MVE

Medium voltage IP00 soft starter

User Manual

BENSHAW
Applied Motor Controls

Contents

1 About This Manual

The examples and diagrams in this manual are included solely for illustrative purposes. The information contained in this manual is subject to change at any time and without prior notice. In no event will responsibility or liability be accepted for direct, indirect or consequential damages resulting from the use or application of this equipment.

WARNING
Indicates a hazard that may cause personal injury or death.

CAUTION
Indicates a hazard that may damage the equipment or installation.

NOTE
Provides helpful information.

2 Caution Statements

Caution Statements cannot cover every potential cause of equipment damage but can highlight common causes of damage. It is the installer's responsibility to read and understand all instructions in this manual prior to installing, operating or maintaining the equipment, to follow good electrical practice including applying appropriate personal protective equipment and to seek advice before operating this equipment in a manner other than as described in this manual.

- Read and understand the entire manual before installing operating, or maintaining the soft starter. Follow all applicable local and national codes.
- Apply appropriate personal protective equipment (PPE) and clothing, and follow safe electrical work practices.
- Disconnect all power and ensure that the soft starter is de-energised before servicing the equipment.
- Do not rely on visual indications such as switch position or fuse removal for determining a de-energised condition. Always assume that a terminal is energised until it is checked and ensure that a terminal is de-energised and grounded.
- Isolate the soft starter completely from the power supply before attempting any work on the soft starter or motor.
- Always use a properly rated voltage sensing device to confirm power is off.
- Before servicing the soft starter, ensure that all static charge has been discharged by grounding it with an appropriate grounding device.
- Metal debris in the enclosure can cause equipment failure.
- The control inputs are powered by the soft starter. Do not apply external voltage to the control input terminals.
- Contacts or switches operating the control inputs must be suitable for low voltage, low current switching (ie gold flash or similar).
- Cables to the control inputs must be segregated from mains voltage and motor cabling.
- Some contactor coils are not suitable for direct switching with PCB mount relays.

WARNING – ELECTRICAL SHOCK HAZARD
The soft starter contains dangerous voltages when connected to mains voltage. Only a qualified electrician should carry out the electrical installation. Improper installation of the motor or the soft starter may cause equipment failure, serious injury or death. Follow this manual and local electrical safety codes.

SHORT CIRCUIT
The soft starter is not short circuit proof. After severe overload or short circuit, the operation of the soft starter should be fully tested by an authorised service agent.

GROUNDING AND BRANCH CIRCUIT PROTECTION
It is the responsibility of the user or person installing the soft starter to provide proper grounding and branch circuit protection according to local electrical safety codes.

ARC FLASH HAZARD
Medium voltage equipment has a potential risk of arc flash. When insulation or isolation between electrified conductors is breached or can no longer withstand the applied voltage, a short circuit occurs through the air. This may cause a phase-to-ground and/or a phase-to-phase fault.

Although unlikely, arc fault can be caused by:

- Contamination in the insulation caused by deterioration over time
- Inadequate insulation system on cable terminals
- Overvoltage
- Incorrect protection coordination settings
- Overheating of the contact area, due to incorrect tightening of connections
- Foreign matter, such as metal debris, vermin, tools or maintenance equipment left in the starter

This equipment has been designed to mitigate an arc fault, however it is the responsibility of the site engineer to ensure that personnel are protected from serious injury that may result from an arc fault.

3 General Description

3.1 Overview

Soft starter main components:

- Power assembly (3 x phase arms)
- Multilingual controller with fibre-optic cables
- Power interface board, including diagnostic board
- 3 x CTs – 1000:1

3.2 Feature List

Versatile starting and stopping options

- Constant current
- Current ramp
- Timed voltage ramp start
- Coast To Stop
- Timed voltage ramp soft stop

Protection

- Undervoltage / Overvoltage (27, 59)
- Mains frequency (81)
- Phase loss (47)
- Phase sequence (47)
- Shorted SCR (3)
- Motor Overload (thermal model) (49, 51)
- Instantaneous Overcurrent (two stages) (50, 51)
- Time-overcurrent (51)
- Ground Fault (50G)
- Undercurrent (37)
- Current Imbalance (46, 60)
- Motor thermistor (26, 49)
- Excess Start Time (48)
- Power circuit / Power loss (32)
- Input Trip (94, 95)
- Internal/external communications failure (85)

Extensive input and output options

- Remote control inputs
  (3 x fixed, 2 x programmable)
- Relay outputs
  (4 x fixed, 3 x programmable)
- Analog output
  (1 x programmable)
- Serial port (with module)

Comprehensive feedback

- Starter status LEDs
- Date and time stamped event logging
- Operational counters (number of starts, hours-run, kWh)
- Performance monitoring (current, voltage, power factor, kWh)
- User-programmable monitoring screen
- Multi-level password protection

Accessories (optional)

- Communication modules: Ethernet (Profinet, Modbus TCP, Ethernet/IP), Profibus, DeviceNet, Modbus RTU, and USB

3.3 Model Code

Control Voltage
C12 = 85 ~ 264 VAC or 90 ~ 350 VDC*

Supply Voltage
V02 = 2300 VAC 50/60 Hz
V03 = 3300 VAC 50/60 Hz
V04 = 4160 VAC 50/60 Hz
V06 = 6600 VAC 50/60 Hz
V11 = 11000 VAC 50/60 Hz
V13 = 13800 VAC 50/60 Hz

Current Rating @ AC53b 4-30 : 1770

0070 = 70 A	0700 = 700 A
0110 = 110 A	0800 = 800 A
0200 = 200 A	0900 = 900 A
0220 = 220 A	1000 = 1000 A
0250 = 250 A	1100 = 1100 A
0300 = 300 A	1200 = 1200 A
0360 = 360 A	1300 = 1300 A
0400 = 400 A	1400 = 1400 A
0450 = 450 A	1500 = 1500 A
0500 = 500 A	1600 = 1600 A
0540 = 540 A	1700 = 1700 A
0600 = 600 A	

* Control voltage input range using an approved switch mode power supply unit with 24 VDC, 10 A (minimum) output capacity.

3.4 Accessories

Communication Modules

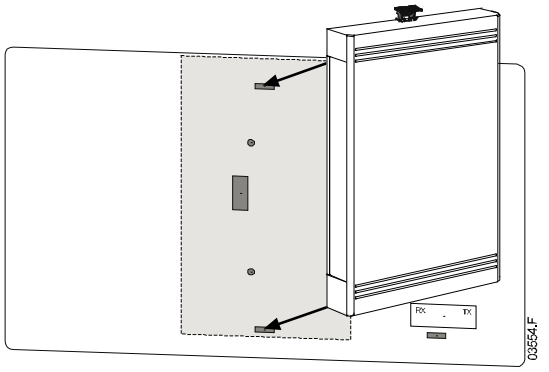
The soft starter can support network communication via easy-to-install communications modules. Each soft starter can support one communications module at a time.

Available protocols:

Ethernet (Profinet, Modbus TCP, Ethernet/IP), Profibus, DeviceNet, Modbus RTU, and USB.

- **Installing Communication Modules**

Communication modules attach to the back of the controller:



LV motor test resistor assembly

LV motor test resistor assemblies are used for low voltage motor testing. They reduce the resistance across a phase arm, increasing the strength of the non-conduction feedback signals. For more information, see *Low voltage motor test* on page 59.

Starter Trip and Event Logger Software

The Starter Trip and Event Logger Software allows you to download the trip and event logs from the soft starter, for separate analysis.

To use the Starter Trip and Event Logger Software with the soft starter, the soft starter must be fitted with a USB Module or a Modbus Module.

For further information, or for a copy of the software, contact your local supplier.

4 Specifications

Supply

Mains Voltage (U_r)

- V02 ..... 2.3 kV Phase-phase
- V03 ..... 3.3 kV Phase-phase
- V04 ..... 4.16 kV Phase-phase
- V06 ..... 6.6 kV Phase-phase
- V11 ..... 11.0 kV Phase-phase
- V13 ..... 13.8 kV Phase-phase

Rated Frequency (fr) ..... 50/60 Hz

Rated lightning impulse withstand voltage (U_p) [1]

- V02 ~ V04 ..... 40 kV
- V06 ..... 60 kV
- V11 ..... 75 kV
- V13 ..... 95 kV

Rated power frequency withstand voltage (U_d) [1]

- V02 ~ V04 ..... 10 kV
- V06 ..... 20 kV
- V11 ..... 42 kV
- V13 ..... 38 kV

Rated normal current (I_r)

- 0070 ..... 70 A
- 0110 ..... 110 A
- 0200 ..... 200 A
- 0220 ..... 220 A
- 0250 ..... 250 A
- 0300 ..... 300 A
- 0360 ..... 360 A
- 0400 ..... 400 A
- 0450 ..... 450 A
- 0500 ..... 500 A
- 0540 ..... 540 A
- 0600 ..... 600 A
- 0700 ..... 700 A
- 0800 ..... 800 A
- 0900 ..... 900 A
- 1000 ..... 1000 A
- 1100 ..... 1100 A
- 1200 ..... 1200 A
- 1300 ..... 1300 A
- 1400 ..... 1400 A
- 1500 ..... 1500 A
- 1600 ..... 1600 A
- 1700 ..... 1700 A

Form designation ..... Bypassed semiconductor motor starter form 1

Control voltage ..... 85 ~ 264 VAC or 90 ~ 350 VDC [2]

Typical power consumption

- During Start (Control supply) ..... ≤150 W
- During Run ..... 70 W continuous [3]

Inputs

Inputs on Controller

Start (C23, C24) ..... 24 VDC, 8 mA approx

Stop (C31, C32) ..... 24 VDC, 8 mA approx

Reset (C41, C42) ..... 24 VDC, 8 mA approx

Input A (C53, C54) ..... 24 VDC, 8 mA approx

Input B (C63, C64) ..... 24 VDC, 8 mA approx

Motor thermistor (B4, B5) ..... Trip point > 3.6 kΩ

..... Reset > 1.6 kΩ

Inputs on power interface board
- Bypass readback input (C73, C74) ..... 24 VDC, 8 mA approx
- Fan Fail (C1, C2) ..... 24 VDC, 8 mA approx
- DOL protection activated (C3, C4) ..... 24 VDC, 8 mA approx
- Power supply fail input (C5, C6) ..... 24 VDC, 8 mA approx

NOTE
All control inputs are potential free. Do not apply external voltage to these inputs.

Outputs

Outputs on Controller
- Output Relay A (43, 44) ..... Normally Open
- Output Relay B (51, 52, 54) ..... Changeover
- Output Relay C (61, 62, 64) ..... Changeover
- Analog output (B10, B11) ..... 0-20 mA or 4-20 mA

Ratings of output relays on Controller
- ..... 10 A @ 250 VAC resistive
- ..... 6 A @ 250 VAC 15 p.f. 0.3
- ..... 10 A @ 30 VDC resistive

Outputs on power interface board
- Main contactor (13, 14) ..... Normally Open
- Bypass contactor (23, 24) ..... Normally Open
- Run Output/ PFC (33, 34) ..... Normally Open
- Phase arm power supply control relay output (43, 44) ..... Normally Open

Ratings of output relays on power interface board
- ..... 10 A @ 250 VAC resistive
- ..... 10 A @ 30 VDC resistive

Environmental

Degree of Protection
- Power Assembly IP00
- Controller ..... IP54/ NEMA 12

Operating temperature ..... - 10 ˚C to + 60 °C, above + 50 °C with derating
- Humidity ..... 5%~95% Relative Humidity

Storage temperature ..... - 25 ˚C to + 70 ˚C
- Humidity ..... 5%~95% Relative Humidity

Operating Altitude ..... 0~1000 m, above 1000 m with derating
Pollution degree ..... Pollution Degree 3
Vibration ..... Designed to IEC 60068-2-6-Fc

EMC Emission (Designed to IEC 60947-4-2)

Equipment class (EMC) ..... Class A
Conducted radio frequency emission ..... 0.15 MHz to 0.5 MHz: < 79 dB µV
- ..... 0.5 to 5 MHz: < 73 dB µV
- ..... 5 to 30 MHz: < 73 dB µV

Radiated radio frequency emission ..... 30 to 230 MHz: < 30 dB µV/m
- ..... 230 MHz to 1000 MHz: < 37 dB µV/m

This product has been designed as Class A equipment. Use of this product in domestic environments may cause radio interference, in which case the user may be required to employ additional mitigation methods.

EMC Immunity (Designed to IEC 60947-4-2)

Electrostatic Discharge ..... 6 kV contact discharge, 8 kV air discharge
Radio Frequency Electromagnetic Field ..... 80 to 1000 MHz: 10 V/m
Fast Transients 5/50 ns (main and control circuits) ..... 2 kV line to earth, 1 kV line to line
Surges 1.2/50 µs (main and control circuits) ..... 2 kV line to earth, 1 kV line to line
Voltage dip and short time interruption (safe shutdown) ..... 5000 ms (at 0% nominal voltage)

Certification

UL (models ≤ 4.2 kV only) ..... UL 347, 6th edition

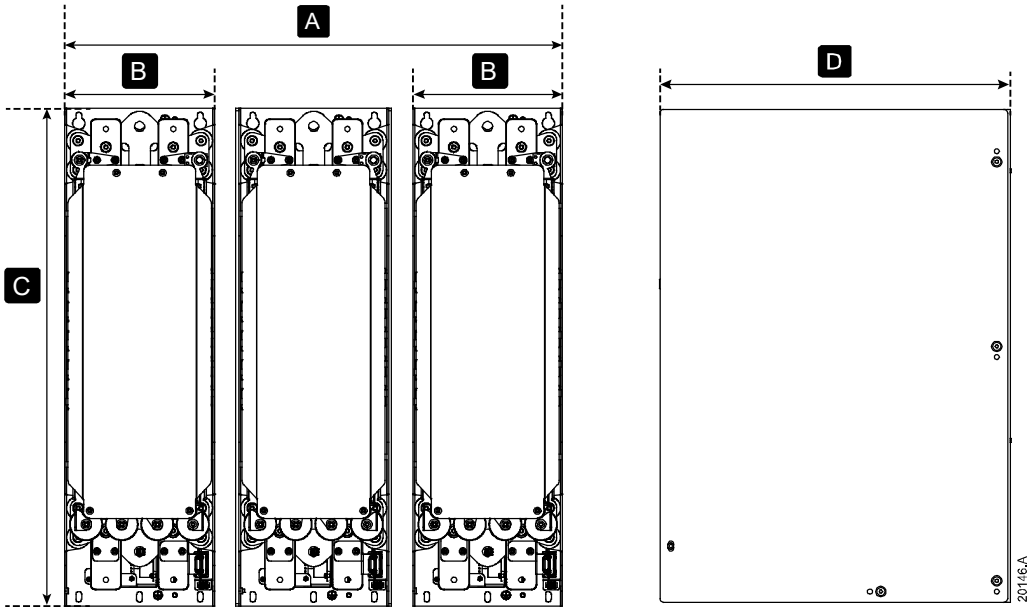
[1] Higher ratings may be available on request.

[2] Control voltage input range using an approved switch mode power supply unit with 24 VDC, 10 A (minimum) output capacity.

[3] Excludes contactors and/or circuit breakers.

5 Installation

5.1 Dimensions and Weights



Front view Side view

	A mm (inch)	B mm (inch)	C mm (inch)	D mm (inch)	Weight (phase arm) kg (lb)
V02: 0070~0450	750 (29.5)	246 (9.7)	584 (23.0)	508 (20.0)	38.4 (84.7)
V03: 0070~0450					39.5 (87.1)
V04: 0070~0450					
V06: 0070~0450			652 (25.7)	600 (23.6)	53.3 (117.5)
V02: 0500~0540	750 (29.5)	246 (9.7)	584 (23.0)	600 (23.6)	43.4 (95.7)
V03: 0500~0540					44.5 (98.1)
V04: 0500~0540					
V06: 0500~0540			652 (25.7)	660 (26.0)	58.9 (127.9)
V11: 0070~0540	978 (38.5)	308 (12.1)	1000 (39.4)	602 (23.7)	105 (231.5)
V13: 0070~0540	1048 (41.3)		1100 (43.3)	764 (30.1)	125 (275.6)

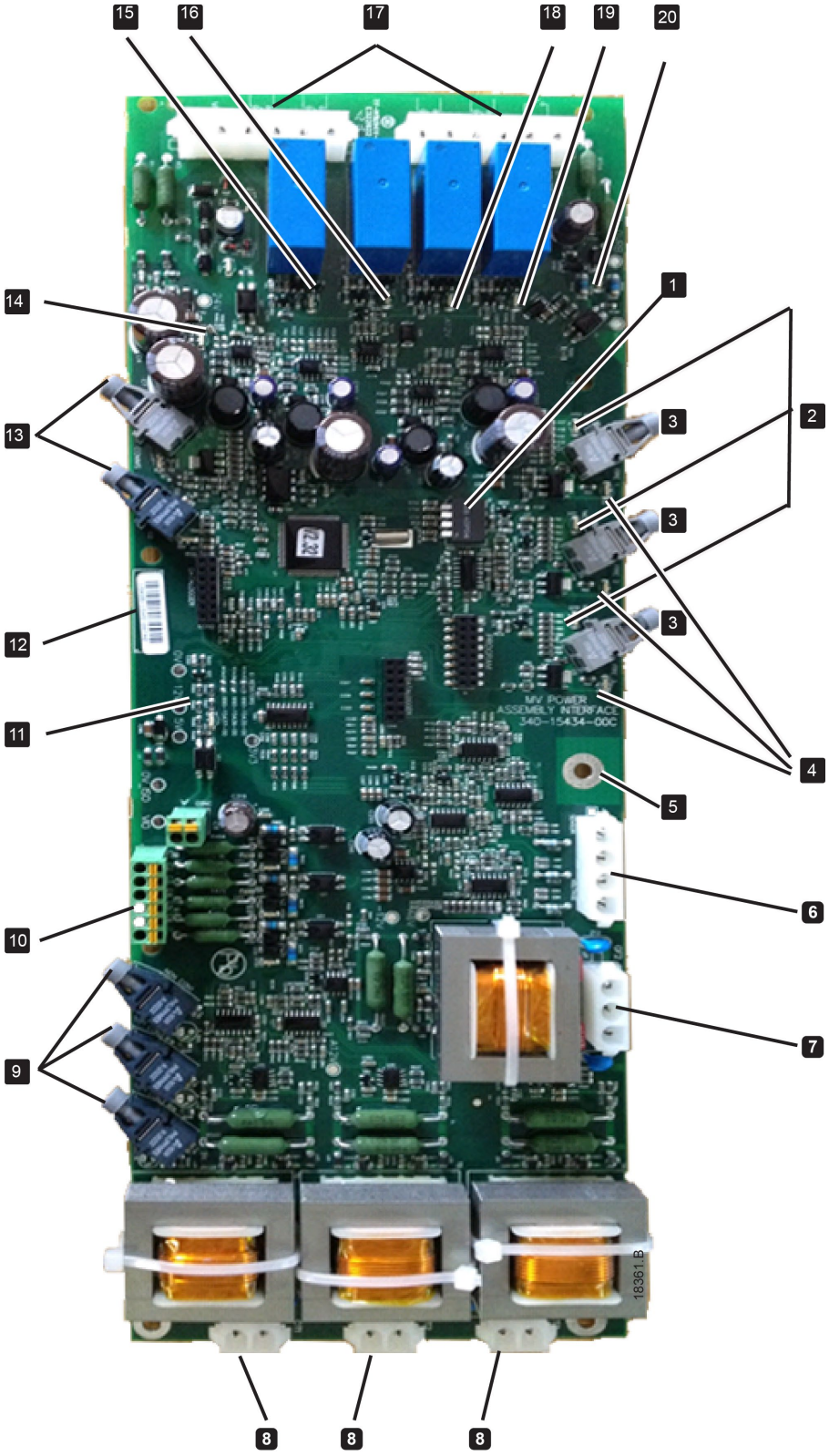
Packaged dimensions and weights

The weight values are indicative only and include the soft starter or phase arm but not other related components.

	Individual phase arm					Complete power assembly		
	Width mm (inch)	Height mm (inch)	Depth mm (inch)	Weight kg (lb)	Width mm (inch)	Height mm (inch)	Depth mm (inch)	Weight kg (lb)
V02	352 (13.9)	625 (24.6)	862 (33.9)	60 (132.3)	882 (34.7)	625 (24.6)	862 (33.9)	165 (363.8)
V03								
V04								
V06	352 (13.9)	715 (28.1)	862 (33.9)	76 (167.6)	950 (37.4)	715 (28.1)	862 (33.9)	210 (463.0)
V11	400 (15.7)	650 (25.6)	1050 (41.3)	140 (308.6)	1250 (49.2)	650 (25.6)	1050 (41.3)	370 (815.7)
V13	554 (21.8)	823 (32.4)	1050 (41.3)	165 (363.8)	1404 (55.3)	823 (32.4)	1050 (41.3)	470 (1036)

NOTE
For models 0600 and above, contact your local supplier.

