## BRISBANE CITY

## COUNCIL

# CONTRACT BW70107-06/07 PUMP STATION SWITCHBOARD REPLACEMENT <br> SP 160 MANATON PARK 

## OPERATION AND MAINTENANCE MANUALS

## BRISBANE CITY COUNCIL

CONTRACT BW70107-06/07
PUMP STATION SWITCHBOARD
REPLACEMENT
SP160 MANATON PARK

## Supply and Installation of Switchboard

Our Job No. 0720

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2. GRAPHIC DISPLAY
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By - Whelan Electrical Services Pty Ltd
1 Harvest Street YANDINA QLD 4561

Phone No. 54467133
Fax No. 54468118

# 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). |

Notel 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 $3 \times \mathrm{M} 3 \times 8$ 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! Orientation 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 $3 \times(2 \times \mathrm{M} 4 \times 15)$ 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 $3 \times M 3 \times 35$ metal spacers with <br> $3 \times M 3 \times 4$ screws + washers. | Combination: VFX size 2 with scom and CRIO option



| 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 |
| :--- | :--- |
| $\mathbf{1}$ | Fasten flat cable with clip. |
| 2 | Encoder option on top of control board. |

### 1.3 General information



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



| Position | Description |
| :--- | :--- |
| $\mathbf{1}$ | 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 | $10001-20000$ | $0-9999$ (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.

### 2.1 Coil status list

Table 1 Coil status list

| Modbus <br> logical <br> no | Modbus <br> no | Function/Name | Range/Unit | Product <br> MSF <br> 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 con- <br> sumption | $0->1=$ Reset | 206 |
| 26 | 25 | Pump control | Off, on; off=0, on=1 | 022 |
| 27 | 26 | Full voltage start <br> 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 <br> 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 <br> input failure | No, yes; no=0, yes=1 | 101 |
| 32 | 31 | Run at current limit <br> 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 | 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 | O=No Pre-Alarm, <br> 1=Pre-alarm |  |

### 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<->1 | 205 |
| 30002 | 1 | Power consumption low word |  | 205 |
|  |  |  |  |  |
| 30005 | 4 | Output shaft power high word | $0+2 \mathrm{E} 9 \mathrm{~W}, 1 \mathrm{~W}<->1$ | 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 | $\begin{aligned} & 0-+2 \mathrm{E} 8 \mathrm{Nm}, 0.1 \mathrm{Nm} \\ & <->1 \end{aligned}$ | 207 |
| 30012 | 11 | Shaft torque low word | " | 207 |
|  |  |  |  |  |
| 30017 | 16 | Software version | r01 $==>$ HB = release code, LB =01 |  |
| 30018 | 17 | Software variant | $\begin{aligned} & \mathrm{v001}==>\mathrm{HB}=0, L B \\ & =01 \end{aligned}$ |  |
| 30019 | 18 | Current | $0-6553.5 \mathrm{~A}, 0.1 \mathrm{~A}<->1$ | 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 |

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 | Heatsink temperature | $\begin{aligned} & 30.0 \cdot 100.0^{\circ} \mathrm{C}, \\ & 0.1^{\circ} \mathrm{C}<=>1 \end{aligned}$ |  |
|  |  |  |  |  |
| 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 | $1=\mathrm{VFB} / \mathrm{VFX}, 2=\mathrm{MSF}$ |  |
|  |  |  |  |  |
| 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 |
|  |  |  |  |  |

Table 2 Input register list (continuing)

| Modbus <br> logial <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

Table 3 Holding register list

| Modbus logical no | $\begin{gathered} \text { Modbus } \\ \text { no } \end{gathered}$ | Function/Name | Range/Unit | $\left\lvert\, \begin{gathered} \text { Product } \\ \text { MSF } \\ \text { menu } \end{gathered}\right.$ |
| :---: | :---: | :---: | :---: | :---: |
| 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 | $50-60 \mathrm{~Hz} 1 \mathrm{~Hz}<->1$ | 046 |
| 40003 | 2 | Nominal motor current | $25 \% 150 \%$ Insoft in Amp. $0.1 \mathrm{~A}<->1$ | 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 | $\begin{aligned} & 25 \%-150 \% \text { Pnsoft in } \\ & W ; \\ & \text { Bit15=0->1W }<->1 \\ & \text { Bit15=1->100W }<->1 \end{aligned}$ | 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, $1 \mathrm{sec}<->1$ | 091 |
| 40014 | 13 | Max alarm response delay | 0.1-25.0sec $0.1 \mathrm{~s}->1$ | 093 |
| 40015 | 14 | Max alarm limit | 5-200\% Pn 1\%<->1 | 092 |
| 40016 | 15 | Max pre-alarm response delay | $\begin{aligned} & " 0.1-25.0 \mathrm{sec}, \\ & 0.1 \mathrm{sec}<=1 \\ & \text { VFB } 40014 \text { is used for } \\ & \text { all delays" } \end{aligned}$ | 093 |
| 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 | $0.1-25.0 \sec 0.15<->1$ | 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 |
|  |  |  |  |  |

Table 3 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 40028 | 27 | Anln 1, setup | O=OFF, No remote analogue control. $1=0-10 \mathrm{~V} / 0-20 \mathrm{~mA}$ $2=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}$ | 023 |
| 40037 | 36 | AnOut 1, function | 1-3 | 055 |
| 40038 | 37 | AnOut 1, setup | O= 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 | $1-60 \mathrm{sec}, 1 \mathrm{sec}<->1$ | 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 | $\begin{aligned} & 100-40 \% \text { U, } \\ & 1 \% \text { Un }<->1 \end{aligned}$ | 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 | $\begin{aligned} & 50-250 \% \mathrm{Tn}, \\ & 1 \% \mathrm{Tn}<->1 \end{aligned}$ | 017 |
| 42011 | 2010 | Torque control | ```Off = Torque control OFF 1 = Linear characteristic. 2 = Square characteristic.``` | 025 |
| 42012 | 2011 | Volt age ramp with current limit | Off, 150-500\% In 1\% $\ln <->1$ | 020 |
| 42013 | 2012 | Current limit at start | Off, 150-500\% In 1\% $\ln <->1$ | 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 (continuing)

| 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, $1-60 \mathrm{sec}, 1 \mathrm{l}<->1$ | 039 |
| 42022 | 2021 | Slow speed OC-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 | Off, 0.1-10.Osec $0.1 \mathrm{sec}<->1$ | 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 | $\text { Off, } 1-60 \mathrm{sec},$ $1 \mathrm{sec}<->1$ | 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 $T_{n}, 1 \%<->1$ | 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 | 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 | 0->1 = Auto-set | 815 |
| 6 | 5 | Reset power consumption | $0->1=$ Reset | 6F1 |
| 7 | 6 | Reset Run-Time | 0->1 = Reset | 601 |
| 8 | 7 | Reset Trip Log | 0->1 = Reset | 7B0 |
| 10 | 9 | Auto-restart, Overtemp trip | Off, on; off=0, on=1 | 242 |
| 11 | 10 | Autorestart, $\mathrm{I}^{2} \mathrm{t}$ | Off, on; off $=0$, on=1 | 243 |
| 12 | 11 | Auto-restart, Overvolt D | Off, on; of $\mathrm{f}=0$, 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 $=0, \mathrm{on}=1$ | 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 | no, yes; no=0, yes=1 | 271 |

### 3.2 Input register list

## Table 5 Input register list

| Modbus logical no | Modbus no | Function/Name | Range/Unit | $\begin{array}{\|c\|} \hline \text { Product } \\ \text { VFB/VFX } \\ \text { menu } \end{array}$ |
| :---: | :---: | :---: | :---: | :---: |
| 30001 | 0 | Power consumption high word | 0-2E9 Wh, 1 Wh<->1 | 6FO |
| 30002 | 1 | Power consumption low word |  | 6F0 |
| 30003 | 2 | Electrical power high word | $0-+-2 E 9$ W, 1 W <->1 | 640 |
| 30004 | 3 | Electrical power low word |  | 640 |
| 30005 | 4 | Output shaft power high word | $\begin{aligned} & 0-+-2 E 9 W, \\ & 1 \text { W<->1 } \end{aligned}$ | 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 min $<->1$ | 6D0 |
| 30009 | 8 | Mains time hour | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 6E0 |
| 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 | $\begin{aligned} & 1-+-2 \text { E8 Rpm, } \\ & 1 \text { rpm<->1000 } \end{aligned}$ | 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 | $\begin{aligned} & \text { V1.23-> Release } \\ & \text { Bit 15-14=0,0 } \\ & \text { Bit } 13-8=1, \\ & \text { LB }=23 \end{aligned}$ | 920 |
| 30018 | 17 | Option/variant version | $\begin{aligned} & \hline \text { OPT V2.34 -> } \\ & \text { HB }=2, \\ & \text { LB }=34 \end{aligned}$ | 920 |
| 30019 | 18 | Current | $0-6553.5 \mathrm{~A}, 0.1 \mathrm{~A}<->1$ | 650 |
|  |  |  |  |  |
| 30023 | 22 | Output voltage | 0-6553.5 V, 0.1V<.>1 | 660 |
|  |  |  |  |  |
| 30028 | 27 | Product type number |  | 910 |

Table 5 Input register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | $\begin{gathered} \text { Product } \\ \text { VFB/VFX } \\ \text { menu } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: |
| 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, 1h<->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 h, 1h<->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 n | 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 | $\begin{array}{\|c} \hline \text { Product } \\ \text { VFB/VFX } \\ \text { menu } \end{array}$ |
| :---: | :---: | :---: | :---: | :---: |
| 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 | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 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 | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 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 | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 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 | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 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 | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 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 | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 7A0 |
| 30129 | 128 | Trip time 10 min | 0-59 Min, 1 min<->1 | 7A0 |
| 30130 | 129 | Trip message 10 | See trip message 1. | 7A0 |

### 3.3 Holding register list

Table 6 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 | $\begin{aligned} & 100-18000 \mathrm{rpm} \\ & \text { Bit15 }=0->1 \mathrm{rpm}<->1 \\ & \text { Bit15 }=1->100 \mathrm{rpm}<->1 \end{aligned}$ | 225 |
| 40005 | 4 | Nominal motor power | $\begin{aligned} & 1-3276700 \mathrm{~W} \\ & \text { Bit15 }=0->1 \mathrm{~W}<->1 \\ & \text { Bit15 }=1->100 \mathrm{~W}<->1 \end{aligned}$ | 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 | $\begin{aligned} & 0=\mathrm{Off} \\ & 1=O n \end{aligned}$ | 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 | $\begin{aligned} & 0=\mathrm{Off}, \\ & 1=\mathrm{On} \end{aligned}$ | 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 |
| 40019 | 18 | Min alarm limit | 0-400\% Tn | 818 |
| 40021 | 20 | Min pre-alarm | 0-400\% Tn | 819 |
| 40022 | 21 | Parameter set | $0=\mathrm{A}$, $-\quad 4=\mathrm{DI} 3$, <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 |

Table 6 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | $\begin{aligned} & \text { Product } \\ & \text { VFB/VFX } \\ & \text { menu } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: |
| 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 | $\begin{aligned} & 0=\mathrm{Off}, \\ & 1=0 \mathrm{n} \end{aligned}$ | 415 |
| 40032 | 31 | AnIn 2, function | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Speed, }, \\ & 2=\text { Torque } \end{aligned}$ | 416 |
| 40033 | 32 | Antn 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 | Anin 2, gain | -4.00-+4.00 |  |
| 40036 | 35 | Anln 2, bipolar | $\begin{aligned} & 0=\text { Off, } \\ & 1=0 \mathrm{n} \end{aligned}$ | 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 | $\begin{aligned} & 0=\mathrm{Off}, \\ & 1=\mathrm{On} \end{aligned}$ | 435 |
| 40042 | 41 | AnOut 2, function | 0=Torque, 4=Current, <br> $1=$ Speed, 5=El.power, <br> $2=$ Shaft power, 6=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 |

Table 6 Holding register list (continuing)

| $\begin{gathered} \text { Modbus } \\ \text { logical } \\ \text { no } \end{gathered}$ | 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 | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=O n \end{aligned}$ | 43A |
| 40063 | 62 | CA1 Value | " $0=$ Speed, $1=$ Torque, <br> 2=Shaft_Power, 3=El Power, <br> $4=$ Current, $5=$ Output Voltage, <br> 6=Frequency, <br> $7=$ DC voltage, $8=$ Tempera- <br> ture, $9=$ Energy, 10=Run <br> Time, <br> 11=Mains Time, 12=Process <br> Speed, 13=Anin1, 14=Anin" | 821 |
| 40064 | 63 | CA1 Level | 0-1E6 depending on 40063 | 822 |
| 40065 | 64 | CA2 Value | " $0=$ Speed, $1=$ Torque, <br> 2=Shaft_Power, 3=El Power, <br> 4=Current, $5=$ Output Voltage, <br> 6=Frequency, <br> $7=$ DC voltage, $8=$ Tempera- <br> ture, $9=$ Energy, $10=$ Run <br> Time, <br> 11=Mains Time, 12=Process <br> Speed, 13=Anin1, 14=Anin" | 823 |
| 40066 | 65 | CA2 Level | O-1E6 depending on 40065 | 824 |
| 40067 | 66 | CD1 | $\begin{aligned} & " 0=\text { DigIn1, } 1=\text { DigIn2, } \\ & 2=\text { DigIn3, } 3=\text { DigIn } 4,4=\text { Acc, } \\ & 5=\text { Dec } \\ & 6=12 \mathrm{t}, 7=\text { Run, } 8=\text { Stop, } \\ & 9=\text { Trip, } 10=\text { Max Alarm, } \\ & 11=\text { Min Alarm, } 12=\text { Vlimit, } \\ & 13=\text { AtMax Speed, } 14=\text { Climit, }, \\ & 15=\text { Tlimit, } 16=0 \text { vertemp, } \\ & 17=\text { Overvolt G, } 18=O v e r v o l t ~ \\ & \text { D," } \end{aligned}$ | 825 |
| 40068 | 67 | CD2 | $\begin{aligned} & \text { "0=DigIn1, 1=Digln2, } \\ & 2=\text { DigIn3, } 3=\text { Digln4, } 4=\text { Acc, } \\ & 5=\text { Dec, } \\ & 6=12 \mathrm{t}, 7=\text { Run, } 8=\text { Stop, } \\ & 9=\text { Trip, } 10=\text { Max Alarm, } \\ & 11=\text { Min Alarm, } 12=\text { Vlimit, } \\ & 13=\text { AtMax Speed, 14=Climit, }, \\ & 15=\text { Tlimit, 16=Overtemp, } \\ & 17=\text { Overvolt G, 18=Overvolt } \\ & \text { D," } \end{aligned}$ | 825 |

Table 6 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40069 | 68 | Logic Y Arg1 | $\begin{aligned} & 0=C A 1,1=!\mathrm{A} 1,2=\mathrm{CA} 2, \\ & 3=!\mathrm{A} 2,4=\mathrm{CD1} 1,5=!\mathrm{D} 1, \\ & 6=\mathrm{CD} 2,7=!\mathrm{D} 2 \end{aligned}$ | 831 |
| 40070 | 69 | Logic Y op 1 | $1=\&, 2=+, 3=\wedge$ | 832 |
| 40071 | 70 | Logic Y Arg2 | $\begin{aligned} & 0=\mathrm{CA} 1,1=!\mathrm{A} 1,2=\mathrm{CA} 2, \\ & 3=!\mathrm{A} 2,4=\mathrm{CD1} 1,5=!\mathrm{D} 1, \\ & 6=\mathrm{CD} 2,7=!\mathrm{D} 2 \end{aligned}$ | 833 |
| 40072 | 71 | Logic Y op2 | $0=1=\&, 2=+, 3=\wedge$ | 834 |
| 40073 | 72 | Logic Y Arg3 | $\begin{aligned} & 0=\mathrm{CA} 1,1=!\mathrm{A} 1,2=\mathrm{CA} 2, \\ & 3=!\mathrm{A} 2,4=\mathrm{CD1} 1,5=!\mathrm{D} 1, \\ & 6=\mathrm{CD} 2,7=!\mathrm{D} 2 \end{aligned}$ | 835 |
| 40074 | 73 | Logic 2 Arg1 | $\begin{aligned} & 0=\mathrm{CA} 1,1=!\mathrm{A} 1,2=\mathrm{CA} 2, \\ & 3=!\mathrm{A} 2,4=\mathrm{CD1}, 5=!\mathrm{D} 1, \\ & 6=\mathrm{CD} 2 ; 7=!\mathrm{D} 2 \end{aligned}$ | 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\% <-> 0x2000 |  |
| 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 | $\begin{array}{ll} 0=\text { Remote, } & 3=\text { Rem } / \text { digin1, } \\ 1=\text { Keyboard, } & 4=\text { Comm } / \\ \text { digin1 } & \\ 2=\text { Comm, } & \end{array}$ | 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 |

Table 6 Holding register list (continuing)

| Modbus <br> logical <br> no | Modbus <br> no | Function/Name | Range/Unit | Product <br> VFB/VFX <br> menu |
| :--- | :--- | :--- | :--- | :--- |
| 41010 | 1009 | DigIn 3 | $0-11$ | 423 |
| 41011 | 1010 | DigIn 4 | $0-11$ | 424 |
|  |  |  |  | 0 ( |

Table 6 Holding register list (continuing)

| Modbus <br> logical <br> no | Modbus <br> no | Function/Name | Range/Unit | Product <br> VFB/VFX <br> menu |
| :---: | :--- | :--- | :--- | :--- |
|  |  |  |  |  |
| 41081 | 1080 | Dev Delay | $50-999 \mathrm{~ms}$ |  |
| 41082 | 1081 | Set Load | $25-100 \%, 101 \%=$ Off |  |

Table 7 Parameter set 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 | $\begin{aligned} & 0=\text { Linear } \\ & 1=\text { Scurve } \end{aligned}$ | 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, $0.01 \mathrm{~s}<=>1$ | 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 | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { On } \end{aligned}$ | 31A |
| 41113 | 1112 | Spinstart | $\begin{aligned} & 0=O f f, \\ & 1=O n \end{aligned}$ | 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- Max imum 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, | 32 E |
| 41127 | 1126 | Skip speed 2 Low | 0-2*Motor sync speed, | 32F |

Table 7 Parameter set $A$ (continuing)

| *** | *** | VFB/VFX <br> Parameter set A | *** | *** |
| :---: | :---: | :---: | :---: | :---: |
| 41128 | 1127 | Skip speed 2 High | 0-2*Motor sync speed, | 32G |
| 41129 | 1128 | Jog speed | 0-£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, 0.01s<->1 | 343 |
| 41133 | 1132 | Flux optimization | $\begin{aligned} & 0=0 f f, \\ & 1=0 \mathrm{n} \end{aligned}$ | 344 |
| 41134 | 1133 | PID-controller | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=0 \mathrm{n}, \\ & 2=\text { Invert } \end{aligned}$ | 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, $0.01 \mathrm{~s}<->1$ | 347 |
| 41137 | 1136 | PID-controller D time | 0.01-30.00s, $0.01 \mathrm{~s}<->1$ | 348 |
| 41138 | 1137 | Low voltage overrride | 0=Off, 1=On | 351 |
| 41139 | 1138 | Rotor locked | 0=Off, 1=On | 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 | $0=0 \mathrm{~N}, 1=0 \mathrm{FF}$ | 356 |


| $* * *$ | $* * *$ | VFB/VFX Parameter set B | $* * *$ | $* * *$ |
| :---: | :---: | :--- | :--- | :--- |
| $41201-41299$ | $1200-1298$ | $/ *$ Parameter set B */ |  |  |
| $* * *$ | $* * *$ | VFB/VFX Parameter set C | $* * *$ | $* * *$ |
| $41301-41399$ | $1300-1398$ | $/ *$ Parameter set C */ |  |  |
| $* * *$ | $* * *$ | VFB/VFX Parameter set D | $* \star *$ | $* * *$ |
| $41401-41499$ | $1400-1498$ | $/ *$ 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 MOD. BUS 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 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 | $0 \rightarrow 1$ = Reset | 6D1 |
| 7 | 6 | Reset Run-Time | $0 \rightarrow 1=$ 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 | Autorestart, $\mathrm{I}^{2} \mathrm{t}$ | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 243 |
| 12 | 11 | Auto-restart, Overvolt D | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 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 | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 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 | Autorestart, Power fault | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 24C |
| 22 | 21 | Autorestart, Low voltage | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 24D |

Table 8 Coil status list (continuing)

| Modbus <br> logical 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 H 1 |
| 40 | 39 | Reset Run Time 3 | $0->1=$ Reset | 611 |
| 41 | 40 | Reset Run Time 4 | $0->1=$ Reset | $6 \mathrm{J1}$ |
| 42 | 41 | Reset Run Time 5 | $0->1=$ Reset | 6 K 1 |
| 43 | 42 | Reset Run Time 6 | $0->1=$ Reset | 6 LL 1 |

### 4.2 Input register list

## Table 9 Input register list

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 30001 | 0 | Power consumption high word | 0-2E9 Wh, 1 Wh<->1 | 600 |
| 30002 | 1 | Power consumption low word |  | 600 |
| 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 | 0-59 Min, 1 min<->1 | 6B0 |
| 30009 | 8 | Mains time hour | 0-65535 h, $1 \mathrm{~h}<->1$ | 6C0 |
| 30010 | 9 | Mains time min | 0-59 Min, 1 min<->1 | 6C0 |
| 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 | $\begin{aligned} & 1-+-2 \text { E8 Rpm, } \\ & 1 \mathrm{rpm}<->1000 \end{aligned}$ | 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 | $\begin{aligned} & \text { OPT V2.34 -> } \\ & \mathrm{HB}=2, \\ & \mathrm{LB}=34 \end{aligned}$ | 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 | $\begin{aligned} & 0=\text { Remote, } \\ & 1=\text { Keyboard, } \\ & 2=\text { Serial comm } \end{aligned}$ |  |

Table 9 Input register list (contimuing)

| 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 | $\begin{aligned} & 0-2000.0 \mathrm{~Hz}, \\ & 0.1 \mathrm{~Hz}<->1 \end{aligned}$ | 670 |
| 30039 | 38 | DC-link voltage | 0-1000V, 0.1V <->1 | 680 |
| 30040 | 39 | Warning | 0-31 | 6HO |
| 30043 | 42 | Digital input status |  | 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, $1 \mathrm{~h}<->1$ | 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 h, 1h<->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 Input register list (continuing)

| Modbus <br> logical <br> no | Modbus <br> no | Function/Name | Range/Unit | Product <br> FDU <br> menu |
| :---: | :---: | :--- | :--- | :--- |
| 30110 | 109 | Trip time 4 h | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 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 | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 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 | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 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 | $0-65535 \mathrm{~h}, 1 \mathrm{h<->1}$ | 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 | $0-65535 \mathrm{~h}, 1 \mathrm{h<->1}$ | 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 | $0-65535 \mathrm{~h}, 1 \mathrm{h<->1}$ | $7 \mathrm{A0}$ |
| 30129 | 128 | Trip time 10 min | $0-59$ Min, 1 min<->1 | $7 \mathrm{A0}$ |
| 30130 | 129 | Trip message 10 | See trip message 1. | 7 Al |

### 4.3 Holding register list

Table 10 Holding register list

| Modbus logical no | $\begin{gathered} \text { Modbus } \\ \text { no } \end{gathered}$ | 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 | $\begin{aligned} & 100-18000 \mathrm{rpm} \\ & \text { Bit15 }=0->1 \mathrm{rpm}<->1 \\ & \text { Bit15 }=1->100 \mathrm{rpm}<->1 \end{aligned}$ | 225 |
| 40005 | 4 | Nominal motor power | $\begin{aligned} & 1-3276700 \mathrm{~W} \\ & \text { Bit 15=0->1W<->1 } \\ & \text { Bit15=1->100W }<->1 \end{aligned}$ | 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 | $0=A$, $4=013$, <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 |
| 40024 | 23 | Relay 2 | 0-21 | 452 |
|  |  |  |  |  |

Table 10 Holding register list (continuing)

| 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, 4=Current, 2=Shaft power, 5=El.power, 3=Frequency, 6=Outp.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-+4.00 $0.01<->1$ | 434 |
| 10042 | 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 | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA}, \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=\text { User defined } \end{aligned}$ | 437 |
| 40044 | 43 | AnOut 2, offset | -100\% - +100\% 1\% <-> 1 | 438 |
| 40045 | 44 | AnOut 2, gain | -4.00-+4.00, 0.01 <-> 1 | 439 |
|  |  |  |  |  |

Table 10 Holding register list (continuing)

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

Table 10 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product FDU menu |
| :---: | :---: | :---: | :---: | :---: |
| 40067 | 66 | CD1 | $\begin{aligned} & \text { O=DigIn1, 1=Digın2, } \\ & 2=\text { DigIn3, } 3=\text { DigIn } 4, \\ & 4=\text { DigIn5, } 5=\text { DigIn }, \\ & 6=\text { DigIn }, 7=\text { Acc, } 8=\text { Dec, } \\ & 9=12 t, 10=\text { Run, } 11=\text { Stop, } \\ & 12=\text { Trip, } 13=\text { Max Alarm, } \\ & 14=\text { Min Alarm, } 15=\text { Vlimit, } \\ & 16=\text { Flimit, } 17=\text { Glimit, } \\ & 18=\text { Tlimit, } 19=O v e r t e m p, \\ & 20=\text { Overvolt G, } \end{aligned}$ | 825 |
| 40068 | 67 | CD2 | $\begin{aligned} & \text { 0=DigIn1, 1=Digln2, } \\ & 2=\text { Digin }, 3=\text { DigIn } 4, \\ & 4=\text { Digin5, } 5=\text { Digln }, \\ & 6=\text { DigIn } 7,7=\text { Acc, } 8=\text { Dec, } \\ & 9=12 \mathrm{t}, 10=\text { Run, } 11=\text { Stop, } \\ & 12=\text { Trip, } 13=\text { Max Alarm, } \\ & 14=\text { Min Alarm, } 15=\text { Vlimit, } \\ & 16=\text { Flimit, } 17=\text { Glimit, } \\ & 18=\text { Tlimit, } 19=0 \text { overtemp, } \\ & 20=\text { Overvolt G, } \end{aligned}$ | 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 |
|  |  |  |  |  |
| 11001 | 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 | $\begin{aligned} & 0=\text { Remote, } \quad 3=\text { Rem } / \text { digin1, } \\ & 1=\text { Keyboard, } \\ & \text { d=Comm } / \\ & \text { digin1 } \\ & 2=\text { Comm }, \end{aligned}$ | 213 |
| 41005 | 1004 | Operation.rotation | 0=R+L, 1=R, 2=L | 214 |

Table 10 Holding register list (continuing)

\begin{tabular}{|c|c|c|c|c|}
\hline Modbus logical no \& Modbus no \& Function/Name \& Range/Unit \& Product FDU menu \\
\hline 41006 \& 1005 \& Utility auto restart mask \& 0-10 \& 240 \\
\hline 41007 \& 1006 \& Utility.auto restart \& 0-10 \& 241 \\
\hline 41008 \& 1007 \& Digln 1 \& 0-11 \& 421 \\
\hline 41009 \& 1008 \& Digln 2 \& 0-11 \& 422 \\
\hline 41010 \& 1009 \& DigIn 3 \& 0-11 \& 423 \\
\hline 41011 \& 1010 \& DigIn 4 \& 0-11 \& 424 \\
\hline 41012 \& 1011 \& DigIn 5 \& 0-11 \& 425 \\
\hline 41013 \& 1012 \& Digln 6 \& 0-11 \& 426 \\
\hline 41014 \& 1013 \& DigOut 1 \& 0-21 \& 441 \\
\hline 41015 \& 1014 \& DigOut 2 \& 0-21 \& 442 \\
\hline 41022 \& 1021 \& Process unit \& \begin{tabular}{ll}
\(0=\) None, \& \(3=\mathrm{m} / \mathrm{s}\), \\
\(1=\mathrm{rpm}\), \& \(4=/ \mathrm{min}\), \\
\(2=\%\), \& \(5=/ \mathrm{hr}\)
\end{tabular} \& 6E1 \\
\hline 41023 \& 1022 \& Process scale \& 0-10.000, 0.0001 <=> 1 \& 6E2 \\
\hline 41024 \& 1023 \& Multiple display 1 \& \(0=\) Speed, \(\quad 6=\) Frequency,
\(1=\) Torque,
\(2=\) DC voltage,
\(2=\) Shaft power, \(8=\) Temp,
\(3=\) El power,
\(4=\) =Drive
\(4=\) Current,
\(5=\) Status,

speed \& 110 <br>
\hline 41025 \& 1024 \& Multiple display 2 \& See 41024 \& 120 <br>

\hline 41026 \& 1025 \& Utility language \& $$
\begin{array}{ll}
\text { O=English, } & \text { 3=Dutch, } \\
\text { 1=German, } & \text { 4=French } \\
2=\text { Swedish, }
\end{array}
$$ \& 231 <br>

\hline 41027 \& 1026 \& Utility keyboard locked \& 0=Unlocked, 1=Locked \& 232 <br>
\hline 41028 \& 1027 \& Serial com. address \& 1.247 \& 252 <br>

\hline 41029 \& 1028 \& Serial com. Baud-rate \& $$
\begin{array}{ll}
\hline 1=2400, & 4=19200, \\
2=4800 & 5=38400 \\
3=9600, &
\end{array}
$$ \& 251 <br>

\hline 41031 \& 1030 \& Serkal com. contact broken \& \& <br>
\hline 41033 \& 1032 \& V/Hz Curve \& $0=$ Linear, 1=Square \& 211 <br>
\hline 41034 \& 1033 \& IxR Comp \& 1-25\% \& 216 <br>
\hline
\end{tabular}

Table 10 Holding register list (continuing)

| $\begin{gathered} \text { Modbus } \\ \text { logical } \\ \text { no } \end{gathered}$ | 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 | "O=Loc / Rem Ana, 1=Loc/ Rem Comm, 2=PID, $3=$ MotPot, $4=$ Pre- sets, $5=$ Jog, 6=Torque Limit, $7=$ Pump/ Fan, $8=$ Custom1, $9=$ Custom2" | 271 |
| 41038 | 1037 | Punp/Fan Control | "0=Off, 1=Load PID, 2=Freq PID, 3=Load Direct, 4=Freq Direct" | 281 |
| 71039 | 1038 | No of Drives | 1-4 w/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 Frea | $0-100 \mathrm{~Hz}$ (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 |
| ?1088 | 1087 | Use Inputs |  | 28J |
| 1091 | 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 |

Table 10 Holding register list (continuing)

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

Table 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 | 0=decelation, 1=coast | 319 |
| 41113 | 1112 | Spinstart | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { On } \end{aligned}$ | 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 | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=0 \mathrm{n} \end{aligned}$ | 341 |
| 41134 | 1133 | PID-controller | $\begin{aligned} & 0=\text { Off, } \\ & 1=0 \mathrm{n}, \\ & 2=\text { Invert } \end{aligned}$ | 343 |
| 41135 | 1134 | PID-controller $P$ gain | 0.1-30.0, 0.1<->1 | 344 |
| 41136 | 1135 | PID-controller I time | 0.01-300.00s, $0.01 \mathrm{~s}<->1$ | 345 |
| 41137 | 1136 | PID-controller D time | 0.01-30.00s, $0.01 \mathrm{~s}<->1$ | 346 |
| 41138 | 1137 | Low voltage overrride | $0=0 f f, 1=0 n$ | 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 |

Table 11 Parameter set A (cominuing)

| *** | *** | FDU <br> Parameter set A | *** | *** |
| :---: | :---: | :---: | :---: | :---: |
| 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 |
| 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 | 0- maximum_freq. see R/W rpm | 321 |
| 41149 | 1148 | Max Frequency | minimum freq-2*motor sync freq see R/ Wrpm | $322{ }^{1}$ |
| 41150 | 1149 | Min Frequency Mode | 0=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 | $32 E$ |
| 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*/ |  |  |

## Emotron AB

Mörsaregatan 12
SE-250 24 Helsingborg, Sweden
Tel: +46 42169900
Fax: +46 42169949
E-mail: info@emotron.com
Internet: www.emotron.com


# SERIAL <br> COMMUNICATION OPTION 

## INSTRUCTION MANUAL <br> - ENGLISH

Valid for the following models:
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 safery instructions, warnings etc. as mentioned in these instruction manuals are to be known to the user. The following indications can appear in this manual. Always read these first and be aware of their content before continuing.

> NOTE! Additional information as an aid to avoiding problems.

| CAUTION | Failure to follow these <br> instructions can result in <br> malfunction or damage to <br> the softstarter or the <br> frequency inverter. |
| :--- | :--- |


| WARNING | Failure to follow these <br> instructions can result in serious <br> injury to the user in addition <br> to serious damage to the soft- <br> starter or the frequency inverter. |
| :--- | :--- |



### 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 uith 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 rypical 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.

### 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

SP160 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement OM Manual
Request message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 01 |
| Start address HI | 00 |
| Start address LO | 10 |
| Number of Coils HI | 00 |
| Number of Coils LO | 01 |
| CRC LO | $6 D$ |
| 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 $=2$.

SP160 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement 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 | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 02 |
| Byte count | 01 |
| Input no.2 (02h)status | 00 |
| CRC LO | A1 |
| CRC HI | 88 |

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

### 2.3.3 Read Holding Registers

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

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

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 |  |
| CRC HI | 05 |

## Response message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 03 |
| Byte count | 06 |
| Reg no. O, (Oh) data HI | 0 F |
| Reg no. O, (Oh) 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.

### 2.3.4 Read Input Registers

Read the contents of analogue read-only information.

## EXAMPLE

Request the Shaft Torque. It is 452.0 Nm . It has a long representation, 2 registers are used.
452.0 Nm, unit 0.1 Nm - 4520 ( 000011 A 8 h ).

## 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 (OAh) data HI | 00 |
| Reg no. 10 (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.

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

## Request message.

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

Response message.

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

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

### 2.3.6 Force Single Register

Set the value of one analogue changeable parameter.

## EXAMPLE

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

## Request message.

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

## Response message.

| Field name | Hex value |
| :--- | :--- |
| Slave address | 01 |
| Function | 06 |
| Start address HI | 00 |
| Start address LO | $0 D$ |
| 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 parameters changeable with this function code.

### 2.3.7 Force Multiple Coil

Set the status of multiple digital changeable parameters.

## EXAMPLE

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

Coil no. $=0-1$ Reset $->1$

$$
\text { Run }=1
$$

->- 00000011 (03h)

## 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 0011B) | 03 |
| CRC LO | 9 E |
| CRC HI | 96 |

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## Response message.

| 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 $0.1 \mathrm{sec}->-250$ (00FAh)
$55 \%$, unit $1 \%$-> 55 ( 0037 h )

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Request message.

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

## Response message.

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

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

### 2.3.9 Force/Read Multiple Register

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

## EXAMPLE

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

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

## Request message.

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

Response message.

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

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

### 2.4 Errors, exception codes

Two kinds of errors are possible:

- Transmission errors.
- Operation errors.


### 2.4.1 Transmission errors

Transmission errors are:

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

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

### 2.4.2 Operation errors

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

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

Exception response message.

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

Table 24 Exception codes.

| Exc. code | Name | Description |
| :--- | :--- | :--- |
| 01 | Illegal <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 wait at least 5 minutes to allow the buffer capacitors to discharge.

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


Fig. 5 Installation of the option card.


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

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

NOTE! Under construction, to be defined.

### 3.3 RS485 Multipoint network

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


Fig. 7 RS 485 mulitpoint network

### 3.3.1 RS485 connection

Table 25 RS485 pinning

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

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


Fig. 8 RS485 wiring

### 3.3.2 RS485 termination.

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

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


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

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### 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 | $T X$ from module |
| 3 | RX to module |
| 5 | Ground |

### 3.4.2 RS232 wiring

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

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


Fig. 12 RS232 wiring.

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

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

The following parameters have to be set-up:

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

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

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Serial comm. unit address[111]

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

## Serial comm. baudrate[112]

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

## Serial comm. parity[113]

| $1 \mid 13$ 0 |  |  |
| :--- | :--- | :--- |
|    |  | 0 |
| Default: | 0 |  |
| Range: | 0.1 |  |
| This parameter will select the parity.  <br> 0 No parity. <br> 1 Even parity. |  |  |

## Serial comm. broken alarm[114]

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

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


### 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.

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

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

### 3.7 Parameter List

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

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

Table 27 Parameter types

| Parameter type | Modbus logical <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.

### 3.8 Coil status list

Table 28 Coil status list

| Modbus <br> logical <br> no | Modbus <br> no | Function/Name | Range/Unit | Product <br> MSF <br> 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 con- <br> sumption | O->1 = Reset | 206 |
| 26 | 25 | Pump control | Off, on; off=0, on=1 | 022 |
| 27 | 26 | Full voltage start <br> 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 <br> 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 <br> input failure | No, yes; no=0, yes=1 | 101 |
| 32 | 31 | Run at current limit <br> time-out | No, yes; no=0, yes=1 | 102 |
| 33 | 32 | Jog forward from <br> keyb. enable | No, yes; no=0, yes=1 | 103 |
| 34 | 33 | Jog reverse from keyb. <br> 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 | O=No Pre-Alarm, <br> 1=Pre-alarm |  |

### 3.10 Input register list

Table 30 Input register list

| Modbus logial no | Modbus no | Function/Name | Range/Unit | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 30001 | 0 | Power consumption high word | 0-2E9 Wh,1Wh<->1 | 205 |
| 30002 | 1 | Power consumption low word |  | 205 |
| 30003 | 2 | Electrical power high word | $0+2 \mathrm{E} 9 \mathrm{~W}, 1 \mathrm{~W}<->1$ | S51 |
| 30004 | 3 | Electrical power low word |  | S51 |
| 30005 | 4 | Output shaft power high word | $0+2 \mathrm{E} 9 \mathrm{~W}, 1 \mathrm{~W}<->1$ | 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 | $\begin{aligned} & 0-+2 \mathrm{E} 8 \mathrm{Nm}, 0.1 \mathrm{Nm} \\ & <->1 \end{aligned}$ | 207 |
| 30012 | 11 | Shaft torque low word | " | 207 |
| 30017 | 16 | Software version | $\begin{aligned} & \text { r23 -> r= release, } \\ & \text { Bit 15-14 =0,0 } \\ & \text { LB =23 } \end{aligned}$ |  |
| 30018 | 17 | Software variant | V001 -> HB=0, LB=01 |  |
| 30019 | 18 | Current | 0-6553.5A, 0.1A<->1 | 005 |
| 30020 | 19 | Phase 1 current | " | 211 |
| 30021 | 20 | Phase 2 current | " | 212 |
| 30022 | 21 | Phase 3 current | " | 213 |
| 30024 | 23 | Line main voltage | " | 202 |
| 30025 | 24 | Line main voltage 1 | " | 214 |
| 30026 | 25 | Line main voltage 2 | " | 215 |
| 30027 | 26 | Line main voltage 3 | " | 216 |
| 30028 | 27 | Product type number | 1-19 See description in 3.12.1. |  |
| 30029 | 28 | Control start by / Control mode | $\begin{aligned} & 1=\text { Keyboard } \\ & 2=\text { Remote } \\ & 3=\text { Serial comm. } \end{aligned}$ | 006 |
| 30031 | 30 | Serial comm. unit address | 1-247 | 111 |

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Table 30 Input register list (contiruing)

| Modbus logial no | $\begin{array}{\|c} \text { Modbus } \\ \text { no } \end{array}$ | 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 | $\begin{aligned} & 30.0-100.0^{\circ} \mathrm{C} \\ & 0.1^{\circ} \mathrm{C}<-1 \end{aligned}$ |  |
|  |  |  |  |  |
| 30041 | 40 | Operation mode | 1-7 See description in 3.12.3. |  |
| 30042 | 41 | Operation status | 1-11 See description in 3.12.4. |  |
|  |  |  |  |  |
| 30047 | 46 | Used thermal capacity | 0-150 \%, 1\%<->1 | 073 |
| 30048 | 47 | Power factor | 0.00-1.00,0.01 $<>1$ | 204 |
| 30049 | 48 | Current ratio | $80-150 \%, 1 \%<->1$ |  |
| 30050 | 49 | Voltage ratio | $50-150 \%, 1 \%<->1$ | F12 |
| 30051 | 50 | Phase sequence | $\begin{aligned} & 0-2 \\ & 0=\text { None, } \\ & 1=\text { RST, } \\ & 2=\text { RTS } \end{aligned}$ | 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 |
|  |  |  |  |  |

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 |
|  |  |  |  |  |
| 30121 | 120 | Trip message 7 | See trip message 1. | 907 |
|  |  |  |  |  |
| 30124 | 123 | Trip message 8 | See trip message 1. | 908 |
|  |  |  |  |  |
| 30127 | 126 | Trip message 9 | See trip message 1. | 909 |
|  |  |  |  |  |
| 30130 | 129 | Trip message 10 | See trip message 1. | 910 |

### 3.11 Holding register list

Table 31 Holding register list

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product MSF menu |
| :---: | :---: | :---: | :---: | :---: |
| 40001 | 0 | Nominal motor voltage | $\begin{array}{\|l} 200.0-700.0 \mathrm{~V} \\ 0.1 \mathrm{~V}<->1 \end{array}$ | 041 |
| 40002 | 1 | Nominal motor frequency | $50-60 \mathrm{~Hz} \mathrm{1Hz}<->1$ | 046 |
| 40003 | 2 | Nominal motor current | $\begin{aligned} & 25 \%-150 \% \text { Insoft in } \\ & \text { Amp. } 0.1 \mathrm{~A}<->1 \end{aligned}$ | 042 |
| 40004 | 3 | Nominal motor speed | $\begin{aligned} & 500-3600 \mathrm{Rpm} \\ & \text { Bit15 }=0->1 \mathrm{ppm}<->1 \end{aligned}$ | 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 | 1-250sec,1sec<->1 | 091 |
| 40014 | 13 | Max alarm response delay | $0.1-25.0 \mathrm{sec} 0.1 \mathrm{~s} \gg 1$ | 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 | $0.1-25.0 \sec 0.1 s<->1$ | 099 |
| 40019 | 18 | Min alarm limit | 5-200\% Pn 1\%<->1 | 098 |
| 40020 | 19 | Min pre-alarm response delay | $0.1-25.0 \mathrm{sec} 0.1 \mathrm{~s}<->1$ | 097 |
| 40021 | 20 | Min pre-alarm | 5-200\% Pn 1\%<->1 | 096 |
| 40022 | 21 | Parameter set | $\begin{aligned} & 0=\text { External input } \\ & \text { selection } \\ & 1-4=\text { Par. set 1-4 } \end{aligned}$ | 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 | 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 |
|  |  |  |  |  |

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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 | O= 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 | $1-60 \mathrm{sec}, 1 \mathrm{sec}<->1$ | 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 | $\begin{aligned} & 100-40 \% \text { U, } \\ & 1 \% \text { Un<->1 } \end{aligned}$ | 013 |
| 42008 | 2007 | Stop time ramp 2 | Off,1-120sec, 1s<->1 | 014 |
| 42009 | 2008 | Initial torque at start | 0-200\% Tn,1\% Tn<->1 | 016 |
| 42010 | 2009 | End torque at start | $\begin{aligned} & 50-200 \% \mathrm{Tn}, \\ & 1 \% \mathrm{Tn}<->1 \end{aligned}$ | 017 |
| 42011 | 2010 | Torque control | ```Off= Torque control OFF 1 = Linear characteristic. 2 = Square characteristic.``` | 025 |
| 42012 | 2011 | Voltage ramp with current limit | $\begin{aligned} & \text { Off, } 150-500 \% \text { In } \\ & 1 \% \ln <->1 \end{aligned}$ | 020 |
| 42013 | 2012 | Current limit at start | Off, 150-500\% In 1\% $\ln <->1$ | 021 |
| 42014 | 2013 | DC-Brake current limit | $\begin{aligned} & 100-300 \% \ln \\ & 1 \% \ln <->1 \end{aligned}$ | 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 | $\begin{aligned} & \text { Off, 0.1-2.0sec } \\ & 0.1 \mathrm{sec}<->1 \end{aligned}$ | 030 |

SP160 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement OM Manual Table 31 Holding register list (continuing)

| Modbus <br> logical <br> no | Modbus <br> no | Function/Name | Range/Unit | Product <br> MSF <br> menu |
| :--- | :--- | :--- | :--- | :--- |
| 42018 | 2017 | Slow speed digital input | Off, 1-100 edges, 1 <br> 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 <br> class | Off, 2-40sec, 1s<->1 | 072 |
| 42024 | 2023 | Starts per hour limitation | Off, 1-90/hour, 1<->1 | 074 |
| 42025 | 2024 | Locked rotor alarm | Off, 0.1-10.0sec <br> 0.1 sec<->1 | 075 |
| 42026 | 2025 | Voltage unbalance alarm | $5-25 \%$ Un, 1\% Un<->1 | 081 |
| 42027 | 2026 | Response delay voltage <br> unbal. | Off,1-60sec, 1sec<->1 | 082 |
| 42028 | 2027 | Over voltage alarm | $100-150 \%$ Un <br> $1 \%$ Un<->1 | 083 |
| 42029 | 2028 | Response delay over voltage | Off, 1-60sec, 1s<->1 | 084 |
| 42030 | 2029 | Under voltage alarm | $75-100 \%$ Un <br> $1 \%$ Un<->1 | 085 |
| 42031 | 2030 | Response delay under volt- <br> age | Off, 1-60sec, <br> 1 sec<->1 | 086 |
| 42032 | 2031 | Reset to factory settings | No, yes; no=0, yes=1 | 199 |

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### 3.12 Parameter description MSF

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

### 3.12.1 Softstarter type (30028).

Table 32 Sofistarter type

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

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

Table 33 Serinl comm. contaal 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).

| $\mathbf{1}$ | Phase input failure | F1 |
| :---: | :--- | :--- |
| $\mathbf{2}$ | Motor protection, overload | F2 |
| $\mathbf{3}$ | Soft start overheated | F3 |
| $\mathbf{4}$ | Current limit timeout | F4 |
| $\mathbf{5}$ | Locked rotor | F5 |
| $\mathbf{6}$ | Above max power limit | F6 |
| $\mathbf{7}$ | Below min power limit | F7 |
| $\mathbf{8}$ | Voltage unbalance | F8 |
| $\mathbf{9}$ | Over voltage | F9 |
| $\mathbf{1 0}$ | Under voltage | F10 |
| $\mathbf{1 1}$ | Starts/hour exceeded | F11 |
| $\mathbf{1 2}$ | Shorted thyristor | F12 |
| $\mathbf{1 3}$ | Open thyristor | F13 |
| $\mathbf{1 4}$ | Motor terminal open | F14 |
| $\mathbf{1 5}$ | Serial comm. broken | F15 |
| $\mathbf{1 6}$ | Phase reversal alarm | F16 |

### 3.12.6 Relay indication K1 (40023).

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

### 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 sec . to avoid serial comm. contact broken alarm.

### 3.13.1 MSF response delay

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

Table 34 Response delay table for setting (forcing) registers

| Modbus <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.

