Client :
BRISBANE WATER
Document Title :
SP 174 Jesmond Rd Main Switchboard

## SP 174 Jesmond Rd Main Switchboard



Issue :
Book 1 of 1
Date of Issue: MAY 2004

Author :
MPA Engineering


DELIVERY TO:
Brisbane Water
C/o Jesmond Road
ATTENTION:
James Reid

## $\sqrt{2}$

FROM: M.P.A Engineering Pty. Ltd. Unit 3, 22-24 Strathwyn St Brendale Qld 4500

DEL. No: 7194-12DD
DATE SENT: 25 May 2004
SENT BY: Karen Newton

Customer Ref No: BW.30-03/04

| Item | Qty | Description | Part Number |
| :---: | :---: | :---: | :---: |
| $\bigcirc 01$ | 1 | Critec Surge Diverter | TDS180-4S-277 |
| \%2 | 1 | Multitrode Level Sensor | MTR-A |
| 03 | 1 | Phase Fail Relay | 252-PSGW |
| $\checkmark 04$ | 1 | 2 Pos 1 Pole Selector Switch | Low / High |
| $\checkmark 5$ | 1 | 2 Pos 3 Pole Selector Switch | Remote / Manual |
| r06 | 1 | 6A 3 Phase Circuit Breaker | DTCB6306C |
| -07 | 1 | 32A 3 Phase Circuit Breaker | DTCB6332C |
| - 08 | 1 | 16A 1 Phase Circuit Breaker | DTCB6116C |
| -69 | 1 | 10A 1 Phase Circuit Breaker | DTCB6110C |
| $\checkmark 10$ | 1 | 2A 1 Phase Circuit Breaker | DTCB6102C |
| -11 | 3 | 6A HRC Fuse | NNS6 |
| $\sqrt{12}$ | 3 | 32A HRC Fuse Holder | NW32 |
| 13 | 1 | RCBO 10A | DSRCBH1030A |
| $\checkmark 14$ | 1 | Start Push Button Green | D5P-F301W3LX10 |
| -15 | 1 | Stop Push Button Red | D5P-F402W3LX01 |
| $\checkmark 16$ | 1 | Reset Push Button | D5P-F607W3LX10 |
| 46 | 1 | Amber Pilot Light | D5P-P53DL0 |
| 247 | 1 | Red Pilot Light | D5-3R7 |
| 18 | 2 | Red LED 240VAC | D5-3N5260RD |
| 49 | 1 | Amber LED 24VAC | D5-3N5260AR |

wrwampaeng.comiau


## SP174 JESMOND RD

| 1 | MPA Test Sheets and Information |
| :---: | :--- |
| 2 | Critec Surge Suppressor |
| 3 | Critec Surge Filter |
| 4 | Emotron Soft Starter |
| 5 | Crompton Instruments Phase Fail and <br> Trandsducers |
| 6 | Startco Motor Protection Relay |
| 7 | ATS Circuit Diagram and Tests |
| 8 | CA6 Contactors |
| 9 | CA7 Contactors |
| 10 | CT7 Thermal Overloads |
| 11 | Miniature Circuit Breakers |
| 12 | XS125 MCCB |
| 13 | XS400 MCCB |
| 14 | Control and Signalling Unit |
| 15 | Control Relays |
| 16 | Hour Run Meter |
| 17 | Multitrode Relay |
| 18 | Electronic Timer |
| 19 |  |
| 20 |  |

## Engineering Pty ltd <br> Specialists in Machine and Plant Automation

SWITCHBOARD INSULATION TEST REPORT


Specialists in Machine and Plant Automation

## SWITCHBOARD TEST SHEET - MAJOR PROJECT

PROJECT

$\qquad$ JOB NUMBER 7194
DESCRIPTION Jermand Rd

DRAWING Nos $\qquad$
$480^{\circ}$
TEST DATE $12.5 \cdot 01$

www.mpaeng.com.au

Certified

Gold Integrator


| Electrical Operational | ACC | RE. | Done / Comment |
| :---: | :---: | :---: | :---: |
| Isolate control circuits, turn on all CB'S, isolators Place fuse links in carriers. <br> Surge arrestor earth to be disconnected Disconnect all electronic equipment. |  |  | \% |
| Megger power circuits and record on separate Insulation Test Record sheet | $\checkmark$ |  |  |
| Operate each device (Switch, C/B, Contactor, Overload etc). for correct operation. |  |  |  |
| Shunt tripping correct |  |  | $N A$ |
| All indicating lights operational | $\checkmark$ |  |  |
| Check mechanical interlocks and freedom of operation of electrical switches. | $\checkmark$ |  |  |
| Check Operation of key interlocks where installed |  |  | $N A$ |
| Check phasing of all incoming and outgoing circuits | $\checkmark$ |  |  |
| TOL trips contactor and fault light indication | $\checkmark$ |  |  |
| Hours run meter operates | $\checkmark$ |  |  |
| Ammeter load test - all phases |  |  | NA |
| Voltmeter test - all phases |  |  | NA |
| TOL reset coils operate | $\checkmark$ |  |  |
| Contactor operation quiet | 7 |  |  |
| Control circuit full function test |  |  |  |
| VSD Operation Checklist completed for each drive |  |  |  |
| Electrical- Final |  |  |  |
| MPA Nameplate / Rating plate fitted | 7 |  |  |
| Timeclock battery reserve operates | - |  |  |
| Timers set to correct time range | $\checkmark$ |  |  |
| TOL set to correct motor current if known. If unknown, set to minimum | 7 |  |  |
| Time clock setting correct or to OFF | - |  |  |
| Ammeter and voltmeter, zero adjusted. | - |  |  |
| Wire numbers are correct to drawing | $\checkmark$ |  |  |
| Marked up / As Constructed copy of the drawings placed in board | $5$ |  |  |
| All toois and spares provided and packed | , |  |  |
| Vacuum and touch up paintwork. |  |  |  |
| Photos taken |  |  |  |

$\qquad$ Signature $\qquad$ Date $\qquad$

Completed Product
Verified by MPA (Print Name)



Page 3 of 3
FORM F17/ Revised 7/03
F:VAdminlQUALITY\Quality revised 2003ISwitchboard Inspection FormsISWITCHBOARD TEST



## He's no dummy... MPA Managing Director puts resus first

As part of our continuing staff education program, and in accordance with the ongoing thrust of implementing the Electrical Safety Act 2002, MPA Engineering has embarked on a number of in-house training programs to maintain our compliance with all requirements of the new Act.

To this end I have recently completed a train the trainer course and a number of St John Ambulance first aid courses, which allow me to provide in-house training in resuscitation and low voltage rescue techniques.

The advantages of providing this statutory training in-house, are two fold. As well as scheduling basic training at times to suit our work commitments, we can also use this formal learning environment to reinforce the important elements of our company's commitment to safe work practices - both here at MPA and whilst working on site for our clients.

This has substantial advantages for our clients, providing them with the assurance that all MPA staff come to their site having both the correct attitude and knowledge to complete their work.
Greg Bott
Managing Director

## Inside:

## - Moxon Timbers makes the grade!

- INB... helping passengers travel faster
- Staff Focus - Ben Hynes
- Indigo creates clean technology


Providing a safe working environment is considered a priority. MPA can make implementing new safety measures in the workplace easy - by using the best product or service for the job - sourced from the most superior ranges of safety equipment available. Products include • light curtains • light grids • light arrays • emergency stop devices

- laser scanners - light barriers • safety switches • sensors and control units • fixed enclosing guards
- safety relays • photoelectric switches • control and signal devices • safety PL.Cs el al.

Don't take chances with safety... call MPA Engineering today!
the engineers, the ideas, the solutions...

## MOKOM THIDPES makEs the graale!

Founded in Brisbane over 100 years ago, the Australian, family owned company Moxon Timbers, sources domestic timber and flooring both nationally and internationally for the building industry. Their range of timber products includes Australian cypress, jarrah and spotted gum, as well as teak and many exotic, hard to find species. Imported European Baltic pine for structural use has become a significant part of the business since the late 1990's. Moxon also provides oak products to prize-winning wine makers from a number of countries.

Moxon's Production and Sales Manager, Brian Spillane approached MPA to improve their timber stress-grading machine, by introducing the latest control technology. Designed in the early 1970's, the machine controls were outdated, with some requiring manual operation. The gearbox had to be adjusted manually from inside the machine, making it a cumbersome way to vary the speed. It also required some additional safety features - which workplaces are now providing to ensure operator safety.

In consultation with the client, David Daymond - an MPA Control Systems Engineer - designed, programmed and installed a new system, using a Siemens S7200 224 PLC, Siemens MM440 Variable Speed Drive, Siemens OP3 Operator Panel, SMC Pneumatics, CMG motor/gearbox and SICK Safety Relays (UE43-2's). He ensured the functionality of all mechanical specifications and the drive features, and interpreted the original grading algorithm to suit the new control system - with a view to making its performance even better than the original.

To set parameters for bending limits - which define grades and their associated bending pressure - the Operator Panel was installed, making it easy to calibrate the process. Using a reference bar and by pressing a button on the Operator Panel, the bending sensors on the machine are readily reset to zero. With fewer manual adjustments required by the operator and with a turn of the dial, the timber stress-grading machine can process timber at between 30 and 80 metres per minute. Statistical data from each batch of timber can also be collated in a timely manner. For example, batch quantities with averages are collected, and the speed can then be read and adjusted accurately on a dial, with the runtime recorded in hours, as well as kilometres, thereby assisting in maintenance requirements.

Brian Spillane from Moxon Timbers says, "The upgrade has improved the functionality and accuracy of the machine to the point where we now have repeatability that was previously thought unattainable".

## Source www.moxontimbers.com/index.htm and www.moxonoak.com/index.htm



## FACT FILE - GRADING TIMBER... HOW IS IT DONE?

## - To ascertain the grade of a length of timber, it is passed

 through a timber stress-grading machine.- As it moves through the machine, a cylinder applies pressure over a 915 mm span and measures deflection at intervals of 150 mm
- Paint colours representing the various grades are applied at each measurement interval, and the length of timb: given a final colour grade at the end of the process.
- The graded timber is segregated and stacked in packs of the various grades.


## INB....helping passengars travel faster

At times the traffic on our roads appears to be endless. It can move slowly, making even the shortest journey feel quite stressful. Recognising that traffic growth in Brisbane will only increase in the future, Queensland Transport and the Brisbane City Council are developing strategies to reduce traffic congestion on our roads. A vital component of these strategies is the construction of a busway network, which will reach across Brisbane and encourage commuters to use public transport. The Queensland Transport Busways website describes a busway as "systems of busway stations and interchanges, connected by dedicated bus lanes which form an innovative rapid transport system aimed at increasing the speed, reliability and comfort of bus services"

The first busway in the network, the South East Busway opened in April 2001 and carries approximately two million passengers per month. The Inner Northern Busway (INB), which is the second busway in the network, will stretch 4.7 km and will be utilised by buses and emergency vehicles, and when completed, it will link the Brisbane CBD to the Royal Brisbane Hospital, with a number of busway stations en route.

The INB is to be constructed in stages and consists of 10 sections. Of interest is Section 3 ? INB, which commenced in ¿.,.ember 2002 and involves a two-lane busway between Roma Street and Normanby Fiveways. Constructed under an Alliance contract between Thiess, Sinclair Knight Merz and Queensland Transport, this section of the INB was completed in December 2003. It includes an underground tunnel of approximately 80 m in length, which runs beneath the Roma Street railway line.

Electrical Contractors for the project, O'Donnell Griffin contracted MPA Engineering to design, program and commission a PLC system, which controls stormwater pumps and lighting, and monitors environmental conditions in the tunnel such as air nuality, as well as the power y to the tunnel. Ben Hynes,
a uenior Engineer with MPA worked in conjunction with Greg Brown from Sinclair Knight Merz and Mal Diery, Industrial Projects Manager from O'Donnell Griffin to develop a 24 hour-a-day continuous control system for the tunnel.

The following environmental conditions and power supply factors are monitored using an Allen-Bradley SLC5/05 PLC:

- Stormwater - The stormwater pump station consists of three pumps - duty, standby and storm. The PLC automatically controls each pump via a series of processes that are determined according to the water level detected.
- ighting - There are five svels of lighting within the tunnel, which are designed to maintain the lighting level to be equivalent to the natural light outside the tunnel. The PLC controds the lighting levels via

photometer readings, and adjusts the lighting when the reading falls below a predetermined level, providing bus and emergency vehicle drivers with uninterrupted visibility on entering the tunnel.
- Air quality - Environmental sensors within the tunnel monitor Nitrogen Dioxide, Carbon Monoxide, and Compressed Natural Gas levels. Air visibility, direction and speed are also monitored.
- Power supply - Mains power is monitored by a Crompton Integra 2000 power meter. The PLC communicates with the power meter using Modbus RTU and provides information regarding the systems incoming power supply.
An Allen-Bradley PanelView 600 Colour Touch Panel is mounted on the PLC switchboard. This provides an operator interface to the PLC system and is connected via DeviceNet, which is a flexible network solution connecting industrial devices to PLCs and computers. All instruments monitored by the PLC are displayed on the Touch Panel, and in the case of air quality and power supply these are displayed as instantaneous values.

The control system is linked to the Busway Operations Centre (BOC) at Woolloongabba via an Ethernet connection. It is designed to run automatically, however it may be controlled manually from the Centre, making it possible for Queensland Transport to monitor the tunnel.

David Grosse - Principal Busways Officer, responsible for the management of the BOC confirmed, "We have seven tunnels on the South East Busway, and now two extra tunnels on the INB to monitor. These tunnels represent a risk to passenger safety, and as such we are very much reliant on a quality control system such as the one developed by MPA Engineering."

Contributing to the development of this important busway network has been an exciting opportunity for MPA, and there is no doubt that the people of Brisbane will benefit from faster, more relaxing and safer travel through the inner northern suburbs of this city.


With Ben Hynes, Senior Engineer, RPEQ

When Ben was young, his friend's older brother, whom Ben greatly admired and regarded as a mentor, became an electrical engineer. So Ben, with an interest in maths and science decided to follow in his footsteps.

Ben subsequently attended the Queensland University of Technology and graduated with Honours 2A in 1995. His first engineering position was as a Systems Project Engineer with a firm specialising in building management systems. In 1998, Ben decided to concentrate on the area of automation, which saw him accept a position at MPA Engineering.

Recognising that Ben had exceptional customer service skills and an eye for detail, Ben was stationed on a permanent basis with MPA's key corporate client, Castlemaine Perkins. Working in the brewing section, Ben provided engineering and PLC maintenance, including managing upgrades and attending to breakdowns. After his successful stint in the brewing section, Ben was offered additional work in the packaging area, where he worked on system upgrades, and ensured that new machinery integrated effectively with the existing systems.

After working on site at Castlemaine Perkins for over three and a half years, Ben moved back into MPA's head office at Brendale in order to gain experience in other areas of automation. Since then, Ben has successfully worked on a diverse range of engineering projects for clients including Castrol, Amcor Cartonboard and Hume Masterpanel.

#  

W7 ith diverse interests in property, hotels and technology, Indigo is an entrepreneurial development group listed as one of the Top 25 privately owned organisations in Queensland. A focus of the Technology Division is the promotion of world leading environmental technology for air pollution control. At the forefront of this technology is the Indigo Agglomerator, a retrofitted device that agglomerates fine particles created by fossil fuel burning furnaces, which are prevalent in the energy and cement industries. The fine particles removed by the Agglomerator are among the most dangerous to the environment, because they may contain heavy metal toxins. They are easily carried by air movement, are respirable - resulting in health risks and are detrimental to global greenhouse conditions.

The Agglomerator treats flue gases prior to them entering an electrostatic precipitator. Using electrostatic forces, the fine particles attach to larger, much easier to collect particles. A bipolar charger is used to charge half of the particles positively
and half negatively. When a fine particle comes close to an oppositely charged large particle, it is attracted and attaches - forming agglomerates, which are then collected in the electrostatic precipitator.

MPA Engineering was recently contracted by Indigo Technologies to design a controller for the Agglomerator. With specifications not easily met with "off-the-shelf" products, David Poole, Principal Engineer at MPA custom-designed the hardware and software to control a pair of high voltage transformer rectifiers - which form the basis of the Agglomerator. The controller provides Indigo Technologies with enhanced performance and gives them an edge over their competitors.

Several controllers were constructed by MPA, and then commissioned by Indigo Technologies. They have been installed at Vales Point Power Station in New South Wales, with the other travelling to Jack Watson Power Station in Mississippi, USA. Tests conducted by Indigo on the Agglomerator have produced positive and encouraging results - boding well for a cleaner environment.

Staff Focus-from page 3...

Reflecting on his career to date, Ben states that professionally speaking, his most memorable moment would have been his work for the New Yeast Room at Castlemaine Perkins. He says, "That particular job had everything. Many highs, many lows, stress, tight deadlines, contractural dramas were all a part of it. However, as expected, at the end of it all, the client received a very good system that has been functioning reliably for the last three or so years. It was the most challenging PLC program I have had to do so far. I learnt a lot, and am proud to say it still works very well."

Ben believes that when you work for a small to medium sized company, you tend to get thrown into the deep end. But rather than viewing this as a negative, Ben has used it as an opportunity to develop his ability to successfully think on his feet, and not panic when things don't go according to plan.

When asked what he enjoys most about working at MPA Ben says, "The diversity. MPA has a very diverse client-base, which often means one day you'll be working on an installation such as a water treatment plant, the next you're upgrading a guillotine for cutting cartonboard, or commissioning a new VSD at a timber mill. Some of the sites I have visited are really from different ends of the spectrum."

Seen by his colleagues as highly professional, motivated and knowledgeable, with a gregarious and positive outlook, Ben is an ideal choice for the most challenging projects MPA has to offer.

## QUICK QUIZ with Ben...

1. Favourite past-time? Beer tasting.
2. What are you reading at the moment? Well, I was going to read "The Cat in the Hat", but I have decided to wait for the movie.
3. Who do you most admire? Greg Bott (my performance appraisal is due).
4. Favourite food? Indian, Thai, Italian, German, Seafood... how about I just say all.
5. Who would you most like to have dinner with - where and why? My wife (she will be reading this) at the Sheraton Seafood Buffet (refer to previous reason).
6. Favourite holiday destination? Norfolk Island. No mobile phone coverage.
7. Most prized possession? That's rather personal isn't it?
8. Childhood hero? Fred Flintstone. Hey, he drinks beer and he bowls!
9. Favourite movie? Pulp Fiction.
10. Best ad on tv? The Hahn Premium Light ad, where the bloke bomb dives into the romantically set up spa.

Jusi joking!
An engineer was crossing a road one day when a frog called out to him and said, "If you kiss me, I'll turn into a beautiful princess." He bent over, picked up the frog and put it in his pocket.

The frog spoke up again and said, "If you kiss me and turn me back into a beautiful princess, I will stay with you for one week. The engineer took the frog out of his pocket, smiled and returned it to the pocket.

The frog then cried out, "If you kiss me and turn me bap into a princess, I'll stay with and do ANYTHING you walith Again the engineer took the frog out, smiled at it and put it back into his pocket.

Finally, the frog asked, "What is the matter? l've told you I'm a beautiful princess, that 'Ill stay with you for a week and do anything you want. Why won't you kiss me?"

The engineer said, "Look, I'm an engineer. I don't have time for a girffriend, but a talking frog is very cool!"

Distributor

Gold Integrator
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IPA ENGINEERING
a company introduction...

## Snapshot

 of Clients- Amcor Group
- Arnotts Biscuits
- Boral Group
- Bundaberg Sugar Group
- Carlton United Breweries
- Castlemaine Perkins
- Castrol Australia
- City / Shire Councils: Beaudesert, Brisbane, Caboolture, Caloundra, Gold Coast, Maroochy, Pine Rivers, Redland, Townsville
- CSR Readymix Group
- Defiance Milling
- Fisher \& Paykel Manufacturing
- George Weston Milling
- Hills Industries
- Hume Masterpanel
- James Hardie Group
- John Goss Projects
- Namoi Cotton Group
- Network Ten Ltd
- OneSteel
- Paul's Limited
- Pepsi Cola
- Pioneer Roof Tiles
- PPINeta
- Queensland Nickel
- Queensland Department of Health (RBH and RWH)
- Shell Australia and Fiji
- Siemens
- Sigma Pharmaceuticals
- Smith's Snackfoods
- South Pacific

Breweries (PNG)

- Stanwell Corporation
- Tip Top Bakeries
- Tubemakers Group
- United KG
- Western Milling


## About us...

MPA Engineering is a leading electrical systems integrator, specialising in sophisticated machine and plant automation solutions. Based in Brisbane, Queensland, MPA services customers throughout Australia, as well as internationally.

Established in 1990, MPA is a highly competent, customer focused organisation dedicated to providing the best design, manufacture, installation and commissioning of electrical control systems to some of Australia's prominent manufacturers and processing companies, including
CSR Humes, Pioneer Roof Tiles, Castlemaine Perkins and Sigma Pharmaceuticals.
A team of skilled and industrially experienced, professional engineers, execute large and contractually challenging engineering projects. A specialised team of trades-people, technical specialists and office staff, supports this expertise. MPA is therefore well equipped to develop and implement industrial solutions to improve plant productivity. MPA has quality assurance in compliance with the requirements of ISO9001; all project work and software designs are undertaken to comply with the QA system. MPA maintains Workers' Compensation for all its employees and holds Public and Products Liability cover for \$10,000,000 and Professional Indemnity cover for $\$ 1,000,000$. These levels are able to be reviewed on a proje basis and can be increased to any appropriate level.

MPA consists of seven divisions:

- Engineering Services;
- Electrical Workshop and Installations;
- Technical Services;
- Information Technology Services;
- Electronic and Embedded Control Services;
- Research and Development Projects; and
- Product Sales Division.


## Engineering Services

MPA's team of professional engineers provide practical, effective and competitively priced industrial automation and process control solutions. This team designs, installs and commissions systems for a diverse range of manufacturers, no matter how large or small the organisation. MPA's areas of expertise include: electrical consulting and project management; factory automation; water and sewerage control; PLC based control systems and SCAD systems; switchboard design; basic and general software programming using a number of languages, (e.g. Visual Basic, Visual C++, SQL); weigh batching systems; power station and standby power systems; and hazardous area systems. MPA is also a Siemens Systems Integrator, as well as a CITECT Gold Integrator.

## Electrical Workshop and Installations

MPA's Electrical Workshop provides clients with a complete industrial and commercial switchboard design, manufacturing, installation and commissioning service. From the very largest of motor control centres to the smaller control panels for OEMs, the Workshop builds high quality switchboards to client specification. All boards are manufactured to AS3439 and MPA has designed a Form 3B switchboard which is type tested for a fault current rating of 63 kA at 415 V for one second and 50kA for three seconds, with loads up to 3000A. MPA holds an electrical contractors license and undertakes electrical installations and contract work, specialising in the industrial environment.

SP174 Jesmond Road Fig Tree Pocket SPS Main Switchboard OM Manual
Technical Services
MPA's Technical Service Division specialises in the repair and maintenance of electrical equipment. MPA supplies, services and commissions AC and DC drives and positioning systems, as well as PLCs. This Division also provides breakdown assistance for electrical controls and general industrial machinery. It is also responsible for general machine retrofits and upgrades including PLC or CNC control systems. The Technical Workshop provides a repair service for electronic equipment and boards for industrial and non-industrial applications, including linear and switched mode power supplies, microprocessor controller boards, process / motion controller boards, electronic displays, monitors and special obsolete PCB's.

Information Technology Services
MPA's IT Division provides a wide range of IT related services to clients, including custom application development, database programming, and control system integration with management information systems.

Filectronic and Embedded Control Services
IPA provides an in-house embedded control design service for specialised applications. Full PC board development using ProTool with microprocessor software is also available. This service can take projects from the concept stage right through to the working prototype.

Research and Development Projects
MPA has an ongoing commitment to R\&D projects, and is continuing to develop products required by industry. A number of in-house products have been developed for the industrial market, including moving electronic message displays or "marquees", cut to length solutions, automatic controllers and batching software.

Product Sales Division
MPA's Product Sales Division focuses on the sale of automation equipment and industrial computers. MPA distributes Siemens PLCs, automation products, - CADA systems, and a diverse range of drives - which are available either s standard off-the-shelf products, or they can be engineered to meet specific customer needs. Variable Speed Drives (or VF Drives) allow the matching of the speed of the motor-driven equipment to the process requirement, resulting in significant energy savings. With technical support from in-house engineering staff, the Sales Division offers customers an extensive range of automation equipment to suit most industrial applications, including:

- Automatic Guillotine and Press Brake Systems
- Automatic Power Backgauges
- Batching Software
- EasyControl - 1 or 2 Axis Controllers
- Hazardous Area Products
- IKUSI Radio Remote Controllers
- Instrotech Range of Instrumentation and Process Control Products
- Level Measurement Systems
- Moving Electronic Message Displays
- Process Instrumentation and Data Acquisition Products
- SCADA Systems
- Siemens Industrial Automation Products - including PLCs, HMI Systems and Power Supplies
Uninterruptible Power Supplies (UPS)
- Variable Speed Drives
- Vision and Control Products.


## Project Profiles

Since MPA's inception in 1990, the company has developed a reputation as one of Queensland's leading specialists in machine and plant automation. In this time, MPA has engineered a wide range of major projects - for information on more projects visit www.mpaeng.com.au. A small selection of these are listed below:

## Brewing Projects

- Castlemaine Perkins, Milton - Design and commissioning of PLC software for new Yeast Room; Maintenance role in the Packaging and Brewing Departments; PLC programming modifications to new and existing systems.
- South Pacific Holdings, PNG - Design, programming and installation of the upgrade to existing mobile pump controllers.


## Concrete, Brick and Tile Manufacturing Projects

- Boral Petrie Quarry - Design, programming, installation and commissioning the upgrade of the PLC / SCADA system.
- CSR Humes - Engineered the electrical upgrade to Batch Plant 3 at Eagle Farm.


## Industrial Projects

- Queensland Towbars - Electrical design and commissioning of automatic conveyor systems as well as an electric drying oven.
- Royal Brisbane Hospitals Complex - Design, programming and commissioning of RBH high voltage network control system, motor control switchboard and PLC control system for the new East and West Block Complexes.


## Petrochemical Projects

- Castrol Australia - Installation of all electrical controls and instruments for the new additive tank at the Whinstanes site. Heat trace was installed on all pipework to maintain the additive at a useable temperature.
- Nationwide Oil - Designed, manufactured, installed and commissioned a floor standing, outdoor switchboard including a PLC, Touch Panel and Remote Operator Interface for the new unloading and treatment process.


## Sugar Industry Projects

- Moreton Sugar Mill - Engineered the remote control of train crossing lights.
- Rocky Point Sugar Mill - Designed closed loop process control system, incorporating SCADA and PLC programming and commissioning.


## Water and Sewage Treatment Plant Projects

- Gold Coast City Council - Design, programming, installation and commissioning of a water purification process control system.
- Redland Shire Council - Switchboard manufacture, PLC and CITECT SCADA supply, as well as programming and commissioning services.


## CRIIECTDE

Transient Discriminating Filter


The TDF series has been specifically designed for process control applications to protect the switched mode power supply units on devices such as PLC controllers, SCADA systems and motor controllers. Units are UL Recognized and available for 3A, 10A and 20A loads and suitable for $110-120 \mathrm{~V}$ ac/dc and 220-240Vac circuits.

- In-line series protection
- High efficiency low pass sine wave filtering - ideal for the protection of switched mode power supplies
- Three modes of protection: L-N, L-G \& N-G
- 35 mm DIN rail mount - simple installation
- Transient Discriminating (TD) Technology provides increased service life
- LED status indication and opto-isolated output for remote status monitoring

The TDF is a series connected, single phase surge filter providing an aggregate surge capacity of $50 \mathrm{kA}(8 / 20 \mu \mathrm{~s})$ across L-N, L-G. and N-G. The low pass filter provides up to 65 dB of attenuation to voltage transients. Not only does this reduce the residual letthrough voltage, but it also helps further reduce the steep voltage rate-of-rise providing superior protection for sensitive electronic equipment.

| Model | TDF3A 120 V | $\begin{aligned} & \text { TDF3A } \\ & 240 \mathrm{~V} \end{aligned}$ | TDF10A 120 V | TDF10A 240 V | $\begin{aligned} & \text { TDF20A } \\ & 120 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & \text { TDF20A } \\ & 240 \mathrm{~V} \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Item Number for Europe | 700001 | 700002 | 700003 | 700004 | 700005 | 700006 |
| Nominal Voltage $U_{n}$ | 120 V | 240 V | 120 V | 240 V | 120 V | 240 V |
| Distribution System | 1Ph 2W+G |  |  |  |  |  |
| Max. Cont. Operating Voltage $U_{c}$ | 170 V | 340 V | 170 V | 340 V | 170 V | 340 V |
| Stand-off Voltage | 240 V | 400 V | 240 V | 400 V | 240 V | 400 V |
| Frequency | 0 to 60Hz | $50 / 60 \mathrm{~Hz}$ | 0 to 60Hz | 0 to 60Hz | 0 to 60 Hz | $50 / 60 \mathrm{~Hz}$ |
| Max. Line Current L | 3A |  | 10A |  | 20A |  |
| Operating Current © Un | 135 mA | 250 mA | 240 mA | 480 mA | 240 mA | 480 mA |
| Max. Discharge Current $I_{\text {max }}$ | 20kA $8 / 20 \mu \mathrm{~L}$ L-N 20kA $8 / 20 \mu \mathrm{~L}$ L-G 10kA $8 / 20 \mu \mathrm{~s} \mathrm{~N}-\mathrm{G}$ |  |  |  |  |  |
| Protection Modes | All modes protected via L-N, L-G \& N-G |  |  |  |  |  |
| Technology | TD Technology <br> In-line series low pass sine wave filter |  |  |  |  |  |
|  | $\begin{aligned} & 500 \mathrm{~V} \\ & <250 \mathrm{~V} \end{aligned}$ | $\left\lvert\, \begin{aligned} & 700 \mathrm{~V} \\ & <600 \mathrm{~V} \end{aligned}\right.$ | $\begin{aligned} & 500 \mathrm{~V} \\ & <250 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 700 \mathrm{~V} \\ & <600 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 500 \mathrm{~V} \\ & <250 \mathrm{~V} \end{aligned}$ | $\begin{aligned} & 700 \mathrm{~V} \\ & <600 \mathrm{~V} \end{aligned}$ |
| Filtering © 100 kHz | -62dB |  | -65dB |  | -53dB |  |
| Status | Green LED. On=Ok. isolated opto-coupler output ${ }^{(1)}$ |  |  |  |  |  |
| Dimensions | $4 \mathrm{M} .90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 72 \mathrm{~mm}$ <br> $\left(3.5^{*} \times 2.6^{\prime \prime} \times 2.8^{*}\right)$$\quad$$8 \mathrm{M} .90 \mathrm{~mm} \times 68 \mathrm{~mm} \times 144 \mathrm{~mm}$ <br> $\left(3.5^{\prime \prime} \times 2.6^{\prime \prime} \times 5.6^{*}\right)$ |  |  |  |  |  |
| Weight | 0.35 kg (0.77lb) $\quad 0.75 \mathrm{~kg}$ (0.771b) |  |  |  | 10.8kg (1.7 ${ }^{\text {b }}$ |  |
| Enclosure | DIN 43 880, UL94V-0 thermoplastic, IP 20 (NEMA-1) |  |  |  |  |  |
| Connection | $1 \mathrm{~mm}^{2}$ to $6 \mathrm{~mm}^{2}$ (\#18AWG to \#10) |  |  |  |  |  |
| Mounting | 35 mm top hat DIN rail |  |  |  |  |  |
| Back-up Overcurrent Protection | $3 \mathrm{~A}-10 \mathrm{~A}$ |  |  |  | 20A |  |
| Temperature | $-35^{\circ} \mathrm{C}$ to $+55^{\circ} \mathrm{C}\left(-31^{\circ} \mathrm{F}\right.$ to $\left.+131^{\circ} \mathrm{F}\right)$ |  |  |  |  |  |
| Humidity | 0\% to 90\% |  |  |  |  |  |
| Warranty | 5 years |  |  |  |  |  |
| Approvals | UL 1449, UL 1283, CSA 22.2, C-Tick, CE (NOM 3A, 120V) |  |  |  |  |  |
| Surge Rated to Meet | ANSUEEE C62.41-1991 Cat A, Cat B, Cat C |  |  |  |  |  |

(1) Opto-coupler output can be connected to DAR275V to provide form $C$ dry contacts

年
SP174 Jesmond Road Fig Tree Pocket SPS Main Switch TロE-DINLINE"
SURGE SUPPRESSOR

INSTALLATION INSTRUCTIONS

## Includes TDS-AR Alarm Relay

 and TDS-SC Surge Counter
## ERICD'

$$
\begin{aligned}
& \text { ERICO Lightning Technologies Pty. Ltd. design }
\end{aligned}
$$

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## Erfitin

## I. WARNINGS

- Prior to installation ensure that the unit is of the correct voltage and frequency, and is
the type recommended for the local power of the correct voltage and frequency, and is
the type recommended for the local power distribution, and for the equipment being protected.
- Hazardous voltages may exist internally to the modules. The units should be installed (and replaced) only by qualified personnel (and replaced) only by qualified personnel Safety Standards.
- Do not power three phase connected units without the upstream neutral connected. Failure to do so may damage the units and/ or the load.
- Where the unit has an earth terminal, this
must be connected to a low impedance earth

Where the unit has an earth terminal, this
must be connected to a low impedance earth (<10 $\Omega$ ) for correct operation. palce TMAS 1145 Active 10/12/2014 not be relied on in isolation.

PAGE 4

- If connecting to the TDS Opto-coupler alarm outputs do not reverse the $+/$ connections or exceed the maximum permissible ratings as damage may occur.
- Use only the TDS-AR Alarm Relay with TDS-DINLINE.
- Use only TDS-SC Surge Counter with TDS DINLINE.
- Units must be installed in an enclosure or panel, ensure this does not cause the units environmental ratings to be exceeded.
- Do not "Megger" or "Flash Test" circuits with TDS-DINLINE units installed.
- All instructions must be followed to ensure correct and safe operation.
- Diagrams are illustrative only, and should


## 2. INTRODUCTION

This Installation Manual details the preferred procedure for the installation of TDSDINLINE ${ }^{\text {TA }}$ SURGE SUPPRESSORS and options.

The TDS-DINLINE SURGE SUPPRESSORS are available in a variety of surge ratings, which are packaged in the $2 \mathrm{M}, 4 \mathrm{M}$ and 8 M "DIN $43880^{n}$ compliant enclosures. They are designed to suit many distribution systems including TN-C, TN-S, TN-C-S (MEN) and TT. They can be selected for use with distribution systems with nominal RMS voltages of 110 / $120,220 / 230 / 240 \mathrm{~V}$ or 277 V at frequencies of $50 / 60 \mathrm{~Hz}$.

Recommended installation and connection of the ALARM RELAY (TDS-AR) is detailed in

Section 14. Installation and connection of the Surge Counter (TDS-SC) is detailed in section 15.

## 3. QUICK INSTALLATION GUIDE

Install in the following manner:

1. Ensure that power is removed from the area and circuits to be connected.
2. Install the DIN mounting rail, if not fitted.
3. Snap lock the Surge Suppressor to the rail.
4. Connect wiring to the indicated terminals.
5. Ensure compliance with supplied instructions.
6. Apply power and observe correct operation of Status Indicators, and alarm facilities if utilised.

## ERFLTE4

## 4. PROTECTION CONCEPTS

To optimise effectiveness of installed protection a concept of "Unprotected" and "Protected" wiring should be followed. Wiring from the transient source to the Surge Suppressor should be considered "Unprotected" and kept remote from all other wiring (approximately 300 mm ) where possible. Wiring on the equipment side of the Surge Suppressor should be considered "Protected".

The separation of "Protected" from
"Unprotected" wiring is recommended in order to minimise the risk of transients conducted on "Unprotected" wiring cross coupling on to "Protected" circuits, thus compromising the level of protection available from the Surge Suppressor.


## 5. MOUNTING

Surge Suppressors are designed to clip to 35 mm top hat DIN rails (to Standard EN50022). Unless otherwise mechanically restrained, use horizontal DIN rails with the


Surge Suppressor fixing clip to the bottom, ie label text the correct way up.

Units must be installed in an enclosure or panel to provide the appropriate degree of electrical and environmental protection.

Only use enclosures that:

- Do not cause the internal temperature to exceed 55 deg C .
- Provide adequate electrical and safety protection.
- Prevent the ingress of moisture and water.
- Allow Surge Suppressor Status Indication to be inspected.


## 6. VOLTAGE RATINGS

Ensure that the correct voltage rating unit is installed. Exceeding the nominal voltage rating under transient conditions may affect product life. Do not exceed the Maximum Permissible Abnormal Over Voltage rating.

| Model | Nominal Voltage | Maximum <br> Permissibie <br> Abnormal <br> Over Voltage |
| :---: | :---: | :---: |
| TDS XXX-120 | $110-120 \mathrm{Vac}$ | 240 Vac |
| TDS XXX-208 | 208 Vac | 260 Vac |
| TDS XXX-240 | $220-240 \mathrm{Vac}$ | 415 Vac |
| TDS XXX-277 | $220-277 \mathrm{Vac}$ | 480 Vac |

## 7. PROTECTION MODES

Protection Modes refers to how the internal protection is arranged and applied to the circuit to be protected.
TDS-DINLINE Surge Suppressors are Single Mode units which provide protection between two conductors connected to the terminals marked T1 and T2. These units can be connected to provide protection from PhaseNeutral* or Phase-Earth* or Neutral-Earth. To allow the status indication and alarm circuitry to operate, a neutral connection is required for Phase-Earth* configured units, and a Phase* connection is required for Neutral-Earth configured units.

* Note. Some users may be used to the terminology "Active" or "Line", in place of "Phase". For consistency "Phase" is used throughout this documentation.


## SINGLE MODE UNITS



## CONNECTION OPTIONS

Ph-N Protection Ph-E Protection N-E Protection Ph-Ph Protection


|  | PROTECTONMODE |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Terminals | Ph-N | Ph-E | $\mathrm{N}-E$ | $\mathrm{Ph}_{\mathrm{x}}-\mathrm{Ph}_{y}$ |
| $\mathrm{~T}_{1}$ | Ph | E | E | $\mathrm{Ph}_{\mathrm{x}}$ |
| T 2 | N | Ph | N | $\mathrm{Ph}_{\mathrm{y}}$ |
| X | Ph | N | Ph | $\mathrm{Ph}_{\mathrm{x}}$ |

Phase to Phase protection can also be provided by Surge Suppressors, provided that the nominal and maximum voltage ratings are not exceeded.

## 8. CONDUCTOR SIZES

Each Surge Suppressor terminal is designed to accept wire sizes from $1.5 \mathrm{~mm}^{2}$ to $6 \mathrm{~mm}^{2}$, solid or stranded conductor. Insulation should be stripped back 8 mm before terminating into the tunnel terminal.

Where two conductors require termination in the same tunnel terminal, conductors should be limited to a maximum size of $4 \mathrm{~mm}^{2}$.

Do not use excessive force when tightening the terminal.


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## 9 CONDUCTOR LENGTH

To optimise transient performance, attempt to connect units in the "Preferred" fashion as depicted on pages 11 and 12 . Some units have double terminals to facilitate this. Take care not to run parallel "protected" and "unprotected" wiring.


Where this is not possible due to layout or conductor sizing, use the "Non-preferred" " T " connection method as depicted on page 13. With this connection method, the "T" lead length should be kept as short as practicable (less than 100 mm ) and wires should be bundled together. The " T " conductor should be equal in size to the main conductor, up to a maximum of $6 \mathrm{~mm}^{2}$.

## NON-PREFERRED CONNECTION METHOD




## UNETALLATMEN TNETERETIUNE



## 10. RCD, ELCB

Where $\mathrm{RCD} /$ /ELCBs (Residual Current Devices / Earth Leakage Circuit Breakers) are fitted the Surge Suppressor units should be installed in the circuit prior to these devices
(ie upstream). Where this can not be avoided and RCDs/ELCBs are installed upstream, nuisance tripping of the RCD/ELCB may occur during transient activity.
Contact your local representative for advice if upstream RCDs/ELCBs can not be avoided.


PRUE:4 4 TMS1145
Active 10/12/2014

## II. ISOLATION AND FUSING

Overcurrent and short circuit protection must be provided to protect the Surge Suppressor and associated wiring if a fault develops. The overcurrent protection should be installed in such a manner to also provide a means of isolating the TDS-DINLINE module from the mains supply. This is an important safety consideration and is required in the event that any future maintenance or testing is needed.

For Surge Suppressors installed in the "preferred" connection method (page 12), upstream overcurrent protection should be installed based on the maximum current carrying capacity of the conductors. Australian regulations AS3000-1991, Table B2 specifies the following upstream protection for the protection of single phase circuits.

|  |  |  |
| :---: | :---: | :---: |
| Conductor Size |  | ed Fuse |
| A mm² | $C B$ or Fuse | Rewirable Fuse |
| $1.5 \mathrm{~mm}^{2}$ | 16A | 12A |
| $2.5 \mathrm{~mm}^{2}$ | 20A | 16A |
| $4.0 \mathrm{~mm}^{2}$ | 25A | 20A |
| 6.0 mm² | 32A | 25A |
| Fuse selection based on maximum curent carying capacity of conductor. Smaller rated fuse may be selected il required. $C B=$ Circuit Breaker. |  |  |

## ERIEZ

For Surge Suppressors installed in the "nonpreferred" connection method (page 13), depending upon the size and fusing in the main circuit, the " $T$ " connection may require independent fusing to be installed.

Circuits with upstream protection rated at greater than 100A must have a 100A HRC fuse or circuit breaker installed in the $T$ connection as detailed by the following diagram.

Warning:
Isolation/fusing installed in the "T" connection may disconnect the Surge Suppressor from the circuit/equipment to be protected. The remote alarm contacts of the ALARM RELAY (TDSAR ) should be used to detect this occurrence. Operation of the isolation/fuse will remove the protection from the circuit.

|  |  |  |  |
| :---: | :---: | :---: | :---: |
| Supply Conductor Size | Upstream* Protection | T.Connection Size | Required T-Connection Fuse |
| A mm ${ }^{\text {a }}$ | A fuse rating | Bmm² | B luse rating |
| $1.5 \mathrm{~mm}^{2}$ | 16A | $1.5 .6 \mathrm{~mm}^{2}$ | Nil |
| $2.5 \mathrm{~mm}^{2}$ | 20 A | $2.5 \cdot 6 \mathrm{~mm}^{2}$ | Nil |
| $4.0 \mathrm{~mm}^{2}$ | $25 \%$ | $4.6 \mathrm{~mm}^{2}$ | Nil |
| $6.0 \mathrm{~mm}^{2}$ | 32A | ¢ mm² | Nil |
| $>6.0 \mathrm{~mm}^{2}$ | <100A | $6 \mathrm{~mm}^{2}$ | $\mathrm{Nil}^{+*}$ |
| $>6 \mathrm{~mm}^{2}$ | $>100 \mathrm{~A}$ | $6 \mathrm{~mm}^{2}$ | $100 \mathrm{~A}^{*}$ |
| Fuse rating A seiection based on maximum current carring capaciy ol <br> conduclor.Smaller rating luse may be selecced ir required. <br> - Short dircaili prolection selection baseed on $\mathbb{R}^{2}$ r rting of cable and fuse. |  |  |  |

## INEYALLATION INETHUETIGNG:

The selection of the 100A HRC fuse is not based on the load carrying capacity of the main circuit but the ${ }^{4} \mathrm{~T}$ " connection $\mathrm{I}^{2}$ t rating. The " $T$ " connection under normal conditions does not carry the load current. Only under surge or fault conditions does this connection carry large currents. Under Australian Standard AS3008.1-1989 it is permissible to rate the protection for these types of circuits by the $\mathrm{I}^{2} \mathrm{t}$ ratings of the cable. For installation of Surge Suppressor in countries not covered by these regulations it is recommended that this practice be followed, unless it conflicts with the compliance of the local regulations.

## I2. STATUS INDICATION

A characteristic of all transient and surge protection devices is that they degrade in proportion to the magnitude and number of
incident surges to which they have been subjected. Status indication should be periodically monitored to determine if replacement is required.

## $2 S$ units

These units are identified by the single Status Indicator provided on the front panel. When power is applied and full surge capacity is available the Status Indicator will be illuminated. Should the indicator fail to illuminate the Surge Suppressor should be replaced, as optimum protection is no longer provided. Note: The Status Indicator will not operate (regardless of surge capacity) if power is not available.

## 4 S units

These units are identified by two Status Indicators which are provided on the front panel. These Status Indicators monitor
separate protection segments. Each Status Indicator is illuminated when power is available and when full surge capacity is available by that segment. The Surge Suppressor should be replaced if either Status Indicator fails to illuminate. Note: The Status Indicators will not operate (regardless of surge capacity) if power is not available.

## 8 S units

These units are identified by four Status Indicators which operate similar to above. The Surge Suppressor should be replaced if any two or more Status Indicators fail to illuminate.

## 13. MAINTENANCE \& TESTING

Before removing any unit from service ensure that power to the device is isolated. Replacement of any Surge Suppressor should only be undertaken in accordance with all relevant Electricity and Safety Standards by suitably qualified personnel.

TDS-DINLINE units should be inspected periodically, and also following any periods of lightning or transient activity. Check the status indicators and replace if recommended in Section 12 -STATUS INDICATION.

For high transient exposure sites or those of a critical operational nature, it is recommended that the alarm outputs be monitored to provide an additional warning of reduced capacity (refer Section 14-ALARM RELAY. TDS-AR).

TDS-DINLINE Surge Suppressor units are designed for optimum performance under severe transient activity. To provide this performance, electronic components in the unit are encased in a patented proprietary, shock and thermal absorbent compound. Units cannot be serviced, they must be replaced.

Do not attempt to open or tamper with the units in any way as this may compromise performance and will void warranty.

Do not "Megger" or perform other types of electrical tests that apply voltages greater than the nominal operating voltage of the Surge Suppressor. The Suppressor will attempt to limit these voltages thereby affecting the test result. Where these tests must be performed, remove the Surge Suppressor from circuit first.

## 14. ALARM RELAY (TDS-AR)

The Surge Suppressor status monitoring circuit which provides the visual status display also provides a low voltage optocoupler alarm output circuit. This should only be connected to the TDS ALARM RELAY. The TDS-AR voltage free alarm contacts may then provide output to external alarm systems or remote monitoring circuits.

The TDS ALARM RELAY provides fully isolated potential free change-over alarm output contacts. One TDS-AR can be used per Suppressor opto-coupler alarm or Multiple Suppressor opto-coupler alarms can be connected in series to the one TDS-AR to provide a common output.
$1 \times$ TDS－AR supports：
$20 \times \operatorname{TDS} 140-2 \mathrm{~S}$
or $10 \times \operatorname{TDS} 180-4 S$
or $5 \times$ TDS 1160－8S
or relative combinations．
It is recommended that the TDS－AR unit be powered from the same power circuit that feeds to the Surge Suppressor being monitored，however it can be powered from other circuits．This allows for example，one TDS－AR unit to be connected to separate Surge Suppressors that are protecting a three phase circuit．

To satisfy Australian wiring regulations the phase supply to the TDS－AR needs to be protected by an overcurrent fuse／circuit breaker．The overcurrent protection should be selected according to the wiring size
connecting to the TDS－AR Phase and Neutral terminals．For reference a table of values is given on page 24.

Note．Depending upon the usage of the TDS－ AR output contacts，failure of power to the TDS－AR may be interpreted as a failure of one or more Surge Suppressors．Visual inspection of all units Status displays would determine this．

|     <br> STATUS Protection Operational Protection Alarm Fault Mode |
| :--- |
| DISPLAY |
|  |



## MULTIPLE ALARM CONNECTION EXAMPLE


*WARNING - Connections are polarity sensitive. Do not reverse.

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TDS-AR SPECIFICATIONS:
Output Contact Ratings

| Nominal switching capacity | 2 A 30 VDC |
| :--- | :--- |
| Maximum switching power | 60 W 125 VA |
| Maximum switching voltage | $220 \mathrm{VDC}, 250 \mathrm{VAC}$ |
| Maximum switching current | 2 A |
| Input to output isolation | 4 kV |
| Note: TDS-AR operates on supply voltages <br> of $100-480 \mathrm{~V}$ Vrms. |  |

## TDS-AR OVERCURRENT PROTECTION

The power supply to the TDS-AR circuit must be provided with upstream overcurrent protection. The fuse rating should be based on
the wiring size used to connect to the TDS-AR Ph \& N terminals.

Australian regulations AS3000-1991, Table B2 specifies the following upstream protection for single phase circuits, unenclosed in air.

| Cable Size | HRC Fuse or CB | Rewirable Fuse |
| :--- | :--- | :--- |
| $1.5 \mathrm{~mm}^{2}$ | 16 A | 12 A |
| $2.5 \mathrm{~mm}^{2}$ | 20 A | 16 A |
| $4 \mathrm{~mm}^{2}$ | 25 A | 20 A |
| $6 \mathrm{~mm}^{2}$ | 32 A | 25 A |

Where overcurrent protection of the appropriate rating or smaller is already fitted in the upstream circuit, overcurrent protection at the TDS-AR will not be required.

## INETRLLATMEN ONE母GHETIYNE <br> PTosidinline

## ALARM TESTING

Testing of the Alarm Relay which is connected to a fully functional Surge Suppressor unit can be accomplished by removing power to the Surge Suppressor only. The Alarm Relay Status indication and output contacts should alter from the Normal to Fault condition.

Testing of the Alarm Relay unit alone may be accomplished by disconnecting the $+/$. connections to the unit. When power is applied the "Fault" Status Indicator should be illuminated. By connecting the $+/$ - terminals together, the "Normal" Status Indicator should be illuminated. The output contacts should alter to the appropriate state.

## USE OF OTHER INTERFACES

Only ERICO TDS-AR units are recommended for the interfacing of equipment to the TDSDINLINE opto-coupler alarm output circuit.

The direct connection of other equipment to the opto-coupler alarm output circuit may not provide sufficient isolation or exceed the optocoupler specifications. This may damage the Surge Suppressor and/or the connected equipment. Warranty may be voided under such circumstances.


## I5. TDS-SC SURGE COUNTER

The Surge Counter is designed to interface to the TDS DINLINE units via the supplied CT, to record the number of surges and impulses diverted. This is achieved by measuring the transient current diverted by the TDS protection device. It is important that the CT be installed into the circuit where it is measuring the surge current only, and not where mains load current is passed through the core. Method 1 and Method 2 (page 28) detail the correct connection. Page 27 shows an incorrect connection as the equipment load current is passed through the CT core. The magnetic field from the load carrying conductor may cause the CT core to saturate. The surge Counter may fail to record any transients and additionally dangerously high voltages may be present on the TDS-SC \& CT terminals.

## WARNINGS

- Do not install CT into load current carrying circuits.
- CT must be installed into surge current path only.
- Only install the CT and Surge Counter after all power and transient sources are removed and isolated from the equipment the Surge Counter is to monitor.
- Do not open circuit or disconnect connections on the secondary of the CT when monitored circuit is powered or connected to possible transient source. Hazardous voltages may exist in the secondary circuit and in the CT/TDS-SC if these instructions are not followed.
- Only this CT should be used with the TDSSC Surge Counter, other suppliers devices may not operate correctly or pose a safety hazard.
- These instructions should only be carried out by qualified personnel in accordance with relevant national electrical and safety codes. Hazardous voltage may exist in the monitored system.



## ERft

## SURGE COUNTER CONNECTION METHODS*



Correct Method 1


Correct Method 2

- Typical connecions only


## 14. TYPICAL DOMESTIC INSTALLATION (from 80A fused supply)



## 17. EXTENDED WARRANTY

This product has a limited warranty to be free from defects in materials and workmanship for a period of five (5) years from the date of dispatch from the Manufacturer. The Purchaser acknowledges that lightning is a natural event with statistical variation in behaviour and energy levels which may exceed product ratings, and $100 \%$ protection is not offered and cannot be provided for. Therefore the Manufacturer's liability is limited to the repair or replacement of the product (at the Manufacturer's sole option) which in its judgement has not been abused, misused, interfered with by any person not authorised by the Manufacturer, or exposed to energy or transient levels exceeding the Manufacturer's specifications for the product. The product must be installed and earthed (where applicable) in strict accordance with the Manufacturer's specifications and all relevant national Electricity and Safety Standards. The Manufacturer and the

Purchaser mutually acknowledge that the product, by its nature, may be subject to degradation as a consequence of the number and severity of surges and transients that it experiences in normal use, and that this warranty excludes such gradual or sudden degradation. This warranty does not indemnify the Purchaser of the product for any consequential claim for damages or loss of operations or service or profits. Customers should contact their nearest manufacturer's agent to obtain a Product Repair Authorisation Number prior to making any claim under this warranty. This is only a summary of the warranty given by the Manufacturer. The full text of the warranty is set out in the Manufacturer's Conditions of Quotation and Sale. The above limited warranty is additional to rights which arise in respect of the sale of industrial and technical products and services to knowledgable buyers under the Australian Trade Practices Act 1974 as amended.

## I 8. SIX POINT PLAN

TDS-DINLINE SURGE SUPPRESSORs form an important part of the much larger ERICO lightning, surge and transient protection philosophy (ERICO Lightning Technologies "Six Point Plan"). The level of protection and the degree of attention dedicated to each of the six points will require careful consideration for each site. The degree of protection required is determined by the individual site location/exposure with the aid of risk management principals.

For further advice on your protection needs please contact your local representative.

SP174 Jesmond Road Fig Tree Pocket SPS Main Switchboard OM Manual


Technopark, Dowsings Point, Tasmania, Australia. GPO Box 536 Hobart, Tasmania, Australia 7001 Telephone: 61 (0) 362373200 Facsimile: 61 (0) 362730399

## SERIAL COMMUNICATION ADDENDUM to the

## INSTRUCTION MANUAL - ENGLISH, 01-1989-01

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## 1. MOUNTING DESCRIPTION

### 1.1 Flat cable selection and connection to control board



| Position | Description |
| :--- | :--- |
| 1 | Extra long 8-8 pole flat cable for size 5 inverters. |
| 2 | Long 8-8 pole flat cable for FDU \& VFX size 1-4. |
| 3 | Short 8-8 pole flat cable for VFB/MSF. |
| 4 | Long 8-12 pole flat cable for old version of control <br> board (FDU only). |

Note! Flat cable number 4 should only be used only on old FDU control boards where contact X 4 is $\mathbf{1 2}$ pole.

IMPORTANT! Make sure that the flat cable is connected with the correct polarity in both ends. Incorrect fitting may result in damage to the circuit boards! The male contacts (on the flat cable) has a pin which matches the hole of the circuit board mircomatch contacts.


Connect the flat cable to the female micromatch contact X4 on the control board. The male/female contact must have the same number of poles.

PIN must be guided into the HOLE!

