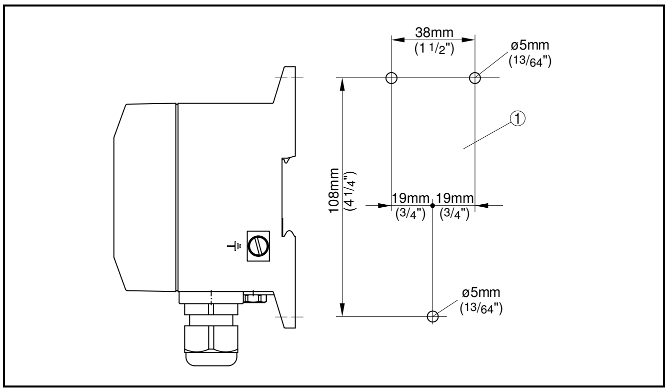

Fig. 8: VEGADIS 11 and VEGADIS 12 wall mounting

1 Drill dimension

VEGADIS 61

VEGADIS 61 can be mounted in the following ways:

- Carrier rail 35 x 7.5 according to EN 50022
- Wall mounting
- Tube mounting

Wall mounting

VEGADIS 61 for wall mounting is supplied with a mounting socket.

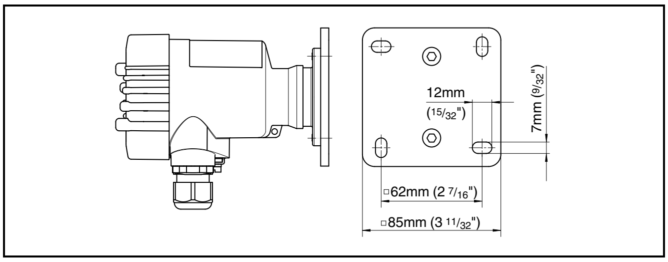

Fig. 9: VEGADIS 61 for wall mounting, bottom view of mounting plate.

1 Drill dimension

Carrier rail mounting

VEGADIS 61 for mounting on carrier rail is supplied with a mounting adapter.

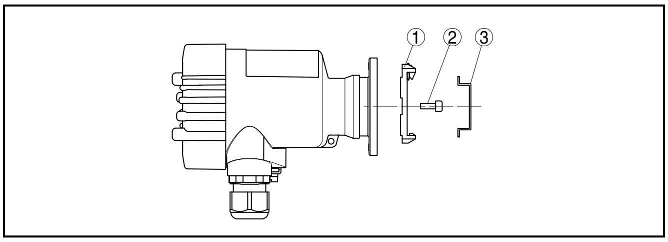

Fig. 10: VEGADIS 61 for mounting on carrier rail

1 Adapter plate
2 Screw M4 x 6
3 Carrier rail

Tube mounting

VEGADIS 61 for tube mounting is supplied with the measuring instrument holder BARMONT.C (comes with delivery as mounting accessory).

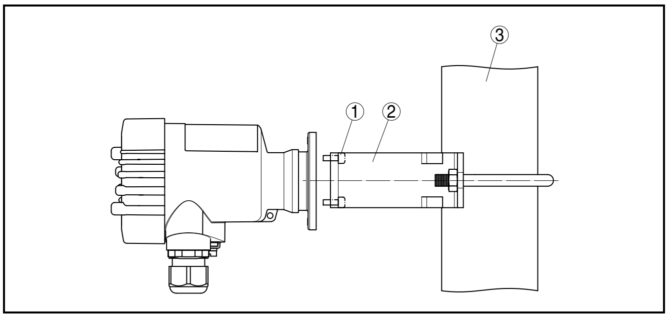

Fig. 11: VEGADIS 61 for tube mounting

1 4 screws M5 x 12
2 Measuring instrument holder BARMONT.C
3 Tube

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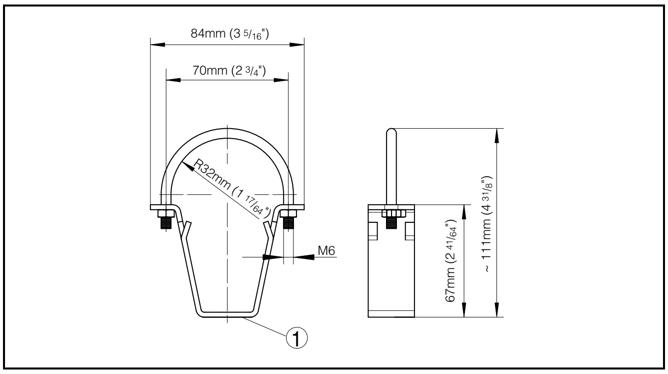

Fig. 12: Measuring instrument holder BARMONT.C

1 4 x holes 5 mm for mounting screws M5 x 12

PLICSCOM

The indicating and adjustment module PLICSCOM can be inserted in the following housing versions and instruments:

- All sensors of the plics® instrument family, in the single as well as in the double chamber housing (optionally in the electronics or connection compartment)
- External indicating and adjustment unit VEGADIS 61

VEGADIS 175

VEGADIS 175 can be mounted in the following ways:

- Front panel mounting

Front panel mounting

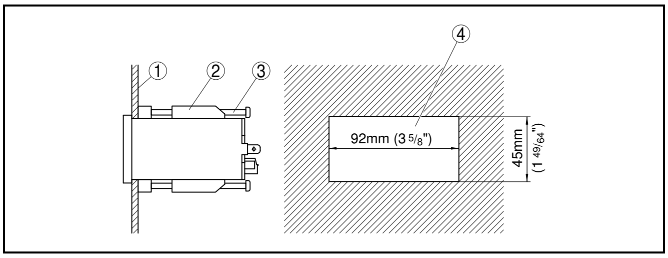

Fig. 13: VEGADIS 175 for panel mounting

1 Front panel
2 Fixing hook
3 Screw

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4 Connecting to power supply

4.1 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, overvoltage arresters should be installed

Tip:
We recommend VEGA overvoltage arresters B61-300 (power supply VEGADIS) and B62-36G (sensor supply).

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.

Selecting connection cable
Standard two-wire cable without screen is used for connection of the sensors.

Cable screening and grounding
Connect the cable screen on both ends to ground potential. In the sensor, the screen must be connected directly to the internal ground terminal. The ground terminal outside on the housing must be connected to the potential equalisation.

If potential equalisation currents are expected, the screen connection on VEGADIS 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.

4.2 Wiring plan, VEGADIS 11

Passive sensors

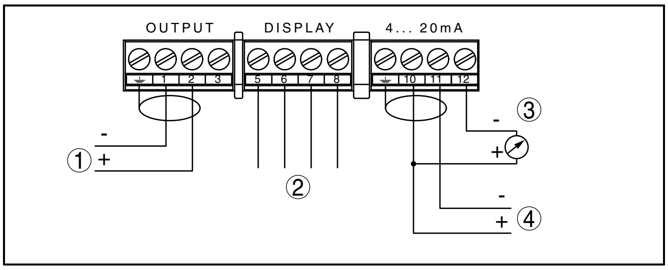

Fig. 14: Wiring plan, VEGADIS 11 for passive sensors

1 *Sensor (passive)*
2 *Indicating module (assignment see chart)*
3 *Control instrument*

Note:
Passive sensors need a power supply. They represent current sinks and emboss a current of 4 … 20 mA to the supply circuit. The supply voltage is loop through VEGADIS 11. On the output (terminals 1/2), VEGADIS 11 provides the power supply for the connected sensors. Power supply and measured value transmission are carried along the same two-wire cable.

Active sensors

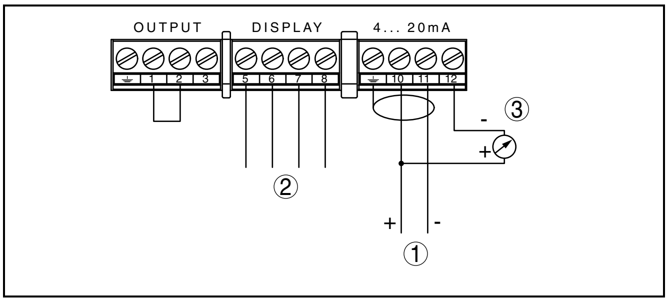

Fig. 15: Wiring plan, VEGADIS 11 for active sensors

1 *Sensor (active)*
2 *Indicating module*
3 *Control instrument*
4 *Voltage supply/Signal output*

Note:
The input (terminals 10/11) is provided for connection of transmitters with own, separate power supply. The output (terminal 1/2) is bridged.

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Sensors with signal conditioning instrument

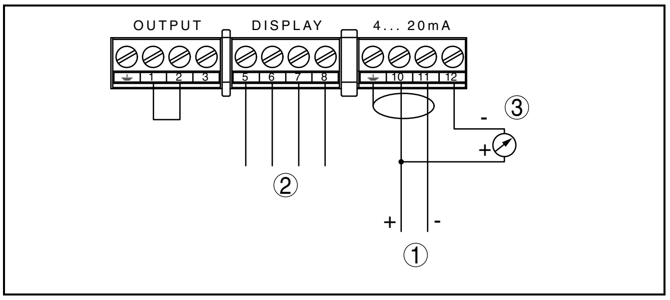

Fig. 16: Wiring plan, VEGADIS 11 for signal conditioning instrument

1. *Signal conditioning instrument*
2. *Indicating module*
3. *Control instrument*

Note:
The input (terminals 10/11) is provided for connection of signal conditioning instruments. Connection and operation in Ex ia is not possible. The output (terminal 1/2) is bridged.

4.3 Wiring plan, VEGADIS 12

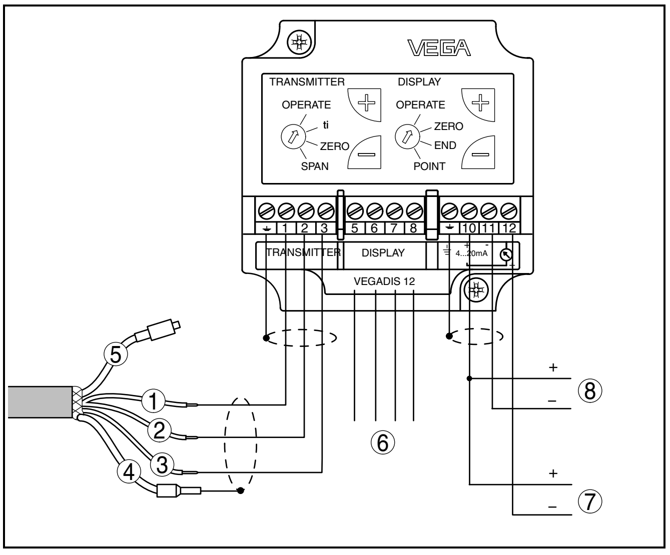

Fig. 17: Wiring plan, VEGADIS 12

1. *brown (+)*
2. *blue (-)*
3. *Yellow*
4. *Screen*
5. *Breather capillaries with filter element*
6. *Indicating module*
7. *Control instrument*
8. *Voltage supply/Signal output*

4.4 Wiring plan, VEGADIS 61

Wiring plan

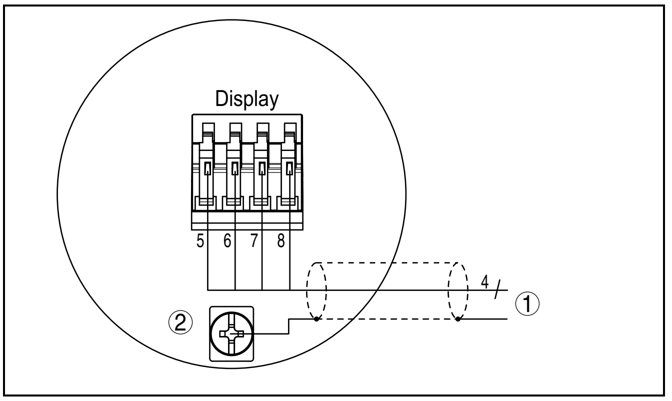

Fig. 18: Wiring plan, single chamber housing

1. *plics® sensor*
2. *Grounding on both ends with non-Ex. With Ex, grounding at one sensor end is recommended, see EN 60079-14.*

4.5 Wiring plan, VEGADIS 175

Passive sensors

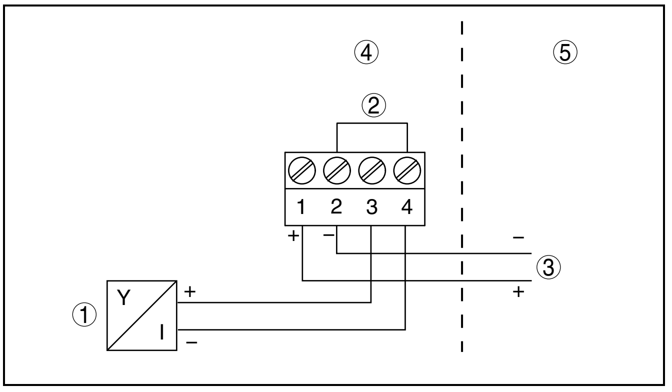

Fig. 19: Wiring plan, VEGADIS 175 for passive sensors

1. *Sensor (passive)*
2. *Bridged internally*
3. *Voltage supply/Signal output*
4. *Ex area*
5. *Non-Ex area*

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Active sensors

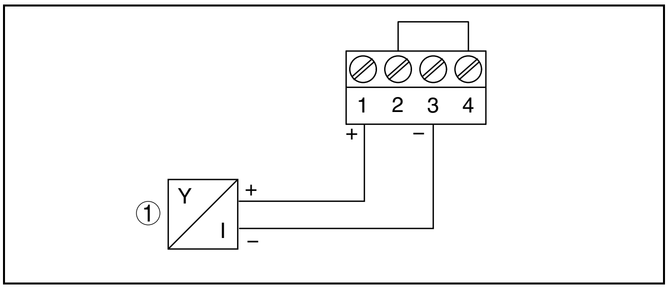

Fig. 20: Wiring plan, VEGADIS 175 for active sensors

1 Sensor (active)
2 Bridged internally

5 Operation

5.1 Adjustment on VEGADIS 11

The display is located in the housing cover, the adjustment elements are accessible after removing the cover.

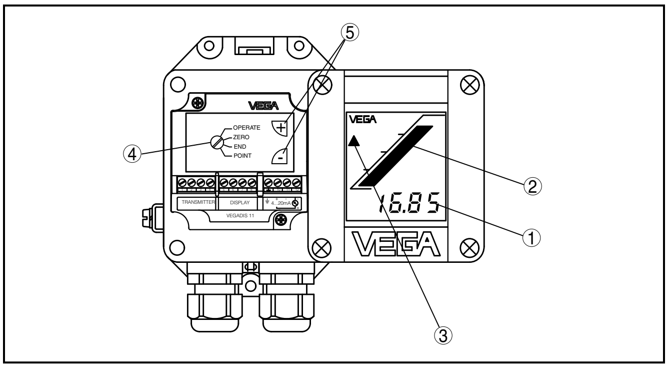

Fig. 21: Indicating and adjustment elements

1 *Digital indication*
2 *Bar graph indication*
3 *Tendency indication*
4 *Rotary switch*
5 *Adjustment keys* ***+/-***

Key functions

- [***Rotary switch***] to select:
  - Operate = Measured value indication
  - ZERO = Adjustment of the min. value
  - SPAN = Adjustment of the max. value
  - Point = Shifting of the decimal point

- [**+/-**] key:
  - Change value of the digital indication

5.2 Adjustment on VEGADIS 12

The display is located in the housing cover, the adjustment elements are accessible after removing the cover.

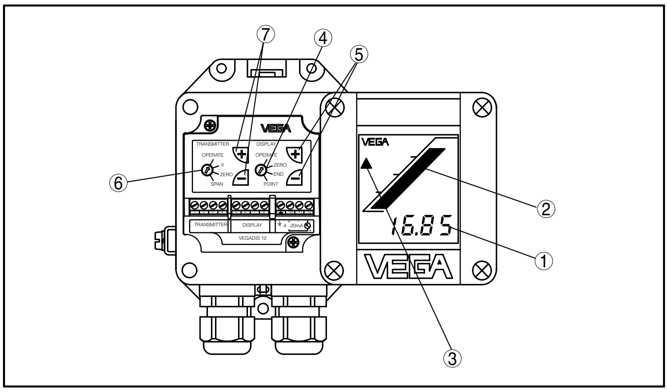

Fig. 22: Indicating and adjustment elements

1 *Digital indication*
2 *Bar graph indication*
3 *Tendency indication*
4 *Rotary switch "Indication"*
5 *Adjustment keys* ***+/-*** *display*
6 *Rotary switch "Pressure transmitter"*
7 *Adjustment keys +/- Pressure transmitter*

Key functions

- [***Rotary switch***] to select:
  - Operate = Measured value indication
  - ZERO = Adjustment of the min. value
  - SPAN = Adjustment of the max. value
  - Point = Shifting of the decimal point

- [**+/-**] key:
  - Change value of the digital indication

5.3 Adjustment on VEGADIS 61 and PLICSCOM

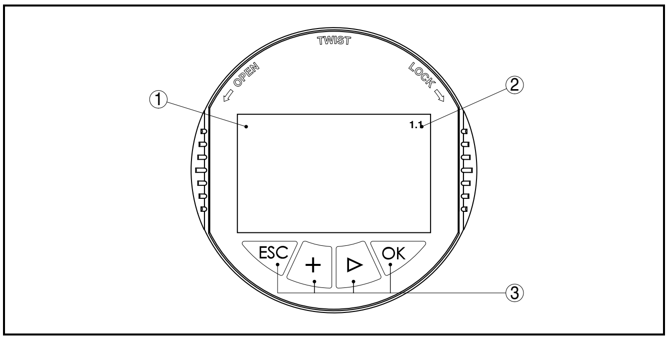

Fig. 23: Indicating and adjustment elements

1 *LC display*
2 *Indication of the menu item number*
3 *Adjustment keys*

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Key functions

- *[OK]* key:
  - Move to the menu overview
  - Confirm selected menu
  - Edit parameter
  - Save value

- *[->]* key to select:
  - menu change
  - list entry
  - Select editing position

- *[+]* key:
  - Change value of the parameter

- *[ESC]* key:
  - interrupt input
  - jump to the next higher menu

5.4 Adjustment on VEGADIS 61 with PACTware™

PACTware™/DTM

plics® sensors can be adjusted via PACTware™ independent of the respective signal output 4 … 20 mA/HART, Profibus PA or Foundation Fieldbus via VEGADIS 61. To adjust with PACTware™, an instrument driver for the particular sensor is required.

All currently available VEGA DTMs are provided as DTM Collection with the current PACTware™ version on CD. They are available from the responsible VEGA agency for a token fee. The basic version of this DTM Collection incl. PACTware™ is available as a free-of charge download from Internet.

To use the entire range of functions of a DTM, incl. project documentation, a DTM licence is required for that particular instrument family. This licence can be bought from the VEGA agency serving you.

Connection of the PC to VEGADIS 61

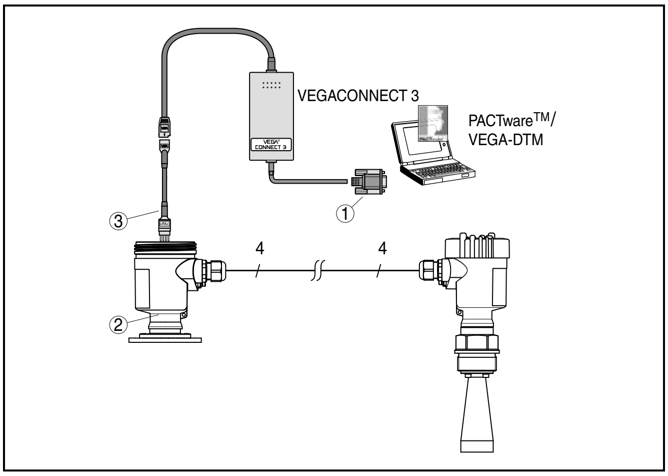

Fig. 24: Connection to VEGADIS 61

1 RS232 connection
2 VEGADIS 61
3 I^2C adapter cable for VEGACONNECT 3

To adjust with PACTware™, a VEGACONNECT 3 with I^2C adapter cable (art. no. 2.27323) as well as a power supply unit is necessary in addition to the PC and the suitable VEGA-DTM.

5.5 Adjustment on VEGADIS 175

Indication and adjustment are carried out on the front via a clear LC display and three keys.

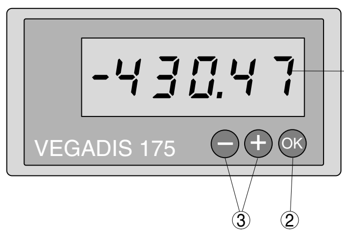

Fig. 25: Indicating and adjustment elements

1 Digital indication
2 Key (OK)
3 Adjustment keys +/-

Key functions

- *[OK]* key:
  - Move to the menu overview
  - Confirm selected menu
  - Edit parameter
  - Save value

- *[+]/[-]* keys:
  - Change value of the parameter

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6 Technical data

General data

VEGADIS 11, 12	
Series	Instrument for panel or wall mounting or mounting on carrier rail 35 x 7.5 according to EN 50022
Materials	
– Housing	plastic PBT
– Inspection window of the indication	Lexan
– Breather facility	PTFE filter element
– Ground terminal	316Ti/316L
Weight approx.	400 g (0.882 lbs)
VEGADIS 61	
Series	Instrument for panel or wall mounting or mounting on carrier rail 35 x 7.5 according to EN 50022
Materials	
– Housing	Plastic PBT, Alu die-casting powder-coated, 316L
– Inspection window in housing cover	Polycarbonate (UL-746-C listed)
– Ground terminal	316Ti/316L
Weight, depending on the housing material and mounting technology	500 … 1300 g (1.10 … 2.87 lbs)
PLICSCOM	
Series	Module for insertion in VEGADIS 61
Materials	
– Housing	ABS
– Inspection window	Polyester foil
Weight approx.	100 g (0.22 lbs)
VEGADIS 175	
Series	Module unit for front panel mounting
Materials	
– Housing front	Alu die-casting
– Housing	Sheet steel galvanized
– Rear of the housing	ABS
Weight approx.	300 g (0.66 lbs)

Input

VEGADIS 11	
Connection to	individual passive or active sensors 4 … 20 mA/HART
Transmission	analogue, 4 … 20 mA
Max. input current	150 mA
Connection cable to the sensor	2-wire
Voltage loss	4.5 V at 20 mA
VEGADIS 12	
Connection to	VEGAWELL 72 - 4 … 20 mA/HART, VEGABAR 74, 75
Transmission	analogue, 4 … 20 mA
Max. input current	150 mA
Connection cable to the sensor	3-wire (VEGA special cable with breather capillaries or standard cable)
Max. cable length	200 m
Voltage loss	4.5 V at 20 mA
VEGADIS 61	
Connection to	VEGA plics® sensors
Data transmission	digital (I^2C-Bus)
Connection cable	4-wire, screened
Max. cable length	25 m
VEGADIS 175	
Transmission	analogue, 4 … 20 mA (reverse battery protection)

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HART protocol	The indicator is suitable for transmission of the HART protocol
Max. input current	150 mA (shortcircuit current)
Voltage loss	< 2 V with 20 mA

Indications

VEGADIS 11, 12

LC multiple function display	
– Bargraph (quasianalogue indication)	20 segments
– Digital value	-9999 … 9999
– Tendency indicators	Symbols for rising or falling values

VEGADIS 61, PLICSCOM

LC display	in dot matrix
Power supply display light	through the sensor, voltage range see sensor operating instructions manual
Power supply display heating	
– Operating voltage	24 V DC +5 %
– Power	1.7 W
– Switch on point	-5 °C (+23 °F)

VEGADIS 175

LC display	
– Height of figures	17 mm
– Indication range	-19999 … 19999
– Offset	-19999 … 32767

Ambient conditions

VEGADIS 11, 12

Ambient temperature	-20 … +70 °C (-4 … +158 °F)
Storage and transport temperature	-40 … +85 °C (-40 … +185 °F)

VEGADIS 61, PLICSCOM

Ambient temperature	-15 … +70 °C (+5 … +158 °F)
Ambient temperature with heating	-40 … +70 °C (-40 … +158 °F)
Storage and transport temperature	-40 … +80 °C (-40 … +176 °F)

VEGADIS 175

Ambient temperature	-10 … +60 °C (+14 … +140 °F)
Storage and transport temperature	-25 … +70 °C (-13 … +158 °F)
Climatic class	according to EN 60654-1, class B2

Electrical protective measures

VEGADIS 11, 12

Protection	IP 67
Overvoltage category	III
Protection class	III

VEGADIS 61

Protection	IP 66/IP 67
Overvoltage category	III
Protection class	II

PLICSCOM

Protection	
– unassembled	IP 20
– mounted into VEGADIS 61 without cover	IP 40

VEGADIS 175

Protection	
– between front frame and front panel	IP 65
– Terminal	IP 20

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ESD	6 kV/8 kV
Electromagnetic fields	10 V/m
Burst (power supply)	2 kV
Surge	1 kV
Electromagnetic fields	10 V/m

Approvals[1]

VEGADIS 11	
ATEX	ATEX II 2G EEx ia IIC T6
VEGADIS 12	
ATEX	ATEX II 2G EEx ia IIC T6
UL	Cl. I,II,II; Div. 1; Gr. A-G
VEGADIS 61	
ATEX ia	ATEX II 1G, 2G EEx ia IIC T6
ATEX D	ATEX II 1/2D IP6X T
IEC	IEC Ex ia IIC T6
FM	FM Cl.I-III, Div1 (IS)
CSA	CSA Cl.I-III, Div1 (IS)
VEGADIS 175	
ATEX	ATEX II 1G EEx ia IIC T6

Environmental instructions

VEGA environment management system	certified according to DIN EN ISO 14001

You can find detailed information under www.vega.com.

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[1] Deviating data in Ex applications: see separate safety instructions.

7 Dimensions

VEGADIS 11, 12

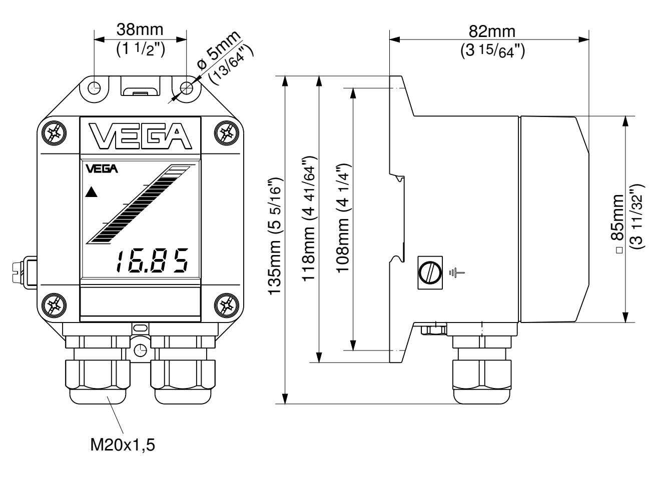

Fig. 26: VEGADIS 11, 12

VEGADIS 61

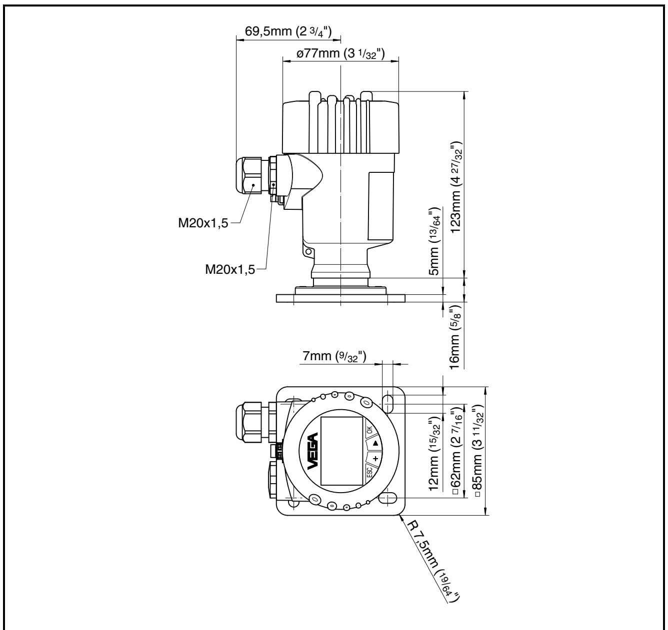

Fig. 27: VEGADIS 61

PLICSCOM

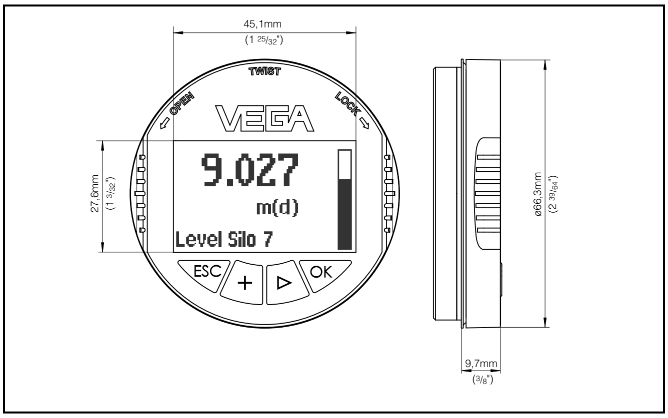

Fig. 28: PLICSCOM

VEGADIS 175

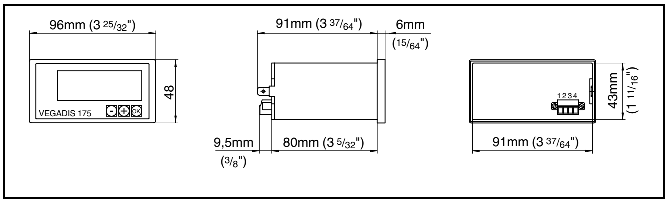

Fig. 29: VEGADIS 175

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8 Product code

VEGADIS 11

Approval
- **.X** without
- **EX.X** ATEX II 2 G EEx ia IIC T6

DIS11

VEGADIS 12

Approval
- **.X** without
- **EX.X** ATEX II 2G EEx ia IIC T6

Adjustment unit for pressure transmitter
- **B** mounted

Display
- **X** without
- **A** mounted

Protective cover
- **X** without
- **W** with

DIS12

VEGADIS 61

Approval
- **XX** without
- **CX** ATEX II 1G, 2G, EEx ia IIC T6
- **CI** IEC Ex ia IIC T6

Housing / Protection
- **K** Plastic / IP66

Cable entry / Plug connection
- **M** M20x1.5 / without
- **N** ½NPT / without

Mounting / Material
- **A** for wall mounting / aluminium
- **B** for wall mounting / stainless steel
- **C** for rail mounting / plastic
- **D** for tube mounting / stainless steel

DIS61.

PLICSCOM

Housing cover
- **K** of plastic
- **A** of aluminium
- **V** of stainless steel 316L
- **X** without

Version
- **B** with background light
- **H** with heating

PLICSCOM.

VEGADIS 175

Approval
- **.X** without
- **EX.X** ATEX II 1 G EEx ia IIC T6

DIS175

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17. Radio Modem

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

RADIO MODEM

1. DR-900 DATA RADIO MODEM TECHNICAL DETAILS

2. TC-900DR USER MANUAL

D Series

Data Radio Modem

DR900 - Digital Radios

*Trio DataCom's **D Series** are high performance cost effective data radio modems designed as an alternative to hard wired data transport. Transmit your data over radio with a fully integrated data radio modem designed for fixed point-to-point and point-to-multipoint applications.*

The **D Series** is available as either a half duplex or a full duplex* 853-929 MHz +/- 5MHz radio, including a fully integrated 4800 / 9600 bps data modem. These units operate equally well in either a stand-alone configuration, or as part of a large communication system.

This complete package forms an attractively priced product for the transmission of data over radio in fixed applications thus providing a viable alternative to costly networks of buried media.

Features:

- Fully integrated half and full duplex* radio and modem
- Transparent and non-intrusive remote diagnostic facilities (Optional)
- Inbuilt data routing and multiplexing capabilties, multi-port operation
- Simultaneous delivery of multiple protocols using Trio DataCom's unique MultiStream™ technology
- Digital Signal Processing (DSP) modem
- Selectable 300-19,200 bps asynchronous RS232 user interface
- Built-in antenna diplexer*
- Integrated supervisory data channel
- Unique collision avoidance facility, for unsolicited report-by-exception
- Software selectable configuration parameters
- Internal repeater operation
- Housed in an attractive yet robust metal enclosure
- Range of ancillary equipment - full duplex base / repeater stations and hot-standby base station

Radio

The **D Series** radio has been designed to meet worldwide regulatory guidelines, including FCC, and has adjustable power output up to 5 Watts. This fully synthesised radio is programmable in 6.25/7.5 kHz increments to accommodate various worldwide channel spacings. The receiver section has a wide tuning range with an excellent signal-to-noise ratio. Exceptional frequency stability is achieved by intelligent microprocessor controlled temperature compensation. An extended operating temperature range of -30 to 60^0 C makes the unit ideal for commercial and industrial applications.

Modem

The in-built modem includes a custom DSP developed for data communications over narrow band radio systems.

This system offers minimum occupied bandwidth and optimal data integrity (using the standard HDLC protocol with CCITT CRC error detection) inhibiting the transfer of any rogue unwanted data caused by interference or squelch headers / tails.

The Trio DataCom DSP provides:

- the interface between the asynchronous RS232 user communication and the synchronous radio link layer.
- an inbuilt multipexer / router which allows for simultaneous transportation of multiple protocols over the one radio network.

Applications

The **D Series** is ideal for use in a variety of sophisticated and critical SCADA and Distributed Information Systems, where complex routing of multiple data protocols and remote diagnostics and wireless network management are important factors.

Remote units and a number of full duplex base station / repeater models, suitable for a variety of requirements, make up the **D Series**. At the top of the range, the DH model is a genuine, duplicated hot standby base for systems where nothing short of ultra reliability is acceptable.

Telemetry Systems - Utilities (Gas, Water, Electricity), Railways, Mining, Telecommunications, Industry. Where network status, system control, data collection and fault conditions are required.

Transaction Processing - Point of Sale Credit Terminals, Stock Control, Direct Order, Banks, Building Societies, Stock Brokers, Gambling Organizations, etc, where Point of Sale, inventory, credit, or transaction data requires collection and distribution.

Common Carrier Data Services - The high speed, low cost and spectrum efficiency of this device make it well suited to all forms of common carrier data networking.

Alarm Monitoring - Fire, Power, Intrusion & Essential Services Alarm Reporting.

designs products & **solutions**

* Available for DR900 full duplex 1 W version (853 ± 5 MHz / 929 ± 5 MHz)

D Series - Data Radio Modem

DR900 - Digital Radios

Configuration

Configuration using Trio's **D Series** programming software (DRProg) is completely Windows© based for all parameters, such as; frequency, transmitter power, digital mute level, PTT timer, system configurations, port settings.

Network Management & Diagnostic (Optional)

A large distributed network, or even a simple point-to-point link, requires comprehensive fault reporting and diagnostics to ensure a high level of availability. Trio **D Series** data radio modem products offer sophisticated in-built diagnostics using the optional **TView**™ software. This capability allows the customer to remotely monitor and maintain their system, minimising the likelihood of failures, by pointing out component degradation and decreasing the time to diagnose and repair. There is no necessity to visit the master station or interfere with the host data integrity, other than additional data transfer. For further details, consult the **TView** data sheet.

Collision Avoidance

A unique fully integrated, yet independent, low speed supervisory data channel embedded within the primary bit-stream provides collision avoidance facilities which are transparent to the user. The use of this feature makes this product ideally suited for reliable, error free data transmissions between stations in high density point-to-multipoint data networks.

The benefits include:

- Multiple asynchronous applications operating on the one radio channel.
- Enhanced performance of report-by-exception networks.

Related Products

- Base Stations (DB900)
- Hot Standby Base Station (DH900)
- 9 Port Stream Router Multiplexer (MSR)
- Network Management and Diagnostic Software (TView™)
- D Series Programming Software (DRProg™)

Specifications:

RADIO	
Frequency Range**	853-929 MHz +/- 5MHz
Channel Selection	Fully programmable
Frequency Splits	76 MHz Tx/Rx frequency split available including simplex
Frequency Stability	±1ppm (-10 to 60ºC ambient, opt. -30 to 70ºC) Higher frequency stability options are available due to intelligent processor controlled temperature compensation
Aging	<= 1ppm/annum
Half / Full Duplex	half duplex or full duplex*
Data Rate (rf)	4800 / 9600 bps
Configuration	All configuration via Windows software

TRANSMITTER	
Tx Power	5 W (+37 dBm) or 1 W* (+30 dBm) (software programmable)
Modulation	Narrow band digital filtering binary GMSK
Occupied Bandwidth	Meets various international regulatory guidelines for point-to-point and point-to-multipoint
Tx Attach Time	< 1 mSecond
Timeout Timer	Programmable 1-255 seconds
Tx Spurious	<= -65 dBm

RECEIVER	
Sensitivity	-115 dBm for 12 dB SINAB
Blocking	> 75 dB (EIA)
Intermodulation	<= 70 dB (EIA)
Spurious Response	<= 70 dB (EIA)
Select. and Desense	70 dB (EIA)
AFC Tracking	±3 kHz tracking @ -90 dBm/attack time <10 mS
Mute	Programmable digital mute

CONNECTIONS	
User Data Port	2 x DB9 RS232 female ports
Antenna	SMA female bulkhead (optional N)
Power	2 pin locking. Mating connector supplied

MODEM	
Data Serial Port #1	Full duplex, DB9 RS232, DCE (modem), 300-19,200 bps asynchronous, hardware/software handshaking
Data Serial Port #2	Full duplex, DB9 RS232, 300-9600 bps asynchronous, software handshaking
Data Storage	On-board RAM
Channel Data Rate	4800 / 9600 bps, full duplex
Bit Error Rate	< 1×10^{-6} @ -108 dBm (4800 bps) < 1×10^{-6} @ -105 dBm (9600 bps)
Collision Avoidance	Trio DataCom's unique supervisory channel C/DSMA collision avoidance system
MultiStream™	Trio DataCom's unique simultaneous delivery of multiple data streams (protocols)

GENERAL	
Power Supply	13.8 Vdc nominal (11-16 Vdc)
Transmit Current	600 mA max. @ 1 W 1700 mA max. @ 5 W
Receive Current	175 mA
Dimensions	260 x 161 x 65 mm (robust metal enclosure)
Weight	1.3 kg

* Available for DR900 full duplex 1 W version (853 ± 5 MHz / 929 ± 5 MHz)
** Various sub-frequency bands available.
Note: Model codes previously known as xxxDR are now depicted as DRxxx.

Local regulatory conditions may determine the suitability of individual versions in different countries. It is the responsibilty of the buyer to confirm these regulatory conditions.

Performance data indicates typical values related to the described unit. Information subject to change without notice.

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TRIO DATACOM

TC-900DR

900 MHz
Full Duplex Data Transceiver

User Manual

Issue 13 : February 2001

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Modifications

Issue 1	February 1993 (Preliminary)
Issue 2	May 1993 Major Changes to Section 3
Issue 3	September 1993
	Minor Changes to sections, 3.1, 3.2.1, 3.2.2.1, 3.2.7, 3.4.3, 3.4.4, 4.4, 4.5, 4.7, 4.7.2, 4.7.3
	Major Changes; Inserted new section 3.2.6 KISS/SLIP Deleted section 4 Programming Deleted section 5.7.5, 5.7.6, 5.7.7 AFC Alignment
	Removed Filter Alignment Setup Diagram
	Inserted RSSI Level cf Received Signal (typical)
Issue 4	February 1994
	Minor Changes to all sections
	Additions to Section 3 for Firmware V2.2 and Synchronous Operation
Issue 5	March 1994
	Addition of section 5.2.6.1 and 5.2.6.4
	Revised figure on page 75
Issue 6	September 1994
	Addition to Section 3.2.5, 4.7.1, 4.7.2, 4.7.3, 4.7.4
	Addition of Sections 3.3.11.1, 3.3.11.2, 4.5.1,
Issue 7	April 1995
	Addition to Sections 3.8.11.2 and 3.8.12.5 Rev D Sync LED
Issue 8	September 1995
	Insertion of new Section 3.2
Issue 9	June 1998
	Section 3.3.6 replaced
Issue 10	February 1999

Modifications (cont.)

Issue 11	February 1999
	Minor changes to Sections 1.5, 3.3.1,
	Deleted Section 1.6, 4.5.1
	Replaced Section 5
Issue 12	July 2000
	Minor Change to Section 7
Issue 13	February 2001
	Change of Company Name

SECTION 1

INTRODUCTION

1 INTRODUCTION

1.1 GENERAL

The TC-900DR is a Full Duplex 900 MHz Radio, featuring a fully integrated 4800 or 9600 bps data modem.

The entire unit is housed in a robust metal enclosure that provides a compact and transportable means for the transmission of data over radio.

The product has been fully designed and developed in Australia, by an Australian owned and managed company.

The TC-900DR meets the ACA SP4/89 specification which covers radio data transmissions over point-to-point and point-to-multipoint systems.

It is ideally suited for applications such as :

- Transaction Processing.
- Public Utility Telemetry Systems.
- Alarm Monitoring.
- Supervisory Control and Data Acquisition.
- Energy Distribution.
- Inventory Control
- Common Carrier Data Services.
- Temporary Installations

The modem provides byte oriented packet data communications over narrow band FM systems, using digital filtered binary FSK modulation.

The TC-900DR can be supplied for use with 12.5kHz, 15kHz, 25kHz or 30kHz channel spacings. Its operational parameters can be programmed with the TC-D Series installation programmer. This is a separate software package that runs on an IBM compatible PC under Windows 95/98/NT.

1.2 FACTORY QUALITY ASSURANCE

The TC-900DR has been designed and manufactured with particular emphasis placed on the following points :

- State of the art design techniques.
- Simple assembly/disassembly.
- Minimal alignment requirements.
- Manufactured using quality components.

All units have been manufactured using automated assembly procedures. This assures attention to detail and a high level of quality control.

All components used are of high quality, and conform to Trio DataCom's required specifications. The component suppliers provide batch, date and manufacturing criteria that are required to meet quality control standards.

Each unit is individually tested with an inbuilt self diagnostic program. It is then passed through a set of automatic test procedures with minimal human intervention. This ensures a consistently manufactured and performing product. Many of the alignments are factory set and should not require re-alignment in the field.

Trio DataCom's quality control does not finish here. Once each unit has passed its individual tests, it is placed in a cyclic heat/cooling chamber. This chamber is automatically cycled from -10^{0}C to +65^{0}C, twice, over a twenty hour period. During this time, the modem controller - using external precision calibrated test equipment - monitors and stores frequency stability versus temperature data. The TC-900DR uses this information to achieve its temperature compensated, frequency stability level of 1ppm.

Power output is measured during the temperature cycling. This is achieved by having the unit connected to a PC and various test equipment via a GPIB. Units that fail any of these tests are reported by the test program and corrective action taken before going through the complete cycle once again. Each unit shipped from the factory comes with a factory alignment printout which details:

- Configuration.
- Transmit frequency.
- Receive frequency.
- Receiver sensitivity.
- Transmitter power output.
- Transmitter modulation.

In most cases, the radio transmitter as shipped from the factory will require no re-alignment.

It is this care and quality control that ensures that the purchaser of a TC-900DR radio modem, obtains a consistently manufactured and performance specified product, which has been "burned in" to minimise any operational failures.

1.3 FEATURES

Advanced microwave and digital techniques were employed during the design phase of the TC-900DR, ensuring an innovative and state of the art product.

Features include :

- Fully integrated full duplex radio and modem
- Built in antenna diplexer
- Power output +30dBm (1 Watt nom) at antenna connector
- Radio meets ACA SP4/89 requirements 2/90
- In-built transparent remote diagnotics capability.
- Custom single chip modem - digital signal processing
- 4800 & 9600 bps transfer rates, full duplex
- Selectable 110..19k2 asynchronous RS-232 host interface
- Unique collision avoidance facilities
- Integrated supervisory signalling channel
- Software selectable configuration parameters
- Configurable bit error rate testing
- Excessive temperature power fold-back
- Auxiliary port for use with an optional supervisory audio handset

1.4 SPECIFICATIONS

1.4.1 RADIO SECTION

Rx frequency range	:	923MHz to 933MHz (see note 1)
Tx frequency range	:	847MHz to 857MHz (see note 2)
Channel spacing	:	Fully synthesized 12.5kHz / 25kHz, [opt 15/30] with programmable 1/2 channel raster offset
Frequency stability	:	1 ppm (-10^{0}C to 65^{0}C amb), [opt -30^{0}C to 70^{0}C], aging <= 1ppm/Annum
Power output at Antenna connector	:	+30 dBm ±1dBm (1W nom) switchable under software control 200mW/1W
Duty cycle	:	Continuous
Output impedance	:	50 Ohms
Timeout timer	:	Programmable from 1 sec. to 28 minutes (max)
Tx key up time	:	<= to 1mS (output _ 1dB of power).
Rx sensitivity	:	0.5uV at antenna input for 12 dB SINAD at "delayed Rx signal" test point.
Rx intermodulation	:	>= 70 dB spurious free dynamic range.
Rx spurious responses	:	<= -65 dB.
Tx spurious emissions	:	<=-65 dBc (ref unmodulated carrier).

Full duplex with single antenna.

Note 1. The reciprocal frequency option for point-to-point operation or point to multi-point base repeaters is available as follows :
- *Rx frequency range 847MHz to 857 MHz.*
- *Tx frequency range 923MHz to 933 MHz.*

Note 2. The transmitter is normally supplied, with its frequency offset from the receiver by 76 MHz.

1.4.2 MODEM SECTION

User Ports	:	DB-9 connector, EIA RS232, DCE, serial asynchronous, 300..19k2 baud, 7/8 bit, no/odd/even parity.
Data Rate	:	4800/9600 bps Full Duplex.
BER	:	Less than 10E-6 @ -105dbm measured at antenna port
Data Format	:	Narrow band digital filtered binary FSK Modulation, using Trio DataCom's DFM4-9 digital modem chipset, including Trio's unique supervisory signalling channel C/DSMA collision avoidance scheme.
Synchronisation Delay	:	20 milliseconds.

1.4.3 RADIO AND MODEM SECTIONS COMBINED

Occupied bandwidth	:	Meets ACA SP4/89 guidelines for point-to-point and point-to-multipoint assignments.
Mean deviation	:	±1.5 kHz (4800bps), ±2.75 kHz (9600bps)
Power requirements	:	14 Volts AC 10VA or 13.8Volts DC (11 to 16V Max).
Transmit current	:	<= to 600 mA.
Receive current	:	175 mA.
Size	:	241mm x 161mm x 65mm.
Weight	:	1.3Kg.

1.4.4 CONNECTORS

User RS-232 Connection	:	DB9 female wired as DCE (modem). (AMP Part # 747844-5)
Mating connectors	:	DB9 male solder type. (AMP Part # 747983-3) Backshell to suit. (AMP Part # 205729-1). Optional supplied to order.
Antenna Connection	:	Gold plated SMA female bulkhead. (E.F.JOHNSON Part # 142-0701-501)
Mating connector	:	SMA male to RG223 crimp type. (E.F.JOHNSON Part # 142-0407-006) Optional supplied to order
AC/DC Power Connector	:	2 pin locking (9A rating). (PCB SOCKET MOLEX Part # M5569-2A2)
Mating connector	:	(RECEPTACLE MOLEX Part# M5557-2R) (RECEPT PINS MOLEX Part # M5556-TL). Supplied with standard unit.
Supervisory Audio Handset Connector	:	6 pin modular jack. (AMP Part # 520250-3)
Mating connector	:	6 pin modular jack plug. (AMP Part # 5-641337-3). Supplied with optional audio handset.

1.5 OPTIONAL ACCESSORIES

Trio stock a large range of ancillary devices including coax cables, RF connectors, antennas, lightning protection, power supplies, etc.

Please contact Sales for futher information.

SECTION 2

HARDWARE TECHNICAL DESCRIPTION

2 HARDWARE TECHNICAL DESCRIPTION

2.1 GENERAL

The TC-900DR is a 900 MHz full duplex radio complete with radio modem and antenna diplexer. In this and subsequent descriptions to follow, references have been made to block diagrams, circuit diagrams and component loading diagrams.

These can be found in appendix A, at the rear of this manual.

The unit can be divided into five major sub-blocks :

Radio section.

Antenna diplexer section.

Audio handset.

Modem section.

Unit housing assembly.

2.2 RADIO SECTION

The radio section is built on a single PCB with approximate dimensions of 193mm x 152mm x 1.6mm.

This section consists of the following main blocks :

- Receiver.
- Transmitter.
- Frequency control.
- Interfaces.

Each of these blocks can be further broken down as follows :

- Receiver.
  - Pre-amplifier.
  - Mixer.
  - 45 MHz I.F. filter.
  - FM I.F. & Demodulator
  - Audio processing.
    - - Data.
    - - Voice.
  - RSSI processing.
- Transmitter.
  - Audio processing.
    - - Data.
    - - Voice.
  - Modulator.
  - Multiplier.
  - Mixer.
  - Power amplifier.
  - Control.
    - - PTT.
    - - Power.
- Frequency control
  - Synthesiser.
  - Local oscillator.
  - AFC
- Interfaces
  - Modem section.
  - Antenna diplexer.
  - Audio handset.

2.2.1 RECEIVER

The general form of the receiver circuitry is shown in diagrams "DR9 Macro Block Diagram" (drawing number TC01-05-19 sheet 3/3), and "900 MHz Radio - Block Diagram" (drawing number TC01-05-19 sheet 2/3).

2.2.1.1 PRE-AMPLIFIER

The receiver pre-amplifier obtains signal direct from the antenna diplexer port - connector X2. It consists of two stages. The first stage is optimised to give a low noise figure, while the second is optimised to produce gain.

The central devices used are MRF5711 high frequency transistors. They provide the basis for a wide band amplifier that can receive from the lowest band frequency range of 852 to 854 MHz to the higher band frequency range of 928 to 930 MHz.

The RF selectivity is provided by the diplexer filter.

Strip line impedance matching networks are employed to ensure optimum performance of the amplifier.

The overall gain of the pre-amplifier is set to 20dB.

2.2.1.2 MIXER

The receiver mixer consists of a 180 "rat race hybrid ring" followed by a passive Schottky mixer diode.

The mixer injection frequency is set 45MHz from the required receive frequency, (high side injection for 930 MHz receive and low side for 850 MHz receive). This results in an I.F. frequency output of 45 MHz.

The level of the injection is set to 6 dBm by the amplifier stage Q3.

2.2.1.3 FIRST I.F. STRIP FILTER

The required receiver mixer product is filtered by the first I.F. filter. The filter is a bandpass crystal controlled device, centred on 45 MHz, and provides image rejection for the second IF Mixer.

The filter is aligned for optimum response by adjustment of inductors L4,L3 and L5.

2.2.1.4 FM IF and DEMODULATOR

The heart of the demodulator section is an NE615D high performance low power mixer FM IF system IC.

This device incorporates a mixer/oscillator, two limiting intermediate frequency amplifiers, a quadrature detector, muting circuitry, logarithmic RSSI, and a voltage regulator.

The input to the device is from the output of the 45 MHz first IF strip filter. This is applied at RF_{in} and RF_{bypass} pins (U2-p1,p2).

This signal is applied internally to a Gilbert cell mixer, which is set to convert the signal down to 455kHz.

The mixer injection is supplied by an internal oscillator, which is driven by an external oscillating signal applied at the XTAL OSC pins (U2-p3,p4).

The basic injection frequency is governed by the 44.545 MHz crystal XTAL1. This produces a mixer output product of 455 kHz.

The output of the mixer is available at MIXER OUT (U1-p20). This is applied to a 455kHz centred bandpass filter. This acts as the "front end" filter, CF1.

The bandwidth and rolloff characteristics of this filter are set, depending on the required baud rate of the data being used on the modem, and the required channel spacing. Refer to Circuit Diagram for filter types.

The filtered output is then applied to the input of the internal IF amplifier, IF AMPIN (U1-p18). The bandwidth of the amplifier is about 40 MHz, with a gain of about 39 dB(uv). C10 and C11 provide IF amplifier decoupling.

The output is available at IF AMP OUT (U1-p16). This is applied to a 455kHz centered bandpass filter. This acts as the "rear end" filter, CF2.

Again the filter selection depends on the required bandwidth. Refer to Circuit Diagram for filter types.

The filtered output is then applied to the input of the internal IF limiter, LIMITER IN (U1-p14). The bandwidth of the limiter is about 28 MHz, with a gain of about 62 dB(uv). C13 and C14 provide IF limiter decoupling.

The signal from the second limiting amplifier is passed to an internal Gilbert cell quadrature detector, as well as to LIMITER OUT (U1-p11).

One of the Gilbert cell ports is driven directly by the IF, the other by a tuned quadrature network, which is driven by the IF signal from LIMITER OUT. The tuned network is based around a ceramic resonator CF3. The Q of the network is varied depending on the required baud rate used by the modem. For 9600 baud the link LK3 is inserted, giving a higher damping factor than that required for 4800 baud, where the link is removed.