### 4.1.1 Mounting option card



Fig. 14 Installation of the option card in VFB.


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

### 4.2 Installation of VFX types

NOTE! Pictures are under construction, to be defined.

### 4.3 RS485 Multipoint network

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


Fig. 16 RS 485 multipoint network

### 4.3.1 RS485 connection

Table 35 RS485 pinning

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

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


Fig. 17 RS485 wiring

### 4.3.2 RS485 termination.

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

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


NOTE! Physical connection can be either 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.

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



Fig. 21 RS232 wiring

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

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

The following parameters have to be set-up:

- Unit address.
- Baud rate.

Serial comm. unit address[262]

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

Serial comm. baud rate[261]

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

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

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

## Ref control

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

|  | 212 Ref Control <br> Stp  |
| :--- | :--- |
| Commalt: | Remote |
| Range | Remote, keyboard, Comm, Rem/ <br> Digln1,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/DigIn1. See Instruction Manual VFB/VFX for further description.
$\left.\begin{array}{|l|l|}\hline & \begin{array}{ll}213 & \text { Run/Stp } \\ \text { Stp }\end{array} \\ \hline \text { Cefault: } & \text { Remote } \\ \text { Comm }\end{array}\right]$

### 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 | $\|c\|$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.

### 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 | 601 |
| 8 | 7 | Reset Trip Log | $0 \rightarrow 1$ = Reset | 7B0 |
| 10 | 9 | Auto-restart, Overtemp trip | $\begin{aligned} & \text { Off, on; of } f=0, \\ & \text { on=1 } \end{aligned}$ | 242 |
| 11 | 10 | Auto-restart, $1^{2} \mathrm{t}$ | $\begin{aligned} & \text { Off, on; of } f=0, \\ & \text { on=1 } \end{aligned}$ | 243 |
| 12 | 11 | Auto-restart, Overvolt D | $\begin{aligned} & \text { Off, on; off=0, } \\ & \text { on=1 } \end{aligned}$ | 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 | $\begin{aligned} & \text { Off, on; of } f=0, \\ & \text { on=1 } \end{aligned}$ | 246 |
| 15 | 14 | Auto-restart, PTC | $\begin{aligned} & \text { Off, on; of } f=0, \\ & \text { on=1 } \end{aligned}$ | 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 | $\begin{aligned} & \text { Off, on; of } f=0, \\ & \text { on=1 } \end{aligned}$ | 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 | Power consumption low word |  | 6FO |
| 30003 | 2 | Electrical power high word | $0-+-2 E 9 W, 1$ W $->1$ | 640 |
| 30004 | 3 | Electrical power low word |  | 640 |
| 30005 | 4 | Output shaft power high word | $\begin{aligned} & 0-+-2 E 9 W, \\ & 1 \text { W<->1 } \end{aligned}$ | 630 |
| 30006 | 5 | Output shaft power low word |  | 630 |
| 30007 | 6 | Operation time high word | 0-65535 h, $1 \mathrm{~h}<->1$ | 6D0 |
| 30008 | 7 | Operation time low word | 0-59 Min, 1 min<->1 | 6D0 |
| 30009 | 8 | Mains time hour | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 6E0 |
| 30010 | 9 | Mains time min | 0-59 Min, 1 min<->1 | 6E0 |
| 30011 | 10 | Shaft torque high word | $\begin{aligned} & 0-2 \mathrm{E} \text { Nm, } \\ & 0.1 \mathrm{Nm}<->1 \end{aligned}$ | 620 |
| 30012 | 11 | Shaft torque low word | " | 620 |
| 30013 | 12 | Process speed high word | $\begin{aligned} & 1-+-2 E 8 \mathrm{Rpm}, \\ & 1 \mathrm{rpm}<->1000 \end{aligned}$ | 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 | $\begin{aligned} & \text { V1.23 -> Release } \\ & \text { Bit } 15-14=0,0 \\ & \text { Bit } 13-8=1, \\ & L B=23 \text { See } 4.11 . \end{aligned}$ | 920 |
| 30018 | 17 | Option/variant version | $\begin{aligned} & \text { OPT V2.34 -> } \\ & H B=2, \\ & L B=34 \end{aligned}$ | 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 | See description in 4.11. | 910 |

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Table 39 Input register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 30029 | 28 | Control start by / Control mode | $\begin{aligned} & 0=\text { Remote, } \\ & 1=\text { Keyboard, } \\ & 2=\text { Serial comm } \end{aligned}$ |  |
| 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 voitage | 0-1000V, 0.1V<->1 | 680 |
| 30040 | 39 | Warning | 0-31 See description in 4.11.3. | 6H0 |
|  |  |  |  |  |
| 30043 | 42 | Digital input status | See description in 4.11.6. | 6B0 |
| 30044 | 43 | Analog input status 1 | $-100-+100 \%, 1 \%<->1$ | 6C0 |
| 30045 | 44 | Analog input status 2 | $-100-+100 \%, 1 \%<->1$ | 6C0 |
| 30046 | 45 | Param_version | For internal use |  |
|  |  |  |  |  |
| 30052 | 51 | Emotron product | 1=VFB/VFX, 2=MSF |  |
|  |  |  |  |  |
| 30101 | 100 | Trip time 1 h | 0-65535 h, 1h<->1 | 710 |
| 30102 | 101 | Trip time 1 min | 0-59 Min, 1 min<->1 | 710 |
| 30103 | 102 | Trip message 1 | 0-31 See description in 4.11.3. | 710 |
| 30104 | 103 | Trip time 2 h | 0-65535 h, 1h<->1 | 720 |
| 30105 | 104 | Trip time 2 min | 0-59 Min, 1 min<->1 | 720 |

SP160 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement OM Manual Table 39 Input register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | $\begin{array}{\|c\|} \hline \text { Product } \\ \text { VFB/VFX } \\ \text { menu } \end{array}$ |
| :---: | :---: | :---: | :---: | :---: |
| 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 | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 740 |
| 30111 | 110 | Trip time 4 min | $0-59$ Min, 1 min<->1 | 740 |
| 30112 | 111 | Trip message 4 | See trip message 1. | 740 |
| 30113 | 112 | Trip time 5 h | 0-65535 h, 1h<->1 | 750 |
| 30114 | 113 | Trip time 5 min | 0-59 Min, 1 min<->1 | 750 |
| 30115 | 114 | Trip message 5 | See trip message 1. | 750 |
| 30116 | 115 | Trip time 6 h | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 760 |
| 30117 | 116 | Trip time 6 min | -599 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 | 0-59 Min, 1 min<->1 | 770 |
| 30121 | 120 | Trip message 7 | See trip message 1. | 770 |
| 30122 | 121 | Trip time 8 h | $0-65535 \mathrm{~h}, 1 \mathrm{~h}<->1$ | 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 | O-65535 h, 1h<->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 |

### 4.10 Holding register list

Table 40 Holding register list

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40001 | 0 | Nominal motor voltage | 100.0-700.0V | 222 |
| 40002 | 1 | Nominal motor frequency | $50-300 \mathrm{~Hz}$ | 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 | $\begin{aligned} & 1-3276700 \mathrm{~W} \\ & \text { Bit15=0->1W<->1} \\ & \text { Bit15=1->100W }<->1 \end{aligned}$ | 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 | $\begin{aligned} & 0=\text { Off, } \\ & 1=0 n \end{aligned}$ | 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 |

SP160 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement OM Manual Table 40 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40022 | 21 | Parameter set | $0=A$, $4=D 13$, <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 See description in 4.11.4. | 451 |
| 40024 | 23 | Relay 2 | $0-21$ See description in 4.11.4. | 452 |
| 40025 | 24 | Relay 3 | Not defined yet. |  |
| 40026 | 25 | Relay 4 | Not defined yet. |  |
| 40027 | 26 | AnIn 1, function | $\begin{aligned} & 0=\text { Off, } \\ & 1=\text { Speed, } \\ & 2=\text { Torque } \end{aligned}$ | 411 |
| 40028 | 27 | AnIn 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 | AnIn 1, gain | -4.00-+4.00, 0.01 <-> 1 | 414 |
| 40031 | 30 | AnIn 1, bipolar | $\begin{aligned} & 0=\mathrm{Off}, \\ & 1=O \mathrm{n} \end{aligned}$ | 415 |
| 40032 | 31 | AnIn 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 |
|  |  |  |  |  |
| 40036 | 35 | AnIn 2, bipolar | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=0 \mathrm{n} \end{aligned}$ | 41A |
| 40037 | 36 | AnOut 1, function | $\begin{aligned} & \text { 0=Torque, } \\ & 1=\text { Speed, } \quad 4=\text { Current, } \\ & 2=\text { Shaft power, } 5=\text { El.power, } \\ & 3=\text { Frequency, } 6=\text { Outp.voltage } \end{aligned}$ | 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 |

SP160 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement OM Manual Table 40 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 40041 | 40 | AnOut 1, bipolar | $\begin{aligned} & 0=\text { Off }, \\ & 1=O n \end{aligned}$ | 435 |
| 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 | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA} \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=\text { User defined } \end{aligned}$ | 437 |
| 40044 | 43 | AnOut 2, offset | $-100 \%-+100 \% 1 \%$ <-> 1 | 438 |
| 40045 | 44 | AnOut 2, gain | -4.00-+4.00, $0.01<->1$ | 439 |
| 40046 | 45 | AnOut 2, bipolar | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=0 \mathrm{n} \end{aligned}$ | 43A |
| 40047 | 46 | AnOut 3, function | $0=$ Torque, $4=$ Current, <br> $1=$ Speed, $5=$ El.power, <br> $2=$ Shaft power, $6=$ Outp <br> $3=$ Frequency, voltage |  |
| 40048 | 47 | AnOut 3, setup | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA}, \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=\text { User defined } \end{aligned}$ |  |
| 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 | $\begin{aligned} & 0=0 f f, \\ & 1=0 n \end{aligned}$ |  |
| 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 | $\begin{aligned} & 0=0-10 \mathrm{~V} / 0-20 \mathrm{~mA}, \\ & 1=2-10 \mathrm{~V} / 4-20 \mathrm{~mA}, \\ & 2=\text { User defined } \end{aligned}$ |  |

SP160 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement OM Manual Table 40 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | $\begin{aligned} & \text { Product } \\ & \text { VFB/VFX } \\ & \text { menu } \end{aligned}$ |
| :---: | :---: | :---: | :---: | :---: |
| 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 | $\begin{aligned} & 0=0 f f, \\ & 1=0 n \end{aligned}$ |  |
| 41001 | 1000 | Comm, ref | 100\% <-> 0x2000 |  |
| 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 | $\begin{aligned} & \text { O=Remote, } \quad \text { 3=Rem/digin1, } \\ & 1=\text { Keyboard, } \quad \text { =Comm } / \\ & \text { digin1 } \\ & 2=\text { Comm, } \end{aligned}$ | 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 See description in 4.11.6. | 421 |
| 41009 | 1008 | Digln 2 | 0-11 See description in 4.11.6. | 422 |
| 41010 | 1009 | Digln 3 | 0-11 See description in 4.11.6. | 423 |
| 41011 | 1010 | Digin 4 | 0-11 See description in 4.11.6. | 424 |
|  |  |  |  |  |
| 41014 | 1013 | DigOut 1 | 0-21 See description in 4.11.4. | 441 |
| 41015 | 1014 | DigOut 2 | 0-21 See description in 4.11.4. | 442 |
| 41018 | 1017 | Crio enable | $\begin{aligned} & 0=0 f f, \\ & 1=0 n \end{aligned}$ | 281 |
| 41019 | 1018 | Crio control | $\begin{aligned} & 0=4 \text {-Speed }, \\ & 1=3 \text {-pos, } \\ & 2=\text { Analogue } \end{aligned}$ | 282 |

SP160 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement OM Manual
Table 40 Holding register list (continuing)

| Modbus logical no | Modbus no | Function/Name | Range/Unit | Product VFB/VFX menu |
| :---: | :---: | :---: | :---: | :---: |
| 41020 | 1019 | Crio relay 1 | 0-21 See description in 4.11.4. | 283 |
| 41021 | 1020 | Crio relay 2 | 0-21 See description in 4.11.4. | 284 |
| 41022 | 1021 | Process unit | $0=$ None, $3=\mathrm{m} / \mathrm{s}$, <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, $7=0 C$ 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 | $\begin{array}{ll} 0=\text { English, } & 3=\text { Dutch, } \\ 1=\text { German, } & 4=\text { French } \\ 2=\text { Swedish, } & \end{array}$ | 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 | $0=$ None |  |
|  |  |  |  |  |
| 41032 | 1031 | MVB card on/off | $\begin{aligned} & 0=\text { Off }, \\ & 1=0 n \end{aligned}$ | 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 | 1102 | Q-stop time | 0.00-3600.00 See description in 4.11.7 | 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 |  |
| 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 | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=0 \mathrm{n} \end{aligned}$ | 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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Toble 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 | 32D |
| 41126 | 1125 | Skip speed 1 High | 0-2*Motor sync speed, see description in 4.11.7 | 32E |
| 41127 | 1126 | Skip speed 2 Low | 0-2*Motor sync speed, see description in 4.11.7 | 32F |
| 41128 | 1127 | Skip speed 2 High | 0-2*Motor sync speed, see description in 4.11.7 | 32G |
| 41129 | 1128 | Jog speed | $0 \pm 2 *$ 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, 0.01s<->1 | 343 |
| 41133 | 1132 | Fux optimization | $\begin{aligned} & 0=0 \mathrm{ff}, \\ & 1=0 \mathrm{n} \end{aligned}$ | 344 |
| 41134 | 1133 | PID-controller | $\begin{aligned} & 0=\text { Off }, \\ & 1=0 \mathrm{n}, \\ & 2=\text { Invert } \end{aligned}$ | 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, 0.01s<->1 | 348 |
| 41138 | 1137 | Low voltage overrride | $0=0 f f, 1=0 n$ | 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 |
| 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 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 |
|  |  | 1111111 | 255 |
|  |  | $3508 \mathrm{~h} \rightarrow$ |  |
|  |  |  |  |
|  |  |  |  |

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4.11.2 Inverter type (30028).

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


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

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 |
| $12=$ = > nom | $13=$ Brake | $14=$ Sgnl<Offset | $15=$ Alarm |
| $16=$ Pre Alarm | $17=$ Max Alarm | $18=$ Max Pre-Alrm | $19=$ Min Alrm |
| $20=$ Min Pre-Alrm | $21=$ Deviation |  |  |

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



| Bit 12-15 | Spare |  |
| :--- | :--- | :--- |
| Bit 11 | INT_ERROR | $0 \times 0800$ |
| Bit 10 | POWER_FAULT | $0 \times 0400$ |
| Bit 9 | LOCKED_ROTOR | $0 \times 0200$ |
| Bit 8 | MON_ALARM | $0 \times 0100$ |
| Bit 7 | MOTOR_LOST | $0 \times 0080$ |
| 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 | IIT | $0 \times 0002$ |
| 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 $0 \times 0 \mathrm{~A} 00$ should be written to the register.

If the value $0 x 0123$ 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 Digln (41008,41009).

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

### 4.11.7 Representation of speed.

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

### 4.12 Performance

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

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

### 4.12.1 VFB/VFX response delay

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

## 5. CRC GENERATION

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

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

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

## Generation in steps:

- Step 1 Load a 16 -bit register with $0 x F F F F$ (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 00000000 0001) .
- Step 5 Repeat Steps 3 and 4 until eight shifts have been performed. When this is done, a complete eight-bit byte will have been processed.
- Step 6 Repeat Steps $2 \ldots 5$ 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 CRC generation is shown on this page.
The function takes two arguments:

