## BRISBANE WATER

## HINDES STREET SEWAGE PUMP STATION

## ELECTRICAL SWITCHBOARD OPERATION AND MAINTENANCE MANUAL

## Developed by:



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### 1.0 INTRODUCTION

These operating instructions cover the Hindes Street Sewage pumping station electrical equipment supplied by J \& P Richardson Industries Pty Ltd in October 2006.

### 1.1 Operating Instructions

Normal operation of the pumping station is in the automatic mode with control by means of the Multitrode Level Controller.

Manual operation control of the station is available by means of the Multitrode Level Controller.


## $\sqrt{76}$

- 2. Description of

Operation

### 2.0 DESCRIPTION OF OPERATION

### 2.1 Mode Selection

The station can be operated either automatically or manually by means of the Multitrode Level Controller.

### 2.2 Manual Control

Select the desired pump to "MANUAL" on the Multitrode Level Controller.

## N.B. DO NOT LEAVE IN MANUAL WHILE STATION UNATTENDED

### 2.3 Automatic Control

For automatic control of the station: -
a). Select the desired pump to "AUTOMATIC" on the Multitrode Level Controller.
b). Select the desired duty control on the Multitrode Level Controller.

For NORMAL OPERATION, each of the pumps should be set to "AUTO" on the Multitrode Level Controller.

### 3.0 ELECTRICAL EQUIPMENT TECHNICAL INFORMATION

## XS250 and XH250 series

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

XS250NJ (35kA) 3 pole

| Ampere rating | Min | Max | Cat. No. |
| :---: | :---: | :---: | :---: |
| 160 | 100 | 160 | WS250N 1603 3 |
| 250 | 160 | 250 | WxS250NJ 2503 \% |
| 250 | Non-Auto | ( sec$\left.)^{4}\right)$ |  |

XS250NJ (35kA) 4 pole

| 160 | 100 | 160 | 4 XS250NJ1604 |
| :---: | :---: | :---: | :---: |
| 250 | 160 | 250 | XS250NJ12504 |
| 250 | Non-Aut | $1 \mathrm{sec})^{4}$ ) | XS250NN 41 ) |

XH250NJ (50kA) 3 pole

| 160 | 100 | 160 | XH250NJ16033 |
| :--- | :--- | :--- | :--- |
| 250 | 160 | 250 | XH250NJ 2503 |

## XH250NJ (50kA) 4 pole

| 160 | 100 | 160 | XH250NJ16044 |
| :--- | :--- | :--- | :--- |
| 250 | 160 | 250 | $X H 250 N 125044$ |


| Short circuit capacity |  |  |
| :---: | :---: | :---: |
| Model | IIC | Voltage |
| XS250NJ | 35 kA (AS 2184) | 415 V 50 Hz |
| XH250NJ | 50 kA | 415 V 50 Hz |
| OC use | $\left.11 /{ }^{3}\right)$ | Voltage |
| XS250NJ | 40 kA | 250 V DC |
| XH250NJ | 40 kA | 250 V DC |

Refer to ratings chart at the front of this section. For ratings to AS 3947-2 and AS 2184, and Ics/lcu.

Dimensions (mm)

| Description | Height | Width | Depth | kg |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| XS250NJ | 3 pole | 165 | 105 | 86 | 1.85 |
| XH250NJ | 3 pole | 165 | 105 | 103 | 2.1 |
| XS250NJ | 4 pole | 165 | 140 | 86 | 2.4 |
| XH250NJ | 4 pole | 165 | 140 | 103 | 2.6 |



Notes: ${ }^{1}$ ) Isolating switch only - no protection.
${ }^{2}$ ) MCCB's only.
${ }^{3}$ ) Poles in series.
${ }^{4}$ ) Short time rating. Refer rating chart for complete technical data. Special low instantaneous magnetic generator protection MCCB's available on request.

## Connections and mountings

MCCB accessories
Front-connection type (FC)

Compression terminals


Attached flat bar


Types of terminal screws (Compression terminal and bar)
Breakers and screw size

| XE series XS series XH series <br> (Economical) (Standard) (High-fault level) | XM series <br> (Motor protection) |
| :--- | :--- | :--- | :--- |

## Pan headed screw



| XS125CJ | M8 | XH125NJ | M8 |
| :--- | :--- | :--- | :--- |
| 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 |



Rear-connection type (RC)

Bolt stud
Horizontal (standard)

Applicable breakers

- XE series XE225NC
- XS series

XS250, XS400
XS630, XS800.

- XH series

XH160, XH250, XH400, XH630, XH800.

- XM series

XM30PB.

Vertical


Flat bar stud


Applicable breakers
Horizontal ') XS1250, XV1250NE
Vertical XS1600, XS2000NE XS2500NE.

Notes: The arrangement of the flat bar can be made by the user.
If not specified the horizontal arrangement will be supplied.
${ }^{\prime}$ ) Vertical arrangement also available on request, contact NHP for details.

## Types of connections and mountings

MCCB accessories
Plug-in Type

## Switchboard use




[^0]
## Types of connections and mountings

## Draw-out type (DO indent)

Two-position type
Applicable breakers

- XS series

XS400, XS630, XS800, XS1250.

- XH series

XH160, XH250, XH400, XH630, XH800.

- The plug-in type breaker is housed in the draw-out cradle.
- The draw out cradle has two positions "connected" and "isolated".
- The auxiliary circuits are automatically connected or isolated by the auxiliary circuit terminals on the plug-in breaker.
- Manual connector type is available.
- Safety trip (first draw out mechanism). The breaker will trip automatically if it is drawn out while still in the 'on' position.
- Position keylock in isolated position (optional). Available on request.
- IP 20 degree of protection (optional). Available on request.



The 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.


## XS250NJ, XH250NJ

Time/current characteristic curves


Ambient compensating curves



Breakers with terminal bars available on request.


Plug-in (optional)


Outline dimensions (mm)


Outline dimensions (mm)


- Breakers with terminals bars available on request.

Rear connected (optional)


Note: In the standard selection mode, both terminals on the line side and the load side are in the horizontal direction

Plug-in (optional)


Drilling plan




Drilling plan

## Motor operators for XH250NJ

MCCB accessories

Outline dimensions (mm)
Front connected (standard)


Rear connected (optional)


Note: In the standard selection mode, both terminals on the line side and the load side are in the horizontal direction

Plug-in (optional)


ASL: Arrangement Standard Line t: Handle frame centre line


## Tembreak MCCB's



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

Tables based on the following maximum pre-arching $I^{2}$ 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 Brovara-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 $1^{2}$ 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 ( ${ }^{2} T$ ).
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 Plus MCCB's - Selectivity and Cascade tables at 415V

Guide
Downstream
MCCB
XS400SE XH400SE XS630SE XH630SE XS800SE XH800SE XS1250SE XS1600SE
50
65
$50 \quad 65 \quad 50$
65
85
kA (rms)



Upstream MCCB


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

Guide


| Downstream |  | XH800PJ | XS1250NE | XS1600NE | XS2000NE | XS2500NE |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| MCCB | kA (rms) | 85 | 65 | 100 | 100 | 100 |

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## Motor Starting - Introduction

Generally, an item of switchgear is selected on the basis of one or more performance criteria, be it currenUpower 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 Starting <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 takeover to interrupt the fault current therefore limiting ' energy passed through the starter components. When this is successfully achieved, the combination is said to be co-ordinated.

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

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

The standards
The requirements of several standards can be applied to these combination units. The Wiring Rules, AS 3000, are concerned mainly with setting standards for the fixed wiring. In this regard the concern is the wiring between the protection device and the motor.
As motors can experience short term overloading the current rating of a fuse can be up 4 times and a circuit breaker 2.5 times the full load rating of the motor. The Wiring Rules allow the overload protection and the short circuit protection to be provided by different devices. This allows magnetic only circuit breakers, or back-up type fuses, to be used in conjunction with a contactor/thermal overload relay configuration.
Isolating switches must also be provided in the motor or control circuit. These are to be in clear view of any person working on the motor, or provided with a locking device.
AS 3947.4.1 specifies testing requirements for the combination of components required to perform the motor control and protection functions. If the equipment has been mounted in a switchboard it is possible to meet the testing requirements of AS 3947.2 short circuit withstand of the outgoing circuit at the same time as the tests to AS 3947.4.1 are performed.
Both standards look at the performance of the equipment when a fault occurs on the outgoing circuit. It is accepted in these standards that some damage may be sustained by the components of the starter when subjected to short circuit conditions.

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

Type ' 1 '
Under short circuit conditions the starter shall not cause danger to persons or the installation. The starter itself may need repair.

## Type ' 2 '

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

Type '2' $\infty$-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


## Motor Starting Protective devices selection

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

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

As the circuit breaker or fuse is operating in conjunction with separate motor overload protection, it is the contactor which responds to overload problems. This is different to a protective device on a distribution circuit. For this application the advantages of the circuit breakers easy return to service has caused a general trend towards using circuit breakers.
Consideration should be given to preventing unskilled people from reclosing a tripped circuit breaker in a motor control application. This can be done by making the switchboard only accessible to the correct people, or by requiring the switchboard to be opened to reset the circuit breaker.

It must be assumed with both Type '1' and Type '2' co-ordination that if the short circuit protective device has operated there is a fault in the motor, or wiring to it and that the starter itself needs attention.
It is the let-through energy of the protective device which determines the damage to the starter. As this varies greatly between different models, it is essential that only proven combinations are used.
NHP, Sprecher + Schuh and Terasaki have now conducted many tests on different combinations and these are detailed in the co-ordination tables.

## Terasaki circuit breakers for short circuit protection

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

## TemBreak

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

## TemBreak electronic type

The rated current of the electronic type TemBreak is adjustable in 15 steps from $50 \%$ to $100 \%$ of the nominal rated current, using the base current (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.


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



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.

## Type ' 2 ' short circuit co-ordination Terasaki Din-T at 50kA

The 10kA Din-T miniature circuit breaker gives an amazing 50kA performance when used in the combinations shown in the co-ordination tables. For the low current ratings, the resistance of the thermal overloads assists in reducing the current to a level that the Din-T can handle with ease. For the higher ratings a Sprecher + Schuh limiter block lifts the combined performance to the 50kA level.
All the listed Din-T combinations include a rotary isolator which allows external control. To reset the starter after a short circuit, access to the breaker is required. This can be used to prevent unskilled operators from reclosing the motor starter after a fault.
it should also be remembered that whenever the circuit breaker trips under high fault currents, the contactor must be checked for welded contacts.


KTA 3 Motor starter combination

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



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



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

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



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


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

## Motor circuit application table for DOL starting General applications

High fault range


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
M

[^2]Motor circuit application table for DOL FIRE PUMP starting duty Breaker type and current rating (A)
M

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

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



TemBreak XV400NE mining breaker


Sprecher + Schuh 1000V CA 6 contactor
(Refer Part A for more information)

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

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

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

1. Voltage surges during MCCB opening.
2. Nuisance tripping due to in-rush current.
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 | - |
| 2 | $5 \times$ supply voltage |
| 3rd re-arcing voltage |  |

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

The numerous cases of re-arcing are mainly a result of older style "dependant manual closing" devices, which rely on the operator speed for opening or closing.
All Terasaki MCCB's are of the "manually independent closing" type, with high speed opening to prevent re-arcing between the contacts.

## 2. Nuisance tripping due to in-rush current

 When feeding a circuit containing a PFC unit the circuit breaker and the PFC unit can be exposed to a large in-rush current, equal to the instantaneous value of the power source. The end result of this is a large in-rush current, which could cause the circuit breaker to operateinstantaneously 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.

$$
\begin{aligned}
& \text { Capacitor Rated Current }=\frac{\mathrm{kVAR} \times 1000}{\sqrt{3 \times V}}(\mathrm{~A}) \\
& \text { kVAR: Capacitor Rating } \\
& \text { V: Source Voltage } \\
& \text { MCCB Rating }=\text { Capacitor Rated Current } \times 1.5 \text { (A) } \\
& \text { Once the MCCB rating has been determined, the MCCB } \\
& \text { type should be selected according to the short circuit fault } \\
& \text { level of the system. }
\end{aligned}
$$

## MCCB's selection for power factor capacitor application

促

Note: ') Select applicable short circuit rating required by system specifications.
${ }^{2}$ ) TemBreak Plus MCCBs can also be used.

## 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 ( $I_{0} \times I_{1}$ ) that should be used when in high frequency applications


[^3] must not exceed the values shown in Column 4.

## Circuit breaker 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
$\square$ Rated voltage which determines the number of poles required to be involved in the interruption of the circuit.
(1) 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


Example: For a Din-T10 to break 10kA at 110V DC it must have 2 poles connected in series.
Breaking capacities of TemBreak MCCB in DC systems
MCCB
有

## Notes:

${ }^{1}$ ) Time constant $(L / R)<=15 \mathrm{~ms}$; excludes $50 / 63 \mathrm{~A}$ where the time constant $(L / R)<=4 \mathrm{~ms}$
${ }^{2}$ ) Special version of the standard AC circuit breaker. Standard circuit breakers cannot be used at these ratings. Please specify for use on 500 or 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 (L/R) 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 circuit $>10 \mathrm{kA}$

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


## 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.


MCCB selection for 50 V DC battery applications 3 poles in parallel
TemBreak MCCBs may be connected with 3 poles in parallel.
Rated current $=3 \times 0.8=2.4 \times$ MCCB nominal rated current (In) for 3 poles in parallel.

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.

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

1. Definitions
$P=\quad$ Rated capacity of welder in kVA .
V $=$ Welder rated voltage.
I1 = Maximum primary current (PN).
$\mathrm{T}_{1}=$ Current 'ON' period.
$\mathrm{T}_{\mathbf{2}}=$ Current 'OFF' period.
$\mathrm{T}_{\mathbf{1}}+\mathrm{T}_{\mathbf{2}}=$ One welding cycle time.
B = Duty ratio, current 'ON' period divided by one welding cycle.
$\mathbf{I e}=\quad$ 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:

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

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, $\mathrm{T}_{1}$ with the MCCB characteristic curve to ensure that it will not trip.


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

## General guide lines for MCCB selection

| Selection factor | MCCB rating |
| :--- | :--- |
| Resistance welders | 3.00 max |
| Transformer arc welders | 2.00 max |

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

The maximum demand of the circuit excluding that of the largest welding machine plus
i) Three times the primary current of the largest resistance welding.
ii) Two times the primary ratings of the largest transformer arc welders.

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

b) Instantaneous setting

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

$$
I_{m}=\frac{P_{m} \times 1000}{V} \times 1.3 \times K
$$

The value of K varies depending on the type of welder control employed. (Some form of synchronous closing is nearly always employed in order to stabilise the welding work and to prevent nuisance tripping of the MCCB).
$K=1$ to 1.5 for synchronous type with peak control.
$K=1.4$ to 3 for synchronous type without peak control.
$K=2$ to 6 for non-synchronous soft start type.
If the protection of the thyristor stack is also required, the instantaneous trip setting must be greater than Im, but less than the surge on-state current rating of the thyristor stack:

where:
Is = surge on-state current rating of thyristor stack, in A
Im = maximum welder input current at start of welding, in A
$I_{\text {nst }}=M C C B$ 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 $15 \times$ the Primary Current.


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

|  | Single-phase transformer | Three-phase transformer |  |
| :---: | :---: | :---: | :---: |
| (kVA) | First peak <br> multiplier Decay time <br> constant | First peak multiplier | Decay time constant |
| 5-10 | 34 |  |  |
| 5-20 |  |  | 60whwex |
| 30 | Mex: 4 | 20 | , 3-6 |
| 50.6 |  |  | WVk |
| $75$ |  |  | , |
| $100$ |  | 細䫆 |  |
| 150 |  |  |  |
| $0$ |  |  |  |
| 300 \% |  |  | $6 \quad 10$ |

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

## MCB selection for high pressure sodium lamps

## Assumption

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

This table provides details for Din-T type ' $C$ ' MCB's
Power Number of fittings per phase


## 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 $=\frac{42}{3}=14$
Therefore from the table above a 32A MCB should be selected.

A short circuit rating as appropriate must be selected.

## MCB selection for fluorescent lighting loads

## Assumptions

1. The power rating of the ballast is $25 \%$ of power of the tubes.
2. Power factor -0.6 for non compensated fittings 0.86 for compensated fittings.
3. MCB's are installed in an enclosure with external ambient of $25^{\circ} \mathrm{C}$.
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


## MCB selection for incandescent lighting loads

## Assumptions

1) Tungsten lamps have theoretical inrush current of 14 times normal current, when switched from coid.
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 $415 / 240 \mathrm{~V} 3$ phase and neutral or 240 V single phase system and 240 V lamps.
5) MCB is used for circuit protection only, not switching. For switching duties of Din-T MCB's refer NHP.

Method
In order to cope with this inrush the following formula should be used to calculate breaker size:
Breaker rating $=\frac{W \times 10}{P \times 240 \times 1 \text { inst }}$
Where $W=$ total wattage
Where $P=$ Number of phases
I inst $=$ Minimum instantaneous tripping co-efficient.
C curve $=5$
D curve $=10$

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

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

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. Therefore, incoming conductors must be insulated

Insulating distance from Line-End for $380 / 415 \mathrm{~V}$
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
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

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

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

Significant voltage transients may also be produced as inductive circuits are switched and contribute to an arcing fault.
These problems affect all circuit breaker installations to varying degrees.
To ensure that problems are not created by the installation please observe the following recommendations.


## Notes:

1: Always observe LINE $L O A D$ 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.
${ }^{8}$ ) TL100EM MCCB's must use a TL100EMTLC lineside terminal cover. XV400 can use either a terminal cover or Interpole Barriers.

## MCCB mounting angles

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

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

Diagram at right is only applicable to $X M 30 \mathrm{~PB}$ motor circuit protectors.



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

## Calculation of circuit fault level

## NHP Nomogram

## Fault calculation

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

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

## How to use the Nomogram

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

However, many Supply Authorities are now installing low impedance transformer eg. $5 \%$ or less. Thus if the impedance is $5 \%$ then the fault level will be 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.
Description
5006 Specification for corrosive proofing of MCCB's
5025 De-rated current of ACB's when enclosed
5093 De-rated current of MCCB's when enclosed
5088
5067
5065
5074
5078
5087
5083
5086
5195

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





## Connections and mountings

MCCB accessories
Rear-connection type (RC)

## Bolt stud



Applicable breakers
0 XS series
XS125CJ, XS125NJ
] XH series
XH125NJ, XH125PJ

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

ASL: Arrangement Standard Line H: Handle frame centre line

Note: XS125NS 1 pole only
Drilling plan


Rear connected (optional)


975 tor accessory wiring when necossany

Panel mount


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

Plug-in (optional)

Mountirig block
Drilling plan



Plug-in Type
Switchboard use


Types of plug-in mounting blocks for switchboard use


## 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. |
| :--- | :--- | :--- | :--- |
| XS125 | IP 20 | $2,3 \mathrm{P}$ | $1=2$ |
| XH125 |  |  |  |

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


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



Ambient compensating curves


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

ASL: Arrangement Standard Line H: Handle frame centre line

Note: XS125NS 1 pole only


Drilling plan

Rear connected (optional)


## 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 limiters co-ordination chart

For fault current levels up to 50 kA at 415 V
Circut breakr

## Tembreak MCCB's

|  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |

Notes: ') 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 $1^{2} t$ 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 Brovara-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 $1^{2} t$ 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 (I $\mathrm{I}_{\text {pax }}$ ) 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.

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



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

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


## Upstream MCCB

| MCCB | kA (rms) | $\begin{gathered} \text { XS400SE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH400SE } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS630SE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH630SE } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS800SE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH800S } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS1250SE } \\ 65 \end{gathered}$ | $85$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
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## Standard TemBreak MCCB's - Selectivity and Cascade tables at 415V

Guide
$X X / Y Y$
Selectivity Cascade


## Upstream MCCB



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



Upstream MCCB
Downstream


## Motor Starting - Introduction

Generally, an item of switchgear is selected on the basis of one or more performance criteria, be it current/power carrying or interrupting capabilities.
Additional consideration is often necessary when several different pieces of switchgear are connected in series, none more so than in motor starting applications. As motors play a significant part in most modern day electrical systems it is important to ensure that the components of switchgear controlling and protecting the motor will interact with each other, or in other words, they are "co-ordinated".

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

(\#)

What problems can occur?
At the instant the motor is supplied with power it draws an "in-rush current" to its terminals, before gradually decaying to a normal operating current.
Should the in-rush current be high, it could be detected by the SCPD and classed as a fault current. If a high in-rush current should occur or even after repeated stop-start (inching) operations of the motor the SCPD may trip, albeit without a fault in the system. This is commonly known as "nuisance tripping" of the SCPD.
Special care must be taken when selecting a SCPD for motor-starting applications to prevent nuisance tripping, and at the same time ensuring adequate protection to the motor and associated cabling.
Another function of the SCPD is to protect the control device (e.g. contactor) from high-current, high-energy faults. Therefore, attention must also be paid when selecting an SCPD-Starter (contactor + thermal overload relay) combination.

When clearing a fault every SCPD has a finite opening time, which will result in an amount of fault current and energy being "let-through" to the downstream system and other devices. At the same time, a control device, such as a contactor can only withstand a finite level of fault current and energy, otherwise internal damage could occur.
Even at relatively low fault levels the electromagnetic forces created by the fault current can cause the contacts of a contactor to lift. This can cause heating or even mild arcing which in turn can damage or weld the contacts of the contactor.
Furthermore, the let-through current of the SCPD can distort the bi-metal strip in the overload relay. This can prevent the restoration of the bi-metal strip to its original configuration on cooling, altering the relay's protection characteristics and resulting in under or over protection of the motor.

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

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


## Motor Starting <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 takeover to interrupt the fault current therefore limiting energy passed through the starter components. When this is successfully achieved, the combination is said to be $\infty$-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 overbad 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 ' $\infty$-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


## Motor Starting Protective devices selection

In most cases very little difference will be noticed in the service performance of a system using fuses as against circuit breakers.
The circuit breaker is easier when it comes to restoring power, but as tripping should only be the result of a system fault it is unwise to reclose the circuit breaker without finding the cause. In this regard it is normal for only a "skilled person" to attend to fuse replacement and they are more likely to check for other problems.

As the circuit breaker or fuse is operating in conjunction with separate motor overload protection, it is the contactor which responds to overload problems. This is different to a protective device on a distribution circuit. For this application the advantages of the circuit breakers easy return to service has caused a general trend towards using circuit breakers.
Consideration should be given to preventing unskilled people from reclosing a tripped circuit breaker in a motor control application. This can be done by making the switchboard only accessible to the correct people, or by requiring the switchboard to be opened to reset the circuit breaker.

It must be assumed with both Type '1' and Type ' 2 ' co-ordination that if the short circuit protective device has operated there is a fault in the motor, or wiring to it and that the starter itself needs attention.
It is the let-through energy of the protective device which determines the damage to the starter. As this varies greatly between different models, it is essential that only proven combinations are used.
NHP, Sprecher + Schuh and Terasaki have now conducted many tests on different combinations and these are detailed in the $\infty$-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 50kA rms prospective short circuit. The protection is due to the special current limiting effect of the XM30PB.
Motor starter protection
The XM30PB circuit breaker has been developed for motor starter protection and is suitable as the Short Circuit Protection Device (SCPD) for motor starters equipped with either direct connected or CT connected overcurrent relays.

## XM30PB compared to HRC fuse

The circuit breaker tripping characteristic is more suitable for protection of starters than the HRC fuse. Unlike the HRC fuse, the breaker can be selected to trip instantaneously at a predetermined current level just lower than the maximum breaking current of the starter contactor, thus always protecting the contactor against opening fault currents higher than its capability. This can be seen from the typical breaker and fuse tripping characteristics compared to the contactor breaking capacity in figure 1.
No protection is provided by the fuse when the overcurrent is of value $B$ to $C$ amps should the contactor open by earth fauit 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.


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



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.

## Type ' 2 ' short circuit co-ordination Terasaki Din-T at 50kA

The 10kA Din-T miniature circuit breaker gives an amazing 50kA performance when used in the combinations shown in the $\infty$-ordination tables. For the low current ratings, the resistance of the thermal overbads 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




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

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



Notes: ') Thermal or electronic overload relays may be used.
${ }^{2}$ ) Use with separate mounting bracket.
Combinations based on the overioad relay tripping before the circuit breaker at overioad currents up to the motor locked rotor current.


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

## Motor circuit application table for DOL starting General applications

High fault range


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.
${ }^{\prime}$ ) 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.


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. ${ }^{\prime}$ ) 80,100 and 125 amp refers to Din-T10H type.
${ }^{2}$ ). Type 'SE' TemBreak MCCB only.
${ }^{3}$ ) TL100NJ up to 100 A only.
If co-ordination to IEC 947-4-1 is required refer to Type 1 and 2 co-ordination tables, contact NHP.
Din-T MCB's are calibrated to IEC 898 Curve 'C' \& 'D'. Selected sizes of 'D' Curve are available from stock. Refer NHP.

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

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. ') 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.

## Application cata

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




TemBreak XV400NE mining breaker


Sprecher + Schuh
1000V CA 6 contactor
(Refer Part A for more
information)

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

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

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

1. Voltage surges during MCCB opening.
2. Nuisance tripping due to in-rush current.
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 actuaily 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 | $-5 \times$ supply voltage |
| 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.
Capacitor Rated Current $=\frac{\mathrm{kVAR} \times 1000}{\sqrt{3} \times \mathrm{V}} \quad(\mathrm{A})$
kVAR: Capacitor Rating
V: Source Voltage
MCCB Rating $=$ Capacitor Rated Current $\times 1.5$ (A)
Once the MCCB rating has been determined, the MCCB
ype should be selected according to the short circtit fault
evel of the system.

## MCCB's selection for power factor capacitor application

l

[^4]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/lnstantaneous 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 ( $I_{0} \times I_{1}$ ) that should be used when in high frequency applications.


[^5] must not exceed the values shown in Column 4.


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

## Breaking capacities of TemBreak MCCB in DC systems

MCCB


## Notes:

${ }^{1}$ ) Time constant $(L / R)<=15 \mathrm{~ms}$; excludes 50/63A where the time constant (L/R) $<=4 \mathrm{~ms}$.
${ }^{7}$ ) Special version of the standard AC 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 250V DC 3-pole breakers must be used, with all three poles connected in series as shown.
The time constant (L/R) of the circuit should be:
less than 2 ms at rated current.
less than 2.5 ms for overload ( 2.5 x in).
less than 7 ms for short circuit $\leq 10 \mathrm{kA}$.
less than 15 ms for short circuit $>10 \mathrm{kA}$.


## 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.


MCCB selection for 50 V DC battery applications 3 poles in parallel TemBreak MCCBs may be connected with 3 poles in parallel.
Rated current $=3 \times 0.8=2.4 \times$ MCCB nominal rated current (In) for 3 poles in parallel.

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.

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

1. Definitions
$\mathbf{P}=\quad$ Rated capacity of welder in KVA .
V = Welder rated voltage.
$11=\quad$ Maximum primary current (PN).
$\mathrm{T}_{1}=\quad$ Current 'ON' period.
$T_{2}=$ Current 'OFF' period.
$T_{1}+T_{2}=$ One welding cycle time.
$B=$ Duty ratio, current 'ON' period divided by one welding cycle.
Ie $=$ Thermally equivalent continuous current.
2. MCCB selection
a) Current rating

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

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



## The thermally equivalent continuous current, le, may be calculated from:

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

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 $l_{1}$ and the current 'ON' period, T1 with the MCCB characteristic curve to ensure that it will not trip.


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

## General guide lines for MCCB selection

| Selection factor | MCCB rating |
| :--- | :--- |
| Resistance welders | 3.00 max |
| Transformer arc welders | 2.00 max |

SAA wiring rules states that a circuit breaker protecting a circuit from which one or more weiders 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 weiders.

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

b) Instantaneous setting

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


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:

where:
Is $=$ surge on-state current rating of thyristor stack, in $A$
Im = maximum welder input current at start of welding، in $A$
$I_{\text {wst }}=$ MCCB 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 LVILV transformer protection

When selecting an MCCB to protect the primary of an LVILV 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.


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


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

## MCB selection for high pressure sodium lamps

## Assumption

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

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


## 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 $=\frac{42}{3}=14$
Therefore from the table above a 32A MCB should be selected.
A short circuit rating as appropriate must be selected.


## 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 $415 / 240 \mathrm{~V} 3$ phase and neutral or 240 V single phase system and 240 V lamps.
5) MCB is used for circuit protection only, not switching. For switching duties of Din-T MCB's refer NHP.

Method
In order to cope with this inrush the following formula should be used to calculate breaker size:
Breaker rating $=\frac{W \times 10}{P \times 240 \times 1 \text { inst }}$.

Where $W$ = total wattage
Where P = Number of phases
I inst
$C$ curve $=5$
D curve $=10$

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

## TemBreak MCCB clearance requirements at 380/415V

Clearance requirements for MCCB's (phase to phase and earth).
When MCCB's are called upon to interrupt large short circuits ionised gas and arcing material is expelled from the vents, usually at the top of the MCCB.
This ionised gas is highly conductive and is also at an elevated temperature when it exits the MCCB via the arc vents. Care must be taken therefore to avoid an arcing fault occurring due to the presence of the ionised gas. Therefore, incoming conductors must be insulated

Insulating distance from Line-End for $380 / 415 \mathrm{~V}$
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 termina 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.
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)

B2 Distance from breaker end to insulator
C Clearance between breakers
D Distance from breaker side to side plate (earthed metal)

B1 Distance from breaker end to ceiling (earthed metal)
Table 1
This table is valid for $\mathbf{3 8 0 / 4 1 5 \mathrm { V }}$



## Notes:

1: Always observe LINEAOAD 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.

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


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

## Calculation of circuit fault level

## NHP Nomogram

Fault calculation
The NHP Nomogram is a simple and easy to use aid. Developed by NHP to enable convenient and accurate calculation of circuit fault current.
When selecting circuit breakers for the use in modern distribution systems, it is important to calculate the fault level and then choose an MCCB with breaking capacity that is either higher or at least equal to the circuit fault current.

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

However, many Supply Authorities are now installing low impedance transformer eg. $5 \%$ or less. Thus if the impedance is $5 \%$ then the fault level will be 56 kA . If the impedance is unknown on the side of caution choose $\mathrm{Z}=$ $5 \%$ 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. | Description |
| :--- | :--- |
| 5006 | Specification for corrosive proofing of MCCB's |
| 5025 | De-rated current of ACB's when enclosed |
| 5093 | De-rated current of MCCB's when enclosed |
| 5088 | De-rating of TemBreak electronic MCCB's when enclosed |
| 5067 | DC applications of ACB's |
| 5065 | Reverse connection |
| 5074 | Thyristor protection with MCCB's |
| 5078 | ELCB's at high frequency |
| 5087 | ACB's and MCCB's at high altitude |
| 5083 | Circuit breaker life mechanical and electrical |
| 5086 | TemBreak UVT: transient response time |
| 5195 | Inspection and maintenance of earth leakage and moulded case circuit breakers. |

## IP rating protection against ingress of dust and liquids



| IP 1st digit <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 $95^{\circ}$ |
| 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 parts, protection against ingress of dust | 6 Protection against strong jets of water eg. ship decks |
| $\cdot$ | 7 Protection against temporary immersion in water |
|  | 8 Protection against indefinite immersion in water - under pressure |

ELECTRICAL
PROTECTION


## Detailed specifications for ERICO's

## TRANSIENT DISCRIMINATING FILTER, TDF-10A SERIES

## Applications

ightning transients and surges are a major cause of expensive electronic :quipment failure and business disruption. Damage may result in loss of computers, data commmunications, loss of revenue, and loss of profits. The new Transient Discriminating Filter ${ }^{\text {TM }}$ family of TVSS devices offer sconomical and reliable protection from power transients with the convenence of easy installation on 35 mm DIN rail mountings.

The TDF series has been specifically designed for process control applicaions to protect the switched mode power supply units on devices such as ?LC controllers, SCADA systems and motor controllers. Units are availtble for $3 \mathrm{~A}, 10 \mathrm{~A}$ and 20 A loads and in a range of clamping voltages ncluding $30 \mathrm{~V}, 150 \mathrm{~V}, 275 \mathrm{~V}$. The range is intended for use in conjunction with ERICO's Universal Transient Barrier UTB's to provide a coordinated upproach to protection of both the power and data control circuits.

The TDF is a series connected single phase surge Gilter providing an iggregate surge capacity of $50 \mathrm{kA}(8 / 20 \mu \mathrm{~s})-20 \mathrm{kA}$ L-N \& L-G and 10 kA V-G. The space efficient low pass filter, provides some 65 dB of attenuaion to voltage transients. Not only does this reduce the residual let hrough voltage, but it helps further reduce the steep rates of rise of volttge and current providing superior protection for sensitive electronic squipment.

## Features

- Compact design fits into most distribution boards and motor control centres
- High efficiency filtering - ideal for the protection of switched mode power supplies from large $\mathrm{dv} / \mathrm{dt}$ and $\mathrm{di} / \mathrm{dt}$ transients
- Three modes of protection L-N, L-G, N-G
- 35mm DIN rail mount - DIN 43880 profile matches common MCB's
- LED indication and opto-isolated output for remote status monitoring
- Transient Discriminating Technology ensures safe operation during abnormal over-voltage events
- UL1449 Edition 2 recognized
- Large 50 kA surge capacity provides a high level of protection and long operational life
- 5 year limited warranty


## PROCESS CONTROL TVSS PROTECTION

## SPECIFICATIONS

## Operation:

Models available
Nominal line voltage
Max Continuous Operating Voltage MCOV
TDF-10A-120V
TDF-10A-240V
$120 \mathrm{VAC} / 125 \mathrm{VDC}$
240 VAC
170 Vms
340Vrms
Max Load Current
Input frequency
Earth leakage current
$50 / 60 \mathrm{~Hz}$
Proteclion:
Maxaggregate surge rating
Protection modes
Max surge current/mode L-N
50kA 8/20 s
L-N, L-G and N-G
20kA $8 / 20 \mu \mathrm{~s}$
L-G 20kA $8 / 20 \mu \mathrm{~s}$
N-G 10kA $8 / 20 \mu \mathrm{~s}$


SPD circuit description

Filter:
Inductor
Capacitor type
Attenuation@100kHz L-N
Performance:
UL1449 SVR L-N
ANSI/IEEE C62.41 Cat B3-500A ringwave
Cat Cl-3kA, $8 / 20 \mu \mathrm{~s}$
Alarms and Indicators:
Protection status indication
Physical Data:


Series low pass LC filter
Transient Discriminating Technology
Thermal fusing
Ferrite cored
$\mathrm{X} \& \mathrm{Y}$ grade interference suppression polypropylene film
65 dB
$500 \mathrm{~V} \quad 700 \mathrm{~V}$
22 V
28 V
262 V
481 V
Red LED, On = OK. Opto-isolated output
$144 \mathrm{~mm} \times 88 \mathrm{~mm} \times 70 \mathrm{~mm}$
750 g (approx)
Flame Retardant UL94V-O
Screw terminals
$1.0 \mathrm{~mm}^{2}-6.0 \mathrm{~mm}^{2}$
DIN T35 Rail
DIN 43880
IP20
$-30^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$
0-90\%
Spark eroded finish
5 years
UL1449 Ed 2, UL1283 recognised, CSA22.2 C-Tick AS3260
ANSI/IEEE C62.41 Cat A, Cat B, Cat C AS/NZS 1768-1991 Cat A, B, C

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development, specifications are subject to change without notice. © Copyright 1999

Part Number Description
TDF-10A-120V 120V 1 phase, $50 \mathrm{kA} 8 / 20 \mu \mathrm{~s}$, 10A series TVSS protector TDF-10A-240V 240 V 1 phase, $50 \mathrm{kA} 8 / 20 \mu \mathrm{~s}$, 10A series TVSS protector

| Hobart | ph:161'3 6237-3200 | fax +613 6273-0399 | Adelaide | ph:461 8 8366-6555 |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Sydney | ph:+61 $29479-8500$ | fax $+6129980-5092$ | Perth | ph:46189358-1233 | faxt61 89350-1404 |
| Melboume | ph:+61 $39894-2677$ | fax $+6139894-3216$ | Singapore | phi+ 65-763-2471 | tax+65763-2397 |
| Canberta | ph:+61 2 6257-305s | faxct61 2 6257-3127 | Thadand | pf: ${ }^{662627-9037-8 ~}$ | tax +662 627-9168 |

ERICO's coordinated approach to facility protection - CADWELD, CRITEC, ERITECH


## Detailed Specifications for ERICO's

 TDS-DINLINE SURGE DIVERTER TDS180-4S
## Applications

Lightning transients and surges are a major cause of expensive electronic equipment failure and business disruption. Damage may result in loss of computers, data and communications, loss of revenue, and loss of profits. The new TDSDINLINE family of surge diverters and filters offer economical and reliable protection from power transients in even the most strenuous applications.

