# SP086 INDOOROOPILLY ROAD SEWAGE PUMP STATION SWITCHBOARD 

## OPERATION \& MAINTENANCE MANUAL

## JOB No A4229

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| :---: | :---: | :---: |
|  | 2 | MOULDED CASE CIRCUIT BREAKER |
|  | 3 | MINIATURE CIRCUIT BREAKER |
|  | 4 | CONTACTOR \& THERMAL OVERLOAD |
|  | 5 | Control relay \& Phase faluve relay |
|  | 6 | CHASSIS |
|  | 7 | FUSE \& FUSE HOLDER |
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|  | 9 | human machine interface |
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## AUTOMATIC TRANSFER SWITCH

## 1. ATyS 6 TECHNICAL DETAILS

2. ATyS TECHNICAL GUIDE
3. ATyS D10 \& D20 OPERATING INSTRUCTIONS

## ATyS 6 Automatic Transfer Switches 125 to 1600 A

ATyS $6 m$


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

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

## Functions <br> References <br> Characteristics <br> Accessories: see page A. 142 <br> Dimensions: see page A. 148

## 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 (1, 0, II).
- $A C-22$ and $A C-23$ and $A C-31$ 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 | 6 e | 6m |
| :---: | :---: | :---: |
| ATS $^{+}$ | X | X |
| 3 L sensing [1+ | X | X |
| 0, I, Il contiol | X | X |
| Fault relay | X | $\underline{\chi}$ |
| $\left\{\begin{array}{l} \text { Option COM }+V O \\ \text { Metering }\left(1, P, Q_{1}, \mathrm{P},\right. \end{array}\right.$ | $\cdots$ | $\frac{x}{x}=$ |

- ATS : Automatic Transfert Switch.


## References


$125 \mathrm{~A} \quad 160 \mathrm{~A}$

| Standard device - 230 VAC | 125 A | 160 A | 250 A | 400 A |
| :---: | :---: | :---: | :---: | :---: |
| Aly 6 e |  |  |  |  |
| No. of poles | References | References | References | References |
| 3 pole | 15633012 | 15633016 | 15633025 | 15633040 |
| 4 pole | 15634012 | 15634016 | 15634025 | 15634040 |
| Aly 6 m |  |  |  |  |
| 3 pole | 15733012 | 15733016 | 15733025 | 15733040 |
| 4 pole | 15734012 | 15734016 | 15734025 | 15734040 |

Other voltages
$12,24 \mathrm{VDC}$ comsult US

## Accessories

| Bridging bars |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 1 pole | 41090019 | 41090019 | 41090025 | 41090039 |
| Voltage sensing and power supply kit |  |  |  |  |
| 3 pale | 15593012 | 15593012 | 15593025 | 15593040 |
| 4 pole $=-$ Neutral on the right | 15594012 | 15594012 | 15594025 | 15594040 |
| 4 pole _ Neutral on the left | 15594013 | 15594013 | 15594026 | 15594041 |
| Plug-in optional modules |  |  |  |  |
| COM RS485 (No. 1) | 15992000 | 15992000 | 15992000 | 15992000 |
| 2 inputs/2 putputs (No.2) | 15992001 | 15992001 | 15992001 | 15992001 |
| Remote control interface |  |  |  |  |
| ATyS D10 interace | 15992010 | 15992010 | 15992010 | 15992010 |
| ATy D D20 interface | 15992020 | 15992020 | 15992020 | 15992020 |
| Terminal shrouds (1) set) 1 "xa) |  |  |  |  |
| 3 pole | 26943014 | 26943014 | 26943021 | 26943021 |
| 4 pole | 26944014 | 26944014 | 26944021 | 26944021 |
| Terminal screens (1 set top and bottom) |  |  |  |  |
| 3 pole | 15093012 | 15093012 | 15093025 | 15093025 |
| 4 pale | 15094012 | 15094012 | 15094025 | 15094025 |
| Pre-breaking and signalling of position \| and || auxiliary contacts |  |  |  |  |
| $2^{\text {m }}$ AC | 15990002 | 15990002 | 15990012 | 15990012 |
| Control voltage transformer |  |  |  |  |
| $400 / 230 \mathrm{VAC}$ | 15994063 | 15994063 | 15994063 | 15994063 |
| Padlocking (factory fitted) |  |  |  |  |
| Paadlocking in the 3 positions 1,0 and $1 \mathrm{I}^{n}$ option | 15990003 | 15990003 | 15990003 | 15990003 |
| Key handle interlocking system (factory fitted) |  |  |  |  |
| Locking using RONIS EL119P lock in paallocked position | 15091006 | 15091006 | 15091006 | 15091006 |
| Mounting spacers |  |  |  |  |
| 1 set of 2 spacers | 15090001 | 15090001 | 15090001 | 15090001 |
| Door protective surround |  |  |  |  |
|  | 15390012 | 15390012 | 15390012 | 15390012 |

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

$250 \mathrm{~A} \quad 400 \mathrm{~A}$


## ATyS 6 Automatic Transfer Switches 125 to 1600 A

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

## References

| Standard device - 230 VAC | 630 A | 800 A | 1000 A | 1250 A | 1600 A |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ATyS be |  |  |  |  |  |
| No. of poles | References | References | References | References | References |
| 3 pole | 15633063 | 15633080 | 15633100 | 15633120 | 15633160 |
| 4 pole | 15634063 | 15634080 | 15634100 | 15634120 | 15634150 |
| ATyS 6 m |  |  |  |  |  |
| 3 pole | 15733063 | 15733080 | 15733100 | 15733120 | 15733150 |
| 4 pole | 15734063 | 15734080 | 15734100 | 15734120 | 15734160 |

Other voltages
$12,24 \mathrm{VDC}$

Accessories

| Bridging bars |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 pole | 41090063 | 41090080 | 4109 0080 | 41090120 | 41090160 |
| Voltage sensing and power supply kit |  |  |  |  |  |
| 3 pole | 15593063 | 15593080 | 15593080 | 15593120 | 15593160 |
| 4 pole | 15594063 | 15594080 | 1559 4080 | 15594120 | 15594160 |
| 4 pole | 15594064 | 15594081 | 15594081 | 15594121 | 1559.4761 |
| Plug-in optional modules |  |  |  |  |  |
| COM RS485 (No. 1) | 15992000 | 15992000 | 15992000 | 15992000 | 15992000 |
| 2imputs/2 outputs (No.2) | 15992001 | 15992001 | 15992001 | 15992001 | 15992001 |
| Remote control interface |  |  |  |  |  |
| ATy 510 interface | 15992010 | 15992010 | 15992010 | 15992010 | 15992010 |
| ATyS D20 interface | 15992020 | 15992020 | 15992020 | 15992020 | 15992020 |
| Terminal shrouds (1 set) ${ }^{\text {(1)2er }}$ |  |  |  |  |  |
| 3 pole lop/bottam/front (0) / rear (1) | 26943051 | " | - |  | $\cdots$ |
| 4 poie Lop/botum / front (i) / rear (1) | 26944051 | - | - | $\cdots$ | - |
| Terminal screens ( 1 set top and bottom) |  |  |  |  |  |
| 3 pole | 15093063 | 15093080 | 15093080 | 1509 30B0 | 15093160 |
| 4 pole | 15094063 | 1509 4080 | 15094080 | 1509 4080 | 15094160 |
| Pre-breaking and signalling of position I and II auxiliary contacts |  |  |  |  |  |
| $2^{\text {nd }} \mathrm{AC}$ NONC changeover | 15990022 | 15990032 | 15990032 | 15990032 | 15990032 |
| Control voltage transformer |  |  |  |  |  |
| $400 / 230 \mathrm{VAC}$ | 15994063 | 15994120 | 15994120 | 15994120 | 15994120 |
| Padlocking (factory fitted) |  |  |  |  |  |
| "Padlacking in the 3 positions i, 0 and 11" option | 15990003 | 15990004 | 15990004 | 15990004 | 15990004 |
| Key handle interlocking system (factory fited) |  |  |  |  |  |
| Locking LSing RONIS EL11AP lock in padlocked position | 15091006 | 15091004 | 15097004 | 15091004 | 15091004 |
| Mounting spacers |  |  |  |  |  |
| 1 set of 2 spacers | 15090001 | $\square$ | $\cdots$ | - | - |
| Door protective surround |  |  |  |  |  |
|  | 15390012 | 15390080 | 15390080 | 15390080 | 15390080 |

(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 $\mathrm{Ith}^{\left(40^{\circ} \mathrm{C}\right)}$ | 125 A | 160 A | 250 A | 400 A | 630 A | 800 A | 1000 A | 1250 A | 1600 A |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Rated insulation voltage $U_{1}(\mathrm{M}$ | 800 | 800 | 800 | 800 | 1000 | 1000 | 1000 | 1000 | 1000 |
| Rated impulse withstand voltage U Ump ( kV | 8 | 8 | 8 | 8 | 12 | 12 | 12 | 12 | 12 |
| Rated operational currents $I_{e}(A)$ |  |  |  |  |  |  |  |  |  |
| Rated voltage Load duly category | $\mathrm{B}^{(1)}$ | $\mathrm{B}^{(1)}$ | $B^{17}$ | $\mathrm{B}^{(1)}$ | $B^{11)}$ | $\mathrm{B}^{111}$ | $\mathrm{B}^{10}$ | $\mathrm{B}^{17}$ | $B^{(1)}$ |
| 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 | $2 \times 800$ |
| Peak current value: making and breaking (kA peak) | 18 | 18 | 23 | 23 | 45 | 41 | 80 | 80 | 96 |


| Overload capacity |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| Operating class |  |  |  |  |  |  |  |  |  |
| Material class | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| Connection |  |  |  |  |  |  |  |  |  |
| Minimum Cu cable section ( $\mathrm{mm}^{2}$ ) | 35 | 50 | 95 | 185 | $2 \times 150$ | $2 \times 18$ | $2 \times 240$ |  |  |
| Minimum Cu busbar section (mm) |  |  |  | $\bigcirc$ | $2 \times 30 \times$ | $2 \times 40 \times$ | 2×50x | $2 \times 60 \times$ | 2×80 $\times 5$ |
| Maximum Cu cable section ( $\mathrm{mm}^{2}$ ) | 50 | 95 | 150 | 240 | $2 \times 300$ | $2 \times 30$ | $4 \times 185$ | $4 \times 185$ | $6 \times 185$ |
| Maximum Cu busbar width (mm) | 25 | 25 | 32 | 32 | 50 | 63 | 63 | 63 |  |
| Min. tigitening torque ( Nm ) | 9 | 9 | 20 | 20 | 20 | $\cdots$ |  | 20 | 40 |

## Switching time

| [1-11 or $\\|-1$ ( $(1)$ | 0.75 | 0.75 | 1.3 | 1.3 | 1.3 | 2.6 | 2.6 | 2.6 | 2.6 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| [1-0 or II-0 (s) ${ }^{\text {a }}$ | 0.45 | 0.45 | 0.85 | 0.85 | 0.85 | 1.6 | 1.6 | 1.6 | . 6 |
| Duration of "electrical blackout" $(\mathrm{s}$ ) | 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 (M)

| $184 / 276$ | $184 / 276$ | $184 / 276$ | $184 / 276$ | $184 / 276$ | $184 / 276$ | $184 / 276$ | $184 / 276$ | $184 / 276$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Control supply power demand (during transfer)

| Supply 230 VAC inrush / nominal (VA) | 420 / 80 | 420 / B0 | $400 / 100$ | 400/100 | $420 / 110$ | $450 / 120$ | 450/120 | 450/120 | $450 / 120$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Mechanical characteristics |  |  |  |  |  |  |  |  |  |
| Endurance (number of operating cycles) | 10000 | 10000 | 8000 | B 000 | 5000 | 4000 | 4000 | 4000 | 3000 |
| 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 "

## Automatic transfer switch ATyS Technical guide

 (GB)

Automatic transfer switch ATYS
TECHNICAL GUIDE

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[^0]
## 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.

## NORMALEMERGENCY 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



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.

- Network / Network permutation

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

- Inverse two conductors of a three phases network to

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

- Bypass applications



## 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.

Position


0

2


## 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.

Position

1


2

Position

1


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...)
1

2



## 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 <br> ambient and motor temperatures |
| C | long shutdown $\leq 15 \mathbf{s}$ | after loss of mains | Constant Genset preheat operation to allow fast start <br> sequence |
| B | short shutdown $\leq \mathbf{1 ~ s}$ | permanent rotation | Generator connected to the Main as a motor without <br> prime mover being started. <br> Constant Genset preheat operation to allow fast start <br> sequence. Motor started thanks to rotor inertia. |
| A | without shutdown | running In parallel with the <br> 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 | G1 | G2 | G3 | G4 |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| Frequency | $+/-2,5 \%$ | $+/-1,5 \%$ | $+/-0,5 \%$ |  |  |
| operationpermanent <br> transient | $+/-18 \%$ | $+/-12 \%$ | $+/-10 \%$ | Specific | requirements |
| Voltage |  |  |  |  |  |
| permanent | $+/-5 \%$ | $+/-2,5 \%$ | $+/-1 \%$ |  |  |

## 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.



## 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.


## Automatic transfer switch ATyS

TECHNICAL GUIDE

## 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).


## 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.

## 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.

Automatic transfer switch ATyS
TECHNICAL GUIDE

## 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
$>0$ 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.

# afficheurs déportés - Remote interfaces ATyS D10 \& D20 

## Notice d'utilisation - Operating instructions

| (F) GB | MAKE YOUR BUSINESS SAFE |
| :---: | :---: | :---: |


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## 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 $6 \mathrm{e}, 6 \mathrm{~m}$ and C30 products to allow remote access to display or control features.

## 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 $6 \mathrm{e}, 6 \mathrm{~m}$ or C 30 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%\mathrm{ humidity at }55\mp@subsup{5}{}{\circ}\textrm{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, 6 m or C30).


- ATyS Product faulty, transfer error
- Possible to reset after error disappearance the power supplies


## 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, 6 m or C30) display is deactivated as soon as the remote interface is connected.


- only on ATyS 6e and 6m



## Display



## Keypad



## Software version

Software version of the master product is displayed immediately after ATyS $6 \mathrm{e}, 6 \mathrm{~m}$ or C30 power on.


$\Longrightarrow$| Display |
| :--- |
| Keypad |
| Software version |
| Programming |
| Control and Test modes |
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| Visualisation |

## Programming

$>$ Enter into programming mode
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 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

MODE-

- 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, 6 m ou C30)

## Programming

Navigation in programming mode
O


- 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

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

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## Programming

## ARCHITECTURE OF THE PROGRAMMING MENU




## Programming

VARIABLES CHARACTERISTICS

## > Setup

| LCD | Denomination | Setting range | Default values |
| :---: | :---: | :---: | :---: |
| nt | Type of network <br> (cf. ATyS 6 or C30 instruction manual) | 1BL, 2BL, 2NBL 3NBL, 4NBL, 41NBL, 42NBL | 4NBL |
| Un | Network Nominal voltage <br> Phase-Neutral voltage for 1BL \& 41NBL <br> Phase-Phase voltage for others | 100 to 480 V | 400 V |
| ScE** | Source 1 - Switch I or II configuration <br> Source 1 (controlled and displayed) linked to switch I or II (depending on cabling) | I, II | 1 |
| Fn | Network nominal Frequency | 50 or 60 Hz | 50 Hz |
| $\mathrm{Ct}^{*}$ | 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 |

[^1]
## 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 | $101-119 \%$ <br> $(<0 U)$ | $110 \%$ |
| uU | Network 1 under voltage threshold | $80-98 \%$ | $85 \%$ |
| uUh | Network 1 under voltage threshold hysteresis | $81-99 \%$ <br> $(>u U)$ | $95 \%$ |
| oU | Network 2 over voltage threshold | $102-120 \%$ | $115 \%$ |
| oUh | Network 2 over voltage threshold hysteresis | $101-119 \%$ <br> $(<0 U)$ | $110 \%$ |
| uU | Network 2 under voltage threshold | $80-98 \%$ | $85 \%$ |
| uUh | Network 2 under voltage threshold hysteresis | $81-99 \%$ <br> $(>u 0)$ | $95 \%$ |

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 | $100.5-119.5 \%$ <br> $(<\mathrm{oF})$ | $103 \%$ |
| uF | Network 1 under frequency threshold | $80-99 \%$ | $95 \%$ |
| uFh | Network 1 under frequency threshold hysteresis | $80.5-99.5 \%$ <br> $(>$ uF) | $97 \%$ |
| oF | Network 2 over frequency threshold | $101-120 \%$ | $105 \%$ |
| oFh | Network 2 over frequency threshold hysteresis | $100.5-119.5 \%$ <br> $(<0 \mathrm{~F})$ | $103 \%$ |
| uF | Network 2 under frequency threshold | $80-99 \%$ | $95 \%$ |
| uFh | Network 2 under frequency threshold hysteresis | $80.5-99.5 \%$ <br> $(>\mathrm{uF})$ | $97 \%$ |

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

## Programming

$>$ Timers

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

## $>$ Communication

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

| LCD | Denomination | Setting range | Default values |
| :--- | :--- | :--- | :--- |
| Add | Device address | 1 to 247 | 5 |
| bd | Communication speed | $2400,4800,9600$, | 9600 |
| StoP | Stop bit | 19200,38400 |  |
| PAr | Parity bit | 1,2 | 1 |

## Programming

## > Inputs/Outputs

- 2 inputs ( $\mathrm{In} 1, \mathrm{In} 2$ ) and 2 outputs (Ou1, Ou2) as standard on ATyS C30.
- Possibility to connect 2 modules 2 Inputs/2 Outputs on ATyS 6e \& 6 m .
- First module: In1, In2, Ou1, Ou2
- Second module In3, In4, Ou3, Ou4.

| Input/Output | Function | Relay State |
| :--- | :--- | :--- |
| 11 to I4 | Ft1, Ft2, Ft3, Ft4, Pri, <br> Mtf, S2A, Man, TOL, TFL, EJP, CTS | NO or NC |
| O1 to O4 | S1A, S2A, LS, I | NO |

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

- Step 3: press "validation"
E. Step 4: press "bottom" push button to acces nO variable selection


## 0.1

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## Programming

- Variables description Inputs

| Variable | Description |
| :--- | :--- |
| Ft1 | Fault input 1. The fault led is blinking as soon as the input is active and <br> 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. <br> 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. <br> The transfer switch is immediately driven in 0 position. <br> 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. <br> The transfer switch is immediately driven in 0 position. <br> Keypad action (Esc) necessary to Reset the fault |
| Pri | Priority network selection. <br> 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. <br> Re-transfer from priority network to backup network is allowed from input activation (1 s front). <br> 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 <br> from ATyS (inhibited when S2A is selected) |
| Man** | Information transfer system in manual mode. <br> 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 <br> before DTT ends. If DTT is set to its maximum value (60s), the transfer is initiated as soon as <br> the input is activated (1 s front) |
| TOL** | Remote test on load. Started from input activation. <br> Re-transfer is blocked until input de-activation |
| TFL | Remote test off load. <br> Started from input activation (remote genset start/stop) |
| EJP | 2 inputs one automatically affected to EJP |
| input 1 for EJP advice, to start generator |  |
| inputransfer is activated when input 2 disapears |  |,

* only on ATyS C30, specific fault operation ( Ft 2 and Ft 3 )
** only as option on ATyS C30, standard features on ATyS 6e et 6 m .

Outputs

| Variable | Description |
| :--- | :--- |
| S1A | Source 1 available. <br> Output activated as soon as source 1 is considered available (similar to front led source 1) |
| S2A | Source 2 available. <br> 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. <br> The relay is activated before permutation on standby network according to LS timer. <br> The relay is de-activated after retransfer on mains network and LS timer countdown |

Remote_interfaces ATyS
OPERATION

## Programming

LOAD SHEDDING CONFIGURATION
LS variable allows associated LS timer configuration.

| Output | Associated funciton | Setting range | Default value |
| :--- | :--- | :--- | :--- |
| O1 to O4 | LS | 0 to $60 \mathrm{~s}(\mathrm{sDTT})^{*}$ | 2 |

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

Example: load shedding configuration


## 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 |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| $\therefore$ | - Step 2: Press "validation" push button to make control or test led become fixed |  |  |  |  |  |  |
| $\square$ CONTROL |  |  |  |  |  |  |  |
| Access code is displayed directly |  |  |  |  |  |  |  |
| TEST MODE TEST |  |  |  |  |  |  |  |
| 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 |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| $\stackrel{\square}{=}$ | Press "validation" push button to enter |  |  |  |  |  |  |

## Control and Test modes

$>$ Exit control or test modes

MODE- Press "ESC" push button

The new operational mode (automatic or manual) depends on information from master ATyS ( $6 \mathrm{e}, 6 \mathrm{~m}$ ou C30)


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

OPERATION
ATyS D20


## Operational sequences

Refer to ATyS $6 \mathrm{e}, 6 \mathrm{~m}$ 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. values.

Examples:

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

> 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



| $\mathbf{~} \mathrm{FFt}$ |
| :---: |
| GO |


| [0 |
| :---: |




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


# 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

## TemBreak <br> MCCB's

## NHP

## Electronic type S630CE

## 50kA

Current rating: $\quad 252-630 \mathrm{~A}$
Approvals and Tests: AS/NZS 3947-2, IEC60947-2
Interrupting capacity:

AC use | Voltage | Icu | ICS |
| :--- | :--- | :--- |
| $380 / 415$ | 50 | 50 |

## Over Current Relay:

- Electronic, for general \& selectivity applications
- 6 dial selectable characteristic curves suited for a variety of applications

- Base current $I r$ is adjustable from $40 \%-100 \%$ of the nominal rated current $I n$.
- STD setting 2.5-8(x $\left.\left.I_{R}\right)^{2}\right)$
- INST setting 10-14 (x $\left.I_{R}\right)^{2}$ )


## 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 togale) | 103 | 103 |


| Ampere <br> Rating | $J_{\text {R }}$ Adjust. |  |
| :--- | :--- | :--- |
| NRC | 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: | $\begin{aligned} & \text { PTA }_{3)} \\ & \text { GF }_{3} \\ & \text { PTA }^{2} \text { GF }_{3)} \end{aligned}$ | S630 CE 3 AP 630 <br> S630 CE 3 AG 630 <br> 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 |
|  | $\mathrm{GF}+\mathrm{NP}{ }_{3}$ ) | 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 3630 |  |
| 2) | The STD and Instantaneous pickup currents $\left(l_{\mathrm{zd}} \& h_{i}\right)$ settings are not individually adjustable, however by selecting different curve types and different $I_{R}$ settings the values will vary. Curve $1 \& 2 I_{\mathrm{sd}}=2.5 \times I_{R}$, curve $3 I_{\mathrm{sd}}=5 \times I_{R}$, curve $4-6 I_{\mathrm{sd}}=8 \times I_{\mathrm{R}}$. $I_{\mathrm{R}}$ dial setting $0.4-0.63 I_{i}=14 \times I_{R}$ and $I_{R}$ dial setting $0.8-1.0 I_{i}=10 \times I_{R}$. Refer curve examples \& setting data on pages 18 to 30 . |  |
|  | $N R C=$ Nominal rated current, $\quad I_{R}=$ Current adjustment dial setting, $\quad S T D=$ Short Time Delay, $\quad \operatorname{INS} T=$ instantaneous |  |
| 3) | To order a MCCB with 630 is a S630CE 3 P | ion after the pole to make up n. |

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

OPRRATMNG CMARACTERISTICS

## ELECTRONIC CHARACTERISTICS

E630-NE, S630-CE, S630-GE

$\mathrm{ln}=630 \mathrm{~A}$


Nole
(1) $I_{1}$ max. $=10 \times I_{n}$. (2) Standard setting of $I_{N}$ is $100 \%$ of $/ n$. For any other setting please specify when ordering.


## (DPRRATMNG CMARACTERUSTICS

## LET-THROUGH PEAK CURRENT CHARACTERISTICS

H400-NJ, H $400-\mathrm{NE}, \mathrm{L} 400-\mathrm{NJ}, \mathrm{J} 400-\mathrm{NE} .415 \mathrm{~V}$ AC.


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


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


Prospective short circuit current in RMS sym.(KA)

Selectivity \＆Cascade Tables
＠ 400 ／ 415 V

St abed ypargual wiprepuełs әut puoкəg

## Selec

| 山 鳫 70 |  |  |  | $\begin{array}{r} \text { 씿 } \\ \text { 品 } \\ \stackrel{\text { 1 }}{125} \end{array}$ |  | $\begin{array}{r} \text { 崖 } \\ \stackrel{\text { Na }}{\rightleftarrows} \\ 125 \end{array}$ | $\begin{array}{r} \text { 岩 } \\ \stackrel{0}{\mathbf{0}} \\ \stackrel{y}{x} \\ 100 \end{array}$ | $\begin{aligned} & \text { 䛵 } \\ & \text { ( } \\ & \text { 85 } \\ & \hline \end{aligned}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 25／50 | 25／25 | 25／36 | 25，36 | 25／65 | 25i／25 | 25／25 | 25／25 | 25／25 | 25／25 |
| 36／65 | 36／36 | 36／50 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65，70 | 65／65 | 65／50 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70，70 | 70\％70 | 50／50 | 65／65 | 65／65 | 85／50 | 85／50 | 100／100 | 85／85 | 85／85 |
| 36／50 | 36／36 | 36／36 | 36／65 | 36／65 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65：70 | 65／65 | 50／50 | 50165 | 50／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70／70 | 70／70 | 50／50 | 50／65 | 50／65 | 85！65 | 85／65 | 100\％100 | 85／85 | 85／85 |
| 25／50 | 25／25 | 25／25 | 25／50 | 25／50 | 25／25 | 25／25 | 25／25 | 25／25 | 25／25 |
| 36／65 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65／70 | 65／65 | 50／50 | 50／65 | 50／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70，70 | 70／70 | 50，50 | 50／65 | 50／65 | 7070 | 70／70 | 70／70 | 70／70 | 70／70 |
| 70，70 | 7070 | 50／50 | 50／65 | 50／65 | 85／85 | 85／85 | 100／100 | 85／85 | 85／85 |
| 70，70 | 70／70 | 50／50 | 50／65 | 50／65 | 85／85 | 85／85 | 100，100 | 85／85 | 85／85 |
| 10／50 | 10／36 | 25／25 | 25／25 | 25／36 | 25／25 | 25／25 | 25／36 | 25／25 | 25／25 |
| 10／65 | 10／50 | 25／36 | 25／36 | 25／50 | 36／36 | 36／36 | 36／50 | 36／36 | 36／36 |
| 10，50 | 10／50 | 25／50 | 25／50 | 25／50 | 50\％50 | 50，50 | 50，50 | 50／50 | 50／50 |
| 10，70 | 10／65 | 25／50 | 25／50 | 25／65 | 50／50 | 50／50 | 50／65 | 50／50 | 50，50 |
| 10／70 | 10／70 | 25／50 | 25／50 | 25／65 | 70／36 | 70／36 | 70，85 | 70，70 | 70\％70 |
| 19，70 | 10，70 | 25／50 | 25／65 | 25／65 | 125／85 | 125／85 | 125／100 | 125／85 | 125／85 |
| 10／70 | 10／70 | 25／50 | 25／65 | 25／65 | 125／85 | 125／85 | 125／100 | 125／85 | 125／85 |
|  |  | 25／36 | 25／36 | 25／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
|  |  | 25／50 | 25／50 | 25／50 | 50／50 | 50／50 | 50／50 | 50／50 | 50／50 |
|  |  |  |  |  | 70／70 | 70／70 | 70，70 | 70／70 | 70／70 |
|  |  |  |  |  | 30／45 | 30／45 | 30／45 | 35／45 | 35／45 |
|  |  |  |  |  | 30／65 | 30／65 | 30／65 | 35／65 | 36／65 |
|  |  |  |  |  | 30／85 | 30／85 | 30／85 | 35／85 | 35／85 |
|  |  |  |  |  | 30／65 | 30／65 | 30／85 | 30／85 | 30／85 |
|  |  |  |  |  | 30／65 | 30／65 | 30，85 | 30／85 | 30／85 |
| 1 |  |  | 1 | 1 | 30／65 | 30／65 | 30／85 | 30／85 | 30／85 |
|  |  |  | 1 | ！ | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
| ， |  |  |  |  | 15／50 | 15／50 | 20／50 | 35／50 | 35／50 |
| 1 | 1 |  | 1 |  | 15／85 | 15／85 | 20／85 | 35／85 | 35／85 |
|  | 1 |  |  |  | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
|  |  |  | 1 |  | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
|  |  |  | ＋ |  | ！ |  | 20／65 | 35／65 | 35／65 |
|  | 1 |  | 1 | 1 | 1 |  | － | 35／85 | 35／85 |

$\rightarrow$ Nuress




## APPGCATION DATA

CASCADE TABLES

| $\begin{gathered} \text { CASCADE } \\ \left(480-415 V^{\prime}\right) \end{gathered}$ |  | $\begin{aligned} & \text { M } \\ & \stackrel{y}{\mathrm{~N}} \\ & \underset{\mathrm{~N}}{2} \end{aligned}$ | $\begin{aligned} & \text { n } \\ & \stackrel{N}{N} \\ & \text { ñ } \end{aligned}$ | $\begin{aligned} & \text { N } \\ & \underset{\sim}{n} \\ & \underset{y y}{c} \end{aligned}$ | $\begin{aligned} & \text { 工 } \\ & \text { N } \\ & \text { U } \end{aligned}$ | $\begin{aligned} & \frac{1}{2} \\ & \stackrel{n}{2} \end{aligned}$ | $n$ $\stackrel{n}{9}$ $\stackrel{0}{2}$ | $\begin{aligned} & \text { の } \\ & \stackrel{\rightharpoonup}{\nabla} \\ & \text { R} \end{aligned}$ | $\begin{aligned} & \text { I } \begin{array}{l} \text { ה } \\ \stackrel{y}{2} \end{array} \end{aligned}$ | $\stackrel{\Gamma}{\square}$ | $\begin{aligned} & \text { m} \\ & \substack{\mathbf{n} \\ \stackrel{y}{2}} \end{aligned}$ | $n$ <br>  <br>  |  | M 0 0 0 0 | 공 <br> $\sum_{2}$ |  | N |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Downstream MCCBs | $\begin{gathered} \text { KA } \\ \text { (RMS) } \end{gathered}$ | 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 | B5 | 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 | － | － | － | $\stackrel{-}{-}$ | － | － | － | 125 | 150 | － | － | － | 70 | 125 | 125 | 150 |
| H160NJ $\because$ | 125 | － | － | － | － | － | － | － | － | 200 | － | － | － | － | － | － | 200 |
| S250NJ | 36 | － | － | － | － | － | － | 65 | － | － | － | － | － | 65 | 85 | 85 | 125 |
| S250G．J | 65 | － | － | － | － | － | － | － | － | － | － | － | － | 70 | 125 | 125 | 150 |
| S250PE | 70 | － | － | － | － | － | － | － | － | － | － | － | － | － | 125 | 125 | 150 |
| H250NJ | 125 | $-$ | $\cdots$ | － | － | － | － | － | － | － | － | －－ | － | － | － | － | 200 |
| E400NJ | 25 | － | － | － | － | － | － | － | － | － | － | － | － | 36 | 65 | 65 | － |
| S400CJ | 36 | － | － | － | － | $=$ | － | － | － | － | － | － | － | 50 | 70 | 70 | － |
| S400NJ | 50 | － | $\div$ | $\stackrel{-}{-}$ | － | － | － | － | － | $\square$ | － | － | 50 | 65 | 85 | 85 | － |
| S400GJ | ． 70 | － | － | － | － | － | － | － | － | － | － | ， | 50 | － | 125 | 125 | － |
| H400NJ | 125 | － | $-$ | － | － | － | － | － | － | － | － | － | － | － | － | － | － |

Note：＇）Aatings 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 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{gathered} \text { CASCADE } \\ \text { (9) } \left.380-415 V^{\prime}\right) \end{gathered}$ |  | $n$ $\stackrel{0}{\circ}$ $\stackrel{8}{8}$ |  |  |  | ＋ $\stackrel{+}{\mathbf{O}}$ Z | $\begin{aligned} & \text { 荌 } \\ & \stackrel{0}{\mathbf{O}} \end{aligned}$ | $\begin{aligned} & \text { M } \\ & \stackrel{H}{H} \\ & \stackrel{0}{O} \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { on } \\ & \text { N } \\ & \text { त } \\ & \text { m } \\ & \hline \end{aligned}$ | $\begin{aligned} & \text { ひ } \\ & \text { W } \\ & \text { h } \\ & m \end{aligned}$ | $\begin{aligned} & \underset{\sim}{1} \\ & \underset{\omega}{\omega} \\ & \underset{\sim}{0} \end{aligned}$ |  | $\begin{aligned} & \text { X } \\ & \text { N } \\ & \text { O} \\ & \text { ² } \end{aligned}$ |  |  | $\begin{aligned} & \text { X } \\ & \text { N } \\ & \text { H } \\ & 0 \\ & \text { Win } \end{aligned}$ | 合 合 in m |
| Downstream MCCBs | $\begin{gathered} \text { KA } \\ \text { (RMS) } \end{gathered}$ | 36 | 50 | 70 | 125 | 200 | 200 | 36 | 50 | 70 | 125 | 65 | 65 | 65 | 200 | 65 | 85 |
| E12．5NJ | 25 | 38 | － 36 | 50 | 65 | 85. | 85 | 36 | － | 50 | － | 38 $=$ | 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 | $\square$ | 50 | $\square$ |
| S180NJ | 36 | － | ＇ 50 | 65 | 85 | 125 | 125 | － | 50 | 50 | － | $\div-$ | 65 | 65 | － | － | － |
| S160GJ | 65 | － | － | 70 | 125 | 150 | 150 | － | － | 70 | － | － | － | － | － | － | － |
| H160NJ | 125 | － | － | － | － | 200 | 200 | － | － | － | － | － | － | 65. | － | 65 | － |
| E250N」 | 25 | 36 | 36 | 50 | 65 | 85 | 85 | 36 | － | 50 | － | － | 36 | 50 | － | － | － |
| S250NJ． | 36 | － | 50. | 65 | 85 | 125 | 125. | － | － | 65 | － | －＇ | 65 | － | － | － | － |
| S250GJ | 65 | － | － | 70 | 125 | $\cdots 150$ | 150 | $\stackrel{-}{-}$ | － | 70 | － | － | － | － | － | － | － |
| S250PE | 70 | － | － | － | 125 | 150 | 150 | － | $\cdots$ | － | － | $\because$－ | － | － | － | － | － |
| H250NJ | 125 | － | － | － | － | 200 | 200 | － | － | － | － | － | － | － | － | － | － |
| E400NJ | 25 | 36 | 36 | 50 | 65 | 85 | 85 | 36 | － | 50 | 38 | － | － | － | 36 | － | 38 |
| S400Cd | 36 | － | 50 | 65 | 70 | 100 | 100 | － | － | 65 | 50 | － | － | － | 50 | － | 50 |
| S400N ${ }^{\text {a }}$ | 50 | － | － | 70 | 85 | ＇ 125 | 125 | － | 36 | 70 | 65 | － | － | 50 | 65 | － | 85 |
| S400GJ | 70 | － | － | － | 125 | 150 | 150 | － | 36 | － | － | － | $\cdots$ | 50 | － | 36 | 85 |
| H400NJ ： | 325 | － | ：－ | － | － | 200 | 200 | － | － | － | － | －－1 | － | － | － | － | － |

Note：＇）Ratings have not been verified where a dash＂－＂is shown．
All pick－up and time delay setlings are to be set at a maximum for upstream MCCBs


## APPLICATMON DATA

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

| Upstream MCCB |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| SELECTIVITY／CASCADE <br> © 415 V AC |  |  | m <br>  <br>  <br> Z | $$ | $\begin{aligned} & \text { nI } \\ & \text { NN } \\ & \text { GZ } \\ & \text { Qt } \end{aligned}$ | $\begin{aligned} & \text { n } \\ & \text { Hy } \\ & \underset{y}{c} \end{aligned}$ | $\begin{aligned} & \text { n } \\ & \text { Hi } \\ & \end{aligned}$ | $\begin{aligned} & \text { 毋 } \\ & \stackrel{\rightharpoonup}{\circ} \\ & \hline \end{aligned}$ |  | I总Z2 |
|  | Amp rating | $\begin{gathered} \text { KA } \\ \text { (RMS) } \end{gathered}$ |  |  |  |  |  |  |  |  |
| Downstream MCB |  |  | 25 | 36 | 65 | 36 | 65 | 36 | 70 | 125 |
| DTCE6 | 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 |
| DSRECBH $/$ | 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 |
| :---: |
| $\mathbf{X X / X Y Y}$ |
| Selectivity $\quad$ Cascade |

Notes：All figures stated are at $400 / 415 \mathrm{~V}$ AC．


APPLICATION DATA

## MOTOR STARTING TYPE 1 CO－ORDINATION TABLES

## Short－CIrcult 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

|  |  | Terasakd Comblnations |  |
| :---: | :---: | :---: | :---: |
| Motor Size <br> （kW） | Approx．amps © $400 / 415 \mathrm{~V}$（A） | mecs | Contactor |
| 0.37 | 1.1 | XM30PE／1．4 | CA7－9 |
| 0.55 | 1.5 | XM30P日 2 | CA7－${ }^{\text {a }}$ |
| 0.75 | 1.8 | XM30PE／2．8 | ：CAT－A |
| 1.1 | 2.6 | XM30PB／4．0 | CA7－8 |
| 1.5 | 3.4 | Хм330－${ }^{\text {／}}$ | CA7－- |
| 2.2 | 4.8 | XM30P日／8 | CA7－9 |
| 3 | 6.5 | XM30PE／10 | CA7－9 |
| 4 | 8.2 | XM3゙0FB／12 | ：CAT－${ }^{\text {a }}$ |
| 5.5 | 11 | S125Gd／20 | －CA7－12 |
| 7.5 | 14 | S125Gd／20 | CA7－18 |
| 11 | 21 | S125G／33 | CA7－23 |
| 15 | 28 | S125G／50 | CA7－30 |
| 18.5 | 34 | S125GL／50 | CA7－87 |
| 22 | 40 | －S125G／／ES | CA7－43 |
| 30 | 55 | S125GLM00 | CA7－80 |
| 37 | 66 | S125GL／00 | CA7－72 |
| 45 | 80 | S125GL／125 | CA7－85 |
| 55 | 100 | S125GJ／125 | CAB－110 |
| 5 | 130 | S250PE／250 | CAB－140 |
| 0 | 155 | S250PE／250 | CAB－180 |
| 10 | 200 | S250PE／250 | CAB－210 |
| 32 | 225 | S400GE／400 | CAB－210 |
| 60 | 270 | S400GE／400 | CAB－300 |
| 00 | 361 | S400GE／400 | CAB－420 |


| Terasak Combinationis |  | Sprecher＋Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overload Relay | Theimal Setting（A） | KT7 Circuit Breaker | Contactor |
| CT 7－24 | $1.0{ }^{\circ}=1.8$ | KTA7－25S－1．0A | CA7－9 |
| CT 7－24 | 1．0－1．8 | KTA7－25S－1．6A | CA7－9 |
| CT 7－24 | 1．8－24 | KTA7－25S－2．5A | CA7－9 |
| CT 7－24 | 2．4－4．0 | KTA7－25S－2．5A | CA7－9 |
| GT 7－24 | 2．4－4．0 | KTA7－25S－4．0A | 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 | 0．0－10 | KTA7－25S－10A | CA7－9 |
| CT 7－24 | 10－＇18 | KTA7－25H－16A | CA7－12 |
| CT 7－24 | 10－18 | KTA $7-25 \mathrm{H}-16 \mathrm{~A}$ | CA7－16 |
| GT 7－24 | 16－24 | KTA7－45H－20A | CA7－23 |
| CT 7－45 | 18－80 | 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 | КТАЗ－100－63A | CA7－60 |
| ｜CT 7－75 | 80，－ 75 | КТАЗ－100－90A | CA7－72 |
| CT 7－100 | 70－80 | КТАЗ－100－90A | CA7－85 |
| CEF 1－11／12 | 20－180 | KTA3－160S－100A | CA6－110 |
| CEEF 1－1／1／2 | 20－180 | KTA3－160S－160A | CA6－140 |
| CEF 1－11／M2 | 20－， 180 | KTA3－160S－160A | CA6－180 |
| CEEF 1－41／42 | 180－400 | KTA3－250S－200A | CA6－210 |
| CEF 1－41／42 | 180＇－400 | KTA3－250S－250A | CA6－250 |
| CEF 1－41／42 | 180－400 | KTA3－400S－320A | CA6－300 |
| CEF 1－41／42 | $160^{\circ}-400$ | KTA3－400S－400A | CA6－420 |

Notes：－Thermal or electronic overload relays may be used．
－XM30PB MCCB＇s can be replaced with S $125 \mathrm{GJ} / 20$ if required．
－Comblnations based on the thermal overioad relay tripping before the circuit breaker at overioad currents up to the motor locked rotor current．


## APPLCGATUON DATA

## MOTOR STARTING TYPE 2 CO-ORDINATION TABLES

## Short-CIrcult Co-Ordinatlon 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

|  |  | Teresakl Combinations |  |
| :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Motor SIze } \\ & \text { (kW) } \\ & \hline \end{aligned}$ | Approx. amps ${ }^{(6)}$ $400 / 415 \mathrm{~V}$ (A) | Mcca | Contactar |
| 0.37 | 1.1 | XMSOPBM. 4 | CA7-9 |
| 0.55 | 1.5 | XM30PB/2 | CA7- -1 |
| 0.75 | 1.8 | XM80PB/2.0 | CA7- ${ }^{\text {c }}$ |
| 1.1 | 2.6 | XM30PE/4.0 | CA7-1日 |
| 1.5 | 3.4 | XMSOPB/5 | CA7-18 |
| 2.2 | 4.8 | XMSOPB/8 | CA7-10 |
| 3 | 6.5 | XMSOPE/40 | CA7-S0 |
| 4 | 8.2 | XM30PEM2 | CA7-80 |
| 5.5 | 11 | S125Gu/20 | CA7-80 |
| 7.5 | 14 | S125G/20 | CA7-S0 |
| 11 | 21 | S125G//32 | CA7-30 |
| 15 | 28 | S125GL/50 | CA7-43 |
| 18.5 | 34 | S125G.l/50 | CA7-43 |
| 22 | 40 | S125G.//83 | CA7-43 |
| 30 | 55 | S125Gl/100 | CA7-72 |
| 37 | 66 | S125G. $/ 100$ | CAT̄-72 |
| 45 | 80 | S125G. $/ 125$ | CAB-105 |
| 55 | 100 | S250PE180 | CAE-105 |
| 75 | 130 | S250PEP250 | CAB-140 |
| 90 | 155 | S250PE/250 | CAE-170 |
| 110 | 200 | 8250PEP250 | CAB-210 |
| 132 | 225 | S400PE/400 | CAB-210 |
| 160 | 270 | S400PE/400 | CAE-300 |
| 200 | 361 | S400PE/400 | 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 betore the circuit breaker at overload currents up to the motor locked rotor current.

TYPE 2
50/65 kA

| Terasakl Comblnations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overload Relay | Thermal Setting (A) | KT7 Circult Breaker | Contactor |
| CT 7-24 | 1.0-1.8 | KTA7-25S-1A | CA7.9 |
| CT 7-24 | 1.0-1.8 | KTA7-25S-1.6A | CA7-9 |
| CT 7-24 | 1.8-2.4 | 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 | 4.0-8.0 | KTA7-25S-6.3A | CA7-9 |
| CT 7-24 | 8.0-10 | KTA7-25S-6.3A | CA7-9 |
| CT 7-24 | 8.0-10. | KTA7-25S-10A | CA7-9 |
| \|CT 7-24 | 10-16 | KTA7-25H-16A | CA7-12 |
| CT 7-24 | 10-10 | KTA7-25H-16A | CA7-16 |
| CT 7 -24 | 18-24 | KTA7-45H-20A | CA7-23 |
| CT 7-45 | 18-30 | KTA7-45H-32A | CA7-30 |
| CT 7-45 | 30-46 | KTA7-45H-45A | CA7-37 |
| CT 7-45 | 30-46 | KTA7-45H-45A | CA7-43 |
| CT 7-75 | 45-80 | KTA3-100-63A | CA7-60 |
| CT 7-75 | 80-75 | КТАЗ-100-90A | CA7-72 |
| \|CT 7-100 | 70-80 | KTA3-100-90A | CA7.85 |
| CEF 1-11/12 | 20-180 | KTA3-160S-100A | CA6-110 |
| CEEF 1-11/12 | 20-180 | KTA3-160S-160A | CA6-140 |
| CEEF 1-11/12 | 20-180 | KTA3-160S-160A | CA6-180 |
| CEF 1-41/42 | 100-400 | КТАЗ-250S-200A | CA6-210 |
| CEEF 1-41/42 | 180-400 | KTA3-2505-250A | CA6-250 |
| CEEF 1-41/42 | 160-400 | KTA3-400S-320A | CA6-300 |
| CEF 1-41/42 | 160-400 | KTA3-400S-400A | CA6-420 |



## APPRICATION DATA

## MOTOR STARTING TYPE 2 CO-ORDINATION

## Short-CIrcult 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



| Terasakl Comblnations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overfoad Relay | Therimal <br> Setting (A) | KT7 Circult Breaker | Contactor |
| CT 7-24 | 1.0-1. ${ }^{\text {c }}$ | KTA7-25S-1A | CA 7-9 |
| CT 7-24 | 1.0-1.6 | KTA7-25S-1.6A | CA 7.9 |
| CT $\overline{\text { ¢ }}$ - 24 | $1.6-2.4$ | KTA 7 -25S-2.5A | CA 7-9 |
| CT 7-24 | 2.4-4.0 | KTA7-25H-2.5A | CA 7.9 |
| CT 7-24 | 2:4-4.0 | KTA7-25H-4A | CA 7-9 |
| CT 7-24 | 4.0-8.0 | KTA7-25H-6.3A | CA 7.9 |
| CT 7-24 | e. 0 - 10 | KTA7-25H-6.3A | CA 7 -9 |
| CT. 7-24 | '6.0-10 | KTA7-25H-10A | CA 7 -9 |
| CT 7-24 | 10-16 | KTA7-45H-16A | CA 7.12 |
| CT 7-24 | 10:-18 | KTA 7 -45-16A | CA 7-16 |
| CT 7-24 | 18-24 | KTA 7 -45H-20A | CA 7-23 |
| CT 7.45 | 18-30 | KTA 7 - 5 H-32A | CA 7-30 |
| CT 7.45 | 30-45 | KTA7-45H-45A | CA 7.37 |
| CT 7-45 | 30-45 | KTA 7 -45-45A | CA 7-43 |
| CT 7-75. | 45-60 | KTA3-100-63A | CA.7-60 |
| CT 7-75 | 80-75 | KTA3-100-90A | CA7-72 |
| GT 7-100 | 70-80 | KTA3-100-90A | CA7-65 |
| CEF 1-11/12 | 20-180 | - | - |
| CEF 1-11/12 | 20-480 | - | - |
| CEF 1-11/12 | 20-180- | - | - |
| GEF 1-41/42 | 100-400. | - | - |
| CEF 1-41/42 | 160-400 | - | - |
| CEF 1-41/42 | 180-400. | - | - |
| CEF 1-41/42 | 180-400 | - | - |

[^2]

OPPLICATION DATA

## MOTOR STARTING TYPE 2 CO-ORDINATION

## Short-Circuit Co-OrdInatlon DOL Motor Starting Table

Type '2'
Terasakl MCCB's \& Sprecher + Schuh KT7's
DOL starting $100 \mathrm{kA} @ 400 / 415 \mathrm{~V}$ to ASINZS 60947.4.1

|  |  | Terasakd Combinatoris |  |
| :---: | :---: | :---: | :---: |
| Motor Size <br> (kW) | Approx. ampse $40 \mathrm{D} / 415 \mathrm{~V}$ (A) | м | Comitactor |
| 0.37 | 1.1 | H125NL/20 | CA 730 |
| 0.55 | 1.5 | H125Nu/P20 | CA 7-90 |
| 0.75 | 1.8 | H125Nuf20 | CA 7 -30 |
| 1.1 | 2.6 | H125NJ/20 | CA 7-90 |
| 1.5 | 3.4 | $\mathrm{H} 125 \mathrm{~N} / 20$ | CA 7 -90 |
| 2.2 | 4.8 | H125NJ/20 | CA 7-30 |
| 3 | 6.5 | H125NL/2O | CA 7-30 |
| 4 | 8.2 | H1,25NW | GA 7-30 |
| 5.5 | 11 | H125N/20 | CA 7-30 |
| 7.5 | 14 | H125NL/20 | GA 7-30 |
| 11 | 21 | H1,25N, /32 | CA 7-30 |
| 15 | 2B | H125N/50 | CA 7-43 |
| 18.5 | 34 | H125N1/50 | CA 7.49 |
| 22 | 40 | H125Nu/A3 | CA 7 -43 |
| 30 | 55 | H125-N, $/ 100$ | CA 7-80 |
| 37 | 66 | H125-NIM00 | CA 7-72 |
| 45 | 80 | H125-N1M25 | CA 7 -85 |
| 55 | 100 | H250-NE/160 | CA 6-95 |
| 75 | 130 | H250-NEP50 | CA 8-140 |
| 90 | 155 | H250-NE/250 | CA ${ }^{\text {® } 140}$ |
| 110 | 200 | H250-NE/250 | CA E-180 |
| 132 | 225 | H400-NE/400 | CA 5-420 |
| 160 | 270 | H400-NE/400 | CA O-420 |
| 200 | 361 | H400-NE/400 | CA 6-420 |


| Terasakl Combinations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overload Relay | Thermal <br> Setting (A) | $\mathrm{KT7}$ Ctrcult Breaker | Contector |
| CiT 7-24 | 1.0-1.8 | KTA7-25S-1A | CA 7-9 |
| CT 7-24 | 1.0-1.8 | KTA7-25S-1.6A | CA $7-9$ |
| CT 7-24 | 1.6-2.4 | KTA7-25S-2.5A | CA $7-9$ |
| GT゙ 7-24 | 2.4-4.0 | KTA7-25H-2.5A | CA 7-9 |
| CT 7-24 | 2.4-4.0 | KTA7-25H-4A | CA 7-9 |
| GT 7-24 | 4.0-6.0 | KTA7-25H-6.3A | CA 7-9 |
| CT 7-24 | 8.0-10 | KTA7-25H-6.3A | CA 7-9 |
| GT 7-24 | 8.0-10 | KTA 7 -25H-10A | CA 7-9 |
| CT 7-24 | 10-18 | KTA7-45H-16A | CA 7-12 |
| CT 7-24 | 10-18 | KTA7-45H-16A | CA 7-16 |
| CT $7-24$ | 1日-24 | KTA 7 -45H-20A | CA 7-23 |
| CT 7 -45 | 1B-30 | KTA7-45H-32A | CA 7.30 |
| \|CT 7-45 | 30-46 | KTA7-45H-45A | CA 7-37 |
| \|СТ 7-45 | $30-45$ | KTA $7-45 \mathrm{H}-45 \mathrm{~A}$ | CA 7.43 |
| CT 7-75 | 45-60 | - | - |
| CT 7-75 | 60-75 | $-$ | - |
| CT 7-100 | 70-80 | - | - |
| CEF 1-11/12 | 20'-180 | - | - |
| CEF 1-11/12 | 20-180 | - | - |
| CEFF 1-11/12 | 20-180 | - | - |
| CEF 1-41/42 | 180-400 | $\cdot$ | $\cdot$ |
| CEF 1-41/42 | 100-400 | - | - |
| GEF 1-41/42 | 100-400 | $\cdot$ | $\cdot$ |
| CEF 1-41/42 | 160-400 | $\cdot$ | $\bullet$ |

[^3]- Combinations based on the thermal overload relay iripping before the circuil breaker at overioad currents up to the motor locked rotor current.
[NSTALLATRON
INSULATION DISTANCE IN mm (AT 440V AC MAXIMUM)

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



## ONSTALLATION

## TEMPERATURE RATINGS \& DERATINGS

Calibration Temperature: $45^{\circ} \mathrm{C}$

| MccBrype | $\begin{gathered} \text { Connection } \\ \text { Iype } \end{gathered}$ | $\begin{aligned} & \text { Reitingancalibration } \\ & \text { femperalure:( } 50^{\circ} \mathrm{C} \text { ) } \end{aligned}$ | Ratedicurrent $(\mathrm{A})$ |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $50^{\circ} \mathrm{C}$ | $55^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \hline \text { E125-NJ } \\ & \text { S125-NJ } \\ & \text { S125-GJ } \end{aligned}$ | Front <br> Rear <br> 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 |
|  |  | 100 A | 97 | 94 | 90 | 87 |
|  |  | 125 A | 121 | 117 | 113 | 109 |
| $\begin{aligned} & \text { H125-NL } \\ & \text { L125-NJ } \end{aligned}$ | 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 |
| $\begin{aligned} & \hline \mathrm{S} 160-\mathrm{NJ} \\ & \mathrm{~S} 160-\mathrm{GJ} \end{aligned}$ | 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 |
| $\begin{aligned} & \mathrm{H} 160-\mathrm{NJ} \\ & \text { L160-NW } \end{aligned}$ | Front Rear <br> 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 |
| $\begin{aligned} & \text { E250-NJ } \\ & \text { S250-NJ } \\ & \text { S250-G. J } \end{aligned}$ | Front Rear Plug-in | 160A | 156 | 151 | 146 | 141 |
|  |  | 250 A | 243 | 235 | 227 | 219 |
| $\begin{aligned} & \mathrm{H} 250-\mathrm{NJ} \\ & \mathrm{~L} 250-\mathrm{NJ} \end{aligned}$ | Front <br> Rear <br> Plug-in | 160A | 156 | 151 | 147 | 143 |
|  | Front Rear | 250A | 244 | 237 | 230 | 223 |
| E400-NJ | Front Rear <br> Plug-in | 250 A | 244 | 237 | 230 | 223 |
| S400-CJ |  | 400A | 390 | 380 | 369 | 358 |
| $\begin{aligned} & \text { S400-NJ } \\ & \text { S400-GJ } \end{aligned}$ |  |  |  |  |  |  |
| $\begin{aligned} & \mathrm{H} 400-\mathrm{NJ} \\ & \mathrm{~L} 400-\mathrm{NJ} \end{aligned}$ | $\begin{aligned} & \text { Front } \\ & \text { Rear } \end{aligned}$ | 250 A | 243 | 237 | 230 | 223 |
|  |  | 400A | 390 | 381 | 371 | 361 |
|  | Plug-in | 250A | 243 | 237 | 231 | 224 |
|  |  | 400A | 392 | 384 | 376 | 368 |

Calibration Temperature: $30^{\circ} \mathrm{C}$

| MCCB\% | Connection | Ratingaralitraion | Ratedicuremin) |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Lype | (emperature(80\%C) | $35^{\circ} \mathrm{C}$ | $40^{\circ} \mathrm{C}$ | $45^{\circ} \mathrm{C}$ | $50^{\circ} \mathrm{C}$ | $55^{\circ}$ | $60^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ |
| H250-NW | Plug-in Conn. | 250 A | 244 | 236 | 225 | 219 | 209 | 200 | 190 |


| MCCBIype | Connection ITpe | Rating | Ratedicunent(A) |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $30^{\circ} \mathrm{C}$ | $35^{\circ} \mathrm{C}$ | $40^{\circ} \mathrm{C}$ | $45^{\circ} \mathrm{C}$ | $50^{\circ} \mathrm{C}$ | $55^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \text { S250-PE } \\ & \text { H250-NE } \end{aligned}$ | Front | 250A | 250 | 250 | 250 | 250 | 237.5 | 225 | 200 | 200 |
|  |  |  |  |  |  |  |  |  |  |  |
|  | Plug-in | 250A |  |  |  | 225 | 200 | 200 | 157.5 | 157.5 |
| $\begin{aligned} & \hline \text { S400-NE } \\ & \text { S400-GE } \end{aligned}$ | Front Rear <br> Plug-in | 250A | 250 | 250 | 250 | 250 | 250 | 250 | 225 | 200 |
|  |  | 400A | 400 | 400 | 400 | 400 | 400 | 380 | 360 | 320 |
| $\begin{aligned} & \mathrm{H} 400-\mathrm{NE} \\ & \mathrm{~L} 400-\mathrm{NE} \end{aligned}$ | 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 |
| $\begin{aligned} & \text { E630-NE } \\ & \text { S630-CE } \\ & \text { S630-GE } \end{aligned}$ | Front Rear* | 630 A | 630 | 630 | 630 | 630 | 598.5 | 598.5 | 567 | 504 |



## DRMENSIONS

E630-NE, S630-CE, S630-GE

ASL: Arrangement Standard Line
ut :Handle Frame Centre Line



## ©PERATMNG CMARACTERISTICS

## ELECTRONIC PROTECTION

## Optional Functions

Three optional functions are available:

## Ground Fault Trip (G)

This function trips the MCCB after time delay, tg , if the ground fault current exceeds the preset threshold, $I_{\mathrm{g}}$. 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, ${ }^{{ }_{\mathrm{N}}}$, if current in the neutral conductor exceeds the rated current, $I_{\mathrm{n}}$, 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, $I_{\mathrm{p}}$.

## 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:



## OPERATMNG CHARACTERUSTICS

## 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 630 A models preset characteristics. The effects of the left adjustment dial (labelled $I_{R}(\mathrm{~A})$ ), and the right adjustment dial (labelled Characteristics) are detailed in the tables shown underneath each time/current graph.

Tolerances of Characteristics

| Characteristios |  | Tolerance |
| :---: | :---: | :---: |
| Long. Time Delay | $t_{R}$ | +/. $20 \%$ |
| Short Time Delay | 1 so | +/. 15\% |
|  | $t_{\text {sd }}$ | Total clearing time +50 ms , resettable time -20 ms |
| Instantaneous | $h$ | +/. $20 \%$ |
| Preferential trip Alarm | Ip | +/. 10\% |
|  | $t p$ | +/-10\% |
| Ground Fault Trip | 19 | +/. $15 \%$ |
|  | $t_{9}$ | Total clearing time +50 ms , resettable time -20 ms |
| Neutral Protection | 1 N | +/-15\% |



## OPRRATUNG CHARACTERISTICS

## LET-THROUGH ENERGY CHARACTERISTICS

H $400-\mathrm{NJ}, \mathrm{H} 400-\mathrm{NE}, \mathrm{L} 400-\mathrm{NJ}, \mathrm{L} 400-\mathrm{NE} .415 \mathrm{~V}$ AC.


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


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



## accessorore

## 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.


## 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 400 A and 630 A 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


## DNSTALLOTRON

## 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.

Plüg-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.


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.

## accessornes

## INSULATION ACCESSORIES

Interpole Barriers (BA)
Interpole barriers provide maximum insulation berween 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 Boch Ends


Inrerpole Barriers berween Adjacent MCCBs

## NHP

## Electronic type <br> S400GE

## 70kA

Current rating
100-400A
Approvals and Tests:
Standards AS/NZS 3947-2, and IEC60947-2
Interrupting capacity:

AC use | Voltage | Icu | Ics |
| :---: | :---: | :---: |
|  | 70 | 50 |

## Over Current Relay:

- Electronic, for general \& selectivity applications
- 7 dial selectable characteristic curves suited for a variety of applications

- Base current $I r$ is adjustable from $40 \%-100 \%$ of the nominal rated current in.
- STD setting 2.5-10(x/R) 2)
- INST setting 13-14 (x $\left.I_{R}\right)^{2}$ )

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 togale) | 103 | 103 |


| Ampere <br> Rating | $\boldsymbol{I}_{\text {R }}$ Adjustment |  |
| :--- | :--- | :--- |
| NRC | Min-Max. | Cat. No. 1) |
| $\mathbf{2 5 0}$ | $100-250$ | S400 GE_250 |
| $\mathbf{4 0 0}$ | $160-400$ | S $_{200}$ 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: | $\begin{aligned} & \text { PTA 3) }_{\text {GF }}^{3} \\ & \text { PTA + GF } \end{aligned}$ | S400 GE 3 AP \# S400 GE 3 AG \# 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 \# |
|  | $\mathrm{GF}+\mathrm{NP}{ }_{3}$ ) | S400 GE 4 AGN \# |
|  | $\mathrm{PTA}+\mathrm{GF}+\mathrm{NP}_{3}$ ) | 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 ( $h_{\text {do }} \& A_{i}$ ) settings are not individually adjustable, however by selecting different curve types and different $I_{R}$ settings the values will vary. Curve $1 \& 2 I_{s d}=2.5 \times I_{R,}$ curve $3 I_{\mathrm{sd}}=5 \times I_{\mathrm{R}}$, curve $4-7 I_{\mathrm{Ad}}=10 \times I_{\mathrm{R}}$. I $\mathrm{I}_{\mathrm{A}}$ dial setting $0.4-0.9 \hat{h}_{i}=14 \times I_{R}$ and $t_{R}$ dial setting $0.95-1.0 h_{\hat{L}}=13 \times I_{R}$. Refer curve examples \& setting data on pages 18 to 30 . |  |
|  | $N R C=$ Nominal rated current, $\quad I_{R}=$ Current adjustment dial setting, $\quad$ STD $=$ Short Time Delay, $\quad$ INST $=$ instantaneous |  |
| 3) | To crder 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


## DIRAENSIONS

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

ASL: Arrangement Standard Line
t : Handle Frame Centre Line



INSTALRATMON
INSULATION DISTANCE IN mm (AT 440V AC MAXIMUM)

| mader | 13 | ir | 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 |  |  | G. | 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 |  | - | N $J$ | 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 |  | 1 | 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 |  | $\because$ | 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.

## ONSTALLATRON

## TEMPERATURE RATINGS \& DERATINGS

Calibration Temperature: $45^{\circ} \mathrm{C}$

| MCCBTy | Connection iype | Ratingatcalibration रemperalure: $\left(50^{\circ} \mathrm{C}\right)$ | Râaledicürent (A) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $50^{\circ} \mathrm{C}$ | $55^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \text { E125-NJ } \\ & \text { S125-NJ } \\ & \text { S125-GJ } \end{aligned}$ | 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 |
| $\begin{aligned} & \mathrm{H} 125-\mathrm{NJ} \\ & \mathrm{~L} 125-\mathrm{NJ} \end{aligned}$ | 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 |
| $\begin{aligned} & \text { S160-NJ } \\ & \text { S160-GJ } \end{aligned}$ | Front <br> Rear <br> 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 |
| $\begin{aligned} & \text { H160-NJ } \\ & \text { L160-NJ } \end{aligned}$ | Front Rear <br> Plug-in | 160 A | 156 | 151 | 147 | 143 |
| E250-NJ | Fiont Rear Plug-in | 20A | 19 | 18.5 | 18 | 17.5 |
|  |  | 32A | 31 | 30 | 29 | 28 |
|  |  | 50A | 48 | 46 | 44 | 42 |
|  |  | 63 A | 61 | 59 | 57 | 55 |
|  |  | 100A | 97 | 94 | 91 | 88 |
|  |  | 125A | 121 | 117 | 113 | 109 |
| $\begin{aligned} & \mathrm{E} 250-\mathrm{NJ} \\ & \text { S250-NJ } \\ & \mathrm{S} 250-\mathrm{GJ} \\ & \hline \end{aligned}$ | Front Rear Plug-in | 160 A | 156 | 151 | 146 | 14) |
|  |  | 250 A | 243 | 235 | 227 | 219 |
| $\begin{aligned} & \mathrm{H} 250-\mathrm{NJ} \\ & \mathrm{~L} 250-\mathrm{NJ} \end{aligned}$ | Fron: Rear Plug-in | 160A | 156 | 151 | 147 | 143 |
|  | $\begin{aligned} & \text { Front } \\ & \text { Rear } \end{aligned}$ | 250 A | 244 | 237 | 230 | 223 |
| $\begin{aligned} & \text { E400-NJ } \\ & \text { S400-CJ } \\ & S 400-\mathrm{NJ} \\ & \mathrm{~S} 400-\mathrm{GJ} . \end{aligned}$ | Front Rear <br> Plug-in | 250A | 244 | 237 | 230 | 223 |
|  |  | 400A | 390 | 380 | 369 | 358 |
| $\begin{aligned} & \mathrm{H} 400-\mathrm{NJ} \\ & \mathrm{~L} 400-\mathrm{NJ} \end{aligned}$ | Front Rear | 250 A | 243 | 237 | 230. | 223 |
|  |  | 400A | 390 | 381 | 371 | 361 |
|  | Plug-in | 250A | 243 | 237 | 231 | 224 |
|  |  | 400 A | 392 | 384 | 376 | 368 |

Calibration Temperalure: $30^{\circ} \mathrm{C}$

| $\begin{gathered} \text { WCOBrype } \\ \hline \end{gathered}$ |  | Ratingar cillialion | Patedicurenil $(A)$ |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $35^{\circ} \mathrm{C}$ | $40^{\circ} \mathrm{C}$ | $45^{\circ} \mathrm{C}$ | $50^{\circ} \mathrm{C}$ | $55^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \mathrm{H} 250-\mathrm{NJ} \\ & \text { L250-NJ } \end{aligned}$ | Plug-th Conn. |  | 2504 | 244 | 236 | 225 | 219 | 209 | 200 | 190 |


| MCCBuyp | Connection Type: | Rating | (RatediCurien ( $A$ ) |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $30^{\circ} \mathrm{C}$ | $35^{\circ} \mathrm{C}$ | $40^{\circ} \mathrm{C}$ | $45^{\circ} \mathrm{C}$ | $50^{\circ} \mathrm{C}$ | $55^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | $65^{\circ} \mathrm{C}$ |
| $\begin{aligned} & \text { S250-PE } \\ & \text { H250-NE } \end{aligned}$ | 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 |
| $\begin{aligned} & \text { S400-NE } \\ & \text { S400-GE } \end{aligned}$ | Front | 250A | 250 | 250 | 250 | 250 | 250 | 250 | 225 | 200 |
|  | Rear Plug-in | 400 A | 400 | 400 | 400 | 400 | 400 | 380 | 360 | 320 |
| $\begin{aligned} & \text { H400-NE } \\ & \text { L400-NE } \end{aligned}$ | Front Rear | 250 A | 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 |
| $\begin{aligned} & \text { E630-NE } \\ & \text { S630-CE } \\ & \text { S630-GE } \end{aligned}$ | Front Rear | 630 A | 630 | 630 | 630 | 630 | 598.5 | 598.5 | 567 | 504 |

Selectivity \＆Cascade Tables
＠ 400 ／ 415 V

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| XX／Y YSelectivity／Cascade |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 岩 | $\begin{array}{r} \text { 崖 } \\ \stackrel{0}{尸} \\ \underset{125}{ } \end{array}$ | 岩 |  |  |  |  |  |  |  |
| 70 | 125 | 50 |  |  |  |  |  |  |  |
| 25／50 | 25／25 | 25／36 | 25／36 | 25／65 | 25／25 | 25／25 | 25／25 | 25／25 | 25／25 |
| 36／65 | 36／36 | 36／50 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65／70 | 65／65 | 65／50 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 | ．65／65 | 65／65 |
| 70／70 | 70／70 | 50／50 | 65／65 | 65／65 | 85／50 | 85／50 | 100／100 | ．85／85 | 85／85 |
| 136／50 | 36／36． | 36／36： | 36／65 | 36／65 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| $65 / 70$ | 65／65 | 50／50， | 50／65 | 50／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70／70 | 70，70 | 50／50 | 50／65 | 50／65 | ．85／65 | 85／65 | 100／100 | 85／85 | 85／85 |
| 25／50 | 25／25 | ：25／25 | 25／50 | 25／50 | 25／25 | 25／25 | 25／25 | 25／25 | 25／25 |
| －36／65 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | ，36／36 | 36／36 | 36／36 | 36／36 |
| 6 $65 / 70$ | ：65／65 | 50，50 | 50／65 | 50／65 | ¢65／65 | 65／65 | －65／65 | 65／65 | 65／65 |
| 70／70 | 70\％70 | 50\％50 | 50／65 | 50／65 | 70／70 | 70，70 | 70／70 | 70／70 | 70／70 |
| 70／70 | 70，70 | 50\％50 | 50／65 | 50／65 | 85／85 | ：85／85 | 100／100 | 85／85 | 85／85 |
| 70／70 | 70／70 | 50／50 | 50／65 | 50／65 | 85／85 | ；85／85 | 100／100 | ．85／85 | 85／85 |
| 10／50 | 10／36 | 25／25 | 25／25 | 25／36 | ＇25／25 | 25／25 | 25／36 | 25／25 | 25／25 |
| 10／65 | 10／50 | 25／36 | 25／36 | 25／50 | ．38／36 | 36／36 | 36／50 | 36／36 | 36／36 |
| 10／50 | 10，50 | 25／50 | 25／50 | 25／50 | ${ }^{2} 50 / 50$ | 50／50 | 50／50 | 50／50 | 50\％50 |
| 10，70 | 10／85 | 25／50 | 25／50 | 25／65 | 50／50 | 50／50 | 50／65 | 50／50 | 50／50 |
| 10／70 | －1070 | 25／50 | 25／50 | 25／65 | 70／36 | 70／36 | 70\％85 | 70／70 | 70／70 |
| 10，70 | 1070 | 25／50 | 25／65 | 25／65 | 125／85 | 125／85 | 125／100 | 125／85 | 125／85 |
| 10\％70 | 10／70 | 25／50 | 25／65 | 25／65 | 125／85 | 125／85 | 125／100 | 125／85 | 125／85 |
|  |  | 25／36 | 25／36 | 25／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
|  |  | 25／50 | 25／50 | 25／50 | 50／50 | 50，50 | 50／50 | 50／50 | 50，50 |
|  |  |  |  |  | 70，70 | 70／70 | 70／70 | 70，70 | 70／70 |
| 1 |  |  |  |  | 30／45 | 30／45 | 30／45 | 35／45 | 35／45 |
|  | $\cdots$ |  |  |  | 30／65 | 30／65 | 30／65 | 35／65 | 36／65 |
|  |  | $J$ |  | 1 | 30／85 | 30／85 | 30／85 | 35／85 | 35／85 |
|  |  |  | 1 | 1 | 30／65 | 30／65 | 30\％85 | 30／85 | 30／85 |
| 1 |  |  |  |  | 30／65 | 30／65 | 30／85 | 30／85 | 30／85 |
|  |  |  |  |  | 30／65 | 30／65 | 30\％85 | 30／85 | 30／85 |
| $\times$－ | 1 |  | I | $\cdots$ | －15／65 | 15／65 | ：20／65 | 35／65 | － $35 / 65$ |
|  |  |  | ${ }^{1} 1$ | $\because$ | 15／50 | 15／50 | ：20／50 | ． $35 / 50$ | 35／50 |
|  |  |  |  |  | 15／85 | 15／85 | 20／85 | 35／85 | 35／85 |
|  |  |  |  |  | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
|  | 1 |  | ！ |  | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
|  |  |  |  |  |  |  | 20／65 | 35／65 | 35／65 |
|  |  |  | ， |  |  |  |  | 35／85 | 35／85 |



## APPLICATION DATA

## CASCADE TABLES

| CASCADE <br> （38）380－415VAC ${ }^{1}$ ） |  | $\begin{aligned} & \stackrel{m}{\sim} \\ & \underset{\sim}{Z} \end{aligned}$ |  |  |  | $\begin{aligned} & \stackrel{\rightharpoonup}{v} \\ & \underset{\sim}{c} \end{aligned}$ |  | $\begin{aligned} & \stackrel{\sim}{\stackrel{\rightharpoonup}{\circ}} \\ & \stackrel{\rightharpoonup}{2} \end{aligned}$ |  | $\stackrel{\text { 긍 }}{\stackrel{2}{2}}$ | $\begin{aligned} & \text { M } \\ & \text { M } \\ & \text { 2nc } \end{aligned}$ |  | $\begin{aligned} & \text { N } \\ & \text { Noㅁ } \\ & \text { R } \end{aligned}$ | $\begin{aligned} & \text { N } \\ & \text { N} \\ & \text { on } \\ & \text { on } \end{aligned}$ |  |  | N |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Downstream MCCBs | (RMS) | 25 | 36 | 65 | 125 | 200 | 36 | 65 | 125 | 200 | 25 | 36 | 65 | 70 | 125 | 125 | 200 |
| E125NJ | 25 | － | 36 | 38 | 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 | $\div$ | － | 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 | － | － | － | － | － | － | － | － | － | － | $\square$ | － | － | － | － | 200 |
| E400NJ | 25 | － | － | － | － | $\stackrel{+}{+}$ | － | － | － | － | － | － | － | 36 | 65 | 65 | － |
| S400C． | 36 | － | － | － | － | － | － | － | － | － | － | － | － | 50 | 70 | 70 | － |
| S400NJ | $50^{\circ}$ | － | － | － | － | － | － | － | － | － | － | － | 50 | 65 | 85 | 85 | － |
| S400G ${ }^{\text {d }}$ | 70 | － | － | － | － | － | － | － | － | － | － | － | $50^{\prime}$ | － | 125 | 125 | － |
| H400NJ | 125 | － | － | － | － | － | － | － | － | － | $\stackrel{-}{-}$ | － | － | － | － | － | － |

Note：＇）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 <br> （13 380－415 VAC＇） |  | $\begin{aligned} & n \\ & \stackrel{n}{8} \\ & \stackrel{C}{2} \end{aligned}$ | $\begin{aligned} & n \infty \\ & \text { Bo } \\ & 0.8 \\ & \text { 20 } \\ & \hline \end{aligned}$ |  |  | $\begin{aligned} & \text { 「 } \\ & \stackrel{\rightharpoonup}{\circ} \\ & \underset{\sim}{C} \end{aligned}$ | $\begin{aligned} & \text { 「 } \\ & \stackrel{+}{O} \\ & \underset{i}{2} \end{aligned}$ |  | $\begin{aligned} & \text { 』 } \\ & \stackrel{\sim}{0} \\ & \underset{\Pi}{m} \end{aligned}$ | $\begin{aligned} & \text { ఱ } \\ & \text { (2) } \\ & \text { م } \end{aligned}$ |  | $\begin{aligned} & \times \\ & \text { 区 } \\ & \text { O } \\ & \text { O } \\ & \text { in } \end{aligned}$ | $\begin{aligned} & \text { 㐅 } \\ & \text { O } \\ & \text { O } \\ & \text { Z } \end{aligned}$ |  |  |  |  |
| Downstream MCCBs | $\begin{aligned} & \text { KA } \\ & \text { (RMS) } \end{aligned}$ | 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 | － | $50^{\circ}$ | － | 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 | － |
| Si60NJ | 36 | － | 50 | 65 | 85 | 125 | 125 | － | 50 | 50 | － | － | 65 | 65 | － | － | － |
| S160GJ | 65 | － | $=$ | 70 | 125 | 150 | 150 | － | － | 70 | － | － | － | － | － | － | － |
| H160NJ | 125 | － | － | － | － | 200 | 200. | － | － | － | － | $\cdots$ | － | 65 | － | 65 | － |
| E250NJ | 25 | 36 | 36 | 50 | 65 | 85 | 85 | 36 | － | 50 | $\because$ | $\stackrel{-}{-}$ | 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：＇）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

## APPLIGATHON DATA

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

| Upstream MCCB |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| SELECTIVITY / CASCADE <br> (9) 415 V AC |  |  |  | $\begin{aligned} & \text { NI } \\ & \text { NN } \\ & \text { GK } \\ & \text { ci } \end{aligned}$ | N N O 2 | $\begin{aligned} & \text { N } \\ & \text { N } \\ & \mathbf{O} \end{aligned}$ | $n$ + + ¢ |  | I $\stackrel{+}{+}$ 을 |
| MCB | rating | (RMS) | 2536 | 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 | 15.4 | 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

| $\mathbf{X X} / \underset{\mathbf{Y}}{\text { Selectivity }}$ | Cascade |
| :---: | :---: |

Notes: All figures stated are at $400 / 415 \mathrm{~V}$ AC.


APPLICATION DATA

## MOTOR STARTING TYPE 1 CO-ORDINATION TABLES

Short-Circult Co-Ordination Motor Starting Table
Type ' 1 '
Terasaki MCCB's \& Sprecher + Schuh KTT's
DOL starting 50/65 KA © 400/415 V to ASNZS 60947.4.1

|  |  | Terasakl Combinations |  |
| :---: | :---: | :---: | :---: |
| Motor Slze $(\mathrm{kW})$ | Approx. amps $400 / 415 \mathrm{~V}$ (A) | MCCB | Contactor |
| 0.37 | 1.1 | XM30PE/1.4 | CAT-E |
| 0.55 | 1.5 | XM30PE2 | CA7- |
| 0.75 | 1.8 | XM30FE/2. ${ }^{\text {a }}$ | CA7- |
| 1.1 | 2.6 | XM30PE/4.0 | CA7-B |
| 1.5 | 3.4 | XM30РE/5 | CAT- ${ }^{\text {a }}$ |
| 2.2 | 4.8 | ХM30РВ保 | CA7 |
| 3 | 6.5 | XM30PE/10 | CA7- |
| 4 | 8.2 | XM30PE/12 | CAT-E |
| 5.5 | 11 | 5125G1/20 | CAT-12 |
| 7.5 | 14 | S125G1/20 | CA7-16 |
| 11 | 21 | S125G1/32 | CA7-2B |
| 15 | 28 | S125G./50 | CAP-30 |
| 18.5 | 34 | S125G1/50 | CA7-37 |
| 22 | 40 | S125G.La3 | CA7-4 ${ }^{3}$ |
| 30 | 55 | S125G//100 | CA7-50 |
| 37 | 66 | S125G//100 | CA7-72 |
| 45 | 80 | S125G//125 | CA7-85 |
| 55 | 100 | S125G./125 | CAE-110 |
| 5 | 130 | S250PE/250 | CAB-140 |
| 0 | 155 | 5250PER250 | CRE-180 |
| 10 | 200 | S950PE/250 | Cre-210 |
| 32 | 225 | S400GE/400 | CAE-210 |
| 60 | 270 | S400EE/400 | CAB-SOO |
| 00 | 361 | S400GE/400 | CAB-420 |


| Terasakl Comblnations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overload Relay | Thermal <br> Setting (A) | KT7 Circult Breaker | Contactor |
| CT 7-24 | 1.0-1.8 | KTA7-25S-1.0A | CA7.9 |
| GT 7-24 | 1.0-1.0 | KTA7-25S-1.6A | CA7-9 |
| CT 7-24 | 1.8-2.4 | 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.4.0A | CA7-9 |
| GT 7-24 | 4.0-6.0 | KTA7-25S-6.3A | CA7.9 |
| CT 7-24 | 8.0-10 | KTA7-25S-6.3A | CA7-9 |
| GT 7-24 | 6.0-10 | KTA7-25S-10A | CA7-9 |
| CT 7-24 | 10-18 | KTA 7 -25H-36A | CA7-12 |
| CT 7-24 | 10-16 | KTA7-25H-16A | CA7-16 |
| CT 7-24 | 10-24 | KTA7-45H-20A | CA7-23 |
| CT 7-45 | 10-30 | 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 7-75 | 45-80 | KTA3-100-63A | CA7-60 |
| CT 7-75 | 80-75 | КТАЗ-100-90A | CA7.72 |
| CT 7-100 | 70-80 | KTA3-100-90A | CA7-85 |
| CEFF 1-11/12 | 20-180 | KTA3-160S-100A | CAE-110 |
| CEF 1-11/12 | 20-180 | KTA3-160S-160A | CA6-140 |
| CEF 1-11/12 | 20-180 | KTA3-1605-160A | CA6-180 |
| CCEF 1-41/42 | 180-400 | KTA3-250S-200A | CA6-210 |
| CEF 1-41/42 | 180-400 | KTA3-250S-250A | CA6-250 |
| CEEF 1-41/42 | 180-400 | KTA3-400S-320A | CAB-300 |
| ICEF 1-41/42 | 160-400: | KTA3-400S-400A | CA6-420 |

Noles: - Thermal or electronic overload relays may be used.

- XM30PB MCCB's can be replaced with S125GJ/20 if required.

Combinations based on the thermal overbad relay ripping before the circuit. breaker at overload cusrents up to the molor locked rotor current.


## APPLICATION DATA

## MOTOR STARTING TYPE 2 CO-ORDINATION TABLES

## Short-CIrcult 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


| Terasakd Combinations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overload Relay | Thermà Setting. (A) | KT7 Circuit Breaker | Contactor |
| GT ブ-24 | 1.0-1.8. | KTA7-25S-1A | CA7-9 |
| CT 7-24 | 1.0-1.6 | KTA7-25S-1.6A | CA7-9 |
| CTT 7-24 | 1.0-2.4 | 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 | 0.0-10: | KTA 7 -25S-10A | CA7-9 |
| CT 7-24 | 10̀-10 | KTA7-25H-16A | CA7-12 |
| CTT 7-24 | 10-16 | KTA 7 -25H-16A | CA7-16 |
| CT. 7-24 | 10-24. | KTA 7 -45H-20A | CA7-23 |
| CT 7-45 | 18:30 | KTA 7 -45H-32A | CA7-30 |
| CT 7-45 | 30-45 | KTA 7 -45H-45A | CA7-37 |
| CT 7-45 | 30-45, | KTA 7 -45H-45A | CA7-43 |
| CT 7-75 | 45-60 | KTA3-100-63A | CA7-60 |
| CT 7-75 | 80-75 | KTA3-100-90A | CA7-72 |
| CT 7-100 | 70-60 | KTA3-100-90A | CA7-85 |
| CEF 1-11/12 | 20-180 | KTA3-160S-100A | CA6-110 |
| CEFF 1-11/12 | 20-180. | KTA3-160S-160A | CA6-140 |
| CEF 1-11/12 | 20-180 | KTA3-160S-160A | CA6-180 |
| CEEF 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 | KTA3-400 S-320A | CA6-300 |
| CEF 1-41/42 | 160-400 | KTA3-400S-400A | CA6-420 |

- 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.

## APPLICATION DATA

## MOTOR STARTING TYPE 2 CO-ORDINATION

Short-CIrcult Co-Ordination DOL Motor Starting Table
Type '2'
Terasaki MCCB's \& Sprecher + Schuh KT7's
DOL starting $85 \mathrm{KA} 400 / 415 \mathrm{~V}$ to AS/NZS 60947.4.1

|  |  | Terasakl Comblnations |  |
| :---: | :---: | :---: | :---: |
| Motor Size $(\mathbf{k W})$ | Approx. amps © $400 / 415 \mathrm{~V}$ (A) | MCCs | Cointactor |
| 0.37 | 1.1 | XM30РB/-1. 4 | CA 7- |
| 0.55 | 1.5 | XM30PB/2 | CA 7- |
| 0.75 | 1.8 | XM30PB/2.6 | CA 7-8 |
| 1.1 | 2.6 | XMSOPB/4.0 | CA 7-10 |
| 1.5 | 3.4 | XMSOPB/5 | CA 7-18 |
| 2.2 | 4.8 | XM30PB/8 | CA 7-30 |
| 3 | 6.5 | XMS0PB/10 | CA 7-30 |
| 4 | 8.2 | XMSOPE/12 | CA 7-30 |
| 5.5 | 11 | H125Nif2o | CA 7-30 |
| 7.5 | 14 | H125NJ/20 | CA 7-30 |
| 11 | 21 | H125N $\sqrt{132}$ | CA 7-30 |
| 15 | 28 | H125NL/50 | GA 7.43 |
| 18.5 | 34 | H1205N/50 | CA $7-43$ |
| 22 | 40 | H125N//33 | CA 7-43 |
| 30 | 55 | H125N $/ / 100$ | CA 7-72 |
| 37 | 66 | H125N $/$ /100 | CA 7-72 |
| 45 | 80 | H125NL/ 60 | CA $\mathrm{B}-105$ |
| 55 | 100 | H160Nal/ 180 | CA B-105 |
| 75 | 130 | H250PE/250 | CA 8-210 |
| 90 | 155 | H250PE/250 | CA $\mathrm{B}_{\text {-210 }}$ |
| 110 | 200 | H250PE/250 | CA 0 -210 |
| 132 | 225 | H400NE/400 | CA B-210 |
| 160 | 270 | H400NE/400 | GA B-800 |
| 200 | 361 | H400NE/400 | CA 6-420 |


| Terasakl Combinations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overload Relay | Thermal Setting (A) | KT7 Circult Breaker | Contactor |
| Ci̇i 7-24 ... | 1.0-1.0 | KTA7-25S-1A | CA $7-9$ |
| CTt 7-24 | 1.0-1.0 | KTA7-25S-1.6A | CA 7.9 |
| CT 7-24 | 1.8-2.4 | KTA7-25S-2.5A | CA 7-9 |
| CTT 7-24 | 2.4-4.0 | KTA7-25H-2.5A | CA 7.9 |
| Cİ 7-24 | 2.4-4.0 | KTA7-25H-4A | CA 7-9 |
| CT 7-24 | 4.0-8.0 | KTA7-25H-6.3A | CA 7 -9 |
| CT 7-24 | 8.0-10 | KTA7-25H-6.3A | CA $7-9$ |
| CT. $7-24$ | 8.0-10 | KTA7-25H-10A | CA $7-9$ |
| CTi 7-24 | 10-10 | KTA7-45H-16A | CA 7-12 |
| CTT 7-24 | 10-18 | KTA $7-45 \mathrm{H}-16 \mathrm{~A}$ | CA 7-16 |
| CT'7-24 | 18-24 | KTA7-45H-20A | CA 7-23 |
| CFF 7-45 | 18-30 | KTA7-45H-32A | CA $7-30$ |
| CT 7-45 | 30-45 | KTA $7-45 \mathrm{H}-45 \mathrm{~A}$ | CA 7-37 |
| CT 7-45 | 30-45 | KTA7-45H-45A | CA 7-43 |
| CT 7-75 | 45-60 ${ }^{\circ}$ | KTA3-100-63A | CA7-60 |
| CT 7-75 | 600-75 | KTA3-100-90A | CA7-72 |
| CT: 7-100 | 70-80 | KTA3-100-90A | CA7-85 |
| CEF 1-11/12 | 20-160 | - | - |
| CEF 1-11/12 | 20-180 | - | - |
| CEF 1-11/12 | 20-180 | - | $\cdot$ |
| CEF 1-41/42. | 160-400 | $\cdot$ | - |
| CEF 1-41/42 | 160-400 | - | $\cdot$ |
| CEF 1-41/42 | 160-400. | - | $\cdot$ |
| CEF 1-41/42 | 160-400 | $\cdot$ | $-$ |

Notes: - Thermal or electronic overtoad relays may be used.

- XM30PB combinations can be replaced with H125GJ/20 and CA7-30 if requirad.
- Combinations based on the thermal overload relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.


## APPLDGATION DATA

## MOTOR STARTING TYPE 2 CO-ORDINATION

## Short-CIrcutt Co-Ordinatlon DOL Motor Starting Table

Type '2'
Terasaki MCCB's \& Sprecher + Schuh KT7's
DOL starting $100 \mathrm{KA} @ 400 / 415 \mathrm{~V}$ to ASNZS 60947.4.1

| Terasakd Comblnations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overlaad Relay | Thermal Setting (A) | KT7 Cireuit Breaker | Contactor |
| CT 7-24 | 1.0-1.: | KTA7-25S-1A | CA 7-9 |
| CT 7-24 | 1.0-1.6 | KTA7-25S-1.6A | CA 7-9 |
| CT 7-24 | 1.6-2.4 | KTA7-25S-2.5A | CA 7.9 |
| CT 7-24 | 2.4-4.0 | KTA7-25H-2.5A | CA 7-9 |
| CT 7-24 | 2.4-4.0 | KTA $7-25 \mathrm{H}-4 \mathrm{~A}$ | CA 7-9 |
| CT 7-24 | 4.0-8.0 | KTA7-25H-6.3A | CA 7-9 |
| [CT 7-24 | 6.0-10 | KTA $7-25 \mathrm{H}-6.3 \mathrm{~A}$ | CA $7-9$ |
| \|CT $7-24$ | 9.0'-10 | KTA $7-25 \mathrm{H} \cdot 10 \mathrm{~A}$ | CA $7-9$ |
| CT 7-24 | 10-18 | KTA7-45H-16A | CA 7 -12 |
| CT 7-24 | 10-18 | KTA 7 -45 H -15A | CA 7.15 |
| CT 7-24 | 18-24 | KTA7-45H-20A | CA 7.23 |
| CT 7-45 | 1B-30 | KTA7-45H-32A | CA 7-30 |
| CT 7-45 | 30-45 | KTA7-45H-45A | CA 7-37 |
| \|cT 7 -4. | 30-45 | KTA7-45H-45A | CA 7.43 |
| CTT 7-75 | 45-80 | - | - |
| CTC 7-75 | 80-75 | - | - |
| GT 7-100 | 70-80 | - | - |
| GEF 1-11/12 | 20-180 | - | - |
| CEF 1-11/12 | 20-180 | - | - |
| CEF 1-11/2 | 20-180 | $\cdot$ | - |
| CEF 1-41/42 | 160-400 | $\cdot$ | - |
| CEF 1-41/42 | 160-400 | - | - |
| CEF 1-41/42 | 160-400 | - | - |
| CEF 1-41/42 | 160-400 | - | - |

## OPERATING CHARACTERISTICS

## ELECTRONIC CHARACTERISTICS

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

$\ln =400 \mathrm{~A} ; 250 \mathrm{~A}$


Nole
(1) $/$ i max. $=13 \times \ln$. (2) Standard setting of $I_{\mathrm{N}}$ is $100 \%$ of $I_{\mathrm{n}}$. For any other setting please specity when ordering.


## OPRRATMNG CHARACTERUSTICS

## LET-THROUGH PEAK CURRENT CHARACTERISTICS

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


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


Prospective short circuit currant in RMS sym.(kA)

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


S400-CJ, S400-NJ, S400-NE, 5400-GJ, $5400-\mathrm{GE}, 690 \mathrm{~V}$ AC.



## OPERATMNG CMARACTERISTICS

## THERMAL MAGNETIC PROTECTION

## Adjustment Dials



1. $I_{\mathrm{R}}$ is the thermal element adjustment dial and is used to set the rated current to match the conductor rating.
$I_{\mathrm{R}}$ can be ser between 0.63 and 1.0 times $I_{\mathrm{n}}$.
2. $I_{\mathrm{i}}$ is the magnetic element adjustment dial and is used to set the short circuit tripping threshold to suit the application.
$I_{\mathrm{i}}$ can be set between 6 and 12 times $I_{\mathrm{n}}$ on 125 A and 400 A frame models.
$I_{\mathrm{i}}$ can be set between 6 and 13 times $I_{\mathrm{n}}$ on 250 A frame models with ratings of $160 \mathrm{~A}, 200 \mathrm{~A}$ and 250 A .
$I_{\mathrm{i}}$ can be set between 6 and 12 times $I_{\mathrm{n}}$ on 250 A frame models with ratings of 125 A and less.

Models, Types and Rated Currents of Thermal Elements

| Moder | TVPe | Curculfeting ho(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 | -G.J | 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 | -G. | 160, 200, 250 |
| H250 | -NJ | 160, 250 |
| L250 | - NJ | 160,250 |
| E400 | - NJ | 250, 400 |
| 5400 | -C.J | 250, 400 |
| S400 | - NJ | 250, 400 |
| S400 | -GV | 250,400 |
| H400 | -NJ | 250, 400 |
| L400 | -NJ | 250, 400 |



OPERATVNG CHARACTERISTICS

## LET-THROUGH ENERGY CHARACTERISTICS

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


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

H160-NJ, L160-NJ, S250-PE, H250-NE, H250-NJ, L250$\mathrm{NJ}$.690 V AC .


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


[^4]

## ACCESSORDES

## 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 Connecrion


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 400 A and 630 A 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 Comnection


## 

## 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 cannor 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.


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. Mounred on base plate with connection bars mounted for front access.
Insulation plates are supplied as standard and must be fitted.

2. Terminations in separate comparment. Connection bàrs 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.

## 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 | lcu | ICS |
| :--- | :--- | :--- | :--- |
| AC use | $380 / 400$ | 65 | 36 |
| DC use 250 V | 40 | 40 |  |

Trip unit:
Adjustable thermal ( 0.63 lr to $100 \% / \mathrm{r}$ ) and adjustable magnetic ( $6 / \mathrm{m}$ to 12 m )

Dimensions (mm)

| Poles | 3 | 4 |
| :--- | :--- | ---: |
| $H$ | 155 | 155 |
| $W$ | 90 | 120 |
| $D$ (less toggle) | 68 | 68 |
| Togale cut-out |  | Standard DIN |


| Ampere <br> Rating <br> NRC | Adj. $/{ }^{1} 1$ <br> Min-Max. | $\begin{aligned} & \text { Adj. Im }{ }^{\prime \prime} \\ & \text { Min-Max. } \end{aligned}$ | Cat. No. |
| :---: | :---: | :---: | :---: |
| 20 | 12.5-20 | 120-240 | $\begin{aligned} & \text { S125 GJ } 320 \\ & \text { S125 GJ } 420 \end{aligned}$ |
| 32 | 20-32 | 192-384 | $\begin{aligned} & \text { S125 GJ } 332 \\ & \text { S125 GJ } 432 \end{aligned}$ |
| 50 | 32-50 | 300-600 | $\begin{aligned} & \text { S125 GJ } 350 \\ & \text { S125 GJ } 450 \end{aligned}$ |
| 63 | 40-63 | 378-756 | $\begin{aligned} & \text { S125 GJ } 363 \\ & \text { S125 GJ } 463 \\ & \hline \end{aligned}$ |
| 100 | 63-100 | 600-1200 | $\begin{aligned} & \text { S125 GJ } 3100 \\ & \text { S125 GJ } 4100 \end{aligned}$ |
| 125 | 80-125 | 750-1500 | $\begin{aligned} & \text { S125 GJ } 3125 \\ & \text { S125 GJ } 4125 \end{aligned}$ |


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

Replaces: XH 125 NJ, TL100NJ, Note: check exact ratings or dimenions to suit your application requirement

## DUMENSUONS

## E125-NJ, S125-NJ, S125-GJ

ASL: Arrangement Standard Line
나: Handle Frame Centre Line


INSULATION DISTANCE IN mm (AT 440V AC MAXIMUM)

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


## APPLICATION DATA

## SELECTIVITY (DISCRIMINATION) AND CASCADE

## 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 ( $\mathrm{I}_{\text {pekk }}$ ) and energy let-through ( $\mathrm{I}^{2} \mathrm{t}$ ).

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.

Selectivity \＆Cascade Tables
© $400 / 415 \mathrm{~V}$
st abed ypadğuial wıpıepueis әчı puoкәg

| $X X / Y Y$Seloctuity $l^{\prime}$ Cascads |  |  |  | $\begin{array}{r} \text { 唇 } \\ \stackrel{\text { den }}{\stackrel{1}{\rightleftarrows}} \end{array}$ |  |  |  |  | $\begin{aligned} & \text { 唇 } \\ & \text { م } \\ & \text { x } \\ & 85 \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 岂 苞 70 70 | $\begin{array}{r} \text { 宸 } \\ \text { 号 } \\ 125 \\ 125 \end{array}$ | $\begin{gathered} \text { 山⿱丷口力口内 } \\ \text { en } \\ 50 \\ 50 \end{gathered}$ |  |  |  |  |  |  |  |
| 25／50 | 25／25 | 25／36 | 25／36 | 25／65 | 25／25 | 25／25 | 25／25 | 25／25 | 25／25 |
| 36／65 | 36／36 | 36／50 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65／70 | 65／65 | 65／50 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70，70 | 70／70 | 50／50 | 65／65 | 65／65 | 85／50 | 85／50 | 100／400 | 85／85 | 85／85 |
| 36／50 | 36／36 | 36／36 | 36／65 | 36／65 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
| 65／70 | 65／65 | 50／50 | 50／65 | 50／65 | 65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70／70 | 70／70 | 50／50 | 50／65 | 50／65 | 85／65 | ．85／65 | 100／100 | 85／85 | 85／85 |
| 25／50 | 25／25 | 25／25 | 25／50 | 25／50 | 25／25 | 25／25 | 25／25 | 25／25 | 25／25 |
| 36／65 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 | 38／36 | 36／36 | 36／36 |
| 65／70 | 65／65 | 50／50 | 50／65 | 50／65 | －65／65 | 65／65 | 65／65 | 65／65 | 65／65 |
| 70，70 | ．70\％70 | 50，50 | 50／65 | 50／65 | 70／70 | 70／70 | $70 / 70$ | 70／70 | 70／70 |
| 70，70 | 70\％70 | 50／50 | 50，65 | 50／65 | 85／85 | 85／85 | 100／100 | 85／85 | 85／85 |
| 70／70 | 70／70 | 50／50 | 50／65 | 50／65 | 85／85 | 85／85 | 100，100 | 85／85 | 85／85 |
| 10／50 | 10，36 | 25／25 | 25／25 | ．25／36 | 25／25 | 25／25 | 25／36 | 25；25 | 25／25 |
| 10／65 | 10／50 | 25／36 | 25／36 | 25／50 | 36／36 | 36／36 | 36／50 | 36／36 | 36／36 |
| 10／50 | 10／50 | 25／50 | 25／50 | 25／50 | 50／50 | 50／50 | 50／50 | 50／50 | 50／50 |
| 10，70 | 10／65 | 25／50 | 25／50 | 25／65 | 50／50 | 50／50 | 50／65 | 50，50 | 50／50 |
| 10／70 | 10，70 | 25／50 | 25／50 | 25／65 | ．70／36 | 70／36 | 70／85 | 70／70 | 70／0 |
| 10，70 | 1070 | 25／50 | 25／65 | 25／65 | 125／85 | 125／85 | 125／100 | 125／85 | 125／85 |
| 10，70 | 10，70 | 25／50 | 25／65 | 25／65 | 125／85 | 125／85 | 125／100 | 125／85 | 125／85 |
|  |  | 25／36 | 25／36 | 25／36 | 36／36 | 36／36 | 36／36 | 36／36 | 36／36 |
|  |  | 25／50 | 25／50 | 25／50 | 50／50 | 50\％50 | 50／50 | 50／50 | 50／50 |
| 1 |  |  | 1 |  | 70，70 | 70／70 | 70／70 | 70，70 | 70／70 |
|  |  |  |  |  | 30／45 | 30／45 | 30／45 | 35／45 | 35／45 |
|  | ， | I |  |  | 30／65 | 30／65 | 30／65 | 35／65 | 36／65 |
| $\cdots$ |  |  | 1 |  | ．30／85 | 30／85 | 30／85 | 35／85 | 35／85 |
|  |  |  |  |  | 30／65 | 30／65 | 30／85 | 30／85 | 30／85 |
|  |  |  |  |  | 30／65 | ．30／65 | 30／85 | 30／85 | 30／85 |
|  |  |  |  |  | 30／65 | 30／65 | 30\％85 | 30／85 | 30／85 |
|  |  |  |  |  | 15／65 | 15／65 | 20／65 | 35／85 | 35／65 |
|  |  |  |  |  | 15／50 | 15／50 | 20／50 | 35／50 | 35／50 |
|  |  |  |  |  | 15／85 | 15／85 | 20／85 | 35／85 | 35／85 |
|  |  |  |  | ， | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
|  | 1 |  |  | ， | 15／65 | 15／65 | 20／65 | 35／65 | 35／65 |
|  |  |  |  | 1 |  |  | 20／65 | 35／65 | 35／65 |
|  |  |  |  |  |  |  |  | 35／85 | 35／85 |

## APPLICATMON DATR

CASCADE TABLES

| CASCADE <br> © 380－415 V AC ${ }^{\prime}$ ） |  |  | $$ | $$ | $\begin{aligned} & I \\ & \text { I } \\ & \text { M } \\ & \text { Z } \end{aligned}$ | $\begin{aligned} & \stackrel{\rightharpoonup}{N} \\ & \text { M } \\ & \text { Z } \end{aligned}$ | $\begin{aligned} & \stackrel{\infty}{\stackrel{\circ}{\circ}} \\ & \stackrel{2}{2} \end{aligned}$ | $\begin{aligned} & \text { の } \\ & \stackrel{\rightharpoonup}{\circ} \\ & \underset{C}{2} \end{aligned}$ | $\begin{aligned} & \text { I } \\ & \text { 흔 } \\ & \text { 2 } \end{aligned}$ | $\begin{aligned} & \stackrel{\rightharpoonup}{\circ} \\ & \stackrel{\text { B}}{2} \end{aligned}$ |  | $\begin{aligned} & \text { N } \\ & \text { Non } \\ & \text { 를 } \end{aligned}$ |  | $\begin{aligned} & \text { N్ } \\ & \text { H} \\ & \text { O } \\ & \boldsymbol{m} \end{aligned}$ | $\begin{aligned} & \text { I } \\ & \text { U } \\ & \text { K } \\ & \text { Z } \end{aligned}$ |  | $\begin{aligned} & \text { Kin } \\ & \text { M } \\ & \text { Z } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Downstream MCCBs | $\begin{aligned} & \text { KA } \\ & \text { (RMS) } \end{aligned}$ | 25 | 36 | 65 | 125 | 200 | 36 | 65 | 125 | 200 | 25 | 36 | 65 | 70 | 125 | 125 | 200 |
| E125NJ | 25 | － | 36 | 36 | 65 | 85 | 38 | 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 |
| S250G．J | 65 | － | － | － | － | － | － | － | － | － | － | － | － | 70 | 125 | 125 | 150 |
| S250PE | 70 | － | － | － | － | － | － | － | － | － | － | － | － | － | 125 | 125 | 150 |
| H250NJ | 125 | － | － | － | － | － | － | － | － | － | － | － | － | － | － | － | 200 |
| E400NJ | 25 | － | － | － | － | － | － | － | － | － | － | － | － | 36 | 65 | 65 | － |
| S400CJ | 36 | － | － | － | － | － | － | － | － | － | － | － | － | 50 | 70 | 70 | － |
| 5400 NJ | 50 | － | － | － | － | － | － | － | － | － | － | － | 50 | 65 | 85 | 85 | － |
| S400GJ | 70 | － | － | － | － | － | － | － | － | － | － | － | 50 | － | 125 | 125 | － |
| H400NJ | 125 | － | － | － | － | － | － | － | － | － | － | － | － | － | － | － | － |

Note：＂）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 <br> © 380－415VAC ${ }^{1}$ ） |  | $\begin{aligned} & \text { a } \\ & \stackrel{\rightharpoonup}{\circ} \\ & \stackrel{i}{2} \end{aligned}$ |  |  |  | $\begin{aligned} & \text { 「 } \\ & \stackrel{\rightharpoonup}{O} \\ & \underset{Z}{2} \end{aligned}$ | $\begin{aligned} & \text { F } \\ & \stackrel{\rightharpoonup}{\circ} \\ & \underset{m}{2} \end{aligned}$ |  |  | $\begin{aligned} & \text { o } \\ & \text { W } \\ & \text { i } \\ & \hline \end{aligned}$ |  | $\times$ か 0 0 on n | $\begin{aligned} & \text { 㐅 } \\ & \text { © } \\ & \text { O } \\ & \text { ¿ㄹ } \end{aligned}$ |  |  | $\begin{aligned} & \text { X } \\ & \text { N } \\ & \text { N} \\ & 0 \\ & \text { n } \end{aligned}$ | $\begin{aligned} & \text { শ } \\ & \stackrel{0}{\circ} \\ & \underset{\circ}{0} \\ & \boldsymbol{m} \end{aligned}$ |
| Downstream MCCBs | $\begin{gathered} \text { KA } \\ \text { (RMS) } \end{gathered}$ | 36 | 50 | 70 | 125 | 200 | 200 | 36 | 50 | 70 | 125 | 65 | 65 | 65 | 200 | 65 | 85 |
| E125NJ | 25 | 36 | $3 \overline{6}$ | 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 | － | － | $\square$ | － | 200 | 200 | － |  | － | － | － | － | 65 | － | 50 | － |
| S160NJ | 36 | － | 50 | 65 | 85 | 125 | 125 | － | 50 | 50 | － | － | 65 | 65 | － | － | － |
| S160GJ | 85 | － | － | 70 | 1.25 | 150 | 150 | － | － | 70 | － | － | － | － | $\div$ | － | － |
| H160NJ | 125 | － | － | － | － | 200 | 200 | － | － | － | － | － | － | 65 | － | 65 | － |
| E250NJ | 25 | 36 | 36 | 50 | 65 | 85 | 85 | 36 | － | 50 | － | － | 36 | 50 | $\stackrel{-}{-}$ | － | － |
| 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 |
| S400G」 | 70 | － | $\bigcirc$ | － | 125 | 150 | 150 | － | 36 | － | － | － | － | 50 | － | 36 | 85 |
| H400NJ | 125 | － | － | － | － | 200 | 200 | － | － | － | － | － | － | － | － | － | － |

Note：＇）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


## APPLRCATMON DATA

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

| Upstream MCCB |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| SELECTIVITY / CASCADE <br> (S) 415 V AC |  |  | $\underset{\sim}{N}$ | $\stackrel{N}{N}$ | Nエ | $\begin{aligned} & \text { N } \\ & \text { N } \end{aligned}$ | N U O | 号 | $\begin{aligned} & \text { ne } \\ & \stackrel{\rightharpoonup}{8} \stackrel{\rightharpoonup}{8} \end{aligned}$ | I |
| Downstream MCB | Amp rating | $\begin{gathered} \text { KA } \\ \text { (RMS) } \end{gathered}$ | 2 | c | ce |  | 2 | c | ¢ ${ }^{\text {m }}$ | C |
|  |  |  | 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 1 | 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 | 425 | 15/15 | 15/15 | 10/10 | 1010 |  |
| 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 | $\therefore 6$ | 3/10 | $3 / 10$ | $3 / 10$ | $\cdots$ | . | $\because$ | - | - |
| SRCB | 16-20 | 6 | $3 / 10$ | . $3 / 10$ | $3 / 10$ | -: | 1. | $\bigcirc$ | - | - |



Notes: All figures stated are at $400 / 415 \vee \mathrm{AC}$.


## APPLICATION DATA

## MOTOR STARTING TYPE 1 CO-ORDINATION TABLES

## Short-Circult 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

|  |  | Terasakl Combinations |  |
| :---: | :---: | :---: | :---: |
| Motor Size (kW) | Approx. amps © ${ }^{(1)}$ $400 / 415 \mathrm{~V}$ (A) | MÇC̃ | Gontactar |
| 0.37 | 1.1 | XM30PB/1.4 | CA7- |
| 0.55 | 1.5 | XM30PB/2 | CA7- |
| 0.75 | 1.8 | ХM30РВ/2.8 | CA7- |
| 1.1 | 2.6 | XM30PE/4.0 | CA7- |
| 1.5 | 3.4 | XM30РB/5 | CA7- |
| 2.2 | 4.8 | Хм30РВ ${ }^{\text {/ }}$ | CA7- |
| 3 | 6.5 | XM30PB/10 | CA7- |
| 4 | 8.2 | XM30PB/12 | GA7-8 |
| 5.5 | 11 | S125G/20 | CA7-12 |
| 7.5 | 14 | S125G1/20 | CA7-1B |
| 11 | 21 | S125G $1 / 32$ | CA7-23 |
| 15 | 28 | S125Gl/50 | CA7̇30 |
| 18.5 | 34 | S125GJ/50 | CA7-37 |
| 22 | 40 | S125G//a3 | CA $\overline{7}-43$ |
| 30 | 55 | S125G/100 | CA7-80 |
| 37 | 66 | S125G//100 | CA7-72 |
| 45 | 60 | S125Gd/25 | CA7-85 |
| 55 | 100 | S120G $1 / 120$ | CAQ-110 |
| 5 | 130 | S250PE/250 | CAE-140 |
| 0 | 155 | S250PE/250 | CAB-180 |
| 10 | 200 | S250PE/250 | CAB-210 |
| 32 | 225 | S400GE/400 | CAB-210 |
| 60 | 270 | S400GE/400 | CAB-S00 |
| 00 | 361 | S400GE/400 | CAB-420 |


| Terasak Combinations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overioad Relay | Thermal Setting (A) | KT7 Circuit Breaker | Contactor |
| CT 7-24 | 1.0-1.6 | KTA7-25S-1.0A | 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-4.0A | CA7-9 |
| CT 7-24 | 4.0-8.0 | KTA7-25S-6.3A | CA7-9 |
| CT 7-24 | 8.0-10 | KTA7-25S-6.3A | CA7-9 |
| GT 7-24 | 8.0-10 | KTA7-25S-10A | CA7-9 |
| CT 7-24 | 10-18 | KTA7-25H-16A | CA7-12 |
| CT 7-24 | 10-18 | KTA7-25H-16A | CA7-16 |
| CT 7-24 | 18-24 | 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 |
| GT 7-45 | 30-45 | KTA7-45H-45A | CA7-43 |
| CT 7-7̇ら | 45-80 | KTA3-100-63A | CA7-60 |
| \|CT 7-75 | 80-75 | KTA3-100-90A | CA7-72 |
| CT 7-100 | 70-80 | КТАЗ-100-90A | CA7-85 |
| CEF 1-11/12 | 20-160 | KTA3-160S-100A | CA6-110 |
| CEFF 1-11/12 | 20.-180. | KTA3-160S-160A | CA6-140 |
| CEF 1-11/12 | 20-160 | KTA3-160S-160A | CA6-180 |
| CEF 1-41/42 | 180-400 | KTA3-250S-200A | CA6-210 |
| CEF 1-41/42 | 180-400 | KTA3-250S-250A | CA6-250 |
| CEEF 1-41/42 | 180-400 | KTA3-400S-320A | CA6-300 |
| CEFF 1-41/42 | 180-400 | 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 overoad relay tripping betore the circuit breaker at overload currents up to the motor locked rotor current.


## APPGICATMON DATA

## MOTOR STARTING TYPE 2 CO-ORDINATION TABLES

## Short-CIrcult 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

|  |  | Terasak Comblnations |  |
| :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Motor Size } \\ & \text { (kW) } \end{aligned}$ | Approx. amps © $400 / 415$ V (A) | Mcce | Contactor |
| 0.37 | 1.1 | XM30PB/1.4 | 「, CA7- ${ }^{\text {a }}$ |
| 0.55 | 1.5 | XM30РE/2 | CA7- |
| 0.75 | 1.8 | XM30̈PB/2.8 | $\stackrel{F}{\square} \mathrm{CA7-B}$ |
| 1.1 | 2.6 | XM30PB/4.0 | C CA7-18 |
| 1.5 | 3.4 | ХM30РВ/5 | CA7-18 |
| 2.2 | 4.8 | XM30PE/8 | CA7-18 |
| 3 | 6.5 | XM30PB/10 | ${ }^{\text {Ca7-30 }}$ |
| 4 | 8.2 | XM30PB/12 | CA7-30 |
| 5.5 | 11 | S125G//20 | $\because$ CA7-30 |
| 7.5 | 14 | 3125Gl/20 | ${ }^{1}$ CAT-30 |
| 11 | 21 | S125GL/32 | CA7-30 |
| 15 | 28 | S125G//50 | CA7-48 |
| 18.5 | 34 | 8125GL/50; | $\therefore$ CAT-43 |
| 22 | 40 | S125G1/E8 | CA7-43 |
| 30 | 55 | S125G//400 | CA7-72' |
| 37 | 66 | S125G. $/ 100$ | CA7-72; |
| 45 | 80 | S125G. $/ 125$ | CAE-105 |
| 55 | 100 | S250PE/160 | CAB-105 |
| 75 | 130 | S250PEf250 | - CAB-140. |
| 90 | 155 | S250PE/250 | CAO-170 |
| 110 | 200 | S250PE/250 | CAB-210 |
| 132 | 225 | S400PE/400 | Cat-210 |
| 160 | 270 | S400PE/400 | CAE-300 |
| 200 | 361 | S400PE/400 | CAB-420 |


| Terasakl Comblnations. |  | Sprecher + Schuh Comblnations |  |
| :---: | :---: | :---: | :---: |
| Overioad Relay. | Thermal <br> Setting (A) | KT7 Circuit Breaker | Contactor |
| CT 7-24 | 1.0-1.8 = | KTA7-25S-1A | CA7-9 |
| CT 7.24. | 1.0-1.8 | KTA7-25S-1.6A | CA7-9 |
| CT 7-24 | 1.8-2.4 | 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 | 4.0-8.0 | KTA7-25S-6.3A | CA7-9 |
| CT 7-24 | . $8.0-10$ | 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 | 10-18 | KTA7-25H-16A | CA7-16 |
| CT 7-24 | 10-24 | KTA 7 -45H-20A | CA7-23 |
| CT 745 | 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 | 80-75 | KTA3-100-90A | CA7-72 |
| CT 7-100 | 70-80 | КТАЗ-100-90A | CA7-85 |
| CEF 1-11/12 | 20-180 | КТАЗ-160S-100A | CA6-110 |
| CEF 1-11/12 | 20-180 | KTA3-160S-160A | CA6-140 |
| CEF 1-11/12 | 20-180 | КTA3-160S-160A | CA6-180 |
| CEF 1-41/42 | 160-400 | KTA3-250S-200A | CA6-210 |
| CEF 1-41/42 | 160-400 | КТАЗ-250S-250A | CA6-250 |
| CEF 1-41/42 | 160-400 | КTA3-400S-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 it required.

Combinations based on the thermal overload relay tripping betore the circuit
breaker at overload currents up to the motor locked rotor current.


APPLICATION DATA

## MOTOR STARTING TYPE 2 CO-ORDINATION

Short-CIrcult Co-Ordination DOL Motor Starting Table
Type '2'
Terasaki MCCB's \& Sprecher + Schuh KT7's
DOL starting 85 KA @ $400 / 415 \mathrm{~V}$ to $\mathrm{AS} / \mathrm{NZS}$ 60947.4.1

|  |  | Terasakl Cómbinations |  |
| :---: | :---: | :---: | :---: |
| Motor Size $(k W)$ | Approx. amps 9 400/415 V (A) | Mcci | Contactor |
| 0.37 | 1.1 | XM30PB/1.4 | CA $7-9$ |
| 0.55 | 1.5 | XM30PB/2 | CA 7-9 |
| 0.75 | 1.8 | XM30РB/2.0 | CA $7-9$ |
| 1.1 | 2.6 | XM30PB/4.0 | CA 7-18 |
| 1.5 | 3.4 | XM30PB/5 | CA 7-18 |
| 2.2 | 4.8 | XM50PB/8 | CA $7-30$ |
| 3 | 6.5 | XM30PE/10 | CA 7 -30 |
| 4 | 8.2 | XM30PB/12 | CA 7.30 |
| 5.5 | 11 | H125N1/20 | CA 7 -30 |
| 7.5 | 14 | H125NL/20 | CA $7-30$ |
| 11 | 21 | H125N/32 | CA 7-30 |
| 15 | 28 | H125N//50 | CA $7-43$ |
| 18.5 | 34 | H125N//50 | CA 7-49 |
| 22 | 40 | H125N1/38 | CA 7 -43 |
| 30 | 55 | H125N $/ 1 / 100$ | CA $7-72$ |
| 37 | 66 | H125N $\mathrm{L} / 100$ | CA 7-72 |
| 45 | 80 | H125NJ/160 | CA $8-105$ |
| 55 | 100 | H180Nは/160 | CA - 105 |
| 75 | 130 | H250PE/250 | CA - 210 |
| 90 | 155 | H250PE/250 | CA Q-210 |
| 110 | 200 | H250PE/250 | CA 8-210 |
| 132 | 225 | H400NE/400 | GA B-210 |
| 160 | 270 | H400NE/400 | CA B-S00 |
| 200 | 361 | H400NE 4400 | CA 6-420 |


| Terasakl Combinations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overlaad Relay | Thermal Setting (A) | KT7 Circuit Breaker | Contactor |
| C'T 7-24 | 1.0-1.0 | KTA7-25S-1A | CA 7.9 |
| CT 7-24 | 1.0-1.0 | KTA7-25S-1.6A | CA 7.9 |
| CT 7-24 | 1.0-2.4 | KTA7-25S-2.5A | CA 7-9 |
| CT 7-24 | 2.4-4.0 | KTA7-25H-2.5A | CA 7-9 |
| CT 7-24 | 2.4-4.0 | KTA7-25H-4A | CA 7-9 |
| CT 7-24 | 4.0-6.0 | -KTA7-25H-6.3A | CA 7-9 |
| CT 7-24 | 8.0-10 | KTA7-25H-6.3A | CA 7-9 |
| CT 7-24 | 8.0-10 | KTA7-25H-10A | CA 7-9 |
| CT' 7-24 | 10-18 | KTA7-45H-16A | CA 7-12 |
| CT 7-24 | -10-18 | KTA7-45H-16A | CA 7-16 |
| CT 7-24 | 10-24 | KTA7-45H-20A | CA 7-23 |
| CT 7-45 | 18-30 | KTA7-45H-32A | CA 7-30 |
| CT 7-45 | 30-45 | KTA7-45H-45A | CA 7-37 |
| \|CT 7-45 | 30--45 | KTA7-45H-45A | CA 7-43 |
| CT 7-75 | 45-60 | KTA3-100-63A | CA7-60 |
| CT 7-75 | 80-75 | KTA3-100-90A | CA7-72 |
| CT 7-100 | 70-80 | KTA3-100-90A | CA7-85 |
| CEF 1-11/12 | 20-180 | $\cdot$ | - |
| CEF 1-11/12 | 20-180 | $\cdot$ | - |
| CEF 1-11/12 | 20-180 | - | - |
| CEF 1-41/42 | 160-400 | - | - |
| CEF 1-41/42 | 180-400 | - | - |
| CEF 1-41/42 | 100-400 | - | - |
| CEF 1-41/42 | 160-400 | - | - |

[^5]- XM30PB combinations can be replaced with H125GJ/20 and CA7-30 if required.

Combinations based on the thermal overioad 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-Circult Co-Ordination DOL Motor Starting Table

Type '2'
Terasaki MCCB's \& Sprecher + Schuh KT7's
DOL staring $100 \mathrm{kA} @ 400 / 415 \mathrm{~V}$ to AS/NZS 60947.4.1

|  |  | Terasakd Comblnitions |  |
| :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Motor Slze } \\ & \text { (kW) } \end{aligned}$ | Approx. ampa 9 $400 / 415 \mathrm{~V}$ (A) | Mccis | Conntactar |
| 0.37 | 1.1 | H12.5N/20 | CA 7-30 |
| 0.55 | 1.5 | H125NL/20 | CA $730^{\circ}$ |
| 0.75 | 1.8 | H125Nif20 | CA $7-30$ : |
| 1.1 | 2.6 | H125Ni220 | CA'7-30 |
| 1.5 | 3.4 | H125N/ $/ 20$ | CA 7-30 |
| 2.2 | 4.8 | H125Ni/20 | CA 7 -30 |
| 3 | 6.5 | H125N120 | CA 7 -30 |
| 4 | 8.2 | H125N. $22^{\circ}$ | CA 7 - 80 |
| 5.5 | 11 | H12SiNL/20 | CA 730 |
| 7.5 | 14 | H125Ni/20 | CA 7.30 |
| 11 | 21 | H125NL/32 | CA 7.30 |
| 15 | 28 | H125NU550 | CA 7.49 |
| 18.5 | 34 | H125N/50 | CA 7-43 |
| 22 | 40 | H125NL/ES | CA 7-43 |
| 30 | 55 | H125-NMM00 | CA 7-80 |
| 37 | 66 | H125-N $\mathrm{H}_{1} 100$ | CA 7-72 |
| 45 | 80 | H125-N/5125 | CA 7-85 |
| 55 | 100 | H250-NE/180 | CA $0-85$ |
| 75 | 130 | H250-NE\%250 | CA E-140 |
| 80 | 155 | H250-NE/250 | CA E-140 |
| 110 | 200 | H250-NE/250 | CA E-1BO |
| 132 | 225 | H400-NE/400 | CA -420. |
| 160 | 270 | H400-NE/400 | CA $0-420$ |
| 200 | 361 | H400-NE/400 | CA $8-420$ |


| Terasakd Comblnations |  | Sprecher + Schuh Combinations |  |
| :---: | :---: | :---: | :---: |
| Overiaad Relay | Thermal Stting (A) | KT7 Cireult Breaker | Contactor |
| CT 7-24 | 1.0-1.8 | KTAT-25S-1A | CA 7-9 |
| CT 7-24 | 1.0-1.8 | KTAT-25S-1.6A | CA 7-9 |
| \|CT 7-24 | 1.8-24 | KTAT-25S-2.5A | CA 7-9 |
| CT 7-24 | 2.4-4.0 | KTA7-25-3-2.5A | CA 7-9 |
| \|cT 7-24 | 2.4-4.0 | KTA7-25H-4A | CA 7-9 |
| CT 7-24 | 4.0-8.0 | KTA7-25H-6.3A | CA $7-9$ |
| CT 7-24 | 8.0-10 | KTAT-25H-6.3A | CA 7-9 |
| CT 7-24 | 6.0-10 | KTA 7 -25H-10A. | CA $7-9$ |
| CT 7-24 | 10-18 | KTA 7 -45H-16A. | CA 7 -12 |
| CT 7-24 | 10-16 | KTA 7 -45-16A | CA 7-16 |
| CT 7-24 | 18-24 | KTA7-45-20A | CA 7-23 |
| CT 7-45 | 18-30, | KTA7-45H-32A | CA 7.30 |
| CT 7-45 | 50-45' | KTA $7-45 \mathrm{H}-45 \mathrm{~A}$ | CA 7.37 |
| CT 7-45 | 30-45 | KTA $7-45 \mathrm{H}-45 \mathrm{~A}$ | CA 7-43 |
| CT 7-75 | 45-80 | - | - |
| CT 7-75 | BO-75 | - | - |
| CT 7-100 | 70-80 | - | - |
| CEF 1-11/12 | 20-180 | $\cdot$ | - |
| CEF 1-11/12 | 20-180 | - | - |
| GEF 1-11/12 | 20-180 | - | $\cdot$ |
| GEF 1-41/42 | 160-400 | - | - |
| CEF 1-41/42 | $160-400$ | - | - |
| CEEF 1-41/42 | 160-400 | - | - |
| CEF 1-41/42 | 160-400 | - | - |

[^6]

OPERATING CHARACTERUSTUS

## THERMAL MAGNETIC CHARACTERISTICS

125A Frame MCCBs

Time/current characteristic curves
E125-NJ,S125-NJ, S125-GJ


Time/current characteristic curves H125-NJ, L125-NJ



## (OPERATMNG CRARACTERISTICS

## THERMAL MAGNETIC PROTECTION

Adjustment Dials


1. $I_{\mathrm{R}}$ is the thermal element adjustment dial and is used to set the rated current to match the conductor rating.
$I_{\mathrm{R}}$ 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.
$I_{\mathrm{i}}$ can be set between 6 and 12 times $I_{\mathrm{n}}$ on 125 A and 400 A frame models.
$I_{\mathrm{i}}$ can be set between 6 and 13 times $I_{\mathrm{n}}$ on 250 A frame models with ratings of $160 \mathrm{~A}, 200 \mathrm{~A}$ and 250 A .
$I_{\mathrm{i}}$ can be set between 6 and 12 times $I_{\mathrm{n}}$ on 250 A frame models with ratings of 125 A and less.

Models, Types and Rated Currents of Thermal Elements

| प96] |  |  |
| :---: | :---: | :---: |
| S125 - | -NF: | 16, 20, 25, 32, 40, 50, 63, 80, 100, 125 |
| E125: | - NJ | 20,32, 50, 63, 100, $125{ }^{\circ}$ |
| S125 | -NJ | 20,32, 50, 63, 100, 125 |
| S125 | GW | 20, 32, 50, 63, 100, 125 |
| H125 | -NJ | 20,32, 50,63, 100, 125 |
| $L 125$ | - NJ | 20, 32, 50, 63, 100, 125 |
| S160 | -NF | $16.20,25,32,40,50,63,80,100,125,160$ |
| S160 | - $\mathrm{NiJ}^{1}$ | 20, 32, 50, 63, 100, 125, 160 |
| S160 | Cul | 50, 63, 100, 125, 160 |
| H160 | - NJ | 160 |
| L160 | - NJ | 160 |
| E250. | $\cdots$ | $20,32,50,63,100,125,160,200,250$ |
| S250 | -NJ | 160, 200, 250 |
| S250 | -G.J | 160,200, 250 |
| H250 | - NJ | 160, 250 |
| L250 | -NJ | 160,250 , |
| E400 | NJ | 250,400 ${ }^{\circ}$ |
| S400 | -CJ | 250,400 |
| S400 | -NJ | 250,400 r |
| \$400 | -G. ${ }^{\text {a }}$ | 250,400 |
| H400 | - NJ | 250,400 . |
| L400: | - NJ | 250,400 |

## OPRRATING CHARACTERISTICS

## LET-THROUGH PEAK CURRENT CHARACTERISTICS

S125-NF. 240V AC


Prospective short circuit current in RMS sym.(kA)
E125-NJ, S125-NJ, S125-GJ. 440 V AC.


Prospective short circult current in RMS sym.(kA)

S160-NF. 240 V AC.


Prospective short circuil current in RMS sym.(kA)
S125-NJ, S125-GJ. 690 V AC.



Prospective short circuit current in RMS sym.(kA)

OPRRATUNG CMARACTERISTICS
LET-THROUGH ENERGY CHARACTERISTICS

## S125-NF. 240 V AC



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


S160-NF. 240 V AC


S125-NJ, S $125-\mathrm{GJ} .690 \mathrm{~V}$ 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 <br> rating <br> 20 | Min | Max | Cat. No. |
| :--- | :--- | :--- | :--- |
| 32 | 12.5 | 20 | XS125C.J 20 3 |
| 50 | 20 | 32 | XS125CJ 32 3 |
| 63 | 32 | 50 | XS125CJ 50 3 |
| 100 | 40 | 63 | XS125CJ 63 3 |
| 125 | 63 | 100 | XS125CJ 100 3 |
| 125 | 80 | 125 | XS125CJ 125 3. |

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 502 |
| 63 | 40 | 63 | XS125NJ 632 |
| 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 |
| $\mathbf{1 2 5}$ | 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 425 4 |

## Notes: ') MCCB's only.

${ }^{2}$ ) Load-break isolating switch only-no overload or short circuit protection.
${ }^{3}$ ) Poles in series.
") Shor 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)

| Descriptio |  | Heigh | 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) | 415 V 50 Hz |
| X 5125 NJ | $30 \mathrm{kA} \mathrm{(AS2184)}$ | 415 V 50 Hz |
| DC use | (/ ${ }^{\text { }}$ ) | Voltage |
| X 5125 CJ | 10 kA | 250V DC |
| X5125NJ | 15 kA | 250 VDC |

Refer this section for ratings to AS 3947-2 and
AS 2184, and Icsflcu.

## Connections and mountings

Front-connection type (FC)

Compression terminals


Attached flat bar
 Breakers and screw size
XS series
(Economical) (Standard (Standard)

XH series XM series (High-fault level) (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

Breaker


Applicable breakers

- XS series

XS125CJ, XS 125NJ

- XH series

XH125NJ, XH125PJ


Plug-in (optional)
Mounting block


## Types of connections and mountings

Plug-in Type

Switchboard use


Types of plug-in mounting blocks for


## Plug-in type

Degree of protection
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. |
| :--- | :--- | :--- | :--- |
| $X S 125$ | IP 20 | $2,3 P$ | $1=2$ | XH125

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

Crimp lugs (compression type)

 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.


```
XS125CJ, XS125NJ, XH125NJ,
XH125NJ
```

Time/current characteristic curves


Ambient compensating curves



## TemBreak XS125CS, CJ, NS, NJ, XH125NJ, PJ and TL30F MCC̃Bs

ASL: Arrangement Standard Line H: Handle frame centre line

Note: XS125NS 1 pole only

## Drilling plan



Front connected (standard)



Plug-in (optional)
Mounting block
Drilling plan


## Motor operators for XS125

## MCCB accessories

Outline dimensions (mm)
Front connected (standard)


Rear connected (optional)


ASL: Arrangement Standard Line
H : Handle frame centre line

Notes: 'Above outline dimensions are for AC motors. Contact NHP for details for DC motors

Miniature circuit breakers and fuse fault current İimiters co-ordination chart
For fault current levels up to 50 kA at 415 V

| Circuit breaker Type | Rating amps | Min. fuse amps ') | Maximum fuse - amp |  |
| :---: | :---: | :---: | :---: | :---: |
|  |  |  | BS 88 | DIN |
| Safe-T | 6-10 | 50 | $160{ }^{2}$ ) | 160 |
|  | 16-25 | 63 | $200{ }^{\text {2 }}$ ) | 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 $\mathrm{I}^{2} \mathrm{t}$ for both BS 88 and DIN fuses:
$160 \mathrm{~A}-0.62 \times 10^{5}, \quad 200 \mathrm{~A}-1.2 \times 10^{5}, \quad 250 \mathrm{~A}-2.1 \times 10^{5}$.
Suitable fuses include NHP, GEC, Siemens and Bovara-Crady.
Fuses with higher current ratings may be used providing $I^{2} t$ values are equal to, or less than the levels above. Semi-conductor fuses have very low $I^{2} t$ 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 backup 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 (timecurrent curves), Peak Let Through Current ( $\mathrm{I}_{\text {peak }}$ ) and Energy Let Through ( ${ }^{2} \mathrm{~T}$ ).
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.


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.


Note: ') Dependant on the number of poles. Refer to NHP.

TemBreak P／us MCCB＇s－Selectivity and Cascade tables at 415V
Guide

## XX／YY

Selectivity Cascade
Upstream MCCB

| Downstream MCCB | kA（rms） | $\begin{gathered} \text { XS400SE } \\ 50 \end{gathered}$ | $\underset{65}{\text { E }}$ | $\begin{gathered} \text { XS630SE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH630SE } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS800SE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH800SE } \\ 65 \end{gathered}$ | $\begin{gathered} \mathrm{XS} 1250 \mathrm{SE} \\ 65 \end{gathered}$ | $\begin{gathered} X S 1600 S E \\ 85 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| XS125cJ | $\because 18$ | 15／50 | 45／50 | 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 | $\therefore 35 / 65$ | 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 | 18／48 |
| 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 |
| $\underline{\mathbf{X H 2 5 P P}}$ | 65 | － | F－ | 10／50 | 1065 | $25 / 50$ | 25／65 | 50／65 | 50／65 |
| xS400CJ | 35 | －150 | －150 | $10 / 50$ | 10／65 | 25／50 | 25／65 | 35／42 | 35／42 |
| XS400NJ | 50 | － | 165 | 10／50 | 10／50 | 25／50 | 25／65 | 50／65 | 50／65 |
| XS400SE | 50 | － | －165 | 10／50 | 10／65 | 25i50 | ${ }^{\text {＂} 25 / 65}$ | 50／65 | 50／65 |
| $\times \mathrm{X} 400 \mathrm{PJ}$ | 65 | － | $\cdots$ | 10／50 | 10／65 | 25／50 | －25／65 | 50／65． | 50／65 |
| XH400SE | 65 | － | $\therefore-$ | 10／50 | 10／65 | 25／50 | 25／65 | 50／65 | 50／65 |
| XH400P⿳E | 65 | $\div$ | a－ | 10／50． | 10／65 | 25／50 | 亿 25／65 | 50／65 | 50／65 |
| XS630CJ | 45 | － |  | － | －／50 | 7／50 | $7 / 50$ | $30 / 45$ | 30／45 |
| XS6630NJ | 65 | － | $\therefore$ | － | － | 7150 | 7／65 | $30 / 65$ | 30／85． |
| XS630SE | 50 | － | －－ | ．－ | －／65 | $\because$ | $\therefore-$ | 30／65 | 30／85 |
| XH630PJ： | 85 | － | ＂ | － | － | 8 | \％ | 30／65 | 30／85 |
| XH630SE | 65 | － | － | － | － | $\square$ | ${ }^{\text {b }}$ | 30／65 | 30／85 |
| $\times \mathrm{H} 630 \mathrm{PE}$ | 65 | － | $\because \because$ | － | － | \％ | $\cdots$ | 30／65 | 30／85 |
| XSB0ÖNJ | 65 | $\div$ | \％ | － | － | 2 | －－ | 15／65 | 20／85 |
| XS800SE | 50 | $\therefore$ | 4， | －－ | － | ， | －${ }^{1} 65$ | 15／65 | 20／85 |
| XH800PJ | 85 | － | $\therefore$－ | － | － | $\cdots$ | \％－ | 15／65 | 20／85 |
| XH800SE | 65 | ＂－ | N－ | ：－ | ，－ | 盛 | $\cdots$ | 15／65 | 20／85 |
| XH800PE | 65 | $=$ | $\cdots$ | － | $\square$ | Fis | $\cdots$ | 15／65 | 20／85 |
| XST250SE | 65 | － | － | － | － | \％ | Te－ | － | 20／65 |

Śtandard ŤemBreak MCCB's - Selectivity and Cascade tables at 415 V


Selectivity Cascade
Upstream MCCB

| Downstream MCCB | kA (rms) | $\begin{gathered} \mathrm{XH} 125 \mathrm{NJ} \\ 50 \end{gathered}$ | $\begin{gathered} \mathrm{XS} 250 \mathrm{NJ} \\ 35 \end{gathered}$ | $\begin{gathered} \mathrm{XH} 250 \mathrm{NJ} \\ 50 \end{gathered}$ | $\begin{gathered} \text { XS400CJ } \\ 35 \end{gathered}$ | $\begin{gathered} \mathrm{XS} 400 \mathrm{NJ} \\ 50 \end{gathered}$ | $\begin{gathered} \text { XS400NE } \\ 50 \end{gathered}$ | $\begin{gathered} \mathrm{XH} 400 \mathrm{NE} \\ 65 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 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 | - | -130 | -130 | -130 | -/30 | 6/30 | 6/30 |
| XS250NJ | 35 | - | - | - | $\because$ | 4/50 | $6 / 50$ | 6/65 |
| XH250NJ | 50 | - | - | - | - | 4/50 | 6/50 | 6/65 |
| XS400CJ | 35 | - | - | - | - | $-150$ | -150 | -150 |
| XS400NJ | 50 | - | - | - | - | - | - | -/65 |
| XS400NE | 50 | - | - | - | - | - | $=$ | -/65 |
| XH400NE | 65 | - | - | - | - | - | - | - |
| XS630CJ | 45 | - | - | $\bullet$ | $\bullet$ | - | - | - |
| XS630NJ | 65 | - | - | - | - | - | - | - |
| XS630NE | 50. | - | : - | - | - | - | - | - |
| XH630NE | 65 | - | - | - | - | - | - | - |
| XS800NJ | 65 | - | - | - | - | - | - | - |
| XS800NE | 50 | - | - | - | - | - | - | - |
| XS1250NE | 65 | - | - | - | - | - | - | - |
| XS16000NE | 100 | - | - | - | - | - | - | - |

Upstream MCCB

| Downstream MCCB | kA (rms) | $\begin{gathered} \mathrm{XS} 630 \mathrm{CJ} \\ 45 \end{gathered}$ | $\begin{gathered} \text { XS630NJ } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS630NE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH63ONE } \\ 65 \end{gathered}$ | XS800NJ 65 | $\begin{gathered} \text { XS800NE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XHBOONE } \\ 65 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 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 | 8/50 | $10 / 50$ | 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 | - | - | - | - | - | - | $\cdot$ |
| XH630NE | 65 | - | - | - | - | - | - | - |
| XS800NJ | 65 | - | - | - | - | - | - | - |
| XS800NE | 50 | - | - | - | - | - | - | - |
| XS1250NE | 65 | - | - | $\bullet$ | - | - | - . | - |
| XS1600NE | 100 | - | - | - | - | - | - | - |

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| Downstream MCCB | Upstream MCCB |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | kA (rms) | $\begin{gathered} \text { XH800PJ } \\ 85 \end{gathered}$ |  | $\begin{gathered} \mathrm{XS} 1250 \mathrm{NE} \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS1600NE } \\ 100 \end{gathered}$ |  | XS2000NE |  | $\begin{gathered} \text { XS2500NE } \\ 100 \end{gathered}$ |
| XS125CJ | 18 | 10/30 | 4 | 18/18 |  | $18 / 18$ |  | 18/18 | 18/18 |
| XS125NJ | 30 | 10/30 |  | 30/30 |  | 30/30 |  | 30/30 | 30/30 |
| XH125NJ | 50 | 212/65 | L | 50/50 |  | 50̧/50 |  | 50/50 | 50150 |
| XE225NC | 18 | 8/30 |  | 18/18 |  | 18/18 |  | 18/18 | 18/18 |
| XS250NJ | 35 | 8/65 | in | 25/35 | i | 35/35 | : | 35/35 | 35/35 |
| XH250NJ | 50 | 10/65 |  | 35/50 |  | 50/50 |  | 50/50 | 50/50 |
| XS400'CJ | 35 | ${ }_{\square}^{5}$ ¢ 6/65 | ! | 20/42 | r | 35/42 | * | 35/42 | 35/42 |
| XS400NJ | 50 | 6/65 |  | 20/65 |  | 35/65 |  | 35/65 | 50/65 |
| XS400NE | 50 | 6/65 | 号 | 20/65 |  | 35/65 |  | 35/65 | 50/65 |
| XH400NE | 65 | $\cdots$ |  | $20 / 65$ |  | 35/65 |  | 35/65 | 50/65 |
| XS630cJ $\quad:$ | 45 | - 150 | \% | 15/45 |  | $20 / 45$ | ; | 35/45 | 35/45 |
| XS630NJ | 65 | -185 |  | 15/65 |  | 20/85 |  | 35/85 | 35/85 |
| XS630NE | 50 | -185 |  | 15/65 |  | - 20\%65 | $\because$ | 35/85 | 35/85 |
| XH630NE | 65 | -/85 |  | 15/65 |  | 20/85 |  | 35/85 | 35/85 |
| XS8OONJ $\because$ | 65. | 985 |  | 15/65 |  | 20/85 |  | 35/85 | 35/85 |
| XS800NE | 50 | -185 |  | 15/65 |  | 20/85 |  | 35/85 | 35/85 |
| XS1250NE - | 65 | - - | $\cdots$ | - |  | 20゙\% 65 | rr | 35/65 | 35/65 |
| XS1600NE | 100 | - | ' | - |  | - |  | - | 35/65 |



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.


## Motor Stärting <br> 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 lakeover 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



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 (lo) select switch and the pickup current (11) 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 50 kA 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.


[^7]
# Type '1' short circuit co-ordination Motor starter co-ordination table for DOL starting 50 kA at 415 V to AS 3947-41 

## TYPE 1 50kA



[^8] 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 50 kA 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 <br> size <br> kW | Approx. amps @ 415V | Sprecher + <br> Schuh <br> isolator | Terasaki circuit breaker | Sprecher + <br> Schuh <br> current <br> 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 |

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

## TYPE 2 50 kA



[^9]
## Type '2' short circuit co-ordination <br> Motor starter co-ordination table for DOL starting 65kA, 415V to AS 3947-4-1

## TYPE 2 65kA

$\left.\begin{array}{|llllll|}\hline \begin{array}{l}\text { Motor } \\ \text { size } \\ \text { kW }\end{array} & \begin{array}{l}\text { Approx. } \\ \text { amps }\end{array} & \begin{array}{l}\text { Terasaki } \\ \text { circuit } \\ \text { breaker }\end{array} & \begin{array}{l}\text { Sprecher + Schuh } \\ \text { contactor }\end{array} & \begin{array}{l}\text { Sprecher + Schuh } \\ \text { overload relay }\end{array} \\ \hline 0.37 & 1.1 & \text { XM30PB/1.4 } & \text { Cettings } \\ \text { range } \\ \text { amps }\end{array}\right]$
${ }^{2}$ ) 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.

