INSTRUCTION MANUAL

SIMOVAC-SSRVS and SIMOVAC-SSRVS-AR

Medium-voltage, solid-state, reduced-voltage controllers
77617000057

SIEMENS

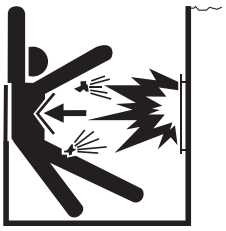
⚠ DANGER

Hazardous voltages and high-speed moving parts.

Will cause death, serious injury, or property damage.

Always de-energize and ground the equipment before maintenance. Read and understand this instruction manual before using equipment. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which will cause death, severe injury or equipment damage. Follow all safety instructions contained herein.

Type SIMOVAC non-arc-resistant and type SIMOVAC-AR arc-resistant controllers



⚠ DANGER

Arc flash and explosion hazard.

Will cause death, serious injury or property damage.

No equipment can completely eliminate the risk of arc flash.

SIMOVAC-AR equipment is not arc-resistant unless all of the following conditions are met:

1. All pressure relief devices are free to operate as designed.
2. The fault energy available to the equipment does not exceed the internal arcing short-circuit current rating and rated arcing duration of the equipment.
3. There are no obstructions around the equipment that could direct the arcing exhaust products into an area intended to be protected.
4. The equipment is installed in accordance with the information in the instruction manuals and drawings.

Type SIMOVAC-AR arc-resistant controllers

Important

The information contained herein is general in nature and not intended for specific application purposes. It does not relieve the user of responsibility to use sound practices in application, installation, operation, and maintenance of the equipment purchased. Siemens reserves the right to make changes in the specifications shown herein or to make improvements at any time without notice or obligation. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material or both, the latter shall take precedence.

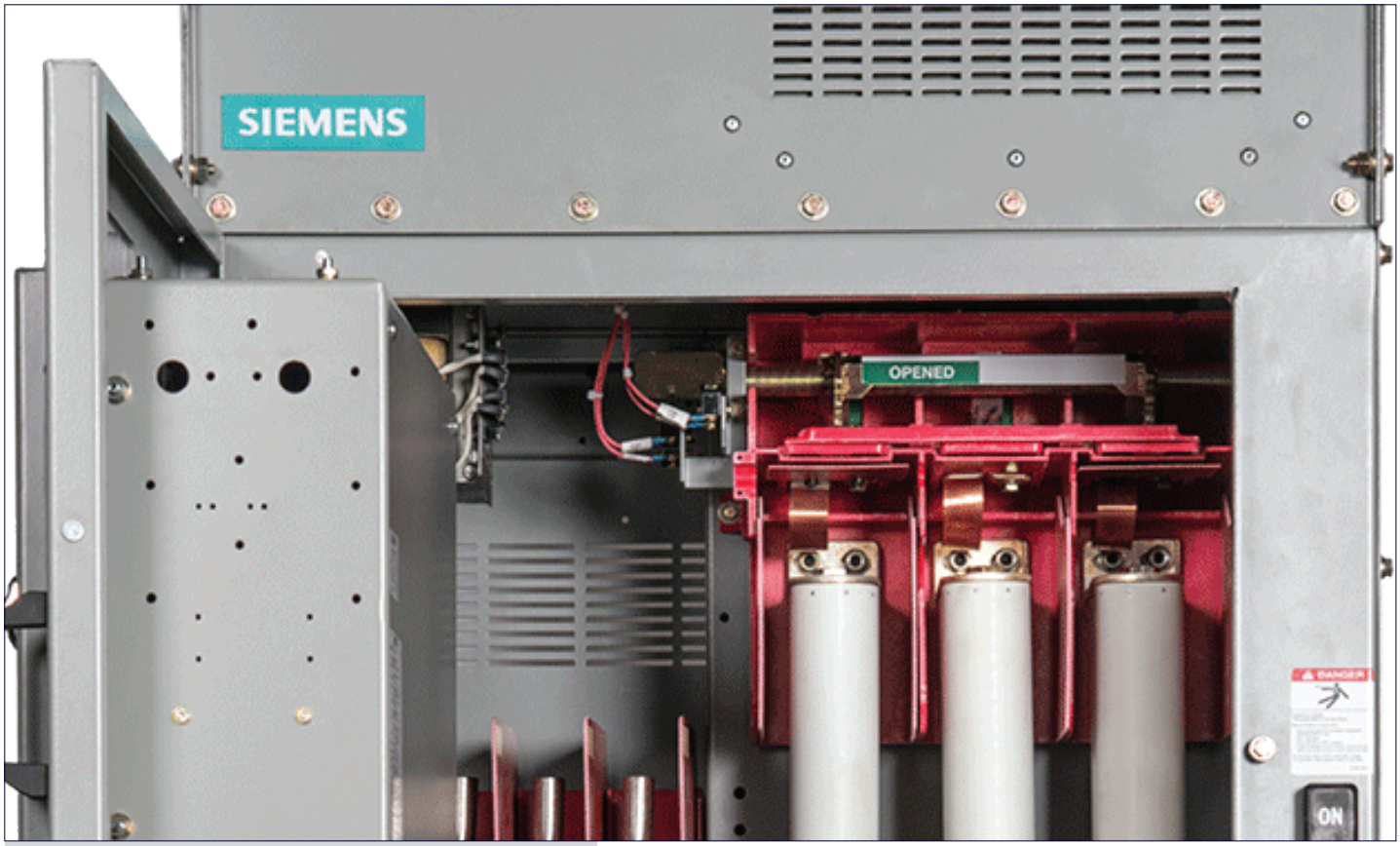
Qualified person

For the purpose of this instruction manual a qualified person is one who has demonstrated skills and knowledge related to the installation, construction, and operation of the equipment and the hazards involved. In addition, this person has the following qualifications:

- **Is trained** and authorized to de-energize, clear, ground and tag circuits and equipment in accordance with established safety procedures.
- **Is trained** in the proper care and use of protective equipment, such as: rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc. in accordance with established safety practices.
- **Is trained** in rendering first aid.

Further, a qualified person shall also be familiar with the proper use of special precautionary techniques, personal protective equipment, insulation and shielding materials, and insulated tools and test equipment. Such persons are permitted to work within limited approach of exposed live parts operative at 50 volts or more, and shall, at a minimum, be additionally trained in all of the following:

- The skills and techniques necessary to distinguish exposed energized parts from other parts of electric equipment.
- The skills and techniques necessary to determine the nominal voltage of exposed live parts.
- The approach distances specified in NFPA 70E® and the corresponding voltages to which the qualified person will be exposed.
- The decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely.



Note:
These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise that are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local sales office.

The contents of this instruction manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens Industry, Inc. The warranty contained in the contract between the parties is the sole warranty of Siemens Industry, Inc. Any statements contained herein do not create new warranties or modify the existing warranty.

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Introduction

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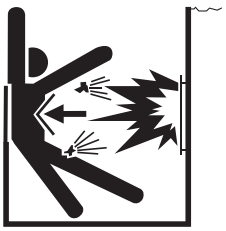
Type SIMOVAC-SSRVS™ non-arc-resistant and type SIMOVAC-AR™ arc-resistant controllers



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3. There are no obstructions around the equipment that could direct the arcing exhaust products into an area intended to be protected.
4. The equipment is installed in accordance with the information in the instruction manuals and drawings.

Type SIMOVAC-SSRVS-AR™ arc-resistant controllers

Introduction

The SIMOVAC family of medium-voltage controller equipment is designed to meet all applicable UL, CSA and NEMA standards.

The type SIMOVAC-SSRVS-AR equipment is classified as arc-resistant and has been tested for resistance to internal arcing in accordance with ANSI/IEEE C37.20.7.

Successful application and operation of this equipment depends as much upon proper installation and maintenance by the user as it does upon the proper design and fabrication by Siemens.

The purpose of this instruction manual is to assist the user in developing safe and efficient procedures for the installation, maintenance and use of the equipment.

Note: This instruction manual does not apply to medium-voltage switchgear or power circuit breakers, which may be provided in the same overall assembly. If the equipment includes switchgear or power circuit breakers, consult the instruction manual applicable to that equipment.

This instruction manual supplements the information in the instruction manual for the SIMOVAC and SIMOVAC-AR medium-voltage controllers provided in instruction manual IC1000-F320-A105-XX-XXXX.

Contact the nearest Siemens representative if any additional information is desired.

Signal words

The signal words “danger,” “warning” and “caution” used in this instruction manual indicate the degree of hazard that may be encountered by the user. These words are defined as:

Danger - Indicates an imminently hazardous situation that, if not avoided, **will** result in death or serious injury.

Warning - Indicates a potentially hazardous situation that, if not avoided, **could** result in death or serious injury.

Caution - Indicates a potentially hazardous situation that, if not avoided, **may** result in minor or moderate injury.

Notice - Indicates a potentially hazardous situation that, if not avoided, **may** result in property damage.

Hazardous procedures

In addition to other procedures described in this instruction manual as dangerous, the user must adhere to the following:

- Always work only on de-energized equipment. The equipment should be isolated, grounded and have all control power removed before performing any tests, maintenance or repair.
- Always let an interlock device or safety mechanism perform its function without forcing or defeating the device.

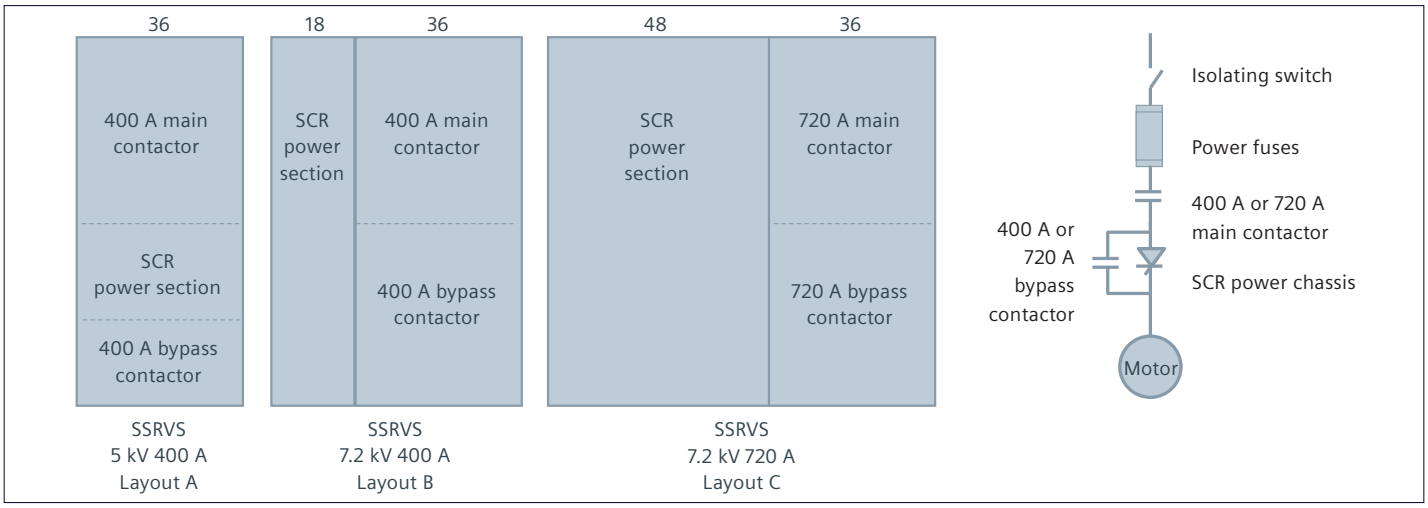
Field service operation and warranty issues

Siemens can provide competent, well-trained field service representatives to provide technical guidance and advisory assistance for the installation, overhaul, repair and maintenance of Siemens equipment, processes and systems. Contact regional service centers, sales offices or the factory for details, or telephone Siemens field service at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S.

For medium-voltage customer service issues, contact Siemens at +1 (800) 333-7421 or +1 (423) 262-5700 outside the U.S.

General description

Figure 1: SSRVS



General introduction

The SIMOVAC and SIMOVAC-AR controllers solid-state reduced-voltage starter (SSRVS)used in is an integrated system of vacuum contactors and components arranged for convenient access within a common enclosure consisting of one or more free-standing structural sections.

Each SSRVS controller is an assembly of one or more vertical sections, arranged as shown in Figure 1. Arrangements in Figure 1 and dimensions and other data in Table 1 are typical only, and the specific drawings for the actual equipment should be used for design and installation.

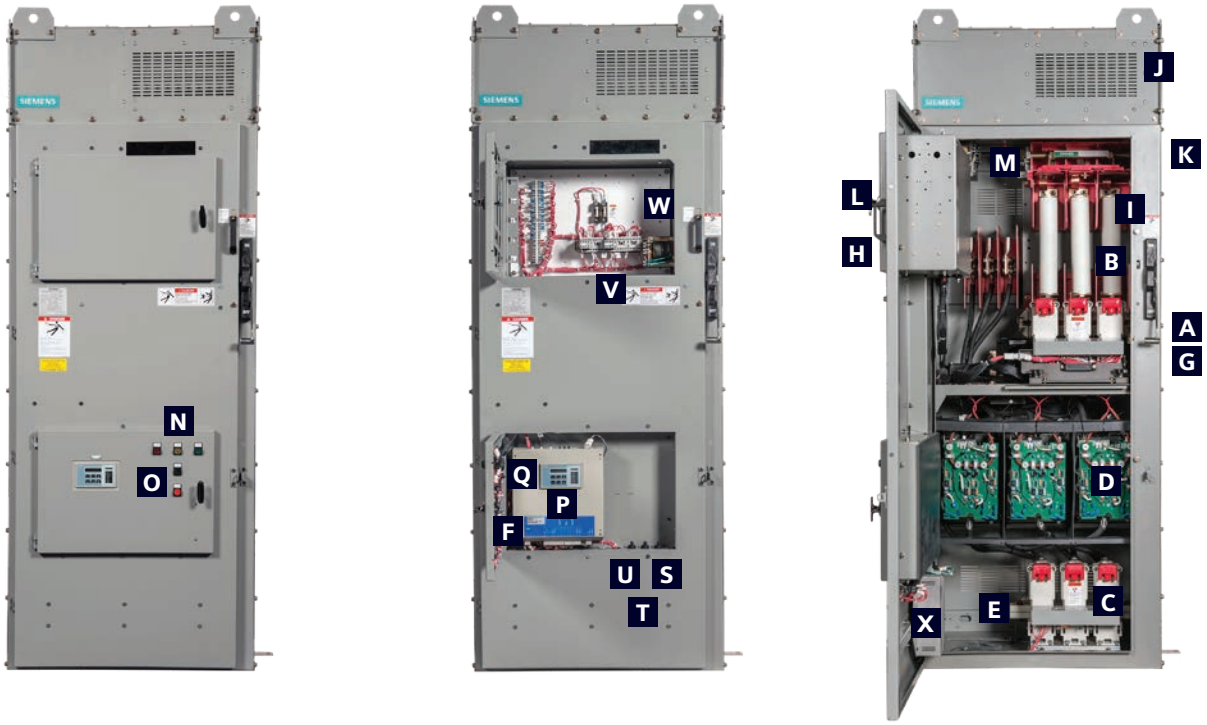
Table 1: SSRVS dimensions

Horse-power	Ampere rating A	Inter-rupting kA	Dimensions in inches (mm)[1, 8] Height[1]	Width	Depth[7]	Weight in lbs (kg)[2, 9]	Lay-out
2.3 kV to 2.4 kV							
600	155	63	95 (2,413)	36 (914)	30 (762)[3]	1,833 (832)	A
1,200	288	63	95 (2,413)	36 (914)	30 (762)[3]	1,833 (832)	A
1,500	400	63	95 (2,413)	36 (914)	30 (762)[3]	1,833 (832)	A
2,750	600	63	95 (2,413)	84 (2,134)	30 (762)[5]	3,453 (1,566)	C
3,000	720	50	95 (2,413)	84 (2,134)	30 (762)[5]	3,453 (1,566)	C
4.0 kV to 4.8 kV							
1,000	155	63	95 (2,413)	36 (914)	30 (762)[3]	1,833 (832)	A
2,250	288	63	95 (2,413)	36 (914)	30 (762)[3]	1,833 (832)	A
3,000	400	63	95 (2,413)	36 (914)	30 (762)[3]	1,833 (832)	A
4,500	600	63	95 (2,413)	84 (2,134)	30 (762)[5]	3,453 (1,566)	C
5,500	720	50	95 (2,413)	84 (2,134)	30 (762)[5]	3,453 (1,566)	C
6.6 kV to 6.9 kV							
2,000	155	63	95 (2,413)	54 (1,372)	30 (762)[4]	2,488 (1,128)	B
3,500	288	63	95 (2,413)	54 (1,372)	30 (762)[4]	2,488 (1,128)	B
5,000	400	63	95 (2,413)	54 (1,372)	30 (762)[4]	2,488 (1,128)	B
6,750	600	50	95 (2,413)	84 (2,134)	30 (762)[5]	3,453 (1,566)	C
8,600	720	50	95 (2,413)	84 (2,134)	30 (762)[5]	3,453 (1,566)	C

Footnotes:

1. Maximum shipping group is four vertical sections.
2. Weights are for complete controller in one or two vertical sections.
3. Add 455 lbs (205 kg) for SIMOVAC-AR arc-resistant controller.
4. Add 730 lbs (330 kg) for SIMOVAC-AR arc-resistant controller.
5. Add 1,140 lbs (517 kg) for SIMOVAC-AR arc-resistant controller.
6. Add 17" (432 mm) for height of SIMOVAC-AR arc-resistant controller (total 112" (2,845 mm)).
7. Add 10.5" (257 mm) for depth of SIMOVAC-AR arc-resistant controller (total 40.5" (1,029 mm)).
8. Add 6" (152 mm) width for single-section controller or 12" (304 mm) for two-section controller for outdoor (non-arc-resistant). Height increases to 107.3" (2,725 mm) and depth increases to 37.4" (950 mm).
9. Add 710 lbs (322 kg) for single-section controller (layout A), 1,420 lbs (644 kg) for two-section controller (layout B) or 1,750 lbs (794 kg) for two-section controller (layout C) for outdoor (non-arc-resistant).

Figure 2: SSRVS components (typical, up to 5.0 kV, 400 A shown)



Item	Description	Item	Description
A	Main contactor (plug-in shown)	M	Isolating switch limit switches (DST and DSI)
B	Medium-voltage main circuit fuses	N	Indicating lights (L/ON, L/OFF, L/BPC)
C	Bypass contactor	O	Pushbuttons (PB/start, PB/stop)
D	Silicon-controlled rectifier stack assembly with RC snubbers and firing boards	P	Soft-starter control module
		Q	Soft-starter digital control unit
E	Electronic potential transformer	R	Switches (local/remote SW/L-R or local/remote/ communications SW/L-R-C) (optional; not shown)
F	Switch mode power supply (behind Q)		
G	Current transformers (behind A)	S	SW/RUN-TEST switch
H	Load connections	T	SW/TF control switch
I	Mechanical and electrical interlocks (not shown)	U	SW/SS-DOL switch, soft start or direct on-line start
J	Main horizontal bus	V	Interposing relays (R/FT, R/SMPS, R/SS, R/AS, R/RS)
K	Isolating switch with isolating switch shutter	W	CPT-SMPS (24 Vac secondary voltage) for power control boards
L	Control power transformer (behind low-voltage compartment)	X	EPT/RX electronic potential transformer receiver

Each SSRVS is divided into medium-voltage and low-voltage compartments. Both compartments are accessible via the compartment individual door. In order to open the medium-voltage unit door, the vacuum contactor must be open, the isolating switch must be open (OFF), and the door unlatched. The low-voltage compartment door may be opened without disconnecting the power. The medium-voltage and low-voltage compartments are segregated by metal barriers.

Medium-voltage compartment components identification

The medium-voltage compartment contains the following main components (refer to Figure 2):

1. Main contactor compartment, including isolating switch and isolating switch shutter (item K)
2. Medium-voltage main contactor (item A)
3. Medium-voltage main fuses (quantity of 3) (item B)
4. Optional control power transformer (CPT) (up to 3.0 kVA) (item L)

5. Medium-voltage bypass contactor (BPC) (item C)
6. Silicon controlled rectifier (SCR) power stack assembly complete with RC snubbers and firing boards (item D)
7. Electronic potential transformer (EPT) (item E)
8. Switch mode power supply (SMPS) (item F)
9. Current transformers (CTs) (item G)
10. Main bus compartment (item J)
11. Load connections (item H)
12. Mechanical and electrical interlocks (item I)
13. DST and DSI are limit switches actuated by the movement of the isolating switch main shaft. DSI disconnects the CPT secondary when the isolating switch is opened. DST prevents operation of the main contactor from a test power source when the isolating switch is closed (item M).

The electrical power is distributed through the optional main horizontal bus, which extends the entire length of the controller. The main bus is located in the upper portion of the vertical section (item J).

If main bus is provided, vertical bus is provided to supply the controller. The vertical bus system supplies power through the medium-voltage isolating switch.

The horizontal and vertical bus systems are isolated from the front of the medium-voltage compartment by means of metal barriers.

Low-voltage door components Identification

The low-voltage compartment door allows access to the following main components (refer to Figure 2: SSRVS components (typical, up to 5.0 kV, 400 A shown) on page 7):

14. L/ON is the red lamp indicating the main contactor is closed (item N).
15. L/OFF is the green lamp indicating the main contactor is opened (item N).
16. L/BPC is the amber lamp indicating the bypass contactor is closed (item N).

Note: When all three lamps (L/ON, L/OFF and L/BPC) are illuminated, this indicates that the soft starter tripped either because of a fault indicated by the control module or from an internal motor protection initiated action.

17. PB/start is the start pushbutton initiating a local start command (item O).
18. PB/stop is the stop pushbutton initiating a local stop command (item O).
19. Control module is the soft starter control module that houses control boards and a CPU. The control module (item P) is installed inside the low-voltage compartment and the digital control unit (DCU) (item Q) is accessible on the low-voltage door.
20. Optional local/remote SW/L-R control switch or local/remote/communication SW/L-R-C control switch (item R not shown).
21. Optional resistance-temperature detectors (RTD) relay (not shown).

Low-voltage compartment components identification

The low-voltage compartment door may be opened without disconnecting the power. The functionality of switch mode power supply (item F) and firing boards (on item D) are confirmed by LEDs, that are connected on the SCR power stack assembly. The green LEDs confirm the switch mode power supply (item F) functionality and the red LEDs confirm individual firing channel functionality as well.

The low-voltage compartment contains the following main components (refer to Figure 2: SSRVS components (typical, up to 5.0 kV, 400 A shown) on page 7):

22. Provision for control voltage supply connection; terminals L and N. An optional CPT up to 3 kVA is available, and when supplied is located at item L.
23. SW/RUN-TEST is a two-position control test switch: test or normal operation positions (item S).
24. SW/TF is a two-position control switch: test SCR firing channels or off. The SW/RUN-TEST must be at test position to perform the SCR firing test (refer to Firing test procedure on page 90) (item T).
25. SW/SS-DOL is a two-position control switch: soft start or direct on line start (item U).

26. R/FT is an interposing relay controlled by the internal fault relay of the soft starter. The R/FT relay is energized only when the starter trips on a fault and the controller is energized. The normally closed contact is connected in series with the NC trip contact of the optional motor protection relay (MPR) or RTD relay (item V).
27. R/SMPS is an interposing relay controlled by the internal firing logic of the soft starter. The R/SMPS relay is energized only during the SCR firing process. The normally open contact is connected in series with the SMPS transformer that supplies 24 Vac to the switch mode power supply (SMPS) (item V).
28. CPT-SMPS (24 V ac secondary voltage) energizes the power supply power control boards (PCBs) that feed the firing PCBs in the power section. This is required only during soft start and soft stop periods (item W).
29. R/SS is an interposing relay controlled by the internal immediate relay of the soft starter. The R/SS relay is energized when starter is in any condition except for stop and de-energized at stop. Its normally open contact is used in series with MC contact to hold the main contactor MC energized during the soft stop process (item V).
30. R/AS is an interposing relay controlled by the internal end of acceleration relay. The R/AS relay is energized after the end of the starting process to close the BPC (item V).
31. R/RS is an interposing relay, that seals in the start condition. The R/RS relay is energized to start and run and deenergized to cause soft stop (item V).
32. EPT-RX is the electronic potential transformer/receiver. The EPTRX supplies the filtered 120 V ac three-phase signal to the control module (item E).

Control fuses

The soft starter includes control fuses with the conventional voltage sensing using an inductive voltage transformer.

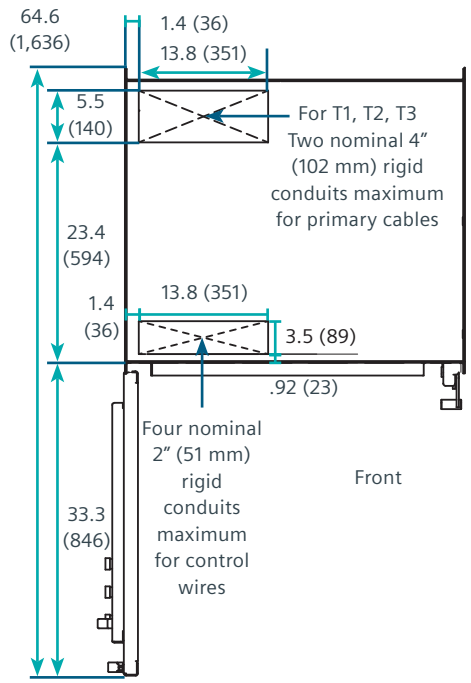
Two fuses are located in the low-voltage compartment. The 30 A fuse protects the control circuit with switch SW/RUN-TEST (item S) in RUN position. The 10 A fuse protects the control circuit with switch SW/T-S-T in TEST position.