5.2 Terminations on the Power Interface Board



1	CT ratio selector DIP switch S1	
2	Non-conduction LEDs (green)	
3	Gate firing fibre-optic connectors	
4	Firing status LEDs (red)	
5	Earth termination point (for voltage sensing ground connections)	
6	Voltage sensing input connector (V0 ~ V3)	
7	Ground fault CT connector (GF1, GF2)	
8	Line CT connectors (CT1 [L11/L12], CT2 [L21/L22], CT3 [L31/L32])	
9	Non-conduction readback fibre-optic connectors	
10	Fan Fail (C1, C2), DOL protection activated (C3, C4) and Power supply fail input (C5, C6)	
11	ID resistors	
12	Serial number	
13	Fibre-optic connections and LEDs to controller (Rx = Green, Tx = Red)	
14	Control supply LED (green)	
15	Phase arm power supply control relay output and LED (green)	
16	PFC contactor relay output and LED (green)	
17	Control terminals	
	C73, C74	Bypass readback input (BPR)
	13, 14	Main device relay output (MC)
	23, 24	Bypass device relay output (BC)
	33, 34	PFC contactor relay output (PF)
	43, 44	Phase arm power supply control relay output (PAPS) / Fan control relay output
	V In (A1, A2)	Control supply input
18	Bypass device relay output and LED (green)	
19	Main device relay output and LED (green)	
20	Bypass readback input and LED (green)	

NOTE
The fan fail (C1, C2) and power supply fail (C5, C6) inputs are wire linked.

5.3 Power Circuits

Overview

The soft starter is designed to operate as part of a system including other components.

- A bypass switching device (contactor or vacuum circuit breaker) is required in all installations.
- A main switching device (contactor or circuit breaker) is required in all installations. This can be located in the soft starter panel or the upstream feeder panel.
- If contactors are used for one or both switching devices, appropriately rated fuses must be installed upstream of the main switching device to provide short circuit protection if the short circuit level of the network/supply is higher than the short circuit rating of the contactor.

Additional components may also be required to comply with soft starter panel specifications.

Main Switching Device

The soft starter can be installed with a main contactor or a circuit breaker.

- Select a contactor with an AC3 rating greater than or equal to the full load current rating of the connected motor.
- Select a circuit breaker greater than or equal to the full load current rating of the connected motor.

The main switching device is associated with terminals L1, L2, L3 on the supply side of the soft starter. The coil is associated with output terminals 13, 14 of the soft starter (see *Power Circuit Configuration* on page 16).

To ensure that the potentially dangerous medium voltage area is isolated from the low voltage control area, power is supplied to the main switching device coil from the control voltage terminal block.

Bypass Switching Device

The soft starter must always be installed with a bypass contactor or circuit breaker.

- Select a contactor with an AC3 rating greater than or equal to the full load current rating of the connected motor.
- Select a circuit breaker greater than or equal to the full load current rating of the connected motor.

The bypass switching device is associated with terminals L1, L2, L3 on the supply side of the soft starter, and bypass terminals T1B, T2B, T3B on the motor side. The coil is associated with output terminals 23, 24, and the auxiliary Normally Open contact is associated with input terminals C73, C74 of the soft starter.

To ensure that the potentially dangerous medium voltage area is isolated from the low voltage control area, power is supplied to the bypass switching device coil from the control voltage terminal block.

R Rated Protection Fuses

If contactors are used for one or both switching devices, appropriately rated fuses must be installed upstream of the main switching device to provide short circuit protection if the short circuit level of the network/supply is higher than the short circuit rating of the contactor. Select the appropriate fuse based on the motor's rated full load current.

Transient/ Overvoltage Protection

Overvoltage protection should be installed if there is a risk of high voltage transients at the installation. Contact your local supplier for details.

Line Inductors

Output line inductors may be required depending on various factors, including the soft starter model, the system operating voltage, the cable type, and the length of the cable run between the soft starter and the motor.

If required, line inductors are typically installed in a shielded caged enclosure at the soft starter end of the motor cable.

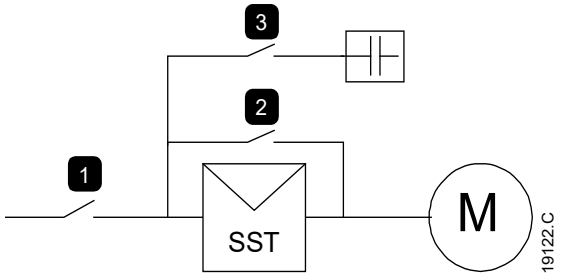
To find out if line inductors are required for your specific installation, contact your local supplier for advice. You will need to provide information about the motor output cable, including the cable length, cable type, and cable inductance and capacitance per km.

Power Factor Correction

CAUTION
Power factor correction must be switched in using a dedicated contactor. Installing power factor correction capacitors with no contactor may damage the soft starter.

Power factor correction capacitors should be selected based on the motor data and the required final power factor. Select a contactor according to the required kVAr.

The soft starter must control the power factor correction capacitor contactor. Use the PFC output (terminals 33, 34 on the power interface board).

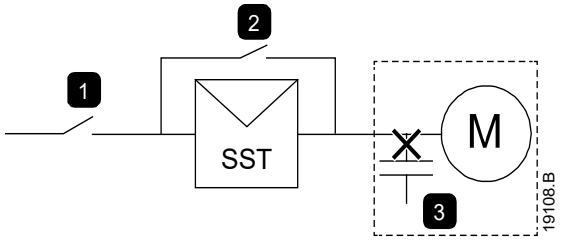


1	Main switching device
2	Bypass switching device
3	PFC capacitor contactor

Capacitive surge arrestors

Capacitive surge arrestors are not compatible for use with soft starters. Using capacitive surge arrestors for motor protection may damage the soft starter.

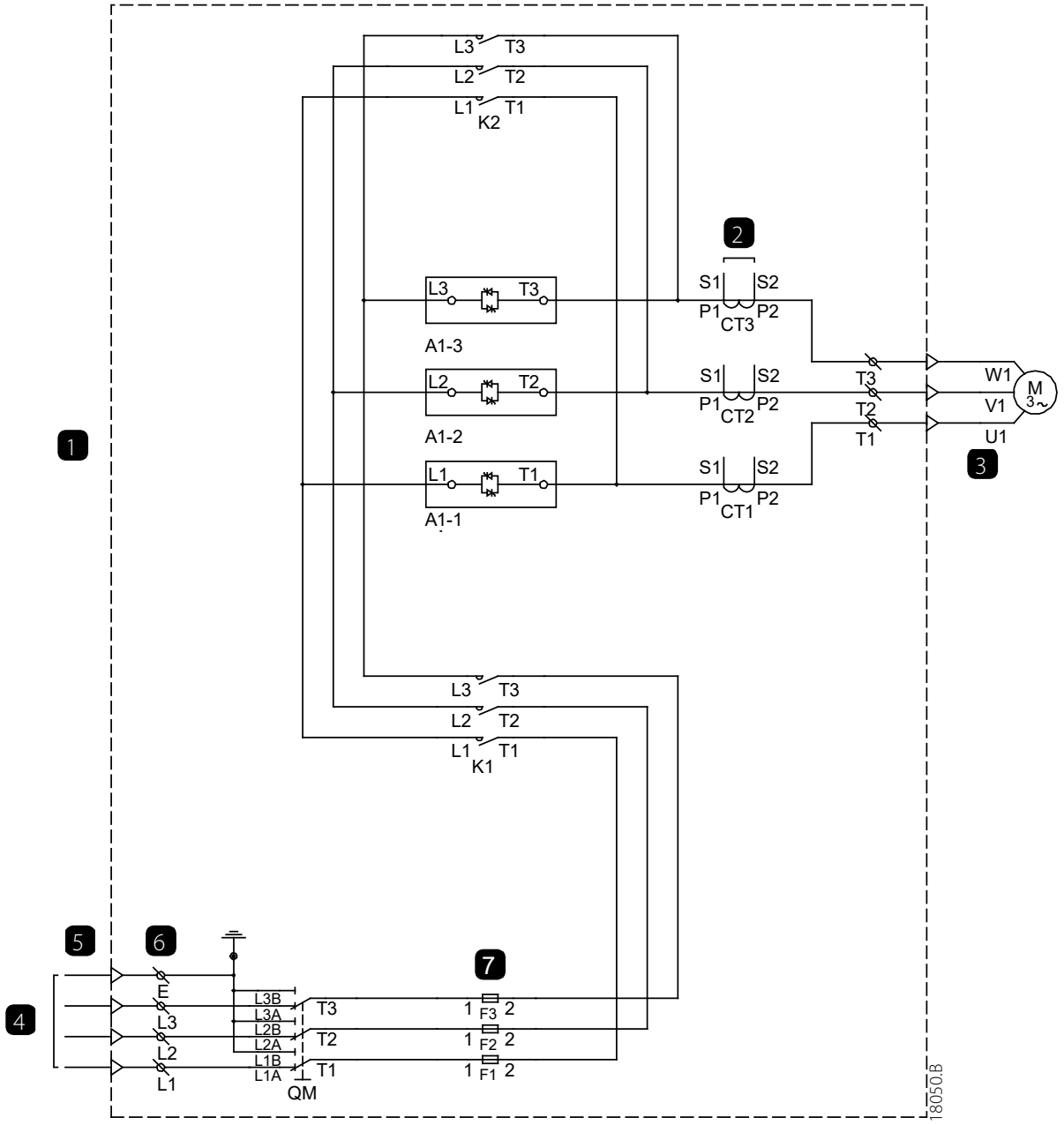
CAUTION
Capacitive surge arrestors may be mounted in the motor termination box. Check the motor datasheet and check inside the termination box before connecting the soft starter. Disconnect any capacitive surge arrestors.



1	Main switching device
2	Bypass switching device
3	Capacitive surge arrestor

Power Circuit Configuration

Soft starter power circuit with main contactor, bypass contactor, main isolator/ earth switch, R Rated fuses and current transformers. When used with contactors, soft starter must be installed with fuse if the short circuit level of the network/supply is higher than the short circuit rating of the contactors.



1	Soft starter panel
A1-1 ~ A1-3	Phase arms 1 ~ 3
2	Current transformers
3	Motor cables
4	Three-phase supply
5	Supply cables
6	Panel earth bar
QM	Main isolator / Earth switch disconnector

L1-L3	Input power terminals (supply side)
T1-T3	Output power terminals (motor side)
7	Fuses (F1-3)
K1	Main contactor
K2	Bypass contactor

5.4 Operation mode selector switch (S1)

The soft starter can soft start the motor, or can DOL start the motor with or without protection. Use the operation mode selector switch (S1) to select the start mode.

SST position (soft start)

- The customer's external control signals start and stop the motor.
- The soft starter performs a normal soft start.
- All soft starter protections are active.
- Relay outputs on the soft starter's power interface board control the line, bypass and PFC contactors.

DOL+ position (DOL with protection)

- The customer's external control signals start and stop the motor.
- The line and bypass contactors start the motor DOL.
- All soft starter protections are active.
- Relay outputs on the soft starter's power interface board control the line, bypass and PFC contactors.

NOTE
This mode allows the motor to be started when there is a fault with one of the soft starter phase arms. The controller and power interface board must be in healthy working state.

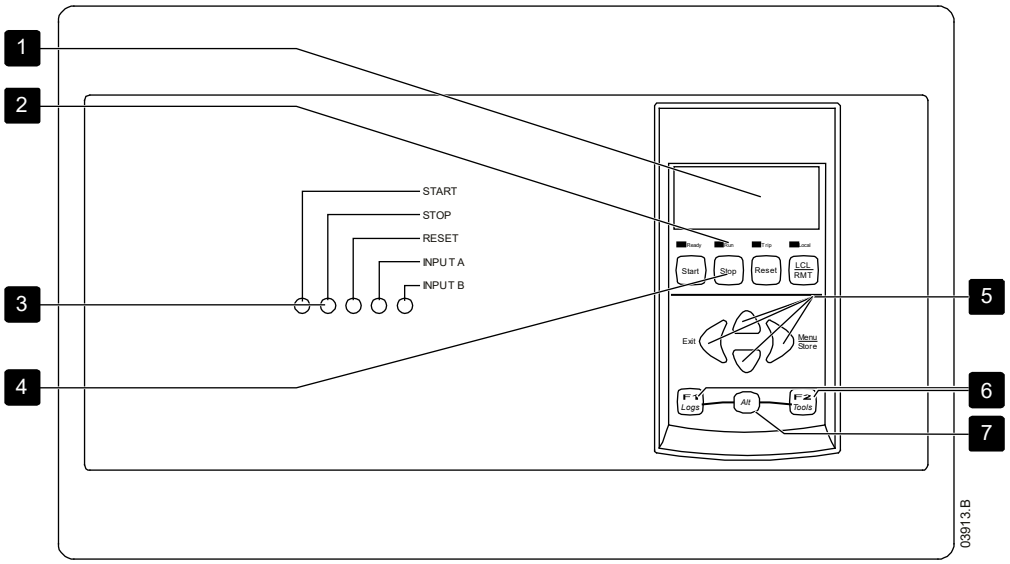
DOL position (DOL without protection)

- The customer's external control signals start and stop the motor.
- The line and bypass contactors start the motor DOL.
- All soft starter protections are bypassed.
- The line and bypass contactors are controlled by the start and stop control signals.
- The PFC contactor (if used) must be controlled by a separate manual switch.

NOTE
This mode allows emergency operation of the motor when there is a major failure of any soft starter component. Back-up fuses provide short circuit protection. Additional protections such as motor protection or RTD overtemperature may be available if separate protection equipment is installed.

6 Controller

6.1 Controller

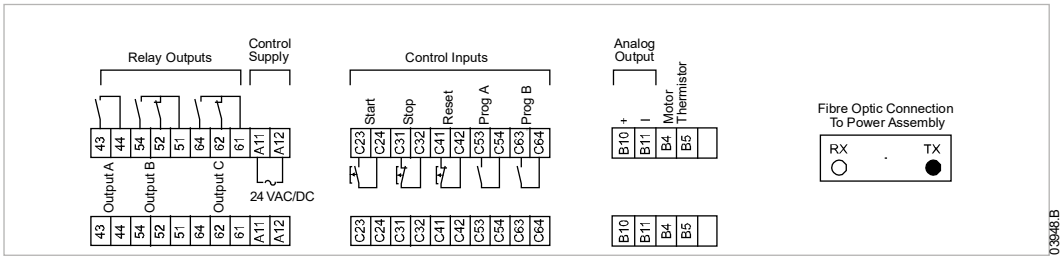


1	Four-line display for status and programming details.
2	Status LEDs
3	Control input LEDs
4	Soft starter local control buttons

5	Menu navigation buttons:
	▶: Exit the menu or parameter, or cancel a parameter change.
	◀: Enter a menu or parameter, or save a parameter change.
	▲ ▼: Scroll to the next or previous menu or parameter, or change the setting of the current parameter.
6	Shortcut buttons for quick access to common tasks.
7	Alt button. Use with F1 or F2 to open performance logs or commissioning tools.

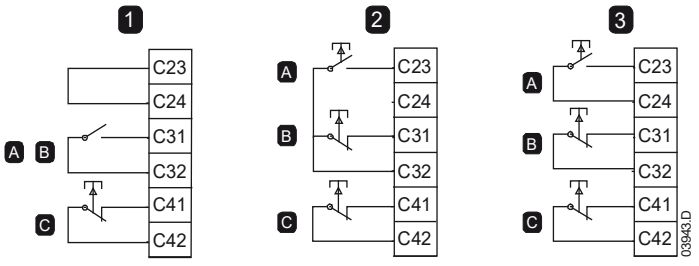
6.2 Terminal Block (controller)

Terminations on the controller use plug-in terminals. Unplug the terminal blocks, complete the wiring, then re-plug the terminal blocks into the controller.



6.3 Control Wiring

The soft starter has three fixed inputs for remote control. These inputs should be controlled by contacts rated for low voltage, low current operation (gold flash or similar).



1	Two-wire control
2	Three-wire control
3	Four-wire control
A	Start
B	Stop
C	Reset

CAUTION
The control inputs are powered by the soft starter. Do not apply external voltage to the control input terminals.

Cables to the control inputs must be segregated from mains voltage and motor cabling.

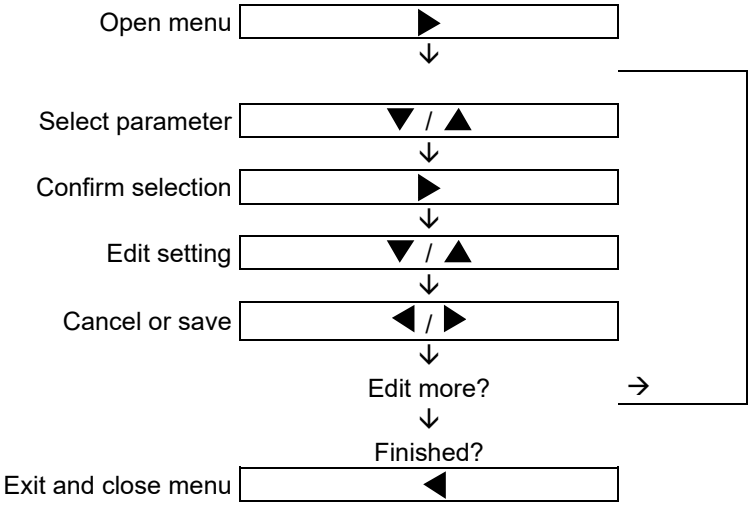
The reset input can be normally open or normally closed. Use parameter 6M to select the configuration.

NOTE
Reset input is normally closed by default.

6.4 Menu Shortcuts

The F1 and F2 buttons offer keyboard shortcuts to the Auto-Stop menu. Use parameters 8B and 8C (on page 52) to select the shortcut target.

6.5 Using the Controller



6.6 Starter Status LEDs

LED name	On	Flashing
Ready	The motor is stopped and the starter is ready to start.	The motor is stopped and the starter is waiting for the *Restart Delay* (parameter 4M) or *Motor Temperature Check* (parameter 4N).
Run	The motor is in run state (receiving full voltage).	The motor is starting or stopping.
Trip	The starter has tripped.	The starter is in warning state.
Local	The starter is in Local control mode.	–

If the starter is in remote control mode, the Local LED will be off.

If all LEDs are off, the starter is not receiving control voltage.

NOTE
When the Controller is powered up, the Ready LED flashes for 5 seconds as part of the initialisation routine.

6.7 Displays

The controller displays a wide range of performance information about the soft starter. The top half of the screen shows real-time information on current or motor power (as selected in parameter 8D). Use the ▲ and ▼ buttons to select the information shown on the bottom half of the screen.

- Starter status
- User programmable screen
- Motor temperature
- Current

- Motor power
- Voltage
- Last start information
- Date and time
- Performance graphs
- SCR conduction

Operating Feedback

NOTE
Screens shown here are with the default settings.

- **Starter Status**

The starter status screen shows details of the starter's operating status, including motor current, power and temperature.

```
          0A
Ready
M1 000%              000.0kW
```

- **Programmable screen**

The soft starter's user-programmable screen can be configured to show the most important information for the particular application. Use parameters 8E to 8H to select which information to display.

```
          0A
Ready
00000 kWh          00000hrs
```

- **Motor Temperature**

The temperature screen shows which motor data set is in use, and the temperature of the motor as a percentage of total thermal capacity.

```
          0A
Primary Motor Set
➤ M1 000%          M2 000%
```

NOTE
M2 xxx% temperature is not applicable to this product.

- **Current monitoring screen**

The current screen shows real-time line current on each phase.

```
          0A
Phase Currents (Gnd Crnt XX.XA)
000.0A  000.0A       000.0A
```

- **Motor Power**

The motor power screen shows motor power (kW, HP and kVA) and power factor.

```
          0A
000.0kW              0000HP
0000kVA          -. - - pf
```

- **Voltage**

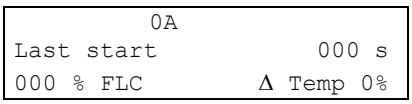
The voltage screen shows real-time line voltage across each phase.

```
          0A
Line Voltages
00000   00000         00000
```

- **Last Start Information**

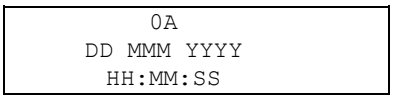
The last start information screen shows details of the most recent start:

- start duration (seconds)
- maximum start current drawn (as a percentage of motor full load current)
- calculated rise in motor temperature



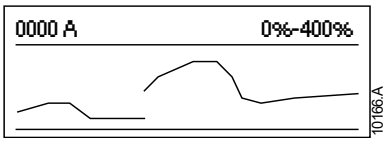
- **Date and Time**

The date/time screen shows the current system date and time (24 hour format). For details on setting the date and time, see *Set Date and Time* on page 21.