This gives the two input signals applied to the Gilbert cell a 90 degree phase relationship, the output of which is the demodulated audio/data signal.

The output signal is available at UNMUTED AUDIO OUT (U1-p9). A gated output is also available at MUTED AUDIO OUT (U1-p8).

2.2.1.5 AUDIO PROCESSING

2.2.1.5.1 DATA

The demodulated data signal output has been assigned to the UNMUTED AUDIO OUT pin (U1-p9). This ensures no interruption to the flow of data.

The signal is filtered by the C22, R20, R29 and C23 filter network. This is to remove any high frequency components produced at the output of the quadrature detector.

It is then amplified and DC level shifted by op-amp U1:C. The amount of DC bias applied to the signal can be varied by the potentiometer VR2. For correct processing by the modem, this level is set to 2V. The AC level of the signal is set to about 1 V_{p-p}

2.2.1.5.2 AUDIO

The demodulated audio signal output has been assigned to the MUTED AUDIO OUT pin (U1-p8). This allows switching control of the audio passed to the handset earpiece.

The signal is filtered by R23 and C17. This is to remove any high frequency components produced at the output of the quadrature detector.

It is then buffered, amplified and level shifted by op-amp U1:D, and presented to the handset via coupling capacitor C20 and connector X3-p2.

The mute control signal is applied to the NE615 (FM IF system IC) MUTE IN pin (U2-p5). When active, the audio output signal from the IC is attenuated by greater than 60dB.

2.2.1.6 RSSI

The RSSI output is presented by the NE615 at RSSI OUT (U2-p7). This signal is logarithmic with an output range greater than 90 dB. It is used for audio mute processing, and by the modem section as a data qualifier signal.

The signal is first passed through a unity gain buffer, op-amp U1:B, before it is split.

The RSSI level is compared with the setting of "audio mute adj" potentiometer VR1, by op-amp U1:A. The result is passed to the MUTE IN pin of the NE615.

This allows a suitable mute cutoff point to be set for the received audio sent to the handset earpiece.

The RSSI signal is also passed to the modem section for processing via R19 and connector X1-p21.

2.2.2 TRANSMITTER

The general form of the transmit circuitry is shown in diagrams "DR9 Macro Block Diagram" (drawing number TC01-05-19 sheet 3/3), and "900 MHz Radio - Block Diagram" (drawing number TC01-05-19 sheet 2/3).

2.2.2.1 AUDIO PROCESSING

2.2.2.1.1 DATA

The transmit data signal enters the radio section via connector J*3-p13, from the modem section. It is biased via R68 and R75 to a DC level of about 0.86V. The signal is then passed through a level setting potentiometer VR2, used to set the level of transmit deviation.

It is then presented to the input of the modulator circuit.

2.2.2.1.2 VOICE

The transmit voice signal enters the radio section via connector X3-p4, from the microphone in the handset. The pre-amp in the microphone circuit is given some bias via R76.

The signal is first passed through a clipping circuit. This consists of back to back clamping diode pair D2, AC-coupled via C154. This ensures that a maximum transmit deviation level is imposed.

The modulator circuitry is based around a low power FM transmitter system IC,MC2833. Included in this device is a microphone amplifier and clipper. The audio is passed to the amplifier via R76 at the MIC AMP INPUT pin (U7-p5).

Feedback for gain is supplied by R76, and band limiting by C50. The amplifier output is presented at MIC AMP OUTPUT (U7-p4).

Further low pass filtering is provided by the network of R71, C49, R59.. and C42... C43 provides a rising response below 100Hz. This filtering is needed to shape the base band signal, so as the transmit frequency spectrum stays within channel boundaries.

The audio is coupled into the modulator circuit at the MODULATOR INPUT pin of the MC2833 (U7-p3).

2.2.2.2 MODULATOR

The heart of the modulator section is an MC2833 low power FM transmitter system IC. This device is a one chip FM transmitter subsystem designed for FM communication equipment. It includes a microphone amplifier, a variable reactance modulator, a voltage controlled oscillator, and two auxiliary transistors.

Data is fed directly to the input of the reactance modulator at the MODULATOR INPUT pin (U7-p3). The audio channel is fed via an inbuilt clipper amplifier in the MC2833. The output of this variable reactance circuit is used to modulate the FM carrier.

The carrier frequency of the modulator is provided by an internal oscillator, which is driven by an external oscillating signal applied at the RF OSC pins (U7-p15,p16).

This oscillating signal is governed by the 20.166 MHz crystal XTAL3. The actual applied frequency is set by the modulating signal, which slightly varies ("pulls") the crystal frequency. This is achieved by connection of the crystals circuit to the output of the variable reactance circuit VARIABLE REACTANCE OUTPUT (U7-p1). This output is coupled to the crystal via a frequency trimming coil L6.

The output FM signal is presented at the RF OUTPUT pin (U7-p14).

2.2.2.3 MULTIPLIER

The output of the modulator is passed to a frequency tripler stage employing auxiliary transistor TR2. This places the carrier frequency at 60.5 MHz.

It then passes to a frequency doubler stage employing auxiliary transistor TR1, where the carrier is moved up to 121 MHz.

The signal is amplified through these stages to a level of about -4 dBm at 121 MHz.

2.2.2.4 MIXER

The transmit FM signal at 121 MHz when mixed with the VCO frequency by U8 produces a transmitter signal 76 MHz from the receiver frequency.

The mixer employed is an MCL SBL-1X monolithic doubly balanced mixer (U8).

The transmit VCO signal is amplified to a level of about +6 dBm by Q2, and applied to the "L" input of the mixer. The 121 MHz signal is applied to the "I" input of the mixer.

To select the correct mixing product for the transmitter, a tunable filter using C78 and a coupled stripline circuit is used.

The output signal is then buffered by two MRF5711 transistors Q4 and Q5, to provide about +4 dBm of signal level, which is applied to the final amplifier section.

2.2.2.5 POWER AMPLIFIER

The power amplifier provides an overall gain of about 30dB. This is achieved by three stages of amplification.

The first stage uses an MRF5711 transistor (Q8). This device is primarily designed for high gain, low-noise, small signal amplifiers, and is ideal for a transmitter pre amplifier. This stage provides about 13 dB of gain. The power control circuit acts on this stage to provide constant power at the PA. output connector.

The second stage uses an MRF8372 transistor (Q9). This device is primarily designed for wideband, large signal predriver stages, in the 800MHz range. This provides a further 10 dB of gain.

The final stage uses two MRF8372 transistors (Q10, Q11) in a parallel configuration to provide the final output power. Each of these stages provides about 10 dB of gain. The output impedance is matched to 50 ohms via the use of balanced impedance strip lines.

The transmitted signal is presented at connector X4, at a level of about +32 dBm, where it is passed to the diplexer section.

2.2.2.6 CONTROL

2.2.2.6.1 PTT

PTT must be activated for the TC-900DR to transmit an RF signal. There are two sources of PTT, the audio handset, and the modem section.

PTT from the audio handset is referred to as "manual PTT". It enters the radio section via connector X3-p6. It is passed to the PTT control switch transistor Q12. PTT is active LOW, and turns on Q12 when applied.

PTT from the modem section enters the radio section via connector X1-p12, "/PTT". It is connected to the PTT control switch transistor Q12.

When PTT is not activated the transmitter is totally disabled. All stages of the transmit chain are turned off. This is to ensure that power consumption is kept to a minimum.

The PTT signal connects to the start of the transmit chain at the multiplier stage.

The internal transistors of the MC2833 IC, TR1 and TR2 have their bases effective grounded, turning off the devices. Similarly the mixer output buffer and amplifier transistors Q4 and Q5 are turned off as are the final amplifier stages employing Q8, Q9, Q11 and Q10.

When the PTT is activated, bias is applied to all these stages and transmission is possible.

Note : Tx enable must also be active to allow transmission.

2.2.2.6.2 TRANSMIT ENABLE

Transmit enable is a further control placed on the transmitter circuits. No transmission is possible unless the transmit enable signal is active. The signal enters the radio section via connector X1-p11, "/TX EN", from the modem section.

This signal basically enables the PTT switching transistor Q12, thus providing VCC for the 20.166 MHz oscillator section of the MC2833 modulator IC, and bias to the handset microphone.

2.2.2.6.3 POWER

The RF power output of the TC-900DR can be set to two levels. Low power level is 200mW, and high power is 1W.

This level is controlled by two dc levels. One signal is a control level from the modem section, the other from an RF detector located at the output of the transmitter itself. These two signals are used in conjunction to hold the output power constant.

The signal from the modem section enters the radio section via connector X1-p10, "TXPWR". The signal is fed to an op-amp comparison circuit U9:A, via level setting potentiometer VR4.

The level is compared to that actually detected at the output of the transmitter, by the circuit based around diode D3. The comparator output is then used to bias the first stage of the P.A. section (Q8) of the transmitter, hence varying the transistor gain performance and ultimately the output RF power. This basic feedback network is required to keep the power at a constant level, regardless of any external conditions.

The detected output power level is also fed back to the modem section for monitoring and analysis via connector X1-p9, "TXPWR SENSE".

2.2.2.6.4 TEMPERATURE SENSE

A temperature sensing device is included in the radio section. The device used is an LM335 precision temperature sensor, U6. It is operated as a two terminal zener diode, with a breakdown voltage directly proportional to absolute temperature, with an output of +10 mV per degree kelvin.

The temperature data output is passed to the modem section for analysis and processing via connector X1-p14, "TEMP SENSE".

During the "Burn In" cycle, that the TC-900DR is passed through during production, the unit calibrates the output of the sensor to the test temperature. In particular it stores the hottest temperature reached by the test cycle (about 65C).

If the unit reaches this maximum temperature setting while operating in the field, the modem section of the TC-900DR will automatically signal the power control circuit to place the transmitter into low power mode (200mW).

This low level of output power is retained until the temperature sensor signals the modem section, that the temperature has fallen back below the maximum temperature. When this occurs the transmitter is placed back to its previous power setting. A hysteresis is built into the microprocessor control circuitry to stop power jitter.

This scheme is referred to as "High Temperature Fold Back". It is used to protect the transmitter final power transistors from any damage that may be encountered under extreme temperature conditions.

2.2.3 FREQUENCY CONTROL

2.2.3.1 SYNTHESISER

The synthesiser section provides a local oscillator for use by the receiver and transmitter sections.

The synthesiser circuitry is based around a TBB206 PLL frequency synthesiser IC.

This device is a complex PLL circuit in CMOS technology for processor controlled frequency synthesis. The processor resides in the modem section, and three basic control lines are used to interface to the device. The enable "EN", data "DA" and clock "CL" control signals are passed to the TBB206 via connector X1-p16,p17,p18 respectively.

The reference frequency for the synthesiser is applied to the "RI" pin of the TBB206 (U3-p2). This reference is provided by a 12.000 MHz voltage adjustable temperature compensated crystal oscillator (VTCXO), XTAL2. This input has a sensitive preamplifier for a 16-bit (R)eference divider. C33 provides AC coupling for the input.

The VCO frequency is applied to the "FI" input pin of the TBB206 (U3-p8). This input has a highly sensitive preamplifier for a 12-bit N divider and a 7-bit A divider. C29 provides AC coupling for the input.

The actual signal applied to the "FI" input is from the output of a TBB202 dual modulus divider IC (U4-p4). This is to transform the actual VCO frequency of between 786 MHz and 996 MHz, down to a frequency acceptable for use by the "FI" input.

The divider ratio selected by the TBB202 is determined by the state of the "MOD" input pin (U4-p6). If the signal is HIGH, then a ratio of 1:128 is used. If the signal is LOW, a ratio of 1:129 is used. The state of this signal is controlled by the TBB206 synthesiser "MOD" output pin (U3-p7). The TBB206 drives this output LOW at the beginning of a cycle. When the A divider has reached its set value, the "MOD" output is set to HIGH. When the N divider reaches its set value, the output is set LOW again and the cycle is repeated.

The input to the TBB202 divider is from the VCO output via a strip line impedance matching network. The signal is applied to the "I1" pin (U44-p1).

The TBB202 can be placed into standby mode, when not in use. This is achieved by connection of the "STB" pin (U4-p7), to the multi function output port of the TBB206 synthesiser (U3-p6). This port is driven by the DFM4-9 modem IC located in the modem section.

The phase detector signal is provided on the "PD" pin of the TBB206 (U3-p12). This signal has especially short anti backlash pulses to avoid any "dead zones", and to neutralise any small phase deviations. This signal is passed to the loop filter of the VCO circuit.

A lock detect indication is given by the TBB206 synthesiser at the "LD" output pin (U3-p14). This signal is filtered and shaped by the network using R47 and C36, and presented to the modem section for monitoring and processing, via connector X1-p19.

2.2.3.2 VCO

The VCO used is an MQC309 series VCO. The exact device used depends on the required frequencies that the unit has to work with.

Two types are used :

A. MQC309 798 - Frequency range of 784 MHz to 816 MHz

Gives unit frequency ranges of :
- Transmit : 905 MHz to 937 MHz
- Receive : 829 MHz to 861 MHz

B. MQC309 978 - Frequency range of 962 MHz to 994 MHz

Gives unit frequency ranges of :
- Transmit : 841 MHz to 873 MHz
- Receive : 917 MHz to 949 MHz

The 798 type employs low side injection to the mixers, whereas the 978 type employs high side injection.

The loop filter consists of R44, C40, C41 and R43.

The output of the VCO is passed to the receiver mixer via RXMIX, and to the transmitter mixer via TXMIX signal lines. Each of these is impedance matched by strip line circuits for optimum performance.

The layout and selection of all these components has been done in such a way so as to minimise VCO noise being impressed onto either the transmitted or received RF signals.

2.2.3.3 VCO TEMPERATURE COMPENSATION

Frequency temperature compensation is provided for by an input to the reference oscillator circuit.

During the "Burn In" cycle, that the TC-900DR is passed through during production, the unit calibrates the output of the temperature sensor to the test temperature and to any frequency variations that occur, and stores the results.

When the unit is operating in the field, the temperature of the unit is constantly being analysed. Should a frequency offset be required based on the calibration measurements, the modem section signals to the 12.000 MHz reference oscillator to vary its frequency slightly. This signal is passed to the radio section via connector X1-p15, "TEMP COMP". The voltage on this line "pulls" the reference oscillator XTAL2 onto a new frequency, which corresponds to the correct offset required.

Note : Because the temperature compensation for the installed VTCXO is held in the NVRAM of the modem it is imperative that modems and radio boards are maintained as matched pairs. Should either the VCO or NVRAM require replacement it is highly recommended that the unit be returned to the manufacturer for re-calibration.

2.2.3.4 RECEIVER AFC

Automatic frequency control is provided for the received signal. The control signal is applied to the radio section from the modem section via connector X1-p22, "AFC CTL".

The basic injection frequency to the front end mixer of the NE615 FM demodulator IC (U2), is governed by the 44.545 MHz crystal XTAL1. The actual applied frequency can be set by the level of the AFC signal, which slightly varies ("pulls") the XTAL1 crystal frequency via the varactor diode DV1.

The modem section monitors the average DC level of the received signal (DATA signal X1-p13), which gives an indication of received frequency drift.

From this the modem section calculates the required compensation necessary and applies it to the "AFC CTL" signal line.

A reference signal is passed back to the modem section from the radio section via connector X1-p23, "AFC REF". This is processed by the modem section, and used to help determine the level of AFC signal level.

2.2.4 INTERFACES

2.2.4.1 MODEM SECTION

The radio section interfaces to the modem section via connector X1. Attached permanently to this connector is a 90mm length of 26 way ribbon cable, fitted with a female 26 way connector at the other end. This attaches to connector JX3 on the modem section PCB.

Refer to interface diagram "RADIO MODEM INTERFACE", drawing number TC01-05-18 sheet 1/3.

CONNECTOR X1/JX3 PIN NUMBERS	SIGNAL DESCRIPTION	
1	13V8 POWER SUPPLY RAIL	
2	13V8 POWER SUPPLY RAIL	
3	13V8 POWER SUPPLY RAIL	
4	GROUND	
5	GROUND	
6	GROUND	
7	8V POWER SUPPLY	
8	8V POWER SUPPLY	
9	TXPWR SENSE	(o/p- TRANSMIT POWER SENSE)
10	TXPWR	(i/p - TRANSMIT POWER LEVEL)
11	/TX EN	(i/p - TRANSMIT ENABLE)
12	/PTT	(i/p - PRESS TO TALK)
13	DATA	(i/p - TRANSMIT DATA)
14	TEMP SENSE	(o/p - TEMPERATURE SENSOR)
15	TEMPCOMP	(i/p-TEMPERATURE COMPENSATION)
16	EN	(i/p - ENABLE FOR SYNTH)
17	DA	(i/p - DATA FOR SYNTH)
18	CK	(i/p - CLOCK FOR SYNTH)
19	LD	(o/p - LOCK DETECT FROM SYNTH)
20	DATA OUT	(o/p - RECEIVED DATA)
21	RSSI	(o/p - RSSI SIGNAL)
22	AFC CTL	(i/p - AFC CONTROL)
23		(UNUSED)
24	SUPPLY/MIC	(UNUSED)
25	TEST1	(UNUSED)
26	TEST2	(UNUSED)

2.2.4.2 ANTENNA DIPLEXER

The interface between the radio section and the antenna diplexer section is via coaxial connectors X4 and X2, and low loss coaxial cables.

CONNECTOR	SIGNAL DESCRIPTION
X4	TRANSMITTER OUTPUT
X2	RECEIVER INPUT

2.2.4.3 AUDIO HANDSET

The interface between the radio section and the audio handset is via the modular-6 pin connector X3.

CONNECTOR X3 PIN NUMBERS	SIGNAL DESCRIPTION
1	8V POWER SUPPLY
2	AUDIO OUT (o/p - AUDIO TO EARPIECE)
3	GROUND
4	MIC (i/p - MICROPHONE AUDIO)
5	GROUND
6	MANUAL PTT (i/p - HANDSET PTT)

2.3 ANTENNA DIPLEXER SECTION

2.3.1 GENERAL

The antenna diplexer section of the TC-900DR is a separate plug in module, that "piggy backs" the radio section PCB.

The diplexer performs two major tasks. Firstly it couples both the transmit and receive RF paths to the antenna while providing high isolation between them, and secondly it provides image and spurious rejection for each of these paths, with high Q bandpass filters.

The isolation between the transmit side and the receive side is greater than 50 dB.

The diplexer consists of two teflon PCB's bonded together using a critical temperature and pressure process. The top and bottom outer layers are connected via brass eyelets, that are pressed through the PCB. This eliminates the need for through hole plating of Teflon, which requires the use of dangerous chemicals.

The design is essentially two continuous ground planes, filled in between, with laminate dielectric, and stripline filter tracks which are centrally located between these ground planes.

The etching of the filter tracks is closely monitored and controlled to ensure an accuracy of better than 0.001" in track width and spacing.

The diplexer has been factory tested to ensure bandpass and performance characteristics are met. The diplexer has approximately 3 dB of loss at 930 MHz and 2 dB of loss at 850 MHz.

This diplexer requires no alignment in the field.

2.3.2 INTERFACES

The antenna diplexer connects to the radio section via low loss coaxial cables and connectors, and to the units antenna via a SMA connector.

Two versions of the diplexer are available, depending on the transmit and receive frequencies used. The difference between the two is the loading of the SMA connector.

TYPE-A CONNECTIONS *(Transmit frequency = 930 MHz range)*

DIPLEXER CONNECTOR	SIGNAL DESCRIPTION AND DESTINATION
850 MHz port	RF RECEIVE - RADIO SECTION X2
930 MHz port	RF TRANSMIT - RADIO SECTION X4
ANT port	ANTENNA

TYPE-B CONNECTIONS *(Transmit frequency = 850 MHz range)*

DIPLEXER CONNECTOR	SIGNAL DESCRIPTION AND DESTINATION
850 MHz port	RF TRANSMIT - RADIO SECTION X4
930 MHz port	RF RECEIVE - RADIO SECTION X2
ANT port	ANTENNA

2.4 AUDIO HANDSET SECTION

2.4.1 GENERAL

Refer to diagram "MTCU HANDSET MAIN PCB & MIC PCB CIRCUIT DIAGRAM", drawing number 5015-A200-50.

The handset provides an audio link between units, to assist in link setup and commissioning. It is not intended for general use and the equipment is not licensed for voice operation only.

Caution : When the handset is inserted into the TC-900DR, reliable data transmission or reception is not possible. Unintentional voice traffic on a point to multi point system may cause data corruption to other units.

The data transmission section of the modem is totally disabled, if the handset is plugged in when the TC-900DR is turned on.

The handset contains two PCB's, a receive board and a microphone board, which are connected by a 10 way ribbon cable. Acoustic padding is also included in the handset for improved performance.

The microphone board contains an ECM30 electret microphone, along with a common emitter preamplifier stage (Q1), to provide transmit voice audio.

There are four indication LED's that are not used by the TC-900DR.

The receiver board contains a 78L05 5V voltage regulator (REG1). This is used to supply power to the LF353 receive amplifier (U2-p7), which drives a DH32-30 ohm earpiece.

The sidetone circuit provided by U2-p1 is disabled and not used by the TC-900DR. Similarly, the LED drivers are disabled.

The PTT switch places a ground connection onto its output signal line, for processing by the radio section.

2.4.2 INTERFACES

The audio handset connects directly to the radio section via the RJ11 connector, X3. Attached to the handset is an 8 way flexible curly cord.

PIN NUMBER	HANDSET CONNECTOR	X3 PIN NUMBER	RADIO SECTION CONNECTOR X3
1	LED CLK	-	UNUSED
2	LED DATA	-	UNUSED
3	13V2	1	8V POWER SUPPLY
4	DGND	3	GROUND
5	PTT	6	MANUAL PTT
6	MIC	4	MIC
7	MIC RET	5	GROUND
8	EAR PHONE	2	AUDIO OUT

2.5 MODEM SECTION

The modem section is built on a single PCB with approximate overall dimensions of 165mm x 152mm x 18mm.

It consists of the following main blocks :

Modem control

- DFM4-9 modem.
- Reset and watchdog.
- Memory.
  - External NVRAM.
  - External RAM.

Host interface.

Radio interface.

Transmit signal conditioning.

Receive signal conditioning.

- Data recovery.
- Clock recovery.

User indications.

Power supply

Interfaces.

- Radio section.
- Port A.
- Port B.
- Power.

2.5.1 MODEM CONTROL

2.5.1.1 DFM4-9 MODEM

The modem section is controlled by a DFM4-9 Trio DataCom modem IC, (U5).

This device is specifically designed to provide data communications from a host computer over a radio channel.

The DFM4-9 is capable of full duplex operation, at data rates of 4800 baud or 9600 baud over the radio channel. The transmitter and receiver data rates may be set independently. The host computer interface provides two RS232 asynchronous serial ports, configurable for a variety of baud rates, and data formats.

In the standard delivery format of the modem, only one asynchronous serial port is operational. (Port A).

Advanced data recovery techniques are employed to ensure excellent performance in both good and noisy signal environments.

The data transmission method used, employs advanced optimal waveform shaping techniques. This maximises the recovered signal at the destination receiver, while remaining within the allocated RF channel bandwidths. The method uses computer generated Finite Impulse Response (FIR) techniques, to derive the transmitted waveform data.

The modem features a unique supervisory signalling channel, which embeds low speed data in the primary bit-stream, and is transparent to the user of the primary channel.

To drive the DFM4-9 modem clocking circuits, an external resonator is required. A 19.6608 MHz crystal (XTAL1) is applied to the OSC pins (U5-p9,10) of the device to achieve this.

A 4 way DIP switch is supplied to set up some configuration parameters of the modem. These are only read by the DFM4-9 at device power up. They connect to the "ESx" pins of the device (U5-p3,p5,p6,p7). Switches 1 and 2 are presently unused, switches 3 and 4 are defined in section 4.5.1.

2.5.1.2 RESET AND WATCHDOG

A MAX690 reset and watchdog IC (U3), is used to perform a variety of ancillary functions. This device provides a fixed length reset pulse for the proper initialisation of the modem chip on power up and reinitialisation. The MAX690 monitors the level of the VCC power supply line. If the voltage moves out of specification, the reset output is activated. This ensures that the modem chip recovers correctly in the event of a power failure. The reset signal is applied to the "RESET" pin of the modem (U5-p8).

The MAX690 provides a power monitoring function, which gives advance warning of imminent power supply failure. The DFM4-9 modem checks this signal, applied to its "PF" pin (U5-p2), before performing any transactions with the non-volatile memory, thus preventing accidental corruption of the contents of this memory. This "advance warning", is the length of time that the power supply capacitors hold their charge, after loss of power, before the Vcc supply rail drops below its cutoff level, and a reset pulse is generated.

The MAX690 also includes a "watchdog" timer. This timer must be strobed at a minimum rate, to prevent a reset pulse being generated. The DFM4-9 provides this signal at its "WDO" pin (U5-p22). Should the DFM4-9 modem operation go astray for some reason, it is probable that it will no longer perform this strobing function correctly. This condition is treated as irrecoverable and the MAX690 will timeout on its watchdog function and re-initialise the modem.

2.5.1.3 MEMORY

2.5.1.3.1 EXTERNAL NVRAM

The DFM4-9 modem, has a wide variety of configurable operating parameters, all of which are stored in an ST24C04 NVRAM IC, (U4). These parameters are read at power up, and determine the operating characteristics of the modem.

The NVRAM has 4096 bits of memory. It is accessed using the standard I^2C, two wire, bus interface . A feature of this particular device, is a write protect function for one area of the memory.

This write protect feature prevents configuration data being inadvertently corrupted should some anomaly in modem operation occur. A hardware signal line is used to override this write protection feature, so that the configuration data may be changed by manual means. This signal can be accessed via the front panel connector, and is used when the TC-DFM9IP modem programmer is connected.

2.5.1.3.2 EXTERNAL RAM

External RAM is used to store data frames.

The RAM used may be either a 6264-8K or 62256-32K byte IC (U9). The standard TC-900DR is supplied with an 8K package. The DFM4-9 modem, tests the size of the attached RAM on power up.

All of the externally connected RAM is used to store packet data, and is allocated evenly between transmit and receive data. This memory is connected to the modem chip, by an 8 bit bus, and 3 control lines.

Two 8 bit 74HC573 latches (U8 and U10), are used to latch the memory address off the bus, before the data read or write cycle. The read/write control line to the RAM, is passed as the top address line in the MSB address latch.

The RAM read cycle operates as follows :

- The modem sets the two latch control lines, LADR_EN and HADR_EN, high.
- The high-address/R_select is then placed on the 8 bit bus.
- The HADR_EN line is set low to latch the data into U8.
- The lower eight address bits are placed on the bus.
- The LADR_EN line is set to low to latch the data into U10.
- The modem bus port is set to input mode.
- The RAM CE line is set low.
- The modem reads the data off the bus.

The RAM write cycle operates as follows :

- The modem sets the two latch control lines LADR_EN and HADR_EN, high.
- The high-address/W_select is then placed on the 8 bit bus.
- The HADR_EN line is set low to latch the data into U8.
- The lower eight address bits are placed on the bus.
- The LADR_EN line is set to low to latch the data into U10.
- The modem bus port is set to output mode.
- The modem writes the data to the bus.
- The RAM CE line is set low to write the data into the RAM.

Note: WARNING
A modem containing a 32K RAM package will not be compatible with a modem containing an 8K RAM package if end to end flow control is being used over the data link.

2.5.2 HOST INTERFACE

The host interface is provided by two RS232 ports, configured as DCE. These ports are presented to the user as 9 way female DMIN connectors, designated as PORT A and PORT B.

With the standard TC-900DR, only PORT A is operational.

The RS232 level translation is performed by two LT1081/MAX232 line transceivers (U1 and U2). These require a single five volt supply, and include internal charge pumps to generator the required +10V and -10V rails.

The four input and four output lines implement one full duplex serial port with RTS/CTS/DTR and DCD. This is PORT A. A second full duplex port with no handshake lines is provided on PORT B.

2.5.3 RADIO INTERFACE

The interface to the radio is via a 26 pin PCB header connector, X4.

The modem section has full control over the connected radio transceiver. It provides :

- Four lines for synthesiser control (used for RF channel selection).
- RSSI detection.
- Temperature sense input.
- Transmit power sense input.
- Temperature compensation for the synthesiser reference frequency.
- Receiver AFC.
- PTT control.
- Analogue lines for receive and transmit data signals.
- Regulated +13.8V and +8V power supplies.

Input to the receiver signal port, RXSIG, is offset by 2.0V DC, with a signal level of 1Vp-p AC.

The transmit signal output, TXSIG, has a signal level of 1Vp-p for 4800BPS, and 2Vp-p for 9600BPS, with a nominal DC offset of 2.0V. This offset may vary by ±1v according to the modulator temperature compensation requirements.

An ADC0834 four channel ADC (U6), is used to monitor various analogue quantities within the radio. The DFM4-9 modem communicates with the ADC by controlling 3 lines. An active high chip select, "ADCS" line (U5-p33), a data clock, "DCLK" line (U5-p35), and a serial data, "SD" line (U5-p36).

The state of the data line from the ADC is clocked into internal registers of the DFM4-9 on the rising edge of the clock line. The data stream consists of a four bit preamble, which includes the channel address. From the 5th clock pulse onward, the ADC drives the data line with the data of the conversion, MSB first. The transaction is terminated with the CS line being set to inactive low.

The first channel is used to monitor temperature, by measuring the voltage from an LM335 monolithic temperature sensor U6. The LM335 is situated in the radio section, adjacent to the 20.1666MHz XTAL and VCXO synthesiser reference oscillator, and is fed into the modem section via connector X4-p14, ADC0.

The second channel is used to monitor RSSI, by measuring the RSSI output of the NE615 IF circuit. This signal is fed to the modem section from the radio section via connector X4-p21, ADC1.

The third channel is used to monitor the power level output by the RF transmitter, by measuring a voltage derived in the power control section of the radio. This is used to determine the "health" of the radio transmitter. This signal is fed to the modem section from the radio section via connector X4-p9, ADC2.

The fourth channel of the ADC, is used to measure the voltage of the +13.8 volt supply rail and to sense the presence of the audio handset at power up. The handset derives microphone bias from the modulator stage, and the voltage at this point is measured and compared with a fixed nominal value, to determine if the handset is connected at the time of TC-900DR power up. This signal is fed to the modem section from the radio section via connector X4-p24, ADC3. This 4th ADC channel is also multiplexed to measure the AFC control voltage so that an indication of received signal frequency can be made. U14:D is used to perform this switching function.

An auxiliary latch (U11) is provided to supply some of the output control to the radio section.

The latch receives data from the same data buss as the RAM. The lower six bits are fed to an R/2R ladder network DAC (RN2), which is used to present an analogue voltage to the radio's local oscillator synthesiser frequency reference. This correction voltage provides for excellent temperature stability of the radio. This signal is fed to the radio section via connector X4-p15, TEMP COMP.

The two top bits of the latch, drive auxiliary functions within the radio section.

Bit 6 is used to control the power of the RF transmitter in the radio section. This can be set to a HIGH level of 1W, or to a LOW level of 200mW. This signal is fed to the radio section via connector X4-p10, TXPWR.

Bit 7 provides the RF transmitter enable signal to the radio section. No RF signal can be transmitted unless this signal is set to active. This signal is fed to the radio section via connector X4-p11, TX EN.

2.5.4 TRANSMIT SIGNAL CONDITIONING

The transmit section of the DFM4-9 modem, outputs a byte of data, four times per bit period, on the "TDx" pins (TD1..TD7, U5-p56..49).

The parallel data is presented to an eight bit R/2R ladder network (RN1). This is a simple DAC which produces the transmit waveform at its output.

This signal is fed into opamp (U13:C) for amplification and filtering. This stage is a single pole low pass filter, used to attenuate clocking noise in the waveform. Two more filter stages follow, U13:B and U13:D.

By using 4 samples per bit, and an 8 bit resolution, precise control of the waveform shape is possible.

The gain and pole frequency of amplifier stage U13:C is switched by the DFM4-9 modem, via a 74HC4066 CMOS FET switches (U14:A). This is to produce the required waveform for the two data rates currently available. The bit rate output signal, "BRO" is provided at U5-p44.

For 4800 baud, components C43 and R45, are "included" in the feedback loop of the amplifier stage. When 9600 baud is selected, switch U14:A is turned OFF, and the components are "excluded" from the circuit.

2.5.5 RECEIVE SIGNAL CONDITIONING

The data receiver, consists of several functional blocks. Some of these are implemented by internal functions of the modem IC, and the remainder by external circuitry.

The incoming analogue signal, is routed to two separate sections of circuitry. One to process the received clock, the other to process the received data.

2.5.5.1 DATA RECOVERY

The data recovery is based around an "Integrating Data Slicer" circuit.

This circuit consists of a non-inverting, resetable integrator (U16:A, U12:C and U15:D), a dual peak detector (U12:A,B) and a reference divider.

The received signal is passed into the modem section from the radio section via connector X4-p20, "RXSIG".

The signal is integrated by the non-inverting integrator formed by U16:A, and U12:C, and then forwarded on to a comparator (U7:B), where it is "squared up", ready to be read by the DFM4-9 modem.

An output signal is provided by the modem IC, to indicate the sampling point. In fact this signal, called "RxCLKOUT", is pulsed high immediately after the sampling operation has taken place.

The integrator is reset at the end of each bit period, by the 74HC4066 FET switch, U15:D, after the value of the bit has been read. The DFM4-9 provides this reset signal at the reset integrator "RxCLKOUT" pin (U5-p19).

The integrated receive signal, is then fed to the dual peak detector, where the positive and negative peaks of the integrated signal are detected, and stored on the capacitors C28 and C27.

The peak detector's attack time is determined by the output resistance of the opamps (U12:A,B) and the bulk resistance of the diodes (D7, D4). The decay time however is determined by the values of the hold capacitors (C28, C27) and the summing resistors (R24, R25).

Four diodes (D5, D6, D8, D9) are used to clamp the reference rail. If the incoming signal has a large DC shift, this clamping arrangement ensures that the data slicer reference level is quick to settle somewhere near its final operating point. This clamp however does impose a maximum allowable input signal level. Exceeding this level will cause the integrated signal to directly modulate the reference rail. The derived reference voltage level, is amplified and output back to the radio section, where it is used for AFC in the receiver.

2.5.5.2 CLOCK RECOVERY

The received clock signal is presented to the DFM4-9 modem at its "RXCLK" input (U5-p4).

Within the DFM4-9, a phase-locked-loop is used for data clock recovery, which relies on level transitions in the data signal.

This mechanism maintains the data sampling point in the center of the bit cells by comparing the signal's level transitions with an internal clock.

An error in the relative phase of the RXCLK signal and the internal clock, causes the internal clock to increase or decrease in speed, to bring the phase error to zero.

The phase-locked-loop clock recovery mechanism within the DFM4-9 modem, maintains the sampling point in the center of the bit cells, but the use of the integrator demands that this take place at the end of the bit cell. This means that the signal fed to the DFM4-9 modem RXCLK input must be delayed by half a bit period.

To obtain this, the received signal is passed through a half bit delay, low-pass filter (U16:D, U12:D, U7:A). The delay characteristics of this filter, are switchable between the available data rates of 4800 and 9600 baud operation, by five 74HC4066 FET switches. These switches are controlled by the "BRO" output of the DFM4-9.

2.5.6 USER INDICATIONS

There are four indication LED's supplied for user information. POWER, TXMIT, SYNC and RXSIG. The POWER LED is green, TXMIT LED is red and the other two are yellow.

The POWER LED (LED4), is driven from the 13V8 power supply line. When supply is present the LED is activated.

The TXMIT LED (LED3), is activated when PTT is present. It is driven when the switching transistor Q3 is turned ON by the DFM4-9 modem "PTT" output going active (UX3-p38).

The SYNC LED (LED2), is activated when a valid data stream has been detected. It is driven when the switching transistor Q2 is turned ON by the DFM4-9 modem "SYNC" output going active (U5-p43).

The RXSIG LED (LED1), is activated when the received signal level is at a usable level. It is driven when the switching transistor Q1 is turned ON by the DFM4-9 modem "RXSIG" output going active (U5-p43).

2.5.7 POWER SUPPLY

The power supply is based around the use of three voltage regulators that supply +13V8, +8V and +5V.

The incoming power is applied to a bridge rectifier (BR1),. Normally two legs of this bridge are linked out, so it provides only reverse polarity protection shunt diodes. A special manufacturing option allows for AC input, where the links are removed. A 2200uF electrolytic capacitor (C2), provides filtering for AC inputs.

This is then applied to an LT1086 low dropout regulator (REG1). The output of this is set to 13V8 and feeds the RF final amplifier, and the following two regulators.

The 8V regulator (REG2) takes it's input directly from the 13V8 rail, its output is routed to the radio section, and provides supply for one of the amplifier devices.

The 5V regulator (REG3) provides the supply rail for the modem section logic circuits. It takes it's input from the 13V8 rail via diode D1. Extra filtering capacitance is provided by C7.

2.5.8 INTERFACES

2.5.8.1 RADIO SECTION

The modem section interfaces to the radio section via connector JX3. The physical link between the two sections is achieved via a 90mm length of 26 way ribbon cable.

Refer to interface diagram "RADIO MODEM INTERFACE", drawing number TC01-05-18 sheet 1/3.

CONNECTOR JX3 PIN NUMBER	SIGNAL DESCRIPTION	
1	13V8 POWER SUPPLY RAIL	
2	13V8 POWER SUPPLY RAIL	
3	13V8 POWER SUPPLY RAIL	
4	GROUND	
5	GROUND	
6	GROUND	
7	8V POWER SUPPLY	
8	8V POWER SUPPLY	
9	ADC2	(i/p - TRANSMIT POWER SENSE)
10	TXPWR	(o/p - TRANSMIT POWER LEVEL)
11	/TX EN	(o/p - TRANSMIT ENABLE)
12	/PTT OUT	(o/p - PRESS TO TALK)
13	TXSIG	(o/p - TRANSMIT DATA)
14	ADC0	(i/p - TEMPERATURE SENSOR)
15	TEMPCOMP	(o/p- TEMPERATURE COMPENSATION)
16	EN	(o/p - ENABLE FOR SYNTH)
17	DA	(o/p - DATA FOR SYNTH)
18	CK	(o/p - CLOCK FOR SYNTH)
19	LD	(i/p - LOCK DETECT FROM SYNTH)
20	RXSIG	(i/p - RECEIVED DATA)
21	ADC1	(i/p - RSSI SIGNAL)
22	AFC CTL	(o/p - AFC CONTROL)
23	SPARE	(UNUSED)
24	ADC3	(FOR SUPPLY/HANDSET)
25	TEST1	(UNUSED)
26	TEST2	(UNUSED)

2.5.8.2 PORT A

The modem section interfaces to the host user via the 9 way female DMIN type connector JX1.

CONNECTOR JX1 PIN NUMBER	SIGNAL DESCRIPTION	
1	DATA CARRIER DETECT	(DCD)
2	RECEIVE DATA OUTPUT	(RXD)
3	TRANSMIT DATA IN	(TXD)
4	DATA TERMINAL READY	(DTR)
5	COMMON	(COM)
6	DATA SET READY/prog mode	(DSR)
7	REQUEST TO SEND	(RTS)
8	CLEAR TO SEND	(CTS)
9	RING INDICATE/BER Test Mode	(RI)

Note: Pin 6 and pin 9 provide a dual function which depends on the mode that the TC-900DR is operating in.

2.5.8.3 PORT B

For the standard delivery version of the TC-900DR, port B is normally not enabled. This port provides no handshake lines except DCD (parallel connected with DCD on Port A) and DSR which is wired active.

CONNECTOR JX1 PIN NUMBER	SIGNAL DESCRIPTION	
1	DATA CARRIER DETECT	(DCD)
2	RECEIVE DATA OUTPUT	(RXD)
3	TRANSMIT DATA IN	(TXD)
4		
5	COMMON	(COM)
6	DATA SET READY/prog mode	(DSR)
7		
8		
9	RECEIVE SIGNAL STRENGTH INDICATOR	(RSSI)

Pin 9 is used to output the RSSI signal for external measurement.

The RSSI output ranges from 0 to 5 Volts, where 5 volts indicates the strongest signal. It is important to note that this port output has a high impedance of around 50K ohms and loading will decrease accuracy of the recorded measurement.

2.5.8.4 POWER

Power is supplied to the modem section via connector X1. Typically +13.8V DC is applied to the top pin, with the common connected to the bottom pin.

SECTION 3

OPERATIONAL DESCRIPTION

3 OPERATIONAL DESCRIPTION

3.1 GENERAL

The Trio DataCom TC-900DR radio modem, is a full duplex 4800/9600 bits per second device, which converts digital data into an analogue form suitable for transmission over a radio channel. It uses specially filtered direct binary frequency modulation techniques to achieve this. It conversely, converts the analogue signal derived from a radio channel into a digital data signal.

The heart of the unit is the DFM4-9 modem IC. This performs all waveform shaping, randomising and de-randomising, NRZ/NRZI conversion, clock recovery, and HDLC framing and CRC error generation and checking. These functions are performed simultaneously, allowing full duplex operation at up to 9600bps.

The modem is fully HDLC compatible. The user is provided with two RS232 compatible ports, which may each be configured with a standard PAD interface or SLIP/KISS protocol driver. The unit may also be configured for repeater operation.

It may be configured to use RS232 handshake lines, or XON/XOFF flow control on Port A.

The modem features a unique supervisory signalling channel, which embeds low speed data in the primary bit-stream, and is transparent to the user of the primary channel.

The supervisory signalling channel can be disabled if not required. It could be used to pass low speed data such as E and M status or C/DSMA control schemes.

The data rate of the supervisory signalling channel can be set independently for transmit and receive. It can range from about 40 to 533 bps with the primary channel rate at 4800 baud, and 80 to 1067 bps at a primary channel rate of 9600 baud.

NOTE: with the supervisory signalling channel active, the bit-stream is not compatible with standard HDLC interface devices (such as 8530).

The host user port may be configured for baud rates of 300 to 19K2, with 7 or 8 bit character size, 1 or 2 stop bits, and parity off/odd/even.

The DFM4-9 modem includes several data tables which are used to generate waveforms with different characteristics. This is primarily for optimum performance at differing baud rates. A custom data table can be placed into the NVRAM of the modem, for specialised applications.

Configuration of the modem is fully programmable, with parameters held in non-volatile memory. All configuration parameters are accessible with the TC-DFM9IP Installation Program.

Configuration parameters include but are not limited to:

Supervisory Signalling Channel rate.
XON/XOFF or RTS/CTS/DTR/DCD handshake mode.
Default transmitter lead in delay.
Constant specifying minimum RF RSSI for valid receive.
Constant specifying minimum Tx power level.
Asynchronous serial port parameters.
User interface operating mode :
- User port interface protocol
- PAD Parameters

3.2 TC-900DR MODEM FIRMWARE REVISION VA2.3.0

3.2.1 FUNCTIONAL CHANGES AND ADDITIONS

The Diagnostics "M" command (serial port Mode) completed. The implementation of this command was not finished in time for VA2.2 release. This command is used to configure either of the two user ports, for character length, number of stop bits, parity odd/even/off.

1. Bit 7 is used to address which port is being referenced (set to "0" for Port B, or set to "1" for Port A).
2. Bit 6 determines the character size. Set to "0" for 8 bit, or "1" for 7 bit character size.
3. Bit 5 is set to "1" to enable parity, "0" to disable parity.
4. Bit 4 determines Odd (set bit to "1"), or Even (set bit to "0") parity if Bit 5 is set.
5. Bit 3 determines the number of stop bits. Set to "0" for 1 stop bit, or set to "1" for 2 stop bits.
6. Bits 2, 1, and 0 are used to select the baud rate. The following table shows the available rates. The 19.2K baud selection should only be made for Port A if Port B is disabled. The last selection of 110 baud may be deleted from future firmware revisions.

Bit	Bit 1	Bit 0	Baud Rate
0	0	0	300
0	0	1	600
0	1	0	1,200
0	1	1	2,400
1	0	0	4,800
1	0	1	9,600
1	1	0	19,200
1	1	1	110

Channel Access Strategy 3 is now defined. This is selected by setting bits 1 and 0 (TxCtrl1 and TxCtrl0) in "Config1", both to "1". This mode forces a randomly generated delay **before** transmission begins, even if the channel is perceived to be clear. This delay mechanism is similar to that used in Channel Access Strategy 2 when the channel is perceived to be busy. This operating mode is useful in systems that include remote terminals that generate reports at regular fixed intervals. In such a system, slight differences in this interval between two remotes, would cause them to become synchronised for some time, and thus transmissions from them would consistently collide. Inserting a randomly generated delay before all transmissions will reduce the incidence of this effect.

The RS232 DCD handshake line now becomes active only during output of received data. Formerly, the DCD line indicated real time SYNC status of the modem data receiver. To facilitate the use of RS232 to RS422/RS485 converters, the DCD line is driven **active** a short time (approximately 0.5mS) before the received data is output to the user port, and lingers for approximately 2 to 3 character times (i.e. is proportional to baud rate of user port). The modem generates only one DCD function, which is available on pin 1 of both Port A and Port B. Thus the DCD pin of both user ports will be activated when either port is outputting received data.

3.2.2 OTHER ENHANCEMENTS

Improvements in handling of the RS232 RTS line (Port A), makes the modem more tolerant in the timing of rapid OFF transitions of this handshake line, immediately after the end of the last character of a message. It has been observed that communications drivers in many PLCs turn their RTS output line OFF very shortly after the end of a message, resulting in the loss of the last character of the message with previous modem firmware revisions. This revision does not suffer this problem.

The random number generator used for the Channel Access Timer, has been improved to make it more random.

3.3 FACILITIES AND CONFIGURATION INFORMATION FIRMWARE VERSION 2.2

3.3.1 GENERAL

The TC-900DR provides fully transparent remote diagnostics facilities, and expanded data stream switching, which supports advanced stream trunking applications.

The diagnostics core, supports the reporting of current analogue conditions, including temperature, RSSI (Received Signal Strength Indication), RF transmitter power, AFC (i.e. received signal frequency offset), and supply voltage. Also, an extensive range of operating parameters may be changed remotely, including remote (RF) channel change.

Configuration options, allow various system topology's, so that the location of the system's diagnostics controller is flexible.

The data stream switching mechanism has been upgraded to allow either MUX/DeMUXing or multi-stream routing functions, independently for each port.

A few other minor upgrades to previous revisions of firmware are:

* Two different "ticker clocks" implemented, one running at 1mS, and used for a) PAD Character Input Timers, and b) Channel Access Timer when running in Collision Avoidance mode. The other "ticker clock" runs at 10mS, and is used for the PTT timer, and a host of other internal functions, not accessible by configuration programming.
* When XON/XOFF flow control is enabled on PortA, the CTS output line continues to operate correctly, indicating the flow control state. XON/XOFF characters are generated in addition to, and reflect state changes on this line. As before, the DTR input line is ignored while XON/XOFF flow control is set, and the RTS line is not required to be true to validate transmit data.
* The modem stores data for transmission in buffer memory, which is limited. It also keeps track of frame boundaries of the stored data, and the number of frames it can manage is also limited by the amount of memory used to record the position of the frame boundaries. Thus it is possible that the modem can approach overflow before exhausting data buffer space, if frames are small. This flow control state is activated when the "frame boundary memory" approaches half full, for similar reasons used in data buffer management.
* If the Supervisory Signalling Channel is enabled in both transmit and receive directions, and PortA is configured in Repeater Mode, then the received Supervisory Signalling Channel data is also repeated, by being copied from the Supervisory Signalling Channel receiver to the Supervisory Signalling Channel transmitter.
* RSSI measurements are full eight bit conversion, so the "min_RSSI" configuration parameter lies in the range 0 - 255 (decimal). This is only important when setting this parameter without the aid of the DRPROG programmer.

3.3.2 INTERNAL DATA STREAM ROUTING

Essentially, all data streams travelling in both directions (transmit and receive), are examined and tested for a match with the diagnostics receive SID header code. If this match test is successful, then the data frame is copied into a buffer for the diagnostics core to process. The data frame also continues in the original direction as well. Thus diagnostics frames received from the radio channel (receive data), and from the stream switcher (transmit data, from one of the physical ports), are copied as they pass between the HDLC "device" and the data stream "switcher". Messages generated by the diagnostics core in response to received commands, are always sent back to the source of the command. That is, if a status request is received from the radio channel side of the modem, then the response is directed back out of the radio channel.

This dual access structure, allows the diagnostics controller to be located on either side of the modem, and thus supports any system topology.

3.3.3 DIAGNOSTICS REPEAT FUNCTION

Some applications will require that the "base" unit in a point to multi-point system repeats diagnostics frames. This will be the case where the system diagnostics controller is attached to a remote terminal in the system, and polls the system population from this point. The "base" unit must re-transmit diagnostics frames which are not addressed to itself. A "diagnostics repeat" configuration bit enables this function.

3.3.4 DIAGNOSTICS FRAME STRUCTURE

Diagnostics data frames, are structured according to a defined protocol. A frame consists 1st of the SID header code, which would normally (but not necessarily) be 00. Following this is a three byte address of the destination unit, followed by a three byte source address. An addressed unit responding to a diagnostics command, will swap these two address fields around, in the response frame. The destination address in a diagnostics frame to a TC-900DR unit, is in fact the unique (factory) serial number of the unit. By convention, the diagnostics controller (a DOS based PC), will use a unique address for itself, outside the range of permissible TC-900DR addresses (e.g. 000000). Following the two address fields, is a single character command/response code, which is in turn followed by any operands that may or may not be required for the command/response. Total frame size is limited to 17 bytes. After the SID header, address fields, and command/response mnemonic, this allows up to nine bytes of data to be transferred per diagnostics frame.

3.3.5 DIAGNOSTICS COMMAND SET

The following is a list of the command set recognised by the diagnostics core in the TC-900DR Firmware. Also is tabulated the response to each command. The following examples use address 123456 for the TC-900DR unit address, and 000000 for the address of the system diagnostics controller. For the purposes of clarity only, each byte in the example messages is separated by a comma. Mnemonics are represented in quoted form to indicate an ASCII character (e.g. "C" is actually binary byte h'43).

B Warm Boot Command.

This command forces the addressed unit to perform a "warm boot". Previous to this, the unit will have been halted (see "H" command), and one or more parameters changed with "P" and "W" commands.

Syntax:-

Command:- 12,34,56,00,00,00,"B"

Response:- 00,00,00,12,34,56,"b"

C Calibration Constant Poll.

This command requests the addressed unit to reply with it's internal Analogue To Digital Converter (ADC) calibration constants. These are necessary to accurately interpret the data sent in Status Poll ("S") replies. This command has no operands, and the response mnemonic is "c". The form of the command and reply is:

Syntax:-

Command:- 12,34,56,00,00,00,"C"

Response:- 00,00,00,12,34,56,"c",tt,rr,pp,ff,ss

Where:-

tt = Temperature calibration code

rr = RSSI calibration code

pp = Transmit Power calibration code

ff = Received Frequency Offset calibration code

ss = Power Supply calibration code

D Powered Up Response

This command is sent from the modem to the controller in response to a status poll ("S") immediately after the modem has been powered up. The modem will continue to send this command in response to a status poll until the controller acknowledges the command with a "d". The modem will then respond normally to a status poll.

This mechanism is used by the controller to determine whether it requires calibration data from the modem.

Syntax:-

Command:- 00,00,00,12,34,56"D"

Response:- 12,34,56,00,00,00"d"

F Set New RF Synthesiser Frequency.

This command forces the unit to set the RF synthesiser to a new frequency, thus selecting another radio channel. This command has one operand, which defines the source of the synthesiser data. A value of zero, indicates that the frequency data has already been set with a parameter set command. Values from one to four select one of the channels stored in the NVRAM of the modem configuration. The addressed unit responds with an "f" reply, before executing the channel change command (i.e. on the old channel).

Syntax:-

Command:- 12,34,56,00,00,00,"F",nn

Response:- 00,00,00,12,34,56,"f"

Where:-

nn = 00 to 04 to select data source.

H Halt Command.

This command forces the addressed unit to halt all internal operations, except diagnostics processing. This is necessary, when changing some parameters, before a warm boot command is issued to the re-configured unit.

Syntax:-

Command:- 12,34,56,00,00,00,"H"

Response:- 00,00,00,12,34,56,"h"

M Set Serial Port Mode.

This command forces the addressed unit to change the operating mode of one or both serial ports. Parameters such as character size, number of stop bits, parity etc. are changed with this command. It should be noted, that data may be lost while the operating mode of the serial ports is changed.

Syntax:-

Command:- 12,34,56,00,00,00,"M",xx

Response:- 00,00,00,12,34,56,"m"

Where:-

xx = Serial port address bit and mode data

P Parameter Set command.