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


## Motor circuit application table for DOL starting General applications

High fault range

| Motor rating (kW) | Approx. <br> FLC <br> (amps) | Din-T <br> C \& D <br> Curve | Safe-T | $\begin{aligned} & \text { XS125CJ } \\ & \text { XS125NJ } \\ & \text { XH125NJ } \end{aligned}$ | XE225NC | $\begin{aligned} & \text { XS250NJ } \\ & \text { XH250NJ } \end{aligned}$ | XS400SE <br> XH400SE <br> XS400CJ <br> XS400NJ | XH630SE <br> XS630SE <br> XS630CJ <br> XS630NJ | XS800NJ <br> XH800SE XS1250SE <br> XS800SE 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 | $\left.100{ }^{\prime}\right)$ | 80 | 100 |  |  |  |  |  |
| 22 | 40 | $125{ }^{\text {') }}$ | 100 | 100 |  |  |  |  |  |
| 25 | 46 | $125{ }^{1}$ ) | 100 | 100 |  |  |  |  |  |
| 30 | 55 |  |  | 125 |  | 160 |  |  |  |
| 37 | 68 |  |  | $125{ }^{\text { }}$ ) | 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 415 V 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.
') 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. <br> FLC <br> (amps) | $\begin{aligned} & \text { Din-T } \\ & \text { C \& D } \\ & \text { Curve } \end{aligned}$ | Safe-T | $\begin{aligned} & \text { XS125CJ } \\ & \text { XS125NJ } \\ & \text { XH125NJ } \\ & \text { TL100NJ }{ }^{3} \text { ) } \end{aligned}$ | XE225NC | $\begin{aligned} & \text { XS250NJ } \\ & \text { XH250NJ } \end{aligned}$ | XS400SE <br> XH400SE <br> XS400CJ <br> XS400NJ | XH630SE <br> XS630SE <br> XS630CJ <br> XS630NJ | XS800NJ <br> XH800SE <br> XS800SE | $\begin{aligned} & \text { XS1250SE } \\ & 1000 \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 ; | 1.1 | 4 | 6 | - | . |  | \% |  |  |  |
| 0.55 | 1.5 | 4 | 6 | 20 |  |  | , |  |  |  |
| 0,75; | 1:8 $8^{4}$ | 4 | 6 | $20{ }^{2}$ |  |  | \% | \% $\quad$, |  |  |
| 1.1. | 2.6 | 6 | 6 | 20 |  |  | . |  |  |  |
| 1.5.\% | 3.4 | 10 | $6 \because$ | $20 .$. |  |  | $\cdots$ | ' $\cdot$ |  | . |
| 2.2 . | 4.8 | 10 | 10 | 20 ! |  |  | - |  |  |  |
| $3.0 \%$ | 6.5 | 16 | 16 | 20 in |  |  | \% | \% |  |  |
| 4. | 8.2 | 20 | 16 | 20 |  |  | . |  |  |  |
| 4.5 | 9 9, | 20 | 16 | 20 |  |  | ! | $\because$ |  | - |
| 5.5 ! | 11 | 25 | 20 | 20 |  |  |  |  |  |  |
| 7.5. | 14 ? | 32 | 25 | 20 |  |  | d |  |  |  |
| 10 | 19 | 40 | 40 | 32 |  |  |  |  |  |  |
| 11. | 21 | 50 | 40 | 32 |  | , | i |  |  |  |
| 15 : | 28 | 50 | 50 | 50 |  |  | $\because$ |  |  |  |
| 18.5 | 34 | 63 | 63 h | 50 |  |  | ; |  |  |  |
| 22... | 40 | $80^{1}$ ) | 63 | 63 二, |  |  | $\because$ |  |  |  |
| 25 . | $46!$ | 100 ${ }^{\text {1 }}$ | 80 | $100 \%$ |  |  | y | $\because$ |  |  |
| 30 | 55 | $125{ }^{\text {1 }}$ ) | 100 | 100 . |  | 160 |  |  |  |  |
| 37 | $66^{\circ}$ | 125!) | .." | 100 | . 125 | 160 | $\because$ | $\cdots$ |  |  |
| 45 | 80 :" |  |  | 125 | 125 | 160 | 250 |  |  | 1 |
| 55 | 100 \% |  |  |  | . 150 | 160 | 250 |  |  |  |
| 75. | 130 |  | ! |  | 175 | 250 | 250 |  |  |  |
| 90 . | 155\% |  |  | \% | 225 | 250 | 250 | $\therefore$ |  |  |
| 110. | 200 |  |  | : |  | 250 | 250 | 400 |  |  |
| 132: : | 225 |  | $\because$ | $\because$ |  |  | 400 . | . 4000 |  | : |
| 160. |  |  |  |  |  |  | 400 : | 400 |  |  |
| 185 | 320 ${ }^{\text {a }}$, |  |  | - |  |  | 400 : | 400 | $800 .{ }^{2}$ ) |  |
| 200 | 361 |  |  |  |  |  | $400^{2}$ ) : | 630 | $800{ }^{2}$ ) |  |
| 220:": : | 380 |  |  | $\because \cdot$ |  |  |  | $630{ }^{-1}$ | 800 |  |
| 250 | 430 |  |  |  |  |  |  | 630 | 800 |  |
| 280 | 480 |  |  | \% |  |  | - | 630 in | 800 |  |
| 300. | 510 |  |  |  |  |  | 亿 | 630 | 800 |  |
| 375 $\therefore$, | 650 |  |  | ; ${ }^{\text {a }}$ |  |  | $\because$ |  | $800{ }^{2}$ ) | 1000 |

Notes: These motor circuit application tables are to be used as a selection guide for average 3 phase, 4 pole 415 V motors for standard applications only. The table is based on holding $125 \%$ FLC continuously and $350 \%$ FLC for at least 20 seconds.
') 80, 100 and 125 amp refers to Din-T10H type.
${ }^{2}$ ) Type 'SE' TemBreak MCCB only.
${ }^{2}$ ) TL100NJ up to 100A only.
If co-ordination to IEC 947-4-1 is required refer to Type 1 and 2 co-ordination tables, conlact NHP.
Din-T MCB's are calibrated to IEC 898 Curve ' $C$ ' 8 ' $D$ '. Selected sizes of ' $D$ ' Curve are avaitable from stock. Refer NHP.

Motor cirçuit application table for DOL FİRE PUMP starting dûty
Breaker type and current rating ( A )


Notes: These motor circuit application tables are to be used as a selection guide for average 3 phase, 4 pole 415 V 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.


## 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.
3. 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
2nd re-arcing
3rd re-arcing
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-ofthumb.

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

kVAR: Capacitor Rating
V: Source Voltage
MCCB Rating $=$ Capacitor Rated Current $\times 1.5(\mathrm{~A})$
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 415 V (3Ø) |  | Recommended MCCB's ') ') Typer/Rating (A) |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Capacitor rating (kVAR) | Capacitor rated current (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 |  | XS400C $/ 1400$ | 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 |  |  | . |  |

[^10]
## MCCB use in high frequency $(400 \mathrm{~Hz})$ applications

General
Terasaki TemBreak MCCB's are designed to operate primarily in 50 or 60 Hz systems. However, it is possible to use the same MCCB's in high frequency $(400 \mathrm{~Hz})$ 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 400 Hz 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 $50 / 60 \mathrm{~Hz}$ 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 ( $l_{0} \times I_{\text {, }}$ ) that should be used when in high frequency applications.


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

## C̄ircuit brêaker selection for DC applications

The characteristics of an MCB or MCCB for DC applications are different from $A C$. 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:

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

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 | Breaking <br> capacity <br> type | KA ${ }^{\prime}$ ) |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

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

## Breaking capacities of TemBreak MCCB in DC systems

мссв

| type | 24/48/60V | 125 V | 250 V | 350 V | 500 V | 600 V |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| XS125NJ | 25 | 20 | 15 | 10 | $7.5^{2}$ ) | $\left.5^{2}\right)$ |
| 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 ${ }^{\text { }}$ ) | - | 40 | 40 | 30 | 20 | 20 |
| (XS1600ND ${ }^{3}$ ) | - | 40 | 40 | 30 | 20 | 20 |
| XS2000 ${ }^{\text {( }}$ ) ${ }^{\text {\% }}$ | - | 40 | 40 | 30 | 20 | 20 |
| XS2500ND ${ }^{3}$ ) | - | 40 | 40 | 30 | 20 | 20. |

## Notes:

') Time constant (L/R) $<=15 \mathrm{~ms}$; excludes $50 / 63 \mathrm{~A}$ where the time constant (LIR) $<=4 \mathrm{~ms}$.
${ }^{2}$ ) Special version of the standard $A C$ circuit breaker. Standard circuit breakers cannot be used at these ratings. Please specify for use on 500 or 600 V DC on application. Indent only.
${ }^{3}$ ) Magnetic trip only, without overload protection. Indent only.
For voltage levels up to and including 250 V DC standard 2-pole breakers maybe be used, with both poles connected in series. For voltage levels greater than 250 V DC 3 -pole breakers must be used, with all three poles connected in series as shown.
The time constant (LR) of the circuit should be:
less than 2 ms at rated current.
less than 2.5 ms for overload ( $2.5 \times \mathrm{in}$ ).
less than 7 ms for short circuit $\leq 10 \mathrm{kA}$.
less than 15 ms for short circuil > 10 kA .



## 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.

## 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


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.

## Sెelection of MCCB's for use in welder circuits

1. Definitions
$\mathbf{P}=\quad$ Rated capacity of welder in kVA.
$\mathbf{V}=\quad$ Welder rated voltage.
11 = Maximum primary current (PN).
$\mathrm{T}_{1}=$ 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.
$\mathbf{l e}=\quad$ 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, le, may be calculated from:

$$
l e=\frac{P \times 1000}{V} \times \sqrt{B} \quad\left(B=\frac{T_{1}}{T_{1}+T_{2}}\right)
$$

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 11 and the current 'ON' period, T1 with the MCCB characteristic curve to ensure that it will not trip.


Current

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, 1 m , at the start of welding is given by:

$$
\mathrm{I}_{\mathrm{m}}=\frac{P_{\mathrm{m}} \times 1000}{\mathrm{~V}} \times 1.3 \times \mathrm{K}
$$

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 lm , but less than the surge on-state current rating of the thyristor stack:
$\mathrm{I}_{\mathrm{m}} \quad<\mathrm{l}_{\text {inst }}<$

1.1
where:
Is $=$ surge on-state current rating of thyristor stack, in A
Im $=$ maximum welder input current at start of welding, in $A$
$I_{\text {wst }}=M C C B$ Instantaneous trip setting, in $A$
$1.1=$ Factor to allow for $\pm 10 \%$ 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.

## 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 240 V |  |  | 3 phase 415V |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Transformer (kVA) | MCCB type | MCCB rating | $\begin{aligned} & \mathrm{BC}(\mathrm{kA}) \\ & \text { at } 240 \mathrm{~V} \end{aligned}$ | MCCB type | MCCB rating | BC (kA) <br> at 415 V |
| 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 |  |  |  |
|  | XH250N」 | 160 | 85 |  |  |  |
| 20 | XS250NJ | 160 | 50 | XS125NJ | 63. | 30 |
|  | XH250NJ | 160 | 85 |  |  |  |
| 30 |  |  |  | XS125NJ | 100 | 30 |
| 50. |  |  |  | XS125NJ | 125 | 30 |
| 75 |  |  |  | XE225NC | 225 | 18 |
|  |  |  |  | XS250N」 | 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

| (kVA) | Single-phase transformer |  | Three-phase transformer |  |
| :---: | :---: | :---: | :---: | :---: |
|  | 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.


## M̈CB 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 $\mathbf{1 0}$ minutes with the current decaying exponentially.
3. Based on $415 / 240 \mathrm{~V} 3$ phase or 240 V single phase systems.

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

| Power Number of fittings per phase |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 50W | 2 | 4 | 7 | 2 | 9 |  | 12. | 24 | 36 | 9 | 48 | 60 | 76 | 108 |
| 70w | 1 | 3 | 5 |  | 6 |  | 8 | 17 | 25 |  | 34 | 42 | 54 | 77 |
| \|150W, | - | 1 | 2 |  | 3 | $\stackrel{1}{2}$ | 4 | 8 | 12 | $\cdots$ | 16 | 20 | 25 | 36 |
| 250W | - | - | 1 | $\because$ | 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 | 9 | 4 |  | 6 | 10 | 16. | \% | 20 | 25 | 32 | 50 |

## Example

Given 42 lamps each 250 W installed on a 415 V 3 phase system.
Which MCB must be selected?
Number of tubes per phase $=$ $\qquad$ $=14$
Therefore from the table above a 32A MCB should be selected.
A short circuit rating as appropriate must be selected.

## $\bar{M} C B$ 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 $25^{\circ} \mathrm{C}$.
4. Based on $415 / 240 \mathrm{~V} 3$ phase or 240 V 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 | $2 \times 20$ | 32 | 47 | 57 | 72 | 83 | 110 |
|  | $2 \times 40$ | 16 | 23 | 28 | 36 | 41 | 55 |
|  | $2 \times 65$ | 10 | 14 | 17 | 22 | 25 | 35 |
|  | $2 \times 80$ | 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 $415 / 240 V 3$ phase and neutral or 240 V single phase system and 240 V lamps.
5) $M C B$ 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:
Breaker rating $=\frac{W \times 10}{P \times 240 \times 1 \text { inst }}$
Where $W=$ total wattage
Where $P=$ Number of phases
1 inst = Minimum instantaneous tripping co-efficient.
C curve $=5$
D curve $=10$

## TemBreak MCCB clearance requirements at $380 / 415 \mathrm{~V}$

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.

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.

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.

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)
Table 1
This table is valid for $380 / 415 \mathrm{~V}$

| MCCB type | A | B1 | B2 | C | D |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | 30 | 10 | 10. | 0 | 25 |
| XS125CJ, XS'125NJ, 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 |
| XH4OOOSE, XS630CJ, XS630NJ, XS630SE, XS800NJ, XS800SE | 120 | 70 | 40 | 0 | 30 |
| XH630SE, XH800SE, XH800PE | 150 | 80 | 50 | 0 | 40 |
| XS 1250SE | 150 | ${ }^{3} 70$ | 40 | 0 | 30 |
| XH630PJ, XH800PJ, XS1600NE, XS2000NE, XS2500NE | 150 | 150 | 100 | 0 | 100 |



## 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 -120 mm (XV1250NE - 150 mm ) To sides of breaker -40 mm .

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.



## 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 2000 kVA transformer is $6.5 \%-7 \%$ impedance. This results in a fault level of $40-43 \mathrm{kA}$.

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 56 kA . 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 2000 kVA transformer, with $Z=5 \%$ is 56 kA . 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 50 kA to 6.7 kA .


## 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.
5006
5025
5093
5088
5067
5065
5074
5078
5087
5083
5086
5195
Description
Specification for corrosive proofing of MCCB's
De-rated current of ACB's when enclosed
De-rated current of MCCB's when enclosed
De-rating of TemBreak electronic MCCB's when enclosed
DC applications of ACB's
Reverse connection
Thyristor protection with MCCB's
ELCB's at high frequency
ACB's and MCCB's at high altitude
Circuit breaker life mechanical and electrical
TemBreak UVT: transient response time
inspection and maintenance of earth leakage and moulded case circuit breakers.

## IP rating protection against ingress of dust and liquids



| IP 1st digit <br> Degree of protection against contact and ingress of foreign bodies | IP 2nd digit <br> 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 50 mm | 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 12 mm | 2 Protection against obliquely falling water, up to an angle of $15^{\circ}$ |
| 3 Protection against contact with wires etc., with diameters greater than 2.5 mm , or ingress of solid foreign bodies with diameters greater than 2.5 mm | 3 Protection against obliquely sprayed water, up to an angle of $60^{\circ}$ from the vertical |
| 4 Protection against contact with wires etc., with diameter greater than 1 mm , or ingress of solid foreign bodies with diameters greater than 1 mm | 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 pars, 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 | TemBreak MCCB's

## NHP

Accessories to suit 125-630AF MCCBs $\square$
External accessories Cat. No.

Door interlocking, variable depth Suits MCCB types


Note: Handles supplied with shaft


## ACCESSORUES

## OPERATING HANDLES \& LOCKING DEVICES

TemBreak 2 handles are extremely reliable, having been designed to endure the same switching dury 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 ( 8 mm 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 $\operatorname{ON}(\mathrm{I})$ and $\operatorname{OFF}(\mathrm{O})$ 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



MCCB ON 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.

Cubicle Door Cutouts


Using TomBreak 2 Operating Handlos


Using other MCCB Operating Handles

## ACCESSORUES

## OPERATING HANDLES \& LOCKING DEVICES

## Door Mounted Handle (HP)



Door Mounted Handle with Oprional Keylock
Breaker Mounted Handle (HB)


Breaker Mounted Handle Padlocked in the OFF Position

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.

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 $125 \mathrm{~A}, 160 \mathrm{~A}$ and 250A frame models accept padlocks with 5 mm hasp diameter. Locking devices for 400A and 630A frame models accept padlocks with 8 mm hasp diameter.


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

*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 E : Handle Centre Line

Padlock dimensions (mm)



DURMENSIONS

## Door Mounted Handle

| Appllcabto MCCB. | A *1 | - | B | c | D | II | Shaft support |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { E250 } \\ & \text { S250 (except S250-PE) } \end{aligned}$ | 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 shatt 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 suppon may be removed.



ASL: Arrangement Standard Line 나: Handle Frame Centre Line q : Handle Centre Line

Padlock dimensions (mm)



## DIRTENSIONS

## Door Mounted Handle

| Applicable MCCB | A* ${ }^{\text {a }}$ | B | C | D | Shatt suppert |
| :---: | :---: | :---: | :---: | :---: | :---: |
| E400 E630 | 270 min . | 12 | 107.5 | - | Withoun |
| S400 S630 | 610 max. | 280 | 447.5 | 261 | With + |
| H400 | 307 min . | 12 | 107.5 | - | Withour |
| 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 curting 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 shati support may be removed.


ASL: Arrangement Standard Line it :Handle Frame Centre Line $q$ : Handle Centre Line

Padiorin dimenslons (mm)


## Accessories to suit 125-630AF MCCBs

$\square$

External accessories
Door interlocking, variable depth
Suits MCCB types


| IP54 rated |  |
| :--- | :--- |
| Grey/black | T2HP40R5BNA4 |
| Grey/black $\mathrm{c} / \mathrm{w}$ key lock | T2HP40R5BKA4 |
| Red/yellow | T2HP40R5RNA4 |
| Red/yellow $\mathrm{c} / \mathrm{w}$ key lock | T2HP40R5RKA4 |
|  |  |
| IP65 rated |  |
| Grey/black |  |
| Grey/black $\mathrm{c} / \mathrm{w}$ key lock | T2HP40R6BNA4 |
| Red/yellow | T2HP40R6BKA4 |
| Red/yellow c/w key lock | T2HP40R6RNA4 |

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.


## 

## OPERATING HANDLES \& LOCKING DEVICES

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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 ( 8 mm 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 $\mathrm{ON}(1)$ and $\operatorname{OFF}(\mathrm{O})$ 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


MCCB ON

$M C C B$ ON 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.

Cubicle Door Cutouts


Using TenBreak 2 Operaring Handles


Using other MCCB Operating Handles


## ACCBESORMES

## OPERATING HANDLES \& LOCKING DEVICES

Door Mounted Handle (HP)


Door Mounted Hrndle with Oprional Krylack
Breaker Mounted Handle (HB)


Breaker Mounted Handle Padlocked in the OFF Posirion

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.

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 250 A frame models accept padlocks with 5 mm hasp diameter. Locking devices for 400 A and 630 A frame models accept padlocks with 8 mm hasp diameter.


5250 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 | 11 | A 11 | B | c | 11 | Shat support |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { E125 } \\ & \text { S125 } \end{aligned}$ |  | 540 max. | 370 | 421 |  | With + |

[^11]

> ASL: Arrangement Standard Line H: Handle Frame Centre Line $\mathbf{E}:$ Handle Centre Line

Padlock dimensions (mm)



## D日RTENSUONS

## Door Mounted Handle

| Appleabls MCCB : | $\therefore$. | A ${ }^{1}$ | 8 | c | D. | If Shaft eupport |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| E250 |  | 540 max. | 370 | 421 | 186 | With + |
| S250 (except S250-PE) |  |  |  |  |  |  |
| $\begin{aligned} & \text { S250-PE } \\ & \text { H125 L125 } \\ & \text { H160 L160 } \end{aligned}$ |  | 575 max. | 370 | 421 | 221 | With + |
| H250 L250 |  |  |  |  |  |  |

* 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 shaf so short that it does not protrude beyond the shaff support, the shaft support may be removed.



ASL: Arrangement Standard Line of: Handle Frame Centre Line G: Handle Centre Line

Padiock dimensions (mm)


TEMBREAK 2 MCCBs
DINMENSUONS
Door Mounted Handle

| Appleable MCCE | A *1 | B | C | D | Shatt support |
| :---: | :---: | :---: | :---: | :---: | :---: |
| E400 E630 | 270 min. | 12 | 107.5 | - | Without |
| S400 S630 | 610 max. | 280 | 447.5 | 261 | With + |
| H400 | 307 mis. | 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 cutring the shaft.

+ The shalt 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 shafi suppori may be removed.



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

## MINIATURE CIRCUIT BREAKER

1. MCB TECHNICAL DETAILS
2. MCB/RCD TECHNICAL DETAILS

## Miniature circuit breakers

Din-T6 series 6 kA MCB

- 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 | DTCB6113' |
| 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 | DTCB6213C |
| 16 | DTCB6216C |
| 20 | DTCB6220C |
| 25 | DTCB6225C |
| 32 | DTCB6232C |
| 40 | DTCB6240C |
| 50 | DTCB6250C |
| 63 | DTCB6263C |

3 pole 3 modules

| 2 | OTCB6302C |
| :--- | :--- |
| 4 | OTCB6304C |
| 6 | DTCB6306C |
| 10 | DTCB6310C |
| 13 | 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 VAC |  |
| $2 P$ | $240-415 \mathrm{VAC}$ |  |
| $3 P$ | $240-415 \mathrm{VAC}$ |  |
| DC use | 1 P | 2 P I) |
| 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 $50 / 60 \mathrm{~Hz}$.
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 $-55^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$, according to IEC 88 part 2-1 (duration 96 hours).
Operating temperature
From $-25^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$, according to
VIE 0664 parts 1 and 2.
Use at 400 Hz
At 400 Hz the magnetic trip current is approximately $50 \%$ higher than in $\mathrm{AC} 50 / 60 \mathrm{~Hz}$.

Notes: ') 2 pole MCB connected in series. The line side is the "OFF" (bottom) side of the MCB, and connects to CD chassis tee-offs. ${ }^{1}$ 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 <br> (A) | Test current | Tripping time | Applications |
| :---: | :---: | :---: | :---: |
| B | $\begin{aligned} & 3 \times \operatorname{In} \\ & 5 \times \operatorname{In} \end{aligned}$ | $\begin{gathered} 0.1<t<45 \mathrm{~s}(\operatorname{In} \leq 32 \mathrm{~A}) \\ 0.1<t<90 \mathrm{~s}(\operatorname{In}>32 \mathrm{~A}) \\ t<0.1 \mathrm{~s} \end{gathered}$ | Only for resistive loads eg: <br> - electrical heating <br> - water heater <br> - stoves. |
| C | $\begin{aligned} & 5 \times \operatorname{In} \\ & 10 \times \operatorname{In} \end{aligned}$ | $\begin{gathered} 0.1<t<15 \mathrm{~s}(\operatorname{In} \leq 32 \mathrm{~A}) \\ 0.1<t<30 \mathrm{~s}(\operatorname{In}>32 \mathrm{~A}) \\ t<0.1 \mathrm{~s} \end{gathered}$ | Usual loads such as: <br> - lighting <br> - socket outlets <br> - small motors |
|  | $\begin{aligned} & 10 \times \mathrm{In} \\ & 20 \times \mathrm{In} \end{aligned}$ | $\begin{gathered} 0.1<t<4 \mathrm{~s}(* *)(\mathrm{In} \leq 32 \mathrm{~A}) \\ 0.1<t<8 \mathrm{~s}(\mathrm{In}>32 \mathrm{~A}) \\ \mathrm{t}<0.1 \mathrm{~s} \end{gathered}$ | 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 $30^{\circ} \mathrm{C}$. |  |  |  |
|  | Test current |  | Tripping time |
| $1.13 \times \mathrm{In}$ |  |  | $\begin{aligned} & t \geq 1 \mathrm{~h}(\mathrm{In} \leq 63 \mathrm{~A}) \\ & \mathrm{t} \geq 2 \mathrm{~h}(\mathrm{In}>63 \mathrm{~A}) \end{aligned}$ |
| $1.45 \times$ In |  |  | $\begin{aligned} & t<1 h(\operatorname{In} \leq 63 \mathrm{~A}) \\ & \mathrm{t}<2 \mathrm{~h}(\mathrm{In}>63 \mathrm{~A}) \end{aligned}$ |
| $2.55 \times$ In |  |  | $\begin{aligned} & 1 \mathrm{~s}<\mathrm{t}<60 \mathrm{~s}(\text { In } \leq 32 \mathrm{~A}) \\ & 1 \mathrm{~s}<\mathrm{t}<120 \mathrm{~s}(\text { In }>32 \mathrm{~A}) \end{aligned}$ |

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: 0-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 0.1 s .
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: $0-\mathrm{t}-\mathrm{CO}-\mathrm{t}-\mathrm{CO}$.

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 1 h when current is 1.6 In .

0 - 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) |
| :---: | :---: |
| $\leq 6000$ | 6000 |
| $>6000$ | 0.75 Icn min. 6000 |
| $\leq 10000$ | 0.75 Icn min. 7500 |
| $>10000$ |  |

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.


## 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


## 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 $45^{\circ} \mathrm{C}$, 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: $16 \mathrm{~A} \times 0.7=11.2 \mathrm{~A}$
As the MCB is working at $45^{\circ} \mathrm{C}$ it shall be given another factor ( $90 \%=0.9$ ):
In at $45^{\circ} \mathrm{C}=\mathrm{In}$ at $30^{\circ} \mathrm{C} \times 0.9=11.2 \mathrm{~A} \times 0.9=10.1 \mathrm{~A}$.

Note: ') Applicable for MCBs working at maximum rated currents.

The thermal calibration of the MCBs was carried out at an ambient temperature of $30^{\circ} \mathrm{C}$. Ambient temperatures different from $30^{\circ} \mathrm{C}$ influence the bimetal and this results in earlier or later thermal tripping.
0.5-6 A


## 10 A



16-40 A


50-63 A


## Din-T MCBs Technical data

## Effects of frequency on the tripping characteristic

All the MCBs are designed to work at frequencies of $50-60 \mathrm{~Hz}$, 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 $50-60 \mathrm{~Hz}$.

## 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 terminats of the device at rated current.

## Power loss per pole

| In <br> $(\mathrm{A})$ | Voltage drop <br> $(\mathrm{V})$ | Energy loss <br> $(\mathbf{W})$ | Resistance <br> $(\mathrm{mOhm})$ |
| :---: | :---: | :---: | :---: |
| 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 ${ }^{2}$ t

The limitätion 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

## Din-T MCBs Technical data

## Din-T 6

6 kA
$\mathbf{I}^{2} \mathbf{t}$ Let-through energy at 240/415 V


Id Limited peak current at $230 / 400 \mathrm{~V}$


## 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 6 | 0.5... 63 A | 20 | 25 | - | - |

## 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 $-25^{\circ} \mathrm{C}$ up to $+50^{\circ} \mathrm{C}$
- 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,CD (B curve Din-T 10 only).

Number of poles: $1 \mathrm{P}, 1 \mathrm{P}+\mathrm{N}, 2 \mathrm{P}, 3 \mathrm{P}, 3 \mathrm{P}+\mathrm{N}, 4 \mathrm{P}$
The short-circuit breaking capacity is: $6 / 10 \mathrm{k} A$, energy limiting class 3

- Terminal capacity from 1 up to $35 \mathrm{~mm}^{2}$ rigid wire or 1.5 up to $25 \mathrm{~mm}^{2}$ 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

E 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 $\mathrm{x}, \mathrm{y}, \mathrm{z}$ ) minimum 18 shocks 5 ms half-sinusoidal acc. to IEC 60068-2-27
- Vibration resistance: 3 g (direction $\mathrm{x}, \mathrm{y}, \mathrm{z}$ ) 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.

## Din-T MCBs Technical data



## Din-T MCBs Technical data

Miniature circuit breakers - Din-T 6
Dimensions in mm.


## Miniature circuit breakers

Din-T15 series 15 kA, $20 \mathrm{kA}, 25 \mathrm{kA}$ 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


1 pole 1 module ${ }^{3}$ )

|  | C-Curve <br> In (A) | Icu (kA) |
| :--- | :--- | :--- |
| 6 | 25 | DTCB15106C |
| 6 | 25 | DTCB15110C |
| 10 | 25 | DTCB15113C |
| 13 | 25 | DTCB15116C |
| 16 | 25 | DTCB15120C |
| 20 | 25 | DTCB15125C |
| 25 | 20 | DTCB15132C |
| 32 | 20 | DTCB15140C |
| 40 | 15 | DTCB15150C |
| 50 | 15 | DTCB15163C |
| 63 |  |  |

3 pole 3 modules ${ }^{3}$ )

| 6 | 25 | DICB15306C |
| :---: | :---: | :---: |
| 10 | 25 | DTCB15310C |
| 13 | 25 | - DTCB15313C |
| 16 | 25 | DICB15316C |
| 20 | 25 | DTCB15320C |
| 25 | 25 | DTCB15325C |
| 32 | 20 | DICB15332C |
| 40 | 20 | DTCB15340C. |
| 50 | 15 | DTCB15350C |
| 63 | 15 | DTCB15363C |

2 pole 2 modules ${ }^{3}$ )

|  | In (A) | Icu (kA) |
| :--- | :--- | :--- |
| 6 | 25 | C Curve <br> $\mathbf{5}-\mathbf{1 0}$ In |
| 10 | 25 | DTCB15206C |
| 13 | 25 | DTCB15210C |
| 16 | 25 | DTCB15213C |
| 20 | 25 | DTCB15216C |
| 25 | 25 | DTCB15220C |
| 32 | 20 | DTCB15225C |
| 40 | 20 | DTCB15232C |
| 50 | 15 | DTCB15240C |
| 63 | 15 | DTCB15250C |

4 pole 4 modules ${ }^{2}$ ) ${ }^{3}$ )

| 6 | 25 | (i) dicib15406C |
| :---: | :---: | :---: |
| 10 | 25 | (1) dTCB15410C |
| 13 | 25 | - ${ }^{\text {- DTCB15413C }}$ |
| 16 | 25 | B dTEB15416C |
| 20 | 25 | - Diteri5420\% |
| 25 | 25 | (1) DTCB15425C |
| 32 | 20 | (1) DTCB15432C |
| 40 | 20 |  |
| 50 | 15 | -1] 0icb15450C |
| 63 | 15 | $1]^{1}$ DTCB15463C |


| In $(A)$ | $6-63$ |
| :--- | :--- |
| $1 P$ | $240 V A C$ |
| $2 P$ | $240 / 415 V A C$ |
| $3 P$ | $240 / 415 V A C$ |
| $4 P$ | $240 / 415 V A C$ |

Shock resistance (in $\mathrm{x}, \mathrm{y}, \mathrm{z}$ 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 $-55^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$ according to VDE 0664 parts 1 and 2
0 perating temperature
from $-25^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$ 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 $A C$ $50 / 60 \mathrm{~Hz}$

## 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 $40^{\circ} \mathrm{C}$.

| Test <br> current | Tripping <br> time |
| :---: | :---: |
| $1.05 \times$ In | $\mathrm{t} \geq 1 \mathrm{~h}(\ln \leq 63 \mathrm{~A})$ |
|  | $\mathrm{t} \geq 2 \mathrm{~h}($ In $>63 \mathrm{~A})$ |
| $1.30 \times$ In | $\mathrm{t}<1 \mathrm{~h}($ In $\leq 63 \mathrm{~A})$ |
|  | $\mathrm{t}<2 \mathrm{~h}($ In $>63 \mathrm{~A})$ |

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: 0-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: 0-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 $\mathrm{In}>63 \mathrm{~A}$ ).

0 - 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 $\quad$ 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

## Din-T MCBs Technical data <br> 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


# Din-T MCBs Technical data <br> Definitions related to circuit breakers 

MCB $=$ Miniature Circuit Breaker

## Short-circuit (making and breaking) capacity <br> 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.

## 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 | $\left.K^{1}\right)$ |
| :---: | :--- |
| 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, $16 \mathrm{~A},{ }^{\circ} \mathrm{C}$ curve type MCBs, with an operating ambient temperature of $45^{\circ} \mathrm{C}$, 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: $16 \mathrm{~A} \times 0.7=11.2 \mathrm{~A}$
As the MCB is working at $45^{\circ} \mathrm{C}$ it shall be given another factor ( $90 \%=0.9$ ):
In at $45^{\circ} \mathrm{C}=\operatorname{In}$ at $30^{\circ} \mathrm{C} \times 0.9=11.2 \mathrm{~A} \times 0.9=10.1 \mathrm{~A}$.

Note: ') Applicable for MCBs working at maximum rated currents.

The thermal calibration of the MCBs was carnied out at an ambient temperature of $30^{\circ} \mathrm{C}$. Ambient temperatures different from $30^{\circ} \mathrm{C}$ influence the bimetal and this results in earlier or later thermal tripping.


10 A


16-40 A


50-63A


## Din-T MCBs Technical data

## Effects of frequency on the tripping characteristic

All the MCBs are designed to work at frequencies of $50-60 \mathrm{~Hz}$, 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 $50-60 \mathrm{~Hz}$.

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 <br> $(\mathrm{A})$ | Voltage drop <br> $(V)$ | Energy loss <br> $(W)$ | Resistance <br> $(\mathrm{mOhm})$ |
| :---: | :---: | :---: | :---: |
| 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 $\mathrm{I}^{2} t$
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

## Din-T MCBs Technical data

Din-T 15
15 kA

## C curve

$\mathrm{I}^{2} \mathrm{t}$ Let-through energy at 240 V


## 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.

## Din-T MCBs + RCDs Technical data <br> 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 $-25^{\circ} \mathrm{C}$ up to $+50^{\circ} \mathrm{C}$
- 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 $35 \mathrm{~mm}^{2}$ rigid wire or 1.5 up to $25 \mathrm{~mm}^{2}$ flexible wire
- Screw head suitable for flat or Pozidrive screwdriver

E Can be connected by means of both pin or fork busbars

- The toggle can be sealed in the ON or 0 OF 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.
E Maximum voltage between two phases; 440 V
(1. 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 $\mathrm{x}, \mathrm{y}, \mathrm{z}$ ) minimum 18 shocks 5 ms half-sinusoidal acc. to IEC 60068-2-27
- Vibration resistance: 3 g (direction $\mathrm{x}, \mathrm{y}, \mathrm{z}$ ) 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.


## Din-T MCBs Technical data



## 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
(1) Sensitivity 10 and 30 mA
- Din rail mount
- Suits CD chassis
- Type " $A$ " residual current device ( $A C / D C$ )

| Amp rating <br> (A) | Modules $(18 \mathrm{~mm})$ | Voltage $(A C)$ | Short circuit (kA) | Trip <br> Sensitivity <br> (mA) | Cat. No ${ }^{1}$ ) ${ }^{\text {a }}$ ) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 6 | 1 | 240 | 10 | 30 | DSRCBHO630A |
| 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 | []DRCBH0610A |
| 10 | 1 | 240 | 10 | 10 | DSRCBH1010A |
| 16 | 1 | 240 | 10 | 10 | DSRCBH1610A |
| 20 | 1 | 240 | 10 | 10 | DSRCBH2010A |
| 25 | 1 | 240 | 10 | 10 | D DSRCBH2510A |
| 32 | 1 | 240 | 10 | 10 | D) DSRCBH3210A |
| 40 | 1 | 240 | 10 | 10 | [ DSRCBH4010A |

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: ') Neutral not switched.
${ }^{2}$ ) Will not accept side mounting accessories.
i Available on indent only.

## 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.
- $\quad$ 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 (I $\Delta n$ ) 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.



Note: Nuisance tripping may be experienced in VFD and motor starting applications refer NHP.

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



# Din-T MCBs + RCDs Technical data <br> 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 $(\mathrm{I} 1+\mathrm{I} 2=0)$ but in case of an earth fault, the vectorial sum differs from zero ( $\mathrm{I} 1+\mathrm{I} 2=\mathrm{Id}$ ), 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 $A C$ 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 ( $\mathrm{I} \Delta \mathrm{m}$ )
A value of the $A C$ 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 (I $\Delta \mathrm{C}$ )
A value of the $A C$ 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 $A C$ 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 $A C$ 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 ( $\mathbf{I} \Delta \mathrm{n}$ )
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)

## 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 $D C$ 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 $\left.A C \backsim{ }^{1}\right)^{2}$ )
The type $A C$ RCDs are designed to release with sinusoidal residual currents which occur suddenly or slowly rise in magnitude.


| Residual current | Tripping time |
| :---: | :---: |
| $0.5 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=\propto$ |
| $1 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=<300 \mathrm{~ms}$ |
| $2 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=<150 \mathrm{~ms}$ |
| $5 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=\leq 40 \mathrm{~ms}$ |



Tripping curve type AC
${ }^{\text {I }}$ ) Standard in Australia
${ }^{2}$ ) Type A acceptable in Australia

## Type A


${ }^{3}$ ) ${ }^{4}$ )
Certain devices during faults can be the source of nonsinusoidal 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 $0.006 \mathrm{~A} D C$ during one single interval of time, expressed in angular measure of at least $150^{\circ}$.

|  | Residual current |  |
| :--- | :--- | :--- |
| 1. For sinusoidal residual current | Tripping time |  |
|  | $0.5 \times I \Delta \mathrm{n}$ | $\mathrm{t}=\infty$ |
|  | $1 \times \mathrm{I} \Delta \mathrm{n}$ | $\mathrm{t}=\ll 300 \mathrm{~ms}$ |
| $2 \times I \Delta \mathrm{n}$ | $\mathrm{t}=<150 \mathrm{~ms}$ |  |
|  | $5 \times I \Delta \mathrm{n}$ | $\mathrm{t}=\leq 40 \mathrm{~ms}$ |

2. For residual pulsating direct current


Tripping curve type A
${ }^{3}$ ) Standard in New Zealand
) DSRCBH is type A.

## Din-T MCBs + RCDs Technical data

## Nuisance tripping

All DinSafe RCDs have a high level of immunity to transient currents, against current impulses of $8 / 20 \mu \mathrm{~s}$ according to EN $61008 / 61009$ and VDE 0664.T1.
Type A, AC
50 A 8/20 $\mu \mathrm{s}$
Type S. .3000 A $8 / 20 \mu s$


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)


## IEST-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 $>4 \mathrm{~mm}$.


## I-ON

Contacts in closed position. Ensure continuity in the main circuit.

## 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.


## IOGGLE

To manually switch the RCBO ON or OFF

## Din-T MCBs + RCDs Technical data

## Product related information

Influence of temperature on RCBOS (DinSafe DSRCB)
The thermal calibration of the RCBO was carried out at an ambient temperature of $30^{\circ} \mathrm{C}$. Ambient temperatures different from $30^{\circ} \mathrm{C}$ influence the bimetal and this results in earlier or later thermal tripping.
0.5-6A


10 A



## Din-T MCBs + RCDs Technical data

## Tripping current as a function of the frequency

All RCOS are designed to work at frequencies of $50-60 \mathrm{~Hz}$, 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.

| 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 ' |  |  |  |  |  |  |  |
| 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: ') The standard NHP/Terasaki type is the "type AC" in Australia, Type " $A$ " in New Zealand.
${ }^{2}$ ) The standard NHP/Terasaki OSRCBH single pole RC8O is "type A" in Australia and New Zealand.
${ }^{1}$ ) 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 $A C$ " $8 C O$ will trip at $(0,8 \times 30 \mathrm{~mA}) 24 \mathrm{~mA}$.

## 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) | $\mathbf{6}$ | $\mathbf{1 0}$ | $\mathbf{1 3}$ | $\mathbf{1 6}$ | $\mathbf{2 0}$ | $\mathbf{2 5}$ | $\mathbf{3 2}$ | $\mathbf{4 0}$ | $\mathbf{5 0}$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathbf{Z}$ (mOhm) | 45.8 | 16.4 | 12.5 | 10.6 | 7.3 | 5.4 | 3.2 | 2.6 | 1.9 |
| $\mathbf{P}$ (W) | 1.65 | 1.7 | 2.1 | 2.7 | 2.9 | 3.3 | 3.4 | 4.2 | 4.8 |

## Din-T MCBs + RCDs Technical data

RCBO (DSRCB) let-through energy $I^{2} t$
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)
Curve C

Let-through energy at 230 V


RCCB - Din-Safe safety switch (DSRCD)
RCBO-Din-Safe (DSRCBH)


Dimensions in mm

Din-T MCBs + RCDs Technical data
Overview Din-Safe RCDs

## CONTACTOR AND THERMAL OVERLOAD

## 1. CA6 CONTACTOR TECHNICAL DETAILS <br> 2. CA7 CONTACTOR TECHNICAL DETAILS <br> 3. CT7 SERIES THERMAL OVERLOAD TECHNICAL DETAILS

Refer catalogue CA 6, 2212, SACS


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

Ratings to IEC 947 and AS $3497400 / 415$ V
O For CA 7 contactors with coil terminals on line side, add $\ldots . \operatorname{AC}$ to Catalogue No. Eg-CA 7-9-10-240 V AC ${ }^{3}$ )

- For CA 7 contactors with coil terminals on load side, add $\ldots$... AC-U to Catalogue No. Eg - CA 7-9-10-240 V AC-U

$\mathrm{AC} 3 \quad \mathrm{AC} 3 \quad \mathrm{AC} 1^{\circ}$ ) $\mathrm{AC} 1^{\circ}$ ) Auxiliary contacts
400/415 V 400/415 V Amps Amps standard

| $\left.k W^{1}\right)$ | Amps ${ }^{\text {1 }}$ | $40^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | $\mathrm{N} / \mathrm{O}$ | 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-El-11...V AC ${ }^{4}$ ) |  |
| 90 (75) | 155 (55) | 250 | 210 | 1 | 1 | 8 | CA 6-140-El-11...V AC) |  |
| 100 (90) | 170 (65) | 250 | 210 | 1 | 1 | 8 | CA. 6-170-El-11...V AC ${ }^{4}$ ) |  |
| 132 (111) | 225 (80) | 350 | 300 | 1 | 1 | 8 | CA 6-210-El-11...V AC') |  |
| 150 (133) | 258 (95) | 350 | 300 | 1 | 1 | 8 | CA 6-250-E!-11...V AC') |  |
| 185 (163) | 320 (115) | 450 | 380 | 1 | 1 | 8 | CA 6-300-El-11...V AC') |  |
| 250 (225) | 425 (160) | 500 | 425 | 1 | 1 | 8 | CA 6-420-El-11...V AC) |  |
| 220 (220) | 370 (155) | 500 | 420 | 2 | 2 | 8 | CA 5-370...V AC') |  |
| 265 (280) | 450 (200) | 600 | 510 | 2 | 2 | 8 | CA 5-450...V AC') |  |
| 325 (355) | 550 (250) | 780 | 645 | 2 | 2 | 8 | CA 5-550...V AC') |  |
| 430 (500) | 700 (340) | 1000 | 850 | 2 | 2 | 8 | CA 5-700...V AC') |  |
| 520 (550) | 860 (380) | 1100 | 930 | 2 | 2 | 8 | CA 5-860...V AC') |  |
| 600 | 1000 | 1200 | 1020 | 1 | 1 | 8 | CA 5-1000...V AC5) |  |
| 700 | 1150 | 1350 | 1150 | 1 | 1 | 8 | CA 5-1200...V AC) |  |

Notes: ') 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-E1...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.
${ }^{\text {}) ~ E l e c t r o n i c a l l y ~ c o n t r o l l e d ~ m e c h a n i s m ~(E C M) ~ w i t h ~ i n t e r f a c e ~ s u f f i x ~(E I) ~}$
5) $55^{\circ} \mathrm{C}$ enclosed.
${ }^{9}$ ) Contact NHP for recommended cable size.
$240 / 415 \mathrm{~V}$ rated coils are suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS $60038: 2000$.

## CA 61000 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 $\mathrm{S}+\mathrm{S} 1000$ 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 $3400 / 415$ volt applications up to 500 kW .


1000 V contactor CA 5-370


1000 V contactor CA 5-550


1000 V contactor CA 5-860

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 El 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.
O Very low pick-up and hold coil consumption (constant VA)
O No contact chatter because of defined pick-up and drop-out voltages
O High contact reliability due to minimised tendency to contact bounce
O Built-in suppression circuits

- Built-in PLC interface

O Wide voltage tolerance of coils suitable for $50 / 60 \mathrm{~Hz}$ (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. | $\mathbf{4 0 0 / 4 1 5}$ V AC $\mathbf{3} \mathbf{~ k W}$ | $\mathbf{1 0 0 0}$ V AC $\mathbf{3} \mathbf{~ k W}$ |
| :--- | :---: | :---: |
| 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.

Robust and versatile
O Rated up to 1000 volts

- Type 2 co-ordination with fuses or circuit breakers
O High thermal capacity
O High switching capacity
O Mechanical interlock does not increase overall width
O Up to 8 auxiliary contacts
O Flexible busbars and mounting plates available for quick assembly of starter combinations
O Choice of electronic motor protection or CT 6 thermal overloads
O Plug-in voltage suppressors
Safety first
O Arc chamber cannot be removed with the contactor energised
- Contactor cannot be energised unless arc chambers are locked into place


CA 6-170-El is a 90 kW contactor with ECM

O Switch position indicator (manual operation of contactor not possible)
O Closed arc chambers prevent hot gases escaping. Safety distance in front of contactor not necessary
O Touch proof design using special insulated terminal blocks and terminal covers
O No cadmium or asbestos (environmentally safe)


CA 6 contactor fitted with CEF 1-12 electronic protection provides the ideal starter.


Refer Catalogue C-CO

## Fuse protection DOL starting ${ }^{1}$ ) <br> 50/65 kA @400/415 V to AS 3947.4.1

Fuse

| Motor size $\mathbf{k W}$ | Approx. amps @ 400/415 V | NHP HRC fuse to BS88 | Sprecher + Schuh contactor | Sprecher + Schuh overload relay $\left.{ }^{2}\right)^{3}$ ) | 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 ${ }^{\text {4 }}$ ) | 160-400 |
| 132 | 225 | NTMF-355 | CA 6-210-EI | CEF 1-41/42 ${ }^{\text {4 }}$ ) | 160-400 |
| 150 | 250 | NTMF-355 | CA 6-250-EI | CEF 1-41/42 ${ }^{\text {4 }}$ ) | 160-400 |
| 185 | 320 | NTTM-450 | CA 6-300-EI | CEF 1-41/42 ${ }^{1}$ ) | 160-400 |
| 250 | 425 | NTTM-560 | CA 6-420-EI | CEF 1-52 *) | 160-630 |
| 320 | 538 | NTLM-7.10 | CA 5-550 | CEF 1-52 ${ }^{\text {- }}$ | 160-630 |
| 380 | 650 | NTLM-800 | CA 5-700 | CEF 1-11/12P ${ }^{\text {4 }}$ ) | 300-1200 |

Notes: ') 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

Refer Catalogue C-CO

## TemBreak circuit breakers DOL starting $50 \mathrm{kA} @ 400 / 415 \mathrm{~V}$ 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 | СT 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 | СТ 7-75 ${ }^{2}$ ) | 60-75 |
| 45 | 80 | XH125NJ/125 | CA 6-105-EI | CT 6-90 | 70-90 |
| 55 | 100 | XH125NJ/125 ${ }^{\text {) }}$ | 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 ${ }^{\text { }}$ ) | 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.
') 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


Réfer catalogue CĀ

## CA 6 Contactors



| Type | $\mathbf{a}$ | $\mathbf{b}$ | $\mathbf{b 1}$ | $\mathbf{c}$ | $\mathbf{c 1}$ | od | d1 | d2 | ge | 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 | be | e1 | e2 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| CT 6-90...CT 6-110 | 120 | 148 | 193 | 161 | 151.5 | $\mathbf{4 1}$ | 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 |

## 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.

## CEF 1-42 for contactors

CA 6-210(EI) to CA 6-420EI.
Notes: ') 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).
${ }^{5}$ ) $\mathrm{CT}=$ direct mounting on CA $6, \mathrm{CTA}=$ for separate mounting.



CA $6-85$, CA $6-105+$ CT 6-90, CT 6-110 ${ }^{1}$ )


CA 6-105-EI, CA 6-140(EI), CA 6-170-EI + CT 6-150, CT 6-200


CA 6-210-EI...CA 6-420-EI + CWE 4-630


CA 6-85, CA 6-105 + CEF 1 )


CA 6-105-EI, CA 6-140(EI), CA 6-170-EI + CEF 1


CA 6.210.EI...CA 6-420.EI + CEF 1-42

Notes: ') 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.
${ }^{\text {}}$ ) $\mathrm{R}=$ Reset button: 3.5 mm travel $=$ Reset , 6 mm travel $=$ test.
$\left.{ }^{5}\right)$ Earthing terminal.
${ }^{\circ}$ ) For $1 \ldots 4$ CA 6-P auxiliary contact blocks.

$\rightarrow$

Refer calalogue CA $\overline{6}, 2212$, SACS


Contactor CA 7-9


Contactor CA 7.72


Contactor CA 6-105-Et


Contactor CA 6-170-EI


Contactor CA 6-250-EI


Contactor CA 6-420-EI

Ratings to IEC 947 and AS $3497400 / 415$ V
O For CA 7 contactors with coil terminals on line side, add ...V AC to Catalogue No. Eg-CA 7-9-10-240 V AC ${ }^{\text { }}$ )
O 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


| AC 3 $400 / 415 \mathrm{~V}$ kW ') | AC 3 400/415 V Amps ${ }^{1}$ ) | AC 1 Amps $40^{\circ} \mathrm{C}$ | $A C 1^{\circ}$ Amps $60^{\circ} \mathrm{C}$ | Auxiliary contacts standard <br> 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 $7-60-00 \ldots$... 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...VAC |  |
| 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 ACV) |  |
| 90 (75) | 155 (55) | 250 | 210 | 1 | 1 | 8 | CA 6-140-EI-11...V. AC' ${ }^{\text {a }}$ |  |
| 100 (90) | 170 (65) | 250 | 210 | 1 | 1 | 8 | CA 6-170-EI-11...V ACY) |  |
| 132 (111) | 225 (80) | 350 | 300 | 1 | 1 | 8 | CA 6-210-EI-11...V AC) |  |
| 150 (133) | 258 (95) | 350 | 300 | 1 | 1 | 8 | CA 6-250-EI-11...V AC) |  |
| 185 (163) | 320 (115) | 450 | 380 | 1 | 1 | 8 | CA 6-300-E1-11...V AC') |  |
| 250 (225) | 425 (160) | 500 | 425 | 1 | 1 | 8 | CA 6-420-E1-11...V AC') |  |
| 220 (220) | 370 (155) | 500 | 420 | 2 | 2 | 8 | CA 5-370...V AC') |  |
| 265 (280) | 450 (200) | 600 | 510 | 2 | 2 | 8 | CA 5-450...V. AC') |  |
| 325 (355) | 550 (250) | 780 | 645 | 2 | 2 | 8 | CA 5-550... $V$ : AC') |  |
| 430 (500) | 700 (340) | 1000 | 850 | 2 | 2 | 8 | CA 5-700...V AC') |  |
| 520 (550) | 860 (380) | 1100 | 930 | 2 | 2 | 8 | CA 5-860...V AC) |  |
| 600 | 1000 | 1200 | 1020 | 1 | 1 | 8 | CA 5-1000...V AC') |  |
| 700 | 1150 | 1350 | 1150 | 1 | 1 | 8 | CA 5-1200...V, AC) |  |

Notes: ') 1000 volt ratings ( ).
${ }^{2}$ ) Add control voltage to Cat. No. when ordering: 24, 32, 110, 240, 415, 440 V 50 Hz . Standard voltages for CA $6-105-\mathrm{EI} . .250-\mathrm{El}$ are $24,48,110,240$ and 415 VAC . Standard voltages for CA $6-300-\mathrm{EI} . .420-\mathrm{EI} 48,110,240$ and 415 VAC . Standard voltages for CA 5-370 $\ldots 1200,110,240$ and 415 VAC .
${ }^{3}$ ) All CA 7 coils can be reversed for line or load side coil terminals as required. Both versions are held in NHP slock for convenience.
${ }^{\text {a }}$ ) Electronically controlled mechanism (ECM) with interface suffix (EI).
) $55{ }^{\circ} \mathrm{C}$ enclosed.
${ }^{9}$ ) Contact NHP for recommended cable size.
$240 / 415 \mathrm{~V}$ rated colls are suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS 60038 : $\mathbf{2 0 0 0}$.

Refer catalogué $\mathrm{S}^{\prime}$ Ãcs

## 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 contactsCommon auxiliaries from 9 to 85 amps
Three fitting positions
O Front mounting
O Side mounting left
O 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 |  |  | 9 A |
| :---: | :---: | :---: | :---: | :---: |
| CA 7-12 | 5.5 kW |  |  | 12 A |
| CA 7-16 | 7.5 kW |  | [8: | 16 A |
| CA 7-23 | 11 kW |  | \% | 23 A |
| CA 7-30 | 15 kW | 45 mm | E | 30 A |
| CA 7-37 | 18.5 kW |  | $\xrightarrow{\square}$ | 37 A |
| CA 7-43 | 22 kW | 54 mm |  | 43 A |
| CA 7-60 | 30 kW |  |  | 60 A |
| CA 7-72 | 37 kW | 72 mm |  | 72 A |
| CA 7-85 | 45 kW |  |  | 85 A |

## With CA 7 you have more clip on

 accessoriesCommon accessories from 9 to 85 amps
O On and off delay pneumatic timers
O Coil mounted electronic timers on delay, off delay, star delta
O Coil mounted 24 V DC interface
O Coil mounted RC and varistor suppressor modules
O Mechanical latch
O Mechanical interlock
O Mechanical interlock with integrated N/C interlock contacts
O Moulded wire link sets for DOL, reversing and star delta starters
O Large choice of front and side mounting auxiliary contacts


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 9 mm 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 9 mm wide and further minimises space requirements.


## With Sprecher + Schuh you can choose the best protection for your motors.




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.



High tech electronic protection type CEP 7 in trip class 10 or 20.


Standard thermal overloads type CT 7

Refer Catalogue C-co
Automatic Type ' 2 ' co-ordination ${ }^{1}$ ) with no-oversizing of contactors
DOL starting
50/65 kA @ 400/415 V


| Motor size kW | Approx. amps (@) $400 / 415 \mathrm{~V}$ | Sprecher + Schuh circuit breaker | Setting range amps | Magnetic amps | Sprecher + Schuh contactor | $\begin{aligned} & \mathrm{AC}-3 \\ & \mathrm{amps} \\ & \hline \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 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 -45 ${ }^{\text {K }}$ | 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: $\quad$ ) 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 $230 / 400 \mathrm{~V}$ in accordance with AS 60038:2000



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 <br> fuse to BS88 | Sprecher + Schuh contactor | Sprecher + Schuh overload relay $\left.{ }^{2}\right)^{3}$ ) | 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 ${ }^{\text {4 }}$ ) | 160-400 |
| 132 | 225 | NTMF-355 | CA 6-210-EI | CEF 1-41/42 ${ }^{\text {4 }}$ ) | 160-400 |
| 150 | 250 | NTMF-355 | CA 6-250-EI | CEF 1-41/42 ${ }^{\text {4 }}$ ) | 160-400 |
| 185 | 320 | NTTM-450 | CA 6-300-EI | CEF 1-41/42 ${ }^{\text {) }}$ | 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 ${ }^{\text {¢ }}$ ) | 300-1200 |

Notes: ') 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


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 ${ }^{\text {' }}$ ) | 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 ${ }^{\text {') }}$ | 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

Rêer Catalogue C - CO
TemBreak circuit breakers DOL starting. 85 kA @ 400/415 V to AS 3947.4.1

| Motor size kW | Approx. FLC @ $400 / 415 \mathrm{~V}(\mathrm{~A})$ | 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

| Motor size kW | Approx. amps @ 400/415 V | Sprecher + Schuh isolator | Terasaki circuit breaker | Sprecher + Schuh current limiter | Sprecher + Schuh contactor | 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: $\quad 240 / 415 \mathrm{~V}$ rating suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS 60038: 2000

Refer Catalogue C - CO
TemBreak circuit breakers DOL starting. $85 \mathrm{kA} @ 400 / 415 \mathrm{~V}$ to AS 3947.4.1

| Motor size kW | Approx. FLC © $400 / 415 \mathrm{~V}$ (A) | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh thermal $0 / L$ 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 | XM30РB/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 1-4 1/42/52 | 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-El | 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

| 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: $\quad 240 / 415 \mathrm{~V}$ rating suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS $60038: 2000$
General data CA 7-9...CA 7-85

Rated insulation voltage $U_{i}$

| IEC |  |  |  |  | 690 V |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| UL, CSA |  |  |  |  | 600 V |  |  |  |  |  |
| Rated impulse voltage withstand $\mathrm{U}_{\text {imp }}$ |  |  |  |  | 8 kV |  |  |  |  |  |
| Test voltage |  |  |  |  |  |  |  |  |  |  |
| 1 minute (to IEC 947-4) |  |  |  |  | 2500 V |  |  |  |  |  |
| Rated voltage $\mathrm{U}_{6}$ |  |  |  |  |  |  |  |  |  |  |
| AC |  |  |  |  | 110, 240, 400/415, |  |  | 500, 690 V |  |  |
| DC |  |  |  |  | 24, 48, 110, |  |  | 220, 440 V |  |  |
| Rated frequency of coil |  |  |  |  | $50 / 60 \mathrm{~Hz}$ |  |  |  |  |  |
| Ambient temperature |  |  |  |  |  |  |  |  |  |  |
| Storage |  |  |  |  | $-55 \ldots+80^{\circ} \mathrm{C}\left(-67 \ldots 176{ }^{\circ} \mathrm{F}\right)$ |  |  |  |  |  |
| Operation at nominal current |  |  |  |  | $-25 \ldots+60^{\circ} \mathrm{C}\left(-13 \ldots 140{ }^{\circ} \mathrm{F}\right)$ |  |  |  |  |  |
| Maximum with $15 \%$ AC 1 current reduction $>60^{\circ} \mathrm{C}$ |  |  |  |  | $-25 . .+70^{\circ} \mathrm{C}\left(-13 \ldots 158{ }^{\circ} \mathrm{F}\right)$ |  |  |  |  |  |
| 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 |  |  |  |  |  |  |  |  |  |  |
| $1 \mathrm{~s}(\mathrm{~A})$ | 210 | 210 | 290 | 380 | 480 | 525 | 650 | 1100 | 1150 | 1250 |
| $4 \mathrm{~s}(\mathrm{~A})$ | 140 | 150 | 220 | 280 | 360 | 390 | 480 | 820 | 860 | 910 |
| $10 \mathrm{~s}(\mathrm{~A})$ | 100 | 120 | 175 | 220 | 290 | 310 | 375 | 640 | 680 | 710 |
| $15 \mathrm{~s}(\mathrm{~A})$ | 90 | 100 | 150 | 200 | 250 | 270 | 325 | 560 | 600 | 620 |
| $60 \mathrm{~s} \mathrm{(A)}$ | 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 |



## 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 $40^{\circ} \mathrm{C}$

| $\left.t_{e}{ }^{\prime}\right)$ | $[\mathrm{A}]$ | 32 | 32 | 32 | 32 | 50 | 50 | 85 | 100 | 100 | 100 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| $230 / 240 \mathrm{~V}$ | $[\mathrm{~kW}]$ | 10 | 10 | 13 | 13 | 18 | 20 | 25 | 36 | 36 | 40 |
| $400 / 415 \mathrm{~V}$ | $[\mathrm{~kW}]$ | 18 | 18 | 23 | 23 | 32 | 36 | 45 | 64 | 64 | 71 |
| 690 V | $[\mathrm{~kW}]$ | 30 | 30 | 38 | 38 | 54 | 60 | 75 | 108 | 108 | 120 |

Ambient temperature $60^{\circ} \mathrm{C}$

| $\left.l_{\theta}{ }^{\prime}\right)$ | $[A]$ | 32 | 32 | 32 | 32 | 45 | 45 | 63 | 100 | 100 | 100 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| $230 / 240 \mathrm{~V}$ | $[\mathrm{~kW}]$ | 8 | 8 | 10 | 10 | 14 | 16 | 20 | 29 | 29 | 34 |
| $400 / 415 \mathrm{~V}$ | $[\mathrm{~kW}]$ | 14 | 14 | 17 | 17 | 26 | 28 | 36 | 51 | 51 | 61 |
| 690 V | $[\mathrm{~kW}]$ | 24 | 24 | 29 | 29 | 44 | 48 | 60 | 86 | 86 | 102 |

$A C$ motor switching
AC 2, AC 3, AC 4

| 2301240 V | [A] | 11.5 | 14.5 | 20 | 26.5 | 34 | 37 | 42 | 62 | 70 | 85 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $400 / 415 \mathrm{~V}$ | [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 |
| 2301240 V | [ kW ] | 3 | 4 | 5.5 | 7.5 | 10 | 11 | 13 | 18.5 | 22 | 25 |
| $400 / 415 \mathrm{~V}$ | [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 |  |  |  |  |  |  |  |  |  |  |  |
| $I_{\theta} \mathrm{AC} 4,50 \mathrm{~Hz}$ | max. 690 V [ A$]$ | 135 | 180 | 240 | 345 | 450 | 555 | 645 | 900 | 1080 | 1275 |
| Rated breaking capacity |  |  |  |  |  |  |  |  |  |  |  |
| $l_{0} \mathrm{AC} 4$ | max. $460 \mathrm{~V}[\mathrm{~A}]$ | 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 $g G$ 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 $[\mathrm{m} \Omega]$ | 2.7 | 2.7 | 2.7 | 2 | 2 | 2 | 1.5 | 0.9 | 0.9 | 0.9 |
| Power dissipated by all circuits at le AC 3 <br> Total power dissipation | 0.7 | 1.2 | 2.1 | 3.2 | 5.4 | 8.2 | 8.3 | 9.7 | 14 | 19.5 |
| at le AC $3 \quad \mathrm{AC}$ 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)
$\begin{array}{llllllllllllllllllllll}\text { Make (mS) } & 40 \ldots 70 & 40 \ldots 70 & 40 \ldots 70 & 40 \ldots 70 & 50 \ldots 80 & 50 \ldots 80 & 50 \ldots 80 & 20 \ldots 40 & 20 \ldots 40 & 20 \ldots 40\end{array}$ Break (mS) $7 \ldots 15 \quad 7 \ldots 15 \quad 7 \ldots 15 \quad 7 \ldots 15 \quad 7 \ldots 15 \quad 7 \ldots 15 \quad-\quad-\quad-\quad$ -

Note: ') Contact NHP for recommended cable size.

## GCS comberor cat

athenstois

Dimensions in (mm)


Mounting position


## Contactor (AC control)

| Type | a | b | c | c1 | c2 | od | d1 | d2 $\left.{ }^{\prime}\right)$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CA $7-9 \ldots$ CA $7-23^{2}$ ) | 45 | 81 | 80.5 | 75.5 | 6 | 4.5 | 60 | 35 |
| CA 7-30 $\ldots$ 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 $\ldots$ CA $7-85$ | 72 | 122 | 117 | 111.5 | 8.5 | 5.4 | 100 | 55 |

(DC control)

| Type | $\mathbf{a}$ | $\mathbf{b}$ | $\mathbf{c}$ | $\mathbf{c 1}$ | $\mathbf{c 2}$ | od | d1 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CA 7-9C...CA 7-16C | 45 | 81 | 106.5 | 101.5 | 6 | 4.5 | 60 |
| CA 7-23C | 45 | 81 | 123.5 | 119 | 6 | 4.5 | 60 |
| CA 7-30C...CA 7-37C | 45 | 81 | 141.5 | 136.5 | 6.5 | 4.5 | 60 |
| CA 7-43C | 54 | 81 | 144.5 | 140 | 6.5 | 4.5 | 60 |
| CA 7-60C...CA 7-85C | 72 | 122 | 117 | 111.5 | 8.5 | 5.4 | 100 |

Accessories

| Contactor with |  | (AC control) <br> $(\mathbf{m m})$ | (DC control) <br> $(\mathbf{m m})$ |
| :--- | :--- | :--- | :--- |
| Front mounting auxiliary contact | 2 or 4 pole | $\mathrm{c} / \mathrm{c} 1+39$ | $\mathrm{c} / \mathrm{c} 1+39$ |
| Side mounting auxiliary contact | 1 or 2 pole | $\mathrm{a}+9$ | $\mathrm{a}+9$ |
| Pneumatic timing module |  | $\mathrm{c} / \mathrm{c} 1+58$ | - |
| Electronic timing module | coil mounting | $\mathrm{b}+24$ | $\mathrm{~b}+24$ |
| Mechanical interlock | mounts between contactors | $\mathrm{a}+9$ | $\mathrm{a}+9$ |
| Mechanical latch |  | $\mathrm{c} / \mathrm{c} 1+61$ | - |
| Interface | coil mounting | $\mathrm{b}+9$ | - |
| Suppressor | coil mounting | $\mathrm{b}+3$ | $\mathrm{~b}+3$ |
| With inscriptions ${ }^{3}$ ) | labels | +0 | +0 |
|  | label support system V4N5 | +5.5 | +5.5 |

Notes: ') DIN Rail mounting 35 mm to EN 50022.
${ }^{2}$ ) Dimensions for 4 pole contactors same as 3 pole with auxiliary.
${ }^{3}$ ) Dimensions with inscriptions.

## Acs enconmio grerions CEP?

Dimensions in (mm)
CEP 7, CEP 7s and CEP 7-B mounted on CA 7 contactors
CA

CEP 7 with separate mounting bracket



Contactor, timer and overload selection chart for auto transformer starters

| ATS kW | Line <br> contactor | Trans <br> contactor | Star <br> 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 <br> contactor | Delta <br> contactor | Star <br> 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 |



CT 7-24, CT 7-45, СT 7-75

| Type | For contactor | a | b | b1 | c | c1 | c2 | c3 | c4 | c5 | od | d1 | d2 | e1 | e2 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CT 7-24 | CA 7-9... 23 | 45 | 127 | 83 | 96 | 91 | 15 | 51 | 39 | 5 | 4.5 | 60 | $35^{\prime}$ ) | 16.5 | 51 |
|  | CA 7-30... 37 | 45 | 127 | 83 | 105 | 99 | 6.5 | 51 | 39 | 9.5 | 4.5 | 60 | $\left.35^{1}\right)$ | 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 | $\left.45^{1}\right)$ | 16.5 | 57 |
| CT 7-75 | CA 7-60... 85 | 72 | 185 | 120 | 125 | 120 | 8.5 | 51 | 39 | 28.5 | 5.4 | 100 | $55^{\prime}$ ) | 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 | $35^{\prime}$ ) | 16 | 3 |
| CT 7-75 | 60 | 90 | 44 | 117 | 112 | 15 | 51 | 5.4 | 74 | $50^{\prime}$ ) | 16 | 0 |
| CT 7.90 | 100 | 120 | - | 135 | - | 5 | 51 | 6.2 | 74 | $80^{\prime}$ ) | 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.

Thermal overload relays to IEC 947 and AS 3947


Cat. No. CT 7-24


Cat. No. CT 7-45


Cat. No. CT 7.75


Cat. No, CT 7-100

CT 7 thermal overload


Cat. No. CT 7-24-P-A


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

Terasaki
$\left.\begin{array}{lllllll}\begin{array}{l}\text { Motor } \\ \text { size } \mathbf{k W}\end{array} & \begin{array}{l}\text { Approx. } \\ \text { amps }\end{array} & \begin{array}{l}\text { lerasaki } \\ \text { breaker }\end{array} & \text { or } & \begin{array}{l}\text { NHP HRC } \\ \text { fuse to BS88 }\end{array} & \begin{array}{l}\text { Sprecher + Schuh } \\ \text { Contactor type }\end{array} & \begin{array}{l}\text { Sprecher + Schuh } \\ \text { thermal O/L relay type }\end{array} \\ \hline 0.37 & 1.1 & \text { XM30PB/1.4 } & \text { NTIA-6 } & \text { CA 7-9 } & \text { Setting range }\end{array}\right]$

Notes: Fuses $65 \mathrm{kA} . \times \mathrm{XH} 125 \mathrm{NJ}$ 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.
$240 / 415 \mathrm{~V}$ rating suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS 60038 : 2000

## 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 | ХM30PB/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 $7.75{ }^{2}$ ) | $60 \cdot 75$ |
| 45 | 80 | XH125NJ/125 | CA 6-105-EI | CT 6-90 | 70-90 |
| 55 | 100 | XH125NJ/125 ${ }^{\text {) }}$ | CA 6-105-EI | CT 6-110 | 85-110 |
| 75 | 130 | XH250NJ/250 | CA 6-140-El | CT 6-150 | 105-150 |
| 90 | 155 | XH250NJ/250 | C A6-170-E1 | CT 6-200 | 140-200 |
| 110 | 200 | XH250NJ/250 ${ }^{\text {) }}$ ) | CA 6-210-El | CEF 1-41/42 | 160-400 |
| 132 | 225 | XS400SE/400 | CA 6-210-El | 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-E1 | CEF 1-4 1/42 | $160 \cdot 400$ |
| 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 ${ }^{\text {² }}$ | 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 molor 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.
$240 / 415 \mathrm{~V}$ rating suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS 60038: $\mathbf{2 0 0 0}$

Refer Catalogue C-co
TemBreak circuit breakers DOL starting. 85 kA @ 400/415 V to AS 3947.4.1

| Motor size kW | Approx. FLC @ 400/415 V (A) | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh thermal $\mathrm{O} / \mathrm{L}$ 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

| Motor size kW | Approx. amps @ 400/415 V | Sprecher + Schuh isolator | Terasaki circuit breaker | Sprecher + Schuh current limiter | Sprecher + Schuh contactor | Sprecher + Schuh thermal $0 / L$ 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 |

[^12]


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 6-170El-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 6-250El-11 | CA 6-140EI-11 | CA 6-105-11 | RZ7 FSY2D | CEF 1-41 |
| 185 | CA 6-300EI-11 | CA 6-210EI-11 | CA 6-140El-11 | RZ7 FSY2D | CEF 1-41 |
| 220 | CA 6-420E1-11 | 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 <br> contactor | Delta <br> contactor | Star <br> contactor | Timer | Overload |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 7.5 | CA 7-9-10 | CA 7-9-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-12-10 |
| $\mathbf{1 1}$ | CA 7-12-10 | CA 7-12-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| $\mathbf{1 5}$ | CA 7-16-10 | CA 7-16-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| $\mathbf{1 8 . 5}$ | CA 7-23-10 | CA 7-23-01 | CA 7-12-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| $\mathbf{2 2}$ | 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 |
| $\mathbf{1 8 5}$ | 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 |

## 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 | $0 d$ | d1 | d2 | e1 | e2 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CT 7-24 | CA 7-9... 23 | 45 | 127 | 83 | 96 | 91 | 15 | 51 | 39 | 5 | 4.5 | 60 | $35^{\prime}$ ) | 16.5 | 51 |
|  | CA 7-30... 37 | 45 | 127 | 83 | 105 | 99 | 6.5 | 51 | 39 | 9.5 | 4.5 | 60 | $35^{\prime \prime}$ | 16.5 | 51 |
| CT 7-45 | CA 7-30... 37 | 60 | 140 | 97 | 105 | 99 | 6.5 | 51 | 39 | 6.5 | 4.5 | 60 | $35^{\prime}$ ) | 16.5 | 57 |
|  | CA 7-43 | 60 | 140 | 97 | 107 | 103 | 6.5 | 51 | 39 | 8.5 | 4.5 | 60 | $45^{\prime}$ ) | 16.5 | 57 |
| CT 7-75 | CA $7-60 \ldots 85$ | 72 | 185 | 120 | 125 | 120 | 8.5 | 51 | 39 | 28.5 | 5.4 | 100 | $55^{\prime}$ ) | 16.5 | 82 |

Separate mounting with bracket


Separate mounting


| Type | a | b | b1 | c | c1 | c2 | c3 | $\boldsymbol{0 d}$ | d1 | d2 | e1 | e2 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CT $7-24$ | 45 | 85 | 44 | 95 | 70.5 | 5 | 51 | 4.5 | $60 \ldots 74$ | $\left.35^{1}\right)$ | 16 | 3 |
| CT $7-75$ | 60 | 90 | 44 | 117 | 112 | 15 | 51 | 5.4 | 74 | $\left.50^{\prime}\right)$ | 16 | 0 |
| CT $7-90$ | 100 | 120 | - | 135 | - | 5 | 51 | 6.2 | 74 | $\left.80^{\prime}\right)$ | 16 | 7 |

Notes: ') 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.


Tripping characteristics
These tripping characteristics comply with IEC 947 and are the mean values of the bands at $20^{\circ} \mathrm{C}$ 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

## CONTROL RELAY \& PHASE FAILURE RELAY

## 1. IDEC CONTROL RELAY TECHNICAL DETAILS <br> 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


|  | Part Number |  |  |
| :---: | :---: | :---: | :---: |
| Model | Blade Terminal | $\begin{gathered} \text { PCB } \\ \text { Términal } \end{gathered}$ | Coil Voltage Code (Standard Stack in bold) |
| Basic | RH1B-U | RHIV2-U | AC6V. AC12V. AC24V, AC110V, AC120V. AC220V. AC240V DC6V. DC12V. DC24V. DC48V, DC110V |
| With Indicator | RH1B-UL | - |  |
| With Check Button | RH1B-UC | - |  |
| With Indicator end 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 |
| Basic | RH2B-U | RH2V2-U | AC6V, AC12V, AC24V, AC110-120V, <br> AC220-240V <br> DC6V, DC12V. DC24V, DC48V, DC100-110V |
| With Indicator | RH2B-UL | RH2V2-UI |  |
| 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 | - |  |
| 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 ${ }^{\text {' }}$ | RH3B-ULC | - |  |
| Top Bracket Mounting | RH38-UT | - |  |
| With Dioda (DC coil only) | RH38-0* | RH3V2-D* | DC6V, DC12V. DC24V. DC48V. DC110V |
| With Indicator and Diode (DC coil only) | RH38-L. ${ }^{*}$ | - |  |
| 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* | - |  |

Circuit Breakers
$A^{1}$

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 AC12OV
Pari No. LCoil Volage code

Relays \& Sockets
RH Series

Sockets (for Blade Terminal Models)

| Relays | Standard DIN Rail Mount ${ }^{\text {I }}$ | Finger-safe DIIN Rail Moumt ${ }^{\text { }}$ | 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 |
| RH4日 | SH48-05 | SH4B-05C | SH48-51 | SH48-62 |
|  |  |  |  | Elips. Do not use unless you plan to insen pullaver wire sping. Replacemenı horseshoe clip par number is Y778-011. |

Hold Down Springs \& Clips

| Appearance | Description | Relay | For DIN Mount Socket | Far Through Panal 8 PCB Hount Socket | Min Drder Diy |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Pullover Wire Spring | R H 1 B | SY2S-02F1 ${ }^{2}$ | SY4S-51F1 | 10 |
|  |  | AH2B | SY4S-02F1 ${ }^{2}$ |  |  |
|  |  | FH3B | SH38-05F1 ${ }^{2}$ |  |  |
|  |  | HH48 | SH48-02F1 ${ }^{\text {2 }}$ |  |  |
|  | Leat Spring (side latch) | RH1B, RH2B, RH3B, RH48 | SFA-202 ${ }^{\text { }}$ | SFA-302 ${ }^{3}$ |  |
|  | Leaf Spring (top latch) | PH18, AH2B, RH3B, RH4B | SFA-101 ${ }^{3}$ | SFA-301 ${ }^{3}$ | . |

$\Delta^{2}$
Must use horseshoe clip when mounting in OIN mount socket. Aeplacement horseshoe clip pan number is M78.011.
3. Two required per relay.

AC Coil Ratings

| $\begin{gathered} \text { Voltage } \\ \text { (V) } \end{gathered}$ | Ratad Curemt (mA) $155 \%$ at $200^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  | Coil Resistance ( 0 ) $\pm \mathbf{4 0 \%}$ at $\mathbf{2 0}{ }^{\circ} \mathrm{C}$ |  |  |  | Operation Characteristics (againat rated values at $\mathbf{2 0}{ }^{\circ} \mathrm{C}$ ) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | AC 50Hz |  |  |  | AC $60 \mathrm{~Hz}_{2}$ |  |  |  |  |  |  |  |  |  |  |
|  | SPDT | DPOT | 3PDT | 4PDT | SPDT | DPDT | 3PDT | 4PDT | SPDT | DPDT | 3PDT | 4PDT | $\begin{array}{\|l\|} \hline \text { Max Continuous } \\ \text { Applied Voftaga } \\ \hline \end{array}$ | Pickup Voltage | Dropout Voltage |
| 6 | 170 | 240 | 330 | 387 | 150 | 200 | 280 | 330 | 330 | 9.4 | 6.4 | 5.4 |  |  |  |
| 12 | 86 | 121 | 165 | 196 | 75 | 100 | 140 | 165 | 165 | 39.3 | 25.3 | 21.2 |  |  |  |
| 24 | 42 | 60.5 | B1 | 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 | - | $\begin{aligned} & 9.4- \\ & 10.8 \end{aligned}$ | - | - | - | 8.0-9.2 | - | - | - | - | - | - | 110\% | 80\% maximum | $\begin{gathered} 30 \% \\ \text { minimum } \end{gathered}$ |
| 120 | B. 6 | - | 16.4 | 19.5 | 7.5 | - | 142 | 16.5 | 16.5 | - | 10,800 | 7,360 |  |  |  |
| 220 | 4.7 | - | B. 8 | 10.7 | 4.1 | - | 7.7 | 9.1 | 9.1 | - | 10,800 | 7,360 |  |  |  |
| 220-240 | - | 4.7.5.4 | - | - | - | 4.0-4.8 | - |  | - | 18.820 | - | - |  |  |  |
| 240 | 4.9 | - | 8.2 | 9.8 | 4.3 | - | 7.1 | 8.3 | 8.3 | - | 12.100 | 9.120 |  |  |  |

DC Coil Ratings

| Vahtage (V) | Rated Current (mA) $\pm 15 \%$ af $20^{\circ} \mathrm{C}$ |  |  |  | Coil Resistance ( 0 ) $\pm 10 \%$ at $20^{\circ} \mathrm{C}$ |  |  |  | $\begin{gathered} \text { Oparation Characteristics } \\ \text { (against rated values at } 20^{\circ} \mathrm{C} \text { ) } \end{gathered}$ |  |  | Standard coil vollages are in BOLD. |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | SPOT | DPDT | 3PDT | 4PDT | SPDT | OPDT | 3PDT | 4PDT | Mex Continuous Applied Voltage | Pickup Voltage | Dropout Voltage |  |
| 6 | 128 | 150 | 240 | 250 | 47 | 40 | 25 | 24 | 110\% | $\begin{aligned} & 80 \% \\ & \text { maximum } \end{aligned}$ | 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 |  |  |  |  |

Contact Ratings

|  |  | 300 N | 210w | 30 DC | 10A | 7A |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| DPDT | 10A | 1650VA 300W | $\begin{aligned} & \text { 1100VA } \\ & 225 \mathrm{~W} \end{aligned}$ | 110 AC | 10A | 7.5A |
| 3PDT |  |  |  | 220 AC | 7.5A | 5A |
| 4 PDT |  |  |  | 30 DC | 10A | 7.54 |

Note: Inductive load for the rated load - $\cos \theta=0.3, L / R=7 \mathrm{~ms}$

TÜV Ratings

| Voltage | RH1 | RH2 | RH3 | RH4 |
| :---: | :---: | :---: | :---: | :---: |
| $240 V A C$ | 10 A | 10 A | 7.5 A | 7.5 A |
| 30 ADC | 10 A | $\cdot 10 \mathrm{~A}$ | 10 A | 10 A |

## UL Ratings

| Voltage | Resistive |  |  | General Use |  |  | Horse Power Rating |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \mathrm{RH} 1 \\ & \mathrm{RH} 2 \end{aligned}$ | RH3 | - RH4 | $\begin{aligned} & \mathrm{RH1} \\ & \mathrm{RH} 2 \end{aligned}$ | RH3 | RH4 | $\begin{aligned} & \overline{\mathrm{RH} 1} \\ & \mathrm{RH} 2 \end{aligned}$ | RH3 | RH4 |
| 240 V AC | 10A | 7.5A | 7.5A | 7 A | 6.5A | 5A | 1/3 HP | 1/3 HP | - |
| 120 VAC | - | 10A | 10A | - | 7.5A | 7:5A | 1/6 HP | 1/6 HP | - |
| 30 VDC | 10A | 10A | - | 7 A | - | - | - | - | - |
| $28 V D C$ | - | - | 10A | - | - | - | - | - | - |

## CSA Ratings

| Voltage |  |  |  |  | General Use: |  |  |  | Horse Power Rating |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | RH1 | RH2 | RH3 | RH4 | RH1 | RH2 | RH3 | RH4 | RH1.2.3 |
| 240 VAC | 10A | 10A | - | 7.5A | 7A | 7 A | 7A | 5A | $1 / 3 \mathrm{HP}$ |
| 120 VAC | 10A | 10A | 10A | 10A | 7.5A | 7.5A | - | 7.5A | 1/6 HP |
| 30 VCC | 10A | 10A | 10 A | 10A | 7 A | 7.5A | - | - | - |

A
$A C: \cos \theta=1.0, D C: L / R=0 \mathrm{~ms}$
Socket Specifications

|  | E. Sockets | Temináa | Electrical Rating | $\therefore$ Wire Sizo | Torque |
| :---: | :---: | :---: | :---: | :---: | :---: |
| DIN'Räil | - SH1B-05 | (Coill) M3 screws (contact) M3.5 screws with captive wire clamp | 250V, 10A | Maximum up to 2-\$12AWG | $\begin{aligned} & 5.5-9 \mathrm{in} \bullet \mathrm{lbs} \\ & 9-11.5 \mathrm{in} \bullet \mathrm{lbs} \end{aligned}$ |
| Mount Sockets $\qquad$ | $\begin{aligned} & \text { SH2B-05 } \\ & \text { SH3B-05 } \\ & \text { SH4B-05 } \end{aligned}$ | M3.5 screws with captive wire clamp | 300V. 10A | Maximum up to 2-\#12AWG | 9-11.5 in ${ }^{\text {l }}$ bs |
| D: <br> Finger-safe DIN Raiil Mount | $\therefore$ SH1B-05C | (coil) M3 screws (contact) M3.5 screws with captive wire clamp, fingersafe | 250V. 10A | Maximum up to 2- ${ }^{\text {1 }}$ 12AWG | $\begin{aligned} & 5.5-9 \text { in } \bullet \text { lbs } \\ & 9-11.5 \text { in } \bullet \mathrm{lbs} \\ & \hline \end{aligned}$ |
|  | $\begin{aligned} & \text { SH2B-05C } \\ & \text { SH3B-05C } \\ & \text { SH4B-05C } \end{aligned}$ | M3.5 screws with captive wire clamp. fingersafe | 300V. 10A | Maximum up to 2-\#12AWG | $9 \cdot 11.5 \mathrm{in} \bullet \mathrm{lbs}$ |
| Through <br> Panel <br> Mount <br> Socket | $\therefore$$\therefore$ SH1B-51 <br> $\therefore$ SH2B-51 <br>  SH3B-51 <br>  SH4B-51 | Solder | 300V, 10A | - |  |
| PCB Mount Socket 5 | SH1B-62 | PCB mount | 250V. 10A | - | - |
|  | $\left\{\begin{array}{r} \text { SH2B-62 } \\ \text { SH3B-62 } \\ \text { SH4B-62 } \\ \hline \end{array}\right.$ | PCB mount $\because \quad$  <br>   <br>   <br>   | $300 \mathrm{~V}, 10 \mathrm{~A}$ | $\cdots$ - | $\because$ - |

Accessories

| Description | Appearänce | Use with S | Part No. | Remarks ti |
| :---: | :---: | :---: | :---: | :---: |
| Aluminum' DIN Rail (1 meter length) |  | All DIN rail sockets | BNDN1000 | IDEC offers álow-profile DIN reil (BNDN1000). The BNDN1000 is designed to accommodate DIN mount sockets. Made of durable extruded aluminum, the BNDN1000 measures $0.413(10.5 \mathrm{~mm})$ in height and 1.37 $(35 \mathrm{~mm})$ in width (DIN standard). Standard length is $39^{*}(1,000 \mathrm{~mm})$. |
| DIN Rail End Stop |  | DIN rail | BNL5 | 9.1 mm wide. |
| Replacement Hold-Down Spring Anchor | $88$ | 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

| Comtact Material |  | Silver cadmium oxide |
| :---: | :---: | :---: |
| Contact Resistance ${ }^{1}$ |  | $50 \mathrm{~m} \Omega$ maximum |
| Minimum Applicabla Load |  | 24 V DC, $30 \mathrm{~mA} ; 5 \mathrm{VDC}, 100 \mathrm{~mA}$ (referenca value) |
| Operate Time ${ }^{\text {2 }}$ | $\begin{aligned} & \text { SPOT } \\ & \text { OPDT } \end{aligned}$ | 20 ms maximum |
|  | $\begin{aligned} & \text { 3PDT } \\ & \text { 4POT } \end{aligned}$ | 25ms maximum |
| Release Time ${ }^{\text {2 }}$ | SPDT <br> DPDT | 20 ms maximum |
|  | $\begin{aligned} & \text { 3PDT } \\ & \text { 4PDT } \end{aligned}$ | 25ms maximum |
| Power Consumption (approx.) | SPDT | AC: $1.1 \mathrm{VA}(50 \mathrm{~Hz}), 1 \mathrm{VA}(60 \mathrm{~Hz}) \quad$ DC: 0.8 W |
|  | DPDT | AC: $1.4 \mathrm{VA}(50 \mathrm{~Hz}), 1.2 \mathrm{VA}\{6 \mathrm{CHz}\} \quad \mathrm{DC}: 0.9 \mathrm{~W}$ |
|  | 3PDT | AC: 2VA $150 \mathrm{~Hz} 2,1.7 \mathrm{VA} \mid 60 \mathrm{~Hz}) \quad$ DC: 1.5 W |
|  | 4PDT | AC: $2.5 \mathrm{VA}(50 \mathrm{~Hz}), 2 \mathrm{VA}(6 \mathrm{OHz}) \quad$ DC: 1.5 W |
| Insulation Resistance |  | 100M $\Omega$ minimum ( 500 V DC megger) |
| Dielectric Strength ${ }^{3}$ | SPDT | Between live and dead parts: $2,000 \mathrm{~V} \mathrm{AC}$,1 minute <br> Between contact and coil: $2,000 \mathrm{~V} \mathrm{AC}, 1$ minute <br> Between contacts of the same pole:  <br> $1,000 \mathrm{~V} \mathrm{AC}, 1$ minute  |
|  | $\begin{aligned} & \text { DPDT } \\ & \text { 3PDT } \\ & \text { 4PDT } \end{aligned}$ | Between live and dead parts: $2,000 \mathrm{~V} \mathrm{AC}, 1$ minute <br> Between contact and coil: $2,000 \mathrm{~V} \mathrm{AC,1}$ minute <br> 8etween contacts of different poles: $2,000 \mathrm{~V}$ AC, 1 minute <br> Between contacts of the same pole: $1,000 \mathrm{~V} \mathrm{AC}, 1$ minute |
| Oparating Prequancy |  | Electrical: 1,800 operations/hour maximum <br> Mechanical: 18,000 operations/hour maximum |
| Vibration Resistance |  | Damage limits: 10 to 55 Hz , amplitude 0.5 mm <br> Dperating extremes: 10 to 55 Hz , amplitude 0.5 mm |
| Shock Reaistance |  | Damage limits: $1,000 \mathrm{~m} / \mathrm{s}^{2}(100 \mathrm{G})$ <br> Operating extremes: $200 \mathrm{~m} / \mathrm{s}^{2}(20 \mathrm{~S}-\mathrm{SPDT}, \mathrm{DPDT})$ <br>  $100 \mathrm{~m} / \mathrm{s}^{2}(10 \mathrm{G}-3 \mathrm{PDT}, 4 \mathrm{4PD})$ |
| Mechanical Life |  | 50,000,000 operations minimum |
| Electrical Life | DPDT | $500,000$ operations minimum $\mid 120 \mathrm{~V}$ AC, 10A $\}$ |
|  | $\begin{aligned} & \text { SPDT } \\ & \text { 3PDT } \\ & \text { 4PDT } \\ & \hline \end{aligned}$ | 200,000 operations minimum (120V AC, 10A) |
| Operating Temperature ${ }^{4}$ | SPDT | -25 to $+50^{\circ} \mathrm{C}$ (no freezing) |
|  | DPDT <br> 3PDT <br> 4PDT | -25 to $+40^{\circ} \mathrm{C}$ (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 $5 V D C, 1 A$ vollage drop method
2. Measured at the rated roilage (ai $20^{\circ} \mathrm{C}$ ), excluding contacl bouncing

Release time of relays with diode: 40 ms maximum
3. Relays with indicator or diode: 1000 VAC , i 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 $-2510+40^{\circ} \mathrm{C}$.

## Characteristics (Reference Data)



## Maximum Switching Capacity



DC Load




Continuous Load Current vs. Dperating Temperature Curve (Basic Type, With Check Button, and Top Bracket Mounting Type)


Internal Connection (View from Bottom)
Basic Type


## With Diode (-D type)



With Indicator LED \& Diode (-LD type)

|  | SPDT |  | 3PDT | 4PDT |  | DPDJ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & \text { Below } \\ & \text { 100V OC } \end{aligned}$ |  |  |  | Below 24 V AC/DC |  | Contains an LED indicator and |
|  | 100V OC and over |  |  |  | 24 V AC/DC and over |  | same height as the basic type. |

## Dimensions (mm)

RH1B-U/RH1B-UL/RH1B-UD/RH1B-ULD


RH4B-U/RH4B-UL/RH4B-UD/RH4B-LD


RH2B-U/RH2B-UL/RH2B-UD/RH2B-ULD


RH3B-U/RH3B-UL/RH3B-D/RH3B-LD


RH2B-UT


RH3B-UT
RH4B-UT


## Dimensions con't (mm)

RHIV2-U/RHIV2-UD


RH2V2-U/RH2V2-UL/RH2V2-UD


RH4V2-U/RH4V2-UL/RH4V2-UD


## Standard DIN Rail Mount Sockets

SH2B-05


SH3B-05

## SH1B-05

SH4B-05


Terminal Blocks

## Dimensions con't (mm)



Dimensions con't (mm)

## PCB Mount Sockets

## SH1B-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 $D C$ 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.

.. 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 (lo) flows through the relay coil while the relay is ofl. Leakage current causes coil release failure or adversely atlects the vibration resistance and shock resistance. Design a circuit as shown in the correct example.

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:
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 $1 \mu \mathrm{~F}$
3. Do not use a contact protection circuit as shown below:

| Porer | This protection circuit is very effective in arc suppression when <br> opening the contacts. But, the capacitor is charged while the <br> contacts are opened. When the contacts are closed, the capacitor <br> is discharged through the contacts, increasing the possibility of <br> contact welding. |
| :--- | :--- |

Generally, switching a $D C$ inductive load is more difficult than switching a $D C$ 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 60 W , 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 $\left\{\mathrm{SO}_{2}\right.$ \}, and hydrogen sulfide $\left(\mathrm{H}_{2} \mathrm{~S}\right.$ ).
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 $A C$ relays with RC or DC relays with diode are provided to absarb 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 voitage to terminals of neighboring poles and a negative voltage to the other terminals of neighboring poles to prevent the passibility of short circuits.
- DC relays with a diode have a polarity in the coil terminals. Apply the DC voltage to the correct terminals.



## 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

## 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. Threephase 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

| Redy | Protection | ANS] 00 | Caboro |
| :---: | :---: | :---: | :---: |
| 3-phase 3- or 4-wire | Phase loss and | '47 | 252-PSF |
|  | unbalance 5-15\% |  |  |
| 3-phase 3-or 4-wire | Phase loss, unbalance | 47/27 | 252-PSG |

Please specify system voltage, frequency and required options at time of ordering.

## Specification - Phase Balance

Nominal voltage
$110 \mathrm{~V}, 120 \mathrm{~V}, 208 \mathrm{~V}, 220 \mathrm{~V}, 230 \mathrm{~V}, 240 \mathrm{~V}, 277 \mathrm{~V}$. $380 \mathrm{~V}, 400 \mathrm{~V}, 415 \mathrm{~V}, 440 \mathrm{~V}$ or 480 V
System frequency
Voltage burden
Overload
Set point repeatability
Under-voltage set point

Trip level adjustment Time delay

Auxiliary voltage burden
Output relay
Relay contact rating
Relay mechanical life
Relay reset
Operating temperature
Storage temperature
Temperature co-efficient
Interference immunity

| 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 | 55 mm ( $2.2^{\prime \prime}$ ) wide $\times 70 \mathrm{~mm}\left(2.8^{\prime \prime}\right)$ high $\times 112 \mathrm{~mm}$ (4.4") deep |
| Weight | 0.4 Kg approx. |

50 or 60 Hz
$3 V A$ approx.
$1.2 \times$ rating continuously, $1.5 \times$ rating for $10 \times$ seconds
$>0.5 \%$ of full span
Pre-set at $15 \%$ of nominal voltage. Other values 10 to $30 \%$ to order (model 252-PSG only)

## Connections

## 252-PSF Relay

 252-PSG

Note: Neutral connection not required.

## Dimensions

Model 252


## CHASSIS

## 1. CD-2 CHASSIS TECHNICAL DETAILS

Panelboards, loadcentres and accessories

## CONCEPT•PLUS and Premier busbar chassis - Din-T

-     - Standards AS/NZS 3439

0 Current rating 250 A

- Withstand rating $250 \mathrm{~A} / 20 \mathrm{kA}$ for 0.2 sec
- Splayed busbar to suit $160 \mathrm{~A} \& 250 \mathrm{~A}$ 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
[5 Improved insulation coating

Concept Din-T - 250 to suit Din-T MCBs ( 18 mm pole pitch $)^{3}$ )

|  | 250 A <br> Cote capacity |
| :--- | :--- |
| 12 | CD 2 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: ') 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 " $C D$ " 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.
-

| Accessories <br> Description | Cat. No. |
| :--- | :--- |
| Split tariff kit 250/355 A (supplied loose) | STKCD̈ |
| 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


| $X$ |
| :--- |
| No. of phases  <br> 2 $1 P+N$ (red, black) <br> 3 $3 P$ (red, white, blue) <br> 4 $3 P+N$ (red, white, <br> blue, black) |$.$|  |
| :--- |


| $27 \mathrm{~mm} / 18 \mathrm{~mm}$ |
| :--- |
| $6 / 24$ |
| $12 / 60$ |

$12 / 60 \square$

| $X X$ |  |
| :--- | :--- |
|  |  |
| Pole pitch (mm) |  |
| 18 | Din-T |
| 27 | Din-T10H |
| $27 / 18$ | Hybrid <br> Din-T10H/Din-T |
| 25 | Safe-T |




3 pole CD chassis to suit Din-T MCBs

Panelboards, loadcentres and accessories

## Dimensions (mm)

$C D$ chassis 250 to suit Din-T6, 10 and 15


Escutcheon cut-out details


Notes: ') " X " insert $\mathbf{2}=250 \mathrm{~A}$ or $\mathbf{3}=355 \mathrm{~A}$, current rating does not effect above dims. Maximum current rating of tee-off $=100 \mathrm{~A}$.
'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.

## FUSE \& FUSE HOLDER

## 1. FUSE LINKS TECHNICAL DETAILS

2. FUSE HOLDER TECHNICAL DETAILS

BS compact fuse links

- Complies with BS 88

Refer catalogue NF
lip-in offset tags


Note: $\quad$ ) ${ }^{\prime} M$ ' in catalogue $N o$. denotes motor starting type.

DIN and BS fuse link selection chart

## BS Fuses

| Switch-fuses |  |  |  |  |  |  |  | Fuse type <br> Cat. No. <br> Prefix |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 800 | 630 | 400 | 315 | 250 | 200 | 160 | 125 |  |
|  |  |  |  |  |  |  |  | NNS_ |
|  |  |  |  |  |  |  |  | NNIT_ |
|  |  |  |  |  |  | $\checkmark$ | $\checkmark$ | NTIA |
|  |  |  |  |  |  | $\checkmark$ | $\checkmark$ | NTIS |
|  |  |  |  |  |  | $\checkmark$ | $\checkmark$ | NOS_ |
|  |  |  |  |  |  | $\checkmark$ |  | NTCP_ |
|  |  |  |  |  |  |  |  | NTFP_ |
|  |  |  |  |  |  |  |  | NTSLOO_ |
|  |  | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ |  |  | NTBC_ |
|  |  | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ |  |  | NTC_ |
|  |  | $\checkmark$ | $\checkmark$ | $\checkmark$ | $\checkmark$ |  |  | NTF- |
|  |  | $\checkmark$ | $\checkmark$ | $\checkmark$ |  |  |  | NTKF_ |
|  |  |  |  |  |  |  |  | NTSL3_ |
|  |  | $\checkmark$ |  |  |  |  |  | NTMF_ |
| $\checkmark$ | $\checkmark$ |  |  |  |  |  |  | NTM |
| $\checkmark$ | $\checkmark$ |  |  |  |  |  |  | NTM |
| $\checkmark$ |  |  |  |  |  |  |  | NTLM_ |


| NHP HRC fuse holders |  |  |  |  |  |  |  |  | Fuse type <br> Cat. No. <br> Prefix |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| NC (Bolt-in) |  |  |  |  |  | NV (Clip-in) |  |  |  |
| 315 | 200 | 100 | 63 | 32 | 20 | 63 | 32 | 20 |  |
|  |  |  |  |  |  |  | $\checkmark$ | $\checkmark$ | NNS |
|  |  |  |  |  |  | $\checkmark$ |  |  | NES_ |
|  |  |  |  | $\checkmark$ | $\checkmark$ |  |  |  | NNIT_ |
|  | $\left.\sim^{\prime}\right)$ | $\checkmark$ | $\checkmark$ |  |  |  |  |  | NTIA |
|  | $\left.\sim^{\prime}\right)$ | $\checkmark$ | $\left.\checkmark^{2}\right)$ |  |  |  |  |  | NTIS_ |
|  | $\sim^{\prime \prime}$ | $\checkmark$ |  |  |  |  |  |  | NOS |
|  | $\checkmark$ |  |  |  |  |  |  |  | NTCP_ |
|  | $\checkmark$ |  |  |  |  |  |  |  | NTFP_ |
| $\checkmark$ |  |  |  |  |  |  |  |  | NTBC |
| $\checkmark$ |  |  |  |  |  |  |  |  | NTC |
| $\checkmark$ |  |  |  |  |  |  |  |  | NTF- |
| $\checkmark$ |  |  |  |  |  |  |  |  | NTKF_ |

DIN Fuses

| Switch-fuses |  |  |  |  |  | Fuse type <br> Cat. No. <br> Prefix |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 800 | 630 | 400 | 250 | 160 | 125 |  |
|  |  |  |  | $\checkmark$ | $\checkmark$ | NOO_ |
|  |  |  | $\checkmark$ |  |  | N1 |
|  |  | $\checkmark$ |  |  |  | N2 |
| $\checkmark$ | $\checkmark$ |  |  |  |  | N3 |

Legend:
$\checkmark$ Fuse links fit direct.
') Fuses require 100 MFLK adaptor, see page 11-107.
$\checkmark$ ) 'M' type (motor rated) NTIS not suitable for NC63_. Use NC100 fuse holder.

## HR

High rupturing capacity (HRC) or High breaking - capacity denotes the ability of a fuse slink to interrupt extremely high fault wisents, usually: top to 80 kA . Current limiting fuse-link
A fuse -link that limits the circuit current during it's : operation to a value much lower that 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 lin
been tested to interrupt eg. 80 kA
Rated voltage
The maximum system voltage that the fuse
designed to interrupt Re at voltages may be
The value of current that athiselink will catt continuously
conditions.
Minimum fusing current


The minimum valuéof current that will cause melting of the fuse element.


Thee power released in a fựe link carrying rated currért under a specified condition, usually expressed intwatts.
Time current characteristics (refer table I)
A curve detailing the prearcing-operating time a function of prospective current. Wb
Let through characteristics (l lat) (refer table 2)

"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 tan 7 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 ( $\mathrm{I}^{2} \mathrm{t}$ ) of the downstream (or minor) fuse-link 'doe snot exceed the pre-arcingenergy ( $\left.1^{2} t\right)$ of the upstream (or major) fuse link at the applied system voltage. "Discrimination is normally achieved with the ratio of $1.6^{6}$ between upstream and downstream童

 A curve or chart showing values prearcing' and 'operating' let through energies as a function of prospective current, $\mathrm{I}^{2}$ dis proportional to energy in Amp ${ }^{2}$ seconds.
Cut off characteristics (refer table 3) :
A curve detailing the cut off current as a function of an prospective current. Cut off current being the .: maximum instantaneous value of current let through


 Puse curves $\dot{2}+$ $\qquad$ $\rightarrow$


## Refer Catalogue $\bar{N} F$

Compact fuse holders (Bolt-in)
O New compact size
O Front (FW) or stud/front (SFW) versions
O Smaller dimensions
O Saves panel space


| Dimensions (mm) |  |  | Suggested Max. |  |
| :--- | :--- | :--- | :--- | :--- |
|  | $\mathbf{H}$ | $\mathbf{W}$ | $\mathbf{D}$ | cable size |
| NC32_ | 87 | 27 | 50 | $10 \mathrm{~mm}^{2}$ |
| NC63_ | 109 | 31 | 62 | $25 \mathrm{~mm}^{2}$ |
| NC100_ | 118 | 35 | 72 | $50 \mathrm{~mm}^{2}$ |
| NC200_ | 154 | 54 | 108 | $95 \mathrm{~mm}^{2}$ |

## Standard fuse holders (Bolt-in)

O Ratings from 20 to 200 A
O Front (FW) or stud/front (SFW) versions
O Complies with BS88


N20FW
Dimensions (mm)

|  | $\mathbf{H}$ | $\mathbf{W}$ | $\mathbf{D}$ | cable size |
| :--- | :--- | :--- | :--- | :--- |
| N20_ | 87 | 27 | 50 | $10 \mathrm{~mm}^{2}$ |
| N32_ | 109 | 31 | 62 | $10 \mathrm{~mm}^{2}$ |
| N63_ | 118 | 35 | 72 | $50 \mathrm{~mm}^{2}$ |
| N100_ | 154 | 54 | 108 | $70 \mathrm{~mm}^{2}$ |
| N200_ | 193 | 70 | 149 | $150 \mathrm{~mm}^{2}$ |



Rating (A) | Fuse link to suit
Front wired - bolt in

| 32 |  |  | NNIT | NC32FW |  |
| :---: | :--- | :--- | :--- | :--- | :--- |
| 63 |  | NTIA | NTIS | NC63FW |  |
| 100 | NOS | NTIA | NTIS | NC100FW |  |
| 200 |  | NTIA $\left.^{\prime}\right)$ | NTIS $\left.{ }^{\prime}\right)$ | NC200FW |  |
|  | NTFP | NOS $\left.^{\prime}\right)$ | NTCP |  |  |

Back stud/front wired - bolt in

| 32 |  |  | NNIT | NC32SFW |  |
| :---: | ---: | :--- | :--- | :--- | :--- |
| 63 |  | NTIA | NTIS | NC63SFW |  |
| 100 | NOS | NTIA | NTIS | NC100SFW |  |
| 200 |  | NTIA $^{\prime}$ ) | NTIS ${ }^{1}$ ) | NC200SFW |  |
|  | NTFP | NOS $\left.^{1}\right)$ | NTCP |  |  |

Note: ') Fuses can be fitted using adaptor 100M FLK.
Rating (A) Fuse link to suit Cat. No.

Front wired - bolt in

| 20 | NNIT | N20FW |  |
| :---: | :---: | :--- | :--- |
| 32 | NTIA | N32FW |  |
| 63 | NTIA NTIS | N63FW |  |
| 100 | NTIA ' $^{\prime}$ NTIS ${ }^{\prime}$ ) | N100FW |  |
|  | NOS $^{\prime}$ ) NTCP |  |  |
| 200 | NTBC NTC | N200FW |  |
|  | NTF |  |  |

Back stud/front wired - bolt in

| 20 | NNIT | N20SFW |  |
| :---: | :---: | :---: | :---: |
| 32 | NTIA | N32SFW |  |
| 63 | NTIA NTIS | N63SFW |  |
| 100 | NTIA ' $^{\prime}$ NTIS ${ }^{\prime}$ ) | N100SFW |  |
|  | NOS $^{\prime}$ ) NTCP |  |  |
| 200 | NTBC NTC | N200SFW |  |
|  | NTF |  |  |

Clip-in fuse holders - DIN rail mount
Fast, reliable fitting and removal of fuse links
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 | NV63FWN |  |

## GSM MODEM

## 1. FASTRACK SUPREME GSM MODEM TECHNICAL DETAILS

2. FASTRACK SUPREME GSM MODEM USER GUIDE


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 CPUs: a powerful central processing unit with an ARM9 32 bit, $26-104 \mathrm{MHz}$ 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!

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




## Open AT ${ }^{\text {® }}$ 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 ${ }^{\text {TM }}$
- 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
$\rightarrow$ Hardware and Software Timers
$\rightarrow$ DSP
$\rightarrow \mathrm{SPl}$
$\rightarrow$ ADC
$\rightarrow$ External Interrupt Pins
$\rightarrow$ GPIOs
$\rightarrow$ 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
$\rightarrow$ application dedicated for close monitoring
$\rightarrow$ 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:
$\rightarrow$ Live through Traces
$\rightarrow$ Post mortem through BackTraces

## On field:

$\rightarrow$ 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, controllerless companion wireless peripherals such as Bluetooth \& GPS. Of course, the powerful flexibility of Open AT ${ }^{\circledR}$ Software Suite means that you can also develop your own Plug-Ins and own custom AT commands.


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 | PRODUCT BUILD |
| :--- | :--- |
| $\rightarrow$ Open AT Developer course | $\rightarrow$ IMEI implementation |
| $\rightarrow$ Open AT Expert course | $\rightarrow$ Tailored Delivery (Express \& Fast) |
|  | $\rightarrow$ Tailored Product Configuration |
| PRODUCT DESIGN | AFTER SALES |
| $\rightarrow$ Customer Design Review | $\rightarrow$ Reconfiguration for Wireless CPU |
| $\rightarrow$ Customer Product Certification | $\rightarrow$ Out Of Warranty repair for Wireless CPUe |
| $\rightarrow$ Open AT* Application Code Review | $\rightarrow$ Rapair 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

$\rightarrow$ Simplify your device installation and protect your wireless investment while reducing your field service costs
COMMUNICATION MANAGEMENT
$\rightarrow$ Analyze your traffic load and roaming usage, and adjust your tariff plans to your real usage APPLICATION MANAGEMENT
$\rightarrow$ Benefit from proactive maintenance services to diagnose issues and take action before a significant problem occurs

Moveconn
Smart wireless. Smart business.


[^13]
## wnurwanecomacm

FASTRACK Supreme
User Guide

Reference: WA_DEV_Fastrk_UGD_001<br>Revision: 001e<br>Date: 5 june, 2007



Supports Open $\mathrm{AT}^{-}$embedded ANSIC Applications


| Revision | Date | List of revisions |  |
| :---: | :---: | :--- | :--- |
| 001 | 9 February, 07 | First Issue |  |
| 001 a | 23 February, 2007 | Update DC cable GPIO mapping, add AutoShutDown |  |
| 001 b | 21 May, 07 | Add detail of IES, RTC and serial port autoshutdown |  |
| 001 c | 1 Jun, 07 | Change to Quad Band |  |
| 001 d | 4 Jun, 07 | Update label/packaging photo |  |
| 001 e | 5 Jun, 07 | Comment |  |

The FASTRACK Supreme 10 and FASTRACK Supreme 20 are discrete, rugged cellular Plug \& Play Wireless CPU ${ }^{\text {® }}$ 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 $850 / 900 / 1800 / 1900 \mathrm{MHz}$ 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 $A T^{\ominus}$ ). Open $A T^{\top}$ 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 ${ }^{\otimes}$.

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 ${ }^{\circledR}$ 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.

RoHS
COMPLIANT
2002/95/EC

## 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.



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

$\omega_{(B)}$, WAVECOM ${ }^{\circledR}$, Wireless CPU ${ }^{\oplus}$, Open AT $^{\oplus}$ and certain other trademarks and logos appearing on this document, are filed or registered trademarks of Wavecom S.A. in France or in other countries. All other company and/or product names mentioned may be filed or registered trademarks of their respective owners.

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| General information about Wavecom and its range of <br> products: | www.wavecom.com |
| :--- | :--- |
| Specific support is available for the FASTRACK Supreme <br> Plug \& Play Wireless CPU |  |
| Open AT ${ }^{\oplus}$ Introduction: | TBD |
| Developer community for software and hardware: | www.wavecom.com/OpenAT |

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References

## 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 $A T^{(8)}$ Software Documentation

[1] Getting started with Open AT (Ref.WM_ASW_OAT_CTI_001)
[2] Open $A T^{\circledR}$ Tutorial (Ref.WM_ASW_OAT_UGD_001)
[3] Tools Manual (Ref. WM_ASW_OAT_UGD_003)
[4] Open $A T^{9}$ Programming Guide (Ref. TBD)
[5] Open $A T^{\oplus}$ 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 X 51 and FASTRACK Supreme will use new release of FW6.63. Reference document not yet available and TBC.

### 1.1.3 Fimware Upgrade Documents

[8] Firmware upgrade procedure (Ref. WM_SW_GEN_UGD_001)

### 1.1.4 Delta between M13068 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)


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 | Alternating Current |
| ACM | Accumulated Call Meter |
| AMR | Adaptive Multi-Rate |
| AT | ATtention (prefix for Wireless CPU ${ }^{\otimes}$ commands) |
| CLK | CLocK |
| CMOS | Complementary Metal Oxide Semiconductor |
| CS | Coding Scheme |
| CTS | Clear To Send |
| dB | Decibel |
| dBc | Decibel relative to the Carrier power |
| dBi | Decibel relative to an Isotropic radiator |
| dBm | Decibel relative to one milliwatt |
| DC | Direct Current |
| DCD | Data Carrier Detect |
| DCE | Data Communication Equipment |
| DCS | Digital Cellular System |
| DSR | Data Set Ready |
| DTE | Data Terminal Equipment |
| DTMF | Dual Tone Multi-Frequency |
| DTR | Data Terminal Ready |
| EEPROM | Electrically Erasable Programmable Read-Only Memory |
| EFR | Enhanced Full Rate |
| E-GSM | Extended GSM |
| EMC | ElectroMagnetic Compatibility |
| EMI | ElectroMagnetic Interference |
| ESD | ElectroStatic Discharges |
| ETSI | European Telecommunications Standards institute |
| FIT | FR |


| Abbreviation | Definition |
| :---: | :---: |
| FTA | Full Type Approval |
| GCF | Global Certification Forum |
| GND | GrouND |
| GPIO | General Purpose Input Output |
| GPRS | General Packet Radio Service |
| GSM | Global System for Mobile communications |
| HR | Half Rate |
| 1 | Input |
| IEC | International Electrotechnical Commission |
| IES | Internal Expansion Socket |
| IESM | Internal Expansion Socket Module |
| IMEI | International Mobile Equipment Identification |
| 1/0 | Input / Output |
| LED | Light Emitting Diode |
| MAX | MAXimum |
| ME | Mobile Equipment |
| MIC | MICrophone |
| Micro-Fit | Family of connectors from Molex |
| MIN | MINimum |
| MNP | Microcom Networking Protocol |
| MO | Mobile Originated |
| MS | Mobile Station |
| MT | Mobile Terminated |
| NOM | NOMinal |
| 0 | Output |
| Pa | Pascal (for speaker sound pressure measurements) |
| PBCCH | Packet Broadcast Control CHannel |
| PC | Personal Computer |
| PCL | Power Control Level |
| PDP | Packet Data Protocol |
| PIN | Personal Identity Number |
| PLMN | Public Land Mobile Network |
| PUK | Personal Unblocking Key |
| RF | Radio Frequency |

References

| Abbreviation | Definition |
| :--- | :--- |
| RFI | Radio Frequency Interference |
| RI | Ring Indicator |
| RMS | Root Mean Square |
| RTS | Request To Send |
| RX | Receive |
| SIM | Subscriber Identification Module |
| SMA | SubMiniature version A RF connector |
| SMS | Short Message Service |
| SNR | Signal-to-Noise Ratio |
| SPL | Sound Pressure Level |
| SPK | SpeaKer |
| SRAM | Static RAM |
| TCP/IP | Transmission Control Protocol / Internet Protocol |
| TDMA | Time Division Multiple Access |
| TU | Typical Urban fading profile |
| TUHigh | Typical Urban, High speed fading profile |
| TX | Transmit |
| TYP | TYPical |
| VSWR | Voltage Stationary Wave Ratio |

## 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


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 $A T^{\text {® }}$ Logo
- RoHS logo
- WEEE logo


MEMECOMN
ref: Fastrack Supreme 20


IMEI 355212010002055


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 ${ }^{\circledR}$ 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

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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 $50 \Omega$ RF connection.


SMA connector for antenna 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 | 1/0 | I/O type | Description | Reset State | Comment |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | V+BATTERY | 1 | Power supply | Battery voltage input: <br> - 5.5 V Min. <br> - 13.2 V Typ. <br> - 32 V Max. |  | High current |
| 2 | GND |  | Power supply | Ground |  |  |
| 3 | GPIO21 | 1/0 | 2V8 | General Purpose Input/output | Undefined | Not mux |
| 4 | GPIO25 | 1/0 | 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.

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Figure 8: Sub HD 15-pin connector

Table 2: Sub HD 15-pin connector description

| Pin \# | Signal (CCITT / EIA) | I/O | VO type | Description | Comment |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | CDCD/CT109 | 0 | STANDARD <br> RS232 | RS232 Data Carrier Detect |  |
| 2 | CTXD/CT103 | 1 | STANDARD RS232 | RS232 <br> Transmit serial data |  |
| 3 | BOOT | 1 | CMOS | Boot | This signal must not be connected. Its use is strictly reserved to Wavecom or competent retailers. |
| 4 | CMIC2P | 1 | Analog | Microphone positive line |  |
| 5 | CMIC2N | 1 | Analog | Microphone negative line |  |
| 6 | CRXD/CT104 | 0 | STANDARD <br> RS232 | RS232 <br> Receive serial data |  |
| 7 | CDSR/CT107 | 0 | STANDARD RS232 | $\begin{gathered} \text { RS232 } \\ \text { Data Set Ready } \end{gathered}$ |  |
| 8 | CDTR/CT108-2 | 1 | STANDARD RS232 | $\begin{gathered} \text { RS232 } \\ \text { Data Terminal Ready } \end{gathered}$ |  |
| 9 | GND | - | GND | Ground |  |

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| Pin\# | Signal <br> (CCITT/EIA) | I/O | I/O type | Description | Comment |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 10 | CSPK2P | 0 | Analog | Speaker <br> positive line |  |
| 11 | CCTS/CT106 | 0 | STANDARD <br> RS232 | RS232 <br> Clear To Send |  |
| 12 | CRTS/CT105 | 1 | STANDARD <br> RS232 | RS232 <br> Request To Send |  |
| 13 | CRI/CT125: | 0 | STANDARD <br> RS232 | RS232 <br> Ring Indicator |  |
| 14 | RESET | $1 / O$ | Schmitt | Supreme Plug \& Play reset | Active low |
| 15 | CSPK2N | 0 | Analog | Speaker <br> 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.


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Figure 9: IES connector for feature expansion

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Table 3: IES Connector Description

| Pin : <br> Number | Signal Name |  | $\begin{aligned} & \text { 1/0 } \\ & \text { type } \end{aligned}$ | Voltage | $1 / O^{*}$ | Reset State | Description | Dealing with unused pins |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Nominal | Mux |  |  |  |  |  |  |
| 1 | GND | - |  |  |  |  | Ground |  |
| 2 | GND |  |  |  |  |  | Ground |  |
| 3 | GPIO4 | COLO | C8 | GSM-1V8 | $1 / 0$ | Pull-up | Keypad column 0 | NC |
| 4 | GPIO5 | COL1 | C8 | GSM-1V8 | 110 | Pull-up | Keypad column 1 | NC |
| 5 | GPIO6 | COL2 | C8 | GSM-1V8 | $1 / 0$ | Pull-up | Keypad column 2 | NC |
| 6 | GPIO7 | COL3 | C8 | GSM-1V8 | 1/0 | Pull-up | Keypad column 3 | NC |
| 7 | VPAD-USB |  |  | VPAD-USB | 1 |  | USB Power supply input | NC |
| 8 | USB-DP |  |  | VPAD-USB | 1/0 |  | USB Data | NC |
| 9 | USB-DM |  |  | VPAD-USB | $1 / 0$ |  | USB Data | NC |
| 10 | GSM-1V8* |  |  | GSM-1V8 | 0 |  | 1.8V Supply Output (for GPIO pull-up only) | NC |
| 11 | GSM-2V8* |  |  | GSM-1V8 | 0 |  | 2.8V Supply Output (for GPIO pull-up only) | NC |
| 12 | BOOT |  |  | GSM-1V8 | 1 |  | 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 | 1/O |  | RESET Input | NC or add a test point |
| 14 | AUX-ADC |  | A2 | Analog | 1 |  | Analog to Digital Input | Pull to GND |
| 15 | -SPI1-CS | GPIO31 | C1 | GSM-2V8 | $\bigcirc$ | z | SPI1 Chip Select | NC |
| 16 | SPI1-CLK | GPIO32 | C1 | GSM-2V8 | 0 | Z | SPI1 Clock | NC |
| 17 | SPI1-I | GPIO30 | C1 | GSM-2V8 | 1 | z | SPI1 Data Input | NC |
| 18 | SPI1-IO | GPIO29 | C1 | GSM-2V8 | $1 / 0$ | Z | SPI1 Data Input / Output | NC |
| 19 | SPI2-CLK | GPIO32 | C1 | GSM-2V8 | 0 | 2 | SPI2 Clock | NC |
| 20 | SPI2-10 | GPIO33 | C1 | GSM-2V8 | 1/0 | Z | SPI2 Data Input / Output | NC |
| 21 | -SPI2-CS | GP1O35 | C1 | GSM-2V8 | 0 | Z | SPI2 Chip Select | NC |
| 22 | SP12-1 | GPIO34 | C1 | GSM-2V8 | 1 | 2 | SPI2 Data Input | NC |
| 23 | $\begin{aligned} & \hline \text { CT104- } \\ & \text { RXD2 } \end{aligned}$ | GPIO15 | C1 | GSM-1V8 | 0 | Z | Auxiliary RS232 Receive | Add a test point for firmware upgrade |
| 24 | CT103-TXD2 | GPIO14 | C1 | GSM-1V8 | 1 | 2 | Auxiliary RS232 Transmit | (TXD2) Pull-up to VCC_1V8 with $100 \mathrm{k} \Omega$ and add a test point for firmware update |
| 25 | $\begin{aligned} & \sim \text { CT106- } \\ & \text { CTS2 } \end{aligned}$ | GPIO16 | C1 | GSM-1V8 | 0 | Z | Auxiliary RS232 Clear To Send | (CTS2) Add a test point for firmware update |
| 26 | $\begin{aligned} & \text { ~CT105- } \\ & \text { RTS2 } \end{aligned}$ | GPIO17 | C1 | GSM-1V8 | 1 | Z | Auxiliary RS232 Request To Send | (RTS2) Pull-up to VCC_1V8 with $100 \mathrm{k} \Omega$ and add a test point for |

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| Pin Number | Signal Name |  | $\begin{gathered} \text { I/O } \\ \text { type } \end{gathered}$ | Vọltage | I/O* | Reset State | Description | Dealing with unused pins |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Nominal | Mux |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  | firmware update |
| 27 | GPIO8 | COL4 | C8 | GSM-1V8 | 1/0 | Pull-up | Keypad column 4 | NC |
| 28 | GPIO26 | SCL | A1 | Open Drain | 0 | z | ${ }^{12} \mathrm{C}$ Clock | NC |
| 29 | GPIO19 |  | C1 | GSM-2V8 | $1 / 0$ | 2 |  | NC |
| 30 | GPIO27 | SDA | A1 | Open Drain | $1 / 0$ | $z$ | $1^{2} C$ Data | NC |
| 31 | GPIO20 |  | C1 | GSM-2V8 | $1 / 0$ | Undefined |  | NC |
| 32 | INT0 | GPIO3 | C1 | GSM-1V8 | 1 | $z$ | Interruption 0 Input | If INTO is not used, it should be configured as GPIO |
| 33 | GPIO23 | ** | C1 | GSM-2V8 | 1/0 | z |  | NC |
| 34 | GPIO22 | ** | C1 | GSM-2V8 | $1 / 0$ | Z |  | NC |
| 35 | $\begin{gathered} \hline \text { CT108-2- } \\ \text { DTR1 } \end{gathered}$ | GPIO41 | C1 | GSM-2V8 | 1 | z | Main RS232 Data Terminal Ready | (DTR1) Pull-up to VCC_2V8 with 100k $\Omega$ |
| 36 | PCM-SYNC |  |  | GSM-1V8 | 0 | Pull-down | PCM Frame Synchro | NC |
| 37 | PCM-IN |  | C5 | GSM-1V8 | 1 | Pull-up | PCM Data Input | NC |
| 38 | PCM-CLK |  |  | GSM-1V8 | $\bigcirc$ | Pull-down | PCM Clock | NC |
| 39 | PCM-OUT |  |  | GSM-1V8 | 0 | Pull-up | PCM Data Output | NC |
| 40 | AUX-DAC |  |  | Analog | $\bigcirc$ |  | Digital to Analog Output | NC |
| 41 | VCC-2V8 |  |  | VCC_2V8 | 0 |  | LDO 2.8V Supply Output | NC |
| 42 | GND |  |  |  |  |  | Ground |  |
| 43 | DC-IN |  |  | $\begin{gathered} \hline D C-I N \text { from } \\ 5.5 V \sim 32 V D C \end{gathered}$ | 0 |  | DC voltage input through Micro-Fit connector | NC |
| 44 | DC-IN |  |  | $\begin{gathered} \text { DC-IN from } \\ 5.5 V-32 V D C \end{gathered}$ | 0 |  | DC voltage input through Micro-Fit connector | NC |
| 45 | GND |  |  |  |  |  | Ground |  |
| 46 | 4 V |  |  | 4 V | $\bigcirc$ |  | $\begin{aligned} & \text { 4V DC/DC converter } \\ & \text { Output } \end{aligned}$ | NC |
| 47 | 4V |  |  | 4 V | 0 |  | 4V DC/DC converter Output | NC $\quad$. |
| 48 | GND |  |  |  |  |  | Ground |  |
| 49 | GND |  |  |  |  |  | Ground |  |
| 50 | GND |  |  |  |  |  | Ground |  |

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Figure 10: Power supply cable

| Component | Characteristics |
| :--- | :--- |
| Micro-Fit connector <br> 4-pin | Part number: MOLEX 43025-0400 |
| Cable | Cable length: $\sim 1.5 \mathrm{~m}$ |
| Wire | Core: tinned copper $24 \times 0.2 \mathrm{~mm}$ |
|  | Section: $0.75 \mathrm{~mm}^{2}$ |

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## 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

| Reatiper |  | Cbcsiemonecsicoo |
| :---: | :---: | :---: |
| $\text { Open } \mathbf{A} T^{8}$ | Open AT programmable: <br> - Native execution of embedded standard ANSI C applications, Custom AT command creation, <br> Custom application library creation, Standalone operation. |  |
| Standard | $850 \mathrm{MHz} / 900 \mathrm{MHz}$. <br> E-GSM compliant. <br> Output power: class 4 (2W). <br> Fully compliant with ETSI GSM phase $2+$ small MS. | $1800 \mathrm{MHz} / 1900 \mathrm{MHz}$ <br> Output power: class 1 (1W). <br> Fully compliant with ETSI GSM phase 2 + small MS. |
| GPRS | Class 10. <br> PBCCH support. <br> Coding schemes: CS1 to CS4. <br> Compliant with SMG31bis. <br> Embedded TCPIIP stack. |  |
| EGPRS | Output power: 0.5 W | Output power: 0.4 W |
| (for <br> FASTRACK <br> Supreme. 20 only) | Class 10. <br> PBCCH support. <br> Coding schemes: MCS1 to MCS9. <br> Compliant with SMG31bis. <br> Embedded TCP/IP stack. |  |

Features and Services

| Geatues |  |
| :---: | :---: |
| Interfaces | RS232 (V.24N.28) Serial interface supporting: <br> - Baud rate (bits/s): $300,600,1200,2400,4800,9600,19200,38400,57600$, 115200, 230400, 460800 and 921600. <br> - Autobauding (bits/s): from 1200 to 921600. <br> 2 General Purpose Input/Output gates (GPIOs) available. <br> $1.8 \mathrm{~V} / 3 \mathrm{~V}$ SIM interface. <br> AT command set based on V.25ter and GSM $07.05 \& 07.07$. <br> Open $A T^{\circledR}$ interface for embedded application. <br> Open AT ${ }^{\text {® }}$ Plug-In Compatible. |
| SMS | Text \& PDU. <br> Point to point (MT/MO). <br> Cell broadcast. |
| Data | Data circuit asynchronous. <br> Transparent and Non Transparent modes. <br> Up to 14.400 bits/s. <br> MNP Class 2 error correction. <br> V42.bis data compression. |
| Fax | Automatic fax group 3 (class 1 and Class 2). |
| Audio | Echo cancellation <br> Noise reduction <br> Telephony. <br> Emergency calls. <br> Full Rate, Enhanced Full Rate, Half Rate operation and Adaptive Multi-Rate (FR/EFR/HR/AMR). <br> Dual Tone Multi Frequency function (DTMF). |

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Features and Services

| Feghtes | GSMB500GSME00 | CCSABOORESS4900 |
| :---: | :---: | :---: |
| GSM supplement services. | Call forwarding. <br> Call barring. <br> Multiparty. <br> Call waiting and call hold. <br> Calling line identity. <br> Advice of charge. <br> USSD |  |
| Other | DC power supply <br> Real Time Clock with calendar <br> Complete shielding |  |

For other detailed technical characteristics, refer to Section 8.

Features and Services

### 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

# Fastrack Supreme User Guide <br> Using the FASTRACK Supreme Plug \＆Play 

## 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．

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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 OR 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 $x \times x x$ (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 $200 \mu \mathrm{~s}$.
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.

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### 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).

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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 (ATEO command) in order to avoid useless CPU processing.

For further information on ATEO and ATEI commands, refer to "AT Commands Interface Guide" [6].

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### 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:
- $\langle r s s i\rangle=$ 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 <br> strength indication (<rssi>) | Interpretation of the <br> 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 850 MHz. |
| AT+WMBS $=1, x$ | Select mono band mode extended 900 MHz |
| AT+WMBS $=2, x$ | Select mono band mode 1800 MHz |
| AT+WMBS $=3, x$ | Select mono band mode 1900 MHz |
| AT + WMBS $=4, x$ | Select dual band mode $850 / 1900 \mathrm{MHz}$ |
| AT+WMBS $=5, x$ | Select dual band mode extended $900 \mathrm{MHz} / 1800 \mathrm{MHz}$ |
| AT+WMBS $=6, x$ | Select dual band mode extended $900 \mathrm{MHz} / 1900 \mathrm{MHz}$ |

(*)For further information on the other possible responses and their meaning, refer to "AT Commands Interface Guide" [6].
Remark:
$\mathbf{x}=0$ : The Plug \& Play will have to be reset to start on specified band(s).
$\mathbf{x}=1$ : 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 850 MHz is selected |
| +WMBS : $1, \mathrm{x}$ | Mono band mode extended 900 MHz is selected |
| +WMBS : $2, \mathrm{x}$ | Mono band mode 1800 MHz is selected |
| +WMBS : $3, \mathrm{x}$ | Mono band mode 1900 MHz is selected |
| +WMBS : 4,x | Dual band mode $850 / 1900 \mathrm{MHz}$ are selected |
| +WMBS : 5,x | Dual band mode extended $900 \mathrm{MHz} / 1800 \mathrm{MHz}$ are selected |
| +WMBS : $6, \mathrm{x}$ | Dual band mode extended $900 \mathrm{MHz} / 1900 \mathrm{MHz}$ are selected |

${ }^{*}$ ) For further information on the other possible responses and their meaning, refer to "AT Commands Interface Guide" [6].

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### 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. $A T+C P I N=X X X X X$ to enter PIN code $x x x x$.
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 (*) <br> <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]
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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 | $\begin{aligned} & \text { AT+CPIN=xxxx } \\ & (x x x x=P I N \text { code }) \end{aligned}$ | OK | PIN Code accepted. |
|  |  | +CME ERROR: 16 | Incorrect PIN Code (with +CMEE = 1 mode) ( ${ }^{* *) ~}$ |
|  |  | +CME ERROR: 3 | PIN code already entered (with + CMEE = 1 mode) ( ${ }^{*}$ ) |
| 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. |

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| 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>; <br> (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; <br> (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 " $\mathrm{AT}+\mathrm{CMEE}=1$ " 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.


Troubleshooting

## 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/fags.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 nonsignificant characters | Is the communication program properly configured on PC? | Ensure the setting of the communication program is fit to setting of FASTRACK Supreme. <br> FASTRACK Supreme factory setting is: <br> Data bits $=8$ <br> Parity $=$ none <br> Stop bits = 1 <br> Baud = 115200 bps. <br> 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:

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- 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 $\mathbf{A T}+\mathrm{CMEE}=1$ 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.

Troubleshooting
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. <br> If no success, try bearer selection type by AT command: $\mathrm{AT}+\mathrm{CBST}=0,0,3$ |

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.

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Troubleshooting
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 |  |
| $\begin{gathered} 3,6,8,29,34,38 \\ 41,42,43,44,47, \\ 49,57,58,63,65, \\ 69,70,79,254 \end{gathered}$ | 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].


### 7.1 Architecture



Figure 15: Functional architecture

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### 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

 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 ( $\mathrm{V}+\mathrm{BATTERY}$ ) 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 $800 \mathrm{~mA} / 250 \mathrm{~V}$ 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 $\Leftrightarrow \mathrm{V} 24 N 28$ ) between the internal FASTRACK Supreme Plug \& Play (DCE) and the external world (DTE).

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Functional Description
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 <br> Pin number | I/O | I/O type <br> RS232 <br> STANDARD | Description |
| :---: | :---: | :---: | :---: | :--- |
| CTXD/CT103 | 2 | I | TX | Transmit serial data |
| CRXD/CT104 | 6 | 0 | RX | Receive serial data |
| CRTS/CT105 | 12 | 1 | RTS | Request To Send |
| CCTS/CT106 | 11 | 0 | CTS | Clear To Send |
| CDSR/CT107 | 7 | 0 | DSR | Data Set Ready |
| CDTR/CT108-2 | 8 | 1 | DTR | Data Terminal Ready |
| CDCD/CT109 | 1 | 0 | DCD | Data Carrier Detect |
| CRI/CT125 | 13 | 0 | 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.

Functional Description

### 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 <br> connector <br> (4-pin Micro-Fit) | I/O | I/O <br> Voltage | Reset <br> state | Description | Mulitplex with |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| GPIO21 | 3 | I/O | 2 V 8 | Undefined | General Purpose I/O | No mux |
| GPIO25 | 4 | $1 / O$ | 2 V 8 | 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.


## $7.6 \quad$ 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 2.8 V . But the FASTRACK Supreme now of 1.8 V 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 $200 \mu \mathrm{~s}$.
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 <br> Pin number | I/O | I/O type | Voltage | Description |
| :---: | :---: | :---: | :---: | :---: | :---: |
| RESET | 14 | I/O | Open Drain | 1V8 | FASTRACK Supreme <br> Reset |

Caution: Previous generation M1306B has RESET signal of HIGH level at 2.8 V . But the FASTRACK Supreme now of 1.8 V 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 $200 \mu \mathrm{~s}$ 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].

Functional Description
~RESET

STATE OF THE
Wireless CPU


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 Mlcrophone 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 $2 \mathrm{k} \Omega$.
AC coupling is already embedded in the Wireless CPU ${ }^{\ominus}$.
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 <br> Pin \# | I/O | I/O type | Description |
| :---: | :---: | :---: | :---: | :---: |
| CMIC2P | 4 | 1 | Analog | Microphone positive input |
| CMIC2N | 5 | 1 | Analog | Microphone negative input |

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### 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 |



Functional Description

### 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 $+w h c n f=1,1$
However, the new setting will be taken into account only after a restart. For detail, please refer to Document[6].

Technical Characteristics

## 8 Technical Characteristics

### 8.1 Mechanical Characteristics

Table 15: Mechanical characteristics

| Dimensions | $73 \times 54.5 \times 25.5 \mathrm{~mm}$ (excluding connectors) |
| :---: | :--- |
| Overall Dimension | $88 \times 54.5 \times 25.5 \mathrm{~mm}$ |
| Weight $\quad \therefore$ | $\approx 80$ grams (FASTRACK Supreme only) |
|  | $<120$ grams (FASTRACK Supreme + bridles + power supply cable) |
| Volume | $101.5 \mathrm{~cm}^{3}$ |
| 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.


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Figure 18: Dimensioning diagram

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### 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 5.5 V. |
|  | 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 32 V .

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 <br> (Transient peaks). | the FASTRACK Supreme guarantees its own protection. |
| Is over 32 V <br> (continuous overvoltage) | the protection of the FASTRACK Supreme is done by the <br> fuse (the supply voltage is disconnected). |

The fuse is a $800 \mathrm{~mA} / 250 \mathrm{~V}$ FAST-ACTING $5^{*} 20 \mathrm{~mm}$. See Section 10 for recommended references.
The following table provides information on power consumption of the FASTRACK Supreme, assuming an operating temperature of $+25^{\circ} \mathrm{C}$ and using a 3 V SIM card.


Technical Characteristics

### 8.2.2 Power Consumption

The following table provides information on power consumption of the FASTRACK Supreme, assuming an operating temperature of $+25^{\circ} \mathrm{C}$ 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 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { 조 } \\ & \mathbf{O} \end{aligned}$ | $\mathrm{I}_{\text {poak }}$ | GSM900: During TX bursts @ PCL5 DCS1800 : During TX bursts @ PCLo | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | 1 moj | GSM900 : Average @ PCL5 DCS1800 : Average @ PCLO | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | $I_{\text {peak }}$ | GSM900: During 1TX bursts @ PCL5 DCS1800 : During 1TX bursts @ PCLO | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | $\mathrm{I}_{\text {avg }}$ | GSM900 : Average 1TX/1RX @PCL5 DCS1800: Average 1TX/1RX @PCLO | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
| $\begin{aligned} & \text { 음 } \\ & \text { n } \\ & \frac{0}{0} \\ & 0 \\ & \frac{n}{n} \\ & \frac{0}{0} \end{aligned}$ | $I_{\text {prak }}$ | GSM900: During 2TX bursts @ PCL5 (Gamma 3) <br> DCS1800 : During 2TX bursts @ PCLO (Gamma 2) | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | $\mathrm{I}_{\text {avg }}$ | GSM900: Average 2TX/3RX @ PCL5 (Gamma 3) DCS1800 : Average 2TX/3RX © PCLO (Gamma 2) | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |
|  | $\mathrm{I}_{\text {peak }}$ | 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 |
|  | 1 mvg | GSM900 : Average 1TX/1RX @ PCL8 (Gamma 6) DCS1800 : Average 1TXV1RX @ PCL2 (Gamma 5) | @ 5.5V | TBC | TBC |
|  |  |  | @ 13.2V | TBC | TBC |
|  |  |  | @ 32V | TBC | TBC |

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| Power Consumption in <br> E-GSM 900/DCS 1800 MHz - GPRS class 10 |  |  |  |  | E-GSM 900 | DCS 1800 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\mathrm{I}_{\text {peak }}$ | GSM900: During 2TX bursts @ PCL8 (Gamma 6) DCS1800 : During 2TX bursts @ PCL2 (Gamma 5) |  | @ 5.5V | TBC | TBC |
|  |  |  |  | @ 13.2V | TBC | TBC |
|  |  |  |  | @ 32V | TBC | TBC |
|  | $\mathrm{i}_{\mathrm{ing}}^{\mathrm{ang}}$ | GSM900 : Average 2TX/3RX @ PCL8 (Gàmma 6) DCS 1800 : Average 2TX/3RX @ PCL2 (Gamma 5) |  | @ 5.5V | TBC | TBC |
|  |  |  |  | @ 13.2V | TBC | TBC |
|  |  |  |  | @ 32V | TBC | TBC |
| $I_{\text {avg }}$ in Fast Idle mode Page 9$\left(2^{*}\right)$ |  |  | 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 |
| $I_{\text {avg }}$ in Slow Idle mode Page 9$\left(3^{*}\right)$ |  |  |  | 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$\left(4^{*}\right)$ |  |  |  | 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 |
| :---: | :---: | :---: | :---: | :---: |
| $I_{\text {evg }}$ in Slow Standby mode (with FLASH LED activated) (4*) | Serial port auto shut down deactivated | @ 5.5V | 24 | TBC |
|  |  | @ 13.2 V | TBC | TBC |
|  |  | @ 32V | TBC | TBC |
|  | Serial port auto shut down activated | @ 5.5V | 8 | TBC |
|  |  | @ 13.2 V | 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 |
|  |  | @ 13.2 V | TBC | TBC |
|  |  | @ 32V | TBC | TBC |
|  | Serial port auto shut down activated | @ 5.5 V | 4 | TBC |
|  |  | @ 13.2 V | TBC | TBC |
|  |  | (1) 32V | TBC | TBC |

( $1^{*}$ ): The power consumption might vary by $5 \%$ over the whole operating temperature range $\left(-20^{\circ} \mathrm{C}\right.$ to $\left.+55^{\circ} \mathrm{C}\right)$.
( $2^{*}$ ): In this Mode, the RF function is active and the FASTRACK Supreme synchronized with the network, but there is no communication.
$\left(3^{*}\right)$ : 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.

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### 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 $\mathrm{k} \Omega$ |  | 0.5 |  | mA |  |
| Absolute microphone input voltage |  |  | 100 | mVpp | AC voltage |
| Speaker output current $150 \Omega / / 1 \mathrm{nF}$ |  | 16 |  | mA |  |
| Absolute speaker impedance | 32 | 50 |  | $\Omega$ |  |
| Impedance of the speaker amplifier output in <br> differential mode |  |  | 1 | $\Omega$ | $+/-10 \%$ |

Table 20: Microphone inputs internal audio filter characteristics

| Frequency | Gain |
| :--- | :--- |
| $0-150 \mathrm{~Hz}$ | $<-22 \mathrm{~dB}$ |
| $150-180 \mathrm{~Hz}$ | $<-11 \mathrm{~dB}$ |
| $180-200 \mathrm{~Hz}$ | $<-3 \mathrm{~dB}$ |
| $200-3700 \mathrm{~Hz}$ | 0 dB |
| $>4000 \mathrm{~Hz}$ | $<-60 \mathrm{~dB}$ |

Table 21: Recommended characteristics for the microphone:

| Feature | Value |
| :--- | :--- |
| Type | Electret $2 \mathrm{~V} / 0.5 \mathrm{~mA}$ |
| Impedance | $Z=2 \mathrm{k} \Omega$ |
| Sensitivity | -40 dB to -50 dB |
| SNR | $>50 \mathrm{~dB}$ |
| Frequency response | compatible with the GSM specifications |

Technical Characteristics
Table 22: Recommended characteristics for the speaker:

| Feature | Value |
| :--- | :--- |
| Type | 10 mW, electro-magnetic |
| Impedance | $Z=32$ to $50 \Omega$ |
| Sensitivity | 110 dB SPL min. $(0 \mathrm{~dB}=20 \mu \mathrm{~Pa})$ |
| 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 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathbf{V}_{\mathrm{IL}}$ | CMOS |  |  | 0.84 V |  |
| $\mathbf{V}_{\mathrm{IH}}$ | CMOS | 1.96 V |  |  |  |
| $\mathrm{~V}_{\mathrm{OL}}$ | CMOS |  |  | 0.4 V | $\mathrm{I}_{\mathrm{OL}}=-4 \mathrm{~mA}$ |
| $\mathrm{~V}_{\mathrm{OH}}$ | CMOS | 2.4 V |  |  | $\mathrm{I}_{\mathrm{OH}}=4 \mathrm{~mA}$ |
| $\mathrm{I}_{\mathrm{OH}}$ |  |  |  | 4 mA |  |
| $\mathrm{l}_{\mathrm{OL}}$ |  |  |  | -4 mA |  |

Clamping diodes are present on I/O pads.