- Unsigned char ${ }^{\star}$ 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 \(=0 x F F F F\);
    for ( \(\mathrm{i}=0 ; \mathrm{i}<\mathrm{usDataLen} ; \mathrm{i}++\) )
    \{
        crc_reg \(\wedge=\star\) puchMsg++;
        for ( \(k=0 ; k<8 ; k++\) )
        \{
        if (crc_reg \& \(0 \times 0001\) )
        \{
            crc_reg \(\gg=1\);
            crc_reg \({ }^{\wedge=}\) CRC_POLYNOMIAL;
        \}
        else
            crc_reg >>= 1 ;
        \}
    \}
    return crc_reg;
```

Fig. 22 CRC example.
Emotron AB
Mörsaregatan 12
Box 22225
SE-250 24 Helsingborg
Sweden
Tel.: +46 42169900
Fax: +46 42169949
Email: infogemotron.com
Internet: www.emotron.com

## Emotron MSF 2.0 Softstarter



Instruction manual English

Valid for the following softstarter models: MSF 2.0

## MSF 2.0

## SOFTSTARTER

## Instruction manual

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## Safety instructions

## Safety

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

- The device must be installed by trained personnel.
- Disconnect all power sources before servicing.
- Always use standard commercial fuses, slow blow e.g. gt, gG types, to protect the wiring and prevent short circuiting. To protect the thytistors 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.
lnstalling and/or using such products can have a negative effect on the characteristics designed for your device. The manufacturer is not liable for damage arising as a result of using non-original parts and accessories.

## Emergency

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

## Dismantling and scrapping

The enclosure of the softstarter is made of recyclable material such as aluminium, iron and plastic. Legal requirements for disposal and recycling of these materials must be complied with.
The softstarter contains a number of components demanding special treatment, such as thyristors for example. The circuir boards contain small amounts of tin and lead. Legal requirements for the disposal and recycling of these materials must be complied with.

## General warnings

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


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


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

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## 1. General information

This manual describes the Emotron Softstarter MSF 2.0

### 1.1 How to use the Instruction Manual

This instruction manual tells you how to install and operate the softstarter MSF 2.0. Read the whole Instruction Manual before installing and putting the unit into operation.
Once you are familiar with the softstarter, you can operate in from the control panel by referring to chapter 5 . page 27 .
This chapter describes all the functions and possible settings.

### 1.2 Integrated safety systems

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

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

The softstarter is equipped with a connection for protective earth $\stackrel{\perp}{=}$ (PE).

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

### 1.3 Safety measures

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

- Available to competent personnel at all times.
- Read prior to installation of the device.
- Observed with regard to safery, 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 merhods.
The safery measures laid down in DIN standard VDE 0100 must be guaranteed.

The user must obtain any general and local operating per-
mits and meet any requirements regarding:

- Personnel safety
- Product disposal
- Environmental protection

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

### 1.4 Notes to the Instruction Manual

NOTE: Additional information as an aid to avolding problems.


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


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

## Important

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

### 1.5 Type number

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

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

Fig. 1 Type number.

Table 1

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

### 1.6 Standards

The device is manufactured in accordance with these regulations:

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


### 1.7 Tests in accordance with norm EN 60204 standard

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

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


### 1.8 Transport and packing

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

## Check on receipt

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

Is the packaging damaged?
Check the goods for damage (visual check).

## If you have cause for complaint

If the goods have been damaged during transport:

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


## Packaging for returning the device

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

## Intermediate storage

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

### 1.9 Unpacking MSF-310 and larger types

The MSF 2.0 softstarter is atrached to the plywood box/ loading stool by screws, and the softstarter muse 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 srool, both rop and sides in one piece.
2. Loosen the three (3) screws on the front cover of the softstarter unit, down by the lower logo.
3. Push up the front cover about 20 mm so that the front cover can be removed.
4. Remove the two (2) mounting screws at the bottom of the sofistarcer.
5. Lift up the softstarter unit at the bottom about 10 mm and then push backwards abour 20 mm so that the softstarter can be removed from the mounting hooks* at the top. The hooks are placed under the bortom place and cannor be removed until the softstarter is pulled out.
6. Loosen the two screws (2) for the mounting hooks and remove the hooks.
7. The hooks are used as an upper support for mounting the softstarter.


Fig. 2 Unpacking MSF-310 and larger models.

### 1.10 Glossary

### 1.10.1 Abbreviations

In this manual the following abbreviations are used:
Table 2 Abbreviations

| Abbreviation | Description |
| :--- | :--- |
| FLC | Full load current |
| DOL | Direct on-line |

### 1.10.2 Definitions

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

## Table 3 Definitions

| Name | Description | Unit |
| :--- | :--- | :--- |
| $I_{\text {nsoft }}$ | Nominal softstarter current | A |
| $P_{\text {nsoft }}$ | Nominal softstarter power | $\mathrm{kW}, \mathrm{HP}$ |
| $\mathrm{N}_{\text {nsoft }}$ | Nominal softstarter speed | rpm |
| $\mathrm{T}_{\mathrm{n}}$ | Nominal motor torque | $\mathrm{Nm}, \mathrm{lbft}$ |
| $\mathrm{U}_{\mathrm{n}}$ | Nominal motor voltage | V |
| $\mathrm{I}_{\mathrm{n}}$ | Nominal motor current | A |
| $\mathrm{P}_{\mathrm{n}}$ | Nominal motor power | $\mathrm{kw}, \mathrm{HP}$ |
| $\mathrm{P}_{\text {normal }}$ | Normal load | $\%$ of $\mathrm{P}_{\mathrm{n}}$ |

## 2. Description

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

### 2.1 Background theory

The following two sections deal with motors with squirrelcage rotors. In contrast to a wound rotor, the squirrel-cage rotor consists of straight conductors, which are shortcircuired together at both ends.
When such a motor is connecred directly ro the line volage it will typically draw a starting current of abour 5 to 8 times its nominal current while the resulting starting torque will be about 0.5 to 1.5 times its nominal torque. In the following picture a typical starting characteristic is shown. The xaxis represents the speed relative to the nominal speed while the $y$-axis shows the corque and the currene respectively, even those normalized to their nominal values. The dashed line indicates the nominal values.


Fig. 3 Typical torque characteristics for the DOL start


Fig. 4 Typical current characteristics for the DOL start
For many industrial applications direct on-line starting is not convenient, as the supply in this case has to be dimensioned to deliver the unnecessarily high starting current. Moreover, most applications do not gain anything from the high starting rorque. Instead there is a risk of mechanical wear or even damage because of the resulting jerk at speedup.
The acceleration torque is determined by the difference berween motor and load torque. The figure below shows some typical torque characteristics for constant speed applications. For comparative purposes, the inducion motors' torque characteristic is added to the diagram.


Fig. 5 Typical load torque characteristics
Typical applications with constant load are elevators, cranes and conveyors. Linear load characteristics are found for calendar rollers and smoorhing machines; quadratic correlation berween speed and rorque is rypical for pumps and fans.

Some applications like conveyors or screws may need an initial torque boost. However, for many applications it can be seen that the torque needed is much lower than the torque delivered by the induction motor in a DOL start.
A common method to reduce borh starting torque and current is to decrease the moror voltage during starting. The following figure shows how the motor's torque and current characteristics are changed when the supply voltage is reduced.


Fig. 6 Reduced voltage start
A general rule of thumb is that the torque at each operating point is roughly proportional to the square of the current. This means when the motor current is decreased by a factor of two by means of reducing the supply voltage, the torque delivered by the moror will be decreased by a factor of four (approximately).

$$
\begin{aligned}
& T \sim I^{2} \\
& I_{\mathrm{LV}}=1 / 2 \mathrm{I}_{\mathrm{DOL}} \rightarrow T_{\mathrm{LV}} \approx 1 / 4 T_{\mathrm{DOL}} \\
& \mathrm{I}_{\mathrm{LV}}=1 / 3 \mathrm{I}_{\mathrm{DOL}}>T_{\mathrm{LV}} \approx 1 / 9 T_{\mathrm{DOL}}
\end{aligned}
$$

## LV=low voltage

DOL=Direct on line

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

### 2.2 Reduced voltage starting

This section describes different starting methods which are based on the reduced-voltage principle explained above. A pump and its quadratic torque characteristic are used as an example.
The star-delta starter is the simplest example of a reduced voltage starter. The motor phases are first star connected; at about $75 \%$ of nominal speed the phase connection is then changed ro delca. To enable star-delta start, both ends of all three motor windings have to be available for connection. Moreover, the motor has to be dimensioned for the (higher) voltage in the delta connecrion. The following figure shows the resulting torque and current characteristics.


Fig. 7 Star-delta start

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

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


Fig. 8 Soft starting - voltage ramp
Obviously a much smoother start is realized compared to the star-delta start and the starting current is decreased.

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


Fig. 9 Soft starting - voltage ramp with current limit
Once again the figure illustrates that the resulting performance depends on the combination of motor and load characteristics. In the example above the motor torque is close to the load torque at about half speed. This means for some other applications with different load characteristics (for example a linear corque-speed correlation) this particular motor would need more than three times the nominal current to start.
The most sophisticated electronic softstarters use torque control, which results in an almost constant acceleration during the start. A low starting current is also achieved. However, even this start method uses reduced motor voltage and the quadratic correlation between current and torque described in the first section of this chapter is srill valid. This means, the lowest possible starting current is determined by the combination of motor and load characteristics.


Fig. 10 Soft starting - torque control
For optimal starting performance, correct setring of the softstarter's parameters such as initial torque and end torque at start and start time is important. The choice of paramerers is explained in detail in section 8.7, page 55.

### 2.3 Other starting methods

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


Fig. 11 Rotor-resistance starting
Because of the low starting torque it is often not possible to short-circuit the rotor windings and replace the rotor-resistance starter with a softstarter. However, it is always possible to use a frequency inverter instead. The following illustration shows how the torque and current characteristics are affected when the stator frequency is changed.


Fig. 12 Voltagelfrequency regulation
Thus, such a motor can be started with a quice simple frequency inverter with voltage-frequency regulation. This solution is even valid for all other applications, which for some reason (high load torque compared to moror torque erc.) cannor be starred by a softstarter.

### 2.4 Use of softstarters with torque control

To determine if a specific application benefits from using a softstarter at all, the correlation between the motor's torque characteristic during the start and the load's requirements has to be evaluated. As it can be seen from the examples above, the application will only benefic from using a softstarter if the load torque during the start is clearly below the motor's starting capacity. However, even loads with a high initial release torque may profit from a softstarter. In this case an initial torque boost can be used, thereafter the start ramp is continued reducing the starting current considerably.
The profir can be maximized when using a softstarrer with rorque control. To be able to configure the torque control paramerers for optimal performance, the load characrerisrics (linear, square or constant load, need of initial release torque) must be known. In this case a proper rorque control merhod (linear or square) can be chosen and rorque boost can be enabled if needed. A description of the load characteristics of several common applications and guidelines for proper setrings are found in chaprer 6. page 31, Applications and Functions Selection. Optimization of the torque control parameter is explained in derail in secrion 8.7, page 55.

## 3. Mounting

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

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

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

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


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

### 3.1.1 Cooling

MSF-017 to MSF-250
Table 4 MSF-017 to MSF-250

| MSF <br> model | Minimum free space (mm): |  |  |
| :--- | :--- | :--- | :--- |
|  | above 1) | below | at side |
| $-017,-030,-045$ | 100 | 100 | 0 |
| $-060,-075,-085$ | 100 | 100 | 0 |
| $-110,-145$ | 100 | 100 | 0 |
| $-170,-210,-250$ | 100 | 100 | 0 |

MSF-310 to MSF-1400
Table 5 MSF-310 to MSF-1400.

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

### 3.1 Installation of the softstarter in a cabinet

When installing the softstarter:

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

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

MSF-017 to MSF-835 are all delivered as enclosed versions with front opening. The units have bottom entry for cables etc. see Fig. 20 on page 21 and Fig. 22 on page 23. MSF1000 and MSF-1400 are delivered as open chassis.

### 3.1.2 Mounting schemes

MSF-017 to MSF-250



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

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

Table 6

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

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


Fig. 16 Busbar distances MSF-310 to MSF-835.
Table 7 Busbar distances

| MSF model | Dist. h1 <br> (mm) | Dist. W1 <br> (mm) | Dist.W2 <br> (mm) | Dist.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. 15 Hole pattern for MSF-170 to MSF-250 with upper mounting bracket instead of DIN rail.


Fig. 17 MSF-1000 to MSF-1400


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

## 4. Connections

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

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

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

NOTE: For UL-approval use $75^{\circ} \mathrm{C}$ Copper wire only.

### 4.1 Connecting mains and motor cables



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

Connection of MSF-017 to MSF-085
7. Mounting of EMC gland for control cables

## Device connections

1. Protective earth, $\underset{=}{\perp}$ (PE), mains supply, motor (on the right and left inside of the cabiner)
2. Protective earth, $\underset{=}{\perp}(\mathrm{PE})$, control supply voltage
3. Control supply voltage connection $\mathbf{0 1}, 02$
4. Mains supply L1, L2, L3
5. Motor power supply T1, T2, T3
6. Current transformers (can be mounted outside for bypass see section 8.7.5, page 67)


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

## Connection of MSF-110 to MSF-145

Device connections

1. Protective earth, $\perp$ (PE), mains supply, motor (on the left inside of the cabinet)
2. Protective earth $\perp(\mathrm{PE})$, control supply voltage
3. Control supply volage connection 01,02
4. Mains supply L1, L2, L3
5. Motor power supply $\mathrm{T} 1, \mathrm{~T} 2, \mathrm{~T} 3$
6. Current transformers (can be mounted outside for bypass see section 8.7.5, page 67)
7. Mounting of EMC gland for control cables


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

Connection of MSF-170 to MSF-250
Device connections

1. Protective earth, $\perp$ ( PE ), mains supply, motor (on the left inside of the cabinet)
2. Protective earth $\stackrel{\perp}{=}(\mathrm{PE})$, control supply voltage
3. Concrol supply voltage connection 01,02
4. Mains supply L1, L2, L3
5. Moror power supply T1, T2, T3
6. Current cransformers (can be mounted outside for bypass see secrion 8.7.5, page 67)
7. Mounting of EMC gland for control cables


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

## Connection of MSF-310 to MSF-1400

## Device connections

1. Protective earth, $\stackrel{\perp}{\bar{\sim}}$ (PE), mains supply and motor
2. Protecrive earth, $\xlongequal[=]{\perp}$ (PE), control supply voltage
3. Control supply voltage connection $\mathbf{0 1 , 0 2}$
4. Mains supply L1, L2, L3
5. Motor power supply T1, T2, T3
6. Current transformers (possible to mount outside for bypass see section 8.7.5, page 67)
7. Mounting of EMC gland for control cables

### 4.2 Control Connection



Fig. $23 P C B$ (control board) connections.
Table 8 PCB Terminals

| Terminal | Function | Electrical characteristics |
| :---: | :---: | :---: |
| 01 | Control supply voltage | 100-240 VAC $\pm 10 \%$ alternative |
| 02 |  | $380-500 \mathrm{VAC} \pm 10 \%$ see rating plate |
| PE | Protective Earth | $\stackrel{1}{ \pm}$ |
| 11 | Digital input 1 | $0.3 \mathrm{~V} \rightarrow>0 ; 8-27 \mathrm{~V} \rightarrow 1$ <br> Max. 37 V for 10 sec . Impedance to $0 \mathrm{VDC}: 2.2 \mathrm{k} \Omega$. |
| 12 | Digital input 2 |  |
| 13 | Control signal supply 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 but not overload-roof. |
| 14 | Analogue input, 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 input 3 | $0.3 \mathrm{~V} \rightarrow \mathrm{0}$; 8-27 V $->1$. |
| 17 | Digital input 4 | Max. 37 V for 10 sec . Impedance to $0 \mathrm{VDC}: 2.2 \mathrm{k} \Omega$. |
| 18 | Control signal supply 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 but not overload-proof. |
| 19 | Analogue output | Analogue output contact: <br> $0-10 \mathrm{~V}, 2-10 \mathrm{~V}$; min load impedance $700 \Omega$ <br> 0.20 mA and 4.20 mA ; max load impedance $750 \Omega$ |
| 21 | Programmable relay K1. Factory setting is "Operation" with indication by closing terminal 21 to 22. | 1-pole closing contact, 250 VAC 8 A or 24 VDC 8 A resistive, $250 \mathrm{VAC}, 3 \mathrm{~A}$ inductive. |
| 22 |  |  |
| 23 | Programmable relay $K 2$. Factory setting is "Full voltage" with indication by closing terminals 23 to 24 . | 1 -pole closing contact, 250 VAC 8 A or 24 VDC 8 A resistive, 250 VAC, 3 A inductive. |
| 24 |  |  |
| 31 | Programmable relay K3. Factory setting is "All alarms". Indication by closing terminals 31 to 33 and opening terminals 32 to 33 . | 1-pole change-over contact, 250 VAC 8 A or 24 VDC 8 A resistive, $250 \mathrm{VAC}, 3 \mathrm{~A}$ inductive. |
| 32 |  |  |
| 33 |  |  |
| 69-70 | PTC Thermistor input | Alarm level $2.4 \mathrm{k} \Omega$ S Switch back level $2.2 \mathrm{k} \Omega$. |
| 71-72* | Clickson thermistor | Controlling softstarter cooling fan temperature MSF-310-MSF-1400 |
| 73-74* | NTC thermistor | Temperature measuring of softstarter cooling fin |
| 75 | Current transformer input, cable S1 (blue) | Connection of L1 or T1 phase current transformer |
| 76 | Current transformer input, cable S1 (blue) | Connection of L3, T3 phase (MSF 017 to MSF 250) or L2. T2 phase (MSF 310 to MSF 1400) |
| 77 | Current transformer input, cable S2 (brown) | Common connection for terminals 75 and 76 |
| 78*. | Fan connection | 24 VDC |
| 79* | Fan connection | O VDC |

*Internal connection, no customer use.

### 4.3 Minimum wiring

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

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

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

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

### 4.4 Wiring examples

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

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


Fig. 24 Wiring circuit, "minimum wiving".

## 5. How to get started

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

## WARNING! Mounting, wiring and setting the

 device into operation must be carried out by properly trained personnel.
### 5.1 Checklist

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


### 5.2 Applications



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


03-F17-2
Fig. 25 Standard wiring.

### 5.3 Motor data

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

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


### 5.4 Start and stop



| $3 \mid 20$ | Setting  <br>   <br>   | 4 |
| :--- | :--- | :--- |
| Default: | 4 (Coast) |  |
| Range: | $1,2,3,4,5$ |  |
| 1 | Linear torque control |  |
| 2 | Square torque control |  |
| 3 | Voltage control |  |
| 4 | Coast |  |
| 5 | Brake |  |

Default "Stop method" is Coast (freewheeling).

### 5.5 Setting the start command

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

| $2\|O\| O$ |  |  |
| :--- | :--- | :--- |
|  |  | Setting |
|  |  |  |
|  |  |  |
| Default: | 2 Control source |  |
| Range: | $1,2,3$ |  |
| 1 | Control panel. |  |
| 2 | Remote control. |  |
| 3 |  | Serial communication control. |

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

NOTEI Factory default setting is remote control (2).
To start and stop from the control panel, the "START/ STOP" key is used.

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

### 5.6 Viewing the motor current

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


### 5.7 Starting

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


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

## 6. Applications and functions selection

This chapter is a guide to selecting the correct softstarter rating and softstarter funcrionality for different applications.
To make the right choice the following tools are used:

## The norms AC53a and AC53b

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

## The Applications Rating List

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

## The Applications Function List

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

### 6.1 Softstarter rating according to AC53a

The IEC 60947-4-2 standard for elcetronic sofistarters defines AC 53a as a norm for dimensioning of sofstarters for continuous running withour bypass.

The MSF 2.0 softstarter is designed to run continuously.


Fig. 27 AC53a rating example.


Fig. 28 Duty cycle, non-bypass.
The above example indicates a current rating of 210 Amps with a start current ratio of $5.0 \times \mathrm{FLC}(1050 \mathrm{~A})$ for $30 \mathrm{sec}-$ onds with a $50 \%$ dury cycle and 10 starts per hour.

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

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

### 6.2 Softstarter rating according to AC53b

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


Fig. 29 AC536 rating example.


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

### 6.3 The Applications Rating List

According to the norms AC53a and AC53b a softstarter can have many current ratings.
With help of the Applications Rating List the correct rating can be chosen for most applications.
The Applications Rating List uses two levels for the AC53a norm and one level for the AC53b norm:

AC53a 5.0-30:50-10 (heavy)
This level will be able to start almost all applications and follows directly the cype number of the softstarter.
Example: MSF-370 is designed for 370 A full load current (FLC) and 5 times this current for a starting time of 30 seconds.
AC 53a 3.0-30:50-10 (normal)
This level is for lighter applications and here the MSF 2.0 can manage a higher FLC.
Example: MSF-370 can be used for an application with 450 A FLC if the starting current is not more than 3 times this current for a starting time of 30 seconds.

AC53b 3.0-30:330 (normal with bypass)
This level is for lighter applications when a bypass contactor is used. The MSF 2.0 can in this case be used for applications with an even higher nominal current.

## Example

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

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

## The Applications Rating List

The first column in the Applications Rating List, see Table 9, page 33 gives various applications. If the machine or application is not in this list, try to identify a similar machine or application. If in doubs please contact your supplier. The second and third columns gives typical ratings for the machine or application. The ratings are divided in Nor$\mathrm{mal} /$ Normal with by-pass and Heavy dury.

## Example

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

Table 9 Applications Rating List

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

Table 9 Applications Rating List

| Applications | Normal AC53a 3.0-30:50-10 and Normal with bypass AC53b 3.0-30:300 | $\begin{gathered} \text { Heavy } \\ \text { AC 53a 5.0-30:50-10 } \end{gathered}$ |
| :---: | :---: | :---: |
| Lumber \& Wood Products |  |  |
| Bandsaw |  | x |
| Chipper |  | $x$ |
| Circular Saw |  | X |
| Debarker |  | x |
| Planer |  | $x$ |
| Sander |  | x |

### 6.4 The Application Functions List

This list gives an overview of many different applications with their challenges and a possible solution with one of the many MSF 2.0 funcrions.
Description and use of the table:

## Application

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

## Challenge

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

## MSF 2.0 Solution

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

## Menus

Gives the menu numbers and selection for the MSF 2.0 function.
"200;=1", means: program selection 1 in menu [200].
"323;=1/320,324", means: progranı selection 1 in menu [323], menus [320] and [324] are relared to this function.

Table 10 Application Functions List

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

Table 10 Application Functions List

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

Table 10 Application Functions List

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

## Example

Hammer Mill:

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


### 6.5 Special conditions

### 6.5.1 Small motor or low load

The minimum load current for the MSF 2.0 softstarter is $10 \%$ of the rated current of the softstarter, except for the MSF-017 where the min. current is 2 A . Example: MSF210 , rared current $=210 \mathrm{~A}$. Min. Current 21 A . Please note that this is "minimum load current" and not minimum rated motor current.

### 6.5.2 Ambient temperature below $0^{\circ} \mathrm{C}$

For ambient temperatures below $0^{\circ} \mathrm{C}$ an electric heater or similar must be installed in the cabiner. The softstarter can also be mounted somewhere else since the distance berween the motor and the softstarter is not critical.

### 6.5.3 Phase compensation capacitor

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

### 6.5.4 Shielded motor cable

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

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

### 6.5.5 Pump control with softstarter and frequency inverter together

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

### 6.5.6 Starting with counterclockwise rotating loads

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

### 6.5.7 Running motors connected in parallel

When starting and running motors connected in parallel, the total amount of the motor current must be equal or lower than the rating of the connected softstarter. Please note that it is not possible to have individual settings for each motor or to use the internal thermal motor protection. The start ramp can only be set for an average starting ramp for all the connected motors. This means that the start time may differ from motor to motor.
For motors connected in parallel, torque conrrol is not recommended because of the risk of oscillation between the motors. Voltage control with or without current limit is preferred instead. The use of the braking functionality is not recommended for motors connected in parallel.

### 6.5.8 Running motors linked together

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

### 6.5.9 Step-up transformer for high voltage motor

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

### 6.5.10 How to calculate heat

## dissipation in cabinets

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

### 6.5.11 Insulation test on motor

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

### 6.5.12 Operation above 1000 m

All ratings are stated at 1000 m over sea level.
If an MSF 2.0 is placed at 3000 m for example, it must he derated.

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

## 7. Operation of the softstarter



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

### 7.1 General description of user interface

4
WARNING! Never operate the softstarter with the front cover removed.

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

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

## Setting



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

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

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

### 7.2 Control panel



Fig. 32 Controlpanel.

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

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


### 7.3 LED indication

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

When a start command is given either from the control panel, through the serial communication interface (option) or through the remore control inputs, the start/stop LED will be illuminated. At a stop command the start/stop LED will switch off. The start/stop LED flashes when the softstarter is in standby operation waiting for a start caused by autoreset or analogue start/stop.
When the motor is running, the running LED flashes during ramp up and down and is illuminated continuously at full motor voluage.


Fig. 33 LED indication at different operation situations.

### 7.4 The menu structure

The menus in MSF 2.0 are organized in a 1 -level structure and they are divided into the groups set out in table 8.
For easier commissioning the menus are divided into three groups, Read-out, Setting and Multi Setting. Read-out menus are only for reading; Setting menus are for setting one parameter and Multi Setting menus are for setting several parameters which cannot be undone. The menus are selected by navigating backwards and forwards through the menu system. Sub-menus simplify setring but are not available when the corresponding main function is not acrivated.

Table 11 Menu structure of MSF 2.0.

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

### 7.5 The keys

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

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

Table 12 The keys

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

### 7.6 Control panel lock

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

- Lock control panel by simultaneously pressing hoth "NEXI $\rightarrow$ " and "ENTER $\leftarrow$ " for at least 2 sec. The mossage '- Loc' will be displayed for 2 seconds when locked.
- To unlock control panel, simultaneously press the same 2 keys "NEXI $\rightarrow$ " and "ENTER $\boldsymbol{\square}$ " for ar least 2 sec. The message 'unlo' will be displayed for 2 seconds when unlocked.

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

### 7.7 Overview of softstarter operation and parameter set-up

Table showing how paramecers can be set and operation carried our.

Table 13 Controlsources

| Control source | Control panel lock | Operation |  | Setting of parameters |
| :---: | :---: | :---: | :---: | :---: |
|  |  | Start/Stop | Alarm reset |  |
| Control panel Menu [200]=1. | Unlocked control panel | Control panel | Control panel | Control panel |
|  | Locked control panel | Control panel | Control panel | - |
| Remote Menu [200]=2 | Unlocked control panel | Remote | Remote and control panel | Control panel |
|  | Locked control panel | Remote | Remote and control panel | $\underline{\square}$ |
| Serial comm. <br> Menu [200]=3 | Unlocked control panel | Serial comm. | Serial comm. and control panel | Serial comm. |
|  | Locked control panel | Serial comm. | Serial comm. and control panel | Serial comm. |

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

## 8. Functional description

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

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

Table 14 Menu overview

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

### 8.1 General settings

General sectings for MSF 2.0 contains the following menus: [100] Current
[101] Automatic return menu
[200] Control source
[201] Control panel locked for setrings
[202] Enable US units

### 8.1.1 Current [100]

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


### 8.1.2 Automatic return menu [101]

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


### 8.1.3 Control source [200]

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

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

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


### 8.1.4 Control panel lock [201]

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

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

In locked mode, all paramerers and read-outs (menus) can be displayed, but it is forbidden to change any parameters via the control panel.
The message '-Loc' will be displayed if someone tries to set a parameter in locked mode.

The key lock status can be read out in menu [201].
NOTE: If menu [200] is configured for serial communication control, the softstarter may still be configured via serial communication, regardless of the control panel lock status.

| $2\|O\| 1$ |  |  |  |
| :--- | :--- | :--- | :--- |
|  |  | Read-out   <br>    | Control panel locked for <br> settings |
| Default: | no |  |  |
| Range: | no, YES |  |  |
| no | Control panel is not locked |  |  |
| YES | Control panel is locked |  |  |

### 8.1.5 Enable US units [202]

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

- Powers are ser and shown in HP, menus [212] and [703]
- Power consumprion is shown in MHph, menu [731]
- Shaft torque is shown in Ibft, menu [705]
- Temperacure is shown in degrees Fahrenheir, menu [707]

NOTE: When the setting for us units is changed, the motor data in menus [210-215] is reset to the default values for the chosen units (SI or US customary units) in all parameter sets.
[210] Nominal motor voltage - new default value ( 460 V , for US units enabled)
[211] Nominal motor current - new default value depending on sofsstarter size.
[212] Nominal motor power - new default value depending on softstarter size
[213] Nominal motor speed - new default value depending on softstarter size
[215] Nominal frequency - new default value $(60 \mathrm{~Hz}$, for US units enabled)
If the setting is changed and confirmed with "ENTER", "SEt" is displayed for 2 seconds to indicate successful selection.


### 8.2 Motor data

For optimal performance the MSF 2.0 softstarter should be configured according to the mocor's rating plate:
[210] to [215] Nominal motor dara

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

Nominal moror voltage.

| 2 | 10 | 0 |  |
| :--- | :--- | :--- | :--- |
|  | Setting  <br>  4 | 0 | 0 |
| Nefault: | 400 V |  |  |
| Range: | $200-700 \mathrm{~V}$ |  |  |
| $200-700$ | Nominal motor voltage |  |  |

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

Nominal moror current. The current range is relared to the size of the softstarter.


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


Nominal motor speed.


Nominal motor power factor.


Nominal motor frequency


### 8.3 Motor protection

The MSF 2.0 softstarter is equipped with different motor protection functions. The following menus are available to configure these protection merhods:
[220]-[223] Thermal motor protection
[224]-[227] Start limitation
[228]-[229] Locked rotor
[230] Single phase input failure
[231] Current limit start time expired
For these protection methods the following options are available (all options may not be available for all protection merhods - check the description of the relevant menu for details):

## Off

The protection method is disabled.

## Warning

The appropriate alarm message is shown in the display and relay K 3 is activated (for default configuration of the relays). However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset wen the fault disappears. The alarm may also be reset manually.

Coast
The appropriate alarm message is shown in the display and relay K 3 is activated (for default configuration of the relays). The motor voltage is automatically switched off. The motor freewheels until it stops.

## Stop

The appropriate alarm message is shown in che display and relay K 3 is activated (for default configuration of the relays). The motor is stopped according to the stop sertings in menus [320] to [325].

## Brake

The appropriate alarm message is shown in the display and relay K 3 is activated (for default configuration of the relays). The brake function is activated according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menus [326] to [327] (braking strength and braking time).

### 8.3.1 Thermal motor protection

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

## Thermal motor protection [220]

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

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

| 2,20 | 2 Thetting <br> Thermal motor protection code F2) <br> (Alarm <br>   <br> Default: 2 (Coast) <br> Range: oFF, 1, 2, 3, 4 <br> oFF Thermal motor protection is disabled. <br> 1 Warning <br> 2 Coast <br> 3 Stop <br> 4  |
| :--- | :--- | :--- |

## PTC input [221]

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


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

## Internal protection class [222]

This menu is available if thermal motor protection is enabled in menu [220]. In this menu an internal protection class can be chosen, which enables internal thermal motor protection. With this setting a thermal curve as set out in Fig. 34 is configured. The motor's thermal capacity is calculated continuously based on the chosen curve. If the thermal capacity exceeds $100 \%$ an F 2 alarm occurs and the action chosen in menu [220] is performed. The alarm remains active until the motor model cools down to $95 \%$ of its thermal capacity. The used thermal capacity is shown in menu [223].


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

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


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

## Used thermal capacity [223]

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



Fig. 34 The thermal curve

### 8.3.2 Start limitation

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

## Start limitation [224]

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

## Warning

Alarm message F11 is shown in the display and relay K 3 is activated (for default configuration of the relays). However, the scart will be allowed.

## Coast

Alarm message F11 is shown in the display and relay K 3 is acrivated (for default configuration of the relays). The start will nor be allowed.
A Stare limitation alarm is auromatically reser when a new start signal is given. The start signal can be given via control panel, remore or via serial communication depending on the control source chosen in menu [200]. Regardless of the cho-
sen control source, it is always possible to initiare a reser via the control panel.

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

| 2 | 2 | 0 | Setting |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  | 0 | $F$ | $F$ |

## Number of starts per hour [225]

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


## Min. time between starts [226]

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


## Time to next allowed start [227]

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


### 8.3.3 Locked rotor

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

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

## Locked rotor [228]

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


## Locked rotor time [229]

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


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

### 8.3.4 Phase input failure

All phase input failures shorter than 100 ms are ignored.

## Multiple phase input failure

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

## Single phase input failure

During acceleration and deceleration the behaviour is the same as described above for multiple phase inpur failure. When running with full voltage, the softstatter can be configured for different actions in the event of a single phase input failure (menu [230]).
A phase input failure alarm is automatically reset when a new start signal is given. The start signal can be given via concrol panel, remore or via serial communication depending on the control source chosen in menu 200. Regardless of the chosen control source, it is always possible to initiate a reser via the control panel.

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

## Single phase input failure [230]

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


### 8.3.5 Current limit start time expired

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

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

## Current limit start time expired [231]

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

| $2\|3\| 1$ | Setting  <br>   | Current limit start time expired <br> (alarm code F4) |
| :--- | :--- | :--- |
| Default: | 2 |  |
| Range: | off, 1, 2, 3, 4 |  |
| ofF | Current limit start time expired protection is <br> disabled. |  |
| 1 | Warning |  |
| 2 | Coast |  |
| 3 | Stop |  |
| 4 | Brake |  |

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

### 8.4 Parameter set handling

The use of different parameter sets can be helpful when using one softstarter to start different motors or when working under various load conditions. There are four parameter sets available in MSF 2.0. Parameter set handling is controlled by the following menus:
[240] Select parameter set
[241] Actual parameter set
[242] Copy parameter set
[243] Reser to factory setting

### 8.4.1 Select parameter set [240]



Fig. 35 Parameter overview

## Select parameter set [240]

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

| 2400 0 |  | Setting |
| :---: | :---: | :---: |
| Select parameter set |  |  |
| Default: | 1 |  |
| Range: | 0, 1, 2, 3, 4 |  |
| 0 | External control of parameter sets. |  |
| 1, 2, 3, 4 | Selection of parameter sets 1-4. |  |

## Actual parameter set [241]

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


### 8.4.2 Copy parameter set [242]

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

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


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

### 8.4.3 Reset to factory setting [243]

This menu enables all paramerers to be reser to the default values. This includes all four parameter sets and the common parameters except for parameter [202] (enable US units). As Enable US units is not reset to default, the values loaded for the normal moror dara in menus [210] to [215] correspond to the chosen units (SI or US customary), see description of menu [202] on page 45 for more information. The alarm list, the power consumption and the operation time will nor be affected by reserting the paramerers. When the reser of all parameters to the factory default values has been executed successfully, menu [100] is shown on the display.


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

### 8.5 Autoreset

For several non-critical application-related failure conditions, it is possible to automatically generate a reset and initiate a restart to overcome the fault condition. Autoreset functionality is configured using the following menus:
[250] Autoreset attempts.
[251] to [263] Autoreser items.
In menu [250] the maximum number of automatically generated restarts allowed can be set. When this number is exceeded and a new fault occurs, the softstarter will stay in fault condition because external assistance is required. In menus [251] to [263], autoreset is enabled for the different protection rypes by choosing a delay time. If a fauls occurs for which autoreset is enabled, the motor is stopped according to the action chosen for the relevant protection method (see menus [220] to [231] and [400] to [440] for description of prorection methods and configuration of actions on failures). When the fault has disappeared, and the configured delay time has elapsed, the motor is restarted.

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

The following settings should be applied:

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

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


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

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

### 8.5.1 Autoreset attempts [250]

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

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

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


### 8.5.2 Autoreset items [251]-[263]

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

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

## Thermal motor protection autoreset [251]

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

| 2 | 1 | 0 |  |
| :--- | :--- | :--- | :--- |
|  | 0 | $F$ | $F$ |
| Setting |  |  |  |
| Default | oFF |  |  |
| Range: | oFF, 1-3600 s |  |  |
| ofF | Thermal motor protection <br> autores |  |  |
| $1-3600$ | Delay time for thermal motor protection <br> autoreset |  |  |

## Start limitation autoreset [252]

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

## Locked rotor alarm autoreset [253]

This menu is available if autoreset is activared in menu [250]. In this menu the delay time for an autoreser after a locked rotor alarm (alarm code F5) is configured. As a locked rotor cannor be derecred in stopped stare, the delay rime starts counting immediately after the alarm action has been executed. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

## Current limit start time expired autoreset [254]

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

## Max power alarm autoreset [255]

This menu is available if autoreser is activared in menu [250]. In this menu the delay time for an autoreset after a max power alarm (alarm code F6) is configured. As a max power fault condition cannor be derecred in stopped state, the delay time starts counting immediately after the alarm action has been executed. When the delay time has elapsed, the alarm will be reser and a restart attempt will automatically be made.

## Min power alarm autoreset [256]

This menu is available if autoreser is activared in menu [250]. In this menu the delay time for an autoreset after a min power alarm (alarm code F7) is configured. As a min power fault condition cannor be detected in sropped state, the delay time starts counting immediately after the alarm action has been execured. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

## External alarm autoreset [257]

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