### 1.2 Select product type and follow the instructions

## MSF 017-250 / VFB



| Position | Description |
| :--- | :--- |
| 1 | Remove the original lid on top before installing the <br> option. |



| Position | Description |
| :--- | :--- |
| 2 | Mount the option into place with $3 \times$ M3x4 screws <br> $+3 \times$ washers. |
| 3 | Mount flat cable between control board and option. <br> Note! Polarity! (see step 1) |

## MSF 310-1400



| Position | Description |
| :--- | :--- |
| 1 | Start by removing the lid. |



| Position | Description |
| :--- | :--- |
| 2 | Mount the option with $3 \times M 3 \times 4$ screws + washers. |
| 3 | Connect the flat cable between the option and con- <br> trol board. Note! Polarity! (see step 1) |



| Position | Description |
| :--- | :--- |
| 3 | Connect the flat cable between the option and con- <br> trol board. Note! Polarity! (see step 1) |

## FDU size 1



| Position | Description |
| :--- | :--- |
| 1 | Attatch the scom option to the acrylic glass plate <br> with $3 \times$ M3×8 screws (on top) with M3 nut (on the <br> bottom side). |
| 2 | Make sure that the enclosed ground cable is <br> attatched to the upper right screw (see picture). |

Note! Orlentation of option compared with the arcylic glass plate (hole in plate to the left of the option).


| Position | Description |
| :--- | :--- |
| 3 | Mount $1 \times$ M4×30 METAL spacer in this corner. <br> Note! Position of the METAL spacer is important!!! |
| 4 | Mount $3 \times(2 \times$ M4×15) NYLON spacers here. |



| Position | Description |
| :--- | :--- |
| 5 | Mount the plate onto the spacers with $4 \times \mathrm{M} 4 \times 8$ <br> screws + washers. |
| 6 | Note! connect the ground cable from the option to <br> the metal spacer in the uppper right corner. |


| Position | Description |
| :--- | :--- |
| 7 | Connect the flatcable to the 8 pole female micro- <br> match contact. NOTE! Polarity of the flat cable (see <br> step 1). |
| 8 | If you are using an old control board: Connect the <br> PPU-cable to the control board through the hole in <br> the acrylic glass plate. |

## FDU and VFX size 2



| Position | Description |
| :--- | :--- |
| 1 | Mount the option on $3 \times M 3 \times 35$ metal spacers with <br> $3 \times M 3 \times 4$ screws + washers. |



| Position | Description |
| :--- | :--- |
| 2 | Connect the flatcable from the controlboard to the <br> options 8-pole micromatch contact. Note! Polarity! <br> (see step 1) |
| 3 | Fasten flat cable with clip here |

## FDU and VFX size 3-4



| Position | Description |
| :--- | :--- |
| 1 | Mount the option on $3 \times M 3 \times 35$ metal spacers with <br> $3 \times M 3 \times 4$ screws + washers. |
| 2 | Connect the flatcable to scom option. Note! Polar- <br> ity! (see step 1). |

FDU and VFX size 3-4


| Position | Description |
| :--- | :--- |
| 3 | Fasten the flat cable between option and control- <br> board with a clip. |

## FDU and VFX size 5



| Position | Description |
| :--- | :--- |
| 1 | Connect flatcable to scom option. Note! Polarity! <br> (see step 1). |
| 2 | Mount the option on $3 \times \mathrm{M} 3 \times 35$ metal spacers with <br> $3 \times \mathrm{M} 3 \times 4$ screws + washers. |



| Position |  | Description |
| :--- | :--- | :--- |
| 1 | CRIO option. |  |

Combination: VFX size 5 (or 4) with scom and CRIO option


| Position | Description |
| :--- | :--- |
| 1 | Let the flat cable to the scom option go under CRIO <br> option. |
| 2 | CRIO option. |

Combination: VFX with both scom and PTC option


| Position | Description |
| :--- | :--- |
| 1 | Fasten flat cable with clip. |
| 2 | PTC on top of control board. |

Combination: VFX with both scom and Encoder option


| Position | Description |
| :--- | :--- |
| 1 | Fasten flat cable with clip. |
| 2 | Encoder option on top of control board. |



| Position | Description |
| :--- | :--- |
| 1 | Fasten the flatcable(s) with enclosed clips as close <br> to the metal plate as possible. (picture $=$ example) |



| Position | Description |
| :--- | :--- |
| 1 | Superfluous flat cable length should be folded <br> together and put in clip. (picture $=$ example) |

## 2. PARAMETER LIST FOR MSF

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

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

| Parameter type | Modbus logical <br> numbers | Modbus actual numbers |
| :--- | :--- | :--- |
| Coil Status | $1-10000$ | $0-9999$ (Logical-1) |
| Input Status | $10001-20000$ | $0-9999$ (Logic al-10001) |
| Input Registers | $30001-40000$ | $0-9999$ (Logical-30001) |
| Holding Registers | $40001-50000$ | $0-9999$ (Logical-40001) |

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

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

### 2.1 Coil status list

Table 1 Coil status list

| Modbus logical no | Modbus no | Function/Name | Range/Unlt | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 0 | Alarm reset | 0->1 = Reset |  |
| 2 | 1 | Run /-Stop | Stop=0, Run=1 |  |
| 3 | 2 | Jog forward | Stop=0, Run=1 |  |
| 4 | 3 | Jog reverse | Stop=0, Run=1 |  |
| 5 | 4 | Auto-set monitor | $0->1$ = Auto-set | 089 |
| 6 | 5 | Reset power consumption | 0->1 = Reset | 206 |
| 26 | 25 | Pump control | Off, on; off=0, on=1 | 022 |
| 27 | 26 | Full voltage start D.O.L. | Off, on; off $=0$, on=1 | 024 |
| 28 | 27 | By pass | Off, on; off=0, on=1 | 032 |
| 29 | 28 | Power factor control PFC | Off, on; off=0, on=1 | 033 |
| 30 | 29 | Motor PTC input | No, yes; no=0, yes=1 | 071 |
| 31 | 30 | Run at single phase input failure | No, yes; no=0, yes=1 | 101 |
| 32 | 31 | Run at current limit time-out | No, yes; no=0, yes=1 | 102 |
| 33 | 32 | Jog forward enable | No, yes; no=0, yes=1 | 103 |
| 34 | 33 | Jog reverse enable | No, yes; no=0, yes=1 | 104 |
| 35 | 34 | Phase reversal alarm | Off, on; off=0, on=1 | 088 |

### 2.2 Input status list

| Modbus <br> logical <br> no | Modbus <br> no | Function/Name | Range/Unit | Product <br> MSF <br> menu |
| :--- | :--- | :--- | :--- | :---: |
| 10001 | 0 | Locked key- <br> board info | 0=Unlocked, 1=Locked | 221 |
| 10003 | 2 | Pre-Alarm status | 0=No Pre-Alarm, <br> 1=Pre-Alarm |  |
| 10004 | 3 | Max Pre-Alarm <br> status | O=No Pre-Alarm, <br> 1=Pre-Alarm |  |
| 10005 | 4 | Min Pre-Alarm <br> status | 0=No Pre-Alarm, <br> 1=Pre-alarm |  |

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### 2.3 Input register list

Table 2 Input register list

| Modbus logial no | Modbus no | Function/Name | Range/Unit | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 30001 | 0 | Power consumption high word | 0-2E9 Wh,1Wh $<\cdot>1$ | 205 |
| 30002 | 1 | Power consumption low word |  | 205 |
| 30005 | 4 | Output shaft power high word | O-+2E9 W, 1 W<->1 | 203 |
| 30006 | 5 | Output shaft power low word |  | 203 |
| 30007 | 6 | Operation time high word | 1 hour <->1 | 208 |
| 30008 | 7 | Operation time low word | 1 hour <->1 | 208 |
| 30011 | 10 | Shaft torque high word | $\begin{aligned} & 0-+2 E 8 \mathrm{Nm}, 0.1 \mathrm{Nm} \\ & <->1 \end{aligned}$ | 207 |
| 30012 | 11 | Shaft torque low word | " | 207 |
| 30017 | 16 | Software version | $\begin{aligned} & \text { rO1==> HB = release } \\ & \text { code, LB }=01 \end{aligned}$ |  |
| 30018 | 17 | Software variant | $\begin{aligned} & \mathrm{v} 001==>\mathrm{HB}=0, \mathrm{LB} \\ & =01 \end{aligned}$ |  |
| 30019 | 18 | Current | 0-6553.5A, 0.1A <->1 | 005 |
| 30020 | 19 | Phase 1 current | " | 211 |
| 30021 | 20 | Phase 2 current | " | 212 |
| 30022 | 21 | Phase 3 current | " | 213 |
| 30024 | 23 | Line main voltage | 0-6553.5V, 0.1V<->1 | 202 |
| 30025 | 24 | Line main voltage 1 | " | 214 |
| 30026 | 25 | Line main voltage 2 | " | 215 |
| 30027 | 26 | Line main voltage 3 | " | 216 |
| 30028 | 27 | Softstarter type | 0-19 |  |
| 30029 | 28 | Control start by / Control mode | $\begin{aligned} & 1=\text { Keyboard } \\ & 2=\text { Remote } \\ & 3=\text { Serial comm. } \end{aligned}$ | 006 |
| 30031 | 30 | Serial comm. unit address | 1-247 | 111 |

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Table 2 Input register list (continuing)

| Modbus logial no | Modbus no | Function/Name | Range/Unit | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 30032 | 31 | Serial comm. baudrate | $\begin{aligned} & 2400-38400 \text { Baud, } \\ & 100 \text { Baud <-> } 1 \end{aligned}$ | 112 |
| 30033 | 32 | Serial comm. parity | $\begin{aligned} & 0=\text { No parity } \\ & 1=\text { Even parity } \end{aligned}$ | 113 |
| 30034 | 33 | Serial comm. contact broken | 0-2 | 114 |
| 30035 | 34 | Actual parameter set | 1-4 |  |
| 30036 | 35 | Shaft power \% | $\begin{aligned} & -200 \%-+200 \% \\ & 1 \%<->1 \end{aligned}$ | 090 |
| 30037 | 36 | Heat sink temperature | $\begin{aligned} & 30.0-100.0^{\circ} \mathrm{C}, \\ & 0.1^{\circ} \mathrm{C}<=>1 \end{aligned}$ |  |
| 30041 | 40 | Operation mode | 1-7 |  |
| 30042 | 41 | Operation status | 1-11 |  |
| 30047 | 46 | Used thermal capacity | 0-150 \%, 1\%<->1 | 073 |
| 30048 | 47 | Power factor | 0.00-1.00,0.01 <->1 | 204 |
| 30051 | 50 | Phase sequence | $\begin{aligned} & 0-2 \\ & 0=\text { None, }, \\ & 1=\text { RST, } \\ & 2=\text { RTS } \end{aligned}$ | 087 |
| 30052 | 51 | Emotron product | 1=VFB/VFX, 2=MSF |  |
| 30103 | 102 | Trip message 1 | 0-16 | 901 |
| 30106 | 105 | Trip message 2 | See trip message 1. | 902 |
| 30109 | 108 | Trip message 3 | See trip message 1. | 903 |
| 30112 | 111 | Trip message 4 | See trip message 1. | 904 |
| 30115 | 114 | Trip message 5 | See trip message 1. | 905 |
| 30118 | 117 | Trip message 6 | See trip message 1. | 906 |
|  |  |  |  |  |

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Table 2 Input register list (continuing)

| Modbus <br> loglal <br> no | Modbus <br> no | Function/Name | Range/Unit | Product <br> MSF <br> menu |
| :---: | :---: | :--- | :--- | :--- |
| 30121 | 120 | Trip message 7 | See trip message 1. | 907 |
|  |  |  |  |  |
| 30124 | 123 | Trip message 8 | See trip message 1. | 908 |
|  |  |  |  |  |
| 30127 | 126 | Trip message 9 | See trip message 1. | 909 |
|  |  |  |  |  |
| 30130 | 129 | Trip message 10 | See trip message 1. | 910 |

### 2.4 Holding register list

Taule 3 Holding register list

| Modbus logical no | $\begin{gathered} \text { Modbus } \\ \text { no } \end{gathered}$ | Function/Name | Range/Unit | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 40001 | 0 | Nominal motor voltage | $\begin{aligned} & 200.0-700.0 \mathrm{~V} \\ & 0.1 \mathrm{~V}<->1 \end{aligned}$ | 041 |
| 40002 | 1 | Nominal motor frequency | $50-60 \mathrm{~Hz} \mathrm{1Hz<->1}$ | 046 |
| 40003 | 2 | Nominal motor current | $\begin{aligned} & 25 \%-150 \% \text { Insoft in } \\ & \text { Amp.0.1A }<->1 \end{aligned}$ | 042 |
| 40004 | 3 | Nominal motor speed | $\begin{aligned} & 500-3600 \mathrm{Rpm} \\ & \text { Bit15 }=0->1 \mathrm{rpm}<->1 \end{aligned}$ | 044 |
| 40005 | 4 | Nominal motor power | $\begin{aligned} & 25 \%-150 \% \text { Pnsoft in } \\ & W \\ & \text { Bit 15=0->1W }<->1 \\ & \text { Bit 15=1->100W }<->1 \end{aligned}$ | 043 |
| 40006 | 5 | Nominal motor cos phi | $\begin{aligned} & 50-100, \text { Cos phi = } \\ & 1.00<->100 \end{aligned}$ | 045 |
| 40013 | 12 | Start delay monitor | 1-250sec,1sec <->1 | 091 |
| 40014 | 13 | Max alarm response delay | $0.1-25.0 \sec 0.1 s->1$ | 093 |
| 40015 | 14 | Max alarm limit | 5-200\% Pn 1\%<->1 | 092 |
| 40016 | 15 | Max pre-alarm response delay | $\text { " } 0.1 \cdot 25.0 \mathrm{sec},$ $0.1 \mathrm{sec}<=>1$ VFB 40014 is used for all delays" | 093 |
| 40017 | 16 | Max pre-alarm | 5-200\% Pn 1\%<->1 | 094 |
| 40018 | 17 | Min alarm response delay | $0.1-25.0 \sec 0.1 \mathrm{~s}<->1$ | 099 |
| 40019 | 18 | Min alarm limit | 5-200\% Pn 1\%<->1 | 098 |
| 40020 | 19 | Min pre-alarm response delay | $0.1-25.0 \sec 0.1 \mathrm{~s}<->1$ | 097 |
| 40021 | 20 | Min pre-alarm | 5-200\% Pn 1\%<->1 | 096 |
| 40022 | 21 | Parameter set | $\begin{aligned} & 0 \quad=\text { External input } \\ & \text { selection } \\ & 1-4=\text { Par. set } 1-4 \end{aligned}$ | 061 |
| 40023 | 22 | Relay 1 | 1-5 | 051 |
| 40024 | 23 | Relay 2 | 1-5 | 052 |
|  |  |  |  |  |

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Table 3 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 40028 | 27 | AnIn 1, setup | O= OFF, No remote analogue control. $\begin{aligned} & 1=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 2=2-10 \mathrm{~V} / 4-20 \mathrm{~mA} \end{aligned}$ | 023 |
| 40037 | 36 | AnOut 1, function | $1 \cdot 3$ | 055 |
| 40038 | 37 | AnOut 1, setup | $0=$ OFF, No analogue output. $\begin{aligned} & 1=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 2=2-10 \mathrm{~V} / 4-20 \mathrm{~mA} \end{aligned}$ | 054 |
| 40040 | 39 | AnOut 1, scaling | 5-150\% 1\% <-> 1 | 056 |
| 42001 | 2000 | Initial voltage at start | 25-90\% U, 1\% Un<->1 | 001 |
| 42002 | 2001 | Start time ramp 1 | 1-60sec, $1 \mathrm{sec}<->1$ | 002 |
| 42003 | 2002 | Step down voltage at stop | 100-40\% U,1\% Un<->1 | 003 |
| 42004 | 2003 | Stop time ramp 1 | Off,1-120sec, 1s<->1 | 004 |
| 42005 | 2004 | Initial voltage start ramp 2 | 30-90\% U, 1\% Un<->1 | 011 |
| 42006 | 2005 | Start time ramp 2 | Off,1-60sec, $1 \mathrm{sec}<->1$ | 012 |
| 42007 | 2006 | Step down voltage stop ramp 2 | $\begin{aligned} & 100-40 \% \text { U, } \\ & 1 \% \text { Un<->1 } \end{aligned}$ | 013 |
| 42008 | 2007 | Stop time ramp 2 | Off,1-120sec, 1s<->1 | 014 |
| 42009 | 2008 | Initial torque at start | 0-250\% Tn,1\% Tn<->1 | 016 |
| 42010 | 2009 | End torque at start | $\begin{aligned} & 50-250 \% \text { Tn, } \\ & 1 \% \text { Tn<->1 } \end{aligned}$ | 017 |
| 42011 | 2010 | Torque control | $\begin{aligned} & \text { Off = Torque control } \\ & \text { OFF } \\ & 1=\text { Linear } \\ & \text { characteristic } . \\ & 2=\text { Square } \\ & \quad \text { characteristic. } \end{aligned}$ | 025 |
| 42012 | 2011 | Voltage ramp with current limit | $\begin{aligned} & \text { Off, } 150-500 \% \text { In } \\ & 1 \% \text { In }<->1 \end{aligned}$ | 020 |
| 42013 | 2012 | Current limit at start | $\begin{aligned} & \text { Off, } 150-500 \% \operatorname{In} \\ & 1 \% \ln <->1 \end{aligned}$ | 021 |
| 42014 | 2013 | DC-Brake current limit | $\begin{aligned} & 100-500 \% \ln \\ & 1 \% \ln <->1 \end{aligned}$ | 035 |
| 42015 | 2014 | DC-Brake active time | Off, 1-120sec, 1s<->1 | 034 |

Table 3 Holding register list (comtinuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 42016 | 2015 | Torque boost current limit | $\begin{aligned} & 300-700 \% \ln \\ & 1 \% \ln <->1 \end{aligned}$ | 031 |
| 42017 | 2016 | Torque boost active time | $\begin{aligned} & \text { Off, 0.1-2.0sec } \\ & 0.1 \mathrm{sec}<->1 \end{aligned}$ | 030 |
| 42018 | 2017 | External input edge control | Off, 1-100 edges, 1 edge<->1 | 058 |
| 42019 | 2018 | Slow speed torque | 10-100, 10 <->10 | 037 |
| 42020 | 2019 | Slow speed time at start | Off, 1-60sec, 1s<->1 | 038 |
| 42021 | 2020 | Slow speed time at stop | Off, 1-60sec, 1s<->1 | 039 |
| 42022 | 2021 | Slow speed DC-Brake time | Off, 1-60sec, 1s<->1 | 040 |
| 42023 | 2022 | Motor thermal protection class | Off, $2-40 \mathrm{sec}, 1 \mathrm{~s}<->1$ | 072 |
| 42024 | 2023 | Starts per hour limitation | Off, 1-90/hour, 1<->1 | 074 |
| 42025 | 2024 | Locked rotor alarm | $\begin{aligned} & \text { Off, 0.1-10.0sec } \\ & 0.1 \mathrm{sec}<->1 \end{aligned}$ | 075 |
| 42026 | 2025 | Voltage unbalance alarm | 2-25\% Un, 1\% Un<->1 | 081 |
| 42027 | 2026 | Response delay voltage unbal. | Off,1-60sec, $1 \mathrm{sec}<->1$ | 082 |
| 42028 | 2027 | Over voltage alarm | $\begin{aligned} & 100-150 \% \text { Un } \\ & 1 \% \text { Un<->1 } \end{aligned}$ | 083 |
| 42029 | 2028 | Response delay over voltage | Off, 1-60sec, 1s<->1 | 084 |
| 42030 | 2029 | Under voltage alarm | $\begin{aligned} & 75-100 \% \text { Un } \\ & 1 \% \text { Un<->1 } \end{aligned}$ | 085 |
| 42031 | 2030 | Response delay under voltage | $\begin{aligned} & \text { Off, } 1-60 \mathrm{sec}, \\ & 1 \mathrm{sec}<->1 \end{aligned}$ | 086 |
| 42032 | 2031 | Reset to factory settings | No, yes; no=0, yes=1 | 199 |
| 42033 | 2032 | Reference signal for analogue input control | 0-32767 |  |
| 42034 | 2033 | End torque at stop | 0-100\% of $\mathrm{T}_{\mathrm{n}}, 1 \%<->1$ | 19 |
| 42035 | 2034 | Brake method | 1=dynamic brake; 2=reverse brake | 36 |
| 42036 | 2035 | Digital input selection | $\begin{aligned} & \text { See description in } \\ & 3.12 .10 \end{aligned}$ | 57 |

## 3. PARAMETER LIST FOR VFB/ VFX

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

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

| Parameter type | $\|c\|$Modbus <br> logical <br> numbers | Modbus actual numbers |
| :--- | :--- | :--- |
| Coil Status | $1-10000$ | $0-9999$ (Logical-1) |
| Input Registers | $30001-$ <br> 40000 | $0-9999$ (Logical-30001) |
| Holding Registers | $40001-$ <br> 50000 | $0-9999$ (Logical-40001) |

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

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

### 3.1 Coil status list

Table 4 Coil status list

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 0 | Alarm reset | 0->1 = Reset |  |
| 2 | 1 | Run /-Stop | Stop=0, Run=1 |  |
| 3 | 2 | Run Right | 1=Run R |  |
| 4 | 3 | Run Left | 1=Run L |  |
| 5 | 4 | Auto-set monitor | O->1 = Auto-set | 815 |
| 6 | 5 | Reset power consumption | 0->1 = Reset | 6F1 |
| 7 | 6 | Reset Run-Time | 0->1 = Reset | 6D1 |
| 8 | 7 | Reset Trip Log | $0->1=$ Reset | 780 |
| 10 | 9 | Auto-restart, Overtemp trip | Off, on; off=0, on=1 | 242 |
| 11 | 10 | Auto-restart, $\mathrm{I}^{2} \mathrm{t}$ | Off, on; off $=0$, on=1 | 243 |
| 12 | 11 | Auto-restart, Overvolt D | Off, on; off=0, on=1 | 244 |
| 13 | 12 | Auto-restart, Overvolt G | Off, on; off=0, on=1 | 245 |
| 14 | 13 | Auto-restart, Overvolt L | Off, on; off=0, on=1 | 246 |
| 15 | 14 | Auto-restart, PTC | Off, on; off=0, on=1 | 247 |
| 16 | 15 | Auto-restart, External trip | Off, on; off=0, on=1 | 248 |
| 17 | 16 | Auto-restart, Phase loss motor | Off, on; off=0, on=1 | 249 |
| 18 | 17 | Auto-restart, Alarm | Off, on; off=0, on=1 | 24A |
| 19 | 18 | Auto-restart, Locked rotor | Off, on; off=0, on=1 | 24B |
| 20 | 19 | Auto-restart, Power fault | Off, on; off=0, on=1 | 24C |
| 22 | 21 | Auto-reset, comm_error | Off, on; off=0, on=1 | 24D |
|  |  |  |  |  |
| 30 | 29 | Motor PTC input | $\begin{aligned} & \text { no, yes; no=0, } \\ & \text { yes=1 } \end{aligned}$ | 271 |

### 3.2 Input register list

Table 5 Input register list

| Modbus logical no | Modbus no | Function/Name | Range/Unit | $\begin{array}{\|c} \text { Product } \\ \text { VFB/VFX } \\ \text { menu } \end{array}$ |
| :---: | :---: | :---: | :---: | :---: |
| 30001 | 0 | Power consumption high word | 0-2E9 Wh, $1 \mathrm{~Wh}<->1$ | 6F0 |
| 30002 | 1 | Power consumption low word |  | 6F0 |
| 30003 | 2 | Electrical power high word | 0-+-2E9 W, 1 W <->1 | 640 |
| 30004 | 3 | Electrical power low word |  | 640 |
| 30005 | 4 | Output shaft power high word | $\begin{aligned} & 0-+-2 E 9 \mathrm{~W}, \\ & 1 \mathrm{~W}<->1 \end{aligned}$ | 630 |
| 30006 | 5 | Output shaft power low word |  | 630 |
| 30007 | 6 | Operation time high word | 0-65535 h, $1 \mathrm{~h}<->1$ | 600 |
| 30008 | 7 | Operation time low word | 0-59 Min, $1 \mathrm{~min}<->1$ | 600 |
| 30009 | 8 | Mains time hour | 0-65535 h, $1 \mathrm{~h}<->1$ | 6 E 0 |
| 30010 | 9 | Mains time min | 0-59 Min, 1 min<->1 | 6E0 |
| 30011 | 10 | Shaft torque high word | $\begin{aligned} & 0-+2 \mathrm{E} 8 \mathrm{Nm}, \\ & 0.1 \mathrm{Nm}<-1 \end{aligned}$ | 620 |
| 30012 | 11 | Shaft torque low word | " | 620 |
| 30013 | 12 | Process speed high word | $1-+-2 E 8$ Rpm, $1 \mathrm{rpm}<->1000$ | 6GO |
| 30014 | 13 | Process speed low word | " | 6G0 |
| 30015 | 14 | Shaft speed high word | 0-2E8 rpm,1 rpm<->1 | 610 |
| 30016 | 15 | Shaft speed low word | " | 610 |
| 30017 | 16 | Software version | $\begin{aligned} & \text { V1.23 -> Release } \\ & \text { Bit 15-14=0,0 } \\ & \text { Bit 13-8=1, } \\ & \text { LB =23 } \end{aligned}$ | 920 |
| 30018 | 17 | Option/variant version | $\begin{aligned} & \text { OPT V2.34 -> } \\ & \mathrm{HB}=2, \\ & \mathrm{LB}=34 \end{aligned}$ | 920 |
| 30019 | 18 | Current | 0-6553.5 A, 0.1A <-> 1 | 650 |
| 30023 | 22 | Output voltage | 0-6553.5 V, 0.1V<->1 | 660 |
| 30028 | 27 | Product type number |  | 910 |

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Table 5 Input register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | $\begin{array}{\|c} \text { Product } \\ \text { VFB/VFX } \\ \text { menu } \end{array}$ |
| :---: | :---: | :---: | :---: | :---: |
| 30029 | 28 | Control start by / Control mode | $\begin{aligned} & 0=\text { Remote, } \\ & 1=\text { Keyboard, } \\ & 2=\text { Serial comm } \end{aligned}$ |  |
| 30030 | 29 | Control ref by | $\begin{aligned} & 0=\text { Remote } \\ & 1=\text { Keyboard } \\ & 2=\text { Serial comm } \end{aligned}$ |  |
| 30031 | 30 | Serial comm. unit address | 1-247 | 262 |
| 30032 | 31 | Serial comm. baudrate | $\begin{aligned} & 1=2400,4=19200 \\ & 2=4800 \quad 5=38400 \\ & 3=9600, \end{aligned}$ | 261 |
| 30035 | 34 | Actual parameter set | $\begin{array}{ll} 0-3 ; & \\ 0=A, & 2=C, \\ 1=B & 3=D \end{array}$ | $3 x x$ |
| 30036 | 35 | Shaft torque \% | $-400 \%+400 \% 1 \%<->1$ | 620 |
| 30037 | 36 | Cooler temperature | $\begin{aligned} & -40.0-+100.0^{\circ} \mathrm{C}, \\ & 0.1^{\circ} \mathrm{C}<->1 \end{aligned}$ | 690 |
| 30038 | 37 | Frequency | $\begin{aligned} & 0-2000.0 \mathrm{~Hz}, \\ & 0.1 \mathrm{~Hz}<->1 \end{aligned}$ | 670 |
| 30039 | 38 | DC-link voltage | 0-1000V, 0.1V<->1 | 680 |
| 30040 | 39 | Warning | 0-31 | 6H0 |
| 30043 | 42 | Digital input status |  | 6B0 |
| 30044 | 43 | Analog input status 1 | $-100+100 \%, 1 \%<->1$ | 6C0 |
| 30045 | 44 | Analog input status 2 | $-100+100 \%, 1 \%<->1$ | 6C0 |
| 30046 | 45 | Param_version | For internal use |  |
| 30052 | 51 | Emotron product | 1=VFB/VFX, 2=MSF |  |
| 30101 | 100 | Trip time 1 h | 0-65535 h, 1 $\mathrm{h}<->1$ | 710 |
| 30102 | 101 | Trip time 1 min | 0-59 Min, 1 min <->1 | 710 |
| 30103 | 102 | Trip message 1 | 0-31 | 710 |
| 30104 | 103 | Trip time 2 h | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 720 |
| 30105 | 104 | Trip time 2 min | 0-59 Min, 1 min<->1 | 720 |
| 30106 | 105 | Trip message 2 | See trip message 1. | 720 |
| 30107 | 106 | Trip time 3 h | 0-65535 h, 1h<->1 | 730 |

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Table 5 Input register list (continuing)

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

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### 3.3 Holding register list

Table 6 Holding register list

| $\begin{gathered} \text { Modbus } \\ \text { logical } \\ \text { no } \end{gathered}$ | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40001 | 0 | Nominal motor voltage | 100.0-700.0V | 222 |
| 40002 | 1 | Nominal motor frequency | $50-300 \mathrm{~Hz}$ | 223 |
| 40003 | 2 | Nominal motor current | 25\% I_nom-3200.0A | 224 |
| 40004 | 3 | Nominal motor speed | $\begin{aligned} & 100-18000 \mathrm{rpm} \\ & \text { Bit 15 }=0->1 \mathrm{rpm}<->1 \\ & \text { Bit 15=1->100rpm }<->1 \end{aligned}$ | 225 |
| 40005 | 4 | Nominal motor power | $\begin{array}{\|l} 1-3276700 W \\ \text { Bit 15 }=0->1 W<->1 \\ \text { Bit 15=1->100W }<->1 \end{array}$ | 221 |
| 40006 | 5 | Nominal motor cos phi | $50-100$, cos phi $=1.00<->100$ | 226 |
| 40007 | 6 | Motor ventilation | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Self, } \\ & 2=\text { Forced } \end{aligned}$ | 227 |
| 40008 | 7 | Remote input level edge | $\begin{aligned} & 0=\text { Level, } \\ & 1=\text { Edge } \end{aligned}$ | 215 |
| 40009 | 8 | Encoder pulses | 5-32767 pulses/rev | 252 |
| 40010 | 9 | Encoder enable | $\begin{aligned} & 0=\text { Off } \\ & 1=O n \end{aligned}$ | 251 |
| 40011 | 10 | Aarm select | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Max, } \\ & 2=\text { Min, } \\ & 3=\text { Min+max } \end{aligned}$ | 811 |
| 40012 | 11 | Ramp enable | $\begin{aligned} & 0=\text { Off, } \\ & 1=O n \end{aligned}$ | 812 |
| 40013 | 12 | Start delay monitor | 0-3600sec | 813 |
| 40014 | 13 | Max alarm response delay | 0.1-90.0sec | 814 |
| 40015 | 14 | Max alarm limit | 0-400\% Tn | 816 |
| 40017 | 16 | Max pre-alarm | 0-400\% Tn | 817 |
| 40019 | 18 | Min alarm limit | 0-400\% Tn | 818 |
| 40021 | 20 | Min pre-alarm | 0-400\% Tn | 819 |
| 40022 | 21 | Parameter set | $0=A$, $4=D 13$, <br> $1=B$, $5=D 13+4$, <br> $2=C$, $6=C o m m$ <br> $3=D$,  | 234 |
| 40023 | 22 | Relay 1 | 0-21 | 451 |

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Table 6 Holding register list (contimuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40024 | 23 | Relay 2 | 0-21 | 452 |
| 40027 | 26 | Anln 1, function | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Speed, } \\ & 2=\text { Torque } \end{aligned}$ | 411 |
| 40028 | 27 | Anln 1, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA} \\ & 2=\text { User defined } \end{aligned}$ | 412 |
| 40029 | 28 | Anln 1, offset | -100\% - +100\% 1\% <-> 1 | 413 |
| 40030 | 29 | Anln 1, gain | -4.00-+4.00, $0.01<->1$ | 414 |
| 40031 | 30 | Anin 1, bipolar | $\begin{aligned} & 0=\mathrm{Off}, \\ & 1=\mathrm{On} \end{aligned}$ | 415 |
| 40032 | 31 | Anln 2, function | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Speed, }, \\ & 2=\text { Torque } \end{aligned}$ | 416 |
| 40033 | 32 | Anln 2, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA}, \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=U \text { ser defined } \end{aligned}$ | 417 |
| 40034 | 33 | Anln 2, offset | -100\% - +100\% 1\% <-> 1 | 418 |
| 40035 | 34 | Anln 2, gain | -4.00-+4.00 |  |
| 40036 | 35 | AnIn 2, bipolar | $\begin{aligned} & 0=\text { Off, } \\ & 1=O n \end{aligned}$ | 41A |
| 40037 | 36 | AnOut 1, function | $\begin{aligned} & 0=\text { Torque, } \\ & 1=\text { Speed, } \quad 4=\text { Current, } \\ & 2=\text { Shaft power, } 5=\text { El.power, } \\ & 3=\text { Frequency, } 6=\text { Outp.voltage } \end{aligned}$ | 431 |
| 40038 | 37 | AnOut 1, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA} \\ & 2=\text { User defined } \end{aligned}$ | 432 |
| 40039 | 38 | AnOut 1, offset | -100\% - +100\% 1\% <-> 1 | 433 |
| 40040 | 39 | AnOut 1, gain | $-4.00-+4.000 .01<->1$ | 434 |
| 40041 | 40 | AnOut 1, bipolar | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=\mathrm{On} \end{aligned}$ | 435 |
| 40042 | 41 | AnOut 2, function | 0=Torque, 4=Current, <br> $1=$ Speed, $5=$ El.power, <br> $2=$ Shaft power, $6=0$ outp. <br> $3=$ Frequency, voltage | 436 |
| 40043 | 42 | AnOut 2, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA}, \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=\text { User defined } \end{aligned}$ | 437 |
| 40044 | 43 | AnOut 2, offset | $-100 \%-+100 \% 1 \%<->1$ | 438 |

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Table 6 Holding register list (contimuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40045 | 44 | AnOut 2, gain | $-4.00-+4.00,0.01<->1$ | 439 |
| 40046 | 45 | AnOut 2, bipolar | $\begin{aligned} & 0=\text { Off, } \\ & 1=O n \end{aligned}$ | 43A |
| 40063 | 62 | CA1 Value | " $0=$ Speed, $1=$ Torque, $2=$ Shaft_Power, $3=$ El Power, 4=Current, 5=Output Voltage, 6=Frequency, $7=$ DC voltage, $8=$ Temperature, $9=$ Energy, $10=$ Run Time, 11=Mains Time, 12=Process Speed, 13=Anin1, 14=Anin" | 821 |
| 40064 | 63 | CA1 Level | 0-1E6 depending on 40063 | 822 |
| 40065 | 64 | CA2 Value | " $0=$ Speed, $1=$ Torque, 2=Shaft_Power, 3=El Power, $4=$ Current, $5=$ Output Voltage, $6=$ Frequency, $7=$ DC voltage, $8=$ Temperature, $9=$ Energy, $10=$ Run Time, 11=Mains Time, 12=Process Speed, 13=Anin1, 14=Anin" | 823 |
| 40066 | 65 | CA2 Level | 0-1E6 depending on 40065 | 824 |
| 40067 | 66 | CD1 | $\begin{aligned} & \text { "O=DigIn1, 1=DigIn2, } \\ & 2=\text { DigIn3, } 3=\text { DigIn } 4,4=\text { Acc, } \\ & 5=\text { Dec, } \\ & 6=12 \mathrm{t}, 7=\text { Run, } 8=\text { Stop, } \\ & 9=\text { Trip, } 10=\text { Max Alarm, } \\ & 11=\text { Min Alarm, } 12=\text { Vlimit, } \\ & 13=\text { AtMax Speed, } 14=\text { Climit, }, \\ & 15=\text { Tlimit, } 16=0 \text { vertemp, } \\ & 17=O v e r v o l t ~ G, 18=O v e r v o l t ~ \\ & D, " \end{aligned}$ | 825 |
| 40068 | 67 | CD2 | $\begin{aligned} & \text { "0=DigIn1, 1=Digln2, } \\ & 2=\text { DigIn3, } 3=\text { DigIn } 4,4=\text { Acc, } \\ & 5=\text { Dec, } \\ & 6=12 \mathrm{t}, 7=\text { Run, } 8=\text { Stop, } \\ & 9=\text { Trip, } 10=\text { Max Alarm, } \\ & 11=\text { Min Alarm, } 12=\text { Vlimit, } \\ & 13=\text { AtMaxSpeed, } 14=\text { Climit, }, \\ & 15=\text { Tlimit, } 16=0 \text { vertemp, } \\ & 17=\text { Overvolt G, } 18=\text { Overvolt } \\ & \text { D," } \end{aligned}$ | 825 |

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Table 6 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40069 | 68 | Logic Y Arg1 | $\begin{aligned} & 0=\mathrm{CA} 1,1=!\mathrm{A} 1,2=\mathrm{CA} 2, \\ & 3=!\mathrm{A} 2,4=\mathrm{CD} 1,5=!\mathrm{D} 1, \\ & 6=\mathrm{CD} 2,7=!\mathrm{D} 2 \end{aligned}$ | 831 |
| 40070 | 69 | Logic Y op 1 | $1=\&, 2=+, 3=\wedge$ | 832 |
| 40071 | 70 | Logic Y Arg2 | $\begin{aligned} & 0=\mathrm{CA} 1,1=!\mathrm{A} 1,2=\mathrm{CA} 2, \\ & 3=!\mathrm{A} 2,4=\mathrm{CD} 1,5=!D 1, \\ & 6=\mathrm{CD} 2,7=!D 2 \end{aligned}$ | 833 |
| 40072 | 71 | Logic Y op2 | $0=.1=\&, 2=+, 3=\wedge$ | 834 |
| 40073 | 72 | Logic Y Arg3 | $\begin{aligned} & 0=\mathrm{CA} 1,1=!\mathrm{A} 1,2=\mathrm{CA} 2, \\ & 3=!\mathrm{A} 2,4=\mathrm{CD}, 5=!\mathrm{D} 1, \\ & 6=\mathrm{CD}, 7=\mathrm{ID}, \end{aligned}$ | 835 |
| 40074 | 73 | Logic 2 Arg1 | $\begin{aligned} & 0=\mathrm{CA} 1,1=!\mathrm{A} 1,2=\mathrm{CA} 2, \\ & 3=!\mathrm{A} 2,4=\mathrm{CD} 1,5=!\mathrm{D} 1, \\ & 6=\mathrm{CD} 2,7=!\mathrm{D} 2 \end{aligned}$ | 841 |
| 40075 | 74 | Logic Z op 1 | $1=\&, 2=+, 3=\wedge$ | 842 |
| 40076 | 75 | Logic 2 Arg2 | $\begin{aligned} & 0=\mathrm{CA} 1,1=!\mathrm{A} 1,2=\mathrm{CA} 2, \\ & 3=!\mathrm{A} 2,4=\mathrm{CD} 1,5=!\mathrm{D} 1, \\ & 6=\mathrm{CD} 2,7=!\mathrm{D} 2 \end{aligned}$ | 843 |
| 40077 | 76 | Logic Z op 2 | $0=.1=\&, 2=+, 3=\wedge$ | 844 |
| 40078 | 77 | Logic 2 Arg3 | $\begin{aligned} & 0=\mathrm{CA} 1,1=!\mathrm{A} 1,2=\mathrm{CA} 2, \\ & 3=!\mathrm{A} 2,4=\mathrm{CD} 1,5=!\mathrm{D} 1, \\ & 6=\mathrm{CD} 2,7=!\mathrm{D} 2 \end{aligned}$ | 845 |
| 41001 | 1000 | Comm, ref | 100\% <-> $0 \times 2000$ |  |
| 41002 | 1001 | Operation.drive mode | $\begin{aligned} & 0=\text { Speed, } \\ & 1=\text { Torque, } \\ & 2=\mathrm{V} / \mathrm{Hz} \end{aligned}$ | 211 |
| 41003 | 1002 | Operation.ref ctrl | $\begin{aligned} & 0=\text { Remote }, \\ & 1=\text { Keyboard, } \\ & 2=\text { Comm } \end{aligned}$ | 212 |
| 41004 | 1003 | Operation.run stop ctrl | $\begin{aligned} & 0=\text { Remote, } \quad 3=\text { Rem } / \text { digin1, } \\ & 1=\text { Keyboard, } \quad 4=\text { Comm } / \\ & \text { digin1 } \\ & 2=\text { Comm, } \end{aligned}$ | 213 |
| 41005 | 1004 | Operation.rotation | 0=R+L, 1=R, 2=L | 214 |
| 41006 | 1005 | Utility.auto restart mask | 16-bit mask |  |
| 41007 | 1006 | Utility.auto restart | 0-10 | 241 |
| 41008 | 1007 | Digln 1 | 0-11 | 421 |
| 41009 | 1008 | Digln 2 | 0-11 | 422 |

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Table 6 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 41010 | 1009 | DigIn 3 | 0-11 | 423 |
| 41011 | 1010 | DigIn 4 | 0-11 | 424 |
| 41014 | 1013 | DigOut 1 | 0-21 | 441 |
| 41015 | 1014 | DigOut 2 | 0-21 | 442 |
| 41018 | 1017 | Crio enable | $\begin{aligned} & 0=\text { Off, } \\ & 1=O n \end{aligned}$ | 281 |
| 41019 | 1018 | Crio control | $\begin{aligned} & 0=4 \text {-Speed, } \\ & 1=3 \text {-pos, } \\ & 2=\text { Analogue } \end{aligned}$ | 282 |
| 41020 | 1019 | Crio relay 1 | 0-21 | 283 |
| 41021 | 1020 | Crio relay 2 | 0-21 | 284 |
| 41022 | 1021 | Process unit | $0=$ None, $3=\mathrm{m} / \mathrm{s}$, <br> $1=r p m$, $4=/ \mathrm{min}$, <br> $2=\%$, $5=/ \mathrm{hr}$ | 6G1 |
| 41023 | 1022 | Process scale | 0-10.000, 0.0001 <=> 1 | 6G2 |
| 41024 | 1023 | Multiple display 1 | $0=$ Speed, $6=$ Frequency, <br> $1=$ Torque, $7=$ DC voltage, <br> $2=$ Shaft power, $8=$ Temp,  <br> $3=$ El power, $9=$ Drive <br> $4=$ Current, status, <br> $5=$ Voltage, $10=$ Process <br>  speed | 110 |
| 41025 | 1024 | Multiple display 2 | See 41024 | 120 |
| 41026 | 1025 | Utility language | $\begin{aligned} & 0=\text { English, } \quad 3=\text { Dutch, } \\ & 1=\text { German, } \\ & 2=\text { Swedish, } \end{aligned}$ | 231 |
| 41027 | 1026 | Utility keyboard locked | 0=Unlocked, 1=Locked | 232 |
| 41028 | 1027 | Serial com. address | 1-247 | 262 |
| 41029 | 1028 | Serial com. Baud-rate | $\begin{array}{ll} 1=2400, & 4=19200, \\ 2=4800 & 5=38400 \\ 3=9600, & \end{array}$ | 261 |
| 41031 | 1030 | Serial contact broken | $\begin{aligned} & 0=\text { Continue, } 1=\text { Trip, } 2=\text { Warn- } \\ & \text { ing } \end{aligned}$ |  |
| 41032 | 1031 | MVB card on/off | $\begin{aligned} & 0=\text { Off, } \\ & 1=O n \end{aligned}$ | 291 |

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Table 6 Holding register list (contimuing)

| Modbus <br> logical <br> no | Modbus <br> no | Function/Name | Range/Unit | Product <br> VFB/VFX <br> menu |
| :---: | :---: | :--- | :--- | :--- |
|  |  |  |  |  |
| 41081 | 1080 | Dev Delay | $50-999 m s$ |  |
| 41082 | 1081 | Set Load | $25-100 \%, 101 \%=O f f$ |  |

Table 7 Parancter sel $A$

| *** | *** | VFB/VFX <br> Parameter set A | *** | *** |
| :---: | :---: | :---: | :---: | :---: |
| 41101 | 1100 | Acceleration time | 0.00-3600.00 | 311 |
| 41102 | 1101 | Deceleration time | 0.00-3600.00 | 313 |
| 41103 | 1102 | Q-stop time | 0.00-3600.00 | 31B |
| 41104 | 1103 | Acceleration shape | $\begin{aligned} & 0=\text { Linear, } \\ & 1=\text { S-curve } \end{aligned}$ | 312 |
| 41105 | 1104 | Deceleration shape | $\begin{aligned} & 0=\text { Linear, } \\ & 1=\text { S-curve } \end{aligned}$ | 314 |
| 41106 | 1105 | Q-stop shape | $0=$ Linear |  |
| 41107 | 1106 | start mode | 0=fast, 1=Normal DC | 315 |
| 41108 | 1107 | stop mode | $0=$ decelation, $1=$ coast | 316 |
| 41109 | 1108 | brake release time | 0.00-3.00, 0.01s<=>1 | 317 |
| 41110 | 1109 | brake engage time | 0.00-3.00, $0.01 \mathrm{~s}<=>1$ | 318 |
| 41111 | 1110 | Wait before brake time | 0.00-3.00, 0.01s<->1 | 319 |
| 41112 | 1111 | Vector brake | $\begin{aligned} & 0=\mathrm{Off}, \\ & 1=0 \mathrm{On} \end{aligned}$ | 31A |
| 41113 | 1112 | Spinstart | $\begin{aligned} & 0=\text { Off, } \\ & 1=O n \end{aligned}$ | 31C |
| 41114 | 1113 | Motor pot function | $\begin{aligned} & 0=\text { Volatile }, \\ & 1=\text { Non-volatile } \end{aligned}$ | 325 |
| 41115 | 1114 | Minspeed mode | $\begin{aligned} & 0=\text { Scale }, \\ & 1=\text { Limit } \\ & 2=\text { Stop } \end{aligned}$ | 323 |
| 41116 | 1115 | Minimum speed | O-Maximum speed, | 321 |
| 41117 | 1116 | Maximum speed | Minimum speed-2*motor sync speed, | 322 |
| 41118 | 1117 | Preset speed 1 | 0-2*Motor sync speed, | 326 |
| 41119 | 1118 | Preset speed 2 | 0-2*Motor sync speed, | 327 |
| 41120 | 1119 | Preset speed 3 | 0-2*Motor sync speed, | 328 |
| 41121 | 1120 | Preset speed 4 | 0-2*Motor sync speed, | 329 |
| 41122 | 1121 | Preset speed 5 | 0-2*Motor sync speed, | 32A |
| 41123 | 1122 | Preset speed 6 | 0-2*Motor sync speed, | 32B |
| 41124 | 1123 | Preset speed 7 | 0-2*Motor sync speed, | 32C |
| 41125 | 1124 | Skip speed 1 Low | 0-2*Motor sync speed, | 32D |
| 41126 | 1125 | Skip speed 1 High | 0-2*Motor sync speed, | 32E |
| 41127 | 1126 | Skip speed 2 Low | 0-2*Motor sync speed, | 32F |

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Table 7 Parameter set A (comtinuing)

| *** | *** | VFB/VFX <br> Parameter set A | *** | *** |
| :---: | :---: | :---: | :---: | :---: |
| 41128 | 1127 | Skip speed 2 High | 0-2*Motor sync speed, | 32G |
| 41129 | 1128 | Jog speed | 0- $\pm 2 *$ Motor sync speed, | 32F |
| 41130 | 1129 | Maximum torque | 0-400\%, 1\%<-> 1 or I_max/motor In | 331 |
| 41131 | 1130 | Speed P gain | 0.1-30.0, 0.1<->1 | 342 |
| 41132 | 1131 | Speed I time | 0.01-10.00s, $0.01 \mathrm{~s}<->1$ | 343 |
| 41133 | 1132 | Flux optimization | $\begin{aligned} & 0=O f f, \\ & 1=O n \end{aligned}$ | 344 |
| 41134 | 1133 | PID-controller | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { On, } \\ & 2=\text { Invert } \end{aligned}$ | 345 |
| 41135 | 1134 | PID-controller $P$ gain | $0.1-30.0,0.1<->1$ | 346 |
| 41136 | 1135 | PID-controller I time | 0.01-300.00s, 0.01s<->1 | 347 |
| 41137 | 1136 | PID-controller D time | 0.01-30.00s, $0.01 \mathrm{~s}<->1$ | 348 |
| 41138 | 1137 | Low voltage overrride | O=Off, 1=On | 351 |
| 41139 | 1138 | Rotor locked | $0=0 f f, 1=0 n$ | 352 |
| 41140 | 1139 | Motor lost | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Resume, } \\ & 2=\text { Trip } \end{aligned}$ | 353 |
| 41141 | 1140 | Motor 12t type | $\begin{aligned} & 0=\text { Off }, \\ & 1=\text { Trip } \\ & 2=\text { Limit } \end{aligned}$ | 354 |
| 41142 | 1141 | Motor 12t current | 0-150\% inverter i_nom, 0.1A<->1 | 355 |
| 41143 | 1142 | Speed direction | $\begin{aligned} & 0=R, \\ & 1=L, \\ & 2=R+L \end{aligned}$ | 324 |
| 41144 | 1143 | Start speed | 0-+ 2*Motor sync speed, | 321 |
| 41145 | 1144 | min torque | 0-400\%, 1\%<=>1 or I_nax/motor_In | 332 |
| 41146 | 1145 | overvolt_ctrl | 0=ON, 1=OFF | 356 |


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

## 4. PARAMETER LIST FOR FDU

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

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

| Parameter type | Modbus <br> logical <br> numbers | Modbus actual numbers |
| :--- | :--- | :--- |
| Coil Status | $1-10000$ | $0-9999$ (Logical-1) |
| Input Registers | $30001-$ <br> 40000 | $0-9999$ (Logical-30001) |
| Holding Registers | $40001-$ <br> 50000 | $0-9999$ (Logical-40001) |

The product FDU menu column show the menu number on the control panel for the parameters.

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

### 4.1 Coil status list

Table 8 Coil status list

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 1 | 0 | Alarm reset | 0->1 = Reset |  |
| 2 | 1 | Run /-Stop | Stop=0, Run=1 |  |
| 3 | 2 | Run Right | 1=Run R |  |
| 4 | 3 | Run Left | 1=Run L |  |
| 5 | 4 | Auto-set monitor | 0->1 = Auto-set | 816 |
| 6 | 5 | Reset power consumption | 0->1 = Reset | 6D1 |
| 7 | 6 | Reset Run-Time | $0->1=$ Reset | 6B1 |
| 8 | 7 | Reset Trip Log | $0->1=$ Reset | 7B0 |
|  |  |  |  |  |
| 10 | 9 | Auto-restart, Overtemp trip | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 242 |
| 11 | 10 | Auto-restart, $1^{2} \mathrm{t}$ | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 243 |
| 12 | 11 | Auto-restart, Overvolt D | $\begin{aligned} & \text { Off, on; of } f=0, \\ & \text { on=1 } \end{aligned}$ | 244 |
| 13 | 12 | Auto-restart, Overvolt G | $\begin{aligned} & \text { Off, on; of } f=0, \\ & \text { on=1 } \end{aligned}$ | 245 |
| 14 | 13 | Auto-restart, Overvolt L | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 246 |
| 15 | 14 | Auto-restart, PTC | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 247 |
| 16 | 15 | Auto-restart, External trip | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 248 |
| 17 | 16 | Auto-restart, Phase loss motor | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 249 |
| 18 | 17 | Auto-restart, Alarm | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 24A |
| 19 | 18 | Auto-restart, Locked rotor | $\begin{aligned} & \text { Off, on; off }=0, \\ & \text { on=1 } \end{aligned}$ | 24B |
| 20 | 19 | Auto-restart, Power fault | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 24C |
| 22 | 21 | Auto-restart, Low voltage | Off, on; off=0, on=1 | 24D |

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Table 8 Coil status list (continuing)

| Modbus <br> loglcal no | Modbus <br> no | Function/Name | Range/Unit | Product <br> FDU menu |
| :---: | :---: | :--- | :--- | :--- |
| 23 | 22 | Auto-restart, <br> Comm. error | Off, on; off=0, <br> on=1 | 24 E |
|  |  |  |  |  |
| 30 | 29 | Motor PTC input | no, yes; no=0, <br> yes=1 | 261 |
|  |  |  |  |  |
| 38 | 37 | Reset Run Time 1 | $0->1=$ Reset | $6 \mathrm{G1}$ |
| 39 | 38 | Reset Run Time 2 | $0->1=$ Reset | $6 \mathrm{H1}$ |
| 40 | 39 | Reset Run Time 3 | $0->1=$ Reset | 6 I 1 |
| 41 | 40 | Reset Run Time 4 | $0->1=$ Reset | $6 \mathrm{J1}$ |
| 42 | 41 | Reset Run Time 5 | $0->1=$ Reset | $6 \mathrm{K1}$ |
| 43 | 42 | Reset Run Time 6 | $0->1=$ Reset | $6 \mathrm{L1}$ |

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### 4.2 Input register list

Table 9 Inpur register list

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 30001 | 0 | Power consumption high word | 0-2E9 Wh, $1 \mathrm{~Wh}<->1$ | 600 |
| 30002 | 1 | Power consumption low word |  | 6D0 |
| 30003 | 2 | Electrical power high word | 0-+-2E9 W, 1 W<->1 | 630 |
| 30004 | 3 | Electrical power low word |  | 630 |
| 30007 | 6 | Operation time high word | 0-65535 h, $1 \mathrm{~h}<->1$ | 6B0 |
| 30008 | 7 | Operation time low word | O-59 Min, $1 \mathrm{~min}<->1$ | 6B0 |
| 30009 | 8 | Mains time hour | 0-65535 h, $1 \mathrm{~h}<->1$ | 6 CO |
| 30010 | 9 | Mains time min | O-59 Min, 1 min<->1 | 6C0 |
| 30011 | 10 | Shaft torque high word | $\begin{aligned} & \mathrm{O}-+-2 \mathrm{E} 8 \mathrm{Nm}, \\ & 0.1 \mathrm{Nm}<->1 \end{aligned}$ | 620 |
| 30012 | 11 | Shaft torque low word | " | 620 |
| 30013 | 12 | Process speed high word | $1-+-2 E 8 \mathrm{Rpm}$, <br> $1 \mathrm{rpm}<->1000$ | 6E0 |
| 30014 | 13 | Process speed low word | " | 6E0 |
| 30017 | 16 | Software version | $\begin{aligned} & \text { V1.23-> Release } \\ & \text { Bit } 15-14=0,0 \\ & \text { Bit } 13-8=1, \\ & \text { LB }=23 . \end{aligned}$ | 920 |
| 30018 | 17 | Option/variant version | $\begin{aligned} & \mathrm{OPT} \text { V2.34-> } \\ & \mathrm{HB}=2, \\ & \mathrm{LB}=34 \end{aligned}$ | 920 |
| 30019 | 18 | Current | 0-6553.5 A, 0.1A <-> 1 | 640 |
| 30023 | 22 | Output voltage | 0-6553.5 V, 0.1V $<->1$ | 650 |
| 30028 | 27 | Product type number |  | 910 |
| 30029 | 28 | Control start by / Control mode | $\begin{aligned} & 0=\text { Remote, } \\ & 1=\text { Keyboard, } \\ & 2=\text { Serial comm } \end{aligned}$ |  |

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Table 9 Input register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 30030 | 29 | Control ref by | $\begin{aligned} & 0=\text { Remote } \\ & 1=\text { Keyboard } \\ & 2=\text { Serial comm } \end{aligned}$ |  |
| 30031 | 30 | Serial comm. unit address | 1-247 | 262 |
| 30032 | 31 | Serial comm. baudrate | $\begin{aligned} & 1=2400,4=19200, \\ & 2=4800 \quad 5=38400 \\ & 3=9600, \end{aligned}$ | 261 |
| 30035 | 34 | Actual parameter set | $\begin{array}{ll} 0-3 ; & \\ 0=A, & 2=C, \\ 1=B & 3=D \end{array}$ | 3 XX |
| 30036 | 35 | Shaft torque \% | -400\%+400\% 1\%<->1 | 620 |
| 30037 | 36 | Cooler temperature | $\begin{aligned} & -40.0-+100.0^{\circ} \mathrm{C}, \\ & 0.1^{\circ} \mathrm{C}<->1 \end{aligned}$ | 690 |
| 30038 | 37 | Frequency | $\begin{aligned} & \mathrm{O}-2000.0 \mathrm{~Hz}, \\ & 0.1 \mathrm{~Hz}<->1 \end{aligned}$ | 670 |
| 30039 | 38 | DC-link voltage | 0-1000V, 0.1V<->1 | 680 |
| 30040 | 39 | Warning | 0-31 | 6 HO |
| 30043 | 42 | Digital input status |  | 6B0 |
| 30044 | 43 | Analog input status 1 | $-100-+100 \%, 1 \%<->1$ | 6C0 |
| 30045 | 44 | Analog input status 2 | $-100-+100 \%, 1 \%<->1$ | 6C0 |
| 30046 | 45 | Param_version | For internal use |  |
| 30052 | 51 | Emotron product | 1=VFB/VFX, 2=MSF |  |
| 30101 | 100 | Trip time 1 h | 0-65535 h, 1h<>>1 | 710 |
| 30102 | 101 | Trip time 1 min | $0-59 \mathrm{Min}, 1 \mathrm{~min}<\cdot>1$ | 710 |
| 30103 | 102 | Trip message 1 | 0-31 | 710 |
| 30104 | 103 | Trip time 2 h | 0-65535 h, 1h $\langle\rightarrow 1$ | 720 |
| 30105 | 104 | Trip time 2 min | 0-59 Min, 1 min<->1 | 720 |
| 30106 | 105 | Trip message 2 | See trip message 1. | 720 |
| 30107 | 106 | Trip time 3 h | 0-65535 h, 1h<->1 | 730 |
| 30108 | 107 | Trip time 3 min | 0-59 Min, 1 min<->1 | 730 |
| 30109 | 108 | Trip message 3 | See trip message 1. | 730 |

Table 9 Inpua register list (contimuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 30110 | 109 | Trip time 4 h | 0-65535 h, 1h $->1$ | 740 |
| 30111 | 110 | Trip time 4 min | $0-59 \mathrm{Min}, 1 \mathrm{~min}$ <->1 | 740 |
| 30112 | 111 | Trip message 4 | See trip message 1. | 740 |
| 30113 | 112 | Trip time 5 h | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 750 |
| 30114 | 113 | Trip time 5 min | 0-59 Min, 1 min<->1 | 750 |
| 30115 | 114 | Trip message 5 | See trip message 1. | 750 |
| 30116 | 115 | Trip time 6 h | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 760 |
| 30117 | 116 | Trip time 6 min | 0-59 Min, 1 min<->1 | 760 |
| 30118 | 117 | Trip message 6 | See trip message 1. | 760 |
| 30119 | 118 | Trip time 7 h | 0-65535 h, 1h<->1 | 770 |
| 30120 | 119 | Trip time 7 min | 0-59 Min, 1 min<->1 | 770 |
| 30121 | 120 | Trip message 7 | See trip message 1. | 770 |
| 30122 | 121 | Trip time 8 h | 0-65535 h, 1h<->1 | 780 |
| 30123 | 122 | Trip time 8 min | 0-59 Min, 1 min<->1 | 780 |
| 30124 | 123 | Trip message 8 | See trip message 1. | 780 |
| 30125 | 124 | Trip time 9 h | 0-65535 h, 1h<->1 | 790 |
| 30126 | 125 | Trip time 9 min | 0-59 Min, 1 min<->1 | 790 |
| 30127 | 126 | Trip message 9 | See trip message 1. | 790 |
| 30128 | 127 | Trip time 10 h | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 7 AO |
| 30129 | 128 | Trip time 10 min | 0-59 Min, 1 min<->1 | 7 AO |
| 30130 | 129 | Trip message 10 | See trip message 1. | 7 AO |

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### 4.3 Holding register list

Table 10 Holding register list.

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 40001 | 0 | Nominal motor voltage | 100.0-700.0V | 222 |
| 40002 | 1 | Nominal motor frequency | $50-300 \mathrm{~Hz}$ | 223 |
| 40003 | 2 | Nominal motor current | 25\% I_nom-3200.0A | 224 |
| 40004 | 3 | Nominal motor speed | $100-18000 \mathrm{rpm}$ <br> Bit $15=0->1$ rpm $<->1$ <br> Bit15=1->100rpm<->1 | 225 |
| 40005 | 4 | Nominal motor power | $\begin{aligned} & 1-3276700 \mathrm{~W} \\ & \text { Bit } 15=0>1 \mathrm{~W}<->1 \\ & \text { Bit } 15=1->100 \mathrm{~W}<->1 \end{aligned}$ | 221 |
| 40006 | 5 | Nominal motor cos phi | 50-100, cos phi $=1.00<->100$ | 226 |
| 40008 | 7 | Remote input level edge | $\begin{aligned} & 0=\text { Level, } \\ & 1=\text { Edge } \end{aligned}$ | 215 |
| 40011 | 10 | Aarm select | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Max, } \\ & 2=\text { Min, } \\ & 3=\text { Min+max } \end{aligned}$ | 811 |
| 40012 | 11 | Ramp enable | $\begin{aligned} & 0=\mathrm{Off}, \\ & 1=\mathrm{On} \end{aligned}$ | 812 |
| 40013 | 12 | Start delay monitor | 0-3600sec | 813 |
| 40014 | 13 | Max alarm response delay | 0.1-90.0sec | 814 |
| 40015 | 14 | Max alarm limit | 0-400\% Tn | 816 |
| 40017 | 16 | Max pre-alarm | 0-400\% Tn | 817 |
| 40018 | 17 | Min alarm response delay | 40014 is used for all delays |  |
| 40019 | 18 | Min alarm limit | 0-400\% Tn | 818 |
| 40021 | 20 | Min pre-alarm | 0-400\% Tn | 819 |
| 40022 | 21 | Parameter set | $0=\mathrm{A}$, $4=\mathrm{DI} 3$, <br> $1=\mathrm{B}$, $5=\mathrm{DI} 3+4$, <br> $2=\mathrm{C}$, $6=\mathrm{Comm}$ <br> $3=\mathrm{D}$,  | 234 |
| 40023 | 22 | Relay 1 | 0-21 | 451 |
| 40024 | 23 | Relay 2 | 0-21 | 452 |
|  |  |  |  |  |

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Table 10 Holding register list (contimuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 40027 | 26 | Anln 1, function | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Speed, }, \\ & 2=\text { Torque } \end{aligned}$ | 411 |
| 40028 | 27 | Anln 1, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA} \\ & 2=\text { User defined } \end{aligned}$ | 412 |
| 40029 | 28 | Anln 1, offset | $-100 \%-+100 \% 1 \%<->1$ | 413 |
| 40030 | 29 | Anln 1, gain | -4.00-+4.00, $0.01<->1$ | 414 |
| 40032 | 31 | Anln 2, function | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Speed, } \\ & 2=\text { Torque } \end{aligned}$ | 416 |
| 40033 | 32 | Anln 2, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA} \\ & 2=\text { User defined } \end{aligned}$ | 417 |
| 40034 | 33 | Anln 2, offset | $-100 \%-+100 \% 1 \%<->1$ | 418 |
| 40035 | 34 | Anln 2, gain | $-4.00-+4.00,0.01<->1$ | 419 |
| 40037 | 36 | AnOut 1, function | $0=$ Torque, $1=$ Speed, $\quad 4=$ Current, $2=$ Shaft power, $5=$ El.power, $3=$ Frequency, $6=$ Out p.voltage | 431 |
| 40038 | 37 | AnOut 1, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA} \\ & 2=\text { User defined } \end{aligned}$ | 432 |
| 40039 | 38 | AnOut 1, offset | $-100 \%-+100 \% 1 \%<->1$ | 433 |
| 40040 | 39 | AnOut 1, gain | $-4.00-+4.000 .01<->1$ | 434 |
| 40042 | 41 | AnOut 2, function | $0=$ Torque, $4=$ Current <br> $1=$ Speed, $5=$ El.power, <br> $2=$ Shaft power, $6=$ Outp. <br> $3=$ Frequency, voltage | 436 |
| 40043 | 42 | AnOut 2, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=U \text { ser defined } \end{aligned}$ | 437 |
| 40044 | 43 | AnOut 2, offset | $-100 \%-+100 \%$ 1\% <-> 1 | 438 |
| 40045 | 44 | AnOut 2, gain | $-4.00-+4.00,0.01<->1$ | 439 |
|  |  |  |  |  |

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Table 10 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 40062 | 61 | Aarm select | $\begin{aligned} & 0=o f f, 1=\max , 2=\min , \\ & 3=\min +\max \end{aligned}$ | 812 |
| 40063 | 62 | CA1 Value | $\begin{aligned} & \text { "0=Frequency, 1=Torque } \\ & (\text { Nm), } \\ & 2=\text { Torque(\%), } 3=\text { El Power, } \\ & 4=\text { Current, } \\ & 5=\text { Voltage, } 6=\text { DC Voltage, } \\ & 7=\text { Temp, } \\ & 8=\text { Energy, } 9=\text { Run Time, } \\ & 10=\text { Mains Time, } \\ & 10=\text { Process Spd, 11=Anln1, } \\ & 12=\text { Anln2" } \end{aligned}$ | 821 |
| 40064 | 63 | CA1 Level | $\begin{aligned} & \hline 0=\text { Frequency, } 1=\text { Torque } \\ & \text { (Nm), } \\ & 2=\text { Torque(\%), } 3=\text { El Power, } \\ & 4=\text { Current, } \\ & 5=\text { Voltage, } 6=\text { DC Voltage, } \\ & 7=\text { Temp, } \\ & 8=\text { Energy, } 9=\text { Run Time, } \\ & 10=\text { Mains Time, } \\ & 10=\text { Process Spd, 11=Anln1, } \\ & 12=\text { Anln2" } \end{aligned}$ | 822 |
| 40065 | 64 | CA2 Value | $\begin{aligned} & \text { "O=Frequency, 1=Torque } \\ & (\text { Nm), } \\ & 2=\text { Torque(\%), } 3=\text { El Power, } \\ & 4=\text { Current, } \\ & 5=\text { Voltage, } 6=\text { DC Voltage, } \\ & 7=\text { Temp, } \\ & 8=\text { Energy, } 9=\text { Run Time, } \\ & 10=\text { Mains Time, } \\ & 10=\text { Process Spd, 11=Anln1, } \\ & 12=\text { Anln2" } \end{aligned}$ | 823 |
| 40066 | 65 | CA2 Level | $\begin{aligned} & \text { "0=Frequency, } 1=\text { Torque } \\ & \text { (Nm), } \\ & 2=\text { Torque( } \% \text { ), } 3=\text { El Power, } \\ & 4=\text { Current, } \\ & 5=\text { Voltage, } 6=\text { DC Voltage, } \\ & 7=\text { Temp, } \\ & 8=\text { Energy, } 9=\text { Run Time, } \\ & 10=\text { Mains Time, } \\ & 10=\text { Process Spd, } 11=\text { AnIn1, } \\ & 12=\text { AnIn2" } \end{aligned}$ | 824 |

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Table 10 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 40067 | 66 | CD1 |  | 825 |
| 40068 | 67 | CD2 | $\begin{aligned} & 0=\text { Digln } 1,1=\text { Digln2, } \\ & 2=\operatorname{Dig} \ln 3,3=\text { Dig } \ln 4, \\ & 4=\text { Digln }, 5=\text { Dig } \ln 6, \\ & 6=\text { Digln }, 7=\text { Acc, } 8=\text { Dec, } \\ & 9=12 t, 10=\text { Run, } 11=\text { Stop, } \\ & 12=\text { Trip, } 13=\text { Max Alarm, } \\ & 14=\text { Min Alarm, } 15=\text { Vlimit, } \\ & 16=\text { Flimit, } 17=\text { Glimit, } \\ & 18=\text { Tlimit, } 19=\text { Overtemp, } \\ & 20=\text { Overvolt G, } \end{aligned}$ | 826 |
| 40069 | 68 | Logic Y |  | 827 |
| 40070 | 69 | Logic $Z$ |  | 828 |
| 40071 | 70 | Logic Y |  | 829 |
| 40072 | 71 | Logic $Y$ |  | 830 |
| 40073 | 72 | Logic Y |  | 831 |
| 40074 | 73 | Logic Z |  | 832 |
| 40075 | 74 | Logic Z |  | 833 |
| 40076 | 75 | Logic Z |  | 834 |
| 40077 | 76 | Logic Z |  | 835 |
| 40078 | 77 | Logic Z |  | 836 |
|  |  |  |  |  |
| 41001 | 1000 | Comm. ref. |  |  |
| 41003 | 1002 | Operation.ref ctrl | $\begin{aligned} & 0=\text { Remote, } \\ & 1=\text { Keyboard, } \\ & 2=\text { Comm } \end{aligned}$ | 212 |
| 41004 | 1003 | Operation.run stop ctrl | $\begin{aligned} & 0=\text { Remote }, \quad 3=\text { Rem } / \text { digin1, } \\ & 1=\text { Keyboard, } \quad 4=\text { Comm } / \\ & \text { digin1 } \\ & 2=\text { Comm, } \end{aligned}$ | 213 |
| 41005 | 1004 | Operation.rotation | $0=R+L, 1=R, 2=L$ | 214 |

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Table 10 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 41006 | 1005 | Utility auto restart mask | 0-10 | 240 |
| 41007 | 1006 | Utility.auto restart | 0-10 | 241 |
| 41008 | 1007 | Digln 1 | 0-11 | 421 |
| 41009 | 1008 | Digln 2 | 0-11 | 422 |
| 41010 | 1009 | Digln 3 | 0-11 | 423 |
| 41011 | 1010 | Digln 4 | 0-11 | 424 |
| 41012 | 1011 | Digln 5 | 0-11 | 425 |
| 41013 | 1012 | Digln 6 | 0-11 | 426 |
| 41014 | 1013 | DigOut 1 | 0-21 | 441 |
| 41015 | 1014 | DigOut 2 | 0-21 | 442 |
| 41022 | 1021 | Process unit | $0=$ None, $3=\mathrm{m} / \mathrm{s}$, <br> $1=\mathrm{rpm}$, $4=/ \mathrm{min}$, <br> $2=\%$, $5=/ \mathrm{hr}$ | 6E1 |
| 41023 | 1022 | Process scale | 0-10.000, 0.0001 <=> 1 | 6E2 |
| 41024 | 1023 | Multiple display 1 | $0=$ Speed,, $6=$ Frequency, <br> $1=$ Torque, $7=$ DC voltage, <br> $2=$ Shaft power, $8=$ Temp,  <br> $3=$ El power, $9=$ Drive <br> $4=$ Current, status, <br> $5=$ Voltage, $10=$ Process <br>  speed | 110 |
| 41025 | 1024 | Multiple display 2 | See 41024 | 120 |
| 41026 | 1025 | Utility language | $0=$ English, $3=$ Dutch, <br> $1=$ German, 4=French <br> $2=$ Swedish,  | 231 |
| 41027 | 1026 | Utility keyboard locked | 0=Unlocked, 1=Locked | 232 |
| 41028 | 1027 | Serial com. address | 1-247 | 252 |
| 41029 | 1028 | Serial com. Baud-rate | $\begin{array}{ll} 1=2400, & 4=19200, \\ 2=4800, & 5=38400 \\ 3=9600, & \end{array}$ | 251 |
| 41031 | 1030 | Serkal com. contact broken |  |  |
| 41033 | 1032 | $\mathrm{V} / \mathrm{Hz}$ Curve | $\begin{aligned} & 0=\text { Linear, } \\ & 1=\text { Square } \end{aligned}$ | 211 |
| 41034 | 1033 | IxR Comp | 1-25\% | 216 |