Transient Discriminating Technology (TDS) introduces the first quantum leap in transient suppression technology for mains powered equipment. It offers a new level of safety and reliability, yet retains optimum protection levels critical for electronic equipment. TDS is an active frequency based device that discriminates between the slower mains voltages and the higher speed transients. When transient frequencies are detected the patented TDS "Quick-Switch" technology "switches in" robust protection devices to limit the transient to safe levels. The frequency discrimination circuit controlling the TDS "Quick-Switch" ensures that the device is virtually immune to the effects of the $50 / 60 \mathrm{~Hz}$ sustained overvoltages, allowing fault voltages of up to 480 Vrms without degradation, and providing over-voltage robustness in excess of the demanding new and emerging standards.

TDS technology is essential for any site where abnormal over-voltages can occur or where the possible catastrophic failure of traditional technologies due to overvoltage events can not be tolerated.

The TDS180-4S unit provides this technology in a single mode shunt-only, 72 mm width module. Its unique design allows it to be configured for $\mathrm{Ph}-\mathrm{N}$ or $\mathrm{Ph}-\mathrm{E}$ or N - E applications.

Rated to a surge capacity of $80 \mathrm{kA}(8 / 20 \mu \mathrm{~s})$, internally 160 kA of surge material is provided for additional robustness and to provide long service life. The unit is designed for sites with a medium risk of transients or for secondary protection applications. For the protection of high exposure sites or critical equipment higher surge rated TDS DINLINE units, or TDS MOVTEC ${ }^{\text {rM }}$ should be installed.

## Features

- Robust against abnormal over-voltage
- UL1449 Edition 2 compliant
- Single phase primary protection for medium exposure sites or secondary protection applications
- Single mode protection, configurable to $\mathrm{Ph}-\mathrm{N}, \mathrm{Ph}-\mathrm{E}$ or $\mathrm{N}-\mathrm{E}$ protection
- 35 mm DIN rail mount, DIN 43880 profile matches common MCBs
- 72 mm width compact design fits into most switch and distribution boards
- Electronic status indicator ideal for poorly illuminated locations
- Long Service life
- Optional retrofittable TDS Alarm Relay for remote alarms


## TDS－DINLINE SURGE DIVERTER TDS180－4S

## SPECIFICATIONS



Operation：
Nominal input voltage
Input frequency
Max．permissible abnormal over－voltage
Power systems
Earth leakage current
Protection： Modes
Let through voltage＠3kA $8 / 20 \mu \mathrm{~s}$
Let through voltage＠20kA $8 / 20 \mu \mathrm{~s}$
Surge rating 8／20ps
Surge rating $10 / 350 \mu \mathrm{~s}$
Energy rating
Multipulse ${ }^{\text {TM }}$ capability
Aggregate surge material
Alarms and Indicators： Protection status indication

Alarm contacts
Physicals：
Environmental rating
Operating conditions
Enclosure style
Dimensions（W x D x H）
Weight
Encapsulation
Enclosure material
Surface finish
Wiring terminals
Warranty
Test standards
Approvals
UL1449 Edition 2
AS 3260，IEC 950
Certificate of suitability， Electricity Regulator
Surge rated to meet

ANSI／IEEE C62．45－1987 Life cycle testing
AS／NZS 1768－1991 Cat A，Cat．B，Cat C．
BS 6651：1992 Cat A，Cat B．
IEC801－5 Installation Class 5.
IEC 61643－1

Note：Other operating vollages and frequencies are available on applicalion．
For specifications on other DNLLNE protucts，refer＇to relevant Specificstions Sheet．
Exceeding norninal operating vollage while transient everds ocour may affect product life
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## Model Number

TDS180－4S－277

Description
TDS 277V 80KA SURGE SUPPRESSOR

| Hobar Sychey Melboums Cantera | pt：＊61 3 E237－3200中 <br> 中か：612 2 257－3055 | 120x＋6136273－0399 lax＋61 $29980-5092$ lax＋61 3 2894 3216 fax＋61262573127 | noelatce <br> Perth <br> Singapore <br> Thatand |  <br> ph： 6 61 8 9058－1233 <br> ph： $65-763-2477$ <br> Dh： 6626 627－9037－4 | t20x＋6100360－6550 tux－6189258－1404 <br> 6x $+65753-2397$ <br> 64x＋652027－9168 | ${ }^{\bullet}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ERICO＇s coordinated approach to facility protection－CADWELD，CRITEC，ERITECH |  |  |  |  |  | www．erico．com |




## Detailed Specifications for ERICO's TDS-DINLINE ALARM RELAY TDS-AR <br> Features

## Applications

Lightning transients and surges are a major cause of expensive electronic equipment failure and business disruption. Damage may result in loss of computers, data and communications, loss of revenue, and loss of profits. The new TDS-DINLINE family of surge diverters and filters offer economical and reliable protection from power transients in even the most strenuous applications.

The TDS-DINLINE products provide internal monitoring and visual indication of their protection status. Because it is important that the status protection be monitored to ensure that optimum protection is being provided, the indication circuit also provides a low voltage optocoupler alarm output circuit. The TDS-AR connects to the TDSDINLINE opto-coupler outputs and provides a fully isolated potential free change-over alarm contact.

For installations not readily accessible, or for remote or unattended locations, it is recommended that the status of the TDS-DINLINE units be monitored via the TDS-AR Alarm Relay. This will allow prompt detection if optimum protection is not being provided at that site. Only the TDS-AR should be used for remote monitoring of TDS-DINLINE products, as use of other interfaces may cause damage to the diverters or connected circuits.

One TDS-AR can be used with up to 20 opto-coupler outputs. Optocoupler outputs can be connected in series to the one TDS-AR to provide a common output. This allows for one TDS-AR unit to monitor an entire three phase TDS-DINLINE protection system. It is recommended that the TDS-AR unit be powered from the downstream power circuit that feeds to the units being monitored. However it can be supplied from other circuits. The wide input range of the TDS-AR power supply ( $100-480 \mathrm{Vrms}$ ) allows it to be used on many distribution systems.

- Retrofittable TDS Alarm Relay for Transient Discriminating DNLNE Surge Diverters
- UL1449 Edition 2 compliant
- For use with external alarm and monitoring systems
- Potential free change over contacts
- 4000 V isolation
- 35 mm DIN rail mount, DIN 43880 profile matches common MCBs
- 72 mm width compact design fits into most switch and distribution boards
- Electronic indicators ideal for poorly illuminated locations
- For use with up to 20 DINLINE opto coupler outputs
- $100-480 \mathrm{Vms}$ operating range

The TDS-AR can also be used with standard technology DINLINE

# TDS DINLINE ALARM RELAY TDS-AR 

## SPECIFICATIONS



|  | Number of Opto-couplers: |  |
| :--- | :---: | :---: |
| Product | One DAR-275V <br> can support | One TDS-AR <br> can support |
| DSD140-2S/DSD155-2T | $1-8$ | $1-20$ |
| DSF-10A-XXX/DSF-20A-XXX | $1-4$ | $1-10$ |
| DSD180-4S/DSD1110-4T | $1-2$ | $1-5$ |
| DSD1160-8SDSD1220-8T | $1-2$ | $1-6$ |
| DSD355-8T | - | $1-20$ |
| TDS140-XXX | - | $1-10$ |
| TDS180-XXX | - | $1-5$ |

## Operation:

Input voltage
Max, operating voltage
Power systems

Surge immunity:
Power supply

Ouiput contacts:
Contact types
Nominal switching capacity
Maximum switching power
Maximum switching voltage
Maximum switching curent
Isolation to other circuits

Physicals:
Environmental rating
Operating conditions
Enclosure style
Dimensions ( $\mathrm{W} \times \mathrm{D} \times \mathrm{H}$ )
Weight
Encapsulation
Enclosure material
Surface finish
Wiring terminals
Warranty
$100 \mathrm{~V}-480 \mathrm{Vrms}$
480 V ms
TN-C, TN-S, TN-C-S (MEN), TT

3kA $8 / 20 \mu \mathrm{~s}$, Cat B AS-1768

Change over
2A, 30VDC
$60 \mathrm{~W}, 125 \mathrm{VA}$
$220 \mathrm{VDC}, 250 \mathrm{VAC}$
2A
4kV

1P20
-35 to $+55^{\circ} \mathrm{C}, 0-90 \%$ humidity
DIN 43880
$72 \times 88 \times 70 \mathrm{~mm}$
350 g (approx.)
Shockguard
Flame Retardent UL94V-0
Spark eroded finish
Accepts up to $6 \mathrm{~mm}^{2}$
5 years

Test standards:
Approvals
AS 3260, IEC 950
C Tick
ACA TS001
Certificate of suitability,
Electricity Regulator

Note: For specifications on other DONL INE proctucts, refer to relevant Specifications Sheet.
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## Model Number

TDS-AR

## Description <br> TDS ALARM RELAY

| Hobart | ph:46136237-3200 | 1ax+6136273-0399 | Adelaide | pht+6188366-5555 | tox+618 8360-6556 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Sydrey | ph:461 2 9479-8500 | Pax+61 2 9980-5092 | Perth | ph:+618 9358-1233 | tax+et $89358-1404$ |
| Melboume | ph:+6139894-2677 | fact6139894-3216 | Singapiore | ph:* Ex-76]-2477 | Fax+ 55 763-2397 |
| Canbera | ph:461 26257.3085 | fax+6126257-3127 | Thadand | ph: 6592 [527-9037-8 | 1ax+662 527-9168 |

## Din-T6 series 6kA MCB

[ Standards AS3111, IEC 898.
[] Approval No. N13374.
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 (250A \& 355A).


## 1 pole 1 module

| $\ln (\mathrm{A})$ | $\begin{aligned} & C \text {-Curve } \\ & 5 \text {-10in } \\ & \hline \end{aligned}$ |
| :---: | :---: |
| 2 | D DMET6102c |
| 4 | WNeI6104c |
| 6 | WSINT6106C |
| 10 | W DIN 6110 C |
| 16 | WDINT6116C |
| 20 | 1 $\mathrm{ClNT} / 612 \mathrm{C}$ |
| 25 | W6iNT6125C |
| 32 | W1NT6132C |
| 40 | 68iN-16140C |
| 50 | Y0iN-T61500 |
| 63 | WhiNT6163C |


| $\begin{aligned} & D-\text { Curve } \\ & 10-20 \text { In } \end{aligned}$ |
| :---: |
| WVINT6102D |
|  |
|  |
|  |
| Wbineth1660 |
| W, ETET620 |
| WVIN-T612501 |
| WRN-T6132D ${ }^{\text {W }}$ |
| W. DIN-161400\% |
| DINT6150D |
| W81N-161630 |

2 pole 2 modules

| 2 | WVINT 6202 C |
| :---: | :---: |
| 4 | WDINT6204C |
| 6 | DiN16206\% |
| 10 | 1201T6210\% |
| 16 | WINET6246\% |
| 20 | KpINUT620c |
| 25 | WUTN T6225c |
| 32 | W8INTT232C |
| 40 | WbiNT 16240 c |
| 50 | EINTT6250C |
| 63 | VINET6263C |


| 3 pole 3 modules |  |
| :---: | :---: |
| 2 | Win |
| 4 | DiNT6304C |
| 6 | DIN-T6306C |
| 10 | URINT6310cy |
| 16 | WLinT 6316 C |
| 20 | DINT 6320 C |
| 25 | DIN-6325G |
| 32 | 1-EINT63320 |
| 40 |  |
| 50 | STN-T6350ch |
| 63 | EDiNT6363C |

Short circuit capacity 6000 amps

| $\ln (A)$ | $2-63$ |
| :--- | :--- |
| 1P | 240 VAC |
| $2 P$ | 240 V AC |
| $3 P$ | $240-415 \mathrm{VAC}$ |


| DC use | 1P | 2P ' |
| :--- | :--- | :--- |
| Short circuit | 6000 A | 6000 A |
| Max.voltage (DC) | $24 / 48 \mathrm{~V}$ | 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 7716.3 and DIN 40046 part 8.

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 approximately VDE 0664 parts 1 and 2.

Use at 400 Hz
At 400 Hz the magnetic trip current is approximately $50 \%$ higher than in $\mathrm{AC} 50 / 60 \mathrm{~Hz}$.

| Accessories |
| :--- |
| Add on RCD |
| Auxiliary/alarm |
| Shunt trip |
| Padlockable bracket |
| Link bars \& terminals |
| Enclosures |
| Busbar chassis |

## Notes: ') 2 poles in series (not $2 \times$ single poles).

The line side is the "OFF" (bottom) side of the MCB. i) Available on indent only.

## Din-T6 series 6kA MCB (cont)

Technical data

| Number of poles |  | $\mathbf{1}$ | $\mathbf{2}$ | $\mathbf{3}$ |
| :--- | :--- | :--- | :--- | :--- |
| Width | $(\mathrm{mm})$ | 18 | 36 | 54 |
| Depth | $(\mathrm{mm})$ | 68 | 68 | 68 |
| Rated voltage | $(\mathrm{V} \mathrm{AC})$ | 240 | 240 | 415 |
| Highest rated current | $(\mathrm{A})$ | 63 | 63 | 63 |
| Terminal capacity | Line side | $\left(\mathrm{mm}^{2}\right)$ | 25 | 25 |
|  | Load side | $\left(\mathrm{mm}^{2}\right)$ | 25 | 25 |

Number of switching operations

| Operations 240V AC, $\operatorname{In} \operatorname{Cos} \varphi=0.9$ | 10000 | 10000 | 10000 |  |
| :--- | :--- | :--- | :--- | :--- |
| DC @ $I_{\mathrm{n}}$ |  | 4000 | 4000 | 4000 |
| Insulation resistance | $(\mathrm{M} \Omega)$ | $>10^{8}$ | $>10^{8}$ | $>10^{\circ}$ |
| Dielectric strength | $(\mathrm{kV})$ | 2.5 | 2.5 | 2.5 |



Ambient temperature influence
The thermal calibration of the Din-T6 series was carried out at $30^{\circ} \mathrm{C}$. Temperatures above or below will alter the trip characteristics controlled through the bi-metal.
See curve below


| Voltage drop and energy loss <br> Voltage <br> drop $(\mathrm{V})$ |  |  | Energy <br> loss $(\mathrm{W})$ |
| :--- | :--- | :--- | :--- |
| $\mathbf{2}$ | 0.82 | 1.6 | Internal <br> resistance <br> $(\mathrm{m} \Omega)$ |
| 4 | 0.57 | 2.3 | 410 |
| 6 | 0.21 | 1.3 | 142.5 |
| 10 | 0.13 | 1.3 | 35 |
| 16 | 0.11 | 1.8 | 13 |
| 20 | 0.14 | 2.8 | 6.9 |
| 25 | 0.10 | 3.0 | 4.0 |
| 32 | 0.09 | 3.0 | 2.8 |
| 40 | 0.08 | 4.7 | 2.0 |
| 50 | 0.090 | 4.5 | 1.8 |
| 63 | 0.088 | 5.56 | 1.4 |

Catalogue number structure for Din-T MCB's $(6,10,10 \mathrm{H} \& 15)$

| DIN-T |
| :--- |
| $X$ <br> Constant <br> NHP DIN format |
| Short circuit <br> capacity (A)  <br> 4.5 4500 <br> 6 6000 <br> 10 10000 <br> 10 H 10000 <br> 15 15000 |


| $X$ <br> Polarity <br> 1 |
| :--- |
| 2 |


| $X X$ <br> 1 <br> $\ln (A)$ <br> 05 <br> 01 <br> 02 |
| :--- |
| 04 |
| 06 |
| 10 |
| 16 |
| 20 |


| $X$ |
| :--- |
| Curve <br> type <br> B <br> C <br> $D$$\quad 3 \ln -5 \ln -10 \ln$ |



## Din-T6 and Din-T10 series MCB's

## Magnetic release

An electromagnet striker ensures instantaneous tripping in case of short circuit. IEC 898 describes the following types

| Curve type | Test current | Tripping time | Applications |
| :---: | :---: | :---: | :---: |
| C | 5 ln | $\pm 0.1 \mathrm{~s}$ | Usual loads such as: |
|  | 101n | t<0.1s | - lighting |
|  |  |  | - socket outtets |
|  |  |  | - small motors') |
| $\overline{0}$ | 10 ln | $t \geq 0.1 \mathrm{~s}$ | Control and protection of cir- |
|  | 20 ln | $t<0.1$ s | cuits having high transient |
|  |  |  | inrush currents (large |
|  |  |  | motors, ${ }^{\text {² }}$ ) transformers etc). |

Note: ') C curve MCBs are suitable for general motor starting applications, see motor starting tables section 10.
${ }^{2}$ ) D curve MCBs may be selected in more arduous starting applications or may allow a lower current rating MCB to ber selected. Refer NHP.

Tripping characteristics according to IEC 898 (time-current tables)

Din-T6: from 2 to 6A Din-T10: from 0.5 to 6A


## Thermal release

The release is initiated by a bimetal strip in case of overload. IEC 898 defines the range of release for specific overload values. Reference ambient temperature is $30^{\circ} \mathrm{C}$.

| Test current | Tripping time |
| :--- | :--- |
| $1.13 \ln$ | $\geq 1 \mathrm{~h}(\ln \leq 63 A)$ |
|  | $\geq 2 h(\ln >63 A)$ |
| $1.45 \ln$ | $t<1 \mathrm{~h}(\ln \leq 63 A)$ |
|  | $t<2 \mathrm{ln}(\mathrm{ln}>63 \mathrm{~A})$ |
| $2.55 \ln$ | $1 \mathrm{~s}<\mathrm{t}<60 \mathrm{~s}$ |
|  | $(\ln \leq 32 A)$ |
|  | $1 \mathrm{~s}<t<120 \mathrm{~s}$ |
|  | $(\ln >32 \mathrm{~A})$ |

Din-T6 (2-40A)


Din-T6 (50-63A)
Din-T10 and Din-T15 (0.5-63A)


Din-T10H (80-125A)



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

For fault current levels up to 50 kA at 415 V


## Tembreak MCCB's

## KN1251TC.

Notes: ') Minimum fuse size is based on grading under overload of one MCB with one set of luses. Where a single set of fuses
prolects more than one MCB, the minimum fuse size shall be increased to allow for load biasing effects.
${ }^{7}$ ) Maximum fuse size based on testing to AS 3439.1 clause 8.2.3.

Tables based on the following maximum pre-arching $I^{2} t$ 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 Brovara-Crady.
Fuses with higher current ratings may be used providing $I^{2} \mathrm{t}$ 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.

Upstream MCCB .

## XS400SE

Downstream XS125CJ XS125NJ XH125NJ XS250NJ XH250NJ XS400CJ XS400NJ

| MCB | KA (rms) | 18 | 30 | 50 | 35 | 50 | 35 | 50 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

拱

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

## Motor circuit application table for DOL starting General applications

High fault range


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 applicalions only. The table is based on holding $125 \%$ of full load curent (FLC) continuously and $600 \%$ of FLC for at least 10 seconds. Lower circuit breaker ratings are possible in some applications. Refer NHP.

1) 80,100 and 125 amp refers to Din-T10H type.
${ }^{2}$ ) Type 'SE' TemBreak MCCB only.
${ }^{3}$ ) Use magnetic-only TemBreak MCCB. Refer NHP.
Adjustable magnetic trips set to high. Thermal magnetic TemBreak adjuslable $63 \%-100 \%$ 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) | $\begin{aligned} & \text { Din-T } \\ & C \& D \end{aligned}$Curve | $\begin{aligned} & \mathrm{XS} 125 \mathrm{CJ} \\ & \text { XS125NJ } \end{aligned}$ |  |  | XS400SE XH630SE |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  | XH400SE | XS630SE | XS800NJ |  |
|  |  |  |  | XH125NJ |  | XS250NJ | XS400CJ | XS630CJ | XH800SE | XS1250SE |
|  |  |  | Safe-T | TL100NJ ${ }^{\text {² }}$ | XE225NC | XH250NJ | XS400NJ | XS630NJ | XS800SE | 1000 |


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[^6]
## Din－T10 series 10kA MCB

| 3 pole 3 modules |  |
| :---: | :---: |
| $\ln (\mathrm{A})$ | $\begin{aligned} & \text { C-Curve } \\ & 5 \text {-10in } \end{aligned}$ |
| 0.5 | idinT10305C |
| 1 | ［］DNT10301c |
| 2 | 6．DiN－T10302C |
| 4 | DIINTIO304C |
| 6 | WhinT10306C |
| 10 | DiNT10310C |
| 16 | DIN－10316世 |
| 20 | DIN－T10320C |
| 25 | S BIN－10325C |
| 32 | E1N－10332C |
| 40 | －Din T10340c |
| 50 | DINT10350c |
| 63 | \％DINT10363C |


| $\begin{aligned} & \text { D - Curve } \\ & \text { 10-20In } \\ & \hline \end{aligned}$ |
| :---: |
| Din Tr 03050 |
| DilkTS03010 |
| BDINT103020 |
| BDINTH0304日 |
| D DINT103060 |
| DINT10310D |
| DINT10316D |
| DiNTT103200 |
| DiNT10325B |
| ViNTH103320 |
| WVy |
|  |
| K人) |



4 pole 4 modules

| 6 | Winint 0405 C |
| :---: | :---: |
| 10 | DiNT10410\％ |
| 16 | DiNT10416C |
| 20 | Wint 10420 C |
| 25 | VIN T10 025 C |
| 32 | DINT10432C |
| 40 | WSINT10440c |
| 50 |  |
| 63 | W．DINTT10463C |



Accessories
Add on RCD
Auxiliary／alarm
Shunt trip
Padlock bracket
Link bars \＆terminals
Enclosures
Busbar chassis

Notes：＇）D curve Din－T 10 MCB＇s not available in 40 to 63 amp ． i）Available on indent only


## Din-T10 series 10kA MCB (cont.)

Technical data

| Number of protected poles |  | 1 | 2 | 3 | 4 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Width: 0.5 to 63 A | $(\mathrm{~mm})$ | 18 | 36 | 54 | 72 |
| Depth | $(\mathrm{mm})$ | 68 | 68 | 68 | 68 |
| Rated voltage | (VAC) | $240 / 415$ | $240 / 415$ | 415 | 415 |
| Highest rated current | (A) | 63 | 63 | 63 | 63 |


| Number of switching operations: |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| DC 1 ln | 4000 | 4000 | 4000 | 4000 |  |
| at $220 \mathrm{~V}, \cos \varphi=0.9$ | 10000 | 10000 | 10000 | 10000 |  |
| at $415 \mathrm{~V}, \cos \varphi=0.9$ | 10000 | 10000 | 10000 | 10000 |  |
| Insulation resistance | $(\mathrm{M} \Omega)>10^{6}$ | $>10^{8}$ | $>10^{6}$ | $>10^{8}$ |  |
| Dielectric rigidity | $(\mathrm{kV})$ | 4 | 4 | 4 | 4 |
| Terminal capacity Line (OFF side) $\left(\mathrm{mm}^{2}\right) 35$ | 35 | 35 | 35 |  |  |

Voltage drop and energy loss

| In (A) | Voltage <br> drop (V) | Energy <br> loss $(\mathrm{W})$ | Internal <br> resistance <br> $(\mathrm{m} \Omega)$ |
| :--- | :--- | :--- | :--- |
| 0.5 | 3.100 | 1.55 | 6200 |
| 1 | 1.700 | 1.7 | 1700 |
| 2 | 0.900 | 1.8 | 450 |
| 4 | 0.500 | 2 | 125 |
| 6 | 0.318 | 1.91 | 53 |
| 10 | 0.140 | 1.4 | 14 |
| 16 | 0.128 | 2.05 | 8 |
| 20 | 0.110 | 2.2 | 5.5 |
| 25 | 0.092 | 2.31 | 3.7 |
| 32 | 0.103 | 3.28 | 3.2 |
| 40 | 0.088 | 3.5 | 2.2 |
| 50 | 0.090 | 4.5 | 1.8 |
| 63 | 0.088 | 5.56 | 1.4 |

## Use at DC

At DC the magnetic tripping current is approximately $40 \%$ higher than at $\mathrm{AC}, 50 / 60 \mathrm{~Hz}$.
Shock resistance
(In X, Y, $Z$ directions). 20 g with shock duration 10 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 689-2 6/90.
Storage temperature
From $-55^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$. According to VDE 0664 part $1 \& 2$.
Operating temperature
From $-25^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$. According to IEC 88 part $2-1$ (duration 96 hours).
Use at 400 Hz
At 400 Hz the magnetic tripping current is approximately $50 \%$ higher than at AC $50 / 60 \mathrm{~Hz}$.

Influence of ambient temperature
The thermal calibration of Din-T10 MCB's was carried out at an ambient temperature of $30^{\circ} \mathrm{C}$ (IEC 898). Ambient temperatures different from $30^{\circ} \mathrm{C}$, influence the bi-metal and this results in earlier or later thermal tripping (see curves below).

IEC $898\left(30^{\circ} \mathrm{C}\right)$





## Din-T6 and Din-T10 series MCB's

## Magnetic release

An electromagnet striker ensures instantaneous tripping in case of short circuil. IEC 898 describes the following types

| Curve type | Test current | Tripping time | Applications |
| :---: | :---: | :---: | :---: |
| C | $\begin{aligned} & 5 \mathrm{in} \\ & 10 \mathrm{in} \end{aligned}$ | t20.1s <br> <0.1s | Usual loads such as: <br> - lighting <br> - socket outlets <br> - small motors') |
| $\overline{\text { D }}$ | $\begin{aligned} & 10 \mathrm{ln} \\ & 20 \mathrm{ln} \end{aligned}$ | $\begin{aligned} & t \geq 0.1 \mathrm{~s} \\ & t<0.1 \mathrm{~s} \end{aligned}$ | Control and protection of circuits having high transient inrush currents (large motors.? transformers etc). |

## Note: ') C curve MCBs are suitable for general motor starting applications

 see motor starting tables section 10.${ }^{7}$ ) D curve MCEs may be selected in more arduous starting applications or may allow a lower current rating MCB to ber selected. Refer NHP.

## Thermal release

The release is initiated by a bimetal strip in case of overload. IEC 898 defines the range of release for specific overload values. Reference ambient temperature is $30^{\circ} \mathrm{C}$.

| Test current | Tripping time |
| :---: | :---: |
| 1.13 ln | $\operatorname{t21h}(\ln \leq 63 \mathrm{~A})$ |
|  | $\underline{\mathrm{D}} 2 \mathrm{~h}(\mathrm{ln}>63 \mathrm{~A})$ |
| 1.45 In | $\mathrm{t}<1 \mathrm{~h}(\mathrm{ln} 563 \mathrm{~A})$ |
|  | t<2h (in $>63 \mathrm{~A})$ |
| 2.55 ln | 1s < t < 60 s |
|  | ( $\mathrm{l} \leq 532 \mathrm{~A}$ ) |
|  | 1s $<1<120 s$ |
|  | ( $\mathrm{ln}>3$ 32A) |

$\square$
C

Din-T6: from 2 to 6A
Din-T10: from 0.5 to 6A


Din-T6: from 2 to 6A Din-T10: from 0.5 to 6A


Dimensions Safe-T with shunt trip Din-T6, 10, 10H and 15 series

Safe-T shunt (6-63A)


Din-T6 (2-40A)


Safe-T shunt (80-100A)


Din-T6 (50-63A)
Din-T10 and Din-T15 (0.5-63A)


Din-T10H (80-125A)

| $\Theta$ | $\theta$ | $\theta$ | $\theta$ |
| :---: | :---: | :---: | :---: |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
| $\Theta$ | $\theta$ | $\theta$ | $\theta$ |



All dimensions in mm


Safe-T with shunt
Din-T6 MCB
Din-T10 MCB
Din-T10H MCB
Din-T15 MCB

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

For fault current levels up to 50 kA at 415 V


## Tembreak MCCB's



Notes: ') 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 $1^{2 t}$ 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 Brovara-Crady.
Fuses with higher current ratings may be used providing $l^{2} t$ values are equal to, or less than the levels above. Semi-conductor fuses have very low $1^{2} t$ 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 instaliations containing fire and smoke control equipment, evacuation equipment and lifts.

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


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

## Motor circuit application table for DOL starting General applications

## High fault range



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 sec onds. 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.
${ }^{\text {J }}$ ) 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 | Approx. | Din-T | XS125CJ |  | XS400SE XH630SE |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | XS125NJ |  | XH400SE | XS630SE | XS800NJ |  |
| rating | FLC | C \& D |  | XH125NJ | XS250NJ | XS4000 J | XS6300 $J$ | XH800SE | XS1250 |
| 車㬵 | Hemer | Cry |  | TLintat | Tratel! |  |  | Msink | Y497 |



[^7]
# Motor circuit application table for DOL FIRE PUMP starting duty 

 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. ') 80,100 and 125 amp refers to Din-T10H type.
${ }^{2}$ ) Type 'SE' TemBreak MCCB only.
₹ 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.

Valid for the following Soft starter Models: MSF-017 to MSF-1400

## MSF

SOFT STARTER

## INSTRUCTION MANUAL

Document number: 01-1363-01
Edition: r 2
Date of release: 2001-04-20
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## Safety

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

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


## Operating and maintenance personnel

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

## Installation of spare parts

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

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

## Emergency

You can switch the device off at any time with the mains switch connected in front of the soft starter (both motor and control voltage must be switched off).

## Dismantling and scrapping

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

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

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## 1. GENERAL INFORMATION

### 1.1 Integrated safety systems

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

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

The soft starter is fitted with a connection for protective earth $\stackrel{1}{=}$ (PE).

MSF soft starters are all enclosed [P 20, except MSF-1000 and MSF-1400 which are delivered as open chassi IP00.

### 1.2 Safety measures

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

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

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

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

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

- Safety of personnel.
- Product disposal.
- Environmental protection.

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

### 1.3 Notes to the instruction Manual

!
WARNING! Wamings are marked with a warning triangle.

## Sedal number

The information given in these instructions only applies to the device with the serial number given on the label on the front page. A plate with the serial number is fixed to the device.

## Important

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

NOTE! These instructions only apply to the soft starters having the serial number given on the front page, and not for all models.

### 1.4 How to use the Instruction Manual

This instruction manual tells you how to install and operate the MSF soft starter. Read the whole. Instruction Manual before installing and putting the unit into operation. For simple start-up, read chapter 2 . page 8 to chapter 3. page 10.

Once you are familiar with the soft starter, you can operate it from the keyboard by referring to the chapter 13. page 79. This chapter describes all the functions and possible setting.

### 1.5 Standards

The device is manufactured in accordance with these regulations.

- IEC 947-4-2
- EN 60204-1 Electrical equipment of machines, part 1, General reguirements and VDE 0113.
- EN 50081-2, EMC Emission
- EN 50081-1, EMC Emission with bypass
- EN 50082-2, EMC Immunity
- GOST
- UL508


### 1.6 Tests in accordance with norm EN60204

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

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


### 1.7 Inspection at delivery



Fig. 1 Scope of delivery.

### 1.7.1 Transport and packing

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

## Check on receipt:

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


## Is the packaging damaged?

- Check the goods for damage (visual check).


## If you have cause for complaint

If the goods have been damaged in transport:

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


## Packaging for retuming the device

- Pack the device so that it is shock-resistant.


## Intermedlate storage

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

### 1.8 Unpacking of MSF-310 and larger types

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

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


Fig. 2 Unpacking of MSF-310 and larger models.

### 2.1 General

The MSF is installed directly between the mains and the supply cable to the motor. If a mains contactor is used it can be activated by the integrated K1 relay.


The MSF is developed for soft starting, stopping and braking three-phase motors.

There are 3 different kinds of soft starting control methods:

- Control method 1-Phase

The single phase controlled soft starters provide only a reduction in starting torque no control of current or torque. These starters need a main and bypass contactor as well as external motor protections. This is a open loop voltage controller. These starters are mainly in the power up to 7.5 kW .

- Control method 2-Phase The two phase starters can start a motor without a mains contactor, but in that case voltage still is present at the motor when it's stopped. These starters are mainly in the power up to 22 kW .
- Control method 3-Phase

In the three phase Soft Starters there are different technologies:

- Voltage control
- Current control
- Torque control


## Voltage control

This method is the most used control method. The starter gives a smooth start but doesn't get any feedback on current or torque. The typical settings to optimize a voltage ramp are: Initial voltage, ramp time, dual ramp time.


Fig. 3 Voltage control

## Current control

The voltage ramp can be used with a current limit which stops the voltage ramp when the set maximum current level is reached. The maximum current level is the main setting and must be set by the user depending the maximum current allowed for the application.


Fig. 4 Current control

## Torque control

Is the most sufficient way of starting motors. Unlike voltage and current based systems the soft starter monitors the torque need and allows to start with the lowest possible current. Using a closed loop torque controller also linear ramps are possible. The voltage ramp can not hold back the motor starting torque this results in a current peak and unlinear ramps. In the current ramp there will be no peak current, but a higher current for a longer period of time during the start compared to torque control. Current starting doesn't give linear ramps. The linear ramps are very important in many applications. For an example, to stop a pump with an unlinear ramp will give water hammer. Soft starters which doesn't monitor the torque, will start and stop to fast if the load is lighter than the setting of current or ramp time.


Fig. 5 Torque control

### 2.2 MSF control methods

MSF Soft Starters control all three phases supplied to the motor. It manages all the 3 possible starting methods where the closed loop Torque control is the most efficient way of starting and stopping motors.

### 2.2.1 General features

As mentioned above soft starters offer you several features and the following functions are available:

- Torque controlled start and stop
- Current limit control at start
- Application "Pump"
- External analogue input control
- Torque booster at start
- Full voltage start (D.O.L)
- Dual voltage ramp at start and stop
- Bypass
- Dynamic DC-brake or Softbrake
- Slow speed at start and stop
- Jogging forward and reverse
- Four parameter sets
- Analogue output indicating current, power or voltage
- Viewing of current, voltage, power, torque, power consumption, elapsed time etc.
- Integrated safety system acc. to $\$ 1.1$, page 6 , with an alarm list.


## 3. HOW TO GET STARTED



Fig. 6 Standand uiring.
This chapter describes briefly the set-up for basic soft start and soft stop by using the default "Voltage Ramp" function.


WARNING! Mounting, wiring and setting the device into operation must be carried out by propelly trained personnel. Before setup, make sure that the Installation is according to chapter 6. page 24 and the Checkist below.