This command stores the contents of the operand string to a storage buffer. No other action is taken. This command should be immediately followed by a "W" command. See "W" command below. The parameter may be either a bit quantity, a byte quantity, a word quantity, or a string quantity. The diagnostics core in the modem firmware determines this from the parameter indentifier, which indexes an internal lookup table. String quantities are of indefinite length, and determined by the length of the operand string in the received "P" command. The "P" command response ("p"), echoes the complete received string. This is unique to the "P" and "W" commands.

Syntax:-

Command:- 12,34,56,00,00,00,"P",nn,aa,bb,cc,...

Response:- 00,00,00,12,34,56,"p",nn,aa,bb,cc,...

Where:-

nn = parameter identifier

aa, bb, cc,... are data value(s) for selected parameter

R Parameter Readback command.

This command forces the addressed unit to read the state of the addressed parameter, and send this data back the the command originator (diagnostics controller) in a reply message. Again the size of the parameter (bit, byte, word, or string) is determined by the parameter identifier. String parameters are returned as a string of eight consecutive bytes.

Syntax:-

Command:- 12,34,56,00,00,00,"R",nn

Response:- 00,00,00,12,34,56,"r",nn,aa,bb,...hh

S Status Poll.

This command requests the addressed unit to reply with the current value of analogue quantities, present temperature, last/present received RSSI, transmit power of last transmission, received frequency offset of last/present received signal, and present supply voltage.

Syntax:-

Command:- 12,34,56,00,00,00,"S"

Response:- 00,00,00,12,34,56,"s",tt,rr,pp,ff,ss

Where:-

tt = Temperature conversion code

rr = RSSI conversion code

pp = Transmit Power conversion code

ff = Received Frequency Offset conversion code

ss = Power Supply conversion code

T Diagnostics Watchdog Timer command.

This command forces the addressed unit to (re)set a special watchdog timer. The operand value is a word (16_bit) quantity. A zero value will disable the timer. A non-zero value will initialise the timer. This timer, while non-zero, will be decremented periodically. If the timer is decremented to zero, then the TC-900DR will perform a cold boot, thus restoring operating parameters from the NVRAM configuration memory. This command should be used in conjunction with parameter set and write commands. If a parameter change renders the unit in-operable, then either it will not continue to receive further "T" commands to reset the timer, or the system diagnostics controller may cease to send the timer reset commands, thus will eventually cause the unit to cold boot.

Syntax:-

Command:- 12,34,56,00,00,00,"T",nnnn

Response:- 00,00,00,12,34,56,"t"

Where:-

nnnn = timer reset value (16 bit value)

V Request Firmware Version String command.

This command requests the addressed unit to reply with a string indicating it's firmware version number. Future firmware versions may provide further facilities that may then be used, by sending appropriate commands.

Syntax:-

Command:- 12,34,56,00,00,00,"V"

Response:- 00,00,00,12,34,56,"v","A2.2.0"

W Write Parameter command.

This command is used in conjunction with the "P" parameter set command. This parameter write command must be identical to the previous parameter set command. Providing they are identical (excepting the command mnemonic), then the operand is written to the selected modem operating parameter. Changing some parameters while normal operation continues could produce improper operation, possibly resulting in corrupted parameters, so the unit should be halted with a HALT command before such parameters are changed.

Syntax:-

Command:- 12,34,56,00,00,00,"W",nn,aa,bb,cc,...

Response:- 00,00,00,12,34,56,"w",nn,aa,bb,cc,...

Where:-

nn = parameter identifier

aa, bb, cc,... are data value(s) for selected parameter

3.3.6 PARAMETER SET

The following is a list of parameters which may be remotely set. Parameters marked with a "*", should only be changed while the unit is in a halted state, followed by a warm boot command. Parameters marked with a "#", may only be referenced in an "R" readback command. Attempts to change these with "P" and "W" commands may produce unpredictable results.

Parameter Identifier	Parameter Type(Size)	Parameter Name
00 (^@)	undefined	not defined, reserved to facilitate future expansion
01 (^A)	undefined	not defined, Trio DataCom test use only
02 (^B)	byte	Drift_Offset
03 (^C)	word	PTT_Time
04 (^D)	string	Synthesiser Data for channel change
05 (^E)	byte	min_RSSI
06 (^F)	byte	Tx_LID
07 (^G)	byte	Slot_Num
08 (^H)	byte	Slot_Time
09 (^I)	word	SIDA1 and SIDA2
0A (^J)	word	SIDB1 and SIDB2
0B (^K)	word	SIDD1 and SIDD2
0C (^L)	byte	KISS_adrA
0D (^M)	byte	KISS_adrB
0E (^N)	byte	EOMA_code
0F (^O)	byte	EOMB_code
10 (^P)	byte	input_timeA
11 (^Q)	byte	input_timeB
12 (^R)	byte	frame_sizeA
13 (^S)	byte	frame_sizeB
14 (^T)	bit *	SLIP/KISS_mode portA
15 (^U)	bit *	SLIP/KISS_mode portB
16 (^V)	bit	EOM_enable portA
17 (^W)	bit	EOM_enable portB
18 (^X)	bit *	KISS_mode portA
19 (^Y)	bit *	KISS_mode portB
1A (^Z)	bit	RTS/CTS_interlock portA
1B (^[)	bit *	PORTB_enable
1C (^\)	bit *	Repeat_Enable portA
1D (^])	bit *	Repeat_Enable portB

1E (^^)	bit *	(Not defined, reserved for Error Recovery Enable)
1F (^_)	bit *	(Not defined, reserved for Error Recovery Enable)
20 ( )	bit	LiveFrame portA
21 (!)	bit	LiveFrame portB
22 (")	bit	XonXoffMode portA
23 (#)	bit	XonXoffMode portB
24 ($)	byte	PORTA_Config
25 (%)	byte	PORTB_Config
26 (&)	bit	diags_repeat
27 (')	bit	TxPWR_HI/LOW
28 (()	bit	SID_Enable
29 ())	bit	RTS2PTT
2A (*)	bit	SYNC2PTT
2B (+)	bit	SCDO_Default
2C (,)	bit	SupChnFunc
2D (-)	bit	TxCtrl1
2E (.)	bit	TxCtrl0
2F (/)	byte	Config1
30 (0)	byte #	SMR1 (portA serial port mode)
31 (1)	byte #	SMR0 (portB serial port mode)
32 (2)	byte #	BRR1 (portA serial port baud rate)
33 (3)	byte #	BRR0 (portB serial port baud rate)
		Additions for version A2.3.0
34 (4)	byte	err_limit (Frame Error output for Base Station)
35 (5)	byte	err_flags
36 (6)	word	good_cnt
37 (7)	word	bad_cnt
38 (8)	word	lost_sync_cnt
39 (9)	word	lost_RSSI_cnt
		Additions for version A2.3.1
3A (:)	byte	DCD_timeA
3B (;)	byte	DCD_timeB
3C (<)	byte	Diags_Delay

3.3.7 ADVANCED STREAM ROUTING FUNCTIONS

The TC-900DR provides advanced stream routing functions. For each port, there is allocated two SID (Stream IDentifier) codes, and a configuration flag that determines how these two codes are used.

With the flag off, SIDx1 (where x is A or B for portA and portB respectively) defines the SID code of received frames that are de-multiplexed to the port, and SIDx2 defines the SID code that is inserted by the modem at the front of every frame it transmits. Thus only one data stream passes through the port, and the modem manages the insertion and extraction of SID header codes.

With the configuration flag on, SIDx1 and SIDx2 define a range of streams that will be passed from the received data to the port. SIDx1 defines the lowest stream, while SIDx2 defines the highest stream. The SID header codes remain on the received frames, and are passed to the port. For transmit data, the modem assumes that the SID header codes are already in place, being inserted by some external device, and no processing is performed on the transmit data. For this application, it is highly desirable that a SLIP (or KISS) driver be employed so that frame boundaries are defined.

These functions are independent for each port, so it is possible to construct (say), a multi-drop, multi-hop repeated data system, where one stream can be "peeled off" at each repeater site. There are many other possibilities, the TC-900DR product simply requiring suitable configuration to construct a vast range of network topologies.

3.4 FACILITIES AND CONFIGURATION INFORMATION VERSION 2

3.4.1 GENERAL

The TC-900DR, provides two independent user data streams, which are multiplexed onto the radio channel data stream. The stream switching protocol also provides for an embedded remote diagnostics facility.

The two (asynchronous) user ports can be configured for a variety of baud rates, character sizes, parity, and stop bits.

Flow control on user Port_A may be set to use RTS/CTS/DTR/DCD handshake lines, or XON/XOFF characters. Flow control for Port_B may be set to use XON/XOFF characters, or no flow control. Port_B is not supported by RTS/CTS/DTR handshake lines.

Data is transported in (HDLC) frames, protected by a 16 bit CRC error checking sequence, conforming to the CCITT standard. Received frames found to contain errors are discarded. The TC-900DR does not release received data frames to the user port, until completely received, and error checked.

Maximum frame size is configurable for each port independently, and may be set to any value between 4 and 255. Frame size limiting is disabled by setting this parameter to zero (0).

Each user port, is supported with PAD functions conforming to X3, or SLIP*[1] or KISS* protocol interface.

For Point To Multipoint applications, a unique collision avoidance mechanism is available, with configurable channel access parameters.

All configuration parameters are held in a non-volatile memory. Normally, this memory can only be written when the radio modem is connected to a programmer.

3.4.2 BRIEF OVERVIEW OF MODEM INTERNAL OPERATION.

3.4.2.1 DATA TRANSMITTER

Each physical user port, is supported by a "driver", in this case a PAD (Packet Assembler/Dis-assembler) or SLIP/KISS. This function transfers the data from the port, to a buffer memory. This buffer not only stores the raw user data, but also keeps track of frame boundaries. Another functional block, retrieves that stored data, and feeds it to a third mechanism, which generates the data waveform which is applied to the radio transmitter modulator.

[1] * SLIP ®™ KISS ®™

3.4.2.2 DATA RECEIVER.

The receiver extracts data frames from the received signal, and stores the contents of the frames into buffer memory. It may also perform a steering function, if more than one port is enabled. A second function is to retrieve the stored data, and send it to the user port(s), consistent with some flow control regime.

3.4.3 SELECTING FRAME SIZE

The selection of maximum frame size is a compromise between channel through-put and data propagation time over the link.

The receiving modem collects and stores the incoming data frame, and on detecting the end of the frame, checks if an error has occurred. If not, then the stored data is released for transfer to the user data port. If an error has occurred, then the stored data is "flushed" from the data store. Thus a delay is introduced between the time the frame data begins to enter the destination radio modem, and the time this data begins to emanate from the user port. This delay is effectively the length of the data frame, which consists of the user's data, plus the framing overhead. This overhead will include at least 24 bits for the HDLC Flag and FCS (error checking data), plus another 8 bits if SID (Stream IDentifier) codes are enabled (refer to detailed description elsewhere in this document), plus the duration of the transmitter Lead-In-Delay, if the radio transmitter had to be started up to send the data. Thus larger frames reduce the proportional overhead, but increase the end to end propagation delay.

On the assumption that the radio transmitter was already on, and that the frames include the SID header, then every frame includes 32 bits of overhead.

Assuming that the user port is configured for 8 bit character size (8 bit data no parity, or 7 bit data and parity), and 1 stop bit, then each character is carried as a 10 bit sequence on the asynchronous user channel. On the radio channel data stream, user data is stripped of the start and stop bits used on the asynchronous user port, and transmitted as eight bit "octets", and so the character rate is 1/8th of the bit rate, while on the asynchronous user port, the character rate is 1/10th of the bit rate. For every 16 user characters 32 bits are stripped off, so if the maximum frame size parameter is set to 16, and the nominal baud rates are the same, then the effective character rates on the asynchronous user channel and the synchronous radio data channel will be the same. This also assumes that the supervisory signalling channel is not enabled, and does not allow for the overhead introduced by the HDLC "dummy zero" stuffing mechanism.

3.4.4 CONFIGURING PAD PARAMETERS

The Packet Assembler/Dis-assembler (PAD) can be configured with a variety of parameters. Each user port is supported by an identical but independent PAD.

The configuration parameters of the PAD, control how the user data (to be transmitted) is framed. There are three distinct mechanisms that can cause the frame that will carry the user data to be closed.

The first of these is the Maximum Frame Size parameter, already discussed above. As each character is input to the modem, a counter is incremented, and when this counter reaches the set maximum frame size, the data storage mechanism that operates within the modem, will close the frame. This function may be disabled, by setting the parameter to zero.

The second mechanism, is the use of a specified End Of Message (EOM) character. This function is enabled/disabled by a flag in a configuration byte for the port driver. The EOM character may be any 8 bit character. When the EOM function is enabled, all incoming user data is compared to the selected EOM character code, and in the event of a match, the current frame is closed. Note that this match only triggers the frame closure mechanism. The matching character is not deleted from the user data stream, and in fact becomes the last user character in the frame.

The third mechanism, is the implementation of a timer. If the timer is enabled, each character received from the user port re-starts the timer. If the time duration between successive user characters allows the timer to expire, then the frame closure mechanism is invoked. The timer counts in units of "ticker clocks", which is a time interval generated by the modem internally, and is approximately 2.5mS. The reload value for the timer can be set from 1 to 255 ticker clocks. The timer mechanism is disabled by setting the PAD timer parameter to zero.

There is a single bit configuration flag, that allows the radio modem to begin transmitting user data, even before the frame is deemed to be complete. In this case, as soon as there is any data in the storage buffer, the modem begins the transmission procedure. Providing that the input character rate is greater than or equal to the character rate on the synchronous radio channel, then there is no danger of an under-run condition, where the modem transmitter runs out of data before the PAD deems a frame end. However, should this occur, the modem data transmitter function simply closes the frame itself. Further data is carried in the next frame. This may or may not cause problems elsewhere in a system context. If higher protocol layers are employed (e.g. X.25, AX.25 etc.), where address and control fields normally occupy fixed positions in data frames, then the above scenario should not be allowed to occur.

The major advantage of allowing the radio modem to begin the transmission procedure before the frame is deemed to be complete, is that it avoids a (store and forward) delay in the modem transmitter, similar to that required in the receiver. For applications where a transparent point to point link is all that is required, this mode provides the most time efficient transport mechanism.

In fact with the immediate transmission function enabled, there is little necessity to enable the EOM or timer functions of the PAD.

3.4.5 SUPERVISORY SIGNALLING CHANNEL: APPLICATIONS & CONFIGURATION.

The reader is referred to drawing number TC01-05-18, which provides a diagramatic view of this section.

The Supervisory Signalling Channel (SSC) is implemented by the insertion of extra data bits in the primary bit-stream on the synchronous radio channel. These extra bits are inserted between primary data octets, at a rate which can be set to range from once every octet, to once every 15 octets. The SSC operates independently for transmit and receive directions, and can be disabled by setting the rate variable to zero.

The SSC, when enabled, can be configured either to provide end-to-end flow control for Port_A data, or implement the collision avoidance mechanism.

3.4.5.1 PORT_A END TO END FLOW CONTROL APPLICATION.

In this configuration, the SSC is used to carry flow control information for data on Port_A at each end of the link.

SSC data inserted into the transmitted bit-stream, relates to the flow of the primary data stream received. When handshake lines are employed, the DTR line locally controls the flow of receive data to the user port. The state of this line is also logically combined with the "fill" state of the receive buffer, and the result is then sent as SSC data in the transmit data stream. Thus the state of the transmitted SSC data bit is one ("1") if the DTR line is in a "false" state, OR the receive buffer is more than half (approximately) full. In the case where XON/XOFF flow control is used, the DTR line input is instead replaced with the state of the last received XON or XOFF control character.

SSC data extracted from the received bit-stream, is logically combined with the "fill" state of the transmit buffer, and the result is output to the CTS line of the modem. The CTS output line is set to "false" if the transmit buffer is more than half (approximately) full, OR the received SSC data bit is a one ("1"). Thus the CTS line is set to "false" if the local transmit buffer is more than half (approximately) full, OR the remote receive buffer is more than half full, OR the remote DTR input line is "false" (or equivalent XOFF received).

Data flow control is exercised only at the user port. No flow control is used on the radio channel, so once data is entered into the transmit buffer, it will be transmitted. This is the reason why the buffers are only allowed to become half full before the flow control mechanism engages. If the flow of receive data is stopped by deactivating the DTR line, the remaining data in the transmit buffer will not overflow the receive buffer. It should be noted that some hysteresis is used in the buffer occupancy tests, to prevent the CTS line from changing state too often, as some hosts (e.g. DOS machines) appear to get confused when this happens.

If the SSC is not configured for end to end flow control, or is disabled, then the flow control mechanisms still operate at a local level. That is, the CTS line (or equivalent XON/XOFF control regime) reflects the fill state of the local transmit buffer.

3.4.5.2 COLLISION AVOIDANCE APPLICATION.

When the SSC is allocated to transporting collision avoidance data, the transmitted SSC data reflects the state of the radio receiver. Other processes in the modem, measure the RSSI signal from the radio receiver, and compare this measurement to a preset threshold level. This threshold value is also held in the non-volatile configuration memory. The result of the comparison is copied to the modem pin that drives the RXSIG LED. The transition of the RXSIG signal from off to on, (re)starts an internal timer. This time is a fixed value of 35 ±5mS. The SSC data transmitted, is simply a copy of the RXSIG pin state, until the timer terminates, and there-after, the modem data receiver must be "SYNC'd" to maintain the "1" state of the SSC transmit data. Thus the SSC data transmitted by the modem will indicate that the radio channel receiver is busy, using only RSSI for the first 35 ±5mS, but after this time, data receiver SYNC is used to qualify this state. This prevents low level RF interference from effectively blocking the channel.

At the receiving end, the recovered SSC data is used by the radio modem to determine when the receiver of the destination station is free. This data can then be used to control it's channel access strategy. Channel access strategies are dealt with in more detail elsewhere in this document.

In such a data transport system, there is a single unit which performs the function of Master, and two or more stations which operate as Slaves. The SSC need only operate in one direction, that from Master to Slaves. In the reverse direction, the SSC can be disabled. That is the SSC in the Slaves is enabled in the data receiver only, while in the Master, it is enabled only in the data transmitter.

3.4.5.3 RECEIVED SSC DATA DEFAULT STATE

The received SSC data bit is stored in an internal latch. This latch is updated each time a SSC data bit is extracted from the incoming bit-stream. However, if the radio receiver looses signal, then a default state is forced into the latch. This default state is configurable.

For applications which use the SSC for collision avoidance, this configuration bit would normally be set to "1", so that the remote station would not attempt channel access while the signal from the base is lost.

For applications which use the SSC for end to end flow control, setting the default state of the SSC receive data latch to "0", would cause the CTS output line to indicate local flow control status only, until the destination unit enables it's transmitter, where-upon the received SSC data would reflect the state of the destination receive buffer and DTR input line. Alternatively, setting the default state to "1", would ensure that the CTS output line would be in a "FALSE" state, until the destination unit enables it's transmitter, where-upon the received SSC data would reflect the state of the destination receive buffer and DTR input line.

An associated configuration bit, is one that allows the automatic activation of the radio transmitter, whenever the data receiver attains SYNC. When this configuration bit is set to "1", the modem will automatically activate the radio transmitter's PTT control line when the data receiver is SYNC'd. This could be used at the base end of a small point to multipoint network, using the SSC for flow control, and would not require the host connected to base, to specifically activate the radio transmitter to establish the end to end link.

3.4.6 SLIP/KISS PROTOCOL DRIVERS

In addition to a generic PAD, two other host interface protocols are supported, "Serial Line Interface Protocol", SLIP, which hails from the world of UNIX(tm), and an extension of SLIP, KISS "Keep It Simple Stupid", (a rather unfortunate phrase in the present context, but a protocol standard proposed by Phil Kahn, USA, specifically for the control of radio connected data terminals) which includes a facility to send commands which are addressed to the DCE device itself. These commands set operating parameters of the radio-modem DCE, such as transmitter lead-in delay, or radio channel (RF frequency).

Neither of these protocol standards, specify anything about the construction of data packets on the radio channel. Allocation of address, control, and information fields is the user's responsibility.

As standard, the modem is equipped with an 8K (8192 bytes, 32K optional) data storage memory to hold transmit and receive data. This memory is divided equally between transmit and receive buffer space, and equally between the two user ports, so the largest frame size is 4095 bytes, if only PortA is enabled, (or 2047 bytes each if both user ports are enabled), before the frame check sequence (FCS)is appended.

Additionally, the modem can store up to sixty four separate frames for each direction, again split between the two user ports if both are enabled, though the total byte count is still limited to 8192 total.

3.4.6.1 SLIP Protocol Description/Definition

The SLIP protocol, is a data transport protocol, originated and used extensively in UNIX(tm) based systems, and thus also closely associated with TCP/IP networked systems. Although not truly a "standard" it is so widely used that it has become the defacto standard for serial interface in UNIX and many other networked systems. SLIP is a method of framing messages containing binary data, on asynchronous channels. The asynchronous serial channel is configured for eight bit character size, no parity, and one stop.

A specific binary code called FEND (Frame End, hexadecimal value=C0) is reserved to define a frame boundary. Should this same code occur in the data message to be transferred across the channel controlled under SLIP, then an escape sequence is used so that the message byte will not be confused for a FEND. This escape sequence, involves replacing the message hexadecimal C0 code with a two byte sequence FESC, TFEND. FESC (Frame Escape) is the binary code hexadecimal DB, and TFEND (Transposed FEND) is binary code hexadecimal DC. Likewise, if the FESC character ever appears in the user data, it is replaced with the two character sequence FESC, TFESC (Transposed FESC). The TFESC is the binary code hexadecimal DD. The following table clarifies this.

ABBREVIATION	DESCRIPTION	HEX.VALUE
FEND	Frame end	C0 (192)
FESC	Frame escape	DB (219)
TFEND	Transposed frame end	DC (220)
TFESC	Transposed frame escape	DD (221)

As characters arrive at the SLIP receiver, they are appended to a buffer containing the current frame. Receiving a FEND marks the end of the frame, and consequently, succeeding bytes are considered part of the next frame.

Receipt of a FESC code puts the SLIP receiver into "escaped mode", causing it to translate a following TFESC or TFEND back to a FESC or FEND code, appending it to the buffer, and resuming it's normal state. Receipt of any byte other than TFESC or TFEND while in escaped mode, is an error. No translation occurs, and the SLIP receiver leaves escaped mode. A TFESC or TFEND received while not in escaped mode is treated as an ordinary character and stored accordingly. Reception of consecutive FEND characters, causes no action to be taken (i.e. is not interpreted as zero length frames).

An example of a typical SLIP frame is shown below. The message consists of the string DA,C4,C0,C5,DB,20,BD,DC,DD. The SLIP frame will be:-

<FEND>,DA,C4,<FESC>,<TFEND>,C5,<FESC>,<TFESC>,20,BD,DC,DD,<FEND>

==> C0,DA,C4,DB,DC,C5,DB,DD,20,BD,DC,DD,C0

3.4.6.2 KISS Protocol Description/Definition

The KISS protocol is an extension of SLIP. It uses the same method of framing packets, using FEND, FESC, TFEND, and TFESC codes. However, the first byte in each frame is reserved as a control code, that defines the function/content of the frame, and also contains an address.

This addressing scheme allows up to sixteen "Terminal node controllers" (TNC's), to share a multidrop buss. The top nibble of the control code carries the TNC address, and the lower nibble carries the command code. Normally the address is set at zero for installations containing only one TNC. Note that some extensions have been proposed for the KISS protocol, that properly support addressed multidrop line operation of multiple TNCs, that the present TC-900DR modem firmware does not implement. The following table shows the commands defined by KISS, and the comment column indicates how the TC-900DR modem interprets them.

COMMAND	FUNCTION	COMMENTS
0	**Data Frame**	The rest of the frame is data to be transmitted.
1	**TxDelay**	The next byte is the RF transmitter key-up delay in octets.
2	**Slotnum**	The next byte is the Slotnum parameter.
3	**Slot-Time**	The next byte is the "Slot" interval in "ticker clocks".
4	**TxTail**	The next byte is the time to hold up the RF transmitter after the closing FLAG has been sent. This command is obsolete, and not implemented in the TC-900DR.
5	**FullDuplex**	The next byte is zero for half duplex, non-zero for full duplex. This command is not implemented in the TC-900DR, as it always operates in full duplex mode.
6	**SetHardware**	Specific for each TNC. This parameter has values between 00 and 03, and commands the TC-900DR to set RF channels 0 to 3. Values above 3 are ignored by the present modem firmware, but may be used in future versions.
F	**ExitKISS**	Exit KISS and return control to higher level TNC control program. This command is not implemented in the TC-900DR.

3.4.7 RF TRANSMITTER CONTROL AND CHANNEL ACCESS STRATEGIES

There are three conditions which cause the modem to activate the radio transmitter. These are: a) receiver SYNC if enabled, as described above; b) RTS if enabled, as described below; and c) the existence of a data frame ready for transmission. The first two mechanisms are absolute, and if enabled, cause an immediate activation of the radio transmitter. There are two configuration bits that control how the availability of a data frame, will activate the radio transmitter, and thus gain access to the channel. For the purposes of this description, these are referred to as Modes A, B, and C.

In Mode A, channel access is immediate. The radio transmitter is activated, and the modem then proceeds to send a preamble sequence, followed by the data. The preamble sequence is necessary for receiver synchronisation, and the length is a configuration parameter. Further discussion of these aspects of the modem configuration are dealt with elsewhere in this document.

In Mode B, the modem will attempt channel access only if the radio receiver is NOT receiving a signal (i.e. the measured RSSI level is below the minimum RSSI threshold as described elsewhere in this document). This method could be used for small point to multipoint systems, where the base station would enable it's radio transmitter on receiving a transmission. Typically this would be done at the base unit by enabling the SYNC-PTT function, as described above. This implements a basic collision avoidance system, without the use of the Supervisory Signalling Channel, which then remains available for flow control applications.

In Mode C, the modem will attempt channel access only if the data receiver is SYNC'd, and the SSC data is "0" (i.e. base receiver free). This is the full Collision Avoidance system as described in detail above.

In the latter two cases, if another data frame is ready for transmission at the time the present one is ending, then it is automatically appended as another frame, and the transmission continues. Obviously since the radio transmitter is already enabled, no preamble is required or sent. The modem itself does not limit the number of consecutive frames it will transmit. If data continues to be input to the modem, once channel access is gained, it continues to be transmitted. It is the responsibility of the user to manage any maximum channel access time in overall system design. However, if the PTT timer is enabled (dealt with in detail elsewhere in this document), and the set time is reached, then the modem will disable the radio transmitter PTT line. User data will now be lost.

For the two latter strategies, if channel access fails (i.e. signal at radio receiver in the former case, or SSC=1 in latter case), then the modem uses a timed delay mechanism before testing for channel availability again.

3.4.7.1 SELECTING "SLOTIME" AND "SLOTNUM" VALUES

This delay time is necessary to prevent multiple remotes from attempting to gain access to the channel as soon as it is signalled to be clear after another transmission has finished, as this would result in the transmissions from all these remotes colliding. Instead, when a modem fails to gain channel access, it generates a randomly selected delay time, and when this time has expired, it again tests for channel availability.

There are two parameters which are used to generate the delay time. The "Slotime" parameter defines the size of the time increment used in selecting the delay. This value defines a time counted in "ticker clocks" (approximately 2.5mS), and has an allowable range of 0 to 255. The "SlotNum" parameter defines the upper limit of the random number generator. The random number generator selects an integer between one and the value of "SlotNum", and then multiplies this by the value of "Slotime" to derive the delay time. The "SlotNum" parameter has a maximum allowable range of 1 to 16.

These two parameters together provide a very flexible method of tuning the channel access characteristics of a system, and should be regarded as system tuning parameters. In the absence of any knowledge of a system configuration, Trio DataCom's set default values for these to parameters to 4 and 16 for "Slotime" and "SlotNum" respectively.

3.4.7.2 PTT CONTROL BY RTS LINE

Applications relying on establishing a point to point link before data is transferred, would normally require some "manual" method of activating the radio transmitter. A configuration bit enables the RTS input line to be used as a PTT control. The modem is always generating a data signal. During the time when no user data is available, the modem continually generates an "idle" bit-stream of HDLC FLAGs. This sequence produces no data output at the receiving radio modem.

3.4.8 SELECTING FLOW CONTROL REGIMES

The type of flow control to be used on the radio modem port(s), depends on the user's application and capabilities of the equipment which the user interfaces to the TC-900DR.

Port_A, which is always active, can be configured to use the standard RS232 handshake lines RTS/CTS/DTR, or use XON/XOFF protocol.

3.4.8.1 PORT_A, HARDWARE HANDSHAKE FLOW CONTROL

If hardware handshake lines are configured, then RTS must be active to validate characters input to the modem for transmission. As each character is received (i.e. at the end of each character bit sequence) the state of the RTS input line is tested to validate the character. If the RTS line is tested "true", then the character is stored ready for transmission. If "false", then the character is discarded. The modem provides flow control of transmit data with the CTS line. The CTS line is set "false" to indicate that no more transmit data should be input. Normally, most terminals or hosts will still send one or two more characters after the CTS line is set "false", and this is normal and allowed for in the CTS control logic. In fact the modem will continue to accept and store transmit data (providing the RTS line is still active) even though it has set the CTS line to "false", however the user then risks the occurrence of an overflow condition. If the transmit buffer becomes full, then further data is discarded.

A configuration bit, further controls the state of the CTS output line in relation to the RTS input line. If the bit is clear, then the CTS output will always indicate the flow control state, regardless of the state of the RTS input. If the bit is set, the CTS line is conditional on the state of the RTS input. If the RTS input is "false", then the CTS output is also "false". If the RTS input is "true", then the CTS output indicates the flow control state. This latter configuration is typical of a "wired" modem.

The modem's internal data store holds both the raw user data, and records the position of frame boundaries (as defined by PAD operation) in the data. A limited amount of memory is allocated to storing the frame boundary data. When this memory space is full, the modem sets the CTS output to false, even though the character storage space may not be full. The frame boundary storage space is sufficient to hold data for 64 frames. If the modem has both ports (Port_A and Port_B) enabled, then this space is evenly divided between the two, or if Port_B is disabled, then up to 64 frames can be stored for Port_A. If data continues to be input when the CTS line has been set to "false" because no more frame boundaries can be recorded, then the frame closure mechanism may abort. This has the effect that a frame will not be closed when defined by PAD configuration. An example of this, is where the PAD is configured to close the frame on receiving a <CR> (carriage return) EOM. If the frame boundary space is full, when a <CR> is input, then the subsequent characters will be appended to the same frame. Another attempt to create a new frame will not occur until the same or another frame close condition (as defined by PAD configuration) occurs, in this case another <CR>. This logic avoids the unnecessary loss of data.

Situations where the data storage space or frame boundary storage space become full, would be rare, and would only be likely to occur if the transmitter could not gain access to the channel, or the input data rate exceeds the channel transmission rate for some time.

Normally the TC-900DR is manufactured with an 8 kilobyte memory for data storage. This memory space is divided equally between transmit and receive data storage. If both user ports are enabled, then each half is equally divided between the ports (i.e. 2K/2K/2K/2K for Port_A transmit, Port_A receive, Port_B transmit, Port_B receive). If Port_B is disabled, then 4K is available for each of the transmit and receive data storage functions for Port_A.

The DTR line controls the flow of receive data to the user port. While the DTR input line is "true", available received data is output from the port. If the DTR input is "false", then receive data output ceases.

3.4.8.2 PORT_A XON/XOFF FLOW CONTROL PROTOCOL

When XON/XOFF flow control is configured for Port_A, the CTS line is set "true", the RTS input line is not required to validate input data, and receive data is not dependent on the state of the DTR line. Instead of controlling the CTS line, the modem sends XON/XOFF characters (embedded in the receive data stream), to the port. The flow of receive data is controlled by the receipt of XON/XOFF characters in the transmit data stream. These control characters are trapped out of the transmit data stream, and are not transmitted.

The underlying flow control logic is the same as RTS/CTS/DTR control. An XON is sent instead of a "false" to "true" transition of the CTS line, and an XOFF is sent instead of a "true" to "false" transition on the CTS line. A received XON is recorded by an internal flag that emulates a "true" state on the DTR line, and a received XOFF is recorded by the flag to emulate a "false" state on the DTR line.

This method of flow control would be considered to be less reliable, since a lost XON or XOFF control character could cause either an overflow condition, or data flow to stop altogether.

3.4.8.3 PORT_B FLOW CONTROL

User Port_B can be configured for no flow control, or XON/XOFF flow control. When XON/XOFF flow control is configured, it operates identically to Port_A, except that this port has no CTS line to set "true". Flow control on Port_B operates at a local level only, since end to end flow control via the SSC is available only for Port_A.

If XON/XOFF flow control is disabled, then no flow control is used on Port_B, as there are no RTS/CTS/DTR lines implemented on Port_B. Users should be careful to avoid overflow conditions, to avoid loss of data.

It will now be obvious that the RTS input line on Port_A can be used by more than one function in the modem. RTS can have no function, or be used in Port_A flow control, and/or provide a manual PTT facility.

3.4.9 SETTING MINIMUM RSSI LEVEL

The data receiver of the modem is continually running. It will be in one of two states. It is not SYNC'd, and thus looking for HDLC FLAGs in the radio receiver signal, or it is SYNC'd, and recovering frame data to be checked and stored. If the radio receiver is not receiving a signal, then the recovered signal applied to the data receiver of the modem, will consist only of noise. To prevent the modem from erroneously locking onto noise, a minimum RSSI level must be present to validate the recovered signal applied to the modem data decoder. This threshold level, is stored in the non-volatile configuration memory. It should be set by applying a signal to the radio receiver, which produces a desired SiNaD result, a desired bit error rate, or more crudely, a predetermined absolute signal level into the antenna connector of the TC-900DR. The modem (operating in Test/Program mode) is then commanded to measure the RSSI level, which produces a response of a message indicating the measured level, in hexadecimal. This process should be repeated several times, then an average taken. The analogue to digital conversion performed in this way, is an eight bit conversion. In normal operation, the modem performs a six bit conversion when measuring the RSSI level, so the average of the levels measured in the test mode should now be divided by four. The result should now be stored in the configuration memory, at the address reserved for it.

3.4.10 SETTING PTT TIMER

The modem implements a PTT timer. This timer can be disabled entirely by setting the PTT Timer configuration value to zero. The timer value is a 16 bit number, that counts in "ticker clocks". If the timer is enabled, whenever the modem activates the PTT control to the radio transmitter, it initialises the timer with the configured value. The timer is decremented while the PTT control remains active, and if it terminates, the PTT control is deactivated. No other action is taken, and all other functions within the modem are oblivious to this condition, so data frames continue to be output, and thus lost. The PTT timer is to be considered an emergency override mechanism only, in case an error occurs in the operation of the user's host equipment and/or software. To reset this time-out state, conditions must be met that would cause the modem to normally deactivate the PTT control. The PTT timer will then be re-initialised the next time the PTT control is activated. The time-out period may be set in "ticker clock" (2.5mS) increments to over 160 seconds.

3.4.11 DATA STREAM SWITCHING, SELECTING AND ENABLING SID CODES

The TC-900DR radio modem includes a feature that provides data stream switching. This is achieved by placing a Stream Identifier code (SID) at the beginning of every frame. This code functions as a simple addressing function. If both user ports of the TC-900DR are enabled, then SID codes should also be enabled, so that data frames carry a code which identifies the originating port (A or B), thus the port to which the frame data should be directed when the frame is received at the destination station.

However this stream switching mechanism is not only confined to this simple application. The SID codes for each user port, are contained in the configuration memory, and are thus "soft". It would be possible to engineer a small (up to 256 stations) network using an individual SID code for each remote station. Since the modem receiver will discard frames which are headed by an SID code which is not recognised, only frames specifically addressed would be stored and passed on to the attached host. The SID code is allocated to the port, so the modem uses the same SID code both for transmission and receipt of frames. Therefore in such a system, the master would be configured with SID codes disabled. The host attached to the master would preface each message with the eight bit address of the destination remote. The message from the remote emanating from the port will have the SID code removed. A message received from a remote, will have the SID code of the sending station at the beginning as the first byte. The remote modem itself places this code at the head of the frame.

Another application of the stream switching feature, is a remote diagnostics facility. This is a facility which is planned for release in the next firmware version. A reserved SID code will be used to address a diagnostics function within the modem. A command/addressing protocol is being developed that employs the units own unique serial number for addressing. "Stay tuned for further updates!".

The SID code is placed in the first octet of each frame. This provides up to 256 unique codes. However, to avoid possible future compatibility problems where higher level protocols are in use on the same channel (e.g. AX.25, etc.), it is suggested that the SID codes used have bit0 set to "1". Such higher level protocols normally use extended addressing where more than one octet is used to carry the destination/source address. A frame using an SID code with bit0 set, will fail an address test and be discarded by such systems. Conversely, if this modem receives a frame containing a higher level protocol, bit 0 of the first octet will normally be set to "0", so will not match any SID code stored in the configuration memory, and be discarded.

By default, Trio DataCom sets the SID codes to 03 and 05 for ports A and B respectively. We have also reserved SID code 00 for the diagnostics facilities.

3.4.11.1 Separate Tx And Rx SID Codes. (Firmware Revision V2.1 onwards)

Firmware revision V2.1.0 onwards allows the Transmit and Receive SID codes to be different. Normally the RxSID and TxSID parameters (separate for each port) would be programmed the same. By programming them to be different, means that a TC-900DR unit will receive frames carrying a SID code that matches the configured RxSID code, but transmit frames which carry a SID code that is specified by the TxSID code configuration parameter. Applications for this feature are in small point to multipoint systems, using a central "community" repeater.

3.4.11.2 Repeater Operation Mode. (Firmware Revision V2.1 onwards)

The TC-900DR radio modem may also be configured in a repeater mode. The repeater function is enabled as a protocol driver on a port. Thus each user port driver can individually be configured for repeater operation. Essentially, what this does is automatically routes the received data frames back to the transmitter. If SID codes are enabled, then the original SID codes are stored as part of the data frame, and thus the retransmitted frame is identical to that received. Note that only frames received error free will be repeated.

When a port driver is configured for repeater operation, the RxSID and TxSID codes stored in configuration data in the NVRAM are used to define a range of streams to be repeated. The RxSID code configuration parameter defines the lowest SID stream to be repeated, and the TxSID code configuration parameter defines the highest SID stream that will be repeated. Thus it is possible to configure a unit to perform a repeater function for two separate ranges of streams, by configuring both user ports with a repeater driver, or to configure one end of a data link to also be a repeater for a range of other streams.

3.4.12 SETTING TRANSMITTER LEAD_IN_DELAY

Whenever the radio transmitter is activated a timer is started. No data frames are transmitted until this timer terminates, so that the destination unit receiver has time to synchronise it's data receiver before frame data is begun. The radio transmitter is very fast, reaching final output power and frequency stability in a matter of a few hundred microseconds (other sections of this document deal with the receiver synchronising aspects). This timer counts in octets, not "ticker clocks" as most other timed functions do, so the actual time elapsed is a function of the radio channel bit rate. However, the synchronisation time is primarily a function of the number of bits to the receiver. Trio DataCom would suggest a value of 25 to 50 (decimal) for this parameter, but it's final value will depend on signal strength and quality at the receiving point, and should best be determined by test.

3.5 FACTORS AFFECTING MODEM SYNCHRONISATION TIME

3.5.1 (UN)SCRAMBLER AND HDLC STATE MACHINE

It can be shown, that the un-scrambler in the receiving unit will synchronise to the scrambler in the sending unit in 17 bits maximum.

The receiving unit must then detect an HDLC FLAG, which will take another 15 bits maximum. Thus the HDLC state machine and unscrambler should be synchronised in 32 bits maximum.

3.5.2 PHASE LOCKED LOOP

Before valid data can be read for the unscrambler, the phase locked loop (PLL) must lock. The time required for this to occur is affected by signal quality and content. The PLL relies on level transitions of the binary signal, on which to lock. It essentially compares the phase of an internal counter, with the phase of the incoming data bits. A detected phase error, will cause the internal counter to speed up or slow down, to reduce the phase error. The greater the error, then the greater the speed adjustment to the internal counter.

If the incoming data stream has few transitions, then the internal counter will "catch up" to it quicker, since it's speed is adjusted less often. The PLL will synchronise to within 90% of the correct phase (from 0%), in 16 to 36 bits time, depending on the number of transitions.

In practice, even though the PLL has not reached 90% lock, meaningful data will still be obtained as long as a good strength, clean signal is available.

3.5.3 ERROR CONTROL

Having recovered the raw data, the modem then applies the bit-stream to a de-ramdomiser, which is based on a recursive tapped shift register, described by the polynomial:

$$X^{17} + X^{12} + 1$$

The output of the de-randomiser is then fed through another conversion function, to convert the NRZI data to NRZ.

The data is now an HDLC data stream, conforming to ISO3309. It is then applied to a function which detects HDLC FLAGs, and extracts "dummy zeros", which were inserted by the transmitter. Frame boundaries are detected at this point.

The modem calculates and appends a 16 bit Cyclic Redundancy Checksum (CRC) word to the end of each frame. This calculation uses the polynomial:

$$X^{16} + X^{12} + X^5 + 1$$

This is sometimes referred to as CRC-CCITT since it is a CCITT standard.

The 1's complement is taken of the calculation result and this FCS is appended to the end of the data frame and sent MSB first. (Refer to ISO 3309 for more information)

At the receiver, this calculation is repeated on the received data, and the result checked. A detected error, will cause the receiver to discard the entire frame. A higher protocol level (determined by the user) will detect the lost packet, and initiate a re-send of the packet.

In terms of the reliability of this FCS, it can be claimed that the following will be detected : [2]

All single bit errors.

All double bit errors.

Any odd number of errors.

Any burst error less than 16 bits long.

Most large burst errors.

From here emanates the original frame data, provided the FCS was correct. If not then the frame data is discarded. The data is stored in externally addressed memory, connected to the modem IC. Maximum data packet size is determined by the amount of available memory. Normally the modem is fitted with an 8K CMOS RAM, of which half (4096 bytes) is allocated to the receiver. The modem can be fitted with an external memory up to 32K with no other modifications. The receiver section of the modem can store up to 32 separate data packets.

How this data is handled from this point on, depends on the user protocol implemented by the modem on the user interface.

3.5.4 TRANSMISSION FORMAT AND TIMING

The data to be transmitted is input to the modem, via the user interface protocol implemented on the user interface. The modem stores the data packet(s) in externally addressed memory, connected to the DFM4-9 modem IC. Maximum data packet size is determined by the amount of available memory. Normally the modem is fitted with an 8K CMOS RAM, of which half (4096 bytes) is allocated to the transmitter. The modem can be fitted with an external memory up to 32K with no other modifications. The transmitter section of the modem can store up to 32 separate data packets.

Most of the transmitter functions are performed internally in the modem IC, with only a DAC (Digital to Analogue Converter) and final low pass filter implemented by external circuitry.

The data is placed into an HDLC frame (consistent with ISO3309), complete with dummy zeroes where required. During transmission, a CRC calculation (CRC-CCITT) is performed, and when the end of the data packet is reached, this FCS (Frame Check Sequence) is appended to the end of the frame, before the closing HDLC FLAG.

Where two or more consecutive frames are sent, only one FLAG octet is used to delimit the frames. All frames are composed of an integral number of octets.

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[2] "Data and Computer Communications" William Stallings

Data from the HDLC formatting stage is fed through a function, to convert the NRZ data to NRZI format.

The NRZI encoded data stream is now fed to a data randomiser, to ensure that there is no DC component to the data stream. This is based on a recursive seventeen bit shift register with two taps.

3.5.5 COLLISION AVOIDANCE SCHEME

The unique supervisory signalling channel facility available in this product is ideally suited to the implementation of a highly effective collision avoidance mechanism. This is a highly desirable feature in a multipoint data network, in that it allows vastly increased usage of the available channel capacity.

For instance, take a point-to-multipoint network, with a central base station, and a large number of remote data terminals scattered around the central station.

This is a split frequency duplex channel, where the central station is able to transmit on frequency F1, and simultaneously receive on frequency F2. Remote stations transmit on frequency F2, and receive on frequency F1.

If a transmission by one remote station is "crashed" by a transmission by another remote station, then the base station may not get the message correctly, and thus not acknowledge it. If there is no control over when the remote stations transmit, then because the remote stations cannot "hear" each other, their transmissions will begin to collide more often as the data traffic increases. This type of system will suffer a total blockage as the total traffic requirement approaches about 50% of the channel capacity.

Now, if the base station could quickly inform all other remote terminals, when the base receiver is busy because one of the remote terminals is transmitting, then this message can be delivered to the base receiver without being "jumped on" by another terminal blindly "crashing in". The next terminal can then deliver it's message when the receiver is signaled to be free. Of course collisions are still possible, but the occurrence of these can be dramatically reduced by this type of scheme.

Now to implementation specifics. The supervisory signalling channel in the modem, can be set independently for transmit and receive directions. For the purposes of this collision avoidance scheme, the supervisory signalling channel is only required in the base transmit direction. In the reverse direction, the supervisory signalling channel is disabled. The base transmitter is active full time, sending only FLAGs when it has no real data to send. The base controller, then indicates to the whole population of remote terminals, the current status of the base receiver, in the value of the supervisory signalling channel data bits.

The remote data terminals are programmed so that they will not begin a transmission if the received supervisory signalling channel data indicates that the base receiver is currently busy. This would result in remote terminals queuing for access to the base receiver. To prevent all these remote terminals all beginning a transmission as soon as the base indicates a free receiver, a "windowed" timing mechanism would be implemented, with a random factor added in the terminal's selection of a "window".

There are many factors that would determine the quantification of system variables, but this short description serves to illustrate a basic approach.

3.6 TEMPERATURE COMPENSATION

Periodically, the modem controller reads the voltage on the temperature transducer mounted on the radio section. This value is then used in a table look-up procedure, to derive correction data to be applied to the modulator circuitry via a transmit waveform offset voltage. This is provided by the output of the six bit DAC (UX8/RN2), which is fed to the correction voltage input of the 12MHz reference oscillator.

The offset table is constructed in the temperature calibration cycle performed during the factory testing procedure. The radio-modem is temperature cycled twice from -10C to +65C. During this time, the necessary data is determined to correct the temperature induced frequency errors. At the end of the cycle, the final database is constructed and written to the non-volatile memory.

3.7 USER INDICATIONS

The TC-900DR provides three LED's that show status information to the user - RXSIG, SYNC, and TXMIT indications.

In all operation modes of the modem except "Programmer mode" (see the section below on special modes of operation), the RXSIG LED indicates the level of the RSSI signal from the radio IF strip, compared to a threshold set in the configuration data read from the non-volatile memory. If the signal is above the threshold, then the LED indicator is turned on. There is no hysteresis applied in this process.

In normal operation, the SYNC LED 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. While the modem is SYNC'd, it does not continue to measure RSSI levels.

The TXMIT LED indicator is connected directly to the modem's PTT output transistor. It is active whenever the PTT line to the radio section is active low.

3.8 SPECIAL MODES OF OPERATION

3.8.1 GENERAL

Part of the power-up/reset initialisation phase of the TC-900DR modem, is a set of tests to determine whether the modem should enter a special operation mode.

There are three of these "special" modes. *Whilst in these modes the TC-900DR will not operate in its standard run mode.*

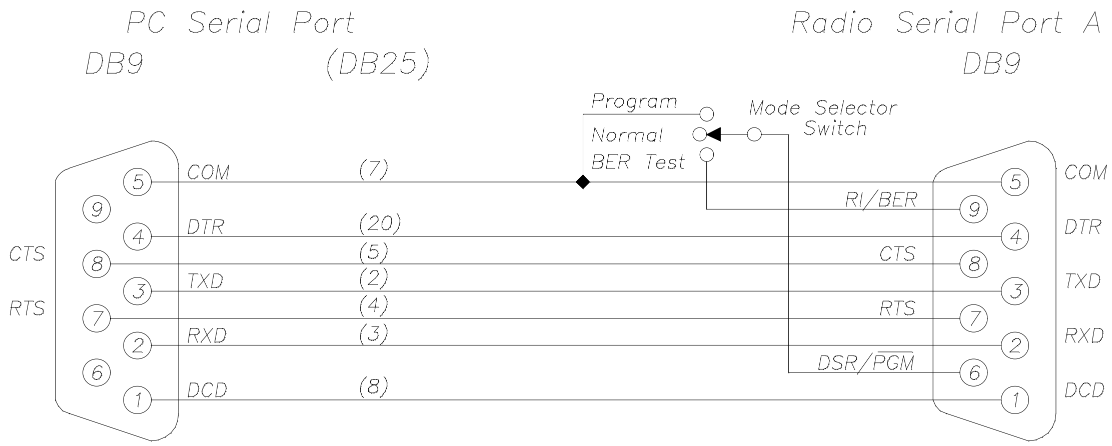
- Programmer mode.
- Bit error rate test mode.
- Handset mode.

These modes are only entered if the required setup conditions are present at power up of the TC-900DR. An error mode of operation can also be entered into, if during normal operation of the TC-900DR modem, an error condition occurs.

3.8.2 PROGRAMMER MODE

Pin 6 on the DB9 connector of Port A, is normally the DSR line. This pin is pulled high by a resistor to +13.8v, so that to a connected DTE the DSR signal implies that this DCE is ready.

However, if this pin is connected to pin 5 when the modem is powered up, the controller senses this, and attempts to enter "Programmer mode". The modem sends out of the serial port, an ASCII "?" (question mark) character, and waits for the programmer to reply with a password. The SYNC LED toggles on and off with every output of the "?" prompt until the correct password is entered. This mode is sustained for approximately 30 seconds. 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. This password protection scheme provides some defense against unauthorised tampering with the TC-900DR modems configuration data.



3.8.3 BIT ERROR RATE TEST MODE

Pin 9 of the DB9 connector of Port A, is normally the Ring Indicate output line. The modem includes a resistive pulldown to ground to show a negative condition on this line. However, if this pin is driven positive (typically by connecting it to pin 6), then the modem's data transmitter and receiver will enter the BER test mode.

It 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.

A test point on the modem section PCB, is available to monitor this point with a frequency counter. (In fact this test point is always active, and may be used to monitor the received data decoded by the DFM4-9 modem IC at any time). 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.

An internal timer is used to generate a time equivalent to 1000 bits. Every error bit detected, will activate the SYNC LED, and restart the timer. If and when the timer expires, the SYNC LED is deactivated. Thus, for error rates of 1 in 103 and above, the SYNC LED will be ON most of the time. A 1 in 104 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.

Other functions performed in this state include RXSIG indication, and temperature compensation. The state of pin 9 is constantly monitored in this mode. If the pin ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts it's initialisation phase.

3.8.4 HANDSET MODE

The DFM4-9 modem tests for the presence of a handset plugged into the handset audio port at power up.

This is done by measuring the voltage on channel 4 of the analogue to digital converter (UX10-p6). This signal is passed into the modem section from the radio section via connector X4-p24, "ADC3".

If a handset is plugged in, then the measured voltage will be about 2V, but if it isn't installed, then the voltage will be about 4V. The measured voltage is compared to 3V to determine whether the handset is plugged in. If this test succeeds, then the modem will not generate a data stream. However, it will continue to indicate received RF signal strength, and perform temperature compensation. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will activate the TXMIT LED.

3.8.5 ERROR INDICATION MODES

3.8.5.1 GENERAL

There are three error conditions that will cause the RXSIG and SYNC LEDs to be used for error indications and not their normal purpose. Two of these are fatal conditions, that cause the modem to restart after the duration of the error indication phase.

3.8.5.2 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 four 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.

3.8.5.3 NVRAM READ ERROR

The DFM4-9DR modem accesses the non-volatile memory as part of it's initialisation phase, to get 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 it's initialisation from scratch.

3.8.5.4 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 for comparison.

Tx PWR Error		NVRAM Error		TBB206 Error Synthesiser	
RXSIG	SYNC	RXSIG	SYNC	RXSIG	SYNC
☼	●	☼	●	☼	●
●	☼	●	●	●	☼
☼	●	☼	●	●	●
●	☼	●	●	●	☼
☼	●	●	☼	☼	●
●	☼	●	●	●	●
☼	●	●	☼		repeat
●	☼	●	●		
continue			repeat		

3.9 SYNCHRONOUS OPERATION MODE FIRMWARE REVISION: V2.1

3.9.1 GENERAL

The TC-900DR when operating in Synchronous mode, implements a V.24 like interface. The unit uses a special wiring harness that converts the two 9 pin "D" connectors on the end panel of the TC-900DR to a standard 25 pin "D" connector for user interface.

Synchronous Mode implements a bit level interface. Data is carried on a bit by bit basis. No framing or error detection is performed. Modem operation is full duplex.

Current implementations of SYNC mode, do not provide a DCD signal in the 25 pin RS232 interface.