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Thule 10 Holding register list (contimuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 41035 | 1034 | Mains | $0=400 \mathrm{~V}, 1=230 \mathrm{~V}$ | 217 |
| 41036 | 1035 | Select Macro | $\begin{aligned} & \text { "0=Loc/Rem Ana, 1=Loc/ } \\ & \text { Rem Comm, } \\ & 2=\text { PID, } 3=\text { MotPot, } 4=\text { Pre- } \\ & \text { sets, } 5=\text { Jog, } \\ & 6=\text { Torque Limit, } 7=\text { Pump/ } \\ & \text { Fan, } \\ & 8=\text { Custom1, } 9=\text { Custom2" } \end{aligned}$ | 271 |
| 41038 | 1037 | Punp/Fan Control | " $0=$ Off, 1=Load PID, 2=Freq PID, 3=Load Direct, 4=Freq Direct ${ }^{\prime}$ | 281 |
| 41039 | 1038 | No of Drives | $1-4 \mathrm{w} / \mathrm{o}$ rio, 1.6 with rio | 282 |
| 41040 | 1039 | Select Drive | $0=$ Sequence, 1=Run Time | 283 |
| 41071 | 1070 | Start Delay | 0-30s (Default: 0) | 28M |
| 41073 | 1072 | Stop Delay | 0-30s (Default: 0) | 280 |
| 41075 | 1074 | Standby Freq | 0-100Hz (Default: 0) | 28Q |
| 41077 | 1076 | Stdby Delay | 0-60s (Default: 0) | 28R |
| 41078 | 1077 | Act.Level | 0-100\% (Default: 0) | 28 S |
| 41079 | 1078 | Act.Rise/FII | 0=Rise, 1=Fall (Default: 0) | 28 T |
| 41080 | 1079 | Digital in 7 |  | 427 |
| 41081 | 1080 | Digital in 8 |  | 428 |
| 41082 | 1081 | Lower Band |  | 288 |
| 41083 | 1082 | Upper Band |  | 287 |
| 41084 | 1083 | Lower Band Limit |  | 28C |
| 41085 | 1084 | Upper Band Limit |  | 28B |
| 41086 | 1085 | Settle time |  | 28D |
| 41087 | 1086 | Transition frequency |  | 28E |
| 41088 | 1087 | Use Inputs |  | 28J |
| 41091 | 1090 | Output potential 1 |  | 28K |
| 41092 | 1091 | Output potential 2 |  | 28L |
| 41093 | 1092 | Output potential 3 |  | 28M |
| 41094 | 1093 | Output potential 4 |  | 28N |
| 41095 | 1094 | Output potential 5 |  | 280 |
| 41096 | 1095 | Output potential 6 |  | 28P |
| 41097 | 1096 | Drives on at master change |  | 286 |

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Table 10 Holding register list (consinuing)

| Modbus <br> logical <br> no | Modbus <br> no | Functlon/Name | Range/Unit | Product <br> FDU <br> menu |
| :--- | :--- | :--- | :--- | :--- |
| 41098 | 1097 | Change condition |  | 284 |
| 41099 | 1098 | Change timer |  | 285 |

Tuble 11 Parameter set A

| *** | *** | FDU <br> Parameter set A | *** | *** |
| :---: | :---: | :---: | :---: | :---: |
| 41101 | 1100 | Acceleration time | 0.00-3600.00 | 311 |
| 41102 | 1101 | Deceleration time | 0.00-3600.00 | 313 |
| 41104 | 1103 | Acceleration shape | $\begin{aligned} & 0=\text { Linear }, \\ & 1=\text { S-curve } \end{aligned}$ | 312 |
| 41105 | 1104 | Deceleration shape | $\begin{aligned} & 0=\text { Linear }, \\ & 1=\text { S-curve } \end{aligned}$ | 314 |
| 41107 | 1106 | start mode | 0=fast, 1=Normal DC | 318 |
| 41108 | 1107 | stop mode | O=decelation, 1=coast | 319 |
| 41113 | 1112 | Spinstart | $\begin{aligned} & 0=\mathrm{Off}, \\ & 1=\mathrm{On} \end{aligned}$ | 31C |
| 41114 | 1113 | Motor pot function | $0=$ Volatile, 1=Non-volatile | 325 |
| 41130 | 1129 | Maximum torque | 0-400\%, 1\%<-> 1 or I_max/motor In | 332 |
| 41133 | 1132 | Flux optimization | $\begin{aligned} & 0=\text { Off }, \\ & 1=O n \end{aligned}$ | 341 |
| 41134 | 1133 | PID-controller | $\begin{aligned} & 0=\text { Off }, \\ & 1=\text { On, } \\ & 2=\text { Inver } t \end{aligned}$ | 343 |
| 41135 | 1134 | PIO-controller P gain | 0.1-30.0, $0.1<->1$ | 344 |
| 41136 | 1135 | PID-controller I time | 0.01-300.00s, $0.01 \mathrm{~s}<\gg 1$ | 345 |
| 41137 | 1136 | PID-controller D time | 0.01-30.00s, $0.01 \mathrm{~s}<->1$ | 346 |
| 41138 | 1137 | Low voltage overrride | $0=O f f, 1=0 n$ | 351 |
| 41139 | 1138 | Rotor locked | $0=0 \mathrm{ff}, 1=0 \mathrm{n}$ | 352 |
| 41140 | 1139 | Motor lost | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Resume, } \\ & 2=\text { Trip } \end{aligned}$ | 353 |

SP174 Jesmond Road Fig Tree Pocket SPS Main Switchboard OM Manual
Table 11 Parameter set A (continuing)

| *** | *** | FDU <br> Parameter set A | *** | *** |
| :---: | :---: | :---: | :---: | :---: |
| 41141 | 1140 | Motor 12t type | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=\text { Trip, } \\ & 2=\text { Limit } \end{aligned}$ | 354 |
| 41142 | 1141 | Motor 12t current | 0-150\% inverter i_nom, 0.1A<->1 | 355 |
| 41145 | 1144 | Acc MotPot | 16.00-3600s (Default: 2s) | 312 |
| 41146 | 1145 | Acc>Min Freq | 16.00-3600s (Default: 2s) | 313 |
| 41147 | 1146 | Dec MotPot | 16.00-3600s (Default: 2s) | 316 |
| 41148 | 1147 | Min Frequency | O- maximum_freq. see R/W rpm | 321 |
| 41149 | 1148 | Max Frequency | minimum freq-2*motor sync freq see R/ Wrpm | 322 |
| 41150 | 1149 | Min Frequency Mode | O=scale, 1=limit, $2=$ stop | 323 |
| 41151 | 1150 | Frequency Direction | $0=R, 1=L, 2=R+L$ | 324 |
| 41152 | 1151 | Preset Frequency 1 | 0-2*motor sync freq see R/W rpm | 326 |
| 41153 | 1152 | Preset Frequency 2 | 0-2* motor sync freq see R/W rpm | 327 |
| 41154 | 1153 | Preset Frequency 3 | 0-2*motor sync freq see R/W rpm | 328 |
| 41155 | 1154 | Preset Frequency 4 | 0-2*motor sync freq see R/W rpm | 329 |
| 41156 | 1155 | Preset Frequency 5 | 0-2*motor sync freq see R/W rpm | 32A |
| 41157 | 1156 | Preset Frequency 6 | 0-2*motor sync freq see R/W rpm | 32B |
| 41158 | 1157 | Preset Frequency 7 | 0-2*motor sync freq see R/W rpm | 32C |
| 41159 | 1158 | Skip Frequency 1 Low | 0-2*motor sync freq see R/W rpm | 32D |
| 41160 | 1159 | Skip Frequency 1 High | 0-2*motor sync freq see R/W rpm | 32E |
| 41161 | 1160 | Skip Frequency 2 Low | 0-2*motor sync freq see R/W rpm | 32F |
| 41162 | 1161 | Skip Frequency 2 High | 0-2*motor sync freq see R/W rpm | 32G |
| 41163 | 1162 | Jog Frequency | O-+2*motor sync freq see R/W rpm | 32 H |
| 41164 | 1163 | Sound Char |  | 342 |
| 41165 | 1164 | Dec<MinFreq | 0.50-3600s (Default: 2s) | 317 |
| 41166 | 1165 | Torque Lim | On/Off | 331 |


| $* * *$ | $* * *$ | FDU Parameter set B | $* * *$ | $* * *$ |
| :---: | :---: | :---: | :---: | :---: |
| $41201-41299$ | $1200-1298$ | $/ *$ Parameter set B */ |  |  |
| $* * *$ | $* * *$ | FDU Parameter set C | $* * *$ | $* * *$ |
| $41301-41399$ | $1300-1398$ | $/ *$ Parameter set C */ |  |  |
| $* * *$ | $* * *$ | FDU Parameter set D | $* * *$ | $* * *$ |
| $41401-41499$ | $1400-1498$ | $/ *$ Parameter set D*/ |  |  |

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MSF
SOFTSTARTERS
INSTRUCTION MANUAL

## PARAMETER SET LIST-MSF



SP174 Jesmond Road Fig Tree Pocket SPS Main Switchboard OM Manual

|  |  | Factory setting | Parameter Sets |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | 1 | 2 | 3 | 4 |
| 071 | Motor PTC input | no |  | Common for all parameter sets |  |  |
| 072 | Internal motor thermal protection class | 10 |  |  |  |  |
| 073 | Used thermal capacity | - | $\underline{\square}$ |  | $\longrightarrow$ | - |
| 074 | Starts per hour limitation | OFF |  |  |  |  |
| 075 | Locked rotor alarm | OFF |  |  |  |  |
|  |  |  |  |  |  |  |
| 081 | Voltage unbalance alarm | 10 |  |  |  |  |
| 082 | Response delay voltage unbalance alarm | ofF |  |  |  |  |
| 083 | Over voltage alarm | 115 |  |  |  |  |
| 084 | Response delay over voltage alarm | OFF |  |  |  |  |
| 085 | Under voltage alarm | 85 |  |  |  |  |
| 086 | Response delay under voltage alarm | oFF |  |  |  |  |
| 087 | Phase sequence | $\underline{-}$ |  |  |  |  |
| 088 | Phase reversal alarm | öf |  | Common for-all-parameter set |  | --- - |
|  |  |  |  |  |  |  |
| 089 | Auto set power limits | no |  | Common for all parameter sets |  |  |
| 090 | Output shaft power | - |  |  |  |  |
| 091 | Start delay power limits | 10 |  |  |  |  |
| 092 | Max power alarm limit | 115 |  |  |  |  |
| 093 | Max alarm response delay | ofF |  |  |  |  |
| 094 | Max power pre-alarm limit | 110 |  |  |  |  |
| 095 | Max pre-alarm response delay | OFF |  |  |  |  |
| 096 | Min pre-alarm power limit | 90 | . |  |  |  |
| 097 | Min pre-alarm response delay | OFF |  |  |  |  |
| 098 | Min power alarm limit | 85 |  |  |  |  |
| 099 | Min alarm response delay | OFF |  |  |  |  |
|  |  |  |  |  |  |  |
| 101 | Run at single phase input failure | no |  |  |  |  |
| 102 | Run at current limit time-out | no |  |  |  |  |
|  |  |  |  |  |  |  |
| 103 | Jog forward enable | OFF |  |  |  |  |
| 104 | Jog reverse enable | OFF |  |  |  |  |
|  |  |  |  |  |  |  |
| 105 | Automatic return menu | oFF |  | Common for all parameter sets |  |  |
|  |  |  |  |  |  |  |
| 111 | Serial comm. unit address | 1 |  | Common for all parameter sets |  |  |
| 112 | Serial comm. baudrate | 9.6 |  | Common for all parameter sets |  |  |
| 113 | Serial comm. parity | 0 |  | Common for all parameter sets |  |  |
| 114 | Serial comm. contact broken | 1 |  | Common for all parameter sets |  |  |
|  |  |  |  |  |  |  |
| 199 | Reset to factory settings | no |  | Common for all parameter sets |  |  |
|  |  |  |  |  |  |  |
| 201 | Current | - | - | - - | $\square$ | - |
| 202 | Line main voltage | - |  | - | - | $\underline{\square}$ |
| 203 | Output shaft power | - | - | - | - | - |
| 204 | Power factor | - | - | $\square$ | - | - |
| 205 | Power consumption | - | - | -- | - |  |
| 206 | Reset power consumption | no |  | Common for all parameter sets |  |  |
| 207 | Shaft torque | - | - | - | $\square$ | - |
| 208 | Operation time | - | - | - | - | - |
|  |  |  |  |  |  |  |
| 211 | Current phase L1 | - | - | - | - | - |
| 212 | Current phase L2 | - | - | - | - | - |
| 213 | Current phase L3 | $\square$ | $\square$ | - | $\underline{\square}$ | - |
|  |  |  |  |  |  |  |
| 214 | Line main voltage L1-L2 | - | - | - | - | - |
| 215 | Line main voltage L1-L3 | - | - | - | - | - |
| 216 | Line main voltage L2-L3 | - | - | - | - | - |
|  |  |  |  |  |  |  |
| 221 | Locked keyboard info | no | - | - | - | - |

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



## MSF

## SOFT STARTER

## INSTRUCTION MANUAL

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## SAFETY INSTRUCTIONS

## 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 $\mathrm{gl}, \mathrm{gG}$, 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 safery of the device.
4. The operator must do what he can to ensure that no unauthorised person is working on the device.
5. The operator must immediately report any changes to the device which reduce its safety to the user.
6. The user must undertake all necessary measures to operate the device in perfect condition only.

## Installation of spare parts

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

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

## Emergency

You can switch the device off at any time with the mains switch connected 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 plastic. 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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### 1.1 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 IP 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.

NOTEI The safety measures must remain in forceat all times. Should questions or uncertaintles arise, please contact your local sales outlet.

### 1.3 Notes to the Instruction Manual



## WARNING! Warnings are marked with a warning triangle.

## Serial 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 inquiryororder is dealt with correctly and swiftly.

NOTE! These instructions only apply to the soft starters having the serial number glven 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 requirements and VDE 0113.
- EN 5000.1 2 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 rype 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 returning the device

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


## Intermediate 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 K 1 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.


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


WARNING! Mounting, wirng and setting the device into operation must be carrled out by properly tralned personnel. Before setup, make sure that the installation is according to chapter 6. page 24 and the Checklist 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 protective earth.
- Connect the control voltage to terminals 01 and ${ }^{0} 02$ ( $100-240$ VAC or $380-500$ VAC).
- Connect relay K1 (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 start/stop command from keyboard.

### 3.2 Main functions/Applications

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

Switch on the control voltage (normally $1 \times 230$ 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 voltage 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 maln function is chosen according to the appilcation. 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.

NOTE! The default settings are for a standard 4-pole motor acc. 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.



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.

| $0\|0\| 6 \mid$ |  |  |
| :--- | :--- | :--- |
|  |  |  |
|  |  | 2 |
|  | Selectlon of control mode |  |
| Default: | 2 |  |
| Range: | $1,2,3$ |  |

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

NOTEI 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 4 / 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.


### 3.7 Starting



WARNINGI Make sure that all safety measures have been taken before starting the motor In order to avold 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 function voltage ramp.

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

## 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 List.

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 ratio of $5.0 \times$ FLC (1050A) for 30 seconds with a $50 \%$ duty cycle and 10 starts per hour.

NOTE! If more than $\mathbf{1 0}$ 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.

NOTEI 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/light 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

NOTEI-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 current for each application
- Main 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 $450 \%$.
- 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


### 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 func-
tion.

Table 2 Application Function List

| Application/ Duty | Problem | Solution MSF | Menus |
| :---: | :---: | :---: | :---: |
| PUMP Normal | Too fast start and stops | MSF Pump application with following start/stop features: | 22 |
|  | Non linear ramps | Linear ramps without tacho. |  |
|  | Water hammer | Torque ramps for quadratic load |  |
|  | High current and peaks during starts. |  |  |
|  | Pump is going in wrong direction | Phase reversal alarm | 88 |
|  | Dry running | Shaft power underload | 96-99 |
|  | High load due to dirt in pump | Shaft power overload | 92-95 |
| COMPRESSOR Normal | Mechanical shock for compressor, motor and transmissions | Linear Torque ramp or current limit start. | $\left\lvert\, \begin{aligned} & 25 ;=1 \text { or } \\ & 20,21 \end{aligned}\right.$ |
|  | Small fuses and low current available. |  |  |
|  | Screw compressor going in wrong direction | Phase sequence alarm | 88 |
|  | Damaged compressor if liquid ammonia enters the compressor screw. | Shaft power overload | 92-95 |
|  | Energy consumption due to compressor is running unloaded | Shaft power underload | 96-99 |
| CONVEYOR Normal/Heavy | Mechanical shocks for transmissions and transported goods. | Linear Torque ramp | 25;=1 |
|  | Filling or unloading conveyors | Slow speed and accurate position control. | 37-40,57,58 |
|  | Conveyor jammed | Shaft power overload | 92-95 |
|  | Conveyor belt or chain is off but the motor is still running | Shaft power underload | 96-99 |
|  | Starting after screw conveyor have stopped due to overload. | Jogging in reverse direction and then starting in forward. |  |
|  | Conveyor blocked when starting | Locked rotor function | 75 |
| FAN Normal | High starting current in end of ramps | Torque ramp for quadratic need | $25 ;=2$ |
|  | Slivering belts. |  |  |
|  | Fan is going in wrong direction when starting. | Catches the motor and going easy to zero speed and then starting in right direction. |  |
|  | Belt or coupling broken | Shaft power underload | 96-99 |
|  | Blocked filter or closed damper. |  |  |
| PLANER Heavy | High inertia load with high demands on torque and current control. | Linear Torque ramp gives linear acceleration and lowest possible starting current. | $25 ;=1$ |
|  | Need to stop quick both by emergency and production efficiency reasons. | Dynamic DC brake without Contactor for medium loads and controlled sensor less soft brake with reversing contactor for heavy loads. | $\begin{aligned} & 36 ;=1,34,35 \\ & 36 ;=2,34,35 \end{aligned}$ |
|  | High speed lines | Conveyor speed set from planer shaft power analog output. | 54-56 |
|  | Worn out tool | Shaft power overload | 92-95 |
|  | Broken coupling | Shaft power underload | 96-99 |
| ROCK CRUSHER Heavy | High enertia | Linear Torque ramp gives linear acceleration and lowest possible starting current. | $25 ;=1$ |
|  | Heavy load when starting with material | Torque boost | 30,31 |
|  | Low power if a diesel powered generator is used. |  |  |
|  | Wrong material in crusher | Shaft power overload | 92-95 |
|  | Vibrations during stop | Dynamic DC brake without Contactor | 36;=1,34,35 |
| BANDSAW Heavy | High inertia load with high demands on torque and current control. | Linear Torque ramp gives linear acceleration and lowest possible starting current. | $25 ;=1$ |
|  | Need to stop quick both by emergency and production efficiency reasons. | Dynamic DC brake without Contactor for medium loads and controlled sensor less soft brake with reversing contactor for heavy loads. | $\begin{aligned} & 36 ;=1,34,35 \\ & 36 ;=2,34,35 \end{aligned}$ |
|  | High speed lines | Conveyor speed set from band saw shaft power analog output. | 54-56 |
|  | Worn out saw blade | Shaft power overload |  |
|  | Broken coupling, saw blade or belt | Shaft power underload |  |
| CENTRIFUGE Heavy | High inertia load | Linear Torque ramp gives linear acceleration and lowest possible starting current. | $25 ;=1$ |
|  | To high load or unbalanced centrifuge | Shaft power overload |  |
|  | Controlled stop | Dynamic DC brake without Contactor for medium loads and controlled sensor less soft brake with reversing contactor for heavy loads. | $\begin{aligned} & 36 ;=1,34,35 \\ & 36 ;=2,34,35 \end{aligned}$ |
|  | Need to open centrifuge in a certain position. | Braking down to slow speed and then positioning control. | 37-40,57,58 |

Table 2 Application Function 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 overload | 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

|  |  | $\begin{aligned} & \text { O} \\ & \stackrel{\circ}{n} \\ & \text { O} \\ & \stackrel{0}{0} \\ & 0 \\ & 0 \\ & 0 \\ & 0 \end{aligned}$ |  |  |  |  |  |  |  | A <br> 0 <br> 0 <br> 0 <br> 0 <br> 0 <br> 0 <br> 0 <br> 0 <br> 0 <br> 0 <br> 0 <br> 0 <br> 0 <br> 0 | (Т-980) әуеля доләал э!шеика |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 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.

NOTEI Voltage and torque ramp for starting only with softbrake.

Table 4 Start/stop combination.


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 Ambient 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 control cable to fulfill EMC regulations acc. to $\S 1.5$, page 6.

### 4.7.6 Slip 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 pumpandsoft 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 paraliel

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 $\left(\mathrm{I}_{\mathrm{N}}\right)$ ", "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 $\S 7.22$, 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.

Setting/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


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.

### 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


Fig. 14 LED indication at different operation situation.


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 $\downarrow$ " 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 $\Theta$ and $\Omega$ 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. | PREV |
| Display next menu. |  |
| 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 " 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.

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

### 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 |  | Start/Stop | JOG fwd/rev | 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.

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

NOTE! 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.

Table 7 MSF-017 to MSF-250.

| MSF model | Class | Connection | Conv./ Fan | Dimension HxWxD (mm) | Hole dist. w1 (mm) | Hole dist. h1 (mm) | Diam./ screw | Weight (kg) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| -017, -030 | IP 20 | Busbars | Convection | 320×126×260 | 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 | Minimum | ree sp | (mm): | Dimension Connection |  | ening torqu | for bolt (Nm) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| m | 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 | $15 \times 4$ (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 <br> model | Class | Connection | Conv./ <br> Fan | Dimension <br> HxWxD (mm) | Hole dist. <br> w1 (mm) | Hole dist. <br> h1 (mm) | Dlam./ <br> screw | Welght <br> (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 |
| $-1000,-1400$ | IP00 | 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): |  |  | Dimension Connection, busbars AI | Tlightening torque for bolt ( Nm ) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | above 1) | below | at side |  | Cable | PE-cable | Supply and PE |
| -310, -370, -450 | 100 | 100 | 0 | 40×8 (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.


| MSF | e | f |
| :---: | :--- | :--- |
| -310 to -450 | 44 | 39 |
| -570 to -835 | 45.5 | 39 |

Observe that the two supplied mounting hooks (see $\$ 1.8$, page 7 and Fig. 2 on page 7 must be used for mounting the soft starter as upper support (only MSF310 to MSF-835).


Fig. 21 Busbar distances MSF - 310 to MSF -835.

Table 11 Busbar distances

| MSF model | Dlst. h1 <br> (mm) | Dist. w1 <br> (mm) | Dist. w2 <br> (mm) | Dlst. w3 <br> (mm) |
| :--- | :--- | :--- | :--- | :--- |
| -310 to -450 | 104 | 33 | 206 | 379 |
| -570 to -835 | 129 | 35 | 239.5 | 444 |
| $-1000-1400$ |  | 55 | 322.5 | 590.5 |

Fig. 20 Hole pattern 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, $\stackrel{\perp}{=}(\mathbf{P E})$, 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. 25 Connection of MSF-110 to MSF-145.

## Connection of MSF-110 to MSF-145

## Device connections

1. Protective earth, $\stackrel{\perp}{\perp}$ (PE), Mains supply, Motor (on the left inside of the cabinet)
2. Protective earth $\stackrel{\perp}{\perp}$ (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 $\S 7.12$, 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 connections

1. Protective earth, $\perp$ (PE), Mains supply, Motor (on the left inside of the cabinet)
2. Protective earth $\stackrel{\perp}{\perp}(\mathrm{PE})$, 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 $\S 7.12$, 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, $\stackrel{\perp}{=}$ (PE), Mains supply and Motor
2. Protective earth, $\stackrel{\perp}{\perp}$ (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 $\mathbb{\$} 7.12$, page 43)
7. Mounting of EMC gland for control cables

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



Fig. 28 Connections on the PCB, control card.
Table 12 PCB Terminals

| Terminal | Function | Electrical characteristics |
| :---: | :---: | :---: |
| 01 | Supply voltage | 100-240 VAC $\pm 10 \% / 380-500$ VAC $\pm 10 \%$ |
| 02 |  |  |
| PE | Gnd | $\underline{1}$ |
| 11 | Digital inputs for start/stop and reset. | $0-3 \mathrm{~V} \rightarrow 0 ; 8-27 \mathrm{~V} \rightarrow 1$ 1. Max. 37 V for 10 sec . Impedance to 0 VDC: $2.2 \mathrm{k} \Omega$. |
| 12 |  |  |
| 13 | Supply/control voltage to PCB terminal 11 and 12, $10 \mathrm{k} \Omega$ potentiometer, etc. | +12 VDC $\pm 5 \%$. Max. current from +12 VDC: 50 mA . Short circuit proof. |
| 14 | Remote analogue input control, 0-10 V , 2-10 V, 0-20 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. | $0-3 \mathrm{~V}$-> 0; 8-27 V-> 1. Max. 37 V for 10 sec . Impedance 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 VDC $\pm 5 \%$. Max. current from +12 VDC $=50 \mathrm{~mA}$. Short circuit proof. |
| 19 | Remote analogue output control | Analogue Output contact: <br> O-10V, 2-10V; 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 8 A resistive, 250 VAC, 3 A inductive. |
| 22 |  |  |
| 23 | Programmable relay K2. Factory setting is "Full voltage" indication by closing termiñal" $23=24$ | 1-pole closing contact, 250 VAC 8 A or 24 VDC 8 A resistive, 250 VAC, 3 A inductive. |
| 24 |  |  |
| 31 | Alarm relay K3, closed to 33 at alarm. | 1-pole change over contact, 250 VAC 8 A or 24 VDC 8 A resistive, $250 \mathrm{VAC}, 3 \mathrm{~A}$ inductive. |
| 32 | Alarm relay K3, opened at alarm. |  |
| 33 | Alarm relay K3, common terminal. |  |
| 69-70 | 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 | 0 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 $\stackrel{\perp}{\Perp}$ (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 KI then controls it. Always use standard commerclal, slow blow fuses, e.g. type gl, gG to protect the wiring and prevent short circuiting. To protect the thyristors against shortcircult currents, superfast semiconductor fuses can be used If preferred. The nomal guarantee is valid even If superfast semiconductor fuses are not used. All signal inperts 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 $\S 7.18$, page 52
- PTC input, see $\$ 7.21$, page 55

For more information see $\$ 6.3$, 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 |
|  |  | Parameter set selection |  | 057-058 | 7.19 |
|  |  |  |  | 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 retur | enu | 105 | 7.26 |
|  |  | Factory d |  | 199 | 7.28 |
| View functions | 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 down voltage 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:
$\left.\begin{array}{|l|l|l|}\hline 001 & 0 \\ \hline & & 3 \\ \hline & & 0 \\ \hline\end{array} \begin{array}{l}\text { Setting the initial voltage at } \\ \text { start ramp } 1\end{array}\right]$

| 0 0 4 <br> 0   |  |  |
| :--- | :--- | :--- | :--- |
|  | O | Setting of stop ramp 1 |
|  | F | F |
| Default: | oFF |  |
| Range: | oFF, 2-120 sec |  |
| oFF | Stop ramp disabled |  |
| $\mathbf{2 - 1 2 0}$ | Set "Ramp down time" at stop |  |

### 7.1.1 RMS current [005]



NOTE! This is the same read-aut 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.

| 006 |  |
| :---: | :---: |
|  | 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: 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. |

NOTEI 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 $\leftarrow$ / 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.



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 voltage ramp at start/stop, initial voltage at start and step down-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:

| 0 | 1 | 1 |
| :--- | :--- | :--- |
| 0 |  |  |$|$|  |  | Setting the initlal voltage at <br> start ramp 2 |
| :--- | :--- | :--- |
|  |  | 9 |
| Default: | $90 \%$ |  |
| Range: | $30-90 \% U_{n}$ |  |
| Set the start voltage for start ramp 2. The initial <br> voltage for start ramp 2 is limited to the initial volt- <br> age at start (menu 001). see § 7.1, page 36. |  |  |



| 0 | 1 | 3 | 0 |
| :--- | :--- | :--- | :--- |
| 0 |  |  |  |$|$|  |  | Setting of step down voltage <br> in stop ramp 2 |  |
| :--- | :--- | :--- | :--- |
|  |  | 4 | 0 |
| Default: | $40 \%$ |  |  |
| Range: | $100-40 \% U_{n}$ |  |  |
| Set the step down voltage for stop ramp 2. The <br> step down voltage for stop ramp 2 is limited to the <br> Step down voltage at stop (menu 003). |  |  |  |


| 0 1 4 0 |  |
| :--- | :--- | :--- | :--- |
|     <br>  $O$ $F$ $F$ |  |
| Default: | oFF |
| Range: | OFF, 2-120 sec |
| oFF | Stop ramp 2 disabled |
| 1-60 | Set the stop ramp 2 time. A dual <br> voltage stop ramp is active. |

### 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.



| 018 0  <br>    <br>    |  |
| :--- | :--- | :--- |
| End torque at stop |  |
| Default: | 0 |
| Range: | $0-100 \%$ of Tn |
| Insert end torque at stop in percent of the nominal <br> motor torque. |  |

### 7.6 Current limit (Main Function)

The Current Limit function is used to limit the current drawn when starting ( $150-500 \%$ 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.
NOTEI Make sure that nominal motor current in menu 042 is correctly inserted.

### 7.6.1 Voltage ramp with current limit

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 § 7.1, page 36).
3. Set the current limit to a suitable value e.g. $300 \%$ of In in menu 020 .

| 0 | 2 | 0 | Voltage ramp with current |
| :--- | :--- | :--- | :--- |
|  | 0 | $F$ | $F$ |
| limit at start |  |  |  |

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.


NOTE! 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-approprlate-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 $\S 7.1$, page 36 ), 16,17 and 18 (see $§ 7.5$, page 39 ).

| 0 | 2 | 2 | 0 |
| :--- | :--- | :--- | :--- |
|  | 0 | $F$ | $F$ |
| Default: | oFF |  |  |
| Range: | oFF, on |  |  |
| ofF | Pump control disabled. Voltage <br> Ramp enabled. |  |  |
| on | Pump 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 setting is voltage (U).


Fig. 38 Setting voltage or current for analogue input.


NOTEI 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 | Fetting 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.


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


| 0 | 3 | 1 | 0 |
| :--- | :--- | :--- | :--- |
|  | 3 | 0 |  |
|  | 3 | 0 | 0 |
|  | Torque boost current limit |  |  |
| Default: | 300 |  |  |
| Range: | $300-700 \%$ of In |  |  |
| The Torque boost current controller use selected <br> value as the motor current reference. |  |  |  |

NOTEI Check whether the motor can accelerate the load with "Torque booster", without any harmful mechanlcal 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.

NOTEI If one like to use the alarm functions, the extended functions or the viewing functions the 2-pcs 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 avallable. Code No 01-2020-00.


A!
CAUTIONI If the current transformers are not mounted as in Fig. 43 on page 44 and $\S$ 6.2, page 28, the alarm and viewing functions will not work. Do not forget to set menu 032 to 0 N , 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.

| (0)330 |  |  | Setting of PFC |
| :---: | :---: | :---: | :---: |
| 0 | $F$ | F |  |
| Default: |  | OFF |  |
| Range: |  | oFF, on |  |
| orF |  | PFC disabled |  |
| on |  | PFC enabled. The Full voltage relay function does not work. |  |

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

### 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 safery, the soft starter has à digital iñput 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 safery, the soft starter has a digital input signal for monitoring standstill. So that the output voltage is stopped immediately (see menu 57-58, 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 ts 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 $\$ 7.28$, page 63) and select the Bypass functlon again.



Fig. 46 Braking time


| $0 \mid 36$ |  |  |
| :--- | :--- | :--- |
|  |  |  |
|  |  |  |



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 slgnal.

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 $\S 7.19$, page 53 for more instructions.

- Slow Speed during a selected time period. The slow speed will be active after a stop command for a selected time period. See $\S 7.19$, 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 $\S 7.25$, page 61 for more instructions.

### 7.15.1 Slow speed controlled by an external signal.

With these setting it is possible to have an external pulse or edge signial 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 $\S 7.15 .2$, 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 $\S 7.19$, 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 time 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 $\S 7.14$, 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 an 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 time

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 $\S 7.14$, 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.

| $0 \mid 3180$ |  |  | Slow speed time at start |
| :---: | :---: | :---: | :---: |
|  |  | F |  |
| Default: |  | OFF |  |
| Range: |  | OFF, 1-60 sec |  |
| ofF |  | Slow speed at start is disabled |  |
| $1-60$ |  |  | w speed time at start. |




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, $\S 7.15 .4$, 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 $\$ 7.25$, page 61 for more instructions

- External 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 $\S 7.19$, 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.


### 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   |  |  |
| :--- | :--- | :--- |
|  |  |  |
|  |  |  |



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 § 7.12, 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 Wiving for analogue output.
2. Set Jumper J2 on the PCB board to voltage ( $U$ ) or current (I) signal position. Factory setting is voltage - $(-)$-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 | $\mathbf{I}_{\text {scale }}$ | $\mathbf{U}_{\text {scale }}$ | $\mathbf{P}_{\text {scale }}$ |
| :--- | :--- | :--- | :--- |
| $100 \%$ | $0-5 \times I_{n}$ | $0-720 \mathrm{~V}$ | $0-2 \times P_{\mathrm{n}}$ |
| $50 \%$ | $0-2.5 \times I_{\mathrm{n}}$ | $0-360 \mathrm{~V}$ | $0-P_{\mathrm{n}}$ |

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


### 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 $\S 7.14$, page 46 .
- Slow speed external controlled. See $\S 7.15 .1$, page 48.
- Jog functions forward or reverse enabled. See $\mathbb{C}$ 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.


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.
NOTE! If the Main Function Analogue control is programmed (see § 7.8, page 41) the analogue input can not be used for digital signal input. The menu 57 is then automatically set to OFF.


NOTEI Jog forward, reverse has to be enabled, see § 7.25, page 61.

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.).


### 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.

| $071{ }^{\circ}$ |  |  | Motor PTC input |
| :---: | :---: | :---: | :---: |
|  | n | 0 |  |
| Default: |  | no |  |
| Range: |  | no, YES |  |
| no |  | Motor PTC input is disabled |  |
| YES |  | Motor PTC input is activated: Connect the PTC to terminals 69 and 70 , see table 12, page 32 and § Fig. 30, page 34. <br> - A to hot motor will give an F2 alarm. The alarm can only be resetted after cooling down of the motor. |  |

NOTE! Open terminals will glve 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.

| 0 | 7 | 2 | 0 |
| :--- | :--- | :--- | :--- |
|  |  | Internal motor thermal <br> protection |  |
| Default: | 10 |  |  |
| Range: | oFF, 2-40 sec |  |  |
| oFF | Internal motor protection is disabled. |  |  |
| $\mathbf{2 - 4 0}$ | Selection of the thermal curve <br> according to Fig. 57 <br> - <br> - Check that menu 042 is set to the <br> proper motor current (see § 7.16, <br> page 50). <br> - If the current exceeds the 100\% <br> level an F2 alarm is activated. <br> - The motor model thermal capacity <br> must cool down to 95\% before reset <br> can be accepted. <br> - Used thermal capacity in menu 073 <br> in § 7.21, page 55. |  |  |

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


CAUTIONI Used thermal capacity is set to 0 if the control board loses its supply (terminal 01 and 02). This means that the intemal 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




| $0.75{ }_{0}^{\circ}$ |  |  | Locked rotor alarm |
| :---: | :---: | :---: | :---: |
| 0 | $F$ | $F$ |  |
| Default: |  | OFF |  |
| Range: |  |  | .0-10.0 sec |
| oFF |  |  | drotor alarm is disabled |
| 1.0-10.0 |  |  | alarm is given when the rotor The alarm is active duringg and running. |




| Default: | 85 |
| :--- | :--- |
| Range: | $75-100 \mathrm{U}_{\mathrm{n}}$ |

Insert limit in \% of nominal motor voltage. Min voltage of the 3 input phases is compared with the selected value. This is a category 2 alarm.




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 $\oint 7.23 .2$, 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.


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

The actual power is regarded as 1.00 xPact .
The set levels are:

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

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

### 7.23.2 Pre-alarm

| O) 910 |  | Start delay power limits |
| :---: | :---: | :---: |
|  | 10 |  |
| Default: |  | 10 sec |
| Range: $\quad 1$ |  | sec |
| From start command during selected delay time, all power load monitor alarms and pre-alarms are disabled. |  |  |



| 0 9 3 <br> 0   |  |
| :--- | :--- | :--- | :--- |
|  0  | Response delay max alarm |
| Default: | oFF |
| Range: | oFF, 0.1-25.0 sec |
| oFF | Max Alarm is disabled. |
| $\mathbf{0 . 1 - 2 5 . 0}$ | Sets the response delay of the Max <br> Alarm level. |

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.

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

| $0 \mid 9$ | 4 | 0 |
| :--- | :--- | :--- | :--- |




| 0 9 7 |  |
| :--- | :--- | :--- | :--- |
|  0 | Min pre-alarm response delay |
| Default: | oFF |
| Range: | oFF, 0.1 - 25.0 sec |
| oFF | Min Pre-Alarm is disabled. |
| $\mathbf{0 . 1 - 2 5 . 0}$ | Sets the response delay of the Min <br> Pre-Alarm level. The Min Pre-alarm is <br> disabled during a stop ramp down. |



Min pre-alarm response delay



Min alarm response delay

| Default: | oFF |
| :--- | :--- |
| Range: | oFF, 0.1-25.0 sec |
| oFF | Min Alarm is disabled |
| $\mathbf{0 . 1 - 2 5 . 0}$ | Sets the response delay of the Min <br> Alarm level. The Min alarm is disa- <br> bled during a stop ramp down. |


bled during a stop ramp down.


### 7.24 Resume alarms

### 7.24.1 Phase input failure F1

- Multiple phase fallure.

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 F1 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\|0|10 |  |  | Run at single phase loss |
| :---: | :---: | :---: | :---: |
|  | $n$ | 0 |  |
| Default: |  | no |  |
| Range: |  |  |  |
| no |  |  | arter trips if a single phase detected. Alarm F1 (category appear after 2 sec . |
| YES |  |  | arter continues to run after a phase loss. <br> F1 appears after 2 sec . loose phase is reconnect the is reset automatically. ning on 2 phases, a stop comwill 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.

| 1020 |  |  | Run at current limit time-out |
| :---: | :---: | :---: | :---: |
|  | n | 0 |  |
| Default: |  | no |  |
| Range: |  | no, YES |  |
| no |  |  | arter trips if the current limit ut is exceeded. Alarm F4 (cate appears. |
| YES |  |  | arter continues to run after the limit time-out has exceeded: F4 appears urrent is no longer controlled he soft starters ramps up to full ge with a $6 s$ ramp time. the alarm with either ENTER/ T key or by giving a stop com- |

### 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).

| 1050 |  |  | Automatic return menu |
| :---: | :---: | :---: | :---: |
| 0 | F | F |  |
| Default: |  | off | - |
| Range: |  |  | 999 |
| 1-999 |  |  | ng "+"/"-" will lead through nu system. |

### 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.
Serial comm unit address


| Default: | 1 |
| :--- | :--- |
| Range: | $1-247$ |
| This parameter will select the unit address. |  |


| 113 |  |  |
| :---: | :---: | :---: |
|  | 0 |  |
| Default: | 0 |  |
| Range: | 0.1 |  |
| This parameter will select the parity. 0 No parity. <br> 1 Even parity. |  |  |

## Serial comm. broken alarm

If control mode is 'Serial comm. control' and no con-tact-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 com-
munication is re-established. It is also possible to reset
If an alarm occurs, it is automatically reset if the com-
munication is re-established. It is also possible to reset the alarm-from the soft starter keyboard.

| 1 1 4 0 |  | Serial comm. contact <br> interrupted |
| :--- | :--- | :--- |
|  |  |  |
| Default: | 1 |  |
| Range: | ofF, 1, 2 |  |
| This parameter will control the behaviour in the soft <br> starter when the serial comm. is interrupted. <br> oFF No alarm and continue operation. <br> 1 | Alarm and stop operation. |  |
| 2 | Alarm and continue operation. |  |

Serial comm. contact Interrupted

This parameter will control the behaviour in the soft starter when the serial comm. is interrupted.

1 Alarm and stop operation.
Alarm and continue operation.
-
$\qquad$

[^0]
### 7.28 Reset to factory setting [199]

When selecting reset to factory settings:

- 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.


NOTEI Reset to factory settings is not allowed at run.


NOTEI The power factor vlewing will not work at bypass even if the current transformers are mounted outside the soft start.


| 206 ${ }^{\circ}$ |  |  | Reset of power consumption |
| :---: | :---: | :---: | :---: |
|  | n | 0 |  |
| Default: |  | no |  |
| Range: |  | no, YES |  |
| no |  | No reset of power consumtion. |  |
| YES |  | Reset power consumption in menu 205 to 0.000 . |  |


| 2 1 2 0$\quad$ RMS current in phase L2 |  |  |  |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  |  | 0 | 0 |



### 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 $\leftarrow$ " 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.

| 2 2 1 <br> 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 ( $\mathrm{F} 1-\mathrm{F} 16$ ). 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 ).


The soft statter 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 K 3 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 K 3 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 K 3 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 ' 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. TROUBLESHOOTING

### 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 <br> (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. <br> If internal protection is used, perhaps an other class could be used (menu 072). <br> 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 (Voltage unbalance) | Main supply voltage unbalance. | Check mains supply. |
|  | $\begin{aligned} & \text { F9 } \\ & \text { (Over voltage) } \end{aligned}$ | M ain supply over voltage. | Check mains supply. |
|  | $\begin{aligned} & \text { F10 } \\ & \text { (Under voltage) } \end{aligned}$ | 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 <br> (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 (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 <br> (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 <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. Deselect 'Run at current limit time-out' in menu 102, if stop is desired at current limit time-out. |
|  | F12 <br> (Shorted 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 <br> (Serial communication broken) | Serial communication broken. | Make a reset and try to establish contact. Check contacts, cables and option board. 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, motor reaches full speed but it jerks or vibrates. | If 'Torque control' or 'Pump control' is selected, it is necessary to input motor data into the system. | Input nominal motor data in menus 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 starting 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 motor 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 -forthe_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 short 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-145 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 $0^{20} 0$ ", 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: 01-1736-01
- LONWORKS: 01-1737-01
- FIP IO:

01-1738-01

- INTERBUS-S:

01-1735-01
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 external 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 <br> $95-300 \mathrm{~mm}^{2}$

MSF type Cu Cable
Bolt for connection to busbar
Dimensions in mm
Order No. single
Data: Parallel cables, Cu or Al
Cables
MSF type and Cu Cable
Bolt for connection to busbar
Dimensions in mm
Order No. parallel

310
M10
$33 \times 84 \times 47 \mathrm{~mm}$ 9350
$2 \times 95-300 \mathrm{~mm}^{2}$
310 to -835
M10
$35 \times 87 \times 65$
9351


Fig. 64 The terminal clamp.

## 12. TECHNICAL DATA

| 3x200-525 V 50/60 Hz Model | MSF017 |  | MSF-030 |  | MSF-045 |  | MSF-060 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Soft starter rating according to AC35a, see chapter 4. page 13 | $\begin{array}{\|c\|} \hline 5.0-30: 50-10 \\ \text { heavy } \end{array}$ | $\left\lvert\, \begin{aligned} & \text { 3.0-30:50-10 } \\ & \text { normal/Illght } \end{aligned}\right.$ | $\begin{gathered} 5.0-30: 50-10 \\ \text { heavy } \end{gathered}$ | $\begin{aligned} & \hline \text { 3.0-30:50-10 } \\ & \text { normal/IIght } \end{aligned}$ | $\left\|\begin{array}{c} 5.0-30: 50-10 \\ \text { heavy } \end{array}\right\|$ | $\left\|\begin{array}{l} 3.0-30: 50-10 \\ \text { normal/IIght } \end{array}\right\|$ | $\begin{array}{\|c\|} \hline 5.0-30: 50-10 \\ \text { heavy } \end{array}$ | $\begin{aligned} & \text { 3.0-30:50-10 } \\ & \text { normal/IIght } \end{aligned}$ |
| 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 50/60Hz Model | MSF-017 |  | MSF-030 |  | MSF-045 |  | MSF-060 |  |
| 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-(100-240V)- | 01-1321-01 |  | 01-1322-01 |  | 01-1323-01 |  | 01-1324-01 |  |
| Order number: supply volt age ( $380-500 \mathrm{~V}$ ) | 01-1321-02 |  | 01:1322-02 |  | 01-1323-02 |  | 01-1324-02 |  |
| Electrical Data |  |  |  |  |  |  |  |  |
| Recommended wiring fuse (A) 1) | 25/50 | 32 | 35/80 | 50 | 50/125 | 80 | 63/160 | 100 |
| Semi-conductor fuses, if required | 80 A |  | 125 A |  | 160 A |  | 200 A |  |
| Power loss at rated motor load (W) | 50 | 70 | 90 | 120 | 140 | 180 | 180 | 215 |
| Power consumption control card | 20 VA |  | 20 VA |  | 25 VA |  | 25 VA |  |
| Mechanical Data |  |  |  |  |  |  |  |  |
| Dimensions in mm- $\mathrm{H} \times \mathrm{W} \times \mathrm{D}$ | 320×126x 260 |  | 320×126×260 |  | $320 \times 126 \times 260$ |  | 320×126x260 |  |
| Mounting position (Vertical/Horizontal) | Verticall ${ }^{-\cdots}$ |  | ----_Vertical |  | Vert. or Horiz. |  | Vert. or Horiz. |  |
| Weight (kg) | 6.7 |  | 6.7 |  | 6.9 |  | -- - 6.9 |  |
| Connection busbars Cu, ( bolt) | 15x4 (M6) |  | 15×4 (M6) |  | 15×4 (M6) |  | 15×4 (M8) |  |
| Cooling system | Convection |  | Convection |  | Fan |  | Fan |  |
| General Electrical Data |  |  |  |  |  |  |  |  |
| Number of fully controlled phases | 3 |  |  |  |  |  |  |  |
| Voltage tolerance control | Control $+/-10 \%$ |  |  |  |  |  |  |  |
| 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 tolerance | +/.10\% |  |  |  |  |  |  |  |
| Relay contacts | $3 \times 8 \mathrm{~A}, 250 \mathrm{~V}$ resistive load, 3 A 250 VAC inductive ( $\mathrm{PF}=0.4$ ) |  |  |  |  |  |  |  |
| Type of protection/Insulation |  |  |  |  |  |  |  |  |
| Type of casing protection | IP 20 |  |  |  |  |  |  |  |
| Other General Data |  |  |  |  |  |  |  |  |
| Ambient temperatures |  |  |  |  |  |  |  |  |
| In operation | $0.40^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |
| Max.e.g. at $80 \%$ IN | $\cdots-=-20{ }^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |
| In storage | (-25) $(+770)^{\circ} \mathrm{C}-\quad=-\cdots=-\cdots$ |  |  |  |  |  |  |  |
| 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 602041, UL508 |  |  |  |  |  |  |  |
| EMC, Emission | EN 50081-2, (EN 50081-1 with bypass contactor) |  |  |  |  |  |  |  |
| EMC, Immunity | EN 50082-2 |  |  |  |  |  |  |  |
| 1) Recommended wiring fuses for:Heavy (first column): ramp/direct start <br> Normal/Lght (second column): ramp start |  |  |  |  |  |  |  |  |
| NOTEI Short clrcult withstand MSF017-060 5000 rms A when used with K5 or RK5 fuses. |  |  |  |  |  |  |  |  |

* 2-pole motor

* 2-pole motor

| 3x200-525 V 50/60 Hz Model | MSF-170 |  | MSF-210 |  | MSF-250 |  | MSF-310 |  | MSF-370 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Soft starter rating according to AC35a, see chapter 4. page 13 | $\begin{aligned} & 5.0-30: \\ & 50-10 \\ & \text { heary } \end{aligned}$ | $\begin{array}{\|c\|} \hline 3.0-30: \\ 50-10 \\ \text { normal/tight } \\ \hline \end{array}$ | $\begin{aligned} & \text { 5.0.30: } \\ & \text { 50-10 } \\ & \text { heavy } \end{aligned}$ | $\begin{array}{\|c\|} \hline 3.0-30: \\ 50-10 \\ \text { normal/light } \end{array}$ | $\begin{aligned} & \text { 5.0.30: } \\ & \text { 50.10 } \\ & \text { heavy } \end{aligned}$ | $\begin{array}{\|c\|} \hline 3.0-30: \\ 50-10 \\ \text { normal/llght } \end{array}$ | $\begin{aligned} & \text { 5.0.30: } \\ & 50.10 \\ & \text { heary } \end{aligned}$ | $\begin{gathered} 3.030 ; \\ 50-10 \\ \text { normal/IIght } \end{gathered}$ | $\begin{aligned} & 5.0-30: \\ & 50.10 \\ & \text { heary } \end{aligned}$ | $\begin{array}{\|c\|} \hline 3.0-30: \\ 50-10 \\ \text { normal/ilght } \end{array}$ |
| 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 voltage (100-240V) | 01-1309-11 |  | 01-1310-11 |  | 01-1311-11 |  | 01-1312-01 |  | 01-1313-01 |  |
| Order no. for supply voltage (380-550V) | 01-130912 |  | 01.1310-12 |  | 01-1311-12 |  | 01-1312-02 |  | 01.1313-02 |  |
| $3 \times 200-690$ V 50/60 Hz Model | MSF-170 |  | MSF-210 |  | MSF-250 |  | MSF310 |  | MSF370 |  |
| 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 |  | 01-1330-01 |  | 01-1331-01 |  | 01-1332-01 |  | 01-1333-01 |  |
| Order no. for supply voltage ( $380-550 \mathrm{~V}$ ) | 01-1329-02 |  | 01-1330-02 |  | 01-1331-02 |  | 01-1332-02 |  | 01-1333-02 |  |
| Electrical Data |  |  |  |  |  |  |  |  |  |  |
| Recommended wiring fuse ( $A$ ) 1) | 200/400 | 200 | 250/400 | 315 | 250/500 | $\bigcirc 315$ | 315/630 | 400 | 400/800 | 500 |
| Semi-conductor fuses, if required | 700 A |  | 700 A |  | 700 A |  | 800 A |  | $\cdots-1000 .{ }^{\text {a }}$ |  |
| Power loss at rated motor load (W) | 510 | 630 | 630 | 750 |  | 50 W | 930 | 1100 | 1100 | 1535 |
| Power consumption control card | 35 VA |  | 35 VA |  | 35 VA |  | 35 VA |  | 35 VA |  |
| Mechanical Data |  |  |  |  |  |  |  |  |  |  |
| Dimensions mm HxWxD incl. brackets | $500 \times 260 \times 260$ |  | $500 \times 260 \times 260$ |  | $500 \times 260 \times 260$ |  | $532 \times 547 \times 278$ |  | $532 \times 547 \times 278$ |  |
| 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 AI/Cu (bolt) | $30 \times 4{ }^{-}$(M10)---- |  | $30 \times 4$ (M10) |  | 30x4 (M10) |  | 40x8 (M12) |  | 40×8(M12) |  |
| Cooling system | Fan |  | fan |  | Fañ ${ }^{-}$ |  | - - ..Fan |  | Fan |  |
| General Electrical Data |  |  |  |  |  |  |  |  |  |  |
| Number of fully controlled phases | 3 |  |  |  |  |  |  |  |  |  |
| Voitage tolerance control | Control +/-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 tolerance | +/-10\% |  |  |  |  |  |  |  |  |  |
| Relay contacts | $8 \mathrm{~A}, 250 \mathrm{~V}$ resistive load, 3A, 250 V inductive load ( $\mathrm{PF}=0.4$ ) |  |  |  |  |  |  |  |  |  |
| Type of protection/insulation |  |  |  |  |  |  |  |  |  |  |
| Type of casing protection | IP 20 |  |  |  |  |  |  |  |  |  |
| Other General Data |  |  |  |  |  |  |  |  |  |  |
| Ambient temperatures In operation | $0.40{ }^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |
| Max.e.g. at $80 \% I_{N}$ | $50^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |
| In storage | $(-25)-(+70)^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |
| Relative air humidity | 95\%, non-condensing |  |  |  |  |  |  |  |  |  |
| Max. attitude without derating | ..... (See separate: Technical information 151) 1000 m |  |  |  |  |  |  |  |  |  |
| Norms/Standards, Conform to: | IEC 947-42, EN 292, EN 60204-1, (UL508, only 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: Heavy (first column): ramp/direct start <br> Normal/Lght (second column): ramp start |  |  |  |  | eavy (first column): ramp/direct start ormal/LIght (second column): ramp start |  |  |  |  |  |
| NOTE! Stort clrcult withstand MSF170-250 18000 mms A when used wth K5 or RK5 fuses. |  |  |  |  |  |  |  |  |  |  |

* 2-pole motor

| 3x200-525V 50/60Hz Model | MSF-450 |  | MSF-570 |  | MSF-710 |  | MSF-835 |  | MSF-1000 |  | MSF-1400 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Soft etartar rating according to AC35a, seo chapter 4. page 13 | $\begin{aligned} & \text { 5.0-30: } \\ & \text { 50-10 } \\ & \text { heary } \end{aligned}$ | $\begin{gathered} 3.0-30: \\ 50-10 \\ \text { nomat/ } \\ \text { light } \end{gathered}$ | $\begin{aligned} & \text { 5.0-30: } \\ & \text { 50-10 } \\ & \text { heavy } \end{aligned}$ | $\begin{aligned} & \text { 3.0-30: } \\ & 50.10 \\ & \text { nomal/ } \\ & \text { Igght } \end{aligned}$ | $\begin{aligned} & 5.0-30: \\ & 50-10 \\ & \text { heavy } \end{aligned}$ | $\begin{gathered} 3.0-30: \\ 50-10 \\ \text { nomat/ } \\ \text { light } \end{gathered}$ | $\begin{aligned} & \text { 5.0-30: } \\ & 50-10 \\ & \text { heavy } \end{aligned}$ | $\begin{gathered} 3.0-30: \\ 50-10 \\ \text { normal/ } \\ \text { light } \end{gathered}$ | $\begin{aligned} & 5.0-30 \\ & 50-10 \\ & \text { heavy } \end{aligned}$ | $\begin{gathered} \text { 3.0-30: } \\ 50-10 \\ \text { nomgal/ } \\ \text { light } \end{gathered}$ | 5.0-30: $50-10$ heavy | $\begin{gathered} 3.0-30: \\ 50-10 \\ \text { nombl/ } \\ \text { llaht } \end{gathered}$ |
| Raled 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 | 1250 |
| Order no. for supply voltege ( $100-240 \mathrm{~V}$ ) | 01-1341-01 |  | 01-1315-01 |  | 01-1316-01 |  | 01-1317.01 |  | 01-1318-01 |  | 01-131901 |  |
| Order no. for supply voltege (380-550V) | 01-1314-02 |  | 01-1315-02 |  | 01-1316-02 |  | 01-1317.02 |  | 01-1318-02 |  | 01-1319-02 |  |
| $3 \times 200-690 \mathrm{~V} 50 / 60 \mathrm{~Hz}$ Model | MSF-450 |  | MSF-570 |  | MSF-710 |  | M5F-835 |  | MSF-1000 |  | MSF-1400 |  |
| Rated current of soft starter ( A ) | 450 | 549 | 570 | 640 | 710 | 835 | 835 | 880 | 1000 | 1125 | 1400 | 1524 |
| Molor power for 690 V | 400 | 560 | 560 | 630 | 710 | 800 | 800 |  | 1000 | 1120 | 1400 | 1600 |
| Order no. for supply voltage ( $100-240 \mathrm{~V}$ ) | 01-1334-01 |  | 01-1335-01 |  | 01-1336-01 |  | 01-1337-01 |  | 01-1338-01 |  | 01-133901 |  |
| Order no. for supply voltage (380-550V) | 01-1334-02 |  | 01-1335-02 |  | 01-1336-02 |  | 01-1337.02 |  | 01-1338-02 |  | 01-1339-02 |  |
| Electrical Data |  |  |  |  |  |  |  |  |  |  |  |  |
| Recommended wiring fuse (A 1) | 500/1 k | 630 | 630/1 k | 800 | 800/1 k | 1 $k$ | $1 \mathrm{k} / 1.2 \mathrm{k}$ | 1 k | $1 \mathrm{k} / 1.4 \mathrm{k}$ | 1.2 k | 1.4 K/1.8 K | 1.8 k |
| Semi-conductor fuses, if required | 1250 A |  | 1250 A |  | 1800 A |  | 2500 A |  | 3200 A |  | 4000 A |  |
| Power loss at rated motor load (W) | 1400 | 1730 | 1700 | 2100 | 2100 | 2500 | 2500 | 2875 | 3000 | 3375 | 4200 | 4950 |
| Power consumption contral card | 35 VA |  | 35 VA |  | 35 VA |  | 35 VA |  | 35 VA |  | 35 VA |  |
| Mecharlcal Data |  |  |  |  |  |  |  |  |  |  |  |  |
| Dimensions mm $\mathrm{H} \times \mathrm{W} \times \mathrm{D}$ incl. brackets | $532 \times 547 \times 278$ |  | $687 \times 640 \times 302$ |  | 687×640×302 |  | 687x640×302 |  | 900×875×336 |  | $900 \times 875 \times 336$ |  |
| Mounting position (Vertical/Horizontal) | Vert. or Hariz. |  | 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) | 40×8 (M12) |  | 40×10(M12) |  | 40×10(M12) |  | 40×10(M12) |  | 75x10(M12) |  | 75×10(M12) |  |
| Cooling system | Fan |  | Fan |  | Fan |  | Fan |  | Fan |  | Fan |  |
| General Electrical Data |  |  |  |  |  |  |  |  |  |  |  |  |
| Number of fully controlled pheses | 3 |  |  |  |  |  |  |  |  |  |  |  |
| Voltage tolerance control | Control +/. $10 \%$ |  |  |  |  |  |  |  |  |  |  |  |
| Valtage tolerance motor | Motor $200 \cdot 525+/ \cdot 10 \% / 200.690+5 \%,-10 \%$ |  |  |  |  |  |  |  |  |  |  |  |
| Recommended fuse for control card (A) | Max 10 A |  |  |  |  |  |  |  |  |  |  |  |
| Frequency | $50 / 60 \mathrm{~Hz}$ |  |  |  |  |  |  |  |  |  |  |  |
| Frequency tolerance | +/10\% |  |  |  |  |  |  |  |  |  |  |  |
| Relay contacts | 8 8, 250 V resistive load, $3 \mathrm{~A}, 250 \mathrm{~V}$ inductive load ( $\mathrm{PF}=0.4$ ) |  |  |  |  |  |  |  |  |  |  |  |
| Type of protection/Insulation |  |  |  |  |  |  |  |  |  |  |  |  |
| Type of casing protection | $\text { IP } 20$ |  |  |  |  |  |  |  | 1 P 00 |  |  |  |
| Other General Data |  |  |  |  |  |  |  |  |  |  |  |  |
| Ambient temperatures In aperation | $0.40{ }^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |  |  |
| Max. e.g. at $80 \% 1_{\mathrm{N}}$ | $50^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |  |  |
| In storage | $(-25) \cdot(+70)^{\circ} \mathrm{C}$ |  |  |  |  |  |  |  |  |  |  |  |
| Relative air humidlty | 95\%, non-condensing |  |  |  |  |  |  |  |  |  |  |  |
| Max. altitude without derating | (See separate: Technical information 151) 1000 m |  |  |  |  |  |  |  |  |  |  |  |
| Norms/Standards, Conform to: | IEC 947-42, EN 292, EN 60204-1 |  |  |  |  |  |  |  |  |  |  |  |
| EMC, Emission | EN 50081-2, (EN 50081-1 with bypass contactor) |  |  |  |  |  |  |  |  |  |  |  |
| EMC, Immunity | EN 50082-2 |  |  |  |  |  |  |  |  |  |  |  |
| 1) Recommended wiring fuses for: | Heavy (first column): ramp/direct start <br> 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 | FWP Bussmann fuse |  |
| :---: | :---: | :---: |
|  | A | $\mathrm{I}^{2} t$ (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 MENULIST

| Menu number | Functlon/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 | $\cdots$ | - |  | 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, $2-120 \mathrm{sec}$ | 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\% In | 1.4 | oFF |  | page 39 |
| 021 | Current limit at start | oFF, 150-500\% $\mathrm{I}_{\mathrm{n}}$ | 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 | $300-700 \% I_{n}$ | 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 | $200 \cdot 700 \mathrm{~V}$ | $1 \cdot 4$ | 400 |  | page 50 |
| 042 | Nominal motor current | $\begin{gathered} 25-\left.150 \%\right\|_{\text {nsoft }} \text { in } \\ \text { Amp } \end{gathered}$ | 1-4 | $\mathrm{I}_{\text {nsoft }}$ in Amp |  | page 50 |
| 043 | Nominal motor power | $\begin{gathered} 25 \cdot 300 \% \text { of } P_{\text {nsoft }} \text { in } \end{gathered}$ | 1-4 | $\mathrm{P}_{\text {nsoft }}$ 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 | Functlon/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 input | 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\% $U_{n}$ | 1-4 | 10 |  | page 56 |
| 082 | Response delay voltage uñbalance-alarm- | -...OFF, $1-60 \mathrm{sec}$ | 1-4 | oFF |  | page 56 |
| 083 | Over voltage alarm | $100-150 \% U_{n}$ | 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 voitage alarm | oFF, 1-60 sec | 1-4 | oFF |  | page 57 |
| 087 | Phase sequence | L123, L321 | - | - |  | 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 | $\square$ | $\square$ |  | page 57 |
| 091 | Start delay power limits | $1-250 \mathrm{sec}$ | 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 sec | 1-4 | oFF |  | page 58 |
| 094 | Max power pre-alarm limit | 5-200\% Pn | 1-4 | 110 |  | page 58 |
| 095 | Max pre-alarm response delay | ofF, 0.1-25.0 sec | 1-4 | oFF |  | page 58 |
| 096 | Min pre-alarm power limit | $-5.200 \% \mathrm{Pn}$ | 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 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 - 38.4 kBaud | - | 9.6 |  | page 62 |


| Menu number | Functlon/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 |  | $\cdots$ |  | page 63 |
| 203 | Output shaft power | -9999.9999 kW | - | $\underline{\square}$ |  | page 63 |
| 204 | Power factor | 0.00-1.00 |  | - |  | page 63 |
| 205 | Power consumption | 0.000-2000 MWh | - | - |  | 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 |  | - |  | page 64 |
| 213 | Current phase L3 | 0.0-9999 Amp | - | - |  | page 64 |
|  |  |  |  |  |  |  |
| 214 | Line main voltage L1-L2 | 0.720 V | - | - |  | page 64 |
| 215 | Line main voltage L1-L3 | 0-720 V | - | - |  | page 64 |
| 216 | Line main voltage L2-L3 | 0.720 V | - | -- |  | 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 | -- | - |  | page 65 |

Explanation of units:
U Input line voltage
Un Nominal motor voltage.
In Nominal motor current.
Pn Nominal motor power.
$\mathrm{Nn} \quad$ 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 functlons for motor control, menus 020-025, can only be selected one at a time.

## 14. INDEX

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## QUICK INSTALLATION CARD - MSF



Fig. 1 Standard wiring.


Fig. 2 Connections on the PCB, control card.