### 3.1 Checklist

- Mount the soft starter in accordance with chapter 6. page 24.
- Consider the power loss at rated current when dimensioning a cabinet, max. ambient temperature is $40^{\circ} \mathrm{C}$ (see chapter 12 . page 74).
- Connect the motor circuit according to Fig. 6.
- Connect the protecrive earth.
- Connect the control voltage to terminals 01 and 02 ( $100-240$ VAC or $380-500 \mathrm{VAC}$ ).
- Connect relay K. 1 (PCB terminals 21 and 22) to the contactor - the soft starter then controls the contactor.
- Connect PCB terminals 12 and 13 to, e.g., a 2-way switch (closing non-return) or a PLC, etc., to obtain control of soft start/soft stop. ${ }^{1}$ )
- Check that the motor and supply voltage corresponds to values on the soft starter's rating plate.
- Ensure the installation complies with the appropriate local regulations.

1) The menu 006 must be put to 01 for seart/stop command from keyboard.

### 3.2 Main functions/Applications

##  <br> WARNING! Make sure that all safety measures have been taken before switching on the supply.

Switch on the control voltage (normally $1 \times 230 \mathrm{~V}$ ), all segments in the display and the two LED's will be illuminated for a few seconds. Then the display will show menu 001. An illuminated display indicates there is supply volcage on the PCB. Check that you have mains voltage on the mains contactor or on the thyristors. The settings are carried out according to following:

The first step in the settings is to set menu 007 and 008 to "ON" to reach the main functions 020-025 and motor data 041-046.

NOTE! The main function is chosen according to the application. The tables in the applications and functions selection (table 1, page 15), gives the information to choose the proper main function.

### 3.3 Motor Data

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

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

| 0 | 4 | 1 | 0 |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  |  |  |  |
|  | 4 | 0 | 0 |$\quad$|  |  |
| :--- | :--- | :--- |


| $0 \mid 4$ |  |
| :--- | :--- | :--- | :--- |
|  |     <br>   4 5 |
| Default: | Nominal current soft starter |
| Range: | $25 \%-150 \%$ of $n_{\text {soft }}$ in Amp |




NOTE! Now go back to menu 007 and set it to "oFF" and then to menu 001.

### 3.4 Setting of the start and stop ramps

The menu's 002 and 003 can now be set to adjust the start ramp up time and the stop ramp down time.


Estimate the starting-time for the motor/machine. Set "ramp up time" at start ( $1-60 \mathrm{sec}$ ).
Key "ENTER $\&$ " to confirm new value.
Key "NEXT $\rightarrow$ ", "PREV $\leftarrow$ " to change menu.


Set "ramp down time" at stop (2-120 s).
"oFF" if only soft start requires.

### 3.5 Setting the start command

As default the start command is set for remote operation via terminal 11, 12 and 13 . For easy commissioning it is possible to set the start command on the start key on the keyboards. This is set with menu 006.


Menu 006 must be set to 1 to be able to operate from keyboard.

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

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

To reset from the keyboard, the "ENTER $\leftarrow$ / RESET" key is used. A reset can be given both when the motor is running and when the motor is stopped. A reset by the keyboard will not start or stop the motor.

### 3.6 Viewing the motor current

Set the display to menu 005. Now the Motor current can be viewed on the display.


NOTE! The menu 005 can be selected at any time when the motor is running.

### 3.7 Starting



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

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


Fig. 7 Example of start ramp with main fundion voltage ramp.

## 4. APPLICATIONS AND FUNCTIONS SELECTION

This chapter is a guide to select the correct soft starter rating and the selection of the Main function and additional functions for each different application.

To make the right choice the following tools are used:

- The norm AC53a.

This norm helps selecting the soft starter rating with regard to duty cycle, starts per hour and maximum starting current.

- The Application Rating Ust.

With this list the soft starter rating can be selected depending on the kind of application used. The list use 2 levels of the AC53a norm. See table 1, page 15.

- The Application Function List.

This table gives an complete overview of most common applications and duties. For each applications the menu's that can be used are given. See table 2, page 17.

- Function and Combination matrix.

With these tables it is easy to see which combinations of Main and additional functions are possible, see table 3, page 19 and table 4, page 19.

### 4.1 Soft starter rating according to AC53a

The IEC947-4-2 standard for electronic starters defines AC53a as a norm for dimensioning of a soft starter.

The MSF soft starter is designed for continuous running. In the Applications table (table 1, page 15) two levels of AC53a are given. This is also given in the technical data tables (see chapter 12. page 74).


Fig. 8 Rating example AC53a.
The above example indicates a current rating of 210 Amps with a start current racio of $5.0 \times$ FLC (1050A) for 30 seconds with a $50 \%$ duty cycle and 10 starts per hour.

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


Fig. 9 Duty cycle, non bypass.

### 4.2 Soft starter rating according to AC53b

This norm is made for Bypass operation. Because the MSF soft starter is designed for continuous operation this norm is not used in the selection tables in this chapter.


Fig. 10 Rating example AC53b.


Fig. 11 Duty cycle, bypassed
The above example indicates a current rating of 210 Amps with a start current ratio of $5.0 \times$ FLC (1050A) for 30 seconds with a 24 -minute period between starts.

### 4.3 MSF Soft starter ratings

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

NOTE! Because the MSF soft starter is designed for continuous operation the norm AC53b is not used in the application rating list.

With help of the Application Rating List with typical starting currents and categories in the AC53a level (see table 1 , page 15 and table 2, page 17) it is easy to select the proper soft starter rating with the application.

The Application Rating List uses two levels for the AC53a norm:

- AC53a 5.0-30:50-10 (heavy duty)

This level will be able to start all applications and follows directly the type number of the soft starter. Example: MSF 370 is 370 Amps FLC and then 5 time this current in starting.

- AC 53a 3.0-30:50-10 (normal/llght duty) This level is for a bit lighter applications and here the MSF can manage a higher FLC.
Example: MSF 370 in this norm manage 450 Amps FLC and the 3 times this current in starting

NOTE! To compare Soft Starters it's important to ensure that not only FLC (Full Load Current) is compared but also that the operating parameters are identical.

### 4.4 The Application Ratings List

Table 1 gives the Application Ratings List. With this list the rating for the soft starter and Main Function menu can be selected.

Description and use of the table:

- Applications.

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

- AC53a ratings.

The rating according to AC53a norm is here classified in 2 ratings. The first for normal/light duty (3.0-30:50-10) and the second for heavy duty (5.0-30:50-10)

- Typical Starting current. Gives the typical starting cùrrent for each application
- Maln Function menu.

The Main Function menu is advised here.
"25;=1", means: program selection 1 in menu 25.

- Stop function.

Gives a possible Stop function if applicable.
"36;=1/38-40", means: program selection 1 in menu 36 , also menus 38 to 40 can be selected.

## EXAMPLE:

Roller Mill:

- This is an application for heavy duty,
- Typical starting current of $350 \%$.
- Main function Torque ramp start (menu 25) will give the best results.
- Stop function Dynamic Brake (menu 36, selection 1) can be used.
- As well as the Slow Speed at start and stop (menu $38-40$ ) can be used for better start and stop performance.

Table 1 Applications Rating List

| Appllcations | AC53a 3.0-30:50-10 (normal/light) | AC 53a 5.0-30:50-10 (heavy) | Typlcal starting current \% | Maln function Menu nr. | Stop function Menu nr. |
| :---: | :---: | :---: | :---: | :---: | :---: |
| General \& Water <br> Centrifugal Pump <br> Submersible Pump <br> Corveyor <br> Compressor: Screw <br> Compressor, Reciprocating <br> Fan <br> Mixer <br> Agitator |  |  |  |  |  |
|  | $x$ | 300 l\|l|l |  |  |  |
|  | x |  | 300 | 22 | 22 |
|  |  | X | 300-400 | 25:=1 | 36:=1/38-40 |
|  | $x$ |  | 300 | 25 | - |
|  | $x$ |  | 400 | 25;=1 | - |
|  | X |  | 300 | 25;=2 | - |
|  |  | $x$ | 400-450 | 25:=1 | - |
|  |  | $\times$ | 400 | 25:=1 | - |
| Metals 8 Minin |  |  |  |  |  |
| Belt Conveyor $x$ $x$ 400 $25:=1$ $36 ;=1 / 38-40$ <br>  Dust Collector $x$  350  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Rock Crusher |  | X | 400 | 25; $=1$ | - |
| Roller Conveyor <br> Roller Mill |  | $x$ | 350 | 25;=1 | 36:=1/38-40 |
|  |  | x | 450 | 25:=1 | $36 ;=1$ or 2 |
| Tumbler <br> Wire Draw Machine |  | $x$ | 400 | 25;=1 | - - |
|  |  | $\times$ | 450 | 25;=1 | $36 ;=1$ or 2 |
|  |  |  |  |  |  |
| Bottle Washer |  |  | 300 | 125;=2 |  |
| Centrifuge |  | , x | 400 | 25;=1 | $36 ;=1$ or 2 |
| Dryer <br> Mill <br> Palletiser <br> Separator <br> Shicer |  | $x$ | 400 | 25;=2 |  |
|  |  | $x$ | 450 | 25;=1 | 36;=1 or 2 |
|  |  | $x$ | 450 | 25; $=1$ |  |
|  |  | $\times$ | 450 | 25:=1 | 36;=1 or 2 |
|  | $\times$ |  | 300 | 25;=1 |  |
| Pulp and Paper |  |  |  |  |  |
| Re-Pulper <br> Shredder <br> Trolley |  | $x$ | 450 | 25;=1 |  |
|  |  | x | 450 | 25:=1 |  |
|  |  | $\times$ | 450 | $25 ;=1$ |  |
| Petrochemical <br> Ball Mill <br> Centrifuge <br> Extruder <br> Screw Conveyor |  |  |  |  |  |
|  |  | $\times$ | 450 | 25;=1 |  |
|  |  | $x$ | 400 | 25; $=1$ | $36 ;=1 \propto 2$ |
|  |  | $x$ | 500 | 25;=1 |  |
|  |  | $\times$ | 400 | 25;=1 |  |
| Transport \& Machine Tool <br> Ball Mill <br> Grinder <br> Material Conveyor <br> Palletiser <br> Press <br> Roller Mill <br> Rotary Table <br> Trolley <br> Escalator <br> Lumber 81 Wood Products <br> Bandsaw <br> Chipper <br> Circuiar Saw <br> Debarker <br> Planer <br> Sander |  |  |  |  |  |
|  |  | $x$ | 450 | 25;=1 |  |
|  |  | X | 350 | 25;=1 | 36;=1 |
|  |  | x | 400 | 25; $=1$ | 36; $=1 / 38.40$ |
|  |  | x | 450 | 25; $=1$ |  |
|  |  | $x$ | 350 | 25:=1 |  |
|  |  | $x$ | 450 | 25;=1 |  |
|  |  | x | 400 | 25;=1 | $36 ;=1 / 38-40$ |
|  |  | $x$ | 450 | 25;=1 |  |
|  |  | X | 300-400 | 25:=1 |  |
|  |  |  |  |  |  |
|  |  | $x$ | 450 | 25:=1 | 36:=1 or 2 |
|  |  | $x$ | 450 | 25;=1 | 36:=1 or 2 |
|  |  | $x$ | 350 | 25:=1 | 36:=1 or 2 |
|  |  | x | 350 | 25:=1 | $36:=1$ or 2 |
|  |  | x | 350 | 25;=1 | 36; $=1$ or 2 |
|  |  | $\times$ | 400 | 25;=1 | 36;=1 ¢ 2 |

### 4.5 The Application Functions List

This list gives an overview of many different applications/duties and a possible solution with one of the many MSF functions.

Description and use of the table:

- Application /Duty.

This column gives the various applications and level of duty. If the machine or application is not in this list, try to identify a similar machine or application. If in doubt pleas contact your supplier.

- Problem.

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

- Solution MSF.

Gives the possible solution for the problem using one the MSF function.

- Menus.

Gives the menu numbers and selection for the MSF

## function.

"25;=1", means: program selection 1 in menu 25.
"36; $=1 / 34,35$ ", means: program selection 1 in menu 36 , menus 34 and 35 are related to this function.

Table 2 Application Function List


Table 2 Application Fundion List

| Application/ Duty | Problem | Solution MSF | Menus |
| :---: | :---: | :---: | :---: |
| MIXER Heavy | Different materials | Linear Torque ramp gives linear acceleration and lowest possible starting current. | 25;=1 |
|  | Need to control material viscosity | Shaft power analog output | 54.56 |
|  | Broken or damaged blades | Shaft power overload | 92-95 |
|  |  | Shaft power underload | 96-99 |
| HAMMER MILL Heavy | Heavy load with high breakaway torque | Linear Torque ramp gives linear acceleration and lowest possible starting current. | 25;=1 |
|  |  | Torque boost in beginning of ramp. | 30,31 |
|  | Jamming | Shaft power overioad | 92-95 |
|  | Fast stop | Controlled sensor less soft brake with reversing contactor for heavy loads. | 36;=2,34,35 |
|  | Motor blocked | Locked rotor function | 75 |

## EXAMPLE:

## Hammer Mill:

- This is an application for heavy duty,
- Main function Torque ramp start (menu 25) will give the best results.
- Torque boost to overcome high breakaway torque (menu 30 and 31 )
- Overload alarm function for jamming protection (menu 92 and 95)
- Stop function Soft Brake (menu 36, selection 2) can be used. Menu 34 and 35 to set the brake time and strength.


### 4.6 Function and combination matrix

Table 3 gives an overview of all possible functions and combination of functions.

1. Select function in the horizontal "Main Function" column. Only one function can be selected in this column, at a time.
2. In the vertical column "Additional Functions" you will find all possible function that can be used together with your selected main function.

Table 3 Combination matrix

|  |  | $\begin{aligned} & \text { O} \\ & 0 \\ & 0 \\ & 0 \\ & \stackrel{0}{E} \\ & \mathbb{N} \\ & \frac{0}{0} \\ & 0 \end{aligned}$ |  |  | Torque boost (030) |  |  |  |  | Parameter sets (061) | Dynamic Vector Brake (036-1) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Voltage ramp start/stop (default) | X | X | X | X | X | X | X | X | X | X | X |  |
| Torque control start/stop (menu 025) |  |  | X | X | X | X | X | X | X | X | X |  |
| Voltage ramp with current limit (menu 020) |  | X | $x$ | $x$ | X | X | X | X | X | X | X | X |
| Current limit start (menu 021) |  | X | X | X | X | X | X | X | X | X | X | X |
| Pump control (menu 022) |  |  | X |  |  |  |  |  | X | X |  |  |
| Analog input (menu 023) |  |  |  |  |  |  |  |  | X | X |  |  |
| Direct on line start (menu 024) |  |  | X |  |  |  |  |  | X | X |  |  |

By using one parameter set, the following start/stop table is given.

NOTE! Voltage and torque ramp for starting only with softbrake.

Table 4 Start/stop combination.

| ( |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Voltage ramp start | X |  |  |  | X | X | X |
| Torque control start |  | X |  |  | X | X | X |
| Current limit start | $x$ |  |  |  | X | X | X |
| Voltage ramp with current limit | X |  |  |  | X | X | X |
| Pump control |  |  | X |  | X |  |  |
| Analog input |  |  |  | X | X |  |  |
| Direct on line start |  |  |  |  | X |  |  |

By using different parameter sets for start and stop, it is possible to combine all start and stop functions.

### 4.7 Special condition

### 4.7.1 Small motor or low load

The minimum load current for the soft starter is $10 \%$ of the rated current of the soft starter. Except for the MSE-017 there the min. current is 2 A . Example MSE-210, rated current $=210 \mathrm{~A}$. Min. Current 21 A . Please note that this is "min. load current" and not min . rated motor current.

### 4.7.2 Amblent temperature below $0^{\circ} \mathrm{C}$

For ambient temperatures below $0^{\circ} \mathrm{C}$ e.g. an electrical heater must be installed in the cabinet. The soft starter can also be mounted in some other place, due to that the distance between the motor and the soft starter is not critical.

### 4.7.3 Phase compensation capacitor

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

### 4.7.4 Pole-changing contactor and two speed motor

The switching device must be connected between the output of the soft starter and the motor.

### 4.7.5 Shielded motor cable

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

NOTE! The soft starter should be wired with shielded cortrol cable to fulfill EMC regulations acc. to § 1.5, page 6.

### 4.7.6 Sllp ring motors

Slip ring motors can not be used together with the soft starter. Unless the motor is rewinded (as a squirrel cage motor). Or keep the resistors in, please contact your supplier.

### 4.7.7 Pump control with soft starter and frequency Inverter together

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

### 4.7.8 Starting with counter clockwise rotating loads

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

### 4.7.9 Running motors in parallel

When starting and running motors in parallel the total amount of the motor current must be equal or lower than the connected soft starter. Please note that it is not possible to make individual settings for each motor. The start ramp can only be set for an average starting ramp for all the connected motors. This applies that the start time may differ from motor to motor. This is also even if the motors are mechanically linked, depending on the load etc.

### 4.7.10 How to calculate heat dissipation in cabinets

See chapter 12. page 74 "Technical Data", "Power loss at rated motor load ( $\mathrm{I}_{\mathrm{N}}$ )", "Power consumption control card" and "Power consumption fan". For further calculations please contact your local supplier of cabinets, e.g. Rittal.

### 4.7.11 Insulation test on motor

When testing the motor with high voltage e.g. insulation test the soft starter must be disconnected from the motor. This is due to the fact that the thyristors will be seriously damage by the high peak voltage.

### 4.7.12 Operation above 1000 m

All ratings are stated at 1000 m over sea level.
If a MSF is placed for example at 3000 m it must be derated unless that the ambient temperature is lower than 40 C and compensate for this higher pressure.

To get information about motors and drives at higher altitudes please contact your supplier to get technical information nr 151.

### 4.7.13 Reversing

Motor reversing is always possible. See Fig. 31 on page 34 for the advised connection of the reverse contactors.

At the moment that the mains voltage is switched on, the phase sequence is monitored by the control board. This information is used for the Phase Reverse Alarm (menu 88 , see $\$ 7.22$, page 56 ).

However if this alarm is not used (factory default), it is also possible to have the phase reversal contactors in the input of the soft starter.

## 5. OPERATION OF THE SOFT STARTER



Fig. 12 MSF soft starter models.

### 5.1 General description of user interface



WARNING! Never operate the soft starter with removed front cover.

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

Setring/configuration is done either from the builtin keyboard or by a computer/control system through the serial interface or bus (option). Controlling the motor i.e. start/stop, selection of parameter set, is done either from the keyboard, through the remote control inputs or through the serial interface (option).

## Setting

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

Switch on the supply (normally $1 \times 230 \mathrm{~V}$ ), all segments in the display will light up for a few seconds. Then the display will show menu 001. An illuminated display indicates there is supply voltage on the PCB.

Check that you have voltage on the mains contactor or on the thyristors. To be able to use all extended functions and optimize of the performance, program the motor data.

### 5.2 PPU unit



Fig. 13 PPU unit.
The programming and presentation unit (PPU) is a build-in operator panel with two light emitting diodes, three + four seven-segment LED-displays and a keyboard.

### 5.3 LED display

The two light emitting diodes indicates start/stop and running motor/machine. When a start command is given either from the PPU, through the serial interface (option) or through the remote control inputs, the start/stop-LED will be illuminated.

At a stop command the start/stop-LED will switch off. When the motor is running, the running-LED is flashing during ramp up and down and is illuminated continuously at full motor voltage.


Fig. 14 LED indication at different operation situation.

### 5.4 The Menu Structure

The menus are organised in a simple one level structure with the possibility to limit the number of menus that are reachable by setting the value in menu 007 to "oFF" (factory setting). With this setting only the basic menus 001, 002, 003, 004, 005, 006 and 007 can be reached.

This to simplify the setting when only voltage start/ stop ramps are used.

If menu 007 is in "on" and menu 008 "oFF" it is possible to reach all viewing menus and alarm lists as well.


Fig. 15 Menu structure.

### 5.5 The keys

The function of the keyboard are based on a few simple rules. At power up menu 001 is shown automatically. Use the "NEXT $\rightarrow$ " and "PREV $\leftarrow$ "keys to move between menus. To scroll through menu numbers, press and hold either the "NEXT $\rightarrow$ " or the "PREV $\leftarrow$ " key. The " + " and "-" keys are used to increase respectively decrease the value of setting. The value is flashing during setting. The "ENTER \&" key confirms the setting just made, and the value will go from flashing to stable. The "START/STOP" key is only used to start and stop the motor/machine.
The $\bar{A}$ and $\overline{\boldsymbol{Q}}$ keys are only used for JOG from the keyboard. Please note one has to select enable in menu 103 or 104 , see $\S 7.25$, page 61 .

Table 5 The keys

| Start/stop motor operation. | START |
| :--- | :---: |
| Sisplay previous menu. |  |
| Display next menu. | PREV |
| Decrease value of setting. |  |
| Increase value of setting. |  |
| Confirm setting just made. |  |
| Alarm reset. |  |
| JOG Reverse |  |
| JOG Forward |  |

### 5.6 Keyboard lock

The keyboard can be locked to prohibit operation and parameter setting by an unauthorised. Lock keyboard by pressing both keys "NEXT $\rightarrow$ " and "ENTER $\leftrightarrow$ " for at least 2 sec . The message ' - Loc' will display when locked. To unlock keyboard press the same 2 keys "NEXT $\rightarrow$ " and "ENTER $\leftarrow$ " for at least 2 sec . The message 'unlo' will display when unlocked.

In locked mode it is possible to view all parameters and read-out, but it is forbidden to set parameters and to operate the soft starter from the keyboard.

The message '-Loc' will display if trying to set a parameter or operate the soft starter in locked mode.

The key lock status can be read out in menu 221.


### 5.7 Overview of soft starter operation and parameter set-up.

Table with the possibilities to operate and set parameters in soft starter.

Control mode is selected in menu 006 and Parameter set is selected in menu 061. For the keyboard lock function, see $\S 7.30$, page 65 .

Table 6 Control modes

| Control mode ${ }^{\text {Operation/ }} \begin{gathered}\text { Set-up }\end{gathered}$ |  | Start/Stop | JOG fwd/rey | Alarm reset | Setting of parameters |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Parameter set with external selection Menu 061=0 |  |  | Parameter set with Internal selection Menu 061=1-4 |
| Keyboard Menu 006=1 | Unlocked keyboard |  | Keyboard | Keyboard | Keyboard | ------- | Keyboard |
|  | Locked keyboard | - | - | -- | - | - |
| Remote <br> Menu 006=2 | Unlocked keyboard | Remote | Remote | Remote and keyboard | Remote | Keyboard |
|  | Locked keyboard | Remote | Remote | Remote | Remote | - |
| Serial comm. Menu 006=3 | Unlocked keyboard | Serial comm | Serial comm | Serial comm. and keyboard | - | Serial comm |
|  | Locked keyboard | Serial comm | Serial comm | Serial comm | -- | Serial comm |

## 6. INSTALLATION AND CONNECTION

Mounting, wiring and setting the device into operation must be carried out by trained personnel (electricians specialised in heavy current technology):

- In accordance with the local safety regulations of the electricity supply company.
- In accordance with DIN VDE 0100 for setting up heavy current plants.
Care must be taken to ensure that personnel do not come into contact with live circuit components.


WARNING! Never operate the soft starter with removed front cover.

### 6.1 Installation of the soft starter in a cabinet

When installing the soft starter:

- Ensure that the cabinet will be sufficiently ventilated, after the installation.
- Keep the minimum free space, see the tables on page 25.
- Ensure that air can flow freely from the bottom to the top.

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

MSF-017 to MSF-835 soft starters are all delivered as enclosed versions with front opening. The units have bottom entry for cables etc. see Fig. 25 on page 29 and Fig. 27 on page 31. MSF-1000 and MSF-1400 are delivered as open chassis.

NOTE! The soft starter should be wired with shielded control cable to fulfill EMC regulations acc. to § 1.5, page 6.

NOTEI For UL-approval use $75^{\circ} \mathrm{C}$ Copper wire only.
MSF-017 to MSF-250


Fig. 16 MSF-017 to MSF- 250 dimensions.


Fig. 17 Hole pattern for MSF-017 to MSF-250 (backside view).


Fig. 18 Hole pattern for MSF-170 to MSF-250 with upper mounting bracket instead of DIN-rail.

## MSF-017 to MSF-250

Table 7 MSF-017 to MSF-250.

| MSF model | Class | Connection | Conv./ | Dimension HxWxD (mm) | Hole dist. w 1 (mm) | Hole dist. h 1 (mm) | Dlam./ screw | Welght (kg) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| -017, -030 | IP 20 | Busbars | Convection | 320x126×260 | 78.5 | 265 | 5.5/M5 | 6.7 |
| $\begin{aligned} & -045,-060, \\ & -075,-085 \end{aligned}$ | IP 20 | Busbars | Fan | $320 \times 126 \times 260$ | 78.5 | 265 | 5.5/M5 | 6.9 |
| -110, -145 | IP 20 | Busbars | Fan | $400 \times 176 \times 260$ | 128.5 | 345 | 5.5/M5 | 12.0 |
| -170, -210, -250 | IP 20 | Busbars | Fan | $500 \times 260 \times 260$ | 208.5 | 445 | 5.5/M5 | 20 |

Table 8 MSF-017 to MSF-250

| MSF <br> model | Minimum free space (mm): |  |  | Dimenston Connection busbars Cu | Tightening torque for boit (Nm) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | above 1) | below | at side |  | Cable | PE-cable | Supply and PE |
| -017, -030,-045 | 100 | 100 | 0 | 15x4 (M6), PE (M6) | 8 | 8 | 0.6 |
| -060, -075,-085 | 100 | 100 | 0 | 15x4 (M8), PE (M6) | 12 | 8 | 0.6 |
| -110,-145 | 100 | 100 | 0 | $20 \times 4$ (M10), PE (M8) | 20 | 12 | 0.6 |
| -170, -210, -250 | 100 | 100 | 0 | 30x4 (M10), PE (M8) | 20 | 12 | 0.6 |
| 1) Above: wall-soft starter or soft starter-soft starter |  |  |  |  |  |  |  |

## MSF-310 to MSF-1400

Table 9 MSF-310 to MSF-1400 see Fig. 20 on page 26.

| MSF model | Class | Connection | Conv./ Fan | Dimension HxWxD (mm) | Hole dist. w1 (mm) | Hole dist. h1 (mm) | Dlam./ screw | Weight (kg) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| -310 | IP 20 | Busbars | Fan | $532 \times 547 \times 278$ | 460 | 450 | 8.5/M8 | 42 |
| -370, -450 | IP 20 | Busbars | Fan | $532 \times 547 \times 278$ | 460 | 450 | 8.5/M8 | 46 |
| -570 | IP 20 | Busbars | Fan | $687 \times 640 \times 302$ | 550 | 600 | 8.5/M8 | 64 |
| -710 | IP 20 | Busbars | Fan | $687 \times 640 \times 302$ | 550 | 600 | 8.5/M8 | 78 |
| -835 | IP 20 | Busbars | Fan | $687 \times 640 \times 302$ | 550 | 600 | 8.5/M8 | 80 |
| -1000, -1400 | IPOO | Busbar | Fan | $900 \times 875 \times 336$ | Fig. 23 |  | 8.5/M8 | 175 |

Table 10 MSF-310 to MSF-1400.

| MSF model | Minimum free space (mm): |  |  | Dimenslon Connection, busbars Al | Tightening torque for bolt (Nm) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | above 1) | below | at slde |  | Cable | PE-cable | Supply and PE |
| -310, -370, -450 | 100 | 100 | 0 | 40x8 (M12) | 50 | 12 | 0.6 |
| -570, -710, -835 | 100 | 100 | 0 | 40×10 (M12) | 50 | 12 | 0.6 |
| -1000, -1400 | 100 | 100 | 100 | $75 \times 10$ (M12) | 50 | 12 | 0.6 |
| 1) Above: Wall-soft starter or soft starter-soft starter |  |  |  |  |  |  |  |



Fig. 19 MSF - 310 to MSF -835.


Fig. 20 Hole pattem for screw attachment, MSF-310 to MSF-835. Hole distance ( mm ).


Fig. 22 MSF-1000 to - 1400


Fig. 23 Hole pattern busbar MSF-1000 to -1400.

### 6.2 Connections



Fig. 24 Connection of MSF-017 to MSF -085.

## Connection of MSF-017 to MSF-085

## Device connections

1. Protective earth, $\perp$ (PE), Mains supply, Motor (on the right and left inside of the cabinet)
2. Protective earth, $\underset{\square}{\perp}$ (PE), Control voltage
3. Control voltage connection 01, 02
4. Mains supply L1, L2, L3
5. Motor power supply T1, T2, T3
6. Current transformers (possible to mount outside for bypass see $\$ 7.12$, page 43 )
7. Mounting of EMC gland for control cables


Fis. 25 Cornection of MSF-110 to MSF-145.

## Connection of MSF-110 to MSF-145

## Device connectlons

1. Protective earth, $\frac{1}{\approx}$ (PE), Mains supply, Motor (on the left inside of the cabinet)
2. Protective earth $\perp$ (PE), Control voltage
3. Control voltage connection 01,02
4. Mains supply L1, L2, L3
5. Motor power supply T1, T2, T3
6. Current transformers (possible to mount outside for bypass see $\$ 7.12$, page 43 )
7. Mounting of EMC gland for control cables


Fig. 26 Connection of MSF-170 to MSF-250

## Connection of MSF-170 to MSF-250

## Device connectlons

1. Protective earth, $\perp(\mathrm{PE})$, Mains supply, Motor (on the left inside of the cabinet)
2. Protective earth $\perp$ (PE), Control voltage
3. Control voltage connection 01,02
4. Mains supply L1, L2, L3
5. Motor power supply T1, T2, T3
6. Current transformers (possible to mount outside for bypass see $\$ 7.12$, page 43)
7. Mounting of EMC gland for control cables


Fig. 27 Connection of MSF-170 to MSF-1400.

## Connection of MSF-310 to MSF-1400

## Device connections

1. Protective earth, $\stackrel{\perp}{\perp}$ (PE), Mains supply and Motor
2. Protective earth, $\frac{1}{5}$ (PE), Control voltage
3. Control voltage connection 01, 02
4. Mains supply L1, L2, L3
5. Motor power supply T1, T2, T3
6. Current transformers (possible to mount outside for bypass see $\$ 7.12$, page 43)
7. Mounting of EMC gland for control cables

### 6.3 Connection and setting on the PCB control card



Fig. 28 Comrections on the $P C B$, control carr.
Table 12 PCB Teminals

| Terminad | Function | Eectrical charactertstics |
| :---: | :---: | :---: |
| 01 | Supply voltage | $100-240$ VAC $\pm 10 \% / 380-500$ VAC $\pm 10 \%$ |
| 02 |  |  |
| PE | Gnd | $\frac{1}{4}$ |
| 11 | Digital inputs for start/stop and reset. | $0-3 \mathrm{~V} \rightarrow 0 ; 8-27 \mathrm{~V} \rightarrow 1$. Max. 37 V for 10 sec . Impedance to $0 \mathrm{VDC}: 2.2 \mathrm{k} \Omega$. |
| 12 |  |  |
| 13 | Supply/control voltage to PCB terminal 11 and 12, $10 \mathrm{k} \Omega$ potentiometer, etc. | $+12 \mathrm{VDC} \pm 5 \%$. Max. current from $+12 \mathrm{VDC}: 50 \mathrm{~mA}$. Short circuit proof. |
| 14 | Remote analogue input control, 0-10 V, $2.10 \mathrm{~V}, 0-20 \mathrm{~mA}$ and $4-20 \mathrm{~mA}$ /digital input. | Impedance to terminal 15 ( 0 VDC ) voltage signal: $125 \mathrm{k} \Omega$ current signal: $100 \Omega$ |
| 15 | GND (common) | 0 VDC |
| 16 | Digital inputs for selection of parameter set. | $0-3 \vee \rightarrow 0 ; 8-27 \vee \rightarrow 1 \text {. Max. } 37 \mathrm{~V} \text { for } 10 \mathrm{sec} \text {. Imped- }$ ance to $0 \mathrm{VDC}: 2.2 \mathrm{k} \Omega$ |
| 17 |  |  |
| 18 | Supply/control voltage to PCB terminal 16 and 17, $10 \mathrm{k} \Omega$ potentiometer, etc. | $+12 \mathrm{VDC} \pm 5 \%$. Max. current from $+12 \mathrm{VDC}=50 \mathrm{~mA}$. Short circuit proof. |
| 19 | Remote analogue output control | Analogue Output contact: <br> $0-10 \mathrm{~V}, 2-10 \mathrm{~V}$; min load impedance $700 \Omega$ <br> $0-20 \mathrm{~mA}$ and $4-20 \mathrm{~mA}$;max load impedance $750 \Omega$ |
| 21 | Programmable relay K1. Factory setting is "Operation" indication by closing terminal 21-22. | 1-pole closing contact, 250 VAC $8 A$ or 24 VDC 8A resistive, $250 \mathrm{VAC}, 3 \mathrm{~A}$ inductive. |
| 22 |  |  |
| 23 | Programmable relay K2. Factory setting is "Full voltage" indication by closing terminal 23-24. | 1 -pole closing contact, 250 VAC 8 A or 24 VDC 8A resistive, $250 \mathrm{VAC}, 3 \mathrm{~A}$ inductive. |
| 24 |  |  |
| 31 | Alarm relay K 3 , closed to 33 at alarm. | 1-pole change over contact, 250 VAC $8 A$ or 24 VDC 8A resistive, 250 VAC, 3 A inductive. |
| 32 | Alarm relay K3, opened at alarm. |  |
| 33 | Alarm relay K3, common terminal. |  |
| 6970 | PTC Thermistor input | Alarm level $2.4 \mathrm{k} \Omega$ Switch back level $2.2 \mathrm{k} \Omega$ |
| 71-72* | Clickson thermistor | Controlling soft starter cooling fine temperature MSF:310-MSF-1400 |
| 73.74* | NTC thermistor | Temperature measuring of soft starter cooling fine |
| 75 | Current transformer input, cable S1 (blue) | Connection of L1 or T1 phase current transformer |
| 76 | Current transformer input, cable S1 (blue) | Connection of L3, T3 phase (MSF 017 - MSF 250) or L2, T2 phase (MSF 310 - MSF 1400) |
| 77 | Current transformer input, cable S2 (brown) | Common connection for terminal 75 and 76 |
| 78* | Fan connection | 24 VDC |
| 79* | Fan connection | O VDC |

*Internal connection, no customer use.

### 6.4 Minimum wiring



Fig. 29 Wiring circuit, "Minimum wiring".
The figure above shows the "minimum wiring". See
$\$ 6.1$, page 24 , for tightening torque for bolts etc.

1. Connect Protective Earth (PE) to earth screw marked $\perp$ (PE).
2. Connect the soft starter between the 3-phase mains supply and the motor. On the soft starter the mains side is marked L1, L2 and L3 and the motor side with T1, T2 and T3.
3. Connect the control voltage ( $100-240 \mathrm{VAC}$ ) for the control card at terminal 01 and 02 .
4. Connect relay K1 (terminals 21 and 22) to the control circuit.
5. Connect PCB terminal 12 and 13 (PCB terminal 11-12 must be linked) to, e.g. a 2 -position switch (on/oFF) or a PLC, etc., to obtain control of soft start/stop. (For start/stop command from keyboard menu 006 must be set to 01).
6. Ensure the installation complies with the appropriate local regulations.

## NOTE! The soft starter should be wired with shielded

 control cable to fulfill EMC regulations acc. to § 1.5, page 6.NOTEI If local regulations say that a mains contactor should be used, the K1 then controls it. Always use standard commercial, slow blow fuses, e.g. type gl, gG to protect the wiring and prevent short circuiting. To protect the thyristors against shortcircuit currents, superfast semiconductor fuses can be used if preferred. The normal guarantee is valid even if superfast semiconductor fuses are not used. All signal inputs and outputs are galvanically insulated from the mains supply.

### 6.5 Wiring examples

Fig. 30 gives an wiring example with the following functions.