Three fuses are located in the medium-voltage power section, one per phase. The control fuses are located at the smaller PCBs PC2075 (for 120 V ac and 240 V ac control voltage) or PC2076 (for 125 V dc control voltage). These fuses are connected at the input side of the firing switch mode power supplies and rated 10 A.

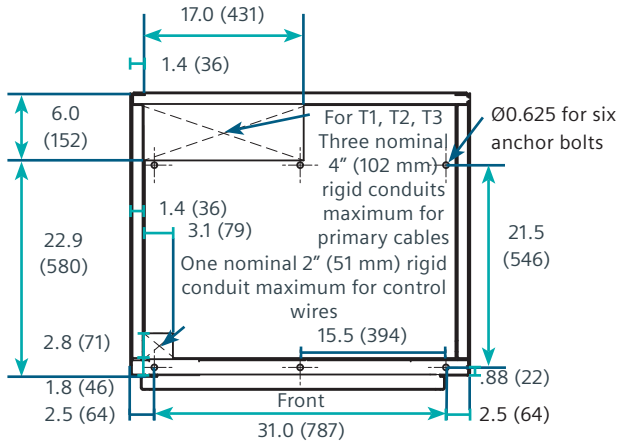
Notes: For 120 V ac and 240 V ac control voltages, a blown fuse will prevent firing only the affected phase. For 125 V dc control voltage, any blown fuse will prevent firing of all three phases.

One fuse and one spare control fuse are located in the low-voltage compartment, inside the input connector of the EPT-RX (item X).

Figure 3: SSRV controller, non-arc-resistant, 400 A, up to 5.0 kV

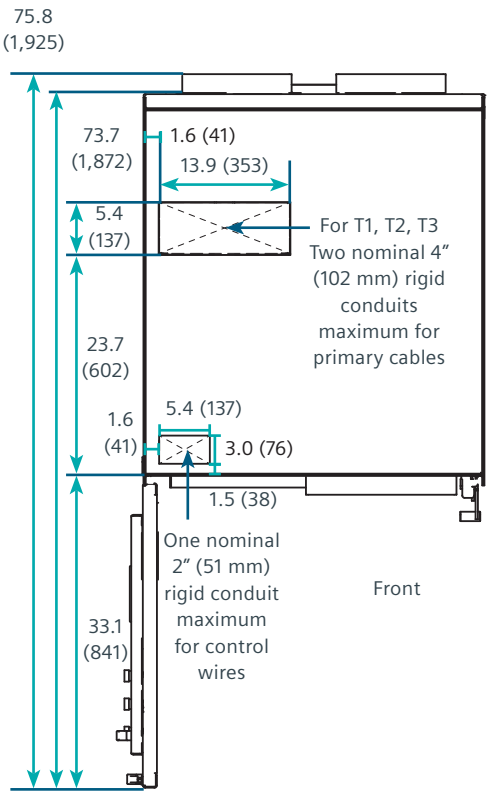


Top view

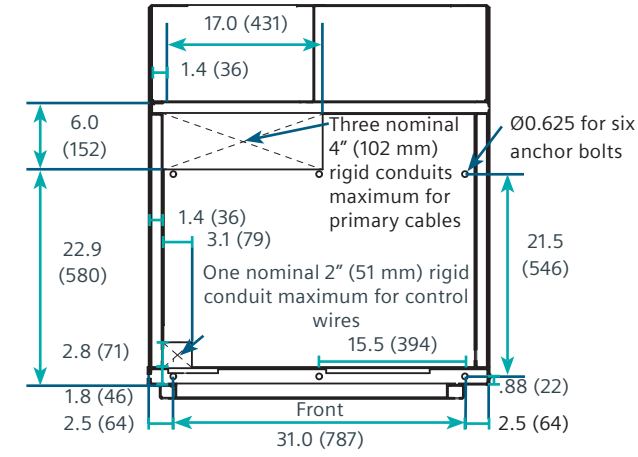


Floor plan

Figure 4: SSRV controller, arc-resistant, 400 A, up to 5.0 kV

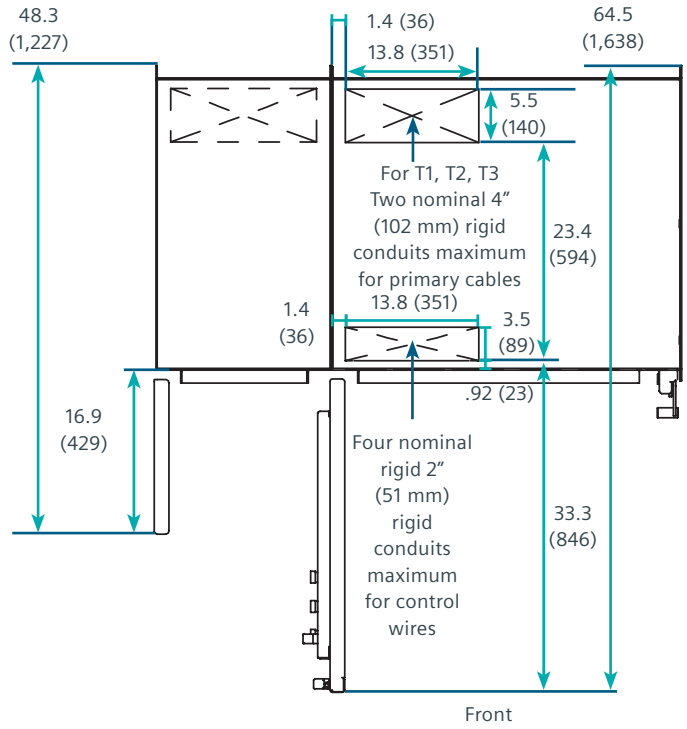


Top view

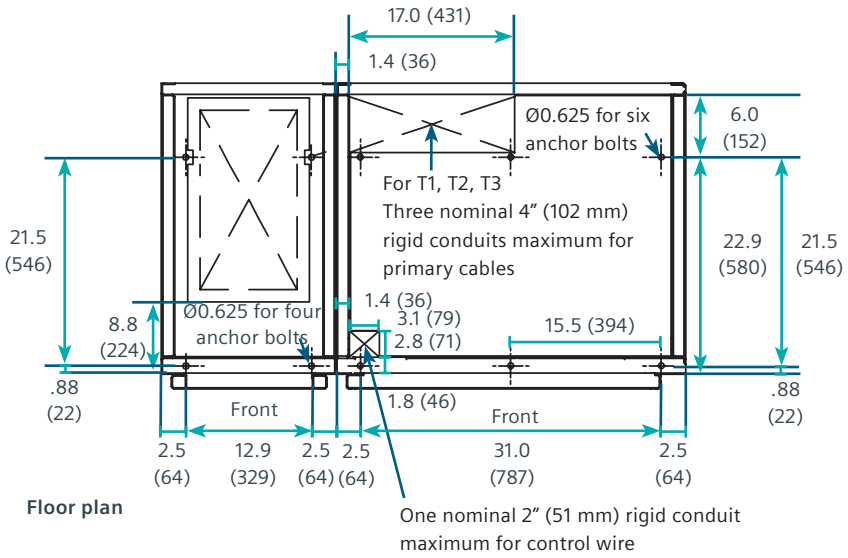


Floor plan

Figure 5: SSRV controller, non-arc-resistant, 400 A, above 5.0 kV up to 7.2 kV

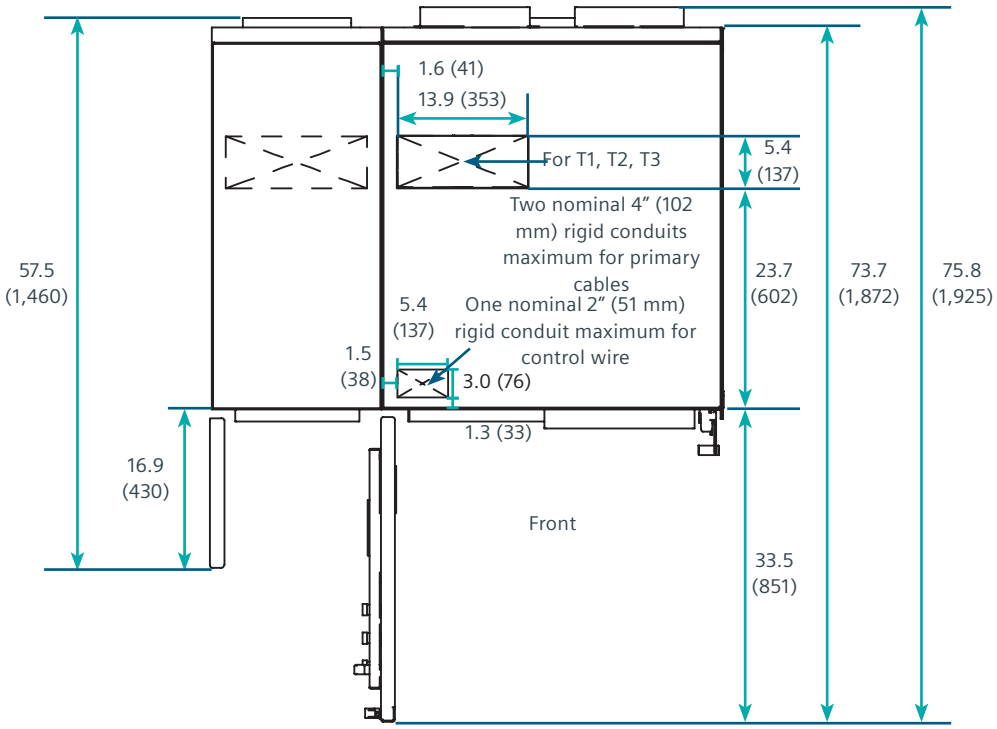


Top view

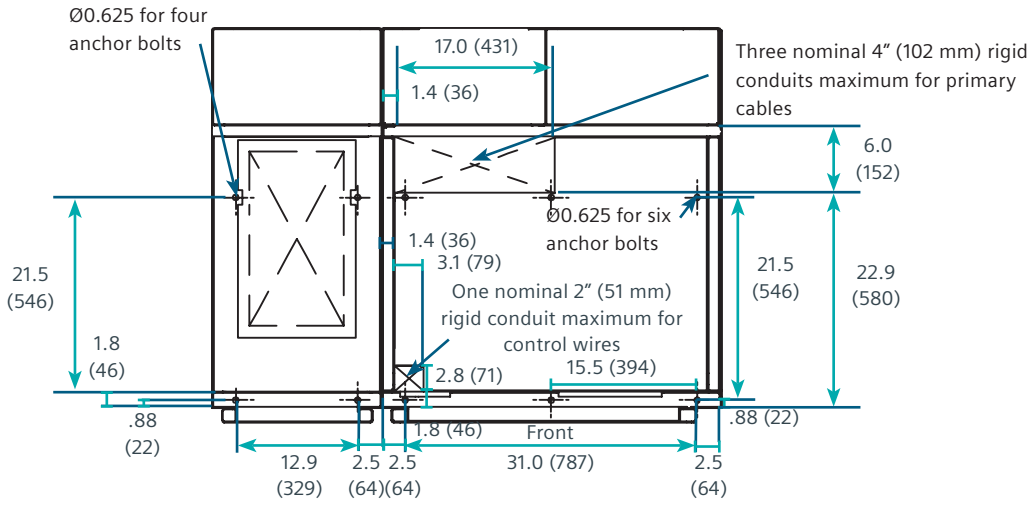


Floor plan

Figure 6: SSRV controller, arc-resistant, 400 A, above 5.0 kV up to 7.2 kV

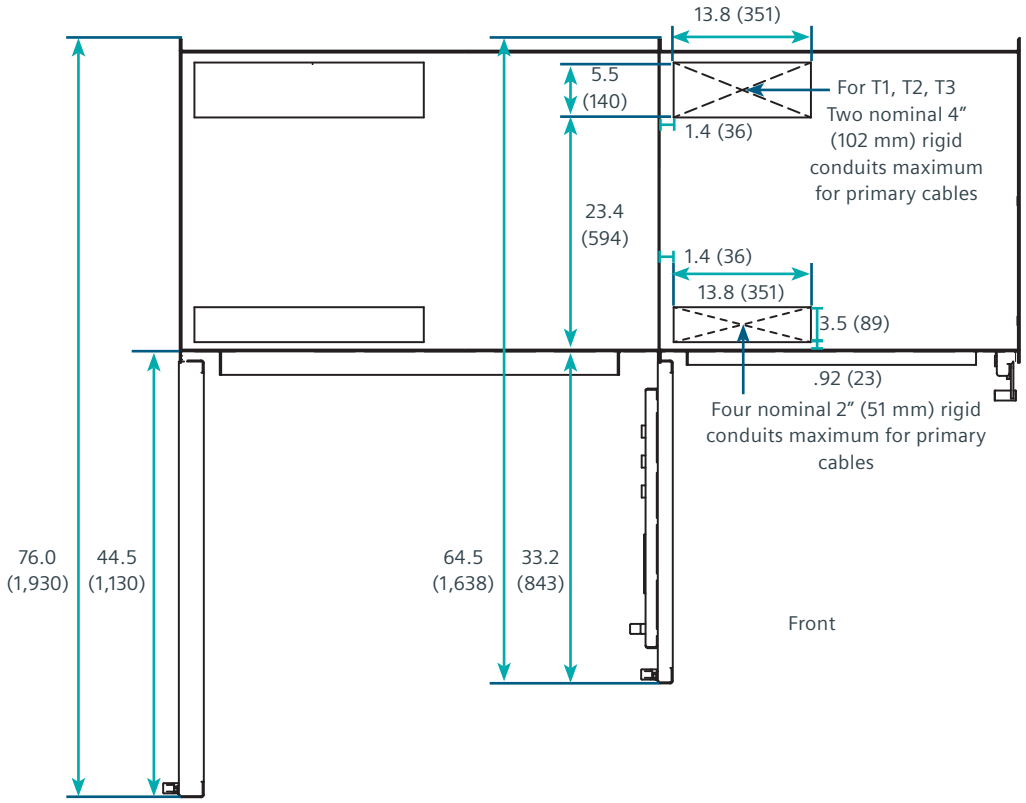


Top view

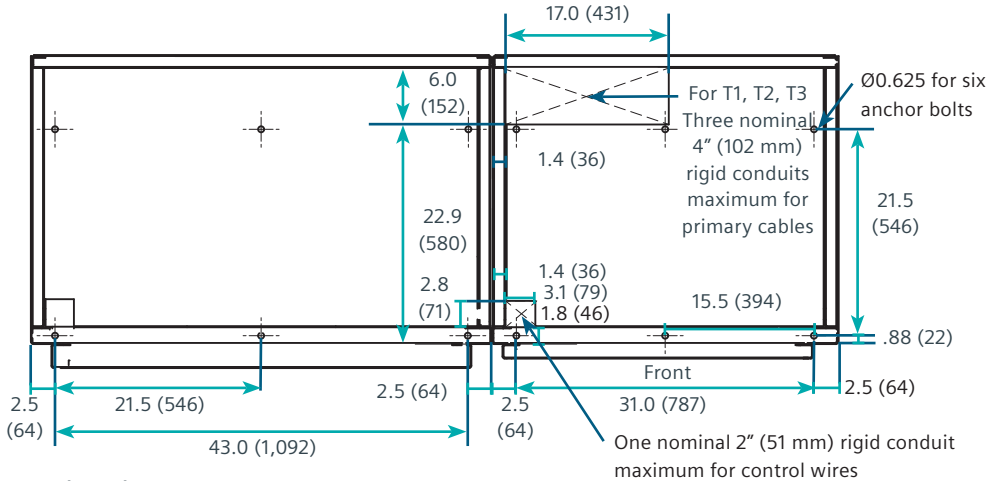


Floor plan

Figure 7: SSRV controller, non-arc-resistant, 720 A, up to 7.2 kV

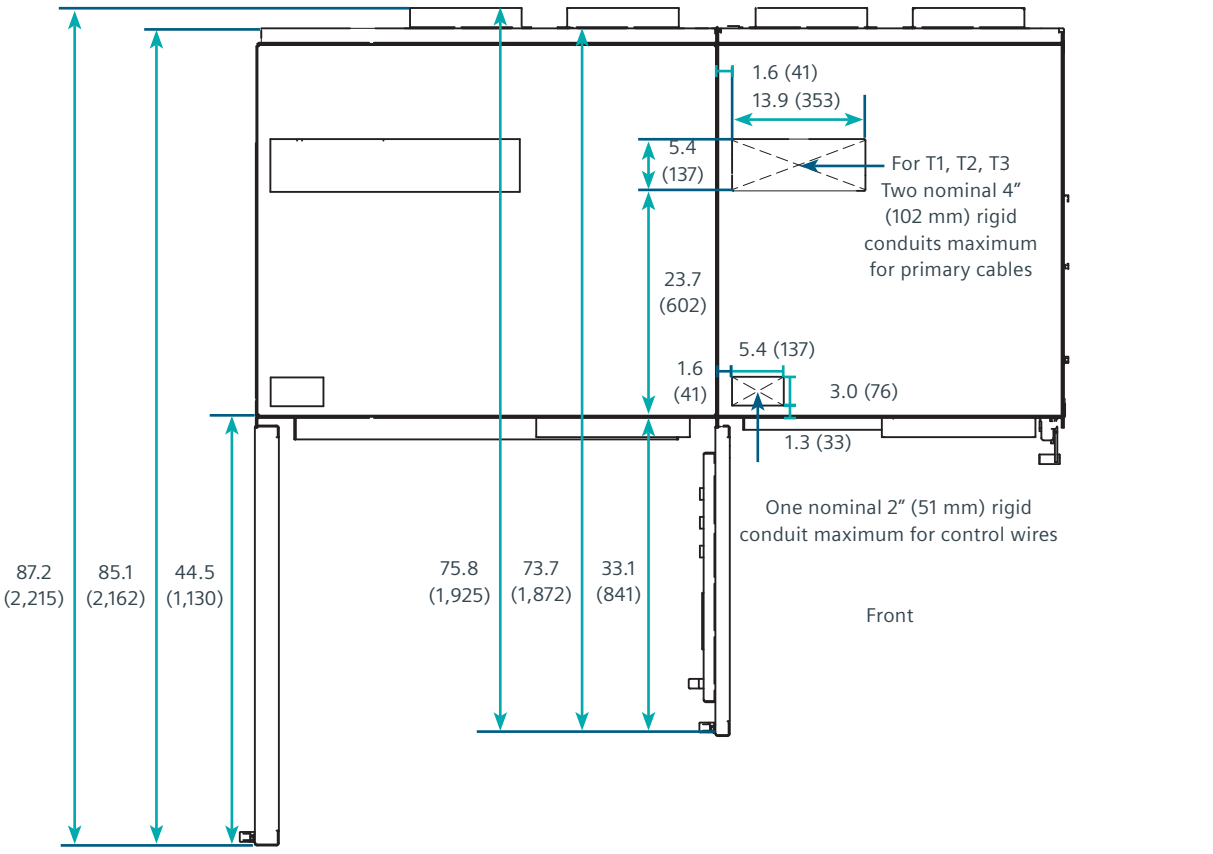


Top view

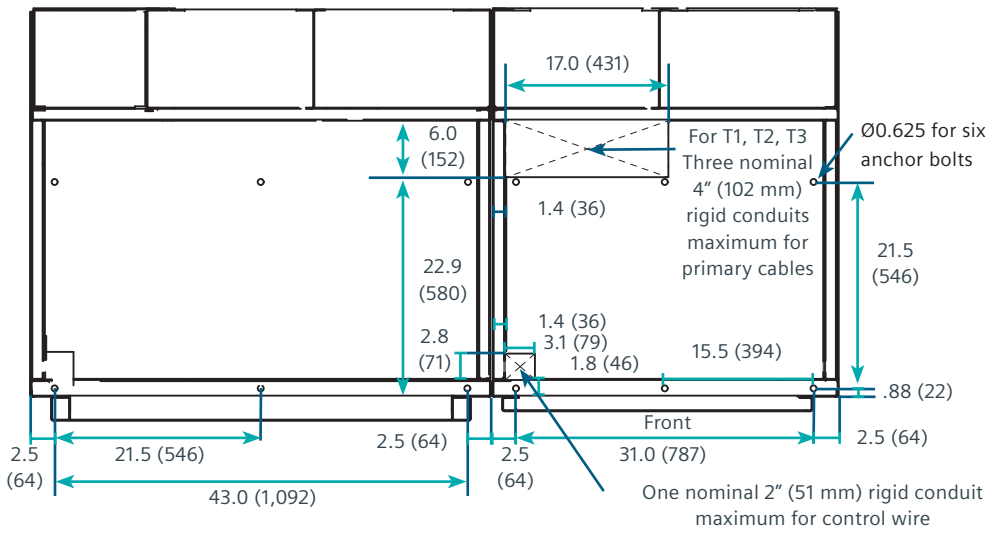


Floor plan

Figure 8: SSRV controller, arc-resistant, 720 A, up to 7.2 kV

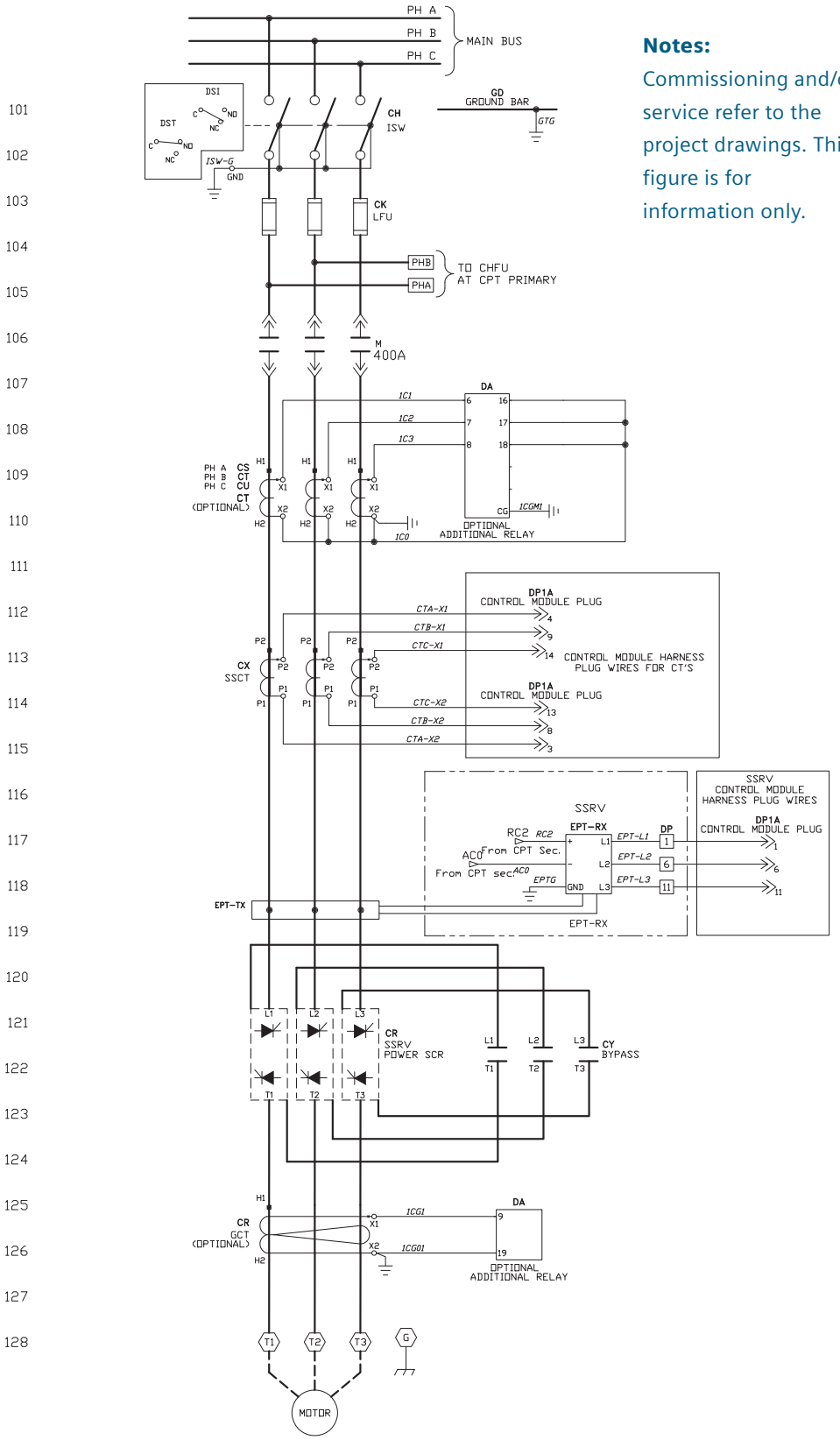


Top view



Floor plan

Figure 9: Typical one-line diagram (power and control schemes)

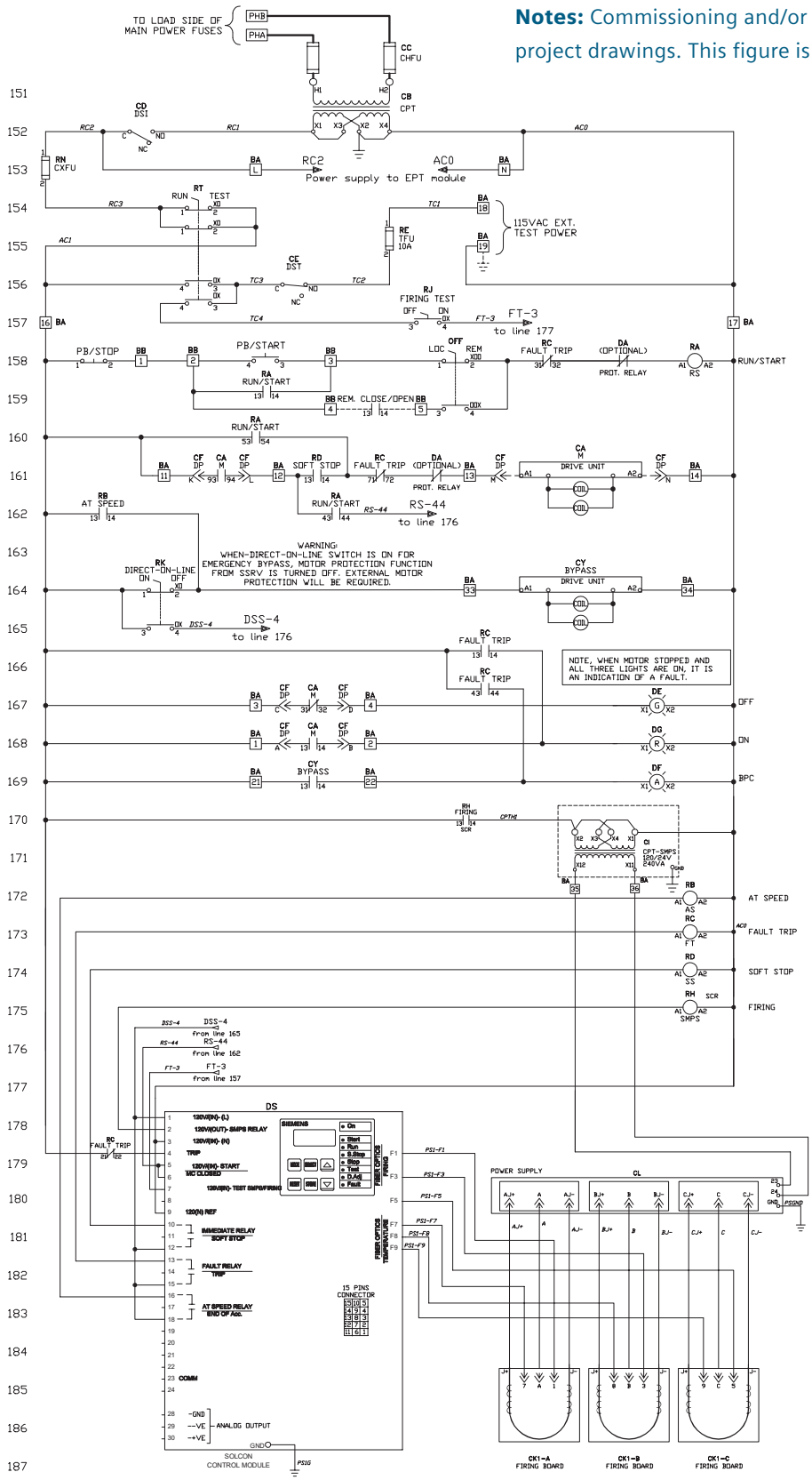


Notes:

Commissioning and/or service refer to the project drawings. This figure is for information only.