## Phase input failure autoreset [258]

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

## Voltage unbalance alarm autoreset [259]

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

## Over voltage alarm autoreset [260]

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

## Under voltage alarm autoreset [261]

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

## Serial communication autoreset [262]

This menu is available if autoreset is activated in menu [250]. In this menu the delay time for autoreset after a serial communication broken alarm (alarm code F 15 ) is configured. The delay time starts counting when the fault is gone. This means serial communication has to be re-established. When the delay time has elapsed, the alarm will be reset and a restart attempt will automatically be made.

## Softstarter overheated autoreset [263]

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

### 8.6 Serial communication

There are several serial communication options available for MSF 2.0 (see page 107 for more information). The softstarter can be configured and concrolled via serial communication if this is configured in menu [200] (see page 44). The following parameters are available to configure serial communication:
[270] Serial comm. unit address
[271] Serial comm. baudrate
[272] Serial comm. parity
[273] Serial comm. contact broken

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

Serial comm. unit address [270]
Serial communication unit address.


## Serial comm. baudrate [271]

Serial communication baudrate.


Serial comm. parity [272]
Serial communication parity.


## Serial comm. contact broken [273]

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

## Off

Serial communication contact broken alarm is disabled.

## Warning

Alarm message F15 is shown in the display and relay K 3 is activated (for default configuration of the relays). However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset when the fault disappears. The alarm may also be reset manually from the control panel.

## Coast

Alarm message F 15 is shown in the display and relay K 3 is accivared (for default configuration of the relays). The motor voltage is automatically switched off. The motor freewheels uncil it stops.

## Stop

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

## Brake

Alarm message F15 is shown in the display and relay K3 is activated (for default configuration of the relays). The brake funcrion is activated according to the braking method chosen in menu [323] and the moror is stopped according to the alarm brake sertings in menus [326] to [327] (braking strength and braking time).
A serial communication broken alarm is automatically reset when a new start signal is given. The start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu 200 . Regardless of the chosen control source, it is always possihle to initiate a reset via control panel.

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


### 8.7 Operation settings

Operation setrings include parameters for configuration of starting and stopping, some of these can be pre-configured for pump applications. Furthermore, some special sertings for stop behaviour at alarm, parameters for slow speed and jog and additional settings such as bypass operation, power factor control and control of the internal fan are included in this section.
[300] Preser pump control parameters
[310]-[317] Start
[320]-[327] Srop including srop at alarm
[330]-[3351 Slow speed/]OG
[340]-[342] Additional settings
The MSF Softstarter controls all three phases supplied to the motor. In contrast to a simple softstarter controlling only one or two phases, the three-phase control enables different starting methods, voltage, current and torque control. A currene limit can even be used in combination with either voltage or torque control.

Wirh voltage control the output voltage to the motor is linearly increased to full line voltage during the ser start time. The softscarter gives a smooth start but docs not get any feedback on current or corque. The cypical settings to optimize a voltage controlled start are the initial voltage and the start time.
With current concrol the outpur voltage to the motor is regulated so the set current limit is not exceeded during the start. Even with this starting method the starter does not get any feedback on the motor torque. However, current concrol can be combined with both voltage and torque control. The rypical sertings to optimize a current controlled start are the current limit and the maximum starting rime.
Torque control is the most sophisticated way of starting motors. The softstarter continually monitors the motor torque and controls the output voltage to the motor so the torque follows the set ramp. Both linear- and square torque ramps can be chosen according to the application requirments. In this way constant acceleration can be accomplished during start which is very important in many applications. Torque control can also be used for stopping with constant deceleration. For pumps constant deceleration is important for avoiding water hammer.

### 8.7.1 Preset pump control [300]

With this multi-setring parameter the MSF 2.0 softstarter can easily be configured for pump applications. The following parameters are set if preset pump control paramerers are chosen.
[310] Start method is set to square torque control (2)
[312] Initial torque at start is set to $10 \%$
[313] End torque at start is set to $125 \%$
[315] Start time is set to 10 seconds
[314] and [316] Current limit at start and torque boost are deactivared.
[320] Stop method is set to square torque concrol (2)
[321] End torque at stop is set to $10 \%$
[325] Stop time is set to 15 seconds.
These settings will lead to a smooth start with linear acceleration and a linear stop without water hammer for most pump applications. However, if the pre-set parameters need to be adapted for a specific application, the values in the relevant menus can be adapted.
The following figure shows rypical current characreristics at start and speed curve at stop.


Fig. 36 Pump control. Current at start and speed at stop.
When the pre-setting of the parameters for pump control has been executed successfully, "SEt" is shown in the display for two seconds. After that "no" will he shown again.

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


### 8.7.2 Start

With MSF 2.0, torque control, voltage control and direct on-line are available as start methods. Torque control is available both for loads with a linear torque characteristic like conveyors and planers and with square corque characteristics for pumps and fans. In general torque control is recommended as a starting merhod; voltage control may be used when for some special reasons a linear voltage ramp is desired. With Direct on-line (DOL) as a start method, neither the current nor the voltage will be controlled; full voltage is applied to the motor immediarely. DOL can be used to start the motor if the softstarter has been damaged and the thyristors are short-circuited.
All start methods can be combined with a current limit. However, only a properly configured torque-controlled start will lead to constant acceleration. For this reason it is not recommended to set a current limit for pump applications. With a proper set-up of the corque control parameters, the starting current will be very low. For applications with variable load characteristics from start to start, the current limit functionality may be useful to avoid overloading the mains fuses. However, as the motor torque is proportional to the square of the current, setting a low current limit will limit the motor torque considerably. If the current limit is set too low in relation to the application's requirements, the motor will not be able to accelerate the load.

## Start method [310]

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


## Torque control

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


Fig. 37 Torque control at start
A Properly configured torque-controlled start will lead to a linear speed increase and low starting current without current peaks.


Fig. 38 Current and speed in torque control

To optimize the start, use the setting for initial torque as scart, menu [311] and end corque at start, menu [312].
When the start command is given, the motor should immediarely start to rotate to avoid unnecessary heat development in the motor. If required, increase the initial corque at start.

The end torque at start should be adjusted so that the time for the motor to come up to nominal speed approximately matches the start time set in menu [315]. If the actual start time is much shorter than the set start time in menu [315], the End torque at stop can be decreased. If the motor does not reach full speed before the stare time set in menu [315] has expired, the end torque at stop has to be increased to avoid current peaks and jerking at the end of the ramp. This may be needed for high inertia loads such as planers, saws and centrifuges.
The read-out of shaft torque in percentage of $T_{n}$ in menu [706] may be useful for fine-cuning the start ramp.

## Initial torque at start [311]

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


## End torque at start [312]

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


## Voltage control

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


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

## Initial voltage at start [313]

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


## Direct on-line, DOL

If this alternative is selected in menu [310], the motor can be accelerated as if it was connected directly to the mains.
For this type of operation:
Check whether the motor can accelerate the required load (DOL start). This function can be used even with shorted thyristors.


Fig. 40 DOL-start.

## Current limit

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

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


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

## Current limit at start [314]

In this menu the current limit at start is set.


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

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

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

## Start time [315]

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


## Torque boost

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

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


Fig. 42 The principle of the torque boost when starting the motor.

## Torque boost current limit [316]

In this menu torque boost is enabled and the current limit for torque boost is configured.


## Torque boost active time [317]

This menu is available if torque boost is enabled in menu [316]. In this menu the time for the torque boost to be active is selected.


NOTEI Check whether the motor can accelerate the load with "Torque boost" without any harmful mechanical stress.

NOTE: Check that the nominal motor current is configured properly in menu [221].

### 8.7.3 Stop

With MSF 2.0, four stop methods are available: torque control, voltage control, coast and braking. Torque control is available for loads with linear or square torque characteristic. A torque or voltage-controlled stop is used for applications where the motor stopping suddenly could harm the application, e.g. water hammer in pump applications. In general a torque-controlled stop is recommended for these applications. The voltage-controlled stop can be used if a linear voltage ramp is desired. When coast is selected as a stop method, the voltage to the motor will be switched off and the motor will be left freewheeling. Braking may be used in applications where the motor needs to be stopped quickly, e.g for planers and bandsaws.

Any start method except for direct on-line (DOL) can be combined with any stop method, e.g. torque control can be used at start and brake for stop. The DOL start method can only be combined with coast or brake stop methods.

## Stop method [320]

In this menu the stop method is chosen. The menus necessary for configuring the stop will be available depending on the chosen stop method.

| 320 |  | Setting |
| :---: | :---: | :---: |
|  | 4 Stop method |  |
| Default: | 4 |  |
| Range: | 1, 2, 3, 4, 5 |  |
| 1 | Linear torque control |  |
| 2 | Square torque control |  |
| 3 | Voltage control |  |
| 4 | Coast |  |
| 5 | Brake |  |

## Torque control

With torque control at stop, the torque to the motor will be controlled from the nominal torque down to the chosen end torque at stop (menu [321]). Examples for the torque ramps for linear and square torque control are shown in Fig. 43. The default value for end torque at stop is 0 ; this value may be increased if the motor is standing still before the stop is finished to avoid unnecessary heat development in the motor. With the end torque at stop set properly, the motor speed will decrease linearly down to standstill.


Fig. 43 Torque control at stop

## End torque at stop [321]

This menu will be available if torque control is chosen as stop method in menu [320] (alternative 1 or 2). In this menu the end torque at stop is configured.

| 32 1 Setting <br>   0 |  |
| :--- | :--- | :--- |
| End torque at stop |  |
| Default: | $0 \%$ |
| Range: | $0-100 \%$ of $T_{n}$ |
| $0-100$ | End torque at stop. |

## Voltage control

With voltage control at stop, the voltage to the motor will be decreased to the chosen step down voltage at stop immediately after a stop signal. Then the voltage to the motor will follow a linear ramp down to the minimum voltage of $25 \%$ of the nominal voltage. An example of this voltage ramp is shown in Fig. 44.


Fig. 44 Menu numbers for step down voltage at stop and stop time.

## Step down voltage at stop [322]

This menu is available if voltage control is chosen as stop method in menu [320] (alternative 3). In this menu the step down voltage at stop is chosen in percentage of the nominal motor voltage.


## Braking

Braking can be used in applications where there is a need for a quick stop.

There are two built-in braking methods: dynamic vector brake for normal loads and reverse current brake for heavy loads with high inertia. In both braking methods the MSF 2.0 continuously detects the motor speed. At low speed the DC brake mode is activated until the motor is standing still. The MSF 2.0 will automatically turn off the output voltage when the motor has stopped or when the stop time has expired. Optionally an external rotation senaor can be connected via digital input, see description for menu [500] on page 77 for more information.

## Dynamic vector brake

With dynamic vector brake, the braking torque applied to the motor will increase with decreasing speed. Dynamic vector brake can be used for all loads which are not rotating too close to synchronous speed when the motor voltage is switched off. This is valid for most applications as the load speed usually decreases because of frictional losses in gears or belt drives as soon as the motor voltage is switched off. However, loads with very high inertia may remain at high speed even though the motor is not supplying any torque. For these applications the reverse current brake can be used instead.
When the dynamic vector brake is used, no additional connections or contactors are needed.

## Reverse current brake

With reverse current brake, a very high braking torque can be applied to the motor even close to synchronous speed. All kind of loads can be stopped quickly using reverse current brake, including loads with very high inertia. If high braking torques are needed, it should be checked carefully whether the motor, the gear or belt drive and the load can withstand the high mechanical forces. To avoid harmful vibrations, it is generally recommended to select as low a braking torque as possible which also fulfils the demands for a short braking time.
For reverse current brake, two mains contactors are needed. The connection is shown in Fig. 45. The contactors have to be controlled by the MSF's relay outputs. During start and full voltage operation contactor K 1 will be closed, for braking K1 will be opened and after a time delay K2 will be closed to change the phase sequence.

NOTE: For several start/stops it is recommend that the motor temperature be monitored using the PTC input.


WARNING: When reverse current brake is selected, the relays K1 and K2 are automatically programmed for reverse current brake functionality. The relay setting remains even if reverse current brake is deactivated. Therefore it may be necessary to adapt the relay functions manually.


Fig. 45 Reverse current brake wiring example.

## Braking method [323]

This menu is available if brake is selected as stop method in menu [320] (alternative 5) or if alarm brake is activated in menu [326] (sec description of menus [326] to [327] for more information). In this menu the brake method is selecred.


## Braking strength [324]

This menu is available if brake is selected as stop method in menu [320] (alternative 5). In this menu the braking strength is selected. To avoid unnecessary heat development in the motor and high mechanical scress it is generally recommended to select as low a braking strength as possible which still fulfils the demands for a short braking time.


## Stop time [325]

This menu is available if any stop method except coast is selected in menu [320] (alrernative 1, 2, 3 or 5). In this method the desired stop time is selected.


## Alarm braking

For most alarms it is possible to configure them so that when they are triggered either operation continues or the motor stops (see chaprer 9. page 95 for more information). Brake is one of the actions available. If this option is chosen, the braking funcrionality is acrivated according to the brake method selected in menu [323] (see description of the braking functionality above for more information). While the braking strength and stop time chosen in menus [324] and [325] are used for braking on a stop signal, different braking strengths and rimes can be configured in menus [326] and [327] if braking is activated by an alarm. This function may mainly be used in combination with an external alarm (see description on page 73), where an external signal is used to initiare a quick stop with a higher braking strength and a shorter braking time compared to normal operation.
If alarm braking is disabled in menu [326] and brake is chosen as an alarm action, the voltage to the motor will be switched off and the motor will freewheel if the specific alarm occurrs.

## Alarm braking strength [326]

In this menu braking as an alarm action is enabled and the alarm braking strength is selected. If alarm braking is not activated, the motor will be left freewheeling if an alarm occurs for which brake is configured as alarm action.


NOTE: If alarm brake is enabled, the braking method chosen in menu [323] is used.

## Alarm braking time [327]

This menu is available if alarm brake is enabled in menu 327. In this menu the braking time to be used in the cvent of braking as an alarm action is configured.


### 8.7.4 Slow speed and JOG functions

MSF 2.0 is able to run the motor at a fixed slow speed for a limited period of time. The slow speed will be about $14 \%$ of the full speed in the forward direction and $9 \%$ in the reverse direction.

NOTE: As the motor torque during slow speed is limited to about $30 \%$ of the nominal torque, slow speed can not be used in applications which need a high brake-away torque to start rotating.

The following funcrions are possible:

## Slow speed during a selected time period

Slow speed will be active for a selected time period before a start is initiated or after a stop is performed.

## Slow speed controlled by an external signal

The time period during which slow speed is active before a start is initiated or after a stop is performed is controlled by an external signal via the analogue/digital input. Slow speed will be active until a selected number of pulses has been detected on the input.

## Slow speed using the JOG commands

Slow speed can be activated independently from a start or stop via the control panel using the jog keys, via remote control using the analogue/digital input or via serial communication depending on the control source chosen in menu [200].


Fig. 46 Slow speed controlled by an external signal.

## Slow speed for a selected time

Slow speed in forward direction can be activated before a stare and/or after a stop. The resulting speed curve is shown in Fig. 47 overleaf. Slow speed will be active for the time period selected in menus |331] and [332]. Slow speed can be combined with any start and stop method. However, when slow speed at stop is used, it should be ensecured that the motor speed is decreased to a low value when slow speed is activated. If necessary, brake can be activated as stop method in menu [320].
The slow speed strength can be adapted to the application's requirements in menu [330]. Maximum available slow speed strength corresponds to about $30 \%$ of nominal motor torque.
If so desired, the DC brake can be activated after slow speed at stop. If activated, the DC brake will be active for the time period chosen in menu [333].
Slow speed during a selected time is configured using the following menus:
[330] Slow speed strength
[331] Slow speed time at start
[332| Slow speed time at stop
[333] DC-brake at slow speed
[324] Braking strength

## Slow speed controlled by an external signal

Slow speed controlled by an external signal is basically the same functionality as slow speed during a selected time described above. An external signal connected to the analogue/digital inpur is also used to deacrivare slow speed before the set time pcriod has expired.
When slow speed at start is configured and the analoguel digital inpur (menu [500]) is configured for slow speed, the motor will start rotating at slow speed in a forward direction after a start signal. When the number of edges set in menu [501] is detected on the analogue/digital input, slow speed is deactivated and a start is performed according to the start settings (menu [310] Off).
When slow speed at stop is configured and the analogue/digital input (menu [500]) is configured for slow speed, the motor will start totating with slow speed in forward direccion after a stop has performed. When the number of pulses set in menu [501] is detected on the analogue/digital input, slow speed is deactivated and the DC brake is activated if configured in menu [333].

Slow speed controlled by an external signal is configured using the following menus:
[500] Digital/analogue input
[501] Digital input pulses
[330] Slow speed strength
[331] Slow speed time at start
[332] Slow speed time at stop
[333] DC-brake at slow speed
[324] Braking strength

## Slow speed strength [330]

In this menu the slow speed strength is selected. The chosen setring applies for both slow speed during a selected time period, slow speed controlled by an external signal and slow speed using the JOG commands. The maximum serting (100) for the slow speed strength corresponds to about $30 \%$ of the nominal motor torque.

## Slow speed time at start [331]

In this menu slow speed at start is activated and the time is set for which slow speed is active before a start. If slow speed at start is controlled by an external signal via the analogue/ digital input, the set time becomes the maximum time for which slow speed is acrivared before a start is performed - if the number of edges set in menu [501] is not derected during the slow speed period.



Fig. 47 Slow speed at start/stop during a selected time period.

## Slow speed time at stop [332]

In this menu slow speed at stop is activated and the time is set for which slow speed is active after a stop. If slow speed at stop is controlled by an external signal via the analogue/digital input, the set time becomes the maximum time for which slow speed is activared after a stop - if the number of edges is ser in menu [501] is not detected during the slow speed period.


## DC brake at slow speed [333]

In this menu the DC brake can be activated after slow speed at stop. This may be useful for loads with high interia or if an exact stop position is desired. The DC brake will be active during the time set in this menu.

NOTE: The brake strength used for DC brake after slow speed corresponds to the brake strength used for braking as stop method. The braking strength can be adjusted in menu [324].



Fig. 48 Jog keys
If remore control is chosen (menu [200]=2) and the JOG commands are enabled in menus [334] and [335], the JOG commands can be given via analogue/digital input. The analogue/digital input can be configured either for jog forward or jog reverse (see description of menu [500] on page 77 for more information). Slow speed will be active as long as the signal on the analogue/digital inpur is active.
If serial communication concrol is chosen (menu [200]=3) and the JOG commands are enabled in menus [334] and [335], the JOG commands can be given via serial communication. (See separate instruction manual for serial communications options.)

## JOG forward enable [334]

In this menu the command for JOG in forward direction is enabled. Depending on the control source chosen in menu [200], the JOG forward command may be accepted from the control panel, via remote control or serial communication.

NOTE! The enable functions are for all control sources.


## Slow speed using the JOG commands

Slow speed in forward or reverse direction can be activated using the JOG commands. To use the JOG commands these have to be independently enabled for slow speed in forward or reverse direction in menus [334] and [335]. Depending on the control source chosen in menu [200], the JOG commands are accepted via control panel, remotely via analogue/ digital input or via serial communications.
If the control panel is chosen as control source (menu [200]=1) and the JOG commands are enabled in menus [334] and [335], the JOG keys on the control panel can be used. Slow speed in forward or reverse direction will be active as long as the relevant button is pushed.

## JOG reverse enable [335]

In this menu the command for JOG in reverse direction is enabled. Depending on the concrol source chosen in menu [200,], the JOG reverse command may be accepted from the control panel, via remote control or serial communication.

| 3 | 3 | 5 | 0 |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  |  |  |  |
|  | SOG reverse enable |  |  |
| Default: | F | F |  |
| Range: | oFF |  |  |
| oFF | JOG reverse disabled |  |  |
| on | JOG reverse enabled |  |  |

### 8.7.5 Additional settings [340]-[342]

In this section the bypass functionality, power factor control and the control of the internal fan are described.

## Bypass [340]

As the MSF 2.0 is designed for continuous running, a bypass contactor is not normally needed. However, where there is high ambient temperature or ocher special conditions, the use of a bypass contactor can be advantageous. In this case the by-pass contactor can be controlled by one of the relays. By default, relay K2 is configured to control a bypass contactor (for full voltage functionality, see description of menus [530]-[532] on page 85 for more information).
The use of a bypass contactor can be combined with any start and stop method without any connection changes being necessary. However, to use the motor protection functions, the load monitor and the viewing functions in bypassed state, the current transformers have to be moved outside the softstarter. For this purpose an optional extension cable is available, see chapter 12. page 107 (Options) for more information. Figures 49-51 below show a connection example.

If a bypass contactor is used, bypass operation must be enabled in menu [340] for the softstarter to work properly.


> CAUTION: If the current transformers are not moved outside the softstarter, several alarm functions will not work properly.


Fig. 49 Bypass wiring example MSF 310-1400.


Fig. 50 Current transformer position for Bypass on MSF-017 to MSF-250.


Fig. 51 Current transformer position for Bypass on MSF-310 to MSF- 1400 .

## Power Factor Control PFC [341]

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



CAUTION: If Power Factor Control is used, the EMC Directive will not be complied with. External measures will be necessary to meet the requirements of the EMC Directive.

## Fan continuously on [342]

This menu enables the internal fan to be switched on continuously. the default setting is for the fan only to run when the softstarter heatsink is too warm. The lifetime of the fan is increased by only running it when needed.


### 8.8 Process protection

The MSF 2.0 softstarter is equipped with different functions for process protection:
[400]-[413] Load monitor
[420] Exrernal alarm
[430]-[440] Mains protection

### 8.8.1 Load monitor

The MSF 2.0 has a built-in load monitor, which continuously supervises the motor shaft power. This means, the process can easily be protected both from overload and underload conditions. The load monitor functionality includes borh alarms and pre-alarms for overload (max power) and underload (min power). While the max. and min power alarms can be configured to affect operation (OFF, Warning, Coast, Stop, Brake), the respective prealarms only give an indication that an over- or underload situation may be close. The pre-alarm status is available on one of the programmable relays K 1 to K 3 if so configured (see description of the relays, menus [530] to [532] on page 85 for more information)

All load monitor alarms and pre-alarms are configured using a delay time and an alarm margin. The alarm margin is chosen as a percentage of nominal motor load. A max power alarn will occur when the actual power exceeds the normal load plus the max power alarm margin and a min power alarm will occur when the accual load is lower than the normal load minus the min power margin. Normal load is the shaft power needed under normal operation conditions. The defaule normal load is considered to be $100 \%$ of the nominal motor power. Depending on the dimensioning of the motor with respect to the application, this value may need to be adapted. Normal load can easily be adapted by using the Autoset function in menu [411]. When an Autoset is performed the actual motor shaft power will be measured and stored to the Normal load.

A start delay can be configured to avoid faulty alarms due to initial over- or underload situations at start.

Fig. 52 illuserates the load monitor functionality with an example of a load curve.
If the operation has been interrupred due to a max or min power alarm, a manual reset and a new start signal is needed to continue operation. The reset and the start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via control panel.

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

NOTEI The load monitor alarms are disabled during deceleration.

NOTE: When using the load monitor, check that the nominal motor power is set properly in menu [212].


Fig. 52 Load monitor alarm functions

For max and min power alarms the following alarm actions are available:

## Off

The procection method is deacrivated.

## Warning

The appropriare alarm message is shown in the display and relay K 3 is activated (for default configuration of the relays). However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reser when the fault disappears. The alarm may also be reset manually.

## Coast

The appropriace alarm message is shown in the display and relay K 3 is activated (for default configuration of the relays). The motor voltage is automatically switched off. The motor freewheels uncil it srops.

## Brake

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). The brake function is acrivared according to the braking method chosen in menu [323] and the moror is stopped according to the alarm brake settings in menus [326] to [327] (braking scrength and braking cime).
If the operation has been interrupted due to a max or min power alarm, a reset signal and a new start signal are needed to restart the motor. The reset and the start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via control panel.

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

## Stop

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

## Max power alarm [400]

In this menu max power alarm is enabled and a proper alarm action is selected. The pre-alarm functionality for max power is automatically enabled together with the max power alarm.


## Min power alarm [401]

In this menu min power alarm is enabled and a proper alarm action is selected. The pre-alarm functionality for min power is automatically enabled together with the min power alarm.


## Start delay power alarms [402]

This menu is available if max or min power alarm is enabled in menu [400] or [401]. In this menu the start delay for the power alarms and pre-alarms is selected. A start delay is useful for avoiding faulty alarms due to initial over- or underload situations. The start delay begins when a start of the motor is initiated.


## Max power alarm margin [403]

This menu is available if Max power alarm is enabled in menu [400]. In this menu the max power alarm margin is configured. The margin is selected as percentage of nominal motor power. A max power alarn will occur if the actual motor shaft power exceeds the normal load (menu [412]) plus the chosen max power alarm margin for a longer time period than the max power alarm response delay set in menu [404].


## Max power alarm response delay [404]

This menu is available if max power alarm is enabled in menu [400]. In this menu the response delay for the max power alarm is configured. A max power alarm will occur if the actual motor shaft power exceeds the normal load (menu [412]) plus the max power alarm margin set in menu [403] for a longer time period than the chosen max power alarm response delay.

| 40 | 4 Setting Max power alarm response <br> delay <br>  0.5  <br> Default: 0.5 s  <br> Range: $0.1-90.0 \mathrm{~s}$  <br> $0.1-90.0$ Response delay for max power alarm.  |
| :--- | :--- | :--- |

## Max power pre-alarm margin [405]

This menu is available if max power alarm is enabled in menu [400]. In this menu the max power pre-alarm margin is configured. The margin is selected in percent of nominal motor power. A max power pre-alarm will occur if the actual motor shaft power exceeds the normal load (menu [412]) plus the chosen max power pre-alarm margin for a longer time period than the max power pre-alarm response delay set in menu [406]. The max power pre-alarm status is available on one of the programmable relays $\mathrm{K} 1-\mathrm{K} 3$ if so configured (see description of the relays, menus [530] to [532] for more information).


## Max power pre-alarm response delay [406]

This menu is available if max power alarm is enabled in menu [ 400 ]. In this menu the response delay for max power pre-alarm is configured. A max power pre-alarm will occur if the actual motor shaft power exceeds the normal load (menu 14121) plus the max power pre-alarm margin set in menu [405] for a longer time period than the chosen max power pre-alarm response delay.


## Min power pre-alarm margin [407]

This menu is available if min power alarm is enabled in menu [401]. In this menu the min power pre-alarm margin is configured. The margin is selected as a percentage of nominal motor power. A min power pre-alarm will occur if the actual moror load is below the nominal load (menu [412]) minus the chosen min power pre-alarm margin for a longer time period than the min power pre-alarm response delay set in menu [408]. The min power pre-alarm status is available on one of the programmable relays $\mathrm{K} 2-\mathrm{K} 3$ if so configured (see description of the relays, menus [530] to [532] for more information.

| 4 0 <br> 0  |  | Min power pre-alarm margin |
| :---: | :---: | :---: |
| - | 8 |  |
| Default: | 8\% |  |
| Range: | 0-10 | of $\mathrm{P}_{\mathrm{n}}$ |
| 0-100 | Min | er pre-alarm margin. |

## Min power pre-alarm response delay [408]

This menu is available if min power alarm is enabled in menu [401]. In this menu the response delay for min power pre-alarm is configured. A min power pre-alarm will occur if the actual motor shaft power is below the normal load (menu [412]) minus the min power pre-alarm margin set in menu [407] for a longer time period than the chosen min power pre-alarm response delay.

| $4\|0\| 8$ |  |  |
| :--- | :--- | :--- | :--- |
|  |  | Setting |
|  | Min power pre-alarm response <br> delay |  |
| Default: | 0.5 s |  |
| Range: | $0.1-90.0 \mathrm{~s}$ |  |
| $0.1-90.0$ | Response delay for Min power pre-alarm. |  |

## Min power alarm margin [409]

This menu is available if min power alarm is enabled in menu [401]. In this menu the min power alarm margin is configured. The margin is selected as a percentage of nominal motor power. A min power alarm will occur if the actual motor shaft power is below the normal load (menu [412]) minus the chosen min power alarm margin for a longer time period than the min power alarm response delay set in menu [410].


## Min power alarm response delay [410]

This menu is available if min power alarm is enabled in menu [401]. In this menu the response delay for min power alarm is configured. A min power alarm will occur if the actual motor shaft power is below the normal load (menu [412]) minus the min power alarm margin set in menu [409] for a longer time period than the chosen min power alarm response delay.


## Autoset [411]

This menu is available if max or min power alarm is enabled in menu [400] or [401]. The Auroser command performs a measurement of the actual motor load and automatically sets the normal load in menu [412].
To perform an Autoser, select YES, and press Enter during normal operation. If Autoser has been executed successfully, "SEt" is shown in the display for two seconds. After that "no" is shown again. An Autoset can also be initiated via the analogue/digital input, see description of menu [500] for more information.

NOTE: Autoset is only allowed during full voltage running.

| 411) ${ }_{0}^{0}$ |  |  | Autoset | Multi Setting |
| :---: | :---: | :---: | :---: | :---: |
|  | n | 0 |  |  |
| Default: |  | no |  |  |
| Range: |  | no, |  |  |
| no |  | No a |  |  |
| YES |  | Auto |  |  |

## Normal load [412]

This menu is available if Max or Min power alarm is enabled in menu [400] or [401]. Normal load is the shaft power needed under normal operation conditions. By default, Normal load is considered to be $100 \%$ of the nominal motor power. Depending on the dimensioning of the motor with respect to the application, this value may need to be adapted. Normal load can easily be adapted by using the Auroset function in menu [411]. Normal load is set as apercentage of nominal motor power.

NOTE: When using the load monitor, check that the nominal motor power is set properly in menu [212].


## Output shaft power [413]

This menu is available if max or min power alarm is enabled in menu [400] or [401]. The menu provides a read-out of the actual shaft power. It can be used as input information when the normal load is set manually.


### 8.8.2 External alarm [420]

The MSF 2.0 can generate an alarm according to the status of an external signal. For a detailed description of the external alarm functionality see section 8.9.5, page 89 .
The following alternatives are available for external alarm:

## Off

External alarm is deactivated.

## Warning

Alarm message F 17 is shown in the display and relay K 3 is activated (for default configuration of the relays) if the external alarm input is opened. However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset when the external alarm input is closed again. The alarm may also be reset manually.

## Coast

Alarm message F17 is shown in the display and relay K 3 is activated (for default configuration of the relays) if the external alarm input is opened. The motor voltage is automatically switched off. The motor freewheels until it stops.

## Stop

Alarm message F17 is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm inpur is opened. The motor is stopped according to the stop settings in menus [320] to [325].

## Brake

Alarm message F 17 is shown in the display and relay K 3 is activated (for default configuration of the relays) if the external alarm inpur is opened. The brake function is acrivared according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menus [326] to [327] (braking strength and braking time).

## Spinbrake

The functionality for the spinbrake alternative is the same as described above for the brake alternative. However, if spinbrake is chosen, braking can even be initiated from an inactive state by opening the external alarm input. This means the softstarter can carch a freewheeling motor and brake it down to standstill. The spinbrake alternative is only available for external alarm.

If the operation has been interrupted due to an external alarm, a reset signal and a new start signal are needed to restart the motor. The reset and the start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiare a reser via control panel..

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


### 8.8.3 Mains protection

The MSF 2.0 continuously monitors the mains volcage.
This means the motor can easily be protected from over- and undervoltages as well as from voltage unbalance conditions. A phase reversal alarm is also available.

For mains protection the following alternatives are available:
Off
The protection method is deactivared.

## Warning

The appropriate alarm message is shown in the display and relay K 3 is activated (for defaulr configuration of the relays). However, the motor is not stopped and operation continues.

The alarm message will disappear and the relay will be reset when the fault disappears. The alarm may also be reser manually.

## Coast

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

## Stop

The appropriate alarm message is shown in the display and relay K 3 is activated (for default configuration of the relays). The motor is stopped according to the srop sertings in menus [320] to [325].

## Brake

The appropriate alarm message is shown in the display and relay K3 is activated (for default configuration of the relays). The brake function is activated according to the braking merhod chosen in menu [323] and the motor is stopped according to the alarm brake settings in menus [326] to [327] (braking strength and braking time).
An overvoltage, undervoltage or voltage unbalance alarm is automatically reset when a new start signal is given. If the operation has been interrupted due to a phase reversal alarm, a reser signal and a new start signal are needed to restart the motor. The reset and the start signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiate a reset via concrol panel.

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

## Voltage unbalance alarm [430]

in this menu voltage unbalance alarm is enabled and a proper action is selected.


## Unbalance voltage level [431]

This menu is available if voltage unbalance alarm is enabled in menu [430]. In this menu the maximum allowed voltage unbalance level is selected. If the difference between any two line voltages exceeds the chosen level for the response delay time set in menu [432], a voltage unbalance alarm will occur and the action selected in menu [430] will be execured.


## Response delay voltage level unbalance alarm [432]

This menu is available if voltage unbalance alarm is enabled in menu [430]. In this menu the response delay for voltage unbalance alarm is selected. If the difference between any two line voltages exceeds the level set in menu [431] for the chosen response delay time, a voltage unbalance alarm will occur and the action selected in menu [430] will be executed.


## Overvoltage alarm [433]

In this menu overvoltage alarm is enabled and a proper action is selected.


## Overvoltage level [434]

This menu is available if overvolage alarm is enabled in menu [433]. In this menu the voltage level for an overvoltage alarm is selected. If any line voltage exceeds the chosen level for the response delay time set in menu [435], an overvoltage alarm will occur and the action selected in menu [433] will be executed.

| 4 3 4 |  | Setting |
| :---: | :---: | :---: |
| 15 Overvoltage level |  |  |
| Default: $\quad 115 \%$ |  |  |
| Range: | 100-150\% of $U_{n}$ |  |
| 100-150 | Overvoltage level |  |

## Response delay overvoltage alarm [435]

This menu is available if overvoltage alarm is enabled in menu [433]. In this menu the response delay for overvoltage alarm is selected. If any line voltage exceeds the level set in menu [434] for the chosen response delay time, an overvoltage alarm will occur and the action selected in menu [433] will be executed.

| 43 |  |  |  |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  |  |  | Setting |

## Undervoltage alarm [436]

In this menu undervoltage alarm is enabled and a proper action is selected.


## Undervoltage level [437]

This menu is available if undervoltage alarm is enabled in menu [436]. In this menu the voltage level for an undervoltage alarm is selected. If any line voltage is below the chosen level for the response delay time set in menu [438], an undervoltage alarm will occur and the action selected in menu [436] will be executed.


## Response delay undervoltage alarm [438]

This menu is available if undervoltage alarm is enabled in menu [436]. In this menu the response delay for undervoltage alarm is selected. If any line voltage is below the level ser in menu [437] for the chosen response delay time, an undervoltage alarm will occur and the action selected in menu [436] will be execured.

| 438 |  |  |
| :--- | :--- | :--- |
|  |  | Setting |
|  |  | 1 |

Phase sequence [439]
In this menu the actual phase sequence is shown.

## NOTE! The actual phase sequence can only be shown

 with a motor connected.

## Phase reversal alarm [440]

In this menu phase reversal alarm is enabled and a proper action can be chosen. The softstarter will derect the phase sequence prior to each start attempt. If the actual phase sequence does not match the phase sequence stored during activation of phase reversal alarm, the action chosen in this menu will be execured. If alternative 2 (Coast) is chosen, no start will be performed if the wrong phase sequence is detected.
To activare phase reversal alarm, a motor has to be connected and the mains voltage has to be switched on. This means activation of phase reversal alarm can either be done in stopped state with the mains contactor switched on manually or during full volage running.


### 8.9 1/0 settings

In this section the programmable inputs and outputs are described.
[500]-[513] Input signals
[520]-[534] Ourpur signals
A connection example using most of the available in- and outputs is shown in Fig. 53.
This section includes also detailed descriptions of the following functions:

- Start/stop/reset command functionality
- Start right/left functionality
- External alarm functionality
- External control of parameter set


### 8.9.1 Input signals

The MSF 2.0 has one programmable analogue/digital input and four programmable digital inputs for remote control.

## Analogue/digital input [500]

The analogue/digital input can either be programmed for analog or digital functionality. The following alrernatives are available when using the inpur for digital signals:

## Rotation sensor

An excernal rotation sensor can be used for the braking functions. If the analogue/digital input is configured for rotation sensor functionality in menu [500], braking will be deactivated if the number of edges chosen in menu [501] is detected on the input.

## Slow speed

This alternative is used for slow speed controlled by an external signal (see the description of slow speed and jog functions in section 8.7.4, page 63 for more information). If the number of edges set in menu [501] is detected on the input, slow speed at start or stop will be finished.

## Jog Forward

With this alternative, slow speed in forward direction can be activated via the analogue/digital input. Slow speed will be active as long as the input signal is high. See the description of slow speed and jog functions in section 8.7.4, page 63 for more information. Note that "JOG" forward has to be enabled in menu [334] to use this function.

## Jog reverse

With this alternative, slow speed in reverse direction can be activated via the analogue/digital input. Slow speed will be active as long as the input signal is high. See the description of slow speed and jog functions in section 8.7.4, page 63 for more information. Note thar "JOG" reverse has to be enabled in menu [335] to use this function.