- Analogue input control, see $\$ 7.7$, page 40
- Parameter set selection, see $\$ 7.20$, page 54
- Analogue output, see $\$ 7.18$, page 52
- PTC input, see $\$ 7.21$, page 55

For more information see $\S 6.3$, page 32 .


Fig. 30 Analogue input control, parameter set, analogue output and PTC input.


Fig. 31 Fonvard/reverse wiring circuit.

## 7. FUNCTIONAL DESCRIPTION SET-UP MENU

This chapter describes all the parameters and functions in numerical order as they appear in the MSF. Table 13 gives an overview of the menus, see also Chapter 13. page 79 (set-up menu list).

Table 13 Set-up Menu overview

|  | Menu number | Parameter group |  | Menu numbers | See § |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Basic functions | 001-008 | Basic | Ramp up/down parameters | 001-005 | 7.1 |
|  |  |  | Start/Stop/Reset command | 006 | 7.2 |
|  |  |  | Menu Expansion | 007-008 | 7.3 |
| Extended functions | 011-199 | Voltage control dual ramp |  | 011-014 | 7.4 |
|  |  | Torque control parameters |  | 016-018 | 7.5 |
|  |  | Main functions |  | 020-025 | 7.6-7.10 |
|  |  | Additional functions |  | 030-036 | 7.11-7.14 |
|  |  | Slow speed and Jog functions |  | $\begin{aligned} & \text { 037-040, 57-58, } \\ & 103-104 \end{aligned}$ | $\begin{aligned} & 7.15,7.19, \\ & 7.25 \end{aligned}$ |
|  |  | Motor Data Setting |  | 041-046 | 7.16 |
|  |  | Outputs | Relays | 051-052 | 7.17 |
|  |  |  | Analogue output | 054-056 | 7.18 |
|  |  | Input | Digital input | 057-058 | 7.19 |
|  |  | Parameter set selection |  | 061 | 7.20 |
|  |  |  | Motor protection | 071-075 | 7.21 |
|  |  |  | Main protection | 081-088 | 7.22 |
|  |  |  | Application protection | 089-099 | 7.23 |
|  |  |  | Resume alarms | 101, 102 | 7.24 |
|  |  | Auto return menu |  | 105 | 7.26 |
|  |  | Factory defaults |  | 199 | 7.28 |
| View functlons | $201-915$ | Main view |  | 201-208 | 7.29 |
|  |  | RMS current per phase |  | 211-213 | 7.29 |
|  |  | RMS voltage per phase |  | 214-216 | 7.29 |
|  |  | Keyboard lock status |  | 221 | 7.30 |
|  |  | Alarm list |  | 901-915 | 7.31 |

### 7.1 Ramp up/down parameters



Fig. 32 Menu numbers for start/stop ramps, initial voltage at start and step doun woltage at stop.

Determine the starting time for the motor/machine. When setting the ramp times for starting and stopping, initial voltage at start and step down voltage at stop, proceed as follow:


Set the initial voltage. Normally the factory setting, $30 \%$ of $U_{n}$, is a suitable choice.


| O | O | 4 | 0 |
| :--- | :--- | :--- | :--- | |  | O | F |
| :--- | :--- | :--- |
|  | F |  |

### 7.1.1 RMS current [005]

NOTE! This is the same read-out as function 201, see § 7.28, page 63.



### 7.2 Start/stop/reset command

Start/stop of the motor and reset of alarm is done either from the keyboard, through the remote control inputs or through the serial interface (option). The remote control inputs start/stop/reset (PCB terminals 11,12 and 13) can be connected for 2 -wire or 3 -wire control.

| $0060_{0}^{0}$ |  |
| :---: | :---: |
|  | $2$ |
| Default: | 2 |
| Range: | 1,2,3 |
| 1 | START/STOP/RESET command via the keyboard. <br> - Press the "START/STOP" key on the keyboard to start and stop the soft starter. <br> - Press "ENTER/RESET" key to reset a trip condition. |
| 2 | Via Remote control. START/STOP/ RESET commands. The following control methods are possible: <br> - 2-wire start/stop with automatic reset, see § 7.2.1, page 37. <br> - 2-wire start/stop with separate reset, see § 7.2.2, page 37. <br> - 3-wire start/stop with automatic reset at start, see § 7.2.3, page 37. <br> WARNING! The motor will start if terminals 11, 12, 13 is in start position. |
| 3 | START/STOP/RESET commands via serial interface option. Read the operating instruction supplied with this option. |

NOTE! A reset via the keyboard will not start or stop the motor.

NOTE! Factory default setting is 2 , remote control.
To start and stop from the keyboard, the "START/ STOP" key is used.

To reset from the keyboard, the "ENTER $\longleftarrow$ / RESET" key is used. A reset can be given both when the motor is running and when the motor is stopped. A reset from the keyboard will not start or stop the motor.

### 7.2.1 2-wire start/stop with automatic reset at start



Closing PCB terminals 12 and 13 , and a jumper between terminal 11 and 12 , will give a start command. Opening the terminals will give a stop. If PCB terminals 12 and 13 is closed at power up a start command is given (automatic start at power up). When a start command is given there will automatically be a reset.

### 7.2.2 2-wire start/stop with separate reset



Closing PCB terminals 11,12 and 13 will give a start and opening the terminals 12 and 13 will give a stop. If PCB terminals 12 and 13 are closed at power up a start command is given (automatic start at power up). When PCB terminals 11 and 13 are opened and closed again a reset is given. A reset can be given both when the motor is running and stopped and doesn't affect the start/stop.

### 7.2.3 3-wire start/stop with automatic reset at start.



PCB terminal 12 and 13 are normally closed and PCB terminal 11 and 13 are normally open. A start command is given by momentarily closing PCB terminal 11 and 13. To stop, PCB terminal 12 and 13 are momentarily opened.

When a start command is given there will automatically be a reset. There will not be an automatic start at power up.

### 7.3 Menu expansion setting.

In order to use the viewing menus and/or the extended functions menu 007 must be set to "On", then one reach read out of the viewing menus 201915. To be able to set any extended functions in the menus 011-199 menu 008 must be set to "on" as well.

| 0 0 7 <br> 0   |  |  |  |
| :--- | :--- | :--- | :--- |
|  | 0 | $F$ | $F$ |
|  | Selecting of extended <br> functlons and vlewing <br> functions |  |  |
| Default: | oFF |  |  |
| Range: | OFF, on |  |  |
| ofF | Only function 1-7 are visible |  |  |
| on | - View functions 201-915 are visible <br> - Extended functions (menu 008) <br> selectable |  |  |


| 0 0 8 <br> 0   |  |  |  |
| :--- | :--- | :--- | :--- |
|  | 0 | $F$ | Selecting of extended <br> functions |
|  |  |  |  |
| Default: | oFF |  |  |
| Range: | oFF, on |  |  |
| ofF | Only view function 201-915 are visi- <br> ble. |  |  |
| on | All the function menus are visible |  |  |

NOTE! Menu 007 must be "on".

### 7.4 Voltage control dual ramp

To achieve even smoother ramps at start and or stop, a dual ramp can be used.


Fig. 33 Menu numbers for dual woltage ramp at start/stop, initial voltage at start and step doun-voltage at stop.

The settings are carried out by beginning with the settings in menus 001-004 and 007-008 and proceed with the following steps:


Set the start voltage for start ramp 2. The initial voltage for start ramp 2 is limited to the initial voltage at start (menu 001), see § 7.1, page 36.

| 0 1 <br> 0  |  |  | Setting of start ramp 2 |
| :---: | :---: | :---: | :---: |
| 0 | F | F |  |
| Default: |  | oFF |  |
| Range: |  | oFF, | -60 sec |
| oFF |  |  | ramp 2 disabled |
| 1-60 |  |  | e start ramp 2 time. A e ramp is active. |


| 0 | 1 | 3 |
| :--- | :--- | :--- | |  |  | 4 | 0 |
| :--- | :--- | :--- | :--- |


| 0 1 4 <br> 0   |  |  |  |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  | 0 | $F$ | $F$ |

### 7.5 Torque control parameters

See also $\S 7.10$, page 42 and chapter 4 . page 13 for more information on the Torque control setting.


### 7.6 Current limit (Main Function)

The Current Limit function is used to limit the current drawn when searting (150-500\% of In). This means that current limit is only achieved during set start-up time.

Two kinds of current limit starts are available.

- Voltage ramp with a limited current. If current is below set current limit, this start will act exactly as a voltage ramp start.
- Current limit start.

The soft starter will control the current up to set current limit immediately at start, and keep it there until the start is completed or the set start-up time expires.
See Fig. 34 Current limit.
NOTE! Make sure that nominal motor current in menu 042 is correctly inserted.

### 7.6.1 Voltage ramp with current Ilmit

The settings are carried out in three steps:

1. Estimate starting-time for the motor/machine and select that time in menu 002 (see $\S 7.1$, page 36).
2. Estimate the initial voltage and select this voltage in menu 001 (see $\S 7.1$, page 36).
3. Set the current limit to a suitable value e.g. $300 \%$ of In in menu 020.

| 020 |  |  | Voltage ramp with current limit at start |
| :---: | :---: | :---: | :---: |
| 0 | $F$ | $F$ |  |
| Default: |  | oFF |  |
| Range: |  | ofF, 150-500\% In |  |
| OFF |  | Voltage Ramp mode with current limit disabled. Voltage Ramp enabled. |  |
| 150-500 |  |  | limit level in Voltage ramp |

NOTEI Only possible when Voltage Ramp mode is enabled.
Menus 021-025 must be "oFF".


Fig. 34 Current limit

### 7.6.2 Current limit

The settings are carried out in two steps:

1. Estimate starting time for the motor/machine and select that time in menu 002 (see $\S 7.1$, page 36 ).
2. Set the current limit to a suitable value e.g. $300 \%$ of In in menu 021.


NOTEI Only possible when Voltage Ramp mode is enabled. Menus 020, 022-025 must be "oFF".

NOTEI Even though the current limit can be set as low as 150\% of the nominal motor current value, this minimum value cannot be used generally. Considerations must be given to the starting torque and the motor before setting the appropriate current limit. "Real start time" can be longer or shorter than the set values depending on the load conditions. This applies to both current limit methods.


Fig. 35 Current limit
If the starting time is exceeded and the soft starter is still operating at current level, an alarm will be activated. It is possible to let the soft starter to either stop operation or to continue. Note that the current will rise uncontrolled if the operation continues (see $§$ 7.24 .2 , page 61 ).

### 7.7 Pump control (Main Function)

By choosing pump control you will automatically get a stop ramp set to 15 sec . The optimising parameters for this main function are start and stop time; initial torque at start and end torque at start and stop. End torque at stop is used to let go of the pump when it's no longer producing pressure/flow, which can vary on different pumps. See Fig. 36.


Fig. 36 Pump control

## Pump application

The pump application is using Torque ramps for quadratic load. This gives lowest possible current and linear start and stop ramps. Related menus are 2, 4 (see $\$ 7.1$, page 36 ), 16,17 and 18 (see $§ 7.5$, page 39 ).

| 0220 |  |  | Setting of pump control |
| :---: | :---: | :---: | :---: |
| 0 | $F$ | $F$ |  |
| Default: |  | OFF |  |
| Range: |  |  |  |
| ofF |  |  | control disabled. Voltage enabled. |
| on |  |  | control application is enabled. |

NOTE! Only possible when Voltage Ramp mode is enabled. Menu 020-021, 023-025 must be "oFF".

### 7.8 Analogue Input Control (Main Function)

Soft starting and soft stopping can also be controlled via the Analogue Input Control ( $0-10 \mathrm{~V}, 2-10 \mathrm{~V}, 0-20 \mathrm{~mA}$ and $4-20 \mathrm{~mA}$ ). This control makes it possible to connect optional ramp generators or regulators.

After the start command, the motor voltage is controlled through the remote analogue input.


WARNING! The remote analogue control may not be used for continuous speed regulation of standard motors. With this type of operation the increase in the temperature of the motor must be taken into consideration.

To install the analogue input control, proceed by:

1. Connect the ramp generator or regulator to terminal $14(+)$ and $15(-)$.


Fig. 37 Wiring for analogue input.
2. Set Jumper J1 on the PCB control card to voltage (U) or current control (I) signal position, see Fig. 38 and Fig: 24 on page 28. Factory setring is voltage (U).


Fig. 38 Setting voltage or current for analogue input.

| 0 | 2 | 3 | 0 |
| :--- | :--- | :--- | :--- | |  | 0 | Selection of Analogue Input <br> control |
| :--- | :--- | :--- |
|  | 0 | $F$ |
| Default: | oFF |  |
| Range: | oFF, 1, 2 |  |
| oFF | Analogue input disabled. <br> Voltage Ramp enabled. |  |
| 1 | Analogue input is set for 0-10V/ <br> O-20mA control signal |  |
| 2 | Analogue input is set for 2-10V/ <br> $4-20 m A$ |  |

NOTE! Only possible when Voltage Ramp mode is enabled. Menu 020-022, 024, 025 must be "ofF"

### 7.9 Full voltage start, D.O.L. (Main Function)

The motor can be accelerated as if it was connected directly to the mains. For this type of operation:

Check whether the motor can accelerate the required load (D.O.L.-start, Direct On Line start). This function can be used even with shorted thyristors.

| 0 2 4 <br> 0   |  |  |  |
| :--- | :--- | :--- | :--- | :--- |
|  | 0 | $F$ | Setting of D.o.L start |
|  |  |  |  |
| Default: | oFF |  |  |
| Range: | oFF, on |  |  |
| ofF | D.O.L. start disabled. <br> Voltage Ramp enabled. |  |  |
| on | D.O.L. start enabled |  |  |

NOTE! Only possible when Voltage Ramp mode is enabled. Menu 020-023, 025 must be "off".


Fig. 39 Full voltage start.

### 7.10 Torque control (Main function)

This main function can be used to make a start according to a pre-defined torque reference curve. Two different load characteristics, linear and square, are possible to select.

At start/stop the torque controller will follow the selected characteristic.

A torque start/stop behaviour can be seen in Fig. 40.

A perfect start and stop with torque ramps have a good linearity of current. To optimise this, use the setting of initial torque (menu 16) and end torque (menu 18). See also $\S 7.5$, page 39 .

## Example:

Default for initial torque is $10 \%$ so if starting a more heavy load this will result in a small current peak in beginning of ramp. By increasing this value to $30 /$ $70 \%$ the current peak will not appear.

The end torque is increased mainly if the application has a high inertial load, like planers, saws and centrifuges. A current peak will appear in the end of ramp because the load is pushing the speed more or less by itself. By increasing this level to 150-250\% the current will be linear and low.

| 0 2 5 <br> 0   |  |  |
| :--- | :--- | :--- | :--- |
|  | 0 | Torque control at start/stop |
|  | 0 | $F$ |
| Default: | oFF |  |
| Range: | oFF, 1, 2 |  |
| oFF | Torque control is disabled Voltage <br> Ramp enabled. |  |
| $\mathbf{1}$ | Torque control with linear torque <br> characteristic |  |
| $\mathbf{2}$ | Torque control with square torque <br> characteristic |  |

NOTEI Torque control mode is only possible when Voltage Ramp mode is enabled (menu 020-024 are "oFF").


Fig. 40 Torque control at start/stop.


Fig. 41 Current and speed in torque control.

### 7.11 Torque boost

The Torque Booster enables a high torque to be obtained by providing a high current during $0.1-2 \mathrm{sec}$ at start. This enables a soft start of the motor even if the break away torque is high at start. For example in crushing mills applications etc.

When the torque booster function has finished, starting continues according to the selected start mode.


Fig. 42 The principle of the Torque Booster when starting the motor in voltage ramp mode.

See $\int 4.6$, page 19 , which main function that can be used with the torque boost.

| 030 |  |  | Torque boost active time |
| :---: | :---: | :---: | :---: |
| 0 | F | F |  |
| Default: |  | OFF |  |
| Range: |  | oFF | 1-2 sec |
| ofF |  | Torq | boost disabled |
| 0.1-2.0 |  | Set | Torque boost time. |


| 0 | 3 | 1 |
| :--- | :--- | :--- | |  |  |  |
| :--- | :--- | :--- |
|  | 3 | 0 | Torque boost current limit

NOTE! Check whether the motor can accelerate the load with "Torque booster", without any harmful mechanical stress.

### 7.12 Bypass

In cases of high ambient temperatures or other reason it may sometimes be necessary to use a by-pass contactor to minimize the power loss at nominal speed (see Technical Data). By using the built-in Full Voltage Relay function an external contactor can be used to Bypass the soft starter when operating at nominal speed.

Bypass contactor can also be used if soft stop is required. Normally a Bypass contactor is not necessary as the device is designed for continues running conditions, see Fig. 29 on page 33 for wiring example.

NOTE! If one like to use the alarm functions, the extended functions or the viewing functions the 2-pes current transformers must be mounted outside the soft start as shown in Fig. 44 and Fig. 45 on page 45 . For this purpose an optional extension cable for the current transformers is available. Code No 01-2020-00.

| 0 3 2 <br> 0   |  |  |  |
| :--- | :--- | :--- | :--- |
|  | 0 | $F$ | $F$ |
| Default: | oFF |  |  |
| Range: | oFF, on |  |  |
| ofF | Bypass disabled of Bypass |  |  |
| on | Bypass enabled. <br> Program either relay K1 or K2 to <br> function 2 to control the bypass con- <br> tactor, see.menu 51/52. |  |  |

## !

## CAUTION! If the current transformers are not

 mounted as in Fig. 43 on page 44 and $\$$ 6.2, page 28, the alarm and viewing functions will not work. Do not forget to set menu 032 to ON , otherwise there will be an F12 alarm and at the stop command will be a freewheeling stop.For further information see chapter 6.2 page 28.


Fig. 43 . Bypass wiring example MSF 310-1400.


Fig. 44 Current transformer position when Bypass MSF-017 to MSF-250.


Fig. 45 Current transformer position when Bypass MSF-310 to MSF-1400.

### 7.13 Power Factor Control

During operation, the soft starter continuously monitors the load on the motor. Particularly when idling or when only partially loaded, it is sometimes desirable to improve the power factor. If Power factor control (PFC) is selected, the soft starter reduces the motor voltage when the load is lower. Power consumption is reduced and the degree of efficiency improved.


NOTE! If the PFC is used the EMC-directive is not fulfilled.

### 7.14 Brake functions

There are two built in braking methods for applications were the normal stop ramp is not enough.

## - Dynamic DC-brake

Increases the braking torque by decreasing speed.

- Soft brake

Gives a high torque at the start of the braking and then also increasing torque by decreasing speed.

In both methods the MSF detects when the motor is standing still, so rotating in wrong direction is avoided.

## Dynamic Vector Brake

- Possible to stop motors with high inertia loads from close to synchronous speed.
- At $70 \%$ of the nominal speed a DC-brake is activated until the motor is standing still or the selected Braking Time has expired (see menu 34, next page).
- No contactor needed.
- For extra safety, the soft starter has a digital input signal for monitoring standstill so that at real motor standstill will stop the output voltage immediately (see $\S 7.19$, page 53 ).


## Soft brake

- Even very high inertia loads can be stopped
- The Soft brake is a controlled reversing of the motor as the MSF measures the speed during braking.
- Two contactors are needed which can be placed on the in- or output of the soft starter. On the input the first contactor is connected to relay K1 which is also used as a mains contactor.
- At $30 \%$ of the nominal speed a DC-brake is activated until the motor is standing still or the selected Braking Time has expired (menu 34, next page).
- For extra safety, the soft starter has a digital input signal for monitoring standstill. So that the output voltage is stopped immediately (see menu 57-58, $\varsigma$ 7.19, page 53).

See Fig. 47 on page 47 for the following set-up sequence:

- Soft brake is activated if menu $36=2$ and menu 34 has a time selected (see next page).
- Menu 51 and 52 are automatically set to 5 and 4 to get the correct relay functions on K1 and K2 (see $\$$ 7.17, page 51).
- Relay K1 should be used to connect a contactor for supply L1, L2, L3 to MSF or motor.
- Relay K2 is used to connect phase shifting contactor to change L1, L2 and L3 to MSF or motor.
- At start K1 is activated and connects L1, L2, L3 then the motor starts. At stop K1 opens and disconnects L1, L2, and L3 and after 1s K2 connects with the other phase sequence and the braking of the motor is active.

NOTE! Soft brake uses both programmable relays. For other functions, see also the function table in chapter 7. page 35.

NOTE! For several start/stops it is recommend to use the PTC input.


WARNING! If the Soft Brake function has been selected once and after that the Bypass function is selected, then the relay functions on K1 and K2 remain in the Soft Brake functionality. Therefore it is necessary to change the relay functions in menu 51-52 manually to the Bypass functions (see $\$ 7.17$, page 51 ) or reset to default in menu 199 (see $\S 7.28$, page 63) and select the Bypass function again.

| 0 | 3 | 4 | 0 |
| :--- | :--- | :--- | :--- |
|  | $\quad$ Braking time |  |  |
|  |  | 0 | $F$ |


Nom. speed

03-F121
Fig. 46 Braking time

| 0315: |  | Brakng strength |
| :---: | :---: | :---: |
| 1 | 010 |  |
|  | 100.500\% |  |
| Range: |  |  |  |




Fig. 47 Soft brake wiring example.

### 7.15 Slow speed and Jog functions

The soft starter is able to run the motor at a fixed slow speed for a limited period of time.

The slow speed will be about $14 \%$ of the full speed in the forward direction and $9 \%$ in the reverse direction.

## The following functions are possible:

- Slow speed controlled by an external signal. The digital input is used to run at slow speed at a start or stop command for a selected number of pulses (edges) generated by an external sensor (photo cell, micro switch, etc.). See $\$ 7.19$, page 53 for more instructions.
- Slow Speed during a selected time perlod. The slow speed will be active after a stop command for a selected time period. See $\$ 7.19$, page 53 for more instructions.
- Slow Speed using the "JOG"-commands.

The slow Speed can be activated via the JOG keys on the keyboard or externally via the analogue input. See $\$ 7.25$, page 61 for more instructions.

### 7.15.1 Slow speed controlled by an extemal slgnal.

With these setting it is possible to have an external pulse or edge signal controlling the time that the Slow Speed is active either after a Start command or a Stop command or at both commands. The following menu's are involved:

| Menu | Function | See page |
| :--- | :--- | :--- |
| 57 | Digital input selection | page 53 |
| 58 | Pulse selection | page 53 |
| 37 | Slow speed torque | page 49 |
| 38 | Slow speed time at start | page 49 |
| 39 | Slow speed time at stop | page 49 |
| 40 | DC-Brake at slow speed | page 49 |

Installation is as follows:

1. Set the analogue input selection for Slow Speed operation. Menu 57=2. See $§ 7.19$, page 53. See Fig. 37 on page 41 for a wiring example.
2. Select in menu 38 (see $\$ 7.15 .2$, page 49) the Slow Speed at Start time. This time will now be the absolute maximum time for Slow Speed to be active after a start command, in case the external signal will not appear.
3. Select in menu 39 (see $\$ 7.15 .2$, page 49 ) the Slow Speed at Stop time. This time will now be the absolute maximum time for Slow Speed to be active after a stop command, in case the external signal will not appear.
4. Select in menu 57 (see $\$ 7.19$, page 53 ) the number of edges to be ignored by the Slow Speed input, before a start or stop is executed at slow speed. The edges are generated by an external sensor (photo cell, micro switch, etc.).

The Slow Speed torque (menu 37) and DC-Brake after Slow Speed (menu 40) can be selected if needed. (see $\$ 7.15 .4$, page 49 ).

When the number of edges exceeds or the ime expire, a start according to selected main function is made.

At stop, the motor will ramp down (if selected) and DC brake (if selected) before a slow speed forward at stop will begin. Slow speed will last as long as the number of edges on the external input is below parameter value in menu 036 and the max duration time doesn't expires. When the number of edges exceeds or the time expire, a stop is made.

In Fig. 48 on page 48 the selected number of edges are 4. It is recommended to select DC-brake (se $\$ 7.14$, page 46) before a slow speed at stop if it is a high inertia load. See Fig. 29 on page 33 for wiring diagram. In case one use DC-brake, see $\S 7.15 .4$, page 49.


Fig. 48 Slow speed controlled by ant external signal.
This additional function can be used together with most of the main functions (see $\S 4.6$, page 19).


### 7.15.2 Slow speed during a selected tlme

It is possible to have a slow speed in forward direction before a start and after a stop. The duration of the slow speed is selectable in menus 038 and 039.

It is recommended to select DC brake (see $\$ 7.14$, page 46) before a slow speed at stop if it is a high inertia load. This slow speed function is possible in all control modes, keyboard, remote and serial communication.


Fig. 49 Slow speed at start/stop during a selected time.
The Slow speed torque (menu 37) and the DC-Brake after Slow speed (menu 40, $\bigvee 7.15 .4$, page 49) can be selected if needed.

### 7.15.3 Jog Functions

The Jog commands can be used to let the motor run at a Slow speed (forward or reverse) as long as the Jog command is active.

The Jog commands can be activated in 2 different ways:

- Jog keys

The Jog-Forward and Jog-reverse keys on the control panel. The keys can be programmed separate for each function. See $\S 7.25$, page 61 for more instructions

- Extemal Jog command

The external command is given via terminal 14 at the digital input. Only 1 function (forward or reverse) can be programmed to the digital input at the time. See $\$ 7.19$, page 53 for more instructions.

### 7.15.4 DC-brake after slow speed at stop [040]

A DC-brake after a slow speed at stop is possible to have, i.e. for a high inertia load or for a precise stop.

The current is controlled and the reference value for the normal DC-brake function is used (see $\$ 7.15 .4$, page 49 ).
The duration for the DC-brake is possible to select.
This DC-brake function is not applied when the "JOG $\Omega$ " and "JOG $\Omega$ " keys are used.

| $040{ }_{0}^{\circ}$ |  |  | DC-Brake at slow speed |
| :---: | :---: | :---: | :---: |
| 0 | $F$ | $F$ |  |
| Default: |  | OFF |  |
| Range: |  | OFF, 1-60 |  |
| ofF |  | DC-brake after slow speed at stop disabled. |  |
| 1.60 |  |  | ake duration time after slow at stop. |

### 7.16 Motor data setting

The first step in the settings is to set menu 007 and 008 to "on" to be able to reach the menus 041-046 and enter the motor data.

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


NOTEI Now go back to menu 007, 008 and set it to "ofF" and then to menu 001.


### 7.17 Programmable relay K1 and K2

The soft starter has three built-in auxiliary relays, K3 (change over contacts), is always used as an alarm relay. The other two relays, K1 and K2 (closing contacts), are programmable.

K1 and K2 can be set to either "Operation", "Full Voltage" or "Pre-alarm" indication. If DC-brake is chosen the relay K2 will be dedicated to this function.


Fig. 50 Start/stop sequence and relay function "Operation" and "Full voltage".

| 0 5 1 <br> 0   |  |  |
| :--- | :--- | :--- |
|  |  |  |


| 0.5 | 2 |  |
| :--- | :--- | :--- |
|  |  |  |
|  |  | 2 |
| Default: | 2 |  |
| Range: | $1,2,3,4,5$ |  |
| $\mathbf{1}$ | $K 2$ is set for "Operation" |  |
| $\mathbf{2}$ | $K 2$ is set for "Full Voltage" |  |
| $\mathbf{3}$ | $K 2$ is set for "Power pre-alarm" |  |
| $\mathbf{4}$ | K 2 is set for "Softbrake" |  |
| $\mathbf{5}$ | K 2 is set for "Run" |  |

©
WARNING! If the Soft Brake function has been selected once and after that the Bypass function is selected, then the relay functions on K1 and K2 remain in the Soft Brake funetionality. Therefore it is necessary to change the relay functions in menu $51-52$ manually to the Bypass functions (see § 7.12, page 43) or reset to default in menu 199 (see § 7.28, page 63) and select the Bypass function again.

### 7.18 Analogue output

The soft starter can present current, voltage and power on an analogue output terminal, for connection to a recording instrument or a PLC. The output can be configured in 4 different ways, $0-10 \mathrm{~V}$,
$2-10 \mathrm{~V}, 0-20 \mathrm{~mA}$ or $4-20 \mathrm{~mA}$. To install the instrument proceed as follows:

1. Connect the instrument to terminal $19(+)$ and 15 (-).


Fig. 51 Wiring for analogue output.
2. Set Jumper J2 on the PCB board to voltage (U) or current (I) signal position. Factory setuing is voltage (U). See Fig. 52 on page 52 and Fig. 24 on page 28.

4. Choose a read-out value in menu 055

5. Set analogue output gain to adjust the range of chosen analogue output value in menu 056.


Example on settings:

| Set value | $\mathbf{I}_{\text {scale }}$ | $\mathbf{U}_{\text {scale }}$ | $\mathbf{P}_{\text {scale }}$ |
| :--- | :--- | :--- | :--- |
| $100 \%$ | $0-5 \times I_{n}$ | $0-720 \mathrm{~V}$ | $0-2 \times P_{\boldsymbol{n}}$ |
| $50 \%$ | $0-2.5 \times I_{n}$ | $0-360 \mathrm{~V}$ | $0-P_{\mathrm{n}}$ |

Fig. 52 Setting of current or voltage output.
3. Set the parameter in menu 054.

| 0 5 4 <br> 0   |  |  |  |
| :--- | :--- | :--- | :--- |
|  | 0 | $F$ | $F$ |
|  | Analogue output |  |  |
| Default: | ofF |  |  |
| Range: | ofF, 1, 2 |  |  |
| oFF | Analogue ouput is disabled |  |  |
| $\mathbf{1}$ | Analogue output is set to <br> O-10V/O-2OmA |  |  |
| $\mathbf{2}$ | Analogue output is set to <br> O-10V/4-20mA |  |  |

### 7.19 Digital input selection

The analogue input can be used as a digital input. This is programmed in Menu 57. There are 4 different functions:

- Rotation sensor input for braking functions. See $\$ 7.14$, page 46.
- Slow speed external controlled. See $\S 7.15 .1$, page 48.
- Jog functions forward or reverse enabled. See $\$$ 7.25 , page 61.

Fig. 53 shows how to set the input for voltage or current control, with jumper J1 the control board. The default setting for J 1 is voltage control.


Depending on the selection made in menu 57, menu 58 is used to program the number of the edges. The edges can be generated by an external sensor (photo cell, micro switch etc.).

| 0 | 5 | 8 | 0 |
| :--- | :--- | :--- | :--- |
|  |  |  | 1 |

Fig. 53 Setting of J1 for current or voltage control.
Fig. 54 shows a wiring example for the analogue input as it is used for digital input.


Fig. 54 Wiring for slow speed external input.
NOTEI If the Main Function Analogue control is programmed (see $\S 7.8$, page 41) the analogue input can not be used for digital signal input. The menu 57 is then automatically set to OFF.


NOTE! Jog fonward, reverse has to be enabled, see $\S 7.25$, page 61.

### 7.20 Parameter Set

Parameter Set, an important function which can be handy when using one soft starter to switch in and start different motors, or working under variable load conditions. For example; starting and stopping conveyor belts with different weight on the goods from time to time.

For sets of parameters can be controlled either from the keyboard, the external control inputs or the serial interface (option). Up to 51 different parameters can be set for each Parameter Set.


Fig. 55 Parameter overview
When 'Parameter set' in menu 061 is set to 0 (external selection), only parameters in menu 006 (Control mode) and .061 (Parameter set) can be changed. All other parameters are not allowed to change.

It is possible to change parameter set at stop and at full voltage running.


Fig. 56 Connection of external control inputs.

| Parameter Set | PS1 (16-18) | PS2 (17-18) |
| :---: | :---: | :---: |
| 1 | Open | Open |
| 2 | Closed | Open |
| 3 | Open | Closed |
| 4 | Closed | Closed |

### 7.21 Motor protection, overload (F2 alarm)

In many cases it is convenient to have a complete starter. The soft starter have a possibility to use either an input PTC signal from the motor, an internal thermal model of the motor for thermal protection or both together at the same time. Slight overload for long time and several overloads of short duration will be detected with both methods.

| 0 7 1 <br> 0   |  |  |
| :--- | :--- | :--- |
|  |  | n |

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

NOTEI The internal motor thermal protection will still generate an alarm if it is not selected oFF.

| 0720 |  |  |  |
| :---: | :---: | :---: | :---: |
|  | 1 | 0 | protection |
| Default: |  | 10 |  |
| Range: |  |  | -40 sec |
| oFF |  | Int | al motor protection is disabled. |
| 2-40 |  |  | ion of the thermal curve ding to Fig. 57 <br> $k$ that menu 042 is set to the er motor current (see § 7.16, 50). <br> current exceeds the 100\% an F2 alarm is activated. <br> motor model thermal capacity cool down to $95 \%$ before reset be accepted. <br> thermal capacity in menu 073 7.21 , page 55 . |

NOTE! If 'Bypass' is used check that the current transformers are placed and connected correctly (see Fig. 43 on page 44).


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


Fig. 57 The thermal curve


### 7.22 Mains protection



| 0 8 3 0 |  |  |
| :--- | :--- | :--- |
|   | 1 | 1 |


| 0 8 4 0 |  |
| :--- | :--- | :--- | :--- |
| \begin{tabular}{\|l|l|l|l|}
\hline
\end{tabular} |  |
| Default: | oFF |
| Range: | oFF, 1-60 sec |
| ofF | Olarm |


| 0 8 5 0 <br>  O F F |
| :--- | :--- | :--- |


| 0 8 6 0 |
| :--- | :--- | :--- |
|  O F |




NOTE! The actual phase sequence can be viewed in menu 87.

### 7.23 Application protection (load monitor)

### 7.23.1 Load monitor max and min/protection

 (F6 and F7 alarms)MSF has a built in load monitor based on the output shaftpower. This is a unique and important function which enables protection of machines and processes driven by the motor connected to the soft starter. Both a Min and Max limit is possible to select.

In combination with the pre-alarm function, see $\$ 7.23 .2$, page 58 , this create a powerful protection. An auto set function is also included for an automatic setting of the alarm limits. A start-up delay time can be selected to avoid undesired alarms at start-up, see Fig. 58 on page 60.

NOTE! The load monitor alarms are all disabled during a stop ramp.


| 09 | 0 | 0 |  |
| :--- | :--- | :--- | :--- |
|  |  |  | Output shaftpower in \% |
|  |  |  | 0 |
| Default: | - |  |  |
| Range: | $0-200 \%$ |  |  |
| Measured output shaftpower in \% of nominal motor <br> power. |  |  |  |

NOTE! System must be in full voltage running before an auto set is permitted.

The actual power is regarded as $1.00 \times \mathrm{xPact}$.
The set levels are:

| Power max alarm limit[092]: | 1.15 xP actual |
| :--- | :--- |
| Power max pre-alarm limit[094]: | $1.10 \times \mathrm{x}$ actual |
| Power min pre-alarm limit[096]: | $0.90 \times \mathrm{x}$ actual |
| Power min alarm limit[098]: | 0.85 xP actual |

A successful auto set shows a message 'Set' for 3 s and if something goes wrong a message 'no' will be showed.

| $0 / 9$ | 1 | 0 |  |
| :--- | :--- | :--- | :--- |
|  |  | 1 | 0 |
|  | Start delay power limits |  |  |
|  |  |  |  |
| Default: | 10 sec |  |  |
| Range: | $1-250$ sec |  |  |
| From start command during selected delay time, all <br> power load monitor alarms and pre-alarms are disa- <br> bled. |  |  |  |



Insert limit in \% of nominal motor power. The actual power in \% of nominal motor power, could be read out in menu 090. If output shaft power exceeds selected limit, an F6-alarm occurs after the response delay time. The 'Auto set' function in menu 089, affect this limit even if the alarm is set "oFF" in menu 093. This is a category 1 alarm.