3.9.2 DATA RECEIVER

While sufficient RF signal is present into the radio receiver, the data decoder is continually extracting data bits from the received signal, and outputting these to the user interface connector. If the received RF signal into the radio receiver falls below the minimum threshold, then the data decoder stops.

3.9.3 SETTING MINIMUM RSSI LEVEL

The data decoder of the modem is continually running while sufficient RF signal is present into the radio receiver. If the radio receiver is not receiving a signal, then the recovered signal applied to the data decoder of the modem, will consist only of noise. To prevent the modem from erroneously locking onto noise and producing "garbage" at the RxD pin, a minimum RSSI level must be present to validate the recovered signal applied to the modem data decoder. This threshold level, is stored in the non-volatile configuration memory. It should be set by applying a signal to the radio receiver, which produces a desired bit error rate, a desired SiNaD result, or more crudely, a predetermined absolute signal level * into the antenna connector of the TC-900DR. The modem (operating in Test/Program mode) is then commanded to measure the RSSI level, which produces a response of a message indicating the measured level, in hexadecimal. This process should be repeated several times, then an average taken. The analogue to digital conversion performed in this way, is an eight bit conversion. In normal operation, the modem performs a six bit conversion when measuring the RSSI level, so the average of the levels measured in the test mode should now be divided by four. The result should now be stored in the configuration memory, at the address reserved for it. The DR9_PRGM programmer available from Trio DataCom Pty Ltd facilitates this process.

*Use a signal generator modulated with a sine wave frequency of half the nominal bit rate of the unit (e.g. for a 4800BPS unit, use 2400Hz modulation).

3.9.4 DATA RECEIVER CLOCK OUTPUT

The receive section of the modem, includes a clock line driven by the modem. This signal is used to synchronise the transfer of receive data to the user system. The RCO (Rx_Clock_Output, pin17 in the DB25 connector) line changes from ON (TRUE) to OFF (FALSE) as the RxD (Receive_Data, pin3 in the DB25 connector) line outputs the next bit, and from OFF (FALSE) to ON (TRUE) in the nominal centre of the bit cell. This conforms to the V.24 specification.

3.9.5 OTHER RS232 RECEIVER CONTROL LINES

The DSR (Data_Set_Ready) line is driven true by the modem. This line is in fact merely tied to the internal +13.8volt rail via a 4K7 resistor. The DTR (Data_Terminal_Ready) input is unused in Synchronous mode.

3.9.6 DATA TRANSMITTER

The transmit data input is continually sampled and coded for transmission. This process consists of sampling the data input, randomising the bit pattern so that the DC component of the transmitted stream is zero, and generating a waveform suitable for application to the modulator of the FM radio transmitter.

3.9.7 DATA TRANSMITTER CLOCKS

The modem transmit data interface, includes two clock lines. One clock line, TCO (Transmit_Clock_Out, pin15 in DB25 connector) is driven by the modem, the other, TCI (Transmit_Clock_In, pin24 in the DB25 connector) can be enabled to allow the external user to supply a transmit data clock. This is implemented by synchronising the internal clock generator to the user's clock (within a small frequency range). This function is essentially a Phase Locked Loop, and effectively adjusts the phase of the internal clock to match that of the input clock. If the user clock source stops, then the modem will continue to generate the internal clock at it's nominal rate. In accordance with specification V.24, the state of the transmit data line (TxD, pin2 in the DB25 connector) is sampled on the ON to OFF transition of the clock, the bit cell boundary occurs with the OFF to ON transition of the clock.

3.9.8 TRANSMITTER RTS/CTS LINES

Two other control lines are included in the transmitter interface. The RTS (Ready_To_Send) input line, is used to control the radio RF transmitter. The CTS (Clear_To_Send) output line is driven by the modem, to indicate that the modem transmitter is ready to accept transmit data. The RTS to CTS time is determined by an internal timer. A configuration parameter is used to load the internal timer when the RTS line is activated, which must expire before the modem activates the CTS line. This time is necessary to allow the remote receiver to settle and synchronise to the data stream, before the user at the transmitting end begins sending data. However it should be noted, that the CTS signal does not perform any flow control function within the modem.

3.9.9 PHASE SYNCHRONISM WITH GLOBAL CLOCKS

When data is transferred over more than short distances, and synchronism must be maintained to some external global master clock (e.g. Telecom DDN network), then the propagation delay, and thus phase shift of the data becomes significant. A facility is provided, to introduce a phase delay in the transmitted data stream, of up to 3/4 of a bit, in 1/4 bit steps. This delay is adjusted so that minimum phase offset results at the receiver of the destination station.

3.9.10 TRANSMIT TIMER

The modem implements a transmit (PTT) timer. This timer can be disabled entirely by setting the PTT Timer configuration value to zero. The timer value is a 16 bit number, that counts in increments of 2.5 milliseconds. If the timer is enabled, whenever the modem activates the PTT control to the radio transmitter, it initialises the timer with the configured value. The timer is decremented while the RTS line remains active, and if it terminates, the PTT control is deactivated. No other action is taken, and all other functions within the modem are oblivious to this condition, including the CTS line, so data continues to be "carried", and thus lost. The PTT timer is to be considered an emergency override mechanism only, in case an error occurs in the operation of the user's host equipment and/or software. To reset this timeout state, the RTS line must be taken from ON to OFF. The PTT timer will then be re-initialised the next time the RTS line is activated. The timeout period may be set in 2.5mS increments to over 160 seconds.

3.9.11 LED INDICATORS

3.9.11.1 Received Signal Strength Indication. RXSIG LED

In all operation modes of the modem except "Programmer Mode" (see section below on special modes of operation), the RXSIG LED indicates the level of the RSSI signal from the radio IF strip, compared to a threshold set in the configuration data read from the non-volatile memory. If the signal is above the threshold, then the LED indicator is turned on. There is no hysteresis applied in this process.

3.9.11.2 Data Carrier Detect Indication. SYNC LED

In "Synchronous" operation mode (V2.1.x), prior to modem hardware revision "D", and firmware revision "V2.1.4", the SYNC LED is superfluous and not driven.

Note that firmware revision V2.1.5 onwards should only be used in SYNC mode.

From modem hardware Revision D onwards, the SYNC LED drive is used to generate a DCD function in the user interface connector, and requires firmware revision V2.1.4 onwards (i.e. firmware revision V2.1.4 onwards drives the SYNC LED ON 20mS after the "leading edge" of the RxSig LED).

This means that the SYNC LED drive should always show this function and not be allowed to show low Tx Power (see Error indication modes section 3.8.5.2). To facilitate this the Min Tx Pwr parameter in the TC-900DR modem should be set to zero, when the modem is built for synchronous operation.

3.9.11.3 Radio Transmitter Active Indication. TXMIT LED

This LED indicator is connected directly to the modem's PTT output drive. It is illuminated whenever the PTT line to the radio board is active.

3.9.12 SPECIAL MODES OF OPERATION

3.9.12.1 Programmer Mode

Part of the power-up/reset initialisation phase of the modem, are tests to determine whether the modem should enter a special operation mode. The first, is a test for "Programmer Mode". Pin6 on the DB9 connector of Port A, is normally the DSR line. To this end, this pin is pulled high by a resistor to +13.8v, so that to a connected DTE this signal says that this DCE is ready. However, if this pin is connected to pin5 (Com) when the modem is powered up, the modem senses this, and attempts to enter "Programmer Mode". The modem sends out of PORTA, an ASCII "?" (question mark) character, and waits for the programmer to reply with a password. 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. This password protection scheme provides some defence against unauthorised tampering with the radio/modem's configuration data.

3.9.12.2 Bit Error Rate Test Mode

The next test, is one for "Bit Error Rate Test Mode". Pin9 of the DB9 connector of Port A, is normally the Ring Indicate output line. The modem includes a resistive pulldown to Gnd to show a negative condition on this line. However, if this pin is driven positive (typically by connecting it to pin6), then the modem's data transmitter and receiver will enter the BER test mode. It 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. A test point on the modem PCB, is available to monitor this point with a frequency/event counter. (In fact this test point is always active, and may be used to monitor the received data decoded by the modem IC). Each error bit 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. An internal timer is used to generate a time equivalent to 1000 bits. Every error bit detected, will activate the SYNC LED, and restart the timer. If and when the timer expires, the SYNC LED is deactivated. Thus, 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. Other functions performed in this state include RXSIG indication, and temperature compensation. The state of pin9 is constantly monitored in this mode. If the pin ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts it's initialisation phase.

3.9.12.3 Order_Wire/Handset Mode

Failure of the BERT Mode test, brings the modem to test for the presence of a handset plugged into the handset audio port. This is done by measuring the voltage on channel 4 of the analogue to digital converter. If a handset is plugged in, then the measured voltage will be about 2 volt, but if it isn't installed, then the voltage will be about 4 volt. The measured voltage is compared to 3 volt to determine whether the handset is plugged in. If this test succeeds, then the modem will not generate a data waveform to the radio transmitter. However, it will continue to indicate received RF signal strength, and perform temperature compensation. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will activate the TXMIT LED.

3.9.12.4 Error Indication Modes

There are three error conditions that will cause the RXSIG and SYNC LEDs to be used for error indications and not their normal purpose. Two of these are "fatal" conditions, that cause the modem to restart after the duration of the error indication phase.

3.9.12.5 Transmit Power Low

While the modem activates the radio transmitter, it periodically checks the level of the radio transmitter output 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 four times per second. Of course, the TXMIT LED will also be on in this case. 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. The user should be aware that from Revision D of the modem PCB, this state will cause incorrect operation of the DCD output line. As stated above, the Min Tx Pwr parameter should be set to zero.

3.9.12.6 NVRAM Read Error

The modem accesses the non-volatile memory as part of it's initialisation phase, to get configuration data. If the communication protocol with the memory 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 winks on and off twice, then the other. A total of five cycles of this occurs, then the modem restarts it's initialisation from scratch.

3.9.12.7 Radio Frequency Synthesiser, Lock Detect Error

If at any time during normal operation, BERT mode, or handset mode, the 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 off. Then the latter LED ON again, swap LEDS, and OFF. This will give the appearance of a sweeping motion between the LEDs. The following table shows all three modes for comparison.

Tx PWR Error		NVRAM Error		TBB206 Error Synthesiser	
RXSIG	SYNC	RXSIG	SYNC	RXSIG	SYNC
☼	●	☼	●	☼	●
●	☼	●	●	●	☼
☼	●	☼	●	●	●
●	☼	●	●	●	☼
☼	●	●	☼	☼	●
●	☼	●	●	●	●
☼	●	●	☼		repeat
●	☼	●	●		
continue			repeat		

3.9.13 WIRING ADAPTOR HARNESS FOR TC-900DR SYNCHRONOUS MODEL

PORT A	1 (DCD)	(RCO)	17	DB25F
	2 (RxD)	(RxD)	3	
	3 (TxD)	(TxD)	2	
	4 (DTR)	(DTR)	20	
	5 (Com)	(Com)	7	
	6 (DSR)	(DSR)	6	
	7 (RTS)	(RTS)	4	
	8 (CTS)	(CTS)	5	
	9 (RI)			
PORT B	1 (DCD)	(DCD)	8	
	2 (RxD)	(TCO)	15	
	3 (TxD)	(TCI)	24	
	4			
	5 (Com)			
	6 (DSR)			
	7			
	8			
	9 (RSSI)			

SECTION 4

ALIGNMENT PROCEDURE

4 ALIGNMENT PROCEDURE

4.1 GENERAL

This section details operational performance and alignment procedures that may be required for the TC-900DR. During servicing it may also be necessary to measure specific performance parameters as a means of verifying the presence of a fault condition.

4.2 TEST EQUIPMENT REQUIRED

The following list of test equipment is required to carry out all of the procedures detailed below.

- Frequency counter accurate to better than 100 Hz at 1 GHz
- FM Signal generator. 455 kHz to 1 GHz. -120 dBm to +10dbm. Synthesised in 100 Hz steps.
- Spectrum analyser 10 MHz to 1GHz. Dispersion down to 2kHz/cm. 80+ dB dynamic range. IF b/w down to 1 kHz.
- RF Power meter to 1GHz. -20 to +30 dbm. Accuracy ± 0.25 dB.
- Digital volt meter.
- HP3406 RF Millivoltmeter or similar.
- RF Test leads, MCX male and SMA male.
- Audio noise and distortion test set.
- Audio oscillator.
- Surface mount repair tools.

4.3 TEST POINT LOCATIONS

Both the radio section PCB and the modem section PCB contain numerous test points. They are easily located on the PCB's, and are detailed below.

4.3.1 MODEM SECTION PCB

TEST POINT	SIGNAL	DESCRIPTION
TP1	TxCLK	Transmit clock
TP2	BER TST	BER test output
TP3	SYNC	Synchronised output
TP4	RxCLKOUT	Integrator reset
TP5	RxCLK	Receive clock
TP6	RxDATA	Receive data
TP7	DATA OUT	Transmit data
TP8	INTEGRATOR	Rx integrator reset

4.3.2 RADIO SECTION PCB

TEST POINT	SIGNAL	DESCRIPTION
FINAL PA SECTION		
TP31	TXPWR-2	Bias to Q8
TP25	TXPWR-3	Bias to Q8
TP27	TXPWR-4	Bias to Q9
TP14	+8v	Power Supply
TP15	TXEN	Transmit enable
TP20	RxMIXOUT	Rx mixer bias
TP28	TXPA-1	Bias to Q10
TP29	TXPA-2	Bias to Q11
TP26	+13V8	Power supply
TP33	PWR CONT	Power control supply
TP30	PTT+8V	Press to talk
121 MHz SECTION		
TP13	DATA	Tx data input
TP17	60.5 MHz	Modulated 60.5MHz
TP16	121 MHz	Output of doubler
TP18	121 MHz	Modulated 121 MHz
TP32	MIC	Tx Mic audio input
NE615 IF SECTION		
TP6	415kHz I/P	455 filter input/second mixer output
TP9	QUAD	Quad detector
TP8	DATA	Rx data out
TP10	AUDIO	Rx audio out
TP7	RSSI	RSSI output
TP4	MUTE	Mute control output
TP1	2nd L.O	Second Xtal oscillator
TP2	2nd L.O	Second Xtal oscillator
TP3	IF Input	45 MHz IF filter input
TP5	IF Output	45 MHz IF filter output
TP19	VCO	VCO oscillator injection
SYNTHESISER/VCO SECTION		
TP12	LOCK DET	Synthesiser lock detect
TP11	+5V	Synthesiser +5v supply
AUXILIARY HANDSET INTERFACE SECTION		
TP21	MIC	Tx mic audio input
TP22	PTT	Manual press to talk
TP23	+8V	Handset +8V supply
TP24	AUDIO OUT	Rx audio output

4.4 ADJUSTMENT POINTS

All adjustment points are located on the radio section PCB. The following is a list of these adjustable components.

COMPONENT	ADJUSTMENT
XTAL2	VCO reference frequency
VR3	Deviation level set
L10	Tripler filter
L9	Doubler filter
L7	121 MHz filter
L8	121 MHz final filter
L6	Tx frequency set (121MHz Osc)
VR4	Tx power control adjust
C78	Tx mixer tunable filter
VR1	Rx audio mute adjust
VR2	Rx data DC BIAS offset adjust
L3	45 MHz filter alignment
L1	44.545 oscillator adjust
L4	45 MHz filter alignment
L5	45 MHz filter alignment

4.5 LINK OPTIONS

Several options are set in the TC-900DR modem by the setting of links on the radio section PCB. Listed below is an option table for the various combinations.

LINK NUMBER	SETTING	DESCRIPTION	
LK2	IN	AFC option disabled	
	OUT	AFC option enabled	(factory standard)
LK4	IN	PWR control disable	
	OUT	PWR control enabled	

4.6 HOUSING

The TC-900DR has been designed with the serviceability of the unit in mind. Construction of the unit is robust yet easily dismantled. The unit is primarily assembled in an aluminium extrusion with a central chassis that is fixed to the front panel.

4.6.1 DISASSEMBLY PROCEDURE

To disassemble the unit, simply remove the two silver screws on the underside of the unit and the six black screws located on the front panel (the front panel of the unit has the two DB9 connectors protruding from it). Ensure you do not loose the attached nylon washers, as these prevent the Lexan front panel label being damaged upon replacing and tightening the six screws. Simply slide the unit out of the extrusion clasping front panel and the complete unit is exposed to you.

Caution : When re-assembling be careful not to foul the ribbon cable against the case when sliding the unit into its case as this may inadvertently damage the cable.

4.6.2 MODEM AND POWER SUPPLY PCB

All components and connections to the modem section PCB are accessible without removing the PCB from the chassis. If access to the rear of the PCB is required, firstly remove two nuts that clamp the C TO-220 power supply regulator to the front panel. Once this is removed, simply remove the four screws securing the PCB to the chassis.

The PCB is now free to work on, and can be folded out so as to service the unit in an open accessible condition whilst still connected to the radio section PCB. If required, the modem section PCB can be separated from the radio section PCB by simply unplugging the ribbon cable.

NOTE: Regulators will need to have heat-sinks fitted if unit is to be operated in this condition for excessive time periods.

4.6.3 ANTENNA DIPLEXER

The antenna diplexer is mounted on top of the radio section PCB. It is easily removed by firstly disconnecting the two miniature RF connectors (MCX type) from the PCB.

Care should be taken when unplugging these connectors so as not to damage them, it is important to remove and insert connectors in a vertical direction.

Secondly, remove the nut securing the antenna output connector from the central mounting chassis. The last two remaining screws must be removed which secure the diplexer to two metal PCB standoffs on the radio section PCB. The diplexer can now be removed.

Testing of the radio section PCB can be continued without the antenna diplexer, by connecting to the receiver and transmitter ports separately.

Miniature MCX RF Connectors are available from Trio DataCom if required.

4.6.4 RADIO SECTION PCB

The radio section consists of a two sided PCB which has surface mount components on one side and conventional components on the other. Several critical test points are accessible on the component side of the PCB which minimises removal of the PCB from the chassis.

To remove the PCB from the chassis, fifteen screws must be removed. Upon removal of these screws, the PCB can be manoeuvred from the chassis and once again can fold out so as to be serviceable as a complete unit.

NOTE : It is essential that all RF Deck mounting bolts are fitted and secure upon reassembly as many of these bolts provide inter-stage isolation and secure grounding ensuring the product meets all specifications.

Once service of the unit is complete, reassembly is simply the reversal of the above procedures.

Care should be taken when sliding the complete chassis assembly back into the extrusion. Ensure that the ribbon cable connecting the modem and radio section PCB's is carefully "tucked" away within its designated slot so as not to damage the cable.

4.7 ALIGNMENT DESCRIPTION

CAUTION - As the TC-900DR is capable of full duplex operation, care should be taken to avoid damage to sensitive test equipment such as signal generators or spectrum analysers. It is recommended that a 30db 2 Watt pad be connected between the unit and any test equipment prior to testing.

This section is for alignment/adjustment of the RF Deck and should be read in conjunction with Section 2 (Hardware Technical Description) and Section 7 (Fault Finding) if faults or difficulties are experienced.

For initial alignment, proceed in the following order :

Reference oscillator & synthesiser.

121 MHz Tx modulated injection oscillator.

Tx final stage/Power control.

Receiver and audio mute

4.7.1 REFERENCE OSCILLATOR AND SYNTHESIZER

1 Check VCXO (XTAL2) for reference frequency o/p at a level of 550 mV rms with an RF Millivoltmeter, and the VCO o/p for an RF level of around 150 mV rms.

2 Check that the TBB202 dual modulus prescaler (U4) is producing an output of approximately 7 MHz and a level of 550 mV rms at the "IF" i/p to the TBB206 synthesiser I.C.(U3-p8)

3 Ensure that the synthesiser has been programmed to a frequency within the range of the VCO, and check that the VCO is locked by observing a high (5V) level on Lock detect output of the synthesiser I.C.(U3-p14). Note that very short duration pulses to ground is normal.

4 Program the synthesiser with the following VCO frequencies according to VCO type and ensure lock occurs at both ends of the frequency range. These frequencies are 2 MHz beyond the published specification.
VCO TYPE: MQC-798
Maximum 786MHz VCO = 907MHz Tx or 831MHz Rx
Minimum 814MHz VCO = 935MHz Tx or 859MHz Rx
VCO TYPE: MQC-978
Maximum 996MHz VCO = 875MHz Tx or 951MHz Rx
Minimum 960MHz VCO = 839MHz Tx or 915MHz Rx

5 Program the VCO to a given frequency within the range as specified above and measuring the VCO o/p frequency, adjust the 12 MHz (VCXO) reference trimmer to bring the frequency within 250 Hz of the VCO frequency.
Note: Unit is temperature compensated at factory and no field adjustment of Ref. Oscillator is possible. If VCO frequency is not correct (±1500Hz), consult factory for service advice.
Note ensure that the VCXO control input is within its active range (1-4 Volts).

6 Check the VCO power o/p by monitoring the Rx mixer bias at TP20, where approximately 200 mVDC should be measured.

7 With a spectrum analyser set to the VCO frequency and a dispersion of about 5 or 10 kHz per cm, check that the reference sidebands are less than -60dBc in the adjacent channel.

8 Check VTCXO Reference frequency is F(tx) +121 MHz for 853 remote units or F(tx) -121 MHz for master units. If Reference is out by more than ±1.5kHz, drift offset should be applied via the programmer or unit should be returned for factory service. attempting to alter Reference trimmer will void temperature compensation process and should only be done in an emergency and as a temporary measure.

4.7.2 121 MHZ MODULATOR

Note - make sure the transmitter is loaded with a suitable attenuator on the antenna or Tx o/p socket before energising

1. For Initial alignment set all coil cores to their nominal positions as per the table below :

Miller coils

L9	5 turns from top of coil can
L10	2 turns
L7	4 turns
L8	5 turns
L6	0 turns

To prevent the final transmitter stages from producing excessive power whilst low level stages are being aligned, it is suggested that the Tx post mixer tunable filter be de-tuned. Energise the transmitter via manual PTT from the auxiliary handset.

2. Tune L7 through L10 for peak o/p. For initial alignment this can be done by monitoring the 121 MHz level at TP18 initially and then at the input to the SBL-1X transmit mixer (U8), where a level of about 75mV should be measured by an RF millivoltmeter (e.g HP11960).

Typical RF millivoltmeter readings for each stage are :

TP17	125 mV RF = 0.25 VDC on HP11960 probe.
TP16	40 mV RF = 0.06 VDC on HP11960 probe.
TP18	550 mV RF = 1.0 VDC on HP11960 probe.
121 MHz i/p to mixer	75 mV RF = 0.13 VDC on HP11960 probe.

Note: The signal at TP17 is present as long as "Tx En" is active. The subsequent test points require PTT to also be active.

If the complete transmit chain is known to be operative then the 121 MHz o/p can be peaked by first de-tuning C78 on the tunable Tx filter until the Tx power o/p is less than 100 mW and then tuning Inductors L7 to L10 for maximum output at the Tx frequency.

3. With the radio section links set for the desired data rate (see link table above),set the peak deviation as per the chart below with VR3, and center frequency to 121.000 MHz with L6.
   NOTE : THESE ADJUSTMENTS ARE INTERACTIVE. ENSURE ALL COILS ARE SECURE

BAUD RATE	DEVIATION LEVEL
4800 bps	± 1.5 kHz peak
9600 bps	± 2.75 kHz peak

4. Note that temperature compensation is applied to the 121MHz oscillator so attempting to adjust either VR3 or L6 will upset compensation and should only be done as a temporary measure. Return unit to factory for repair if errors >±500Hz are detected.

4.7.3 TX FINAL

NOTE: It is essential that all RF Deck mounting bolts are fitted and secure upon reassembly as many of these bolts provide inter-stage isolation and secure grounding ensuring the product meets all specifications.

1 Ensure the 121 MHz Tx injection is operating correctly.

2 Check Q2,4,5,8, are all biased correctly as per the voltage chart.
Temporarily disable the Tx power control circuitry by shorting LK4 located on the top side of the board near the ribbon cable.
Energise the transmitter via the manual PTT on the auxiliary handset.

3 Tune the Tx filter tuning capacitor C78 for a peak output power measured at Antenna port or X4.

4 With full drive, Q9 driver collector current as seen across TP26//TP27 should be approximately 45 mA (100mVDC), and NOT MORE THAN 55mA (120mVDC).

5 With full drive at Q9 each final transistor should be drawing around 175 mA(385mVDC) as seen across TP26/TP29 or TP28. The output power measured directly at the final connector should be between +32 and +34 dbm without power control.

6 Re-enable the power control circuitry and with the 'Txpwr' control line set at +5VDC, set VR4 for +32 dbm+/- 0.25 dB at the tx o/p socket X4. Check that the current in EACH final collector does NOT EXCEED 225 mA.

7 Check with the spectrum analyser that the Tx o/p is free from spurious signals.

Note 1 . Prior to the diplexer the VCO level is nominally about -20 dbc.

Note 2 . Close in mixing products (less than +/- 30 MHz) must be greater than 65db below the carrier, as they are not attenuated by the diplexer filters.

D.C. Voltages of Radio Section

RF Output Power set to +32 dbm at X4 (diplexer input) with 13.8 VDC supply

Transistor	Base	Emitter	Collector
Q2	1.66 VDC	0.92 VDC	6.96 VDC
Q4	1.79 VDC	1.06 VDC	6.46 VDC
Q5	1.80 VDC	1.08 VDC	7.51 VDC
Q8	1.05 VDC	0.31 VDC	4.02 VDC
Q9	0.47 VDC	0 VDC	13.35 VDC
Q10	0.28 VDC	0 VDC	13.05 VDC
Q11	0.29 VDC	0 VDC	13.16 VDC
Q12	7.17 VDC	7.97 VDC	7.88 VDC
Q1	7.29 VDC	7.97 VDC	7.91 VDC
Q13	4.56 VDC	3.84 VDC	7.97 VDC
Q7	1.14 VDC	0.41 VDC	6.68 VDC
Q6	1.13 VDC	0.40 VDC	7.52 VDC
Q3	1.06 VDC	0.33 VDC	7.59 VDC

4.7.4 RECEIVER

The receiver section requires little or no alignment once factory aligned.

4.7.4.1 No AFC Models (Xtal 1 = 45.455MHz)

1. Adjust L1 for 45.455 MHz measured with pickup loop near L1.
2. In emergency adjust coils L3, L4 and L5 for best SINAD at TP8.
3. Adjust audio mute VR1 to mute handset audio at 10dB SINAD
4. Adjust VR2 for 2.0 VDC at TP8 whilst receiving data off-air.

4.7.4.2 AFC Models

Monitor 44.545 MHz with pickup at L1. Test for 44.545 ±1.5KHz

Consult factory for alignment or service information.

SECTION 5

INSTALLATION AND COMMISSIONING

5 INSTALLATION OVERVIEW

All Data Radio Modem devices needs to be properly installed and commissioned in order to function reliably. It is important that installers are familiar with RF products / installations and are geared up with appropriate tools necessary to confirm the ongoing reliability of a communications system.

This chapter is intended as a short form checklist to ensure such radio devices are installed correctly and that important tests are made and recorded at each site for future reference should a problem eventuate.

Installers should check that each data radio has been programmed to suit their specific requirements before installation.

5.1 GENERAL

Installations play a critical role in network performance. Although this is a known fact, installations are often performed poorly or given little regard. It is essential that the installation is performed in a professional manner with careful attention and consideration to the following items :

1. Adequate primary power cable - relative to the length of cable to minimise voltage drop.
2. Shielded data cable between the unit and any external data equipment.
3. Low loss coax used for antenna feed line.
4. Careful termination of RF connectors.
5. A suitable antenna for the requirement.
6. Suitable placement of the antenna.
7. Adequate signal strength from the base station / other radio communications device.

5.2 INSTALLATION

The following information should assist when installing and commissioning data radio systems.

5.2.1 DATA CONNECTION

In industrial environments connection to any external device should be by shielded data cable with the shield connected to the connector shell to minimise data corruption, and/or radio interference.

5.2.2 MOUNTING

The radio modem should be mounted in a cool, dry, and vibration free environment. Mounting of the unit should be in a location providing easy access to screws and all connections.

5.2.3 POWER CONNECTIONS

The power required for 5 Watt (Tx) at 13.8VDC, is typically 2.0 Amps. As the Tx key up current is significant, the gauge of primary power wiring should be considered. It is suggested that a minimum of 18 gauge stranded copper wire be used for distances of up to two metres and a minimum of 14 gauge for longer distances up to 5 metres.

Ensure correct polarity to avoid costly repairs.

5.2.4 COAX CABLE CONNECTION

It is important to select the correct cable and connectors for each application as a poor selection can seriously degrade the performance of the unit.

As an example, for each 3dB of cable and connector loss, half the transmitter power is lost and twice the receiver signal power is required to produce the same bit error rate.

In some installations where strong signals are present, a compromise of cable and connector cost may be acceptable.
It is essential that all connector terminations are performed as per the manufacturers specifications (especially at 900MHz and above) and if connectors are to be used outside, it is essential that a sealant such as amalgamating tape be used to seal connectors. DO NOT use acetic cure silicon to seal the connectors.

It is also important that coax cables are not stressed by tight bends, kinking or excessive flexing. Ensure that coax cables have sufficient strain relief and are secure. If large diameter rigid or semi rigid cable is used, it is recommended to use a short length of high quality RG58 or RG223 cable between the unit and main cable feed.

The following chart is a guide to losses in various types of coaxes at 400MHz and 900MHz over distance, please consider this when installing the unit.

CABLE TYPE	LOSS RELATIVE TO DISTANCE							
	1 dB		3 dB		6 dB		9 dB	
	450MHz	900MHz	450MHz	900MHz	450MHz	900MHz	450MHz	900MHz
RG58C/U	2.3m	1.6m	7m	5m	14m	10m	20m	15m
RG223/U	3.1m	2.3m	9m	7m	18m	14m	28m	21m
RG213/U	6.1m	4m	18m	12m	37m	24m	55m	37m
HELIAX LDF4-50A	19m	14m	57m	43m	114m	87m	171m	130m
HELIAX LDF5-50A	38m	25m	114m	75m	229m	150m	343m	225m

5.3 ANTENNA INSTALLATION

The selection of antennas and their placement is one of the most important factors when installing a radio based network. People often use a simile, it is like putting square wheels on a Mercedes Benz..... very true comparison.

Antennas are generally mounted to a vertical pole with either vertical or horizontal polarisation as per the licence requirement.

Antennas should be mounted as high as practical and away from metal surfaces which can cause reflections.

Determining the type of antenna is very important and as a typical generic example, Point to Multipoint (PTMP) systems generally employ high gain (3, 6, or 9dB gain) omni directional antennas at the base station sites and either omni directional whips (unity gain) or preferably high gain directional yagi antennas (9 or 14dB gain) at the remote sites.

5.3.1 YAGI ANTENNAS

Yagi antennas not only provide signal gain and directivity, but also provides protection from interfering signals which are outside the beam width of the antenna. Yagi antennas are essential when communicating over very long distances.

Yagi antennas are polarised and must be mounted either vertically (elements pointing from the ground to the sky) or horizontally (elements in parallel with the horizon).

As a general rule, Point to Multipoint remote units are vertically polarised, while Point to Point links are horizontally polarised.

When mounting yagi antennas with vertical polarisation, it should be noted that the dipole (loop section of antenna) has a drain hole. The small drain hole on one end of the dipole must be pointed towards the ground so that water will drain out of the antenna.

5.3.2 OMNI DIRECTIONAL ANTENNAS

Omni directional antennas provide a radiation pattern of equal strength through 360^0 in the horizontal plane. This makes them ideal for base antennas in point to multipoint systems because they can reach the remote antennas.

Omni directional antennas are also used at remote sites (although yagi antennas are preferred) and are typically ground independent “whip” type antennas. The main reason for using whips at remote sites is for aesthetics as they are far less obtrusive than a yagi.

Regardless of the type, antennas need to be mounted properly and in a suitable location as covered below.

5.3.3 ANTENNA PLACEMENT

Antenna placement is of paramount importance and plays a big part of the antennas and in turn systems performance.

When choosing antenna locations the aim is to find the largest path of unobstructed space and locate the antennas within that space. It is important to locate antennas as high as possible and definitely clear of any moving obstructions.

Where possible it is important to avoid mounting antennas:

1. Against or adjacent to steel structures.
2. In an area which will have constant intermittent obstructions - people walking past, vehicles driving past etc. That is, mount antennas well above such moving obstructions.
3. Near any electrical equipment.
4. Near metal beams, structures etc.
5. Inside any metal enclosures, tin sheds / warehouses etc. - note meshed wire fences act like a “brick wall” to RF transmissions.
6. Away from guard rails or support beams.

Note: Sometimes installations in such environments are unavoidable and where this is the case, certain care can be taken to still ensure a reliable installation. Please consult Trio for assistance on a case by case basis.

If tests indicate poor signal strength then the antennas at one or both ends of the link should be raised, and/or moved clear of obstructing objects, or if directional antennas are employed they should be checked for correct directional orientation and polarisation (horizontal or vertical signal orientation).

5.3.4 REFLECTIONS AND OUTPUT POWER

Ideally, the propagation path should be clear Line of Site (LOS).

The biggest problem with UHF radio when used within “steel” buildings or obstructed paths is the large presence of signals randomly reflected from the surrounding obstructions or “steel” walls. These signals cannot be eliminated, but by maintaining a 10 to 20dB margin between the wanted and unwanted signals, problems should not be experienced. The simplest way to do this is to use directional gain antennas.

These antennas will provide attenuation to all signals arriving from a direction other than the direct path. Where steel walls or structure exist immediately behind the antenna location, the high front to back ratio of such antennas will negate such high level reflections. Power output should be set at the minimum level required to achieve a 25dB fade margin, in order to minimise the amount of RF being reflected, and to avoid saturating the receiver front end and therefore reducing the margin between wanted and unwanted signals.

5.4 COMMISSIONING - RSSI LEVEL

When commissioning a data radio network, it is important to ensure that the incoming received signal strength (RSSI) is adequate to provide reliable communications.

Note: A good signal path should allow for approximately 30dB fade margin.

Received signal strength (RSSI) of the incoming signal is available as an analogue output on Trio data radio modems. This RSSI output ranges from 0 to approx 4 Volts, where 4 Volts indicates the strongest signal. The actual values of received signal strength can be determined by comparing the output voltage against the calibrated graph supplied in the handbook.

By referring to the RSSI chart alignment of aerials can be optimised to achieve the greatest signal strength (highest output voltage).

Note: Be sure to stand clear of aerials when measuring this output voltage, touching or standing in close proximity to aerials will give inaccurate readings.

5.4.1 CHECKING DATA COMMUNICATIONS

If the host computer and remote equipment are capable of performing data integrity tests then connect the host and terminal data equipment to the radio modems.

Remove and re-apply power to each radio modem to ensure they are both in data comms mode, and run data tests on the link.

5.4.2 BIT ERROR RATE (BER) TESTING

If the connected data equipment is NOT capable of running data integrity tests then the TC-450DS modems can be put into a BER test mode, whereby the data channel can be tested in each direction to a reasonable level without external test equipment. To run a link test with the radio modems themselves, they must BOTH be put into BER test mode.

To place the unit in BER mode connect pin 6 and pin 9 of port A together and apply power..

The transmitter can be activated by driving the RTS pin (7) of port A positive. The unit will then send a predefined pseudo random sequence which is tested for accuracy by the receiving unit and any errors displayed on the front panel 'SYNC' lamp.

Each error bit will illuminate the lamp for approximately 1000 bits duration, therefore error rates above 1 in 1000 will show an almost constant error indication.

To return the unit to normal data transmission mode simply power it up without pin 9 connected to pin 6.

For further information on radio path problems please contact Trio DataCom for detailed advice.

Note : BER testing is not viable in an operational point to multi-point environment as the BER test will interfere with other operative units.

5.4.3 OUTPUT POWER - VSWR

Upon installation of equipment an output power measurement should be done using a suitable power meter. Forward and reflected power should be measured at the antenna port and recorded for future reference. The reflected power measurement should be as a minimum 3 : 1 of the forward power. If this is not the case, investigate possible causes such as poor terminations, faulty antenna etc.

5.4.4 DATA CONNECTION

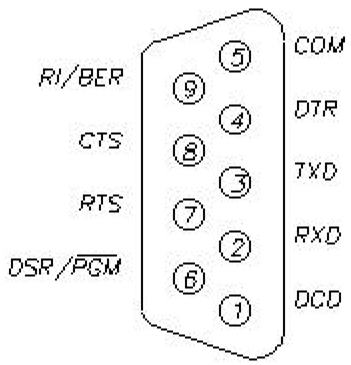
The data connection is via a DB9 connector labelled 'Port A', which is wired as a DCE as shown below. The port labelled 'Port B' is not used for the standard configuration but can be enabled by the programmer for use as a totally independent second data channel. In industrial environments connection to the modem should be by shielded data cable with the shield connected to the connector shell to minimise data corruption, and radio interference.

- User Serial "Port A" Pin Assignment

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)

EXTERNAL VIEW OF `PORT A'



NOTE: Pin 6 and pin 9 provide a dual function which depends on the mode that the TC-450DR is operating in.

- User Serial "Port B" Pin Assignment.

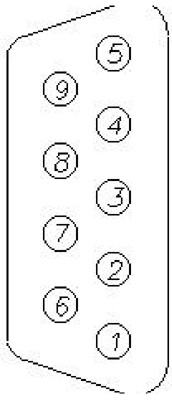
Port B of the TC450DR is essentially unused in its standard configuration but can be enabled by the Programmer for use as a totally independent second data channel. This port is essentially used for specific applications and only has one connection that may be of use for installation purposes. This connection (Pin 9) is Receive Signal Strength Indicator (RSSI) output.

This RSSI output ranges from 0 to 5 Volts, where 5 Volts indicates the strongest signal. It is important to note that this Port output has a high impedance of around 10K ohms and loading will decrease accuracy of the recorded measurement.

PIN NO. & FUNCTION

1. DATA CARRIER DETECT
2. RECEIVE DATA O/P (RxD)
3. TRANSMIT DATA O/P (TxD)
4. DATA TERMINAL READY (DTR)
5. COMMON
6. DATA SET READY (DSR)
7. REQUEST TO SEND (RTS)
8. CLEAR TO SEND (CTS)
9. RECEIVE SIGNAL STRENGTH

EXTERNAL VIEW OF `PORT B'



5.5 GENERAL CHECKLIST

The following is a simple commissioning checklist which should be used at every site not only to ensure correct installation, but also as a reference list for problems which may eventuate.

TRIO SITE COMMISSIONING CHECK LIST / RECORD			
Company:		Operator:	
Site Location:		Date:	
Link to:		Serial #:	
Radio Type:		Config File Name:	
Antenna Type / Gain		Path Distance	
Tx Power at Radio		Measured RSSI Volts	
Reflected Power		Fade Margin	
VSWR		Line of Site to Base	
Tx Power at Antenna		DC volts at Radio (Tx)	
Site QA Inspection:			
Notes:			
Signed		Date	

SECTION 6

FAULT FINDING

6 FAULT FINDING

This section is to assist with difficulties that may be experienced when installing or working on the TC-900DR.

6.1 MODEM/GENERAL

The following is a list of possible problem areas, and suggested checks that can be made to isolate any general problem that may have occurred.

1. POWER SUPPLY

a) Check for +13.8 Volts at supply input.
b) Check fuse on Modem P\S PCB (1 Amp SLO-BLOW).
c) Check supply volts:

Modem P\S	i) 13.8 Volts
	ii) 8 Volts
	iii) 5 Volts
RF Deck	i) 13.8 Volts
	ii) 8 Volts
	iii) 5 Volts

2. ANTENNA

a) Check antenna, cable and connectors for damage or water
b) Check forward and reflected power at antenna connector of unit.
VSWR should be <= 1.5:1

3. PROGRAMMING

Check programming information. e.g.
i)Transmit and receive frequencies are within the operating band of the unit
ii) User interface configuration.

4. INTERFACE

a) Check connections to Port A (DB9 Connector).
b) Check cable to host communications.
c) Interface commands to unit are incorrect or communications are not established correctly.

5. POOR TRANSMITTER PERFORMANCE

a) Check correct transmit frequency programmed.
b) Check transmitter carrier frequency.
c) Check transmitter deviation.
d) Check RF output power level.

6. POOR RECEIVER PERFORMANCE

a) Check correct receive frequency programmed.
b) Check receive sensitivity.
c) Check audio output level and DC bias to modem.
d) Check mute threshold.

6.2 RECEIVER

The following is a list of problem areas, and suggested checks that can be made to isolate any receiver specific problems that may have occurred.

6.2.1 RECEIVE SENSITIVITY LOW

1 Check mixer drive level by measuring DC bias developed across R27.

2 Check for correct DC bias conditions and supply volts on RF Amp, Local Osc buffer, and IF Strip, compared to voltage charts.

3 Ensure 44.545 MHz oscillator (part of NE615 IF IC) is within ± 250 Hz. This is best carried out by using a communications test set such as an IFR1200 or similar in receiver mode with frequency error displayed.

4 Ensure that the local oscillator is netted to frequency by monitoring the Tx mixer injection with a pick up loop connected to a sensitive frequency counter of high stability. Adjust the VCXO frequency reference until correct L.O. frequency is observed. Note that the VCO and synthesiser use the VCXO as the frequency standard. Measure the Synthesiser LOCK signal to ensure the VCO is in phase lock.

5 With a 50 ohm signal generator tuned to 455 kHz, apply signal via a 1nF capacitor to the inputs of the 1st and second IF Amp sections of the 615 IF IC and compare the level required to produce the correct RSSI level.

6 With a 50 OHM signal generator tuned to 45.000 MHz, apply signal to the points defined on the IF test chart and compare RF level required to produce the reference RSSI level as specified at TP4.

7 Apply signal frequency to the RF input connector at X2 and compare the level required to produce RSSI reference level at TP4 with that shown in the IF Level Chart.

8 Reconnect the Antenna Diplexer and apply the signal generator to the Antenna terminal of the diplexer. Adjust the generator level to provide the same Rx mixer bias from applied RF signal as was noted in 7) above. The level required should be no more than 3 dB (Rx diplexer path loss) greater.

Note that the RSSI signal provided by the IF IC is a fairly accurate logarithmic scale between 0.5 and 4VDC, providing about 0.5 VDC for each 10 dB of signal applied to the input of the IF Strip, and can be used as a reasonable measure of signal providing it is unmodulated and on center frequency at 455 kHz.

6.2.2 RECEIVER LEVEL CHART

The following chart lists the level (terminated) of a 50 OHM signal generator to produce 2.0VDC of RSSI at TP4 when applied as specified to the point shown and at the frequency indicated.

FREQUENCY	CONNECTION POINT AND APPLICATION	NOM LEVEL
455 kHz	Pin 20 of IC U2 NE615 via 1nF	-72 dBm
455 kHz	Pin 18 of IC U2 NE615 via 1nF	-74 dBm
455 kHz	Pin 1(i/p) of IF Filter CF2 via 1nF	-58 dBm
455 kHz	Pin 14 of IC U2 NE615 via 1nF	-43 dBm
45 MHz	Rx i/p at X2 via coax direct	-49 dBm
45 MHz	Mixer i/p following R.F. Amp	-62 dBm
45 MHz	Mixer diode (D1) o/p across C100	-61 dBm
45 MHz	Junction of 1st & 2nd 45 MHz crystal filter	-77 dBm

6.3 TRANSMITTER

The following is a list of problem areas, and suggested checks that can be made to isolate any transmitter specific problems that may have occurred.

1. NO TRANSMIT

   1. Check PTT circuit.
   2. Check unit is programmed within its operational range.
   3. Check if manual PTT (Rear Aux connector) keys transmitter.
   4. Check if any transmitter output is present. Tuning required?

2. TRANSMITTER SPURIOUS EXCESSIVE

The probable cause is dependent upon the nature of the spurious as follows:

Carrier ± 910kHz. - IF detector signal (2x455) modulating or mixing with carrier. - Check 1n bypass on reference i/p to power control op-amp. Check bypasses on collectors and supply lines of low level transmitter stages, and L.O. buffer.

Carrier ± 20.166 and/or 40.333. - Excessive harmonics of 20.166 crystal oscillator in 121 MHz FM driver IC (U7). Check all pins of IC (U7) for correct DC conditions. Check all tuning inductors for 'normal Q', as 'soft' tuning will almost surely indicate an incorrect or faulty capacitor, or inductor.

Carrier ± VCXO reference frequency (approximately 7 MHz). - Reference signal modulating VCO, or mixing with carrier in L.O.buffers. - Check Synthesiser supply bypasses, check for defective joints or components in and around the resistive divider at output of VCO.

Note that it is imperative that low frequency divider products be attenuated before they can reach the base/emitter junctions of the L.O. buffer transistors where they can mix with the VCO frequency.

Note also that poor SMD solder joints will provide nonlinear conductance and give rise to frequency mixing in this area. Check for faulty components or poor joints around the Synthesiser to VCO frequency control area, or VCO supply line bypassing.

Excessive Transmitter power radiated or conducted to the area of the VCO can also cause spurious effects and may enhance the levels of otherwise acceptable levels of spurious. If this is suspected, check that ALL chassis securing bolts are fitted and tight on the RF deck, and that ALL bypass capacitors and chokes are fitted and correct in and around the final Tx stages.

3. TRANSMITTER POWER LOW OR UNSTABLE :

1. *Firstly - Ensure that ALL RF Deck mounting bolts are fitted and secure.*
2. Check that the feed resistors used for current indication on all stages of the final are of correct value and firmly in circuit.
3. Check that the Tx L.O. buffer and post mixer buffers are correctly biased as per the voltage charts.
4. If necessary disconnect the final stages from the Tx post mixer buffers by removing the solder bridge between Q5 and Q8, and with an appropriate instrument measure the RF power available from the Tx buffers to the final pre-driver.
   Note that the o/p impedance of the buffer is 50 OHM and must be measured by a 50 OHM instrument. It is highly recommended that a measuring spectrum analyser be used here as this instrument will also display the relationship between the wanted signal and other spurious or unwanted mixing products.
   The nominal display seen at this point by a spectrum analyser is shown on the spectrum charts attached.
5. To test the final stages separate from the buffers - inject a signal from a 50 OHM generator at Tx frequency into pre-driver (Q8) via C122. The level required to drive the final to full output is shown on the Tx level chart.
6. Check that the current drawn by the driver transistor as measured across the feed resistor (TP28 to TP27) is within spec, and if not check and or replace the driver transistor or associated components as necessary.
7. Check that the current drawn by each final transistor as indicated by the voltage across the 2.2 OHM (2x4.7 ohm in parallel) collector feed resistors (TP26 to TP28 and TP29) is within the range stated in the voltage charts, and that both are within 10% of each other. If in error check components around final pair and replace final transistors as necessary.

NOTE it is possible for power transistors to be partly defective due to current or thermal abuse, and the fact that the devices are actually drawing current does not always indicate that they are producing full power at the collector.

TX LEVEL CHART :

Frequency	**Connection Point & Application**	**Level Remarks**
Base band	Data from modem section TP13 (4800 baud)	2 VD.C
Base band	Applied data signal to modulator U7 pin 3 (4800 baud level from modem)	1 V_{p-p}
Base band	Audio signal to modulator TP32	0.84 VD.C 60 mV_{p-p} for VR3 set for maximum value 400 mV_{p-p} for VR3 set for minimum value
Base band	Audio signal to modulator U7- pin 4	1.3 VD.C 0.5 V_{p-p}
121 MHz	Signal level at TP18:A	-5 dBm
Final Tx frequency	Output to diplexer connector X1	3W at maximum power setting

SECTION 7

APPENDIX A

DRAWINGS

7 APPENDIX A DRAWINGS

TC01-08-12	Data Radio Mounting Details
TC01-08-11	Data Radio Assembly Details
TC01-04-05	Data Radio Basic Modem 9K6/4K8 Component Loading Details
TC01-00-05	450DR / 900DR Packet Modem (2 sheets)
TC01-08-10	PWB Manufacturing Details 900DR Data Radio - Radio Board (2 sheets)
TC01-00-10	Data Radio Project Sheet
TC01-00-10	Data Radio Final PA (AFC Fitted)
TC01-00-10	Data Radio 121 MHz OSC (AFC Fitted)
TC01-00-10	Data Radio - Synthesiser - VCO (AFC Fitted)
TC01-00-10	Data Radio - NE6154K8/9K6 (AFC Fitted)
TC01-04-15	850-930 MHz Antenna Diplexer Component Side Assembly
TC01-05-10	Radio Board Top Side (C/S) Test Point & Adjustment Location Details
TC01-05-10	Radio Board Bottom Side (S/S) Test Point & Adjustment Location Details
TC01-05-16	Duplex Radio BER/S+N/N vs Sig
TC01-05-17	AFC Alignment Setup - Block Diagram
TC01-05-12	4800/9600 BPS Modem Functional Diagram
TC01-05-23	Asynchronous Modem Functional Diagram
TC01-05-19	Macro Block Diagram
TC01-05-18	Radio Section - Modem Section Interface
DR9-BLOK	900MHz Radio Block Diagram
	RSSI Level cf Received Signal (typical)

SECTION 8

APPENDIX B

GLOSSARY of TERMS and ABBREVIATIONS

8 APPENDIX B GLOSSARY

ADC:	Analogue to digital converter.
AFC:	Automatic frequency control.
BER:	Bit error rate.
bps:	Bits per second.
C/DSMA:	Carrier or data sense, multiple access scheme.
COM:	Common.
CRC:	Cyclic redundancy checksum.
CTS:	Clear to send.
DAC:	Digital to analogue converter.
DCD:	Data carrier detect.
DCE:	Data communications equipment.
DFM4-9:	Trio DataCom digital modem chipset.
DIP:	Dual in line package.
DOTAC:	Department of Transport and Communications.
DSR:	Data set ready.
DTR:	Data terminal ready.
FCS:	Frame check sequence.
FEND:	Frame end.
FESC:	Frame escape.
FIFO:	First in first out.
FIR:	Finite impulse response.

FM :	Frequency modulation.
FSK:	Frequency shift keying.
GPIB:	General purpose interface bus.
HADR_EN:	High address enable signal.
IC :	Integrated circuit.
I.F.:	Intermediate frequency.
i/p:	Input.
KISS:	Keep it simple stupid.
LADR_EN:	Low address enable signal.
MSB:	Most significant bit.
NVRAM:	Non volatile RAM.
NRZ:	Non return to zero.
NRZI:	Non return to zero - inverted.
o/p:	Output.
PCB:	Printed circuit board.
PLL:	Phase locked loop.
PMP:	Point-to-multipoint.
ppm:	Parts per million.
PTP:	Point-to-point.
PTT:	Press to talk.
RF :	Radio frequency.
RI :	Ring indicate.
R_select:	RAM read select signal.
SIO:	Serial input/output.
RSSI:	Receive signal strength indication.
RTS:	Request to send.
Rx :	Receive.
RXD:	Receive data output.
SCADA:	Supervisory control and data acquisition.
SLIP:	Serial line interface protocol.

TC-900DR: Trio DataCom 900MHz full duplex data transceiver.

TC-DFM9IP: Trio DataCom TC-900DR parameter programming software suite.

TFEND: Transposed Frame End.

TFESC: Transposed Frame Escape.

TNC: Terminal node controller.

Tx : Transmit.

TXD: Transmit data in.

VCO: Voltage controlled oscillator.

W_select: RAM write select signal

18. Seal Failure Relay

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

SEAL FAILURE RELAY

1. KFA6-ER-1.6 SEAL FAILURE RELAY TECHNICAL DETAILS

Features

- 1-channel signal conditioner
- 230 V AC supply
- Level sensing input
- Adjustable range 5 kΩ ... 150 kΩ
- Latching relay output
- Minimum/maximum control

Function

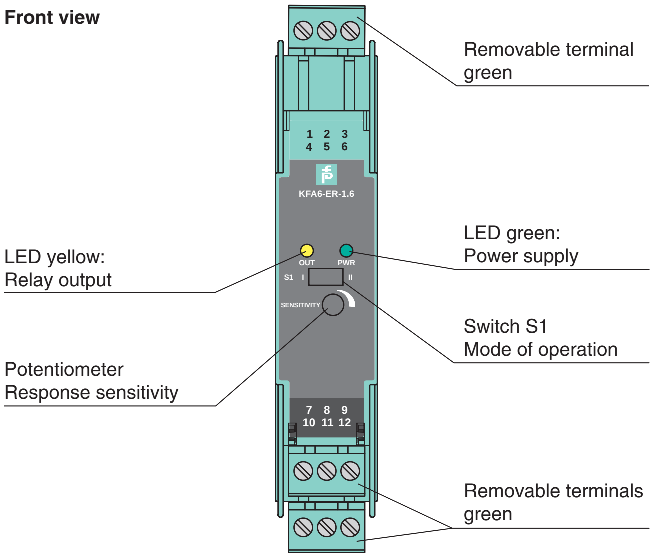
This signal conditioner provides the AC measuring voltage for the level-sensing electrodes.