## Autoset

When the analogue/digital input is configured for Autoser, a rising edge on the input will initiate an Autoset. Note that an Autoset only can be performed during full voltage running. See description of load monitor functionality in secrion 8.8.1 , page 69 for more information

The following alternatives are available when using the input for analogue signals:

Analogue start/stop: 0-10 V/0-20 mA or 2-10 V/4-20 mA:
The analogue/digital input is used for the reference signal which concrols analogue start stop. Two signal ranges ( $0-10 \mathrm{~V} / 0-20 \mathrm{~mA}$ or $2-10 \mathrm{~V} / 4-20 \mathrm{~mA}$ ) can be chosen. Analogue start/stop is activated if alternative 6 or 7 is chosen in menu [500]. See the description of Analogue start/stop on page 79 for more information.



Fig. 53 Connection example when using the digital and analogue inputs and outputs

## Digital input

The analogue/digital input is used as a digital input if one of alternatives $1-5$ in menu [500] is selected. Jumper JI has to be set for voltage control, which is the default setting.
The input signal is interpreced as 1 (high) when the input voltage exceeds 5 V . When the input voltage is below 5 V the input signal is interpreted as 0 (low). The input signal can be generated using the internal control supply voltage by connecting a switch between terminal 14 (analogue/digital inpur) and 18 (supply voltage to terminals 14,16 and 17).


## Digital input pulses [501]

This menu is available if the analogue/digital input is programmed for digital input signals for rotation sensor (alternative 1) or for slow speed (alternative 2) in menu [500]. In this menu the number of edges is chosen to deactivate the braking function or the slow speed function respectively. .

NOTE: All edges, both positive and negative transitions, will be counted.


Fig. 54 Wiring for digital input signal.

## Analogue input

The analogue/digital input is used as an analogue inpur if one of alternatives 6-7 in menu [500] is selected. In this case, the input can be configured for voltage or current signal using jumper J1 (see Fig. 55). By default jumper J1 is set to voltage signal. According to the chosen alternative in menu [500], the signal will be interpreted as $0-10 \mathrm{~V} /$ $0-20 \mathrm{~mA}$ or $2-10 \mathrm{~V} / 4-20 \mathrm{~mA}$ (see Fig. 56).


Fig. 55 Wiring for analogueldigital input and setting of fl for analogue current or voltage control.


Fig. 56 Analogue input

## Analogue start/stop

Stares and stops can be performed according to a process signal on the analogue/digital input. This means that e.g. the operation of a pump may be controlled according to a flow signal.
Analogue start/stop is available if remote concrol or serial communication conerol is chosen in menu [200] (alternarives 2 or 3 ).

NOTE: Analogue start/stop is not available if control panel is chosen as control source in menu [200] (alternative 1).

If a start signal is given via remote or serial communication (according to the setting in menu [200]), the softstarter will check the reference signal on the analogue/digital signal. A start will be performed if the level of the reference signal is below the analogue start/stop on-value chosen in menu
[502] for a longer time than the analogue start/stop delay time set in menu [504]. A scop will be performed if the reference signal exceeds the analogue start/stop off-value chosen in menu [503] for a longer time than the analogue scart/ stop delay time set in menu [504].

NOTE: If the selected analogue start/stop on-value is bigger than or equal to the off-value, a level above the on-value at the analogue input will cause a start. A value below the off-value will in this case cause a stop.

The start/stop LED on the front of the MSF will be flashing if the softstarter is in standby mode waiting for an analogue start.

> Warning: A flashing start/stop LED is indicating standby mode - e.g. waiting for an analogue start. The motor may be started automatically at a moment's notice

## Analogue start/stop on-value [502]

This menu is available if analogue start/srop is activated in menu [500] (alcernative 6 or 7). If the reference signal on the analogue/digital inpur is below the chosen on-level for a longer time than the analogue start/stop delay rime chosen in menu [504], a start will be performed..

NOTE: If the selected analogue start/stop on-value is bigger than or equal to the off-value, a level above the on-value at the analogue/digital input will cause a start.

NOTE: An analogue start will only be performed if the softstarter has been set to standby mode by a valid start signal via remote control or serial communication.

The analogue start/stop on-value is chosen as a percentage of the inpur signal range. This means, if the analogue/digital inpur is configured for $0-10 \mathrm{VDC} / 0-20 \mathrm{~mA}$ (alternative 6 in menu [ 500 ]), $25 \%$ corresponds to 2.5 V or 5 mA . If the analogue/digital input is configured for $2-10 \mathrm{VDC} / 4-20 \mathrm{~mA}$ (alternative 7 in menu [.500]), $25 \%$ corresponds to 4 V or 8 mA .


## Analogue start/stop off-value [503]

This menu is available if analogue starc/stop is activated in menu [500] (alternatives 6 or 7). If the reference signal on the analogue/digital input exceeds the chosen off-level for a longer time than the analogue start/stop delay time chosen in menu [504], a stop will be performed.

## NOTE: If the selected analogue start/stop off-value is

 less than or equal to the on-value, a level below the offvalue at the analogue/dightal input will cause a stop.NOTE: A stop will also be performed if the softstarter receives a stop signal via remote control or serial communication.

The analogue start/stop off-value is chosen as a percentage of the inpur signal range. This means if the analogue/digital input is configured for $0-10 \mathrm{~V} / 0-20 \mathrm{~mA}$ (alcernative 6 in menu [ 500 ]), $25 \%$ corresponds to 2.5 V or 5 mA . If the analogue/digital input is configured for $2-10 \mathrm{~V} / 4-20 \mathrm{~mA}$ (alternative 7 in menu [500]), $25 \%$ corresponds to 4 V or 8 mA .


## Analogue start/stop delay time [504]

This menu is available if analogue start/stop is activated in menu [ 500 ] (alternatives 6 or 7). In this inenu the delay time for starts and srops caused by the a nalogue reference signal is ser.


## Digital inputs

The MSF 2.0 has four programmable digitat inputs. The four inputs and their corresponding control supply terminals are shown overleaf in Fig. 57.


Fig. 57 Wiring for digital inputs 1-4.
The four digital inputs are electrically identical. The digital inputs can be used for remote concrol of start, stop and reset, for choice of parameter set and for external alarm.

## Stop signal

If remore concrol is chosen in menu [200] (alternative 2), one digital input has to be programmed as stop signal.

NOTE: No starts will be allowed if the input set for stop signal is open or if no input is configured for stop signal.

If the moror is running a stop will be performed according to the stop setrings in menus \{320] to [325] as soon as the input configured for stop signal is opened. If more than one input is configured for stop signal, opening one of these will lead to a stop. Accordingly no starts will be allowed if any of these inpurs is open.

## Start and reset signal

The digital inputs can be configured for scveral different start signals (start, start R or start L signal). Closing any input, which is configured for start, will start the motor. Moreover, a rising edge on any input configured for start is interpreted as a reser signal.

NOTE: If more than one digital input is configured for any of the start signals (start, start R or start L), closing more than one of these inputs at the same time will lead to a stop. However, if several digital inputs are configured for the same start functionality, e.g. start R , closing any of these inputs will lead to a start.

Naturally the softstarter has no way of controlling the motor's running direction internally. However, if rwo mains concacrors - one for each phase sequence - are used, these can be controlled by the softstarter using the programmable relays. The sertings for the programmable relays in menus [530] to [532] correspond to the different start signals, which can be chosen for the digital inputs. In this way differenc running direcrions for the motor can be chosen.

## Example

1. If only one running direction is used, digital input 1 can be configured for start signal and digital input 2 for stop signal (default setring). In this case relay K1 may be configured for operation (default setting) and can control the mains relay. When digital inputs 1 and 2 are closed, the mains contactor will be activated and the motor will start. When digital input 2 is opened the moror will stop. The mains contactor will be deactivated after the stop has been finished.
2. If two running directions are desired, digital input 1 can be configured for stare R , digital input 2 for stop and digital input 3 for start L. Relay K1 controls the mains contactor for running in right direction and may be configured for Operation R. Relay K2 controls the mains contactor with the opposite phase sequence for running in left direction and may be configured for Operation L . In this case closing digital inputs 1 and 2 (start right command) will lead to activation of the mains contactor for running in right direction and the motor will start in right direction. Opening digital input 2 will lead to a stop; the mains contactor for running right will be deactivated after the stop has been finished. Closing digital imputs 2 and 3 (while digital input 1 is open) will lead to activation of the mains contactor for running in left direction and the motor will start in left direction.

For more information see the description of the start right/ left funcrionality in section 8.9.4, page 87.

## External alarm

The digital inputs can be configured as external alarm inputs. If an input configured for external alarm is opened, the action chosen in menu [420] for external alarm is performed. See description of the external alarm functionality in section 8.9.5, page 89 for more information.

NOTE: If more than one digital Input is configured for external alarm, opening any of these will lead to an external alarm.

## Parameter set

This configuration enables choice of paramerer ser hy an external signal. See descriprion of external control of parameter set in section 8.9.6, page 90 for more information.

## Digital input 1 function [510]

In this menu the function for digital input 1 (terminal 11) is selected.


## Digital input 2 function [511]

In this menu the function for digital input 2 (terminal 12) is selected.


## Digital input 3 function [512]

In this menu the function for digital inpur 3 (terminal 16) is selected.


## Digital input 4 function [513]

In this menu the function for digital input 4 (terminal 17) is selected.

| 5 1 0 <br> 0   |  | Setting |
| :---: | :---: | :---: |
| Dlgital input 4 function |  |  |
| Default: | 4 |  |
| Range: | oFF, |  |
| oFF | Digit |  |
| 1 | Start |  |
| 2 | Stop |  |
| 3 | Para |  |
| 4 | Para |  |
| 5 | Exter |  |
| 6 | Start |  |
| 7 | Start |  |

### 8.9.2 Output signals

The MSF 2.0 has one programmable analogue output and threc programmable relays.

## Analogue output

The analogue output can present current, voltage, shaft power and torque for conncetion to a recording instrument, PLC etc. Tbe external device is connected to terminals 19 $(+)$ and $15(-)$ according to Fig. 58 below. The analogue ourput can be configured for voltage or current signal. The
selection is made by jumper J 2 on the control board. The default setting for $J 2$ is voltage signal according to Fig. 58.


Fig. 58 Wiring for analogue output and setting of J2 for analogue current or voltage signal.

## Analogue output [520]

In this menu the analogue output can be set to provide either one of the signal ranges shown in Fig. 59.


Fig. 59 Analogue output

| 5210 |  |  | Setting |
| :---: | :---: | :---: | :---: |
| Analogue output |  |  |  |
| Default: |  | oFF |  |
| Range: |  | OFF, |  |
| ofF |  | Anal |  |
| 1 |  | Ana |  |
| 2 |  | Ana |  |
| 3 |  | Ana |  |
| 4 |  | Anal |  |

## Analogue output function [521]

This menu is available if the analogue ourpur is enabled in menu [520] (alternatives 1-4). In this menu the desired output function is chosen.


The scaling of the analogue output is reset to the default values $(0-100 \%)$ if a new output value is chosen in menu [521].

## Analogue output scaling

By default the scaling of the analogue output corresponds to Fig. 60. In this case the signal range of the analogue ourput chosen in menu [520] corresponds to 0 to $100 \%$ of the nominal motor current $I_{n}$, the nominal motor voltage $U_{n}$, the nominal motor power $P_{n}$ or the nominal motor torque $\mathrm{T}_{\mathrm{n}}$ respectively.

## Example

If $0-10 \mathrm{~V} / 0-20 \mathrm{~mA}$ is chosen in menu [520] (alternative 1) and RMS current is chosen as output value in menu [521] (alternative 1), a current of $100 \%$ of the nominal motor current gives 10 V or 20 mA at the analogue output. A current of $25 \%$ of the nominal motor current gives 2.5 V or 5 mA at the analogue output.
The scaling of the analogue output may be adapted for higher resolution or if values above the nominal values are to be monitored. The scaling is done by choosing a minimum scaling value in menu [522] and a maximum value in menu [523]. An example for a different scaling is shown in Fig. 60.


Fig. 60 Scaling of analogue output
With the scaling for wide range (menu [522]=50 and menu [523]=500) according to the example in Fig. 60 the following will apply.
If $0-10 \mathrm{~V} / 0-20 \mathrm{~mA}$ is chosen in menu [ 520 ] (alternative 1) and RMS current is chosen as output value in menu [521] (alternative 1), a current of $100 \%$ of the nominal motor current gives approximately 1.1 V or 2.2 mA ar the analogue output.

## Scaling analogue output, min [522]

This menu is available if the analogue output is enabled in menu [520]. In this menu the minimum value to be shown at the analogue output is chosen. The value is chosen in percent of $\mathrm{l}_{\mathrm{n}}, \mathrm{U}_{\mathrm{n}}, \mathrm{P}_{\mathrm{n}}$ or $\mathrm{T}_{\mathrm{n}}$ according to the output value chosen in menu [521].


NOTE: The minimum value for scaling the analogue output is reset to the default value $0 \%$ If a new output value is chosen in menu [521].

## Scaling analogue output, max [523]

This menu is available if the analogue output is enabled in menu [520]. In this menu the maximum value to be shown at the analogue ourpur is chosen. The value is chosen as a percentage of $I_{n}, U_{n}, P_{n}$ or $T_{n}$ according to the output value chosen in menu [521].


NOTE: The maximum value for scaling the analogue output is reset to the default value $\mathbf{1 0 0 \%}$ If a new output value is chosen in menu [521].

## Programmable relay outputs

The soffstarter has three built-in relays, K1, K2 and K3. All three relays are programmable.
For relay K1 (terminals 21 and 22) and K2 (terminals 23 and 24) the contact function can be programmed in menus [533] and [534] respectively to be normally open ( NO ) or normally closed (NC). Relay K3 is a change-over relay with three terminals (31-33), the NO functionality is available between terminals 31 and 32 , NC functionality between terminals 32 and 33.
The relays can be used to control mains contactors or a bypass contactor or to indicate alarm conditions. As illustrated in Fig. 61 overleaf, the Operation setting (alternative 1) should be chosen to activate the mains contactor both during start, full voltage operation and stop. If a by-pass contactor is used, this can be controlled by a relay with the serring Full volrage (2). The serrings Run (5) and Brake (4) are used when reverse current brake is chosen as stop merhod. In this case one relay has to be configured for Run and will control the mains contactor during the start and during full voltage operation. Another relay has to be configured for Brake and will control the contactor with reversed phase sequence during braking. For security reasons the relay configured for Brake will not be activated until after a time delay of 500 ms after deactivation of the relay configured for Run.
The setrings Run R, Run L, Operation R and Operation L are used for the start right/lefr funcrionality. Consult section 8.9.4, page 87 for more information.

Different alarms can also be indicated on the relay outputs. With the serting Power pre-alarms (alternative 3), both a Max power pre-alarm or a Min power pre-alarm occurring will activate the relay. When Power alarms (10) is chosen as a setting, both a Max power alarm or a Min power alarm will activate the relay. If so desired, the relays can instead be pro-
grammed to react only to one specific power alarm or prealarm (11-14).

Wirh setring All alarms (15) the relay will be activated for any alarm. As the power pre-alarms are nor considered to be real alarms, the relay will not react to those. With alternative 16 chosen, even the power alarms are excluded. When Exiernal alarm (17) is chosen, only an External alarm will activate the relay. With setring 18, Autoreset expired, the relay will be activated when an additional fault occurs after the maximum allowed number of autoreser attempts have been executed. This may indicate that external help is needed to rectify a re-occurring fault (see description of Autoreset in section 8.5, page 52 for detailed information). With alternative 19 the relay will indicate all alarms which need a manual reser. This includes all alarms which are not solved with an automaric Autoreser, e.g. all alarms for which Autoreset is not enabled and each alarm occurring after the maximum allowed number of autoreset attempts has been executed.


Fig. 61 The relay functions for operation, run and full voltage.

## Relay K1 [530]

In this menu the function for relay K 1 (terminals 21 and 22) is chosen.

| $530_{0}^{0}$ | Relay K1 Setting |
| :---: | :---: |
|  |  |
| Default: | 1 |
| Range: | oFF, 1-19 |
| oFF | Relay inactive |
| 1 | Operation |
| 2 | Full voltage |
| 3 | Power pre-alarms |
| 4 | Brake |
| 5 | Run |
| 6 | Run R |
| 7 | Run L |
| 8 | Operation R |
| 9 | Operation L |
| 10 | Power alarms |
| 11 | Max power alarm |
| 12 | Max power pre-alarm |
| 13 | Min power alarm |
| 14 | Min power pre-alarm |
| 15 | All alarms (except power pre-alarms) |
| 16 | All alarms (except power alarms and prealarms) |
| 17 | External alarm |
| 18 | Autoreset expired |
| 19 | All alarms which need manual reset |

NOTE: If relay K1 is chosen to be inactive (oFF), the relay state is determined by the contact function in menu [533].


WARNING: When reverse current brake is activated by changing the settings in menu [320] (stop method), [323] (braking method) or [326] (alarm brake strength), relay K1 is automatically set for Run (5). If a different setting is desired for the specific application, the relay setting has to be changed afterwards.

## Relay K2 [531]

In this menu the function for relay K 2 (rerminals 23 and 24) is chosen.

| $5\|3\|$   <br>   Setting <br> Relay K2   <br> Default: 2  <br> Range: oFF, 1-19  <br> oFF Relay inactive  <br> $1-19$ See menu "Relay K1 [530]" for setting <br> alternatives.  |
| :--- | :--- | :--- |

NOTE: If relay K 2 is chosen to be inactive (oFF), the relay state is determined by the contact function in menu [534].


WARNING: When reverse current brake is activated by changing the settings in menu [320] (stop method), [323] (braking method) or [326] (alarm brake strength), relay K2 is automatically set for Brake (4). If a different setting is desired for the specific application, the relay setting has to be changed afterwards.

## Relay K3 [532]

In this menu the function for relay K 3 (terminals $31-33$ ) is chosen.


## K1 contact function [533]

In this menu the contact function for relay K1 can be chosen. The available alternatives are Normally open ( $1=$ Closing on relay acrivation) and Normally closed (2=Opening on relay activation).

| 5 | 3 |  |  |
| :--- | :--- | :--- | :--- |
|  |  | Setting |  |
|  |  |  | 1 |

## K2 contact function [534]

In this menu the contact function for relay K2 can be chosen. The available alternatives are Normally open ( $1=$ Closing on relay activation) and Normally closed ( $2=$ Opening on relay activation).

| 5 | 3 | 4 | Setting |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  |  |  | 1 |

### 8.9.3 Start/stop/reset command functionality

Starting/stopping of the motor and alarm reset is done either from the control panel, through the remote control inputs or through the serial communication interface depending on the control source chosen in menu [200].

## Control panel

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

To reser from the control panel, the "ENTER $\leftarrow$ /RESET" key is used.

Regardless of the chosen control source, it is always possible to initiate a reset via the control panel.

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

## Serial communication

For description of the start, stop and reset commands via serial communication see the operation instruction supplied with this oprion.

## Remote control

When remote control is chosen in menu [200], the digital inputs are used to start and stop the motor and to reset upcoming alarms. In the following sections different possibilities for connecring the digital inpurs are described. For the following explanations the following sertings are assumed:

| Menu | Description | Setting |
| :--- | :--- | :--- |
| 510 | Digital input 1 (terminal 11) | Start signal (1) |
| 511 | Digital input 2 (terminal 12) | Stop signal (2) |

2-wire start/stop with automatic reset at start


Fig. 62 2-wire connection of terminals for start/stop/automatic reset at start

An external switch is connected between terminals 12 and 13 and a jumper is connected between terminals 11 and 12 .

## Start

Closing terminal 12 to terminal 13 will give a start command. If terminal 12 is closed to terminal 13 at power up, a start command is given immediately (automatic start at power up).

## Stop

Opening rerminal 12 will give a stop command.
Reset
When a start command is given there will automatically be a reset.

## 2-wire start/stop with separate reset



Fig. 63 2-wire connection of terminals for start/stop/separate reset

One external switch is connected between terminals 11 and 13 and a second swirch is connected between terminals 12 and 13.

## Start

Closing terminals 11 and 12 to terminal 13 will give a start command. If terminals 11 and 12 are closed at power up, a start command is given immediately (automatic start at power up).

## Stop

Opening terminal 12 will give a stop command.

## Reset

When terminal 11 is opened and closed again a reset is given. A reset can be given both when the motor is running and when it is stopped.

3-wire start/stop with automatic reset at start


Fig. 64 Connection of terminals for start/stop/reset
An external switch is connected berween terminals 11 and 13 and a second switch is connected berween terminals 12 and 13 .

The connection between terminal 11 and 13 is normally open and the connection between terminal 12 and 13 is normally closed.

## Start

Closing terminal 11 momentarily to terminal 13 , will give a start command. There will not be an automatic start at power up as long as terminal 11 is open.

## Stop

To stop, terminal 12 is momentarily opened.

## Reset

When a start command is given there will automatically be a reset.

### 8.9.4 Start right/left functionality

The digital inputs can be configured to enable starting a motor in two different directions in combination with the programmable relays K1 and K2. A connection example is shown in Fig. 65. For the following description of the start right/left funcrionality, the following settings for the digital inputs are assumed.

| Menu | Description | Setting |
| :--- | :--- | :--- |
| 510 | Digital input 1 (terminal 11) | Start R signal (6) |
| 511 | Digital input 2 (terminal 12) | Stop signal (2) |
| 512 | Digital input 3 (terminal 16) | Start L signal (7) |



Fig. 65 Connection for start rightlleft

The configuration of the relays depends on the application's requirements. For applications which do not use the reverse current brake functionality, the following setrings may be used.

| Menu | Description | Setting |
| :--- | :--- | :---: |
| 530 | Relay K1 (terminals 21 and 22) | Operation R (8) |
| 531 | Relay K2 (terminals 23 and 24) | Operation L (9) |

With these sertings the functionality is as follows:
If terminals 1 and 12 are closed to terminal 13 while terminal 16 is open, the mains contactor for running in right direction will be activated by relay K 1 and the motor will start in right direction. If terminal 12 is opened, a stop according to the stop settings in menus [320] to [325] will be performed. When the stop is finished, the mains contactor for running right will be deactivared by relay K1.

If terminal 12 is closed to terminal 13 and terminal 16 is closed to terminal 18 while terminal 11 is open, the mains contactor for running in left direction will be activared by relay K2 and the motor will start in left direction. If terminal 12 is opened, a stop according to the stop settings in menus [320] to [325] will be performed. When the stop is finished, the mains contactor for running left will be deactivated by relay K2.

If both start terminals ( 11 and 16) are closed to their respective supply voltage at the same time, a stop is performed in the same way as described above. In this case no start will be allowed.
A motor can be reversed from right to left direction as follows: When the motor is running in right direction, terminal 11 is opened. Terminal 16 is then closed to terminal 18. In this case the voltage to the motor is switched off and the mains contactor for running right is deactivated by relay K1. After a time delay of 500 ms the mains contactor for running left will be activated by relay K2 and a start in left direcrion will be performed. The moror can be reversed from running left to running right in the same way by opening terminal 16 while running left and then closing terminal 11.


[^0]

WARNING: If configured according to the description above, relays K1 and K2 will never be activated at the same time. There is a time delay of 500 ms for the change-over between the relays. However, if the relays are not configured properly, they may be activated at the same time.

For applications which use the reverse current brake functionality, the following settings for the relays may be used.

| Menu | Description | Setting |
| :--- | :--- | :--- |
| 530 | Relay K1 (terminals 21 and 22) | Run R (6) |
| 531 | Relay K2 (terminals 23 and 24) | Run L (7) |

With these settings the functionality is as follows:
If terminals 11 and 12 are closed to terminal 13 while terminal 16 is open, the mains contactor for running in right direction will be activated by relay K 1 and the motor will start in right direction. If terminal 12 is opened the voltage to the motor is switched off and the mains contactor for running right is deactivated by relay K 1 . After a time delay of 500 ms the mains contactor for running left will be activated by relay K 2 and the reverse current brake will brake the motor to standstill. When the stop is finished, the mains contactor for running left will be deactivared by relay K2.
If terminal 12 is closed to terminal 13 and terminal 16 is closed to terminal 18 while terminal 11 is open, the mains contactor for running in left direction will be activated by relay K 2 and the motor will start in lefr direction. If terminal 12 is opened the voltage to the motor is switched off and the mains contactor for running left is deactivated by relay K 2 . After a time delay of 500 ms the mains contacror for running right will be activated by relay K 1 and the reverse current brake will brake the motor to standstill. When the stop is finished, the mains contactor for running right will be deacrivated by relay K1.
If both start terminals ( 11 and 16) are closed to their respective supply voltage at the same time, a stop is performed in the same way as described above. In this case no start will be allowed.

A motor can be reversed in the same way as described above for applications which do not use the reverse current brake functionality.

[^1]NOTE: When reverse current brake is activated by changing the settings in menu [320] (stop method), [323] (braking method) or [326] (alarm brake strength), relay K1 is automatically set for Run (5) and relay K2 is automatically set for Brake (4). To use the start right/ left functionality in combination with reverse brake, the relay settings have to be adapted as described above once reverse current brake has been enabled.

### 8.9.5 External alarm functionality

The external alarm functionality is used to generate an alarm depending on the state of an external alarm signal. Each of the digital inputs can be configured for external alarm signal. Fig. 66 shows a connection example with digital input 3 (terminal 16) configured for external alarm signal.


Fig. 66 Connection of terminals for external alarm
If any digital inpur is configured for external alarm signal, opening this inpur will cause an external alarm to occur if external alarm is enabled in menu [420].

NOTE: If more than one digital input is configured for external alarm signal, opening any of these inputs will generate an external alarm if external alarm is enabled in menu [420].

The following alarm actions are available for external alarm:

## Off

External alarm is disabled.

## Warning

An F17 alarm message is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm input is opened. However, the motor is not stopped and operation continues. The alarm message will disappear and the relay will be reset when the external alarm input is closed again. The alarm may also be reset manually.

## Coast

An F17 alarm message is shown in the display and relay K3 is activated (for default configuration of the relays) if the external alarm input is opened. The motor voltage is automatically switched off. The motor freewheels uncil it stops.

## Stop

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

## Brake

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

## Spinbrake

The functionality for the spinbrake alternative is the same as described above for the brake alternative. However, if spinbrake is chosen, braking can even be initiated from an inactive state by opening the external alarm input. This means the softstarter can catch a freewheeling motor and brake it down to standstill. The Spinbrake alternative is only available for external alarm.

External alarm can be used together with any setting for the control source chosen in menu [200].

If the operation has been interrupted due to an external alarm, a reset signal and a new start signal are needed to restart the motor. The reset and the start signal can be given via control panel, remote or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control source, it is always possible to initiarc a reser via control panel.

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

### 8.9.6 External control of parameter set

The parameter set can be chosen via the digital inputs if external control of parameter set is chosen in menu [240] (alternative 0 ). For this purpose any of the digital inputs can be configured for parameter ser input 1 (PS1, alternative 3 in menus [510] to [513]) or parameter set inpur 2 (PS2, alternative 4 in menus [510] to [513]). Fig. 67 shows a connection example for external control of parameter set, in this example digital inputs 3 and 4 are configured for PS1 and PS2.


Fig. 67 Connection of external control inputs.
Table 15 How parameter set inputs are evaluated

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

It is possible to use just one digital input to change berween two parameter sets. According to the example above, digital input 3 is configured for PS1. If no digital inpur is configured for PS2, PS2 is considered to be open. In this case digital input 3 can be used to change between parameter set 1 and 2.
Changing the parameter set via external signal is only execured in stopped mode and at full voltage operation. If the input signals for PS1 and PS2 are changed during acceleration or deceleration, only the new parameters for the control source (menu [200]), the analogue/digital input (menu [500]), the digital input pulses (menu [501]), the analogue start/stop on- and off-value (menus [502] and [503]) and the analogue start/stop delay (menu [504]) are loaded immediately. All other parameters will not change until the softstarter is in stopped mode or at full voltage running. In this way a change of the concrol source will take effect. immediately, which can be useful for changing from remore to manual operation for maintenance.

NOTE: No parameters, except for the control source in menu [200] and the parameter set in menu [240], may be changed if external control of parameter set is activated in menu [240] (alternative 0).

### 8.10 View operation

MSF 2.0 includes numerous viewing functions which eliminate the need for additional transducers and meters for monitoring the operation.
[700] to [716] Operation (current, voltage, power etc.)
[720] to [725] Status (softstart status, input/output status) [730] to [732] Stored values (operation time etc.)

### 8.10.1 Operation

## RMS current

| $7 / 0$ | 0 |  |  |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  |  | 0. | 0 |
| Read-out |  |  |  |
|  |  |  |  |

NOTE! This is the same read-out as menu [100].

## Line main voltage



Power factor


## Output shaftpower

The output shaft power is shown in kW or in HP depending on the setting for Enable US units in menu [202].


## Output shaftpower in percentage unit



NOTE: This is the same read-out as menu [413].

## Shaft torque

The shaft torque is shown in Nm or in lbft depending on the setting for Enable US units in menu [202].


Shaft torque in percentage unit


## Softstarter temperature

The softstart temperature is shown in degrees Celsius or in degrees Fahrenheit depending on the setting for Enable US unics in menu [202].


Current phase 11


## Current phase L2



## Current phase L3



Line main voltage L1-L2

| 7 | 1 | 1 |
| :--- | :--- | :--- |$\quad$| 0 |
| :--- |$\quad$ Read-out

Line main voltage L1-L3

| 7 | 1 | 2 | 0 |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  |  |  |  |
|  |  |  | Read-out |
|  |  |  |  |
| Range: | $0-720 \mathrm{~V}$ |  |  |

Line main voltage L2-L3

| 7 | 1 | 3 |  |
| :--- | :--- | :--- | :--- |
|  |  |  |  |
|  |  |  | 0 |
|  |  |  |  |

Phase sequence


Used thermal capacity


Time to next allowed start


### 8.10.2 Status

Softstarter status

| 0 |  | Read-out |
| :---: | :---: | :---: |
| 0 Softstarter status |  |  |
| Range: | 1-12 |  |
| 1 | Stopped, no alarm |  |
| 2 | Stopped, alarm |  |
| 3 | Run with alarm |  |
| 4 | Acceleration |  |
| 5 | Full voltage |  |
| 6 | Deceleration |  |
| 7 | Bypassed |  |
| 8 | PFC |  |
| 9 | Braking |  |
| 10 | Slow speed forward |  |
| 11 | Slow speed reverse |  |
| 12 | Standby (waiting for Analogue start/stop or Autoreset) |  |

## Digital Input Status

Stacus of the digital inputs $\mathbf{1 - 4}$ from left to right. L or H are displayed for input status low (open) or high (closed).


## Analogue/digital Input status

Status of the analogue/digital input when it is used as digital input. L and H are displayed for input status low (open) and high (closed).


## Analogue/digital input value

Value on the analogue/digital input as a percentage of the input range. This read-our depends on the configuration of the analogue/digital inpuc in menu [500], e.g. if the analogue/digital input is configured for analogue start/stop $0-10 \mathrm{~V} / 0-20 \mathrm{~mA}$ (alcernative 6 ), an input signal of 4 V or 8 mA will be shown as $40 \%$. However, if the analogue $/ \mathrm{dig}$ ital inpur is configured for analogue start/stop $2.10 \mathrm{~V} / 4-20$ mA (alternative 7), an input signal of 4 V or 8 mA will be shown as $25 \%$.


## Relay status

Status of the relays K1 to K3 from the left to the right. L or H are displayed for relay status low (opened) or high (closed). The stacus described for relay K3 corresponds to the status of terminal 3 .


## Analogue Output value

Value on the analoguc ourput as a percentage of the output range. This read-our depends on the configuration of the analogue output in menu [520], e.g. if the analogue/digital input is configured for $0-10 \mathrm{~V} / 0-20 \mathrm{~mA}$ (alternative 1) or for $10-0 \mathrm{~V} / 20-0 \mathrm{~mA}$ (alternative 3), an output signal of 4 V or 8 mA will be shown as $40 \%$. However, if the analogue ourput is configured for $2-10 \mathrm{~V} / 4-20 \mathrm{~mA}$ (alternative 2) or 10-2 V/20-4 mA (alternative 4), an output signal of 4 V or 8 mA will be shown as $25 \%$.


### 8.10.3 Stored values

Operation time. The operation time is the time during which the motor connected to the softstarter is running, not the time during which the supply power is on.
If the acrual value for the operation time exceeds 9999 hours the display will alternate between the four lower digits and the higher digits.

## Example

If the actual operation time is 12467 , 1 will be shown for 1 s , then 2467 will be shown for 5 s and so on.


## Energy consumption



## Reset energy consumption

In this menu the stored power consumption (menu [713]) can be reser to 0 .


### 8.11 Alarm list

The alarm list is generated automatically. It shows the latest 15 alarms (F1-F17). The alarm list can be useful for cracking failures in the softstatter or its control circuit. In the alarm list both the alarm message and the operation time is saved for each alarms that occurs. In menu [800] the latest alarm message and the corresponding operation time are shown alternately, in the same way, older alarms are shown in menus [801] to [814].

## Example

- If the latest alarm was a phase input failure ( F 1 ), which occurred at operation time 524. F1 is shown for 4 s then 524 is shown for $2 s$ and so on.
- If the latest alarm was a thermal motor protection alarm (F2), which occurred at operation time 17852. F2 is shown for 3 s , after that 1 is shown for 1 s , then 7852 is shown for $2 s$ and so on.


## Alarm list, latest error



## Alarm list, error



| Menu | Function |
| :--- | :--- |
| 802 | Alarm list, error 13 |
| 803 | Alarm list, error 12 |
| 804 | Alarm list, error 11 |
| 805 | Alarm list, error 10 |
| 806 | Alarm list, error 9 |
| 807 | Alarm list, error 8 |
| 808 | Alarm list, error 7 |
| 809 | Alarm list, error 6 |
| 810 | Alarm list, error 4 |
| 811 | Alarm list, error 2 |
| 812 | Alarm list, error 1 |
| 813 |  |
| 814 |  |

### 8.12 Softstarter data

In menus [900] to [902] the sofstsarter rype is shown and the sofstsarter's software version is specified.

## Softstarter type

| 9,0 | 0 | 0 |
| :--- | :--- | :--- |
|  |  | Read-out |
|  |  | 1 |
|  | 7 |  |
| Range: |  | $17-1400 \mathrm{~A}$ |

## Software variant

| 9 | 0 | 1 |  |
| :--- | :--- | :--- | :--- |
| V | 2 | 2 | 0 |
| Read-out |  |  |  |

Software version

| 9 O | 2 | 0 |
| :--- | :--- | :--- |
|  |  | Read-out |
|  | $R$ | 1 |

## 9. Protection and alarm

MSF 2.0 is equipped with functions for motor protection, process protection and protection of the softstarter itself.

### 9.1 Alarm codes

Different alarm codes are used for the different errors, see Table 16 for a description of the alarm codes used. When an alarm occurs, this is indicated with the appropriate alarm message flashing in the display. If more than one alarm is active at the same time, the alarm code for the last alarm is presented on the display. The alarm code for each occurring alarm is also saved in the alarm list in menus [800] to [814].

### 9.2 Alarm actions

For most protection mechods a proper action can be chosen to be performed if the relevant alarm occurs. The following alternatives are available as alarm actions (all alternatives may not be available for all protection methods - check Table 16):

## Off

The alarm is deactivated.

## Warning

The appropriate alarm code is Hashing in the display and relay K 3 is acrivated (for default configuration of the relays) if an the alarm occurs. However, the motor is not stopped ans operation continues. The alarm message in the display will disappear and the relay will be reser when the alarm has disappeared. The alarm may also be reset manually. This setting alternative may be useful if it is desired to control operation in alarm state by an external control unit.

## Coast

The appropriate alarm code is flashing in the display and relay K 3 is activated (for defaule configuration of the relays) if an the alarm occurs. The motor voltage is automatically switched off. The motor is freewheels until it stops.
This setting altemative is useful if continuous running or active stopping could harm the process or the motor. This may be appplicable for applications with very high inertia that use braking as the normal stop method. In this case it may be a good idea to choose Coast as alarm action on thermal motor protection alarm, because continuous running or braking could harm the motor seriously when this alarm has occurred.

## Stop

The appropriate alarm code is flashing in the display and relay K3 is activated (for defaule configuration of the relays) if an alarm occurs. The motor is stopped according to the stop settings in menus [320] to [325].
This setting is useful for applications where a correct stop is imporcant. This may apply to most pump applications, as Coast as an alarm action could cause water hammer.

## Brake

The appropriate alarm code is flashing in the display and relay K3 is activated (for default configuration of the relays) if an alarm occurs. The brake function is activated according to the braking method chosen in menu [323] and the motor is stopped according to the alarm brake settings in menus [326] to [327] (braking strength and braking time). If alarm braking is deactivated in menu [326] and Brake is chosen as an alarm action, the action will be the same as described above for Coast.

Brake as an alarm action may mainly be used in combination with External alarm, where an external signal is used to iniriace a quick stop with a higher braking strength and a shorter braking time compared to normal operation.

## Spinbrake

The functionality for the Spinbrake alternative is the same as described above for the Brake alternative. However, if Spinbrake is chosen, braking can even be initiated from an inactive state. This means the softstarter can catch a freewheeling motor and brake it down to standsrill.

The Spinbrake alternative is only available for External alarm. It may be useful c.g. for test running of planers and bandsaws after tool exchange. It may be desirable to accelerate the tool up to a specific spced and then leave it coasting to check if there is any unbalance. In this case it is possible to activate braking immediately by opening the external input.

In Table 16 below the alarm actions available for each alarm type are specificd in detail.

### 9.3 Reset

For the following explanations it is important to distinguish berween Reset and Restart. Reset means that the alarm message on the display disappears and the alarm relay K3 (for default configuration of the relays) is deactivated. If the operation has been interrupted duc to an alarm the softstatter is prepared for a Restart. However, giving a Reset signal without giving a new start signal will never lead to a start.

The Reset signal can be given via control panel, remotely or via serial communication depending on the control source chosen in menu [200]. Regardless of the chosen control method, it is always possible to give a Reset signal via control panel.
If an alarm occurs whose alarm action is configured for Warning (see description of alarm actions above), the alarm will automatically be reser as soon as the failure disappears. The alarm may also be resec manually by giving a Reset signal as described above.

If operation has been interrupred due to an alarm, a Reset signal and a new start signal may be needed to Restart the motor. However, some alarms are automatically reset when a new start signal is given. Table 16 covers all alarm types and
whether they need a Reset signal (manual reset) or if they are reset automatically when a new start signal is given.

An alarm can always be reset by giving a Reset signal, even if the failure that caused the alarm has not disappeared yer. Giving a Reset will cause the alarm message on the display to disappear and the alarm relay K 3 to be deactivated (for default configuration of rhe relays). However, if operation has been interrupted due to an alarm, a Restart will not be
possible until the failure has disappeared. If a new start signal is given while the failure still is active, the alarm message will appear flashing in the display and the alarm relay K3 will be activated again (for default configuration of the relays).
MSF 2.0 is also provided with an Autoreset function. This functionality is described in detail in section 8.5, page 52.

### 9.4 Alarm overview

Table 16 Alarm overview

| Alarm code | Alarm description | Alarm action | Protection system | Reset |
| :---: | :---: | :---: | :---: | :---: |
| F1 | Phase input failure. | Warning Coast | Motor protection (menu [230]) | Automatic Reset when new start signal is given. |
| F2 | Thermal motor protection | Off <br> Warning <br> Coast <br> Stop <br> Brake | Motor protection (menu [220]) | Separate Reset signal needed. |
| F3 | Soft start overheated | Coast |  | Separate Reset signal needed. |
| F4 | Current limit start time expired. | Off <br> Warning <br> Coast <br> Stop <br> Brake | Motor protection (menu [231]) | Automatic Reset when new start signal is given. |
| F5 | Locked rotor alarm. | Off Warning Coast | Motor protection (menu [228]) | Separate Reset signal needed. |
| F6 | Max power alarm. | Off <br> Warning <br> Coast <br> Stop <br> Brake | Process protection (menu [400]) | Separate Reset signal needed. |
| F7 | Min power alarm. | Off <br> Warning <br> Coast <br> Stop <br> Brake | Process protection (menu [401]) | Separate Reset signal needed. |
| F8 | Voltage unbalance alarm. | Off <br> Warning <br> Coast <br> Stop <br> Brake | Process protection (menu [430]) | Automatic Reset when new start signal is given. |
| F9 | Overvoltage alarm. | Off <br> Warning Coast Stop Brake | Process protection (menu [433]) | Automatic Reset when new start signal is given. |
| F10 | Undervoltage alarm. | Off <br> Warning <br> Coast <br> Stop <br> Brake | Process protection (menu [436]) | Automatic Reset when new start signal is given. |

Table 16 Alarm overview

| Alarm <br> code | Alarm description | Alarm action | Protection system | Reset |
| :--- | :--- | :--- | :--- | :--- |
| F11 | Start limitation. | Off <br> Warning <br> Coast | Motor protection <br> (menu [224]) | Automatic Reset when new start signal is <br> given. |
| F12 | Shorted thyristor. | Coast |  | Separate Reset signal needed. |
| F13 | Open thyristor. | Coast |  | Separate Reset signal needed. |
| F14 | Motor terminal open. | Coast |  | Separate Reset signal needed. |
| F15 | Serial communication <br> contact broken. | Off <br> Warning <br> Coast <br> Stop <br> Brake | Control source pro- <br> tection (menu <br> [273]) | Automatic Reset when new start signal is <br> given. |
| F16 | Phase reversal alarm. | Off <br> Warning <br> Coast | Process protection <br> (menu [440]) | Separate Reset signal needed. |
| F17 | External alarm. | Off <br> Warning <br> Coast <br> Stop <br> Brake <br> Spinbrake | Process protection <br> (menu [420]) | Separate Reset signal needed. |

## 10. Troubleshooting

### 10.1 Fault, cause and solution

| Observation | Fault indication | Cause | Solution |
| :---: | :---: | :---: | :---: |
| The display is not illuminated. | None | No control supply voltage. | Switch on the control supply voltage. |
| The motor does not run. | F1 <br> (Phase input failure) | Fuse defective. | Renew the fuse. |
|  |  | No mains supply. | Switch on the mains supply. |
|  | F2 <br> (Thermal motor protection) | PTC connection could be open. Incorrect nominal motor current could be entered in menu [211]. | Check the PTC input if PTC protection is used. <br> If internal thermal motor protection is used, perhaps an other internal thermal protection class could be used (menu [222]). <br> Cool down the motor and restart. |