### 7.23.2 Pre-alarm

It could be useful to know if the load is changing towards a load alarm limit. It is possible to insert both a Max and Min pre-alarm limit based on the motor output shaft power. If the load exceeds one of these limits, a pre-alarm condition occurs.

It should be noted that it is not normal alarms. They will not be inserted in the alarm list, not activating the alarm relay output, not displayed on the display and they will not stop operation. But it is possible to activate relay K 1 or K 2 if a pre-alarm condition occurs. To have pre-alarm status on any of these relays, select value 3 in menu 051 or 052 (see $\$ 7.17$, page 51 ).

A start-up delay time can be selected in menu 091 to avoid undesired pre-alarms at start-up. Note that this time is also shared with power Max and Min alarms.

NOTE! The pre-alarm status is always available on the serial communication.

## $094)^{\circ}$



Insert limit in \% of nominal motor power. The actual power in \% of nominal motor power, could be read out in menu 090. If output shaft power exceeds selected limit, a pre-alarm occurs after the response delay time. The 'Auto set' function in menu 089, affect selected limit even if the pre-alarm is set "oFF" in menu 095.


| O 9 6 0 |  |  |
| :--- | :--- | :--- |
|  |  | 9 |




| 0 | 9 | 8 | 0 |
| :--- | :--- | :--- | :--- |$|$|  |  |  |  |
| :--- | :--- | :--- | :--- |
|  |  | 8 | 5 |



### 7.24 Resume alarms

### 7.24.1 Phase input fallure F1

- Multiple phase failure.

Shorter failure than 100 ms is ignored. If failure duration time is between 100 ms and 2 s , operation is temporary stopped and a soft start is made if the failure disappears before 2 s . If failure duration time is longer than 2 s , an F 1 alarm is given in cat. 2.

- Single phase fallure.

During start up (acceleration) the behaviour is like multiple phase failure below. When full voltage running there is a possibility to select the behaviour.

| $1.010_{0}^{0}$ |  |  | Run at single phase loss |
| :---: | :---: | :---: | :---: |
|  | n | 0 |  |
| Default: |  | no |  |
| Range: |  |  |  |
| no |  |  | tarter trips if a single phase detected. Alarm F1 (category appear after 2 sec . |
| YES |  |  | starter continues to run after a phase loss. <br> F1 appears after 2 sec . loose phase is reconnect the m is reset automatically. <br> ning on 2 phases, a stop comd will give a Direct on line stop wheel) |

### 7.24.2 Run at current limit time-out F4

In modes 'Current limit at start' and 'Voltage ramp with current limit at start' an alarm is activated if still operating at current limit level when selected ramp time exceeds. If an alarm occurs there is a possibility to select the behaviour.

| 1 0 2 <br> 0   |  |  |
| :--- | :--- | :--- | :--- |
|  |  | Run at current Ilmit time-out |
| Default: | no |  |
| Range: | no, YES |  |
| no | Soft starter trips if the current limit <br> time-out is exceeded. Alarm F4 (cate <br> gory 2) appears. |  |
| YES | Soft starter continues to run after the <br> current limit time-out has exceeded: <br> - Alarm F4 appears <br> - The current is no longer controlled <br> and the soft starters ramps up to full <br> voltage with a 6s ramp time. <br> - Reset the alarm with either ENTER/ <br> RESET key or by giving a stop com- <br> mand. |  |

### 7.25 Slow speed with JOG

Slow speed with "JOG" is possible from the "JOG" keys, but also from terminals, see menu 57 page 53 and serial comm. The "JOG" is ignored if the soft starter is running. The slow speed "JOG" function has to be enabled for both forward and reverse directions in menus 103 and 104, see below.

NOTE! The enable functions is for all control modes.


Fig. 59 The 2 Jog keys.

### 7.26 Automatic return menu

Often it is desirable to have a specific menu on the display during operation, i.e. RMS current or power consumption. The Automatic return menu function gives the possibility to select any menu in the menu system.

The menu selected will come up on the display after 60 sec . if no keyboard activity. The alarm messages (F1-F16) have a priority over menu 105 (as they have for all menus).


### 7.27 Communication option, related Parameters

The following parameters have to be set-up:

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

Setting up the communication parameter must be made in local 'Keyboard control' mode. See $\S 7.2$, page 37.


| 1 1 3 0 <br>     <br>    0 |  |
| :--- | :--- | :--- | :--- |
| Default: | 0 |
| Range: | 0.1 |
| This parameter will select the parity. <br> 0 <br> 1 | No parity. <br> Even parity. |

## Serial comm. broken alarm

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

1 Continue without any action at all.
2 Stop and alarm after 15 sec .
3 Continue and alarm after 15 sec .
If an alarm occurs, it is automatically reset if the communication is re-established. It is also possible to reset the alarm from the soft starter keyboard.

| 1 | 1 | 4 |
| :--- | :--- | :--- | |  |  |  |
| :--- | :--- | :--- |
|  |  |  |

### 7.28 Reset to factory setting [199]

When selecting reset to factory setting:

- All parameters in all parameter sets will have default factory settings.
- Menu 001 will appear on the display.
- Note that the alarm list, the power consumption and the operation time will not have default settings.

| 19 9 9 ${ }_{0}^{0}$ |  |  | Reset to factory settings |
| :---: | :---: | :---: | :---: |
|  | n | 0 |  |
| Default: |  | no |  |
| Range: |  | no, |  |
| no |  | No r |  |
| YES |  |  | all functions to the factory ts incl. all 4 Parameter Sets. |

NOTEI Reset to factory settings is not allowed at run.

### 7.29 View operation

## General

The soft start includes as standard a numerous metering functions which eliminates the need of additional transducers and meters.

## Measured values

- Current RMS 3-phase current and per phase
- Voltage RMS 3-phase voltage and per phase
- Output shaft power/torque $\mathrm{kW} / \mathrm{Nm}$
- Power factor
- Power consumption in kWh
- Operation time in hours


## Viewing of the measured values

After setting motor data and extended functions one can set menu 008 in oFF and will then automatically move to menu 201, the first menu viewing the measured values and thus eliminate to scroll through menu 011 to menu 199.



NOTE! The power factor viewing will not work at bypass even if the current transformers are mounted outside the soft start.


NOTEI This is the same read-out as menu 005 see $\$ 7.1 .1$, page 36.


### 7.30 Keyboard lock

The keyboard can be locked to prohibit operation and parameter setting by an unauthorised. Lock keyboard by pressing both keys "NEXT $\rightarrow$ " and "ENTER $\leftrightarrow$ " for at least 2 sec . The message '- Loc' will display when locked. To unlock keyboard press the same 2 keys "NEXT $\rightarrow$ " and "ENTER 4 " for at least 2 sec. The message 'unlo' will display when unlocked.

In locked mode it is possible to view all parameters and read-out, but it is forbidden to set parameters and to operate the soft starter from the keyboard.

The message '-Loc' will display if trying to set a parameter or operate the soft starter in locked mode.

The key lock status can be read out in menu 221.

| 2 | 2 | 1 | 0 |
| :--- | :--- | :--- | :--- |
|  | $\quad$ Locked keyboard Info |  |  |
|  |  | $n$ | 0 |
|  |  |  |  |
| Default: | no |  |  |
| Range: | no, YES |  |  |
| no | Keyboard is not locked |  |  |
| YES |  | Keyboard is locked |  |

### 7.31 Alarm list

The alarm list is generated automatically. It shows the latest 15 alarms (F1-F16). The alarm list can be useful when tracing a failure in the soft starter or its control circuit. Press key "NEXT $\rightarrow$ " or "PREV $\leftarrow$ " to reach the alarm list in menus 901-915 (menu 007 has to be ON).


## 8. PROTECTION AND ALARM

The soft starter is equipped with a protection system for the motor, the machine and for the soft starter itself.
Three categories of alarm are available:

## Category 1

Alarm that stops the motor and need a separate reset before a new start can be accepted.

## Category 2

Alarm that stops the motor and accepts a new start command without any separate reset.

## Category 3

Alarm that continues to run the motor.

All alarm, except pre-alarm, will activate the alarm relay output K3, flash a red fault number on the display and it will also be placed in the alarm list. As long as the alarm is active, the display is locked in the alarm indication.

The relay output K3 can be used in the control circuit for actions needed when alarm occurs.

If more than one alarm is active, it is the last alarm that is presented on the display.

### 8.1 Alarm description

### 8.1.1 Alarm with stop and requiring a separate reset

Operation will stop for a category 1 alarm. A separate reset is needed before a new start command is accepted. It is possible to reset from keyboard (pushing "ENTER/RESET") regardless of selected control mode. It is also possible to reset the alarm from the actual control mode (i.e. if control mode is serial communication, a reset is possible to do from serial communication).

A reset is accepted first when the alarm source goes back to normal.

When a reset is made, the alarm relay output K3 is deactivated, the alarm indication on the display disappear and the original menu shows.

After a reset is made the system is ready for a new start command.

### 8.1.2 Alarm with stop and requiring only a new start command

Operation will stop for a category 2 alarm. A restart can be done and at the same time the alarm relay output K3 is deactivated, the alarm indication on the display disappear and the original menu shows.

It is still possible to reset the alarm in the same way as for category 1 alarms (see 8.1.1), if a start is not required at the time.

### 8.1.3 Alarm with continue run

Operation will continue run for a category 3 alarm. Some different reset behaviour is possible (see remarks for the specific alarms in $\$ 8.2$, page 67 ).

- Automatic reset when the alarm source goes back to normal.
- Automatic reset when a stop command is given.
- Manual reset during run.

When the reset occurs, the alarm relay output K3 is deactivated, the alarm indication on the display disappear and the original menu shows.

### 8.2 Alarm overview

| Display indication | Protective function | Alarm category | Remark |
| :---: | :---: | :---: | :---: |
| F1 | Phase input failure. | Cat 3. Run with auto reset. | Single phase failure when full voltage running if menu 101 'Run at phase loss' = YES. If the fault phase comes back, an automatic reset is made. |
|  |  | Cat 2. Stop with reset in start. | Multiple phase failure or single phase failure when not full voltage running or if menu $101^{\prime}$ Run at phase loss' = no. |
| F2 | Motor protection, overload. | Cat 1. Stop with manual reset. | If menu 071 'Motor PTC input' = YES, cool down the motor. <br> If menu 071 'Motor PTC input' = no, the internal model has to 'cool' down. |
| F3 | Soft start overheated | Cat 1. Stop with manual reset. | If not cooled down, a reset will not be accepted. |
| F4 | Full speed not reached at set current limit and start time. | If menu 102 'Run at current limit time-out' $=$ no. <br> Cat 2. Stop with reset in start. | The current limit start is not completed. |
|  |  | If menu 102 'Run at current limit time-out' = YES. <br> Cat 3. Run with manual reset. | When start time expired, a 6 sec ramp is used to reach full voltage, without control of the current. Reset the alarm with either a manual reset or a stop command. |
| F5 | Locked rotor. | Cat 1. Stop with manual reset. | Motor and/or machine protection. |
| F6 | Above max power limit. | Cat 1. Stop with manual reset. | Machine protection. |
| F7 | Below min power limit. | Cat 1. Stop with manual reset. | Machine protection. |
| F8 | Voltage unbalance. | Cat 2. Stop with reset in start. | Motor protection. |
| F9 | Over voltage. | Cat 2. Stop with reset in start. | Motor protection. |
| F10 | Under voltage. | Cat 2. Stop with reset in start. | Motor protection. |
| F11 | Starts / hour exceeded. | Cat 2. Stop with reset in start. | Motor and/or machine protection. |
| F12 | Shorted thyristor. | Cat 3. Run with manual reset. | When stop command comes, the stop will be a 'Direct On Line' stop, and the soft starter will be resetted. After this fault it is possible to start only in 'Direct On Line' mode. One or more thyristors probably damaged. |
| F13 | Open thyristor. | Cat 1. Stop with manual reset. | One or more thyristors probably damaged. |
| F14 | Motor terminal open. | Cat 1. Stop with manual reset. | Motor not correctly connected. |
| F15 | Serial communication broken. | If menu 114 Serial comm. contact broken =1. Cat 2. Stop with reset in start. | Serial communication broken will stop operation. Run from keyboard if necessary. |
|  |  | If menu 114 Serial comm. contact broken $=2$. Cat 3 . Run with auto reset. | Serial communication broken will not stop operation. Stop from keyboard if necessary. |
| F16 | Phase reversal alarm. | Cat 1. Stop with manual reset. | Incorrect phase order on main voltage input. |

## 9. TROUBLE SHOOTING

### 9.1 Fault, cause and solution

| Observation | Fault Indication | Cause | Solution |
| :---: | :---: | :---: | :---: |
| The display is not illuminated. | None | No control voltage. | Switch on the control voltage. |
| The motor does not run. | F1 (Phase input failure) | Fuse defective. | Renew the fuse. |
|  |  | No mains supply. | Switch the main supply on. |
|  | F2 <br> (Motor protection, overload) | Perhaps PTC connection. Perhaps incorrect nominal motor current inserted (menu 042). | Check the PTC input if PTC protection is used. If internal protection is used, perhaps an other class could be used (menu 072). Cool down the motor and make a reset. |
|  | F3 <br> (Soft start overheated) | Ambient temperature to high. soft starter duty cycle exceeded. Perhaps fan failure. | Check ventilation of cabinet. Check the size of the cabinet. Clean the cooling fins. If the fan(s) is not working correct, contact your local MSF sales outlet. |
|  | F4 <br> (Full speed not reached at set current limit and start time) | Current limit parameters are perhaps not matched to the load and motor. | Increase the starting time and/or the current limit level. |
|  | F5 (Locked rotor) | Something stuck in the machine or perhaps motor bearing failure. | Check the machine and motor bearings. Perhaps the alarm delay time can be set longer (menu 075). |
|  | F6 <br> (Above max power limit) | Overload | Over load. Check the machine. Perhaps the alarm delay time can be set longer (menu 093). |
|  | F7 <br> (Below min power limit) | Underload | Under load. Check the machine. Perhaps the alarm delay time can be set longer (menu 099). |
|  | F8 <br> (Voltage unbalance) | Main supply voltage unbalance. | Check mains supply. |
|  | F9 (Over voltage) | Main supply over voltage. | Check mains supply. |
|  | F10 (Under voltage) | Main supply under voltage. | Check mains supply. |
|  | F11 <br> (Starts / hour exceeded) | Number of starts exceeded according to menu 074. | Wait and make a new start. Perhaps the number of starts / hour could be increased in menu 074. |
|  | F13 (Open thyristor) | Perhaps a damaged thyristor. | Make a reset and a restart. If the same alarm appears immediately, contact your local MSF sales outlet. |
|  | F14 <br> (Motor terminal open) | Open motor contact, cable or motor winding. | If the fault is not found, reset the alarm and inspect the alarm list. If alarm F12 is found, a thyristor is probably shorted. <br> Make a restart. If alarm F14 appears immediately, contact your local MSF sales outlet. |


| Observation | Fault Indication | Cause | Solution |
| :---: | :---: | :---: | :---: |
| The motor does not run. | F15 <br> (Serial communication broken) | Serial communication broken. | Make a reset and try to establish contact. Check contacts, cables and option board. <br> Verify <br> - System address (menu 111). <br> - Baudrate (menu 112). <br> - Parity (menu 113). <br> If the fault is not found, run the motor with keyboard control if urgent (set menu 006 to "1"). See also manual for serial communication. |
|  | F16 <br> (Phase reversal) | Incorrect phase sequence on main supply. | Switch L2 and L3 input phases. |
|  | ---- | Start command comes perhaps from incorrect control source. (I.e. start from keyboard when remote control is selected). | Give start command from correct source (menu 006). |
|  | -LOC | System in keyboard lock. | Unlock keyboard by pressing the keys 'NEXT' and 'ENTER' for at least 3 sec . |
| The motor is running but an alarm is given. | F1 (Phase input failure) | Failure in one phase. Perhaps fuse defective. | Check fuses and mains supply. Deselect 'Run at single phase input failure' in menu 101, if stop is desired at single phase loss. |
|  | F4 (Full speed not reached at set current limit and start time) | Current limit parameters are perhaps not matched to the load and motor. | Increase the starting time and/or the current limit level. Deselect 'Run at current limit time-out' in menu 102, if stop is desired at current limit time-out. |
|  | F12 <br> (Shor ted thyristor) | Perhaps a damaged thyristor. | When stop command is given, a free wheel stop is made. Make a reset and a restart. If alarm F14 appears immediately, contact your local MSF sales outlet. <br> If it is urgent to start the motor, set soft starter in 'Direct On Line' (menu 024). It is possible to start in this mode. |
|  |  | By pass contactor is used but menu 032 'Bypass' is not set to "on". | Set menu 032 'Bypass' to "on". |
|  | F15 (Serial communication broken) | Serial communication broken. | Make a reset and try to establish contact. Check contacts, cables and option board. <br> Verify <br> - System address (menu 111). <br> - Baudrate (menu 112). <br> - Parity (menu 113). <br> If the fault is not found, run the motor with keyboard control if urgent, see also manual for serial communication. |


| Observation | Fault Indication | Cause | Solution |
| :---: | :---: | :---: | :---: |
| The motor jerks etc. | When starting, mot or reaches full speed but it jerks or vibrates. | If 'Torque control' or 'Pump control' is selected, it is necessary to input motor data into the system. | Input nominal mot or data in menus 041-046. Select the proper load characteristic in menu 025. Select a correct initial- and end torque at start in menus 016 and 017. If 'Bypass' is selected, check that the current transformers are correct connected. |
|  |  | Starting time too short. | Increase star ting time. |
|  |  | Starting voltage incorrectly set. | Adjust starting voltage. |
|  |  | Motor too small in relation to rated current of soft starter. | Use a smaller model of the soft starter. |
|  |  | Motor too large in relation to load of soft starter. | Use larger model of soft starter. |
|  |  | Starting voltage not set correctly | Readjust the start ramp. |
|  |  |  | Select the current limit function. |
|  | Starting or stopping time too long, soft does not work. | Ramp times not set correctly. | Readjust the start and/or stop ramp time. |
|  |  | Motor too large or too small in relation to load. | Change to another motor size. |
| The monitor function does not work. | No alarm or pre-alarm | It is necessary to input nominal motor data for this function. Incorrect alarm levels. | Input nominal mot or data in menus 041-046. Adjust alarm levels in menus 091-099. If 'Bypass' is selected, check that the current transformers are correct connected. |
| Unexplainable alarm. | F5, F6, F7, F8, F9, F10 | Alarm delay time is to short. | Adjust the response delay times for the alarms in menus 075, 082, 084, 086, 093 and 099. |
| The system seems locked in an alarm. | F2 <br> (Motor protection, overload) | PTC input terminal could be open. <br> Motor could still be to warm. If internal motor protection is used, the cooling in the internal model take some time. | PTC input terminal should be shor $t$ circuit if not used. Wait until motor PTC gives an OK (not overheated) signal. Wait until the internal cooling is done. Try to reset the alarm after a while. |
|  | F3 <br> (Soft start overheated) | Ambient temperature to high. Perhaps fan failure. | Check that cables from power part are connected in terminals 073, 074, 071 and 072. MSF-017 to MSF-1.45 should have a short circuit between 071 and 072 . Check also that the fan(s) is rotating. |
| Parameter will not be accepted. | -.. | If the menu number is one of 020-025, only one can bee selected. <br> In other words only one main mode is possible at a time. | Deselect the other main mode before selecting the new one. |
|  |  | If menu 061, 'Parameter set' is set to " 0 ", the system is in a remote parameter selection mode. It is now impossible to change most of the parameters. | Set the menu 061, 'Parameter set' to a value between "1" - "4" and then it is possible to change any parameter. |
|  |  | During acceleration, deceleration, slow speed, DC brake and Power factor control mode, it is impossible to change parameters. | Set parameters during stop or full voltage running. |
|  |  | If control source is serial comm., it is impossible to change parameters from keyboard and vice versa. | Change parameters from the actual control source. |
|  |  | Some menus include only read out values and not parameters. | Read-out values can not be altered. In table 13, page 35, read-out menus has '--' in the factory setting column. |
|  | -Loc | Keyboard is locked. | Unlock keyboard by pressing the keys 'NEXT' and 'ENTER' for at least 3 sec . |

## 10. MAINTENANCE

In general the soft starter is maintenance free. There are however some things which should be checked regularly. Especially if the surroundings are dusty the unit should be cleaned regularly.

## WARNING! Do not touch parts inside the enclosure of the unit when the control and motor voltage is switched on.

## Regular maintenance

- Check that nothing in the soft starter has been damaged by vibration (loose screws or connections).
- Check external wiring, connections and control signals. Tighten terminal screws and busbar bolts if necessary.
- Check that PCB boards, thyristors and cooling fin are free from dust. Clean with compressed air if necessary. Make sure the PCB boards and thyristors are undamaged.
- Check for signs of overheating (changes in colour on PCB boards, oxidation of solder points etc.). Check that the temperature is within permissible limits.
- Check that the cooling fan/s permit free air flow. Clean any external air filters if necessary.

In the event of fault or if a fault cannot be cured by using the fault-tracing table in chapter 9. page 68.

## 11. OPTIONS

The following option are available. Please contact your supplier for more detailed information.

### 11.1 Serial communication

For serial communication the MODBUS RTU (RS232/RS485) option card is available order number: 01-1733-00.


Fig. 60 Option RS232/485

### 11.2 Field bus systems

Various option cards are available for the following bus systems:

- PROFIBUS DP order number: 01-1734-01
- Device NET, order number:
- LONWORKS:

01-1736-01

- FIP IO: 01-1737-01
- INTERBUS-S:

01-1738-01

Each system has his own card. The option is delivered with an instruction manual containing the all details for the set-up of the card and the protocol for programming.


Fig. 61 Option Profibus

### 11.3 External PPU.

The external PPU option is used to move the PPU (keyboard) from the soft starter to the front of a panel door or control cabinet.

The maximum distance between the soft starter and the external PPU is 3 m .
The option can be factory mounted (01-2138-01) or it can be built in later (01-2138-00). For both versions instruction /data sheet are available.


Fig. 62 Shows an example of the External PPU after it has been built in.

### 11.3.1 Cable kit for extemal current transformers

This kit is used for the bypass function, to connect the external current transformers more easy. order number: 01-2020-00.


Fig. 63 Cable kit

### 11.4 Terminal clamp

Data: Single cables, Cu or Al
Cables $\quad 95-300 \mathrm{~mm}^{2}$
MSF type Cu Cable
Bolt for connection to busbar
Dimensions in mm
Order No. single
$33 \times 84 \times 47 \mathrm{~mm}$

Data: Parallel cables, Cu or Al
Cables
$2 \times 95-300 \mathrm{~mm}^{2}$
MSF type and Cu Cable
Bolt for connection to busbar
Dimensions in mm
Order No. parallel


Fig. 64 The terminal clamp.

## 12. TECHNICALDATA

| $3 \times 200-525$ V 50/60 Hz Model | MSF-017 |  | MSF-030 |  | MSF045 |  | MSF060 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Sof starter rating aceording to AC353, weo chapter 4. page 13 | $\begin{gathered} \text { 5.0-30:50-10 } \\ \text { heavy } \end{gathered}$ | $\begin{aligned} & \text { 3.0-30:50.10 } \\ & \text { nomod/light } \end{aligned}$ | $\begin{gathered} 5.0-30.50-10 \\ \text { hosy } \end{gathered}$ | $\left\|\begin{array}{l} 3.0-30: 50-10 \\ \text { normal/light } \end{array}\right\|$ | $\left\|\begin{array}{c} 5.0-30: 50-10 \\ \text { heay } \end{array}\right\|$ | $\left\|\begin{array}{l\|} 3.0-30: 50.10 \\ \text { nomal } / \text { Reght } \end{array}\right\|$ | $\begin{gathered} 5.0-30: 50.10 \\ \text { heavy } \end{gathered}$ | $\left\|\begin{array}{l} 3.0-30: 50-10 \\ \text { nomal } / 18 \mathrm{hth} \end{array}\right\|$ |
| Rated current of soft starter (A) | 17 | 22 | 30 | 37 | 45 | 60 | 60 | 72 |
| Recommended motor size (kW) for 400 V | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 30 | 37 |
| Recommended motor size (kW) for 525 V | 11 | 15 | 18.5 | 22 | 30 | 37 | 37 | 45 |
| Order number: supply voltage ( $100-240 \mathrm{~V}$ ) | 01.1301-01 |  | 01.1302-01 |  | 01.1303-01 |  | 01.1304.01 |  |
| Order number: supply voltage ( $380-500 \mathrm{~V}$ ) | 01.1301-02 |  | 01.1302-02 |  | 01.1303 .02 |  | 01.1304 .02 |  |
| 3x200-690V $50 / 60 \mathrm{~Hz}$ Model | MSF017 |  | MSF-030 |  | MSF-045 |  | MSF060 |  |
| Rated current of soft starter (A) | 17 | 22 | 30 | 37 | 45 | 60 | 60 | 72 |
| Motor power for 690V | 15 | 18.5 | 22 | 30 | 37 | 55 | 55 | 75* |
| Order number: supply voltage ( $100-240 \mathrm{~V}$ | 01-1321-01 |  | 01-1322.01 |  | 01.1323-01 |  | 01.1324 .01 |  |
| Order number; supply woltage ( 380.500 V ) | 01.1321.02 |  | 01.1322.02 |  | 01.1323-02 |  | 01.1324-022 |  |
| Eloctrical Data |  |  |  |  |  |  |  |  |
| Recommended wiring fuse ( $A$ ) 1) | 25/50 | 32 | 35/80 | 50 | 50/125 | 80 | 63/160 | 100 |
| Semi-conductor fuses, if required |  |  | 125 A |  | 160 A |  | 200 A |  |
| Power loss at rated motor load (W) | 50 | 70 | 90 | 120 | 140 | 180 | 180 | 215 |
| Power consumplion control eard | 20 VA |  | 20 VA |  | 25 VA |  | 25 VA |  |
| Mochanical Dato |  |  |  |  |  |  |  |  |
| Oimensions in mm $\mathrm{H} \times \mathrm{W} \times \mathrm{O}$ | $320 \times 126 \times 260$ |  | $320 \times 126 \times 260$ |  | 320×126×260 |  | $320 \times 126 \times 260$ |  |
| Mounting position (Vertical/Horizontal) | Vertical |  | Vertical |  | Vert. or Horiz. |  | Vert. or Horiz. |  |
| Weight (kg) | 6.7 |  | 6.7 |  | 6.9 |  | 6.9 |  |
| Connection busbars Cu , (bolt) | $15 \times 4$ (M6) |  | 15×4 (M6) |  | 15x4 (M6) |  | $15 \times 4$ (M8) |  |
| Cooling system | Convection |  | Convection |  | Fan |  | Fan |  |
| General Eloctrical Dato |  |  |  |  |  |  |  |  |
| Number of fully controlled phases | 3 |  |  |  |  |  |  |  |
| Volt age tolerance control | Contral $+/ .10 \%$ |  |  |  |  |  |  |  |
| Voltage tolerance motor | Motor 200-525 +/-10\%/200-690+5\%, $10 \%$ |  |  |  |  |  |  |  |
| Recommended fuse for control card (A) | Max 10 A |  |  |  |  |  |  |  |
| Frequency | $50 / 60 \mathrm{~Hz}$ |  |  |  |  |  |  |  |
| Frequency toderance | +// $10 \%$ |  |  |  |  |  |  |  |
| Relay contacts | $3 \times 8 \mathrm{~A}, 250 \vee$ resistive load, 3 A 250 VAC inductive ( $\mathrm{PF}=0,4$ ) |  |  |  |  |  |  |  |
| Typo of protection/meulation |  |  |  |  |  |  |  |  |
| Type of casing protection | IP 20 |  |  |  |  |  |  |  |
| Other Genoral Dats |  |  |  |  |  |  |  |  |
| Amblent temperatures |  |  |  |  |  |  |  |  |
| In aperation | 0:40 ${ }^{\circ}$ |  |  |  |  |  |  |  |
| Max.eg. ${ }^{\text {a }} 80 \%$ in | $50^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |
| In storage | (-25) - + + 70 ) ${ }^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |
| Relative air humidity | 95\%, non-condensing |  |  |  |  |  |  |  |
| Max. attitude wlthout derating | (See separate: Technical information 151) 1000 m |  |  |  |  |  |  |  |
| Norms/Standards, Contorm to: | IEC 947-4-2, EN 292, EN 60204-1, UL508 |  |  |  |  |  |  |  |
| EMC, Emission | EN 50081-2, (EN 50081.1 with bypass contactor) |  |  |  |  |  |  |  |
| EMC, Immunity | EN 50082.2 |  |  |  |  |  |  |  |
| 1) Recommended wiring fuses for: $\begin{aligned} & \text { Heary (first codumn): ramp/direct start } \\ & \text { Normal/ Lught (second column): ramp staxt }\end{aligned}$ |  |  |  |  |  |  |  |  |
| HOTEI Short clrcult withatand MSF017-060 $5000 \mathrm{~mm} \mathrm{~A} \mathrm{when} \mathrm{used} \mathrm{with} \mathrm{K5} \mathrm{of} \mathrm{RKS} \mathrm{fuses}$. |  |  |  |  |  |  |  |  |

* 2 -pole motor

| 3x200-525 V 50/60 Hz Model | MSF-075 |  | MSF-085 |  | MSF-110 |  | MSF-145 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Soft starter rattag according to AC353, 100 chaptor 4. Pago 13 | $\begin{array}{\|c\|} \hline 5.0-30: 50-10 \\ \text { hemvy } \end{array}$ | $\begin{aligned} & \text { 3.0-30:50-10 } \\ & \text { normal/प8gt } \end{aligned}$ | $\begin{array}{\|c\|} \hline 5.0-30: 50-10 \\ \text { hoosyy } \end{array}$ | $\left\|\begin{array}{c} 3.030: 50-10 \\ \text { normal/ight } \end{array}\right\|$ | $\begin{gathered} 5.0-30: 50-10 \\ h e \mathrm{wy} \end{gathered}$ | $\left\|\begin{array}{l} 3.0-30: 50-10 \\ \text { normal/light } \end{array}\right\|$ | $\begin{gathered} 5.0-30: 50-10 \\ \text { heavy } \end{gathered}$ | $\left\|\begin{array}{l} 3.0-30: 50-10 \\ \text { normal/llxht } \end{array}\right\|$ |
| Rated current of sont starter (A) | 75 | 85 | 85 | 96 | 110 | 134 | 145 | 156 |
| Recommended motor size (kW) for 400 V | 37 | 45 | 45 | 55* | 55 | 75 | 75 |  |
| Recommended motor size (kW) for 525 V | 45 | 55 | 55 | 75* | 75 | 90 | 90 | 110 |
| Order number for supply voltage ( $100-240 \mathrm{~V}$ ) | $01.1305-01$ |  | 01.1306.01 |  | 01-1307-01 |  | 01-1308-01 |  |
| Order number for supply voltage ( 380.550 V ) | 01-1305-02 |  | 01-1306.02 |  | 01.1307.02 |  | 01-1308-02 |  |
| $3 \times 200-690$ V 50/60 Hz Model | MSF-075 |  | MSF-085 |  | MSF-110 |  | MSF-145 |  |
| Rated currem of soft starter (A) | 75 | 85 | 85 | 90 | 110 | 134 | 145 | 156 |
| Motor power for 690 V | 55 | 75 | 75 | 90 | 90 | 110 | 132 | 160* |
| Order number for supply voltage ( $100-240 \mathrm{~V}$ ) | 01.1325-01 |  | 01.1326 .01 |  | 01.1327-01 |  | 01-1328.01 |  |
| Order number for supply voltage ( $380-550 \mathrm{~V}$ ) | 01-1325-02 |  | 01.1326.02 |  | 01-1327-02 |  | 01-1328-02 |  |
| Eloctrical Data |  |  |  |  |  |  |  |  |
| Recommended wiring fuse ( $A$ ) 1) | 80/200 | 100 | 100/250 | 125 | 125/315 | 180 | 160/400 | 200 |
| Semi-conductor fuses, if required | 250 A |  | 315 A |  | 350 A |  | 450 A |  |
| Power loss at rated metor load (W) | 230 | 260 | 260 | 290 | 330 | 400 | 440 | 470 |
| Power consumption controt card | 25 VA |  | 25 VA |  | 25 VA |  | 25 VA |  |
| Mechankal Data |  |  |  |  |  |  |  |  |
| Dimensions in $\mathrm{mm} \mathrm{H} \times W \times \mathrm{O}$ | 320×126x260 |  | 320x126x260 |  | 400×176×260 |  | $400 \times 176 \times 260$ |  |
| Mounting position (Vertical/Horizontal) | Vert. or Horz. |  | Vert. or Horiz. |  | Vert. or Horiz. |  | Vert. or Horiz. |  |
| Weight (kg) | 6.9 |  | 6.9 |  | 12 |  | 12 |  |
| Connection, busbars Cu , (bolt) | 15x4 (M8) |  | 15×4 (M8) |  | 20x4 (M10) |  | $20 \times 4$ (M10) |  |
| Cooling system | Fan |  | Fan |  | Fan |  | Fan |  |
| General Efoetrieal Data |  |  |  |  |  |  |  |  |
| Number of fully controlled phases | 3 |  |  |  |  |  |  |  |
| Voltage toterance control | Control $+/$ 10\% |  |  |  |  |  |  |  |
| Voltage tolerance motor | Motor 200-525 +/-10\%/200-690 + 5\%, -10\% |  |  |  |  |  |  |  |
| Recommended fuse fox control card (A) | Max 10 A |  |  |  |  |  |  |  |
| Frequency | $50 / 60 \mathrm{~Hz}$ |  |  |  |  |  |  |  |
| Frequency tolerance | +/-10\% |  |  |  |  |  |  |  |
| Relay contacts | 84, 250 V resistive load, 34, 250 V inductive load ( $\mathrm{PF}=0.4$ ) |  |  |  |  |  |  |  |
| Type of proteetion/trsutation |  |  |  |  |  |  |  |  |
| Type of casing protection | IP 20 |  |  |  |  |  |  |  |
| Other Genoral Data |  |  |  |  |  |  |  |  |
| A mbient temperatures in operation | $0.40{ }^{\circ}$ |  |  |  |  |  |  |  |
| Max.eg. at $80 \% 1_{N}$ | $50 \sim$ |  |  |  |  |  |  |  |
| In storage | $(-25) \cdot(+70){ }^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |
| Relative air hurndity | 95\%, non-condenslng |  |  |  |  |  |  |  |
| Max. altitude without derating | (See separate: Technical information 151) 1000 m |  |  |  |  |  |  |  |
| Norms/Standards, Conform to: | IEC 947-4-2, EN 292, EN 60204-1, UL508 |  |  |  |  |  |  |  |
| EMC, Emission | EN 50081-2,(EN 50081.1 with bypass contactor) |  |  |  |  |  |  |  |
| EMC, Immunity | EN 50082.2 |  |  |  |  |  |  |  |
| 1) Recommended wiring fuses tor: $\begin{aligned} & \text { He } \\ & \text { No }\end{aligned}$ | avy (first column): ramp/direct start may/Light (second column) : ramp start |  |  |  |  |  |  |  |
| NOTEI Shos t circuit withstand MSF076-145 $\mathbf{1 0 0 0 0} \mathrm{rms}$ A when usod with K5 or RKS tuses. |  |  |  |  |  |  |  |  |