Table 1 PCB Terminals

| Terminal | Function | Electrical charactertstics |
| :---: | :---: | :---: |
| 01 | Supply voltage | $\begin{aligned} & 100-240 \mathrm{VAC} \pm 10 \% / 380-500 \mathrm{VAC} \\ & \pm 10 \% \end{aligned}$ |
| 02 |  |  |
| PE | Gnd | 1 |
| 11 | Digital inputs for start/stop and reset. | $0.3 \mathrm{~V} \rightarrow 0 ; 8-27 \mathrm{~V} \rightarrow 1$ 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 VDC $\pm 5 \%$. Max. current from +12 VDC: 50mA. Short circuit proof. |
| 14 | Remote analogue input control, $0.10 \mathrm{~V}, 2.10 \mathrm{~V}, 0.20 \mathrm{~mA}$ and $4-20$ mA/digital input. | Impedance to terminal 15 ( 0 VDC ) volt age signal: $125 \mathrm{k} \Omega$, current sig nal: $100 \Omega$. |
| 15 | GND (common) | O VDC |
| 16 | Digital inputs for selection of parameter set. | $0-3 V->0 ; 8-27 V->1$. Max. $37 V$ for 10 s . Impedance 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 VDC $\pm 5 \%$. Max. current from $+12 \mathrm{VDC}=50 \mathrm{~mA}$. Short circuit proof. |
| 19 | Remote analogue out put control | Analogue Output contact: $0-10 \mathrm{~V}, 2-10 \mathrm{~V}$; min load impedance $700 \Omega 0-20 \mathrm{~mA}$ 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 8 A resistive, 250 VAC, 3A inductive. |
| 22 |  |  |
| 23 | Programmable relay K2. Factory setting is "Full voltage" indication by closing terminal 23-24. | 1-pole closing contact, 250 VAC 8A or 24 VDC 8A resistive, 250 VAC, $3 A$ inductive. |
| 24 |  |  |
| 31 | Alarm relay K3, closed to 33 at alarm. | 1-pole change over contact, 250 VAC 8 A or 24 VDC 8 A resistive, 250 VAC, 3 A inductive. |
| 32 | Alarm relay K 3 , opened at alarm. |  |
| 33 | Alarm relay K3, common terminal. |  |
| 69-70 | 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-170-MSF-835 |
| 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.


Fig. 3 Menu structure.

| Men nr. | Function/Parameter | Range | Par. set | Factory setting | Page |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 001 | Initial voltage at start | 25.90\% of U | 1.4 | 30 | page 36 |
| 002 | Start time ramp 1 | 1.60 s | 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 s | 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 s | 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 s | 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 | $\begin{aligned} & \text { OFF, } 150 . \\ & 500 \% I_{n} \end{aligned}$ | 1-4 | OFF | page 39 |
| 021 | Current limit at start | $\begin{aligned} & \hline \text { OFF, } 150 . \\ & 500 \% I_{n} \end{aligned}$ | 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, $0.1-2.0 \mathrm{~s}$ | 1.4 | ofF | page 43 |
| 031 | Torque boost current limit | 300.700\% $1_{n}$ | 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 | Braking time | off, 1-120 s | 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 s | 1.4 | oFF | page 49 |
| 039 | Slow speed time at stop | ofF, 1-60 s | 1.4 | ofF | page 49 |
| 040 | DC-Brake at slow speed | ofF, 1-60 s | 1-4 | ofF | page 49 |
| 041 | Nominal motor voltage | 200-700 V | 1-4 | 400 | page 50 |
| 042 | Nominal motor current | $\begin{aligned} & 25-150 \% I_{\text {nsoft }} \\ & \text { in Amp } \end{aligned}$ | 1-4 | $\begin{gathered} I_{\text {ssof inp }} \text { in } \\ \text { Amp } \end{gathered}$ | page 50 |
| 043 | Nominal motor power | $\begin{aligned} & 25-300 \% \text { of } \\ & \mathrm{P}_{\text {nsoft }} \text { in } \mathrm{kW} \end{aligned}$ | 1-4 | $\begin{gathered} \mathrm{P}_{\text {nsiff }} \text { in } \\ \mathrm{kN} \end{gathered}$ | page 50 |
| 044 | Nominal speed | $500-3600 \mathrm{rpm}$ | 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 |
|  |  |  |  |  |  |
| 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 puises | 1-100 | 1 - 4 | 1 | page 53 |
|  |  |  |  |  |  |
| 061 | Parameter set | 0, 1, 2, 3, 4 |  | 1 | page 54 |
|  |  |  |  |  |  |
| 071 | Motor PTC input | 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 |


| Ment nr. | Function/Parameter | Range | Par. set | Factory setting | Page |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 075 | Locked rotor alarm | OFF, 1.0-10.0 s | 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 |  |  | 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\% Pr |  |  | page 57 |
| 091 | Start delay power limits | 1.250 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 s | 1.4 | oFF | page 58 |
| 094 | Max power pre-alarm limit | 5-200\% Pn | 1.4 | 110 | page 58 |
| 095 | Max pre-alarm response delay | ofF, 0.1-25.0 s | 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 s | 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 s | 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 | $\underset{\text { kBaud }}{2.4-38.4}$ |  | 9.6 | page 62 |
| 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 |  |  | page 63 |
| 204 | Power factor | 0.00-1.00 |  | - | page 63 |
| 205 | Power consumption | $\begin{gathered} 0.000-2000 \\ \mathrm{MWh} \end{gathered}$ | $\cdots$ | - | page 63 |
| 206 | Reset power consumption | no, YES | - | no | page 64 |
| 207 | Shaft torque | -9999-9999Nm |  |  | page 64 |
| 208 | Operation time | Hours |  |  | page 64 |
|  |  |  |  |  |  |
| 211 | Current phase L1 | $0.0 \cdot 9999 \mathrm{Amp}$ |  |  | page 64 |
| 212 | Current phase L2 | 0.0 .9999 Amp |  | - | page 64 |
| 213 | Current phase L3 | 0.0 .9999 Amp |  |  | page 64 |
| 214 | Line main voltage L1-L2 | 0.720 V |  |  | page 64 |
| 215 | Line main voltage L1-L3 | 0.720 V |  |  | page 64 |
| 216 | Line main voltage L2 - L3 | 0.720 V |  | - | page 64 |
|  |  |  |  |  |  |
| 221 | Locked keyboard info | no, YES |  | no | page 65 |
|  |  |  |  |  |  |
| 901 | Alarm list, Latest error | F1-F16 | - |  | page 65 |
| $\begin{array}{\|l\|} \hline 902 \\ 915 \\ \hline \end{array}$ | Alarm list, Older error in chronological order | F1-F16 |  |  | page 65 |



# SERIAL <br> COMMUNICATION OPTION 

INSTRUCTION MANUAL

- ENGLISH


## Valid for the following models: <br> EMOTRON Modbus RTU

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## SAFETY INSTRUCTIONS

## Instruction manual

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

## Technically qualified personnel

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

## Installation

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

## Opening the frequency inverter or softstarter



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

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

## EMC Regulations

EMC regulations must be followed to fulfill the EMC standards.

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## 1. GENERAL INFORMATION

### 1.1 Introduction

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

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

Physical connection can be either RS232 or RS485.
It acts as a slave with address $1-247$ in a master-slave configuration. The communication is half duplex. It has a standard non return to zero (NRZ) format.
Baudrates are possible from 2400 up to 38400 bits per sec.
The character frame format (always 11 bits) has:
one start bit
eight data bits
one or two stop bits
even or no parity bit
(The frequency inverters VFB/VFX have no parity).
A Cyclic Redundancy Check is included.

### 1.2 Description.

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

- VFB/VFX Frequency inverters:

VFB40-004 to VFB40-046
VFB40-018 to VFX40-1k2
VFX50-018 to VFX50-1k2
specific information about the frequency inverters is in chapter 4. page 53.
-MSF softstarters:
MSF-017 - MSF-1400
specific information about the sofstarters is in chapter 3. page 29.

### 1.3 Users

This instruction manual is intended for:

- installation engineers
- designers
- maintenance engineers
- service engineers


### 1.4 Safety

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

## NOTEI Additional information as an aid to avoiding problems.

```
CAUTION
```

Failure to follow these instructions can result in malfunction or damage to the softstarter or the frequency inverter.


Failure to follow these instructions can result in serious injury to the user in addition to serious damage to the softstarter or the frequency inverter.


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### 1.5 Delivery and unpacking.

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

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

## 2. MODBUS RTU

### 2.1 General

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


Fig. 1 Network configuration.
The master can address individual slaves. Slaves return a message (called a 'response') to queries that are addressed to them individually.

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


Fig. 2 Shows the MODBUS RTU data exchange.
Modbus RTU uses a binary transmission protocol.
If even parity is used, each character (8 bit data) is sent as:
Table 22 Character frame with no parity.

| $\mathbf{1}$ | Start bit. |
| :---: | :--- |
| $\mathbf{8}$ | Data bits, hexadecimal 0-9,A-F, least signifi- <br> cant bit sent first. |
| $\mathbf{1}$ | Even parity bit. |
| $\mathbf{1}$ | Stop bit. |

If no parity is used each character ( 8 bit data) is sent as:
Table 23 Character frame with parity.

| $\mathbf{1}$ | Start bit. |
| :---: | :--- |
| $\mathbf{8}$ | Data bits, hexadecimal 0-9,A-F, least signifi- <br> cant bit sent first. |
| $\mathbf{2}$ | Stop bit. |



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

### 2.2 Framing

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

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

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

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

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

| Header | START | T1-T2-T3-T4 |
| :--- | :---: | :--- |
|  | ADDRESS | 8 bits |
|  | FUNCTION | 8 bits |
| Data | DATA | $\mathrm{n} \times 8$ bits |
|  | CRC CHECK | 16 bits |
|  | END | T1-T2-T3-T4 |

### 2.2.1 Address field

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

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

### 2.2.2 Function field

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

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

Examples are:

- to read the ON/OFF states of a group of inputs;
- to read the data contents of a group of parameters;
- to read the diagnostic status of the slave;
-to write to designated coils or registers within the slave.
When the slave responds to the master, it uses the function code field to indicate either a normal (error-free) response or that some kind of error occurred (called an exception response). For a normal response, the slave simply echoes the original function code. For an exception response, the slave returns a code that is equivalent to the original function code with its most significant bit set to a logic 1 .

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

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

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

### 2.2.3 Data field

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

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

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

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

### 2.2.4 CRC Error checking field

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

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

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

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2.3 Functions

Emotron supports the following MODBUS function codes.

| Function name | Function code |
| :--- | :--- |
| Read Coil Status | $1(01 \mathrm{~h})$ |
| Read Input Status | $2(02 \mathrm{~h})$ |
| Read Holding Registers | $3(03 \mathrm{~h})$ |
| Read Input Registers | $4(04 \mathrm{~h})$ |
| Force Single Coil | $5(05 \mathrm{~h})$ |
| Force Single Register | $6(06 \mathrm{~h})$ |
| Force Multiple Coils | $15(0 \mathrm{Fh})$ |
| Force Multiple Registers | $16(10 \mathrm{~h})$ |
| Force/Read Multiple <br> Holding Registers | $23(17 \mathrm{~h})$ |

### 2.3.1 Read Coil Status

Read the status of digital changeable parameters.

## EXAMPLE

Requesting the motor PTC input ON/OFF-state. It is ON.
PTC input: $\quad$ Modbus no $=29$ (1Dh)
On: $\quad$ Yes $=1$ coil $=0001$
1 byte of data: Byte count=01

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Request message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 01 |
| Start address HI | 00 |
| Start address LO | $1 D$ |
| Number of Coils HI | 00 |
| Number of Coils LO | 01 |
| CRC LO | 60 |
| CRC HI | CC |

Response message.

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

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

### 2.3.2 Read Input Status

Read the status of digital read-only information.

## EXAMPLE

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

SP174 Jesmond Road Fig Tree Pocket SPS Main Switchboard OM Manual Request message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 02 |
| Start address HI | 00 |
| Start address LO | 02 |
| Number of Inputs HI | 00 |
| Number of Inputs LO | 01 |
| CRC LO | 18 |
| CRC HI | OA |

## Response message.

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

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

### 2.3.3 Read Holding Registers

Read the value of analogue changeable information.
Example, requesting the Nominal Motor Voltage, Nominal Motor Frequency and the Nominal Motor Current. Their values are $400.0 \mathrm{~V}, 60 \mathrm{~Hz}$ and 15.5 A .
400.0 V , unit $0.1 \mathrm{~V}-4000$ (0FA0h)

60 Hz unit $1 \mathrm{~Hz}-60$ ( 003 Ch )
15.5 A , unit $0.1 \mathrm{~A}-155(009 \mathrm{Bh})$

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## Request message.

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

## Response message.

| Fleid name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 03 |
| Byte count | 06 |
| Reg no. 0, (Oh) data Hi | $0 F$ |
| Reg no. 0, (0h) data LO | AO |
| Reg no. 1, (1h) data HI | 00 |
| Reg no. 1, (1h) data LO | 3 C |
| Reg no. 2, (2h) data HI | 00 |
| Reg no. 2, (2h) data LO | $9 B$ |
| CRC LO | 20 |
| CRC HI | 34 |

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

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### 2.3.4 Read Input Registers

Read the contents of analogue read-only information.

## EXAMPLE

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

452-0-Nm,-unit $0.1 \mathrm{Nm}-4520$ (000011A8h).
Request message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 04 |
| Start address HI | 00 |
| Start-address LO- | OA |
| Number of Registers HI | 00 |
| Number of Registers LO | 02 |
| CRC LO | 51 |
| CRC HI | C9 |

Response message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 04 |
| Byte count | 04 |
| Reg no. $10(\mathrm{OAh})$ data HI | 00 |
| Reg no. $10(\mathrm{OAh})$ data LO | 00 |
| Reg no. 11 (OBh) data HI | 11 |
| Reg no. 11 (OBh) data LO | A8 |
| CRC LO | F6 |
| CRC HI | 6 A |

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

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### 2.3.5 Force Single Coil

Set the status of one changeable digital parameter.

## EXAMPLE

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

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

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

Response message.

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

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

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### 2.3.6 Force Single Register

Set the value of one analogue changeable parameter.

## EXAMPLE

Ser the Response Delay Max Alarm to 12.5 sec .
Modbus no 13 -> address LO (0Dh)
12.5 s , unit $0.1 \mathrm{~s}-125$ (7Dh)

Request message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 06 |
| Start address HI | 00 |
| Start address.LO | $O D$ |
| Data HI | 00 |
| Data LO | 7 D |
| CRC LO | D8 |
| CRC HI | 28 |

Response message.

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

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

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### 2.3.7 Force Multiple Coil

Set the status of multiple digital changeable parameters.

## EXAMPLE

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

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

## Request message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 0 F |
| Start address HI | 00 |
| Start address LO | 00 |
| Number of Coils HI | 00 |
| Number of Coils LO | 02 |
| Byte count | 01 |
| Coil no. O-1 status <br> (0000 OO11B) | 03 |
| CRC LO | 9 E |
| CRC HI | 96 |

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| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | OF |
| Start address HI | 00 |
| Start address LO | 00 |
| Number of Coils HI | 00 |
| Number of Coils LO | 02 |
| CRC LO | D4 |
| CRC HI | OA |

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

### 2.3.8 Force Multiple Register

Set the contents of multiple changeable analogue parameters.

## EXAMPLE

Set the Response Delay Min Alarm to 25.0 sec and the Min Alarm Level to 55\%.
25.0 sec , unit $0.1 \mathrm{sec}->-250(00 \mathrm{FAh})$
$55 \%$, unit $1 \%$-> 55 ( 0037 h )

## Request message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 10 |
| Start address HI | 00 |
| Start address LO | 11 |
| Number of Registers HI | 00 |
| Number of Registers LO | 02 |
| Byte count | 04 |
| Data HI reg $17(11 \mathrm{~h})$ | 00 |
| Data LO reg $17(11 \mathrm{~h})$ | FA |
| Data HI reg $18(12 \mathrm{~h})$ | 00 |
| Data LO reg $18(12 \mathrm{~h})$ | 37 |
| CRC LO | 52 |
| CRC HI | 88 |

## Response message.

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

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

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### 2.3.9 Force/Read Multiple Register

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

## EXAMPLE

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

1450 rpm , unit $1 \mathrm{rpm} \rightarrow 1450$ (05AAh)
17000 W , unit 1 W -> 17000 (4268h)

## Request message.

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

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Response message.

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

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

### 2.4 Errors, exception codes

Two kinds of errors are possible:

- Transmission errors.
- Operation errors.


### 2.4.1 Transmission errors

Transmission errors are:

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

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

### 2.4.2 Operation errors

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

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

Exception response message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 84 |
| Exception code | 02 |
| CRC LO | C 2 |
| CRC HI | C 1 |

Table 24 Exception codes.

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

## 3. SOFTSTARTER MSF DATA

### 3.1 Installation bookshelf types

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


Fig. 4 MODBUS RTU option card.


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

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


Fig. 5 Installation of the option card.


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

### 3.2 Installation of MSF-170 to MSF-1400

## NOTE! Under construction, to be defined.

### 3.3 RS485 Multipoint network

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


Fig. 7 RS 485 mulitpoint network

### 3.3.1 RS485 connection

Table 25 RS485 pinning

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

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


Fig. 8 RS485 wiring

### 3.3.2 RS485 termination.

The-R-S485 network-must always be terminated, to avoid transmission problem. The termination must take place at the end of the network. In Fig. 8 this means that the termination must take place at the slave 2 unit.

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


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

### 3.4 RS232 point to point network

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


Fig. 11 RS232 point to point network

### 3.4.1 RS232 connection

Table 26 RS232 pinning

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

### 3.4.2 RS232 wiring

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

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


Fig. 12 RS232 wiring.
NOTEI Physical connection can be either RS232 or RS485, not both on the same time:-

### 3.5 Set-up Communication Parameters for Softstarter MSF

The following parameters have to be set-up:

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

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

## Serial comm. unit address[111]

| 1 1 0 |  |  |
| :--- | :--- | :--- |
|  |  |  |
|  |  |  |
|  |  |  |
| Default: | 1 |  |
| Range: | $1-247$ |  |
| This parameter will select the unit address. |  |  |

Serial comm. baudrate[112]

| $1\|1\| 2$ | 0 |  |  |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  |  |  |  |
|  |  | 9. | 6 |

Serial comm. parity[113]

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

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

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

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


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### 3.6 Softstarter MSF in serial comm. control mode

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

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


### 3.6.1 Selection of control mode [006]

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


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

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

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

### 3.7 Parameter List

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

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

Table 27 Parameter types

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

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

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

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### 3.8 Coil status list

Table 28 Coil status list

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

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### 3.9 Input status list

Table 29 Input status list

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

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3.10 Input register list

Table 30 Input register list

| Modbus logial no | Modbus no | Function/Name | Range/Unit | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 30001 | 0 | Power consumption high word | 0-2E9 Wh,1Wh<->1 | 205 |
| 30002 | 1 | Power consumption low word |  | 205 |
| 30003 | 2 | Electrical power ${ }^{-1 i g h}{ }^{-}$word | O-+2E9-W-1-W $<->1$ | S51 |
| 30004 | 3 | Electrical power low word |  | S51 |
| 30005 | 4 | Output shaft power high word | 0-+-2E9 W, 1 W <->1 | 203 |
| 30006 | 5 | Output shaft power low word |  | 203 |
| 30007 | 6 | Operation time high word | 0.1 days <->1 | 208 |
| 30008 | 7 | Operation time low word | 0.1 days <->1 | 208 |
| -30011. | 10... | Shaft torque high word | $0$ | 207 |
| 30012 | 11 | Shaft torque low word | " | 207 |
| 30017 | 16 | Software version | $\begin{aligned} & r 23->r=\text { release }, \\ & \text { Bit } 15-14=0,0 \\ & \text { LB }=23 \end{aligned}$ |  |
| 30018 | 17 | Software variant | v001 -> HB=0, LB=01 |  |
| 30019 | 18 | Current | $0.6553 .5 \mathrm{~A}, 0.1 \mathrm{~A}\langle->1$ | 005 |
| 30020 | 19 | Phase 1 current | " | 211 |
| 30021 | 20 | Phase 2 current | " | 212 |
| 30022 | 21 | Phase 3 current | " | 213 |
| 30024 | 23 | Line main voltage | " | 202 |
| 30025 | 24 | Line main voltage 1 | " | 214 |
| 30026 | 25 | Line main voltage 2 | " | 215 |
| 30027 | 26 | Line main voltage 3 | " | 216 |
| 30028 | 27 | Product type number | $\begin{aligned} & \text { 1-19 See description } \\ & \text { in } 3.12 .1 . \end{aligned}$ |  |
| 30029 | 28 | Control start by / Control mode | $\begin{aligned} & 1=\text { Keyboard } \\ & 2=\text { Remote } \\ & 3=\text { Serial comm. } \end{aligned}$ | 006 |
| 30031 | 30 | Serial comm. unit address | 1-247 | 111 |

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Table 30 Input register list (continuing)

| Modbus logial no | Modbus no | Function/Name | Range/Unit | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 30032 | 31 | Serial comm. baudrate | $\begin{aligned} & 2400-38400 \text { Baud, } \\ & 100 \text { Baud <-> } 1 \end{aligned}$ | 112 |
| 30033 | 32 | Serial comm. parity | $0=$ No parity 1=Even parity | 113 |
| 30034 | 33 | Serial comm. contact broken | 0-2 See description in 3.12.2. | 114 |
| 30035 | 34 | Actual parameter set | 1-4 |  |
| 30036 | 35 | Shaft power \% | $\begin{aligned} & -200 \%-+200 \% \\ & 1 \%<->1 \end{aligned}$ | 090 |
| 30037 | 36 | Cooler temperature | $\begin{gathered} 30.0-100.0^{\circ} \mathrm{C} \\ 0.1^{\circ} \mathrm{C}<-1 \end{gathered}$ |  |
|  |  |  |  |  |
| 30041 | 40 | Operation mode | $\begin{aligned} & \text { 1-7 See description in } \\ & 3.12 .3 \text {. } \end{aligned}$ |  |
| 30042 | 41 | Operation status | 1-11 See description in 3.12.4. |  |
|  |  |  |  |  |
| 30047 | 46 | Used thermal capacity | 0-150 \%, 1\%<->1 | 073 |
| 30048 | 47 | Power factor | 0.00-1.00,0.01 $<->1$ | 204 |
| 30049 | 48 | Current ratio | $80-150 \%, 1 \%<->1$ |  |
| 30050 | 49 | Voltage ratio | $50-150 \%, 1 \%<->1$ | F12 |
| 30051 | 50 | Phase sequence | $\begin{aligned} & 0-2 \\ & 0=\text { None }, \\ & 1=\text { RST, } \\ & 2=\text { RTS } \end{aligned}$ | 087 |
| 30052 | 51 | Emotron product | 1=VFB/VFX, 2=MSF |  |
|  |  |  |  |  |
| 30103 | 102 | Trip message 1 | 0. 16 See description in 3.12.5. | 901 |
|  |  |  |  |  |
| 30106 | 105 | Trip message 2 | See trip message 1. | 902 |
|  |  |  |  |  |
| 30109 | 108 | Trip message 3 | See trip message 1. | 903 |
|  |  |  |  |  |
| 30112 | 111 | Trip message 4 | See trip message 1. | 904 |
|  |  |  |  |  |

SP174 Jesmond Road Fig Tree Pocket SPS Main Switchboard OM Manual Table 30 Input register list (continuing)

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

### 3.11 Holding register list

Table 31 Holding register list

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

SP174 Jesmond Road Fig Tree Pocket SPS Main Switchboard OM Manual Table 31 Holding register list (continuing)

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

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Table 31 Holding register list (continuing)

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

### 3.12 Parameter description MSF

The MODBUS logical number inside brackets.
For more information on any parameter/function, see Instruction Manual MasterStart MSF Softstarter.

### 3.12.1 Softstarter type (30028).

1 . .-TTable-32-Sofistartermppe

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

### 3.12.2 Serial comm. contact broken (30034).

Täble-33-Serial comm: contact-broken-

| $\mathbf{0}$ | No action when communication is lost. |
| :---: | :--- |
| $\mathbf{1}$ | Stop and alarm after 15 sec. when communication is <br> lost. |
| $\mathbf{2}$ | Continue and alarm after 15 sec. when communication <br> is lost. |

Communication is considered lost if no request is made to this unit within 15 sec .
3.12.3 Operation mode (30041).

| $\mathbf{1}$ | Voltage control. |
| :---: | :--- |
| $\mathbf{2}$ | Torque control. |
| $\mathbf{3}$ | Current limit control. |
| $\mathbf{4}$ | Ramp with current limit control. |
| $\mathbf{5}$ | Pump application. |
| $\mathbf{6}$ | Analogue input voltage control. |
| $\mathbf{7}$ | Direct On Line start. |

3.12.4 Operation status (30042).

| $\mathbf{1}$ | Stopped. |
| :---: | :--- |
| $\mathbf{2}$ | Stopped with alarm condition. |
| $\mathbf{3}$ | Run with alarm condition. |
| $\mathbf{4}$ | Run acceleration. |
| $\mathbf{5}$ | Run full voltage. |
| $\mathbf{6}$ | Run deceleration. |
| $\mathbf{7}$ | Run by passed. |
| $\mathbf{8}$ | Run power factor control. |
| $\mathbf{9}$ | Run DC brake. |
| $\mathbf{1 0}$ | Run at slow speed forward. |
| $\mathbf{1 1}$ | Run at slow speed reverse. |

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3.12.5 Alarm (30103).

3.12.6 Relay indication K1 (40023).

| $\mathbf{1}$ | Indicates 'Operation'. |
| :---: | :--- |
| $\mathbf{2}$ | Indicates 'Full voltage'. |
| $\mathbf{3}$ | Indicates 'Pre alarm'. |

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3.12.7 Relay indication K2 (40024).

| $\mathbf{1}$ | Indicates 'Operation'. |
| :---: | :--- |
| $\mathbf{2}$ | Indicates 'Full voltage'. |
| $\mathbf{3}$ | Indicates 'Pre alarm'. |
| $\mathbf{4}$ | Indicates 'DC-brake function is chosen'. |

3.12.8 Analogue output value (40037).

| $\mathbf{1}$ | RMS current (range 0-5(In). |
| :---: | :--- |
| $\mathbf{2}$ | Main input RMS voltage <br> (range 0-532V). |
| $\mathbf{3}$ | Output shaft power (range 0-2(Pn). |

### 3.12.9 Reset to factory setings (42032)

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

### 3.13 Performance

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

Max 2 requests per sec. to reduce system disturbance.
Min 1 request per $15-\mathrm{sec}$. to avoid serial comm. contact broken alarm.

### 3.13.1 MSF response delay

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

Table 34 Response delay table for setting (foraing) registers

| Modbus <br> logical nr | Parameter | Response-delay// <br> recommended time <br> out |
| :--- | :--- | :--- |
| $40001-40006$ | Nominal motor data | $500 \mathrm{~ms} /$ data |
| 42032 | Reset to factory set- <br> tings | 3.5 sec |
|  | Other registers | 250 ms |

## 4. INVERTER VFB/VFX DATA

### 4.1 Installation bookshelf types

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


Fig. 13 MODBUS RTU option card.


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

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


Fig. 14 Installation of the option card in VFB.


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

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### 4.2 Installation of VFX types

NOTEI Pictures are under construction, to be defined.

### 4.3 RS485 Multipoint network

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


Fig. 16 RS 485 mullipoint network

### 4.3.1 RS485 connection

Table 35 RS485 pinning

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

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


Fig. 17 RS485 wiring

### 4.3.2 RS485 termination.

The-RS485_network must always be terminated, to avoid transmission problem. The termination must take place at the end of the network. In finure 5 this means that the rermination must take place at the slave 2 unit.

Switch \$1 (see Fig. 4) sets the termination ON or OFF as indicated in the Fig. 18 and Fig. 19.


NOTEI Physical connection can be elther RS232 or RS485, not both
on the same time.

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### 4.4 RS232 point to point network

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


Fig. 20 RS232 point to point network

### 4.4.1 RS232 connection

Table 36 RS232 pinning

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

### 4.4.2 RS232 wiring

The RS232 port consists of a sub-D 9 pole female connector.
The wiring should be done acc. to Fig. 20.
NOTEI Use an 1:1 cable WITHOUT a pin 2-3 crossing.


Fig. 21 RS232 uiring NOTE! Physical connection can be either RS232 or RS485, not both on the same time.

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

The following parameters have to be set-up:

- Unit address.
- Baud rate.

Serial comm. unit address[262]

|  | 262 Address <br> Stp |
| :--- | :--- |
| Default: | 1 |
| Range | $1-247$ |
| This parameter will select the unit address. |  |

Serial comm. baud rate[261]

|  | 261 <br> Stp |
| :--- | :--- |
| Default: | 9600 |
| Range | $2400,4800,9600,19200,38400$ |
| This parameter will select the baudrate. |  |

### 4.6 Frequency inverter VFB/VFX in serial comm Control Mode

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

## Ref control

To be able to use the serial comm as a source for the speed or torque reference menu 212 has to be set to Comm or Comm/ Digln1. See Instruction Manual VFB/VFX for further description.

|  | 212 Ref Control <br> Stp  |
| :--- | :--- |
| Default: | Remote |
| Range | Remote, keyboard, Comm, Rem/ <br> DigIn1,or Comm/Digln1 |
| This parameter will select reference source |  |

## Run/Stp ctrl

To be able to use the serial comm as a source for starting and stopping the inverter menu 213 has to be set to Comm or Comm/Digln1. See Instruction Manual VFB/VFX for further description.

|  | 213 Run/Stp <br> Stp  |
| :--- | :--- |
| Default: | Remote |
| Range | Remote, keyboard, Comm, Rem/ <br> DigIn1, or Comm/Digln1 |
| This parameter will select run/stop source |  |

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4.7 Parameter List

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

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

Table 37 Parameter type

| Parameter type | Modbus <br> logical <br> numbers | Modbus actual numbers |
| :--- | :--- | :--- |
| Coil Status | $1-10000$ | $0-9999$ (Logical-1) |
| Input Registers | $30001-$ <br> 40000 | $0-9999$ (Logical-30001) |
| Holding Registers | $40001-$ <br> -50000 | $0-9999$ (Logical-40001) |

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

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

### 4.8 Coil status list

Table 38 Coil status list

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

4.9 Input register list

Table 39 Input register list

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 30001 | 0 | Power consumption high word | 0-2E9 Wh, 1 Wh<->1 | 6FO |
| 30002 | 1 | Powerconsumption-lowword |  | -6F0 |
| 30003 | 2 | Electrical power high word | O-t-2E9 W, 1 W $<->1$ | 640 |
| 30004 | 3 | Electrical power low word |  | 640 |
| 30005 | 4 | Output shaft power high word | $\begin{aligned} & 0-+-2 E 9 \mathrm{~W}, \\ & 1 \mathrm{~W}<>1 \end{aligned}$ | 630 |
| 30006 | 5 | Output shaft power low word |  | 630 |
| 30007 | 6 | Operation time high word | $0 \cdot 65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 600 |
| 30008 | 7 | Opērātiōn time-low word- | 0--59-Min-1. min $<->1$ | 600 |
| 30009 | 8 | Mains time hour | 0-65535 h, $1 \mathrm{~h}<->1$ | 6 60 |
| 30010 | 9 | Mains time min | 0-59 Min, 1 min $<\gg 1$ | 6E0 |
| 30011 | 10 | Shaft torque high word | $\begin{aligned} & \mathrm{O}+-2 \mathrm{ER} \mathrm{Nm}, \\ & 0.1 \mathrm{Nm}<->1 \end{aligned}$ | 620 |
| 30012 | 11 | Shaft torque low word | " | 620 |
| 30013 | 12 | Process speed high word | $\begin{aligned} & 1-+-2 \mathrm{E} 8 \mathrm{Rpm}, \\ & 1 \mathrm{rpm}<-1000 \end{aligned}$ | 6G0 |
| 30014 | 13 | Process speed low word | " | 6G0 |
| 30015 | 14 | Shaft speed high word | 0-2E8 rpm, 1 rpm<>1 | 610 |
| 30016 | 15 | Shaft speed low word | " | 610 |
| 30017 | 16 | Software version | $\begin{aligned} & \text { V1.23-> Release } \\ & \text { Bit } 15-14=0,0 \\ & \text { Bit } 13-8=1, \\ & \text { LB }=23 \text { See } 4.11 . \end{aligned}$ | 920 |
| 30018 | 17 | Option/variant version | $\begin{aligned} & \text { OPT V2.34 -> } \\ & \text { HB }=2, \\ & \text { LB }=34 \end{aligned}$ | 920 |
| 30019 | 18 | Current | $0-6553.5 \mathrm{~A}, 0.1 \mathrm{~A}$ <-> 1 | 650 |
|  |  |  |  |  |
| 30023 | 22 | Output voltage | $0.6553 .5 \mathrm{~V}, 0.1 \mathrm{~V}<->1$ | 660 |
|  |  |  |  |  |
| 30028 | 27 | Product type number | See description in 4.11. | 910 |

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Table 39 Input register list (comtimuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 30029 | 28 | Control start by / Control mode | 0=Remote, <br> 1=Keyboard, <br> $2=$ Serial comm |  |
| 30030 | 29 | Control ref by | $\begin{aligned} & 0=\text { Remote } \\ & 1=\text { Keyboard } \\ & 2=\text { Serial comm } \end{aligned}$ |  |
| 30031 | 30 | Serial comm. unit address | 1-247 | 262 |
| 30032 | 31 | Serial comm. baudrate | $\begin{aligned} & 1=2400,4=19200 \\ & 2=4800 \quad 5=38400 \\ & 3=9600, \end{aligned}$ | 261 |
|  |  |  |  |  |
| 30035 | 34 | Actual parameter set | $\begin{array}{ll} 0-3 ; & \\ 0=A, & 2=C, \\ 1=B & 3=D \end{array}$ | 3XX |
| 30036 | 35 | Shaft torque \% | -400\%+400\% 1\%<->1 | 620 |
| 30037 | 36 | Cooler temperature | $\begin{aligned} & -40.0-+100.0^{\circ} \mathrm{C} \\ & 0.1^{\circ} \mathrm{C}<->1 \end{aligned}$ | 690 |
| 30038 | 37 | Frequency | $\begin{aligned} & \mathrm{O-2000.0Hz,} \\ & 0.1 \mathrm{~Hz}<->1 \end{aligned}$ | 670 |
| 30039 | 38 | DC-link voltage | 0-1000V, 0.1V<->1 | 680 |
| 30040 | 39 | Warning | 0-31 See description in 4.11.3. | 6 HO |
| 30043 | 42 | Digital input status | See description in 4.11.6. | 6B0 |
| 30044 | 43 | Analog input status 1 | $-100+100 \%, 1 \%<->1$ | 6 CO |
| 30045 | 44 | Analog input status 2 | $-100+100 \%, 1 \%<->1$ | 6C0 |
| 30046 | 45 | Param_version | For internal use |  |
| 30052 | 51 | Emotron product | 1=VFB/VFX, 2=MSF |  |
| 30101 | 100 | Trip time 1 h | 0-65535 h, 1h<->1 | 710 |
| 30102 | 101 | Trip time 1 min | $0-59 \mathrm{Min}, 1 \mathrm{~min}<->1$ | 710 |
| 30103 | 102 | Trip message 1 | 0.31 See description in 4.11.3. | 710 |
| 30104 | 103 | Trip time 2 h | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<>1$ | 720 |
| 30105 | 104 | Trip time 2 min | 0-59 Min, 1 min $<>1$ | 720 |

SP 174 Jesmond Road Fig. Tree Pocket SPS Main Switchboard OM Manual Table 39 Input register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | $\begin{gathered} \text { Product } \\ \text { VFB/VFX } \\ \text { menu } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: |
| 30106 | 105 | Trip message 2 | See trip message 1. | 720 |
| 30107 | 106 | Trip time 3 h | 0-65535 h, 1h<->1 | 730 |
| 30108 | 107 | Trip time 3 min | 0-59 Min, 1 min<->1 | 730 |
| 30109 | 108 | Trip-message-3 | See trip message 1. | 730 |
| 30110 | 109 | Trip time 4 h | 0-65535 h, 1h<->1 | 7.40 |
| 30111 | 110 | Trip time 4 min | 0-59 Min, 1 min<->1 | 740 |
| 30112 | 111 | Trip message 4 | See trip message 1. | 740 |
| 30113 | 112 | Trip time 5 h | 0-65535 h, 1h<->1 | 750 |
| 30114 | 113 | Trip time 5 min | $0-59 \mathrm{Min}, 1 \mathrm{~min}<->1$ | 750 |
| 30115 | 114 | Trip message 5 | See trip message 1. | 750 |
| 30116 | 115 | Trip time 6 h | 0-65535 h, 1h<->1 | 760 |
| 30117 | 116 | Trip time 6 min | O-59 Min, 1 min<->1 | 760 |
| 30118 | 117 | Trip message 6 | See trip message 1. | 760 |
| 30119 | 118 | Trip time 7 h | 0-65535 h, 1h<->1 | 770 |
| 30120 | 119 | Trip time 7 min | 0-59 Min, 1 min<->1 | 770 |
| 30121 | 120 | Trip message 7 | See trip message 1. | 770 |
| 30122 | 121 | Trip time 8 h | 0-65535 h, 1h<->1 | 780 |
| 30123 | 122 | Trip time 8 min | 0-59 Min, 1 min<->1 | 780 |
| 30124 | 123 | Trip message 8 | See trip message 1. | 780 |
| 30125 | 124 | Trip time 9 h | 0-65535 h, 1h<->1 | 790 |
| 30126 | 125 | Trip time 9 min | 0-59 Min, 1 min<->1 | 790 |
| 30127 | 126 | Trip message 9 | See trip message 1. | 790 |
| 30128 | 127 | Trip time 10 h | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 7 AO |
| 30129 | 128 | Trip time 10 min | 0-59 Min, 1 min<->1 | 7AO |
| 30130 | 129 | Trip message 10 | See trip message 1. | 7 AO |

### 4.10 Holding register list

## Taulc 40 Holding register list

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

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Table 40 Holding register list (contiming)

| $\begin{array}{\|c} \text { Modbus } \\ \text { logical } \\ \text { no } \end{array}$ | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40022 | 21 | Parameter set | $0=\mathrm{A}$, $4=\mathrm{DI} 13$, <br> $1=\mathrm{B}$, $5=\mathrm{DI} 3+4$, <br> $2=\mathrm{C}$, $6=$ Comm <br> $3=\mathrm{D}$,  | 234 |
| 40023 | 22 | Relay 1 | 0-21. See description in 4.11:4. | 451. |
| 40024 | 23 | Relay 2 | 0-21 See description in 4.11.4. | 452 |
| 40025 | 24 | Relay 3 | Not defined yet. |  |
| 40026 | 25 | Relay 4 | Not defined yet. |  |
| 40027 | 26 | Anln 1, function | $\begin{aligned} & 0=0 f f, \\ & 1=\text { Speed, } \\ & 2=\text { Torque } \end{aligned}$ | 411 |
| 40028 | $27{ }^{-}$ | Añln 1, setup | $\begin{aligned} 0 & =0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ -1 & =2.10 \mathrm{~V} / 4-20 \mathrm{~mA} \\ 2 & =\text { User defined } \end{aligned}$ | 412 |
| 40029 | 28 | Anin 1, offset | $-100 \%$ - $100 \% 1 \%<->1$ | 413 |
| 40030 | 29 | Anln 1, gain | $-4.00 \cdot+4.00,0.01<>1$ | 414 |
| 40031 | 30 | Anln 1, bipolar | $\begin{aligned} & 0=0 f f, \\ & 1=0 n \end{aligned}$ | 415 |
| 40032 | 31 | Anln 2, function | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Speed, }, \\ & 2=\text { Torque } \end{aligned}$ | 416 |
| 40033 | 32 | AnIn 2, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA}, \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=\text { User defined } \end{aligned}$ | 417 |
| 40034 | 33 | Anln 2, offset | -100\% + +100\% 1\% <-> 1 | 418 |
| 40036 | 35 | Anln 2, bipolar | $\begin{aligned} & 0=O f f, \\ & 1=O n \end{aligned}$ | 41A |
| 40037 | 36 | AnOut 1, function | $\begin{aligned} & \text { 0=Torque, } \\ & 1=\text { Speed, } \quad \text { 4=Current, } \\ & 2=\text { Shaft power, } 5=\text { El.power, } \\ & 3=\text { Frequency, } 6=0 \text { utp.voltage } \end{aligned}$ | 431 |
| 40038 | 37 | AnOut 1, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA} \\ & 2=\text { User defined } \end{aligned}$ | $432$ |
| 40039 | 38 | AnOut 1, offset | $-100 \%-+100 \% 1 \%<->1$ | 433 |
| 40040 | 39 | AnOut 1, gain | $-4.00-+4.000 .01 \ll 1$ | 434 |

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Table 40 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40041 | 40 | AnOut 1, bipolar | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=0 \mathrm{n} \end{aligned}$ | 435 |
| 40042 | 41 | AnOut 2, function | $0=$ Torque, $4=$ Current, <br> $1=$ Speed, $5=$ El.power, <br> $2=$ Shaft power, $6=0$ Outp. <br> $3=$ Frequency, voltage | 436 |
| 40043 | 42 | AnOut 2, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA}, \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=\text { User defined } \end{aligned}$ | 437 |
| 40044 | 43 | AnOut 2, offset | -100\% - +100\% 1\% <-> 1 | 438 |
| 40045 | 44 | AnOut 2, gain | $-4.00 \cdot+4.00,0.01<>1$ | 439 |
| 40046 | 45 | AnOut 2, bipolar | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=0 \mathrm{n} \end{aligned}$ | 43A |
| 40047 | 46 | AnOut 3, function | O=Torque, 4=Current, <br> $1=$ Speed, $5=$ El.power, <br> $2=$ Shaft power, $6=$ Outp <br> $3=$ Frequency, voltage |  |
| 40048 | 47 | AnOut 3, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 1=2.10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=U \text { ser defined } \end{aligned}$ |  |
| 40049 | 48 | AnOut 3,offset | -100\% - +100\% 1\% <-> 1 |  |
| 40050 | 49 | AnOut 3, gain | $-4.00-+4.00,0.01<->1$ |  |
| 40051 | 50 | AnOut 3, bipolar | $\begin{aligned} & 0=0 f f, \\ & 1=O n \end{aligned}$ |  |
| 40052 | 51 | AnOut 4, function | $0=$ Torque, 4=Current, <br> $1=$ Speed, $5=$ El.power, <br> $2=$ Shaft power, 6=Outp <br> $3=$ Frequency, voltage |  |
| 40053 | 52 | AnOut 4, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA}, \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=\text { User defined } \end{aligned}$ |  |
| 40054 | 53 | AnOut 4, offset | -100\% - +100\% 1\% <-> 1 |  |
| 40055 | 54 | AnOut 4, gain | -4.00-+4.00, $0.01<->1$ |  |
| 40057 | 56 | AnOut 5, function | $0=$ Torque, $4=$ Current, <br> $1=$ Speed, $5=$ El.power, <br> $2=$ Shaft power, $6=$ Outp <br> $3=$ Frequency, voltage |  |
| 40058 | 57 | AnOut 5, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA}, \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=\text { User defined } \end{aligned}$ |  |

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Table 40 Holding register list (continuing)

| Modbus logical no | $\left\lvert\, \begin{gathered} \text { Modbus } \\ \text { no } \end{gathered}\right.$ | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40059 | 58 | AnOut 5, offset | $-100 \%-+100 \% 1 \%<->1$ |  |
| 40060 | 59 | AnOut 5, gain | -4.00-+4.00, $0.01<->1$ |  |
| 40061 | 60 | AnOut 5, bipolar | $\begin{aligned} & 0=\mathrm{Off}, \\ & 1=0 \mathrm{n} \end{aligned}$ |  |
|  |  |  |  |  |
| 41001 | 1000 | Comm, ref | 100\% <-> $0 \times 2000$ |  |
| 41002 | 1001 | Operation.drive mode | $\begin{aligned} & 0=\text { Speed, } \\ & 1=\text { Torque, } \\ & 2=\mathrm{V} / \mathrm{Hz} \end{aligned}$ | 211 |
| 41003 | 1002 | Operation.ref ctrl | $\begin{aligned} & 0=\text { Remote } \\ & 1=\text { Keyboard, } \\ & 2=\text { Comm } \end{aligned}$ | 212 |
| 41004 | 1003 | Operation run stop ctrl | $\begin{aligned} & \begin{array}{l} 0=\text { Remote, } \\ 1=\text { Keyboard, } \end{array} \\ & \begin{array}{l} 3=\text { Rem } / \text { digin1, } \\ \text { digin1 } \end{array} \\ & 2=\text { Comm }, \end{aligned}$ | 213 |
| 41005 | 1004 | Operation.rotation | 0=R+L, 1=R, 2=L | 214 |
| 41006 | 1005 | Utility.auto restart mask | 16-bit mask |  |
| 41007 | 1006 | Utility.auto restart | 0-10 | 241 |
| 41008 | 1007 | Digln 1 | 0-11 See description in 4.11.6. | 421 |
| 41009 | 1008 | Digln 2 | 0-11 See description in 4.11.6. | 422 |
| 41010 | 1009 | DigIn 3 | $0-11$ See description in 4.11.6. | 423 |
| 41011 | 1010 | Digln 4 | 0-11 See description in 4.11.6. | 424 |
| 41014 | 1013 | DigOut 1 | 0-21 See description in 4.11.4. | 441 |
| 41015 | 1014 | DigOut 2 | 0-21 See description in 4.11.4. | 442 |
|  |  | - |  |  |
| 41018 | 1017 | Crio enable | $\begin{aligned} & 0=\text { Off, } \\ & 1=O n \end{aligned}$ | 281 |
| 41019 | 1018 | Crio control | $\begin{aligned} & 0=4 \text {-Speed } \\ & 1=3 \text {-pos, } \\ & 2=\text { Analogue } \end{aligned}$ | 282 |

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Table 40 Holding register list (contimaing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 41020 | 1019 | Crio relay 1 | $0-21$ See description in 4.11.4. | 283 |
| 41021 | 1020 | Crio relay 2 | 0.21 See description in 4.11.4. | 284 |
| 41022 | 1021 | Process unit | $0=$ None, $3=\mathrm{m} / \mathrm{s}$, <br> $1=r p m$, $4=/ \mathrm{min}$, <br> $2=\%$, $5=/ \mathrm{hr}$ | 6G1 |
| 41023 | 1022 | Process scale | 0-10.000, 0.0001 $<1$ | 6G2 |
| 41024 | 1023 | Multiple display 1 | $\begin{array}{ll} 0=\text { Speed, } & 6=\text { Frequency, } \\ 1=\text { Torque, } & 7=D C \text { voltage, } \\ 2=\text { Shaft power, } 8=\text { Temp } \\ 3=\text { El power, } & 9=\text { Drive } \\ 4=\text { Current, } & \text { status, } \\ 5=\text { Voltage, } & 10=\text { Process } \\ & \text { speed } \end{array}$ | 110 |
| 41025 | 1024 | Multiple display 2 | See 41024 | 120 |
| 41026 | 1025 | Utility language | $0=$ English, $3=$ Dutch, <br> $1=$ German, $4=$ French <br> $2=S w e d i s h, ~$   | 231 |
| 41027 | 1026 | Utility keyboard locked | O=Unlocked, 1=Locked | 232 |
| 41028 | 1027 | Serial com. address | 1-247 | 262 |
| 41029 | 1028 | Serial com, Baud-rate | $\begin{array}{ll} 1=2400, & 4=19200, \\ 2=4800, & 5=38400 \\ 3=9600, & \end{array}$ | 261 |
| 41030 | 1029 | Serial com. parity | O=None |  |
|  |  |  |  |  |
| 41032 | 1031 | MVB card on/off | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=0 \mathrm{n} \end{aligned}$ | 291 |

Table 41 Parameter set $A$

| *** | *** | VFB/VFX <br> Parameter set A | *** | *** |
| :---: | :---: | :---: | :---: | :---: |
| 41101 | 1100 | Acceleration time | 0.00-3600.00 See description in 4.11.7 | 311 |
| 41102 | 1101 | Deceleration time | 0.00-3600.00 See description in 4.11.7 | 313 |
| 41103 | -1-102 | Qsitop time - - | 0.00-3600.00 See description in 4.11.7 | 31B |
| 41104 | 1103 | Acceleration shape | $0=$ Liñear, 1=S-curve | 312 |
| 41105 | 1104 | Deceleration shape | $\begin{aligned} & 0=\text { Linear, } \\ & 1=\text { S-curve } \end{aligned}$ | 314 |
| 41106 | 1105 | Q-stop shape | 0=Linear |  |
| 41111 | 1110 | Wait before brake time | 0.00-3.00, 0.01s <->1 | 319 |
| 41112 | 1111 | Vector brake | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=0 \mathrm{n} \end{aligned}$ | 31A |
| 41113 | 1112 | Spinstart | $\begin{aligned} & 0=\text { Off } f, \ldots \\ & 1=0 n \end{aligned}$ | 31C |
| 41114 | 1113 | Motor pot function | $\begin{aligned} & 0=\text { Volatile }, \\ & 1=\text { Non-volatile } \end{aligned}$ | 325 |
| 41115 | 1114 | Minspeed mode | $\begin{aligned} & 0=\text { Scale, } \\ & 1=\text { Limit, } \\ & 2=\text { Stop } \end{aligned}$ | 323 |
| 41116 | 1115 | Minimum speed | O- Maximum speed, see description in 4.11 .7 | 321 |
| 41117 | 1116 | Maximum speed | Minimum speed-2*motor sync speed, see description in 4.11.7 | 322 |
| 41118 | 1117 | Preset speed 1 | 0-2*Motor sync speed see description in 4.11.7 | 326 |
| 41119 | 1118 | Preset speed 2 | 0-2*Motor sync speed, see description in 4.11.7 | 327 |
| 41120 | 1119 | Preset speed 3 | 0-2*Motor sync speed, see description in 4.11 .7 | 328 |
| 41121 | 1120 | Preset speed 4 | 0-2*Motor sync speed, see description in 4.11.7 | 329 |
| 41122 | 1121 | Preset speed=5 | 0-2*Motor sync speed, see description_in_4.11.7 | 32A |
| 41123 | 1122 | Preset speed 6 | 0-2*Motor sync speed, see description in 4.11.7 | 32B |
| 41124 | 1123 | Preset speed 7 | 0-2*Motor sync speed, see description in 4.11.7 | 32C |

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Table 41 Parameter set $A$ (continuing)

| *** | *** | VFB/VFX <br> Parameter set A | *** | *** |
| :---: | :---: | :---: | :---: | :---: |
| 41125 | 1124 | Skip speed 1 Low | 0-2* Motor sync speed, see description in 4.11.7 | 320 |
| 41126 | 1125 | Skip speed 1 High | 0-2*Motor sync speed, see description in 4.11.7 | 32E |
| 41127 | 1126 | Skip speed 2 Low | $0-2^{*}$ Motor sync speed, see description in 4.11.7 | 32F |
| 41128 | 1127 | Skip speed 2 High | $0-2 *$ Motor sync speed, see description in 4.11.7 | 32G |
| 41129 | 1128 | jog speed | $0 \pm 2 *$ Motor sync speed, see description in 4.11.7 | 32F |
| 41130 | 1129 | Maximum torque | 0-400\%, 1\%<-> 1 or I_max/motor In | 331 |
| 41131 | 1130 | Speed $P$ gain | 0.1-30.0, 0.1<->1 | 342 |
| 41132 | 1131 | Speed I time | 0.01-10.00s, $0.01 \mathrm{~s}<->1$ | 343 |
| 41133 | 1132 | Flux optimization | $\begin{aligned} & 0=O f f, \\ & 1=O n \end{aligned}$ | 344 |
| 41134 | 1133 | PID-controller | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { On, } \\ & 2=\text { Invert } \end{aligned}$ | 345 |
| 41135 | 1134 | PlD-controller P gain | 0.1-30.0, 0.1<->1 | 346 |
| 41136 | 1135 | PID-controller I time | 0.01-300.00s, 0.01s<->1 | 347 |
| 41137 | 1136 | PID-controller D time | 0.01-30.00s, $0.01 \mathrm{~s}<->1$ | 348 |
| 41138 | 1137 | Low voltage overrride | $0=0 \mathrm{ff}, 1=0 n$ | 351 |
| 41139 | 1138 | Rotor locked | $0=O f f, 1=0 n$ | 352 |
| 41140 | 1139 | Motor lost | $\begin{aligned} & 0=\text { Off }, \\ & 1=\text { Resume, } \\ & 2=\text { Trip } \end{aligned}$ | 353 |
| 41141 | 1140 | Motor 12t type | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Trip, } \\ & 2=\text { Limit } \end{aligned}$ | 354 |
| 41142 | 1141 | Motor 12t current | 0-150\% inverter i_nom, 0.1A<->1 | 355 |
| 41143 | 1142 | Speed direction | $\begin{aligned} & 0=R, \\ & 1=L, \\ & 2=R+L \end{aligned}$ | 324 |
| 41144 | 1143 | Start speed | $0-+-2 *$ Motor sync speed, see description i 4.11.7, page 76. | 321 |

Table 42 Parameter set $B, C$ and $D$

| *** | *** | VFB/VFX Parameter set B | *** | *** |
| :---: | :---: | :---: | :---: | :---: |
| 41201-41299 | 1200-1298 | /* Parameter set $\mathrm{B}^{*} /$ |  |  |
| *** | *** | VFB/VFX Parameter set C | *** | *** |
| -41301-41399 | 1300:1398 | /* Parameter set C */ |  |  |
| * | *** | VFB/VFX Parameter set D | *** | ** |
| 41401-41499 | 1400-1498 | /* Parameter set D */ |  |  |

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### 4.11 Parameter description VFB/VFX

The MODBUS logical number inside brackets.
For more information on any parameter/function, see Instruction Manual Vectorflux VFB/VFX.

### 4.11.1 Inverter software version (30017).

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


| Bit F,E | Release Type: | 00 | Release (V) |
| :--- | :--- | :--- | :--- |
|  |  | 01 | Pre release (P) |
|  |  | 10 | Beta (B) |
|  |  | 11 | Alpha (A) |
| Bit D-8 | Major version | 000000 | 0 |
|  |  | 000001 | 1 |
|  |  | 111110 | 62 |
| Bit 7-0 | Minor version | 00000000 | 0 |
|  |  | 00000001 | 1 |
|  |  | 11111110 | 254 |
|  |  | 11111111 | 255 |
|  |  | $3508 \mathrm{~h}->$ |  |
|  |  |  |  |
|  |  |  |  |

SP174 Jesmond Road Fig Tree Pocket SPS Main Switchboard OM Manual 4.11.2 Inverter type (30028).

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


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

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

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

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


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


| Bit $12-15$ | Spare |  |
| :--- | :--- | :--- |
| Bit 11 | INT_ERROR | $0 \times 0800$ |
| Bit 10 | POWER_FAULT | $0 \times 0400$ |
| Bit $9 \cdots$ | $0 \times 0200$ |  |
| Bit 8 | LOCKED_ROTOR | MON_ALARM |
| Bit 7 | MOTOR_LOST | $0 \times 0100$ |
| Bit 6 | EXT_TRIP | $0 \times 0040$ |
| Bit 5 | MOTOR_TEMP | $0 \times 0020$ |
| Bit 4 | OVER_VOLT_L | $0 \times 0010$ |
| Bit 3 | OVER_VOLT_G | $0 \times 0008$ |
| Bit 2 | OVER_VOLT_D | $0 \times 0004$ |
| Bit 1 | IT | $0 \times 0002$ |
| Bit 0 | OVER_TEMP | $0 \times 0001$ |

The corresponding bits should be set to activate the autoreset function. To enable auto reset for Int error (bit 11) and locked rotor (Bit 9 ) the value $0 x 0 \mathrm{~A} 00$ should be written to the register.

If the value $0 \times 0123$ was read, it indicates that MON_ALARM, MOTOR_TEMP, IIT and OVER_TEMP are in auto reset mode and all other functions are swithced off.

### 4.11.6 Digin (41008,41009).

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

### 4.11.7 Representation of speed.

Bit15=0<<1rpm<<>1
Bit15=1<>100rpm<->1

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### 4.12 Performance

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

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

### 4.12.1 VFB/VFX response delay

 The response delay for the VFB/VFX will be maximum 8 ms .
## 5. CRC GENERATION

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

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

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

## Generation in steps:

- Step 1 Load a 16 -bit register with $0 x F F F F$ (all 1's). Call this the CRC register.
- Step 2 Exclusive OR the first eight-bit byte of the message with the low order byte of the 16 -bit CRC register, putting the result in the CRC register.
- Step 3 Shift the CRC register one bit to the right (toward the LSB), zero-filling the MSB. Extract and examine the LSB.
- Step 4 If the LSB is 0 , repeat Step 3 (another shift). If the LSB is 1, Exclusive OR the CRC register with the polynomial value 0xA001 (1010 000000000001 ) .
- Step 5 Repeat Steps 3 and 4 until eight shifts have been performed. When this is done, a complete eight-bit byte will have been processed.


## SP174 Jesmond Road Fig Tree Pocket SPS Main Switchboard OM Manual

- Step 6 Repeat Steps 2 ... 5 for the next eight-bit byte of the message. Continue doing this until all bytes have been processed.
Result The final contents of the CRC register is the CRC value.
- Step 7 When the CRC is placed into the message, its upper and lower bytes must be swapped as described below.
- Placing the CRC into the Message When the 16-bit CRC (two eight-bit bytes) is transmitted in the message, the low order byte will be transmitted first, followed by the high order byte - e.g., if the CRC value is $0 \times 1241$.

| Message |  |
| :--- | :--- |
| CRC LO | 41 |
| CRC HI | 12 |

## Example of CRC Generation Function

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

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

The function returns the CRC as a type unsigned int.

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

```
    \#define CRC_POLYNOMIAL 0xA001
    unsigned int crc_reg;
    unsigned char \(\mathrm{i}, \mathrm{k}\);
    crc_reg \(=0 \times\) FFFF;
    for ( \(\mathrm{i}=0 ; \mathrm{i}<\mathrm{usDataLen} ; \mathrm{i}++\) )
    \{
            crc_reg \(\wedge=\star\) puchMsg+ + ;
            for ( \(k=0 ; k<8 ; k++\) )
            if (crc_reg \& 0x0001)
            \{
                crc_reg \(\gg=1\);
                    crc_reg \(\wedge=\) CRC_POLYNOMIAL;
            \}
            else
                        crc_reg \(\gg=1\);
            \}
    return crc_reg;
```

Fig. 22 CRC example.

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## EXTERNAL PPU - AFTER MOUNTED

Article nr. 01-2138-00 For MSF 017-1400 for aftermounting


The External PPU (Programming and Presentation Unit) is secured with four M4 bolts on a cabinet door, in which holes are punched/drilled as indicated in picture 7. When installed, the external PPU is used to control the MSF sofstarter from a remote location such as a door of an electrical panel/cabinet. The original PPU is replaced by a blank PPU plate which also comprises a cable connector and LEDS for Running, Sart/Stop and Power. This package comes with a 3 m long cable for connection between MSF and external PPU. The external PPU has the same functionality and frone size as the original.


Extern PPU (Programmerings och Presentationsenhet) monteras i en skåpsdörr med fyra M4 bultar och håbild enligt skiss nr 7. Den används för att styra och ställa in MSF mjukstartare när dessa inte är försedda med inbyggd PPU. I dessa fall finns istället en blank PPU. På den blanka PPU'n finns en kontakt samt lysdioder för running, start/stop och power. Till denna option följer det med en kabel som är 3 m lång för anslutning mellan MSF och extern PPU. Extern PPU är lika stor och fungerar på samma sätt som originalet.


De Externe PPU (Programming and Presentation Unit) wordt met vier M4 bouten op een kastdeur bevestigd, waarin de gaten zoals aangegeven in 6ig. 7, zijn geboord/geponst. Hij wordt gebruikt om de MSF softstarter te bedienen in plaats van de PPU op de voorzijde, die in dat geval vervangen wordt door een Blank PPU. Deze heeft een kabelaansluiting en indicatie-LEDs voor run, start/stop en power. Hij wordt geleverd met een 3 m lange kabel waarmee de externe PPU aangesloten wordt op de MSF. De externe PPU heeft dezelfde functionaliteit en afmetingen als de originele.


Die externe PPU (Programmierungs- und Präsentationseinheit) wird mit vier M4 Muttern an einer Schranktür befestigt, in die vorab Löcher gemäss Bild 7 gebohrt wurden. Die PPU wird zum Steuern und Einstellen des MSF Softstarters benurzt, wenn dieser mit keiner eingbauren PPU versehen ist und stattdessen eine Blende hat. Auf der Blende befindet sich ein Kontakt mit Leuchtdioden zur Anzeige von running, start/stop und power. Diese Option beinhaltet ein 3 m langes Kabel, um den MSF an eine externe PPU anzuschliessen. Die externe PPU hat die selben Funktionen und Grösse wie das Original.


El panel de control externo se coloca en el frontal del armario con cuatro tornillos M4, los taladros son como se indica en la foto 7. Este panel se utiliza para controlar el arrancador MSF desde el exterior del armario y reemplaza al que hay en el fronal del arrancador, en lugar de este último hay una placa con el conector y tres leds para running, start/ stop y power. Este "Pack" viene con 3 m de cable para conexión entre el arrancador MSF y el panel exterior. El panel de control externo, tiene la misma funcionalidad y tamaño que el original.



Picture 1 shows the contents of the factory installed PPU (01-2138-01).
Picture 2 shows the contents of the after installed PPU (01-2138-00).
Picture 3 Take away the original PPU by loosing one screw and one cable.
Picture 4 Replace it with blanc PPU by fastening one cable and one screw.
Picture 5 shows an MSF mounted inside a cabinet with blank PPU and cable.
Picture 6 shows the rear of the of the external PPU secured with its 4 M 4 bolts. The depth required is 30 mm .


Bild 1
Bild 2
Bild 3
Bild 4
Bild 5
Bild 6
visar innehållet I den fabriksmonterade PPU optionen (01-2138-01).
visar innehallet I den eftermonterade PPU optionen (01-2138-00). Tag bort original PPU genom att lossa en skruv samt en kabel. Ersätt denna med blank PPU samt tillhörande skruv och kabel. visar en MSF monterad i skåp med blank PPU samt kabel. visar baksidan av extern PPU monterad l skåp med de 4 M4 bultarna. Djup 30 mm

Fig. 1 toont de inhoud van de in de fabriek gemonteerde PPU kit (01-2138-01).
Fig. 2 toont de inhoud van de PPU kit voor na-montage (01-2138-00).
Fig. 3 Demonteer de originele PPU door een schroef los te draaien en de kabel los te halen.
Fig. 4 Vervang hem door de Blank PPU door de kabel aan te sluiten en de schroef vast te draaien.
Fig. 5 laat een MSF met Blank PPU en aansluitkabel in een kast zien.
Fig. 6 toont het achteraanzicht van een met 4 M4 bouten op een kastdeur bevestigde externe PPU. Noodzakelijke inbouwdjepte 30 mm .


Bild 1
Bild 2
Bild 3
Bild 4
zeigt den Inhalt der fabriksmontierten PPU Option (01-2138-01).
zeigt den Inhalt in der externen PPU Option (01-2138-00).
Entfernen Sie die orginale PPU durch lösen einer Schraube und eines Kabels. Ersetzen Sie diese durch eine Blende samt dem dazugehörigen Kabel und Schraube.
Bild 5 zeigt einen in einem Schrank montierten MSF mit einer externen PPU und Bild 6 zeigt die Rückseite einer PHU, die in einem Schrank mit vier M4 Muttern montiert ist. Die benötigte Tiefe ist 30 mm .


La foto 1 muestra el contenido del kit para panel externo moncado en fábrica (01-2138-01).
La foto 2 muestra el contenido del kit montado a posteriori (01-2138-00).
La foro 3 Desmontar el panel original quitando un tornillo $y$ un cable.
La foto 4 Reemplazarlo por la placa conectando el cable y un tornillo.
La foto 5 muestra el MSF montado en armario con la placa y el cable.
La foto 6 muestra el reverso del panel externo montado en armario con los 4 tornillos M4. Profundidad necesaria 30 mm .