Figure 10: Typical one-line diagram (power and control schemes)

Notes: Commissioning and/or service refer to the project drawings. This figure is for information only.



Product specifications

The solid-state, reduced-voltage starter used in SIMOVAC and SIMOVAC-AR medium-voltage controllers is rated in accordance with the following technical data and as shown on the nameplate on the front of the enclosure.

The controllers employ medium-voltage contactors in combination with primary current-limiting fuses for overload and short-circuit protection.

The reduced-voltage starting is performed with SCR technology, that enables soft starting, protection and control of ac medium-voltage motors.

The control module uses phase-angle firing of the SCRs to apply a reduced voltage to the motor, and then gradually increases torque through control of the voltage and current until the motor accelerates to full speed. This starting method decreases the starting current of the motor, reducing electrical stresses on the power system and motor. It also reduces peak starting torque stresses on both the motor and load mechanical components, promoting longer service life and less downtime.

Service conditions

The controller should be used in the conditions shown for normal service conditions:

- Altitude: Less than 3,300 ft (1,000 m) - full ratings. For altitudes between 3,300 ft (1,000 m) and 6,600 ft (2,000 m), derate per Table 2. Above 6,600 ft (2,000 m), consult factory.
- Ambient temperature: +23 °F (-5 °C)minimum to +104 °F (+40 °C) maximum. Average over a period of 24 hours does not exceed +95 °F (+35 °C).
- Relative humidity: 45 percent minimum to 85-percent maximum, non-condensing.

If the controller is to be used in conditions other than those specified above, consult Siemens.

The location in which the controller is to be used should be free from dust, corrosive gas or moisture. When it is to be used in chemical facilities, in outdoor enclosures or in similar locations, take necessary precautions against corrosion, water seepage and condensation.

Table 2: Altitude correction factors for SSRVS starters in medium-voltage controllers

Altitude[1]	Continuous current	Dielectric withstand voltage
Up to 3,300 ft (1,000 m)	100%	100%
6,600 ft (2,000 m)	90%	90%
Above 6,600 ft (2,000 m)	Consult factory	Consult factory

Footnote:

1. For altitudes between 3,300 ft (1,000 m) and 6,600 ft (2,000 m), interpolate between the values shown in the table.

Table 3: General

Item	Details
Supply voltage	2,300 V, 4,160 V, 6,600 V
Maximum continuous current	Full-load amp (motor FLA) multiplied by service factor (SF)
Basic impulse level	60 kV crest excluding control transformer
Dielectric (power-frequency withstand)	Factory tested at 2.25 x nameplate voltage plus 2,000 V for one minute
SCR power stack P.I.V. rating	≥ three times rated voltage
SCR power stack thermal capacity	400% rated motor FLA for 30 seconds
Load	Three-phase, three-wire, squirrel-cage induction motor. Synchronous motor with asynchronous starting characteristics

Table 4: Start/stop parameters

Item	Details
Initial voltage	10% to 50% Vn (supply voltage)/(optional 5% to 85% range)
Current limit	100% to 400% of motor FLA (optional 100% to 700%)
Acceleration time	1 to 30 s (optional 1 to 90 s)
Deceleration time	0 to 30 s (optional 0 to 90 s)
Dual adjustments	Secondary start and stop characteristics for: • Motor FLA • Initial voltage • Current limit • Acceleration time • Deceleration time.
Tachometer and linear acceleration	12 field-selectable curves defining tachometer feedback gain improving linearity
Pump control curves	6 field-selectable curves including torque control curve preventing overpressure (water hammer) during stop operation
Pulse start level and duration	Adjustable level of pulse for an adjustable time 0 to 10 seconds, for starting high-friction load or holding constant current level

Table 5: SSRVS control power

Item	Details
Supply (to be specified)	115 V ac, 230 V ac, 50/60 Hz (+10%, -15%); 125 V dc (+10%, -15%)
Power consumption	350 VA during starting period and less than 20 VA when not starting
Auxiliary contact classification	NEMA A600/P600
Communication	RS-485 with Modbus or Profibus protocols

Table 6: Motor protection

Item	Details
Too many starts	Maximum number of starts range “OFF” or 1 to 10, during a time period 1 to 60 minutes
Starts inhibit	Time period 1 to 60 minutes, where starting is prevented after too many starts fault
Long start time (stall protection)	Maximum allowable starting time 1 to 30 s (optional 1 to 250 s)
Overcurrent (shear-pin)	Two operation functions: during starting trips the starter at 850% and running at 100% to 850% motor FLA; both within one cycle
Electronic overload	According to NEMA or IEC classes 5 to 30
Undercurrent	Trips when current drops below 20% to 90% motor FLA with a time delay of 1 to 40 s
Undervoltage (optional)	Trips when supply voltage drops below 50% to 90% of rated supply voltage Vn with a time delay of 1 to 10 s
Phase loss	Trips when one or two phases are missing
Phase sequence (can be disabled)	Trips when phase sequence is incorrect (reversed)
Incorrect connection and shorted SCR	Prevents starting, trips if motor is not connected or is incorrectly connected to the starter, or in case one or more SCRs have been shorted
Heat-sink over temperature	Trips when heat-sink temperature rises above +185 °F (+85 °C)
External fault 1	Trips when an external contact closes for 2 s
External fault 2	Trips when an external contact closes for 2 s
Unbalance current	Trips when current unbalance exceeds preset value for more than unbalance delay
Ground-fault current	Trips when ground-fault current exceeds preset level for more than ground fault delay
Power on and no start (can be disabled)	Trips when three-phase voltage is connected to the soft-starter input and start signal was not issued for more than 30 s
Bypass open (can be disabled)	Trips if the bypass contactor did not close properly

Control module

Table 7: Control module - typical connections description (refer to Figure 11 on page 24)

Item	Details	Remark
Terminal 1	Control voltage - phase (positive for dc control)	The control voltage operates the electronic circuitry and the auxiliary relay that controls the firing relay.
Terminal 2	Firing control	An internal relay connects the control voltage from terminal 1 to terminal 2 when firing is required during soft start and soft stop. Typically the external relay is controlled by this terminal connects the firing transformer that feeds the firing system.
Terminal 3	Control voltage - neutral (negative for dc control)	It is recommended terminals 1 and 3 be continuously connected to the control voltage.
Terminal 4	• Input - stop command • Input from a NC contact (i.e., from R/FT) • To stop the motor, disconnect control input voltage from terminal 4 for at least 250 ms (no soft stop)	Control input voltage (stop, soft stop, start, terminal inputs 7 and 8) can be the same as control supply (terminals 1 and 3) or voltage from a different source. The control inputs are opto-coupled and isolated from the microprocessor circuitry.
Terminal 5	• Input - soft stop command • Input from a NC contact • To soft stop the motor, disconnect control input voltage from terminal 5 for at least 250 ms	If soft stop is not required, connect a jumper between terminals 4 and 5.
Terminal 6	• Input - start command • Input from a N) contact • To soft stop the motor, connect the control input voltage to terminal 4 for at least 500 ms	Motor will start only if stop (terminal 4) and soft stop (terminal 5) are connected to control input voltage. To reset a fault, the start command must be removed (except for undercurrent protection). The soft starter ignores start within 3 s after stop. Wait at least 3 s before restarting but do not exceed allowable starts per hour allowed for the motor.
Terminal 7	Programmable input - test/reset/multi-soft stop	Refer to Control module - test/reset/multi-soft stop (input terminal 7) on page 26 and Terminal 7 programming on page 54. Multi-soft stop applicable when special software for multi-soft stop is ordered.
Terminal 8	Programmable input - dual adjustment/reset	Refer to Control module - dual adjust/reset (input terminal 8) on page 26 and Terminal 8 programming on page 54.
Terminal 9	Common to terminals 4 to 8	This terminal is a reference for terminals 1, 4, 5, 6, 7 and 8. When control supply and control input voltage are from the same source, connect a jumper between terminals 3 and 9.
Terminal 10	Programmable IMM/#STRT PREAL (NO)	IMM/#STRT PREAL is the immediate/number of starts pre-alarm output relay. Contact capacity: 8 A, 250 V ac, 2,000 VA. Selection between functions is made from the keypad or through the communication. Refer to Control module - immediate/number of starts - pre-alarm (output terminals 10, 11 and 13) on page 26 for IMM/#STRT PREAL programming.
Terminal 11	Programmable IMM/#STRT PREAL (NC)	
Terminal 12	Programmable IMM/#STRT PREAL (common)	

Table 7: Control module - typical connections description (refer to Figure 11 on page 24) (continued)

Item	Details	Remark
Terminal 13	Programmable fault output relay (NO)	Contact capacity: 8 A, 250 V ac, 2,000 VA. Contacts change position upon fault. The contact is programmable to function as fault or fault fail safe. When the fault function is selected, the relay is energized upon fault. The contact returns to its original position when one of the following conditions occurs: • The fault has been removed and the control module has been reset • Disconnection of control supply. When the fault-fail safe function is selected, the relay is energized immediately when the control supply is connected and de-energizes when one of the following conditions occurs: • Fault • Disconnection of control supply. Refer to Main and protection - DCU display page 1 on page 39 for fault relay type programming.
Terminal 14	Programmable fault output relay (NC)	
Terminal 15	Programmable fault output relay (common)	
Terminal 16	Programmable end of acceleration (run) output relay (NO)	Contact capacity: 8 A, 250 V ac, 2,000 VA. Contacts change position at end of acceleration, after an adjustable time delay (contact delay) 0 to 120 s. The contact returns to its original position on soft stop or stop signals, on fault condition or upon voltage outage. The end of acceleration contact (run) can be used for : • Closing a bypass contactor. Use an interposing relay. • Activating a valve after compressor has reaches full speed. • Loading a conveyor after motor reaches full speed. Refer to Start parameters - DCU display page 2 on page 43 and Special control for synchronous motor excitation on page 47 run contact delay programming.
Terminal 17	Programmable end of acceleration (run) output relay (NC)	
Terminal 18	Programmable end of acceleration (run) output relay (common)	
Terminal 19	External fault #1 input	Input from an NO contact that is connected between terminal 19 and a control input voltage that is referred to terminal 21. The soft starter will trip after the contact closes.
Terminal 20	External fault #2 input	Additional fault input, similar to terminal 19.
Terminal 21	Common to terminals 19 and 20	This terminal is a reference for terminals 19 and 20. When control supply voltage and control input voltage to the external faults input are the from the same source, connect a jumper between terminals 3 and 21.
Terminal 22		Standard RS-485; half-duplex with Modbus protocol, baud rate 1,200, 2,400, 4,600, and 9,600 BPS. Twisted shielded pair should be used. Connect shield to ground at the remote end. Terminals 4 and 5 must be wired to control supply for operation in communication mode. Up to 32 units can be connected for Modbus RS-485 communication. For reliable communication, units should be installed in the vicinity of 660 ft (200 m) maximum, from the first to the last unit. Refer to Modbus card on page 55 or to the communication document, FR-901-000-401.
Terminal 23	RS-485 communication (-) (optional)	
Terminal 24	RS-485 communication (+) (optional)	

Table 7: Control module - typical connections description (refer to Figure 11 on page 24) (continued)

Item	Details	Remark
Terminal 25	Programmable insulation alarm output relay (common) (optional)	Contact capacity: 8 A, 250 V ac, 2,000 VA. Relay is energized when the motor insulation level decreases below the insulation alarm level. The relay is de-energized and the alarm will disappear if one of the following conditions occurs: • The insulation level returns to normal for more than 60 s the soft starter resets. • Disconnection of control supply. Refer to Fault parameters on page 51. Insulation test can be performed only when main voltage is not connected to the soft starter (the upstream isolation device must be opened). For correct operation of the insulation test, it is important the soft starter is properly grounded and the control module is properly fastened to the power section. The insulation test option and analog output option cannot be applied together.
Terminal 26	Programmable insulation alarm output relay (NO)	
Terminal 27	Programmable insulation alarm output relay (NC) (optional)	
Analog ground terminal	Ground (optional)	Leave this terminal unconnected. Ground the shield of the analog output signal at the receiving (remote) side. Analog output (0 to 10 V dc or 0 to 20 mA or 4 to 20 mA) generates motor current signal. The signal is related to 2 x motor FLA. For example, full scale (10 V dc or 20 mA) is related to 2 x motor FLA or reflect motor power that is related to Pn. For instance, full scale (10 V dc or 20 mA) is related to motor rated power. Motor rated power is set in the main and protect parameter. Refer to Main and protection - DCU display page 1 on page 39.
Analog terminal out (-)	Analog output (-) (optional)	
Analog terminal out (+)	Analog output (+) (optional)	
Terminal 31	Start command output relay (NO) (optional)	Contact capacity: 8 A, 250 Vac, 2,000 VA. Contact closes upon start command via communication (Modbus or Profibus). The contact opens on soft stop or stop commands via communication (Modbus or Profibus). This contact is used to control the starter via the communication (for example, closing the main contactor).
Terminal 32	Start command output relay (NC) (optional)	
Terminal 33	Up to speed output relay (NO) (optional)	Contact capacity: 8 A, 250 Vac, 2,000 VA. Contact changes position at the end of acceleration after the current is reduced below a programmable current and a time delay. The up to speed relay remains unlatched until the motor stops. The up to speed relay is used to control the excitation system of a synchronous motor. Refer to Start parameter - DCU display page 2 on page 43 for run contact delay programming.
Terminal 34	Up to speed output relay (NC) (optional)	
Terminal 35	Start command output relay (common) (optional)	
D-9 connector	Profibus communication (optional)	Profibus DPV0 and DPV1, up to 12 MBPS. D-type 9-pin connector is applied. Control, monitoring and setting parameters can be achieved via the Profibus connections. Setting is possible only when DPV1 is implemented. Refer to DCU display page 7 - Profibus card on page 56 for programming.
Fiber-optic output #1	Phase L1 firing control via fiber-optic cable	
Fiber-optic output #3	Phase L2 firing control via fiber-optic cable	
Fiber-optic output #5	Phase L3 firing control via fiber-optic cable	
Fiber-optic input #7	Power SCR stack-temperature feedback signal from phase L1	
Fiber-optic input #8	Power SCR stack-temperature feedback signal from phase L2	
Fiber-optic input #9	Power SCR stack-temperature feedback s ignal from phase L3	

Table 7: Control module - typical connections description (refer to Figure 11 on page 24) (continued)

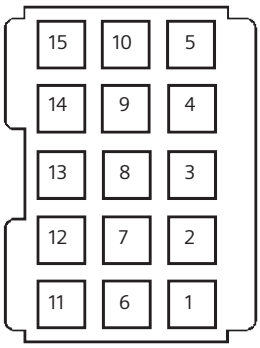
Item	Details	Remark
15-pin connector		Pin 1 - L1 voltage Pin 2 - No connection Pin 3 - CT-L1 (ground) Pin 4 - CT-L1 Pin 5 - No connection Pin 6 - L2 voltage Pin 7 - No connection Pin 8 - CT-L2 (ground) Pin 9 - CT-L2 Pin 10 - No connection Pin 11 - L3 voltage Pin 12 - No connection Pin 13 - CT-L3 (ground) Pin 14 - CT-L3 Pin 15 - no connection

Figure 11: Control module - front view/cover plate installed

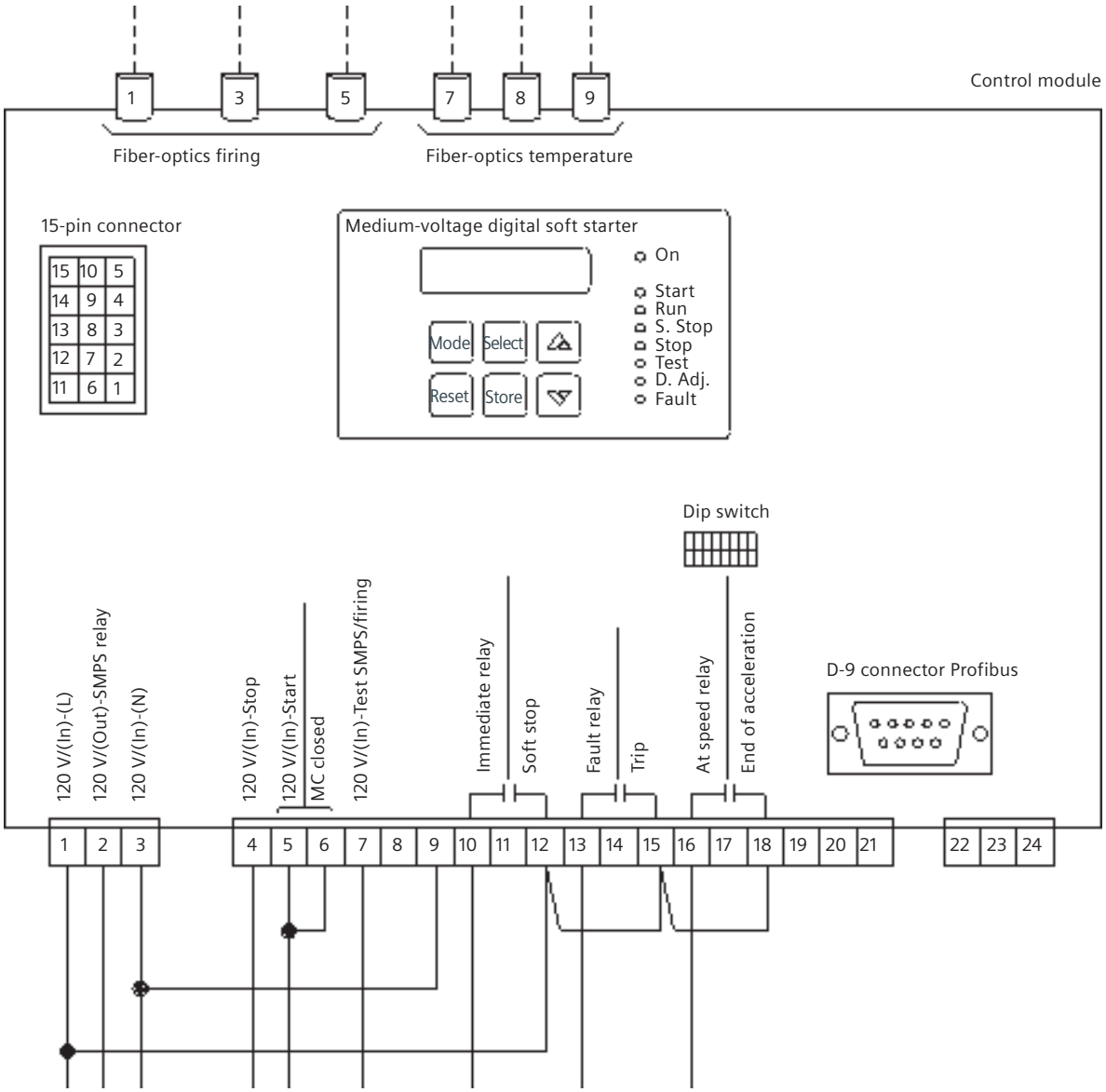
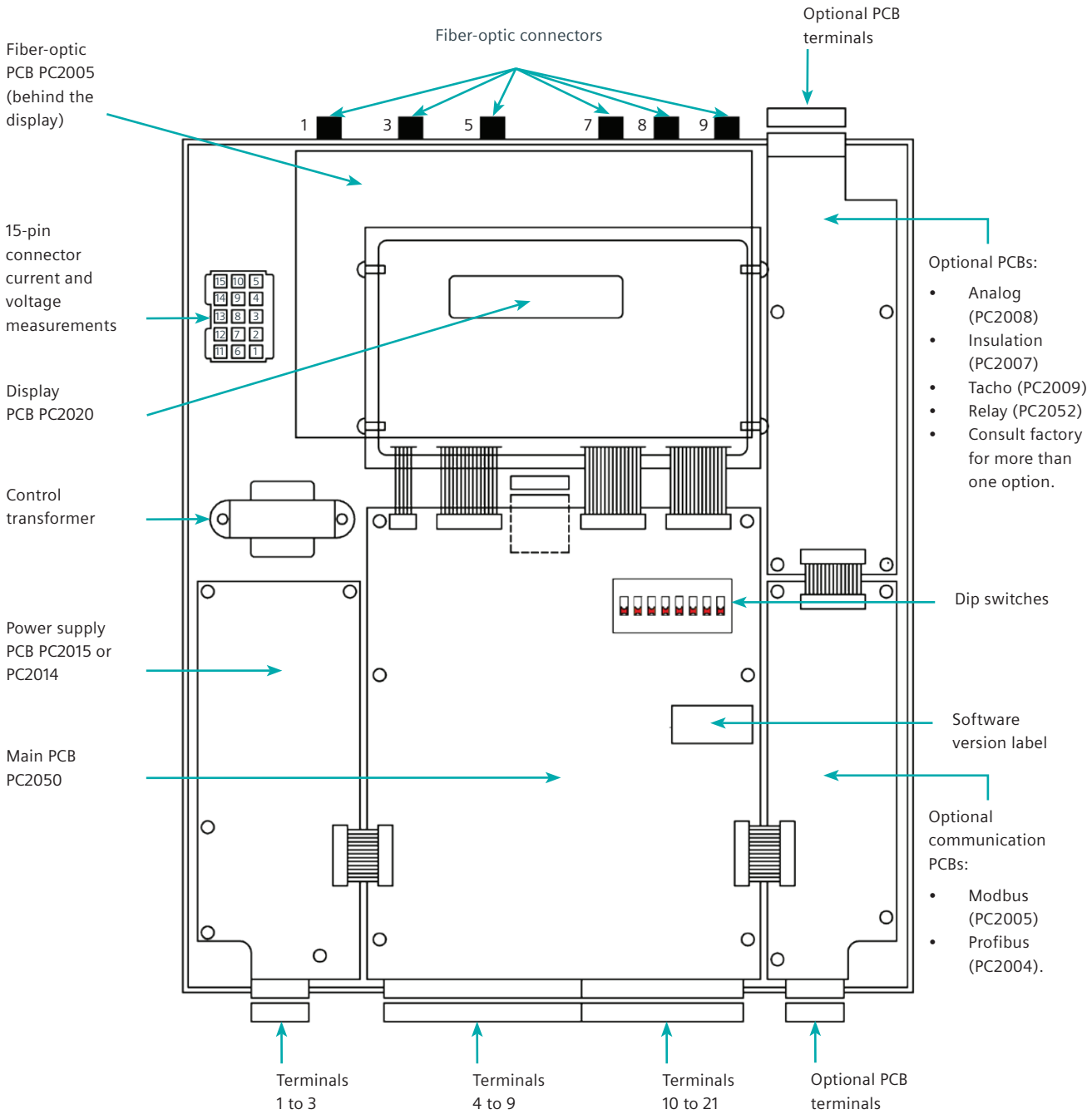


Figure 12: Control module - front view/cover plate removed



Control module – test/reset/multi-soft stop (input terminal 7) (refer to Figure 11: Control module - front view/cover plate installed on page 24)
Input from a NO contact for selection among test, reset and multi-soft stop functions is made from the keypad (refer to I/O programming parameters - DCU display page 6 on page 53) or through the communication Modbus or Profibus protocol.