### 8.2.5 SIM Interface

Table 24: SIM card characteristics

| SIM card | $1.8 \mathrm{~V} / 3 \mathrm{~V}$ |
| :--- | :--- |

### 8.2.6 RESET Signal

Table 25: Electrical characteristics

| Parameter | Min | Typ | Max | Unit |
| :---: | :---: | :---: | :---: | :---: |
| Input Impedance (R )* |  | 330 K |  | $\mathrm{k} \Omega$ |
| Input Impedance ( C ) |  | 10 n |  | nF |

*Internal pull-up

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Table 26: Operating conditions

| Parameter | Minimum | Typ | Maximum | Unit |
| :---: | :---: | :---: | :---: | :---: |
| $\sim$ RESET time (Rt) ${ }^{1}$ | 200 |  |  | $\mu \mathrm{~s}$ |
| $\sim$ RESET time (Rt $)^{2}$ at power up only | 20 | 40 | 100 | ms |
| Cancellation time (Ct) $_{\mathrm{V}_{\mathrm{H}}}$ |  | 34 |  | ms |
| $\mathrm{~V}_{\mathrm{IL}}$ | 0.57 |  |  | V |
| $\mathrm{~V}_{\mathrm{IH}}$ | 0 |  | 0.57 | V |

* $V_{\mathrm{H}:}$ Hysterisis Voltage

1 This reset time is the minimum to be carried out on the $\sim$ 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 |

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 | $>+9 \mathrm{dBc}$ |
| Selectivity @ 400 kHz | $>+41 \mathrm{dBc}$ |
| Linear dynamic range | 63 dB |
| Co-channel rejection | $>=9 \mathrm{dBc}$ |
| Transmitter |  |
| Maximum output power (E-GSM 900/GSM850) <br> at ambient temperature | $33 \mathrm{dBm}+/-2 \mathrm{~dB}$ |
| Maximum output power (DCS1800/PCS1900) <br> at ambient temperature | $30 \mathrm{dBm}+/-2 \mathrm{~dB}$ |
| Minimum output power (E-GSM 900/GSM850) <br> at ambient temperature | $5 \mathrm{dBm}+/-5 \mathrm{~dB}$ |
| Minimum output power (DCS1800/PCS1900) <br> at ambient temperature | $0 \mathrm{dBm}+/-5 \mathrm{~dB}$ |

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### 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 $850 /$ GSM $900 /$ DCS $1800 /$ PCS 1900 MHz |
| :--- | :--- |
| Impedance | 50 Ohms nominal |
| DC impedance | 00 hm |
| 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 | $-20^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$ |
| Operating / Class B | $-30^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |
| Storage | $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |

## 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.

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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 <br> (IEC TR 60721-4) |  | Environmental Classes <br> (IEC 60721-3) |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Storage | Transportation |  | eration |
| Tests | Standards | (IEC 60721-3-1) Class IE13 | (IEC 60721-3-2) Class IE23. | Stationary (IEC 60721-3-3) Class IE35 | $\begin{gathered} \text { Non-Stationary } \\ \text { (IEC 60721-3-7) } \\ \text { Class IE73 } \end{gathered}$ |
| Cold | IEC 60068-2-1 : Ab/Ad | $-25^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $40^{4} \mathrm{C}, 16 \mathrm{~h}$ | $-5^{\circ} \mathrm{C}, 16$ h | $-5^{\circ} \mathrm{C}, 16 \mathrm{~h}$ |
| Ory heat | IEC 60068-2-2 : $\mathrm{Bb} / \mathrm{Bd}$ | $+70^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $+70^{\circ} \mathrm{C} .16 \mathrm{~h}$ | $455^{\circ} \mathrm{C}, 16 \mathrm{~h}$ | $+55^{\circ} \mathrm{C}, 16 \mathrm{~h}$ |
| Change of temperature | $\begin{gathered} \text { IEC } 60068-2-14: \\ \mathrm{Na} / \mathrm{Nb} \end{gathered}$ | $-33^{\circ} \mathrm{C}$ to ambient 2 cycles, $\mathrm{t} 1=3 \mathrm{~h}$ $1^{4} \mathrm{C} \cdot \mathrm{min}^{-1}$ | $40^{\circ} \mathrm{C}$ to ambient 5 cycles, $11=3 \mathrm{~h}$ $\mathrm{t} 2 \mathrm{<} 3 \mathrm{~min}$ | $-5^{\circ} \mathrm{C}$ to ambient 2 cycles, $\mathrm{t} 1=3 \mathrm{~h}$ $0.5^{\circ} \mathrm{C} . \mathrm{min}^{-1}$ | $-5^{\circ} \mathrm{C}$ to ambient 5 cycles, $\mathrm{t} 1=3 \mathrm{~h}$ $12<3 \mathrm{~min}$ |
| Damp heat | IEC 60068-2-56 : Cb | $\begin{gathered} +30^{\circ} \mathrm{C}, 93 \% \mathrm{RH} \\ 96 \mathrm{~h} \end{gathered}$ | $+40^{\circ} \mathrm{C}, 93 \% \mathrm{RH}$ <br> 96 h minimum | $\begin{gathered} +30^{\circ} \mathrm{C}, 93 \% \mathrm{RH}, 96 \\ \mathrm{~h} \end{gathered}$ | $+30^{\circ} \mathrm{C}, 93 \% \mathrm{RH}, 96 \mathrm{~h}$ |
| Damp heat, cyclic | 60068-2-30: Db Variant 1 or 2 | $+40^{\circ} \mathrm{C}, 90 \%$ to $100 \%$ RH One cycle Variant 2 | $+55^{\circ} \mathrm{C}, 90 \%$ to $100 \% \mathrm{RH}$ Two cycles Variant 2 | $\begin{gathered} +30^{\circ} \mathrm{C}, 90 \% \text { to } 100 \% \\ \text { RH } \\ \text { Two cycles } \\ \text { Variant } 2 \end{gathered}$ | $+40^{\circ} \mathrm{C}, 90 \%$ to $100 \% \mathrm{RH}$ Two cycles Variant 1 |
| Vibration (sinusoidal) | IEC 60068-2-6 : Fc | $\begin{gathered} 1-200 \mathrm{~Hz} \\ 2 \mathrm{~m} . \mathrm{s}^{-2} \\ 0,75 \mathrm{~mm} \\ 3 \mathrm{axes} \\ 10 \text { sweep cycles } \end{gathered}$ | $\begin{gathered} 1-500 \mathrm{~Hz} \\ 10 \mathrm{m.5} \\ 3.5 \mathrm{~mm} \\ 3 \mathrm{axes} \\ 10 \text { sweep cycles } \end{gathered}$ | $\begin{gathered} 1-150 \mathrm{~Hz} \\ 2 \mathrm{~m} . \mathrm{s}^{-2} \\ 0,75 \mathrm{~mm} \\ 3 \text { axes } \\ 5 \text { sweep cycles } \end{gathered}$ | $\begin{gathered} 1-500 \mathrm{~Hz} \\ 10 \mathrm{~m} \cdot \mathrm{~s}^{-2} \\ 3,5 \mathrm{~mm} \\ 3 \text { axes } \\ 10 \text { sweep cycies } \end{gathered}$ |
| Vibration (random) | IEC 60068-2-64 : Fh | - | $\begin{gathered} 10-100 \mathrm{~Hz} / 1,0 \mathrm{~m}^{2} . \mathrm{s}^{-3} \\ 100-200 \mathrm{~Hz} /-3 \mathrm{~dB} .0 c t a v e^{-1} \\ 200-2000 \mathrm{~Hz} / 0,5 \mathrm{~m}^{2} \cdot \mathrm{~s}^{-3} \\ 3 \mathrm{axes} \\ 30 \mathrm{~min} \end{gathered}$ | - | - |
| Shock (half-sine) | IEC 60068-2-27 : Ea | - | - | $\begin{gathered} 50 \mathrm{~m} . \mathrm{s}^{-2} \\ 6 \mathrm{~ms} \\ 3 \text { shocks } \\ 6 \text { directions } \end{gathered}$ | $\begin{gathered} 150 \mathrm{~m} \cdot \mathrm{~s}^{2} \\ 11 \mathrm{~ms} \\ 3 \text { shocks } \\ 6 \text { directions } \end{gathered}$ |
| Bump | IEC 60068-2-29 : Eb | - | $250 \mathrm{~m} . \mathrm{s}^{-2}$ 6 ms 50 bumps vertical direction | - | - |
| Free fa! | ISO 4180-2 | - | Two falls in each specified atlitude | - | 2 falls in each specified attitude $0,025 \mathrm{~m}(<1 \mathrm{~kg})$ |
| Drop and topple | IEC 60068-2-31 : Ec | - | One drop on relevant comer 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 <br> spectrum | EN 301 419-(v 4.1.1) <br> EN 301 511 (V 7.0.1) |
| EMC | EN 301 489-1 (edition 2002) |
|  | EN 301 489-7 (edition 2002) |
| Global Certification Forum - Certification <br> Criteria | GCF-CC V3.13.0 |
| PTCRB |  |
| FCC |  |
| IC |  |

### 8.5 Protections

### 8.5.1 Power Supply

The FASTRACK Supreme is protected by a $800 \mathrm{~mA} / 250 \mathrm{~V}$ fuse directly bonded on the power supply cable. The model of fuse used is: FSD $800 \mathrm{~mA} / 250 \mathrm{~V}$ 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 ${ }^{\text {® }}$.

- 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.
wovecome
Make If wireless

# Fastrack Supreme User Guide 

Safety recommendations
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 ${ }^{\circ}$. 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 ${ }^{\ominus}$.
The use of third party equipment or accessories, not made or authorized by Wavecom may invalidate the warranty of the Wireless CPU ${ }^{\text {® }}$.
Do contact an authorized Service Center in the unlikely event of a fault in the Wireless CPU ${ }^{\oplus}$.

### 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.

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5 june, 2007


Recommended Accessories

## 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 <br> adaptor |  | PROCOM |
| Power adaptor (Europe) | EGSTDW P2 EF9W3 24W <br> Out:12 V-2A <br> In: 100 to $240 \mathrm{~V}-50 / 60 \mathrm{~Hz}-550 \mathrm{~mA}$ <br> Mounted with micro-fit connector | EGSTDW (for power adaptor) <br> 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.

Online Support

## 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 $A T^{\circledR}$
- 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.

## HUMAN MACHINE INTERFACE

## 1. HUMAN MACHINE INTERFACE TECHNICAL DETAILS

# 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 $320 \times 240$ PIXEL LCD
- 5-BUTTON KEYPAD FOR ON-SCREEN MENUS
- three front panel led indicators
- POWER UNIT FROM 24 VDC $\pm 20 \%$ SUPPLY
- resistive analog touchscreen


## 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 safery 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.

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 | CBLPROGO |
|  | 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 ${ }^{(8)}$ 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: $\quad+24$ VDC $\pm 20 \%$
Typical Power!: 8 W
Maximum Power ${ }^{2}$ : 14 W
Notes:

1. Typical power with $+2+$ VDC, RS232/485 communications, Ethernet communications, CompaciFlash card installed, and displeny at full brighiness.
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.
5. BATTERY: Lithium coin cell. Typical lifetime of 10 years.
6. LCD DISPLAY

| SIZE | 5.7-inch |
| :--- | :---: |
| TYPE | TFT |
| COLORS | 256 |
| PIXELS | $320 \times 240$ |
| BRIGHTNESS | $500 \mathrm{~cd} / \mathrm{m}^{2}$ |
| BACKLIGHT* | $40,000 \mathrm{HR}$ 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 1 and Type II CompactFlash cards.
7. COMMUNICATIONS

USB Port: Adheres to USB specification I.I. 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 RJI2.
DH485 TXEN: Transmit enable; open collector, $\mathrm{V}_{\mathrm{OH}}=15 \mathrm{VDC}$, $\mathrm{V}_{\mathrm{OL}}=0.5 \mathrm{~V} @ 25 \mathrm{~mA}$ 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 $50^{\circ} \mathrm{C}$
Storage Temperature Range: -20 to $70^{\circ} \mathrm{C}$
Operating and Storage Humidity: $80 \%$ maximum relative humidity (noncondensing) from 0 to $50^{\circ} \mathrm{C}$
Vibration according to IEC 68-2-6: Operational 5 to $8 \mathrm{~Hz}, 0.8^{\prime \prime}(p-p), 8$ to 500 Hz , in $\mathrm{X}, \mathrm{Y}, \mathrm{Z}$ direction, duration: 1 hour, 3 g .
Shock according to IEC 68-2-27: Operational $40 \mathrm{~g}, 9 \mathrm{msec}$ 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, Pant 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
Fast transients (burst)

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
$3 \mathrm{~V} / \mathrm{rms}$
Emissions:
Emissions EN 55011 Class A
Note:
I. 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 ( $56-79 \mathrm{~N}-\mathrm{cm}$ )

1. 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 Il, Pollution Degree 2.
2. MOUNTING REQUIREMENTS: Maximum panel thickness is 0.25 " (6.3 mm ). For NEMA 4X/IP66 sealing, a steel panel with a minimum thickness of $0.125^{\prime \prime}(3.17 \mathrm{~mm})$ is recommended.
Maximum Mounting Stud Torque: 17 inch-pounds (1.92 N-m)
3. WEIGHT: $3.0 \mathrm{lbs}(1.36 \mathrm{Kg})$

## DIMENSIONS In inches (mm)



## Installing and Powering the G306A

## MOUNTING INSTRUCTIONS

This operator interface is designed for through-panel mounting. A panel cutout 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 $4 X /$ 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 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 WTHIN 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 berween signal common and earth ground care must be taken when connecrions: are made to the unil. 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. ${ }^{\text {I }}$
' 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 <br> 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.


## Commúnicating With the G306A

## CONFIGURING A G306A

The G306A is configured using Crimson ${ }^{(8)}$ 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 ${ }^{(8)}$ 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 Por 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:Mrogram Files\Red Lion Controls)Crimson 2.01Devicel after Crimson is installed. This may have already been accomplished if your G306A was configured using the USB por.

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 atso be used to communicate with either a PC or an ICM5.
${ }^{2}$ DB9 adapter not included, I foot long.
${ }^{3}$ DB9 adapter not included, 10 feet long.


## 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 10 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 | - | 24 V |
| 4,7 | RxB | - | COMM |
| 5 | TxEN | 5 | TxEN |
| 6 | COMM | 4 | SHIELD |
| 4,7 | TxB | - | COMM |
| 3.8 | TxA | - | 24 V |

## 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 ${ }^{\circledR}$ SOFTWARE

Crimson ${ }^{80}$ 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 ${ }^{(8)}$ software when configuring your unit.

## FRONT PANEL LEDS

There are three front panel LEDs. Shown below is the default status of the LEDs.

| LEO | 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. |
| YEШOW (MIDDLE) |  |
| OFF | No CompactFlash card is present. |
| STEADY | Valid CompaciFlash card present. |
| FLASHING RAPIDLY | Compac1Flash 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 SLOMLY | 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 wil 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: techsuppon@redlionnet 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 IIO WRING 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 naste 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 $G 3$ 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 Il socket that can accept either Type I or ll 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.
 the CompactFlash card while power is applied. Refer to
"Front Panel LEDs."
Information stored on a CompacıFlash card by a G306A can be read by a card reader attached to a PC. This information is stored in IBM (Windows ${ }^{\text {² }}$ ) PC compatible FATI6 file format.

## NOTE

For reliable operation in all of our products, Red Lion recommends the use of SanDisk ${ }^{(8)}$ and SimpleTech brands of CompactFlash cards. Industrial grade versions that provide up to two million write/erase cycles minimum are available from Red Lion.

## LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, pronise or representation with respect to the products.
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## LOAD BREAK SWITCH

## 1. SLB SERIES LOAD BREAK SWITCH TECHNICAL DETAILS



## SLB Standard load-break switches

SIRCO 125 to 4000 A
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 accessonies to choose from.
Front operated surface mount
(Supplied with external handle and shaft)
SLB 125... 630
AC 21400 V AC $23400 \mathrm{~V} \quad \mathrm{AC} 23400 \mathrm{~V}$
(A) (A)
(A)
(kW)
No. of poles ${ }^{1}$ )
Cat. No.
125 A
160 A
200 A
250 A
315 A
400 A
500 A
630 A
800 A

| (A) | (A) | (kW) |  | Cat. No. |
| :---: | :---: | :---: | :---: | :---: |
| 125 | 125 | 63 | 3 | SLB 125 3P |
|  |  |  | 4 | SLB 1254 P |
| 160 | 160 | 80 | 3 | SLB 160 3P |
|  |  |  | 4 | SLB 1604 P |
| 200 | 200 | 100 | 3 | SLB 200 3P |
|  |  |  | 4 | SLB 2004 P |
| 250 | 250 | 132 | 3 | SLB 250 3P |
|  |  |  | 4 | SLB 250 4P |
| 315 | 315 | 160 | 3 | SLB 315 3P |
|  |  |  | 4 | SLB 315 4P |
| 400 | 400 | 220 | 3 | SLB 400 3P |
|  |  |  | 4 | SLB 400 4P |
| 500 | 400 | 280 | 3 | SLB 500 3P |
|  |  |  | 4 | SLB 500 4P |
| 630 | 500 | 280 | 3 | SLB 630 3P |
|  |  |  | 4 | (i) SLB 630 4P |
| 800 | 800 | 450 | 3 | SLB 800.3P |
|  |  |  | 4 | ()SLB 800 4P |

Notes: ') 6 and 8 pole switches available on indent. Refer NHP. i) Available on indent only.


SLB 800... 3150

## Technical data and dimensions (mm)

## SIRCO SLB 125 to 2500 A

SIRCO 125 to 2500 A


| Rating | Switch body |  | Switch mounting |  | T | U |  | Connection terminals |  |  | Z | AA |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| A | F 3p | F 4p | M 3p | M 4p |  |  | V | $Y$ | X1 | $\times 2$ |  |  |
| 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 |



Technical data and ratings chart

## SIRCO SLB 125 to 630 A

Ratings to AS 3947-3 and IEC 60947-3


Note: $240 / 415 \mathrm{~V}$ ratings suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS 60038: 2000.

## LEVEL TRANSMITTER

## 1. LEVEL TRANSMITTER TECHNICAL DETAILS



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 hydroslatic 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 $\mathrm{Pt1} 00$ temperature sensor
- Accuracy
- Reference accuracy $\pm 0.2 \%$
- PLATINUM version $\pm 0.1 \%$
- 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


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## Function and system design

## Device selection

| Waterpilot FMX21 | PDIFMU2112x-18-21-22•12-002 |  |  |
| :---: | :---: | :---: | :---: |
| Field of application | Hydrostatic level measurement in deep wells e.g. drinking water | Hydrostatic level measurement in wastewater | Hydrostatic level measurement in saltwater |
|  | [) Caution! <br> 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 <br> - Extension cable mounting screw with C1 $1 / 2$ A or $11 / 2$ NPT thread |  |  |
| Outer diameter | 22 mm (0.87 in) | 42 mm ( 1.05 in ) | max. 29 mm (1.14 in) |
| Extension cable | - PE extension cable <br> - PUR extension cable <br> - FEP extension cable |  |  |
| Seals | - FKM Viton <br> - EPDM ${ }^{1}{ }^{1}$ | - FKM Viton | - FKM Viton <br> - EPDM ${ }^{11}$ |
| Measuring ranges | - Cauge pressure: from 0 to 0.1 bar to 0 to 20 bar (0 to 1.5 psi to 0 to 300 psi$)$ <br> - Absolute pressure: from 0 to 2 bar to 0 to 20 bar ( 0 to 30 psi to 0 to 300 psi ) |  | - Cauge pressure: from 0 to 0.1 bar to 0 to 4 bar (0 to 1.5 psi bis 0 to 00 psi ) <br> - 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 <br> - The following output units can be configured: \%, mbat, bar, $\mathrm{kPa}, \mathrm{MPa}, \mathrm{mmH}_{2} \mathrm{O}_{1} \mathrm{mH}_{2} \mathrm{O}_{1}$, in $\mathrm{H}_{2} \mathrm{O}$, ith $\mathrm{H}_{2} \mathrm{O}$, psi and numerous level units. |  |  |
| Overload | Up to 40 bar ( 580 psi ) |  | Up to 25 bar ( 302 psi ) |
| Process temperature range | -10 to $+70^{\circ} \mathrm{C}\left(+14\right.$ to $\left.+158^{\circ} \mathrm{F}\right)$ |  | 0 to $+50^{\circ} \mathrm{C}\left(+32\right.$ to $\left.+122^{\circ} \mathrm{F}\right)$ |
| Reference accuracy | $- \pm 0.2 \%$ of the set span <br> - Optional: $\pm 0.1$ \% of set span (PLATINUM version) |  |  |
| Supply voltage | 10.5 to 35 V DC, Ex: 10.5 to 30 VDC |  |  |
| Output | 4 to 20 mA (invertible) with superimposed digital communication protocol HART 0.0, 2-wire (invertible) |  |  |
| Options | - Large selection of approvals, including ATEX, FM, CSA, Drinking water approval <br> - Broad range of accessories <br> - Integrated Pt100 temperature sensor and TMT 182 temperature head transmitter ( 4 to $20 \mathrm{~mA} / \mathrm{HART}$ ) |  |  |
| Specialties | - High-precision, robust ceramic measuring cell with long-term stability <br> - Automatic density compensation <br> - Customer specific cable marking <br> - Absolute pressure cell |  |  |

[^19]
## 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
$\rho \quad$ Density of the medium
g Gravitational acceleration
$p_{\text {hydr．}}$ Hydrostatic pressure
$p_{\text {atm }}$ 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 $\rightarrow$ 目 26 ＂Accessories＂．

## Temperature measurement with optional Pt100 and TMT 182 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 0.0 ，see also $\rightarrow$ 自 7 ＂Density compensation with Pt100 temperature sensor＂$\rightarrow$ 自 24 ＂Ordering information＂$\rightarrow$ 血 26 Chap．＂Accessories＂and Technical Information Tl078R．

[^20]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 VDC (hazardous areas) or 10.5 to 35 VDC (non-hazardous areas).

Possible measuring point solutions with a transmitter and evaluation units from Endress+Hauser:


Sample applications with FMXZ1
$O P=$ Overvoltage protection, e.g. HAW from Endress + Hauser (not for use in hazardous areas)

- OP on sensor side for field installation: HAWS09/for top-hat/DIN rail: HAW562/intrinsically safe HAW502Z
- OP on power supply side for top-hat/DIN rail: HAW561 (115/230 V) and HAW56IK (24/48 VAC/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 nonhazardous 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 FMK21 with Pt 100
$O P=$ Overvoltage protection e.g. HAW from Endress+Hauser (not for use in hazardous areas)

- OP on sensor side for feld installation: HAW500/for top-hat/DIN rail: HAWSO2/intrinsically safe HAW502Z
- OP on power supply side for top-hat/D/N rail: HAWS01 (IIS/230 V and HAWSOIK (24/48 V AC/DC)

The avervoltage 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 TMT 182 temperature head transmitter can convert the Pt 100 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 Pt 100 signal.
6. If you want to record and evaluate the level and temperature measured value with one device, use the RMA422, RIA45 and RIA40 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


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 "Elects. 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

 Pt 100 temperature sensorThe 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 (egg. PLC)
The Waterpilat FMX21 is available with an optional Pt 100 temperature sensor. Endress+Hauser additionally offers the TMT182 temperature head transmitter to convert the Ptl00 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).


## 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.


Without compensation additional errors of up to $4 \%$ can occur at a temperature of $70^{\circ} \mathrm{C}\left(158^{\circ} \mathrm{F}\right)$ for example. With density compensation, this error can be decreased to $0.5 \%$ in the entire temperature range from 0 to $70^{\circ} \mathrm{C}\left(32\right.$ to $\left.158^{\circ} \mathrm{F}\right)$.

Note!
For further information on the devices, please refer to the appropriate Technical Information:

- TI078R: TMT182 temperature head transmitter ( 4 to $20 \mathrm{~mA} / \mathrm{HART}$ )
- 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 $\rightarrow$ 冒 24 ff "Ordering information", feature 895 "Marking" version "Z1". |

## Input

| Measured variable | FMX21 + Pt100 (optional) | TMT182 temperature head transmitter <br> (optional) |
| :--- | :--- | :--- |
|  | - Hydrostatic pressure of a liquid <br> - Pt100: temperature |  |
| Measuring range | - Customer-specific meature |  |


| Sensor measuring range <br> [bar (psi)] | Smallest span that can be calibrated <br> [bar (psi)] | Maximum overioad/ OPL ${ }^{1)}$ <br> [bar (psi)] | Vacuum resistance $\left\|\mathrm{bar}_{\mathrm{abs}}(\mathrm{psi} \mathrm{abs})\right\|$ | Version in the order code ${ }^{2)}$ |
| :---: | :---: | :---: | :---: | :---: |
| Gauge pressure |  |  |  |  |
| 0.1 (1.5) | 0.01 (0.15) | 5.0 (75.0) | 0.3 (4.5) | IC |
| 0.2 (3.0) | 0.02 (0.3) | 5.0 (75.0) | 0.3 (4.5) | 1D |
| 0.4 (0.0) | 0.04 (1.0) | 0.0 (90.0) | 0 | IF |
| 0.6 (9.0) | 0.06 (1.0) | 10.0 (150) | 0 | IG |
| 1.0 (15.0) | 0.1 (1.5) | 10.0(150) | 0 | IH |
| 2.0 (30.0) | 0.2 (3.0) | 15.0 (225) | 0 | IK |
| 4.0 (60.0) | 0.4 (6.0) | 25.0 (375) | 0 | 1M |
| 10.0 (150) ${ }^{3)}$ | 1.0 (15) | 40.0 (600) | 0 | IP |
| 20.0 (300) ${ }^{3}$ ) | 2.0 (30) | 40.0 (600) | 0 | 10 |
| Absolute pressure |  |  |  |  |
| 2.0 (30.0) | 0.2 (3.0) | 15.0 (225) | 0 | 2K |
| $4.0160 .0)$ | 0.4 (6.0) | 25.0 (375) | 0 | 2M |
| 10.0 (150) ${ }^{31}$ | $1.0(15)$ | 40.0 (600) | 0 | 2P |
| 20.0 (300) ${ }^{3}$ | 2.0 (30) | 40.0 (600) | 0 | 20 |

1) OPL: overpressure limit, depending on the weakest element, in terms of pressure, of the selected components
2) See $\rightarrow$ 医 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).

## FMX21 + Pt100 (optional)

- Change in capacitance
- Pt100: change in resistance

TMT182 temperature head transmitter (optional)

- Ptl00 resistance signal, 4-wire


## Output

| Output signal | FMX21 + Pt100 (optional) <br> 4 to 20 mA with overlying digital HART 6.0 communication protocol, 2 -wire for hydrostatic pressure measured value <br> - Pt100: Temperature-dependent resistance values | TMT182 temperature head transmitter (optional) <br> - 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) <br> 4 to $20 \mathrm{~mA} / \mathrm{HART}$ <br> Options: <br> - Max. alarm (factory setting 22mA): can be set from 21 to 23 mA <br> - Hold measured value: last measured value is held <br> - Min. alarm: 3.6 mA | TMT182 temperature head transmitter (optional) <br> Options: <br> - Max. alarm $\geq 21.0 \mathrm{~mA}$ <br> - Min. alarm $\leq 3.6 \mathrm{~mA}$ |

## Load

FMX21
TMT182 temperature head transmitter (optional)

$$
\begin{aligned}
& R_{L_{\max }} \leq \frac{U-10.5 \mathrm{~V}}{23 \mathrm{~mA}}-2 \cdot 0.9 \frac{\Omega}{\mathrm{~m}} \cdot 1-\mathrm{R}_{\mathrm{add}} \\
& \text { Pol-FMR212 } 12-10-11-11+6000 \\
& R_{\text {Lmax }}=\text { Max. load resistance } \Omega / \\
& R_{\text {add }}=\text { Additional resistances such as resistance of evaluation unit and/or display unit, } \\
& \text { cable resistance } / \Omega \text { / } \\
& U=\text { Supply voltage } M \\
& I=\text { Simple length of extension cable } / \mathrm{m} / \text { (cable resistance per wire } \leq 0.09 \Omega / \mathrm{m} \text { ) }
\end{aligned}
$$

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.


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.


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 $250 \Omega$ has to be taken into account.

| Resolution | Current output: $1 \mu \mathrm{~A}$ |
| :--- | :--- |
|  | 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 <br>  |

## 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). $\rightarrow$ 自 28 "Additional documentation", "Safety instructions" and "Installation/Control Drawings".
- Reverse polarity protection is integrated in the Waterpilot FMX21 and in the TMT1 82 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 GORETEX ${ }^{\circledR}$ filter from Endress + Hauser is suitable for outdoor installations. The terminal box can be ordered as an accessory using the order code for FMX21 $\rightarrow$ 自 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


Electrical connection

FMX21 with Pt100 ${ }^{1}$

(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 $20 \mathrm{~mA} / \mathrm{HART}$ ) ${ }^{11}$


FMX21 with Pt100 and TMT182 temperature head transmitter versions "NB" and "PT" for the features 610 and 020 in the order code $\rightarrow$ 自 24 ff .
(1) Not for FMX2I with an outer diameter of 29 mm (1.14 in).

Wire colors: $\mathrm{RD}=$ red, $\mathrm{BK}=$ black, $\mathrm{WH}=$ white, $\mathrm{YE}=$ yellow, $\mathrm{BU}=$ blue, $\mathrm{BR}=$ 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 VDC |
| Ii | 133 mA |
| Pi | 1.0 W |
| Ci | $10.3 \mathrm{nF}($ sensor $) / 180 \mathrm{pF} / \mathrm{m}($ cable $)$ |
| Li | $0 \mu \mathrm{H}($ sensor $) / 1 \mu \mathrm{H} / \mathrm{m}$ (cable) |
| Ta | $-10^{\circ} \mathrm{C}\left(+14^{\circ} \mathrm{F}\right) \leq \mathrm{Ta} \leq+70^{\circ} \mathrm{C}\left(+158^{\circ} \mathrm{F}\right)$ for $\mathrm{T} 4 ;-10^{\circ} \mathrm{C}\left(+14^{\circ} \mathrm{F}\right) \leq \mathrm{Ta} \leq+40^{\circ} \mathrm{C}\left(+104^{\circ} \mathrm{F}\right)$ for To |


| Supply voltage | Note! <br> - 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 $\rightarrow$ 会 28 "Additional documentation". |  |
| :---: | :---: | :---: |
|  | FMX21 + Pt100 (optional) <br> - 10.5 to 35 V (non-hazardous area) <br> - 10.5 to 30 V (hazardous area) | TMT182 temperature head transmitter (optional) <br> - 11.5 to 35 V DC |
| Cable specifications | FMX21 + Pt1 00 (optional) <br> - Commercially available shielded instrument cable <br> - Terminal, terminal box: 0.08 to $2.5 \mathrm{~mm}^{2}$ ( 28 to 14 AWG) <br> - If the Pt100 signal is directly connected to a display and/or evaluation unit, Endress+Hauser recommends using a shielded cable. | TMT182 temperature head transmitter (optional) <br> - Commercially available shielded instrument cable <br> - Terminal, terminal box: <br> 0.08 to $2.5 \mathrm{~mm}^{2}$ (28 to 14 AWG) <br> - Transmitter connection: max. $1.75 \mathrm{~mm}^{2}$ ( 15 AWG ) |
| Power consumption | FMX21 + Pt100 (optional) <br> - $\leq 0.805 \mathrm{~W}$ at 35 V DC (non-hazardous area) <br> - $\leq 0.690 \mathrm{~W}$ at 30 V DC (hazardous area) | TMT182 temperature head transmitter (optional) $\text { - } \leq 0.805 \mathrm{~W} \text { at } 35 \mathrm{~V} \mathrm{DC}$ |


| Current consumption | FMX21 + Pt100 (optional) <br> - Max. current consumption: $\leq 23 \mathrm{~mA}$ Min. current consumption: $\geq 3.6 \mathrm{~mA}$ <br> - Pt100: $\leq 0.6 \mathrm{~mA}$ | TMT182 temperature head transmitter (optional) <br> - Max. current consumption $: \leq 23 \mathrm{~mA}$ <br> Min. current consumption: $\geq 3.5 \mathrm{~mA}$ <br> - Pt100 via temperature head transmitter: $\leq 0.6 \mathrm{~mA}$ |
| :---: | :---: | :---: |
| Residual ripple | FMX21 + Pt100 (optional) | TMT182 temperature head transmitter (optional) |
|  | - No impact on 4 to 20 mA signal to $\pm 5 \%$ residual ripple within the permitted voltage range (according to HART Hardware Specification HCF_SPEC-54 (DIN IEC 60381-1)). | $\mathrm{U}_{\mathrm{ss}} \geq 3 \mathrm{~V} \text { at } \mathrm{U}_{\mathrm{b}} \geq 13 \mathrm{~V}, \mathrm{f}_{\text {max }}=1 \mathrm{kHz}$ |

## Performance characteristics

| Reference operating conditions | FMX21 + Pt100 (optional) <br> - As per IEC 60770 <br> - Ambient remperature $\mathrm{T}_{\mathrm{A}}=$ constant, in range: +21 to $+33^{\circ} \mathrm{C}\left(+70^{\circ} \mathrm{F}\right.$ to $\left.+91^{\circ} \mathrm{F}\right)$ <br> - Humidity $\varphi=$ constant, in range: 20 to 80 \% RH <br> - Ambient pressure $P_{A}=$ constant, in range: 800 to 1000 mbar ( 12.47 to 15.37 psi ) <br> - Position of the measuring cell $=$ constant , in range: vertical: $\pm 1^{\circ}$ <br> - Supply voltage constant: 21 V DC to 27 V DC <br> - Load with HART: $250 \Omega$ <br> - PtIOO: DJN EN $60770 \mathrm{~T}_{\mathrm{A}}=25^{\circ} \mathrm{C}\left(77^{\circ} \mathrm{F}\right)$ | TMT182 temperature head transmitter (optional) <br> Calibration temperature $25^{\circ} \mathrm{C}\left(77^{\circ} \mathrm{F}\right) \pm 5 \mathrm{~K}$ |
| :---: | :---: | :---: |


| Reference accuracy | FMX21 + Pt100 (optional) | TMT182 temperature head transmitter (optional) |
| :---: | :---: | :---: |
|  | The reference accuracy comprises the non-linearity after limit point configuration, hysteresis and nonrepeatability in accordance with IEC 60770. <br> - Setting $\pm 0.2 \%$ <br> - to TD 5:1: $<0.2 \%$ of the set span <br> - from TD 5:1 to TD $10: 1 \pm(0.02 \times$ TD +0.1$)$ <br> PLATINUM version: <br> - Setting $\pm 0.1 \%$ (optional) <br> - to TD 5:1: < $0.1 \%$ of the set span <br> - from TD 5:1 to TD $10: 1 \pm(0.02 \times$ TD $)$ <br> - Class B to DIN EN 60751 <br> - Pt100: max. $\pm 1 \mathrm{~K}$ | - $\pm 0.2 \mathrm{~K}$ <br> - With Pt100: max. $\pm 0.9 \mathrm{~K}$ |


| Long-term stability | FMX21 + Pt100 (optional) <br> - $\leq 0.1 \%$ of URL/year <br> - $\leq 0.25 \%$ of URL $/ 5$ years | TMT 182 temperature head transmitter (optional) $\leq 0.1 \mathrm{~K}$ per year |
| :---: | :---: | :---: |
| Influence of medium temperature | - Thermal change in the zero 0 to $+30^{\circ} \mathrm{C}\left(+32\right.$ to $+80^{\circ}$ -10 to $+70^{\circ} \mathrm{C}(+14$ to +158 <br> - Temperature coefficient (T -10 to $+70^{\circ} \mathrm{C}(+14$ to +1 | span <br> \% <br> 1\% <br> output span <br> L |
| Warm-up period | $\begin{aligned} & \text { FMX21 + Pt100 (optional) } \\ & \text { FMX21:<6s } \\ & \text { Pt100: } 20 \mathrm{~ms} \end{aligned}$ | TMT182 temperature head transmitter (optional) 4 s |


| Step response time | FMX21 + Pt100 (optional) | - |
| :--- | :--- | :--- |
|  | - FMX21: 400 ms (T90 time), $500 \mathrm{~ms}(\mathrm{~T} 99$ time) |  |
|  | - Pt100: 100 s (T90 time), 300 s (T99 time) |  |

## Installation

## Installation instructions



Installation examples，here illustrated with FMX2I with an outer diameter of $22 \mathrm{~mm}(0.87 \mathrm{in}$ ）
1 Extension cable mounting screw can be ordered via order code or as an accessory $\rightarrow$ 会 24 ff
2 Terminal box can be ordered via order code or as an accessory $\rightarrow$ 臽 24 ff
3 Extension cable bending radius $>120 \mathrm{~mm}(4.72 \mathrm{in})$
4 Mounting clamp can be ordered via order code or as an accessory $\rightarrow$ 居 24 ff
5 Extension cable，length $\rightarrow$ 自 21
0 Guide pipe
7 Additional weight can be ordered as an accessory for FMX2 1 with an outer diameter of 22 mm （ 0.87 in ）and 29 mm （ 1.14 in）$\rightarrow$ 自 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 $\rightarrow$ 䜿 24 ff（SD552P／00／A6）．
－Endress＋Hauser recommends using twisted，shielded cables．

## Ambient conditions

| Ambient temperature range | FMX21 + Pt100 (optional) <br> - FMX21 with outer diameter of $22 \mathrm{~mm}(0.87 \mathrm{in})$ and $42 \mathrm{~mm}(1.65 \mathrm{in}):$ $-10 \text { to }+70^{\circ} \mathrm{C}\left(+14 \text { to }+158^{\circ} \mathrm{F}\right)$ <br> ( $=$ medium temperature) <br> - FMX21 with outer diameter of $29 \mathrm{~mm}(1.14 \mathrm{in})$ : $0 \text { to }+50^{\circ} \mathrm{C}\left(+32 \text { to }+122^{\circ} \mathrm{F}\right)$ <br> ( $=$ medium temperature) <br> Terminal box <br> - -40 to $+80^{\circ} \mathrm{C}\left(-40\right.$ to $\left.+176^{\circ} \mathrm{F}\right)$ | TMT182 temperature head transmitter (optional) $-40 \text { to }+85^{\circ} \mathrm{C}\left(-40 \text { to }+185^{\circ} \mathrm{F}\right)$ |
| :---: | :---: | :---: |
| Storage temperature range | FMX21 + Pt100 (optional) <br> a -40 to $+80^{\circ} \mathrm{C}\left(-40\right.$ to $\left.+176^{\circ} \mathrm{F}\right)$ <br> Terminal box <br> - -40 to $+80^{\circ} \mathrm{C}\left(-40\right.$ to $\left.+170^{\circ} \mathrm{F}\right)$ | TMT182 temperature head transmitter (optional) $-40 \text { to }+100^{\circ} \mathrm{C}\left(-40 \text { to }+212^{\circ} \mathrm{F}\right)$ |
| Degree of protection | FMX21 + Pt100 (optional) <br> - IP68, permanently hermetically sealed at 40 bar ( 580 psi ) ( $\sim 400 \mathrm{~m} \mathrm{H}_{2} \mathrm{O}$ ) <br> Terminal box (optional) <br> - IP66/IP67 | TMT182 temperature head transmitter (optional) <br> - IPOO, condensation permitted |


| Electromagnetic compatibility (EMC) | FMX21 + Pt100 (optional) <br> - EMC in accordance with all the relevant requirements of the EN 01326 series. Details are provided in the Declaration of Conformity. <br> - Maximum deviation $<0.5 \%$ of the span. | TMT182 temperature head transmitter (optional) <br> - EMC in accordance with all the relevant requirements of the EN 01326 series. Details are provided in the Declaration of Conformity. |
| :---: | :---: | :---: |
| Overvoltage protection | FMX21 + Pt100 (optional) <br> Integrated overvoltage protection to EN 61000-4-5 ( 500 V symmetrical/ 1000 asymmetrical) Install overvoltage protection $\geq 1.0 \mathrm{kV}$, external if necessary | TMT182 temperature head transmitter (optional) Install overvoltage protection, external if necessary. |

## Process conditions

| Medium temperature range | FMX21 + Pt100 (optional) <br> - FMX21 with outer diameter of $22 \mathrm{~mm}(0.87 \mathrm{in})$ and $42 \mathrm{~mm}(1.05 \mathrm{in})$ : $-10 t 0+70^{\circ} \mathrm{C}\left(+14 t 0+158^{\circ} \mathrm{F}\right)$ <br> - FMX21 with outer diameter of 29 mm ( 1.14 in ): 0 to $+50^{\circ} \mathrm{C}\left(+32\right.$ to $\left.+122^{\circ} \mathrm{F}\right)$ | TMT182 temperature head transmitter (optional) |
| :---: | :---: | :---: |
| Medium temperature limits | FMX21 + P1100 (optional) <br> - FMX21 with outer diameter of $22 \mathrm{~mm}(0.87 \mathrm{in})$ and $42 \mathrm{~mm}(1.65 \mathrm{in})$ : $-20 \text { to }+70^{\circ} \mathrm{C}\left(-4 \text { to }+158^{\circ} \mathrm{F}\right)$ <br> Note! <br> In hazardous areas incl. CSA GP, the medium temperature limit is at -10 to $+70^{\circ} \mathrm{C}$ $\left(+14\right.$ to $\left.+158^{\circ} \mathrm{F}\right)$. <br> a FMX21 with outer diameter of $29 \mathrm{~mm}(1.14 \mathrm{in})$ : 0 to $+50^{\circ} \mathrm{C}\left(+32\right.$ to $\left.+122^{\circ} \mathrm{F}\right)$ <br> (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


Versions of the FMX21
1 Version＂ 1 ＂for feature 45 ＂Probe tube＂or＂Accessories＂in the order code $\rightarrow$ 青 24 ff
2 Version＂2＂for feature 45 ＂Probe tube＂in the order code $\rightarrow$ 亩 24 ff
3 Version＂5＂for feature 45 ＂Probe tube＂in the order code $\rightarrow$ 首 24 ff
4 Pressure compensation tube
5 Extension cable
Protection cap

Dimensions of the mounting clamp


Mounting clamp，version＂PO＂for feature 620 ＂Accessories＂in the order code $\rightarrow$ 自 24 ff

## Dimensions of the extension

 cable mounting screws

Extension cable mounting screws
1 Extension cable mounting screw C $11 / 2$ A, version "PQ" for feature 620 "Accessories" in the order code $\rightarrow$ 自 24 ff
2 Extension cable mounting screw I 1/2 NPT, version "PR" for feature 020 "Accessories" in the order code $\rightarrow$ Biff

Note!
Application in unpressurized containers only.

Dimensions of the IP66/IP67 terminal boxes with filters


Terminal box / Version "PS" or "PT" for feature 020 "Accessories" in the order code $\rightarrow$ 自 24 ff
Dummy plug M20x 1.5
GORE-TEX ${ }^{8}$ filter
Ground connection / terminals for 0.08 to $2.5 \mathrm{~mm}^{2}$ (28 to 14 AWG)
4 to $20 \mathrm{~mA} /$ terminals for 0.08 to $2.5 \mathrm{~mm}^{2}$ (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 TMT 182 temperature head transmitter


TMT182 temperature head transmitter (4 to $20 \mathrm{~mA} / H A R T$ ), version "PT" for feature 020 "Accessories" in the order code $\rightarrow$ 區 24 ff .

Terminal box with integrated TMT 182 temperature head transmitter ( 4 to 20 mA / HART)


|  | $\underset{\Delta}{0}$ | Note! <br> A distance of $>7 \mathrm{~mm}$ ( $>0.28 \mathrm{in} \mathrm{mm}$ ) must be maintained between the terminal strip and the TMT 182 temperature head transmitter. |
| :---: | :---: | :---: |
| Weight |  | - Level probe, outer diameter $22 \mathrm{~mm}(0.87 \mathrm{in}): 344 \mathrm{~g}(12.133 \mathrm{oz})$ <br> - Level probe, outer diameter 29 mm ( 1.14 in ): 394 g ( 13.896 oz) <br> - Level probe, outer diameter 42 mm ( 1.05 in ): $1376 \mathrm{~g}(48.532 \mathrm{oz})$ <br> - PE extension cable: $52 \mathrm{~g} / \mathrm{m}(0.33 \mathrm{lbs} / 1 \mathrm{ft})$ <br> - FEP extension cable: $108 \mathrm{~g} / \mathrm{m}(0.072 \mathrm{lbs} / 1 \mathrm{ft})$ <br> - PUR extension cable: $00 \mathrm{~g} / \mathrm{m}(0.039 \mathrm{lbs} / 1 \mathrm{ft})$ <br> - Mounting clamp: $170 \mathrm{~g}(5.996 \mathrm{oz})$ <br> - Extension cable mounting screw G1 $1 / 2 \mathrm{~A}: 770 \mathrm{~g}(27.158 \mathrm{oz})$ <br> - Extension cable mounting screw $11 / 2$ NPT: 724 g (25.535 oz) <br> - Terminal box: $235 \mathrm{~g}(8.288 \mathrm{oz})$ <br> - Temperature head transmitter: 40 g ( 1.41 loz ) <br> - Additional weight: $300 \mathrm{~g}(1.376 \mathrm{oz})$ <br> - Adapter weight: 39 g |


| Material | - Level probe, outer diameter $22 \mathrm{~mm}(0.87 \mathrm{in}): 1.4435$ (AIS1 316L) <br> - Level probe, outer diameter 29 mm ( 1.14 in ): 1.4435 (AISI 316L) <br> - Sensor sleeve: PPS (polyphenylene sulfide); heat-shrink tube/cover: polyolefin. <br> The materials used ensure that metal does not come in contact with the medium. <br> - Level probe, outer diameter 42 mm ( 1.05 in ): 1.4435 (AISI 316L) <br> - Process ceramic: $\mathrm{Al}_{2} \mathrm{O}_{3}$ aluminum oxide ceramic <br> - Seal (internal): EPDM or Viton <br> - Protection cap: - PPO (polyphenylene oxide) for FMX21 with outer diameter 22 mm and 29 mm . - PFA (perfluoroalkoxy) for FMX21 with outer diameter 42 mm . <br> - Extension cable insulation: either PE-LD (low-density polyethylene), FEP (fluorinated ethylene propylene) or PUR (polyurethane), for further information, see $\rightarrow$ 冒 21 "Extension cable". <br> - Mounting clamp: 1.4404 (AISI 316L) and fiberglass reinforced PA (polyamide) <br> - Extension cable mounting screw G11/2 A: 1.4301 (AISI 304) <br> - Extension cable mounting screw 1½ NPT: 1.4301 (AISI 304) <br> - Terminal box: PC (polycarbonate) <br> - 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 Tefion 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 Tefion 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: $8.0 \mathrm{~mm}(0.31 \mathrm{in}) \pm 0.25 \mathrm{~mm}( \pm 0.01 \mathrm{in})$
- FMX21: $3 \times 0.227 \mathrm{~mm}^{2}(3 \times 26$ AWG) + pressure compensation tube with Teflon filter
- FMX21 with Pt100 (optional): $7 \times 0.227 \mathrm{~mm}^{2}(7 \times 26 \mathrm{AWG})+$ pressure compensation tube with Teflon filter
- Pressure compensation tube with Teflon filter: outer diameter $2.5 \mathrm{~mm}(0.1 \mathrm{in})$, internal diameter 1.5 mm (0.06 in)

Cable resistance of PE/PUR/FEP extension cable

- Cable resistance per wire: $\leq 0.09 \Omega / \mathrm{m}$

Cable length of PE/PUR/FEP extension cable

- Please refer also to $\rightarrow$ El 10 , Chap. "Load".
- Cable length that can be ordered
- Customer-specific length in meters or feet ( $\rightarrow$ 皿 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. $950 \mathrm{~N}(213.56 \mathrm{lbf})$
- Cable extraction force: typical $\geq 400 \mathrm{~N}$ ( 89.92 lbf ) PE, FEP / typical $\geq 150 \mathrm{~N}$ ( 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 $2.5 \mathrm{~mm}^{2}$ (28 to 14 AWG)
Note!
The 4-terminal strip is not intended for use in hazardous areas incl. CSA GP.

## Human interface

## Field Xpert SFX 100

Field Xpert is an industrial PDA with integrated $3.5^{\prime \prime}$ touchscreen from Endress+Hauser based on Windows Mobile. It communicates via wireless with the optional VIATOR ${ }^{\otimes}$ Bluetooth ${ }^{\otimes}$ 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 BAO60S/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 $\rightarrow$ www.endress.com $\rightarrow$ Download $\rightarrow$ 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 $T 4 / T 0^{1121}$

- ATEX II 3 G ExnA IIC T5/T6 ${ }^{1131}$
- FM: IS CI. I, Div. 1 Gp. A-D; AEx ia Cl. I Zone 1 IIC ${ }^{11}$
- CSA C/US: IS CI. I, Div. 1 Gp. A-D; Ex ia Cl. 1 Zone 1 IIC"
- CSA: General Purpose
- IEC Ex ia IIC To Gb ${ }^{\text {I }}$
- NEPSI Ex ia IIC To
${ }^{13}$ Only for Waterpilot FMX21 without Pt100 and TMT182
${ }^{21}$ T4/T6:
Temperature class T 4 at $-10^{\circ} \mathrm{C}\left(+14^{\circ} \mathrm{F}\right)<\mathrm{Ta}<+70^{\circ} \mathrm{C}\left(+158^{\circ} \mathrm{F}\right)$
Temperature class To at $-10^{\circ} \mathrm{C}\left(+14^{\circ} \mathrm{F}\right)<\mathrm{Ta}<+40^{\circ} \mathrm{C}\left(+104^{\circ} \mathrm{F}\right)$
${ }^{31} \mathrm{~T} 5 / \mathrm{T} 0$ :
Temperature ciass T 5 at $-10^{\circ} \mathrm{C}\left(+14^{\circ} \mathrm{F}\right)<\mathrm{Ta}<+70^{\circ} \mathrm{C}\left(+158^{\circ} \mathrm{F}\right)$
Temperature class T 6 at $-10^{\circ} \mathrm{C}\left(+14^{\circ} \mathrm{F}\right)<\mathrm{Ta}<+60^{\circ} \mathrm{C}\left(+140^{\circ} \mathrm{F}\right)$


## 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 $\rightarrow 28$ "Additional documentation", "Safety instructions" and "Installation/Control Drawings".

| Drinking water approval (for FMX21 with outer diameter $22 \mathrm{~mm}(0.87 \mathrm{in})$ ) | - KTW certificate <br> - NSF 61 approval <br> - 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 addicion, the following standards were also applied for the Waterpilot FMX21: |
|  | - DIN EN 60770 (IEC 60770 ): <br> Transmitters for use in industrial process control systems <br> Part 1: Methods for performance evaluation <br> - DIN 16086: <br> Electrical pressure measuring instruments, pressure sensors, pressure transmitters, pressure measuring instruments, concepts, specifications on data sheets <br> - EN 61326: <br> Electrical equipment for measurement, control and laboratory use - EMC requirements <br> - EN 61010-1 (IEC 61010-1): <br> Safety requirements for electrical equipment for measurement, control and laboratory use <br> - EN 60529: <br> 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.

$\rightarrow$ Ordering information for FMX21 continued on next page.

## FMX21 (continued)



Additional ordering information (optional)


| 590 |  |  |  |  |  |  |  |  |  | ditional approval |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  | LQ | KTW potable water approval NSF potable water approval ACS potable water approval (in preparation) |


| 610 |
| :--- |
| 620 |

## Accessories


－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 $29 \mathrm{~mm}(1.14 \mathrm{in})$ 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： $300 \mathrm{~g}(10.581 \mathrm{oz})$
－Order number 52006153 ，see also＂Ordering information＂$\rightarrow$ 首 24

| TMT182 temperature head transmitter（ 4 to 20 mA ／ HART） | －2－wire temperature head transmitter，configured for a measuring range from -20 to $+80^{\circ} \mathrm{C}\left(-4\right.$ to $\left.+158^{\circ} \mathrm{F}\right)$ ． This setting offers a temperature range of 100 K which can be easily mapped．Please note that the Pt 100 resistance thermometer is designed for a temperature range from -10 to $+70^{\circ} \mathrm{C}\left(-14\right.$ to $\left.+176^{\circ} \mathrm{F}\right) \rightarrow 20$ ． <br> －＂Ordering information＂$\rightarrow$ 気 24 ， |
| :---: | :---: |
| s | Note！ <br> 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 $\rightarrow$ 尽 19 ． <br> －Material： 1.4301 （AISI 304） <br> －order number 52008264 （ $\mathrm{G} 11 / 2 \mathrm{~A}$ thread），order number 52009311 （NPT1 $1 / 2$ thread），see also＂Ordering information＂$\rightarrow$ E 24 |
| Terminals | －Four terminals in strip for terminal box，suitable for wire cross－section： 0.08 to $2.5 \mathrm{~mm}^{2}$（ 28 to 14 AWG） <br> －Order number： 52008938 |
| ＊ | Note！ <br> 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． <br> －$\rightarrow$ 目 24，＂Ordering information＂and the documentation SD552P／00／A6． |
| （1） | Note！ <br> The cable shortening kit is not intended for the FMX21 with FM／CSA approval． |

Installation tool－ indicating the customer－ specific length on the cable


I 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 $\rightarrow$ 意 24 ＂Ordering information＂．
－Mark tolerance：up to $\pm 50 \mathrm{~mm}$（ 1.97 in ） \｛The mark tolerance corresponds to a measured error from up to $\pm 50 \mathrm{~mm}$（ 1.97 in ）．
－Material：PET
－Adhesive：acrylic
－Immunity to temperature change： -30 to $+100^{\circ} \mathrm{C}\left(-22\right.$ to $\left.+212^{\circ} \mathrm{F}\right)$

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 $22 \mathrm{~mm}(0.87 \mathrm{in})$ and $29 \mathrm{~mm}(1.14 \mathrm{in}))$

Testing adapter
A FMX21 level probe connection
B Compressed air hose connection，internal diameter of quick coupling piece $4 \mathrm{~mm}(0.16 \mathrm{in})$
－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 $\rightarrow$ 鍳 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： $39 \mathrm{~g}(1.376 \mathrm{oz})$
－Order number 52011808 ，see also $\rightarrow$ 気 24 ＂Ordering information＂．

## Additional documentation

| Field of activities | - Pressure measurement: FA004P/00/EN <br> - Recording technology: FA014R/09/EN <br> - System components: FA016K/09/EN |
| :---: | :---: |
| Technical Information | - Technical Information Waterpilot FMX167 with 4 to 20 mA analog output: TI35IP/00/EN <br> - Technical Information Deltapilot M: TI437P/00/EN <br> - Temperature head transmitter iTEMP HART TMT182: TI078R/09/EN |
| Operating Instructions | - Waterpilot FMX21: BA380P/00/EN <br> - Cable shortening kit: SD552P/00/A6 <br> - Field Xpert: BA060S/04/EN |
| Safety instructions | - ATEX II 2 G: XA454P/00/A3 <br> - ATEX 113 G: XA485P/00/A3 <br> - IECEx Ex ia IIC: XA455P/00/EN <br> - NEPSI Ex ia IIC: XA456P/00/B2 |
| Installation/ Control Drawings | - FM IS Cl. I, Div. 1, Gp. A - D / Cl. I Zone 1 IIC: ZD231 P/00/EN <br> - CSA C/US IS Cl. I, Div. 1, Gp. A - D / Cl. I Zone 1, IIC: 2D232P/00/EN |
| Drinking water approval | - SD289P/00/A3 (NSF) <br> - SD319P/00/A3 (KTW) <br> - 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

| $\square \mathrm{mbar}$ | $\square \mathrm{mmH2O}$ |
| :--- | :--- |
| $\square \mathrm{bar}$ | $\square \mathrm{mH} 2 \mathrm{O}$ |
|  | $\square \mathrm{fH} 2 \mathrm{O}$ |
| $\square \mathrm{psi}$ | $\square \mathrm{inH2O}$ |
| $\square \mathrm{mmHg}$ | $\square \mathrm{Pa}$ |
| $\square \mathrm{kgf} / \mathrm{cm} 2$ | $\square \mathrm{kPa}$ |
| $\square \mathrm{MPa}$ |  |

Empty calibration (a)
(Empty) low pressure value $\qquad$ (Empty) low level value $\qquad$
Full calibration (b)
(Full) high pressure value $\qquad$ (Full) high level value $\qquad$

## Damping

Damping: $\qquad$ sec
Pressure $\quad$ The following configuration data sheet has to be filled in and included with the order if the option

## Pressure Engineerung Unit (a)

| $\square \mathrm{mbar}$ | $\square \mathrm{mmH} 2 \mathrm{O}$ | $\square \mathrm{mmHg}$ | $\square \mathrm{Pa}$ |
| :--- | :--- | :--- | :--- |
| $\square \mathrm{bar}$ | $\square \mathrm{mH} 2 \mathrm{O}$ |  | $\square \mathrm{kPa}$ |
| $\square \mathrm{psi}$ | $\square \mathrm{ftH2O}$ |  | $\square \mathrm{MPa}$ |
|  | $\square \mathrm{inH2O}$ | $\square \mathrm{kgf} / \mathrm{cm} 2$ |  |

## Calibration Range / Output

LRV:
(pressure engineering unit)
URV: $\qquad$ (pressure engineering unit)

## Damping

Damping $\qquad$ sec

## 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 umits is unquestiomable.


## Sample MiR Application



Dip Swatch Settings


## Wiring Diagram



Physical Dimensions


## SAMPle Application



Product Specifications


All MultiTrode Products carry a two year warranty

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Tel: +15619948090 Fax:+1 5619946282 E-mail: sales@mulititrode.net




## 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.

## e: The MTRA is intended for harge 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 ( $0.5,15 \mathrm{sec}$ ). 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



## Sample Applicatión



Die Switch Settings
 Sw $1 \& 2$ ——Sw $3 \ldots$ Pump activation delays： $0.5 \& 10 \mathrm{sec}$ ——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
IK 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： mira | Discharge ONLY |
| :---: | :---: |
| Probe Inputs： |  |
| Sensor inputs | MTR：2／MTRA：3 |
| Sensor voltage | 10／12vac Hominal |
| Sensor current | 0.8 mA max．（per sensor） |
| Sensitivity | 1k，4k，20k，80k |

Relay Outputs：

| MTRA relay output | 2 relays ：both N／0 |
| :---: | :---: |
| MTRA Output delay | Pump：0．5，10；Alarm： 0.5 ，is sec |
| Relay contact rating | 250 YAC |
|  | 5 A Resistive， 2 A Inductive |
| Relay contaca life | $10^{5}$ Operations |
| Terminal size | $2 \times 2.5 \mathrm{~mm}^{1}$ ，\＃13 |
| Display LEDs： | Power On Pump Alarm |
| MTRA | Green Yellow Red |

Physical Product：

| Dimensions（mm） | $72 \mathrm{H} \times 45 \mathrm{~W} \times 114 \mathrm{D}$ |
| :--- | :--- |
| Mounting | DIN Rail or $2 \times \mathrm{M} 4$ Screws \＃6 |
| Enclosure | Makrolon（ self extinguishing） |


| Power Supply： |  |
| :---: | :---: |
| Supply Yoltage AC | 24，110，240，415 Vac＊－50／60 Hz |
| Power Consumption | 3.5 Wates max＊（HTR only） |
| Supply Yoltage DC | 12 or 24VDC， |
| Power Consumption | 3 watts max |
| Environmental Range： |  |
| Centigrade | － $10^{\prime}$ to $+60^{\circ} \mathrm{C}$ |
| Fahrenheit | $+14^{\prime}$ to $+140^{\prime} \mathrm{F}$ |



## 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 10 m of cable．

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MultiTrode Inc．－USA 6560 East Rogers Circle，


## 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 controlied 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

MTR/MTRA Installation \& Troubleshooting

### 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 1516 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
" $C$ " 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 $(\mathrm{HI})$, becomes wet again.

WATEA - WASTEWATER - PUNP STATION - IECHNOLOGI

### 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*).

WATER - WASTEWATER - PUMP STAIIOH - IECHHOLOGY

## 6 Troubleshooting

| I have checked all the DIPswitches and settings <br> but in discharge mode as soon as the bottom <br> sensor gets wet the pump turns on then turns off <br> almost straight away. | - <br> The installation went fine but now and again the <br> pump will not turn on even though I am sure the <br> probe is wet. <br> and commissioning, the probe in the bottom of the tank is wired <br> into the Hi terminal instead of the Lo terminal. |
| :--- | :--- |
| All wiring is complete and all DIPswitches have <br> been checked but the pump will not turn on at all. | Check the sensitivity level set on the relay, some times the level is <br> set for foul water but due to changes in the flow the water <br> becomes grey or clear, try changing the setting from 20K to <br> $80 \mathrm{~K} \Omega$ and monitor the results carefully. |

* Please contact your distributor or agent before returning any product for repair or warranty claim.


Visit www.multitrode.com for the latest information

1. 24 VDC POWER SUPPLY TECHNICAL DETAILS
2. $24 \mathrm{VDC} / 13 \mathrm{VDC}$ 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

| Voltage: | 190 to 264 vac, or 190 to 400 VDC |
| :---: | :---: |
| 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. cat | Constant current |
| Short circuit protection | Indefi inte, auto-reseting |
| Over-voltage protection | 17.5 to 20 V latching ( 13.8 Vdc outpu) 31.5 to 39 V latching ( 27.6 Vdc outpul) |
| Ripple \& noise 100 MHz bandwidth | $28 \mathrm{mVp}-\mathrm{p}$ (13.8Vdc output) $55 \mathrm{mVp}-\mathrm{p}$ (27.6Vdc output) |
| ENVIRONMENTAL |  |
| Operating temperature | 0 to $70^{\circ} \mathrm{C}$ ambient with derating, $5 . . .90 \%$ relative humidity (non-condensing) |
| Over-temperature protection | Automatic \& auto-resetting |
| Cooling requirement | Natural convection |
| Efliciency | 80\% minimum |

STANDARDS \& APPROVALS

| Safety | Complies with AS/NZS 60950, class 1, |
| :--- | :--- |
|  | NSW Office of Fais 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 $\mathrm{i} / \mathrm{p}-\mathrm{o} / \mathrm{p}$ | 4242VDC for 1 minute |
| $\mathrm{i} / \mathrm{p}$-ground | 2121VDC for 1 minute |
| o/p-ground | 707VDC lor 1 minute |

ALARMS \& BATTERY FUNCTIONS

| Converter ON/OK alarm | Indicated by voltage-free changeover relay <br>  |
| :--- | :--- |
| green LED | ON=PSU OK |
| Battery low (\& fuse) alarm | 10.2 to 12.6 V for 12 V battery, adjustable 20.4 <br> to 25.2 V for 24 V batery, adjustable Indicated <br>  <br> green LED: ON=BAT OK |
| Low voltage disconnect | 9.6 to 12 V for 12 V battery, adjustable <br> 19.2 to 24 V 2 for 4 V bathery, adjustable |
| Charger over-load protection | Auto-reseting electranic circuit breaker |
| Reverse polarity protection | Internal battery fuse |
| Battery to load voltage drop | 0.2 to. 0.25 V typical |


| MECHANICAL |  |
| :--- | :--- |
| Case size | $264 \mathrm{~L} \times 172 \mathrm{~W} \times 67 \mathrm{H} \mathrm{mm}$ |
| Case size with heatsink | $264 \mathrm{~L} \times 186 \mathrm{~W} \times 67 \mathrm{H} \mathrm{mm}$ |
| Rack size | $2320 \times 19^{\circ} \mathrm{W} \times 2 \mathrm{RU} \mathrm{H}$ |
| Weight | 1.9 kg |
| Weight with heatsink | 2.1 kg |
| Weight (rack mounted version) | 5.5 kg |

## Selection Table

| MODEL NUMBER | OUTPUT |  |  | $\begin{gathered} \hline \text { OUTPUT } \\ \hline \text { POWER } \end{gathered}$ | Note: Non standard batery charging current available on request. ie PB251-12CM-H-10 for 10 A . |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | VDC | ILOAD | $\mathrm{I}_{\text {BATt }}$ |  |  |
| PB251-12CM | 13.8 V | 16A | 2A | 220W |  |
| PB251-12CM-H | 13.8 V | 20A | 2A | 275W |  |
| PB251-24CM | 27.6 V | 11A | 2A | 300W |  |
| PB251-24CM-H | 27.6 V | 12A | 2 A | 330W |  |
| PB251-12RML | 13.8 V | 20A | 4A | 275W |  |
| PB251-12B | 13.8 V | 20A | 4A | 275W |  |
| PB251-24RML | 27.6 V | 12A | 2 A | 330W |  |

## PB251 Series

275-330 WATTS DC UPS

Technical Illustrations


P8251**RML \& -128 ME CHANIC AL OUTLINE


NOTES:

1. $2 \mathrm{AU} \times 19^{\circ}$ rack enclosure per IEC 297
2. Mounting slous are suiaride for M6 hatdware
3. Mounting slots are suiage tor M6 hatdware.
4. I meler IE $¢$ mains cord with Aus balian plug is suppled with unit 5. PB251-128 alarm terminal is DB25 femate
5. PB251-128 ouput and ta nery connector is Hirose Pn. HS 28R - 1 A Hating conneclor is Hirose mm . HS 2 BP -4A (nor supplied).
 suistable for ring or tork lugs up $\Delta \varepsilon \mathrm{mm}$ wide.

front yiew

pb25:128 Dutput a eatteay connectoa


PG251-12B AlAAM CONNECTOR
?
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 voltage | $\begin{aligned} & 12 \mathrm{VDC}(9.2-16) \\ & 24 \mathrm{VDC}(19-32) \\ & 48 \mathrm{VCC}(38-63) \\ & 110 \mathrm{VDC}(85-140) \end{aligned}$ |
| :---: | :---: |
| Inrush current | 20A max. for 110 V only |
| OUTPUT |  |
| Output voltage | See table |
| Voltage adjustment | $\pm 10 \%, \pm 5 \%$ for PBIH $\cdot \mathrm{F}$ |
| Output current | See table |
| Ripple \& noise | Output Volts $\times 1 \%+50 \mathrm{mV}$ to -100 mV pk-pk |
| Line regulation | 0.8\% over input range |
| Load regulation | 0.9\%, 0\%-100\% load |
| Temperature coefficient | $0^{\circ} \mathrm{C}$ to $50^{\circ} \mathrm{C}, 0.03 \%$ per ${ }^{\circ} \mathrm{C}$ |
| Overvoltage protection | O.V. clamp, PBIH-F <br> Output shutdown, PBIH-G, J, M, R - input must be switched off for at least 305 to reactivate |
| Overcurrent protection | Fold back - PBIH-F <br> Current limiting, P8IH-G, J, M, R (PBIH-R series is adjustable); PBIH110xxR models are not adjustable |
| Drift | Output $V \times 0.5 \%+15(\mathrm{mV})$ per 8 hrs after 1 hr warm-up |
| Rise Time | $\begin{aligned} & 200 \mathrm{mS} \text { max. - PBIH-F, M, R } \\ & 100 \mathrm{mS} \text { max. - P8IH-G, } \mathrm{J}\left(\text { at } 25^{\circ} \mathrm{C}\right) \end{aligned}$ |
| Holdup time | 10 mS (only 110V input) |
| Remote sense | PBIH-R Series only |



| OPERATING |  |
| :---: | :---: |
| Efficiency | 70\%-89\% |
| Safety isolation (1 minute) | Type - 12, 24, 48V input <br> Input - Output: 1500 VAC <br> input- Case: 1500VAC <br> Output- Case: 500VAC <br> Type- 110 V input <br> Input- Output: 2000VAC <br> Input- Case: 2000VAC <br> Output- Case: 500VAC |
| Insulation resistance | 50M (500VDC) Input - Case |
| Parallel operation | Consult sales office for details |
| Remote control | PBIH-R Series: <br> Open link: output normal Short link: output off |
| ENVIRONMENTAL |  |
| Operating temperature | $0^{\circ} \mathrm{C}$ to $50^{\circ} \mathrm{C}$ full load |
| Cooling | Convection cooled |
| Storage temperature | $-20^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ |
| Humidity | 85\% |
| Shock | 30G, PBHH-F, G and J |
| Vibration | $\begin{aligned} & (5 \mathrm{~Hz}-10 \mathrm{~Hz}, 10 \mathrm{~mm}), \\ & (10 \mathrm{~Hz}-50 \mathrm{~Hz}) 2 \mathrm{G}, \mathrm{PBIH}-\mathrm{F}, \mathrm{G} \text { and J } \end{aligned}$ |
| STANDARDS AND APPROVALS |  |
| Safety | Designed to UL1950 |
| C-tick | AS/N2S CISPR11 Group 1، Class A |
| MECHANICAL |  |
| Weight | PBIH-F : 250g <br> PBIH-G: 380g <br> PBIH-J: 410g <br> P8IH-M : 800g <br> P8IH-R: 1.4 kg |

## PBIH Series

15-150 WATTS DC/DC SINGLE OUTPUT

Selection Table

| MODEL NUMBER | INPUT | OUTPUT |  | OUTPUT POWER |
| :---: | :---: | :---: | :---: | :---: |
| PBIH-1205F | 9.2-16V | 5 V | 3A | 15W |
| PBIH-1212F | $9.2-16 \mathrm{~V}$ | 12 V | 1.2A | 15W |
| PBIH-1215F | $9.2-16 \mathrm{~V}$ | 15V | 1A | 15W |
| PBIH-1224F | $9.2-16 \mathrm{~V}$ | 24 V | 0.62 A | 15W |
| PBIH-2405F | 19-32V | 5 V | 3 A | 15W |
| PBIH-2412F | 19-32V | 12 V | 1.2 A | 15W |
| PBIH-2415F | 19-32V | 15 V | 1A | 15W |
| P8IH-2424F | 19-32V | 24V | 0.62A | 15W |
| PBIH-4805F | $38-63 \mathrm{~V}$ | 5 V | 3A | 15W |
| PBIH-4812F | 38.63 V | 12 V | 1.2A | 15W |
| PBIH-4815F | $38-63 \mathrm{~V}$ | 15 V | 1 A | 15W |
| PBIH-4824F | $38-63 \mathrm{~V}$ | 24 V | 0.62A | 15W |
| PBIH-11005F | 85-140V | 5 V | 3A | 15W |
| PBIH-11012F | 85-140V | 12 V | 1.2A | 15W |
| PBIH-11015F | $85-140 \mathrm{~V}$ | 15 V | 1 A | 15W |
| PBIH-11024F | 85.140 V | 24 V | 0.62A | 15W |
| PBIH-1205G | $9.2-16 \mathrm{~V}$ | 5 V | 5A | 25W |
| PBIH-1212G | $9.2-16 \mathrm{~V}$ | 12V | 2.1 A | 25W |
| PBIH-1215G | $9.2-16 \mathrm{~V}$ | 15 V | 1.7 A | 25W |
| PBIH-1224G | $9.2-16 \mathrm{~V}$ | 24 V | 1.1A | 25W |
| PBIH-1248G | 9.2 .16 V | 4BV | 0.5A | 25W |
| PBIH-2405G | 19-32V | 5 V | 5 A | 25W |
| PBIH-2412G | 19-32V | 12 V | 2.1 A | 25W |
| PBIH-2415G | 19-32V | 15 V | 1.7 A | 25W |
| PBIH-2424G | 19-32V | 24 V | 1.1A | 25W |
| PBIH-2448G | 19.32V | 48 V | 0.5A | 25W |
| PBIH-4805G | 38.63 V | 5 V | 5 A | 25W |
| PBIH-4812G | 38.63 V | 12 V | 2.1 A | 25W |
| PBIH-4815G | 38-63V | 15 V | 1.7A | 25W |
| PBIH-4824G | 38.63 V | 24 V | 1.1A | 25W |
| PBIH-4848G | $38-63 \mathrm{~V}$ | 48 V | 0.5 A | 25W |
| PBIH-11005G | 85-140V | 5 V | 5 A | 25W |


| MODEL NUMBER | INPUT | OUTPUT |  | OUTPUT POWER |
| :---: | :---: | :---: | :---: | :---: |
| PBIH-11012G | 85.140 V | 12 V | 2.1A | 25W |
| PBIH-11015G | 85-140V | 15 V | 1.7 A | 25W |
| PBIH-11024G | $85-140 \mathrm{~V}$ | 24 V | 1.1 A | 25W |
| PBIH-11048G | 85-140V | 48 V | 0.5A | 25W |
| PBIH-1205J | $9.2-16 \mathrm{~V}$ | 5 V | 8A | 50W |
| P8IH-1212J | $9.2 \cdot 16 \mathrm{~V}$ | 12 V | 3.3A | 50W |
| PBIH-1215J | $9.2-16 \mathrm{~V}$ | 15 V | 2.7 A | 50w |
| PBIH-1224J | $9.2-16 \mathrm{~V}$ | 24 V | 1.7 A | 50W |
| PBIH-1248J | $9.2-16 \mathrm{~V}$ | 48 V | 0.8A | 50W |
| PBIH-2405J | 19-32V | 5 V | 10A | 50W |
| PBIH-2412J | 19-32V | 12 V | 4.3A | 50W |
| PBIH-2415J | 19.32 V | 15 V | 3.4 A | 50W |
| PBIH-2424J | 19.32 V | 24 V | 2.5 A | 50W |
| PBIH-2448) | 19-32V | 48 V | 1A | 50W |
| PBIH-4805 | $3 \mathrm{~B}-63 \mathrm{~V}$ | 5 V | 10A | 50W |
| PBIH-4812J | 38-63V | 12 V | 4.3A | 50W |
| PBIH-4815J | 38.63 V | 15V' | 3.4 A | 50W |
| PBIH-4824J | $38-63 \mathrm{~V}$ | 24 V | 2.5A | 50W |
| PBIH-4848J | 38.63 V | 48 V | 1 A | 50w |
| PBIH-11005J | 85-140V | 5 V | 10 A | 50w |
| PBIH-11012J | 85-140V | 12 V | 4.3A | 50W |
| PBIH-11015」 | B5-140V | 15 V | 3.4A | 50W |
| PBIH-11024J | 85-140V | 24 V | 2.5 A | 50W |
| PBIH-11048J | 85.140 V | 48 V | 1A | 50W |
| PBIH-1205M | $9.2-16 \mathrm{~V}$ | 5 V | 18A | 100W |
| PBIH-1212M | 9.2-16V | 12 V | 9 A | 100W |
| PBIH-1215M | 9.2-16V | 15 V | 7A | 100W |
| PBIH-1224M | $9.2-16 \mathrm{~V}$ | 24 V | 4.5A | 100W |
| PBIH-1248M | $9.2-16 \mathrm{~V}$ | 48 V | 2A | 100W |
| PBIH-2405M | 19-32V | 5 V | 20A | 100W |
| PBIH-2412M | 19-32V | 12 V | 9 A | 100W |
| PBIH-2415M | 19.32V | 15 V | 7 A | 100W |


| MODEL NUMBER | INPUT | OUT | PUT | OUTPUT POWER |
| :---: | :---: | :---: | :---: | :---: |
| PBIH-2424M | 19.32 V | 24 V | 5A | 100W |
| PBIH-2448M | 19-32V | 48 V | 2A | 100W |
| P81H-4805M | $38-63 \mathrm{~V}$ | 5 V | 20A | 100W |
| PBIH-4812M | $38-63 \mathrm{~V}$ | 12 V | 9A | 100W |
| P81H-4815M | $38-63 \mathrm{~V}$ | 15 V | 7A | 100W |
| P81H-4824M | 38-63V | 24 V | 5 A | 100W |
| PBIH-4848M | $38-63 \mathrm{~V}$ | 48 V | 2A | 100W |
| PBIH-11005M | 85-140V | 5 V | 20A | 100W |
| PBIH-11012M | 85.140 V | 12 V | 9A | 100W |
| PBIH-11015M | $85-140 \mathrm{~V}$ | 15 V | 7A | 100W |
| PBIH-11024M | $85-140 \mathrm{~V}$ | 24 V | 5A | 100W |
| PBIH-11048M | $85-140 \mathrm{~V}$ | 48 V | 2A | 100W |
| PBIH-1205R | $9.2-16 \mathrm{~V}$ | 5 V | 27A | 150W |
| PBIH-1212R | $9.2-16 \mathrm{~V}$ | 12 V | 13A | 150W |
| PBIH-1215R | 9.2-16V | 15 V | 10A | 150W |
| PBIH-1224R | 9.2-16V | 24 V | 6.5A | 150W |
| PBIH-1248R | $9.2-16 \mathrm{~V}$ | 48 V | 3.3 A | 150W |
| PBIH-2405R | 19-32V | 5 V | 30 A | 150W |
| PBIH-2412R | 19.32 V | 12 V | 14A | 150W |
| PBIH-2415R | 19-32V | 15 V | 11A | 150W |
| PBIH-2424R | 19-32V | 24 V | 7 A | 150W |
| PBJH-2448R | 19.32 V | 48 V | 3.5A | 150W |
| PBJH-4805R | $38-63 \mathrm{~V}$ | 5 V | 30A | 150W |
| PBIH-4812R | $38-63 \mathrm{~V}$ | 12 V | 14 A | 150W |
| PBIH-4815R | 38-63V | 15 V | 11 A | 150W |
| PBIH-4824R | 38.63 V | 24 V | 7 A | 150W |
| PBIH-4848R | $38-63 \mathrm{~V}$ | 48 V | 3.5 A | 150W |
| PBIH-11005R | $85-140 \mathrm{~V}$ | 5 V | 30A | 150W |
| PBIH-11012R | 85.140 V | 12 V | 14A | 150W |
| PBIH-11015R | 85.140 V | 15 V | 11 A | 150W |
| PBIH-11024R | 85-140V | 24 V | 7 A | 150W |
| PBIH-11048R | 85-140V | 48 V | 3.5A | 150W |

PBIH-F



| Torminal | Connectlon |
| :---: | :---: |
| 0 | FG |
| 1 | $\mathrm{DC}+\mathrm{V}$ in |
| 2 | $O V$ in |
| 3 | LFG |
| 4 | NO |
| 5 | NO |
| 6 | $-V$ out |
| 7 | $+V$ out |


| Terminal | Connection |
| :---: | :---: |
| 1 | FG |
| 2 | $\mathrm{DC}+\mathrm{V}$ in |
| 3 | OV in |
| 4 | LFG |
| 5 | -V out |
| 6 | $+V$ out |
| 7 | NC |

PBIH-M


PBIH-R


| Terminal | Connection |
| :---: | :---: |
| 1,2 | $+V$ out |
| 3 | $+S$ |
| 4 | $-S$ |
| 5,6 | $-V$ out |
| 7 | Remote |
| 8 | Control |
| 9 | $D C+V$ in |
| 9 | DC OV in |
| 10 | $F G$ |

## General Characteristics

## IDISCHARGE CHARACTERSTICS

- Charging characterstics




## 8efipher Derice







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A canmexit pathondriver,
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## -Spocincations sublect to chango whicut prior notico

## Distravted bry

GS Kuasa International Ltd
Te-1, NuhLemmbeat, Mrat-bl
Toago 105-000



Performance Dafa at $25^{\circ} \mathrm{C}\left(77^{\circ} \mathrm{F}\right)$
(Amperes and Wath per call]
Amperes to F.Y.1. 60 Volts Per Cell

| Nincole |  | $\frac{1}{\min }$ | $\underset{\sim}{9}$ | $\begin{aligned} & 10 \\ & \text { nin } \end{aligned}$ | $\begin{aligned} & 18 \\ & \min \end{aligned}$ | $\begin{aligned} & \mathbf{2 0} \\ & \text { min } \end{aligned}$ | $\begin{aligned} & \text { 24 } \\ & \text { nin } \end{aligned}$ | $$ | $\begin{aligned} & 24 \\ & \min \\ & \hline \end{aligned}$ | $\begin{aligned} & \operatorname{con} \\ & \hline \text { min } \end{aligned}$ | $\begin{aligned} & 25 \\ & \text { min } \end{aligned}$ | 1 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1004212 | A | 141.0 | 179.0 | 16, 2 | 1.1 | sat | 124 | 13 | 20.4 | 0.8 | 240 | 22. |
|  | w | 270 | IT0.0 | 1510 | 110 | $\mathbf{M 2}$ | 71 | ת. 1 | $\omega$ | Sils | 51.6 | 4 |
| L006S0 12 | A | 1uso | 1340 | 1140 | 10.5 | 0.0 | 54.0 | 48.3 | 40 | 0.5 | 50 | 30.0 |
|  | W | \%20. | 2620 | 1200 | 180.0 | 1210 | 1080 | \% 3.5 | 0.5 | 7.0 | 70, | 57.5 |
| 60043-12 | A | 3710. | $17 \%$ | 1420 | 1050 | 0 | $\pi 0.4$ | 02 | 55.4 | 51. | 44.6 | 7. |
|  | w | 220.0 | 3300 | 250.0 | 10.0 | 15.0 | 122 | 11.0 | 1050 | 7.0 | 20.8 | 72.5 |
| vores 6 | A | 120 | 2300 | 1780 | 1240 | 189 | 20 | 741 | $\cdots 0$ | - 1 | 555 | 4.0 |
|  | w | <200 | 12.0 | 5040 | 230 D | 14.0 | 157.0 | 1000 | 125.0 | 1140 | 106.0 | B6. |
| L0N1094 | A | dro | 1120 | 278 | 0.0 | 1290 | 1120 | 07.0 | $\underline{120}$ | 81.0 | 74.0 | $\omega$ |
|  | w | 1620 | 5800 | 403.0 | 200.0 | 24.0 | 2070 | 1270 | 107.0 | 1560 | 1410 | 115.0 |
| Lowl2s6 | A | 44.0 | 3 PaO | 3 ma | 200 | 160 | 120 | 1210 | 110.0 | 101.8 | 2 | 73.0 |
|  | w | T80 | ${ }^{6} 53.0$ | 506. 0 | 2310 | 110.0 | 2610 | 2300 | 200.0 | 193.0. | 1760 | 1410 |
| L004100-12N | - | 170. | 212.0 | 2720 | 1070 | 140 | 1120 | \% | mo | 11.0 | 740 | $\infty 0.0$ |
|  | w | 4030 | 5240 | 4050 | 15000 | 2410 | 20\% 0 | 180 | 167.0 | 1340 | 1410 | 118.0 |
| 4002006 | A | 7200 | 4240 | 152.0 | 810 | 240.0 | 220 | 18.0 | 1740 | 1620 | 14.0 | 1200 |
|  | w | 12040 | 1066. 0 | 2000 | 417.0 | 4*6.0 | 11.0 | [14,0 | 320 | 300 | 320 | 20.0 |

Amperes to F.V.1.70 Volts Per Cell

|  |  | $\underline{\square}$ | $\stackrel{3}{3}$ |  | $15$ | min | $\begin{aligned} & 25 \\ & \hline \min \end{aligned}$ | min | min | $4$ | in | 1 | ${ }_{6}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \% | 1 | 120 | 10.0 | 及 | 5 | 4.8 | 4.1 | 3 | 323 | 27. | $\underline{0}$ | 20 | 13) |  |
|  | w | 211.0 | imo | 1230 | 1080 | th, | 7. | 69. | 41. | 59 | 51.3 | 0. | 2 m | 19 |
| U0150-12 | A | 120 | 130 | \%. 0 | 785 | 1.0 | 4.6 | cal | 125 |  | *5.5 | 29. | 18.0 |  |
|  | w | Tr. 0 | 2450 | 174. | 137.0 | 170 | 1020 | n. | 11.0 | 2, 5 | 40 | 560 | 15.0 |  |
| 4001421 | $\wedge$ | 240 | 1730 | ze | $8 \times 1$ | 72.4 | 6 | Co. 5 | 51. | \% | 4 | 26.5 | 2J |  |
|  | w | 24\% | 308.0 | 221.0 | 78.0 | 10.0 | 1780 | 118.0 | 1020 | 12. | 4 | 0. | 1 |  |
| L00784 | A | 2020 | 207.0 | 140 | 110 | 24s | 11.1 | 720 | 08 | 57. | ת | 4.3 | 7 |  |
|  | W | 1120 | \$70 | 2630 | 2000 | 76.0 | 540 | 18 | 20 | 19.0 | 1020 | 4 | 52 |  |
| 4001100 | A | 1240 | 2 mo | $1 \times 4.0$ | 1810 | $13 \times 0$ | O4, | Pa | 5. | mo | 10 | s80 | 30 |  |
|  | w | 10 | 40 | 251.0 | 270 | 2 LO | 20.0 | 1280 | 1620 | 10.0 | 13 | 112 | $\pi 00$ |  |
|  | A | 40s0 | 14.0 | 24.0 | 159 | 138.0 | 1240 | 120.0 | 200 | 4. | - | 72 | 45 |  |
|  | w | 6820 | 611.0 | 479.0 | 10 | T2 | 2560 | 21 | 2010 | 140 | 170. | 140 | N |  |
| $100-1$ | A | 34,0 | 270 | 1940 | 1.0 |  |  | mo | 550 | 71. |  |  |  |  |
|  | W | $5 \times 40$ | 4570 | 151.0 | 270 | 28.0 | 230 | tero | 1620 | 10. | 1 | 112 | On |  |
| (00-800 6 | , | ca | S54, 0 | 3850 | 7720 | 150 | 210 | 12 | 170.0 | 154 | 1420 | 1160 | 72.0 |  |
|  | w |  |  |  |  |  |  |  |  |  |  |  |  |  |

Amperes to F.V.I. 80 Vols Perr Cell











 $4006000-1$



## PROXIMITY SWITCH

## 1. NJ20+U1+E2 PROXIMITY SWITCH TECHNICAL DETAILS

Inductive proximity switches
NJ20+U1+E2
Comfort series
20 mm embeddable


## ( $\epsilon$

| Switching element function | PNP Make function |
| :---: | :---: |
| Pated operating distance $\mathrm{s}_{\mathrm{n}}$ | 20 mm |
| Installation | embeddable |
| Assured operating distance $\mathrm{s}_{\mathrm{a}}$ | 0... 16.2 mm |
| Reduction factor $\mathrm{ral}_{\text {Al }}$ | 0,35 |
| Reduction factor ${ }^{\text {r }}{ }^{\text {u }}$ | 0,35 |
| Reduction factor $\mathrm{r}_{2} \mathrm{Z}^{\text {a }}$ | 0,8 |
| Operating voltage $U_{B}$ | $10 \ldots 60 \mathrm{~V}$ |
| Switching frequency 1 | $0 \ldots 150 \mathrm{~Hz}$ |
| Hysteresis H | $1 \ldots 10$ typ. $5 \%$ |
| Reverse polarity protection | - Protected against reverse polarity |
| Short circuit protection | pulsing |
| Voltage drop $\mathrm{U}_{\mathrm{f}}$ | 152.8 V |
| Operating current $l_{L}$ | 0.. 200 mA |
| Off-state current $I_{\text {I }}$ | $0 \ldots 0,5 \mathrm{~mA}$ typ. $0,01 \mathrm{~mA}$ |
| No-load supply current $\mathrm{l}_{0}$ | $\leq 10 \mathrm{~mA}$ |
| Operating voltage display | LED, green |
| Indication of the switching state | LED, yellow |
| Standards | EN 60947-5-2 |
| Ambient temperature | $-25 \ldots 70^{\circ} \mathrm{C}$ ( $248 . . .343 \mathrm{~K}$ ) |
| Storage temperature | $-25 \ldots 85^{\circ} \mathrm{C}(248 \ldots 358 \mathrm{~K})$ |
| Connection type | terminal compartment |
| Core cross-section | , up to $2.5 \mathrm{~mm}^{2}$ |
| Housing material | PBT |
| Sensing face | PBT |
| Protection degree | 1 1P68 |

## Connection_type:



## PUSHBUTTON \& INDICATORS

## 1. PUSH BUTTON TECHNICAL DETAILS

2. HOUR RUN METER TECHNICAL DETAILS

## Series D7 Pilof Devices

22 mm Design Saves Panel Space

Heavy Duty Ratings

Modular Design Reduces Inventory

Order Assembled or by Component

## 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's rugged D7 pilot devices offer maximum flexibility and a wide choice for all applications. This 22 mm 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.




Complitiongossontics
Superior Dosign



Selector Switch Safety

- Positive Detent
- Constant Energy
$\rightarrow$

$K$-Seal
- Dual wiping action - Lubrication trapping extends sealing life




Non-Iliuminated and Illuminated
Flush Push Button Operators (D7x-F)


Non-llluminated Guarded and Non-llluminated Maintained Push Button Operators ( $\mathrm{D} 7 \mathrm{x}-\mathrm{G}$ and $\mathrm{D} 7 \mathrm{x}-\mathrm{FA}$ )


Illuminated and Non-Illuminated Knob Selector Switch Operators (D7x-LS \& D7x-S)


Illuminated and Non-Illuminated
Momentary Mushroom Operators
40 mm and 60 mm ( D 7 x -LMM \& D7x-MM)


Illuminated and Non-llluminated
Push-Pull Mushroom Operators $30 \mathrm{~mm}, 40 \mathrm{~mm}$, and 60 mm (D7x-MP)


Mushroon Key Release Operator 40 mm (D7x-MK)


Non-Illuminated 3-Position Multi-Function Operators (D7x-U3)


Illuminated and Non-llluminated 2-Position Multi-Function Operators (D7x-LU2 \& D7x-U2)


Toggle Switch Operators (D7M-JM)


Reset Operators (D7x-R)


Selector $\operatorname{Jog}$ Operators ( D 7 x - SJ )


Potentiometer with Resistive Element (D7P- POT)

*For Monolithic Devices see the D7D Monolithic Flyer
sprecher +
schuh

Front-of-Panel (Operators) ©
Mechanical Ratings


Back-of-Panel Components ©
Electrical Ratinqs


[^21]Back－of－Panel Components ©，continued


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 F Openings in Enclosure |  |
| :---: | :--- |
| Enclosure Type | Openings May Be Closed By Equipment Marked．．． |
| 2 | $2,3,3 \mathrm{R}, 3 \mathrm{~S}, 4,4 \mathrm{X}, 6,6 \mathrm{P}, 11,12,12 \mathrm{~K}, 13$ |
| 3 | $3,3 \mathrm{R}, 3 \mathrm{~S}, 4,4 \mathrm{X}, 6,6 \mathrm{P}$ |
| 3 R | $3,3 \mathrm{R}, 3 \mathrm{~S}, 4,4 \mathrm{X}, 6,6 \mathrm{P}$ |
| 3 S | $3,3 \mathrm{R}, 3 \mathrm{~S}, 4,4 \mathrm{X}, 6,6 \mathrm{P}$ |
| 4 | $4,4 \mathrm{X}, 6,6 \mathrm{P}$ |
| 4 X | 4 X |
| 6 | $6,6 \mathrm{P}$ |
| 6 P | 6 P |
| 11 | 11 |
| $12,12 \mathrm{~K}$ | $12,12 \mathrm{~K}, 13$ |
| 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 | $\checkmark$ |

－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．

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-torelease 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 |
| . ${ }^{2}$ | Lens | Muliti-function | Acetal |
| 's | Lens, knob | Illuminated push button, illuminated momentary mushroom, illuminated selector switch | Polyamide |
| 흘 | Knob | Non-illuminated selector switch | Glass-filled polyamide |
| D7 | 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 beze/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/polycartonate 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 |

## sprecher+ schuh

## Pilot Devices

Series D7D Monolithic

## Specifications


(- Operating temperatures below $0^{\circ} \mathrm{C}\left(32^{\circ} \mathrm{F}\right)$ are based on the absence of treezing moisture and liquids.
(2) 3M MV018-R/S \#(22... 18 AWG) or 3M MVU14-6R/S (\#16... 14 AWG)

B-1

Pilot Devices Series D7 - Heavy Duty/Oil Tight

Approximate Dimensions - millimeters 0
Panel Hole Spacing

(0 Dimensions are not intended to be used for manufacturing purposes.

Pilot Devices

Approximate Dimensions - millimeters (1)



Back-of-Panel Components Dual Circuit Contact Block (Max. of 1 Deep) (D7x-X__D/D7-X01S)


Non-illuminated Knob Lever Selector Switch Operators (D7x-H)


Key Selector Switch Operators (D7x-K)

$30 \times 40 \mathrm{~mm}$ Snap-in-Legend Plate (D7-11)

$30 \times 50 \mathrm{~mm}$ Snap-in-Legend Plate (D7-12)


[^22]
## sprecher + schuh

Approximate Dimensions - millimeters 0 (2)


[^23]Pilot Devices

Approximate Dimensions - millimeters ©


[^24]Approximate Dimensions - millimeters (1)


+ Pilot Devices

Approximate Dimensions - millimeters ©



| Type 4/13 (IPG6)-Metal Enclosures |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Cat. No. | No. of Units <br> (Holes) | A | B | Knockout/ <br> Conduit <br> Openings |
| D7-1MP (1MY) | 1 | 99 <br> $(3-9 / 32)$ | 62 <br> $(2-7 / 16)$ | PG11 <br> PG16 |
| 07-2MP | 2 | 137 <br> $(5-13 / 32)$ | 100 <br> $(3-15 / 16)$ | PG11 <br> PG16 |
| D7-3MP | 3 | 174 <br> $(6-27 / 32)$ | 137 <br> $(5-13 / 32)$ | PG11 |
| D7-5MP | 5 | 249 <br> $(9-13 / 32)$ | 212 <br> $(8.11 / 32)$ | PG16 |



Dimensions are not intended to be used for manufacturing purposes.

## DIN HALF SIZE HOUR METER

## TH63.TH64 Hour Meters



TH63 series (without reset button)

RoHS Directive compatibility information http://www.nais-e.com/

## Features

## 1. Compact to save panel space

The $24 \times 48 \mathrm{~mm}$ hour meters are just half the DIN $48 \times 48$ standard size. They help save the panel space.

UL File No.: E42876 CSA File No.: LR39291

지 ( 1

## 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 $48 \times 48$ 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 $50 / 60 \mathrm{~Hz}$ 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 |  | $12 \mathrm{~V} \mathrm{AC}$,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 rangé). |  | 85 to $115 \%$ of rated operating voltage |
| Rated frequency |  | $50 / 60 \mathrm{~Hz}$ (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. $100 \mathrm{M} \Omega$, Between live and dead metal parts (At 500 V DC) |
| kdown voltage (Initial value) |  | 2.000 Vrms, Between live and dead metal parts |
| temperature rise |  | $55^{\circ} \mathrm{C} 131{ }^{\circ} \mathrm{F}$ |
| Vibration resistance | Functional | 10 to 55 Hz : 1 cycle/min double amplitude of 0.5 mm ( 10 min on 3 axes) |
| Shock resistance | Functioñal | Min $98 \mathrm{~m} / \mathrm{s}^{2}\{10 \mathrm{G}\}$ (4times on 3 axes) |
|  | Destructive | Min $980 \mathrm{~m} / \mathrm{s}^{2}\{100 \mathrm{G}\}$ ( 5 times on 3 axes) |
| Ambient temperature |  | -10 to $+50^{\circ} \mathrm{C}+14$ to $+122^{\circ} \mathrm{F}$ |
| Ambient humidity |  | Max. 85\% RH (non-condensing) |
| Weight |  | Approx. 80 g 2.82 oz |

Product types

| Туре. | Operating voltage | Part number | Operating voltage | Part number | Operating voltage | Part number |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TH63 series (without reset button) | 100 V AC | TH631 | 24 V AC | TH634 | 115 to 120V AC | TH637 |
|  | 200 V AC | TH632 | 48 V AC | TH635 | 220 V AC | TH638 |
|  | 12 VAC | TH633 | 110 V AC | TH636 | 240 V AC | TH639 |
| TH64 series (with reset button) | 100 V AC | TH641 | 24 V AC | TH644 | 115 to 120 V AC | TH647 |
|  | 200 V AC | TH642 | 48 V AC | TH645 | 220 V AC | TH648 |
|  | 12 VAC | TH643 | 110 V AC | TH646 | 240 V AC | TH649 |

[^25]TH63.TH64

## Applicable standard

| Safoty standard | EN61010-1 | Pollution Degree 2/Overvoltage Category II |
| :---: | :---: | :---: |
| EMC | (EMI)EN61000-6-4 <br> Radiation interference electric field strength <br> Noise terminal voltage <br> (EMS)EN61000-6-2 <br> Static discharge immunity <br> RF electromagnetic field immunity <br> EFT/B immunity <br> Surge immunity <br> Conductivity noise immunity <br> Power frequency magnetic field immunity <br> Voltage dip/Instantaneous stop/Noltage fluctuation immunity | EN55011 Group1 ClassA <br> EN55011 Group1 ClassA |

## Dimensions



## Wiring diagram

## - Panel cutout dimensions



Operating power supply


## Mounting

1. Cut a $22.2_{0}^{+0.3} \times 45_{0}^{+0.6} \mathrm{~mm}\left(.874^{+.012} \times\right.$ $1.772^{.024}$ 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


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 conneclion 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 $-10^{\circ}$ or above $+50^{\circ} \mathrm{C}$
- 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.

- LH 2 H

Ambient conditions:
Overvoltage category III, contamination factor 2, indoor use. Ambient temperature and humidity -10 and $+55^{\circ} \mathrm{C}$ and $35 \%$ to $85 \% \mathrm{RH}$ 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 $+50^{\circ} \mathrm{C}$ and below $85 \% \mathrm{RH}$ 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 $+55^{\circ} \mathrm{C}$, 35 to $85 \% \mathrm{RH}$ (with no condensation at $20^{\circ} \mathrm{C}$ )
- 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 EN609473 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)

# PRESSURE TRANSMITTER \& ADJUSTMENT UNIT 

## 1. VEGABAR74 PRESSURE TRANSMITTER TECHNICAL DETAILS

## 2. VEGADIS PRESSURE ADJUSTMENT UNIT TECHNICAL DETAILS

Drocess pressure/Hydrostatic


## Product Information

## Content

1 Description of the measuring principle ..... 3
2 Type overview ..... 4
3 Mounting instructions. ..... 5
4 Electrical connection
4.1 General prerequisites. ..... 6
4.2 Voltage supply ..... 6
4.3 Connection cable ..... 6
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4.5 Wiring plan VEGABAR 74, 75 ..... 6
5 Operation
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5.2 Adjustment with VEGADIS 12 ..... 7
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6 Technical data ..... 8
7 Dimensions. ..... 12
8 Product code ..... 15

Take note of safety instructions for Ex applications
Please note the Ex specific safety information which you can find on our homepage www.vega.comiservicesldownloads 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.

## 1 Description of the measuring principle

## Measuring princlple

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 ${ }^{(1)}$ measuring cell. Base element and diaphragm consist of high purity sapphire-ceramic ${ }^{\circledR}$.

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 ${ }^{\oplus}$ 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 ${ }^{(8}$ measuring cell in VEGABAR 74

## 1 Diaphragm

2 Soldered glass bond
3 Base element
The advantages of the CERTEC ${ }^{\oplus}$ 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 ${ }^{\text {® }}$ measuring cell is the measuring unit of VEGABAR 75. This unit consists of a CERTEC ${ }^{\circledR}$ 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. $0.3 \mathrm{~cm}^{3}, F D A$-listed)
3 FeNi adapter
4 CERTEC ${ }^{\text {® }}$ measuring cell
The advantages of the METEC ${ }^{(1)}$ 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 ${ }^{\text {® }}$ | METEC ${ }^{(1)}$ |
| :---: | :---: | :---: |
| Diaphragm: | Ceramic | Metal |
| Media: | gas, vapours and liquids, also abrasive | gases, vapours and liquids also with higher temperatures |
| Process fitting: | Thread from $1 \frac{1}{2}{ }^{\prime \prime}$, flanges from DN 40 , fittings for the food processing and paper industry | Thread from $11 / 2^{\prime \prime}$, flanges from DN 40 , fittings for the food processing industry |
| Material: | 316L | 316L |
| Measuring range: | .1 ... 60 bar ( $-14.5 \ldots 870 \mathrm{psi})$ | -1 ... 25 bar (-14.5 ... 363 psi ) |
| Smallest measuring range: | 0.1 bar (1.45 psi) | 0.1 bar (1.45 psi) |
| Process temperature: | $-40 \ldots+120^{\circ} \mathrm{C}\left(-40 \ldots+248{ }^{\circ} \mathrm{F}\right)$ | $-12 \ldots+200^{\circ} \mathrm{C}\left(-40 \ldots+392^{\circ} \mathrm{F}\right)$ |
| Deviation in characteristics: | < 0.075 \% | < 0.075 \% |
| Signal output: | $4 \ldots 20 \mathrm{~mA} / \mathrm{HART}$ | $4 . .20 \mathrm{~mA} / \mathrm{HART}$ |
| Remote adjustment/ indication: | VEGADIS 12 | VEGADIS 12 |

## 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 appro－ priate regulations，conformity and type approval certifi－ cates 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，VEGAS－ TAB 690，VEGADIS 371 as well as VEGAMET signal condition－ ing 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 $5 \ldots 9 \mathrm{~mm}$ ensures the seal effect of the cable entry．

## $4 . . .20 \mathrm{~mA} / \mathrm{HART}$ 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 regu－ lations must be noted for the connection cable．

## 4．4 Cable screening and grounding

If screened cable is necessary，the cable screen must be con－ nected 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． $1 \mathrm{nF}, 1500 \mathrm{~V}$ ）．

## 4．5 Wiring plan VEGABAR 74， 75

## Direct connection



Fig．3：Wire assignment，connection cable
1 brown（ + ）：fo power supply or to the processing system
2 blue（－）：to power supply or to the processing sysiem
3 yellow：is only required with VEGADIS 12，otherwise connect to minus
4 Screen
5 Breather capillaries with fiker 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（ $4 \ldots 20 \mathrm{~mA}$ measurement）
3 Screen
4 Breather capillanies
5 Suspension cable

5 Operation

### 5.1 Overview

VEGABAR 74 and 75 can be adjusted with the following adjustment media:

- Indicatior/Adjustment VEGADIS 12
- Adjustment software according to FDT/DTM standard, e.g. PACTware ${ }^{\text {TM }}$ 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 [+]kay change value
3 l-] key change value

### 5.3 Adjustment with PACTware ${ }^{\text {TM }}$

## PACTware ${ }^{\text {TM/DTM }}$

VEGABAR 74 and 75 sensors are adjusted via the signal cable by means of PACTware ${ }^{\text {TM. }}$.

An instrument driver for the respective VEGABAR is necessary for the adjustment with PACTware ${ }^{\text {TM }}$.

All currently available VEGA DTMs are provided as DTM Collection with the current PACTware ${ }^{\text {TM }}$ version on CD. They are available from the responsible VEGA agency for a token fee. The basic version of this DTM Collection incl. PACTware ${ }^{\text {TM }}$ 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 $250 \Omega$

Connection of the PC via VEGACONNECT 4


Fig. 8: Connecting the PC via HART to the signal cable
VEGABAR
2 HART resistor $250 \Omega$ (optional depending on processing)
3 Connection cable with 2 mm pins and terminals
4 Processing systemPLCNottage 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 ${ }^{\text {TM }}$ are available as DD. The instrument descriptions are already implemented in the current version of $\mathrm{AMS}^{\text {M }}$. For older versions of AMS $^{\text {TM }}$, a free-of-charge download is available via Internet.

## 6 Technical data

## General data

Material 316L corresponds to 1.4404 or 1.4435

## VEGABAR 74

Materials，wetted parts
－Process fitting
316 L
－Diaphragm
sapphire ceramic ${ }^{\text {® }}$（ $99.9 \%$ oxide ceramic）
－Seal FKM（Viton），Kalrez 6375，EPDM，Chemraz 535
－Seal process fitting thread $\mathrm{G} 1 / 2 \mathrm{~A}, \mathrm{G} 11 / 2$ A Klingersil C－4400

## VEGABAR 75

Materials，wetted parts
－Process fitting
－Process diaphragm
Materials，non－wetted parts
－Isolating liquid
Hastelloy C276

## Common data

Materials，non－wetted parts
－Housing
－Ground termina
－Connection cable
－type label support on cable
Weight
316Ti／316L
PUR，FEP，PE
PE－HART
$0.8 \ldots 8 \mathrm{~kg}$（1．764 $\ldots 17.64 \mathrm{lbs})$ ，depending on process fitting

## Output variable

| Output signal | $4 \ldots 20 \mathrm{~mA} H A R T$ |
| :--- | :--- |
| Failure signal | $22 \mathrm{~mA}(3.6 \mathrm{~mA})$ ，adjustable |
| Max．output current | 22.5 mA |
| Damping（ $63 \%$ of the input variable） | $0 \ldots 10 \mathrm{~s}$, adjustable |
| Step response or adjustment time | $70 \mathrm{~ms}(\mathrm{ti}: 0 \mathrm{~s}, 0 \ldots 63 \%)$ |
| Fulfilled NAMUR recommendations | NE 43 |

## Additional output variable－temperature（with VEGABAR 74）

Processing is made via HART－Multidrop

| Range | $-50 \ldots+150^{\circ} \mathrm{C}\left(-58 \ldots+302^{\circ} \mathrm{F}\right)$ |
| :---: | :---: |
| Resolution | $1^{\circ} \mathrm{C}\left(1.8^{\circ} \mathrm{F}\right)$ |
| Accuracy |  |
| －in the range of $0 \ldots+100^{\circ} \mathrm{C}\left(+32 \ldots+212^{\circ} \mathrm{F}\right)$ | $\pm 3 \mathrm{~K}$ |
| －in the range of $-50 \ldots 0^{\circ} \mathrm{C}\left(-58 \ldots+32^{\circ} \mathrm{F}\right)$ and $+100 \ldots+150^{\circ} \mathrm{C}$ | typ．$\pm 4 \mathrm{~K}$ |

## Input variable

Parameter
Measuring range
Turn down
－recommended
－Max．

Level
see product code

1 ： 10
1 ： 30

## Reference conditions and actuating variables（similar to DIN EN 60770－1）

Reference conditions according to DIN EN 61298－1
－Temperature
－Relative humidity
－Air pressure
Determination of characteristics
Characteristics
Calibration position
$+18 \ldots+30^{\circ} \mathrm{C}\left(+64 \ldots+86^{\circ} \mathrm{F}\right)$
45 ．．． $75 \%$
860 ．．． $1060 \mathrm{mbar} / 86$ ．．． $106 \mathrm{kPa}(12.5 \ldots 15.4 \mathrm{psi})$
limit point adjustment according to DIN 16086
linear
upright，diaphragm points downward

Deviation determined according to the limit point method according to IEC 60770")
Applies to digital HART interface as well as to analogue current
output $4 \ldots 20 \mathrm{~mA}$. Specifications refer to the set span. Tum down
(TD) = nominal measuring range/set span.
Deviation

- Turn down 1 : 1 up to 5 : $1<0.075 \%$
- Turn down > 10: 1

Deviation with absolutely flush process fittings EV, FT

- Turn down 1: 1 up to 5:1
< $0.05 \%$
- Turn down > 10:1 < $0.01 \% \times$ TD

Deviation with absolute pressure measuring range 0.1 bar

- Turn down 1:1 up to $5: 1 \quad<0.25 \% \times$ 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 $4 \ldots 20 \mathrm{~mA}$. Specifications refer to the set span. Tum down (TD) = nominal measuring range/set span.
Average temperature coefficient of the zero signal
In the compensated temperature range $0 \ldots+100^{\circ} \mathrm{C}\left(212^{\circ} \mathrm{F}\right)$,
reference temperature $20^{\circ} \mathrm{C}\left(68^{\circ} \mathrm{F}\right)$.
Average temperature coetficient of the zero signal

- Turn down 1:1 < $0.05 \% / 10 \mathrm{~K}$
- Turn down $1: 1$ up to $5: 1 \quad<0.1 \% / 10 \mathrm{~K}$
- Turn down up to $10: 1 \quad<0.15 \% / 10 \mathrm{~K}$

Outside the compensated temperature range
Average temperature coefficient of the zero signal

- Turn down 1:1 typ. $10.05 \% / 10 \mathrm{~K}$

Thermal change, current output
Applies also to the analogue $4 \ldots 20 \mathrm{~mA}$ current output and
refers to the set span.
Thermal change, current output $<0.15 \%$ at $-40 \ldots+80^{\circ} \mathrm{C}\left(-40 \ldots+176{ }^{\circ} \mathrm{F}\right)$

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 $4 \ldots 20 \mathrm{~mA}$.
Specifications refer to the set span. Turn down (TD) = nominal
measuring range/set span.
Long-term drift of the zero signal $<(0.1 \% \times$ TD $) / 1$ year

## Ambient conditions

Ambient, storage and transport temperature

- Connection cable PE
$-40 \ldots+60^{\circ} \mathrm{C}\left(-40 \ldots+140^{\circ} \mathrm{F}\right)$
- Connection cable PUR, FEP
$-40 \ldots+85^{\circ} \mathrm{C}\left(-40 \ldots+185^{\circ} \mathrm{F}\right)$


## Process conditions

VEGABAR 74
Product temperature depending on the measuring cell seal

- FKM (e.g. Viton)
$-20 \ldots+100^{\circ} \mathrm{C}\left(-4 \ldots+212^{\circ} \mathrm{F}\right)$
- EPDM
- Kalrez 6375 (FFKM)
$-40 \ldots+100^{\circ} \mathrm{C}\left(-40 \ldots+212^{\circ} \mathrm{F}\right), 1 \mathrm{~h}: 140^{\circ} \mathrm{C} / 284^{\circ} \mathrm{F}$ cleaning temperature
$-10 \ldots+100^{\circ} \mathrm{C}\left(+14 \ldots+212^{\circ} \mathrm{F}\right)$
- Chemraz 535
$-30 \ldots+100^{\circ} \mathrm{C}\left(-22 \ldots+212^{\circ} \mathrm{F}\right)$


## VEGABAR 75

Medium temperature (temperature: $\mathrm{pabs}>1$ bar ( $14.5 \mathrm{psi} / \mathrm{p}_{\mathrm{abs}}<1 \mathrm{bar}(14.5 \mathrm{psi})$

- Standard
- with cooling element and screening sheet
$-12 \ldots+150^{\circ} \mathrm{C} /-12 \ldots+130^{\circ} \mathrm{C}\left(+10 \ldots+302^{\circ} \mathrm{F} /+10 \ldots+266^{\circ} \mathrm{F}\right)$
$-12 \ldots+180^{\circ} \mathrm{C} /-12 \ldots+130^{\circ} \mathrm{C}\left(+10 \ldots+356^{\circ} \mathrm{F} /+10 \ldots+266^{\circ} \mathrm{F}\right)$
$-12 \ldots+200^{\circ} \mathrm{C} /-12 \ldots+130^{\circ} \mathrm{C}\left(+10 \ldots+392^{\circ} \mathrm{F} /+10 \ldots+266^{\circ} \mathrm{F}\right)$
${ }^{1)}$ Incl. non-linearity, hysteresis and non-repeatability.

| Common data |  |
| :--- | :--- |
| Vibration resistance | mechanical vibrations with 4 g and $5 \ldots 100 \mathrm{~Hz}^{21}$ |
| Shock resistance | Acceleration $100 \mathrm{~g} / 6 \mathrm{~ms}^{3)}$ |

## Electromechanical data

Connection cable

- Configuration four wires, one suspension cable, one breather capillary, screen braiding,
- Wire cross-section metal foil, mantle
$0.5 \mathrm{~mm}^{2}$ (AWG no. 20)
- wire resistance
$<0.036 \Omega / \mathrm{m}(0.011 \Omega / \mathrm{t})$
- Standard length

6 m (19.69 t)

- max. length with VEGADIS 12
$200 \mathrm{~m}(656.2 \mathrm{ft})$
- Min. bending radius at $25^{\circ} \mathrm{C} / 77^{\circ} \mathrm{F}$

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
- EEx-ia instrument

Permissible residual ripple

| $-<100 \mathrm{~Hz}$ | $\mathrm{U}_{\text {ss }}<1 \mathrm{~V}$ |
| :--- | :--- |
| $-100 \mathrm{~Hz} \ldots 10 \mathrm{kHz}$ | $\mathrm{U}_{\text {ss }}<10 \mathrm{mV}$ |
| Load | see diagram |



Fig. 9: Voltage diagram

- HARTload

2 Voltage limit Ex instrument
3 Voltage limit non-Ex instrument
4 Supply vothage
Load in conjunction with VEGADIS 12
see diagram

[^26]

Fig. 10: Vottage diagram
1 HARTload
2 Voltage limit Ex instrument
3 Voltage limit non-Ex instrument
4 Supply vohage

## Electrical protective measures

| Protection | IP $68(25$ bar)/IP 69 K |
| :--- | :--- |
| Overvoltage category | III |
| Protection class | III |

## Approvals ${ }^{4 / 5)}$

ATEXia
ATEXD
ATEX II 1G EEx ia IIC T6, ATEX II 2G EEx ia IIC T6
ATEX ia + D
ATEX II 1/2D, 2D IP6X T
Ship approval
Other approvals
ATEXII 1G EEX ia IIC T6, ATEX II 1/2D, 2D IP6X T
GL, LRS, ABS, CCS, RINA, DNV WHG

## CE conformity

EMC (89/336/EWG) Emission EN 61326: 1997 (class B), susceptibility EN 61326: 1997/A1:
LVD (73/23/EWG)

## Environmental instructions

VEGA environment management system
certified according to DIN EN ISO 14001
You can find detailed information under www.vega.com.

## 7 Dimensions

VEGABAR 74 - threaded fitting


Fig. 11: VEGABAR74-threaded fitting: $G V=G 1 / 2$ A manometerconnection EN 837, $G I=G 1 / 2 A$ inner $G 1 / 4, G G=G 11 / 2 A, G N=11 / 2 N P T, G M=G 11 / 2 A 70 \mathrm{~mm}$

## VEGABAR 74 - hyglenic fitting 1



Fig. 12: VEGABAR 74 - hygienic fitting: $C C=$ Tri-Clamp $11_{2}^{\prime}, C A=$ Tri-Clamp 2", $L A$ = hygienic fitting with compressionnut F40, TA = Tuchenhagen Varivent DN 32, $T B=$

Tuchenhagen Varivent DN 25, RARB $=$ bolting $D N 4010 N 50$ according to DIN 11851, $K A=$ conus DN 40

VEGABAR 74 - hygienic fitting 2


Fig. 13: $V E G A B A R 74 A A=D R D, K A=$ conus $D N 40$
VEGABAR 74 - flange fitting


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

VEGABAR 74 - threaded fitting for paper Industry


Fig. 15: VEGABAR - connection for paper industry: $B A B B=M 44 \times 1.25$

## VEGABAR 74 - extension fitting for paper industry



Fig. 16: VEGABAR-extension fitting for paper industry: EV/FT = absolutely flush for pulper ( $E V 2$-times flattened), $E G=$ extension for ball valve fitting ( $L=$ order-specific)

VEGABAR 75 - threaded fitting


Fig. 17: VEGABAR - threaded fitting: $G G=G 1 / 12 A, G N=11 / 2 N P T, G L=G 1 / 1 / 2 A$ thread length $55 \mathrm{~mm}, B B=M 44 \times 1.25, B E=M 56 \times 1.25$

VEGABAR 75 -hyglenic fitting 1


Fig. 18: VEGABAR 75 - hygienic fitting: CACF $=$ Tri-Clamp $2^{2} /$ Tr-Clamp 21/8", $L A=$ hygienic fitting with compression nut F40, TA = Tuchenhagen Varivent DN 32, RV/ $R W=$ botting $D N 4 O D N 50$ according to $D / N 11851, K A=$ conus $D N 40, A A=D R D$

## VEGABAR 75 - hygienic fitting 2



Fig. 19: VEGABAR 75 - hygienic fitting: $S A=S M S D N 38, S B=S M S D N 51$

8 Product code

VEGABAR 74


VEGABAR 75

'-dicating and adjustment

|  |
| :---: |
| VEGADIS |
| VEGADIS 1 ? |
| VEGADIS 6 |
| Pticscom |
|  |



## Product Information



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Take note of safety instructions for Ex applications
Please note the Ex specific safety information which you will find on our homepage www.vega.comlservicesldownloads 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.

## 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 $4 \ldots 20 \mathrm{~mA}$ 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 $4 \ldots 20 \mathrm{~mA}$ 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 $72-4 \ldots 20 \mathrm{~mA}$ HART hydrostatic pressure transmitters. VEGADIS 12 can be connected at any point to the $4 \ldots 20 \mathrm{~mA}$ signal cable. It is provided with a breather facility for sensor ventilation via the capillary line in the special cable.


## 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 ${ }^{\text {® }}$ 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 ${ }^{\circledR}$ 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 backlightenables 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 $-40^{\circ} \mathrm{C}\left(-40^{\circ} \mathrm{F}\right)$.


Fig. 3: Configuration VEGADIS 61 and PLICSCOM
1 Sensor
2 VEGADIS 61
3 PLICSCOM

## Advantages:

- Universal use for all plics ${ }^{\circledR}$ 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 $4 \ldots 20 \mathrm{~mA}$ signal cable and is suitable for active (four-wire) as well as passive (two-wire) sensors.


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 sillo



Fig. 6: Level measurement in a chip silo with VEGAPULS 6B, remote indication end 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.

## 2 Type overview

|  | VEGADIS 11 | VEGADIS 12 | VEGADIS 61 |
| :---: | :---: | :---: | :---: |
|  |  |  |  |
| Indication: | digital and quasi-analogue | digital and quasi-analogue | Dot-Matrix |
| Signal: | 4 ... $20 \mathrm{~mA}, 4$... $20 \mathrm{~mA} / \mathrm{HART}$ | 4 ... $20 \mathrm{~mA}, 4$... 20 mA HART | $1^{2} \mathrm{C}$ bus |
| Sensors: | 4... 20 mA passive or active | VEGABAR 74, 75; VEGAWELL 72-4... 20 mA/HART | plics ${ }^{\text {® }}$ sensors |
| Mounting: | Wall, rail mounting | Wall, rail mounting | Wall, rail, tube mounting |
| Ambient temperature: | $-20 \ldots+70^{\circ} \mathrm{C}\left(-4 \ldots+158^{\circ} \mathrm{F}\right)$ | $-20 \ldots+70^{\circ} \mathrm{C}\left(-4 \ldots+158^{\circ} \mathrm{F}\right)$ | $-20 \ldots+70^{\circ} \mathrm{C}\left(-4 \ldots+158^{\circ} \mathrm{F}\right)$ |
|  |  | VEGADIS 175 |  |
| Indication: | Dot-Matrix | digital |  |
| Signal: | $\mathrm{I}^{2} \mathrm{C}$ bus | $4 \ldots 20 \mathrm{~mA}, 4 \ldots 20 \mathrm{~mA} / \mathrm{HART}$ |  |
| Sensors: | plics ${ }^{\text {® }}$ sensors | 4 ... 20 mA passive or active |  |
| Mounting: | in the sensor or in VEGADIS 61 | Front panel |  |
| Ambient temperature: | $-15 \ldots+70^{\circ} \mathrm{C}\left(+5 \ldots+158^{\circ} \mathrm{F}\right)$ | $-10 \ldots+60^{\circ} \mathrm{C}\left(+14 \ldots+140^{\circ} \mathrm{F}\right)$ |  |

## 3 Mounting instructions

## VEGADIS 11 and VEGADIS 12

VEGADIS 11 and VEGADIS 12 are configured for the following installation and mounting options:

- Carrier rail $35 \times 7.5$ 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 $35 \times 7.5$ according to EN 50022
- Wall mounting
- Tube mounting


Fig. 9: VEGADIS 61 for wall mounting, bottom view of mounting plate.
1 Drill dimension

## Carrier rall 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 $M 4 \times 6$
3 Carnier 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
14 screws M5 $\times 12$
2 Measuring instrument holder BARMONT.C 3 Tube

## Wall mounting

VEGADIS 61 for wall mounting is supplied with a mounting socket.


Fig. 12: Measuring instrument holder BARMONT.C
$14 \times$ holes 5 mm for mounting screws M5 $\times 12$

## PLICSCOM

The indicating and adjustment module PLICSCOM can be inserted in the following housing versions and instruments:

- All sensors of the plics ${ }^{\text {® }}$ 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 panal
2 Fixing hook
3 Screw

## 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 applicatlons

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. $1 \mathrm{nF}, 1500 \mathrm{~V}$ ). 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 $4 \ldots 20 \mathrm{~mA}$ 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 Controlinstrument
4 Vohtage 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.

## Sensors with signal conditioning instrument



Fig. 16: Wining plan, VEGADIS 11 for signal conditioning instrument
1 Signal conditioning instrument
2 Indicating module
3 Controlinstrument

## 5

## 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: Wining plan, VEGADIS 12

```
brown (+)
    blue (-)
    Yellow
    Screan
    Breather capillaries with fitter element
    Indicating module
    Control instrument
    Voltage supply/Signal output
```

143-EN-071203

### 4.4 Wiring plan, VEGADIS 61

## Wiring plan



Fig. 18: Wiring plan, single chamber housing
1 plics ${ }^{\circledR}$ 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 Exarea
5 Non-Ex area

Active sensors


Fig. 20: Wiring plan, VEGADIS 175 for active sensors
1 Sensor (activa)

## 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 Digitalindication
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 Digitalindication
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 sw/tch] to select:
- Operate $=$ Measured value indication
- ZERO = Adjustment of the min. value
- SPAN = Adjustment of the max. value
- Point = Shifting of the decimal point
- [ $+/-\mathrm{J}$ key:
- Change value of the digital indication


### 5.3 Adjustment on VEGADIS 61 and PLICSCOM



Fig. 23: Indicating and adjustment eloments
1 LC display
2 Indication of the menu item number
3 Adjustment keys

## 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 ${ }^{\text {™ }}$

## PACTware ${ }^{\text {TM／DTM }}$

plics ${ }^{(2)}$ sensors can be adjusted via PACTware ${ }^{\text {TM }}$ independent of the respective signal output $4 \ldots 20 \mathrm{~mA} / \mathrm{HART}$ ，Profibus PA or Foundation Fieldbus via VEGADIS 61．To adjust with PACTware ${ }^{\text {TM }}$ ，an instrument driver for the particular sensor is required．
All currently available VEGA DTMs are provided as DTM Collec－ tion with the current PACTware ${ }^{\text {TM }}$ version on CD．They are avail－ able from the responsible VEGA agency for a token fee．The basic version of this DTM Collection incl．PACTware ${ }^{\text {TM }}$ is available as a free－of charge download from Internet．
To use the entire range of functions of a DTM，incl．project doc－ umentation，a DTM licence is required for that particular instru－ ment 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
$3 I^{2} C$ adapter cable for VEGACONNECT 3
To adjust with PACTware ${ }^{\text {TM }}$ ，a VEGACONNECT 3 with $I^{2} \mathrm{C}$ adapt－ er cable（art．no．2．27323）as well as a power supply unit is nec－ essary 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 Kay（OK）
3 Adjustment keys＋1－

## Key functions

－［OK］key：
－Move to the menu overview
－Confirm selected menu
－Edit parameter
－Save value
－$[+/ /[-]$ keys：
－Change value of the parameter

## 6 Technical data

| General data |  |  |
| :---: | :---: | :---: |
| VEGADIS 11, 12 |  |  |
|  | Series | Instrument for panel or wall mounting or mounting on carrier rail $35 \times 7.5$ 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 | Insirumeni for panel or wall mounting or mounting on carrier rail $35 \times 7.5$ 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 lechnology | $500 \ldots 1300 \mathrm{~g}$ (1.10 ... 2.87 lbs ) |
| PLICSCOM |  |  |
|  | Series | Module for insertion in VEGADIS 61 |
| Materials |  |  |
|  | - Housing | ABS |
|  | - Inspection window | Polyester foil |
|  | Weight approx. | $100 \mathrm{~g}(0.22 \mathrm{lbs})$ |
| 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 $4 \ldots .20 \mathrm{mA/HART}$ |
|  | Transmission | analogue, $4 \ldots 20 \mathrm{~mA}$ |
|  | Max, input current | 150 mA |
|  | Connection cable to the sensor | 2-wire |
|  | Voltage loss | 4.5 V al 20 mA |
|  | VEGADIS 12 |  |
|  | Connection to | VEGAWELL $72-4 \ldots 20 \mathrm{~mA}$ (HART, VEGABAR 74, 75 |
|  | Transmission | analogue, $4 \ldots 20 \mathrm{~mA}$ |
|  | 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 |
|  | Vollage loss | 4.5 V at 20 mA |
|  | VEGADIS 61 |  |
|  | Connection to | VEGA plics ${ }^{\text {* }}$ sensors |
|  | Data transmission | digital ( ${ }^{2} \mathrm{C}$-Bus) |
|  | Connection cable | 4-wire, screened |
|  | Max. cable length | 25 m |
|  | VEGADIS 175 |  |
|  | Transmission | analogue, $4 \ldots 20 \mathrm{~mA}$ (reverse battery protection) |

Technical data

| HART protocol | The indicator is suitable for transmission of the HART protocol |
| :--- | :--- |
| Max. input current | 150 mA (shortcircuit current) |
| Voltage loss | $<2 \mathrm{~V}$ with 20 mA |

## Indications

VEGADIS 11, 12
LC multiple function display

- Bargraph (quasianalogue indication) 20 segments
- Digital value
-9999 ... 9999
- Tendency indicators

VEGADIS 61, PLICSCOM
LC display
Power supply display light
Power supply display heating

- Operating voltage

Symbols for rising or falling values

- Power
1.7 W
- Switch on point
in dot matrix

VEGADIS 175
LC display
$\begin{array}{ll}\text { - Height of figures } & 17 \mathrm{~mm} \\ \text { - Indication range } & -19999 \ldots 19999 \\ \text { - Offset } & -19999 \ldots 32767\end{array}$

## Ambient conditions

VEGADIS 11, 12
Ambient temperature
Storage and transport temperature
VEGADIS 61, PLICSCOM
Ambient temperature
Ambient temperature with heating
Storage and transport temperature

$$
\begin{aligned}
& -20 \ldots+70^{\circ} \mathrm{C}\left(-4 \ldots+158^{\circ} \mathrm{F}\right) \\
& -40 \ldots+85^{\circ} \mathrm{C}\left(-40 \ldots+185^{\circ} \mathrm{F}\right) \\
& -15 \ldots+70^{\circ} \mathrm{C}\left(+5 \ldots+158^{\circ} \mathrm{F}\right) \\
& -40 \ldots+70^{\circ} \mathrm{C}\left(-40 \ldots+158^{\circ} \mathrm{F}\right) \\
& -40 \ldots+80^{\circ} \mathrm{C}\left(-40 \ldots+176^{\circ} \mathrm{F}\right) \\
& -10 \ldots+60^{\circ} \mathrm{C}\left(+14 \ldots+140^{\circ} \mathrm{F}\right) \\
& -25 \ldots+70^{\circ} \mathrm{C}\left(-13 \ldots+158^{\circ} \mathrm{F}\right) \\
& \text { according to } \mathrm{EN} 60654-1 \text {, class } \mathrm{B} 2
\end{aligned}
$$

VEGADIS 175
Ambient temperature
Storage and transport temperature
Climatic class

## 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

| ESD | $6 \mathrm{kV} / 8 \mathrm{kV}$ |
| :---: | :---: |
| Electromagnetic fields | $10 \mathrm{~V} / \mathrm{m}$ |
| Burst (power supply) | 2 kV |
| Surge | 1 kV |
| Electromagnetic fields | $10 \mathrm{~V} / \mathrm{m}$ |
| Approvals ${ }^{\text {1 }}$ |  |
| VEGADIS 11 |  |
| ATEX | ATEX II 2G EEx ia IIC T6 |
| VEGADIS 12 |  |
| ATEX | ATEX II 2G EEx ia IIC T6 |
| UL | CI. I,II,II; Div. 1; Gr. A-G |
| VEGADIS 61 |  |
| ATEXia | ATEX II 1G, 2G EEx ia IIC T6 |
| ATEX D | ATEX II 1/2D IP6X |
| IEC | IEC Ex ia IIC T6 |
| FM | FM CIIIIII, Divi (IS) |
| CSA | CSA CI.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.
" 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

## 8 Product code

## VEGADIS 11

$\square$
. $x$ without
DIS11

VEGADIS 12


## VEGADIS 61



PLICSCOM


VEGADIS 175


## RADIO MODEM

## 1. DR-900 DATA RADIO MODEM TECHNICAL DETAILS

2. TC-900DR USER MANUAL

## (D) Series <br> Data Radio Modem <br> 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* $853-929 \mathrm{MHz}+/-5 \mathrm{MHz}$ radio, including a fully integrated $4800 / 9600 \mathrm{bps}$ 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 adio 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)
* Inbuili dala routing and múltiplexing capabilties, multi-port operation
* Simultaneous delivery of multiple protocols using Trio DataCom's
. . unique MultiStream™ techñology
* Digital SIgnal Processing (DSP) modem
- Selectable 300-19,200 bps asynchronous RS232 user intefface
$\qquad$ s
* Buill-in antenna diplexer*
- integrated supervisory data channel
* Unique collisiōn avoidance facility, for unsolicited report-byexception
* Soffware 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 sutput up to 5 Watts. This fully synthesised radio is programmable .n $6.25 \pi .5 \mathrm{kHz}$ 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 $60^{\circ} \mathrm{C}$ 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 / roüter 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 slation / 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

## D Series - Data Radio Modem <br> DR900 - Digital Radios

## Configuration

Configuration using Trio's D Series programming software (DRProg) is completely Windows ${ }^{\ominus}$ 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 ${ }^{\text {TM }}$ 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.

## Specifications:

| 510 | , |
| :---: | :---: |
| Frequency Range** | $853-929 \mathrm{MHz}+/-5 \mathrm{MHz}$ |
| Channel Selection | Fully programmable |
| Frequency Splits | $76 \mathrm{MHz} \mathrm{Tx} / \mathrm{Rx}$ frequency split available including simplex |
| Frequency Stability | $\pm 1 \mathrm{ppm}\left(-10\right.$ to $60^{\circ} \mathrm{C}$ ambient, opt. -30 to $70^{\circ} \mathrm{C}$ ) 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 |
| Uivisumbuen |  |
| Tx Power | $5 \mathrm{~W}(+37 \mathrm{dBm})$ or $1 \mathrm{~W}^{*}(+30 \mathrm{dBm})$ (software programmable) |
| Modulation | Narrow band digital filtering binary GMSK |
| Occupied Bandwidth | Meets various intemational regulatory guidelines for point-to-point and point-to-multipoint |
| Tx Attach Time. | $<1 \mathrm{mSecond}$ |
| Timeout Timer | Programmable 1-255 seconds |
| Tx Spurious | $<=-65 \mathrm{dBm}$ |
| fichuris |  |
| Sensitivity | -115 dBm for 12 dB SINAB |
| Blocking | $>75 \mathrm{~dB}$ (EIA) |
| Intermodulation | $<=70 \mathrm{~dB}$ (EIA) |
| Spurious Response | $<=70 \mathrm{~dB}$ (ElA) |
| Select. and Desense | 70 dB (EIA) |
| AFC Tracking | $\pm 3 \mathrm{kHz}$ tracking @ -90 dBm/attack time < 10 mS |
| Mute | Programmable digital mute |

## 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

$\therefore \quad$ Base Stations (DB900)
$\therefore \quad$ Hot Standby Base Station (DH900)
$\therefore \quad 9$ Port Stream Router Multiplexer (MSR)
$\therefore \quad$ Network Management and Diagnostic Software (TView ${ }^{\text {TM }}$ )
$\because \quad$ D Series Programming Software (DRProgM)

| Couniciows |  |
| :---: | :---: |
| User Data Port Antenna Power | $2 \times$ DB9 RS232 female ports SMA female buikhead (optional N) <br> 2 pin locking. Mating connector supplied |
| W0DEM |  |
| Data Serial Port \#1 | Full duplex, DB9 RS232, DCE (modem), 30019,200 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 | $4800 / 9600 \mathrm{bps}$, full duplex |
| Bit Error Rate | $<1 \times 10^{-6} @-108 \mathrm{dBm}$ (4800 bps) |
|  | $<1 \times 10^{-8}$ @ -105 dBm (9600 bps) |
| Collision Avoidance | Trio DataCom's unique supervisory channel C/DSMA collision avoidance system |
| Multistream ${ }^{\text {TM }}$ | Trio DataCom's unique simultaneous delivery $n$ nfmultiple data ṡtreams (protocols) |
| CGTETa |  |
| 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 | $260 \times 161 \times 65 \mathrm{~mm}$ (robust metal enclosure) |
| Weight | 1.3 kg |


designs products \& SO/UtiOnS
$\square$


## TC-900DR

## 900 MHz <br> Full Duplex Data Transceiver

User Manual

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## IMPORTANT NOTICE

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## Modifications

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## 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 $12.5 \mathrm{kHz}, 15 \mathrm{kHz}, 25 \mathrm{kHz}$ or 30 kHz 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 $-10^{\circ} \mathrm{C}$ to $+65^{\circ} \mathrm{C}$, 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 1 ppm .

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 +30 dBm (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
\{ $4800 \& 9600 \mathrm{bps}$ 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 : 923 MHz to 933 MHz (see note 1)
Tx frequency range : 847MHz to 857MHz (see note 2)
Channel spacing : Fully synthesized $12.5 \mathrm{kHz} / 25 \mathrm{kHz}$, [opt 15/30] with programmable $1 / 2$ channel raster offset

Frequency stability : $1 \mathrm{ppm}\left(-10^{\circ} \mathrm{C}\right.$ to $65^{\circ} \mathrm{C}$ amb), $\left[\mathrm{opt}-30^{\circ} \mathrm{C}\right.$ to $\left.70^{\circ} \mathrm{C}\right]$, aging <= 1ppm/Annum

Power output $\quad: \quad+30 \mathrm{dBm} \pm 1 \mathrm{dBm}(1 \mathrm{~W}$ nom $)$
at Antenna connector
switchable under software control $200 \mathrm{~mW} / 1 \mathrm{~W}$
Duty cycle
Continuous
Output impedance
Timeout timer
Tx key up time
Rx sensitivity
50 Ohms
Programmable from 1 sec . to 28 minutes (max)
: <= to 1 mS (output _ 1 dB of power).
0.5 uV at antenna input for 12 dB SINAD at "delayed $R x$ signal" test point.

Rx intermodulation : $\quad>=70 \mathrm{~dB}$ spurious free dynamic range.
Rx spurious responses : $<=-65 \mathrm{~dB}$.
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 847 MHz to 857 MHz .
- Tx frequency range 923 MHz 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, $300 . .19 \mathrm{k} 2$ 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. |
| Synchronisati |  | 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 : $\pm 1.5 \mathrm{kHz}$ (4800bps), $\pm 2.75 \mathrm{kHz}$ ( 9600 bps )
Power requirements : 14 Volts $A C 10 \mathrm{VA}$ or 13.8 Volts DC ( 11 to 16 V Max).
Transmit current : <= to 600 mA .
Receive current : 175 mA .
Size $\quad: \quad 241 \mathrm{~mm} \times 161 \mathrm{~mm} \times 65 \mathrm{~mm}$.
Weight : 1.3 Kg .

### 1.4.4 CONNECTORS



### 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 $193 \mathrm{~mm} \times$ $152 \mathrm{~mm} \times 1.6 \mathrm{~mm}$.

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 X 2 . 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 20 dB .

### 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 45 MHz 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 $R F_{\text {in }}$ and $R F_{\text {bypass }}$ pins (U2-p1,p2).

This signal is applied internally to a Gilbert cell mixer, which is set to convert the signal down to 455 kHz .

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 455 kHz 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 $\mathrm{dB}(\mathrm{uv})$. C10 and C11 provide IF amplifier decoupling.

The output is available at IF AMP OUT (U1-p16). This is applied to a 455 kHz 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 $62 \mathrm{~dB}(\mathrm{uv})$. 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 2 V . The $A C$ level of the signal is set to about $1 \mathrm{~V}_{\mathrm{p}-\mathrm{p}}$

### 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 60 dB .

### 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 $\cup 1: B$, 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 0.86 V . 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 100 Hz . 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 30 dB . 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 800 MHz 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 X 4 , 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, "TTX 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 200 mW , and high power is 1 W .

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 $\ln$ " 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 ( 200 mW ).

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. C 29 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 " 11 "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 ( $\mathrm{U} 3-\mathrm{p} 6$ ). 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 $\times 1-\mathrm{p} 15$, "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 X 1 . Attached permanently to this connector is a 90 mm 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 $\times 1 / J \times 3$ SIGNAL DESCRIPTION PIN NUMBERS

| 1 | 13 V 8 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 | ITXEN | (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 |
| :--- | :--- |
|  |  |
| X2 | TRANSMITTER OUTPUT |
|  | 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 <br> PIN NUMBERS |  | SIGNAL DESCRIPTION |
| :---: | :--- | :--- |
| 1 |  | BV 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 $0.001^{\prime \prime}$ 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 $=930 \mathrm{MHz}$ 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 $=850 \mathrm{MHz}$ range)

| DIPLEXER CONNECTOR |  |
| :---: | :--- |
| 850 MHz port |  |
| 930 MHz port | RF TRAL DESCRIPTION AND DESTINATION - RADIO SECTION X4 |
| ANT port | RF RECEIVE - RADIO SECTION X2 |
|  | 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 $\times 3$ |
| :---: | :---: | :---: | :---: |
| 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 $165 \mathrm{~mm} \times 152 \mathrm{~mm} \times 18 \mathrm{~mm}$.

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 $I^{2} C$, 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 $6264-8 \mathrm{~K}$ or $62256-32 \mathrm{~K}$ byte IC (U9). The standard TC-900DR is supplied with an 8 K 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 74 HC 573 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 $32 K$ RAM package will not be compatible with a modem containing an $8 K$ 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 +10 V and -10 V 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, X 4 .
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 +13.8 V and +8 V power supplies.

Input to the receiver signal port, RXSIG, is offset by 2.0 V DC, with a signal level of $1 \mathrm{Vp}-\mathrm{p}$ $A C$.

The transmit signal output, TXSIG, has a signal level of $1 \mathrm{Vp}-\mathrm{p}$ for 4800 BPS , and $2 \mathrm{Vp}-\mathrm{p}$ for 9600 BPS , with a nominal DC offset of 2.0 V . This offset may vary by $\pm 1 \mathrm{v}$ 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 20.1666 MHz 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 1 W , or to a LOW level of 200 mW . 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 74 HC 4066 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 ( $\mathrm{U} 12: \mathrm{A}, \mathrm{B}$ ) 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 ( $\cup 7: B$ ), 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 74 HC 4066 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 ( U -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 74 HC 4066 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 13 V 8 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 +13 V 8 , +8 V and +5 V .

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 $A C$ 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 13 V 8 and feeds the RF final amplifier, and the following two regulators.

The 8 V regulator (REG2) takes it's input directly from the 13 V 8 rail, its output is routed to the radio section, and provides supply for one of the amplifier devices.

The 5 V regulator (REG3) provides the supply rail for the modem section logic circuits. It takes it's input from the 13 V 8 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 90 mm length of 26 way ribbon cable.

Refer to interface diagram "RADIO MODEM INTERFACE", drawing number TC01-05-18 sheet $1 / 3$.

## CONNECTOR JX3 SIGNAL DESCRIPTION <br> PIN NUMBER

| 1 | 13 V 8 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 | ITX 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 SIGNAL DESCRIPTION
PIN NUMBER

| 1 |  |  |
| :--- | :--- | :--- |
| 2 | DATA CARRIER DETECT | (DCD) |
| 3 | RECEIVE DATA OUTPUT | (RXD) |
| 4 | TRANSMIT DATA IN | (TXD) |
| 5 | DATA TERMINAL READY | (DTR) |
| 6 | COMMON | (COM) |
| 7 | DATA SET READY/prog mode | (DSR) |
| 8 | REQUEST TO SEND | (RTS) |
| 9 | CLEAR TO SEND | (CTS) |
|  | 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 SIGNAL DESCRIPTION
PIN NUMBER

| 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 50 K ohms and loading will decrease accuracy of the recorded measurement.

### 2.5.8.4 POWER

Power is supplied to the modem section via connector X 1 . Typically +13.8 V 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, NRZNRZI conversion, clock recovery, and HDLC framing and CRC error generation and checking. These functions are performed simultaneously, allowing full duplex operation at up to 9600 bps .

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 19 K 2 , 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 19.2 K 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 ( TxCtrl 1 and $\operatorname{TxCtrl0\text {)in"Config1",bothto"}1\text {".Thismodeforcesarandomlygenerated}}$ 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 0.5 mS ) 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 1 mS , 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 10 mS , 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 ASClI character (e.g. "C" is actually binary byte $h^{\prime} 43$ ).

## 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:- $\quad 12,34,56,00,00,00$, " $B "$
Response:- $\quad 00,00,00,12,34,56, " \mathrm{b"}$

## 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:- $\quad 12,34,56,00,00,00, " \mathrm{C"}$
Response:- $\quad 00,00,00,12,34,56, " c "$, tt,rr,pp,ff,ss
Where:-
$\mathrm{tt}=$ Temperature calibration code
rr = RSSI calibration code
pp = Transmit Power calibration code
$\mathrm{ff}=$ 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:- $\quad 00,00,00,12,34,56{ }^{\prime \prime} D^{\prime \prime}$
Response:- $\quad 12,34,56,00,00,00$ "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:- $\quad 12,34,56,00,00,00, " F ", n n$
Response:- 00,00,00,12,34,56,"f"
Where:-
$\mathrm{nn}=00$ 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:- $\quad 12,34,56,00,00,00, " H "$
Response:- $\quad 00,00,00,12,34,56, " h "$

## 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:- $\quad 12,34,56,00,00,00, " \mathrm{M}^{\prime \prime}, \mathrm{xx}$
Response:- $\quad 00,00,00,12,34,56, " \mathrm{~m}^{\prime}$
Where:-
$x x=$ 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:- $\quad 12,34,56,00,00,00, " P^{\mu}, n n, a a, b b, c c, \ldots$
Response:- $\quad 00,00,00,12,34,56, " p ", n n, a a, b b, c c, \ldots$
Where:-
$n n=$ parameter identifier
$\mathrm{aa}, \mathrm{bb}, \mathrm{cc}, \ldots$ 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:- $\quad 12,34,56,00,00,00, " \mathrm{R} ", n n$
Response:- $\quad 00,00,00,12,34,56, " r ", n n, a a, b b, \ldots h h$

## 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:- $\quad 00,00,00,12,34,56, " s ", \mathrm{tt}, \mathrm{rr}, \mathrm{pp}, \mathrm{ff}, \mathrm{ss}$
Where:-
$\mathrm{tt}=$ Temperature conversion code
rr = RSSI conversion code
$\mathrm{pp}=$ Transmit Power conversion code
$\mathrm{ff}=$ 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:- $\quad 12,34,56,00,00,00, " \mathrm{~T} ", \mathrm{nnnn}$
Response:- $\quad 00,00,00,12,34,56, " t "$
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:- $\quad 12,34,56,00,00,00, " V "$
Response:- $\quad 00,00,00,12,34,56, " v ", " A 2.2 .0^{\prime \prime}$

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:- $\quad 12,34,56,00,00,00, " W ", n n, a a, b b, c c, \ldots$
Response:- $\quad 00,00,00,12,34,56, " w ", n n, a a, b b, c c, \ldots$
Where:-
$\mathrm{nn}=$ parameter identifier
$\mathrm{aa}, \mathrm{bb}, \mathrm{cc}, \ldots$ 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 |
| $03\left({ }^{\wedge} \mathrm{C}\right)$ | 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 |
| OA (^J) | word | SIDB1 and SIDB2 |
| OB (^K) | word | SIDD1 and SIDD2 |
| OC (^L) | byte | KISS_adrA |
| OD (^M) | byte | KISS_adrB |
| OE ( ${ }^{\wedge}$ ) | byte | EOMA_code |
| OF (^) | byte | EOMB_code |
| 10 (^P) | byte | input_timeA |
| 11 (^Q) | byte | input_timeB |
| 12 (^R) | byte | frame_sizeA |
| 13 (^S) | byte | frame_sizeB |
| 14 (^${ }^{\wedge}$ ) | 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 |
| 1 A (^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 | TxCtri0 |
| 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.

