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

MSF
SOFT STARTER

INSTRUCTION MANUAL

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Safety

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

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

Operating and maintenance personnel

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

Installation of spare parts

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

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

Emergency

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

Dismantling and scrapping

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

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

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1. GENERAL INFORMATION

1.1 Integrated safety systems

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

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

The soft starter is fitted with a connection for protective earth ⏚ (PE).

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

1.2 Safety measures

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

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

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

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

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

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

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

1.3 Notes to the Instruction Manual

WARNING! Warnings are marked with a warning triangle.

Serial number

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

Important

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

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

1.4 How to use the Instruction Manual

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

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

1.5 Standards

The device is manufactured in accordance with these regulations.

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

1.6 Tests in accordance with norm EN60204

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

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

1.7 Inspection at delivery

Fig. 1 Scope of delivery.

1.7.1 Transport and packing

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

Check on receipt:

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

Is the packaging damaged?

- Check the goods for damage (visual check).

If you have cause for complaint

If the goods have been damaged in transport:

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

Packaging for returning the device

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

Intermediate storage

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

1.8 Unpacking of MSF-310 and larger types

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

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

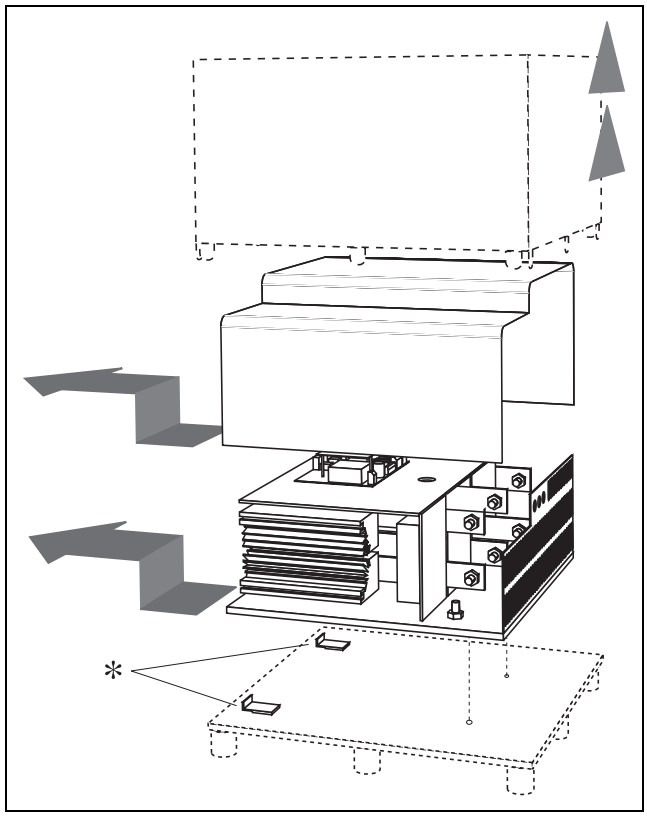
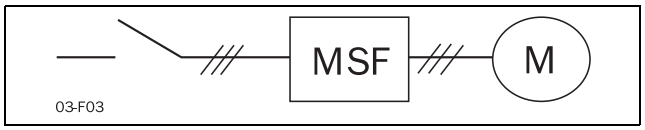


Fig. 2 Unpacking of MSF-310 and larger models.

2. DESCRIPTION

2.1 General

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



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

There are 3 different kinds of soft starting control methods:

- **Control method 1-Phase**
  The single phase controlled soft starters provide only a reduction in starting torque no control of current or torque. These starters need a main and bypass contactor as well as external motor protections. This is a open loop voltage controller. These starters are mainly in the power up to 7.5 kW.
- **Control method 2-Phase**
  The two phase starters can start a motor without a mains contactor, but in that case voltage still is present at the motor when it´s stopped. These starters are mainly in the power up to 22 kW.
- **Control method 3-Phase**
  In the three phase Soft Starters there are different technologies:
  - Voltage control
  - Current control
  - Torque control

Voltage control

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

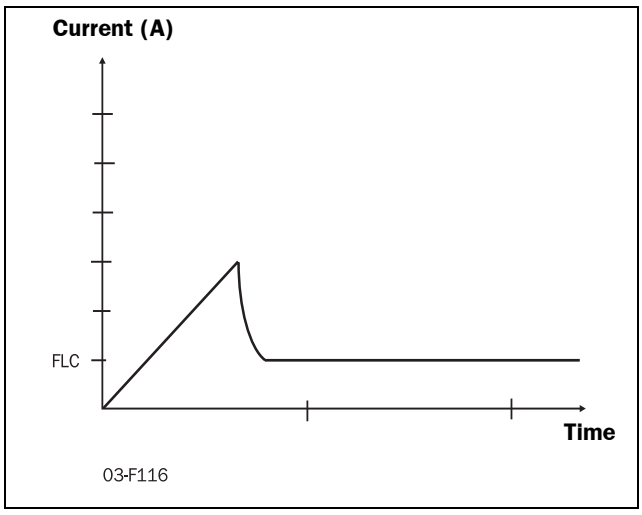


Fig. 3 Voltage control

Current control

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

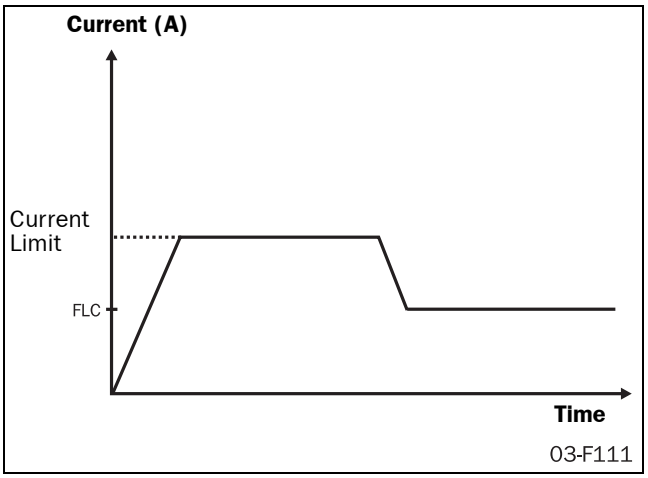


Fig. 4 Current control

Torque control

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

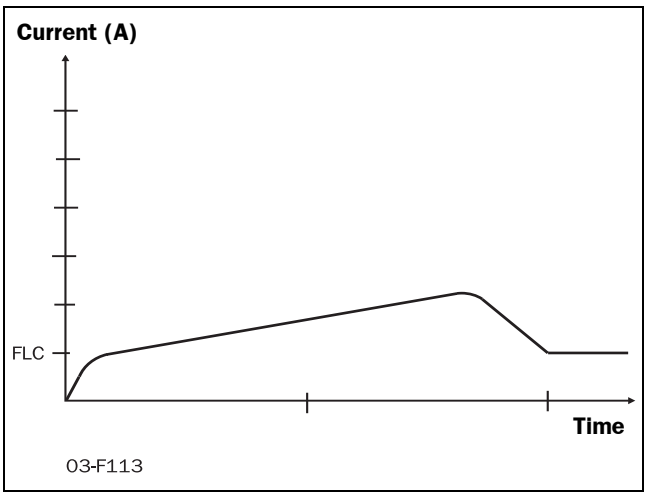


Fig. 5 Torque control

2.2 MSF control methods

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

2.2.1 General features

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

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

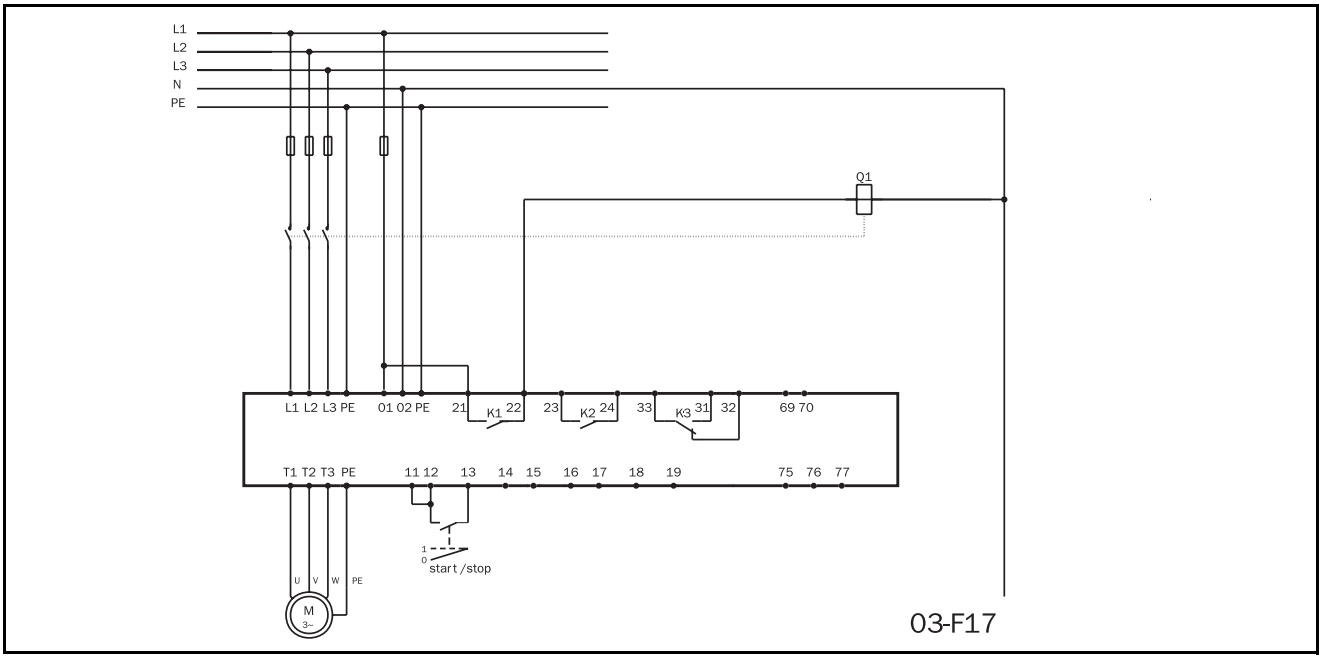


Fig. 6 Standard wiring.

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

WARNING! Mounting, wiring and setting the device into operation must be carried out by properly trained personnel. Before set-up, make sure that the installation is according to chapter 6. page 24 and the Checklist below.

3.1 Checklist

- Mount the soft starter in accordance with chapter 6. page 24.
- Consider the power loss at rated current when dimensioning a cabinet, max. ambient temperature is 40ºC (see chapter 12. page 74).
- Connect the motor circuit according to Fig. 6.
- Connect the protective earth.
- Connect the control voltage to terminals 01 and 02 (100 - 240 VAC or 380-500 VAC).
- Connect relay K1 (PCB terminals 21 and 22) to the contactor - the soft starter then controls the contactor.
- Connect PCB terminals 12 and 13 to, e.g., a 2-way switch (closing non-return) or a PLC, etc., to obtain control of soft start/soft stop.[1])
- Check that the motor and supply voltage corresponds to values on the soft starter's rating plate.
- Ensure the installation complies with the appropriate local regulations.

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

3.2 Main functions/Applications

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

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

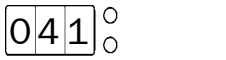
The first step in the settings is to set menu 007 and 008 to "ON" to reach the main functions 020-025 and motor data 041-046.

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

3.3 Motor Data

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

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

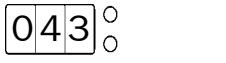


Nominal motor voltage

Default:	400 V
Range:	200-700 V

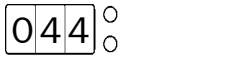
Nominal motor current

Default:	Nominal current soft starter
Range:	25% - 150% of In_{soft} in Amp



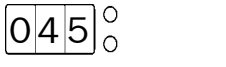
Nominal motor power

Default:	Nominal power soft starter
Range:	25% - 300% of Pn_{soft} in kW



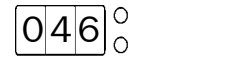
Nominal motor speed

Default:	Nominal speed soft starter
Range:	500-3600 rpm



Nominal motor cos phi

Default:	0.86
Range:	0.50-1.00



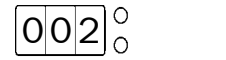
Nominal frequency

Default:	50 Hz
Range:	50/60 Hz

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

3.4 Setting of the start and stop ramps

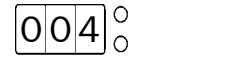
The menu´s 002 and 003 can now be set to adjust the start ramp up time and the stop ramp down time.



Start time ramp 1

Default:	10 sec
Range:	1-60 sec

Estimate the starting-time for the motor/machine. Set "ramp up time" at start (1-60 sec).
Key "ENTER ↵ " to confirm new value.
Key "NEXT → ", "PREV ← " to change menu.



Stop time ramp 1

Default:	oFF
Range:	oFF, 2-120 sec

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

3.5 Setting the start command

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

006	
2	**Selection of control mode**
Default:	2
Range:	1,2,3

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

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

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

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

3.6 Viewing the motor current

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

005	
0.0	**RMS current read-out**
Default:	-
Range:	0.0-9999 Amp.

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

3.7 Starting

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

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

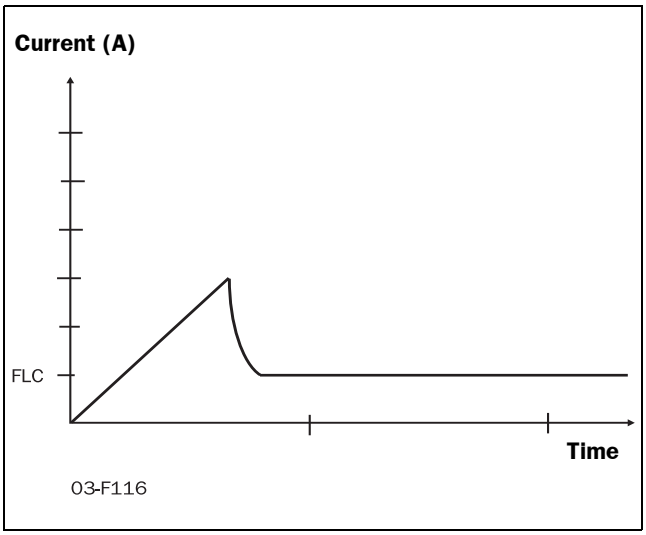


Fig. 7 Example of start ramp with main function voltage ramp.

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

To make the right choice the following tools are used:

- **The norm AC53a.**
  This norm helps selecting the soft starter rating with regard to duty cycle, starts per hour and maximum starting current.
- **The Application Rating List.**
  With this list the soft starter rating can be selected depending on the kind of application used. The list use 2 levels of the AC53a norm. See table 1, page 15.
- **The Application Function List.**
  This table gives an complete overview of most common applications and duties. For each applications the menu's that can be used are given. See table 2, page 17.
- **Function and Combination matrix.**
  With these tables it is easy to see which combinations of Main and additional functions are possible, see table 3, page 19 and table 4, page 19.

4.1 Soft starter rating according to AC53a

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

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

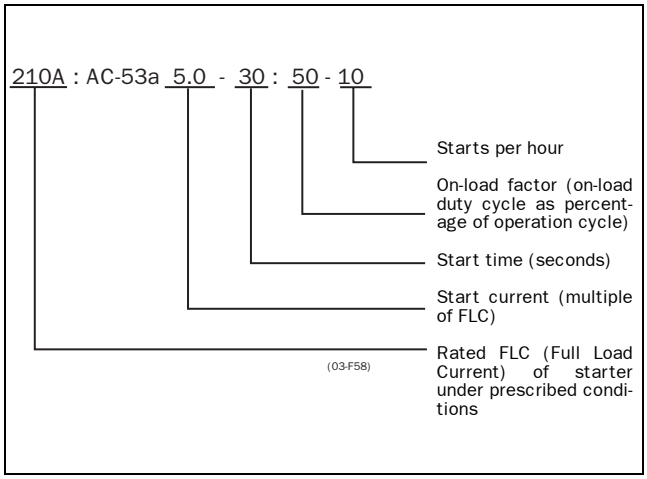


Fig. 8 Rating example AC53a.

The above example indicates a current rating of 210 Amps with a start current ratio of 5.0 x FLC (1050A) for 30 seconds with a 50% duty cycle and 10 starts per hour.

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

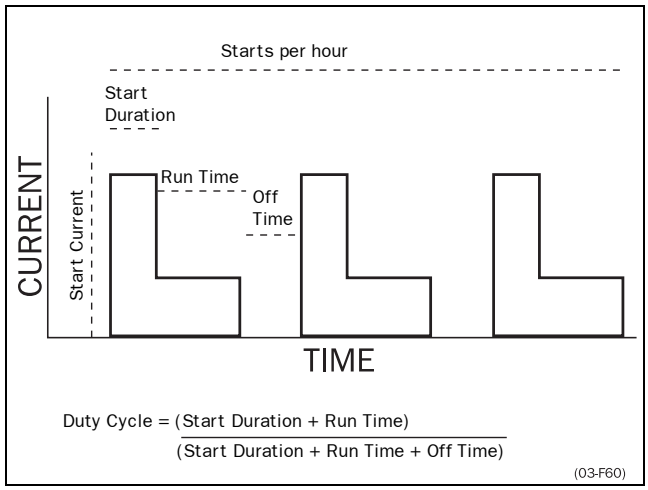


Fig. 9 Duty cycle, non bypass.

4.2 Soft starter rating according to AC53b

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

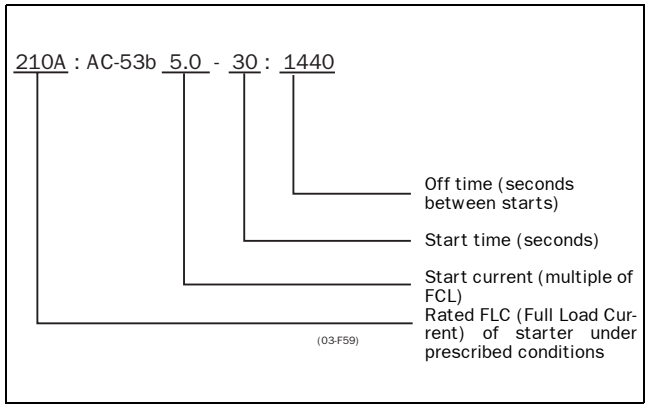


Fig. 10 Rating example AC53b.

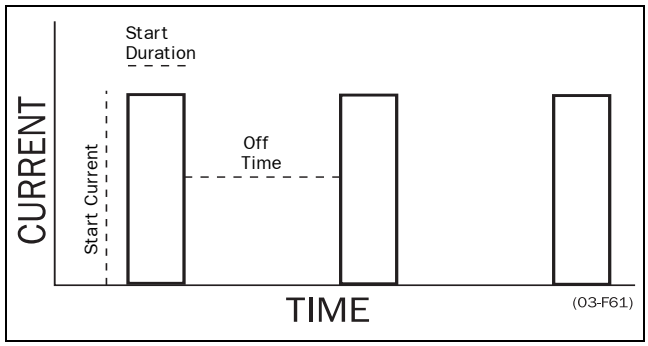


Fig. 11 Duty cycle, bypassed

The above example indicates a current rating of 210 Amps with a start current ratio of 5.0 x FLC (1050A) for 30 seconds with a 24-minute period between starts.

4.3 MSF Soft starter ratings

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

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

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

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

- **AC53a 5.0-30:50-10 (heavy duty)**
  This level will be able to start all applications and follows directly the type number of the soft starter. Example: MSF 370 is 370 Amps FLC and then 5 time this current in starting.
- **AC 53a 3.0-30:50-10 (normal/light duty)**
  This level is for a bit lighter applications and here the MSF can manage a higher FLC.
  Example: MSF 370 in this norm manage 450 Amps FLC and the 3 times this current in starting

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

4.4 The Application Ratings List

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

Description and use of the table:

- **Applications.**
  This column gives the various applications. If the machine or application is not in this list, try to identify a similar machine or application. If in doubt pleas contact your supplier.
- **AC53a ratings.**
  The rating according to AC53a norm is here classified in 2 ratings. The first for normal/light duty (3.0-30:50-10) and the second for heavy duty (5.0-30:50-10)
- **Typical Starting current.**
  Gives the typical starting current for each application
- **Main Function menu.**
  The Main Function menu is advised here.
  "25;=1", means: program selection 1 in menu 25.
- **Stop function.**
  Gives a possible Stop function if applicable.
  "36;=1 / 38-40", means: program selection 1 in menu 36, also menus 38 to 40 can be selected.

EXAMPLE:

Roller Mill:

- This is an application for heavy duty,
- Typical starting current of 450%.
- Main function Torque ramp start (menu 25) will give the best results.
- Stop function Dynamic Brake (menu 36, selection 1) can be used.
- As well as the Slow Speed at start and stop (menu 38-40) can be used for better start and stop performance.

Table 1 Applications Rating List

Applications	AC53a 3.0-30:50-10 (normal/light)	AC 53a 5.0-30:50-10 (heavy)	Typical starting current %	Main function Menu nr.	Stop function Menu nr.
General & Water					
Centrifugal Pump	x		300	22	22
Submersible Pump	x		300	22	22
Conveyor		x	300-400	25;=1	36;=1 / 38-40
Compressor: Screw	x		300	25	-
Compressor, Reciprocating	x		400	25;=1	-
Fan	x		300	25;=2	-
Mixer		x	400-450	25;=1	-
Agitator		x	400	25;=1	-
Metals & Mining					
Belt Conveyor		x	400	25;=1	36;=1 / 38-40
Dust Collector	x		350	25;=1	-
Grinder	x		300	25;=1	36;=1
Hammer Mill		x	450	25;=1	36;=2
Rock Crusher		x	400	25;=1	-
Roller Conveyor	x	x	350	25;=1	36;=1 / 38-40
Roller Mill		x	450	25;=1	36;=1 or 2
Tumbler		x	400	25;=1	-
Wire Draw Machine		x	450	25;=1	36;=1 or 2
Food Processing					
Bottle Washer	x		300	25;=2	
Centrifuge		x	400	25;=1	36;=1 or 2
Dryer		x	400	25;=2	
Mill		x	450	25;=1	36;=1 or 2
Palletiser		x	450	25;=1	
Separator		x	450	25;=1	36;=1 or 2
Slicer	x		300	25;=1	
Pulp and Paper					
Re-Pulper		x	450	25;=1	
Shredder		x	450	25;=1	
Trolley		x	450	25;=1	
Petrochemical					
Ball Mill		x	450	25;=1	
Centrifuge		x	400	25;=1	36;=1 or 2
Extruder		x	500	25;=1	
Screw Conveyor		x	400	25;=1	
Transport & Machine Tool					
Ball Mill		x	450	25;=1	
Grinder		x	350	25;=1	36;=1
Material Conveyor		x	400	25;=1	36;=1 / 38-40
Palletiser		x	450	25;=1	
Press		x	350	25;=1	
Roller Mill		x	450	25;=1	
Rotary Table		x	400	25;=1	36;=1 / 38-40
Trolley		x	450	25;=1	
Escalator		x	300-400	25;=1	
Lumber & Wood Products					
Bandsaw		x	450	25;=1	36;=1 or 2
Chipper		x	450	25;=1	36;=1 or 2
Circular Saw		x	350	25;=1	36;=1 or 2
Debarker		x	350	25;=1	36;=1 or 2
Planer		x	350	25;=1	36;=1 or 2
Sander		x	400	25;=1	36;=1 or 2

4.5 The Application Functions List

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

Description and use of the table:

- **Application /Duty.**
  This column gives the various applications and level of duty. If the machine or application is not in this list, try to identify a similar machine or application. If in doubt pleas contact your supplier.
- **Problem.**
  This column describes possible problems that are familiar for this kind of application.
- **Solution MSF.**
  Gives the possible solution for the problem using one the MSF function.
- **Menus.**
  Gives the menu numbers and selection for the MSF function.
  "25;=1", means: program selection 1 in menu 25.
  "36;=1 / 34,35", means: program selection 1 in menu 36, menus 34 and 35 are related to this function.