|  | F3 (Softstarter overheated) | Ambient temperature too high. Softstarter duty cycle exceeded. Could be fan failure. | Check ventilation of cabinet. Check the size of the cabinet. Clean the cooling fins. If the fan(s) is (are) not working correctly, contact your local MSF sales outlet. |
|  | F4 (Current limit start time expired) | Current limit parameters are perhaps not matched to the load and motor. | Increase the start time (menu [315]) and/or the current limit at start (menu [314]). |
|  | F5 <br> (Locked rotor) | Something stuck in the machine or perhaps motor bearing failure. | Check the machine and motor bearings. Perhaps the Locked rotor time can be set longer (menu [229]). |
|  | F6 <br> (Max power alarm) | Overload | Check the machine. <br> Perhaps the Max power alarm response delay can be set longer menu [404]. |
|  | F7 <br> (Mn power alarm) | Underload | Check the machine. Perhaps the Min power alarm response delay can be set longer menu [410]. |
|  | F8 <br> (Voltage unbalance) | Mains supply voltage unbalance. | Check mains supply. |
|  | F9 (Overvoltage) | Mains supply overvoltage. | Check mains supply. |
|  | $\begin{aligned} & \text { F10 } \\ & \text { (Undervoltage) } \end{aligned}$ | Mains supply undervoltage. | Check mains supply. |
|  | F11 <br> (Start limitation) | Number of starts per hour exceeded, min time between starts not kept. | Wait and start again. <br> Perhaps the number of starts per hour could be increased in menu [225] or the min time between starts could be decreased (menu [226]). |
|  | F13 <br> (Open thyristor) | Perhaps a damaged thyristor. | Initiate a reset and a restart. If the same alarm appears immediately, contact your local MSF sales outlet. |
|  | F14 <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> Initiate a restart. If alarm F14 appears immediately, contact your local MSF sales outlet. |


| Observation | Fault indication | Cause | Solution |
| :---: | :---: | :---: | :---: |
| The motor does not run. | F15 <br> (Serial communication contact broken) | Serial communication contact broken. | Initiate a reset and try to establish contact. Check contacts. cables and option board. <br> Verify <br> - Serial communication unit address [270]. <br> - Baudrate menu [271]. <br> - Parity menu [272]. <br> If the fault is not found, run the motor from the control panel if urgent set menu [200] to 1 . See also manual for serial communication. |
|  | F16 <br> (Phase reversal) | Incorrect phase sequence on main supply. | Switch L2 and L3 input phases. |
|  | F17 (External alarm) | External alarm signal input open | Check the digital input configured for External alarm. Check the configuration of the digital inputs (menus [510] to [513]). |
|  |  | Start command comes perhaps from incorrect control source. (I.e. start from control panel when remote control is selected). | Give start command from correct control source menu [200]. |
| The motor is running but an alarm is given. | F1 <br> (Phase input failure) | Failure in one phase. Perhaps fuse is defective. | Check fuses and mains supply. Select a different alarm action for Single phase input failure in menu [230] if stop is desired at single phase loss. |
|  | F4 <br> (Current limit start time expired) | Current limit parameters are perhaps not matched to the load and motor. | Increase the start time (menu [315]) and/or the current limit at start (menu [314]). Select a different action for Current limit start time expired alarm in menu [231], if stop is desired at current limit time-out. |
|  | F12 <br> (Shorted thyristor) | Perhaps a damaged thyristor. | When stop command is given, a freewheel stop is made. Initiate a reset and a restart. If alarm F14 appears immediately, contact your local MSF sales outlet. <br> If the motor must be started urgently, the softstarter can start the motor direct on-line (DOL). Set the start method to DOL in this case (menu $[310]=4$ ). |
|  |  | Bypass contactor is used but menu [340] 'Bypass' is not set to "on". | Set menu [340] Bypass to on. |
|  | F15 <br> (Serial communication contact broken) | Serial communication contact broken. | Initiate a reset and try to establish contact. Check contacts, cables and option board. <br> Verify <br> - Serial communication unit address [270]. <br> - Baudrate menu [271]. <br> - Parity menu [272]. <br> If the fault is not found, run the motor from the control panel if urgent, see also manual for serial communication. |


| Observation | Fault indication | Cause | Solution |
| :---: | :---: | :---: | :---: |
| The motor jerks etc. | When starting, motor reaches full speed but it jerks or vibrates. | If "Torque control" or "Pump control" is selected, it is necessary to input motor data into the system. | Input nominal motor data in menus [210]-[215]. Select the proper torque control alternative in menu [310] (linear or square) according to the load characteristic. <br> Select a correct initial- and end torque at start in menus [311] and [312]. If 'Bypass' is selected, check that the current transformers are correctly connected. |
|  |  | Start time too short. | Increase start time [315]. |
|  |  | If voltage control is used as start method, the initial voltage at start may be too low. Starting voltage incorrectly set. | Adjust initial voltage at start [311]. |
|  |  | Motor too small in relation to rated current of softstarter. | Use a smaller model of the softstarter. |
|  |  | Motor too large in relation to load of softstarter. | Use larger model of softstarter. |
|  |  | Starting voltage not set correctly. | Readjust the start ramp. |
|  |  |  | Select the current limit function. |
|  | Starting or stopping time too long. | Ramp times not set correctly. | Readjust the start and/or stop ramp time. |
|  |  | Motor too large or too small in relation to load. | Change to another motor size. |
| The monitor function does not work. | No alarm or pre-alarm | It is necessary to input nominal motor data for this function. Incorrect alarm margins or normal load. | Input nominal motor data in menus [210]-[215]. Adjust alarm margins and normal load in menus [402] [412]. Use Autoset [411] if needed. If a Bypass contactor is used, check that the current transformers are correctly connected. |
| Unexplainable alarm. | F5, F6, F7, F8, F9, F10 | Alarm delay time is too short. | Adjust the response delay times for the alarms in menus [229], [404], [410], [432]. [435] and [438]. |
| The system seems locked in an alarm. | F2 <br> (Thermal motor protection) | PTC input terminal could be open. Motor could still be too warm. If internal motor protection is used, the cooling in the internal model may take some time. | PTC input terminal should be short circuit if not used. Wait until motor PTC gives an OK (not overheated) signal. Wait until the internal cooling is done. Try to restart after a while. |
|  | F3 <br> (Softstarter overheated) | Ambient temperature to high. Perhaps fan failure. | Check that cables from power part are connected in terminals 71 to 74. MSF-017 to MSF-250 should have a jumper between terminals 71 and 72. Check also that the fan(s) is(are) rotating. |


| Observation | Fault indication | Cause | Solution |
| :---: | :---: | :---: | :---: |
| Parameter will not be accepted. |  | If menu 240, "Parameter set" is set to " 0 ", the system is configured for external control of parameter set. Most parameters are not allowed to be changed in this mode. | Set the menu 240, "Parameter set" to a value between " 1 " - " 4 " and then any parameter can be changed. |
|  |  | During start, stop and slow speed changing parameters is not permitted. | Set parameters during standstill or full voltage running. |
|  |  | If control source is serial comm., it is impossible to change parameters from keyboard and vice versa. | Change parameters from the actual control source. |
|  |  | Some menus include only readout values and not parameters. | Read-out values cannot be altered. In Table 14, read-out menus have 'in the factory setting column. |
|  | -Loc | Control panel is locked for settings. | Unlock control panel by pressing the keys "NEXT" and "ENTER'"for at least 3 sec . |

## 11. Maintenance

In general the softstarter is maintenance-frec. There are however some things which should be checked regularly. In particular, if the surroundings are dusty the unit should be cleaned regularly.

WARNINGI Do not touch parts inside the enclosure of the unit when the control supply voltage or the mains supply voltage is switched on.

### 11.1 Regular maintenance

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


## 12. Options

The following options are available. Please contact your supplier for more derailed information.

### 12.1 Serial communication

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


Fig. 68 Option RS232/485

### 12.2 Fieldbus systems

Various option boards are available for the following bus systems:

- PROFIBUS DP order part number: 01-1734-01
- Device NET, order part number: 01-1736-01

Each system has its own board. The option is delivered with an instruction manual containing all the details for the installation and sec-up of the board and the protocol for programming.


Fig. 69 Profibus Option

### 12.3 External control panel

The external control panel oprion is used to move the control panel from the softstarter to the front of a panel door or control cabinet.

The maximum distance berween the softstarter and the external control panel is 3 m .

The part number to order for the external control panel is $01-2138-00$. A separate data sheet for this option is available.


Fig. 70 Use of the external control panel.

### 12.3.1 Cable kit for external current transformers

This kit is used for the bypass function, to connect the current transformers externally. order patt number: 01-202000.


Fig. 71 Cable kit

### 12.4 Terminal clamp

| Data: Single cables, Cu or Al |  |
| :--- | :--- |
| Cables | $95-300 \mathrm{~mm}^{2}$ |
| MSF type Cu Cable | 310 |
| Bolt for connection to busbar | M 10 |
| Dimensions in mm | $33 \times 84 \times 47 \mathrm{~mm}$ |
| Part no. single | 9350 |
| Data: Parallel cables, Cu or Al |  |
| Cables | $2 \times 95-300 \mathrm{~mm}^{2}$ |
| MSF type and Cu Cable | 310 to 835 |
| Bolt for connection to busbar | M 10 |
| Dimensions in mm | $35 \times 87 \times 65$ |
| Part no. parallel | 9351 |



Fig. 72 The terminal clamp.

## 13. Technical data

### 13.1 Electrical specifications

Table 17 Typical motor power at mains voltage 400 V

| MSF model | $\begin{gathered} \text { Heavy } \\ \text { AC-53a 5.0-30:50-10 } \end{gathered}$ |  | $\begin{gathered} \text { Normal } \\ \text { AC-53a 3.0-30:50-10 } \end{gathered}$ |  | Normal with bypass AC-53b 3.0-30:300 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Power @400V [kW] | Rated current [A] | Power @400V [kW] | Rated current <br> [A] | Power @400V [kW] | Rated current <br> [A] |
| MSF-017 | 7.5 | 17 | 11 | 22 | 11 | 25 |
| -030 | 15 | 30 | 18.5 | 37 | 22 | 45 |
| -045 | 22 | 45 | 30 | 60 | 37 | 67 |
| -060 | 30 | 60 | 37 | 72 | 45 | 85 |
| -075 | 37 | 75 | 45 | 85 | 55 | 103 |
| -085 | 45 | 85 | 45 | 96 | 55 | 120 |
| -110 | 55 | 110 | 75 | 134 | 90 | 165 |
| -145 | 75 | 145 | 75 | 156 | 110 | 210 |
| -170 | 90 | 170 | 110 | 210 | 132 | 255 |
| -210 | 110 | 210 | 132 | 250 | 160 | 300 |
| -250 | 132 | 250 | 132 | 262 | 200 | 360 |
| -310 | 160 | 310 | 200 | 370 | 250 | 450 |
| -370 | 200 | 370 | 250 | 450 | 315 | 555 |
| -450 | 250 | 450 | 315 | 549 | 355 | 675 |
| -570 | 315 | 570 | 400 | 710 | 450 | 820 |
| -710 | 400 | 710 | 450 | 835 | 500 | 945 |
| -835 | 450 | 835 | 500 | 960 | 630 | 1125 |
| -1000 | 560 | 1000 | 630 | 1125 | 800 | 1400 |
| -1400 | 800 | 1400 | 900 | 1650 | 1000 | 1800 |

Table 18 Typical motor power at mains voltage 460 V

| MSF model | $\begin{gathered} \text { Heavy } \\ \text { AC-53a 5.0-30:50-10 } \end{gathered}$ |  | $\begin{gathered} \text { Normal } \\ \text { AC-53a 3.0-30:50-10 } \end{gathered}$ |  | Normal with bypass AC-53b 3.0-30:300 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Power @460V [hp] | Rated current <br> [A] | Power @460V [hp] | Rated current <br> [A] | Power @460V [hp] | Rated current [A] |
| MSF-017 | 10 | 17 | 15 | 22 | 20 | 25 |
| -030 | 20 | 30 | 25 | 37 | 30 | 45 |
| -045 | 30 | 45 | 40 | 60 | 50 | 68 |
| -060 | 40 | 60 | 50 | 72 | 60 | 85 |
| -075 | 60 | 75 | 60 | 85 | 75 | 103 |
| -085 | 60 | 85 | 75 | 96 | 100 | 120 |
| -110 | 75 | 110 | 100 | 134 | 125 | 165 |
| -145 | 100 | 145 | 125 | 156 | 150 | 210 |
| -170 | 125 | 170 | 150 | 210 | 200 | 255 |
| -210 | 150 | 210 | 200 | 250 | 250 | 300 |
| -250 | 200 | 250 | 200 | 262 | 300 | 360 |
| -310 | 250 | 310 | 300 | 370 | 350 | 450 |
| -370 | 300 | 370 | 350 | 450 | 450 | 555 |
| -450 | 350 | 450 | 450 | 549 | 500 | 675 |
| -570 | 500 | 570 | 600 | 710 | 650 | 820 |
| -710 | 600 | 710 | 700 | 835 | 800 | 945 |
| -835 | 700 | 835 | 800 | 960 | 900 | 1125 |
| -1000 | 800 | 1000 | 900 | 1125 | 1000 | 1400 |
| -1400 | 1000 | 1400 | 1250 | 1650 | 1500 | 1800 |

Table 19 Typical motor power at mnins voltage 525 V

| MSF model | $\begin{gathered} \text { Heavy } \\ \text { AC-53a 5.0-30:50-10 } \end{gathered}$ |  | $\begin{gathered} \text { Normal } \\ \text { AC-53a 3.0-30:50-10 } \end{gathered}$ |  | Normal with bypass AC-53b 3.0-30:300 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Power @525v [kW] | Rated current [A] | Power ©525V [kW] | Rated current <br> [A] | Power @ 525V [kW] | Rated current <br> [A] |
| MSF-017 | 11 | 17 | 15 | 22 | 15 | 25 |
| -030 | 18.5 | 30 | 22 | 37 | 30 | 45 |
| -045 | 30 | 45 | 37 | 60 | 45 | 68 |
| -060 | 37 | 60 | 45 | 72 | 55 | 85 |
| -075 | 45 | 75 | 55 | 85 | 75 | 103 |
| -085 | 55 | 85 | 55 | 96 | 75 | 120 |
| -110 | 75 | 110 | 90 | 134 | 110 | 165 |
| -145 | 90 | 145 | 110 | 156 | 132 | 210 |
| -170 | 110 | 170 | 132 | 210 | 160 | 255 |
| -210 | 132 | 210 | 160 | 250 | 200 | 300 |
| -250 | 160 | 250 | 160 | 262 | 250 | 360 |
| -310 | 200 | 310 | 250 | 370 | 315 | 450 |
| -370 | 250 | 370 | 315 | 450 | 355 | 555 |
| -450 | 315 | 450 | 400 | 549 | 450 | 675 |
| -570 | 400 | 570 | 500 | 710 | 560 | 820 |
| -710 | 500 | 710 | 560 | 835 | 630 | 945 |
| -835 | 560 | 835 | 710 | 960 | 800 | 1125 |
| -1000 | 710 | 1000 | 800 | 1125 | 1000 | 1400 |
| -1400 | 1000 | 1400 | 1250 | 1650 | 1400 | 1800 |

Table 20 Typical motor power at mains voltage 575 V

| MSF model | $\begin{gathered} \text { Heavy } \\ \text { AC-53a 5.0-30:50-10 } \end{gathered}$ |  | $\begin{gathered} \text { Normal } \\ \text { AC-53a 3.0-30:50-10 } \end{gathered}$ |  | Normal with bypass AC-53b 3.0-30:300 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Power @575V [hp] | Rated current <br> [A] | Power @575V [hp] | Rated current <br> [A] | Power @575V [hp] | Rated current <br> [A] |
| MSF-017 | 15 | 17 | 20 | 22 | 25 | 25 |
| -030 | 25 | 30 | 30 | 37 | 40 | 45 |
| -045 | 40 | 45 | 50 | 60 | 60 | 68 |
| -060 | 50 | 60 | 60 | 72 | 75 | 85 |
| -075 | 75 | 75 | 75 | 85 | 100 | 103 |
| -085 | 75 | 85 | 75 | 90 | 125 | 120 |
| -110 | 100 | 110 | 125 | 134 | 150 | 165 |
| -145 | 150 | 145 | 150 | 156 | 200 | 210 |
| -170 | 150 | 170 | 200 | 210 | 250 | 255 |
| -210 | 200 | 210 | 250 | 250 | 300 | 300 |
| -250 | 250 | 250 | 250 | 262 | 350 | 360 |
| -310 | 300 | 310 | 400 | 370 | 450 | 450 |
| -370 | 400 | 370 | 500 | 450 | 600 | 555 |
| -450 | 500 | 450 | 600 | 549 | 700 | 675 |
| -570 | 600 | 570 | 700 | 640 | 800 | 820 |
| -710 | 700 | 710 | 800 | 835 | 1000 | 945 |
| -835 | 800 | 835 | 900 | 880 | 1250 | 1125 |
| -1000 | 1000 | 1000 | 1250 | 1125 | 1500 | 1400 |
| -1400 | 1500 | 1400 | 1500 | 1524 | 2000 | 1800 |

Table 21 Typical motor power at mains voltage 690 V

| MSF model | $\begin{gathered} \text { Heavy } \\ \text { AC-53a 5.0-30:50-10 } \end{gathered}$ |  | $\begin{gathered} \text { Normal } \\ \text { AC-53a 3.0-30:50-10 } \end{gathered}$ |  | Normal with bypass AC-53b 3.0-30:300 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Power @690V [kW] | Rated current [A] | Power @690V [kW] | Rated current [A] | Power @690V [kW] | Rated current [A] |
| MSF-017 | 15 | 17 | 18,5 | 22 | 22 | 25 |
| -030 | 22 | 30 | 30 | 37 | 37 | 45 |
| -045 | 37 | 45 | 55 | 60 | 55 | 68 |
| -060 | 55 | 60 | 55 | 72 | 75 | 85 |
| -075 | 55 | 75 | 75 | 85 | 90 | 103 |
| -085 | 75 | 85 | 90 | 90 | 110 | 120 |
| -110 | 90 | 110 | 110 | 134 | 160 | 165 |
| -145 | 132 | 145 | 132 | 156 | 200 | 210 |
| -170 | 160 | 170 | 200 | 210 | 250 | 255 |
| -210 | 200 | 210 | 250 | 250 | 250 | 300 |
| -250 | 250 | 250 | 250 | 262 | 355 | 360 |
| -310 | 315 | 310 | 355 | 370 | 400 | 450 |
| -370 | 355 | 370 | 400 | 450 | 500 | 555 |
| -450 | 400 | 450 | 560 | 549 | 630 | 675 |
| -570 | 560 | 570 | 630 | 640 | 800 | 820 |
| -710 | 710 | 710 | 800 | 835 | 900 | 945 |
| -835 | 800 | 835 | 900 | 880 | 1120 | 1125 |
| -1000 | 1000 | 1000 | 1120 | 1125 | 1400 | 1400 |
| -1400 | 1400 | 1400 | 1600 | 1524 | 1800 | 1800 |

### 13.2 General electrical specifications

## Table 22 General electrical specifications

| Parameter | Description |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |

## General

| Mains supply voltage | $200-525 \mathrm{~V} \pm 10 \%$ <br> $200-690 \mathrm{~V}+5 \% .-10 \%$ |
| :--- | :--- |
| Control supply voltage | $100-240 \mathrm{~V} \pm 10 \%$ |
| $380-500 \mathrm{~V} \pm 10 \%$ |  |

Control signal inputs

| Digital input voltage | $0-3 \mathrm{~V} \rightarrow 0,8-27 \mathrm{~V} \rightarrow 1$. Max 37 V for 10 sec. |
| :--- | :--- |
| Digital input impedance to GND $(0 \mathrm{VDC})$ | $2.2 \mathrm{k} \Omega$ |
| Analoueg input voltage/Current | $0-10 \mathrm{~V}, 2-10 \mathrm{~V}, 0-20 \mathrm{~mA}, 4-20 \mathrm{~mA}$ |
| Analoueg input impedance to GND ( 0 VDC ) | Voltage signal $125 \mathrm{k} \Omega$, current signal $100 \Omega$ |

Control signal outputs

| Output relays contact | $8 \mathrm{~A}, 250 \mathrm{VAC}$ or 24 VDC resistive load; $3 \mathrm{~A}, 250 \mathrm{VAC}$ inductive load (PF 0.4) |
| :--- | :--- |
| Analogue output voltage/current | $0-10 \mathrm{~V}, 2-10 \mathrm{~V}, 0-20 \mathrm{~mA}, 4-20 \mathrm{~mA}$ |
| Analogue output load impedance | Voltage signal min load $700 \Omega$, current signal max load $750 \Omega$ |

Control signal supply

| +12 VDC | $+12 \mathrm{VDC} \pm 5 \%$. Max current 50 mA. Short circuit proof. |
| :--- | :--- |

### 13.3 Fuses and power losses

Table 23 Fuses, power losses

| Model | Recommended wiring fuses [A] First column Ramp start/second column Direct-on-line start |  | Power loss at rated motor load [W] No losses with bypass |  | Power consumption control card [VA] |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Heavy | Normal | Heavy | Normal |  |
| MSF-017 | 25/50 | 32 | 50 | 70 | 20 |
| -030 | 35/80 | 50 | 90 | 120 | 20 |
| -045 | 50/125 | 80 | 140 | 180 | 25 |
| -060 | 63/160 | 100 | 180 | 215 | 25 |
| -075 | 80/200 | 100 | 230 | 260 | 25 |
| -085 | 100/250 | 125 | 260 | 290 | 25 |
| -110 | 125/315 | 180 | 330 | 400 | 25 |
| -145 | 160/400 | 200 | 440 | 470 | 25 |
| -170 | 200/400 | 200 | 510 | 630 | 35 |
| -210 | 250/400 | 315 | 630 | 750 | 35 |
| -250 | 250/500 | 315 | 750 | 750 | 35 |
| -310 | 315/630 | 400 | 930 | 1100 | 35 |
| -370 | 400/800 | 500 | 1100 | 1535 | 35 |
| -450 | 500/1000 | 630 | 1400 | 1730 | 35 |
| -570 | 630/1000 | 800 | 1700 | 2100 | 35 |
| -710 | 800/1000 | 1000 | 2100 | 2500 | 35 |
| -835 | 1000/1200 | 1000 | 2500 | 2875 | 35 |
| -1000 | 1000/1400 | 1200 | 3000 | 3375 | 35 |
| -1400 | 1400/1800 | 1800 | 4200 | 4950 | 35 |

### 13.4 Mechanical specifications including mechanical drawings

| MSF <br> Model | Dimensions H*W*D [mm] | Mounting position [Vertical/ Horizontal] | Weight [kg] | Connection busbars [mm] | PE screw | Cooling system | Protection class |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| -017, -030 | $320 * 126 * 260$ | Vertical | 6.7 | 15*4, Cu (M6) | M6 | Convection | IP20 |
| $\begin{aligned} & -045,-060,-075 \\ & -085 \end{aligned}$ | 320*126*260 | Vert. or Horiz. | 6.9 | 15*4, Cu (M6) | M6 | Fan | IP20 |
| -110, -145 | 400*176*260 | Vert. or Horiz. | 12 | 20*4, Cu (M10) | M8 | Fan | IP20 |
| -170, -210, -250 | $500 * 260 * 260$ | Vert. or Horiz. | 20 | 30*4, Cu (M10) | M8 | Fan | IP20 |
| -310, -370, -450 | 532*547*278 | Vert. or Horiz | 46 | 40*8, Al (M12) | M8 | Fan | IP20 |
| -570, -710, -835 | 687*640*302 | Vert. or Horiz | 80 | 40*10, Al (M12) | M8 | Fan | IP20 |
| -1000, -1400 | 900*875*336 | Vert. or Horiz | 175 | 75*10, Al (M12) |  | Fan | IPOO |




Fig. 73 MSF-310 to MSF-835.

### 13.5 Derating at higher temperature

By derating the current to $80 \%$ of nominal current, the MSF can be operated at an ambient temperature of up to $50^{\circ} \mathrm{C}$. E.g. a MSF-045 can operate a heavy load of 36 A ( 45 $\mathrm{A}^{*} 0.8$ ).

### 13.6 Environmental conditions

| Normal operation |  |
| :--- | :--- |
| Temperature | $0-40^{\circ} \mathrm{C}$ |
| Relative humidity | $95 \%$, non-condensing |
| Max altitude without derating | 1000 m |
| Storage |  |
| Temperature | $-25-+70^{\circ} \mathrm{C}$ |
| Relative humidity | $95 \%$, non-condensing |

### 13.7 Standards

| Market | Standard | Description |
| :--- | :--- | :--- |
|  | IEC 60947-1 | Low-voltage switch gear and control gear. General part. |
|  | IEC 60947-4-2 | AC semiconductors motor controller and starters |
|  | EN 60204-1 | Safety of machinery - Electrical equipment of machines |
| European | Machinery Directive | $89 / 392 / E C C$, Amendment 98/37/ECC |
|  | EMC Directive | $89 / 336 / E C C$, Amendment 91/263/ECC, 93/68/ECC |
|  | Low Voltage Directive | $73 / 23 / E C C$, Amendment 93/68/ECC |
| Russian | GOST R | Russia certificate of conformity |
| American | UL 508 | Outline of investigation for power conversion equipment. <br> Only models MSF-017 to MSF-250 up to 600 VAC |

### 13.8 Power- and signal connectors.

Table 24 PCB Terminals

| Terminal | Function | Electrical characteristics |
| :---: | :---: | :---: |
| 01 | Control supply voltage | 100-240 VAC $\pm 10 \%$ alternative |
| 02 |  | $380-500 \mathrm{VAC} \pm 10 \%$ see rating plate |
| PE | Protective Earth | $\underline{1}$ |
|  |  |  |
| 11 | Digital input 1 | $\begin{aligned} & 0-3 \mathrm{~V} \rightarrow 0 ; 8-27 \mathrm{~V}->1 . \\ & \text { Max. } 37 \mathrm{~V} \text { for } 10 \mathrm{sec} \text {. Impedance to } 0 \mathrm{VDC}: 2.2 \mathrm{k} \Omega . \end{aligned}$ |
| 12 | Digital input 2 |  |
| 13 | Control signal supply 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 but not overload-roof. |
| 14 | Analogue input, 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 input 3 | $0-3 \vee \rightarrow 0 ; 8-27 \vee->1 .$ <br> Max. 37 V for 10 sec . Impedance to $0 \mathrm{VDC}: 2.2 \mathrm{k} \Omega$. |
| 17 | Digital input 4 |  |
| 18 | Control signal supply voltage to PCB terminal 16 and 17, $10 \mathrm{k} \Omega$ potentiometer, etc. | $+12 \mathrm{VDC} \pm 5 \%$. Max. current from $+12 \mathrm{VDC}=50 \mathrm{~mA}$. Short circuit-proof but not overload-proof. |
| 19 | Analogue output | Analogue output contact: <br> $0-10 \mathrm{~V}, 2-10 \mathrm{~V}$; min load impedance $700 \Omega$ <br> $0-20 \mathrm{~mA}$ and $4-20 \mathrm{~mA}$; max load impedance $750 \Omega$ |
|  |  |  |
| 21 | Programmable relay K1. Factory setting is "Operation" with indication by closing terminal 21 to 22. | 1-pole closing contact, 250 VAC 8 A or 24 VDC 8 A resistive, $250 \mathrm{VAC}, 3$ A inductive. |
| 22 |  |  |
| 23 | Programmable relay K2. Factory setting is "Full voltage" with indication by closing terminals 23 to 24 . | 1-pole closing contact, 250 VAC 8 A or 24 VDC 8 A resistive, $250 \mathrm{VAC}, 3$ A inductive. |
| 24 |  |  |
|  |  |  |
| 31 | Programmable relay K3. Factory setting is "All alarms". Indication by closing terminals 31 to 33 and opening terminals 32 to 33 . | 1-pole change-over contact, 250 VAC 8 A or 24 VDC 8 A resistive, $250 \mathrm{VAC}, 3 \mathrm{~A}$ inductive. |
| 32 |  |  |
| 33 |  |  |
|  |  |  |
| 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 softstarter cooling fan temperature MSF-310-MSF-1400 |
| 73-74* | NTC thermistor | Temperature measuring of softstarter cooling fin |
| 75 | Current transformer input, cable S1 (blue) | Connection of L1 or T1 phase current transformer |
| 76 | Current transformer input, cable S1 (blue) | Connection of L3, T3 phase (MSF 017 to MSF 250) or L2, T2 phase (MSF 310 to MSF 1400) |
| 77 | Current transformer input, cable S2 (brown) | Common connection for terminals 75 and 76 |
| 78* | Fan connection | 24 VDC |
| 79* | Fan connection | O VDC |

*Internal connection, no customer use.

### 13.9 Semi-conductor fuses

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

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

| Type | FWP Bussmann fuse |  |
| :--- | :--- | :--- |
| A | $\mathbf{I}^{\mathbf{t}}$ (fuse) $\times \mathbf{1 0 0 0}$ |  |
| MSF-017 | 80 | 2.4 |
| MSF-030 | 125 | 7.3 |
| MSF-045 | 150 | 11.7 |
| MSF-060 | 200 | 22 |
| MSF-075 | 250 | 42.5 |
| MSF-085 | 300 | 71.2 |
| MSF-110 | 350 | 95.6 |
| MSF-145 | 450 | 137 |
| MSF-170 | 700 | 300 |
| MSF-210 | 700 | 300 |
| MSF-250 | 800 | 450 |

NOTE: Short circult withstand MSF017-MSF060 5000 rms A when used with K5 or RK5 fuses.

NOTE: Short circuit withstand MSF075-MSF145 10000 rms A when used with K5 or RK5 fuses.

NOTE! Short circult withstand MSF170-250 18000 rms A when used with K5 or RK5 fuses.

## 14. Set-up menu list

| Menu | Function/Parameter | Range | Parameter alt. <br> Alarm codes | Param. <br> set | Factory <br> setting | Value | Page |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |


|  | General settings |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 100 | Current | $0.0-9999$ A |  | -- | - |  | page 44 |
| 101 | Automatic return menu | oFF, 1-999 |  | - | oFF |  | page 44 |
|  |  |  |  |  |  |  |  |
| 200 | Control source | $1,2,3$ | 1. Control panel <br> 2. Remote control <br> 3. Serial comm. | $1-4$ | 2 |  | page 44 |
| 201 | Control panel locked for settings | no, YES |  | - | - |  | page 44 |
| 202 | Enable US units | oFF, on |  | - | oFF | page 45 |  |


|  | Motor data |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :---: | :---: | :---: | :---: |
| 210 | Nominal motor voltage | $200-700 \mathrm{~V}$ |  | $1-4$ | 400 |  | page 45 |
| 211 | Nominal motor current | $25-200 \%$ of $\mathrm{I}_{\text {noft }}$ in A |  | $1-4$ | $\mathrm{I}_{\text {nsoft }}$ |  | page 45 |
| 212 | Nominal motor power | $25-400 \%$ of $\mathrm{P}_{\text {nsoft }}$ in <br> kW resp. hp |  | $1-4$ | $\mathrm{P}_{\text {nsoft }}$ |  | page 45 |
| 213 | Nominal speed | $500-3600 \mathrm{rpm}$ |  | $1-4$ | $N_{\text {nsoft }}$ |  | page 45 |
| 214 | Nominal power factor | $0.50-1.00$ |  | $1-4$ | 0.86 |  | page 45 |
| 215 | Nominal frequency | $50,60 \mathrm{~Hz}$ |  | - | 50 | page 45 |  |


|  | Motor protection |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | THERMAL MOTOR PROTECTION |  |  |  |  |  |
| 220 | Thermal motor protection | oFF, 1, 2, 3, 4 | oFF <br> 1. Warning <br> 2. Coast <br> 3. Stop <br> 4. Brake | 1-4 | 2 | page 46 |
| 221 | PTC input | oFF, on |  | 1-4 | OFF | page 47 |
| 222 | Internal protection class | OFF, 2-40 s |  | 1-4 | 10 | page 47 |
| 223 | Used thermal capacity | 0-150\% |  | - | - | page 47 |
|  | START LIMITATION |  |  |  |  |  |
| 224 | Start limitation | oFF, 1, 2 | oFF <br> 1. Warning <br> 2. Coast | 1-4 | oFF | page 48 |
| 225 | Number of starts per hour | oFF, 1-99 |  | 1-4 | oFF | page 49 |
| 226 | Min time between starts | OFF, 1-60 min |  | 1-4 | OFF | page 49 |
| 227 | Time to next allowed start | 0-60 min |  | - | - | page 49 |
|  | LOCKED ROTOR |  |  |  |  |  |
| 228 | Locked rotor alarm | oFF, 1, 2 | oFF <br> 1. Warning <br> 2. Coast | 1-4 | oFF | page 49 |
| 229 | Locked rotor time | 1,0-10,0 s |  | 1-4 | 5.0 s | page 49 |
|  | SINGLE PHASE INPUT FAILURE |  |  |  |  |  |
| 230 | Single phase input failure | 1, 2 | 1. Warning <br> 2. Coast | 1-4 | 2 | page 50 |
|  | CURRENT LIMIT START TIME EXPIRED |  |  |  |  |  |


| Menu | Function/Parameter | Range | Parameter alt. <br> Alarm codes | Param. <br> set | Factory <br> setting | Value | Page |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 231 | Current limit start time expired | oFF, 1, 2,3,4 | OFF <br> 1. Warning <br> 2. Coast <br> 3. Stop <br> 4. Brake | $1-4$ | 2 |  | page 50 |


|  | Parameter set handling |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 240 | Select parameter set | 0, 1, 2, 3, 4 | 0-External control of parameter set 1-4 - Parameter set 1-4 | - | 1 | page 51 |
| 241 | Actual parameter set | 1, 2, 3, 4 |  | $\cdots$ | - | page 51 |
| 242 | Copy parameter set | $\begin{aligned} & \text { no, P1-2, P1-3, P1-4, } \\ & \text { P2-1, P2-3, P2-4, P3- } \\ & \text { 1, P3-2, P3-4, P4-1, } \\ & \text { P4-2, P4-3 } \end{aligned}$ | no - no action P1-2 - Copy parameter set 1 to parameter set 2 etc. | - | no | page 51 |
| 243 | Reset to factory settings | no, YES |  | - | no | page 52 |


|  | Autoreset |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 250 | Autoreset attempts | oFF, 0-10 |  | 1-4 | oFF |  | page 52 |
| 251 | Thermal motor protection autoreset | oFF, 0-3600 s |  | 1-4 | oFF |  | page 53 |
| 252 | Start limitation autoreset | OFF, 0-3600 s |  | 1-4 | OFF |  | page 53 |
| 253 | Locked rotor alarm autoreset | oFF, 0-3600 s |  | 1.4 | oFF |  | page 53 |
| 254 | Current limit start time expired autoreset | oFF, 0-3600 s |  | 1-4 | oFF |  | page 53 |
| 255 | Max power alarm autoreset | oFF, 0-3600 s |  | 1-4 | OFF |  | page 53 |
| 256 | Min power alarm autoreset | oFF, 0-3600 s |  | $1-4$ | oFF |  | page 53 |
| 257 | External alarm autoreset | OFF, 0-3600 s |  | 1.4 | oFF |  | page 53 |
| 258 | Phase input failure autoreset | oFF, 0-3600 s |  | 1-4 | oFF |  | page 53 |
| 259 | Voltage unbalance alarm autoreset | oFF, 0-3600 s |  | 1-4 | oFF |  | page 53 |
| 260 | Overvoltage alarm autoreset | OFF, 0-3600 s |  | 1.4 | OFF |  | page 53 |
| 261 | Undervoltage alarm autoreset | OFF, 0-3600 s |  | $1-4$ | OFF |  | page 53 |
| 262 | Serial communication autoreset | oFF, 0-3600 s |  | $1-4$ | OFF |  | page 53 |
| 263 | Softstarter overheated autoreset | oFF, 0-3600 s |  | $1-4$ | oFF |  | page 53 |


|  | Serial communication |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 270 | Serial comm. unit address | 1-247 |  | - | 1 | page 54 |
| 271 | Serial comm. baudrate | 2.4-38.4 kBaud |  | - | 9.6 | page 55 |
| 272 | Serial comm. parity | 0, 1 | 0. No parity <br> 1. Even parity | - | 0 | page 55 |
| 273 | Serial comm, contact broken | oFF, 1, 2, 3, 4 | oFF <br> 1. Warning <br> 2. Coast <br> 3. Stop <br> 4. Brake | m | 3 | page 55 |


|  | Operation settings |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  | PRE-SETTING |  |  |  |  |  |  |
| 300 | Preset pump control parameters | no, yes |  | - | no |  | page 55 |
|  | START |  |  |  |  |  |  |


| Menu | Function/Parameter | Range | Parameter alt. <br> Alarm codes | Param. <br> set | Factory <br> setting | Value | Page |
| :--- | :--- | :--- | :--- | :---: | :---: | :---: | :---: |
| 310 | Start method | $1,2,3,4$ | 1. Linear torque control <br> 2. Square torque control <br> 3. <br> Voltage control | $1-4$ | 1 |  | page 57 |
| 311 | Initial torque at start | $0-250 \%$ of $\mathrm{T}_{\mathrm{n}}$ |  | $1-4$ | 10 |  | page 58 |
| 312 | End torque at start | $25-250 \%$ of $\mathrm{T}_{\mathrm{n}}$ |  | $1-4$ | 150 |  | page 58 |
| 313 | Initial voltage at start | $25-80 \%$ of $U$ |  | $1-4$ | 30 |  | page 58 |
| 314 | Current limit at start | off, $150-500 \%$ of $\mathrm{I}_{\mathrm{n}}$ |  | $1-4$ | ofF | page 59 |  |


| 315 | Start time | 1.60 s |  | 1-4 | 10 | page 59 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 316 | Torque boost current limit | off, $300-700 \%$ of $\mathrm{I}_{n}$ |  | 1-4 | oFF | page 60 |
| 317 | Torque boost active time | $0.1-2.0 \mathrm{~s}$ |  | 1-4 | 1.0 | page 60 |
|  | STOP |  |  |  |  |  |
| 320 | Stop method | 1, 2, 3, 4, 5 | 1. Linear torque control <br> 2. Square torque control <br> 3. Voltage control <br> 4. Coast <br> 5. Brake | 1-4 | 4 | page 60 |
| 321 | End torque at stop | 0-100\% of $\mathrm{T}_{\mathrm{n}}$ |  | 1-4 | 0 | page 61 |
| 322 | Step down voltage at stop | 100-40\% of U |  | 1-4 | 100 | page 61 |
| 323 | Braking method | 1, 2 | 1. Dynamic vector brake <br> 2. Reverse current brake | - | 1 | page 62 |
| 324 | Braking strength | 150-500\% |  | 1-4 | 150 | page 62 |
| 325 | Stop time | 1-120 s |  | 1-4 | 10 | page 63 |
| 326 | Alarm braking strength | oFF, 150-500\% |  | 1-4 | oFF | page 63 |
| 327 | Alarm braking time | $1-120 \mathrm{~s}$ |  | 1-4 | 10 | page 63 |
|  | SLOW SPEED / JOG |  |  |  |  |  |
| 330 | Slow speed strength | 10-100 |  | 1-4 | 10 | page 65 |
| 331 | Slow speed time at start | oFF, 1-60 s |  | 1-4 | oFF | page 65 |
| 332 | Slow speed time at stop | oFF, 1-60 s |  | 1-4 | oFF | page 66 |
| 333 | DC brake at slow speed | oFF, 1-60 s |  | 1-4 | oFF | page 66 |
| 334 | Jog forward enable | oFF, on |  | 1-4 | oFF | page 66 |
| 335 | Jog reverse enable | ofF, on |  | 1-4 | oFF | page 66 |
|  | ADDITIONAL SETTINGS |  |  |  |  |  |
| 340 | Bypass | oFF, on |  | 1-4 | oFF | page 67 |
| 341 | Power Factor Control (PFC) | oFF, on |  | 1-4 | oFF | page 69 |
| 342 | Fan continuously on | oFF, on |  | 1-4 | oFF | page 69 |


|  | Process protection |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | LOAD MONITOR |  |  |  |  |  |
| 400 | Max power alarm | oFF, 1, 2, 3, 4 | oFF <br> 1. Warning <br> 2. Coast <br> 3. Stop <br> 4. Brake | 1-4 | oFF | page 71 |
| 401 | Min power alarm | oFF, 1, 2, 3, 4 | ofF <br> 1. Warning <br> 2. Coast <br> 3. Stop <br> 4. Brake | 1-4 | oFF | page 71 |
| 402 | Start delay power alarms | $1-999 \mathrm{~s}$ |  | 1-4 | 10 | page 71 |


| Menu | Function/Parameter | Range | Parameter alt. Alarm codes | Param. set | Factory setting | Value | Page |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 403 | Max power alarm margin | 0-100\% of $\mathrm{P}_{\mathrm{n}}$ |  | 1-4 | 16 |  | page 71 |
| 404 | Max power alarm response delay | $0.1-90.0 \mathrm{~s}$ |  | 1-4 | 0.5 |  | page 71 |
| 405 | Max power pre-alarm margin | 0-100\% of $P_{n}$ |  | 1-4 | 8 |  | page 72 |
| 406 | Max power pre-alarm response delay | $0.1-90.0 \mathrm{~s}$ |  | 1-4 | 0.5 |  | page 72 |
| 407 | Min power pre-alarm margin | 0-100\% of $P_{n}$ |  | 1-4 | 8 |  | page 72 |
| 408 | Min power pre-alarm response delay | $0.1-90.0 \mathrm{~s}$ |  | 1-4 | 0.5 |  | page 72 |
| 409 | Min power alarm margin | 0-100\% of $P_{n}$ |  | 1-4 | 16 |  | page 72 |
| 410 | Min power alarm response delay | $0.1-90.0 \mathrm{~s}$ |  | 1-4 | 0.5 |  | page 73 |


| 411 | Autoset power limits | no, YES |  | -- | no | page 73 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 412 | Normal load | 0-200\% of $\mathrm{P}_{\mathrm{n}}$ |  | 1-4 | 100 | page 73 |
| 413 | Output shaft power | 0.0-200.0\% of $\mathrm{P}_{\mathrm{n}}$ |  | - | - | page 73 |
|  | EXTERNAL ALARM |  |  |  |  |  |
| 420 | External alarm | oFF, 1, 2, 3, 4, 5 | oFF <br> 1. Warning <br> 2. Coast <br> 3. Stop <br> 4. Brake <br> 5. Spinbrake | 1-4 | oFF | page 73 |
|  | MAINS PROTECTION |  |  |  |  |  |
| 430 | Voltage unbalance alarm | oFF, 1, 2, 3, 4 | oFF <br> 1. Warning <br> 2. Coast <br> 3. Stop <br> 4. Brake | $1-4$ | oFF | page 74 |
| 431 | Voltage unbalance level | $2-25 \%$ of $U_{n}$ |  | $1-4$ | 10 | page 75 |
| 432 | Response delay voltage unbalance alarm | $1-90 \mathrm{~s}$ |  | $1-4$ | 1 | page 75 |
| 433 | Overvoltage alarm | oFF, 1, 2, 3, 4 | oFF <br> 1. Warning <br> 2. Coast <br> 3. Stop <br> 4. Brake | 1-4 | oFF | page 75 |
| 434 | Overvoltage level | 100-150\% of $U_{n}$ |  | 1-4 | 115 | page 75 |
| 435 | Response delay overvoltage alarm | 1.90 s |  | 1-4 | 1 | page 75 |
| 436 | Undervoltage alarm | oFF, 1, 2, 3, 4 | oFF <br> 1. Warning <br> 2. Coast <br> 3. Stop <br> 4. Brake | 1-4 | OFF | page 75 |
| 437 | Undervoltage leve! | 75-100\% of $U_{n}$ |  | 1.4 | 85 | page 76 |
| 438 | Response delay undervoltage alarm | $1-90 \mathrm{~s}$ |  | $1-4$ | 1 | page 76 |
| 439 | Phase sequence | L123, L321 |  | - | - | page 76 |
| 440 | Phase reversal alarm | oFF, 1, 2 | oFF <br> 1. Warning <br> 2. Coast | -- | oFF | page 76 |


|  | I/O settings |  |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  | INPUT SIGNALS |  |  |  |  |  |  |


| Menu | Function/Parameter | Range | Parameter alt. Alarm codes | Param set | Factory setting | Value | Page |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 500 | Digital/analogue input | ofF, 1, 2, 3, 4, 5, 6, 7 | off <br> 1. Digital, Rotation sensor <br> 2. Digital, Slow speed <br> 3. Digital, Jog fwd <br> 4. Digital, Jog rev <br> 5. Digital, Autoset <br> 6. Analogue start-stop, <br> $0-10 \mathrm{~V} / 0-20 \mathrm{~mA}$ <br> 7. Analogue start-stop, <br> 2-10V/4-20 mA | 1-4 | oFF |  | page 77 |
| 501 | Digital input pulses | 1-100 |  | 1-4 | 1 |  | page 78 |
| 502 | Analogue start-stop on-value | 0-100\% of signal range |  | 1-4 | 25 |  | page 79 |
| 503 | Analogue start-stop off-value | $0-100 \%$ of signal range |  | 1-4 | 75 |  | page 80 |
| 504 | Analogue start-stop delay time | 1-999 s |  | 1-4 | 1 |  | page 80 |


| 510 | Digital input 1 function | oFF, 1, 2, 3, 4, 5, 6, 7 | oFF <br> 1. Start signal <br> 2. Stop signal <br> 3. Parameter set input 1 <br> 4. Parameter set input 2 <br> 5. External alarm signal <br> 6. Start R signal <br> 7. Start L signal | - | 1 | page 81 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 511 | Digital input 2 function | OFF, 1, 2, 3, 4, 5, 6, 7 | See 510 | -- | 2 | page 81 |
| 512 | Digital input 3 function | OFF, 1, 2, 3, 4, 5, 6, 7 | See 510 | - | 3 | page 82 |
| 513 | Digital input 4 function | oFF, 1, 2, 3, 4, 5, 6, 7 | See 510 | - | 4 | page 82 |
|  | OUTPUT SIGNALS |  |  |  |  |  |
| 520 | Analogue output | oFF, 1, 2, 3, 4 | oFF <br> 1. $0-10 \mathrm{~V} / 0-20 \mathrm{~mA}$ <br> 2. $2-10 \mathrm{~V} / 4-20 \mathrm{~mA}$ <br> 3. $10-0 \mathrm{~V} / 20-0 \mathrm{~mA}$ <br> 4. $10-2 \mathrm{~V} / 20-4 \mathrm{~mA}$ | 1-4 | oFF | page 82 |
| 521 | Analogue output function | 1, 2, 3, 4 | 1. RMS current <br> 2. Line voltage <br> 3. Shaft power <br> 4. Torque | 1-4 | 1 | page 82 |
| 522 | Scaling analogue output, min | $0-500 \%$ of value range |  | 1-4 | 0 | page 83 |
| 523 | Scaling analogue output, max | $0-500 \%$ of value range |  | 1-4 | 100 | page 84 |
|  |  |  |  |  |  |  |


| Menu | Function/Parameter | Range | Parameter alt. Alarm codes | Param. set | Factory setting | Value | Page |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 530 | Relay K1 | off, 1-19 | oFF <br> 1. Operation <br> 2. Full voltage <br> 3. Power pre-alarms <br> 4. Brake <br> 5. Run <br> 6. Run R <br> 7. Run L <br> 8. Operation R <br> 9. Operation L <br> 10. Power alarms <br> 11. Max power alarm <br> 12. Max power pre-alarm <br> 13. Min power alarm <br> 14. Min power pre-alarm <br> 15. All alarms (except <br> power pre-alarms) <br> 16. All alarms (except power alarm and prealarms) <br> 17. External alarm <br> 18. Autoreset expired <br> 19. All alarms which need manual reset | - | 1 |  | page 85 |
| 531 | Relay K2 | off, 1-19 | Same as 530 |  | 2 |  | page 85 |


| 532 | Relay K3 | off, 1-19 | Same as 530 | - | 15 | page 85 |  |
| :--- | :--- | :--- | :--- | :---: | :---: | :---: | :---: |
| 533 | K1 contact function | 1,2 | 1. N.O. <br> 2. N.C. | - | 1 |  | page 85 |
| 534 | K2 contact function | 1,2 | 1. N.O. <br> 2. N.C. | - | 1 | page 86 |  |


|  | View operation |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | OPERATION |  |  |  |  |  |
| 700 | Current | 0.0-9999 A |  | -- | -- | page 91 |
| 701 | Line main voltage | 0.720 V |  | - | - | page 91 |
| 702 | Power factor | 0.00-1.00 |  | - | - | page 91 |
| 703 | Output shaft power | -999-9999 kW |  | - | - | page 91 |
| 704 | Output shaft power in percentage units | 0-200\% of $\mathrm{P}_{\mathrm{n}}$ |  | - | - | page 91 |
| 705 | Shaft torque | -999-9999 Nm |  | - | - | page 91 |
| 706 | Shaft torque in percentage units | $0-250 \%$ of $\mathrm{T}_{n}$ |  | -- | - | page 91 |
| 707 | Softstarter temperature | $\begin{aligned} & \text { low, } 30-96^{\circ} \mathrm{C} \\ & \text { low, } 85-204^{\circ} \mathrm{F} \end{aligned}$ |  | - | -- | page 92 |
| 708 | Current phase L1 | 0.0-9999 A |  | -- | - | page 92 |
| 709 | Current phase L2 | 0.0-9999 A |  | - | - | page 92 |
| 710 | Current phase L3 | $0.0-9999 \mathrm{~A}$ |  | - | - | page 92 |
| 711 | Line main voltage L1-L2 | $0-720 \mathrm{~V}$ |  | - | - | page 92 |
| 712 | Line main voltage L1-L3 | 0.720 V |  | - | - | page 92 |
| 713 | Line main voltage L2-L3 | $0-720 \mathrm{~V}$ |  | -- | - | page 92 |
| 714 | Phase sequence | L--, L123, L321 |  | - | - | page 92 |
| 715 | Used thermal capacity | 0-150\% |  | -- | - | page 92 |
| 716 | Time to next allowed start | 0-60 min |  | - | - | page 92 |


| Menu | Function/Parameter | Range | Parameter alt. <br> Alarm codes | Param. <br> set | Factory <br> setting | Value |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | Page


|  | STORED VALUES |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 730 | Operation time | $0-9999999 \mathrm{~h}$ |  | - | - |  |
| 731 | Energy consumption | $0.000-2000 \mathrm{MWh}$ |  | - | - | page 94 |
| 732 | Reset energy consumption | no, YES |  | - | no |  |


|  | Alarm list |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 800 | Alarm list, latest error | F1-F17, h |  | - | - |  | page 94 |
| 801 | Alarm list, error 14 | F1-F17, h |  | - | - |  | page 94 |
| 802 | Alarm list, error 13 | F1-F17, h |  | - | - |  | page 94 |
| 803 | Alarm list, error 12 | F1-F17, h |  | - | - |  | page 94 |
| 804 | Alarm list, error 11 | F1-F17, h |  | - | -- |  | page 94 |
| 805 | Alarm list, error 10 | F1-F17, h |  | - | - |  | page 94 |
| 806 | Alarm list, error 9 | F1-F17, h |  | --- | - |  | page 94 |
| 807 | Alarm list, error 8 | F1-F17, h |  | - | -- |  | page 94 |
| 808 | Alarm list, error 7 | F1-F17, h |  |  | - |  | page 94 |
| 809 | Alarm list, error 6 | F1-F17, h |  | - | - |  | page 94 |
| 810 | Alarm list, error 5 | F1-F17, h |  | - | - |  | page 94 |
| 811 | Alarm list, error 4 | F1-F17, h |  | - | - |  | page 94 |
| 812 | Alarm list, error 3 | F1-F17, h |  | - | - |  | page 94 |
| 813 | Alarm list, error 2 | F1-F17, h |  | - | - |  | page 94 |
| 814 | Alarm list, error 1 | F1-F17, h |  | - | - |  | page 94 |


|  | Softstarter data |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 900 | Softstarter type | $17-1400 \mathrm{~A}$ |  | - | 17 |  |
| 901 | Software variant text | Same as label |  | - | page 95 |  |
| 902 | Software version text | Same as label |  | - | R15 |  |

Explanation of units:

| $U$ | Input line voltage |
| :--- | :--- |
| $U_{n}$ | Nominal motor voltage. |
| $I_{n}$ | Nominal motor current. |
| $P_{n}$ | Nominal motor power. |
| $N_{n}$ | Nominal motor speed. |
| $T_{n}$ | Nominal shaft torque. |
| $I_{\text {nsoft }}$ | Nominal current softstarter. |
| $P_{n s o f t}$ | Nominal power softstarter. |
| $N_{n s o f t}$ | Nominal speed sofstarter. |

Calculation shaft torque

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

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DEDICATED DRIVE

## Emotron AB, Mörsaregatan 12, SE-250 24 Helsingborg, Sweden

Tel: +46 421699 00, Fax: +46 42169949

## E-mail: info@emotron.se

Internet: www.emotron.com

## MODEL G306-GRAPHIC COLOR LCD OPERATOR INTERFACE TERMINAL WITH QVGA DISPLAY AND TOUCHSCREEN



FOR USE IN HAZARDOUS LOCATIONS:
Class 1, Division 2, Groups $A, B, C$, and $D$ Class II, Division 2, Groups F and G
Class III, Division 2

- CONFIGURED USING CRIMSON SOFTWARE (VERSION 2.0 OR LATER)
- UPTO 5 RS-232/422/485 COMMUNICATIONS PORTS (2 RS-232 AND 1 RS-422/485 ON BOARD, 1 RS-232 AND 1 RS422/485 ON OPTIONAL COMMUNICATIONS CARD)
- 10 bASE T/100 BASE-TX ETHERNET PORT TO NETWORK UNITS AND HOST WE PAGES
- USB PORT TO DOWNLOAD THE UNITS CONFIGURATION FRON A PC OR FOR DATA TRANSFERS TO A PC
- UNIT'S CONFIGURATION IS STOPED IN NON-VOLATILE MEMORY (4 MEYTE FLASH)
- COMPACTFLASHe SOCKET TO IINCREASE MEMORY CAPACITY
- 5.T-INCH STN PASSIVE MATRIX 256 COLOR QVGA $320 \times 240$ PIXEL LCD
- 5-BUTTON KEYPAD FOR ON-SCREEN MENUS
- THREE FRONT PANEL LED INDICATORS
- POWER UNIT FROM 24 VDC $\pm 20 \%$ SUPPLY
- resistive analog touchscreen


## GENERAL DESCRIPTION

The G306 Operator Interface Terminal combines unique capabilities normally expected from high-end units with a very affordable price. It is built around a high performance core with integrated functionality. This core allows the G306 to perform many of the nomal features of the Paradigm range of Operator Interfaces while improving and adding new features.

The G306 is able to communicate with many different types of hardware using high-speed RS232/422/485 communications ports and Ethemet 10 Base T/100 Base-TX communications. In addition, the G306 features USB for fast downloads of configuration files and access to trending and data logging. A CompactFlash socket is provided so that Flasb cards can be used to collect vour trending and data logging information as well as to store larger configuration files.

In addition to accessing and controlling of external resources, the G306 allows a user to easily view and enter information. Users can enter data through the touchscreen and/or front panel 5-button keypad.

## FETY SUMMARY

mill safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the controller to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the controller.


The protective conductor terminal is bonded to conductive parts of the equipment for safety purposes and must be connected to an external protective earthing system.
WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUTTABILITY FOR CLASS I. DIVISION 2/CLASS II, DIVISION 2/CLASS III, DIVISION 2


CAUTION: Risk Of Danger. Read complete instructions prior to installation and operation of the unit.

## CONTENTS OF PACKAGE

- G306 Operalor Interface.
- Panel gasket
- Template for panel cutout.
- Hardware packet for mounting unit into panel.
- Terminal block for connecting powet.


## ORDERING INFORMATION

| MODEL NO. | DESCRIPTION | PART NUMBER |
| :---: | :---: | :---: |
| G306 | Operator Interface for indoor applications, textured finish with embossed keys | G306C000 |
| G3CF | 64 MB CompactFlash Card ${ }^{5}$ | G3CF064M |
|  | 256 MB CompactFlash Card ${ }^{5}$ | G3CF256M |
|  | 512 MB CompactFlash Card ${ }^{5}$ | G3CF512M |
| G3RS | RS232/485 Optional Communications Cards | G3RS0000 |
| G3CN | CANopen Optional Communications Cards | G3CNODO0 |
| PSDR7 | DIN Rail Power Supply | PSDR7000 |
| SFCRM2 | Crimson $2.0{ }^{2}$ | SFCRM200 |
| CBL | RS-232 Programming Cable | CBLPROG0 |
|  | USB Cable | CBLUSBOO |
|  | Communications Cables ${ }^{1}$ | CBLDocx ${ }^{\text {x }}$ |
| DR | DIN Rail Mountable Adapter Products ${ }^{3}$ | DRucxuex |
|  | Replacement Battery ${ }^{4}$ | BAL3R004 |
| G3FILM | Protective Films | G3FILMO6 |

1 Contact your Red Lion distributor or visit our website for complete selection.
2 Use this part number to purchase Crimson on CD with a printed manual, USB cable, and RS-232 cable. Otherwise. download for free from หึw:redlion.net.
${ }^{3}$ Red Lion offers R1 modular jack adapters. Refer to the DR literature for complete details.
${ }^{4}$ Battery type is lithium coin type CR2025.
${ }^{5}$ Industrial grade two million write cycles.

[^2]
## Spectrications

## 1. POWER REQUIREMENTS:

Must use Class 2 or SELV rated power supply.
Power connection via removable three position terminal block.
Supply Voltage: $\quad+24 \mathrm{VDC}=20 \%$
Typical Powerl: \& W
Mavimum Power2: 14 W
Notes:

1. Typical power with +24 VDC, RS232;485 communications, Ethemet communications. Compact Flash cardi installed and displony al full brighmess.
2. Maximum power indicates the mosi power that can be drann from the G306. Refer to "Power Supply: Requirements" under "Installing and Powering the G306."
3. The G506s circuit common is nol connected to the enclosure of the unit. See "Commecting 10 Earth Giround" in the section "Installing and Powering the G306.'
4. Read "Poser Supply Requirements" in the section "Insialling and" Powering the G306" for additional power supply: informarion.
5. BATTER ${ }^{\text {: }}$ : Lithium coin cell. Typical lifetime of 10 years.
6. LCD DISPLAY:

| SIZE | 5.7-inch |
| :--- | :---: |
| TYPE | STN |
| COLORS | 256 |
| PIXELS | $320 \times 240$ |
| BRIGHTNESS | $165 \mathrm{~cd} / \mathrm{m}^{2}$ |
| BACKLIGHT* | $20,000 \mathrm{HR}$ TYP. |

*Lifetime at room temperature. Refer to "Display" in "Software/Unit Operation"
4. 5-KEY KEYPAD: for on-screen menus.
5. TOUCHSCREEN: Resistive analog
6. MEMORI:

On Board User Memory: 4 Mbyte of non-volatile Flash memory.
Memory Cara: CompactFlash Type II slot for Type I and Type II CompactFlash cards.
7. COMMUNICATIONS:

USB Port: Adleres to USB specification 1.1. Device only using Type B conrection.


WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZAROOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.

Serial Ports: Format and Baud Rates for each port are individually saftware programmable up to 115,200 baud
PGM Port: RS232 port via RJ12.
COMMS Ports: RS422/485 port via RJ45, and RS232 port via R112.
DH 485 TXEN: Transmit enable; open collector, $\mathrm{V}_{\mathrm{OH}}=15 \mathrm{VDC}$, $V_{\mathrm{OL}}=0.5 \mathrm{~V}$ @ 2.5 mA max.
Note: For additional information on the communications or signal common and comections to earth groumd please see the "Connecting to Earth Ground" in the section "Installing and Powering the G306."
Ethernet Port: 10 BASE-T / 100 BASE-TX
RJ45 jack is wired as a NIC (Network Interface Card).
lsolation from Ethernet network to G3 operator îterface: 1500 Vins
8. ENVTRONMENTAL CONDITIONS:

Operating Temperature Range: 0 to $50^{\circ} \mathrm{C}$
Storage Temperature Range: 20 to $70^{\circ} \mathrm{C}$
Operating and Storage Humidity: $80 \%$ maximum relative humidity (noncondensing) from 0 to $50^{\circ} \mathrm{C}$.
Vibration: Operational 5 to $8 \mathrm{~Hz}, 0.8^{\prime \prime}(p-p), 8$ to 500 Hz in X. Y, 2 direction duration: 1 hour, 3 g .
Sbock: Operational $40 \mathrm{~g}, 9 \mathrm{msec}$ in 3 directions.
Altitude: Up to 2000 meters.
9. CERTIFICATJONS AND COMPLLANCES

SAFETY
UL Recomized Component Fite \#E179259, UL61010-1, CSA 22.2 No. 6101011 Recognized to U.S. and Canadian requirements under the Component Recognition Program of linderwriters Laboratories, inc.
UL Listed, File \#E211967, UL61010-1, L1L1604, CSA 22.2 No .610101. CSA 22.2 No. 213-M1987
LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
Type $4 \times$ Enciosure rating (Face only), UL50
IECEE CB Scheme Test Certificate 扎S/9737/UL,
CB Scheme Test Repan \#EI79259-V01-S04
lssued by Underwriters Laboratories lnc.
IEC 61010-1. EN 61010-1: Safety requirements for elecrical equipment for measurement, control, and laboratory use, Parl.
IP66 Enclosure rating (Face only), IEC 529
ELECTROMAGNETIC COMPATIBILITY
Emissions and lmmunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.
Irmmunity to lndustrial locations:

| Electrostatic discharge | EN 61090-42 | Criterion A |
| :---: | :---: | :---: |
|  |  | 4 kV contact discharge |
|  |  | 8 kV air discharge |
| Electromagnetic RF fields | EN 61000-4-3 | Criterion A |
|  |  | $10 \mathrm{~V} / \mathrm{m}$ |
| Fast transients (burst) | EN 61000-4-4 | Criterion A |
|  |  | 2 kV power |
|  |  | 1 LV signal |
| Surge | EN 6100045 | Criterion A |
|  |  | $\begin{aligned} & 1 \mathrm{kVL} \mathrm{~L}, \\ & 2 \mathrm{kV} \text { L\&N-E power } \end{aligned}$ |
| RF conducted interference | EN 61000-4-6 | Criterion A |
|  |  | 3 V/rms |
| Emissions: |  |  |
| Enissions | EN 55011 | Class A |

Note:

1. Criterion A: Normal operation within specified limits.
2. CONSTRUCTION: Steel rear metal enclosure with NEMA 4X/IP66 aluminum front plate for indoor use only when comectly frted with the gasket provided, Installation Category Il, Pollution Degre 2.
3. MOUNTING REQUIREMENTS: Maximum panel thickness is 0.25" (6.3 mm ). For NEMA 4X/IP66 sealing a steel panel with a minirnum thickness of $0.125^{\prime \prime}(3.17 \mathrm{~mm})$ is recommended.
Maximpm Mounting Stud Torque: 17 inch-pounds ( $1.92 \mathrm{~N}-\mathrm{ra}$ )
4. WEIGHT: $3.0 \mathrm{lbs}(1.36 \mathrm{Kg})$

## DIMENSIONS In inches (mm)




## MOUNTING INSTRUCTIONS

his operator interface is designed for through-panel mounting. A panel cutdiagram and a template are provided. Care should be taken to remove any: loose material from the mounting cut-out to prevent that material from falling into the operator interface during installation. A gasket is provided to enable sealing to NEMA 4X/IP66 specification. Install the ten kep nuts provided and tighten evenly for uniform gasket compression.
Note: Tightening the kep nuts beyond a maximum of 17 inch-pounds (1.92 N. $m$ ) may: cause damage to the front panel.


ALL NONINCENDIVE CIRCUITS MUST BE WRED USING DIVISION 2 WRING METHODS AS SPECIFIED IN ARTICLE 5014 (b), 502-A (b), AND 503-3 (b) OF THE NATIONAL ELECTRICAL CODE, NFPA 70 FOR INSTALLATION WITHIN THE UNITED STATES, OR AS SPECIFIED IN SECTION 19-152 OF CANADIAN ELECTRICAL CODE FOR INSTALLATION IN CANADA.

## CONNECTING TO EARTH GROUND



The protective conductor terminal is bonded to conductive parts of the equipment for safety purposes and must be connected to an external protective earthing system.

Each G306 has a chassis ground terminal on the back of the unit Your unit should be connected to earth ground (protective earth).

The chassis ground is not connected to signal common of the unit. Maintaining isolation between earth ground and signal common is not required to operate your umit. But, other equipment connected to this unit may require isolation between signal common and earth ground. To maintain isolation benween signal common and earth groumd care must be taken when connections are mode to the unit. For example, a power supply with isolation between its signal common and earth ground must be used. Also, plugging in a USB cable may connect sigital common and earth ground. ${ }^{1}$

1. USB's shield may be connected to earth ground at the host USB's shield in turn may also be connected to signal common.

## POWER SUPPLY REQUIREMENTS

The G306 requires a 24 VDC power supply. Your unit may draw considerably less than the maximum rated power depending upon the options being used. As additional features are used your unit will draw increasing amounts of power. ltems that could cause increases in current are additional conmunications, optional communications card. CompactFlash card. and other features programmed through Crimson.

In any case, it is very important that the power supply is nounted correctly if the unit is to operate reliably. Please take care to observe the following points:

- The power supply must be mounted close to the unit, with usually not more than 6 feet ( 1.8 m ) of cable between the supply and the operator interface. Jdeally, the shortest length possible should be used.
- The wire used to connect the operator interface's power supply should be at least 22 -gage wire. If a longer cable run is used, a heavier gage wire should be used. The routing of the cable should be kept away from large contactors, inverters, and other devices which may generate significant electrical noise.
- A power supply with a Class 2 or SELV rating is to be used. A Class 2 or SELV power supply provides isolation to accessible circuits from hazardous voltage levels generated by a mains power supply due to single faults. SELV is an acronym for "safety extra-low voltage." Safety extra-low voltage circuits shall exhibit voltages safe to touch both under nomal operating conditions and after a single fault, such as a breakdown of a layer of basic insulation or after the failure of a single component has occurred.



## CONFIGURING A G306

The G306 is configured using Crimson software. Crimson is available as a free download from Red Lion's website, or it can be purchased on CD. Updates to Crimson for new features and drivers are posted on the website as they become available. By configuring the G306 using the latest version of Crimson, you are assured that your unit bas the most up to date feature set Crimson software can ifigure the G306 through the RS232 PGM port, USB port, or CompactFlash.
The USB port is connected using a standard USB cable with a Type B connector. The driver needed to use the USB port will be installed with Crinnson.

The RS232 PGM port uses a programming cable made by Red Lion to connect to the DB9 COM port of your computer. If you choose to make your own cable, use the "G306 Port Pin Out Diagram" for wiring information

The CompactFlash can be used to program a G3 by placing a configuration file and firmware on the CompactFlash card. The card is then inserted into the target G3 and powered. Refer to the Crimson Jiterature for more infomation on the proper narnes and locations of the files.

## USB, DATA TRANSFERS FROM THE COMPACTFLASH CARD



WARNING - DO NOT CONNECT OR DISCONNECT CABLES WHILE POWER IS APPLIED UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS. USB PORT IS FOR SYSTEM SET-UP AND DIAGNOSTICS AND IS NOT INTENDED FOR PERMANENT CONNECTION.
In order to transfer data from the CompactFlash card via the USB port a drivet must be installed on your computer. This driver is installed with Crimson and is located in the folder C:IProgram Files\Red Lion ControlslCrimson 2.01Devicel after Crimson is installed This may have already been accomplished if your G306 was configured using the USB port

Once the driver is installed, connect the G306 to your PC with a USB cable, and low "Mounting the CompactFlash" instructions in the Crimson 2 user manual.

## CABLES AND DRIVERS

Red Lion has a wide range of cables and drivers for use with many different communication types. A list of these drivers and cables along with pin outs is available from Red Lion's website. New cables and drivers are added on a regular basis. If making your own cable, refer to the "G306 Port Pin Outs" for wining information.

## ETHERNET COMMUNICATIONS

Ethernet communications can be established at either 10 BASE-T or 100 BASE-TX. The G306 unit's R145 jack is wired as a NIC (Network Interface Card). For example, when wiring to a hub or switch use a straigh-through cable, but when connecting to another NIC use a crossover cable.

The Ethernet connector contains two LEDs. A yellow LED in the upper right and a bi-color green/amber LED in the upper left. The LEDS represent the following statuses:

| LED COLOR | DESCRIPTION |
| :--- | :--- |
| YELLOW solid | Link established. |
| YELLOW fashing | Data being transferred. |
| GREEN | 10 BASE-T Communications |
| AMBER | 100 BASE-TX Communications |

On the rear of each unit is a unique 12 -digit MAC address and a block for marking the unit with an IP address. Refer to the Crimson manual and Red Lion's website for additional information on Ethemet communications.

## RS232 PORTS

The G306 has two RS232 ports. There is the PGM port and the COMMS port. Although only one of these ports can be used for programming, both ports can be used for communications with a PLC.

The RS232 ports can be used for either master or slave protocols with any G306 configuration.

Examples of RS 232 communications could involve another Red Lion product or a PC. By using a cable with RJ12 ends on it, and a twist in the cable, RS232 communications with another G3 product or the Modular Controller can be established. Red Lion part numbers for cables with a twist in them are CBLPROG0 ${ }^{1}$, CBLRLC01 ${ }^{2}$, or CBLRC02 ${ }^{3}$.

G3 RS232 to a PC

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| G3: RJ12 | Name | PC: DB9 | Name |
| 4 | COMM | 1 | DCD |
| 5 | TX | 2 | Rx |
| 2 | RX | 3 | Tx |
|  | N/C | 4 | DTR |
| 3 | COM | 5 | GND |
|  | N/C | 6 | DSR |
| 1 | CTS | 7 | RTS |
| 6 | RTS | 8 | CTS |
|  | N/C | 9 | RI |

CONNECTING A GJOG OPERATOR INTERFACE TO AN ICMS


${ }^{1}$ CBLPROGO can also be used to conumunicate with either a PC or an ICM5
${ }^{2}$ DB9 adapter not included, 1 foot long.
${ }^{3}$ DB9 adapter not included, 10 feet long.

G306 PORT PIN OUTS


## RS422/485 COMMS PORT

The G306 has one RS422/485 port. This port can be configured to act as - ェ RS422 or RS485.


Note: All Red Lion devices connect $A$ to $A$ and $B$ to $B$, except for Paradigm devices. Refer to wnw.redlion.net for additional information.

## Examples of RS485 2-Wire Connections

G3 to Red Lion RJ11 (CBLRLC00)
DLC, IAMS, ITMS, PAXCDC4C

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| G3: RJ45 | Name | RLC: RJ11 | Name |
| 5 | TxEN | 2 | TxEN |
| 6 | COM | 3 | COM |
| 1 | TxB | 5 | B- |
| 2 | T×A | 4 | A+ |

G3 to Modular Controller (CBLRLC05)

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| G3 | Name | Modular Controller | Name |
| 1,4 | T×B | 1,4 | T×B |
| 4,1 | R×B | 4,1 | R×B |
| 2,3 | T×A | 2,3 | T×A |
| 3,2 | R×A | 3,2 | R×A |
| 5 | TXEN | 5 | TXEN |
| 6 | COM | 6 | COM |
| 7 | T×B | 7 | TXB |
| 8 | TXA | 8 | TXA |

## DH485 COMMUNICATIONS

The G306's RS422/485 COMMS port can also be used for Allen Bradley DH485 communications.

WARNING: DO NOT use a standard DH485 cable to connect this port to Allen Bradley equipment. A cable and wining diagram are available from Red Lion.

G3 to AB SLC 500 (CBLABD03)

| Connections |  |  |  |
| :---: | :---: | :---: | :---: |
| RJ45: RLC | Name | RJ45: A-B | Name |
| 1 | $\cdots$ | TxB | 1 |
| 2 | TXA | 2 | A |
| 3,8 | RXA | $\ddots$ | B |
| 4,7 | RXB | $\ddots$ | 24 V |
| 5 | TXEN | 5 | COMM |
| 6 | COMM | 4 | TXEN |
| 4,7 | TXB | $\cdot$ | SHIELD |
| 3,8 | TXA |  | COMM |
|  |  |  | $24 V$ |



## :RIMSON SOFTWARE

Crimson software is available as a free download from Red Lion's website or can be purchased on a CD, see "Ordering lnformation" for part number. The test version of the software is alway's available from the website, and updating our copy is free.

## JISPLAY

This operator interface uses a liquid crystal display (LCD) for displaying text nd graphics. The display utilizes a cold cathode fluorescent tube (CCFL) for glating the display. The CCFL tubes can be dimmed for low light conditions.
These CCFL tubes have a limited lifetime. Backlight lifetime is based upon oe amount of time the display is tumed on at full intensity. Tuming the acklight off when the display is not in use can extend the lifetime of your acklight. This can be accomplished through the Crimson software when onfiguring your unit. .

## FRONT PANEL LEDS

There are three froṇt panel LEDs. Shoum below is the default status of he LEDs.

| SEO | InPICATION |
| :---: | :---: |
| Meper Mq, |  |
| FLASHING | Unit is in the boot loader, no valid configuration is loaded. ${ }^{\text {a }}$ |
| STEADY | Unit is powered and running an application. |
|  |  |
| OFF | No Compactflash card is present |
| STEADY | Valid CompactFlash card present. |
| FLASHING RAPIDLY | CompactFlash card being checked. |
| FLICKERING | Unit is writing to the CompactFlash, either because it is storing data, or because the PC connected via the USB port has locked the drive. ${ }^{2}$ |
| FLASHING SLOWLY | Incorrectly formatted CompactFlash card present |
|  |  |
| FLASHING | A tag is in an alarm state. |
| STEADY | Valid configuration is toaded and there are no alams presem. |

1. The operator interface is shipped without a configuration. After downloading a configuration, if the light remains in the flashing state continuously, try cycling power. If the LED still continues to flash, try downioading a configuration again.
2. Do not turn off power to the unit while this light is flickering. The unit writes data in two minute intervals. Later Microsoft operating systems will not lock the drive unless they need to write data; Windows 98 may lock the drive any time it is mounted, thereby interfering with logging. Refer to "Mounting the CompactFlash" in the Crimson 2 User Manual.

## TOUCHSCREEN

This operator interface utilizes a resistive analog touchscreen for user input The unit will only produce an audible tone (beep) when a touch on an active touchscreen cell is sensed. The touchscreen is fully functional as soon as the operator interface is initialized, and can be operated with gloved hands.

## KEYPAD

The $G 306$ keypad consists of five keys that can be used for on-screen menus.

## TROUBLESHOOTING YOUR G306

If for ally reason you have trouble operating, connecting, or simply have questions concerning your new G306, contact Red Lion's teclunical support. For contact information, refer to the back page of this bulletin for phone and fax numbers.

EMAIL: techsuphorigred lionnet Web Site: lith: $/ 1$ wuw redionnel

## BATTERY \& TIME KEEPING

WARNING - EXPLOSION HAZARD - THE AREA MUST BE KNOWN TO EE NON-HAZARDOUS BEFORE SERVICING/ REPLACING THE UNIT AND BEFORE INSTALLING OR REMOVING I/O WRING AND BATTERY.


WARNING - EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN DISCONNECTED AND THE AREA IS KNOWN TO BE NON-HAZARDOUS.

A bsttery is used to keep time when the unit is without power. Typical accuracy of the G306 time keeping is less than one minute per month drit. The battery of a G306 unit does not affect the unit's memory, all configurations and data is stored in non-volatile memory.


CAUTION: RISK OF ELECTRIC SHOCK
The inverter board, attached to the mounting plare, supplies the high voltage to operate the backlight. Touching the inverter board may result in injury to personnel.


CAUTION: The circuit board contains static sensitive components. Before handling the operator interface without the rear cover attached, discharge static charges from your body by touching a grounded bare meal object. Ideally; handle the operator interface at a static controlled clean workstation. Also, do not touch the surface areas of the circuit board. Dir, oil, or other contaminants may adversely affect circuit operation.
To change the battery of a G306, remove power, cabling and then the rear cover of the unit. To remove the cover, remove the four screws designated by the arrows on the rear of the unit. Then, by lifting the top side, hinge the cover, thus providing clearance for the connectors on the botom side of the PCB as shown in the illustration below. Install in the reverse manner.


Remove the old battery* from the holder and replace with the new battery. Replace the rear cover, cables, and re-apply power. Using Crimson or the unit's keypad, enter the correct time and date.

* Please note that the old battery must be disposed of in a manner that complies with your local waste regulations. Also. the batten' must not be disposed of in fire, or in a manner whereby it nag: be damaged and its convents come into contact with humzan skin.

The battery used by the G306 is a lithium tope CR2025.



## OPTIONAL COMMUNICATION CARD

Red Lion offers optional communication cards for fieldbus communications. These communication cards will allow your G306 to communicate with many of the popular fieldbus protocols.

Red Lion is also offering a communications card for additional RS232 and RS422/485 communications. Visit Red Lion's website for information and availability of these cards.

## CUSTOM LOGO

Each G3 operator interface has an embossed area containing the Red Lion logo. Red Lion can provide custom logos to apply to this area Contact your distributor for additional information and pricing.


## COMPACTFLASH SOCKET

CompactFlash socket is a Type II socket that can accept either Type I or Il cards. Use cards with a minimum of 4Mbytes with the G306's CompactFlash socket Cards are available at most computer and office supply retailers.

CompactFlash can be used for configuration transfers, larger configurations, data logging, and trending.
 the CompactFlash card while power is applied Refer to
"Front Panel LEDs."

Information stored on a CompactFlash card by a G306 can be read by a card reader attached to a PC. This information is stored in IBM (Windows ${ }^{\text {e }}$ ) PC compatible FATI 6 file format

## NOTE

For reliable operation in all of our products, Red Lion recommends the use of SanDisk ${ }^{\text {® }}$ and SimpleTech brands of CompactFlash cards.

Industrial grade versions that provide up to two million write/erase cycles minimum are available from Red Lion.

## LIMITED WARRANTY

The Company warants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used undes proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, pronise or representation with respect to the products. The customer agees to hold Red Lion Controls harmless fom, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC ond based upon personal injuries, deaths, property danage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any exient liable, including without limitation penalties imposed by the Consumer Product Safery Act (PL. 92-573) and liability imposed upon any person pursuant to the Magauson-Moss Warranty Act (PL. 93-637), as now in effect or as amended hereafter.
No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowiedges the disclaimers and limitations contained herein and relies on no other wartanties or affirmations.

| Red Lion Controls BV | Red Lon Controls AP |
| :---: | ---: |
| Basicweg 11b | 31, Kaki Buklt Road 3, |
| NL - 3821 BR Amersfoort | \#06-04/05 TechLink |
| Tel $+31(0) 334723225$ | Singapore 417818 |
| Fax $+31(0) 334893793$ | Tel $+656744-6613$ |

## TC-900DR USER GUIDE

41 Aster Avenue Carrum Downs 3201 Australia Tel: 61397750505 Fax: 61397750606 www.trio.com.au

## Gẹ̃NERAL

The Trio DataCom TC-900DR is a full duplex 900 MHz Radio featuring a fully integrated 4800/9600 bps data radio modem and antenna diplexer. Configuration of the unit is fully programmable, with parameters held in non volatile memory (NVRAM). All configuration parameters are accessible using the TC-DRPROG installation package, consisting of a programming lead, manual and software which will run on a PC under Windows 95/98/NT. It is essential that each unit is programmed to suit individual requirements prior to operation. For detailed information refer to the TC-900DR Handbook.

## DATA CONNECTION

The data connection is via a DB9 connector labeled 'Port A' (shown below), which is wired as a DCE.

Jser Serial "Port A" Pin Assignment.
TERNAL VIEW OF `PORT A
NOTE; Pin 6 and pin 9 provide a dual function which depends on the mode that the TC-900DR is operating in.


## User Serial "Port B" Pin Assignment.

not $B$ can be used as a secondary data stearn lependent of Port $A$ ) once configured by the programmer. Port B also has one connection that may be of use for installation. This connection (Pin 9) is Receive Signal Strength Indicator (RSSI) output. 0-5V where 1.5 V typically indicates -110 dBm and every 0.5 V increase indicates an improvement of > 10 dBm .
EXTERNAL VIEW OF'PORT B'


[^3]
## POWER CONNECTIONS

The power required is 13.8 VDC nominal, at $600 \mathrm{~mA}(T x)$ nominal. If the POWER LED indicator is not illuminated once power is applied, check the internal 1 Amp fuse fitted within the unit.

POWER CONNECTOR TOP PIN
BOTTOM PIN

## AUXILIARY CONNECTOR

PIN ASSIGNMENT
+VE SUPPLY (13.8VdC. GROUND

The auxiliary connector is primarily for use with the optional audio handset. The connections to this auxiliary 6 pin RJ11 connector are as follows:
PIN NUMBER
$\frac{1}{2}$
2
3
4
5
6
FUNCTION
8 VOLTS
AUDIO OUT
GROUND
MIC INPUTISENSE
GROUND
MANUAL PTT

External view of socket


The optional audio handset is recommended as an aid in checking installations for radio path viability. This audio handset will only function when fitted prior to applying power to the unit.
The modem upon power up will check the presence of the handset and will inhibit data being transmitted so that voice communications can be established.
Once the path tests have been conducted the audio handsets MUST be REMOVED and the unit powered up with the handset removed before data communication can commence.

## USER INDICATIONS

The TC-900DR provides 4 LED's that show status information to the user - POWER, RXSIG, SYNC, and TXMIT indications.

The POWER is indicated by a green LED and simply signifies that power has been applied to the unit.
The RXSIG LED (yellow) indicates the level of RSSI signal from the radio IF strip, compared to a threshold lievel set in the configuration data programmed by the user. If the signal is above the threshoid, then the LED indicator is turned on.
In all operation modes except "Programmer mode", the SYNC LED (yellow) indicates when the modem has detected a valid data stream. The SYNC LED is activated, when the modem detects a valid HDLC flag sequence, and remains active until an invalid sequence of seven or more consecutive " 1 " bits is detected.
The SYNC LED will not be tumed on if the RSSI signal strength (as indicated by the RXSIG LED) is below the minimum threshold. This prevents false SYNC detection from noise.
The TXMIT LED (red) indicator is connected directly to the modem's PTT output transistor. Whenever the radio is transmitting, this TXMIT LED indicator will be on.

## SPECIAL MODES OF OPERATION

Part of the power-up/reset initialisation phase of the TC-900DR are tests to determine if the modem should enter one of 3 "special operation" modes. In these modes the TC-900DR won't operate in its standard run mode.

- Programmer mode.
- Bit error rate test mode
- Handset mode.

These modes are only entered if the required setup conditions are present at power up. An error mode of operation can also be entered into, if during normal operation, an error condition occurs.

## PROGRAMMER MODE

CABLE - Pins 2, 3, 4, 5 straight through with Pin 6 on the DB9 connector of Port $A$, connected to pin 5 . When the modem is powered up with this fitted, the controlier senses this and attempts to enter "Programmer mode" and the "SYNC" LED will flash approx. onice per second. (Note, the TC-DRPROG programming software and lead has the required connections). Failure to supply the correct password in time, will cause the modem to abandon the "Programmer mode" attempt, and go on with it's normal power-up procedure.

## bIT ERROR RATE TEST MODE

Pin 9 of the DB9 connector of Port A, is normally the Ring Indicate output line. However, if this pin is driven positive (connecting it to pin 6 [DSR] and pin 7 [RTS]), then the modem's data transmitter and receiver will enter the BER test mode. This will activate the RF transmitter, and generate a scrambled bit pattern which should be decoded at a receiver as a constant logic "1" level in the unscrambled data. Any errors in the decoded bitstream, will be " 0 ", and the receiver portion of the modem in this mode, will activate the SYNC LED every time it sees a "0" bit.

Note: As the TC-900DR is full duplex this test can operate in both directions simultaneously.
Every error bit detected, will activate the SYNC LED. For error rates of 1 in $10^{3}$ and above, the SYNC LED will be ON most of the time. A 1 in $10^{4}$ error rate will show the SYNC LED active for approximately $10 \%$ of the time. This function provides a crude indication of Bit Error Rate for installation purposes. Note: Error count messages
(ET:XXXX) for every 10,000 bits are presented to Port $A$ for the user. If pin 9 ceases to be driven positive, then the BER Test mode is terminated, and the modem restarts it's initialisation phase.

## HANDSET MODE

The modem tests for the presence of a handset plugged into the handset auxiliary port at power up. If a handset is plugged in, the modem will not generate a data stream. However, it will continue to indicate received RF signal strength. The handset has a PTT button, and this signal is connected across the modem's PTT output. Thus the handset PTT switch will not activate the TXMIT LED. It is essential to remove the handset from the unit and reapply power to the unit in order to return to normal operation.

## ERROR INDICATION MODES

There are 3 error conditions that cause the RXSIG \& SYNC LEDs to be used for error indications and not their normal purpose. Two are fatal conditions, that cause the modem to restart after the duration of the error indication phase.

## TRANSMIT POWER LOW

While the modem activates the radio transmiter, it periodically checks the transmit power. If the power measurement is less than a threshold set in the non-volacile memory, then the RXSIG and SYNC LEDs are made to alternate, approximately 4 times per second. The TXMIT LED will also be on during this process. This indication condition will persist for the duration of the transmission. As soon as the transmission is discontinued, the error indication will cease, and the two LEDs revert to their normal function. Factory set to 100 milliWatts.

## NVRAM READ ERROR

The DFM4-9DR modem accesses the non-volatile memory as part of it's initialisation phase, to read programming configuration data. If the communication protocol with the device is violated, or the non-volatile memory CRC checksum is found to be incorrect, then the modem indicates this by flashing the RXSIG and SYNC LEDs twice alternately. That is, one LED operates ON and OFF twice, then the other. A total of five cycles of this occurs, then the modem restarts initialisation.

## SYNTHESISER LOCK DETECT ERROR

If at any time during normal operation, BER mode, or handset mode, the TBB206 frequency synthesiser indicates an out of lock condition, the modem enters an error indication mode for a short time before restarting.
One LED is tumed ON ( 0 ), the LEDs are swapped, then both tumed OFF (*). Then the latter LED ON again, swap LEDS, and then OFF. This will give the appearance of a sweeping motion between the LEDs. The following tabie shows all error condition displays.

| TXPWR Ert |  | NVRAM Em |  | SYNTH Err |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| RXSIG | SYNC | RXSIG | SYNC | RXSIG | SYNC |
| 0 | - | 0 | - | 0 | - |
| - | 0 | - | - | - | 0 |
| 0 | - | 0 | - | - | - |
| - | 0 | - | - | - | 0 |
| 0 | - | - | 0 | 0 | - |
| - | 0 | - | - | - | - |
| 0 | - | - | 0 |  | repeat |
| - | 0 | - | - |  |  |

## MOUNTNG AND ANTENNA CONNECTION

The TC-900DR should be mounted in a cool, dry, vibration free environment, whilst providing easy access to screws and connections. There are 4 mounting holes on the unit. The antenna should be an external yagi antenna but can be a ground independent dipole mounted via a feeder to the antenna connector (SMA type) for short range applications. However the whole radio modem should be clear of the associated data equipment to prevent mutual interference.

## ASSEMBLY OF́ POWER LEAD

A smaill plastic bag containing a molex connector (M5557-2R) and two pins (M5556-TL) is provided in the packing box.
The pins are designed to take 18-24 (AWG) wire size with insulation range $1.3-3.10 \mathrm{~mm}$.
Please take care when crimping the pins.
09/03
Level


$\underbrace{\text { Mr }}_{\text {Registration }}$
$\underset{\text { Services }}{\square}$
$\underbrace{a-2}_{\text {Solutions }}$

## Operating Instructions

## Waterpilot FMX167

Level probe


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## 1 Safety instructions

### 1.1 Designated use

The Waterpilot FMX167 is a hydrostatic pressure sensor for measuring the level of fresh water, wastewater and seawater. Versions with a Pt 100 resistance thermometer can detect temperature at the same time. The optional temperature transmitter converts the Pt 100 signal into a $4 \ldots 20 \mathrm{~mA}$ signal.

The manufacturer shall not accept any liability for damage arising from improper use or if the device is used for purposes for which it was not intended.

### 1.2 Installation, commissioning and operation

The Waterpilot FMX167 and the temperature transmitter TMT181 (optional) are designed as failsafe to the state of the art and comply with prevailing regulations and EC directives. If the devices are not used properly or for purposes for which they were not intended, they may become hazards arising from the particular application, e.g. product overflow through incorrect installation or adjustment. For these reasons, only trained personnel authorised by the plant operator may install, connect electrically, commission, operate and maintain the measuring system. Trained personnel must have read and understood these Operating Instructions and heed the instructions. Any changes and repairs to the devices may only be performed if the Operating Instructions expressly permit this.

### 1.3 Operational safety

### 1.3.1 Explosion hazardous area (optional)

Devices for use in hazardous areas are additionally identified on the nameplate ( $\rightarrow$ see Page 6 ). If the device is to be installed in an explosion hazardous area, then the specifications in the certificate as well as all national and local regulations must be observed. A separate Ex documentation is enclosed with the device and is an integral part of this documentation. The installation regulations, connection values and Safety Instructions listed in this document must be observed. The documentation number of the related Safety Instructions (XAs) is also indicated on the nameplate.

- Ensure that all personnel are suitably qualified.

| Versions in the order code <br> (e.g. FMX167-D ...) | Certificate | Protection |
| :--- | :--- | :--- |
| B | ATEX | ATEX II 2 G EEx ia IIC To |
| C | ATEX | ATEX II 3 G EEx nA II T6 |
| D | FM | IS, Class I, Division 1, Groups A-D |
| E | CSA | IS, Class I, Division 1, Groups A-D |

### 1.4 Notes on safety conventions and icons

In order to highlight safety-relevant or alternative operating procedures in the manual, the following conventions have been used, each indicated by a corresponding icon in the margin.

| Symbol | Meaning |
| :--- | :--- |
|  | Warning! <br> A warning highlights actions or procedures which, if not performed correctly, will lead to <br> personal injury, a safety hazard or destruction of the instrument. |
|  | Caution! <br> Caution highlights actions or procedures which, if not performed correctly, may lead to <br> personal injury or incorrect functioning of the instrument. |
|  | Note! <br> A note highlights actions or procedures which, if not performed correctly, may indirectly <br> affect operation or may lead to an instrument response which is not planned. |


| Ex | Device certified for use in explosion hazardous area <br> If the device has this symbol embossed on its nameplate, it can be installed in an explosion <br> hazardous area or a non-explosion hazardous area, according to the approval. |
| :--- | :--- |
|  | Explosion hazardous area <br> Symbol used in drawings to indicate explosion hazardous areas. <br> - Devices used in hazardous areas must possess an appropriate type of protection. |
|  | Safe area (non-explosion hazardous area) <br> Symbol used in drawings to indicate, if necessary, non-explosion hazardous areas. <br> - <br> Devices used in hazardous areas must possess an appropriate type of protection. Lines <br> used in hazardous areas must meet the necessary safety-related characteristic quantities. |


|  | Direct voltage <br> A terminal to which or from which a direct current or voltage may be applied or supplied. |
| :--- | :--- |
| $\sim$ | Alternating voltage <br> A terminal to which or from which an alternating (sine-wave) current or voltage may be <br> applied or supplied. |
| $\square$ | Grounded terminal <br> A grounded terminal, which as far as the operator is concerned, is already grounded by <br> means of an earth grounding system. |
| $\square$ | Protective grounding (earth) terminal <br> A terminal which must be connected to earth ground prior to making any other connection <br> to the equipment. |
| $\square$ | Equipotential connection (earth bonding) <br> A connection made to the plant grounding system which may be of type e.g. neutral star or <br> equipotential line according to national or company practice. |

## 2 Identification

### 2.1 Device designation

- Waterpilot FMX167 for hydrostatic level measurement, refer to Section 2.1.1.
- Waterpilot FMX167 with optional Pt 100 resistance thermometer for simultaneous level and temperature measurement, refer to Section 2.1.1.
- Waterpilot FMX167 with optional Pt 100 resistance thermometer and optional temperature transmitter TMT181, refer to Sections 2.1.1 and 2.1.2.


### 2.1.1 Nameplate Waterpilot FMX167

The nameplate is fitted to the FMX167 extension cable.


Fig. I: Nameplate for Waterpilot FMXI67
1 Order code
See the specifications on the order confirmation for the meaning of the individual letters and digits.
2 Serial number
3 Length of extension cable
4 Nominal measuring range
5 Current output
6 Supply voltage
7 TAG
8 Wetted materials
9 Ex symbol (optional)
10 CSA symbol (optional)
11 FM symbol (optional)
12 Pay attention to the installation instructions in the Operating Instructions!
13 ID number of notified body with regard to ATEX (optional)
14 Text for approval (optional)
15 Approval symbol (optional)
16 Test date (optional)
17 Symbol: Observe Safety Instructions, indicating the documentation number, e.g. XAI3IP-C (optional)
18 Wining diagram FMX 167
19 Wiring diagram Pt 100 if Waterpilot was ordered with Pt 100.

The following information is also provided on the FMX1 67 with outer diameter $=22 \mathrm{~mm}(0.87 \mathrm{in})$ and 42 mm ( 1.66 in ):


Fig. 2: FMX 167 labeling
1 Serial number
2 Nominal measuring range
3 CE symbol or approval symbol
4 ID number of notified body with regard to ATEX (optional)
5 Text for approval (optional)

### 2.1.2 Nameplate of temperature transmitter TMT181



Fig. 3: $\quad$ Nameplate of temperature transmitter TMT181
1 Order code of temperature transmitter TMT181-A41DA
A: Version for non-hazardous area
4: 4-wire
1: Sensor Pt 100
D: Temperature transmitter with settings for $-20 \ldots+80^{\circ} \mathrm{C}\left(-4 \ldots+174^{\circ} \mathrm{F}\right)$ range
A: Label: Standard version
2 Serial No.
3 Current output: 4 ... 20 mA
4 Supply voltage: 8... 35 V DC

### 2.2 Scope of supply

The scope of delivery comprises:

- Waterpilot FMX167, optionally with integrated Pt 100 resistance thermometer
- Optional accessories ( $\rightarrow$ see also Chapter 7)

Documentation supplied:

- Operating Instructions BA231P (this document)
- Final inspection report
- Drinking water approval SD126P (optional)
- Devices which are suitable for use in hazardous areas: additional documentation such as Safety Instructions (XAs), Control or Installation Drawings (ZDs)


### 2.3 CE mark, declaration of conformity

The device is designed to meet state-of-the-art safety requirements, has been tested and left the factory in a condition in which it is safe to operate. The device complies with the applicable standards and regulations as listed in the EC declaration of conformity and thus complies with the statutory requirements of the EC Directives. Endress+Hauser confirms the successful testing of the device by affixing to it the CE mark.

## 3 Installation

### 3.1 Incoming acceptance and storage

### 3.1.1 Incoming acceptance

- Check the packaging and the contents for damage.
- Check the shipment, make sure nothing is missing and that the scope of supply matches your order.


### 3.1.2 Storage

The device must be stored in a dry, clean area and protected against damage from impact (EN 837-2).

Storage temperature range:

- FMX167: $-40 \ldots+80^{\circ} \mathrm{C}\left(-40 \ldots+176^{\circ} \mathrm{F}\right)$
- TMT181: $-40 \ldots+100^{\circ} \mathrm{C}\left(-40 \ldots+212^{\circ} \mathrm{F}\right)$


### 3.2 Installation conditions



Fig. 4: Installation examples
For accessories see Page 18, Chapter 7.
1 Extension cable mounting screw can be ordered via order code or as an accessory
2 Terminal housing can be ordered via order code or as an accessory
3 Extension cable bending radius $>120 \mathrm{~mm}(4.72 \mathrm{in})$
4 Mounting clamp cän be ordered via order code or as an accessory
5 Extension cable up to 300 m ( 384 ft )
o Guide tube
7 Additional weight can be ordered as an accessory
8 Protection cap

## Note!

- A sideways movement of the level probe can lead to measuring errors. Therefore install the probe at a point free from flow and turbulence, or use a guide tube. The internal diameter of the guide tube should be at least $1 \mathrm{~mm}(0.04 \mathrm{in})$ bigger than the outer diameter of the selected FMX167.
- The cable must end in a dry room or in a proper terminal box. The terminal box from Endress+Hauser provides optimum humidity and climatic protection and is suitable for outdoor installation.
- Protective cap: to avoid mechanical damage to the measuring cell, the device is provided with a protective cap.
You can order protective caps ( 5 pieces per set) as spare part directly from your Endress+Hauser Service Organisation using Order No.: 52008999.


### 3.2.1 Dimensions

$\rightarrow$ For dimensions, please refer to the Technical Information for Waterpilot TI351P, "Mechanical construction" section ( $\rightarrow$ see also: www.endress.com $\rightarrow$ Download).

### 3.3 Installation instructions

### 3.3.1 Installing Waterpilot with a mounting clamp



Fig. S: Installing Waterpilot FMX 107 with a mounting clamp
I Extension cable
2 Mounting clamp
3 Clamping jaws

## How to mount the mounting clamp:

1. Mount the mounting clamp (Pos. 2). When selecting the type of fixing, note the weight of the extension cable (Pos. 1) and the device.
2. Raise clamping jaws (Pos. 3). Place extension cable (Pos. 1) acc. to Figure 5 between clamping jaws.
3. Hold extension cable (Pos. 1) tight and push clamping jaws (Pos. 3) back down. Fix clamping jaws by tapping lightly.

### 3.3.2 Installing Waterpilot with cable mounting screw



Fig. 6:
Installing the Waterpilot FMX107 with cable mounting screw, here depicted with G $11 / 2$ thread
1 Extension cable
2 Mounting screw cap nut
3 Sealing ring
4 Clamping sleeve
5 Mounting screw adapter
0 Top edge of clamping sleeve
7 required length of extension cable and FMXI67 probe before assembly
7' after assembly Pos. 7 is located next to the mounting screw with
G1/12 thread: sealing surface of mounting screw adapter
$11 / 2$ NPT thread run-out of mounting screw adapter

Note!
If you want to lower the level probe to a certain depth, place the top edge of the clamping sleeve 4 cm ( 1.57 in ) higher than the required depth. Then push the extension cable and the clamping sleeve into the adapter as described in the following Section, Step 6.

## How to mount the cable mounting screw with G $11 / 2$ or NPT thread:

1. Mark required length of extension cable, refer to "Note" on this Page.
2. Insert probe through measuring opening and carefully lower on extension cable.

Fix extension cable to prevent it from slipping.
3. Push adapter (Pos. 5) over extension cable and screw tightly in measuring opening.
4. Push sealing ring (Pos. 3) and cap (Pos. 2) from top onto cable. Press sealing ring into cap.
5. Place clamping sleeve (Pos. 4) around extension cable (Pos. 1) acc. to Figure 6.
6. Push extension cable and clamping sleeve (Pos. 4) into adapter (Pos. 5).
7. Push cap (Pos. 2) and sealing ring (Pos. 3) onto adapter (Pos. 5) and screw tightly to adapter.

Note!
Remove the cable mounting screw in the opposite sequence of operation to installation.

### 3.3.3 Mounting the terminal box

Mount the optional terminal box with four screws (M 4). $\rightarrow$ For dimensions of the terminal box, please refer to the Technical Information for Waterpilot TI351P, "Mechanical construction" section $(\rightarrow$ see also: www.endress.com $\rightarrow$ Download).

### 3.3.4 Mounting the temperature transmitter TMT181



Fig. 7: Mounting the temperature transmitter, depicted here with terminal box Only open terminal box with a screwdriver.
1 Mounting screws
2 Mounting springs
3 Temperature transmitter TMT181
4 Circlips
5 Terminal box

## How to mount the temperature transmitter:

1. Insert the mounting screws (Pos. 1) with the mounting springs (Pos. 2) through the boring of the temperature transmitter (Pos. 3).
2. Fix the mounting screws with the circlips (Pos. 4).

The circlips, mounting screws and springs are contained in the scope of supply of the temperature transmitter.
3. Screw the temperature transmitter tightly in the field housing. (thread tapper max. 6 mm (0.23 in))

Warning!
To prevent damage to the temperature transmitter, do not tighten the mounting screw too tightly.

### 3.4 Checking the installation

Check that all screws are seated firmly.

## 4 Wiring

### 4.1 Connecting the device

Note!
When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions (XAs) or Installation or Control Drawings (ZDs).

- The supply voltage must match the supply voltage on the nameplate. ( $\rightarrow$ See also Page 6 ff , Sections 2.1.1 and 2.1.2.)
- Switch off supply voltage before you connect the device.
- The cable must end in a dry room or in a proper terminal box. The terminal box with GORE-TEX ${ }^{8}$ filter, IP 66/IP 67 from Endress+Hauser is suitable for outdoor installation.
- Connect device acc. to the following figures. A polarity protection is integrated in the Waterpilot FMX167 and the temperature transmitter TMT181. Changing the polarities will not destroy the devices.


## Waterpilot FMX167, Standard


$\begin{array}{ll}\text { Fig. 8: } & \text { FMXI } 07 \text { electrical connection, versions " } 7 \text { " or } \\ & \text { " } 3 \text { " for Feature } 70 \text { "Additional options" in the } \\ & \text { order code. }\end{array}$
I Not for FMXI 07 with outer diameter $=29 \mathrm{~mm}$ ( 1.15 in )

Waterpilat FMX167 with Pt 100


Fig. 9:
FMX107 electrical connection with Pt 100, versions " 1 " or " 4 " for Feature 70 "Additional options" in the order code.

1 Not for FMXIO7 with outer diameter $=29 \mathrm{~mm}$ (1.15 in)

Wire colors: $\mathrm{RD}=$ red, $\mathrm{BK}=$ black, $\mathrm{WH}=$ white, $\mathrm{YE}=$ yellow, $\mathrm{BU}=$ blue, $\mathrm{BR}=$ brown

Waterpilot FMX 167 with Pt 100 and temperature transmitter TMT181 ( $4 \ldots 20 \mathrm{~mA}$ )


Fig. 10: FMX167 with Pt 100 and TMT181 temperature transmitter ( $4 . . .20 \mathrm{~mA}$ ), version "5" for Feature 70 in the order code

1 Not for FMXI 67 with outer diameter $=29 \mathrm{~mm}(1.15 \mathrm{in})$
Wire colours: $\mathrm{RD}=$ red, $\mathrm{BK}=$ black, $\mathrm{WH}=$ white, $\mathrm{YE}=$ yellow, $\mathrm{BU}=$ blue, $\mathrm{BR}=$ brown

### 4.1.1 Supply voltage

| Certificate | Supply voltage <br> FMX167 | FMX167 + Pt 100 | Temperature transmitter <br> TMT181 |
| :--- | :--- | :--- | :--- |
| Standard | $10 \ldots 30$ V DC | $10 \ldots 30 \mathrm{~V} \mathrm{DC}$ | $8 \ldots 35 \mathrm{~V} \mathrm{DC}$ |

### 4.1.2 Cable specification

- FMX167 with optional Pt 100
- Commercially available installation cable
- Terminals in terminal box FMX 167:0.08... $2.5 \mathrm{~mm}^{2}$
- Temperature transmitter TMT181 (optional)
- Commercially available installation cable
- Terminals in terminal box FMX 167:0.08 ... $2.5 \mathrm{~mm}^{2}$
- Transmitter terminals: max. $1.75 \mathrm{~mm}^{2}$

Note!
For versions with outer diameter $=22 \mathrm{~mm}(0.87 \mathrm{in})$ and 42 mm ( 1.66 in ) the extension cables are shielded. In the following cases Endress+Hauser recommends use of a shielded cable for the cable extension:

- for large distances between extension cable end and display and/or evaluation unit,
- for large distances between extension cable end and temperature transmitter
- for directly connecting Pt 100 signals to the display and/or evaluation unit.


### 4.1.3 Power consumption/current drain

|  | FMX 167 | FMX $167+$ Pt 100 | Temperature transmitter <br> TMT181 |
| :--- | :--- | :--- | :--- |
| Power consumption | $\leq 0.675 \mathrm{~W}$ at 30 VDC | $\leq 0.675 \mathrm{~W}$ at 30 VDC | $\leq 0.875 \mathrm{~W}$ at 35 VDC |
| Current drain | max. $\leq 22.5 \mathrm{~mA}$ <br> $\min . \geq 3.5 \mathrm{~mA}$ | $\max . \leq 22.5 \mathrm{~mA}$ <br> $\min . \geq 3.5 \mathrm{~mA}$ <br> Pt $100: \leq 0.6 \mathrm{~mA}$ | $\max . \leq 25 \mathrm{~mA}$ <br> $\min . \geq 3.5 \mathrm{~mA}$ |

### 4.1.4 Load

The maximum load resistance is dependent on the supply voltage $\left(\mathrm{U}_{\mathrm{b}}\right)$ and must be determined for every current loop separately. Refer to the equations and diagrams for "FMX 167" and "Temperature transmitter".
The total resistance resulting from the resistances of the connected devices, the connecting cable and if necessary, the resistor of the extension cable may not exceed the load resistance.

## FMX167

$\mathrm{R}_{\text {tot }} \leq \frac{\mathrm{U}_{\mathrm{b}}-10 \mathrm{~V}}{0.0225 \mathrm{~A}}-2 \cdot 0.09 \frac{\Omega}{\mathrm{~m}} \cdot 1-\mathrm{R}_{\mathrm{add}}$

$R_{t o t}=$ Max. load resistance $\Omega /$
$R_{\text {add }}=$ additional resistances, e.g. resistance of evaluating device and/or the display instrument, line resistance $\Omega$ /
$U_{b}=$ Supply voltage $M$
$l=$ Simple length of extension cable $(\mathrm{m} /$ (cable resistance per wire $\leq 0,09 \Omega / \mathrm{m}$ )

## Temperature transmitter

$$
\mathrm{R}_{\mathrm{tot}} \leq \frac{\mathrm{U}_{\mathrm{b}}-8 \mathrm{~V}}{0.025 \mathrm{~A}}-\mathrm{R}_{\mathrm{add}}
$$

POIfMX107xx-10-ri-xr-xx-00


Fig. 11: Load chart FMX167 for estimating load resistance. Subtract the additional resistances, e.g. resistance of extension cable,
from the calculated value as shown in the resistances, e.g. resistance of extension cable,
from the calculated value as shown in the equation.


Fig. 12: Load chart temperature transmitter for estimating load resistance. Subtract the additional resistances from the calculated value as shown in the equation.

### 4.2 Wiring up the measuring unit

### 4.2.1 Overvoltage protection

Note!

- In order to protect the Waterpilot FMX167 and the temperature transmitter TMT181 from Iarge transients, Endress+Hauser recommends the installation of an overvoltage protector upstream and downstream of the display and/or evaluation device as shown in the figure.