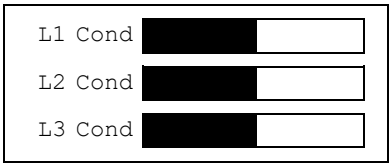
- **Performance Graph**

The performance graph provides a real-time display of operating performance. Use parameters 8I~8L to select which information to display.



- **SCR Conduction Bargraph**

The SCR conduction bargraph shows the level of conduction on each phase.



6.8 Display Calibration

The displayed values for current, voltage and power factor can be calibrated if required. Contact your local supplier for advice.

6.9 Commissioning Menu (Tools)

The Commissioning Menu provides access to commissioning and testing tools.

Press **ALT** then **F2** to open the Commissioning Menu.

The Commissioning Menu is protected by the access code.

The default access code is 0000.

6.10 Set Date and Time

To set the date and time:

1. Open the Commissioning Menu.
2. Scroll to the date/time screen.
3. Press the ▶ button to enter edit mode.
4. Press the ▶ and ◀ buttons to select which part of the date or time to edit.
5. Use the ▲ and ▼ buttons to change the value.
6. To save changes, press the ▶ button. The soft starter will confirm the changes.
   To cancel changes, press the ◀ button.

6.11 Simulation Tools

Software simulation functions let you test the soft starter's operation and control circuits without connecting the soft starter to mains voltage.

The simulation tools are accessed via the Commissioning Menu. The simulations are only available when the soft starter is in Ready state, control voltage is available and the controller is active.

NOTE
Access to the simulation tools is protected by the security access code.
The default access code is 0000.

Run simulation

The run simulation simulates a motor starting, running and stopping to confirm that the soft starter and associated equipment have been installed correctly.

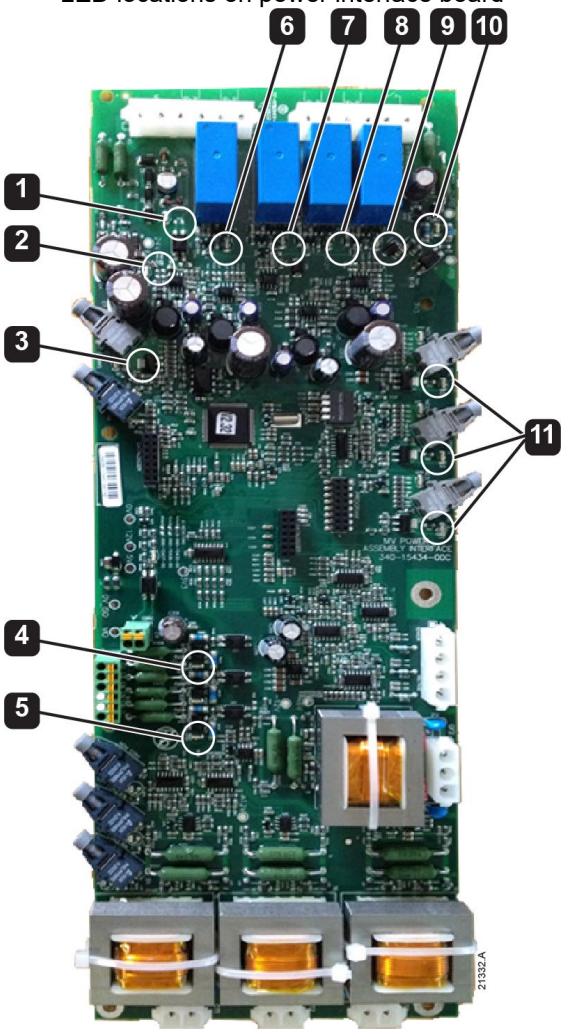
The run simulation provides a safe method of confirming that the installation is operating as expected. The simulation is particularly useful to confirm the correct configuration of the main and bypass switching devices, fibre-optic controls and programmable outputs.

Feedback is provided via the display and the status LEDs. The simulation can be terminated at any time by pressing **EXIT**. The starter will return to the Commissioning Menu.

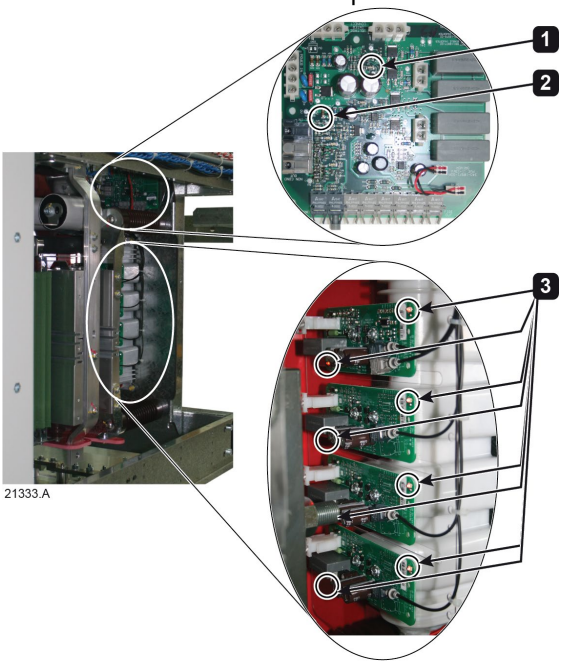
NOTE
The soft starter must be disconnected from mains voltage.
The simulation is only available when the soft starter is in Ready state.

- **LED locations**

LED locations on power interface board



LED locations on each phase arm



1	Low control volts (green)
2	Control supply LED (green)
3	Controller/power interface board communications (red)
4	Protection active input (C3) (green)
5	Protection active input (C4) (green)
6	Phase arm power supply control relay output (green)
7	PFC contactor relay output (green)
8	Bypass device relay output (green)
9	Main device relay output (green)
10	Bypass readback input (green)
11	Firing status LEDs (red)
12	Gate drive power supply (green)
13	Firing signal (red)
14	Firing status LEDs (orange)

- **Procedure**

To use the run simulation:

1. Press **ALT** then **F2** to open the Commissioning Menu.
2. Scroll to Run Simulation and press ▶.

```
Run Simulation
Ready
Apply Start Signal
```

   - On the controller, the Run LED flashes.
   - On the power interface board, the low control volts, control supply and protection active LEDs activate.

3. Press **START** or activate the start input. The soft starter simulates its pre-start checks and closes the main contactor relay.

```
Run Simulation
Pre-Start Checks
STORE to Continue
```

   - On the controller, if parameter 7A (*7A Output Relay A Functionality*) is set to 'Main Contactor', the Relay A LED on the controller activates.
   - On the power interface board, the phase arm power supply control relay and main device LEDs activate.
   - On the gate drive boards, the gate drive power supply LEDs activate.
   - On the firing boards on each phase arm, the firing status LEDs activate.

NOTE
If mains voltage is connected, an error message is shown. Remove mains voltage and proceed to the next step.

```
Run Simulation
ATTENTION!
Remove Mains Volts
STORE to Continue
```

4. Press ▶. The soft starter simulates starting.

```
Run Simulation
Starting X:XXs
STORE to Continue
```

   - On the controller, the Start LED activates.
   - On the power interface board, the phase 1 firing status LED starts to flash.
   - On phase arm 1, the firing signal and firing status LEDs start flashing.

5. Press ▶. The soft starter simulates running. The bypass contactor relay closes.

```
Run Simulation
Running
Apply Stop Signal
```

- On the controller, the Run LED stays on without flashing and the Start LED turns off.
- If parameter 7D (*7D Output Relay B Functionality*) is set to 'Run', the Relay B LED on the controller activates.
- On the power interface board, the PFC contactor and bypass device LEDs activate. The phase 2 firing LED flashes.
- The firing signal and firing status LEDs stop flashing on phase arm 1 and start flashing on phase arm 2.

6. Press **STOP** or activate the stop input. The soft starter simulates stopping. The bypass contactor relay opens.

```
   Run Simulation
   Stopping X:XXs
STORE to Continue
```

- On the controller, the Run LED and Stop LED flash. The Relay B LED turns off.
- On the power interface board, the Phase 3 firing LED flashes.
- The firing signal and firing status LEDs stop flashing on phase arm 2 and start flashing on phase arm 3.

7. Press ▶. The Ready LED flashes and the main contactor relay opens.

```
   Run Simulation
      Stopped
STORE to Continue
```

- On the controller, the Run LED flashes. The Stop LED turns off.
- On the power interface board, all LEDs turn off except control supply and protection active.
- The LEDs on all three phase arms turn off.

8. Press ▶ to return to the commissioning menu.

NOTE
Run simulation can be exited at any stage by pressing ◀.

Protection Simulation

The protection simulation simulates activation of each protection mechanism to confirm that the soft starter and associated control circuits are responding correctly.

To use the protection simulation:

1. Open the Commissioning Menu.
2. Scroll to Protection Simulation and press ▶.
3. Use the ▲ and ▼ buttons to select the protection you want to simulate.
4. Press and hold ▶ to simulate the selected protection.
5. The screen is displayed momentarily. The soft starter's response depends on the Protection Action setting (parameter group 16).

```
        0.0A
Tripped
Selected Protection
```

6. Use ▲ or ▼ to select another simulation, or press **EXIT** to exit.

NOTE
If the protection trips the soft starter, reset before simulating another protection. If the protection action is set to 'Warn and Log', no reset is required.

If the protection is set to 'Warn and Log', the warning message can be viewed only while the ▶ button is pressed.

If the protection is set to 'Log only', nothing appears on the screen but an entry will appear in the log.

Output Signal Simulation

The output signal simulation simulates output signalling to confirm that outputs and associated control circuits are operating correctly.

NOTE
To test operation of the flags (motor temperature and low/high current), set an output relay to the appropriate function and monitor the relay's behaviour.

To use the output signal simulation:

1. Open the Commissioning Menu.
2. Scroll to Output Signalling Simulation and press ▶.
3. Use the ▲ and ▼ buttons to select a function to simulate, then press ▶.
4. Use the ▲ and ▼ buttons to turn the signal on and off. To confirm correct operation, monitor the state of the output.

```
    Prog Relay A
Off
On
```

5. Press **EXIT** to return to the simulation list.

Analog Output Simulation

The analog output simulation uses the ▲ and ▼ buttons to change the analog output current at terminals B10, B11 of the controller.

```
Analog Output
0%                    4 mA
```

Attach an external current measuring device to terminals B10, B11 of the controller. Use the ▲ or ▼ button to adjust the percentage value in the lower left hand corner of the display. The current measuring device should indicate the same level of current as shown at the lower right corner of the display.

6.12 Input/Output Status

Temperature Sensors State

This screen shows the state of the motor thermistors and RTD/PT100s.

```
Temp Sensors State
Thermistor: 0
RTDs A->G:OOOOOOO
S = Shrt H=Hot C=Cld O=Opn
```

NOTE
The use of RTDs is not supported by this product and this screen will always indicate 0 (ie Open) for RTDs A->G.

Digital I/O State

This screen shows the current status of the digital inputs and outputs.

```
  Digital I/O State
  Inputs:  1000000
  Outputs: 0000000
```

The top line of the screen shows the start, stop, reset and programmable inputs A and B, then '00'. The screen shows input C23~C24 closed with all other inputs open.

The bottom line of the screen shows programmable output A, the fixed Run output, programmable outputs B and C, then '000'. The screen shows all outputs open.

Analog I/O State

This screen shows the current status of the Analog I/O

```
   Analog I/O State
Input: - - - - %
Output A: 04.0mA
```

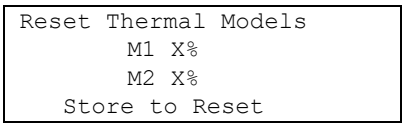
NOTE
Input is not supported by this product and this screen will always indicate Input: - - - - %

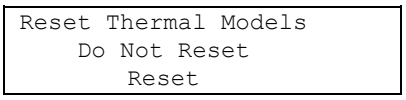
6.13 Reset Thermal Models

The soft starter's thermal modelling software constantly monitors the motor's performance. This allows the starter to calculate the motor's temperature and ability to start successfully at any time.

The thermal model for the active motor can be reset if required.

1. Open the Commissioning Menu.
2. Scroll to Reset Thermal Models and press ▶.
3. At the confirmation prompt press **STORE** to confirm or **EXIT** to cancel the action. You may have to enter your access code.
4. Select Reset and press ▶.
   Selecting Do Not Reset returns to previous screen.





When the thermal model has been reset, the screen will display a confirmation message then return to the previous screen.

CAUTION
Resetting the motor thermal model will compromise thermal model protection and may compromise motor life. Only reset the thermal model in an emergency.

6.14 Monitoring

Logs Menu

The Logs Menu provides information on events, trips and starter performance.

Press **ALT** then **LOGS** to open the Logs.

- **Trip Log**

The Trip Log stores details of the eight most recent trips, including the date and time the trip happened. Trip 1 is the most recent and trip 8 is the oldest stored trip.

To open the Trip Log:

1. Press **ALT** then **LOGS** to open the Logs.
2. Scroll to Trip Log and press ▶.
3. Use the ▲ and ▼ buttons to select a trip to view, and press ▶ to display details.
4. Use the ▲ and ▼ buttons to scroll through available details.

To close the log and return to the main display, press **EXIT** repeatedly.

- **Event Log**

The Event Log stores time-stamped details of the starter's 99 most recent events (actions, warnings and trips), including the date and time of the event. Event 1 is the most recent and event 99 is the oldest stored event.

To open the Event Log:

1. Press **ALT** then **LOGS** to open the Logs.
2. Scroll to Event Log and press ▶.
3. Use the ▲ and ▼ buttons to select an event to view, and press ▶ to display details.

To close the log and return to the main display, press **EXIT** repeatedly.

- **Starter Trip and Event Logger Software**

The Starter Trip and Event Logger Software allows you to download the trip and event logs from the soft starter, for separate analysis.

The software is compatible with all The Manufacturer medium voltage soft starters using control software version 1.29 or later.

For further information, or for a copy of the software, contact your local supplier.

- **Performance Counters**

The performance counters store statistics on the starter's operation:

- Hours run (lifetime and since counter last reset)
- Number of starts (lifetime and since counter last reset)
- Motor kWh (lifetime and since counter last reset)
- Number of times the thermal model has been reset

The resettable counters (hours run, starts and motor kWh) can only be reset if the *Adjustment Lock* (parameter 15B) is set to Read & Write.

To view the counters:

1. Open the Logs Menu.
2. Scroll to Counters and press ▶.
3. Use the ▲ and ▼ buttons to scroll through the counters. Press ▶ to view details.
4. To reset a counter, press **STORE** (enter access code if required) then use the ▼ button to select Reset. Press **STORE** to confirm the action.

To close the counters and return to the main display, press the **EXIT** repeatedly.

7 Operation

CAUTION
We recommend testing the soft starter's setup on a low voltage motor before beginning operation on a medium voltage motor. This allows the operator to test that the soft starter is correctly connected to the auxiliary equipment.

7.1 Start, Stop and Reset Commands

The soft starter can be controlled in three ways:

- using the buttons on the controller
- via remote inputs
- via a serial communication link

The **LCL/RMT** button controls whether the soft starter will respond to local control (via the controller) or remote control (via the remote inputs).

The Local LED on the controller is on when the soft starter is in local control mode and off when the soft starter is in remote control mode.

Control via the fieldbus communication network is always enabled in local control mode, and can be enabled or disabled in remote control mode (parameter 6R *Comms in Remote*). Control via the serial communication network requires an optional communication module.

The **STOP** button on the controller is always enabled.

7.2 Using the Soft Starter to Control a Motor

To soft start the motor, press the **START** button on the controller or activate the Start remote input. The motor will start using the start mode selected in parameter 2A.

To stop the motor, press the **STOP** button on the controller or activate the Stop remote input. The motor will stop using the stop mode selected in parameter 2H.

To reset a trip on the soft starter, press the **RESET** button on the controller or activate the Reset remote input.

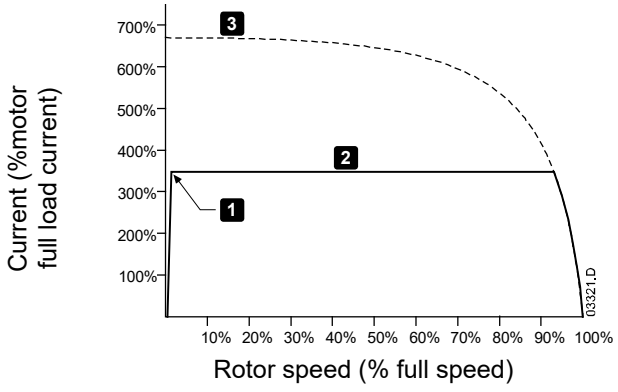
To stop the motor with a coast to stop, regardless of the setting of parameter 2H *Stop Mode*, press the local **STOP** and **RESET** buttons at the same time. The soft starter will remove power from the motor and open the main contactor, and the motor will coast to stop.

7.3 Soft Start Methods

Constant Current

Constant current is the traditional form of soft starting, which raises the current from zero to a specified level and keeps the current stable at that level until the motor has accelerated.

Constant current starting is ideal for applications where the start current must be kept below a particular level.



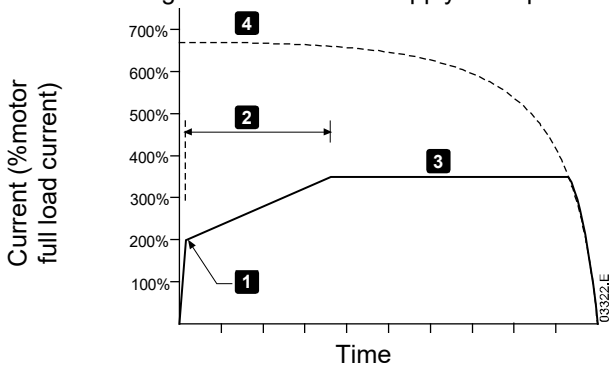
1: *Initial Current* (parameter 2C)
2: *Current Limit* (parameter 2D)
3: Full voltage current

Constant Current with Current Ramp

Current ramp soft starting raises the current from a specified starting level (1) to a maximum limit (3), over an extended period of time (2).

Current ramp starting can be useful for applications where:

- the load can vary between starts (for example a conveyor which may start loaded or unloaded). Set the initial current (parameter 2C) to a level that will start the motor with a light load, and the current limit (parameter 2D) to a level that will start the motor with a heavy load.
- the load breaks away easily, but starting time needs to be extended (for example a centrifugal pump where pipeline pressure needs to build up slowly).
- the electricity supply is limited (for example a generator set), and a slower application of load will allow greater time for the supply to respond.

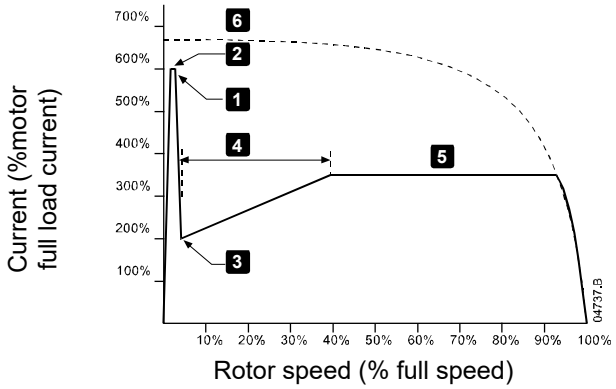


1: *Initial Current* (parameter 2C)
2: *Start Ramp Time* (parameter 2B)
3: *Current Limit* (parameter 2D)
4: Full voltage current

Constant Current with Kickstart

Kickstart provides a short boost of extra torque at the beginning of a start, and can be used in conjunction with current ramp or constant current starting.

Kickstart can be useful to help start loads that require high breakaway torque but then accelerate easily (for example helical rotor pumps).



1: *Kickstart Level* (parameter 2G)
2: *Kickstart Time* (parameter 2F)
3: *Initial Current* (parameter 2C)
4: *Start Ramp Time* (parameter 2B)
5: *Current Limit* (parameter 2D)
6: Full voltage current

Timed Voltage Ramp

Timed voltage ramp (TVR) soft starting ramps the application of voltage to the motor over a defined time period. The voltage ramp reduces the initial starting torque and slows the motor's rate of acceleration.

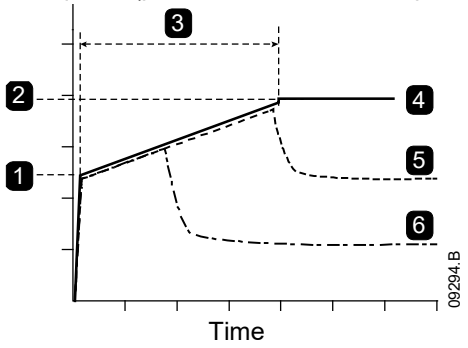
TVR starting can be useful for applications where multiple motors of different sizes are connected in parallel, and/or the loads are not mechanically linked.