[^27]
### 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 $1 / 8$ th of the bit rate, while on the asynchronous user port, the character rate is $1 / 10$ th 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 2.5 mS . 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 $35 \pm 5 \mathrm{mS}$. 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 $35 \pm 5 \mathrm{mS}$, 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 8 K ( 8192 bytes, 32 K 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 $=C 0$ ) 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 CO 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, $20, B D, D C, D D$. The SLIP frame will be:-

$$
\begin{aligned}
& <\text { FEND }>, D A, C 4,<F E S C>,<T F E N D>, C 5,<F E S C>,<T F E S C>, 20, B D, D C, D D,<F E N D> \\
& ==>\quad C 0, D A, C 4, D B, D C, C 5, D B, D D, 20, B D, D C, D D, C 0
\end{aligned}
$$

### 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 |
| :--- |

### 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 2.5 mS ), 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 $<C R>$ (carriage return) EOM. If the frame boundary space is full, when a $<C R>$ 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. $2 \mathrm{~K} / 2 \mathrm{~K} / 2 \mathrm{~K} / 2 \mathrm{~K}$ for Port_A transmit, Port_A receive, Port_B transmit, Port_B receive). If Port_B is disabled, then 4 K 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" ( 2.5 mS ) 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 8 K CMOS RAM, of which half (4096 bytes) is allocated to the receiver. The modem can be fitted with an external memory up to 32 K 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 8 K CMOS RAM, of which half ( 4096 bytes) is allocated to the transmitter. The modem can be fitted with an external memory up to 32 K 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.

[^28]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 12 MHz 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 +65 C . 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 +13.8 v , 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 2 V , but if it isn't installed, then the voltage will be about 4 V . The measured voltage is compared to 3 V 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 ( 0 ), the LEDs are swapped, then both turned OFF ( $\bullet$ ). 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 |
| 0 | - | 0 | - | 0 | - |
| - | 0 | $\bullet$ | - | - | 0 |
| 0 | - | 0 | - | - | - |
| $\bullet$ | 0 | - | - | $\bullet$ | 0 |
| 0 | - | $\bullet$ | 0 | 0 | - |
| - | 0 | - | - | - | - |
| 0 | $\bullet$ | $\bullet$ | 0 |  | repeat |
| - | 0 | - | - |  |  |
| 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 4800 BPS unit, use 2400 Hz 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 +13.8 volt rail via a 4 K 7 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, TCl (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 2.5 mS 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 20 mS 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 +13.8 v , 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 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 0 | $\bullet$ | 0 | $\bullet$ | 0 | $\bullet$ |
| $\bullet$ | 0 | $\bullet$ | $\bullet$ | $\bullet$ | 0 |
| 0 | $\bullet$ | 0 | $\bullet$ | $\bullet$ | $\bullet$ |
| $\bullet$ | 0 | $\bullet$ | $\bullet$ | $\bullet$ | 0 |
| 0 | $\bullet$ | $\bullet$ | 0 | 0 | $\bullet$ |
| $\bullet$ | 0 | $\bullet$ | $\bullet$ | $\bullet$ | $\bullet$ |
| 0 | $\bullet$ | $\bullet$ | 0 |  | repeat |
| $\bullet$ | 0 | $\bullet$ | $\bullet$ |  |  |
| continue |  |  |  | repeat |  |

### 3.9.13 WIRING ADAPTOR HARNESS FOR TC-900DR SYNCHRONOUS MODEL

| PORT A | 1 (DCD) | (RCO) |  | 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 $1 \mathrm{GHz} .-120 \mathrm{dBm}$ to +10 dbm . Synthesised in 100 Hz steps.
- Spectrum analyser 10 MHz to 1 GHz . Dispersion down to $2 \mathrm{kHz} / \mathrm{cm} .80+$ dB dynamic range. IF b/w down to 1 kHz .
- RF Power meter to $1 \mathrm{GHz} .-20$ to +30 dbm . Accuracy $\pm 0.25 \mathrm{~dB}$.
- Digital volt meter.
- HP3406 RF Millivoltmeter or similar.
- $\quad$ 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 | $+8 \mathrm{v}$ | Power Supply |  |
| TP15 | TXEN | Tran | mit enable |
| TP20 | RxMIXOUT |  | Rx mixer bias |
| TP28 | TXPA-1 | Bias | Q10 |
| TP29 | TXPA-2 | Bias | Q11 |
| TP26 | +13V8 | Pow | supply |
| TP33 | PWR CONT | Pow | control supply |
| TP30 | PTT+8V | Pres | to talk |
| 121 MHz SECTION |  |  |  |
| TP13 | DATA | Tx d | a input |
| TP17 | 60.5 MHz | Mod | lated 60.5 MHz |
| TP16 | 121 MHz | Outp | t of doubler |
| TP18 | 121 MHz | Mod | lated 121 MHz |
| TP32 | MIC | Tx | c audio input |

NE615 IF SECTION
TP6
TP9
TP8
TP10
TP7
TP4
TP1
TP2
TP3
TP5
TP19
415 kHz I/P 455 filter input/second mixer output
QUAD Quad detector
DATA Rx data out
AUDIO Rx audio out
RSSI RSSI output
MUTE Mute control output
2nd L.O Second Xtal oscillator
2nd L.O Second Xtal oscillator
IF Input $\quad 45 \mathrm{MHz}$ IF filter input
IF Output $\quad 45 \mathrm{MHz}$ IF filter output
VCO VCO oscillator injection
SYNTHESISERNCO SECTION
TP12 LOCK DET Synthesiser lock detect
TP11 +5 V Synthesiser +5 V supply
AUXILIARY HANDSET INTERFACE SECTION
TP21 MIC Tx mic audio input
TP22 PTT Manual press to talk
TP23 +8V Handset +8 V 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 30 db 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 ( 5 V ) 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 786 MHz VCO $=907 \mathrm{MHz}$ Tx or 831 MHz Rx
Minimum 814 MHz VCO $=935 \mathrm{MHz}$ Tx or 859 MHz Rx
VCO TYPE: MQC-978
Maximum $\quad 996 \mathrm{MHz}$ VCO $=875 \mathrm{MHz}$ Tx or 951 MHz Rx
Minimum $\quad 960 \mathrm{MHz} \mathrm{VCO}=839 \mathrm{MHz}$ Tx or 915 MHz 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 ( $\pm 1500 \mathrm{~Hz}$ ), 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 -60 dBc in the adjacent channel.

8 Check VTCXO Reference frequency is $\mathrm{F}(\mathrm{tx})+121 \mathrm{MHz}$ for 853 remote units or $\mathrm{F}(\mathrm{tx})-121 \mathrm{MHz}$ for master units. If Reference is out by more than $\pm 1.5 \mathrm{kHz}$, 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 L 7 through L 10 for peak $\mathrm{o} / \mathrm{p}$. 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 75 mV should be measured by an RF millivoltmeter (e.g HP11960).

Typical RF millivoltmeter readings for each stage are :
TP17 125 mV RF $=0.25 \mathrm{VDC}$ on HP11960 probe.
TP16 $\quad 40 \mathrm{mVRF}=0.06 \mathrm{VDC}$ on HP11960 probe.
TP18 $\quad 550 \mathrm{mV}$ RF $=1.0 \mathrm{VDC}$ on HP11960 probe.
$121 \mathrm{MHz} \mathrm{i} / \mathrm{p}$ to mixer $\quad 75 \mathrm{mVRF}=0.13 \mathrm{VDC}$ 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 $121 \mathrm{MHz} \mathrm{o} / \mathrm{p}$ 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 4800 bps

DEVIATION LEVEL
$\pm 1.5 \mathrm{kHz}$ peak
$9600 \mathrm{bps} \quad \pm 2.75 \mathrm{kHz}$ peak
4. Note that temperature compensation is applied to the 121 MHz 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 $> \pm 500 \mathrm{~Hz}$ 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 ( 100 mVDC ), and NOT MORE THAN 55mA (120mVDC).

5 With full drive at Q9 each final transistor should be drawing around 175 $\mathrm{mA}(385 \mathrm{mVDC})$ 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 +5 VDC , set VR4 for $+32 \mathrm{dbm}+/-0.25 \mathrm{~dB}$ at the tx o/p socket X 4 . Check that the current in EACH final collector does NOT EXCEED 225 mA .

7 Check with the spectrum analyser that the $T \times o / p$ 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 $+/-30 \mathrm{MHz}$ ) 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 X 4 (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 $1=\mathbf{4 5 . 4 5 5 M H z}$ )

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 $44.545 \pm 1.5 \mathrm{KHz}$
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 instailed 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 13.8 VDC , 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 3 dB 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 900 MHz 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 400 MHz and 900 MHz over distance, please consider this when installing the unit.

| CABLE TYPE | LOSS RELATIVE TO DISTANCE |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1 dB |  | 3 dB |  | 6 dB |  | 9 dB |  |
|  | 450 MHz | 900 MHz | 450 MHz | 900 MHz | 450 MHz | 900 MHz | 450 MHz | 900 MHz |
| RG58C/U | 2.3 m | 1.6m | 7 m | 5 m | 14m | 10m | 20m | 15m |
| RG223/U | 3.1 m | 2.3m | 9 m | 7m | 18m | 14m | 28m | 21m |
| RG213/U | 6.1 m | 4m | 18m | 12m | 37m | 24m | 55m | 37m |
| $\begin{aligned} & \mathrm{HELIAX} \\ & \text { LDF4-50A } \end{aligned}$ | 19m | 14m | 57m | 43m | 114m | 87m | 171m | 130m |
| $\begin{aligned} & \hline \text { HELIAX } \\ & \text { LDF5-50A } \\ & \hline \end{aligned}$ | 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 9 dB 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 14 dB 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 $360^{\circ}$ 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 20 dB 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 25 dB 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 30 dB 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 $B E R$ 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 10 K 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 OIP (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 |  | Dine of Site to Base |  |
| Tx Power at Antenna |  | Date |  |
| Site QA Inspection: |  |  |  |
|  |  |  |  |
| Notes: |  |  |  |

## 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 PIS PCB ( 1 Amp SLO-BLOW).
c) Check supply volts:
$\begin{array}{ll}\text { Modem PIS } & \text { i) } 13.8 \text { Volts }\end{array}$
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 $\pm 250 \mathrm{~Hz}$. 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 1 nF 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 4 VDC , 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 1 nF | -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
2. Check PTT circuit.
3. Check unit is programmed within its operational range.
4. Check if manual PTT (Rear Aux connector) keys transmitter.
5. 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 $\pm 910 \mathrm{kHz}$. - IF detector signal $(2 \times 455)$ modulating or mixing with carrier. Check 1 n bypass on reference $\mathrm{i} / \mathrm{p}$ to power control op-amp. Check bypasses on collectors and supply lines of low level transmitter stages, and L.O. buffer.

Carrier $\pm 20.166$ 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 $\pm$ 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 ( $2 \times 4.7 \mathrm{ohm}$ 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 <br> $60 \mathrm{mV}_{\mathrm{p}-\mathrm{p}}$ for VR3 set for maximum value $400 \mathrm{mV}_{\mathrm{p}-\mathrm{p}}$ for VR3 set for minimum value |
| Base band | Audio signal to modulator U7- pin 4 | $\begin{aligned} & 1.3 \mathrm{VD.C} \\ & 0.5 \mathrm{~V}_{\mathrm{p}-\mathrm{p}} \end{aligned}$ |
| 121 MHz | Signal level at TP18:A | $-5 \mathrm{dBm}$ |
| Final Tx frequency | Output to diplexer connector X 1 | $3 W$ 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 900 MHz Radio Block Diagram
RSSI Level of 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. |
| Fin |  |

FM: Frequency modulation.
FSK: Frequency shift keying.
GPIB: General purpose interface bus.
HADR_EN: High address enable signal.
$I C: \quad$ 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: $\quad$ 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 900 MHz 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

## 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 $5 \mathrm{k} \Omega$... $150 \mathrm{k} \Omega$
- 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



Halmac Services (Qldd) Pty. Ltd. AC.N. 098852923
AB.N. 40741712113

## SIGNAL ISOLATOR

## 1. ECT SIGNAL ISOLATOR TECHNICAL DETAILS

WロRLDWIDE

## 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:

| Powergipilhry | Page |
| :--- | :---: |
| 2-Wire, Output-Loop Powered <br> $(12-42 \mathrm{Vdc})$ | $2-3$ |
| 2-Wire, Input-Loop Powered <br> (5.5VIp) | $4-5$ |
| 4-Wire, Line/Mains Powered <br> $(117 \mathrm{Vac}, 230 \mathrm{Vac}, 24 \mathrm{Vdc})$ | $6-7$ |



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 1500 Vrms ). 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



Underwriter's Laboratories: General Location*
${ }^{4}$ utad
C $€$ CE: Conlormant 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 $1-5 \mathrm{~V}$ ) and converts it to a standard, isolated $4-20 \mathrm{~mA}$, 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 24 V 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 overioaded loop.


Figure 4. Restore a loop experiencing "bucking" power supplies to normal operation.


## Specifications

| Performance | Accuracy: $\pm 0.1 \%$ of span ( $\pm 0.2 \%$ for 0-150 AC inputs) <br> Stability: $\pm 0.2 \%$ of reading per year Isolation: WITHOUT -RF OPTION: 1500 V rms between input and output; WITH -RF OPTION: <br> 500 Vrms between input and output Output Response Time: DC Inputs, 100 msec to $99 \%$ of output maximum; AC Inputs, 400 msec to $99 \%$ of output Ripple: 10 mV peak-topeak maximum measured across a 250 ohm resistor Over-Voltage Protection: 48V, maximum on output; 48 V reverse polarity protection on output | Performance (continued) <br> Ambient Conditions | Maxim <br> Overra 250\% <br> Voltage scale Burden with 4-2 maximu Load $\frac{V_{s}-12}{0.02}$ <br> Output Limitin 30 mA Opera s $-40^{\circ} \mathrm{C}$ ( $-40^{\circ} \mathrm{F}$ Storag $-40^{\circ} \mathrm{C}$ $\left(-40^{\circ} \mathrm{F}\right.$ | Input <br> e: Current Inputs <br> ull scale; DC <br> puts, $150 \%$ of full <br> 1V maximum <br> mA input; 0.01 V <br> with 0-5A input pability: $d \mathrm{c}=\mathrm{ohms}$ <br> urrent 25mA typical; ximum <br> R Range: <br> $+85^{\circ} \mathrm{C}$ <br> $+185^{\circ} \mathrm{F}$ ) <br> Range: <br> $+85^{\circ} \mathrm{C}$ <br> $+185^{\circ} \mathrm{F}$ ) | Ambient Conditions (Continued) <br> Adjustments <br> Weight | Ambient Temperature Effect: $\pm 0.007 \%$ of span $/{ }^{\circ} \mathrm{C}$ typical; $\pm 0.015 \%$ of span $/{ }^{\circ} \mathrm{C}$ maximum <br> Relative Humidity: $0-95 \%$ non-condensing RFVEMI Protection: Less than $\pm 0.1 \%$ of span error when tested at $10 \mathrm{~V} / \mathrm{m} @ 20-1000 \mathrm{MHz}$ WITH -RF OPTION: Less than $\pm 0.1 \%$ of span error when tested at $30 \mathrm{~V} / \mathrm{m@}$ $20-1000 \mathrm{MHz}$ <br> Common Mode Rejection: <br> Exceeds 95 dB (60 6 Hz with a limit of 1500 V rms <br> Type: Front panel pots <br> Span: $\pm 10 \%$ <br> Zero: $\pm 5 \%$ (non-interactive when span is set first) $145 g(5 \mathrm{oz})$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Ordering Information |  |  |  |  |  |  |
| - Unfo |  | Outur | Power |  |  | Housting |
| ECT <br> 2-wire <br> (Output-Loop <br> Powered) <br> Isolator/Converter | 4-20MA into 50 ohms 1-5V into 1 Mohm $\mathbf{0 - 1 0 V}$ into 1 Mohm 0-150AC into 100 kohms 0-5AAC into 0.002 ohms | 4-20MA <br> into 600 <br> ohms with <br> 24 Vdc <br> power <br> supply | 12-42DC | -RF Enhanced R provides $30 \mathrm{~V} / \mathrm{m}$ protection with le span error <br> -EM Externally-m transformer for c with 0.5Aac inpu | Ml filtering <br> 1000 MHz <br> an $\pm 0.1 \%$ of <br> ed input <br> input (available only) | DIN Aluminum DIN-style housing mounts on 32mm G-type (EN50035) and 35 mm Top Hat (EN50022) rails FLB2 Externallymounted 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 $R-B O X$ 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 FieldMount 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.


Page 4

## Specifications

| Performanc | Accuracy: $\pm 0.075 \%$ of span Stability: $\pm 0.2 \%$ of reading per year Isolation: '500Vrms between input and output Output Response: 20 msec maximum to $99 \%$ of output Ripple: 10 mV peak-topeak maximum measured across a 250 ohm resistor Over-Voltage Protection: 48 V , maximum on output; 48 V , reverse polarity protection on output Maximum Input Overrange: $200 \%$ of full scale Burden: 5.5V when out- |  | Performance puts are shorted for (continued) $4-20 \mathrm{~mA}$ inputs, 10.5 V with 250 ohm load (Output load voltage is reflected on input. Output should be trimmed for anticipated output load) <br> Output Current <br> Limiting: 30 mA with 250 ohm output load <br> Ambient Operating Range: <br> Conditions $-29^{\circ} \mathrm{C}$ to $+82^{\circ} \mathrm{C}$ <br> $-20^{\circ} \mathrm{F}$ to $+180^{\circ} \mathrm{F}$ <br> Storage Range: <br> $-40^{\circ} \mathrm{C}$ to $+85^{\circ} \mathrm{C}$ <br> $\left(-40^{\circ} \mathrm{F}\right.$ to $\left.+185^{\circ} \mathrm{F}\right)$ |  | Ambient Conditions (Continued) <br> Adjustments <br> Weight | Ambient Temperature Effect: <br> $\pm 0.018 \%$ of span ${ }^{\circ} \mathrm{C}$; $\pm 0.005 \%$ of span $/{ }^{\circ} \mathrm{C}$ gain change Relative Humidity: $0-95 \%$ non-condensing RFI/EMI Protection: Less than $\pm 0.1 \%$ of span error when tested at $10 \mathrm{~V} / \mathrm{m}$ @ $20-1000 \mathrm{MHz}$ WITH -RF OPTION: Less than $\pm 0.1 \%$ of span error when tested at $30 \mathrm{~V} / \mathrm{m}$ @ $20-1000 \mathrm{MHz}$ Common Mode Rejection: Exceeds 95 dB © 60 Hz with a limit of 1500 Vrms <br> Type: Front panel pots Trim: $\pm 1 \%$ $145 \mathrm{~g}(5 \mathrm{oz})$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Ordering Information |  |  |  |  |  |  |
| O Oifl | T-00 | Oufun | Pawer |  |  | Housting |
| ECT <br> 2-wire <br> (input-Loop <br> Powered) <br> Isolator/ <br> Converter | $\begin{aligned} & \text { 4-20MA } \\ & \text { into } \\ & 275 \text { ohms } \end{aligned}$ | 4-20MA into 0.250 ohms | Current Loop Excitation at 4mA: 5.5VLP 5.5 volts loop powered with $4-20 \mathrm{~mA}$ (plus voltage across output load) | -RF Enhan filtering pro (18) 20-1000 with less th span error | RFI/EMI es $30 \mathrm{~V} / \mathrm{m}$ Hz protection $\pm 0.1 \%$ of | DIN Aluminum DIN-style housing mounts on 32mm G-type (EN50035) and 35 mm 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 computerbased 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 117 Vac , 230 Vac , and 24 Vdc 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 24 V power to a 2-wire, output-loop powered instrument. This eliminates the need for an additional power supply (Figure 10). IMPORTANT: Our $2 \times 4$-20MA dual input model provides a transmitter excitation of 16 V . 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 16 V TX EXCITATION PROVIDED ON $2 \times 4$-20MA DUAL INPUT MODEL

Page 6

## Specifications



Ordering Information

| Unil |  | Ofpul | Rower | Qptions | Housing |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ECT <br> 4-Wire <br> (Line/Mains) <br> Powered <br> Isolator/ <br> Converter | SINGLE INPUT CHANNEL: <br> 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 <br> DUAL INPUT CHANNELS: <br> 2X4-20MA into 25 ohms $2 \times 1-5 \mathrm{~V}$ into 1 Mohm 2X0-10V into 1 Mohm (Other AC ranges also available) | SINGLE OUTPUT <br> CHANNEL: <br> 4-20MA into <br> 1000 ohms <br> $0-10 \mathrm{~V}$ into <br> 5 kohms minimum <br> DUAL OUTPUT <br> CHANNELS: <br> 600 ohms <br> 2X1-5V into 5 kohms minimum <br> 2X0-10V into 5 kohms minimum <br> DUAL OUTPUT <br> CHANNELS <br> (Signal Splitter): <br> 2X4-20MA into <br> 600 ohms <br> (available with <br> 4-20mA input only) | $\begin{aligned} & 24 \mathrm{DC}, \pm 10 \% \\ & 117 \mathrm{AC}, \\ & 50 / 60 \mathrm{~Hz}, \pm 10 \% \\ & 230 \mathrm{AC}, \\ & 50 / 60 \mathrm{~Hz}, \pm 10 \% \\ & \text { (3 watts maximum } \\ & \text { for single channel } \\ & \text { models; } 5 \text { watts } \\ & \text { maximum for } \\ & \text { dual output } \\ & \text { channel models) } \end{aligned}$ | -EM Externally-mounted input transformer for current input (available with 0-5AAC input only) -TX 24 V transmitter excitation ( 16 V for $2 \times 4$ 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 $30 \mathrm{~V} / \mathrm{m}$ @ $20-1000 \mathrm{MHz}$ protection with less than $\pm 0.1 \%$ of span error (-EM option required for $A C$ current input) <br> -EP External power, output stage powered by external source (only available on signal splitter in DIN housing) | DIN Aluminum DIN-style housing mounts on 32 mm G-type (EN50035) and 35 mm Top Hal (EN50022) rails FLB2 Externallymounted flange provides a secure mount and ensures resistance to vibration |

When ordering, specity: Unit / Input / Output / Power / Oplions [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 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 | 日8 |
| AC Power Single InputDual Outputs \& -TX | +TX | +IN | -IN | A +OUT | A -OUT | B + OUT | B.OUT |  | AC | ACC | GND |
| OC Power Single InpuvDual Outputs \& -TX | +TX | + IN | - N | A +OUT | A -out | 8 +OUT | B OUT |  | DC | DCC | GND |
|  | T1 | T2 | 13 | 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 | + ${ }^{\text {N }}$ | - N | +OUT | -out |  | AC | ACC | GND |  |  |
| Power with DC Inputs or -EM Option | $\cdots$ | CT/PT | CTIPT | +OUT | -OUT |  | DC | DCC | GND |  |  |
| DC Power wilh -TX Option | +TX | + N | - 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 | 77 | т8 | T9 | 81 | B2 | B3 | 84 | B5 | B6 | 87 | B8 | B9 |
| AC Power \& Dual inputs/Dual Outputs | A + TX | A + +N | A - N |  |  |  | B +7 TX | $B+1 \mathrm{~N}$ | B-1N | A +out | A. OLT |  | 8 +OUT | B-OUT |  | AC | ACC | GNO |
| DC Power \& Dual Inputs/Dual Outpuls | $A+7 \times$ | $A+1 \mathrm{~N}$ | A-IN |  |  |  | $\mathrm{B}+\mathrm{TX}$ | B +iN | $\mathrm{B} \cdot \mathrm{N}$ | A +OUt | A -OUT |  | B +OUT | B -OUT |  | DC | DCC | GND |

[^29]
## 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



- GRIIECPTD Technology with thermal disconneth protection
- Compact design fits into DiN distribution panel boards and motor control centers
35 mm Din rail mount-Din 43880 profile mathes common circuit breakers
Indication flag and voltage free contactiprovide remote status monitoring
Separate plug and base design facilitates replacement of afailed sutge module
- $100 \mathrm{kA} 8 / 20 \mathrm{maxinum}$ surge rating provides protection suitableifor subbolistribution panels and along operational life
- Available in various operating voltages to sutt 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 capiial outlays, such as computers and communications equipment, as well as consequential loss of revenue and profits due to unscheduled system down-time.
The TDS 1100 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.

CRTTEC* TD technology helps ensure reliable and continued operatior 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 TDS 1100 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 | IDS110025R277 | TDS11002SR560 |
| :---: | :---: | :---: | :---: | :---: |
| Nominal Voltage $\mathrm{U}_{n}$ | 120-150V- | 220.240 V - | 240-277V- | 480-560V- |
| Max. Cont. Operating Voltage $U_{\text {S }}$ | 170V- | 275V- | $320 \mathrm{~V}-$ | 610 V - |
| Stand off Voltage | 240V | 440 V - | 480V- | 700V- |
| Frequency | 0-100Hz |  |  |  |
| Short Circuit Current Rating isc | 25kAIC |  |  |  |
| Required Back-up Fuse | 125AgL, if supply $>100 \mathrm{~A}$ |  |  |  |
| Technology Used | TD with thermal disconnect |  |  |  |
| Protection |  |  |  |  |
| Maximum Discharge Current Imax | 100kA $8 / 20 \mu \mathrm{~s}$ |  |  |  |
| Nominal Discharge Current in | 50kA \&/20 | 40kA 8/20 ${ }^{\text {s }}$ | 40kA $8 / 20 \mu \mathrm{~s}$ | $40 \mathrm{kA} 8 / 20 \mu \mathrm{~s}$ |
| Protectiori Mades | Single mode (L-G, L-N or N-G) |  |  |  |
| Voltage Protection Level Up © 3kA | < 400V | $<700 \mathrm{~V}$ | < 800V | $<1.6 \mathrm{kV}$ |
| Voltage Protection Level Up@ 20kA | <650 | $<1000$ | < 1.1 kV | $<2 \mathrm{kV}$ |
| Alarms and Indicators |  |  |  |  |
| Status Indication | Mechanical flag / remote contacts ( R model only) Change-over, $250 \mathrm{~V}-10.5 \mathrm{~A}, \max 1.5 \mathrm{~mm}^{2}$ (HT4AWG) terminals |  |  |  |
| Physical Data |  |  |  |  |
| Dimensions | 2 modules wide, $90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 35 \mathrm{~mm}$ |  |  |  |
| Weight | 0.24 kg approx. |  |  |  |
| Endosure | DIN 43 880, ULSAV-0 thermoplastic, IP 20 (NEMA-1) |  |  |  |
| Connection | $\begin{aligned} & \leq 35 \mathrm{~mm}^{2} \text { (H2AWG) solid } \\ & \leq 2.5 \mathrm{~mm}^{2} \text { (HAAWG) stranded } \end{aligned}$ |  |  |  |
| Mounting | 35 mm top hat DIN rail |  |  |  |
| Temperature | $-40^{\circ} \mathrm{C}$ to $+80^{\circ} \mathrm{C}\left(-40^{\circ} \mathrm{F}\right.$ to $\left.+176^{\circ} \mathrm{F}\right)$ |  |  |  |
| Humidity | 0 10 90\% |  |  |  |
| Test Standards |  |  |  |  |
| Approvals. | CE, IEC ${ }^{\text {™ }}$ 61643-1, UL** 1449 Pending |  |  |  |
| Surge Rated to Meet | IEC 61643-1 Class I and IIANSINEE C62.41-1991 Cat A, Cat B, Cat C |  |  |  |

Due to a policy of conlinual product development, specifications are subject io change without notice.

## CRITEC ${ }^{\circ}$ DDI/DAR/TDS SC

## DIN Decoupling Inductor/ DINLINE Alarm Relay \& Surge Counter



- Use for decoupling of spark gaps and MOVs - allows correct coordination of different SPD technologies
- $35 \mathrm{~mm}^{2}$ 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.


| Model | DDI 35 | DDI 63 | DAR275V | TOS SC |
| :---: | :---: | :---: | :---: | :---: |
| Item Number for Europe | 700465 | 700475 | 700900 | 701250 |
| Nominal Voltage $U_{n}$ | - | - | 20-110V-3, 100-240V- | - |
| System Compatibility(1) | - | - | TN-C, TN-S, TN-C-S \& TT |  |
| Max. Cont. Operating Voltage $\mathrm{Us}_{\text {r }}$ | 500V~200V--- |  | 275 V | - |
| Stand-off Voltage | - | - | 275 V | - |
| Operating Current (Q) $\mathrm{U}_{\mathrm{n}}$ |  | . | 20 mA | - |
| Frequency | 0 to 60 Hz |  |  | - |
| Max. Line Current $\mathrm{I}_{1}$ | 35 A @ $40^{\circ} \mathrm{C}$ | $63 \mathrm{~A} @ 40^{\circ} \mathrm{C}$ | - | - |
| Temperature Increase | $45^{\circ} \mathrm{C}$ (9) max line current ( $\mathrm{l}_{1}$ ) |  | - | - |
| Inductance | $7.5 \mu \mathrm{H}$ | $15 \mu \mathrm{H}$ | - | - |
| Resistance | $4.5 \mathrm{~m} \Omega$ | $1.7 \mathrm{~m} \Omega$ | - | - |
| Technology | - | - | CT - trip threshold 300A 8/20 ${ }^{\text {s }}$ |  |
| Status | - | - | Red/Green LEDs Change-over contact ${ }^{(1)}$ | Maximum count 9999 Non-resettable |
| Dimensions | $2 \mathrm{M} .90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 36 \mathrm{~mm}$ ( $3.5^{\prime \prime} \times 2.6^{\prime \prime} \times 1.4^{\prime \prime}$ ) approx. | $4 \mathrm{M} .90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 72 \mathrm{~mm}$ ( $3.5^{\prime \prime} \times 2.6^{\prime \prime} \times 2.8^{\prime \prime}$ ) approx. | 2 M . <br> $90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 36 \mathrm{~mm}$ $\left(3.5^{\prime \prime} \times 2.6^{\prime \prime} \times 1.4^{\prime \prime}\right)$ | $g(T)$ |
| Weight | 0.45 kg (1 lb) approx. | $1 \mathrm{~kg}(2.2 \mathrm{lb})$ approx. | 0.2 kg (0.44 lb$)$ |  |
| Enclosure | DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1) |  |  |  |
| Connection | $\begin{aligned} & \leq 35 \mathrm{~mm}^{2} \text { (\#2AWG) solid } \\ & \text { s25 } \mathrm{mm}^{2} \text { (\#4AWG) stranded } \\ & \hline \end{aligned}$ |  | $1 \mathrm{~mm}^{2}$ to $6 \mathrm{~mm}^{2}(\# 18 A W G$ to \#10) |  |
| Mounting | 35 mm top hat DIN rail |  |  |  |
| Back-up Overcurrent Protection | 35A | 63A | - | - |
| Temperature | $-40^{\circ} \mathrm{C}$ to $+70^{\circ} \mathrm{C}\left(-40^{\circ} \mathrm{F}\right.$ to $\left.+158^{\circ} \mathrm{F}\right)$ |  | $-35^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}\left(-31^{\circ} \mathrm{F}\right.$ to $\left.+131^{\circ} \mathrm{F}\right)$ |  |
| Humidity | 0\% to 90\% |  |  |  |
| Warranty Approvals | $\begin{aligned} & 5 \text { years } \\ & C E \end{aligned}$ |  | CSA22.2 <br> C-Tick, AS 3260, CE | - |

(1) Form $C=$ Change-over contact (Form C dry contact), 400V-/3A $1 \mathrm{~mm}^{2}$ to $6 \mathrm{~mm}^{2}$ (\#18AWG to \#10AWG) connecting wire

## CRITEC TBDF

## 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 oplications to protect the switched mode power supply units on wices such as PLC controllers, SCADA systems and motor controllers. Units are UL Recognized and available for 3A, 10A and 20A loads and suitable for $110-120 \mathrm{~V}$ acdc and 220-240Vac circuits.
The TDF is a series connected, single phase surge filter providing an aggregate surge capacity of $50 \mathrm{kA}(8 / 20 \mu \mathrm{~s})$ across L-N, L-PE, and N-PE. The low pass filter provides up to 65 dB of attenuation to voltage transients. Not only does this reduce the residual letthrough voltage, but it also helps further reduce the steep voltage rate-of-rise providing superior protection for sensitive electronic
 equipment.

| Model | $\begin{array}{\|l\|} \hline \text { TDF3A } \\ 120 \mathrm{~V} \\ \hline \end{array}$ | $\begin{array}{\|l\|l\|} \hline \text { TDF3A } \\ 240 \mathrm{~V} \\ \hline \end{array}$ | $\begin{array}{\|l} \text { TDF10A } \\ \text { 120V } \\ \hline \end{array}$ | $\begin{aligned} & \text { TDF10A } \\ & 240 \mathrm{~V} \\ & \hline \end{aligned}$ | $\begin{array}{\|l} \hline \text { TDF20A } \\ 120 \mathrm{~V} \\ \hline \end{array}$ | $\begin{aligned} & \text { TDF20A } \\ & 240 \mathrm{~V} \\ & \hline \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Item Number for Europe | 700001 | 700002 | 700003 | 700004 | 700005 | 700006 |
| Nominal Voltage $\mathrm{U}_{\mathrm{n}}$ | 120 V | 240 V | 120 V | 240 V | 120 V | 240 V |
| Distribution System | 1Ph 2W+G, TN-S \& TN-C-S |  |  |  |  |  |
| Max. Cont. Operating Voltage $U_{c}$ | 170 V | 340 V | 170 V | 340 V | 170 V | 340 V |
| Stand-off Voltage | 240 V | 400 V | 240 V | 400 V | 240 V | 400 V |
| Frequency | 0 to 60 Hz | 50/60Hz | 0 to 60 Hz | 0 to 60 Hz | 0 to 60 Hz | $50 / 60 \mathrm{~Hz}$ |
| Max. Line Current IL | 3A |  | 10A |  | 20A |  |
| Operating Current © $\mathrm{U}_{\mathrm{n}}$ | 135 mA | 250 mA | 240 mA | 480 mA | 240 mA | 480 mA |
| Max. Discharge Current $\mathrm{I}_{\max }$ | 20KA $8 / 20 \mu \mathrm{~S}$ L-N 20kA $8 / 20 \mu \mathrm{~S}$ L-PE 10kA $8 / 20 \mu \mathrm{~S}$ N-PE |  |  |  |  |  |
| Protection Modes | All modes protected |  |  |  |  |  |
| Technology | TD Technology In-line series low pass sine wave filter |  |  |  |  |  |
| $\begin{aligned} & \text { Voltage Protection Level Up } \\ & @ 500 \mathrm{~A}, 8 / 20 \mu \mathrm{~s} \text { (UL SVR) } \\ & @ \text { Cat B3, 3kA } 8 / 20 \mu \mathrm{~s} \end{aligned}$ | $\begin{aligned} & 500 \mathrm{~V} \\ & <250 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 700 \mathrm{~V} \\ & <600 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 500 \mathrm{~V} \\ & <250 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 700 \mathrm{~V} \\ & <600 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 500 \mathrm{~V} \\ & <250 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 700 \mathrm{~V} \\ & <600 \mathrm{~V} \end{aligned}$ |
| Filtering © 100 kHz | Green LED. On=Ok. Isolated opto-coupler output ${ }^{(1)}$. . . |  |  |  |  |  |
| Status |  |  |  |  |  |  |
| Dimensions | $4 \mathrm{M} .90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 72 \mathrm{~mm}$ $8 \mathrm{M} .90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 144 \mathrm{~mm}$ <br> $\left(3.5^{\prime \prime} \times 2.6^{\prime \prime} \times 2.8^{\prime \prime}\right)$ $\left(3.5^{\prime \prime} \times 2.5^{\prime \prime} \times 5.6^{\prime \prime}\right)$ |  |  |  |  |  |
| Weight | 0.35 kg (0.77 lb) |  |  |  | $10.8 \mathrm{~kg}(1.7 \mathrm{lb})$ |  |
| Enclosure | DIN 43880, UL94V-0 thermoplastic, IP 20 (NEMA-1) |  |  |  |  |  |
| Connection | $1 \mathrm{~mm}^{2}$ to $6 \mathrm{~mm}^{2}$ (\#18AWG to \#10) |  |  |  |  |  |
| Mounting | 35 mm top hat DIN rail |  |  |  |  |  |
| Back-up Overcurrent Protection | 3A 110 A |  |  |  | 20 A |  |
| Temperature | $-35^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}\left(-31^{\circ} \mathrm{F}\right.$ to $\left.+131^{\circ} \mathrm{F}\right)$ |  |  |  |  |  |
| 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/EEE C62.41.2 Cat A, Cat B, Cat C |  |  |  |  |  |

[^30]

## 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 20 mA signals from transmitters, valves and adjusters


## C $\mathrm{CONS}_{\text {us }}$



## Function and system design

## Measuring principle

The device separates active $0 / 4$ to 20 mA 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 intrinsicaliy 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.


## Input

| Direction of power transmission nonEx $\rightarrow$ Ex | - 0/4 to 22 mA , (for specified accuracy) <br> - 0 to 40 mA operating range <br> - Max. effective voltage < 26 V for specified accuracy <br> - $I_{\max }=100 \mathrm{~mA}$ (short-circuit current of protective diode in event of overvoltage) <br> - $\mathrm{U}_{\max }=30 \mathrm{~V}$ (limiting voltage of protective diode) <br> - Reverse polarity protection <br> - $\mathrm{R}_{\mathrm{i}}<400 \Omega$ (without HART ${ }^{\otimes}$ resistor $232 \Omega$ ) |
| :---: | :---: |
| Direction of power transmission Ex $\rightarrow$ nonEx | - 0/4 to 22 mA , (for specified accuracy) <br> - Intrinsically safe as per ATEX, FM, CSA, TIIS, GHOST, NEPSI <br> - 0 to 40 mA operating range <br> - Reverse polarity protection <br> - $\mathrm{R}_{\mathrm{i}}<120 \Omega$ (without HART ${ }^{\text {® }}$ resistor $232 \Omega$ ) <br> - Max. effective voltage $<26 \mathrm{~V}$ |

## Output

| Direction of power transmission nonEx $\rightarrow$ Ex | - $0 / 4$ to 22 mA , (for specified accuracy) <br> - 0 to 40 mA operating range (max. current depends on the load) <br> - Max. load (load resistance) $=0$ to $600 \Omega$ <br> - Intrinsically safe as per ATEX, FM, CSA, TIIS, GHOST, NEPSI - ATEX: <br> II (1) GD [EEx ia] IIC/IIB, II (1) GD [EEx ib] IIC/IIB |
| :---: | :---: |
| Direction of power transmission Ex $\rightarrow$ nonEx | - $0 / 4$ to 22 mA (for specified accuracy) <br> - 0 to 40 mA operating range (max. current depends on the load) <br> - Max. load (load resistance) $=0$ to $600 \Omega$ |

## Galvanic isolation

Testing voltage: $\quad>1.5 \mathrm{kV} \mathrm{AC}$ between input and output
$>1.5 \mathrm{kV} \mathrm{AC}$ 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 20 mA current loop. |
| :--- | :--- |
| Starting current (intrinsic <br> consumption) | $<50 \mu \mathrm{~A}$ |
| Voltage drop | $<(1.9 \mathrm{~V}+400 \Omega \times$ current loop) for nonEx $\rightarrow$ Ex |
|  | $<(3.9 \mathrm{~V}+120 \Omega \times$ current loop) for Ex $\rightarrow$ nonEx |

## Performance characteristics

| Current transmission | $< \pm 10 \mu \mathrm{~A}+0.15 \%$ of measured value |
| :--- | :--- |
| Load error | $\leq 0.02 \%$ of measured value $/ 100 \Omega$ |
| Temperature drift | $\leq \pm 0.01 \% / 10 \mathrm{~K}\left(0.0056 \% / 10^{\circ} \mathrm{F}\right)$ |
| Residual ripple at output | $<30 \mathrm{mV} \mathrm{eff}$ for 20 mA loop current and $600 \Omega$ load |

## Transmission behavior

HART ${ }^{\text {protocol }} \quad$ Bidirectional transmission possible

|  | Step-function response |
| :---: | :---: |
| Settling time ( $10 \%$ to $90 \%$ of full scale value) | $<0.5 \mathrm{~ms}$ for $500 \Omega$ load for non $\mathrm{Ex} \rightarrow \mathrm{Ex}$ <br> $<0.3 \mathrm{~ms}$ for $500 \Omega$ load for $\mathrm{Ex} \rightarrow$ non Ex |
|  | Frequency response |
| Large signal limit frequency | 050 Hz for $500 \Omega$ load for non $\mathrm{Ex} \rightarrow \mathrm{Ex}$ 1300 Hz for $500 \Omega$ load for $\mathrm{Ex} \rightarrow$ 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 $+60^{\circ} \mathrm{C}\left(-4\right.$ to $\left.+140^{\circ} \mathrm{F}\right)$ |
| :--- | :--- |
| Storage temperature | -20 to $+80^{\circ} \mathrm{C}\left(-4\right.$ to $\left.170^{\circ} \mathrm{F}\right)$ |
| Installation height | As per IEC $61010-1:<3000 \mathrm{~m}$ above MSL |
| Climate class | As per IEC $60054-1$ Class B2 |
| Degree of protection | IP 20 |
| Relative humidity | $<95 \%$ (without condensation) |
| Electromagnetic compatibility Interference immunity as per IEC 61326 (industry) and NAMUR NE21 <br> (EMC)  |  |

## Mechanical construction

## Design, dimensions

Housing for top-hat rail as per IEC 60715 TH35:


Dimensions of RB223

| Weight | Approx. $150 \mathrm{~g}(5.29 \mathrm{oz})$. |
| :--- | :--- |
| Material | Housing: plastic PC, UL 940 |
| Terminals | - Coded, pluggable screw terminal, core size $1.5 \mathrm{~mm}^{2}$ solid, or $1.0 \mathrm{~mm}^{2}$ strand with ferrule |
|  | Communication socket on the front via 2 mm jack plug |

## Human interface



## Certificates and approvals

| CE mark | Directive 89/330/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 חA 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 <br> $0 / 4-20 \mathrm{~mA}$ galvanic signal isolation. 1/2-channel <br> Intrinsically safe as an option, $1: 1$ transmission.

B1-directional HART-communication.
Housing 22.5 mm , Mont. Rail 35 mm , IP20.

| Approval: |  |
| :---: | :---: |
| A | Non-hazardous area <br> ATEX II(1)GD(EEx ia)IIC <br> FM AIS IIII,III/1/ABCDEFG1 <br> CSA (Ex ia) $1,11, I I / 1 /$ ABCDEFG 1 <br> TIIS (EEx ia) IIC |


|  |  | Channel: |  |
| :--- | :--- | :--- | :--- |
|  |  | 1 | 1 x |
|  | 2 | 2 x |  |


|  |  |  | Trängisydon directiön: |
| :--- | :--- | :--- | :--- |
|  |  | A <br> B | Ex-nonEx <br> nonEx-Ex |
| RB223- |  |  |  |

## Accessories

## Accessories

The following accessories are available:

| Oídér códe. | Accésióry |
| :--- | :--- |
| 51002408 | Protective housing IPoo for field mounting |
| 51004148 | Adhesive label, printed (max. 2x10 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
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Instruments international
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# Endress + Hauser 

People for Process Automation

## TIMER

## 1. IDEC DIGITAL TIMER TECHNICAL DETAILS <br> 2. ELECTRONIC TIMING RELAY TECHNICAL DETAILS

## GT3D - DigitalTimers

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. LA96764
File No File No. LR83814

$\square$
Cert. No. BL9801133323911 (LVD) Cert. No. E9971113332388 (EMC)

## Specifications

|  |  | E6T3D-2 | 6T3D-3 | GT3D-4 | 6T3D-8 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Operation System |  | Solid state CMOS circuitry |  |  |  |
| Operation |  | Multi-mode |  |  | Multi-mode one-shot output |
| Time Range |  | 0.015 to 99.9 hours |  |  |  |
| Rated Voltage |  | 100 to $240 \mathrm{~V} \mathrm{AC} \mathrm{( } 50 / 60 \mathrm{~Hz}$ ), 24 V AC ( $50 / 60 \mathrm{~Hz}$ //24V DC |  |  |  |
| Contact Ratings |  | 125 V AC/250V AC, 3A: 3OV DC/1A (resistive load) | 125 V AC/250V AC. 5A; 30VDC/5A (resistive load) |  |  |
| Contact Form |  | Delayed SPDT + instantaneous SPDT | Delayed DPDT | Delayed DPDT | Delayed DPDI |
| Minimum Applicable |  | $5 \mathrm{~V}, 10 \mathrm{~mA}$ (reference value) |  |  |  |
| Voltage Tolerance |  | AF20 (100-240V AC): 85 to 264 V AC AD24 (AC): 20.4 to 26.4 V AC AD24 (DC): 21.6 to 26.4 V DC |  |  |  |
| Error |  | $\pm 0.3 \% \pm 50 \mathrm{~ms}$ (voltage, repeat, and temperature) |  |  |  |
| Setting Error |  | $\pm 0.5 \% \pm 50 \mathrm{~ms}$ |  |  |  |
| Reset Time | $\cdots$ | 60 ms maximum |  |  |  |
| Insulation Resistanc |  | 100M $\Omega$ 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: 750 V AC, 1 minute |  |  |  |
| Power Consumption | AF20 | 11.8 VA | 11.6VA | $\begin{aligned} & 3.7 \mathrm{VA}(100 \mathrm{~V} \mathrm{AC}, 60 \mathrm{~Hz}) \\ & 11.6 \mathrm{VA}(200 \mathrm{~V} \mathrm{AC}, 60 \mathrm{~Hz}) \end{aligned}$ |  |
|  | AD24 AC/DC | 1VA/0.8W | 2.1VAO.9W | 2.1VA /0.9W |  |
| Mechanical Life |  | 10,000,000 operations minimum | 5,000,000 operations minimum |  |  |
| Electrical Lifo lat rat | load) | 50,000 operations minimum | 100,000 operations minimum |  |  |
| Outputs | Relay | 250V AC, 3A, 30V DC, 1A (resistive load) | 240 V AC/ 24V DC. 5A (resistive load) |  |  |
| Vibration Resistance |  | 100 N (approximate 10G) |  |  |  |
| Shock Resistance |  | Operating extremes: 100N (approximate 10G) Damage limits: 500N (approximate 50G) |  |  |  |
| Operating Temperatu |  | -10 to $+50^{\circ} \mathrm{C}$ |  |  |  |
| Storage Temperature |  | -30 to $+80^{\circ} \mathrm{C}$ |  |  |  |
| Operating Humidity |  | 45 to $85 \% \mathrm{RH}$ |  |  |  |
| Weight (approximate) |  | 70 g | 759 | 76 g |  |
| Housing Color |  | Gray |  |  |  |

## Part Number List

| Mode of Operation | Time Renge | Output | Contact | Rated Voltage Code | Complete Part No. |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | 8-Pin | 11-Pin |
| 1-A. ON-delay 1 <br> 1-B: Interval 1 first <br> 1-C: Cycle 1 (OFF first) <br> 1-D: Oycle 3 (ON first) | 0.015 to 99.9 hours | $250 \mathrm{VAC}, 3 \mathrm{~A}$, <br> 30V DC. 1A <br> (resistive load) | Delayed SPDT <br> + instantaneous SPDT | 100 to 240 V AC $(50 / 60 \mathrm{~Hz})$ | GT3D-2AF20 | GT3D-2EAF20 |
|  |  |  |  | 24V AC/DC | GT3D-2AD24 | - |
|  |  | 240 V AC. 24V DC. 5A (resistive load) | Delayed DPDT | 100 to 240 V AC $(50 / 60 \mathrm{~Hz})$ | GT3D-3AF20 | GT3D-3EAF20 |
|  |  |  |  | 24V AC/DC | GT3D-3AD24 | - |


| Mode of Operation | Time <br> Hange | Output | Contact | Rated Voltage Code | Complata Part No. |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  | A (11-Pin) | B (11-Pin) |
| 1-A: ON-delay 11-B: Interval 1 first1-C: Cycle 1 (OFf first)1-D: Crele 3 (ON first)2-A: ON-delay 22-B: Cycle 22-C: Signal ON/OF-delay 12-D: Signal OFF-delay 12-E: Interval 22-F: One-shot cycle3-A: Signal ON/OFF-delay 23-B: Signal OFF-delay 23-C: One-shot 13-D: One-shot ON-delay3-E: One-shot 23-F: Signal ON/OF-delay 3 | 0.01 sto 99.9 hours | 240 V AC/24V DC, 5 A (resistive load) | Delayed DPDT | 100 to $240 \mathrm{~V} \mathrm{AC}(50 / 60 \mathrm{~Hz})$ | GT3D-4AF20 | GT3D-4EAF20 |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  | 24 V AC/DC | GT3D-4AD24 | - |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

## Part Numbers: GT3D-8

| Mode of Operation | Time Range | Output | Contact | Hated Voltage Code | Complete Part No. (11-Pin) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1: ON-delay one-shot 1 <br> 2: Cycle one-shot <br> 3: 0 N -delay one-shot 2 | 0.01 s to 99.9 hours | $240 \mathrm{~V} \mathrm{AC/24V}$ DC, 5 A (resistive load) | Delayed DPDT | 100 to $240 \mathrm{~V} \mathrm{AC}(50 / 60 \mathrm{~Hz})$ | GT3D-8AF20 |
|  |  |  |  | 24 V AC/DC | GT3D-8A024 |

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. $\mathrm{A}(11$-pin) and $\mathrm{B}(11$-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




GT3D-3 Timing Diagrams


## 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



GT3D-4 Timing Diagrams


Terminal Blocks

## GT3D-4 Timing Diagrams



GT3D-4 Timing Diagrams


## GT3D-4 Timing Diagrams

One-Shot ON-Delay
Time Remaining



Signal ON/OFF-Delay 3
Time Remaining


Time Elapsed
$3-F$

GT3D Series
Timers

$\mathrm{Tb}=$ Shorter than single-shot output time
$\mathrm{T}=\mathrm{T}^{\prime}+\mathrm{T}^{-}$
$T O=$ Single-shot output time (selected from A, B, C, D, E or F)

Instructions: Setting GT3D-2, GT3D-3 Timers


| Stap 1 | Desired Made/Selection A |  |  |  | Te Remarks |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Select the desired time display and operation modes. | Time Display Mode | (1) Indicator Mode Selector | Operation ${ }^{\text {ha }}$ Mode | Q Dperation Mode Selector | 1. Use the flat screwdriver to set the selectors. Since selecters do not |
|  | Time elapsed | 1 | ON-delày 1 |  |  |
|  | Time remaining | 1.1 |  |  |  |
|  | Time elapsed | 1 |  |  | may be nec̈essary. <br> 2. The © 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 (1)(2) to set the operation mode. <br> 3. The © Operation Mode Selector has two blank modes which are not intended for use. Ahways have this selector set to A, B, C, or D. |
|  | Time remaining | 18 |  |  |  |
|  | Time elapsed | 1 |  |  |  |
|  | Time remaining | 1. |  |  |  |
|  | $\therefore$ Time elapsed | 1 | Cycle 3 |  |  |
|  | Time-remaining | 1 |  |  |  |
| 2 Step 2 | Lr Desired Operation |  | Selaction |  |  |
| Select a time range that contains the desired period of time: | Bre |  | (1) Time Range Solactor |  | 1. The (3) Time Range Selector controls both the decimal point indica tor (9.99, 99.9; 999) and the time increment indicators S (seconds), M (minutes), ańd H (hours). <br> 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. <br> 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: $i$. |
|  |  |  | $\begin{aligned} & \text { Decimal Point } \\ & \text { in Indicatoir } \end{aligned}$ | Timia Incrament Indicator |  |
|  | 0.01 secon | ds to 9.99 seconds | 9.99 | S |  |
|  | 0.1 second | s to 99.9 seconds | 99.9 |  |  |
|  | 1 secono | to 999 seconds | 999. |  |  |
|  | 0.1 minute | s to 99.9 minutes | 99.9 | M |  |
|  | 1 minute | to 999 minutes | 999 |  |  |
|  | 0.1 hours to 99.9 hours |  | 99.9 | $\mathrm{H}^{\prime}$ |  |
| Step 3 | Desired Operation. |  | Selection |  |  |
| Set the precise period of time desired by using the (4) Time Setting Digital Switch. |  |  |  |  | Use the (9):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. |

## Instructions: Setting GT3D-4 Timers



|  | Step. 1 |  | Desirad | Mode/Selection |  | Remarks |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Select the desired time display and operation modes. | Time Displey Mode | © Indicator Mode Selector | Operation Mode | $\begin{aligned} & \text { (2) Operation } \\ & \text { Mode Selector } \end{aligned}$ |  |
|  |  | Time elapsed | 1 | ON-delay 1 Interval 1 | $\begin{aligned} & A \\ & B \end{aligned}$ | 1. Usa a flat screwdriver to set the selectors. Since selectors do not tum all the way around, both clockwise and counterclockwise |
|  |  | Time remaining | 1. | Cycie 1 D: Cycle 3 | $\begin{aligned} & \text { C } \\ & \text { D } \end{aligned}$ | rotation is necessary. |
|  |  | Time elapsed | 2 | ON -delay 2 <br> Cycle 2 <br> Signal ON/OFF-dëlay 2 | $\begin{aligned} & A \\ & B \\ & C \end{aligned}$ | 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. |
|  |  | Time remaining | 2 | Signal 0F-delay 1 Interval 2 One-shot cycle | $\begin{aligned} & D \\ & E \\ & F \end{aligned}$ | selectors(1) to set the operation mode. |
| 界 |  | Time elapsed | 3 | Signal ON/OFF-delay 2 Signal 0FF-delay 2 One-shot 1 | $\begin{aligned} & A \\ & B \\ & \text { C } \end{aligned}$ | Mode Selector has two blank modes which are not intended for use. When using mode setting "1," always have the operation mode selactor set to $\mathrm{A}, \mathrm{B}, \mathrm{C}$, or D . |
|  |  | Time remaining | 3 | One-shot ON-delay One-shot 2 Signal ON/OFF-delay 3 | D E F |  |
|  | Step 2 | Desired Operation |  | Selection |  | Remarks |
|  | Select a time range that contains the desired period of time. | Base Time Ranges |  | (2) Time Ranige Selector |  | 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). |
|  |  |  |  | Decimal Point Indicator | Tima Incrament Indicator |  |
|  |  | 0.01 seconds to 9.99 seconds |  | 9.99 | S | 2. Chose which base time range contains the targeted timer setting. Then use the (D) Time Range Selector to set the decimal point indicator and time increment indicator to its corresponding pair of settings. <br> 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 houris 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 |  |  |
|  |  | 1 minute to 999 minutes |  | 999 |  |  |
|  |  | 0.1 hours to 99.9 hours |  | 99.9 | H |  |
|  | Stap 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. |

[^31]Instructions: Setting GT3D-8Timers



It is important to remember that the (a) 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



## Panel Mounting Accessories

Panel Mount Sockets and Hold-Down Springs


For information on installing the hold-down springs, see page 838.

Flush Panel Mount Adapter and Sockets that use an Adapter


## 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.)


皆


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.
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.

## Inputs Instructions, continued

For contact input, use gold-plated contacts to make sure that the residual voltage is less than 1 V when the contacts are closed.


For transistor input, use transistors with the following specifications; VCE $=40 \mathrm{~V}, \mathrm{VCES}=1 \mathrm{~V}$ or less. $1 \mathrm{C}=50 \mathrm{~mA}$ or more, and $\operatorname{ICBO}=50 \mu \mathrm{~A}$ or less. The resistance should be less than $1 \mathrm{k} \Omega$ 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 30 V and have 1 V . When the signal voltage switches from H to L , a signal is input to the timer


Inputs: GT3A-4, -5, -6

| Starit Input | The start input initiates a time-delay operation and controls output status. | No-voltage cöntact inputs and NPN apen collector transistor inputs äre applicable. |
| :---: | :---: | :---: |
| Hessat Inpurt | When the reset input is activated, the time is reset, and contacts return to original state. | 24V DC, 1mA maximum |
| Gete Input | The time-delay operation is suspended while the gate input is on (pause). | Input response time: 50́msec maximum |

## Dimensions

Switches \& Pilot Lights Switches \&



Analog GT3 Timer, 8-Pin with SR2P-06


Digital GT3 Timer, 8-Pin with SR2P-06


Analog GT3 Timer, 11-Pin with SR3P-05


## Analog GT3 Timer, 11-Pin with SR3P-06



Digital GT3 Timer, 11-Pin with SR3P-06


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 | $= \pm \frac{1 \times \text { Maximum Measured Value }- \text { Minimum Measured Value } \times 100 \%}{2 \text { Maximum Scale Value }}$ |
| :--- | :--- |
| Voltage Error | $= \pm \frac{\mathrm{TV}-\operatorname{Tr} \times 100 \%}{\mathrm{Tr}}$ |

Tv: Average of measured values at voltage $V$
Tr : Average of measured values at the rated voltage
Temperature Error

$$
= \pm \frac{\mathrm{Tt}-\mathrm{T} 20 \times 100 \%}{\mathrm{~T} 20}
$$

Tt: Average of measured values at ${ }^{\circ} \mathrm{C}$
T20: Average of measured values at $20^{\circ} \mathrm{C}$
Setting Error
$= \pm$ Average of Measured Values - Set Value $\times 100 \%$
Maximum Scale Value

Technical Data

| Timing Characteristics (according to VDE 0435, Par 2021) |  |  | Life expectancy (electrical) | 4 million ops. at 1 $\mathrm{N} 250 \mathrm{VAC}, \cos \varphi=1$ |
| :---: | :---: | :---: | :---: | :---: |
| Timing ranges for |  |  |  | 0.2 million ops. at $6 \mathrm{~A} / 250 \mathrm{VAC}, \cos \varphi=1$ |
| R27-FSM-A, B, C, D, E, F, I, \& L | (1s) | 0.05... 1 sec |  | 1.5 million ops. at $1 \mathrm{~N} / 250 \mathrm{VAC}, \cos \varphi=0.3$ |
| R27-FSH | (3s) | $0.15 . . .3$ sec |  | 0.3 million ops. at $3 \mathrm{~A} 250 \mathrm{VAC}, \cos \varphi=0.3$ |
|  | (10s) | $0.5 . . .10 \mathrm{sec}$ |  | 0.5 million ops. at $6 \mathrm{~A} / 24 \mathrm{VDC}$, resistive |
|  | (1mn) | 0.05 ... 1 min |  | 2 million ops. at 4A/24VOC, resistive |
|  | (3mm) | $0.15 . .3$ min |  | 2 million ops. at 0.2 A 230 VDC , resistive |
|  | (10mn) | 0.5... 10 min |  | 1 million ops. at $0.4 \mathrm{~N} / 24 V D C, L R=20 \mathrm{~ms}$ |
|  | (17) | $0.05 . .1$ hour |  | 1 million ops, al $0.2 \mathrm{~N} 110 \mathrm{VDC}, \mathrm{UR}=20 \mathrm{~ms}$ |
|  |  | 0.15... 3 hours |  | 1 million ops. at $0.1 \mathrm{~N} 230 \mathrm{VDC}, \mathrm{UR}=20 \mathrm{~ms}$ |
|  | (10h) <br> (60h) | 0.5... 10 hours <br> 3... 60 hours | Lite expectancy (mechanical) | 30 million operations |
| R27-FS0 | (2.5s) | $0.15 \ldots 2.5 \mathrm{sec}$ | General Data Insulation Characteristics | $2 \mathrm{kVAC} / 50 \mathrm{~Hz}$ test voltage according to VDE 0435 and $6 \mathrm{kV} 1.2 / 20 \mu \mathrm{~s}$ surge voltage according to IEC <br> 947-1 between all inputs and outputs |
|  | (10s) | 0.5.. 10 sec |  |  |
|  | (80s) <br> (10mn) | $\begin{aligned} & 4 \ldots 80 \mathrm{sec} \\ & 0.5 \ldots 10 \mathrm{~min} \end{aligned}$ | EMCAnterference Immunity | Performance of following requirements: <br> - Surge capacity of the supply voltage according to IEC1000-4-5: $4 \mathrm{kV} \mathrm{1.2/50} \mathrm{\mu s}$ <br> - Burst according to IEC 1000-4-4: $6 \mathrm{kV} / 6 / 50 \mathrm{~ns}$ <br> - ESD discharge according to IEC 1000-4-2: <br> - Contact 8 kV , air 8 kV <br> - Electromagnetic HF field according to IEC 801-3 and conducted electromagnetic HF signal according to IEC 801-6: Level 3 |
| Setting accuracy | $\pm 5 \%$ of full scale value |  |  |  |
| Repeatability | $\pm 0.2 \%$ of the setting values |  |  |  |
| Tolerance | Voltage: $\pm 0.001 \% \% \Delta U$ |  |  |  |
|  | Tempera | . $25 \% /{ }^{\circ} \mathrm{C}$ |  |  |
| Power Supply <br> Supply voltages | 24...48VDC and 24...240VAC, $50 / 60 \mathrm{~Hz}$ (dual vollage) |  |  |  |
|  | 12VDC |  | EMC/Emission | Electromagnetic fietds according to EN 55022 : Class B |
|  | 24...240V AC or DC (universal vollage) |  | Safe isolation | According to VDE 106, part 101 |
| Voltage tolerance | AC: $-15 \% \ldots+10 \%$ |  | Climatic withstand | 56 cycles (24h) at $25 \ldots 40^{\circ} \mathrm{C}$ and $95 \%$ relative humidity according to IEC 68-2-30 and IEC 68-2-3. |
|  | DC: $-20 \% \ldots+20 \%$ |  | Vibration resistance | 4 g in 3 axis at $10 \ldots 500 \mathrm{~Hz}$, test FC according |
| Power consumption | AC: 5VA at 240 V |  | Shock resistance | 50 g according to IEC 68-2-27 |
|  | DC: 0.5 W at 24 V |  | Protection class | Enclosure: IP40 |
| Time energized | 100\% |  |  | IP30 (single function) |
| Reset time | 50 ms |  |  | Terminal: ${ }^{\text {P20 }}$ according to IEC 947-1 |
| Voltage interruption | s20ms without reset (supply vollage) |  | Weight | 100 g |
| Inpui Impedance | Relay On: 3k-13k ohms Relay Off: $0.7 \mathrm{k}-4 \mathrm{k}$ ohms |  | Approval/Standards | UL, C-UL up to 240VAC, Germanischer Loyd, CE |
|  |  |  | Ambient temperature | Open: $\quad-25^{\circ} \mathrm{C} \ldots+60^{\circ} \mathrm{C}$ |
| Cable length (supply voltage control) | 250 meters (800 ft.) max. |  |  | $\begin{array}{ll} \text { Enclosed: } & -25^{\circ} \mathrm{C} \ldots+45^{\circ} \mathrm{C} \\ \text { Storage } & -25^{\circ} \mathrm{C} \ldots+85^{\circ} \mathrm{C} \\ \hline \end{array}$ |
| Pulse Control ( $\mathrm{B1}$ ) |  |  | Connections Screw temi | M3.5 for Pozidrive No.2, Phillips and slotted screws No. 2 suitable for power screwdriver. |
| Impulse duration | $250 \mathrm{~ms} \mathrm{(AC)}$,230 ms ( OC ) |  | Rated tightening torquWire Siz | $0.8 \mathrm{Nm}(\max .1 .2 \mathrm{Nm}) \times[8.8 \mathrm{lb}-\mathrm{in})$ |
| Input voltage | Supply voltage range |  |  | Dual-chamber system for terminal cross-sections |
| Input curent | 1 mA |  |  | of $1 \times 0.5 \mathrm{~mm}^{2}$ (solid) or $2 \times 2.5 \mathrm{~mm}^{2}$ (flexible with |
| Max. Leakage Curent | 400 micro Amps |  |  | sleeve), AWG 20... 14. |
| Cable length | max. $250 \mathrm{~m}(800$ thi) without parallel load between B 1 \& A 2 |  | Finger Protection | According to VDE 0106 |
|  |  |  | Mounting | - Snap-on mounting ( 35 mm DIN-rail) <br> - Side mounting on CA7/CA4 conlactors and CS7/CS4 with dovetail joint [surface mounting in any position] |
|  | $\begin{aligned} & \max .50 \\ & B 1 \& B 2 \end{aligned}$ | .) with load (<3k 2 ) between |  |  |
| Outputs Type of outputs | Outputs | Relay contacts: hard silver | Relays | any position] <br> - Screw fixing by Panel Mount Adapter and two screws (M4) [surface mounting in any position] |
| Maximum admissible operating voltage | Atternating current: 440VAC |  | Disposal | Synthetic material without dioxin according to ECl EFTA notification No. 93/0141/D. Electrical contacts contain cadmium. |
| Dielectric Coil to contact Withstand | $5,000 \mathrm{~V}$ |  |  |  |
| Voltage |  |  | Standards | EN 60947-1, EN 60947-5-1, EN 50081-1, IEC 947, UL 508. CSA 22.2 |
| Current $f_{\text {mi }}:(A C 1)$ Power: | 8A (5A for RZ7-FSO) |  | R27 Relative Scale Setting Knob |  |
|  | according to IEC947-5-1: |  | Series RZ7 Timing Relays have a "relative scale" seting knob numbered 0 to 1,0 . Think abo this as 0 ro $100 \%$ of the relay's built-in rime range. Example: To set an RZ7-FS riming relay (with a 0.05 to I minute range) to activate after 25 seconds: |  |
|  | 3 A 440VAC (inductive load, AC14) |  |  |  |  |
|  | 3A250VAC (inductive load, AC15) |  | $1)$ Divide the desired activation time (25 seconds) |  |
|  | 1A24VDC (inductive load, DC13) according to UL 508: |  | hy the maximum rime limit of the relay ( 60 seconds.). |  |
|  |  |  |  |  |  |
|  | 3N120VAC (B300) |  | $25+60=.416$ | E- |
| Short circuit resistance | 10 AgL (fast blow fuse) |  | 2) Rotare the serring knob ro | sst the . 4 mark. |

## ||sprecher + schuh

Dimensions


Panel Mount Adaptor (26.506.221-01)

- Dimensions are in millimeters
- Dimensions not intended for manufacturing purposes



## VARIABLE SPEED DRIVE

## 1. VARIABLE SPEED DRIVE USER MANUAL



# SDRIVE <br> VARIABLE SPEED DRIVE 

variable speed drive
User Manual

Edition: October 2007
SD70MT01CI Rev. C

## SAFETY SYMBOLS

Always follow safety instructions to prevent accidents and potential hazards from occurring.

WARNING | This symbol means improper operation may results in serious personal |
| :--- |
| injury or death. |

Identifies shock hazards under certain conditions. Particular attention should
be given because dangerous voltage may be present. Maintenance
operation should be done by qualified personnel

## Edition of October 2007

This publication could present technical imprecision or misprints. The information here included will be periodically modified and updated, and all those modifications will be incorporated in later editions. To consult the most updated information of this product you might access through our website www.power-electronics.com where the latest version of this manual can be downloaded.

Revisions

| Date | Revision | Description |
| :--- | :--- | :--- |
| $10 / 04 / 2007$ | A | Software updating (2) to Software version SW Ver 1.3 <br> Chapter 12 (MODBUS Communication). |
| $11 / 06 / 2007$ | B | Update of chapters 8, 9, 10 (Modbus addresses). <br> Dimensions and connections for Frame 3 <br> Update of chapters 11, 12. <br> Updated software version SW 1.3 (08) |

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## SAFETY INSTRUCTIONS

## IMPORTANT!

- Read this manual carefully to maximise the performance of this product and to ensure its safe use.
- In this manual, safety messages are classified as follows:



## WARNING

Do not remove the cover while the power is applied or the unit is in operation. Otherwise electric shock could occur.

Do not run the drive with the front cover removed. Otherwise you may get an electric shock due to the high voltage terminals or exposure of charged capacitors.

Do not remove the cover except for periodic inspections or wiring, even if the input power is not applied. Otherwise you may access the charged circuits and get an electric shock.

Wiring and periodic inspections should be performed at least 10 minutes after disconnecting the input power and after checking the DC Link voltage is discharged with a meter (below 30VDC).
Otherwise you may get an electric shock.

Operate the switches with dry hands.
Otherwise you may get an electric shock.
Do not use cables with damaged insulation.
Otherwise you may get an electric shock.

Do not subject the cables to abrasions, excessive stress, heavy loads or pinching.
Otherwise, you may get an electric shock.

## CAUTION

Install the drive on a non-flammable surface. Do not place flammable material nearby. Otherwise fire could occur.

Disconnect the input power if the drive gets damaged. Otherwise it could result in a secondary accident or fire.

After the input power is applied or removed, the drive will remain hot for a couple of minutes. Touching hot parts may result in skin burns.

Do not apply power to a damaged drive or to a drive with parts missing even if the installation is complete. Otherwise you may get an electric shock.

Do not allow lint, paper, wood chips, dust, metallic chips or other foreign matter into the drive. Otherwise fire or accident could occur.


## WARNINGS

## RECEPTION

- The SDRIVE 700 is carefully tested and perfectly packed before leaving the factory.
- In the even of transport damage, please ensure that you notify the transport agency and POWER ELECTRONICS: 902402070 (International +34 9613665 57) or your nearest agent, within 24 hrs from receipt of the goods.


## UNPACKING

- Make sure model and serial number of the variable speed drive are the same on the box, delivery note and unit
- Each variable speed drive is supplied with a SDRIVE 700 technical manual


## SAFETY

- Before operating the drive, read this manual thoroughly to gain and understanding of the unit. If any doubt exists then please contact POWER ELECTRONICS, (902 $402070 /+34961366557$ ) or your nearest agent.
- Wear safety glasses when operating the drive with power applied and the front cover is removed.
- Handle the drive with care according to its weight.
- Install the drive according to the instructions within this manual.
- Do not place heavy objects on the drive.
- Ensure that the mounting orientation is correct.
- Do not drop the drive or subject it to impact.
- The SDRIVE 700 drives contain static sensitive printed circuits boards. Use static safety procedures when handling these boards.
- Avoid installing the drive in conditions that differ from those described in the Technical Characteristics section.


## CONNECTION PRECAUTIONS

- To ensure correct operation of the drive it is recommended to use a SCREENED CABLE for the control wiring.
- For EMERGENCY STOP, make sure supply circuitry is open
- Do not disconnect motor cables if input power supply remains connected. The internal circuits of the SDRIVE 700 series will be damaged if the incoming power is connected and applied to output terminals ( $\mathrm{U}, \mathrm{V}, \mathrm{W}$ ).
- It is not recommended to use a 3 -wire cable for long distances. Due to increased leakage capacitance between conductors, over-current protective feature may not operate correctly.
- Do not use power factor correction capacitors, surge suppressors, or RFl filters on the output side of the drive. Doing so may damage these components.
- Always check whether the DC Link LED is OFF before wiring terminals. The capacitors may hold high-voltage even after the input power is disconnected. Use caution to prevent the possibility of personal injury.

TRIAL RUN

- Verify all parameters before operating the drive. Alteration of parameters may be required depending on application and load.
- Always apply voltage and current signals to each terminal that are within levels indicated within this manual. Otherwise, damage to the drive may result.


## OPERATION PRECAUTIONS

- When the Auto Restart function is enabled, keep clear of driven equipment, as the motor will restart suddenly after a fault is reset.
- The "STOP / RESET" key on the keypad is active only if the appropriate function setting has been made. For this reason, install a separate EMERGENCY STOP push button that can be operated at the equipment.
- If a fault reset is made with the reference signal still present then a restart will occur. Verify that it is permissible for this to happen, otherwise an accident may occur.
- Do not modify or alter anything within the drive.
- Before programming or operating the SDRIVE 700 series, initialise all parameters back to factory default values.


## EARTH CONNECTION

- The drive is a high frequency switching device and leakage current may flow. Ground the drive to avoid electrical shock. Use caution to prevent the possibility of personal injury.
- Connect only to the dedicated ground terminal of the drive. Do not use the case or the chassis screw for grounding
- When installing, grounding wire should be connected first and removed last.
- The earth cable must have a minimal cross sectional area that meets local country electrical regulations
- Motor ground must be connected to the drive ground terminal and not to the installation's ground. We recommend that the section of the ground connection cable should be equal or higher than the active conductor.
- Installation ground must be connected to the drive ground terminal.


## 1. INTRODUCTION

### 1.1. Designation Code



* In case of 230Vac power supply, consult availability with Power Electronics


### 1.2. Drive description

The SDRIVE700 is a UNIQUE drive:
$>$ Due to its mechanical design.
FFA (Full Frontal Access) has reached an important objective: to make easy, in a significant way, its installation and maintenance thanks to its modular independence. It is available in IP00, IP20 and IP54.
$>$ Due to features.
First speed drive incorporating a Graphical Display with 3.5" TFT touch screen for fast and easy programming.

- Real time clock and perpetual calendar.
- USB 2.1 Communication Port.
- Fibre Optic Port.
$\Rightarrow$ Due to its reliability.
FPA (Fault Preventing Algorithms) is able to detect critical situations and correct them avoiding unnecessary downtime in production. Power Electronics has employed a new control strategy: MCA (Motion Combined Algorithms) combining all the advantages of different traditional motor control and ensuring robustness and stability.



## 2. INSTALLATION AND CONNECTION

### 2.1. Basic Configuration

The following devices are required to operate the drive. Proper peripheral devices must be selected and correct connections must be done to ensure proper operation. An incorrectly applied or installed drive can result in system malfunction or reduction in product life as well as component damage. You must read and understand this manual thoroughly before proceeding.
Use a power source with a voltage within the permissible range
of drive input power rating. Equipment is provided to operate
with the neutral connected to the ground.

### 2.2. Environmental Conditions


#### Abstract

Verify ambient conditions of mounting location. Ambient temperature should not be below $-30^{\circ} \mathrm{C}$ or exceed $50^{\circ} \mathrm{C}$. It is necessary to consider the use of the equipment according to normal duty or heavy duty. It is recommended to consult the tables of standard types included in this manual to guarantee correct use of the equipment. Relativity humidity should be less than $95 \%$ (non-condensing). Altitude șhould be below 1.000 m ( 3.300 ft ). SD700 is offered with IP00, IP20 and IP54 protection degree. Nevertheless, we recommend protecting it from conductive dust (dry or wet) and water drops. As an electronic device, the SD700 will have a longer life if the installation is done properly in a clean place, with a correct ventilation system and protected from mechanical vibrations.


### 2.3. Drive Mounting

SD700 should be mounted vertically. It should be well fastened through the anchorages designed for this to avoid any movement.

If the drive is installed inside a cabinet the heated air must be vented out of the cabinet to ensure correct cooling. To avoid such a situation it is also necessary to leave enough horizontal and vertical space with any adjacent equipment.
We recommend cooling the cabinet to evacuate dissipated heat.

### 2.4. Power Connection and Control Wiring

### 2.4.1. Power Wiring

Input terminals (drive supply) and output terminals (motor supply) are accessible from the bottom. SD700 is designed for working with 3-phase supply with the neutral connected to the earth.

It is not necessary to use power factor correction capacitors at the SD700 input, and do not connect them to the output of the drive.

Line voltage should be connected to L1, L2 and L3 terminals, and earth will be connected to the terminals assigned for this function.

Motor should be connected to the terminals indicated as $U, V$ and $W$.


Figure 2.1 Power Connection Detail

We recommend installing the drive according to the following connection:


Figure 1.2 Power wiring connection
Note: It is recommended to use an earth cross section equal or higher than active wires cross section.

## CAUTION

Line voltage must never be connected to $\mathrm{U}, \mathrm{V}$ and W terminals. Otherwise the drive will be damaged.

### 2.4.2. Control Wiring

Control wiring should be installed as far as possible from the power wiring. If you have to pass the control wiring next to the power wiring it should do perpendicularly. The cable should be screened and the shield should be connected to ground.
Do not use voltages of 24 Vdc and 220 Vac into the same cable.

### 2.4.3. Observations before Trial Run

Before applying voltage, we recommended to check that the power wiring is connected correctly and to verify that the connections are correctly fastened.

It is recommended to close the doors of SD700 before applying voltage the first time.
Before applying voltage to the drive and configuring it, make sure the line voltage is compatible with drive power supply. On the contrary, the drive will be damaged.
After applying voltage to the drive, verify the display is turned on and the status led of the DC bus is also illuminated.
Check line voltages when the display is lit. If the drive does not read one of the 3 phases then check input power wiring.
Before starting the SD700, the parameters should be programmed correctly for proper operation of the motor. Ensure the correct motor parameters are entered before giving the first "start" command to the drive.

## WARNING

It is absolutely necessary that the installer guaranties the correct observance of the law and the regulations that are in force in those countries or areas where this device is going to be installed.

## 3. POWER RANGE

### 3.1. Power Range at 400 Vac

| FRAME | CODE | Operation Temperature $50^{\circ} \mathrm{C}$ HEAVY DUTY |  |  | Operation Temperature $40^{\circ} \mathrm{C}$ HEAVY DUTY |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | I(A) Rated | Power (kW) at 400 Vac | $150 \%$ Overload | I(A) Rated | Power (kW) at 400 Vac | 120\% Overload |
| 1 | SD70006 $5 \mathrm{x} \times \mathrm{xx}$ | 6 | 2,2 | 9 | 7,5 | 3 | 9 |
|  | SD70007 5xx xx | 7,5 | 3 | 11 | 9,4 | 4 | 11 |
|  | SD70009 5x x xx | 9 | 4 | 14 | 11 | 5,5 | 14 |
|  | SD70012 $5 \mathrm{x} \times \mathrm{xx}$ | 12 | 5,5 | 18 | 15 | 7,5 | 18 |
|  | SD70018 5x x xx | 18 | 7,5 | 27 | 23 | 11 | 27 |
|  | SD70024 5x x xx | 24 | 11 | 36 | 30 | 15 | 36 |
| 2 | SD70032 $5 \mathrm{x} \times \mathrm{xx}$ | 32 | 15 | 48 | 40 | 18,5 | 48 |
|  | SD70038 5xxxx | 38 | 18,5 | 57 | 48 | 22 | 57 |
|  | SD70048 5x x xx | 48 | 22 | 72 | 60 | 30 | 72 |
| 3 | SD70060 $5 \mathrm{x} \times \mathrm{xx}$ | 60 | 30 | 90 | 75 | 37 | 90 |
|  | SD70075 5xxxx | 75 | 37 | 113 | 94 | 45 | 113 |
|  | SD70090 $5 \mathrm{x} \times \mathrm{xx}$ | 90 | 45 | 135 | 113 | 55 | 135 |
|  | SD70115 5x $\times$ xx | 115 | 55 | 173 | 144 | 75 | 173 |
| 4 | SD70150 5x x xx | 150 | 75 | 225 | 188 | 90 | 225 |
|  | SD70170 5xxxx | 170 | 90 | 255 | 213 | 110 | 255 |
| 5 | SD70210 $5 \mathrm{x} \times \mathrm{xx}$ | 210 | 110 | 315 | 263 | 132 | 315 |
|  | SD70250 $5 \mathrm{x} \times \mathrm{xx}$ | 250 | 132 | 375 | 313 | 160 | 375 |
|  | SD70275 5xx xx | 275 | 150 | 413 | 344 | 200 | 426 |
| 6 | SD70330 5xx xx | 330 | 160 | 495 | 413 | 220 | 495 |
|  | S070370 5xxxx | 370 | 200 | 555 | 463 | 250 | 555 |
|  | SD70460 5xxxx | 460 | 250 | 690 | 575 | 315 | 690 |
| 7 | SD70580 5xx xx | 580 | 315 | 870 | 725 | 400 | 870 |
|  | SD70650 5 xxxx | 650 | 355 | 975 | 813 | 450 | 975 |
|  | SD70720 5 xxxx | 720 | 400 | 1080 | 900 | 500 | 1080 |
| 8 | SD70840 5 xxxx | 840 | 450 | 1260 | 1050 | 560 | 1260 |
|  | SD70925 5xxxx | 925 | 500 | 1388 | 1156 | 630 | 1388 |
| 9 | SD71030 5xxxx | 1030 | 560 | 1545 | 1288 | 710 | 1545 |
|  | SD71150 5xxxx | 1150 | 630 | 1725 | 1438 | 800 | 1725 |
|  | SD71260 $5 \mathrm{x} \times \mathrm{xx}$ | 1260 | 710 | 1890 | 1575 | 900 | 1890 |
|  | SD71440 5xxxx | 1440 | 800 | 2160 | 1800 | 1000 | 2160 |
| 10 | SD71580 5xx xx | 1580 | 900 | 2370 | 1975 | 1100 | 2370 |
|  | SD71800 5xxxx | 1800 | 1000 | 2700 | 2250 | 1200 | 2700 |
| 11 | SD72200 5xxxx | 2200 | 1200 | 3300 | 2750 | 1500 | 3300 |

Table 3.1 Table of power and current data at 400V

## NOTES:

- Rated power for standard A.C. motors of 4-pole (1500rpm).
- For higher power units contact Power Electronics.
- The motor nameplate must be checked to ensure that the selected variable speed drive is correct for each specific motor.


### 3.2. Power Range at 690 Vac

| FRAME | CODE | Operation Temperature $50^{\circ} \mathrm{C}$ HEAVY DUTY : |  |  | Operation Temperature $40^{\circ} \mathrm{C}$ HEAVY DUTY |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 1(A) Rated | Power (kW) at 690 Vac | $150 \%$ Overload | I(A) Rated | Power (kW) at 690Vac | $120 \%$ Overload |
| 3 | SD70052 6x x xx | 52 | 45 | 78 | 65 | 55 | 78 |
|  | SD70062 6x $\times$ xx | 62 | 55 | 93 | 78 | 75 | 93 |
|  | SD70080 6xxxx | 80 | 75 | 120 | 100 | 90 | 120 |
| 4 | SD70105 6x $\times$ xx | 105 | 90 | 157 | 131 | 110 | 157 |
| 5 | SD70130 6xxxx | 130 | 110 | 195 | 163 | 132 | 195 |
|  | SD70150 6xxxx | 150 | 132 | 225 | 188 | 160 | 225 |
|  | SD70170 6x $\times \mathrm{xx}$ | 170 | 160 | 255 | 213 | 200 | 255 |
| 6 | SD70210 6xxxx | 210 | 200 | 315 | 263 | 250 | 315 |
|  | SD70260 6xxxx | 260 | 250 | 390 | 325 | 315 | 390 |
|  | SD70320 6x x xx | 320 | 315 | 480 | 400 | 355 | 480 |
| 7 | SD70385 6x x xx | 385 | 355 | 578 | 481 | 450 | 578 |
|  | SD70460 $6 \mathrm{x} \times \mathrm{xx}$ | 460 | 450 | 690 | 575 | 500 | 690 |
| 8 | SD70550 6x $\times$ xx | 550 | 500 | 825 | 688 | 630 | 825 |
|  | SD70660 6xxxx | 660 | 630 | 990 | 825 | 800 | 990 |
| 9 | SD70750 6x $\times \mathrm{xx}$ | 750 | 710 | 1125 | 938 | 900 | 1125 |
|  | SD70840 6x x xx | 840 | 800 | 1260 | 1050 | 1000 | 1260 |
|  | SD70950 6x $\times$ x $x$ | 950 | 900 | 1425 | 1188 | 1100 | 1425 |
| 10 | SD71140 $6 \times \times \times x$ | 1140 | 1000 | 1710 | 1425 | 1300 | 1710 |
|  | SD71270 $6 \mathrm{x} \times \mathrm{xx}$ | 1270 | 1200 | 1905 | 1588 | 1600 | 1905 |
|  | SD71420 6xxxx | 1420 | 1400 | 2130 | 1775 | 1700 | 2130 |
| 11 | SD71500 6x x xx | 1500 | 1500 | 2250 | 1875 | 1800 | 2250 |
|  | SD71800 6x $\times$ x ${ }^{\text {a }}$ | 1800 | 1800 | 2700 | 2250 | 2000 | 2700 |

Table 3.2 Table of power and current data at 690 V
NOTES:

- Rated power for standard A.C. motors of 4-pole (1500rpm).
- For higher power units contact Power Electronics.
- The motor nameplate must be checked to ensure that the selected variable speed drive is correct for each specific motor.


## 4. TECHNICAL CHARACTERISTICS

| INPUT | Power supply <br> Input frequency <br> Input current <br> Input power factor <br> Power factor <br> Momentary power loss <br> EMC input filter <br> Harmonics filter | 380-500Vac $550-690 \mathrm{Vac}(-20 \%$ to $+10 \%$ ) 3-Phase <br> 230Vac optional* ${ }^{*}$ <br> 48 to 62 Hz <br> $\leq$ Output current <br> 20.98 (of fundamental) <br> $\leq 0.88$ <br> $>2 \mathrm{sec}$ (depending on the load) <br> Second environment, limits 3 and 4 <br> First environment, limit 1 and 2 optional built in <br> Choke coils 3\% impedance |
| :---: | :---: | :---: |
| OUTPUT | Motor output voltage <br> Output frequency <br> Overload capacity <br> Efficiency (at full load) <br> Motor power (kW) <br> Motor voltage <br> Control method <br> Carrier frequency <br> Output dV/dt filter <br> Output cable length | OVac to $100 \%$ Input voltage 0 to $\pm 250 \%$ <br> $150 \%$ duning 60 sec at $50^{\circ} \mathrm{C}$ <br> $>97 \%$ <br> 50 to $150 \%$ of SD700 reting <br> 5 to 500 Vac <br> Vector control without encooder (Sensorless, open loop). <br> Vector Control and VHz <br> 4 to 8 kHz - PEWave (without losses) <br> 500 to $800 \mathrm{~V} / \mathrm{\mu s}$ (accerording to SD700 raing) <br> Maximum 300 meters ${ }^{\text {T }}$ |
| ENVIRONAENTAL CONDITIONS | - Ambient temperature Altitude <br> Altitude de-rating <br> Degree protection <br> Ambient humidity <br> Display degree protection | Minimum: $30^{\circ} \mathrm{C}$ Maximum: $+50^{\circ} \mathrm{C}$ 1000m <br> $>1000 \mathrm{~m}$, $1 \%$ per $100 \mathrm{~m} ; 3000 \mathrm{~m}$ meximum IPOO, IP20 and IP54 <br> <95\%, non-condensing <br> P54 |


| MOTOR PROTECTIONS | Rotor locked <br> Motor overioad (thermal model) <br> Phase current imbalance, phase voltage imbalance <br> Motor over-temperature (PTC signal) <br> Speed limit <br> Torcue limit |
| :---: | :---: |
| $\begin{aligned} & \text { DRNE } \\ & \text { PROTECTIONS } \end{aligned}$ | Output current limit <br> Overload <br> IGBT's overload <br> Input phase loss <br> Low input voltage, High input voltage <br> DC Bus voltage limit <br> Low DC Bus voltage <br> High input frequency <br> Low input frequency <br> IGBT temperature <br> Heat-sink over-temperature <br> Power supply fault <br> Drive thermal mode <br> Ground fauit <br> Software and Hardware fault <br> Analogue input signal loss (speed reference loss) |


| digital inputs | 6 progranmable inputs, active high (24Vdc) <br> 1 PTC input <br> " $k$ " $=$ Conditions are corriect PTC resistance value is between $90 \Omega \pm 10 \%$ and $1 K 5 \pm 10 \%$ <br> ${ }^{\circ} F=$ P Possible short-circuit in wining. PTC resistènce value is lower than $90 \Omega \pm 10 \%$, or excessive temperatre <br> in the motor, PTC resistance value is higher than $1 K 5 \pm 10 \%$ <br> 1 programmable digital input (controiled by jumper, a fault is generated when it is disconnected, to avid dangercus stuations during programming) <br> Additional features: solalated power supply |
| :---: | :---: |

* Consult availability with Power Electronics.
** Cable length could be increased depending on cable type. Consult with Power Electronics.

| ANALOGUE INPUTS | 2 programmable and differential inputs. Operation modes: <br> Current signal: $0-20 \mathrm{~mA}, 4-20 \mathrm{~mA}$. <br> Voltage signal: $0-10 \mathrm{Vdc}, \pm 10 \mathrm{Vdc}$, differential <br> Additional features: Optically insulated |
| :---: | :---: |
| ENCODER INPUTS | Optional encoder boards are available for two differential encoders (one availabie for the user, one available for vector control mode). Others types of encoders can be used as necessary Additional features: <br> . . Voltages inputs from 5 to 24 Vdc |
| DIGTAL OUTPUTS | 3 programmable changeover relays (250Vac, 8 A or 30Vdc, 8 A ) |
| ANALOGUE OUTPUTS | 2 isolated programmable outputs: $0-20 \mathrm{~mA}, 4-20 \mathrm{~mA}_{3} 0-10 \mathrm{Vdc}$ y $\pm 10 \mathrm{Vdc}$ |
| POTENTIOMETER. VOLTAGE | 10 Vdc power supply voltage for speed reference by potentiometer (26mA maximum) |
| USER POWER SUPPLY | 24 Vdc user power supply regulated and shor-circuit protected |
| COMARUNICATION | From a communication perspective the SD700 will provide:  <br> Standard Hardware: Optional Hardware: <br> USB Port Optic Fibre <br> RSS32 Port Ethemet <br> RS485 Port  <br> Software Protocols:  <br> Standard:  <br> Modbus-RTU Optional: <br>   <br>  Profibus <br>  Devicenet <br>  TCPAP <br>  N2 Metasys |



| CONTROL | $\because$ | Local from keypad <br> Remote from digital inputs <br> Serial communications |
| :--- | :--- | :--- | :--- |



| OTHERS | Real time clock Perpetual calendar |
| :---: | :---: |
| CERTIFICATION CE, UL, GUL CTICk |  |

* Possibility of increasing length. Consult with Power Electronics.


## 5. DIMENSIONS

### 5.1. Dimensions of Frames 3, 4 and 5

| REFERENCE$380-500 V$ | REFERENCE$550-690 \mathrm{~V}$ | DIMENSIONS |  |  |  |  |  |  |  |  |  |  | WEIGHT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | H1 | H2 | W1 | W2 | W3 | D1 | D2 | Y1 | Y2 | Y3 | Y4 |  |
| SD70060 5xxxx | SD70052 6x $\times$ xx | 853.5 | 838.5 | 300.5 | 200 | 140 | 358 | - | 827 | 15 | - | - | - |
| SD70075 5xxxx | SD70062 6x $x$ xx | 853.5 | 838.5 | 300.5 | 200 | 140 | 358 | - | 827 | 15 | - | - | - |
| SD70090 $5 \times \times \times x$ | SD70080 6x x xx | 853.5 | 838.5 | 300.5 | 200 | 140 | 358 | - | 827 | 15 | - | - | - |
| SD70115 5x x xx | - | 853.5 | 838.5 | 300.5 | 200 | 140 | 358 | - | 827 | 15 | - | - | - |
| SD70150 5 xxxx | SD70105 6xxxx | 1245 | 1206 | 320 | 251 | - | 438.5 | - | 881 | 527.5 | 353.5 | - | 100 |
| SD70170 5xxxx | - | 1245 | 1206 | 320 | 251 | $\cdot$ | 438.5 | - | 881 | 527.5 | 353.5 | - | 100 |
| SD70210 $5 \mathrm{x} \times \mathrm{xx}$ | SD70130 $6 \mathrm{x} \times \mathrm{xx}$ | 1712 | 1667 | 431 | 396 | - | 528 | 460 | 1403.5 | 1240.5 | 81.5 | - | 180 |
| SD70250 5xxxx | SD70150 6x $x$ xx | 1712 | 1667 | 431 | 396 | - | 528 | 460 | 1403.5 | 1240.5 | 81.5 | - | 180 |
| SD70275 5xxxx | SD70170 6x $\times$ xx | 1712 | 1667 | 431 | 396 | - | 528 | 460 | 1403.5 | 1240.5 | 81.5 | - | 180 |



Figure 5.1 Dimensions of Frame 3


Figure 5.2 Dimensions of Frame 4

Figure 5.3 Dimensions of Frame 5

### 5.2. Dimensions of Frames 6 and 7

| REFERENCE$380-500 \mathrm{~V}$ | REFERENCE$550-690 \mathrm{~V}$ | DIMENSIONS |  |  |  |  |  |  |  |  |  |  | WEIGHT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | H1 | H2 | W1 | W2 | W3 | D1 | D2 | Y1 | Y2 | Y3 | Y4 |  |
| SD70330 $5 \mathrm{x} \times \mathrm{xx}$ | SD70210 6xxxx | 1712 | 1667 | 786 | 747 | - | 529 | 460 | 1602 | 1208.5 | 230.5 | 81.5 | 340 |
| SD70370 5x x xx | SD70260 6xxxx | 1712 | 1667 | 786 | 747 | - | 529 | 460 | 1602 | 1208.5 | 230.5 | 81.5 | 340 |
| SD70460 $5 \mathrm{x} \times \mathrm{xx}$ | SD70320 6x $\times$ xx | 1712 | 1667 | 786 | 747 | - | 529 | 460 | 1602 | 1208.5 | 230.5 | 81.5 | 340 |
| SD70580 $5 \mathrm{x} \times \mathrm{xx}$ | SD70385 6x $\times$ xx | 1712 | 1667 | 1132 | 1097 | - | 529 | 460 | 1602 | 1208.5 | 230.5 | 81.5 | 470 |
| SD70650 $5 \mathrm{x} \times \mathrm{xx}$ | SD70460 6xxxx | 1712 | 1667 | 1132 | 1097 | - | 529 | 460 | 1602 | 1208.5 | 230.5 | 81.5 | 470 |
| SD70720 $5 \times \times \times x$ | - | 1712 | 1667 | 1132 | 1097 | - | 529 | 460 | 1602 | 1208.5 | 230.5 | 81.5 | 470 |




SD70DTD0003CE

Figure 5.4 Dimensions of Frame 6


Figure 5.5 Dimensions of Frame 7

### 5.3. Dimensions of Frames 8 and 9

| REFERENCE$380-500 V$ | REFERENCE$550-690 V$ | DIMENSIONS |  |  |  |  |  |  |  |  |  |  | WEIGHT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | H1 | H2 | W1 | W2 | W3 | D1 | D2 | Y1 | Y2 | Y3 | Y4 |  |
| SD70840 5x x xx | SD70550 6x x xx | 1712 | 1667 | 1482 | 1447 | - | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | - |
| SD70925 5xxxx | SD70660 6x x xx | 1712 | 1667 | 1482 | 1447 | - | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | - |
| SD71030 5xxxx | SD70750 6x $x \times x$ | 1712 | 1667 | 2352 | 747 | 38 | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | - |
| SD71150 $5 \times x \times x$ | SD70840 $6 \mathrm{x} \times \mathrm{xx}$ | 1712 | 1667 | 2352 | 747 | 38 | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | - |
| SD71260 $5 \mathrm{x} \times \mathrm{xx}$ | SD70950 6xx xx | 1712 | 1667 | 2352 | 747 | 38 | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | - |
| SD71440 $5 \mathrm{x} \times \mathrm{xx}$ | - | 1712 | 1667 | 2352 | 747 | 38 | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | - |




Figure 5.6 Dimensions of Frame 8


Figure 5.7 Dimensions of Frame 9

### 5.4. Dimensions of Frames 10 and 11

| REFERENCE 380-500V: | REFERENCE 550-690V | DIMENSIONS |  |  |  |  |  |  |  |  |  |  | WEIGHT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | H1 | H2 | W1 | W2 | W3 | D1 | D2 | Y1 | Y2 | Y3 | Y 4 |  |
| SD71580 5xxxx | SD71140 $6 \mathrm{x} \times \mathrm{xx}$ | 1712 | 1667 | 3402 | 1097 | 38 | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | . |
| SD71800 $5 \times \times x \times$ | SD71270 6x x xx | 1712 | 1667 | 3402 | 1097 | 38 | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | - |
| - | SD71420 $6 \times \times \times x$ | 1712 | 1667 | 3402 | 1097 | 38 | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | $\cdot$ |
| SO72200 5xxxx | SD71500 $6 \times x \times x$ | 1712 | 1667 | 4452 | 1447 | 38 | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | - |
| - | SD71800 $6 \mathrm{x} \times \mathrm{xx}$ | 1712 | 1667 | 4452 | 1447 | 38 | 528 | 460 | 1619 | 1209 | 247.5 | 81.5 | - |



Figure 5.8 Dimensions of Frame 10


Figure 5.9 Dimensions of Frame 11

### 5.5. Dimensions of Frames 4 and 5 (IP00)

| REFERENCE | DIMENSIONS |  |  |  |  |  |  |  |  |  |  | WEIGHT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | H1 | H2 | W1 | W2 | W3 | D1 | D2 | Y1 | Y2 | Y3 | Y4 |  |
| SD70150 $50 \times \mathrm{xx}$ | 1124 | 1100.5 | 320 | 285 | 245 | 438.5 | . | 778.5 | 527.5 | 250.5 | - | - |
| SD70170 $50 \times \mathrm{xx}$ | 1124 | 1100.5 | 320 | 285 | 245 | 438.5 | - | 778.5 | 527.5 | 250.5 | - | - |
| SD70210 $50 \times x \mathrm{x}$ | 1124 | 1100.5 | 436 | 396 | 394 | 507 | 500 | 1136 | 650.5 | 250.5 | 81.5 | 118 |
| SD70250 $50 \times x x$ | 1124 | 1100.5 | 436 | 396 | 394 | 507 | 500 | 1136 | 650.5 | 250.5 | 81.5 | 118 |
| SD7027550x xx | 1124 | 1100.5 | 436 | 396 | 394 | 507 | 500 | 1136 | 650.5 | 250.5 | 81.5 | . 118 |



Figure 5.10 Dimensions of Frame 4 IP00


Figure 5.11 Dimensions of Frame 5 IP00

### 5.6. Dimensions of Frames 6 and 7 (IP00)

| REFERENCE | DIMENSIONS |  |  |  |  |  |  |  |  |  |  | WEIGHT |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | H1 | H2 | W1 | W2 | W3 | D1 | D2 | Y1 | Y2 | Y3 | Y4 |  |
| SD70330 $50 \times \mathrm{xx}$ | 1124 | 1100.5 | 786 | 746 | 744 | 507 | 500 | 1136 | 650.5 | 250.5 | 81.5 | 236 |
| SD70370 $50 \times \times x$ | 1124 | 1100.5 | 786 | 746 | 744 | 507 | 500 | 1136 | 650.5 | 250.5 | 81.5 | 236 |
| SD70460 $50 \times x \mathrm{x}$ | 1124 | 1100.5 | 786 | 746 | 744 | 507 | 500 | 1136 | 650.5 | 250.5 | 81.5 | 236 |
| SD70580 $50 \times \mathrm{xx}$ | 1124 | 1100.5 | 1136 | 1096 | 1094 | 507 | 500 | 1136 | 650.5 | 250.5 | 81.5 | 350 |
| SD70650 $50 \times x \mathrm{x}$ | 1124 | 1100.5 | 1136 | 1096 | 1094 | 507 | 500 | 1136 | 650.5 | 250.5 | 81.5 | 350 |
| SD70720 $50 \times x \mathrm{x}$ | 1124 | 1100.5 | 1136 | 1096 | 1094 | 507 | 500 | 1136 | 650.5 | 250.5 | 81.5 | 350 |



Figure 5.12 Dimensions of Frame 6 IP00


Figure 5.13 Dimensions of Frame 7 IP00

## 6. CONNECTION TERMINALS

### 6.1. Power Connections

### 6.1.1. Frame 3 Connections



Figure 6.1 Power connections location for SD70060 5x - SD70115 5x and SD70052 6x - SD70080 6x

### 6.1.2. Frame 4 Connections



Figure 6.2 Power connections location for SD70150 5x - SD70170 5x and SD70105 6x

### 6.1.3. Frame 5 Connections



Figure 6.3 Power connections location for SD70210 5x - SD70275 5x and SD70130 6x - SD70170 6x

### 6.1.4. Frame 6 Connections



SD700TD0007Al

Figure 6.4 Power connections location for SD70330 5x-SD70460 6x and SD70210 6x-SD70320 6x

### 6.1.5. Frame 7 Connections



Figure 6.5 Power connections location for SD70580 $5 x-$ SD70720 $5 x$ and SD70385 6x-SD70460 6x

### 6.1.6. Frame 8 Connections



SD70DTD0017AI

Figure 6.6 Power connections location for SD70840 5x - SD70925 5x and SD70550 6x - SD70660 6x

### 6.1.7. Frame 9 Connections



Figure 6.7 Power connections location for SD71030 $5 x-$ SD71440 $5 x$ and SD70750 6x - SD70950 6x

### 6.1.8. Frame 10 Connections



Figure 6.8 Power connections location for SD71580 5x-SD71800 5x and SD71140 6x-SD71420 6x

### 6.1.9. Frame 5 Connections - IP00



SD70DTD0022AI

Figure 6.9 Power connections location for SD70210 50 - SD70275 50 - IP00

### 6.2. Control Connections

The following figure shows the SD700 control board. Although the control board is insulated galvanically, for safety reasons it is recommended not change the wiring while the equipment is connected to the input power supply.

## CAUTION

Changes of control wiring or bridges should be performed at least 10 minutes after disconnecting the input power and after checking the DC Link voltage is discharged with a meter (below 30Vdc). Otherwise, you may get an electric shock.


Figure 6.10 Control board of SD700

### 6.2.1. Connectors and Jumpers Description



Figure 6.11 Location and description of user connectors

### 6.2.2. Control Wiring

The following figure provides an overview of the standard wiring of control terminais through the X 1 and X 2 user connectors.

X1 CONNECTOR


Factory Settings
Common Terminal +24 Vdc DI1 $\rightarrow$ 06: Slart - Resel / Stop
DI2 $\rightarrow 00:$ Not used
DI3 $\rightarrow 00$ : Not used
DH $\rightarrow 00$ : Not used
DI5 $\rightarrow 00$ : Not used
D:6 $\rightarrow$ 17: Control 2

Motor PTC Input

Analogue Ref. Signal ( $0-10 \mathrm{Vdc}$ ).

Power supply for Analogue Signal ( $+10 \mathrm{Vdc} / 26 \mathrm{~mA}$ )
Programmable V or mA
Common Terminal OVdc
Terminal $\mathbf{+ 2 4 V d c}$

RS485 A - Serial communication
RS485 B - Serial communication
oVdc Terminal - Serial communication
RS232 Rx - Serial communication
RS232 Tx - Serial communication
Programmable $V$ or mA
Power supply common for Analogue Signal
Analogue Reference Signal (0-20mA, 4-20mA)
Programmable $V$ or $m A$
Power supply common for Analogue Signal

X2 CONNECTOR


Figure 6.12 Example of standard wiring of control terminals
Digital inputs' can be configured individually or collectively. Details on varying standard configurations are available to assist the user.
The following figure shows typical wiring configuration for a 3 wire start/stop push button system.


Figure 6.13 3-wire control terminals wiring

### 6.3. Control Terminals Description



## 7. DISPLAY UNIT AND CONTROL KEYPAD

### 7.1. Keypad Unit Description

The display of the SD700 is removable for remote installation, as the illustration shows. There are three leds on the display which indicate the drive operational status, one LCD screen with 4 lines of 16 characters each and keys for control and parameter setting.


Figure 7.1 Display Unit and Keypad

### 7.1.1. LEDs for Status Indication

Leds offer an easy method of identifying if the SD700 is powered up, if the drive is supplying output voltage, or if the drive has tripped.

- Led ON: Yellow colour. When it is lit, indicates equipment is powered up.
- Led RUN: Green colour. When it is lit, indicates the motor is powered by the SD700.
- Led FAULT: Red colour. When it is blinking, indicates the equipment is in fault status.


Figure 7.2 Status Visualization

### 7.1.2. Alphanumeric LCD Display

SD700 display has a LCD screen of four lines with sixteen characters each (16x4). Each line has different functions.

- Status Line: It is the top line

It is always present and shows the SD700 status (STR - Start, STP - Stop, etc...). It also shows the output current and the motor speed.
It is not configurable by the user.

- Visualization Line 1: It is the second line of the screen. It is always present and allows the selection of variables from the visualization menu.
It is configurable by the user.
- Visualization Line 2: It is the third line of the screen. It is always present and allows the selection of variables from the visualization menu. It is configurable by the user.
- Programming Line: It is the fourth line. It is used to display and / or set different parameters within the SD700.


SDTOTCOOOBA

Figure 7.3 Detail of Display Lines

### 7.1.3. Control Keys

Function keys have multiple uses and can be operated individually or in combination with other keys:


It allows access to different parameters groups and sub-groups, it displays code explanations and allows adjustment of parameter values in combination with other keys. If a group has no sub-groups, it allows direct access to the parameters of the group.

To modify numeric parameters:


Simultaneously pushed, the value will increase.

Simultaneously pushed, the value will decrease.

To modify parameters of numbered options:


Simultaneously pushed will ascend the user through the varying options.
Simultaneously pushed will descend the user through the varying options.
It allows upward movement through the parameters groups and allows navigation for different parameters within a parameter group. It also allows the increase of parameters value.

It allows downward movement through the parameters groups and allows navigation for different parameters within a parameter group. It also allows the decrease of parameters value.


When pushed for 2 seconds (approx.) it allows navigation between the programming line and visualisation lines available to the user. It also offers the possibility of escaping back to the previous sub-group or group.


To start the drive from the keypad when the control has been set as local control (check drive configuration).


To stop the drive from the keypad when the control has been set as local control. In the case of tripping this key can be used to reset the drive, if local control is enabled.

In the following figure you can see a programming example where you can observe the operation explained previously.


Figure 7.4 Example of parameters navigation

## 8. STATUS MESSAGES

### 8.1. Status Line

The upper line of the display corresponds to the status line. In this line we can display the equipment status, motor current (A) and the motor speed (\%). It is always displayed and it is not programmable by the user.


Figure 8.1 Status Line Description

## GENERAL STATUS

| Screen | OFF $\quad 0.0 \mathrm{~A} \quad+0.0 \%$ |
| :--- | :--- |
| Description | Present status of the drive |
|  | First field of the display status line |
| Range | * (See chapters 8.2, 8.3 and 11) |
| Modbus address | $\mathbf{4 0 2 1 9}$ |
| Modbus range | 0 to 201 |


| STATUS MESSAGES |  |  |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 0 | $\rightarrow$ | OFF | 4 | $\rightarrow$ | DEC | 12 | $\rightarrow$ | OCB |
| 1 | $\rightarrow$ | ON | 5 | $\rightarrow$ | SPG | 15 | $\rightarrow$ | TBR |
| 2 | $\rightarrow$ | ACL | 6 | $\rightarrow$ | EST | 41 | $\rightarrow$ | IN1 |
| 3 | $\rightarrow$ | RUN | 10 | $\rightarrow$ | SPN | 42 | $\rightarrow$ | IN2 |
|  |  |  |  |  |  |  |  |  |

Note: See description of the status messages in chapter 8.2


Note: See description of the warning messages in chapter 8.3

| FAULT MESSAGES |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 120 | $\rightarrow$ | NFL | 139 | $\rightarrow$ | F19 | 158 | $\rightarrow$ | F38 |  | $\rightarrow$ F57 |
| 121 | $\rightarrow$ | F01 | 140 | $\rightarrow$ | F20 | 159 | $\rightarrow$ | F39 |  | $\rightarrow$ F58 |
| 122 | $\rightarrow$ | F02 | 141 | $\rightarrow$ | F21 | 160 | $\rightarrow$ | F40 |  | $\rightarrow$ F59 |
| 123 | $\rightarrow$ | F03 | 142 | $\rightarrow$ | F22 | 161 | $\rightarrow$ | F41 |  | $\rightarrow \mathrm{F60}$ |
| 124 | $\rightarrow$ | F04 | 143 | $\rightarrow$ | F23 | 162 | $\rightarrow$ | F42 |  | $\rightarrow$ F61 |
| 125 | $\rightarrow$ | F05 | 144 | $\rightarrow$ | F24 | 163 | $\rightarrow$ | F43 | 182 | $\rightarrow$ F62 |
| 126 | $\rightarrow$ | F06 | 145 | $\rightarrow$ | F25 | 164 | $\rightarrow$ | F44 |  | $\rightarrow$ F63 |
| 127 | $\rightarrow$ | F07 | 146 | $\rightarrow$ | F26 | 165 | $\rightarrow$ | F45 | 184 | $\rightarrow$ F64 |
| 128 | $\rightarrow$ | F08 | 147 | $\rightarrow$ | F27 | 166 | $\rightarrow$ | F46 |  | $\rightarrow \mathrm{F} 65$ |
| 129 | $\rightarrow$ | F09 | 148 | $\rightarrow$ | F28 | 167 | $\rightarrow$ | F47 | 186 | $\rightarrow$ F66 |
| 130 | $\rightarrow$ | F10 | 149 | $\rightarrow$ | F29 | 168 | $\rightarrow$ | F48 | 187 | $\rightarrow \mathrm{F} 67$ |
| 131 | $\rightarrow$ | F11 | 150 | $\rightarrow$ | F30 | 169 | $\rightarrow$ | F49 | 188 | $\rightarrow \mathrm{F68}$ |
| 132 | $\rightarrow$ | F12 | 151 | $\rightarrow$ | F31 | 170 | $\rightarrow$ | F50 |  | $\rightarrow$ F69 |
| 133 | $\rightarrow$ | F13 | 152 | $\rightarrow$ | F32 | 171 | $\rightarrow$ | F51 | 190 | $\rightarrow$ F70 |
| 134 | $\rightarrow$ | F14 | 153 | $\rightarrow$ | F33 | 172 | $\rightarrow$ | F52 |  | $\rightarrow$ F71 |
| 135 | $\rightarrow$ | F15 | 154 | $\rightarrow$ | F34 | 173 | $\rightarrow$ | F53 | 192 | $\rightarrow \mathrm{F72}$ |
| 136 | $\rightarrow$ | F16 | 155 | $\rightarrow$ | F35 | 174 | $\rightarrow$ | F54 |  |  |
| 137 | $\rightarrow$ | F17 | 156 | $\rightarrow$ | F36 | 175 | $\rightarrow$ | F55 |  |  |
| 138 | $\rightarrow$ | F18 | 157 | $\rightarrow$ | F37 | 176 | $\rightarrow$ | F56 |  |  |

Note: See description of the fault messages in chapter 11
Read / Write Read Only

| MAOTOR OUTPUT CURRENT |  |
| :---: | :---: |
| Screen | OFF $\overline{\underline{0.0 A}}+\mathbf{0 . 0 \%}$ |
| Description | Motor output current |
|  | Second field of the display status line |
| Units | A |
| Modbus address | 40163 |
| Modbus range | Real Value $=($ Modbus Value $/ 10)$ |
| Read / Write | Read Only |
| M MOTOR SPEED |  |
| Screen Description | OFF 0.0A ${ }^{\text {+ }}$ 0.0\% |
|  | Motor output speed |
|  | Third field of the display status line |
| Units | \% |
| Modbus address | 40170 |
| Modbus range | Real Value $=($ Modbus Value $/ 10)$ |
|  | $8192=100 \%$ of the motor rated speed |
| Read / Write | Read Only |

## Notes:

Equipment status.
Parameter Equipment Status has Word size like the rest of Modbus parameters, but in this case, the more significant byte (MSB), is reserved for internal use (bit by bit). User should only use the less significant byte (LSB) to access to the information of the drive status.

## Alternation of two statuses.

During the standard running of the equipment, the drive status value will appear in a stable and continuous way, only changing when the drive status changes (from 'Accelerating' to 'Run', for example).
Nevertheless, there are two situations where the status value alternates between two statuses in a blink way:

- First case: If the equipment presents a Warning, this one will appear by alternating with the equipment status, for example, Normal status 'RUN' and the warning 'ILT' in alternative way.
- Second case: If a faults occurs, the status value will alternate between the last status of the drive before occurring the fault and the current fault number, for example, normal status 'RUN' and 'F40' in alternative way.


### 8.2. List of Status Messages

| Screen | Name | Description |
| :---: | :---: | :---: |
| OFF | Deactivated power | Drive power is deactivated. |
| ON | Activated power | Drive power is activated. |
| ACL | Accelerating | Drive is increasing the output frequency. Motor increasing in speed, it is accelerating. |
| RUN | Running | Drive is operating at reference speed. Operation at steady status. |
| DEC | Decelerating | Drive is decreasing the outpul frequency. Motor decreasing in speed, it is decelerating. |
| SPG | Stopping | Drive is decreasing the output frequency due to a stop command. Motor is stopping by ramp until zero speed is reached. |
| STO | Free run stop when a fault occurs | Drive is stopping by free run stop after a fault occurs (emergency stop). Motor stopping time is determined by inertia as the drive outpul has tumed off. |
| SPN | Flying start | 'Flying start' operation must be configured if required. The SD700 will search for the actual motor shaft speed once the drive has received a start command. |
| DCB | DC brake | SD700 is applying DC current injection to stop the motor. |
| HEA | Non condensing current is activated | SD700 is injecting DC current to prevent moisture condensing within the motor. <br> $\triangle$ CAUTION: Although the motor is not running there is dangerous voltage. Run Led will be lit during this process. Be careful to avoid damages and personal injury. |
| TBR | DC brake ON delay | Drive is applying a delay time before DC current injection is active. When this time is elapsed, the DC brake will be active. |
| IN1 | Inch speed 1 | SD700 is working according to inch speed 1 command and 'Start + Inch speed 1' mode is active. When operated in this mode the 'Start + Inch speed 1" command is dominant over other inputs programmed for "Starl" functionality. Therefore it one input is configured as 'Start' and it is deactivated; in spite of this deactivated input, the drive will start when 'Start + Inch speed $1^{\prime}$ command is received. This is also valid for Inch speed 2 and 3. |
| IN2 | Inch speed 2 | SD700 is working according to inch speed 2 command. 'Start + Inch speed 2' mode is active. |
| IN3 | Inch speed 3 | SD700 is working according to inch speed 3 command. 'Start + Inch speed 3' mode is active. |

### 8.3. List of Warning Messages

| Screen | Name | Description |
| :---: | :--- | :--- |
| MOL | Motor overload | This message will appear when motor thermal model is increasing the <br> estimated motor temperature. |
| MOC | Motor over-current | Motor current is higher than the rated current value. |
| DOC | Drive over-current | This message will appear if the output current is higher than 125\% of the <br> nominal current. |
| ILT | Current limitation | Current limit algorithm has been activated. |
| TLT | Torque limitation | Torque limit algorithm has been activated. |
| VLT | Voltage limitation | A high DC Link voltage level has been detected and the voltage limit control <br> algorithm has been activated to protect the drive. |
| ACO | Asymmetric current | Asymmetry in output currents of the drive has been detected. |
| AVO | Output voltage imbalance | Asymmetry in output voltage of the drive has been detected. |
| AVI | Input voltage imbalance | Asymmetry in input voltage of the drive has been detected. |
| OVV | High input voltage | Input voltage of the equipment is reaching a dangerous level. The value is <br> above the set value (protections settings). |
| UNV | Low input voltage | Input voltage of the equipment is reaching a dangerous level. The value is <br> below the set value (protections settings). |
| S1L | Speed limit 1 reached | Motor speed has reached speed limit 1. |
| S2L | Speed limit 2 reached | Motor speed has reached speed limit 2. |

## 9. VISUALIZATION AND STATUS PARAMETERS. GROUP GO

These parameters constantly indicate the input signal status and dynamic parameter status of the SD700. Visualization lines are the second and the third lines. The user can select the parameter to be displayed in each line from the different visualization options.

To select a display parameter you should move to the cursor to the second or third line. For this, you need to press ESC $/ \uparrow \downarrow$ key for two seconds approximately. The cursor moves from one line to the next. Once located on the second or third line you can navigate like the programming line (line 4) and select the desired parameter to be displayed. Once selected these parameters are saved into memory. These parameters are then displayed on lines 2 and 3 whenever the drive is powered up.

Thanks to these lines user can display desired parameters and obtain additional information easily


Figure 9.1 Visualization Lines Description

### 9.1. Parameters SV. 1 - Motor Visualization

| SV1.1 SPEEDREFERENCE |  |
| :---: | :---: |
| Screen | Sp Ref $=+\mathbf{0 0 0 \%}$ |
| Units | \% motor speed |
| Modbus address | 40162 |
| Modbus range | $8192=100 \%$ of motor rated speed |
| Read/Write | Read Only |
| Description | It shows the present reference value of speed which is applied to the motor. |
| SV1.2 MOTORSPEED |  |
| Screen | Mtr Speed $=+$ Orpm |
| Units | rpm |
| Modbus address | 40169 |
| Modbus range | Real Value = Modbus Value |
| Read / Write | Read Only |
| Description | It shows the motor speed in revs per minute. |

SV1.3 MOTOR FREQUENCY

| Screen | Mtr Freq $=+\mathbf{0 . 0 H z}$ |
| :--- | :--- |
| Units | Hz |
| Modbus address | $\mathbf{4 0 1 6 7}$ |
| Modbus range | Real Value $=$ Modbus Value |
| Read $/$ Write | Read Only |
| Description | It shows the operating frequency of the motor. |



| Screen | Mtr Vout $=0 \mathrm{~V}$ |
| :--- | :--- |
| Units | V |
| Modbus address | 40166 |
| Modus address | Real Value = Modbus Value |
| Read $/$ Write | Read Only |
|  |  |
| Description | It shows the present voltage applied to the motor. |


| SV1.5 MOTOR CURENT |  |
| :---: | :---: |
| Screen | Mtr lout $=0.0 \mathrm{~A}$ |
| Units | A |
| Modbus address | 40163 |
| Modbus range | Real Value $=($ Modbus Value $/ 10)$ |
| Read / Write | Read Only |
| Description | It shows the present current flowing to the motor. |


| SV1.6 HOTOR TORQUE |  |
| :---: | :---: |
| Screen | Mtr Torqe $=0.0 \%$ |
| Units | \% motor torque |
| Modbus address | 40164 |
| Modbus range | $8192=100 \%$ of motor rated torque |
| Read / Write | Read Only |
| Description | It shows the present torque applied to the motor. |

SV1.7 BOTOR POWER FACTOR

| Screen | Mtr Pfactr $=0.0$ |
| :--- | :--- |
| Units | - |
| Modbus address | 40168 |
| Modbus range | Real Value $=($ Modbus Value $/ 10)$ |
| Read $/$ Write | Read Only |
| Description | It shows the power factor of the motor. |


| SV1.8 | HAOTOR POWER CONSUMPTION |
| :--- | :--- |
| Screen Mtr Pwr $=+0.0 \mathrm{~kW}$ <br> Units kW |  |
| Modbus address 40165 <br> Modbus range Real Value $=($ Modbus Value / 10) <br> Read $/$ Write Read Only <br> Description It shows the instantaneous power consumption of the motor. |  |

SV1.9 CURRENT CONSUMPTION PER PHASE OF'THE MOTOR

| Screen Units | ${ }_{l}^{0.0 \mathrm{~A}} 00.0 \mathrm{~A} \quad 0.0 \mathrm{~A}$ |
| :---: | :---: |
| Modbus address | $40177 \rightarrow$ Phase U |
|  | $40178 \rightarrow$ Phase V |
|  | $40179 \rightarrow$ Phase W |
| Modbus range | Real Value $=($ Modbus Value $/ 10$ ) |
| Read / Write | Read Only |
| Description | It shows the instantaneous current of each phase of the motor ( $U, V$ and $W$ ). |

## SV1.10 VOLTAGE APPLIED TO THE MOTOR PHASES

| Screen | Vmt $=0 \quad 0 \quad$ OV |
| :--- | :--- |
| Units | $V$ |

SV1.11 HOTOR PTC CONNECTION

| Screen | PTC Motor $=\mathbf{0}$ |
| :--- | :--- |
| Units | - |
| Modbus address | $\mathbf{4 0 2 1 8}$ |
| Modbus range | 0 to 1 |
| Read $/$ Write | Read Only |
|  |  |
| Description | It shows if the motor PTC (temperature sensor) is connected. <br>  <br>  <br>  <br>  <br>  <br>  <br> X: PTC Connected <br> $0:$ PTC Not Connected |

SV1:12 MOTOR TEMAPERATURE

| Screen | Motor Temp $=0.0 \%$ |
| :---: | :---: |
| Units | \% motor heat |
| Modbus address | 40173 |
| Modbus range | $8192=100 \%$ of the motor temperature |
| Read / Write | Read Only |
| Description | It shows the estimated motor temperature. A level of $110 \%$ will cause an F25 trip (motor overload). |

### 9.2. Parameters SV. 2 - Drive Visualization

| SV2.1 VOLTAGE APPLIED TO THE DRIVE |  |
| :---: | :---: |
| Screen | 390390390 V |
| Units | $\checkmark$ |
| Modbus address | $40183 \rightarrow$ Phases RS |
|  | $40184 \rightarrow$ Phases ST |
|  | $40185 \rightarrow$ Phases RT |
| Modbus range | Real Value $=$ Modbus Value |
| Read / Write | Read Only |
| Description | It shows the input instantaneous voltage applied to the drive (RS, ST, RT). |
| SV2.2 AVERAGE INPUT VOLTAGE TO THE DRIVE |  |


| Screen | $\operatorname{lnp} \mathrm{Vol}=390 \mathrm{~V}$ |
| :--- | :--- |
| Units | V |
| Description | It shows the average input voltage to the drive. |

SV2.3 FREQUENCY OF THE INPUT VOLTAGE TO THE DRIVE

| Screen Units | $50.0 \quad 50.0$ | 50.0 Hz |
| :---: | :---: | :---: |
|  | Hz |  |
| Modbus address | $40159 \rightarrow$ | Phases RS |
|  | $40160 \rightarrow$ | Phases ST |
|  | $40161 \rightarrow$ | Phases RT |
| Modbus range | Real Value | $=($ Modbus Value / 10) |
| Read / Write | Read Only |  |
| Description | It shows the | e frequency of the input |

## SV2.4 DC LINK VOLTAGE OF THE DRIVE

| Screen | Bus vol =540V |
| :--- | :--- |
| Units | Vdc |
| Modbus address | 40171 |
| Modbus range | Real Value $=$ Modbus Value |
| Read $/$ Write | Read Only |
| Description | It shows DC Link voltage of the drive. |


| SV2.5 | IGBT TEMPERATURE |
| :--- | :--- |
| Screen | IGBT Temp $=+23^{\circ} \mathrm{C}$ |
| Units | ${ }^{\circ} \mathrm{C}$ |

## DRIVE TEMPERATURE

| Screen | Temp Equip $=+\mathbf{2 6}^{\circ} \mathrm{C}$ |
| :--- | :--- |
| Units | ${ }^{\circ} \mathrm{C}$ |
| Modbus address | $\mathbf{4 0 2 4 0}$ |
| Modbus range | Real Value $=($ Modbus Value $/ 100)$ |
| Read $/$ Write | Read Only |
| Description | It shows the temperature measured inside the electronics chamber of the drive. |

### 9.3. Parameters SV. 3 - External Visualization

## SV3.1 AVERAGE VALUE OF THE ANALOGUE INPUT 1

| Screen | ANLG IN1 $=+0.0 \mathrm{~V}$ |
| :--- | :--- |
| Units | Vor mA |
| Modbus address | $\mathbf{4 0 1 8 6}$ |
| Modbus range | Real Value $=($ Modbus Value $/ 1000)$ |
| Read $/$ Write | Read Only |
|  |  |
| Description | It shows the value of Analogue Input 1. |

## SV3.2 REFERENCE VALUE OF THE ANALOGUE INPUT 1

| Screen | AIN1 Refr $=+0.00 \%$ |
| :--- | :--- |
| Units | $\%$ bottom scale Al1 |
| Modbus address | 40190 |
| Modbus range | $8192=100 \%$ maximum range of the Analogue Input 1 |
| Read $/$ Write | Read Only |
| Description | It shows the value or the PID reference proportional to Analogue Input 1 in percentage. |

## SV3. 3 VALUE OF THE SENSOR 1 ASSOCIATED TO THE AI1

| Screen | AlN1 $\mathbf{S}=+0.001 / \mathbf{s}$ |
| :--- | :--- |
| Units | Engineering units |
| Modbus address | $\mathbf{4 0 2 6 2}$ |
| Modbus range | Real Value = (Modbus Value / 10) |
| Read $/$ Write | Read Ônly |
| Description | It shows the value of sensor 1 associated to the Analogue Input 1. |


| AVERAGE VALUE OF THE ANALOGUE INPUT 2 |  |
| :---: | :---: |
| Screen | ANLG ${ }^{\text {IN2 }}=+0.0 \mathrm{~V}$ |
| Units | $V$ or mA |
| Modbus address | 40187 |
| Modbus range | Real Value $=($ Modbus Value $/ 1000)$ |
| Read / Write | Read Only |
| Description | It shows the value of the Analogue Input 2. |
| SV3.5 RE | ERENCE VALUE OF THE ANALOGUE INPUT 2 |


| Screen | AlN2 Refr $=+\mathbf{0 . 0 0 \%}$ <br> $\%$ bottom scale Al2 |
| :--- | :--- |
| Units |  |
| Modbus address | $\mathbf{4 0 1 9 1}$ |
| Modbus range | $8192=100 \%$ maximum range of the Analogue Input 2 |
| Read $/$ Write | Read Only |
| Description | It shows the value or the PID reference proportional to the Analogue Input 2 signal. |


| SV3.6 | VALUE OF THE SENSOR 2 ASSOCIATED TO.THE A2 |
| :--- | :--- |
| Screen | AIN $2 \mathbf{S}=+0.00 \mathrm{Bar}$ |
| Units | Engineering units |
| Modbus address | $\mathbf{4 0 2 6 3}$ |
| Modbus range | Real Value $=($ Modbus Value $/ 10)$ |
| Read $/$ Write | Read Only |
| Description | It shows the value of sensor 2 associated to the Analogue Input 2. |

SV 3.7 ANALOGUE OUTPUT 1 VALUE

| Screen | ANL OUT1 $=+4.0 \mathrm{~mA}$ |
| :--- | :--- |
| Units | Vor mA |
| Modbus address | $\mathbf{4 0 1 9 2}$ |
| Modbus range | Real Value $=($ Modbus Value $/ 1000)$ |
| Read $/$ Write | Read Only |
| Description | It shows the value of Analogue Output 1. |




| Screen | AOUT2 Refer $=+\mathbf{0} .0 \%$ |
| :---: | :---: |
| Units | \% associated magnitude |
| Modbus address | 40195 |
| Modbus range | $8192=100 \%$ maximum range of the Analogue Output 2 |
| Read / Write | Read Only |
| Description | It shows the magnitude value associated to the Analogu |


| SV3.11 STATUS OF DIGITAL INPUTS |  |
| :---: | :---: |
| Screen | Input DG: 000000 0 |
| Units | - |
| Modbus address | 40196 |
| Modbus range | $\mathrm{LSB} \rightarrow \mathrm{BITO} \rightarrow \mathrm{MFI1}$ |
|  | BIT6 $\rightarrow$ PTC |
|  | 0 to 1 |
| Read / Write | Read Only |
| Description | It shows whether the Digital Inputs are activated or not, from DI1 to DI6. The final is another input which shows the status of the motor PTC signal. |
|  | X : Active |
|  | $0:$ Not Active |

SVV.12 STATUS OF OUTPUT RELAYS

| Screen | Relays: X 0 X |
| :--- | :--- |
| Units | - |
| Modbus address | 40197 |
| Modbus range | BIT $0 \rightarrow$ R1; Range from 0 to 1 <br>  <br>  <br>  <br> BIT $1 \rightarrow$ R2; Range from 0 to 1 |
| Read $/$ Write | Read Only; Range from 0 to 1 |
|  |  |
| Description | It shows whether the output relays are activated or not. |
|  | X Active |
|  | $0:$ Not Active |


| SV3.13 | MACHINE SPEED ASSOCLATED TO THE MOTOR |
| :--- | :--- |
| Screen Speed $M=+0.000 \mathrm{~m} / \mathrm{s}$ <br> Units Depending on configuration  <br> Modbus address - (This parameter is not accessible through Modbus communication) <br> Description It shows the speed of the motor in engineering units. Pressing <br> to the following sub-parameters of configuration: |  |


| Screen | Range | Description |  |
| :---: | :---: | :---: | :---: |
| Scale ftr $=1$ | 0.001-10 | To set the ratio factor between motor speed and machine speed. |  |
| Units $\mathrm{Ma}=\mathrm{m} / \mathrm{s}$ | $\mathrm{m} / \mathrm{s}$ <br> $\mathrm{m} / \mathrm{m}$ <br> $\mathrm{cm} / \mathrm{s}$ <br> $\mathrm{cm} / \mathrm{m}$ <br> v/s <br> v/m | It allows selection of the units to be displayed. |  |
|  |  | Unts | Description |
|  |  | $\mathrm{m} / \mathrm{s}$ | Meters / second |
|  |  | $\mathrm{cm} / \mathrm{s}$ | Centimeters / second |
|  |  | cm/m | Centimeters/minute |
|  |  | v/s | Turns/second |
|  |  | $\mathrm{v} / \mathrm{m}$ | Turns / minute |

Note: They both are settable during run.

### 9.4. Parameters SV. 4 - Internal Visualization

| SV4.1 | ACTUAL.FAULT |
| :--- | :--- |
| Screen | Actual Fault $=00$ |
| Units | - |
| Modbus address | $\mathbf{4 0 2 3 5}$ |
| Modbus range | Fault Number |
| Read / Write | Read Only |
| Description | It shows the present code fault. See fault history 'G13 FAULT HISTORY'. |


| SV4:2 | DRIVE RATED CURRENT |
| :--- | :--- |
| Screen | Drive Curr $=170 \mathrm{~A}$ |
| Units | A |
| Modbus address | $\mathbf{4 0 2 0 9}$ |
| Modbus range | Real Value $=($ Modbus Value $/ 10)$ |
| Read $/$ Write | Read Only |
| Description | It shows the drive rated current (maximum current of the equipment at $50^{\circ} \mathrm{C}$ ). |


| SV4.3 $\quad$ DRIVERATED VOLTAGE |  |
| :--- | :--- |
| Screen | Drive Volt $=400 \mathrm{~V}$ |
| Units | V |
| Modbus address | $\mathbf{4 0 2 1 0}$ |
| Modbus range | Real Value $=($ Modbus Value / 10) |
| Read $/$ Write | Read Only |
| Description | It shows the drive rated voltage. |

$\square$

| Screen | S/W x.xx |
| :--- | :--- |
| Units | - |
| Modbus address | 40206 |
| Modbus range | Real Value = Modbus Value |
| Read / Write | Read Only |
|  |  |
| Description | It shows the software version installed into the equipment. |


| SV4.5 | HARDWARE VERSION |
| :--- | :--- |
| Screen | HW Y.y |
| Units | - |
| Modbus address | $\mathbf{4 0 2 0 7}$ |
| Modbus range | Real Value $=($ Modbus Value $/ 100)$ |
| Read $/$ Write | Read Only |
| Description | It shows the hardware version of the equipment. |


| SV4. 6 | PID REFERENCE VALUE |
| :--- | :--- |
|  | PID R\% $=+0.0 \%$ |
| Screen | $\%$ feedback range |
| Units | 40204 |
| Modbus address | $8192=100 \%$ maximum range of the Analogue Input |
| Modbus range | Read Only |
| Read $/$ Write |  |
| Description | it shows the reference value in PID mode of the equipment standard program. |

SV4.7 PID FEEDBACK VALUE

| Screen | PID F\% $=+\mathbf{0 . 0 \%}$ |
| :--- | :--- |
| Units | $\%$ Al used as feedback |
| Modbus address | $\mathbf{4 0 2 0 5}$ |
| Modbus range | $8192=100 \%$ maximum range of the Analogue Input <br> Read $/$ Write |
| Read Only |  |
| Description | It shows the feedback value in PID mode of the equipment standard program. |


| SV4.8 | PID ERROR VALUE |
| :--- | :--- |
|  | PID Error $=+0.0 \%$ |
| Screen | \% feedback range |
| Units | $\mathbf{4 0 2 0 3}$ |
| Modbus address | $8192=100 \%$ maximum range of the Analogue Input |
| Modbus range 8 <br> Read $/$ Write  | Read Only |
|  |  |
| Description | It shows the error value in PID mode, that means, the difference between the <br> reference value and the real value of the system feedback signal. |
|  |  |

## SV4.9 STATUS OE COMPARATORS

| Screen | Comparators: 000 |
| :--- | :--- |
| Units | - |
| Modbus address | $\mathbf{4 0 2 3 2} \rightarrow$ Comparator 1 |
|  | $\mathbf{4 0 2 3 3} \rightarrow$ Comparator 2 |
|  | $\mathbf{4 0 2 3 4} \rightarrow$ Comparator 3 |
| Modbus range | 0 to 1 |
| Read / Write | Read Only |
| Description | It shows if comparators are activated or not. |
|  | X: Active |
|  | $0:$ Not Active. |

### 9.5. Parameters SV. 5 - Programmable Parameters

This group is not only a display group. Some parameters such as speed, pressure and inch speeds can be adjusted in this group. These parameters are also available in their corresponding parameter groups. This is a simple way to allow user adjustment of basic parameters without entering the main programming groups.

```
SV5:1 SPEED REFERENCEIN LOCAL HODE ,
\begin{tabular}{ll} 
Screen & \begin{tabular}{l} 
Local \(\mathbf{S p}=+\mathbf{1 0 0 \%}\) \\
Units
\end{tabular} \\
\begin{tabular}{ll} 
U motor speed
\end{tabular} \\
Modbus address & \(\mathbf{4 0 1 2 4}\) \\
Modbus range & \(-250 \%=-20480\) to \(+250 \%=20480\) \\
Read \(/\) Write & YES
\end{tabular}
Description It shows the speed reference value in local mode (introduced by keypad). See parameter ' \(\mathrm{G} 3.3 \rightarrow\) Local speed reference' for additional data.
```

SV5.2 PID REFERENCEIN LOCAL MODE

| Screen <br> Units | PID Local $=+\mathbf{1 0 0 \%}$ <br> $\%$ feedback |
| :--- | :--- |
| Modbus address | $\mathbf{4 0 1 4 9}$ |
| Modbus range | $0.0 \%=0$ to $400 \%=32760$ |
| Read / Write | YES |
| Description | It allows user to select the PID reference in local mode. See parameter 'G6.2 $\rightarrow$ PID <br> local reference' for additional data. |

SV5.3 MULTI-REFERENCE 1

| Screen | Mref1 $=+10.0 \%$ <br> Units |
| :--- | :--- |
| $\%$ motor speed |  |

SV5.4 BUULI-REFERENCE 2

| Screen | Mref2 $=\mathbf{+ 2 0 . 0 \%}$ <br> $\%$ motor speed |
| :--- | :--- |
| Units | \% |
| Modbus address | $\mathbf{4 0 0 5 3}$ |
| Modbus range | $-250 \%=-20480$ to $+250 \%=20480$ |
| Read $/$ Write | YES |
| Description | It allows user to set the speed value assigned to Multi-reference 2. See parameter |
|  | 'G14.2 $\rightarrow$ Multi-reference 2' for additional data. |


| SV5.5 | MULTI-REFERENCE 3 |
| :--- | :--- |
|  |  |
| Screen | Mref3 $=+30.0 \%$ |
| Units | $\%$ motor speed |
| Modbus address | 40054 |
| Modbus range | $-250 \%=-20480$ to $+250 \%=20480$ |
| Read $/$ Write | YES |
|  |  |
| Description | It allows user to set the speed value assigned to Multi-reference 3. See parameter |
|  | 'G14.3 $\rightarrow$ Multi-reference 3 ' for additional data. |

## SV5.6 MULTI-REFERENCE 4

| Screen | Mref4 $=+\mathbf{4 0 . 0 \%}$ |
| :--- | :--- |
| Units | $\%$ motor speed |
| Modbus address | $\mathbf{4 0 0 5 5}$ |
| Modbus range | $-250 \%=-20480$ to $+250 \%=20480$ |
| Read $/$ Write | YES |
| Description | It allows user to set the speed value assigned to Multi-reference 4. See parameter |
|  | 'G14.4 $\rightarrow$ Multi-reference 4' for additional data. |

## SV5.7 MULTI-REFERENCE 5

| Screen | Mref5 $=+50.0 \%$ |
| :--- | :--- |
| Units | $\%$ motor speed |
| Modbus address | $\mathbf{4 0 0 5 6}$ |
| Modbus range | $-250 \%=-20480$ to $+250 \%=20480$ |
| Read $/$ Write | YES |
| Description | It allows user to set the speed value assigned to Multi-reference 5. See parameter <br>  <br>  <br> 'G14.5 $\rightarrow$ Multi-reference 5' for additional data. |

## SV5.8 MULTI-REFERENCE 6

| Screen | Mref6 $=+\mathbf{6 0 . 0 \%}$ |
| :--- | :--- |
| Units | $\%$ motor speed |
| Modbus address | $\mathbf{4 0 0 5 7}$ |
| Modbus range | $-250 \%=-20480$ to $+250 \%=20480$ |
| Read $/$ Write | YES |
| Description | It allows user to set the speed value assigned to Multi-reference 6. See parameter <br>  |
|  | 'G14.6 $\rightarrow$ Multi-reference 6' for additional data. |

SV5.9 MULTI-REFERENCE 7

| Screen | Mref7 $=+\mathbf{7 0 . 0 \%}$ |
| :--- | :--- |
| Units | $\%$ motor speed |
| Modbus address | $\mathbf{4 0 0 5 8}$ |
| Modbus range | $-250 \%=-20480$ to $+250 \%=20480$ |
| Read $/$ Write | YES |
|  |  |
| Description | It allows user to set the speed value assigned to Multi-reference 7. See parameter |
|  | 'G14.7 $\rightarrow$ Multi-reference 7' for additional data. |


| SV5.10 IN | SPEED 1 |
| :---: | :---: |
| Screen | Inch Spd1 = 0.00\% |
| Units | \% motor speed |
| Modbus address | 40092 |
| Modbus range | $-250 \%=-20480$ to $+250 \%=20480$ |
| Read / Write | YES |
| Description | It allows user to set the step frequency 1 value. See parameter ' $G 15.1 \rightarrow$ Inch speed $1^{\prime}$ for additional data. |


| SV5.11 | InCH SPEED 2 |
| :--- | :--- |
| Screen Spd2 $=\mathbf{0 . 0 0 \%}$ | Inch <br> $\%$ motor speed |
| Units |  |
| Modbus address | $\mathbf{4 0 0 9 3}$ |
| Modbus range | $-250 \%=-20480$ to $+250 \%=20480$ |
| Read $/$ Write | YES |
| Description | It allows user to set the step frequency 2 value. See parameter ' $\mathrm{G} 15.2 \rightarrow$ Inch speed |
|  | 2 ' for additional data. |


| SV5.12 | NCH SPEED 3 |
| :--- | :--- |
| Screen | Vel Fija3 $=0.00 \%$ |
| Units | \% motor speed |
| Modbus address | $\mathbf{4 0 0 9 4}$ |
| Modbus range | $-250 \%=-20480$ to $+250 \%=20480$ |
| Read $/$ Write | YES |
| Description | It allows user to set the step frequency 3 value. See parameter 'G15.3 $\rightarrow$ Inch speed  <br>  3' for additional data. |

SV5:13 LOCAL MANUAL SPEED REFERENCE

| Screen | PMP manSP $=+\mathbf{0}$. $0 \%$ |
| :---: | :---: |
| Units | \% motor speed |
| Modbus address | 42042 |
| Modbus range | $-250 \%=-20480$ to $+250 \%=20480$ |
| Read / Write | YES |
| Description | To set the value of the manual speed reference in local. For additional details, check parameter ' $\mathrm{G} 25.1 .3 \rightarrow$ Value of speed reference for LOCAL source in manual mode', |

SV5.14: LOCAL SETPOINT 1 FOR:PID
\(\left.\begin{array}{ll}Screen \& PMP MRe1=\mathbf{0 . 0 \%} <br>

Units \& \% motor speed\end{array}\right]\)| Modbus address | $\mathbf{4 2 1 5 1}$ |
| :--- | :--- |
| Modbus range | $0-32760$ |
| Read / Write | YES |


| SV5.15 | LOCAL SETPOINT 2 FOR PID |
| :--- | :--- |
| Screen | PMP MRe2 $=0.0 \%$ |
| Units | $\%$ motor speed |

## SV5.16 LOCAL SETPOINT 3 FOR PID

| Screen | PMP MRe3 $=\mathbf{0 . 0 \%}$ |
| :--- | :--- |
| Units | \% motor speed |
| Modbus address | $\mathbf{4 2 1 5 3}$ |
| Modbus range | $0-32760$ |
| Read $/$ Write | YES |
| Description | To set the local setpoint 3 for PID. Multi-reference 3. For additional details, check <br> parameter 'G25.1.7 $\rightarrow$ Local setpoint 3 for PID'. |

SV5.17 LOCAL SETPOINT4 FOR PID

| Screen | PMP MRe4 $=0.0 \%$ |
| :--- | :--- |
| Units | $\%$ motor speed |
| Modbus address | 42154 |
| Modbus range | $0-32760$ |
| Read / Write | YES |
| Description | To set the local setpoint 4 for PID. Multi-reference 4. For additional details, check <br> parameter 'G25.1.8 $\rightarrow$ Local setpoint 4 for PID'. |

SV5.18 LOCAL SETPOINT 5 FOR PID
\(\left.\begin{array}{ll}Screen \& PMP MRe5=0.0 \% <br>

Units \& \% motor speed\end{array}\right]\)| Modbus address | $\mathbf{4 2 1 5 5}$ |
| :--- | :--- |
| Modbus range | $0-32760$ |
| Read / Write | YES |
| Description | To set the local setpoint 5 for PID. Multi-reference 5. For additional details, check <br> parameter 'G25.1.9 $\rightarrow$ Local setpoint 5 for PID'. |

## SV5.18 LOCAL SETPOINT 6 FOR PID

| Screen | PMP MRe6 $=0.0 \%$ |
| :--- | :--- |
| Units | $\%$ motor speed |
| Modbus address | $\mathbf{4 2 1 5 6}$ |
| Modbus range | $0-32760$ |
| Read / Write | YES |
| Description | To set the local setpoint 6 for PID. Multi-reference 6. For additional details, check <br> parameter 'G25.1.10 $\rightarrow$ Local setpoint 6 for PID'. |

## SV5.20 LOCAL SETPOINT 7 FOR PID

| Screen | PMP MRe7 $=0.0 \%$ |
| :--- | :--- |
| Units | $\%$ motor speed |
| Modbus address | $\mathbf{4 2 1 5 7}$ |
| Modbus range | $0-32760$ |
| Read / Write | YES |
| Description | To set the local setpoint 7 for PID. Multi-reference 7. For additional details, check <br> parameter 'G25.1.11 $\rightarrow$ Local setpoint 7 for PID'. |


| SV5.21 | LOCAL SETPOINT 8 FOR PID |
| :--- | :--- |
| Screen | PMP MRe8 $=0.0 \%$ |
| Units | $\%$ motor speed |
| Modbus address | $\mathbf{4 2 1 5 8}$ |
| Modbus range | $0-32760$ |
| Read $/$ Write | YES |
| Description | To set the local setpoint 8 for PID. Multi-reference 8. For additional details, check <br> parameter 'G25.1.12 $\rightarrow$ Local setpoint 8 for PID'. |


| SV5.22 | TIAE FOR AUTOMATIC STOP |
| :--- | :--- |
| Screen | T AutOFF $=$ OFF |
| Units | Hours |
| Modbus address | 42044 |
| Modbus range | $0-999$ |
| Read $/$ Write | YES |
| Description | Time for Automatic Stop. For additional details, check parameter G25.1.13 |


| SV5.23 R | AANING. TIME FOR AUUTOMATIC STOP |
| :---: | :---: |
| Screen | TIME OFF $=$ OFF |
| Units | Minutes |
| Modbus address | 42356 |
| Modbus range | 0-6000 |
| Read / Write | Read Only |
| Description | It shows the remaining time in minutes, for the automatic stopping of the system. |
| SV5.24 MAXMUMELOW LEVEL |  |
| Screen | MAX flow $=10001 / \mathrm{s}$ |
| Units | Engineering units |
| Modbus address | 42143 |
| Modbus range | 0-32760 |
| Read / Write | YES |
| Description | It allows setting a level for the maximum flux as in parameter 'G25.10.2 $\rightarrow$ Maximum allowed flow. |


| SV5.25 RE | T LEVEL FOR THE FLOW CONTROL ALGORITHM |
| :---: | :---: |
| Screen | RESET LEVL $=+100 \%$ |
| Units | \% maximum range of sensor |
| Modbus address | 42145 |
| Modbus range | 0-100 |
| Read / Write | YES |
| Description | It allows setting a reset level for the flux control algorithm as in parameter 'G25.10.4 $\boldsymbol{\rightarrow}$ Flow percentage to reset algorithm'. |
| SV5.26 FLOW LEVEL FOR SLEEP MODE |  |
| Screen | SLEP FLO $=0.01 / \mathrm{s}$ |
| Units | Engineering units |
| Modbus address | 42324 |
| Modbus range | 0-32760 |
| Read / Write | YES |
| Description | It allows setting a flow level to sleep the drive (sleep mode) as in parameter 'G25.4.11 $\rightarrow$ Flow level to sleep the drive'. |

### 9.6. Parameters SV. 6 - Registers

This group includes several registers of general information about the drive use. Therefore, we can visualize a total and partial counter for running time (RUN)


| SV6.2 PARTIAL TIME OF RUNNING.RUN) |  |
| :---: | :---: |
| Screen | PAR $=$ d h |
| Units | Days and Hours |
| Modbus address | $40552 \rightarrow$ Days |
|  | $40553 \rightarrow$ Hours |
| Modbus range | Days $\rightarrow$ Real Value $=$ Modbus Value |
|  | Hours $\rightarrow 1=0.1$ hours |
| Read / Write | Read Only |
| Description | It shows the partial time during which the drive is running (RUN). |
| SV6.3 RESETIFOR PARTIAL TIME COUNTER OF RUNNING (RUN) |  |
| Screen | CLEAR PARTIAL $=\mathrm{N}$ |
| Units | - |
| Modbus address | 40554 |
| Modbus range | 0 to $1(\mathbf{N}=0, Y=1)$ |
| Read / Write | YES |
| Description | It allows resetting the counter of partial time for running status (RUN). |

### 9.7. Parameters SV. 8 - Pump Control

| 8.1 VALUES OF PID REFERENCE AND FEEDBACK |  |
| :---: | :---: |
| Screen | $\mathrm{R}=0.0 \mathrm{Bar} \quad 0.0 \mathrm{Bar}$ |
| Units | Engineering units |
| Modbus address | $42007 \rightarrow$ PID reference (left hand) |
|  | $42009 \rightarrow$ Feedback signal (right hand) |
| Modbus range | Real Value $=$ (Modbus Value $/ 10$ ) |
| Read / Write | Read Only |
| Description | It shows the PID reference value (left hand) and the sensor value which is sent by the feedback signal (right hand). |

## SV8.2 DRIVE STATUS DURING PUMAP CONTROL



| Status | Description |
| :--- | :--- |
| REGL | Drive is regulating in PID mode. |
| PMAN | The drive is at protected manual mode. |
| OMAN | Drive is in manual mode, not protective mode. |
| HIPP | Drive is stopped (pause) due to high pressure, according to the read <br> data in the analogue input. |
| HIPR | A fault due to high pressure has occurred according to the read data <br> in the analogue input or in the digital input. |
| FLOD | The drive has stopped (Pause status) due to No Flow detection. |
| NFLO | The drive has tripped (Fault status) due to No Flow detection. |
| CAVS | The drive has stopped (Pause status) due to Cavitation. |
| CAVI | The drive has tripped (Fault status) due to Cavitation. |
| LOPR | The drive has tripped due to low pressure fault. |
| LOWA | The drive has tripped due to a fault detected in one of the digital <br> inputs configured as 'No Water' |
| CYCL | The drive has tripped due to excessive starting cycles. |
| IRFA | The drive has tripped due to a fault in the irrigation equipment which <br> has been detected in the digital input configured in that option. |
| FLOW | The drive is limiting the speed to limit the flow. |
| OFF | The drive has received the stop command. |


| Status | Description |
| :---: | :--- |
| SLEP | The drive is in sleep mode because there is no flow demand. |
| BYPA | The drive is forcing the speed after starting or stopping some of the <br> fixed pumps. |
| RAMP | Setpoint ramp activated. |
| FILL | The drive is running at reduced speed because Pipe Fill function is <br> active. |
| COMP | The time of automatic stop has expired and the drive is stopped. |
| JOCK | The Jockey pump is running. |
| PRIM | Priming pump is connected. |
| FINP | Fault occurred because the pressure switch is open. |

Additionally, the reference in PID mode (as \%) followed by feedback (as \%) is shown.