Once the measured medium reaches the electrodes, the unit reacts by energizing a form C changeover relay contact.

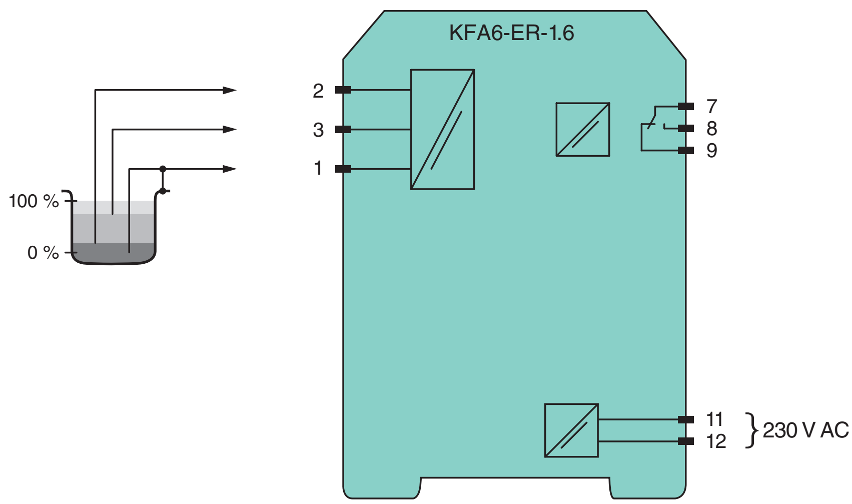
The module is voltage and temperature stabilized and guarantees defined switching characteristics. An electronic holding circuit is used that allows minimum/maximum control. Since the conductance of the media may vary, the relay response sensitivity is adjustable.

The normal output state can be reversed through the mode of operation switch S1.

Assembly



Connection



Release date 2009-08-06 11:21 Date of issue 2009-08-06 096046_ENG.xml

General specifications	
Signal type	Digital input
Supply	
Connection	terminals 11 (L1), 12 (N)
Rated voltage	207 ... 253 V AC, 45 ... 65 Hz
Power consumption	approx. 0.8 W
Input	
Connection	terminals 1 (mass), 2 (min), 3 (max)
Open circuit voltage/short-circuit current	approx. 10 V AC (approx. 1 Hz) / approx. 5 mA
Control input	min./max. control system: terminals 1, 2, 3 on/off control system: terminals 1, 3
Response sensitivity	5 ... 150 kΩ , adjustable via potentiometer (20 turns)
Output	
Connection	terminals 7, 8, 9
Output	1 changeover contact
Contact loading	253 V AC/2 A/cos ϕ > 0.7; 40 V DC/2 A resistive load
Energized/de-energized delay	approx. 1 s / approx. 1 s
Electrical isolation	
Input/output	basic insulation according to EN 50178, rated insulation voltage 253 V_{eff}
Input/power supply	basic insulation according to EN 50178, rated insulation voltage 253 V_{eff}
Output/power supply	basic insulation according to EN 50178, rated insulation voltage 253 V_{eff}
Directive conformity	
Electromagnetic compatibility	
Directive 2004/108/EC	EN 61326-1:2006
Low voltage	
Directive 2006/95/EC	EN 50178:1997
Conformity	
Insulation coordination	EN 50178
Electrical isolation	EN 50178
Electromagnetic compatibility	NE 21
Protection degree	IEC 60529
Ambient conditions	
Ambient temperature	-20 ... 60 °C (253 ... 333 K)
Mechanical specifications	
Protection degree	IP20
Connection	screw connection, max. 2.5 mm^2
Mass	approx. 110 g
Dimensions	20 x 107 x 115 mm (0.8 x 4.2 x 4.5 in) , housing type B1
Mounting	pull-out latches using for screw mounting
Indication and operation	
Operating elements	switch S1 Position I open circuit current: In the open circuit current principle, the relay becomes active when the limit is reached. Position II closed circuit current: In closed circuit current principle, the relay is activated when power is applied. The relay is deactivated when the limit is reached.
General information	
Supplementary information	Statement of Conformity, Declaration of Conformity and instructions have to be observed where applicable. For information see www.pepperl-fuchs.com.

Release date 2009-08-06 11:21 Date of issue 2009-08-06 096046_ENG.xml

19. Surge Diverter & Surge Reduction Filter

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

SIGNAL ISOLATOR

1. ECT SIGNAL ISOLATOR TECHNICAL DETAILS

MOORE INDUSTRIES WORLDWIDE

ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

June 2009

Description

ECT DIN-style signal isolators, converters, repeaters, boosters and splitters feature solid metal housings that stand up to the continuous, daily rigors of process control and factory automation applications.

Rugged and reliable, the ECT is available in 2-wire (loop) and 4-wire (line/mains) powered models. The complete family delivers economical solutions for an expansive range of signal interface applications.

- **Isolate Signals** to stop erratic measurements caused by ground loops.
- **Convert Signals** so field instruments can interface directly with an indicator, recorder, DCS, PLC or PC-based SCADA system.
- **Split One Signal** to allow one primary measurement to be sent to two separate systems.
- **Get two isolators in one.** The ECT is available in dual channel I/O models that provide application flexibility while reducing space requirements and costs.
- **Protect Equipment and Signals (Area Isolation)** by eliminating common electrical paths.
- **Amplify (Boost) Signals** so that more instruments can be added to an overburdened loop.
- **Solve "Bucking" Power Supplies** by stopping a conflict caused by a 4-wire transmitter and a DCS both trying to power the same process loop.
- **Step Down Dangerous,** high voltage signals to safer levels to protect plant personnel.
- **Solve DCS Start-Up Problems** caused by non-isolated transmitters by installing an ECT in each troublesome loop.

To choose the right ECT for your application, first determine the power supply characteristics:

Power Supply Type	Page
2-Wire, **Output-Loop** Powered (12-42Vdc)	2-3
2-Wire, **Input-Loop** Powered (5.5Vlp)	4-5
4-Wire, **Line/Mains** Powered (117Vac, 230Vac, 24Vdc)	6-7

***Featuring metal DIN-style housings, the ECT** snaps securely onto standard G-type and Top Hat rails.*

Features

- **Current and voltage inputs.** Available models handle Current and Voltage Signals.
- **2-wire (loop) and 4-wire (line/mains) powered.** Versatile choices allow you to match the ECT to the type of AC or DC power available at each location.
- **Superior signal isolation (up to 1500Vrms).** Industrial-strength protection stops ground loops, motor noise, and other electrical interferences from affecting process signals.
- **RFI/EMI protection.** The ECT provides an effective barrier against the unpredictable, harmful effects of radio frequency and electromagnetic interference. When ordered with the -RF option, the ECT delivers enhanced protection for especially noisy environments.

Certifications

C UL US Listed **Underwriter's Laboratories:** General Location*

CE **CE:** Conformant to EMC 89/336/EEC EN 61326

*Certification not applicable to ECT-DIN models equipped with the RF option.

ECT-DIN

Signal Isolator, Converter,
Repeater, Booster and Splitter

2-Wire, Output-Loop Powered Models

This ECT model derives operating power from its output side where loop power is typically made available by the receiving device, such as a DCS.

Stop Ground Loop Noise

Differences in potential between a grounded transmitter and a grounded receiving device may result in unpredictable ground loop problems, which can lead to signal drift. Use the ECT to break the galvanic path between the field instrument and receiving device (Figure 1).

Convert Signals

The ECT takes one process signal type (such as 1-5V) and converts it to a standard, isolated 4-20mA, allowing devices with incompatible signal types to interface with one another (Figure 1).

Divert and Protect (Area Isolation) Signals

Using the ECT, you can send the output from one transmitter to a second location; protect expensive monitoring/control equipment by eliminating common electrical paths; or create a buffer between devices to allow interruption of one leg of a loop without impacting the other (Figure 2).

Amplify (Boost) Signals

If you need to add an instrument to an overloaded loop, use the ECT. It features a high drive capability of 600 ohms (with a 24V power supply) and a low input impedance of just 50 ohms (Figure 3).

Solve "Bucking" Power Supplies

When two devices (such as a 4-wire transmitter and a DCS) are trying to source power to a loop, the result is a non-functioning loop. When neither of the devices can be eliminated, the solution is the ECT. It can operate with powered inputs from both sides, thus restoring normal operations to the loop (Figure 4).

Figure 1. *Input/output loop isolation and signal conversion.*

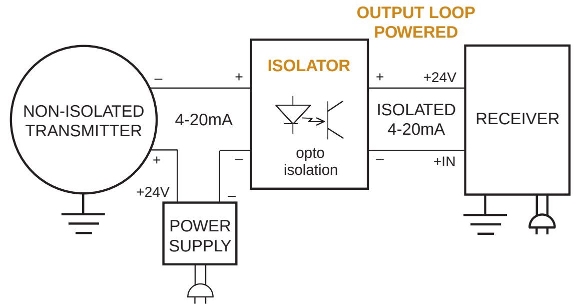


Figure 2. *Divert a process signal, or protect expensive equipment by eliminating a common electrical path.*

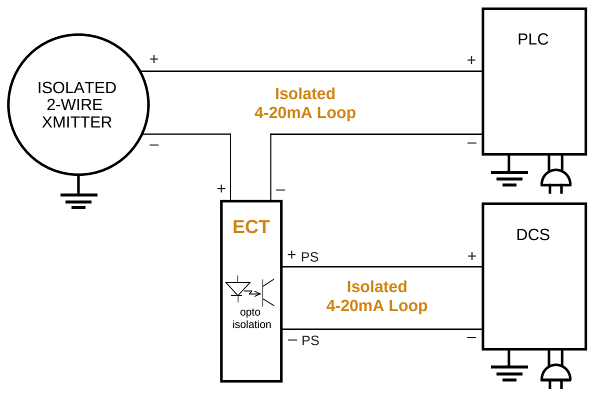


Figure 3. *Boost process signals to allow another instrument to be added to an otherwise overloaded loop.*

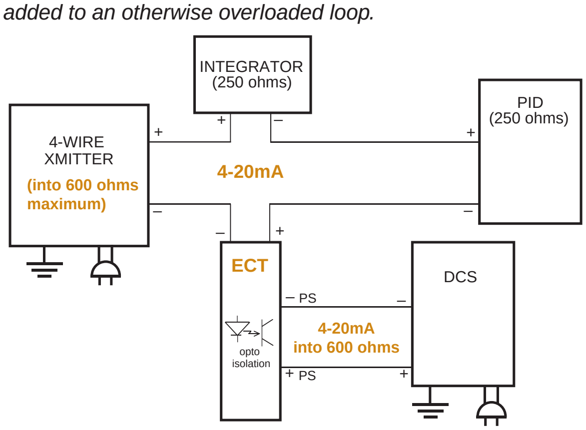
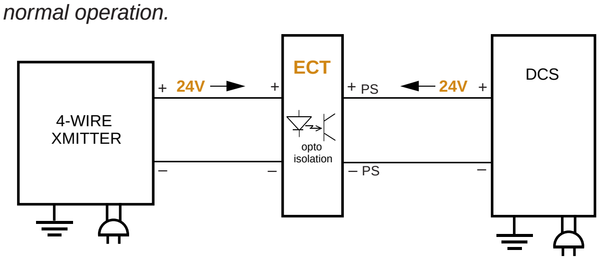


Figure 4. *Restore a loop experiencing "bucking" power supplies to normal operation.*



ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

Specifications

Performance

Accuracy: ±0.1% of span (±0.2% for 0-150 AC inputs)
Stability: ±0.2% of reading per year
Isolation: WITHOUT -RF OPTION: 1500Vrms between input and output; WITH -RF OPTION: 500Vrms between input and output
Output Response Time: DC Inputs, 100msec to 99% of output maximum; AC Inputs, 400msec to 99% of output
Ripple: 10mV peak-to-peak maximum measured across a 250 ohm resistor
Over-Voltage Protection: 48V, maximum on output; 48V reverse polarity protection on output

Performance (continued)

Maximum Input Overrange: Current Inputs 250% of full scale; DC Voltage Inputs, 150% of full scale
Burden: 1V maximum with 4-20mA input; 0.01V maximum with 0-5A input
Load Capability:

$$\frac{Vs - 12Vdc}{0.02A} = \text{ohms}$$

Output Current Limiting: 25mA typical; 30mA maximum

Ambient Conditions

Operating Range: -40°C to +85°C (-40°F to +185°F)
Storage Range: -40°C to +85°C (-40°F to +185°F)

Ambient Conditions (Continued)

Ambient Temperature Effect: ±0.007% of span/°C typical; ±0.015% of span/°C maximum
Relative Humidity: 0-95% non-condensing
RFI/EMI Protection: Less than ±0.1% of span error when tested at 10V/m@ 20-1000MHz WITH -RF OPTION: Less than ±0.1% of span error when tested at 30V/m@ 20-1000MHz
Common Mode Rejection: Exceeds 95dB@60Hz with a limit of 1500Vrms

Adjustments

Type: Front panel pots
Span: ±10%
Zero: ±5%
(non-interactive when span is set first)

Weight

145g (5 oz)

Ordering Information

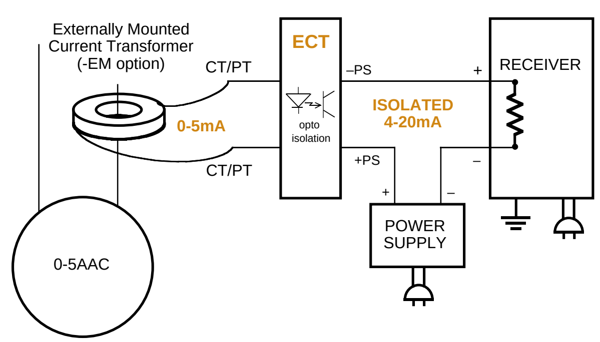
Unit	Input	Output	Power	Options	Housing
ECT **2-wire (Output-Loop Powered)** Isolator/Converter	**4-20MA** into 50 ohms **1-5V** into 1 Mohm **0-10V** into 1 Mohm **0-150AC** into 100 kohms **0-5AAC** into 0.002 ohms	**4-20MA** into 600 ohms with 24Vdc power supply	**12-42DC**	**-RF** Enhanced RFI/EMI filtering provides 30V/m @ 20-1000MHz protection with less than ±0.1% of span error **-EM** Externally-mounted input transformer for current input (available with 0-5Aac input type only)	**DIN** Aluminum DIN-style housing mounts on 32mm G-type (EN50035) and 35mm Top Hat (EN50022) rails **FLB2** Externally-mounted flange provides a secure mount and ensures resistance to vibration

When ordering, specify: Unit / Input / Output / Power / Options [Housing]
Model number example: ECT / 4-20MA / 4-20MA / 12-42DC / -RF [DIN]

Step Down Unsafe High Level Signals

To protect plant personnel, the ECT comes with an optional external input transformer (-EM option) to step down high level AC current inputs to a low level signal. This permits safer servicing without opening the secondary of a current transformer (Figure 5).

Figure 5. *To protect plant personnel, step down potentially dangerous high level AC current signals to lower level signals.*



ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

2-Wire, Input-Loop Powered Models

The 2-wire, input-loop powered ECT derives its operating power from the input side of the process loop (Figure 6). This model provides loop isolation when line power or output-loop power is not available. Its simple hook-up method provides a cost-effective interface between field signals and a computer, DCS or other multiple-input system.

IMPORTANT NOTE: When choosing this type of isolator, notice the total load imposed on the input loop. Because it derives all operating power from the input loop, that loop must be able to handle the isolator's input impedance and output load (maximum output load is 250 ohms).

Single and Multiple Unit Instrument Enclosures

Designed to meet NEMA 4X and IP66 ratings, the *R-BOX* is the perfect solution for protecting the ECT in field and control room applications. Rugged and versatile, it delivers a high impact structure and resistance to ultraviolet rays and chemicals.

The *R-BOX* mounts on a pipe, panel or surface, and comes in a variety of widths to economically accommodate just one, or up to 10, ECTs. It features a pre-installed mounting rail; customizable conduit entry options; a clear cover; and a secure locking mechanism.

For more information, see the *R-BOX* Field-Mount Enclosure for DIN Instruments data sheet.

Figure 6. *The input-loop powered ECT provides loop isolation when line power or output-loop power is not available.*

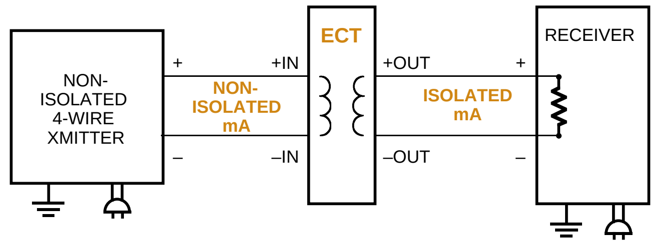
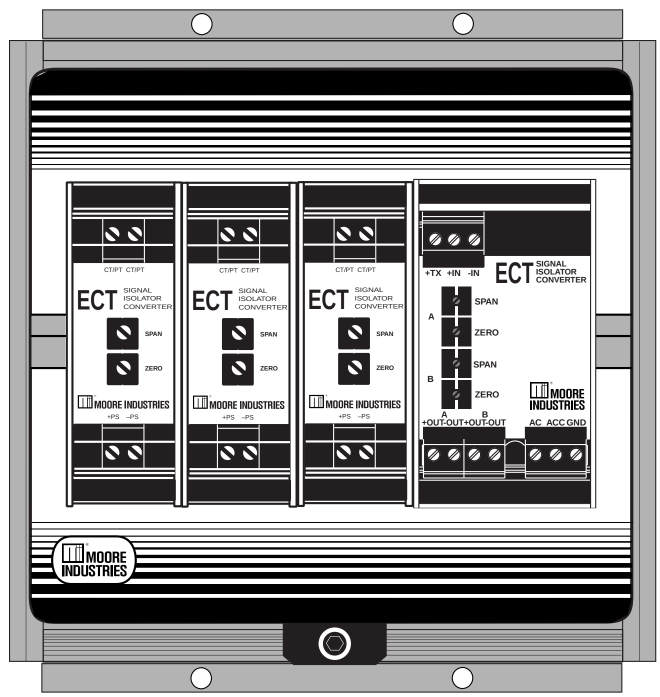


Figure 7. *Available in a variety of widths, our R-BOX field-mount instrument enclosure is designed to protect DIN-rail instruments in even the most rugged environments.*



ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

Specifications

Performance

Accuracy: ±0.075% of span
Stability: ±0.2% of reading per year
Isolation: 500Vrms between input and output
Output Response: 20msec maximum to 99% of output
Ripple: 10mV peak-to-peak maximum measured across a 250 ohm resistor
Over-Voltage Protection: 48V, maximum on output; 48V, reverse polarity protection on output
Maximum Input Overrange: 200% of full scale
Burden: 5.5V when outputs are shorted for 4-20mA inputs, 10.5V with 250 ohm load (Output load voltage is reflected on input. Output should be trimmed for anticipated output load)
Output Current Limiting: 30mA with 250 ohm output load

Ambient Conditions

Operating Range: -29°C to +82°C -20°F to +180°F
Storage Range: -40°C to +85°C (-40°F to +185°F)
Ambient Temperature Effect: ±0.018% of span/°C; ±0.005% of span/°C gain change
Relative Humidity: 0-95% non-condensing
RFI/EMI Protection: Less than ±0.1% of span error when tested at 10V/m @ 20-1000MHz
WITH -RF OPTION: Less than ±0.1% of span error when tested at 30V/m@20-1000MHz
Common Mode Rejection: Exceeds 95dB @ 60Hz with a limit of 1500Vrms

Adjustments

Type: Front panel pots
Trim: ±1%

Weight

145g (5 oz)

Ordering Information

Unit	Input	Output	Power	Options	Housing
ECT 2-wire (Input-Loop Powered) Isolator/ Converter	**4-20MA** into 275 ohms	**4-20MA** into 0-250 ohms	Current Loop Excitation at 4mA: **5.5VLP** 5.5 volts loop powered with 4-20mA (plus voltage across output load)	**-RF** Enhanced RFI/EMI filtering provides 30V/m @ 20-1000MHz protection with less than ±0.1% of span error	**DIN** Aluminum DIN-style housing mounts on 32mm G-type (EN50035) and 35mm Top Hat (EN50022) rails **FLB2** Externally-mounted flange provides a secure mount and ensures resistance to vibration

When ordering, specify: Unit / Input / Output / Power / Options [Housing]
Model number example: ECT / 4-20MA / 4-20MA / 5.5VLP / -RF [DIN]

Need Enhanced Features?

PC-Programmable Universal Interface
Our model SIY signal isolator, converter, and repeater is the ideal plant standard. This 2-wire (loop-powered), microprocessor-based instrument programs in less than a minute to handle a wide range of current and voltage inputs. It even allows creation of custom input linearization curves. For detailed information, see the SIY data sheet.

Unusual Input and Outputs
We have instruments that handle a wide array of non-standard inputs and outputs.

Custom Signal Isolators
We have engineers on hand to modify our instrument to meet your unique needs.

RTD, T/C, mV, Potentiometer, I/P, P/I, Strain Gage, and Frequency Signals
We are the Interface Solution Experts. When you need to interface field processes with computer-based systems, readout equipment, and other instrumentation... our technology, services, and experience help you do it efficiently, safely, and cost-effectively.

ECT-DIN

Signal Isolator, Converter,
Repeater, Booster and Splitter

4-Wire, Line/Mains Powered Models

These ECT models are powered by standard 117Vac, 230Vac, and 24Vdc power supplies (Figure 8). They are designed for applications where line/mains power is readily available, such as the back of a panel or in a control room.

Step Down Unsafe, High Level Signals

To protect plant personnel, the 4-wire ECT comes with an optional external input transformer (-EM option) to step down high level AC current inputs to a low level signal. This permits safer servicing without opening the secondary of a current transformer (Figure 9).

Power a 2-Wire Transmitter

With the -TX option, our 4-wire ECTs provide 24V power to a 2-wire, output-loop powered instrument. This eliminates the need for an additional power supply (Figure 10). ***IMPORTANT:*** Our 2X4-20MA dual input model provides a transmitter excitation of 16V. Refer to Figure 12 for an illustration of dual input model operation.

"Sharing" or "Splitting" a Process Signal

The ECT with dual outputs will take one input and deliver two identical, completely isolated outputs to two separate monitoring or control devices (Figure 11). This is valuable for viewing one process variable at two locations, such as in custody transfer, where two parties require identical information for accountability or billing purposes. Maintenance of one system does not disturb the information being collected at the second location. In addition, a failure at one receiver will not affect the second loop.

One Isolator Does the Work of Two

When ordered with dual input and output channels, the ECT will perform the functions of two isolators (Figure 12). Each of the ECT's two input-to-output channels is independent and completely isolated from the other.

Figure 8. *4-wire ECT models are ideal for use where line (mains) power is readily available.*

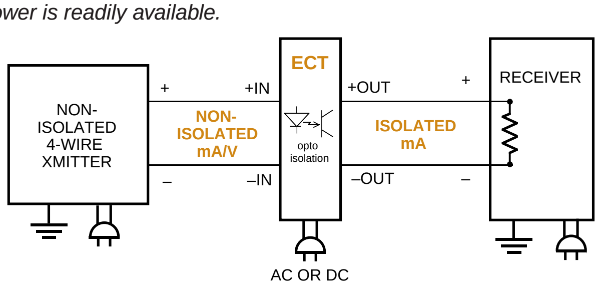


Figure 9. *When ordered with the -EM option, the ECT comes with an externally-mounted current transformer to "step down" high level signals.*

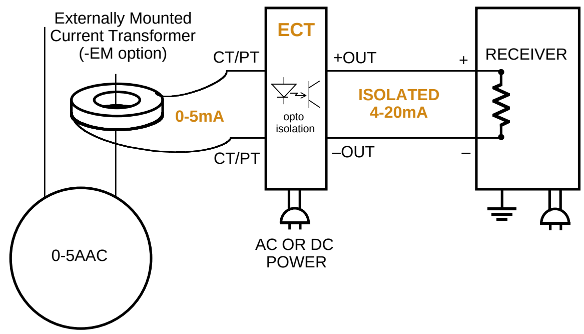


Figure 10. *With the -TX Transmitter Excitation option, the ECT will supply loop power to a 2-wire transmitter.*

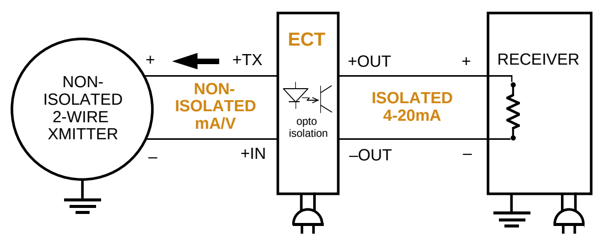


Figure 11. *The ECT takes one process input and delivers two completely isolated signal outputs.*

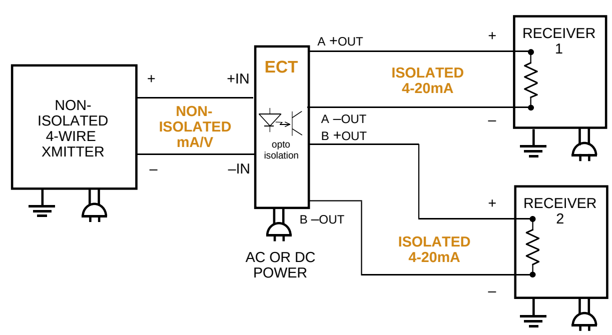
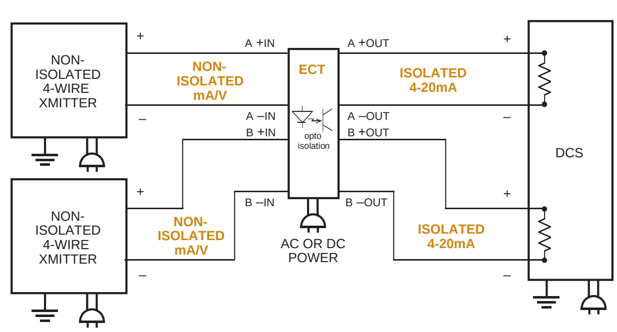


Figure 12. *The ECT takes two process inputs and delivers two completely isolated signal outputs.*



NOTE: ONLY 16V TX EXCITATION PROVIDED ON 2X4-20MA DUAL INPUT MODEL

ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

Specifications

Performance

Accuracy: ±0.1% of span
Stability: ±0.2% of reading per year
Isolation: WITHOUT -RF OPTION: 1500Vrms between input and ouput and power; WITH -RF OPTION: 500Vrms between input and output, 1500Vrms power terminals; DUAL I/O WITHOUT -RF OPTION: 1500Vrms
Output Response Time: DC Input: 100msec, maximum to 99% of output; AC Input: 400msec, maximum, from 0-99% of output
DC Input Resistance: 50 ohms
Ripple: 10mV peak-to-peak maximum measured across 250 ohm resistor
Load Effect: 0.01% of span from 0-100% of rated output (current only)

Performance (continued)

Power Supply Rejection: Exceeds 90dB for current input unit
Maximum Input Overrange: Current inputs, 250% of full scale DC Voltage inputs 150% of full scale
Burden: 1V maximum with 4-20mA input; 0.01V maximum with 0-5A input
Output Current Limiting: 25mA, typical; 30mA, maximum

Ambient Conditions

Operating Range: -40°C to +85°C -40°F to +185°F
Storage Range: -40°C to +85°C (-40°F to +185°F)
Ambient Temperature Effect: ±0.007% of span/°C, typical; ±0.015% of span/°C, maximum
Relative Humidity: 0-95% non-condensing

Ambient Conditions (Continued)

RFI/EMI Protection: Less than ±0.1% of span error when tested at 10V/m@20-1000MHz WITH -RF OPTION: Less than ±0.1% of span error when tested at 30V/m@20-1000MHz; DUAL I/O WITHOUT -RF OPTION: Output unaffected by more than ±0.5% of span@10V/M 20-1000MHz
Common Mode Rejection: Exceeds 95dB@60Hz with a limit of 1500Vrms

Adjustments

Front panel pots
Span: ±10%
Zero: ±5%
(non-interactive when span is set first)

Weight

Single I/O Channel: 384g (13.7 oz)
Dual I/O Channels: 431g (15.4 oz)

Ordering Information

Unit	Input	Output	Power	Options	Housing
ECT 4-Wire (Line/Mains) Powered Isolator/ Converter	SINGLE INPUT CHANNEL: **4-20MA** into 50 ohms **1-5V** into 1 Mohm **0-10V** into 1 Mohm **0-150AC** into 100 kohms **0-5AAC** into 0.002 ohms DUAL INPUT CHANNELS: **2X4-20MA** into 25 ohms **2x1-5V** into 1 Mohm **2X0-10V** into 1 Mohm (Other AC ranges also available)	SINGLE OUTPUT CHANNEL: **4-20MA** into 1000 ohms **0-10V** into 5 kohms minimum DUAL OUTPUT CHANNELS: 600 ohms **2X1-5V** into 5 kohms minimum **2X0-10V** into 5 kohms minimum DUAL OUTPUT CHANNELS (Signal Splitter): **2X4-20MA** into 600 ohms (available with 4-20mA input only)	**24DC,** ±10% **117AC,** 50/60Hz, ±10% **230AC,** 50/60Hz, ±10% (3 watts maximum for single channel models; 5 watts maximum for dual output channel models)	**-EM** Externally-mounted input transformer for current input (available with 0-5AAC input only) **-TX** 24V transmitter excitation (16V for 2X4-20MA DUAL INPUT model) for powering a 2-wire transmitter (available on 4-20mA input models only; standard on models with 2X4-20mA output) **-RF** Enhanced RFI/EMI filtering provides 30V/m@ 20-1000MHz protection with less than ±0.1% of span error (-EM option required for AC current input) **-EP** External power, output stage powered by external source (only available on signal splitter in DIN housing)	**DIN** Aluminum DIN-style housing mounts on 32mm G-type (EN50035) and 35mm Top Hat (EN50022) rails **FLB2** Externally-mounted flange provides a secure mount and ensures resistance to vibration

When ordering, specify: Unit / Input / Output / Power / Options [Housing]
Model number example: ECT / 1-5V / 4-20MA / 117AC / -RF [DIN]

ECT-DIN

Signal Isolator, Converter, Repeater, Booster and Splitter

Figure 13. Dimensions for 2-Wire and 4-Wire ECT-DIN models

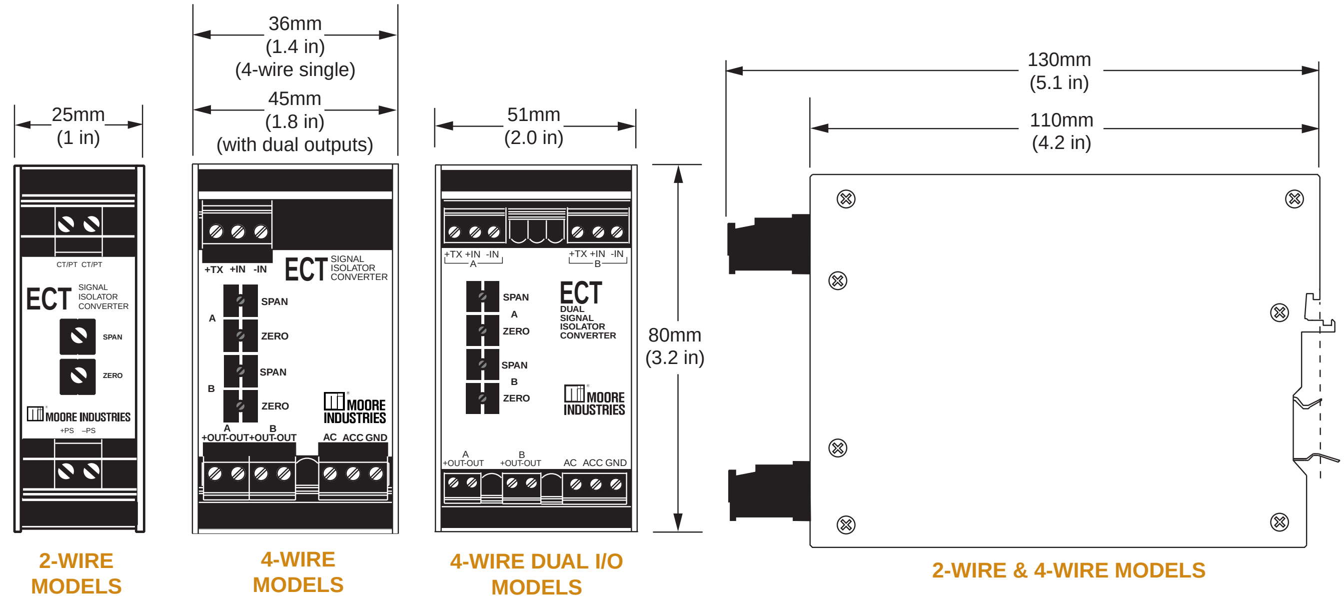


Table 1. Terminal Designations for 2-Wire Units

2-Wire Output-Loop Powered Models	Top Terminals (left to right)		Bottom Terminals (left to right)	
Output-Loop Powered	+IN	-IN	+PS	-PS
Output-Loop Powered with -EM Option	CT/PT	CT/PT	+PS	-PS
2-Wire Input-Loop Powered Models	**Top Terminals (left to right)**			
Input-Loop Powered	+IN	-IN	+OUT	-OUT

Table 4. Key to Table Abbreviations

Key	Definition
A	Channel 1 on dual output models
B	Channel 2 on dual output models
AC	AC line power input
ACC	AC line power return (neutral)
CT/PT	Current Transformer/Potential Transformer input
DC	+DC power input
DCC	-DC power input
GND	Ground
IN	Input signal (+ or -)
OUT	Output signal (+ or -)
-TX	Transmitter excitation for powering 2-wire transmitter

Table 2. Terminal Designations for 4-Wire Units

4-Wire (Line/Mains-Powered) Models	Top Terminals (left to right)			Bottom Terminals (left to right)							
	T1	**T2**	**T3**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**
AC Power Single Input/Dual Outputs & -TX	+TX	+IN	-IN	A +OUT	A -OUT	B +OUT	B -OUT		AC	ACC	GND
DC Power Single Input/Dual Outputs & -TX	+TX	+IN	-IN	A +OUT	A -OUT	B +OUT	B -OUT		DC	DCC	GND
	T1	**T2**	**T3**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**		
Power with AC Inputs or -EM Option		CT/PT	CT/PT	+OUT	-OUT		AC	ACC	GND		
AC Power with -TX Option	+TX	+IN	-IN	+OUT	-OUT		AC	ACC	GND		
Power with DC Inputs or -EM Option		CT/PT	CT/PT	+OUT	-OUT		DC	DCC	GND		
DC Power with -TX Option	+TX	+IN	-IN	+OUT	-OUT		DC	DCC	GND		

Table 3. Terminal Designations for 4-Wire Dual I/O Units

4-Wire (Line/Mains-Powered) Dual I/O Models	Top Terminals (left to right)									Bottom Terminals (left to right)								
	T1	**T 2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**B8**	**B9**
AC Power & Dual Inputs/Dual Outputs	A +TX	A +IN	A -IN				B +TX	B +IN	B -IN	A +OUT	A -OUT		B +OUT	B -OUT		AC	ACC	GND
DC Power & Dual Inputs/Dual Outputs	A +TX	A +IN	A -IN				B +TX	B +IN	B -IN	A +OUT	A -OUT		B +OUT	B -OUT		DC	DCC	GND

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Tel: 86-21-62491499 • FAX: 86-21-62490635
United Kingdom • sales@mooreind.com
Tel: 01293 514488 • FAX: 01293 536852

20. Timer

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

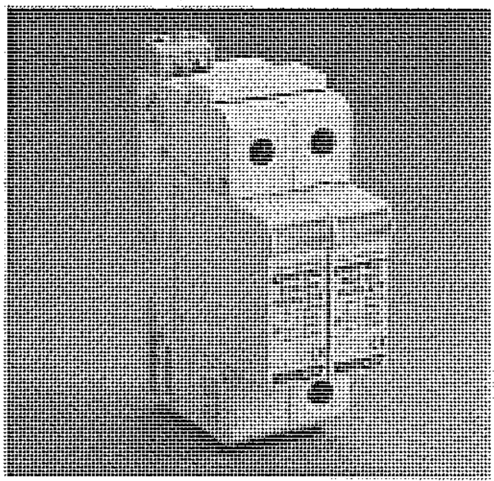
SURGE DIVERTER & SURGE REDUCTION FILTER

1. TDS1100 SURGE DIVERTER TECHNICAL DETAILS
2. DAR ALARM RELAY TECHNICAL DETAILS
3. TDF SURGE REDUCTION FILTER TECHNICAL DETAILS
4. BARRIER RB223 TECHNICAL DETAILS

CRITEC® TDS1100

Asia/Australia
Europe
Latin America
North America

TDS Surge Diverter - TDS1100 Series



- CRITEC® TD Technology with thermal disconnect protection
- Compact design fits into DIN distribution panel boards and motor control centers
- 35 mm DIN rail mount – DIN 43 880 profile matches common circuit breakers
- Indication flag and voltage-free contacts provide remote status monitoring
- Separate plug and base design facilitates replacement of a failed surge module
- 100kA 8/20 maximum surge rating provides protection suitable for sub-distribution panels and a long operational life
- Available in various operating voltages to suit most common power distribution systems

Surges and voltage transients are a major cause of expensive electronic equipment failure and business disruption. Damage may result in the loss of capital outlays, such as computers and communications equipment, as well as consequential loss of revenue and profits due to unscheduled system down-time.

The TDS1100 series of surge suppressors provide economical and reliable protection from voltage transients on power distribution systems. They are conveniently packaged for easy installation on 35 mm DIN rail within main distribution panelboards.

CRITEC® TD technology helps ensure reliable and continued operation during sustained and abnormal over-voltage events. Internal thermal disconnect devices help ensure safe or at end-of-life. A visual indicator flag provides user-feedback in the event of such operation. As standard, the TDS1100 provides a set of voltage-free contacts for remote signaling that maintenance is due.

The convenient plug-in module and separate base design facilitates replacement of a failed surge module without needing to undo installation wiring.

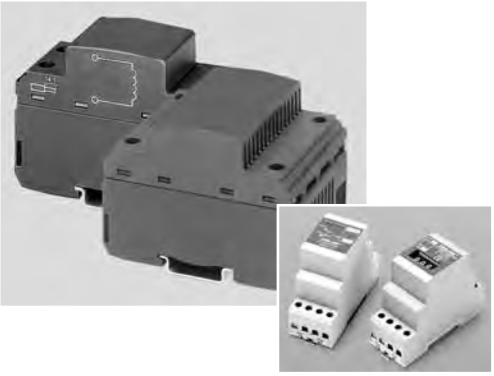
Model	**TDS11002SR150**	**TDS11002SR240**	**TDS11002SR277**	**TDS11002SR560**
Nominal Voltage U_n	120-150V~	220-240V~	240-277V~	480-560V~
Max. Cont. Operating Voltage U_c	170V~	275V~	320V~	610V~
Stand off Voltage	240V~	440V~	480V~	700V~
Frequency	0 - 100Hz			
Short Circuit Current Rating Isc	25kAIC			
Required Back-up Fuse	125AgL, if supply > 100A			
Technology Used	TD with thermal disconnect			
Protection				
Maximum Discharge Current Imax	100kA 8/20µs			
Nominal Discharge Current In	50kA 8/20µs	40kA 8/20µs	40kA 8/20µs	40kA 8/20µs
Protection Modes	Single mode (L-G, L-N or N-G)			
Voltage Protection Level Up @ 3kA	< 400V	< 700V	< 800V	< 1.6kV
Voltage Protection Level Up @ 20kA	< 650	< 1000	< 1.1kV	< 2kV
Alarms and Indicators				
Status Indication	Mechanical flag / remote contacts (R model only) Change-over, 250V~ / 0.5A, max 1.5 mm² (#14AWG) terminals			
Physical Data				
Dimensions	2 modules wide, 90 mm x 68 mm x 35 mm			
Weight	0.24 kg approx.			
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1)			
Connection	≤35 mm² (#2AWG) solid ≤25 mm² (#4AWG) stranded			
Mounting	35 mm top hat DIN rail			
Temperature	-40°C to +80°C (-40°F to +176°F)			
Humidity	0 to 90%			
Test Standards				
Approvals	CE, IEC™ 61643-1, UL® 1449 Pending			
Surge Rated to Meet	IEC 61643-1 Class I and II ANSI/IEEE C62.41-1991 Cat A, Cat B, Cat C			

Due to a policy of continual product development, specifications are subject to change without notice.

CRITEC® DDI/DAR/TDS SC

Asia/Australia
Europe
Latin America

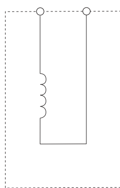
DIN Decoupling Inductor/ DINLINE Alarm Relay & Surge Counter



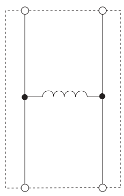
- Use for decoupling of spark gaps and MOVs – allows correct coordination of different SPD technologies
- 35 mm² tunnel terminals – accepts large cable size
- 63A model features top and bottom terminals – flexible installation
- The DINLINE Alarm Relay (DAR) is used with TDF products where alarm contacts are required for remote signaling
- The TDS-SC Surge Counter provides a non-resettable record of the number of surges diverted

Decoupling inductors are installed between spark gap and MOV protection devices to ensure correct coordination. As the decoupling inductors are installed in series with the load, two units are available, a compact unit for circuits up to 35A and a larger unit for 63A circuits.

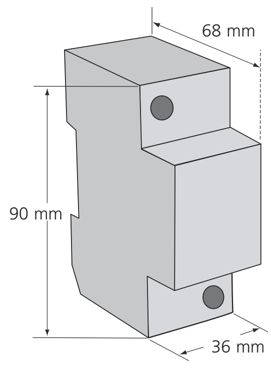
The DAR (DINLINE Alarm Relay) can be connected to TDF units to provide potential free change-over alarm contacts. The TDS SC (Surge Counter) unit is designed to provide visual indication of the number of surges registered. It uses a current transformer through which the ground conductor connecting to one, or all, of the surge protection modules is fed. Current diverted by the operation of the surge module, which exceeds a 300A trip threshold, will be registered on the counter.



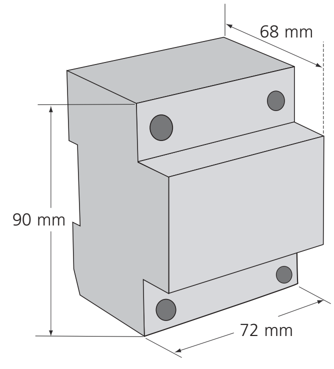
DDI 35



DDI 63



DDI 35



DDI 63

Model	DDI 35	DDI 63	DAR275V	TDS SC
Item Number for Europe	700465	700475	700900	701250
Nominal Voltage U_n	-	-	20-110V---, 100-240V~	–
System Compatibility(1)	-	-	TN-C, TN-S, TN-C-S & TT	
Max. Cont. Operating Voltage U_c	500V~ 200V---		275V	-
Stand-off Voltage	-	-	275V	-
Operating Current @ U_n	-	-	20mA	-
Frequency	0 to 60Hz			-
Max. Line Current I_L	35A @ 40°C	63A @ 40°C	-	-
Temperature Increase	45° C @ max line current (I_L)		-	-
Inductance	7.5µH	15µH	-	-
Resistance	4.5mΩ	1.7mΩ	-	-
Technology	-	-	CT - trip threshold 300A 8/20µs	
Status	-	-	Red/Green LEDs Change-over contact(1)	Maximum count 9999 Non-resettable
Dimensions	2 M. 90 mm x 68 mm x 36 mm (3.5" x 2.6" x 1.4") approx.	4 M. 90 mm x 68 mm x 72 mm (3.5" x 2.6" x 2.8") approx.	2 M. 90 mm x 68 mm x 36 mm (3.5" x 2.6" x 1.4") (excluding CT)	
Weight	0.45 kg (1 lb) approx.	1 kg (2.2 lb) approx.	0.2 kg (0.44 lb)	
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1)			
Connection	≤35 mm² (#2AWG) solid ≤25 mm² (#4AWG) stranded		1 mm² to 6 mm² (#18AWG to #10)	
Mounting	35 mm top hat DIN rail			
Back-up Overcurrent Protection	35A	63A	-	-
Temperature	-40°C to +70°C (-40°F to +158°F)		-35°C to +55°C (-31°F to +131°F)	
Humidity	0% to 90%			
Warranty Approvals	5 years CE		CSA22.2 C-Tick, AS 3260, CE	-

(1) Form C = Change-over contact (Form C dry contact), 400V~/3A 1 mm² to 6 mm² (#18AWG to #10AWG) connecting wire

CRITEC® TDF

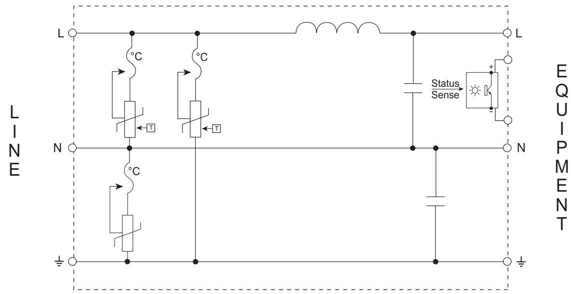
Asia/Australia
Europe
Latin America
North America

Transient Discriminating Filter

- In-line series protection
- High efficiency low pass sine wave filtering – ideal for the protection of switched mode power supplies
- Three modes of protection: L-N, L-PE & N-PE
- 35 mm DIN rail mount – simple installation
- Transient Discriminating (TD) Technology – provides increased service life
- LED status indication and opto-isolated output – for remote status monitoring

The TDF series has been specifically designed for process control applications to protect the switched mode power supply units on devices such as PLC controllers, SCADA systems and motor controllers. Units are UL Recognized and available for 3A, 10A and 20A loads and suitable for 110-120V ac/dc and 220-240Vac circuits.

The TDF is a series connected, single phase surge filter providing an aggregate surge capacity of 50kA (8/20µs) across L-N, L-PE, and N-PE. The low pass filter provides up to 65dB of attenuation to voltage transients. Not only does this reduce the residual let-through voltage, but it also helps further reduce the steep voltage rate-of-rise providing superior protection for sensitive electronic equipment.



Model	TDF3A 120V	TDF3A 240V	TDF10A 120V	TDF10A 240V	TDF20A 120V	TDF20A 240V
Item Number for Europe	700001	700002	700003	700004	700005	700006
Nominal Voltage U_n	120V	240V	120V	240V	120V	240V
Distribution System	1Ph 2W+G, TN-S & TN-C-S					
Max. Cont. Operating Voltage U_c	170V	340V	170V	340V	170V	340V
Stand-off Voltage	240V	400V	240V	400V	240V	400V
Frequency	0 to 60Hz	50/60Hz	0 to 60Hz	0 to 60Hz	0 to 60Hz	50/60Hz
Max. Line Current I_L	3A		10A		20A	
Operating Current @ U_n	135mA	250mA	240mA	480mA	240mA	480mA
Max. Discharge Current I_{max}	20kA 8/20 µs L-N 20kA 8/20 µs L-PE 10kA 8/20 µs N-PE					
Protection Modes	All modes protected					
Technology	TD Technology In-line series low pass sine wave filter					
Voltage Protection Level U_p @ 500A, 8/20µs (UL SVR) @ Cat B3, 3kA 8/20µs	 500V <250V	 700V <600V	 500V <250V	 700V <600V	 500V <250V	 700V <600V
Filtering @100kHz	-62dB		-65dB		-53dB	
Status	Green LED. On=Ok. Isolated opto-coupler output(1)					
Dimensions	4 M. 90 mm x 68 mm x 72 mm (3.5" x 2.6" x 2.8")		8 M. 90 mm x 68 mm x 144 mm (3.5" x 2.6" x 5.6")			
Weight	0.35 kg (0.77 lb)		0.75 kg (0.77 lb)		0.8 kg (1.7 lb)	
Enclosure	DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1)					
Connection	1 mm² to 6 mm² (#18AWG to #10)					
Mounting	35 mm top hat DIN rail					
Back-up Overcurrent Protection	3A		10A		20A	
Temperature	-35°C to +55°C (-31°F to +131°F)					
Humidity	0% to 90%					
Warranty	5 years					
Approvals	UL 1449, UL 1283, CSA 22.2, C-Tick, CE (NOM 3A, 120V)					
Surge Rated to Meet	ANSI/IEEE C62.41.2 Cat A, Cat B, Cat C					

(1) Opto-coupler output can be connected to DAR275V to provide Form C dry contacts, Page 35

Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Technical Information

Barrier RB223

One or two-channel, loop-powered barrier for the safe separation of 4 to 20 mA standard signal circuits

Application

- Separation of active 0/4 to 20mA signals from transmitters, valves and adjusters

Your benefits

- Compact side-by-side housing
- Space-saving one-channel and two-channel version
- No power supply necessary
- International Ex approvals ATEX, FM, CSA, TIIS, NEPSI
- Installation in Zone 2, Zone 22 permitted
- Can be used up to SIL3
- Bidirectional HART® transmission
- Communication sockets for HART® + integrated HART® resistor for sensor configuration

TI132R/09/en
71030519

Endress+Hauser
People for Process Automation

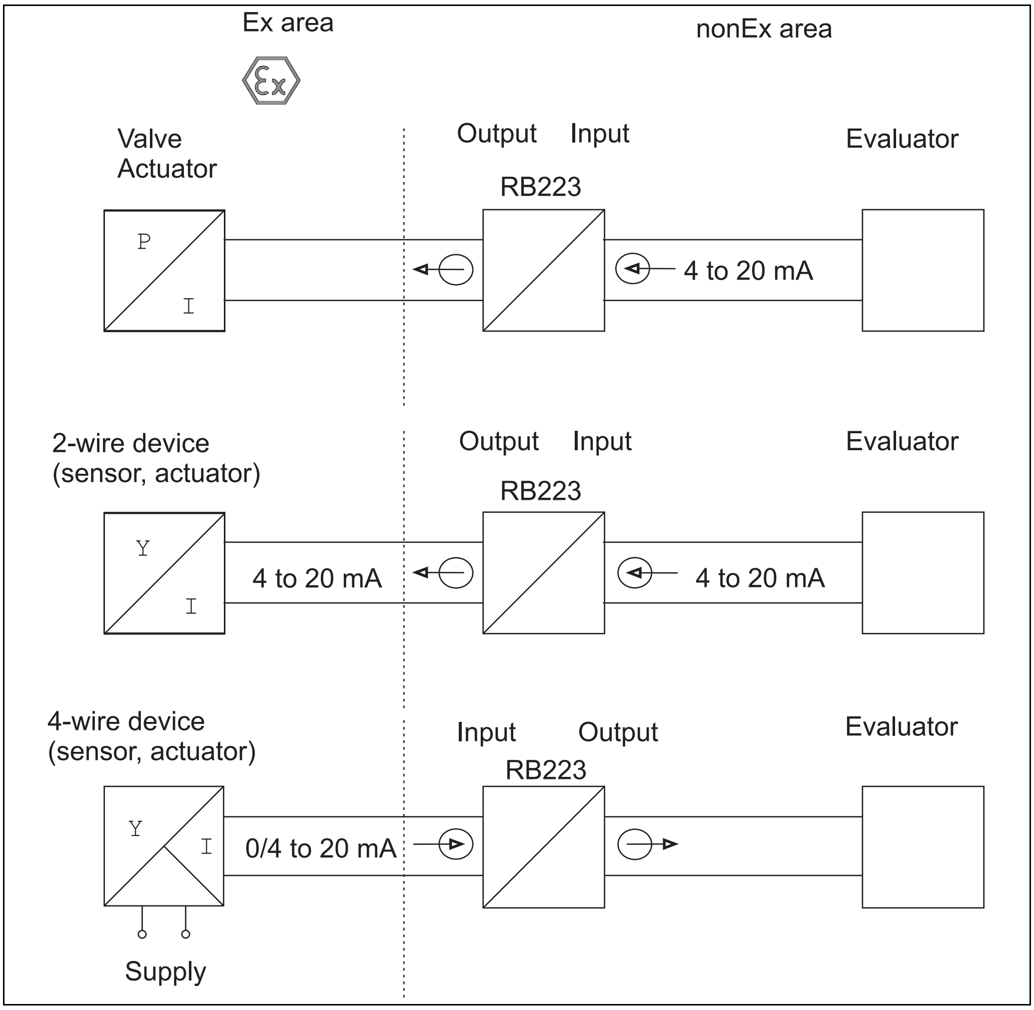
Function and system design

Measuring principle

The device separates active 0/4 to 20mA signals from transmitters, valves and adjusters. It has one analog input and one intrinsically safe analog output, or one output and one intrinsically safe input. A two-channel version of the device is also optionally available. The barrier is used for the intrinsically safe operation of sensors, valves and adjusters.
Power is supplied to the device from the current loop. It does not have its own power supply.