NOTE
TVR soft starting is not suitable for high inertia loads (such as fans), which require a high level of voltage to accelerate the load.

NOTE
For multiple motors of the same sizes, and/or mechanically coupled loads, use constant current starting.

For a timed voltage ramp start, the following are typical values and can be adjusted to suit your specific application:

- Add the FLC value of all the connected motors. Use this combined value to set parameter 1A *Motor Full Load Current*. (Note that the combined value must not exceed the starter rating.)
- Set parameter 2C *Initial Current* to 100%, parameter 2D *Current Limit* to 600%, and set the ramp time as required (parameter 2B *Start Ramp Time*).



1: *Initial Current* (parameter 2C)
2: *Current Limit* (parameter 2D)
3: *Start Ramp Time* (parameter 2B)
4: Full voltage
5: Motor 1 current
6: Motor 2 current

7.4 Stop Methods

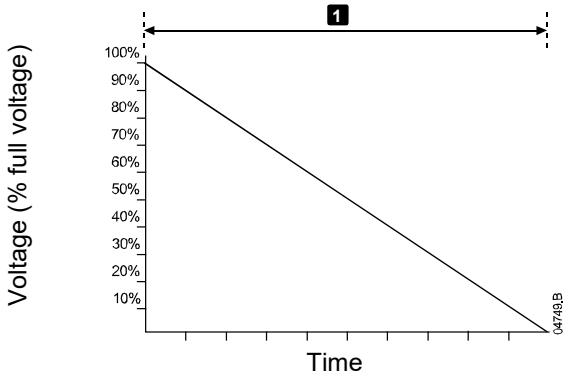
Coast to Stop

Coast to stop lets the motor slow at its natural rate, with no control from the soft starter. The time required to stop will depend on the type of load.

Timed Voltage Ramp Soft Stop

Timed voltage ramp stopping reduces the voltage to the motor gradually over a defined time. This can extend the stopping time of the motor and may avoid transients on generator set supplies.

NOTE
The load may continue to run after the stop ramp is complete.

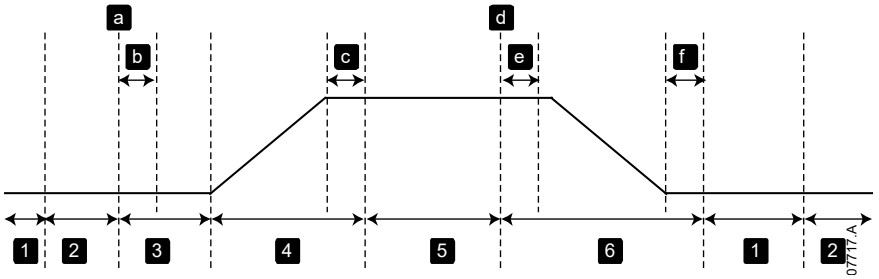


1: *Stop Time* (parameter 2I)

7.5 Operating States

Start and Run States

The soft starter has six operating states, and performs the following actions in each state:



Starter State		Starter actions
1	Not ready	Control power is on. The starter may be in Restart Delay mode or waiting for the motor to cool down before allowing a start.
2	Ready	The starter is initialised and waiting for a start command.
3	Pre-start checks	A start command has been received (a). The main contactor closes (b) and the starter performs a series of internal and external checks.
4	Starting	The starter ramps the SCRs up to full conduction and closes the bypass contactor (c).
5	Running	The motor is running normally.
6	Stopping	A stop command has been received (d). The starter opens the bypass contactor (e), ramps the SCRs down to no conduction, then opens the main contactor (f).

Trip States

The starter's response to a trip depends on the starter's state when the trip occurs.

- **Trip while starting (bypass contactor not yet closed)**

State	Function
Not ready	Perform system checks.
Ready	Wait for start command.
Start command received	Main contactor closes.
Pre-Start Checks	Perform connection checks.
Starting	Ramp up SCR firing angles.
Trip command	Turn SCRs off then open main contactor.
Tripped	Wait for reset command.
Reset command received	Trip cleared and starter returns to Not Ready state or Ready state.

- **Trip while running (bypass contactor closed)**

State	Starter action
Not ready	Perform system checks.
Ready	Wait for start command.
Start command received	Main contactor closes.
Pre-Start Checks	Perform connection checks.
Starting	Ramp up SCR firing angles.
Full conduction	SCRs at 100% conduction. Verify current is < 120% FLC then close bypass contactor.
Running	Normal motor run state (bypassed mode).
Trip command	Open bypass contactor. Turn SCRs off then open main contactor.
Tripped	Wait for reset command.
Reset command received	Trip cleared and starter returns to Not Ready or Ready state.

- **Instantaneous Overcurrent Stage 2 trip**

The main contactor opens immediately, regardless of the starter's state.

8 Motor Protection

8.1 Motor, System and Soft Starter Protection Mechanisms

The soft starter incorporates extensive protection features to ensure safe operation of the motor, system and soft starter. Most protection features can be customised to suit the installation. Use parameter group 4 Protection Settings to control the situation where the protections will activate and parameter group 16 Protection Action to select the soft starter's response. The default response is to trip the soft starter.

8.2 Protection Coordination

Check protection settings on the supply side of the starter to ensure correct coordination with the parameters of the soft starter.

When using fuse and main contactors, set the upstream circuit breaker protection parameters according to the ratings for fuse and contactor. The contactor must not open if the current is above its maximum breaking current value. The fuse must act first or the upstream breakers instantaneous trip level must be less than the contactor's maximum breaking current level.

If using circuit breakers only, set the soft starter's maximum instantaneous trip time < 150 ms. Always use a suitable external protection relay with a circuit breaker to ensure instantaneous overcurrent trip functionality.

Voltage must not be continuously maintained on the phase arms while the motor is off. Short circuit protective equipment must be installed in all cases.

8.3 Motor Overload Protection

The soft starter offers motor overload protection based on an advanced I^2t thermal model. The motor thermal model monitors the performance of the motor at all stages of operation and constantly calculates its temperature.

The thermal model adjusts itself according to the motor's recent operating history (including temperature rise from previous operation).

Motor thermal model

The motor thermal model has two components:

- Motor windings: These have a low thermal capacity and affect the short-term thermal behaviour of the motor. This is where the heat is generated by the current.
- Motor body: This has a large thermal capacity and affects the long-term behaviour of the motor.

The motor thermal model includes considerations for the following:

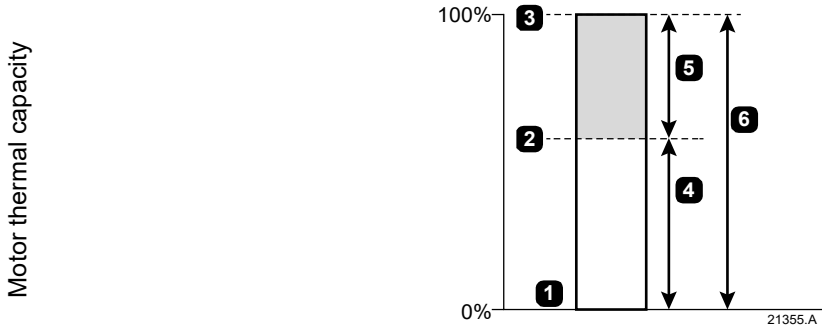
- Motor current, iron losses, winding resistance losses, motor body and winding thermal capacities, cooling during run and cooling at standstill.
- The percentage of the rated capacity of the motor. This sets the displayed value for the thermal model and is affected by factors such as the motor FLC and motor service factor.

Thermal model overload protection has a number of advantages over thermal relays.

- The percentage of motor thermal capacity used during each start is stored in memory. The starter can be configured to automatically determine whether or not the motor has sufficient thermal capacity remaining to successfully complete another start.
- The memory function of the model means that the motor is fully protected in “warm start” situations. The model uses data from the real-time clock to account for elapsed cooling time, even if control power has been removed.
- The actual full load current, locked rotor current, locked rotor time and motor service factor can be used to more accurately tune the model.

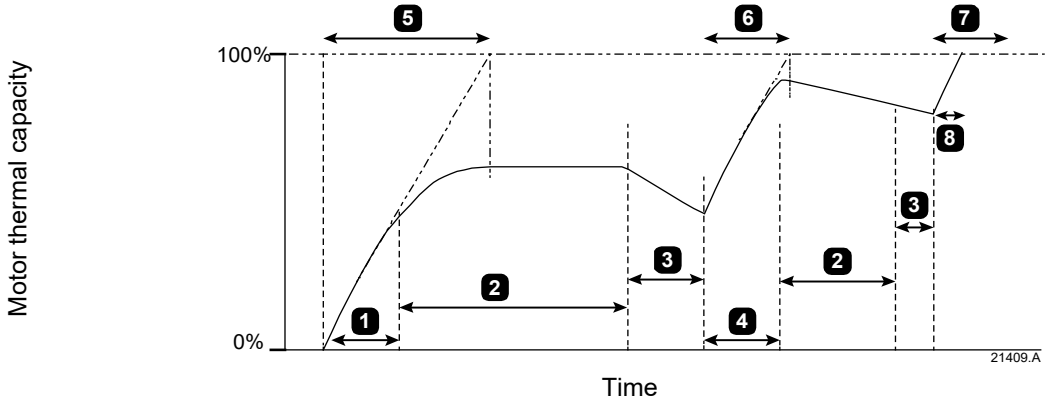
Motor thermal capacity

The motor thermal model permits the motor to operate safely within its available thermal capacity, with any combination of hot or cold starts and allowing for cooling between starts.



1	Ambient temperature (0% thermal capacity)
2	Steady state temperature
3	Motor overload protection trip point
4	Motor temperature rise from cold start to full load (Δt_1)
5	Thermal capacity available for hot start
6	Thermal capacity available for cold start

Motor heating



1	Cold start
2	Running at FLC
3	Off
4	Warm start
5	Locked rotor time (cold)
6	Locked rotor time (warm)
7	Locked rotor time (hot)
8	Failed start - insufficient thermal capacity (see *Hot start*)

- **Cold start**

When a motor starts from ambient temperature, it can withstand a longer locked rotor time (cold locked rotor time). The motor temperature rises while the motor is running until it reaches the steady state temperature.

- **Warm start**

If another start occurs before the motor has cooled completely from the first operating cycle, the locked rotor time is shorter (hot locked rotor time). The available thermal capacity for this start is less.

In this example, the second start is successful.

- **Hot start**

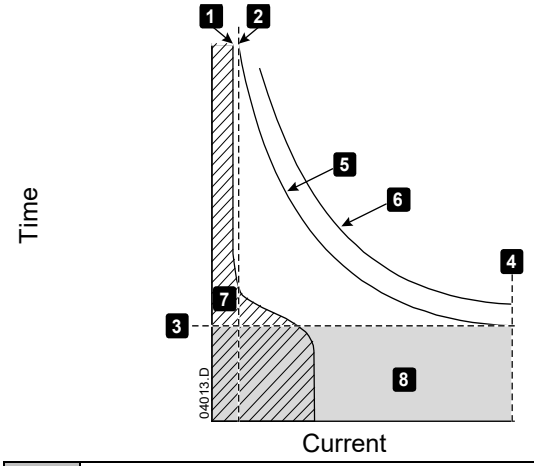
If another start is attempted before the motor has cooled (excessive heating from previous starts and/or not enough off time for cooling), the overload protection will trip.

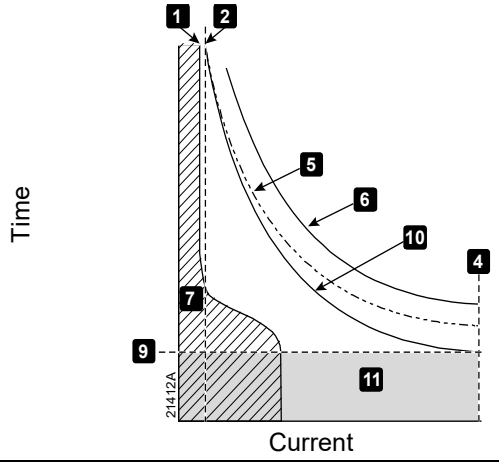
Motor thermal model protection set-up

The motor information configured in the starter defines the motor thermal model protection curve. Accurate motor data is critical for good operation of the thermal model. Configure the starter settings according to the motor nameplate and datasheet:

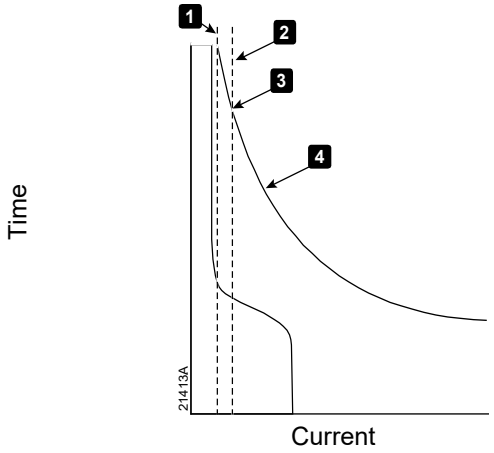
- 1A *Motor Full Load Current*
- 1B *Locked Rotor Time*
- 1C *Locked Rotor Current*
- 1D *Motor Service Factor*

The motor data assumes the motor is starting from ambient temperature and defines the cold start thermal model protection curve.





1	Parameter 1A *Motor Full Load Current*
2	Parameter 1D *Motor Service Factor*
3	Parameter 1B *Locked Rotor Time*
4	Parameter 1C *Locked Rotor Current*
5	Motor thermal model protection curve (cold)
6	Motor failure curve
7	Typical motor operating current
8	Motor thermal capacity (from cold start)
9	Locked rotor time for hot start
10	Motor thermal model protection curve: hot start
11	Motor thermal capacity (from hot start)



1	Safe running current level (motor FLC multiplied by motor service factor)
2	Operating current above safe running level
3	Trip point
4	Motor thermal model protection curve

The safe running level for the motor current is the motor FLC multiplied by the service factor. If the motor current remains below the safe running level during operation, motor overload protection will not activate.

If the current exceeds the safe running level, the starter will reach the motor thermal model protection curve. Higher levels of current reach the trip point more quickly.

9 Programmable Parameters

9.1 Programming Menu

The Programming Menu lets you view and change programmable parameters that control how the soft starter operates.

You can access the Programming Menu at any time, including while the soft starter is running. Any changes to the start profile take effect immediately.

To open the Programming Menu, press the **MENU** button while viewing the monitoring screens.

To navigate through the Programming Menu:

- to scroll through parameter groups, press the ▲ or ▼ button.
- to open a submenu, press the ▶ button.
- to view the parameters in a group, press the ▶ button.
- to return to the previous level, press the **EXIT** button.
- to close the Programming Menu, press the **TOOLS** button.

Adjustment Lock

You can lock the Programming Menu to prevent users from altering parameter settings. The adjustment lock can be turned on and off using parameter 15B.

To lock the programming menu:

1. Open the Programming Menu.
2. Open the Extended Menu.
3. Select 'Advanced'.
4. Enter the Access Code.
5. Select parameter 15B *Adjustment Lock*
6. Select and store 'Read Only'.

If a user attempts to change a parameter value when the adjustment lock is active, an error message is displayed:

```
Access Denied
Adj Lock is On
```

Altering Parameter Values

To change a parameter value:

- scroll to the appropriate parameter in the Programming Menu and press ▶ to enter edit mode.
- to alter the parameter setting, use the ▲ and ▼ buttons. Pressing ▲ or ▼ once will increase or decrease the value by one unit. If the button is held for longer than five seconds, the value will increase or decrease at a faster rate.
- to save changes, press **STORE**. The setting shown on the display will be saved and the controller will return to the parameter list.
- to cancel changes, press **EXIT**. The controller will ask for confirmation, then return to the parameter list without saving changes.

Load/Save Settings

The Load/Save Settings menu requires an access code and allows users to:

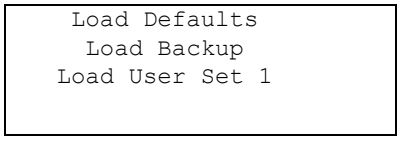
- Load the soft starter's parameters with default values
- Load parameter settings from an internal file
- Save the current parameter settings to an internal file

In addition to the factory default values file, the soft starter can store two user-defined parameter files. These files contain default values until a user file is saved.

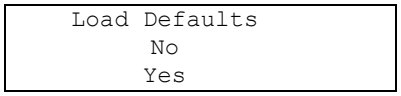
NOTE
Load defaults will not reset any changes to parameter group 20 'Restricted'.

To load or save settings:

1. Open the Programming Menu
2. Scroll to Load/Save Settings and press the ▶ button.
3. Scroll to the required function and press the ▶ button. Enter the access code when prompted.



4. At the confirmation prompt, select YES to confirm or NO to cancel and then **STORE** to load/save the selection.



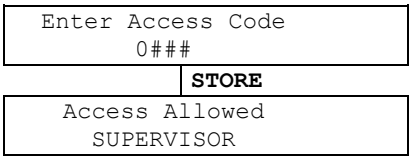
When the action has been completed, the screen will briefly display a confirmation message, then return to the Load/Save Settings screen

Access Code

Critical parameters (parameter group 20 and higher) are protected by a four-digit security access code, preventing unauthorised users from viewing or modifying parameter settings.

When a user attempts to enter a restricted parameter group, the controller prompts for an access code. The access code is requested once for the programming session, and authorisation continues until the user closes the menu.

To enter the access code, use the **EXIT** and ▶ buttons to select a digit, and the ▲ and ▼ buttons to change the value. When all four digits match your access code, press **STORE**. The controller will display an acknowledgement message before continuing.



To change the access code, use parameter 15A.

9.2 Standard Menu

The standard menu provides access to commonly used parameters, allowing the user to configure the soft starter as required for the application. For details of individual parameters, see *Parameter Descriptions* on page 42.

1		**Motor Data-1**
	1A	*Motor Full Load Current*
2		**Start/Stop Modes-1**
	2A	*Start Mode*
	2B	*Start Ramp Time*
	2C	*Initial Current*
	2D	*Current Limit*
	2H	*Stop Mode*
	2I	*Stop Time*
3		**Auto-Start/Stop**
	3C	*Auto-Stop Type*
	3D	*Auto-Stop Time*
4		**Protection**
	4A	*Excess Start Time*
	4C	*Undercurrent*
	4D	*Undercurrent Delay*
	4E	*Instantaneous Overcurrent*
	4F	*Instantaneous Overcurrent Delay*
	4G	*Phase Sequence*
6		**Inputs**
	6A	*Input A Function*
	6B	*Input A Name*
	6C	*Input A Trip*
	6D	*Input A Trip Delay*
	6E	*Input A Initial Delay*
	6F	*Input B Function*
	6G	*Input B Name*
	6H	*Input B Trip*
	6I	*Input B Trip Delay*
	6J	*Input B Initial Delay*
7		**Outputs**
	7A	*Relay A Function*
	7B	*Relay A On Delay*
	7C	*Relay A Off Delay*
	7D	*Relay B Function*
	7E	*Relay B On Delay*
	7F	*Relay B Off Delay*
	7G	*Relay C Function*
	7H	*Relay C On Delay*
	7I	*Relay C Off Delay*
	7M	*Low Current Flag*
	7N	*High Current Flag*
	7O	*Motor Temperature Flag*
8		**Display**
	8A	*Language*
	8B	*F1 Button Action*
	8C	*F2 Button Action*
	8D	*Display A or kW*
	8E	*User Screen - Top Left*
	8F	*User Screen - Top Right*

8G	*User Screen - Bottom Left*
8H	*User Screen - Bottom Right*

9.3 Extended Menu

The extended menu gives access to all of the soft starter's programmable parameters.