SV8.3-STATUS OF FIXED PUMPS 1, 2 AND 3


| Status | Description |
| :---: | :--- |
| OFF | Pump disabled by keypad. |
| RDY | Pump ready to start. |
| ON | Pump started. |
| FLT | Pump in a fault status (input which controls the signal is <br> active). <br> Note: See digital input configuration (parameter 'G4.1.4 $\rightarrow$ <br> Selection of digital inputs configuration') in Pump Control <br> mode (parameter 'G1.7 $\rightarrow$ Program activation', option <br> 'PUMP'). |



## SV8.5 READ FLOW.VALUE

| Screen | Flow $=0.01 / \mathbf{s}$ |
| :--- | :--- |
| Units | Engineering units |
| Modbus address | $\mathbf{4 2 1 4 2}$ |
| Modbus range | Real Value $=($ Modbus Value $/ 10)$ |
| Read $/$ Write | Read Only |
| Description | It shows the present value read by the analogue input or by pulse input where sensor <br> is connected. |


| SV8. 6 | STATUS OF PUMP PROGRAB |
| :--- | :--- |
| Screen | ESTATUS PUMP PROGRAM |
| Units | - |
| Modbus address | 42002 |
| Modbus range | 0 to 22 |
|  | (See 'Modbus range' in parameter SV8.2) |
| Read / Write | Read Only |
|  | In the visualization lines of the display, it is possible to select this option. In this way <br> the following messages are going to be shown according to the current program <br> status: |


| Status | Description |
| :---: | :---: |
| PID REGULATION | Drive is regulating in PID mode. |
| PROTECTED MANUAL | The drive is at protected manual mode. |
| OVERRIDE MANUAL | Drive is in manual mode, not protective mode. |
| HI PRESSURE PAUS | Drive is stopped (pause) due to high pressure, according to the read data in the analogue input. |
| HI PRESSURE FAUL | A fault due to high pressure has occurred according to the read data in the analogue input or in the digital input. |
| NO FLOW PAUSE | The drive has stopped (Pause status) due to No Flow detection. |
| NO FLOW FAULT | The drive has tripped (Fault status) due to No Flow detection. |
| CAVITATION PAUSE | The drive has stopped (Pause status) due to Cavitation. |
| CAVITATION FAULT | The drive has tripped (Fault status) due to Cavitation. |
| LO PRESSURE FAUL | The drive has tripped due to low pressure fault. |
| LO WATER FAULT | The drive has tripped due to a fault detected in one of the digital inputs configured as 'No Water' |
| CYCLING FAULT | The drive has tripped due to excessive starling cycles. |
| IRRIGATOR FAULT | The drive has tripped due to a fault in the irrigation equipment which has been delected in the digital input configured in that option. |
| LIMITING FLOW | The drive is limiting the speed to limit the flow. |
| PUMP STOP | The drive has received the stop command. |
| SLEPT NO DEMAND | The drive is in sleep mode because there is no flow demand. |
| BYPASSING SPEED | The drive is forcing the speed after starling or stopping some of the fixed pumps. |
| SETPOINT RAMP | Setpoint ramp activated. |
| PIPE FILLING | The drive is running at reduced speed because Pipe Fill function is active. |
| COMPLETED | The time of automatic stop has expired and the drive is stopped. |
| JOCKEY PUMP ON | The Jockey pump is running. |
| PRIMING PUMP ON | The Priming pump (suction filling) is connected. |
| PRESSU SWITCH ON | The pressure switch is open. |

## 10.DESCRIPTION OF PROGRAMMING PARAMETERS

The different parameters of the SD700 are displayed in the alphanumeric LCD. These parameters are organized in groups ( G 1 to G 25 ). To access to the parameters or sub-groups which are in a lower level, press the ${ }^{*}$ key. When you have accessed the desired parameter, this parameter will be shown as either a numerical value or a list of possible options


Figure 10.1 Detail of Programming Line.

See the information below for the whole parameter list and possible options of configuration.


Figure 10.2 Parameters structure from group G1 to group G3


SO7OITG00558I

Figure 10.3 Parameters structure of subgroup S4.1 (G4)


Figure 10.4 Parameters structure from subgroup S4.2 (G4) to subgroup S4.3(G4)


Figure 10.5 Parameters structure from subgroup S4.3 (G4) to group G7


Figure 10.6 Parameters structure from group G7 to subgroup S8.1 (G8)


Figure 10.7 Parameters structure from subgroup S8.1 (G8) to subgroup S8.2 (G8)


Figure 10.8 Parameters structure from subgroup $S 8.2$ (G8) to subgroup 59.1 subgroup (G9)


Figure 10.9 Parameters structure from subgroup S9.2 (G9) to subgroup S9.3 (G9)


SD70ITG0062CI

Figure 10.10 Parameters structure from subgroup G10 to group G11


SD70ITG0063AI

Figure 10.11 Parameters structure from group G12 to group G14


SD70ITG0064CI

Figure 10.12 Parameters structure from group G15 to subgroup S19.3 (G19)


Figure 10.13 Parameters structure from group G20 to subgroup S25.1 (G25)


Figure 10.14 Parameters structure from subgroup S25.1 (G25) to subgroup S25.4 (G25)


Figure 10.15 Parameters structure from subgroup S25.4 (G25) to subgroup S25.6 (G25)


Figure 10.16 Parameters structure from subgroup S25.6 (G25) to subgroup S25.9 (G25)


Figure 10.17 Parameters structure from subgroup S25.9 (G25) to subgroup S25.11 (G25)

### 10.1. Group 1 - G1: Options Menu



## $2 \rightarrow$ TOTAL LOCK

When the total lock of the parameters is activated, we can only modify parameters G1.1 and G1.2 until the password is introduced again to unlock parameters.

| G1.2 ACCESSPASSWORD |  |
| :---: | :---: |
| Screen | 2 PASSWORD__OFF |
|  | 2 PASSWORD___? OFF |
| Description | Access password |
| Range | OFF, 0000 to 9999 |
| Default value | 0 |
| Set on run | YES |
| Function | It allows user to introduce an access password to lock parameters and avoid unauthorized changes in the programming. |
|  | If we select option ' $1 \rightarrow$ PARTIAL LOCK' or ' $2 \rightarrow$ TOTAL LOCK' in parameter ' $\mathrm{G} 1.1 \rightarrow$ PARAMETERS LOCK', this screen appears automatically to request the introduction of the access password: |

Parameters lock is executed when we introduce the password and this one is memorized after elapsing a few seconds.

To unlock parameters setting you should access to the parameter G 1.1 and select option ' $0 \rightarrow$ NO'. Next, this screen appears automatically to request the introduction of the access password:

2 PASSWORD $\qquad$ ?OFF

Parameters unlock is executed once the password is introduced and after elapsing a few seconds. This password is the same one used for locking parameters.

| G1.2b | OCK PASSWORD RECOVERY |
| :---: | :---: |
| Screen | 3 PSW ERR = XXXX |
| Description | Recovery of the unlock password (access) |
| Range | 0000 to 9999 |
| Default value | 0000 |
| Set on run | YES |
| Function | It supplies information to recover the introduced lock password, according to the expression: |

Unlock password=(XXXX / 2) - 3
Note: This parameter appears when an incorrect password is introduced to unlock parameters.

## G1.4 LANGUAGE SELECTION

| Screen | 4 LANG = ESPANOL |
| :--- | :--- |
| Description | Selection of the user language |
| Range | ENGLISH |
|  | ESPANOL |
| DEUTSCH |  |
| Default value | ESPANOL <br> Set on run |
| NO |  |
| Function | It allows user to select the language. All of the screens (parameters and configurable <br> options for each parameter) will appear in the language selected by user. |
|  |  |

## G1.5_PARAAAETERS INITIALIZE

| Screen | $\mathbf{5}$ INITIALISE $=\mathbf{0}$ |
| :--- | :--- |
| Description | Parameters initialize to default values |
| Range | $0-3$ |
|  | (See 'Function' for additional information) |
| Default value | 0 |
| Set on run | NO |

Function It allows selecting the parameters that we desire to initialize back to the factory default values (factory settings)

Options description:
$0 \rightarrow \mathrm{NO} \operatorname{IN} \mid T$
Any parameter is initialized.
$1 \rightarrow$ USR PRMTR
User parameters are only initialized, this is, all of the parameters groups, except for the groups G2 MOTOR NAMEPLATE DATA and G19 FINE TUNING.
$2 \rightarrow$ MTR PRMTR
Motor data are only initialized, this is, parameters of the groups G2 and G19.
$3 \rightarrow$ ALL PRMTR
All parameters of the drive are initialized.

| G1.6 TO HIDE SOME CONFIGURATION MENUS |  |
| :--- | :--- |
| Screen | 6 SHORT Menu = NO |
| Description | To hide some configuration menus |
| Range | NO |
|  | YES |
| Default value | NO |
| Set on run | NO |
| Function |  |
|  | When this parameter is active, configuration menus are hidden. Groups G1 OPTIONS |
|  | MENU, G10 LIMITS, and Visualization groups are only visible. |

G1.7 PROGRABACTIVATION

| Screen | 7 PROG $=$ STANDARD |
| :--- | :--- |
| Description | Program activation |
| Range | STANDARD |
|  | PUMP |
| Default value | STANDARD |
| Set on run | NO |

Function It allows selecting additional functionalities. If option PUMP is selected, the extended functionality for the pump control (G25 PUMP CONTROL) will be available.

The group G25 will be hidden if the pump program is not active. Once selected the pump program, a character will appear in the upper line of the display, beside the drive status, indicating constantly that the pump program is active. The letter " b " appears in Spanish and the letter " $p$ " for English / German.

The most of parameters relative to the pump control are located in group G25, except for those settings relative to inputs and outputs that can be found in groups G4 and G7

Additionally, there are some visualization screens included in visualization groups SV. 5 and SV. 8
$\bigwedge$ WARNING: The activation of pump program changes the inputs and outputs configuration of the equipment automatically. See parameter 'G4.1.4 $\rightarrow$ Selection of Digital Input configuration' for additional information. Output relays are also configured automatically (see 'S8.1 Output Relays'). Make sure there is not a hazard of accidental starting to avoid property damage or personal injury.

### 10.1.1. Subgroup 1.10 - S1.10: Eloader (EEPROM loader)

| G1.10.1 SAVE PARAMETERS FROA DRIVE TO DISPLAY |  |
| :---: | :---: |
| Screen | UPLOAD $=\mathbf{N}$ |
| Description | Save parameters from the drive to the display unit |
| Range | $N$ |
|  | Y |
| Default value | N |
| Set on run | NO |
| Function | When this parameter is set to ' $Y$ ', the parameters copy to the display starts automatically, saving the drive configuration. It exists one sub-screen that shows the load process: |
|  | UPLOADING....100\% |
|  | When the load process is finished, this sub-screen disappears and 'UPLOAD $=N$ ' is displayed again. |

## G1.10.2 SAVE PARAMETERS FROM DISPLAY TO DRIVE

| Screen | DOWNLOAD = N |
| :--- | :--- |
| Description | Save parameters from the display unit to the drive |
| Range | N |
| Default value | Y |
| Set on run | NO |
| Function | When this parameter is set to ' $Y$ ', the copy of the parameters (stored into the display) <br> to the drive starts automatically, modifying and programming the parameters of this <br> new drive. It exists one sub-screen that shows he unload process: |
|  |  |

DOWNLOADING.... $100 \%$
When the unload process is finished, this sub-screen disappears and 'DOWNLOAD $=\mathrm{N}$ ' is displayed again.

## G1.11 DRIVE FAN CONTROL MODE

Screen
Description

Range $\quad$| 11 FAN CTRL = FIXE |
| :--- |
| Control mode of the drive fan |
|  |
| FIXE |
| TEMP |
| (See 'Function' for additional information) |

### 10.1.2. Remote Control Functions

|  | HOST START CONTROL |
| :--- | :--- |
| Screen | - |
| Range | $0-1$ |
| Modbus address | 40562 |
| Modbus range | 0 to 1 |
| Read $/$ Write | YES |
| Description | It allows giving the start command to the equipment through communications network. |

## HOST STOP CONTROL

| Screen | - |
| :--- | :--- |
| Range | $0-1$ |
| Modbus address | 40563 |
| Modbus range | 0 to 1 |
| Read $/$ Write | YES |

Description It allows giving the stop command to the equipment through communications network.

## HOST RESET CONTROL

| Screen | - |
| :--- | :--- |
| Range | $0-1$ |
| Modbus address | 40564 |
| Modbus range | 0 to 1 |
| Read / Write | YES |

Description It allows giving the reset command to the equipment through communications network.
HOST TRIP CONTROL

| Screen | - |
| :--- | :--- |
| Range | $0-1$ |
| Modbus address | 40565 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Description | It allows the equipment to generate a fault through communications network. |

### 10.2. Group 2 - G2: Motor Nameplate Data

| G2.1 | HOTOR RATED CURRENT |
| :--- | :--- |
|  |  |
| Screen | 1 MTR CUR $=00.00 \mathrm{~A}$ |
| Extended info. | MOTOR CURRENT |


| 2 MOTOR RATED VOLTAGE |  |
| :---: | :---: |
| Screen | $2 \mathrm{MTR} \mathrm{VOLT}=400 \mathrm{~V}$ |
| Extended info. | MOTORVOLTAGE |
| Description | Motor rated voltage |
| Range | 220-999V |
| Default value | 400 V |
| Set on run | YES |
| Modbus address | 40283 |
| Modbus range | 220 to 999 |
| Read / Write | YES |
| Function | It allows setting the motor rated voltage according to the motor nameplate. |
| G2.3 MOTOR RATED POWER |  |
| Screen | $3 \mathrm{MTR} \mathrm{PWR}=00.0 \mathrm{~kW}$ |
| Extended info. | MOTOR POWER |
| Description | Motor rated power |
| Range | 0.0-6500kW |
| Default value | * (Value depending on the drive rated current) |
| Set on run | YES |
| Modbus address | 40285 |
| Modbus range | 0 to 65000 |
| Read / Write | YES |
| Function | It allows setting the motor rated power according to the motor nameplate. |


| G2.4 MOTOR RPM |  |
| :---: | :---: |
| Screen | 4 MTR RPM $=1485$ |
| Extended info. | MOTOR SPEED(TPM) |
| Description | Motor rpm |
| Range | 0-24000rpm |
| Default value | 1485 |
| Set on run | YES |
| Modbus address | 40286 |
| Modbus range | 0 to 24000 |
| Read / Write | YES |
| Function | It allows setting the motor rated speed according to the motor nameplate. |
| G2.5 COSINE PHI |  |
| Screen | 5 MTR PFA $=0.85$ |
| Extended info. | MTR POWER FACTOR |
| Description | Cosine Phi |
| Range | 0 to 0.99 |
| Default value | 0.85 |
| Set on run | YES |
| Modbus address | 40288 |
| Modbus range | $0 \text { to } 99$ |
| Read / Write | YES |
| Function | It allows setting the motor cosine Phi according to the motor nameplate. |
| G2.6 MOTOR RATED FREQUENCY |  |
| Screen | $6 \mathrm{MTR} \mathrm{FRQ}=50 \mathrm{~Hz}$ |
| Extended info. | MOTOR FREQUENCY |
| Description | Motor rated frequency |
| Range | $1-100 \mathrm{~Hz}$ |
| Default value | 50 Hz |
| Set on run | YES |
| Modbus address | 40284 |
| Modbus range | 0 to 100 |
| Read / Write | YES |
| Function | It allows setting the motor rated frequency according to the motor nameplate. |

## G2. 7 MOTOR COOLING AT ZERO SPEED

Screen $\quad 7$ MTR COOL $=\mathbf{4 0 \%}$
Extended info. MOTOR COOLING
Description Motor cooling at zero speed
Range
Default value OFF, 20 - 100\%

Set on run
40\%

Modbus address
40287
Modbus range 8274,1638 to 8192
Read / Write YES
Function It calibrates the drive with the characteristics of the motor will be controlled. It provides information for the protection of the motor thermal model.

The following settings can be taken as reference:

| Submersible pumps | $\boldsymbol{\rightarrow}$ | $20 \%$ |
| :--- | :--- | :--- |
| Self-cool motor | $\boldsymbol{\rightarrow}$ | $40 \%$ |
| Forced-cool motor | $\boldsymbol{\rightarrow}$ | $100 \%$ |

The drive capacity ( kW ) should be between $50 \%$ and $150 \%$ of the motor power. The motor must have from 2 to 12 poles.
If the motor power is in HP, convert them in kW by using the next formula:

$$
k W=\frac{H P \cdot 746}{1000}
$$

Thermal model is reset when disconnecting the drive power.
These parameters should be introduced before starting the drive. If we introduce illogical values, the drive will not operate correctly.
Introduce the rated parameters of the motor nameplate, current, voltage, frequency, power, speed (rpm) and cosine phi. When the motor nameplate offers multiple configuration possibilities, or the start-delta motor configuration of the winding has been modified, ensure the correct data is introduced for the appropriate configuration.

Calculate the motor cooling efficiency at zero speed and introduce that value ( $40 \%$ is a commonly used value). Where open structures, forced cooling or water-cool motors are used, a higher efficiency at zero speed will be obtained. If the equipment is operating at low speeds for a long time and trips are generated by the thermal model, and the motor is not too much hot, increase the $\%$ of the cooling. Thermal model is deactivated by introducing OFF. We advise installing a thermal protection independent to the motor.


Figure 10.18 Specific thermal reduction of the motor

### 10.3. Group 3 - G3: References

| Screen | 1 REF1 SPD = LOCAL |
| :---: | :---: |
| Description | Reference source 1 of speed |
| Range | NONE |
|  | Al1 |
|  | Al2 |
|  | Al1 + Al2 |
|  | RESER |
|  | LOCAL |
|  | MREF |
|  | PMOT |
|  | PID |
|  | (See 'Function' for additional information) |
| Default value | LOCAL |
| Set on run | YES |
| Modbus address | 40122 |
| Modbus range | 0 to 8 |
| Read / Write | YES |
| Function | It allows selecting the reference source 1 of speed. |
|  | Possible reference sources are the following ones: |
|  | NONE $\quad \rightarrow$ Reference source 1 has not been selected. |
|  | Al1 $\quad \rightarrow$ The reference will be introduced through the Analogue Input 1. |
|  | Al2 $\quad \rightarrow$ The reference will be introduced through the Analogue Input 2. |
|  | $\mathrm{Al} 1+\mathrm{Al} 2 \rightarrow$ The reference will be the addition of the signals introduced through the Analogue Inputs 1 and 2. |
|  | RESER $\quad \rightarrow$ Reserved for future use. |
|  | LOCAL $\quad \rightarrow$ The reference will be introduced by keypad and will be set in ' $G 3.3$ <br> $\rightarrow$ Local speed reference'. |
|  | MREF <br> $\rightarrow$ Multi-reference. It allows activating different references by digital inputs. For this, you need to configure the digital inputs (See ' $\$ 4.1$ Digital Inputs'). |
|  | PMOT $\quad \rightarrow$ Reference taken by motorized potentiometer with or without reference memorizing. |
|  | PID $\rightarrow \quad \begin{aligned} & \text { It will take as reference the value set in the parameters of the PID } \\ & \text { function. }\end{aligned}$ |

G3.2 REFERENCE SOURCE 2 OF SPEED

| Screen | 2 REF2 SPD = LOCAL |
| :--- | :--- |
| Description | Reference source 2 of speed |
| Range | NONE |
|  | Al1 |
|  | Al2 |
|  | Al1 + Al2 |
|  | RESER |
|  | LOCAL |
|  | MREF |
|  | PMOT |
|  | PID |
|  | LOCAL |
| Default value |  |
| Set on run | YES |
| Modbus address | 40123 |
| Modbus range | 0 to 8 |
| Read / Write | YES |
|  | It allows selecting the reference source 2 of speed. |
| Function | See 'Function' in parameter 'G3.1 $\rightarrow$ Reference source 1 of speed' for additional |
|  | information about the configuration options. |

## G3.3 LOCAL SPEED REFERENCE

| Screen | 3 LOCAL SPD $=+100 \%$ |
| :---: | :---: |
| Extended info. | LOCAL SPEED |
| Description | Local speed reference |
| Range | -250\% to $+250 \%$ |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40124 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows user to set the value of the motor spinning speed whenever the reference source of speed is set to 'LOCAL' in parameter 'G3.1 $\rightarrow$ Reference source 1 of speed' or 'G3.2 $\rightarrow$ Reference source 2 of speed', depending on the reference source selected. |

### 10.4. Group 4 - G4: Inputs

### 10.4.1. Subgroup 4.1-S4.1: Digital Inputs

| G4.1.1 MODO DE CONTROLPRINCIPAL |  |
| :---: | :---: |
| Screen | 1 CNTROL MODE1 $=1$ |
| Description | Main control mode |
| Range | $0-3$ <br> (See 'Function' for additional information) |
| Default value | 1 |
| Set on run | YES |
| Modbus address | 40040 |
| Modbus range | $0 \rightarrow$ NONE |
|  | $1 \rightarrow$ LOCAL |
|  | $2 \rightarrow$ REMOTE |
|  | $3 \rightarrow$ SERIAL COMMS |
| Read / Write | YES |
| Function | It allows user to set the main control mode of the drive to give the orders that drive it (Start/Stop, Reset, ...). |
|  | The configuration options of the main control mode are: |
|  | $0 \rightarrow \text { NONE }$ <br> Control mode 1 is not operative. |
|  | $1 \rightarrow$ LOCAL Drive control is realized from keypad, this is, the signals that control it is given through the keypad of the drive itself. |
|  | $2 \rightarrow$ REMOTE Drive control is realized through control terminals, this is, by activating or deactivating signals connected to the control terminals of the drive. |
|  | $3 \rightarrow$ SERIAL COMMS <br> Drive control is realized through communication bus, this is, signals that drive the drive will be sent through it. |

G4.1.2 ALTERNATIVE CONTROL MODE

| Screen | 2 CNTROL MODE2 $=2$ |
| :--- | :--- |
| Description | Alternative control mode |
| Range | $0-3$ |
| Default value | 2 |
| Set on run | YES |
| Modbus address | 40041 |
| Modbus range | 0 to 3 |
| Read $/$ Write | YES |

Function It allows user to set the secondary control mode (or alternative) of the drive to give the orders that drive it (Start/Stop, Reset, ...).

The configuration options of the alternative control mode are the same than the main control mode, therefore, see 'Function' in parameter 'G4.1.1 $\rightarrow$ Main control mode' to obtain additional information.

Note: Control mode 2 (alternative) will be activated through digital inputs. For that, one of them should be configured (parameters 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration') with the option ' $17 \rightarrow$ CONTROL 2'. When the input configured for that is activated, the alternative control mode will be activated, disabling the main control mode.

| G4.1.3 RE | ET FROBA KEYPAD |
| :---: | :---: |
| Screen | 3 RESET MODE $=\mathrm{Y}$ |
| Description | Reset from keypad |
| Range | N |
|  | S |
|  | (See 'Function' for additional information) |
| Default value | $Y$ |
| Set on run | YES |
| Modbus address | 40039 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It enables or disables the possibility of resetting a fault from the keypad unit (LOCAL). |
|  | Options: |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Reset from keypad unit is not possible. |
|  | $Y \rightarrow$ YES |
|  | It is possible to reset the equipment by reset key from the keypad unit. |


| G4.1.4 | SELECTION OF DIGITAL INPUTS CONFIGURATION |
| :--- | :--- |
| Screen | 4 DIGIT I MODE $=1$ |
| Description | Selection of digital inputs configuration |
| Range | $0-5$ |
|  | (See 'Function' for additional information) |
| Default value | 1 |
| Set on run | NO |
| Modbus address | 40038 |
| Modbus range | 0 to 5 |
| Read $/$ Write | YES |

Function It determines the configuration mode of digital inputs. All of the selectable configuration modes assign specific functions to some digital inputs together except for the option ' 1 $\rightarrow$ ALL PROGRAMMABLE', that allows us to configure them individually.

Description of the configuration modes:

## $0 \rightarrow 3$ WIRES

It allows controlling the functions of Star//Stop and Reset through the terminals of multi-function digital inputs. Digital inputs will be configured like this:

DI1: '01 $\rightarrow$ START' (NO)
D12: $04 \rightarrow$ STOP1 - RESET' $(N C)$
DI3: $03 \rightarrow$ STOP2 - RESET' (NC)
DI4: '15 $\rightarrow$ REFERENCE 2' (NO)
DI5: '10 $\rightarrow$ INV SPEED' (NC)
DI6: '17 $\rightarrow$ CONTROL 2' $(\mathrm{NO})$
Push buttons are connected to the terminals of the digital inputs 1,2 and 3 . In this mode, all of the digital inputs are used, therefore, we cannot add other functionality to this configuration.

## $1 \rightarrow$ ALL PROGRAMMABLE

It allows user to configure each digital input individually. The functions assignment to the inputs is realized in parameters ' $\mathrm{G} 4.1 .5 \rightarrow$ Multi-function Digital Input 1 configuration' to ' $\mathrm{G} 4.1 .10 \rightarrow$ Multi-function Digital Input 6 configuration'.
$2 \rightarrow$ MREF 2 WIRES
Two of the six digital inputs, D15 and D16, are configured to select the settings of multiple references, getting up to 4 references set before. These ones can be speed references or PID references. See group G14 MULTIREFERENCES

The four remaining inputs (DI1 to DI4) can be programmed individually in the parameters 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.8 $\rightarrow$ Multi-function Digital Input 4 configuration'.

Note: To configure this mode, as well as selecting this option, it is necessary to realize one of the settings described below.

1. Choice of 'multi-references' as speed references.

We should set the parameter ' $\mathrm{G} 3.1 \rightarrow$ Reference source 1 of speed' and/or 'G3.2 $\rightarrow$ Reference source 2 of speed' with option 'MREF'.
2. Choice of 'multi-references' as PID references.

First, we should enable the PID regulator in 'G3.1 $\rightarrow$ Reference source 1 of speed' and/or 'G3.2 $\rightarrow$ Reference source 2 of speed' option 'PID', and next, select option 'MREF' in parameter 'G6.1 $\boldsymbol{\rightarrow}$ Source selection for introducing reference signal'.

## $3 \rightarrow$ MREF 3 WIRES

Three of the six digital inputs, DI4, DI5 and DI6, are configured to select the settings of the multiple references, getting up to 7 references set before. These ones can be speed references or PID references. See group G14 MULTI-REFERENCES.

The three remaining inputs (DI1 to $\mathrm{D} \mid 3$ ) can be programmed individually in the parameters 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.7 $\rightarrow$ Multi-function Digital Input 3 configuration'.

Note: To configure this mode, as well as selecting this option, it is necessary to realize one of the settings described below.

1. Choice of the 'multi-references' as speed references. We should set the parameter 'G3.1 $\rightarrow$ Reference source 1 of speed' and/or 'G3.2 $\rightarrow$ Reference source 2 of speed' with option 'MREF'.
2. Choice of the 'multi-references' as PID references. First, we should enable the PID regulator in 'G3.1 $\rightarrow$ Reference source 1 of speed' and/or 'G3.2 $\rightarrow$ Reference source 2 of speed' option 'PID', and next, select option 'MREF' in parameter 'G6.1 $\rightarrow$ Source selection for introducing reference signal'.

## $4 \rightarrow$ MOTORIZED POT

It allows setting the speed reference by two push buttons connected to digital inputs:
DI5: Up (it increases the speed reference). Contact NO.
DI6: Down (it decreases the speed reference). Contact NC.
The reference limits will be the speed limits of the equipment that are set in group G 10 LIMITS.

While 'Up' push button is pressed, the speed increase can be set according to a double ramp in group G5 ACCELERATION AND DECELERATION RAMPS. In case of decreasing the speed occurs the same thing, this is, that decrease can be set in the same way:
'G5.7 $\rightarrow$ Ramp 1 for reference increase of motorized potentiometer'
'G5.8 $\rightarrow$ Ramp 1 for reference decrease of motorized potentiometer'
'G5.9 $\rightarrow$ Ramp 2 for reference increase of motorized potentiometer'
'G5.10 $\rightarrow$ Ramp 2 for reference decrease of motorized potentiometer'
'G5.11 $\rightarrow$ Speed for changing the acceleration and deceleration ramp'
See group G5 ACCELERATION AND DECELERATION RAMPS for additional information about these parameters.

Note: In this mode, the speed reference set by the potentiometer will be memorized even if the motor is stopped, and also if the power supply is lost.

Note: For using this function it is necessary to set 'G3.1 $\rightarrow$ Reference source 1 of speed' or 'G3.2 $\rightarrow$ Reference source 2 of speed' with option 'PMOT' according to the selected source.

We can observe the operation of the motorized potentiometer in the following figure.


S070rtcC0024A1

Figure 10.19 Motorized potentiometer operation

## $5 \rightarrow$ ERASAB POT

It operates like option ' $4 \rightarrow$ MOTORIZED POT', but when the motor is stopped or the power supply is lost, the speed reference will not be memorized, but the minimum reference value set in 'G10.1 $\rightarrow$ Minimum speed limit 1' or 'G10.3 $\rightarrow$ Minimum speed limit 2' will be taken.

D15: Up (it increases the speed reference). Contact NO
DI6: Down (it decreases the speed reference). Contact NC.
The reference limits will be the speed limits of the equipment that are set in group G10 LIMITS

Like in the previous mode, we can set the increase and the decrease of the speed (while push buttons 'Up' or 'Down' are pressed) according to a double ramp for each case (settings in group G5 ACCELERATION AND DECELERATION RAMPS). Read option ' $4 \rightarrow$ MOTORIZED POT'.

See figure 10.19.
Note: For using this function it is necessary to set 'G3.1 $\rightarrow$ Reference source 1 of speed' or 'G3.2 $\rightarrow$ Reference source 2 of speed' with option 'PMOT' according to the selected source.

【. Caution: Digital input configuration changes automatically the settings of the digital inputs themselves. Make sure there is not a hazard of accidental starting to avoid personal injuries or property damages.

Pumps program activation, in 'G1.7 $\rightarrow$ Program activation' set to 'PUMP', requires the following considerations:

There are some configuration options available when the pump program is active, which can be set in the same way that the options available in the standard program. Nevertheless, when the pump program is active, the drive will assume that only the configurable options from 50 to 69 (for 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration') can be set, without taking into consideration the setting on parameter 'G4.1.4 $\rightarrow$ Digital Input configuration selection', which means a block setting.

All that means that the user will configure the pump program freely, according to his requirements, selecting the correct functionality and protections. For a correct programming of the digital inputs when the pump program is active, there is additional information in G25 PUMP CONTROL.

Note: $\quad$ Selection of the pump program will set all the Digital Inputs (from G4.1.5 to G4.1.10) to mode ' $00 \rightarrow$ NO USE'. If re-programming is needed, it will be necessary to configure their functionality in a separate way again. So it guarantees a safety installation operation, avoiding that hardware external to the equipment can cause any kind of damage.

Note: The digital outputs will also be affected due to pump control activation.
To select one auxiliary pump it is necessary to act in the following way:

- Set any free digital input to options ' $52 \rightarrow$ FIX PUMP1 FLT', '53 $\rightarrow$ FIX PUMP2 FLT', '54 $\rightarrow$ FIX PUMP3 FLT', '55 $\rightarrow$ FIX PUMP4 FLT' or '56 $\rightarrow$ FIX PUMP5 FLT'.
- To enable the control of the pump 1, 2, 3, 4 and/or 5 set the corresponding parameter G25.9.1, G25.9.2, G25.9.3, G25.9.4 and G25.9.5 respectively to ' $Y$ '.
To remove this pump configuration and release the relay for another use, the user should:
- Disable the control of the pump in the corresponding parameter G25.9.1, G25.9.2, G25.9.3, G25.9.4 or G25.9.5 respectively, by setting these parameters to ' N '.

| G4.1.5 MULTI-FUNCTIONDIGITAL INPUT 1 CONFIGURATION |  |
| :---: | :---: |
| Screen | 5 DIGITL IN $1=06$ |
| Description | Multi-function Digital Input 1 configuration |
| Range | 00-70 |
|  | (See 'Function' for additional information) |
| Default value | 06 |
| Set on run | NO |
| Modbus address | 40032 |
| Modbus range | 0 to 70 |
| Read / Write | YES |
| Function | It allows user to configure the Digital Input 1 for its individual use. |
|  | The configuration options for each multi-function digital input are the following ones: |
|  | $00 \rightarrow$ NO USE |
|  | The input is not programmed. |
|  | $01 \rightarrow \text { START }$ <br> 'Start' command from a push button with a normally open contact (NO). |
|  |  |
|  | Note: For configuring this option, it is also necessary to configure another input as a 'Stop' command from a push button with a normally closed contact (NC) previously. |
|  | $02 \rightarrow$ STOP1 |
|  | 'Stop' command in mode 1 from a push button with a normally closed contact ( NC ), according to the setting of the parameter ' $\mathrm{G} 7.1 \rightarrow$ Stop mode $1^{1}$. |
|  | $03 \rightarrow$ STOP2 - RESET |
|  | 'Stop' command in mode 2 from a push button with a normally closed contact ( NC ), according to the setting of the parameter 'G7.2 $\rightarrow$ Stop mode 2 '. Activation of the input in this mode also acts as a 'Reset' signal. |
|  | $04 \rightarrow$ STOP1 - RESET |
|  | 'Stop' command in mode 1 from a push button with a normally closed contact ( NC ), according to the setling of the parameter ' $\mathrm{G} 7.1 \rightarrow$ Stop mode 1 '. Activation of the input in this mode also acts as a 'Reset' signal. |
|  | $05 \rightarrow$ START/STOP |
|  | It allows starting when closed and stopping when open (2 wires start / stop). (NO). |
|  | $06 \rightarrow$ START-RST/STOP |
|  | It allows starting when closed and stopping when open (2 wires start/stop). |
|  | $07 \rightarrow$ RESET |
|  | 'Reset' signal by push bution (NC). |
|  | $08 \rightarrow$ START + INCH1 |
|  | 'Start' command and inch speed 1 (programmed in ' $\mathrm{G} 15.1 \rightarrow$ Inch speed ${ }^{\text {' }}$ ) taken as reference. (NO). |

```
O9 -> START + INCH2
                    'Start' command and inch speed 2 (programmed in 'G15.2 }->\mathrm{ Inch speed 2')
    taken as reference. (NO).
    Note: If two inputs, configured with options '08 -> START + INCH1' and '09
    START + INCH2', are activated simultaneously, combination of 'Start +
    Inch speed 3' is obtained. Inch speed 3 is programmed in parameter 'G15.3
    -> Inch speed 3'.
10 -> INV SPEED
    It causes a deceleration of the motor until motor is stopped, and inverts the
    rotation direction. (NO).
    Note: Rotation inversion must be enabled in parameter 'G10.11 }->\mathrm{ To
    enable speed inversion'.
11 -> RESERVE
    Reserved for future use.
12 -> RESERVE
    Reserved for future use.
13 -> INV INCHS
    It inverts the inch speed reference set in 'G15.1 }->\mathrm{ Inch speed 1','G15.2 }
    Inch speed 2' or 'G15.3 }->\mathrm{ Inch speed 3'.(NO).
    Note: Rotation inversion must be enabled in parameter 'G10.9 }->\mathrm{ To enable
    speed inversion'.
14 - ACC/DEC 2
    It activates the use of the alternative acceleration and deceleration ramps
    programmed in 'G5.3 }->\mathrm{ Acceleration ramp 2' and 'G5.4 }->\mathrm{ Deceleration
    ramp 2'. (NO).
15 -> REFERENCE 2
It allows selecting the alternative speed reference programmed in 'G3.2 }
    Reference source 2 of speed'. (NO).
16 -> RESERVE
    Reserved for future use.
17 -> CONTROL 2
It activates the alternative control mode programmed in 'G4.1.2 }
    Alternative control mode'. (NO).
18 -> START/STP - RST
Like option '06 }->\mathrm{ START - RST/STOP', but 'Reset' signal will be activated
    after the drive is stopped. (NO).
19 -> STOP (2)
'Stop' command in mode 2 from a push button with a normally closed
contact (NC), according to the setting of the parameter 'G7.2 }->\mathrm{ Stop mode
2'.
20 }->\mathrm{ SPEED LIMIT 2
Change to the alternative speed limits programmed in 'G10.3 }->\mathrm{ Minimum
speed limit 2' and 'G10.4 }->\mathrm{ Maximum speed limit 2'. (NO).
21 -> DC BRAKE
    It allows activating or deactivating dynamic brake unit. (NO).
22 }->\mathrm{ START MODE 2
    To select the alternative starting mode (Ramp / Spin) adjusted in parameter
    'G7.5 -> Start mode 2'. (NO)
```

```
23 }->\mathrm{ CURRENT LIMI2
    To select the alternative current limit adjusted in 'G10.7 -> Alternative
    current limit'. (NO).
24 -> EXTERN EMERGE
    To generate the fault 'F56 EMERGEN.STOP'. (NC).
50 -> PMP START/STP
    Automatic starting of the system. (NO).
51 -> FLOW PULSE
    Pulse input for the flowmeter. (NO).
52-> FIX PUMP1 FLT
    Auxiliary pump 1 fault. (NO).
53-> FIX PUMP2 FLT
    Auxiliary pump 2 fault. (NO).
54->FIX PUMP3 FLT
    Auxiliary pump 3 fault. (NO).
55 -> FIX PUMP4 FLT
    Auxiliary pump 4 fault. (NO).
56 ->. FIX PUMP5 FLT
    Auxiliary pump 5 fault. (NO).
57->MAN PROTstart
    Manual starting including those protections enabled by the user. (NO).
58-> HI PRESS FLT
    High Pressure trip. (NC).
59 -> LO WATER FLT
    No Water trip. (NC)
60 -> LO PRESS FLT
    To detect a low pressure situation.(NO)
61->FFOW SWITCH
    To connect an external flow switch (open / closed). (NC).
62 -> IRRIGAT TRIP
    To detect an external fault from the irrigation equipment. (NO).
63-> SETPONT PIN1
    (Low bit).
```

    Configuration of the low, medium and high bit respectively, for multiple PID
    setpoints selection, according to the following table:
    | DIGITAL INPUTS |  |  | PID SETPOINT |
| :---: | :---: | :---: | :---: |
| $\mathrm{DI}(\mathrm{z})=65$ | $D I(y)=64$ | $\mathrm{DI}(\mathrm{x})=63$ |  |
| 0 | 0 | 0 | G25.1.5 'SETPT1' |
| 0 | 0 | X | G25.1.6 'SETPT2' |
| 0 | X | 0 | G25.1.7 'SETPT3' |
| 0 | X | X | G25.1.8 'SETPT4' |
| X | 0 | 0 | G25.1.9 'SETPT5' |
| X | 0 | X | G25.1.10 'SETPT6' |
| X | X | 0 | G25.1.11 'SETPT7' |
| X | X | X | G25.1.12 'SETPT8' |

They are NO contacts

# $64 \rightarrow$ SETPONT PIN2 <br> (Medium bit) <br> See option '63' above. <br> $65 \rightarrow$ SETPONT PIN3 <br> (High bit). <br> See option '63' above. 

$66 \rightarrow$ MAN REF 2
To select the second source or the alternative source for the speed reference adjusted in 'G3.2 $\rightarrow$ Selection for speed reference 2'. (NO).
$67 \rightarrow$ MAN OVR STAR
Manual starting without protections, for testing starting. (NO).
$69 \rightarrow$ PRESSUR SWITC
Detection of the pressure existing in the system to be used with the Priming pump. (NO).
$70 \rightarrow$ ALTER PID STP
When the input configured with this option is activated, the pump program will consider the alternative PID setpoint according to the setting of the parameter 'G25.2.2 $\rightarrow$ Alternative PID setpoint source'. (NO).

| G4.1.6 | MULTI-FUNCTION DIGITAL INPUT 2 CONFIGURATION |
| :--- | :--- |
| Screen | $\mathbf{6}$ DIGITL IN $\mathbf{2}=\mathbf{0 0}$ |
| Description | Multi-function Digital Input 2 configuration |
| Range | $00-70$ |
| Default value | 00 |
| Set on run | NO |
| Modbus address | 40033 |
| Modbus range | 0 to 70 |
| Read / Write | YES |
| Function | It allows user to configure the Digital Input 2 for its individual use. |
|  |  |
|  | See 'Function' in parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' for <br> additional information about the configuration options. |


| MULTI-FUNCTION DIGITAL INPUT 3 CONFIGURATION |  |
| :---: | :---: |
| Screen | 7 DIGITL IN 3 = 00 |
| Description | Multi-function Digital Input 3 configuration |
| Range | 00-70 |
| Default value | 00 |
| Set on run | NO |
| Modbus address | 40034 |
| Modbus range | 0 to 70 |
| Read / Write | YES |
| Function | It allows user to configure the Digital Input 3 for its individual use. |
|  | See 'Function' in parameter 'G4.1.5 $\boldsymbol{\rightarrow}$ Multi-function Digital Input 1 configuration' for additional information about the configuration options. |

## G4.1.8 HULTI-FUNCTION DIGITAL INPUT 4 CONFIGURATION

| Screen | $\mathbf{8}$ DIGITL IN $\mathbf{4}=\mathbf{0 0}$ |
| :--- | :--- |
| Description | Multi-function Digital Input 4 configuration |
| Range | $00-70$ |
| Default value | 00 |
| Set on run | NO |
| Modbus address | $\mathbf{4 0 0 3 5}$ |
| Modbus range | 0 to 70 |
| Read / Write | YES |
| Function | It allows user to configure the Digital Input $\mathbf{4}$ for its individual use. |
|  | See 'Function' in parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' for <br> additional information about the configuration options. |


G4.1.10 MULTI-FUNCTION DIGITAL INPUTI 6 CONFIGURATION

| Screen | $\mathbf{1 0}$ DIGITL IN $\mathbf{6}=\mathbf{1 7}$ |
| :--- | :--- |
| Description | Multi-function Digital Input 6 configuration |
| Range | $00-70$ |
| Default value | 17 |
| Set on run | NO |
| Modbus address | $\mathbf{4 0 0 3 7}$ |
| Modbus range <br> Read / Write | 0 to 70 |
| YES |  |
| Function | It allows user to configure the Digital Input 6 for its individual use. |
|  | See 'Function' in parameter 'G4.1.5 $\boldsymbol{\rightarrow}$ Multi-function Digital Input 1 configuration' for <br> additional information about the configuration options. |

### 10.4.2. Subgroup 4.2 - S4.2: Analogue Input 1

| G4:2.1 | TO ENABLE SENSOR OF ANALOGUE INPUT 1 |
| :--- | :--- |
| Screen | 1 SENSOR 1 ? $?=\mathrm{N}$ |
| Description | It enables the sensor of the Analogue Input 1 |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | NO |
| Modbus address | 40268 |
| Modbus range | 0 to 1 |
| Read / Write | YES |

Function It allows user to use the Analogue Input 1 and to access to the needed parameters for configuring the sensor. See 'G4.2.2 $\rightarrow$ Selection of sensor 1 units' up to 'G4.2.7 $\rightarrow$ Maximum range of sensor $1^{\prime}$.
$\mathrm{N} \rightarrow \mathrm{NO}$
The analogue input will remain scaled in default units (\%).
$Y \rightarrow Y E S$
The analogue input and any variables relating to the analogue input will be configured in the engineering units selected in 'G4.2.2 $\rightarrow$ Selection of sensor 1 units'.

| G4.2.2 SELECTION OF SENSOR 1 UNITS |  |
| :---: | :---: |
| Screen | 2 SENSOR $1=1 / \mathrm{s}$ |
| Description | Selection of units of measurement for the sensor 1 |
| Range | \%, l/s, $\mathrm{m}^{3} / \mathrm{s}, \mathrm{l} / \mathrm{m}, \mathrm{m}^{3} / \mathrm{m}, \mathrm{l} / \mathrm{h}, \mathrm{m}^{3} / \mathrm{h}, \mathrm{m} / \mathrm{s}, \mathrm{m} / \mathrm{m}, \mathrm{m} / \mathrm{h}, \mathrm{Bar}, \mathrm{kPa}, \mathrm{Psi}, \mathrm{m},{ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F},{ }^{\circ} \mathrm{K}$ |
| Default value | 1/s |
| Set on run | NO |
| Modbus address | 40272 |
| Modbus range | 0 to 16 |
| Read / Write | YES |
| Function | It allows selecting different units of measurement for the Analogue Input 1 according to the sensor that is going to be used. |
|  | If this parameter is modified, the minimum and maximum values are affected by the proper conversion. For this reason, the settings of the parameters ' $\mathrm{G} 4.2 .5 \rightarrow$ Minimum range of sensor 1 ' and ' $G 4.2 .7 \rightarrow$ Maximum range of sensor 1 ' should be checked. |
| Note: | This parameter is only available if ' $\mathrm{G} 4.2 .1 \rightarrow$ To Enable sensor of Analogue Input 1 ' is set to ' $Y$ '. |


| G4.2.3 ANALOGUE INPÜT 1 FORMAT |  |  |
| :---: | :---: | :---: |
| Screen | 3 AIN1 FORMAT $=\mathbf{V}$ |  |
| Description | Analogue Input 1 format |  |
| Range | $\checkmark$ |  |
|  | mA |  |
| Default value | $\checkmark$ |  |
| Set on run | NO |  |
| Modbus address | 40264 |  |
| Modbus range | 0 to 1 |  |
| Read / Write | YES |  |
| Function | It allows user to configure the current signal, according to | put 1 to connect a voltage or ed to introduce the reference. |

G4.2.4 MINIMUM RANGE OF ANALOGUE INPUT 1

| Screen | $4 \mathrm{INmin} 1=+0 \mathrm{~V}$ |
| :---: | :---: |
| Extended info. | ANILOWRANGE |
| Description | Minimum range of the Analogue Input 1 |
| Range | -10 to +10V (max. G4.2.6) |
|  | +0 to +20 mA (max. G4.2.6) |
| Default value | + V |
| Set on run | YES |
| Modbus address | 40248 |
| Modbus range | -10000 to +10000 (max. G4.2.6) |
|  | 0 to +20000 (max. G4.2.6) |
| Read / Write | YES |
| Function | It allows setting the minimum voltage or current value for the Analogue Input 1 according to the characteristics of the sensor that is going to be connected. |

## G4.2.5 AAINIMUA RANGE OF SENSOR 1

| Screen | $5 \mathrm{Smi1}=+0.01 / \mathrm{s}$ |
| :---: | :---: |
| Extended info. | SENSi LOW RANGE |
| Description | Minimum range of sensor 1 |
| Range | -3200 to +3200 Engineering units (max. G4.2.7) |
| Default value | +0.01/s |
| Set on run | YES |
| Modbus address | 40254 |
| Modbus range | -3200 to 3200 (max. G4.2.7) |
| Read / Write | YES |
| Function | It allows setting the minimum units value of the sensor connected to the Analogue Input 1. This value should also correspond to the minimum voltage or current level of the sensor set in ' $\mathrm{G} 4.2 \mathrm{H} \rightarrow$ Minimum range of Analogue Input 1'. |
| Note: | The setting of this parameter should be checked if the sensor units are changed in parameter 'G4.2.2 $\rightarrow$ Selection of sensor 1 units'. It is necessary to set this value to operate in open loop and closed loop. |
| Note: | This parameter will be only available if 'G4.2.1 $\rightarrow$ To enable sensor of Analogue Input 1 ' is set to ' $Y$ '. |


| G4.2.6 MAXIMUM RANGE OF ANALOGUE INPUT 1 |  |
| :---: | :---: |
| Screen | $6 \mathrm{INmax} 1=+10 \mathrm{~V}$ |
| Extended info. | AN1 HIGH RANGE |
| Description | Maximum range of the Analogue Input 1 |
| Range | -10 to +10 V (min. G4.2.4) |
|  | +0 to +20 mA (min. G4.2.4) |
| Default value | +10V |
| Set on run | YES |
| Modbus address | 40244 |
| Modbus range | -10000 to +10000 (min. G4.2.4) |
|  | 0 to +20000 (min. G4.2.4) |
| Read / Write | YES |
| Function | It allows setting the maximum voltage or according to the characteristics of the sen |

## G4.2.7 MAXIMUM RANGE OF SENSOR 1

| Screen | $7 \mathrm{Sma1}=+10.01 / \mathrm{s}$ |
| :---: | :---: |
| Extended info. | RNG ALTO SENSOR1 |
| Description | Maximum range of sensor 1 |
| Range | -3200 to +3200 Engineering units (min. G4.2.5) |
| Default value | +10.01/s |
| Set on run | YES |
| Modbus address | 40250 |
| Modbus range | -3200 to 3200 (min. G4.2.5) |
| Read / Write | YES |
| Function | It allows setting the maximum units value of the sensor connected to the Analogue Input 1. This value should also correspond to the maximum voltage or current level of the sensor set in 'G4.2.6 $\rightarrow$ Maximum range of Analogue Input 1'. |
| Note: | The setting of this parameter should be checked if the sensor units are changed in parameter 'G4.2.2 $\rightarrow$ Selection of sensor 1 units'. It is necessary to set this value to operate in open loop and closed loop. |
| Note: | This parameter will be only available if ' $\mathrm{G} 4.2 .1 \rightarrow$ To enable sensor of Analogue Input 1 ' is set to ' $Y$ '. |


| G4.2.8 SP | ED FOR THE MINIMUM RANGE OF ANALOGUE INPUT 1 |
| :---: | :---: |
| Screen | 8 SPD LO1 = +0\% |
| Extended info. | 8PD LO RNG AN1 |
| Description | Speed corresponding to the minimum range of the Analogue Input 1 |
| Range | -250\% to +250\% (max. G4.2.9) |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 40246 |
| Modbus range | -20480 to 20480 (max. G4.2.9) |
| Read / Write | YES |

$$
\begin{array}{ll}
\text { Function } & \text { If the Analogue Input } 1 \text { is used for introducing the speed reference (setting of } \\
\text { parameter ' } G 4.2 .1 \rightarrow \text { To enable sensor of Analogue Input } 1 \text { ' to ' } N \text { '), we can set in this } \\
\text { parameter the value of this reference corresponding to the minimum voltage or current } \\
\text { level set in parameter ' } \mathrm{G} 4.2 .4 \rightarrow \text { Minimum range of Analogue Input } 1 \text { '. } \\
& \text { The value set here is a percentage of the motor rated speed (' } G 2.4 \rightarrow \text { Motor rpm'). }
\end{array}
$$



Q4.2.9 $\rightarrow$ Speed for the maximum range of anabogue input 1
G4.3.9 $\rightarrow$ Speed for the maxdmum range of analogue inpur 2
G4. $2.8 \rightarrow$ Speed for the minimum range of analogue input 1
G4.3.8 $\rightarrow$ Speed for the oxinimum range of analogue input 2
G10.2 $\rightarrow$ Maximum spoed limit 1
G10.4 $\rightarrow$ Maximum speed limit 2
G10.1 $\rightarrow$ Mindruen speed knil 1
G10.3 $\rightarrow$ Mininum speed limil 2

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Figure 10.20 Scaling of the speed limits for the analogue inputs

G4.2.9 SPEED FOR THE MAXIBUM RANGE OF ANALOGUE INPUT 1
Screen 9 SPD HI1 $=+100 \%$

Extended info. SPDHIG RNG AN1
Description Speed corresponding to the maximum range of the Analogue Input 1
Range $\quad-250 \%$ to $+250 \%$ ( $\mathrm{min} . \mathrm{G} 4.2 .8$ )
Default value $\quad+100 \%$
Set on run YES
Modbus address 40242
Modbus range $\quad-20480$ to 20480 (min. G4.2.8)
Read / Write YES

Function If the Analogue input 1 is used for introducing the speed reference (setting of parameter 'G4.2.1 $\rightarrow$ To enable sensor of Analogue Input 1 ' to ' $N$ '), we can set in this parameter the value of this reference corresponding to the maximum voltage or current level set in parameter ' $\mathrm{G} 4.2 .6 \rightarrow$ Maximum range of Analogue Input 1'.

The value set here is a percentage of the motor rated speed ('G2.4 $\rightarrow$ Motor rpm').
See figure 10.20

| G4.2.14 PR | TECTION FOR ANALOGUE INPUT 1 LOSS |
| :---: | :---: |
| Screen | 14 AIN1 LOSS $=$ N |
| Description | Protection for the Analogue Input 1 loss |
| Range | N |
|  | $Y$ <br> (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 40266 |
| Modbus range | 0 to 1 |
| Read/Write | YES |
| Function | It allows user to decide about the behaviour of the equipment when the signal connected to the Analogue Input 1 is lost. |
|  | Options: |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Disabled function. |
|  | Drive does not realize any action in case of the analogue input signal is lost. |
|  | $Y \rightarrow$ YES |
|  | Drive will stop generating the fault 'F42 AIN1 LOSS', since the sensor will be considered damaged, when a sharp drop down to zero value in the level of the analogue input signal is detected. |

## G4.2.15 ZERO BAND FILTER FOR ANALOGUE INPUT 1

| Screen | $1512 \mathrm{BAND}=\mathrm{OFF}$ |
| :---: | :---: |
| Extended info. | ANT ZEROBAND |
| Description | Zero band filter for the Analogue Input 1 |
| Range | OFF=0.0-2.0\% |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40270 |
| Modbus range | 0 to 163 |
| Read / Write | YES |
| Function | Setting a value in this parameter, we obtain a filtering of the Analogue Input 1 signal, eliminating a possible electrical noise associated to the signal that impedes reading a zero value when it must be read. |
|  | The aim of this parameter is supplying a pre-defined zero area for controls by analogue inputs, especially for speed control. It eliminates small errors in the reference voltage near to zero reference point. |
| Note: | The function of zero band filter is not applied to the reference signals through digital inputs, since these settings are absolute zero. |



Figure 10.21 Analogue input of reference with zero band filter

## G4.2.16 LOW PASS FILTER FOR ANALOGUE INPUT 1

| Screen | 16 FILTER1 $=$ OFF |
| :--- | :--- |
| Extended info. | AN1 STABIL FILT |
| Description | Low Pass filter for the Analogue Input 1 |
| Range | OFF $=0.0-20.0 \%$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40274 |
| Modbus range | 0 to 200 |
| Read $/$ Write | YES |

Function It allows filtering the signal of the Analogue Input 1. By setting the value of this time constant we can eliminate possible instabilities in the value of the same ones due to noise, wiring faults, etc.

Note: When applying a Low Pass filter to any analogue signal, a delay time in the own signal is generated. This delay time is the value of the configured time constant approximately.

### 10.4.3. Subgroup 4.3 - S4.3: Analogue Input 2

| G4.3.1 TO | ENABLE SENSOR OF ANALOGUE INPUT 2 |
| :---: | :---: |
| Screen | 1 SENSOR 2 ? = N |
| Description | It enables the sensor of the Analogue Input 2 |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | NO |
| Modbus address | 40269 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows user to use the Analogue Input 2 and to access to the needed parameters for configuring the sensor. See 'G4.3.2 $\rightarrow$ Selection of sensor 2 units' up to 'G4.3.7 $\rightarrow$ Maximum range of sensor $2^{\prime}$. |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | The analogue input will remain scaled in default units (\%). |
|  | $Y \rightarrow Y \mathrm{SES}$ |
|  | The analogue input and any variables relating to the analogue input will be configured in the engineering units selected in 'G4.3.2 $\rightarrow$ Selection of sensor 2 units'. |

## G4.3.2 SELECTION OF SENSOR 2 UNITS

Screen
Description
Range
Default value
Set on run
Modbus address 40273
Modbus range 0 to 16
Read / Write
Function It allows selecting different units of measurement for the Analogue Input 2 according to the sensor that is going to be used.

If this parameter is modified, the minimum and maximum values are affected by the proper conversion. For this reason, the settings of the parameters ' $\mathrm{G} 4.3 .5 \rightarrow$ Minimum range of sensor 2 ' and 'G4.3.7 $\rightarrow$ Maximum range of sensor 2 ' should be checked.

Note: $\quad$ This parameter is only available if 'G4.3.1 $\rightarrow$ To enable sensor of Analogue Input 2' is set to ' $Y$ '.


G4:3.5 BiNIMUM RANGE OF SENSOR 2

| Screen | $5 \mathrm{Smi2}=+0.0 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | SENS2LOW RANGE |
| Description | Minimum range of sensor 2 |
| Range | -3200 to +3200 Engineering units (max. G4.3.7) |
| Default value | +0.08ar |
| Set on run | YES |
| Modbus address | 40255 |
| Modbus range | -3200 to 3200 (max. G4.3.7) |
| Read/Write | YES |
| Function | It allows setting the minimum units value of the sensor connected to the Analogue Input 2. This value should also correspond to the minimum voltage or current level of the sensor set in 'G4.3.4 $\rightarrow$ Minimum range of Analogue Input 2'. |
| Note: | The setting of this parameter should be checked if the sensor units are changed in parameter 'G4.3.2 $\rightarrow$ Selection of sensor 2 units'. It is necessary to set this value to operate in open loop and closed loop. |
| Note: | This parameter will be only available if ' $\mathrm{G} 4.3 .1 \rightarrow$ To enable sensor of Analogue Input 2 ' is set to ' $Y$ '. |

G4.3.6 MAXIMUM RANGE OF ANALOGUE INPUT 1

| Screen | $6 \mathrm{INmax} 2=+20 \mathrm{~mA}$ |
| :---: | :---: |
| Extended info. | AN2 HIGH RANGE |
| Description | Maximum range of the Analogue Input 1 |
| Range | -10 to +10 V (min. G4.3.4) |
|  | +0 to +20mA (min. G4.3.4) |
| Default value | +20mA |
| Set on run | YES |
| Modbus address | 40245 |
| Modbus range | -10000 to +10000 (min. G4.3.4) |
|  | 0 to +20000 (min. G4.3.4) |
| Read / Write | YES |
| Function | It allows setting the maximum voltage or current value for the Analogue Input 2 according to the characteristics of the sensor that is going to be connected. |

G4.3.7 MAXIMUM RANGE OF SENSOR 2

| Screen | $7 \mathrm{Sma} 2=+10.0 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | SENS2 HIGH RANGE |
| Description | Maximum range of sensor 2 |
| Range | -3200 to +3200 Engineering units (min. G4.3.5) |
| Default value | +10.0Bar |
| Set on run | YES |
| Modbus address | 40251 |
| Modbus range | -3200 to 3200 (min. G4.3.5) |
| Read / Write | YES |
| Function | It allows setting the maximum units value of the sensor connected to the Analogue Input 2. This value should also correspond to the maximum voltage or current level of the sensor set in 'G4.3.6 $\rightarrow$ Maximum range of Analogue Input 2'. |
| Note: | The setting of this parameter should be checked if the sensor units are changed in parameter 'G4.3.2 $\rightarrow$ Selection of sensor 2 units'. It is necessary to set this value to operate in open loop and closed loop. |
| Note: | This parameter will be only available if 'G4.3.1 $\rightarrow$ To enable sensor of Analogue Input 2 ' is set to ' $Y$ '. |

## G4.3.8 SPEED FOR THE MINIMUM RANGE OF ANALOGUE INPUT 2

| Screen | 8 SPD LO2 $=+0 \%$ |
| :---: | :---: |
| Extended info. | SPD LO RNG AN2 |
| Description | Speed corresponding to the minimum range of the Analogue Input 2 |
| Range | -250\% to $+250 \%$ (max. G4.3.9) |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 40247 |
| Modbus range | -20480 to 20480 (max. G4.3.9) |
| Read / Write | YES |

Function If the Analogue Input 2 is used for introducing the speed reference (setting of parameter ' $\mathrm{G} 4.3 .1 \rightarrow$ To enable sensor of Analogue Input 2 ' to ' $N$ '), we can set in this parameter the value of this reference corresponding to the minimum voltage or current level set in parameter 'G4.3.4 $\boldsymbol{\rightarrow}$ Minimum range of Analogue Input 2'.

The value set here is a percentage of the motor rated speed ('G2.4 $\boldsymbol{\rightarrow}$ Motor rpm').
See figure 10.20 .

## G4.3.9 SPEED FOR THE MAXIMUM RANGE OF ANALOGUE INPUT 2,

| Screen | 9 SPD HI2 $=+100 \%$ |
| :---: | :---: |
| Extended info. | SPD HIG RNG AN2 |
| Description | Speed corresponding to the maximum range of the Analogue Input 2 |
| Range | $-250 \%$ to $+250 \%$ (min. G4.3.8) |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40243 |
| Modbus range | -20480 to 20480 ( $\mathrm{min} . \mathrm{G4.3.8}$ ) |
| Read / Write | YES |
| Function | If the Analogue Input 1 is used for introducing the speed reference (setting of parameter 'G4.3.1 $\rightarrow$ To enable sensor of Analogue Input 2 ' to ' $N$ '), we can set in this parameter the value of this reference corresponding to the maximum voltage or current level set in parameter ' $\mathrm{G} 4.3 .6 \rightarrow$ Maximum range of Analogue Input 2'. |
|  | The value set here is a percentage of the motor rated speed ('G2.4 $\boldsymbol{\rightarrow}$ Motor rpm'). |
|  | See figure 10.20. |

## G4.3.14 PROTECTION FOR ANALOGUE INPUT 2 LOSS

| Screen | 14 AIN2 LOSS $=\mathbf{N}$ |
| :---: | :---: |
| Description | Protection for the Analogue Input 2 loss |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 40267 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows user to decide about the behaviour of the equipment when the signal connected to the Analogue Input 2 is lost. |
|  | Options: |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Disabled function. |
|  | Drive does not realize any action in case of the analogue input signal is lost. |
|  | $Y \rightarrow$ YES |
|  | Drive will stop generating the fault 'F43 AIN2 LOSS', since the sensor will be considered damaged, when a sharp drop down to zero value in the level of the analogue input signal is detected. |

G4.3.15 ZERO BAND FILTER FOR ANALOGUE INPUT 2

| Screen | 152_Z_BAND $=$ OFF |
| :---: | :---: |
| Extended info. | ANM2 IEROBAND |
| Description | Zero band filter for the Analogue Input 2 |
| Range | OFF $=0.0-2.0 \%$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40271 |
| Modbus range | 0 to 163 |
| Read / Write | YES |
| Function | Setting a value in this parameter, we obtain a filtering of the Analogue Input 2 signal, eliminating a possible electrical noise associated to the signal that impedes reading a zero value when it must be read. |
|  | The aim of this parameter is supplying a pre-defined zero area for controls by analogue inputs, especially for speed control. It eliminates small errors in the reference voltage near to zero reference point. |

See figure 10.21 .
Note: The function of zero band filter is not applied to the reference signals through digital inputs, since these settings are absolute zero

## G4:3.16 LOW PASS FILTER FOR ANALOGUE INPUT 2

| Screen | 16 FILTER2 $=$ OFF |
| :---: | :---: |
| Extended info. | AIN STABIL FILT |
| Description | Low Pass filter for the Analogue Input 2 |
| Range | OFF=0.0-20.0\% |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40275 |
| Modbus range | 0 to 200 |
| Read / Write | YES |
| Function | It allows filtering the signal of the Analogue Input 2. By setting the value of this time constant we can eliminate possible instabilities in the value of the same ones due to noise, wiring faults, etc. |

Note: When applying a Low Pass filter to any analogue signal, a delay time in the own signal is generated. This delay time is the value of the configured time constant approximately.

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### 10.4.4. Subgroup 4.4 - S4.4: Pulse Input

This input is used for the flow limitation algorithm. See subgroup S25.10 Flow Limitation Algorithm.
For using this input you must have a flow meter with a pulse digital output of pulsewidth greater than 50 ms .

| G4.4.1 SENSOR UNITS OF PULSE INPUT |  |
| :---: | :---: |
| Screen | 1 Sensr U = I/m |
| Description | Sensor units of pulse input |
| Range | \%, l/s, $\mathrm{m}^{3} / \mathrm{s}, \mathrm{l} / \mathrm{m}, \mathrm{m}^{3} / \mathrm{m}, \mathrm{l} / \mathrm{h}, \mathrm{m}^{3} / \mathrm{h}, \mathrm{m} / \mathrm{s}, \mathrm{m} / \mathrm{m}, \mathrm{m} / \mathrm{h}$ |
| Default value | $1 / \mathrm{m}$ |
| Set on run | YES |
| Modbus address | 40581 |
| Modbus range | 0 to 9 |
| Read / Write | YES |
| Function | It allows selecting the units of measurement for reading the flow. |

G4.4.2 FLOWMETER CONFIGURATION

| Screen | $2 \mathrm{PIs} / \mathrm{s}=1001 / \mathrm{s}$ |
| :---: | :---: |
| Extended info. | LQUAMOUNTIPULS |
| Description | Flowmeter configuration |
| Range | 0 to 32760 Flow units |
| Default value | 1001/s |
| Set on run | YES |
| Modbus address | 40582 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows setting the amount of the fluid per pulse received. |
|  | For example, if setting is ' $1001 / \mathrm{s}$ ' (default value) and the present flow is $5001 / \mathrm{s}, 5$ pulses per second will be received. |

G4.4.3, MAXIMUMRANGE OF FLOWHETER.

| Screen | $3 \mathrm{M} \mathrm{Rng}=10001 / \mathrm{s}$ |
| :---: | :---: |
| Extended info. | ELOW MAX RANGE |
| Description | Maximum range of flowmeter |
| Range | 0 to 32760 Flow units |
| Default value | 10001/s |
| Set on run | YES |
| Modbus address | 40583 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows setting the maximum range of the flowmeter. It is used to calculate the reset level of the flow control algorithm. The percentage set in 'G25.10.4 $\rightarrow$ Flow percentage to reset algorithm' is linked to the value set in this parameter. |
|  | For example, if 100 units are set as maximum range in this parameter, and we want that the reset level of the flow algorithm is below 30 units, then G25.10.4 should be set to ' $30 \%$ '. |

### 10.5. Group 5 - G5: Acceleration and Deceleration Ramps

## G5.1 ACCELERATION RAMP 1

| Screen | 1 ACCE1 $=3.0 \% / \mathrm{s}$ |
| :--- | :--- |
| Extended info. | INTHL ACCEL |
| Description | Acceleration ramp 1 |
| Range | $0.01-650 \% / \mathrm{s}$ |
| Default value | $3.0 \% / \mathrm{s}$ |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 3 9 2}$ |
| Modbus range | 10 to 65000 |
| Read / Write | YES |

Function It allows user to set the acceleration ramp 1 according to the requirements of each process.

The setting is in acceleration units (increase in \% of speed per second). For example, an acceleration ramp of $10 \% /$ s means that the drive increases its speed by $10 \%$ of motor rated speed per each second elapsed. If parameter 'G5.5 $\rightarrow$ Speed for acceleration ramp change' is set to 'OFF', drive will search the reference speed by following the acceleration pattern set in this parameter.

See figures 10.22 and 10.23
For instance, we have a motor of 50 Hz and 4 poles with a synchronism rated speed of 1500 rpm . If we set the acceleration ramp to $5 \% / \mathrm{s}$, motor will take 20 seconds to reach the $100 \%$ of its speed ( 1500 rpm ) from $0 \%$ (motor is completely stopped at the beginning).

Note: Usually, it should be used slower settings supported by the application. An acceleration ramp too much fast can cause equipment overload (ILT status), making that this ramp is ignored and replaced with a slower ramp automatically.

To get a better programming you must be realistic with these settings. If you need fast accelerations and/or decelerations, we advise you to use slower settings firstly until the remaining operations are checked.

| G5.2 | DECELERATION RAAAP 1 |
| :--- | :--- |
| Screen |  |
| Extended info. | 2 DECEL1 $=3.0 \% / \mathrm{s}$ |
| Description | Deceleration ramp 1 |
| Range | $0.01-650 \% / \mathrm{s}$ |
| Default value | $3.0 \% / \mathrm{s}$ |
| Set on run | YES |
| Modbus address | 40394 |
| Modbus range | 10 to 65000 |
| Read / Write | YES |

Function It allows user to set the deceleration ramp 1 according to the requirements of each process.

The setting is in deceleration units (decrease in \% of speed per second). For example, a deceleration ramp of $10 \% / \mathrm{s}$ means that the drive decreases its speed by $10 \%$ of motor rated speed per each second elapsed. If parameter 'G5.6 $\rightarrow$ Speed for deceleration ramp change' is set to 'OFF', drive will search the reference speed by following the deceleration pattern set in this parameter.

See figures 10.22 and 10.23 .
Note: Usually, it should be used slower settings supported by the application. A deceleration ramp too much fast can cause motor regeneration to the drive (VLT). For this, drive will replace the set ramp with a slower ramp automatically.

To get a better programming you must be realistic with these settings. If you need fast accelerations and/or decelerations, we advise you to use slower settings firstly until the remaining operations are checked.

## G5.3. ACCELERATION RAMP 2

| Screen | 3 ACCE 2 $=1.0 \% / \mathrm{s}$ |
| :--- | :--- |
| Extended info. | SACOOND ACCELE |
| Sescription | Acceleration ramp 2 |
| Range | $0.01-650 \% / \mathrm{s}$ |
| Default value | $1.0 \% / \mathrm{s}$ |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 3 9 3}$ |
| Modbus range | 10 to 65000 |
| Read $/$ Write | YES |

Function It allows user to set the alternative acceleration ramp according to the requirements of each process.

The setting is in acceleration units (increase in \% of speed per second). For example, an alternative acceleration ramp of $10 \% / \mathrm{s}$ means that the drive increases its speed by $10 \%$ of motor rated speed per each second elapsed. If parameter 'G5.5 $\rightarrow$ Speed for acceleration ramp change' is set to a specific value, drive will search the reference speed by following the acceleration pattern set in parameter 'G5.1 $\rightarrow$ Acceleration ramp 1', and once reached the change speed, drive will continue the search of the reference speed by applying the alternative acceleration pattern set in this parameter.

See parameter 'G5.1 $\rightarrow$ Acceleration ramp 1' for additional information.
See figures 10.22 and 10.23 .

| G5.4 D | ELERATION RABAP 2 |
| :---: | :---: |
| Screen | 4 DECEL2 $=1.0 \% / \mathrm{s}$ |
| Extended info. | SECOND DECELE |
| Description | Deceleration ramp 2 |
| Range | 0.01 -650\%/s |
| Default value | 1.0\%/s |
| Set on run | YES |
| Modbus address | 40395 |
| Modbus range | 10 to 65000 |
| Read / Write | YES |

Function It allows user to set the alternative deceleration ramp according to the requirements of
each process.
The setting is in deceleration units (decrease in $\%$ of speed per second). For example,
an alternative deceleration ramp of $10 \% / \mathrm{s}$ means that the drive decreases its speed by
$10 \%$ of motor rated speed per each second elapsed. If parameter ' $G 5.6 \rightarrow$ Speed for
deceleration ramp change' is set to a specific value, drive will search the reference
speed by following the deceleration pattern set in parameter ' $\mathrm{G} 5.2 \rightarrow$ Deceleration
ramp 1 ', and once reached the change speed, drive will continue the search of the
reference speed by applying the alternative deceleration set in this parameter.

See parameter 'G5.2 $\rightarrow$ Deceleration ramp 2' for additional information.
See figures 10.22 and 10.23.

## G5.5 SPEED FOR ACCELERATIONRANAP CHANGE

| Screen | $5 \mathrm{BRK} A C C=O F F$ |
| :---: | :---: |
| Extended info. | BREAKPOINT ACL |
| Description | Speed for acceleration ramp change |
| Range | OFF, 0 to 250\% |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40396 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows using the alternative acceleration ramp (parameter G5.3). <br> When drive is accelerating and the speed set in this parameter is reached, drive will start to apply the alternative acceleration ramp from that moment on. If this parameter is set to 'OFF' (default value), drive will only apply the acceleration ramp 1 (parameter G5.1). |

Note: The alternative acceleration ramp can be selected independently of drive speed. This selection can be realized through digital inputs (by configuring one of them with the option ' $14 \rightarrow$ ACC/DEC 2 ') or by using the output functions of comparators (for example, if the magnitude of the comparator is the drive rated current, when the drive output current exceeds a defined level, calculated as \% of $\ln$, a ramp change occurs)

See figures 10.22 and 10.23 .

## G5.6 SPEED FOR DECELERATION RAMAP CHANGE

| Screen | 6 BRK DEC $=$ OFF |
| :--- | :--- |
| Extended info. | BREAKPOINT DCL |
| Description | Speed for deceleration ramp change |
| Range | OFF, 0 to $250 \%$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40397 |
| Modbus range | 0 to 20480 |
| Read $/$ Write | YES |

Function It allows using the alternative deceleration ramp (parameter G5.4).
When the drive is decelerating and the speed set in this parameter is reached, drive will start to apply the alternative deceleration ramp from that moment on. If this parameter is set to 'OFF' (default value), drive will only apply the deceleration ramp 1 (parameter G5.2).

Note: The alternative deceleration ramp can be selected independently of drive speed. This selection can be realized through digital inputs (by configuring one of them with the option ' $14 \rightarrow$ ACC/DEC 2') or by using the output functions of comparators (for example, if the magnitude of the comparator is the drive rated current, when the drive output current is below a defined level, calculated as $\%$ of $\ln$, a ramp change occurs).

See figures 10.22 and 10.23 .


Figure 10.22 Main and alternative acceleration /deceleration ramps


| G5.1 $\rightarrow$ Acceleration ramp 1 | $=5 \% / \mathrm{s}$ |
| :--- | :--- |
| G5.2 $\rightarrow$ Deceleration ramp 1 | $=10 \% / \mathrm{s}$ |
| G5.3 $\rightarrow$ Acceleration ramp 2 | $=25 \% / \mathrm{s}$ |
| G5.4 $\rightarrow$ Deceleration ramp 2 | $=30 \% / \mathrm{s}$ |
| G5.5 $\rightarrow$ Speed for accel. ramp change | $=25 \% / \mathrm{s}$ |
| G5.6 $\rightarrow$ Speed tor decel. ramp change | $=60 \% / \mathrm{s}$ |

Figure 10.23 Application example of main and alternative acceleration / deceleration ramps

| G5.7 R/ | AP 1 OF REFERENCE INCREASE FOR MOTORIZED POTENTIOMETER |
| :---: | :---: |
| Screen | 7 MPT INC1 $=1.0 \% / \mathrm{s}$ |
| Extended info. | MOTOPOTINCI |
| Description | Ramp 1 of reference increase for motorized potentiometer function |
| Range | 0.01-650\%/s |
| Default value | 1.0\%/s |
| Set on run | YES |
| Modbus address | 40400 |
| Modbus range | 10 to 65000 |
| Read / Write | YES |
| Function | It allows setting the ramp 1 of reference increase for motorized potentiometer function. |
|  | This function is configured in 'G4.1.4 $\rightarrow$ Selection of digital inputs configuration' with the option ' $4 \rightarrow$ MOTORIZED POT' or ' $5 \rightarrow$ ERASAB POT'. Additionally, it is necessary to set 'G3.1 $\rightarrow$ Reference source 1 of speed' or 'G3.2 $\rightarrow$ Reference source 2 of speed' with the option 'PMOT' depending on the selected source is 1 or 2. |
|  | With this function, user can introduce the speed reference by means of two push buttons connected to the digital inputs DI5 (up or increase the speed reference) and DI6 (down or decrease the speed reference). |
|  | While we press 'Up' push button, we can increase the speed by applying up to two different ramps previously set (ramps 1 and 2 of reference increase). The ramp change is set in parameter 'G5.11 $\rightarrow$ Speed for ramp change with motorized potentiometer'. If G5.11 is set to 'OFF', any ramp change will not be done. In this case, the drive will search the reference speed by only applying the ramp 1 for reference increase of motorized potentiometer set in this parameter. |
|  | Setting is realized in acceleration units (increase in \% of speed per second). |
|  | See figure 10.24. |


| G5.8 R | P 1 OF REFERENCE DECREASE FOR MOTORIZED POTENTIOMETER |
| :---: | :---: |
| Screen | 8 MPT DEC1 $=3.0 \% / \mathrm{s}$ |
| Extended info. | MOTOPOTDECI |
| Description | Ramp 1 of reference decrease for motorized potentiometer function |
| Range | 0.01-650\%/s |
| Default value | 3.0\%/s |
| Set on run | YES |
| Modbus address | 40399 |
| Modbus range | 10 to 65000 |
| Read / Write | YES |

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| Function | It allows setting the ramp 1 of reference decrease for motorized potentiometer function |
| :---: | :---: |
|  | This function is configured in 'G4.1.4 $\boldsymbol{\rightarrow}$ Selection of digital inputs configuration' with the option ' $4 \rightarrow$ MOTORIZED POT' or ' $5 \rightarrow$ ERASAB POT'. Additionally, it is necessary to set ' $\mathrm{G} 3.1 \rightarrow$ Reference source 1 of speed' or 'G3.2 $\rightarrow$ Reference source 2 of speed' with the option 'PMOT' depending on the selected source is 1 or 2 . |
|  | With this function, user can introduce the speed reference by means of two push buttons connected to the digital inputs DI5 (up or increase the speed reference) and DI6 (down or decrease the speed reference). |
|  | While we press 'Down' push button, we can decrease the speed by applying up to two different ramps previously set (ramps 1 and 2 of reference decrease). The ramp change is set in parameter ' $\mathrm{G} 5.11 \rightarrow$ Speed for ramp change with motorized potentiometer'. If G5.11 is set to 'OFF', any ramp change will not be done. In this case, the drive will search the reference speed by only applying the ramp 1 for reference decrease of motorized potentiometer set in this parameter. |
|  | Setting is realized in deceleration units (decrease in \% of speed per second). |
|  | See figure 10.24. |

## G5.9_RAMP 2 OF REFERENCE INCREASE FOR MOTORIZED POTENTIOMETER

Screen $\quad 9$ MPT INC2 $=1.0 \% / \mathrm{s}$

## Extended info <br> MOTO POT INC2

Description
Range
Default value
0.01 - $650 \% / \mathrm{s}$
1.0\%/s

Set on run YES
Modbus address 40398
Modbus range 10 to 65000
Read / Write
YES
Function It allows setting the ramp 2 of reference increase for motorized potentiometer function.
This function is configured in 'G4.1.4 $\rightarrow$ Selection of digital inputs configuration' with the option ' $4 \rightarrow$ MOTORIZED POT' or ' $5 \rightarrow$ ERASAB POT'. Additionally, it is necessary to set ' $\mathrm{G} 3.1 \rightarrow$ Reference source 1 of speed' or ' $\mathrm{G} 3.2 \rightarrow$ Reference source 2 of speed' with the option 'PMOT' depending on the selected source is 1 or 2 .

With this function, user can introduce the speed reference by means of two push buttons connected to the digital inputs D15 (up or increase the speed reference) and DI6 (down or decrease the speed reference).

While we press 'Up' push button, we can increase the speed by applying up to two different ramps previously set (ramps 1 and 2 of reference increase). The ramp change is set in parameter ' $G 5.11 \rightarrow$ Speed for ramp change with motorized potentiometer'. The drive will apply the ramp 1 until the speed exceeds the value set in G5.11. From that moment on, drive will start to apply the ramp 2 . If G 5.11 is set to 'OFF', any ramp change will not be done, and the drive will search the reference speed by only applying the ramp 1 for reference increase of motorized potentiometer set in this parameter.

Setting is realized in acceleration units (increase in \% of speed per second).
See figure 10.24 .

| G5.10 RAMAP 2 OF REFERENCE DECREASE FOR MOTORIZED POTENTIOMETER |  |
| :---: | :---: |
| Screen | 10 MPT DEC2 $=3.0 \% / \mathrm{s}$ |
| Extended info. | MOTO POT DEC2 |
| Description | Ramp 2 of reference decrease for motorized potentiometer function |
| Range | 0.01-650\%/s |
| Default value | 3.0\%/s |
| Set on run | YES |
| Modbus address | 40401 |
| Modbus range | 10 to 65000 |
| Read / Write | YES |
| Function | It allows setting the ramp 2 of reference decrease for motorized potentiometer function. |
|  | This function is configured in ' $\mathrm{G} 4.1 .4 \rightarrow$ Selection of digital inputs configuration' with the option ' $4 \rightarrow$ MOTORIZED POT' or ' $5 \rightarrow$ ERASAB POT'. Additionally, it is necessary to set 'G3.1 $\rightarrow$ Reference source 1 of speed' or ' $\mathrm{G} 3.2 \rightarrow$ Reference source 2 of speed' with the option 'PMOT' depending on the selected source is 1 or 2 . |
|  | With this function, user can introduce the speed reference by means of two push buttons connected to the digital inputs DI5 (up or increase the speed reference) and DI6 (down or decrease the speed reference). |
|  | While we press 'Up' push button, we can decrease the speed by applying up to two different ramps previously set (ramps 1 and 2 of reference decrease). The ramp change is set in parameter ' $G 5.11 \rightarrow$ Speed for ramp change with motorized potentiometer'. The drive will apply the ramp 1 until the speed is below the value set in G5.11. From that moment on, drive will start to apply the ramp 2. If G5. 11 is set to 'OFF', any ramp change will not be done, and the drive will search the reference speed by only applying the ramp 1 for reference decrease of motorized potentiometer set in this parameter. |
|  | Setting is realized in deceleration units (decrease in \% of speed per second). |
|  | See figure 10.24. |
| G5.11 SPEED FOR RAMP CHANGE WITH MOTORIZED.POTENTIOMETER |  |
| Screen | 11 MPOT BRK = OFF |
| Extended info. | MOTO POT BRKPOIN |
| Description | Speed for increase / decrease ramps change with motorized potentiometer |
| Range | OFF=0 to $250 \%$ (of speed reference) |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40402 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | This parameter allows using the alternative ramps of reference increase and decrease with motorized potentiometer function, selected in 'G4.1.4 $\rightarrow$ Selection of digital inputs configuration' with the option ' $4 \rightarrow$ MOTORIZED POT' or ' $5 \rightarrow$ ERASAB POT', and also set 'G3.1 $\rightarrow$ Reference source 1 of speed' or 'G3.2 $\rightarrow$ Reference source 2 of speed' with the option 'PMOT' depending on the selected source is 1 or 2 . |
|  | Change speed is set in this parameter. When the speed is above or below the change speed, drive will start to apply the alternative ramps. If this parameter is set to 'OFF', any ramp change will not be done, this is, drive only applies the ramps set in 'G5.7 $\rightarrow$ Ramp 1 of reference increase for motorized potentiometer' and 'G5.8 $\rightarrow$ Ramp 1 of reference decrease for motorized potentiometer'. |

See figure 10.24.


Figure 10.24 Main and alternative acceleration / deceleration ramps of motorized potentiometer

G5.12 TIME CONSTANT TO FILTER THE SPEED
Screen 12 SP FLT $=0.250$ s

Extended info. SMOOT SPD FILTER

| Description | Time constant for the filtering of speed signal |
| :--- | :--- |
| Range | $0.000-60.0 \mathrm{~s}$ |

Refaut value 0.250 s
Default value 0.250s
Set on run YES
Modbus address 40403
Modbus range 0 to 60000
Read/Write YES
Function It provides with S - Curve filter for the speed reference changes, including Start/Stop commands. The S - Curve filter limits acceleration and deceleration changes by making soft.

It is especially useful in cranes and elevators
Note: If different value is not required, set to default value. A value different to ' 0 ' will affect to the system response

### 10.6. Group 6 - G6: PID Control

SDRIVE 700 is provided with a PID regulator that allows controlling automatically a process which depends on the physical variable according to the motor speed (for example, pressure, flow, height, current, temperature, etc.). The functions of PID regulator will be set in the parameters of this group, after enabling the PID regulator in parameters ' $\mathrm{G} 3.1 \rightarrow$ Reference source 1 of speed' or ' $\mathrm{G} 3.2 \rightarrow$ Reference source 2 of speed' (option 'PID').
The PID regulator operates correctly with factory settings, nevertheless, if you want to optimize the setting, you can follow the next steps:

- Increase the proportional gain (parameter G6.3) until the first oscillation is taken place; then, set it to $40 \%$ of the value in which the oscillation occurred.
- Decrease the integration time (parameter G6.4) until the first oscillation is taken place; then, set it to $150 \%$ of the value in which the oscillation occurred.
- Increase the derivation time (parameter G6.5) until achieving a small impulse without occurring oscillation. Usually, derivation time does not exceed $25 \%$ of integration time.

| G6.1 SOURCE SELECTION FOR INTRODUCING REFERENCE SIGNAL |  |
| :---: | :---: |
| Screen | 1 SEL REF = MREF |
| Description | Selection of introduction source for PID regulator setpoint |
| Range | NONE |
|  | Al1 |
|  | A12 |
|  | RESERV |
|  | MREF |
|  | LOCAL |
|  | locPID |
|  | (See 'Function' for additional information) |
| Default value | MREF |
| Set on run | YES |
| Modbus address | 40142 |
| Modbus range | 0 to 6 |
| Read / Write | YES |
| Function | It allows user to select the source for introducing the setpoint of PID regulator. |
|  | Selection options: |
|  | NONE $\quad \rightarrow$ Source disabled. |
|  | Al1 $\quad \rightarrow$ Setpoint of PID regulator is introduced by Analogue Input 1. |
|  | $\mathrm{Al2} \rightarrow$ Setpoint of PID regulator is introduced by Analogue Input 2. |
|  | RESERV $\rightarrow$ Reserved for future use. |
|  | MREF $\quad \rightarrow$ Setpoint of PID regulator is introduced by means of digital inputs configured as multi-references (see parameter ' $\mathrm{G} 4.1 .4 \rightarrow$ Selection of digital inputs configuration', and 'G3.1 $\rightarrow$ Reference source 1 of speed' or 'G3.2 $\rightarrow$ Reference source 2 of speed'). |
|  | LOCAL $\rightarrow$ Setpoint of PID regulator is introduced by keypad. Value adjusted in ' $\mathrm{G} 3.3 \rightarrow$ Local speed reference'. |
|  | locPID $\quad \rightarrow$ Setpoint of PID regulator is introduced by keypad. Value adjusted in 'G6.2 $\rightarrow$ PID local reference'. It allows having two speed references set from keypad, since 'G3.3 $\rightarrow$ Local speed reference' is not modified when this parameter is adjusted. |


| G6.2 PID LOCAL REFERENCE |  |
| :---: | :---: |
| Screen | 2 PID LOC = +0.0\% |
| Extended info. | PIDLOCAL SETPOI |
| Description | Local reference for PID regulator |
| Range | +0.0\% to +400\% |
| Default value | +0.0\% |
| Set on run | YES |
| Modbus address | 40149 |
| Modbus range | 0 to 32760 |
| Read/Write | YES |
| Function | Setpoint value of PID regulator is set in this parameter when option 'locPID' is selected in parameter 'G6.1 $\rightarrow$ Source selection for introducing reference signal'. |
|  | The value of parameter ' $\mathrm{G} 3.3 \rightarrow$ Local speed reference' is not modified when a setpoint value of PID regulator is set here. Parameter G3.3 together with this one, offer the possibility of having two references or setpoints adjusted from keypad for PID regulator. |
| Note: | This parameter will only be available if ' $\mathrm{G} 6.1 \rightarrow$ Source selection for introducing reference signal' is set to 'locPID'. |
| G6.3 SELECTION OF FEEDBACK:SIGNAL SOURCE |  |
| Screen Description Range | 3 SEL FBK = Al2 |
|  | Selection of feedback signal source for PID regulator |
|  | NONE |
|  | Al1 |
|  | Al2 |
|  | RESERV |
|  | (See 'Function' for additional information) |
| Default value Set on run | Al2 |
|  | YES |
| Modbus address Modbus range Read / Write | 40143 |
|  | 0 to 3 |
|  | YES |
| Function | It allows selecting the source through which the feedback signal will be introduced to close the control loop. |
|  | Selection options are the following ones: |
|  | NONE $\quad \rightarrow$ The PID function is not active. |
|  | Al1 $\quad \rightarrow$ Feedback signal introduced through the Analogue Input 1. |
|  | Al2 $\quad \rightarrow$ Feedback signal introduced through the Analogue Input 2. |
|  | RESERV $\rightarrow$ Reserve. |

G6.4 PROPORTIONAL GAIN OF PID CONTROL

| Screen | 4 GAIN Kp $=8.0$ |
| :---: | :---: |
| Extended info. | PID PROPORTIONAL |
| Description | Proportional gain of PID control |
| Range | 0.1 to 20 |
| Default value | 8.0 |
| Set on run | YES |
| Modbus address | 40144 |
| Modbus range | 1 to 200 |
| Read / Write | YES |
| Function | It allows setting the proportional gain of PID regulator. |
| Note: | Usually, default value is enough for a good control. If a higher control response is required, increase this value. An increase of this value can introduce a higher instability to the system. |

## G6.5 INTEGRATION TIME OF PID.CONTROL

| Screen | $5 \mathrm{INTEGRAL}=0.0 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | PIDINIEGRAL |
| Description | Integral time of PID control |
| Range | 0.0-1000s, Max. |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 40145 |
| Modbus range | 0 to 10000, 10001 |
| Read / Write | YES |

Function It allows setting the integration time of PID control.
Note: Usually, default value is enough for a good control. If this value is increased, system accuracy is improved, but its response can become slower.

| G6.6 DE | IVATION TIME OF PID CONTROL |
| :---: | :---: |
| Screen | 6 DIFFEREN $=0.0 \mathrm{~s}$ |
| Extended info. | PID DIFFERENTIAL |
| Description | Derivation time of PID control |
| Range | 0.0-250s |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 40146 |
| Modbus range | 0 to 2500 |
| Read / Write | YES |
| Function | It allows setting the derivation time of PID control. |
| Note: | Usually, default value is enough for a good control. If this value is increased, then the system response is increased, but accuracy can decrease. |


| G6.7 PID OUTPUT INVERSION |  |
| :---: | :---: |
| Screen | 7 INVERT PID = N |
| Description | Inversion of PID regulator output |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | NO |
| Modbus address | 40147 |
| Modbus range | 0 to 1 |
| Read/ Write | YES |
| Function | It allows inverting the output of PID regulator. |
|  | Options: |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  |  |
|  | PID regulator responds in normal mode. When the feedback signal value is above the reference signal value, speed will be decreased. If the feedback signal is below the reference signal, speed will be increased. |
|  | In short, PID regulator responds with a speed increase from a feedback signal drop. This one is the normal setting when PID regulator is used for example, in a constant pressure control application. A pressure drop (feedback) due to a higher demand requires a speed increase of the pump to maintain the pressure. |
|  | $Y \rightarrow$ YES |
|  | Inversion enabled. |
|  | PID regulator responds in inverse mode. When the feedback signal value is above the reference signal value, speed will be increased. If the feedback signal is below the reference signal, speed will be decreased. |
|  | This means that PID regulator response from a feedback signal drop is a decrease of the output speed. This is the typical response required when, for example, PID regulator is used for temperature control. A temperature decrease (feedback) due to a lower demand requires that fan speed decreases to maintain the temperature. |
| G6:B PID CONTROL ERROR |  |
| Screen | 8 ERR PID $=+\mathbf{0} 0 \%$ |
| Description | PID control error |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | 40148 |
| Modbus range | - |
| Read / Write | Read Only |
| Function | It shows the difference between the reference or setpoint value of PID regulator (source of which is set in 'G6.1 $\rightarrow$ Source selection for introducing reference signal') and the feedback signal value of the process (source of which is set in 'G6.3 $\rightarrow$ Selection of feedback signal source'). |
|  | This parameter is read only. |

### 10.7. Group 7 - G7: Start / Stop Mode Configuration

| G7.1 STOPMODE 1 |  |
| :---: | :---: |
| Screen | 1 STOP 1 = RAMP |
| Description | Stop mode 1 |
| Range | RAMP |
|  | SPIN |
| Default value | RAMP |
| Set on run | YES |
| Modbus address | 40003 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows selecting the main stop mode of drive. The selected option must be the appropriate one for each application. |
|  | Selection options: |
|  | RAMP <br> $\rightarrow$ Drive will stop by applying a frequency ramp to stop the motor, this is, drive applies a 'zero' speed reference and decelerates down to that speed according to the pattern set in ' $\mathrm{G} 5.2 \rightarrow$ Deceleration ramp 1'. |
|  | SPIN $\quad \rightarrow$ Drive will turn off the output voltage to the motor and this one will stop by inertia. Stopping time is determined by system inertia. This stop option is recommended for applications with big inertias (mills, fans, crushers, etc.), with the purpose of avoiding possible motor regeneration to the drive. |

Note: $\quad$ Stop mode 1 or 2 (parameter G7.2) can be selected through a digital input (by configuring a digital input with options '02 $\rightarrow$ STOP1' or '04 $\rightarrow$ STOP1 - RESET' for stop mode 1, or with options '19 $\rightarrow$ STOP (2)' or '03 $\rightarrow$ STOP2 - RESET' for stop mode 2, in parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration') or by configuring the output function of one of the comparators (options '02 $\rightarrow$ STOP 1' and ' $03 \rightarrow$ STOP 2 ' in parameter 'G9.1.9 $\rightarrow$ Selection of output function for Comparator 1', 'G9.2.9 $\rightarrow$ Selection of output function for Comparator 2' or 'G9.3.9 $\rightarrow$ Selection of output function for Comparator 3'), or automatically by setting a changing speed in ' $\mathrm{G} 7.3 \rightarrow$ Changing speed for stop mode'.

See figures 10.25 and 10.27 .

| G7.2 | STOP MODE 2 |
| :--- | :--- |
| Screen | 2 STOP 2 = SPIN |
| Description | Stop mode 2 |
| Range | RAMP |
|  | SPIN |
| Default value | SPIN |
| Set on run | YES |
| Modbus address | 40004 |
| Modbus range | 0 to 1 |
| Read / Write | YES |

Function It allows selecting the alternative stop mode of drive. The selected option must be the appropriate one for each application.

See parameter 'G7.1 $\rightarrow$ Stop mode 1' to obtain information about selection options.
Note: $\quad$ Stop mode 1 or 2 (parameter G7.2) can be selected through a digital input (by configuring a digital input with options '02 $\rightarrow$ STOP1' or '04 $\rightarrow$ STOP1 - RESET' for stop mode 1, or with options '19 $\rightarrow$ STOP (2)' or '03 $\rightarrow$ STOP2 - RESET' for stop mode 2, in parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration') or by configuring the output function of one of the comparators (options '02 $\rightarrow$ STOP 1' and '03 $\rightarrow$ STOP 2' in parameter $' G 9.1 .9 \rightarrow$ Selection of output function for Comparator 1 ', 'G9.2.9 $\rightarrow$ Selection of output function for Comparator 2 ' or ' $\mathrm{G} 9.3 .9 \rightarrow$ Selection of output function for Comparator 3 '), or automatically by setting a changing speed in ' $\mathrm{G} 7.3 \rightarrow$ Changing speed for stop mode'.

See figures 10.25 and 10.27

G7.3 CHANGING SPEED FOR STOP MODE

| Screen | 3 BRK STP 2 = OFF |
| :---: | :---: |
| Extended info. | STP2 UNDER SPEED |
| Description | Changing speed for stop mode (from stop by RAMP to Stop by SPIN) |
| Range | OFF=0 to $250 \%$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40005 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | Drive changes the stop mode from RAMP to SPIN by setting this parameter to a value different to zero, when drive is stopping and reaches the speed value set in this parameter. |
|  | We suppose that drive has the stop mode 1 or 2 set by RAMP (depending on the stop mode selected is the main or alternative one) as stop mode selected. When drive receives the stop command, the drive will stop by applying a deceleration ramp from the operating speed (steady status) until reaching the speed set here, and from that moment on, drive will apply the stop mode by SPIN (drive turns off the output to the motor and this one is stopped by inertia) until stopping. If this parameter is set to 'OFF', stop mode change will not be realized. |

See figures 10.25 and 10.27 .
Note: $\quad$ This parameter has only effect when stop mode 1 or 2 (depending on the mode selection) is set to 'RAMP'.


Figure 10.25 Change from stop mode by RAMP to stop mode by SPIN

Note: Stop mode 1 or 2 (parameter G7.2) can be selected through a digital input (by configuring a digital input with options '02 $\rightarrow$ STOP1' or '04 $\rightarrow$ STOP1 - RESET' for stop mode 1 , or with options ' $19 \rightarrow$ STOP $(2)$ ' or ' $03 \rightarrow$ STOP2 - RESET' for stop mode 2, in parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration') or by configuring the output function of one of the comparators (options ' $02 \rightarrow$ STOP 1 ' and ' $03 \rightarrow$ STOP 2 ' in parameter 'G9.1.9 $\rightarrow$ Selection of output function for Comparator 1', 'G9.2.9 $\rightarrow$ Selection of output function for Comparator 2' or 'G9.3.9 $\rightarrow$ Selection of output function for Comparator 3 '), or automatically by setting a changing speed in ' $\mathrm{G} 7.3 \rightarrow$ Changing speed for stop mode'.

| G7.4 | START MODE |
| :--- | :--- |
| Screen | 4 START = RAMP |
| Description | Start mode definition |
| Range | RAMP |
|  | SPIN |
|  | (See 'Function' for additional information) |
| Default value | RAMP |
| Set on run | YES |
| Modbus address | 40002 |
| Modbus range | 0 to 1 |
| Read $/$ Write | YES |
|  |  |
| Function | It allows selecting the main start mode of the motor. |
|  |  |
|  | Selection options: |


| RAMP | Orive will start by applying a frequency ramp to the motor until <br> reaching the speed or setpoint value. <br> See figures 10.26 and 10.27. |
| :--- | :--- |
| SPIN $\quad \rightarrow$In this mode, drive searches the motor shaft speed and the output <br> frequency of the drive is set to match with the actual motor speed. <br> From this point, the motor is accelerated up to the reference speed. <br> This allows starting loads that are already rotating without braking the <br> motor when the drive receives a start command, by accelerating <br> progressively up to reference speed. <br> See figure 10.26. |  | See figure 10.26 .

If starting a load that are already rotating is required (for example, a fan) in a conventional way, several problems can appear due to the motor power supply starts from 0 Hz to the reference frequency (setpoint of speed). This means that rotor would rotate faster that stator and a sudden braking of the load would be generated, due to this, a mechanical blow is produced and its consequent regeneration. If we select the option 'SPIN', then we can start loads in movement avoiding these problems.

Note: When drive starts by 'SPIN', rotation direction applied to the motor is the same rotation direction of reference speed. When speed reference is 0.0 , rotation direction applied to the motor is positive.

The following figure shows the drive behaviour at starting by 'SPIN'. In this case, the starting is due to an input power loss and reestablishment of it again.

Drive can also start in this way if:

- Option 'SPIN' is configured (motor is stopped by inertia) in parameter 'G7.1 $\rightarrow$ Stop mode 1' or ' $\mathrm{G} 7.2 \rightarrow$ Stop mode 2 (depending on the stop mode selection realized before).
- Drive receives the stop command and stars to stop the motor. Drive receives the start command again before motor is stopped completely.


Figure 10.26 Start by 'SPIN' of drive when input power is lost and restored again

## G7.5_START MODE 2

| Screen | 5 START 2 = RAMP |
| :--- | :--- |
| Description | Start mode 2 definition |
| Range | RAMP |
|  | SPIN |
| Default value | RAMP |
| Set on run | YES |
| Modbus address | 40015 |
| Modbus range | 0 to 1 |
| Read / Write | YES |

Function It allows selecting the alternative start mode of the motor.
See parameter 'G7.4 $\rightarrow$ Start mode' to obtain information about selection options.
See figures 10.26 and 10.27 .
Note: Start mode 2 (alternative start mode) is selected through a digital input configured with option '22 $\rightarrow$ START MODE 2 ' (in parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration').
G7.6 START DELAY TIME

| Screen | 6 START DLY $=$ OFF |
| :--- | :--- |
| Extended info. | RETRASO ARRANQUE |
| Description | Start delay time |
| Range | OFF $=0-6500 \mathrm{~s}$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40006 |
| Modbus range | 0 to 65000 |
| Read / Write | YES |
| Function | It allows setting a delay time from the drive receives the start command to begin the <br> motor starting. |

See figure 10.27 .

| G7.7 ST | P DELAY TIME |
| :---: | :---: |
| Screen | 7 STOP DLY = OFF |
| Extended info. | DELAY TO STOP |
| Description | Stop delay time |
| Range | OFF=0-6500s |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40007 |
| Modbus range | 0 to 65000 |
| Read / Write | YES |
| Function | It allows setting a delay time from the drive receives the stop command to begin the motor stopping. |
|  | See figure 10.27. |



```
G7.1 }->\mathrm{ Stop mode 
G7.2 }->\mathrm{ Stop mode 2
G7.3 -> Changing speed for slop mode
G7.4 }->\mathrm{ Sart mooe
G7.6 }->\mathrm{ Start delay lime at - t1, and t:0-4
G7.7 }->\mathrm{ Stoo detay time }\quad=6-4\mathrm{ and tis-102
G7.9 -> Delay time Delween stop and next star = L0-ty
```

Figure 10.27 Parameters representation of group G7

## G7.8 MINIMUM STOP SPEED

| Screen | 8 STP MIN SP = N |
| :--- | :--- |
| Description | Minimum stop speed |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 40008 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
|  |  |
| Function | It allows user the possibility of stopping the motor if the speed reference is below the <br>  |
|  |  |

Options
$\mathrm{N} \rightarrow \mathrm{NO}$
If the drive is decelerating, motor will reach the minimum speed defined as lower speed limit (set in 'G10.1 $\rightarrow$ Minimum speed limit 1' or 'G10.3 $\rightarrow$ Minimum speed limit 2'), even if speed reference is below these settings. For example, if ' $\mathrm{G} 10.1 \rightarrow$ Minimum speed limit 1 ' is set to ' $+30.00 \%$ ', and the speed reference is $+20.00 \%$, then drive will operate at $+30.00 \%$ and not below that value.

If the drive is decelerating and the reference is below the lower speed limit, then drive will stop by spin.
While reference is below this limit, drive will be ready. Once reference exceeds the lower speed limit, the drive will start until reaching the reference value introduced, whenever the start command is activated.

Note: If stopping the motor when reference is below a predefined speed is required, this parameter must be set to ' $Y$ '. Additionally, you must set the correct values in ' $\mathrm{G} 10.1 \rightarrow$ Minimum speed limit 1' or ' $\mathrm{G} 10.3 \rightarrow$ Minimum speed limit 2'.

| G7.9 DE | AY TIME BETWEEN STOP AND NEXT START |
| :---: | :---: |
| Screen | 9 OFFdly $=$ OFF |
| Extended info. | DELAY AFTER STOP |
| Description | Delay time to start after stopping the drive |
| Range | OFF $=0.000-10.000$ s |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40014 |
| Modbus range | 0 to 10000 |
| Read / Write | YES |
| Function | It allows setting a delay time between the moment the drive has stopped and the next starting. |

At the moment of the drive is stopped, it begins to count the time set in this parameter. Several situations can occur:

1. Drive receives the start command after elapsing the minimum time set in this parameter.
In this case, the drive will not count any delay time more at the moment of the starting, whenever any delay time is not set in parameter ' $\mathrm{G} 7.6 \rightarrow$ Start delay time'.
2. Drive receives the start command before elapsing the minimum time set in this parameter.
In this case, if any delay time at the starting has not been set in G7.6, the drive will start immediately after elapsing the minimum time set here.
If a start delay time has been set in G7.6, the drive will begin to count this time from the moment of receiving the start command. If the start delay time elapses before this minimum time, the drive will wait for this minimum time is elapsed to start. If the minimum time elapses before the start delay time, the drive will wait for the start delay time is elapsed to start.

In short, the drive will wait for the time set in this parameter at least before starting.


Figure 10.28 Drive starting and stopping according to the parameters G7.6 and G7.9

## G7.10 RUN AFTER OCCURING POWER LOSS

| Screen | 10 RUN AFTR VFL $=\mathbf{Y}$ |
| :---: | :---: |
| Description | Run after occurring power loss |
| Range | N |
|  | S |
|  | (See 'Function' for additional information) |
| Default value | Y |
| Set on run | YES |
| Modbus address | 40009 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows setting the equipment to start automatically when input power is lost and restored immediately (power supply loss or instant power supply loss). |
|  | Configuration options: |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Drive will not start after recovering input power, even if the start command is activated. User must deactivated the start command and activate again. See figure 10.29 . |
|  | $Y \rightarrow Y E S$ |
|  | Drive will start automatically when input power is restored after power loss occurring, whenever the start command follows activated. <br> See figure 10.30 . |

Note: If Start/Stop control is realized from the keypad, the drive will not start automatically when input power is restored after power loss occurring, since the signal is not kept activated.


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Figure 10.29 Parameter G7.10 set to 'N'. Running does not continue after recovering input power


Figure 10.30 Parameter G7.10 set to ' $Y$ '. Running continues after recovering input power

## G7.11 ACCURACY SETTING FOR STARTING BY SPIN

| Screen | 11 SPNstr B = OFF |
| :---: | :---: |
| Extended info. | SPIN START TUNE |
| Description | Accuracy setting for starting by spin |
| Range | OFF=0, 1 - 100\% |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40017 |
| Modbus range | 0 to 1000 |
| Read / Write | YES |
| Function | It allows setting the accuracy of the speed searching function when the drive starts by SPIN mode. |
|  | Usually, the optimum value is between 2 and $5 \%$. As the value is lower, more accuracy is required. |

## G7.12 DELAY TIME FOR START COMMAND AFTER STOP (2)

| Screen | 12 OFFdly2 = OFF |
| :--- | :--- |
| Extended info. | DELEA AFIER STP2 |
| Description | Delay time for start command after stop (delay time between stop and next start (2)) |
| Range | OFF $=0.0-6500.0 \mathrm{~s}$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40031 |
| Modbus range | 0 to 65000 |
| Read / Write | YES |
| Function | Delay time for start command after producing a stop. If the start command is given <br> after the time set in this parameter has elapsed, the drive will start immediately. |
|  |  |

### 10.8. Group 8 - G8: Outputs

### 10.8.1. Subgroup 8.1 - S8.1: Output Relays

| G8.1.1 SELECTION OF RELAY 1 CONTROL SOURCE |  |
| :---: | :---: |
| Screen | 1 SEL RELAY $1=02$ |
| Description | Selection of the control source for the Relay 1 |
| Range | $00-32$ <br> (See 'Function' for additional information) |
| Default value | 02 |
| Set on run | NO |
| Modbus address | 40362 |
| Modbus range | 0 to 32 |
| Read / Write | YES |
| Function | It allows configuring the operation for Relay 1 according to the following options: |
|  | $00 \rightarrow$ ALWAYS OFF Output is not active. |
|  | $01 \rightarrow$ ALWAYS ON <br> When the drive is powered, the output relay is activated. |
|  | $02 \rightarrow$ NO FAULTS <br> There is no fault in the drive. When a fault occurs, the relay will be activated. |
|  | $03 \rightarrow$ GENERAL FAULT <br> Drive fault or low input voltage will activate the relay. |
|  | $04 \rightarrow$ START |
|  | Relay is active when the drive has received the start command. |
|  | $05 \rightarrow$ RUN |
|  | The relay will be energized after the drive is started. |
|  | $06 \rightarrow$ READY <br> Drive is ready for start (no fault and no warning). |
|  | $07 \rightarrow$ ZERO SPEED <br> Drive is running at zero speed. |
|  | $08 \rightarrow$ SET SPEED <br> Speed has reached the value set as reference. |
|  | $09 \rightarrow$ SP DIRECTION <br> The relay is activated when the speed direction is negative. |
|  | $10 \rightarrow$ RESERVE Reserved for future use. |
|  | $11 \rightarrow$ SPREF DIRECT <br> The relay is activated when the speed reference direction is negative. |
|  | $12 \rightarrow$ RESERVE Reserved for future use. |

$13 \rightarrow$ SP LIMIT
Maximum or minimum speed limit 1 (main limits) has been reached, or maximum or minimum speed limit 2 (alternative limits) has been reached, depending on the selected limits. All of these limits are set in group G10 LIMITS.
$14 \rightarrow$ CURR LIMIT
Limit of motor current adjusted in 'G10.5 $\rightarrow$ Current limit' has been reached.
$15 \rightarrow$ VOLT LIMIT
DC Bus voltage limit has been reached (740V).
$16 \rightarrow$ TORQ LIMIT
Torque limit adjusted in G10.7 has been reached.
$17 \rightarrow$ COMPARATOR1
When the Comparator 1 output is active, relay is activated. See group G9 COMPARATORS
$18 \rightarrow$ COMPARATOR2
When the Comparator 2 output is active, relay is activated. See group G9 COMPARATORS.
$19 \rightarrow$ COMPARATOR3
When the Comparator 3 output is active, relay is activated. See group G9 COMPARATORS
$20 \rightarrow$ ACC / DEC 2
Relay is activated if the alternative acceleration / deceleration ramps are being used. These alternative ramps are set in 'G5.3 $\rightarrow$ Acceleration ramp 2' and ' $\mathrm{G} 5.4 \rightarrow$ Deceleration ramp 2') and are selected through one of the digital inputs (option ' $14 \rightarrow$ ACC/DEC 2 ' in parameter 'G4.1.5 $\rightarrow$ Multifunction Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration'), or by means of the output function of one of the comparators (option '09 $\rightarrow$ ACC / DEC 2' in parameter 'G9.1.9 $\rightarrow$ Selection of output function for Comparator 1 ' to 'G9.3.9 $\rightarrow$ Selection of output function for Comparator $3^{\prime}$ ).
$21 \rightarrow$ REFERENCE 2
Relay is activated if reference 2 ('G3.2 $\rightarrow$ Reference source 2 for speed') has been selected through one of the digital inputs (option ' $15 \rightarrow$ REFERENCE 2 ' in parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration'), or by means of the output function of one of the comparators (option ' $10 \rightarrow$ REFERENCE 2' in parameter 'G9.1.9 $\rightarrow$ Selection of output function for Comparator 1 ' to ' $\mathrm{G} 9.3 .9 \rightarrow$ Selection of output function for Comparator 3').

## $22 \rightarrow$ STOP 2

Relay is activated if stop mode 2 (G7.2) is being used. Stop mode 2 is selected through one of the digital inputs (option '19 $\rightarrow$ STOP 2 ' in parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration'), or by means of the output function of one of the comparators (option '03 $\rightarrow$ STOP 2' in parameter 'G9.1.9 $\rightarrow$ Selection of output function for Comparator 1' to 'G9.3.9 $\rightarrow$ Selection of output function for Comparator 3').


| G8.1.3 OF | DELAY TIME FOR RELAY 1 |
| :---: | :---: |
| Screen | $3 \mathrm{~T} 1 \mathrm{R}^{\text {O }}$ OFF $=0.0 \mathrm{~s}$ |
| Extended info. | R1 DEACTIV DELAY |
| Description | OFF delay time for the Relay 1 |
| Range | 0.0-999s |
| Default value | 0.0 s |
| Set on run | YES |
| Modbus address | 40364 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows user to set a delay time before deactivating the Relay 1. |
|  | If during this time, the deactivation condition disappears, the relay will be not deactivated, this is, the relay will follow activated. |

## G8.1.4 RELAY 1 INVERSION

Screen
Description
Range

Default value Set on run

Modbus address 40365
Modbus range 0 to 1
Read / Write
Function It allows user to invert the logic of the Relay 1.
Relay 1 has one normally open contact (terminals 26/27) and another normally closed contact (terminals 27/28).
$\mathrm{N} \rightarrow \mathrm{NO}$
No inversion.
$Y \rightarrow Y E S$
Inversion of relay logical function.

X2 CONNECTOR


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Figure $10.31 \times 2$ connector. Connections for the outputs relays

| Screen | 5 SEL RELAY $2=03$ |
| :---: | :---: |
| Description | Selection of the control source for the Relay 2 |
| Range | 00-32 |
| Default value | 03 |
| Set on run | NO |
| Modbus address | 40366 |
| Modbus range | 0 to 32 |
| Read / Write | YES |
| Function | It allows configuring the operation of the Relay 2. |
|  | See parameter 'G8.1.1 $\rightarrow$ Selection of Relay 1 control source' to obtain information about the configuration options. |
| G8:1.6 ON DELAY TIME FOR RELAY 2 |  |
| Screen | 6 T R2 ON $=0.0 \mathrm{~s}$ |
| Extended info. | P2 ACTIVAT DELAY |
| Description | ON delay time for the Relay 2 |
| Range | 0.0-999s |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 40367 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows user to set a delay time before activating the Relay 2. |
|  | If during this time, the activation condition disappears, the relay will be not activated. |
| G8.1.7 OFF DELAY TIABE FOR RELAY 2 |  |
| Screen | 7 T R2 OFF $=0.0 \mathrm{~s}$ |
| Extended info. | R2 DEACTIV DELAY |
| Description | OFF delay time for the Relay 2 |
| Range | 0.0-999s |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 40368 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows user to set a delay time before deactivating the Relay 2. |
|  | If during this time, the deactivation condition disappears, the relay will be not deactivated, this is, the relay will follow activated. |


| G8.1.8 RELAY 2 INVERSION |  |
| :---: | :---: |
| Screen | 8 INVERT REL2 $=$ N |
| Description | Logic inversion of the Relay 2 |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | NO |
| Modbus address | 40369 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows user to invert the logic of the Relay 2. |
|  | Relay 2 has one normally open contact (terminals 29/30) and another normally closed contact (terminals 30/31). <br> See figure 10.31 . |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | No inversion. |
|  | $Y \rightarrow Y E S$ |

## G8.1.9 SELECTION OF RELAY 3 CONTROL SOURCE

| Screen | 9 SEL RELAY 3 $=05$ |
| :--- | :--- |
| Description | Selection of the control source for the Relay 3 |
| Range | $00-32$ |
| Default value | 05 |
| Set on run | NO |
| Modbus address | $\mathbf{4 0 3 7 0}$ |
| Modbus range | 0 to 32 |
| Read / Write | YES |
| Function | It allows configuring the operation of the Relay 3. |

## G8.1.10 RETARDO ALA CONEXIÓNDEL RELÉ 3

| Screen | $10 \mathrm{TR3} \mathrm{ON}=0.0 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | R3 ACTIVAT DELAY |
| Description | ON delay time for the Relay 3 |
| Range | 0.0-999s |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 40371 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows user to set a delay time before activating the Relay 3. |
|  | If during this time, the activation condition disappears, the relay will be not activated. |

## G8.1.11 OFF DELAY TIME FOR RELAY 3

| Screen | 11 T R3 OFF $=0.0 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | RS DEACTIV DELAY |
| Description | OFF delay time for the Relay 3 |
| Range | 0.0-999s |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 40372 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows user to set a delay time before deactivating the Relay 3. |
|  | If during this time, the deactivation condition disappears, the relay will be not deactivated, this is, the relay will follow activated. |


| G8.1.12 RELAY 3 INVERSION |  |
| :---: | :---: |
| Screen | 12 INVERT REL3 $=$ N |
| Description | Logic inversion of the Relay 3 |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | NO |
| Modbus address | 40373 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows user to invert the logic of the Relay 3. |
|  | Relay 3 has one normally open contact (terminals $32 / 33$ ) and another normally closed contact (terminals 33/34). <br> See figure 10.31. |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
| No inversion. |  |
|  | $Y \rightarrow$ YES |
|  | Inversion of relay logical function. |


| G8.1.13 SPEED FOR DISCONNECTING RELAY IN OPTION CRANE |  |
| :---: | :---: |
| Screen | 13 CRAspdOF $=+5.0 \%$ |
| Extended info. | CRANE BRKOf SPD |
| Description | Speed for disconnecting the relay in option Crane |
| Range | +0.0\% to $+250 \%$ |
| Default value | +5.0\% |
| Set on run | YES |
| Modbuš address | 40597 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | This parameter allows setting the speed below which, any relay configured with option ' 32 CRANE BRAKE' will be deactivated. |

### 10.8.2. Subgroup 8.2 - S8.2: Analogue Outputs

## G8.2.1 MODE SELECTION FOR ANALOGUE OUTPUT 1

| Screen <br> Description <br> Range | 1 ANLG OUT1 $=01$ <br> Mode selection for the Analogue Output 1 <br> $00-27$ <br> (See 'Function' for additional information) |
| :--- | :--- |
| Default value <br> Set on run | NO <br> Modbus address <br> Modbus range <br> Read / Write | | 40342 <br> 0 to 27 <br> YES |
| :--- |
| Function |$\quad$| It allows user to configure the Analogue Input 1 according to the following options: |
| :--- |

```
12 }->\mathrm{ SPEED REF
            Signal proportional to the speed reference.
            Units: %Motor speed.
13 -> Reserved
            Reserved for future use.
14 }->\mathrm{ PID REFERENCE
                            Signal proportional to the reference in PID mode.
    Units: %.
15 -> PID FEEDBACK
    Signal proportional to the feedback in PID mode.
    Units: %.
16 -> PID ERROR
                            Signal proportional to the error (difference between reference signal and
    feedback signal) in PID mode.
    Units: %.
17 }->\mathrm{ ANLG INPUT 1
    Analogue Input 1 signal is transferred to analogue output.
    Units: %.
18 -> ANLG INPUT 2
    Analogue Input 2 signal is transferred to analogue output.
    Units: %.
19 -> ANLG INPUT 1+2
Signal proportional to the addition of the two inputs. This allows course and
fine setting of the signal.
Units: %
20 -> CURRENT FLOW
Analogue signal proportional to the read flow through analogue input or
pulse input.
Units: %.
21 -> MAX SCALE
It forces the output to the maximum value.
Units: 100% bottom scale.
22 -> ABSOLUT SPEED
Signal proportional to the motor speed without sign (absolute value).
Units: %Motor speed.
27 -> MACRO PUMP
OV = Pump OFF
10V = Pump ON
Units:
Note: This option is not directly programmable by user for any of the analogue outputs. This option is automatically set for Analogue Input 1 when the user enables the fixed pump 4 (in parameter 'G25.9.4 \(\rightarrow\) To enable fixed pump associated to Analogue Output 1'), and it will be automatically set to Analogue Input 2 when the user enables the fixed pump 5 (in parameter 'G25.9.5 \(\rightarrow\) To enable fixed pump associated to Analogue Output 5'). For both outputs, the configuration will always be from 0 to 10 V , where 0 V indicates that pump is disconnected and 10 V indicates that pump is connected.
```

| G8.2.2 FORMAT SELECTION FOR ANALOGUE OUTPUT 1 |  |
| :---: | :---: |
| Screen | 2 FORMT $1=4.20 \mathrm{~mA}$ |
| Description | Format selection for the Analogue Output 1 |
| Range | 0-10V |
|  | $\pm 10 \mathrm{~V}$ |
|  | 0-20mA |
|  | 4-20mA |
| Default value | 4-20mA |
| Set on run | NO |
| Modbus address | 40343 |
| Modbus range | 0 to 3 |
| Read / Write | YES |
| Function | It allows configuring the Analogue Output 1 in one of four possible formats according to the system requirements. |



Figure 10.32 Format of analogue outputs

## G8.2.3 LOW RANGE SELECTION OF ANALOGUE OUTPUT 1

| Screen | 3 MIN1 RNG $=+0 \%$ |
| :---: | :---: |
| Extended info. | minranganaouti |
| Description | Low range selection of Analogue Output 1 |
| Range | -250\% to +250\% |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 40344 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows setting the minimum level of the Analogue Output 1. |
|  | Minimum value setting can be higher than the value of maximum level. This allows the user to achieve inverse scaling. In this way, as the magnitude taken as reference in $'$ 'G8.2.1 $\rightarrow$ Mode selection for Analogue Output 1 ' increases, the output will decrease and vice versa. |
|  | See figure 10.32 . |


| G8.2.4 HIG | H RANGE SELECTION OF ANALOGUE OUTPUT 1 |
| :---: | :---: |
| Screen | 4 MAX1 ${ }^{\text {RNG }}=+100 \%$ |
| Extended info. | MAXRANG ANAOUTI |
| Description | High range selection of Analogue Output 1 |
| Range | $-250 \%$ to $+250 \%$ |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40345 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows setting the maximum level of the Analogue Output 1. |
|  | Maximum value setting can be lower than the value of minimum level. This allows the user to achieve inverse scaling. In this way, as the magnitude taken as reference in 'G8.2.1 $\rightarrow$ Mode selection for Analogue Output 1 ' increases, the output will decrease and vice versa. |
|  | See figure 10.32. |

## G8.2.5 FILTER SELECTION FOR ANALOGUE OUTPUT 1

| Screen | 5FILTER 1 = OFF |
| :--- | :--- |
| Extended info. | FFLTER ANAOUTPU1 |
| Description | Filter selection for the Analogue Output 1 |
| Range | OFF $=0.0-20.0$ s |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40346 |
| Modbus range | 0 to 200 |
| Read / Write | YES |
| Function | It allows selecting a filter for the Analogue Output 1 value and, in the same time, <br> setting a value. |
|  | Sometimes, if the analogue signal appears slightly unstable, improved stability and <br> response can be achieved with the addition of a suitable filter value. |
|  | Note: |
|  | Filter use can add a slight delay to the analogue output signal. |

## G8.2.6 MODE SELECTION FOR ANALOGUE OUTPUT 2

| Screen | $\mathbf{6}$ ANLG OUT2 = 02 |
| :--- | :--- |
| Description | Mode selection for the Analogue Output 2 |
| Range | $00-27$ |
| Default value | 02 |
| Set on run | NO |
| Modbus address | 40347 |
| Modbus range 0 to 27 <br> Read / Write  | YES |
| Function | It allows user to configure the Analogue Input 2. For this, see parameter 'G8.2.1 - |
|  | Mode selection for Analogue Output 1' where different configuration options are listed <br> and explained. |


| G8.2.7 FORMAT SELECTION FOR ANALOGUE OUTPUT 2 |  |
| :---: | :---: |
| Screen | 7 FORMT $2=4.20 \mathrm{~mA}$ |
| Description | Format selection for the Analogue Output 2 |
| Range | 0-10V |
|  | $\pm 10 \mathrm{~V}$ |
|  | 0-20mA |
|  | 4-20mA |
| Default value | 4-20mA |
| Set on run | NO |
| Modbus address | 40348 |
| Modbus range | 0 to 3 |
| Read / Write | YES |
| Function | It allows configuring the Analogue Output $\mathbf{1}$ in one of four possible formats according to the system requirements. |

## G8.2.8 LOW RANGE SELECTION OF ANALOGUE OUTPUT 2

| Screen | 8 MIN2 RNG $=+0 \%$ |
| :---: | :---: |
| Extended info. | MIN RANG ANAOUT2 |
| Description | Low range selection of Analogue Output 2 |
| Range | -250\% to +250\% |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 40349 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |

Function It allows setting the minimum level of the Analogue Output 2.
Minimum value setting can be higher than the value of maximum level. This allows the user to achieve inverse scaling. In this way, as the magnitude taken as reference in ' $\mathrm{G} 8.2 .6 \rightarrow$ Mode selection for Analogue Output 2' increases, the output will decrease and vice versa.

See figure 10.32 .

| G8.2.9 HIGH RANGE SELECTION OF ANALOGUE OUTPUT 2 |  |
| :---: | :---: |
| Screen | $9 \mathrm{MAX2} 2 \mathrm{RNG}=+100 \%$ |
| Extended info. | MAX RANG ANAOUT2 |
| Description | High range selection of Analogue Output 2 |
| Range | -250\% to $+250 \%$ |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40350 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows setting the maximum level of the Analogue Output 2. |
|  | Maximum value setting can be lower than the value of minimum level. This allows the user to achieve inverse scaling. In this way, as the magnitude taken as reference in 'G8.2.6 $\rightarrow$ Mode selection for Analogue Output 2' increases, the output will decrease and vice versa. |
|  | See figure 10.32 . |

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| G8.2.10 FIL | ER SELECTION FOR ANALOGUE OUTPUT 2 |
| :---: | :---: |
| Screen | 10 FILTER $2=$ OFF |
| Extended info. | FILTER AMAOUTPU2 |
| Description | Filter selection for the Analogue Output 2 |
| Range | OFF=0.0-20.0s |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40351 |
| Modbus range | 0 to 200 |
| Read / Write | YES |
| Function | It allows selecting a filter for the Analogue Output 2 value and, in the same time, setting a value. |
|  | Sometimes, if the analogue signal appears slightly unstable, improved stability and response can be achieved with the addition of a suitable filter value. |

Note: Filter use can add a slight delay to the analogue output signal.

Next, we expound some examples about how the analogue outputs must be configured.

## Example 1.

We want to configure Analogue Output 1 as 0 to 10 V output for a sensor to measure the speed motor of 1440 rpm , rotating in inverse direction ( -1440 rpm ), with a range from -3000 rpm to +3000 rpm . Motor rated speed is 1500 rpm .

- Set mode of Analogue Output 1 in $\mathrm{G8} 2.1$ to ${ }^{\prime} 01 \rightarrow$ SPEED MOTOR' (motor speed).
- Select format for Analogue Output 1 in G8.2.2 to ' 0 - 10V'.
- Set minimum and maximum values (high range and low range) of the Analogue Output 1 scale in parameters G8.2.3 (for low range) and G8.2.4 (for high range).
G8.2.3 $\rightarrow$ '-200\%' since -3000 rpm is $-200 \%$ of the motor rated speed (1500rpm)
G8.2.4 $\rightarrow$ ' $+200 \%$ ' since +3000 rpm is $+200 \%$ of the motor rated speed ( 1500 rpm )

$$
\frac{V_{\max }-V_{\min }}{R n g_{\max }-R n g_{\min }} \cdot(\text { Motor speed })+V_{s p d 0}
$$

Where,

| $V_{\text {max }}$ | $\rightarrow$ Maximum voltage of Analogue Output 1 |
| :--- | :--- |
| $V_{\text {min }}$ | $\rightarrow$ Minimum voltage of Analogue Output 1 |
| $R_{n g}$ | $\rightarrow$ Maximum speed of the motor |
| $R_{\text {max }}$ | $\rightarrow$ Minimum speed of the motor |
| $V_{\text {velo }}$ | $\rightarrow$ Output voltage at zero speed of the motor (Orpm) |

Replacing values,

$$
\frac{10-0}{+3000-(-3000)} \cdot(-1440)+5=2.6 \mathrm{~V}
$$

With this setting, the value of the Analogue Output 1 will be 2.6 V when motor rotates in inverse direction at 1440 rpm.


Figure 10.33 Example 1. Analogue Output 1 with format '0-10V'

## Example 2.

Like previous example, now the same motor is rotating at -1440rpm (inverse direction rotation), with a range from -3000 rpm to +3000 rpm and 1500 rpm as rated speed. Analogue Output 1 will be configured as $\pm 10 \mathrm{~V}$ output.

- Set mode of Analogue Output 1 in G8.2.1 to '01 $\rightarrow$ SPEED MOTOR' (motor speed).
- Select format for Analogue Output 1 in G8.2.2 to ' $\pm 10 \mathrm{~V}$ '.
- Set minimum and maximum values (high range and low range) of the Analogue Output 1 scale in parameters G 8.2 .3 (for low range) and G8.2.4 (for high range).
G8.2.3 $\rightarrow$ '-200\%' since -3000 rpm is $-200 \%$ of the motor rated speed (1500rpm) G8.2.4 $\rightarrow$ ' $+200 \%$ ' since +3000 rpm is $+200 \%$ of the motor rated speed ( 1500 rpm )

Then,

$$
\frac{+10-(-10)}{+3000-(-3000)} \cdot(-1440)+0=-4.8 \mathrm{~V}
$$

With this setting, the value of Analogue Output 1 will be -4.8 V when motor rotates in inverse direction at 1440 rpm .


Figure 10.34 Example 2. Analogue Output 1 with format ' $\pm 10 \mathrm{~V}$ '

## Example 3.

We want to configure Analogue Output 2 as 4 to 20 mA output. This analogue value represents the current of the motor, the rated current of which is 20 A with a consumption range from 0 A to 50 A .

- Set mode of Analogue Output 2 in G8.2.6 to '02 $\rightarrow$ CURRENT MOTOR' (motor current).
- Select format for Analogue Output 2 in G8.2.7 to ' 4 - 20mA'.
- Set minimum and maximum values (high range and low range) of the Analogue Output 2 scale in parameters G8.2.8 (for low range) and G8.2.9 (for high range).
G8.2.8 $\rightarrow$ ' $+0 \%$ ' ( 0 A )
G8.2.9 $\rightarrow$ ' $+250 \%$ ' since 50 A is $+250 \%$ of motor rated current (20A)

$$
\frac{I_{\max }-I_{\min }}{R n g_{\max }-R n g_{\min }} \cdot(\text { Motor current })+I_{\text {in } 0}
$$

Where,

| $\mathrm{I}_{\max }$ | $\rightarrow$ Maximum current of Analogue Output 2 |
| :--- | :--- |
| $\mathrm{I}_{\min }$ | $\rightarrow$ Minimum current of Analogue Output 2 |
| $\mathrm{Rng}_{\text {max }}$ | $\rightarrow$ Maximum current of the motor |
| $\mathrm{Rng}_{\min }$ | $\rightarrow$ Minimum current of the motor |
| $\mathrm{I}_{\text {int } 0}$ | $\rightarrow$ Output current when motor current is $0 A$ |

Replacing the values,

$$
\frac{20-4}{50-0} \cdot(20)+4=10.4 m A
$$

With this setting, Analogue Output 2 will supply 10.4 mA when motor current is 20 A .


SD701TCCOO14A

Figure 10.35 Example 3. Analogue Output 2 with format ' $4-20 \mathrm{~mA}$ '

## Example 4.

Now, we want to configure Analogue Output 2 as 0 to 20 mA output, the analogue value of which represents the current of the previous motor, with a rated current of 20 A and a consumption range from 0 A to 50A.

- Set mode of Analogue Output 2 in G8.2.6 to '02 $\rightarrow$ CURRENT MOTOR' (motor current).
- Select format for Analogue Output 2 in G8.2.7 to ' $0-20 \mathrm{~mA}^{\prime}$ '.
- Set minimum and maximum values (high range and low range) of the Analogue Output 2 scale in parameters G8.2.8 (for low range) and G8.2.9 (for high range)
$\mathrm{G} 8.2 .8 \rightarrow$ '+0\%' (OA)
G8.2.9 $\rightarrow$ ' $+250 \%$ ' since 50 A is $+250 \%$ of motor rated current (20A)

Then,

$$
\frac{20-0}{50-0} \cdot(20)+0=8 m A
$$

Analogue Output 2 will supply 8 mA when motor current is 20 A .


SD7OITCCOO15AI

Figure 10.36 Example 4. Analogue Output 2 with format ' $0-20 \mathrm{~mA}$ '

### 10.9. Group 9-G9: Comparators

### 10.9.1. Subgroup 9.1 - S9.1: Comparator 1

| G9.1.1 SO | URCE SELECTION FOR COAPAPARATOR 1 |
| :---: | :---: |
| Screen | 1 COMP 1 SEL $=00$ |
| Description | Selection of the source for the Comparator 1 |
| Range | $00-22$ |
| Default value | 00 |
| Set on run | YES |
| Modbus address | 40302 |
| Modbus range | 0 to 22 |
| Read / Write | YES |
| Function | It allows user to select the source for the Comparator 1 according to the following options: |
|  | $00 \rightarrow$ NONE <br> There is no source for the comparator. |
|  | $01 \rightarrow$ SPEED MOTOR <br> Comparison signal is motor speed. |
|  | $02 \rightarrow$ CURRENT MOTOR Motor current signal. |
|  | $03 \rightarrow$ VOLTAGE MOTOR Motor voltage signal. |
|  | $04 \rightarrow$ POWER MOTOR Motor power signal. |
|  | $05 \rightarrow$ TORQUE MOTOR Motor torque signal. |
|  | $06 \rightarrow$ PF MOTOR <br> Motor cosine de phi. |
|  | $07 \rightarrow$ TEMP MOTOR <br> Motor temperature signal. |
|  | $08 \rightarrow$ FREQUENCY MTR Drive input frequency. |
|  | $09 \rightarrow$ INPUT VOLTAGE Drive input voltage. |
|  | $\begin{aligned} & 10 \rightarrow \text { DC BUS } \\ & \text { DC Bus voltage. } \end{aligned}$ |
|  | $11 \rightarrow$ DRIVE TEMP Drive temperature |
|  | $12 \rightarrow$ SPEED REF Speed reference. |
|  | $13 \rightarrow$ Reserved Reserved for future use. |
|  | $14 \rightarrow$ PID REFERENCE <br> Speed reference in PID mode. |

```
15 -> PID FEEDBACK
                System feedback signal
16 -> PID ERROR
                PID error signal (difference between reference signal and feedback signal of
                the sensor).
17 -> ANLG INPUT 1
                                    Signal connected to Analogue Input 1.
18 -> ANLG INPUT 2
                            Signal connected to Analogue Input 2.
19 -> ANLG INPUT 1+2
                Sum of signals connected to analogue inputs 1 and 2.
20 }->\mathrm{ Reserved
                Reserved for future use.
21 -> MAX SCALE
                We will get a maximum value, forcing the comparator in order to obtain the
                needed status (always activated or deactivated).
22 -> ABSOLUT SPEED
                Comparison signal is motor speed without sign (absolute value).
```

G9.1:2 TYPE SELECTION FOR COMPARATOR 1

| Screen | 2 COMP 1 TYPE $=0$ |
| :---: | :---: |
| Description | Selection of Comparator 1 type |
| Range | $0-1$ <br> (See 'Function' for additional information) |
| Default value | 0 |
| Set on run | YES |
| Modbus address | 40303 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows selecting the operation mode of the Comparator 1. Operation modes are: |
|  | $0 \rightarrow$ Normal Comparator 1 will be activated when the ON condition is given (setting realized in ' $G 9.1 .3 \rightarrow$ Activation value of Comparator 1 in normal mode') and will be deactivated when the OFF condition is given (setting realized in 'G9.1.7 $\rightarrow$ Deactivation value of Comparator 1 in normal mode'). |
|  | $1 \rightarrow$ Window |
|  | Comparator 1 will be activated when signal is within the limit 1 (setting realized in 'G9.1.5 $\rightarrow$ Limit 1 for Comparator 1 in window mode') and limit 2 (setting realized in 'G9.1.4 $\rightarrow$ Limit 2 for Comparator 1 in window mode'), and additionally, limit 2 is higher than limit 1 . If limit 2 is lower than limit 1 , logical function of comparator output will be inverted. |

In the following figure we can observe easily the behaviour of the comparator output for each operation mode.


NORMAL MODE

WINDOW MODE
Limit $2>$ Limil 1

WINDOW MODE
Limit $2<$ Limit 1

Figure 10.37 Operation modes of the comparators

## G9.1.3 ACTIVATION VALUE OF COMPARATOR 1 IN NORMAL MODE

| Screen | 3 SP C1 ON $=+100 \%$ |
| :---: | :---: |
| Extended info. | C1 ACTIVAT LEVEL |
| Description | Activation value of Comparator 1 in normal mode |
| Range | -250\% to +250\% |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40305 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |

Function It allows setting the activation value of the Comparator 1 output.
Output of Comparator 1 will be activated when source signal of Comparator 1
(selected in G9.1.1) is higher than the value set in this parameter, and additionally, ON delay time (set in G9.1.6) has elapsed.
If, after the ON condition is given, this one disappears before elapsing ON delay time, the output of the comparator will be not activated.