7
A Area to be cut out
Yta som ska skäras ut
Dit gedeelte verwijderen
Ausgeschnittene Flache
Area de Corte

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IW250PMSH Edition 4 April 1997

# Thermistor Trip, Speed Sensing, Phase Angle Protector Relay Installation Instructions 

IINSTRUMENTS

Models Covered
252-PMM
252-PSG
252-PMT
$253-P H 3$
252-PSF
252-PMM
252-PMT

## Introduction

Thermistor Trip Relay (252-PMM \& 252-PMT)
Tip inputs are monitored within_settable limits. In the event of the input moving outside these limits, the unit will initiate a trip signal via a double pole changeover relay. An illuminated green LED indicates when the thermistor temperature is within normal working limits.
The unit is designed such that the alarm relay is energised at normal temperatures is reached, until manual intervention occurs.
Model 252-PMM has the facility for manual resetting, so that the trip condition remains after normal operating temperature. is reached, until manual intervention occurs.

## Installation

The Protector should be installed in a dry position, not in direct sunlight and where the ambient temperature is reasonably stable and will not be outside the range 0 to 60 degrees Celsius. Mounting will normally be on a vertical surface but other positions will not affect the operation and vibrations should be kept to a minimum. The Protectors are designed for mounting on a 35 mm rail to DIN 46277. Alternatively they may be screw fixed, a special adaptor can be supplied to mount 252 types.

To mount a protector on a DIN rail, the top edge of the cutout on the back is hooked over one edge of the rail and the bottom edge carrying the release clip clicked into place. Check that the unit is firmly fixed. Removal or repositioning may be achieved by levering down the release clip and lifting the unit up and off the rail.

Phase Balance Relay (252-PSF \& 252-PSG)
Trip inputs are monitored within settable limits. In the event of the input moving outside these limits, the unit will initiate a trip signal via a double pole changeover relay. An illuminated red LED indicates that the supply is within limits.

Speed Sensing Relay (253-PH3)
Trip inputs are monitored within settable limits. In the event of the input moving outside these limits, the unit will initiate a trip signal. The illuminated red LED's indicates that the single pole output relays are in an energised state and at normal running speed all thiee relays should be energised. Units are factory adjusted for normal running speed $=$ 0.75 mA output. The meter adjust pot on the product front is used for this requirement, which also ensures the trip levels are set to the calibrated values. Terminal 8 is connected to terminal 5 internally. Terminals 15 and 16 give a $0 / 1 \mathrm{~mA}$ signal proportion to speed. Terminal 8 is connected to terminal 5 internally.
No. 1 Relay energises on rising speed
No. 2 Relay energises on rising speed
No. 3 Relay de-energises on rising speed
This product is designed for use only with magnetic coil inductive sensors.

## 252-PMM, 252-PMT \& 253-PH3

Pick up, input and output leads should be kept separate from any other wiring.

Setting Controls (252-PSF, 252-PSG)
These products have two calibration facilities which can be set to suit operating requirements and they are factory calibrated as follows:-

1. \% unbalance set points

Voltages of and below 380 volts L-L are calibrated to
$1.0 \%$ class index of rated voltage. Voltages above 380 volts L-L are calibrated to $1.5 \%$ class index of rated voltage.
2. Time Delay

For all voltage ranges $10 \%$ maximum delay.
3. Voltage Withstand

Continuous overload $=1.35 \times$ rated voltage
Setting Up (all other models)
The calibration marks around the controls are provided as a guide if the installer does not have access to accurate equipment. The maximum error of the calibration marks is typically $10 \%$ of the span of the control concerned.

## Maintenance

The unit should be inspected to normal standards for this class of equipment. For example remove accumulations of dust and check all connections for tightness and corrosion. In the unlikely event of a repair being necessary it is recommended that the unit is returned to the factory or to the nearest Crompton Instruments Service Centre, (details on page 2). Should repair be attempted then replacement components must be of the same type, rating and tolerance as those used in the original circuit. It is important that should calibration be deemed necessary, say after repair, then this should only be attempted if the required high accuracy equipment is available. With any enquiry please quote the full model number found on the side label. The unit must be recalibrated after repair.

## Electromagnetic Compatibility (EMC) Installation Requirements

This product range has been designed to meet the certification requirements of the EU Directives when installed to a good code of practice for EMC in industrial environments. e.g.

1. Screen output and low signal input leads. In the event of RF fields causing problems where screened leads can not be used, provision for fitting RF suppression components, such as ferrite absorbers, line filters Etc., must be made.
N.B. It is good practice to install sensitive electronic instruments, that are performing critical functions, in EMC enclosures that protect against electrical interference causing a disturbance in function.
2. Avoid routing leads alongside cables and products that are, or could be, a source of interference.
3. To protect the product against permanent damage, surge transients must be limited to 2 kV pk.
4. Electro Static Discharge (ESD) precautions must be taken at all times when handling this product.
For assistance on protection requirements please contact your local sales office.

## Connection Diagrams



Output Relay


252-PMM can operate in either an automatic or a manual reset mode.
For automatic the reset link $\mathrm{R} 1-\mathrm{R} 2$ is to be disconnected. For manual the reset link R1-R2 must be inserted.

Relay


Connection diagrams should be carefully followed to ensure correct polarity and phase rotation where nappticable. External voltage transformers may be used on 252-PSF and $252-\mathrm{PSG}$ to extend the range. Connection wires should be sized to comply to applicable regulations and codes of practice. These products do not have internal fuses therefore external fuses musj be used for safety protection under fault conditions.

## Dimensions in mm

Model 252


LOW VOLTAGE DIRECTIVE:- Thls product comples with BSEN61010-1

## WARNING

Voltages dangerous to human life may be present at some of the terminals of this unit. Ensure all supplies are de-energised before attempting any connectiondisconnection. It it is necessary to make adjusiments with the power connected then exercise extreme caution.
This product is manufactured by Crompton Instruments Limited, Freaboumes Road, Witham. Essex. CM8 3AH. Telephone 01376512601 , Fax: ( 01376 ) 518320.
Our policy is one of continuous development, and although the information is correct at the time of publlcation. we reserve the right to supply products differing in construction or dimenslon from those illustrated and described.

Sales Centres

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| :---: |

## Page 1 of 3

Ref: IW256NA - Rev 4 - Sept 02
Products Covered
256-TW*U, 256-TX*U, 256-TY*U
253-TA*U, 253-TV*U, 253-TZU
256-TT*U,

* $=$ Any letter or number


## Introduction

Paladin Transducers give a dc output proportional to the input. Zero and span adjustments are accessible without opening the transducer. The cases are moulded in a tough flame retardant material.

## Instaliation

The Transducer should be installed in a dry position, not in direct sunlight and where the ambient temperature is reasonably stable and will not be outside the range 0 $60^{\circ} \mathrm{C}$. Mounting will normally be on a vertical surface but other positions will not affect the operation and vibration should be kept to a minimum. The
Transducers are designed for mounting on a 35 mm rail to DIN 46277. Alternatively they may be screw fixed. To mount a Transducer on a DIN rail, the top edge of the cut-out on the back is hooked over one edge of the rail and the bottom edge carrying the release clip clicked into place. Check that the unit is firmly fixed. Removal or repositioning may be achieved by levering down the release clip and lifting the unit up and off the rail. Connection diagrams should be carefully followed to ensure correct polarity and phase rotation. External current and voltage transformers may be used to extend the range. Current Transformers must be used with models 256-TWG, 256-TWH, 256-TWN. These products do not have internal fuses therefore; external fuses must be used for safety protection under fault conditions. Side labels show full connection information and data.

## Fusing and connections

This unit must be fitted with external fuses in voltage and auxiliary supply lines. Voltage input lines must be fused with a quick blow fuse 1A maximum. Auxiliary supply lines must be fused with a slow blow fuse rated 1A maximum. Choose fuses of a type and with a breaking capacity appropriate to the supply and in accordance with local regulations.

## Electromagnetic Compatibility

This unit has been designed to provide protection against EM (electro-magnetic) interference in line with requirements of $E U$ and other regulations. Precautions necessary to provide. proper operation of this and adjacent equipment will be installation dependent and so the following can only be general guidance:-

- Avoid routing wiring to this unit alongside cables and products that are, or could be, a source of interference.
- The auxiliary supply to the unit should not be subject to excessive interference. In some cases, a supply line filter may be required.
- To protect the product against incorrect operation or permanent damage, surge transients must be


## Paladin Transducers Class 0.5

250 Series - Watt, VA, Var, Volts, Amps, Frequency, Integrating $\&$ D.C. Transducers
controlled. It is good EMC practice to suppress differential surges to 2 kV or less at the source. The unit has been designed to automatically , recover from typical transients, however in extreme circumstances it may be necessary to temporarily disconnect the auxiliary supply for a period of greater than 5 seconds to restore correct operation.

- Screened communication and small signal leads are recommended and may be required. These and other connecting leads may require the fitting of RF suppression components, such as ferrite absorbers. line filters etc., if RF fields cause problems.
- It is good practice to install sensitive electronic instruments that are performing critical functions in EMC enclosures that protect against electrical interference causing a disturbance in function.


## Commissioning

The units are calibrated at the factory for full accuracy. No further adjustments are required. Zero and span adjustment where provided are under the bungs on the front panel. Trimming these will degrade the accuracy of this transducer, but may be used to compensate for local conditions.

## Maintenance

No routine maintenance is required. Should repair be necessary it is recommended that the transducer be returned to the factory or to the nearest Crompton Instruments Service Centre.

## Screw torque

Main terminal screws should be tightened to 1.35 Nm or 1.0 ftllbf only. Detachable terminal connector screws should be tightened to 0.9 Nm or $0.7 \mathrm{ft} / \mathrm{l} f$ only. Where fitted, terminal covers are held in place by miniature self tapping screws into plastic. These screws should be tightened by hand only, sufficiently to secure the terminal cover and prevent it vibrating.

Low Voltage Directive:- This product complies with BSEN61010-1

## Warning

- During normal operation, voltages hazardous to life may be present at some of the terminals of this unit. Installation and servicing should be performed only by qualified, properly trained personnel' abiding by local regulations. Ensure all supplies are deenergised before attempting connection or other procedures.
- It is recommended adjustments be made with the supplies de-energised, but if this is not possible, then extreme caution should be exercised.
- Terminals should not be user accessible after installation and external installation provisions must be sufficient to prevent hazards under fault conditions.


## Page 2 of 3

Ref: IW256NA - Rev 4 - Sept 02

This product is manufactured by Crompton Instruments, Freebournes Road, Witham, Essex. England CM8 3AH. Telephone +44(0) 1376 509509, Fax: +44 (0) 1376 509511.

Fig No: 1


Fig No:3
WATTS
types 256-TWNU
( 3 phase, 4 wire
3 CT's
3WYENYE pts)
(2 $1 / 2$ element)


## INSTALLATION INSTRUCTIONS

Paladin Transducers Class 0.2 250 Series

## WATTS

256-TWKU Single Phase 2 wire - Fig 1
256-TWKU Q8 FA Single Phase 3 wire - Fig 2
256-TWMU 3 phase 3 wire unbal - Fig 4
256 TWNU 3 phase 4 wire unbal - Fig 5VA
VA
256-TYKU Single Phase 2 wire - Fig 1
256-TYMU 3 Phase 3 wire bal or unbal - Fig 4
256 TYNU 3 phase 4 wire bal or unbal - Fig 5
VARS
256-TXKU-SingléPhase 2-wire-Fig"1
256-TXKU Q8 FA Single Phase 3 wire - Fig 2
256-TXMU 3 phase 4 wire unbal - Fig 3
256 TXNU 3 phase 3 wire unbal - Fig 4
AC AMPERES (Fig 6)
253-TAAU Average sensing input milliamps output 253-TALU Average sensing input $4 / 20$ milliamps o/p 243-TARU RMS sensing input any standard output AC VOLTS (Fig 7)
253-TVAU Average sensing input milliamps output
253-TVLU Average-sensing-input-4/20-milliamps o/p
253-TVRU RMS sensing input any standard output
253-TVZU Suppressed zero and standard output FREQUENCY (Fig 7)
253-THZU Frequency
INTEGRATING AC AMPERES (Fig 8)
253-TAPU Time delay 8 minutes
253-TAMU Time delay 15 minute
253-TANU Time delay 30 minutes
DC INPUTIDC OUTPUT (Fig 9)
256-TTAU DC Current input
256-TTVU DC Voltage input
256-TTMU DC mV input
256-TTFU Thermocouple -Fe/Const
256-TTNU Thermocouple - Ni Cr5/NiAi
256-TTPU Thermocouple - Pt Rh/Pt
Fig No: 5
WATTS
types 256-TWNU
or VA 256-TYNU
: (2 phase, 4 wire -
3 CTS 2 phase/ neutral Pts)
(2 1/2 element)


The Information contained in these installation instructions is for use only by installers trained to make electrical power installations and is intended to describe the correct method of installation for this product. However, Tyco Electronics has no control over the field conditions, which influence product installation.
It is the user's responsibility to determine the suitability of the installation method in the user's field conditions. Tyco Electronics' only obligations are those in Tyco Electronics' standard Conditions of Sale for this product and in no case will Tyco Electronics be liable for any other incidental, indirect or consequential damages arising from the use or misuse of the products. Crompton is a trademark.

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## Page 3 of 3

Ref: IW256NA - Rev 4 - Sept 02

Connection Diagrams (continued)

## INSTALLATION INSTRUCTIONS

## Paladin Transducers Class 0.2 250 Series

1) When no terminal screws are fitted to terminals 13 and 14 the transducer application /characteristics do not necessitate the use of a separate auxiliary supply
2) Point(s) indicated to be grounded - if no other point(s) in the CT and/or PT secondary circuit(s) are grounded.
3) Three phase hook-ups necessitate phase sequence 1-2-3

Fig No: 6 AC AMPERES
types253-TAAU
253-TALU
253-TARU

Fig No: 7
AC VOLTS
types253-TVAU
253-TVLU
253-TVRU
253-TVZU
or Frequency
253-THZU


Fig No: 8 INTEGRATING AC AMPERES
types253-TAPU
253-TAMU
253-TANU

Fig No: 9 INPUT/DC OUTPUT
types 256-TTAU
(DC CURRENT INPUT)
256-TTVU (DC VOLT INPUT)
256-TTMU: (DC mV INPUT)
256-TTFU (THERMOCOUPLE FE/CONST)
256-TTNU (THERMOCOUPLE -
$\mathrm{NiCir} / \mathrm{NiAi})$
256-TTPU (Thermocouple -PtRh/Pt)

## Dimensions

|  | A | B | $N^{\circ}$ of release clips |
| :--- | :--- | :--- | :--- |
| 253 | 75 | 60 | 1 |
| 256 | 150 | 135 | 2 |

Model 252


[^1] arising from the use or misuse of the products. Crompton is a trademark.

## MPU-16A MANUAL

## MOTOR PROTECTION UNIT

REVISION 13
NOVEMBER 1997


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## 1. INTRODUCTION

### 1.1 GENERAL

Accuracy in design and improvements in materials have allowed designers to decrease the thermal mass and to increase the operating temperature of modern motors. The trend is to utilize the full capability of these motors in spite of the resulting decrease in their ability to tolerate overloads. The modelling technique used by the MPU-16A provides dynamic protection for a motor that is allowed to operate at its design limit.

### 1.2 FEATURES AND OPTIONS

- $I^{2} t$ thermal-overload protection.
- Overcurrent protection.
- Undercurrent protection.
- Current-unbalance protection.
- Phase-reverse protection.
- Motor-temperature sensing and overtemperature protection.
- Earth-fault protection.
- Front-panel programming.
- Program-change lockout.
- Nonvolatile memory for programmed values and values-at-trip.
- Parameter-selectable, isolated analog output.
- Digital display of:

Motor current
Peak motor current
Percent current modulation
Percent current unbalance
Motor temperature
Earth-leakage current
Percent $1^{2}$ t
Meter values-at-trip
Minutes-to-reset
CT-primary ratings
Trip-and-alarm set points.

- Provision for 5-A or 1-A CT's.
$-40^{\circ} \mathrm{C}$ to $60^{\circ} \mathrm{C}$ operating temperature.
- Optional dc supply voltage.
- Optional electroluminescent backlit display.
- Optional remote-keypad input.
- Optional RS-485 communications interface.


### 1.3 ORDERING INFORMATION

- Determine MPU-16A model number from Table 1.
-Supplied with ICT-2, ICT-2 interconnection cable ( $6 \mathrm{~m}, 20 \mathrm{ft}$ ), and mounting hardware.
- Order window-type CT (EFCT-1, EFCT-2, or other) for zero-sequence earthfault detection.
- Order TU-16 test unit for training or functional testing.



## 2. FRONT-PANEL ANNUNCIATION, INDICATION, AND PROGRAMMING

### 2.1 GENERAL (See Figure 1)

MPU-16A modes are listed on the front panel. Modes 0 to 5 are used to enter trip-and-alarm set points and to annunciate trips and alarms. Modes 6, 7, and F are used to enter motor full-load current, motor service factor, and CT-primary ratings. Mode 8 is used to select special functions. Modes $9, A, b, C, d$, and $E$ are used to display operating values and values-at-trip.

### 2.2 LIQUID-CRYSTAL DISPLAY

The left digit of the four-digit liquid-crystal display uses a hexadecimal format ( 0 to $F)$ to indicate the mode displayed. The remaining digits (designated from left to right as value digits 1,2 , and 3 ) display set-point values, meter readings, and trip-and-alarm codes.

For value digits greater than 999, the last value digit is replaced by E to indicate an extended range. To obtain the actual value, multiply the reading by 100 . For example, 30 E is read as 3000 .

### 2.3 KEYPAD

Four keypad switches provide the operator interface to the MPU-16A. Tactile-feedback switches are used to provide positive indication that switch contact has been made:

RAMP - This switch is used to adjust values in Modes 0 to 8 and F. Under normal operation this switch is inoperative. To make the RAMP switch operative, the program-change lockout must be defeated by connecting MPU-16A terminals 20 and 21. To change a set point, ENTER must be pressed within three seconds after RAMP is released. If ENTER is not pressed within three seconds, the display will return to its pre-adjusted value. One arrow up and two arrows down indicate that the RAMP switch is bidirectional. To ramp up: press and hold. To reverse: release, press again within one second and hold.

MODE - This switch is used to select the mode displayed. Bidirectional operation is the same as for RAMP.


MPU-16A FRONT PANEL
FIGURE 1

RESET - This switch is used to reset trips and alarms. It is also used to display motor current in percent of full-load current (Mode 9), RTD peak temperature during the most-recent emergency thermal reset (Mode C), and time-to-reset (Mode E). It is used with ENTER to reset latched alarms, manually reset current modulation (Mode A), manually reenable temperature protection after an emergency thermal reset (Mode $4)$, and initiate an emergency thermal reset (Mode E).

ENTER - This switch is used to enter values in Modes 0 to 8 and F, and to access a second level in all modes. Values can be entered only when the program-change lockout is defeated. This prevents unauthorized or unintentional program changes during normal operation. When the program-change lockout is defeated, the value displayed in Modes 0 to 8 or $F$ will be entered if ENTER is pressed within three seconds after RAMP is released.

In Modes 0 to 5, 8, and $F$, the second-level set point will be displayed while ENTER is pressed. In Modes 9 and $b$ to $E$, the value immediately prior to the most recent trip will be displayed while ENTER is pressed. In Modes 6, 7, and A, information specific to the mode will be displayed while ENTER is pressed. If the program-change lockout is defeated, the second level in Modes 0 to 5,8 , and $F$ will remain displayed for three seconds after ENTER is released to allow RAMP to be pressed to initiate a second-level program change.

### 2.4 LED INDICATORS

The red TRIP/ALARM LED is on if a trip or alarm has occurred. It flashes when the program-change lockout is defeated (program enable active); however, ON has priority over FLASH. The green PROCESSOR-RUN LED is on when the processor is functional.

### 2.5 PROGRAMMING

The MPU-16A has individual trip-and-alarm control relays and all trip-and-alarm set points can be individually adjusted or deleted. At the top of each set-point range, the delete code "ddd" is displayed. If "ddd" is entered, the set point is deleted and the associated protection is disabled.

To enable program changes, the program-change lockout must be defeated by connecting MPU-16A terminals 20 and 21. Remove this connection when programming is completed. This will prevent unauthorized or unintentional program changes.

To program trip set points in Modes 0 to 5, and the firstllevel of Modes 6, 7, 8, and F:

## - Press MODE to select the mode,

- press RAMP to adjust, and within three seconds of release,
- press ENTER.

To program alarm set points in Modes 0 to 5, and the second level of Modes 8 and F:

- Press MODE to select the mode,
- press ENTER, and within three seconds of release,
- press RAMP to adjust, and within three seconds of release,
- press ENTER.

All programmed values and values-at-trip are stored in a nonvolatile memory that retains its data indefinitely-even if supply voltage is lost. It is not necessary to reprogram the unit when supply voltage is restored.

### 2.6 TRIPS AND ALARMS

When a trip occurs:

- The trip relay operates,
- the red TRIP/ALARM LED comes ON,
- the display automatically switches to the mode that initiated the trip, and
- the mode digit is followed by a trip code.

With the exception of autoreset which can be enabled for Mode 0 , all trips must be individually reset.

When an alarm occurs:

- The alarm relay operates,
- the red TRIP/ALARM LED comes ON, and
- the display does not switch to the mode that initiated the alarm; however,
- an alarm code is displayed if the mode that initiated the alarm is selected.

Unless latching alarms are selected in Mode 8, alarms automatically reset when conditions return to normal. See Section 3.10.2 and Table 3.

### 2.7 DEFAULT VALUES

A set of default values are preprogrammed at the factory. Default values are listed in their respective mode descriptions in Section 3.

To reload factory default values:

- Remove the supply voltage,
- connect MPU-16A terminals 20 and 21 to enable program changes, and
- with RESET pressed, apply the supply voltage.


## 3. MODE DESCRIPTIONS

### 3.1 GENERAL

This section contains a description of each mode. It explains operational characteristics, describes special functions, and lists set-point ranges, display codes, and default values.

### 3.2 MODE 0 - $\mathrm{I}^{2}$ t LIMIT

This mode is used to enter overload-class set points and to annunciate overload alarms and trips.

In order to meet CSA, UL, and NEMA requirements, an overload relay set at 100\% must ultimately trip when tested at $100 \%$ FLA, trip within 8 minutes when tested at $200 \%$ FLA, and trip within the number of seconds indicated by its class designation when tested at $600 \%$ FLA. The overload class for a MPU-16A is the time, in seconds, entered in Mode 0 . The Mode-0 set point is determined by equating $I^{2}$ t at $600 \%$ FLA to the allowable locked-rotor $I^{2}$ t. For example, if lockedrotor current is $735 \%$ FLA and if allowable locked-rotor time is 20 seconds, the $I^{2}$ t limit is:

$$
\begin{aligned}
& 6^{2} \times t=7.35^{2} \times 20, \text { and } \\
& t=30 \text { seconds-this is the Mode- } 0 \text { set point. }
\end{aligned}
$$

Ultimate current is the minimum value of continuously applied current that will cause a relay to trip. For a MPU-16A, ultimate current is the product of FLA and service factor which are entered in Modes 6 and 7 respectively. With 26 service factors from $100 \%$ to $125 \%$, and 45 classes from 1 s to 45 s , a total of 1170 cold curves are available. One of these cold curves is shown as the $0 \%-1^{2} t$ curve in Figure 2.

The $0 \%-l^{2}$ t curve is a maximum-time-to-trip curve for motor current above the ultimate current. Motor current in this range causes $I^{2} t$ to tend toward a limit above the $100 \%$ trip level. Motor current below the ultimate current causes $I^{2}$ t to tend toward a limit that is less than $100 \%$ as shown in the inset graph in Figure 2. In all cases, $I^{2} t$ responds exponentially toward a final value. The time constant for this response is derived from entered service factor and $I^{2}$ tlimit values so that $I^{2} t$ continually tracks used thermal capacity in the motor. This dynamic modelling is operational with or without RTD compensation. If a motor is equipped with a RTD temperature sensor, the MPU-16A thermal model can compensate for high ambient temperature and loss of ventilation.


FIGURE 2

Used thermal capacity determines the time-to-trip for excursions above the ultimate current. For the Class-20, 1.15 service factor example shown in Figure 2, sustained operation at $100 \%$ FLA will cause $I^{2} t$ to tend toward $75 \%$. The time to trip for current above the ultimate current is reduced as shown by the $75 \%-1^{2} t$ curve.

The MPU-16A trips in Mode 0 when $I^{2}$ t reaches $100 \%$. It will not reset until $I^{2}$ t has decreased to $30 \%$. The time required for $I^{2} t$ to decrease to $30 \%$ is a function of the time constant. For EMERGENCY THERMAL RESET, see Section 3.16. Percent $I^{2}$ t and minutes-to-reset are displayed in Mode E. See Section 3.16. The MPU-16A can be programmed in Mode 8 to automatically reset when $\mathrm{I}^{2}$ t decreases to $30 \%$. See Section 3.10.1 and Table 3.

As recommended by NEMA MG1-14.35 and MG1-20.56, the largest of the three phase-currents is used for the $I^{2}$ t model to compensate for the additional heating caused by current unbalance.

| Set-Point Range .................................. 1 s to 45 s @ 600\% FLA |  |
| :---: | :---: |
| Set-Point Step Size.......... | 1 s |
| Display Codes: |  |
| Trip.. | OFFF |
| Alarm. | OAAA* |
| Set Point Deleted | Oddd* |
| Default Values: |  |
| Trip.. | 10 s @ 600\% FLA |
| Alarm................ | 9s@600\% FLA |

* Alarm is on when $I^{2} t \geq$ (Alarm Set Point/Trip Set Point) $\times 100 \%$. Deleting the TRIP function automatically deletes the ALARM function.


### 3.3 MODE 1 - OVERCURRENT

This mode is used to enter overcurrent set points and to annunciate overcurrent alarms and trips. Overcurrent protection is referred to as "jam" protection and it is active only after the motor is running. The MPU-16A considers the motor to be running when motor current remains between $10 \%$ and $125 \%$ FLA for more than 10 seconds.

An instantaneous short-circuit trip at 1200\% FLA can be enabled in Mode 8. See Section 3.10.3 and Table 3. A short-circuit trip will occur within 10 ms in 11 of 15 occurrences and within 80 ms in 4 of 15 occurrences.


### 3.5 MODE 3 - CURRENT UNBALANCE

This mode is used to enter current-unbalance set points and to annunciate current-unbalance alarms and trips. Two equations are used to calculate current unbalance.

For $I_{\max } \leq \mathrm{I}_{\text {FLA }}$ :

$$
\begin{equation*}
\text { Unbalance }=\left[\left(I_{\max }-I_{\text {min }}\right) / I_{\text {FLA }}\right] \times 100 \% \tag{3.1}
\end{equation*}
$$

For $I_{\text {max }}>I_{\text {FLA }}$ :

$$
\begin{equation*}
\text { Unbalance }=\left[\left(l_{\max }-I_{\min }\right) / I_{\max }\right] \times 100 \% \tag{3.2}
\end{equation*}
$$

Where: $\quad \begin{aligned} & I_{\text {max }}=\text { maximum phase current } \\ & \\ & \\ & I_{\text {min }}=\text { minimum phase current } \\ & I_{\text {FLA }}=\text { full-load current }\end{aligned}$

In addition to current-unbalance protection, phase-reverse protection is provided. Phase-reverse detection is active in the first three seconds of each start. This feature can be enabled and phase sequence selected in Mode 8. See Sections 3.10.6, 3.10.7, and Table 3.
Set-Point Range ..... 5\% to 75\%
Set-Point Step Size ..... 1\%
Trip Time ..... 5 s
Alarm Time ..... 1 s
Alarm Hysteresis ..... 2\%
Phase-Reverse Trip Time ..... $2.0 \pm 1.2 \mathrm{~s}$
Display Codes:Trip3FFF
Alarm ..... 3AAA
Set Point Deleted ..... 3ddd*
Trip on AbC Sequence ..... 3AbC
Trip on bAC Sequence ..... 3bAC
Default Values:
Trip ..... 25\%
Alarm ..... 15\%

* Deleting the current-unbalance trip does not disable the phase-reverse trip.


### 3.6 MODE 4 - TEMPERATURE

This mode is used to enter temperature set points and to annunciate temperature alarms and trips. Rated winding temperature for a motor is the sum of ambient temperature, lrated temperature rise, and an allowance for hot spots. The response of a temperature sensor embedded in a stator winding is too slow to protect a motor against most overload conditions; however, it will accurately indicate steady-state temperature and provide protection against loss of ventilation and high ambient temperature. If ambient temperature remains below $40^{\circ} \mathrm{C}$ and if there is no loss of ventilation, an accurate thermal model can provide protection against most overloads. If an embedded RTD temperature sensor is used to provide hot-motor compensation by adding a bias to the thermal model, then protection is extended to include overloads initiated when stator temperature is high. See Section 3.10 .4 and Table 3. Only one sensor is required since the variation among sensors in the same motor is small compared to the temperature rise of the motor.

### 3.6.1 RTD

If an open-RTD or shorted-RTD sensor is detected, hot-motor compensation will automatically' be disabled and an alarm code will be displayed. If a RTD is not connected, delete the Mode-4 set points to avoid an open-RTD alarm.

The temperature trip is disabled by an emergency thermal reset in Mode $E$, and 4 Fdd is automatically displayed if the keypad has not been actuated in the previous 60 seconds. The Mode- 4 trip is automatically re-enabled if the RTD temperature is decreasing and is $20^{\circ} \mathrm{C}$ below the trip set point. A Mode- 4 trip can be manually re-enabled by simultaneously pressing ENTER and RESET.
Set-Point Range
$50^{\circ} \mathrm{C}$ to $220^{\circ} \mathrm{C}$ $5^{\circ} \mathrm{C}$

Set-Point Step Size
Trip-and-Alarm Times
1 s
Alarm Hysteresis
$3^{\circ} \mathrm{C}$
Display Codes:
Trip................................................ 4FFF
Alarm.............................................. 4AAA
Open-RTD Alarm........................... 4AAO
Shorted-RTD Alarm ....................... 4AA1
Set Point Deleted........................... 4ddd
Trip Disabled.................................. 4Fdd
Default Values:
Trip
$125^{\circ} \mathrm{C}$
Alarm:........................................... $100^{\circ} \mathrm{C}$

### 3.5 MODE 3 - CURRENT UNBALANCE

This mode is used to enter current-unbalance set points and to annunciate current-unbalance alarms and trips. Two equations are used to calculate current unbalance.

For $I_{\text {max }} \leq I_{\text {FLA }}$ :

$$
\begin{equation*}
\text { Unbalance }=\left[\left(I_{\max }-I_{\min }\right) / I_{F L A}\right] \times 100 \% \tag{3.1}
\end{equation*}
$$

For $I_{\text {max }}>I_{F L A}:$

$$
\begin{equation*}
\text { Unbalance }=\left[\left(I_{\max }-I_{\min }\right) / I_{\max }\right] \times 100 \% \tag{3.2}
\end{equation*}
$$

$$
\text { Where: } \begin{array}{ll} 
& I_{\text {max }}=\text { maximum phase current } \\
& I_{\text {min }}=\text { minimum phase current } \\
& I_{\text {FLA }}=\text { full-load current }
\end{array}
$$

In addition to current-unbalance protection, phase-reverse protection is provided. Phase-reverse detection is active in the first three seconds of each start. This feature can be enabled and phase sequence selected in Mode 8. See Sections 3.10.6, 3.10.7, and Table 3.
Set-Point Range ..... $5 \%$ to $75 \%$
Set-Point Step Size ..... 1\%
Trip Time ..... 5 s
Alarm Time ..... 1 s
Alarm Hysteresis ..... 2\%
Phase-Reverse Trip Time ..... $2.0 \pm 1.2 \mathrm{~s}$
Display Codes:Trip3FFF
Alarm ..... 3AAA
Set Point Deleted ..... 3ddd*
Trip on AbC Sequence ..... 3AbC
Trip on bAC Sequence ..... 3bAC
Default Values:
Trip ..... 25\%
Alarm ..... 15\%

* Deleting the current-unbalance trip does not disable the phase-reverse trip.



### 3.6.2 PTC

The actual set point is not important because trip temperature depends upon the Nominal Response Temperature (NRT) of the thermistor. The trip-and-alarm points are the same regardless of set-point values. It is recommended that the NRT value be entered for future reference.

As with the RTD, the temperature trip is disabled by an emergency thermal reset in Mode E, and 4Fdd is automatically displayed if the keypad has not been actuated in the previous 60 seconds. The Mode-4 trip is automatically re-enabled on a cooling transition through the NRT. A Mode-4 trip can be manually re-enabled by simultaneously pressing ENTER and RESET. Unlike the RTD, faulted-sensor detection is not provided and a trip will occur if the PTC opens.
Trip/Alarm Resistance ..... 3300 ohms
Reset Resistance 2000 ohms
Display Codes:4FFF
Alarm ..... 4AAA
Set Point Deleted ..... 4ddd
Trip Disabled ..... 4FddDefault Values:
Trip ..... $125^{\circ} \mathrm{C}$
Alarm ..... $100^{\circ} \mathrm{C}$

### 3.7 MODE 5 - EARTH FAULT

This mode is used to enter earth-fault set points and to annunciate earth-fault alarms and trips. Set points are expressed in percent of the earth-fault-CT-primary rating entered in the second level of Mode F.

Optional CT's (EFCT-1 or EFCT-2) with 5-A-primary ratings are available for sensitive earth-fault detection in applications where earth-fault current is less than 800 A and inrush current is less than 2.5 kA . If inrush current is greater than 1 kA but less than 2.5 kA , a flux conditioner should be used to prevent nuisance tripping. If earth-fault current is greater than 800 A , inrush current is greater than 2.5 kA , or if a trip level greater than 5 A is required, use a $5-\mathrm{A}$ - or 1-A-secondary earth-fault CT that will not saturate at the prospective currents.

Earth-fault cuirrent can be derived from the phase currents by using the ICT-2 residual connection. See Section 5.5.2. When this connection is used, the primary rating of the phase CT's must be entered in both levels of Mode F. Due to CT errors, trip set points should be greater than $10 \%$ with the residual connection.

Earth-fault detection in a two-CT configuration requires an earth-fault CT. Do not use a residuali-type connection with two phase-CT's because an earth fault in the derived phase will not be detected.
Four earth-fault-trip times are available. See Section 3.10 .5 and Table 3. If instantaneous earth-fault trip is selected, the trip will occur in 10 ms or less in 11 of 15 occurrences and in 80 ms or less in 4 of 15 occurrences.
Set-Point Rapge ...................................... $1 \%$ to $100 \%$ of Earth-Fault-
CT-Primary Rating

Trip...
Alarm!............................................ 5AAA
Set Pôint Deleted........................... 5ddd
Default Values:
Trip ................................................................................................
Alarm

### 3.8 MODE 6 - FULL-LOAD CURRENT

This mode is used to enter the full-load current (FLA) of the motor and to indicate the firmware revision level. FLA range is a function of the phase-CT-primary rating entered in Móde F. It is necessary to enter the CT rating in Mode F before FLA is entered in Mode 6 because Mode 6 is set to the minimum value of the FLA range when the CTirating is entered. The firmware revision level is displayed by pressing ENTER.

Set-Point Range
9 A to 800 A
Set-Point Step Size................................... 1 A
FLA Range.
0.45 to $0.93 \times$ Phase-CT-Primary Rating

Default Value 100 A

### 3.9 MODE 7 - SERVICE FACTOR

This mode is used to enter the service factor and to indicate the hardware configuration. Service factor is the factor by which the ultimate-trip current exceeds the full-load current entered in Mode 6. The hardware configuration code is displayed by pressing ENTER. See Table 2.

Set-Point Range $100 \%$ to $125 \%$
Set-Point Step Size 1\%
Default Value
$100 \%$

## HARDWARE CONFIGURATIONS

| DISPLAY CODE | TEMP SENSOR OPTION |
| :---: | :---: |
| 7008 | Platinum |
| 7009 | Nickel |
| 700 A | PTC |
| 700 C | Copper |

TABLE 2

### 3.10 MODE 8 - PROGRAM (See Tables 3 \& 4)

This mode is used to select special program options. Any combination in Tables 3 and 4 can be selected by entering the appropriate hexadecimal numbers in Mode 8 in the same way that trip-and-alarm set points are entered in Modes 0 to 5.

Default Values:
Table 3 8000
Table 4.......................................... 8000
3.10.1 AUTORESET

When autoreset is ON, a Mode-0 trip will automatically reset when $I^{2} t$ decreases to $30 \%$. See Section 3.2.

Default OFF

### 3.10.2 ALARM LATCH

When the alarm latch is ON, all alarms that occur in Modes 0 to 5 will latch and must be individually reset. To reset a latched alarm, use MODE to select the alarm and press ENTER and RESET simultaneously.

Default. OFF

|  |  | VALUE DIGIT 2 |
| :---: | :---: | :---: |
|  |  | PHASE SEQUENCE $0=\mathrm{AbC}$ $1=\mathrm{bAC}$ |
|  |  | PHASE REVERSE <br> $0=$ DISABLE $\quad 1=$ ENABLE |
|  |  | EARTH-FAULT-TRIP TIME $00=$ INSTANTANEOUS $\begin{aligned} & 01=0.25 \mathrm{SECOND} \\ & 10=0.5 \mathrm{SECOND} \\ & 11=1.0 \text { SECOND } \end{aligned}$ |
|  |  | סודוד |
| $\begin{aligned} & \text { Oz } \\ & \text { O } \\ & \text { and } \end{aligned}$ | $\text { nmo คO>0め vouA } \omega \mathrm{NN}$ | VALUE DIGIT 3 |
|  |  | $\begin{aligned} & \text { HOT-MOTOR COMP } \\ & 0=\mathrm{OFF} \end{aligned} 1=\mathrm{ON}$ |
|  | $\overrightarrow{-u-4000} \rightarrow \Delta \nu-1000$ | $\begin{aligned} & \text { SHORT-CIRCUIT TRIP } \\ & 0=\mathrm{OFF} \\ & 1=\mathrm{ON} \end{aligned}$ |
| $\begin{aligned} & \stackrel{\sim}{\tilde{\sim}} \\ & \stackrel{0}{\omega} \\ & \stackrel{\rightharpoonup}{0} \\ & 0 \end{aligned}$ | $\Delta-0 \circ \Delta-00 \rightarrow-0 \circ \sim-\circ \%$ | $\begin{aligned} & \text { ALARM LATCH } \\ & 0=\mathrm{OFF} \quad 1=\mathrm{ON} \end{aligned}$ |
|  | $\rightarrow 0 \rightarrow 0 \rightarrow 0 \rightarrow 0 \rightarrow 0 \rightarrow 0 \rightarrow 0 \rightarrow 0$ | $\begin{aligned} & \text { AUTORESET (MODE } 0) \\ & 0=0 F F \quad 1=\mathrm{ON} \end{aligned}$ |

MODE 8 - PROGRAM
(2nd Level Without Communications Interface)


NOTE:

TABLE 4

### 3.10.3 SHORT-CIRCUIT TRIP

The instantaneou's short-circuit trip at $1200 \%$ FLA should not be enabled unless the interrupting capacity of the interrupting device is rated for the available fault level. If short-circuit trip is enabled, phase CT's must be selected so that motor FLA is between $4 ; 5 \%$ and $75 \%$ of the phase-CT-primary rating. See Sections 3.3 and 3.17.

Default $\qquad$ OFF

### 3.10.4 HOT-MOTOR COMPENSATION (RTD Only)

The MPU-16A's thermal model assumes a $40^{\circ} \mathrm{C}$ ambient temperature and it calculates a thermal time constant from the programmed values of service factor and $I^{2} t$ limit. It is important that actual motor values be used. so that the model can track motor temperature. If the model time constant is too short, premature trips can occur and premature resets will be allowed. If the modiel time constant is too long, motor temperature can be excessive before a trip occurs.

When hot-motor compensation is ON, motor temperature measured by the RTD can bias the thermal model. This bias provides protection against high ambient temperature, loss of ventilation, or premature reset. With hot-motor compensation, the minimum percent $l^{2} t$ value is:

$$
\frac{\text { Measured Temp }\left({ }^{\circ} \mathrm{C}\right)-40^{\circ} \mathrm{C}}{\text { Temperature Trip Set Point }\left({ }^{\circ} \mathrm{C}\right)-40^{\circ} \mathrm{C}} \times 100 \%
$$

Hot-motor compensation is disabled if the Mode-4-trip set point is deleted, if an open-RTD or shorted-RTD sensor is detected, or if the Mode-4 trip is disabled by an emergency thermal reset. See Sections 3.6 and 3.16.

Hot-motor compensation cannot be selected on units configured for PTCthermistor temperature sensors.

Default OFF

### 3.10.5 EARTH-FAULT TRIP DELAY

Four earth-fault-trip times (instantaneous, $0.25 \mathrm{~s}, 0.5 \mathrm{~s}$, or 1.0 s ) are available. See Section 3.7.

Default $\qquad$ Instantaneous

### 3.10.6 PHASE REVERSE

If phase-reverse protection is enabled, phase sequence will be checked during the first three seconds of each start. See Section 3.5.

Default
Disabled

### 3.10.7 PHASE SEQUENCE

If phase-reverse protection is enabled, select sequence $A b C$ or $b A C$. See Section 3.5 .

Default AbC

### 3.10.8 ANALOG-OUTPUT PARAMETER

For units without RS-485 communication interface, one of the following parameters can be directed to the isolated analog output:
Current (Mode 9) 0 to 125\% FLA
$1^{2} t$ (Mode E) 0 to 100\%
Temperature (Mode C) ................. 0 to $200^{\circ} \mathrm{C}$
Earth Leakage (Mode d)
0 to 100\%
$\qquad$ Current

Default.

### 3.10.9 RELAY OPERATING MODE

Each output-relay driver can be independently operated in a fail-safe or non-failsafe mode. In the fail-safe mode, the output relays are energized when supply voltage is on and the unit is not in a trip-or-alarm condition. The output relays are de-energized if supply voltage is off or if a trip-or-alarm condition occurs. MPU-16A labelling shows the relays de-energized. In the non-fail-safe mode, the output relays are energized only during a trip-or-alarm condition.

Default Values:
Trip Relay.
Fail Safe
Alarm Relay
Fail Safe

### 3.11 MODE 9 - AMMETER

This mode is used to display the largest of the three phase-currents. Mode 9 is automatically displayed when supply voltage is applied. For currents above 999 A, the last value digit is replaced by $E$ to indicate an extended range. To obtain the actual value, multiply the reading by 100 . For example, 30 E is read as 3000 A .

Motor current aș a percentage of full-load current is displayed by pressing RESET. The pretrip ammeter value can be recalled by pressing ENTER.

Range
0 to $10 \times$ FLA
Resolution ................................................ 1 A for I < 1000 A
Accuracy ............................................. $\pm 0.3 \%$ Full Scale:or
$\pm 3 \%$ Reading
See Technical Specifications in Section 7 for metering accuracy vs ICT interconnection cable length.

### 3.12 MODE A - PEAK CURRENT / \% CURRENT MODULATION

This mode is used to display the maximum phase current measured since the previous reset in Mode A. The extended-range notation applies for values above 999 A . See Section 2.2. Unlike the ammeter, the peak-reading ammeter is operational only after the motor is running. The MPU-16A considers the motor to be running when imotor current remains between $10 \%$ and $125 \%$ FLA for more than 10 seconds.

Mode A is also used to display percent current modulation. Reciprocating loads can produce pulsating motor currents. These pulsating currents can be considered to be amplitude-modulated current waveforms.

NEMA MG1-20.82 defines percent modulation as:

$$
\begin{equation*}
\% \text { Mod }=[\text { Peak Variation } /(1.414 \times \text { FLA })] \times 100 \% \tag{3.3}
\end{equation*}
$$

Peak percent modulation for the present run cycle can be displayed in Mode A by pressing ENTER. It is automatically reset each time the motor stops and can be manually reset by simultaneously pressing ENTER and RESET.

Peak Current:
Range ............................................ 0 to $6 \times$ FLA
Resolution ..................................... 1 A for $\mathrm{I}<1000 \mathrm{~A}$, 100 A for $\mathrm{I} \geq 1000 \mathrm{~A}$
Percent Modulation:
Range ........................................... 0 to 100\%
Resolution...................................... 1\%

### 3.13 MODE b - CURRENT-UNBALANCE DISPLAY

This mode is used to display percent current unbalance. The unbalance value is calculated using equations 3.1 and 3.2. See Section 3.5.

The pre-trip current unbalance value can be recalled by pressing ENTER.
Range 0 to 100\%
Resolution 1\%

### 3.14 MODE C - TEMPERATURE DISPLAY

This mode is used to display RTD temperature or PTC-thermistor status. If the unit is configured for a RTD sensor, Mode C will display temperature in ${ }^{\circ} \mathrm{C}$. If the unit is configured for a PTC thermistor, Mode $C$ will display 0 to 10 when the sensor temperature is below the NRT ( $\mathrm{R}<2000$ ohms) and 200 to $255(R>3300$ ohms) when the sensor temperature is above the NRT.

The pre-trip value can be recalled by pressing ENTER.
An emergency thermal reset will temporarily disable the Mode-4 trip. The peak value reached while the Mode-4 trip was disabled can be displayed by pressing RESET. The peak temperature reached will be in ${ }^{\circ} \mathrm{C}$ if the unit is configured for a RTD; however, a unit configured for a PTC will display the PTC trip indication if the NRT has been exceeded. Peak values are not saved if control power is lost.

RTD:
Range ............................................ 0 to $255^{\circ} \mathrm{C}$
Resolution ....................................... $1{ }^{\circ} \mathrm{C}$
Accuracy ....................................... $\pm 2^{\circ} \mathrm{C}$
Sensor-Open Indication................. $255^{\circ} \mathrm{C}$
Sensor-Short Indication .................. $255^{\circ} \mathrm{C}$

PTC:
Trip Indication ................................ 200 to 255
Reset Indication .............................. 0 to 10

### 3.15 MODE d - EARTH LEAKAGE

This mode is used to display earth-leakage current. The extended-range notation applies in Mode d.

The pre-trip earth-leakage value can be recalled by pressing ENTER.


### 3.16 MODE E - PERCENT I ${ }^{2}$ / / TIME-TO-RESET / EMERGENCY THERMAL RESET

This mode is used to display percent $I^{2} t$ which is a measure of used thermal capacity. See Section 3.2. If the increase in $I^{2} t$ during a typical start is known, the value in Mode E will indicate if sufficient thermal capacity is available to start a hot motor.

Mode E is also used to display time in minutes until a Mode-0 reset will be allowed if a Mode-0 trip has occurred. Reset time is a function of the time constant. Reset time is displayed when RESET is pressed; however, the reset time can be longer than the value displayed if hot-motor compensation is enabled. See Section 3.10.4.

EMERGENCY THERMAL RESET will reduce $I^{2} t$ to $0 \%$, reset Mode 0 , and temporarily disable Mode 4 and hot-motor compensation. For EMERGENCY THERMAL RESET:

- Defeat program-change lockout by connecting MPU-16A terminals 20 and 21,
- select Mode E, and
- press ENTER and RESET simultaneously.

The pre-trip percent $I^{2}$ t value can be recalled by pressing ENTER.

| Percent $\mathrm{I}^{2}$ t: |  |
| :---: | :---: |
| Range ... | 0 to 100\% |
| Resolution! | ..... 1\% |
| Trip Value | .... 100\% |
| Reset Value | .............................. 30\% |
| e-to-Reset: |  |
| Range ... | ... 0 to 85 minutes |
| Resolutio | 1 minute |

### 3.17 MODE F - CT-PRIMARY RATINGS

This mode is used to enter phase-CT- and earth-fault-CT-primary ratings in the same way that trip-and-alarm set points are entered. Mode-F set points change in 5-A or 50-A increments and all four digits display the CT-primary rating when a set point is being adjusted. When a new rating is entered, the display returns to the three-value-digit format and the extended-range notation applies for values above 999 A. See Section 2.2.

Phase CT's should be selected so that motor full-load current is approximately $70 \%$ of the primary rating. The FLA programming range in Mode 6 is $45 \%$ to $93 \%$ of the phase-CT-primary rating. If short-circuit trip is enabled, phase CT's must be selected so that motor FLA is between $45 \%$ and $75 \%$ of the phase-CT-primary rating. Mode F must be programmed before Mode 6 because Mode 6 is set to the bottom of the FLA range when the phase-CT-primary rating is entered.

The primary rating for the EFCT-1 and EFCT-2 is 5 A . If a $5-\mathrm{A}$ - or 1-A-secondary earth-fault CT is used, the primary rating of the earth-fault CT must be entered. If the residual connection is used, enter the primary rating of the phase CT's in both levels of Mode F.

All programmed values and values-at-trip are stored in nonvolatile memory. When data are retrieved from this memory, error-detection techniques check for corrupted data. If data are suspect, the unit will trip, "FbAd" will be displayed, and default values will be loaded. If "FbAd" is displayed, defeat the program-change lockout, reprogram the unit, and reset Mode F.
Phase-CT-Primary Ratings.................... 20 A to 1200 A in 5-A increments
Earth-Fault-CT-Primary Ratings:
$\quad$ EFCT-1 and EFCT-2 ................... 5 A
5-A- or 1-A-Secondary CT .......... 50 A to 2000 A in $50-\mathrm{A}$ increments
Display Codes:
Invalid Data Trip........................... FbAd
Default Values:
Phase-CT-Primary Rating ............ 150 A
Earth-Fault-CT-Primary Rating..... 5 A


This section contains information to assist in selecting $\mathbb{C} T$ ratios and set-point

To enable program changes, the program-change lockout must be defeated by connecting MPU-16A terminals 20 and 21. See Section 5.4.7. All values entered

Select the primary rating of the phase CT's between 1.07 and $2.22 \times$ motor FLA. If short-circuit trip is to be used, the primary rating of the phase CT's must be between 1.33 and $2.22 \times$ motor FLA. Enter the phase-CT-primary rating in Mode F.

### 4.3 EARTH-FAULT-CT SELECTION (Mode F, 2nd Level)

Earth-fault protection is low-level protection. High-level faults must be cleared by fuses or by circuit breakers which limit the energy let-through to a fault. In a solidly-grounded installation, select an earth-fault CT that will not saturate below the operating value of the high-level devices and enter the CT-primary rating in the second level of Mode F.

Optional CT's (EFCT-1 or EFCT-2) with 5-A-primary ratings are available for sensitive earth-faụlt detection in applications where earth-fault current is less than 800 A and inrush jcurrent is less than 2.5 kA . If inrush current is greater than 1 kA but less than 2.5 kA , a flux conditioner should be used to prevent nuisance tripping. If earth-fault current is greater than 800 A , inrush current is greater than 2.5 kA , or if a trip level greater than 5 A is required, use a $5-\mathrm{A}$ - or $1-\mathrm{A}$-secondary earth-fault $C T$ that will not saturate at the prospective currents.

The residual connection can be used if earth-fault set points are greater than $10 \%$ of the primary rating of the phase CT's. If the residual connection is used, enter the primary rating of the phase CT's in both levels of Mode F.

## $4.4 \quad I^{2}$ t Limit (Mode 0)

Use locked-rotor data for the motor to determine the Mode-0 set point. For example, if locked-rotor current is $735 \%$ FLA and if allowable locked-rotor time is 20 seconds, the $1^{2}$ t limit is:

$$
\begin{aligned}
& 6^{2} \times t=7.5^{2} \times 20, \text { and } \\
& t=30 \text { seconds—this is the Mode- } 0 \text { set point. }
\end{aligned}
$$

Enter "030" as the trip set point. If alarm indication is required, enter an alarm set point that is a percentage of the trip set point. For this example, an alarm at $90 \%$ $1^{2} t$ requires an alarm set point at $0.9 \times 30=27$ seconds.

### 4.5 TRIP-AND-ALARM SET POINTS (Modes 1 to 5)

Enter trip-and-alarm set points for Modes 1 to 5:

- Overcurrent, or "jam", protection should be set below the current at which breakdown torque occurs.
- If loss-of-load protection is required, undercurrent should be set between the no-load current and the minimum operating current.
- A voltage unbalance of $1 \%$ can produce as much as $10 \%$ current unbalance. Observe current unbalance in Mode $b$ to determine if set points less than the default values can be used.
- Select temperature set points according to the insulation class of the motor. Class-B insulation is rated at $130^{\circ} \mathrm{C}\left(40^{\circ} \mathrm{C}\right.$ ambient $+80^{\circ} \mathrm{C}$ rise $+10^{\circ} \mathrm{C}$ hotspot allowance). Class-F insulation is rated at $155^{\circ} \mathrm{C}\left(40^{\circ} \mathrm{C}\right.$ ambient + $105^{\circ} \mathrm{C}$ rise $+10^{\circ} \mathrm{C}$ hot-spot allowance). Trip temperature should be at least $5^{\circ} \mathrm{C}$ below the rated temperature of the insulation. Alarm temperature should be at least $5^{\circ} \mathrm{C}$ below the trip temperature.
- Earth-fault set points require coordination with upstream devices.

If specific data are not available for trip-and-alarm set-point selection, initially use the default values and observe meter values to determine operating set points.

### 4.6 FULL-LOAD CURRENT (Mode 6)

Enter motor full-load current in Mode 6. The phase-CT-primary rating must be entered in Mode $F$ before motor full-load current is entered in Mode 6.
4.7 SERVICE FACTOR (Mode 7)

Service factor is the factor by which the ultimate-trip current exceeds full-load current. Most electrical codes allow set-points up to $115 \%$ and $125 \%$ for motors with service factors of 1.0 and 1.15 respectively.

### 4.8 PROGRAM (Mode 8)

Using Tables 3 and 4, select the functions required and enter the appropriate codes in Mode 8.


A basic motor-protection system consists of a MPU-16A motor protection unit, an ICT-2 interface CT, and three customer-supplied phase CT's. An ICT-1 is available to replace the ICT-2 in special CT-ratio applications. To utilize temperature sensing, the motor must be equipped with a RTD or PTC sensor. An earth-fault CT is usually required for earth-fault detection.

### 5.2 COMPONENT MOUNTING

### 5.2.1 PANEL-MOUNT CONFIGURATION

Outline dimensions and mounting details for the panel-mount MPU-16A are shown in Figure 3. The MPU-16A mounts in a $92-\mathrm{mm}$ (3.62-in) square cutout (1/4 DIN) and is secured tol the panel by the panel-mount clamp. To mount the MPU-16A, insert it through the panel cutout and slip the panel-mount clamp over the MPU-16A body. Slide the clamp forward until the latch tabs snap into the mating holes. Lock the unit in place by tightening the four clamp screws against the mounting panel.
.-. CAUTION .-.
OVER TIGHTENING THE CLAMP SCREWS WILL DEFORM THE CLAMP AND CAUSE THE LATCH TABS TO RELEASE.

### 5.2.2 SURFACE-MOUNT CONFIGURATION

Outline dimensions and mounting details for the surface-mount MPU-16A are shown in Figure 4. Mount the MPU-16A using M4 (No. 8) screws and externaltooth lockwashers. Surface-mount MPU-16A's have panel-mount-clamp latch holes and are supplied with panel-mount clamps and hole plugs. This allows surface-mount units to be panel mounted as described in Section 5.2.1; however, $100-\mathrm{mm}$ (3.94-in) mounting centres cannot be maintained. If the unit is surface mounted, insert hole plugs in the latch holes.

### 5.2.3 ICT-2 INTERFACE CT

Outline dimensions and mounting details for the ICT-2 interface CT are shown in Figure 5. Locate the ICT-2 near the phase CT's.

### 5.2.4 EFCT-1 AND EFCT-2 EARTH-FAULT CT'S

Outline dimensions and mounting details for the EFCT-1 and EFCT-2 earth-fault CT's are shown in Figures 6 and 7.


PANEL-MOUNT MPU-16A OUTLINE AND MOUNTING DETAILS
FIGURE 3


## FIGURE 4



NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).
2. MOUNTING SCREWS: $\mathrm{M} 4 \times 20$ OR $8-32 \times 0.875$.
3. OVERALL HEIGHT WHEN MOUNTED ON DIN EN50022 $35 . \mathrm{mm} \times 7.5-\mathrm{mm}$ TOP-HAT RAJL.
4. SHORTING SCREWS ARE ACCESSIBLE FROM BOTTOM OF ICT-2.
5. SHORTING SCREWS: $6-32 \times 0.375$ NICKEL-PLATED-BRASS BINDING HEAD. DO NOT SUBSTITUTE.

FIGURE 5

$5.0(0.20)$ ø
RECESSED FOR
B-mm HEXNUT
$1.0(0.04)$


1. DIMENSIONS IN MILLIMETRES (INCHES).
2. MOUNTING SCREWS: $M 4 \times 12$ OR $8-32 \times 0.50$.

## EFCT-1 OUTLINE AND MOUNTING DETAILS

## ! <br> FIGURE 6

1


NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).
2. MOUNTING SCREWS: $\mathrm{M} 4 \times 12$ OR $8-32 \times 0.50$.

EFCT-2 OUTLINE AND MOUNTING DETAILS

FIGURE 7

### 5.3 SHIELDED CABLES

Motor protection equipment must operate in electrically noisy environments. Use shielded, twisted cables for all low-level signals to minimize electrostatic and electromagnetic coupling. The shield must enclose the signal conductors as completely as posisible and the shield must have only one connection to ground.

Input-cable shields from the ICT-2, the temperature sensor, and the remote program-enable switch must be grounded at the MPU-16A end only. Analog- and communications-output cables should be grounded at the receiver end only.

Terminate foil-shielded input cables as shown in Figure 8:

1. Strip $150 \mathrm{~mm}\left(6^{\prime \prime}\right)$ of outer jacket from the cable.
2. Peel and strip the foil shield from the drain and insulated wires.
3. Trim the insulated wires to $50 \mathrm{~mm}\left(2^{\prime \prime}\right)$, and strip $6 \mathrm{~mm}(1 / 4$ ") of insulation from each wire. Leave the drain wire full length.
4. Connect the insulated wires to the terminal block.
5. Group the drain wires from all shielded input cables and twist them together. Trim the drain wires to length and attach the crimp-type ground lug provided. For panel-mount units, fasten the lug with the shield screw. For surface-mount units, install the lug between the screw head and the lockwasher on one of the MPU-16A mounting screws.
6. Repeat steps 1 and 2 at the other end of the cable. Cut off the drain wire and use heat-shrink sleeving or tape to insulate the shield from ground.

### 5.4 MPU-16A CONNECTIONS

All connections to the MPU-16A are made through two plug-in, wire-clamping terminal blocks. Each terminal will accept one No. 14 AWG conductor. The supply-voltage terminal block has a keying pin blocking terminal 9 so that supply voltage cannot belaccidentally applied to the signal terminals. See Figures 9 and 10 for typical connections and control circuits.
a) OUTER JACKET REMOVED AND FOIL SHIELD PEELED

b) CONDUCTORS PREPARED FOR TERMINATION


SHIELD-GROUND END


UNGROUNDED END

## SHIELDED-CABLE PREPARATION

FIGURE 8


TYPICAL MPU-16A CONNECTION DIAGRAM

FIGURE 9


ALTERNATE COIL CIRCUIT FOR PLC STATUS INPUT


ALTERNATE COIL CIRCUIT FOR TRIP CONTACTS BETWEEN COIL AND NEUTRAL


TYPICAL CONTROL CIRCUITS
FIGURE 10

### 5.4.1 ICT-2 INTERCONNECTION CABLE

Connect the MPU-16A to the ICT-2 with the interconnection cable supplied. See Figures 12 and 13. Prepare the shielded-conductor groups as outlined in Section 5.3. The following colour code is recommended:

| A |  | Black | Shielded-Group 1 |
| :--- | :--- | :--- | :--- |
| B | White |  |  |
| C | Red |  |  |
| COM | Green |  |  |
| EF(1,2) | Blue <br> Brown | Shielded-Group 2 |  |

Ground the cable shields at the MPU-16A only.

### 5.4.2 POWER SUPPLY

The MPU-16A power supply is protected by a time-delay fuse, F3, which is externally accessible only on units with SW, D1, D2, and D4 power-supplies. SW units are supplied with fuses for $120-\mathrm{Vac}$ operation. D1, D2, and D4 units are fused for 12,24 , and 48 Vdc operation respectively. All other units are internally fused for the supply indicated on the MPU-16A nameplate. See Section 7 for recommended F3 fuses.

Derive supply voltage from the line side of the motor starter or from an independent source. Connect supply voltage to terminals 1 and 3 (L1 and L2) as shown in Figure 9. In 120-Vac systems, L2 is usually designated as the neutral conductor. Direct-current power supplies use L1 for the positive terminal and L2 for the negative terminal. Ground terminal 8.

### 5.4.3 TRIP-RELAY CONTACTS

A set of Form C relay contacts are provided for use in a contactor- or breakercontrol circuit. These contacts are designated TRIP and are available at terminals 5,6 , and 7. The trip contacts are rated 8 A resistive at 250 Vac and are protected by an 8-A fuse, F1. Three typical contactor control circuits are shown in Figure 10. The trip relay is shown de-energized.

### 5.4.4 ALARM-RELLAY CONTACTS

A set of Form C relay contacts are provided for use in an indication or supervisorycontrol circuit. These contacts are designated ALARM and are available at terminals 10, 11, and 12. The alarm contacts are rated 8 A resistive at 250 Vac and are protected by an 8-A fuse, F2. The alarm relay is shown de-energized.

NOTE: USE No. 14 AWG CONDUCTORS FOR SUPPLY-VOLTAGE AND OUTPUT-RELAY CONNECTIONS.

### 5.4.5 RTD TEMPERATURE SENSOR

The MPU-16A nameplate indicates the RTD sensor type that the temperature circuit is configured for. Lead compensation requires equal lead resistances. Use shielded, three-conductor, No. 16 AWG to No. 22 AWG cable to connect the RTD sensor to terminals 17, 18, and 19 as shown in Figure 9. Ground the cable shield at the MPU-16A only.

The MPU-16A indicates an alarm if the RTD opens or shorts. Delete temperature sensing in Mode 4 if a RTD is not connected.

### 5.4.6 PTC THERMISTOR TEMPERATURE SENSOR

The MPU-16A nameplate indicates if the temperature circuit is configured for a PTC thermistor. Use No. 16 AWG to No. 22 AWG cable to connect the PTC thermistor to terminals 17 and 18. Install a jumper between terminals 17 and 19 as shown in Figure 9. If shielded cable is used, ground the shield at the MPU-16A only.

A PTC thermistor switches from a low resistance to a high resistance above its Nominal Response Temperature (NRT). Consequently, shorted-sensor and opensensor detection is not provided. If the unit is configured for a PTC thermistor and if a thermistor is not used, delete temperature sensing in Mode 4.

### 5.4.7 PROGRAM-CHANGE LOCKOUT

As explained in Sections 2.3 and 2.5, program-change lockout prevents unauthorized or unintentional changes. It is recommended that a keylock switch be connected to MPU-16A terminals 20 and 21 to allow programming. To prevent program changes while the motor is running, use a two-pole keylock switch as an interlock as shown in Figures 9 and 10. If the switch is mounted more than 1 m ( 3 ft ) from the MPU-16A, use shielded cable and ground the shield at the MPU-16A end only.

### 5.4.8 ANALOG OUTPUT

An isolated analog output is available at terminals 23 and 24. Terminal 23 is negative. Use shielded cable and ground the cable shield at the receiver.

### 5.4.9 COMMUNICATIONS INTERFACE

The optional RS-485 communications interface replaces the analog output at terminals 23 and 24 . See communications interface manuals.

### 5.5 ICT-2 CONNECTIONS

The MPU-16A uses an ICT-2 interface CT to simplify wiring and to minimize CT burden. The ICT-2 contains four signal-conditioning interface transformers which are interconnected as shown in Figure 11. These transformers isolate the MPU-16A from the phase and earth-fault CT's. Also, they eliminate the need for CT shorting contacts when the MPU-16A is disconnected. Phase-CT and earth-fault-CT secondaries can be simultaneously grounded through terminal 22 and a jumper to terminal 20. For in-line applications, the CT secondaries can be isolated by removing shorting screws $\mathrm{A}, \mathrm{B}$, and C through holes in the bottom of the ICT-2. See Figure 5.