When the reset function is selected, connect terminal 7 to control input voltage (use a NO momentary contact) to reset the soft starter.

When the test function is selected, connect terminal 7 to control input voltage (use a NO contact) to conduct a firing test to the soft starter. For more details on the firing test, refer to I/O programming parameters - DCU display page 6 on page 53 and Firing test page 90.

When the multi-soft stop optional function is selected, connect terminal 7 to control input voltage (use a NO contact) to operate the soft starter in a multi-soft stop procedure.

Control module - dual adjust/reset (input terminal 8) (refer to Figure 11: Control module - front view/cover plate installed on page 24)
Input from a NO contact for selection between dual adjust and reset functions is made from the keypad (refer to Dual-adjustment parameters - DCU display page 4 on page 50) or through the communication Modbus or Profibus protocol.

When the dual-adjustment function is selected - connect terminal 8 to control input voltage to operate the soft starter with the dual-adjustment characteristic. The dual-adjustment characteristic is programmed as explained in Dual-adjustment parameters - DCU display page 4 on page 50. The primary and dual-adjustment settings can be switched before and/or during starting.

When the reset function is selected - connect terminal 8 to control input voltage (use a NO momentary contact) to reset the soft starter.

Control module - immediate/number of starts pre-alarm (output terminals 10, 11 and 12) (refer to Figure 11: Control module - front view/cover plate installed on page 24)

Programmable functions
When immediate (after start signal) is selected, the relay is energized upon the start signal. The relay is de-energized when one of the following occurs:

- Fault
- Control supply outage
- Stop signal.

When soft stop is operated, the relay is de-energized at the end of the soft stop process.

The relay incorporates on and off delays of 0-3,600 s each.

The immediate relay can be used for the following purposes:

- Interlock with other systems
- Signalling
- Delay the opening of a main contactor at the end of soft stop, thus allowing current to decrease to zero before opening the vacuum contactor
- Switch to and from dual-adjustment settings with a time delay from the start signal (refer to section on special control for synchronous motor excitation on page 47).

When configured to # strts prealarm, the relay is energized if a start command will cause the soft starter to trip on too many starts.

Table 8: Control module - dip-switch settings

Switch number	Switch function	Switch off	Switch on
1	Display format	Minimized	Maximized
2	Tachometer	Disabled	Enabled
3	Must be off	—	—
4	Must be off	—	—
5	LCD language selection	Refer to tables 8 and 9	Refer to tables 8 and 9
6	LCD language selection	Refer to tables 8 and 9	Refer to tables 8 and 9
7	Extended settings	Disabled	Enabled
8	Software lock	Open	Locked

Control module - dip-switch settings on the main PCB (refer to Figure 12: Control module - front view/cover plate removed on page 25)

The dip switch has eight separate switches (refer to Table 8). It is located behind the front cover of the control module.

Switch #1 display modes (refer to Table 9)

Two display modes are available:

- Maximized – display of all possible parameters
- Minimized – display of pre-selected parameters.

Setting switch #1 to “off” will minimize the LCD displays.

Table 9: Switch #1 display modes

Maximized mode - switch #1 - on	Maximized mode - switch #1 - off
Display only	Display only
Main and protect	Main parameters
Start parameters	Start parameters
Stop parameters	Stop parameters
Dual adjustment	Statistical data
Fault parameters	
I/O programming	
Communication parameters	
Statistical data	

Table 10: Language selection switches #5 and #6

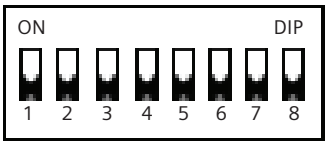
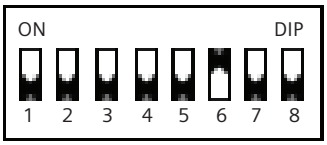
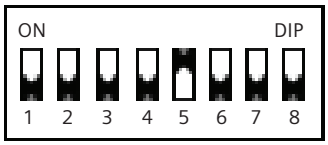
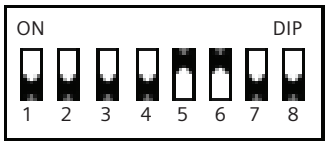
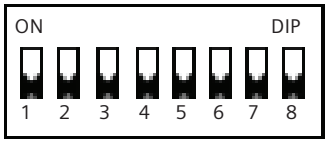
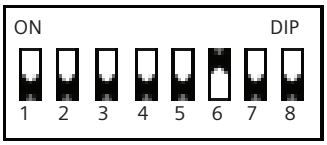
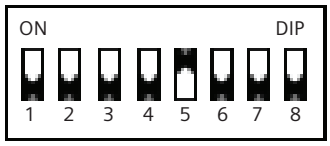
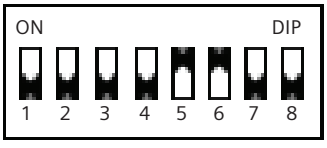
Language	Switch #5	Switch #6	Switch position
English	Off	Off	
French	Off	On	
German	On	Off	
Spanish	On	On	

Table 11: Language selection switches #5 and #6 options

Language	Switch #5	Switch #6	Switch position
English	Off	Off	
Russian	Off	On	
Special set	On	Off	
Chinese	On	On	

Switch #2 tachometer feedback (0 to 10 V dc)

Set switch #2 to "on" when using tachometer feedback.

Note: To operate the tachometer feedback, consult with the factory for specific settings for each application.

Switches #5 and #6 language selection (refer to Tables 10 and 11)

Language selection is defined by the switch settings and software version shown on the internal label.

For software version: MVSTMB.GN-ddmmyy (where "ddmmyy" represents software version date in six-digit format. For example, 010709 refers to July 1, 2009).

Optional software version (requires special digital controller unit display) available (refer to Table 11).

Table 12: Switch #7 extended settings

Parameter	Range switch #7 - off	Range switch #7 - on
Initial voltage	10% to 50%	5%[1] - 80%
Current limit	100% to 400%	700% with the maximum limitation of 440 x starter FLC/motor FLA)
Pulse time	100% to 400%	700% if pulse time > 1 s with the maximum limitation of 440 x starter FLC/motor FLA)
Acceleration time	1 s to 30 s	1 s to 90 s
Deceleration time	0 s to 30 s	0 s to 90 s
Maximum starting time	1 s to 30 s	1 s to 250 s

Footnote:

1. Setting the initial voltage to lower than 10 percent is not practical for loaded motors.

NOTICE

Extended settings are for use in very special applications only!

Do not set switch #7 to "on" unless the soft starter is significantly larger than the motor!

When using extended settings for the soft starter, be extremely careful to avoid damaging the motor or the soft starter.

Switch #8 software lock

The software lock prevents undesired parameter modifications.

When locked, pressing the store, ∧ or ∨ keys causes the LCD to display unauthorized access.

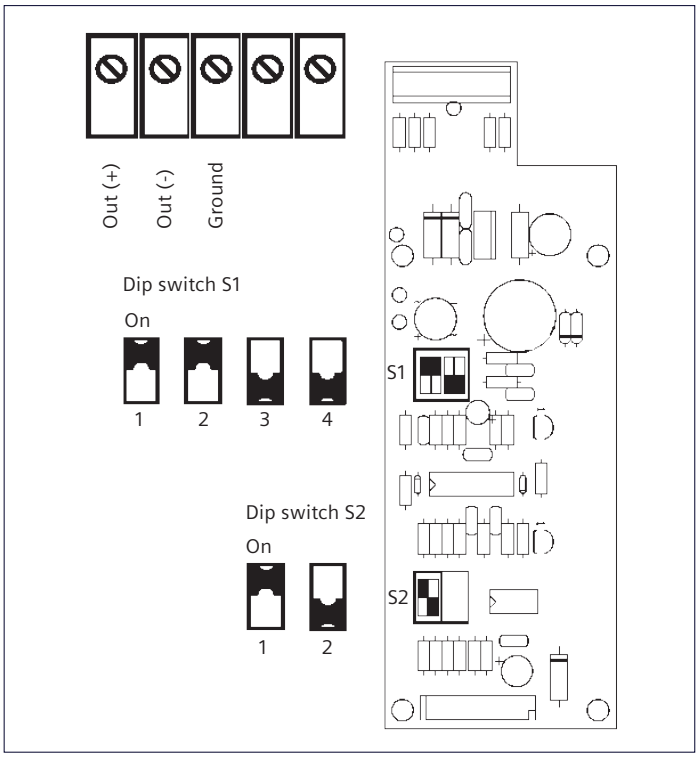


Figure 13: Optional analog PCB

Control module - analog I/O (optional) (terminals ground, out (-), out (+))

Analog PCB is located on the upper right side of the control module (upper right corner of Figure 13) (refer to I/O programming parameters DCU display page 6 on page 53).

Ground terminal (terminal ground)

No connection should be made to this terminal. Ground the shield of the analog output signal at the remote end.

Analog output (terminals out (+), out (-))

Dip switches allow selection among 0 Vdc to 10 Vdc, 0 mA to 20 mA and 4 mA to 20 mA.

The analog value is related to motor FLA, percent to 200 percent of motor FLA (not programmable).

Table 13: Analog output

Switch number	4 mA to 20 mA[1]	0 mA to 20 mA	0 Vdc to 10 V dc
1	On	On	Off
2	On	On	Off
3	Off	Off	On
4	Off	Off	On
1	On	Off	Off
2	Not used	Not used	Not used

Footnote:

1. Factory default setting

Programming the unit

Programming the unit Control keypad

The control keypad is the link between the soft starter and the user. Refer to Figure 14

The soft starter control keypad features are:

- Two lines of 16 alphanumeric characters each with selectable languages: English, French, German, and Spanish. Russian and Chinese characters are optional and must be pre-ordered (refer to Control module - dip-switch settings on the main PCB on page 27).
- Six push-programming keys: mode, reset, select, store, ∧ (up) and ∨ (down) keys.
- Eight indication LEDs: on, start, run, s.stop (soft stop), stop, test, d.adj. (dual adjustment) and fault.

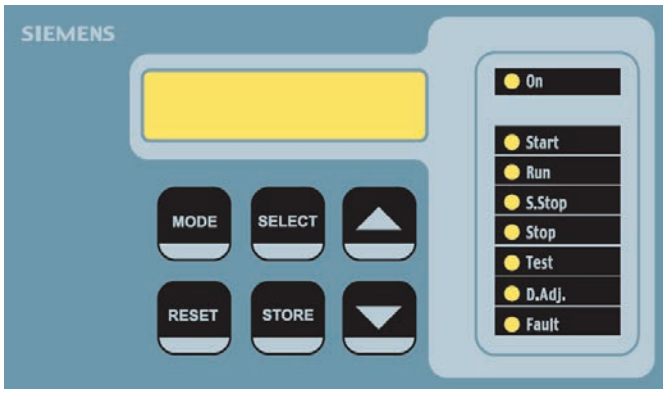


Figure 14: Figure 14: Control keypad

LCD arrangement

CURRENT LIMIT

390%

Upper line displays function.

Lower line displays setting and/or measured values.

Table 14: Programming keys

Key	Details
Mode	Scrolls through the display and programming menus of the DCU. **Note:** Pressing mode continuously increases the speed at which the parameters change.
Select	When a mode name is displayed, pressing this button drills down to the parameters for that mode. When a parameter is displayed, pressing this button scrolls to the next parameter. **Note:** Pressing select continuously increases the speed at which the parameters change.
∧	Allows the operator to increment adjusted values shown in the display. Operator should press this button once to increment one value or continuously to rapidly increment values up to the maximum value.
∨	Allows the operator to decrement adjusted values shown in the display. Operator should press this button once to increment one value or continuously to rapidly increment values down to the minimum value.
Store	Stores modified parameters only when you have scrolled through all parameters and "store enable" is displayed. After you store a parameter successfully, "data saved ok" message displays. **Note:** Pressing this button at any other time has no effect.
Reset	Resets the DCU after a fault has been dealt with and the start command has been removed (except for undercurrent trip. Refer to Main and protection - DCU display page 1 on page 39 and DCU display page 5 on page 51 for undercurrent reset). This cancels the fault displayed and allows you to restart the motor.

Table 15: Status LEDs

Function	Color		Details
On	Green	●	Lights when the control supply voltage is connected to the DCU.
Start	Yellow	●	Lights during soft start indicating that motor supply voltage is ramping up.
Run	Green	●	Lights after completion of the starting process indicating that motor is receiving full voltage.
S. stop	Yellow	●	Lights during soft stop indicating that the motor supply voltage is ramping down.
Stop	Red	●	Lights when the motor is stopped.
Test	Yellow	●	Lights when the soft starter is in SMPS/firing test mode.
D. adj.	Green	●	Lights when dual adjustment is in operation.
Fault	Red	●	Lights upon operation of any of the built-in protections. Flashes when: • Date and time are not set • Insulation alarm optional relay is activated. Refer to Fault parameters - DCU display page 5 on page 51 • Fault is detected but trip after bypass is set to disable. Refer to Fault parameters - DCU display page 5 on page 51.

Reviewing and modifying parameters

Press the mode key several times until the required mode page is reached.

Press the select key to review parameters for this mode.

Once the required parameter is reached, use the ∨ or ∧ keys to modify its value.

To store the new parameters, press the Select key until the store enable message displays and then press the store key. The data saved ok message will display for two seconds.

Initial control voltage energization

A few seconds after the first control voltage energization, the fault LED will flash and the LCD will display:

ALARM:

SET TIME & DATE

Set the time and date as described in Test/maintenance mode on page 33 and Setting time and date on page 34.

If time and date are not set properly, no time stamp will be applied to faults or events shown in the statistical data.

Note: If the reset button is pressed, this message will no longer be shown.

Test/maintenance mode

Run self test

Press the mode and ∨ keys simultaneously The test LED will light and the LCD will display:

```
TEST/MAINTENANCE
***OPTIONS***
```

Press the select key. The LCD will display:

```
RUN SELF TEST ?
PUSH UP ARROW
```

Press the ∧ key. The test LED will turn off and the LCD will display:

```
SELF TEST PASSED
```

And after a few seconds the LCD will display:

```
I1      I2      I3
0       0       0    %
```

View software version

Press the mode and ∨ keys simultaneously. The test LED will light and the LCD will display:

```
TEST/MAINTENANCE
***OPTIONS***
```

Press the select key twice. The LCD will display:

```
BTL-R-16/09/2008
MVSTMB.GN-121008
```

Press the mode and ∨ keys simultaneously to exit the test/ maintenance mode. The test LED will turn off and the LCD will display:

```
I1      I2      I3
0       0       0    %
```

Obtain default parameters

Press the mode and ∨ keys simultaneously. The test LED will light and the LCD will display:

```
TEST/MAINTENANCE
***OPTIONS***
```

Press the select key three times. The LCD will display:

```
STORE    ENABLE
DEFAULT PARAMET.
```

Press the store and mode keys simultaneously. The test LED will turn off and the LCD will display:

```
DATA SAVED OK
```

After a few seconds, the LCD will display:

```
I1      I2      I3
0       0       0    %
```

NOTICE

Restoring default parameters erases all previous settings.

The parameters and settings appropriate to the motor and system must be reprogrammed. At a minimum, reprogram rated line voltage and starter FLC (as shown on the rating label for the soft starter) and all other parameters of the main and protect mode page of the control unit (refer to DCU display page 1 on page 39).

Reset statistical data

Press the mode and ∨ keys simultaneously. The test LED will light and the LCD will display:

```
TEST/MAINTENANCE
***OPTIONS***
```

Press the select key four times. The LCD will display:

```
RESET STATISTICS
```

Press the reset and store keys simultaneously. The test LED will turn off and the LCD will display:

```
DATA SAVED OK
```

After a few seconds, the LCD will display:

```
STATISTICAL  DATA
          - **** -
```

Press the mode key and return to:

```
I1        I2        I3
0         0         0    %
```

Calibrate voltage and current (factory use only)

Press the mode and ∨ keys simultaneously. The test LED will light and the LCD will display:

```
TEST/MAINTENANCE
***OPTIONS***
```

Press the select key five times. The LCD will display:

```
VOLTAGE  ADJUST.
98% OF Vn
```

Press the select key. The LCD will display:

```
CURRENT ADJUST.
23% OF FLC
```

Press the mode and ∨ keys simultaneously to exit the test/maintenance mode.

The test LED will turn off and the LCD will display:

```
I1        I2        I3
0         0         0    %
```

Setting time and date

Press the mode and ∨ keys simultaneously. The test LED will light and the LCD will display:

```
TEST/MAINTENANCE
***OPTIONS***
```

Press the select key seven times. The LCD will display:

```
hh.mm        mm.dd.yy
09:10        01/19/08
```

Underline the mark under the hour value. Modify the hour value with ∨ or ∧ keys. Press store key. The LCD will display:

```
hh.mm        mm.dd.yy
12:10        01/29/08
```

Underline the mark under the minute value. Repeat the same procedure as for the hour settings to the minutes, day, month and year settings. After the store key is pressed the last time, the LCD will display:

```
TEST/MAINTENANCE
***OPTIONS***
```

Press the mode and ∨ keys simultaneously to exit the test/maintenance mode. The test LED will turn off and the LCD will display:

```
I1        I2        I3
0         0         0    %
```

Mode pages

Upon initiation of a start command, the LCD displays the motor operating rms current:

```
I1      I2      I3
0       0       0   %
```

You can review all mode pages by pressing the mode key:

```
MAIN & PROTECT.
        - **** -
```

```
START PARAMETERS
        - **** -
```

```
STOP PARAMETERS
        - **** -
```

```
DUAL ADJUSTMENT PARAMETERS
```

```
FAULT PARAMETERS
        - **** -
```

```
I/O PROGRAMMING PARAMETERS
```

```
COMM. PARAMETERS
        - **** -
```

```
STATISTICAL DATA
        - **** -
```

Dual-adjustment parameters, fault parameters, I/O programming parameters and communication parameters pages are skipped if soft starter is programmed to minimized mode. These pages are shown only in maximized mode. Refer to Control module - dip-switch settings on main PCB on page 27 for changing mode from minimized mode to maximized mode.

Table 16: Overview of all mode pages and factory defaults

DCU display page 0	DCU display page 1		DCU display page 2		DCU display page 3	DCU display page 4[1]
DISPLAY MODE PAGE	MAIN & PROTECT _****_		START PARAMETERS _****_		STOP PARAMETERS _****_	DUAL ADJUSTMENT PARAMETERS
Display and default values	Display and default values	Display and default values	Display and default values	Display and default values (continued)	Display and default values	Display and default values
I1 I2 I3 0 0 0 %	RATED LINE VOLT. 6,600 V	OVERLOAD PROTECT ENABLE WHILE RUN	SOFT START CURVE 1 (STANDARD)	STARTS PERIOD 20 MIN.	SOFT STOP CURVE 1 (STANDARD)	DA: INIT. VOLT. 30%
I1 I2 I3 0 0 0 A	STARTER FLC 150 AMP.	UNBALANCE TRIP 20% OF FLA	START TACHO. GAIN 0 (MIN. GAIN)	START INHIBIT 15 MIN.	STOP TACHO. GAIN 0(MIN. GAIN)	DA: INIT. CURRENT 100%
VOLTAGE FREQ. 4,000 V 59.9 Hz	MOTOR FLA 150 AMP.	UNBALANCE DELAY 5 SEC.	PULSE LEVEL 70% OF FLA	RUN CONTACT DLY 5 SEC.	DEC. TIME 0 SEC.	DA: CUR. LIMIT 400% OF FLA
POWER 1,500 KW	RATED MOTOR PWR 1,000 KW	GND FAULT TRIP 20% OF FLA	PULSE TIME 0.0 SEC.	STORE ENABLE START PARAMETERS	FINAL TORQUE 0 (MIN.)	DA: ACC. TIME 10 SEC.
REACTIVE POWER 500 KVAR	SERVICE FACTOR 100%	GND FAULT DELAY 5 SEC.	INITIAL VOLTAGE 30%		STORE ENABLE STOP PARAMETERS	DA: DEC. TIME 0 SEC.
POWER FACTOR 0.85	UNDERCURR. TRIP 0% OF FLA	UNDERVOLT. TRIP 70% OF VN	INITIAL CURRENT 100%			DA: MOTOR FLA 150 AMP.
THERMAL CAPACITY 0%	UNDERCURR. DELAY 10 SEC.	UNDERVOLT. DELAY 5 SEC.	CURRENT LIMIT 400% OF FLA			STORE ENABLE D. ADJ. PARAMETERS
MOTOR INSULATION 52.8 Mohm	O/C - SHEAR PIN 850% OF FLA	OVERVOLT. TRIP 120% OF VN	ACC. TIME 10 SEC.			
OPTION CARD NOT INSTALLED	O/C DELAY 0.5 SEC	OVERVOLT. DELAY 2 SEC.	MAX. START TIME 30 SEC.			
	OVERLOAD CLASS 10 ANSI OR IEC	STORE ENABLE MAIN & PROTECT	NUMBER OF STARTS 1			

Table 16: Overview of all mode pages and factory defaults (continued)

DCU display page 5[1]	DCU display page 6[1]	DCU display page 7[1]		DCU display page 8		DCU display page 9[2]
FAULT PARAMETERS - **** -	I/O PROGRAMMING PARAMETERS	COMM. PARAMETERS - **** -		STATISTICAL DATA - **** -		TEST/ MAINTENANCE ***OPTIONS***
Display and default values	Display and default values	Display and default values	Display and default values (continued)	Display and default values	Display and default values (continued)	Display and default values
UV & PL AUTO RST NO	PROG. INPUT #7 RESET	**Applicable when Modbus optional PCB installed**	**Applicable when Profibus optional PCB installed**	T SINCE LST STRT NO DATA	LAST 10 TRIPS hh.mm mm.dd.yy	RUN SELF TEST? PUSH UP ARROW
UNDER CUR. RESET OFF	PROG. INPUT #8 DUAL ADJUSTMENT	COMM. PROTOCOL MODBUS	COMM. PROTOCOL PROFIBUS	LAST STRT PERIOD NO DATA	PREVIOUS TRIP -10 hh.mm mm.dd.yy	PROGRAM VERSION MVSTMB. GN-110808
BYPASS OPEN TRIP ENABLE	FAULT RELAY TYPE FAULT	BAUD RATE 9600 (MODBUS)	BAUD RATE AUTO (PROFIBUS)	LAST STRT MAX I NO DATA		STORE ENABLE DEFAULT PARAMET.
TRIP AFTER BYPASS ENABLE	IMM/# STRT PREAL IMMEDIATE	PARITY CHECK EVEN	PROFI.NETWORK ID OFF	TOTAL RUN TIME 0 HOURS		RESET STATISTICS
BYPASS AUTO RST NO	RELAY ON DELAY 0 SEC.	SERIAL LINK NO. OFF	S. LINK PAR. SAVE DISABLE	TOTAL # OF START 0		VOLTAGE ADJUST. 15 % OF VN
SET CURVE 0 FLT ENABLE	RELAY OFF DELAY 0 SEC.	S. LINK PAR. SAVE DISABLE	SER. LINK CONTROL DISABLE	TOTAL ENERGY 0 KWH		CURRENT ADJUST. 99% OF FLC
PWR ON & NO STRT ENABLE	ANALOG OUTPUT NORMAL	SER. LINK CONTROL DISABLE	FRONT COM ADDRESS OFF	TOTAL R. ENERGY 0 KVARH		hh.mm mm.dd.yy 00:00 01/01/00
INSULATION ALARM OFF	STORE ENABLE I/O PROG.PARAM.	FRONT COM ADDRESS OFF	STORE ENABLE COMM. PARAMETERS	LAST TRIP NO DATA		
INSULATION TRIP OFF		STORE ENABLE COMM. PARAMETERS		TRIP CURRENT 0 % OF FLA		
PHASE SEQUENCE POSITIVE				TOTAL # OF TRIPS 0		
STORE ENABLE FAULT PARAMETERS						

Footnotes:

1. Appears only in maximized mode. Refer to Control module - dip-switch settings on main PCB on page 27 for changing mode from minimized mode to maximized mode.
2. Refer to Test/maintenance mode on page 33 for entering test/ maintenance.