Measuring system

The standard instrument has one analog input and one analog output. A two-channel instrument with two analog inputs and two analog outputs is available as an option.



G09-RB223ZZ-15-00-xx-en-000

Input

Direction of power transmission nonEx ➔ Ex

- 0/4 to 22 mA, (for specified accuracy)
- 0 to 40 mA operating range
- Max. effective voltage < 26 V for specified accuracy
- I_{max} = 100 mA (short-circuit current of protective diode in event of overvoltage)
- U_{max} = 30 V (limiting voltage of protective diode)
- Reverse polarity protection
- R_i < 400 Ω (without HART® resistor 232 Ω)

Direction of power transmission Ex ➔ nonEx

- 0/4 to 22 mA, (for specified accuracy)
- Intrinsically safe as per ATEX, FM, CSA, TIIS, GHOST, NEPSI
- 0 to 40 mA operating range
- Reverse polarity protection
- R_i < 120 Ω (without HART® resistor 232 Ω)
- Max. effective voltage < 26 V

Output

Direction of power transmission nonEx ➔ Ex

- 0/4 to 22mA, (for specified accuracy)
- 0 to 40 mA operating range (max. current depends on the load)
- Max. load (load resistance) = 0 to 600 Ω
- Intrinsically safe as per ATEX, FM, CSA, TIIS, GHOST, NEPSI
  - ATEX:
    II (1) GD [EEx ia] IIC/IIB, II (1) GD [EEx ib] IIC/IIB

Direction of power transmission Ex ➔ nonEx

- 0/4 to 22mA (for specified accuracy)
- 0 to 40 mA operating range (max. current depends on the load)
- Max. load (load resistance) = 0 to 600 Ω

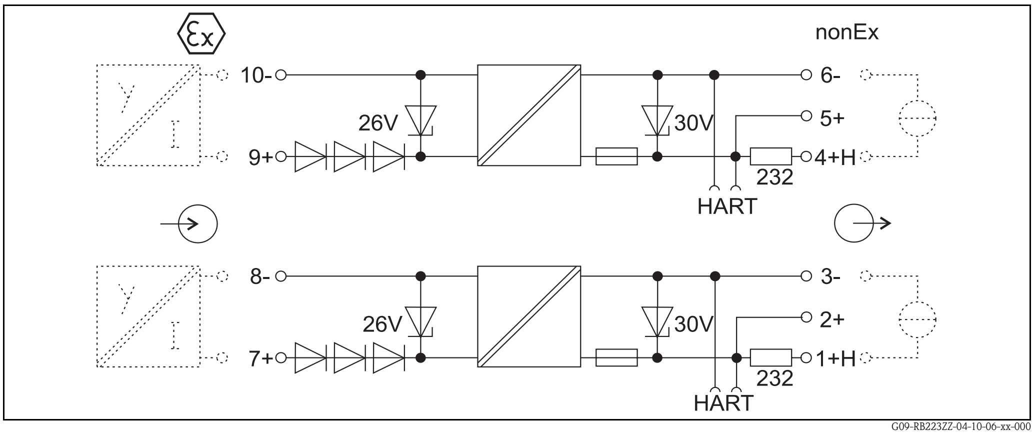
Galvanic isolation

Testing voltage:

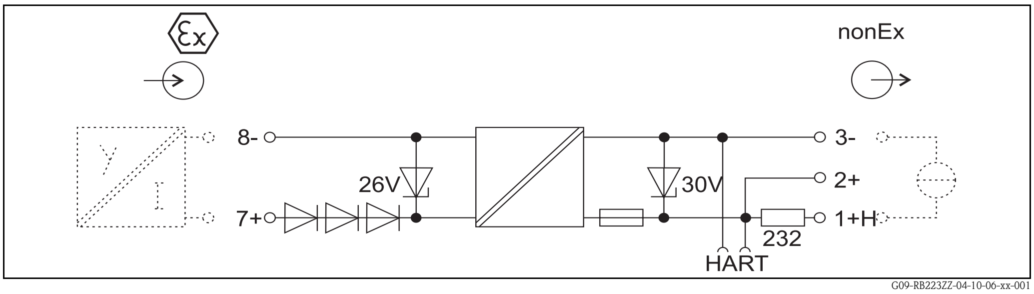
> 1.5 kV AC between input and output
> 1.5 kV AC between the channels

Power supply

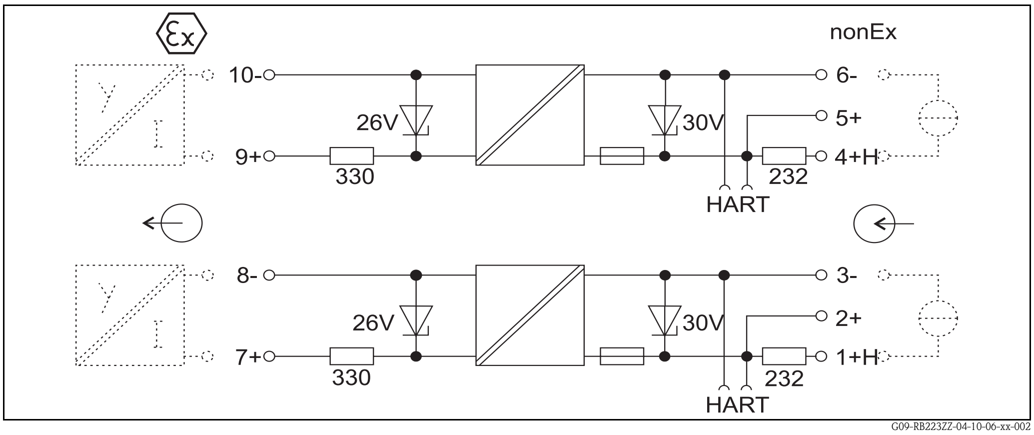
Electrical connection



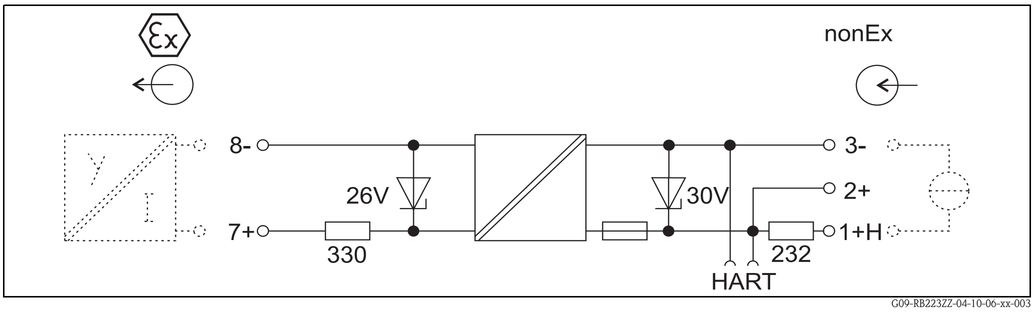
RB223 connection, Ex-nonEx two-channel



RB223 connection, Ex-nonEx one-channel



RB223 connection, nonEx-Ex two-channel



RB223 connection, nonEx-Ex one-channel

Supply voltage	The device is powered from the standard 0/4 to 20mA current loop.
Starting current (intrinsic consumption)	< 50 µA
Voltage drop	< (1.9 V + 400 Ω x current loop) for nonEx → Ex < (3.9 V + 120 Ω x current loop) for Ex → nonEx
Power loss	< 0.2 W for 20 mA (per channel) without HART® resistor < 0.3 W for 20 mA (per channel) with HART® resistor

Performance characteristics

Current transmission	< ± 10 μA + 0.15% of measured value
Load error	≤ 0.02% of measured value/100 Ω
Temperature drift	≤ ±0.01%/10 K (0.0056%/10 °F)
Residual ripple at output	< 30mV$_{eff}$ for 20 mA loop current and 600 Ω load

Transmission behavior

HART®protocol	Bidirectional transmission possible

Step-function response

Settling time (10% to 90% of full scale value)	< 0.5 ms for 500 Ω load for nonEx ➔ Ex < 0.3 ms for 500 Ω load for Ex ➔ nonEx

Frequency response

Large signal limit frequency	650 Hz for 500 Ω load for nonEx ➔ Ex 1300 Hz for 500 Ω load for Ex ➔ nonEx

Installation

Mounting	Mounting in a cabinet on a mounting rail TS 35 as per IEC 60715.
Orientation	No restrictions
Installation instructions	Installation and setup conditions as per IEC 60715.

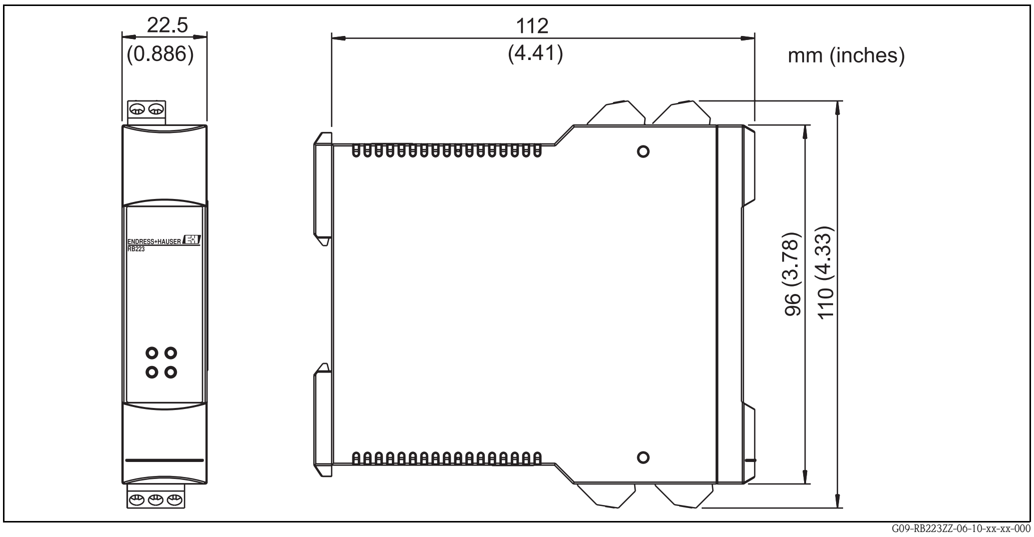
Environment

Ambient temperature range	-20 to +60 °C (-4 to +140 °F)
Storage temperature	-20 to +80 °C (-4 to 176 °F)
Installation height	As per IEC 61010-1: < 3000 m above MSL
Climate class	As per IEC 60654-1 Class B2
Degree of protection	IP 20
Relative humidity	< 95% (without condensation)
Electromagnetic compatibility (EMC)	Interference immunity as per IEC 61326 (industry) and NAMUR NE21

Mechanical construction

Design, dimensions

Housing for top-hat rail as per IEC 60715 TH35:



Dimensions of RB223

Weight	Approx. 150 g (5.29 oz.)
Material	Housing: plastic PC, UL 940
Terminals	▪ Coded, pluggable screw terminal, core size 1.5 mm^2 solid, or 1.0 mm^2 strand with ferrule ▪ Communication socket on the front via 2 mm jack plug

Human interface

Remote operation

HART® communication:
Communication signals are transmitted bidirectionally.
Communication resistor:
Resistor for HART®communication 232 Ω installed.
Communication sockets:
Access for HART® communicator, e.g. DXR-275

Note!
Pay attention to voltage drop!

Certificates and approvals

CE mark

Directive 89/336/EEC and 73/23/EEC

Ex approval

- ATEX:
  II (1) GD [EEx ia] IIC/IIB
  II (1) GD [EEx ib] IIC/IIB
  II 3 G EEx nA II T4 (facilitates installation in Zone 2 with appropriate housing as per IEC 60079-15)
- FM, CSA TIIS, NEPSI and GHOST accordingly

SIL

Can be used up to SIL3

Ordering information

Product structure

Passive Barrier RB223
0/4-20mA galvanic signal isolation. 1/2-channel
Intrinsically safe as an option, 1:1 transmission.
Bi-directional HART-communication.
Housing 22.5mm, Mont. Rail 35mm, IP20.

	Approval:	
	A	Non-hazardous area
	B	ATEX II(1)GD(EEx ia)IIC
	C	FM AIS I,II,III/1/ABCDEFG1
	D	CSA (Ex ia) I,II,III/1/ABCDEFG1
	E	TIIS (EEx ia) IIC

		Channel:	
		1	1 x
		2	2 x

			Transmission direction:	
			A	Ex-nonEx
			B	nonEx-Ex

RB223-				⇐ Order code

Accessories

Accessories

The following accessories are available:

Order code	Accessory
51002468	Protective housing IP66 for field mounting
51004148	Adhesive label, printed (max. 2x16 chars)
51002393	Metal tag for tag number

Documentation

- Operating Instructions RB223 (BA239R/09)
- ATEX Safety Instructions (XAxxxR/09)
- "System components" brochure (FA016K/09)
- SIL Safety Manual
- Additional Ex approvals

International Head Quarter

Endress+Hauser
GmbH+Co. KG
Instruments International
Colmarer Str. 6
79576 Weil am Rhein
Deutschland

Tel. +49 76 21 9 75 02
Fax +49 76 21 9 75 34 5
www.endress.com
info@ii.endress.com

Endress+Hauser
People for Process Automation

TI132R/09/en/10.06
71030519
FM+SGML 6.0 ProMoDo

21. Variable Speed Drive

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

TIMER

1. IDEC DIGITAL TIMER TECHNICAL DETAILS
2. ELECTRONIC TIMING RELAY TECHNICAL DETAILS

GT3D — Digital Timers

Key features of the GT3D series include:

- Precise time setting using digital thumbwheel switches
- Elapsed or time remaining LCD display
- 6 time ranges, 16 timing functions
- Time delays up to 99.9 hours

UL Recognized
File No. E55996

CSA Certified
File No. LR58183
File No. LR96764
File No. LR83814

Cert. No. BL9801133323911 (LVD)
Cert. No. E9971113332388 (EMC)

Specifications

		GT3D-2	GT3D-3	GT3D-4	GT3D-8
Operation System		Solid state CMOS circuitry			
Operation		Multi-mode			Multi-mode one-shot output
Time Range		0.01s to 99.9 hours			
Rated Voltage		100 to 240V AC (50/60Hz), 24V AC (50/60Hz)/24V DC			
Contact Ratings		125V AC/250V AC, 3A; 30V DC/1A (resistive load)	125V AC/250V AC, 5A; 30V DC/5A (resistive load)		
Contact Form		Delayed SPDT + instantaneous SPDT	Delayed DPDT	Delayed DPDT	Delayed DPDT
Minimum Applicable Load		5V, 10mA (reference value)			
Voltage Tolerance		AF20 (100–240V AC): 85 to 264V AC AD24 (AC): 20.4 to 26.4V AC AD24 (DC): 21.6 to 26.4V DC			
Error		±0.3% ±50ms (voltage, repeat, and temperature)			
Setting Error		±0.5% ±50ms			
Reset Time		60ms maximum			
Insulation Resistance		100MΩ minimum			
Dielectric Strength		Between power and output terminals: 2,000V AC, 1 minute Between contacts of different poles: 2,000V AC, 1 minute Between contacts of the same pole: 750V AC, 1 minute			
Power Consumption (approximate)	**AF20**	11.8VA	11.6VA	3.7VA (100V AC, 60Hz) 11.6VA (200V AC, 60Hz)	
	AD24 AC/DC	1VA/0.8W	2.1VA/0.9W	2.1VA /0.9W	
Mechanical Life		10,000,000 operations minimum	5,000,000 operations minimum		
Electrical Life (at rated load)		50,000 operations minimum	100,000 operations minimum		
Outputs	**Relay**	250V AC, 3A, 30V DC, 1A (resistive load)	240V AC/, 24V DC, 5A (resistive load)		
Vibration Resistance		100N (approximate 10G)			
Shock Resistance		Operating extremes: 100N (approximate 10G) Damage limits: 500N (approximate 50G)			
Operating Temperature		–10 to +50°C			
Storage Temperature		–30 to +80°C			
Operating Humidity		45 to 85% RH			
Weight (approximate)		70g	75g	76g	
Housing Color		Gray			

Part Number List

Part Numbers: GT3D-1/GT3D-2/GT3D-3

Mode of Operation	Time Range	Output	Contact	Rated Voltage Code	Complete Part No.	
					8-Pin	11-Pin
1-A: ON-delay 1 1-B: Interval 1 first 1-C: Cycle 1 (OFF first) 1-D: Cycle 3 (ON first)	0.01s to 99.9 hours	250V AC, 3A, 30V DC, 1A (resistive load)	Delayed SPDT + instantaneous SPDT	100 to 240V AC (50/60Hz)	GT3D-2AF20	GT3D-2EAF20
				24V AC/DC	GT3D-2AD24	—
		240V AC, 24V DC, 5A (resistive load)	Delayed DPDT	100 to 240V AC (50/60Hz)	GT3D-3AF20	GT3D-3EAF20
				24V AC/DC	GT3D-3AD24	—

Part Numbers: GT3D-4

Mode of Operation	Time Range	Output	Contact	Rated Voltage Code	Complete Part No.	
					A (11-Pin)	B (11-Pin)
1-A: ON-delay 1 1-B: Interval 1 first 1-C: Cycle 1 (OFF first) 1-D: Cycle 3 (ON first) 2-A: ON-delay 2 2-B: Cycle 2 2-C: Signal ON/OFF-delay 1 2-D: Signal OFF-delay 1 2-E: Interval 2 2-F: One-shot cycle 3-A: Signal ON/OFF-delay 2 3-B: Signal OFF-delay 2 3-C: One-shot 1 3-D: One-shot ON-delay 3-E: One-shot 2 3-F: Signal ON/OFF-delay 3	0.01s to 99.9 hours	240V AC/24V DC, 5A (resistive load)	Delayed DPDT	100 to 240V AC (50/60Hz)	GT3D-4AF20	GT3D-4EAF20
				24V AC/DC	GT3D-4AD24	—

Part Numbers: GT3D-8

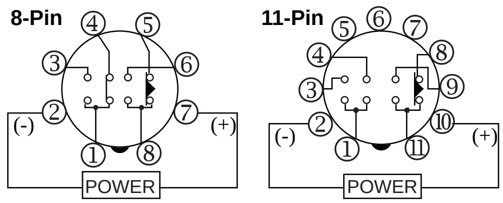
Mode of Operation	Time Range	Output	Contact	Rated Voltage Code	Complete Part No. (11-Pin)
1: ON-delay one-shot 1 2: Cycle one-shot 3: ON-delay one-shot 2	0.01s to 99.9 hours	240V AC/24V DC, 5A (resistive load)	Delayed DPDT	100 to 240V AC (50/60Hz)	GT3D-8AF20
				24V AC/DC	GT3D-8AD24

1. For wiring schematics and timing diagrams GT3D, see pages 815 to 822.
2. For more details about time ranges, see instructions on page 823.
3. A (11-pin) and B (11-pin) differ in the way inputs are wired.
4. For socket and accessory part numbers, see page 838.
5. For timing diagrams overview, see page 794.

Timing Diagrams/Schematics

GT3D-2 Timing Diagrams
Delayed SPDT + Instantaneous SPDT

Operation Mode Selection



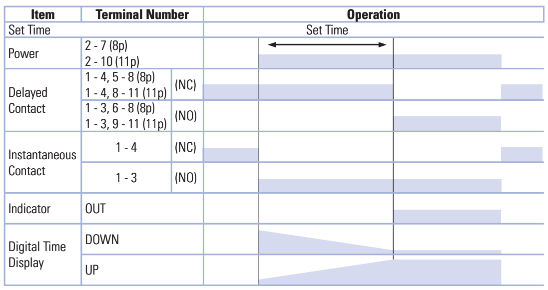
ON-Delay 1

Time Remaining

1 — A

Time Elapsed

1 — A



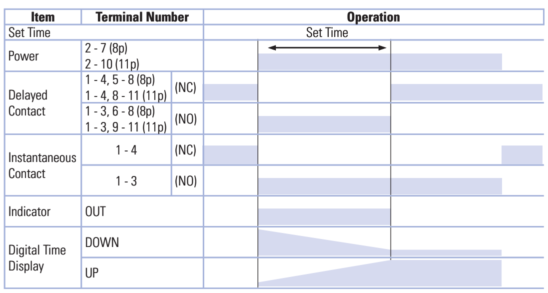
Interval 1

Time Remaining

1 — B

Time Elapsed

1 — B



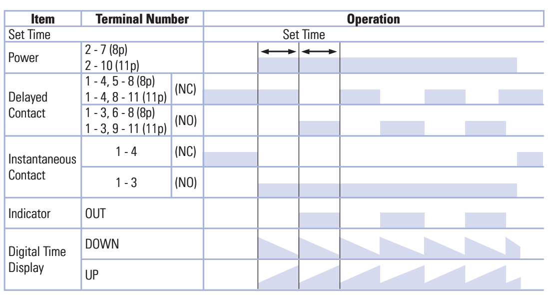
Cycle 1
(OFF first)

Time Remaining

1 — C

Time Elapsed

1 — C



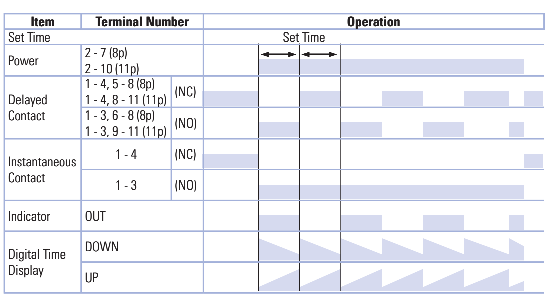
Cycle 3
(ON first)

Time Remaining

1 — D

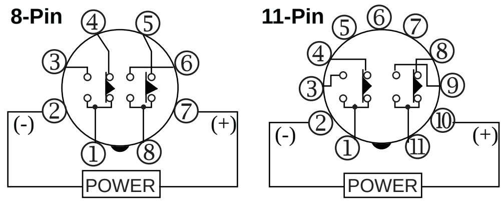
Time Elapsed

1 — D



GT3D-3 Timing Diagrams
Delayed DPDT

Operation Mode Selection



ON-Delay 1

Time Remaining
1 — A

Time Elapsed
1 — A

Item	Terminal Number		Operation
Set Time			Set Time
Power	2 - 7 (8p) 2 - 10 (11p)		
Delayed Contact	1 - 4, 5 - 8 (8p) 1 - 4, 8 - 11 (11p)	(NC)	
	1 - 3, 6 - 8 (8p) 1 - 3, 9 - 11 (11p)	(NO)	
Indicator	OUT		
Digital Time Display	DOWN		
	UP		

Interval 1

Time Remaining
1 — B

Time Elapsed
1 — B

Item	Terminal Number		Operation
Set Time			Set Time
Power	2 - 7 (8p) 2 - 10 (11p)		
Delayed Contact	1 - 4, 5 - 8 (8p) 1 - 4, 8 - 11 (11p)	(NC)	
	1 - 3, 6 - 8 (8p) 1 - 3, 9 - 11 (11p)	(NO)	
Indicator	OUT		
Digital Time Display	DOWN		
	UP		

Cycle 1
(OFF first)

Time Remaining
1 — C

Time Elapsed
1 — C

Item	Terminal Number		Operation
Set Time			Set Time
Power	2 - 7 (8p) 2 - 10 (11p)		
Delayed Contact	1 - 4, 5 - 8 (8p) 1 - 4, 8 - 11 (11p)	(NC)	
	1 - 3, 6 - 8 (8p) 1 - 3, 9 - 11 (11p)	(NO)	
Indicator	OUT		
Digital Time Display	DOWN		
	UP		

Cycle 3
(ON first)

Time Remaining
1 — D

Time Elapsed
1 — D

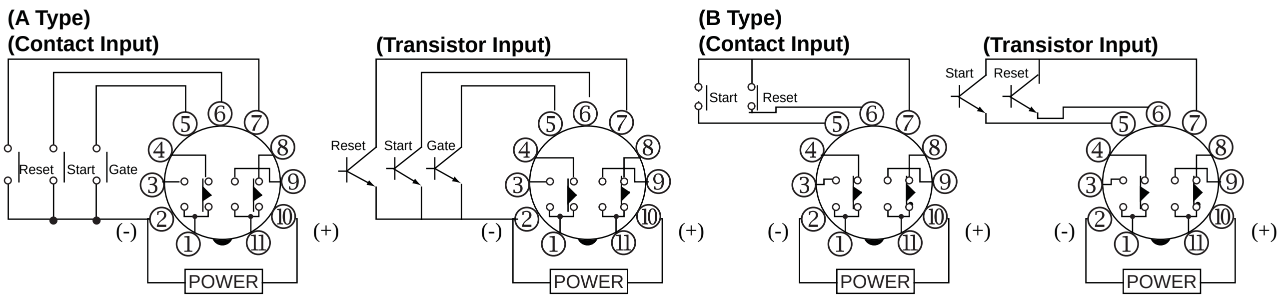
Item	Terminal Number		Operation
Set Time			Set Time
Power	2 - 7 (8p) 2 - 10 (11p)		
Delayed Contact	1 - 4, 5 - 8 (8p) 1 - 4, 8 - 11 (11p)	(NC)	
	1 - 3, 6 - 8 (8p) 1 - 3, 9 - 11 (11p)	(NO)	
Indicator	OUT		
Digital Time Display	DOWN		
	UP		

GT3D-4 Timing Diagrams

These timers require a start input. A gate and reset input are optional. Inputs are controlled by external pushbuttons. Reset occurs when the power is removed or when the reset input is supplied. The gate signal can be used to interrupt (freeze) timer functions. Timer functions resume when the gate input is removed. B style timers are not equipped for gate input.

Delayed DPDT

Operation Mode Selection



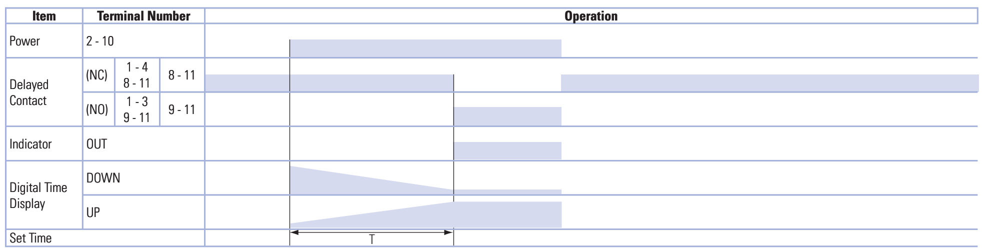
ON-Delay 1

Time Remaining

1 — A

Time Elapsed

1 — A



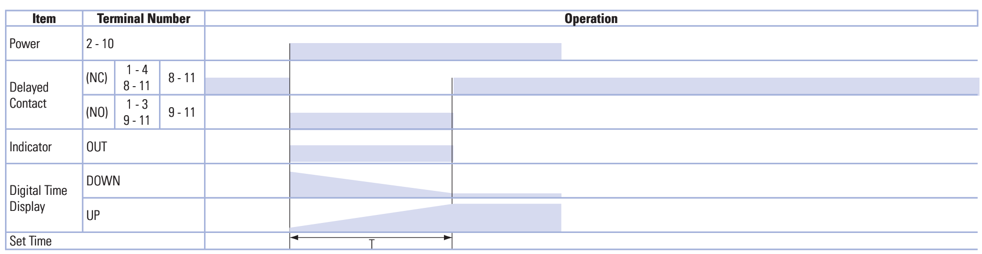
Interval 1

Time Remaining

1 — B

Time Elapsed

1 — B

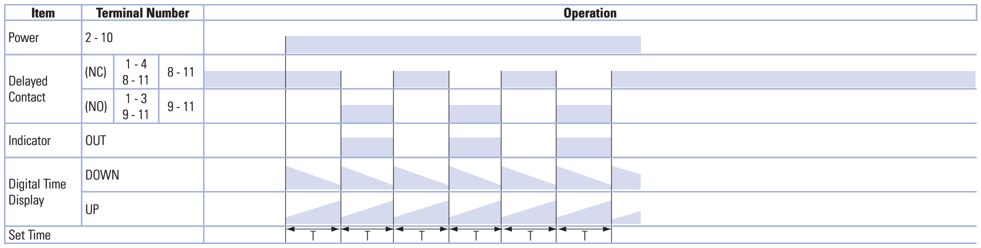


GT3D-4 Timing Diagrams

Cycle 1
(OFF first)

Time Remaining
1 — C

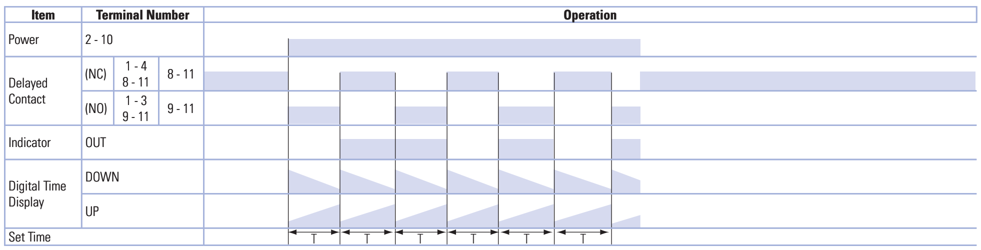
Time Elapsed
1 — C



Cycle 3
(ON first)

Time Remaining
1 — D

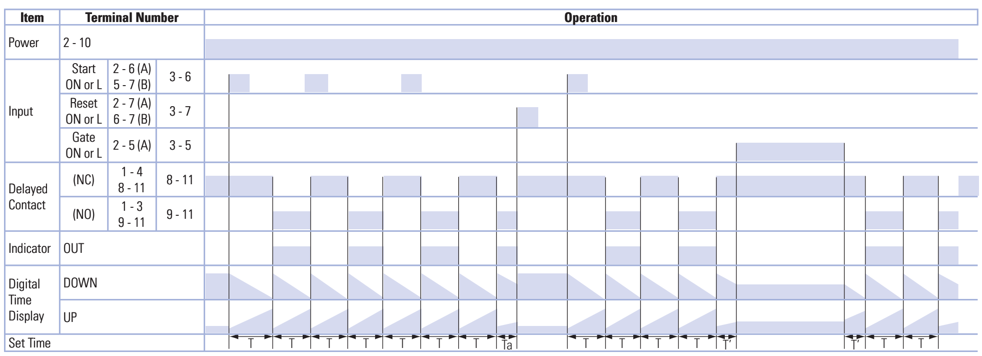
Time Elapsed
1 — D



ON-Delay 2

Time Remaining
2 — A

Time Elapsed
2 — A



GT3D-4 Timing Diagrams

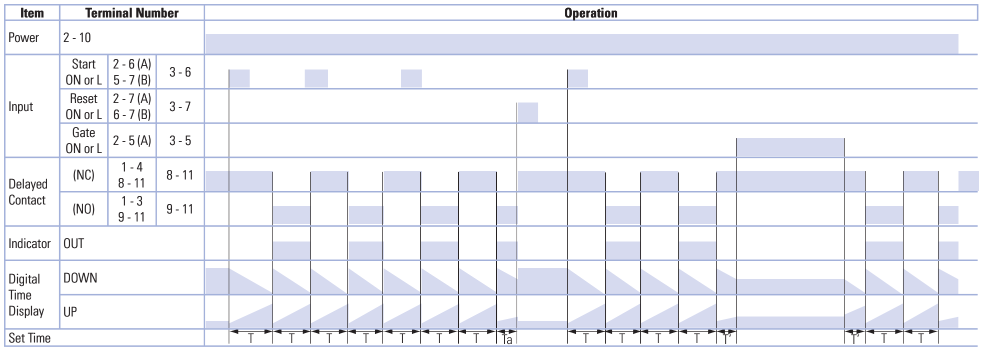
Cycle 2

Time Remaining

2 — B

Time Elapsed

2 — B



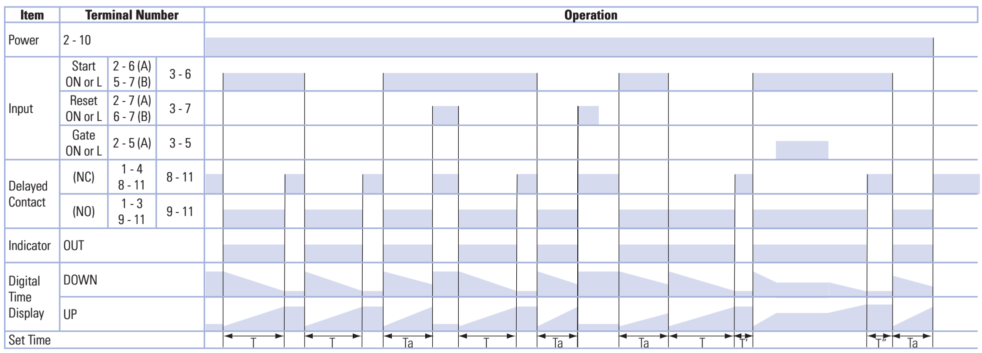
Signal ON/OFF-Delay 1

Time Remaining

2 — C

Time Elapsed

2 — C



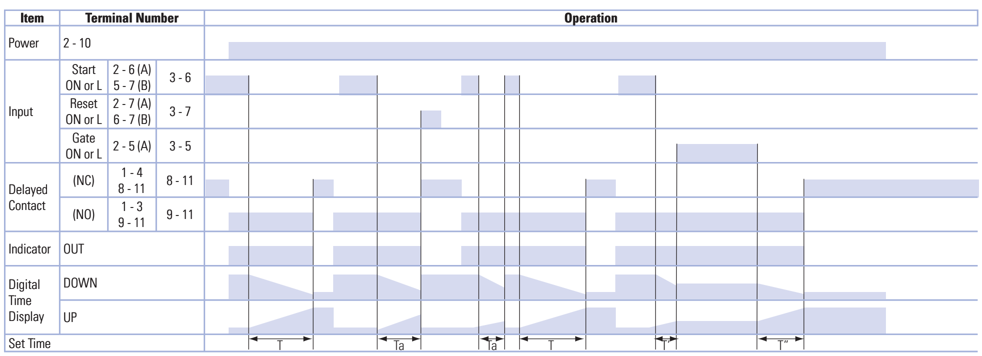
Singal OFF-Delay 1

Time Remaining

2 — D

Time Elapsed

2 — D



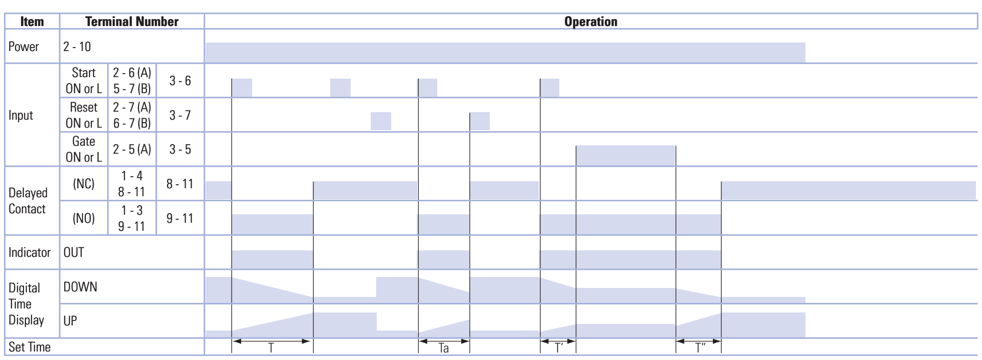
Interval 2

Time Remaining

2 — E

Time Elapsed

2 — E



GT3D-4 Timing Diagrams

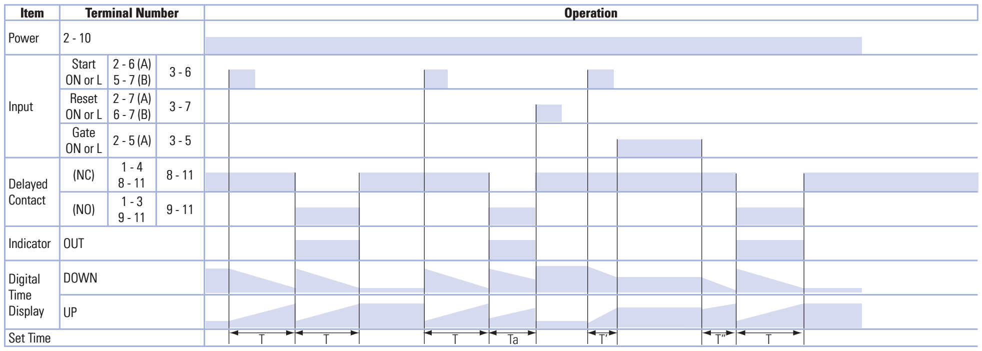
One-Shot Cycle

Time Remaining

2 — F

Time Elapsed

2 — F



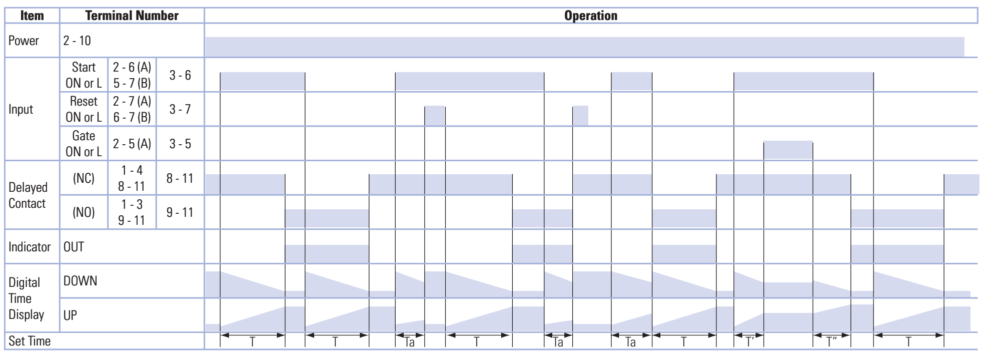
Signal ON/OFF-Delay 2

Time Remaining

3 — A

Time Elapsed

3 — A



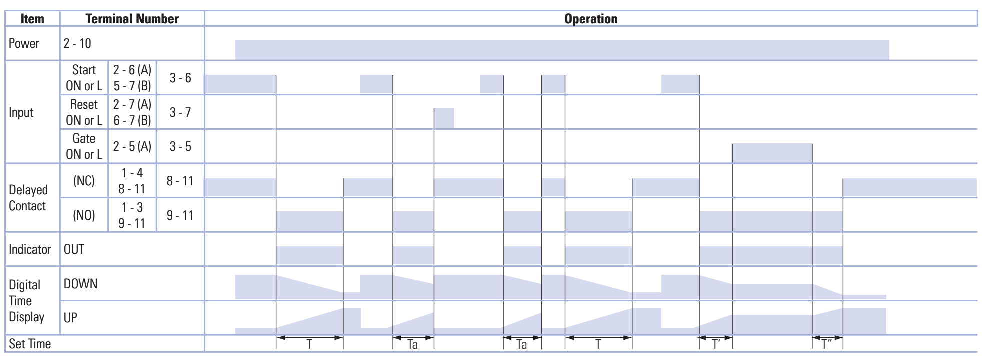
Singal OFF-Delay 2

Time Remaining

3 — B

Time Elapsed

3 — B



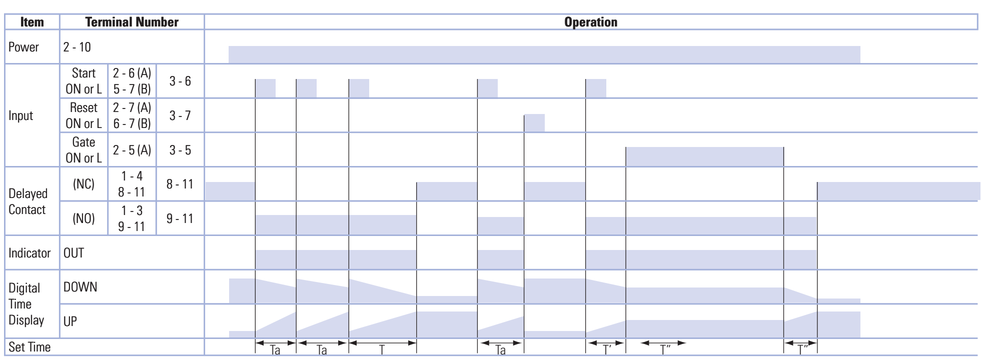
One-Shot 1

Time Remaining

3 — C

Time Elapsed

3 — C



GT3D-4 Timing Diagrams

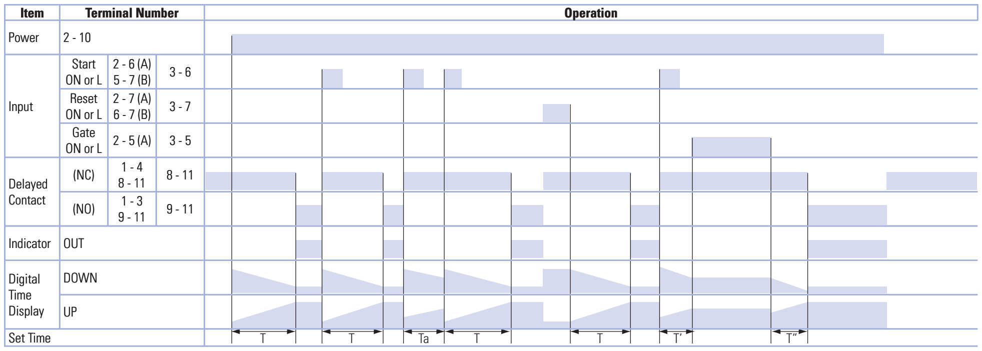
One-Shot ON-Delay

Time Remaining

3 — D

Time Elapsed

3 — D



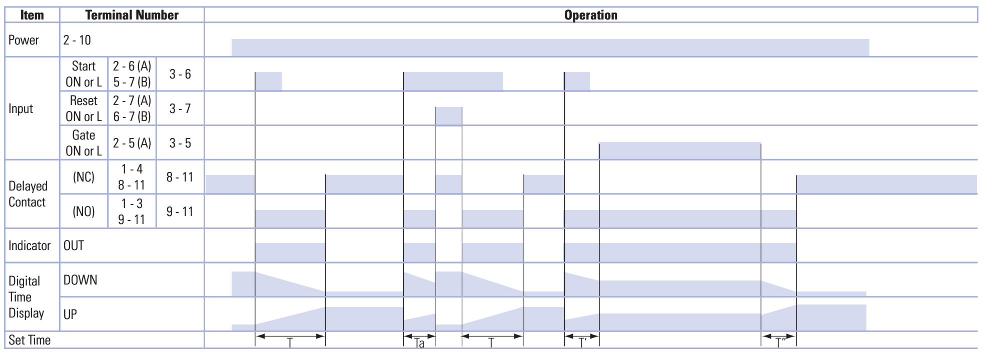
One-Shot 2

Time Remaining

3 — E

Time Elapsed

3 — E



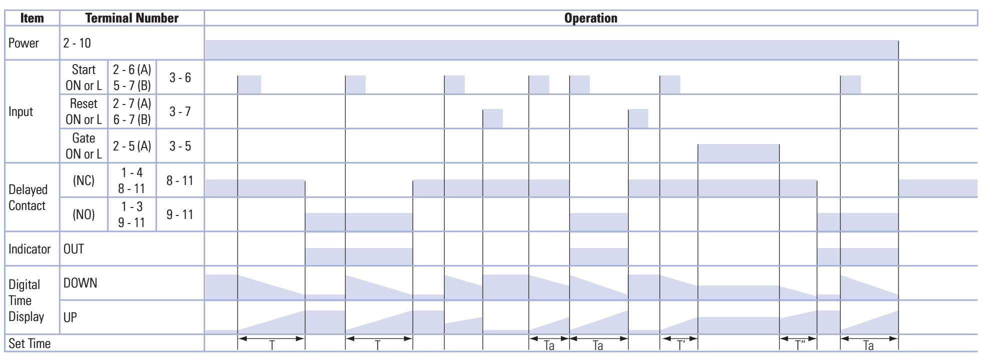
Signal ON/OFF-Delay 3

Time Remaining

3 — F

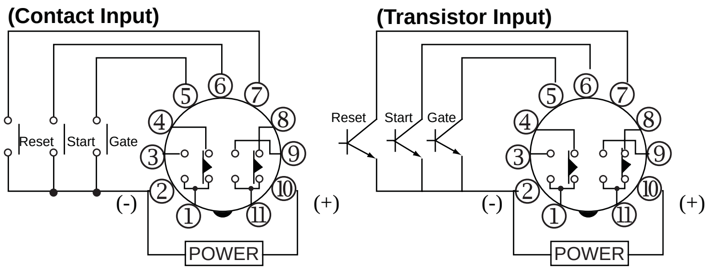
Time Elapsed

3 — F



GT3D-8 Timing Diagrams
Delayed DPDT

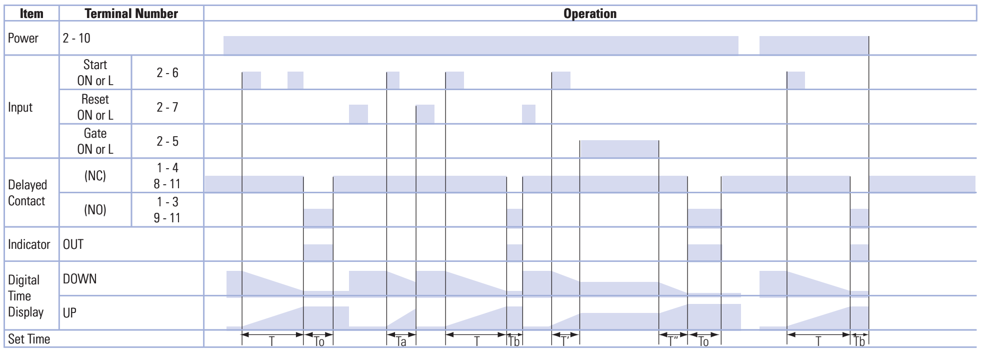
Operation Mode Selection



ON-Delay One-Shot 1

Time Remaining **1**

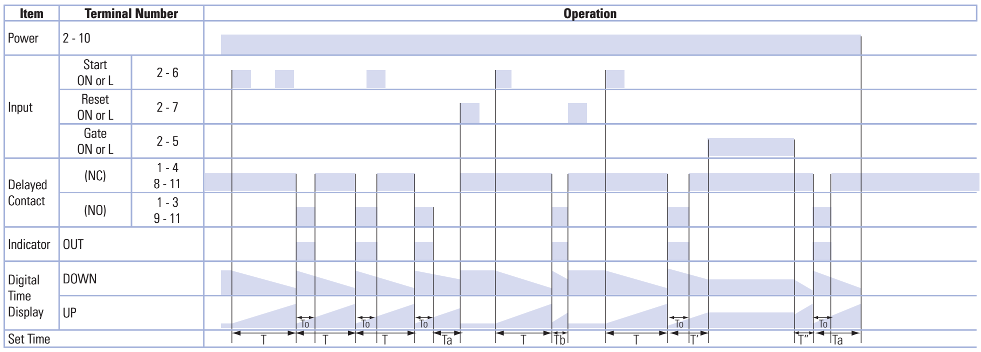
Time Elapsed **1**



Cycle One-Shot

Time Remaining **2**

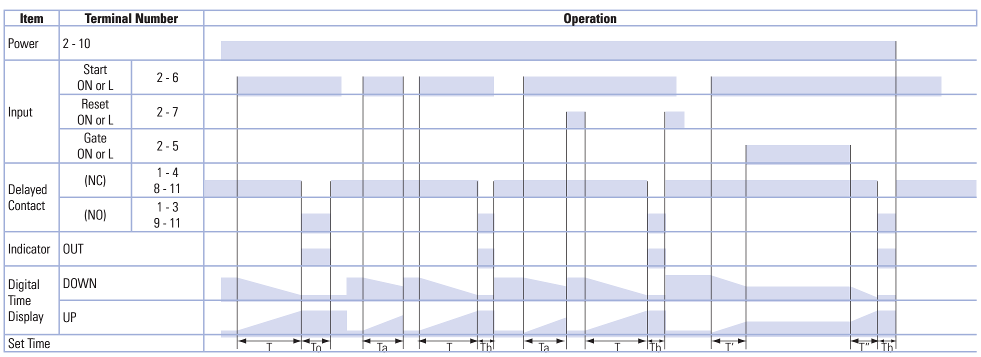
Time Elapsed **2**



ON-Delay One-Shot 2

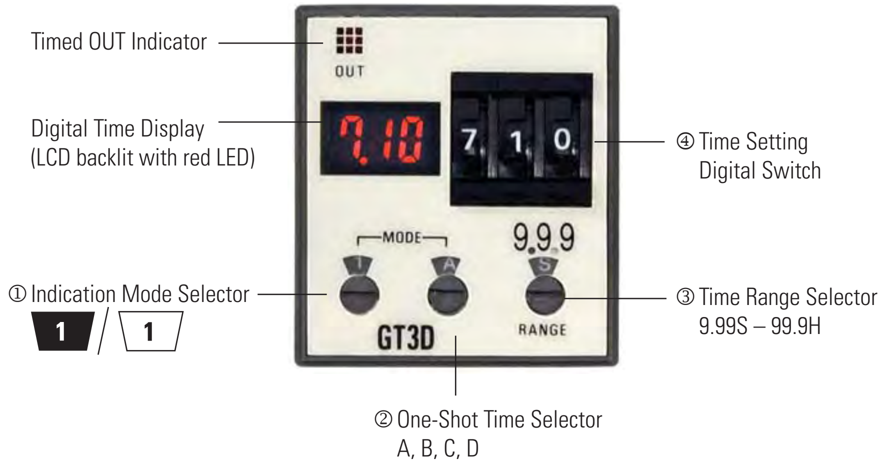
Time Remaining **3**

Time Elapsed **3**



T = Set time
Ta = Shorter than set time
Tb = Shorter than single-shot output time
T = T' + T"
T0 = Single-shot output time (selected from A, B, C, D, E or F)

Instructions: Setting GT3D-2, GT3D-3 Timers



Step 1	Desired Mode/Selection				Remarks
	Time Display Mode	① Indicator Mode Selector	Operation Mode	② Operation Mode Selector	
Select the desired time display and operation modes.	Time elapsed	1	ON-delay 1	A	1. Use the flat screwdriver to set the selectors. Since selectors do not turn all the way around, both clockwise and counterclockwise rotation may be necessary. 2. The ① Indicator Mode Selector determines whether the Digital Time Display shows the time elapsed or time remaining. The ② Operation Mode Selector determines the desired operation mode. Decide which display and mode is desired, then use these two selectors ①② to set the operation mode. 3. The ① Operation Mode Selector has two blank modes which are not intended for use. Always have this selector set to A, B, C, or D.
	Time remaining	1			
	Time elapsed	1	Interval	B	
	Time remaining	1			
	Time elapsed	1	Cycle 1	C	
	Time remaining	1			
	Time elapsed	1	Cycle 3	D	
	Time remaining	1			

Step 2	Desired Operation	Selection		Remarks
		③ Time Range Selector		
	Base Time Ranges	Decimal Point Indicator	Time Increment Indicator	
Select a time range that contains the desired period of time.	0.01 seconds to 9.99 seconds	9.99	S	1. The ③ Time Range Selector controls both the decimal point indicator (9.99, 99.9, 999) and the time increment indicators S (seconds), M (minutes), and H (hours). 2. Chose which base time range contains the targeted timer setting. Then use the ③ Time Range Selector to set the decimal point indicator and time increment indicator to its corresponding pair of settings. 3. Since these configurations offer a complete range of settings from 0.01 seconds to 99.9 hours, the setting of 9.99 for minutes and the 9.99 and 999 settings for hours are not listed and should not be used.
	0.1 seconds to 99.9 seconds	99.9		
	1 second to 999 seconds	999		
	0.1 minutes to 99.9 minutes	99.9	M	
	1 minute to 999 minutes	999		
	0.1 hours to 99.9 hours	99.9	H	

Step 3	Desired Operation	Selection	Remarks
Set the precise period of time desired by using the ④ Time Setting Digital Switch.			Use the ④ Time Setting Digital Switch to set the desired period of time. It is important to remember that the setting of the ③ Time Range Selector determines the units of time measurement as well as the implied decimal point location.

It is important to remember that the ③ Time Range Selector not only selects the time range but also influences the interpretation of the Digital Time Display. Changing the ③ Time Range Selector setting changes the units of time measurement (seconds, minutes, hours) as well as the decimal point location.