See figure 10.38 .
Note: This parameter is only displayed if Comparator 1 is set to normal mode (parameter 'G9.1.2 $\rightarrow$ Type selection for Comparator 1 ' set to ' $0 \rightarrow$ Normal').

G9.1.4 LIMIT 2 FOR COMPARATOR 1 IN WINDOW MODE
Screen $\quad 4$ LIM 2 C1 $=+100 \%$
Extended info. G1 WNDDOW LMint
Description Limit 2 of the Comparator 1 in window mode
Range
Default value $\quad+100 \%$
Set on run YES
Modbus address 40305
Modbus range -20480 to 20480
Read / Write YES
Function It allows defining one of the limits to activate Comparator 1 in window mode.
Output of Comparator 1 will be activated when source signal of Comparator 1
(selected in G9.1.1) is within the limit 1 (set in G9.1.5) and the limit 2, and additionally, ON delay time (set in G9.1.6) has elapsed.
If, after the ON condition is given, this one disappears before elapsing ON delay time, the output of the comparator will be not activated.

See figures 10.39 and 10.40 .
Note: This parameter is only displayed if Comparator 1 is set to window mode (parameter 'G9.1.2 $\rightarrow$ Type selection for Comparator 1 ' set to ' $1 \rightarrow$ Window').

## G9.1.5 LIMIT. 1 FOR COMPARATOR 1 IN WINDOW BAODE

| Screen | 5 LIM 1 C1 $=+0 \%$ |
| :---: | :---: |
| Extended info. | C1 WINDOW LMIT |
| Description | Limit 1 of the Comparator 1 in window mode |
| Range | -250\% to +250\% |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 40304 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows defining one of the limits to activate Comparator $\mathbf{1}$ in window mode. |
|  | Output of Comparator 1 will be activated when source signal of Comparator 1 (selected in G9.1.1) is within the limit 1 and the limit 2 (set in G9.1.4), and additionally, ON delay time (set in G9.1.6) has elapsed. <br> If, after the ON condition is given, this one disappears before elapsing ON delay time, the output of the comparator will be not activated. |
|  | See figures 10.39 and 10.40. |
| Note: | This parameter is only displayed if Comparator 1 is set to window mode (parameter 'G9.1.2 $\rightarrow$ Type selection for Comparator 1 ' set to ' $1 \rightarrow$ Window'). |

G9.1.6_ON DELAY TIME FOR COMPARATOR 1


| G9.1.7 DEACTIVATION VALUE OF COMPARATOR 1 IN NORMAL MODE |  |
| :---: | :---: |
| Screen | 7 SP C1 OF $=+0 \%$ |
| Extended info. | C1 DEACTIV LEVEL |
| Description | Deactivation value of Comparator 1 in normal mode |
| Range | -250\% to +250\% |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 40304 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows setting the deactivation value of the Comparator 1 output. |
|  | Output of Comparator 1 will be deactivated when source signal of Comparator 1 (selected in G9.1.1) is lower than the value set in this parameter, and additionally, OFF delay time (set in G9.1.8) has elapsed. <br> If, after the OFF condition is given, this one disappears before elapsing OFF delay time, the output of the comparator will be not deactivated. |
|  | See figure 10.38. |
| Note: | This parameter is only displayed if Comparator 1 is set to normal mode (parameter 'G9.1.2 $\rightarrow$ Type selection for Comparator 1 ' set to ' $0 \rightarrow$ Normal'). |


| G9.1.8 OFF DELAY TIME FOR COMPARATOR 1 |  |
| :---: | :---: |
| Screen | $8 \mathrm{TC1OF}=0.0 \mathrm{~s}$ |
| Extended info. | C1 DEACTIV DELAY |
| Description | OFF delay time to deactivate Comparator 1 |
| Range | 0.0-999s |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 40307 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a timer to deactivate the output of the Comparator 1. |
|  | When the deactivation condition of the output signal of Comparator 1 is given in normal or window mode, the timer delays the deactivation of this signal for the time set in this parameter. <br> If, after the OFF condition is given, this one disappears before elapsing OFF delay time, the output of the comparator will be not deactivated. |
|  | See figures 10.38, 10.39 and 10.40. |



Figure 10.38 Example. Activation of Comparator 1 in normal mode


Figure 10.39 Example. Activation of Comparator 1 in window mode when limit 2 is higher than limit 1


Figure 10.40 Example. Activation of Comparator 1 in window mode when limit 2 is lower than limit 1

| G9.1.9 SELECTION OF OUTPUT FUNCTION FOR COMPARATOR 1 |  |
| :---: | :---: |
| Screen | 9 SEL FUNT C1 $=00$ |
| Description | Selection of the output function for the Comparator 1 |
| Range | $00-11$ <br> (See 'Function' for additional information) |
| Default value | 00 |
| Set on run | YES |
| Modbus address | 40308 |
| Modbus range | 0 to 11 |
| Read / Write | YES |
| Function | It allows user to select which function will be activated by Comparator 1 according to the following options: |
|  | $00 \rightarrow$ NO USE <br> Comparator output deactivated. Comparator has no effect. |
|  | $01 \rightarrow$ START / STOP <br> When comparator output is activated, it will give the start command, and when comparator output is deactivated it will give the stop command. |
|  | $02 \rightarrow$ STOP 1 |
|  | Stop mode 1 is activated (set in G7.1) when comparator output is activated. |
|  | $03 \rightarrow$ STOP 2 |
|  | Stop mode 2 is activated (set in G7.2) when comparator output is activated. |
|  | $04 \rightarrow$ RESET |
|  | When comparator output is activated, drive reset is executed. |
|  | $05 \rightarrow$ START + INCH1 |
|  | Output of comparator activates the start command and takes 'inch speed $1^{\prime}$ as speed reference. When comparator output is activated, drive will start and will accelerate until the speed reference is reached (in this case the speed reference is inch speed 1, set in parameter G15.1). |
|  | $06 \rightarrow$ START + INCH2 |
|  | Output of comparator activates the start command and takes 'inch speed $\mathbf{2 '}^{\prime}$ as speed reference. When comparator output is activated, drive will start and will accelerate until the speed reference is reached (in this case the speed reference is inch speed 2, set in parameter G15.2). |
|  | $07 \rightarrow$ START + INCH3 |
|  | Output of comparator activates the start command and takes 'inch speed $3^{\prime}$ as speed reference. When comparator output is activated, drive will start and will accelerate until the speed reference is reached (in this case the speed reference is inch speed 3 , set in parameter G15.3). |
|  | $08 \rightarrow$ INV SPEED |
|  | Activation of the comparator output inverts the speed, this is, the rotation direction of the motor. For that, drive applies a deceleration ramp until stopping the motor, and next, changes the rotation direction of the motor and accelerates until reaching the same speed value. |
|  | Note: Rotation inversion function must be enabled in parameter 'G10.9 $\boldsymbol{\rightarrow}$ To enable speed inversion'. |

$09 \rightarrow$ ACC / DEC 2
When comparator output is activated, alternative ramps adjusted in ' $\mathrm{G} 5.3 \rightarrow$ Acceleration ramp 2' and 'G5.4 $\rightarrow$ Deceleration ramp 2' are activated.
$10 \rightarrow$ REFERENCE 2
When comparator output is activated, the alternative reference selected in 'G3.2 $\rightarrow$ Reference source 2 of speed' is activated.
$11 \rightarrow$ SPEED LIMIT 2
When comparator output is activated, the alternative speed limits set in 'G10.3 $\rightarrow$ Minimum speed limit 2' and 'G10.4 $\rightarrow$ Maximum speed limit 2'.

Note: If activation and deactivation levels are set to similar values and delay times are set to OFF, any noise that appears in the signals of selected source can cause an oscillation in the comparator, and therefore, an incorrect operation. You should set these levels keeping a reasonable margin between them, and if it is necessary, set a delay time to improve the operation.

### 10.9.2. Subgroup 9.2 - S9.2: Comparator 2

Comparator 2 operates in the same way of Comparator 1. Additionally, it includes the same setting parameters with the same configuration options. Therefore, figures 10.47, 10.48, 10.49 and 10.50 are also valid for this comparator. For this, we recommend observe these figures in order to understand better its operation.

| G9:2.1 SOURCE SELECTION FOR COMPARATOR 2 |  |
| :---: | :---: |
| Screen | 1 COMP 2 SEL $=00$ |
| Description | Selection of the source for the Comparator 2 |
| Range | 00-22 |
| Default value | 00 |
| Set on run | YES |
| Modbus address | 40311 |
| Modbus range | 0 to 22 |
| Read / Write | YES |
| Function | It allows user to select the source for the Comparator 2. Configuration options are the same than the options for Comparator 1. |
|  | See 'Function' in parameter 'G9.1.1 $\rightarrow$ Source selection for Comparator 1 ' to obtain information about configuration options. |

G9.2.2 TYPE SELECTION FOR COMPARATOR 2

| Screen | 2 COMP 2 TYPE $=0$ |
| :---: | :---: |
| Description | Selection of Comparator 2 type |
| Range | $0-1$ <br> (See 'Function' for additional information) |
| Default value | 0 |
| Set on run | YES |
| Modbus address | 40312 |
| Modbus range | 0 to 1 |
| Read/ Write | YES |
| Function | It allows selecting the operation mode of the Comparator 2. Operation modes are: |
|  | $0 \rightarrow$ Normal <br> Comparator 2 will be activated when the ON condition is given (setting realized in ' $\mathrm{G} 9.2 .3 \rightarrow$ Activation value of Comparator 2 in normal mode') and will be deactivated when the OFF condition is given (setting realized in 'G9.2.7 $\rightarrow$ Deactivation value of Comparator 2 in normal mode'). |

$1 \rightarrow$ Window
Comparator 2 will be activated when signal is within the limit 1 (setting realized in 'G9.2.5 $\rightarrow$ Limit 1 for Comparator 2 in window mode') and limit 2 (setting realized in 'G9.2.4 $\rightarrow$ Limit 2 for Comparator 2 in window mode'), and additionally, limit 2 is higher than limit 1 . If limit 2 is lower than limit 1 , logical function of comparator output will be inverted.

See figure 10.37 to observe the behaviour of the comparator output for each operation mode.

| 9.3 ACTIVATION VALUE OF COMPARATOR 2 IN NORMAL HODE |  |
| :---: | :---: |
| Screen | 3 SP C2 ON = +100\% |
| Extended info. | C2 ACTIVAT LEVEL |
| Description | Activation value of Comparator 2 in normal mode |
| Range | $-250 \%$ to $+250 \%$ |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40314 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows setting the activation value of the Comparator 2 output. |
|  | Output of Comparator 2 will be activated when source signal of Comparator 2 (selected in G9.2.1) is higher than the value set in this parameter, and additionally, ON delay time (set in G9.2.6) has elapsed. <br> If, after the ON condition is given, this one disappears before elapsing ON delay time, the output of the comparator will be not activated. |
|  | See figure 10.38 |
| Note: | This parameter is only displayed if Comparator 2 is set to normal mode (parameter 'G9.2.2 $\rightarrow$ Type selection for Comparator 2' set to ' $0 \rightarrow$ Normal'). |


| G9.2.4 LIMIT 2 FOR COMPARATOR 2 IN WINDOW HODE |  |
| :---: | :---: |
| Screen | 4 LIM 2 C2 $=+100 \%$ |
| Extended info. | C2 WNDOW LMIT2 |
| Description | Limit 2 of the Comparator 2 in window mode |
| Range | -250\% to $+250 \%$ |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40314 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows defining one of the limits to activate Comparator 2 in window mode. |
|  | Output of Comparator 2 will be activated when source signal of Comparator 2 (selected in G9.2.1) is within the limit 1 (set in G9.2.5) and the limit 2, and additionally, ON delay time (set in G9.2.6) has elapsed. <br> If, after the ON condition is given, this one disappears before elapsing ON delay time, the output of the comparator will be not activated. |
|  | See figures 10.39 and 10.40. |
| Note: | This parameter is only displayed if Comparator 2 is set to window mode (parameter 'G9.2.2 $\rightarrow$ Type selection for Comparator 2' set to ' $1 \rightarrow$ Window'). |


| G9.2.5 L | 11 FOR COMPARATOR 2 IN WINDOW MODE |
| :---: | :---: |
| Screen | 5 LIM 1 C2 = +0\% |
| Extended info. | C2 WINDOW LMMT1 |
| Description | Limit 1 of the Comparator 2 in window mode |
| Range | -250\% to $+250 \%$ |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 40313 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows defining one of the limits to activate Comparator 2 in window mode. |
|  | Output of Comparator 2 will be activated when source signal of Comparator 2 (selected in G9.2.1) is within the limit 1 and the limit 2 (set in G9.2.4), and additionally, ON delay time (set in G9.2.6) has elapsed. <br> If, after the ON condition is given, this one disappears before elapsing ON delay time, the output of the comparator will be not activated. |
|  | See figures 10.39 and 10.40. |
| Note: | This parameter is only displayed if Comparator 1 is set to window mode (parameter 'G9.2.2 $\rightarrow$ Type selection for Comparator 2 ' set to ' $1 \rightarrow$ Window'). |
| G9.2.6 ON DELAY TIME FOR COAAPARATOR 2 |  |
| Screen | $6 \mathrm{TC2} \mathrm{ON}=0.0 \mathrm{~s}$ |
| Extended info. | C2 ACTIVAT DELAY |
| Description | ON delay time to activate Comparator 2 |
| Range | 0.0-999s |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 40315 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a timer to activate the output of the Comparator 2. |
|  | When the activation condition of the output signal of Comparator 2 is given in normal or window mode, the timer delays the activation of this signal for the time set in this parameter. <br> If, after the ON condition is given, this one disappears before elapsing ON delay time, the output of the comparator will be not activated. |
|  | See figures 10.38, 10.39 and 10.40. |

G9.2.7 DEACTIVATION VALUE OF COOMPARATOR 2 IN NORMAL MODE

| Screen | 7 SP C2 OF $=+0 \%$ |
| :---: | :---: |
| Extended info. | C2 DEACTIV LEVEL |
| Description | Deactivation value of Comparator 2 in normal mode |
| Range | -250\% to +250\% |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 40313 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows setting the deactivation value of the Comparator 2 output. |
|  | Output of Comparator 2 will be deactivated when source signal of Comparator 2 (selected in G9.2.1) is lower than the value set in this parameter, and additionally, OFF delay time (set in G9.2.8) has elapsed. <br> If, after the OFF condition is given, this one disappears before elapsing OFF delay time, the output of the comparator will be not deactivated. |
|  | See figure 10.38 |
| Note: | This parameter is only displayed if Comparator 2 is set to normal mode (parameter 'G9.2.2 $\rightarrow$ Type selection for Comparator 2 ' set to ' $0 \rightarrow$ Normal'). |

## G9.2.8 OFF DELAY TIABE FOR COMPARATOR 2

| Screen | $8 \mathrm{TC2}$ OF $=0.0 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | CZDEACTIV DELAY |
| Description | OFF delay time to deactivate Comparator 2 |
| Range | 0.0-999s |
| Default value | 0.0 s |
| Set on run | YES |
| Modbus address | 40316 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a timer to deactivate the output of the Comparator 2. |
|  | When the deactivation condition of the output signal of Comparator 2 is given in normal or window mode, the timer delays the deactivation of this signal for the time set in this parameter. <br> If, after the OFF condition is given, this one disappears before elapsing OFF delay time, the output of the comparator will be not deactivated. |
|  | See figures $10.38,10.39$ and 10.40. |


| G9.2.9 SE | ECTION OF OUTPUT FUNCTION FOR COMPARATOR 2 |
| :---: | :---: |
| Screen | 9 SEL FUNT C2 $=00$ |
| Description | Selection of the output function for the Comparator 2 |
| Range | 00-11 |
| Default value | 00 |
| Set on run | YES |
| Modbus address | 40317 |
| Modbus range | 0 to 11 |
| Read / Write | YES |
| Function | It allows user to select which function will be activated by Comparator 2 . |
|  | To get information about the configuration options, see 'Function' in parameter 'G9.1.9 <br> $\rightarrow$ Selection of output function for Comparator 1 '. |
| Note: | If activation and deactivation levels are set to similar values and delay times are set to OFF, any noise that appears in the signals of selected source can cause an oscillation in the comparator, and therefore, an incorrect operation. You should set these levels keeping a reasonable margin between them, and if it is necessary, set a delay time to improve the operation. |

### 10.9.3. Subgroup 9.3 - S9.3: Comparator 3

Comparator 3 operates in the same way of Comparator 1. Additionally, it includes the same setting parameters with the same configuration options. Therefore, figures $10.47,10.48,10.49$ and 10.50 are also valid for this comparator. For this, we recommend observe these figures in order to understand better its operation.

| 3.1 SOURCE SELECTION FOR COMPARATOR 3 |  |
| :---: | :---: |
| Screen | 1 COMP 3 SEL $=00$ |
| Description | Selection of the source for the Comparator 3 |
| Range | 00-22 |
| Default value | 00 |
| Set on run | YES |
| Modbus address | 40320 |
| Modbus range | 0 to 22 |
| Read / Write | YES |
| Function | It allows user to select the source for the Comparator 3. Configuration options are the same than the options for Comparator 1. |
|  | See 'Function' in parameter 'G9.1.1 $\rightarrow$ Source selection for Comparator 1' to obtain information about configuration options. |


| G9.3.2 TYPE SELECTION FOR COMPARATOR 3 |  |
| :---: | :---: |
| Screen | 2 COMP 3 TYPE $=0$ |
| Description | Selection of Comparator 3 type |
| Range | 0-1 <br> (See 'Function' for additional information) |
| Default value | 0 |
| Set on run | YES |
| Modbus address | 40321 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows selecting the operation mode of the Comparator 3. Operation modes are: |
|  | $0 \rightarrow$ Normal |
|  | Comparator 3 will be activated when the ON condition is given (setting realized in 'G9.3.3 $\rightarrow$ Activation value of Comparator 3 in normal mode') and will be deactivated when the OFF condition is given (setting realized in 'G9.3.7 $\rightarrow$ Deactivation value of Comparator 3 in normal mode'). |
|  | $1 \rightarrow$ Window <br> Comparator 3 will be activated when signal is within the limit 1 (setting realized in 'G9.3.5 $\rightarrow$ Limit 1 for Comparator 3 in window mode') and limit 2 (setting realized in 'G9.3.4 $\rightarrow$ Limit 2 for Comparator 3 in window mode'), and additionally, limit 2 is higher than limit 1 . If limit 2 is lower than limit 1 , logical function of comparator output will be inverted. |

See figure 10.37 to observe the behaviour of the comparator output for each operation mode.

| G9.3.3 ACTIVATION VALUE OF COMPARATOR 3 IN NORMAL HODE |  |
| :---: | :---: |
| Screen | $3 \mathrm{SPC3} \mathrm{ON}=+100 \%$ |
| Extended info. | Gsactivat level |
| Description | Activation value of Comparator 3 in normal mode |
| Range | $-250 \%$ to $+250 \%$ |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40323 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows setting the activation value of the Comparator 3 output. |
|  | Output of Comparator 3 will be activated when source signal of Comparator 3 (selected in G9.3.1) is higher than the value set in this parameter, and additionally, ON delay time (set in G9.3.6) has elapsed. <br> If, after the ON condition is given, this one disappears before elapsing ON delay time, the output of the comparator will be not activated. |
|  | See figure 10.38. |
| Note: | This parameter is only displayed if Comparator 3 is set to normal mode (parameter 'G9.3.2 $\rightarrow$ Type selection for Comparator $3^{\prime}$ set to ' $0 \rightarrow$ Normal'). |


| G9.3.4 LIMAIT 2 FOR COMPARATOR 3 IN WINDOW HAODE |  |
| :---: | :---: |
| Screen | 4 LIM 2 C3 $=+100 \%$ |
| Extended info. | Ci WINDOW LIMIT2 |
| Description | Limit 2 of the Comparator 3 in window mode |
| Range | -250\% to $+250 \%$ |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40323 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows defining one of the limits to activate Comparator 3 in window mode. |
|  | Output of Comparator 3 will be activated when source signal of Comparator 3 (selected in G9.3.1) is within the limit 1 (set in G9.3.5) and the limit 2, and additionally, ON delay time (set in G9.3.6) has elapsed. <br> If, after the ON condition is given, this one disappears before elapsing ON delay time, the output of the comparator will be not activated. |
|  | See figures 10.39 and 10.40. |
| Note: | This parameter is only displayed if Comparator 3 is set to window mode (parameter 'G9.3.2 $\rightarrow$ Type selection for Comparator 3 ' set to ' $1 \rightarrow$ Window'). |

G9.3.5 LIMIT 1 FOR COMPARATOR 3 IN WINDOW MODE

| Screen | 5 LIM 1 C3 $=+0 \%$ |
| :---: | :---: |
| Extended info. | G WINDOW LMITI |
| Description | Limit 1 of the Comparator 3 in window mode |
| Range | -250\% to $+250 \%$ |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 40322 |
| Modbus range | -20480 to 20480 |
| Read/Write | YES |
| Function | It allows defining one of the limits to activate Comparator 3 in window mode. |
|  | Output of Comparator 3 will be activated when source signal of Comparator 3 (selected in G9.3.1) is within the limit 1 and the limit 2 (set in G9.3.4), and additionally, ON delay time (set in G9.3.6) has elapsed. <br> If, afler the ON condition is given, this one disappears before elapsing ON delay time, the output of the comparator will be not activated. |
|  | See figures 10.39 and 10.40. |
| Note: | This parameter is only displayed if Comparator 3 is set to window mode (parameter 'G9.3.2 $\rightarrow$ Type selection for Comparator $3^{\prime}$ set to ' $1 \rightarrow$ Window'). |

## G9.3.6 ONDELAY TIME FOR COAPARATOR 3

| Screen | 6TC3 ON $=0.0 \mathrm{~s}$ |
| :--- | :--- |
| Extended info. | CIACTVAT DELAY |
| Description | ON delay time to activate Comparator 3 |
| Range | $0.0-999 \mathrm{~s}$ |
| Default value | 0.0 s |
| Set on run | YES |
| Modbus address | 40324 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a timer to activate the output of the Comparator 3. |
|  | When the activation condition of the output signal of Comparator 3 is given in normal <br> or window mode, the timer delays the activation of this signal for the time set in this <br> parameter. <br> If, after the ON condition is given, this one disappears before elapsing ON delay time, <br> the output of the comparator will be not activated. |
|  | See figures 10.38, 10.39 and 10.40. |

## G9.3.7 DEACTIVATION VALUE OF COMPARATOR 3 IN NORMAL MODE

| Screen | 7 SP C3 OF $=+0 \%$ |
| :---: | :---: |
| Extended info. | CSDEACTVLEVEI |
| Description | Deactivation value of Comparator 3 in normal mode |
| Range | -250\% to +250\% |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 40322 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows setting the deactivation value of the Comparator 3 output. |
|  | Output of Comparator 3 will be deactivated when source signal of Comparator 3 (selected in G9.3.1) is lower than the value set in this parameter, and additionally, OFF delay time (set in G9.3.8) has elapsed. <br> If, after the OFF condition is given, this one disappears before elapsing OFF delay time, the output of the comparator will be not deactivated. |
|  | See figure 10.38. |
| Note: | This parameter is only displayed if Comparator 3 is set to normal mode (parameter 'G9.3.2 $\rightarrow$ Type selection for Comparator 3' set to ' $0 \rightarrow$ Normal'). |


| G9.3.8 O | DELAY TIAE FOR COMPARATOR 3 |
| :---: | :---: |
| Screen | $8 \mathrm{TC3} \mathrm{OF}=0.0 \mathrm{~s}$ |
| Extended info. | CJDEACTMDELAY |
| Description | OFF delay time to deactivate Comparator 3 |
| Range | 0.0-999s |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 40325 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a timer to deactivate the output of the Comparator 3. |
|  | When the deactivation condition of the output signal of Comparator 3 is given in normal or window mode, the timer delays the deactivation of this signal for the time set in this parameter. <br> If, after the OFF condition is given, this one disappears before elapsing OFF delay time, the output of the comparator will be not deactivated. |

See figures $10.38,10.39$ and 10.40 .

G9.3.9 SELECTION OF OUTPUT FUNCTION FOR COMPARATOR 3

| Screen | 9 SEL FUNT C3 $=00$ |
| :--- | :--- |
| Description | Selection of the output function for the Comparator 3 |
| Range | $00-11$ |
| Default value | 00 |
| Set on run | YES |
| Modbus address | 40326 |
| Modbus range 0 to 11 <br> Read $/$ Write  | YES |
| Function | It allows user to select which function will be activated by Comparator 3. |
|  | To get information about the configuration options, see 'Function' in parameter 'G9.3.9  <br>  $\rightarrow$ Selection of output function for Comparator 3 '. |
|  |  |

Note: If activation and deactivation levels are set to similar values and delay times are set to OFF, any noise that appears in the signals of selected source can cause an oscillation in the comparator, and therefore, an incorrect operation. You should set these levels keeping a reasonable margin between them, and if it is necessary, set a delay time to improve the operation.

### 10.10.Group 10 - G10: Limits

G10.1 MINIMUM SPEED LIMIT 1

| Screen | 1 MIN1 SP $=+0.00 \%$ |
| :---: | :---: |
| Extended info. | SPEED MIN LIMMIT |
| Description | Minimum speed limit 1 |
| Range | -250\% to 'G10.2' \% |
| Default value | +0.00\% |
| Set on run | YES |
| Modbus address | 40102 |
| Modbus range | -20480 to 'G10.2' |
| Read / Write | YES |

Function It allows setting the minimum speed limit 1 that the drive can apply to the motor.
It is set in \% of motor rated speed.
Note: Commands to operate out of these limits are restricted to those limits.


Figure 10.41 Speed applied when maximum and minimum speed limits are performing.

| MAXIMUM SPEED LIMITT 1 |  |
| :---: | :---: |
| Screen | $2 \mathrm{MAX} 1 \mathrm{SP}=+100 \%$ |
| Extended info. | SPEED MAX LMIT1 |
| Description | Maximum speed limit 1 |
| Range | 'G10.1' \% to +250\% |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40104 |
| Modbus range | 'G10.1' to 20480 |
| Read / Write | YES |
| Function | It allows setting the maximum speed limit 1 that the drive can apply to the motor. |
|  | It is set in \% of motor rated speed. |
| Note: | Commands to operate out of these limits are restricted to those limits. See figure 10.41 . |

## G10.3 BINIMUM SPEED LIMIT 2

| Screen | 3 MIN2 SP $=-100 \%$ |
| :--- | :--- |
| Extended info. | SPEED MIN LIMIT2 |
| Description | Minimum Speed limit 2 |
| Range | $-250 \%$ to 'G10.4' $\%$ |
| Default value | $-100 \%$ |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 1 0 3}$ |
| Modbus range | -20480 to 'G10.4' |
| Read $/$ Write | YES |

Function It allows setting the minimum speed limit 2 that the drive can apply to the motor.
It is set in \% of motor rated speed.
Note: $\quad$ Selection of minimum speed limit 2 and maximum speed limit 2 (alternative speed limits) is realized through one of the digital inputs (parameters from 'G4.1.5 $\rightarrow$ Multifunction Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration' set to option '20 $\rightarrow$ SPEED LIMIT 2') or by means of the output function of one of the comparators (parameters 'G9.1.9 $\rightarrow$ Selection of output function for Comparator 1', 'G9.2.9 $\rightarrow$ Selection of output function for Comparator 2' and 'G9.3.9 $\rightarrow$ Selection of output function for Comparator 3 ' set to option '11 $\rightarrow$ SPEED LIMIT 2').

Note: Commands to operate out of these limits are restricted to those limits. See figure 10.41 .

| G10.4 MAA | XIMUA SPEED LIMATT 2 |
| :---: | :---: |
| Screen | 4 MAX2 SP $=+100 \%$ |
| Extended info. | SPEED MAX LMIT2 |
| Description | Maximum speed limit 2 |
| Range | 'G10.3' \% to +250\% |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 40105 |
| Modbus range | 'G10.3' to 20480 |
| Read / Write | YES |

Function It allows setting the maximum speed limit 2 that the drive can apply to the motor.
It is set in \% of motor rated speed.
Note: Selection of minimum speed limit 2 and maximum speed limit 2 (alternative speed limits) is realized through one of the digital inputs (parameters from 'G4.1.5 $\rightarrow$ Multifunction Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration' set to option ' $20 \rightarrow$ SPEED LIMIT 2') or by means of the output function of one of the comparators (parameters 'G9.1.9 $\rightarrow$ Selection of output function for Comparator 1', 'G9.2.9 $\rightarrow$ Selection of output function for Comparator 2' and 'G9.3.9 $\rightarrow$ Selection of output function for Comparator 3' set to option ' $11 \rightarrow$ SPEED LIMIT 2').

Note: Commands to operate out of these limits are restricted to those limits. See figure 10.41 .

| G10.5 CURRENT LIMIT |  |
| :---: | :---: |
| Screen | 51 LIMIT $=\ldots$ A |
| Extended info. | MAX CURRET |
| Description | Output current limit |
| Range | $0.25 \cdot \mathrm{In}$ to $1.50 \cdot \mathrm{In}$ |
| Default value | * (depending on the drive capacity) |
| Set on run | YES |
| Modbus address | 40106 |
| Modbus range | 2048 to 12288 |
| Read / Write | YES |
| FunctionNote: | It allows setting the output current limit. |
|  | Motor current will be within this programmed limit. When this protection is active, the drive status of current limitation (ILT) is displayed. |
|  | In normal operation status, avoid adjusting values very lower than value of motor rated current, since several effects (torque boost settings, fast acceleration and deceleration) can produce false results. |
|  | We do not recommend that current limit works constantly in applications when themotor is at steady status. Damage may occur to the motor and the torque variations can affect the load. Current limit should work only when an overload occurs, or due to excessive acceleration and deceleration values, or because motor data details are entered incorrectly. |

## G10.6 TRIP'TIME BECAUSE OF CURRENTLIMITT

| Screen | 61 LIM TO $=$ OFF |
| :---: | :---: |
| Extended info. | OMOUT MAX CURRE |
| Description | Trip time because of current limit |
| Range | 0 to 60s, OFF |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40453 |
| Modbus range | 0 to 600, 610 |
| Read/Write | YES |
| Function | It allows setting the trip time because of current limit has been reached. |
|  | This parameter provides with the possibility of tripping the drive automatically if current limit (set in G10.5) has been reached during a time set in this parameter. |

## G10.7 ALTERNATIVE CURRENT LIAAIT

| Screen | 71. MAX2 = A |
| :---: | :---: |
| Extended info. | MAX CURRENT2 |
| Description | Alternative current limit |
| Range | $0.25 \cdot \ln$ to $1.50 \cdot \mathrm{ln}$ |
| Default value | * (depending on the drive capacity) |
| Set on run | YES |
| Modbus address | 40109 |
| Modbus range | 2048 to 12288 |
| Read / Write | YES |

Function It allows setting the alternative output current limit

Motor current will be within this programmed limit. When this protection is active, the drive status of current limitation (ILT) is displayed.

Note: In normal operation status, avoid adjusting values very lower than value of motor rated current, since several effects (torque boost settings, fast acceleration and deceleration) can produce false results.

We do not recommend that current limit works constantly in applications when the motor is at steady status. Damage may occur to the motor and the torque variations can affect the load. Current limit should work only when an overload occurs, or due to excessive acceleration and deceleration values, or because motor data details are entered incorrectly.

## G10.B CHANGE SPEED FOR I.BAX2 (ALTERNATIVE CURRENT LIAIIT)

| Screen | 8 MI2 brSP $=$ OFF |
| :--- | :--- |
| Extended info. | MAX CURR BRK SPD |
| Description | Change Speed to alternative current limit |
| Range | OFF $=0 \%,+1$ to $+250 \%$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 1 1 0}$ |
| Modbus range | 0 to 20480 |
| Read $/$ Write | YES |

Function It allows setting the speed level to change from current limit 1 (set in G10.5) to current limit 2 (set in G10.7).
Additionally, it is possible to select the alternative current limit 2 by using one digita input (parameters 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration 6 ') set to option ' $23 \rightarrow$ CURRENT LIMI2'

| G10.9 TORQUE LIMIT |  |
| :---: | :---: |
| Screen | 9 MAX TOR $=+150 \%$ |
| Extended info. | MAX TORQUE |
| Description | Torque limit |
| Range | -250\% to +250\% |
| Default value | +150\% |
| Set on run | YES |
| Modbus address | 40107 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |

Function It allows setting a torque limit value.
This value is the maximum motor torque that the drive will allow the motor to supply to the load.

Note: In applications with low and medium loads (clean water pumps, fans, etc.) where high torque is not required, default value is enough. Nevertheless, in applications with high load (mills, heavy tool, etc.) you must increase the torque limit to allow that drive reaches the torque values required by the load at specific moments.

G10.10 TRIP TLME BECAUSE OF TORQUE LIMIT

| Screen | 10 T LIM TO $=$ OFF |
| :---: | :---: |
| Extended info. | TIMEOUT MAX TORO |
| Description | Trip time because of torque limit |
| Range | 0 to 60s, OFF |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40455 |
| Modbus range | 0 to 600, 610 |
| Read / Write | YES |
| Function | It allows setting the trip time because of torque limit has been reached. |
|  | This parameter provides with the possibility of tripping the drive automatically if torque limit (set in G 10.9 ) has been reached during a time set in this parameter. |

## G10.11 TO ENABLE SPEEDINVERSION

| Screen | 11 INVERSION? = N |
| :---: | :---: |
| Description | To enable speed inversion |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 40108 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It enables or disables the possibility of inverting the motor speed. This function prevents the motor running in negative rotation direction. |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Disabled inversion. |
|  | Motor running in negative rotation direction is not allowed. |
|  | $Y \rightarrow$ YES |
|  | Enabled inversion. |
|  | Motor running in both rotation directions is allowed. |

### 10.11.Group 11 - G11: Protections

G11.1 TRIP TIME BECAUSE OF SPEED LIMIT

| Screen | 1 SP LIM TO $=$ OFF |
| :--- | :--- |
| Extended info. | TLAXLMIMN SPD |
| Description | Trip time because of speed limit has been reached |
| Range | 0 to 60 s, OFF |
| Default value | OFF |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 4 5 2}$ |
| Modbus range | 0 to 600,610 |
| Read / Write | YES |

Function It allows setting a delay time to generate the fault 'F49 SPD LIMIT' when the drive reaches the predefined speed limit

## G11.2 MAXIBUM TIME FOR STOP LIMIT

| Screen | 2 STOP TO = OFF |
| :---: | :---: |
| Extended info. | TMESOUT STOPPING |
| Description | Maximum time for stop limit |
| Range | OFF=0.0 to 999s |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40454 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a maximum time of stop limit. |
|  | It supplies a safety function to stop the drive automatically if the motor has not stopped after the time set in this parameter has elapsed and if the drive has received a stop command. The drive will fault on 'F45 STOP T/O'. |
|  | This function is used to protect from uncontrolled stops where motor needs a longer time than the predict time to stop. As well as other protections integrated into the drive, this time can be set to turn off the output voltage and stop the motor by free run (spin) if this time has elapsed and the motor has not stopped completely. Controlled stop time is calculated in standard conditions during system operation. Stop limit time must be set to a higher value than controlled stop time value. |

Note: With a high input voltage, the drive has a limited capacity to absorb in DC Bus the power regenerated by high inertial loads. This can prevent the equipment from following the speed reference beyond this limit. Stop limit time can be used to provide with protection from control losses due to excessive regeneration. Stop limit time is also useful to protect from incorrect setting of parameters of the PID regulator in closed loop control.

| G11.3 GR | UNND FAULT DETECTION |
| :---: | :---: |
| Screen | 3 GND I LIMIT $=10 \%$ |
| Extended info. | GND CURR MAXLEV |
| Description | Ground fault detection |
| Range | OFF, 0-30\% In |
| Default value | 10\% |
| Set on run | YES |
| Modbus address | 40456 |
| Modbus range | 0 to 2458 |
| Read / Write | YES |
| Function | It allows setting a value of leakage current to ground. |
|  | It provides with the option of tripping the equipment (drive turns off the output to the motor) because of fault 'F20 GROUND FLT' automatically, if a leakage current higher than the value set in this parameter has been reached |

G11.4 LOW INPUT VOLTAGE LEVEL
Screen 4 LOW VOLT $=360 \mathrm{~V}$

Extended info. LO INPUT VOLTAGE
Description Minimum level of input voltage
Range $\quad 323-425 \mathrm{~V}$ (for 400V)/586-621V (for 690V)
Default value $\quad 360 \mathrm{~V}$ (for 400 V ) $/ 600 \mathrm{~V}$ (for 690 V )
Set on run YES
Modbus address 40457
Modbus range $3230-4250$ (for 400V)/5860-6210 (for 690V)
Read / Write YES
Function It allows setting a minimum level of input voltage.
Drive will trip (it turns off the output to the motor) because of fault 'F14 LW V IN' when average voltage, measured at the input of the equipment, is lower than the value set in this parameter during the time adjusted in 'G11.5 $\rightarrow$ Trip time because of low input voltage'.

Note: Protection from low input voltage is a combination of this parameter and 'G11.5 $\rightarrow$ Trip time because of low input voltage'.

Note: In case of the drive is powered with an input voltage of 690 V , the default value of this parameter will be 600 V and the range will be $586-621 \mathrm{~V}$.

G11.5 TRIP TIME BECAUSE OF LOW INPUT VOLTAGE

| Screen | 5 LOW $\vee$ TO $=5 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | LOINP VOL TIMEO |
| Description | Trip time because of low input voltage |
| Range | 0.0-60s, OFF |
| Default value | 5s |
| Set on run | YES |
| Modbus address | 40458 |
| Modbus range | 0 to 600,610 |
| Read / Write | YES |

Function It allows setting a time, once elapsed it, a trip because of low input voltage will be generated.

Drive will trip (it turns off the output to the motor) because of fault 'F14 LWV IN' when average voltage, measured at the input of the equipment, is lower than the value set in 'G11.4 $\rightarrow$ Low input voltage level' during the time adjusted in this parameter.

Note: Protection from low input voltage is a combination of parameter 'G11.4 $\rightarrow$ Low input voltage level' and this one.

## G11.6 HIGH INPUT VOLTAGE LEVEL

| Screen | $6 \mathrm{HIGH} \mathrm{VOLT}=440 \mathrm{~V}$ |
| :---: | :---: |
| Extended info. | HINPUT VOLTAGE |
| Description | Maximum level of input voltage |
| Range | 418-550V (for 400V) / 726-759V (for 690V) |
| Default value | 440 V (for 400V) / 740V (for 690V) |
| Set on run | YES |
| Modbus address | 40459 |
| Modbus range | 4180-5500 (for 400V)/7260-7590 (for 690V) |
| Read / Write | YES |
| Function | It allows setting a maximum level of input voltage |

Drive will trip (it turns off the output to the motor) because of fault ' $\mathrm{F} 13 \mathrm{HIV} \operatorname{N}$ ' when average voltage, measured at the input of the equipment, is higher than the value set in this parameter during the time adjusted in 'G11.7 $\rightarrow$ Trip time because of high input voltage'.

Note: Protection from high input voltage is a combination of this parameter and 'G11.7 $\rightarrow$ Trip time because of high input voltage'.

Note: In case of the drive is powered with an input voltage of 690 V , the default value of this parameter will be 740 V and the range will be $726-759 \mathrm{~V}$.

G11.7 TRIP TIME BECAUSE OF HIGH INPUT VOLTAGE

| Screen | $7 \mathrm{HIV} \mathrm{TO}=5 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | HIINP VOL TMMEO |
| Description | Trip time because of high input voltage |
| Range | 0.0-60s, OFF |
| Default value | 5 s |
| Set on run | YES |
| Modbus address | 40460 |
| Modbus range | 0 to 600, 610 |
| Read / Write | YES |
| Function | It allows setting a time, once elapsed it, a trip because of high input voltage will be generated. |
|  | Drive will trip (it turns off the output to the motor) because of fault ' F 13 HIV IN' when average voltage, measured at the input of the equipment, is higher than the value set in 'G11.6 $\rightarrow$ High input voltage level' during the time adjusted in this parameter. |

Note: Protection from high input voltage is a combination of parameter 'G11.6 $\rightarrow$ High input voltage level' and this one.

| G11.8 TRIP DELAY TIME DUE TO OUTPUT VOLTAGE IMBALANCE |  |
| :---: | :---: |
| Screen | 8 Dlasy VO $=1.0 \mathrm{~s}$ |
| Extended info. | VOUT EXTRIP DLY |
| Description | Trip delay time due to output voltage imbalance |
| Range | 0.0-10s, OFF |
| Default value | 1.0 s |
| Set on run | YES |
| Modbus address | 40463 |
| Modbus range | 0 to 100, 101 |
| Read / Write | YES |
| Function | It allows setting a delay time before generating the trip when an output voltage imbalance has been detected. Once elapsed that time, drive will trip because of fault 'F18 IMB V OUT'. |
| G11.9 PERFORGANCE IN CASE OFIINPUT POWER LOSS |  |
| Screen | 9 LOW V BHV = 0 |
| Description | Performance of the drive in case of input power loss occurs during operation |
| Range | $0-2$ <br> (See 'Function' for additional information) |
| Default value | 0 |
| Set on run | YES |
| Modbus address | 40462 |
| Modbus range | 0 to 2 |
| Read / Write | YES |
| Function | It modifies the performance of the drive when input power drops while motor is running, according to the selected option: |
|  | $0 \rightarrow$ NO FAULT <br> No action will be done by the drive. |
|  | $\rightarrow$ FAULTS <br> Drive will trip because of fault ' F 11 VIN LOSS'. |
|  | $2 \rightarrow$ STOP |
|  | Drive will not trip because of fault and will try to control the motor stopping while $D C$ Bus voltage level allows it. |


| G11.10 P | MOTOR OPTION |
| :---: | :---: |
| Screen | 10 PTC EXT ? $=\mathbf{N}$ |
| Description | To enable PTC motor option |
| Range | N |
|  | Y <br> (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 40462 |
| Modbus range | 0 to 1 |
| Read / Write | YES |

```
Function It allows user to enable or disable the PTC motor option.
    A PTC sensor can be connected directly to the drive to detect high motor temperature
    (terminals 8 and 9 on control board). If PTC value is higher or equal than 1K5 }10%\mathrm{ , a
    fault will be generated in the drive 'F40 EXT / PTC'. On the other hand, if the value
    decreases below }90\Omega\pm10%\mathrm{ , a fault will be generated too.
    Options:
    N}->\textrm{NO
    PTC motor option is disabled.
Y Y YES
    PTC motor option is enabled.
```


## G11.11 PUBPP OVERLOAD LEVEL

| Screen | 11 PUMP OV $=20.0 \mathrm{~A}$ |
| :--- | :--- |
| Extended info. | PUMP OVERLOADLV |
| Description | Pump overload level |
| Range | $0.0-3200 \mathrm{~A}$ |
| Default value | 20.0 A |
| Set on run | YES |
| Modbus address | 40289 |
| Modbus range | 0 to 32000 |
| Read $/$ Write | YES |

Function It allows setting the current value that determines the overload level of the pump.
The overload protection is a combination of this parameter together with parameters ' $\mathrm{G} 11.12 \rightarrow$ Filter for pump overload' and ' $\mathrm{G} 11.13 \rightarrow$ Trip delay time because of pump overload'.

When the output current of the drive is higher than the current set in this parameter during the time adjusted in parameter G11.13, the drive turns off its output generating the fault 'F57 PUMP OVERLOA'.

We can set the value for a low-pass filter to read the current in order to avoid oscillations by means of the parameter G11.12.

G11.12 FILTER FOR PUMP OVERLOAD

| Screen | 12 PMovI FIL $=$ OFF |
| :--- | :--- |
| Extended info. | PMP OLL FILIER <br> Description |
| Filter for pump overload |  |
| Range | OFF $=0,1$ to 5 s |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40290 |
| Modbus range | Oto 50 |
| Read $/$ Write | YES |

Function It allows setting the value of the low-pass filter in order to avoid oscillations when the output current of the drive is read.

The overload protection is a combination of this parameter together with parameters 'G11.11 $\rightarrow$ Pump overload level' and 'G11.13 $\rightarrow$ Trip delay time because of pump overload'.
When the output current of the drive is higher than the current set in parameter G11.11 during the time adjusted in parameter G11.13, the drive turns off its output generating the fault 'F57 PUMP OVERLOA'.

| G11.13 TRIP DELAY TIPE BECAUSE OF PUMP OVERLOAD |  |
| :---: | :---: |
| Screen | 13 Povl DLY = OFF |
| Extended info. | PMP OVERLOAD DLY |
| Description | Trip delay time because of pump overload |
| Range | OFF=0.0-999.9s |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40291 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a delay time to generate the drive trip because of pump overload. |
|  | The overload protection is a combination of this parameter together with parameters 'G11.11 $\boldsymbol{\rightarrow}$ Pump overload level' and 'G11.12 $\rightarrow$ Filter for pump overload'. |

When the output current of the drive is higher than the current set in parameter G11.11 during the time adjusted in this parameter, the drive turns off its output generating the fault 'F57 PUMP OVERLOA'.

We can set the value for a low-pass filter to read the current in order to avoid oscillations by means of the parameter G11.12.

## G11.14 TO ENABLE UNDERLOAD PROTECTION

## Screen

| Description | To enable or disable the underload protection of the pump |
| :--- | :--- |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | $\mathbf{4 2 0 8 5}$ |
| Modbus range | 0 to 1 |
| Read / Write | YES |

Function It allows the possibility of protecting the pump from underload status.
$\mathrm{N} \rightarrow \mathrm{NO}$
Underload protection disabled
$Y \rightarrow Y E S$
Underload protection enabled.

To protect the pump from underload status, it is necessary to realize the following settings:
a) Set to ' $Y$ ' this parameter.
b) Set a value of underload current in parameter G11.15, below which the first detection condition will be fulfilled.
c) Set a value of underload speed in parameter G11.16, above which the second detection condition will be fulfilled.
d) Set a delay time for activation of underload protection in parameter G11.17. Once elapsed, the last underload condition will be activated.

If three previous conditions are fulfilled, the drive will stop the pump to protect it from underload status.

## G11.15 UNDERLOAD CURRENT

| Screen | 15 ULD CUR $=$ |
| :--- | :--- |
| Extended info. |  |
| UNDERLOAD CURREN |  |

See 'Function' in parameter 'G11.14 $\rightarrow$ To enable underload protection' to obtain information about the setting of underload parameters.

G11.16 UNDERLOAD SPEED

| Screen | 16 ULD SPD $=+100 \%$ |
| :--- | :--- |
| Extended info. | UNDERLOAD SPEED |
| Description | Underload speed <br> Range |
| Default value $+100 \%$ to $+250 \%$ <br> Set on run  <br> Modbus address 42087 <br> Modbus range 0 to 20480 <br> Read $/$ Write YES |  |

Function It allows setting a value for underload speed, above which the second detection condition to activate the protection is fulfilled.

This parameter operates together with parameters 'G11.15 $\rightarrow$ Underload current' and 'G11.17 $\rightarrow$ Delay time to activate underload protection'.

See 'Function' in parameter 'G11.14 $\rightarrow$ To enable underioad protection' to obtain information about the setting of underload parameters.

| G11.17 DELAY TIME TO ACTIVATE UNDERLOAD PROTECTION |  |
| :---: | :---: |
| Screen | 17 ULD DELY $=10 \mathrm{~s}$ |
| Extended info. | UNDERLOAD DELAY, |
| Description | Delay time to activate underload protection |
| Range | 0-999s |
| Default value | 10s |
| Set on run | YES |
| Modbus address | 42088 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a delay time to activate the underioad protection. The drive will wait for this time before activating the protection and then will stop. |
|  | This parameter operates together with parameters 'G11.15 $\rightarrow$ Underload current' and 'G11.16 $\rightarrow$ Underload speed'. |
|  | See 'Function' in parameter 'G11.14 $\rightarrow$ To enable underload protection' to obtain information about the setting of underload parameters. |

### 10.12.Group 12 - G12: Auto Reset

| G12.1 AUTO RESET |  |
| :---: | :---: |
| Screen | 1 AUTO RESET $=$ N |
| Description | To enable or disable auto reset function |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 40571 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows enabling or disabling auto reset function. |
|  | When this function is active, the drive is reset automatically after occurring a fault (it will be reset all of the faults programmed in parameters 'G12.5 $\rightarrow$ Selection of fault 1 to be reset' to ' $\mathrm{G} 12.8 \rightarrow$ Selection of fault 4 to be reset'). |
|  | Options: |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Auto reset function is disabled. |
|  | $Y \rightarrow Y E S$ |
|  | Auto reset function is enabled. |

CAUTION: Auto reset function can cause unexpected automatic startings. Before activating this function, ensure the installation fulfils the needed requirements to be configured in this way, to prevent property damages or personnel injuries.

| G12.2 NUMBER OF AUTO RESET ATIEMPTS |  |
| :---: | :---: |
| Screen | 2 ATTEMP NUMBR $=1$ |
| Extended info. | MAX ATIEMPT NUMB |
| Description | Number of auto reset attempts |
| Range | 1-5 |
| Default value | 1 |
| Set on run | YES |
| Modbus address | 40572 |
| Modbus range | 1 to 5 |
| Read / Write | YES |
| Function | It allows user to set the maximum number of auto reset attempts realized by the drive in case of a fault occurs. |
|  | This parameter together with 'G12.4 $\boldsymbol{\rightarrow}$ Reset time for the counter of auto reset attempts' control the drive to carry out auto reset function in a controller manner. |



Figure 10.42 Example. Application of auto reset function for 5 faults

## G12.3 DELAY TIME BEFORE AUTO RESET

| Screen | 3 RSTR DEL $=5 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | TIME BEFORE RESEI |
| Description | Delay time before executing auto reset function |
| Range | 5-120s |
| Default value | 5 s |
| Set on run | YES |
| Modbus address | 40573 |
| Modbus range | 5 to 120 |
| Read / Write | YES |
| Function | It allows setting the time elapsed from occurring the fault to the fault is reset. |
|  | See figure 10.42. |

G12.4 RESET TIME FOR COUNTER OF AUTO RESET ATTEAPTS

| Screen | 4 RS COUNT $=15 \mathrm{~min}$ |
| :---: | :---: |
| Extended info. | AUTORESET TIMOUT |
| Description | Time to reset the counter of auto reset attempts |
| Range | 1-60min |
| Default value | 15 min |
| Set on run | YES |
| Modbus address | 40574 |
| Modbus range | 1 to 60 |
| Read / Write | YES |
| Function | It allows setting the time, once elapsed it, the counter of auto reset attempts will be | reset to zero. Two situations are possible:

1) Reset time of the counter elapses before the drive realizes the attempts number of auto reset adjusted in parameter G12.2. In this case, the counter will be reset to zero.
2) Drive realizes the attempts number of auto reset without achieving to start before the reset time of the attempts counter elapses. In this case, the fault is remained and the time value, at which the last faulty attempt of auto reset occurred, is remained by the reset timer of the attempts counter.

See figure 10.42.

## G12.5 SELECTION OF FAULT 1 TO BE RESET

| Screen | $\mathbf{5}$ F1 AUTO RST $=0$ |
| :--- | :--- |
| Description | Selection of fault 1 to be reset |
| Range | $0-25$ |
|  | (See 'Function' for additional information) |
| Default value | 0 |
| Set on run | YES |
| Modbus address | 40575 |
| Modbus range | 0 to 25 |
| Read $/$ Write | YES |

Function If auto reset function is enabled in 'G12.1 $\rightarrow$ AUTO RESET' (option ' $Y$ '), the drive will consider the fault programmed here as resettable automatically. Fault 1 to be reset is selected according to the following options:
$0 \rightarrow 0$ NO AUTO RESET
There is no fault programmed. If parameters ' $\mathbf{G 1 2 . 5} \rightarrow$ Selection of fault 1 to be reset' to ' $\mathrm{G} 12.8 \rightarrow$ Selection of fault 4 to be reset' are set like this, auto reset function is not executed.

```
1-> ALL THE FLTS
                            All of the faults can be reset automatically.
2-> 11 VIN LOSS
                            To reset fault F11, input power loss.
3->13HIVIN
                            To reset fault F13, high input voltage.
4->14LWVIN
                            To reset fault F14, low input voltage.
5 -> 18 IMB V OUT
                            To reset fault F18, output voltage imbalance.
```

```
6 > 19 IMB I OUT
                            To reset fault F19,output current imbalance.
7 
                            To reset fault F20, ground fault.
8->21 I LIM T/O
    To reset fault F21, current limit time out.
9 > 22 TQ LIM T/O
                            To reset fault F22, torque limit time out.
10 ->27 DL SMTH
                            To reset fault F27, DC Bus charge fault.
11 -> 40 EXT / PTC
    To reset fault F40, motor PTC fault.
12 }->41\mathrm{ COMMS TRIP
    To reset fault F41, fault signal from communication network.
13->42 AIN1 LOSS
    To reset fault F42, Analogue Input 1 signal loss.
14 ->43 AIN2 LOSS
    To reset fault F43, Analogue Input 2 signal loss.
15 ->47 COMMS T/O
    To reset fault F47, communication time out
16 ->49 SPD LIMIT
    To reset fault F49, exceeded speed limit.
17 }->65\mathrm{ LOW PRESSURE
    To reset fault F65, minimum pressure.
18 ->66 HI PRESSURE
    To reset fault F66, maximum pressure.
19 -> 67 LOW WATER
    To reset fault F67, low water.
20 -> 31 SCR L1
    To reset fault F31, fault on phase L1 of rectifier.
21 }->32\mathrm{ SCR L2
    To reset fault F32, fault on phase L2 of rectifier.
22 }->33\mathrm{ SCR L3
    To reset fault F33, fault on phase L3 of rectifier.
23 }->68\mathrm{ CAVIT/UNDERL
    To reset fault F68, cavitation / underload trip.
24 ->69 FLOW SWITCH
    To reset fault F69, 'No Flow' trip.
25->70 IRRIGATOR F
    To reset fault F70, irrigator trip.
```

CAUTION: At the moment of selecting faults that can be reset, you should pay special attention to option ' $1 \rightarrow$ ALL THE FLTS'. In this case, the protections of the drive and the motor will be disabled. It is not recommended select this option since the drive could try to reset internal trips causing serious damage to the drive itself.

| G12.6 SELECTION OF FAULT 2 TO BE RESET |  |
| :---: | :---: |
| Screen | 6 F2 AUTO RST $=0$ |
| Description | Selection of fault 2 to be reset |
| Range | 0-25 |
| Default value | 0 |
| Set on run | YES |
| Modbus address | 40576 |
| Modbus range | 0 to 25 |
| Read / Write | YES |
| Function | If auto reset function is enabled in ' $\mathrm{G} 12.1 \rightarrow$ AUTO RESET' (option ' $Y$ '), the drive will consider the fault programmed here as resettable automatically. Fault 2 to be reset is selected according to the options explained in section 'Function' of parameter ' G 12.5 <br> $\rightarrow$ Selection of fault 1 to be reset'. |

$\triangle$ CAUTION: At the moment of selecting faults that can be reset, you should pay special attention to option ' $1 \rightarrow$ ALL THE FLTS'. In this case, the protections of the drive and the motor will be disabled. It is not recommended select this option since the drive could try to reset internal trips causing serious damage to the drive itself.

| G12.7 SELECTION OF FAULT 3 TO BE RESET |  |
| :---: | :---: |
| Screen | $7 \mathrm{F3}$ AUTO RST $=0$ |
| Description | Selection of fault 3 to be reset |
| Range | 0-25 |
| Default value | 0 |
| Set on run | YES |
| Modbus address | 40577 |
| Modbus range | 0 to 25 |
| Read / Write | YES |
| Function | If auto reset function is enabled in ' $\mathrm{G} 12.1 \rightarrow$ AUTO RESET' (option ' $Y$ '), the drive will consider the fault programmed here as resettable automatically. Fault 3 to be reset is selected according to the options explained in section 'Function' of parameter 'G12.5 <br> $\rightarrow$ Selection of fault 1 to be reset'. |

$\triangle$ CAUTION: At the moment of selecting faults that can be reset, you should pay special attention to option ' $1 \rightarrow$ ALL THE FLTS'. In this case, the protections of the drive and the motor will be disabled. It is not recommended select this option since the drive could try to reset internal trips causing serious damage to the drive itself.

| G12.8 SE | ECTION OF FAULT 4 TO BE RESET |
| :---: | :---: |
| Screen | 8 F4 AUTO RST $=0$ |
| Description | Selection of fault 4 to be reset |
| Range | 0-25 |
| Default value | 0 |
| Set on run | YES |
| Modbus address | 40578 |
| Modbus range | 0 to 25 |
| Read / Write | YES |
| Function | If auto reset function is enabled in ' $G 12.1 \rightarrow$ AUTO RESET' (option ' $Y$ '), the drive will consider the fault programmed here as resettable automatically. Fault 4 to be reset is selected according to the options explained in section 'Function' of parameter 'G12.5 <br> $\rightarrow$ Selection of fault 1 to be reset'. |

CAUTION: At the moment of selecting faults that can be reset, you should pay special attention to option ' $1 \rightarrow$ ALL THE FLTS'. In this case, the protections of the drive and the motor will be disabled. It is not recommended select this option since the drive could try to reset internal trips causing serious damage to the drive itself.

### 10.13.Group 13 - G13: Fault History

G13.1 REGISTER 1 OF FAULT HISTORY

| Screen | 1 F0 NO FAULT |
| :---: | :---: |
| Extended info. | LAST FAULTOFXX |
| Description | Register 1 of fault history |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | 40432 |
| Modbus range | - |
| Read / Write | Read Only |
| Function | The first parameter of this group allows visualizing the information about the last fault and additionally, it will be used as the first register of fault history. |
|  | Drive shows this screen in case of a trip has been produced in the equipment. By pressing $\square$ key two seconds approximately, you can access to the extended information that shows the fault order: LAST FAULT=Fxx (when fault is solved). |
|  | The equipment is reset by pressing the STOP-RESET key from display or by using an external reset (if it is connected). Some faults can be reset automatically by using auto reset function (see group G12 AUTO RESET). |

## Fault storage

It shows a list of the last five faults in chronological order. The most recent fault appears in first place (G13.1). Each time that a faults occurs the drive shows the fault in parameter G13.1. After the fault is solved and reset, this fault will be shifted to the following position of fault register (G13.2). The previous faults will shift down one position. The oldest fault message (stored in 'G13.6 $\rightarrow$ Register 5 of fault history') will be lost.

By pressing ${ }^{*}$ key two seconds approximately, you can access to the extended information that shows the fault order:

> FIFTH FAULT=Fxx up to FIRST FAULT=Fxx

Next, all of the faults are shown:

| 0 | $\rightarrow$ | F0 NO FAULT |
| ---: | :--- | :--- |
| 1 | $\rightarrow$ | F1 I LIM FLT |
| 2 | $\rightarrow$ | F2V LIM FLT |
| 3 | $\rightarrow$ | F3 PDINT FLT |
| 4 | $\rightarrow$ F4 U+DESAT |  |
| 5 | $\rightarrow$ | F5 U-DESAT |
| 6 | $\rightarrow$ | F6 V+DESAT |
| 7 | $\rightarrow$ | F7 V-DESAT |
| 8 | $\rightarrow$ | F8 W+DESAT |
| 9 | $\rightarrow$ | F9 W-DESAT |
| 10 | $\rightarrow$ | F10 NEG DESAT |
| 11 | $\rightarrow$ | F11 VIN LOSS |
| 12 | $\rightarrow$ | F12 IMB VIN |
| 13 | $\rightarrow$ | F13 HIV IN |
| 14 | $\rightarrow$ | F14 LWV IN |
| 15 | $\rightarrow$ | F15 CURL VdC |
| 16 | $\rightarrow$ | F16 HIVdC |
| 17 | $\rightarrow$ | F17 LW VdC |
| 18 | $\rightarrow$ | F18 IMB V OUT |
| 19 | $\rightarrow$ | F19 IMB I OUT |
| 20 | $\rightarrow$ | F20 GROUND FLT |
| 21 | $\rightarrow$ | F21 I LIM T/O |
| 22 | $\rightarrow$ | F22 TQ LIM T/O |
| 25 | $\rightarrow$ | F25 MTR OIL |
| 27 | $\rightarrow$ | F27 DL SMTH |
| 28 | $\rightarrow$ | F28 MICRO FLT |
| 29 | $\rightarrow$ | F29 DSP FLT |
| 30 | $\rightarrow$ | F30 WATCHDOG |
| 31 | $\rightarrow$ | F31 SCR L1 |
| 32 | $\rightarrow$ | F32 SCR L2 |

```
F33 SCRL3
F F34 IGBT TEMP
F F35 PHSEL1 LOSS
F36 PHSE L2 LOSS
F37 PHSE L3 LOSS
FF40 EXT /PTC
F41 COMMS TRIP
F42 AIN1 LOSS
F43 AIN2 LOSS
F44 CALFLT
F45 STOP T/O
F F46 EEPROM FLT
F47 COMMS T/O
->
F49 SPD LIMIT
F50 PSU FAULT
F51 SCR TEMP
F52 SUPPLY FAN
F53 INTRNAL TEMP
F54 WATCHDOG TMR
F F56 EMERGEN.STOP
F57 PUMP OVERLOA
F65 LOWPRESSURE
F66 HIPRESSURE
F67 LOW WATER
F68 CAVITATION
F69 FLOW SWITCH
F7O IRRIGATOR FL
F71CYCLING
F F72 IN PRES SW
```

| G13.2 REGISTER 2 OF FAULT HISTORY |  |
| :---: | :---: |
| Screen | 2 FO NO FAULT |
| Extended info. | Eifinfaultajo |
| Description | Register 2 of fault history |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | 40433 |
| Modbus range | - |
| Read / Write | Read Only |
| Function | It allows visualizing the information of the fault stored in register 2 of fault history. |
|  | To obtain information about data storage in the different registers and visualize the fault list, see section 'Function' in parameter 'G13.1 $\rightarrow$ Register 1 of fault history'. |

## G13.3 REGISTER'3 OF FAULT HISTORY

| Screen | 3 FO NO FAULT |
| :---: | :---: |
| Extended info. | FOURTH FAULTEPXX |
| Description | Register 3 of fault history |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | 40434 |
| Modbus range | - |
| Read / Write | Read Only |
| Function | It allows visualizing the information of the fault stored in register 3 of fault history. |
|  | To obtain information about data storage in the different registers and visualize the fault list, see section 'Function' in parameter ' $\mathrm{G} 13.1 \rightarrow$ Register 1 of fault history'. |


G13.5 REGISTER 5 OF FAULTHISTORY

| Screen | 5 FO NO FAULT |
| :---: | :---: |
| Extended info. | SECOMD FAULTEEX |
| Description | Register 5 of fault history |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | 40436 |
| Modbus range | - |
| Read / Write | Read Only |
| Function | It allows visualizing the information of the fault stored in register 5 of fault history. |
|  | To obtain information about data storage in the different registers and visualize the fault list, see section 'Function' in parameter 'G13.1 $\rightarrow$ Register 1 of fault history'. |


| G13.6 REGISTER 6 OF FAULT HISTORY |  |
| :---: | :---: |
| Screen | 6 FO NO FAULT |
| Extended info. | EIRST FAULTEFXX |
| Description | Register 6 of fault history |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | 40437 |
| Modbus range | - |
| Read / Write | Read Only |
| Function | It allows visualizing the information of the fault stored in register 6 of fault history. |
|  | To obtain information about data storage in the different registers and visualize the fault list, see section 'Function' in parameter 'G13.1 $\rightarrow$ Register 1 of fault history'. |
| G13.7 ERASE FAULT HISTORY |  |
| Screen <br> Description <br> Range |  |
|  | To erase fault history register |
|  | $\mathrm{N}$ |
|  | Y <br> (See 'Function' for additional information) |
|  |  |
| Default value | (See 'Function' for additional information) N |
| Set on run | YES |
| Modbus address | 40438 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows user to erase the faults stored in registers of fault history. |
|  | Options: |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ Function disabled. |
|  |  |
|  | $Y \rightarrow Y E S$ |
|  | It erases fault history (last six faults). The screen returns to default value after all of the faults have been erased. |

### 10.14.Group 14 - G14: Multi-references

This parameters group allows user to set multiple references for the equipment. These references will be activated by using digital inputs configured as multiple speed references or PID setpoints.

To use them like this, you must proceed in the following manner:

1) Select option ' $2 \rightarrow$ MREF 2 WIRES' or ' $3 \rightarrow$ MREF 3 WIRES' in parameter 'G4.1.4 $\rightarrow$ Selection of digital inputs configuration'.
2) Once realized the previous setting, you must select if multi-references are speed references or PID setpoints.

- If multi-references are speed references, you must only select the option 'MREF' in parameter 'G3.1 $\rightarrow$ Reference source 1 of speed' or in 'G3.2 $\rightarrow$ Reference source 2 of speed', depending on the reference source of speed is selected.
- If multi-references are PID setpoints; first, you must to enable the PID regulator by selecting option 'PID' in 'G3.1 $\rightarrow$ Reference source 1 of speed' or in ' $\mathrm{G} 3.2 \rightarrow$ Reference source 2 of speed'. Next, you must select option 'MREF' in parameter 'G6.1 $\rightarrow$ Source selection for introducing reference signal'.

When you select option ' $2 \rightarrow$ MREF 2 WIRES' in parameter 'G4.1.4 $\rightarrow$ Selection of digital inputs configuration', digital inputs 5 and 6 are configured automatically to select multiple references (DI5 represents high bit and DI6 represents low bit). The combination of these inputs offers the possibility of selecting up to four different speed references or PID setpoints (depending on the selected option explained above)

The following table relates the inputs DI5 and DI6 to the selected multi-reference

| PARAMETER | REFERENCE | DI5 | DI6 |
| :---: | :---: | :---: | :---: |
| G14.4 | MREF 4 | 0 | 0 |
| G14.5 | MREF 5 | 0 | 1 |
| G14.6 | MREF 6 | 1 | 0 |
| G14.7 | MREF 7 | 1 | 1 |

When you select option ' $3 \rightarrow$ MREF 3 WIRES' in parameter 'G4.1.4 $\rightarrow$ Selection of digital inputs configuration', digital inputs 4,5 and 6 are configured automatically to select multiple references (DI4 represents high bit and DI6 represents low bit). The combination of these inputs offers the possibility of selecting up to seven different speed references or PID setpoints (depending on the selected option explained above).

The following table relates the inputs DI4, DI5 and DI6 to the selected multi-reference:

| PARAMETER | REFERENCE | D14 | DI5 | DI6 |
| :---: | :---: | :---: | :---: | :---: |
| G14.1 | MREF 1 | 0 | 0 | 1 |
| G14.2 | MREF 2 | 0 | 1 | 0 |
| G14.3 | MREF 3 | 0 | 1 | 1 |
| G14.4 | MREF 4 | 1 | 0 | 0 |
| G14.5 | MREF 5 | 1 | 0 | 1 |
| G14.6 | MREF 6 | 1 | 1 | 0 |
| G14.7 | MREF 7 | 1 | 1 | 1 |

[^32] deactivation of the digital inputs.


Figure 10.43 Selection of multi-references through digital inputs

## G14.1_HULTI-REFERENCE 1

| Screen | 1 MREF $1=+10.0 \%$ |
| :---: | :---: |
| Extended info. | MULT-REFERENCE1 |
| Description | Multi-reference 1 |
| Range | -250\% to $+250 \%$ |
| Default value | +10.0\% |
| Set on run | YES |
| Modbus address | 40052 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows user to set the value of multi-reference 1. This value is set in \% of motor rated speed. |
|  | For additional information, see chapter 10.14 (G14 MULTI-REFERENCES) and figure 10.43. |

## G14.2 MULTI-REFERENCE 2

| Screen | 2 MREF 2 $=\mathbf{+ 2 0 . 0} \%$ |
| :--- | :--- |
| Extended info. | MULTRREFERENCE2 |
| Description | Multi-reference 2 |
| Range | $-250 \%$ to $+250 \%$ |
| Default value | $+20.0 \%$ |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 0 5 3}$ |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |

Function It allows user to set the value of multi-reference 2 . This value is set in $\%$ of motor rated speed.

For additional information, see chapter 10.14 (G14 MULTI-REFERENCES) and figure 10.43 .
G14.3 WUULTI-REFERENCE 3

| Screen | 3 MREF 3 = +30.0\% |
| :---: | :---: |
| Extended info. | MULTHEFERENCES |
| Description | Multi-reference 3 |
| Range | -250\% to $+250 \%$ |
| Default value | +30.0\% |
| Set on run | YES |
| Modbus address | 40054 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |

Function It allows user to set the value of multi-reference 3. This value is set in $\%$ of motor rated speed.

For additional information, see chapter 10.14 (G14 MULTI-REFERENCES) and figure 10.43.

| G14.4 M | TI-REFERENCE 4 |
| :---: | :---: |
| Screen | 4 MREF $4=+40.0 \%$ |
| Extended info. | MULT-REFERENCE4 |
| Description | Multi-reference 4 |
| Range | -250\% to +250\% |
| Default value | +40.0\% |
| Set on run | YES |
| Modbus address | 40055 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows user to set the value of multi-reference 4. This value is set in $\%$ of motor rated speed. |
|  | For additional information, see chapter 10.14 (G14 MULTI-REFERENCES) and figure 10.43 . |

## G14.5 HULTI-REFERENCE 5

| Screen | 5 MREF $5=+50.0 \%$ |
| :---: | :---: |
| Extended info. | MULT-REFERENGES |
| Description | Multi-reference 5 |
| Range | -250\% to $+250 \%$ |
| Default value | +50.0\% |
| Set on run | YES |
| Modbus address | 40056 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows user to set the value of multi-reference 5. This value is set in \% of motor rated speed. |
|  | For additional information, see chapter 10.14 (G14 MULTI-REFERENCES) and figure 10.43. |

## G14:6 MULTI-REFERENCE 6

| Screen | 6 MREF $6=+60.0 \%$ |
| :---: | :---: |
| Extended info. | MÚLTT-REFERENGE6 |
| Description | Multi-reference 6 |
| Range | -250\% to +250\% |
| Default value | +60.0\% |
| Set on run | YES |
| Modbus address | 40057 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows user to set the value of multi-reference 6. This value is set in \% of motor rated speed. |
|  | For additional information, see chapter 10.14 (G14 MULTI-REFERENCES) and figure 10.43. |


| G14.7 MU | TI-REFERENCE 7 |
| :---: | :---: |
| Screen | 7 MREF $7=+70.0 \%$ |
| Extended info. | MULT-REFERENCE7, |
| Description | Multi-reference 7 |
| Range | -250\% to +250\% |
| Default value | +70.0\% |
| Set on run | YES |
| Modbus address | 40058 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows user to set the value of multi-reference 7. This value is set in $\%$ of motor rated speed. |
|  | For additional information, see chapter 10.14 (G14 MULTI-REFERENCES) and figure 10.43. |

### 10.15.Group 15 - G15: Inch Speeds

This group of parameters allows setting the value of three possible inch speeds of the motor. Inch speed selection can be realized through a comparator output or by means of a digital input configured for this purpose, one input for inch speed 1 and other one for inch speed 2 . For inch speed 3, a combination of two previous inputs is required.

To select an inch speed through a comparator output you must set the output function of the Comparator 1,2 or 3 to option ' $05 \rightarrow$ START + INCH $1^{\prime}$, ' $06 \rightarrow$ START + INCH2' or ' $07 \rightarrow$ START + INCH3' for Comparator 1, 2 or 3 in parameter G9.1.9, G9.2.9 or G9.3.9 respectively.

In case of selecting an inch speed through digital input you must select option '08 $\rightarrow$ START + INCH1' (for inch speed 1 ) or ' $09 \rightarrow$ START + INCH2' (for inch speed 2 ) in one of the parameters 'G4.1.5 $\rightarrow$ Multifunction Digital Input 1 configuration' to ' $\mathrm{G} 4.1 .10 \rightarrow$ Multi-function Digital Input 6 configuration'. Inch speed 3 is selected by combination of the two digital inputs configured as inch speed 1 and 2.

|  | INPUTS |  |
| :---: | :---: | :---: |
| SPEED | DIX | DIY |
| Inch speed 1 | 1 | 0 |
| Inch speed 2 | 0 | 1 |
| Inch speed 3 | 1 | 1 |

Note: The activation of this function includes the start command. Therefore, this signal prevails over any other input configured as start.


Figure 10.44 Operation of the SD700 according to the activation of the inch speeds through digital inputs

| G15.1 INCH SPEED 1 |  |
| :---: | :---: |
| Screen | 1 INCH1 $=+0.00 \%$ |
| Extended info. | MCH SPEED 1 |
| Description | Inch speed 1 |
| Range | -250\% to $+250 \%$ |
| Default value | +0.00\% |
| Set on run | YES |
| Modbus address | 40092 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows user to set a value as inch speed 1. |


| G15.2 INCH SPEED 2 |  |
| :---: | :---: |
| Screen | 2 INCH2 $=+0.00 \%$ |
| Extended info. | INCH BPEED 2 |
| Description | Inch speed 2 |
| Range | -250\% to +250\% |
| Default value | +0.00\% |
| Set on run | YES |
| Modbus address | 40093 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows user to set a value as inch speed 2. |
|  | For more information, see chapter 10.15 (G15 INCH SPEEDS) and figure 10.44. |


| G15.3 INCH SPEED 3 |  |
| :---: | :---: |
| Screen | 3 INCH3 $=+0.00 \%$ |
| Extended info. | HCH SPEED 3 |
| Description | Inch speed 3 |
| Range | $-250 \%$ to $+250 \%$ |
| Default value | +0.00\% |
| Set on run | YES |
| Modbus address | 40094 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows user to set a value as inch speed 3. |
|  | For more information, see chapter 10.15 (G15 INCH SPEEDS) and figure 10.44. |

### 10.16.Group 16 - G16: Skip Frequencies

| G16.1 SKIP FREQUENCY 1 |  |
| :---: | :---: |
| Screen | 1 SKIP $1=+0.0 \%$ |
| Extended info. | SKIP FREGUENCY 1 |
| Description | Skip frequency 1 |
| Range | $-250 \%$ to $+250 \%$ |
| Default value | +0.0\% |
| Set on run | YES |
| Modbus address | 40132 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows user to set the first skip frequency. |
|  | With this, user achieves an operation area not selectable, this is, where reference speeds cannot be adjusted to avoid resonance frequencies. The drive will only take these reference values when is changing speed (during acceleration and deceleration), but it will not operation at these speed values. |
|  | One this value is set, the bandwidth adjusted in ' $\mathrm{G} 16.3 \rightarrow$ Skip bandwidth' will be based on it, forming a frequency range that the drive will avoid. |

See example and figure 10.45 in parameter ' $G 16.3 \rightarrow$ Skip bandwidth'.

## G16.2 SKIP'FREQUENCY 2

| Screen | 2 SKIP 2 $=+0.0 \%$ |
| :--- | :--- |
| Extended info. | SKIP |
| SKIP. FREQUENCY 2 |  |

With this, user achieves an operation area not selectable, this is, where reference speeds cannot be adjusted to avoid resonance frequencies. The drive will only take these reference values when is changing speed (during acceleration and deceleration), but it will not operation at these speed values.

One this value is set, the bandwidth adjusted in 'G16.3 $\rightarrow$ Skip bandwidth' will be based on it, forming a frequency range that the drive will avoid.

See example and figure 10.45 in parameter ' $\mathrm{G} 16.3 \rightarrow$ Skip bandwidth'.

G16:3 SKIP BANDWIDTH

| Screen | 3 SKIP BAND = OFF |
| :---: | :---: |
| Extended info. | OFFSET BAND |
| Description | Skip band |
| Range | OFF=0-20\% |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40134 |
| Modbus range | 0 to 1638 |
| Read / Write | YES |
| Function | It allows setting the band of frequencies, inside of which, drive does not operate, in spite of the drive goes through that band of frequencies during the acceleration and deceleration. |

## Example.

We suppose that skip frequency 1 ( G 16.1 ) is set to ' $40 \%$ ', skip frequency 2 (G16.2) is set to ' $80 \%$ ', and the skip bandwidth is set to ' $20 \%$ '. The avoided frequencies will be from ' $40 \%-10 \%$ ' to ' $40 \%+10 \%$ ' and from ' $80 \%-10 \%$ ' to ' $80 \%+10 \%$ ', this is, from $30 \%$ to $50 \%$ and from $70 \%$ to $90 \%$. Now, we suppose that reference frequency 1 (speed reference 1) is $55 \%$, out of the two skip bandwidths. Reference frequency 2 (speed reference 2) is $85 \%$, therefore, is inside of one skip bandwidth.

In the first case (reference frequency $1=55 \%$ ), the drive will only take the frequency values that are inside of skip bandwidth while is accelerating or decelerating until reaching the value of $55 \%$ (in this case during the acceleration), speed at which the drive will remain operating.

In the second case, when reference frequency 2 is inside of one of the skip bandwidths ( $85 \%$ ), two situations are possible:
a) Drive is accelerating; then, frequency will be increased up to $85 \%$, it will not stop here, but it will be increased up to $90 \%$ (maximum limit value of the skip bandwidth).
b) Drive is decelerating; then, frequency will be decreased down to $85 \%$, it will not stop here, but it will be decreased down to $70 \%$ (minimum limit value of the skip bandwidth).

In the following figure we can observe the behaviour of the frequency signal according to the skip frequencies and speed references.


Figure 10.45 Example. Frequency signal according to the speed reference and skip frequencies

### 10.17.Group 17 - G17: Brake

| G17.1_TI | FOR DC BRAKE ACTIVATION |
| :---: | :---: |
| Screen | 1 T DC BRAKE = OFF |
| Extended info. | DCCURRENT LEVEL |
| Description | Time for DC brake activation |
| Range | OFF=0.0-99s |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40025 |
| Modbus range | 0 to 990 |
| Read / Write | YES |
| Function | It allows user to set the time during which DC brake will be activated. |


| G17.2 CU | RENT APPLIED TO THE BRAKE |
| :---: | :---: |
| Screen | 2 DC CURR $=0 \%$ |
| Extended info. | DC CURRENT LEVEL |
| Description | Current applied to the brake |
| Range | 0-100\% |
| Default value | 0\% |
| Set on run | YES |
| Modbus address | 40022 |
| Modbus range | 0 to 8192 |
| Read / Write | YES |
| Function | It allows setting the current value applied to the brake. |
|  | A proper current value must be set to brake the load inertia correctly. If this value is too low the load will not be stopped in time. On the other hand, if the value is too high the power components of the drive will be stressed. |


| G17.3 VO | TAGE APPLIED TO THE BRAKE |
| :---: | :---: |
| Screen | 3 DC VOLTS $=0.0 \%$ |
| Extended info. | DC BR VOLT LEVEI |
| Description | Voltage applied to the brake |
| Range | 0.0-25\% |
| Default value | 0.0\% |
| Set on run | YES |
| Modbus address | 40023 |
| Modbus range | 0 to 2048 |
| Read / Write | YES |
| Function | It allows setting the level of DC voltage applied to the brake. |
|  | A proper voltage value must be set to brake the load inertia correctly. If this value is too low the load will not be stopped in time. On the other hand, if the value is too high the power components of the drive will be stressed. |


| G17.4 NO | CONDENSING HEATING CURRENT |
| :---: | :---: |
| Screen | 41 HEATING $=$ OFF |
| Extended info. | Hic HEATING |
| Description | Non condensing heating current |
| Range | OFF=0.0-30\% |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40024 |
| Modbus range | 0 to 2458 |
| Read / Write | YES |
| Function | It allows setting the DC current value to avoid humidity or condensation forming inside the motor. |

Note: You must only modify this parameter if condensation or humidity problems inside the motor are present.
¢ CAUTION: Although the motor is not running there is dangerous voltage. RUN led will be lit during this process. Be careful to avoid property damage and personal injuries.
G17.5 USE OF EXTERNAL BRAKE

| Screen | 5 DYN BRAK = N |
| :---: | :---: |
| Description | Use of external brake |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 40026 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | User must configure the drive if an external dynamic brake is going to be used. |
|  | Options: |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Application does not require the use of external brake. |
|  | $Y \rightarrow Y E S$ |
|  | External brake is going to be installed. |

G17.6 VOLTAGE FOR ACTIVATING REGENERATION CONTROL

| Screen | 6 VDC BRAKE $=$ OFF |
| :--- | :--- |
| Extended info. | VDCBRAKE START |
| Description | Voltage for activating the regeneration control |
| Range | For VIN $=400 \mathrm{~V} / 500 \mathrm{~V} \rightarrow 800$ to $810 \mathrm{~V}, \mathrm{OFF}=811$ |
|  | For VIN $=690 \mathrm{~V} \rightarrow 1150$ to 1160 V, OFF $=1161$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40509 |
| Modbus range | For VIN $=400 \mathrm{~V} / 500 \mathrm{~V} \rightarrow 800$ to 810,811 |
|  | For VIN $=690 \mathrm{~V} \rightarrow 1150$ to 1160,1161 |
| Read $/$ Write | YES |

Function It allows setting the DC Bus voltage level to activate voltage regeneration control.
When an external brake is used, in some applications although braking resistors are not enough to dissipate energy returned to the drive at specific moments. In this case, the drive will use the regeneration control to limit DC bus voltage with the level value set here, by acting over motor deceleration.

### 10.18.Group 19 - G19: Fine Tuning

### 10.18.1. Subgroup 19.1-S19.1: IGBT Control

| Screen | 1 TYPE CTRL $=\mathrm{V} / \mathrm{Hz}$ |
| :---: | :---: |
| Description | Selection of control type |
| Range | $\mathrm{V} / \mathrm{Hz}$ |
|  | PEVE |
|  | (See 'Function' for additional information) |
| Default value | $\mathrm{V} / \mathrm{Hz}$ |
| Set on run | NO |
| Modbus address | 40522 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows selecting the drive control type. Configuration options are: |
|  | $\mathrm{V} / \mathrm{Hz} \quad \rightarrow$ Scalar control mode. <br> Drive carries out the control by applying a voltage / frequency ramp to the motor. |
|  | PEVE $\rightarrow$Compensation of stator voltage drop. <br> Torque delivery is improved at specific moments when motor <br> overload is present. |

G19:1.2 COMBUTATION FREQUENCY

| Screen | 2 FRQ $=\mathbf{4 0 0 0} \mathrm{Hz}$ |
| :--- | :--- |
| Extended info. | MODULAT FREOUENC |
| Description | Commutation frequency |
| Range | $4000-8000 \mathrm{~Hz}$ |
| Default value | 4000 Hz |
| Set on run | YES |
| Modbus address | 40523 |
| Modbus range | 4000 to 8000 |
| Read / Write | YES |
| Function | It allows modifying the commutation frequency of the output stage to the motor. This |
|  | allows reducing the noise of the own motor. |


| G.19:1:3 | PEWAVE CONTROL |
| :--- | :--- |
| Screen | 3 PEWAVE=Y |
| Description | Pewave control |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | Y |
| Set on run | YES |
| Modbus address | 40524 |
| Modbus range | 0 to 1 |
| Read / Write | YES |

```
Function It allows user to select Pewave control.
    This control mode improves motor noise tone.
    N }->\textrm{NO
        Pewave control deactivated.
    Y YES
        Pewave control activated.
        Commutation frequency (G19.1.2) is slightly modified on a random basis to
        improve the noise tone generated by the motor
```


### 10.18.2. Subgroup 19.2-S19.2: Motor Load

| G19.2.1 Mal | IRAUM FLUX |
| :---: | :---: |
| Screen | 1 MIN FLUX $=100 \%$ |
| Extended info. | MINIMUMFLIX |
| Description | Minimum flux level |
| Range | 40-100\% |
| Default value | 100\% |
| Set on run | NO |
| Modbus address | 40502 |
| Modbus range | 3277 to 8192 |
| Read / Write | YES |
| Function | It allows setting the minimum flux level used by the motor during low load conditions. |
|  | With this dynamic system of flux optimization, noise and power losses are reduced thanks to the automatic adaptation of the flux level during low load conditions. It is used in applications where load changes slowly (pumps, fans, ...). In these applications, the minimum value is introduced. <br> The more dynamic is the system behaviour, the more you must increase the minimum flux level. In applications that require dynamic behaviour, for example servos and cranes, you must set this parameter to default value ( $100 \%$ ). |
| Note: | If too low value is used can produce instability and current peaks. To avoid this, increase this parameter value. <br> The algorithm is disabled when this parameter is set to $100 \%$. |


| G19.2:2 INI | IAL VOLTAGE |
| :---: | :---: |
| Screen | 2 V BOOST $=0.0 \%$ |
| Extended info. | BOOST VOLTAGE |
| Description | Initial voltage |
| Range | 0.0-100\% |
| Default value | 0.0\% |
| Set on run | YES |
| Modbus address | 40592 |
| Modbus range | 0 to 8192 |
| Read / Write | YES |
| Function | It allows setting the initial voltage level to apply to the motor at the moment of starting. Using this function it is possible to improve breakaway torque when starting heavy loads. |
|  | This parameter is used in association with parameter 'G19.2.3 $\rightarrow$ Torque boost band'. |
| Note: | Set a low value first. Increase the value gradually until achieving a proper value to start correctly the installation. <br> Do not set values higher than needed ones, since this would produce current limitation and unnecessary overstress of the drive and motor. |


| G19.2.3_..T0 | RQUE BOOST BAND |
| :---: | :---: |
| Screen | 3 BW BOOST $=0.0 \%$ |
| Extended info. | BOOST BAND |
| Description | Torque boost band |
| Range | 0.0-100\% |
| Default value | 0.0\% |
| Set on run | YES |
| Modbus address | 40593 |
| Modbus range | 0 to 8192 |
| Read / Write | YES |
| Function | It allows setting a band or range of frequencies during which torque boost set in 'G19.2.2 $\rightarrow$ Initial voltage' will be applied at the moment of starting. Using this function it is possible to improve breakaway torque when starting heavy loads. |
|  | This parameter is used in association with previous parameter G19.2.2. |


| G19.2.4 SLIP COMPENSATION |  |
| :---: | :---: |
| Screen | 4 SLIP COMPENS $=\mathbf{N}$ |
| Description | Slip compensation |
| Range | N |
|  | $Y$ |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 40505 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | If this function is active, it helps to compensate the slip on the motor. This function must be enabled in case of heavy load able to provoke a high slip during the starting. |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Function disabled. |
|  | $Y \rightarrow Y E S$ |


| G19.2.5 DR | VE DAMAPING |
| :---: | :---: |
| Screen | 5 DAMPING $=0.0 \%$ |
| Description | Damping of the drive |
| Range | 0.0-20.0\% |
| Default value | 0.0\% |
| Set on run | YES |
| Modbus address | 40506 |
| Modbus range | 0 to 1638 |
| Read / Write | YES |
| Function | It allows setting a damping value for the drive when operates with no loaded motors. |
|  | If the motor is operating with no load and a high oscillation in the current is detected, then it is recommended to increase this value. Nevertheless, avoid operating with very high values (higher than $1.5 \%$ ). |


| G19.2.6 COMPENSATING BANDWIDTH OF TORQUE TRANSITORY |  |
| :---: | :---: |
| Screen | 6 TTP EAND $=0.0 \%$ |
| Description | Compensating bandwidth of torque transitory |
| Range | 0.0-10.0\% |
| Default value | 0.0\% |
| Set on run | YES |
| Modbus address | 40507 |
| Modbus range | 0 to 819 |
| Read / Write | YES |
| Function | It allows setting an initial value for a band of frequencies, where the torque transitory will be compensated. |
|  | This function helps in the starting when the load is heavy and a high torque boost is required. This value can be increased when strikes and oscillations are observed during the motor starting. Nevertheless, do not to modify this value unnecessarily since the motor operation will be affected. |


| G19.2.7 CU | RRENT LIMIT FACTOR |
| :---: | :---: |
| Screen | 71 SLIP $=2.0 \%$ |
| Extended info. | ISLP COMPENSAT |
| Description | Current limit factor |
| Range | 0.0-20.0\% |
| Default value | 2.0\% |
| Set on run | YES |
| Modbus address | 40508 |
| Modbus range | 0 to 1638 |
| Read / Write | YES |
| Function | It allows setting the current limit factor. |
|  | It modifies the speed by reducing the output frequency to keep the output current within a controllable margins (display shows the warning message ILT). Adjusting this parameter can improve the stability of the current limit function considering the motor slip. |
| Note: | We only recommend setting this value when limitation current action is unstable. Usually, this value must be set to the motor rated slip. A low value will improve the stability although the current limit action will operate earlier. |


| 619:2.9 IN | LAL FREQUENCY |
| :---: | :---: |
| Screen | 9 STR FRQ $=0.0 \%$ |
| Extended info. | START FREQUENCY |
| Description | Starting initial frequency |
| Range | 0.0-100\% |
| Default value | 0.0\% |
| Set on run | YES |
| Modbus address | 40594 |
| Modbus range | 0 to 8192 |
| Read/Write | YES |
| Function | It allows setting an initial frequency that will be applied at the moment of the drive starting. |

 algorithm will improve the instability of the drive.

In some applications, during a certain frequency range, excessive current oscillation may be generated, and this may cause the drive trip in overcurrent or over voltage protections. In order to avoid these oscillations, the value of this parameter must be decreased down to a certain frequency value, below which a special algorithm to improve the instability of the drive will be implemented, as mentioned before.

This parameter operates together with parameters 'G19.2.11 $\rightarrow$ Stabilize factor in acceleration' and 'G19.2.12 $\rightarrow$ Stabilize factor in deceleration'.

Note: Whenever there is no instability in the system (installation), do not modify the default value of this parameter

| G19.2.11 STABILIZE FACTOR IN ACCELERATION |  |
| :---: | :---: |
| Screen | 11 STA F AC = OFF |
| Extended info. | STAGILIVEFACC |
| Description | Stabilize factor in acceleration |
| Range | $80.0-99.9 \%$, OFF $=100 \%$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40019 |
| Modbus range | 6554 to 8192 |
| Read / Write | YES |
| Function | It allows setting a value as stabilize factor during acceleration. |
|  | Usually, the instability of the system is reduced during the acceleration by decreasing the value of this parameter. |
|  | This parameter operates together with parameter 'G19.2.10 $\rightarrow$ Frequency $\mathrm{V} / \mathrm{Hz}$ change'. See 'Function' in parameter G19.2.10 for additional information. |

G19.2.12 STABILIZE FACTOR IN DECELERATION

| Screen | 12 STA F DC $=$ OFF |
| :--- | :--- |
| Extended info. | STABILIE E DEC |
| Sescription | Stabilize factor in deceleration |
| Range | $80.0-99.9 \%$, OFF $=100 \%$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 0 2 0}$ |
| Modbus range | 6554 to 8192 |
| Read $/$ Write | YES |

Function It allows setting a value as stabilize factor during deceleration.
Usually, the instability of the system is reduced during the deceleration by decreasing the value of this parameter.

This parameter operates together with parameter 'G19.2.10 $\rightarrow$ Frequency $\mathrm{V} / \mathrm{Hz}$ change'. See 'Function' in parameter G19.2.10 for additional information.

G19.2.13 REGENERATION BUS VOLTAGE

| Screen | 13 CTR Vbus $=0 F F$ |
| :---: | :---: |
| Extended info. | REGEN BUSVOI |
| Description | Regeneration of bus voltage |
| Range | For VIN $=400 \mathrm{~V} / 500 \mathrm{~V} \rightarrow 625$ to $799 \mathrm{~V}, \mathrm{OFF}=800 \mathrm{~V}$ |
|  | For VIN $=690 \mathrm{~V} \rightarrow 950$ to $1250 \mathrm{~V}, \mathrm{OFF}=1251 \mathrm{~V}$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40021 |
| Modbus range | For VIN $=400 \mathrm{~V} / 500 \mathrm{~V} \rightarrow 625$ to 799, 800 |
|  | For VIN $=690 \mathrm{~V} \rightarrow 950$ to 1250, 1251 |
| Read / Write | YES |
| Function | It allows setting a voltage value in order to remove over voltage fault. |
|  | If the setting of the previous parameters 'G19.2.10 $\rightarrow$ Frequency $\mathrm{V} / \mathrm{Hz}$ change', 'G19.2.11 $\rightarrow$ Stabilize factor in acceleration' and 'G19.2.12 $\rightarrow$ Stabilize factor in deceleration' has not been enough to reduce the instability of the system, then, in case of fault 'F2 V LIM FLT' is produced, decrease the value of this parameter until the fault disappears. |
|  | The optimum result will be obtained when this parameter is used together with the previous parameters G19.2.10, G19.2.11 y G19.2.12. |

### 10.18.3. Subgroup 19.3-S19.3: Motor Model

G19.3.1 STATOR RESISTANCE

| Screen | 1 R STATOR $=0.9 \%$ |
| :---: | :---: |
| Extended info. | STATOR RESISTOR |
| Description | Stator resistance (Rs) |
| Range | 0.0-9.9\% |
| Default value | 0.9\% |
| Set on run | YES |
| Modbus address | 40482 |
| Modbus range | 0 to 811 |
| Read / Write | YES |

Function It allows setting the value of the stator resistance.
This parameter is used to compensate for motor voltage drop. It is very important for applications with large torque transients, especially at low speed. If the resistance value is very low, then the motor torque produced at the starting will be reduced. When this value is increased, then the torque boost will be increased.

The value of the stator resistance is set as \% of motor rated impedance. Consider the following table for approximate Rs values according to the motor power ratings:

| Power (kW) | Rs value (\%) |
| :---: | :---: |
| 75 | $\overline{1.5-2}$ |
| 150 | $1-1.5$ |
| 300 | $0.6-1.2$ |
| 450 | $0.35-0.7$ |
| 630 | $0.25-0.5$ |

Note: If this value is set too high then increased motor current can reach the current limit (G10.5), avoiding motor speed increase. We recommend consulting the standard value table, since Rs value is variable according to the drive capacity.

### 10.19.Group 20 - G20: Serial Communication Controls

| G20.1 | COMMUNICATION PROTOCOL |
| :--- | :--- |
| Screen | 1 PROTOCOL $=M$ |
| Description | Communication protocol |
| Range | M |
| Default value | M |
| Set on run | YES |
| Function | It allows selecting the communication protocol to be used. |
|  | If you want to access to the drive internal variables through serial port, this parameter <br> must be set to the desired protocol. |
|  | Option: |
|  | $\mathrm{M} \rightarrow$ MODBUS. |


| G20.2 LIM | IT TIME FOR COAMMUNICATION |
| :---: | :---: |
| Screen | 2 COMMS T/O $=$ OFF |
| Extended info. | COMMS TIMEOUT |
| Description | Limit time for serial communication |
| Range | OFF $=0-250$ s |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 40413 |
| Modbus range | 0 to 250 |
| Read / Write | YES |
| Function | It allows setting the limit time for serial communication. |
|  | This parameter provides with the option of generating a drive trip (F47 COMMS T/O) if the time elapsed from the last valid data transmission has exceeded the limit time set in this parameter. Serial communication with the drive is possible through RS232 terminals, RS485 terminals or USB port. |
| Note: | Do not modify this parameter if is not necessary. |

### 10.19.1. Subgroup 20.3-S20.3: Modbus

G20.3.1 COMMUNICATION ADDRESS

| Screen | 1 COMMS ADDR $=10$ |
| :---: | :---: |
| Extended info. | COMM ADDRESS |
| Description | Drive address for communication |
| Range | 1-255 |
| Default value | 10 |
| Set on run | YES |
| Modbus address | 40414 |
| Modbus range | 1 to 255 |
| Read / Write | YES |
| Function | It allows assigning an identification address to the drive for communicating with it from the network. If communication is required with several drives, different address is required for each unit. |


| G20.3.2 | COMAMUNICATION SPEED |
| :--- | :--- |
| Screen | 2 BAUDS $=9600$ |
| Description | Communication speed |
| Range | 600 |
|  | 1200 |
|  | 2400 |
|  | 4800 |
|  | 9600 |
| Default value | 9600 |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 4 1 5}$ |
| Modbus range | 0 to 4 |
| Read / Write | YES |
|  |  |
| Function |  |
|  |  |
|  |  |
|  |  |


| G20.3.3 | COMMUNICATION PARITY |
| :--- | :--- |
| Screen | 3 PARITY = NONE |
| Description | Selection of communication parity |
| Range | ODD |
|  | NONE |
|  | EVEN |
| Default value | NONE |
| Set on run | YES |
| Modbus address | 40416 |
| Modbus range | 0 to 2 |
| Read / Write | YES |
|  |  |
| Function | It allows setting the parity of MODBUS serial communication. |
|  | It is used for data validation. If you do not want to validate data, set this parameter to |
|  | 'NONE'. Parity selection must be the same than the parity of the master of the |
|  | communication bus on which the drive is integrated. |

### 10.19.2. Subgroup 20.4-S20.4: Modbus TCP

This parameter group is used to configure the drive when it must operate in an Ethernet network communication.

G20.4.1 IP ADDRESS(A)

| Screen | 1 IP PARAM A = 192 |
| :---: | :---: |
| Description | IP address ( $A$ ) of the equipment |
| Range | 0-255 |
| Default value | 192 |
| Set on run | YES |
| Modbus address | 40374 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field $A$ of the IP address assigned to the equipment in the local network of the user. This address must be provided by the network administrator of the own user. |
|  | The format of the IP address is the following one: A.B.C.D. <br> Therefore, the setting of this address is realized by introducing a value in each parameter that configure the complete address, this is, by assigning a value to each one of the 4 parameters (from parameter ' $\mathrm{G} 20.4 .1 \rightarrow \mathrm{IP}$ address $(\mathrm{A}$ )' to parameter 'G20.4.4 $\rightarrow$ IP address (D)'. |

G20.4.2 IP ADDRESS (B)

| Screen | 2 IP PARAM B = 168 |
| :--- | :--- |
| Description | IP address (B) of the equipment |
| Range | $0-255$ |
| Default value | 168 |
| Set on run | YES |
| Modbus address 40375 <br> Modbus range 0 to 255 <br> Read / Write  | YES |
| Function | It allows setting the field B of the IP address assigned to the equipment in the local <br> network of the user. This address must be provided by the network administrator of the <br> own user. |
|  | See 'Function' in parameter 'G20.4.1 $\rightarrow$ IP address (A)' for additional information. |

## G20.4:3 IP ADDRESS (C)

| Screen | 3 IP PARAM $\mathrm{C}=1$ |
| :---: | :---: |
| Description | IP address ( C ) of the equipment |
| Range | 0-255 |
| Default value | 1 |
| Set on run | YES |
| Modbus address | 40376 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field C of the IP address assigned to the equipment in the local network of the user. This address must be provided by the network administrator of the own user. |
|  | See 'Function' in parameter ' $\mathrm{G} 20.4 .1 \rightarrow \mathrm{IP}$ address $(A)$ ' for additional information. |


| G20.4.4 IP | DDRESS (D) |
| :---: | :---: |
| Screen | 4 IP PARAM D $=143$ |
| Description | $1 P$ address ( D ) of the equipment |
| Range | 0-255 |
| Default value | 143 |
| Set on run | YES |
| Modbus address | 40377 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field D of the IP address assigned to the equipment in the local network of the user. This address must be provided by the network administrator of the own user. |
|  | See 'Function' in parameter 'G20.4.1 $\rightarrow \mathrm{IP}$ address (A)' for additional information. |

G20.4.5 SUBNET MASK ADDRESS (A)

| Screen | 5 SUBNET A = 255 |
| :---: | :---: |
| Description | Subnet Mask address (A) |
| Range | 0-255 |
| Default value | 255 |
| Set on run | YES |
| Modbus address | 40378 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field $A$ of the Subnet Mask address of the local network of the user. This address must be provided by the network administrator of the own user. |
|  | The format of the Subnet Mask address is the following one: A.B.C.D. <br> Therefore, the setting of this address is realized by introducing a value in each parameter that configure the complete address, this is, by assigning a value to each one of the 4 parameters (from parameter ' $G 20.4 .5 \rightarrow$ Subnet Mask address $(A)$ ' to parameter ' $\mathrm{G} 20.4 .8 \rightarrow$ Subnet Mask address (D)'. |

## G20.4.6 SUBNET MASK ADDRESS (B)

| Screen | 6 SUBNET B $=255$ |
| :---: | :---: |
| Description | Subnet Mask address (B) |
| Range | 0-255 |
| Default value | 255 |
| Set on run | YES |
| Modbus address | 40379 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field $B$ of the Subnet Mask address of the local network of the user. This address must be provided by the network administrator of the own user. |
|  | See 'Function' in parameter ' $\mathbf{G 2 0 . 4 . 5} \rightarrow$ Subnet Mask address (A)' for additional information. |


| G20.4.7 SUBNET MASK ADDRESS (C) |  |
| :---: | :---: |
| Screen | 7 SUBNET C = 255 |
| Description | Subnet Mask address (C) |
| Range | 0-255 |
| Default value | 255 |
| Set on run | YES |
| Modbus address | 40380 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field C of the Subnet Mask address of the local network of the user. This address must be provided by the network administrator of the own user. |
|  | See 'Function' in parameter ' $\mathrm{G} 20.4 .5 \rightarrow$ Subnet Mask address (A)' for additional information. |

G20.4.8 SUBNET MASK ADDRESS (D)

| Screen | 8 SUBNET D $=0$ |
| :--- | :--- |
| Description | Subnet Mask address (D) |
| Range | $0-255$ |
| Default value | 0 |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 3 8 1}$ |
| Modbus range | 0 to 255 |
| Read Write | YES |

Function It allows setting the field D of the Subnet Mask address of the local network of the user. This address must be provided by the network administrator of the own user.

See 'Function' in parameter 'G20.4.5 $\rightarrow$ Subnet Mask address (A)' for additional information.

| G20.4.9 GATEWAY ADDRESS (A) |  |
| :---: | :---: |
| Screen | 9 GATEWAY A $=0$ |
| Description | Gateway address ( A ) |
| Range | 0-255 |
| Default value | 0 |
| Set on run | YES |
| Modbus address | 40382 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field $A$ of the Gateway address of the local network of the user. This address is needed to the drive access to an external network. This address must be provided by the network administrator of the own user. |
|  | The format of the Gateway address is the following one: A.B.C.D. <br> Therefore, the setting of this address is realized by introducing a value in each parameter that configure the complete address, this is, by assigning a value to each one of the 4 parameters (from parameter 'G20.4.9 $\rightarrow$ Gateway address (A)' to parameter ' $\mathrm{G} 20 \cdot 4.12 \rightarrow$ Gateway address (D)'. |

## G20.4:10 GATEWAY ADDRESS (B)

| Screen | 10 GATEWAY B $=\mathbf{0}$ |
| :--- | :--- |
| Description | Gateway address $(B)$ |
| Range | $0-255$ |
| Default value | 0 |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 3 8 3}$ |
| Modbus range | 0 to 255 |
| Read $/$ Write | YES |

Function It allows setting the field $B$ of the Gateway address of the local network of the user. This address is needed to the drive access to an external network. This address must be provided by the network administrator of the own user.

See 'Function' in parameter 'G20.4.9 $\rightarrow$ Gateway address $(A)^{\prime}$ ' for additional information.

G20.4.11 GATEWAY ADDRESS (C)

| Screen | 11 GATEWAY $\mathrm{C}=0$ |
| :--- | :--- |
| Description | Gateway address (C) |
| Range | $0-255$ |
| Default value | 0 |
| Set on run | YES |
| Modbus address | $\mathbf{4 0 3 8 4}$ |
| Modbus range | 0 to 255 |
| Read $/$ Write | YES |

Function It allows setting the field C of the Gateway address of the local network of the user. This address is needed to the drive access to an external network. This address must be provided by the network administrator of the own user.

See 'Function' in parameter 'G20.4.9 $\rightarrow$ Gateway address (A)' for additional information.

G20.4.12 GATEWAY ADDRESS (D)
Screen $\quad 12$ GATEWAY D $=0$
Description Gateway address (D)
Range 0-255
Default value
0
Set on run YES
Modbus address 40385
Modbus range 0 to 255
Read / Write YES

Function It allows setting the field $D$ of the Gateway address of the local network of the user. This address is needed to the drive access to an external network. This address must be provided by the network administrator of the own user.

See 'Function' in parameter 'G20.4.9 $\rightarrow$ Gateway address $(A)^{\prime}$ ' for additional information.

| G20.4.13 _ M | ADDRESS ( $A$ ) |
| :---: | :---: |
| Screen | $13 \mathrm{MAC} A=12$ |
| Description | MAC address (A) |
| Range | 0-255 |
| Default value | 12 |
| Set on run | YES |
| Modbus address | 40386 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field $A$ of the MAC address. This address is unique and exclusive, and is associated to the LAN board / drive. It must be provided by Power Electronics. |
|  | The format of the MAC address is the following one: A.B.C.D.E.F. <br> Therefore, the setting of this address is realized by introducing a value in each parameter that configure the complete address, this is, by assigning a value to each one of the 6 parameters (from parameter ' $\mathrm{G} 20.4 .13 \rightarrow$ MAC address $(A)$ ' to parameter 'G20.4.18 $\rightarrow$ MAC address (D)'. |


| G20:4.14 CMAC ADDRESS (B) |  |
| :---: | :---: |
| Screen | $14 \mathrm{MAC} \mathrm{B}=34$ |
| Description | MAC address (B) |
| Range | 0-255 |
| Default value | 34 |
| Set on run | YES |
| Modbus address | 40387 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field $B$ of the MAC address. This address is unique and exclusive, and is associated to the LAN board / drive. It must be provided by Power Electronics. |
|  | See 'Function' in parameter 'G20.4.13 $\rightarrow$ MAC address (A)' for additional information. |

G20.4.15 MAC ADDRESS (C)

| Screen | $\mathbf{1 5}$ MAC C $=56$ |
| :--- | :--- |
| Description | MAC address (C) |
| Range | $0-255$ |
| Default value | 56 |
| Set on run | YES |
| Modbus address | 40388 |
| Modbus range | 0 to 255 |
| Read $/$ Write | YES |

Function It allows setting the field C of the MAC address. This address is unique and exclusive, and is associated to the LAN board / drive. It must be provided by Power Electronics.

See 'Function' in parameter ' $G 20.4 .13 \rightarrow$ MAC address $(A)$ ' for additional information.

G20.4.16 MAC ADDRESS (D)

| Screen | $\mathbf{1 6 ~ M A C ~ D = 7 8}$ |
| :--- | :--- |
| Description | MAC address (D) |
| Range | $0-255$ |
| Default value | 78 |
| Set on run | YES |
| Modbus address | 40389 |
| Modbus range | 0 to 255 |
| Read $/$ Write | YES |

Function It allows setting the field $D$ of the MAC address. This address is unique and exclusive, and is associated to the LAN board / drive. It must be provided by Power Electronics.

See 'Function' in parameter ' $\mathrm{G} 20.4 .13 \rightarrow$ MAC address $(A)$ ' for additional information.

| G20.4:17 M | ADDRESS (E) |
| :---: | :---: |
| Screen | $17 \mathrm{MAC} \mathrm{E}=90$ |
| Description | MAC address ( E ) |
| Range | 0-255 |
| Default value | 90 |
| Set on run | YES |
| Modbus address | 40390 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field E of the MAC address. This address is unique and exclusive, and is associated to the LAN board / drive. It must be provided by Power Electronics. |
|  | See 'Function' in parameter 'G20.4.13 $\rightarrow$ MAC address (A)' for additional information. |

G20.4.18 MAC ADDRESS (F)

| Screen | 18 MAC F = 171 |
| :--- | :--- |
| Description | MAC address (F) |
| Range | $0-255$ |
| Default value | 171 |
| Set on run | YES |
| Modbus address | 40391 |
| Modbus range | 0 to 255 |
| Read / Write | YES |
| Function | It allows setting the field F of the MAC address. This address is unique and exclusive, |
|  | and is associated to the LAN board / drive. It must be provided by Power Electronics. |
|  | See 'Function' in parameter 'G20.4.13 $\rightarrow$ MAC address (A)' for additional information. |

### 10.20.Group 25 - G25: Pump Control

This parameters group will be available if parameter 'G1.7 $\rightarrow$ Program activation' is set to option 'PUMP'.

### 10.20.1. Pumps Program General Description.

The objective of this functionality is to achieve a comprehensive control of the pumping systems using variable speed drives of SDRIVE 700 series, using in that cases the minimum peripherical devices as possible. The program comprises all that options which allows controlling the process correctly, avoiding the use of those external auxiliary devices such as timers, relays, PLC, etc.

This program has been thought to control the drive and additionally to control up to 5 auxiliary fixed pumps. Apart of this there is the possibility of using one of this pumps as Jockey pump (it will operate only under very low demand conditions in case of the drive is in sleep mode) or one pump can be used as Priming pump (it will operate to fulfil the aspiration pipe if the system requires this function).

### 10.20.2. Operation modes.

There are three operation modes basically:

- Manual Protected Mode: One of the digital inputs must be set as Automatic and a second digital input must be set as Protected Manual. Both inputs must be closed to start. In this operation mode the system protections are operative (for example, high pressure, cavitation, etc.). A main speed reference source and an alternative speed reference source exist, they are set by means of a digital input.
- Manual Non Protected Mode: This is an operation mode thought for commissioning and test of the system. It is not recommended for a normal operation since the protections are not active. There are two possibilities of configuring this mode:
o Manual non protected mode with exclusive control from the keypad.
- Manual non protected mode controlled by the digital inputs.

A main speed reference source and an alternative speed reference source exist, they are set by means of a digital input.

- Pumps Mode: The drive will operate in regulation mode with all the available functions and the protections will be operative.


### 10.20.3. General Descriptions of Protections.

In case of the pump program is active, the drive will function in three different ways depending on the activated protections:

- Faults of the Drive (Standard Program): Here we can find those trips of the drive or trips of the installation that have been configured in the standard program of the drive. In case of any of these conditions occur, the motor controlled by the drive will stop, followed by the fixed pumps and the display will show the corresponding fault message.
- Pause of the Pumps Program: Certain protections can be configured to stop the drive temporary without tripping by fault. For all of them there is only one time to start after the pause, and this time will start once the cause which provoked the pause disappears. The protections which can be set in this way are:
- High Pressure: Configurable at Pause mode or at Fault mode. If it is set as Pause, the displayed message will be 'HI PRESSURE PAUS' but if this is set to Fault, the message will be 'F66 HI PRESSURE'.
- No Flow: Configurable at Pause mode or at Fault mode. If it is set as Pause, the displayed message will be 'NO PLOW PAUSE' but if this is set to Fault, the message will be 'F69 FLOW SWITCH'.
- Cavitation: Configurable at Pause mode or at Fault mode. If it is set as Pause, the displayed message will be 'CAVITATION PAUSE' but if this is set to Fault, the message will be 'F68 CAVIT/UNDERL'.

Note: The pauses are not faults, consequently the do not generate a fault code and they will not be stored in the fault history.

- Faults of Pumps Program: That means the drive or installation faults that have been configured from the pump program. In case of any of these conditions occur, the motor controlled by the drive will stop, followed by the fixed pumps and the display will show the corresponding fault message. These fault will be treated in the same way than the general faults, some of them are:
- High Pressure Fault: It can be provoked through a digital input which has been configured in this mode or by comparison of the received data of an analogue input. This information will be compared with the setting realized in parameters 'G25.6.11 $\rightarrow$ Minimum speed for minimum pressure fault' to ' $G 25.6 .13 \rightarrow$ Maximum pressure level'. The display will show 'F66 HI PRESSURE'.
- Low Pressure Fault: Pipe broken possibility. The display will show 'F65 LOW PRESSURE'.
- No Water Fault: This is especially useful in the use of level proves at wells. The display will show 'F67 LOW WATER'.
o Short Starting Cycle Fault: Produced when the drive tries to start before the established time between a start and a stop has expired. For additional information, see 'G25.6.20 $\rightarrow$ Cycle time of the drive'. In this case, the display will show 'F71 CYCLING'.
o Irrigation Equipment Fault: Produced by a digital input configured for this objective. The display will show 'F70 IRRIGATOR F'.
- No Flow Fault: Produced by a digital input configured in this option. The display will show 'F69 FLOW SWITCH'.
- Cavitation: Produced by operation on underload conditions. The display will show 'F68 CAVIT/UNDERL'.
- Pressure Switch: (Only with Priming pump). The Pressure switch is open out of the allowed time, indicating a sudden pressure loss. The display will show 'F72 IN PRESS SW'.


### 10.20.4. Inputs Configuration.

For inputs configuration, it is necessary to consider some rules which will help in order to get a correct system configuration.

- Digital input for flow acquisition by pulse counter.

All digital input can be configured in this option '51 $\rightarrow$ FLOW PULSE'. The parameters for setting the flowmeter are located in the subgroup S4.4 Pulse Input.

The read flow can be used to limit the flow of the application, see group G25.10 Flow Limitation Algorithm. An analogue output can be configured to show this information (by setting the option ' $20 \rightarrow$ CURRENT FLOW'), in this way this information can be used for the PLC or even can be connected to the drive as a feedback signal in PID mode without needing the use of external converter of pulses signal into $4-20 \mathrm{~mA}$ signal.

- Inputs programming.

There are some configuration options available when the pump program is active, which can be set in the same way that the options available in the standard program.

Nevertheless, when the pump program is active, the drive will assume that only the configurable options from 50 to 69 (for ' $G 4.1 .5 \rightarrow$ Multi-function Digital Input 1 configuration 1 ' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration') can be set, without taking into consideration the setting on parameter 'G4.1.4 $\rightarrow$ Selection of digital inputs configuration', which means a block setting

All that means that the user will configure the pump program freely, according to his requirements, selecting the correct functionality and protections.

The options for inputs configuration, standard program options as well as pump program options have been detailed in the corresponding group G4.1 Digital Inputs.

### 10.20.5. Inputs Configuration Rules.

It is necessary to have into consideration the following rules for a correct digital input configuration when the Pump Program is active:

- Mutual Exclusion Rule:
o If the pump program is deactivated, the user can only set options from 0 to 23 for the digital inputs, which are options for functionalities related to the standard program.
- If the pump program is active, the user can only set options from 50 to 69 for the digital inputs, which are options for functionalities related to the pump program.
- System Start Terminal Rule (Automatic):

To ensure the start and the stop of the system, the user must first of all configure one of the digital inputs as option ' $50 \rightarrow$ PMP START/STP'. On the contrary, the drive does not allow configuring any other option. Once this is done, it is possible to configure the resting inputs as necessary (respecting always the configuration rules).

- Rule for Multiple References Selection:

With the pump program is possible to operate using up to 8 different regulation setpoints in PID mode (settable in G25.1.5 to G25.1.12). To active each different setpoint 3 digital inputs configured as options 63, 64 and 65 can be used. It is necessary to take into consideration the following items:

- No Digital Input could be configured as '64 $\rightarrow$ SETPONT PIN2' unless previously other different input has been configured as ' $63 \rightarrow$ SETPONT PIN1'.
- No Digital Input could be configured as '65 $\rightarrow$ SETPONT PIN3' unless previously two different inputs have been configured as options '63 $\rightarrow$ SETPONT PIN1' and '64 $\boldsymbol{\rightarrow}$ SETPONT PIN2'
- Rule for Selection / De-selection of Auxiliary Pumps:

For selecting one auxiliary pump it is necessary to act in the following way:

- Set any digital input to options '52 $\rightarrow$ FIX PUMP1 FLT', '53 $\rightarrow$ FIX PUMP2 FLT', '54 $\rightarrow$ FIX PUMP3 FLT', '55 $\rightarrow$ FIX PUMP4 FLT' or '56 $\rightarrow$ FIX PUMP5 FLT'.
- To enable the control of the pump in the corresponding parameter G25.9.1, G25.9.2, G25.9.3, G25.9.4 and G25.9.5 respectively.

To remove this fixed pump configuration and release the relay for another different use, it is necessary to:

- To disable the control of the pump in the corresponding parameter G25.9.1, G25.9.2, G25.9.3, G25.9.4 and G25.9.5 respectively.


### 10.20.6. Outputs Configuration.

Regarding to the outputs, it is useful to take into account some considerations which will help for a correct configuration of the system.

- Digital outputs.

There are some configuration options for the outputs that are only available if the pump program is operative, but they cannot be used in the standard program: ' $28 \rightarrow$ PUMP CNTRL', '29 $\rightarrow$ JOCKEY PUMP' and '30 $\rightarrow$ PRIMING PUMP'. The needed information has been detailed in the corresponding group G8.1 Digital Outputs.

## - Analogue outputs.

The options available in the standard program can also be used for the pump program, and additionally the option ' $20 \rightarrow$ CURRENT FLOW', that can be configured to provide the read flow at any of the analogue output formats.

- Example 1 for configuring the analogue output as read flow.

In case the flowmeter data configured in G4.4 are
Units: litres
Pulses / second: 1001/s
Maximum Range: 1000 litres
Analogue output setting:
Format: $\quad 0-10 \mathrm{~V}$
Minimum Range: 0
Maximum Range: 100\%
For a read flow of 500 litres, the analogue output will be:

$$
x=\frac{\text { Read value } * 10 \mathrm{~V}}{\text { Maximum Range }}=\frac{500 * 10}{1000}=5 \mathrm{~V}
$$

- Example 2 for configuring the analogue output as read flow.

If the flowmeter data configured in G4.4 are:
Units: litres
Pulses / second: $1001 / \mathrm{s}$
Maximum Range: 1000 litres
Analogue output setting:
Format: $4-20 \mathrm{~mA}$
Minimum Range: 0
Maximum Range: $100 \%$
For a read flow of 500 litres, the analogue output is:

$$
\mathrm{x}=\left(\left(\frac{\mathrm{Re} \text { adValue }}{\text { MaximumRange }}\right) *(20-4)\right)+4=\left(\left(\frac{500}{1000}\right) * 16\right)+4=12 \mathrm{~mA}
$$

Additionally exists the option ' $27 \rightarrow$ MACRO PUMP', that it is not directly settable by the user for any of the analogue outputs. On the contrary, this option is automatically set for the program to the Analogue Output 1 in case of the user enables the Fixed Pump 4, and it will be automatically set for the Analogue Output 2 when the user enables the Fixed Pump 5. For both outputs, the format configuration will always be 0 to 10 V , where 0 means the pump is OFF and 10 V means the pump is ON.

### 10.20.7. Subgroup 25.1-S25.1: Setpoints

G25.1.1 CONTROL BODE

| Screen | 1 CONTROL MODE $=1$ |
| :---: | :---: |
| Description | Control mode |
| Range | 0 |
|  | 1 |
|  | (See 'Function' for additional information) |
| Default value | 1 |
| Set on run | NO |
| Modbus address | 42035 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows selecting the control mode according to the following configuration options: |
|  | $0 \rightarrow$ MANUAL |
|  | This control mode is thought for commissionings and tests. It is not thought for a continuous operation since protections are disabled. In this control mode display shows 'OVERRIDE MANUAL'. |
|  | With this option it is necessary to operate from the keypad, but the speed reference can be introduced by using an analogue input or by keypad. |
|  | $1 \rightarrow$ PUMP |
|  | The drive will start in pump control mode. Selection of automatic operation in regulation mode (it allows to control flow, pressure). |


| .12 SOURCE SELECTION FOR SPEED REFERENCE IN MANUAL MODE |  |
| :---: | :---: |
| Screen | 2 MAN SPD REF = LOCAL |
| Description | Selection of the source for the main speed reference in manual mode |
| Range | LOCAL |
|  | Al1 |
|  | Al2 |
|  | (See 'Function' for additional information) |
| Default value | LOCAL |
| Set on run | NO |
| Modbus address | 42041 |
| Modbus range | 0 to 2 |
| Read / Write | YES |
| Function | It allows selecting the source for the speed reference when manual mode is activated by means of the activation of one digital input configured as 'MANUAL PROTECTED' or as 'OVERRIDE MANUAL' (parameters 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration', option '57 $\rightarrow$ MAN PROTstart' and ' $67 \rightarrow$ MAN OVR STAR' respectively). |
|  | Configuration options are the fallowing ones: |
|  | LOCAL $\quad \rightarrow$ Speed reference is introduced from keypad. |
|  | Al1 $\rightarrow$ Speed reference is introduced by means of Analogue Output 1. |
|  | $\mathrm{Al2}$ ( $\rightarrow$ Speed reference is introduced by means of Analogue Output 2. |


| G25.1.3 VALUE OF SPEED REFERENCE FORLOCAL SOURCE IN MANUAL MODE |  |
| :---: | :---: |
| Screen | 3 MAN SPEED $=+\mathbf{0} .0 \%$ |
| Extended info. | MANUAL SPEED |
| Description | Value of speed reference in manual mode when local source is selected |
| Range | -250\% to $+250 \%$ |
| Default value | +0.0\% |
| Set on run | YES |
| Modbus address | 42042 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |
| Function | It allows setting the speed reference of the drive to operate in manual mode (protected or not) when 'LOCAL' source has been selected (in parameter 'G25.1.2 $\rightarrow$ Source selection for speed reference in manual mode' and/or 'G25.1.4 $\rightarrow$ Source selection for alternative speed reference in manual mode') and whether the speed reference is the main reference or the alternative reference. |
|  | Therefore, it is possible to select one analogue input as source for main speed reference in 'G25.1.2 $\rightarrow$ Source selection for speed reference in manual mode' (option 'Al1' or 'Al2'), and on the other hand, to select the keypad as source for alternative speed reference in 'G25.1.4 $\rightarrow$ Source selection for alternative speed reference in manual mode' (option 'LOCAL'). In this way, when digital input configured as alternative reference (parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration', option '15 $\rightarrow$ REFERENCE $2^{\prime}$ ) is activated, the speed of drive pump is the set one in this parameter from keypad. In case of the digital input configured as alternative is not activated and keypad is selected as source for main speed reference (parameter G25.1.2 set to 'LOCAL'), the value set here will be applied directly as speed reference of the drive pump. This functionality is interchangeable between main and alternative speed references, this is, we can select the main speed reference by analogue input and the alternative by keypad and vice versa. |

## G25.1.4 SOURCE SELECTION FOR ALTERNATIVE SPEED REFERENCE IN MANUAL' MODE

| Screen | 4 ALT MAN S R = LOCAL |
| :--- | :--- |
| Description | Selection of the source for the alternative speed reference in manual mode |
| Range | LOCAL |
|  | Al1 |
|  | Al2 |
| Default value | LOCAL |
| Set on run | YES |
| Modbus address | 42043 |
| Modbus range | 0 to 2 |
| Read / Write | YES |
| Function | It allows selecting the source for the alternative speed source in manual mode. |
|  | See 'Function' in parameter 'G25.1.2 $\rightarrow$ Source selection for speed reference in <br> manual mode' to obtain information about the configuration options. |

Screen
Extended info.
Description
Range
Default value
Set on run
Modbus address
Modbu range 0 15
Mo 32760
Read / Write YES
Function It allows setting the value of the local setpoint 1 for PID.
It is possible to operate with the following units $\%, \mathrm{l} / \mathrm{s}, \mathrm{m} / \mathrm{s}, \mathrm{l} / \mathrm{min}, \mathrm{m}^{3} / \mathrm{min}, \mathrm{l} / \mathrm{h}, \mathrm{m}^{3} / \mathrm{h}, \mathrm{m} / \mathrm{s}$, $\mathrm{m} / \mathrm{min}, \mathrm{m} / \mathrm{h}, \mathrm{Bar}, \mathrm{kPa}, \mathrm{Psi}, \mathrm{m},{ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F},{ }^{\circ} \mathrm{K}$. It depends on the units of the sensor used.

In case of operating with unique local setpoint in PID mode, its value will be set in this parameter.

In case of operating with multiple PID setpoints, the speed applied for each case will depend on the activating status of the digital inputs configured with options '63 $\rightarrow$ SETPONT PIN1' (Low Bit), ' $64 \rightarrow$ SETPONT PIN2' (Medium Bit) and ' $65 \rightarrow$ SETPONT PIN3' (High Bit) in parameters 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration'.

The assignment of multiple setpoints is realized according to the following table:

| DIGITAL INPUTS |  |  | PID SETPOINT |
| :---: | :---: | :---: | :---: |
| $\mathrm{Dl}(\mathrm{z})=65$ | $\mathrm{Dl}(\mathrm{y})=64$ | Dl $(x)=63$ |  |
| 0 | 0 | 0 | G25.1.5 'SETPT1' |
| 0 | 0 | X | G25.1.6 'SETPT2' |
| 0 | X | 0 | G25.1.7 'SETPT3' |
| 0 | X | X | G25.1.8 'SETPT4' |
| X | 0 | 0 | G25.1.9 'SETPT5' |
| X | 0 | X | G25.1.10 'SETPT6' |
| X | X | 0 | G25.1.11 'SETPT7' |
| X | X | X | G25.1.12 'SETPT8' |

## G25.1.6 LOCAL SETPOINT 2 FOR PID

| Screen | $6 \mathrm{SETPT} 2=0.0 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | LOGAL SETPOINT 2 |
| Description | Local setpoint 2 for PID |
| Range | 0-3276 Engineering units |
| Default value | 0.0Bar |
| Set on run | YES |
| Modbus address | 42152 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |

Function It allows setting the value of the local setpoint 2 for PID.
It is possible to operate with the following units $\%, \mathrm{l} / \mathrm{s}, \mathrm{m} / \mathrm{s}, \mathrm{l} / \mathrm{min}, \mathrm{m}^{3} / \mathrm{min}, \mathrm{l} / \mathrm{h}, \mathrm{m}^{3} / \mathrm{h}, \mathrm{m} / \mathrm{s}$, $\mathrm{m} / \mathrm{min}, \mathrm{m} / \mathrm{h}, \mathrm{Bar}, \mathrm{kPa}, \mathrm{Psi}, \mathrm{m},{ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F},{ }^{\circ} \mathrm{K}$. It depends on the units of the sensor used.

See 'Function' in parameter 'G25.1.5 $\rightarrow$ Local setpoint 1 for PID' for additional information.

| G25.1.7 LO | AL SETPOINT 3 FOR PID |
| :---: | :---: |
| Screen | 7 SETPT3 $=0.0 \mathrm{Bar}$ |
| Extended info. | LOCAL SEIPOINT 3 |
| Description | Local setpoint 3 for PID |
| Range | 0-3276 Engineering units |
| Default value | 0.0Bar |
| Set on run | YES |
| Modbus address | 42153 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows setting the value of the local setpoint 3 for PID. |
|  | It is possible to operate with the following units $\%, \mathrm{l} / \mathrm{s}, \mathrm{m} / \mathrm{s}, \mathrm{l} / \mathrm{min}, \mathrm{m}^{3} / \mathrm{min}, \mathrm{l} / \mathrm{h}, \mathrm{m}^{3} / \mathrm{h}, \mathrm{m} / \mathrm{s}$, $\mathrm{m} / \mathrm{min}, \mathrm{m} / \mathrm{h}, \mathrm{Bar}, \mathrm{kPa}, \mathrm{Psi}, \mathrm{m},{ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F},{ }^{\circ} \mathrm{K}$. It depends on the units of the sensor used. |
|  | See 'Function' in parameter 'G25.1.5 $\boldsymbol{\rightarrow}$ Local setpoint 1 for PID' for additional information. |


| G25.1.8 LO | AL SETPOINT 4 FOR PID |
| :---: | :---: |
| Screen | 8 SETPT4 $=0.0 \mathrm{Bar}$ |
| Extended info. | LOGAL SEIPOINT 4 |
| Description | Local setpoint 4 for PID |
| Range | 0-3276 Engineering units |
| Default value | 0.0Bar |
| Set on run | YES |
| Modbus address | 42154 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows setting the value of the local setpoint 4 for PID. It is possible to operate with the following units $\%, 1 / \mathrm{s}, \mathrm{m} / \mathrm{s}, 1 / \mathrm{min}, \mathrm{m}^{3} / \mathrm{min}, 1 / \mathrm{h}, \mathrm{m}^{3} / \mathrm{h}, \mathrm{m} / \mathrm{s}$, $\mathrm{m} / \mathrm{min}, \mathrm{m} / \mathrm{h}, \mathrm{Bar}, \mathrm{kPa}, \mathrm{Psi}, \mathrm{m},{ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F},{ }^{\circ} \mathrm{K}$. It depends on the units of the sensor used. |
|  | See 'Function' in parameter 'G25.1.5 $\boldsymbol{\rightarrow}$ Local setpoint 1 for PID' for additional information. |

G25.1.9: LOCAL SETPOINT 5 FOR PID

## Screen

Description Local setpoint 5 for PID
Range
Set on run
0.0Bar

YES
Modbus address 42155
Modbus range 0 to 32760
Read / Write YES
Function It allows setting the value of the local setpoint 5 for PID.
It is possible to operate with the following units $\%, 1 / \mathrm{s}, \mathrm{m} / \mathrm{s}, 1 / \mathrm{min}, \mathrm{m}^{3} / \mathrm{min}, \mathrm{l} / \mathrm{h}, \mathrm{m}^{3} / \mathrm{h}, \mathrm{m} / \mathrm{s}$, $\mathrm{m} / \mathrm{min}, \mathrm{m} / \mathrm{h}$, Bar, $\mathrm{kPa}, \mathrm{Psi}, \mathrm{m},{ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F},{ }^{\circ} \mathrm{K}$. It depends on the units of the sensor used.

See 'Function' in parameter 'G25.1.5 $\boldsymbol{\rightarrow}$ Local setpoint 1 for PID' for additional information.

G25.1.10 LOCAL SETPOINT 6 FOR PID

| Screen | 10 SETPT6 = 0.0Bar |
| :---: | :---: |
| Extended info. | LOGAL SETPOINT B |
| Description | Local setpoint 6 for PID |
| Range | 0-3276 Engineering units |
| Default value | 0.0Bar |
| Set on run | YES |
| Modbus address | 42156 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows setting the value of the local setpoint 6 for PID. |
|  | It is possible to operate with the following units $\%, 1 / \mathrm{s}, \mathrm{m} / \mathrm{s}, \mathrm{l} / \mathrm{min}, \mathrm{m}^{3} / \mathrm{min}, 1 / \mathrm{h}, \mathrm{m}^{3} / \mathrm{h}, \mathrm{m} / \mathrm{s}$, $\mathrm{m} / \mathrm{min}, \mathrm{m} / \mathrm{h}, \mathrm{Bar}, \mathrm{kPa}, \mathrm{Psi}, \mathrm{m},{ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F},{ }^{\circ} \mathrm{K}$. It depends on the units of the sensor used. |
|  | See 'Function' in parameter 'G25.1.5 $\rightarrow$ Local setpoint 1 for PID' for additional information. |

## G25.1.11 LOCAL SETPOINT 7 FOR PID

| Screen | 11 SETPT7 $=\mathbf{0 . 0 B a r}$ |
| :--- | :--- |
| Extended info. | LOCAL SEIPOINT |
| Description | Local setpoint 7 for PID |
| Range | $0-3276$ Engineering units |
| Default value | 0.0Bar |
| Set on run | YES |
| Modbus address | $\mathbf{4 2 1 5 7}$ |
| Modbus range | 0 to 32760 |
| Read $/$ Write | YES |

Function It allows setting the value of the local setpoint 7 for PID
It is possible to operate with the following units $\%, 1 / \mathrm{s}, \mathrm{m} / \mathrm{s}, \mathrm{l} / \mathrm{min}, \mathrm{m}^{3} / \mathrm{min}, \mathrm{l} / \mathrm{h}, \mathrm{m}^{3} / \mathrm{h}, \mathrm{m} / \mathrm{s}$, $\mathrm{m} / \mathrm{min}, \mathrm{m} / \mathrm{h}$, Bar, $\mathrm{kPa}, \mathrm{Psi}, \mathrm{m},{ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F},{ }^{\circ} \mathrm{K}$. It depends on the units of the sensor used.

See 'Function' in parameter 'G25.1.5 $\rightarrow$ Local setpoint 1 for PID' for additional information.

## G25.1.12 LOCAL SETPOINT 8 FOR PID

| Screen | 12 SETPT8 $=0.0 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | LOCAL SETPOINT 8 |
| Description | Local setpoint 8 for PID |
| Range | 0-3276 Engineering units |
| Default value | 0.0 Bar |
| Set on run | YES |
| Modbus address | 42158 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows setting the value of the local setpoint 8 for PID. |
|  | It is possible to operate with the following units $\%, \mathrm{l} / \mathrm{s}, \mathrm{m} / \mathrm{s}, \mathrm{l} / \mathrm{min}, \mathrm{m}^{3} / \mathrm{min}, \mathrm{l} / \mathrm{h}, \mathrm{m}^{3} / \mathrm{h}, \mathrm{m} / \mathrm{s}$ $\mathrm{m} / \mathrm{min}, \mathrm{m} / \mathrm{h}$, Bar, $\mathrm{kPa}, \mathrm{Psi}, \mathrm{m},{ }^{\circ} \mathrm{C},{ }^{\circ} \mathrm{F},{ }^{\circ} \mathrm{K}$. It depends on the units of the sensor used. |
|  | See 'Function' in parameter 'G25.1.5 $\boldsymbol{\rightarrow}$ Local setpoint 1 for PID' for additional information. |


| G25.1:13 Ti | E FOR AUTOMATIC STOP |
| :---: | :---: |
| Screen | 13 T AutOFF $=$ OFF |
| Extended info. | AUTO-OFF DELAY |
| Description | Setting of a time for automatic stop |
| Range | OFF, 0.1-99.9h |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 42044 |
| Modbus range | 0 to 999 |
| Read / Write | YES |
| Function | It allows setting a time, after elapsing it, the drive will stop automatically. Once this time is set, this one starts elapsing immediately. At the moment of drive is stopped (once elapsed the time for automatic stop), parameter value become 'OFF' and the status of pump program will change to 'COMPLETED'. If you want to the drive to stop automatically again, you must adjust the stop time again. |

There are two visualization parameters related to this parameter:

- 'SV5.22 $\rightarrow$ T AutoOFF=OFF', it is directly parameter G25.1.13 translated to the visualization group SV5.
- 'SV5.23 $\rightarrow$ TIME OFF=OFF', that shows the remaining time in minutes for automatic stop of the system.


### 10.20.8. Subgroup 25.2 - S25.2: PID Setting

| G25.2.1 PID SETPOINT SOURCE |  |
| :---: | :---: |
| Screen | 1 PID SETP = LOCAL |
| Description | Selection of the source for PID setpoint |
| Range | LOCAL |
|  | Al1 |
|  | Al2 |
|  | (See 'Function' for additional information) |
| Default value | LOCAL |
| Set on run | YES |
| Modbus address | 42045 |
| Modbus range | 0 to 2 |
| Read / Write | YES |
| Function | It allows selecting the source to introduce the PID setpoint. |
|  | Selection options: |
|  | LOCAL $\quad \rightarrow$ PID setpoint is introduced from keypad. |
|  | Al1 $\quad \rightarrow$ PID setpoint is introduced by means of Analogue input 1. |
|  | Al2 $\quad \rightarrow$ PID setpoint is introduced by means of Analogue Input 2 . |


| G25.2.2 ALTERNATIVE PID SETPOINT SOURCE |  |
| :---: | :---: |
| Screen | 2 PID aSTP = LOCAL |
| Description | Selection of the alternative source for PID setpoint |
| Range | LOCAL |
|  | Al1 |
|  | Al2 |
|  | (See 'Function' for additional information) |
| Default value | LOCAL |
| Set on run | YES |
| Modbus address | 42374 |
| Modbus range | 0 to 2 |
| Read / Write | YES |
| Function | It allows selecting the alternative source to introduce the PID setpoint. |
|  | Selection options: |
|  | LOCAL $\quad \rightarrow$ PID setpoint is introduced from keypad. |
|  | AI1 $\quad \rightarrow$ PID setpoint is introduced by means of Analogue Input 1. |
|  | AI2 $\quad \rightarrow$ PID setpoint is introduced by means of Analogue Input 2. |


| G25.2.3_PID FEEDBACK SOURCE |  |
| :---: | :---: |
| Screen | 3 PID FBK = Al2 |
| Description | Selection of the source for PID feedback signal |
| Range | Al1 |
|  | Al2 |
|  | PULSE |
|  | (See 'Function' for additional information) |
| Default value | Al2 |
| Set on run | YES |
| Modbus address | 42046 |
| Modbus range | 0 to 2 |
| Read / Write | YES |
| Function | It allows selecting the source to introduce PID feedback signal. |
|  | Selection options: |
|  | Al1 $\rightarrow$ Feedback signal is introduced through Analogue Input 1. |
|  | Al2 $\quad \rightarrow$ Feedback signal is introduced through Analogue Input 2. |
|  | PULSE $\quad \rightarrow$ Feedback signal is introduced through configurable Multi-function Digital Input programmed for this purpose (parameter G4.1.5 to G4.1.10). See Subgroup S4.4 Pulse Input for additional information. |

G25.2.4 PROPORTIONAL GANN OF PID REGULATOR

| Screen | 4 PID Kc $=1.0$ |
| :---: | :---: |
| Extended info. | PROPORTIONAL PID |
| Description | Proportional gain of PID regulator |
| Range | 0.1-20 |
| Default value | 1.0 |
| Set on run | YES |
| Modbus address | 42047 |
| Modbus range | 1 to 200 |
| Read / Write | YES |
| Function | It allows setting the value of the proportional gain for the PID regulator according to the requirements of the installation. |

Note: The default value is usually proper for pump control application. Nevertheless, if it is necessary to have a higher control response, then increase this value. If this value is increased, a higher instability can be introduced in the system.
G25.2.5 INTEGRAL TIME OF PID REGULATOR

| Screen | $5 \mathrm{PID} \mathrm{It}=5.0 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | INTEGRAL PID |
| Description | Integral time of PID regulator |
| Range | 0.1-999.9s, Max |
| Default value | 5.0s |
| Set on run | YES |
| Modbus address | 42048 |
| Modbus range | 1 to 9999, 10000 |
| Read/ Write | YES |

Function | It allows setting the integral time of PID regulator according to the requirements of the |
| :--- |
| installation. |

Note: $\quad$| The default value is usually proper for pump control application. If this value is |
| :--- |
| increased, accuracy of the system is improved, but system response can be slow |
| down. |

## G25.2.6 DERIVATION TIME OF PID REGULATOR

| Screen | 6 PID Dt $=0.0 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | DIFFERENTIAL PID |
| Description | Derivation time of PID regulator |
| Range | 0.0-250s |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 42049 |
| Modbus range | 0 to 2500 |
| Read / Write | YES |
| Function | It allows setting the derivation time of PID regulator according to the requirements of the installation. |
| Note: | The default value is usually proper for pump control application. Therefore, we recommend do not modify this setting. If this value is increased, the system response is improved but system accuracy can be reduced slightly. |


| G25.2.7 ERROR OF PID REGULATOR |  |
| :---: | :---: |
| Screen | 7 PID ERR = + $\mathrm{xx} . \mathrm{x}$ \% |
| Description | Error of PID regulator |
| Range | +0 to +100\% |
| Default value | - |
| Set on run | - |
| Modbus address | 42050 |
| Modbus range | - |
| Read / Write | Read Only |
| Function | It displays the difference between the value of PID setpoint (source of which is set in 'G25.2.1 $\rightarrow$ PID setpoint source') and the value of the feedback signal of the process (source of which is set in 'G25.2.3 $\rightarrow$ PID feedback source') in percentage. |
|  | This parameter is read only. |

## G25.2.8 ERROR OF PID REGULATOR IN ENGINEERING UNITS

| Screen | $\mathbf{8}$ ERR $=+\mathbf{x x} . \mathbf{x x k P a}$ |
| :--- | :--- |
| Description | Error of PID regulator in engineering units |
| Range | +0.0 to +3276 Engineering units |
| Default value | - |
| Set on run | - |
| Modbus address | $\mathbf{4 2 0 5 1}$ |
| Modbus range | - |
| Read $/$ Write | Read Only |

Function It displays the difference between the value of PID setpoint (source of which is set in 'G25.2.1 $\rightarrow$ PID setpoint source') and the value of the feedback signal of the process (source of which is set in 'G25.2.3 $\rightarrow$ PID feedback source') in engineering units (Bar, $\mathrm{kPa}, \mathrm{m}^{3} / \mathrm{s}$, etc.).

This parameter is read only.

| G25.2.9 | PID OUTPUT INVERSION |
| :--- | :--- |
| Screen <br> Description <br> Range | 9 PID INVERT $~=~ N ~$ |
| Inversion of the PID regulator output |  |

In this case, the PID regulator response when the feedback signal is falling down is a reduction of the output speed. For example, this operation is typical for a temperature control by means of PID mode. A reduction of the temperature (feedback signal) due to a lower demand, requires that the speed of the fan is reduced to keep the temperature.

### 10.20.9. Subgroup 25.3-S25.3: Start Conditions

## General considerations for starting conditions.

During the setpoint ramp, neither the conditions for the activation of fixed pumps nor the conditions for sleep mode will be considered. Only when the drive is in regulation mode (see parameter 'G25.7.4 $\rightarrow$ Setpoint ramp' for additional information) those conditions will be considered.
During the bypass process (connection of fixed pumps) these conditions will be not considered either.