Table 17: Display mode - DCU display page 0[1, 2]

Display	Description
DISPLAY MODE PAGE	Displays on minimized mode and maximized mode.
Display and default values	**Description**
I1 I2 I3 0 0 0 %	Displays operating current in each of the three phases as a percentage of motor FLA. DCU default display. After pressing the mode or select keys, a time delay is initiated. Following the delay, the LCD returns to this display.
I1 I2 I3 0 0 0 A	Displays the current of the motor in A.
VOLTAGE FREQ. 4,000 V 59.9 Hz	Displays line voltage and frequency. Frequency is displayed after start command only.
POWER 1,500 KW	Displays motor power in kW.
REACTIVE POWER 500 KVAR	Displays motor reactive power in kVAR.
POWER FACTOR 0.85	Displays motor power factor.
THERMAL CAPACITY 0%	Displays motor's thermal capacity in %. When thermal capacity is 100% motor will trip on overload.
MOTOR INSULATION 52.8 Mohm	Displays the motor winding insulation level (displays only if the optional motor insulation PCB is installed).
OPTION CARD NOT INSTALLED	Displays only if there is no motor insulation or analog optional PCBs installed in the soft starter. **Notes:** This ignores the optional communication PCBs. Even if a communication PCB is installed, this message can display.

Footnotes:

1. In this page, parameters cannot be programmed.
2. Browsing the display in display mode is possible by pressing the select keys or the ∨ or ^ keys.

Table 18: Main and protection - DCU display page 1

DCU display page 1	Range	Description
MAIN & PROTECT _****_	Displays on minimized mode and maximized mode.	
Display and default values	**Range**	**Description**
RATED LINE VOLT. 6,600 V	2,300 V to 15,000 V	Sets soft starter rated voltage. Soft starter rated voltage is shown on controller rating label. **Note:** Setting rated line voltage to other than the value on the label will cause incorrect operation and invalid data on the soft starter display.
STARTER FLC 150 AMP.	20 A to 1,800 A (10 A steps)	Sets soft starter full-load current (FLC). Starter FLC is shown on controller rating label. **Note:** Setting starter FLC to other than the value on the label will cause incorrect operation and invalid data on the soft starter display.
MOTOR FLA 150 AMP.	30% to 100% of soft starter FLC (1 to 100 – 1 A; >100 – 5 A)	Sets motor FLA. Should be programmed as shown on the motor nameplate.
RATED MOTOR PWR 1,000 KW	50 KW to 40,000 KW	Sets motor rated power as indicated on the motor nameplate. KW = 0.746 x HP (neglecting motor efficiency).
SERVICE FACTOR 100%	100% to 130%	Sets motor rated service factor as indicated on the motor nameplate.
UNDERCURR. TRIP 0% OF FLA	0% (=OFF)/ 20% to 90% of FLA (1%)	Sets undercurrent trip protection. Sets the time delay for under current trip protection. Trips the soft starter when the motor current drops below the level set for a time period longer than undercurrent delay. **Notes:** Operational when the motor is running (the run LED is "on") and can be set to auto-reset. Refer to Fault adjustment parameters - DCU display page 5 on page 51.
UNDERCURR. DELAY 10 SEC.	1 s to 40 s (1)	
O/C - SHEAR PIN 850% OF FLA	100% to 850% of motor FLA setting (5%)	Sets overcurrent shear-pin protection. Sets O/C – shear-pin delay time. Operational when soft starter is energized and has three trip functions: 1 At all times. If I > 850% of motor FLA, it trips the soft starter within one-cycle (overrides the value of the O/C – shear-pin setting). 2 During starting. If I > 850% of motor FLA, it trips the soft starter after O/C delay. 3 While running. If I > O/C – SHEAR PIN setting of motor FLA, it trips the soft starter after O/C delay. **Note:** The overcurrent shear-pin protection is not intended to replace current-limiting fuses to protect from short current!
O/C DELAY 0.5 SEC	0.0 – 5 s. **Note:** When set to 0.0, actual delay is 200 ms.	

Table 18: Main and protection - DCU display page 1 (continued)

DCU display page 1	Range	Description
MAIN & PROTECT _****_	Displays on minimized mode and maximized mode.	

Display and default values	Range	Description
OVERLOAD CLASS 10 ANSI OR IEC	5 to 30	Sets overload class characteristics. Sets overload protect functionality. The soft starter allows motor protection according to ANSI and IEC classes 5 to 30. Tripping curves are shown in Figure 14 NEMA class overload curves. The overload protection incorporates a thermal capacity register that calculates heating minus dissipation of the motor. The soft starter trips when the register fills up (thermal capacity=100%). The time constant, in seconds, for cool down after overload trip is:
OVERLOAD PROTECT ENABLE WHILE RUN	Disable/enable while run/enable	The overload protection can be set to protect the motor as set in the overload protect parameter: ENABLE – motor is protected at all time. ENABLE WHILE RUN – motor is protected only when in run. DISABLE – motor is not overload protected by the soft starter. **Note:** In order to restart after overload trip, the thermal register must be 50% or less.
UNBALANCE TRIP 20% OF FLA	10% to 100%/ OFF	Sets unbalance trip level. Sets unbalance trip delay. Trips the soft starter when current unbalance increases above level, which is set for a time longer than unbalance delay. **Note:** Operational only after the start signal.
UNBALANCE DELAY 5 SEC.	1 s to 60 s	
GND FAULT TRIP 20% OF FLA	10-100%/OFF	Sets ground fault level. Sets ground fault trip delay. Trips the soft starter when ground current increases above level, which is set for a time longer than unbalance. **Note:** Operational only after the start signal.
GND FAULT DELAY 5 SEC.	1 s to 60 s	
UNDERVOLT. TRIP 70% OF VN	50% to 90%	Sets undervoltage trip level. Sets undervoltage trip delay. Trip the soft starter when mains voltage drops below the level, which is set for a time longer than undervoltage delay. **Note:** Operational only after the start signal. Can be set to auto-reset. When voltage drops to zero (voltage outage), the soft starter will trip immediately, thus overriding the delay.
UNDERVOLT. DELAY 5 SEC.	1 s to 10 s	
OVERVOLT. TRIP 120% OF VN	110% to 125%/ OFF	Sets overvoltage trip. Sets overvoltage trip delay. Trips the soft starter when main voltage increases above the level, which is set for a time longer than overvoltage delay. It cannot be set lower than the undervoltage setting. **Note:** Operational only after the start signal.
OVERVOLT. DELAY 2 SEC.	1 s to 10 s	
STORE ENABLE MAIN & PROTECT.		Storing modified parameters. To store selected parameters scroll through all parameters until store enable main & protect is reached, then press the store key. After a parameter is stored successfully, the data saved ok message will display. If the soft starter fails to store the parameter, the LCD will display the storage error message (refer to Storage error on page 60 for more details). **Note:** Pressing the store key when the "store enable" message does not appear on the display has no effect.

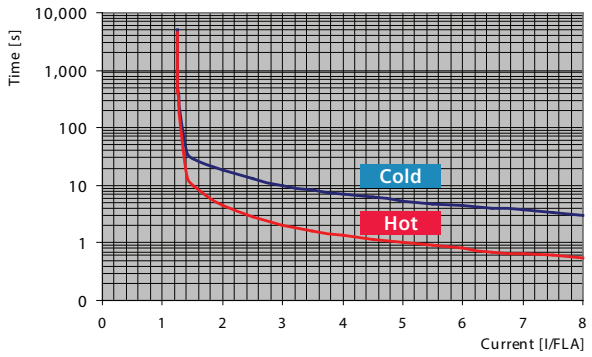
Class	5	10	15	20	25	30
IEC	160	320	480	640	800	960
NEMA	140	280	420	560	700	840

Tripping curves of the integrated overload protection

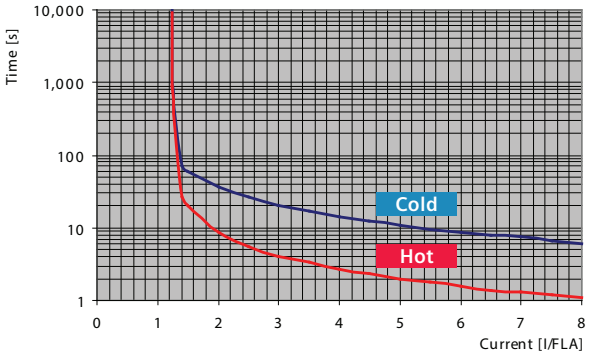
The soft starter allows motor protection according to NEMA class 5, 10, 15, 20, 25 or 30 and IEC class 5, 10, 15, 20, 25 or 30.

Figure 15: NEMA and IEC class overload curves

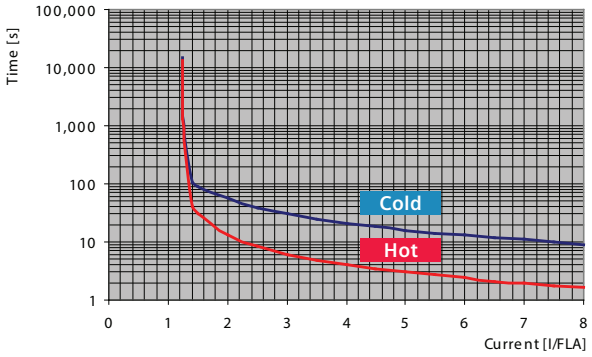
NEMA class 5



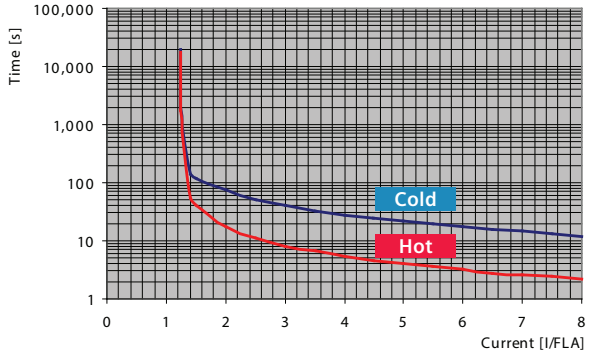
NEMA class 10



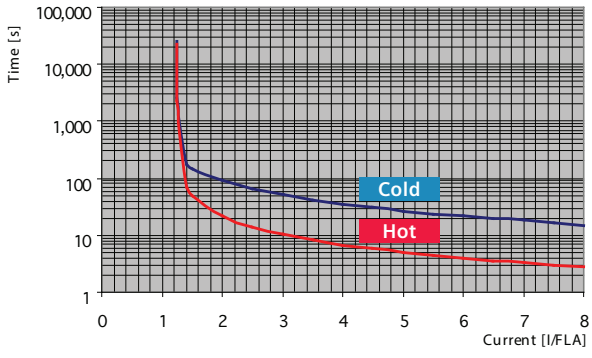
NEMA class 15



NEMA class 20



NEMA class 25



NEMA class 30

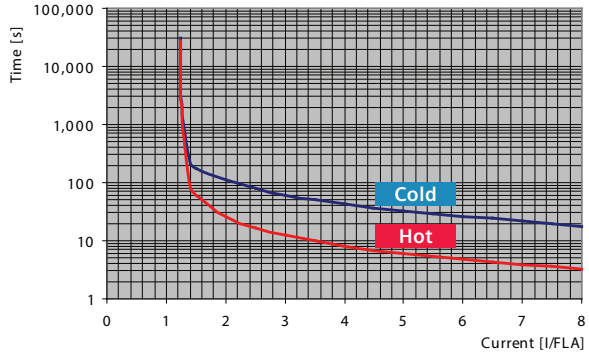
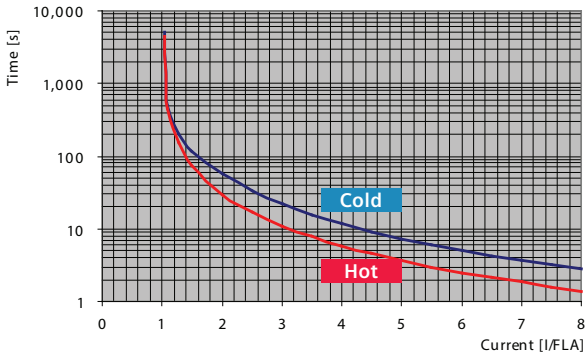
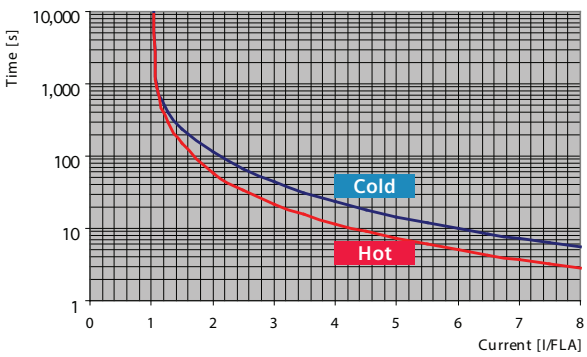


Figure 15: NEMA and IEC class overload curves (continued)

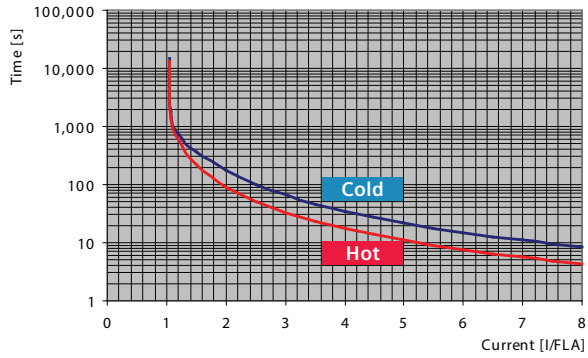
IEC class 5



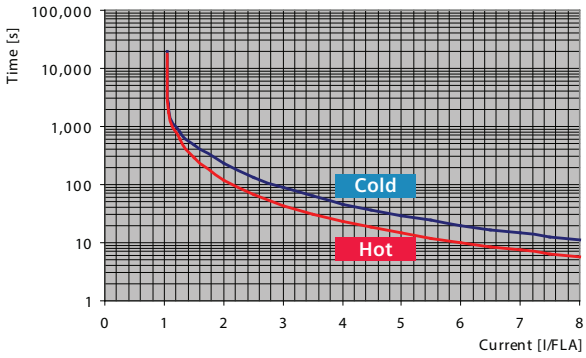
IEC class 10



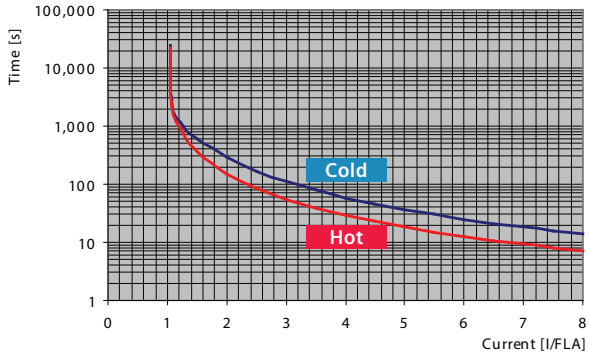
IEC class 15



IEC class 20



IEC class 25



IEC class 30

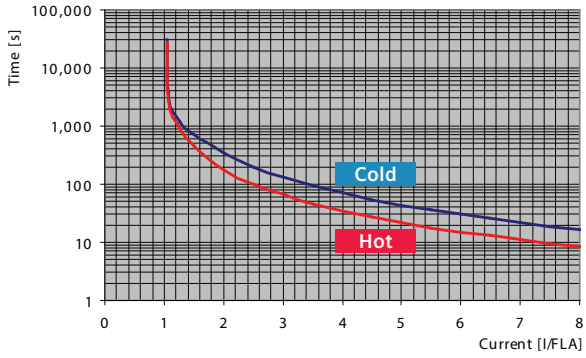


Table 19: Start parameters - DCU display page 2

DCU display page 2	Range	Description
START PARAMETERS - **** -	Displays on minimized mode and maximized mode.	
Display and default values	**Range**	**Description**
SOFT START CURVE 1 (STANDARD)	0 (basic)/1! (standard)/2!/3!/4!/5 (torque)	Sets soft start curve. Refer to Soft start curves on page 47.
START TACHO. GAIN 0(MIN. GAIN)	0 (minimum gain)/ 1!/2!/3!/4!/5/	1! represents the 2nd level tachometer gain. 2! represents the 3rd level tachometer gain. 5 represents the 6th level tachometer gain. **Notes:** • This parameter will appear only if the optional PCB is installed and dip switch #2 is set to "on". Refer to Control module - dip-switch settings on the main PCB on page 27 for dip-switch setting details • Tachometer feedback is operational in its basic form. Additional curves except for the basic linear curve are optional. • Consult the factory for the correct tachometer selection and mechanical installation.

PULSE LEVEL
70% OF FLA
	For pulse time
	<1 s 70% to 700% of motor FLA;
	for pulse time ≥1 s 70% to 400% of motor FLA
	Note: The range of the pulse level can be extended to 70% to 700% even if pulse time ≥1 s by using the extended setting as described in Control module - dip-switch settings on the main PCB on page 27.
		Sets pulse start level and sets pulse start time. Intended to start high-friction loads, that require high starting torque for a short time or for pedestal start by holding the current at a required level for some time. The pulse is defined by its current level and time duration. After this pulse, the voltage is ramped down to initial voltage setting before ramping up again to full voltage according to the start parameters settings. For pulse time <1 s, pulse level can be set to 70% to 700% of motor FLA. For pulse time ≥1 s, pulse level can be set to 70% to 400% of motor FLA
		Notes:
		• Pulse start is not effective on soft-start curve 0
		• When using the extended setting, the range of the pulse level can be set as follows:
		  • For pulse level <1 s, pulse level can be set to 70% to 700%.
		  • For pulse time ≥1 s, pulse level can be set to 70% to 700% with the limitation of: 440 x (starter FLC/motor FLA).
		• For extended setting, refer to Control module - dip-switch settings on the main PCB on page 27.

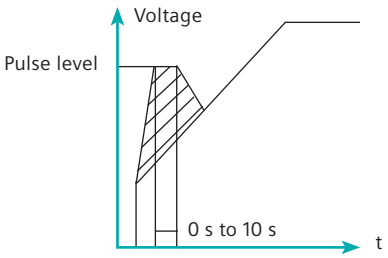
PULSE TIME 0.0 SEC.	0 s to 10 s	

Table 19: Start parameters - DCU display page 2 (continued)

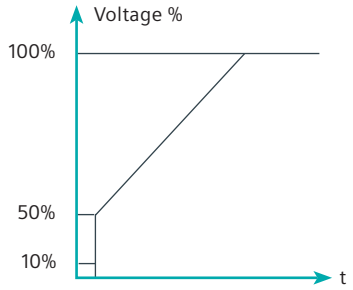
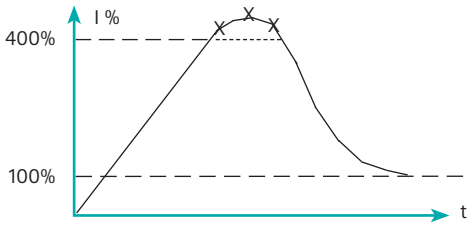
DCU display page 2	Range	Description
START PARAMETERS - **** -	Displays on minimized mode and maximized mode.	
Display and default values	**Range**	**Description**
INITIAL VOLTAGE 30%	10% to 50% After reaching 50%, the display changes to: INITIAL CURRENT 100-400% **Note:** The range of the initial voltage can be extended to 5% to 80% by using the extended setting as described in Control module - dip-switch settings on the main PCB on page 27.	Sets motor's initial starting voltage. The motor's torque is proportional to the square of the voltage. This adjustment also determines the inrush current and mechanical shock. A setting that is too high may cause high initial mechanical shock and high inrush current. This can occur even if current limit is set low because the initial voltage setting overrides the current limit setting. A setting too low may result in prolonged time until the motor starts to turn. In general, this setting should be high enough so the motor starts turning immediately after a start signal. **Notes:** When initial voltage reaches the maximum set value, the displays switches to initial current. When initial current is set, the soft starter causes current ramp instead of voltage ramp. 
INITIAL CURRENT 100%		
CURRENT LIMIT 400% OF FLA	100% to 400%. **Note:** The range of the current limit can be extended to 100% to 700% by using the extended setting as described in Control module - dip-switch settings on the main PCB on page 27.	Set motor's current limit during starting. A setting too high will increase the current drawn from system and a faster acceleration will be generated. A setting too low may prevent the motor from completing the acceleration process and reaching full speed. In general, this setting should be set to a value that is high enough to prevent stalling and produces an acceleration time within the limits established by the motor supplier. **Note:** Current limit does not operate during run and soft stop. 

Table 19: Start parameters - DCU display page 2 (continued)

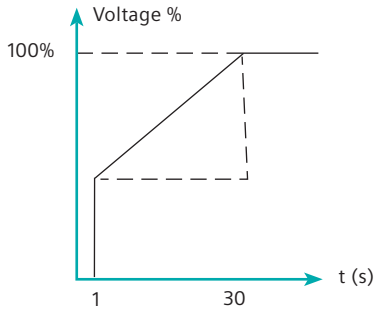
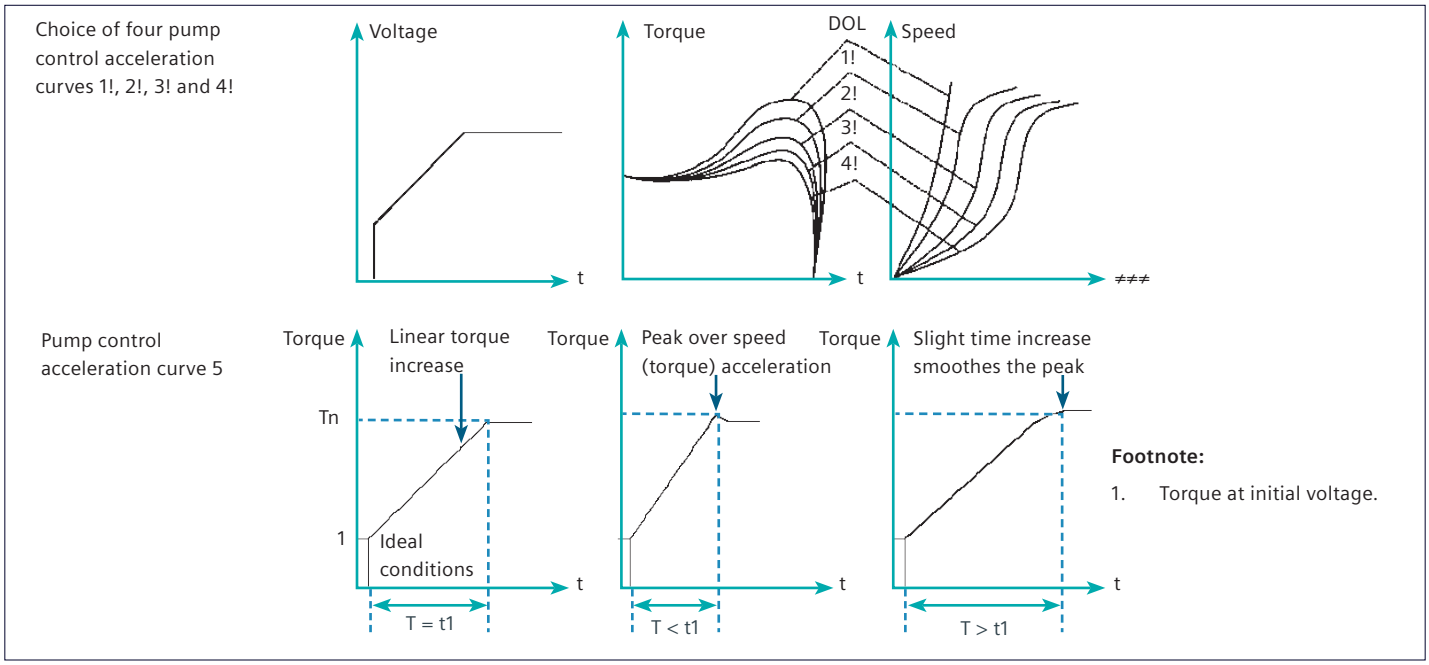
DCU display page 2	Range	Description
START PARAMETERS - **** -	Displays on minimized mode and maximized mode.	
Display and default values	**Range**	**Description**
ACC. TIME 10 SEC.	1 s to 30 s **Note:** The range of the acceleration time can be extended to 1 s to 90 s by using the extended setting as described in Control module - dip-switch settings on the main PCB on page 27.	Sets acceleration time of the motor. Determines the motor's voltage ramp up time, from initial to full voltage. It is recommended to set acceleration time to the minimum acceptable value, which is approximately 5 s. **Notes:** Since current limit overrides acceleration time, when current limit is set low, the starting time will be longer than the acceleration time setting. • When the motor reaches full speed before voltage reaches nominal, acceleration setting is overridden, causing voltage to quickly ramp up to nominal. • Using starting curves 2!, 3! and 4! prevents quick ramp up. 
MAX. START TIME 30 SEC.	1 s to 30 s **Note:** The range of the maximum start time can be extended to 1 s to 250 s by using the extended setting as described in Control module - dip-switch settings on the main PCB on page 27.	Sets maximum start time. The maximum allowable start time, from the start signal to the end of the acceleration process. If voltage/speed does not reach nominal values during maximum start time then the soft starter will trip the unit and record a fault. The LCD will display the long start time fault message. For example, this can occur when the current limit setting is too low.
NUMBER OF STARTS 1	1 to 10/Off	Sets number of starts permitted during starts period. Limits the number of starts during the period of time defined by starts period. If the number of starts limit is exceeded during the start period, the start inhibit period will take effect.
STARTS PERIOD 20 MIN.	1 to 60 minutes	Sets starts period during which the number of starts is being counted.
START INHIBIT 15 MIN.	1 to 60 minutes	Sets starts inhibit time which starting is disabled after too many starts trip. During the start inhibit period, the WAIT BEFORE RST XX MIN message will be displayed.