Instructions: Setting GT3D-4 Timers

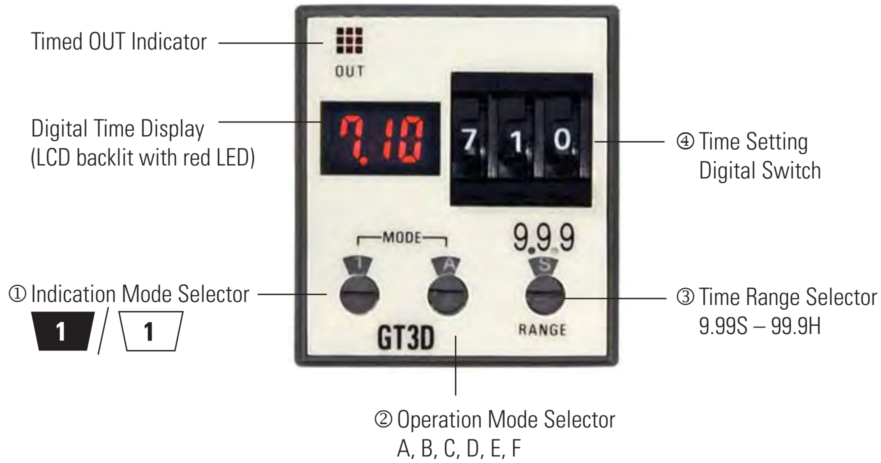
Step 1	Time Display Mode	① Indicator Mode Selector	Operation Mode	② Operation Mode Selector	Remarks
Select the desired time display and operation modes.	Time elapsed	1	ON-delay 1 Interval 1 Cycle 1 D: Cycle 3	A B C D	1. Use a flat screwdriver to set the selectors. Since selectors do not turn all the way around, both clockwise and counterclockwise rotation is necessary. 2. The ① Indicator Mode Selector determines whether the Digital Time Display shows the time elapsed or time remaining. The ② Operation Mode Selector determines the desired operation mode. Decide which display and mode is desired; then use these two selectors①② to set the operation mode. 3. When using the indicator mode setting "1," the ② Operation Mode Selector has two blank modes which are not intended for use. When using mode setting "1," always have the operation mode selector set to A, B, C, or D.
	Time remaining	1			
	Time elapsed	2	ON-delay 2 Cycle 2 Signal ON/OFF-delay 2 Signal OFF-delay 1 Interval 2 One-shot cycle	A B C D E F	
	Time remaining	2			
	Time elapsed	3	Signal ON/OFF-delay 2 Signal OFF-delay 2 One-shot 1 One-shot ON-delay One-shot 2 Signal ON/OFF-delay 3	A B C D E F	
	Time remaining	3			

Step 2	Desired Operation: Base Time Ranges	Selection: ③ Time Range Selector – Decimal Point Indicator	Selection: ③ Time Range Selector – Time Increment Indicator	Remarks
Select a time range that contains the desired period of time.	0.01 seconds to 9.99 seconds	9.99	S	1. The ③ Time Range Selector controls both the decimal point indicator (9.99, 99.9, 999) and the time increment indicators S (seconds), M (minutes), and H (hours). 2. Chose which base time range contains the targeted timer setting. Then use the ③ Time Range Selector to set the decimal point indicator and time increment indicator to its corresponding pair of settings. 3. Since these configurations offer a complete range of settings from 0.01 seconds to 99.9 hours, the setting of 9.99 for minutes and the 9.99 and 999 settings for hours are not listed and should not be used.
	0.1 seconds to 99.9 seconds	99.9		
	1 second to 999 seconds	999		
	0.1 minutes to 99.9 minutes	99.9	M	
	1 minute to 999 minutes	999		
	0.1 hours to 99.9 hours	99.9	H	

Step 3	Desired Operation	Selection	Remarks
Set the precise period of time desired by using the ④ Time Setting Digital Switch.			Use the ④ Time Setting Digital Switch to set the desired period of time. It is important to remember that the setting of the ③ Time Range Selector determines the units of time measurement as well as the implied decimal point location.

It is important to remember that the ③ Time Range Selector not only selects the time range but also influences the interpretation of the Digital Time Display.
Changing the ③ Time Range Selector setting changes the units of time measurement (seconds, minutes, hours) as well as the decimal point location.

Instructions: Setting GT3D-8 Timers



Step 1	Desired Mode of Operation		Selection		Remarks
	Operation Mode	Time Display Mode	① Indicator Mode Selector		
Select the time display and operation modes.	ON-Delay One-Shot	Time elapsed	1		1. Use a flat screwdriver to set the selectors. Since selectors do not turn all the way around, both clockwise and counterclockwise rotation is necessary. 2. The GT3D-8 ① Indicator Mode Selector selects both whether the Digital Time Display displays the time elapsed or time remaining and also the mode of operation. Decide which display and mode is desired. Then use this selector to set the operation mode.
		Time remaining	1		
	Cycle One-Shot	Time elapsed	2		
		Time remaining	2		
	ON-Delay One-Shot 2	Time elapsed	3		
		Time remaining	3		
Step 2	**Desired Mode of Operation**		**Selection**		**Remarks**
	Desired Single-Shot Output Time		② Single-Shot Output Time Selector		
Select the single shot output time.	0.1 seconds		A		On the GT3D-8 timers, the desired single-shot output time can be selected from the A, B, C, D, E, and F modes using the ② One-Shot Output Time Selector.
	0.5 seconds		B		
	1 second		C		
	5 seconds		D		
	10 seconds		E		
	50 seconds		F		
Step 3	**Desired Operation**		**Selection**		**Remarks**
	Base Time Ranges		③ Time Range Selector		
			Decimal Point Indicator	Time Increment Indicator	
Select a time range that contains the desired period of time.	0.01 seconds to 9.99 seconds		9.99	S	1. The ③ Time Range Selector controls both the decimal point indicator (9.99, 99.9, 999) and the time increment indicators S (seconds), M (minutes), and H (hours). 2. Chose which base time range contains the targeted timer setting. Then use the ③ Time Range Selector to set the decimal point indicator and time increment indicator to its corresponding pair of settings. 3. Since these configurations offer a complete range of settings from 0.01 seconds to 99.9 hours, the setting of 9.99 for minutes and the 9.99 and 999 settings for hours are not listed and should not be used.
	0.1 seconds to 99.9 seconds		99.9		
	1 second to 999 seconds		999		
	0.1 minutes to 99.9 minutes		99.9	M	
	1 minute to 999 minutes		999		
	0.1 hours to 99.9 hours		99.9	H	
Step 4	**Desired Operation**		**Selection**		**Remarks**
Set the precise period of time desired by using the ④ Time Setting Digital Switch.					Use the ④ Time Setting Digital Switch to set the desired period of time. It is important to remember that the setting of the ③ Time Range Selector determines the units of time measurement as well as the implied decimal point location.

It is important to remember that the ③ Time Range Selector not only selects the time range but also influences the interpretation of the Digital Time Display. Changing the ③ Time Range Selector setting changes the units of time measurement (seconds, minutes, hours) as well as the decimal point location.

GT3 Series

Accessories

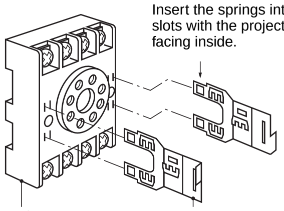
DIN Rail Mounting Accessories

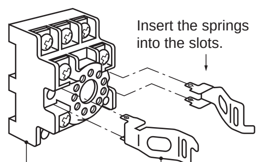
DIN Rail/Surface Mount Sockets and Hold-Down Springs

DIN Rail Mount Socket				Applicable Hold-Down Springs	
Style	**Appearance**	**Use with Timers**	**Part No.**	**Appearance**	**Part No.**
8-Pin Screw Terminal (dual tier)		GT3A-1, 2, 3 (8-pin) GT3D-1, 2, 3 (8-pin) GT3F-1, 2 (8-pin) GT3W (8-pin) GT3S	SR2P-05		SFA-203
11-Pin Screw Terminal (dual tier)		GT3A-1, 2, 3 (11-pin) GT3A-4, 5, 6 GT3D-1, 2, 3 (11-pin) GT3D-4, 8 GT3F-1, 2 (11-pin) GT3W (11-pin)	SR3P-05		
8-Pin Fingersafe Socket		GT3A-1, 2, 3 (8-pin) GT3D-1, 2, 3 (8-pin) GT3F-1, 2 (8-pin) GT3W (8-pin) GT3S	SR2P-05C		
11-Pin Fingersafe Socket		GT3A-1, 2, 3 (11-pin) GT3A-4, 5, 6 GT3D-1, 2, 3 (11-pin) GT3D-4, 8 GT3F-1, 2 (11-pin) GT3W (11-pin)	SR3P-05C		
8-Pin Screw Terminal		GT3A-1, 2, 3 (8-pin) GT3D-1, 2, 3 (8-pin) GT3F-1, 2 (8-pin) GT3W (8-pin) GT3S	SR2P-06		SFA-202
11-Pin Screw Terminal		GT3A-1, 2, 3 (11-pin) GT3A-4, 5, 6 GT3D-1, 2, 3 (11-pin) GT3D-4, 8 GT3F-1, 2 (11-pin) GT3W (11-pin)	SR3P-06		
DIN Mounting Rail Length 1000mm		—	BNDN1000		

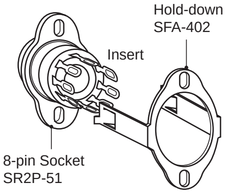
Installation of Hold-Down Springs

DIN Rail Mount Socket





Panel Mount Socket



Panel Mounting Accessories

Panel Mount Sockets and Hold-Down Springs

Panel Mount Socket				Applicable HD Springs	
Style	Appearance	Use with Timers	Part No.	Appearance	Part No.
8-Pin Solder Terminal		GT3A- (8-pin) GT3D- (8-pin) GT3W- (8-pin) GT3F- (8-pin) GT3S	SR2P-51		SFA-402
11-Pin Solder Terminal		GT3A- (11-pin) GT3D- (11-pin) GT3W- (11-pin) GT3F- (11-pin)	SR3P-51		

For information on installing the hold-down springs, see page 838.

Flush Panel Mount Adapter and Sockets that use an Adapter

Accessory	Description	Appearance	Use with Timers	Part No.
Panel Mount Adapter	Adaptor for flush panel mounting GT3 timers		All GT3 timers	RTB-G01
Sockets for use with Panel Mount Adapter	8-pin screw terminal	 (Shown: SR6P-M08G for Wiring Socket Adapter)	All 8-pin timers	SR6P-M08G
	11-pin screw terminal		All 11-pin timers	SR6P-M11G
	8-pin solder terminal		All 8-pin timers	SR6P-S08
	11-pin solder terminal		All 11-pin timers	SR6P-S11

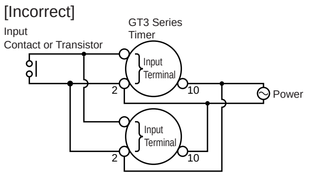
No hold down springs are available for flush panel mounting.

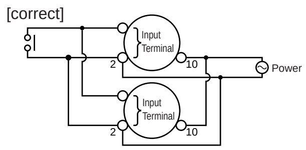
Instructions: Wiring Inputs for GT3 Series

Inputs Inputs

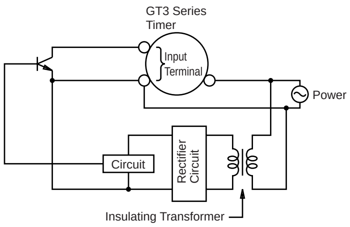
To avoid electric shock, do not touch the input signal terminal during power voltage application.

When connecting the input signal terminals of two or more GT3A timers to the same contact or transistor, the input terminals of the same number should be connected. (Connect Terminals No.2 in common.)

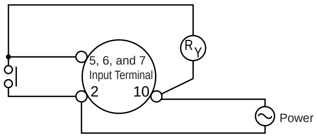




In a transistor circuit for controlling input signals, with its primary and secondary power circuits isolated, do not ground the secondary circuit.



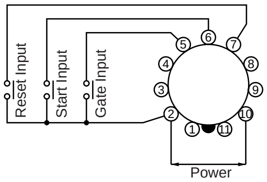
Connect the input signal terminals of the GT3A timers to Terminal No.2 only. Never apply voltage to other terminals; otherwise, the internal circuit may be damaged.



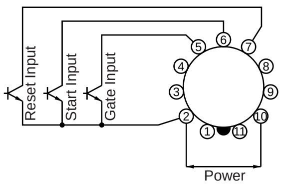
Input signal lines must be made as short as possible and installed away from power cables and power lines. Use shielded wires or a separate conduit for input wiring.

Inputs Instructions, continued

For contact input, use gold-plated contacts to make sure that the residual voltage is less than 1V when the contacts are closed.

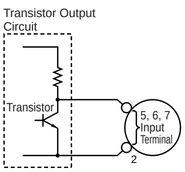


For transistor input, use transistors with the following specifications; VCE = 40V, VCES = 1V or less, IC = 50 mA or more, and ICBO = 50μA or less. The resistance should be less than 1kΩ when the transistor is on. When the output transistor switches on, a signal is input to the timer.



Inputs: GT3A-1, -2, -3

Transistor output equipment such as proximity switches and photoelectric switches can input signals if they are voltage/current output type, with power voltage ranges from 18 to 30V and have1V. When the signal voltage switches from H to L, a signal is input to the timer

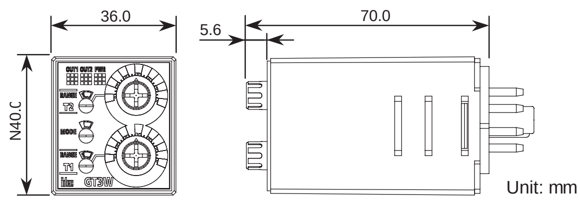


Inputs: GT3A-4, -5, -6

Start Input	The start input initiates a time-delay operation and controls output status.	No-voltage contact inputs and NPN open collector transistor inputs are applicable.
Reset Input	When the reset input is activated, the time is reset, and contacts return to original state.	24V DC, 1mA maximum
Gate Input	The time-delay operation is suspended while the gate input is on (pause).	Input response time: 50msec maximum

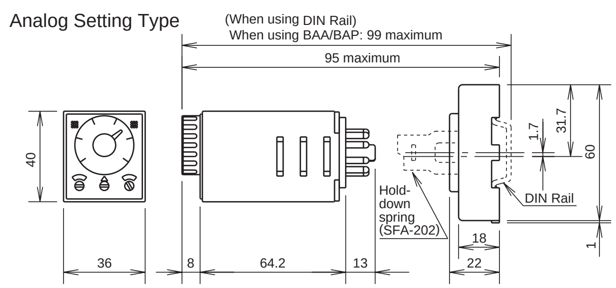
Switches & Pilot Lights
Display Lights
Relays & Sockets
Timers
Terminal Blocks
Circuit Breakers

Dimensions

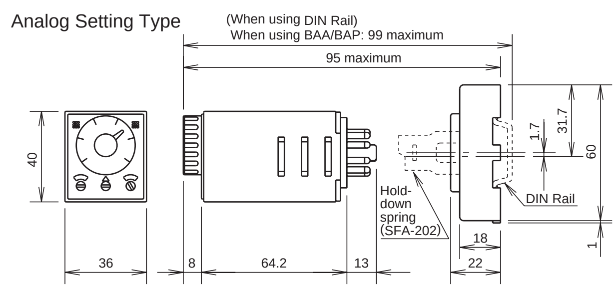


NOTE: GT3W series are UL Listed when used in combination with following IDEC's sockets:
GT3W-A11, A33: SR2P-06* pin type socket.
GT3W-A11E: SR3P-05* pin type socket.
(*-May be followed by A,B,C or U)
The socket to be used with these timers are rated:
-Conductor Temperature Rating 60ºC min.
-Use 14AWG max.(2mm^{2}max.) Copper conductors only
-Terminal Torque 1.0 to 1.3 N-m

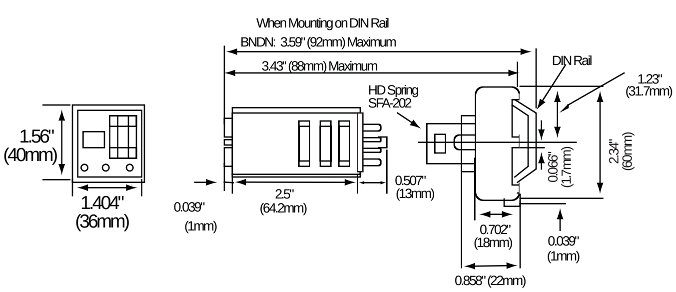
Analog GT3 Timer, 8-Pin with SR2P-06



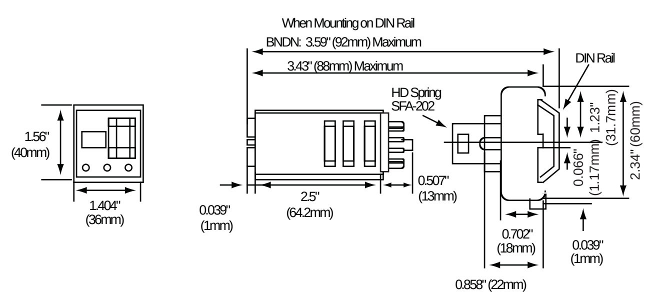
Analog GT3 Timer, 11-Pin with SR3P-06



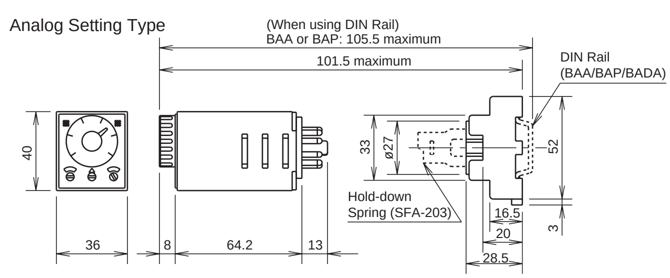
Digital GT3 Timer, 8-Pin with SR2P-06



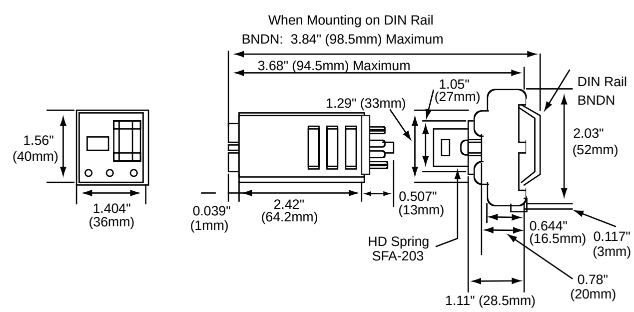
Digital GT3 Timer, 11-Pin with SR3P-06



Analog GT3 Timer, 11-Pin with SR3P-05

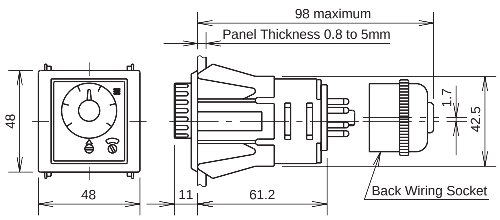


Digital GT3 Timer, 11-Pin with SR3P-05

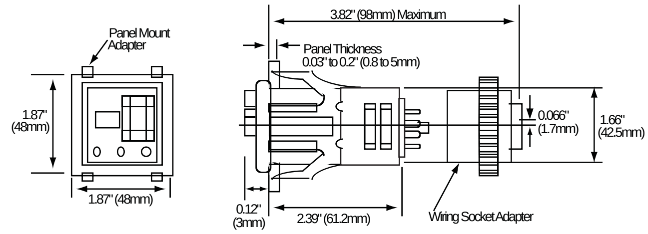


Panel Mount Adapter

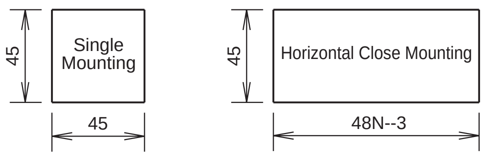
Analog GT3 Timer, 8-Pin and 11-Pin with SR6P-S08 or SR6P-S11



Digital GT3 Timer, 8-Pin and 11-Pin with SR6P-S08 or SR6P-S11

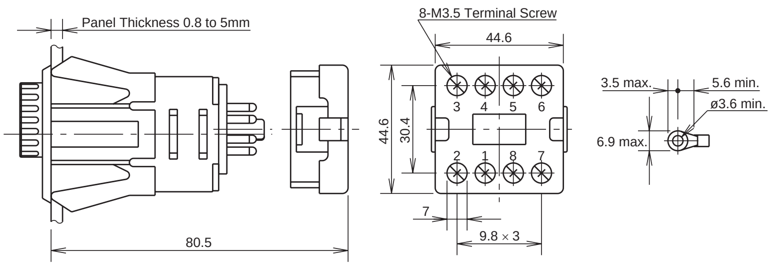


Mounting Hole Layout

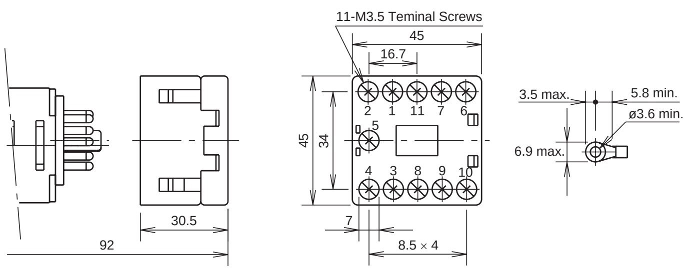


Tolerance: +0.5 to 0
N: No. of timers mounted

Analog and Digital GT3 Timer, 8-Pin with SR6P-M08G



Analog and Digital GT3 Timer, 11-Pin with SR6P-M11G



General Instructions for All Timer Series

Load Current

With inductive, capacitive, and incandescent lamp loads, inrush current more than 10 times the rated current may cause welded contacts and other undesired effects. The inrush current and steady-state current must be taken into consideration when specifying a timer.

Contact Protection

Switching an inductive load generates a counter-electromotive force (back EMF) in the coil. The back EMF will cause arcing, which may shorten the contact life and cause imperfect contact. Application of a protection circuit is recommended to safeguard the contacts.

Temperature and Humidity

Use the timer within the operating temperature and operating humidity ranges and prevent freezing or condensation. After the timer has been stored below its operating temperature, leave the timer at room temperature for a sufficient period of time to allow it to return to operating temperatures before use.

Environment

Avoid contact between the timer and sulfurous or ammonia gases, organic solvents (alcohol, benzine, thinner, etc.), strong alkaline substances, or strong acids. Do not use the timer in an environment where such substances are prevalent. Do not allow water to run or splash on the timer.

Vibration and Shock

Excessive vibration or shocks can cause the output contacts to bounce, the timer should be used only within the operating extremes for vibration and shock resistance. In applications with significant vibration or shock, use of hold down springs or clips is recommended to secure a timer to its socket.

Time Setting

The time range is calibrated at its maximum time scale; so it is desirable to use the timer at a setting as close to its maximum time scale as possible. For a more accurate time delay, adjust the control knob by measuring the operating time with a watch before application.

Input Contacts

Use mechanical contact switch or relay to supply power to the timer. When driving the timer with a solid-state output device (such as a two-wire proximity switch, photoelectric switch, or solid-state relay), malfunction may be caused by leakage current from the solid-state device. Since AC types comprise a capacitive load, the SSR dielectric strength should be two or more times the power voltage when switching the timer power using an SSR.

Generally, it is desirable to use mechanical contacts whenever possible to apply power to a timer or its signal inputs. When using solid state devices, be cautious of inrushes and back-EMF that may exceed the ratings on such devices. Some timers are specially designed so that signal inputs switch at a lower voltage than is used to power the timer (models designated as “B” type).

Timing Accuracy Formulas

Timing accuracies are calculated from the following formulas:

Repeat Error $= \pm \dfrac{1 \times \text{Maximum Measured Value} - \text{Minimum Measured Value} \times 100\%}{2 \text{ Maximum Scale Value}}$

Voltage Error $= \pm \dfrac{Tv - Tr \times 100\%}{Tr}$

Tv: Average of measured values at voltage V
Tr: Average of measured values at the rated voltage

Temperature Error $= \pm \dfrac{Tt - T20 \times 100\%}{T20}$

Tt: Average of measured values at °C
T20: Average of measured values at 20°C

Setting Error $= \pm \dfrac{\text{Average of Measured Values - Set Value} \times 100\%}{\text{Maximum Scale Value}}$

sprecher+schuh

Technical Information

Series RZ7-FS Electronic Timing Relays

Technical Data

Timing Characteristics (according to VDE 0435, Part 2021)		
Timing ranges for		
RZ7-FSM-A, B, C, D, E, F, I, & L	(1s)	0.05…1 sec
RZ7-FSH	(3s)	0.15…3 sec
	(10s)	0.5…10 sec
	(1mn)	0.05…1 min
	(3mn)	0.15…3 min
	(10mn)	0.5…10 min
	(1h)	0.05…1 hour
	(3h)	0.15…3 hours
	(10h)	0.5…10 hours
	(60h)	3…60 hours
RZ7-FSQ	(2.5s)	0.15…2.5 sec
	(10s)	0.5…10 sec
	(80s)	4…80 sec
	(10mn)	0.5…10 min
Setting accuracy	±5% of full scale value	
Repeatability	±0.2% of the setting values	
Tolerance	Voltage: ±0.001%/%ΔU Temperature: ±0.025%/°C	
Power Supply		
Supply voltages	24…48VDC and 24…240VAC, 50/60Hz (dual voltage) 12VDC 24…240V AC or DC (universal voltage) 346…440VAC, 50/60Hz	
Voltage tolerance	AC: -15%... +10% DC: -20%... +20%	
Power consumption	AC: 5VA at 240V DC: 0.5W at 24V	
Time energized	100%	
Reset time	50ms	
Voltage interruption	≤20ms without reset (supply voltage)	
Input Impedance	Relay On: 3k-13k ohms Relay Off: 0.7k-4k ohms	
Cable length (supply voltage control)	250 meters (800 ft.) max.	
Pulse Control (B1)		
Impulse duration	≥50ms (AC), ≥30ms (DC)	
Input voltage	Supply voltage range	
Input current	1 mA	
Max. Leakage Current	400 micro Amps	
Cable length	max. 250 m (800 ft.) without parallel load between B1 & A2 max. 50 m (160 ft.) with load (<3kΩ) between B1 & B2	
Outputs		
Type of outputs	Relay contacts: hard silver	
Maximum admissible operating voltage	Alternating current: 440VAC	
Dielectric Coil to contact Withstand Voltage	5,000 V	
Switching capacity		
Current I_{th}: (AC1)	8A (5A for RZ7-FSQ)	
Power:	2000VA according to IEC947-5-1: 3A/440VAC (inductive load, AC14) 3A/250VAC (inductive load, AC15) 1A/24VDC (inductive load, DC13) according to UL 508: 1.5A/250VAC (B300) 3A/120VAC (B300)	
Short circuit resistance	10 A gL (fast blow fuse)	

Life expectancy (electrical)	4 million ops. at 1A/250VAC, cosφ = 1 0.2 million ops. at 6A/250VAC, cosφ = 1 1.5 million ops. at 1A/250VAC, cosφ = 0.3 0.3 million ops. at 3A/250VAC, cosφ = 0.3 0.5 million ops. at 6A/24VDC, resistive 2 million ops. at 4A/24VDC, resistive 2 million ops. at 0.2A/230VDC, resistive 1 million ops. at 0.4A/24VDC, L/R = 20ms 1 million ops. at 0.2A/110VDC, L/R = 20ms 1 million ops. at 0.1A/230VDC, L/R = 20ms
Life expectancy (mechanical)	30 million operations
General Data Insulation Characteristics	2 kVAC/50 Hz test voltage according to VDE 0435 and 6 kV 1.2/50 µs surge voltage according to IEC 947-1 between all inputs and outputs
EMC/Interference Immunity	Performance of following requirements: - Surge capacity of the supply voltage according to IEC1000-4-5: 4 kV 1.2/50 µs - Burst according to IEC 1000-4-4: 6 kV/ 6/50ns - ESD discharge according to IEC 1000-4-2: - Contact 8 kV, air 8 kV - Electromagnetic HF field according to IEC 801-3 and conducted electromagnetic HF signal according to IEC 801-6: Level 3
EMC/Emission	Electromagnetic fields according to EN 55 022: Class B
Safe isolation	According to VDE 106, part 101
Climatic withstand	56 cycles (24h) at 25…40°C and 95% relative humidity according to IEC 68-2-30 and IEC 68-2-3.
Vibration resistance	4 g in 3 axis at 10…500 Hz, test FC according
Shock resistance	50 g according to IEC 68-2-27
Protection class	Enclosure: IP40 IP30 (single function) Terminal: IP20 according to IEC 947-1
Weight	100g
Approvals/Standards	UL, C-UL up to 240VAC, Germanischer Lloyd, CE
Ambient temperature	Open: –25°C…+60°C Enclosed: –25°C…+45°C Storage –25°C…+85°C
Connections — Screw terminal -	M3.5 for Pozidrive No.2, Phillips and slotted screws No.2 suitable for power screwdriver.
Rated tightening torque -	0.8 Nm (max. 1.2 Nm) - [8.8 lb-in]
Wire Size -	Dual-chamber system for terminal cross-sections of 1 x 0.5mm² (solid) or 2 x 2.5mm² (flexible with sleeve), AWG 20…14.
Finger Protection -	According to VDE 0106
Mounting Relays	– Snap-on mounting (35mm DIN-rail) – Side mounting on CA7/CA4 contactors and CS7/CS4 with dovetail joint [surface mounting in any position] – Screw fixing by Panel Mount Adapter and two screws (M4) [surface mounting in any position]
Disposal	Synthetic material without dioxin according to EC/EFTA notification No. 93/0141/D. Electrical contacts contain cadmium.
Standards	EN 60947-1, EN 60947-5-1, EN 50081-1, IEC 947, UL 508. CSA 22.2

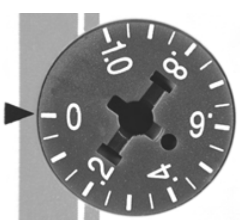
RZ7 Relative Scale Setting Knob

Series RZ7 Timing Relays have a "relative scale" setting knob numbered 0 to 1.0. Think about this as 0 to 100% of the relay's built-in time range. Example: To set an RZ7-FS timing relay (with a 0.05 to 1 minute range) to activate after 25 seconds:

1) Divide the desired activation time (25 seconds) by the maximum time limit of the relay (60 seconds).

   25 ÷ 60 = .416

2) Rotate the setting knob to just past the .4 mark.

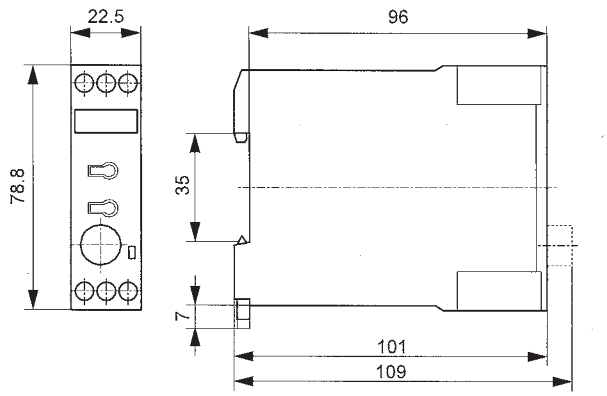


sprecher+schuh

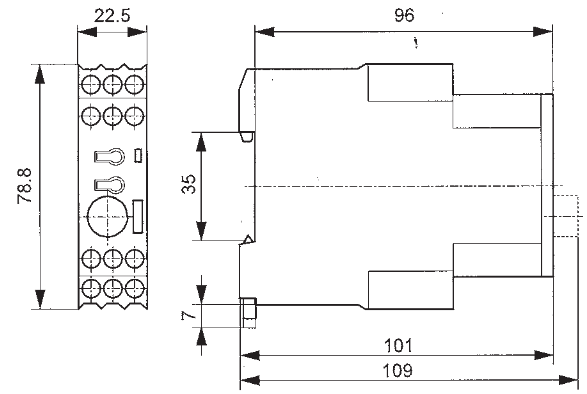
Dimensions

Series RZ7-FS Timing Relays *(one and two pole)*

- Dimensions are in millimeters
- Dimensions not intended for manufacturing purposes



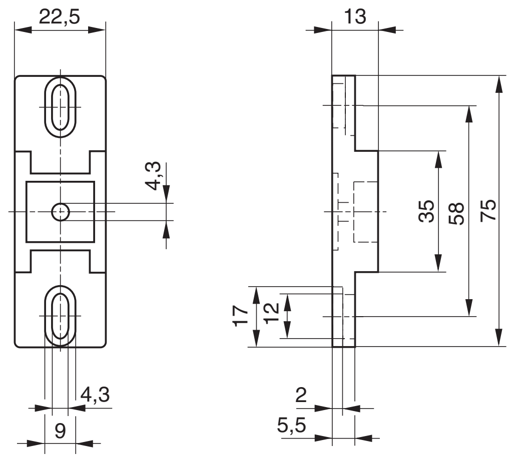
RZ7-FS (1 SPDT contact)



RZ7-FS (2 SPDT contacts)

Panel Mount Adaptor (26.506.221-01)

- Dimensions are in millimeters
- Dimensions not intended for manufacturing purposes



22. Test Sheets

Halmac Services (Qld) Pty. Ltd.
A.C.N. 098 852 923
A.B.N. 40 741 712 113

TEST SHEET

1. PUMP STATION SP086 TEST SHEET

Halmac Services (Qld) Pty Ltd
ACN 098 852 923 ABN 40 741 712 113 ECL 53064

30 Palmer Place, Murarrie Qld 4172
All hours Telephone (07) 3249 9500
Email: info@halmac.net.au

PO Box 3467, Tingalpa DC Qld 4173
Facsimile (07) 3249 9599
Web: www.halmac.net.au

CERTIFICATE OF:

(Please mark relevant check-box)

☒ **TESTING AND COMPLIANCE** (Electrical installations)
Issued in accordance with s159 of the *Electrical Safety Regulation 2002*

☒ **TESTING AND SAFETY** (Electrical equipment)
Issued in accordance with s15 of the *Electrical Safety Regulation 2002*

* Work performed for:

* Name — Title: — Given name/s: Queensland Urban — Surname: Utilities

* Address — Street: Indooroopilly Road

Suburb/town: Taringa — Postcode: 4068

* Electrical installation / equipment tested (detailed list of all work done):

- Installation of new Main Switchboard (using existing mains cables)
- Replacement of new Motor Control Switchboard (using existing & new cables)
- New main Earth Rod & Cable.
- Earth Continuity & Insulation Test
- Polarity Test

* Date of test 30 / 07 / 2010 * Electrical contractor licence number 53064

Name on contractor licence Halmac Services Qld Pty Ltd

Electrical contractor phone number 07 3249 9500

For **electrical installations**, this certifies that the electrical installation, to the extent it is affected by the electrical work, has been tested to ensure that it is electrically safe and is in accordance with the requirements of the wiring rules and any other standard applying under the *Electrical Safety Regulation 2002* to the electrical installation.

For **electrical equipment**, this certifies that the electrical equipment, to the extent it is affected by the electrical work, is electrically safe.

Name Dave Jackson (C16507)
Person who performed, or person who is responsible for work

Signature Date 15 / 9 / 2010

* **Indicates a mandatory field**

V2.02-2008

DESIGN & INSPECTION ROUTE SCHEDULE

CUSTOMER: B/W	PROJECT NAME: INDRO	PROJECT OFFICER:MN
JOB NO:A4229	SWITCHBOARD NAME:	DRAWING NO:

IS THIS SWITCHBOARD IDENTICAL, OR SIMILAR, TO A PREVIOUS DESIGN? YES (OELETE AS APPLICABLE)
IF "NO" COMPLETE SWITCHBOARD DESIGN REVIEW. IF "YES" PROVIDE PREVIOUS DRAWING NO. REFERENCE ....

(TICK APPLICABLE SECTION BELOW: YES / NO / N/A (Not Applicable)

DESCRIPTION	INSPECTION/TEST YES	NO	N/A	INSP.	DATE
					30/6/10
SHEET METALWORK - UNPAINTED	✓			TB	30/6/10
SHEET METALWORK - PAINTED	✓			TB	30/6/10
FRONT LAYOUT AS PER DWG	✓			TB	30/6/10
DITTO - SHARP EDGES REMOVED	✓			TB	30/6/10
WIRING BUILDING WIRE	✓			TB	30/6/10
FLEX	✓			TB	30/6/10
CRIMP LUGS	✓			TB	30/6/10
BUSBARS AFTER MANUFACTURE	✓			TB	30/6/10
BUSBARS - AFTER ASSEMBLY	✓			TB	30/6/10
FITTING OUT - BEFORE WIRING	✓			TB	30/6/10
FITTING OUT - AFTER WIRING	✓			TB	30/6/10
NAME PLATES - BEFORE FITTING	✓			TB	30/6/10
NAME PLATES - AFTER FITTING	✓			TB	30/6/10
MEGGER &/OR H.V. TEST	✓			TB	30/6/10
FUSES/C-B'S - CORRECT SIZE	✓			TB	30/6/10
WIRE & TERMINALS NUMBERED	✓			TB	30/6/10
CONTROL & POWER CONN. TIGHT	✓			TB	30/6/10
POINT TO POINT TEST	✓			TB	30/6/10
FUNCTIONAL TEST	✓			MN	01/07
COMPLETE S/BOARD TESTING	✓			MN	01/07
PLC/PROGRAMMING	✓			MN	01/07
FULL DOCUMENTATION IN DWG POCKET					
CORRECT DRAWING IN BOARD					
PACKING					

IF BUSBARS ARE APPLICABLE COMPLETE DETAIL BELOW	
• Sizing as per approved shop drawings	✓
• Accessible terminations and fixings	✓
• Adequate supports and spacing	✓
• Bolts correct type and torque tension	✓
• Compartment segregation	✓
• Phase-Phase & Phase-Earth Clearance	✓

INSULATION TEST

1. Megger between phases, phase to N/L phases to earth, with MEN link removed. Note details below in Table "Megger 1"
2. Megger N/L to earth with MEN link removed.
3. Apply 2.5kV for (1) min., phase to phase, phase to NL, and 3-phases to earth.
4. Remove HI VOLT tester and repeat Item (1). Note details below in Table "Megger 2".

HV TEST Set Details: ....
"MEGGER" Detail: 5159016 Serial No. ....
"HI POT" TEST VOLTAGE: ....kV Duration .... mins
"MEGGER" TEST VOLTAGE: 500 Volts D.C.
INSTRUMENT CALIBRATION: 26/6/10

TEST	MEGGER 1	"HI POT"	MEGGER 2
Red-White	20 M Ohm	.... mA	.... M Ohm
White-Blue	20 M Ohm	.... mA	.... M Ohm
Red-Blue	20 M Ohm	.... mA	.... M Ohm
Red-Neutral	20 M Ohm	.... mA	.... M Ohm
White-Neutral	20 M Ohm	.... mA	.... M Ohm
Blue-Neutral	20 M Ohm	.... mA	.... M Ohm
R.W.B.-Earth	20 M Ohm	.... mA	.... M Ohm

REQUEST FOR RELEASE

'As Built' Dwgs-Completed					
Test Reports - O.K.	✓			MN	01/07
Delivery Docket - Completed					
Packaging - Completed					

I certify that the electrical switchboard has been tested in accordance with the prescribed procedure and is suitable for connection to supply.

Certificate of Competency No : 103876

Signature of Electrical Mechanic : [signature]

WIRE COLOURS	240V ACTIVE: Red	240V NEUTRAL: Black
ELV-AC ACTIVE:	ELV-AC COMMON:	ELV DEVICES: Grey
ELV-DC POSITIVE: Orange	ELV-DC NEGATIVE: violet	TELEMETRY: Grey

NOTES: ....

Inspected by: JONATHAN of HALMAC DATE: 30/06/10

HS ITP 001 Rev 01 March 09

Halmac Services (Qld) Pty Ltd

Accepted by: .... of .... DATE: ....

Release Authorized by: .... of .... DATE: ....

TEST RESULTS

Description of Test	Results
Point to Point Test Done	As PER DRAWINGS.
Retested board after	ok.
variations.	
All PLC I/O tested.	ok
All probes connected and	ok.
tested.	
Transfer switch changed	ok.
wiring and tested.	

Tested By (Print Name): Mohammed.

Signed: ______________ Date: 30/06/10.

Customer Witness: ______________ Date: ______________

Halmac Services

Inspection & Test Procedure
Pre-Factory Acceptance Test (Pre-FAT)

PRE-FAT INSPECTION

Purpose
The purpose of the Pre-FAT is to check the completeness of the scope of work and minimise the time required to complete the FAT. The Pre-FAT will check scope of work, wiring, labelling, workmanship and equipment functionality.

This section is to be completed only at the conclusion of the Pre-FAT:

Final Pre-FAT Results

	YES	NO	Comments
Pre-FAT Completed	✓		
Minor NCRs Generated	✓		
Major NCRs Generated		✓	
Pre-FAT Accepted			

Notes:
1. Pre-FAT results to be recorded above by Contractor
2. Pre-FAT results to be approved by Commissioning Engineer at Pre-FAT (if present) or at the start of the FAT. NCRs are to be generated by the Commissioning Engineer for all NCRs still.

Contractor's Tester Signature .... **Date** 01/07/10

Contractor's Witness Signature .... **Date** ....

Commissioning Engineer Signature .... **Date** ....

Documentation	From	To	Done
1. Completed and signed Pre-Fat test sheet	Contractor	Commissioning Engineer	✓
2. Non conformances (if present)	Commissioning Engineer	Contractor, SWC	✓

Prerequisites
Prerequisites for the Pre-Fat are included in Section A of the record sheets.

Procedure
The Tester and Witness (both from the Contractor) complete these sheets during testing. These sheets must be submitted to the Commissioning Engineer for approval at the commencement of the FAT. All non-conformances noted during the Pre-FAT should be rectified by the contractor prior to the FAT.

The Commissioning Engineer would not normally witness the Pre-FAT, but has the right to do so. If the Commissioning Engineer does witness the test, Non Conformance Reports (NCR) may be issued to the tester for non-conformances in the testing procedure or manufacture.

Halmac Services

SWITCHBOARD METALWORK CHECKLIST

CUSTOMER: B/WATER

PROJECT: INDROOPHILLY **JOB NO:** A9229

SWITCHBOARD DESIGNATION: ______________

SWITCHBOARD DRAWING NO'S: ______________

CUBICLE INSPECTION

		Inspect		Date	Action Req. (if rejected)
		Acc	Rej		
1.	Material thickness	✓			
2.	Adequate metal stiffening & bracing	✓			
3.	Access panels & doors	✓			
4.	Adequate wiring space provision	✓			
5.	Cable entry/gland plates correctly located	✓			
6.	Ventilation louvres & mesh	✓			
7.	Specified IP rating	✓			
8.	Adequate framework to allow lifting	✓			
9.	Lifting facilities fitted	✓			
10.	Lift off door hinges	✓			
11.	Segregation partitions	✓			
12.	Suitable locking & latching	✓			
13.	All rust/corrosion removed prior to painting	✓			
14.	All sharp edges removed prior to painting	✓			
15.	Cubicle checked against drawing	✓			
16.	Welds visually OK	✓			
17.	Rubber retainers fitted	✓			

PAINT FINISH

a.	Paint colour & gloss as per drawings or detailed on order	✓			
b.	No grinding or buffing marks visible through paint	✓			
c.	No blemishes or spots on paint	✓			
d.	Under coats applied as specified	✓			
e.	Top coats applied as specified	✓			
f.	Paint thickness (if specified)				

COMMENTS:

....

....

....

FORM CHECKED FOR COMPLETION BY: Mohammed.

SIGNED: [signature]

DATE: 01/07/10.

HS CL 005 Rev 01 March 09

Halmac Services (Qld) Pty Ltd
ACN 098 852 923 ABN 40 741 712 113 ECL 53064
30 Palmer Place, Murarrie Qld 4172 PO Box 3467, Tingalpa DC Qld 4173
Telephone (07) 3249 9500 Facsimile (07) 3249 9599 Web www.halmac.net.au

JOB NAME: Indooroopilly

CLIENT: Brisbane

No: A4229

CC:

MCC CELL INSPECTION AND TEST REPORT

TIER: 3 CELL: 1

DESIGNATION: ~~SP086~~ Pump No 2

SIZE: 160 KW or 315 AMPS

PHYSICAL INSPECTION	RESULT	COMMENTS
Paint Finish good/no marks	good	
Labels complete/correct	yes	
Door Handles operational	N/A	
Door Handle Interlocks	N/A	
Components good/correct	good	
Phase Colour Markings	yes	
Shrouds secure/fitted	yes	
Danger Labels attached		no danger labels added
Earthing connections made	yes	
Termination Layout	yes	
Wire Colours correct	yes	
Wire Sizes appropriate	yes	
Wire Numbers fitted/readable	yes	
Wire Connections made/firm	yes	
Cleanliness	yes	

FUNCTION / OPERATIONAL TEST	RESULT	COMMENTS
Phase Check (voltage)	good	
Neutral Check (continuity)	good	
Earth Check (continuity)	good	
MCCB Check (operation/voltage)	good	
Control MCB/Fuse Check (voltage)	good	
Remote/Off/Local Selector	good	
Emergency Stop	good	
Available Lamp	N/A	
Local Start	✓	
Run Lamp	N/A	
Local Stop	✓	
Remote (Command) Start/Stop	✓	
Contactor Aux Check	✓	
Control Relay Aux Check	✓	
Overload Trip	N/A	
Shunt Trip	N/A	
Thermistor Trip	good	
CT Ratio Check	N/A	
Ammeter Check	N/A	
Transducer 4-20mA Check	N/A	
Connected Load Test	✓	
Speed Control Check	✓	
Speed Feedback Check	✓	
Ramp Up/ Ramp Down Check	✓	
Communications Check	✓	
PLC Input/Output Check	✓	

REFERENCE DRAWINGS FOR CELL

DRAWING TITLE	DRAWING NUMBER	REV
Pump No 2	486/5/7-0176-003	A

OVERALL COMMENTS

1 X KFA6-EK-1.6 RELAY ON BACK ORDER.
ALL CABLES IN PLACE. WILL HAVE TO BE DONE ON SITE.

TESTED BY: [signature] DATE: 09/07/10 WITNESSED BY: DATE: CLIENT: DATE:

Halmac Services (Qld) Pty Ltd
ACN 098 852 923 ABN 40 741 712 113 ECL 53064
30 Palmer Place, Murarrie Qld 4172 PO Box 3467, Tingalpa DC Qld 4173
Telephone (07) 3249 9500 Facsimile (07) 3249 9599 Web www.halmac.net.au

JOB NAME: Indooroopilly

No: A4229

CLIENT: Brisbane water

CC:

MCC CELL INSPECTION AND TEST REPORT

TIER: 4 CELL: 1

DESIGNATION: Pump No 1

SIZE: 160 KW or 315 AMPS

PHYSICAL INSPECTION	RESULT	COMMENTS
Paint Finish good/no marks	good	
Labels complete/correct	yes	
Door Handles operational	N/A	
Door Handle Interlocks	N/A	
Components good/correct	good	
Phase Colour Markings	yes	
Shrouds secure/fitted	yes	
Danger Labels attached		no danger labels added
Earthing connections made	yes	
Termination Layout	yes	
Wire Colours correct	yes	
Wire Sizes appropriate	yes	
Wire Numbers fitted/readable	yes	
Wire Connections made/firm	yes	
Cleanliness	yes	

FUNCTION / OPERATIONAL TEST	RESULT	COMMENTS
Phase Check (voltage)	good	
Neutral Check (continuity)	good	
Earth Check (continuity)	good	
MCCB Check (operation/voltage)	good	
Control MCB/Fuse Check (voltage)	good	
Remote/Off/Local Selector	good	
Emergency Stop	good	
Available Lamp	N/A	
Local Start	✓	
Run Lamp	N/A	
Local Stop	✓	
Remote (Command) Start/Stop	✓	
Contactor Aux Check	✓	
Control Relay Aux Check	✓	
Overload Trip	N/A	
Shunt Trip	N/A	
Thermistor Trip	good	
CT Ratio Check	N/A	
Ammeter Check	N/A	
Transducer 4-20mA Check	N/A	
Connected Load Test	✓	
Speed Control Check	✓	
Speed Feedback Check	✓	
Ramp Up/ Ramp Down Check	✓	
Communications Check	✓	
PLC Input/Output Check	✓	

REFERENCE DRAWINGS FOR CELL

DRAWING TITLE	DRAWING NUMBER	REV
Pump No 1	486/5/7-076-002	A

OVERALL COMMENTS

1 x KFA6-ER-1.6 RELAY ON BACK ORDER. ALL CABLES ARE IN PLACE. WILL HAVE TO BE DONE ON SITE.

TESTED BY: [signature] DATE: 09/07/10 · WITNESSED BY: ____ DATE: ____ CLIENT: ____ DATE: ____

QUEENSLAND UrbanUtilities

ABN 72 002 765 795

SP086 INDOOROOPILLY ROAD SEWAGE PUMP STATION

COMMISSIONING PLAN

In Attendance

Name	Role During Commissioning	Company
John Clayton	Commissioning Manager	QUU
Dave Jackson	Project Manager	Halmac Services
SAM WALLIN	ELECTRICIAN	HALMAC SERVICES
JOHN THOMAS	ELECTRICAL T/A	HALMAC SERVICES

Doc Id: 006536 Active Date: Brisbane Water Confidential
Printed: 25/06/2010 Owner: Gerard Anderson
Note: Printed copies of this document should be verified for currency against the published electronic copy.

INTRODUCTION

!! IMPORTANT !!
This commissioning Procedure is not to replace the electrical contractors own internal quality control and statutory documentation.

At all times during the switchboard upgrade, the pump station must be capable of running at least 1 of the 2 pumps. To achieve this during the switchboard changeover, a temporary pumping system will be configured by installing a temporary distribution and starter panel. A new Motorola RTU will be utilised to control the 2 pumps using interim hydrostatic level sensor and Multitrode electrodes.

The works also includes the modification of other existing switchboards on site and also various field installations.

1.1 SEQUENCE OF WORKS

The sequence of works shall be:

1. Station Preliminary Works
   a. Miscellaneous Station Preliminary Works

2. Switchboard Changeover Procedure
   a. PHASE A – CONNECTION OF NEW CT ENCLOSURE
      Step A1 - Run Station on Generator Supply
      Step A2 - Install supply cables to new CT enclosure
      Step A3 - Re-energise station transformer
      Step A4 - Energise new CT Enclosure
   b. PHASE B – CONNECTION OF TEMPORARY SWITCHBOARD & PUMP VSD
      Step B1 – Install Supply Cable to Temporary Switchboard
      Step B2 – Energise and Test Temporary Switchboard
      Step B3 – Connect pump No.2 VSD on Temporary Switchboard
      Step B4 – Run Pump No.2 on Temporary Switchboard
      Step B5 – Run Station on existing Pump Switchboard on Mains Supply
      Step B6 – Run Pump No.2 on temporary switchboard
      Step B7 – Connect Pump No.1 VSD on temporary switchboard
      Step B8 – Run Pump No.1 on Temporary Switchboard
   c. PHASE C - INSTALL NEW PUMP STATION SWITCHBOARD
      Step C1 - Disconnect existing switchboard supply cables from ATS switchboard
      Step C2 – Run Station on temporary pump switchboard
      Step C3 – Remove existing pump switchboard
      Step C4 – Install new switchboard and connection of supply cables
      Step C5 – Connect new pump switchboard to station CT Isolator
      Step C6 – Energise and test new pump switchboard
      Step C7 – Run new and temporary switchboards on Energex mains
   d. PHASE D - INSTALL PUMPS ON NEW PUMP SWITCHBOARD
      Step D1 – Reconnect Pump No.1 from temporary switchboard to new pump Switchboard
      Step D2 – Test & Commission Pump No.1 on new pump switchboard
      Step D3 – Disconnect ATS-Supply cable from New CT enclosure and Existing ATS Switchboard
      Step D4 – Re-connect Pump No.2 from Temporary Pump Switchboard to New Pump Switchboard
      Step D5 – Test & Commission Pump No.2 on New Pump Switchboard

e. PHASE E – REMOVE REDUNDANT SWITCHBOARDS AND CABLES
    - Step E1 – Disconnect 'Gen-Supply' cables from Generator
    - Step E2 – Remove redundant cables from Existing ATS Switchboard and Temporary Pump Switchboard
    - Step E3 – Remove Existing ATS Switchboard and Existing VSD's
    - Step E4 – Remove Temporary Pump Switchboard and cables

f. PHASE F – CONNECT STANDBY GENERATOR TO NEW SWITCHBOARD
    - Step F1 – Install new Genset cables to New Pump Switchboard
    - Step F2 – Test Generator connection to New Pump Switchboard
    - Step F3 – Test Generator Auto starts and runs each pump
    - Step F4 – Return Energex Supply

3. Post Changeover

1.2 MAINTENANCE CHECK OF EXISTING INSTALLATION

Before the works on site can commence, Water Distribution staff are to ensure that both pumps are fully operational and shall perform a thorough maintenance inspection of the site. Operating from the on-site permanent generator the Pump Station will also be tested at normal full load, a minimum of one pump to ensure that the generator is fully operational.

1.3 PRE COMMISSIONING CHECKLIST

The following checklist is to be completed and signed by the electrical contractor.