* 2-pole motor

| $3 \times 200-525$ V 50/60 Hz Model | MSF-170 |  | MSF-210 |  | MSF-250 |  | MSF-310 |  | MSF-370 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Soft starter rating according to AC35a, soe chapter 4. pago 13 | $\begin{aligned} & \text { 5.0-30: } \\ & \text { 50-10 } \\ & \text { hoavy } \end{aligned}$ | $\begin{array}{\|c\|} \hline 3.0-30: \\ 50-10 \\ \text { normal/light } \end{array}$ | $\begin{aligned} & 5.0-30: \\ & 50-10 \\ & \text { heavy } \end{aligned}$ | $\begin{array}{\|c\|} \hline 3: 0-30: \\ 50-10 \\ \text { normal/ight } \end{array}$ | 5.0-30: 50.10 heavy | $\begin{array}{\|c\|} \hline 3.0-30: \\ 50-10 \\ \text { mormal/Itght } \end{array}$ | $\begin{aligned} & 5.0-30: \\ & 50-10 \\ & \text { hoavy } \end{aligned}$ | $\begin{array}{\|c\|} \hline 3.0-30: \\ 50-10 \\ \text { normal/light } \end{array}$ | $\begin{aligned} & 5.0-30: \\ & 50-10 \\ & \text { heavy } \end{aligned}$ | $\begin{array}{\|c\|} \hline 3.0-30: \\ 50-10 \\ \text { normal/ } 11 \mathrm{ght} \end{array}$ |
| Rated current of soft starter (A) | 170 | 210 | 210 | 250 | 250 | 262 | 310 | 370 | 370 | 450 |
| Recommended motor size (kW) for 400 V | 90 | 110 | 110 | 132 | 132 | 160* | 160 | 200 | 200 | 250 |
| Recommended motor size (kW) for 525 V | 110 | 132 | 132 | 160 | 160 | 200* | 200 | 250 | 250 | 315 |
| Order no. for supply volt age ( $100-240 \mathrm{~V}$ ) | 01.1309.11 |  | 01-1310-11 |  | 01-1311-11 |  | 01.1312.01 |  | 01-1313-01 |  |
| Order no. for supply voltage ( $380-550 \mathrm{~V}$ ) | 01-1309-12 |  | 01-1310-12 |  | 01-1311-12 |  | 01.1312.02 |  | 01-1313-02 |  |
| $3 \times 200-690$ V $50 / 60 \mathrm{~Hz}$ Model | MSF-170 |  | MSF210 |  | MSF. 250 |  | MSF310 |  | MSF-370 |  |
| Rated current of soft starter (A) | 170 | 210 | 210 | 250 | 250 | 262 | 310 | 370 | 370 | 450 |
| Motor power for 690 V | 160 | 200 | 200 | 250 | 250 | 250 | 315 | 355 | 355 | 400 |
| Order no. for supply voltage ( $100-240 \mathrm{~V}$ ) | 01-1329-01 |  | 01.133001 |  | 01-1331.01 |  | 01-1332-01 |  | 01-1333-01 |  |
| Order no. for supply volt age ( $380-550 \mathrm{~V}$ ) | 01-1329-02 |  | 01-133002 |  | 01.1331.02 |  | 01-1332-02 |  | 01.1333-02 |  |
| Eloctrical Data |  |  |  |  |  |  |  |  |  |  |
| Recommended wiring fuse (A) 1) | 200/400 | 200 | 250/400 | 315 | 250/500 | 315 | 315/630 | 400, | 400/800 | 500 |
| Semi-conductor fuses, if required | 700 A |  | 700 A |  | 700 A |  | 800 A |  | 1000 A |  |
| Power loss at rated motor load (W) | 510 | 630 | 630 | 750 | 750 W |  | 930 | 1100 | 1100 | 1535 |
| Power consumption control card | 35 VA |  | 35 VA |  |  | 35 VA | 35 VA |  | 35 VA |  |
| Mochanical Data |  |  |  |  |  |  |  |  |  |  |
| Dimensions mm $\mathrm{H} \times \mathrm{W} \times \mathrm{D}$ incl. brackets | 500x $260 \times 260$ |  | $500 \times 260 \times 260$ |  | $500 \times 260 \times 260$ |  | 532×547×278 |  | 532×547×278 |  |
| Mounting position (Vertical/Horizontal) | Vert. or Horiz. |  | Vert. or Horiz. |  | Vert. or Horiz. |  | Vert. or Horiz. |  | Vert. or Horiz. |  |
| Weight (kg) | 20 |  | 20 |  | $20$ |  | 42 |  | 46 |  |
| Connection, Busbars Al/Cu (bolt) | $30 \times 4$ (M10) |  | $30 \times 4$ (M10) |  | $30 \times 4$ (M10) |  | 40×8 (M12) |  | 40x8(M12) |  |
| Cooling system | Fan |  | Fan |  | Fan |  | Fan |  |  |  |
| Genoral Eloctrical Data |  |  |  |  |  |  |  |  |  |  |
| Number of fully controlled phases | 3 |  |  |  |  |  |  |  |  |  |
| Voltage tolerance control | Control $+/ \cdot 10 \%$ |  |  |  |  |  |  |  |  |  |
| Voltage tolerance motor | Motor 200-525 +// 10\%/200-690 + 5\%, -10\% |  |  |  |  |  |  |  |  |  |
| Recommended fuse for control card (A) | Max 10A |  |  |  |  |  |  |  |  |  |
| Frequency | $50 / 60 \mathrm{~Hz}$ |  |  |  |  |  |  |  |  |  |
| Frequency tolerance | +/-10\% |  |  |  |  |  |  |  |  |  |
| Relay contacts | $8 \mathrm{~A}, 250 \mathrm{~V}$ resistive load, $3 \mathrm{~A}, 250 \mathrm{~V}$ inductive load ( $\mathrm{PF}=0.4$ ) |  |  |  |  |  |  |  |  |  |
| Type of protection/insulation |  |  |  |  |  |  |  |  |  |  |
| Type of casing protection | IP 20 |  |  |  |  |  |  |  |  |  |
| Othor General Data |  |  |  |  |  |  |  |  |  |  |
| Ambient temperatures in operation | $0.40^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |
| Max.e.g. at $80 \% /_{\text {N }}$ | $50^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |
| In storage | (.25) $\cdot(+70)^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |
| Relative air humidity | 95\%, non-condensing |  |  |  |  |  |  |  |  |  |
| Max. altitude without derating | (See separate: Technical information 151) 1000 m |  |  |  |  |  |  |  |  |  |
| Norms/Standards, Conform to: | IEC 947-4-2, EN 292, EN 60204-1, (UL508, ordy MSF-170 to MSF-250) |  |  |  |  |  |  |  |  |  |
| EMC, Emission | EN 50081-2. (EN 50081-1 with bypass contactor) |  |  |  |  |  |  |  |  |  |
| EMC, Immunity | EN 50082-2 |  |  |  |  |  |  |  |  |  |
| 1) Recommended wiring fuses for: $\begin{aligned} & \text { Heavy (first column): ramp/direct start } \\ & \text { Normal/Light (second column): ramp start }\end{aligned}$ |  |  |  |  |  |  |  |  |  |  |
| NOTE! Short circult withstand MSF170-250 $\mathbf{1 8 0 0 0} \mathrm{mms}$ A when used with K5 or RK5 fuses. |  |  |  |  |  |  |  |  |  |  |

[^8]| $3 \times 200-525 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ Model | MSF-450 |  | MSF-570 |  | MSF-710 |  | MSF-835 |  | MSF-1000 |  | MSF-1400 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Soft starter rating according to AC35a, see chapter 4. page 13 | $\begin{aligned} & \text { 5.0.30: } \\ & .50 .10 \\ & \text { heasy } \end{aligned}$ | $\begin{gathered} 3.0-30: \\ 50-10 \\ \text { normaz/ } \\ \text { light } \end{gathered}$ | $\begin{aligned} & \text { 5.0.30: } \\ & \text { 50.10: } \\ & \text { heazy } \end{aligned}$ | $\begin{gathered} 3.0-30: \\ 50-10 \\ \text { nommal! } \end{gathered}$ light | $\begin{gathered} 5.0-30 \\ 50-10 \\ \text { heary } \end{gathered}$ | $\begin{gathered} \text { 3.0-30: } \\ \text { 50.10 } \\ \text { mommal/ } \\ \text { light } \end{gathered}$ | $\begin{aligned} & 5.0-30 \text { : } \\ & 50-10 \\ & \text { heavy } \end{aligned}$ | $\begin{gathered} \text { 3.0-30: } \\ 50-10 \\ \text { mombal/ } \\ \text { lightit } \end{gathered}$ | $\begin{gathered} 5.0-30: \\ 50-10 \\ \text { heavy } \end{gathered}$ | $\begin{gathered} 3.0-30: \\ 50-10 \\ \text { normad/ } \\ \text { Eght } \end{gathered}$ | $\begin{aligned} & 5.0 .30 \text { : } \\ & 50-10 \\ & \text { heaky } \end{aligned}$ | $\begin{gathered} 3.0-30: \\ 50-10 \\ \text { normad/ } \\ \text { light } \end{gathered}$ |
| Rated current of soft starter (A) | 450 | 549 | 570 | 710 | 710 | 835 | 835 | 960 | 1000 | 1125 | 1400 | 1650 |
| Recommended motor size (kW) for 400 V | 250 | 315 | 315 | 400 | 400 | 450 | 450 | 560 | 560 | 630 | 800 | 930 |
| Recommended motor size (kW) for 525 V | 315 | 400 | 400 | 500 | 500 | 560 | 600 | 630 | 660 | 710 | 1000 | 250 |
| Order no. for supply voltage (100240V) | 01-1341-91 |  | 01-1315-01 |  | 01.1316-01 |  | 01-1317-01 |  | 01.1318 .01 |  | 01.131901 |  |
| Order no. for supply voltace (380.550V) | 01.1314.02 |  | 01.1315-02 |  | 01.1316-02 |  | 01-1317-02 |  | 01-1318-02 |  | 01.131902 |  |
| $3 \times 200-690 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ Model | MSF-450 |  | MSF570 |  | MSF. 710 |  | MSF-835 |  | MSF. 1000 |  | MSF-1400 |  |
| Rated current of soft starter ( $A$ ) | 450 | 549 | 570 | 640 | 710 | 835 | 835 | 880 | 1000 | 1125 | 1400 | 1524 |
| Motor power for 690 V | 400 | 560 | 560 | 630 | 710 | 800 | 800 |  | 1000 | 1120 | 1400 | 1600 |
| Order no. for supply volt age ( 100.240 V ) | 01.1334-01 |  | 01-1335-01 |  | 01-1336-01 |  | 01.1337.01 |  | 01.133801 |  | 01.133901 |  |
| Order no. for supply voltage ( 380.550 V ) | 01.133402 |  | 01.1335-02 |  | 01.1336-02 |  | 01-1337-02 |  | 01-1338.02 |  | 01.133902 |  |
| Electrical Data |  |  |  |  |  |  |  |  |  |  |  |  |
| Recommended wiring fuse (A 1) | 500/1 k | 630 | 630/1 k | 800 | 800/1k | 1 k | $1 \mathrm{k} / 1.2 \mathrm{k}$ | 1 k | 1k/1.4 k | 1.2 k | $1.4 \mathrm{k} / 1.8$ | 1.8 k |
| Semi-conductor fuses, if required | $1250 \mathrm{~A}$ |  | 1250 A |  | 1800 A |  | 2500 A |  | 3200 A |  | 4000 A |  |
| Power loss et rated motor load (W) | 1400 | 1730 | 1700 | 2100 | 2100 | 2500 | 2500 | 2875 | 3000 | 3375 | 4200 | 4950 |
| Pow er consumption control card | 35 VA |  | 35 VA |  | 35 VA |  | 35 VA |  | 35 VA |  | 35 VA |  |
| Mechanical Data |  |  |  |  |  |  |  |  |  |  |  |  |
| Pimensions mm HxW×D incl. brackets | $532 \times 547 \times 278$ |  | $687 \times 640 \times 302$ |  | 687x640×302 |  | 687x640×302 |  | 900x $875 \times 336$ |  | 900×875 336 |  |
| Mounting position (Vertic al/Horizontal) | Vert. or Horiz. |  | Vert. or Horiz. |  | Vert. or Horiz. |  | Vert. or Horiz. |  | Vert. or Horiz. |  | Vert. or Horiz. |  |
| Weight (kg) | 46 |  | 64 |  | 78 |  | 80 |  | 175 |  | 175 |  |
| Connection, Busbars Al (bolt) | 40x8(M12) |  | 40×10(M12) |  | 40×10(M12) |  | 40×10 (M12) |  | 75×10(M12) |  | 75x10 (M12) |  |
| Cooling system | Fan |  | Fan |  | Fan |  | Fan |  | Fan |  | Fan |  |
| General Electrical Data |  |  |  |  |  |  |  |  |  |  |  |  |
| Number of fully controiled phases | 3 |  |  |  |  |  |  |  |  |  |  |  |
| Voltage tolerance contror | Control $+/ \cdot 10 \%$ |  |  |  |  |  |  |  |  |  |  |  |
| Voltage tolerance motor | Motor 200-525 +/-10x/200690 + 5\%, -10\% |  |  |  |  |  |  |  |  |  |  |  |
| Recommended fuse for control card (A) | Max 10A |  |  |  |  |  |  |  |  |  |  |  |
| Frequency | $50 / 60 \mathrm{~Hz}$ |  |  |  |  |  |  |  |  |  |  |  |
| Frequency tolerance | +/10\% |  |  |  |  |  |  |  |  |  |  |  |
| Relay contacts | 84, 250 V resistive load, $3 \mathrm{~A}, 250 \mathrm{~V}$ inductive load ( $\mathrm{PF}=0.4$ ) |  |  |  |  |  |  |  |  |  |  |  |
| Type of protection/insulation |  |  |  |  |  |  |  |  |  |  |  |  |
| Type of casing protection | IP 20 |  |  |  |  |  |  |  | IPOO |  |  |  |
| Other General Data |  |  |  |  |  |  |  |  |  |  |  |  |
| Ambient temperatures In operation | $0.40{ }^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |  |  |
| Max. e.e. at $80 \% /_{\text {N }}$ | $50^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |  |  |
| In storage | $(-25) \cdot(+70){ }^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |  |  |
| Relative air humidity | 95\%, non-condensing |  |  |  |  |  |  |  |  |  |  |  |
| Max. adtitude without derating | (See separate: Technical information 151) 1000 m |  |  |  |  |  |  |  |  |  |  |  |
| Norms/Standards, Conform to: | IEC 947-42. EN 292, EN 602041 |  |  |  |  |  |  |  |  |  |  |  |
| EMC, Emission | EN 50081-2. (EN 50081-1 with bypass contactor) |  |  |  |  |  |  |  |  |  |  |  |
| EMC, Immunity | EN 50082-2 |  |  |  |  |  |  |  |  |  |  |  |
| 1) Recommended wiring fuses for: | Heary (first column): ramp/direct start Normal/Lght (second column): ramp start |  |  |  |  |  |  |  |  |  |  |  |

## Semi-conductor fuses

Always use standard commercial fuses to protect the wiring and prevent short circuiting. To protect the thyristors against short-circuit currents, superfast semiconductor fuses can be used if preferred (e.g. Bussmann type FWP or similar, see table below).

The normal guarantee is valid even if superfast semiconductor fuses are not used.

| Type | A | FWP Bussmann fuse |
| :---: | :---: | :---: |
|  | I't (fuse) $\times 1000$ |  |
| MSF-017 | 80 | 2.4 |
| MSF-030 | 125 | 7.3 |
| MSF-045 | 150 | 11.7 |
| MSF-060 | 200 | 22 |
| MSF-075 | 250 | 42.5 |
| MSF-085 | 300 | 71.2 |
| MSF-110 | 350 | 95.6 |
| MSF-145 | 450 | 137 |
| MSF-170B | 700 | 300 |
| MSF-210B | 700 | 300 |
| MSF-250B | 800 | 450 |
| MSF-310 | 800 | 450 |
| MSF-370 | 1000 | 600 |
| MSF-450 | 1200 | 2100 |
| MSF-570 | 1400 | 2700 |
| MSF-710 | 1800 | 5300 |
| MSF-835 | 2000 |  |
| MSF-1000 | 2500 |  |
| MSF-1400 | 3500 |  |

## 13. SET-UP MENU LIST

| Menu number | Function/Parameter | Range | Par.set | Factory setting | Value | Page |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 001 | Initial voltage at start | 25-90\% of U | 1-4 | 30 |  | page 36 |
| 002 | Start time ramp 1 | 1.60 sec | 1-4 | 10 |  | page 36 |
| 003 | Step down voltage at stop | 100-40\% U | 1-4 | 100 |  | page 36 |
| 004 | Stop time ramp 1 | oFF, 2-120 sec | 1-4 | oFF |  | page 36 |
| 005 | Current | 0.0-9999 Amp | - | - |  | page 36 |
| 006 | Control mode | 1, 2, 3 | 1-4 | 2 |  | page 37 |
| 007 | Extended functions \& metering | oFF, on | -- | oFF |  | page 38 |
| 008 | Extended functions | oFF, on | - | oFF |  | page 38 |
| 011 | Initial voltage start ramp 2 | 30.90\% U | 1-4 | 90 |  | page 38 |
| 012 | Start time ramp 2 | oFF, 1-60 sec | 1-4 | oFF |  | page 38 |
| 013 | Step down voltage stop ramp 2 | 100-40\% U | 1-4 | 40 |  | page 38 |
| 014 | Stop time ramp 2 | oFF, 2-120 sec | 1-4 | oFF |  | page 38 |
|  |  |  |  |  | - |  |
| 016 | Initial torque at start | 0-250\% Tn | 1-4 | 10 |  | page 39 |
| 017 | End torque at start | 50-250\% Tn | 1-4 | 150 |  | page 39 |
| 018 | End torque at stop | 0-100\% Tn | 1-4 | 0 |  | page 39 |
| 020 | Voltage ramp with current limit at start | oFF, 150-500\% $\mathrm{In}^{\text {n }}$ | 1-4 | oFF |  | page 39 |
| 021 | Current limit at start | oFF, 150-500\% $\mathrm{In}^{\text {n }}$ | 1-4 | oFF |  | page 40 |
| 022 | Pump control | oFF, on | 1-4 | oFF |  | page 40 |
| 023 | Remote analogue control | oFF, 1, 2 | 1-4 | ofF |  | page 41 |
| 024 | Full voltage start D.O.L | oFF, on | 1-4 | oFF |  | page 41 |
| 025 | Torque control | oFF, 1, 2 | 1-4 | oFF |  | page 42 |
|  |  |  |  |  |  |  |
| 030 | Torque boost active time | oFF, 0.1 - 2.0 sec | 1-4 | oFF |  | page 43 |
| 031 | Torque boost current limit | 300-700\% In | 1-4 | 300 |  | page 43 |
| 032 | Bypass | oFF, on | 1-4 | oFF |  | page 43 |
| 033 | Power Factor Control PFC | . oFF, on | 1-4 | oFF |  | page 46 |
| 034 | Brake active time | ofF, 1-120 sec | 1-4 | off |  | page 47 |
| 035 | Braking strength | 100-500\% | 1-4 | 100 |  | page 47 |
|  |  |  |  |  |  |  |
| 036 | Braking methods | 1, 2 | 1-4 | 1 |  | page 47 |
| 037 | Slow speed torque | 10-100 | 1-4 | 10 |  | page 49. |
| 038 | Slow speed time at start | oFF, 1-60 sec | 1-4 | oFF |  | page 49 |
| 039 | Slow speed time at stop | ofF, 1-60 sec | 1-4 | oFF |  | page 49 |
| 040 | DC-Brake at slow speed | oFF, 1.60 sec | 1-4 | oFF |  | page 49 |
|  |  |  |  |  |  |  |
| 041 | Nominal motor voltage | 200-700 V | 1-4 | 400 |  | page 50 |
| 042 | Nominal motor current | 25-150\% $I_{\text {nsoft }}$ in Amp | 1-4 | Insoft in Amp |  | page 50 |
| 043 | Nominal motor power | $\underset{\mathrm{kW}}{25-300 \% \text { of } P_{\text {nsoft }} \text { in }}$ | 1-4 | $P_{\text {nsoft }}$ in kW |  | page 50 |
| 044 | Nominal speed | 500-3600 rpm | 1-4 | $\mathrm{N}_{\text {nsoft }}$ in rpm |  | page 50 |
| 045 | Nominal power factor | 0.50-1.00 | 1.4 | 0.86 |  | page 50 |
| 046 | Nominal frequency | $50,60 \mathrm{~Hz}$ | - | 50 |  | page 50 |


| Menu number | Function/Parameter | Range | Par.set | Factory setting | Value | Page |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | . |  |  |  |  |
| 051 | Programmable relay K1 | 1, 2, 3, (4), 5 |  | 1 |  | page 51 |
| 052 | Programmable relay K2 | 1, 2, 3, 4, 5 | - | 2 |  | page 51 |
|  |  |  |  |  |  |  |
| 054 | Analogue output | ofF, 1, 2 | 1-4 | oFF |  | page 52 |
| 055 | Analogue output value | 1, 2, 3 | 1.4 | 1 |  | page 52 |
| 056 | Scaling analogue output | 5-150\% | 1-4 | 100 |  | page 52 |
| 057 | Digital input selection | oFF, 1, 2, 3, 4 | 1-4 | ofF |  | page 53 |
| 058 | Digital input pulses | 1-100 | 1-4 | 1 |  | page 53 |
|  |  |  |  |  |  |  |
| 061 | Parameter set | 0,1,2,3,4 | - | 1 |  | page 54 |
|  |  |  |  |  |  |  |
| 071 | Motor PTC inpert | no, YES | - - | no |  | page 55 |
| 072 | Internal motor thermal protection class | OFF, 2-40 sec |  | 10 |  | page 55 |
| 073 | Used thermal capacity | 0-150\% | - | - |  | page 55 |
| 074 | Starts per hour limitation | oFF, 1-99/hour | 1.4 | ofF |  | page 55 |
| 075 | Locked rotor alarm | oFF, 1.0-10.0 sec | 1-4 | oFF |  | page 55 |
|  |  |  |  |  |  |  |
| 081 | Voltage unbalance alarm | 2-25\% Un | 1-4 | 10 |  | page 56 |
| 082 | Response delay voltage unbalance alarm | oFF, 1-60 sec | 1.4 | OFF |  | page 56 |
| 083 | Over voltage alarm | 100-150\% Un | 1-4 | 115 |  | page 56 |
| 084 | Response delay over voltage alarm | oFF, 1-60 sec | 1-4 | OFF |  | page 56 |
| 085 | Under voltage alarm | 75-100\% Un | 1-4 | 85 |  | page 57 |
| 086 | Response delay under voltage alarm | oFF, 1-60 sec | 1-4 | OFF |  | page 57 |
| 087 | Phase sequence | L123, L321 | $\square$ | $\cdots$ |  | page 57 |
| 088 | Phase reversal alarm | oFF, on | - | OFF |  | page 57 |
|  |  |  |  |  |  |  |
| 089 | Auto set power limits | no, YES | - | no |  | page 57 |
| 090 | Output shaft power | 0.0-200.0\% Pn | -- | - |  | page 57 |
| 091 | Start delay power limits | $1 \cdot 250 \mathrm{sec}$ | 1-4 | 10 |  | page 58 |
| 092 | Max power alarm limit | 5-200\% Pn | 1.4 | 115 |  | page 58 |
| 093 | Max alarm response delay | off, $0.1-25.0 \mathrm{sec}$ | 1.4 | off |  | page 58 |
| 094 | Max power pre-alarm limit | $5-200 \% \mathrm{Pn}$ | 1.4 | 110 |  | page 58 |
| 095 | Max prealarm response delay | ofF, 0.1-25.0 sec | 1-4 | oFF | . | page 58 |
| 096 | Min pre-alarm power limit | 5-200\% Pn | 1-4 | 90 |  | page 58 |
| 097 | Min pre-alarm response delay | oFF, 0.1-25.0 sec | 1-4 | OFF |  | page 59 |
| 098 | Min power alarm limit | 5-200\%Pn | 1-4 | 85 |  | page 59 |
| 099 | Min alarm response delay | oFF, $0.1-25.0 \mathrm{sec}$ | 1-4 | OFF |  | page 59 |
|  |  |  |  |  |  |  |
| 101 | Run at single phase input failure | no, YES | 1-4 | no |  | page 61 |
| 102 | Run at current limit time-out | no, YES | 1-4 | no |  | page 61 |
|  |  |  |  |  |  |  |
| 103 | Jog forward enable | OFF, on | 1-4 | ofF |  | page 61 |
| 104 | jog reverse enable | ofF, on | 1-4 | oFF |  | page 61 |
|  |  |  |  |  |  |  |
| 105 | Automatic return menu | oFF, 1-999 | - | OFF |  | page 62 |
|  |  |  |  |  |  |  |
| 111 | Serial comm. unit address | 1-247 | - | 1 |  | page 62 |
| 112 | Serial comm. baudrate | $2.4 \cdot 38.4$ kBaud | $\square$ | 9.6 |  | page 62 |


| Menu number | Function/Parameter | Range | Par.set | Factory setting | Value | Page |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 113 | Serial comm. parity | 0, 1 | - | 0 |  | page 62 |
| 114 | Serial comm. contact broken | oFF, 1, 2 | - | 1 |  | page 62 |
|  |  |  |  |  |  |  |
| 199 | Reset to factory settings | no, YES | ---- | no |  | page 63 |
|  |  |  |  |  |  |  |
| 201 | Current | 0.0-9999 Amp | - | - |  | page 63 |
| 202 | Line main voltage | 0-720 V | - | - |  | page 63 |
| 203 | Output shaft power | -9999-9999 kW | - | $\cdots$ |  | page 63 |
| 204 | Power factor | 0.00-1.00 | -- | - |  | page 63 |
| 205 | Power consumption | 0.000-2000 MWh |  | $\square$ |  | page 63 |
| 206 ' | Reset power consumption | no, YES | - | no |  | page 64 |
| 207 | Shaft torque | -9999-9999 Nm |  | - |  | page 64 |
| 208 | Operation time | Hours | -- | - |  | page 64 |
|  |  |  |  | , |  |  |
| 211 | Current phase L1 | 0.0-9999 Amp | - | --- |  | page 64 |
| 212 | Current phase L2 | 0.0-9999 Amp | - | $\cdots$ |  | page 64 |
| 213 | Current phase L3 | 0.0-9999 Amp | - | - |  | page 64 |
|  |  |  |  |  |  |  |
| 214 | Line main voltage L1-L2 | 0-720V | - | - |  | page 64 |
| 215 | Line main voltage L1-L3 | 0.720 V | - | - |  | page 64 |
| 216 | Line main voltage L2-L3 | 0-720V | - | - |  | page 64 |
|  |  |  |  |  |  |  |
| 221 | Locked keyboard info | no, YES | - | no |  | page 65 |
|  |  |  |  |  |  |  |
| 901 | Alarm list, Latest error | F1-F16 | - | - |  | page 65 |
| 902-915 | Alarm list, Older error in chronological order | F1-F16 | - | $\square$ |  | page 65 |

Explanation of units:

| U | Input line voltage |
| :--- | :--- |
| Un | Nominal motor voltage. |
| In | Nominal motor current. |
| Pn | Nominal motor power. |
| Nn | Nominal motor speed. |
| Tn | Nominal shaft torque. |
| Insoft | Nominal current soft starter. |
| Pnsoft | Nominal power soft starter. |
| Nnsoft | Nominal speed soft starter. |

Calculation shaft torque

$$
T_{n}=\frac{P_{n}}{\left(\frac{N_{n}}{60} \times 2 \pi\right)}
$$

NOTE! The six main functions for motor control, menus 020-025, can only be selected one at a time.
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Accessories
Add on RCD
Auxiliary/alarm
Shunt trip
Padiock bracket
Link bars \& terminals
Enclosures
Busbat chassis

Notes: ') D curve Din-T10 MCB's not available in 40 to 63 amp. i Available on indent only

## Din-T10 series 10kA MCB (cont.)

| Technical data |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Number of protected poles |  | 1 | 2 | 3 | 4 |
| Width: 0.5 to 63A | (mm) | 18 | 36 | 54 | 72 |
| Depth | (mm) | 68 | 68 | 68 | 68 |
| Rated voitage | (VAC) | 240/41 | 240/415 | 415 | 415 |
| Highest rated current | (A) | 63 | 63 | 63 | 63 |
| Number of switching operations: |  |  |  |  |  |
| $D C$ © $I_{n}$ |  | 4000 | 4000 | 4000 | 4000 |
| at 220V, $\cos \varphi=0.9$ |  | 10000 | 10000 | 10000 | 10000 |
| at 415V, $\cos \varphi=0.9$ |  | 10000 | 10000 | 10000 | 10000 |
| Insulation resistance | (M) | $>10^{\circ}$ | $>10^{6}$ | $>10^{6}$ | $>10^{6}$ |
| Dielectric rigidity | (kV) | 4 | 4 | 4 | 4 |
| Terminal capacity Line (OFF side) ( $\mathrm{mm}^{2}$ ) |  | ) 35 | 35 | 35 | 35 |
| Load (ON side) | $\left(\mathrm{mm}^{2}\right)$ |  | 25 | 25 | 25 |

Voltage drop and energy loss

| In (A) | Voltage <br> drop (V) | Energy <br> loss (W) | Internal <br> resistance <br> $(\mathrm{m} \Omega)$ |
| :--- | :--- | :--- | :--- |
| 0.5 | 3.100 | 1.55 | 6200 |
| 1 | 1.700 | 1.7 | 1700 |
| 2 | 0.900 | 1.8 | 450 |
| 4 | 0.500 | 2 | 125 |
| 6 | 0.318 | 1.91 | 53 |
| 10 | 0.140 | 1.4 | 14 |
| 16 | 0.128 | 2.05 | 8 |
| 20 | 0.110 | 2.2 | 5.5 |
| 25 | 0.092 | 2.31 | 3.7 |
| 32 | 0.103 | 3.28 | 3.2 |
| 40 | 0.088 | 3.5 | 2.2 |
| 50 | 0.090 | 4.5 | 1.8 |
| 63 | 0.088 | 5.56 | 1.4 |

## Use at DC

At DC the magnetic tripping current is approximately $40 \%$ higher than at $A C, 50 / 60 \mathrm{~Hz}$.

Shock resistance
( $\ln \mathrm{X}, \mathrm{Y}, \mathrm{Z}$ directions). 20 g with shock duration 10 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 689-2 6/90.
Storage temperature
From $-55^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$. According to VDE 0664 part $1 \& 2$.
Operating temperature
From $-25^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}$. According to IEC 88 part 2-1 (duration 96 hours).

Use at 400 Hz
At 400 Hz the magnetic tripping current is approximately $50 \%$ higher than at AC $50 / 60 \mathrm{~Hz}$.

## influence of ambient temperature

The thermal calibration of Din-T10 MCB's was carried out at an ambient temperature of $30^{\circ} \mathrm{C}$ (IEC 898). Ambient temperatures different from $30^{\circ} \mathrm{C}$, influence the bi-metal and this results in earlier or later thermal tripping (see curves below).

IEC $898\left(30^{\circ} \mathrm{C}\right)$






## Din-T6 and Din-T10 series MCB's

## Magnetic release

An electromagnet striker ensures instantaneous tripping in case of short circuit. IEC 898 describes the following types

| Curve type | Test current | Tripping time | Applications |
| :---: | :---: | :---: | :---: |
| C | $\begin{aligned} & 5 \ln \\ & 10 \ln \end{aligned}$ | $\begin{aligned} & t \geq 0.1 \mathrm{~s} \\ & t<0.1 \mathrm{~s} \end{aligned}$ | Usual loads such as: <br> - lighting <br> - socket outlets <br> - small motors') |
| $\overline{\text { D }}$ | $\begin{aligned} & 10 \mathrm{ln} \\ & 20 \mathrm{in} \end{aligned}$ | $\begin{aligned} & {[\geq 0.1 \mathrm{~s}} \\ & \mathrm{t}<0.1 \mathrm{~s} \end{aligned}$ | Control and protection of circuits having high transient inrush currents (large motors, ${ }^{2}$ ) transformers etc). |

Note: ${ }^{1}$ ) C curve MCBs are suitable for general motor starting applications, see motor starting tables section 10.
${ }^{2}$ ) D curve MCBs may be selected in more arduous starting applications or may altow a lower current rating MCB to ber selected. Refer NHP.

Thermal release
The release is initiated by a bimetal strip in case of overload. IEC 898 defines the range of release for specific overload values. Reference ambient temperature is $30^{\circ} \mathrm{C}$.

| Test current | Tripping time |
| :--- | :--- |
| $1.13 \ln$ | $\geq 1 h(\ln \leq 63 A)$  <br>  $t 2 h(\ln >63 A)$ <br> $1.45 \ln$ $t<1 \mathrm{ln}(\ln \leq 63 A)$ <br>  $t<2 h(\ln >63 A)$ <br> $2.55 \ln$ $1 s<t<60 \mathrm{~s}$ <br>  $(\ln \leq 32 A)$ <br>  $1 \mathrm{l}<t<120 \mathrm{~s}$ <br>  $(\ln >32 A)$ <br>   |

Tripping characteristics according to IEC 898 (time-current tables)
$\square$
Din-T6: from 2 to 6A
Din-T10: from 0.5 to 6A

$\square$
Din-T6: from 2 to 6A Din-T10: from 0.5 to 6A


Dimensions Safe-T with shunt trip Din-T6, 10, 10H and 15 series

Safe-T shunt (6-63A)


Safe-T shunt (80-100A)


Din-T6 (2-40A)


Din-T6 (50-63A)
Din-T10 and Din-T15 (0.5-63A)


Din-T10H (80-125A)

| 6 |  |  |  |
| :---: | :---: | :---: | :---: |
| $\theta$ | $\theta$ | $\theta$ | $\theta$ |
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|  |  |  |  |
|  |  |  | $\square$ |
|  |  |  |  |
|  |  |  |  |
| $\theta$ | $\theta$ | $\theta$ | $\theta$ |



All dimensions in mm

| Safe-T with shunt |
| :--- |
| Din-T6 MCB |
| Din-T10 MCB |
| Din-T10H MCB |
| Din-T15 MCB |

## IPHASAK

## Apdication itato

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


## Tembreak MCCB's



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

Tables based on the following maximum prearching $\left.\right|^{2}$ t for both BS 88 and DIN fuses:
$160 \mathrm{~A}-0.62 \times 10^{5}, \quad 200 \mathrm{~A}-.1 .2 \times 10^{5}, 250 \mathrm{~A}-2.1 \times 10^{5}$.
Suitable fuses include NHP, GEC. Siemens and Brovara-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 $\mathrm{I}^{2} \mathrm{t}$ values and may suit some applications.

Attention is also drawn to AS 3000 clause 7.10 .4 .4 regarding the use of lault current limiters in installations containing fire and smoke control equipment, evacuation equipment and lifts.

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


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

## ADDLCationdile

## Motor circuit application table for DOL starting General applications

High fault range


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.
${ }^{\text { }}$ ) 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.

## $(9)$ 1rithalf

## Motor circuit application table for reduced voltage starting General applications

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

|  |  |  |  | XS125CJ |  |  | XS400SE | XH630SE |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | XS125N |  |  | XH400SE | XS630SE | 800 N |  |
| rating |  |  |  | H1 |  | XS250 | XS400 | XS63 | H800 | 250 |
|  | (amps) | Curv | Safe-T | TL1 | X 2225 | XH250 | XS400N | XS630N | XS800S |  |
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[^9]
## Motor circuit application table for DOL FIRE PUMP starting duty

 Breaker type and current rating (A)|  |  |  |  | 12 |  |  | XS40 | XH630SE |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Motor |  | Din-T |  | S12 |  |  | XH400SE | XS630SE | XS800N |  |
| rating | FLC | C \& |  | XH125 | 100F | X 5250 | X 5400 C | XS630CJ | XH800SE | 50 |
| (kW) | (amps) | Curve | Safet XM30P | TL100 | TL100C | XE225NC XH2 | XS400NJ | X 5630 N | XS800SE | 000 |
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| $450.2(4)$ |  |  |  |  |  |  |  |  |  |  |

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.
') 80.100 and 125 amp refers to Din-T10H type.
${ }^{2}$ ) Type 'SE' TemBreak MCCB only.
${ }^{9}$ ) 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.