Table 19: Start parameters - DCU display page 2 (continued)

DCU display page 2	Range	Description
START PARAMETERS - **** -	Displays on minimized mode and maximized mode.	
Display and default values	**Range**	**Description**
RUN CONTACT DLY 5 SEC.	0 s to 120 s After reaching 120 s, keep pressing for 10 s the ^ key and only if optional relay PCB is installed. The display changes to: TURN BYPASS ON AT 120-250%.	Sets time delay for end of acceleration relay to close after completion of starting process. End of acceleration relay can signal that the motor is at the run position, which can be used for motor ramping-up information.
TURN BYPAS ON AT 120 % OF FLA		For information on turn bypass on at and minimum time to bypass, refer to special control for synchronous motor excitation on page 47.
MIN TIME TO BYPS 3 SEC.	3 s to 60 s	
STORE ENABLE START PARAMETERS		Same as Store enable main and protection on page 39.

Figure 16: Soft start curves



Soft start curves

The soft starter incorporates six starting curves to enable you to select a suitable torque curve.

- Soft start curve 0
  Basic curve. This curve uses less feedback signals. Use this curve if other curves do not provide expected results.

NOTICE

When operating on soft start curve 0, motor must be loaded. If unloaded, motor vibration may occur towards the end of the soft-start process.

- Soft start curve 1!
  Standard curve (Default). This curve is the most suitable curve for preventing prolonged starting and motor overheating.
- Soft start curves 2!, 3! and 4!
  Pump control: induction motors produce peak torque of up to three times the rated torque towards the end of starting process. In some pump applications, this peak may cause pressure surge in the pipes. During acceleration, before reaching peak torque, the pump control program automatically controls the voltage ramp up, thus, reducing peak torque.
- Soft start curve 5 (torque)
  Torque controlled acceleration. This provides a smooth time-controlled torque ramp for the motor and the pump.

Notes: Start with soft start curve 1!. If towards the end of acceleration, peak torque is too high (for example, pump pressure is too high), proceed to curves 2!, 3!, 4! or 5 in that order.

Special control for synchronous motor excitation

The parameters "turn bypas on at" and "min time to byps" are used for special cases involving synchronous motor excitation system.

These parameters are active only under the following conditions:

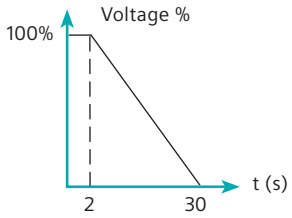
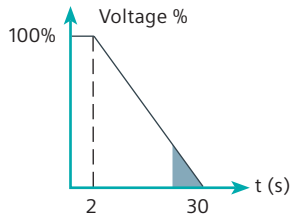
- Optional relay PCB is installed.
- When setting the run contact delay parameter after reaching 120 s (maximum value) and the operator keeps pressing the ∧ key for an additional 10 s.

The parameter "turn bypas on at" determines motor current below which the soft starter goes into run condition and closes the end of acceleration relay.

The parameter "min time to byps" assures that run condition cannot be reached before the set time after the beginning of the starting process.

This special feature is for synchronous motor starting application where the motor current at asynchronous speed may be at higher level than regular asynchronous motor starting condition. In this case, the level of current at which the run condition is being achieved can be programmed.

Table 20: Stop parameters - DCU display page 3

DCU display page 3	Range	Description
STOP PARAMETERS - **** -	Displays on minimized mode and maximized mode. Refer to Control module - dip-switch settings on the main PCB on page 27 for changing mode.	
Display and default values	**Range**	**Description**
SOFT STOP CURVE 1 (STANDARD)	0 (basic)/ 1! (standard)/ 2!/3!/4!/5 (torque)	Sets soft stop curve. Refer to Curves on page 49.
STOP TACHO. GAIN 0(MIN. GAIN)	0 (minimum gain)/ 1! (standard)/ 2!/3!/4!/5	1! represents the 2nd level tachometer gain. 2! represents the 3rd level tachometer gain. 5 represents the 6th level tachometer gain. **Notes:** • This parameter will appear only if the optional PCB is installed and dip switch #2 is set to "on". Refer to Control module - dip-switch settings on the main PCB on page 27 for dip-switch setting details. • Tachometer feedback is operational in its basic form. Additional curves except for the basic linear curve are optional. • Consult the factory for the correct tachometer selection and mechanical installation.
DEC. TIME 0 SEC.	0 s to 30 s **Note:** The range of the deceleration time can be extended to 0 s to 90 by using the extended setting as described in Control module - dip-switch settings on the main PCB on page 27.	Sets deceleration time of the motor. Used for controlled deceleration of high-friction loads. Determines the motor's voltage ramp down time. **Notes:** The soft starter operates with a bypass contactor. The bypass contactor is controlled by the control module end of the acceleration relay. Upon soft stop initiation the end of acceleration relay is de-energized, the load is transferred to the soft starter, and voltage begins ramping down. 
FINAL TORQUE 0 (MIN.)	0 (minimum) to 10 (maximum)	Sets final torque during soft stop. Determines torque towards the end of a soft stop. If the current still flowing after speed is softly reduced to zero, consider increasing the final torque setting. 
STORE ENABLE STOP PARAMETERS		Same as Table 18: Main and protection - DCU display page 1 on page 39.

Curves

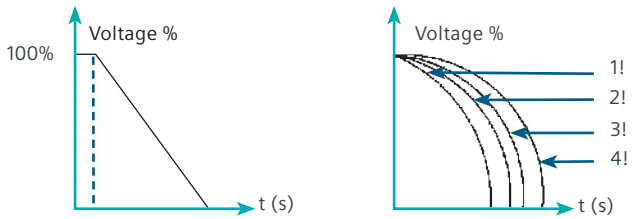
Soft stop initiation opens the end of acceleration contact and opens the bypass contactor. Load will be transferred to the soft starter medium-voltage SCR (thyristors) and voltage begins to ramp down. The soft starter incorporates five stopping curves that enable you to select the suitable torque curve:

- Soft stop curve 1!
  Standard curve (default) voltage is linearly reduced from nominal to zero. The most stable and suitable curve for preventing prolonged stopping and motor overheating.
- Soft stop curves 2!, 3!, 4! pump control
  In some pump applications when pumping at higher elevation, a considerable part of the torque is constant and does not decrease with speed. During the deceleration process when voltage decreases it may happen that the motor torque abruptly falls below load torque (instead of smoothly decreasing speed to zero), thus closing the valve and causing water hammer. Curves 2!, 3! and 4! eliminate the water hammer phenomenon. In pump applications, the load torque decreases as the square of the speed, thus correcting control of voltage will reduce torque adequately and assure a smooth deceleration until stop condition.

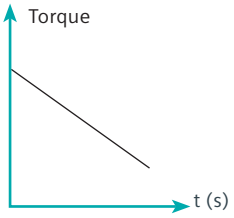
Notes: It is recommended that soft stop curve 1! be used for all standard applications (not pumps). To reduce water hammer, select soft stop curve 2!, then 3!, then 4! in that order.

- Soft stop curve 5
  Torque curve provides linear deceleration of the torque. In certain loads, linear torque deceleration results in a linear speed deceleration, which eliminates stall condition risk.

Notes: Initially use soft stop curve 1!. If the motor stalls quickly instead of slowly decreasing its speed, select soft stop curve 2!, 3!, 4! or 5 in that order until the problem is solved.



Choice of soft stop curves 1!, 2!, 3! and 4!



Soft stop curve 5

Figure 17: Optional soft stop curves

NOTICE

When operating on soft stop curve 0, motor must be loaded. If unloaded, motor vibration may occur towards the end of the soft-stop process.

Table 21: Dual-adjustment parameters - DCU display page 4

DCU display page 4	Range	Description
DUAL ADJUSTMENT PARAMETERS	Displays on maximized mode only. Refer to Control module - dip-switch settings on the main PCB on page 27 for changing mode.	
Display and default values	**Range**	**Description**
DA: INIT. VOLT. 30%	10% to 50% After reaching 50%, the display changes to: DA: INITIAL CURRENT 100-400%. **Note:** The range of the DA: INITIAL VOLTAGE can be extended to 10% to 80% by using the extended setting as described in Control module - dip-switch settings on the main PCB on page 27.	Sets motor's initial starting voltage in dual-adjustment mode. (Motor torque is directly proportional to the square of the voltage.)
DA: INIT. CURRENT 100%		
DA: CUR. LIMIT 400% OF FLA	100% to 400%. **Note:** The range of the DA: CURRENT LIMIT can be extended to 100% to 500% by using the extended setting as described in Control module - dip-switch settings on the main PCB on page 27.	Sets motor highest current during starting in dual-adjustment mode.
DA: ACC. TIME 10 SEC.	1 s to 30 s **Note:** The range of the DA: ACC. TIME can be extended to 1 s to 90 s by using the extended setting as described in Control module - dip-switch settings on the main PCB on page 27.	Sets acceleration time of the motor in dual-adjustment mode. Refer to Table 19: Start parameters: ACC. TIME on page 43.
DA: DEC. TIME 0 SEC.	0 s to 30 s **Note:** The range of the DA: DEC. TIME can be extended to 0 s to 90 s by using the extended setting as described in Control module - dip-switch settings on the main PCB on page 27.	Sets deceleration time of the motor in dual-adjustment mode. Refer to Table 20: Stop parameters: DEC. TIME on page 48.
DA: MOTOR FLA 150 AMP.	33% to 100% of starter FLC	Sets motor FLA in dual-adjustment mode. Refer Motor FLA in Table 18: Main and protection: - DCU display page 1 on page 39.
STORE ENABLE D. ADJ PARAMETERS		Same as STORE ENABLE MAIN & PROTECT Table 18: Main and protection - DCU display page 1 on page 39.

Table 22: Fault adjustment parameters - DCU display page 5

DCU display page 5	Range	Description
FAULT PARAMETERS - **** -	Displays on maximized mode only. Refer to Control module - dip-switch settings on the main PCB on page 27 for changing mode.	
Display and default values	**Range**	**Description**
UV & PL AUTO RSTNO	No/Yes	Sets undervoltage and phase auto loss reset. If UV & PL AUTO RST is set to "no", then soft starter will not automatically reset after an undervoltage or phase loss fault occurs. If the UV & PL AUTO RST setting is "yes", then the DCU will automatically reset. **Notes:** • DCU reset is performed only after the start signal is removed. • Refer to Table 18: Main and protection - DCU display page 1 on page 39 for details on setting of UNDERVOLT. TRIP.
UNDER CUR. RESET OFF	10 to 120 minutes/Off.	Sets undercurrent reset time delay. If the undercurrent reset setting is "off", then soft starter will not automatically reset after an undercurrent trip fault occurs. If the undercurrent reset setting is set to a time value, the soft starter will automatically reset with a delay (the time defined for undercurrent reset). If the start command is not removed, the motor will restart automatically after the delay time. During the delay time, a message U/C TRIP.RST IN: XX MIN. is displayed. **Notes:** • If the start command is not removed, motor will restart automatically after the delay time! • Refer to Table 18: Main and protection - DCU display page 1 on page 39 for details on setting UNDER CURRENT TRIP.
BYPASS OPEN TRIP ENABLE	Enable/disable	Sets bypass open trip protection and becomes operational when the bypass contactor does not close after end of acceleration (EOA) contact commands the interposing relay R/AS to close. Sets to enable when motor current is running through the internal CTs. Sets to disable when motor current is not running through the internal CTs.
TRIP AFTER BYPASS ENABLE	Enable/disable	Sets trip after bypass trip. Trip after bypass can be set to disable if the motor is protected by an additional relay usually upstream to the soft starter. If during operation a fault occurs, fault LED will flash and soft starter will display the fault but will not trip the motor until the soft starter is stopped.
BYPASS AUTO RST NO	Yes/no	Sets bypass auto-reset. When trip after bypass is set to "disable" and if during operation a fault occurs, fault LED will flash and the soft starter will display the fault but will not trip the motor until the soft starter is stopped. In this case the soft starter will go to the trip position. If bypass auto-reset is set to "yes", the soft starter will automatically reset the fault. **Notes:** DCU reset is performed only after the start signal is removed. To restart the motor resume the start command.

Table 22: Fault adjustment parameters - DCU display page 5 (continued)

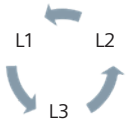
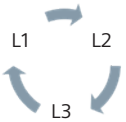
DCU display page 5	Range	Description
FAULT PARAMETERS - **** -	Displays on maximized mode only. Refer to Control module - dip-switch settings on the main PCB on page 27 for changing mode.	
Display and default values	**Range**	**Description**
SET CURVE 0 FLT ENABLE	Enable/disable	Set curve to 0 message may occur during starting with special conditions involving system and/or load. Change start (and stop, if used) curve to soft start curve 0 and soft stop curve 0. Sets set curve fault to disable, only if set curve to 0 fault occurs during starting and if soft start curve 0 is not good enough for the application. When set to disable, verify that motor starts normally with the selected curve.
PWR ON & NO STRT ENABLE	Enable/disable	Sets power on and no start trip. Power on and no start trip is operational upon main voltage connection and trips the motor when main voltage is connected to the soft starter for more than 30 seconds without a start signal. **Note:** Set to disable only in special situations and consult factory.
INSULATION ALARM OFF INSULATION TRIP OFF	Off/0.2 to 20 Mohm	Sets insulation alarm level. Activates insulation alarm trip. Applicable only if optional insulation PCB and resistor unit are installed and connected. Insulation testing is enabled only when motor is not running and after 60 seconds being at the stop state. While motor is running, the value of the insulation resistance shown in the display is the last measured value prior starting the motor. While testing, if the insulation level drops below alarm level, a message: motor insulation alarm will display and the insulation alarm relay will be energized. The fault LED on the control keypad of the soft starter will blink. The alarm will disappear if insulation level returns to normal for more than 60 seconds. While testing, if the insulation level drops below fault level, the message insulation trip will display and the fault relay of the soft starter will go to the fault position (as programmed in the I/O programming parameters on page 53). The fault LED on the front of the soft Starter will light. In this status, the motor cannot be started.
PHASE SEQUENCE POSITIVE	Positive/negative/ignore	Sets phase sequence protection of the soft starter. Allows to start the motor in positive sequence (normally A, B, C or 1, 2, 3) of the main voltage or in the negative sequence (normally C, B, A or 3, 2, 1) of the main voltage or, when set to ignore, in both sequences. Negative sequence  Positive sequence 
STORE ENABLE FAULT PARAMETERS		Same as STORE ENABLE MAIN & PROTECT Table 18: Main and protection - DCU display page 1 on page 39.

Table 23: I/O programming parameters - DCU display page 6

DCU display page 6	Range	Description
I/O PROGRAMMING PARAMETERS	Displays on maximized mode only. Refer to Control module - dip-switch settings on the main PCB on page 27 for changing mode.	
Display and default values	**Range**	**Description**
PROG. INPUT #7 RESET	Reset/test/multi-soft stop (optional)	Sets terminal 7; mode of operation. Refer to Test/reset/multi-soft stop (input terminal 7) on page 26 and Terminal 7 programming on page 54.
PROG. INPUT #8 DUAL ADJUSTMENT	Dual adjustment/reset	Sets terminal 8; mode of operation. Refer to Dual-adjustment parameters - DCU display page 4 on page 50 and Terminal 8 programming on page 54.
FAULT RELAY TYPE FAULT	Fault/fault–fail safe	Sets fault relay mode of operation. When configured to fault, the internal relay is energized upon fault. When configured to fault fail safe, the relay is de-energized upon fault. In this mode, while normal operation, the contacts are open. Relay will also de-energize upon control power outage.
IMM/# STRT PREAL IMMEDIATE	Immediate/number starts prealarm	Sets immediate/number starts prealarm mode of operation. When configured to immediate, the relay is energizes at the start signal after the programmed relay on delay time has elapsed. It de-energizes at the end of the deceleration time (if any) after the programmed relay off delay time has elapsed. When configured to number starts prealarm, the relay is energized if a start command causes the soft starter to trip on too many starts.
RELAY ON DELAY 0 SEC.	0 s to 3,600 s	Sets immediate/number starts prealarm mode on delay time.
RELAY OFF DELAY 0 SEC.	0 s to 3,600 s	Sets immediate/number starts prealarm mode off delay time.
ANALOG OUTPUT RELATIVE CURRENT	Relative current/relative power	When set to relative current, the full scale of the optional analog PCB output is related to 200% of motor FLA (2 x [motor rated current]), or when set to relative power, the full scale of the analog PCB output is related to 100% of motor power (1x [motor rated power]). Motor rated power is set in the main and protect parameter. Refer to Main and protection - DCU display page 1 on page 39.
STORE ENABLE I/O PROG. PARAM.		Same as store on Main and protection - DCU display page 1 on page 39.

Table 24: Terminal 7 programming

Input terminal 7 programmed function	Description
RESET (default setting)	Input terminal 7 is used as reset to reset all soft starter faults. The reset command will take effect only if the start command is removed (except for undercurrent fault).
TEST	While input terminal 7 is "on" firing test can be performed. Refer to firing test on page 90 for firing test procedure.
MULTI-SOFT STOP (Optional only if optional software is installed.)	While input terminal 7 is "on", the soft starter will go to run even if current is not running through the soft starter. This will enable multi-soft stop operation.

Table 25: Terminal 8 programming

Input terminal 8 programmed function	Description
DUAL ADJUSTMENT (default setting)	Input terminal 8 is used to start and stop from the dual-adjustment parameters on. Refer to dual-adjustment parameters - DCU display page 4 on page 50 for programming.
RESET	Input terminal 8 is used as reset to reset all soft starter faults. The reset command will take effect only if the start command is removed.

Table 26: Communication parameters - DCU display page 7 - Modbus card

DCU display page 7	Range	Description
COMM. PARAMETERS - **** -	Displays on maximized mode only. Refer to Control module - dip-switch settings on the main PCB on page 27 for changing mode.	
Display and default values	**Range**	**Description**
COMM. PROTOCOL MODBUS	Modbus	Sets communication protocol. Operational when the optional communication PCB is installed.
BAUD RATE 9600 (MODBUS)	1,200, 2,400, 4,800, 9,600	Sets baud rate.
PARITY CHECK EVEN	Even and odd numbers	Sets communication to parity check.
SERIAL LINK NO. OFF	Off, 1 to 247	Sets communication serial link number.
S. LINK PAR. SAVE DISABLE	Enable/disable	Enables parameters modification via serial communication.
SER. LINK CONTROL DISABLE	Enable/disable	Enables start, stop, reset, etc., via serial communication.
FRONT COM ADDRESS OFF	Off, 1 to 247	Future enhancement.
STORE ENABLE COMM. PARAMETERS		**Notes:** Same as store enable and protection. Refer to Main and protection - DCU display page 1 on page 39. After changing communication parameters and storing them, control power must be switched "off" and "on" to load new communication parameters.

Table 27: Communication parameters - DCU display page 7 - Profibus card

DCU display page 7	Range	Description
COMM. PARAMETERS - **** -	Displays on maximized mode only. Refer to Control module - dip-switch settings on the main PCB on page 27 for changing mode.	
Display and default values	**Range**	**Description**
COMM. PROTOCOL MODBUS	Profibus/Modbus	Sets communication protocol. Operational when the optional communication PCB is installed.
BAUD RATE AUTO (PROFIBUS)		User can not change baud rate value. Maximum rate is 12 Mbps.
PROFI.NETWORK ID OFF	Off, 1 to 126	Sets the Profibus network identification. When set to off, the Profibus PCB will not function.
S. LINK PAR. SAVE DISABLE	Enable/disable	Enables parameters modification via serial communication.
SER. LINK CONTROL DISABLE	Enable/disable	Enables start, stop, reset, etc., via serial communication.
FRONT COM ADDRESS OFF	Off, 1 to 247	Future enhancement.
STORE ENABLE COMM. PARAMETERS		**Notes:** Same as store enable and protection. Refer to Main and protection - DCU display page 1 on page 39. After changing communication parameters and storing them, control power must be switched "off" and "on" to load new communication parameters.

Table 28: Statistical data - DCU display page 8

DCU display page 8	Range	Description
STATISTICAL DATA - **** -	Displays on minimized and maximized modes.	
Display and default values	**Range**	**Description**
T SINCE LST STRT NO DATA		Displays time since last start in minutes.
LAST STRT PERIOD NO DATA		Displays last starting time in seconds. Starting time is the duration until motor current drops to nominal.
LAST START MAX I NO DATA		Displays last starting maximum starting current.
TOTAL RUN TIME 0 HOURS		Displays the motor's total run time.
TOTAL # OF START 0		Displays the total number of starts.
TOTAL ENERGY 0 KWH		Displays motor kWH consumption.
TOTAL R. ENERGY 0 KVARH		Displays motor kVARH consumption.
LAST TRIP NO DATA		Displays the cause of the motor last trip.
TRIP CURRENT 0 % OF FLA		Displays motor current when the motor was tripped by the soft starter protection.
TOTAL # OF TRIPS 0		Displays the total number of trips.
LAST 10 TRIPS: hh.mm mm.dd.yy		Displays motor trip history.
PREVIOUS TRIP-1 hh.mm mm.dd.yy		
PREVIOUS TRIP-2 hh.mm mm.dd.yy		
NO DATA		
NO DATA		

Motor and soft starter protection

Protection functions are distinguished between adjustable protection functions and non-adjustable protection functions. Upon fault, the motor stops, fault LED lights and fault relay contact opens.

The LCD shows TRIP: < fault description>. (For example, TRIP: UNDERCURRENT).

NOTICE

When a fault occurs, refer to the commissioning and troubleshooting sections of this instruction manual and instruction manual IC1000-F320-A105-XX-XXXX before attempting to identify the cause of the fault.

Adjustable protection functions

Undercurrent

The function undercurrent trips the soft starter when line current drops below the preset level for the preset time.

Check undercurrent trip and undercurrent delay settings; check line currents through L1, L2, L3. For protection parameters settings, refer to Main and protection - DCU display page 1 on page 39.

O/C – shear pin

The function O/C - shear pin trips the soft starter:

Instantaneously when current exceeds 850- percent of starter FLC

- During starting when current exceeds 850-percent of motor FLA
- During running when current exceeds 100-850-percent of motor FLA with a programmable delay of 0-5 s. Delay is overridden when current reaches 850-percent of starter FLC.

Check that the motor is not stalled or jammed. Check motor FLA, starter FLC settings. Check motor and cable connections. Perform an insulation-resistance test to verify motor and cable insulation condition. For protection parameters settings, refer to Main and protection - DCU display page 1 on page 39.

Overload

The overload function trips the soft starter when current exceeds the overload trip level and the thermal register has filled up. Check motor FLA, starter FLC and overload settings and check motor current, then wait at least 15 minutes to let the motor and soft starter cool down before restarting. Also check motor thermal capacity as displayed in the data page refer to Display mode - DCU display page 0 on page 38. For protection parameters settings, refer to Main and protection - DCU display page 1 on page 39.

Current unbalance

Current unbalance is the difference between maximum and minimum values of motor three line currents divided by motor maximum current or motor FLA, whichever is greater. A fault condition is set when the actual unbalance is greater than the setpoint for more than unbalance delay. For protection parameters settings, refer to Main and protection - DCU display page 1 on page 39.

Ground fault

The function trips the motor when ground current exceeds the preset ground fault trip for more than ground fault delay. Check motor and cable connections.Perform an insulation-resistance test to verify motor and cable insulation condition. For protection parameters settings, refer to Main and protection - DCU display page 1 on page 39.

Under/no voltage
The function under/no voltage trips the soft starter when line voltage drops below the preset level for the preset time. When voltage drops to zero, the Soft Starter trips immediately with no delay. Check undervoltage trip and undervoltage delay settings, check line voltages on L1, L2, L3.For protection parameters settings, refer to Main and protection - DCU display page 1 on page 39.

Overvoltage
The function overvoltage trips the soft starter when line voltage increases above the preset level for the preset time. Check overvoltage trip and overvoltage delay settings, check line voltages on L1, L2, L3. For protection parameters settings, refer to Main and protection - DCU display page 1 on page 39.

Long start time
The function long start time trips the soft starter if output voltage does not reach nominal at the preset maximum start time. Check motor FLA, starter FLC and maximum start time settings. Increase initial voltage, current limit and maximum start time or decrease acceleration time as necessary. For parameters settings, refer to Start parameters - DCU display page 2 on page 43.

Open bypass
The function open bypass operates when the bypass contactor does not close after end of acceleration (EOA) contact of the soft starter closes.

Note: This protection can be disabled by setting bypass open trip to disable when the bypass is connected to a separate circuit such that the starter CTs do not measure motor current when the bypass contactor is closed.

For parameter settings, refer to Fault parameters - DCU display page 5 on page 51.

Set curve to 0
Trip occurs if the soft starter is programmed with a non-suitable preset starting curve for the application. Change start parameters to soft start curve 0. The curve requires a minimum of starting feedback information from the control module. For parameter settings, refer to Soft start curves on page 47.

Power on and no start
Operate upon main voltage energization. The function is activated when main voltage is connected to the soft starter for more than 30 s without a start signal.