1		**Motor Data-1**
	1A	*Motor Full Load Current*
	1B	*Locked Rotor Time*
	1C	*Locked Rotor Current*
	1D	*Motor Service Factor*
2		**Start/Stop Modes-1**
	2A	*Start Mode*
	2B	*Start Ramp Time*
	2C	*Initial Current*
	2D	*Current Limit*
	2E	*Reserved*
	2F	*Kickstart Time*
	2G	*Kickstart Level*
	2H	*Stop Mode*
	2I	*Stop Time*
3		**Auto-Start/Stop**
	3A	*Reserved*
	3B	*Reserved*
	3C	*Auto-Stop Type*
	3D	*Auto-Stop Time*
4		**Protection**
	4A	*Excess Start Time*
	4B	*Excess Start Time-2*
	4C	*Undercurrent*
	4D	*Undercurrent Delay*
	4E	*Instantaneous Overcurrent*
	4F	*Instantaneous Overcurrent Delay*
	4G	*Phase Sequence*
	4H	*Current Imbalance*
	4I	*Current Imbalance Delay*
	4J	*Frequency Check*
	4K	*Frequency Variation*
	4L	*Frequency Delay*
	4M	*Restart Delay*
	4N	*Motor Temperature Check*
	4O	*Ground Fault Level*
	4P	*Ground Fault Delay*
	4Q	*Undervoltage*
	4R	*Undervoltage Delay*
	4S	*Overvoltage*
	4T	*Overvoltage Delay*
	4U	*Instantaneous Overcurrent S2*
	4V	*Instantaneous Overcurrent Delay S2*
5		**Auto-Reset Trips (*Reserved*)**
	5A	*Reserved*
6		**Inputs**
	6A	*Input A Function*
	6B	*Input A Name*
	6C	*Input A Trip*

	6D	*Input A Trip Delay*
	6E	*Input A Initial Delay*
	6F	*Input B Function*
	6G	*Input B Name*
	6H	*Input B Trip*
	6I	*Input B Trip Delay*
	6J	*Input B Initial Delay*
	6K	*Reserved*
	6L	*Reserved*
	6M	*Reset/Enable Logic*
	6N	*Reserved*
	6O	*Reserved*
	6P	*Reserved*
	6Q	*Local/Remote*
	6R	*Comms in Remote*
7		**Outputs**
	7A	*Relay A Function*
	7B	*Relay A On Delay*
	7C	*Relay A Off Delay*
	7D	*Relay B Function*
	7E	*Relay B On Delay*
	7F	*Relay B Off Delay*
	7G	*Relay C Function*
	7H	*Relay C On Delay*
	7I	*Relay C Off Delay*
	7J	*Reserved*
	7K	*Reserved*
	7L	*Reserved*
	7M	*Low Current Flag*
	7N	*High Current Flag*
	7O	*Motor Temperature Flag*
	7P	*Analog Output A*
	7Q	*Analog A Scale*
	7R	*Analog A Maximum Adjustment*
	7S	*Analog A Minimum Adjustment*
	7T	*Reserved*
	7U	*Reserved*
	7V	*Reserved*
	7W	*Reserved*
8		**Display**
	8A	*Language*
	8B	*F1 Button Action*
	8C	*F2 Button Action*
	8D	*Display A or kW*
	8E	*User Screen - Top Left*
	8F	*User Screen - Top Right*
	8G	*User Screen - Bottom Left*
	8H	*User Screen - Bottom Right*
	8I	*Graph Data*
	8J	*Graph Timebase*
	8K	*Graph Maximum Adjustment*
	8L	*Graph Minimum Adjustment*
	8M	*Mains Reference Voltage*

9		**Motor Data-2**
	9A	*Reserved*
	9B	*Motor FLC-2*
	9C	*Reserved*
	9D	*Reserved*
	9E	*Reserved*
10		**Start/Stop Modes-2**
	10A	*Start Mode-2*
	10B	*Start Ramp-2*
	10C	*Initial Current-2*
	10D	*Current Limit-2*
	10E	*Reserved*
	10F	*Kickstart Time-2*
	10G	*Kickstart Level-2*
	10H	*Stop Mode-2*
	10I	*Stop Time-2*
11		**RTD/PT100 (*Reserved*)**
	11A	*Reserved*
12		**Slip-Ring Motors**
	12A	*Motor Data-1 Ramp*
	12B	*Motor Data-2 Ramp*
	12C	*Changeover Time*
	12D	*Slip Ring Retard*
15		**Advanced**
	15A	*Access Code*
	15B	*Adjustment Lock*
	15C	*Emergency Run*
16		**Protection Action**
	16A	*Motor Overload*
	16B	*Excess Start Time*
	16C	*Undercurrent*
	16D	*Instantaneous Overcurrent*
	16E	*Current Imbalance*
	16F	*Frequency*
	16G	*Input A Trip*
	16H	*Input B Trip*
	16I	*Motor Thermistor*
	16J	*Starter Communication*
	16K	*Network Communication*
	16L	*Reserved*
	16M	*Battery/Clock*
	16N	*Ground Fault*
	16O	*Reserved*
	16P	*Reserved*
	16Q	*Reserved*
	16R	*Reserved*
	16S	*Reserved*
	16T	*Reserved*
	16U	*Reserved*
	16V	*Undervoltage*
	16W	*Overvoltage*

9.4 Parameter Descriptions

1 Motor Data-1

The parameters in Motor Data-1 configure the soft starter to match the connected motor. These parameters describe the motor's operating characteristics and allow the soft starter to model the motor's temperature.

1A – *Motor Full Load Current*

Range:	5 - 1000 A	**Default:**	100 A
Description:	Matches the starter to the connected motor's full load current. Set to the full load current (FLC) rating shown on the motor nameplate.		

1B – Locked Rotor Time

Range:	0:01 - 2:00 (minutes:seconds)	**Default:**	10 seconds
Description:	Sets the maximum length of time the motor can sustain locked rotor current from cold before reaching its maximum temperature. Set according to the motor datasheet.		

1C – Locked Rotor Current

Range:	400% - 800% FLC	**Default:**	600%
Description:	Sets the locked rotor current of the connected motor, as a percentage of full load current. Set according to the motor datasheet.		

1D – Motor Service Factor

Range:	100% - 120%	**Default:**	105%
Description:	Sets the motor service factor used by the thermal model. If the motor runs at full load current, it will reach 100%. Set according to the motor datasheet.		

2 Start/Stop Modes-1

2A – Start Mode

Options:	Constant Current (default)
Description:	Selects the soft start mode.

2B – Start Ramp Time

Range:	0:01 - 3.00 (minutes:seconds)	**Default:**	1 second
Description:	Sets the ramp time for current ramp starting (from the initial current to the current limit).		

2C – Initial Current

Range:	50% - 600% FLC	**Default:**	400%
Description:	Sets the initial start current level for current ramp starting, as a percentage of motor full load current. Set so that the motor begins to accelerate immediately after a start is initiated. If current ramp starting is not required, set the initial current equal to the current limit.		

2D – Current Limit

Range:	50% - 600% FLC	**Default:**	400%
Description:	Sets the current limit for constant current and current ramp soft starting, as a percentage of motor full load current.		

2E – Reserved

Description:	This parameter is reserved for future use.

2F – Kickstart Time

Range:	0 – 2000 milliseconds	**Default:**	0000 milliseconds
Description:	Sets the kickstart duration. A setting of 0 disables kickstart.		

2G – Kickstart Level

Range:	100% - 700% FLC	**Default:**	500%
Description:	Sets the level of the kickstart current.		

CAUTION
Kickstart subjects the mechanical equipment to increased torque levels. Ensure the motor, load and couplings can handle the additional torque before using this feature.

2H – Stop Mode

Options:	Coast To Stop (default) TVR Soft Stop
Description:	Selects the stop mode.

2I – Stop Time

Range:	0:00 - 4:00 (minutes:seconds)	**Default:**	0 second
Description:	Sets the time for soft stopping the motor using timed voltage ramp. If a main contactor is installed, the contactor must remain closed until the end of the stop time.		

3 Auto-Stop

The soft starter can be programmed to stop automatically, after a specified delay or at a specified time of day.

WARNING
This function should not be used in conjunction with remote two-wire control.
The soft starter will still accept start and stop commands from the remote inputs or serial communication network. To disable local or remote control, use parameter 6Q.

3A – *Reserved*

Reserved for future use.

3B – *Reserved*

Reserved for future use.

3C – Auto-Stop Type

Options:	Off (default)	The soft starter will not auto-stop.
	Timer	The soft starter will auto-stop after a delay from the next start, as specified in parameter 3D.
	Clock	The soft starter will auto-stop at the time programmed in parameter 3D.
Description:	Selects whether the soft starter will auto-stop after a specified delay, or at a time of day.	

3D – Auto-Stop Time

Range:	00:01 - 24:00 (hours:minutes)	**Default:**	1 minute
Description:	Sets the time for the soft starter to auto-stop, in 24 hour clock format.		

4 Protection Settings

These parameters determine when the soft starter's protection mechanisms will activate. The activation point for each protection mechanism can be set to suit the installation.

The soft starter responds to protection events by tripping, warning, or writing the event to the event log. The response is determined by the Protection Action settings. The default response is a trip.

CAUTION
The protection settings are vital for safe operation of the soft starter and motor. Defeating the protection may compromise the installation and should only be done in the case of emergency.

4A – *Excess Start Time*

Excess start time is the maximum time the soft starter will attempt to start the motor. If the motor does not transition to Run mode within the programmed limit, the starter will trip. Set for a period slightly longer than required for a normal healthy start. A setting of 0 disables excess start time protection.

Range:	0:00 - 2:00 (minutes:seconds)	**Default:**	20 seconds

Description: Set as required.

4B – Excess Start Time-2

Range: 0:00 - 2:00 (minutes:seconds) **Default:** 20 seconds
Description: Set as required.

4C – Undercurrent

Range: 0% - 100% **Default:** 20%
Description: Sets the trip point for undercurrent protection, as a percentage of motor full load current. Set to a level between the motor's normal working range and the motor's magnetising (no load) current (typically 25% to 35% of full load current). A setting of 0% disables undercurrent protection.

4D – Undercurrent Delay

Range: 0:00 - 4:00 (minutes:seconds) **Default:** 5 seconds
Description: Slows the soft starter's response to undercurrent, avoiding trips due to momentary fluctuations.

4E – *Instantaneous Overcurrent*

The soft starter can be configured to trip if the average current of all three phases exceeds a specified level while the motor is running. See *4U, 4V – Instantaneous Overcurrent Stage 2* on page 46 for more information and examples.

Range: 80% - 600% FLC **Default:** 400%
Description: Sets the trip point for instantaneous overcurrent protection, as a percentage of motor full load current.

4F – Instantaneous Overcurrent Delay

Range: 0:00 - 1:00 (minutes:seconds) **Default:** 0 second
Description: Slows the soft starter's response to overcurrent, avoiding trips due to momentary overcurrent events.

NOTE
This protection is only active during run and must be coordinated with *Instantaneous Overcurrent Stage 2* (parameters 4U, 4V).

4G – Phase Sequence

Options: Any Sequence
Positive Only (default)
Negative Only
Description: Selects which phase sequences the soft starter will allow at a start. During its pre-start checks, the starter examines the sequence of the phases at its input terminals and trips if the actual sequence does not match the selected option.

4H – Current Imbalance

Range: 10% - 50% **Default:** 30%
Description: Sets the trip point for current imbalance protection.

4I – Current Imbalance Delay

Range: 0:00 - 4:00 (minutes:seconds) **Default:** 5 seconds
Description: Slows the soft starter's response to current imbalance, avoiding trips due to momentary fluctuations.

NOTE
The soft starter will display a Current Imbalance trip only when phase loss at the supply terminals occurs during Run mode. When a phase loss occurs during other modes of operation, the soft starter will trip on Motor Connection.

4J – Frequency Check

Options: Do Not Check
Start Only
Start/Run
Run Only (default)

Description: Determines when and if the starter will monitor for a frequency trip.

4K – Frequency Variation

Options: ± 2 Hz
± 5 Hz (default)
± 10 Hz
± 15 Hz

Description: Selects the soft starter's tolerance for frequency variation.

4L – Frequency Delay

Range: 0:01 - 4:00 (minutes:seconds) **Default:** 5 seconds

Description: Slows the soft starter's response to frequency disturbances, avoiding trips due to momentary fluctuations.

NOTE
If the mains frequency drops below 35 Hz or rises above 75 Hz, the starter will trip immediately, irrespective of the settings for Frequency Trip parameters.

4M – *Restart Delay*

Range: 00:01 - 60:00 (minutes:seconds) **Default:** 30 minutes

Description: The soft starter can be configured to force a delay between the end of a stop and the beginning of the next start. During the restart delay period, the display shows the time remaining before another start can be attempted.

4N – Motor Temperature Check

Options: Do Not Check (default)
Check

Description: Selects whether the soft starter will verify the motor has sufficient thermal capacity for a successful start. The soft starter compares the motor's calculated temperature with the temperature rise from the last motor start and only operates if the motor is cool enough to start successfully.

4O – Ground Fault Level

Range: 1 A - 40 A **Default:** 1 A

Description: Sets the trip point for ground fault protection. Ground fault is a dynamic trip based on phase current measurements every half-cycle.

4P – Ground Fault Delay

Range: 0:01 - 4:00 (minutes:seconds) **Default:** 3 seconds

Description: Slows the soft starter's response to ground fault variation, avoiding trips due to momentary fluctuations.

NOTE
Ground fault accuracy is within ± 1 A of the set value.

4Q – Undervoltage Level

Range: 100 – 18000 V **Default:** 100 V

Description: Sets the trip point for undervoltage protection. Set as required.

4R – Undervoltage Trip Delay

Range: 0:00 – 4:00 (minutes:seconds) **Default:** 5 seconds

Description: Slows the soft starter's response to undervoltage, avoiding trips due to momentary fluctuations.

4S – Overvoltage Level

Range: 100 – 18000 V **Default:** 7200 V

Description: Sets the trip point for overvoltage protection. Set as required.

4T – Overvoltage Trip Delay

Range: 0:00 – 4:00 (minutes:seconds) **Default:** 5 seconds

Description: Slows the soft starter's response to overvoltage, avoiding trips due to momentary fluctuations.

4U, 4V – Instantaneous Overcurrent Stage 2

The soft starter has two instantaneous trip functions, stage 1 and 2. These protection functions are configured to be complementary.

Stage 1 must be configured to protect the motor against a locked rotor (shearpin) situation during run mode. Stage 1 should trigger at lower current/higher time values than Stage 2.

Stage 2 must be configured to protect the main switching device. When Stage 2 triggers, the starter opens the main switching device.

If the main switching element is a contactor (protected by a fuse), then this function must be coordinated with the fuse to ensure that the contactor does NOT open until the fuse ruptures.

If the main switching element is a breaker, then the delay must be minimised to provide the best possible protection to the SCR.

Parameter 4U *Instantaneous Overcurrent S2*

Range: 30 A – 4400 A **Default:** 4400 A

Description: Sets the trip point for instantaneous overcurrent stage 2 protection in amperes. Set as required.

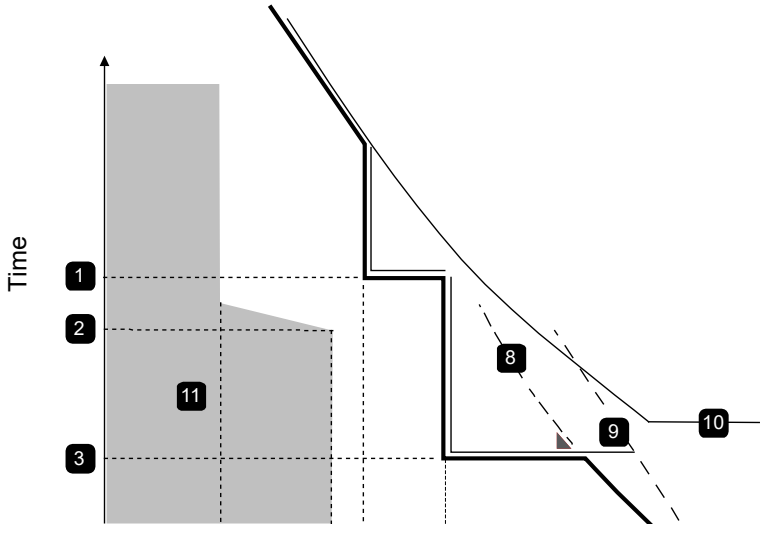
Parameter 4V *Instantaneous Overcurrent Delay S2*

Range: 10 – 1000 ms **Default:** 10 milliseconds

Description: Sets the duration required for current to exceed the level set in parameter 4U before a trip occurs. Set as required.

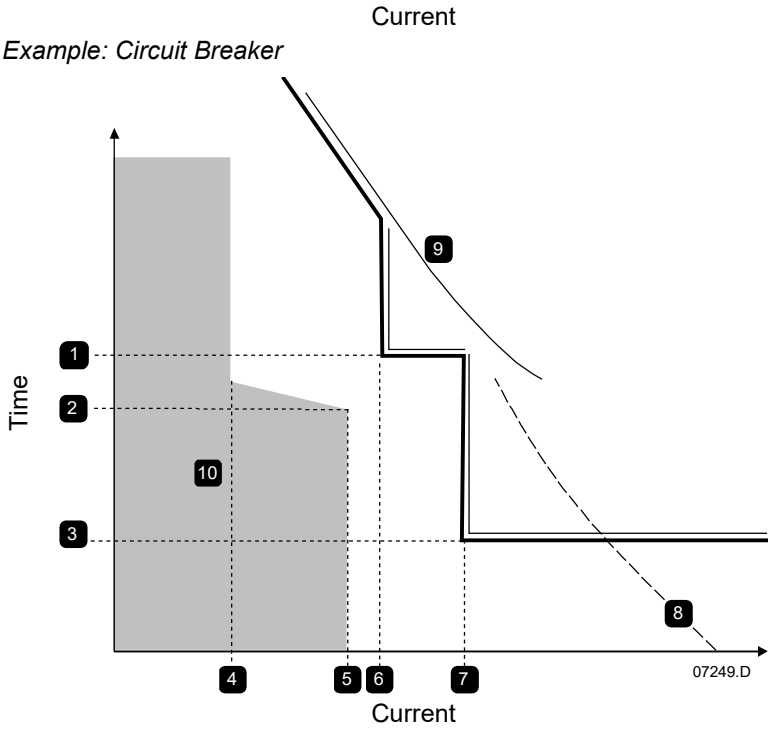
NOTE
This protection is active during starting, running and stopping. It must be coordinated with *Instantaneous Overcurrent* (parameters 4E, 4F).

Example: Contactor and Fuse



1	Instantaneous Overcurrent Delay - Stage 1 (4F)
2	Motor start time
3	Instantaneous Overcurrent Delay - Stage 2 (4V)
4	FLC
5	Motor start current
6	Instantaneous Overcurrent-Stage 1 (4E)
7	Instantaneous Overcurrent - Stage 2 (4U) to trip external upstream breaker
8	Fuse
9	SCR
10	Thermal model curve
11	Motor operation (shaded area of graph)

Example: Circuit Breaker



1	Instantaneous Overcurrent Delay - Stage 1 (4F)
2	Motor start time
3	Instantaneous Overcurrent Delay - Stage 2 (4V)
4	FLC
5	Motor start time
6	Instantaneous Overcurrent -Stage 1 (4E)
7	Instantaneous Overcurrent -Stage 2 (4U) to trip main breaker
8	SCR
9	Thermal model curve
10	Motor operation (shaded area of graph)

5 Auto-Reset Trips (Reserved)

This parameter group is reserved for future use.

6 Inputs

The soft starter has two programmable inputs, which allow remote control of the soft starter.

6A – Input A Function

Options:	Motor Set Select	The soft starter can be configured with two separate sets of motor data. To use the secondary motor data, parameter 6A must be set to 'Motor Set Select' and C53, C54 must be closed when a start command is given. The soft starter checks which motor data to use at a start, and will use that motor data for the entire start/stop cycle.
	Input Trip (N/O) (default)	Input A can be used to trip the soft starter. When parameter 6A is set to Input Trip (N/O), a closed circuit across C53, C54 trips the soft starter. (See parameters 6C, 6D, 6E)
	Input Trip (N/C)	When parameter 6A is set to Input Trip (N/C), an open circuit across C53, C54 trips the soft starter. (See parameters 6C, 6D, 6E)
	Local/Remote Select	Input A can be used to select between local and remote control, instead of using the **LCL/RMT** button on the controller. When the input is open, the starter is in local mode and can be controlled via the controller. When the input is closed, the starter is in remote mode. The **START** and **LCL/RMT** buttons are disabled, and the soft starter will ignore any Local/Remote select command from the serial communications network. To use Input A to select between local and remote control, parameter 6Q must be set to 'LCL/RMT Anytime' or 'LCL/RMT When Off'.

	Emergency Run	In emergency run the soft starter continues to run until stopped, ignoring all trips and warnings (see parameter 15C for details). Closing the circuit across C53, C54 activates emergency run. Opening the circuit ends emergency run and the soft starter stops the motor.
	Starter Disable	The soft starter can be disabled via the control inputs. An open circuit across C53, C54 will disable the starter. The soft starter will not respond to start commands. If running, the soft starter will allow the motor to coast to stop, ignoring the soft stop mode set in parameter 2H.
Description:	Selects the function of Input A.	

6B – Input A Name

Options:	Input Trip (default)	Controller
	Low Pressure	PLC
	High Pressure	Vibration Alarm
	Pump Fault	Field Trip
	Low Level	Interlock Trip
	High Level	Motor Temperature
	No Flow	Motor Protection
	Starter Disable	Feeder Protection
Description:	Selects a message for the controller to display when Input A is active.	

6C – Input A Trip

Options:	Always Active (default)	A trip can occur at any time when the soft starter is receiving power.
	Operating Only	A trip can occur while the soft starter is running, stopping or starting.
	Run Only	A trip can only occur while the soft starter is running.
Description:	Selects when an input trip can occur.	