Table 2 Application Function List

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

Table 2 Application Function List

Application/ Duty	Problem	Solution MSF	Menus
MIXER Heavy	Different materials	Linear Torque ramp gives linear acceleration and lowest possible starting current.	25;=1
	Need to control material viscosity	Shaft power analog output	54-56
	Broken or damaged blades	Shaft power overload	92-95
		Shaft power underload	96-99
HAMMER MILL Heavy	Heavy load with high breakaway torque	Linear Torque ramp gives linear acceleration and lowest possible starting current.	25;=1
		Torque boost in beginning of ramp.	30,31
	Jamming	Shaft power overload	92-95
	Fast stop	Controlled sensor less soft brake with reversing contactor for heavy loads.	36;=2,34,35
	Motor blocked	Locked rotor function	75

EXAMPLE:

Hammer Mill:

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

4.6 Function and combination matrix

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

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

Table 3 Combination matrix

Main Functions / **Additional functions**	Dual ramp start	Dual ramp stop	Bypass (032)	Power factor control (033)	Torque boost (030)	Jogging with keyboard/terminal	Timer controlled slow speed	External controlled slow speed	Complete protection	Parameter sets (061)	Dynamic Vector Brake (036-1)	Softbrake (036-2)
Voltage ramp start/stop (default)	X	X	X	X	X	X	X	X	X	X	X	
Torque control start/stop (menu 025)			X	X	X	X	X	X	X	X	X	
Voltage ramp with current limit (menu 020)		X	X	X	X	X	X	X	X	X	X	X
Current limit start (menu 021)		X	X	X	X	X	X	X	X	X	X	X
Pump control (menu 022)			X						X	X		
Analog input (menu 023)									X	X		
Direct on line start (menu 024)			X						X	X		

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

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

Table 4 Start/stop combination.

START FUNCTION / **STOP FUNCTION**	Voltage ramp stop	Torque control stop	Pump control	Analog input	Direct on line stop	Dynamic Vector Brake	Softbrake
Voltage ramp start	X				X	X	X
Torque control start		X			X	X	X
Current limit start	X				X	X	X
Voltage ramp with current limit	X				X	X	X
Pump control			X		X		
Analog input				X	X		
Direct on line start					X		

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

4.7 Special condition

4.7.1 Small motor or low load

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

4.7.2 Ambient temperature below 0°C

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

4.7.3 Phase compensation capacitor

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

4.7.4 Pole-changing contactor and two speed motor

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

4.7.5 Shielded motor cable

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

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

4.7.6 Slip ring motors

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

4.7.7 Pump control with soft starter and frequency inverter together

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

4.7.8 Starting with counter clockwise rotating loads

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

4.7.9 Running motors in parallel

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

4.7.10 How to calculate heat dissipation in cabinets

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

4.7.11 Insulation test on motor

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

4.7.12 Operation above 1000 m

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

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

4.7.13 Reversing

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

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

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

Fig. 12 MSF soft starter models.

5.1 General description of user interface

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

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

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

Setting

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

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

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

5.2 PPU unit

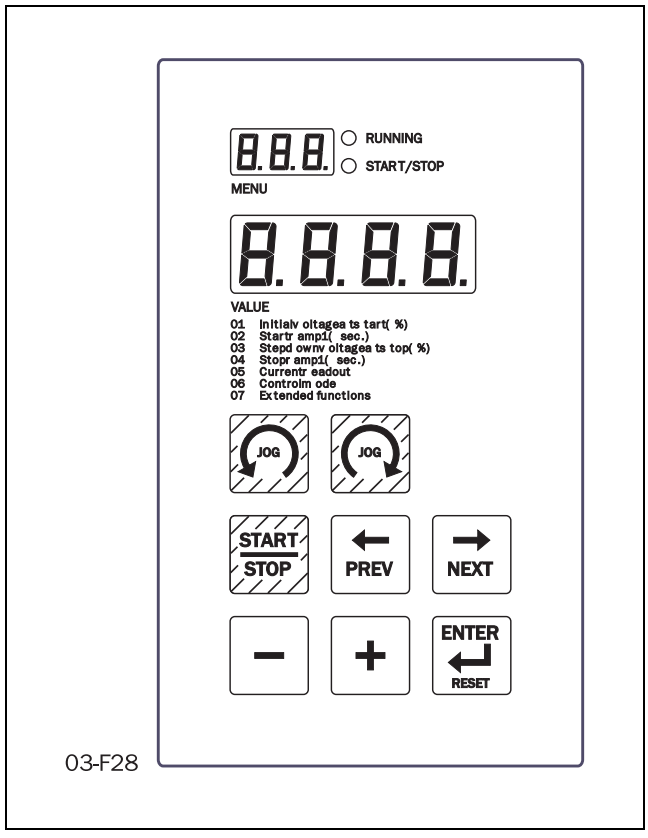


Fig. 13 PPU unit.

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

5.3 LED display

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

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

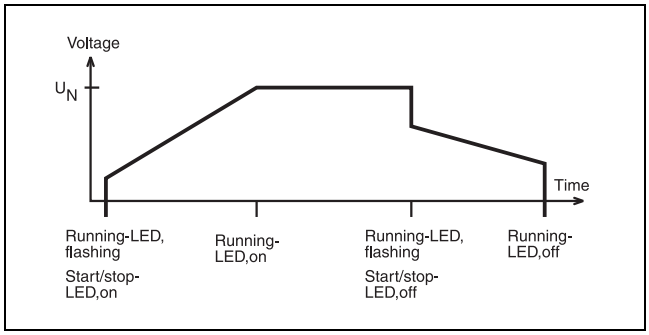


Fig. 14 LED indication at different operation situation.

5.4 The Menu Structure

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

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

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

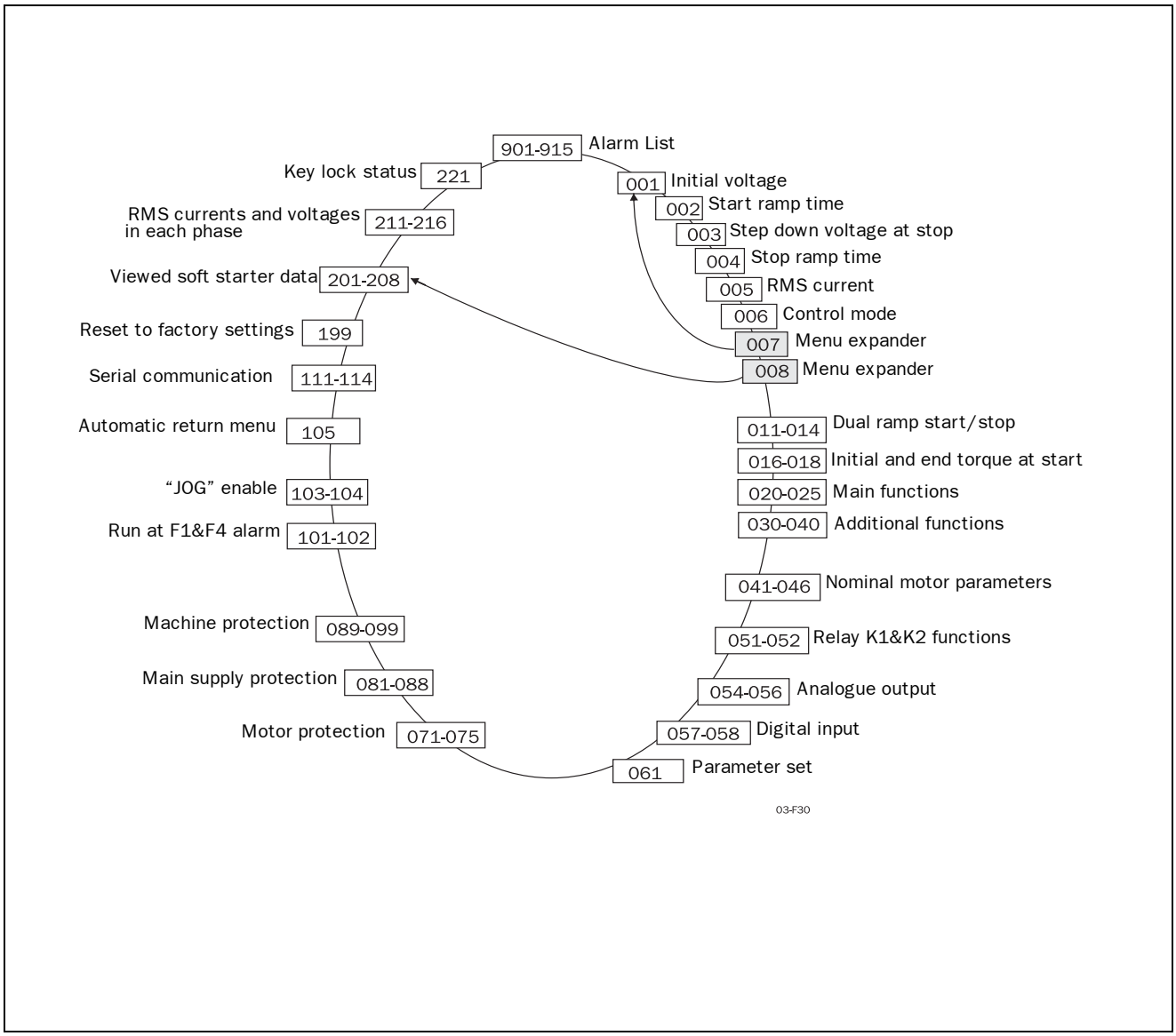


Fig. 15 Menu structure.

5.5 The keys

The function of the keyboard are based on a few simple rules. At power up menu 001 is shown automatically. Use the “NEXT →” and “PREV ←”keys to move between menus. To scroll through menu numbers, press and hold either the “NEXT →” or the “PREV ←” key. The ”+” and ”–” keys are used to increase respectively decrease the value of setting. The value is flashing during setting. The ”ENTER ↵” key confirms the setting just made, and the value will go from flashing to stable. The ”START/STOP” key is only used to start and stop the motor/machine.
The and keys are only used for JOG from the keyboard. Please note one has to select enable in menu 103 or 104, see § 7.25, page 61.

Table 5 The keys

Start/stop motor operation.	START/STOP
Display previous menu.	PREV
Display next menu.	NEXT
Decrease value of setting.	−
Increase value of setting.	+
Confirm setting just made. Alarm reset.	ENTER RESET
JOG Reverse	JOG
JOG Forward	JOG

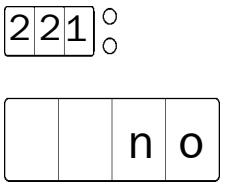
5.6 Keyboard lock

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

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

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

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



Locked keyboard info

Default:	no
Range:	no, YES
no	Keyboard is not locked
YES	Keyboard is locked

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

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

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

Table 6 Control modes

Control mode	Operation/ Set-up	Start/Stop	JOG fwd/rev	Alarm reset	Setting of parameters	
					Parameter set with external selection Menu 061=0	Parameter set with internal selection Menu 061=1-4
Keyboard Menu 006=1	Unlocked keyboard	Keyboard	Keyboard	Keyboard	----------	Keyboard
	Locked keyboard	----------	----------	----------	----------	----------
Remote Menu 006=2	Unlocked keyboard	Remote	Remote	Remote and keyboard	Remote	Keyboard
	Locked keyboard	Remote	Remote	Remote	Remote	----------
Serial comm. Menu 006=3	Unlocked keyboard	Serial comm	Serial comm	Serial comm. and keyboard	----------	Serial comm
	Locked keyboard	Serial comm	Serial comm	Serial comm	----------	Serial comm

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

- In accordance with the local safety regulations of the electricity supply company.
- In accordance with DIN VDE 0100 for setting up heavy current plants.

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

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

6.1 Installation of the soft starter in a cabinet

When installing the soft starter:

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

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

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

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

NOTE! For UL-approval use 75°C Copper wire only.

MSF-017 to MSF-250

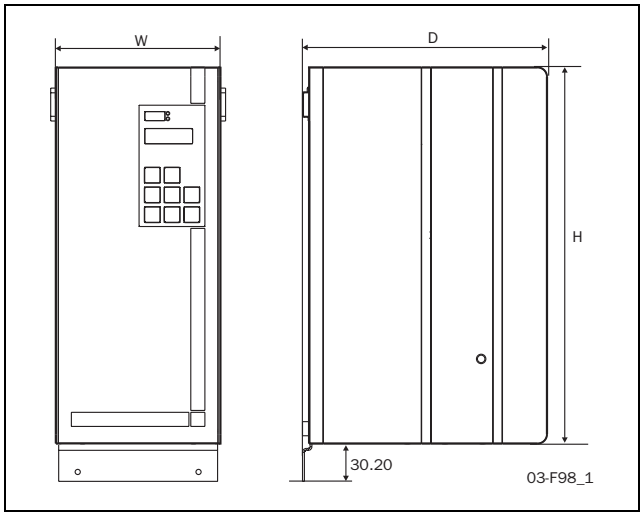


Fig. 16 MSF-017 to MSF-250 dimensions.

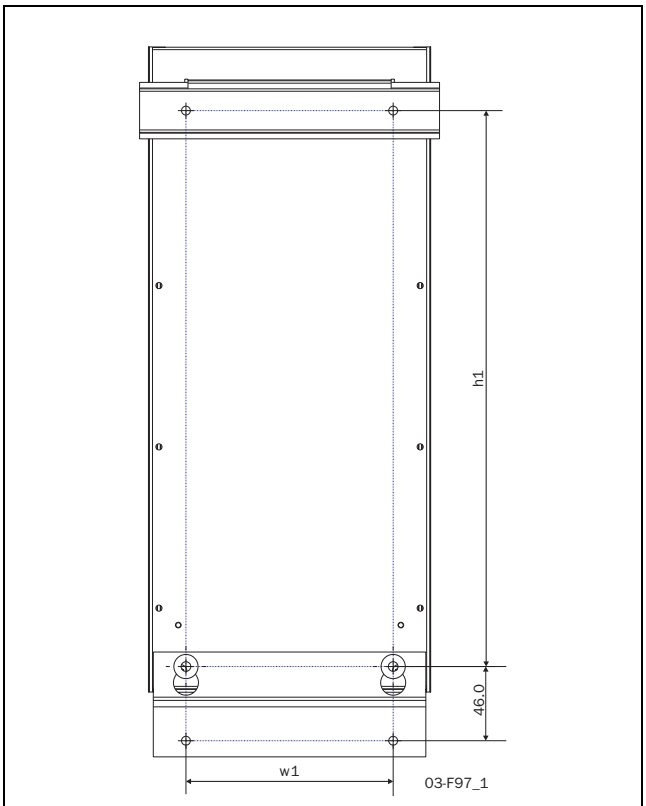


Fig. 17 Hole pattern for MSF-017 to MSF-250 (backside view).

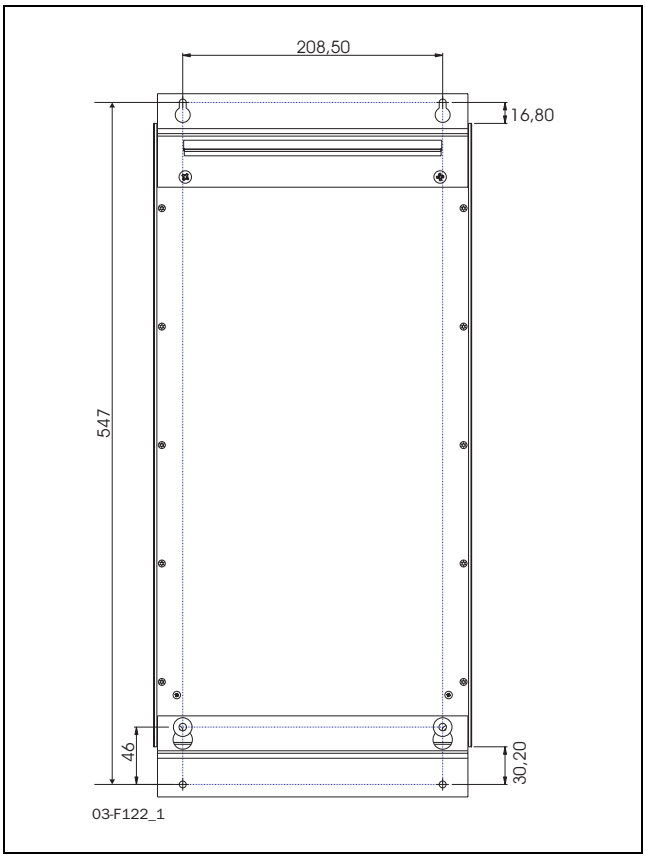


Fig. 18 Hole pattern for MSF-170 to MSF-250 with upper mounting bracket instead of DIN-rail.

MSF-017 to MSF-250

Table 7 MSF-017 to MSF-250.

MSF model	Class	Connection	Conv./ Fan	Dimension HxWxD (mm)	Hole dist. w1 (mm)	Hole dist. h1 (mm)	Diam./ screw	Weight (kg)
-017, -030	IP 20	Busbars	Convection	320x126x260	78.5	265	5.5/M5	6.7
-045, -060, -075, -085	IP 20	Busbars	Fan	320x126x260	78.5	265	5.5/M5	6.9
-110, -145	IP 20	Busbars	Fan	400x176x260	128.5	345	5.5/M5	12.0
-170, -210, -250	IP 20	Busbars	Fan	500x260x260	208.5	445	5.5/M5	20

Table 8 MSF-017 to MSF-250

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

MSF-310 to MSF-1400

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

MSF model	Class	Connection	Conv./ Fan	Dimension HxWxD (mm)	Hole dist. w1 (mm)	Hole dist. h1 (mm)	Diam./ screw	Weight (kg)
-310	IP 20	Busbars	Fan	532x547x278	460	450	8.5/M8	42
-370, -450	IP 20	Busbars	Fan	532x547x278	460	450	8.5/M8	46
-570	IP 20	Busbars	Fan	687x640x302	550	600	8.5/M8	64
-710	IP 20	Busbars	Fan	687x640x302	550	600	8.5/M8	78
-835	IP 20	Busbars	Fan	687x640x302	550	600	8.5/M8	80
-1000, -1400	IP00	Busbar	Fan	900x875x336	Fig. 23		8.5/M8	175

Table 10 MSF-310 to MSF-1400.

MSF model	Minimum free space (mm):			Dimension Connection, busbars Al	Tightening torque for bolt (Nm)		
	above 1)	below	at side		Cable	PE-cable	Supply and PE
-310, -370, -450	100	100	0	40x8 (M12)	50	12	0.6
-570, -710, -835	100	100	0	40x10 (M12)	50	12	0.6
-1000, -1400	100	100	100	75x10 (M12)	50	12	0.6
1) Above: Wall-soft starter or soft starter-soft starter							

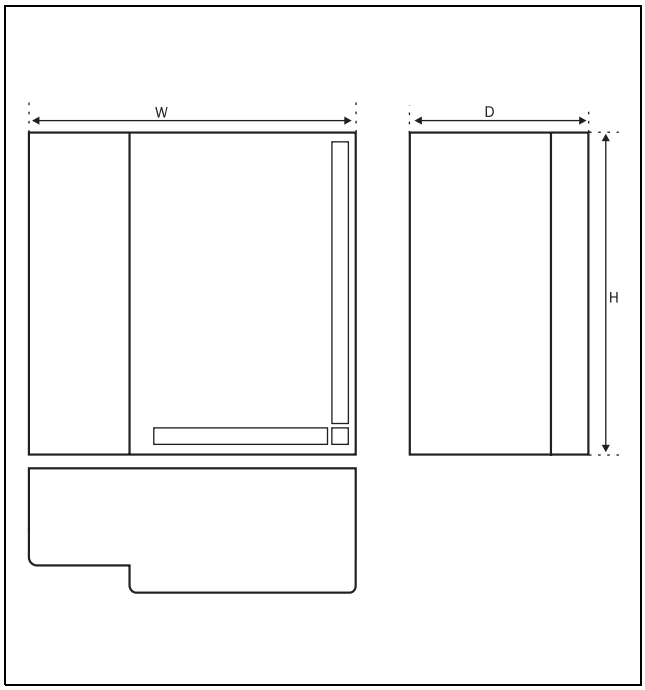


Fig. 19 MSF -310 to MSF -835.

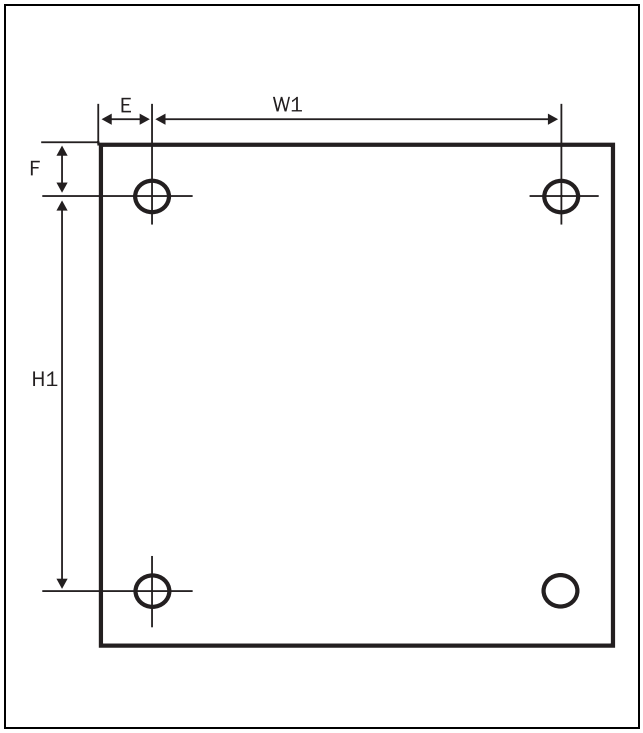


Fig. 20 Hole pattern for screw attachment, MSF-310 to MSF-835. Hole distance (mm).

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

Observe that the two supplied mounting hooks (see § 1.8, page 7 and Fig. 2 on page 7 must be used for mounting the soft starter as upper support (only MSF-310 to MSF-835).

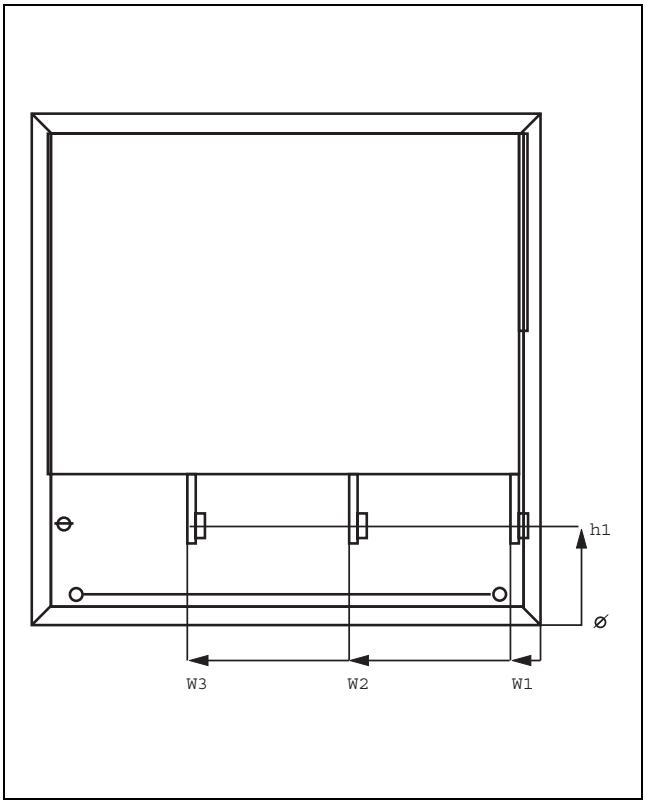


Fig. 21 Busbar distances MSF -310 to MSF -835.