- The Waterpilot FMX 167 has an integrated overvoltage protection to EN 61000 of $\leq 1.2 \mathrm{kV}$ as standard.


Fig. 13: Wining up the measuring unit
1 Power supply, display and evaluation unit with one input for Pt 100
2 Power suppiy, display and evaluation unit with one input for $4 \ldots 20 \mathrm{~mA}$
3 Power supply, display and evaluation unit with two inputs for $4 \ldots 20 \mathrm{~mA}$
OP Overvoltage protection e.g. HAW from Endress+Hauser

### 4.3 Checking the wiring

Perform the following checks after completing electrical installation of the device:

- Does the supply voltage match the specifications on the nameplate?
- Is the device connected as per Section 4.1?
- Are all screws firmly tightened?
- Optional terminal box: are the cable glands tight?


## 5 Operation

Note!
Endress+Hauser offers extensive measuring point solutions with display and/or evaluation units for the Waterpilot FMX167 and the temperature transmitter TMT181. For more information, please contact your nearest Endress+Hauser Service Organisation. For contact addresses, please go to www.endress.com/worldwide.

## 6 Maintenance

No special maintenance work is required for the Waterpilot FMX167 or for the optional temperature transmitter TMT181.

### 6.1 Exterior cleaning

Please note the following points when cleaning the exterior of the device:

- Do not use a cleaning agent that is aggressive to the housing surface or the seal.
- Waterpilot FMX167: avoid any mechanical damage to the membrane or the extension cable.


## $7 \quad$ Accessories

There are a number of accessories available for the Waterpilot FMX167. You can order them separately from Endress+Hauser.

## Mounting clamp

- Endress+Hauser offers a mounting clamp for simple FMX167 mounting. $\rightarrow$ See also Page 10, Section 3.3.1.
- Material: 1.4435 (AISI 316L) and glass fiber reinforced PA (polyamide)
- Order number: 52006151


## Terminal box

- Terminal box IP $60 /$ IP 67 with GORE-TEX ${ }^{\oplus 1}$ filter incl. 3 mounted terminals.

The terminal box is also suitable for installing a temperature transmitter (Order No. 52008794) or for four additional terminals (Order No. 52008938). $\rightarrow$ See also Page 12, Section 3.3.4.

- Order number: 52006152

Additional weight for FMX167 with $\mathrm{d}_{\mathrm{O}}=22 \mathrm{~mm}(0.87 \mathrm{in})$ and $\mathrm{d}_{\mathrm{O}}=29 \mathrm{~mm}(1.15 \mathrm{in})$


- To prevent sideways movement leading to measuring errors or to ensure that the device lowers into a guide tube, Endress+Hauser provides additional weights.
You can screw several weights together. The weights are then attached directly to the FMX167. For FMX167 with outer diameter $=29 \mathrm{~mm}(1.15 \mathrm{in})$, a maximum of 5 weights may be screwed on to FMX167.
- Material: 1.4435 (AISI 316L)
- Weight: 300 g
- Order number: 52006153


## Temperature transmitter TMT 181 ( $4 . .20 \mathrm{~mA}$ )

- Temperature transmitter, 2 -wire, preset for measuring range from $-20 \ldots+80^{\circ} \mathrm{C}\left(-4 \ldots+176^{\circ} \mathrm{F}\right)$. This setting offers an easily displayable temperature range of 100 K . Note that the Pt 100 resistance thermometer is designed for a temperature range of $-10 \ldots+70^{\circ} \mathrm{C}\left(+14 \ldots+158^{\circ} \mathrm{F}\right)$.
$\rightarrow$ See also Page 12, Section 3.3.4.
- Order number: 52008794


## Cabel mounting screw

- Endress+Hauser offers extension cable mounting screws to simplify the installation of the FMX167 and to close the measuring open. $\rightarrow$ See also Page 11, Section 3.3.2.
- Material: 1.4301 (AISI 304)
- Order number for extension cable mounting screw with G $11 / 2$ A thread: 52008264
- Order number for extension cable mounting screw with 1 1/2 NPT thread: 52009311


## Terminals

- Four terminals in strip for FMX1 67 terminal box, suitable for wire cross-section of $0.08 \ldots 2.5 \mathrm{~mm}^{2}$
- Order number: 52008939

Test adapter for FMX167 with $\mathrm{d}_{\mathrm{O}}=22 \mathrm{~mm}(0.87 \mathrm{in})$ and $\mathrm{d}_{\mathrm{O}}=29 \mathrm{~mm}(1.15 \mathrm{in})$


Abb. 14: Test adapter
A Connection suitable for level probe FMXIO7
B Connection compressed air hose, internal diameter, quick hose gland $4 \mathrm{~mm}(0.157 \mathrm{in})$

- Endress+Hauser offers a test adapter to simplify the function test of level probes.
- Note the maximum pressure for the compressed air hose and the maximum level probe overload. $(\rightarrow$ For the maximum level probe overload refer to Technical Information for Waterpilot TI351P or Internet: www.endress.com $\rightarrow$ Download)
- The maximum pressure for the supplied quick hose gland is 10 bar (145 psi).
- Adapter material: 1.4301 (AISI 304)
- Quick hose gland material: Anodized aluminum
- Adapter weight: 39 g
- Order number: 52011868


## 8 Trouble-shooting

### 8.1 Faults on Waterpilot FMX167 and Waterpilot FMX167 with optional Pt 100

| Error description | Cause | Action |
| :---: | :---: | :---: |
| No measuring signal | Connection of $4 \ldots 20 \mathrm{~mA}$ line incorrect | Connect device acc. to Section 4.1, Page 13. |
|  | No supply voltage over 4... 20 mA line | Check current loop. |
|  | Supply voltage too low (min. 10 V DC) | - Check supply voltage. <br> - Total resistance grater than max. load resistance, refer to Section 4.1, Page 15. |
|  | Waterpilot defective | Replace Waterpilot. |
| Temperature measuring value inaccurate/incorrect (only with Waterpilot FMXI 67 with Pt 100) | Pt 100 connected to 2-wire circuit, line resistance not compensated | - Compensate line resistance. <br> - Connect Pt 100 as 3-wire or 4-wire circuit. |

### 8.2 Faults of temperature transmitter TMT181

| Error description | Cause | Action |
| :---: | :---: | :---: |
| No measuring signal | Connection of $4 \ldots 20 \mathrm{~mA}$ line incorrect | Connect device acc. to Section 4.1, Page 13. |
|  | No supply voltage over 4... 20 mA line | Check current loop. |
|  | Supply voltage too low (min. 8 V DC) | - Check supply voltage. <br> - Total resistance grater than max. load resistance, refer to Section 4.1, Page 13. |
| Error current $\leq 3,6 \mathrm{~mA}$ or $\geq 21 \mathrm{~mA}$ | Connection of Pt 100 incorrect | Connect device acc. to Section 4.1, Page 13. |
|  | Connection of $4 . . .20 \mathrm{~mA}$ line incorrect | Connect device acc. to Section 4.1, Page 13. |
|  | Pt 100 resistance thermometer defective | Replace Waterpilot FMX167. |
|  | Temperature transmitter defective | Replace temperature transmitter. |
| Measuring value inaccurate/incorrect | Pt 100 connected in 2-wire circuit, line resistance not compensated | - Compensate line resistance. <br> - Connect Pt 100 as 3 -wire or 4-wire circuit. |

### 8.3 Spare Parts

Note!
You can order spare parts directly from your nearest Endress+Hauser Service Organisation.
Membrane protective cap

- 5 pieces in set
- Order No.: 52008999

Pressure compensation set

- 10 pieces in set, comprising Teflon filter and sleeve for extension cable
- Order No.: 52005578


## 9 Technical Data

For technical data, please refer to the Technical Information for Waterpilot TI351P $(\rightarrow$ see also: www.endress.com $\rightarrow$ Download).

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## Declaration of Contamination Erklärung zur Kontamination

# Endress+Hauser <br> <br> It 

 <br> <br> It}

People for Process Automation

Because of legal regulations and for the safety of our employees and operating equipment, we need the "declaration of contamination", with your signature, before your order can be handled. Please make absolutely sure to include it with the shipping documents, or - even better - attach it to the outside of the packaging.
Aufgrund der gesetzlichen Vorschriften und zum Schutz unserer Mitarbeiter und Betriebseinrichtungen, benötigen wir die unterschriebene "Erklärung zur Kontamination", bevor Ihr Auftrag bearbeitet werden kann. Legen Sie diese unbedingt den Versandpapieren bei oder bringen Sie sie idealenweise außen an der Verpackung an.

## Type of instrument / sensor

Geräte-/Sensortyp

Serial number
Seriennummer
$\qquad$

Process data/Prozessdaten Temperature / Temperatur__ $\left.\right|^{\circ} \mathrm{C} \mid$ Pressure / Druck $\quad$ Pa $\mid$
Conductivity / Leitfähigkeit $\qquad$ |S| Viscosity / Viskosität $\qquad$ $\left|\mathrm{mm}^{2} / \mathrm{s}\right|$

## Medium and warnings

Warnhinweise zum Medium


|  | Medium / concentration Medium /Konzentration | Identification CAS No. | flammable entzündlich | toxic giftig | corrosive ätzend | harmful/ irritant gesundheitsschädlich/ reizend | other * sonstiges* | harmless unbedenklich |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Process medium |  |  |  |  |  |  |  |  |
| Medium im Prozess |  |  |  |  |  |  |  |  |
| Medium for process cleaning |  |  |  |  |  |  |  |  |
| Medium zur Prozessreinigung |  |  |  |  |  |  |  |  |
| Returned part cleaned with |  |  |  |  |  |  |  |  |
| Medium zur Endreinigung |  |  |  |  |  |  |  |  |

* explosive; oxidising; dangerous for the environment; biological risk; radioactive
* explosiv; brandfördernd; umweltgefährlich; biogefährlich; radioaktiv

Please tick should one of the above be applicable, include security sheet and, if necessary, special handling instructions.
Zutreffendes ankreuzen; trifft einer der Warnhinweise zu, Sicherheitsdatenblatt und ggf. spezielle Handhabungsvorschriften beilegen.
Reason for return / Grund zur Rücksendung $\qquad$

Company data / Angaben zum Absender

| Company / Firma | Contact person / Ansprechpartner |
| :--- | :--- |
| Address / Adresse | Department / Abteilung |
|  | Phone number/ Telefon |
|  | Fax / E-Mail |
|  | Your order No. / Ihre Auftragsnr. |

We hereby certify that the returned parts have been carefully cleaned. To the best of our knowledge they are free from any residues in dangerous quantities.
Hiermit bestätigen wir, dass die zurückgesandten Teile sorgâltig gereinigt wurden, und nach unserem Wissen frei von Rückständen in gefahrbringender Menge sind.

## Operating Instructions

VEGABAR 74
4 ... $20 \mathrm{~mA} / \mathrm{HART}$


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## Supplementary documentation

## Information:

Depending on the ordered version, supplementary documentation belongs to the scope of delivery. You find this documentation in chapter "Product description".

Instructions manuals for accessories and replacement parts

- Tip:

To ensure reliable setup and operation of your VEGABAR 74, we offer accessories and replacement parts. The associated documents are:

- Supplementary instructions manual 32036 "Welded socket and sea/s"
- Operating instructions manual 32798 "Breather housing VEGABOX 02"
- Operating instructions manual 20591 "External indicating and adjustment unit VEGADIS 12"


## 1 About this document

### 1.1 Function

This operating instructions manual provides all the information you need for mounting, connection and setup as well as important instructions for maintenance and fault rectification. Please read this information before putting the instrument into operation and keep this manual accessible in the immediate vicinity of the device.

### 1.2 Target group

This operating instructions manual is directed to trained personnel. The contents of this manual should be made available to these personnel and put into practice by them.

### 1.3 Symbolism used



Information, tip, note
This symbol indicates helpful additional information.
Caution: If this warning is ignored, faults or malfunc-
tions can result.
Warning: If this warning is ignored, injury to persons and/or serious damage to the instrument can result.
Danger: If this warning is ignored, serious injury to persons and/or destruction of the instrument can result.

## Ex applications

This symbol indicates special instructions for Ex applications.

- List

The dot set in front indicates a list with no implied sequence.
$\rightarrow$ Action
This arrow indicates a single action.
1 Sequence
Numbers set in front indicate successive steps in a procedure.

For your safety

## 2 For your safety

### 2.1 Authorised personnel

All operations described in this operating instructions manual must be carried out only by trained specialist personnel authorised by the operator.
During work on and with the device the required personal protection equipment must always be worn.

### 2.2 Appropriate use

VEGABAR 74 is a pressure transmitter for measurement of gauge pressure, absolute pressure and vacuum

You can find detailed information on the application range in chapter "Product description".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

Due to safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden.

### 2.3 Warning about misuse

Inappropriate or incorrect use of the instrument can give rise to applicatior-specific hazards, e.g. vessel overfill or damage to system components through incorrect mounting or adjustment.

### 2.4 General safety instructions

This is a high-tech instrument requiring the strict observance of standard regulations and guidelines. The user must take note of the safety instructions in this operating instructions manual, the country-specific installation standards as well as all prevailing safety regulations and accident prevention rules.

The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for troublefree operation of the instrument.

During the entire duration of use, the user is obliged to determine the compliance of the required occupational safety measures with the current valid rules and regulations and also take note of new regulations.

### 2.5 Safety approval markings and safety tips

The safety approval markings and safety tips on the device must be observed.

### 2.6 CE conformity

VEGABAR 74 is in CE conformity with EMC (89/336/EWG), fulfils NAMUR recommendation NE 21 and is in CE conformity with LVD (73/23/EWG)

Conformity has been judged according to the following standards:

- EMC:
- Emission EN 61326: 2004 (class B)
- Susceptibility EN 61326: 2004 including supplement A
- LVD: EN 61010-1: 2001

VEGABAR 74 is not subject to the pressure device guideline."

### 2.7 Fulfilling NAMUR recommendations

VEGABAR 74 fulfills the following NAMUR recommendations:

- NE 21 (interference resistane and emitted interference)
- NE 43 (signal level for failure information)
- NE 53 (compatibility sensor and indicating/adjustment components)

VEGA instruments are generally upward and downward compatible:

- Sensor software to DTM VEGABAR 74 HART
- DTM VEGABAR 74 for adjustment software PACTware ${ }^{T M}$

The parameter adjustment of the basic sensor functions is independent of the software version. The range of available functions depends on the respective software version of the individual components.

The software version of VEGABAR 74 HART can be read out via PACTware ${ }^{\text {TM }}$.

1) Due to the flush diaphragm, no own pressure compartment is formed.

For your safety

You can view all software histories on our website www.vega. com. Make use of this advantage and get registered for update information via e-mail

### 2.8 Safety instructions for Ex areas

Please note the Ex-specific safety information for installation and operation in Ex areas. These safety instructions are part of the operating instructions manual and come with the Exapproved instruments.

### 2.9 Environmental instructions

Protection of the environment is one of our most important duties. That is why we have introduced an environment management system with the goal of continuously improving company environmental protection. The environment management system is certified according to DIN EN ISO 14001.

Please help us fulfil this obligation by observing the environmental instructions in this manual:

- Chapter "Packaging, transport and storage"
- Chapter "Disposal"


## 3 Product description

### 3.1 Configuration

## Scope of delivery

## Components

The scope of delivery encompasses:

- VEGABAR 74 pressure transmitter
- Documentation
- this operating instructions manual
- Test certificate for pressure transmitters
- Ex-specific "Safety instructions" (with Ex-versions)
- if necessary, further certificates

VEGABAR 74 consists of the following components:

- Process fitting with measuring cell
- Housing with electronics
- Connection cable (direct cable outlet)

The components are available in different versions.


Fig. 1: Example of a VEGABAR 74 with process fitting G1/2 A
1 Connection cable
2 Housing with electronics
3 Process fitting with measuring cell

### 3.2 Principle of operation

VEGABAR 74 is a pressure transmitter for use in the paper, food processing and pharmaceutical industry. Thanks to the high protection class IP 68/IP 69 K it is particularly suitable for use in humid environment. Depending on the version, it is used for level, gauge pressure, absolute pressure or vacuum measurements. Measured products are gases, vapours and liquids, also with abrasive contents.

The sensor element is the CERTEC ${ }^{(\boxplus)}$ measuring cell with flush, abrasion resistant ceramic diaphragm. The hydrostatic pressure of the medium or the process pressure causes a capacitance change in the measuring cell via the diaphragm. This change is converted into an appropriate output signal and outputted as measured value.
The CERTEC ${ }^{(1)}$ measuring cell is also equipped with a temperature sensor. The temperature value can be processed via the signal output.

Supply Two-wire electronics $4 \ldots 20 \mathrm{~mA} / \mathrm{HART}$ for power supply and measured value transmission over the same cable.

The supply voltage range can differ depending on the instrument version.

The data for power supply are stated in chapter "Technical data" in the "Supplement".

### 3.3 Operation

VEGABAR $744 \ldots 20 \mathrm{~mA} /$ HART can be adjusted with different adjustment media:

- with external adjustmentindication VEGADIS 12
- an adjustment software according to FDT/DTM standard, e.g. PACTware ${ }^{\text {TM }}$ and PC
- with a HART handheld

The kind of adjustment and the adjustment options depend on the selected adjustment component. The entered parameters are generally saved in the respecitive sensor, when adjusting with PACTware ${ }^{\text {TM }}$ and PC optionally also in the PC.

## 3．4 Packaging，transport and storage

$\left.\begin{array}{ll}\text { Packaging } & \begin{array}{l}\text { Your instrument was protected by packaging during transport．} \\ \text { Its capacity to handle normal loads during transport is assured } \\ \text { by a test according to DIN EN } 24180 .\end{array} \\ \text { The packaging of standard instruments consists of environ－} \\ \text { ment－friendly，recyclable cardboard．For special versions，PE } \\ \text { foam or PE foil is also used．Dispose of the packaging material } \\ \text { via specialised recycling companies．}\end{array}\right\}$

## 4 Mounting

### 4.1 General instructions

Materials, wetted parts

Temperature limits

Make sure that the wetted parts of VEGABAR 74, especially the seal and process fitting, are suitable for the existing process conditions such as pressure, temperature etc. as well as the chemical properties of the medium.

You can find the specifications in chapter "Technical data" in the "Supplement".

Higher process temperatures often mean also higher ambient temperatures. Make sure that the upper temperature limits stated in chapter "Technical data" for the environment of the electronics housing and connection cable are not exceeded.


Fig. 2: Temperature ranges
1 Process temperature
2 Ambient temperature

## Connection

- The connection cable has a capillary for atmospheric pressure compensation
$\rightarrow$ Lead the cable end into a dry space or into a suitable terminal housing.


## - Information:

VEGA recommends the breather housing VEGABOX 02 or the indicationadjustment VEGADIS 12. Both contain terminals and a ventilation filter for pressure compensation. For mounting outdoors, a suitable protective cover is available.

## 4．2 Mounting steps

Sealing／Screwing in threaded versions

Sealing／Screwing in flange versions

Sealing／Screwing in hygienic fittings

Seal the thread with teflon，hemp or a similar resistant seal material on the process fitting thread $11 / 2$ NPT
$\rightarrow$ Screw VEGABAR 74 into the welded socket．Tighten the hexagon on the process fitting with a suitable wrench Wrench size，see chapter＂Dimensions＂

Seal the flange connections according to DIN／ANSI with a suitable，resistant seal and mount VEGABAR 74 with suitable screws

Use the seal suitable for the respective process fitting．You can find the components in the line of VEGA accessories in the supplementary instructions manual＂Welded socket and seals＂．

## 5 Connecting to power supply

### 5.1 Preparing the connection

## Note safety instructions

Take note of safety instructions for Ex applications

## Select power supply

Selecting connection cable
industrial areas, screened cable should be used. For HART multidrop operation we recommend as standard practice the use of screened cable.


Fig. 3: Connection of VEGABAR 74
1 Direct connection
2 Connection via VEGABOX 02 or VEGADIS 12
Cable screening and grounding

Select connection cable for Ex applications


If screened cable is necessary, connect the cable screen on both ends to ground potential. In the VEGABOX 02 or VEGADIS 12, the screen must be connected directly to the internal ground terminal. The ground terminal on the outside of the housing must be connected to the potential equalisation (low impedance).

If potential equalisation currents are expected, the connection on the processing side must be made via a ceramic capacitor (e.g. $1 \mathrm{nF}, 1500 \mathrm{~V}$ ). The low frequency potential equalisation currents are thus suppressed, but the protective effect against high frequency interference signals remains.

Take note of the corresponding installation regulations for Ex applications. In particular, make sure that no potential equalisation currents flow over the cable screen. In case of grounding on both sides this can be achieved by the use of a capacitor or a separate potential equalisation.

### 5.2 Connection procedure

Direct connection
Proceed as follows:
1 Wire the connection cable up to the connection compartment. The bending radius must be at least $25 \mathrm{~mm} .^{2}$ )
2 Connect the wire ends to the screw terminals according to the wiring plan

Via VEGABOX 01 or VEGADIS 12

Proceed as follows:
1 Snap connection housing onto the carrier rail or screw it to the mounting plate
2 Loosen the cover screws and remove the cover
3 Insert the cable through the cable entry into the connection housing housing
4 Loosen the screws with a screwdriver
5 Insert the wire ends into the open terminals according to the wiring plan
6 Tighten the screws with a screwdriver
7 Check the hold of the wires in the.terminals by lightly pulling on them
8 Tighten the compression nut of the cable entry. The seal ring must completely encircle the cable
9 Connect the supply cable according to steps 3 to 8
10 Screw the housing cover back on
The electrical connection is finished.

## 5．3 Wiring plan

Direct connection


Fig．4：Wire assignment，connection cable
1 brown（＋）：to power supply or to the processing system
2 blue（－）：to power supply or to the processing system
3 yellow：is only required with VEGADIS 12，otherwise connect to minus or with VEGABOX 01 to terminal $3^{3}$
4 Screen
5 Breather capillaries with filter element

## Connection via VEGABOX 02



Fig．5：Terminal assignment VEGABAR 74
1 To power supply or the processing system
2 Screan

| Wire number | Wire colour／Polarity | VEGABAR 74 terminal |
| :--- | :--- | :--- |
| 1 | brown $(+)$ | 1 |
| 2 | blue $(-)$ | 2 |
| 3 | Yellow | 2 |
|  | Screen | Ground |

3）For customer－specific versions already connected with blue（ - ）when being shipped．
Connect screen to ground terminal．Connect ground terminal on the outside of the housing as prescribed．The two terminals are galvanically connected．


Fig. 6: Terminal assignment, VEGADIS 12
1 To power supply or the processing system Control instrument ( 4 ... 20 mA measurement) Screens
Breather capillanies
Suspension cable

| Wire number | Wire colour/Polarity | Terminal VEGADIS <br> 12 |
| :--- | :--- | :--- |
| 1 | brown $(+)$ | 1 |
| 2 | blue $(-)$ | 2 |
| 3 | Yellow | 3 |

5) Connect screen to ground terminal. Connect ground terminal on the outside of the housing as prescribed. The two terminals are galvanically connected.

## 6 Set up

### 6.1 Setup steps without VEGADIS 12

After mounting and electrical connection, VEGABAR 74 is ready for operation.
$\rightarrow$ Switch on voltage
The electronics now carries out a self-check for approx. 2 seconds. Then VEGABAR 74 delivers a current of $4 \ldots 20 \mathrm{~mA}$ according to the actual level.

### 6.2 Setup steps with VEGADIS 12

Adjustment volume

- zero - measuring range begin
- span - measuring range end
- ti- Integration time

Adjustment system

Adjustment steps, adjustment


Fig. 7: Adjustment elements of VEGADIS 12
1 Rotary switch: choose the requested function
2 It] key, change value (rising)
3 [-] key, change value (falling)

- With the rotary switch the requested function is selected
- With the $[+]$ and $[-J$ keys, the signal current or the integration time are adjusted
- Finally the rotary switch is set to position "OPERATE"

The set values are transmitted to the EEPROM memory and remain there even in case of voltage loss.

Proceed as follows for adjustment with VEGADIS 12:
1 Open housing cover
2 Connect hand multimeter to terminals 10 and 12
3 Meas. range begin: Set rotary switch to "zero"

4 Empty the vessel or reduce process pressure
5 Set a current of 4 mA with the $[+]$ and $[-]$ keys
6 Meas. range end: Set rotary switch to "span"
7 Fill the vessel or increase process pressure
8 Set a current of 20 mA with the $[+]$ and $[-]$ keys
9 Operation: Set rotary switch to "OPERATE"
10 Close housing cover
The adjustment data are effective, the output current $4 \ldots 20 \mathrm{~mA}$
corresponds to the actual level.
Adjustment steps, integration time

Proceed as follows for the adjustment of the integration time with VEGADIS 12:

1 Open housing cover
2 Set rotary switch to "ti"
3 By pushing the [-] key 10 -times, make sure that the integration time is set to 0 sec .
4 For every 1 sec . requested integration time, push the [+] key once.
5 The integration time is the time required by the output current signal to reach $90 \%$ of the actual height after a sudden level change.
6 Set rotary switch to "OPERATE"
7 Close housing cover
Adjustment steps, scaling The display outputs the current $4 \ldots 20 \mathrm{~mA}$ as bar graph and digital value.

With 4 mA no segment of the bar graph appears, with 20 mA all segments appear. This assignment is fix.

You can scale the digital value to any value between -9999. +9999 via the adjustment module.

Proceed as follows for scaling the indication of VEGADIS 12:
1 Open housing cover
2 Initial value: Set rotary switch to "zero"
3 Set the requested value, e.g. 0 with the [ + ] and $[-]$ keys
4 Final value: Set the rotary switch to "span"
5 Set the requested value, e.g. 1000 with the [ +$]$ and $[-]$ keys
6 Decimal point: Set the rotary switch to "point"
7 With the [+] and [-] keys you can adjust the requested value, e.g. 8888 (no decimal point)

[^4]
## 7 Setup with PACTware ${ }^{\text {TM }}$

### 7.1 Connect the PC with VEGACONNECT 3

Connecting the PC to the signal cable


Fig. 8: Connecting the $P C$ to the signal cable
1 RS232 connection (with VEGACONNECT 3) or USB connection (with VEGACONNECT 4)
2 VEGABAR 74
3 HART adapler cable
4 HART resistance 250 Ohm (optional depending on the processing)

Necessary components:

- VEGABAR 74
- PC with PACTware ${ }^{\text {TM }}$ and suitable VEGA DTM
- VEGACONNECT 3 or 4 with HART adapter cable (art. no. 2.25397)
- HART resistance approx. 250 Ohm
- Power supply unit


## - Note:

With power supply units with integrated HART resistance (internal resistance approx. 250 Ohm ), an additional external resistance is not necessary (e.g. VEGATRENN 149A, VEGADIS 371, VEGAMET 381/624/625, VEGASCAN 693). In such cases, VEGACONNECT 3 can be connected parallel to the $4 \ldots 20 \mathrm{~mA}$ cable.
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7.2 Connect the PC with VEGACONNECT 4

## Connection via HART



Fig. 9: Connecting the PC via HART to the signal cable
1 VEGABAR 74
2 HART resistance 250 Ohm (optional depending on the processing)
3 Connection cable with 2 mm pins and terminals
4 Processing systam/PLCNoltage supply

## Necessary components:

- vegabar 74
- PC with PACTware ${ }^{\text {TM }}$ and suitable VEGA DTM
- VEGACONNECT 4
- HART resistance 250 Ohm (optional depending on the processing)
- Power supply unit or processing system


## Note:

With power supply units with integrated HART resistance (internal resistance approx. 250 Ohm ), an additional external resistance is not necessary. This applies, e.g. to the VEGA instruments VEGATRENN 149A, VEGADIS 371, VEGAMET 381). Also usual Ex separators are most of the time equipped with a sufficient current limitation resistor. In such cases, VEGACONNECT 4 can be connected parallel to the $4 \ldots 20 \mathrm{~mA}$ cable.

## 7．3 Parameter adjustment with PACTware ${ }^{\text {TM }}$

Further setup steps are described in the operating instructions manual＂DTM Collection／PACTware ${ }^{\text {TM＂}}$ attached to each CD and which can also be downloaded from our homepage．A detailed description is available in the online help of PACTware ${ }^{\text {TM }}$ and the VEGA DTMs．

## Note：

Keep in mind that for setup of VEGABAR 74，DTM－Collection in the actual version must be used．

All currently available VEGA DTMs are provided in the DTM Collection on CD and can be obtained from the responsible VEGA agency for a token fee．This CD includes also the up－to－ date PACTware ${ }^{\text {TM }}$ version．The basic version of this DTM Collection incl．PACTware ${ }^{\text {TM }}$ is also available as a free－of－ charge download from the internet．

Go via www．vega．com and＂Downloads＂to the item＂Soft－ ware＂．

## 7．4 Parameter adjustment with AMS ${ }^{\text {TM }}$ and PDM

For VEGA sensors，instrument descriptions for the adjustment programs AMS ${ }^{T M}$ and PDM are available as DD or EDD．The instrument descriptions are already implemented in the current versions of AMS ${ }^{\text {TM }}$ and PDM．For older versions of AMS $^{\text {TM }}$ and PDM，a free－of－charge download is available via Internet．

Go via www．vega．com and＂Downloads＂to the item＂Soft－ ware＂．

## 7．5 Saving the parameter adjustment data

It is recommended to document or save the parameter adjustment data．They are hence available for multiple use or service purposes．

The VEGA DTM Collection and PACTware ${ }^{\text {TM }}$ in the licensed， professional version provide suitable tools for systematic project documentation and storage．

## 8 Maintenance and fault rectification

### 8.1 Maintenance

When used as directed in normal operation, VEGABAR 74 is completely maintenance free.

### 8.2 Fault clearance

Reaction in case of failures

Causes of malfunction VEGABAR 74 offers maximum reliability. Nevertheless faults can occur during operation. These may be caused by the following, e.g.:

- Sensor
- Process
- Supply
- Signal processing

The first measures to be taken are to check the output signals as well as to evaluate the error messages via the indicating and adjustment module. The procedure is described below. Further comprehensive diagnostics can be carried out on a PC with the software PACTware ${ }^{\text {TM }}$ and the suitable DTM. In many cases, the causes can be determined in this way and faults can be rectified.

24 hour service hotline However, if these measures are not successful, call the VEGA service hotline in urgent cases under the phone no. +49 1805 858550.

The hotline is available to you 7 days a week round-the-clock. Since we offer this service world-wide, the support is only available in the English language. The service is free of charge, only the standard telephone costs will be charged.

Connect a handheld multimeter in the suitable measuring range according to the wiring plan.
? $4 \ldots 20 \mathrm{~mA}$ signal not stable

- Level fluctuations
$\rightarrow$ Adjust integration time via PACTware ${ }^{\text {TM }}$
- no atmospheric pressure compensation
$\rightarrow$ Check the capillaries and cut them clean

Maintenance and fault rectification

Reaction after fault rectlication

## 9 Dismounting

### 9.1 Dismounting steps

## Warning:

Before dismounting, be aware of dangerous process conditions such as e.g. pressure in the vessel, high temperatures, corrosive or toxic products etc.

Take note of chapters "Mounting" and "Connecting to power supply" and carry out the listed steps in reverse order.

### 9.2 Disposal

The instrument consists of materials which can be recycled by specialised recycling companies. We use recyclable materials and have designed the electronics to be easily separable.

## WEEE directive 2002/96/EG

This instrument is not subject to the WEEE directive 2002/96/ EG and the respective national laws (in Germany, e.g. ElektroG). Pass the instrument directly on to a specialised recycling company and do not use the municipal collecting points. These may be used only for privately used products according to the WEEE directive.

Correct disposal avoids negative effects to persons and environment and ensures recycling of useful raw materials.

Materials: see chapter "Technical data"
If you cannot dispose of the instrument properly, please contact us about disposal methods or return.

## , 로菅

Supplement

## 10 Supplement

### 10.1 Technical data

General data
Manufacturer VEGA Grieshaber KG, D-77761 Schiltach
Type name
Parameter, pressure
VEGABAR 74

Measuring principle
Communication interface
Gauge pressure, absolute pressure, vacuum
Ceramic-capacitive, dry measuring cell
None

## Materials and weights

Material 316L corresponds to 1.4404 or 1.4435
Materials, wetted parts

- Process fitting 316L
- Diaphragm sapphire ceramic ${ }^{\text {® }}$ (99.9 \% oxide ceramic)
- Seal FKM (e.g. Viton), Kalrez 6375, EPDM, Chem-
- Seal process fitting thread $G 1 / 2 A$, raz 535

G11/2 A
Materials, non-wetted parts

- Housing
- Ground terminal
- Connection cable
- type label support on cable

Weight

316L
316Ti/316L
PUR, FEP, PE
PE-HART
$0.8 \ldots 8 \mathrm{~kg}$ ( $1.8 \ldots 17.6 \mathrm{lbs}$ ), depending on process fitting


Supplement

Range
Resolution
$-50 \ldots+150^{\circ} \mathrm{C}\left(-58 \ldots+302^{\circ} \mathrm{F}\right)$

Accuracy

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


## Input variable

## Adjustment

Zero adjustable $\quad-20 \ldots+95 \%$ of the nominal measuring range
Span adjustable
$3.3 \ldots+120 \%$ of the nominal measuring range
Recommended max. turn down
Nominal measuring ranges and overioad resistance

| Nominal renge | Overload, max. pressures | Overioad, min. pressure |
| :---: | :---: | :---: |
| Gauge pressure |  |  |
| $0 \ldots 0.1 \mathrm{bar} / 0 \ldots 10 \mathrm{kPa}$ | 15 bar/1500 kPa | -0.2 bar/ 20 kPa |
| $0 \ldots 0.2 \mathrm{bar} / 0 \ldots 20 \mathrm{kPa}$ | $20 \mathrm{bar} / 2000 \mathrm{kPa}$ | -0.4 barl-40 kPa |
| $0 \ldots 0.4 \mathrm{bar} / 0 . .40 \mathrm{kPa}$ | $30 \mathrm{bar} / 3000 \mathrm{kPa}$ | -0.8 bar/ $/ 80 \mathrm{kPa}$ |
| $0 \ldots 1 \mathrm{bar} / 0 . .100 \mathrm{kPa}$ | $35 \mathrm{bar} / 3500 \mathrm{kPa}$ | . 1 bar/-100 kPa |
| $0 \ldots 2.5$ bar/0 ... 250 kPa | $50 \mathrm{bar} / 5000 \mathrm{kPa}$ | .1 bar $/ 100 \mathrm{kPa}$ |
| $0 \ldots 5$ bar/0. .500 kPa | $65 \mathrm{bar} / 6500 \mathrm{kPa}$ | -1 bar/-100 kPa |
| $0 \ldots 10$ barto ... 1000 kPa | $90 \mathrm{bar} / 9000 \mathrm{kPa}$ | -1 bar $/ 100 \mathrm{kPa}$ |
| $0 \ldots 25 \mathrm{bar} / 0 . .2500 \mathrm{kPa}$ | $130 \mathrm{bar} / 13000 \mathrm{kPa}$ | -1 bar/-100 kPa |
| $0 \ldots 60 \mathrm{bar} 0 . . .6000 \mathrm{kPa}$ | 200 bar 20000 kPa | -1 bar $/ 100 \mathrm{kPa}$ |
| -1 ... 0 bar/-100 ... 0 kPa | '35 bar/3500 kPa | -1 bar/-100 kPa |
| -1... 1.5 bar $/ 100 \ldots 150 \mathrm{kPa}$ | $50 \mathrm{bar} / 5000 \mathrm{kPa}$ | -1 bar $/ 100 \mathrm{kPa}$ |
| -1 ... 5 bar/-100 .. 500 kPa | $65 \mathrm{bar} / 6500 \mathrm{kPa}$ | -1 bar/-100 kPa |
| -1 ... $10 \mathrm{bar} /-100 \ldots 1000 \mathrm{kPa}$ | $90 \mathrm{bar} / 9000 \mathrm{kPa}$ | -1 bar/-100 kPa |
| -1 ... 25 bart-100 ... 2500 kPa | $130 \mathrm{bar} / 13000 \mathrm{kPa}$ | -1 bar/-100 kPa |
| -1...60 bar $/ 100 \ldots 6000 \mathrm{kPa}$ | $300 \mathrm{bar} / 30000 \mathrm{kPa}$ | -1 bar/-100 kPa |
| -0.05 .. $0.05 \mathrm{bar} /-5 \ldots 5 \mathrm{kPa}$ | $15 \mathrm{bar} / 1500 \mathrm{kPa}$ | -0.2 bar $/ 20 \mathrm{kPa}$ |
| -0.1 ... 0.1 bar/-10 ... 10 kPa | $20 \mathrm{bar} / 2000 \mathrm{kPa}$ | -0.4 bar/ 40 kPa |

a) Limited to 200 bar according to the pressure device directive.

Nㅡㄹㅜㅜ

| Naminal range | Overload, max. pressure6) | Overload, min. pressure |
| :---: | :---: | :---: |
| -0.2 ... 0.2 barl-20 ... 20 kPa | $30 \mathrm{bar} / 3000 \mathrm{kPa}$ | -0.8 bar/-80 kPa |
| -0.5 .. $0.5 \mathrm{bar} / 50 \ldots 50 \mathrm{kPa}$ | $35 \mathrm{bar} / 3500 \mathrm{kPa}$ | - 1 bar/-100 kPa |
| Absolute pressure |  |  |
| $0 \ldots 0.1 \mathrm{bar} / 0 \ldots 10 \mathrm{kPa}$ | $15 \mathrm{bar} / 1500 \mathrm{kPa}$ |  |
| 0 ... $1 \mathrm{bar} / 0 . .100 \mathrm{kPa}$ | $35 \mathrm{bar} / 3500 \mathrm{kPa}$ |  |
| $0 \ldots 2.5$ bar $0 . . .250 \mathrm{kPa}$ | $50 \mathrm{bar} / 5000 \mathrm{kPa}$ |  |
| $0 \ldots 5 \mathrm{bar} / 0 . .500 \mathrm{kPa}$ | 65 bar/6500 kPa |  |
| $0 \ldots 10 \mathrm{bat} / 0 \ldots 1000 \mathrm{kPa}$ | $90 \mathrm{bar} / 9000 \mathrm{kPa}$ |  |
| $0 \ldots 25$ bar/0 ... 2500 kPa | $130 \mathrm{bar} / 13000 \mathrm{kPa}$ |  |
| $0 \ldots 60 \mathrm{bar} / 0 . .6000 \mathrm{kPa}$ | $200 \mathrm{bar} / 2 \mathrm{D} 000 \mathrm{kPa}$ |  |

Reference conditions and influencing variables (similar to DIN EN 60770-1)
Reference conditions according to DIN EN 61298-1

| - Temperature | $+15 \ldots+25^{\circ} \mathrm{C}\left(+59 \ldots+77^{\circ} \mathrm{F}\right)$ |
| :--- | :--- |
| - Relative humidity | $45 \ldots 75 \%$ |
| - Air pressure | $860 \ldots 1060 \mathrm{mbar} / 86 \ldots 106 \mathrm{kPa}$ |
|  | $(12.5 \ldots 15.4 \mathrm{psi})$ |
| Determination of characteristics | Limit point adjustment according to |
|  | IEC $61298-2$ |
| Characteristics | linear |
| Reference installation position | upright, diaphragm points downward |
| Influence of the installation position | $<0.2 \mathrm{mbar} / 20 \mathrm{~Pa}(0.003 \mathrm{psi})$ |

## Deviation determined according to the limit point method according to IEC 60770¹

Applies to digital HART interface as well as to analogue current output $4 \ldots 20 \mathrm{~mA}$. Specifications refer to the set span. Turn down (TD) = nominal measuring range/set span.

Deviation

- Turn down 1:1 up to 5:1
- Turn down up to 10:1

Deviation with absolutely flush process fittings EV, FT

- Turn down 1:1 up to 5:1
$<0.05 \%$
28432-EN-070718
VEGABAR 74-4 ... $20 \mathrm{mAHART} \quad 29$

Deviation with absolute pressure measuring range 0.1 bar

- Turn down 1:1 up to 5:1
$<0.25 \% \times$ TD
- Turn down up to 10:1
$<0.05 \% \times$ TD


## Influence of the product or ambient temperature

Applies to digital HART interface as well as to analogue current output $4 \ldots 20 \mathrm{~mA}$.
Specifications refer to the set span. Turn down (TD) = nominal measuring range/set span.

## Average temperature coefficient of the zero signal

In the compensated temperature range of $0 \ldots+100^{\circ} \mathrm{C}\left(+212{ }^{\circ} \mathrm{F}\right)$, reference temperature $20^{\circ} \mathrm{C}\left(68^{\circ} \mathrm{F}\right)$ :

Average temperature coefficient of the zero signal

- Turn down 1:1
$0.05 \% / 10 \mathrm{~K}$
- Turn down 1:1 up to 5:1
<0.1 \%/10 K
- Turn down up to 10:1
<0.15 \%/10 K
Outside the compensated temperature range:
Average temperature coefficient of the zero signal
- Turn down 1:1
typ. <0.05 \%/10 K

Thermal change of the current output
Applies also to the analogue $4 \ldots 20 \mathrm{~mA}$ current output and refers to the set span.
Thermal change, current output $\quad<0.15 \%$ at $-40 \ldots+80^{\circ} \mathrm{C}\left(-40 \ldots+176{ }^{\circ} \mathrm{F}\right)$
Long-term stability (similar to DIN 16086, DINV 19259-1 and IEC 60770-1)
Applies to digital HART interface as well as to analogue current output $4 \ldots 20 \mathrm{~mA}$.
Specifications refer to the set span. Turn down (TD) $=$ nominal measuring range/set span.
Long-term drift of the zero signal < $0.1 \% \times$ TD)/1 year

## Total deviation (similar to DIN 16086)

The total deviation (max. practical deviation) is the sum of basic accuracy and long-term stability:
$F_{\text {total }}=F_{\text {perf }}+F_{\text {stab }}$
$F_{\text {perf }}=V\left(\left(F_{T}\right)^{2}+\left(F_{K 1}\right)^{2}\right)$
With

- $F_{\text {total }}$ : Total deviation
- $F_{\text {pert: }}$ Basic accuracy
- $F_{\text {stab }}$ : Long-term drift


## Vers

- $F_{T}$ : Temperature coefficient (influence of medium or ambient temperature)
- $\mathrm{F}_{\mathrm{KI}}$ : Deviation


## Ambient conditions

Ambient, storage and transport temperature
-- Connection cable PE
$-40 \ldots+60^{\circ} \mathrm{C}\left(-40 \ldots+140^{\circ} \mathrm{F}\right)$

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


## Process conditions

The specifications of the pressure stage are used as an overview. The specifications on the type plate are applicable.
Pressure stage, process fitting

- Thread 316L PN 60
- Thread Alu

PN 25

- Hygienic fittings 316L

PN 10, PN 16, PN 25, PN 40

- Flange 316L, flange with extension PN 40 or $150 \mathrm{lbs}, 300 \mathrm{lbs}$ 316L

Product temperature depending on the measuring cell seal
~ FKM (e.g. Viton)
$-20 \ldots+100^{\circ} \mathrm{C}\left(-4 \ldots+212^{\circ} \mathrm{F}\right)$

- EPDM $-40 \ldots+100^{\circ} \mathrm{C}\left(-40 \ldots+212^{\circ} \mathrm{F}\right), 1 \mathrm{~h}: 140^{\circ} \mathrm{C} /$
~ Kalrez 6375 (FFKM)
~ Chemraz 535
Vibration resistance
Shock resistance
$284^{\circ} \mathrm{F}$ cleaning temperature
$-10 \ldots+100^{\circ} \mathrm{C}\left(+14 \ldots+212^{\circ} \mathrm{F}\right)$
$-30 \ldots+100^{\circ} \mathrm{C}\left(-22 \ldots+212^{\circ} \mathrm{F}\right)$

Electromechanical data
Connection cable

- Configuration
- Wire cross-section
- wire resistance
- Standard length

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- max. length with VEGADIS 12
mechanical vibrations with 4 g and $5 \ldots 100 \mathrm{~Hz}^{\mathrm{B}}$ )
Acceleration $\left.100 \mathrm{~g} / 6 \mathrm{~ms}^{9}\right)$
four wires, one suspension cable, one breather capillary, screen braiding, metal foil, mantle $0.5 \mathrm{~mm}^{2}$ (AWG no. 20)
$<0.036 \mathrm{Ohm} / \mathrm{m}$ (0.011 Ohm/t)
6 m (19.685 ft)
$200 \mathrm{~m}(656.168 \mathrm{ft})$

8) Tested according to the regulations of German Lloyd, GL directive 2.
${ }^{9}$ ) Tested according to EN 60068-2-27.

- Min. bending radius at $25^{\circ} \mathrm{C} / 77^{\circ} \mathrm{F}$

25 mm ( 0.985 in )

- Diameter approx. 8 mm ( 0.315 in )
- Colour - standard PE

Black

- Colour - standard PUR

Blue

- Colour - Ex-version Blue


## Voltage supply

Supply voltage

- Non-Ex instrument
12 ... 36 V DC
- EEx ia instrument

12 ... 29 V DC
Permissible residual ripple

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



Fig. 10: Voltage diagram VEGABAR 74
1 HART load
2 Voltage limit Ex instrument
3 Voltage limtt non-Ex instrument
Voltage supply

Load in conjunction with VEGADIS



Fig. 11: Voltage diagram VEGABAR 74 wth VEGADIS 12 HART load
Voltage limit Ex instrument
Voltage limit non-Ex instnument
Voltage supply

## Integrated overvoltage protection

Nominal leakage current $(8 / 20 \mu s)$
10 kA
Min. response time
$<25 \mathrm{~ns}$

## Electrical protective measures

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

Approvals ${ }^{10)}$

ATEX ia

Ship approvals
Others

ATEX II 1G EEx ia IIC T6; ATEX II 2G EEx ia IIC T6

GL, LRS, ABS, CCS, RINA, DNV WHG
10.2 Dimensions

VEGABAR 74 - threaded fitting


VEGABAR 74 - hygienic fitting 1


Fig. 13: VEGABAR 74 hygienic fifting: $C C=$ Tri-Clamp 1汭, $C A=$ Tri-Clamp $2^{*}, L A=$ hygienic filting with compression nut F40, TA = Tuchenhagen Varivent ON 32, TB = Tuchenhagen Varivent ON 25, RA/RB = bolting ON 40/DN 50 according fo OIN 11851



VEGABAR 74 - hygienic fitting 2


Fig. 14: VEGABAR $74 \mathrm{KA} / K H=$ cone $D N 40, A A=D R D, S D / S E=$ Anderson $3^{\circ}$ long/short fiting
81LOLO-N3-टとち8

VEGABAR 74 - flange connection


Fig. 15: VEGABAR 74 - flange connection
1 Flange connection according to DIN 2501
2 Flange fitting according to ANSI B16.5
Flange with extension
Order-specific

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VEGABAR 74 - threaded fitting for paper industry


Fig. 16: VEGABAR 74 - connection for paper industry: $B A / B B=M 44 \times 1.25$

VEGABAR 74 - extension fitting for paper industry


Fig. 17: VEGABAR 74 -extension fitting for paper industy. EV/FT = absolutaly fush for putper (EV 2-times flattened), EG = 28432-EN-070718 extension for ball valve fitting ( $L=$ onder-specific)

## 10．3 Industrial property rights

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## V尼區

VEGA Grieshaber KG
Am Hohenstein 113
77761 Schiltach
Germany
Phone +49 7836 50-0
Fax +497836 50-201
E-mail: info@de.vega.com
www.vega.com

## 

All statements concerning scope of delivery, application, practical use and operating conditions of the sensors and processing systems correspond to the information available at the time of printing.
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Subject to change without prior notice
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## CERTIFICATE OF <br> TEST

## Project:- PUMP STATION SP160 MANATON PARK

## Client:- BRISBANE CITY COUNCIL

"Whelan Electrical Services Pty Ltd certify that the electrical installation, to the extent it is effected by the electrical work, has been tested to ensure it is electrically safe and is in accordance with the requirements of the wiring rules and any other standard applying to the electrical installation under the Electrical Safety Regulation 2002"

Signed:-

4.500

H 5.160
6.500

4mary
50 m trs.

## SP160 MANATON PARK SEWAGE PUMPING STATION <br> SITE COVER SHEET






$\frac{\text { RTU DIGITAL INPUTS }}{-24 \text { VOC PowE SUPPLY }}$


- ${ }^{24}$ QOEC POLER SER SUPPLY


| LEGEND: |  |
| :---: | :---: |
| $\pm$ | SwITCHBOARO Pow |
| $\varnothing$ | swithboard control terminal |
| $\square$ | Switcheoard generator term. |
| - | fill ferminal |
| $\pm$ | plc terrinal |
| $\square$ | RTU TERRINAL |
| - | SS temminal |
| - | PLL//RTU MARSh. fuse terhinal |
| $\bigcirc$ | PLİRTU Marsh Llink terminal |
| - | disconnect Plug |
| $\square^{1}+12$ | rtu digtal input |
| (0) +12 | rtu igital output |
| an-2 | rtu analogive input |
| 90022 | riu analogue output |

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COMMMON RTU VO SCHMMON RTU VO
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Sheet 09
FOR CONSTRUCTION


$\frac{\text { SP160 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement OM Manual }}{6} \frac{1}{8} \frac{1}{10}$

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SP160 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement OM Manual



SPI60 Jesmond Road Indooroopilly SPS Pump Station Switchboard Replacement OM Manua


concrete slab layout


SLAB \& CONDUITS ALL DIMENSIONS TO BE CONFIRMED ON SITE :? ?

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14 January 2008

Brisbane City Council
GPO Box 2567
BRISBANE QLD 4000

ATTENTION: Warren Henderson

## Dear Warren,

## RE: CONTRACT NO. BW70107-06/07 SEWAGE PUMP STATION 160 - MANATON PARK

Please find attached one (1) copy of the operation and maintenance manual for the above contract.

If you have any queries please contact me.


[^0]:    CAUTION: Very high currents can arise when the motor is reversed from running at full speed in one direction to running at full speed in the opposite direction.

[^1]:    

    WARNING: If configured according to the description above, relays K1 and K2 will never be activated at the same time. There is a time delay of $\mathbf{5 0 0} \mathbf{~ m s}$ for the change-over between the relays. However, if the relays are not configured properly, they may be activated at the same time.

[^2]:    zompactFlash is a registered trademark of CompactFlash Association.

[^3]:    TE: Port B Pin 9 output has a high impedance of ind 50K OHMS and loading will decrease accuracy of the RSSI measurement.

[^4]:    8 Set rotary switch to "OPERATE"
    9 Close housing cover
    The adjustment data are effective, the output current $4 \ldots 20 \mathrm{~mA}$ corresponds to the actual level.