6D – Input A Trip Delay

Range:	0:00 - 4:00 (minutes:seconds)	**Default:** 0 second
Description:	Sets a delay between the input activating and the soft starter tripping.	

6E – Input A Initial Delay

Range:	00:00 - 30:00 (minutes:seconds)	**Default:** 0 second
Description:	Sets a delay before an input trip can occur, after the soft starter has entered the state selected in 6C.	

6F, 6G, 6H, 6I, 6J – Input B Trip

Parameters 6F~6J configure the operation of Input B, in the same way as parameters 6A~6E configure Input A. See Input A for details.

- 6F *Input B Function* (**Default:** Input Trip (N/O))
- 6G *Input B Name* (**Default:** Input Trip)
- 6H *Input B Trip* (**Default:** Always Active)
- 6I *Input B Trip Delay* (**Default:** 0:00)
- 6J *Input B Initial Delay* (**Default:** 0:00)

6K – *Reserved*

Reserved for future use.

6L – *Reserved*

Reserved for future use.

6M – Remote Reset Logic

Options:	Normally Closed (default) Normally Open
Description:	Selects whether the soft starter's remote reset input (terminals C41, C42) is normally open or normally closed.

6N – *Reserved*

Reserved for future use.

6O – *Reserved*

Reserved for future use.

6P – *Reserved*

Reserved for future use.

6Q – Local/Remote

Options:	LCL/RMT Anytime (default)	**LCL/RMT** button is always enabled.
	LCL/RMT When Off	**LCL/RMT** button is enabled when the starter is off.
	Local Control Only	The **LCL/RMT** button and remote start/stop inputs are disabled.
	Remote Control Only	The **START** and **LCL/RMT**) buttons are disabled.
Description:	Selects when the **LCL/RMT** button can be used to switch between local and remote control, and enables or disables the local control buttons and remote control inputs. The **STOP** button on the controller is always enabled. The reset input and **RESET** button on the controller are always enabled.	

WARNING
The **STOP** button on the controller is always enabled. When using two-wire remote control, the soft starter will restart if the remote start/stop and reset inputs are still active.

6R – Comms in Remote

Options:	Disable Control in RMT Enable Control in RMT (default)
Description:	Selects whether the starter will accept Start, Stop and Reset commands from the serial communication network when in Remote mode. The Force Comms Trip and Local/Remote commands are always enabled.

7 Outputs

The soft starter has three programmable outputs, which can be used to signal different operating conditions to associated equipment.

7A – Relay A Function

Options:	Off	Relay A is not used.
	Main Contactor (default)	The relay closes when the soft starter receives a start command, and remains closed as long as the motor is receiving voltage.
	Run	The relay closes when the starter changes to run state.
	Trip	The relay closes when the starter trips (see parameter 16A to 16X).
	Warning	The relay closes when the starter issues a warning (see parameter 16A to 16X).
	Low Current Flag	The relay closes when the low current flag activates while the motor is running (see parameter 7M *Low Current Flag*).
	High Current Flag	The relay closes when the high current flag activates while the motor is running (see parameter 7N *High Current Flag*).
	Motor Temperature Flag	The relay closes when the motor temperature flag activates (see parameter 7O *Motor Temperature Flag*).

Input A Trip	The relay closes when Input A activates to trip the soft starter.
Input B Trip	The relay closes when Input B activates to trip the soft starter.
Motor Overload	The relay closes when the starter trips on Motor Overload.
Current Imbalance	The relay closes when the starter trips on Current Imbalance.
Undercurrent	The relay closes when the starter trips on Undercurrent.
Instantaneous overcurrent	The relay closes when the starter trips on Instantaneous Overcurrent.
Frequency	The relay closes when the starter trips on Frequency.
Ground Fault	The relay closes when the starter trips on Ground Fault.
Heatsink Overtemperature	Not applicable
Phase Loss	The relay closes when the starter trips on Phase Loss.
Motor Thermistor	The relay closes when the starter trips on Motor Thermistor.
Changeover Contactor	The relay closes when the high rotor resistance current ramp has reached full voltage, allowing use with a slip-ring motor.
Undervoltage	The relay closes when the mains voltage drops below the level set in parameter 4Q.
Ready	The relay closes when the starter transitions into Ready mode.
Local	The relay is open when the starter is in local control mode, and closed in remote control mode.

Description: Selects the function of Relay A (normally open).

7B – Relay A On Delay

Range: 0:00 - 5:00 (minutes:seconds) **Default:** 0 second

Description: Sets the delay for closing Relay A.

7C – Relay A Off Delay

Range: 0:00 - 5:00 (minutes:seconds) **Default:** 0 second

Description: Sets the delay for re-opening Relay A.

7D~7I – Output Relays B and C

Parameters 7D~7I configure the operation of Relays B and C in the same way as parameters 7A~7C configure Relay A. See Relay A for details.

Relay B is a changeover relay.

- 7D *Relay B Function* **Default:** Run
- 7E *Relay B On Delay* **Default:** 0 second
- 7F *Relay B Off Delay* **Default:** 0 second

Relay C is a changeover relay.

- 7G *Relay C Function* **Default:** Trip
- 7H *Relay C On Delay* **Default:** 0 second
- 7I *Relay C Off Delay* **Default:** 0 **second**

7J – *Reserved*

Reserved for future use.

7K – *Reserved*

Reserved for future use.

7L – *Reserved*

Reserved for future use.

7M – Low Current Flag

The soft starter has low and high current flags to give early warning of abnormal operation. The current flags can be configured to indicate an abnormal current level during operation, between the normal operating level and the undercurrent or instantaneous overcurrent trip levels. The flags can signal the situation to external equipment via one of the programmable outputs.

The flags clear when the current returns within the normal operating range by 10% of the programmed flag value.

Range: 1% - 100% FLC **Default:** 50%

Description: Sets the level at which the low current flag operates, as a percentage of motor full load current.

7N – High Current Flag

Range: 50% - 600% FLC **Default:** 100%

Description: Sets the level at which the high current flag operates, as a percentage of motor full load current.

7O – *Motor Temperature Flag*

The soft starter has a motor temperature flag to give early warning of abnormal operation. The flag can indicate that the motor is operating above its normal operating temperature but lower than the overload limit. The flag can signal the situation to external equipment via one of the programmable outputs.

Range: 0% - 160% **Default:** 80%

Description: Sets the level at which the motor temperature flag operates, as a percentage of the motor's thermal capacity.

7P – *Analog Output A*

The soft starter has an analog output, which can be connected to associated equipment to monitor motor performance.

Options:

Current (% FLC) (default)	Current as a percentage of motor full load current.
Motor Temperature (%)	Motor temperature as a percentage of the motor rated current (calculated by the soft starter's thermal model).
Motor kW (%)	Motor kilowatts. 100% is motor FLC (parameter 1A) multiplied by mains voltage. Power factor is assumed to be 1.0. $\frac{\sqrt{3} \cdot V \cdot I_{FLC} \cdot pf}{1000}$
Motor kVA (%)	Motor kilovolt amperes. 100% is motor FLC (parameter 1A) multiplied by mains voltage. $\frac{\sqrt{3} \cdot V \cdot I_{FLC}}{1000}$
Motor pf	Motor power factor, measured by the soft starter.
Voltage (%Mains)	The average voltage measured on three phases as a percentage of the mains voltage.

Description: Selects which information will be reported via the analog output.

7Q – Analog A Scale

Range:
0-20 mA
4-20 mA (default)

Description: Selects the range of the analog output.

7R – Analog A Maximum

Range: 0% - 600% **Default:** 100%

Description: Calibrates the upper limit of the analog output to match the signal measured on an external current measuring device.

7S – Analog A Minimum

Range:	0% - 600%	**Default:**	0%
Description:	Calibrates the lower limit of the analog output to match the signal measured on an external current measuring device.		

7T – *Reserved*

Reserved for future use.

7U – *Reserved*

Reserved for future use.

7V – *Reserved*

Reserved for future use.

7W – *Reserved*

Reserved for future use.

8 Display

These parameters allow the controller to be tailored to individual users' requirements.

8A – Language

Options:	English (default)	Português
	Chinese	Français
	Español	Italiano
	Deutsch	Russian
Description:	Selects which language the controller will use to display messages and feedback.	

8B, 8C – *F1 Button Action*

Options:	None Setup Auto-Start/Stop
Description:	Selects the function of the **F1** and **F2** buttons on the controller. • 8B *F1 Button Action* **Default:** Setup Auto-Start/Stop • 8C *F2 Button Action* **Default:** None

8D – Display A or kW

Options:	Current (default) Motor kW
Description:	Selects whether the soft starter will display current (amperes) or motor kilowatts on the main monitoring screen.

8E, 8F, 8G, 8H – User-Programmable Screen

Options:	Blank	Displays no data in the selected area, allowing long messages to be shown without overlapping.
	Starter State	The starter's operating state (starting, running, stopping or tripped). Only available for top left and bottom left positions on the screen.
	Motor Current	The average current measured on three phases.
	Motor pf	The motor's power factor, measured by the soft starter.
	Mains Frequency	The average frequency measured on three phases.
	Motor kW	The motor's running power in kilowatts.
	Motor HP	The motor's running power in horsepower.
	Motor Temperature	The motor's temperature, calculated by the thermal model.
	kWh	The number of kilowatt hours the motor has run via the soft starter.
	Hours Run	The number of hours the motor has run via the soft starter.
	Analog Input	n/a
	Mains Voltage	The average voltage measured on three phases.

Description: Selects which information will be displayed on the programmable monitoring screen.

- 8E *User Screen - Top Left* **Default:** Starter State
- 8F *User Screen - Top Right* **Default:** Blank
- 8G *User Screen - Bottom Left* **Default:** kWh
- 8H *User Screen - Bottom Right* **Default:** Hours Run

8I – *Graph Data*

The soft starter has a real-time performance graph to report the behaviour of critical operating parameters.

Options:	Current (% FLC) (default)	Current as a percentage of motor full load current.
	Motor Temperature (%)	Motor temperature as a percentage of the motor rated current (calculated by the soft starter's thermal model).
	Motor kW (%)	Motor kilowatts. 100% is motor FLC (parameter 1A) multiplied by mains voltage. Power factor is assumed to be 1.0. $\frac{\sqrt{3} \cdot V \cdot I_{FLC} \cdot pf}{1000}$
	Motor kVA (%)	Motor kilovolt amperes. 100% is motor FLC (parameter 1A) multiplied by mains voltage. $\frac{\sqrt{3} \cdot V \cdot I_{FLC}}{1000}$
	Motor pf	Motor power factor, measured by the soft starter.
	Voltage (%Mains)	The average voltage measured on three phases as a percentage of the mains voltage.

Description: Selects which information the graph will display.

8J – *Graph Timebase*

Options:	10 seconds	10 minutes
	30 seconds	30 minutes
	1 minute (default)	1 hour
	5 minutes	

Description: Sets the graph time scale. The graph will progressively replace the old data with new data.

8K – Graph Maximum

Range: 0% – 600% **Default:** 400%

Description: Adjusts the upper limit of the performance graph.

8L – Graph Minimum

Range: 0% – 600% **Default:** 0%

Description: Adjusts the lower limit of the performance graph.

8M – Mains Reference Voltage

Range: 100 – 14000 V **Default:** 400 V

Description: Provides the reference voltage for the analog output and performance graphs.

9 Motor Data-2

The soft starter can support two different starting and stopping motor data sets.

To select the secondary motor data set, a programmable input must be configured to parameter set selection (parameters 6A and 6F) and the input must be active when the soft starter receives a start signal.

NOTE
You can only choose which motor data set to use while the soft starter is stopped.

9A – *Reserved*

Reserved for future use.

9B – Motor FLC-2

Range:	5 - 1000 A	**Default:**	100 A
Description:	Sets the secondary motor's full load current.		

9C – *Reserved*

Reserved for future use.

9D – *Reserved*

Reserved for future use.

9E – *Reserved*

Reserved for future use.

10 Start/Stop-2

10A – *Start Mode-2*

Options:	Constant Current (default)
Description:	Selects the soft start mode.

10B – *Start Ramp-2*

Range:	0:01 - 3.00 (minutes:seconds)	**Default:**	1 second
Description:	Sets the ramp time for current ramp starting (from the initial current to the current limit).		

10C – ***Initial Current-2***

Range:	50% - 600% FLC	**Default:**	400%
Description:	Sets the initial start current level for current ramp starting, as a percentage of motor full load current. Set so that the motor begins to accelerate immediately after a start is initiated. If current ramp starting is not required, set the initial current equal to the current limit.		

10D – *Current Limit-2*

Range:	50% - 600% FLC	**Default:**	400%
Description:	Sets the current limit for constant current and current ramp soft starting, as a percentage of motor full load current.		

10E – *Reserved*

Reserved for future use.

10F – Kickstart Time-2

Range:	0 - 2000 (milliseconds)	**Default:**	0000 milliseconds
Description:	Sets the kickstart duration. A setting of 0 disables kickstart.		

10G – Kickstart Level-2

Range:	100% - 700% FLC	**Default:**	500%
Description:	Sets the level of the kickstart current.		

10H – *Stop Mode-2*

Options:	Coast To Stop (default) TVR Soft Stop
Description:	Selects the stop mode.

10I – Stop Time-2

Range:	0:00 - 4:00 (minutes:seconds)	**Default:**	0 second
Description:	Sets the stop time.		

11 RTD/PT100 (Reserved)

This parameter group is reserved for future use.

12 Slip-Ring Motors

These parameters allow the soft starter to be configured for use with a slip-ring motor.

12A – Motor 1 Ramp

Options: Single Ramp (default)
Dual Ramp

Description: Selects whether to use a single or dual current ramp profile for soft starting. Set to single ramp for non-slip ring induction motors, or dual ramp for slip-ring induction motors.

12B – Motor 2 Ramp

Options: Single Ramp (default)
Dual Ramp

Description: Selects whether to use a single or dual current ramp profile for soft starting. Set to single ramp for non-slip ring induction motors, or dual ramp for slip-ring induction motors.
Parameter 12B selects the ramp configuration for the secondary motor.

12C – Changeover Time

Range: 100 - 500 (milliseconds) **Default:** 150 milliseconds

Description: Sets the delay between the rotor resistance relay closing and the low resistance current ramp starting. Set so that the contactor has enough time to close, but the motor does not slow down.
Parameter 12C only applies if parameter 12A or 12B is set to 'Dual Ramp', and an output relay is set to 'Changeover Contactor'.

12D – Slip-Ring Retard

Range: 10% - 90% **Default:** 50%

Description: Sets the level of conduction after the rotor resistance contactor closes, as a percentage of full conduction.
Set so that no current pulse occurs, but the motor retains enough speed to start correctly.

15 Advanced

15A – Access Code

Range: 0000 - 9999 **Default:** 0000

Description: Sets the access code to control access to restricted sections of the menus.

Use the **EXIT** and ▶ buttons to select which digit to alter and use the ▲ and ▼ buttons to change the value. After the last digit is set press **STORE**.

NOTE
In the event of a lost access code, contact your supplier for master access code that allows you to re-program a new access code.

15B – Adjustment Lock

Options:	Read & Write (default)	Allows users to alter parameter values in the Programming Menu.
	Read Only	Prevents users altering parameter values in the Programming Menu. Parameter values can still be viewed.

Description: Selects whether the controller will allow parameters to be changed via the Programming Menu.

15C – Emergency Run

Options: Disable (default)
Enable

Description: Selects whether the soft starter will permit emergency run operation. In emergency run, the soft starter will start (if not already running) and continue to operate until emergency run ends, ignoring stop commands and trips.
Emergency run is controlled using a programmable input.

CAUTION
Continued use of Emergency Run is not recommended. Emergency Run may compromise the starter life as all protections and trips are disabled.

Using the starter in 'Emergency Run' mode will void the product warranty.

16 Protection Action

These parameters define how the soft starter will respond to different protection events. The soft starter can trip, issue a warning, or ignore different protection events as required. All protection events are written to the event log. The default action for all protections is to trip the soft starter.

CAUTION
Defeating the protection may compromise the starter and motor, and should only be done in the case of emergency.

16A~16W – Protection Actions

Options: Trip Starter (default)
Warn and Log
Log Only

Description: Selects the soft starter's response to each protection.

- 16A *Motor Overload*
- 16B *Excess Start Time*
- 16C *Undercurrent*
- 16D *Instantaneous Overcurrent*
- 16E *Current Imbalance*
- 16F *Frequency*
- 16G *Input A Trip*
- 16H *Input B Trip*
- 16I *Motor Thermistor*
- 16J *Starter Communication*
- 16K *Network Communication*
- 16L *Reserved*
- 16M *Battery/Clock*
- 16N *Ground Fault*
- 16O~16U *Reserved*
- 16V *Undervoltage*
- 16W *Overvoltage*

20 Restricted

These parameters are restricted for Factory use and are not available to the user.

10 Commissioning

10.1 Site Acceptance Test (SAT) Procedure

Preparation

- **Document familiarisation**

Ensure that all preliminary details are recorded before visiting the customer. Compile a folder with all available information. (Include Site readiness form).

		Date	Initial
1.	All team members must be familiar with the soft starter operating manual.		
2.	Review the schematics, general arrangement drawings and bill of materials (BOM) for the installation.		
3.	Record motor details from datasheet and nameplate.		
4.	Review speed-torque and speed-current curves for the motor, if available.		
5.	Review speed-torque curves for the load, if available.		

- **Site familiarisation**

Installation environment

Become familiar with the environment where the soft starter will be located. Gain an understanding of the customer's operating approach and their operational requirements for the soft starter.

		Date	Initial
1.	Determine the location of the soft starter in relation to the motor and load.		
2.	Determine the location of the soft starter in relation to mains and control supply feeders.		
3.	Understand the overall mains supply system – from the supply source through to the motor.		
4.	Understand the overall control and operations system – start/stop philosophy, monitoring, signalling.		

Safety

Gain enough understanding of the customer's site safety procedures to ensure you can comply.

		Date	Initial
1.	Complete the customer's site induction process and review site safety requirements and practices.		
2.	All team members must be aware of site safety and electrical lock-out procedures, including paperwork, authorisations, physical padlocking etc.		
3.	Identify any potential hazards and discuss these with customer contact.		
4.	Review the procedure for stopping the motor from different locations (eg control room or near the motor).		
5.	Review the procedure for turning off the MV mains supply.		

Emergency procedures

Ensure that all team members know how to respond in case of emergency on site, whether related to the commissioning or not.

		Date	Initial
1.	Review the procedure for notifying an emergency and activating alarms.		
2.	Review the alarms which may occur, and familiarise the team with the appropriate response in each case.		
3.	Identify and visit emergency exits and the evacuation assembly area.		
4.	Identify the location of a first-aid kit and fire extinguisher etc.		
5.	Identify the customer's point of contact for emergencies and take their contact details: Name: _____ Phone: _____		

Site Acceptance Test Procedure

- **Physical checks: Mechanical assemblies**

Power Assembly

Before beginning the commissioning process, check that the power assembly has arrived in good condition and all connections are correct.

	Date	Initial
1. All critical bolts on the power assembly are checked and marked in the factory. Check that all marks are still aligned.		
2. Check that all power connections are tightened to the correct torque.		
3. Check the fibre-optic connections for any loss/poor connection. Check also the fibre-optic cables for any sign of visible damage or sharp bend.		
4. Check the following connections:		
• firing connections		
• gate-cathode leads		
• pulse transformer leads at gate drive board		
5. Check each phase arm visually for any sign of damage:		
• Phase arm 1		
• Phase arm 2		
• Phase arm 3		

Enclosure

Check that the enclosure contains all agreed components and is in a fit state for commissioning, including safety precautions and adequate isolation between the low voltage and medium voltage compartments.

	Date	Initial
1. Check that all agreed components have been installed into the enclosure and have been fitted correctly, with adequate insulation & tight connections (use 'N/A' if not fitted):		
• power circuit as per electrical drawing, including terminations etc.		
• cable connections		
• earth bonding		
• Isolator / earthing switch mechanism		
• input / output bushing		
2. Check that all LV connections < M5 are tight (eg low voltage control terminals).		
3. Check that there is no debris, dust or other foreign material in the enclosure.		
4. Check that the enclosure and floor (if metal) are earthed.		

- **Physical checks: Electrical assemblies**

Power supplies and subsystem

Test that the soft starter power supply and electrical subsystem show the expected characteristics.