## G25.3.1 WAKE UP LEVEL OF THE DRIVE

| Screen | 1 LP Pon $=0.0$ Bar |
| :--- | :--- |
| Extended info. | ALFAKENINGLEVEL |
| Description | Wake up level of the drive |
| Range | $0.0-3276$ Bar |
| Default value | $0.0 B a r$ |
| Set on run | YES |
| Modbus address | 42064 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |

Function It allows setting the wake up level of the drive. The value is set in units.
For example, if the PID setpoint is 5Bar and the value set in this parameter is 2Bar, then we are placing the wake up level below 3Bar ( $5 \mathrm{Bar}-2 \mathrm{Bar}=3 \mathrm{Bar}$ ).


NOTE: For this example, we have taken as stop condition of the drive pump (sleep mode activation) a speed value. concretety, the sleep speed assigned to the local setpotnt 1. But the stop condition can be any one of the remain speeds associated to each one of the PID local setpoints (in case of the stop condition is the speed signal), or can also be the flow detection, the flow level or the output current level.

Figure 10.46 Activation and deactivation of Sleep Mode

## G25:3.2 START SPEED FOR THE FIXED PUMPS

| Screen | $2 \mathrm{FP} \mathrm{SpON}=+90.0 \%$ |
| :---: | :---: |
| Extended info. | FIX PMP STAR SPD |
| Description | Start speed for the fixed pumps |
| Range | -250\% to +250\% |
| Default value | +90.0\% |
| Set on run | YES |
| Modbus address | 42055 |
| Modbus range | -20480 to 20480 |
| Read / Write | YES |

Function It allows setting the drive speed above of which the fixed pumps will start.
This one is an optional condition that can be disabled. For that, you must set this parameter value to $0 \%$, in that way, any speed for above of this one is able to start the pumps. This is, the speed of the drive is not considered to start the fixed pumps. So we force this condition to be fulfilled, therefore, it is not already a condition.

The value is set as percentage of motor speed.
At the moment of starting of the fixed pumps, additionally, it will also considered the start delay time for each fixed pump (parameter G25.3.4 to G25.3.8) and the PID error (parameter 'G25.3.3 $\rightarrow$ Minimum PID error to start the fixed pumps').


G25.3.2 $\rightarrow$ Stan speed for the fixed pumps
G25.3.4 $\rightarrow$ Detay ime io stan fixed pump 1 (Relay 1 )
G25.3.5 $\rightarrow$ Delay time to stant fixed pump 2 (Retay 2)
G25.3.6 $\rightarrow$ Delay time to start fixed pump 3 (Relay 3)
G25.3.7 $\rightarrow$ Delay time to start fixed pump 4 (AO1)
G25.3.8 $\rightarrow$ Delay time to start fixed pump 5 (AO2)
G25.5.1 $\rightarrow$ Speed bypass at the slarting of fixed pumps
G25.5.2 $\rightarrow$ Time of speed bypass after slarting fixed pumps

Figure 10.47 Starting of the fixed pumps according to the starting speed and the delay time for each pump

| G25.3.3 MINIMUM PID ERROR TO START THE FLXED PUAPS |  |
| :---: | :---: |
| Screen | 3 FP ErON $=+10.0 \%$ |
| Extended info. | FIX PMP STAR ERR |
| Description | Minimum PID error to start the fixed pumps |
| Range | OFF=0 to $+200 \%$ |
| Default value | +10.0\% |
| Set on run | YES |
| Modbus address | 42056 |
| Modbus range | 0 to 16384 |
| Read / Write | YES |
| Function | It allows setting the PID error above of which the fixed pumps will start. |
|  | This one is an optional condition that can be considered or not, depending on the setting. If this parameter is set to $0.0 \%$, any value could start the fixed pumps. |
|  | This parameter allows user to consider the PID error (\%) when the fixed pumps must be started. |
|  | At the moment of starting of the fixed pumps, additionally, it will also considered the drive speed (parameter ' $\mathrm{G} 25.3 .2 \rightarrow$ Start speed for the fixed pumps') and the start delay time for each fixed pump (parameter G25.3.4 to G25.3.8). |



> G25.3.2 $\rightarrow$ Start speed tor the fixed pumps
> G25.3.3 $\rightarrow$ Minimum PID error to start the fixed pumps
> G25.3.4 $\rightarrow$ Delay time to start fixed pump 1 (Relay 1)
> G25.3.5 $\rightarrow$ Delay time to starl fixed pump 2 (Relay 2)
> G25.3.6 $\rightarrow$ Delay time to start fixed pump 3 (Relay 3 )
> G25.3.7 $\rightarrow$ Delay time to start fixed pump 4 (AO1)
> G25.3.8 $\rightarrow$ Delay time to stan fixed pump 5 (AO2)
> G25.5.1 $\rightarrow$ Speed bypass at the starting of fixed pumps
> G25.5.2 $\rightarrow$ Time of speed bypass after slarting fixed pumps

Figure 10.48 Starting of the fixed pumps according to the start speed, the PID error and the delay time for each pump

|  | G25:3.4 DELAY TIME TO START FIXED PUMAP 1 (RELAY 1) |
| :---: | :---: |
| Screen | 4 FP T1 ON $=10 \mathrm{~s}$ |
| Extended info. | FIX PMP1 STR DLY |
| Description | Delay time to start the fixed pump 1 (Relay 1 ) |
| Range | OFF=0-6000s |
| Default value | 10s |
| Set on run | YES |
| Modbus address | 42062 |
| Modbus range | 0 to 60000 |
| Read / Write | YES |
| Function | It allows setting a delay time to start the fixed pump associated to the Relay 1. |
|  | At the moment of starting the fixed pumps, additionally, it will also be considered the drive speed (parameter 'G25.3.2 $\rightarrow$ Start speed for the fixed pumps') and the PID error ('G25.3.3 $\rightarrow$ Minimum PID error to start the fixed pumps'). |
| Note: | If time is too short, overpressure can be generated in the system. On the contrary, if time is too long, under-pressure can be generated. |
|  | See figures 10.47 and 10.48. |

G25.3.5 DELAY TIME TO START FIXED PUMP 2 (RELAY 2 )

| Screen | 5 FP T2 ON $=10 \mathrm{~s}$ |
| :--- | :--- |
| Extended info. | FUX PMP2 STR DLY |

Description Delay time to start the fixed pump 2 (Relay 2)
Range $\quad O F F=0-6000$ s

Default value 10s
Set on run YES
Modbus address 42065
Modbus range 0 to 60000
Read / Write YES
Function It allows setting a delay time to start the fixed pump associated to the Relay 2.
At the moment of starting the fixed pumps, additionally, it will also be considered the drive speed (parameter 'G25.3.2 $\rightarrow$ Start speed for the fixed pumps') and the PID error ('G25.3.3 $\rightarrow$ Minimum PID error to start the fixed pumps').

Note: If time is too short, overpressure can be generated in the system. On the contrary, if time is too long, under-pressure can be generated.

See figures 10.47 and 10.48 .

G25.3.6 DELAY TIME TO START FIXED PUMP 3 (RELAY 3)
Screen $\quad 6$ FP T3 ON $=10 \mathrm{~s}$

Description Delay time to start the fixed pump 3 (Relay 3)
Range OFF $=0-6000 \mathrm{~s}$
Default value 10 s
Set on run YES
Modbus address 42066
Modbus range 0 to 60000
Read / Write YES

| Function | It allows setting a delay time to start the fixed pump associated to the Relay 3. |
| :---: | :---: |
|  | At the moment of starting the fixed pumps, additionally, it will also be considered the drive speed (parameter 'G25.3.2 $\rightarrow$ Start speed for the fixed pumps') and the PID error ('G25.3.3 $\rightarrow$ Minimum PID error to start the fixed pumps'). |
| Note: | If time is too short, overpressure can be generated in the system. On the contrary, if time is too long, under-pressure can be generated. |
|  | See figures 10.47 and 10.48 . |


| G25.3.7 DELAY TIME TO START FIXED PUMP 4 (AO1) |  |
| :---: | :---: |
| Screen | $7 \mathrm{FP} \mathrm{T4} \mathrm{ON}=10 \mathrm{~s}$ |
| Extended info. | FIX PMP4 STR DLY |
| Description | Delay time to start the fixed pump 4 (Analogue Output 1) |
| Range | OFF $=0-6000 \mathrm{~s}$ |
| Default value | 10s |
| Set on run | YES |
| Modbus address | 42067 |
| Modbus range | 0 to 60000 |
| Read / Write | YES |
| Function | It allows setting a delay time to start the fixed pump associated to the Analogue Output 1. |
|  | At the moment of starting the fixed pumps, additionally, it will also be considered the drive speed (parameter 'G25.3.2 $\rightarrow$ Start speed for the fixed pumps') and the PID error ('G25.3.3 $\rightarrow$ Minimum PID error to start the fixed pumps'). |
| Note: | If time is too short, overpressure can be generated in the system. On the contrary, if time is too long, under-pressure can be generated. |
|  | See figures 10.47 and 10.48 . |

G25.3.8 DELAY TIAE TO START FIXED PUBP 5 (AO2)

| Screen | 8 FP T5 ON $=10 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | FIX PMP5 STR DLY |
| Description | Delay time to start the fixed pump 5 (Analogue Output 2) |
| Range | OFF $=0-6000 \mathrm{~s}$ |
| Default value | 10s |
| Set on run | YES |
| Modbus address | 42068 |
| Modbus range | 0 to 60000 |
| Read / Write | YES |
| Function | It allows setting a delay time to start the fixed pump associated to the Analogue Output 2. |
|  | At the moment of starting the fixed pumps, additionally, it will also be considered the drive speed (parameter 'G25.3.2 $\rightarrow$ Start speed for the fixed pumps') and the PID error ('G25.3.3 $\rightarrow$ Minimum PID error to start the fixed pumps'). |
| Note: | If time is too short, overpressure can be generated in the system. On the contrary, if time is too long, under-pressure can be generated. |
|  | See figures 10.47 and 10.48 |

### 10.20.10. Subgroup 25.4 - S25.4: Stop Conditions

| G25.4.1 DE | AY TIME BEFORE ACTIVATING SLEEP MODE |
| :---: | :---: |
| Screen | 1 LP T SLP $=20 \mathrm{~s}$ |
| Extended info. | DRIVE SLEEPDELY |
| Description | Delay time before activating sleep mode |
| Range | OFF=0, 1-999s |
| Default value | 20s |
| Set on run | YES |
| Modbus address | 42306 |
| Modbus range | 0 to 9990 |
| Read / Write | YES |
| Function | It allows setting a delay time to activate sleep mode. This delay time is applicable to the following conditions: sleep speed, 'No Flow' input, flow measurement and sleep current. If either of them is fulfilled, the time to activate sleep mode will start elapsing. |
| Note: | Drive is configured to go to sleep according to the conditions of the installation as factory setting. Nevertheless, all of the parameters values described below must be checked properly according to each installation to guarantee a correct functionality. If you do not want the equipment goes in sleep mode, these parameters must be adjusted for that purpose. |



NOTE: For this example, we have taken as stop condition of the drive pump (sleep mode activation) a speed value, concretely. the sleep speed assigned to the local setpoint 1 . But the stop condition can be any one of the remain speeds associated to each one of the PID local setpoints (in case of the stop condition is the speed signal), or can also be the flow detection, the flow level oo the output current level.

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Figure 10.49 Sleep Mode deactivation

## G25.4.2 SLEEP SPEED FOR LOCAL SETPOINT 1

| Screen | 2 SLPsp1 $=+40.0 \%$ |
| :---: | :---: |
| Extended info. | DRV SLEEP SPEED1 |
| Description | Sleep speed assigned to local setpoint 1 |
| Range | +0.0\% to $+250 \%$ |
| Default value | +40.0\% |
| Set on run | YES |
| Modbus address | 42307 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the value of the sleep speed 1, below which the drive will go to sleep whenever local setpoint 1 is selected. It is set in $\%$ of motor speed. |
|  | See figure 10.49 |


G25.4.4 SLEEP SPEED FOR LOCAL SETPOINT 3

| Screen | 4 SLPsp2 $=+40.0 \%$ |
| :---: | :---: |
| Extended info. | DRV SLEEP SPEED3 |
| Description | Sleep speed assigned to local setpoint 3 |
| Range | +0.0\% to +250\% |
| Default value | +40.0\% |
| Set on run | YES |
| Modbus address | 42309 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |

Function It allows setting the value of the sleep speed 3, below which the drive will go to sleep whenever local setpoint 3 is selected. It is set in \% of motor speed.

See figure 10.49


| Screen | 5 SLPsp2 $=+40.0 \%$ |
| :---: | :---: |
| Extended info. | DRV SLEEP SPEED4 |
| Description | Sleep speed assigned to local setpoint 4 |
| Range | +0.0\% to $+250 \%$ |
| Default value | +40.0\% |
| Set on run | YES |
| Modbus address | 42310 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the value of the sleep speed 4, below which the drive will go to sleep whenever local setpoint 4 is selected. It is set in \% of motor speed. |
|  | See figure 10.49. |

## G25.4.6 SLEEP SPEED FOR LOCAL SETPOINT 5

| Screen | 6 SLPsp5 $=+40.0 \%$ |
| :---: | :---: |
| Extended info. | DRV SLEEP SPEEDS |
| Description | Sleep speed assigned to local setpoint 5 |
| Range | +0.0\% to +250\% |
| Default value | +40.0\% |
| Set on run | YES |
| Modbus address | 42311 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the value of the sleep speed 5 , below which the drive will go to sleep whenever local setpoint 5 is selected. It is set in \% of motor speed. |
|  | See figure 10.49. |

## G25.4.7 SLEEP SPEED FOR LOCAL SETPOINT 6

| Screen | $7 \mathrm{SLPsp2}=+40.0 \%$ |
| :---: | :---: |
| Extended info. | DRV SLEEP SPEED |
| Description | Sleep speed assigned to local setpoint 6 |
| Range | +0.0\% to $+250 \%$ |
| Default value | +40.0\% |
| Set on run | YES |
| Modbus address | 42312 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the value of the sleep speed 6 , below which the drive will go to sleep whenever local setpoint 6 is selected. It is set in \% of motor speed. |
|  | See figure 10.49 . |

## G25.4.8 SLEEP SPEED FOR LOCAL SETPOINT 7

| Screen | 8 SLPsp7 $=+\mathbf{4 0 . 0 \%}$ |
| :--- | :--- |
| Extended info. | ORV SLEEP SPEED7 |


| G25.4.9 SL | EP SPEED FOR LOCAL SETPOINT 8 |
| :---: | :---: |
| Screen | 9 SLPsp8 $=+40.0 \%$ |
| Extended info. | DRV SLEEP SPEED |
| Description | Sleep speed assigned to local setpoint 8 |
| Range | +0.0\% to $+250 \%$ |
| Default value | +40.0\% |
| Set on run | YES |
| Modbus address | 42314 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the value of the sleep speed 8, below which the drive will go to sleep whenever local setpoint 8 is selected. It is set in $\%$ of motor speed. |
|  | See figure 10.49. |

G25.4:10 TO ENABLE 'NO FLOW' INPUT TO SLEEP THE DRIVE

| Screen | 10 FLsw ENA $=$ N |
| :---: | :---: |
| Description | To enable the 'No Flow' input to sleep the drive |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 42323 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows enabling or disabling the 'No Flow' input with the purpose that the drive goes in sleep mode. |
|  | It operates when the drive speed is below the speed set in 'G25.6.17 $\rightarrow$ Minimum stop speed by 'No Flow' detection', above which, 'No Flow' input only can operate as protection (PAUSE, FAULT). |
|  | Options: |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | 'No Flow' input disabled. |
|  | $Y \rightarrow Y E S$ |
|  | 'No Flow' input enabled. |
|  | When this input is activated, and after delay time set 'G25.4.1 $\rightarrow$ Delay time before activating sleep mode' has elapsed, the drive goes in sleep mode. |

See figure 10.49.

## G25.4:11 FLOW LEVEL TO SLEEP THE DRIVE

| Screen | 11 FSI L $=0.01 / \mathrm{s}$ |
| :--- | :--- |
| Extended info. | FLOw SLEEP LEVEL |
| Description | Flow level to sleep the drive |
| Range | OFF $=0.0$ to 3276 Flow units |
| Default value | $0.01 / \mathrm{s}$ |
| Set on run | YES |
| Modbus address | 42324 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
|  |  |
| Function | It allows setting the flow level to activate the sleep mode. |

The flow will be monitored and when it is below the level set in this parameter, delay time to activate sleep mode will start elapsing. Once elapsed this delay time, the drive will go in sleep mode.

So it allows setting the value of the flow read through pulse input or analogue input, below which, a situation of ' $n$ o demand' will be detected. This situation will send the drive to sleep.

When this parameter is set to 'OFF', it will be disabled. The source of flow reading is set in parameter 'G25.10.1 $\rightarrow$ Flow reading source'.

See figure 10.49 .

## G25.4.12 OUTPUT CURRENT LEVEL TO SLEEP THE DRIVE

| Screen | 12 I SLEEP $=\mathrm{xxxA}$ |
| :---: | :---: |
| Extended info. | CURR SLEEP LEVEL |
| Description | Level of output current to sleep the drive |
| Range | $\mathrm{OFF}=0$ to 1229A |
| Default value | xxxA |
| Set on run | YES |
| Modbus address | 42325 |
| Modbus range | 0 to 12290 |
| Read / Write | YES |
| Function | It allows setting the output current level to activate the sleep mode. |

Output current will be monitored and when it is below the level set in this parameter, delay time to activate sleep mode will start elapsing. Once elapsed this delay time, the drive will go in sleep mode.

So it allows setting the output current level, below which, a situation of 'no demand' will be detected. This situation will send the drive to sleep.

When this parameter is set to 'OFF', it will be disabled.
See figure 10.49.

Note: The drive can go to sleep in all of the conditions simultaneously. Any fulfilled condition will begin the delay time to activate sleep mode or will keep it active in case of the condition that began it disappears.

| G25.4.13 MAXIMUM PID ERROR TO STOP THE FIXED PUMPS |  |
| :---: | :---: |
| Screen | 13 FP erOFF $=+0.0 \%$ |
| Extended info. | EPUMP STOP ERROR |
| Description | Maximum PID error to stop the fixed pumps |
| Range | -250\% to +0.0\% |
| Default value | +0.0\% |
| Set on run | YES |
| Modbus address | 42072 |
| Modbus range | -20480 to 0 |
| Read / Write | YES |
| Function | It allows setting the PID error below which, the fixed pumps will be stopped. Any error value more negative than the value set in this parameter will stop a fixed pump. |
|  | This one is an optional condition that can be considered or not according to the setting If this parameter is set to $+0.0 \%$, this condition will not be considered. |
|  | This parameter allows user to consider the PID error (\%) at the moment of stopping the fixed pumps. |
|  | At the moment of stopping the fixed pumps, additionally, it will also be considered the drive speed (parameter G25.4.19 to G25.4.26, stop speeds assigned to each local setpoint, depending on the selected local setpoint) and the stop delay time for each fixed pump (G25.4.14 for pump 1, G25.4.15 for pump 2, G25.4.16 for pump 3. G25.4.17 for pump 4 and G25.4.18 for pump 5). |



| G25.4.13 $\rightarrow$ Maximum PID error to slog the fixed pumps | G25.4.21 $\rightarrow$ Slop speed 3 for one fixed purnp |
| :---: | :---: |
| G25.4.14 $\rightarrow$ Delay time to stop fixed pump 1 (Relay 1) | G25.4.22 $\rightarrow$ Stop speed 4 for one fixed pump |
| G25.4.15 $\rightarrow$ Delay time to stog fixed pump 2 (Relay 2) | G25.4.23 $\rightarrow$ Slop speed 5 for tone fixed pump |
| G25.4.16 $\rightarrow$ Delay time to smp fixed pumg 3 (Relay 3) | G25.4.24 $\rightarrow$ Stop speed 6 tor one fixed pump |
| G25.4.17 $\rightarrow$ Delay lime to stop fixed pump 4 (AO1) | G25.4.25 $\rightarrow$ Stop speed 7 for one fixed pump |
| G25.4.18 $\rightarrow$ Delay time to stop fixed pump 5 (AO2) | G25.4.26 $\rightarrow$ Stop speed 8 for one fixed pump |
| G25.4.19 $\rightarrow$ Stop speed 1 for one lixed pump | G25.5.3 $\rightarrow$ Speed bypass al the stopping of fixed pumps |
| G25.4.20 $\rightarrow$ Slop speed 2 tor one fixed pump | G25.5.4 $\rightarrow$ Time of speed bypass after stopping fixed pumpos |

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Figure 10.50 Stopping of the fixed pumps according to the stop speed associated to each local setpoint for PID, the PID error and the delay time for each pump

## G25.4.14 DELAY TIME TO STOP FIXED PUMP 1 (RELAY 1)

| Screen | 14 FP T1 OF $=10 \mathrm{~s}$ |
| :--- | :--- |
| Extended info. | FPUMP1 STP DELAY |

Description $\quad$ Delay time to stop the fixed pump 1 (Relay 1 )
Range $\quad 0-6000$ s
Default value 10 s
Set on run YES

Modbus address 42073
Modbus range 0 to 60000
Read / Write YES

Function It allows setting the delay time to stop the fixed pump associated to the Relay 1.
At the moment of stopping the fixed pumps, additionally, it will also be considered the drive speed (parameter G25.4.19 to G25.4.26, stop speeds assigned to each local setpoint, depending on the selected local setpoint) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps').

See figure 10.50.

Note: If time is too short, overpressure can be generated in the system. On the contrary, if time is too long, under-pressure can be generated.

## G25.4:15 DELAY TIME TO STOP FIXED PUMA 2 (RELAY 2)

| Screen | 15 FP T2 OF $=10 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | EPUMP2 STP DELAY |
| Description | Delay time to stop the fixed pump 2 (Relay 2) |
| Range | 0-6000s |
| Default value | 10s |
| Set on run | YES |
| Modbus address | 42077 |
| Modbus range | 0 to 60000 |
| Read/Write | YES |
| Function | It allows setting the delay time to stop the fixed pump associated to the Relay 2. |
|  | At the moment of stopping the fixed pumps, additionally, it will also be considered the drive speed (parameter G25.4.19 to G25.4.26, stop speeds assigned to each local setpoint, depending on the selected local setpoint) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps'). |
|  | See figure 10.50 |

Note: If time is too short, overpressure can be generated in the system. On the contrary, if time is too long, under-pressure can be generated.

| Screen | $16 \mathrm{FP} \mathrm{T3} \mathrm{OF}=10 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | FPUMP3 STP DELAY |
| Description | Delay time to stop the fixed pump 3 (Relay 3) |
| Range | 0-6000s |
| Default value | 10 s |
| Set on run | YES |
| Modbus address | 42078 |
| Modbus range | 0 to 60000 |
| Read / Write | YES |
| Function | It allows setting the delay time to stop the fixed pump associated to the Relay 3. |

At the moment of stopping the fixed pumps, additionally, it will also be considered the drive speed (parameter G25.4.19 to G25.4.26, stop speeds assigned to each local setpoint, depending on the selected local setpoint) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps').

See figure 10.50 .

Note: If time is too short, overpressure can be generated in the system. On the contrary, if time is too long, under-pressure can be generated.

G25.4.17 DELAY TIME TO STOP FIXED PUHP 4 (AO1)

| Screen | 17 FP T4 OF $=10 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | FPUMP4 STP DELAY |
| Description | Delay time to stop the fixed pump 4 (Analogue Output 1) |
| Range | 0-6000s |
| Default value | 10s |
| Set on run | YES |
| Modbus address | 42079 |
| Modbus range | 0 to 60000 |
| Read / Write | YES |
| Function | It allows setting the delay time to stop the fixed pump associated to the Analogue Output 1. |
|  | At the moment of stopping the fixed pumps, additionally, it will also be considered the drive speed (parameter G25.4.19 to G25.4.26, stop speeds assigned to each local setpoint, depending on the selected local setpoint) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps'). |
|  | See figure 10.50. |

Note: If time is too short, overpressure can be generated in the system. On the contrary, if time is too long, under-pressure can be generated.

| G25.4.18 D | AY TIME TO STOP FIXED PUMP 5 (AO2) |
| :---: | :---: |
| Screen | 18 FP T5 OF $=10 \mathrm{~s}$ |
| Extended info. | FPUMPS STP DELAY |
| Description | Delay time to stop the fixed pump 5 (Analogue Output 2) |
| Range | 0-6000s |
| Default value | 10s |
| Set on run | YES |
| Modbus address | 42080 |
| Modbus range | 0 to 60000 |
| Read / Write | YES |
| Function | It allows setting the delay time to stop the fixed pump associated to the Analogue Output 2. |
|  | At the moment of stopping the fixed pumps, additionally, it will also be considered the drive speed (parameter G25.4.19 to G25.4.26, stop speeds assigned to each local setpoint, depending on the selected local setpoint) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps'). |
|  | See figure 10.50. |
| Note: | If time is too short, overpressure can be generated in the system. On the contrary, if time is too long, under-pressure can be generated. |

## G25.4.19 STOP SPEED 1 FOR ONE FIXED PUMP

| Screen | 19 SPD1 of $=\boldsymbol{+ 7 0 . 0} \%$ |
| :--- | :--- |
| Extended info. | FPUMP STP SPEED1 |
| Description | Stop Speed for one fixed pump associated to the local setpoint 1 |
| Range | $+0.0 \%$ to $+250 \%$ |
| Default value | $+70.0 \%$ |
| Set on run | YES |
| Modbus address | $\mathbf{4 2 3 1 5}$ |
| Modbus range | 0 to 20480 |
| Read $/$ Write | YES |

Function It allows setting the speed value below which the drive must remain for stopping a fixed pump whenever the operating setpoint is the local setpoint 1 set in parameter 'G25.1.5 $\rightarrow$ Local setpoint 1 for PID'.

If you want the speed condition is not considered at the moment of stopping fixed pumps, you must set this parameter to a value that is always above the drive speed. In this way, this condition is always fulfilled, and therefore, it is not already a condition.

At the moment of stopping the fixed pumps, additionally, it will also be considered the stop delay time for each fixed pump (parameter G25.4.14 to G25.4.18, depending on the what fixed is referred) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps').

See figure 10.50 .

G25.4.20 STOP SPEED 2 FOR ONE FIXED PUMP

| Screen | 20 SPD2of $=+70.0 \%$ |
| :---: | :---: |
| Extended info. | FPUMP STP SPEED2 |
| Description | Stop speed for one fixed pump associated to the local setpoint 2 |
| Range | +0.0\% to +250\% |
| Default value | +70.0\% |
| Set on run | YES |
| Modbus address | 42316 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the speed value below which the drive must remain for stopping a fixed pump whenever the operating setpoint is the local setpoint 2 set in parameter 'G25.1.6 $\rightarrow$ Local setpoint 2 for PID'. |

See 'Function' in parameter 'G25.4.19 $\boldsymbol{\rightarrow}$ Stop speed 1 for one fixed pump' for additional information.

At the moment of stopping the fixed pumps, additionally, it will also be considered the stop delay time for each fixed pump (parameter G25.4.14 to G25.4.18, depending on the what fixed is referred) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps').

See figure 10.50

## G25.4.21 STOP SPEED 3 FOR ONE FIXED PUAP

| Screen | 21 SPD3of $=+70.0 \%$ |
| :---: | :---: |
| Extended info. | FPUMP STP SPEED3 |
| Description | Stop speed for one fixed pump associated to the local setpoint 3 |
| Range | +0.0\% to +250\% |
| Default value | +70.0\% |
| Set on run | YES |
| Modbus address | 42317 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the speed value below which the drive must remain for stopping a fixed pump whenever the operating setpoint is the local setpoint 3 set in parameter | 'G25.1.7 $\rightarrow$ Local setpoint 3 for PID'.

See 'Function' in parameter 'G25.4.19 $\rightarrow$ Stop speed 1 for one fixed pump' for additional information.

At the moment of stopping the fixed pumps, additionally, it will also be considered the stop delay time for each fixed pump (parameter G25.4.14 to G25.4.18, depending on the what fixed is referred) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps').

See figure 10.50

| G25.4.22 STOP SPEED 4 FOR ONE FIXED PUMP |  |
| :---: | :---: |
| Screen | 22 SPD4of $=+70.0 \%$ |
| Extended info. | FPUMP STP SPEED4 |
| Description | Stop speed for one fixed pump associated to the local setpoint 4 |
| Range | +0.0\% to $+250 \%$ |
| Default value | +70.0\% |
| Set on run | YES |
| Modbus address | 42318 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the speed value below which the drive must remain for stopping a fixed pump whenever the operating setpoint is the local setpoint 4 set in parameter 'G25.1.8 $\rightarrow$ Local setpoint 4 for PID'. |
|  | See 'Function' in parameter 'G25.4.19 $\boldsymbol{\rightarrow}$ Stop speed 1 for one fixed pump' for additional information. |
|  | At the moment of stopping the fixed pumps, additionally, it will also be considered the stop delay time for each fixed pump (parameter G25.4.14 to G25.4.18, depending on the what fixed is referred) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps'). | See figure 10.50 .

## G25.4.23 STOP SPEED 5 FOR ONE FIXED PUMAP

Screen
Extended info
Description Range
Default value
Set on run
Modbus address
Modbus range
Read / Write
Function It allows setting the speed value below which the drive must remain for stopping a fixed pump whenever the operating setpoint is the local setpoint 5 set in parameter 'G25.1.9 $\rightarrow$ Local setpoint 5 for PID'.

See 'Function' in parameter 'G25.4.19 $\boldsymbol{\rightarrow}$ Stop speed 1 for one fixed pump' for additional information.

At the moment of stopping the fixed pumps, additionally, it will also be considered the stop delay time for each fixed pump (parameter G25.4.14 to G25.4.18, depending on the what fixed is referred) and the PID error ('G25.4.13 $\rightarrow$ Maximum PiD error to stop the fixed pumps').

See figure 10.50 .

G25.4.24 STOP SPEED 6 FOR ONE FIXED PUMP

| Screen | 24 SPD6 of $=+70.0 \%$ |
| :---: | :---: |
| Extended info. | FPUMP STP SPEED6 |
| Description | Stop speed for one fixed pump associated to the local setpoint 6 |
| Range | +0.0\% to $+250 \%$ |
| Default value | +70.0\% |
| Set on run | YES |
| Modbus address | 42320 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the speed value below which the drive must remain for stopping a fixed pump whenever the operating setpoint is the local setpoint 6 set in parameter 'G25.1.10 $\rightarrow$ Local setpoint 6 for PID'. |
|  | See 'Function' in parameter 'G25.4.19 $\boldsymbol{\rightarrow}$ Stop speed 1 for one fixed pump' for additional information. |
|  | At the moment of stopping the fixed pumps, additionally, it will also be considered the stop delay time for each fixed pump (parameter G25.4.14 to G25.4.18, depending on the what fixed is referred) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps'). |

See figure 10.50 .

| G25.4.25 STOP SPEED 7 FOR ONE FIXED PUMP |  |
| :---: | :---: |
| Screen | 25 SPD7 of $=+70.0 \%$ |
| Extended info. | FPUMP STP SPEEDI, |
| Description | Stop speed for one fixed pump associated to the local setpoint 7 |
| Range | +0.0\% to +250\% |
| Default value | +70.0\% |
| Set on run | YES |
| Modbus address | 42321 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the speed value below which the drive must remain for stopping a fixed pump whenever the operating setpoint is the local setpoint 7 set in parameter 'G25.1.11 $\rightarrow$ Local setpoint 7 for PID' |
|  | See 'Function' in parameter 'G25.4.19 $\boldsymbol{\rightarrow}$ Stop speed 1 for one fixed pump' for additional information. |
|  | At the moment of stopping the fixed pumps, additionally, it will also be considered the stop delay time for each fixed pump (parameter G25.4.14 to G25.4.18, depending on the what fixed is referred) and the PID error ('G25.4.13 $\rightarrow$ Maximum PID error to stop the fixed pumps'). |

G25．4．26 STOP SPEED 8 FOR ONE FIXED PUMP

| Screen | 26 SPD8of $=+70.0 \%$ |
| :---: | :---: |
| Extended info． | FPUMP STP SPEEDB |
| Description | Stop speed for one fixed pump associated to the local setpoint 8 |
| Range | ＋0．0\％to $+250 \%$ |
| Default value | ＋70．0\％ |
| Set on run | YES |
| Modbus address | 42322 |
| Modbus range | 0 to 20480 |
| Read／Write | YES |

Function It allows setting the speed value below which the drive must remain for stopping a fixed pump whenever the operating setpoint is the local setpoint 8 set in parameter ＇G25．1．12 $\rightarrow$ Local setpoint 8 for PID＇．

See＇Function＇in parameter＇G25．4．19 $\rightarrow$ Stop speed 1 for one fixed pump＇for additional information．

At the moment of stopping the fixed pumps，additionally，it will also be considered the stop delay time for each fixed pump（parameter G25．4．14 to G25．4．18，depending on the what fixed is referred）and the PID error（＇G25．4．13 $\rightarrow$ Maximum PID error to stop the fixed pumps＇）．

See figure 10.50 ．

G25．4．27 LEVEL FOR ACTIVATING SLEEP HODE IN PID INVERSE

| Screen | 27 PIDiSL\％＝0．0\％ |
| :---: | :---: |
| Extended info． | PIDINVE SLEEP\％ |
| Description | Level for activating the sleep mode in PID inverse |
| Range | 0．0\％－250\％ |
| Default value | 0．0\％ |
| Set on run | YES |
| Modbus address | 42327 |
| Modbus range | 0 to 20480 |
| Read／Write | YES |

Function It allows setting the level below which，the drive will go in sleep mode when the PID of the application is inverted（PID inversion is realized in parameter＇G25．2．⿹勹巳 $\rightarrow$ PID output inversion＇）．

The value is set in \％of drive setpoint．

G25．4．28 TO ENABLE SLEEP MODE

| Screen | 28 SLEEP？$=\mathbf{Y}$ |
| :--- | :--- |
| Description | To enable sleep mode |
| Range | N |
|  | Y |
|  | （See＇Function＇for additional information） |
| Default value | Y |
| Set on run | YES |
| Modbus address | $\mathbf{4 2 3 5 8}$ |
| Modbus range | 0 to 1 |
| Read／Write | YES |

Function | It allows enabling or disabling the sleep mode of the drive. |
| :--- |
| This parameter operates together with the option ' 31 SLEEP CONDIT' of the |
| parameter 'G8.1.1 $\rightarrow$ Selection of Relay 1 control source', 'G8.1.5 $\rightarrow$ Selection of |
| Relay 2 control source' and 'G8.1.9 $\rightarrow$ Selection of Relay 3 control source'. User can |
| disable the sleep option of the drive but a PLC receives the warning of fulfiled sleep |
| conditions through the output relay configured with the option ' 31 ' and stops the |
| system. See option ' 31 ' in parameter G8.1.1. |

Options:
$\mathrm{N} \rightarrow$ NO Sleep mode disabled.
$\mathrm{Y} \rightarrow$ YES Sleep mode enabled.

G25.4.29 SLEEP SPEED WHEN SETPOINT IS INTRODUCED THROUGH ANALOGUE INPUT


\subsection*{10.20.11. Subgroup 25.5 - S25.5: Speed Bypass <br> | G25.5.1 SP | ED BYPASS AT THE STARTING OF FIXED PUMPS |
| :---: | :---: |
| Screen | 1 BY SPon $=+70.0 \%$ |
| Extended info. | BYPASS ON SPEED |
| Description | Speed bypass at the starting of fixed pumps |
| Range | +0.0\% to +250\% |
| Default value | +70.0\% |
| Set on run | YES |
| Modbus address | 42081 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting a speed bypass value. The drive speed will be forced to the value set in this parameter during the time set in parameter 'G25.5.2 $\rightarrow$ Time of speed bypass after starting fixed pumps' to avoid over-pressure situations in the system at the starting of a fixed pump. |
|  | See figures 10.47 and 10.48 . |

G25.5.2 TIME OF SPEED BYPASS AFTER STARTING FIXED PUMPS

| Screen | 2 BY T ON = 10s |
| :---: | :---: |
| Extended info. | OYPASS ON DELAY |
| Description | Time of speed bypass after starting fixed pumps |
| Range | OFF=0-999s |
| Default value | 10s |
| Set on run | YES |
| Modbus address | 42082 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a value for the time of speed bypass. During this time, the drive speed will be forced to the value set in parameter ' $\mathrm{G} 25.5 .1 \rightarrow$ Speed bypass at the starting of fixed pumps' to avoid over-pressure situations in the system at the starting of a fixed pump. |
|  | See figures 10.47 and 10.48 . |

## G25.5.3 SPEED BYPASS AT THE STOPPING OF FIXED PUMPS

| Screen | 3 BY SPof $=+90 \%$ |
| :---: | :---: |
| Extended info. | BYPASS OFF SPEED |
| Description | Speed bypass at the stopping of fixed pumps |
| Range | +0.0\% to $+250 \%$ |
| Default value | +90\% |
| Set on run | YES |
| Modbus address | 42083 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting a speed bypass value. The drive speed will be forced to the value set in this parameter during the time set in parameter 'G25.5.4 $\rightarrow$ Time of speed bypass after stopping fixed pumps' to avoid under-pressure situations in the system at the stopping of a fixed pump. |
|  | See figure 10.50 |


| G25.5.4 TIME OF SPEED BYPASS AFTER STOPPING FIXED PUAPS |  |
| :---: | :---: |
| Screen | 4 BY T OFF $=5 \mathrm{~s}$ |
| Extended info. | BYPASS OFF DELAY |
| Description | Time of speed bypass after stopping fixed pumps |
| Range | OFF $=0-999 \mathrm{~s}$ |
| Default value | 5 s |
| Set on run | YES |
| Modbus address | 42084 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a value for the time of speed bypass. During this time, the drive speed will be forced to the value set in parameter 'G25.5.3 $\rightarrow$ Speed bypass at the stopping of fixed pumps' to avoid under-pressure situations in the system at the stopping of a fixed pump. |

See figure 10.50 .

### 10.20.12. Subgroup 25.6-S25.6: Protection

| G25.6.1 D | AY TIME AFTER PROTECTION PAUSE |
| :---: | :---: |
| Screen | $1 \mathrm{PAUSE} / \mathrm{DEL}=20 \mathrm{~s}$ |
| Extended info. | DELAY ATIER PAUS |
| Description | Delay time after protection pause |
| Range | 0-999s |
| Default value | 20s |
| Set on run | YES |
| Modbus address | 42336 |
| Modbus range | 0 to 9990 |
| Read / Write | YES |
| Function | It allows setting a value of delay time before the drive starts after stopping by protection pause. This delay time starts elapsing once the cause that produced the pause disappears. |

For example, we suppose that a pause had been produced due to an over-pressure situation. Once the over-pressure condition disappears, the delay time set in this parameter starts elapsing, and when it is elapsed, the drive will start again.

This delay time will be applied to all of the pauses:

- High pressure (analogue feedback), if option 'PAUSE' is selected in parameter 'G25.6.12 $\rightarrow$ Response from over-pressure'.
- Cavitation, if option 'PAUSE' is selected in parameter 'G25.6.3 $\rightarrow$ Response from cavitation'.
- No Flow Switch, if option 'PAUSE' is selected in parameter 'G25.6.15 $\boldsymbol{\rightarrow}$ Response from 'No Flow' situation'.

Note: In case of 'Cavitation', when the equipment goes into 'pause', the drive is stopped and, therefore, it is not possible to continue monitoring values. Once the cavitation condition disappears, the delay time set in this parameter will start elapsing, and when this time is elapsed, the drive will start again.

| G25.6.2 TO ENABLE CAVITATION PROTECTION |  |
| :---: | :---: |
| Screen | 2 CAVITATION $=\mathbf{N}$ |
| Description | To enable protection of pump from cavitation situation |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 42085 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows enabling or disabling the protection of pump from cavitation situation. |
|  | Options: |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Protection from cavitation disabled. |
|  | $Y \rightarrow$ YES |
|  | Protection from cavitation enabled. |

To protect the pump from cavitation status, it is necessary to realize the following settings:
a) Set to ' $\gamma$ ' this parameter.
b) Set a value of cavitation current in parameter G25.6.4, below which the first detection condition will be fulfilled.
c) Set a value of cavitation speed in parameter G25.6.5, above which the second detection condition will be fulfilled.
d) Set a delay time for activation of cavitation protection in parameter G25.6.6. Once elapsed, the last cavitation condition will be activated.
e) Set a pause time for deactivation of cavitation protection in parameter G25.6.1. From this moment on, the drive will try to start again.

If three previous conditions are fulfilled, the drive will stop the pump to protect it from cavitation status (no water).

Note: To adjust cavitation parameters, Power Electronics recommend, whenever it is possible, follow the next steps:

- If the load is variable, adjust the application for the most frequent load value, for example, select a middle consumption for an irrigator water pump.
- Start the drive at manual speed.
- Set the drive speed to the minimum functional speed (minimum flow in case of pumps) or to the minimum operation level of your application.
- Make a note of the output current and the motor speed.
- Set the cavitation speed to the speed that you have made a note before.
- Set the cavitation current to $6 \%$ less than the current that you have made a note before.
- Set the desired activation time, for example, 10 s .
- Check the system, and if it is necessary, set the parameters for an optimum response again.

| G25.6.3 RE | PONSE FROM CAVITATION |
| :---: | :---: |
| Screen | 3 CAV MODE $=$ FAULT |
| Description | Response of the drive from cavitation situation |
| Range | PAUSE |
|  | FAULT |
|  | (See 'Function' for additional information) |
| Default value | FAULT |
| Set on run | YES |
| Modbus address | 42344 |
| Modbus range | 1 to 2 |
| Read / Write | YES |
| Function | It allows selecting the response of the drive from cavitation situation: |
|  | PAUSE $\quad \rightarrow$ It will generate that the drive stops, and next, fixed pumps. 'CAVITATION PAUSE' will be displayed. Once elapsed the delay time after pause, the drive will start. |
|  | FAULT $\quad \rightarrow$ it will generate a fault, and next, fixed pumps will be stopped. In this case, the visualization will be 'F68 CAVIT/UNDERL'. |


| G25.6.4 CAVITATION CURRENT |  |
| :---: | :---: |
| Screen | 4 CAV CURR $=\quad$ A |
| Extended info. | CAVITATION CURRE |
| Description | Cavitation current |
| Range | (0.2 to 1.50). In |
| Default value | * (This value depends on the drive capacity) |
| Set on run | YES |
| Modbus address | 42086 |
| Modbus range | 0 to 12288 |
| Read / Write | YES |
| Function | It allows setting the cavitation current, below which the first detection condition to activate the protection is fulfilled. This parameter operates together with parameters 'G25.6.5 $\rightarrow$ Cavitation speed' and 'G25.6.6 $\rightarrow$ Delay time to activate cavitation protection'. |
|  | See 'Function' in parameter 'G25.6.2 $\rightarrow$ To enable cavitation protection' to obtain information about the setting of cavitation parameters. |


| G25.6.5 SPEED CAVITATION |  |
| :---: | :---: |
| Screen | 5 CAV SPED $=+100 \%$ |
| Extended info. | CAVITATION SPEED |
| Description | Cavitation speed |
| Range | +0.0\% to +250\% |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 42087 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the cavitation speed, above which the second detection condition to activate the protection is fulfilled. This parameter operates together with parameters $'$ 'G25.6.4 $\rightarrow$ Cavitation current' and 'G25.6.6 $\rightarrow$ Delay time to activate cavitation protection'. |
|  | See 'Function' in parameter 'G25.6.2 $\rightarrow$ To enable cavitation protection' to obtain information about the setting of cavitation parameters. |

G25.6.6 DELAY TIME TO ACTIVATE CAVITATION PROTECTION

| Screen | 6 CAV DELAY $=10 \mathrm{~s}$ |
| :--- | :--- |
| Extended info. | CAVT FLT DELAY |
| Description | Delay time to activate cavitation protection |
| Range | $0-999 \mathrm{~s}$ |
| Default value | 10 s |
| Set on run | YES |
| Modbus address | 42088 |
| Modbus range | 0 to 9990 |
| Read $/$ Write | YES |

Function It allows setting the delay time to activate cavitation protection. The drive will wait for the time before activating the protection and then will stop. This parameter operates together with parameters 'G25.6.4 $\rightarrow$ Cavitation current' and 'G25.6.5 $\rightarrow$ Cavitation speed'.

See 'Function' in parameter 'G25.6.2 $\rightarrow$ To enable cavitation protection' to obtain information about the setting of cavitation parameters.

| G25.6.7 TO | ENABLE LOW PRESSURE PROTECTION |
| :---: | :---: |
| Screen | 7 ENABLE LO PRE $=\mathbf{N}$ |
| Description | To enable low pressure protection |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | $N$ |
| Set on run | YES |
| Modbus address | 42090 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows the possibility of tripping because of low pressure fault 'F65 LOW PRESSURE' and stopping the pump. |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Low pressure protection disabled. |
|  | $Y \rightarrow$ YES |
|  | Low pressure protection enabled. |

## G25.6.9 MINIMUM PRESURE LEVEL

| Screen | 9 LO PRE $=5.0 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | LOPRESSURELEV |
| Description | Minimum pressure level |
| Range | OFF=0 to 3276 Engineering units |
| Default value | 5.0Bar |
| Set on run | YES |
| Modbus address | 42091 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows setting the pressure level, below which the drive will trip because of low pressure fault (F65 LOW PRESSURE). |
| Note: | Default units of measurement which are displayed depend on the selected engineering units. See parameters 'G4.2.2 $\rightarrow$ Selection of sensor 1 units' and 'G4.3.2 $\rightarrow$ Selection of sensor 2 units'. |

G25.6.10 TRIP DELAY TIME BECAUSE OF MINIMUM PRESSURE FAULT

| Screen | 10 Lop DLY $=10.0 \mathrm{~s}$ |
| :--- | :--- |
| Extended info. | LO PRESS FLT DLY |

Function | It allows setting a delay time because of minimum pressure fault. During this time, the |
| :--- |
| pressure remains below the minimum pressure level set in parameter G25.6.9, |
| generating a trip in the drive because of low pressure fault (F65 LOW PRESSURE). |

Note: | The protection from low pressure is deactivated during the pipe filling process. |
| :--- |
| If a pipe is broken during the pipe filling process or when the drive is stopped, then the |
| pipe filling process does not finish by reached pressure, but by time. Once finished the |
| stage of pipe filling, the breakage detection will be activated and will trip after elapsing |
| the set time. |
| Additionally, it is necessary to consider, in case of existing enabled fixed pumps, these |
| ones must be connected for the minimum pressure conditions are evaluated, |
| otherwise, the drive executes the normal connection process of pumps before tripping |
| because of minimum pressure. |

G25.6.11 MINIBUM SPEED FOR MINIMUM PRESSURE FAULT

| Screen | 11 Lop Msp $=+0.0 \%$ |
| :---: | :---: |
| Extended info. | LO PRESS MIN SPED |
| Description | Minimum speed for minimum pressure fault |
| Range | +0.0\% to +250\% |
| Default value | +0.0\% |
| Set on run | YES |
| Modbus address | 42104 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the minimum speed for the trip of minimum pressure fault 'F65 LOW PRESSURE' (possible broken pipe). |
|  | Although hardware or software conditions exist (favourable comparison) to trip because of minimum pressure fault, the trip is not produced while the present motor speed is not lower than the speed set in this parameter, if any of the enabled fixed pumps is not started either. In short, it is an additional safety measurement to guarantee the broken pipe detection with a higher reliability. |
| Note: | This parameter value is set in \% of motor rated speed. |

G25.6.12 RESPONSE FROM OVER-PRESSURE

| Screen | 12 HP MODE = PAUSE |
| :---: | :---: |
| Description | Response of the drive from over-pressure situation |
| Range | PAUSE |
|  | FAULT |
|  | (See 'Function' for additional information) |
| Default value | PAUSE |
| Set on run | YES |
| Modbus address | 42337 |
| Modbus range | 1 to 2 |
| Read / Write | YES |
| Function | It allows setting the response of the drive from over-pressure situation: |
|  | PAUSE $\quad \rightarrow$ It will generate the stopping of the drive, and next, of fixed pumps. 'HI PRESSURE PAUS' will be displayed. Once the high pressure condition disappears, if the delay time after pause has elapsed, the drive will start. |
|  | FAULT $\quad \rightarrow$ It will generate a fault, and next, fixed pumps will be stopped. In this case, the visualization will be 'F66 HI PRESSURE'. |

G25.6.13 MAXIMUM PRESSURE LEVEL

| Screen | 13 HP LEV $=100 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | HIGH PRESS LEVEL |
| Description | Maximum pressure level |
| Range | 0-3276 Engineering units |
| Default value | 100Bar |
| Set on run | YES |
| Modbus address | 42101 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows setting the pressure level, above which the drive recognises a high pressure level by comparing with data received through analogue input (reading of PID feedback sensor). Once exceeded the detection threshold and elapsed the time set in parameter 'G25.6.14 $\rightarrow$ Trip time because of high pressure', the drive will stop by PAUSE or will trip by FAULT, according to the setting realized in parameter 'G25.6.12 $\rightarrow$ Response from over-pressure'. |

## G25.6.14 TRIP TIME BECAUSE OF HIGH PRESSURE

| Screen | $14 \mathrm{HIpr} \mathrm{DLY}=0.0 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | HIPRESS FLT DLY |
| Description | Trip time because of high pressure |
| Range | $0-999 \mathrm{~s}$ |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 42339 |
| Modbus range | 0 to 9990 |
| Read / Write | YES |
| Function | It allows setting the trip time because of high pressure. Once exceeded the detection level set in parameter 'G25.6.13 $\rightarrow$ Maximum pressure level' and elapsed set in this parameter, the drive will stop by PAUSE or will trip by FAULT, according to the setting realized in ' $\mathrm{G} 25.6 .12 \rightarrow$ Response from over-pressure'. |

## G25.6.15 RESPONSE FROM 'NO FLOW' SITUATION

| Screen | 15 FLO SWm = PAUSE |
| :---: | :---: |
| Description | Response of the drive from 'No Flow' detection situation |
| Range | PAUSE |
|  | FAULT |
|  | (See 'Function' for additional information) |
| Default value | PAUSE |
| Set on run | YES |
| Modbus address | 42348 |
| Modbus range | 1 to 2 |
| Read/Write | YES |
| Function | It allows selecting the response of the drive from 'No Flow' detection situation: |
|  | PAUSE $\quad \rightarrow$ It will generate the stopping of the drive, and next, of fixed pumps. 'NO FLOW' will be displayed. Once the high pressure condition disappears, if the delay time after pause has elapsed, the drive will start. |
|  | FAULT $\quad \rightarrow$ It will generate a fault, and next, fixed pumps will be stopped. In this case, the visualization will be 'F69 FLOW SWITCH'. |


| G25.6.16 HABILITACIONINTERRUPTOR DE 'NO FLUJO' EN EL LLENADO DE TUBERIAS |  |
| :---: | :---: |
| Screen | 16 NO FLO/FILL $=$ N |
| Description | To enable 'No Flow' switch during the pipe filling process |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 42352 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows the possibility of enabling or disabling the 'No Flow' switch to stop the drive during the pipe filling process, according to the setting of the parameter 'G.25.6.14 $\rightarrow$ Response from 'No Flow' situation'. |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | Protection from 'No Flow' situation is disabled. <br> The drive will ignore 'No Flow' input during the pipe filling process. |
|  | $Y \rightarrow Y E S$ |
|  | Protection from 'No Flow' situation is enabled. <br> The drive will consider 'No Flow' input during the pipe filling process to stop. |

## G25.6.17 HINIMU STOP SPEED BECAUSE OF 'NO FLOW' DETECTION

| Screen | 17 NO FLsp $=+0.0 \%$ |
| :---: | :---: |
| Extended info. | MOFLÖW MIN SPED |
| Description | Minimum stop speed because of 'No Flow' detection |
| Range | +0.0\% to $+250 \%$ |
| Default value | +0.0\% |
| Set on run | YES |
| Modbus address | 42349 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the minimum stop speed of the drive because of 'No Flow' detection. |
|  | When the motor speed is higher that the speed set in this parameter, the 'No Flow' switch can generate a stopping by PAUSE or by FAULT, if the other conditions above mentioned are fulfilled. On the contrary, when the motor speed is lower than the speed set in this parameter, the 'No Flow' switch can generate that the drive goes in sleep mode, whenever the other needed conditions to activate the sleep mode are fulfilled. Therefore, when the drive speed is lower than the speed set in this parameter, the equipment will check the setting of the parameter 'G25.4.10 $\rightarrow$ To enable 'No Flow' input to sleep the drive'. If this parameter has been set to ' $Y$ ', then the equipment will go to sleep if the other conditions to sleep are fulfilled. |

## G25.6.18 BYPASS TIME FOR 'NO FLOW' SWITCH

| Screen | 18 NO FLbyp $=0.0 \mathrm{~s}$ |
| :---: | :---: |
| Extended info. | NOFLOBYPAS DLY |
| Description | Bypass time for 'No Flow' switch |
| Range | 0.0 to 999s |
| Default value | 0.0s |
| Set on run | YES |
| Modbus address | 42350 |
| Modbus range | 0 to 9990 |
| Read / Write | YES |
| Function | It allows setting the bypass time for the 'No Flow' switch. During this time 'No Flow' input is ignored. This time has only sense elapsed from the starting of the drive, whenever the pipe filling process is not activated. |
|  | If the filling option is has been activated, then the drive will check the setting of the parameter 'G25.6.16 $\rightarrow$ To enable 'No Flow' switch during pipe filling process' before. If this parameter is set to ' $Y$ ', then the option of 'No Flow' during the pipe filling process is active. In this case, the bypass time will be counted although pipe filling process is active. On the contrary, if this parameter is set to ' $N$ ', then the option of 'No Flow' during the pipe filling process is not activated. In this case, the bypass time will start elapsing after pipe filling process finishes. |

## G25.6.19 TRIP DELAY TIME BECAUSE OF 'NO FLOW'

| Screen | 19 NO $\operatorname{FLdly}=0.0 \mathrm{~s}$ |
| :--- | :--- |
| Extended info. | NO FLOW FLT DLY |
| Description | Trip delay time because of 'No Flow' detection |
| Range | 0.0 to 999 s |
| Default value | 0.0 s |
| Set on run | YES |
| Modbus address | 42351 |
| Modbus range | 0 to 9990 |
| Read / Write | YES |

Function It allows setting the delay time from the 'No Flow' switch is opened to the drive stops. In case of the bypass delay time ( G 25.6 .18 ) is also configured, both delay times will be considered.

## G25.6.20 CYCLE TIME OF THE DRIVE

| Screen | 20 CYCLE TI $=0 \mathrm{~m}$ |
| :--- | :--- |
| Extended info. | CYGLERESEE OELY |
| Cescription | CyCle time of the drive |
| Range | OFF $=0$ to $99 m$ |
| Default value | Om |
| Set on run | YES |
| Modbus address | 42353 |
| Modbus range | 0 to 99 |
| Read $/$ Write | YES |

Function It allows setting the time that must elapse from the drive stops to starts again, for the cycle counter (G25.6.21) is reset.

This protection is thought from situations where the drive has problems to keep the pressure and, for example, it goes in sleep mode to wake up immediately (a faulty check valve, incorrect setting of the parameters or problems with measurement sensor). This function also will operate together with cavitation protection avoiding that the drive pump is starting and stopping continuously in cavitation pauses.

If the drive starts a number of times without relaxing for the time set in this parameter, then the drive will trip because of fault 'F71 CYCLING', also stopping the fixed pumps.

G25.6.21 CYCLE COUNTER

| Screen | 21 CYCLE CNT $=\mathbf{5}$ |
| :--- | :--- |
| Extended info. | MAXCYCLESAALOW |
| Description | Cycle COunter |
| Range | $1-5$ |
| Default value | 5 |
| Set on run | YES |
| Modbus address | $\mathbf{4 2 3 5 4}$ |
| Modbus range | 1 to 5 |
| Read $/$ Write | YES |

Function It allows setting the maximum number of allowed cycles without relaxing. If this number is exceeded, then trip will be generated.

Note: Go to sleep and wake up is also considered a cycle

### 10.20.13. Subgroup 25.7-S25.7: Pipe Filling Process / Setpoint Ramp

| G25.7.1 PRESSURE READING SOURCE |  |
| :---: | :---: |
| Screen | 1 PRESSU SOU = PID |
| Description | Pressure reading source |
| Range | PID |
|  | Al1 |
|  | Al2 |
|  | (See 'Function' for additional information) |
| Default value | PID |
| Set on run | YES |
| Modbus address | 42357 |
| Modbus range | 0 to 2 |
| Read / Write | YES |
| Function | It allows selecting the source for the reading of the pressure that determines the end of the pipe filling process (parameter G25.7.3). |
|  | The configurable options are the following ones: |
|  | PID $\quad \rightarrow$ Pressure reading from feedback signal of the PID. |
|  | Al1 $\rightarrow$ Pressure reading from Analogue input 1. |
|  | $\mathrm{Al2}$ ( 2 Pressure reading from Analogue Input 2 |

G25.7.2 SPEED FOR PIPE FILLING PROCESS

| Screen | 2 FILL SP $=+\mathbf{+ 0 . 0 \%}$ |
| :--- | :--- |
| Extended info. | PipE FILING SPD |
| Description | Speed for pipe filling process |
| Range | OFF $=0.0,+0.1$ to $+250 \%$ |
| Default value | $+70.0 \%$ |
| Set on run | YES |
| Modbus address | $\mathbf{4 2 1 1 6}$ |
| Modbus range | 0 to 20480 |
| Read $/$ Write | YES |
|  |  |
| Function | It allows setting the reference speed during the pipe filling process. |


| G25.7.3 PR | SURE FOR THE END OF FILING PROCESS |
| :---: | :---: |
| Screen | 3 FILLP $=2.0 \mathrm{Bar}$ |
| Extended info. | PFIL END PRESSU |
| Description | Pressure level to finish the pipe filling process |
| Range | 0.0-3276 Engineering units |
| Default value | 2.0Bar |
| Set on run | YES |
| Modbus address | 42117 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |


| Function | It allows setting the pressure level that determines the end of the pipe filling process. The sleep function of the drive is disabled during pipe filling process. Once the filling function is finished, the drive will go to the stage of setpoint ramp. The pressure level set in this parameter together with the time set in parameter 'G25.7.4 $\rightarrow$ Safety time for pipe filling process' are the conditions to end the pipe filling process. The condition that is fulfilled before (pressure or time) will force the end of the pipe filling process, changing the equipment from 'FILL' status to setpoint ramp 'RAMP'. |
| :---: | :---: |
| Note: | Default units of measurement which are displayed depend on the selected engineering units. See parameters 'G4.2.2 $\rightarrow$ Selection of sensor 1 units' and 'G4.3.2 $\rightarrow$ Selection of sensor 2 units'. |


| G25.7.4 SA | TY TIME FOR PIPE FILLING PROCESS |
| :---: | :---: |
| Screen | 4 FILL TIM $=15 \mathrm{~m}$ |
| Extended info. | PFILL ENDDELAY |
| Description | Safety time for pipe filling process |
| Range | OFF=0, 1-9999min |
| Default value | 15m |
| Set on run | YES |
| Modbus address | 42118 |
| Modbus range | 0 to 9999 |
| Read / Write | YES |
| Function | It allows setting a safety time to force the end of pipe filling process. <br> The pressure level set in parameter 'G25.7.3 $\rightarrow$ Pressure for the end of pipe filling process' together with the time set in this parameter are the conditions to end the pipe filling process. The condition that is fulfilled before (pressure or time) will force the end of the pipe filling process, changing the equipment from 'FILL' status to setpoint ramp 'RAMP'. |
| Note: | If this time is set to ' 0 ', the drive will not execute the pipe filling process. |

G25.7.5 SETPOINT RAMP
Screen 5 SPT RAMP $=1.0 \mathrm{Bar} / \mathrm{s}$

| Description | Setpoint ramp |
| :--- | :--- |
| Range | $0.01-320.00$ Engineering units /s |
| Default value | $1.0 \mathrm{Bar} / \mathrm{s}$ |

Set on run YES

Modbus address 42119
Modbus range 0 to 32000
Read/Write YES
Function It allows setting the ramp that will be applied to increase the setpoint. After finishing the pipe filling process, or if this process has not been realized from the beginning, the drive will adjust the setpoint value to the present value of the feedback signal provisionally. Then, the setpoint will be increased according to the ramp set in this parameter up to $5 \%$ below the real setpoint selected by user. In that moment, the drive will start the real regulation. During the setpoint ramp, the drive cannot go to sleep by 'no demand'.

By setting a slow setpoint ramp, we achieve a smooth increase of the motor speed.
Note: Default units of measurement which are displayed depend on the selected engineering units. See parameters 'G4.2.2 $\rightarrow$ Selection of sensor 1 units' and ' $G 4.3 .2 \rightarrow$ Selection of sensor 2 units'.

### 10.20.14. Subgroup 25.8 - S25.8: Setpoint Compensation due to Pressure Loss

| 8.1 COHPENSATION PRESSURE AT THE STARTING OF 1 FIXED PUAP |  |
| :---: | :---: |
| Screen | 1 COMP 1 = 0.0Bar |
| Extended info. | SEIPOINT COMPEN1 |
| Description | Compensation pressure at the starting of one fixed pump |
| Range | 0.0-3276 Engineering units |
| Default value | 0.0Bar |
| Set on run | YES |
| Modbus address | 42131 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows compensating the pressure loss in the pipe by increasing the setpoint automatically when one fixed pump is connected. |

Note: Default units of measurement which are displayed depend on the selected engineering units. See parameters 'G4.2.2 $\rightarrow$ Selection of sensor 1 units' and 'G4.3.2 $\rightarrow$ Selection of sensor 2 units'.

## G25.8.2 COMPENSATION PRESSURE AT THE STARTING OF 2 FIXED PUMPS

| Screen | 2 COMP $2=0.0 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | SETPOINT COMPEN2 |
| Description | Compensation pressure at the starting of two fixed pumps |
| Range | 0.0-3276 Engineering units |
| Default value | 0.0Bar |
| Set on run | YES |
| Modbus address | 42132 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows compensating the pressure loss in the pipe by increasing the setpoint automatically when two fixed pumps are connected. |

Note: Default units of measurement which are displayed depend on the selected engineering units. See parameters 'G4.2.2 $\rightarrow$ Selection of sensor 1 units' and 'G4.3.2 $\rightarrow$ Selection of sensor 2 units'.

## G25.8.3 COMPENSATION PRESSURE AT THE STARTING OF 3 FIXED PUAPS

| Screen | 3 COMP $3=0.0 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | SEIPOINT COMPEN3 |
| Description | Compensation pressure at the starting of three fixed pumps |
| Range | 0.0-3276 Engineering units |
| Default value | 0.0Bar |
| Set on run | YES |
| Modbus address | 42133 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |

Function It allows compensating the pressure loss in the pipe by increasing the setpoint automatically when three fixed pumps are connected.

Note: Default units of measurement which are displayed depend on the selected engineering units. See parameters 'G4.2.2 $\rightarrow$ Selection of sensor 1 units' and 'G4.3.2 $\boldsymbol{\rightarrow}$ Selection of sensor 2 units'.

## G25.8.4 COMPENSATION PRESSURE AT THE STARTING OF. 4 FIXED PURAPS

| Screen | $4 \mathrm{COMP} 4=0.0 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | SEIPOINT COMPEN4 |
| Description | Compensation pressure at the starting of four fixed pumps |
| Range | 0.0-3276 Engineering units |
| Default value | 0.0 Bar |
| Set on run | YES |
| Modbus address | 42134 |
| Modbus range | 0 to 32760 |
| Read/Write | YES |
| Function | It allows compensating the pressure loss in the pipe by increasing the setpoint automatically when four fixed pumps are connected. |

Note: Default units of measurement which are displayed depend on the selected engineering units. See parameters 'G4.2.2 $\rightarrow$ Selection of sensor 1 units' and 'G4.3.2 $\rightarrow$ Selection of sensor 2 units'.

G25.8.5 COMAPENSATION PRESSURE AT THE STARTING OF 5 FIXED PUMPS

| Screen | 5 COMP $5=0.0 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | SETPOINT COMPEN5 |
| Description | Compensation pressure at the starting of five fixed pumps |
| Range | 0.0-3276 Engineering units |
| Default value | 0.0Bar |
| Set on run | YES |
| Modbus address | 42135 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows compensating the pressure loss in the pipe by increasing the setpoint automatically when five fixed pumps are connected. |

Note: Default units of measurement which are displayed depend on the selected engineering units. See parameters 'G4.2.2 $\rightarrow$ Selection of sensor 1 units' and 'G4.3.2 $\rightarrow$ Selection of sensor 2 units'.

### 10.20.15. Subgroup 25.9-S25.9: Fixed Pumps Control

| G25.9.1 | TO ENABLE FIXED PUMAP ASSOCIATED TO OUTPUT RELAY 1 |
| :--- | :--- |
|  |  |
| Screen | 1 ENABLE PUMP1 $=\mathbf{N}$ |
| Description | To enable the fixed pump associated to the Output Relay 1 (pump 1) |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 42136 |
| Modbus range | 0 to 1 |
| Read $/$ Write | YES |

Function It allows setting enabling or disabling the fixed pump associated to the Output Relay 1
If this parameter is set to ' $Y$ ', when activating pump control in parameter ' $G 1.7 \rightarrow$ Program activation' (option 'PUMP') and configuring one digital input (parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to ' $\mathrm{G} 4.1 .10 \rightarrow$ Multi-function Digital Input 6 configuration') with option ' $52 \rightarrow$ FIX PUMP1 FLT', the Output Relay 1 is configured with option ' $28 \rightarrow$ PUMP CNTRL' to control fixed pumps. If the pump associated to this relay is not required, we recommend you disable it from this parameter. In this way, the relay can be configured for other uses.
$\mathrm{N} \rightarrow \mathrm{NO}$
To disable the fixed pump associated to the Output Relay 1. The relay is configured with the option ' $00 \rightarrow$ ALWAYS OFF' and free-configuration is allowed for it.
$Y \rightarrow Y E S$
To enable the fixed pump associated to the Output Relay 1. The relay is configured with the option ' $28 \rightarrow$ PUMP CNTRL' and free-configuration is not allowed for it.

| G25.9 2 TO | ENABLE FIXED PUMP ASSOCLATED TO OUTPUT RELAY 2 |
| :---: | :---: |
| Screen | 2 ENABLE PUMP2 $=$ N |
| Description | To enable the fixed pump associated to the Output Relay 2 (pump 2) |
| Range | $N$ |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 42137 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows setting enabling or disabling the fixed pump associated to the Output Relay 2. |
|  | If this parameter is set to ' Y ', when activating pump control in parameter ' $\mathrm{G} 1.7 \rightarrow$ Program activation' (option 'PUMP') and configuring one digital input (parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration') with option ' $53 \rightarrow$ FIX PUMP2 FLT', the Output Relay 1 is configured with option '28 $\rightarrow$ PUMP CNTRL' to control fixed pumps. If the pump associated to this relay is not required, we recommend you disable it from this parameter. In this way, the relay can be configured for other uses. |

```
N}->\textrm{NO
To disable the fixed pump associated to the Output Relay 2. The relay is
configured with the option '00-> ALWAYS OFF' and free-configuration is
allowed for it
Y}->\mathrm{ YES
To enable the fixed pump associated to the Output Relay 2. The relay is configured with the option \(28 \rightarrow\) PUMP CNTRL' and free-configuration is not allowed for it.
```

| G25.9:3_T | TO ENABLE FIXED PUMP ASSOCIATED TO OUTPUT RELAY 3 |
| :---: | :---: |
| Screen | 3 ENABLE PUMP3 $=\mathbf{N}$ |
| Description | To enable the fixed pump associated to the Output Relay 3 (pump 3) |
| Range | $N$ |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 42138 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows setting enabling or disabling the fixed pump associated to the Output Relay 3. |
|  | If this parameter is set to ' $Y$ ', when activating pump control in parameter 'G1.7 $\boldsymbol{\rightarrow}$ |
|  | Program activation' (option 'PUMP') and configuring one digital input (parameter |
|  | 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function |
|  | Digital Input 6 configuration') with option '54 $\rightarrow$ FIX PUMP3 FLT', the Output Relay 3 is configured with option ' $28 \rightarrow$ PUMP CNTRL' to control fixed pumps. If the pump associated to this relay is not required, we recommend you disable it from this parameter. In this way, the relay can be configured for other uses. |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | To disable the fixed pump associated to the Output Relay 3. The relay is configured with the option '00 $\rightarrow$ ALWAYS OFF' and free-configuration is allowed for it. |
|  | $Y \rightarrow Y E S$ |
|  | To enable the fixed pump associated to the Output Relay 3. The relay is configured with the option '28 $\rightarrow$ PUMP CNTRL' and free-configuration is not allowed for it. |

## G25.9.4 TO ENABLE FIXED PUAP ASSOCIATED TO ANALOGUE OUTPUT 1

| Screen | $\mathbf{4}$ ENABLE PUMP4 $=\mathbf{N}$ |
| :--- | :--- |
| Description | To enable the fixed pump associated to the Analogue Output 1 (pump 4) |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | $\mathbf{4 2 1 4 8}$ |
| Modbus range | 0 to 1 |
| Read $/$ Write | YES |

Function It allows setting enabling or disabling the fixed pump associated to the Analogue Output 1.

If this parameter is set to ' $Y$ ', when activating pump control in parameter ' $\mathrm{G} 1.7 \rightarrow$ Program activation' (option 'PUMP') and configuring one digital input (parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration') with option '55 $\rightarrow$ FIX PUMP4 FLT', the Analogue Output 1 is configured with option ' $27 \rightarrow$ MACRO PUMP' to control fixed pumps. If the pump associated to this analogue output is not required, we recommend you disable it from this parameter. In this way, the analogue output can be configured for other uses.
$\mathrm{N} \rightarrow \mathrm{NO}$
To disable the fixed pump associated to the Analogue Output 1. This analogue output is configured with the option '00 $\rightarrow$ NONE' and freeconfiguration is allowed for it.
$Y \rightarrow Y E S$
To enable the fixed pump associated to the Analogue Output 1. This analogue output is configured with the option ' $27 \rightarrow$ MACRO PUMP' and free-configuration is not allowed for it.

| G25.9.5 TO ENABLE FIXED PUMP ASSOCIATED TO ANALOGUE OUTPUT 2 |  |
| :---: | :---: |
| Screen | 5 ENABLE PUMP5 $=\mathrm{N}$ |
| Description | To enable the fixed pump associated to the Analogue Output 2 (pump 5) |
| Range | $N$ |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | YES |
| Modbus address | 42149 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows setting enabling or disabling the fixed pump associated to the Analogue Output 2. |
|  | If this parameter is set to ' $Y$ ', when activating pump control in parameter ' $G 1.7 \rightarrow$ Program activation' (option 'PUMP') and configuring one digital input (parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration') with option ' $56 \rightarrow$ FIX PUMP5 FLT', the Analogue Output 2 is configured with option ' $27 \rightarrow$ MACRO PUMP' to control fixed pumps. If the pump associated to this analogue output is not required, we recommend you disable it from this parameter. In this way, the analogue output can be configured for other uses. |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | To disable the fixed pump associated to the Analogue Output 2. This analogue output is configured with the option '00 $\rightarrow$ NONE' and freeconfiguration is allowed for it. |
|  | $Y \rightarrow Y E S$ |
|  | To enable the fixed pump associated to the Analogue Output 2. This analogue output is configured with the option ' $27 \rightarrow$ MACRO PUMP' and free-configuration is not allowed for it. |


| G25.9.6 AL | ERNATION MODE OF FIXED PUMPS |
| :---: | :---: |
| Screen | 6 FP ALTER MOD $=0$ |
| Description | Alternation mode of fixed pumps |
| Range | $0-2$ <br> (See 'Function' for additional information) |
| Default value | 0 |
| Set on run | YES |
| Modbus address | 42139 |
| Modbus range | 0 to 2 |
| Read / Write | YES |
| Function | It allows selecting the alternation mode used by the drive to start the fixed pumps. |
|  | Options: |
|  | $0 \rightarrow$ LINEAR |
|  | The drive will always start the fixed pumps by following the same sequence, $1,2,3$, and will stop them in the same way, $1,2,3$ (no alternation). |
|  | $1 \rightarrow$ CYCLE |
|  | The first pump to start will be the next one to the last stopped pump. |
|  | $2 \rightarrow$ DUTY SHARE |
|  | The drive will try to make the operation times of all available pumps equal. |

G25.9.7 STARTING PRESSURE OF JOCKEY: PUMP

| Screen | $\mathbf{~ J P o n ~ P ~ = ~ 0 . 0 B a r ~}$ |
| :--- | :--- |
| Extended info. | JOCKEY ON PRESS |
| Description | Starting pressure of Jockey pump |
| Range | $0.0-3276$ Engineering units |
| Default value | $0.0 B a r$ |
| Set on run | YES |
| Modbus address | $\mathbf{4 2 3 7 1}$ |
| Modbus range | 0 to 32760 |
| Read $/$ Write | YES |

Function It allows setting the pressure level, below which the Jockey pump will start
During periods of very low demand (for example, tank filling processor opening a couple of taps) the Jockey pump will start to cover this demand. This pump will only start if the drive is sleeping and additionally, there is some output relay (parameters ' $\mathrm{G} 8.1 .1 \rightarrow$ Selection of Relay 1 control source', 'G8.1.5 $\rightarrow$ Selection of Relay 2 control source' and 'G8.1.9 $\rightarrow$ Selection of Relay 3 control source') configured with the option '29 $\rightarrow$ JOCKEY PUMP'.

| G25.9.8 START DELAY TIME FOR JOCKEY PUMP |  |
| :---: | :---: |
| Screen | $8 \mathrm{JPon} \mathrm{DLY}=20 \mathrm{~s}$ |
| Extended info. | JOCKEY ON DELAY |
| Description | Start delay time for Jockey pump |
| Range | 0-600s |
| Default value | 20 s |
| Set on run | YES |
| Modbus address | 42372 |
| Modbus range | 0 to 6000 |
| Read / Write | YES |
| Function | It allows setting a delay time to start the Jockey pump. |
|  | This time will start elapsing after the condition to start this pump is fulfilled, this is, when the pressure is below the level set in parameter 'G25.9.7 $\rightarrow$ Starting pressure of Jockey pump'. |

## G25.9.9 STOPPING PRESSURE OF JOCKEY PUMP

| Screen | $9 \mathrm{JPof} \mathrm{P}=0.0 \mathrm{Bar}$ |
| :---: | :---: |
| Extended info. | JOCKEY OFF PRESS |
| Description | Stopping pressure of Jockey pump |
| Range | 0.0-3276 Engineering units |
| Default value | 0.0Bar |
| Set on run | YES |
| Modbus address | 42373 |
| Modbus range | 0 to 32760 |
| Read / Write | YES |
| Function | It allows setting the pressure level, above which the Jockey pump will stop. |
|  | If the drive pump starts, then the Jockey pump will stop automatically although the pressure level set in this parameter is not reached. |

## G25.9.10 BYPASS TIME FOR PRIMING PUMP

| Screen | 10 PRp BYP $=300 \mathrm{~s}$ |
| :--- | :--- |
| Extended info. | PRIM.PUM.BYP.DLY |
| Description | Bypass time for the Priming pump |
| Range | $0.1-6000 \mathrm{~s}$ |
| Default value | 300 s |
| Set on run | YES |
| Modbus address | $\mathbf{4 2 1 0 2}$ |
| Modbus range | 0 to 60000 |
| Read $/$ Write | YES |

Function It allows setting the bypass time for the Priming pump.
Once stopped the Priming pump and started the drive, if the digital input configured as pressure switch (parameter 'G4.1.5 $\rightarrow$ Multi-function Digital Input 1 configuration' to 'G4.1.10 $\rightarrow$ Multi-function Digital Input 6 configuration', option '69 $\rightarrow$ PRESSUR SWITC') is opened during the time set in this parameter, the fault 'F72 IN PRESS SW' will be produced.

Note: The fault F72 is only produced if there is some output relay configured with the option '30 $\rightarrow$ PRIMING PUMP' (parameters G8.1.1, G8.1.5 and G8.1.9) and some digital input configured with the option ' $69 \rightarrow$ PRESSUR SWITC' (parameter G4.1.5 to G4.1.10).

| G25.9.11 TR | TIME OF F72 WHILE PRIMING PUMP IS CONNECTED |
| :---: | :---: |
| Screen | 11 PRP DLY $=$ OFF |
| Extended info. | PRIM PUM FLTCH |
| Description | Trip time of F 72 while the Priming pump is connected |
| Range | OFF=0, $0.1-6000 \mathrm{~m}$ |
| Default value | OFF |
| Set on run | YES |
| Modbus address | 42103 |
| Modbus range | 0 to 60000 |
| Read / Write | YES |
| Function | It allows setting a time to produce the fault F72 when the Priming pump is connected. |
|  | If the Priming pump is connected and the time set in this parameter has elapsed from the starting of this pump without detecting pressure in the pressure switch, the fault 'F72 IN PRESS SW' will be produced. |
| Note: | The fault F72 is only produced if there is some output relay configured with the option '30 $\rightarrow$ PRIMING PUMP' (parameters G8.1.1, G8.1.5 and G8.1.9) and some digital input configured with the option '69 $\rightarrow$ PRESSUR SWITC' (parameter G4.1.5 to G4.1.10). |

10.20.16. Subgroup 25.10 - S25.10: Flow Limitation Algorithm

| G25.10.1 FLOW READING SOURCE |  |
| :---: | :---: |
| Screen | 1 FLOW SEL = PULSE |
| Description | Flow reading source |
| Range | Al1 |
|  | Al2 |
|  | PULSE |
|  | (See 'Function' for additional information) |
| Default value | PULSE |
| Set on run | YES |
| Modbus address | 42141 |
| Modbus range | 0 to 2 |
| Read / Write | YES |
| Function | It allows selecting the source to introduce the PID setpoint of the instantaneous flow. |
|  | Selection options: |
|  | Al1 $\quad \rightarrow$ Reference signal (PID setpoint) introduced through Analogue Input 1. |
|  | Al2 $\quad \rightarrow$ Reference signal (PID setpoint) introduced through Analogue Input 2 |
|  | PULSE $\quad \rightarrow$ Reference signal (PID setpoint) introduced by means of a pulse input connected to one Multi-function Digital Input (parameter G4.1.5 to G4.1.10, option '51 $\rightarrow$ FLOW PULSE'). See Subgroup S4.4 Pulse Input for additional information. |

## G25.10.2 AAXI AUMM ALLOWED FLOW

Screen 2 MAX FLOW = 10001/s

Extended info. MAXALLOWED FLOW
Description Value of maximum allowed flow
Range $0.0-3276$ Engineering units
Default value $10001 / \mathrm{s}$
Set on run YES
Modbus address 42143
Modbus range 0 to 32760
Read / Write YES

Function It allows setting the value of the maximum allowed flow.
When the present flow value is higher than the value set in this parameter plus the margin set in 'G25.10.3 $\rightarrow$ Offset percentage over maximum flow' (G25.10.2 + G25.10.3), the flow limitation algorithm will be activated showing the drive status 'FLOW'. In that moment, the speed reference of the pump will start decreasing using the ramp set in 'G25.10.5 $\rightarrow$ Deceleration ramp during algorithm'. The speed reference will decrease until the present flow is lower than the value set in this parameter minus the margin set in G25.10.3 (G25.10.2-G25.10.3). In this moment, the speed will remain constant until the present flow is lower than the flow set in 'G25.10.4 $\rightarrow$ Flow percentage to reset algorithm'. From this moment on, the PID regulator will take up the control again, and the drive will start to regulate normally.

Note: Default units of measurement which are displayed depend on the selected engineering units. See parameters 'G4.2.2 $\boldsymbol{\rightarrow}$ Selection of sensor 1 units' and 'G4.3.2 $\boldsymbol{\rightarrow}$ Selection of sensor 2 units'.

## G25.10.3 OFFSET PERCENTAGE OVER MAXIMUM FLOW

| Screen | 3 OFFSET $=+0 \%$ |
| :---: | :---: |
| Extended info. | OFFSET MAX FLOW |
| Description | Offset percentage over maximum flow |
| Range | +0\% to $+250 \%$ |
| Default value | +0\% |
| Set on run | YES |
| Modbus address | 42144 |
| Modbus range | 0 to 20480 |
| Read / Write | YES |
| Function | It allows setting the offset margin over the maximum allowed flow to activate the flow limitation algorithm. |
|  | It is set in \% of the value set in parameter 'G25.10.2 $\rightarrow$ Maximum allowed flow'. |

## G25.10.4 FLOW PERCENTAGE TO RESET ALGORITHM

| Screen | 4 FLO RES $=+100 \%$ |
| :---: | :---: |
| Extended info. | ELOW RESEE LEVEL |
| Description | Flow percentage to reset algorithm |
| Range | +0 to +100\% |
| Default value | +100\% |
| Set on run | YES |
| Modbus address | 42145 |
| Modbus range | 0 to 100 |
| Read / Write | YES |
| Function | It allows setting the flow level to reset the flow limitation algorithm. |

When the level of the instantaneous read in the source set in parameter G25.10.1 is below the value set in this parameter, the flow limitation algorithm will give the PID regulator the control.

It is set in \% of the range of analogue input 1 or 2 (in case of selecting option ' $0 \rightarrow \mathrm{Al1}$ ' or ' $1 \rightarrow \mathrm{Al}$ ' respectively in parameter ' $\mathrm{G} 25.10 .1 \rightarrow$ Flow reading source') or it is set in $\%$ of the value set in the parameter 'G4.4.3 $\rightarrow$ Maximum range of flow meter' (in case of selecting the option ' $2 \rightarrow$ PULSE' as flow reading source in parameter $G 25.10 .1$ ).
G25.10:5 DECELERATION RAMP DURING ALGORITHA

## Screen

Extended info.
Description
Range
Default value
Set on run
Modbus address 42146
Modbus range 0 to 20480
Read / Write
Function It allows setting the deceleration ramp that will be applied by the drive to decrease the pump speed until the read flow is lower than the flow set in parameter 'G25.10.2 $\rightarrow$ Maximum allowed flow' minus the margin set in ' $\mathrm{G} 25.10 .3 \rightarrow$ Offset percentage over maximum flow' as offiset or deviation margin.

## G25.10.6 UNITS OF BEASUREMENT OF INSTANTANEOUS FLOW

| Screen | 6 UNIT FLOW $=1 / \mathrm{s}$ |
| :--- | :--- |
| Description | Units of measurement of instantaneous flow |
| Range | - |
| Default value | //s |
| Set on run | - |
| Modbus address | $\mathbf{4 2 1 4 7}$ |
| Modbus range | 0 to 9 |
| Read / Write | Read Only |
| Function | Read only parameter that shows the units of measurement of the instantaneous flow, <br> the source of which is set in parameter 'G25.10.1 $\rightarrow$ Flow reading source'. |
|  |  |

### 10.20.17. Subgroup 25.11-S25.11: Registers (Read only)

This subgroup shows the time operated by each auxiliary pump. This time is visualized as amount of days and minutes.

It is especially useful when the alternation mode 'DUTY SHARE' (option ' 2 ' in parameter 'G25.9.6 -7 Alternation mode of fixed pumps') is used to check if the operated times by the auxiliary pumps are equal.

| 5.11.1 OPERATED TIME BY PUMP 1 |  |
| :---: | :---: |
| Screen | $1 \mathrm{P1}=\ldots-\mathrm{od}$---0m |
| Description | Operated time by pump 1 |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | $42011 \rightarrow \mathrm{~m}$ (minutes) |
|  | $42014 \rightarrow$ d (days) |
| Modbus range | Real Value $=$ Modbus Value |
| Read / Write | Read Only |
| Function | Read only parameter. For additional information, see chapter 10.20.17 (S25.11 Registers). |


| G25.11.2 OPERATED TIME BY PUMP 2 |  |
| :---: | :---: |
| Screen | $2 \mathrm{P} 2=-\mathrm{-0d}--0 \mathrm{~m}$ |
| Description | Operated time by pump 2 |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | $42012 \rightarrow \mathrm{~m}$ (minutes) |
|  | $42015 \rightarrow$ d (days) |
| Modbus range | Real Value $=$ Modbus Value |
| Read / Write | Read Only |
| Function | Read only parameter. For additional information, see chapter 10.20.17 (S25.11 Registers). |

G25.11.3 OPERATED TIME BY PUMP: 3

| Screen | 3 P 3 = ----0d ---0m |
| :---: | :---: |
| Description | Operated time by pump 3 |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | $42013 \rightarrow \mathrm{~m}$ (minutes) |
|  | $42016 \rightarrow$ d (days) |
| Modbus range | Real Value $=$ Modbus Value |
| Read / Write | Read Only |
| Function | Read only parameter. For additional information, see chapter 10.20.17 (S25.11 Registers). |

## G25.11.4 OPERATED TIME BY PUAP 4

| Screen | $4 \mathrm{P4}=--\mathrm{0d}-\ldots \mathrm{Om}$ |
| :---: | :---: |
| Description | Operated time by pump 4 |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | $42018 \rightarrow \mathrm{~m}$ (minutes) |
|  | $42020 \rightarrow$ d (days) |
| Modbus range | Real Value = Modbus Value |
| Read / Write | Read Only |
| Function | Read only parameter. For additional information, see chapter 10.20.17 (S25.11 Registers). |

## G25.11.5 OPERATED TIME BY PUMP 5

| Screen | $5 \mathrm{P} 5=\ldots \mathrm{Od}-\mathrm{mm}$ |
| :---: | :---: |
| Description | Operated time by pump 5 |
| Range | - |
| Default value | - |
| Set on run | - |
| Modbus address | $42019 \rightarrow \mathrm{~m}$ (minutes) |
|  | $42021 \rightarrow$ d (days) |
| Modbus range | Real Value $=$ Modbus Value |
| Read / Write | Read Only |
| Function | Read only parameter. For additional information, see chapter 10.20.17 (S25.11 Registers). |


| G25.11.6 RESET COUNTERS |  |
| :---: | :---: |
| Screen | TIME RESTORE $=\mathbf{N}$ |
| Description | Reset counters |
| Range | N |
|  | Y |
|  | (See 'Function' for additional information) |
| Default value | N |
| Set on run | NO |
| Modbus address | 42017 |
| Modbus range | 0 to 1 |
| Read / Write | YES |
| Function | It allows the possibility of resetting the counters of the pumps. |
|  | $\mathrm{N} \rightarrow \mathrm{NO}$ |
|  | The counters of the pumps are not reset. |
|  | $Y \rightarrow$ YES |
|  | All of the counters of the pumps will be reset. |

## 11.MODBUS COMMUNICATION

### 11.1. Technical Specifications

### 11.1.1. Introduction

To guarantee a correct operation of the drive, peripheral elements should be selected correctly and should be connected properly. A wrong installation and/or application could cause a wrong operation of the system or a reduction of the long life of the equipment, and its parts may get damaged. This manual should be read carefully and understood before proceeding.


Figure 11.1 Location and description of the user connectors

The purpose of the Serial Communication Network of the SDRIVE 700 is integrate the drive itself into a network compatible with the protocol of Modbus communications. This is possible by using RS232 or RS485 physical communications port or USB port. For this, it is necessary modify the position of the jumper of the control board JP1101 - JP1104. Communications ports are clearly indicated in that connector. Put the jumper in the desired position according to your needs.


Figure 11.2 Jumper for communications port selection

Modbus communication system allows SD700 drive to be controlled and/or monitored as a slave by a Modbus master from a remote location.

RS485 network allows connecting up to 240 equipments in the same network. Nevertheless, RS232 network only allows connecting one unit (slave) into the network.

SD700 drive operates as a peripheral slave when is connected to Modbus system. This means that the drive do not start the communication task, master will be the one that starts this task. Practically all of the operating modes, parameters and drive characteristics are accessible through serial communications. For example, master can give start and stop order to the drive, control SD700 status, read the current used by the motor,... in short, master can access to the all of the possibilities of the drive.

### 11.1.2. Hardware

| RS232 | Physical level Terminals | 3 cables, optically insulated, half duplex, RS232 single ending <br> $23 \rightarrow$ RS Common (OVdc) <br> $24 \rightarrow$ RS232 Rx (receiving line) <br> $25 \rightarrow R S 232 \mathrm{Tx}$ (transmitting line) |
| :---: | :---: | :---: |
|  | Output signal level | '1' logical $\leq 6.5 \mathrm{~V}$ regarding to 0 V '0' logical $>6.5 \mathrm{~V}$ regarding to OV |
|  | Input signal level | '1' logical < +0.8 V ' 0 ' ${ }^{\prime}$ logical $>+2.4 \mathrm{~V}$ |
|  | Maximum line impedance | $2500 \mathrm{pF}, 3 \mathrm{k} \Omega$ |
|  | Insulation | $\pm 50 \mathrm{Vdc}$ regarding to the earth |
|  | Programmable inputs via Modbus | 7 digital inputs |
|  |  | 2 programmable analogue inputs ( $0-10 \mathrm{~V}, \pm 10 \mathrm{~V}, 0-20 \mathrm{~mA}, 4-20 \mathrm{~mA}$ ) |
|  | Programmable outputs via Modbus | 3 relay outputs <br> 2 programmable analogue outputs $(0-10 \mathrm{~V}, \pm 10 \mathrm{~V}, 0-20 \mathrm{~mA}, 4-20 \mathrm{~mA})$ |
|  | Maximum number of SD700 connected into a network |  |


| RS485 | Physical level Terminals <br> Output signal level <br> Input signal level <br> Insulation <br> Programmable inputs via Modbus <br> Programmable outputs via Modbus <br> Maximum number of SD700 connected into a network Maximum cable length | 2 cables, optically insulated, hall duplax, RS485 differential moda <br> $21 \rightarrow$ RS485 A (negative) <br> $22 \rightarrow$ RS485 B (positive) <br> $23 \rightarrow$ RS Common ( $\mathrm{OVdc} \mathrm{)}$ <br> '1' logical $=+5 \mathrm{~V}$ differential <br> ' 0 ' logical $=-5 \mathrm{~V}$ differential <br> '1' logical $=+5 \mathrm{~V}$ differential <br> ' 0 ' logical $=-5 \mathrm{~V}$ differential <br> $\pm 50 \mathrm{Vdc}$ regarding to the earth <br> 7 digital inputs <br> 2 programmable analogue inputs ( $0-10 \mathrm{~V}, \pm 10 \mathrm{~V}, 0-20 \mathrm{~mA}, 4-20 \mathrm{~mA}$ ) <br> 3 relay outputs <br> 2 programmable analogue outputs ( $0-10 \mathrm{~V}, \pm 10 \mathrm{~V}, 0-20 \mathrm{~mA}, 4-20 \mathrm{~mA}$ ) <br> 240 <br> 1000 m |
| :---: | :---: | :---: |
| USB | Connector: USB 1.1 type B Controller FTDI chip Model FT232BM | For the comect operation of the USB connection you should install the proper drivers. For this, you only-need to access to the information of the proper model in: <br> hitpo:/hemw.fdichip.comNDiversNCP.htm <br> From here, you can download the required files and completat their correct installation. |

Note: USB connection of SD700, in the USB connection of the SD700 a RS232 internal conversion is executed. For this reason, the transmission speed is the indicated one in the section RS232 (9600Baudios). USB connector type is USB 1.1 B (Slave).

Note: Installation in the driver Host of the SD700 USB, USB device of the SD700 will be detected by operating systems XP and 2000, it is only necessary to indicate the driver at the moment of the installation.
In case of operating systems before W98 / Me, execute a search of new Hardware in the device administrator, and complete the installation by indicating the drivers when the computer requires them.

### 11.1.3. Software

| SW Version X.XX | Communication Protocol | Standard Modbus |
| :---: | :---: | :---: |
|  | Transmission Mode | RTU (Remote Terminal Unit) |
|  | Error Detection | CRC-16 (Sum Check) |
|  | Transmission Speed | Selectable by user ( 600 / 1200 / 2400 / 4800 / 9600bps) |
|  | Data length | 8 data bit + optional parity |
|  | Parity | Selectable by user (ODD / EVEN / NONE) |
|  | Stop Bit | 1 |
|  | Address Range | 240 unicast addresses ( 1 - 240) |
|  |  | 1 broadcast address (0) |
|  | Response Time | Minimum 3.5 character to 100 ms maximum |
|  | Supported Modbus functions | 3 registers reading |
|  | Suppod excation codes | 16 registers writing |
|  | Supported exception codes | $1 \rightarrow$ lilegal function |
|  |  | $2 \rightarrow$ Illegal data address |
|  |  | $3 \rightarrow$ Illegal date value |
|  |  | $6 \rightarrow$ Busy, rejected message |
|  |  | $7 \rightarrow$ NAK, negative acknowledgement |

### 11.1.4. RS232 Connections

The following drawing shows a commonly wiring for a RS232 connection:


* The connection of the shield could be realized on the gateway terminals or on the opposite extreme of the cable, depending on the installation conditions.
SD70DTR0005AI

Figure 11.3 RS232 connection

### 11.1.5. RS485 Connections

The following drawing shows a commonly wiring for a RS485 connection:


- The connection of the shieldcould be realized on the gateway terminals or on the opposite extreme of the cable, depending on the installation conditions

SD70DTR0006AI

Figure 11.4 RS485 connection

### 11.2. Supported Modbus Function Codes

Serial communications protocol provided by SD700 drive adheres to Modbus Industrial standard communications protocol of Modicon. The drive uses reading and writing functions between all of the functions that exist in Modbus protocol. The used functions by the drive are the following ones:

| Function | Description | $\ldots$ Registers Number |
| :---: | :---: | :---: |
| 3 | Registers Reading | 120 |
| 16 | Registers Writing | 120 |

The implementation of this function code in the drive allows reading up to 120 registers into a Parameters Group in a frame. If you want to access to a consecutive memory registers, but belonging to different groups, you should access in so many frames as groups are involved.

### 11.2.1. Modbus Function Code $N^{\circ} 3$ : Registers Reading

This function code allows the Modbus controller (master) to read the content of the data registers indicated in the drive (slave). This function code only admits unicast addressing. Broadcast or groupcast addressing are not possible with this function code.

The implementation of this function code in the drive allows reading up to 120 registers with consecutive addresses of the drive in a single frame.

Next, a frame is shown where the master tries to read the content of 3 registers of a drive where the current used by each phase is. The information that should be attached in the ask frame is the following one:

- Data address of the drive.
- Modbus function code (3 Registers reading).
- Starting Data address.
- Registers number for reading.
- CRC-16 code.

The answer of the drive (slave) should contain the following fields:

- Data address of the slave.
- Modbus function code (3 Registers reading).
- Bytes number for reading.
- Bytes number / 2 registers.
- CRC-16 code.

Each register consists of 2 bytes ( $2 \times 8$ bits $=16$ bits). This one is the default length of all of the registers that form the SD700.

### 11.2.1.1. Operation Example of Modbus Function Code ${ }^{\circ} 3$ (Registers Reading)

We suppose that we want to read the motor current (nameplate data) via communications. This data corresponds to the parameter G2.1'1 MTR CUR=00.00A'. The frame that should be transmitted is:

| Modbus <br> Address | Modbus Function <br> Code | Starting Data <br> Address (40282) | Registers Number | CRC-16 |
| :---: | :---: | :---: | :---: | :---: |
| $0 \times 0 \mathrm{~A}$ | $0 \times 03$ | $0 \times 00 \mathrm{~A} 2$ | $0 \times 0001$ | $0 \times 2493$ |

We suppose that instantaneous current of the equipment is $8,2 \mathrm{~A}$. (Modbus value 82 decimal $=$ $0 \times 52$ Hexadecimal). The answer of the slave will be:

| Aodbus <br> Address | Modbus Function <br> Code | Bytas Number | Data (address 20) <br> $(=110)$ | CRC-18 |
| :---: | :---: | :---: | :---: | :---: |
| $0 \times 0 \mathrm{~A}$ | $0 \times 03$ | $0 \times 02$ | $0 \times 0052$ | $0 \times 9 \mathrm{C} 78$ |

### 11.2.2. Modbus Function Code ${ }^{0}$ 16: Registers Writing

This function code allows the Modbus controlier (master) to write the content of the data registers indicated in the drive (slave), whenever those registers are not of Read only. Registers writing by the master does not impede the later modification of those registers by the slave. The implementation of this function code in the drive allows writing up to 5 registers of the drive in a single frame.

Next, a frame is shown where the master tries to write the content of 1 register that stores the acceleration time. The information that should be attached in the ask frame is the following one:

- Data address of the slave.
- Modbus function code (16 Registers writing).
- Starting Data Address.
- Registers number for writing.
- Bytes number for writing.
- Content of registers for writing
- CRC-16 code.

The answer of the slaves includes:

- Data address of the slave.
- Modbus function code (16 Registers writing).
- Starting Data Address.
- Written registers number.
- CRC-16 code.


### 11.3. Addressing Modes

### 11.3.1. Broadcast Addressing Mode

Broadcast addressing mode allows the master to access at the same time to all of the slaves connected to the Modbus network.

The Modbus function code that admits this global addressing mode is:

| Function | Descriptioñ |
| :---: | :---: |
| 16 | Registers Writing |

In order to access to all of the equipments connected in a Modbus network, you must use the address 0 .

When this address is used, all of the slaves in the Modbus network make the required task but they do not prepare any answer.

### 11.4. Summary of Modbus Addresses in Numerical Order

| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40002 | G7.4 | Start mode | RAMP | 0 to 1 |
|  |  |  | SPIN |  |
| 40003 | G7.1 | Stop mode 1 | RAMP | 0 to 1 |
|  |  |  | SPIN |  |
| 40004 | G7.2 | Stop mode 2 | RAMP | 0 to 1 |
|  |  |  | SPIN |  |
| 40005 | G7.3 | Changing speed for stop mode | OFF $=0$ to 250\% | 0 to 12280 |
| 40006 | G7.6 | Start delay time | OFF $=0-6500 \mathrm{~s}$ | 0 to 65000 |
| 40007 | G7.7 | Stop delay time | OFF $=0-6500 \mathrm{~s}$ | 0 to 65000 |
| 40008 | G7.8 | Minimum stop speed | N: No/Y: Yes | 0 to 1 |
| 40009 | G7.10 | Run after occurring power loss | N: No/Y: Yes | 0 to 1 |
| 40014 | 67.9 | Delay time between stop and next start | OFF $=0.000-10.000 \mathrm{~s}$ | 0 to 10000 |
| 40015 | G7.5 | Siart mode 2 | RAMP | 0101 |
|  |  |  | SPIN |  |
| 40017 | G7.11 | Accuracy setting for starting by spin | OFF $=0,1-100 \%$ | 0 to 1000 |
| 40018 | G19.2.10 | Frequency V/Hz change | OFF $=0.0,0.1-100 \%$ | 0 to 8192 |
| 40019 | G19.2.11 | Stabilize factor in acceleration | $80.0-99.9 \%, ~ O F F=100 \%$ | 6554 to 8192 |
| 40020 | G19.2.12 | Stabilize factor in deceleration | 80.0-99.9\%, OFF= $100 \%$ | 6554 to 8192 |
| 40021 | G19.2.13 | Regeneration bus voltage | $\begin{array}{\|l} \hline \text { For } \mathrm{V} / \mathrm{N}=400 \mathrm{~V} / 500 \mathrm{~V} \rightarrow \\ 625 \text { to } 799 \mathrm{~V}, \mathrm{OFF}=800 \mathrm{~V} \\ \text { For } \mathrm{VIN}=690 \mathrm{~V} \rightarrow \\ 950 \text { to } 1250 \mathrm{~V}, \mathrm{OFF}=1251 \mathrm{~V} \\ \hline \end{array}$ | $\begin{aligned} & \text { For VIN }=400 \mathrm{~V} / 500 \mathrm{~V} \\ & 625 \text { to } 799,800 \\ & \text { For VIN }=690 \mathrm{~V} \rightarrow \\ & 950 \text { to } 1250,1251 \end{aligned}$ |
| 40022 | G17.2 | Curent applied to the brake | 0-100\% | 0 to 8192 |
| 40023 | G17.3 | Voliage applied to the brake | 0.0-25\% | 0 to 2048 |
| 40024 | G17.4 | Non condensing heating current | OFF $=0.0-30 \%$ | 0 to 2458 |
| 40025 | G17.1 | Time for DC brake activation | OFF $=0.0-99 \mathrm{~s}$ | 0 to 990 |
| 40026 | G17.5 | Use of extemal brake | $\mathrm{N}: \mathrm{No} / \mathrm{Y}$ : Yes | 0 to 1 |
| 40031 | G7.12 | Delay time for start command after stop (2) | OFF $=0.0-6500.0 \mathrm{~s}$ | 0 to 65000 |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40032 | G4.1.5 | Multi-function Digital Input 1 configuration | OO: NOUSE | 0 to 70 |
|  |  |  | 01: START |  |
|  |  |  | 02: STOP1 |  |
|  |  |  | 03: STOP2 - RESET |  |
|  |  |  | 04: STOP1 - RESET |  |
|  |  |  | 05: START/STOP |  |
|  |  |  | 06: START-RST/STOP |  |
|  |  |  | 07: RESET |  |
|  |  |  | 08: START+1NCH1 |  |
|  |  |  | 09: START+INCH2 |  |
|  |  |  | 10: INV SPEED |  |
|  |  |  | 11: RESERVE |  |
|  |  |  | 12: RESERVE |  |
|  |  |  | 13: INV INCHS |  |
|  |  |  | 14: ACCIDEC 2 |  |
|  |  |  | 15: REFERENCE 2 |  |
|  |  |  | 16: RESERVE |  |
|  |  |  | 17: CONTROL 2 |  |
|  |  |  | 18: START/STP-RST |  |
|  |  |  | 19: STOP (2) |  |
|  |  |  | 20: SPEED LIMIT 2 |  |
|  |  |  | 21: DC BRAKE |  |
|  |  |  | 22: START MODE 2 |  |
|  |  |  | 23: CURRENT LIMI2 |  |
|  |  |  | 24: EXTERN EMERGE |  |
|  |  |  | 50: PMP START/STP |  |
|  |  |  | 51: FLOW PULSE |  |
|  |  |  | 52: FIX PUMP1 FLT |  |
|  |  |  | 53: FIX PUMP2 FLT |  |
|  |  |  | 54: FIX PUMP3 FLT |  |
|  |  |  | 55: FIX PUMP4 FLT |  |
|  |  |  | 56: FIX PUMP5 FLT |  |
|  |  |  | 57: MAN PROTstart |  |
|  |  |  | 58: HI PRESS FLT |  |
|  |  |  | 59: LO WATER FLT |  |
|  |  |  | 60: LO PRESS FLT |  |
|  |  |  | 61: FLOW SWITCH |  |
|  |  |  | 62: IRRIGAT TRIP |  |
|  |  |  | 63: SETPONT PIN1 |  |
|  |  |  | 64: SETPON PIN2 |  |
|  |  |  | 65: SETPONT PIN3 |  |
|  |  |  | 66: MAN REF 2 |  |
|  |  |  | 67: MAN OVR START |  |
|  |  |  | 69: PRESSUR SWITC |  |
|  |  |  | 70: ALTER PID STP |  |
| 40033 | G4,1.6 | Multi-function Digitas Input 2 configuration | 00-70(See G4.1.5) | 0 to 70 |
| 40034 | G4.1.7 | Multi-function Digital Input 3 configuration | 00-70 (See G4.1.5) | 0 to 70 |
| 40035 | G4.1.8 | Multi-function Digital Input 4 configuration | 00-70(See G4.1.5) | 0 to 70 |
| 40036 | G4.1.9 | Multi-function Digital Input 5 configuration | 00-70 (See G4.1.5) | 0 to 70 |
| 40037 | G4.1.10 | Multi-function Digital Input 6 configuration | 00-70 (See G4.1.5) | 0 to 70 |
| 40038 | G4.1.4 | Selection of Digital Inputs configuration | 0: 3 WIRES | 0 to 5 |
|  |  |  | 1: ALL PROGRAMMABLE |  |
|  |  |  | 2: MREF 2 WIRES |  |
|  |  |  | 3: MREF 3 WIRES |  |
|  |  |  | 4: MOTORIZED POT |  |
|  |  |  | 5: ERASAB POT |  |
| 40039 | G4.1.3 | Reset from keypad | N: No/Y: Yes | 0 to 1 |
| 40040 | G4.1.1 | Main control mode | 0: NONE | 0 to 3 |
|  |  |  | 1: LOCAL |  |
|  |  |  | 2: REMOTE |  |
|  |  |  | 3: SERIAL COMMS |  |
| 40041 | G4.1.2 | Altemative control mode | 0: NONE | 0 to 3 |
|  |  |  | 1: LOCAL |  |
|  |  |  | 2: REMOTE |  |
|  |  |  | 3: SERIAL COMMS |  |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40052 | $\begin{aligned} & \text { G14.1 } \\ & \text { SV5 } \end{aligned}$ | Multi-reference 1 | - $250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40053 | $\begin{aligned} & \text { G14.2 } \\ & \text { SV5.4 } \end{aligned}$ | Multi-reference 2 | -250\% to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 t 0+250 \%= \\ & 20480 \end{aligned}$ |
| 40054 | $\begin{aligned} & \text { G14.3 } \\ & \text { SV5.5 } \end{aligned}$ | Multi-reference 3 | -250\% to +250\% | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40055 | $\begin{aligned} & \hline \text { G14.4 } \\ & \text { SV5.6 } \end{aligned}$ | Multi-reference 4 | -250\% to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40056 | $\begin{aligned} & \hline \text { G14.5 } \\ & \text { SV5.7 } \end{aligned}$ | Multi-reference 5 | $-250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40057 | $\begin{aligned} & \hline \text { G14.6 } \\ & \text { SV5.8 } \end{aligned}$ | Multi-reference 6 | $-250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40058 | $\begin{aligned} & \hline \text { G14.7 } \\ & \text { SV5.9 } \end{aligned}$ | Multi-eference 7 | -250\% to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40092 | $\begin{aligned} & \hline \text { G15.1 } \\ & \text { SV5.10 } \end{aligned}$ | Inch speed 1 | - $250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40093 | $\begin{aligned} & \text { G15.2 } \\ & \text { SV5.11 } \end{aligned}$ | Inch speed 2 | - $250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40094 | $\begin{aligned} & \text { G15.3 } \\ & \hline \end{aligned}$ | Inch speed 3 | -250\% to +250\% | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40102 | G10.1 | Minimum speed limit 1 | -250\% to Max. speed 1 | $-250 \%=-20480$ to G10.2 |
| 40103 | G10.3 | Minimum speed limit 2 | -250\% to Max. speed 2 | $-250 \%=-20480$ to G10.4 |
| 40104 | G10.2 | Maximum speed limit 1 | Min. speed 1 to $+250 \%$ | G 10.1 to $+250 \%=20480$ |
| 40105 | G10.4 | Maximum speed limit 2 | Min. speed 2 10 $+250 \%$ | G10.3 to $+250 \%=20480$ |
| 40106 | G10.5 | Current limit | (0.25 to 1.50). In | 2048 to 12288 |
| 40107 | G10.9 | Torque limit | -250\% to 250\% | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40108 | G10.11 | To enable speed inversion | N: No/Y: Yes | 0101 |
| 40109 | G10.7 | Altemative aurrent limit | N No/ Y : Yes | 0 to 1 |
| 40110 | G10.8 | Change speed for I.max2 | OFF=0\%, +1 to +250\% | 0 to 20480 |
| 40122 | G3. 1 | Reference source 1 of speed | NONE | 0 to 8 |
|  |  |  | Al1 |  |
|  |  |  | Al2 |  |
|  |  |  | Al1 + Al2 |  |
|  |  |  | RESER |  |
|  |  |  | LOCAL |  |
|  |  |  | MREF |  |
|  |  |  | PMOT |  |
|  |  |  | PID |  |
| 40123 | G3.2 | Reference source 2 of speed | NONE | 0 to 8 |
|  |  |  | Al1 |  |
|  |  |  | Al2 |  |
|  |  |  | Al1 + Al2 |  |
|  |  |  | RESER |  |
|  |  |  | LOCAL |  |
|  |  |  | MREF |  |
|  |  |  | PMOT |  |
|  |  |  | PID |  |
| 40124 | $\begin{array}{\|l\|} \hline \text { G3.3 } \\ \text { SV5. } \\ \hline \end{array}$ | Local speed reference | $-250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 t 0+250 \%= \\ & 20480 \end{aligned}$ |
| 40132 | G16.1 | Skip frequency 1 | -250 to +250\% | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40133 | G16.2 | Skip frequency 2 | -250 to +250\% | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40134 | G16.3 | Skip bandwidth | OFF $=0-20 \%$ | 0 to 1638 |
| 40142 | G6. 1 | Source selection for introducing reference signal | NONE | 0 to 6 |
|  |  |  | Al1 |  |
|  |  |  | Al2 |  |
|  |  |  | RESERV |  |
|  |  |  | MREF |  |
|  |  |  | LOCAL |  |
|  |  |  | locPID |  |
| 40143 | G6.3 | Selection of feedback signal source | NONE | 0 to 3 |
|  |  |  | Al1 |  |
|  |  |  | Al2 |  |
|  |  |  | RESERV |  |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40144 | G6.4 | Proportional gain of PIO control | 0.1-20 | 1 to 200 |
| 40145 | G6.5 | Integration time of PID control | 0.0-1000s, Max | 0 to 10000, 10001 |
| 40146 | G6. 6 | Derivation time of PID control | 0.0-250s | 0 to 2500 |
| 40147 | G6.7 | PID output inversion | N: No/Y: Yes | 0 to 1 |
| 40148 | G6.8 | PID control error | Read only | - |
| 40149 | $\begin{aligned} & \text { G6.2 } \\ & \text { SV5.2 } \end{aligned}$ | PID local reference | 0.0-400\% | 0 to 32750 |
| 40159 | SV 2.3 | Frequency of the input voltage to the drive | Read only | Frequency Real Value Phases RS = (Modbus Value / 10) |
| 40160 | SV 2.3 | Frequency of the input voltage to the drive | Read only | Frequency Real Value Phases ST = (Modbus Value / 10) |
| 40161 | SV 2.3 | Frequency of the input voltage to the drive | Read only | Frequency Real Vatue Phases RT = (Modbus Value / 10) |
| 40162 | SV1.1 | Speed reference | Read only | $8192=100 \%$ of motor rated speed |
| 40163 | SV1.5 | Motor current | Read only | Real Value = (Modbus Value / 10) |
| 40164 | SV1.6 | Motor torque | Read only | $8192=100 \%$ of motor rated torque |
| 40165 | SV1.8 | Motor power consumption | Read only | $\text { Real Value = } \text { (Modbus }$ $\text { Value } / 10 \text { ) }$ |
| 40166 | SV1.4 | Motor vollage | Read only | Real Value = Modbus Value |
| 40167 | SV1.3 | Motor frequency | Read only | Real Value = Modbus Value |
| 40168 | SV1.7 | Motor power factor | Read only | Real Value = (Modbus Value / 10) |
| 40169 | SV1.2 | Motor speed | Read only | Real Value = Modbus Value |
| 40170 | STATUS LINE | Motor speed. <br> Third field of the first display line. | Read only | $8192=100 \%$ of motor rated speed |
| 40171 | SV2.4 | Vollage applied to the drive | Read only | Real Value = Modbus Value |
| 40173 | SV1.12 | Motor temperakure | Read only | $\begin{aligned} & 8192=100 \% \text { of motor } \\ & \text { temperature } \\ & 110 \%=\text { Trip } \\ & \hline \end{aligned}$ |
| 40176 | SV2.5 | IGBT temperature | Read only | Real Value = Modbus Value |
| 40177 | SV1.9 | Current consumption per phase of the motor (Phase U) | Read only | Real Value Phase U = (Modbus Value / 10) |
| 40178 | SV1.9 | Current consumption per phase of the motor (Phase V) | Read only | Real Value Phase $V=$ (Modbus Value ( 10) |
| 40179 | SV1.9 | Curfent consumption per phase of the motor (Phase W) | Read only | Real Value Phase W = (Modbus Value ( 10) |
| 40180 | SV1.10 | Voltage applied to the motor phases (Phases UV) | Read only | Real Value Phases UV = Modbus Value |
| 40181 | SV1.10 | Vollage applied to the motor phases (Phases VW) | Read only | Real Value Phases $\mathrm{WW}=$ Modbus Value |
| 40182 | SV1.10 | Voltage applied to the motor phases (Phases UW) | Read only | Real Value Phases UW = Modbus Value |
| 40183 | SV2.1 | Voltage applied to the drive (Phases RS) | Read only | Real Value Phases RS = Modbus Value |
| 40184 | SV2.1 | Voltage applied to the drive (Phases ST) | Read only | Real Value Phases ST = Modbus Value |
| 40185 | SV2.1 | Voltage applied to the drive (Phases RT) | Read only | Real Value Phases RT = Modbus Value |
| 40186 | SV3.1 | Average vatue of the Analogue Input 1 | Read only | $\begin{aligned} & \text { Real Value = (Modbus } \\ & \text { Value / 1000) } \end{aligned}$ |
| 40187 | SV3.4 | Average value of the Analogue Input 2 | Read only | $\begin{aligned} & \text { Real Value }=(\text { Modbus } \\ & \text { Value } / 1000) \end{aligned}$ |
| 40190 | SV3.2 | Reference value of the Analogue input 1 | Read only | $\begin{aligned} & 8192=100 \% \text { Maximum } \\ & \text { range of the Al1 } \\ & \hline \end{aligned}$ |
| 40191 | SV3.5 | Reference value of the Analogue Input 2 | Read only | $\begin{aligned} & 8192=100 \% \text { Maximum } \\ & \text { range of the Al2 } \\ & \hline \end{aligned}$ |
| 40192 | SV3. 7 | Analogue Output 1 value | Read only | $\begin{array}{\|l\|} \hline \text { Real Value }=\langle\text { Modbus } \\ \text { Value } / 1000\rangle \\ \hline \end{array}$ |
| 40193 | SV3.9 | Analogue Output 2 value | Read only | $\begin{aligned} & \text { Real Value }=(\text { Modbus } \\ & \text { Value } / 1000) \end{aligned}$ |
| 40194 | SV3.8 | Value of the magnitude associated to A01 | Read only | $\begin{array}{\|l\|} \hline 8192=100 \% \text { Maximum } \\ \text { range of the AO1 } \\ \hline \end{array}$ |
| 40195 | SV3.10 | Value of the magnitude associated to AO2 | Read only | $\begin{aligned} & 8192=100 \% \text { Maximum } \\ & \text { range of the AO2 } \end{aligned}$ |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40196 | SV3.11 | Status of Digital Inputs | Read only | $\begin{aligned} & \text { LSB = BITO = MFI1 } \\ & \text { BIT6 }=\text { PTC } \\ & 0 \text { to } 1 \end{aligned}$ |
| 40197 | SV3.12 | Status of Output Relays | Read only | $\begin{aligned} & \text { BIT } 0=\mathrm{R} 1 ; \text { Range from } 0 \text { to } \\ & 1 \\ & \text { BIT } 1=\mathrm{R} 2 ; \text { Range from } 0 \text { to } \\ & 1 \\ & \begin{array}{l} \text { BIT } 2=R 3 ; \text { Range from } 0 \text { to } \\ 1 \end{array} \end{aligned}$ |
| 40203 | SV4.8 | PID error value | Read only | $8192=100 \%$ Maximum range of the Analogue Input |
| 40204 | SV4.6 | PID reference value | Read only | 8192 = 100\% Maximum range of he Analogue Input |
| 40205 | SV4.7 | PID feedback value | Read only | $8192=100 \%$ Maximum range of he Analogue Input |
| 40206 | SV4.4 | Software version | Read only | Real Value = Modbus Value |
| 40207 | SV4.5 | Hardware version | Read only | $\begin{aligned} & \hline \text { Real Value }=(\text { Modbus } \\ & \text { Value } / 100) \end{aligned}$ |
| 40209 | SV4.2 | Drive rated current | Read only | $\begin{array}{\|l\|} \hline \text { Real Value = (Modbus } \\ \text { Value } / 10 \text { ) } \\ \hline \end{array}$ |
| 40210 | SV4.3 | Drive rated voltage | Read only | Real Value = (Modbus Value / 10 ) |
| 40218 | SV1.11 | Motor PTC connection | Read only | 0 to 1 |
| 40219 | STATUS LINE | General status. First field of the first display line. | Read only | 0 to 201 |
| 40232 | SV4.9 | Status of comparators (Comparator 1) | Read only | 0 to 1 |
| 40233 | SV4.9 | Status of comparators (Comparator 2) | Read only | 0 to 1 |
| 40234 | SV4.9 | Status of comparators (Comparator 3) | Read only | 0 to 1 |
| 40235 | SV4.1 | Actual fault | Read only | Fault number |
| 40240 | SV2.6 | Drive temperature | Read only | $\text { Real Value }=(\text { Modbus }$ Value / 10) |
| 40242 | G4.2.9 | Speed for the maximum range of Analogue Input 1 | G4.2.8 to +250\% | G4.2.8 to +250\% = 20480 |
| 40243 | G4.3.9 | Speed for the maximum range of Analogue Input 2 | G4.3.8 to +250\% | G4.3.8 to $+250 \%=20480$ |
| 40244 | G4.2.6 | Maximum range of Analogue Input 1 | G4.2.4 to +10V | G4.2.4 to 10000 |
|  |  |  | 64.2.4 to 20 mA | G4.2.4 to 20000 |
| 40245 | G4.3.6 | Maximum range of Analogue Input 2 | G4.3.4 to +10V | G4.3.4 to 10000 |
|  |  |  | G4.3.4 1020 mA | G4.3.4 to 20000 |
| 40246 | G4.2.8 | Speed for the minimum range of Analogue Input 1 | -250\% to G4.2.9 | $-250 \%=-20480$ to G4.2.9 |
| 40247 | G4.3.8 | Speed for the minimum range of Analogue Input $2$ | -250\% to G4.3.9 | $-250 \%=-20480$ to G4.3.9 |
| 40248 | G4.2.4 | Minimum range of Analogue Input 1 | -10V to G4.2.6 | $-10=-1000$ to G4.2.6 |
|  |  |  | OmA to G4.2.6 | $0=0$ to G4.2.6 |
| 40249 | G4.3.4 | Minimum range of Analogue Input 2 | -10V to G4.3.6 | $-10=-1000$ to G4.2.6 |
|  |  |  | OmA to G4.3.6 | $0=0$ to G4.2.6 |
| 40250 | G4.2.7 | Maximum range of sensor 1 | G4.2.5 to +3200 Engin. units | G4.2.5 to 3200 |
| 40251 | G4.3.7 | Maximum range of sensor 2 | G4.3.5 to +3200 Engin. units | G4.3.5 to 3200 |
| 40254 | G4.2.5 | Minimum range of sensor 1 | -3200 to G4.2.7 Engin. units | -3200 to G4.2.7 |
| 40255 | G4.3.5 | Minimum range of sensor 2 | -3200 to G4.3.7 Engin. units | -3200 to G4.3.7 |
| 40262 | SV3.3 | Value of the sensor 1 associated to Al1 | Read only | $\begin{aligned} & \text { Real Value }=(\text { Modbus } \\ & \text { Value } / 10) \\ & \hline \end{aligned}$ |
| 40263 | SV3.6 | Value of the sensor 2 associated to Al 2 | Read only | $\begin{aligned} & \text { Real Value = (Modbus } \\ & \text { Value } / 10) \end{aligned}$ |
| 40264 | G4.2.3 | Analogue Input 1 format | $V$ or mA | 0 to 1 |
| 40265 | G4.3.3 | Analogue Input 2 format | $V$ or mA | 0 to 1 |
| 40266 | G4.2.14 | Protection for Analogue Input 1 loss | N: No/Y: Yes | 0 to 1 |
| 40267 | G4.3.14 | Protection for Analogue Input 2 loss | N: No/Y: Yes | 0101 |
| 40268 | G4.2.1 | To enable sensor of Analogue Input 1 | N: No/Y: Yes | 0 to 1 |
| 40269 | G4.3.1 | To enable sensor of Analogue Input 2 | N: No/Y: Yes | 0 to 1 |
| 40270 | G4.2.15 | Zero band filter for Analogue Input 1 | OFF $=0.0-2.0 \%$ | 0 to 163 |
| 40271 | G4.3.15 | Zero band filter for Analogue Input 2 | OFF=0.0-2.0\% | 010163 |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40272 | G4.2.2 | Selection of sensor 1 units | \% | 0 to 16 |
|  |  |  | V/ |  |
|  |  |  | $\mathrm{m}^{3} / \mathrm{s}$ |  |
|  |  |  | Vm |  |
|  |  |  | $\mathrm{m}^{3} / \mathrm{m}$ |  |
|  |  |  | Vh |  |
|  |  |  | $\mathrm{m}^{3} \mathrm{~h}$ |  |
|  |  |  | $\mathrm{m} / \mathrm{s}$ |  |
|  |  |  | $\mathrm{m} / \mathrm{m}$ |  |
|  |  |  | $\mathrm{m} / \mathrm{h}$ |  |
|  |  |  | Bar |  |
|  |  |  | kPa |  |
|  |  |  | Psi |  |
|  |  |  | M |  |
|  |  |  | ${ }^{\circ} \mathrm{C}$ |  |
|  |  |  | ${ }^{\circ} \mathrm{F}$ |  |
|  |  |  | ${ }^{\circ} \mathrm{K}$ |  |
| 40273 | G4.3.2 | Selection of sensor 2 units | \% | 0 to 16 |
|  |  |  | V/s |  |
|  |  |  | $\mathrm{m}^{3} / \mathrm{s}$ |  |
|  |  |  | Vm |  |
|  |  |  | $\mathrm{m}^{3 / m}$ |  |
|  |  |  | Vh |  |
|  |  |  | $\mathrm{m}^{3} / \mathrm{h}$ |  |
|  |  |  | $\mathrm{m} / \mathrm{s}$ |  |
|  |  |  | $\mathrm{m} / \mathrm{m}$ |  |
|  |  |  | $\mathrm{m} / \mathrm{h}$ |  |
|  |  |  | Bar |  |
|  |  |  | ${ }^{\mathrm{kPa}}$ |  |
|  |  |  | Psi |  |
|  |  |  | m |  |
|  |  |  | ${ }^{\circ} \mathrm{C}$ |  |
|  |  |  | ${ }^{\circ}{ }^{\circ} \mathrm{F}$ |  |
|  |  |  | ${ }^{\circ} \mathrm{K}$ |  |
| 40274 | G4.2.16 | Low Pass filter for Analogue Input 1 | OFF $=0.0-20.0 \%$ | 010200 |
| 40275 | G4.3.16 | Low Pass filter for Analogue input 2 | OFF $=0.0-20.0 \%$ | 0 to 200 |
| 40282 | G2.1 | Motor rated current | $\begin{array}{\|l\|} \hline 1 \text { - } 9999 \mathrm{~A} \text { limited from ( } 0.2 \text { - } \\ \text { 1.5. } \mathrm{n} \text { ) } \\ \hline \end{array}$ | 1638 to 12288 |
| 40283 | G2.2 | Motor rated voltage | $220-999 \mathrm{~V}$ | 220 to 999 |
| 40284 | G2.6 | Motor rated frequency | $0-100 \mathrm{~Hz}$ | 0 to 100 |
| 40285 | G2.3 | Motor rated power | 0.0-6500kW | 0 to 65000 |
| 40286 | G2.4 | Motor rpm | 0-24000 rpm | 0 to 24000 |
| 40287 | G2.7 | Motor cooling at zero speed | OFF, 20-100\% | 8274, 1638 to 8192 |
| 40288 | G2.5 | Phi cosine | 0 to 0.99 | 0 to 99 |
| 40289 | G11.11 | Pump overload level | 0.0-3200A | 0 to 32000 |
| 40290 | G11.12 | Filter for pump overload | OFF $=0,1$ to 5 s | 0 to 50 |
| 40291 | G11.13 | Trip delay time because of pump overload | OFF $=0.0-999.9 \mathrm{~s}$ | 0 to 9999 |
| 40302 | G9.1.1 | Source selection for Comparator 1 | 00: NONE | 0 to 22 |
|  |  |  | 01: SPEED MOTOR |  |
|  |  |  | 02: CURRENT MOTOR |  |
|  |  |  | 03: VOLTAGE MOTOR |  |
|  |  |  | 04: POWER MOTOR |  |
|  |  |  | 05: TORQUE MOTOR |  |
|  |  |  | 06: PF MOTOR |  |
|  |  |  | 07: TEMP MOTOR |  |
|  |  |  | 08: FREQUENCY MTR |  |
|  |  |  | 09: INPUT VOLTAGE |  |
|  |  |  | 10: DC BUS |  |
|  |  |  | 11: DRIVE TEMP |  |
|  |  |  | 12: SPEED REF |  |
|  |  |  | 13: Reserved |  |
|  |  |  | 14: PID REFERENCE |  |
|  |  |  | 15: PID FEEDBACK |  |
|  |  |  | 16: PID ERROR |  |
|  |  |  | 17: ANLG INPUT 1 |  |
|  |  |  | 18: ANLG INPUT 2 |  |
|  |  |  | 19: ANLG INPUT 1+2 |  |
|  |  |  | 20: Reserved |  |
|  |  |  | 21: MAX SCALE |  |
|  |  |  | 22: ABSOLUT SPEED |  |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40303 | G9.1.2 | Type selection for Comparator 1 | O: Normal | 0 to 1 |
|  |  |  | 1: Window |  |
| 40304 | $\begin{aligned} & G 9.1 .5 \\ & G 9.1 .7 \end{aligned}$ | G9.1.5/ Limit 1 for Comparator 1 in Window mode <br> G9.1.7 / Deactivation value of Comparator 1 in Normal mode | -250\% to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40305 | $\begin{aligned} & \text { G9.1.4 } \\ & \text { G9.1.3 } \end{aligned}$ | G9.1.4 / Limit 2 for Comparator 1 in Window mode <br> G9.1.3 / Activation value of Comparator 1 in Normal mode | $-250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40306 | 69.1.6 | ON delay time for Comparator 1 | 0.0-999s | 0109999 |
| 40307 | G9.1.8 | OFF delay time for Comparator 1 | 0.0-9999s | 0109999 |
| 40308 | G9.1.9 | Selection of output function for Comparator 1 | 00: NONE | 0 to 11 |
|  |  |  | 01: START / STOP |  |
|  |  |  | 02: STOP 1 |  |
|  |  |  | 03: STOP 2 |  |
|  |  |  | 04: RESET |  |
|  |  |  | 05: START + INCH1 |  |
|  |  |  | 06: START + INCH2 |  |
|  |  |  | 07: START + INCH3 |  |
|  |  |  | 08: INV SPEED |  |
|  |  |  | 09: ACC IDEC 2 |  |
|  |  |  | 10: REFERENCE 2 |  |
|  |  |  | 11: SPEED LIMIT 2 |  |
| 40311 | G9.2.1 | Source selection for Comparator 2 | 00-22 (See G9.1.1) | 0 to 22 |
| 40312 | G9.2.2 | Type selection for Comparator 2 | 0: Normal | 0 to 1 |
|  |  |  | 1: Window |  |
| 40313 | $\begin{aligned} & \text { G9.2.5 } \\ & \text { G9.2.7 } \end{aligned}$ | G9.2.5 / Limit 1 for Comparator 2 in Window mode <br> G9.2.7 / Deactivation value of Comparator 2 in Normal mode | $-250 \%$ to +250\% | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40314 | $\begin{aligned} & \text { G9.2.4 } \\ & \text { G9.2.3 } \end{aligned}$ | G9.2.4 / Limil 2 for Comparator 2 in Window mode <br> G9.2.3 / Activation value of Comparator 2 in Normal mode | $-250 \%$ to +250\% | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40315 | G9.2.6 | ON delay time for Comparator 2 | 0.0-9995 | 0 to 9999 |
| 40316 | G9.2.8 | OFF delay time for Comparator 2 | 0.0-9999s | 0 to 9999 |
| 40317 | G9.2.9 | Selection of output function for Comparator 2 | 00-11 (See G9.1.9) | 01011 |
| 40320 | G9.3.1 | Source selection for Comparator 3 | 00-22 (See G9.1.1) | 0 to 22 |
| 40321 | G9.3.2 | Type selection for Comparator 3 | 0 : Normal | 0 to 1 |
|  |  |  | 1: Window |  |
| 40322 | $\begin{aligned} & \text { G9.3.5 } \\ & \text { G9.3.7 } \end{aligned}$ | G9.3.5/ Limit 1 for Comparator 3 in Window mode G9.3.7 / Deactivation value of Comparator 3 in Normal mode | $-250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40323 | $\begin{gathered} \text { G9.3.4 } \\ \text { G9.3.3 } \end{gathered}$ | G9.3.4 / Limit 2 for Comparator 3 in Window mode <br> G9.3.3 / Activation value of Comparator 3 in Normal mode | $-250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40324 | G9.3.6 | ON delay time for Comparator 3 | 0.0-9995 | 0 to 9999 |
| 40325 | G9.3.8 | OFF delay time for Comparator 3 | 0.0-9999s | 0 to 9999 |
| 40326 | 69.3.9 | Selection of output function for Comparator 3 | 00-11 (See G9.1.9) | 0 to 11 |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40342 | G8.2.1 | Mode selection for Analogue Oulput 1 | 00: NONE | 01027 |
|  |  |  | 01: SPEED MOTOR |  |
|  |  |  | 02: CURRENT MOTOR |  |
|  |  |  | 03: VOLTAGE MOTOR |  |
|  |  |  | 04: POWER MOTOR |  |
|  |  |  | 05: TORQUE MOTOR |  |
|  |  |  | 06: PF MOTOR |  |
|  |  |  | 07: TEMP MOTOR |  |
|  |  |  | O8: FREQUENCY MTR |  |
|  |  |  | 09: INPUT VOLTAGE |  |
|  |  |  | 10: OC BUS |  |
|  |  |  | 11: DRIVE TEMP |  |
|  |  |  | 12: SPEED REF |  |
|  |  |  | 13: Reserved |  |
|  |  |  | 14: PID REFERENCE |  |
|  |  |  | 15: PID FEEDBACK |  |
|  |  |  | 16: PID ERROR |  |
|  |  |  | 17: ANLG INPUT $\dagger$ |  |
|  |  |  | 18: ANLG INPUT 2 |  |
|  |  |  | 19: ANLG INPUT 1+2 |  |
|  |  |  | 20: CURRENT FLOW |  |
|  |  |  | 21: MAX SCALE |  |
|  |  |  | 22: ABSOLUT SPEED |  |
|  |  |  | 27: MACRO PUMP |  |
| 40343 | G8.2.2 | Format selection for Aralogue Output 1 | 0.10 V | 0103 |
|  |  |  | $\pm 10 \mathrm{~V}$ |  |
|  |  |  | 0-20mA |  |
|  |  |  | $4-20 \mathrm{~mA}$ |  |
| 40344 | G8.2.3 | Low range selection of Analogue Ouput 1 | $-250 \% 10+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40345 | G8.2.4 | High range selection of Analogue Ouput 1 | $-250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40346 | G8.2.5 | Filter selection for Analogue Output 1 | OFF $=0.0-20.05$ | D to 200 |
| 40347 | G8.2.6 | Mode selection for Analogue Output 2 | 00-27 (See G8.2.1) | 0 to 27 |
| 40348 | G8.2.7 | Format selection for Analogue Output 2 | 0.10 V | 0103 |
|  |  |  | $\pm 10 \mathrm{~V}$ |  |
|  |  |  | 0-20mA |  |
|  |  |  | 4-20mA |  |
| 40349 | G8.2.8 | Low range selection of Analogue Output 2 | $-250 \%$ t0 $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40350 | G8.2.9 | High range selection of Analogue Output 2 | $-250 \%$ to $+250 \%$ | $\begin{aligned} & -250 \%=-20480 \text { to }+250 \%= \\ & 20480 \end{aligned}$ |
| 40351 | G8.2.10 | Filter selection for Analogue Ouput 2 | OFF $=0.0-20.0 \mathrm{~s}$ | 0 to 200 |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40362 | G8.1.1 | Selection of Relay 1 control source | 00: ALWAYS OFF | 01032 |
|  |  |  | 01: ALWAYS ON |  |
|  |  |  | 02: NO FAULTS |  |
|  |  |  | 03: GENERAL FAULT |  |
|  |  |  | 04: START |  |
|  |  |  | 05: RUN |  |
|  |  |  | 06: READY |  |
|  |  |  | 07: ZERO SPEED |  |
|  |  |  | 08: SET SPEED |  |
|  |  |  | 09: SP DIRECTION |  |
|  |  |  | 10: RESERVE |  |
|  |  |  | 11: SP REF DIRECT |  |
|  |  |  | 12: RESERVE |  |
|  |  |  | 13: SP LIMIT |  |
|  |  |  | 14: CURR LIMIT |  |
|  |  |  | 15: VOLT LIMIT |  |
|  |  |  | 16: TORQ LIMIT |  |
|  |  |  | 17: COMPARATOR 1 |  |
|  |  |  | 18: COMPARATOR2 |  |
|  |  |  | 19: COMPARATOR3 |  |
|  |  |  | 20: ACC / DEC 2 |  |
|  |  |  | 21: REFERENCE 2 |  |
|  |  |  | 22: STOP 2 |  |
|  |  |  | 23: SP LIMIT 2 |  |
|  |  |  | 24: DC BRAKE |  |
|  |  |  | 25: RESERVE |  |
|  |  |  | 26: RESERVE |  |
|  |  |  | 27: RESERVE |  |
|  |  |  | 28: PUMP CNTRL |  |
|  |  |  | 29: JOCKEY PUMP |  |
|  |  |  | 30: PRIMING PUMP |  |
|  |  |  | 31: SLEEP CONDIT |  |
|  |  |  | 32: CRANE BRAKE |  |
| 40363 | G8.1.2 | ON delay time for Relay 1 | 0.0-999s | 0 to 9999 |
| 40364 | G8.1.3 | OFF delay time for Relay 1 | 0.0-999s | 0 to 9999 |
| 40365 | G8.1.4 | Relay 1 inversion | N: No/Y: Yes | 0 to 1 |
| 40366 | G8.1.5 | Selection of Relay 2 control source | 00-32 (See G8.1.1) | 0 to 32 |
| 40367 | G8.1.6 | ON delay time for Relay 2 | 0.0-999s | 0 to 9999 |
| 40368 | G8.1.7 | OFF delay time for Relay 2 | 0.0-999s | 0 to 9999 |
| 40369 | G8.1.8 | Relay 2 inversion | N: Noly: Yes | 0 to 1 |
| 40370 | G8.1.9 | Selection of Relay 3 control source | 00-32 (See G8.1.1) | 0 to 32 |
| 40371 | G8.1.10 | ON delay time for Relay 3 | 0.0-999s | 0 to 9999 |
| 40372 | G8.1.11 | OFF delay time for Relay 3 | 0.0-999s | 0 to 9999 |
| 40373 | G8.1.12 | Relay 3 inversion | $\mathrm{N}:$ Noly: Yes | 0101 |
| 40374 | G20.4.1 | 1 P address (A) | 0-255 | 0 to 255 |
| 40375 | G20.4.2 | $1 P$ address ( $B$ ) | 0-255 | 0 to 255 |
| 40376 | G20.4.3 | $1 P$ address (C) | 0-255 | 0 to 255 |
| 40377 | G20.4.4 | 1 P address (D) | 0-255 | 0 to 255 |
| 40378 | G20.4.5 | Subnet address (A) | 0-255 | 0 to 255 |
| 40379 | G20.4.6 | Subnet address (B) | 0-255 | 010255 |
| 40380 | G20.4.7 | Subnet address (C) | 0-255 | 0 to 255 |
| 40381 | G20.4.8 | Subnet address (D) | 0-255 | 0 to 255 |
| 40382 | G20.4.9 | Gateway address (A) | 0-255 | 0 to 255 |
| 40383 | G20.4.10 | Gateway address (B) | 0-255 | 0 to 255 |
| 40384 | G20.4.11 | Gateway address (C) | 0-255 | 0 to 255 |
| 40385 | G20.4.12 | Gateway address (D) | 0-255 | 0 to 255 |
| 40386 | G20.4.13 | MAC address (A) | 0-255 | 0 to 255 |
| 40387 | G20.4.14 | MAC address (B) | 0-255 | 0 to 255 |
| 40388 | G20.4.15 | MAC address (C) | 0-255 | 0 to 255 |
| 40389 | G20.4.16 | MAC address (D) | 0-255 | 0 to 255 |
| 40390 | G20.4.17 | MAC address (E) | 0-255 | 0 to 255 |
| 40391 | G20.4.18 | MAC address (F) | 0-255 | 0 to 255 |
| 40392 | G5. 1 | Acceleration ramp 1 | 0.01-650\%/ sec | 10 to 65000 |
| 40393 | G5.3 | Acceleration ramp 2 | 0.01-650\%/ sec | 101065000 |
| 40394 | G5.2 | Deceleration ramp 1 | 0.01-650\%/sec | 101065000 |
| 40395 | G5.4 | Deceleration ramp 2 | $0.01-650 \% / \mathrm{sec}$ | 10 to 65000 |
| 40396 | G5.5 | Speed for acceleration ramp change | OFF = 0 to 250\% | 0 to 20480 |
| 40397 | G5.6 | Speed for deceleration ramp change | OFF $=0$ to $250 \%$ | 0 to 20480 |