Table 11 Busbar distances

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

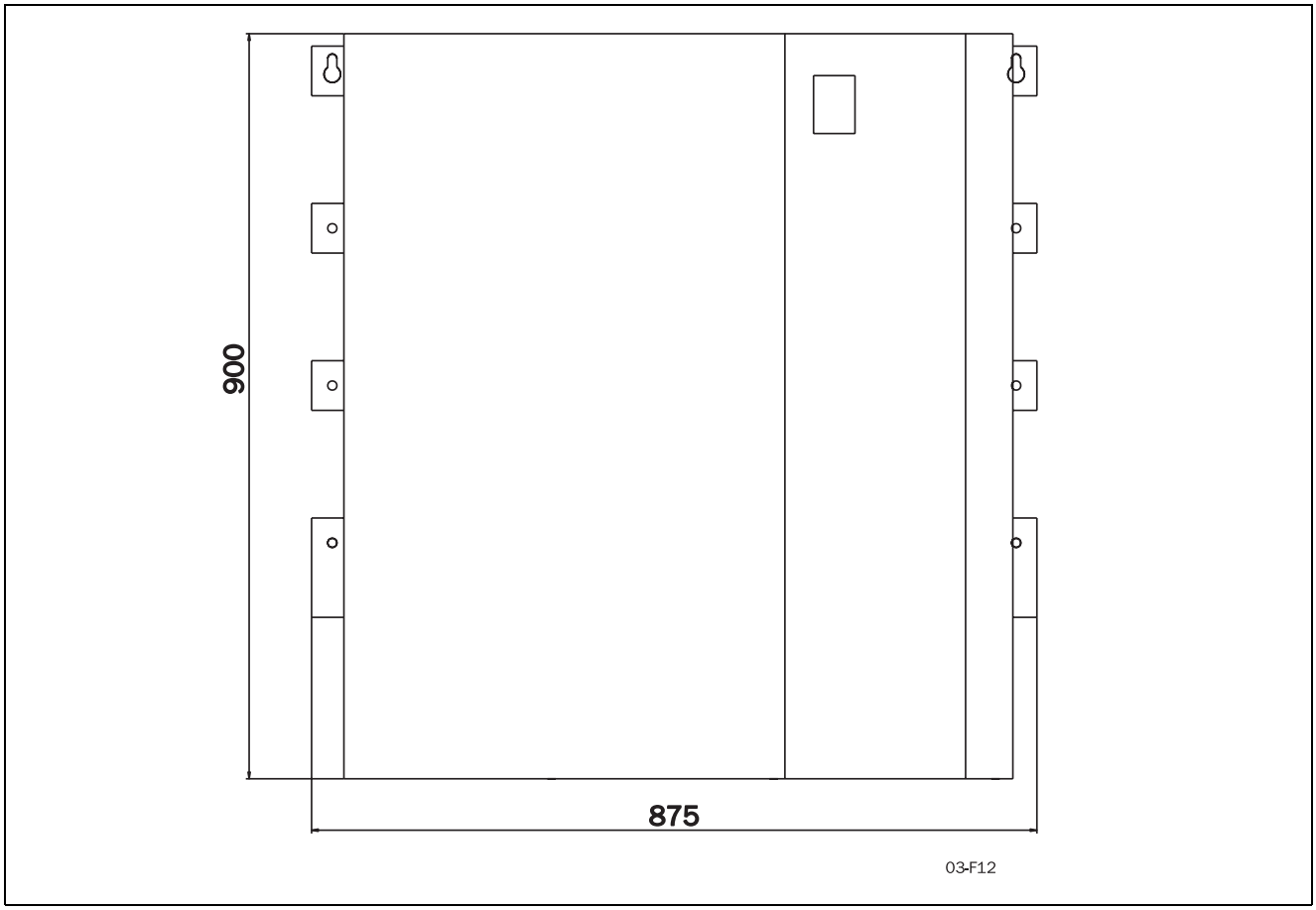


Fig. 22 MSF -1000 to -1400

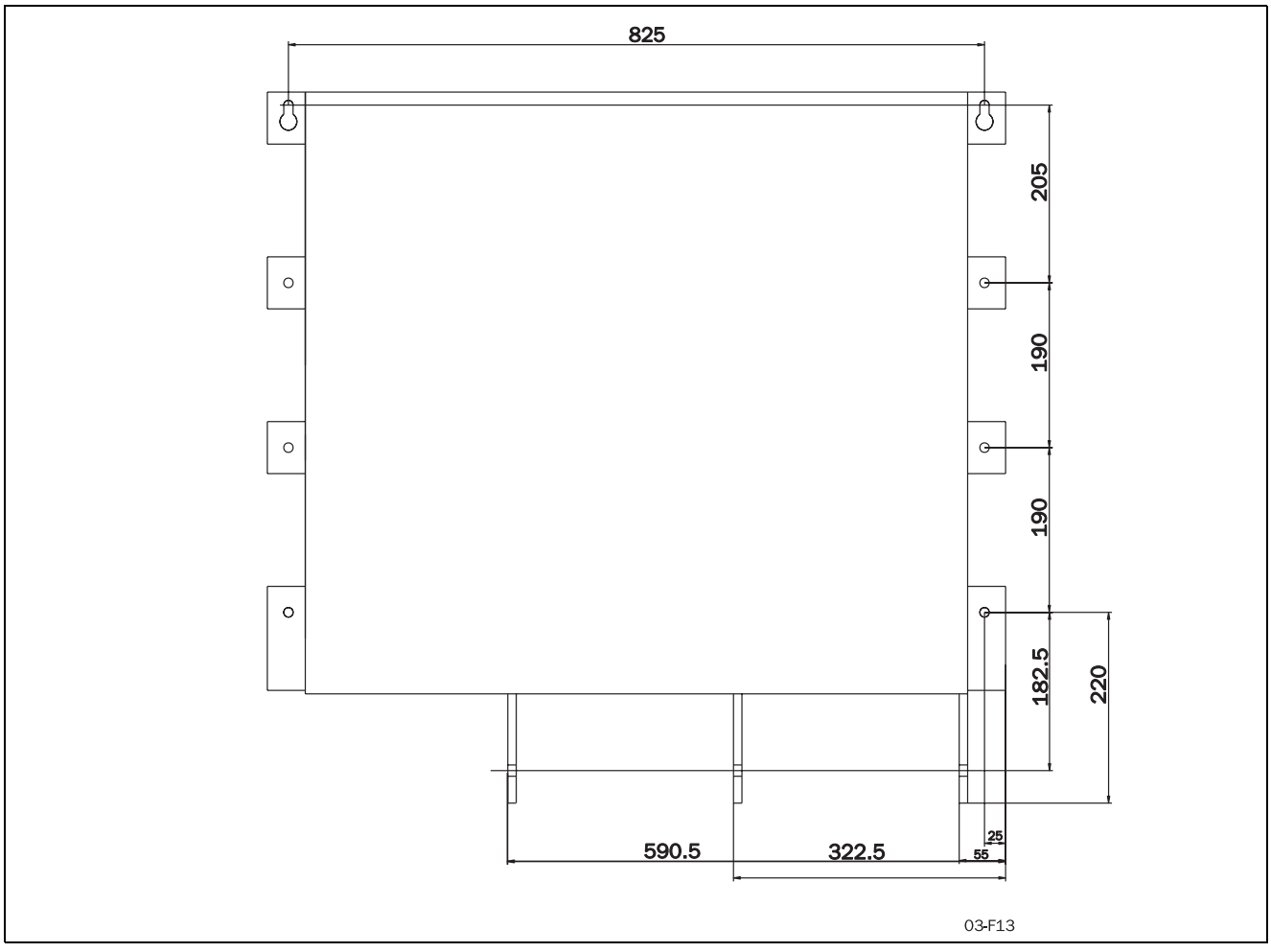


Fig. 23 Hole pattern busbar MSF -1000 to -1400.

6.2 Connections

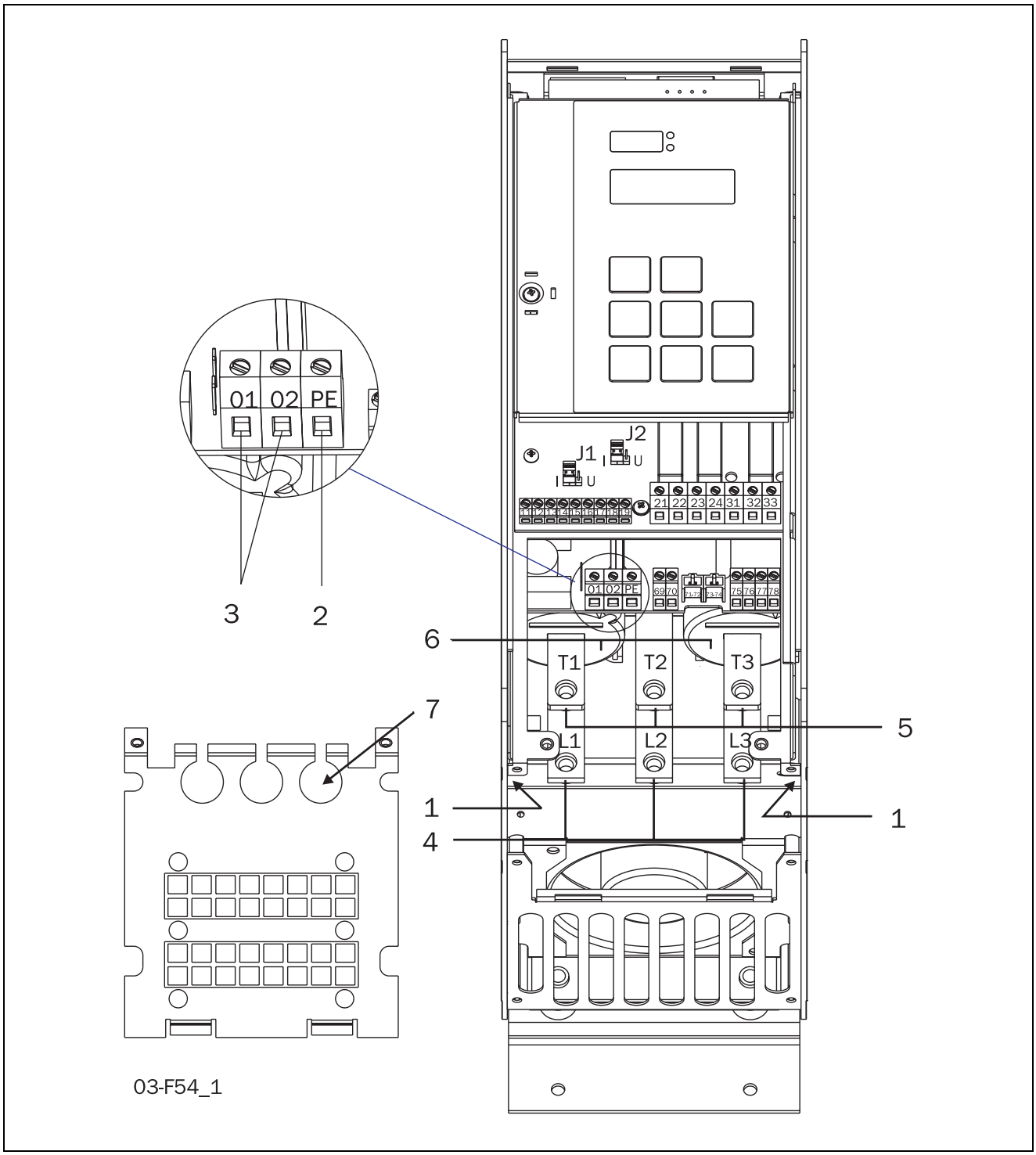


Fig. 24 Connection of MSF-017 to MSF -085.

Connection of MSF-017 to MSF-085

Device connections

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

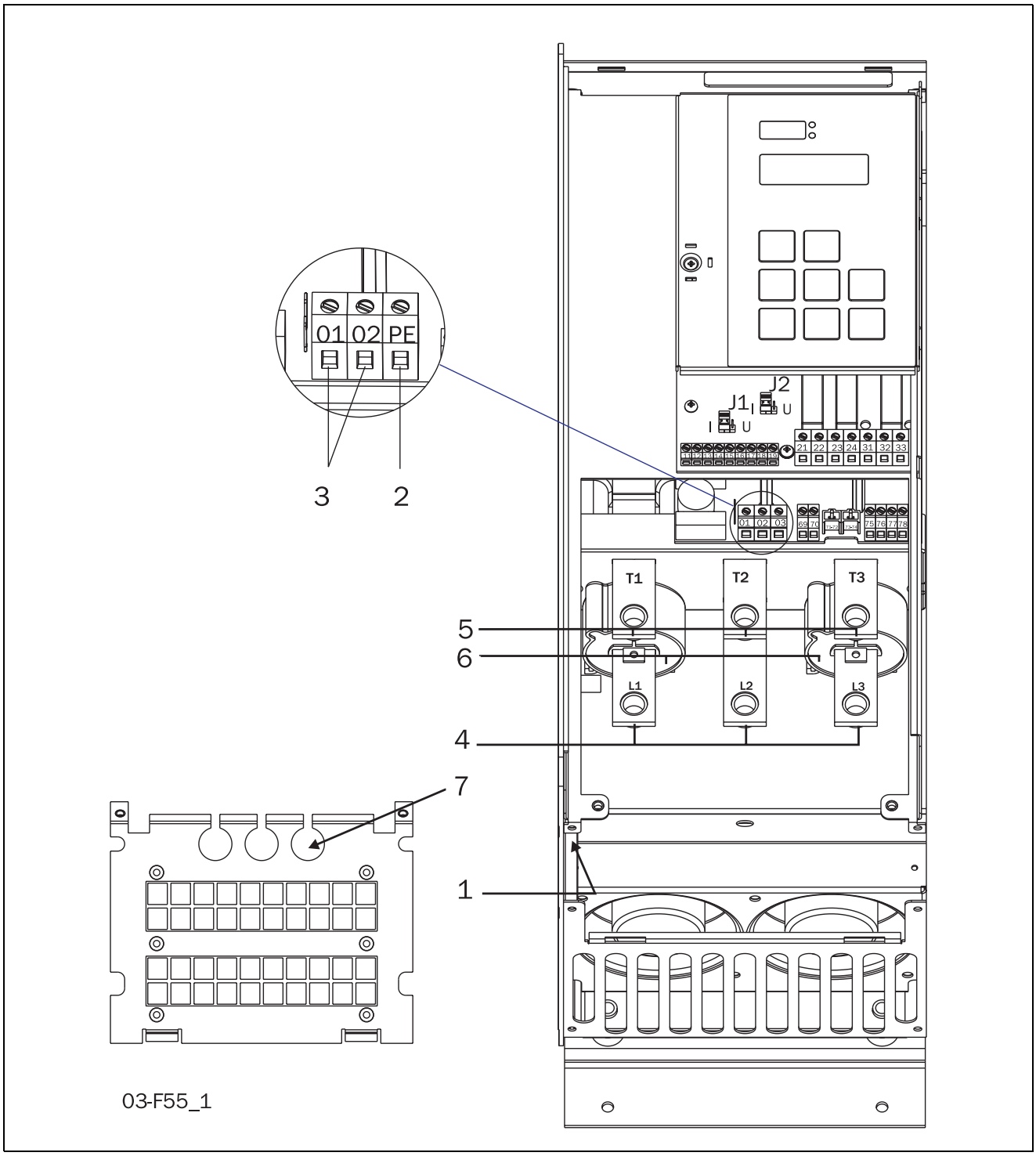


Fig. 25 Connection of MSF-110 to MSF-145.

Connection of MSF-110 to MSF-145

Device connections

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

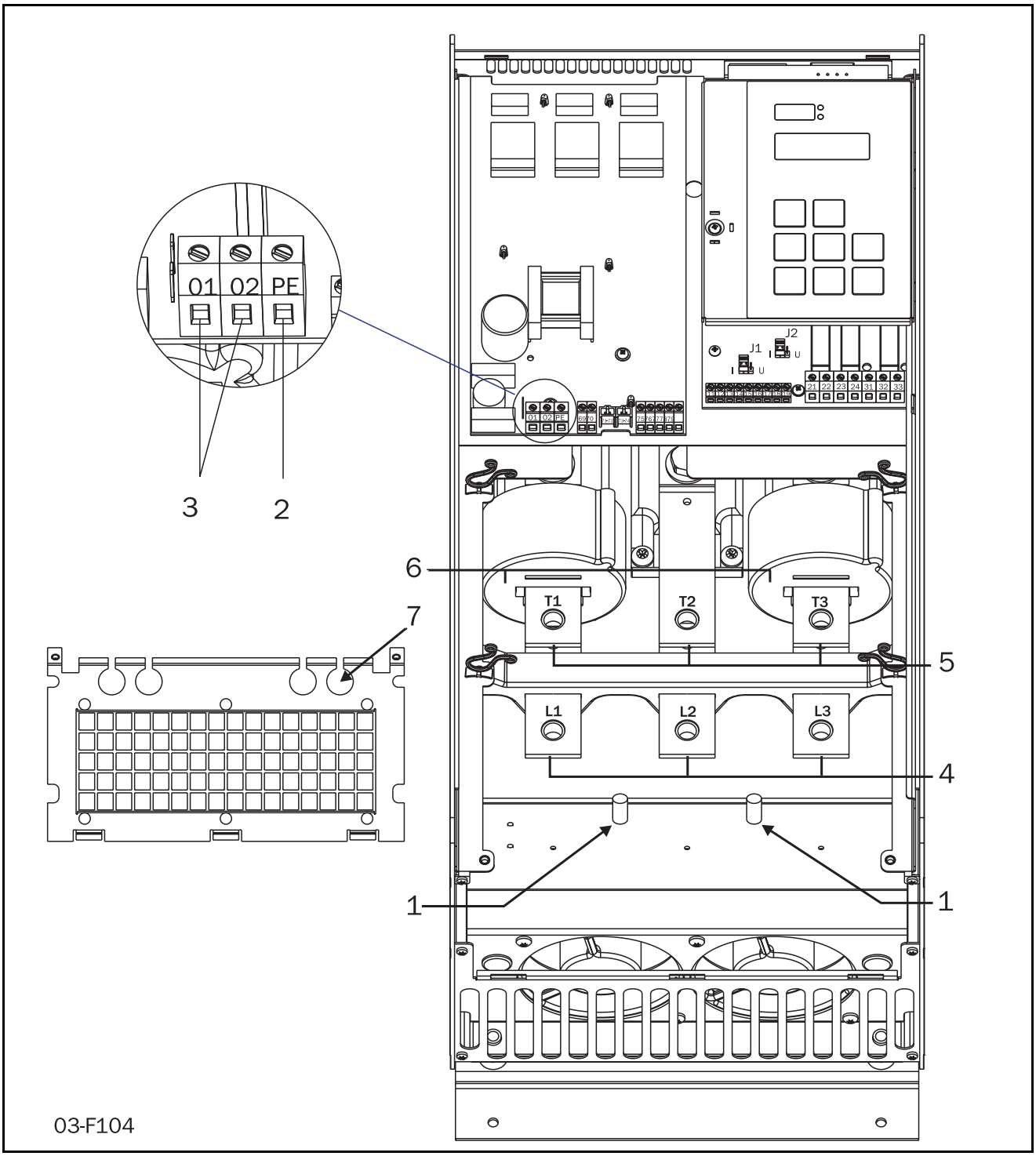


Fig. 26 Connection of MSF-170 to MSF-250

Connection of MSF-170 to MSF-250

Device connections

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

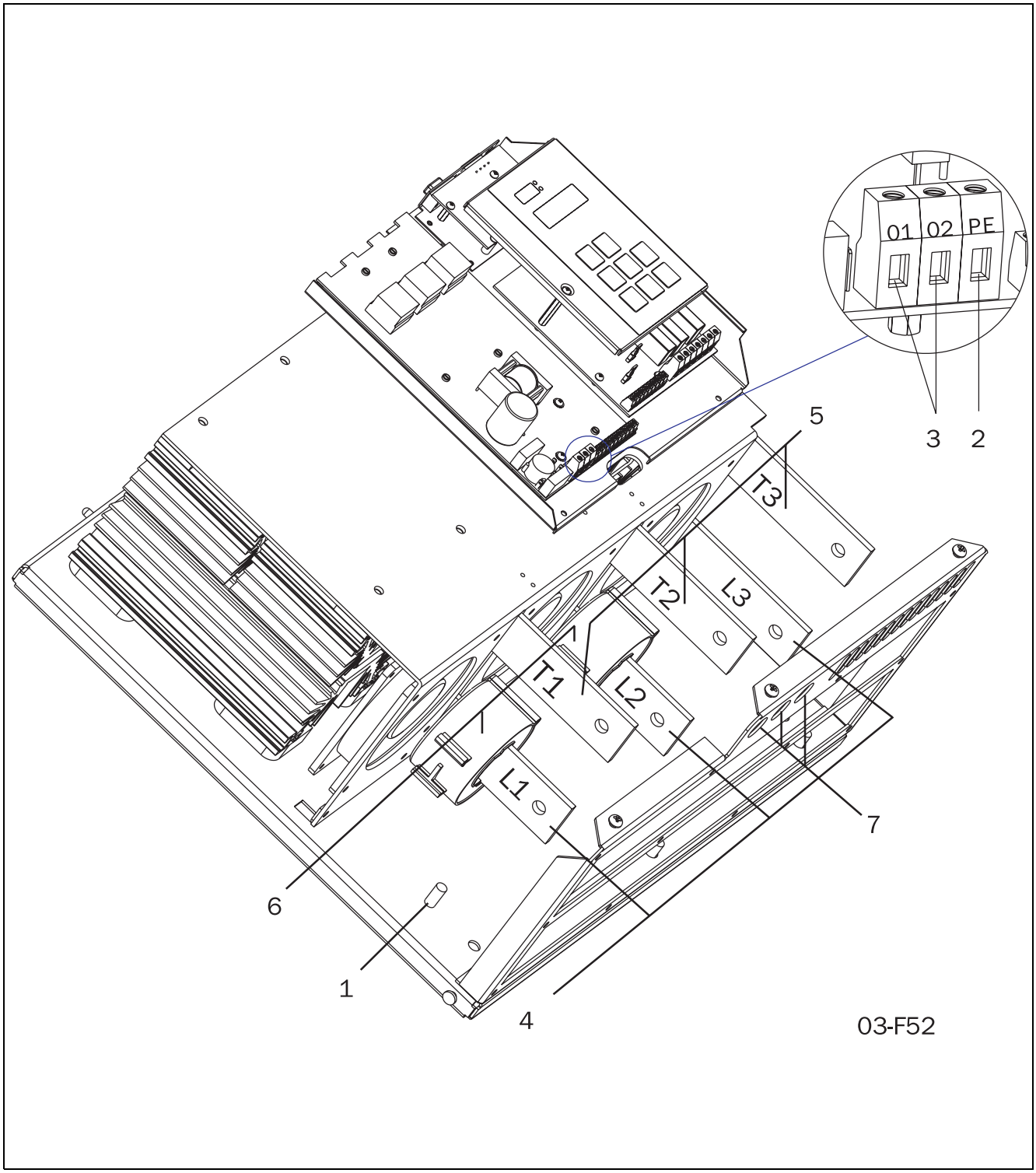


Fig. 27 Connection of MSF-170 to MSF-1400.

Connection of MSF-310 to MSF-1400

Device connections

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

6.3 Connection and setting on the PCB control card

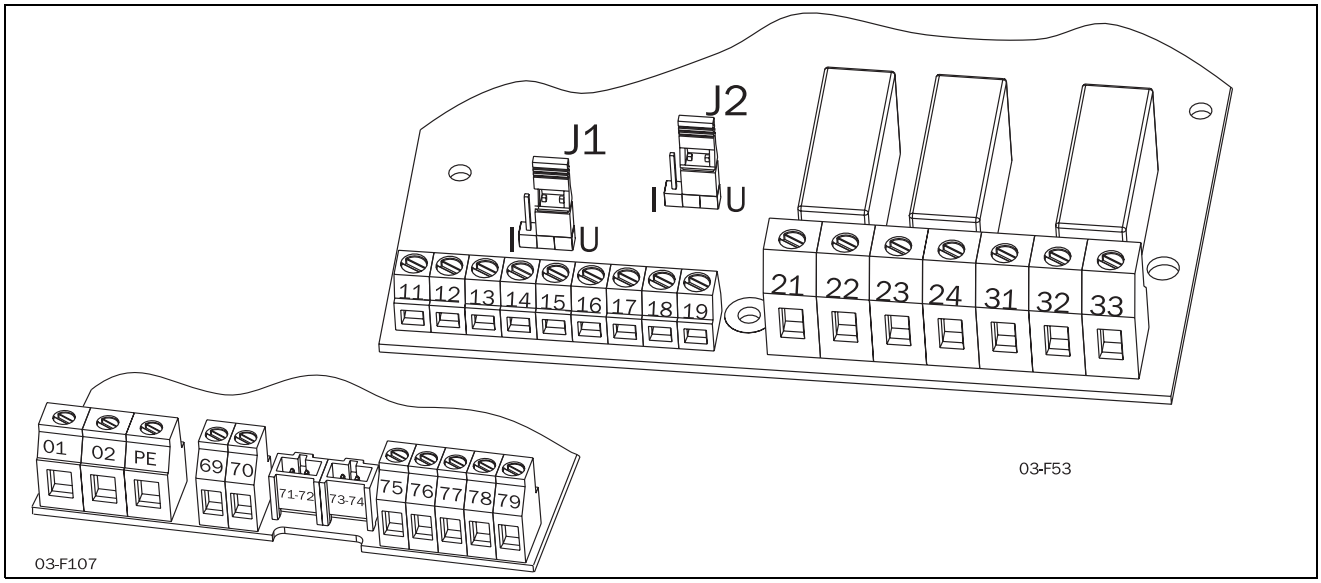


Fig. 28 Connections on the PCB, control card.