	Date	Initial
1. Disconnect the power supply connector on the controller.		
2. Disconnect the power supply and relay connector on the power interface board.		
3. To check the SCRs, perform an insulation resistance test (megger) with a voltage range 500 ~ 1000 VAC.		
• L1~L3 to earth and T1~T3 to earth should be > 1 MΩ		
• L1~T1, L2~T2, L3~T3 should be: V02: 100 kΩ V03: 200 kΩ V04: 200 kΩ V06: 300 kΩ V11: 500 kΩ V13: 600 kΩ		
• Sight insulation resistance values for motor, input and output cables etc., or witness test performed by others.		
4. Check that the auxiliary/ control supply is as expected:		
• Measure and record voltage between Line and Neutral. V_{LN} = _____ V		

	Date	Initial
• Measure and record voltage between Line and Earth. V_{LE} = _____ V		
5. Check that Neutral is properly earthed (at least at the LV supply transformer, but preferably at the main distribution board also).		
6. Measure and record voltage between Neutral and Earth. V_{NE} = _____ V		
• Check the bypass readback input (C73, C74) on the power interface board (volt free).		
• Voltage at all electronic power supply connectors must be 26.5 VDC.		
• Voltage for the contactors (at the connector block) must match the voltage for the contactor coil circuit, as specified on schematic diagrams.		
7. Connect the 24 VDC connector to the power interface board. The power supply LED should illuminate and the fibre-optic TX LED should flash.		
8. Connect the 24 VDC connector to the controller. The start-up message should be displayed on the LCD.		
• Control software _____ / Interface software _____ / Controller _____		

- **Operating Tests**

Motor simulation

Use the soft starter Simulation functions to ensure that the starter is connected correctly to the associated equipment.

	Date	Initial
1. Disconnect the soft starter from the mains supply.		
2. Set the date and time and all necessary parameters.		
3. Reset all performance counters.		
4. Operate the Run Simulation using the keypad on the controller.		
• Check that the relays on the power interface PCB operate and activate the MV contactors.		
• Check that the firing signals are received at the gate drive board.		
• Check that the LEDs on the power interface board, gate drive boards and firing boards activate as expected at each stage of the simulation. See *Run simulation* on page 22 for more details.		
5. Operate the Protection Simulation and confirm that the starter responds as expected.		
6. Operate the Output Signal Simulation and confirm that the starter provides output signalling as expected.		
7. Confirm that the soft starter trips if the thermistor is not present.		

Low voltage motor test

NOTE
The FLC for the low voltage motor must be ≥ 5 A (see parameter 1A *Motor Full Load Current*). The typical value for parameter 2D *Current Limit* is 130%.

NOTE
Models V06~V13 require an LV motor test resistor assembly (part number 995-03946-00). The LV motor test resistor assembly is not required for low voltage testing of V02~V04 models.

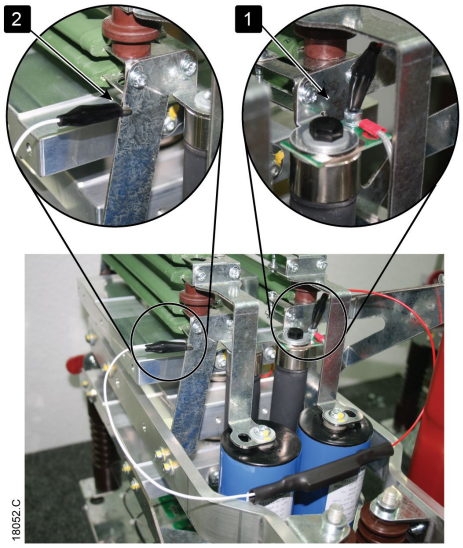
Use the soft starter's low voltage test function to confirm that the soft starter can control a motor.

	Date	Initial
1. Disconnect the soft starter from the mains supply.		
2. **WARNING** Attach one motor test resistor assembly to each phase arm. (See below)		
3. Connect the soft starter to a low voltage mains supply and a low voltage motor.		
4. Configure the soft starter parameters for the low voltage motor.		
5. Use the soft starter to operate the LV motor.		
6. Check that the current and voltage levels are balanced across all three phases.		

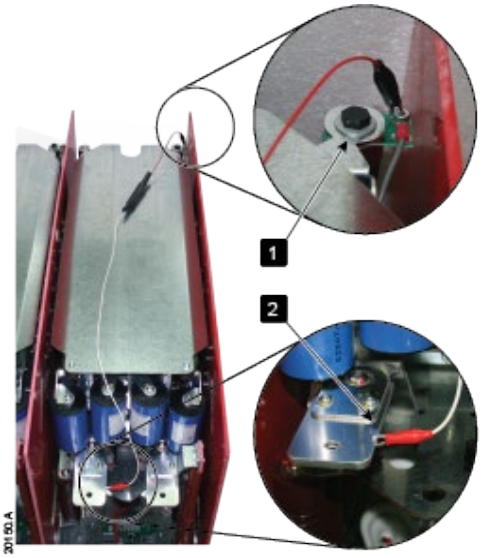
7. Check that all three non-conduction LEDs on the power interface PCB activate fully. All three LEDs should be equally bright.		
8. **WARNING** Remove the non-conduction resistor assembly from each phase arm.		

Connect the LV Motor Test Resistor Assembly

V06



V11-V13



0070~0540

1. Clip one end of the resistor assembly to the bolt on the non-conduction PCB. The non-conduction PCB is located on the side of the phase arm, at the top of the long round grading resistor (see illustrations).
2. Clip the other end of the assembly to the steel bracket behind the grading resistor on the other side of the phase arm.

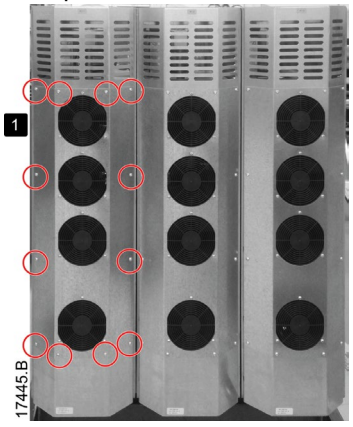
0070~0540, V11-V13

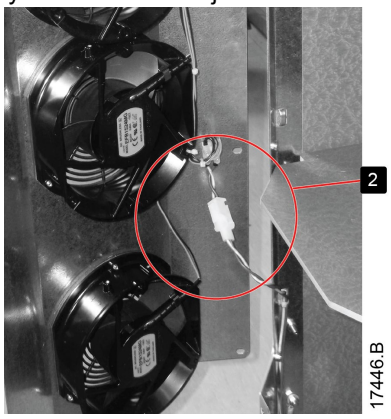
1. Clip one end of the resistor assembly to the bolt on the non-conduction PCB. The non-conduction PCB is located at the back right corner of the phase arm.
2. Clip the other end of the assembly to the busbar at the front left of the phase arm (see illustrations).

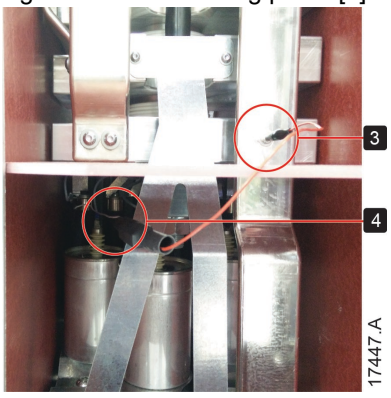
0900~1700, V06

The fan assembly must be removed from each phase arm before the resistor assembly can be connected. The same process must be followed for each phase arm.

1. Remove the 12 screws holding each fan assembly in place [1]. Do not remove the 3 screws holding each fan in place.
2. Disconnect the fan control wiring plug [2].
3. Clip one end of the resistor assembly to the bolt on the busbar [3].
4. Clip the other end of the assembly to the small bolt just below the bushing under the insulating panel [4].







CAUTION
After low voltage mode testing, ensure that the LV motor test resistor assembly is removed from each phase arm before connecting the soft starter to a medium voltage motor. If the LV motor test resistor assemblies remain on the phase arms, the soft starter may suffer severe damage.

CAUTION
After low voltage mode testing, any fan control wiring must be reconnected and the fan assemblies must be screwed to the front of each phase arm before connecting to the medium voltage mains supply.

Medium voltage commissioning test

Check motor datasheets and motor terminal boxes to ensure that no capacitors are installed internally or cabled to the motor terminal box.

Also check that no capacitors are directly connected to the soft starter's output.

Review the parameter settings for MV motor operation.

		Date	Initial
1.	**WARNING** Check that any non-conduction resistors or linking wires are removed from each phase arm.		
2.	Set parameters according to the motor data and application requirements.		
3.	Program inputs and outputs according to the site requirements.		
4.	Connect the soft starter to the medium voltage supply, and connect the motor to the soft starter. Do not connect motor to the load (ie leave the motor uncoupled from the load).		
5.	Use the soft starter to operate the motor and verify that the rotation meets the site requirements.		
6.	Stop the motor.		
7.	Connect the MV motor to the load and use the soft starter to operate the motor.		
8.	Monitor parameters such as voltage, current, power. Calibrate voltage and current readouts as required.		
9.	Once the customer is satisfied that the soft starter operates correctly, record all parameter settings in the user manual (Section 6 Parameter Record). Take one copy of the Parameter Record for supplier records (or fill in the sheet overleaf), and leave the manual with the customer.		
10.	Use the Parameter Archive function to save the programmed settings as "User set 1".		

10.2 Secondary injection testing

The soft starter supports secondary injection testing to prove the correct operation of the soft starter’s protection functions. Secondary injection tests that the soft starter’s current and voltage protection and metering functions are operating according to the parameter settings.

Secondary injection testing uses the soft starter's DOL+ Mode. The soft starter requires power interface board 990-15436-00 and interface software version 2.34 or later.

Current inputs for the testing are applied at the CT test block. Custom test leads must be used to inject three-phase voltage into voltage inputs. Contact your supplier for assistance.

Secondary injection testing requires specialist equipment such as the Omicron CMC 356 relay test set. The test equipment must be configured and operated by a trained specialist. To conduct secondary injection testing, contact your supplier for assistance.

10.3 Dielectric test on the main circuit

Every soft starter is individually dielectric tested (hipot test) at the factory, and the test report is available on request.

Dielectric testing of the entire system at site is at the customer's sole risk. Voltage test levels should be reduced by 20% compared with the standard test values.

CAUTION
The test voltages for dielectric tests should not exceed the ratings of any individual component, such as contactors, circuit breakers or current transformers.

Dielectric test standard voltages

1. IEC 62271-1 (table 1a) test voltages for each rated mains voltage are:

Mains voltage (kV)	Common value (kV)	Clause 7.2.12 80% - Condition check (kV)
2.3-3.6	10	8
4.1-7.2	20	16
11-13.8	28 (42 CCC & Gost)	22.4 (33.6)

2. Standard test voltages used for dielectric tests are:

Mains voltage (kV)	Factory test level (kV)
2.3-3.6	10
4.1-7.2	20
10-12	28
13.8-15	38

Procedure

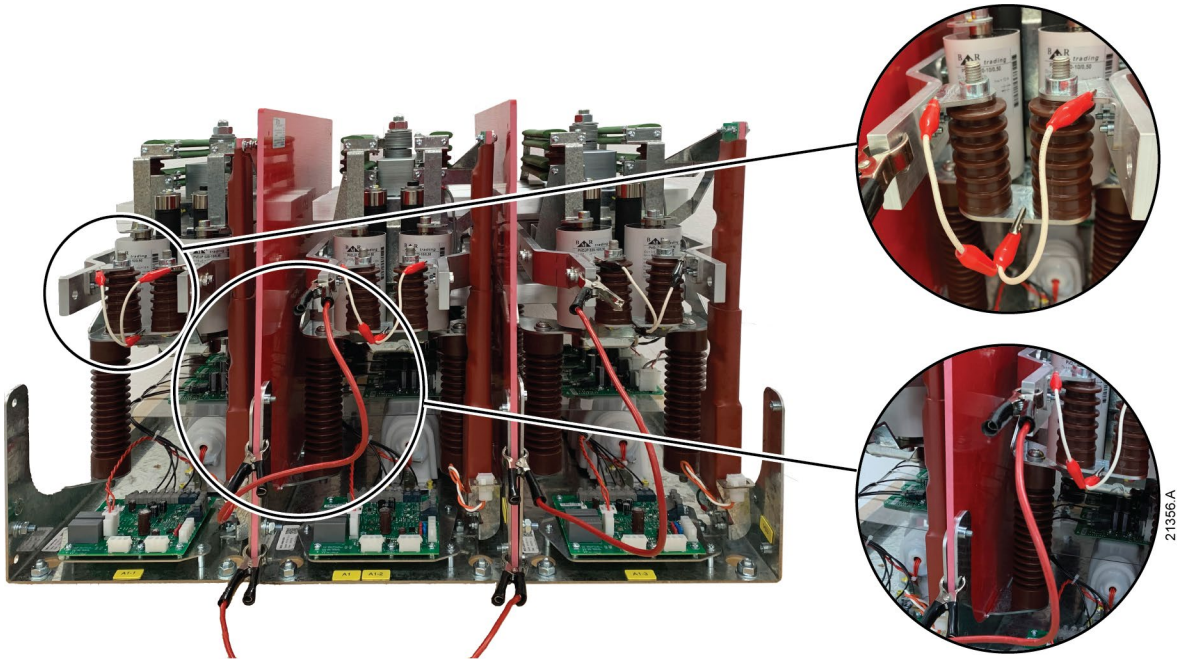
1. Prepare the soft starter:
    1. Connect a high voltage transformer to the starter as for the power frequency withstand test.
    2. Remove MV surge arrestors (if fitted).
    3. Short each phase of the main device input to output.
    4. Short each phase of the bypass device input to output.
    5. Short each phase arm input to output.
    6. Short every SCR, in pairs.
2. Perform the dielectric test:
    1. Connect the ground cable of the high potential tester to panel earth.
    2. Connect the live cable of the high potential tester to the soft starter busbars.
    3. Set the high potential tester for the correct testing voltage according to the mains voltage rating of the starter. For re-testing on site, reduce the standard test voltage by 20%.
    4. Apply PFW voltage to Phase A (B and C connected to ground) for 1 minute
    5. Apply PFW voltage to Phase B (A and C connected to ground) for 1 minute
    6. Apply PFW voltage to Phase C (A and B connected to ground) for 1 minute
    7. Discharge the unit by earthing high voltage parts.

There must be no disruptive discharge. Leakage current must be <30 mA. If the discharge is ≥30 mA, the test result is a fail.

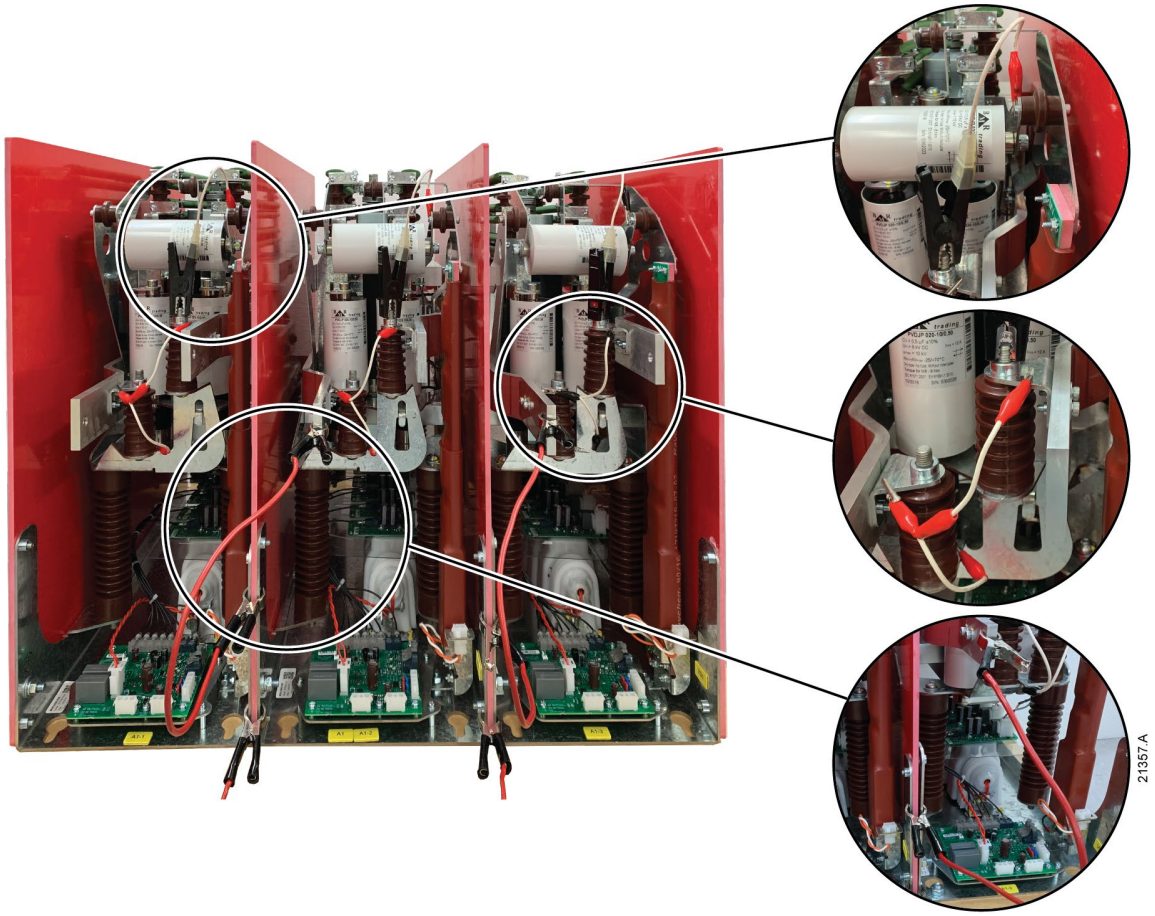
1. Restore the starter to operational condition:
    1. Remove all shorting connections.
    2. Refit the MV surge arrestors (if required).

WARNING – ELECTRICAL SHOCK HAZARD
If the soft starter is not discharged correctly, there is a risk of electrical shock.

- **Short SRCs in pairs: V04**



- **Short SRCs in pairs: V06**

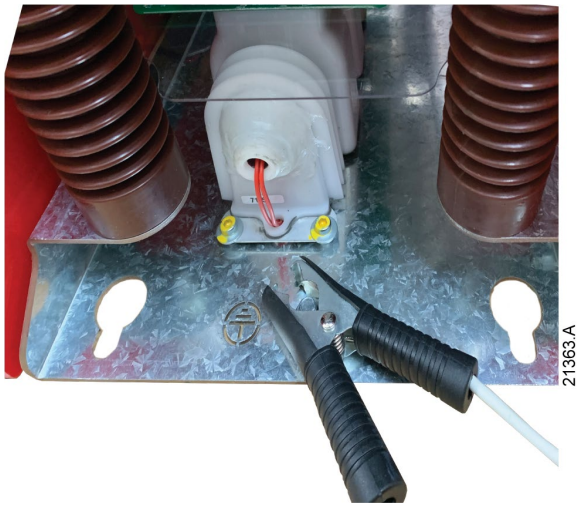


- **V11 ~ V13**

For detailed instructions, contact your local supplier.

- **Connection points: voltage input and earth**


21362.A


21363.A

11 Troubleshooting

The soft starter provides extensive information to help the operator diagnose and remedy any operating difficulties.

In addition to the motor and load protection features already described, the soft starter reports in detail on the starter's own state. Any internal failure will cause the soft starter to trip, and full details will be recorded in the Trip Log and Event Log.

11.1 Protection Responses

When a protection condition is detected, the soft starter will write this to the event log and may also trip or issue a warning. The soft starter's response depends on the Protection Action setting (parameter group 16).

Some protection responses cannot be adjusted by the user. These trips are usually caused by external events (such as phase loss) or by a fault within the soft starter. These trips do not have associated parameters and cannot be set to Warn or Log.

If the soft starter trips you will need to identify and clear the condition that triggered the trip, then reset the soft starter before restarting. To reset the starter, press the **RESET** button on the controller or activate the Reset remote input.

If the soft starter has issued a warning, the soft starter will reset itself once the cause of the warning has been resolved.

Summary of soft starter responses to protection events

Protection response setting	Response actions			
	LED "Trip"	Trip relay output (parameters 7A, 7D, 7G = 'Trip')	Write to event log	Write to trip log
Trip Starter	On	Yes	Yes	Yes
Warn and Log	Flashing	No	Yes	No
Log Only	Off	No	Yes	No

11.2 Trip Messages

This table lists soft starter's protection mechanisms and the probable cause of the trip. Some of these can be adjusted using parameter group 3 Protection Settings and parameter group 16 Protection Action, other settings are built-in system protections and cannot be set or adjusted.

Display	Possible cause/Suggested solution
`Battery/clock`	A verification error has occurred on the real time clock, or the backup battery voltage is low. If the battery is low and the power is off, date/time settings will be lost. The soft starter will continue to soft start and soft stop correctly. Reprogram the date and time. The battery is not removable. In order to replace the battery, the main control PCB must be replaced. Related parameters: 16M
`Bypass fail`	The bypass contactor has welded closed or is not operating correctly. There may be a problem with the control circuit or the contactor coil. Check the condition of the bypass contactor's main poles. Check the operation of the contactor control circuitry and contactor coil. This trip is not adjustable.  **NOTE** You can use the Run Simulation to check the bypass contactor's operation without mains voltage connected.
`Controller`	This is a name selected for a programmable input. See Input A trip.