### 5.5.1 STANDARD CONNECTION

Standard connections with three, phase CT's and an earth-fault CT are shown in Figure 12. Dotted lines indicate 1-A-CT connections. Use shielded cable for EFCT-1 connections. Ensure that only current-carrying phase conductors pass through the earth-fault CT window and that ground conductors do not. For applications where the CT secondaries must be grounded at another location, remove shorting screws $A, B$, and $C$.

### 5.5.2 RESIDUAL EARTH-FAULT CONNECTION

The residual earth-fault connection is shown in Figure 13a. Dotted lines indicate $1-A-C T$ connections. Use three identical phase CT's for this connection.

### 5.5.3 TWO-CT CONNECTION

The two-CT connection is shown in Figures 13b and 13c. Dotted lines indicate 1-A-CT connections. Since this connection derives the current in the unmonitored phase, this connection should be used only in retrofit applications where it is not possible to install a third phase CT.
5.6 CABLE RESTRAINT

All conductors should be restrained within 100 mm (4") of the terminal blocks as shown in Figure 14. Three sizes of adjustable "P" clips are provided for this purpose. For surface-mounted units, restrain the conductors by fastening the "P" clips to the mounting surface. For panel-mounted units, secure the "P" clips to the MPU-16A rear panel. Secure cables to the ICT-2 using the cable-tie eyelets and the cable ties provided.


## NOTES:

1. REMOVE SHORTING SCREWS A, B, AND C TO ISOLATE PHASE-CT AND EARTH-FAULT-CT SECONDARIES FOR IN-LINE APPLICATIONS
2. SHORTING SCREWS A, B, AND C: $6-32 \times 0.375$ NICKEL-PLATED-8RASS BINDING HEAD. DO NOT SUBSTITUTE.
3. SHORTING SCREWS A, B, AND C MUST NOT BE REMOVED FOR RESIDUAL OR TWO-CT CONNECTIONS
4. EACH TERMINAL ON TB1 AND T83 WILL ACCEPT ONE NO. 10 AWG CONDUCTOR.

## ICT-2 SCHEMATIC

FIGURE 11
a) STANDARD CONNECTION

b) STANDARD CONNECTION WITH EFCT


## ICT-2 STANDARD CONNECTIONS

FIGURE 12
a) RESIDUAL CONNECTION

b) TWO-CT CONNECTION


SHORTING SCREWS
A, B CMST MTM
NOTBE REMOVED

SHORTING SCREWS A. B, \& CMUST NOT BE REMOVED
c) TWO-CT CONNECTION WITH EFCT-1


SHORTING SCREWS
A. B, \& C MUST

NOT BE REMOVED

OTHER ICT-2 CONNECTIONS
FIGURE 13

b) PANEL MOUNT


FIGURE 14

## 6. THEORY OF OPERATION

### 6.1 GENERAL (See Figure 15)

A basic MPU-16A consists of a display module, a power-supply module, a processor module, and an analog module. The display module is a "motherboard" for the other modules.

### 6.2 DISPLAY MODULE

The display module has two functions. It is the operator interface and it provides the main bus network for the system. The display module contains the LCD, LCD driver, LED indicators, and bus connectors. The power-supply, processor, analog, and option modules plug into the bus connectors. A sealed-membrane-switch keypad containing four switches and an ESD shield also connect to the bus. A direct-drive LCD allows operation to $-40^{\circ} \mathrm{C}$.

### 6.3 POWER-SUPPLY MODULE

A transformer-isolated power supply provides 5,12 , and 20 Vdc for the other modules. The transformer primary can be connected for 120- or $240-\mathrm{Vac}$ operation. A dc-to-dc converter is used for $120 / 240-\mathrm{Vac} / \mathrm{dc}$ operation or for 12-, 24 -, or $48-\mathrm{Vdc}$ operation. The power-supply module also contains the trip-andalarm relays.

### 6.4 PROCESSOR MODULE

The processor module contains the CMOS 6805 microprocessor, EPROM memory, nonvolatile EEPROM memory, and watchdog circuit.

The EEPROM memory provides 64, 8-bit memory locations to store programmed values and values-at-trip. When supply voltage is lost, a power-fail circuit generates an interrupt and data are written into the EEPROM memory. Hysteresis in the power-fail circuit ensures that the MPU-16A will not attempt to operate unless the supply voltage is within specifications.

The watchdog connected to the CPU reset line will reset the CPU if a watchdog pulse has not been detected for 0.25 second. The watchdog prevents changes to the EEPROM contents until the CPU is reset. If the CPU does not reset, the relay lock-out circuit is set and the green PROCESSOR-RUN LED is turned off. When the relay lock-out circuit is set, the trip-and-alarm relays are de-energized.


## NOTES:

1. TRIP-AND-ALARM RELAYS LOCATED ON POWER-SUPPLY MODULE.
2. PROCESSOR-RUN AND TRIP/ALARM LED'S LOCATED ON DISPLAY MODULE.
3. OPTIONAL MODULES NOT SHOWN.

### 6.5 ANALOG MODULE

The analog module contains input circuits for phase current, temperature, and earth-leakage current. It also contains an eight-channel, multiplexed, ten-bit, A/D converter and an isolated analog-output circuit. All inputs and outputs have MOV protection against electrical transients.

The RTD temperature measurement circuit uses current sources to provide RTD lead compensation. Digital linearization is provided for nickel RTD's.

Serial data are transferred to the isolated analog-output circuit through a dualchannel optical isolator. The analog signal is scaled and buffered to provide the required current or voltage output.

### 6.6 OPTION MODULES

A 50-pin bus connector on the display module accepts a backlighting, remote input, or RS-485 communications interface module.

### 6.7 FIRMWARE

The MPU-16A completes four program scans per second. In 60-Hz applications, each scan has an eleven-cycle sampling interval followed by a four-cycle calculation interval. In each sampling interval, the multiplexed A/D converter obtains 960 samples of the earth-fault and phase-current signals. The multiplexer sequences these four signals so that each measurement is a digital integration of 240 samples uniformly spaced throughout the sampling interval. This technique eliminates nuisance phase-unbalance trips on modulating or rapidly-changing loads.

In order to provide instantaneous short-circuit and earth-fault trips, each current sample is compared to its trip value. If four samples in one sampling interval exceed the trip value, a trip will result.

All other data and $1 / O$ are processed, and all time delays are initiated during the four-cycle calculation interval.

## 7. TECHNICAL SPECIFICATIONS



Supply:
AC (supply voltage codes: $12,24, S W$, and $A D^{*}$ ):
$120 / 240 \mathrm{Vac}, 50 / 60 \pm 1 \mathrm{~Hz}$
10 VA

Maximum Continuous .............. 135/265 Vac
Minimúm Continuous ............... 85/170 Vac
Powerlup Voltage..................... 100/200 Vac
DC (supply voltage code: AD): * 100 to' 240 Vdc 10 W
Maximum Continuous .............. 340 Vdc
Minimum Continuous ............... 90 Vdc
DC (supply voltage codes: D1, D2, and D4): *
12, 24; or 48 Vdc 10 W
Maximum Continuous +50\%
Minimum Continuous $-25 \%$
Fuse (F3)
See Fuse-Selection Chart
Interface-CT Inputs:
Thermal Withstand
Continụous
$5 \times$ CT-Secondary Rating
1-Second $80 \times$ CT-Secondary Rating
Burden $<0.01 \Omega$

Metering Accuracy vs ICT Interconnection Cable Length:

| No. 22 AWG | No. 18 AWG | Accuracy |
| :---: | :---: | :---: |
| $<18 \mathrm{~m}(60 \mathrm{ft})$ | $<45 \mathrm{~m}(150 \mathrm{ft})$ | $\pm 3 \%$ |
| $<30 \mathrm{~m}(100 \mathrm{ft})$ | $<75 \mathrm{~m}(250 \mathrm{ft})$ | $\pm 4 \%$ |
| $>30 \mathrm{~m}(100 \mathrm{ft})$ | $>75 \mathrm{~m}(250 \mathrm{ft})$ | $\pm 5 \%$ |

Temperature Iņput:

|  | 100- $\Omega$ <br> Platinum <br> DIN 43760 | $100-\Omega$ <br> Nickel | $120-\Omega$ <br> Nickel | $10-\Omega$ <br> Copper |
| :--- | :---: | :---: | :---: | :---: | :---: |
| $100^{\circ} \mathrm{C}$ Calibration $(\Omega)$ | 138.5 | 167.2 | 200.6 | 12.9 |
| Sensor Current $(\mathrm{mA})$ | 3.9 | 2.6 | 2.0 | 3.8 |
| Lead Compensation $(\Omega)$ | $<50$ | $<50$ | $<50$ | $<25$ |
| Shorted-RTD Alarm $(\Omega)$ | $<20$ | $<40$ | $<55$ | $<2$ |

* CSA certification pending on $\mathrm{AD}, \mathrm{D} 1, \mathrm{D} 2$, and D 4 .
PTC Thermistor:
Cold Resistance $1500 \Omega \max$
Trip Level ..... $3300 \Omega$
Reset Level ..... $2000 \Omega$
Sensor Current ..... 0.6 mA
Output Relays:
Contact Rating 8 A Resistive, 250 Vac or24 Vdc. B300 Pilot Duty$0.25 \mathrm{hp} @ 120$ Vac
Contact Configuration Form C
Fuse Rating (F1 \& F2) ..... 8 A, 250 Vac
Fuse Type See Fuse-Selection Chart
Analog Output:Parameter
$\qquad$0 to 125\% FLA,0 to $100 \% 1^{2} \mathrm{t}$,0 to $200^{\circ} \mathrm{C}$, or0 to 100\% Earth Leakage
Drive:
4-20 mA $700 \Omega \max$
$0-5 \mathrm{Vdc}$ $25 \mathrm{~mA} \max$
$0-10 \mathrm{Vdc}$ 25 mA max
Isolation to Ground 300 Vac Continuous
Dielectric Strength ..... 1500 Vac
Resolution ..... $\pm 1 \%$ Full Scale
Accuracies:
Ammeter Accuracy ..... $\pm 0.3 \%$ Full Scale or $\pm 3 \%$ Reading
Earth-Leakage Accuracy ..... $\pm 3 \%$ EF-CT-Primary Rating ${ }^{2}$
RTD Temperature Accuracy ..... $\pm 2^{\circ} \mathrm{C}$
${ }^{1}$ Ammeter Full Scale $=10 \times$ FLA
${ }^{2}$ Interface-CT accuracy included
Environment:
Operating Temperature ..... $-40^{\circ} \mathrm{C}$ to $60^{\circ} \mathrm{C}$
Storage Temperature ..... $-55^{\circ} \mathrm{C}$ to $80^{\circ} \mathrm{C}$
Terminal Block Ratings:
MPU-16A ..... $10 \mathrm{~A}, 300 \mathrm{Vac}$, No. 14 AWG
ICT-2, CT Inputs ..... $25 \mathrm{~A}, 500 \mathrm{Vac}$, No. 10 AWG
Certification CSA NRTL/C (Canada \& USA)
(A Ln 82897 NRTL/C
Compliance:Impulse Voltage Withstand to IEC 255-4,Appendix E, Class IIIHigh-Frequency Disturbance to IEC 255-4,Appendix E, Class III
Dielectric to IEC 255-5, Clause 6
Insulation Resistance to IEC 255-5, Clause 7

Fuse-Selection Chart:

| FUSE | HZ | VOLTAGE | RATING | DESCRIPTION |
| :---: | :---: | :---: | :---: | :---: |
| F1, F2 | 60 | 120/240 | $8 \mathrm{~A}, 250 \mathrm{Vac}$ | 1/4" $\times 1 / 1 / 4^{\prime \prime}$ CSA/UL Normal |
|  | 50 |  |  | IEC 127/I F Quick Acting |
| F3 | 60 | 120 | $100 \mathrm{~mA}, 250 \mathrm{Vac}$ | $1 / 4^{\prime \prime} \times 1 / 1 / 4^{\prime \prime} \mathrm{CSA} / \mathrm{UL}$ Time Delay |
|  |  | 240 | $62 \mathrm{~mA}, 250 \mathrm{Vac}$ |  |
| SW | 50 | 120 | $160 \mathrm{~mA}, 250 \mathrm{Vac}$ | IEC 127/III T Time Lag |
|  |  | 240 | $80 \mathrm{~mA}, 250 \mathrm{Vac}$ |  |
| F3 |  | 12 Vdc | $2 \mathrm{~A}, 250 \mathrm{Vac}$ | $1 / 4^{\prime \prime} \times 1 \frac{1 / 4}{}{ }^{\prime \prime}$ CSA/UL Time Delay $5 \times 20 \mathrm{~mm}$ IEC $127 / I I \mathrm{ID}$ |
| $\begin{aligned} & \text { F3 } \\ & \text { D2 } \end{aligned}$ |  | 24 Vdc | $1 \mathrm{~A}, 250 \mathrm{Vac}$ | $1 / 4^{\prime \prime} \times 1 \frac{114^{\prime \prime}}{}$ CSA/UL Time Delay $5 \times 20 \mathrm{~mm} \mathrm{IEC} 127 / I I I \mathrm{TD}$ |
| $\begin{aligned} & \hline \text { F3 } \\ & \text { D4 } \\ & \hline \end{aligned}$ |  | 48 Vdc | 0.5 A 250 Vac | $1 / 4^{\prime \prime} \times 1 \frac{1 / 4}{}{ }^{\prime \prime}$ CSA/UL Time Delay $5 \times 20 \mathrm{~mm} \mathrm{IEC} \mathrm{127/IIITD}$ |

All specifications are subject to change without notice.

## MPU-16A MANUAL COMPATIBILITY

Startco Engineering Ltd. constantly strives to improve its products. These product improvements are upwardly compatible so that a unit can be replaced by a unit of more recent manufacture. As features or enhancements are incorporated, the manual is revised to reflect the changes made. It is important that the manual revision corresponds to both the MPU-16A revision level and the firmware revision level. Consult Table 5 to determine the correct manual for a particular MPU-16A.

MANUAL REVISION LEVELS

| REVISION LEVELS |  |  |  |  | COMMENTS |
| :---: | :---: | :---: | :---: | :---: | :---: |
| MPU-16A |  | FIRMWARE |  | MANUAL |  |
| 60 Hz | 50 Hz | 60 Hz | 50 Hz |  |  |
| 0 | 50 | 0 | 50 | 0, 1 | Initial release. |
| 1 | 51 | 1 | 51 | 1 | Decimal-point driver revised. |
| 2 | 52 | 2 | 52 | 2, 3 | Range change, Modes 6 \& F. |
| 3 | 53 | 3 | 53 | 3 | EFCT-1 trip range increased. |
| 4 | 54 | 4 | 54 | 4, 5 | Emergency thermal reset revised. |
| 5 | 55 | 5 | 55 | 5 | Phase-reverse delay changed. |
| 6 | 56 | 6 | 56 | 6,7 | EF-CT ratio selection, non-fail-safe relay selection, display and input operations released. |
| 7 | 57 | 6 | 56 | 7 | Processor module revision. Manual sections 1 through 4 rewritten. |
| 8 | 58 | 8 | 58 | 8 | Mode-F set point firmware revision. |
| 9 | 59 | 100 | 150 | 9 | ICT-2 released, processor module revised, and manual rewritten. |
| 10 | 60 | 101 | 151 | 10 | RS-485 program option change. |
| 10 | 60 | 101 | 151 | 10A | Minor manual changes. |
| 11 | 61 | 102 | 152 | 11 | Phase sequence firmware revision. |
| 11 | 61 | 102 | 152 | 12 | Manual changes, EFCT-2 added. |
| 13 | 63 | 104 | 154 | 13 | Manual changes, dc power supply added. |

## TABLE 5

The MPU-16A revision level is shown on its nameplate and the firmware revision level is accessed by selecting Mode 6 and pressing ENTER. The manual revision level is listed on the manual title page.

## WARRANTY

The Startco Engineering MPU-16A motor protection unit is warranted to be free from defects in material and workmanship for a period of 12 months from installation, or 18 months from date of invoice, whichever comes first. Startco Engineering Ltd. will (at Startco's option) repair, replace, or refund the original purchase price of a unit which is determined by Startco to be defective if it is returned to Startco, prepaid, within the warranty period. This warranty does not apply to any motor protection unit which has been subjected to misuse, negligence, or accident, or has been misapplied, modified, or improperly installed.

The foregoing provisions are the sole obligation of Startco Engineering Ltd. and exclude all other warranties or guarantees. No warranty or representation is to be taken to have been given or implied from anything said or written in the negotiations between the customer and Startco Engineering Ltd., or their respective representatives, prior to the granting of this warranty, and any statutory or other warranty or condition, expressed or implied, as to the state, quality, or fitness of the goods subject to this warranty is hereby expressly excluded. No agent, distributor, or employee is authorized to extend or enlarge upon this warranty by any verbal or written statement or advertisement.

Under no circumstances shall Startco Engineering Ltd. be liable to the customer or to any person for injury to person, or damage to or loss of property or value caused by unit malfunction, misapplication, modification, or adjustment. Under no circumstances shall Startco Engineering Ltd. be liable for any incidental, consequential, or special damages, losses or expenses in connection with the use of, or inability to use the product for any purpose whatsoever. Disclaimers apply both during and after the term of this warranty.

## MPU-16A WARRANTY REGISTRATION

| Completed warranty registration must be returned within 30 days of purchase. |
| :--- |
| MODEL NO. MPU-16A _ SERIAL NO. $\quad$ PURCHASED FROM |

PURCHASE DATE
INSTALLATION DATE $\qquad$
PURCHASED BY
ADDRESS

CITY $\qquad$ SIGNATURE

PROV. OR STATE $\qquad$ POSTAL OR ZIP CODE $\qquad$
$\qquad$

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## MPU-16A

$-1$

> PROGRAMMABLE MOTTOR PROTECTION UNIT

## REFERENCE GUIDE

## MOTOR PROTECTION UNIT



BET-PDINT MDDEE
 1- OVEBCUmatint (4) 2- UnDERCTRPA!NT (N)
3- GLfarent UnBALANGE (4)


5 - FLLL-LOAD CUFORENT (A) - BENVICE FACTOR 「M1


BTATUB MODEE 8- propcras 9- Anangite (A) A- PEAK CLERENT (A) b-cuprent unaAlanker (76) [ - тICMmertatume (C] d- BARTMLGAKAGA (A) E-perncentrt F. CT PREMAY RATPEEB (A)


Publication: MPU-16A-RG Document: S92-M16A-100RG Printed in Canada.

## DISPLAY CODE SUMMARY.

C_FFF: MODE:TRIP
AAA MODE _ALARM
ddd
MODE _ SET POINT DELETED
1FSC SHORT-CIRCUIT.TRIP
3AbC TRIP ON AbC SEQUENCE
3bAC TRIP ON bAC SEQUENCE
4AAO OPEN-BTD ALARM.
4AA1 SHORTED-RTD ALARM
4Fdd
MODE-4 TRIP DISABLED BY emergency thermal reset
FbAd INVALID DATA

Specifications are subject to change without notice. Startco Engineering Ltd. is not liable for contingent or consequential damages, or for. expenses sústained as a result of incorrect application, incorrect adjustment, or a malfunction. For complete specifications, see MPU-16A manual.
MPU-1GA REFERENCE VALUES MOTOR
 MODE TRIP | ALARM 0


2


3


6
 A \%


F


## TE STARTOO

ansiniebring itto.

$t \cdot 1: \vee 1$

Q-Pulse Id TMSATA5E 10/12/2094e 353 of 519

## GENERAL INFORMATION

## KEYPAD



RAMP and MODE have up/down capability. Pressing once scrolls up. Pressing twice scrolls down. MODE selects 1 of 16 modes. RAMP adjusts set points.

## TRIP/ALARM LED

ON: TRIP-or-ALARM indication.
FLASH: Program changes allowed. ON has priority over FLASH.

## PROCESSOR-RUN LED

ON: Processor functional. OFF: Processor not functional.

PROGRAM-CHANGE LOCKOUT Connect MPU-16A terminals 20 and 21 to enable program changes.

PHASE-CT SELECTION
Select CT-PRIMARY RATING between 1.07 and $2.22 \times$ motor FLA. FLA range is 0.45 to $0.93 \times$ PHASE-CT-PRIMARY RATING.

## PROGRAMMING

For trip set points in Modes 0 to $5^{*}$ and first levels in Modes 6, 7, 8 and F:-
$\square \square \square$ Select MODE,


RAMP to adjust, and within 3 seconds


ENTER to store new value.
For alarm set points in Modes 0 to $5^{*}$ and second levels in Modes 8 and F :

## $\square \square \square$ Select MODE,



ENTER to access alarm set point, and within 3 seconds


RAMP to adjust, and within the next 3 seconds

## 뭄

ENTER to store new value.

* Top of set point range is ddd.
- Enter PHASE-CT-PRIMARY RATING in Mode F before entering FULL-LOAD CURRENT in Mode 6.


## 3

## MODE 0: ${ }^{2}$ t LIMIT (S @ 600\%) (THERMAL OVERLOAD)



Alarm set point e.g. 18 seconds @ 600\% FLA.


Thermal-overload trip,


Reset allowed when $\mathrm{I}^{2} \mathrm{t}<30 \%$.


Thermal-overload alarm, $\square \square$ lo reset


Trip-and-alarm set points deleted. Deleting trip automatically deletes alarm.


Alarm set point deleted.

* AUTORESET and ALARM LATCH can be enabled in Mode 8.



## MODE 1: OVERCURRENT (\%)

## 1300 Trip set point (running) e.g. $300 \%$ FLA.

1200 Alarm set point (running) e.g. $200 \%$ FLA.


Overcurrent trip, $\square \square \cdot \square$ to reset.

\section*{| 1AAA |
| :--- |
| $\square \square \square \square$ |}

Overcurrent alarm,
$\square \square \square$ to reset latched alarm.*

## 1ddd

Trip set point deleted.


Alarm set point deleted.


Short-circuit trip, $\square \square \square \square$ to reset.*

* ALARM LATCH and SHORT-CIRCUIT TRIP can be enabled in Mode 8.

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## 5

## MODE 2: UNDERCURRENT (\%)

2050 Trip set point (running) $\square \square \square \square$ e.g. $50 \%$ FLA.

2075 Alarm set point (running) e.g. $75 \%$ FLA.


Undercurrent trip, $\square \square \square \square$ to reset.


Undercurrent alarm, $\square \square \square$ to reset latched alarm.*
$\mathbf{2 d d} d$
$\square \square \square \square$ Trip set point deleted.


Alarm set point deleted.

* ALARM LATCH can be enabled in Mode 8.


## MODE 3: CURRENT UNBALANCE (\%)



3ddd Trip set point deleted. Phase reverse is not disabled.

## 3 d d d

Alarm set point deleted.


Trip on AbC sequence, $\square \square \square \square$ to reset.•

## 3 bAC $\square \square \square \square$

Trip on bAC sequence,
$\square \square \square \square$ to reset.

* ALARM LATCH can be enabled in Mode 8.
- PHASE REVERSE can be enabled and PHASE SEQUENCE can be selected in Q-PMBede Busi mbstive 10/12/20iqge 359 of 519


## MODE 4: TEMPERATURE ( ${ }^{\circ} \mathrm{C}$ )

## 4125 RTD trip set point e.g. $125^{\circ} \mathrm{C}$. ${ }^{*}$

## 4100 RTD alarm set point e.g. $100^{\circ} \mathrm{C}$. ${ }^{*}$

## 4 F F F Temperature trip, $\square \square \square \square$ to reset.

## 4AAA $\square \square \square \square$

Temperature alarm, $\square \square \square \square$ to reset latched
alarm.

## 4 A A 0 $\square \square \square \square$

Open-RTD alarm, $\square \square \square \square$
alarm. $\bullet \bullet$ to reset latched
Shorted-RTD alarm,

## 4 A A1 $\square \square \square \square$



* With PTC thermistors, enter the nominal response temperature for future reference.
- ALARM LATCH can be enabled in Mode 8.



## MODE 4: - continued

## 4 d d d $\square \square \square \square$

Trip set point deleted.


Alarm set point deleted.

## 4 F d d $\square \square \square \square$

Mode-4 trip is disabled by Emergency Thermal Reset in Mode E. ${ }^{-}$

- This display returns if a switch has not been actuated in the last 60 seconds.
- Mode-4 trip is automatically re-enabled if the RTD temperature is decreasing and is $20^{\circ}$ below the TRIP set point.
- On PTC units, Mode-4 trip is automatically re-enabled on a cooling transition through the response temperature.
- $\square \square \square$ to manually re-enable Mode 4.

12
MODE 6: FULL-LOAD CURRENT (A)
6150 Motor full-load current

FLA range is 0.45 to $0.93 \times$ PHASE-CTPRIMARY RATING.

Program Mode F before entering motor FLA .
6100 Firmware revision.

MODE 7: SERVICE FACTOR (\%)

## MODE 5: EARTH-FAULT (\%)

\section*{| 5040 |
| :--- |
| $\square \square \square \square$ |}

Trip set point e.g. $40 \%$ of earth-fault-CTprimary rating.*


Alarm set point e.g. $20 \%$ of earth-fault-CTprimary rating.

## 5 F F F $\square \square \square \square$

 Earth-fault trip, $\square \square \square \square$ to reset.

Earth-fault alarm, $\frac{\square \square \square \square}{\square \square \square \square}$ arm. | 5 d d d |
| :---: |
| $\square \square \square \square$ |
| $\square \square$ | Trip set point deleted.

 Alarm set point deleted.

- Program EARTH-FAULT-CT-PRIMARY RATING in Mode F.
* Trip delay can be selected in Mode 8.
- ALARM LATCH can be enabled in


Q-Pulse Id TASIL145
mond Road Fig Tree Pocket'SPS Main Switchböard OM Ma


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FAX: (306) 374-2245
INTERNET: www.startcoca
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## MODE 8: PROGRAM ( $2^{\text {nd }}$ LEVEL WITH COMMUNICATIONS INTERFACE)

DEFAULT VALUE ..... 8000

|  |  |  |
| :---: | :---: | :---: |
| VALUE $\because$ RELAY OPERATING MODE |  |  |
| DIGIT 1 | TRIP. | ALARM |
| 0 | FAIL SAFE | FAIL SAFE |
| 1 | FAIL SAFE | NON FAIL SAFE |
| 2 | NON FAIL SAFE | FAIL SAFE |
| 3 | NON FAIL SAFE | NON FAIL SAFE |


| $\begin{gathered} \text { VALUE DIGITS } \\ \hline 2 \& 3 \\ \hline \end{gathered}$ | MPU ADDRESS |
| :---: | :---: |
| $\begin{array}{ll} 0 & 0 \\ 0 & 1 \end{array}$ | COMMUNICATIONS INHIBITED. MPU i <br> MPU 63 |

## DEFAULT VALUES

| MODE | $\square \square \square \square$ | $\square \square \square \square$ |
| :---: | :---: | :---: |
| 0 | 010 | 009 |
| 1 | 300 | 200 |
| 2 | ddd | ddd |
| 3 | 025 | 015 |
| 4 | 125 | 100 |
| 5 | 040 | 020 |
| 6 | 100 | $*$ |
| 7 | 100 | $\cdot$ |
| 8 | 000 | 000 |
| F | 150 | 005 |

* Firmware revision.
- Hardware configuration.

To load default values: remove supply voltage, connect MPU-16A terminals 20 and 21 , and press RESET while supply voltage is applied. Mode F will be displayed.

The MPU-16A manual and PC communication software are available at www.startco.ca.

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## MODE F: CT-PRIMARY RATINGS (A)

F 300 Primary rating of phase CT's 믐) e.g. 300 A.*

F 005 Primary rating of earth-fault CT $\square \square \square$ e.g. 5 A.••

F 12 E Extended range e.g. 1200 A.

FbAd
GDGD
Invalid data. Output relays de-energized and default values loaded.
Reprogramming required.
$\square \square \square \square$

- Requires program enable.
* Entering the PHASE-CT-PRIMARY RATING in Mode F sets Mode 6 to the minimum value of the FLA range.
- All four digits display PRIMARY $\because$ RATING when set point is being adjusted.
- EFCT-1 and EFCT-2 primary ratings are 5 A . See manual for primary ratings above 5 A , for prospective earth-fault currents above 800 A , for surge currents above 1 kA , and for residual connections.
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## MODE d: EARTH LEAKAGE (A)



Earth leak:age e.g. 1.20 A.


Earth leakage prior to mostrecent trip e.g. 4.50 A.

## MODE E: PERCENT $I^{2} t$, TIME-TO-RESET, and EMERGENCY THERMAL RESET

E 088 Used thermal capacity e.g. $88 \%$.


Percent $I^{2}$ t prior to most-recent trip e.g. Mode-0 trip @ 100\%.


Time in minutes until Mode-0 reset allowed e.g. 20 minutes.

E000 Emergency Thermal Reset - requires program enable.

## CAUTION:

- Percent $I^{2}$ t is set to 0 .
- Mode 0 is reset.
- Mode-4 trip is temporarily disabled.

$$
17
$$

MODE b: CURRENT UNBALANCE (\%)


## MODE C: TEMPERATURE $\left({ }^{\circ} \mathrm{C}\right)$

## CO8 RTD temperature <br>  e.g. $80^{\circ} \mathrm{C}$.

CO50
RTD temperature prior to most-recent trip e.g. $50^{\circ} \mathrm{C}$.

RTD peak temperature during most-recent emergency thermal reset e.g. $165^{\circ} \mathrm{C}$.

C 255 PTC trip or RTD sensor out of range.*

* PTC thermistors do not provide actual temperature readings.


# MODE A: PEAK CURRENT (A) and \% CURRENT MODULATION 



Peak running current since last Mode-A reset e.g. 232 A.
$\square \square \square \square$ to reset.

## A 15 E Extended range e.g. 1500 A.

## A 005

\% current modulation e.g. 5\%. $\square \square \square$ to reset.

Percent current modulation displayed is the peak value for the present run cycle. It is automatically reset each time the motor stops.

## MODE 9: AMMETER (A)

## 9140 Motor current <br> 믐 e.g. 140 A.

912 E Extended range e.g. 1200 A .


Motor current prior to mostrecent trip e.g. 180 A .


Motor current in percent of full-load current e.g. $95 \%$ FLA.

Mode 9 is displayed when supply voltage is applied.


SP174 Jesmond Road Fig Tree-Pocket SPS MainSwitchboard OM Manu®il

| monaosoovoctwnto. | VALUE digit 2 |
| :---: | :---: |
|  | $\begin{aligned} & \text { PHASE SEQUENCE } \\ & 0=\mathrm{AbC} \\ & 1=\mathrm{bAC} \end{aligned}$ |
| 000-~-10000 | PHASE REVERSE $0=\mathrm{DISABLE} \quad 1=$ ENABLE |
| $\bigcirc 0$ | EARTH-FAULT DELAY $00=$ INSTANTANEOUS $01=0.25$ SECOND |
| $\rightarrow 0 \rightarrow 0 \rightarrow 0 \rightarrow 0 \rightarrow 0-0-0 \rightarrow 0$ | $\begin{aligned} & 10=0.5 \mathrm{SECOND} \\ & 11=1.0 \text { SECOND } \\ & \hline \end{aligned}$ |


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1. VERIFICATION OF OPTIONS AND SETTINGS. Tick or Fill In Rating and/or Setting of Option fitted.


RIGHT HAND MCCB
MCCB SERIAL No: 03433 No. of POLES: 3 SETTINGS:No. of POLES: 3 SETTINGS:- $\quad$ THERMAL 400 MAGNETIC STD MCCB CATAYOGUETYPE:- $\qquad$ -

MANUAL TRANSFER SWITCH OPTIONS

1. Alarm Switches
2. Auxiliary Contacts
3. Common Load Side Busbars
4. Variable Depth Handles (YFHA Type)
5. Breaker Mounted Handles (XFG Type)
6. Other

MOTOR OPERATOR SERIAL NO: 03122 THERMAL 400 MAGNETIC $S 70$ XS $400 \pi 40030$ TRANSFER SWITCH
OPTIONS

1. Alarm Switches
2. Additional Auxiliary Contacts (1 Standard)
3. Common hoad Side Busbars (4) Special Control Voltage 5. Status Indicator Lights (supplied loose) 6. Other

Tick Intern Check od
$\qquad$
Qty $\qquad$ 1 MOAB


Tick Item Checked


## ENCLOSED TRANSFER SWITCH

Equipment mounted in Enclosure Type: $\qquad$
Confirm any Special Reqiurements: $\qquad$
$\qquad$

## 2. FUNCTIONAL TESTS

## MANUAL TRANSFER SWITCH

Check manual operation of each Circuit Breaker.
Check operation of each accessory fitted to Circuit Breaker.
Check Mechanical Interlock by attempting to close Circuit Breaker while opposite is closed.


## FUNCTIONAL TESTS cont;

## BASIC TRANSFER.SWITCH

Check Electric operation of each Circuit Breaker.
Check operation of each accessory fitted to Circuit Breaker.
Check Electrical Interlocking by attempting to close Circuit Breaker while opposite is closed
Check Mechanical Interlock by attempting to close Circuit Breaker while opposite is closed.


## 3. DIELECTRIC TEST

Test Voltage - 2000V AC between'all Terminals as follows for lisecond:
Terminal to Terminal.
Terminal to Earth.
Left MCCB to Right MCCB.


DATE:OSIOSIOY

Form No. 10001 Issue $10 / 96$
,

Refer catalogue CA 6, 2212

## CA 61000 volt contactor system

The latest in switching technology up to 1000 volts
The CA 6 contactors offer the latest in switching technology up to 1000 volts, from Sprecher + Schuh.
The development of the CA 6 range now covers the CA $6-85$ to the CA 6-420, the complete range covering 1000 volt, AC 3 ratings up to 225 kW with 400/415 volt ratings up to 250 kW . Special design features of these contactors include a unique electronically controlled mechanism (ECM) which is standard on all sizes except the CA 6-85-11.
A choice of motor protection
Thermal overload relays CT 6 as well as the CEF 1 and CET 4 electronic motor protection relays are also rated at 1000 volts. They are ideally suited for combining with the CA 6 and CA 5 contactors providing a choice of quality motor protection solutions. For contactors CA 6-210 and above the standard protection can be CEF or CET 4 electronic motor protection.


Compact 90 kW 1000 volt starter with CEF 1 electronic motor protection.


The CET 4 electronic motor protection relay can be combined with S+S 1000 volt contactors.


CA 6 with CT 6 thermal overload Here, the CT 6 displays innovative design concepts, with the direct mounting of the S+S RT 3 thermistor protection relay.

## High current contactors CA 5

The CA 5-370 ... CA 5-860 high current contactors combine high switching currents up to 1000 volts together with low coil power consumption due to a specially designed coil and magnet system. These rugged and reliable contactors extend the 1000 volt switching capacities of Sprecher + Schuh contactors up to 550 kW as well as being suitable for AC $3400 / 415$ volt applications up to 500 kW .


1000 V contactor CA 5-370


1000 V contactor CA 5-550


1000 V contactor CA 5-860

## Contactors with electronically controlled mechanism (ECM) tested to IEC 947

CA 6 - A complete range The CA 6 range of 1000 volt contactors is now available through to 420 amp . The range now incorporates eight sizes from 45 to 250 kW (C) $400 / 415$ volts and 225 kW at 1000 volts.
Electronically controlied mechanism (ECN)
The electronically controlled mechanism has, with the release of the larger CA 6 contactors, been further improved. As well as providing the unique advantages of electronic coil control, the ECM version now includes a built in PLC interface. These are identified with the suffix El on the Cat. No.
What is "ECM"
ECM stands for "Electronically Controlled Mechanism". With the version EI, an electronic circuit regulates the voltage to the contactor coil. This is achieved using an ASIC (application specific integrated circuit) which precisely controls the pick-up and drop-out levels of the contactor This provides decisive advantages for the user.
O Very low pick-up and hold coil consumption (constant VA)
O No contact chatter because of defined pick-up and drop-out voltages
O High contact reliability due to minimised tendency to contact bounce

○ Built-in suppression circuits
O Built-in PLC interface
O Wide voltage tolerance of coils suitable for $50 / 60 \mathrm{~Hz}$ (OC versions also available)
O EMC compatibility:
(Note EMC is not to be confused with ECM. EMC means that the contactors also conform to Electromagnetic compatibility standards for noise

CA 6

| Cat. No. | $400 / 415 \mathrm{~V} \mathrm{AC} 3 \mathrm{~kW}$ | 1000 V AC 3 kW |
| :--- | :---: | :---: |
| CA $6-85$ | 55 | 45 |
| CA $6-105-(E I)$ | 75 | 55 |
| CA $6-140-E l$ | 90 | 75 |
| CA $6-170-E l$ | 100 | 90 |
| CA $6-210-E l$ | 132 | 111 |
| CA $6-250-E l$ | 150 | 133 |
| CA $6-300-E l$ | 185 | 163 |
| CA $6-420-E l$ | 250 | 225 |

Relation of pick-up to hold-in consumption


Extremely low pick-up and hold-in coil consumption compared with conventional contactors.

## Robust and versatile

O Rated up to 1000 volts
O Type 2 co-ordination with fuses or circuit breakers
O High thermal capacity
O High switching capacity
O Mechanical interlock does not increase overall width

O Up to 8 auxiliary contacts
O Flexible busbars and mounting plates available for quick assembly of starter combinations
O Choice of electronic motor protection or CT 6 thermal overloads
Plug-in voltage suppressors
Safety first
O Arc chamber cannot be removed with the contactor energised
O Contactor cannot be energised unless arc chambers are locked into place


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

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


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

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Fuse protection DOL starting ${ }^{1}$ ) $50 / 65 \mathrm{kA} @ 400 / 415 \mathrm{~V}$ to AS 3947.4 .1

## Fuse

| Motor size kW | Approx. amps <br> @ 400/415 V | NHP HRC fuse to BS88 | Sprecher + Schuh contactor | Sprecher + Schuh overload relay ${ }^{2}{ }^{3}$ ) | Setting range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | NTIA-4 | CA 7-9 | CEP 7 | 1.0-2.9 |
| 0.75 | 1.8 | NTIA-6 | CA 7-9 | CEP 7 | 1.0-2.9 |
| 1.5 | 3.4 | NTIA-10 | CA 7-9 | CEP 7 | 1.6-5 |
| 2.2 | 4.8 | NTIA-16 | CA 7-9 | CEP 7 | 3.7-12 |
| 4.0 | 8.2 | NTIA-20 | CA 7-9 | CEP 7 | 3.7-12 |
| 5.5 | 11 | NTIA-25 | CA 7-12 | CEP 7 | 3.7-12 |
| 7.5 | 14 | NTIA-32 | CA 7-16 | CEP 7 | 12-32 |
| 11 | 21 | NTIS-50 | CA 7-30 | CEP 7 | 12-32 |
| 15 | 28 | NTIS-63 | CA 7-30 | CEP 7 | 12-37 |
| 18.5 | 34 | NTCP-80 | CA 7-37 | CEP 7 | 12-37 |
| 22 | 40 | NTCP-80 | CA 7-43 | CEP 7 | 14-45 |
| 30 | 55 | NTCP-100 | CA 7-60 | CEP 7 | 26-85 |
| 37 | 66 | NTF-125 | CA 7-72 | CEP 7 | 26-85 |
| 45 | 80 | NTF-160 | CA 7-85 | CEP 7 | 26-85 |
| 55 | 100 | NTF-200 | CA 6-105-EI | CT 6-110 | 85-110 |
| 75 | 130 | NTKF-250 | CA 6-140-EI | CT 6-150 | 105-150 |
| 90 | 155 | NTKF-250 | CA 6-170-EI | CT 6-200 | 140-200 |
| 110 | 200 | NTKF-315 | CA 6-210-EI | CEF 1-41/42 ${ }^{\text {a }}$ ) | 160-400 |
| 132 | 225 | NTMF-355 | CA 6-210-El | CEF 1-41/42 ${ }^{\text {® }}$ ) | 160-400 |
| 150 | 250 | NTMF-355 | CA 6-250-EI | CEF 1-41/42 ${ }^{\text {a }}$ ) | 160-400 |
| 185 | 320 | NTTM-450 | CA 6-300-EI | CEF 1-41/42 ${ }^{4}$ ) | 160-400 |
| 250 | 425 | NTTM-560 | CA 6-420-EI | CEF 1-52 ${ }^{4}$ ) | 160-630 |
| 320 | 538 | NTLM-710 | CA 5-550 | CEF 1-52 ${ }^{\text {) }}$ | 160-630 |
| 380 | 650 | NTLM-800 | CA 5-700 | CEF 1-11/12P ${ }^{4}$ ) | 300-1200 |

Notes: ') Fuses with equal or lower let through energy may also be used.
${ }^{2}$ ) Thermal overloads may be used instead of electronic CEP 7.
${ }^{\text { }}$ ) Above 37 kW overloads may also be electronic or thermal.
-) CET 4 may be used instead of CEF 1.
$240 / 415 \mathrm{~V}$ rating suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS 60038:2000
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TemBreak circuit breakers DOL starting
$50 \mathrm{kA} @ 400 / 415 \mathrm{~V}$ to AS 3947.4.1

TemBreak MCCBs


| Motor size kW | Approx. amps | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh overload relay | Setting range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | XM30PB/1.4 | CA 7-9 | CT 7-24-1.6 | 1-1.6 |
| 0.55 | 1.5 | XM30PB/2 | CA 7-9 | CT 7-24-1.6 | 1-1.6 |
| 0.75 | 1.8 | XM30PB/2.6 | CA 7-9 | CT 7-24-2.4 | 1.6-2.4 |
| 1.1 | 2.6 | XM30PB/4.0 | CA 7-16 | CT 7-24-4 | 2.4-4 |
| 1.5 | 3.4 | XM30PB/5 | CA 7-16 | CT 7-24-4 | 2.4-4 |
| 2.2 | 4.8 | XM30PB/8 | CA 7-16 | CT 7-24-6 | 4-6 |
| 3 | 6.5 | XM30PB/10 | CA 7-30 | CT 7-24-10 | 6-10 |
| 4 | 8.2 | XM30PB/12 | CA 7-30 | CT 7-24-10 | 6-10 |
| 5.5 | 11 | XH125NJ/20 | CA 7-30 | CT 7-24-16 | 10-16 |
| 7.5 | 14 | XH125NJ/20 | CA 7-30 | CT 7-24-16 | 10-16 |
| 11 | 21 | XH125NJ/32 | CA $7-30$ | CT 7-24-24 | 16-24 |
| 15 | 28 | XH125NJ/50 | CA 7-43 | CT 7-45-30 | 18-30 |
| 18.5 | 34 | XH125NJ/50 | CA $7-43$ | CT 7-45-45 | 30-45 |
| 22 | 40 | XH125NJ/63 | CA 7-43 | CT 7-45-45 | 30-45 |
| 30 | 55 | XH125NJ/100 | CA 6-85 | CT 7-75 ${ }^{2}$ ) | 45-60 |
| 37 | 66 | XH125NJ/100 | CA 6-85 | CT 7-75 ${ }^{2}$ ) | 60-75 |
| 45 | 80 | XH125NJ/125 | CA 6-105-E1 | CT 6-90 | 70-90 |
| 55 | 100 | XH125NJ/125 ) | CA 6-105-El | CT 6-110 | 85-110 |
| 75 | 130 | XH250NJ/250 | CA 6-140-E1 | CT 6-150 | 105-150 |
| 90 | 155 | XH250NJ/250 | C A6-170-El | CT 6-200 | 140-200 |
| 110 | 200 | XH250NJ/250 ${ }^{\text {') }}$ | CA 6-210-El | CEF 1-41/42 | 160-400 |
| 132 | 225 | XS400SE/400 | CA 6-210-EI | CEF 1-41/42 | 160-400 |
| 150 | 250 | XS400SE/400 | CA 6-250-EI | CEF 1-41/42 | 160-400 |
| 160 | 270 | XS400SE/400 | CA 6-300-EI | CEF 1-41/42 | 160-400 |
| 200 | 361 | XS400SE/400 | CA 6-420-EI | CEF 1-41/42 | 160-400 |
| 200 | 361 | XS400SE/400 | CA 5-450 | CEF 1-22 ${ }^{2}$ ) | 160-400 |
| 250 | 425 | XS630SE/630 | CA 5-700 | CEF 1-52 ${ }^{2}$ ) | 160-630 |
| 320 | 538 | XS630SE/630 | CA 5-700 | CEF 1-52 ${ }^{2}$ ) | 160-630 |

Notes: Overloads may be thermal or electronic.
Combinations based on the overload tripping before the circuit breaker at overload currents up to the motor locked rotor current.
') Use 'magnetic only' breaker or next higher circuit breaker / contactor combination.
${ }^{2}$ ) Use with separate mounting bracket.
Data for 65 kA co-ordination available refer Cat. C-CO.
240/415 V rating suitable for use on 230/400 V in accordance with AS 60038:2000


Refer catalogue CAG

## CA 6 Contactors



| Type | $\mathbf{a}$ | $\mathbf{b}$ | $\mathbf{b 1}$ | $\mathbf{c}$ | $\mathbf{c 1}$ | od | d1 | d2 | øe | e1 | e2 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| CA 6-85/CA 6-105 | 120 | 182 | 170 | 156 | 110 | 5.2 | 145 | 100 | M6 | 16 | 39 |
| CA 6-105EI/CA 6-140/CA 6-170EI | 120 | 182 | 170 | 156 | 110 | 5.2 | 145 | 100 | M8 | 20 | 39 |
| CA 6-210-EI...CA 6-420-EI | 155 | 222 | 205 | 180 | 110 | 6.5 | 180 | 130 | M10 | 25 | 48 |

## CT 6 thermal overload



| Type | a | b | c | c1 | c2 | c3 | c4 | d | d1 | d2 | oe | e1 | e2 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| CT 6-90 ...CT 6-110 | 120 | 148 | 193 | 161 | 151.5 | 41 | 114 | - | 85 | 100 | M6 | 39 | 8.5 |
| CT 6-150...CT 6-200 | 120 | 170 | 193 | 161 | 151.5 | 45 | 114 | - | 85 | 100 | M8 | 39 | 8.5 |
| CTA 6-90... CTA 6-100 | 120 | 133 | 193 | 161 | 151.5 | 41 | - | - | 85 | 100 | M6 | 39 | M6 |
| CTA 6-150...CTA 6-200 | 120 | 176 | 193 | 161 | 151.5 | 45 | - | - | 85 | 100 | M8 | 39 | M8 | \#nats



Electronic motor protection for CA 6 contactor
In addition to standard current transformer operated thermal overloads for CA 6 contactors upto 200 amps, the CEF 1 electronic motor protection relay can also be utilised for the whole CA 6 range. For the contactors CA 6-210(E1)..CA 6-420El the standard overload is the CEF 1-42. The CEF relay provides adjustable trip curves, phase failure protection and thermistor protection as standard.


O Complete contactor range up to 425 amps

- 1000 volt rated
- Available with electronic motor protection CEF 1

O Option for electronic coil control (ECM)

- Built in safety features
- Tested to IEC 947


CA $6-85$, CA 6-105 + CT 6-90, CT 6-110 )


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


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

Notes: ') Shown mounted on optional DOL mounting plate.
${ }^{2}$ ) With one or two auxiliary contact blocks CA 6-P.
${ }^{1}$ ) For third and fourth auxiliary contact blocks add 13.5 mm each.
-) $R=$ Reset button: 3.5 mm travel $=$ Reset, 6 mm travel $=$ tes 1 .
${ }^{3}$ ) Earthing terminal.
6) For 1...4 CA 6-P auxiliary contact blocks.

## Mounting positions CA 6




## The highest switching capacity in the smallest space



## Compact without compromise

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

## With CA 7 you have flexibility with

 auxiliary contactsCommon auxiliaries from 9 to 85 amps
Three fitting positions
O Front mounting
O Side mounting left
O Side mounting right
Alternatively you can choose to combine left, right and front mounting auxiliary contacts to fulfil your requirements.
Instead of the top mounted auxiliary contacts, on or off delay timing modules or mechanical latches can be fitted.



Motor switching rating AC 3 @ 400/415 V

| CA 7-9 | 4 kW | 45 mm |  | 9 A |
| :---: | :---: | :---: | :---: | :---: |
| CA 7-12 | 5.5 kW |  | ) | 12 A |
| CA 7-16 | 7.5 kW |  |  | 16 A |
| CA 7-23 | 11 kW |  | Hexiriciss | 23 A |
| CA 7-30 | 15 kW | 45 mm | - | 30 A |
| CA 7-37 | 18.5 kW |  | Cessera | 37 A |
| CA 7-43 | 22 kW | 54 mm | Hematienser | 43 A |
| CA 7-60 | 30 kW | 72 mm |  | 60 A |
| CA 7-72 | 37 kW |  |  | 72 A |
| CA 7-85 | 45 kW |  | - | 85 A |

## With CA 7 you have more clip on accessories

Common accessories from 9 to 85 amps
O On and off delay pneumatic timers
O Coil mounted electronic timers on delay, off delay, star delta

- Coil mounted 24 V DC interface

O Coil mounted RC and varistor suppressor modules

- Mechanical latch

O Mechanical interlock
O Mechanical interlock with integrated N/C interlock contacts

O Moulded wire link sets for DOL, reversing and star delta starters
O Large choice of front and side mounting auxiliary contacts

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Refer catalogue SACS

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

Coil terminals are always in the correct position
The coil terminations on the CA 7 contactors can be supplied optionally at the top or the bottom of the contactor. It is also a simple task to change this on site should the requirements change.
When CA 7 contactors are used in combination with KTA 7 circuit motor circuit breakers the bottom coil terminations are used. For use with standard CT 7 thermal or CEP 7 electronic overloads the top coil termination should be selected.

Mechanical interlocks save space
Only 9mm wide, the CM 7 mechanical interlock snaps into place between any of the CA 7 contactors. It is allowed also to interlock different sizes of the CA 7 range with the same interlock.
The basic mechanical interlock is supplemented by a variation with built in N/C auxiliary contacts for electrical interlocking. This version is also only 9 mm wide and further minimises space requirements.


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




CA 7 contactors provide improved wiring terminals
The main terminals of all CA 7 contactors are designed to accept at least two cables. At the same time they comply with safety standards regarding touch protection.
The larger contactors CA 7-30 and upwards employ a special cage terminal which allows the connection of two cables in separate chambers.
The ease of wiring with CA 7 contactors saves both time and money.



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


Standard thermal overloads type CT 7

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


| Motor size kW | Approx. amps @ $400 / 415 \mathrm{~V}$ | Sprecher + Schuh circuit breaker | Setting range amps | Magnetic amps | Sprecher + Schuh contactor | AC-3 amps |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.18 | 0.60 | KT 7-25S | 0.40-0.63 | 8.2 | CA 7-9 | 9 |
| 0.25 | 0.80 | KT 7-25S | 0.63-1.00 | 13 | CA 7-9 | 9 |
| 0.37 | 1.10 | KT 7-25S | 1.00-1.60 | 21 | CA 7-9 | 9 |
| 0.55 | 1.50 | KT 7-25S | 1.00-1.60 | 21 | CA 7-9 | 9 |
| 0.75 | 1.80 | KT 7-25S | 1.60-2.50 | 33 | CA 7-9 | 9 |
| 1.10 | 2.60 | KT 7-25S | 2.50-4.00 | 52 | CA $7-9$ | 9 |
| 1.15 | 3.40 | KT 7-25S | 2.50-4.00 | 52 | CA 7-9 | 9 |
| 2.20 | 4.80 | KT 7-25S | 4.00-6.30 | 80 | CA $7-9$ | 9 |
| 3.00 | 6.50 | KT 7-25S | $6.30-10.0$ | 130 | CA 7-9 | 9 |
| 4.00 | 8.20 | KT 7-25S | 6.30-10.0 | 130 | CA 7-9 | 9 |
| 5.50 | 11.00 | KT 7-25S | $10.0-16.0$ | 208 | CA 7-12 | 12 |
| 7.50 | 14.00 | KT 7-25S | 10.0-16.0 | 208 | CA 7-16 | 16 |
| 9.00 | 17.00 | KT 7-25H | 14.5-20.0 | 260 | CA 7-23 | 23 |
| 11.00 | 21.00 | KT 7-25H | 18.0-25.0 | 325 | CA 7-23 | 23 |
| 15.00 | 28.00 | KT $7-45 \mathrm{H}$ | 23.0-32.0 | 416 | CA 7-30 | 30 |
| 18.50 | $\therefore 4.00$ | KT 7-45H | 32.0-45.0 | 585 | CA 7-37 | 37 |
| 22.00 | 40.00 | KT 7-45H | 32.0-45.0 | 585 | CA 7-43 | 43 |
| 30.00 | 55.00 | KT 3-100 | 40.0-63.0 | 882 | CA 7-60 | 60 |
| 37.00 | 66.00 | KT 3-100 | 63.0-90.0 | 1260 | CA 7-72 | 72 |
| 45.00 | 80.00 | KT 3-100 | 63.0-90.0 | 1260 | CA 7-85 | 85 |

Definition Type '2' co-ordination according to IEC 947-4-1:

- The contactor or the starter must not endanger persons or systems in the event of a short circuit
- The contactor or the starter must be suitable for further use
- No damage to the overload relay or other parts may occur with the exception of welding of the contactor or starter contacts provided that these can be easily separated without significant deformation (such as with a screwdriver)
- In the event of a short circuit, fast opening current limiting circuit breakers KT 7 make it possible to build economical, fully short circuit co-ordinated starter combinations in accordance with IEC 947-4-1, Type '2' co-ordination
- Type '2' co-ordination without oversizing of contactors means: Type '1' = Type '2'

Note: ') What is meant by Automatic Type ' 2 ' co-ordination?
The high speed operation of the new KT 7 motor protection circuit breakers means that contactors need not be oversized to achieve type ' 2 ' co-ordination. Simply select the normal AC 3 rated contactor and the corresponding KT 7 circuit breaker and type ' 2 ' co-ordination is assured.
$240 / 415 \mathrm{~V}$ rating suitable for use on 230/400 V in accordance with AS 60038: 2000




Refer Catalogue C-CO
Fuse protection DOL starting ${ }^{1}$ )
Fuse
50/65 kA @ 400/415 V to AS 3947.4.1

| Motor size kW | Approx. amps @ $400 / 415 \mathrm{~V}$ | NHP HRC fuse to BS88 | Sprecher + Schuh contactor | Sprecher + Schuh overload relay $\left.{ }^{2}\right)^{\text { }}$ ) | 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 ${ }^{\text {a }}$ ) | 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 ${ }^{\text {4 }}$ ) | 160-400 |
| 185 | 320 | NTTM-450 | CA 6-300-EI | CEF 1-41/42 ${ }^{\text {( }}$ ) | 160-400 |
| 250 | 425 | NTTM-560 | CA 6-420-EI | CEF 1-52 ${ }^{\text {) }}$ | 160-630 |
| 320 | 538 | NTLM-710 | CA 5-550 | CEF 1-52 ) | 160-630 |
| 380 | 650 | NTLM-800 | CA 5-700 | CEF 1-11/12P ${ }^{\text {¢ }}$ | 300-1200 |

Notes: ') Fuses with equal or lower let through energy may also be used.
${ }^{2}$ ) Thermal overloads may be used instead of electronic CEP 7.
${ }^{\text {) }}$ ) Above 37 kW overloads may also be electronic or thermal.
${ }^{4}$ CET 4 may be used instead of CEF 1.
$240 / 415 \mathrm{~V}$ rating suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS 60038:2000

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

| Motor size kW | Approx. FLC@ $400 / 415 \mathrm{~V}$ (A) | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh thermal O/L type | Setting range (A) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | XM30PB/1.4 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 0.55 | 1.5 | XM30PB/2.0 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 0.75 | 1.8 | XM30PB/2.6 | CA $7-9$ | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 1.1 | 2.6 | XM30PB/4 | CA 7-16 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 1.5 | 3.4 | XM30PB/5 | CA 7-16 | CEP 7-M32-5-10 | 1.6-5 |
| 2.2 | 4.8 | XM30PB/8 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 3 | 6.5 | XM30PB/8 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 4 | 8.2 | XM30PB/10 | CA 7.30 | CEP 7-M32-12-10 | 3.7-12 |
| 5.5 | 11 | TL100NJ/20 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 7.5 | 14 | TL100NJ/20 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 9 | 17 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 10 | 19 | TL100NJ/32 | CA 7 -30 | CEP 7-M32-32-10 | 12-32 |
| 11 | 21 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 15 | 28 | TL100NJ/50 | CA 7-43 | CEP 7-M32-32-10 | 12-32 |
| 18.5 | 34 | TL100NJ/50 | CA 7-43 | CEP 7-M37-37-10 | 12-37 |
| 22 | 40 | TL100NJ/63 | CA 7-43 | CEP 7-M45-45-10 | 14-45 |
| 30 | 55 | TL100NJ/100 | CA 7-72 | CEP 7-M85-85-10 | 26-85 |
| 37 | 66 | TL100NJ/100 | CA 7-72 | CEP 7-M85-85-10 | 26-85 |
| 45 | 80 | TL250NJ/160 | CA 6-105 | CEP 7-M85-85-10 | 26-85 |
| 55 | 100 | TL250NJ/160 | CA 6-105 | CEF 1-11/12 | 0.5-180 |
| 75 | 135 | TL250NJ/250 | CA 6-210-EI | CEF 1-11/12 | 0.5-180 |
| 90 | 160 | TL250NJ/250 | CA 6-210-EI | CEF 1-11/12 | 0.5-180 |
| 110 | 200 | TL250NJ/250 | CA 6-210-EI | CEF 1-41/42/52 | 160-630 |
| 132 | 230 | TL400NE/400 | CA 6-210-EI | CEF 1-41/42/52 | 160-630 |
| 160 | 270 | TL400NE/400 | CA 6-300-EI | CEF 1-41/42/52 | 160-630 |
| 200 | 361 | TL400NE/400 | CA 6-420-EI | CEF 1-41/42/52 | 160-630 |

Din-T circuit breakers with rotary is olator. DOL starting.
$50 \mathrm{kA} @ 400 / 415 \mathrm{~V}$ to AS 3947.4.1

| Motor <br> size <br> kW | Approx. amps @ $400 / 415 \mathrm{~V}$ | Sprecher + Schuh isolator | Terasaki circuit breaker | Sprecher + Schuh current limiter | Sprecher ${ }^{+}$ Schuh contactor | Schuh thermal O/L relay | Thermal overload range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | LA 7-80 | Din-T $10 / 4$ | - | CA 7-9 | CT 7-24 | 0.6-1.6 |
| 0.55 | 1.5 | LA 7-80 | Din-T 10/4 | - | CA 7-9 | CT 7-24 | 1-1.6 |
| 0.75 | 1.8 | LA 7-80 | Din-T 10/4 | - | CA 7-9 | CT 7-24 | 1.6-2.4 |
| 1.1 | 2.6 | LA 7-80 | Din-T 10/6 | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 1.5 | 3.4 | LA 7-80 | Din-T 10/6 | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 2.2 | 4.8 | LA 7-80 | Din-T 10/10 | KTL 3-65 | CA 7-23 | CT 7-24 | 4-6 |
| 3 | 6.5 | LA 7-80 | Din-T 10/16 | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 4 | 8.2 | LA 7-80 | Din-T 10/16 | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 5.5 | 11 | LA 7-80 | Din-T 10/20 | KTL 3-65 | CA 7-23 | CT 7-24 | 10-16 |
| 7.5 | 14 | LA 7-80 | Din-T 10/32 | KTL 3-65 | CA 7-30 | CT 7-45 | 10-16 |
| 11 | 21 | LA 7-80 | Din-T $10 / 40$ | KTL 3-65 | CA 7-30 | CT 7-24 | 16-24 |
| 15 | 28 | LA 7-100 | Din-T 10/63 | KTL 3-65 | CA 7-37 | CT 7.45 | 18-30 |
| 18.5 | 34 | LA 7-100 | Din-T 10/63 | KTL 3-65 | CA 7-37 | CT 7-45 | 30-45 |

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

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

| Motor size kW | Approx.FLC@ 400/415 V (A) | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh thermal O/L type | Setting range (A) |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | XM30PB/1.4 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 0.55 | 1.5 | XM30PB/2.0 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 0.75 | 1.8 | XM30PB/2.6 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 1.1 | 2.6 | XM30PB/4 | CA 7-16 | CEP 7-M32-2.9-10 | 1.0-2.9 |
| 1.5 | 3.4 | XM30PB/5 | CA 7-16 | CEP 7-M32-5-10 | 1.6-5 |
| 2.2 | 4.8 | XM30PB/8 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 3 | 6.5 | XM30PB/8 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 4 | 8.2 | XM30PB/10 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12 |
| 5.5 | 11 | TL100NJ/20 | CA $7-30$ | CEP 7-M32-12-10 | 3.7-12 |
| 7.5 | 14 | TL100NJ/20 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 9 | 17 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 10 | 19 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 11 | 21 | TL100NJ/32 | CA 7-30 | CEP 7-M32-32-10 | 12-32 |
| 15 | 28 | TL100NJ/50 | CA 7-43 | CEP 7-M32-32-10 | 12-32 |
| 18.5 | 34 | TL100NJ/50 | CA 7-43 | CEP 7-M37-37-10 | 12-37 |
| 22 | 40 | TL100NJ/63 | CA 7-43 | CEP 7-M45-45-10 | 14-45 |
| 30 | 55 | TL100NJ/100 | CA 7-72 | CEP 7-M85-85-10 | 26-85 |
| 37 | 66 | TL100NJ/100 | CA 7-72 | CEP 7-M85-85-10 | 26-85 |
| 45 | 80 | TL250NJ/160 | CA 6-105 | CEP 7-M85-85-10 | 26-85 |
| 55 | 100 | TL250NJ/160 | CA 6-105 | CEF 1-11/12 | 0.5-180 |
| 75 | 135 | TL250NJ/250 | CA 6-210-EI | CEF 1-11/12 | 0.5-180 |
| 90 | 160 | TL250NJ/250 | CA 6-210-EI | CEF 1-11/12 | 0.5-180 |
| 110 | 200 | TL250NJ/250 | CA 6-210-EI | CEF 1-41/42/52 | 160-630 |
| 132 | 230 | TL400NE/400 | CA 6-210-EI | CEF 1-41/42/52 | 160-630 |
| 160 | 270 | TL400NE/400 | CA 6-300-EI | CEF 1-41/42/52 | 160-630 |
| 200 | 361 | TL400NE/400 | CA 6-420-EI | CEF 1-41/42/52 | 160-630 |

Din-T circuit breakers with rotary isolator. DOL starting.
Din-T MCBs
50 kA @ 400/415 V to AS 3947.4.1

| Motor size <br> kW | Approx. amps @ 400/415 V | Sprecher + Schuh isolator | Terasaki circuit breaker | Sprecher + Schuh current limiter | Sprecher + Schuh contactor | Sprecher + Schuh thermal O/L relay | Thermal overload range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | LA 7-80 | Din-T 10/4 | - | CA 7-9 | CT 7-24 | 0.6-1.6 |
| 0.55 | 1.5 | LA 7-80 | Din-T 10 / 4 | - | CA 7-9 | CT 7-24 | 1-1.6 |
| 0.75 | 1.8 | LA 7-80 | Din-T 10/4 | - | CA 7-9 | CT 7-24 | 1.6-2.4 |
| 1.1 | 2.6 | LA 7-80 | Din-T $10 / 6$ | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 1.5 | 3.4 | LA 7-80 | Din-T $10 / 6$ | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 2.2 | 4.8 | LA 7-80 | Din-T 10/10 | KTL 3-65 | CA 7-23 | CT 7-24 | 4-6 |
| 3 | 6.5 | LA 7-80 | Din-T 10 / 16 | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 4 | 8.2 | LA 7-80 | Din-T 10/16 | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 5.5 | 11 | LA 7-80 | Din-T $10 / 20$ | KTL 3-65 | CA 7-23 | CT 7-24 | 10-16 |
| 7.5 | 14 | LA 7-80 | Din-T 10 / 32 | KTL 3-65 | CA 7-30 | CT 7-45 | 10-16 |
| 11 | 21 | LA 7-80 | Din-T 10 / 40 | KTL 3-65 | CA 7-30 | CT 7-24 | 16-24 |
| 15 | 28 | LA 7-100 | Din-T 10 / 63 | KTL 3-65 | CA 7-37 | CT 7-45 | 18-30 |
| 18.5 | 34 | LA 7-100 | Din-T 10 / 63 | KTL 3-65 | CA 7-37 | CT 7-45 | 30-45 |

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

|  | General data | CA 7-9...CA 7-85 |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Rated insulation voltage $U_{i}$ IEC |  |  |  |  | 690 V |  |  |  |  |  |
|  | UL, CSA |  |  |  |  | 600 V |  |  |  |  |  |
|  | Rated impulse voltage withstand $\mathrm{U}_{\text {imp }}$ |  |  |  |  | 8 kV |  |  |  |  |  |
|  | Test voltage |  |  |  |  |  |  |  |  |  |  |
|  | 1 minute (to IEC 947-4) |  |  |  |  | 2500 V |  |  |  |  |  |
|  | Rated voltage $U_{s}$ |  |  |  |  |  |  |  |  |  |  |
|  | AC |  |  |  |  | 110. 240, 400/415, 5 |  |  | 500, 690 V |  |  |
|  | DC |  |  |  |  | 24. 48 | 110, | 220, 440 V |  |  |  |
|  | Rated frequency of coil |  |  |  |  | $50 / 60 \mathrm{~Hz}$ |  |  |  |  |  |
|  | Ambient temperature |  |  |  |  |  |  |  |  |  |  |
|  | Storage |  |  |  |  | $-55 \ldots+80^{\circ} \mathrm{C}\left(-67 \ldots 176{ }^{\circ} \mathrm{F}\right)$ |  |  |  |  |  |
|  | Operation at nominal current |  |  |  |  | $-25 \ldots+60^{\circ} \mathrm{C}\left(-13 . .140^{\circ} \mathrm{F}\right)$ |  |  |  |  |  |
|  | Maximum with $15 \%$ AC 1 current reduction $>60^{\circ} \mathrm{C}$ |  |  |  |  | $-25 \ldots+70^{\circ} \mathrm{C}\left(-13 . .158^{\circ} \mathrm{F}\right)$ |  |  |  |  |  |
|  | Climatic withstand |  |  |  |  | Cyclicly changing humid atmosphere to IEC 68-2-30 and DIN 50 016, 56 |  |  |  |  |  |
|  | Maximum altitude |  |  |  |  | 2000 m NN , to IEC 947-4 |  |  |  |  |  |
|  | Protection class |  |  |  |  |  |  |  |  |  |  |
|  | IP 2LX (IEC 529 and DIN 40050) |  |  |  |  | In connected condition |  |  |  |  |  |
|  | Protection against contact |  |  |  |  | Touch protection to VDE 0106, Part 100 |  |  |  |  |  |
|  | Standards |  |  |  |  | IEC 947-1/4; VDE 0660, Part 100/104; UL 508; CSA 22.2. Part 14 |  |  |  |  |  |
|  | Compliance |  |  |  |  | CE; UL; CSA |  |  |  |  |  |
|  | Short time withstand |  |  |  |  |  |  |  |  |  |  |
|  | $1 \mathrm{~s}(\mathrm{~A})$ | 210 | 210 | 290 | 380 | 480 | 525 | 650 | 1100 | 1150 | 1250 |
|  | $4 \mathrm{~s}(\mathrm{~A})$ | 140 | 150 | 220 | 280 | 360 | 390 | 480 | 820 | 860 | 910 |
|  | 10 s (A) | 100 | 120 | 175 | 220 | 290 | 310 | 375 | 640 | 680 | 710 |
|  | $15 \mathrm{~s} \mathrm{(A)}$ | 90 | 100 | 150 | 200 | 250 | 270 | 325 | 560 | 600 | 620 |
|  | 60 s (A) | 60 | 60 | 90 | 125 | 170 | 175 | 200 | 350 | 370 | 380 |
|  | 240 s ( A ) | 40 | 40 | 50 | 60 | 100 | 100 | 120 | 190 | 190 | 200 |
|  | 900 s (A) | 30 | 30 | 38 | 38 | 54 | 60 | 76 | 108 | 108 | 120 |
|  | Minimum cooling time at zero current [Min] | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |



Additional rating data - contactors to IEC 947
Contactor
CA 7-9 CA 7-12 CA 7-16 CA 7-23 CA $7-30$ CA 7-37 CA $7-43$ CA $7-60$ CA $7-72$ CA $7-85$
AC 1 resistive load
switching 3~
Ambient temperature $40^{\circ} \mathrm{C}$

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

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

| $\left.l_{e}{ }^{1}\right)$ | $[\mathrm{A}]$ | 32 | 32 | 32 | 32 | 45 | 45 | 63 | 100 | 100 | 100 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| $230 / 240 \mathrm{~V}$ | $[\mathrm{~kW}]$ | 8 | 8 | 10 | 10 | 14 | 16 | 20 | 29 | 29 | 34 |
| $400 / 415 \mathrm{~V}$ | $[\mathrm{~kW}]$ | 14 | 14 | 17 | 17 | 26 | 28 | 36 | 51 | 51 | 61 |
| 690 V | $[\mathrm{~kW}]$ | 24 | 24 | 29 | 29 | 44 | 48 | 60 | 86 | 86 | 102 |

AC motor switching
AC 2, AC 3, AC 4


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 |  |  |  |  |  |  |  |  |  |  |
| Power dissipated by all circuits at le AC 3 | 0.7 | 1.2 | 2.1 | 3.2 | 5.4 | 8.2 | 8.3 | 9.7 | 14 | 19.5 |
| Total power dissipation |  |  |  |  |  |  |  |  |  |  |
| DC control [w] | 6.7 | 7.2 | 8.1 | 12.4 | 14.6 | 17.4 | 18.4 | 14.6 | 18.9 | - |
| Life span in millions of operations |  |  |  |  |  |  |  |  |  |  |
| Mechanical AC control | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 10 | 10 | 10 |
| DC control | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 10 | 10 | 10 |
| Operating times (DC) |  |  |  |  |  |  |  |  |  |  |
| Make (ms) | 40... 70 | 40... 70 | 40.. 70 | 40...70 | 50.. 80 | 50.. 80 | 50.. 8 | 20... | 20. | 20... 40 |
| Break (ms) | 7... 15 | 7... 15 | 7... 15 | 7... 15 | 7... 15 | 7.. 15 | - | - | - | - |

Note: ') Contact NHP for recommended cable size.