Table 12 PCB Terminals

Terminal	Function	Electrical characteristics
01 02	Supply voltage	100-240 VAC ±10%/380-500 VAC ± 10%
PE	Gnd	⏚
11 12	Digital inputs for start/stop and reset.	0-3 V --> 0; 8-27 V--> 1. Max. 37 V for 10 sec. Impedance to 0 VDC: 2.2 kΩ.
13	Supply/control voltage to PCB terminal 11 and 12, 10 kΩ potentiometer, etc.	+12 VDC ±5%. Max. current from +12 VDC: 50mA. Short circuit proof.
14	Remote analogue input control, 0-10 V, 2-10 V, 0-20 mA and 4-20 mA/digital input.	Impedance to terminal 15 (0 VDC) voltage signal: 125 kΩ, current signal: 100 Ω.
15	GND (common)	0 VDC
16 17	Digital inputs for selection of parameter set.	0-3 V --> 0; 8-27 V--> 1. Max. 37 V for 10 sec. Impedance to 0 VDC: 2.2 kΩ.
18	Supply/control voltage to PCB terminal 16 and 17, 10 kΩ potentiometer, etc.	+12 VDC ±5%. Max. current from +12 VDC = 50mA. Short circuit proof.
19	Remote analogue output control	Analogue Output contact: 0-10V, 2-10V; min load impedance 700Ω 0-20mA and 4-20mA;max load impedance 750Ω
21 22	Programmable relay K1. Factory setting is "Operation" indication by closing terminal 21 - 22.	1-pole closing contact, 250 VAC 8A or 24 VDC 8A resistive, 250 VAC, 3A inductive.
23 24	Programmable relay K2. Factory setting is "Full voltage" indication by closing terminal 23-24.	1-pole closing contact, 250 VAC 8A or 24 VDC 8A resistive, 250 VAC, 3A inductive.
31	Alarm relay K3, closed to 33 at alarm.	1-pole change over contact, 250 VAC 8A or 24 VDC 8A resistive, 250 VAC, 3A inductive.
32	Alarm relay K3, opened at alarm.	
33	Alarm relay K3, common terminal.	
69-70	PTC Thermistor input	Alarm level 2.4 kΩ Switch back level 2.2 kΩ.
71-72*	Clickson thermistor	Controlling soft starter cooling fine temperature MSF-310 - MSF-1400
73-74*	NTC thermistor	Temperature measuring of soft starter cooling fine
75	Current transformer input, cable S1 (blue)	Connection of L1 or T1 phase current transformer
76	Current transformer input, cable S1 (blue)	Connection of L3, T3 phase (MSF 017 - MSF 250) or L2, T2 phase (MSF 310 - MSF 1400)
77	Current transformer input, cable S2 (brown)	Common connection for terminal 75 and 76
78*	Fan connection	24 VDC
79*	Fan connection	0 VDC

*Internal connection, no customer use.

6.4 Minimum wiring

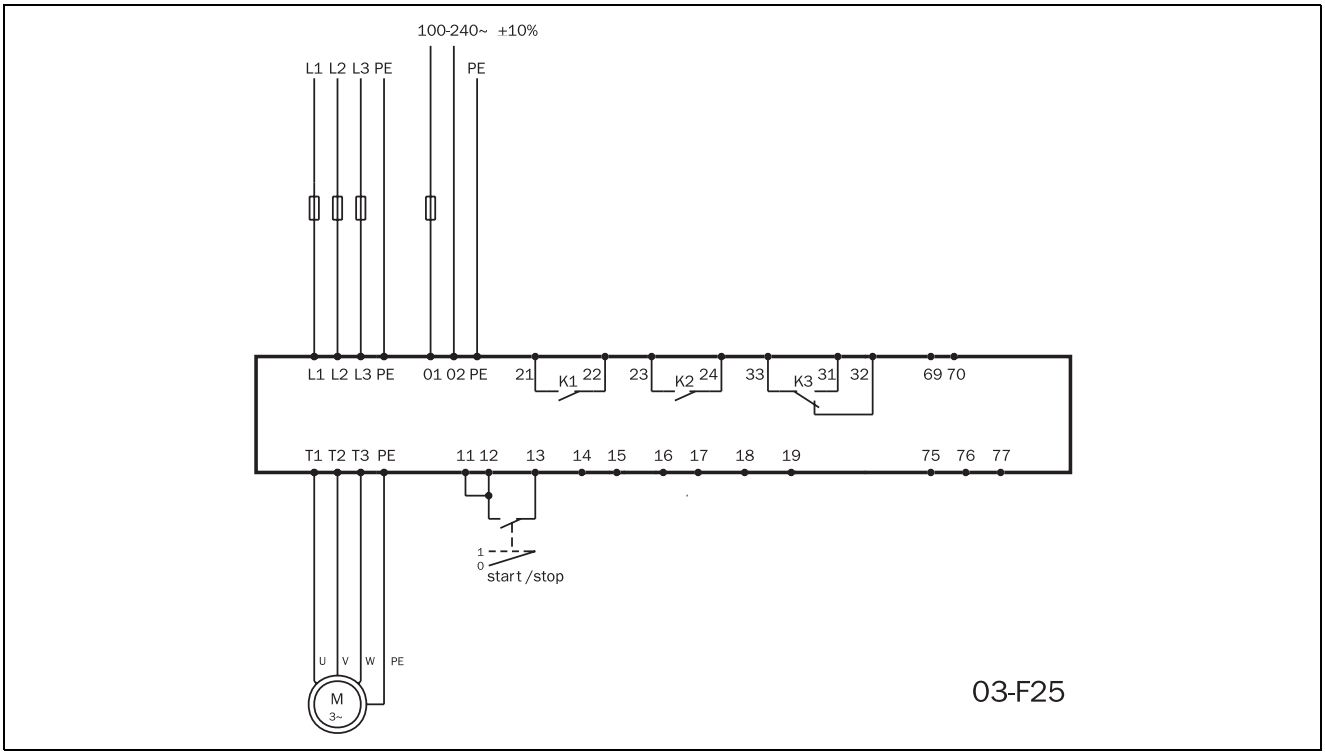


Fig. 29 Wiring circuit, "Minimum wiring".

The figure above shows the "minimum wiring". See § 6.1, page 24, for tightening torque for bolts etc.

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

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

NOTE! If local regulations say that a mains contactor should be used, the K1 then controls it. Always use standard commercial, slow blow fuses, e.g. type gl, gG to protect the wiring and prevent short circuiting. To protect the thyristors against 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.

6.5 Wiring examples

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

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

For more information see § 6.3, page 32.

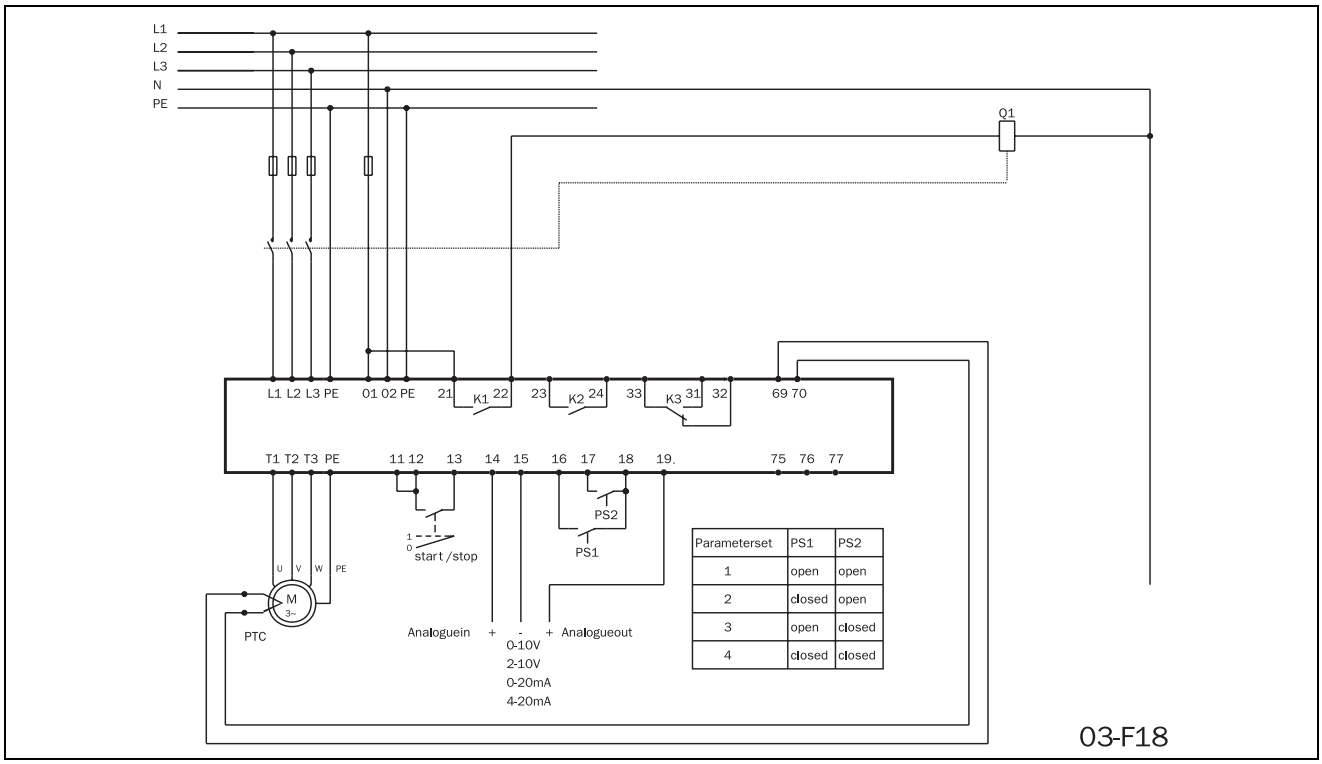


Fig. 30 Analogue input control, parameter set, analogue output and PTC input.

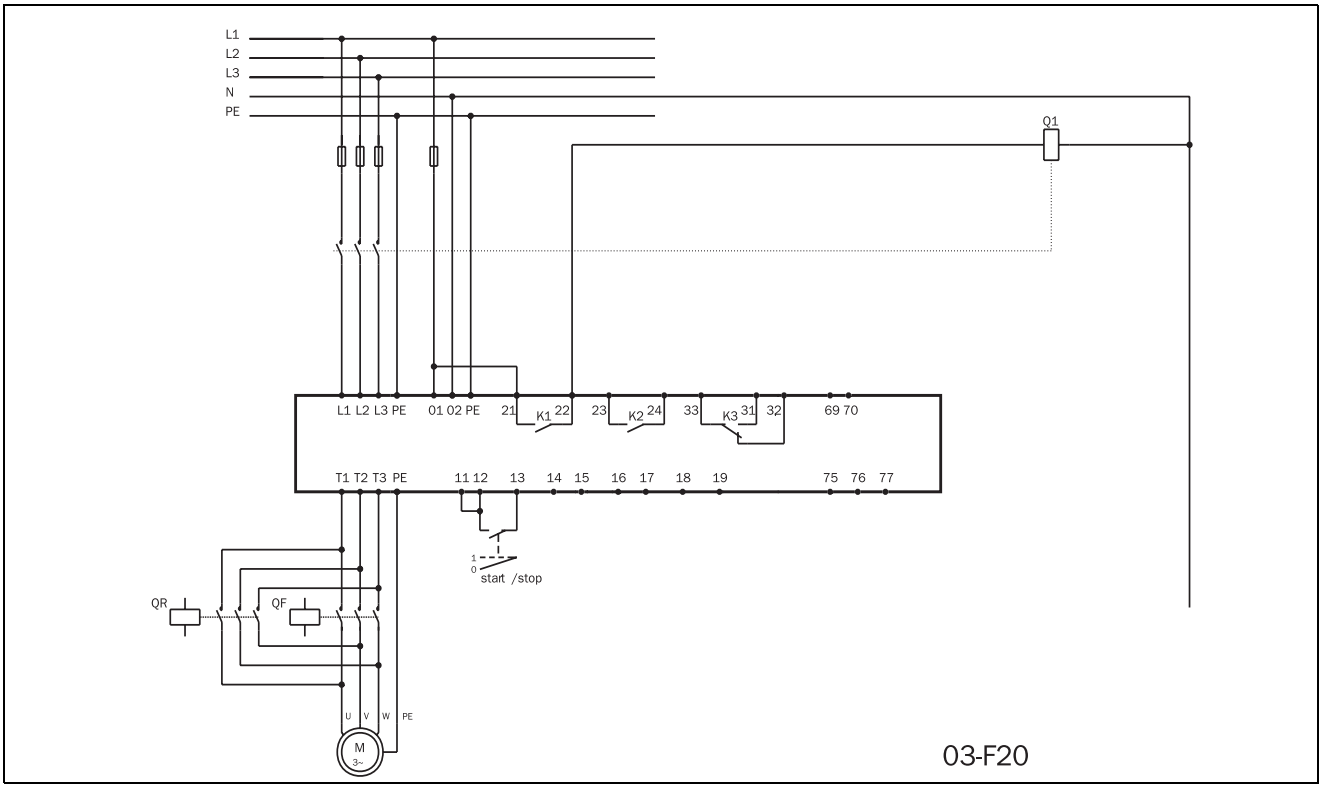


Fig. 31 Forward/reverse wiring circuit.

7. FUNCTIONAL DESCRIPTION SET-UP MENU

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

Table 13 Set-up Menu overview

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

7.1 Ramp up/down parameters

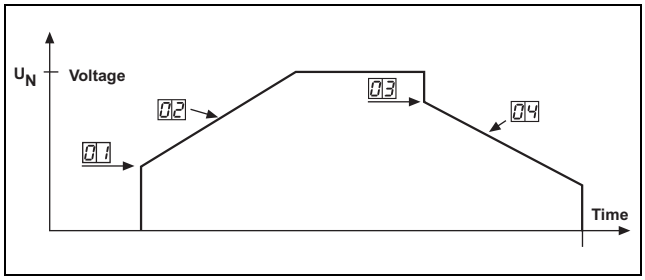


Fig. 32 Menu numbers for start/stop ramps, initial voltage at start and step down voltage at stop.

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

001

30

Setting the initial voltage at start ramp 1

Default:	30%
Range:	25 - 90% U_n
Set the initial voltage. Normally the factory setting, 30% of U_n, is a suitable choice.	

002

10

Setting of start ramp 1

Default:	10 sec
Range:	1-60 sec
Set "Ramp up time" at start.	

003

100

Setting of step down voltage stop ramp 1

Default:	100%
Range:	100-40% of U_n
Step down voltage at stop can be used to stop smoothly.	

004

oFF

Setting of stop ramp 1

Default:	oFF
Range:	oFF, 2-120 sec
oFF	Stop ramp disabled
2-120	Set "Ramp down time" at stop

7.1.1 RMS current [005]

005

0.0

RMS current

Default:	------
Range:	0.0-9999Amp
Read-out of the RMS motor current.	

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

7.2 Start/stop/reset command

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

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

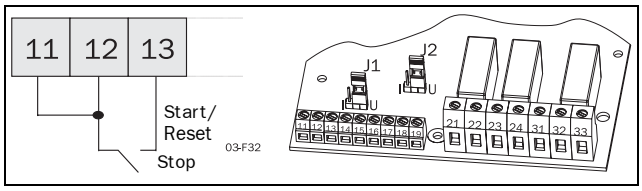
NOTE! A reset via the keyboard will not start or stop the motor.

NOTE! Factory default setting is 2, remote control.

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

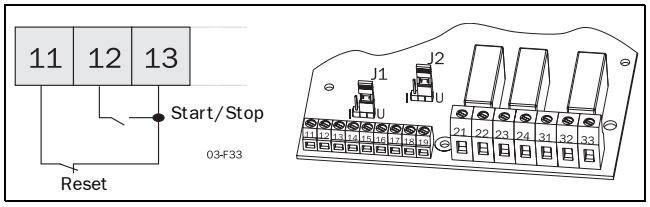
To reset from the keyboard, the "ENTER ↵ / RESET" key is used. A reset can be given both when the motor is running and when the motor is stopped. A reset from the keyboard will not start or stop the motor.

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



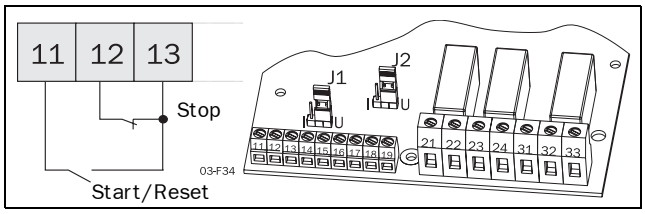
Closing PCB terminals 12 and 13, and a jumper between terminal 11 and 12, will give a start command. Opening the terminals will give a stop. If PCB terminals 12 and 13 is closed at power up a start command is given (automatic start at power up). When a start command is given there will automatically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

7.2.2 2-wire start/stop with separate reset



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

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



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

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

7.3 Menu expansion setting.

In order to use the viewing menus and/or the extended functions menu 007 must be set to "On", then one reach read out of the viewing menus 201-915. To be able to set any extended functions in the menus 011-199 menu 008 must be set to "on" as well.

007	
oFF	**Selecting of extended functions and viewing functions**
Default:	oFF
Range:	oFF, on
oFF	Only function 1-7 are visible
on	- View functions 201-915 are visible - Extended functions (menu 008) selectable

008	
oFF	**Selecting of extended functions**
Default:	oFF
Range:	oFF, on
oFF	Only view function 201-915 are visible.
on	All the function menus are visible

NOTE! Menu 007 must be "on".

7.4 Voltage control dual ramp

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

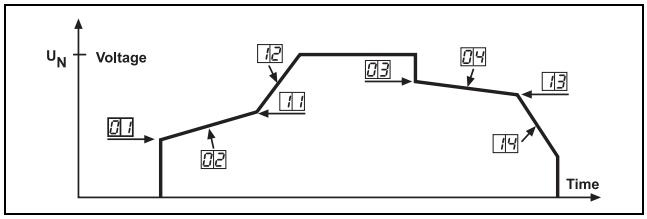


Fig. 33 Menu numbers for dual voltage ramp at start/stop, initial voltage at start and step down-voltage at stop.

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

011	
90	**Setting the initial voltage at start ramp 2**
Default:	90%
Range:	30-90% U_n
Set the start voltage for start ramp 2. The initial voltage for start ramp 2 is limited to the initial voltage at start (menu 001), see § 7.1, page 36.	

012	
oFF	**Setting of start ramp 2**
Default:	oFF
Range:	oFF, 1-60 sec
oFF	Start ramp 2 disabled
1-60	Set the start ramp 2 time. A dual voltage ramp is active.

013	
40	**Setting of step down voltage in stop ramp 2**
Default:	40%
Range:	100-40% U_n
Set the step down voltage for stop ramp 2. The step down voltage for stop ramp 2 is limited to the step down voltage at stop (menu 003).	

014	
oFF	**Setting of stop ramp time 2**
Default:	oFF
Range:	oFF, 2-120 sec
oFF	Stop ramp 2 disabled
1-60	Set the stop ramp 2 time. A dual voltage stop ramp is active.

7.5 Torque control parameters

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

016	**Initial torque at start**
10	
Default:	10
Range:	0 - 250% of Tn
Insert initial torque at start in percent of nominal shaft torque (Tn), see chapter 13. page 79.	

017	**End torque at start**
150	
Default:	150
Range:	50 - 250% of Tn
Insert end torque at start in percent of nominal shaft torque.	

018	**End torque at stop**
0	
Default:	0
Range:	0 - 100% of Tn
Insert end torque at stop in percent of the nominal motor torque.	

7.6 Current limit (Main Function)

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

Two kinds of current limit starts are available.

- **Voltage ramp with a limited current.**
  If current is below set current limit, this start will act exactly as a voltage ramp start.
- **Current limit start.**
  The soft starter will control the current up to set current limit immediately at start, and keep it there until the start is completed or the set start-up time expires.

See Fig. 34 Current limit.

NOTE! Make sure that nominal motor current in menu 042 is correctly inserted.

7.6.1 Voltage ramp with current limit

The settings are carried out in three steps:

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

020	**Voltage ramp with current limit at start**
oFF	
Default:	oFF
Range:	oFF, 150 - 500% In
oFF	Voltage Ramp mode with current limit disabled. Voltage Ramp enabled.
150-500	Current limit level in Voltage ramp mode.

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

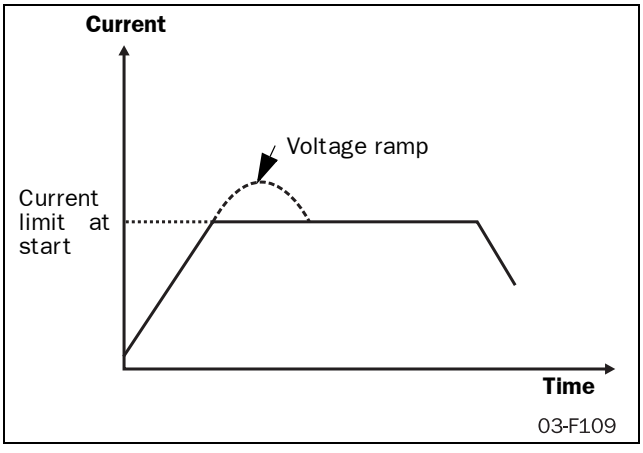


Fig. 34 Current limit

7.6.2 Current limit

The settings are carried out in two steps:

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

021

oFF

Current limit at start

Default:	oFF
Range:	oFF, 150 - 500% In
oFF	Current limit mode disabled. Voltage Ramp enabled.
150-500	Current limit level in current limit mode.

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

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

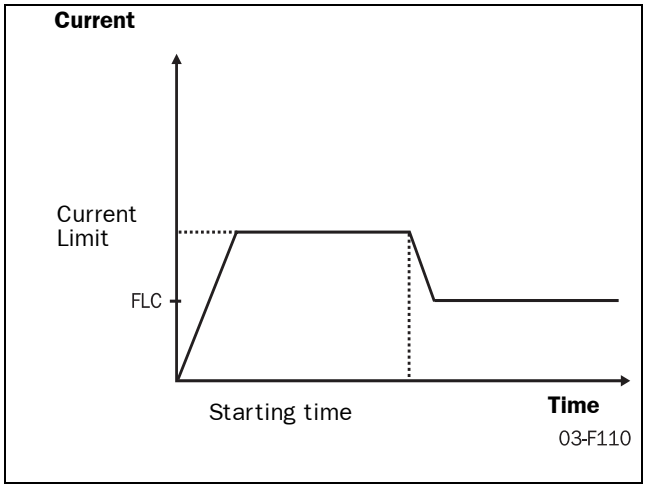


Fig. 35 Current limit

If the starting time is exceeded and the soft starter is still operating at current level, an alarm will be activated. It is possible to let the soft starter to either stop operation or to continue. Note that the current will rise uncontrolled if the operation continues (see § 7.24.2, page 61).