Note: This protection can be disabled by setting power on and no start to disable. Consult factory before setting power on and no start to disable.

Reset the fault and initiate the start command within less than 30 seconds after main voltage is applied to L1, L2 and L3.

Motor insulation (optional)
The function motor insulation trips the soft starter when the motor insulation level decreases below the trip level set. Check motor and cable insulation level. For insulation alarm/trip protection settings, refer to Fault parameters - DCU display page 5 on page 51.

Phase sequence
The function phase sequence trips the soft starter if line phase sequence is wrong. The soft starter can be operated in any phase sequence as set in the phase sequence protection of the soft starter. It allows the starting of the motor in positive sequence (normally, A, B, C or 1, 2, 3) of the main voltage OR in the NEGATIVE sequence (usually, C, B, A or 3, 2, 1) of the main voltage or, when set to ignore, in both sequences. For phase sequence protection setting, refer to Fault parameters - DCU display page 5 on page 51.

Too many starts

The function of too many starts trips the soft starter if number of starts during start period exceeds the preset number.When active, restart will be delayed until the motor and the starter cool down according to start inhibit setting. For protection setting refer to Start parameters - DCU display page 2 on page 43.

Non-adjustable protection functions

Under/over frequency

The function under/over frequency trips the soft starter if frequency is not in the range of 44 Hz to 65 Hz. Check that frequency variations are between 44 Hz to 65 Hz.

Phase loss

The function phase loss trips the starter if one or two phases are missing. Check lines voltages and correct connection.

Wrong parameters

The display shows the wrong parameters if after power up, the parameters are not transferred from RAM to EEPROM or vice-versa. Press reset then load default parameters. Refer to overview of all mode pages and factory default settings on page 36 for more details on loading default parameters. Note that obtaining default parameters erases all previously modified settings and requires the operator to reprogram all parameters differing from the factory default.

Notes: It is especially important to reprogram the rated line voltage and starter FLC (as shown on the label of the soft starter) and all other parameters in main and protect mode page. Refer to Main and protection - DCU display page 1 on page 39.

Storage error

If the display shows storage error when trying to store parameters at the end of a mode page or after loading default parameters, this indicates that the process of storing parameters was unsuccessful. Refer to overview of all mode pages and factory default settings on page 36 or Annex A on for factory default parameters. Press reset and try again. If the condition persists, load default parameters. Refer to overview of all mode pages and factory default settings on page 36. Note that obtaining default parameters erases all previously modified settings and requires the operator to reprogram all parameters differing from the factory default.

Notes: It is especially important to reprogram the rated line voltage and starter FLC (as shown on the label of the soft starter) and all other parameters in main and protection mode page. Refer to Main and protection - DCU display page 1 on page 39.

S. SCR or WR. CON

The function S. SCR or WR. Con is operational after start signal. Trips if motor is not properly connected to the soft starter load terminals, when:

- Motor winding opened or shorted.
- One or more of the SCRs have been shorted.
- Incorrect fiber-optic leads connection.

This protection is not active when soft start curve 0 is selected.

Using an ohmmeter, check the resistance value between SCR/anode and SCR/cathode (heat sink to heat sink). The resistance values should exceed 10 kΩ. The testing method is detailed in Figure 14: SCR anode to cathode resistance test. Refer to Power SCR verification on page 89 for cathode-to-cathode resistance measurement method.

SCRs may fail due to:

- High short current not protected by proper fuses.
- High voltage transients not protected by proper external varistors.
- Frequent starting at maximum conditions or fault conditions.

Over temperature

Thermal sensors are mounted on the heat-sinks of the power section and trip the soft starter when the temperature rises above 185° F (85 °C). If this occurs, the display shows over temperature.

NOTICE

The over temperature protection is designed to operate under normal conditions, such as during extended low overload, insufficient ventilation due to fan stoppage or air flow blockage.

Incorrect soft starter selection, frequent starting at maximum conditions or repeated starting under fault conditions can cause the SCR to overheat and fail before the heat-sink reaches 185° F (85 °C), causing the thermal sensors to trip the soft starter.

External fault 1 and external fault 2

External faults becomes operational when soft starter is energized. The soft starter will trip if contact between terminals 19 and 21 closes for more than 2 s.

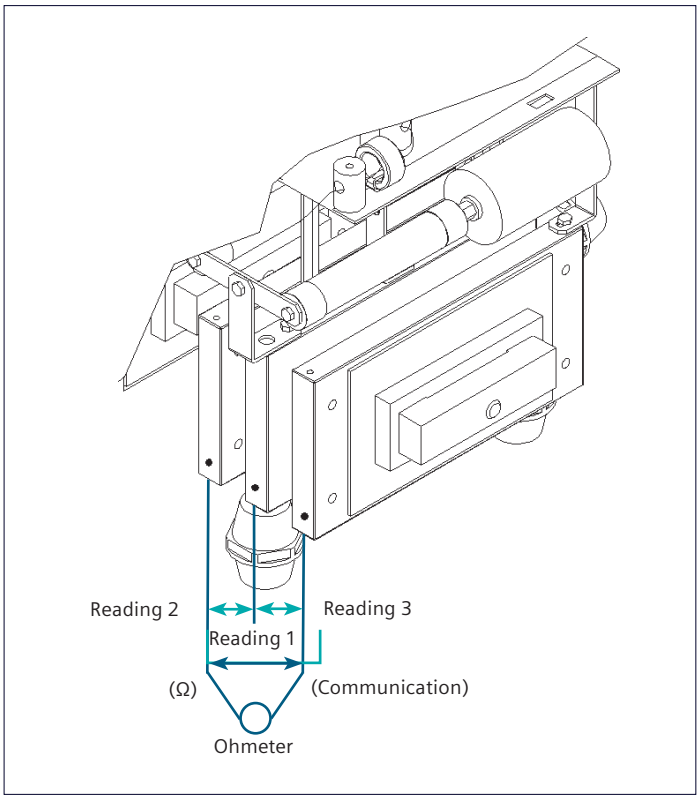


Figure 18: SCR anode to cathode resistance test

Fault and reset Manual reset

When any of the above protections trip (except insulation alarm), the soft starter locks in a fault condition thus disabling firing of the SCR. In this condition, the fault LED lights (refer to Figure 11 on page 24 and Table 15: Status LEDs on page 32), the fault description is displayed on the LCD, and the fault relay operates.

- For local reset, after fault has been removed, press reset key.
- Remote reset can be performed through terminals 7 or 8 (refer to I/O programming parameters - DCU display page 6 on page 53.

When a fault occurs, followed by a voltage outage, the fault condition is latched and reappears upon voltage restoration.

Note: Reset (local, remote, serial link or auto-reset) is not possible as long as the start signal exists, except for undercurrent trip.

Auto-reset
Undervoltage and phase loss faults can auto-reset (refer to fault parameters - DCU display page 5 on page 51). The soft starter will reset itself 60 s after voltage is fully restored, provided that the start signal is removed.

Undercurrent fault can be set to auto-reset (refer to fault parameters - DCU display page 5 on page 51).

The soft starter will reset itself when a programmed time delay has elapsed even if the start signal is not removed.

Motor insulation alarm auto-resets if the insulation resistance exceeds the insulation alarm level (refer to fault parameters - DCU display page 5 on page 51).

Optional devices
RTD relay (TPR-6/6 and 14) (refer to Figure 19: RTD relay TPR-6/6 and 14 low-voltage wiring diagram)
Before setting the TPR-6/6 and 14, read the TPR-6/6 and 14 instruction manual.

The TPR-6 temperature protection relay is a micro-processor based relay, designed to protect electric motors, transformers and other systems from over temperature.

The TPR-6 accepts up to 6 or 14 temperature inputs, that can be programmed for use with thermistors (PTC or NTC) and RTDs (PT100).

Each temperature input can be disabled or enabled, designated as thermistor-PTC or thermistor-NTC or RTD (PT100). Protection levels and time delay are programmable as well as grouping for combining the data in the analog output.

Back-up motor protective relay (MPR) and power meter (PM)
Before setting any motor protective relay and/or power meter, read the instruction manual.

If the motor protective relay or the power meter uses separate (not the internal soft starter) CTs, then set the MPR or the PM according to the manufacturer's instruction manual.

Notes: Inside the soft starter, there is an EPT (electronic potential transformer) and there may also be an optional voltage transformer. The primary rated voltage is according to the starter rated voltage and the secondary rated voltage is 120 Vac.

In the situation where the motor protective relay or the power meter is integrated into the soft starter assembly and is using the current measurement performed by the soft starter internal CTs, special attention must be given to the setting of these devices as discussed below.

- Inside the soft starter, special CTs are used. The primary rated current is according to the starter rated current.
- The secondary rated current of the standard soft starter devices is 2 A. External MPR and PM devices generally require a 5 A input.

CT primary conversion for 5 A MPR or PM current input
If the rated starter current is, for example, 1,000 A, the soft starter CTs are rated 1,000 A/2 A. Note that CTs secondary current is 2 A and external MPR and PM devices require a current input of 5 A. In the situation having 1,000 A flowing, the MPR and PM will receive 2 A instead of 5 A, and will calculate 2/5 x1,000 = 400 A if the MPR and PM are set for a CT ratio of 1,000:5. To compensate for this, the MPR and PM must be set up for a CT ratio of 1,000 x (5/2) = 2,500 (or 2,500:5 ratio), which will allow the MPR and PM devices to read 1,000 A primary current as required.

Table 29: Timing occurrence

Timing and occurrence	Active during			
	Start	Run	Stop	Soft stop
Too many starts with start inhibit period	X			
Electronic overload with curve selection	X[1]	X[1]		
O/C shear pin (jam)				
Soft starter protection - trip immediately at I≥850% motor FLA in one cycle	X	X		X
Motor protection - trip function				
During start - factory set at 850% motor FLA after O/C delay	X			X
During run - adjustable 100% to 850% motor FLA after O/C delay		X		
Undercurrent adjustable time delay		X		
Unbalance current adjustable time delay	X	X		X
Ground fault current adjustable time delay		X		
Phase loss	X	X		X
Phase sequence	X	X	X	
Undervoltage with adjustable time delay. Time delay is overriden in case of phase loss	X	X		X
Overvoltage with adjustable time delay	X	X		X
Long start time (stall protection)	X			
Shorted SCR or wrong connection	X			X
External fault 1 and 2 - input from a NO contact	X	X	X	X
SCR protection by metal-oxide varistors (MOV)	X	X	X	X
Soft starter power section over-temperature	X			X
Soft starter internal test when "on" LED is lit	X	X	X	X
Motor insulation test (optional). Two levels for alarm and trip. When installed, operates when main voltage is removed.			X	
Power on and no start			X	
Bypass open trip		X		
Set curve to 0	X			

Footnote:

1. Electronic overload can be set to operate at all times, during run or it can be disabled.

Insulation-test unit (optional)

If the optional insulation-test unit is installed into the soft starter, refer to the particular instruction manual for operation details. The insulation-test unit monitors deterioration in motor insulation while a motor is de-energized.

Operational notes

- The seven logic inputs of the control module (terminals 4-5-6-7-8-9 and 19-20-21) are high-impedance inputs. An interposing relay should be used for each logic input connected through long wire to a remote location outside the SSRVS enclosure.
- Do not connect power factor correction capacitors in parallel with the motor at the output side of the soft starter. It may cause damage to the starter and/or capacitors.

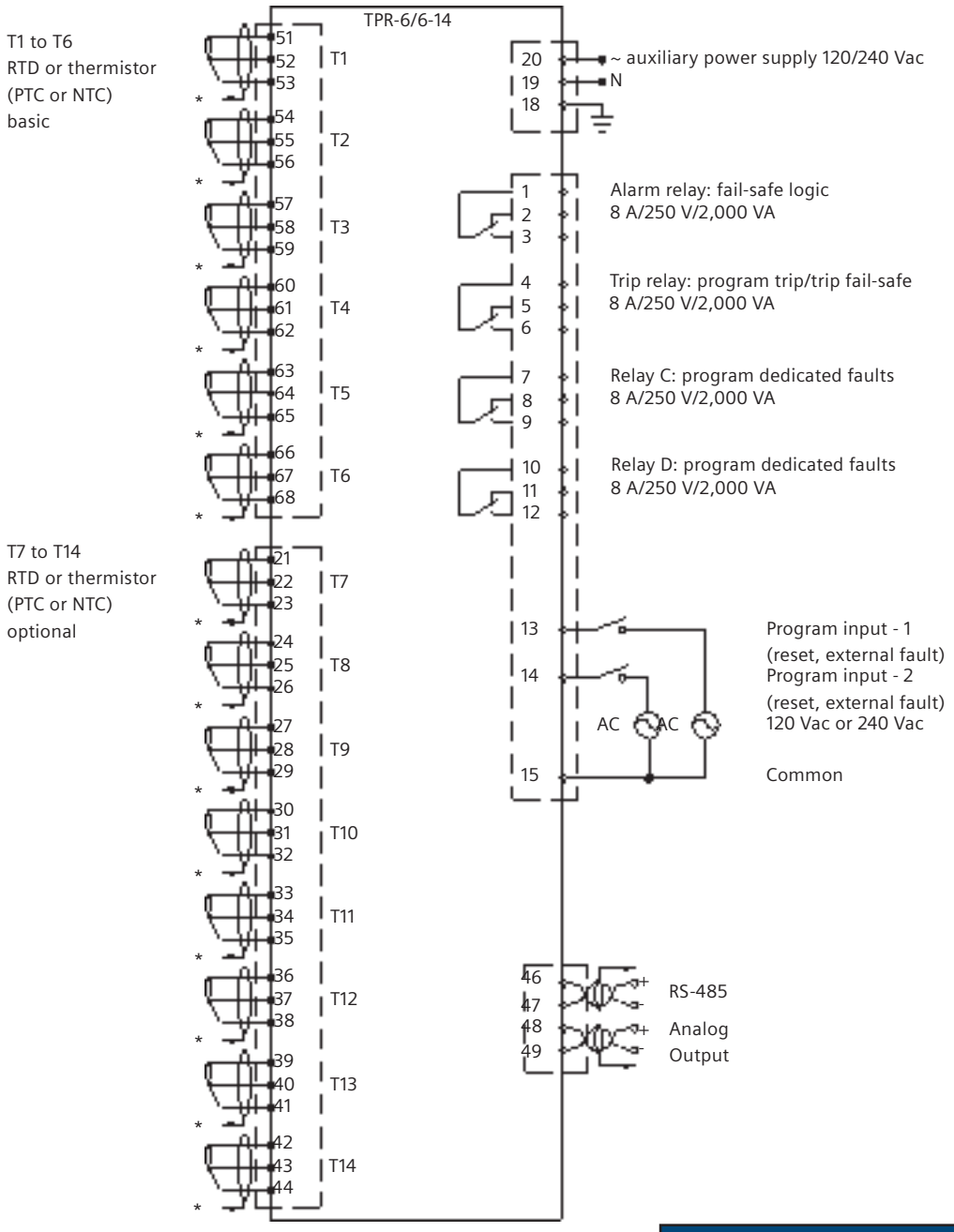
NOTICE

Do not connect capacitors on the motor side of the soft starter.

If capacitors are connected on the motor side of the soft starter, harmonic currents during starting or stopping may damage the capacitors.

- Do not use power factor capacitors at all if the starter is powered from a generator. The capacitors may disturb the voltage regulator of the generator. It may result in significant overvoltages.
- If there are power factor capacitors connected upstream from the starter, and they are mounted close to the starter, it is recommended that the capacitors be disconnected until commissioning is completed.
- Perform an insulation-resistance test on the motor and its cables while disconnected from the soft starter. After the test, leave the cables disconnected to enable the low-voltage testing.
- Solid state devices exhibit very fast switching "on" times of the order of 1 to 2µs (500 kHz to 1 MHz). Fast network and/or system status transition requires special attention from the electrical system designer. DV/dt must be limited to 1,000 V/µs and di/dt lower than 15A/µs during solid-state device operation. Medium-voltage cable lengths should be limited between the unit and the motor as follows to limit the stray capacitance accumulation effect:
  - Less than 1,000 feet (305 meters) (up to 7.2 kV)
- The voltage drop on the primary side from the feeder transformer must not exceed 40 percent during the motor/load application acceleration period.

Figure 19: RTD relay (TPR-6/6 and 14) low-voltage wiring diagram



NOTICE

The analog output circuit is isolated as a group together with the RS-485 communication. When using both connections, verify that analog out user (or RS-485 user) is isolated circuitry.*

* Connect all shield wires to ground

Operation

⚠ DANGER

Hazardous voltages.

Will cause death, serious injury or property damage.

Disconnect, lockout, and ground incoming power and control voltage sources before beginning work on this or any other electrical equipment.

All pre-energization checks outlined in this instruction manual and in instruction manual IC1000-F320-A105-XX-XXXX must be performed before the equipment is energized. This equipment should be energized by qualified personnel only.

Pre-energization check

After installation, field additions or maintenance, the following checklist should be followed in addition to the checklist in instruction manual IC1000-F320-A105-XX-XXXX:

1. Remove all blocks or other temporary holding means used for shipment from all component devices in the controller interior.
2. Retighten all accessible connections in accordance with the torque values provided in Table 30 on page 67.
3. Check the integrity of the bus supports.
4. Check the enclosure to see that it has not been damaged and that electrical spacing has not been reduced.
5. Compare all circuits for agreement with the wiring diagrams that accompany the controller.
6. Make certain that external wiring is clear of bus, and all power wiring is physically secured to withstand the effects of the largest fault current that the supply system is capable of delivering.
7. Verify that all ground connections have been made properly. If sections of the controller were shipped separately, they must be connected in a manner to assure a continuous ground path.
8. Check all devices for damage. Make necessary repairs or replacement prior to energizing.
9. Be sure that each motor is connected to its intended starter. Ensure that fuse rating is in agreement with the rating shown on the drawings.
10. Manually exercise all operating mechanisms, vacuum contactors, magnetic devices and other devices to make certain that they are properly aligned and operate freely.
11. With all loads disconnected, exercise all electrically operated devices with test power to determine that they operate properly. Refer to the wiring diagrams for the required control voltage, frequency and test power terminal designations required to test the vacuum contactor. For the vacuum contactor, this should also include tests at the lower limits of pickup voltage as shown in instruction manual IC1000-F320-A105-XX-XXXX.

12. Test the ground fault protection system (if furnished) in accordance with the manufacturer's instructions.
13. Set all devices with adjustable current and/or voltage settings to proper values.
14. Ensure that overload relay current range and setting is in agreement with the full load current and service factor shown on the nameplate of each motor, taking into account the current transformer ratio used in the controller.
15. Make sure that all fuse connections are correctly torqued.
16. Install any necessary CT circuit wiring, and remove CT short-circuiting jumpers installed for shipment. (Do not remove CT short circuiting jumpers if no load circuit is connected to the CT). If short circuiting type terminal blocks are provided, assure that short circuiting screws are removed or shorting links are in the open position. Check each current transformer secondary circuit for continuity through its protective devices to ground. Do not operate a motor controller with a current transformer's secondary circuit open.
17. To prevent possible damage to equipment or injury to personnel, check that all parts and barriers that may have been removed during wiring and installation have been properly installed.
18. Before closing the enclosure, remove all metal clips, scrap wire, and other debris from the controller interior. Remove any accumulation of dust or dirt, clean out the controller by using a brush, vacuum cleaner or clean lint-free rags. Do not used compressed air, as it will only redistribute contaminants on other surfaces.
19. After all of the power and control connections are made and with all incoming power disconnected, conduct insulation-resistance tests in accordance with the Insulation-resistance test section of this manual on page 68.
20. Install covers, close doors and make certain that no wires are pinched and that all enclosure parts are properly aligned and tightened.
21. Make sure that all current-carrying parts outside the controller have adequate current-carrying capacity and are correctly insulated in accordance with the requirements of the National Electric Code (NEC). All electrical connections should be made carefully per the wiring diagram furnished with the equipment. Tighten all terminals to recommended torque values (refer to Table 30). Use recommended crimping tools if crimp lugs are supplied.

Table 30: Recommended torque values

Thread size	Standard torque metal-to-metal (in-lbs/Nm)	$^{2}/_{3}$ standard torque metal-to-insert (in-lbs/Nm)	$^{1}/_{2}$ standard torque compound-to-insert (in-lbs/Nm)	$^{1}/_{2}$ standard torque compound-to-compound (in-lbs/Nm)
8-32	14-20/1.6-2.3	10-14/1.0-1.6	7-10/0.8-1.2	7-10/0.8-1.2
10-32	20-30/2.3-3.4	13-20/1.6-2.3	10-15/1.2-1.8	10-15/1.2-1.8
1/4-20	40-60/4.5-6.8	26-40/3.2-4.5	20-30/2.3-3.4	20-30/2.3-3.4
5/16-18	168-228/19-25.8	110-150/12.4-17	84-114/9.5-13	84-114/9.5-13
3/8-16	240-360/27-41	160-240/18-27	120-180/13.5-20.5	120-180/13.5-20.5
1/2-13	480-600/54-68	320-400/36-45	240-300/27-34	240-300/27-34

⚠ DANGER

Hazardous voltages.

Will cause death or serious injury.

Follow safe procedures. Exclude unnecessary personnel. Use safety barriers. Keep away from equipment during application of test voltages. Dielectric or Megger* testing should only be conducted by qualified personnel. Refer to dielectric test equipment instructions for safety instructions.

⚠ WARNING

Vacuum interrupters may emit X-ray radiation.

Can result in death or personal injury.

Excessive dielectric test voltage can cause X-radiation to be emitted from vacuum interrupters.

Refer to vacuum contactor instruction manual for dielectric test procedures applicable to the vacuum contactor.

Insulation-resistance test

An ac dielectric test, at 2.25 times the nominal system voltage plus 2,000 V, for one minute, between all phases and from all phases to ground was performed at the factory as part of production. A high-potential test on the soft-starter circuits is not recommended as a field test.

An insulation-resistance test (5 kVdc) is recommended as discussed on page 69.

Since wide variations can occur in insulation values because of atmospheric conditions, contamination and type of test equipment, discrete values for acceptability cannot be given.

* Megger is a registered trademark of Megger Group, Ltd.

Making and recording tests on new equipment, however, and again at regular intervals, will give a comparative indication of change in the condition of insulation. Maintaining a permanent record of these values should be part of the maintenance program.

An ac dielectric test is recommended of the vacuum contactor, disconnected from the soft-starter circuit. This test should be conducted with test applied across the open contacts of the vacuum interrupter, at the test voltage indicated in the instruction manual for the vacuum contactor.

Notes: Do not use dc high-potential testers incorporating half-wave rectification. These devices produce high peak voltages.

⚠ DANGER

Hazardous voltages.

Will cause death or serious injury.

Follow safe procedures. Exclude unnecessary personnel. Use safety barriers. Keep away from equipment during application of test voltages. Dielectric or Megger* testing should only be conducted by qualified personnel. Refer to dielectric test equipment instructions for safety instructions.

These high voltages will produce X-ray radiation. These devices also show erroneous readings of leakage current when testing vacuum interrupters.

The power frequency-withstand test (high-potential test) is performed at the factory as part of production. A high-potential test on the soft-starter circuit is not recommended as a field test.

An insulation-resistance test (5 kVdc) is recommended between the three phases connected together as one group and ground (refer to Figure 20: Soft starter - preparations for insulation-resistance test - three-phases connected together on page 73). An insulation-resistance test should give a very high resistance result.

An insulation-resistance test is also recommended between the three phases (refer to Figure 21: Soft starter - preparation for insulation-resistance test - phase-phase on page 74). Both test set-ups require that the main contactor (MC) and bypass contactor (BPC) be closed or shorted with jumper connections, and also require that the system source be disconnected.

On a soft starter with EPT-TX is connected between the phases, the following minimum insulation resistance values are expected as detailed in Table 31: Resistance values.

* Megger is a registered trademark of Megger Group, Ltd.

Energizing equipment

1. In order to minimize risk of injury or damage, or both, there should be no load on the controller when it is initially energized. Turn off all of the downstream loads, including those such as distribution equipment and other devices which are remote from the controller.
2. The equipment should be energized in sequence by starting at the source end of the system and working towards the load end. In other words, energize the incoming power to the controller or group of controllers, then close the incoming line load-interrupter switch or circuit breaker (if available) and then close the isolating switch for the specific controller involved.
3. After all disconnect and isolating devices have been closed, loads such as motors may be turned on to verify that the system operates as intended.

Table 31: Resistance values

Soft starter rated voltage	L1 to L2 MΩ	L2 to L3 MΩ	L1 to L3 MΩ
2.3 kV	>0.5	>3.0	>4.0
4.16 kV	>1.0	>7.0	>8.0
7.2 kV	>1.5	>11.0	>12.0

Soft starter operation and testing

NOTICE

Refer to Figure 9: Typical one-line diagram (power and control schemes) on page 15 and Figure 2: SSRVS components (typical, up to 5.0 kV, 400 A shown) on page 7.

- The diagram shows a standard wiring for ac control voltage.
- The drawing represents typical soft starter electrical (power and control) configurations.
- Note that the controller you have might be wired differently. The illustrations in this manual are only for generic information. Always refer to the drawings for the specific order for actual wiring.

Soft starter operation description

Refer to general description for Low-voltage and medium-voltage main components, beginning on page 7.