Contactor (AC control)

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

(DC control)

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


| Accessories |  | (AC control) <br> $(\mathrm{mm})$ | (DC control) <br> (mm) |
| :--- | :--- | :--- | :--- |
| Contactor with | 2 or 4 pole | $\mathrm{c} / \mathrm{c} 1+39$ | $\mathrm{c} 1+39$ |
| Front mounting auxiliary contact | 1 or 2 pole | $\mathrm{a}+9$ | $\mathrm{a}+9$ |
| Side mounting auxiliary contact |  | $\mathrm{c} / \mathrm{c} 1+58$ | - |
| Pneumatic timing module | coil mounting | $\mathrm{b}+24$ | $\mathrm{~b}+24$ |
| Electronic timing module | mounts between contactors | $\mathrm{a}+9$ | $\mathrm{a}+9$ |
| Mechanical interlock |  | $\mathrm{c} / \mathrm{c} 1+61$ | - |
| Mechanical latch | coil mounting | $\mathrm{b}+9$ | b |
| Interface | coil mounting | labels | $\mathrm{b}+3$ |
| Suppressor | label support system $\mathrm{V} 4 N 5$ | +0 | $\mathrm{~b}+3$ |
| With inscriptions ${ }^{3}$ ) |  | +5.5 | +0 |

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

## Thermal overload relays to IEC 947 and AS 3947



Cat. No. CT 7-24


Cat. No. CT 7-45


Cat. No. CT 7-75


Cat. No. CT 7-100

## CT 7 thermal overload



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



Notes: Fuses 65 kA . XH125NJ circuit breaker combinations limited to 50 kA , others 65 kA . Overloads may be changed to different types eg. thermal style to electronic. Some combinations also gives Type ' 2 ' performance.
${ }^{1}$ ) Use 'magnetic only' breaker - Refer NHP. $240 / 415 \mathrm{~V}$ rating suitable for use on $230 / 400 \mathrm{~V}$ in accordance with AS $60038: 2000$


Refer Catalogue C-CO
TemBreak circuit breakers DOL starting 50 kA @ $400 / 415 \mathrm{~V}$ to AS 3947.4.1

## TemBreak MCCBs

| Motor size kW | Approx. amps | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh overload relay | Setting range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | XM30PB/1.4 | CA 7-9 | CT 7-24-1.6 | 1-1.6 |
| 0.55 | 1.5 | XM30PB/2 | CA 7-9 | CT 7-24-1.6 | 1-1.6 |
| 0.75 | 1.8 | XM30PB/2.6 | CA 7-9 | CT 7-24-2.4 | 1.6-2.4 |
| 1.1 | 2.6 | XM30PB/4.0 | CA 7-16 | CT 7-24-4 | 2.4-4 |
| 1.5 | 3.4 | XM30PB/5 | CA 7-16 | CT 7-24-4 | 2.4-4 |
| 2.2 | 4.8 | XM30PB/8 | CA 7-16 | CT 7-24-6 | 4-6 |
| 3 | 6.5 | XM30PB/10 | CA 7-30 | CT 7-24-10 | 6-10 |
| 4 | 8.2 | XM30PB/12 | CA 7-30 | CT 7-24-10 | 6-10 |
| 5.5 | 11 | XH125NJ/20 | CA 7-30 | CT 7-24-16 | 10-16 |
| 7.5 | 14 | XH125NJ/20 | CA 7-30 | CT 7-24-16 | 10-16 |
| 11 | 21 | XH125NJ/32 | CA 7-30 | CT 7-24-24 | 16-24 |
| 15 | 28 | XH125NJ/50 | CA 7-43 | CT 7-45-30 | 18-30 |
| 18.5 | 34 | XH125NJ/50 | CA 7-43 | CT 7-45-45 | 30-45 |
| 22 | 40 | XH125NJ/63 | CA 7-43 | CT 7-45-45 | 30-45 |
| 30 | 55 | XH125NJ/100 | CA 6-85 | CT 7-75 ${ }^{2}$ ) | 45-60 |
| 37 | 66 | XH125NJ/100 | CA 6-85 | CT 7-75 ${ }^{2}$ ) | 60-75 |
| 45 | 80 | XH125NJ/125 | CA 6-105-EI | CT 6-90 | 70-90 |
| 55 | 100 | XH125NJ/125 ${ }^{\text { }}$ ) | CA 6-105-EI | CT 6-110 | 85-110 |
| 75 | 130 | XH250NJ/250 | CA 6-140-EI | CT 6-150 | 105-150 |
| 90 | 155 | XH250NJ/250 | C A6-170-EI | CT 6-200 | 140-200 |
| 110 | 200 | XH250NJ/250 ${ }^{\text {I }}$ ) | CA 6-210-EI | CEF 1-41/42 | 160-400 |
| 132 | 225 | XS400SE/400 | CA 6-210-EI | CEF 1-41/42 | 160-400 |
| 150 | 250 | XS400SE/400 | CA 6-250-EI | CEF 1-41/42 | 160-400 |
| 160 | 270 | XS400SE/400 | CA 6-300-EI | CEF 1-41/42 | 160-400 |
| 200 | 361 | XS400SE/400 | CA 6-420-E1 | CEF 1-41/42 | 160-400 |
| 200 | 361 | XS400SE/400 | CA 5-450 | CEF 1-22 ${ }^{2}$ ) | 160-400 |
| 250 | 425 | XS630SE/630 | CA 5-700 | CEF 1-52 ${ }^{2}$ ) | 160-630 |
| 320 | 538 | XS630SE/630 | CA 5-700 | CEF 1-52 ${ }^{2}$ ) | 160-630 |

Notes: Overloads may be thermal or electronic.
Combinations based on the overload tripping before the circuit breaker at overload currents up to the motor locked rotor current.
${ }^{1}$ ) Use 'magnetic only' breaker or next higher circuit breaker/ contactor combination.
${ }^{2}$ ) Use with separate mounting bracket.
Data for 65 kA co-ordination available refer Cat. C-CO.
240/415 V rating suitable for use on 230/400 V in accordance with AS 60038: 2000

TemBreak circuit breakers DOL starting. 85 kA @ 400/415 V to AS 3947.4.1

| Motor size <br> kW | Approx. FLC @ <br> $400 / 415 \mathrm{~V}(\mathrm{~A})$ | Terasaki circuit <br> breaker | Sprecher + Schuh <br> contactor | Sprecher + Schuh <br> thermal O/L type | Setting <br> range (A) |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 0.37 | 1.1 | XM30PB/1.4 | CA 7-9 | CEP 7-M32-2.9-10 | $1.0-2.9$ |
| 0.55 | 1.5 | XM30PB/2.0 | CA 7-9 | CEP 7-M32-2.9-10 | $1.0-2.9$ |
| 0.75 | 1.8 | XM30PB/2.6 | CA 7-9 | CEP 7-M32-2.9-10 | $1.0-2.9$ |
| 1.1 | 2.6 | XM30PB/4 | CA 7-16 | CEP 7-M32-2.9-10 | $1.0-2.9$ |
| 1.5 | 3.4 | XM30PB/5 | CA 7-16 | CEP 7-M32-5-10 | $1.6-5$ |
| 2.2 | 4.8 | 6.5 | XM30PB/8 | CA 7-30 | CEP 7-M32-12-10 |

Din-T circuit breakers with rotary is olator. DOL starting.
50 kA@400/415 V to AS 3947.4.1

| Motor size <br> kW | Approx. amps @ 400/415 V | Sprecher + Schuh isolator | Terasaki circuit breaker | Sprecher + Schuh current limiter | Sprecher + Schuh contactor | Schuh thermal O/L relay | Thermal overioad range |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0.37 | 1.1 | LA 7-80 | Din-T 10 / 4 | - | CA 7-9 | CT 7-24 | 0.6-1.6 |
| 0.55 | 1.5 | LA 7-80 | Din-T $10 / 4$ | - | CA $7-9$ | CT 7-24 | 1-1.6 |
| 0.75 | 1.8 | LA 7-80 | Din-T 10/4 | - | CA $7-9$ | CT 7-24 | 1.6-2.4 |
| 1.1 | 2.6 | LA 7-80 | Din-T $10 / 6$ | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 1.5 | 3.4 | LA 7-80 | Din-T $10 / 6$ | - | CA 7-23 | CT 7-24 | 2.4-4 |
| 2.2 | 4.8 | LA 7-80 | Din-T $10 / 10$ | KTL 3-65 | CA 7-23 | CT 7-24 | 4-6 |
| 3 | 6.5 | LA 7-80 | Din-T $10 / 16$ | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 4 | 8.2 | LA 7-80 | Din-T 10/16 | KTL 3-65 | CA 7-23 | CT 7-24 | 6-10 |
| 5.5 | 11 | LA 7-80 | Din-T 10/20 | KTL 3-65 | CA 7-23 | CT 7-24 | 10-16 |
| 7.5 | 14 | LA 7-80 | Din-T 10/32 | KTL 3-65 | CA 7-30 | CT 7-45 | 10-16 |
| 11 | 21 | LA 7-80 | Din-T 10/40 | KTL 3-65 | CA 7-30 | CT 7-24 | 16-24 |
| 15 | 28 | LA 7-100 | Din-T $10 / 63$ | KTL 3-65 | CA 7-37 | CT 7-45 | 18-30 |
| 18.5 | 34 | LA 7-100 | Din-T 10/63 | KTL 3-65 | CA 7-37 | CT 7-45 | 30-45 |

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

| Main current circuit | CT 7－24 | CT 7－45 | CT 7－75 | CT 7－100 |  |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Rated insulation voltage $U_{i}$ | ［V］ | 690 | 690 | 690 | 1000 |
| Rated impulse withstand voltage $U_{\text {imp }}$ | ［V］ | 6000 | 6000 | 6000 | 8000 |
| Rated operating voltage $U_{\theta}$ | $[\mathrm{V}]$ | 690 | 690 | 690 | 1000 |
| Pollution |  | $\mathrm{III} / 3$ | $\mathrm{III} / 3$ | $\mathrm{III} / 3$ | $\mathrm{II} / 3$ |

Isolation voltage between main current path
and control circuit to DIN，VDE 106，

| Part 101 and Part 101 A1 | M］ | 440 | 440 | 440 | 440 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Current range |  | 0．1．．． 24 | 18．．． 45 | 18．．．60（75） | 70．．． 90 |
| Heat dissipation（for 3 phase） |  |  |  |  |  |
| lower value of adjustment | ［W］ | 2.5 | 3 | $3(7)$ | $<16$ |
| upper value of adjustment | ［W］ | 6 | 7.5 | 7.5 （10） | ＜28 |
| Connections |  | $\stackrel{\text { 毕 }}{2}$ | 嵒 | 囫 | 嵒 |
|  |  | M4 | M6 | M6 | M8 |
| Flexible wire with sleeve | ［ $\mathrm{mm}^{2}$ ］ | $2 \times(1 \ldots 4)$ | $1 \times 25 /$ | $1 \times 25 /$ | 50 |
| E－9 |  |  | $2 \times(1 \ldots 10)$ | $2 \times(1 \ldots 10)$ | 16 |
| Stranded／solid core | ［ $\mathrm{mm}^{2}$ ］ | $2 \times(1 \ldots 6)$ | $2 \times(1 \ldots 16)$ | $2 \times(1 \ldots 16)$ | 50 |
| Tightening torque | ［ Nm ］ | 1.8 | 3.5 | 3.5 | 6 |
| Control circuit |  | CT 7－24 | CT 7－45 | CT 7－75 | CT 7－100 |
| Rated insulation voltage $U_{i}$ | ［V］ | 500 | 500 | 500 | 500 |
| Rated impulse withstand voltage $U_{\text {imp }}$ | ［V］ | 6000 | 6000 | 6000 | 6000 |
| Rated operating voltage $U_{e}$ | ［V］ | 500 | 500 | 500 | 500 |
| Pollution |  | 111／3 | III／3 | 111／3 | 111／3 |
| Rated operating current $/ 8$ |  | N／O／N／C | N／O／N／C | N／O／N／C | N／O／N／C |
| AC 15 220．．．240 V | ［A］ | 1．5／1．5 | 1．5／1．5 | 1．5／1．5 | 1．5／1．5 |
| $400 \ldots 415 \mathrm{~V}$ | ［A］ | 0．5／0．9 | 0．5／0．9 | 0．5／0．9 | 0．5／0．9 |
| 500 V | ［A］ | 0．5／0．8 | 0．5／0．8 | 0．5／0．8 | 0．5／0．8 |
| DC 13.24 V | ［A］ | 0．9／0．9 | 0．9／0．9 | 0．9／0．9 | 0．9／0．9 |
| 60 V | ［A］ | 0．75／0．75 | 0．75／0．75 | 0．75／0．75 | $0.75 / 0.75$ |
| 110 V | ［A］ | 0．4／0．4 | 0．4／0．4 | $0.4 / 0.4$ | 0．4／0．4 |
| 220 V | ［A］ | 0．2／0．2 | 0．2／0．2 | 0．2／0．2 | 0．2／0．2 |

Isolation voltage between main current path
and control circuit to DIN，VDE 106，

| Part 101 and Part 101 A1 | ［V］ | 240 | 240 | 240 | 240 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Conventional thermal current | ［A］ | 6 | 6 | 6 | 6 |
| Short circuit protection fuse | $g L[A]$ | 6 | 6 | 6 | 6 |
| Connections |  |  | $\underset{\sim}{\text { \% }}$ | $\stackrel{\infty}{4}$ | $\stackrel{\sim}{\mathbb{N}}$ |
|  |  | M3．5 | M3．5 | M3．5 | M3．5 |
| Flexible wire with sleeve | ［ $\mathrm{mm}^{2}$ ］ | $2 \times(0.75 \ldots 2.5)$ | $2 \times(0.75 \ldots 2.5)$ | $2 \times(0.75 \ldots 2.5)$ | $2 \times(0.75 \ldots 2.5)$ |
| Stranded／solid core E－F | ［ $\mathrm{mm}^{2}$ ］ | $2 \times(0.75 \ldots 4)$ | $2 \times(0.75 \ldots 4)$ | $2 \times(0.75 \ldots 4)$ | $2 \times(0.75 \ldots 4)$ |
| Tightening torque | ［ Nm ］ | 1.2 | 1.2 | 1.2 | 1.2 |


| General | CT 7-24 | CT 7-45 | CT 7-75 | CT 7-100 |
| :--- | :--- | :--- | :--- | :--- |
| Weight | $[\mathrm{kg}] ~ 0.13$ | 0.21 | 0.21 | 1.3 |

$\xrightarrow{\text { Standards }}$ IEC 947, EN 60 947. DIN VDE 0660, UL, LRS, GUS, CSA
damp/heat, constant, to DIN, IEC 68, Part 2 - 3
damp/heat, cyclic, to DIN, IEC 68, Part 2-30

| Ambient temperature | open | damp/heat, cyclic, to DIN, IEC 68, Part 2-30 |
| :--- | :---: | :---: |
|  | enclosed | $-25 \ldots+60^{\circ} \mathrm{C}$ |
| Temperature compensation | $-25 \ldots+50^{\circ} \mathrm{C}$ |  |
| Shock resistance (sinusoidal 10 ms ) $[\mathrm{G}]$ | continuous temperature range $-5 \ldots+40^{\circ} \mathrm{C}$ to IEC 947, |  |
| Protection | EN 60947; PTB: $-5 \ldots+50^{\circ} \mathrm{C}$ |  |
| Protection | 10 |  |

Contactor, timer and overload selection chart for auto transformer starters

| ATS kW | Line <br> contactor | Trans <br> contactor | Star <br> contactor | Timer | Overload |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 11 | CA 7-23-10 | CA 7-16-10 | CA 7-9-10 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 15 | CA 7-30-00 | CA 723-10 | CA 7-12-10 | RZ7 FSY2D | CEP 7-M37-37-10 |
| 18.5 | CA 7-37-00 | CA 7-30-00 | CA 7-16-10 | RZ7 FSY2D | CEP 7-M37-37-10 |
| 22 | CA 7-43-00 | CA 7-30-00 | CA 7-23-10 | RZ7 FSY2D | CEP 7-M45-45-10 |
| 30 | CA 7-60-00 | CA 7-37-00 | CA 7-30-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 37 | CA 7-72-00 | CA 7-43-00 | CA 7-30-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 45 | CA 7-85-00 | CA 7-60-00 | CA 7-37-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 55 | CA 6-85-11 | CA 7-60-00 | CA 7-43-00 | RZ7 FSY2D | CT 6-110 |
| 75 | CA 6-105-11 | CA 7-85-00 | CA 7-60-00 | RZ7 FSY2D | CT 6-150 |
| 90 | CA 6-140EI-11 | CA 6-85-11 | CA 7-72-00 | RZ7 FSY2D | CT 6-200 |
| 110 | CA 6-170EI-11 | CA 6-105-11 | CA 7-85-00 | RZ7 FSY2D | CEF 1-41 |
| 132 | CA 6-210EI-11 | CA 6-140EI-11 | CA 6-105-11 | RZ7 FSY2D | CEF 1-41 |
| 150 | CA 6-250EI-11 | CA 6-140EI-11 | CA 6-105-11 | RZ7 FSY2D | CEF 1-41 |
| 185 | CA 6-300EI-11 | CA 6-210EI-11 | CA 6-140EI-11 | RZ7 FSY2D | CEF 1-41 |
| 220 | CA 6-420EI-11 | CA 6-210EI-11 | CA 6-140-EI-11 | RZ7 FSY2D | CEF 1-41 |

## Contactor, timer and overload selection chart for star delta starters

| SDS kW | Line <br> Contactor | Delta <br> Contactor | Star <br> contactor | Timer | Overload |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 7.5 | CA 7-9-10 | CA 7-9-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-12-10 |
| 11 | CA 7-12-10 | CA 7-12-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 15 | CA 7-16-10 | CA 7-16-01 | CA 7-9-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 18.5 | CA 7-23-10 | CA 7-23-01 | CA 7-12-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| 22 | CA 7-23-10 | CA 7-23-01 | CA 7-16-01 | RZ7 FSY2D | CEP 7-M32-32-10 |
| $30-37$ | CA 7-37-00 | CA 7-37-00 | CA 7-23-01 | RZ7 FSY2D | CEP 7-M45-45-10 |
| 45 | CA 7-60-11 | CA 7-60-11 | CA 7-30-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 55 | CA 7-60-11 | CA 7-60-11 | CA 7-37-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 75 | CA 7-85-00 | CA 7-85-00 | CA 7-43-00 | RZ7 FSY2D | CEP 7-M85-85-10 |
| 90 | CA 6-85-11 | CA 6-85-11 | CA 7-60-00 | RZ7 FSY2D | CT 6-90 |
| 110 | CA 6-105-11 | CA 6-105-11 | CA 7-72-00 | RZ7 FSY2D | CT 6-110 |
| 132 | CA 6-140EI-11 | CA 6-140EI-11 | CA 7-85-00 | RZ7 FSY2D | CT 6-150 |
| 150 | CA 6-170EI-11 | CA 6-170EI-11 | CA 6-85-00 | RZ7 FSY2D | CTA 6-200 |
| 185 | CA 6-210EI-11 | CA 6-210EI-11 | CA 6-105-11 | RZ7 FSY2D | CEF 1-41 |
| 220 | CA 6-210-EI-11 | CA 6-210-EI-11 | CA 6-140-EI-11 | RZ7 FSY2D | CEF 1-41 |

## 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 | $35^{\prime}$ ) | 16.5 | 51 |
|  | CA 7-30... 37 | 45 | 127 | 83 | 105 | 99 | 6.5 | 51 | 39 | 9.5 | 4.5 | 60 | $35^{\prime}$ ) | 16.5 | 51 |
| CT 7-45 | CA 7-30... 37 | 60 | 140 | 97 | 105 | 99 | 6.5 | 51 | 39 | 6.5 | 4.5 | 60 | $35^{\prime}$ ) | 16.5 | 57 |
|  | CA 7-43 | 60 | 140 | 97 | 107 | 103 | 6.5 | 51 | 39 | 8.5 | 4.5 | 60 | $45^{\prime}$ ) | 16.5 | 57 |
| CT 7.75 | CA 7-60... 85 | 72 | 185 | 120 | 125 | 120 | 8.5 | 51 | 39 | 28.5 | 5.4 | 100 | $55^{\text {1 }}$ ) | 16.5 | 82 |

Separate mounting with bracket


Separate mounting


| Type | $\mathbf{a}$ | $\mathbf{b}$ | $\mathbf{b 1}$ | $\mathbf{c}$ | $\mathbf{c 1}$ | $\mathbf{c 2}$ | c3 | od | d1 | d2 | e1 | e2 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| CT 7-24 | 45 | 85 | 44 | 95 | 70.5 | 5 | 51 | 4.5 | $60 \ldots 74$ | $\left.35^{\prime}\right)$ | 16 | 3 |
| CT 7-75 | 60 | 90 | 44 | 117 | 112 | 15 | 51 | 5.4 | 74 | $\left.50^{\prime}\right)$ | 16 | 0 |
| CT 7-90 | 100 | 120 | - | 135 | - | 5 | 51 | 6.2 | 74 | $\left.80^{\prime}\right)$ | 16 | 7 |

Notes: ') Standard DIN rail to EN 50 022-35.
${ }^{2}$ ) With reset rod, maintain 9 mm maximum operating radius from centre of reset button.
c3 Reset magnet.
c4 Auxiliary contact block.

## Tripping characteristics

These tripping characteristics comply with IEC 947 and are the mean values of the bands at $20^{\circ} \mathrm{C}$ ambient temperature starting from the cold state. Tripping time as a function of operating current. When the motor reaches operating temperature, the tripping time of the motor protection relay falls to approximately $1 / 4$ of the set value (hot state).


CT 7-24..., CT 7-45..., CT 7-75...


CT 7-100-90


Single phase 1 pole switching


Single phase 2 pole switching


Three phase 3 pole switching

Din-Safe single pole width residual
current circuit breaker (DRCB) current circuit breaker (DRCB)
Standards IEC1009, IEC 898.

- Approval N14929.
- Mining approval NSW MDA Ex. 11593, QLD QMD 987445X.
$\square$ One module wide ( 18 mm ).
- Short circuit, overcurrent and earth leakage protection.
- Short circuit protection 10kA.
- Sensitivity $\mathbf{3 0 m A}$.

| Ampere <br> rating | Modules <br> $(18 \mathrm{~mm})$ | Voltage | Short <br> circuit | Trip <br> Sensitivity | Cat. No |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 10 | 1 | 240 | 10 kA | 30 mA | DRCBH 1030 |
| 16 | 1 | 240 | 10 kA | 30 mA | DREBH 1630 |
| 20 | 1 | 240 | 10 kA | 30 mA | DRCBH 2030 |
| 25 | 1 | 240 | 10 kA | 30 mA | DREBH 2530 |
| 32 | 1 | 240 | 10 kA | 30 mA | DRCBH 3230 |



## Operation

This unit combines the overload and short circuit protection of an MCB with earth leakage protection of an RCD. The unit occupies one, sub-circuit (one pole) of the distribution board and provides single phase protection against overload short circuit and earth leakage current.

1) The MCB element provides thermal and magnetic tripping protection which is rated to 10 kA prospective fault current.
2) The RCD element of the device provides core-balance detection of the difference between the active and neutral currents and amplification to provide high sensitivity. The rated residual operating current $(I \Delta n)$ is 30 mA .
3) The green/yellow earth reference cable in case of loss of supply neutral ensures the device will continue to provide earth leakage protection and will operate normally upon detection of an earth leakage current.
Dimension(mm)


Connection diagram


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

DIN-Safe single pole width residual current circuit breaker tripping characteristics



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



## Tembreak MCCB's



Notes: ') Minimum fuse size is based on grading under overioad 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 $8 S 88$ and DIN fuses
$160 \mathrm{~A}-0.62 \times 10^{5}, \quad 200 \mathrm{~A}-1.2 \times 10^{5}, \quad 250 \mathrm{~A}-2.1 \times 10^{5}$.
Suitable fuses include NHP, GEC, Siemens and Bovara-Crady
Fuses with higher current ratings may be used providing $I^{2}$ t values are equal to, or less than the levels above. Semi-conductor fuses have very low $l^{2} t$ 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.

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

```
Guide
```



Upstream MCCB
XS400SE


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


## XS125 series

I Adjustment range 63-100\% of nominal current rating.
$\square$ Standards AS 2184/AS 3947-2.
$\square$ Adjustable thermal and fixed magnetic trip.

- Max. voltage (INSUL) 690 V .

XS125CJ (18kA) 3 pole
Ampere

| rating | Min | Max | Cat. No. |
| :---: | :---: | :---: | :---: |
| 20 | 12.5 | 20 | XS 25 CJ 203 |
| 32 | 20 | 32 | - $\times 5125 \mathrm{C} 323$, |
| 50 | 32 | 50 | WST25ENT50 36, |
| 63 | 40 | 63 | - $\mathrm{XST25C5} 633 \mathrm{y}$ |
| 100 | 63 | 100 | WS125CJ1003 ${ }^{\text {W }}$ |
| 125 | 80 | 125 | W8S15CI253 |
| 125 | Auto | for 1 sec ) | OST2NN3 ${ }^{\text {a }}$ |

XS125NJ (30kA) 2 pole
Ampere

| rating | Min | Max | Cat. No. |
| :---: | :---: | :---: | :---: |
| 20 | 12.5 | 20 |  |
| 32 | 20 | 32 | WS125N132 \% |
| 50 | 32 | 50 | HST125N1 $502 \%$, |
| 63 | 40 | 63 |  |
| 100 | 63 | 100 | 1xS125N1002 |
| 125 | 80 | 125 | 6-S125N51252. |

XS125NJ (30kA) 3 pole

| 20 | 12.5 | 20 | $0 \times 5125 N 1203 \times 5$ |
| :---: | :---: | :---: | :---: |
| 32 | 20 | 32 | XS $125 \mathrm{NJ} 323 \ldots, \ldots$ |
| 50 | 32 | 50 | $\text { रS1 } 125 N 1 / 503 \text {, }$ |
| 63 | 40 | 63 | $\alpha \times 5125 N U 63\}$ |
| 100 | 63 | 100 | $\mathrm{XST}^{125 N 1 / 2003}$ |
| 125 | 80 | 125 | $\times \sin 5 \mathrm{~N} 1253$ |

## XS125NJ (30kA) 4 pole

| 20 | 12.5 | 20 |  |
| :---: | :---: | :---: | :---: |
| 32 | 20 | 32 | 1-25125N1324, |
| 50 | 32 | 50 | WS125N504\% |
| 63 | 40 | 63 | [6 XS $125 \mathrm{NJT3.4}$, |
| 100 | 63 | 100 |  |
| 125 | 80 | 125 |  |

Notes: ') MCCB's only.
${ }^{2}$ ) Load-break isolating switch only-no overload or short circuit protection.
${ }^{3}$ ) Poles in series
${ }^{\text {a }}$ ) Shor time rating. Refer rating chart for technical details.
2 pole models use a 3 pole body with centre pole disabled.
Special generator protection MCCB's available - low instantaneous magnetic setting.


Dimensions (mm)
Description Height Width Depth kg

| XS125CJ | 3 pole | 155 | 90 | 86 | 1.3 |
| :--- | :--- | :--- | :--- | :--- | :--- |
| XS125NJ | 2 pole | 155 | 90 | 86 | 1.3 |
| XS125NJ | 3 pole | 155 | 90 | 86 | 1.3 |
| XS125NJ | 4 pole | 155 | 120 | 86 | 1.58 |



Short circuit capacity

| Model | I/C | Voltage |
| :--- | :--- | :--- |
| $\times S 125 \mathrm{CJ}$ | $18 \mathrm{kA}(\mathrm{AS} 2184)$ | 415 V 50 Hz |
| $\times S 125 \mathrm{NJ}$ | $30 \mathrm{kA}(\mathrm{AS} 2184)$ | 415 V 50 Hz |
| DC use | $\left.1 / \mathrm{C}^{3}\right)$ | Voltage |
| $\times \mathrm{XS} 125 \mathrm{CJ}$ | 10 kA | 250 VDC |
| $\times S 125 \mathrm{NJ}$ | 15 kA | 250 VDC |

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

## Product extensions

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

Base standards
IEC 947-2
BS EN 60947 Par 2
VDE 0660 Part 1
AS 3947-2/Australia
AS 2184-1990/Australia ${ }^{\text {1 }}$
NEMA USA
ANSI C37. 13/USA JIS C 8372IJAPAN JEC 160/JAPAN

Approvals
ASTAUKK, Aust. standards
Marine
NKIJAPAN
LRUK
AB/USA
GUGERMANY
BV/FRANCE
DNV NORWAY

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

Hex socket head bolt

|  | XE225NC | M8 | XS250NJ | M8 | XH250NJ | M8 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| - |  |  |  |  | XH160PJ | M8 |
| (-) |  |  | XS400 | M10 | TL250NJ | M10 |
| ( 5 |  |  | XH400 | M10 | TL400NJ | M10 |
| \% |  |  | XV400 | M10 | XH250PJ | M10 |



Connections and mountings

## Rear-connection type (RC)

## Bolt stud



Applicable breakers
$\square \mathrm{XS}$ series
XS125CJ, XS125NJ

- XH series

XH125NJ, XH125PJ

TemBreak XS125CS, CJ, NS, NJ, XH125NJ, TL30F MCCBs
ASL: Arrangement Standard Line

Outline dimensions (mm)
Front connected (standard)
Note: XS125NS 1 pole only


H: Handle frame centre line Drilling plan


Panel mount


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

Plug-in (optional)

Mounting block

Drilling plan



Types of connections and mountings

## MCCB accessories

Plug-in Type
Switchboard use


Types of plug-in mounting blocks for switchboard use

| Series | Breaker | Pole | Type |
| :---: | :---: | :---: | :---: |
| XS | XS125CJ | 2, 3, 4 | XDM2 |
|  | XS125NJ |  |  |
|  | XE225NC | 3, 4 | XDM3 |
|  | XS250NJ |  |  |
|  | XS400 | 3, 4 | XDM4 |
|  | XS630 | 3, i $^{\text {d }}$ | XDM6 |
|  | XS800 | 3, ® $^{\text {4 }}$ | XDM6 |
|  | XS1250 | 3. i $4^{\text {d }}$ | (i) XDM8 |
| XH | XH125 |  |  |
| $4.9$ | $\times 1600 \mathrm{~J}$ | 3, 14 | ¢ $\times$ DM3 |
|  | XH2502J | 3.14 | XDM4 |
|  | - $\mathrm{XH250NJ}$ | 3, [ ${ }^{3} 4$ | T XOM4 |
|  | X | $3.04$ | $\text { i } \times \mathrm{CM} 6$ |
| , | X 6630 | 3, 4 $6, \mathrm{XPM}$ |  |
| 5 | $\mathrm{XHBOO}$ | $3$$\square$ TOMER |  |
| XM | XM30PB |  |  |

## 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.
$\sqsupset$ 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 | $2,3 P$ | $1=2$ |

XH125

[^2]) Available on indent oniy.

## Crimp lugs (compression type)



Commercially available compression terminals available from CABAC - Cable Accessories and JST Australia.
Key: CAL = CABAC lugs
MT $=$ JST lugs

## Connection

 (one electric cable) If low clearance occurs use a recommended tape or insulation.

Connection
(two electric cables) If low clearance occurs use a recommended tape or insulation.


## XS125CJ, XS125NJ, XH125NJ,

 XH125NJTime/current characteristic curves


Ambient compensating curves


TemBreak XS125CS, CJ, NS, NJ, XH125NJ, PJ and TL30F MCCBs
ASL: Arrangement Standard Line
H: Handle frame centre line
Outline dimensions ( mm )


Note: XS125NS 1 pole only Drilling plan




Panel mount


Panel cut out dimensions shown give an allowance of 1.0 mm around the handle escutcheon.
Plug-in (optional) Mounting block $\quad$ Drilling plan


Outline dimensions (mm)
Front connected (standard)


Rear connected (optional)


Plug-in (optional)


ASL: Arrangement Standard Line
H: Handle frame centre line

[^3]

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

| Circuit breaker |  |  | Maximum fuse - amp |  |
| :---: | :---: | :---: | :---: | :---: |
| Type | Rating amps | Min. fuse amps ') | BS 88 | DIN |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| $\frac{4}{\text { SRCB }}$ |  | $8.860 \% \ldots$ | 200 | 200 |
|  | 10 | 50 | 160 | 160 |
| SRCB | 16-20 | 63 | 200 | 200 |
|  |  | $1620-63,46$ | $160$ |  |
| F\%, +z\% | W, 32-633 | 4 | 160 |  |
| Din-T10 \& | 0.5-6 | 20 | 200 | 200 |
| Din-T15 | 10 | 25 | 200 | 200 |
|  | 16 | 35 | 200 | 200 |
|  | 20-32 | 63 | 200 | 200 |
|  | 40-63 | 100 | 200 | 200 |
| DRCBH |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Din-T10H | 80 | 160 | 200 | 200 |
|  | 100 | 200 | 200 | 200 |
|  | 125 | 250 | 250 | 250 |

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 Bovara-Crady.
Fuses with higher current ratings may be used providing $I^{2} t$ values are equal to, or less than the levels above. Semi-conductor fuses have very low $1^{2}$ 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 ( $\mathrm{l}_{\text {pask }}$ ) and Energy Let Through ( ${ }^{2} \mathrm{~T}$ ).
Selectivity can be "enhanced" beyond the breaking capacity of the downstream device provided it is backed up by an appropriately selected upstream device, which should not trip (unlatch) under stated conditions.

## Cascading (Back-up)

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

## Cascade / Selectivity Tables

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


Selectivity: The Selectivity or Enhanced Selectivity limit of the two nominated devices in series. Up to this level of fault current the downstream device will trip (unlatch) before the upstream device. Above this level, the upstream may also trip.
Cascade: The enhanced or maximum downstream fault current that can be safely interrupted when both breakers are installed in series. Both breakers may trip (unlatch).
The Selectivity and Cascade levels stated by NHP are fully compliant with the requirements of the applicable standards. Selection of breakers should be in accordance with the selection tables.
The figures stated in NHP tables are for nominated Terasaki devices only, and should not be used as guidance for using alternative brands of circuit breakers.


Note: ${ }^{1}$ ) Dependant on the number of poles. Refer to NHP

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


Selectivity Cascade
Upstream MCCB

| Downstream MCCB | kA (rms) | $\begin{gathered} \text { XS400SE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH400SE } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS630SE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH630SE } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS8005 } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH800S } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS1250 } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS1600SE } \\ 85 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | 115/50, |  | -1830 | 18/30\% | $18 / 30$ | 18/18 | 18/ |
| XS125NJ | 30 | 25/50 | 25/50 | 30/30 | 30/30 | 30/30 | 30/30 | 30/30 | $30 / 3$ |
|  |  |  |  |  |  |  |  |  |  |
| XH125PJ | 50 | 35/50 | 35/65 | 50/50 | 50/65 | 50/50 | 50/65 | $50 / 50$ | 50/5 |
|  |  |  |  |  |  |  |  |  |  |
| XE225NC | 18 | 15/30 | 15/30 | 18/30 | 18/30 | 18/30 | 18/30 | 18/18 | 18/ |
|  |  |  |  |  |  |  |  |  |  |
| XH250NJ | 50 | 25/50 | 25/65 | 50/50 | 50/65 | 50/50 | 50/65 | 50/50 | 50/50 |
|  |  |  |  |  |  |  |  |  |  |
| XS400CJ | 35 | -150 | -150 | $10 / 50$ | 10/65 | 25/50 | 25/65 | 35/42 | 35/4 |
|  |  |  |  |  |  |  |  |  |  |
| XS400SE | 50 |  | -165 | 10/50 | 10/65 | 25/50 | 25/65 | 50/65 | 50/6 |
|  |  |  |  |  |  |  |  |  |  |
| XH400SE | 65 |  |  | 10/50 | $10 / 65$ | 25/50 | 25/65 | 50/65 | 50/65 |





|  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| XS800NJ | 65 | - | - | - | - | - | . | 15/65 | $20 / 85$ |




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

## $X X / Y Y$

Selectivity Cascade
Upstream MCCB

| Downstream MCCB | kA (rms) | $\begin{gathered} \mathrm{XH} 125 \mathrm{NJ} \\ 50 \end{gathered}$ | $\begin{gathered} \mathrm{XS} 250 \mathrm{NJ} \\ 35 \end{gathered}$ | $\begin{gathered} \mathrm{XH} 250 \mathrm{NJ} \\ 50 \end{gathered}$ | $\begin{gathered} \text { XS } 400 \mathrm{CJ} \\ 35 \end{gathered}$ | $\begin{gathered} \mathrm{XS} 400 \mathrm{NJ} \\ 50 \end{gathered}$ | $\begin{gathered} \text { XS400NE } \\ 50 \end{gathered}$ | $\begin{gathered} \mathrm{XH} 400 \mathrm{NE} \\ 65 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| XS1250 ${ }^{\text {d }}$ |  | \% $2 \times 150 \%$ |  | 3/50 | 4/35 | $4 / 50$ | 6/50 $\quad 6 / 50$ |  |
| XS125NJ | 30 | -150 | 3/30 | 3/50 | 4/35 | 4/50 | $6 / 50$ | $6 / 50$ |
|  |  |  |  |  |  |  |  |  |
| XE225NC | 18 |  | -130 | -130 | -/30 | -130 | 6/30 | 6/30 |
|  |  |  |  |  |  |  |  |  |
| XH250NJ | 50 |  |  |  |  | 4/50 | 6/50 | 6/65 |
|  |  |  |  |  |  |  |  |  |
| XS400NJ | 50 | . - |  |  |  |  | - | -/65 |
|  |  |  |  |  |  |  |  |  |
| XH400NE | 65 |  |  |  |  |  |  | - |
|  |  |  |  |  |  |  |  |  |
| XS630NJ | 65 | - |  |  |  |  |  |  |
| 16630NE 1 |  |  |  |  |  |  |  |  |
| XH630NE | 65 | . - - |  | $\therefore$ - | . - | - | - | - |
|  |  |  |  |  |  |  |  |  |
| XS800NE | 50 | $\because$ | - | - - | - | - | - | - |
| XS1250NE$65-4+6$ |  |  |  |  |  |  |  |  |
| XS1600NE | 100 |  |  |  |  |  |  | - |

Upstream MCCB

| Downstream MCCB | kA (rms) | $\begin{gathered} \text { XS630CJ } \\ 45 \end{gathered}$ | $\begin{gathered} \text { XS630NJ } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS630NE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH630NE } \\ 65 \end{gathered}$ | $\begin{gathered} \mathrm{XS800} \mathrm{NJ} \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS800NE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH800NE } \\ 65 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |
| XS125NJ | 30 | $6 / 30$ | $6 / 30$ | 18/30 | 18/30 | 10/30 | 18/30 | 18/30 |
| KH125N1 |  |  |  |  |  |  |  |  |
| XE225NC | 18 | $6 / 25$ | 6/30 | 10/30 | 10/30 | 8/30 | 12/30 | 12/30 |
|  |  |  |  |  |  |  |  |  |
| XH250NJ | 50 |  | - | 10/50 | - | 10/65 | $22 / 50$ |  |
| XS400CJ |  |  |  |  |  |  |  |  |
| XS400NJ | 50 | - | - | 7.5/50 | 7.5/65 | 6/50 | 10/50 | 10/65 |
|  |  |  |  |  |  |  |  |  |
| XH400NE | 65 |  |  |  |  |  | - | 10/65 |
|  |  |  |  |  |  |  |  |  |
| XS630NJ | 65 | $\cdots$ - | - | - - | - | - | - |  |
|  |  |  |  |  |  |  |  |  |
| XH630NE | 65 | - | - | - | - | - | - |  |
| XS800NJTh |  |  |  |  |  |  |  |  |
| XS800NE | 50 | - - | - | - | - | - | - |  |
|  |  |  |  |  |  |  |  |  |
| XS1600NE |  |  |  |  |  |  |  |  |

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



| Downstream MCCB | kA (rms) | $\begin{gathered} \text { XH800PJ } \\ 85 \end{gathered}$ | $\begin{gathered} \text { XS1250NE } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS1600NE } \\ 100 \end{gathered}$ | $\begin{gathered} \text { XS2000NE } \\ 100 \end{gathered}$ | $\begin{gathered} \text { XS2500NE } \\ 100 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |
| XS125NJ | 30 | 10/30 | 30/30 | 30/30 | 30/30 | 30/30 |
|  |  |  |  |  |  |  |
| XE225NC | 18 | 8/30 | 18/18 | 18/18 | 18/18 | 18/18 |
|  |  |  |  |  |  |  |
| XH250NJ | 50 | 10/65 | 35/50 | 50/50 | 50/50 | $50 / 50$ |
|  |  |  |  |  |  |  |
| XS400NJ | 50 | 6/65 | 20/65 | 35/65 | 35/65 | 50/65 |
|  |  |  |  |  |  |  |
| XH400NE | 65 | - | 20/65 | 35/65 | 35/65 | 50/65 |
|  |  |  |  |  |  |  |
| XS630NJ | 65 | -/85 | 15/65 | 20/85 | 35/85 | 35/85 |
|  |  |  |  |  |  |  |
| XH630NE | 65 | -/85 | 15/65 | 20/85 | 35/85 | 35/85 |
|  |  |  |  |  |  |  |
| XS800NE | 50 | -/85 | $15 / 65$ | 20/85 | 35/85 | 35/85 |
|  |  |  |  |  |  |  |
| XS1600NE | 100 | - | - | - | - | 35/65 |

## Motor Starting - Introduction

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

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

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


What problems can occur?
At the instant the motor is supplied with power it draws an "in-rush current" to its terminals, before gradually decaying to a normal operating current.
Should the in-rush current be high, it could be detected by the SCPD and classed as a fault current. If a high in-rush current should occur or even after repeated stop-start (inching) operations of the motor the SCPD may trip, albeit without a fault in the system. This is commonly known as "nuisance tripping" of the SCPD.

Special care must be taken when selecting a SCPD for motor-starting applications to prevent nuisance tripping, and at the same time ensuring adequate protection to the motor and associated cabling.
Another function of the SCPD is to protect the control device (e.g. contactor) from high-current, high-energy faults. Therefore, attention must also be paid when selecting an SCPD-Starter (contactor + thermal overload relay) combination.

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

What solutions are available to me? Good component design in association with correct component co-ordination is the only way to ensure reliable protection and operation under abnormal condition.
Terasaki circuit breakers and Sprecher + Schuh starter combinations are tested to provide full and safe co-ordination for most motor starting applications.


## 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 instalied in the switchboard performs in accordance to its own standard. A selection by the customer of the performance required needs to be made, as AS 3947.4.1 allows for Type '1' and Type '2' performance.

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

Type '2'
After a short circuit the starter is suitable for further service. A contact weld is permitted, but it must be easily separated - for example, by a screwdriver, without significant deformation.

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

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

Typical arrangement for co-ordination test


## 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 unskilied 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 (l1) setting dial.

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

## TemBreak motor protection circuit breaker

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

Motor starter protection
The XM30PB circuit breaker has been developed for motor starter protection and is suitable as the Short Circuit Protection Device (SCPD) for motor starters equipped with either direct connected or CT connected overcurrent relays.
XM30PB compared to HRC fuse
The circuit breaker tripping characteristic is more suitable for protection of starters than the HRC fuse. Unlike the HRC fuse, the breaker can be selected to trip instantaneously at a predetermined current level just lower than the maximum breaking current of the starter contactor, thus always protecting the contactor against opening fault currents higher than its capability. This can be seen from the typical breaker and fuse tripping characteristics compared to the contactor breaking capacity in
figure 1.
No protection is provided by the fuse when the overcurrent is of value $B$ to $C$ amps should the contactor open by earth fault relay. If the breaker is used as a SCPD then protection is provided for all currents in excess of the instantaneous trip current of the breaker. Also, the circuit breaker can be tripped by earth fault relay and so prevent the risk of contactor damage due to the long delay of the HRC fuse interruption if the fault current is of a value between $B$ and $C$.

Fig 1.

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

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

| size <br> kW | Approx. amps | circuit breaker | Sprecher + Schuh contactor type | Sprecher + Schuh thermal overload relay type ${ }^{2}$ ) | Settings range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| 0.55 | 1.5 | XM30PB/2 | CA 7-9 | CT 7-24 | 0.16-10 |
|  |  |  |  |  |  |
| 1.1 | 2.6 | XM30PB/4.0 | CA 7-9 | CT 7-24 | 0.16-10 |
|  |  |  |  |  |  |
| 2.2 | 4.8 | ХМЗОРВ/8 | CA 7-9 | CT 7-24 | 0.16-10 |
|  |  |  |  |  |  |
| 4.0 | 8.2 | XM30PB/12 | CA 7-9 | CT 7-24 | 0.16-10 |
|  |  |  |  |  |  |
| 7.5 | 14 | $\mathrm{XH} 125 \mathrm{NJ} / 20$ | CA 7-16 | CT 7-24 | 0.16-16 |
|  |  |  |  |  |  |
| 11 | 21 | $\mathrm{XH} 125 \mathrm{NJ} / 32$ | CA 7-23 | CT 7-24 | 0.16-24 |
| 15 |  |  |  |  |  |
| 18.5 | 34 | $\mathrm{XH} 125 \mathrm{NJ} / 50$ | CA 7-37 | CT 7-45 | 30-45 |
|  |  |  |  |  |  |
| 30 | 55 | XH125NJ/100 | CA 7-60 | CT 7-75 | 18-60 |
| 1774 66 |  |  |  |  |  |
| 45 | 80 | XH125NJ/125 ${ }^{\text {1 }}$ ) | CA. 7-85 | CT 7-100 | 70-90 |
|  |  |  |  |  |  |
| 75 | 130 | $\mathrm{XH} 250 \mathrm{NJ} / 250$ | CA 6 -140-(EI) | CT 6-150 | 105-150 |
|  |  |  |  |  |  |
| 110 | 200 | X $\mathrm{H}^{2} 250 \mathrm{NJ} / 250$ ) | CA 6-210-EI | CEF 1-41/42 | 160-400 |
|  |  |  |  |  |  |
| 160 | 270 | XS400SE/400 | CA 6-300-EI | CEF 1-41/42 | 160-400 |
| 200 |  |  |  |  |  |
| 250 | 425 | XS630SE/630 | CA 6-420-EII CA 5-4 | CEF 1-52 | 160-630 |
|  |  |  |  |  |  |

[^4]
## 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 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.

## TYPE 2 50kA



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 

## TYPE 2 50kA

| Motor <br> size <br> kW | Approx. amps | circuit breaker | Sprecher + Schuh contactor type | Sprecher + Schuh thermal overload relay type ${ }^{\text { }}$ ) | Settings range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| 0.55 | 1.5 | XM30PB/2 | CA 7-9 | CT 7-24-1.6 | 1-1.6 |
|  |  |  |  |  |  |
| 1.1 | 2.6 | XM30PB/4.0 | CA 7-16 | CT 7-24-4 | 2.4-4 |
|  |  |  |  |  |  |
| 2.2 | 4.8 | хм30РВ/8 | CA 7-16 | CT 7-24-6 | 4-6 |
|  |  |  |  |  |  |
| 4 | 8.2 | ХМ30РВ/12 | CA 7-30 | CT 7-24-10 | 6-10 |
| $55, \mathrm{H}$ |  |  |  |  |  |
| 7.5 | 14 | XH125NJ/20 | CA 7-30 | CT 7-24-16 | 10-16 |
|  |  |  |  |  |  |
| 15 | 28 | XH125NJ/50 | CA $7-43$ | CT 7-45-30 | 18-30 |
|  |  |  |  |  |  |
| 22 | 40 | XH125NJ/63 | CA 7-43 | CT 7-45-45 | 30-45 |
|  |  |  |  |  |  |
| 37 | 66 | $\mathrm{XH125NJ} / 100$ | CA $7-85$ | CT 7-75 ${ }^{2}$ ) | 60-75 |
|  |  |  |  |  |  |
| 55 | 100 | XH125NJ/125 ${ }^{\text {' }}$ | CA 6-105-(EI) | CT 6-110 | 85-110 |
|  |  |  |  |  |  |
| 90 | 155 | XH250NJ/250 | CA:6-170-EI | CT 6-200 | 140-200 |
|  |  |  |  |  |  |
| 132 | 225 | XS400SE/400 | CA 6-210-EI | CEF 1-41/42 | 160-400 |
|  |  |  |  |  |  |
| 200 | 361 | XS400SE/400 | CA 6-420-EI | CEF 1-41/42 | 160-400 |
| 200 | 361 | XS400SE/400 | CA 5-450 | CEF 1-22 ${ }^{2}$ ) | 160-400 |
|  |  |  |  |  |  |
| 320 | 538 | XS630SE/630 | CA 5-700 | CEF 1-52 ${ }^{2}$ ) | 160-630 |

Notes: ') Use 'magnetic only' breaker or next higher circuit breaker/contactor combination. Refer NHP
${ }^{2}$ ) Use with separate mounting bracket.
${ }^{\text {J }}$ ) 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 $65 \mathrm{kA}, 415 \mathrm{~V}$ to AS 3947-4-1 

## TYPE 2 65 kA

| Motor size kW | Approx. amps | Terasaki circuit breaker | Sprecher + Schuh contactor | Sprecher + Schuh overload relay ') | Settings range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| 0.55 | 1.5 | XM30PB/2 | CA 7-9 | CEP 7 | 1.0-2.9 |
|  |  |  |  |  |  |
| 1.1 | 2.6 | XM30PB/4.0 | CA 7-16 | CEP 7 | 1.6-5 |
|  |  |  |  |  |  |
| 2.2 | 4.8 | XM30PB/8 | CA 7-16 | CEP 7 | 3.7-12 |
| $3.6 \text {, } 65 \text {, }$ |  |  |  |  |  |
| 4 | 8.2 | XM30PB/12 | CA 7-30 | CEP 7 | 3.7-12 |
|  |  |  |  |  |  |
| 7.5 | 14 | TL30F/30A | CA 7-30 | CEP 7 | 12-32 |
|  |  |  |  |  |  |
| 15 | 28 | TL100NJ/50A | CA 7.43 | CEP 7 | 12-32 |
|  |  |  |  |  |  |
| 22 | 40 | TL100NJ/63A | CA 7-43 | CEP 7 | 14-45 |
|  |  |  |  |  |  |
| 37 | 66 | TL100NJ/100A | CA 7-72 | CEP 7 | 26-85 |
|  |  |  |  |  |  |
| 55 | 100 | XH400SE/250 | CA 6-105-(EI) | CT 6-110 | 85-110 |
|  |  |  |  |  |  |
| 90 | 155 | XH400SE/250 | CA 6-170-EI | CT 6-200 | 140-200 |
|  |  |  |  |  |  |
| 132 | 225 | XH400SE/400 | CA 6-210-EI | CEF 1-41/42 | 160-400 |
|  |  |  |  |  |  |
| 160 | 270 | XH400SE/400 | CA 6-300-E1 | CEF 1-41/42 | 160-400 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| 250 | 425 | XH630SE/630 | CA 5-700 | CEF 1-52 ${ }^{2}$ ) | 160-630 |
|  |  |  |  |  |  |

[^5]

## 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.
${ }^{1}$ ) 80,100 and 125 amp refers to Din-T10H type.
${ }^{2}$ ) Type 'SE' TemBreak MCCB only.
${ }^{3}$ ) Use magnetic-only TemBreak MCCB. Refer NHP.
Adjustable magnetic trips set to high. Thermal magnetic TemBreak adjustable $63 \%-100 \%$ of NRC (nominal rated current). Din-T MCB's are calibrated to IEC 898 Curve ' $C$ ' \& ' $D^{\prime}$. 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


[^6]
## 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.
${ }^{2}$ ) 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



TemBreak XV400NE mining breaker


Sprecher + Schuh
1000 V 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:
1 st re-arcing $\quad-\quad 3 \times$ supply voltage
2nd re-arcing $-5 \times$ supply voltage
3rd re-arcing $\quad-\quad 7 \times$ supply voltage
Internal capacitor damage will occur if the voltage level is greater than the capacitor's Dielectric Strength. With modern-day protection devices, (for example the Terasaki TemBreak MCCB's) this problem will not occur.

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

All Terasaki MCCB's are of the "manually independent closing" type, with high speed opening to prevent re-arcing between the contacts.
2. Nuisance tripping due to in-rush current When feeding a circuit containing a PFC unit the circuit breaker and the PFC unit can be exposed to a large in-rush current, equal to the instantaneous value of the power source. The end result of this is a large in-rush current, which could cause the circuit breaker to operate instantaneously due to its short-circuit protection. (The value of in-rush current will depend on the source voltage, the inductance and reactance in the circuit).
Special care should be taken to ensure that the MCCB selected will not nuisance trip due to high in-rush currents.
The table below shows typical MCCB selections for varying capacitor ratings, and the breaker selection is by a rule-ofthumb.

# Capacitor Rated Current $=\frac{\mathrm{kVAR} \times 1000}{\sqrt{3 \times V}}$ <br> kVAR: Capacitor Rating <br> V: Source Voltage 

MCCB Rating $=$ Capacitor Rated Current $\times 1.5(A)$
Once the MCCB rating has been determined, the MCCB type should be selected according to the short circuit fault level of the system.

MCCB's selection for power factor capacitor application

| Capacitor Capacitor rating rated (kVAR) current (A) | RecommendedMCCB's'? <br> TypeiRating (A) |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Wh 5h wh7 |  |  |  |  |
| 10 - 13.9 |  |  | XS125NJ/32 | XH125NJ/32 |
|  |  |  |  |  |
| $20 \quad 27.8$ |  | (ST25CJISO | XS125NJ/50 | NJ/50 |
| F25 mh34 8 |  |  |  |  |
| $30 \quad 41.7$ |  | XS125CJ/100 | 25NJ/100 | XH125NJ/100 |
|  |  |  |  |  |
| $50 \quad 69.6$ |  | XS125CJ/125 | XS125NJ/125 | XS125NJ/125 |
|  |  |  |  |  |
| $100 \quad 139$ | XE225NC/225 $\because \times$ XS250NJ/250 | $\mathrm{H} 250 \mathrm{NJ} / 250$ | XS400SE/250 | 400SE/25 |
| Z 150 , |  |  |  |  |
| $200 \cdot 278$ | $400 \mathrm{CJ} / 400$ | XS400NJ/400 | XS400SE/400 | XH400SE/400 |
|  |  |  |  |  |
| 400556 XS800NJ/800 XS800SE/800 XH800SE/800 |  |  |  |  |
|  |  |  |  |  |
| 600 . 835 XS1250SE/1250 |  |  |  |  |
|  |  |  |  |  |
| $10001391 \times$ XS2000SE/2000 |  |  |  |  |

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 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.


## XH800NEISE/PE

|  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| XS1600SE | Electronic | 1600 | $2 \times(100 \times 5 t)$ | 900 |

Note: When used at 400 Hz , the rated current setting of the OCR 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 AC. The main differences are as follows:

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

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

- Rated current.
- Rated voltage which determines the number of poles required to be involved in the interruption of the circuit.
- The type of $D C$ system used.
$\sqsupset$ 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:

$$
\mathrm{Isc}=\frac{\mathrm{Vb}}{R i}
$$

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 110 V DC it must have 2 poles connected in series.
Breaking capacities of TemBreak MCCB in DC systems


## Notes:

') Time constant (LR) $<=15 \mathrm{~ms}$; excludes $50 / 63 \mathrm{~A}$ where the time constant (UR) $<=4 \mathrm{~ms}$.
${ }^{2}$ ) 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.
${ }^{\text { }}$ ) 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 (UR) 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.

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 $k V A$.
$V=\quad$ Welder rated voltage.
I1 = Maximum primary current (PN).
$T_{1}=$ Current 'ON' period.
$T_{2}=$ Current 'OFF' period.
$T_{1}+T_{2}=$ One welding cycle time.
$B=$ Duty ratio, current 'ON' period divided by one welding cycle.

Ie $=$ Thermally equivalent continuous current.
2. MCCB selection
a) Current rating

It can be seen from the diagrams below that the welder only draws current intermittently. MCCB selection should be based on the thermally equivalent continuous current, i.e. the current which would produce the MCCB average temperature shown in the diagram below.
It can further be seen that the MCCB temperature will not be constant but will vary as the load varies.


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



$$
\left(B=\frac{T_{1}}{T_{1}+T_{2}}\right)
$$

Note: The rated capacity of a spot welder is normally expressed in terms of its $50 \%$ duty ratio, ie. $8=0.5$.

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.