| Address | Screen | Description | Range . .. | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40398 | G5.9 | Ramp 2 of reference increase for motorized potentiometer | 0.01-650\%/sec | 10 to 65000 |
| 40399 | G5. 8 | Ramp 1 of reterence decrease for motorized potentiometer | 0.01-650\%/sec | 10 to 65000 |
| 40400 | G5. 7 | Ramp 1 of reference increase for motorized potentiometer | 0.01-650\%/sec | 10 to 65000 |
| 40401 | G5.10 | Ramp 2 of reference decrease for motorized potentiometer | 0.01-650\% / sec | 10 to 65000 |
| 40402 | G5. 11 | Speed for ramp change with motorized potentioneter | OFF $=0$ to $250 \%$ | 0 to 20480 |
| 40403 | G5.12 | Time constant to filter the speed | 0.000-60.05 | 0 to 60000 |
| 40413 | G20.2 | Limit time for communication | OFF $=0-250 \mathrm{~s}$ | 0 to 250 |
| 40414 | G20.3.1 | Communication address | 1-255 | 1 to 255 |
| 40415 | G20.3.2 | Communication speed | 600 | 0 to 4 |
|  |  |  | 1200 |  |
|  |  |  | 2400 |  |
|  |  |  | 4800 |  |
|  |  |  | 9600 |  |
| 40416 | G20.3.3 | Communication parity | ODO | 0 to 2 |
|  |  |  | NONE |  |
|  |  |  | EVEN |  |
| 40432 | G13. 1 | Screen for general fault | Read only | - |
| 40433 | G13.2 | Register 1 of fault history | Read only | - |
| 40434 | G13.3 | Register 2 of fault history | Read only | - |
| 40435 | G13.4 | Register 3 of fault history | Read only | - |
| 40436 | G13.5 | Register 4 of fault history | Read only | - |
| 40437 | G13.6 | Register 5 of fault history | Read only | $\checkmark$ |
| 40438 | G13.7 | Erase fault history | N: No/Y: Yes | 0 to 1 |
| 40452 | G11.1 | Trip time because of speed limit | 0.0-605, OFF | 0 to 600.610 |
| 40453 | G10.6 | Trip time because of current limit | 0 to 60s, OFF | 0 to 600, 610 |
| 40454 | G11.2 | Maximum time for stop limit | OFF $=0.0-9995$ | 0 to 9999 |
| 40455 | G10.10 | Trip time because of torque limit | 0 to 60s, OFF | 0 to 600.610 |
| 40456 | G11.3 | Ground fault detection | OFF, $0-30 \% \mathrm{ln}$ | 0 to 2458 |
| 40457 | G11.4 | Low input voltage level | $\begin{aligned} & 323-425 \mathrm{~V}(400 \mathrm{~V}) \\ & 586-621 \mathrm{~V}(690 \mathrm{~V}) \end{aligned}$ | $\begin{array}{\|l\|} \hline 3230 \text { to } 4250 \\ 5860 \text { to } 6210 \\ \hline \end{array}$ |
| 40458 | G11.5 | Trip time because of low input voltage | 0.0-60s, OFF | 0 to 600.610 |
| 40459 | G11.6 | High input voltage level | $\begin{array}{\|l\|} \hline 418-550 \mathrm{~V}(400 \mathrm{~V}) \\ 726-759 \mathrm{~V}(690 \mathrm{~V} \\ \hline \end{array}$ | $\begin{aligned} & 4180 \text { to } 5500 \\ & 7260 \text { to } 7590 \\ & \hline \end{aligned}$ |
| 40460 | G11.7 | Trip time because of high input voltage | 0.0-60s, OFF | 0 to 600.610 |
| 40461 | G11.9 | Performance in case of input power loss | 0: NOFAULT | 0 to 2 |
|  |  |  | 1: FAULT'S |  |
|  |  |  | 2: STOP |  |
| 40462 | G11.10 | PTC motor option | $\mathrm{N}:$ No/Y: Yes | 0 to 1 |
| 40463 | G11.8 | Trip delay time due to output voltage imbalance | 0.0-10s, OFF | 0 to 100, 101 |
| 40482 | G19.3.1 | Stator resistance (Rs) | 0.0-9.9\% | 0 to 811 |
| 40502 | G19.2.1 | Minimum flux | 40-100\% | 3277 to 8192 |
| 40505 | G19.2.4 | Slip compensation | $\mathrm{N}: \mathrm{No} / \mathrm{Y}:$ Yes | 0101 |
| 40506 | G19.2.5 | Drive damping | 0.0-20.0\% | 0 to 1638 |
| 40507 | G19.2.6 | Compensating bandwidth of torque transitory | 0.0-10.0\% | 0 to 819 |
| 40508 | G19.2.7 | Curent limit factor | 0.0-20.0\% | 0 to 1638 |
| 40509 | G17.6 | Voltage for activating regeneration contol | ```For VIN = 400V/500V -> 800 to 810V,OFF=811V For VIN=690V -> 1150 to 1160V,OFF=1161V``` | $\begin{aligned} & \text { For VIN }=400 \mathrm{~V} / 500 \mathrm{~V} \rightarrow \\ & 800 \text { to } 810,811 \\ & \text { For } V / \mathrm{N}=690 \mathrm{~V} \rightarrow \\ & 1150 \text { to } 1160,1161 \end{aligned}$ |
| 40522 | G19.1.1 | Selection of control type | $\mathrm{V} / \mathrm{Hz}$ | 0 to 1 |
|  |  |  | PEVE |  |
| 40523 | G19.1.2 | Commutation frequency | 4000-8000 Hz | 4000 to 8000 |
| 40524 | G19.1.3 | Pewave control | N: No/ Y: Yes | 0 to 1 |
| 40549 | G1.11 | Drive fan control mode | FIXE | 0 to 1 |
|  |  |  | TEMP |  |
| 40550 | SV6. 1 | Total time of running (RUN) (Days) | Read only | Real Value = Modbus Value |
| 40551 | SV6. 1 | Total time of running (RUN) (Hours) | Read only | $1=0.1$ hours |
| 40552 | SV6.2 | Partial time of running (RUN) (Days) | Read only | Real Value = Modbus Value |
| 40553 | SV6. 2 | Partial time of running (RUN) (Hours) | Read only | $1=0.1$ hours |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 40554 | SV6.3 | Reset for partial time counter of running (RUN) | N: No/Y: Yes | 0 to 1 |
| 40562 | HOST CONTROL | It allows giving the start command to the equipment through communications network | 0-1 | 0 to 1 |
| 40563 | HOST CONTROL | It allows giving the stop command to the equipment through communications network | 0-1 | 0 to 1 |
| 40564 | HOST CONTROL | It allows giving the reset command to the equipment through communications network | 0-1 | 0 to 1 |
| 40565 | HOST CONTROL | It ailows the equipment to generate a fault through communications network | 0-1 | 0 to 1 |
| 40571 | G12.1 | Auto Reset | N: No/Y: Yes | 0 to 1 |
| 40572 | G12.2 | Number of Auto Reset attempts | 1-5 | 1 to 5 |
| 40573 | G12.3 | Delay time before Auto Reset | 5-120s | 5 to 120 |
| 40574 | G12.4 | Reset time for the counter of Auto Reset attempts | 1-60min | 1 to 60 |
| 40575 | G12.5 | Selection of fault 1 to be reset | 0: 0 NO AUTO RESET | 01025 |
|  |  |  | 1: ALL OF THE FLTS |  |
|  |  |  | 2:11 VIN LOSS |  |
|  |  |  | 3: 13 HIVIN |  |
|  |  |  | 4: 14 LWVIN |  |
|  |  |  | 5: 18 IMB V OUT |  |
|  |  |  | 6: 19 IMBIOUT |  |
|  |  |  | 7: 20 GROUND FLT |  |
|  |  |  | 8:211LIM T/O |  |
|  |  |  | 9:22 TQLIM TIO |  |
|  |  |  | 10: 27 DL SMTH |  |
|  |  |  | 11:40EXT / PTC |  |
|  |  |  | 12:41COMMS TRIP |  |
|  |  |  | 13: 42 AIN1 LOSS |  |
|  |  |  | 14:43 AIN2 LOSS |  |
|  |  |  | 15: 47 COMMS T/O |  |
|  |  |  | 16: 49 SPD LIMIT |  |
|  |  |  | 17:65 LOW PRESSURE |  |
|  |  |  | 18:66 HI PRESSURE |  |
|  |  |  | 19:67 LOW WATER |  |
|  |  |  | 20:31 SCRL1 |  |
|  |  |  | 21:32 SCR L2 |  |
|  |  |  | 22:33 SCR L3 |  |
|  |  |  | 23:68 CAVIT/UNDERL |  |
|  |  |  | 24: 69 FLOW SWITCH |  |
|  |  |  | 25: 70 IRRIGATOR F |  |
| 40576 | G12.6 | Selection of fault 2 to be reset | 00-25 (See G12.5) | 0 to 25 |
| 40577 | 612.7 | Selection of fault 3 to be reset | 00-25 (See G12.5) | 0 to 25 |
| 40578 | G12.8 | Selection of fault 4 to be reset | 00-25 (See G12.5) | 0 to 25 |
| 40581 | G4.4.1 | Sensor units of Pulse Input | \% | 0 to 9 |
|  |  |  | V's |  |
|  |  |  | $\mathrm{m}^{3 / \mathrm{s}}$ |  |
|  |  |  | $\mathrm{V} / \mathrm{m}$ |  |
|  |  |  | $\mathrm{m}^{3} / \mathrm{m}$ |  |
|  |  |  | In |  |
|  |  |  | $\mathrm{m}^{3} / \mathrm{h}$ |  |
|  |  |  | $\mathrm{m} / \mathrm{s}$ |  |
|  |  |  | $\mathrm{m} / \mathrm{m}$ |  |
|  |  |  | $\mathrm{m} / \mathrm{h}$ |  |
| 40582 | G4.4.2 | Flowmeter configuration | 0 to 32760 Flow units | 0 to 32760 |
| 40583 | G4.4.3 | Maximum range of flowmeter | 0 to 32760 Flow units | 0 to 32760 |
| 40592 | G19.2.2 | Initial voltage | 0.0-100\% | 0 to 8192 |
| 40593 | G19.2.3 | Torque boost band | 0.0-100\% | 0 to 8192 |
| 40594 | G19.2.9 | Initial trequency | 0.0-100\% | 0 to 8192 |
| 40597 | G8.1.13 | Speed for disconnecting relay in option Crane | +0.0\% to $+250 \%$ | 0 to 20480 |


| Address | Screen | Description | Range | Hodbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 42002 | $\begin{aligned} & \hline \text { SV8.21 } \\ & \text { SV8. } 6 \end{aligned}$ | Drive status during pump control. First field of the visualization screen. | Read only | $0 \rightarrow$ REGL |
|  |  |  |  | $\rightarrow$ PMAN |
|  |  |  |  | $2 \rightarrow$ OMAN $-\cdots$ |
|  |  |  |  | $3 \rightarrow$ HIPP |
|  |  |  |  | $4 \rightarrow$ HIPR |
|  |  |  |  | $5 \rightarrow$ FLOD |
|  |  |  |  | $6 \rightarrow$ NFLO |
|  |  |  |  | $7 \rightarrow$ CAVS |
|  |  |  |  | $8 \rightarrow$ CAVI |
|  |  |  |  | $9 \rightarrow$ LOPR |
|  |  |  |  | $\underline{10} \rightarrow$ LOWA |
|  |  |  |  | $11 \rightarrow$ CYCL |
|  |  |  |  | $12 \rightarrow$ IRFA |
|  |  |  |  | $13 \rightarrow$ FLOW |
|  |  |  |  | $14 \rightarrow$ OFF |
|  |  |  |  | $15 \rightarrow$ SLEP |
|  |  |  |  | $16 \rightarrow$ BYPA |
|  |  |  |  | $17 \rightarrow$ RAMP |
|  |  |  |  | $18 \rightarrow$ FILL |
|  |  |  |  | $19 \rightarrow$ COMP |
|  |  |  |  | $20 \rightarrow$ JOCK |
|  |  |  |  | $21 \rightarrow$ PRIM |
|  |  |  |  | $22 \rightarrow$ FINP |
| 42003 | SV8.3 | Status of fixed pumps 1, 2 and 3 (Pump 1) | Read only | $0 \rightarrow$ OFF |
|  |  |  |  | $1 \rightarrow$ RDY |
|  |  |  |  | $2 \rightarrow$ ON |
|  |  |  |  | $3 \rightarrow$ FLT |
| 42004 | SV8.3 | Status of fixed pumps 1, 2 and 3 (Pump 2) | Read only | 0-3(See 42003) |
| 42005 | SV8.3 | Status of fixed pumps 1,2 and 3 (Pump 3) | Read only | 0-3 (See 42003) |
| 42006 | SV8. 2 | Drive status during pump control. (PID Reference). <br> Second field of the visualization screen. | Read only | $8192=100 \%$ Maximum range of the Analogue Input |
| 42007 | SV8. 1 | Values of PID reference and feedback. (PID Reference). | Read only | $\begin{aligned} & \text { Real Value }=(\text { Modbus } \\ & \text { Value } / 10) \end{aligned}$ |
| 42008 | SV8.2 | Drive status during pump control. (Feedback). <br> Third field of the visualization screen. | Read only | $8192=100 \%$ Maximum range of the Analogue Input |
| 42009 | SV8. 1 | Values of PID reference and feedback. (Feedback). | Read only | $\begin{aligned} & \text { Real Value = (Modbus } \\ & \text { Value } / 10) \end{aligned}$ |
| 42011 | G25.11.1 | Operated time by Pump 1 (minutes) | Read only | - |
| 42012 | G25.11.2 | Operated time by Pump 2 (minutes) | Read only | - |
| 42013 | G25.11.3 | Operated time by Pump 3 (minutes) | Read only | - |
| 42014 | G25.11.1 | Operated time by Pump 1 (days) | Read only | - |
| 42015 | G25.11,2 | Operated time by Pump 2 (days) | Read only | - |
| 42016 | G25.11.3 | Operated time by Pump 3 (days) | Read only | - |
| 42017 | G25.11.6 | Reset counters | Read only | - |
| 42018 | G25.11.4 | Operated time by Pump 4 (minutes) | Read only | - |
| 42019 | G25.11.5 | Operated time by Pump 5 (minutes) | Read only | - |
| 42020 | G25.11.4 | Operated time by Pump 4 (days) | Read only | - |
| 42021 | G25.11.5 | Operated time by Pump 5 (days) | Read only | - |
| 42022 | SV8.4 | Status of fixed pumps 4 and 5 (Pump 4) | Read only | 0-3 (See 42003) |
| 42023 | SV8.4 | Status of fixed pumps 4 and 5 (Pump 5) | Read only | 0-3(See 42003) |
| 42035 | G25.1.1 | Control mode | MANUAL | 0 to 1 |
|  |  |  | PUMP |  |
| 42041 | G25.1.2 | Source selection for speed reference in manual mode | LOCAL | 0 to 2 |
|  |  |  | Al1 |  |
|  |  |  | Al2 |  |
| 42042 | $\begin{aligned} & \hline \text { G25.1.3 } \\ & \text { SV5.13 } \end{aligned}$ | Value of speed reference for local source in manual mode | -250\% to +250\% | -20480 to 20480 |
| 42043 | G25.1.4 | Source for the altemative speed reference in manual mode | LOCAL | 0 to 2 |
|  |  |  | Al1 |  |
|  |  |  | Al2 |  |
| 42044 | $\begin{aligned} & \hline \text { G25.1.13 } \\ & \text { SV5.22 } \end{aligned}$ | Time for automatic stop | OFF, $0.1-99.9 \mathrm{~h}$ | 0 to 999 |
| 42045 | G25.2.1 | PID setpoint source | LOCAL | 0 to 2 |
|  |  |  | Al1 |  |
|  |  |  | Al2 |  |


| Address | Screen | Description | Range | Modbus Range. |
| :---: | :---: | :---: | :---: | :---: |
| 42046 | G25.2.3 | PID feedback source | Al1 | 0 to 2 |
|  |  |  | Al2 |  |
|  |  |  | PULSE |  |
| 42047 | G25.2.4 | Proportional gain of PID regulator | 0.1-20 | 1 to 200 |
| 42048 | G25.2.5 | Integral time of PID regulator | 0.1-999.9s, Max. | 1 to 9999; 10000 |
| 42049 | G25.2.6 | Derivation time of PID regulator | 0.0-250s | 0 to 2500 |
| 42050 | G25.2.7 | Error of PID regulator | Read only | - |
| 42051 | G25.2.8 | Eror of PID regulator in engineering units | Read only | - |
| 42055 | G25.3.2 | Start speed for the fixed pumps | -250\% to $+250 \%$ | -20480 to 20480 |
| 42056 | G25.3.3 | Minimum PID error to start the fixed pumps | OFF $=0$ to $+200 \%$ | 0 to 16384 |
| 42062 | G25.3.4 | Delay time to start fixed pump 1 (Relay 1) | OFF $=0-6000 \mathrm{~s}$ | 0 to 60000 |
| 42064 | G25.3.1 | Wake up level of the drive | 0.0-3276Bar | 0 to 32760 |
| 42065 | G25.3.5 | Delay time to start fixed pump 2 (Relay 2) | OFF $=0-6000 \mathrm{~s}$ | 0 to 60000 |
| 42066 | G25.3.6 | Delay time to start fixed pump 3 (Relay 3) | OFF $=0-6000 \mathrm{~s}$ | 0 to 60000 |
| 42067 | G25.3.7 | Delay time to start fixed pump 4 (AO1) | OFF=0-6000s | 0 to 60000 |
| 42068 | G25.3.8 | Delay time to start fixed pump 5 (AO2) | OFF $=0-6000 \mathrm{~s}$ | 0 to 60000 |
| 42072 | G25.4.13 | Maximum PID error to stop the fixed pumps | -250\% to $+0.0 \%$ | -20480 to 0 |
| 42073 | G25.4.14 | Delay time to stop fixed pump 1 (Relay 1) | 0-6000s | 0 to 60000 |
| 42077 | G25.4.15 | Delay time to stop fixed pump 2 (Relay 2) | 0-6000s | 0 to 60000 |
| 42078 | G25.4.16 | Delay time to stop fixed pump 3 (Relay 3) | 0-6000s | 0 to 60000 |
| 42079 | G25.4.17 | Delay time to stop fixed pump 4 (AO1) | 0-6000s | 0 to 60000 |
| 42080 | G25.4.18 | Delay time to stop fixed pump 5 (AO2) | 0-6000s | 0 to 60000 |
| 42081 | G25.5.1 | Speed bypass at the starting of fixed pumps | +0.0\% to $+250 \%$ | 0 to 20480 |
| 42082 | G25.5.2 | Time of speed bypass after staring fixed pumps | OFF $=0-999 \mathrm{~s}$ | 0 to 9999 |
| 42083 | G25.5.3 | Speed bypass at the stopping of fixed pumps | +0.0\% to $+250 \%$ | 0 to 20480 |
| 42084 | G25.5.4 | Time of speed bypass after stopping fixed pumps | OFF $=0-999 \mathrm{~s}$ | 0 to 9999 |
| 42085 | G11.14 | To enable underload protection | $\mathrm{N}:$ No/Y: Yes | 0 to 1 |
| 42085 | G25.6.2 | To enable cavitation protection | N: No/Y: Yes | 0 to 1 |
| 42086 | G11.15 | Underioad current | 0.2 to 1.5 ln | 0 to 12288 |
| 42086 | G25.6.4 | Cavitation current | 0.2 to $1.5 \cdot \mathrm{In}$ | 0 to 12288 |
| 42087 | G11.16 | Underload speed | +0.0\% to $+250 \%$ | 0 to 20480 |
| 42087 | G25.6.5 | Cavitation speed | +0.0\% to $+250 \%$ | 0 to 20480 |
| 42088 | G11.17 | Delay time to activate underload protection | 0-999s | 0 to 9999 |
| 42088 | G25.6.6 | Delay time to activate cavitation protection | 0-999s | 0 to 9999 |
| 42090 | G25.6.7 | To enable low pressure protection | N: No/ Y: Yes | 0 to 1 |
| 42091 | G25.6.9 | Minimum pressure level | OFF $=0$ to 3276 Eng. Units | 0 to 32760 |
| 42092 | G25.6.10 | Trip delay time because of minimum pressure fault | 0-999s | 0 to 9990 |
| 42101 | G25.6.13 | Maximum pressure level | 0-3276 Eng. Units | 0 to 32760 |
| 42102 | G25.9.10 | Bypass time for Priming pump | 0.1-6000s | 0 to 60000 |
| 42103 | G25.9.11 | Trip time of F72 while Priming pump is connected | OFF $=0,0.1-6000 \mathrm{~m}$ | 0 to 60000 |
| 42104 | G25.6.11 | Minimum speed for minimum pressure fault | +0.0\% to $+250 \%$ | 0 to 20480 |
| 42116 | G25.7.2 | Speed for pipe filling process | OFF $=0.0,+0.1$ to $+250 \%$ | 0 to 20480 |
| 42117 | G25.7.3 | Pressure for the end of pipe filling process | 0.0-3276 Eng. Units | 0 to 32760 |
| 42118 | G25.7.4 | Safety time for pipe filling process | OFF=0, 1-9999min | 0 to 9999 |
| 42119 | G25.7.5 | Setpoint ramp | 0.01-320.00 Eng. Units/s | 01032000 |
| 42131 | G25.8.1 | Compensation pressure at the starting of 1 fixed pump | 0.0-3276 Eng. Units | 0 to 32760 |
| 42132 | G25.8.2 | Compensation pressure at the starting of 2 fixed pumps | 0.0-3276 Eng. Units | 0 to 32760 |
| 42133 | G25.8.3 | Compensation pressure at the starting of 3 fixed pumps | 0.0-3276 Eng. Units | 0 to 32760 |
| 42134 | G25.8.4 | Compensation pressure at the starting of 4 fixed pumps | 0.0-3276 Eng. Units | 0 to 32760 |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 42135 | G25.8.5 | Compensation pressure at the starting of 5 fixed pumps | 0.0-3276 Eng. Units | 0 to 32760 |
| 42136 | G25.9.1 | To enable fixed pump associated to Output Relay 1 | N: No / Y: Yes | 0 to 1 |
| 42137 | G25.9.2 | To enable fixed pump associated to Outpul Relay 2 | N: No/Y: Yes | 0 to 1 |
| 42138 | G25.9.3 | To enable fixed pump associated to Output Retay 3 | N: Noly: Yes | 0 to 1 |
| 42139 | G25.9.6 | Altemation mode of fixed pumps | LINEAR | 0 to 2 |
|  |  |  | CYCLE |  |
|  |  |  | DUTY SHARE |  |
| 42141 | G25.10.1 | Flow reading source | Al1 | 0 to 2 |
|  |  |  | A12 |  |
|  |  |  | PULSE |  |
| 42142 | SV8. 5 | Read flow value | Read only | Real Value $=$ (Modbus <br> Value / 10) |
| 42143 | $\begin{aligned} & \hline \text { G25.10.2 } \\ & \text { SV5.24 } \end{aligned}$ | Maximum allowed fow | 0.0-3276 Eng. Units | 0 to 32760 |
| 42144 | G25.10.3 | Offset percentage over maximum fow | +0\% to $+250 \%$ | 0 to 20480 |
| 42145 | $\begin{array}{\|l\|} \hline \text { G25.10.4 } \\ \text { SVS.25 } \\ \hline \end{array}$ | Flow percentage to reset algorithm | +0\% to + $100 \%$ | 0 to 100 |
| 42146 | G25.10.5 | Deceleration during algonithm | +0.0\% to $+250 \%$ | 0 to 20480 |
| 42147 | G25.10.6 | Units of measurement of instantaneous flow | Read only | 0109 |
| 42148 | G25.9.4 | To enable fixed pump associated to Analogue Output 1 | N: No/Y: Yes | 0 to 1 |
| 42149 | G25.9.5 | To enable fixed pump associated to Analogue Output 2 | $\mathrm{N}: \mathrm{No} / \mathrm{Y}: \mathrm{Yes}$ | 0 to 1 |
| 42151 | $\begin{aligned} & \hline \text { G25.1.5 } \\ & \text { SV5.14 } \end{aligned}$ | Local setpoint 1 for PID | 0-3276 Eng. Units | 0 to 32760 |
| 42152 | $\begin{aligned} & \text { G25.1.6 } \\ & \text { SV5.15 } \end{aligned}$ | Local setpoint 2 for PID | 0-3276 Eng. Units | 0 to 32760 |
| 42153 | $\begin{aligned} & \text { G25.1.7 } \\ & \text { SV5.16 } \end{aligned}$ | Local setpoint 3 for PID | 0-3276 Eng. Units | 0 to 32760 |
| 42154 | $\begin{aligned} & \hline \text { G25.1.8 } \\ & \text { SV5.17 } \end{aligned}$ | Local setpoint 4 for PID | 0-3276 Eng. Units | 0 to 32760 |
| 42155 | $\begin{aligned} & \text { G25.1.9 } \\ & \text { SV5. } 18 \end{aligned}$ | Local setpoint 5 for PID | 0-3276 Eng. Units | 0 to 32760 |
| 42156 | $\begin{aligned} & \text { G25.1.10 } \\ & \text { SV5.19 } \end{aligned}$ | Local setpoint 6 for PID | 0-3276 Eng. Units | 0 to 32760 |
| 42157 | $\begin{aligned} & \text { G25.1.11 } \\ & \text { SV5.20 } \end{aligned}$ | Local setpoint 7 for PID | 0-3276 Eng. Units | 0 to 32760 |
| 42158 | $\begin{aligned} & \text { G25.1.12 } \\ & \text { SV5.21 } \end{aligned}$ | Local setpoint 8 for PID | 0-3276 Eng. Units | 0 to 32760 |
| 42306 | G25.4.1 | Delay time before activating sleep mode | OFF $=0,1-999 \mathrm{~s}$ | 0 to 9990 |
| 42307 | G25.4.2 | Sleep speed for local setpoint 1 | +0.0\% $10+250 \%$ | 01020480 |
| 42308 | G25.4.3 | Sleep speed for local setpoint 2 | +0.0\% $10+250 \%$ | 0 to 20480 |
| 42309 | G25.4.4 | Sleep speed for local setpoint 3 | + $0.0 \%$ to $+250 \%$ | 0 10 20480 |
| 42310 | G25.4.5 | Sleep speed for local setpoint 4 | +0.0\% to +250\% | 0 to 20480 |
| 42311 | G25.4.6 | Sleep speed for local setpoint 5 | +0.0\% to $+250 \%$ | 0 to 20480 |
| 42312 | G25.4.7 | Sleep speed for local setpoint 6 | +0.0\% to +250\% | 01020480 |
| 42313 | G25.4.8 | Sleep speed for local setpoint 7 | +0.0\% $10+250 \%$ | 0 to 20480 |
| 42314 | G25.4.9 | Sleep speed for local setpoint 8 | +0.0\% to +250\% | 01020480 |
| 42315 | G25.4.19 | Slop speed 1 for one fixed pump | +0.0\% to +250\% | 0 to 20480 |
| 42316 | G25.4.20 | Stop speed 2 for one fixed pump | +0.0\% $10+250 \%$ | 01020480 |
| 42317 | G25.4.21 | Stop speed 3 for one fixed pump | +0.0\% to +250\% | 0 to 20480 |
| 42318 | G25.4.22 | Stop speed 4 for one fixed pump | +0.0\% 0 + $+250 \%$ | 0 to 20480 |
| 42319 | G25.4.23 | Stop speed 5 for one fixed pump | $+0.0 \%$ to $+250 \%$ | 0 to 20480 |
| 42320 | G25.4.24 | Stop speed 6 for one fixed pump | $+0.0 \%$ to $+250 \%$ | 0 to 20480 |
| 42321 | G25.4.25 | Stop speed 7 for one fixed pump | $+0.0 \%$ to $+250 \%$ | 01020480 |
| 42322 | G25.4.26 | Stop speed 8 for one fixed pump | +0.0\% to + $250 \%$ | 0 to 20480 |
| 42323 | G25.4.10 | To enable 'No Flow' input to slees the drive | $\mathrm{N}: \mathrm{No} / \mathrm{Y}: \mathrm{Yes}$ | 0 to 1 |
| 42324 | $\begin{aligned} & \text { G25.4.11 } \\ & \text { SV5.26 } \end{aligned}$ | Flow level to sleep the drive | OFF $=0.0$ to 3276 Flow units | 0 to 32760 |
| 42325 | G25.4.12 | Output current level to sleep the drive | OFF $=0$ to 1229A | 0 to 12290 |
| 42326 | G25.2.9 | PID output inversion | N: No/Y; Yes | 0 to 1 |


| Address | Screen | Description | Range | Modbus Range |
| :---: | :---: | :---: | :---: | :---: |
| 42327 | G25.4.27 | Sleep level in inverse mode | 0.0\%-250\% | 0 to 20480 |
| 42336 | G25.6.1 | Delay time after protection pause | 0-999s | 0109990 |
| 42337 | G25.6.12 | Response from over-pressure | PAUSE | 1 to 2 |
|  |  |  | FAULT |  |
| 42339 | G25.6.14 | Trip time because of high pressure | 0-999s | 0 to 9990 |
| 42344 | G25.6.3 | Response from cavitation | PAUSE | 1 to 2 |
|  |  |  | FAULT |  |
| 42348 | G25.6.15 | Response from 'No Flow' situation | PAUSE | 1 to 2 |
|  |  |  | FAULT |  |
| 42349 | G25.6.17 | Minimum stop speed because of 'No Flow' detection | +0.0\% to $+250 \%$ | 0 to 20480 |
| 42350 | G25.6.18 | Bypass time for 'No Flow' switch | 0.0-999s | 0 to 9990 |
| 42351 | G25.6.19 | Trip delay time because of 'No Flow' | 0.0-999s | 0 to 9990 |
| 42352 | G25.6.16 | To enable 'No Flow' switch during pipe filling process | $\mathrm{N}: \mathrm{No} / \mathrm{Y}: \mathrm{Yes}$ | 0 to 1 |
| 42353 | G25.6.20 | Cycle time of the drive | OFF=0-99m | 01099 |
| 42354 | G25.6.21 | Cycle counter | 1-5 | 1 to 5 |
| 42356 | SV5.23 | Remaining time for automatic stop | Read only | 0 to 6000 |
| 42357 | G25.7.1 | Pressure reading source | PID | 0 to 2 |
|  |  |  | Al1 |  |
|  |  |  | A12 |  |
| 42358 | G25.4.28 | To enable sleep mode | N: No/Y: Yes | 0 to 1 |
| 42371 | G25.9.7 | Starting pressure of Jockey pump | 0.0-3276 Eng. Units | 0 to 32760 |
| 42372 | G25.9.8 | Start delay time for Jockey pump | 0-600s | 0106000 |
| 42373 | G25.9.9 | Stopping pressure of Jockey pump | 0.0-3276 Eng. Units | 0 to 32760 |
| 42374 | G25.2.2 | Altemative PID setpoint source | LOCAL | 0 to 2 |
|  |  |  | Al1 |  |
|  |  |  | Al2 |  |
| 42375 | G25.4.29 | Sleep speed when setpoint is introduced through Analogue Input | +0.0\% to $+250 \%$ | 0 to 20480 |

### 11.5. Annexe A. Physical Level

The SD700 drive can be connected to a RS485 network by a twisted-pare cable where more equipment is also connected.

RS232 physical port has two separated lines for receiving ( $R x$ ) and transmitting ( $T x$ ). It allows the net to work in full duplex mode. Full duplex means that the master can transmit and receive data simultaneously.

RS485 physical port used in the drive, uses the same twisted-pare cable in the reception ( Rx ) and in the transmission ( $T x$ ). It only allows the RS485 system to work in half duplex mode. Half duplex means that the master cannot transmit and receiver information simultaneously. In a half duplex system, it usually uses the Request-To-Send line (RTS) to control the information flux via half duplex system in a RS232 system.

### 11.6. Annexe B. Modbus Communication Protocol

### 11.6.1. RTU Frame Group

In the RTU frame group, data are transmitted and received as sequences of 8 bits. When you want to transmit a register of 16 bits, it is divided in two sections of 8 bits, and the more significant byte (MSB) is transmitted firstly
If more than 3.5 byte periods between the characters reception, drive considers that the next received byte will correspond to a different frame and it also will consider finished the present frame.

### 11.6.2. Address Field

The address field has 8 bits length and allows addressing 1-240 single addresses, 241-255 group addresses, and one ( 0 ) broadcast addresses.
Each SD700 drive is identified with an address that the master uses to communicate with it All of the SDRIVE 700 drives recognize and execute messages with groupcast or broadcast addressing, but do not answer to the master with a confirmation.

### 11.6.3. Function Field

The function field indicates to the addressed equipment the action to execute. When the slave detects that a communication error has occurred, the more significant bit of this field takes value ' 1 ' to indicate to the master this abnormal situation. There is more information about the exception codes in section 12.5.6

### 11.6.4. Data Field

Data field is used to transmit information to the addressed slaves and from them. The length of data field is 16 (or multiple) bits (transmitted in 2 bytes - byte more significant firstly).

### 11.6.5. Sum Check (CRC)

Sum check is used by the master and slave to detect transmission errors. This code is added at the end of the transmitted frame. The characteristic polynomial of this code is:

$$
\text { CRC-16 }=x^{16}+x^{15}+x^{2}+1
$$

Receiver calculates the CRC of the received messages and compares it with the sum check (CRC) received. If an error occurs, the entire message is ruled out. It is not possible to recover errors inside the message.

### 11.6.5.1. Theory

The entire message (with no start / stop bits nor parity bit) is considered like a continuous sequence to be processed with the more significant byte transmitted firstly. The message is multiplied by $2^{16}$ ( 2 bytes on the left hand) and then is divided by the polynomial shown above.

Quotient is rejected and the rest of 16 bits is added to the message. This rest is initialized to $0 F F F F H$ to avoid a possible sequence of zeros as a valid sequence.

Receiver receives the complete sequence and executes the division with the same characteristic polynomial; if the message has been received with no errors, the rest of the division is zero.

The device used for data serial transmission will send the less significant bit LSB of each character firstly. In the CRC generation, the first transmitted bit is defined like the more significant bit of the dividend.

By convenience, we suppose that there are not carries, and assume that the more significant bit MSB is the right one. For this, if we want to be solid, the bit order of the characteristic polynomial should be inverted. The more significant byte is ruled out if only affects to the quotient and does not affect to the rest.
In this way, original polynomial

$$
x^{16}+x^{15}+x^{2}+1=11000000000000101
$$

## becomes like this

1010000000000001 (A001H)

### 11.6.6. Exception Codes

Protocol errors and data range errors generate an answer of SD700 with an exception answer.
An exception answer consists of the slave address that has detected the error, the function code received by the slave (more significant bit with ' 1 ' value to indicate the exception answer), the error code, and the sum check (CRC).

The exception codes and its causes are summarized in the following table:

| Code | Name | Cause |
| :---: | :--- | :--- |
| 01 | Illegal function | The function code received by the slave is out of range. The range <br> of valid function code is the code 3 and 16 |
| 02 | Illegal data address | Data address received by the slave is out of range |
| 03 | Illegal data value | Data value received by the slave is out of range |
| 06 | Busy, rejected message. | The slave cannot execute the action required by the master <br> immediately |
| 07 | Acknowledgement | The required action cannot be executed |

## 12.FAULT MESSAGES. DESCRIPTIONS AND ACTIONS

When a fault occurs the SD700 will stop the motor and show the generated fault on the display. You can display this fault in the programming line (lower line) while motor current and the speed values at the moment of the fault are displayed in the upper line.
It is possible to navigate through the additional display lines to access other status parameters without resetting the fault. These additional status parameters offer further information about the moment at which the fault occurred. Additionally, the FAULT led will blink and the fault message will be displayed until the fault is remedied and the drive is reset.


Fault Messages


It shows the faults of the drive. In the upper line, are displayed the conditions at trip moment.

Figure 11.1 Fault displaying - Programming Line

### 12.1. Description of Faults List

| DISPLAY | DESCRIPTION: |
| :---: | :---: |
| FONOFAULT | Drive is operative. There is no fault. |
| F1 ILIM FLT | Output current has reached a dangerous level. Its value is above $220 \%$ of the drive rated current. Protection is activated instantaneously. |
| F2 V LIM FLT | DC Bus voltage has reached a dangerous level $>850 \mathrm{Vdc}$. Hardware Protection. Drive will turn off the output to the motor. |
| F3PDINT FLT | DC Bus voltage and the output current of the equipment have reached dangerous levels. |
| F4 U + DESAT | Internal protection within the appropriate IGBT semiconductor has acted. |
| F5U-DESAT |  |
| F6V + DESAT |  |
| F7V-DESAT |  |
| F8 W + DESAT |  |
| F9 W-DESAT |  |
| F10 NEG IGBT | Automatic internal protection of several of the IGBT semiconductors has acted. |
| F11 VIN LOSS | Power supply loss of any input phase for a time higher than 20 ms has occurred. |
| F12 IMB V IN | Input voltage imbalance greater than $\pm 10 \%$ of average input power supply of SD700 for a time higher than 100 ms . |
| F13 HIV IN | Average supply voltage has exceeded the value set in 'G11.6 HIGH VOLT' for greater than the time set in 'G11.7 HIGH V TO'. |
| F14 LWV IN | Average supply voltage is lower than the value set in 'G11.4 LOW VOLT' for greater than the time set in 'G11.5 LOW V TO'. |
| F15 CURL Vdc | Unstable bus voltage. There is a DC Bus voltage ripple higher than 100 Vdc for more than 1.1 sec , |
| F16 HI Vdc | DC Bus voltage has exceeded critical operating level (>850Vdc). Software Protection. |
| F17 LW Vdc | DC Bus voltage is lower than critical operating level ( $<350 \mathrm{Vdc}$ ). |


| DISPLAY | DESCRIPTION |
| :---: | :---: |
| F18 IMB V OUT | Voltage imbalance of more than $\pm 5 \%$ of the average drive output average voltage for a time higher than 100 ms . |
| F19 IMBIOUT | Current imbalance of more than $\pm 25 \%$ of the average output motor current for a time higher than 1 s . |
| F20 GROUND FLT | Current level to the ground has exceeded the level set in 'G11.3 GNDI LIMT'. |
| F21 ILIM T/O | Motor current has exceeded the current limit set in 'G10.5 I LIMIT' for the time set in 'G10.6 I LIM TO'. |
| F22 TQ LIM T/O | Motor torque has exceeded the torque limit set in parameter ' G 10.7 MAX TOR' for the time set in ' G 10.8 T LIMT TO'. |
| F25 MTR O/ | Motor overload calculated by SD700 thermal model has exceeded 110\%. |
| F27 DL SMTH | DC Bus has not charged in the expected time. |
| F28 MICROFLT | Microprocessor has detected wrong data. |
| F29 DSP FLT | DSP has detected wrong data. |
| F30 WATCHDOG | An unknown fault has reset the micraprocessor of the control board. |
| F31 SCRL1 | Trip on conduction status of thyristor 1 . The thyristor has not tumed on correctly. |
| F32 SCR L2 | Trip on conduction status of thyristor 2 . The thyristor has not turned on correctly. |
| F33 SCR L3 | Trip on conduction status of thyristor 3. The thyristor has not tumed on correctly. |
| F34 IGBT TEMP | IGBT internal temperature has reached a level of $110^{\circ} \mathrm{C}$ (See parameter SV2.4). |
| F35 PHSE L1 LOSS | Input phase L1 is not present. Phase fault. |
| F36 PHSE L2 LOSS | Input phase L2 is not present. Phase fault. |
| F37 PHSE L3 LOSS | Input phase L3 is not present. Phase fault. |
| F40 EXT / PTC | Extemal trip or motor PTC device has operated (terminals 8 and 9 ). Values lower than $90 \Omega \pm 10 \%$ or higher than $1 \mathrm{~K} 5 \pm 10 \%$ generate the fault. |
| F41 COMMS TRIP | Trip generated through RS232 or RS485 communication. Master (PLC or PC) is generating a fault in the SD700 through serial communication. |
| F42 AIN1 LOSS | The SD700 is not receiving a signal on Analogue Input 1 and 'G4.2.14 AIN1 LOSS' is set to 'Yes'. The signa! connected to this input has been lost. |
| F43 AIN2 LOSS | The SD700 is not receiving a signal on the Analogue Input 2 and ' $G 4.3$. 14 AIN2 LOSS' is set to 'Yes'. The signal connected to this input has been lost. |
| F44 CAL FLT | Internal reference voltage levels are wrong. |
| F45 STOP T/O | Trip generated due to excessive stopping time. The elapsed time from stop signal activation has exceeded the value set in parameter ' G 11.2 STOP TO'. |
| F46 EEPROM FLT | Non-volatile memory (EEPROM) is faulty. |
| F47 COMMS T/O | Trip generated due to excessive delay of serial communication. The elapsed time from the last valid data transmission has exceeded the time set in parameter ' G 20.2 COMMS T/O'. |
| F48 SPICOM | Trip because data bus transfer is wrong. |
| F49 SPD LIMIT | Motor speed has exceeded the speed limit (parameters G10.1 to G10.4) for the time set in 'G11.1 SP LIM TO'. |
| F50 PSU FAULT | Internal power supply is not supplying the correct voltage. One voltage level has decreased to zero value for 100ms approx. |
| F52 SUPPLY FAN | A fault in the power supply to the cooling fans has occurred. |
| F51 SCR TEMP | Rectifier heat sink temperature has reached a dangerous level. |
| F52 SOFT C TEMP | Overheating of the DC Bus soft charge resistors has occurred. |
| F53 INTRNAL TEMP | Internal temperature of the SD700 control electronics chamber has reached a dangerous level. |
| F54 WATCHDOG TMR | Internal fautt of the microcontroller. |
| F56 EMERGEN.STOP | Digital input configured as 'EXTERN EMERGE' has been activated (NC contact). |
| F57 PUMP OVERLOA | This fault is generated when the output current of the drive is higher than the current set in 'G11.11 PUMP OV' during the time adjusted in 'G11.13 Povl DLY'. |
| F65 LOW PRESSURE | Active only when operating in Pump Control mode. Trip generated when the pressure level is lower than the minimum pressure level set in 'G25.6.7 LoPre'. |
| F66 HI PRESSURE | Active only when operating in Pump Control mode. External trip produced when digital input configured in this option (Hi Pressure Switch) is closed. |
| F67 LOW WATER | Extemal trip produced when Pump Program (G25) is activated and one of the digital inputs has been set as '59 LO WATER FLT'. Under these conditions, if a contact is opened on this digital input, this fault is generated indicating that the pump is working with no load. |
| F68 CAVIT/UNDERL | When the motor current is lower than the cavitation current and the motor speed is higher or equal than the cavitation speed during the time set for that purpose, the fault or the pause is produced according to the setting realized. This protection is to avoid that pump operates with no water (detection is realized by under-load). |
| F69 FLOW SWITCH | The digital input configured as flow detection indicates flow absence according to the settings realized in the corresponding parameters. See the protections set in G25.6 to obtain more detailed information. |
| F70 IRRIGATOR F | The digital input configured as ' 62 IRRIGAT TRIP' detects that an external fault in the irrigating equipment has been produced. |
| F71 CYCLING | Conditions set in group G25.6 are not met regarding to the cycle time of the drive and the cycle counter. The SD700 has started a number of times higher than the allowed number without relaxing the established time. |
| F72 IN PRES SW | This fault is produced because of two causes: <br> 1. After starting the system, the time set in G25.9.11 has been exceeded without the digital input configured as PRESSUR SWITC is activated. <br> 2. After the Priming pump has stopped and the drive pump has started, the digital input configured as PRESSUR SWITC is opened during the time set in G25.9.10. |

### 12.2. Procedure for Fault Solutions

| DISPLAY | POSSIBLE CAUSE | ACTIONS |
| :---: | :---: | :---: |
| FONO FAULT |  |  |
| F1I LIM FLT | Motor output short circuit: | Check output cables and motor for possible wiring faults or short circuits. |
|  | Wiring fault. |  |
|  | Circuit fault. |  |
|  | Motor fault. |  |
| F2 V LIM FLT | High voltage peak on the input. | Check conditions of input power supply. Decrease deceleration ramps. |
|  | High load regeneration. |  |
|  | Deceleration ramp too high (parameters 'G5.2 DECEL1' and 'G5.4 DECEL2'). |  |
| F3 PDINT FLT | See faults F1 and F2. | See faults F1 and F2. |
| F4 U + DESAT <br> F5 U-DESAT <br> F6 V + DESAT <br> F7 V- DESAT <br> F8 W+ DESAT <br> F9 W- DESAT | Short circuit. | Check if there are possible wiring faults or a motor fault. If the fault persists after disconnecting output wires request technical assistance. |
|  | Extreme over current, equipment overload. |  |
|  | Wiring fault; circuit fault. |  |
|  | Desaturation of IGBT; IGBT fault. |  |
| F10 NEG DESAT | Short circuit. | Check conditions of input power supply and wiring conditions. |
|  | Extreme over current; equipment overload. |  |
|  | Wiring fault; circuit fault. |  |
|  | Desaturation of IGBT; IGBT fault. |  |
| F11 VIN LOSS | Input power is incorrect, damaged fuses. | Check conditions of input power supply. |
|  | Input wiring is incorrect. | Check wiring. |
| F12 IMB V IN | Input power is incorrect, damaged fuses. | Check conditions of input power supply. |
|  | Input wiring is incorrect. | Check wiring. |
| F13 HIV IN | Input power is incorrect. | Check input power conditions. |
|  | Incorrect setting of parameter 'G11.6 HIGH VOLT'. | Check parameters settings. |
| F14 LW VIN | Input power is incorrect, damaged fuses. | Check input power conditions. |
|  | Incorrect setting of parameter 'G11.4 LOW VOLT'. | Check parameters settings. |
| F15 CURL Vdc | Input power is incorrect. | Check input power conditions, load type of the application, and all of the motor mechanical parts. If the fault persists after disconnecting output wires, request technical assistance. |
|  | Motor is driving an unstable load. |  |
|  | One of the input fuses is damaged. |  |
| F16 HI Vdc | High voltage peak on the input. | Check conditions of input power supply. |
|  | High load regeneration. | Check stop conditions of the drive. |
|  | Deceleration ramp too high (parameters 'G5.2 DECEL1' and 'G5.4 DECEL2'). | Decrease deceleration ramps. |
| F17 LW Vdc | Input power is wrong, damaged fuses. | Check conditions of input power supply. |
| F18 IMB V OUT | Motor is driving an unstable load. | Check motor circuit completely in case of possible wiring faults or motor fault. If the fault persists after disconnecting output wires, request lechnical assistance. |
|  | Motor wiring fault. |  |
|  | Motor is wrong. |  |
| F19 IMB I OUT | Motor is supporting unstable loads. | Check motor circuit completely in case of possible wiring faults or motor fault. |
|  | Motor wiring fault. |  |
|  | Motor is wrong. |  |
| F20 GROUND FLT | Motor or wiring has short-circuited to ground. | Disconnect the motor and wiring of the SD700 and check motor insulation. |
|  | Ground is incorrectly connected or wrong. | Check and improve the ground connection system. |
| F21 I LIM T/O | Motor stalled. Heavy load. Motor mechanical brake is coupled. | Check the motor load. Increase maximum current limit. |
| F22 TQ LIM T/O | Motor stalled. Heavy load. Motor mechanical brake is coupled. | Check the motor load. Increase maximum torque limit. |


| DISPLAY | POSSIBLE CAUSE | ACTIONS |
| :---: | :---: | :---: |
| F25 MTR O/L | High current used by the motor due to heavy load. | Check the motor load. Check the setting of parameters 'G2.1 MTR CUR' and 'G2.7 MTR COOL' relating to the motor thermal model. Increasing the parameter ' G 2.7 MTR COOL', can be undertaken when there is a motor PTC fitted and it is connected to the SD700. |
|  | The load exceeds the capacity of motor cooling under normal operating conditions. |  |
|  | Incorrect setting of the thermal model parameters. |  |
|  | Phase loss of the motor or a fault in motor windings. |  |
| F27 DL SMTH | Potential damage to the soft charge resistors of the SD700. | Try to reset the fault. Disconnect and re-connect again the input power. If the fault persists contact Power Electronics for technical service. |
| F28 MICRO FLT | Input power fault. | Disconnect and re-connect SD700 input power of the drive. If the same fault appears, initialize all of the parameters (parameter ' G 1.5 INITIALISE') and connect the input power again. If the fault persists, request technical assistance. |
|  | Parameters setting is not recognised. |  |
| F29 DSP FLT | Input power fault. | Disconnect and connect again SD700 input power. If the same fault appears, initialize all of the parameters (parameter ' G 1.5 INITIALISE') and connect the input power again. If the fault persists, request technical assistance. |
|  | Parameters setting is incoherent. |  |
| F30 WATCHDOG | Input power fault. | Reset the fault; if the fault persists, request technical assistance. |
| F31 SCR L1 | A conduction fault has been produced in the corresponding thyristor. The thyristor is OFF when it should be on. | Try to reset the fault. Disconnect and re-connect again the input power. If the fault persists request technical assistance. |
| F32 SCR L2 |  |  |
| F33 SCR L3 |  |  |
| F34 IGBT TEMP | Blocked or poor ventilation. | Check if there is an object blocking ventilation. Improve the cooling. |
|  | Heat sink and cooling fan fault on the SD700. | Check if the heat sink and the cooling fan are operating correctly. |
|  | Ambient temperature is higher than $50^{\circ} \mathrm{C}$. | Check the cooling and thermal conditions. Request technical assistance. |
| F35 PHSE L1 LOSS | Input phase L1 is not connected correctly or there is no voltage on it. | Verify the wiring of the input power supply of the drive. Check input voltage and input fuses. |
| F36 PHSE L2 LOSS | input phase L2 is not connected correctly or there is no voltage in it. |  |
| F37 PHSE L3 LOSS | Input phase L3 is not connected correctly or there is no voltage in it. |  |
| F40 EXT / PTC | External trip device has operated. | Check the external trip switch (if exists). |
|  | Motor is overheated (motor load exceeds the cooling capacity at operating speed). | Check motor temperature. <br> To reset the fault the motor must be return to normal temperature. |
|  | Fault in sensor connection. | Check sensor wiring. |
| F41 COMMS TRIP | Trip generated by a computer through serial communication. | Disconnect the SD700 from the communication network and verify if the fault is generated again. |
| F42 AIN1 LOSS | Analogue input cable has been come loose or disconnected (terminals 10 and 11). | Verity the wiring and the device which provides the analogue signal. |
| F43 AIN2 LOSS | Analogue input cable has been come loose or disconnected (T12 and T13). | Verity the wiring and the device which provides the analogue signal. |
| F44 CAL FLT | SD700 fault, | Verify drive select. Request technical assistance. |
| F45 STOP T/O | Deceleration ramps (parameters 'G5.2 DECEL1' and 'G5.4 DECEL2') are too slow. | Verify that the time set in parameter 'G11.2 STOP TO' to stop the system after setting deceleration ramps and checking the system performance. |
|  | SD700 is voltage limiting voltage due to regeneration from the motor. |  |
| F46 EEPROM FLT | Integrated circuit fault. | Request technical assistance. |


| DISPLAY | POSSIBLE CAUSE | ACTIONS |
| :---: | :---: | :---: |
| F47 COMMS T/O | Communications cable has been come loose or cut. | Verify the wiring of communications system. |
|  | Master device has not sent valid data in the required frame or it has sent incorrect data. | Verify the data and settings of the master device. |
| F48 SPI COM | Input power fault. | Reset the equipment and if the fault persists request technical assistance. |
| F49 SPD LIMIT | Speed reference is higher than the speed limit. | Check the reference source and the motor load. |
|  | Motor speed is out of control or motor is accelerating because of the load. | Verify speed limits. |
| F50 PSU FAULT | Damaged power supply. | Reset the equipment and if the fault persists request technical assistance. |
| F51 SCR TEMP | Temperature limits for SD700 rectifier have been exceeded. | Verify that the ambient conditions are proper for the equipment. <br> Be sure that there is nothing obstructing the cooling fans (dust, papers, dirt, etc) and that these rotate correctly. |
| F52 SOFT C TEMP | Fans of the equipment are operating wrong. | Verify that fans are not obstructed. <br> Check that fans are not dirty and rotate correctly. |
|  | Power supply of the fans has been overheated. | Wait for the temperature of the power supply decreases down to a value in normal conditions and restart it. You can disconnect the equipment, connect it again, and restart the power supply again. If the fault persists request technical assistance of Power Electronics. |
| F53 INTRNAL TEMP | The limit of internal temperature of the electronics chamber has been exceeded. | Verify that the ambient conditions are proper for the equipment. <br> Be sure that there is nothing obstructing the cooling fans (dust, papers, dirt in general) and that these rotate correctly. |
| F54 WATCHDOG TMR | A fault in the microcontroller has occurred. | Disconnect and re-connect the input power of the drive. If the fault persists request technical assistance of Power Electronics. |
| F56 <br> EMERGEN.STOP | An external trip has been produced by closing a contact on the digital input configured in this option. | Verity the wiring of digital input. Check the installation. |
| F57 PUMP OVERLOA | High current used by the motor due to heavy load. | Check the motor load. Check if the motor cooling is appropriate. Check the setting of the parameters related to pump overload in group G11. |
|  | The load exceeds the capacity of the motor cooling under normal operating conditions. |  |
|  | Incorrect setting of the parameters related to pump overload. |  |
|  | Phase loss of the motor or a fault in motor windings. |  |
| F65 LOW PRESSURE | Pressure reference is lower than the minimum pressure level (Active in Pump Control mode only). | Verify the setting of minimum pressure level. |
|  |  | Check the operation of the low pressure switch detector. |
|  |  | Check the status of the analogue inputs 1 and 2 in parameters SV3.1 and SV3.4 in displaying group G0. |
| F66 HI PRESSURE | An external trip has been produced by closing a contact on the digital input configured in this option (Active in Pump Control mode only). | Check if the pressure of the installation exceeds the set limits. |
|  |  | Verify the wiring of digital input. |
| F67 LOW WATER | An external trip has been produced by opening a contact on the digital input. (Active in Pump Control mode only) | A contact has activated to indicate that there is a fault by lack of water. Verity the conditions of the installation |
|  |  | Verify the wiring of digital input. |


| DISPLAY | POSSIBLE CAUSE | ACTIONS |
| :---: | :---: | :---: |
| F68 CAVIT/UNDERL | The pump is operating with no load. | Check if the pump of the installation is not operating with no water. |
|  | Settings of the drive in protections group G25.6 are incorrect. | Verify the settings of the parameters referred to the cavitation protection depending on the installation. |
| F69 FLOW SWITCH | The digital input configured as flow detection indicates absence of the same one. | Check if the pump has water. |
|  |  | Check if the flow detector has water and is connected correctly. |
|  |  | Check the settings in group G25.6. |
| F70 IRRIGATOR F | An external trip to the drive has been produced by closing a contact on the digital input configured as IRRIGAT TRIP. | Verify your irrigating equipment and check if the connections between the drive and the irrigating equipment are correct. |
| F71 CYCLING | The drive shows several start / stop cycles (wake up / sleep) in a short time. | Verify possible leakages in the instailation. |
|  |  | Verify the settings of this protection in group G25.6. |
| F72 IN PRES SW | Breakage or low water in aspiration circuit. | Verify the water level in the aspiration circuit (well, tank, etc.). |
|  |  | Verify the status of the pressure switch. |

### 12.3. Maintenance

SD700 drives consist of many electronic parts such as semiconductor devices. Temperature, humidity, vibration and deteriorated components can reduce its efficiency. To avoid any possible irregularity we recommend making periodic inspections.

### 12.3.1. Warnings

- Be sure to remove the input power while performing maintenance.
- Be sure to perform maintenance after checking the DC Link capacitor has discharged. Check that the voltage between terminals $\operatorname{VDC}(+)-\mathrm{VDC}(-)$ is below DC 30 V . The bus capacitors in the drive main circuit can still be charged even after the power is turned off.
- The correct output voltage of the drive can only be measured by using an RMS voltage meter. Others voltage meters, including digital voltage meters, are likely to display incorrect values caused by the high frequency PWM output voltage of the drive.


### 12.3.2. Routine inspection

Be sure to check the following points before handling the drive:

- Installation site conditions.
- Drive cooling system conditions.
- Excessive vibrations.
- Excessive overheating.


## 12．3．3．Daily and periodic inspections

|  | Inspection element | Inspection | Period |  |  | Inspection method | Criterion | Instrument of Measurement |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | $\frac{2 \pi}{\bar{\Pi}}$ | － | ¢ |  |  |  |
| All | Ambient conditions | Are there dust particles？ Are the ambient temperature and the humidity within specification？ | 0 |  |  | See＂Wamings＂ | Temperature： $-3010+50$ <br> Humidity：below $95 \%$ nan－ condensing． | Thermometer， Hygrometer， Recorder． |
|  | Module | Are there any abnormal noises or oscillations？ | 0 |  |  | Visual and audible． | There are no anomalies． |  |
|  | Input power | Is the input power to the main circuit correct？ | 0 |  |  | Measure the voltage between terminals R，S，T and N． |  | Digital multimeter． Tester． |
|  | Conductor／ Cable | Is the conductor corroded？ <br> is the sheathing of the cable damaged？ |  | 0 <br> 0 |  | Visual check． | No anomaly． |  |
|  | Terminal | Is any damage visible？ |  | 0 |  | Visual check． | No anomaly． |  |
|  | IGBT＇s module Diodes module and Rectifier | Check the resistance value between each one of the terminals |  |  | 0 | Disconnect the cables of the drive and measure the resistance value between： $R, S, T \Leftrightarrow V D C+, V D C-$ and $U, V, W \Leftrightarrow V D C+, V D C-$ with a tester $>10 \mathrm{k} \Omega$ |  | Digital multimeter． Analogue tester． |
|  | Correct capacitor | Have fluid leakages been observed？ <br> Is the capacitor well fastened？ <br> Is any dilation or retraction sign observed？ <br> Measure the capacitance | $0$ | $\bigcirc$ |  | Visual check． <br> Measure the capacitance with a proper instrument． | No anomaly Capacitance higher than $85 \%$ of rated capacitance． | Instrument for measuring capacity． |
|  | Contactor | Is there any contactor chatter？ <br> Is the contact damaged？ |  | $0$ |  | Audible check． <br> Visual check． | No anomaly． |  |
|  | Operating check | Is there any imbalance between output voltage phases？ |  | 0 |  | Measure voltage between output terminals U，V and W． | Balanced voltage between phases i．e．lower than 8 V difference for 400 V models． | Digital multimeter／ RMS voltage meter． |
|  | Cooling fan | Are there any abnormal noises or oscillations？ Is the cooling fan disconnected？ | 0 | 0 |  | Disconnect the power supply （OFF）and rotate the fan manually． <br> Check the connections． | Fan should rotate efforlessly． No anomaly． |  |
| $\begin{aligned} & \frac{\pi}{⿳ 士 口 䒑 口 ⺝ 刂} \\ & \text { n } \end{aligned}$ | Measurement | Is the displayed value correct？ | 0 | 0 |  | Check the reading instrument with an external measurement． | Check the specifed values and the control values． | Vollage meler／ Current meter etc． |
| $\begin{aligned} & \text { 흘 } \\ & \text { in } \end{aligned}$ | All | Is there any noise or abnormal vibrations？ Has any unusual smell been perceived？ | $0$ |  |  | Audible，sensory and visual check． <br> Check if damages have been produced by overheating． | No anomaly． |  |
|  | Insulation resistance | Megger check（between terminals of output circuit and ground terminal） |  |  | 0 | Disconnect the cables U，V and $W$ and join them together．Check the resistance between this join and ground． | More than 5M0 | Megger type 500 V |

Note：Long life of the main components above indicated is based on a continuous operation for the slipulated load．
These conditions can change according to the environment conditions．

## 13.COMMONLY USED CONFIGURATIONS

### 13.1. Start / Stop Commands and Speed Reference by Keypad

### 13.1.1. Parameters Configuration

| Parameter | Name / Description | Value |
| :---: | :---: | :---: |
| G1: Options Menu. |  |  |
| 4 LANG=ENGLISH | G1.4 / Language selection | ENGLISH |
| 7 PROG = STANDARD | G1.7/ Program activation | STANDARD |
| G2: Motor Nameplate. |  |  |
| 1 MTR CURR $=00.00 \mathrm{~A}$ | G2.1 / Motor rated current | A (Set according to motor nameplate). |
| 2 MTR VOLT $=400 \mathrm{~V}$ | G2.2 / Motor rated voltage | $\checkmark$ (Set according to motor nameplate). |
| $3 \mathrm{MTR} \mathrm{PWR}=00.0 \mathrm{~kW}$ | G2.3 / Motor rated power | kW (Set according to motor nameplate). |
| 4 MTR RPM $=1485$ | G2.4 / Motor rpm | rpm (Set according to motor nameplate). |
| 5 MTR PFA $=0.85$ | G2.5 / Cosine Phi | (Set according to motor nameplate). |
| $6 \mathrm{MTR} \mathrm{FRQ}=50 \mathrm{~Hz}$ | G2.6 / Motor frequency | Hz (Set according to motor nameplate). |
| 7 MTR COOL=40\% | G2.7 / Motor cooling at zero speed | Use the following values as a reference: <br> Submersible pumps $\rightarrow 20 \%$ <br> Self-cool motor $\rightarrow 40 \%$ <br> Force-cooled motor $\rightarrow$ 100\% |
| G3: References. |  |  |
| 1 REF1 SPD=LOCAL | G3.1 / Speed reference source 1 | LOCAL $\rightarrow$ Reference will be determined by keypad and is set in G3.3 'Local Speed Reference'. |
| 3 LOCAL SPD $=+100 \%$ | G3.3/Local Speed Reference | 100\% |
| G4: Inputs - S4.1: Digital Inputs. |  |  |
| 1 CNTROL MODE $1=1$ | G4.1.1 / Main Control Mode | $1 \rightarrow$ LOCAL (Drive contol is done by keypad). |
| 3 RESET MODE $=Y$ | G4.1.3 / Reset by keypad | $Y \rightarrow$ YES (Enables reset by keypad). |

### 13.2. Start / Stop Commands by Terminals and Speed Reference by Analogue Input

### 13.2.1. Parameters Configuration

| Parameter | Name / Description | Value |
| :---: | :---: | :---: |
| G1: Options Menu. |  |  |
| 4 LANG=ENGLISH | G1.4 / Language selection | ENGLISH |
| 7 PROG = STANDARD | G1.7/Program activation | STANDARD |
| G2: Motor Nameplate. |  |  |
| 1 MTR CURR $=00.00 \mathrm{~A}$ | G2.1/Motor rated current | A (Set according to motor nameplate). |
| 2 MTR VOLT $=400 \mathrm{~V}$ | G2.2 / Motor rated voltage | V (Set according to motor nameplate). |
| 3 MTR PWR $=00.0 \mathrm{~kW}$ | G2.3/ Motor rated power | kW (Set according to motor nameplate). |
| 4 MTR RPM $=1485$ | G2.4 / Motor rpm | rpm (Set according to motor nameplate). |
| 5 MTR PFA $=0.85$ | G2.5 / Cosine Phi | (Set according to motor nameplate). |
| 6 MTR FRQ $=50 \mathrm{~Hz}$ | G2.6 / Motor frequency | Hz (Set according to motor nameplate). |
| 7 MTR COOL $=40 \%$ | G2.7 / Motor cooling at zero speed | Use the following values as a reference: <br> Submersible pumps $\rightarrow 20 \%$ <br> Self-cool motor $\rightarrow 40 \%$ <br> Force-cooled motor $\rightarrow 100 \%$ |
| G3: References. |  |  |
| 1 REF1 SPD=LOCAL | G3.1 / Speed reference source 1 | LOCAL $\rightarrow$ Reference will be introduced by keypad and is set in G3.3 'Local Speed Reference'. |
| 2 REF2 SPD=LOCAL | G3.2 / Speed reference source 2 | Al1 $\rightarrow$ Reference will be introduced by Analogue Input 1. |
| 3 LOCAL SPD $=+100 \%$ | G3.3 / Local Speed Reference | +100\% |


| Parameter | Name / Description | Value |
| :---: | :---: | :---: |
| G4: Inputs - S4.1: Digital Inputs. |  |  |
| 1 CNTROL MODE1 $=2$ | G4.1.1/ Main Control Mode | $2 \rightarrow$ REMOTE (Drive control is done through control terminals). |
| 4 DIGIT I MODE $=1$ | G4.1.4 / Digital Inputs configuration selection | $1 \rightarrow$ ALL PROGRAMMABLE (all digital inputs can be individually configured by the user) configured by the user). |
| 5 DIGITL IN 1=05 | G4.1.5 / Multi-function Digital Input 1 configuration | $05 \rightarrow$ Start/Stop (Allows the start/stop command to be given by a switch). |
| 6 DIGITL IN $2=15$ | G4.1.6 / Multi-function Digital Input 2 configuration | $15 \rightarrow$ Reference 2 (It allows selecting the alternative speed reference programmed in G3.2.) |

### 13.2.2. Connections drawing

Terminals 1 and 2: start / stop command (NO status). Terminals 1 and 3 : alternative reference command (NO status)

X1 CONNECTOR


X2 CONNECTOR



Figure 13.1 Start / Stop commands by terminals and speed reference by analogue input
Note: Use screened cables for the controls and connect screen to ground.

### 13.3. Start / Stop Commands by Terminals and Speed Reference by Motorized Potentiometer

### 13.3.1. Parameters Configuration

| Parameter | Name / Description | Value |
| :---: | :---: | :---: |
| G1: Options Menu. |  |  |
| 4 LANG=ENGLISH | G1.4 / Language selection | ENGLISH |
| 7 PROG = STANDARD | G1.7/Program activation | STANDARD |
| G2: Motor Nameplate. |  |  |
| 1 MTR CURR $=00.00 \mathrm{~A}$ | G2.1 / Motor rated current | A (Set according to motor nameplate). |
| 2 MTR VOLT $=400 \mathrm{~V}$ | G2.2 / Motor rated voliage | $V$ (Set according to motor nameplate). |
| 3 MTR PWR $=00.0 \mathrm{~kW}$ | G2.3 / Motor rated power | kW (Set according to motor nameplate). |
| 4 MTR RPM $=1485$ | G2.4/ Motor rpm | rpm (Set according to motor nameplate). |
| 5 MTR PFA $=0.85$ | G2.5 / Cosine Phi | (Set according to motor nameplate). |
| $6 \mathrm{MTR} \mathrm{FRQ}=50 \mathrm{~Hz}$ | G2.6 / Motor frequency | Hz (Set according to motor nameplate). |
| 7 MTR COOL=40\% | G2.7 / Motor cooling at zero speed | Use the following values as a reference: <br> Submersible pumps $\rightarrow$ 20\% <br> Self-cool motor $\rightarrow 40 \%$ <br> Force-cooled motor $\rightarrow 100 \%$ |
| G3: References. |  |  |
| 1 REF1 SPD=PMOT | G3.1 / Speed reference source 1 | PMOT $\rightarrow$ Motorized potentiometer with or without reference memory. |
| G4: Inputs - S4.1: Digital Inputs. |  |  |
| 1 CNTROL MODE1 $=2$ | G4.1.1 / Main Control Mode | $2 \rightarrow$ REMOTE (Drive control is done through control terminals). |
| 4 DIGIT I MODE $=1$ | G4.1.4 / Digital Inputs configuration selection | $4 \rightarrow$ MOTORIZED POT (It assigns the function of up and down speed reference to two of the digital inputs. DIF = Up (NO Contact) and D16 = Down (NC Contact). Reference is memorized) $5 \rightarrow$ ERASAB POT (As per above mode without memorizing the reference). |
| 5 DIGITL IN 1=05 | G4.1.5 / Multi-function Digital Input 1 configuration | $05 \rightarrow$ Start/Stop (Allows the start/stop command to be given by a switch). |
| G5: Inputs: Acceleration and Deceleration Ramps. |  |  |
| 7 PMT ACL1 $1.0 \%$ /s | G5.7 / Ramp 1 of reference increase for motorized potentiometer | $1.0 \%$ /s (Modify these ramps to tune operation). If the ramp is increased the speed reference response will be faster. If the ramp is decreased the speed reference response will be slower. |
| 8 PMT DCL1=3.0\% / s | G5.8/Ramp 1 of reference decrease for motorized potentiometer | $3.0 \% / \mathrm{s}$ (Modity these ramps to tune operation). If the ramp is increased the speed reference response will be faster. If the ramp is decreased the speed reference response will be slower. |

### 13.3.2. Connections Drawing

Terminals 1 and 2: start / stop command (NO status). Terminals 1 and 6: up speed command (NO status). Terminals 1 and 7: down speed command (NC status).

X1 CONNECTOR


X2 CONNECTOR


SD70DTCODOAAI

Figure 13.2 Start / Stop commands by terminals and speed reference by motorized potentiometer
Note: Use screened cables for the controls and connect the screen to the ground.

### 13.4. Start / Stop Commands by Terminals and Seven Speed References Selectable by Digital Inputs

### 13.4.1. Parameters Configuration

| Parameter | Name / Description | Value |
| :---: | :---: | :---: |
| G1: Options Menu. |  |  |
| 4 LANG=ENGLISH | G1.4 / Language selection | ENGLISH |
| 7 PROG = STANOARD | G1.7 / Program activation | STANDARD |
| G2: Motor Nameplate. |  |  |
| 1 MTR CURR $=00.00 \mathrm{~A}$ | G2.1 / Motor rated current | A (Set according to motor nameplate). |
| 2 MTR VOLT $=400 \mathrm{~V}$ | G2.2 / Motor rated vollage | $\checkmark$ (Set according to motor nameplate). |
| 3 MTR PWR $=00.0 \mathrm{~kW}$ | G2.3 / Motor rated power | kW (Set according to motor nameplate). |
| 4 MTR RPM $=1485$ | G2.4 / Motor rpm | rpm (Set according to motor nameplate). |
| 5 MTR PFA $=0.85$ | G2.5 / Cosine Phi | (Set according to motor nameplate). |
| 6 MTR FRQ $=50 \mathrm{~Hz}$ | G2.6 / Motor frequency | Hz (Set according to motor nameplate). |
| 7 MTR COOL=40\% | G2.7 / Motor cooling at zero speed | Use the following values as a reference: <br> Submersible pumps $\rightarrow \mathbf{2 0 \%}$ <br> Self-cool motor $\rightarrow 40 \%$ <br> Force-cooled motor $\rightarrow 100 \%$ |
| G3: References. |  |  |
| 1 REF1 SPD=MREF | G3.1/ Speed reference source 1 | MREF $\rightarrow$ Multiple speed references activated by digital inputs. |
| G4: Inputs - S4.1: Digital Inputs. |  |  |
| 1 CNTROL MODE $1=2$ | G4.1.1 / Main Control Mode | $2 \rightarrow$ REMOTE (Drive control is done through control terminals). |
| 4 DIGIT I MODE $=3$ | G4.1.4 / Digital Inputs configuration selection | $3 \rightarrow$ MREF 3 WIRES (Automatically programs digital inputs 4, 5 and 6 as multiple speed references for up to 7 different values. The others digital inputs remain user configurable). |
| 5 DIGITL IN 1=05 | G4.1.5 / Multi-function Digital Input 1 configuration | $05 \rightarrow$ Start/Stop (Allows the start/stop command to be given by a switch). |
| G14: Multi-references. |  |  |
| 1 MREF $1=+10.0 \%$ | G14.1 / Multi-reference 1 | $+10.0 \%$ (Allows setting the setpoint 1 value for the drive. It should be set according to the application requirements). |
| 2 MREF $2=+20.0 \%$ | G14.2 / Multi-reference 2 | $+20.0 \%$ (Allows setting the setpoint 2 value for the drive. It should be sel according to the application requirements). |
| 3 MREF 3=+30.0\% | G14.3 / Multi-reference 3 | $+30.0 \%$ (Allows setting the setpoint 3 value for the drive. It should be set according to the application requirements). |
| 4 MREF $4=+40.0 \%$ | G14.4 / Multi-reference 4 | $+40.0 \%$ (Allows setting the setpoint 4 value for the drive. It should be set according to the application requirements). |
| 5 MREF $5=+50.0 \%$ | G14.5 / Multi-reference 5 | $+50.0 \%$ (Allows setting the setpoint 5 value for the drive. It should be set according to the application requirements). |
| 6 MREF $6=+60.0 \%$ | G14.6 / Multi-reference 6 | $+60.0 \%$ (Allows setting the setpoint 6 value for the drive. It should be set according to the application requirements). |
| 7 MREF 7=+70.0\% | G14.7 / Multi-reference 7 | $+70.0 \%$ (Allows setting the setpoint 7 value for the drive. It should be sel according to the application requirements). |

### 13.4.2. Connections Drawing

Terminals 1 and 2: start / stop command (NO status).
Terminals 1 and 5: multi-reference $A$ (NO status).
Terminals 1 and 6: multi-reference M (NO status)
Terminals 1 and 7: multi-reference B (NO status).

| SPEED | REF | Digital Input 4 <br> Multi-reference-A | Digital Input 5 <br> Multi-reference-M | Digital Input 6 <br> Multi-reference-B |
| :--- | :---: | :---: | :---: | :---: |
| G14.1 $=+10.0 \%$ | MREF1 | 0 | 0 | $X$ |
| G14.2 $=+20.0 \%$ | MREF2 | 0 | $X$ | 0 |
| G14.3 $=+30.0 \%$ | MREF3 | 0 | $X$ | $X$ |
| G14.4 $=+40.0 \%$ | MREF4 | $X$ | 0 | 0 |
| G14.5 $=+50.0 \%$ | MREF5 | $X$ | 0 | $X$ |
| G14.6 $=+60.0 \%$ | MREF6 | $X$ | $X$ | 0 |
| G14.7 $=+70.0 \%$ | MREF7 | $X$ | $X$ | $X$ |

Note: 0 : Not active and X : Active.

X1 CONNECTOR


X2 CONNECTOR


SOTODTC0005A

Figure 13.3 Start / Stop commands by terminals and 7 speeds by digital inputs
Note: Use screened cables for the controls and connect the screen to ground.

### 13.5. Pressure Group Control with 3 Auxiliary Pumps, Start and Stop on Demand

### 13.5.1. Parameters Configuration

| Parameter | Name / Description | Value |
| :---: | :---: | :---: |
| G1: Options Menu. |  |  |
| 4 LANG=ENGLISH | G1.4 / Language selection | ENGLISH |
| 7 PROG = PUMP | G1.7/Program Activation | PUMP (It activates the extended functionality of the pump control in group G25). |
| G2: Motor Nameplate. |  |  |
| 1 MTR CURR $=00.00 \mathrm{~A}$ | G2.1 / Motor rated current | A (Set according to motor nameplate). |
| 2 MTR VOLT $=400 \mathrm{~V}$ | G2.2 / Motor rated voltage | $V$ (Set according to motor nameplate). |
| 3 MTR PWR $=00.0 \mathrm{~kW}$ | G2.3/ Motor rated power | kW (Set according to motor nameplate). |
| 4 MTR RPM $=1485$ | G2.4/ Motor rpm | rom (Set according to motor nameplate). |
| 5 MTR PFA $=0.85$ | G2.5 / Cosine Phi | - (Set according to motor nameplate). |
| $6 \mathrm{MTR} \mathrm{FRQ}=50 \mathrm{~Hz}$ | G2.6 / Motor frequency | Hz (Set according to motor nameplate). |
| 7 MTR COOL $=40 \%$ | G2.7 / Motor cooling at zero speed | Use the following values as a reference: <br> Submersible pumps $\rightarrow 20 \%$ <br> Self-cool motor $\rightarrow 40 \%$ <br> Force-cooled motor $\rightarrow 100 \%$ |
| G4: Inputs - S4.1: Digital Inputs. |  |  |
| 5 DIGITL IN 1=50 | G4.1.5 / Multi-function Digital Input 1 configuration | $50 \rightarrow$ PMP START/STP (Automatic starting of the system). |
| 6 DiGITL IN 2=52 | G4.1.6 / Multi-function Digital Input 2 configuration | $52 \rightarrow$ FIX PUMP1 FLT (Detection of auxiliary pump 1 in faulit status). |
| 7 DIGITL IN 3=53 | G4.1.7 / Multi-function Digital Input 3 configuration | $53 \rightarrow$ FIX PUMP2 FLT (Detection of auxiliary pump 2 in fault status). |
| 8 DIGITL IN 4=54 | G4.1.8 / Mutti-function Digital Input 4 configuration | $54 \rightarrow$ FIX PUMP3 FLT (Detection of auxiliary pump 3 in fault status). |


| Parameter | Name / Description | Value |
| :---: | :---: | :---: |
| G25: Pump Control - S25.1: Setpoints. |  |  |
| 1 CONTROL MODE 1 | G25.1.1/ Control mode | $\dagger \rightarrow$ Pumps. The drive will starl in pump control mode. |
| 5 SETPT1=x.xBar | G25.1.5 / Setpoint 1 for the PID | $\mathrm{x} . \mathrm{x}$ ar $\rightarrow$ Local setpoint 1. (Set according to the installation). |
| G25: Pump Control - S25.2: PID Setting. |  |  |
| 1 PID SETP $=$ LOCAL | G25.2.1 / PID reference source | LOCAL $\rightarrow$ Speed reference introduced by keypad. |
| 3 PID FBK=Al2 | G25.2.3/PID feedback source | Al2 $\rightarrow$ Feedback signal connected to Analogue lnput 2. |
| G25: Pump Control - S25.3: Start Conditions. |  |  |
| 1 Lp Pon=0.0Bar | G25.3.1 / Wake up level of the drive | $\mathrm{x} . \mathrm{x}$ Bar $\rightarrow$ When demand decreases, the drive can go in sleep mode. (It allows seting the wake up level for the drive. This value is set as units of PID setpoint). |
| $2 \mathrm{FP} \mathrm{SpON}=90.0 \%$ | G25.3.2 / Slart speed for the fixed pumps | $90.0 \% \rightarrow$ It sets the drive speed above which fixed pumps will start. (Set according to the installation). |
| $3 \mathrm{FP} \mathrm{ErON}=10.0 \%$ | 625.3.3 / Minimum PIO error to start fixed pumps | $10.0 \% \rightarrow$ This parameter allows user to consider the PID error (\%) at the moment of starting fixed pumps. |
| 4 FP T1 ON=10.0s | G25.3.4 / Delay tirme to start fixed pump 1 | $10.0 \mathrm{~s} \rightarrow$ it sets the delay time to start the fixed pump associated to the Relay 1. |
| 5 FP T2 ON=10.0s | G25.3.5 / Delay time to start fixed pump 2 | $10.0 \mathrm{~s} \rightarrow$ It sets the delay time to start the fixed pump associated to the Relay 2. |
| 6 FP T3 ON= 10.05 | G25.3.6 / Delay time to start fixed pump 3 | $10.0 \mathrm{~s} \rightarrow$ It sets the delay time to start the fixed pump associated to the Relay 3. |
| G25: Pump Control - S25.4: Stop Conditions. |  |  |
| 1 LP T SLP=20s | G25.4.1 / Delay time before activating sleep mode | $20 s \rightarrow$ This delay time will be applied to any conditions that activate the sleep mode. These conditions are: sleep speed, No Flow input, Flow measurement and sleep current. |
| 2 SLPsp $1=+40.0 \%$ | G25.4.2 S Sleep speed for local selpoint 1 | $+40.0 \% \rightarrow$ The drive will sleep below the value set here whenever local sepoint 1 is selected. |
| 13 FP erOFF $=+0.0 \%$ | G25.4.13 / Maximum PID error to stop fixed pumps | $0.0 \% \rightarrow$ This parameter allows user to consider the PID error (\%) at the moment of stopping fixed pumps. (Set according to the requirements). |
| 14 FP T1 OF= 10 s | G25.4.14 / Delay time to stop fixed pump 1 | $10 \mathrm{~s} \rightarrow$ It sets the delay time to stop the fixed pump associated to the Relay 1. |
| 15 FP T2 OF= 10 s | G25.4.15 / Delay time to stop fixed pump 2 | $10 s \rightarrow$ It sets the delay time to stop the fixed pump associated to the Relay 2. |
| 16 FP T 3 OF=10s | G25.4.16 / Delay time to stop fixed pump 3 | $10 s \rightarrow$ It sets the delay time to stop the fixed pump associated to the Relay 3 . |
| 19 SPD10f=+70.0\% | G25.4.19 / Stop speed 1 for one fixed pump | $+70.0 \% \rightarrow$ it sets the speed below which the drive must remain to stop one fixed pump whenever the operating setpoint is local setpoint 1 adjusted in G25.1.5. |
| G25: Pump Control - S25.9: Fixed Pumps Control. |  |  |
| 1 ENABLE PUMP1=Y | G25.9.1 / To enable fixed pump associated to Relay 1 | $\mathrm{Y}=\mathrm{YES} \rightarrow$ if setting is set to NO Relay 1 will be free for user configuration. If set to YES Relay 1 will be pre-defined as fixed speed pump 1. |
| 2 ENABLE PUMP2=Y | G25.9.2 / To enable fixed pump associated to Relay 2 | $\mathrm{Y}=\mathrm{YES} \rightarrow \mathrm{If}$ setting is set to NO Relay 2 will be free for user configuration. If set to YES Relay 2 will be pre-defined as fixed speed pump 2. |
| 3 ENABLE PUMP3=Y | G25.9.3 / To enable fixed pump associated to Relay 3 | $Y=Y E S \rightarrow \mid i$ setting is set to NO Relay 3 will be free for user configuration. If sel to YES Relay 3 will be pre-defined as fixed speed pump 3. |
| 4 FP ALTER MOD $=1$ | G25.9.4 / To enable fixed pump alternation mode | $1 \rightarrow$ Cycle (The pump that starts will be the next pump in sequence to the last pump stopped). |

### 13.5.2. Connections Drawing

There are several configuration options available when pump program is activated. These options can be configured like in standard program.

Nevertheless, unlike standard program, when pump program is activated, the drive will only allow setting the options of each digital input (from G4.1.5 to G4.1.10) and will not consider the setting realized in parameter 'G4.1.4 DIGIT I MODE', where digital inputs are set in groups.

This means that user will configure the pump program as he wants, by selecting the functionality and protections that he needs. For a correct configuration of the inputs when pump program is active, see chapter G25 Pump Control to get additional information.

Note: If the Pump Control program is selected and then de-selected, all of the Digital Inputs will be reset to mode ' 00 ' (i.e. unused). It will be necessary to individually configure Digital Input functionality to suit the application should this occur. This guarantees safe installation and operation in order to prevent any external hardware causing damage to the equipment.

Note: Digital outputs will be affected by pump control activation.
To select an auxiliary pump you must proceed like this:

- Set any free digital input to the options '52 FIX PUMP1 FLT', '53 FIX PUMP2 FLT' or '54 FIX PUMP3 FLT'.
- Enable the pump control in the corresponding parameter G25.9.1, G25.9.2 and G25.9.3 respectively.
To remove the configuration of that fixed pump and release the relay for other use you must Disable the pump control in the corresponding parameter G25.9.1, G25.9.2 and G25.9.3 respectively.

X1 CONNECTOR


Figure 13.4 Pressure Group Control with 3 Auxiliary Pumps, Start and Stop on demand
Note: Use screened cables for the controls and connect the screen to ground

### 13.6. Pressure Group Control with Eight Pressure References

### 13.6.1. Parameters Configuration

| Parameter | Name / Description | Value |
| :---: | :---: | :---: |
| G1: Options Menu. |  |  |
| 4 LANG=ENGLISH | G1.4 / Language selection | ENGLISH |
| 7 PROG = PUMP | G1.7 / Program Activation | PUMP (It activates the extended functionality of the pump control in group G25). |
| G2: Motor Nameplate. |  |  |
| 1 MTR CURR $=00.00 \mathrm{~A}$ | G2.1 / Motor rated current | A (Set according to motor nameplate). |
| $2 \mathrm{MTR} \mathrm{VOLT}=400 \mathrm{~V}$ | G2.2 / Motor rated voltage | V (Set according to motor nameplate). |
| 3 MTR PWR $=00.0 \mathrm{~kW}$ | G2.3 / Motor rated power | kW (Set according to motor nameplate). |
| 4 MTR RPM $=1485$ | G2.4 / Motor rpm | rpm (Set according to motor nameplate). |
| 5 MTR PFA $=0.85$ | G2.5 / Cosine Phi | (Set according to motor nameplate). |
| $6 \mathrm{MTR} \mathrm{FRQ}=50 \mathrm{~Hz}$ | G2.6 / Motor frequency | Hz (Set according to motor nameplate). |
| 7 MTR COOL=40\% | G2.7 / Motor cooling at zero speed | Use the following values as a reference: <br> Submersible pumps $\rightarrow$ 20\% <br> Self-cool motor $\rightarrow 40 \%$ <br> Force-cooled motor $\rightarrow 100 \%$ |
| G3: References. |  |  |
| 1 REF1 SPD=PID | G3.1/ Speed reference source 1 | PID $\rightarrow$ The reference value is set for PID functionality. |
| G4: Inputs - S4.1: Digital Inputs. |  |  |
| 5 DIGITL IN 1=50 | G4.1.5 / Multi-function Digital Input 1 configuration | $50 \rightarrow$ PMP START/STP (Automatic starting of the system). |
| 6 DIGITL IN 2=63 | G4.1.6 / Multi-function Digital Input 2 configuration | $63 \rightarrow$ SETPONT PIN1 (low bit configuration for the selection of multiple setpoints). |
| 7 DIGITL IN 3=64 | G4.1.7 / Multi-function Digital Input 3 configuration | $64 \rightarrow$ SETPONT PIN2 (middle bit configuration for the selection of multiple setpoints). |
| 8 DIGITL IN 4=65 | G4.1.8 / Multi-function Digital Input 4 configuration | $65 \rightarrow$ SETPONT PIN3 (high bit configuration for the selection of multiple setpoints). |
| G4: Inputs - S4.3: Analogue Input 2. |  |  |
| 1 SENSOR 2 ? $=$ S | G4.3.1 / To enable sensor of Analogue Input 2 | $\mathrm{Y}=\mathrm{YES} \rightarrow$ li allows enabling the sensor of the Analogue Input 2 that will be used for PID feedback. |
| 2 SENSOR 2=Bar | G4.3.2 / Selection of sensor 2 units | Bar $\rightarrow$ These units must be set according to type of sensor that user will use in the installation. |
| 3 AIN2 FORMAT=mA | G4.3.3 / Analogue Input 2 Format | $\mathrm{mA} \rightarrow$ These units must be set according to the type of sensor that user will use in the installation. |
| $41 \mathrm{Nmin} 2=+4 \mathrm{~mA}$ | G4.3.4 / Minimum range of Analogue Input 2 | $+4 \mathrm{~mA} \rightarrow$ These units must be set according to the type of sensor that user will use in the installation. |
| $5 \mathrm{Smi}=+0.0 \mathrm{Bar}$ | G4.3.5 / Minimum range of sensor 2 | $+0.0 \mathrm{Bar} \rightarrow$ This range must be set according to the type of sensor that user will use in the installation. |
| 61Nmax2=+20mA | G4.3.6 / Maximum range of Analogue Input 2 | $+20 \mathrm{~mA} \rightarrow$ These units must be set according to the type of sensor that user will use in the installation. |
| $7 \mathrm{Sma}=+10.0 \mathrm{Bar}$ | G4.3.7 / Maximum range of sensor 2 | $+10.0 \mathrm{Bar} \rightarrow$ This range must be set according to the type of sensor that user will use in the installation. |
| G25: Pump Control - S25.1: Setpoints. |  |  |
| 1 CONTROL MODE $=1$ | G25.1.1 / Control mode | $1 \rightarrow$ Pumps. The drive will start in pump control mode. |
| 5 SETPT1=1.0Bar | G25.1.5 / Local setpoint 1 for the PID | 1.0 Bar $\rightarrow$ It allows user to set the value of the speed reference 1 for the equipment. (Set according to the requirements of the applic.) |
| 6 SETPT2=2.0Bar | G25.1.6 / Local setpoint 2 for the PID | $2.0 \mathrm{Bar} \rightarrow \mathrm{It}$ allows user to set the value of the speed reference 2 for the equipment. (Set according to the requirements of the applic.) |
| 7 SETPT3=3.0Bar | G25.1.7 / Local setpoint 3 for the PID | 3.OBar $\rightarrow$ It allows user to set the value of the speed reference 3 for the equipment. (Set according to the requirements of the applic.) |
| 8 SETPT4=4.0Bar | G25.1.8 / Local setpoint 4 for the PID | $4.0 \mathrm{Bar} \rightarrow$ It allows user to set the value of the speed reference 4 for the equipment. (Set according to the requirements of the applic.) |
| 9 SETPT5=5.0Bar | G25.1.9 / Local setpoint 5 for the PID | 5.0Bar $\rightarrow$ It allows user to set the value of the speed reference 5 for the equipment. (Set according to the requirements of the applic.) |
| 10 SETPT6=6.0Bar | G25.1.10 / Local setpoint 6 for the PID | $6.0 \mathrm{Bar} \rightarrow$ It allows user to set the value of the speed reference 6 for the equipment. (Set according to the requirements of the applic.) |
| 11 SETPT7=7.08ar | G25.1.11 L Local setpoint 7 for the PID | $7.08 \mathrm{ar} \rightarrow$ It allows user to set the value of the speed reference 7 for the equipment. (Set according to the requirements of the applic.) |
| 12 SETPT8=8.0Bar | G25.1.12 / Local setpoint 8 for the PID | 8.08 ar $\rightarrow$ It allows user to set the value of the speed reference 8 for the equipment. (Set according to the requirements of the applic.) |


| Parameter | Name / Description | Value |
| :---: | :---: | :---: |
| G25: Pump Control - S25.2: PID Setting. |  |  |
| 3 PID FBK=AI2 | G25.2.3 / PID feedback source | Al2 $\rightarrow$ It allows selecting Analogue Input 2 as feedback signal for PID regulator. |
| G25: Pump Control - S25.3: Start Conditions. |  |  |
| 1 LP Pon=0.0Bar | G25.3.1 / Wake up level of the drive | $x . x$ Bar $\rightarrow$ When demand decreases, the drive can go in sleep mode. (It allows setting the wake up level for the drive. This value is set as units of PID setpoint). |
| G25: Pump Control - S25.4: Stop Conditions. |  |  |
| 1 LP T SLP=20s | G25.4.1 / Delay time before activating sleep mode | $20 s \rightarrow$ This delay time will be applied to any conditions that activate the sleep mode. These conditions are: sleep speed, No Flow input, Flow measurement and sleep current. If anyone of them is met, the time to activate sleep mode will start elapsing. |
| 2 SLPsp1=+40.0\% | G25.4.2 / Sleep speed for local setpoint 1 | $+40.0 \% \rightarrow$ It allows setting the sleep speed 1 below which the drive will sleep whenever local setpoint 1 is selected. (Set according to the installation). |
| 3 SLPsp2=+42.0\% | G25.4.3 / Sleep speed for local setpoint 2 | $+42.0 \% \rightarrow$ It allows setting the sleep speed 2 below which the drive will sleep whenever local setpoint 2 is selected. (Set according to the installation). |
| 4 SLPsp3=+44.0\% | G25.4.4 / Sleep speed for local setpoint 3 | $+44.0 \% \rightarrow$ It allows setting the sleep speed 3 below which the drive will sleep whenever local setpoint 3 is selected. (Set according to the installation). |
| $5 \mathrm{SLPsp4}=+46.0 \%$ | G25.4.5 / Sleep speed for local setpoint 4 | $+46.0 \% \rightarrow$ It allows setting the sleep speed 4 below which the drive will sleep whenever local setpoint 4 is selected. (Set according to the installation). |
| 6 SLPsp=+48.0\% | G25.4.6 / Sleep speed for local setpoint 5 | $+48.0 \% \rightarrow$ It allows setting the sleep speed 5 below which the drive will sleep whenever local setpoint 5 is selected. (Set according to the installation). |
| $7 \mathrm{SLPsp}=+50.0 \%$ | G25.4.7 / Sleep speed for local setpoint 6 | $+50.0 \% \rightarrow$ It allows setting the sleep speed 6 below which the drive will sleep whenever local setpoint 6 is selected. (Set according to the installation). |
| $8 \mathrm{SLPsp}=+52.0 \%$ | G25.4.8 / Sleep speed for local setpoint 7 | $+52.0 \% \rightarrow$ It allows setting the sleep speed 7 below which the drive will sleep whenever local setpoint 7 is selected. (Set according to the installation). |
| 9 SLPsp8=+54.0\% | G25.4.9 / Sleep speed for local setpoint 8 | $+54.0 \% \rightarrow$ It allows setting the sleep speed 8 below which the drive will sleep whenever local setpoint 8 is selected. (Set according to the installation). |

### 13.6.2. Connections Drawing

Terminals 1 and 2: start / stop command (NO status).
Terminals 1 and 3: setpoint pin 1 - PID mode (NO status).
Terminals 1 and 4: setpoint pin 2 - PID mode (NO status).
Terminals 1 and 5: setpoint pin 3 - PID mode (NO status)

| SPEED | SETPT | Digital Input 4 <br> SETPONT PIN3 | Digital Inpul 3 <br> SEIPONT PIN2 | Digital Input 2 <br> SE TPONT P1N 1 |
| :--- | :---: | :---: | :---: | :---: |
| G25.1.5 =1.0Bar | SETPT1 | 0 | 0 | 0 |
| G25.1.6 =2.0Bar | SETPT2 | 0 | 0 | $X$ |
| G25.1.7 =3.0Bar | SETPT3 | 0 | $X$ | 0 |
| G25.1.8 =4.0Bar | SETPT4 | 0 | X | X |
| G25.1.9 =5.0Bar | SETPT5 | X | 0 | 0 |
| G25.1.10 =6.0Bar | SETPT6 | X | 0 | X |
| G25.1.11 =7.0Bar | SETPT7 | X | X | 0 |
| G25.1.12 =8.0Bar | SETPT8 | X | X | X |

Note: 0 : Nol active and $X$ : Active.

## X1 CONNECTOR



## X2 CONNECTOR



Figure 13.5 Pressure Group Control with Eight Pressure Setpoints
Note: Use screened cables for the control and connect the screen to ground.

## 14.CONFIGURATION REGISTER

VARIABLE SPEED DRIVE: SD700.<br>SERIAL No:<br>APPLICATION:<br>DATE:<br>CUSTOMER:<br>NOTES:


#### Abstract

To save parameters into the display: The SD700 can copy the drive configuration into the display to use at a later stage if necessary. This allows the user to test different settings without losing current configuration of the equipment, program multiple drives using one display, or to keep a copy of the drive configuration for future commissioning requirements. To achieve this follow the steps described below:


- Go into subgroup S1.10.
- To memorize parameters into the display:
- Set G1.10.1 UPLOAD=Y
- The display will show: UPLOADING... $100 \%$. Current parameter setting of the drive has been stored into the display.
- To transfer memorized data from display to drive:

> - Set G1.10.2 DOWNLOAD=Y.

- The display will show: DOWNLOADING... $100 \%$. Memorized setting inside the display will be transferred to the drive.

| PARAMETERS | FACTORY SETTINGS | SETTING 1 | SETTING 2 |
| :---: | :---: | :---: | :---: |
| G1: Options Menu |  |  |  |
| 1 LOCK PARMTRS=0 | 0 |  |  |
| 2 PASSWORD_OFF | OFF |  |  |
| 3 PSW ERR=XXXX | Xxxx |  |  |
| 4 LANG=ESPANOL | ESPANOL |  |  |
| 5 INITIALISE $=0$ | 0 |  |  |
| 6 SHORT Menu=NO | NO |  |  |
| 7 PROG = STANDARD | STANDARD |  |  |
|  | G1: Options | : Eloader |  |
| UPLOAD=N |  |  |  |
| DOWNLOAD=N |  |  |  |
| G1: Options Menu |  |  |  |
| 11 FANCTRL=FIXE | FIXE |  |  |


| PARAMETERS | FACTORY SETTINGS | SETTING 1 | SETTING 2 |
| :---: | :---: | :---: | :---: |
| G2: Motor Nameplate Data |  |  |  |
| 1 MTR CUR $=00.00 \mathrm{~A}$ | 00.00A |  |  |
| 2 MTR VOLT $=400 \mathrm{~V}$ | 400 V |  |  |
| MOTOR VOLTAGE |  |  |  |
| 3 MTR PWR $=00.0 \mathrm{~kW}$ | 00.0 kW |  |  |
| MOTOR POWER |  |  |  |
| 4 MTR RPM $=1485$ | 1485 |  |  |
| MOTOR SPEED (pm) |  |  |  |
| 5 MTR PFA $=0.85$ | 0.85 |  |  |
| MIR POWER FACTOR |  |  |  |
| 7 MTR COOL=40\% | 40\% |  |  |
| MOTOR COOLING |  |  |  |
| - 3 : References |  |  |  |
| 1 REF1 SPD=LOCAL | local |  |  |
| 2 REF2 SPD=LOCAL | local |  |  |
| 3 LOCAL SPD $=+100 \%$ |  |  |  |
| LOCAL SPEED | +100\% |  |  |
| G4: Inputs - S4.1: Digital Inputs |  |  |  |
| 1 CNTROL MODE1=1 | 1 |  |  |
| 2 CNTROL MODE2 22 | 2 |  |  |
| 3 RESET MODE $=Y$ | Y |  |  |
| 4 DIGIT I MODE $=1$ | 1 |  |  |
| 5 DIGITL IN 1=06 | 06 |  |  |
| 6 DIGITL IN 2=00 | 00 |  |  |
| 7 DIGITL IN 3=00 | 00 |  |  |
| 8 DIGITL IN 4=00 | 00 |  |  |
| 9 DIGITL IN 5=00 | 00 |  |  |
| 10 DIGILL ${ }^{1 N} 6=17$ | 17 |  |  |
|  | G4: Inputs- S4.2: Analogue Input 1 |  |  |
| 1 SENSOR 1 ? $=$ N | N |  |  |
| 2 SENSOR $1=1 / \mathrm{s}$ | I/s |  |  |
| 3 AIN1 FORMAT $=V$ | $v$ |  |  |
| 4 INmin1 $=+0 \mathrm{~V}$ | +0V |  |  |
| 5 Smi $=+0.01 / \mathrm{s}$ | +0.01/s |  |  |
| SENSILOWRANGE |  |  |  |
| $6 \mathrm{INmax} 1=+10 \mathrm{~V}$ | +10V |  |  |
| AINI HIGH RANGE |  |  |  |
| $\begin{aligned} & 7 \text { Sma } 1=+10.01 / \mathrm{s} \\ & \text { SENSIHIGH RANGE } \end{aligned}$ | +10.01/s |  |  |
| $8 \text { SPD } \frac{L 01=+0 \%}{\text { SPDLO RNG ANN1 }}$ | +0\% |  |  |
| 9 SPD H11 $=+100 \%$ | +100\% |  |  |
| SPD HIG RNG AIN1 |  | - |  |




| PARAMETERS | FACTORY SETTINGS | SETTING 1 | SETTING 2 |
| :---: | :---: | :---: | :---: |
| G6: PID Control |  |  |  |
| 1 SEL REF=MREF2 PID $\angle O C=+0.0 \%$ |  |  |  |
|  |  |  |  |
| PID LOCAL SEIPOI | +0.0\% |  |  |
| 3 SEL FBK=Al2 | Al2 |  |  |
| $4 \text { GAIN Kp=8.0 }$ |  |  |  |
| $5 \text { INTEGRAL }=0.0 \mathrm{~s}$ |  |  |  |
| 6 DIFFEREN $=0.0 \mathrm{~s}$ |  |  |  |
| PID DIFFERENTIAP 0.0 s |  |  |  |
| 7 INVERT PID=N N |  |  |  |
| 8 ERR PID $=+0.0 \% \quad+0.0 \%$ |  |  |  |
| G7: Start / Stop Mode Configuration |  |  |  |
|  |  |  |  |
| 2 STOP $2=$ SPIN SPIN |  |  |  |
| 3 BRK STP $2=0$ FF |  |  |  |
| 4 START $=$ RAMP $\quad$ RAMP |  |  |  |
| 5 START $2=$ RAMP RAMP |  |  |  |
| $6 \text { START DLY }=\text { OFF }$ |  |  |  |
| 7 STOPDLY $=$ OFF |  |  |  |
| 8 STP MIN SP $=\mathrm{N}$ <br> 9 OFFRet = OFF |  |  |  |
|  |  |  |  |
| 10 RUN AFTR VFL $=\mathrm{Y}$ <br> 11 SPNstr B=OFF |  |  |  |
| SPIN START TUNE OFF |  |  |  |
| $12 \text { OFFdy } 2=0 \mathrm{FF}$ |  |  |  |
| G8:Outputs-S8.1: Dutput Relays |  |  |  |
| 1 SEL RELAY 1=02 02 |  |  |  |
| $\begin{array}{ll} 2 \mathrm{TR} 10 \mathrm{~N}=0.0 \mathrm{~s} \\ \mathrm{R} 1 \mathrm{ACTIVATDELAY} \end{array}$ |  |  |  |
| $3 \mathrm{TR1OFF}=0.0 \mathrm{~s}$ |  |  |  |
| R1 DEACTIV DELAY 0.0 s |  |  |  |
| 4 INVERT R1=N N |  |  |  |
| 6 T R2 ON=0.0s |  |  |  |
|  |  |  |  |
| $7 \mathrm{TR} 2 \mathrm{OFF}=0.0 \mathrm{~s}$ |  |  |  |
| R2 DEACIIVDELAY | 0.0 s |  |  |
| 8 INVERT R2-N | N |  |  |
| 9 SEL RELAY 3=05 | 05 |  |  |
| $\begin{aligned} & 10 \text { T R3 ON }=0.0 \mathrm{~s} \\ & \text { R3ACTIVAT DELAY } \end{aligned}$ | 0.0s |  |  |





| PARAMETERS | FACTORY SETTINGS | SETTING 1 | SETTING 2 |
| :---: | :---: | :---: | :---: |
| 6 MREF $6=+60.0 \%$ | +60.0\% |  |  |
| 7 MREF $7=+70.0 \%$ |  |  |  |
| MULT-REFERENCET | +70.0\% |  |  |
| G15: Inch Speeds |  |  |  |
| $1 \text { INCH1=+0.00\%}+$ | +0.00\% |  |  |
| $2 \mathrm{INCH} 2=+0.00 \%$ |  |  |  |
| INCH SPEED 2 | +0.00\% |  |  |
| $3 \text { INCH3 }=+0.00 \%$ | +0.00\% |  |  |
| __ G16: Skip Frequencies |  |  |  |
| 1 SKIP $1=+0.0 \%$ |  |  |  |
| SKIP FREQUENCY 1 | +0.0\% |  |  |
| 2 SKIP $2=+0.0 \%$ |  |  |  |
| SKIP FREQUENCY 2 | +0.0\% |  |  |
| 3 SKIP BAND=OFF | OFF |  |  |
| G17: Brake |  |  |  |
| $\begin{aligned} & 1 \text { TDC BRAKE=OFF } \\ & \text { DCBRAKING TLWE } \end{aligned}$ | OFF |  |  |
| 2 DC CURR 0 \% | 0\% |  |  |
| DCCURRENTLEVEL |  |  |  |
| 3 DC VOLTS $=0.0 \%$ | 0.0\% |  |  |
| $41 \mathrm{HEATING}=$ OFF | OFF |  |  |
| Lde HEATING |  |  |  |
| 5 DYN BRAK $=$ N | N |  |  |
| 6 VDC BRAKE $=$ OFF | OFF |  |  |
| VDC BRAKE START |  |  |  |
| G19: Fine Tuning - 519.1: IGBT Control |  |  |  |
| 1 TYPE CRTL= $\mathrm{V} / \mathrm{Hz}$ | $\mathrm{V} / \mathrm{Hz}$ |  |  |
| 2 FRQ=4000 | 4000 |  |  |
| MODULAT FREQUENC |  |  |  |
| 3 PEWAVE=Y | Y |  |  |
| G19: Fine Tuning-S19.2: MTR Load |  |  |  |
| $1 \text { MIN FLUX }=100 \%$ | 100\% |  |  |
| 2 V BOOST $=0.0 \%$ | 0.0\% |  |  |
| BOOST VOLTAGE |  |  |  |
| 3 BW BOOST $=0.0 \%$ | 0.0\% |  |  |
|  |  |  |  |
| 4 SLIP COMPENS $=$ N | $N$ |  |  |
| 5 DAMPING $=0.0 \%$ | 0.0\% |  |  |
| 6 TPP BAND=0.0\% | 0.0\% |  |  |
| 71 SLIP $=2.0 \%$ | 2.0\% |  |  |
| 9 STR FRQ $=0.0 \%$ | 0.0\% |  |  |
| START FREQUENCY |  |  |  |
| $10 \mathrm{~V} / \mathrm{H}$ BREK=OFF | OFF |  |  |
| EROVITZ CHANGE |  |  |  |
| 11 STAF AC=OFF | OFF |  |  |
| STABIUZE FiACC |  |  |  |






| PARAMETERS FACTORY SETTINGS |  | SETting 1 | SETTING 2 |
| :---: | :---: | :---: | :---: |
| $1 \mathrm{COMP} 1=0.0 \mathrm{Bar}$-G25: Pump Control- S25.8: Setpoint Compensation due to Pressure Loss |  |  |  |
|  |  |  |  |
| SEIPOINT COMPEN1 | 0.08 ar |  |  |
| $2 \mathrm{COMP} 2=0.0 \mathrm{Bar}$ |  |  |  |
| SEIPOINTCOMPEN2 | 0.0Bar |  |  |
| 3 COMP 3=0.0Bar |  |  |  |
| SEIPOINT COMPENS | 0.08ar |  |  |
| 4 COMP $4=0.0 \mathrm{Bar}$ |  |  |  |
| SEIPOITI COMPEM | 0.0Bar |  |  |
| 5 COMP $5=0.0 \mathrm{Bar}$ |  |  |  |
| SEIPOINT COMPENS | 0.08ar |  |  |



## DECLARATION OF CONFORMITY CE

## The Company:

Name:
Address:
Telephone:
Fax:

POWER ELECTRONICS ESPAÑA, S.L.
C/ Leonardo Da Vinci, 24-26, 46980 Paterna (Valencia) +34 961366557
+34 961318201

Declares under its own responsibility, that the product:

Frequency Inverter for A.C. motors
Brand: Power Electronics
Model name: SDRIVE 700 Series

Is in conformity with the following European Directives:

| References | Title |
| :--- | :--- |
| $73 / 23 /$ CEE | Electrical Material intended to be used with certain limits of voltage |
| $93 / 68 /$ CEE | Modification of Directive $73 / 23 /$ CEE |
| $89 / 336 /$ CEE | Electromagnetic Compatibility |
| $92 / 31 /$ CEE | Modification of Directive $89 / 336 /$ CEE |
| $93 / 68 /$ CEE | Modification of Directive $89 / 336 /$ CEE |

References of the harmonized technical norms applied under the Low Voltage Directive:

| References | Title |
| :--- | :--- |
| UNE EN 50178: 1998 | Electronic equipment for use in power installations |

References of the harmonized technical norms applied under the Electromagnetic Compatibility Directive:

| References : | Title |
| :--- | :--- |
| UNE EN 61800-3: 1998 | Adjustable speed electrical power drive systems. Part 3: EMC product standard <br> including specific test methods. |
| UNE-EN 61800-3/A11:2002 | Adjustable speed electrical power drive systems. Part 3: EMC product standard <br> including specific test methods. |

## Paterna, September 3 ${ }^{\text {rd }} 2005$



[^33]
## 3 <br> POWER ELECTRONICS

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```

Halmac Services (Qld) Pty. Ltd.
AC.N. 098852923
ABN 40741712113

## TEST SHEET

## 1. PUMP STATION SP086 TEST SHEET

# Halmac Services (Qld) Pty Ltd 

ACN 098852923 ABN 40741712113 ECl S3064

30 Palmer Place, Murarrie Qld 4172
All hours Telephone (07) 32499500
Email: info@halmac.net.au

PO Box 3467, Tingalpa DC Qid 4173
Facsimile (07) 32499599
Web: www.halmac.net.au

## CERTIFICATE OF:

(Please mark relevant check-box)

* Work performed for:
* Name

$\frac{\text { Queensland Urban }}{\text { Given namels }}$
$\frac{\text { Utilities }}{\text { Sumame }}$
*Address $\frac{\text { Indooroopilly Road }}{\text { Street }}$
Taringa
4068
Subuithown

> Postcode

* 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 Qud Pty Ltd
Electrical contractor phone number 0732499500
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)


## 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 DES/GN? | YES | (DELETE | AS | APPL/CABLE) |
| :---: | :---: | :---: | :---: | :---: |
| If "NO" COMPLETE SWITCHBOARD DES/GN REVIEW. If 'YES' PROVID | NG | ENCE |  |  |

(TCK APPLICABLE SECTION BELOW: YES / NO / N/A (Not Applicable)


| WIRE COLOURS | 240V ATTVE: |  |
| :---: | :---: | :---: |
| ELV-AC ACTIVE: | ELV-AC COMMON: |  |
| EIV-DC Posmue: Drearupe | $\text { ELV-DC NEGATIVE: } \quad \text { Critel }$ | TELEMETRY: CNET; |

> Inspected by: JUNATItAN .

Accepted by: of

Release Authorized by: of

DATE:

DATE:

## TEST RESULTS



## Inspection \& Test Procedure <br> 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 | $\checkmark$ |  |  |
| 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.


Commissioning Engineer Signature $\qquad$ Date $\qquad$

|  | From | To | Done |
| :--- | :---: | :---: | :---: |
| Documentation | Contractor | Commissioning <br> Engineer | Completed and signed Pre-Fat test sheet |
| 2. Non conformances (if present) | Commissioning <br> 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 nonconformances 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.

## SWITCHBOARD METALWORK CHECKLIST

## CUSTOMER: $\quad$ B/WATEX

PROJECT: INDFOOPHILLT JOB NO: A4227

## SWITCHBOARD DESIGNATION:

## SWITCHBOARD DRAWING NOS:

CUBICLE INSPECTION


## PAINT FINISH

| a. $\quad$Paint colour \& gloss as per drawings or <br> detailed on order | $\checkmark$ |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| b. $\quad$No grinding or buffing marks visible through <br> 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:

$\qquad$
$\qquad$
$\qquad$ FORM CHECKED FOR COMPLETION BY: ................................

SIGNED:





DATE:

o. 10



## SP086 INDOOROOPILLY ROAD SEWAGE PUMP STATION

## COMMISSIONING PLAN

In Attendance

| Name | Role During Commissioning | Company |
| :---: | :---: | :---: |
| John Clayton | Commissioning Monager | QUU |
| Daye Jackion |  | Holmac Servicas |
| SAar whtura | ELECTRICSAN | Hetwate sGaluces |
| TOHN THOMA | ECECTRICAC T/A | 14dwade SCrucces |
|  |  |  |

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## 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 AI - 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 BS - 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.l on Temporary Switchboard
c. PHASE C - INSTALLNEW 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 CS - 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 Gom Temporary Pump Switchboard to New Pump Switchboard Step D5 - Test \& Commission Pump No. 2 on New Pump Switchboard

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e. PHASE E - REMOVE REDUNDANT SWITCHBOARDS AND CABLES

Step El - Disconnect 'Gen-Supply' cables from Generator
Slep 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 sball 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 idenlified have been reclified (new pump station switchboard). | OK以Otes 17/0 |
| 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. | $\text { OKV Datei }>1 \not \subset 10$ |

### 1.3.2 Generator Check

| QUU Task | Checked |
| :--- | :---: |
| The stand bye generalor can start run at full load for one hour and has sufficient <br> 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 |  |
| :--- | :--- |
| These are checks that will ensure the pump station is fully operational and that no <br> delays will be incurred due to any pump station problem out side of the contract. <br> These task are desirable to have completed before the SAT but are not essential. <br> The job can proceed if they are not done. <br> Commissioning Manager to request networks maintenance to inspect and rectify if <br> necessary |  |
| The existing reflux valves and associaled limit switches are working correclly. |  |
| The discharge pressure connection point is available and that the isolation valve is <br> functioning correctly. | The dry well exhaust fan is working correctly and quiedly. <br> The wet well does not need pumping out. |
| The flow meters are functioning correctly. <br> Ensure that the station is fully functional (all pumps can run) and fuel is full tank is |  |

### 1.3.4 Discharge Mains Pressure Transducer

| Contractor Tosk | Completed |
| :--- | :--- |
| Install delivery pressure transducer on the discharge rlsing main. <br> Transducer is calibrated to the specifled range (as per spec). | Installed OK |
|  | Range $0(\mathrm{~m})$ to $\mathrm{SU}_{(\mathrm{m})}$ |
|  | OkPA to $\mathrm{SOO}_{\mathrm{kPA}}$ |



## 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 <br> attachment of mounting brackets. These brackets must allow for the adjustment of <br> 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 <br> existing grouting cover over chasing to access existing conduits for removal. | OK 回, |

### 2.2 INSTALL NEW WET WELL INSTRUMENTATION JUNCTION BOX

| Contractor Task | Completed |
| :--- | :--- |
| Install neiv stainless steel instrument J-box including terminals on exterior wall <br> above existing cable pit. This will accommodate connections to wet well level <br> probes and E+H level transmitter termination housing. Cabling from this J-box to <br> wet well electrode box will be in conduits run via existing cable pit. Install new <br> conduit between cable pit and electrode box. Refer to SHEET 23 and 29 for details. |  |

### 2.3 UPGRADE WET WELL LEVEL SENSORS

| Contractor Task | Completed |
| :---: | :---: |
| Remove-ll existing wetwell level prober and Vega level-senser-and their associnted ading 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 books are to be of similar strength and mounted at the same height as existing hooks. |  |

### 2.4 UPGRADE PUMP EMERGENCY STOP SWITCHES

| Contractor Task | Completed |
| :--- | :---: |
| Install new purmp emergency stop stations in dry well adjacent to each pump. Fit <br> label to each stop station. Remoye existing isolating switches and associated cabling <br> and conduits. | $\therefore$ OK Q |

### 2.5 UPGRADE 3Ø AND $1 \varnothing$ 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 eastem wall. Replace with new I phase GPO and associated cabling. <br> 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. | OK $\sqrt{ }$ |
| Remove redundant telecom J-box and outlets and associated cabling behind new pump switchboard location. |  |

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Electrical Contactor's Supervisor


QUU Commissioning Manager

Nelive Date:
Owner: Gerird Anderson
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### 2.6 UPGRADE DELIVERY PRESSURE TRANSMITTER

| Contractor Task | Completed |  |
| :--- | :---: | :---: |
| Remove exjsting pressure transmitter cabling and conduits from dry well. Install | $\%$ |  |
| new pressure transmitter, cabling and associated fitting as per sheet '2l' into new |  |  |
| tapping point in header pipe provided in pump Nol pipework, located in drywell | $\ddots$ |  |
| 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 intemal wall. Fill wall <br> penetration with non-shrink grout. | OK |

### 2.8 UPGRADE STATION LIGHTING CABLING



### 2.9 UPGRADE VENTILATION FAN WIRING

| Contractor Task | Completed |
| :--- | :---: | :---: |
| Remove old wing, conduits and Gitings associated with the ventilation fan. <br> Install new cabling and isolator to ventilation fan. Isolator shall be fitted to vent <br> shaft at the motor. Fit label to isolator. | OK Q |

### 2.10 UPGRADE DRY WELL SUMP PUMP AND STATION ELECTRODES

| Contractor Task | Completed |  |
| :--- | :--- | :--- | :--- |
| Remove existing electrodes, brackets and associated cabling and conduits from the <br> dry well sump pump. Install new Multitrode probes (SHEET 04) including all new <br> stainless stel brackets to facilitate proper mounting of all probes. Run probe <br> cables via conduits to sump level probes J-box. Remove existing 'Dry Well |  |  |
| Flooded' probe and associated cabling and conduits. Install new multitrode probes <br> for 'Station flooded alarm' and 'Station flooded trip'. Run probe cables via <br> conduits to station level probes J-box. |  |  |

### 2.11 INSTALL NEW STROBE LIGHT

Contractor Task
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.

### 2.12 $\operatorname{NSTALL}$ NEW EARTH ELECTRODE

Contractor Task penetration through building for cable run. Adequately seal penetration.


Electrical Contactor's Supervisor
Name: Dave Jackson Date: $2 / P / 10 . .$.
Signature:
Signature:

QUU Commissioning Manoger

Doc Id: 006536
Printed: 25/06/2010

Aclive Date:
Oivner. Gerard Anderson

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## - 2.13 SYSTEM PRE-COMMISSIONING

Run each pump in local mode and record the system curves for the following pump speeds.


Electrical Contactor's Supervisor
Name: Dave Jackson, Date: .3.0/7/10.
Signature:

QUU Commissioning Manager
Name: John Clayton Signature:

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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

|  | Display the A1 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram | OKQ |
| :---: | :---: | :---: |


| Contractor Task |  |
| :--- | :--- |
| Call the QUU Control Room Operator (CRO) and inform them that you are on site. <br> Record the CRO's Name and Officer Code and record the time of the call. <br> Advise CRO that you are working as part of the switchboard changeover project and <br> that you will be taking Energex offline and running the station using the onsite <br> Generator. Glve the operator your contact name and number and advise the <br> operator that communications may be lost to the pump station untll the job is <br> finished. | Name: | CRO:

Elecraical Conlactor's Supervisor


QUU Commissioning Manager

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### 3.1.2 Step A2 - Install supply cables to new CT enclosure

| COMMISSIONING MANAGER | Outcome |
| :--- | :--- | :--- |
| Display the A2 Power Diagram for easy reference during this <br> phase. All references in [ ] refer to the Power Diagram | OKV |


| Contractor Task | Outcome |
| :---: | :---: |
| De-energise Station Transformer - Energex Switching task | ENERGEXTAS COMPLETED |
| Test for Dead at line and load side of pump switchboard Main Switch [QE1] | $N$ QE1 DEAD $\square$ |
| Cut and re-terminate 'MAINS-SUPPLY' cables from Main Switch (QE1) onto Line side of CT Isolator (Q1) i.e. measure and cul $150 \mathrm{~mm} 2 /$ 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. <br> (This will be a permanent connection). | Q1.LINE SIDE CONNECTED |
| Cul and re-lerminate 'ATS-SUPPLY' cables from Existing ATS Switchboard (QE2) onlo Load side of New CT enclosure. CT's i.e. measure and cut $150 \mathrm{~mm} 2 /$ phase ( + neutral) mains cables running from existing pump switchboard Main Switch to existing ATS switchboard and re-terminate into new CT enclosure onlo 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 <br> LOAD SIDE OF CT'SQ1E |
| Confirm correct phasing of cables and perform insulation tests. Record resulis. | OKE/ |
| Energex to install new meters and injection test | OK ${ }^{\text {O }}$ |
| - $\because \because \therefore \therefore \quad \therefore \quad \because \quad \because \quad$ |  |

### 3.1.3 Step A3 - Re-energise station transformer

| COMMISSIONING MANAGER | Outcome |
| :--- | :--- | :--- |
| Display the A3 Power Diagram for easy reference during this |  |
| phase. All references in [ ] refer to the Power Diagram |  |$\quad$ OKR 


| Contractor Task | Outcome |
| :--- | ---: |
| Re-energise Station Transformer - Energex Switching task | ENERGEX TASK <br> COMPLETED Q |
| Test for supply on Line Side of CT Isolator (Q1). | ENERGEX SUPPLY <br> AVAILABYE AT QTE |
| Check Rotation and ensure it is the same as previous. | UE1 LABEL |
| Label Pump Station switchboard Main Switch (QE1) as <br> 'Out of Service- Isolate Elsewhere'. | QTTACHED |

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### 3.1.4 Step A4 - Energise new CT Enclosure

Display the A4 Power Diagram for easy reference during this phase. All references in [] refer to the Power Diagram
Outcome $\quad l$


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Name: Dave Jackson Date $30 / 7 / 1.0 .$.


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### 3.2 PHASE B - CONNECTION OF TEMPORARY SWITCHBOARD \& PUMP VSDS



| Contractor Tesk | 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 400 mm above the current duty $A$ start level. Audible alarm has to be louder than the ambient noise level. |  |
| Acknowledge a maximum 15 minute window is available for the connection of the temporary supply cable. | OKV |
| Activate emergency lighting. Nvi तo gwrepz\% | OK ${ }^{\circ}$ |
| Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present. | OKD |
|  <br>  |  <br>  |
| All switching to be done with no pumps running. Ensure no pumps are running lie. place Pump Station - Common Control - Remole/Local Switch on existing Pump Station switchboard to Local Mode | STN LOCAL MODE LOCAL $\square$ |
| 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] | $\begin{aligned} & \text { ATS CB CONTROI } \\ & \text { OFF } \\ & \text { QE2 OPEN } \\ & \text { QE3 OPEN } \end{aligned}$ |
| Confirm existing ATS Mains CB and Gen CB are open. [QE2: OPEN] [QE3: OPEN] | $\begin{aligned} & \text { QE2 OPEN EP } \\ & \text { QE3 OPEN }[3 \end{aligned}$ |
| OPEN, LOCK and TAG CT Isolator [Q1 OPEN] | (8) Q1 OPEN प̇́ |
| OPEN, LOCK and TAG 'Generator CB' Open [QG OPEN] | (\%) QG OPEN ${ }^{\text {/ / }}$ |
| Test for Dead at Connection Point [B] | N ConXb Dead |
| Install temporary supply TEMP-SUPPLY' cables from Temporary Pump Switchboard [QT1] to Existing ATS Switchboard at Connection Point [B] | OK |

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### 3.2.2 Step B2 - Energise and Test Temporary Pump Switchboard

| COMMISSIONING MANAGER | Outcome |
| :---: | :---: |
| Display the B2 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram | OKY |
| Conitractor Task | Outcome. |
| Remove Lock and Tag and close CT Isolator [Q1 CLOSE] | $\theta$ Q $)^{\text {a }}$ CLOSE 10 |
| Remove Lock and Tag from ATS Mains CB and Generator CB [QE2 OPEN] [QE3 OPEN] | (2) QE2 OPEN व © $\%$ QE3 OPEN $\square$ |
| Switch Existing ATS Switchboard: 'CB CONTROL' switch to 'MAINS' Mode Position [QE2 CLOSE] [QE3: OPEN] | ATS CB CONTROL MAINS QE2 CLOSE QE3: OPEND |
| Cycle pumps i.e. place Pump Station - Common Control - Remole/Local Switch on existing Pump Station switchboard to Remote Mode. Watch pumps start, stop and cycle successfully from level signals. | STN REMOTE MODE REMOTEV |
| Check phase rotation and voltage at temporary switchboard (QT1) | OKV |
| Remove Lock and Tag and Close Generator CB [QG CLOSE] | - QGCLOSE: |
| Switch Existing ATS Switchboard 'SYSTEM MODE' switch to Auto Mode Position | ATS SYSTEM MODE/ |
|  <br> 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]. |  |

## !!! 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.


### 3.2.3 Step B3 - Connect pump No. 2 VSD on to the Temporary Switchboard

| COMMISSIONING MANAGER |
| :--- | :--- | :--- | | Display the B3 Power Diagram for easy reference during this |
| :--- |
| phase. All references in [] refer lo the Power Diagram |,

### 3.2.4 Step B4 - Run Pump No. 2 on Temporary Switchboard

| COMMISS | NING MANAGER | Outcome |
| :---: | :---: | :---: |
|  | Display the 84 Power Diagram for easy reference during this phase. All references in [] refer to the Power Diagram. | ong |


| Contractor Task | Outcome |
| :---: | :---: |
| Confirm temporary switchboard level instruments are terminated and functioning correctly. Verify level signal by comparing with the Existing pump switchboard level. | OṘ' |
| 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 exisling pump switchboard Pump No. 1 \& Pump No. 2 CB's [QE4 OPEN] [QE5 OPEN] | QE4 OPEN-7 QE5 OPEN D |
| Remove Lock and Tag and Close Temporary Switchboard Isolator [QT1 CLOSE] | (6) QTI CLOSE |
| Remove Lock and Tag and Close Temporary Switchboard Pump No. 2 CB [QT5 CLOSE] | (\%) QT5 CLOSE ${ }^{1}$ |



| Commission Pump No. 2 on temporary switchboard. Confirm Auto control from |
| :--- |
| temporary level signals. |
| When all tests for Pump No. 2 are completed then depending on the time of day you <br> will either <br> Continue to Step B7 and cutover Pump No. 1 - OR <br> If stopping work until the following day then continue to Step B5 and stop for the <br> day. |


|  | OKE' |
| :---: | :---: |
|  | $\ddots$ |
|  | $O_{1}$ |

### 3.2.5 Step B5 - Connect Pump No. 1 VSD on temporary switchboard

| COMMISSIONING MANAGER |  | Outcome | $\overline{7}$ |
| :---: | :---: | :---: | :---: |
|  | Display the B5 Power Diagram for easy reference during this phase. All references in [] refer to the Power Diagram |  |  |


| Contractor Task | Outcome |
| :---: | :---: |
| All switching to be done with no pumps running. Ensure no pumps are running l.e. place exisling 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] | (3) QT4 OPEN $\hat{6}$ |
| Test for Dead at QT4 | $N$ QT4 DEAD ${ }^{\text {a }}$ |
| OPEN, LOCK and TAG Existing Pump Switchboard Pump No. 1 CB [QE4 OPEN] | Q QE4 OPEN |
| Test for Dead at QE4 | $N$ QE4 DEAD 0 |
| Pull back, cul \& re-terminate Pump No. 1 VSD Supply Cables onto temporary switchboard Pump No. 1 CB (QT4). | ORワ7 |
| Disconnect, re-terminate Pump No. 1 Motor cables directly onto Temporary Pump Switchboard Pump No. 1 VSD Output terminals: | OKEO |
| Check phasing and CB. Settings | OK $\downarrow$ |
| Re-route \& terminate VSD No. 1 Control Cables, Thermistor and lockout cables. | OK ロ |
| Re-program Pump No. 1 VSD parameters as required. | OK² |

### 3.2.6 Step B6 - Run Pump No. 1 on Temporary Switchboard

| COMMISSIONING MANAGER | Outcomc |
| :--- | :--- | :--- | | Display the B6 Power Diagram for easy reference during this |
| :--- |
| phase. All references in [ ] refer to the Power Diagram |


| Contractor Task | Outcome |
| :--- | :---: |
| All switching to be done with no pumps running. Ensure Pump No. 2 CB on <br> temporary pump station switchboard ls open [QT5 OPEN] | QT5 OPEN bu |




## NOTICE

## THE STATION CAN NOW BE LEFT UNATTENDED AT THIS STAGE




### 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 |
| :---: | :---: | :---: |
|  | Display the C1 Power Diagram for easy reference during this phase. All references in [] refer to the Power Dlagram |  |


| 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 wel well must be provided with audible and visual alarm if the wel well level exceeds 400 mm above the current duly $A$ slart level. Audible alarm has to be louder than the ambient noise level. | OK' |
| Acknowiedge 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 immedlately prior to work commencing. | OKt |
| Ensure emergency diesel pump is ready to run if required and someone experienced In its operation is present. | $\mathrm{OH}$ |
|  <br>  |  |
|  |  |
| Do not proceed until emergency diesel pump is confirmed to be operational and controlling the wet well level. |  |
| Aclivate temporary work area lighting. IV | OK $\square$ |
| All switching to be done with no pumps running: | OK $\downarrow$ |
| 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 CONTRO OFF, QE2: OPEND QE3: OPEND |


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### 3.3.2 Step C2-Run Station on temporary pump switchboard

| COMMISSIONING MANAGER |  | Outcome |
| :---: | :---: | :---: |
|  | Display the C2 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram | OKD |


| Contractor Task | Oulcome |
| :---: | :---: |
|  <br>  |  |
| All switching to be done with no purnps running. | OK, ${ }^{\text {a }}$ |
| Remove LOCK and TAG and Close new CT Isolator [Q1 CLOSE] | Q1 CLOSE, |
| Switch Existing ATS Switchboard 'CB CONTROL' switch to 'MANNS' Mode Position [QE2: CLOSE] [QE3: OPEN] | ATS CB CONTROL MAINS <br> QE2: CLOSE |
| Confirm pumps control on temporary switchboard. Confirm Auto control from temporary level signals for both pumps. | PUMP 1 PUMP 2, |
|  | $4\left(\operatorname{ton} \operatorname{s}^{3}\right)$ |
| Do not proceed untll pumps are confirmed to be working on temporary switchboard le operational and controlling the wet well level. | $\operatorname{Signature}=1930$ |
| Remove LOCK and TAG and Close 'Generator CB' Open [QG CLOSE] | QG CLOSET |
| Switch Existing ATS Switchboard 'SYSTEM MODE' switch to Auto Mode Position | ATS SYSTEM MODE Auto |
|  |  |



### 3.3.3 Step C3 - Remove existing pump switchboard




### 3.3.4 Step C4 -Install new switchboard and connection of supply cables




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### 3.3.5 Step C5 - Connect new pump switchboard to station CT Isolator




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### 3.3.6 Step C6 - Energise and test new pump switchboard





### 3.3.7 Step C7 - Run new and temporary switchboards on Energex mains

| COMMISS | NING MANAGER | Outcome |
| :---: | :---: | :---: |
|  | Display the C7 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram | OKW |


| Contractor Task | utcome |
| :---: | :---: |
|  <br>  |  |
| All switching to be done with no pumps running and with station in 'Local' mode. | $\therefore$ OK $\square^{\prime \prime}$ |
| Remove LOCK and TAG from existing ATS 'Mains CB' (QE2) | $\therefore$ Q QE2 G |
| Switch existing ATS 'CB CONTROL' switch to 'Mains' Mode Position [QE2: CLOSE] [QE3: OPEN] | ATS CB CONTRO MAINS QE2: CLOSE D QE3: OPEN |
| Switch existing ATS 'SYSTEM MODE' swritch to 'Auto' Mode Position | ATS SYSTEM MODE Auto |
| Stop Generator | OK C |
| Confirm pumps control on temporary switchboard from Energex supply. Confirm Auto control from temporary level signals for both pumps. | PUMP $1 \cdot \square$ PUMP 2 |




### 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




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### 3.4.2 Step D2 - Test \& Commission Pump No. 1 on new pump switchboard




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### 3.4.3 Step D3 - Disconnect ATS-Supply cable from New CT enclosure and Existing ATS Switchboard

| COMMISSIONING MANAGER |  | Outcome |
| :---: | :---: | :---: |
|  | Display the D3 Power Diagram for easy reference during this phase. All references in [] refer to the Power Diagram | OKI |


| Contractor Task | Outcome |
| :---: | :---: |
| At all times during the switchboard culover 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 400 mm above the current duty $A$ start level. Audible alarm has to be louder than the ambient noise level. | OKE |
| Ensure emergency diesel pump is ready to run If required and someone experienced in its operation is present. | OK- |
|  <br>  |  $\qquad$ |
| All switching to be done with no pumps running and with station in 'Local' mode. | $\because$ OK |
| Ensure Generator is ready to start, No fauls, Adequate fuel. | OKGI |
| Switch existing ATS 'SYSTEM MODE' switch to Manual Mode Position | ATS SYSTEM MODE Manual, |
| Start Generator | OKD |
| Switch existing ATS 'CB CONTROL'switch to 'Generator' Mode Position [QE2: OPEN] [QE3: CLOSE] | ATS CB CONTROL GENERATOR 4 QE2 OPEN QE3 CLOSE |
| Ópen New Pump Switchboard Pump No. 1 CB [Q4 OPEN] | Q4 OPEN ${ }^{-1}$ |
| Close Temporary Pump Switchboard Pump No. 2 CB [QT5 CLOSE] | QT5 CLOSE |
| Ensure pump cycles successfully. | OKC |
| OPEN, LOCK and TAG Existing ATS Switchboard 'Mains CB' [QE2 OPEN] | (8) QE2 OPEN ${ }^{\text {d }}$ |
| OPEN, LOCK and TAG New CT Enclosure 'CT Isolator' [Q1 OPEN] | Q Q1 OPEN |
| Test for Dead \& disconnect 'ATS-Supply' cable from New CT Enclosure at connection point A and from Existing ATS Switchboard (QE2) | A Connection |



### 3.4.4 Step D4 - Re-connect Pump No. 2 from Temporary Pump Switchboard to New Pump Switchboard






### 3.4.5 Step D5 - Test \& Commission Pump No. 2 on New Pump Switchboard




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### 3.5 PHASE E - REMOVE REDUNDANT SWITCHBOARDS AND CABLES

### 3.5.1. Step E1 - Disconnect 'Gen-Supply' cables from Generator

| COMMISSIONING MANAGER |  | Outcome |
| :---: | :---: | :---: |
|  | Display the E1 Power Diagram for easy reference during this phase. All references in [ ] refer to the Power Diagram |  |


| 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 400 mm above the current duty $A$ start level. Audible alarm has to be louder than the ambient nolse level. |  |
| Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present. | OK |
|  <br>  |  |
| All switching to be done with no pumps runing and with station in 'Local' mode. | $\because \because$ OKX |
| OPEN, LOCK and TAG Existing |  |
| OPEN, LOCK and TAG Existing ATS Swilchboard 'Gen CB' [QE3 OPEN] | 6 QE3 OPEN H/ |
| Switch existing ATS 'CB CONTROL' switch to 'OFF' Mode Position | ATS CB CONTROL |
| Test for Dead at 'Connection Point C ' al Exlsting Generator and Line Side of QE3 at Existing ATS Switchboard | Line Side Q <br> DEADiU <br> Connection <br> Point C Dead |
| Disconnect 'Gen-Supply' cables from Existing Generator 'Connection Point C' and from Existing ATS Switchboard QE3 | OK ${ }^{\text {P }}$ |



## 3．5．2 Step E2－Remove redundant cables from Existing ATS Switchboard and Temporary Pump Switchboard

| COMMISS | NING MANAGER | Outcome |
| :---: | :---: | :---: |
|  | Display the E2 Power Diagram for easy reference during this phase．All references in［］refer to the Power Diagram | $\therefore$ |


| 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 400 mm 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． | 昒 |
| 隹宜 |  |
| All switching to be done with no pumps running and with station in＇Local＇mode． | $\therefore \cdots$ OK ${ }^{\text {a }}$ |
| Remove＇Gen－Supply＇cables from Exișing ATS Switchboard and from existing conduit to Generator．QE3 | OK $\quad$. |
| Remove＇ATS－Supply＇cables from Existing ATS Switchboard | OK ${ }^{\text {d }}$ |
| Disconnect and remove＇Temp－Supply＇cables from Existing ATS Switchboard and Temporary Pump Switchboard | OK D＇ |
| Disconnect and remove Temp VSD Supply Cables from Existing VSD＇s | OK $\quad$ D |

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### 3.5.3 Step E3 - Remove Existing ATS Switchboard and Existing VSD's

| COMMISSIONING MANAGER |  | Outcome |
| :---: | :---: | :---: |
|  | 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 lested 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 400 mm above the current duty $A$ start level. Audible alarm has to be louder than the ambient noise level. | OK O |
| Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present. | K |
|  <br>  |  |
| All switching to be done with no pumps running and with station in 'Local':mode. |  |
| Remove Existing ATS Switchboard including all ancillary cables | OK ${ }^{0}$ |
| Remove Existing Pump VSD units including all ancillary cables | OK C |

### 3.5.4 Step E4 - Remove Temporary Pump Switchboard and cables

| COMMISS | ONING MANAGER | Outcome |
| :---: | :---: | :---: |
|  | Display the E4. Power Diagram for easy reference during this phase. All references in [] refer to the Power Diagram |  |


| Cuntractor Tosk | Outeome |
| :---: | :---: |
| 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 400 mm above the current duty A slart level. Audible alarm has to be louder than the ambient noise level. | OKO |
| Ensure emergency diesel pump is ready to run if required and someone experienced in its operation is present. | OK ${ }^{\text {O }}$ |
|  <br>  |  |
| All switching to be done with no pumps running and with station in 'Local' mode. | OK $\square^{\square}$ |
| Disconnect and remove all temporary cables installed to Temporary Pump Switchboard | O |
| Remove Temporary Pump Switchboard | OK $\square^{\prime}$ |
| Remove all temporary level probes and ancillary equipment | OK $\square$ |

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### 3.6 PHASE F - CONNECT STANDBY GENERATOR TO NEW SWITCHBOARD

### 3.6.1 Step F1 - Install new Genset cables to New Pump Switchboard



| Contractor Task |
| :--- | :--- |
| At all times during the switchboard cutover process an installed and tested |
| independent, battery backed high alarm system (with Multrode level sensor) in the |
| wet well must be provided with audible and visual alarm if the wet well level |
| exceeds 400 mm above the current duty A start level. Audible alarm has to be |
| louder than the ambient noise level. |

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### 3.6.2 Step F2 - Test Generator connection to New Pump Switchboard




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### 3.6.3 Step F3 - Test Generator Auto starts and runs each pump




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### 3.6.4 Step F4 - Return Energex Supply




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## 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 |  |  |
| 240 vac 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. |  |  |

### 4.2 REMOVE EXISTING DIFFERENTIAL PRESSURE TRANSMITTERS

| Contractor Tosk | Outcome |
| :--- | :---: |
| Remove existing differential pressure transmitters and associated cabling and <br> conduits from each pump pipework. | OKD |

### 4.3 INSTALL DRY WELL STROBE LIGHT

| Contractor Task | Outcome |
| :--- | :---: |
| Install strobe alarm light and associaled cabling, conduits and mounting <br> brackets. Mount strobe adjacent to ladder at base of dry well and funclion test. | OK a |

### 4.4 INSTALL NEW GANTRY CRANES

| Contractor Tosk | Outcome |
| :--- | :--- |
| Install isolators and associated cabling for both of the new gantry cranes. Locate <br> Isolators on western wall. Fit labels adjacent to both isolators. | OKV |

### 4.5 INSTALL ODOUR CONTROL JUNCTION BOX

| Contractor Task | Outcome |
| :--- | :--- |
| Install stainless steel junction box including terminals for future odour control <br> plant. Location of this enclosure is at the rear of the building near existing <br> dosing plant. Install power and control cables as per cable schedule and <br> terminate in junction box. | $\ddots$ |
| Connect the Odour Control Unit to the New Control Switchboard |  |

### 4.6 UPGRADE DOSING PLANT CABLING

| Contractor Tosk | Outcome |
| :--- | :---: |
| Install new power and signal cables as per cable schedule to existing dosing <br> plant control panel. Re-terminate power supply at dosing panel; provide <br> additional terminals to terminate signal cable for fulure controls. Remove <br> existing cables and disused conduits. Provide adequate stainless steel unistrut <br> supports for new conduits as they cross from building to dosing plant control <br> panel. |  |
| Connect the Chemical Dosing Unit to the New Control Switchboard | OK 口 |

### 4.7 EXISTING JUNCTION BOXES


3.7 SYSTEM COMMISSIONING

Run each pump in local mode and record the system curves for the following pump speeds.

Not DovE.

$$
\begin{aligned}
& \text { fund Station woekeo } \\
& \text { Cosectish } \\
& 200 \mathrm{KL} \text {. }
\end{aligned}
$$



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 JBoxes, conduits and associated equipment that is no longer in use

### 4.8 REMOVE MOTOROLA RTU

| Contractor Task | Outcome |
| :--- | :---: |
| After the successful installation of the new switchboard, remove redundant <br> Motorola RTU induding antenna and mast and associated cabling and conduits. <br> Any penetrations left in external walls are to be filled with non-shrink grout. | OK |

### 4.9 INSTALL SPARE CONDUIT



### 4.10 RE-GROUT CHASING

| Contractor Task | Outcome |
| :--- | :--- | :--- |
| On completion of installation of all cables and conduits in floor chasing, refill and <br> re-grout to similar standard or better as originally installed. Fabricate and install <br> em galvanised cover plate to cover exposed cable trenching due to new pump <br> switchboard being shorter than the old switchboard. | OK V/ |

Contactor's Supervisor
Name: DAUE JACKMCN..... Date: . $4 / 4 / 10 .$.
Signature:


QUU Commissioning Manager

Signature:

Doc ld: 006536 Active Date
Printed: 25/06/2010 Oivnar: Gerard Anderson
Note: Printed copies of dis document should be verified for currency against the published electronic copy.

## 5 POST CHANGE OVER CHECKLIST

### 5.1 DELIVERABLES FROM RTU PROGRAMMER

| QUU Programmer | Dats Completed |
| :--- | :---: |
| Within 7 days of the change over the following must be completed and signed off by <br> the QUU Programmer <br> Complete Section 4: Post Commissioning | The QUU Programmer will ensure that the Control Room Acceptance (CRA) form is <br> signed by the Manager of the Control Room Officers. The form is to be handed to <br> 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 <br> specified (AS BUILT's, Electrical Certificates and documentation eic). | 13 | 19110 |

### 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 Acceplanice Test Sheet - Completed $\boldsymbol{8}$ signed off. | OK ${ }^{\text {O }}$ |
| Electrical Inspection Sheet - Completed \& signed off. | OK |
| Site Acceptance Test Sheet - Completed \& signed off. | OK口 |
| Commissioning Plan - Completed \& signed off. | OK口 |
| As built Drawings have been updated, drafted and taken to slte along with the Site Specific Functional Specification. | 11 |

### 5.4 SUGGESTIONS FOR IMPROVEMENT




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Please acknowledge receipt by signing and faxing back to Halmac Services on (07) 32499599

Sign.



## DOCUMENT TRANSMITTAL

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[^0]:    You can download this documentation on www.socomec.com

[^1]:    - only on AtyS 6 m
    ** only on ATyS 6e \& 6m
    *** only on ATyS C30.

[^2]:    Notes: - Thermal or electronic overload relays may be used

    - XM30PB combinations can be replaced with H125GJt20 and CA7-30 it required

    Combinations based on the thermal overload relay tripping betore the circult
    beaker at overload curents up to the motor bocked rotor curent.

[^3]:    Notes: - Thermal or electronic overload relays may be used.

[^4]:    

[^5]:    Notes: - Thermal or electronic overload relays may be used.

[^6]:    Notes: - Thermal or electronic overioad relays may be used.
    Combinations based on the thermal overload relay tripping betore the clrcult
    breaker at overload currents up to the mator locked rotor current.

[^7]:    A - Normal CA 3 rating of contactor

    - Maximum breaking current of contactor
    - Cut-oft current of fuse

    I - Instantaneous tripping current of breaker

[^8]:    Notes: ') 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

[^9]:    Notes: ') Use 'magnetic only' breaker or next higher circuit breaker/contactor combination. Refer NHP ${ }^{2}$ ) Use with separate mounting bracket.
    ${ }^{3}$ ) Themal or electronic overoad relays may be used
    Combinations based on the thermal overioad relay tripping before the circuit breaker at overload currents up to the motor locked rotor current.

[^10]:    Note: ') Select applicable short circuit rating required by system specifications.
    ${ }^{2}$ ) TemBreak Plus MCCB5 can also be used.

[^11]:    *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.

[^12]:    Note: $\quad 240 / 415 \mathrm{~V}$ rating suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS 60038: 2000

[^13]:    WAVECOM S.A. - 3, esplanade du Foncet - 92442 Issy-les-Moulineaux Cedex - France - Tet: +33 (01146290800-Fax: +33 (0) 46290808 Wavecom, Inc. - 4810 Eastgate Mall - Second Floor - San Diego, CA 92121 - USA - Tel: +18583620101 - Fax: +1 8585585485 WAVECOM Asia Pacific Ltd. - Unin 201-207, 2nd Floor - Bio-Informatics Centre - No. 2 Science Park West Avenue - Hong Kong Science Park, Shatin - New Territories, Hong Kong - Tel: +852 28240254 - Fax: +85228240255

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[^19]:    1) Recommended for drinking water applications.
[^20]:    1）Not for use in hazardous areas．

[^21]:    0. 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 DR IMPLIED, ARE EXPRESSLY DISCLAIMED.
    (2) Momentary mushroom operators are IP65, multi-function operators have no Type 13 rating. Plastic operators with keys have no Type $4 X$ rating.
    (3) Operating temperatures below $0^{\circ} \mathrm{C}\left(32^{\circ} \mathrm{F}\right)$ are based on the absence of freezing moisture and liquids, UL recognized to $55^{\circ} \mathrm{C}\left(131^{\circ} \mathrm{F}\right)$ - incandescent modute, max $40^{\circ} \mathrm{C}\left(104^{\circ} \mathrm{F}\right)$.
    (4) Low voltage contacts are recommended for applications below $17 \mathrm{~V}, 5 \mathrm{~mA}$.

    Wires less than \#18 $\left(0.75 \mathrm{~mm}^{2}\right)$ may not hold in terminal securely.

[^22]:    - Dimensions are not intended to be used for manufacturing purposes.

[^23]:    0 Dimensions are not intended to be used for manufacturing purposes.
    (3) Panel thickness range is 1.0 ...6.0 maximum. Panel thickness reduced to 4.5 when optional legend plates are used

[^24]:    (0) Dimensions are not intended to be used for manufacturing purposes.

[^25]:    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.

[^26]:    ${ }^{\text {2) }}$ Tested according to the regulations of German Lloyd, GL directive 2.
    ${ }^{3}$ ) Tested according to EN 60068-2-27.

[^27]:    $1 \quad$ * SLIP $\circledR^{\text {TM }}$ KISS $\circledR^{\text {TM }}$

[^28]:    2 "Data and Computer Communications" William Stallings

[^29]:    WORLDWIDE• www.miinet.com

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[^30]:    (1) Opto-coupler output can be connected to DAR275V to provide form C dry sontacts, Page 35

[^31]:    A is important to remember that the (1) Time Range Selector not only selects the time range but also infuences the interpretation of the Digital Time Display
    Changing the $(1)$ Time Range Selector setting changes the units of time measurement (seconds, minutes, hours) as well as the decimal point location.
    Changing the (\$) Time Range Selector setting changes the units of time measurement (seconds, minutes, hours) as well as the decimal point location.

[^32]:    In the following figure you can observe the selection of multi-references according to the activation and/or

[^33]:    David Salvo
    Executive Director