7.7 Pump control (Main Function)

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

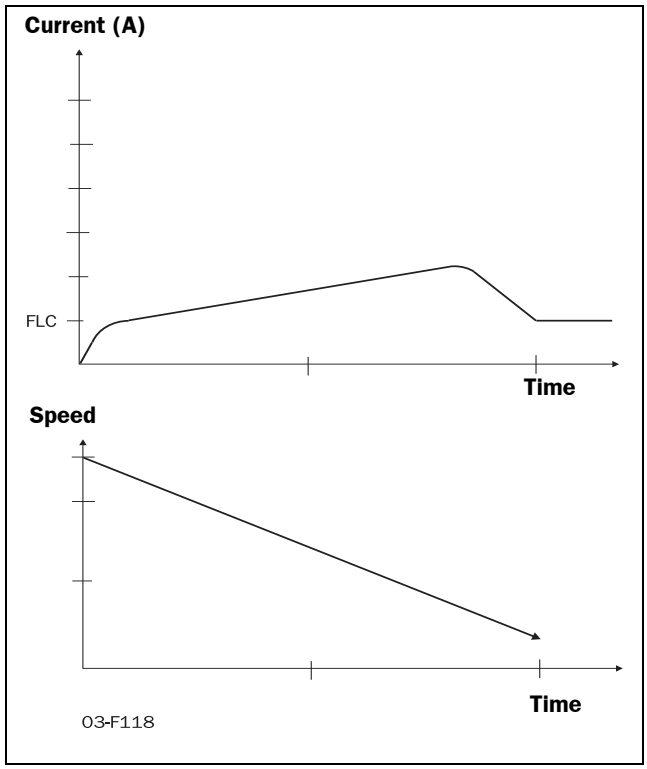


Fig. 36 Pump control

Pump application

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

022

oFF

Setting of pump control

Default:	oFF
Range:	oFF, on
oFF	Pump control disabled. Voltage Ramp enabled.
on	Pump control application is enabled.

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

7.8 Analogue Input Control (Main Function)

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

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

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

To install the analogue input control, proceed by:

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

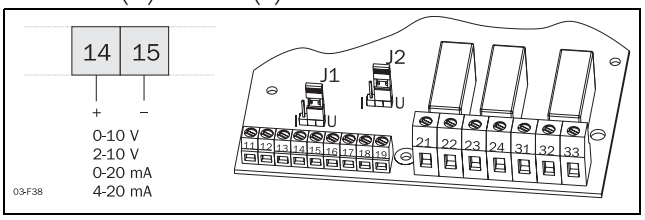


Fig. 37 Wiring for analogue input.

2. Set Jumper J1 on the PCB control card to voltage (U) or current control (I) signal position, see Fig. 38 and Fig. 24 on page 28. Factory setting is voltage (U).

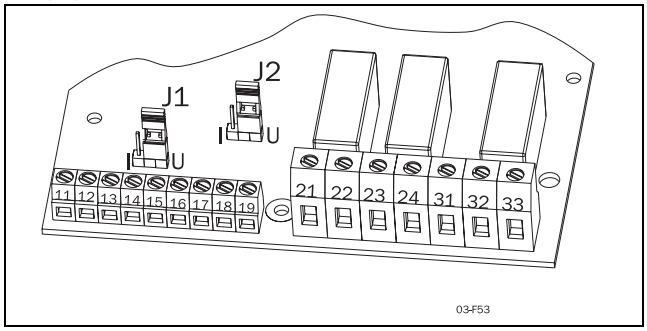


Fig. 38 Setting voltage or current for analogue input.

023	**Selection of Analogue input control**
oFF	
Default:	oFF
Range:	oFF, 1, 2
oFF	Analogue input disabled. Voltage Ramp enabled.
1	Analogue input is set for 0-10V/ 0-20mA control signal
2	Analogue input is set for 2-10V/ 4-20mA control signal.

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

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

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

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

024	**Setting of D.O.L start**
oFF	
Default:	oFF
Range:	oFF, on
oFF	D.O.L. start disabled. Voltage Ramp enabled.
on	D.O.L. start enabled

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

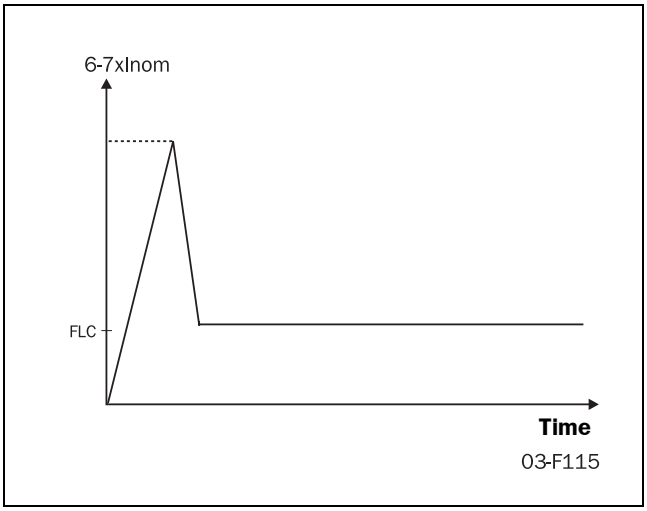


Fig. 39 Full voltage start.

7.10 Torque control (Main function)

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

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

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

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

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

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

025

oFF

Torque control at start/stop

Default:	oFF
Range:	oFF, 1, 2
oFF	Torque control is disabled Voltage Ramp enabled.
1	Torque control with linear torque characteristic
2	Torque control with square torque characteristic

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

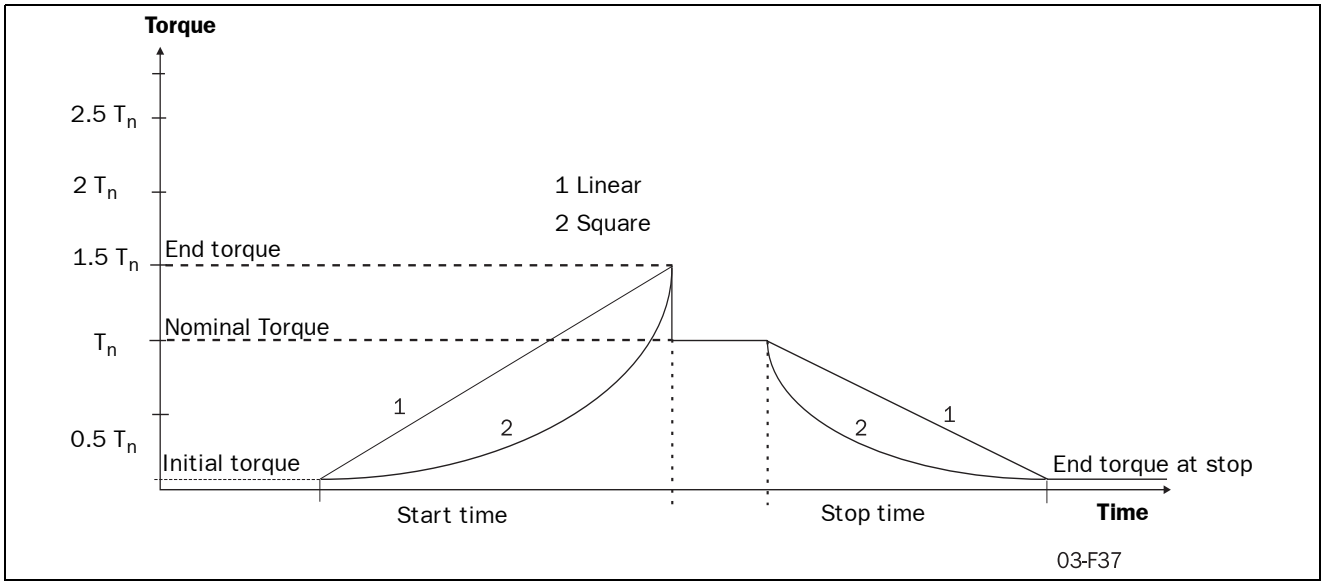


Fig. 40 Torque control at start/stop.

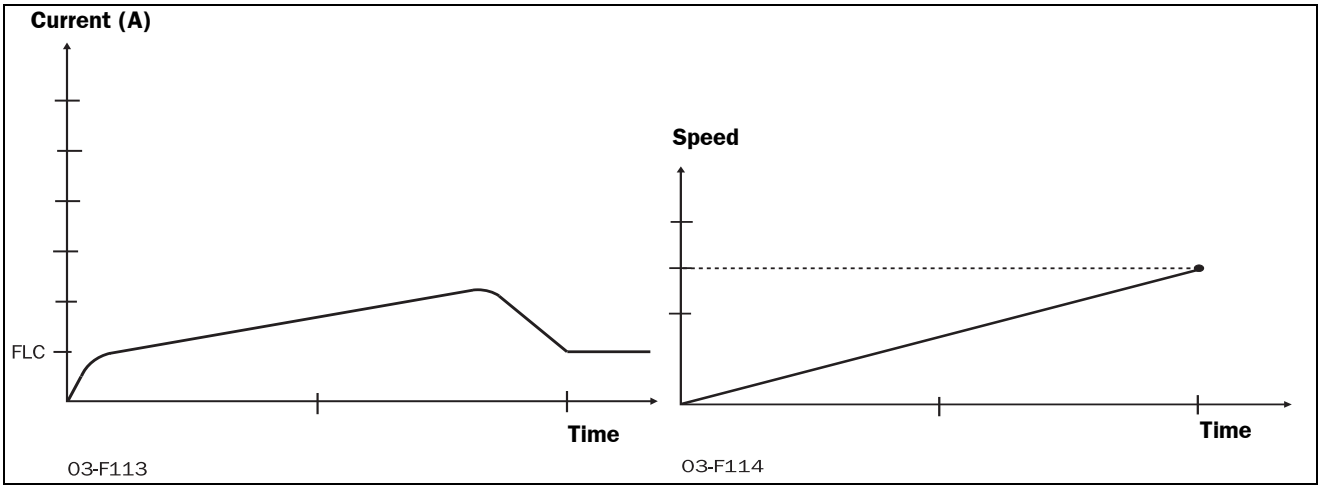


Fig. 41 Current and speed in torque control.

7.11 Torque boost

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

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

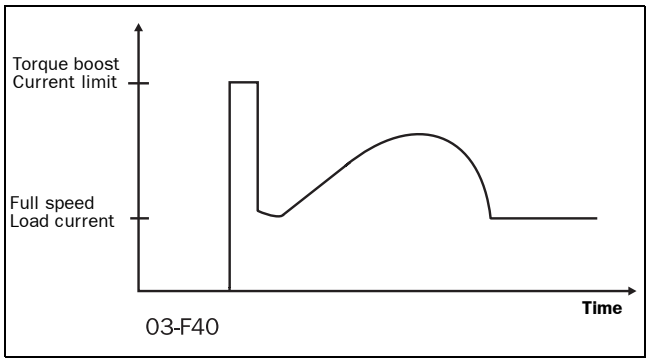


Fig. 42 The principle of the Torque Booster when starting the motor in voltage ramp mode.

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

030

oFF

Torque boost active time

Default:	oFF
Range:	oFF, 0.1 - 2 sec
oFF	Torque boost disabled
0.1-2.0	Set the Torque boost time.

031

300

Torque boost current limit

Default:	300
Range:	300 - 700% of In
The Torque boost current controller use selected value as the motor current reference.	

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

7.12 Bypass

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

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

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

032

oFF

Setting of Bypass

Default:	oFF
Range:	oFF, on
oFF	Bypass disabled
on	Bypass enabled. Program either relay K1 or K2 to function 2 to control the bypass contactor, see menu 51/52.

CAUTION! If the current transformers are not mounted as in Fig. 43 on page 44 and § 6.2, page 28, the alarm and viewing functions will not work. Do not forget to set menu 032 to ON, otherwise there will be an F12 alarm and at the stop command will be a freewheeling stop.

For further information see chapter 6.2 page 28.

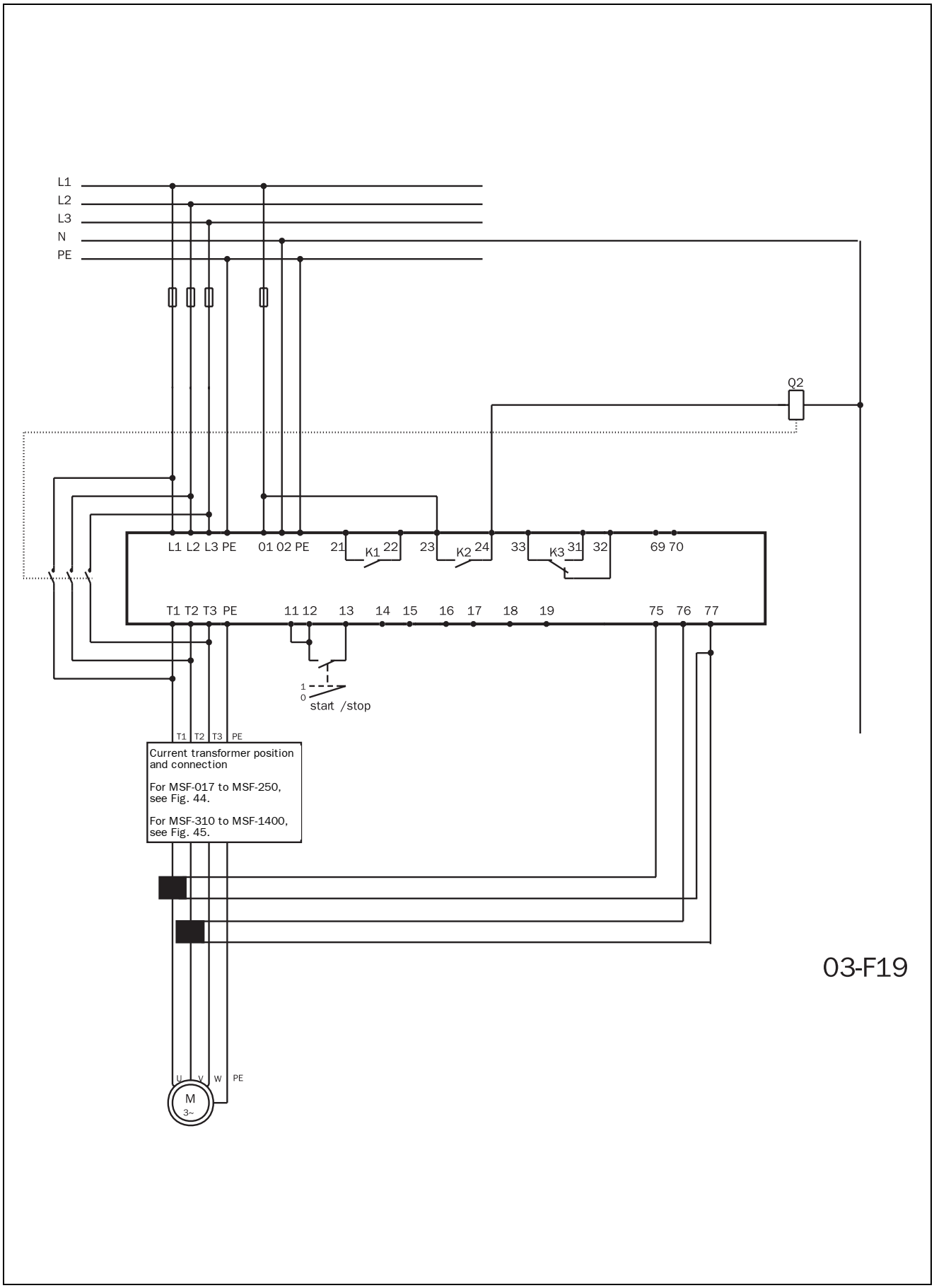


Fig. 43 Bypass wiring example MSF 310-1400.

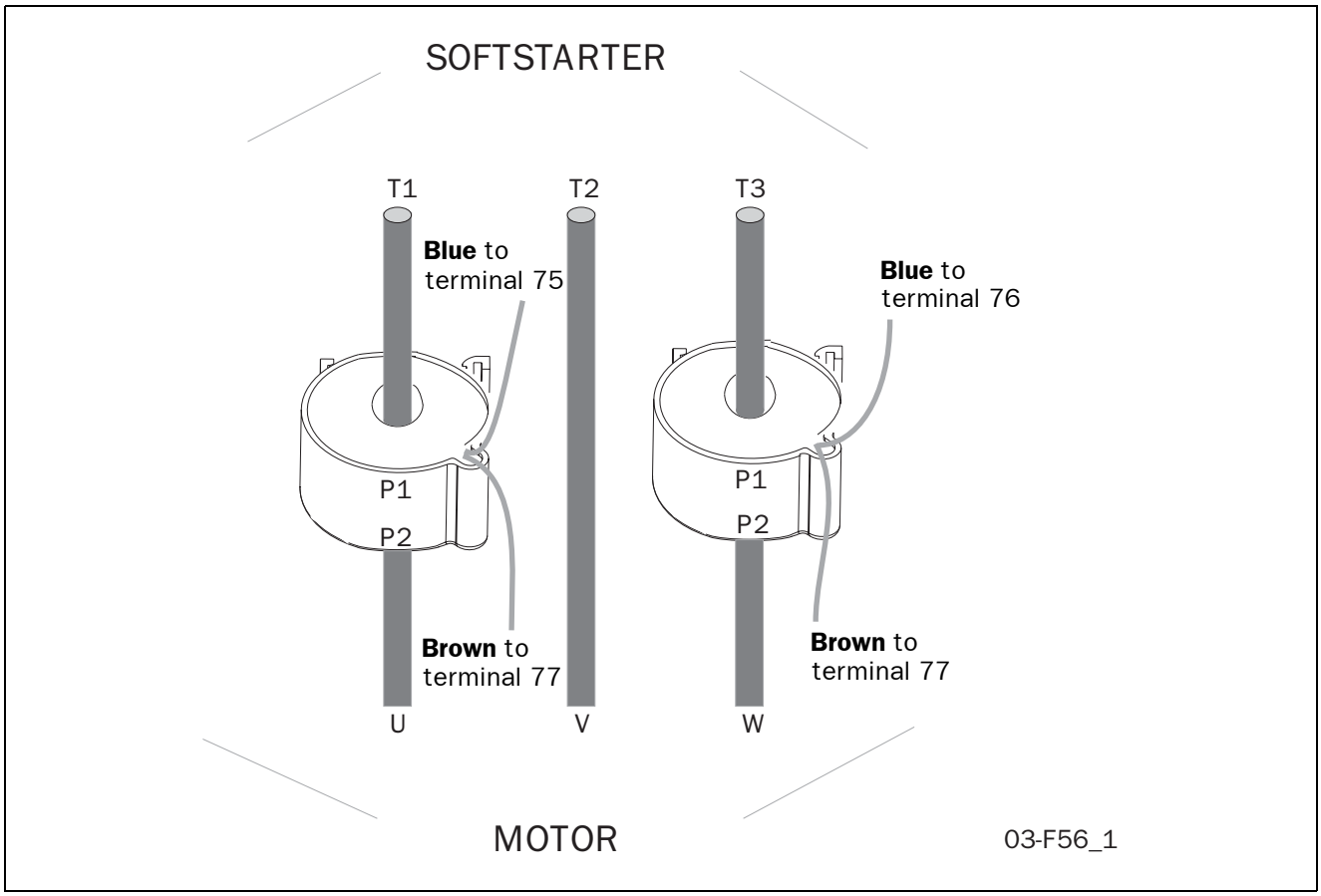


Fig. 44 Current transformer position when Bypass MSF-017 to MSF-250.

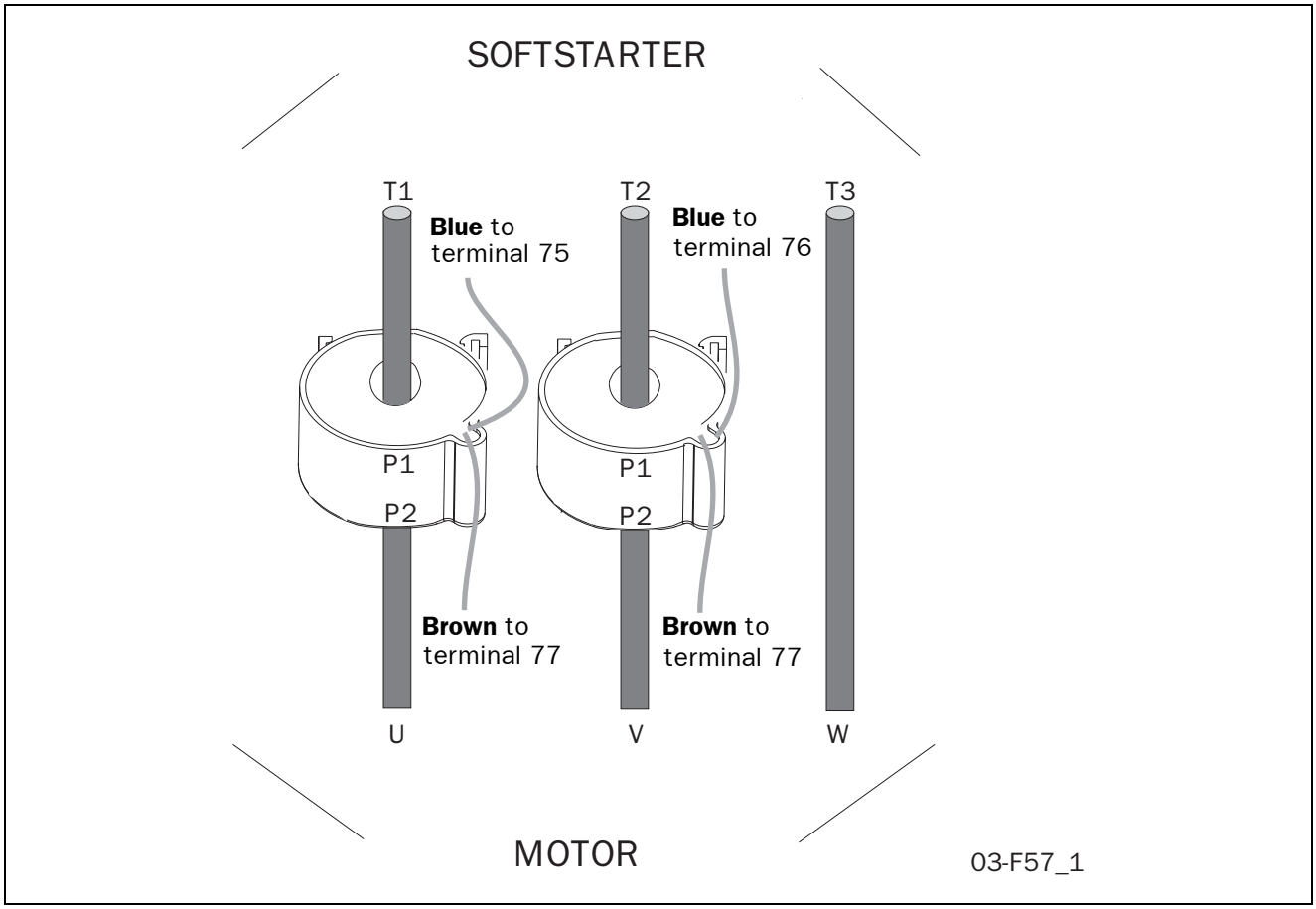


Fig. 45 Current transformer position when Bypass MSF-310 to MSF-1400.

7.13 Power Factor Control

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

033

Setting of PFC

oFF

Default:	oFF
Range:	oFF, on
oFF	PFC disabled
on	PFC enabled. The Full voltage relay function does not work.

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

7.14 Brake functions

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

- **Dynamic DC-brake**
  Increases the braking torque by decreasing speed.
- **Soft brake**
  Gives a high torque at the start of the braking and then also increasing torque by decreasing speed.