\section*{General guide lines for MCCB selection <br> | 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


#### Abstract

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 $\mathrm{I}_{\mathrm{m}}$, 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 $A$
$I_{\text {inst }}=$ 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 shor-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 minimium, 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


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



## Example

Given 42 lamps each 250W installed on a 415 V 3 phase
system.
Which MCB must be selected?
Number of tubes per phase $=$ $\qquad$ $=14$

Therefore from the table above a 32A MCB should be selected.
A short circuit rating as appropriate must be selected.

[^7]
## 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 filtings 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 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.

## 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 ins
= Minimum instantaneous tripping co-efficient.
C curve $=5$
D curve $=10$
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.

[^8]
## 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 right up to the terminal opening of the MCCB. This also applies to the attached busbars supplied as a proprietory part with the MCCB.
Proprietary type interpole barriers may be used to achieve creepage and clearance requirements.
Conductors must not impede the flow of ionised gas.

Insulating distance from Line-End for 380/415V When earth metal is installed within the proximity of the breakers the correct insulating distance must be maintained.

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

Notes: When using the terminal bar (optional), the specified insulating distance must be maintained. All dimensions in mm.
When earthed metal is installed within the proximity of the breakers the correct insulating distance must be maintained (refer to Table 1). This distance is netessary to allow the exhausted arc gases to disperse.

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


Table 1 below illustrates the min clearance that must be maintained
A Distance from lower breaker to open charging part of terminal on upper breaker (front connection) or the distance from lower breaker to upper breaker end (rear connection and plug-in type)

B1 Distance from breaker end to ceiling (earthed metal)

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

| MCCB type | A | B1 | B2 | C | D |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| XS125CJ, XS125NJ, XH125NJ, XH125PJ | 75 | 45 | 25 | 0 | 25 |
|  |  |  |  |  |  |
| XS250NJ | 80 | 60 | 30 | 0 | 25 |
|  |  |  |  |  |  |
| XH250PJ, XS400CJ, XS400NJ, XS400SE | 100 | 70 | 40 | 0 | 30 |
|  |  |  |  |  |  |
| XH630SE, XH800SE, XH800PE | 150 | 80 | 50 | 0 | 40 |
|  |  |  |  |  |  |
| XH630PJ, XH800PJ, XS1600NE, XS2000NE, XS2500NE | 150 | 150 | 100 | 0 | 100 |

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

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

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


## Notes:

1: Always observe LINE/LOAD marking.
2: Ensure insulation on incoming conductors is adequate. Do not use low grade heat shrink (some grades split at operating temperatures).
3: Minimum clearance to earth metal,
Above and below breaker-120mm (XV1250NE-150mm) To sides of breaker -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.
${ }^{\circ}$ ) 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 $40-43 \mathrm{kA}$.

However, many Supply Authorities are now installing low impedance transformer eg. $5 \%$ or less. Thus if the impedance is $5 \%$ then the fault level will be 56 kA . If the impedance is unknown on the side of caution choose $Z=$ $5 \%$ in your calculations.
eg. From the table, the maximum fault level of a 2000 KVA transformer, with $Z=5 \%$ is 56 kA . Proceed then to calculate the resultant fault level by applying the cable size and length in metres to the Transformer secondary fault level and calculate the resultant. By following the example shown it can be seen that the fault level is reduced from 50 kA to 6.7 kA .

## Application notes

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

Ref No.
5006
5025
5093
5088
5067
5065
5074
5078
5087
5083
5086
5195

Description
Specification for corrosive proofing of MCCB's
De-rated current of ACB's when enclosed
De-rated current of MCCB's when enclosed
De-rating of TemBreak electronic MCCB's when enclosed
DC applications of ACB's
Reverse connection
Thyristor protection with MCCB's
ELCB's at high frequency
ACB's and MCCB's at high altitude
Circuit breaker life mechanical and electrical
TemBreak UVT: transient response time
Inspection and maintenance of earth leakage and moulded case circuit breakers.

## IP rating protection against ingress of dust and liquids



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

## XS400 series thermal magnetic type

Adjustment range 63-100\% of nominal current rating.
$\square$ Standards AS 2184/AS 3497-2.

- Max voltage (Insulation) 690V.

Adjustable thermal and magnetic trip.


XS400CJ (35kA) 3 pole
Ampere

| rating | Min | Max | Cat. No. |
| :---: | :---: | :---: | :---: |
| 250 | 160 | 250 | [- 5400 CJ 2503 3 |
| 400 | 250 | 400 | YS 500 CJ 4003 |
| 400 | Non-Aut | ( 0.3 sec ) | [XS400NN31] |

Short circuit capacity

| Model | I/C | Voltage |
| :--- | :--- | :--- |
| $X S 400 \mathrm{CJ}$ | $35 \mathrm{kA}(\mathrm{AS} \mathrm{2184)}$ | 415 V 50 Hz |
| $X S 400 \mathrm{NJ}$ | 50 kA | 415 V 50 Hz |
| DC use | $\left.I / \mathrm{C}{ }^{4}\right)$ | Voltage |
| $X S 400 \mathrm{CJ}$ | 40 kA | 250 VDC |
| $X S 400 \mathrm{NJ}$ | 40 kA | 250 VDC |

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

## XS400NJ (50kA) 3 pole

| 250 | 160 | 250 | $\times S 400 N 12503$ |
| :--- | :--- | :--- | :--- |
| 400 | 250 | 450 | $\times S 400 \mathrm{~N} 4003$ |



Dimensions (mm)

| Description |  | Height | Width | Depth | kg |
| :--- | :--- | :--- | :--- | :--- | :--- |
| XS400CJINJ | 3 pole | 260 | 140 | 103 | 4.7 |



Product extensions
Chassis (TemWay, MHC, UHC)
TemCurve
Residual current relays

Notes: ') Load-break isolating switch only - no protection. ${ }^{2}$ ) MCCB's only.

## Approvals

ASTA/UK, Aust. standards

## Marine

NKJJAPAN
LR/UK
AB/USA
GLGERMANY
BV/FRANCE
DNV NORWAY

Base standards
IEC 947-2
BS EN 60947 Part 2
VDE 0660 Part 1 AS 3947-2/Australia AS 2184-1990/Australia ${ }^{2}$
NEMA USA
ANSI C37. 13/USA
JIS C 8372/JAPAN
JEC 160/JAPAN

## Connections and mountings

MCCB accessories
Front-connection type (FC)

## Compression terminals



Attached flat bar


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

XE series
(Economical)
Pan headed screw


XS125NJ M8
M8

| XS series (Standard) | XH series (High-fault level) | XM series (Motor protection) |
| :---: | :---: | :---: |
| XS125CJ M8 | XH125NJ M8 | XM30PB M5 |
| XS125NJ M8 | XH125PJ M8 |  |

Hex socket head bolt

|  | XE225NC | M8 | XS250NJ | M8 | XH250NJ |
| :--- | :--- | :--- | :--- | :--- | :--- |
|  |  |  | M8 |  |  |
| XH160PJ | M8 |  |  |  |  |

## Connections and mountings

## MCCB accessories

## Rear-connection type (RC)

## Bolt stud

Horizontal (standard)

Flat bar stud


Applicable breakers
$\square$ XE series XE225NC

- XS series

XS250, XS400
XS630, XS800.

## - XH series

XH160, XH250, XH400, XH630, XH800.

- XM series

XM30РB.


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.
${ }^{1}$ ) Vertical arrangement also available on request, contact NHP for details.

## Types of connections and mountings

## MCCB accessories

Plug-in Type

## Switchboard use



Types of plug-in mounting blocks for
switchboard use

| Series | Breaker | Pole | Type |
| :---: | :---: | :---: | :---: |
| XS | XS125CJ | 2, 3, 门4 | XDM2 |
|  | XS125NJ |  |  |
|  | XE225NC | 3. i $^{\text {d }}$ | XDM3 |
|  | XS250NJ |  |  |
|  | XS400 | 3. ${ }^{1}$ | XDM4 |
|  | XS630 | 3, 团 | XDM6 |
|  | XS800 | 3, 4 | XDM6 |
|  | XS1250 | 3. $\square^{4}$ | (i) XDM8 |
|  |  |  |  |
|  |  |  |  |
| $\mathrm{XH} 250 \mathrm{PJ}, 3, \mathrm{i} 4, \mathrm{XDM} 4,4$, |  |  |  |
| XH 250 NJ <br> 3. $\square$ 4 XDM4 |  |  |  |
| x 4400 <br> 3. 4 $\square$ $\square$ XDM6 |  |  |  |
|  |  |  |  |
|  |  |  |  |
| XM XM30 |  |  |  |

## 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. <br> XS125 IP 20 $2,3 P$ $1=2$ <br> XH125    |  |  |  |

[^9]
## Types of connections and mountings

## Draw-out type (DO indent)

## Two-position type i

Applicable breakers
$\square$ XS series
XS400, XS630, XS800, XS 1250.

- XH series

XH160, XH250, XH400, XH630, XH800.
$\square$ The plug-in type breaker is housed in the draw-out cradle.
$\square$ 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.



## Crimp lugs (compression type)

| Nominal wire size ( $\mathrm{mm}^{2}$ ) |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Frame (A) | Breaker | 1.5 | 2.5 | 4 | 6 | 10 | 16 | 25 |  |
| XM30 | XM30PB | CAL1.5-5 | CAL2.5-5 | CAL4-5 | CAL6-5 | CAL10-5 | CAL16-6 |  |  |
|  |  | MT2.5-M5 | MT2.5-M5 | MT4-M5 | MT6-M5 | MT10-M5 | MT16-M5 |  | \% |
| 125 | XS125CJ | - | CAL2.5-8 | CAL4-8 | CAL6-8 | CAL10-8 | CAL16-8 | CAL25-8 | (x) |
|  | XS125NJ | MT2.5-M8 | MT2.5-M8 | MT4-M8 | MT6-M8 | MT10-M8 | MT16-M8 | MT25-M8 |  |
|  | XH125NJ |  |  |  |  |  |  |  | (T) |
|  | XH125PJ |  |  |  |  |  |  |  | $\rightarrow$ |
|  | TL100NJ |  |  |  |  |  |  |  |  |
|  | TL30F |  |  |  |  |  |  |  |  |



Commercially available compression terminals available from CABAC - Cable Accessories and JST Australia.
Key: $\mathrm{CAL}=\mathrm{CABAC}$ 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.


## XS400CJ, XS400NJ

Time/current characteristic curves


Ambient compensating curves


## TemBreak XS400

## Outline dimensions (mm)

## Front connected (standard)




Panel mount


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

## Plug-in (optional)



Motor operators for XS400
MCCB accessories

Outline dimensions (mm)
Front connected (standard)


ASL: Arrangement Standard Line
H: Handle frame centre line

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


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 ${ }^{2}$ 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 (lomex $)$ and Energy Let Through (I2T).
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.

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

Guide


Upstream MCCB
XS400SE




SRCB (1620A) S \&
Note: ") Dependant on the number of poles. Refer to NHP.

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

Guide


Selectivity Cascade
Upstream MCCB

| Downs MCCB | kA (rms) | $\begin{gathered} \text { XS400SE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH400SE } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS630SE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH630SE } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS800SE } \\ 50 \end{gathered}$ | $\begin{gathered} \text { XH800SE } \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS } 1250 S E \\ 65 \end{gathered}$ | $\begin{gathered} \text { XS1600 } \\ 85 \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |
| XS125NJ |  | 5/5 | 25/50 |  | +30/30. | 30/30 | 30/30 | 30/30 | 30/30 |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| XE225NC |  | 15/30 | 15/30 | 18/30 | 18/30 | 18/30 | 18/30 | $18 / 18$ | 18/1 |
|  |  |  |  |  |  |  |  |  |  |
| XH250NJ | 50 | 25/50 | 25/65 | 50/50 | 50/65 | 50/50 | 50/65 | 50/50 | 50/5 |
|  |  |  |  |  |  |  |  |  |  |
| XS400CJ | 35 | -150 | -/50 | 10/50 | 10/65 | 25/50 | 25/65 | 35/42 | 35/4 |
| XS $400 \mathrm{NJ}+4 \mathrm{l}$ |  |  |  |  |  |  |  |  |  |
| XS400SE | 50 |  | -165 | 10/50 | 10/65 | 25/50 | 25/65 | 50/65 | 50/65 |
|  |  |  |  |  |  |  |  |  |  |
| XH400SE | 65 |  |  | $10 / 50$ | 10/65 | 25/50 | 25/65 | 50/65 | 50 |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| XS630SE | 50 |  |  | - | -/65 |  |  | 30/65 | 30/85 |
|  |  |  |  |  |  |  |  |  |  |
| XH630SE | 65 |  |  |  |  |  |  | 30/65 | $30 / 85$ |
| XH630PE \% L - 65 , |  |  |  |  |  |  |  |  |  |
| XS800NJ | 65 |  |  |  |  |  |  | 15/65 | 20/85 |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| XH800PE |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |

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


Upstream MCCB

| MCCB | kA (rms) | XH125N 50 | CS250N 35 | H250 50 | $\begin{array}{r} \text { XS400 } \\ 35 \end{array}$ | $50$ | $50$ | $65$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | , | , |
|  |  |  |  |  |  |  |  |  |
| XH250NJ 50 - 50 - |  |  |  |  |  |  |  |  |
| XS400ct |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| H400NE $\quad 65$ - $\quad 6$. |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| XS630NJ $\quad \because \quad 65$ |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| XH630NE $\quad 655$ |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| XS1250NE |  |  |  |  |  |  |  |  |
| XS 1600 NE |  |  |  |  |  |  |  |  |



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

## Guide <br> 



## 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 What is co-ordination

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

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

It is a requirement of the Australian Standard AS 3947.4.1 that combination motor starters are capable of withstanding the effects of load side short circuits. Some damage to the combination is permitted, but this must be confined and not present a risk to the operator, or damage equipment adjacent to the starter.
Contactors and thermal overload relays only have limited ability to withstand the high current associated with a fault such as an internal motor short. Their design is optimised for performance at much lower currents and to design in the ability to control or withstand high fault levels would add to costs and possibly reduce its performance at normal levels.
The standards
The requirements of several standards can be applied to these combination units. The Wiring Rules, AS 3000, are concerned mainly with setting standards for the fixed wiring. In this regard the concern is the wiring between the protection device and the motor.

As motors can experience short term overloading the current rating of a fuse can be up 4 times and a circuit breaker 2.5 times the full load rating of the motor. The Wiring Rules allow the overload protection and the short circuit protection to be provided by different devices. This allows magnetic only circuit breakers, or back-up type fuses, to be used in conjunction with a contactor/thermal overload relay configuration.
Isolating switches must also be provided in the motor or control circuit. These are to be in clear view of any person working on the motor, or provided with a locking device.
AS 3947:4.1 specifies testing requirements for the combination of components required to perform the motor control and protection functions. If the equipment has been mounted in a switchboard it is possible to meet the testing requirements of AS 3947.2 short circuit withstand of the outgoing circuit at the same time as the tests to AS 3947.4.1 are performed.
Both standards look at the performance of the equipment when a fault occurs on the outgoing circuit. It is accepted in these standards that some damage may be sustained by the components of the starter when subjected to short circuit conditions.

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

## Type '1'

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

Type '2'
After a short circuit the starter is suitable for further service. A contact weld is permitted, but it must be easily separated - for example, by a screwdriver, without significant deformation.

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

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

Typical arrangement for co-ordination test


## 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 .


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

## TYPE 1 50kA

| Motor size kW | Approx. amps | Terasaki circuit breaker | Sprecher + Schuh contactor type | Sprecher + Schuh thermal overload relay type ${ }^{2}$ ) | Settings range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $0.37$ | 1.14 | $30 \mathrm{~PB} / 14$ | CA 7.9 | 4. | 0.16-10 |
| 0.55 - 1.5 |  | ХМЗ $30 \mathrm{~PB} / 2$ | CA 7-9 | CT 7-24 | 0.16-10 |
|  |  | ХM30PB/2 |  |  | 0.16-10 |
| 1.1 | 2.6 | ХМЗОРВ14.0 | CA 7 -9 | CT 7-24 | 0.16-10 |
| 15 | 34 | XM30Р ${ }^{\text {d/5 }}$ | CA79848 | CT. 7.24 | - |
| 22 | 4.8 | ХM30PB/8 | CA 7-9 | CT 7-24 | 0.16-10 |
| 30 | 5 | M $30 \mathrm{~PB} / 10$ | CAM ${ }^{\text {an }}$ | CT7-24 | $0.6-10$ |
| 4.0 | 8.2 | ХM30РB/12 | CA 79 | CT $7-24$ | 0.16-10 |
| $5.5$ | 11 | 8125NU120 | $C A>12$ |  | 0.16 t 6 |
| 75 | 14 | X $\mathrm{H} 125 \mathrm{NJ} / 20$ | CA 7-16 | CT 7-24 | 0.16-16 |
| $10$ | ) | $1125 N / 132$ | CA723 |  | , |
| 11 | 21 | $\times \mathrm{H} 125 \mathrm{NJ} / 32$ | CA 7-23. | CT 7-24 | 0.16-24 |
| 15 | 8 | +125NN/50 | CA $7-30$ U 4 | CT745 | 10. |
| 18.5 | 34 | XH125NJ/50 | CA 7 -37 | CT 7-45 | 30-45 |
| $22$ | $40$ | 125NJ/63. |  |  |  |
| 30 | 55 | XH125NJ/100 | CA $7-60$ | CT 7.75 | 18-60 |
| $37$ | $66$ | $X H 125 N / 100$ | CA77 72 | CT775 1875 |  |
| 45 |  | $\mathrm{XH125NJ} / 125$ ) | CA 7.85 | CT 7-100 | 70-90 |
| $55$ | $00$ | $1125 \mathrm{~N} / 25$ |  |  |  |
| 75 | 130 | XH250NJ/250 | CA 6-140-(EI) | CT 6-150 | 105-150 |
| $90$ | $155$ | $\times 14250 \mathrm{~N} / 2500$ | CA 6-170-El | CT 6-200 ${ }^{\text {cer }}$ |  |
| 110 | 200 | X $\mathrm{H} 250 \mathrm{NJ} / 250$ ) | CA 6-210-EI | CEF 1-41/42 | 1.60-400 |
| $132$ | 25 | $\times$ S400SE/400 | CA 6250 El | CEF 1-41/42 160-400 |  |
| 160 | 270 | XS400SE/400 | CA 6-300-EI | CEF 1-41/42 | 160-400 |
| $200$ | $61$ | S400SEI400 | CA 6-420EILA $5-450$ CEF 1-41/42 $\quad 160400$ |  |  |
| 250 | 425 | XS630SE/630 | CA 6-420-EI/ CA 5-450. CEF 1-52 |  | 160-630 |
| 315 | 30-s | 30 | A $5 \cdot 550$ | CEF 1-52 | 160 |

## 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 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.

## TYPE 2 50kA



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 <br> Motor starter co-ordination table for DOL starting 50kA at 415V to AS 3947-4-1

## TYPE 2 50 kA

| Motor size kW | Approx. amps | Terasaki circuit breaker | Sprecher + Schuh contactor type | thermal overload relay type ${ }^{1}$ ) | Settings range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| 055 | 1.5 | ХМЗЗОРВ/2 | CA $7-9$ | CT 7-24-1.6 | 1.1 |
|  |  |  |  |  |  |
| 1.1 | 2.6 | XM30РB/4.0 | CA 7.16 | CT 7-24-4 | 2.4 |
|  |  |  |  |  |  |
| 2.2 | 4.8. | XM30РB/8 | CA 7.16 | CT 7-24-6 | 4 |
|  |  |  |  |  |  |
| 4. | 8.2 | ХM30РВ/42 | CA 7 -30 | CT 7-24-10 | 6-10 |
|  |  |  |  |  |  |
|  | 14 | $\times \mathrm{H} 125 \mathrm{NJ} / 20$ | CA 7-30 | CT 7-24-16 | 10-16 |
|  |  |  |  |  |  |
| 15 | 28 | $\times \mathrm{H} 125 \mathrm{NJ} / 50$ | CA $7-43$ | CT 7-45-30 | 18-30 |
| 1850 |  |  |  |  |  |
| 22 | 40 | XH125NJ/63 | CA 7-43 | CT 7-45-45 | 30-45 |
|  |  |  |  |  |  |
| 37 | 66 | $\mathrm{XH} 125 \mathrm{NJ} / 100$ | CA 7 - 85 | CT $7-75^{2}$ ): | $60-75$ |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| 132 | 225 | $\times$ X 4000 SE/400 | CA 6-210-EI | CEF 1-41/42 | 160-400 |
|  |  |  |  |  |  |
| 200 | 361 | $\times$ X 400 SE/400 | CA 6-420-EI | CEF 1-4/1/42 | 160-400 |
| 200 | 361 | XS400SE/400 | CA 5-450 | CEF 1-22 ${ }^{2}$ | 160-400 |
|  |  |  |  |  |  |
| 320 | 538 | $\times$ S630SE/630 | CA 5-700 | CEF 1-52. ${ }^{2}$ ) | 160-630 |

Notes: ') Use 'magnetic only' breaker or next higher circuit breaker/contactor combination. Refer NHP.
${ }^{2}$ ) Use with separate mounting bracket.
${ }^{\text {J }}$ ) 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 85KA, 415V to AS 3947-4-1

## TYPE 2 85kA

| Motor size kW | Approx. FLC at 415 V amps | Terasaki circuit breaker | Sprecher + Schuh contactor type | thermal overload type ') | range amps |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| 0.55 | 1.5 | ХM30РP/2 | CA 7-9 | CEP 7-M32-2.9-10 | 1.0-2 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  | 8.2 | ХМЗ0РВ/10 | CA 7-30 | CEP 7-M32-12-10 | 3.7-12. |
|  |  |  |  |  |  |
| 7. | 14 | TL100NJ/20 | CA 7 -30 | CEP 7-M32-32-10 | 12-3 |
|  |  |  |  |  |  |
| 10 T 19 TL100NJ/32 CA7-30 ${ }^{\text {a }}$ CEP 7-M32-32-10 12-32 |  |  |  |  |  |
|  |  |  |  |  |  |
| 15. | 28 | TLL $100 \mathrm{NJ} / 50$ | CA 7-43 | CEP 7-M32-32-10 | 12-32 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| 37.266 TL100NJ/100 |  |  | CA 7-72 | CEP 7-M85-85-10 | 26-85 |
|  |  |  |  |  |  |
| 55 | 100 | TL250NJ/160 | CA 6-105 | CEF 1-11/12 | 0.5-180 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| 132 | 230 | TL400NE/400 | CA 6-210-EI | CEF 1-41/42/52 | 60-630 |
|  |  |  |  |  |  |
| 200 |  | TL400NE/400 | CA 6-420-EI | CEF 1-41/42/52 | 160-630 |

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.
${ }^{1}$ ) 80,100 and 125 amp refers to Din-T10H type.
${ }^{2}$ ) Type 'SE' TemBreak MCCB only
${ }^{3}$ ) Use magnetic-only TemBreak MCCB. Refer NHP.
Adjustable magnetic trips set to high. Thermal magnetic TemBreak adjustable 63\%-100\% of NRC (nominal rated current). Din-T MCB's are calibrated to IEC 898 Curve 'C' \& 'D'. Selected sizes of 'D' Curve are available from stock. Refer NHP.

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

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


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.

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

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




TemBreak XV400NE
mining breaker


[^10]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:
$\begin{array}{ll}\text { 1st re-arcing } & -3 \times \text { supply voltage } \\ \text { 2nd re-arcing } & -5 \times \text { supply voltage } \\ \text { 3rd re-arcing } & -7 \times \text { supply voltage }\end{array}$
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.
4. Nuisance tripping due to in-rush current When feeding a circuit containing a PFC unit the circuit breaker and the PFC unit can be exposed to a large in-rush current, equal to the instantaneous value of the power source. The end result of this is a large in-rush current, which could cause the circuit breaker to operate instantaneously due to its short-circuit protection. (The value of in-rush current will depend on the source voltage, the inductance and reactance in the circuit).
Special care should be taken to ensure that the MCCB selected will not nuisance trip due to high in-rush currents.
The table below shows typical MCCB selections for varying capacitor ratings, and the breaker selection is by a rule-ofthumb.

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

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

## MCCB's selection for power factor capacitor application

| Voltage 415V(3 $(3 \varnothing)$  <br> Capacitor Capacitor  <br> rating rated <br> (kVAR) current (A) | Recommended MCCB's $\left.{ }^{2}\right)^{2}$ ) <br> Type/Rating (A) |
| :---: | :---: |
|  |  |
| $10 \quad 13.9$ | XS125¢J/32 XS125NJ/32 XH125NJ/32 |
|  |  |
| 20 27.8 | XS125CJ/50 $\quad$ XS $125 \mathrm{NJ} / 50 \quad \mathrm{XH} 125 \mathrm{NJ} / 50$ |
|  |  |
| $30 \quad 41.7$ | XS125CJ/100 XS125NJ/100 XH125NJ/100 |
| $40 \quad 55.6$ |  |
| $50 \quad 69.6$ | XS125CJ/125 XS125NJ/125 XS125NJ/125 |
|  |  |
| $100 \quad 139$ | XE225NC/225 XS250NJ/250 XH250NJ/250 XS400SE/250 XH400SE/250 |
|  |  |
| $200 \% 278$ | X XS400CJ/400 XS400NJ/400 XS400SE/400 XH400SE/400 |
|  |  |
| $400 \quad 556$ | XS800NJ/800 XS800SE/800 XH800SE/800 |
|  |  |
| 600 - $835 \quad \therefore$ S 1250 SE1250 |  |
|  |  |
| 1000 1391 | XS2000'SE/2000 |

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

## MCCB use in high frequency ( 400 Hz ) applications

General
Terasaki TemBreak MCCB's are designed to operate primarily in 50 or 60 Hz systems. However, it is possible to use the same MCCB's in high frequency $(400 \mathrm{~Hz})$ applications provided consideration is taken to the effects high frequencies will have on the breaker.
A consequence of high frequencies is an increase in Eddy currents in conductors, including those internal to the breakers. This generally causes an increase of temperature in and around the breaker. As such, some derating allowances must be made when selecting a breaker in these 400 Hz systems.

Thermal Magnetic MCCB's
In low overload (thermal) regions the current required to trip the MCCB is reduced as a result of the heat generated due
to the higher Eddy currents. As a result the thermal protection must be derated to take the heating effect into account.
In short-circuit (magnetic) regions, the demagnetising effects of the Eddy currents mean that a larger fault will be required to trip the breaker. The rule of thumb generally used is that the Magnetic/Instantaneous Trip setting will be approximately twice that at normal $50 / 60 \mathrm{~Hz}$ operation.
Electronic MCCB's
Electronic MCCB's offer better performance at higher frequencies, although some consideration must be taken with regards to the heating effects caused by the Eddy currents. The figures in the table give the maximum Over Current Relay (OCR) rated current setting ( $l_{0} \times I_{1}$ ) that should be used when in high frequency applications.

| MCCB <br> Model | $\begin{aligned} & \text { MCCB } \\ & \text { Type } \end{aligned}$ | Rating at $50 / 60 \mathrm{~Hz}$ (A) | Cable size in $\mathrm{mm}^{2}$ asspecified IEC 947-1 | MCCB rating at 400 Hz <br> (A) |
| :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| XH160PJ Th/Mag 160 |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| XS250NJ | Th/Mag | 160 | 70 | 147 |
|  |  | 250 | 120 | 210 |
|  |  |  |  |  |
|  |  |  |  |  |
| XH250pJ | Th/Mag | 250 | 120 | 240 |
|  |  |  |  |  |
|  |  |  |  |  |
| XS630CJ | Th/Mag | 400 | 240 | 320 |
| $\times 5630 \mathrm{NJ}$ |  | 630 | $2 \times 185$ | 475 |
|  |  |  |  |  |
| XS400SE | Electron | 250 | 120 | 238 |
| XH400NE/SE/PE | Electron | : 400 | 240 | 360 |
| XS630SE | ectro | $630$ | $\times 18$ |  |
|  |  |  |  |  |
| XS800SE | Electron | 800 | $2 \times 240$ | 640 |
| XH800NE/SE/PE |  |  |  |  |
|  |  |  |  |  |
| XS1600SE | Electron | 1600 | $2 \times(100 \times 5 t)$ | 900 |

Note: When used at 400 Hz , the rated current setting of the OCR 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.

Rated voltage which determines the number of poles required to be involved in the interruption of the circuit.

- The type of DC system used.
- Maximum short circuit current to determine the breaking capacity.
As a general rule the Isc (short circuit current at the battery terminals) can be calculated as follows:

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

Where Vb - maximum discharge battery voltage
Where Ri - internal resistance (sum of all calls resistance) generally expressed in Ampere/hour capacity of the battery.

## Terasaki MCB use in DC systems

| MCB type | Breaking capacity kA ${ }^{1}$ ) | of poles connected in s |  |  |  | No. of operations at In | Magnetic trip increase |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | 24/48V | 110 V DC | 125V DC | 250 V DC |  |  |
|  |  |  |  |  |  |  |  |
| Din-T10 | 10 | 1 pole | 2 pole |  |  | 4000 | 40\% |
|  |  |  |  |  |  |  |  |
| Din-T15 10\%\%, 1 pole, 2 pole |  |  |  |  |  |  |  |
| et |  |  |  |  |  |  |  |

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
(ype

## Notes:

${ }^{1}$ ) Time constant ( $L R$ ) $<=15 \mathrm{~ms}$; excludes 50/63A where the time constant ( $\llcorner$ 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 250V 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 x in).
less than 7 ms for short circuit $\leq 10 \mathrm{kA}$.
less than 15 ms for short circuit > 10 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
$\mathbf{P}=\quad$ Rated capacity of welder in kVA.
$\mathbf{V}=\quad$ Welder rated voltage.
$11=\quad$ Maximum primary current (PN).
$\mathrm{T}_{1}=$ Current 'ON' period.
$\mathrm{T}_{2}=$ Current 'OFF' period.
$T_{1}+T_{2}=$ One welding cycle time.
$\mathbf{B}=\quad$ 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:

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

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, $\mathrm{T}_{1}$ 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, $I m$, 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 $A$
1 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 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


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

| Type of fitting | Power (W) | Number of fittings per phase |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Single compensated | 20 | 64 94 | 113 | 143 | 166 | 200 |
|  | 40 | $32 \quad 47$ | . 57 | 72 | 83 | 110 |
|  | 65 | $20 \quad 29$ | 35 | 44 | 51 | 70 |
|  | 80 | 16 : 23 | 28 | 36 | 41 | 55 |
|  |  |  |  |  |  |  |
| Itwin |  |  |  |  |  |  |
| compensated | $2 \times 65^{\circ} 10 \quad 14 \quad 22 \quad 17 \quad 35 \quad 1 \quad 0 \quad 10$ |  |  |  |  |  |
|  | $2 \times 80$ | 8 -11. |  | 17. | 20 | 30 |
| Recommended | Amps | 10 16 | 20 | 25 | 32 | 50 |

MCB rating

## 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
1 inst $\quad=$ 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 МССВ.
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 380/415V
When earth metal is installed within the proximity of the breakers the correct insulating distance must be maintained.

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

Notes: When using the terminal bar (optional), the specified insulating distance must be maintained. All dimensions in mm.
When earthed metal is installed within the proximity of the breakers the correct insulating distance must be maintained (refer to Table 1). This distance is necessary to allow the exhausted arc gases to disperse.
right up to the terminal opening of the MCCB. This also applies to the attached busbars supplied as a proprietory part with the MCCB.
Proprietary type interpole barriers may be used to achieve creepage and clearance requirements.
Conductors must not impede the flow of ionised gas.

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


Table 1 below illustrates the min clearance that must be maintained
A Distance from lower breaker to open charging part of terminal on upper breaker (front connection) or the distance from lower breaker to upper breaker end (rear connection and plug-in type)

B1 Distance from breaker end to ceiling (earthed metal)
Table 1
This table is valid for $380 / 415 \mathrm{~V}$

| MCCB type | A | B1 | B2 | C | D |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| XS125CJ, XS 125NJ, XH125NJ, XH125PJ | 75 | 45. | 25 | 0 | 25 |
| XE225NC, \% |  |  |  |  |  |
| XS250NJ | 80 | 60 | 30 | 0 | 25 |
|  |  |  |  |  |  |
| XH250PJ, XS400CJ, XS400NJ, XS400SE | 100 | 70 | 40 | 0 | 30 |
|  |  |  |  |  |  |
| XH630SE, XH800SE, XH800PE 150 80 50 0 40 |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

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

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

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

These problems affect all circuit breaker installations to varying degrees
To ensure that problems are not created by the installation please observe the following recommendations.


## Notes:

1: Always observe LINE/LOAD marking
2: Ensure insulation on incoming conductors is adequate. Do not use low grade heat shrink (5ome 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.


## 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 50kA to 6.7kA.



## 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



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

## Refer Catalogue SO5

## Dimensions (mm)

Planning example for panel (hole distances)
preferred Drill alternate


Panel thickness range $1 . . .6 \mathrm{~mm}$ Maximum panel thickness reduced when optional legend plate holders are used

Standard momentary pushbutton flush (eg. D5P-F1)


Standard momentary pushbutton guarded (eg. D5P-G1)


Standard maintained pushbutton flush (eg. D5P-FA1)


| Front element | Legend plate carrier used | $X$ | $Y$ |
| :--- | :--- | :---: | :---: |
| Pushbutton | Any | 30 | 50 |
| Mushroom operators 40 mm | Any | 40 | 50 |
| Mushroom operators 60 mm | Any | 60 | 60 |
| Selector jog | Any | 48 | 50 |
| Any | 60 mm diameter | 60 | 60 |
| Any | 90 mm diameter | 90 | 90 |

Illuminated momentary pushbutton flush (eg. D5P-LF3)

llluminated momentary pushbutton guarded (eg. D5S-LG3)


Standard reset operator
(eg. D5P-R607W with D5-ATR...)


Ifluminated maintained pushbutton flush (eg. D5P-LFA3)


Standard and illuminated
momentary pushbutton extended
(eg. D5P-E1 \& D5P-LE3)




Individual part Cat. No.


## Refer Catalogue SD5

## Contact blocks (colour coded)



D5-3X..
for front mounting


D5-3BX... for base mounting


- Snap onto the inside of the enclosure base or onto a hat rail, or secure with two screwed fixing straps
- 3 contact blocks in one contact level possible

Possibilities to combine (Front mounting)
There are maximum 6 contact blocks to be combined


| Technical information |  |
| :--- | :--- |
|  |  |
| Rated thermal current $I_{\text {th }}$ |  |
| without enclosure | (ambient $40^{\circ} \mathrm{C}$ ) |
| with enclosure | $\left(\right.$ ambient $60^{\circ} \mathrm{C}$ ) |

Rated operating voltage $U_{e}$


690 V AC

## Contact travel

85-...

$.3 \mathrm{BX01L}$
O Front or base mounting
O Small overall depth
O Simple snap-on contacts
O Easy to wire
O Self-cleaning contacts
O N/O-Green
O N/C - Red
O Low voltage - Blue

Technical information, continued
Rated operating current $f_{e}$

|  | 24 V | 48 V | 110 V | $220 \mathrm{~V} 230 / 240 \mathrm{~V}$ |  |
| :--- | ---: | ---: | ---: | ---: | ---: |
| $\mathrm{AC}-1$ |  |  |  | 10 A | 10 A |
| $\mathrm{AC}-15$ | 8 A | 8 A | 6 A | 3 A | 3 A |
|  |  | 380 V | 400 V | 415 V | 500 V |
|  |  |  |  | 690 V |  |
| $\mathrm{AC}-1$ | 2.5 A | 2 A | 2.2 A | 1.5 A | 0.75 A |
| $\mathrm{AC}-15$ |  |  |  |  |  |

Rated operating current $/ e$, continued

| DC-13 | 24 V | 48 V | 110 V | 125 V | 220 V |
| :--- | ---: | ---: | ---: | ---: | ---: |
| $-01,-10$ | 3 A | 1.5 A | 0.2 A | 0.6 A | 0.1 A |
| $-01,-\mathrm{E} 10$ | 1.3 A | 0.4 A | 0.13 A | 0.13 A | 65 mA |
| $\mathrm{DC}-13$ | 250 V | 400 V | 440 V | 500 V | 600 V |
| $-01,-10$ | 0.3 A | 0.2 A | 0.04 A | 0.15 A | 0.13 A |
| $-01,-\mathrm{E} 10$ | 65 mA | 26 mA | 26 mA |  |  |

Short-circuit withstand without welding

10 A slow (DT, gG)
6000 operations/hour

| fast (D, gF) | 16 A |
| :--- | :--- |
| slow (DT, gG) | 10 A |

Electrical life

| $\mathrm{AC}-11$ | 0.1 A | 1 A | 2 A | 3 A |
| :--- | :---: | :---: | :---: | :---: |
| millions of operations | 10 | 3 | 1 | 0.5 |
| Contact duty | electronic circuit (H-type- bridges) |  |  |  |
|  | positive opening $\Theta$ | for: $\mathrm{D} 5-3 \times 01$ |  |  |
|  |  |  | D5-3B $\times 01$ |  |



Refer Catalogue SD5

## Lamp elements



D5-3D0.
D5-3R...

## Versions

D5-3D0, D5-3R...


Standard element
Operating voltage max. 250 V
D5-3DD0


With central lamp test Operating voltage max. 250 V

D5-3DB0, D5-3RB..


With series diode and resistor 220 V AC or 240 V AC supply. Use incandescent lamp $130 \mathrm{~V} / 2.4 \mathrm{~W}$ D5-3RDD..


With central lamp test With series diode and resistor 220 V AC or 240 V AC supply Use incandescent lamp $130 \mathrm{~V} / 2.4 \mathrm{~W}$

## Technical information

Lamp socket
Lamp ratings max.
2 W (2.6 W for Pilot lights)
Terminal marking
Terminals according to DIN EN 50013
$0.75 \ldots 2.5 \mathrm{~mm}^{2}$
O Front or base mounting
O Small overall depth
O Easy to wire
O Self-cleaning contacts

Possibilities to combine
D5-3D0, D5-3R... are to be combined with maximum 4 contact blocks or 2 contact blocks and one transformer.


D5-3DD0, D5-3RDD... are to be combined with maximum 2 contact blocks


## Transformers



D5-3TS...


Technical information

## Performance

Terminal marking
Terminals
Lamp socket


D5-3T... (without clear lamp)




## (7) finder



## Catalogue Number:

### 55.32.0054 240VAC

Description:

## RLY W/PB+LED FPIN 2CO 10A

List Price \$ (Not including GST):
$\square$
Unit of Measure:

## EA

Price Schedule:
B2

## Relays-plug-in type

## Flat pin <br> Contact arrangement <br> $2 \mathrm{C} \circ$ <br> Voltage <br> 240 VAC <br> Number of pins <br> 8 <br> Features

- Miniature control relay 2 changeover contacts rated at 10amps 250VAC (AC1)
- LED and press to test as standard. Press to test can be latched
- $2 \mathrm{~mm} \times 0.5 \mathrm{~mm}$ flat pins suitable for plug-in sockets
- PCB mounting
- Small dimensions
- Designed and manufactured to common standards
- Approved by intemational standards
- A large range of bases and sockets including various types of mounting such as DIN rail, rear connected panel mounting, plug-in PCB mounting
- Selection of options include gold flashed contacts, manual test button, flange mounting. high temperature versions and hermetically sealed versions


## Benefits

- Capable of switching a number of substantial loads
- Visual indication for coil operation and latching enables simultaneous testing
- Can fit directly onto printed circuit boards for power switching
- Reduced panel space required to keep switchboard costs to a minimum
- This relay can be offered to manufacturers who export equipment that require these compliance approvals
- Gold contacts offer better switching at lower currents


## (4) Tinder

## Catalogue Number:

### 55.32.0040 24VDC

Description:


RLY W/PB+FLAG 2CO 10A
List Price \$ (Not including GST):
(8)

Unit of Measure:
EA
Price Schedule:
B2

## Relays-plug-in type

Flat pin

Contact arrangement
2 C/O
Voltage
24 VDC
Number of pins
8
Features

- Miniature control relay 2 changeover contacts. 24VDC 10amp (10A 250V AC-1)
- With press-to-test button \& flag, but without LED
- $2 \mathrm{~mm} \times 0.5 \mathrm{~mm}$ flat pins suitable for plug-in sockets
- PCB mounting
- Small dimensions
- Designed and manufactured to common standards
- Approved by international standards
- A large range of bases and sockets including various types of mounting such as DilN rail, rear connected panel mounting. plug-in

PCB mounting

- Selection of options include gold flashed contacts, flange mounting, high temperature versions and hermetically sealed versions

Benefits

- Capable of switching a number of substantial loads
- Visual indication for coil operation and latching enables simultaneous testing
- Can fit directly onto printed circuit boards for power switching
- Reduced panel space required to keep switchboard costs to a minimum
- This relay can be offered to manufacturers who export equipment that require these compliance approvals
- Gold contacts offer better switching at lower currents


|  |  |  |
| :---: | :---: | :---: |
| Rêéer Catalogue- $F 1$ <br> (1) finder ${ }^{\circ}$ <br> The power infrelays since 1954 |  | (71) finder |
|  | Cat. No. | 38.51 |
|  | Description | Relay interface module. |
|  | Contact Data <br> Number \& type <br> Switching current/voltage <br> Max. voltage <br> Dielectric strength (to frame) | $\begin{aligned} & 1 \mathrm{C} / \mathrm{O} \\ & 6 \mathrm{amp} 250 \mathrm{~V}(\mathrm{AC} 1) \\ & 250 \mathrm{VAC} \\ & 4 \mathrm{kV} \text { (coil to contact) } \end{aligned}$ |
|  | Coil data: <br> Supply <br> AC <br> DC | 12, 24 |
| -5ythen | Resistance (ohms) $A C$ <br> DC | $848,3390$ |
|  | ```Current (mA) AC DC``` | $14,7$ |
|  | Power | 0.17 W DC |
|  | Tolerance | $\text { DC }-30 \% \text { to }+$ |
|  | Dimensions ( HxWxProjection mm max.) | $34.5128 \times 5 \times 15$ |
|  | Features | Compact DIN mount Low coil consumtion LED status indication |
|  | Connection diagram | $\left.\right\|_{0} ^{12}$ |
|  | Bases | Not applicable. |

Please read these instructions before use, for proper operation. Please see catalogue for details:

## CAUTIONS FOR OPERATION

$\triangle$ WARNING

- Do not use in a combustible gas environment. It may cause an explosion.


## Before use

1. Before installing, check the frequency and voltage of the region and set the frequency change shaft accordingly.
2. Don't press the reset button with pencil. If the lead of pencil goes inside, the hour mēter might caūse malfuñction.
3. For cleaning the case and cover, do not use thinner or other organic solvents. Such cleaners will dull the surface and can cause cracks.
4. Prevent operating the time switches under the following conditions - ambient temperature of less than $-10^{\circ} \mathrm{C}$ or higher than $+50^{\circ} \mathrm{C}$

- very dusty area
- directly rain/drip exposed area
- very vibratory area


## Panel mounting



## Wiring method

© TH13,23,14,24,40,50,63,64
 make the connection to the accessory flat type connecting lug and connect to the terminals of the meter (Be sure to use the accessory insulating sleeves for covering the terminals.) For TH70, lead terminal shall be soldered with soldering iron.


## For CE marking products

1. EMC directive ( $89 / 336 / E E C$ )

TH series hour meter have conformity to the EMC directive as a device itself. Contorming norms EN50081-2, EN61000-6-2
2. Low voltage directive ( $73 / 23 / \mathrm{EEC}$ )

The condition described below should be followed in order to satisty the EN61010-1 conformity. Environmental conditions: Overvoltage categories II, Pollution degree 2, Indoor use

Ambient temperature/humidity - 10 to $50^{\circ} \mathrm{C} /$ Max. $85 \% \mathrm{RH}$
Matsushita Electric Works, Ltd. Automation Controls Company
Head Office: 1048, Kadoma, Kadoma-shi, Osaka 571-8686, Japan
Telephone: Japan(81)Osaka(06)6908-1050
Facsimile: Japan(81)Osaka(06)6908-5781

－TH13，23，14，24，40，50，63，64

ご使用前にこの説明曹をお読みいただき，正しくお使いください。尚，詳しくはカタログをご覧ください。
安全全上のご注意 けかや取故防止のため，以下のことを必ずお守りください。
 の安全対策を組み込んてくぐさい。


## －注意

－端子結線は確实に行ってください。結線が不交分な場合は，畀常発慜や発䙅の原因と なります。



## 己信用前层

－こ使用になる地域の眶源（周波数，疋住）が，本体表示と合っていることを確認してくだ さい。 $50 / 60 \mathrm{~Hz}$ 共用タイフは，Hz切替䩜をご使用の周波数側に切替えてください。
2．リセットボタンはエンビツの先などで押さないでください。折れた惢などがゆ唿に入口故隐の原因になります。（TH23，24，40，50，64）
3．本体ケースやカノーの汚れをシンナーなどの有煖焒剤で拭かないでください。くもりや ひび割れを生じることがあります。
4．次のような場所では使用しないてください。

- 周弗温度が一10C以下，＋50 以 以上の場所
- 湿気，ホコリ，カスの名し場所

O屋外などの雨や日光の直接当たる場所


## パネルカットす法



THI4．24，40．

－付四の平型沒統子に結線して，本体の端子 （\＃187）と援䊺してください。この堨合必す゚付廆の絶縁スリーブを綬せてご使用 ください。（TH13．23．14．24．40．50．63．64）
リード粮を半田付はして結線してください。 （TH70）

## 



## CEマ．ーキング対広について

1．EMC指令（89／336／EEC）
THシリースアワーメータは，鬥置単体としてEMC指令に過合しています。適用規格 EN50081－2，EN61000－6－2
2．低疑任指令（73／23／EEC）
EN61010－1を洞足させるために，下記の現境条件でご使用ください。場境条件：週㱜圧カテコリーII，污染度2，屋内使用使用温度／湿度 $-10 \sim+50^{\circ} \mathrm{C} / 85 \% \mathrm{RH}$ 以下

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## MultiTrode relay 240vac (mTR 2) installation Sheet. No1

CONTROL OF THREE APPLIANCES IN A CHARGING SITUATION


| RELAY PROGRAM FUNCTIONS |  |
| :---: | :---: |
| $\begin{aligned} & \text { SWTCH No } \\ & \text { SETING } \\ & 1 \quad 2 \\ & \hline \end{aligned}$ | SENSITVYTY |
| OFF OFF | $1 \mathrm{k} \Omega$ Concentroted Acids, Minerals, Alkalines |
| OFF ON | $4 k \Omega \quad \begin{aligned} & \text { Acids, Alkalines, Diluted } \\ & \text { brine, Seo water }\end{aligned}$ |
| ON OFF | $20 \mathrm{~K} \Omega \begin{aligned} & \text { Sullage,Sewage effluent } \\ & \text { Town woter }\end{aligned}$ |
| ON ON | $80 \mathrm{k} \Omega \begin{aligned} & \text { Low conductive liquids, } \\ & \text { Purifled water }\end{aligned}$ |
| $3 \quad 4 \quad 5$ | DELAY ON ACTIVATON |
| OFF OFF OFF | Zero Seconds |
| OFF OFF ON | 2.5 Seconds |
| OFF ON OFF | 5 Seconds |
| OFF ON ON | 10 Seconds |
| ON OFF OFF | 20 Seconds |
| ON OFF ON | 40 Seconds |
| ON ON OFF | 80 Seconds |
| ON ON ON | 160 Seconds |
| 6 | MODE |
| OFF | Discharge |
| ON | Chorge |
|  | DIMENSIONS IN mm. |
|  |  |

## MultiTrode relay 240vac (mtr 2) installation Sheet. noz

CONTROL OF THREE APPLIANCES IN A DISCHARGING SITUATION


## DAAX1YM24

 PAA01XM24 DMBX1YM24 PMB01XM24

Electronic timers
Elektronische zeitrelais Minuteris électroniques Temporizzatore elettronico Elektroniske timere

## [NGLISH

(1) Connections (DAA, DMB) Connect the power supply
to the terminals A1 and $A 2$ to the terminals A1 and A2. Connect the trigger input $S$ between terminals A1 and Y1 (DMBX1 versions only). Connect the relay output according to the ratings as shown in the side diagrams.

SP174 Jesmond Rog
installationshinweise Notice d'installation Instrucciones de instalación Istruzioni per l'installazione Installationsvejledning

## D

(1) Anschlüsse: (DAA, DMB) Schliessen Sie die Betriebsspannung an die Klemmen A1 und A2 und den Schalteingang S zwis chen A 1 und Y 1 an (Nur bei Typ DMX01). Schliessen Sie den Relaisausgang entsprechend den Betriebsdaten an, wie in den Bildern links dargestellt

Keep power OFF Achten Sie während Achten Sie während
dem Anschließen au Spannungsfreiheit
(2) Anschlüsse: (PAA, PMB) Schliessen Sie die Betriebsspannung an 2 und 10 und den Schalteingang 5 zwischen 2 und 5 an (Nur Swischen 2 und 5 an (Nur Sie den Relaisausgang entsprechend den Betriebsdaten an, wie in den Bildern links dargestellt.

Achten Sie während dem Anschließen au Spannungsfreiheit!
(3) Setting of function, time range and delay time Select the desired time range by the lower knob on front as shown on the left.

Adjust the time period on relative scale: 1 to 10 with respect to the chosen range, as shown on the left.
(DMBX1 and PMB01) Select the desired function by the upper knob as shown on the left:

Op: Delay on Operate
In: Interval
2) Connections (PAA, PMB) Connect the power supply to the terminals 2 and 10 . between terminals 2 and 5 (PMB01 versions only). Connect the relay output according to the ratings as shown in the side diagrams.

Keep power OFF while connecting!

$\triangle$
(3) Einstellung von Funktion, Zeitbereich Verzögerungszeit Wählen Sie den gewünscht en Zeitbereich mit dem unteren Drehknopf, wie links im Bild dargestellt.

Stellen Sie, wie links dargestellt, mit dem mit tleren Knopf die Zeit auf der relativen Skala ein: Von 1 bis 10, bezogen auf den gewählten Zeitbereich
(DMBX1 und PMOB1) Wählen Sie eine Funktion Wahlen Sie eine Funktion wie links im Bild dargestellt.

Op: Ansprechverzögerung In: Intervall
HRANCAIS
(1) Raccordements (DAA, DMB)
Raccorder l'alimentation aux bornes A1 et A2. Raccorder l'entrée $S$ du circuit de déclenchement entre les bornes A1 et Y1 (versions DMBX1 seulement). Raccorder le relais de sortie en fonction des caractéristiques comme indiqué dans les diagrammes de côté.

Couper l'alimentation lors des raccordements!
(2) Raccordements (PAA, PMB) Raccorder l'alimentation aux bornes 2 et 10 . Raccorder l'entrée 2 et du circuit de lentree $S$ du circuit de bornes 2 et 5 (versions PMB01 2 seulement). Raccorder le relais de sortie en fonction des caractéristiques comme indiqué dans les diagrammes de côte. Couper l'alimentation lors des raccordements!
(3) Paramétrage de la fonction, gamme de temps et durée temporisation
Sélectionner la gamme de Selectionner la gamme de temps souhaitee au moyen avant comme indique à avant cone

## gauche.

Ajuster la période de temps en échelle relative: 1 à 10 par rapport à la gamme ton central de réglage comme indiqué à gauche.
(DMBX1 et PMB01) Selectionner la fonction souhaitée au moyen du bouton du haut comme indiqué à gauche:
Op: temporisation travail In: Intervalle
mananinstructionsin Switchbaftifg andanstallation by skilled people only!
rachpersonal
Montage et installation par des personnes habilitees seulement El montaje y instalación ha de realizarlo solo personal con experiencia! Il montaggio e l'installazione va eseguito da parte di personale addestrato! Montering og installation må kun foretages af faguddannede personer! ESPANOL
(1) Conexiones (DAA, DMB) Conexiones (DAA, DMB) Conectar la alimentación a os terminales A1 y A2 Conectar la entrada de dis paro $S$ entre los terminales A1 e Y1 (sólo para la versión DMBX1). Conectar la salida de relé según las escalas como se muestra en los dia gramas laterales.

Desconecte la alimentación antes de realizar las conexiones!
(2) Conexiones (PAA, PMB) Conectar la alimentación a Conectar la entrada de dis conectar la entrada de dis5 (sólo para la versión PMB01). Conectar la salida de relé según las escalas como se muestra en los diagramas.

Desconecte la alimentación antes de realizar las conexio nes!
(3) Ajuste de la función, escala de tiempo y retardo Seleccionar la escala de iempo deseada con el do en el frontal como se muestra en la figura Con el potenciómetro central ajus ar el periodo de tiempo a escala relativa de 1 a 10 según el rango respectivo elegido, como se muestra en la figura.

DMBX1 and PMB01 Seleccionar la función deseada con el poten ciómetro superior situado en el frontal, como se mues ra en la figura.
Op: Retardo a la conexión In: Inten~1-
ITIALIANO
(1) Collegamenti (DAA, DMB) Collegare l'alimentazione ai terminali A1 e A2. Collegare lingresso trigger $S$ tra i terminali A1 e Y 1 (solo version DMBX1). Collegare l'uscita relè secondo i valori di carico indicati nel diagramma a sx.
(1) Forbindels Slut stromforsyningen til terminal A1 og A2. Forbind triggerindgang $S$ mellem terminal A1 og Y1 (kun DMBX1udgaver). Tilslut den relæstyrede udgang i orhold til belastningen, som vist i diagrammerne ved siden af.

$\triangle$Staccare l'alimentazione prima di colle gare lo strumento!
(2) Collegamenti (PAA, PMB) Collegare l'alimentazione ai terminali 2 e 10. Collegare terminali 2 e 10. Collegare ingresso trigger S tra iter-
minali 2 e 5 (solo version PMB01). Collegare l'uscita relè secondo i valori di carico indicati nel diagramma a sx.

Forsyningen skal æære koblet fra, mens orbindelserne etableres!
(2) Forbindelser (PAA, PMB) Slut stromforsyningen til terminal 2 og 10. Forbind triggerindgang $S$ mellem terminal 2 og 5 (kun PMB01udgaver). Tilslut den relæstyrede udgang forhold til belastningen, som vist i diagrammerne ved siden af.

$\triangle$Staccare l'alimentazione prima di colle gare lo strumento.

Forsyningen skal ære koblet fra, mens orbindelserne etablees!
(3) Programmazione di fun- (3) Indstilling af funktion, tidszione, gamma tempi e område og forsinkelsestempo di ritardo Selezionare la gamma Selezionare la gamma manopola inferiore sul fronte dello strumento sul fronte figura a sx). Regolare il periodo di tempo su scala relativa: 1 a 10 rispetto alla gamma tempi impostata regolando la manopola centrale come indicato nella figura a sx .
(DMBX1 e PMB01). Selezionare la funzione desiderata tramite la manopola superiore come indicato nella figura a $s x$ :
Op: Ritardo all'eccitazione In: Intervallo
periode
and onsked tidsom Vælg det onskede tidsomade ved hjælp ar vist til venstre. vist

Indstil tidsperioden på relativ skala: 1 til 10 i forhold til det valgte område. Brug den indstillingen, som vist til venstre.
(DMBX1 og PMB01) Vælg den onskede funktion ved hjælp af den øverste knap, som vist til venstre

Op: Indkoblingsforsinkelse ln: Inten!al
 Schalteir offen
Id: Zweifacnes Intervall Dr: Ruckfallverzögerung R: Symmetrischer Taktgeber (zuerst EIN) Rb: Symmetrischer Taktgeber (zuerst AUS)

## demarrage au relấchement

 d: Double intervalle Dr: temporisation au relachementR: Clignoteur symétrique (ON d'abord)
Rb: Clignoteur symétrique
o: Interval on trigger ope d: Double Interval
Dr: Delay on release
R: Symmetrical recycler (ON first)
b: Symmetrical recycle (OFF first)

ncorrect selection o the time range causes fast blinkin of the yellow LE

Mechanical (DAA and DMB)
mounting
Hang the device to the DIN ail being sure that the spring closes. Use a screw driver to remove the produc as shown on the left

## Startup and adjustment

Check if the connections are correct. Turn the power sup ply $O N$, the green LED mode ON. The working olected function chematized on the sid abel. The
he yeflow LED is ON when the relay is energized, it and blinks fast in case of wrong set-up. (OFF d'abord)
6) Hinweis auf.

| DAA, DMB | PAA, PME | (7) Terminals | (7) Anschlussklemmen |
| :---: | :---: | :---: | :---: |
| A1, A2 | 2, 10 | Power supply. | Betriebsspannung |
| A1, Y1 | 2, 5 | Trigger input (DMB, PMB) | Schalteingang (DMB, PMB) |
| 15, 16, 18 | 1, 3, 4 | Relay output. | Relaisausgang |
| 25, 26, 28 | 8,9,11 | 2nd relay output (DPDT versions). | Zweiter Relaisausgang (Typen mit 2-pol. Wechsler). |
|  |  | Each terminal can accept up | Leiterquerschnitt pro |
|  |  | to $2.5 \mathrm{~mm}^{2}$ wires for DAA51 | Anschlußklemme: |
|  |  | and DMB51 and $2 \times 2.5 \mathrm{~mm}^{2}$ | bis $1 \times 2,5 \mathrm{~mm} 2$ (DAA51 und |
|  |  | wires for DAAD1 and | DMB51) |
|  |  | DMB01. | und $2 \times 2,5 \mathrm{~mm} 2$ (DAAO1 |
|  |  |  | und DMB01) |

6) Note

The packing material should be kept for redelivery in case of replacement or repair.
(7) Terminals

Power supply

Relay output.
nd relay output (DPDT ver-
Each terminal can accept up and DMB51 and $2 \times 2.5 \mathrm{~mm}^{2}$ wires for DAAD1 and DMB01.

Lorsque la gamme de temps sélectionnée est incorrecte, la LED jaune clignote rapide ment
(4) Montage (DAA und DMB) Hängen Sie das Relais in die DIN-Schiene ein; die Feder muss einrasten. Bauen Sie das Relais mit eine Schraubendreher aus, so wie links dargestellt.

## Einschalten und

 Einsteflungen Prüfen Sie die Anschlüsse auf Fehlerfreiheit. Schalten Sie die Betriebsspannung $E \mathbb{N}$, die grune Funktionsweise abhängig von der gewählten Funktion, ist auf der Seite des Pelais dargestellt Die gelbe LED lester wenn die Relaisspule strom. führend ist. Sie blinkt langsam während der Funktion und schnell bei falscher EinstellungBitte heben Sie die Originalverpackung für eventuelle Rücksendungen

Bei einer falschen Einstellung des Zeitbereich-es beginnt die gelbe LED
(4) Montage mécanique (DAA et DMB)
Accrocher l'instrument sur le rail DIN en s'assurant du ver rouillage du ressort. Pour déposer linstrument, faire evier avec un petit tournevis comme indiqué.
(5) Démarrage et réglage Constater que les raccorde ments sont corrects Mettre l'instrument sous ter sion (ON) LED verte s'al ume.
Selon la fonction sétection née, le mode de fonction ernent figure sur l'etiquett orsque le relais est sous ension la LED est allumée elle clignote lentement pen dant l'écoulement de la tem porisation et rapidement en cas de configuration incor recte de l'instrument
(6) Note
The packing materiai should be kept for redelivery in cas of replacement or repair.

## (7) Bornes

Alimentation
ntrée circuit de déclenche ment \{DMB, PMB
Relais de sortie
emerselars de sortie (2 Chacune
Chacune des bornes des DAA51 et DMB51 accept es sections de conducteurs usqu'a 2.5 mm 2 . Chacune des bornes des DAAO1 el DMB01 accepte des sections de conducteurs jusqu'à deux fois 2.5 mm 2 .
o: intervailo all'apertur del contatto di comando d: doppio intervallo Dr: Ritardo alla diseccita zione
R: ciclico simmetrico (parenza in ON)
Rb: ciclico simmetrico (partenza in OFF)

Una selezione errata della gamma temp causa il lampeggiamento veloce del LED gialto.
(4) Montaggio sulla guida DIN (DAA e DMB)
Agganciare lo strumento alia guida DIN verificando la chiusura della molla. Per rimuovere l'apparecchio dalla guida usare un caccia vite come mostrato in figura

## (5) Avviamento e regolazioni

 Controllare che i collega menti siano corrett Collegare lo strumento alla ensione di alimentazione, il ED verde si accende. modo di funzionamento, seconda della funzione sele ionata, viene schematizza o sull'etichetta laterale.LED giallo si acce
appena il relè si attiva peggia lentamente durante e temporizzazione e lam peggia velocemente in cas peggia velocemente in cas
(6) Note

Conservare t'imballo origina e in caso di sostituzione riparazione.

## (7) Terminali

Alimentazione
Contatto di comando (DMB MB)
Uscita relè
2da uscita rele (versioni DPDT)
ciascun terminale può accettare cavi fino a $2.5 \mathrm{~mm}^{2}$ er DAA51 e DMB51 e cav no a $2 \times 2.5 \mathrm{~mm}^{2}$ per DAAO e DMB01
lo: Inte ld: Doi
'ed åben trigterval
Dr: Udkoblingsforsinkelse R: Symmetrisk taktgiver (aktiveret first)
Rb: Symmetrisk taktgiver
(deaktiveret forst) (deaktiveret forst)

His det forkerte tidsområde vælges, begynder den gule lysdiode at blinke hurtigt.
(4) Mekanisk montering (DAA og DMB)
Når enheden monteres på DIN-skinnen, skal det sikres at fjederen lukker. Brug en skruetrækker til at fjerne produktet som vist til venstre.
(5) Opstart og justering

Kontrollér, om alle tilslutKontrollér, om alle tilslut-
ninger er foretaget korrekt. ninger er foretaget korrekt.
Tænd for stremforsyningen. Tænd for stremforsyningen.
Derved tændes den gronne Derved tæ
lysdiode.
Dritstunktionen i henhold Dritstunktionen i henhold til den valgte funktion fremgår Den gule iysdiode er Den gule lysdiode er aktiveret, nar rełæet er
aktiveret, den blinker langakiveret, den blinker langblinker hurtigt, hvis der er fejl b, huis der er opsætninger.

## 6) Bemærk

Emballagematerialet ska opbevares og anvendes ti returnering ved udskiftning eller reparationer

## Terminaler

Stromforsyning
Triggerindgang (DMB, PMB)
Relæstyret udgang
2. relæstyret udgang (2polede udgaver)
Hver terminal er klassificeret til ledninger på op til 25 $\mathrm{mm}^{2}$ (DAA5 og DMB551) og mming ledninger pag $2 \times 2,5 \mathrm{~mm}^{2}$ (DAAD1 og DMBO1).


[^0]:    

[^1]:    The Information contained in these installation instructions is for use only by installers trained to make electrical power installations and is intended to describe the correct method of installation for this product. However, Tyco Electronics has no control over the field conditions, which influence product installation.
    It is the user's responsibility to determine the suitability of the installation method in the user's field conditions. Tyco Electronics' only obligations are those in Tyco Electronics' standard Conditions of Sale for this product and in no case will Tyco Electronics be liable for any other incidental, indirect or consequential damages

[^2]:    IP 20 degree of protection and safety trip ') are available for plug-in type breakers, for switchboard and distribution board use.

[^3]:    Notes: 'Above outline dimensions are for AC motors. Contact NHP for details for DC motors.

[^4]:    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.

[^5]:    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

[^6]:    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.
[^7]:    Notes: Observe the requirements of AS 3000 for No. of lighting points on a final sub-circuit.

[^8]:    Notes: Observe the requirements of AS 3000 for No. of lighting points on a final sub-circuit.

[^9]:    IP 20 degree of protection and safety trip ') are available for plug-in type breakers, for switchboard and distribution board use.

[^10]:    Sprecher + Schuh 1000 V CA 6 contactor
    (Refer Part A for more information)