1.3.1 Switchboard Factory Acceptance Test

Contractor Task	Completed
FAT has been completed as per BCC QUU FAT Document and all defects that were identified have been rectified (new pump station switchboard).	OK ☑ Date 30/7/10
Prior to the SAT a FAT must also be completed on the Temporary Pumping System switchboard. The aim of the FAT is to ensure the temporary pumping system can maintain flow control of the site during cut-over. This includes having automatic level control and an independent audible battery backed level alarm. All defects that were identified during the Temporary Pump System FAT have been rectified.	OK ☑ Date 29/7/10

1.3.2 Generator Check

QUU Task	Checked
The stand bye generator can start run at full load for one hour and has sufficient fuel (full tank). This test is mandatory in assuring the generator is fully operational	OK ☑ NA ☐

1.3.3 Pump Station preliminary operational checks

QUU Task	Checked
These are checks that will ensure the pump station is fully operational and that no delays will be incurred due to any pump station problem out side of the contract. These task are desirable to have completed before the SAT but are not essential. The job can proceed if they are not done. Commissioning Manager to request networks maintenance to inspect and rectify if necessary	OK ☑
The existing reflux valves and associated limit switches are working correctly.	OK ☑
The discharge pressure connection point is available and that the isolation valve is functioning correctly.	OK ☑
The dry well exhaust fan is working correctly and quietly.	OK ☑
The wet well does not need pumping out.	OK ☑
The flow meters are functioning correctly.	OK ☐
Ensure that the station is fully functional (all pumps can run) and fuel is full tank is filled after test.	OK ☑

1.3.4 Discharge Mains Pressure Transducer

Contractor Task	Completed
Install delivery pressure transducer on the discharge rising main. Transducer is calibrated to the specified range (as per spec).	Installed OK ☑ Range 0 (m) to 50 (m) 0kPA to 500 kPA

Electrical Contractor's Supervisor

Name: Dave Jackson .... Date: 30/7/10

Signature: ....[signature]..........

BCC QUU Commissioning Manager

Name: John Clayton Date: 30/7/10

Signature: ....J. Clayton..........

Doc Id: 006536 Active Date: Brisbane Water Confidential

Printed: 25/06/2010 Owner: Gerard Anderson

Note: Printed copies of this document should be verified for currency against the published electronic copy.

2 STATION PRELIMINARY WORKS

2.1 UPGRADE REFLUX PROXIMITY SWITCHES

Contractor Task	Completed
Install new proximity switches on existing reflux valves including the fabrication and attachment of mounting brackets. These brackets must allow for the adjustment of the switches. Utilise existing conduits in dry well floor, if these are not suitable then new conduits must be laid in existing floor chasing. This requires the removal of existing grouting cover over chasing to access existing conduits for removal.	OK ☑

2.2 INSTALL NEW WET WELL INSTRUMENTATION JUNCTION BOX

Contractor Task	Completed
Install new stainless steel instrument J-box including terminals on exterior wall above existing cable pit. This will accommodate connections to wet well level probes and E+H level transmitter termination housing. Cabling from this J-box to wet well electrode box will be in conduits run via existing cable pit. Install new conduit between cable pit and electrode box. Refer to SHEET 23 and 29 for details.	OK ☑

2.3 UPGRADE WET WELL LEVEL SENSORS

Contractor Task	Completed
~~Remove all existing wet well level probes and Vega level sensor and their associated cabling and conduits.~~ Mount new E&H level transmitter terminal housing in new instrument J-box. Install cabling and conduits from pump switchboard to instrument J-box as per cable schedule. This cabling is to be routed via existing wall chasing behind switchboard. Install new level probes and level sensor as per SHEET 21. The installation of these new level probes will require the installation of additional hanging hooks in the existing electrode box. These hooks are to be of similar strength and mounted at the same height as existing hooks.	OK ☑

2.4 UPGRADE PUMP EMERGENCY STOP SWITCHES

Contractor Task	Completed
Install new pump emergency stop stations in dry well adjacent to each pump. Fit label to each stop station. Remove existing isolating switches and associated cabling and conduits.	OK ☑

2.5 UPGRADE 3Ø AND 1Ø G.P.O'S

Contractor Task	Completed
Remove all existing 3 phase outlets and GPO's within the pump station and the dry well and associated cabling and disused conduits. Install new 3 phase outlet and 1 phase GPO and associated cabling on northern wall. Remove existing 1 phase GPO and associated cabling and conduits on external eastern wall. Replace with new 1 phase GPO and associated cabling. Remove existing crane isolator and associated cabling and disused conduits. Install isolator and associated cabling for the gantry crane. Locate isolator on northern wall. Fit label to isolator. Remove redundant telecom J-box and outlets and associated cabling behind new pump switchboard location.	OK ☑

Electrical Contactor's Supervisor	QUU Commissioning Manager
Name: **Dave Jackson** Date: 2/8/10	Name: **John Clayton** Date: 2/8/10
Signature: [signature]	Signature: [signature]

2.6 UPGRADE DELIVERY PRESSURE TRANSMITTER

Contractor Task	Completed
Remove existing pressure transmitter cabling and conduits from dry well. Install new pressure transmitter, cabling and associated fitting as per sheet '21' into new tapping point in header pipe provided in pump No1 pipework, located in drywell on pump floor. Fit label to pressure transmitter.	OK ☐

2.7 FLOWMETER TRANSMITTERS

Contractor Task	Completed
Remove redundant flow transmitter cabling and J-box on internal wall. Fill wall penetration with non-shrink grout. NA	OK ☐

2.8 UPGRADE STATION LIGHTING CABLING

Contractor Task	Completed
Ensure double insulation is maintained throughout the installation and extends to the switchboard distribution area. Reuse conduits and Junction boxes if applicable. Remove any redundant conduits and associated wiring. Remove existing fluorescent light fittings behind existing switchboard and in new CT enclosure position including cabling and conduits, and remount on ceiling in front of new pump switchboard position.	OK ☐

2.9 UPGRADE VENTILATION FAN WIRING

Contractor Task	Completed
Remove old wiring, conduits and fittings associated with the ventilation fan. Install new cabling and isolator to ventilation fan. Isolator shall be fitted to vent shaft at the motor. Fit label to isolator.	OK ☑

2.10 UPGRADE DRY WELL SUMP PUMP AND STATION ELECTRODES

Contractor Task	Completed
Remove existing electrodes, brackets and associated cabling and conduits from the dry well sump pump. Install new Multitrode probes (SHEET 04) including all new stainless steel brackets to facilitate proper mounting of all probes. Run probe cables via conduits to sump level probes J-box. Remove existing 'Dry Well Flooded' probe and associated cabling and conduits. Install new multitrode probes for 'Station flooded alarm' and 'Station flooded trip'. Run probe cables via conduits to station level probes J-box.	OK ☐

2.11 INSTALL NEW STROBE LIGHT

Contractor Task	Completed
Install new strobe alarm light and associated cabling, conduits and mounting brackets. Position new strobe light on underside of top floor, between pump access and ladder access.	OK ☐

2.12 INSTALL NEW EARTH ELECTRODE

Contractor Task	Completed
Install new earth electrode pit and electrode adjacent new meter box. Provide new penetration through building for cable run. Adequately seal penetration.	OK ☑

Electrical Contactor's Supervisor

Name: **Dave Jackson** Date: 2/8/10

Signature: D Jackson

QUU Commissioning Manager

Name: **John Clayton** Date: 2/8/10

Signature: [signature]

2.13 SYSTEM PRE-COMMISSIONING

Run each pump in local mode and record the system curves for the following pump speeds.

Pump NO.	Hz	Total Amps	Total kW	Total kVA	Total PF	Voltage THD / phase	Flow L/s	Discharge Pressure (mAHD)	Wet well Level (mAHD)
1	45	200							35%
1	47.5								
1	50								
2	45								
2	47.5								
2	50								

Electrical Contactor's Supervisor

Name: Dave Jackson Date: 30/7/10.

Signature: ....[signature]....

QUU Commissioning Manager

Name: John Clayton Date: 30/7/10

Signature: ..J. Clayton..

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3 SWITCHBOARD CHANGEOVER PROCEDURE

The following sequence of change over works is the order in which they must be followed. **One** pump must be operational at all times. After each phase has been completed, the commissioning manager will record the results and instruct the commissioning team to commence work on the next phase. Note this changeover procedure has been updated from the original Scope of Works document Appendix E to align with the switching sheets.

PHASE A: CONNECTION OF NEW CT ENCLOSURE

3.1 PHASE A – CONNECTION OF NEW CT ENCLOSURE

3.1.1 Step A1 - Run Station on Generator Supply

A1	Display the A1 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
Call the QUU Control Room Operator (CRO) and inform them that you are on site. Record the CRO's Name and Officer Code and record the time of the call. Advise CRO that you are working as part of the switchboard changeover project and that you will be taking Energex offline and running the station using the onsite Generator. **Give the operator your contact name and number and advise the operator that communications may be lost to the pump station until the job is finished.**	Name: Tavi CRO: ______ Time: 0730
Before the following work commences it should be checked that the items below have been completed : - Remove existing fluorescent light fitting from CT enclosure position. - Install CT enclosure in location detailed in site layout drawing. - Install new meter box on external wall and run CT wiring to enclosure.	OK ☑
Install and test independent, battery backed high alarm system (with Multitrode level sensor) in the wet well to provide audible and Visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level. Not Done	OK ☐
Ensure that the station is fully functional (all 2 pumps can run)	P1 ☑ P2 ☑
Ensure Generator is ready to start, No faults, Fuel Tank Full.	OK ☑
QUU Commissioning Manager to ensure standby Diesel pump set is ready to start, No faults, Fuel Tank Full, procedure for starting available etc.	OK ☑
THIS IS A HOLD POINT. **Do not proceed until ALL 2 PUMPS are confirmed to be fully operational, generator available and Diesel standby pump operational**	Signature: J Clayton TIME: 0930
Record the kWhr meter serial numbers.	#

Electrical Contactor's Supervisor

Name: Dave Jackson Date: 30/7/10

Signature: [signature]

QUU Commissioning Manager

Name: John Clayton Date: 30/7/10

Signature: J Clayton

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Contractor Task	Outcome
Record 3 phase motor currents from VSD display panel (At 50Hz) 46HZ. Pump #1 Pump #2	200 A U.__V.__W.__ U. 200 W. A
Check Generator CB is closed. Generator Main CB [QG: CLOSE]	QG CLOSE ☑
All switching to be done with no pumps running. Ensure no pumps are running i.e. place Pump Station - Common Control - Remote/Local Switch on existing Pump Station switchboard to Local Mode	STN LOCAL MODE LOCAL ☑
Switch Existing ATS Switchboard 'SYSTEM MODE' switch to Manual Mode Position	ATS SYSTEM MODE MANUAL ☐
Switch Existing ATS Switchboard 'CB CONTROL' switch to 'GENERATOR' Mode Position [QE3: CLOSE] [QE2: OPEN]	ATS CB CONTROL GENERATOR ☐ QE3: CLOSE ☐ QE2: OPEN ☐
Start Generator using Generator Control Start PB on ATS/Generator Mimic	Generator Starts ☐
Cycle pumps i.e. place Existing Pump Switchboard - Common Control - Remote/Local Switch on existing Pump Station switchboard to Remote Mode. Watch pumps start, stop and cycle successfully.	STN REMOTE MODE REMOTE ☐
THIS IS A HOLD POINT. **Do not proceed until the generator is confirmed to be controlling the pump station correctly i.e. pumps cycle on/off.**	OK ☑
OPEN, LOCK and TAG ATS 'MAINS CB' Open [QE2: OPEN]	QE2: OPEN ☑
OPEN, LOCK and TAG Pump Switchboard Main Switch CB Open [QE1 OPEN]	QE1 OPEN ☑

Did the ATS switch in Auto.
Energy off Auto Transferred to Generator

Electrical Contactor's Supervisor

Name: **Dave Jackson** Date: 26/7/10

Signature: ....

QUU Commissioning Manager

Name: **John Clayton** Date: 30/7/10

Signature: J. Clayton..........

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3.1.2 Step A2 - Install supply cables to new CT enclosure

COMMISSIONING MANAGER		Outcome
A2	Display the A2 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
De-energise Station Transformer – Energex Switching task	ENERGEX TAS COMPLETED ☐
Test for Dead at line and load side of pump switchboard Main Switch [QE1]	QE1 DEAD ☑
Cut and re-terminate 'MAINS-SUPPLY' cables from Main Switch (QE1) onto Line side of CT Isolator (Q1) i.e. measure and cut 150mm2/phase mains cables running from transformer to existing pump switchboard main switch (QE1) and re-terminate into new CT enclosure isolator including neutral cable via gland plate supplied. (This will be a permanent connection).	Q1 LINE SIDE CONNECTED ☑
Cut and re-terminate 'ATS-SUPPLY' cables from Existing ATS Switchboard (QE2) onto Load side of New CT enclosure CT's i.e. measure and cut 150mm2/phase (+ neutral) mains cables running from existing pump switchboard Main Switch to existing ATS switchboard and re-terminate into new CT enclosure onto CT chamber busbar via cable access on lower left hand side of enclosure. (This will be a temporary connection from CT enclosure to ATS).	QE2 CONNECTED TO LOAD SIDE OF CT's Q1 ☑
Confirm correct phasing of cables and perform insulation tests. Record results.	OK ☑
Energex to install new meters and injection test	OK ☑

3.1.3 Step A3 - Re-energise station transformer

COMMISSIONING MANAGER		Outcome
A3	Display the A3 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
Re-energise Station Transformer – Energex Switching task	ENERGEX TASK COMPLETED ☑
Test for supply on Line Side of CT Isolator (Q1).	ENERGEX SUPPLY AVAILABLE AT Q1 ☑
Check Rotation and ensure it is the same as previous.	↻ ☑ ↺ ☐
Label Pump Station switchboard Main Switch (QE1) as 'Out of Service– Isolate Elsewhere'.	QE1 LABEL ATTACHED ☑

Electrical Contactor's Supervisor	QUU Commissioning Manager
Name: **Dave Jackson** Date: 30/7/10	Name: **John Clayton** Date: 30/7/10
Signature: [signature]	Signature: J. Clayton

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3.1.4 Step A4 - Energise new CT Enclosure

COMMISSIONING MANAGER	Outcome
A4 Display the A4 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
All switching to be done with no pumps running. Ensure no pumps are running i.e. place Pump Station - Common Control - Remote/Local Switch on existing Pump Station switchboard to Local Mode	STN LOCAL MODE LOCAL ☑
Close CT Isolator [Q1 : CLOSE]	Q1 CLOSE ☑
Test for supply on Line Side of ATS Switchboard (QE2)	ENERGEX SUPPLY AVAILABLE AT QE2 ☑
Check Rotation and ensure it is the same as previous.	↻ ☑ ↺ ☐
Remove LOCK & TAG from ATS 'Mains CB' (QE2)	QE2 ☑
Switch Existing ATS Switchboard ATS 'CB CONTROL' switch to 'MAINS' Mode Position [QE2: CLOSE] [QE3: OPEN]	ATS CB CONTROL MAINS ☑ QE2 CLOSE ☑ QE3 OPEN ☑
Cycle pumps i.e. place Pump Station - Common Control - Remote/Local Switch on existing Pump Station switchboard to Remote Mode. Watch pumps start, stop and cycle successfully.	STN REMOTE MODE REMOTE ☑
Stop Generator	GENERATOR STOPS ☑
Switch Existing ATS Switchboard 'SYSTEM MODE' switch to 'Auto' Mode Position	ATS SYSTEM MODE AUTO ☑

Electrical Contactor's Supervisor

Name: Dave Jackson Date: 30/7/10

Signature: [signature]

QUU Commissioning Manager

Name: John Clayton Date: 30/7/10

Signature: J. Clayton

PHASE B: CONNECTION OF TEMPORARY SWITCHBOARD AND PUMP VSD's

3.2 PHASE B – CONNECTION OF TEMPORARY SWITCHBOARD & PUMP VSDS

3.2.1 Step B1 – Install Supply Cable to Temporary Switchboard

COMMISSIONING MANAGER	Outcome
B1 Display the B1 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
Install and test independent, battery backed high alarm system (with Multitrode level sensor) in the wet well to provide audible and Visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Acknowledge a maximum 15 minute window is available for the connection of the temporary supply cable.	OK ☑
Activate emergency lighting. NOT required	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during phase B1 the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running. Ensure no pumps are running i.e. place Pump Station - Common Control - Remote/Local Switch on existing Pump Station switchboard to Local Mode	STN LOCAL MODE LOCAL ☑
Switch Existing ATS Switchboard 'SYSTEM MODE' switch to Manual Mode Position	ATS SYSTEM MODE Manual ☑
Switch Station ATS 'CB CONTROL' switch to 'OFF' Mode Position [QE2: OPEN] [QE3: OPEN]	ATS CB CONTROL OFF QE2 OPEN ☑ QE3 OPEN ☑
Confirm existing ATS Mains CB and Gen CB are open. [QE2: OPEN] [QE3: OPEN]	QE2 OPEN ☑ QE3 OPEN ☑
OPEN, LOCK and TAG CT Isolator [Q1 OPEN]	Q1 OPEN ☑
OPEN, LOCK and TAG 'Generator CB' Open [QG OPEN]	QG OPEN ☑
Test for Dead at Connection Point [B]	ConX B DEAD ☑
Install temporary supply 'TEMP-SUPPLY' cables from Temporary Pump Switchboard [QT1] to Existing ATS Switchboard at Connection Point [B]	OK ☑

Electrical Contactor's Supervisor	QUU Commissioning Manager
Name: Dave Jackson Date: 2/8/10	Name: John Clayton Date: 2/8/10
Signature:	Signature: J. Clayton ....

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3.2.2 Step B2 – Energise and Test Temporary Pump Switchboard

COMMISSIONING MANAGER	Outcome
B2 Display the B2 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
Remove Lock and Tag and close CT Isolator [Q1 CLOSE]	Q1 CLOSE ☑
Remove Lock and Tag from ATS Mains CB and Generator CB [QE2 OPEN] [QE3 OPEN]	QE2 OPEN ☑ QE3 OPEN ☑
Switch Existing ATS Switchboard 'CB CONTROL' switch to 'MAINS' Mode Position [QE2 CLOSE] [QE3: OPEN]	ATS CB CONTROL MAINS ☑ QE2 CLOSE ☑ QE3: OPEN ☑
Cycle pumps i.e. place Pump Station - Common Control - Remote/Local Switch on existing Pump Station switchboard to Remote Mode. Watch pumps start, stop and cycle successfully from level signals.	STN REMOTE MODE REMOTE ☑
Check phase rotation and voltage at temporary switchboard (QT1)	OK ☑
Remove Lock and Tag and Close Generator CB [QG CLOSE]	QG CLOSE ☑
Switch Existing ATS Switchboard 'SYSTEM MODE' switch to Auto Mode Position	ATS SYSTEM MODE Auto ☑
THIS IS A HOLD POINT **Do not proceed until all tests for the Temporary Pump Switchboard are completed. Note that the following steps must be continuous. A decision needs to be made as to whether the following steps (B3 to B6) can be completed continuously. If stopping work until the following day then ensure QT1 is open [QT1: OPEN].**	Signature [signature] TIME 1300hrs

!!! WARNING !!!

The following works (B3 to B6) shall be continuous and the station can NOT be left unattended during this work, Multiple shifts shall be used if required and each employee can only working a maximum hours as per their WH&S regulations.

Electrical Contactor's Supervisor	QUU Commissioning Manager
Name: Dave Jackson Date: 2/8/10	Name: John Clayton Date: 2/8/10
Signature: [signature]	Signature: [signature]

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3.2.3 Step B3 – Connect pump No.2 VSD on to the Temporary Switchboard

COMMISSIONING MANAGER	Outcome
B3 Display the B3 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

NOT DONE REQUIRE 3?

Contractor Task	Outcome
OPEN, LOCK and TAG Temporary Pump Switchboard Isolator [QT1 OPEN]	QT1 OPEN ☐
OPEN, LOCK and TAG Temporary Pump Switchboard Pump No.2 CB [QT5 OPEN]	QT5 OPEN ☑
Test for Dead at QT5	QT5 DEAD ☑
OPEN, LOCK and TAG Existing Pump Switchboard Pump No.2 CB [QE5 OPEN]	QE5 OPEN ☑
Test for Dead at QE5	QE5 DEAD ☑
Pull back, cut & re-terminate Pump No.2 VSD Supply Cables onto temporary switchboard Pump No.2 CB (QT5).	OK ☑
Pull back, re-terminate Pump No.2 Motor cables directly onto Pump No.2 VSD Output terminals.	OK ☑
Check phasing and CB Settings	OK ☑
Re-route & terminate VSD No.2 Control Cables, Thermistor and lockout cables.	OK ☑
Re-program Pump No.2 VSD parameters as required.	OK ☑

3.2.4 Step B4 – Run Pump No.2 on Temporary Switchboard

COMMISSIONING MANAGER	Outcome
B4 Display the B4 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
Confirm temporary switchboard level instruments are terminated and functioning correctly. Verify level signal by comparing with the Existing pump switchboard level.	OK ☑
All switching to be done with no pumps running. Ensure no pumps are running i.e. place Pump Station - Common Control - Remote/Local Switch on existing Pump Station switchboard to Local Mode	STN LOCAL MODE LOCAL ☑
Open existing pump switchboard Pump No.1 & Pump No. 2 CB's [QE4 OPEN] [QE5 OPEN]	QE4 OPEN ☑ QE5 OPEN ☑
Remove Lock and Tag and Close Temporary Switchboard Isolator [QT1 CLOSE]	QT1 CLOSE ☑
Remove Lock and Tag and Close Temporary Switchboard Pump No.2 CB [QT5 CLOSE]	QT5 CLOSE ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 4/8/10

Signature: D Jackson

QUU Commissioning Manager

Name: John Clayton Date: 4/8/10

Signature: J Clayton

Commission Pump No.2 on temporary switchboard. Confirm Auto control from temporary level signals.	OK ☑
When all tests for Pump No.2 are completed then depending on the time of day you will either Continue to Step B7 and cutover Pump No.1 OR If stopping work until the following day then continue to Step B5 and stop for the day.	OK ☑

3.2.5 Step B5 – Connect Pump No.1 VSD on temporary switchboard

COMMISSIONING MANAGER	Outcome
B5 Display the B5 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
All switching to be done with no pumps running. Ensure no pumps are running i.e. place existing Pump Station - Common Control - Remote/Local Switch on existing Pump Station switchboard to Local Mode.	STN LOCAL MODE LOCAL ☑
OPEN, LOCK and TAG Temporary Pump Switchboard Pump No.1 CB [QT4 OPEN]	QT4 OPEN ☑
Test for Dead at QT4	QT4 DEAD ☑
OPEN, LOCK and TAG Existing Pump Switchboard Pump No.1 CB [QE4 OPEN]	QE4 OPEN ☑
Test for Dead at QE4	QE4 DEAD ☑
Pull back, cut & re-terminate Pump No.1 VSD Supply Cables onto temporary switchboard Pump No.1 CB (QT4).	OK ☑
Disconnect, re-terminate Pump No.1 Motor cables directly onto Temporary Pump Switchboard Pump No.1 VSD Output terminals.	OK ☑
Check phasing and CB Settings	OK ☑
Re-route & terminate VSD No.1 Control Cables, Thermistor and lockout cables.	OK ☑
Re-program Pump No.1 VSD parameters as required.	OK ☑

3.2.6 Step B6 – Run Pump No.1 on Temporary Switchboard

COMMISSIONING MANAGER	Outcome
B6 Display the B6 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
All switching to be done with no pumps running. Ensure Pump No.2 CB on temporary pump station switchboard is open [QT5 OPEN]	QT5 OPEN ☑

Electrical Contactor's Supervisor

Name: D JACKSON Date: 3/8/10

Signature:

QUU Commissioning Manager

Name: John Clayton Date: 3/8/10

Signature:

Remove Lock and Tag and Close Temporary Switchboard Pump No.1 CB [QT4 CLOSE]	QT4 CLOSE ☐
Commission Pump No.1 on temporary switchboard. Confirm Auto control from temporary level signals.	OK ☑
When all tests for Pump No.1 are completed then open Pump No.2 CB on the temporary pump station switchboard and ensure both pumps cycle effectively.	OK ☑
Commission the telemetry link for the temporary pump station switchboard. Note the antennae connection for the old switchboard will need to be used to allow the temporary switchboard to communicate with QUU Control Room. Check the following alarms to ensure they activate correctly back to the QUU Control Room : Surcharge Occurring Surcharge Imminent Wet Well High Wet Well Invalid Site Power Fail (Motorola AC Fail) Pump 1 Faulted Pump 1 Not in Auto Pump 2 Faulted Pump 2 Not in Auto	OK ☐ OK ☑ OK ☑ OK ☐ OK ☐ OK ☑ OK ☐ OK ☑ OK ☐
THIS IS A HOLD POINT: **Do not proceed until each pump on the temporary switchboard is confirmed to be controlling the wet well level.**	Signature J Clayton TIME 1730

NOTICE

THE STATION CAN NOW BE LEFT UNATTENDED AT THIS STAGE

Electrical Contactor's Supervisor	QUU Commissioning Manager
Name: DAVE JACKSON Date: 3/8/10	Name: John Clayton Date: 3/7/10
Signature:	Signature: J Clayton

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PHASE C: INSTALL NEW PUMP STATION SWITCHBOARD

!!! WARNING !!!

The following works shall be continuous and the station can NOT be left unattended during this work, Multiple shifts shall be used if required and each employee can only working a maximum hours as per their WH&S regulations.

3.3 PHASE C - INSTALL NEW PUMP STATION SWITCHBOARD

3.3.1 Step C1 - Disconnect existing switchboard supply cables from ATS switchboard

COMMISSIONING MANAGER	Outcome
C1 Display the C1 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Acknowledge a maximum 15 minute window is available for removing the existing switchboard supply 'Exist-Supply', providing the pump station level is pumped down to the Duty A stop level immediately prior to work commencing.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
THIS IS A HOLD POINT **Do not proceed until emergency diesel pump is confirmed to be operational and controlling the wet well level.**	Signature J Clayton TIME ___:___
Activate temporary work area lighting. N O	OK ☐
All switching to be done with no pumps running.	OK ☑
Switch Existing ATS Switchboard 'SYSTEM MODE' switch to Manual Mode Position	ATS SYSTEM MODE Manual ☑
Switch Existing ATS Switchboard 'CB CONTROL' switch to 'OFF' Mode Position [QE2: OPEN] [QE3: OPEN]	ATS CB CONTROL OFF ☑ QE2: OPEN ☑ QE3: OPEN ☑

Electrical Contactor's Supervisor	QUU Commissioning Manager
Name: DAVE JACKSON Date: 4/8/10	Name: John Clayton Date: 4/8/10
Signature: [signature]	Signature: J Clayton

Confirm existing ATS 'MAINS CB' is Open [QE2 OPEN]	QE2 OPEN ☐
Confirm existing ATS 'Generator CB' is Open [QE3 OPEN]	QE3 OPEN ☐
OPEN, LOCK and TAG CT Isolator [Q1 OPEN]	Q1 OPEN ☐
OPEN, LOCK and TAG 'Generator CB' Open [QG OPEN]	QG OPEN ☐
Test for Dead at Connection Point [B]	ConX B DEAD ☐
Remove 'EXIST-SUPPLY' cables from ATS Switchboard at Connection Point [B]	OK ☐

3.3.2 Step C2 – Run Station on temporary pump switchboard

COMMISSIONING MANAGER	Outcome
C2 Display the C2 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☐

Contractor Task	Outcome
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running.	OK ☐
Remove LOCK and TAG and Close new CT Isolator [Q1 CLOSE]	Q1 CLOSE ☐
Switch Existing ATS Switchboard 'CB CONTROL' switch to 'MAINS' Mode Position [QE2: CLOSE] [QE3: OPEN]	ATS CB CONTROL MAINS ☐ QE2: CLOSE ☐ QE3: OPEN ☐
Confirm pumps control on temporary switchboard. Confirm Auto control from temporary level signals for both pumps.	PUMP 1 ☐ PUMP 2 ☐
THIS IS A HOLD POINT. **Do not proceed until pumps are confirmed to be working on temporary switchboard ie operational and controlling the wet well level.**	Signature TIME 1930
Remove LOCK and TAG and Close 'Generator CB' Open [QG CLOSE]	QG CLOSE ☐
Switch Existing ATS Switchboard 'SYSTEM MODE' switch to Auto Mode Position	ATS SYSTEM MODE Auto ☐

Electrical Contactor's Supervisor

Name: D. ALG JACKSON Date: 9/8/10

Signature:

QUU Commissioning Manager

Name: John Clayton Date: 4/8/10

Signature:

3.3.3 Step C3 – Remove existing pump switchboard

COMMISSIONING MANAGER	Outcome
C3 Display the C3 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running.	OK ☑
Test for Dead at existing pump switchboard.	Existing pump switchboard DEAD ☑
Disconnect and remove all power cables from existing pump switchboard	OK ☑
Disconnect all ancillary cables from existing pump switchboard	OK ☑
Remove existing pump switchboard	OK ☑

3.3.4 Step C4 – Install new switchboard and connection of supply cables

COMMISSIONING MANAGER	Outcome
C4 Display the C4 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Physically install new pump switchboard and new VSDs	OK ☑
OPEN, LOCK and TAG New Pump Switchboard Normal Supply Main Switch [Q2 OPEN]	Q2 OPEN ☑
OPEN, LOCK and TAG New Pump Switchboard Generator Supply Main Switch [Q3 OPEN]	Q3 OPEN ☑
Connect new supply cables (Mains-Supply-A) to new pump switchboard normal supply main switch (Q2)	OK ☑
Check phasing, check CB settings	OK ☑
Prepare 'Mains-Supply-A' cables for connection to new CT Isolator (Q1).	OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 4/8/10

Signature: [signature]

QUU Commissioning Manager

Name: J. C. Clayton Date: 4/8/10

Signature: J Clayton

Doc Id: 006536 Active Date: Brisbane Water Confidential

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3.3.5 Step C5 – Connect new pump switchboard to station CT Isolator

COMMISSIONING MANAGER	Outcome
C5 Display the C5 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Ensure Generator is ready to start, No faults, Fuel Tank Full.	OK ☑
THIS IS A HOLD POINT! **Do not proceed until generator is confirmed to be working i.e. no alarms and sufficient fuel.**	Signature J Clayton TIME 1030 am
Ensure existing 'Generator CB' is Closed [QG CLOSE]	QG CLOSE ☑
Switch existing ATS 'SYSTEM MODE' switch to Manual Mode Position	ATS SYSTEM MODE Manual ☑
Start Generator	OK ☑
Switch existing ATS 'CB CONTROL' switch to 'Generator' Mode Position [QE2: OPEN] [QE3: CLOSE]	ATS CB CONTROL GENERATOR ☑ QE2: OPEN ☑ QE3: CLOSE ☑
Ensure both pumps cycle successfully	OK ☑
OPEN, LOCK and TAG existing ATS 'MAINS CB' [QE2 OPEN]	QE2 OPEN ☑
OPEN, LOCK and TAG new CT Isolator [Q1 OPEN]	Q1 OPEN ☑
Test for Dead at Connection Point [A]	ConX A DEAD ☑
Terminate 'Mains-Supply-A' cable to CT Isolator at Connection Point [A] and check phasing	OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 4/8/10

Signature: D Jackson

QUU Commissioning Manager

Name: John Clayton Date: 4/8/10

Signature: J Clayton

Doc Id: 006536	Active Date:	Brisbane Water Confidential
Printed: 25/06/2010	Owner: Gerard Anderson	

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3.3.6 Step C6 – Energise and test new pump switchboard

COMMISSIONING MANAGER		Outcome
C6	Display the C6 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Remove LOCK and TAG and Close new CT Isolator [Q1 CLOSE]	Q1 CLOSE ☑
Check voltage and phase rotation at new pump switchboard normal supply main switch (Q2).	OK ☑
OPEN, LOCK and TAG New Pump Switchboard Pump 1 Isolator [Q4 OPEN]	Q4 OPEN ☑
OPEN, LOCK and TAG New Pump Switchboard Pump 2 Isolator [Q5 OPEN]	Q5 OPEN ☑
Remove LOCK and TAG and Close new pump switchboard normal supply main switch [Q2 CLOSE]	Q2 CLOSE ☑
Check voltage and phase rotation at new pump switchboard pump isolators (Q4) and (Q5).	OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 5/8/10

Signature: ....

QUU Commissioning Manager

Name: John Clayton Date: 5/8/10

Signature: ....

Doc Id: 006536 Active Date: Brisbane Water Confidential

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3.3.7 Step C7 – Run new and temporary switchboards on Energex mains

COMMISSIONING MANAGER	Outcome
C7 Display the C7 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Remove LOCK and TAG from existing ATS 'Mains CB' (QE2)	QE2 ☑
Switch existing ATS 'CB CONTROL' switch to 'Mains' Mode Position [QE2: CLOSE] [QE3: OPEN]	ATS CB CONTROL MAINS ☑ QE2: CLOSE ☑ QE3: OPEN ☑
Switch existing ATS 'SYSTEM MODE' switch to 'Auto' Mode Position	ATS SYSTEM MODE Auto ☑
Stop Generator	OK ☑
Confirm pumps control on temporary switchboard from Energex supply. Confirm Auto control from temporary level signals for both pumps.	PUMP 1 ☑ PUMP 2 ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 5/8/10

Signature: DJackson

QUU Commissioning Manager

Name: John Clayton Date: 5/8/10

Signature: J Clayton

Doc Id: 006536 Active Date: Brisbane Water Confidential

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PHASE D: INSTALL PUMPS ON NEW PUMP SWITCHBOARD

3.4 PHASE D - INSTALL PUMPS ON NEW PUMP SWITCHBOARD

3.4.1 Step D1 – Reconnect Pump No.1 from temporary switchboard to new pump switchboard

COMMISSIONING MANAGER		Outcome
D1	Display the D1 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task		Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.		OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.		OK ☑
THIS IS A HOLD POINT! **Do not proceed until emergency diesel pump is confirmed to be operational and controlling the wet well level.**		Signature J Clayton TIME 0700 am
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.		
All switching to be done with no pumps running and with station in 'Local' mode.		OK ☑
OPEN, LOCK and TAG Temp Pump Switchboard Pump 1 Isolator [QT4 OPEN]		QT4 OPEN ☑
Test for Dead at Temporary Pump Switchboard 'Pump No. 1 CB' [QT4]		QT4 DEAD ☑
Test for Dead at New Pump Switchboard 'Pump No. 1 CB' [Q4]		Q4 DEAD ☑
Pull back and re-terminate Pump No.1 pump cables to New Pump Switchboard Pump No.1 VSD output terminals		OK ☑
Check phasing, check CB settings		OK ☑
Terminate Pump VSD No. 1 control cables, thermistor, bearing temperature etc and lockout cables		OK ☑

Electrical Contactor's Supervisor	QUU Commissioning Manager
Name: DAVE JACKSON Date: 9/8/10	Name: John Clayton Date: 9/8/10
Signature: D Jackson	Signature: J Clayton

3.4.2 Step D2 – Test & Commission Pump No.1 on new pump switchboard

COMMISSIONING MANAGER	Outcome
D2 Display the D2 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Switch New Pump Switchboard Local/Remote Switch into Local Mode	STN LOCAL MODE LOCAL ☑
Remove LOCK and TAG and Close New Pump Switchboard Pump No.1 CB [Q4 Close]	Q4 Close ☑
Program Pump No.1 VSD parameters as required	OK ☑
OPEN, LOCK and TAG Test Pump Switchboard Pump No.2 CB [QT5 OPEN]	QT5 OPEN ☑
Test run New Pump Switchboard 'Pump No.1' under Local control, confirming correct rotation	OK ☑
Switch New Pump Switchboard Local/Remote Switch into Remote Mode	STN LOCAL MODE REMOTE ☑
Fully commission Pump No.1 in Remote mode, confirm automatic control from new level probes and pump cycles correctly.	OK ☑
When all tests are completed and Pump No.1 is running satisfactorily then continue.	OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 9/8/10

Signature: D Jackson

QUU Commissioning Manager

Name: John Clayton Date: 9/8/10

Signature: J. Clayton

Doc Id: 006536 Active Date: Brisbane Water Confidential

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3.4.3 Step D3 – Disconnect ATS-Supply cable from New CT enclosure and Existing ATS Switchboard

COMMISSIONING MANAGER	Outcome
D3 Display the D3 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Ensure Generator is ready to start, No faults, Adequate fuel.	OK ☑
Switch existing ATS 'SYSTEM MODE' switch to Manual Mode Position	ATS SYSTEM MODE Manual ☑
Start Generator No	OK ☐
Switch existing ATS 'CB CONTROL' switch to 'Generator' Mode Position [QE2: OPEN] [QE3: CLOSE]	ATS CB CONTROL GENERATOR ☑ QE2 OPEN ☑ QE3 CLOSE ☑
Open New Pump Switchboard Pump No.1 CB [Q4 OPEN]	Q4 OPEN ☑
Close Temporary Pump Switchboard Pump No.2 CB [QT5 CLOSE]	QT5 CLOSE ☑
Ensure pump cycles successfully	OK ☑
OPEN, LOCK and TAG Existing ATS Switchboard 'Mains CB' [QE2 OPEN]	QE2 OPEN ☑
OPEN, LOCK and TAG New CT Enclosure 'CT Isolator' [Q1 OPEN]	Q1 OPEN ☑
Test for Dead & disconnect 'ATS-Supply' cable from New CT Enclosure at connection point A and from Existing ATS Switchboard (QE2)	Connection Point A DEAD ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 9/8/10

Signature: D Jackson

QUU Commissioning Manager

Name: John Clayton Date: 9/8/10

Signature: J Clayton

Doc Id: 006536 Active Date: Brisbane Water Confidential

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3.4.4 Step D4 – Re-connect Pump No.2 from Temporary Pump Switchboard to New Pump Switchboard

COMMISSIONING MANAGER	Outcome
D4 Display the D4 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Remove LOCK and TAG and Close New CT Enclosure 'CT Isolator' [Q1 Close]	Q1 Close ☑
OPEN, LOCK and TAG Temporary Pump Switchboard 'Pump No. 2 CB' [QT5 OPEN]	QT5 OPEN ☑
Close New Pump Switchboard 'Pump No.1 CB' [Q4 CLOSE]	Q4 CLOSE ☑
Stop Generator	OK ☑
Test for Dead at Temporary Pump Switchboard 'Pump No. 2 CB' [QT5]	QT5 DEAD ☑
Test for Dead at New Pump Switchboard 'Pump No.2 CB' [Q5]	Q5 DEAD ☑
Pull back and re-terminate Pump No.2 pump cables to New Pump Switchboard Pump No.2 VSD output terminals	OK ☑
Check phasing (????how without power?????), check CB settings	OK ☑
Terminate Pump VSD No.2 control cables, thermistor, bearing temperature(, moisture in terminal housing???) and lockout cables	OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 9/8/10

Signature: DJackson

QUU Commissioning Manager

Name: John Clayton Date: 9/8/10

Signature: J. Clayton

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3.4.5 Step D5 – Test & Commission Pump No.2 on New Pump Switchboard

COMMISSIONING MANAGER		Outcome
D5	Display the D5 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Switch New Pump Switchboard Local/Remote Switch into Local Mode	STN LOCAL MODE LOCAL ☑
Remove LOCK and TAG and Close New Pump Switchboard 'Pump No.2 CB' [Q5 Close]	Q5 Close ☑
Program Pump No.2 VSD parameters as required	OK ☑
Test run New Pump Switchboard 'Pump No.2' under Local control, confirming correct rotation	OK ☑
Switch New Pump Switchboard Local/Remote Switch into Remote Mode	STN LOCAL MODE REMOTE ☑
Fully commission Pump No.2 in Remote mode, confirm automatic control from new level probes and pump cycles correctly.	OK ☑
When all tests are completed and Pump No.2 is running satisfactorily then continue.	OK ☑
NB Site no longer has standby generator available to run pumps	OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 9/8/10

Signature: D Jackson

QUU Commissioning Manager

Name: John Clayton Date: 9/08/10

Signature: J Clayton

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PHASE E: REMOVE REDUNDANT SWITCHBOARDS AND CABLES

3.5 PHASE E – REMOVE REDUNDANT SWITCHBOARDS AND CABLES

3.5.1 Step E1 – Disconnect 'Gen-Supply' cables from Generator

COMMISSIONING MANAGER	Outcome
E1 Display the E1 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
OPEN, LOCK and TAG Existing Generator 'Gen Main CB' [QG OPEN]	QG OPEN ☑
OPEN, LOCK and TAG Existing ATS Switchboard 'Gen CB' [QE3 OPEN]	QE3 OPEN ☑
Switch existing ATS 'CB CONTROL' switch to 'OFF' Mode Position	ATS CB CONTROL OFF ☑
Test for Dead at 'Connection Point C' at Existing Generator and Line Side of QE3 at Existing ATS Switchboard	Line Side QE3 DEAD ☑ Connection Point C Dead ☑
Disconnect 'Gen-Supply' cables from Existing Generator 'Connection Point C' and from Existing ATS Switchboard QE3	OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 9/8/10

Signature: DJackson

QUU Commissioning Manager

Name: John Clayton Date: 9/8/10

Signature: J. Clayton

3.5.2 Step E2 – Remove redundant cables from Existing ATS Switchboard and Temporary Pump Switchboard

COMMISSIONING MANAGER		Outcome
E2	Display the E2 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Remove 'Gen-Supply' cables from Existing ATS Switchboard and from existing conduit to Generator.QE3	OK ☑
Remove 'ATS-Supply' cables from Existing ATS Switchboard	OK ☑
Disconnect and remove 'Temp-Supply' cables from Existing ATS Switchboard and Temporary Pump Switchboard	OK ☑
Disconnect and remove Temp VSD Supply Cables from Existing VSD's	OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 9/8/10

Signature: D Jackson

QUU Commissioning Manager

Name: John Clayton Date: 9/8/10

Signature: J. Clayton

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3.5.3 Step E3 – Remove Existing ATS Switchboard and Existing VSD's

COMMISSIONING MANAGER	Outcome
E3 Display the E3 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Remove Existing ATS Switchboard including all ancillary cables	OK ☑
Remove Existing Pump VSD units including all ancillary cables	OK ☑

3.5.4 Step E4 – Remove Temporary Pump Switchboard and cables

COMMISSIONING MANAGER	Outcome
E4 Display the E4 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Disconnect and remove all temporary cables installed to Temporary Pump Switchboard	OK ☑
Remove Temporary Pump Switchboard	OK ☑
Remove all temporary level probes and ancillary equipment	OK ☑

Electrical Contactor's Supervisor	QUU Commissioning Manager
Name: DAVE JACKSON Date: 4/8/10	Name:...... Date: ......
Signature: ......[signature]......	Signature: ......

PHASE F: CONECT STANDBY GENERATOR TO NEW SWITCHBOARD

3.6 PHASE F – CONNECT STANDBY GENERATOR TO NEW SWITCHBOARD

3.6.1 Step F1 – Install new Genset cables to New Pump Switchboard

COMMISSIONING MANAGER	Outcome
F1 Display the F1 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task		Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.		OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.		OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.		
All switching to be done with no pumps running and with station in 'Local' mode.		OK ☑
Install required cable ladder for new generator cables		OK ☑
Install new generator cables 'GEN-SUPPLY'-A' from generator to New Pump Switchboard.		OK ☑
Confirm Existing Generator 'Gen Main CB' is locked and tagged and OPEN [QG Open]	🔒	QG OPEN ☑
Test for Dead at Existing Generator (QG)	⚡	QG DEAD ☑
Confirm New Pump Switchboard 'Generator Supply Main Switch' is locked and tagged and OPEN [Q3 Open]	🔒	Q3 OPEN ☑
Test for Dead at New Pump Switchboard 'Generator Supply Main Switch'	⚡	Q3 DEAD ☑
Terminate New Generator cables at Existing Generator 'Connection Point C' (QG)		OK ☑
Terminate New Generator cables at New Pump Switchboard 'Generator Supply Main Switch' (Q3)		OK ☑
Check phasing of cables and perform insulation tests		OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 4/9/10

Signature: DJackson

QUU Commissioning Manager

Name: J. Clayton Date: 4/9/10

Signature: J. Clayton

3.6.2 Step F2 – Test Generator connection to New Pump Switchboard

COMMISSIONING MANAGER	Outcome
F2 Display the F2 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
All switching to be done with no pumps running and with station in 'Local' mode.	OK ☑
Remove LOCK and TAG and Close Existing Generator 'Gen Main CB' [QG Close]	QG Close ☑
Remove LOCK and TAG and Close New Pump Switchboard 'Generator Main Switch CB' [Q3 Close]	Q3 Close ☑
Switch New Pump Switchboard 'Generator Mode' switch to 'Manual' Mode Position	Generator Mode Switch Manual ☑
Start Generator	OK ☑
Test supply at New Pump Switchboard ATS (Q3).	OK ☑
Check Rotation at New Pump Switchboard ATS (Q3).	OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 4/9/10

Signature: [signature]

QUU Commissioning Manager

Name: John Clayton Date: 4/9/10

Signature: J. Clayton

3.6.3 Step F3 – Test Generator Auto starts and runs each pump

COMMISSIONING MANAGER	Outcome
F3 Display the F3 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
Stop Generator	OK ☑
Switch New Pump Switchboard 'Generator Mode' switch to 'Auto' Mode Position	Generator Mode Switch Auto ☑
Simulate Energex failure by opening 'Normal Supply' Main Switch [Q2 OPEN]	Q2 OPEN ☑
Check Generator Starts.	OK ☑
Confirm New Pump Switchboard ATS transfers to 'GEN-SUPPLY'	OK ☑
Confirm a single pump starts and controls from level signals	OK ☑
Confirm pumps duty cycle	OK ☑

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 4/9/10

Signature: [signature]

QUU Commissioning Manager

Name: John Clayton Date: 4/9/10

Signature: J. Clayton

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3.6.4 Step F4 – Return Energex Supply

COMMISSIONING MANAGER	Outcome
F4 Display the F4 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram	OK ☑

Contractor Task	Outcome
At all times during the switchboard cutover process an installed and tested independent, battery backed high alarm system (with Multitrode level sensor) in the wet well must be provided with audible and visual alarm if the wet well level exceeds 400mm above the current duty A start level. Audible alarm has to be louder than the ambient noise level.	OK ☑
Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present.	OK ☑
If at any time during cutover the station wet well level rises above the audible high alarm level, the station Emergency Diesel pump unit must be operated to pump down the level to Duty A Stop level.	
Simulate Energex return by closing 'Normal Supply' Main Switch [Q2 CLOSE]	Q2 CLOSE ☑
Confirm New Pump Switchboard ATS transfers to 'Mains Supply'	OK ☑
Check Generator Stops.	OK ☑
Confirm a single pump starts and controls from level signals	OK ☑
Confirm pumps duty cycle	OK ☑
Ensure Generator has no faults and fuel tank is refilled.	OK ☑

All Good

Electrical Contactor's Supervisor

Name: DAVE JACKSON Date: 4/9/10

Signature: [signature]

QUU Commissioning Manager

Name: John Clayton Date: 9/9/10

Signature: [signature]

4 REMAINING FIELD EQUIPMENT WORKS

Once fully commissioned the station can be left unattended (in remote mode) without having completed the following works, however all of the following works must be carried out within 1 week of completing the changeover works.

4.1 UPGRADE WET WELL WASHER SOLENOID

Contractor Task	Outcome
Install new 24vdc solenoid on existing well washer valve. Existing valve is 240vac type: Goyen Controls 20-1000kPa model 2QUU2. Valve is located on rear wall behind switchboard. Remove old wiring and conduits and re-cable to new 24VDC solenoid. Fit label to solenoid valve.	~~OK ☐~~

4.2 REMOVE EXISTING DIFFERENTIAL PRESSURE TRANSMITTERS

Contractor Task	Outcome
Remove existing differential pressure transmitters and associated cabling and conduits from each pump pipework.	OK ☐

4.3 INSTALL DRY WELL STROBE LIGHT

Contractor Task	Outcome
Install strobe alarm light and associated cabling, conduits and mounting brackets. Mount strobe adjacent to ladder at base of dry well and function test.	OK ☑

4.4 INSTALL NEW GANTRY CRANES

Contractor Task	Outcome
Install isolators and associated cabling for both of the new gantry cranes. Locate isolators on western wall. Fit labels adjacent to both isolators.	OK ☑

4.5 INSTALL ODOUR CONTROL JUNCTION BOX

Contractor Task	Outcome
Install stainless steel junction box including terminals for future odour control plant. Location of this enclosure is at the rear of the building near existing dosing plant. Install power and control cables as per cable schedule and terminate in junction box.	OK ☐
Connect the Odour Control Unit to the New Control Switchboard	~~OK ☐~~

4.6 UPGRADE DOSING PLANT CABLING

Contractor Task	Outcome
Install new power and signal cables as per cable schedule to existing dosing plant control panel. Re-terminate power supply at dosing panel; provide additional terminals to terminate signal cable for future controls. Remove existing cables and disused conduits. Provide adequate stainless steel unistrut supports for new conduits as they cross from building to dosing plant control panel.	OK ☐
Connect the Chemical Dosing Unit to the New Control Switchboard	~~OK ☐~~

4.7 EXISTING JUNCTION BOXES

Contractor Task	Outcome

Contactor's Supervisor

Name: DAVE JACKSON Date: 4/9/10

Signature: [signature]

QUU Commissioning Manager

Name: J. Clayton Date: 4/9/10

Signature: [signature]

3.7 SYSTEM COMMISSIONING

Run each pump in local mode and record the system curves for the following pump speeds.

Pump Number	Hz	Total Amps	Total kW	Total kVA	Total PF	Voltage THD / phase	Flow L/s	Discharge Pressure (mAHD)	Wet well Level (mAHD)
1	45								
1	47.5								
1	50								
2	45								
2	47.5								
2	50								

NOT DONE.
Pump Station worked correctly.
200KW.

Contactor's Supervisor
Name: DAVE JACKSON Date: 4/9/10
Signature: [signature]

QUU Commissioning Manager
Name: John Clayton Date: 9/9/10
Signature: [signature]

Doc Id: 006536 Active Date: Brisbane Water Confidential
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Existing Junction boxes on wall behind switchboard may be reused if required. Remove existing label 'CIG 3 Outlet' from rear wall Junction box. Remove any J-Boxes, conduits and associated equipment that is no longer in use	OK ☑

4.8 REMOVE MOTOROLA RTU

Contractor Task	Outcome
After the successful installation of the new switchboard, remove redundant Motorola RTU including antenna and mast and associated cabling and conduits. Any penetrations left in external walls are to be filled with non-shrink grout.	OK ☑

4.9 INSTALL SPARE CONDUIT

Contractor Task	Outcome
Install spare 40mm conduit in floor chasing between pump switchboard and new VSD stand.	OK ☑

4.10 RE-GROUT CHASING

Contractor Task	Outcome
On completion of installation of all cables and conduits in floor chasing, refill and re-grout to similar standard or better as originally installed. Fabricate and install 6mm galvanised cover plate to cover exposed cable trenching due to new pump switchboard being shorter than the old switchboard.	OK ☑

Contactor's Supervisor	QUU Commissioning Manager
Name: DAVE JACKSON Date: 4/9/10	Name: John Clayton Date: 4/9/10
Signature: DJackson	Signature: J Clayton

5 POST CHANGE OVER CHECKLIST

5.1 DELIVERABLES FROM RTU PROGRAMMER

QUU Programmer	Date Completed
Within 7 days of the change over the following must be completed and signed off by the QUU Programmer Complete Section 4: Post Commissioning	/ /
The QUU Programmer will ensure that the Control Room Acceptance (CRA) form is signed by the Manager of the Control Room Officers. The form is to be handed to the Contracts Manager (CM). good luck	/ /

5.2 DELIVERABLES FROM ELECTRICAL CONTRACTOR

Contractor Task	Date Completed
All documentation required under the contract is to be provided with the time specified (AS BUILT's, Electrical Certificates and documentation etc).	13 19/10

5.3 DELIVERABLES FROM COMMISSIONING MANAGER

Commissioning Manager	Date Completed
All documentation is handed to the Project Manager to that the new switchboard asset can be capitalised and handed over to the customer.	
Factory Acceptance Test Sheet – Completed & signed off.	OK ☐
Electrical Inspection Sheet – Completed & signed off.	OK ☐
Site Acceptance Test Sheet – Completed & signed off.	OK ☐
Commissioning Plan – Completed & signed off.	OK ☐
As built Drawings have been updated, drafted and taken to site along with the Site Specific Functional Specification.	/ /

5.4 SUGGESTIONS FOR IMPROVEMENT

Suggestion	Recommended By
MANUALS READY AWAITING INSTRUCTIONS FOR	
DELIVERY.	

Contactor's Supervisor

Name: [signature] Date: 13/9/10

Signature: DAVE JACKSON

QUU Commissioning Manager

Name:...... Date: ......

Signature: ......

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