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

Dynamic Vector Brake

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

Soft brake

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

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

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

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

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

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

034

Braking time

oFF

Default:	oFF
Range:	oFF, 1 - 120 sec
oFF	Brake function disabled
1-120	Brake time

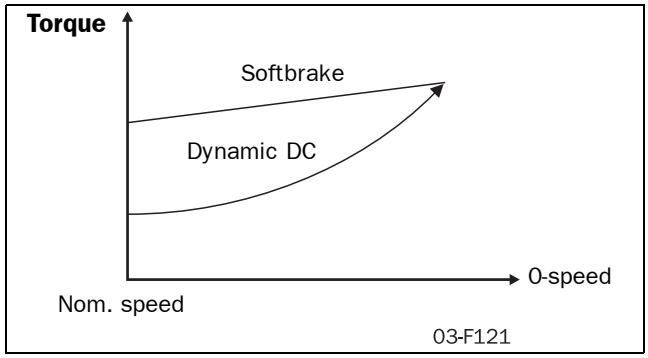


Fig. 46 Braking time

035

Braking Strength

100

Default:	100
Range:	100 - 500%

036

Brake method

1

Default:	1
Range:	1, 2
1	Dynamic vector brake, active
2	Soft brake active

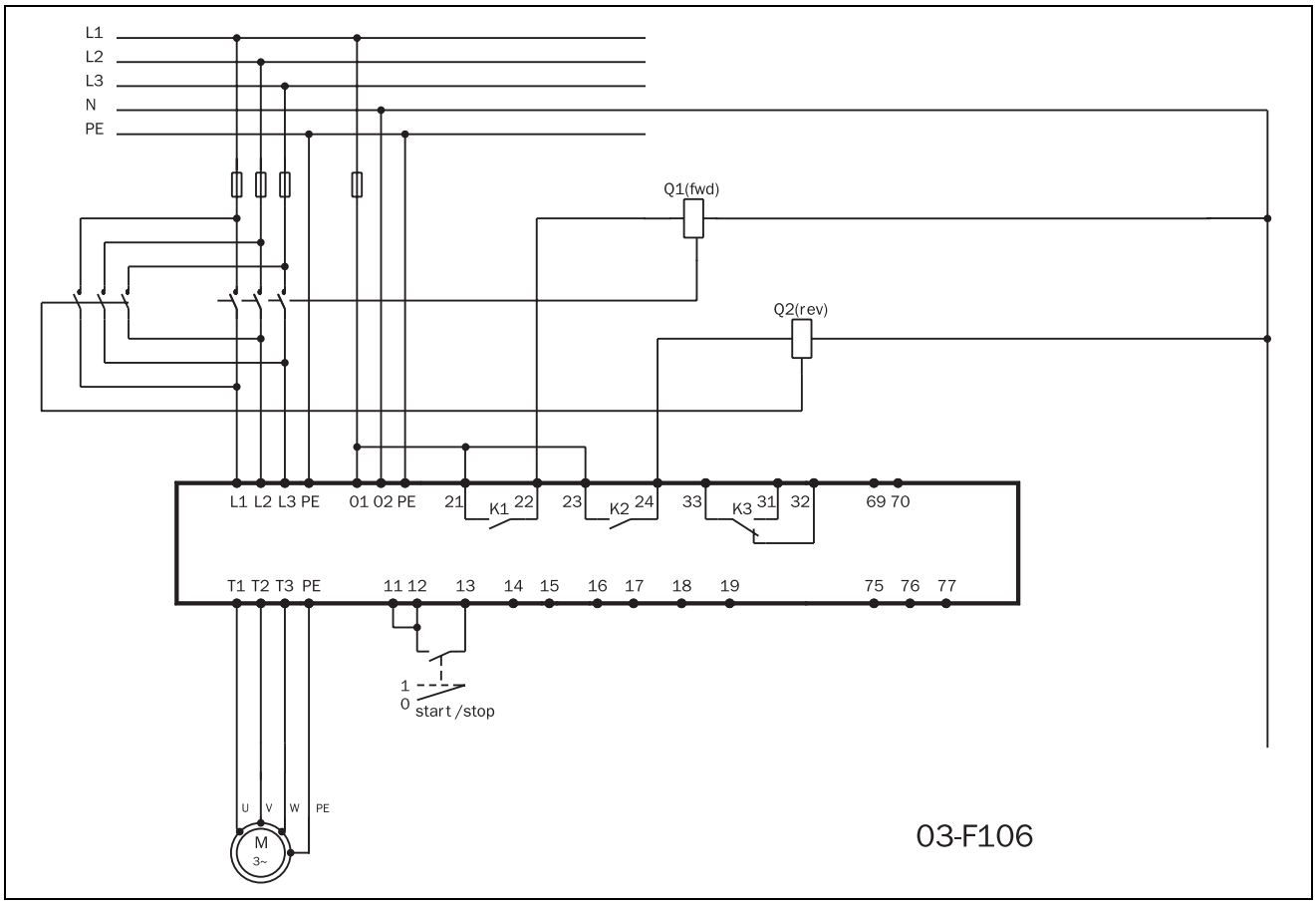


Fig. 47 Soft brake wiring example.

7.15 Slow speed and Jog functions

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

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

The following functions are possible:

- **Slow speed controlled by an external signal.** The digital input is used to run at slow speed at a start or stop command for a selected number of pulses (edges) generated by an external sensor (photo cell, micro switch, etc.). See § 7.19, page 53 for more instructions.
- **Slow Speed during a selected time period.** The slow speed will be active after a stop command for a selected time period. See § 7.19, page 53 for more instructions.
- **Slow Speed using the "JOG"-commands.** The slow Speed can be activated via the JOG keys on the keyboard or externally via the analogue input. See § 7.25, page 61 for more instructions.

7.15.1 Slow speed controlled by an external signal.

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

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

Installation is as follows:

1. Set the analogue input selection for Slow Speed operation. Menu 57=2. See § 7.19, page 53. See Fig. 37 on page 41 for a wiring example.
2. Select in menu 38 (see § 7.15.2, page 49) the Slow Speed at Start time. This time will now be the absolute maximum time for Slow Speed to be active after a start command, in case the external signal will not appear.
3. Select in menu 39 (see § 7.15.2, page 49) the Slow Speed at Stop time. This time will now be the absolute maximum time for Slow Speed to be active after a stop command, in case the external signal will not appear.
4. Select in menu 57 (see § 7.19, page 53) the number of edges to be ignored by the Slow Speed input, before a start or stop is executed at slow speed. The edges are generated by an external sensor (photo cell, micro switch, etc.).

The Slow Speed torque (menu 37) and DC-Brake after Slow Speed (menu 40) can be selected if needed. (see § 7.15.4, page 49).

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

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

In Fig. 48 on page 48 the selected number of edges are 4. It is recommended to select DC-brake (se § 7.14, page 46) before a slow speed at stop if it is a high inertia load. See Fig. 29 on page 33 for wiring diagram. In case one use DC-brake, see § 7.15.4, page 49.

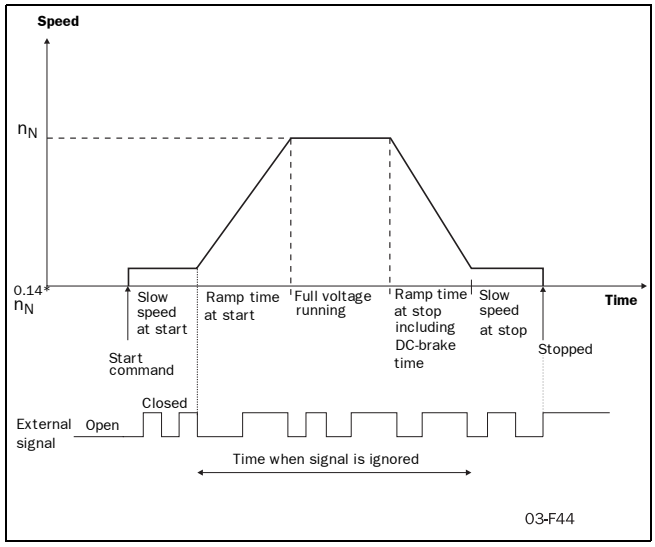


Fig. 48 Slow speed controlled by an external signal.

This additional function can be used together with most of the main functions (see § 4.6, page 19).

037

Slow speed torque

10

Default:	10
Range:	10-100
Select the magnitude of the slow speed torque.	

7.15.2 Slow speed during a selected time

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

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

038

oFF

Slow speed time at start

Default:	oFF
Range:	oFF, 1 - 60 sec
oFF	Slow speed at start is disabled
1-60	Set slow speed time at start.

039

oFF

Slow speed time at stop

Default:	oFF
Range:	oFF, 1 - 60 sec
oFF	Slow speed at stop is disabled
1-60	Set slow speed time at stop.

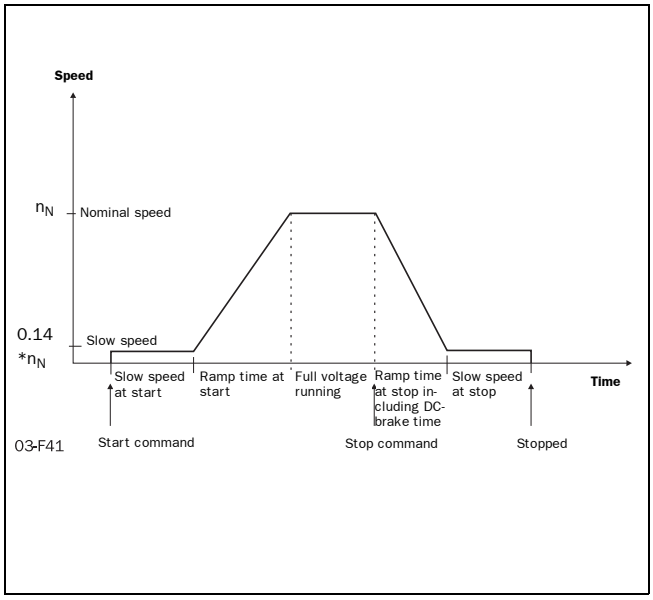


Fig. 49 Slow speed at start/stop during a selected time.

The Slow speed torque (menu 37) and the DC-Brake after Slow speed (menu 40, § 7.15.4, page 49) can be selected if needed.

7.15.3 Jog Functions

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

The Jog commands can be activated in 2 different ways:

- **Jog keys**
  The Jog-Forward and Jog-reverse keys on the control panel. The keys can be programmed separate for each function. See § 7.25, page 61 for more instructions
- **External Jog command**
  The external command is given via terminal 14 at the digital input. Only 1 function (forward or reverse) can be programmed to the digital input at the time. See § 7.19, page 53 for more instructions.

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

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

The current is controlled and the reference value for the normal DC-brake function is used (see § 7.15.4, page 49).
The duration for the DC-brake is possible to select.

This DC-brake function is not applied when the "JOG ⟲ " and "JOG ⟳" keys are used.

040

oFF

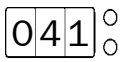
DC-Brake at slow speed

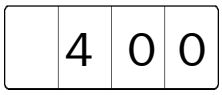
Default:	oFF
Range:	oFF, 1-60
oFF	DC-brake after slow speed at stop disabled.
1-60	DC-brake duration time after slow speed at stop.

7.16 Motor data setting

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

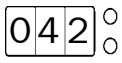
NOTE! The default factory settings are for a standard 4-pole motor acc. to the nominal current and power of the soft starter. The soft starter will run even if no specific motor data is selected, but the performance will not be optimal.

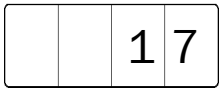




Nominal motor voltage

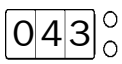
Default:	400 V
Range:	200-700 V
Make sure the soft starters maximum voltage rating is suitable for chosen motor voltage.	

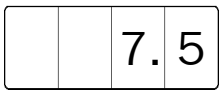




Nominal motor current

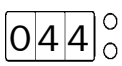
Default:	Nominal soft starter current
Range:	25% - 150% of Insoft in Amp.

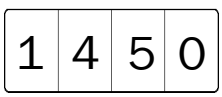




Nominal motor power

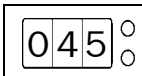
Default:	Nominal soft starter power
Range:	25% - 300% of Pnsoft in kW

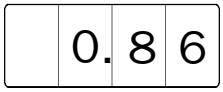




Nominal motor speed

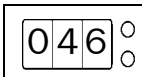
Default:	Nnsoft in rpm
Range:	500-3600 rpm





Nominal motor cos phi

Default:	0.86
Range:	0.50-1.00



Nominal frequency

Default:	50 Hz
Range:	50/60 Hz

NOTE! Now go back to menu 007, 008 and set it to "oFF" and then to menu 001.

7.17 Programmable relay K1 and K2

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

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

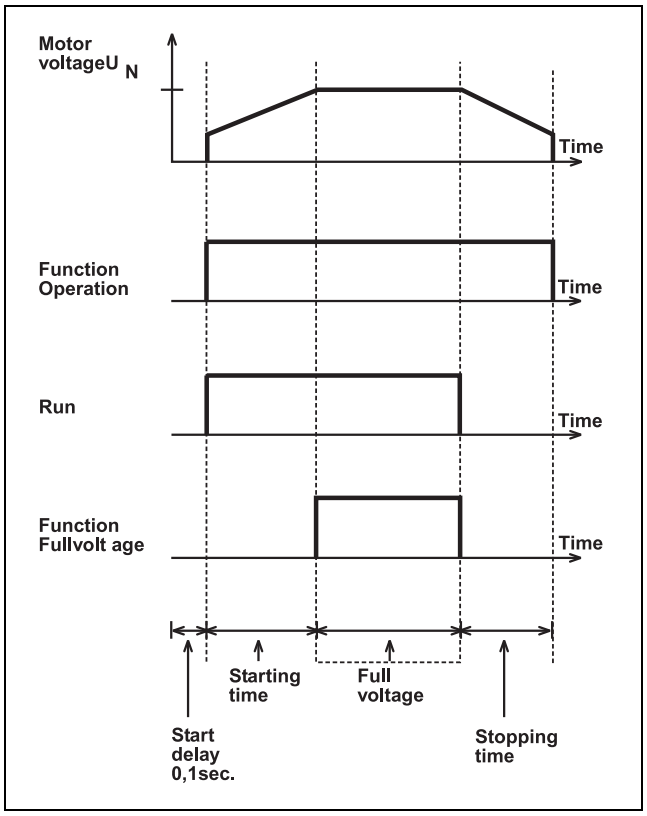


Fig. 50 Start/stop sequence and relay function "Operation" and "Full voltage".

051

Setting of K1 indication

Default:	1
Range:	1, 2, 3, 4, 5
1	K1 is set for "Operation"
2	K1 is set for "Full Voltage"
3	K1 is set for "Power pre-alarm"
4	No function
5	K1 is set for "Run"

052

Setting of K2 indication

Default:	2
Range:	1, 2, 3, 4, 5
1	K2 is set for "Operation"
2	K2 is set for "Full Voltage"
3	K2 is set for "Power pre-alarm"
4	K2 is set for "Softbrake"
5	K2 is set for "Run"

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

7.18 Analogue output

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

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

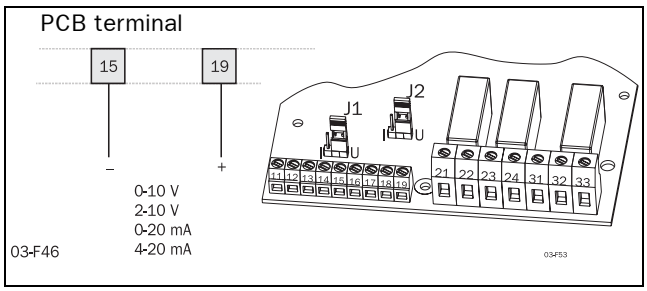


Fig. 51 Wiring for analogue output.

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

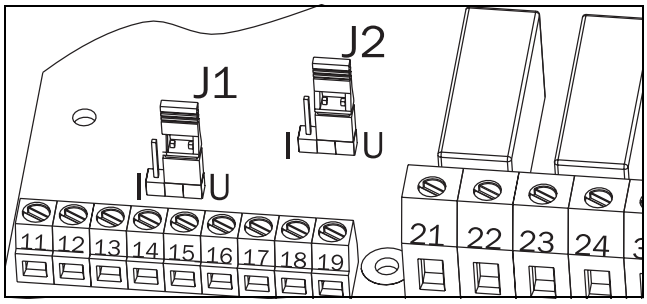


Fig. 52 Setting of current or voltage output.

3. Set the parameter in menu 054.

054	**Analogue output**
oFF	
Default:	oFF
Range:	oFF, 1, 2
oFF	Analogue ouput is disabled
1	Analogue output is set to 0-10V/0-20mA
2	Analogue output is set to 0-10V/4-20mA

4. Choose a read-out value in menu 055

055	**Analogue output value**
1	
Default:	1
Range:	1, 2, 3
1	RMS current, default range 0-5xIn
2	Line input RMS voltage, default range 0-720V
3	Output shaft power, default range 0-2xPn

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

056	**Analogue output gain**
100	
Default:	100%
Range:	5-150%

Example on settings:

Set value	**I_{scale}**	**U_{scale}**	**P_{scale}**
100%	0-5xI_n	0-720V	0-2xP_n
50%	0-2.5xI_n	0-360V	0-P_n

7.19 Digital input selection

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

- Rotation sensor input for braking functions. See § 7.14, page 46.
- Slow speed external controlled. See § 7.15.1, page 48.
- Jog functions forward or reverse enabled. See § 7.25, page 61.

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

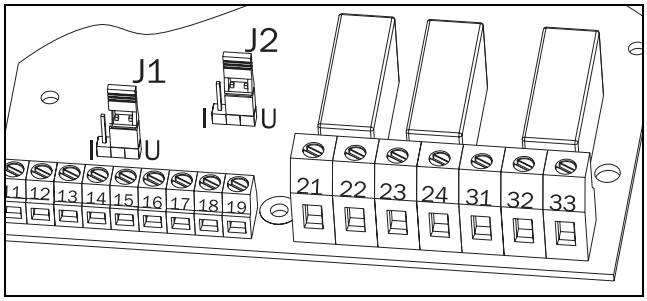


Fig. 53 Setting of J1 for current or voltage control.

Fig. 54 shows a wiring example for the analogue input as it is used for digital input.

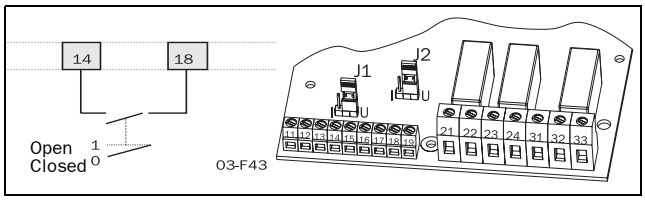


Fig. 54 Wiring for slow speed external input.

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

057

Digital input selection

oFF

Default:	oFF
Range:	oFF, 1-4
oFF	No digital input control
1	Rotation sensor for brake functions
2	Slow speed function
3	Jog forward command
4	Jog reverse command

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

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

058

Digital input pulses

1

Default:	1
Range:	1-100

If Menu 57=1.
A positive or negative edge at analogue input from a rotation sensor will give a signal to stop the braking voltage.
If Menu 57=2
The number of edges to be ignored by the slow speed input, before a start or stop is executed at slow speed.

7.20 Parameter Set

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

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

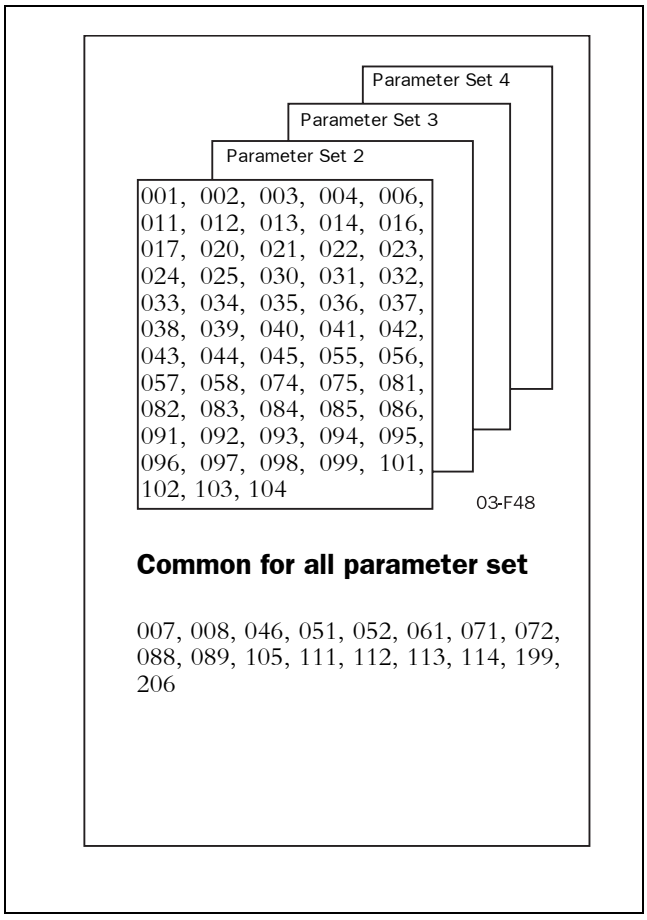
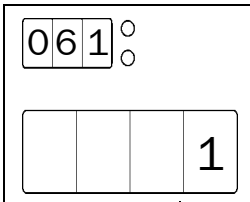


Fig. 55 Parameter overview

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

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



Parameter set

Default:	1
Range:	0, 1, 2, 3, 4
0	Parameter set are selected by the external input 16 and 17 (see below).
1, 2, 3, 4	Selection of parameter set 1-4.

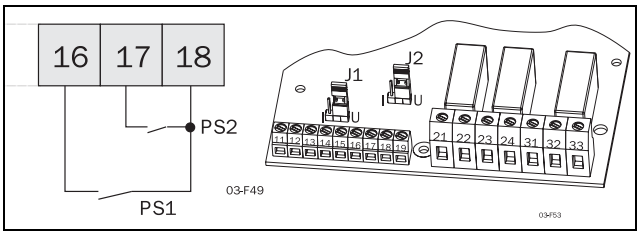


Fig. 56 Connection of external control inputs.

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

7.21 Motor protection, overload (F2 alarm)

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

071

no

Motor PTC input

Default:	no
Range:	no, YES
no	Motor PTC input is disabled
YES	Motor PTC input is activated: - Connect the PTC to terminals 69 and 70, see table 12, page 32 and § Fig. 30, page 34. - A to hot motor will give an F2 alarm. The alarm can only be reset-ted after cooling down of the motor.

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

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

072

10

Internal motor thermal protection

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

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

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

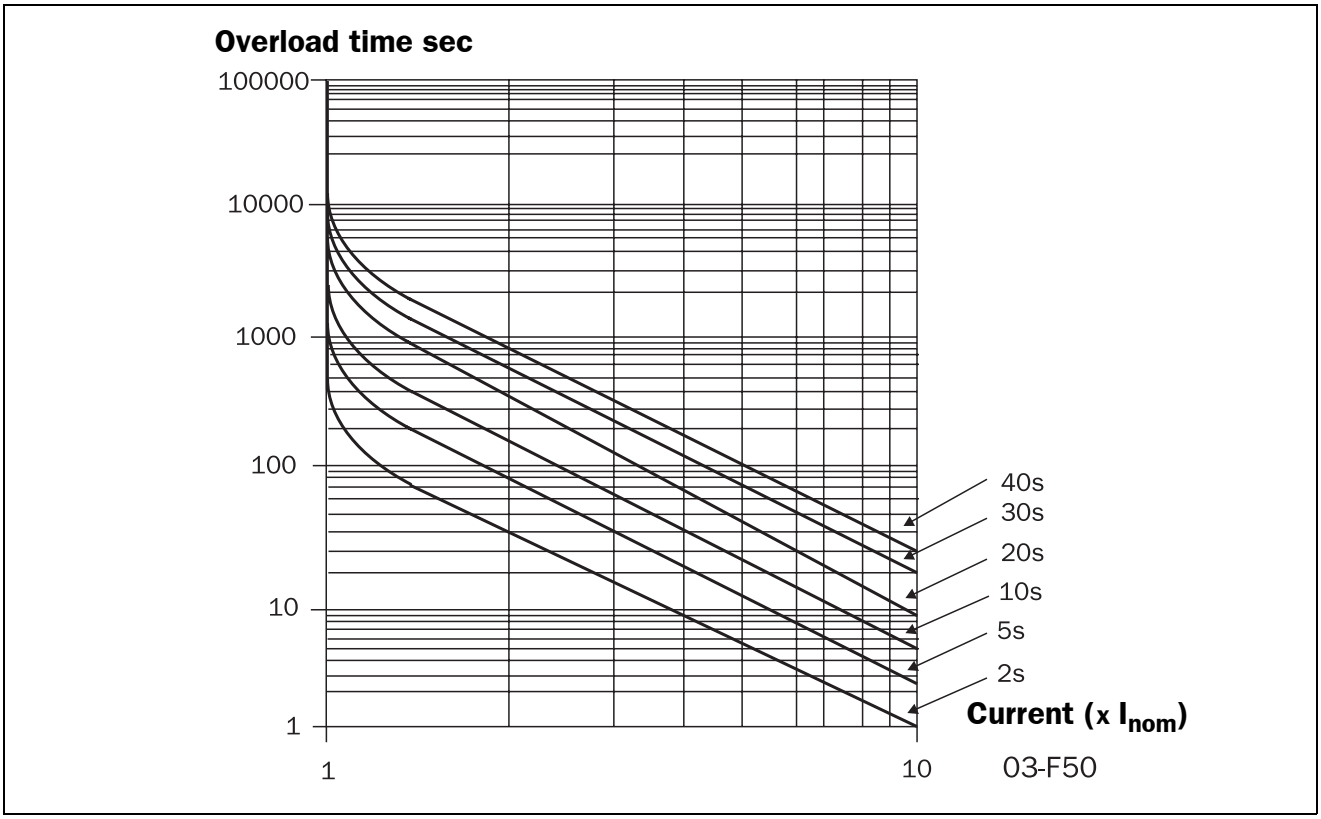


Fig. 57 The thermal curve

7.22 Mains protection

073

Used thermal capacity

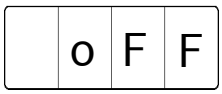
Default:	-
Range:	0-150%
Read-out of the used thermal capacity. If menu 072 'Internal motor thermal protection' is selected oFF, the capacity is shown as if the default class 10 was selected.	