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 3497415 V

O For CA 7 contactors with coil terminals on line side, add ...V AC to Catalogue No. Eg-CA 7-9-10-240V AC ')
O For CA 7 contactors with coil terminals on load side, add ...V AC-U to Catalogue No. Eg-CA 7-9-10-240V AC-U


AC19 AC 1 ๆ Auxiliary contacts

| AC 3 | AC 3 | Amps | Amps |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| kW ${ }^{1}$ ) | Amps ') | $40^{\circ} \mathrm{C}$ | $60^{\circ} \mathrm{C}$ | N/O | N/C | Max. | Cat. No. ${ }^{2}$ ) |  |
| 4 | 9 | 32 | 32 | 1 0 | $\begin{aligned} & 0 \\ & 1 \end{aligned}$ | 9 9 |  |  |
| 5.5 | 12 | 32 | 32 | 1 0 | $\begin{aligned} & 0 \\ & 1 \end{aligned}$ | 9 9 |  |  |
| 7.5 | 16 | 32 | 32 | 1 0 | $\begin{aligned} & 0 \\ & 1 \end{aligned}$ | 9 9 | CA146 10. YAC <br> CATV $16=00 \mathrm{HyAC}$ |  |
| 11 | 23 | 32 | 32 | 1 0 | $\begin{aligned} & 0 \\ & 1 \end{aligned}$ | 9 9 |  |  |
| 15 | 30 | 50 | 45 | 0 | 0 | 8 |  |  |
| 18.5 | 37 | 50 | 45 | 0 | 0 | 8 |  |  |
| 22 | 43 | 85 | 63 | 0 | 0 | 8 |  |  |
| 30 | 60 | 100 | 100 | 0 | 0 | 8 |  |  |
| 37 | 72 | 100 | 100 | 0 | 0 | 8 | KCH $72-00 \mathrm{VACN}$ |  |
| 45 | 85 | 100 | 100 | 0 | 0 | 8 | VCAT 78500.4 VAC |  |
| 55 (45) | 95 (33) | 160 | 135 | 1 | 1 | 8 |  |  |
| 75 (55) | 130 (40) | 160 | 135 | 1 | 1 | 8 |  |  |
| 90 (75) | 155 (55) | 250 | 210 | 1 | 1 | 8 |  |  |
| 75 (55) | 130 (40) | 160 | 135 | 1 | 1 | 8 |  |  |
| 90 (75) | 155 (55) | 250 | 210 | 1 | 1 | 8 |  |  |
| 100 (90) | 170 (65) | 250 | 210 | 1 | 1 | 8 |  |  |
| 132 (111) | 225 (80) | 350 | 300 | 1 | 1 | 8 | CA6-210 E, mivivacy |  |
| 150 (133) | 258 (95) | 350 | 300 | 1 | 1 | 8 |  |  |
| 185 (163) | 320 (115) | 450 | 380 | 1 | 1 | 8 |  |  |
| 250 (225) | 425 (160) | 500 | 425 | 1 | 1 | 8 |  |  |
| 220 (220) | 370 (155) | 500 | 420 | 2 | 2 | 8 |  |  |
| 265 (280) | 450 (200) | 600 | 510 | 2 | 2 | 8 |  |  |
| 325 (355) | 550 (250) | 780 | 645 | 2 | 2 | 8 |  |  |
| 430 (500) | 700 (340) | 1000 | 850 | 2 | 2 | 8 | 4CA5700 vivic) kxx |  |
| 520 (550) | 860 (380) | 1100 | 930 | 2 | 2 | 8 |  |  |
| 600 | 1000 | 1200 | 1020 | 1 | 1 | 8 | CA5 1000. V V AC) 枚 |  |
| 700 | 1150 | 1350 | 1150 | 1 | 1 | 8 |  |  |

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-EI...250-EI are 24, 48, 110. 240 and 415 V AC. Standard voltages for CA 6-300-EI...420-EI 48, 110, 240 and 415 V AC. Standard voltages for CA 5-370 ...1200, 110, 240 and 415 V AC.
${ }^{3}$ ) All CA 7 coils can be reversed for line or load side coil teminals as required. Both versions are held in NHP stock for convenience.
${ }^{1}$ ) Electronically controlled mechanism (ECM) with interface suffix (EI).
$\left.{ }^{5}\right) 55^{\circ} \mathrm{C}$ enclosed.
${ }^{9}$ ) Contact NHP for recommended cable size.

# The highest switching capacity in the smallest space 



## Compact without compromise

Compact without compromise is the best way to describe the CA 7 range of contactors and motor protection relays from Sprecher + Schuh. In spite of the new compact dimensions, the CA 7 range features high breaking capacity and extraordinary flexibility. Up to 18.5 kW the contactors are only 45 mm wide and even the largest 45 kW frame is only 72 mm wide. The CA 7 contactors are the main component in the new Advanced Control System (ACS).

## With CA 7 you have flexibility with auxiliary contacts

Common auxiliaries from 9 to 85 amps
Three fitting positions
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.



## Innovation and ease of use provide solutions for your control systems

Coil terminals are always in the correct position<br>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.<br>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 sizies 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.





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-rdinated 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: ') 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.


Refer Catalogue $\mathrm{C}-\mathrm{CO}$
Fuse protection DOL starting ')
50 \& 65kA @ 415 V to AS 3947.4.1
Fuse

| Motor size kW | Approx. amps @ 415V | NHP HRC fuse to BS88 | Sprecher + Schuh contactor | Sprecher + Schuh overload relay $\left.{ }^{2}\right)^{\prime}$ ) | 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 ${ }^{\text {' }}$ ) | 160-400 |
| 132 | 225 | NTMF-355 | CA 6-210-EI | CEF 1-41/42 ${ }^{\text {' }}$ ) | 160-400 |
| 150 | 250 | NTMF-355 | CA 6-250-EI | CEF 1-41/42 ${ }^{\text {) }}$ | 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 ${ }^{\text {¢ }}$ ) | 160-630 |
| 320 | 538 | NTLM-710 | CA 5-550 | CEF 1-52 ${ }^{\text {) }}$ ) | 160-630 |
| 380 | 650 | NTLM-800 | CA 5-700 | CEF 1-11/12P ${ }^{\text {d }}$ | 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 themal.
${ }^{1}$ ) CET 4 may be used instead of CEF 1.



Din-T circuit breakers with rotary isolator. DOL starting. 50kA @ 415V to AS 3947.4.1

| Motor size kW | Approx. amps @ 415 V | Sprecher + Schuh isolator | Terasaki circuit breaker | Sprecher + Schuh current limiter | Sprecher + Schuh contactor | Sprecher + <br> 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 |





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
AC1 resistive load
switching 3~
Ambient temperature $40^{\circ} \mathrm{C}$

| $\left.l_{0}{ }^{\prime}\right)$ | $[\mathrm{A}]$ | 32 | 32 | 32 | 32 | 50 | 50 | 85 | 100 | 100 | 100 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 240 V | $[\mathrm{~kW}]$ | 10 | 10 | 13 | 13 | 18 | 20 | 25 | 36 | 36 | 40 |
| 415 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 $60^{\circ} \mathrm{C}$

| $\left.I_{\theta}\right)$ | $[\mathrm{A}]$ | 32 | 32 | 32 | 32 | 45 | 45 | 63 | 100 | 100 | 100 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 240 V | $[\mathrm{~kW}]$ | 8 | 8 | 10 | 10 | 14 | 16 | 20 | 29 | 29 | 34 |
| 415 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 |

AC motor switching
AC 2, AC 3, AC 4

| 240 V | [A] | 11.5 | 14.5 | 20 | 26.5 | 34 | 37 | 42 | 62 | 70 | 85 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 415 V | [A] | 9 | 12 | 16 | 23 | 30 | 37 | 43 | 60 | 72 | 85 |
| 690 V | [A] | 5 | 7 | 9.3 | 12 | 17 | 20 | 25 | 34 | 42 | 49 |
| 240 V | [kW] | 3 | 4 | 5.5 | 7.5 | 10 | 11 | 13 | 18.5 | 22 | 25 |
| 415 V | $[\mathrm{kW}]$ | 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 |  |  |  |  |  |  |  |  |  |  |  |
| $I_{0}$ AC $4,50 \mathrm{~Hz}$ | max. 690V [A] | 135 | 180 | 240 | 345 | 450 | 555 | 645 | 900 | 1080 | 1275 |
| Rated breaking capacity |  |  |  |  |  |  |  |  |  |  |  |
| $I_{\theta}$ AC 4 | max. 460 V [A] | 135 | 180 | 240 | 345 | 450 | 555 | 645 | 900 | 1080 | 1275 |
|  | max. 690V [A] | 75 | 105 | 140 | 140 | 255 | 300 | 375 | 510 | 630 | 735 |

Short circuit protection
without protection relay
fuse gG to IEC 947-4-1

| co-ordination type ' 1 ' | $[A]$ | 50 | 50 | 50 | 63 | 100 | 125 | 160 | 200 | 250 | 250 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| co-ordination type ' 2 ' | $[A]$ | 20 | 25 | 25 | 35 | 50 | 80 | 100 | 100 | 125 | 160 |

Main current circuit
resistance
$\begin{array}{lllllllllll}{[\mathrm{m} \Omega]} & 2.7 & 2.7 & 2.7 & 2 & 2 & 2 & 1.5 & 0.9 & 0.9 & 0.9\end{array}$
Power dissipated by all circuits at le AC 3

| [w] | 0.7 | 1.2 | 2.1 | 3.2 | 5.4 | 8.2 | 8.3 | 9.7 | 14 | 19.5 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |

Total power dissipation

| at le $A C 3$ | $A C$ 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 | $A C$ control | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 10 | 10 | 10 |
|  | DC control | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 10 | 10 | 10 |

Operating times (DC)

| Make (mS) | $40 \ldots 70$ | $40 \ldots 70$ | $40 \ldots 70$ | $40 \ldots 70$ | $50 \ldots 80$ | $50 \ldots 80$ | $50 \ldots 80$ | $20 \ldots 40$ | $20 \ldots 40$ | $20 \ldots 40$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Break $(\mathrm{mS})$ | $7 \ldots 15$ | $7 \ldots 15$ | $7 \ldots 15$ | $7 \ldots 15$ | $7 \ldots 15$ | $7 \ldots 15$ | - | - | - | - |

Note: y Contact NHP for recommended cable size.

Dimensions in (mm)


## Mounting position



DC Control


Contactor (AC control)

| Type | a | b | c | c1 | c2 | ød | d1 | d2') |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CA 7-9...CA 7-23 ${ }^{2}$ ) | 45 | 81 | 80.5 | 75.5 | 6 | 4.5 | 60 | 35 |
| CA 7-30...CA 7-37 | 45 | 81 | 97.5 | 92.6 | 6.5 | 4.5 | 60 | 35 |
| CA 7-43 | 54 | 81 | 100.5 | 95.6 | 6.5 | 4.5 | 60 | 45 |
| CA 7-60...CA 7-85 | 72 | 122 | 117 | 111.5 | 8.5 | 5.4 | 100 | 55 |

(DC control)

| Type | a | b | c | c1 | c2 | -d | d1 | d2') |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CA 7-9C...CA 7-16C | 45 | 81 | 106.5 | 101.5 | 6 | 4.5 | 60 | 35 |
| CA 7-23C | 45 | 81 | 123.5 | 119 | 6 | 4.5 | 60 | 35 |
| CA 7-30C...CA 7-37C | 45 | 81 | 141.5 | 136.5 | 6.5 | 4.5 | 60 | 35 |
| CA 7-43C | 54 | 81 | 144.5 | 140 | 6.5 | 4.5 | 60 | 45 |
| CA 7-60C...CA 7-85C | 72 | 122 | 117 | 111.5 | 8.5 | 5.4 | 100 | 55 |

## Accessories

| Contactor with |  | (AC control) (mm) | (DC control) (mm) |
| :---: | :---: | :---: | :---: |
| Front mounting auxiliary contact | 2 or 4 pole | c/c1+39 | clc +39 |
| Side mounting auxiliary contact | 1 or 2 pole | a + 9 | a +9 |
| Pneumatic timing module |  | c/c1+58 | - |
| Electronic timing module | coil mounting | b +24 | b +24 |
| Mechanical interlock | mounts between contactors | $a+9$ | a + 9 |
| Mechanical latch |  | c/c1 +61 | - |
| Interface | coil mounting | b +9 | - |
| Suppressor | coil mounting | b+3 | $b+3$ |
| With inscriptions ${ }^{3}$ ) | labels | +0 | +0 |
|  | label support system V4N5 | +5.5 | +5.5 |

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

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


Cat. No.

| Cat. No. | $\mathbf{a}$ | $\mathbf{b}$ | $\mathbf{b 1}$ | $\mathbf{c}$ | $\mathbf{e 1}$ | $\mathbf{e 2}$ | $\mathbf{d 1}$ | $\mathbf{d 2}$ | $\mathbf{h}$ | $\mathbf{j}$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CA 7-9/12/16/23 with CEP 7 or CEP 7S | 45 | 131 | 86 | 88.5 | 16.5 | 69 | 60 | 35 | 86.5 | 2 |
| CA 7-9/12/16/23 with CEP 7-B | 54 | 137 | 97 | 90.7 | 5.1 | 59 | 60 | 35 | 85.1 | 2 |
| CA 7-30/37 with CEP 7 or CEP 7S | 45 | 136.5 | 91.5 | 92 | 16.5 | 69 | 60 | 35 | 104 | 2 |
| CA 7-30/37 with CEP 7-B | 54 | 137 | 97 | 92.1 | 5.2 | 59 | 60 | 35 | 104.7 | 2 |
| CA 7-43 with CEP 7. CEP 7S or CEP 7-B | 54 | 136.5 | 91.5 | 93 | 22 | 69 | 60 | 45 | 107 | 2 |
| CA 7-60/72/85 with CEP 7, CEP 7S or CEP 7-B | 72 | 188.5 | 120 | 120 | 18 | 84.5 | 100 | 55 | 125.5 | 2 |

CEP 7 with separate mounting bracket

|  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Type | a | b | c | d | e |
| CEP 7-37-P-A | 45 | 90 | 75 | 30 | 75 |
| CEP 7-45-P-A | 55 | 90 | 96.5 | 40 | 75 |
| CEP 7-85-P-A | 70 | 115 | 110 | 55 | 105 |



| Standards | IEC 947, EN 60 947, DIN VDE 0660, UL, LRS, GUS, CSA |
| :--- | :---: | :---: |

Contactor, timer and overload selection chart for auto transformer starters

| ATS kW | Line <br> contactor | Trans <br> contactor | Star <br> Contactor | Timer | Overioad |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 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

| SDSkW | Line contactor | Delta contactor | Star contactor | Timer | Overload |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 7.5 | CA 7-9-10 | CA 7-9-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-12-10 |
| 11 | CA 7-12-10 | CA 7-12-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 15 | CA 7-16-10 | CA 7-16-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 18.5 | CA 7-23-10 | CA 7-23-01 | CA 7-12-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 22 | CA 7-23-10 | CA 7-23-01 | CA 7-16-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 30-37 | CA 7-37-00 | CA 7-37-00 | CA 7-23-01 | RZ7 FSY2D | CEP 7-M45-45-10 |
| 45 | CA 7-60-11 | CA 7-60-11 | CA 7-30-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 55 | CA 7-60-11 | CA 7-60-11 | CA 7-37-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 75 | CA 7-85-00 | CA 7-85-00 | CA 7-43-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 90 | CA 6-85-11 | CA 6-85-11 | CA 7-60-00 | RZ7 FSY2D | CT 6-90 |
| 110 | CA 6-105-11 | CA 6-105-11 | CA 7-72-00 | RZ7 FSY2D | CT 6-110 |
| 132 | CA 6-140El-11 | CA 6-140EI-11 | CA 7-85-00 | RZ7 FSY2D | CT 6-150 |
| 150 | CA 6-170El-11 | CA 6-170El-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-El-11 | CA 6-210-EI-11 | CA 6-140-El-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 | ød | d1 | d2 | e1 | e2 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CT 7-24 | CA 7-9... 23 | 45 | 127 | 83 | 96 | 91 | 15 | 51 | 39 | 5 | 4.5 | 60 | $35^{1}$ ) | 16.5 | 51 |
|  | CA 7-30... 37 | 45 | 127 | 83 | 105 | 99 | 6.5 | 51 | 39 | 9.5 | 4.5 | 60 | $35^{\text { }}$ ) | 16.5 | 51 |
| CT 7-45 | CA 7-30... 37 | 60 | 140 | 97 | 105 | 99 | 6.5 | 51 | 39 | 6.5 | 4.5 | 60 | $35^{\text {1 }}$ ) | 16.5 | 57 |
|  | CA 7-43 | 60 | 140 | 97 | 107 | 103 | 6.5 | 51 | 39 | 8.5 | 4.5 | 60 | $45^{\text {1) }}$ | 16.5 | 57 |
| CT 7-75 | CA 7-60... 85 | 72 | 185 | 120 | 125 | 120 | 8.5 | 51 | 39 | 28.5 | 5.4 | 100 | $55^{\prime}$ ) | 16.5 | 82 |

Separate mounting with bracket


Separate mounting


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

Notes: ') Standard DIN rail to EN 50 022-35
${ }^{2}$ ) With reset rod, maintain 9 mm maximurn operating radius from centre of reset button
c3 Reset magnet
c4 Auxiliary contact block

## General Purpose "Midget" Relays 10A Contact Rating <br> 1, 2, 3, \& 4 Form C Contact



| UL Recognized |
| :--- |
| Files No. E67770 |
| E59804 |
| E64245 |

## Features

- Compact "Midget" size package saves space
- Large switching capacity, (10A)
- Choice of blade or PCB style terminals
- Relay options include indicator light, check button, and top mounting bracket
- DIN rail, surface, panel and PCB type sockets available for a wide range of mounting applications

RH Series Part List


## Coil Ratings


** For RH2 relays $=$ AC110/120V AC
** For RH2 relays $=\mathbf{2 2 0 / 2 4 0 V}$ AC
${ }^{* * *}$ For RH2 relays $=\mathbf{1 0 0} / 110 \mathrm{~V}$ DC

## Ordering Information

Ordering standard voltages results in quickest delivery. Allow extra delivery time for non-standard voltages.

Basic Part No. Coil Voltage:
RH2B-U AC110/120V

## Operational Characteristics

| Maximum continuous applied voltage (AC/DC) @ $20^{\circ} \mathrm{C}$ | $110 \%$ of rated voltage |
| :--- | :--- |
| Minimum operating voltage (AC/DC) @ $20^{\circ} \mathrm{C}$ | $80 \%$ of rated voltage |
| Drop-out voltage (AC) | $30 \%$ or more of the rated voltage |
| Drop-out voltage (DC) | $10 \%$ or more of the rated voltage |

## Contact Ratings

| UL Ratings |  |  |
| :---: | :---: | :---: |
| Motor Load | SPDT, DPDT | 3 3PD |
| 120 V AC | $1 / 6 \mathrm{HP}$ | $1 / 6 \mathrm{HP}$ |
| 240 V AC | $1 / 3 \mathrm{HP}$ | $1 / 3 \mathrm{HP}$ |

Note: Contact ratings continued on following page.
Sliited States: (800) 262-4332 or (408) 747-0550, Canada: (905) 890-8561 or (604) 946-1271

## Contact Ratings

| Voltage | Rating | Resistive |  |  |  | Inductive |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | SPDT | DPDT | 3PDT | 4PDT | SPDT | DPDT | 3PDT | 4PDT |
| 28 V DC | UL | 10A | 10A | 10A | 10A | 7.5A | - | - | 7.5A |
|  | UL | 10A | 10A | 10A | - | 7A | 7A | - | - |
| DC | CSA |  |  |  | 10A |  | 7.5A |  |  |
|  | Nominal |  |  |  |  |  |  | 7.5A | 7.5A |
| 110V DC | Nominal | 0.5A | 0.5A | 0.5A | 0.5A | 0.3A | 0.3A | 0.3 A | 0.3A |
|  | UL | 10A | 10A | 10A | 10A | 7.5A | - | - | 7.5A |
| $120 \mathrm{~V}$ | CSA |  |  |  |  |  | 7.5A |  |  |
|  | Nominal |  |  |  |  | 7A |  | 7.5A |  |
| $\begin{aligned} & 240 \mathrm{~V} \\ & \mathrm{AC} \end{aligned}$ | UL | 10A | 10A |  | 7.5A | 7A | 7A | . | 5A |
|  | CSA |  |  |  |  |  |  | 7A |  |
|  | Nominal | 7A | 7.5A | 7.5A | 4.5A | 5A | 5A | 5 A |  |

*Note: 6.5Apole, 20A total.
Note: Inductive load $\cos \varnothing=0.3, L / R=7 \mathrm{msec}$

## Sockets

| Relay | Sockets |  |  |  |  | Spring (Optional) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | DIN Rail Mount |  | Surface Mount | Panel Mount | PCB Mount |  |
|  | Standard | Fingersafe |  |  |  |  |
| RH1B | SH1B-05 | SH1B-05C | - | SH1B-51 | SH1B-62 | $\begin{aligned} & \text { SY2S-02F1 } \\ & \text { SFA-101 } \\ & \text { SFA-202 } \\ & \text { SY4S-51F1 } \\ & \text { SFA-301 } \\ & \text { SFA-302 } \end{aligned}$ |
| RH2B | SH2B-05 | SH2B-05C | SH2B-02 | SH2B-51 | SH2日-62 | SY4S-02F1 <br> SFA-101 <br> SFA-202 <br> SY4S-51F1 |
| RH3B | SH3B-05 | SH3B-05C | - | SH3B-51 | SH3B-62 | SH3B-05F1 SFA-101, -202 SY4S-51F1 |
| RH4B | SH4B-05 | SH4E-05C |  | SH4B-51 | SH4B-62 | $\begin{aligned} & \text { SH4B-02F1 } \\ & \text { SFA-101,-202 } \\ & \text { SY4S-51F1 } \end{aligned}$ |

Note: See section F for detaits on sockets. All DIN rail mount sockets shown above can be mounted using DIN Rail BNDN-1000.

## Electrical Life Curves




## Internal Circuit

$$
\text { RH1 } \underset{(4)}{\stackrel{\frac{1}{5}}{9}-13}
$$

RH2

RH3

RH4


## Staner Hoh performance electronic timerdelay relay

Typerizhrs single function thines (one changeover orntact)

Refer catalogue RZ7
O 22.5 mm wide.
OIN rail mounting.
O $24 \ldots 240 \mathrm{~V}$ AC, $24 \ldots 48 \mathrm{~V} \mathrm{OC}$ in same relay.
$\mathrm{O} 360 \ldots .440 \mathrm{~V}$ AC available.
O Timing ranges from 0.05 seconds to 60
hours.

O Terminals all touch protected (IP 20).
O DIN rail mounting.
O LED indication.
O 24...240V AC, 24... $48 \vee O C$ in same relay.
O One changeover or two changeover contacts.

## hours.

O multi-function timer also available.


Cat. No.
RZ7-FSA 3A-...


Cat. No.
RZ7-FSB 3L-...


Cat. No.
RZ7-FSC 3A-...

RZ7-FS versions on delay, off delay and on/off delay

| Description | Timing range | Supply ') ") <br> Cat. No. voltage |
| :---: | :---: | :---: |

RZ7-FSA3 - on delay timing relay ${ }^{2}$ ) (FUNCTION-A)
On application of the supply voltage the relay operates with delay $t$.

| 0.05..1s |  |
| :---: | :---: |
| $0.15 \ldots 3 \mathrm{~s}$ |  |
| $0.5 \ldots 10 \mathrm{~s}$ |  |
| 1.5...30s |  |
| 0.05..60s |  |
| $0.15 \ldots .3 \mathrm{~min}$ |  |
| $0.5 \ldots 10 \mathrm{~min}$ |  |
| 1.5...30min |  |
| 0.05..60min |  |
| 0.15..3h |  |
| 0.5..10h |  |
| 3...60h |  |

RZ7-FSB3 - off delay timing relay ${ }^{2}$ ) (FUNCTION-B)

| The relay is energised upon closing the control contact. It resets time $t$ after opening the control contact. | 0.05..1s |  |
| :---: | :---: | :---: |
|  | 0.15...3s |  |
|  | 0.5...10s |  |
|  | 1.5...30s |  |
| U- ${ }_{\text {AIME }}$ | 0.05 ..60s |  |
| $s_{1}$ $\qquad$ A1A1 <br> AA. 1 | $0.15 \ldots .3 \mathrm{~min}$ |  |
| ouve | $0.5 \ldots 10 \mathrm{~min}$ |  |
|  | 1.5...30min |  |
|  | 0.05..60min |  |
|  | 0.15..3h |  |
|  | 0.5..10h | R272 SBEM |
|  | 3..60h |  |

RZ7-FSC3 - on and off delay timing relay (FUNCTION-C)
The relay is energised time $t$ after closing the contact and resets time $t$ after opening the control contact.


| 0.05...1s |  |
| :---: | :---: |
| $0.15 \ldots 3 \mathrm{~s}$ |  |
| 0.5..10s |  |
| $1.5 \ldots 30 \mathrm{~s}$ |  |
| 0.05..60s |  |
| 0.15...3min |  |
| $0.5 \ldots 10 \mathrm{~min}$ |  |
| 1.5..30min |  |
| 0.05..60min |  |
| 0.15...3h |  |
| 0.5..10h |  |
| 3...60h | MivRz |

Note5: ') Add 'U23' to catalogue number for the following voltages: $24 \ldots 48 \mathrm{~V}$ DC; $24 \ldots 240 \mathrm{VAC} 50 / 60 \mathrm{~Hz}$; Add 'A40' to catalogue number for the following voltages: 346 ... 440 V AC $50 / 60 \mathrm{~Hz}$
${ }^{2}$ ) Also available with $2 \mathrm{C} / \mathrm{O}$ contacts refer page 10-16 for ordering details.
${ }^{3}$ ) For pulse control, another voltage than the supply voltage can also be used.
') Special voltage code 'U18' for AC/DC 24... 240 V available on request.


NOTE:
If power is disconnected during actual timing most electronic timers will reset to the preset time, ready for re-application of supply voltage.

## DELAY ON DE-ENERGISATION

1 TIMED CONTACT
Also referred to as: Delay on break
Delay off

FUNCTION DAGGRAM


## MODE OF OPERATION

This timer is permanently supplied. When power is applied to the timer it is prepared for operation. At the closure of the input signal. the relay changes over to the opposite position or on state. Timing does not commence. Al the loss of the input signal timing commences and at the end of the set time delay the relay changes back to ds normal or de-energised state and the timer is reset for its next operation.

## SUITABLE PRODUCTS

OCRFN, MRU1, OCR BCR, BLR, OLRM, BLRM, OLS BLS, MLR RZ7-FSB3, RZ7-FSB4 (2 condacts), M814.
RZ7-FEB.

## STARIDELTA

2 TIMED CONTACTS
This function is utilised to control timed operation of the star and delta contactors in a star della motor starter.

FUNCTION DIAGRAM


## MODE OF OPERATHN

When power is applied to the timer, the sel time delay T1 commences and the star relay changes over to the opposite position or on state. At the end of the set time delay T 1 the star relay changes back to its normal or deenergised state and the fixed presel time T2 commences. At the end of the fixed time delay T 2 the detta relay changes over to the opposite position or on state. The delta retay remains on until power is disconnected from delta relay
SUITABLE PRODUCTS
DOR, CREY4, RZ7-FSY2

## INTERVAL

1 TIMED CONTACT
Also referred to as: One shot

FUNCTION DIAGRAM


MODE OF OPERATION
When power is applied to the timer, the set time delay commences and the retay changes over to the opposite position or on state. Al the end of the set time delay. the relay changes back to its normal or de-energised state. and the timer is resel for its next operation.

SUITABLE PRODUCTS
MRUI, OLR BLR OLRM, BL FM, OLS, BLS, MLR, M814, RZ7-FSD3, RZ7-FSM4 (2 contacts), RZ7-FED.

TRUE DELAY OFF
1 TIMED CONTACT
Also refered to as:
Delay on loss of supply Delay on release

FUNCTION DIAGRAM


MODE OF OPERATION.
When power is applied to the timer, the relay changes over to the opposite or on state. Timing does not commence. When the power is disconnected. the set time delay commences, and the relay remains in its on state. At the end of the set time delay, the relay changes back to its normal or de-energised state, and the timer is resel for its next operation.

SUITABLE PRODUCTS
DKR. PKR. RZ7-FSQ

## DELAY ON ENERGISATION

1 TIMED CONTACT

| Also referred to as: | Detay on |
| :--- | :--- |
|  | Delay on make |
|  | On delay |
|  | Delay on operate |

FUNCTION DIAGRAM


MODE OF OPERATION
When power is applied to the timer, the set time delay commences and the relay remains in its normal state. At the end of the sel tine delay, the relay changes over to the opposite position or on state. At the disconnection of the power supply the relay changes back to its normal state, and the timer is resel for its next operation.

## SUITABLE PRODUCTS

OARFN, OAR BAR OLR BLR OLRM, BLRM, OAS
MRA1, OLS, MAR, MLR CZE7, CRZE7, CRZE4, RZ7-FSA3, RZ7-FSA4 (2 contacts). M814, M815. RZ7-FEA, MRW

## SINGLE SHOT

1 TIMED CONTACT
Also referred to as: Impulse lengthener

FUNCTION DIAGRAM


MODE OF OPERATION
This timer is permanently supplied. Upon the closure of an input signal the retay changes over to the opposite position or on state and timing commences. At the end of the set time delay. the relay changes back to is norma state and the timer is reset for its next operation. The input signal can be held for either a shorter, or longer lime than the preset time delay and it will nol influence the operation of the relay.

## SUITABLE PRODUCTS

MRU1, OLR, BLR, OLRM, BLRM, OLS, BLS, MLR, M814, RZ7-FSL3.

## RECYCLING

1 TIMED CONTACT (OFF PULSE FIRST)

| Also referred to as: | Repeat cycling |
| :--- | :--- |
|  | Symmetricad recycler |
|  | Asymmetrical recycler |

FUNCTION DIAGRAM
Asymmetrical recycter

$$
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$$

## MODE OF OPERATION

When power is applied to the timer, the set time delay of the off pulse commences and the relay remains in its normal state. Al the end of the sel time delay of the off pulse, the relay changes over to the opposite position or on state. The set time delay of the on pulse will now commence and at the end of the set time the relay will change back to its normal or de-energised state. This repeat cycling will continue until power is removed from the timer. The timer will then be resel for its next operation to begin with an off pulse. The operation of a recycling timer with on pulse facility is the same as above. although it starts with an on pulse upon application of the power supply.
SUITABLE PRODUCTS
MRLi1, ODR BDR ODS, BDS, M814, RZ7-FSF3 (on pulse first), RZ7-FSM4 (on pulse first), MDR2U, RZ7-FEF.



Refer catalogue RZ7
Dimensions (mm)


RZ7-FSH3V (1C/O special function)


Surface mount adaptor
RZ7-FSA

RZ7-FS (2 C/O)


(2)

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## $\mathrm{H}+\square \mathrm{Z}$
















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$\square \square \square \square \square \square$



## 1 Introduction

The MultiTrode level control relay is a solid-state electronic module in a hi-impact plastic case with a DIN rail attachment on the back, making a snap-on-snap-off installation. Any number of relays can be easily added to the DIN metal rail then wired together to form a complex pumping system that other wise may have to be controlled and operated by a programmed PLC.

The relay is normally matched with the MultiTrode probe which works in conjunction with the relay and uses the conductivity of the liquid to complete an electrical circuit.

## 2 Electrical Overview



There are 10 screw terminals on the unit. Facing the relay as shown, we look at the bottom terminals (left to right):

- Lo - (Charge mode). This is the point when the probe is dry the relay will turn on.
- Lo - (Discharge mode). This is the point when the probe in the tank is dry the relay will turn off.
- Hi - (Charge mode). This is the point when the probe in the tank is wet a relay will turn off
- Hi - (Discharge mode). This is the point when the probe in the tank is wet a relay will turn on.
- C - is common earth. All earth bonding must be terminated here for correct operation.
- "L" is "live" (240V AC)
- " $N$ " is "neutral" (240V AC)

If the tank is plastic, or if you are conducting tests in a plastic bucket, or the vessel has no earth point inside, you must install an earth rod within the tank, vessel or bucket and make sure that it is bonded back to C on the relay unit.

## 3 DIP Switches

### 3.1 DIP Switches

(See Wiring Diagram for full program functions.)

### 3.1.1 DIP 1 \& 2

DIP 1 and 2 control the Sensitivity, in other words the cleaner the liquid the higher the sensitivity setting must be. Concentrated acids, minerals are by their own chemical composition highly conductive, so a low level of sensitivity is required, purified water is almost an insulator against electrical current flow so a higher sensitivity inside the relay is required.

### 3.1.2 DIP 3, 4 \& 5

DIP switches 3,4 and 5 , control delay on activation. For example, in discharge mode with DIP switches 3, 4 and 5 set to 10 seconds, when the Hi point becomes wet it will activate the motor and it will take 10 seconds of continual coverage of the probe sensor to make the relay close and start the pump. This is invaluable when the probe is in a turbulent part of a well where fluid is splashing around touching the sensors momentarily, and false activation cannot be tolerated.

### 3.1.3 DIP 6

DIP switch 6 controls the charge/discharge function. Set "ON" for charge, and "OFF" for discharge


### 3.2 Relay Contacts \& their Applications

### 3.2.1 Contacts $15,16 \& 18$

Contacts 15,16 , and 18 are used for electronic or visual notification of a change in state at the pump itself. Contacts 15,16 , and 18 are used for more advanced applications because they are a changeover relay, their state may be the same as contacts 25,28 or the opposite. Both sets of contactors are triggered simultaneously. An example is when in discharge mode, (see Figure 1).
You have a gravity flow coming in so the fluid reaches the lower sensor PB1, contacts 15 and 18 are open ( 15 being common to both contact 16 and 18) contacts 25 and 28 are also normally open but contacts 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 purnp, contacts 15 and 16 are open, with 15 and 18 closed.
In advanced applications this state change may be fed into a logic device to indicate the pump is running or the pump has stopped and perhaps light an LED or incandescent light source for visual confirmation that a change has occurred in the relay.

### 3.2.2 Contacts 25 \& 28

Contacts 25 and 28 are used to control pump states. Contacts 25 and 28 are mostly used for turning on motors via a starting relay or solenoid, so, these sets of contacts react to the rising or falling levels of the fluid inside the tank, they will operate to turn on a pump in discharge mode when the top sensor is wet and in charge mode turn on the pump when the bottom sensor is dry.

## 4 Practical Overview

### 4.1 Discharge Mode - DIP switch 6 set to "OFF"



Figure 1 -Discharge Mode
Figure 1 shows two probes, (PB1 connected to Lo and PB2 connected to Hi ). The pit is mostly underground and there is a gravity-fed inlet at the top left-hand side. The pit is empty with PB1 completely dry. Dipswitch 6 is set to "OFF."


The relay operation depends on the electrical conductivity of liquid in the pit, i.e. no liquid $=$ no current flow. The level starts to rise and covers PB1.

This is a discharge operation so we do not want the relay to close and start a pump until the well is full so as the water rises it reaches PB2, the relay closes and the pump starts. The level now drops below PB2 but the pump still continues to run, the level continues to drop below PB1 the relay opens the pump stops.

### 4.2 Charge Mode - DIP switch 6 set to "On"



Figure 2-Charge Mode
Note:
" C " is connected to common bonded earth. The unit will not operate correctly if not earthed.