Display	Possible cause/Suggested solution
Current imbalance	Current imbalance can be caused by problems with the motor, the environment or the installation, such as: • An imbalance in the incoming mains voltage • A problem with the motor windings • A light load on the motor • A phase loss on input terminals L1, L2 or L3 during Run mode • An SCR that has failed open circuit. A failed SCR can only be definitely diagnosed by replacing the SCR and checking the starter's performance. Related parameters: 4H, 4I, 16E
Current Read Err Lx	Where 'X' is 1, 2 or 3. Internal fault (PCB fault). The output from the CT circuit is not close enough to zero when the SCRs are turned off. Contact your local supplier for advice. Related parameters: None
EEPROM fail	• An error occurred loading data from the EEPROM to RAM when the controller powered up. • "Load User Set" has been selected but no saved file is available. Reset the fault and then reload the default settings. If the problem persists, contact your local distributor. Related parameters: None
Excess start time	The motor was unable to accelerate to full speed in the time allowed. Excess start time trip can occur in the following conditions: • parameter 1A *Motor Full Load Current* is not appropriate for the motor • parameter 2D *Current Limit* has been set too low • parameter 2B *Start Ramp Time* has been set greater than the setting for 4A *Excess Start Time* • The motor may have experienced an abnormal increase in loading or might be jammed. Related parameters: 1A, 2B, 2D, 4A, 16B
Feeder Protection	This is a name selected for a programmable input. See Input A trip.
Field Trip	This is a name selected for a programmable input. See Input A trip.
Frequency	The mains frequency has gone beyond the specified range. Check for other equipment in the area that could be affecting the mains supply, particularly variable speed drives and switch mode power supplies (SMPS). If the soft starter is connected to a generator set supply, the generator may be too small or could have a speed regulation problem. Related parameters: 4J, 4K, 4L, 16F
Ground Fault	• Ground current (monitored through a dedicated current transformer) has exceeded the selected level. Test the insulation of the output cables and the motor. Identify and resolve the cause of any ground fault. • The starter may also report a ground fault trip if one phase is lost. Check the supply and the input and output connections at the starter and at the motor end. Related parameters: 4O, 4P, 16N
Heatsink overtemperature	The soft starter is operating at a dangerously high temperature. • Check if ventilation and cooling are adequate. • Reduce the number of consecutive starts by increasing the value set in parameter 4M *Restart Delay*. Related parameters: 4M
High Level	This is a name selected for a programmable input. See Input A trip.
High Pressure	This is a name selected for a programmable input. See Input A trip.
Input A trip Input B trip	The soft starter's programmable input is set to a trip function and has activated. Resolve the trigger condition. Related parameters: 6A, 6C, 6D, 6E, 6F, 6H, 6I, 6J

Display	Possible cause/Suggested solution
Instantaneous overcurrent	There has been a sharp rise in motor current, probably caused by a locked rotor condition (shearpin) while running. This may indicate a jammed load. A trip may also occur when a medium level fault current has been detected. This may indicate a system short circuit. Related parameters: 4E, 4F, 16D
Instantaneous overcurrent S2	There has been a sharp rise in output current, possibly caused by a short circuit condition. Identify and resolve the cause of the fault. Related parameters: 4U, 4V, 16D
Int Comms Fail	Communication has failed between the controller and the power interface board. • Check that the controller is receiving control voltage within the specified range (terminals A11, A12). • Check that the fibre-optic cables between the controller and the interface board are firmly connected. • Check that each fibre-optic cable is emitting light at the Rx end. This trip is not adjustable.
Interlock Trip	This is a name selected for a programmable input. See Input A trip.
Internal fault x	Where 'X' is a number. This trip is not adjustable. The soft starter has tripped on an internal fault. Contact your local supplier with the fault code (X).
Internal fault 94~ Internal fault 98	There has been an internal communication error within the soft starter. Remove then restore control power. This trip is not adjustable.
Internal fault 99~ Internal fault 101	There is a problem with the non-conduction fibre-optic connections. Internal Fault 99 corresponds to phase 1, Internal Fault 100 corresponds to phase 2, Internal Fault 101 corresponds to phase 3. • Check that the fibre-optic cable is properly connected between the non-conduction PCB on the phase arm and the non-conduction readback connector on the power interface board. • If the problem persists, replace the fibre-optic cable. This trip is not adjustable.
Internal fault 105	The power interface board is faulty or damaged. Replace the board. This trip is not adjustable.
Internal fault 106	The selected configuration for the CT ratio selection switches on the power interface board is not valid. • Check the DIP switch settings on the power interface PCB. This trip is not adjustable.
Internal fault 107	Mains voltage has been applied to the starter but no start signal has been received. • The starter will wait 5 seconds for a start signal, after mains voltage is applied. • The starter will wait 30 seconds after a stop signal, before checking for mains voltage. This trip is not adjustable.
L1-T1 shorted L2-T2 shorted L3-T3 shorted	During pre-start checks the starter has detected a shorted SCR as indicated. Isolate the heatsinks and measure the resistance across each SCR pair. The resistance of healthy SCRs should be approximately 100 kΩ per SCR pair. Related parameters: 6S
Low Control Volts	The soft starter has detected a drop in the internal control voltage. • Check the external control supply (A1, A2, A3) and reset the starter. If the external control supply is stable: • the 24 V supply on the main control PCB may be faulty; or • the bypass driver PCB may be faulty. Contact your local supplier for advice. This protection is not active in Ready state. Related parameters: None

Display	Possible cause/Suggested solution
Low Level	This is a name selected for a programmable input. See Input A trip.
Low Pressure	This is a name selected for a programmable input. See Input A trip.
Motor connection	There is a problem with the soft starter's connection to the motor. If only one phase is affected, the error message will indicate which phase (T1, T2, T3). • Ensure the motor is connected to terminals T1, T2, T3 using in-line (three wire) connection. The soft starter does not support inside delta (six wire) connection. • Check that the fibre-optic cables between the power interface board and the soft starter are firmly connected. • Check each output phase of the soft starter for power circuit continuity. This trip is not adjustable.
Motor Connection T1 Motor Connection T2 Motor Connection T3	The motor is not connected correctly to the soft starter. • Check individual motor connections to the soft starter for power circuit continuity. • Check connections at the motor terminal box. This trip is not adjustable.
Motor overload	The motor has reached its maximum thermal capacity. Overload can be caused by: • The soft starter protection settings not matching the motor thermal capacity • Excessive starts per hour or start duration • Excessive current • Damage to the motor windings Resolve the cause of the overload and allow the motor to cool. Related parameters: 1A, 1B, 1C, 1D, 4A, 6J **NOTE** Parameters 1B, 1C and 1D determine the trip current for motor overload protection. The default settings of parameters 1B, 1C and 1D provide Motor Overload Protection: Class 10, Trip Current 105% of FLA (full load amperage) or equivalent.
Motor Protection	This is a name selected for a programmable input. See Input A trip.
Motor Temperature	This is a name selected for a programmable input. See Input A trip.
Motor thermistor	The motor thermistor input has been enabled and: • The resistance at the thermistor input has exceeded 3.6 kΩ for more than one second. • The motor winding has overheated. Identify the cause of the overheating and allow the motor to cool before restarting. • The motor thermistor input has been opened. If thermistors have previously been connected to the soft starter but are no longer required, use the Thermistor Reset function to disable the thermistor. Related parameters: 6Q
Network communication	There is a network communication problem, or the network master may have sent a trip command to the starter. Check the network for causes of communication inactivity. Related parameters: 6M
No Flow	This is a name selected for a programmable input. See Input A trip.
Overvoltage	There has been a voltage surge on the mains. Causes can include problems with a transformer tap regulator or off-loading of a large transformer load. Related parameters: 5I, 5J, 6G
Phase sequence	The phase sequence on the soft starter's input terminals (L1, L2, L3) is not valid. Check the phase sequence on L1, L2, L3 and ensure the setting in parameter 4G is suitable for the installation. Related parameters: 4G, 6P
PLC	This is a name selected for a programmable input. See Input A trip.

Display	Possible cause/Suggested solution
Power loss	This trip is not adjustable. The starter is not receiving mains supply on one or more phases. Check that the main contactor closes when a start command is given, and remains closed until the end of a soft stop. Check the fuses. If testing the soft starter with a small motor, it must draw at least 10% of the starter's programmed FLC setting on each phase. Related parameters: None
Pump Fault	This is a name selected for a programmable input. See Input A trip.
Starter communication	There is a problem with the connection between the soft starter and the optional expansion card. Remove and reinstall the card. If the problem persists, contact your local distributor. Related parameters: None
Starter Disable	This is a name selected for a programmable input. See Input A trip.
Undercurrent	The motor has experienced a sharp drop in current, caused by loss of load. Causes can include broken components (shafts, belts or couplings), or a pump running dry. Related parameters: 5C, 5D, 6D
Undervoltage	Mains voltage has fallen below the level selected. Causes can include an undersized supply or adding a large load to the system. Related parameters: 5G, 5H, 6F
Vibration Alarm	This is a name selected for a programmable input. See Input A trip.
VZC Fail Px	Where 'X' is 1, 2 or 3. Internal fault (PCB fault). Contact your local supplier for advice. Related parameters: None

11.3 General Faults

This table describes situations where the soft starter does not operate as expected but does not trip or give a warning.

Symptom	Probable Cause
The soft starter does not respond to the **START** or **RESET** button on the controller.	• The soft starter may be in Remote control mode. When the soft starter is in Remote control mode, the Local LED on the starter is off. Press the **LCL/RMT** button once to change to Local control.
The soft starter does not respond to commands from the control inputs.	• The soft starter may be in Local control mode. When the soft starter is in Local control mode, the Local LED on the starter is on. Press the **LCL/RMT** button once to change to Remote control. • The control wiring may be incorrect. Check that the remote start, stop and reset inputs are configured correctly (see *Control Wiring* on page 18 for details). • The signals to the remote inputs may be incorrect. Test the signalling by activating each input signal in turn. The appropriate remote control input LED should activate on the controller. • If no external reset is connected, use parameter 6M to set the reset input to normally open or fit a link across terminals C41, C42 on the controller.

Symptom	Probable Cause
The soft starter does not respond to a start command from either the local or remote controls.	• The soft starter may be waiting for the restart delay to elapse. The length of the restart delay is controlled by parameter 4M *Restart Delay*. • The motor may be too hot to permit a start. If parameter 4N *Motor Temperature Check* is set to Check, the soft starter will only permit a start when it calculates that the motor has sufficient thermal capacity to complete the start successfully. Wait for the motor to cool before attempting another start. • The starter may be disabled via a programmable input. If parameter 6A is set to Starter Disable and there is an open circuit on C53, C54, the soft starter will not start. If there is no further need to disable the starter, close the circuit on the input. **NOTE** Parameter 6Q *Local/Remote* controls when the **LCL/RMT** button is enabled.
Motor does not reach full speed.	• If the start current is too low, the motor will not produce enough torque to accelerate to full speed. The soft starter may trip on excess start time. **NOTE** Make sure the motor starting parameters are appropriate for the application and that you are using the intended motor starting profile. If a programmable input is set to Motor Set Select, check that the corresponding input is in the expected state. • The load may be jammed. Check the load for severe overloading or a locked rotor situation.
Erratic motor operation.	• The SCRs in the soft starter require at least 5 A of current to latch. If you are testing the soft starter on a motor with full load current less than 5 A, the SCRs may not latch correctly.
Soft stop ends too quickly.	• The soft stop settings may not be appropriate for the motor and load. Review the soft stop settings. • If the motor is very lightly loaded, soft stop will have limited effect.
Remote start/stop command is overriding Auto-Stop settings when using remote two-wire control.	• Auto-Stop should only be used in remote mode with three-wire or four-wire control.
Parameter settings cannot be stored.	• Make sure you are saving the new value by pressing the **STORE** button after adjusting a parameter setting. If you press **EXIT**, the change will not be saved. • Check that the adjustment lock (parameter 15B) is set to *Read & Write*. If the adjustment lock is set to *Read Only*, settings can be viewed but not changed. You need to know the security access code to change the adjustment lock setting. • The EEPROM may be faulty on the controller. A faulty EEPROM will also trip the soft starter, and the controller will display the message Parameter Out Of Range. Contact your local supplier for advice.
ATTENTION! Remove Mains Volts	• The soft starter will not activate Run Simulation with three-phase power connected. This prevents unintentional direct on-line (DOL) start.
Current values shown on the display are incorrect.	• Check that the setting of the CT ratio selector DIP switch on the power interface board matches the ratio of the CT used.

12 Maintenance

12.1 Safety

NOTE
The soft starter is not user serviceable. The unit should only be serviced by authorised service personnel. Unauthorised tampering with the unit will void the product warranty.

Electrical shock risk

The voltages present in the following locations can cause severe electric shock and may be lethal:

- AC supply cables and connections
- Output cables and connections
- Many internal parts of the starter, and external option units

The AC supply must be disconnected from the starter using an approved isolation device before any cover is removed from the starter or before any servicing work is performed.

12.2 Maintenance Schedule

The table below lists the minimum maintenance requirements. Your maintenance program may include more frequent maintenance. In certain environmental conditions (such as dusty or humid environments), increase the frequency of maintenance to every year.

Part	Instructions	Timing
Filters	Check and clean	Every 3 months (every 6 weeks in dusty environments)
Control terminals	Check tightness	Every 2 years
Earthing terminals	Check tightness	Every 2 years
Cable lugs	Check tightness	Every 2 years
General soft starter	Cleanliness	Every 2 years

12.3 Tools required

Routine servicing requires the following tools:

- Allen keys (standard metric)
- 16 mm spanners
- 16 mm socket
- Torque wrench ≥20 Nm
- Torx drive screwdriver #20
- Small flat bladed screwdriver 3 mm
- Multimeter
- MV Insulation tester

12.4 Thermal Image

After completing commissioning of the soft starter and after the motor has been running fully loaded, take a thermal image of the busbars and other critical parts.

As part of the maintenance program, compare a recent thermal image with the post-commissioning image.

Perform the usual inspection for dust and debris.

13 Appendix

13.1 Parameter Defaults

If you require assistance from your supplier or a service technician, please note all parameter settings in the table below.

1	Primary Motor Settings	User Set 1	User Set 2	Default Value
1A	*Motor Full Load Current*			100 A
1B	*Locked Rotor Time*			00m:10s
1C	*Locked Rotor Current*			600% FLC
1D	*Motor Service Factor*			105%
2	**Start/Stop Modes-1**			
2A	*Start Mode*			Constant Current
2B	*Start Ramp Time*			00m:01s
2C	*Initial Current*			400% FLC
2D	*Current Limit*			400% FLC
2E	*Reserved*			
2F	*Kickstart Time*			0 ms
2G	*Kickstart Level*			500% FLC
2H	*Stop Mode*			Coast To Stop
2I	*Stop Time*			00m:00s
3	**Auto-Start/Stop**			
3A	*Reserved*			
3B	*Reserved*			
3C	*Auto-Stop Type*			Off
3D	*Auto-Stop Time*			00h:01m
4	**Protection Settings**			
4A	*Excess Start Time*			00m:20s
4B	*Excess Start Time-2*			00m:20s
4C	*Undercurrent*			20% FLC
4D	*Undercurrent Delay*			00m:05s
4E	*Instantaneous Overcurrent*			400% FLC
4F	*Instantaneous Overcurrent Delay*			00m:00s
4G	*Phase Sequence*			Positive Only
4H	*Current Imbalance*			30%
4I	*Current Imbalance Delay*			00m:05s
4J	*Frequency Check*			Run
4K	*Frequency Variation*			±5 Hz
4L	*Frequency Delay*			00m:05s
4M	*Restart Delay*			30m:00s
4N	*Motor Temperature Check*			Do Not Check
4O	*Ground Fault Level*			1 A
4P	*Ground Fault Delay*			00m:03s
4Q	*Undervoltage*			100 V
4R	*Undervoltage Delay*			00m:05s
4S	*Overvoltage*			7200 V
4T	*Overvoltage Delay*			00m:05s
4U	*Instantaneous Overcurrent S2*			4400 A
4V	*Instantaneous Overcurrent Delay S2*			10 ms
5	**Auto-Reset Trips (*Reserved*)**			
5A	*Reserved*			
6	**Inputs**			
6A	*Input A Function*			Input Trip (N/O)
6B	*Input A Name*			Input Trip
6C	*Input A Trip*			Always Active
6D	*Input A Trip Delay*			00m:00s

6E	*Input A Initial Delay*			00m:00s
6F	*Input B Function*			Input Trip (N/O)
6G	*Input B Name*			Input Trip
6H	*Input B Trip*			Always Active
6I	*Input B Trip Delay*			00m:00s
6J	*Input B Initial Delay*			00m:00s
6K	*Reserved*			
6L	*Reserved*			
6M	*Reset/Enable Logic*			Normally Closed (N/C)
6N	*Reserved*			
6O	*Reserved*			
6P	*Reserved*			
6Q	*Local/Remote*			LCL/RMT Anytime
6R	*Comms in Remote*			Enable Control in RMT
7	**Outputs**			
7A	*Relay A Function*			Main Contactor
7B	*Relay A On Delay*			00m:00s
7C	*Relay A Off Delay*			00m:00s
7D	*Relay B Function*			Run
7E	*Relay B On Delay*			00m:00s
7F	*Relay B Off Delay*			00m:00s
7G	*Relay C Function*			Trip
7H	*Relay C On Delay*			00m:00s
7I	*Relay C Off Delay*			00m:00s
7J	*Reserved*			
7K	*Reserved*			
7L	*Reserved*			
7M	*Low Current Flag*			50% FLC
7N	*High Current Flag*			100% FLC
7O	*Motor Temperature Flag*			80%
7P	*Analog Output A*			Current (% FLC)
7Q	*Analog A Scale*			4-20 mA
7R	*Analog A Maximum Adjustment*			100%
7S	*Analog A Minimum Adjustment*			0%
7T	*Reserved*			
7U	*Reserved*			
7V	*Reserved*			
7W	*Reserved*			
8	**Display**			
8A	*Language*			English
8B	*F1 Button Action*			Setup Auto-Start/Stop
8C	*F2 Button Action*			None
8D	*Display A or kW*			Current
8E	*User Screen - Top Left*			Starter State
8F	*User Screen - Top Right*			Blank
8G	*User Screen - Bottom Left*			kWh
8H	*User Screen - Bottom Right*			Hours Run
8I	*Graph Data*			Current (% FLC)
8J	*Graph Timebase*			10 seconds
8K	*Graph Maximum Adjustment*			400%
8L	*Graph Minimum Adjustment*			0%
8M	*Mains Reference Voltage*			400 V
9	**Motor Data-2**			
9A	*Reserved*			
9B	*Motor FLC-2*			100 A

9C	*Reserved*			
9D	*Reserved*			
9E	*Reserved*			
10	**Start/Stop Modes-2**			
10A	*Start Mode-2*			Constant Current
10B	*Start Ramp-2*			00m:01s
10C	*Initial Current-2*			400% FLC
10D	*Current Limit-2*			400% FLC
10E	*Reserved*			
10F	*Kickstart Time-2*			0 ms
10G	*Kickstart Level-2*			500% FLC
10H	*Stop Mode-2*			Coast To Stop
10I	*Stop Time-2*			00m:00s
11	**RTD/PT100 (*Reserved*)**			
11A	*Reserved*			
12	**Slip-Ring Motors**			
12A	*Motor Data-1 Ramp*			Single Ramp
12B	*Motor Data-2 Ramp*			Single Ramp
12C	*Changeover Time*			150 ms
12D	*Slip Ring Retard*			50%
15	**Advanced**			
15A	*Access Code*			0000
15B	*Adjustment Lock*			Read & Write
15C	*Emergency Run*			Disable
16	**Protection Action**			
16A	*Motor Overload*			Trip Starter
16B	*Excess Start Time*			Trip Starter
16C	*Undercurrent*			Trip Starter
16D	*Instantaneous Overcurrent*			Trip Starter
16E	*Current Imbalance*			Trip Starter
16F	*Frequency*			Trip Starter
16G	*Input A Trip*			Trip Starter
16H	*Input B Trip*			Trip Starter
16I	*Motor Thermistor*			Trip Starter
16J	*Starter Communication*			Trip Starter
16K	*Network Communication*			Warn and Log
16L	*Reserved*			
16M	*Battery/Clock*			Warn and Log
16N	*Ground Fault*			Trip Starter
16O	*Reserved*			
16P	*Reserved*			
16Q	*Reserved*			
16R	*Reserved*			
16S	*Reserved*			
16T	*Reserved*			
16U	*Reserved*			
16V	*Undervoltage*			Trip Starter
16W	*Overvoltage*			Trip Starter
20	**Restricted**			

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