074

Starts per hour limitation

Default:	oFF
Range:	oFF, 1-99/hour
oFF	Starts per hour limitation is disabled.
1-99	Sets the start per hour limitation alarm. If the selected number is exceeded, alarm F11 occurs.

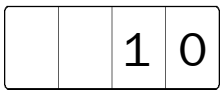
075



Locked rotor alarm

Default:	oFF
Range:	oFF, 1.0-10.0 sec
oFF	Locked rotor alarm is disabled
1.0-10.0	An F5 alarm is given when the rotor locks. The alarm is active during starting and running.

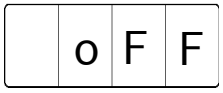
081



Voltage unbalance alarm

Default:	10
Range:	2 -25% U_n
Insert limit in % of nominal motor voltage. Max unbalance in voltage between the 3 input phases is compared with the selected value. This is a category 2 alarm.	

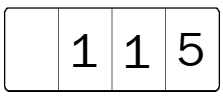
082



Response delay voltage unbalance alarm

Default:	oFF
Range:	oFF, 1-60 sec
oFF	Unbalance voltage alarm is disabled
1-60	Set the response delay time for unbalanced voltage alarm F8.

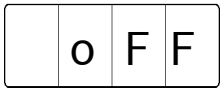
083



Over voltage alarm

Default:	115
Range:	100 -150% U_n
Insert limit in % of nominal motor voltage. Max voltage of the 3 input phases is compared with the selected value. This is a category 2 alarm.	

084



Response delay over voltage alarm

Default:	oFF
Range:	oFF, 1-60 sec
oFF	Overvoltage alarm is disabled
1-60	Set the response delay time for over voltage alarm F9.

085	Under voltage alarm
oFF	
Default:	85
Range:	75-100 U_n
Insert limit in % of nominal motor voltage. Min voltage of the 3 input phases is compared with the selected value. This is a category 2 alarm.	

086	Response delay under voltage alarm
oFF	
Default:	oFF
Range:	oFF, 1-60 sec
oFF	Under voltage alarm is disabled
1-60	Set the response delay time for under voltage alarm F10

087	Phase sequence
- - - -	
Default:	-
Range:	L123, L321
L123 is the direct phase sequence. L321 is the reverse phase sequence.	

088	Phase reversal alarm
oFF	
Default:	oFF
Range:	oFF, on
oFF	Phase reversal alarm is disabled
on	Sets the phase reversal Alarm. - Switch on the power supply first. The phase sequence is stored as the correct sequence. - Sets the menu 088 to “on”. - Any reversal of phase sequence will cause alarm F16.

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

7.23 Application protection (load monitor)

7.23.1 Load monitor max and min/protection (F6 and F7 alarms)

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

In combination with the pre-alarm function, see § 7.23.2, page 58, this create a powerful protection. An auto set function is also included for an automatic setting of the alarm limits. A start-up delay time can be selected to avoid undesired alarms at start-up, see Fig. 58 on page 60.

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

089	Auto set power limits
no	
Default:	no
Range:	no, YES
no	Auto set is disabled
YES	Auto set is activated if ENTER is pressed.

090	Output shaftpower in %
0	
Default:	-
Range:	0-200%
Measured output shaftpower in % of nominal motor power.	

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

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

Power max alarm limit[092]:	1.15xP actual
Power max pre-alarm limit[094]:	1.10xP actual
Power min pre-alarm limit[096]:	0.90xP actual
Power min alarm limit[098]:	0.85xP actual

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

091

Start delay power limits

10

Default:	10 sec
Range:	1-250 sec
From start command during selected delay time, all power load monitor alarms and pre-alarms are disabled.	

092

Max power alarm limit

115

Default:	115
Range:	5-200% Pn
Insert limit in % of nominal motor power. The actual power in % of nominal motor power, could be read out in menu 090. If output shaft power exceeds selected limit, an F6-alarm occurs after the response delay time. The 'Auto set' function in menu 089, affect this limit even if the alarm is set "oFF" in menu 093. This is a category 1 alarm.	

093

Response delay max alarm

oFF

Default:	oFF
Range:	oFF, 0.1-25.0 sec
oFF	Max Alarm is disabled.
0.1-25.0	Sets the response delay of the Max Alarm level.

7.23.2 Pre-alarm

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

It should be noted that it is not normal alarms. They will not be inserted in the alarm list, not activating the alarm relay output, not displayed on the display and they will not stop operation. But it is possible to activate relay K1 or K2 if a pre-alarm condition occurs. To have pre-alarm status on any of these relays, select value 3 in menu 051 or 052 (see § 7.17, page 51).

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

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

094

Max power pre-alarm limit

110

Default:	110
Range:	5 -200% Pn
Insert limit in % of nominal motor power. The actual power in % of nominal motor power, could be read out in menu 090. If output shaft power exceeds selected limit, a pre-alarm occurs after the response delay time. The 'Auto set' function in menu 089, affect selected limit even if the pre-alarm is set "oFF" in menu 095.	

095

Max pre-alarm response delay

oFF

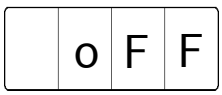
Default:	oFF
Range:	oFF, 0.1 - 25.0 sec
oFF	Max Pre-Alarm is disabled.
0.1-25.0	Sets the response delay of the Max Pre-Alarm level.

096

Min power pre-alarm limit

Default:	90%
Range:	5 -200% Pn
Insert limit in % of nominal motor power. The actual power in % of nominal motor power, could be read out in menu 090. If output shaft power goes below selected limit, a pre-alarm occurs after the response delay time. The 'Auto set' function in menu 089, affect selected limit even if the pre-alarm is set "oFF" in menu 097.	

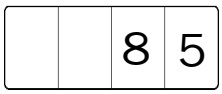
097



Min pre-alarm response delay

Default:	oFF
Range:	oFF, 0.1 - 25.0 sec
oFF	Min Pre-Alarm is disabled.
0.1-25.0	Sets the response delay of the Min Pre-Alarm level. The Min Pre-alarm is disabled during a stop ramp down.

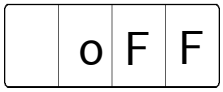
098



Min power alarm limit

Default:	85
Range:	5-200% Pn
Insert limit in % of nominal motor power. The actual power in % of nominal motor power, could be read out in menu 090. If output shaft power goes below selected limit, an F7-alarm occurs after the response delay time. The 'Auto set' function in menu 089, affect this limit even if the alarm is set 'oFF' in menu 099. This is a category 1 alarm.	

099



Min alarm response delay

Default:	oFF
Range:	oFF, 0.1-25.0 sec
oFF	Min Alarm is disabled
0.1-25.0	Sets the response delay of the Min Alarm level. The Min alarm is disabled during a stop ramp down.

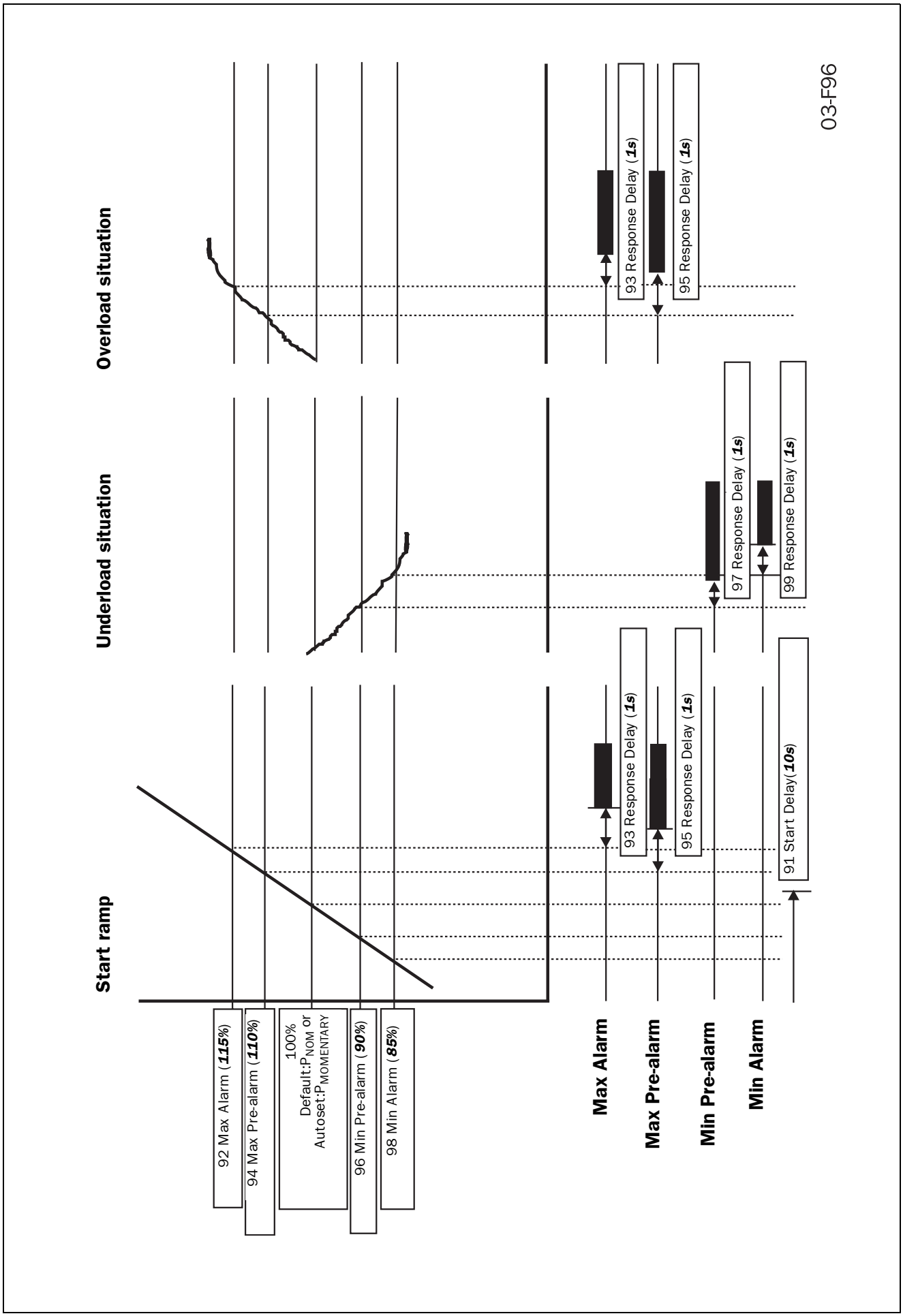


Fig. 58 Load monitor alarm functions.

7.24 Resume alarms

7.24.1 Phase input failure F1

- **Multiple phase failure.**
  Shorter failure than 100ms is ignored. If failure duration time is between 100 ms and 2 s, operation is temporary stopped and a soft start is made if the failure disappears before 2 s. If failure duration time is longer than 2 s, an F1 alarm is given in cat. 2.
- **Single phase failure.**
  During start up (acceleration) the behaviour is like multiple phase failure below. When full voltage running there is a possibility to select the behaviour.

101	**Run at single phase loss**
no	
Default:	no
Range:	no, YES
no	Soft starter trips if a single phase loss is detected. Alarm F1 (category 2) will appear after 2 sec.
YES	Soft starter continues to run after a single phase loss. - Alarm F1 appears after 2 sec. - If the loose phase is reconnect the alarm is reset automatically. - If running on 2 phases, a stop command will give a Direct on line stop (freewheel)

7.24.2 Run at current limit time-out F4

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

102	**Run at current limit time-out**
no	
Default:	no
Range:	no, YES
no	Soft starter trips if the current limit time-out is exceeded. Alarm F4 (category 2) appears.
YES	Soft starter continues to run after the current limit time-out has exceeded: - Alarm F4 appears - The current is no longer controlled and the soft starters ramps up to full voltage with a 6s ramp time. - Reset the alarm with either ENTER/RESET key or by giving a stop command.

7.25 Slow speed with JOG

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

NOTE! The enable functions is for all control modes.

103	**JOG forward enable**
oFF	
Default:	oFF
Range:	oFF, on
oFF	JOG forward disabled
on	JOG forward enabled

104	**JOG reverse enable**
oFF	
Default:	oFF
Range:	oFF, on
oFF	JOG reverse disabled
on	JOG reverse enabled

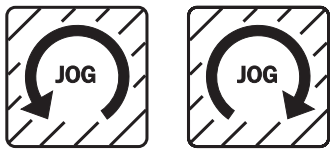
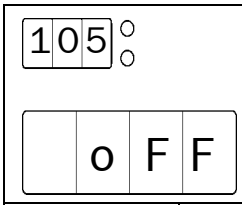


Fig. 59 The 2 Jog keys.

7.26 Automatic return menu

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

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



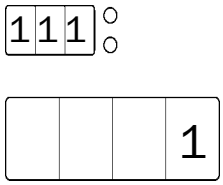
Automatic return menu

Default:	oFF
Range:	oFF, 1-999
1-999	Pressing "+"/"-" will lead through the menu system.

7.27 Communication option, related Parameters

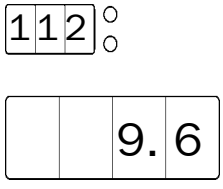
The following parameters have to be set-up:
- Unit address.
- Baud rate.
- Parity
- Behaviour when contact broken.

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



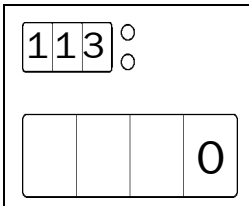
Serial comm unit address

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



Serial comm baudrate

Default:	9.6
Range:	2.4, 4.8, 9.6, 19.2, 38.4 kBaud
This parameter will select the baudrate.	



Serial comm parity

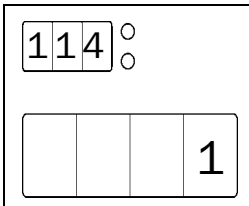
Default:	0
Range:	0.1
This parameter will select the parity. 0 No parity. 1 Even parity.	

Serial comm. broken alarm

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

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

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



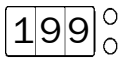
Serial comm. contact interrupted

Default:	1
Range:	oFF, 1, 2
This parameter will control the behaviour in the soft starter when the serial comm. is interrupted. oFF No alarm and continue operation. 1 Alarm and stop operation. 2 Alarm and continue operation.	

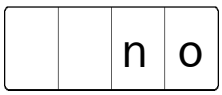
7.28 Reset to factory setting [199]

When selecting reset to factory settings:

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



Reset to factory settings



Default:	no
Range:	no, YES
no	No reset
YES	Reset all functions to the factory defaults incl. all 4 Parameter Sets.

NOTE! Reset to factory settings is not allowed at run.

7.29 View operation

General

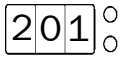
The soft start includes as standard a numerous metering functions which eliminates the need of additional transducers and meters.

Measured values

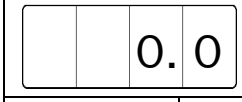
- Current RMS 3-phase current and per phase
- Voltage RMS 3-phase voltage and per phase
- Output shaft power /torque kW/Nm
- Power factor
- Power consumption in kWh
- Operation time in hours

Viewing of the measured values

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

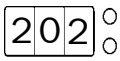


RMS current

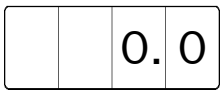


Default:	-
Range:	0.0 - 9999Amp
Read-out of the RMS motor current.	

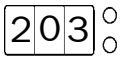
NOTE! This is the same read-out as menu 005 see § 7.1.1, page 36.



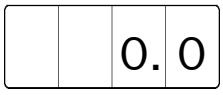
RMS main voltage



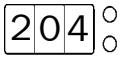
Default:	-
Range:	0-720V
The RMS input main voltage.	



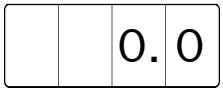
Output motor shaftpower



Default:	-
Range:	-9999 -+9999kW
Viewing will show negative value if generator mode.	

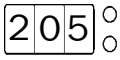


Power factor

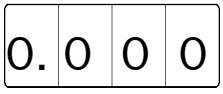


Default:	-
Range:	0.00-1
View the actual power factor.	

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

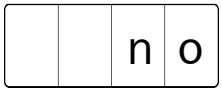


Total power consumption



Default:	-
Range:	0.000 -2000MWh
View the total power consumption.	

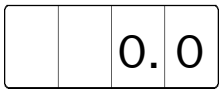
206



Reset of power consumption

Default:	no
Range:	no, YES
no	No reset of power consumtion.
YES	Reset power consumption in menu 205 to 0.000.

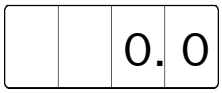
207



Motor shaft torque

Default:	-
Range:	-9999 - + 9999Nm
Viewing will show negative value if generator mode.	

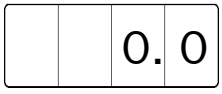
208



Operation time

Default:	-
Range:	Hours
Operation time is calculated when the soft starter is in RUN mode. After 9999 hours the display will show two values. Example: 12467 hours shows 1 1 sec 2467 5sec	

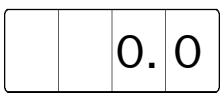
211



RMS current in phase L1

Default:	-
Range:	0.0 - 9999Amp
View the current in phase L1.	

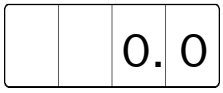
212



RMS current in phase L2

Default:	-
Range:	0.0 - 9999Amp
View the current in phase L2.	

213



RMS current in phase L3

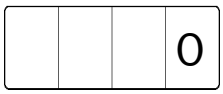
Default:	-
Range:	0.0 - 9999Amp
View the current in phase L3.	

214

Main voltage L1-L2

Default:	-
Range:	0-720V
View main voltage L1-L2.	

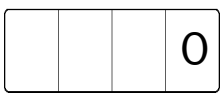
215



Main voltage L1-L3

Default:	-
Range:	0 - 720V
View main voltage L1-L3.	

216



Main voltage L2-L3

Default:	-
Range:	0 - 720V
View main voltage L2-L3.	

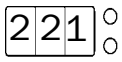
7.30 Keyboard lock

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

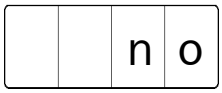
In locked mode it is possible to view all parameters and read-out, but it is forbidden to set parameters and to operate the soft starter from the keyboard.

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

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



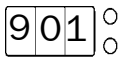
Locked keyboard info



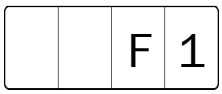
Default:	no
Range:	no, YES
no	Keyboard is not locked
YES	Keyboard is locked

7.31 Alarm list

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



Alarm



Default:	-
Range:	F1-F16
View actual alarm	

8. PROTECTION AND ALARM

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

Category 1
Alarm that stops the motor and need a separate reset before a new start can be accepted.
Category 2
Alarm that stops the motor and accepts a new start command without any separate reset.
Category 3
Alarm that continues to run the motor.

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

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

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

8.1 Alarm description

8.1.1 Alarm with stop and requiring a separate reset

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

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

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

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

8.1.2 Alarm with stop and requiring only a new start command

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

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

8.1.3 Alarm with continue run

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

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

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

8.2 Alarm overview

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

9. TROUBLE SHOOTING

9.1 Fault, cause and solution

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

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

Observation	Fault indication	Cause	Solution
The motor jerks etc.	When starting, motor reaches full speed but it jerks or vibrates.	If 'Torque control' or 'Pump control' is selected, it is necessary to input motor data into the system.	Input nominal motor data in menus 041-046. Select the proper load characteristic in menu 025. Select a correct initial- and end torque at start in menus 016 and 017. If 'Bypass' is selected, check that the current transformers are correct connected.
		Starting time too short.	Increase starting time.
		Starting voltage incorrectly set.	Adjust starting voltage.
		Motor too small in relation to rated current of soft starter.	Use a smaller model of the soft starter.
		Motor too large in relation to load of soft starter.	Use larger model of soft starter.
		Starting voltage not set correctly	Readjust the start ramp.
			Select the current limit function.
	Starting or stopping time too long, soft does not work.	Ramp times not set correctly.	Readjust the start and/or stop ramp time.
		Motor too large or too small in relation to load.	Change to another motor size.
The monitor function does not work.	No alarm or pre-alarm	It is necessary to input nominal motor data for this function. Incorrect alarm levels.	Input nominal motor data in menus 041-046. Adjust alarm levels in menus 091 - 099. If 'Bypass' is selected, check that the current transformers are correct connected.
Unexplainable alarm.	F5, F6, F7, F8, F9, F10	Alarm delay time is to short.	Adjust the response delay times for the alarms in menus 075, 082, 084, 086, 093 and 099.
The system seems locked in an alarm.	F2 (Motor protection, overload)	PTC input terminal could be open. Motor could still be to warm. If internal motor protection is used, the cooling in the internal model take some time.	PTC input terminal should be short circuit if not used. Wait until motor PTC gives an OK (not overheated) signal. Wait until the internal cooling is done. Try to reset the alarm after a while.
	F3 (Soft start overheated)	Ambient temperature to high. Perhaps fan failure.	Check that cables from power part are connected in terminals 073, 074, 071 and 072. MSF-017 to MSF-145 should have a short circuit between 071 and 072. Check also that the fan(s) is rotating.
Parameter will not be accepted.	- - - -	If the menu number is one of 020 - 025, only one can bee selected. In other words only one main mode is possible at a time.	Deselect the other main mode before selecting the new one.
		If menu 061, 'Parameter set' is set to "0", the system is in a remote parameter selection mode. It is now impossible to change most of the parameters.	Set the menu 061, 'Parameter set' to a value between "1" - "4" and then it is possible to change any parameter.
		During acceleration, deceleration, slow speed, DC brake and Power factor control mode, it is impossible to change parameters.	Set parameters during stop or full voltage running.
		If control source is serial comm., it is impossible to change parameters from keyboard and vice versa.	Change parameters from the actual control source.
		Some menus include only read out values and not parameters.	Read-out values can not be altered. In table 13, page 35, read-out menus has '----' in the factory setting column.
	-Loc	Keyboard is locked.	Unlock keyboard by pressing the keys 'NEXT' and 'ENTER' for at least 3 sec.