Let's look at the same relay but in a tank that is charging (DIP 6 is now on). See Figure 3, where liquid is being pumped into a tank, and discharging through a gravity feed, the tank is on steel stands " $x$ " metres above the ground.


With the tank full, PB1 and PB2 will be wet, the relay is off, and the pump has stopped. Water is slowly fed out from the bottom, and now as PB2 $(\mathrm{HI})$ 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.


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 nise 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 tectnique" remember you must simulate a fluid flow to correctly ascertain a good relay or a bad one. (All DIPswitch settings from 1 to 6 should be off.)

Cut two pieces of insulated flexible copper wire one black one red 250 mm long, strip both ends back 10 mm on both cables, and join one black end and one red end. Insert the joined ends into C on the relay box, observing all safe electrical practises. You should have one black wire and one red wire free.
Set your relay for discharge mode (DIP switch 6 is off) with no sensors connected to the unit, connect the red wire to Lo - nothing should happen (if it does return the relay for replacement or repair*). Now connect the black wire to the Hi terminal the relay activated LED should light instantly (if it does not, the relay should be returned for repair*).

## 6 Troubleshooting

| I have checked all the DIPswitches and settings but in discharge mode as soon as the bottom sensor gets wet the pump turns on then tums off almost straight away. | - This is the most common problem encountered with relay set up and commissioning, the probe in the bottom of the tank is wired into the Hi terminal instead of the Lo terminal. |
| :---: | :---: |
| The installation went fine but now and again the pump will not turn on even though $I$ am sure the probe is wet. | - Check the sensitivity level set on the relay, some times the level is set for foul water but due to changes in the flow the water becomes grey or clear, try changing the setting from $20 \mathrm{~K} \Omega$ to $80 \mathrm{~K} \Omega$ and monitor the results carefully. |
| All wiring is complete and all DIPswitches have been checked but the pump will not turn on at all. | - If you have completed the test schedule for the relay and it passed then check the wining to the sensors - for this is now where the problem lies or in the earthing arrangements. If possible check the resistance between the sensor cable and the steel sensor on the probe to prove a solid connection. |

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



## MTR Level Relay



The MTR level relay has proven itself to be simple and extremely reliable in pump stations everywhere. The MTR controls one pump or one alarm. The MTRA controls one pump and one alarm.

- Safe

The extra low sensing voltage ensures maintenance staff and operators are protected at all times.

- Four sensitivities

Allows the relay to operate effectively in a wide range of conductive liquids.

- Activation delays

Each output can have a different time delay to overcome wave action and turbulence.

- LED indication

High intensity LED indicators ensure clear signals. Power On (green). Alarm On (red). Pump On (yellow).

- Dipswitch programmable

All settings are easily selectable from the front panel.

- Proven reliability

The proven design and performance of the relay ensures long-term reliability of the MultiTrode system.

- I.S application

Perfect for I.S application when used with an MTISB.

- Unique two-sensor operation (MTRA only) Pump and alarm can be controlled using two or three sensors. Two-sensor operation is ideal for budget applications or where space is limited.
- DIN rail or screw mounting
- Low installed cost


## Specifications

| Mode of operation: MTR Mode MTRA Mode | Charge/Discharge (Fill or Empty) Discharge ONLY |
| :---: | :---: |
| Probe Inputs: <br> Sensor inputs Sensor voltage Sensor current Sensitivity | MTR : 2 / MTRA : 3 <br> 10/12VAC Nominal <br> 0.8 mA max. (per sensor) <br> 1k, 4k, 20k, 80k |
| Relay Outputs: MTR relay output MTR Output delay | 2 contact sets: $1 \mathrm{~N} / \mathrm{O} \& 1 \mathrm{C} / \mathrm{O}$ <br> $0,2.5,5,10,20,40,80,160 \mathrm{sec}$ |
| MTRA relay output MTRA Output delay | 2 relays : both N/O <br> Pump: 0.5, 10; Alarm: 0.5, 15 sec |
| Relay contact rating <br> Relay contact life Terminal size | 250 VAC <br> 5A Resistive, 2A Inductive <br> $10^{5}$ Operations <br> $2 \times 13$ AWG / $2.5 \mathrm{~mm}^{2}$ |
| Display LEDs: MTR MTRA | Power On Pump Alarm <br> Green Red  <br> Green Yellow Red |
| Physical Product: Dimensions <br> Mounting Enclosure | $2.7 / 8 \mathrm{H} \times 1.3 / 4 \mathrm{~W} \times 4.1 / 2 \mathrm{D}$ (Inches) <br> $72 \mathrm{H} \times 45 \mathrm{~W} \times 114 \mathrm{D}(\mathrm{mm})$ <br> DIN Rail or $2 \times \# 6$ Screws / $2 \times$ M4 Screws <br> Makrolon (self-extinguishing) |
|  |  |

Power Supply:

| Supply Voltage AC | $24,110,240,415 \mathrm{VAC}-50 / 60 \mathrm{~Hz}$ |
| :--- | :--- |
| Power Consumption | 3.5 Watts max |
| Supply Voltage DC | (MTR only) |
| Power Consumption | 3 Watts max |

Environmental Range:

| Centigrade | $-10^{\circ}$ to $+60^{\circ} \mathrm{C}$ |
| :--- | :--- |
| Fahrenheit | $+14^{\circ}$ to $+140^{\circ} \mathrm{F}$ |

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| Available Models \& | Ordering Information |  |
| :---: | :---: | :--- |
| 415VAC | MTR-1 | N/a |
| 240 VAC | MTR-2 | MTRA-2 |
| 110VAC | MTR-3 | MTRA-3 |
| 24 VAC | MTR-4 | MTRA-4 |
| 24 VDC | MTR-5 | MTRA-5 |
| 12 VDC | MTR-6 | MTRA-6 |

Multitrode

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Tel 15619996090 . $10 x+1696282$
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Bulletin No. G306-E Drawing No. LP0588 Released 4/06 www.redlion.net

## MODEL G306-GRAPHIC COLOR LCD OPERATOR INTERFACE TERMINAL WITH QVGA DISPLAY AND TOUCHSCREEN



- CONFIGURED USING CRIMSON SOFTWARE (VERSION 2.0 OR LATER)
- UP TO 5 RS-232/422/485 COMMUNICATIONS PORTS (2 RS-232 ANO 1 RS-422/485 ON BOARD. 1 RS-232 AND 1 RS $422 / 485$ 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 (4 MBYTE FLASH)
- COMPACTFLASH SOCKET TO INCREASE MEMORY CAPACITY
- 5.7-INCH STN PASSIVE 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

FOR USE IN HAZARDOUS LOCATIONS:
Class I, Division 2, Groups A, B, C, and D
Class II, Division 2, Groups F and G
Class III, Division 2

## GENERAL DESCRIPTION

The G306 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 G306 to perform many of the normal features of the Paradigm range of Operator Interfaces while improving and adding new features.

The G306 is able to communicate with many different types of hardware using high-speed RS232/422/48S communications ports and Ethernet 10 Base T/100 Base-TX communications. In addition, the G306 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 G306 allows a user to easily view and enter information. Users can enter data through the touchscreen and/or front panel 5-button keypad.

## SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the controller to direclly 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. DIVSION 2/CLASS II, DIVSION 2/CLASS III, DIVSION 2


[^10]
## CONTENTS OF PACKAGE

- G306 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 |
| :---: | :---: | :---: |
| G306 | Operator interface for indoor applications, textured finish with embossed keys | G306C000 |
| G3CF | 64 MB CompactFlash Card 5 | G3CF064M |
|  | 256 MB CompactFlash Card ${ }^{5}$ | G3CF256M |
|  | 512 MB CompactFlash Card ${ }^{5}$ | G3CF512M |
| G3RS | RS232/485 Optional Communications Cards | G3RS0000 |
| G3CN | CANopen Optional Communications Cards | G3CN0000 |
| PSDR7 | DIN Rail Power Supply | PSDR7000 |
| SFCRM2 | Crimson $2.0{ }^{2}$ | SFCRM200 |
| CBL | RS-232 Programming Cable | CBLPROGO |
|  | USB Cable | CBLUSB00 |
|  | Communications Cables ${ }^{1}$ | CBLxxaxx |
| DR | Din Rail Mountable Adapter Products ${ }^{3}$ | DRxxxxax |
|  | Replacement Battery ${ }^{4}$ | BAL3R004 |
| G3FILM | Protective Films | G3FILM06 |

1 Contact your Red Lion distributor or visit our website for complete selection.
${ }^{2}$ Use this part number to purchase Crimson on CD with a printed manual, USB cable, and RS- 232 cable. Otherwise, downoad 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.


1. POWER REQUIREMENTS:

Must use Class 2 or SELV rated power supply
Power connection via removable three position terminal block.
Supply Voltage: $\quad+24 \mathrm{VDC} \pm 20 \%$
Typical Power': 8 W
Maximum Power2: 14 W
Notes:

1. Typical power with +24 VDC, RS232/485 communications, Ethernet contmunications, CompactFlash card installed, and display at full brightness.
2. Maximum power indicates the most power that can be drawn from the G306. Refer to "Power Supply Requirements" under "Installing and Powering the G306."
3. The G306's circuit common is not connected to the enclosure of the unit. See "Connecting to Earth Ground" in the section "Installing and Powering the G306."
4. Read "Power Supply Requirements" in the section "Installing and Powering the G306" for additional power supply information
5. BATTERY: Lithium coin cell. Typical lifetime of 10 years.
6. LCD DISPLAY:

| SIZE | 5.7-tnch |
| :--- | :---: |
| TYPE | STN |
| COLORS | 256 |
| PIXELS | $320 \times 240$ |
| BRIGHTNESS | $165 \mathrm{~cd} / \mathrm{m}^{2}$ |
| BACKLIGHT* | 20.000 HR TYP. |

*Lifetime at room temperature. Refor to "Display" in "Software/Unit Operation"
4. 5-KEY KEYPAD: for on-screen menus.
5. TOUCHSCREEN: Resistive analog
6. MEMORY:

On Board User Memory: 4 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 1.1. Device only using Type B conrection.


WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS USB PORT IS FOR SYSTEM SET-UP AND dIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

Serial Ports: Format and Baud Rates for each port are individually software programmable up to 115,200 baud.
PGM Port: RS232 port via RJ12.
COMMS Ports: RS422/485 port via RJ45, and RS232 port via RJ12.
DH485 TXEN: Transmit enable; open collector, $\mathrm{V}_{\mathrm{OH}}=15 \mathrm{VDC}$, $\mathrm{V}_{\mathrm{Ot}}=0.5 \mathrm{~V} @ 25 \mathrm{~mA}$ 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 G306."
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 Soorage Humidity: $\mathbf{8 0 \%}$ maximum relative humidity (noncondensing) from 0 to $50^{\circ} \mathrm{C}$.
Vibration: Operational 5 to $8 \mathrm{~Hz}, 0.8^{\prime \prime}(p-p), 8$ to 500 Hz, in $X, Y, Z$
direction, duration: 1 hour, 3 g .
Shock: Operational $40 \mathrm{~g}, 9 \mathrm{msec}$ in 3 directions.
Altitude: Up to 2000 meters.
9. CERTIFICATIONS AND COMPLIANCES:

SAFETY
UL Rocognized 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-I, 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 Enclosure rating (Face only), UL50
IECEE CB Scheme Test Certificate \#US/ $9737 / \mathrm{UL}$,
CB Scheme Test Report \#E179259-V01-S04
Issued by Underwriters Laboratories Inc.
IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
IP66 Enclosure rating (Face only), IEC 529
ELECTROMAGNETIC COMPATIBILITY
Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.
Immunity to Industrial Locations:

| Electrostatic discharge | EN 61000-4-2 | Criterion A <br> 4 kV conlact discharge <br> 8 kV air discharge |
| :---: | :---: | :---: |
| Electromagnetic RF fields | EN 61000-4-3 | Criterion A |
|  |  | $10 \mathrm{~V} / \mathrm{m}$ |
| Fast transients (burst) | EN 61000-4-4 | Criterion A |
|  |  | 2 kV power |
|  |  | 1 kV signal |
| Surge | EN 61000-4-5 | Criterion A |
|  |  | 1 kVL -L, |
|  |  | 2 kV L\&N-E power |
| RF conducted interfercnce | EN 61000-4-6 | Criterion A |
|  |  | $3 \mathrm{~V} / \mathrm{mms}$ |
| Emissions: |  |  |
| Emissions | EN 55011 | Class A |

Note:

1. Criterion A: Normal operation within specified limits.
2. CONSTRUCTION: Steel rear metal enclosure with NEMA 4X/IP66 aluminum front plate for indoor use only when correctly fitted with the gasket provided. Installation Category II, Pollution Degree 2.
3. MOUNTING REQUIREMENTS: Maximum panel thickness is $0.25^{\prime \prime}$ ( 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 ( $1.92 \mathrm{~N}-\mathrm{m}$ )
4. WEIGHT: $3.0 \mathrm{lbs}(1.36 \mathrm{Kg}$ )

## DIMENSIONS In inches (mm)



## INSTALING AND POWERING THE G306

## 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 maximuon of 17 inch-pounds (1.92 N$m$ ) may cause damage to the front panel.


ALL NONINCENDIVE CIRCUITS MUST BE WRED USING DIVISION 2 WRING METHOOS AS SPECIFIED IN ARTICLE 5014 (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 safcty purposes and must be connected to an external protective earlhing system.

The chassis ground is not connected to signal common of the unit. Maintaining isolation between earth ground and signal common is not required to operate your unit. But, other equipment connected to this unit may require isolation between signal common and earth ground. To maintain isolation between signal common and earth ground care must be taken when connections are made to the unit. For example, a power supply with isolation between its signal common and earth ground must be used. Also, plugging in a USB cable may connect signal common and earth ground.'

1. USB's shield may be connected to earth ground at the host USB's shield in turn may also be connected to signal common.

## POWER SUPPLY REQUIREMENTS

The G306 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. ltems 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 volage." 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.

Each G306 has a chassis ground terminal on the back of the unit Your unit should be connected to earth ground (protective earth).

## CONFIGURING A G306

The G306 is configured using Crimson software. Crimson is available as a free download from Red Lion's website, or it can be purchased on CD. Updates to Crimson for new features and drivers are posted on the website as they become available. By configuring the G306 using the latest version of Crimson, you are assured that your unit has the most up to date feature sel Crimson software can configure the G306 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 RS 232 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 "G306 Port Pin Out Diagram" for wiring information.

The CompactFlash can be used to program a G3 by placing a configuration file and firmware on the CompactFlash card. The card is then inserted into the target G3 and powered. Refer to the Crimson literature for more information on the proper names and locations of the files.

## USB, DATA TRANSFERS FROM THE COMPACTFLASH CARD



WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DUGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

In order to transfer data from the CompactFlash card via the USB port, a driver must be installed on your computer. This driver is installed with Crimson and is located in the folder C: Program FilestRed Lion ControkiCrimson 201Devicel after Crimson is installed. This may have already been accomplished if your G306 was configured using the USB port

Once the driver is installed, connect the G306 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 "G306 Port Pin Outs" for wiring information.

## ETHERNET COMMUNICATIONS

Etharnet communications can be established at either 10 BASE-T or 100 BASE-TX. The G306 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 | DESCRIP TION |
| :--- | :--- |
| 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 IPaddress. Refer to the Crimson manual and Red Lion's website for additional information on Ethernet communications.

## RS232 PORTS

The G306 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 G306 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 ${ }^{1}$, CBLRLC $^{2} 1^{2}$, or CBLRC0 $2^{3}$.

G3 RS232 to a PC

| Connoctions |  |  |  |
| :---: | :---: | :---: | :---: |
| G3: RJ12 | Name | PC: DB9 | Name |
| 4 | COMM | 1 | DCD |
| 5 | Tx | 2 | Fx |
| 2 | Fx | 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 |


${ }^{1}$ CBLPROGO can also be used to communicate with either a PC or an ICMS.
${ }^{2}$ DB9 adapter not included, 1 foot long.
${ }^{3}$ DB9 adapter not included, 10 feet long.


## RS422/485 COMMS PORT

The G306 has one RS422/485 pork. This port can be configured to act as either RS422 or RS485.


Note: All Red Lion devices connect $A$ to $A$ and $B$ to $B$, except for Paradigm devices. Refer to www.redlion.net for additional information.

## Examples of RS485 2-Wire Connections

G3 to Red Lion RJ11 (CBLRLC00)
DLC, IAMS, ITMS, PAXCDC4C
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 (CBLRLCO5)

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| G3 | Name | Modular Controller | Name |
| 1.4 | TxB | 1.4 | TxB |
| 4.1 | Rx8 | 4.1 | R×B |
| 2.3 | TXA | 2.3 | T×A |
| 3,2 | RxA | 3.2 | RXA |
| 5 | TXEN | 5 | TXEN |
| 6 | COM | 6 | COM |
| 7 | TxB | 7 | TxB |
| 8 | TXA | 8 | T×A |

## DH485 COMMUNICATIONS

The G306's RS422/485 COMMS port can also be used for Allen Bradiey 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 | T×B | 1 | A |
| 2 | T×A | 2 | B |
| 3,8 | R×A | - | 24 V |
| 4,7 | R×B | - | COMM |
| 5 | TxEN | 5 | TXEN |
| 6 | COMM | 4 | SHIELD |
| 4,7 | T×B | - | COMM |
| 3,8 | T×A | - | $24 V$ |

## CRIMSON SOFTWARE

Crimson software is available as a free download from Red Lion's website or it can be purchased on a CD, see "Ordering Information" for part number. The latest version of the software is always available from the website, and updating your copy is free.

## DISPLAY

This operator interface uses a liquid crystal display (LCD) for displaying text and graphics. The display utilizes a cold cathode fluorescent tube (CCFL) for lighting the display. The CCFL tubes can be dimmed for low light conditions
These CCFL tubes have a limited lifetime. Backlight lifetime is based upon the amount of time the display is turned on at full intensity. Turning the backlight off when the display is not in use can extend the lifetime of your backlight. This can be accomplished through the Crimson software when configuring your unit.

## FRONT PANEL LEDS

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

| LED | indication |
| :---: | :---: |
|  |  |
| FLASHING | Unit is in the boot loader, no valid configuration is loaded. ${ }^{1}$ |
| STEADY | Unit is powered and running an application. |
|  |  |
| OFF | No CompactFlash card is present |
| STEADY | Valid CompactFlash card present. |
| FLASHING RAPIDLY | CompactFlash card being checked. |
| FLICKERING | Unit is writing to the CompactFlash, either because it is storing data, or because the PC connected via the USB port has locked the drive. ${ }^{\text {? }}$ |
| FLASHING SLOMY | Incorrectly formatted CompactFlash card present. |
|  |  |
| 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 Microsof operating systems will not lock the drive unless they need to write data; Windows 98 may lock the drive any time it is mounted, thereby interfering with logging. Refer to 'Mounting the CompactFlash" in the Crimson 2 User Manual.

## TOUCHSCREEN

This operator interface utilizes a resistive analog touchscreen for user input. The unit will only produce an audible tone (beep) when a touch on an aclive 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 G306 keypad consists of five keys that can be used for on-screen menus.

## TROUBLESHOOTING YOUR G306

If for any reason you have trouble operating, connecting, or simply have questions concerning your new G306, contact Red Lion's technical support. For contact information, refer to the back page of this bulletin for phone and fax numbers.

EMAIL: tcchsupport@redlion.net
Web Site: http $\cdot / / \mathbf{w}$ ww.redion.net

## BATTERY \& TIME KEEPING



WARNING - EXPLOSION HAZARD - THE AREA MUST BE KNOWN TO BE NON-HAZARDOUS BEFORE SERNICING/ REPLACING THE UNIT AND BEFORE INSTALING OR REMOVING IO MRING AND EAT TERY.


WARING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUPMENT UNLESS POMER 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 G306 time keeping is less than one minute per month drift. The battery of a G306 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 G306, remove power, cabling, and then the rear cover of the unit. To remove the cover, remove the four screws designated by the arrows on the rear of the unit. Then, by lifting the top side, hinge the cover, thus providing clearance for the connectors on the bottom side of the PCB as shown in the illustration below. Install in the reverse manner.


Remove the old battery* from the holder and replace with the new battery. Replace the rear cover, cables, and re-apply power. Using Crimson or the unit's keypad, enter the correct time and date.

* Please note that the old battery must be disposed of in a manner that complies with your local waste regulations. Also, the battery must not be dispared 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 G306 is a lithium type CR2025.


## OPTIONAL FEATURES AMD ACCESSORIES

## OPTIONAL COMMUNICATION CARD

Red Lion offers optional communication cards for fieldbus communications. These communication cards will allow your G306 to commenicate with many of the popular fieldbus protocols.

Red Lion is also offering a communications card for additional RS232 and RS422/485 communications. Visit Red Lion's website for information and availability of these cards.

## CUSTOM LOGO

Each G3 operator interface has an embossed area containing the Red Lion logo. Red Lion can provide custom logos to apply to this area. Contact your distributor for additional information and pricing.


## COMPACTFLASH SOCKET

CompactFlash socket is a Type II socket that can accept either Type I or II cards. Use cards with a minimum of 4 Mbytes with the G306's Compactriash socket. Cards are available at most computer and office supply retsilers.
Compactlash 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 Compacplash card by a G306 can be read by a card reader attached to a PC. This information is stored in IBM (Windows ${ }^{\text {D }}$ ) PC compatible FAT 16 file format

## NOTE

For reliable operation in all of our producls, 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.

## LMITED WARRANTY

The Company warrants the prochucts it manufactures against defects in materials and workmamaip for a period limited to two years from the dale of shipnent, provided the proctucts haye been stored, hasdled, installed, end used under proper conditions. The Company"s liability under this limitod warrarty shall extend only to the repair or replacenent of a defective produch at The Company's option. The Connpany disclaims all liability for any affirnation, promise or representation with respect to the products. The customer agress to hold Red Lion Conmols harmless from, defend, and indemnify RLC agairst damages, claims, and experses arising out of subsequent sales of RLC products or products sorlaining components manulactured by RLC and based upon personal injuries, deaths, property damage. lost profits, and other matters which Buyer, its amployees, or sub-contractors are or may be to any exterit liable, ineludizg without limitation peralties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upor any person prsuart to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in eflect or as amended hereatter
No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein The Customer acknowledges the disclaimers and limitations contained herein and relies on no other warrarties ar afirmations.

| Red Lion Controk | Red Lion Controks BV | 31, Kaki Bukit Road 3, |
| :---: | :---: | :---: |
| 20 Willow Springs Circle | Basioweg 11b | f06-04/05 TechLink |
| York PA 17402 | NL - 3821 BR Amersfoort | Singapore 417818 |
| Tel + 1 (717) 767-6511 | Tei +31 (0) 334723225 | Tel +65 6744-6613 |
| Fax +1 (717) 764-0839 | Fax +31 (0) 334893793 | Fax +65 6743-3360 |


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4. Switchboard Works Test Results

### 4.0 SWITCHBOARD WORKS TEST RESULTS

## J. \& P. RICHARDSON INDUSTRIES PTY LTD

114 Crmpbell Avenue, WACOL QLD 4076
Ph: (07) 32712911 - Fax: (07) 32713623
E-mail: Jpr@jpr.coniau

## SWITCHBOARD \& SHEETMETAL INSPECTION REPORT



## J. \& P. RICHARDSON INDUSTRIES PTY. LTD.

114 Campbel! Avenue, WACOL QLD 4076
Ph: (07) 32712911 - Fax̀: (07) 32713623
E-mail: Jpr@jpr.com.au

## SWITCBBOARD / SHEEETMETAL INSPECLION CHECKLIST



Yellow Green Red

Awaiting Inspection Inspected/Tested Passed Inspected/Tested Awaiting Rectification

SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT


## SWITCHBOARD CONTINUITY \& INSULATION TEST REPORT



## J. \& P. RICHARDSON INDUSTRIES PTY LTD

114 Campbell Avenue, WACOL QLD 4076 Ph: (07) 32712911 - Fax: (07) 32713623 E-mail: jpr@jpr.com.au

## SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT EARTH LEAKAGE TEST



## J. \& P. RICHARDSON INDUSTRIES PTY LTD

## SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT VFD \& SOFT STARTER SETUP

Customer Name: Brisbane water


J. \& P. RICHARDSON INDUSTRIES PTY LTD

## SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT INDIVIDUAL DRIVES


J. \& P. RICHARDSON INDUSTRIES PTY LTD

## SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT INDIVIDUAL DRIVES



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114 Campbell Avenue, WACOL QLD 4076
Ph: (07) 32712911 -Fax: (07) 32713623
E-mail: jpr@jpr.com.au

## SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT INDIVIDUAL DRIVES



## SWITCHBOARD ELECTRICAL INSPECTION \& TEST REPORT INDIVIDUAL DRIVES

| Customer Name: Bris baine Woter |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Project: Hincles Stinex lota |  |  |  |  |  |  |  |  |
| JPR Job No: $\triangle 140933$ |  |  |  |  |  | Drive: |  |  |
| Constructed by: T R lecy |  |  | Tested by: EEA901 |  |  | Date: $6 / 10106$ |  |  |
|  |  |  |  |  |  |  |  |  |
| Main Functional Unit/s: | Qty | - | Size | - | Fuses/O/L |  |  |  |
| Fuse Fittings | Qty |  | Size |  | Fuse Size |  |  |  |
| Circuit Breakers | Qty | $\sim$ | Size | $\sim$ | O/L |  |  |  |
| Neutral | Regd | - | Size | - | ID | - |  |  |
| Earthing | Checked | $\square$ | Size | - |  |  |  |  |
| C.T.s | Qty |  | Rating |  | Function |  |  |  |
| Torroid | Qty |  | Rating |  | Function |  |  |  |
| Meters | Qty |  | Rating |  | Function |  |  |  |
| Contactors | Qty |  | Rating |  | Voltage |  |  |  |
| Overloads | Qty |  | Rating |  | Function |  |  |  |
| Relays | Qty | - | Rating | - | Voltage | - |  |  |
| Timers | Qty |  | Rating |  | Voltage |  |  |  |
| Control Switches | Qty |  | Rating |  | Function |  |  |  |
| Push Buttons | Qty |  | Rating |  | Function |  |  |  |
| Pilot Lights | Qty |  | Rating |  | Voltage |  |  |  |
| Transformers | Qty |  | Rating |  | Voltage |  |  |  |
| ATT | Qty |  | Rating |  | Function |  |  |  |
| VFD | Qty |  | Rating |  | Function |  |  |  |
| Soft Starter | Qty |  | Rating |  | Function |  |  |  |
| Terminals | Qty |  | Size |  | ID |  |  |  |
| Engraving | Qty | $\checkmark$ | Size | - | ID | 7 |  |  |
| Cabling | Type | - | Size | $<$ | ID | / |  |  |
| Busbars | Type |  | Size |  | ID |  |  |  |
| Escutcheons / Shrouds | Type | $\checkmark$ | Material | - | IP rating | K |  |  |
| Earth Leakage Unit | Qty | 2 | Size | $\sim$ | Function | - |  |  |
| Remote I/O Unit | Qty |  | Size |  | Function |  |  |  |
|  |  |  |  |  |  |  |  |  |
| IP Sealing | Rating | - |  |  |  |  |  |  |
| Door Latches | Qty | - | Type | 5 | Operation | / |  |  |
| Ventilation | Required |  | Type |  | Operation |  |  |  |
| Circuit Schedule | Required |  | Fitted |  | Checked |  |  |  |
| Terminal Tightness | Power | $r$ | Control | - | Result | 7 |  |  |
| Polarity Check | R - R | - | W-W | - | B - B | , |  |  |
| Continuity Check | R - R | $\leqslant$ | W-W | $\checkmark$ | B-B | - | $\mathrm{N}-\mathrm{N}$ | $\sim$ |
| Partially Checked Circuits - Point to Point |  |  |  |  |  |  |  |  |
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## LIVE LOW VOLTAGE WORK

## TESTING SWITCHBOARDS AND CONTROL PANELS WITIIN OUR MANUFACTURING PREMISES

## APRROVED BY: Eric McCulloch (WHSO)

LOCATION: WACOL WORKSHOP DATE: I...I!../.o.6

| AUTHORISATIONS |  |  | PERSONAL PROTECTIVE EQUIPMENT |  |
| :---: | :---: | :---: | :---: | :---: |
| - Autho charge $\qquad$ | isation from person in |  | Long cotton clothing <br> Insulating work gloves in test <br> Insulating mats / covers in test <br> Switchboard rescue kit in test | $\sigma$ YES <br> $\square$ YES <br> $\sigma$ YES <br> $\square$ YES |
|  | TASK | - Isolation po <br> - Work arèa | identified and accessible r of obstructions | $\begin{array}{ll} \theta & \text { YES } \\ 0 & \text { YES } \end{array}$ |
| LIVE LO <br> TESTING <br> AND CON <br> WITHIN <br> MANUFA <br> PREMISES | VOLTAGE WORK <br> SWITCHBOARDS TROL PANELS UR TURING <br> OPTION <br> OPTION | - Unauthorised <br> - P.P.E. is fit f <br> - Test equipme <br> - Written autho a person in ch <br> - JPR authorisa <br> - Approved ded testing. <br> - Approved ded <br> ( $\Lambda$ ) RCD protect <br> $>$ RCD prot <br> $>$ Safety Ob <br> (B) Non RCD pro <br> $>$ Superviso <br> $>$ Safety Ob | access prevented to work area purpose <br> is fit for purpose <br> ty to proceed has been obtained from ge. <br> on to conduct live work is current <br> ated power supply only used for <br> ated power supply in current test outputs used at power supply <br> ion checked daily prior to use <br> ver $\lambda$ / is not required <br> cted outputs used at power supply onsulted prior to use <br> ver is in attendance | $\sigma$ YES <br> $\sigma$ YES <br> $\square$ YES <br> $\checkmark$ YES <br> $\checkmark$ YES <br> $\checkmark$ YES <br> $\boxed{Y} \mathrm{YES}$ <br> G YES <br> $\sigma$ YES <br> a YES <br> - YES <br> - YES <br> - YES |
| I understand and am fully aware of the requirements of this job safety analysis. |  |  |  |  |
| Signatures: | 1. za andr ${ }^{2}$ | 3. | $4 . \quad 5$. |  |

JOB SATETY ANALYSIS

## LIVE LOW VOLTAGE WORK

## TESTING SWITCHBOARDS AND CONTROL PANELS WITIIN OUR MANUFACTURING PREMISES

## APPROVED BY: Eric McCulloch (WHSO)

LOCATION: WACOL WORKSHOP ' DATE: ?....I.I..ध.6


## LIVE LOW YOLTAGE WORK

## TESTING SWITCHBOARDS AND CONTROL PANELS WITIIN OUR MANUFACTURING PREMISES

## APPROVED BY: Eric McCulloch (WHSO)

LOCATION:
WACOL WORKSHOP
DATE: ㅍ…II../oh


## DAILY RISK ASSESSMENT

FOR
LIVE LOW VOLTAGE WORK

## TESTING SWITCHBOARDS AND CONTROL PANELS WITHIN JPR MANUFACTURING PREMISES BY AN INDEPENDENT BODY

APPROVED BY: Eric McCulloch (WHSO)
LOCATION:
WACOL WORKSHOP
DATE: $\nsim 1!, \ldots$
 Drawings

J. $\&$ P. RICHARDSON INDUSTRIES PRY. LTD. A.B.N. 23001952325 Lc. No. 756

TELEPHONE: 32712911 (All hours) 114 CAMPBELL AVENUE - WACOL. BRISBANE Q 4076

| CUSTOMER: |
| :---: |
| ACC $C$ |
| HIES: |
| HIES. ST |


| DAY: MON |
| :--- | :--- |
| DATE: $27 / 11106$ |
| EMP. NO. 180 |


| Nob | B | $M$ | $S$ | 1 |
| :---: | :---: | :---: | :---: | :---: |
| 9 | 0 | 9 | 3 | 3 |
| WORK START TIE |  |  |  |  |
| NORMAL | $75 \Omega$ |  |  |  |

RISK MANAGEMENT HAS BEEN CARRIED OUT IN ACCORDANCE WITH: RISK ASSESS DSAFETY PLAN $『$
I have carried out the work listed \& I confirm it complies with Good Work Practices, Our Quality Goals \& to Customer's Satisfaction.


- TEST mans
- Run cables

For
FIELD EQUIPMENT \& Terminate in macaco.

Customer's Authorisation for live work:

Customers Signature


| DRIVER FATIGUE MANAGEMENT |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| UNIT No. | Over 12 Tonne GYM |  |  |  |
| Driving Time |  | Driving Time |  | Total |
| Start | Finish | Start | Finish | Hours |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  | I certify that the electrical work listed has been basted in accordance with the prescribed procedure and that such work complies in every respect with the requirements of the Electrical Safety Regulation 2002. The electrical equipment listed to the eatery that it is affected by the above electrical work, is electrically sate.

Certificate of Competency No:
Signature of Electrical Worker:


## 5.0 "AS CONSTRUCTED" DRAWINGS


[^0]:    IP 20 degree of protection and safety trip ') are available for plug-in type breakers, for switchboard and distribution board use.

[^1]:    A - Normat CA 3 rating of contactor

    - Maximum breanking current of contactor
    C. Cut-of current of fuso

[^2]:    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.
    ${ }^{1}$ ) 80,100 and 125 amp refers to Din-T10H type.
    ${ }^{2}$ ) Type 'SE' TemBreak MCCB only.
    ${ }^{3}$ ) TL100NJ up to 100A only.
    If co-ordination to IEC 947-4-1 is required refer to Type 1 and 2 co-ordination tables, contact NHP.
    Din-T MCB's are calibrated to IEC 898 Curve 'C' \& 'D'. Selected sizes of 'D' Curve are available from stock. Refer NHP.

[^3]:    Note: When used at 400 Hz , the rated current setting of the OCR

[^4]:    Note: ') Select applicable short circuit rating required by system specifications.
    ${ }^{2}$ ) TemBreak Plus MCCBs can also be used

[^5]:    Note: When used at 400 Hz , the rated current setting of the OCR

[^6]:    Notes: These motor circuit application lables 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 hodding $125 \%$ FLC continuously and $350 \%$ FLC for at least 20 seconds. ${ }^{1}$ ) 80,100 and 125 amp refers to Din-T10H type.
    ${ }^{2}$ ) Type 'SE' TemBreak MCCB only.
    ${ }^{3}$ ) TL. 100 NJ up to 100 A only.
    If co-ordination to IEC 947-4-1 is required refer to Type 1 and 2 co-ordination tables, contact NHP.
    Din-T MCB's are calibrated to IEC 898 Curve ' $C$ ' \& ' $D$ '. Selected sizes of ' $D$ ' Curve are available from stock. Refer NHP.

[^7]:    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.
    ${ }^{\text { }}$ ) TL 100 NJ up to 100A only.
    If co-ordination to IEC 947-4-1 is required refer to Type 1 and 2 co-ordination tables, contact NHP.
    Din-T MCB's are calibrated to IEC 898 Curve 'C' \& 'D'. Selected sizes of 'D' Curve are available from stock. Refer NHP.

[^8]:    * 2 -pole motor

[^9]:    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. $\left.{ }^{\prime}\right) 80,100$ and 125 amp refers to Din-T10H type.
    ${ }^{2}$ ) Type 'SE' TemBreak MCCB only.
    ${ }^{\text {? ) }}$ TL100NJ up to 100A only.
    If co-ordination to IEC 947-4-1 is required refer to Type 1 and 2 co-ordination tables, contact NHP.
    Din-T MCB's are calibrated to IEC 898 Curve ' $C$ ' \& ' $D$ '. Selected sizes of ' $D$ ' Curve are available from stock. Refer NHP.

[^10]:    CompactFlash is a registered trademark of CompactFlash Association.