10. MAINTENANCE

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

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

Regular maintenance

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

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

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

11.1 Serial communication

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

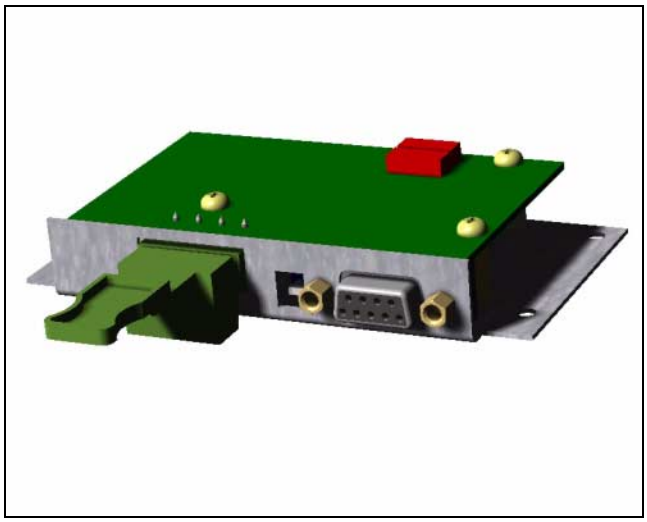


Fig. 60 Option RS232/485

11.2 Field bus systems

Various option cards are available for the following bus systems:

- PROFIBUS DP order number: 01-1734-01
- Device NET, order number: 01-1736-01
- LONWORKS: 01-1737-01
- FIP IO: 01-1738-01
- INTERBUS-S: 01-1735-01

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

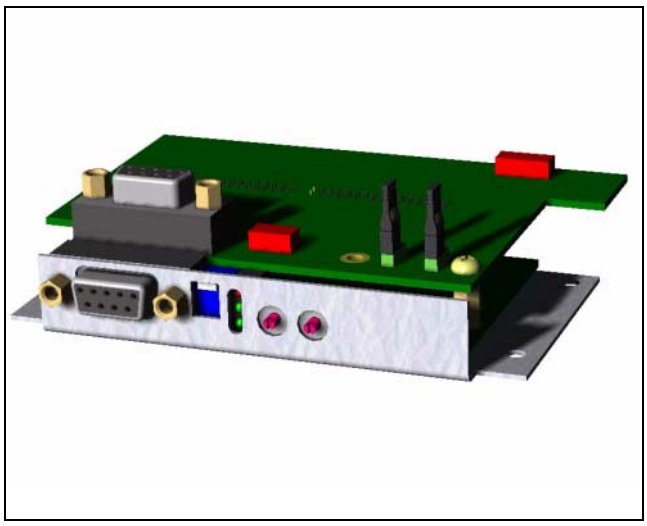


Fig. 61 Option Profibus

11.3 External PPU.

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

The maximum distance between the soft starter and the external PPU is 3 m.

The option can be factory mounted (01-2138-01) or it can be built in later (01-2138-00). For both versions instruction /data sheet are available.

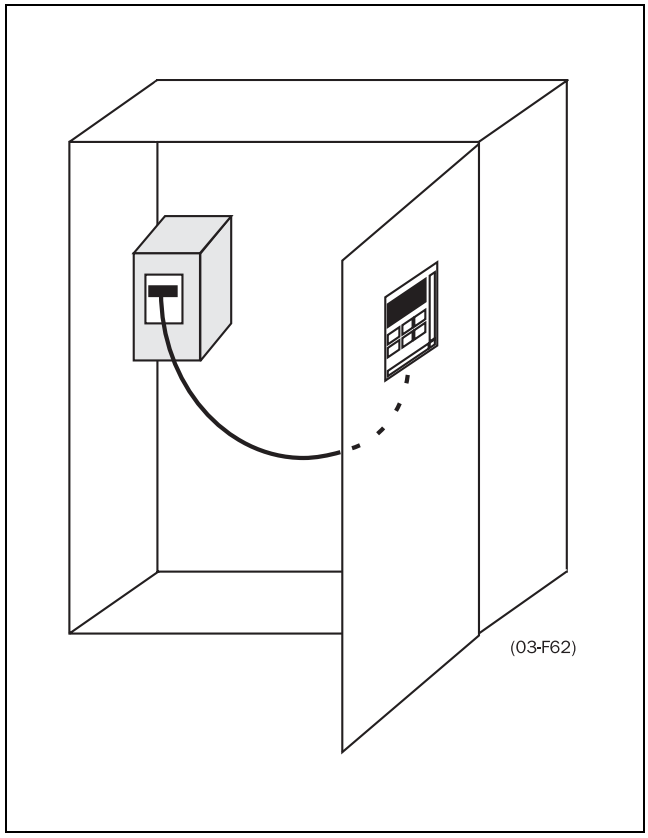


Fig. 62 Shows an example of the External PPU after it has been built in.

11.3.1 Cable kit for external current transformers

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

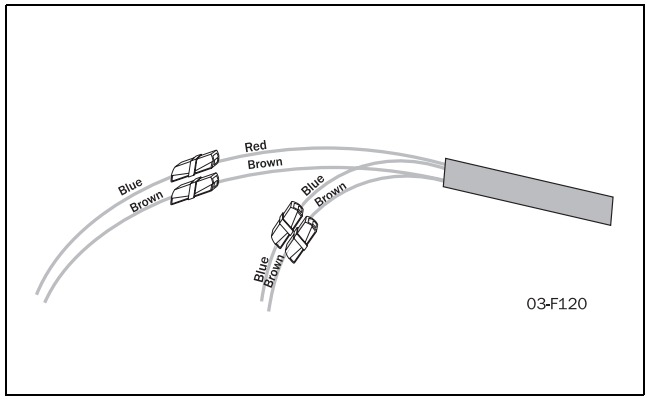


Fig. 63 Cable kit

11.4 Terminal clamp

Data: Single cables, Cu or Al	
Cables	95-300 mm^2
MSF type Cu Cable	310
Bolt for connection to busbar	M10
Dimensions in mm	33x84x47 mm
Order No. single	9350
Data: Parallel cables, Cu or Al	
Cables	2x95-300 mm^2
MSF type and Cu Cable	310 to -835
Bolt for connection to busbar	M10
Dimensions in mm	35x87x65
Order No. parallel	9351

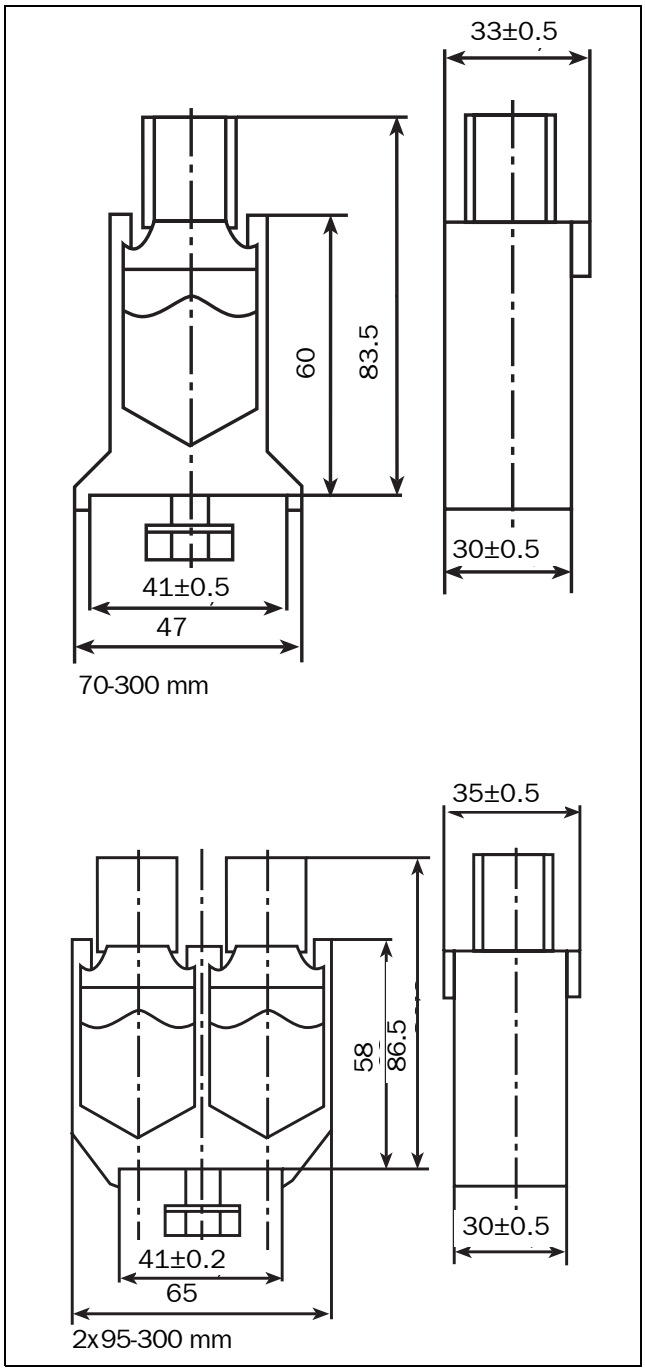


Fig. 64 The terminal clamp.

12. TECHNICAL DATA

3x200–525 V 50/60 Hz Model	MSF-017		MSF-030		MSF-045		MSF-060	
Soft starter rating according to AC35a, see chapter 4. page 13	**5.0-30:50-10 heavy**	**3.0-30:50-10 normal/light**	**5.0-30:50-10 heavy**	**3.0-30:50-10 normal/light**	**5.0-30:50-10 heavy**	**3.0-30:50-10 normal/light**	**5.0-30:50-10 heavy**	**3.0-30:50-10 normal/light**
Rated current of soft starter (A)	17	22	30	37	45	60	60	72
Recommended motor size (kW) for 400 V	7.5	11	15	18.5	22	30	30	37
Recommended motor size (kW) for 525 V	11	15	18.5	22	30	37	37	45
Order number: supply voltage (100-240V)	01-1301-01		01-1302-01		01-1303-01		01-1304-01	
Order number: supply voltage (380-500V)	01-1301-02		01-1302-02		01-1303-02		01-1304-02	
3x200-690V 50/60Hz Model	**MSF-017**		**MSF-030**		**MSF-045**		**MSF-060**	
Rated current of soft starter (A)	17	22	30	37	45	60	60	72
Motor power for 690V	15	18.5	22	30	37	55	55	75*
Order number: supply voltage (100-240V)	01-1321-01		01-1322-01		01-1323-01		01-1324-01	
Order number: supply voltage (380-500V)	01-1321-02		01-1322-02		01-1323-02		01-1324-02	
Electrical Data								
Recommended wiring fuse (A) 1)	25/50	32	35/80	50	50/125	80	63/160	100
Semi-conductor fuses, if required	80 A		125 A		160 A		200 A	
Power loss at rated motor load (W)	50	70	90	120	140	180	180	215
Power consumption control card	20 VA		20 VA		25 VA		25 VA	
Mechanical Data								
Dimensions in mm HxWxD	320x126x260		320x126x260		320x126x260		320x126x260	
Mounting position (Vertical/Horizontal)	Vertical		Vertical		Vert. or Horiz.		Vert. or Horiz.	
Weight (kg)	6.7		6.7		6.9		6.9	
Connection busbars Cu, (bolt)	15x4 (M6)		15x4 (M6)		15x4 (M6)		15x4 (M8)	
Cooling system	Convection		Convection		Fan		Fan	
General Electrical Data								
Number of fully controlled phases	3							
Voltage tolerance control	Control +/- 10%							
Voltage tolerance motor	Motor 200-525 +/- 10%/200-690 + 5%, -10%							
Recommended fuse for control card (A)	Max 10 A							
Frequency	50/60 Hz							
Frequency tolerance	+/- 10%							
Relay contacts	3 x 8A, 250 V resistive load, 3A 250VAC inductive (PF=0.4)							
Type of protection/insulation								
Type of casing protection	IP 20							
Other General Data								
Ambient temperatures								
In operation	0 - 40 °C							
Max. e.g. at 80% IN	50 °C							
In storage	(-25) - (+70) °C							
Relative air humidity	95%, non-condensing							
Max. altitude without derating	(See separate: Technical information 151) 1000 m							
Norms/Standards, Conform to:	IEC 947-4-2, EN 292, EN 60204-1, UL508							
EMC, Emission	EN 50081-2, (EN 50081-1 with bypass contactor)							
EMC, Immunity	EN 50082-2							
1) Recommended wiring fuses for:	**Heavy** (first column): ramp/direct start **Normal/Light** (second column): ramp start							
NOTE! Short circuit withstand MSF017-060 5000 rms A when used with K5 or RK5 fuses.								

* 2-pole motor

3x200–525 V 50/60 Hz Model	MSF-075		MSF-085		MSF-110		MSF-145	
Soft starter rating according to AC35a, see chapter 4. page 13	**5.0-30:50-10 heavy**	**3.0-30:50-10 normal/light**	**5.0-30:50-10 heavy**	**3.0-30:50-10 normal/light**	**5.0-30:50-10 heavy**	**3.0-30:50-10 normal/light**	**5.0-30:50-10 heavy**	**3.0-30:50-10 normal/light**
Rated current of soft starter (A)	75	85	85	96	110	134	145	156
Recommended motor size (kW) for 400 V	37	45	45	55*	55	75	75	
Recommended motor size (kW) for 525 V	45	55	55	75*	75	90	90	110
Order number for supply voltage (100-240 V)	01-1305-01		01-1306-01		01-1307-01		01-1308-01	
Order number for supply voltage (380-550 V)	01-1305-02		01-1306-02		01-1307-02		01-1308-02	
3x200–690 V 50/60 Hz Model	**MSF-075**		**MSF-085**		**MSF-110**		**MSF-145**	
Rated current of soft starter (A)	75	85	85	90	110	134	145	156
Motor power for 690V	55	75	75	90	90	110	132	160*
Order number for supply voltage (100-240 V)	01-1325-01		01-1326-01		01-1327-01		01-1328-01	
Order number for supply voltage (380-550 V)	01-1325-02		01-1326-02		01-1327-02		01-1328-02	
Electrical Data								
Recommended wiring fuse (A) 1)	80/200	100	100/250	125	125/315	180	160/400	200
Semi-conductor fuses, if required	250 A		315 A		350 A		450 A	
Power loss at rated motor load (W)	230	260	260	290	330	400	440	470
Power consumption control card	25 VA		25 VA		25 VA		25 VA	
Mechanical Data								
Dimensions in mm HxWxD	320x126x260		320x126x260		400x176x260		400x176x260	
Mounting position (Vertical/Horizontal)	Vert. or Horiz.		Vert. or Horiz.		Vert. or Horiz.		Vert. or Horiz.	
Weight (kg)	6.9		6.9		12		12	
Connection, busbars Cu, (bolt)	15x4 (M8)		15x4 (M8)		20x4 (M10)		20x4 (M10)	
Cooling system	Fan		Fan		Fan		Fan	
General Electrical Data								
Number of fully controlled phases	3							
Voltage tolerance control	Control +/- 10%							
Voltage tolerance motor	Motor 200-525 +/- 10%/200-690 + 5%, -10%							
Recommended fuse for control card (A)	Max 10 A							
Frequency	50/60 Hz							
Frequency tolerance	+/- 10%							
Relay contacts	8A, 250 V resistive load, 3A, 250 V inductive load (PF=0.4)							
Type of protection/insulation								
Type of casing protection	IP 20							
Other General Data								
Ambient temperatures In operation	0 - 40 °C							
Max. e.g. at 80% I_N	50 °C							
In storage	(-25) - (+70) °C							
Relative air humidity	95%, non-condensing							
Max. altitude without derating	(See separate: Technical information 151) 1000 m							
Norms/Standards, Conform to:	IEC 947-4-2, EN 292, EN 60204-1, UL508							
EMC, Emission	EN 50081-2, (EN 50081-1 with bypass contactor)							
EMC, Immunity	EN 50082-2							
1) Recommended wiring fuses for:	**Heavy** (first column): ramp/direct start **Normal/Light** (second column): ramp start							
NOTE! Short circuit withstand MSF075-145 10000 rms A when used with K5 or RK5 fuses.								

* 2-pole motor

3x200–525 V 50/60 Hz Model	MSF-170		MSF-210		MSF-250		MSF-310		MSF-370	
Soft starter rating according to AC35a, see chapter 4. page 13	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/light**	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/light**	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/light**	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/light**	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/light**
Rated current of soft starter (A)	170	210	210	250	250	262	310	370	370	450
Recommended motor size (kW) for 400 V	90	110	110	132	132	160*	160	200	200	250
Recommended motor size (kW) for 525 V	110	132	132	160	160	200*	200	250	250	315
Order no. for supply voltage (100-240V)	01-1309-11		01-1310-11		01-1311-11		01-1312-01		01-1313-01	
Order no. for supply voltage (380-550V)	01-1309-12		01-1310-12		01-1311-12		01-1312-02		01-1313-02	
3x200–690 V 50/60 Hz Model	**MSF-170**		**MSF-210**		**MSF-250**		**MSF-310**		**MSF-370**	
Rated current of soft starter (A)	170	210	210	250	250	262	310	370	370	450
Motor power for 690 V	160	200	200	250	250	250	315	355	355	400
Order no. for supply voltage (100-240V)	01-1329-01		01-1330-01		01-1331-01		01-1332-01		01-1333-01	
Order no. for supply voltage (380-550V)	01-1329-02		01-1330-02		01-1331-02		01-1332-02		01-1333-02	
Electrical Data										
Recommended wiring fuse (A) 1)	200/400	200	250/400	315	250/500	315	315/630	400	400/800	500
Semi-conductor fuses, if required	700 A		700 A		700 A		800 A		1000 A	
Power loss at rated motor load (W)	510	630	630	750	750 W		930	1100	1100	1535
Power consumption control card	35 VA		35 VA		35 VA		35 VA		35 VA	
Mechanical Data										
Dimensions mm HxWxD incl. brackets	500x260x260		500x260x260		500x260x260		532x547x278		532x547x278	
Mounting position (Vertical/Horizontal)	Vert. or Horiz.		Vert. or Horiz.		Vert. or Horiz.		Vert. or Horiz.		Vert. or Horiz.	
Weight (kg)	20		20		20		42		46	
Connection, Busbars Al/Cu (bolt)	30x4 (M10)		30x4 (M10)		30x4 (M10)		40x8 (M12)		40x8 (M12)	
Cooling system	Fan		Fan		Fan		Fan		Fan	
General Electrical Data										
Number of fully controlled phases	3									
Voltage tolerance control	Control +/- 10%									
Voltage tolerance motor	Motor 200-525 +/- 10%/200-690 + 5%, -10%									
Recommended fuse for control card (A)	Max 10 A									
Frequency	50/60 Hz									
Frequency tolerance	+/- 10%									
Relay contacts	8A, 250 V resistive load, 3A, 250 V inductive load (PF=0.4)									
Type of protection/insulation										
Type of casing protection	IP 20									
Other General Data										
Ambient temperatures In operation	0 - 40 °C									
Max. e.g. at 80% I_N	50 °C									
In storage	(-25) - (+70) °C									
Relative air humidity	95%, non-condensing									
Max. altitude without derating	(See separate: Technical information 151) 1000 m									
Norms/Standards, Conform to:	IEC 947-4-2, EN 292, EN 60204-1, (UL508, only MSF-170 to MSF-250)									
EMC, Emission	EN 50081-2, (EN 50081-1 with bypass contactor)									
EMC, Immunity	EN 50082-2									
1) Recommended wiring fuses for:	**Heavy** (first column): ramp/direct start **Normal/Light** (second column): ramp start									
NOTE! Short circuit withstand MSF170-250 18000 rms A when used with K5 or RK5 fuses.										

* 2-pole motor

3x200–525V 50/60Hz Model	MSF-450		MSF-570		MSF-710		MSF-835		MSF-1000		MSF-1400	
Soft starter rating according to AC35a, see chapter 4. page 13	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/ light**	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/ light**	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/ light**	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/ light**	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/ light**	**5.0-30: 50-10 heavy**	**3.0-30: 50-10 normal/ light**
Rated current of soft starter (A)	450	549	570	710	710	835	835	960	1000	1125	1400	1650
Recommended motor size (kW) for 400 V	250	315	315	400	400	450	450	560	560	630	800	930
Recommended motor size (kW) for 525 V	315	400	400	500	500	560	600	630	660	710	1000	1250
Order no. for supply voltage (100-240V)	01-1341-01		01-1315-01		01-1316-01		01-1317-01		01-1318-01		01-1319-01	
Order no. for supply voltage (380-550V)	01-1314-02		01-1315-02		01-1316-02		01-1317-02		01-1318-02		01-1319-02	
3x200–690V 50/60Hz Model	**MSF-450**		**MSF-570**		**MSF-710**		**MSF-835**		**MSF-1000**		**MSF-1400**	
Rated current of soft starter (A)	450	549	570	640	710	835	835	880	1000	1125	1400	1524
Motor power for 690 V	400	560	560	630	710	800	800		1000	1120	1400	1600
Order no. for supply voltage (100-240V)	01-1334-01		01-1335-01		01-1336-01		01-1337-01		01-1338-01		01-1339-01	
Order no. for supply voltage (380-550V)	01-1334-02		01-1335-02		01-1336-02		01-1337-02		01-1338-02		01-1339-02	
Electrical Data												
Recommended wiring fuse (A 1)	500/1 k	630	630/1 k	800	800/1 k	1 k	1 k/1.2 k	1 k	1k/1.4 k	1.2 k	1.4 k/1.8 k	1.8 k
Semi-conductor fuses, if required	1250 A		1250 A		1800 A		2500 A		3200 A		4000 A	
Power loss at rated motor load (W)	1400	1730	1700	2100	2100	2500	2500	2875	3000	3375	4200	4950
Power consumption control card	35 VA		35 VA		35 VA		35 VA		35 VA		35 VA	
Mechanical Data												
Dimensions mm HxWxD incl. brackets	532x547x278		687x640x302		687x640x302		687x640x302		900x875x336		900x875x336	
Mounting position (Vertical/Horizontal)	Vert. or Horiz.		Vert. or Horiz.		Vert. or Horiz.		Vert. or Horiz.		Vert. or Horiz.		Vert. or Horiz.	
Weight (kg)	46		64		78		80		175		175	
Connection, Busbars Al (bolt)	40x8 (M12)		40x10 (M12)		40x10 (M12)		40x10 (M12)		75x10 (M12)		75x10 (M12)	
Cooling system	Fan		Fan		Fan		Fan		Fan		Fan	
General Electrical Data												
Number of fully controlled phases	3											
Voltage tolerance control	Control +/- 10%											
Voltage tolerance motor	Motor 200-525 +/- 10%/200-690 + 5%, -10%											
Recommended fuse for control card (A)	Max 10 A											
Frequency	50/60 Hz											
Frequency tolerance	+/- 10%											
Relay contacts	8A, 250 V resistive load, 3A, 250 V inductive load (PF=0.4)											
Type of protection/insulation												
Type of casing protection	IP 20								IP00			
Other General Data												
Ambient temperatures In operation	0 - 40 °C											
Max. e.g. at 80% I_N	50 °C											
In storage	(-25) - (+70) °C											
Relative air humidity	95%, non-condensing											
Max. altitude without derating	(See separate: Technical information 151) 1000 m											
Norms/Standards, Conform to:	IEC 947-4-2, EN 292, EN 60204-1											
EMC, Emission	EN 50081-2, (EN 50081-1 with bypass contactor)											
EMC, Immunity	EN 50082-2											
1) Recommended wiring fuses for:	**Heavy** (first column): ramp/direct start **Normal/Light** (second column): ramp start											

Semi-conductor fuses

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

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

Type	FWP Bussmann fuse	
	A	I^2t (fuse) x 1000
MSF-017	80	2.4
MSF-030	125	7.3
MSF-045	150	11.7
MSF-060	200	22
MSF-075	250	42.5
MSF-085	300	71.2
MSF-110	350	95.6
MSF-145	450	137
MSF-170B	700	300
MSF-210B	700	300
MSF-250B	800	450
MSF-310	800	450
MSF-370	1000	600
MSF-450	1200	2100
MSF-570	1400	2700
MSF-710	1800	5300
MSF-835	2000	
MSF-1000	2500	
MSF-1400	3500	

13. SET-UP MENU LIST

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

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

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

Explanation of units:

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

Calculation shaft torque

$$T_n = \frac{P_n}{\left(\frac{N_n}{60} x 2\pi\right)}$$

NOTE! The six main functions for motor control, menus 020–025, can only be selected one at a time.

14. INDEX

N

O

P

Q

R

S

T

U

V

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