Local soft start process

1. Local soft start process is initiated while the following electrical conditions are met:
   - The start pushbutton (PB/start) is depressed
   - The optional control switch SW/L-R (local-remote) is at "local" position
   - The control switch SW/SS-DOL (soft start–direct on line) is at "soft start" position
   - The control switch SW/RUN-TEST is at "run" position
   - The control switch SW/TF (test firing-off) is at "off" position.
2. R/RS control relay is energized and the R/RS normally open contact connected in parallel with the start pushbutton holds the relay energized.
3. Main contactor (MC) is now energized via a normally open contact of R/RS control relay.
4. Start command to the soft starter is initiated after the MC is closed via another normally open contact of R/RS control relay to the soft starter by connecting control voltage to terminals 5 and 6 of the soft starter.
5. R/SMPS control relay is energized and energizes the SMPS transformer via its normally open contact. SMPS transformer supplies 24 Vac to the switch mode power supplies, which supplies energy to the firing boards.
6. R/SS (soft stop/immediate) control relay is energized immediately after start command is initiated to the soft starter.
7. The starter ramps up the voltage to the motor until it reaches full voltage condition.
8. Control relay R/AS (at speed/end of acceleration) is energized after programmable time delay (default of 5 s). The bypass contactor (BPC) is energized through the normally open contact of R/AS control relay.
9. R/SMPS control relay de-energizes after 2 s and disconnects the firing transformer from the control voltage.
10. Motor is now running with the BPC closed and the soft starter power section is idle.

Local soft stop process

1. Local soft stop process is initiated when the stop pushbutton PB/stop is depressed.
2. R/RS control relay is de-energized. Soft starter terminals 4 and 5 are disconnected from the control voltage which causes the soft starter to enter into soft stop process.
3. R/SMPS control relay is energized and energizes the SMPS transformer via its normally open contact. SMPS transformer supplies 24 Vac to the switch mode power supplies, which supply energy to the firing boards.
4. R/AS control relay de-energized (at speed/end of acceleration). Bypass contactor (BPC) de-energizes via the normally open contacts of R/AS control relay.
5. The soft starter ramps down the voltage to the motor.
6. At the end of the soft stop process the soft starter de-energizes R/SS (soft stop/immediate) control relay. Normally open contact of R/SS control relay in series with a normally open contact of main contactor (MC), which holds the MC energized. This enables the MC to be energized until the soft stop process is concluded.
7. R/SMPS control relay is de-energized and de-energizes the firing process via its normally open contact.

Upon fault condition

If trip condition is detected by the soft starter, the control relay R/FT (fault trip) is energized from control module terminal 13. R/FT control relay normally closed contacts open and de-energize R/RS control relay, MC and control module terminal 10.

The three indicating lamps turn "on" and confirm the trip condition (typical soft starter model only).

Remote soft start process (optional)

Selector switches position:

1. Local/remote/off optional selector switch is in the remote position
2. DOL/soft start selector switch is in soft start position.

The process is exactly the same as local soft start process above, but R/RS control relay is directly controlled by the remote start/stop contacts.

NOTICE

Refer to Figure 9: Typical one-line diagram (power and control schemes) on page 15 and Figure 2: SSRVS components (typical, up to 5.0 kV, 400 A shown) on page 7.

- The diagram shows a standard wiring for ac control voltage.
- The drawing represents typical soft starter electrical (power and control) configurations.
- Note that the controller you have might be wired differently. The illustrations in this manual are only for generic information. Always refer to the drawings for the specific order for actual wiring.

Soft start process through communication (optional)

Selector switches position:

1. Local/remote/communication/off optional selector switch is in the communication position.
2. DOL/soft start selector switch is in soft start position.

When the soft start process is to be controlled via communication, an additional relay R/PCB is required in the control module compartment.

When the selector switch is set to communication control, the R/RS control relay is monitored by the R/PCB relay.

Emergency bypass process

Selector switches position:

1. Local/remote/off selector switch (optional) is in the local or remote position.
2. DOL/soft start selector switch is in DOL position.

Switch the selector switch SW/SS-DOL to bypass position only for testing the soft starter or when the soft starter does not function properly.

When selector switch SW/SS-DOL is in DOL position, terminal 1 of the Control Module is disconnected. The soft starter is not in active mode and BPC closing coil is energized. Start/stop command is initiated, the soft start logic being bypassed.

Notes: When selector switch local/remote/communication/off is in Communication position, it is not possible to control the soft starter. When DOL/soft start selector switch is in DOL position motor is not protected unless additional protection is installed.

Low-voltage testing

Accessories required for low-voltage testing

1. Control cable – three wires (two wires and ground) and a two-position control switch, to connect the control voltage.

Notes: Rated power of the control power source should be 2.5 kVA minimum. This will ensure that any inrush current to the soft starter will not cause excessive voltage drop in the control circuitry.

2. Power cables (three phases and ground) and one fused three-phase switch, to connect the low-voltage 480 Vac three-phase main voltage to the cabinet. One side of the cable should be prepared with a connector to main voltage according to the type of connectors used at field. The other side with cable lugs or, more conveniently, with adequate alligator clips according to the bus bar size.

Notes: It is recommended that the 480 Vac power source capacity exceed the low-voltage inductive or resistive load by a factor of ten. Low kVA ratio between low-voltage power source and load may generate high-voltage distortion and prevent soft starter from operating properly.

3. Start/stop toggle switch to simulate the remote start/stop contact.

4. Three-phase 480 Vac induction motor
   5 HP to 10 HP or resistive load. The motor should be loaded by a fan or any other form of inertia (fly wheel) or the resistive load should be sized so that at least 1 A flows during testing. The resistive load test is sufficient to confirm the equipment functionality. The induction motor is recommended for troubleshooting.

5. Digital multimeter (600 Vac).

6. EPT testing module (if soft starter is supplied with standard VT sensor) (optional).

7. Testing harness with three colored wires (supplied with the controller, located in a small plastic bag in the drawing pocket).

Notes: Testing harness for other than 480 Vac can be ordered. The testing voltages (if other than the standard 480 V) is indicated on the testing harness.

Notes and warnings

Notes:

1. The controller is designed to ensure a complete test procedure for the controller, using the above accessories.

2. The test procedure should be used for the following:

   - To verify that the unit functions properly.
   - To learn the operational modes and options of the controller.
   - To test the controller together with the external control system (SCADA system, PLC system, etc.) It is strongly recommended that the user perform as many tests as possible in the low-voltage test mode to debug the external control system hardware and software in this low-voltage mode.
   - To debug the system, the soft starter and control circuits.

NOTICE

- Make sure that medium-voltage power source is disconnected and locked-out.
- Check that the testing control voltage is equal to the rated control voltage.
- Check that the three-phase main testing voltage is equal to 480 Vac +/-10% which is the standard testing voltage.
- Be familiar with the soft starter instruction manual (this document).

Figure 20: Soft starter - preparations for insulation-resistance test - three phases connected together

Open isolating switch.
Disconnect source or
remove primary fuses.
Close contactor for test.

Remove primary fuses
from CPT circuit

Remove primary fuses
from VT circuit

Close bypass
contactor for test

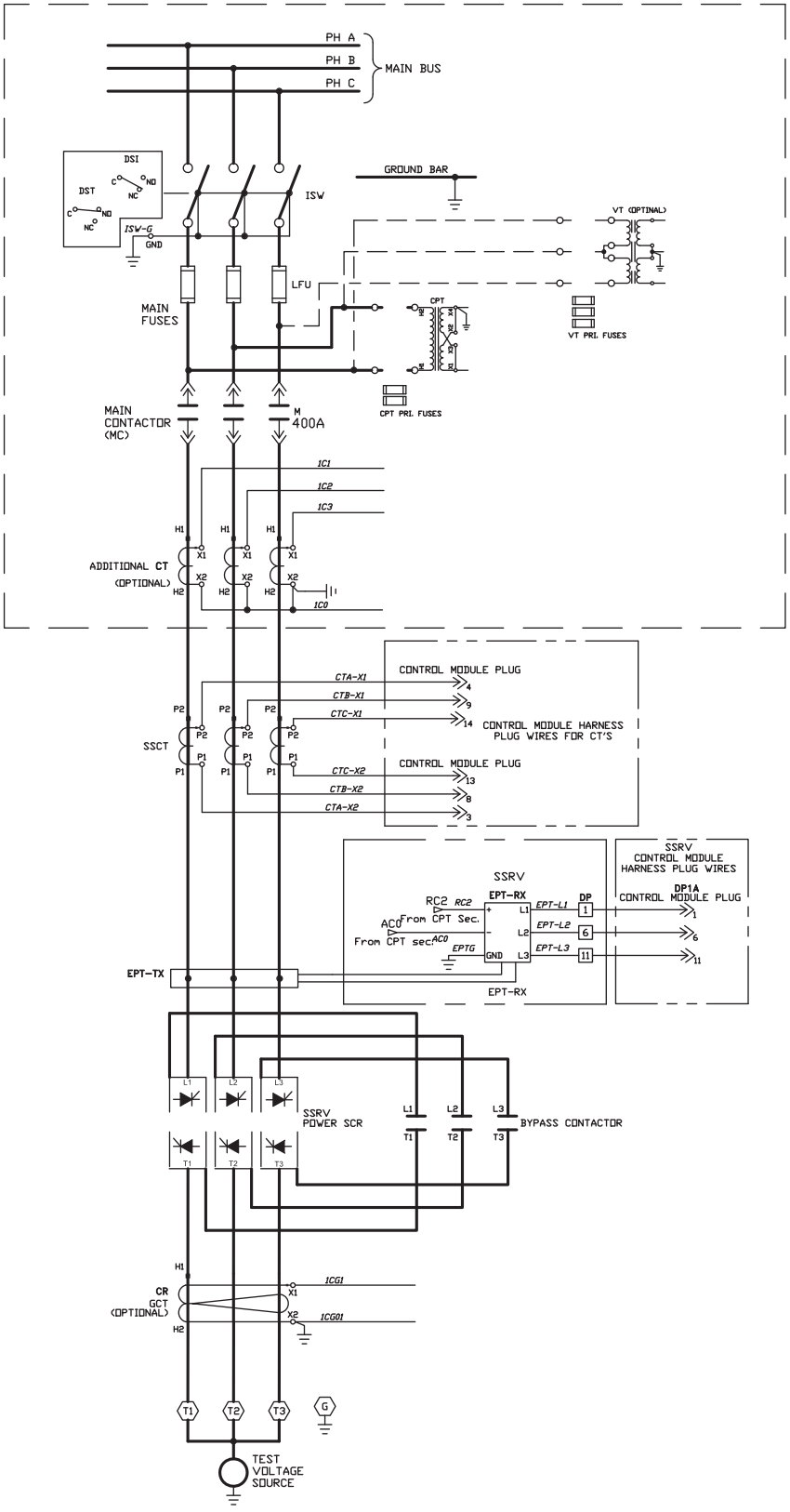


Figure 21: Soft starter - preparations for insulation-resistance test - phase-phase

Open isolating switch disconnect source or remove primary fuses. Close contactor for test.

Remove primary fuses from CPT circuit

Remove primary fuses from VT circuit

Close bypass contactor for test

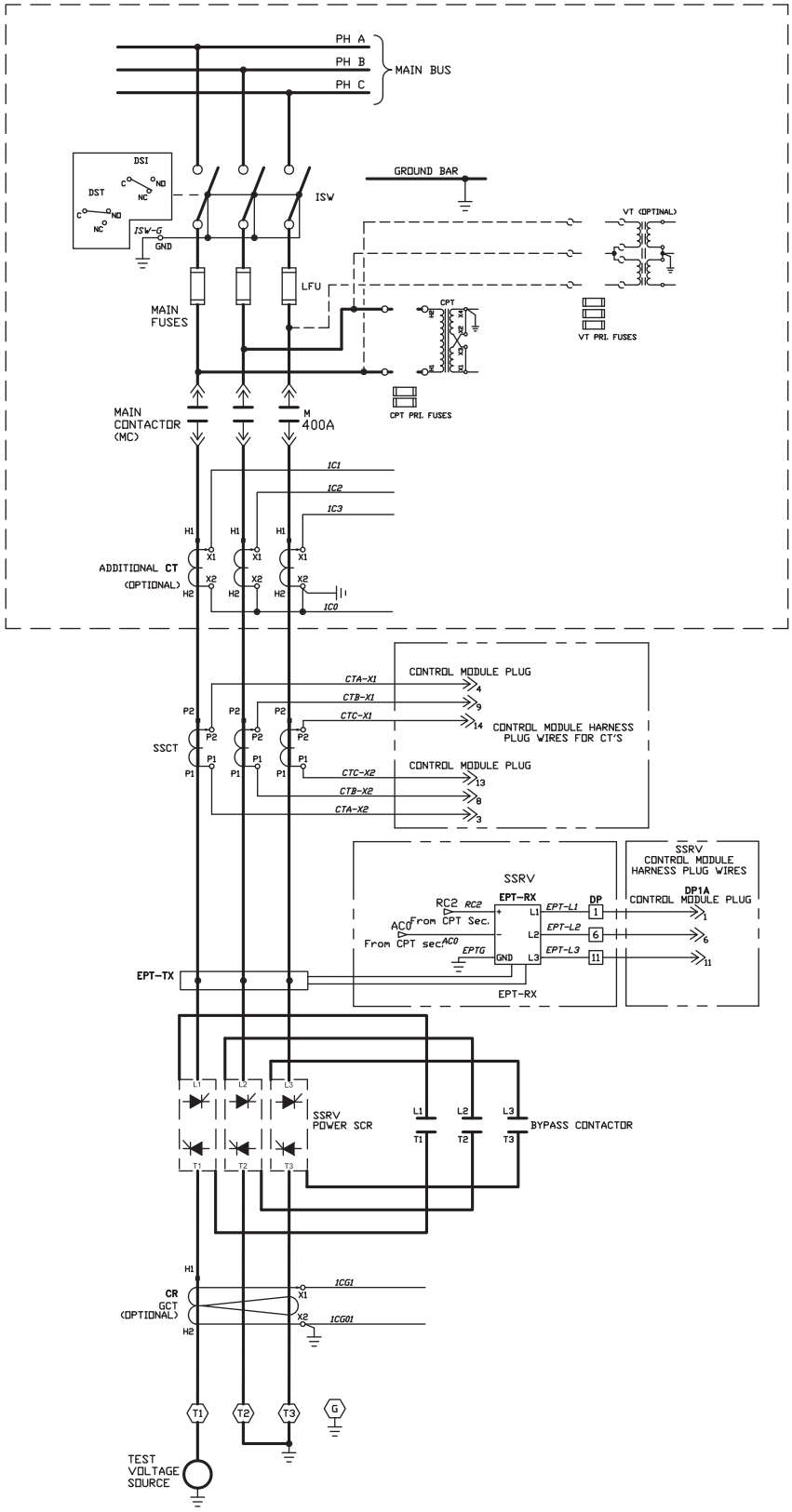


Figure 22: Low-voltage testing

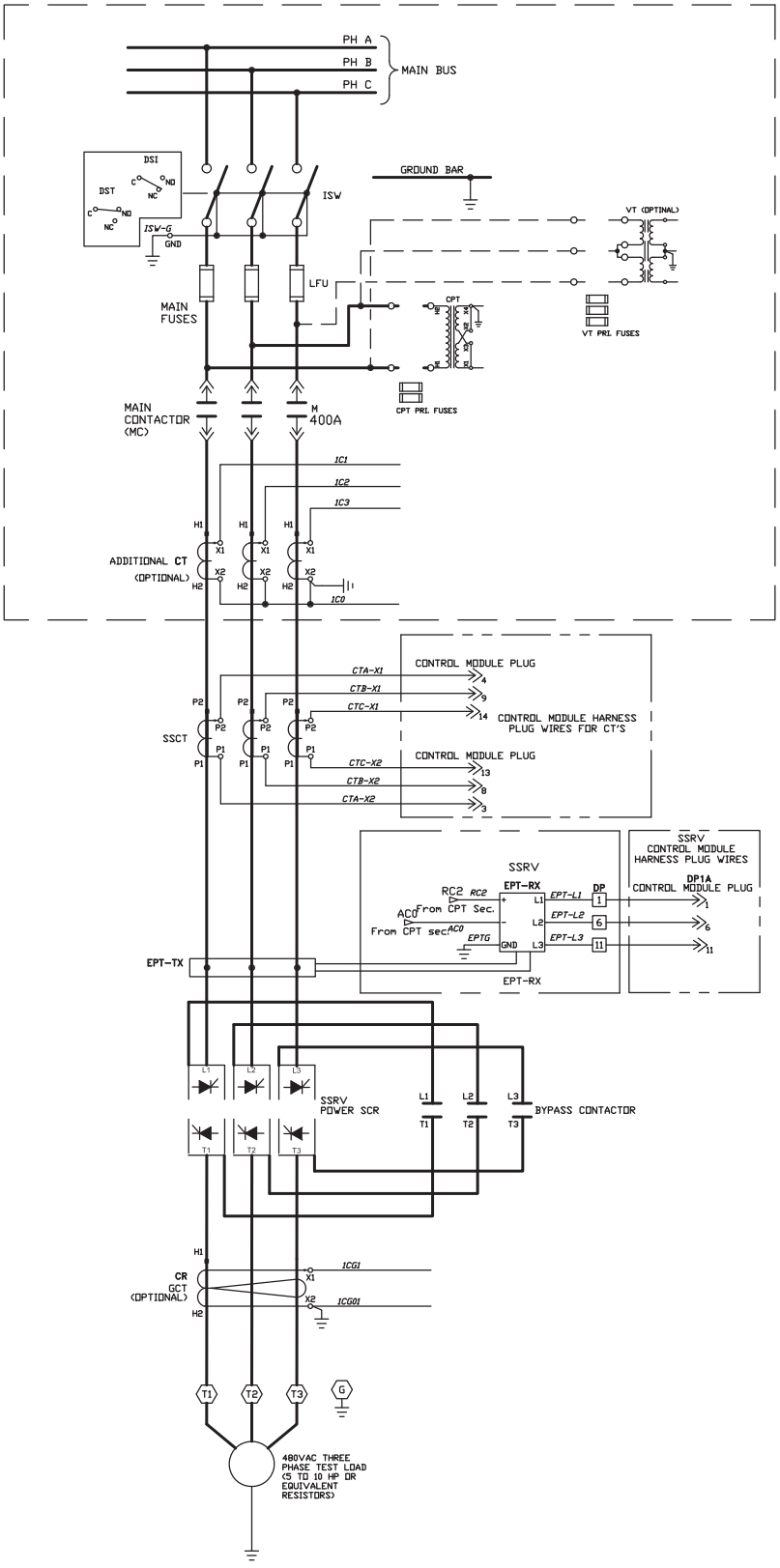
Open isolating switch disconnect source or remove primary fuses. Close contactor for test.

Remove primary fuses from CPT circuit

Remove primary fuses from VT circuit

Refer to EPT test harness installation on page 81.

Close bypass contactor for test



Low-voltage test procedure

1. Open isolating switch disconnect incoming primary voltage source from the controller (L1, L2 and L3).
2. Ground the incoming primary voltage terminals.
3. Follow established lockout/tag out procedures to prevent re-energization of the incoming primary voltage conductors.
4. Remove primary fuses from CPT circuit.
5. Secondary circuits for contactor should be connected.
6. Disconnect the medium-voltage motor connections from the output terminals of the controller (T1, T2 and T3).
7. Visual examination. Verify:
    - No mechanical damage
    - No loose screws
    - No excessive dust
    - No loose parts
    - No cut wires
    - No open fiber-optic wires
    - No broken insulators.
8. Verify ground connection to the ground bus of the controller.
9. Double check that the controller is isolated from both the power system (isolating switch open) and the medium-voltage motor (motor leads disconnected).
10. If the unit is equipped with typical voltage transformers:
    - Remove the primary current-limitng fuses from the voltage transformers
    - Disconnect the three voltage transformer medium-voltage connections.
11. Connect the low-voltage testing harness. Refer to Test harness installation in soft starter on page 81.
12. Connect low-voltage load cables to motor (5 HP to 10 HP, 480 V, 3Ø) or resistor sized to draw at least 1A at 480 V at the output terminals T1, T2 and T3.
13. Connect the control voltage cable (equipped with switch) to terminals TA1-8 and TA1-9 located in low voltage compartment.
14. Connect three-phase cable (equipped with switch) to the main load stabs. Refer to 480 Vac test source connection as noted in Figure 22 on page 77.
15. Connect the start/stop test remote control switch wires to customer terminals:
    - TA1-1 and TA1-2 located in low-voltage compartment for unit with local/remote control switch device.
    - Across PB/start terminal 3 and 4 in low-voltage compartment for unit without local/remote control switch device.
16. Verify isolating switch is open and contactor secondary circuits connected.
17. Set SW/T-S-T (start/test unit) to test unit position.
18. Set SW/DOL soft start selector switch to soft start position.
19. Set the SW/L-R local-remote-off selector switch to local.
20. Turn on control voltage.
21. Turn on the two position (on/off) control voltage switch.
22. The control module should be powered now (display should be on).
23. Verify that red indicating lamp (L/ON) is "on" and the two other lamps are "off."
24. At this time the user must be familiar with the soft starter settings, which are detailed in this instruction manual.
25. Press the reset button on the soft starter control module panel.

26. Enter Main and protection - DCU display page 1 parameters on page 39.
    - Rated line voltage as indicated on the soft starter label
    - Starter FLC as indicated on the soft starter label
    - Motor FLA as indicated on the soft starter label
    - Browse all the way down until you see the message: "store enable main & protect"
    - Press the store button and wait for the message: "data saved ok."
27. Enter start parameters, set:
    - Soft start curve set to 1! (standard)
    - Initial voltage set to 30 percent
    - Number of starts set to "off" (to enable unlimited number of starts with the low voltage motor)
    - Browse all the way down until you see the message: "store enable start parameters"
    - Press the store button and wait for the message: "data saved ok."
28. Enter stop parameters, set:
    - Soft stop curve set to 1! (standard)
    - Dec. time set to 10 s
    - Browse until you see the message: "store enable stop parameters"
    - Press the store button and wait for the message: "data saved ok."
29. Turn off the two position (on/off) control voltage switch.
30. Turn off the control voltage.
31. Release the four screws at the corners of the front panel of the soft starter control unit. Remove the front panel. Identify main PCB - PC2050 and fiber-optic PCB – PC2055.
32. On the main PCB – PC2050 set the required interface language on the display, the position of dip switches 5 and 6 need to be changed. Refer to Tables 10 and 11 on page 28.
33. On the fiber-optic PCB – PC2055 set current gain dip switches for low- voltage motor testing refer to Current gain dip-switches setting on page 79.

Dip switch #1	Dip switch #2	Gain
On	On	1
On	Off	5
Off	On	13.4
Off	Off	67

34. Check that the gain dip switches of the three phases are set identically.
35. Re-install the front panel.
36. Turn on the control voltage.
37. Turn on the two position (on/off) control voltage switch. While 480 Vac main test voltage is still not connected to the cabinet, press the start pushbutton. The main contactor (MC) is energized for a short time and then trips. "Under/no voltage" message is displayed on the screen of the soft starter control unit. Fault lamp lights on the external door.
38. Press reset on the control module. The fault indications are extinguished.
39. Turn on the (three-phase) main test voltage 480 Vac.
40. Verify that the main contactor (MC) is open.
41. Press the start pushbutton. The MC is energized and after a short time, the soft start process begins. The indicating lamp L/ON should indicate that the MC is closed. Since the 480 Vac test motor is not heavily loaded, the starter enters run conditions in few seconds. After in few more seconds (adjustable), the bypass contactor (BPC) closes and the indicating lamp (L/BPC) should indicate that the BPC is closed.
42. If the motor is not loaded, it may vibrate while reaching full speed. If this is the case, verify that soft start curve 1! is used and verify also that gain dip switches are in correct position. If it does not help, add load to the motor or install a larger motor for testing.Press the stop pushbutton.

43. The bypass contactor (BPC) opens and the starter ramps down the voltage to the motor. At the end of the soft stop process, the main contactor (MC) opens and the motor slows down until stop condition.

Notes: If the motor is not loaded, the motor may run normally and then stop abruptly at the end of the soft stop process. Using a low-current clamp-on ammeter, it can be seen that during the soft stop process, motor current is reduced to approximately one-half of its value while running before the soft stop process initiation.

44. Enter start parameters, set:
    - Acc. time set to 20 s
    - Current limit set to 300 percent
    - Browse all the way down until you see the message: "store enable start parameters"
    - Press the store button and wait for the message: "data saved ok"
    - Start the motor again and note that motor accelerates more slowly.
45. When the motor is stopped, change the local/remote selector switch (SW/L-R) to remote. Now, the start/stop pushbuttons at the controller have no effect.
46. Repeat the start/stop process using the external start/stop controls at the remote location.
47. While the motor is stopped, change the DOL/soft start selector switch (SW/DOL) to DOL. The bypass contactor (BPC) closes immediately. The control module should not be powered. Start the motor and notice that motor speed rises to full speed rapidly since it is exposed to full voltage immediately when main contactor (MC) is closed.
48. When the motor is stopped, set DOL/soft start selector switch (SW/DOL) to soft start position and set the local/ remote selector switch (SW/L-R) to local.
49. (If applicable) set the optional motor protection relay (MPR). Note that the MPR cannot sense the start and run process, since the testing low-voltage motor current is very low as compared to the rated current of the medium-voltage motor.
50. Reconfiguration of controller after low- voltage testing:
    - Verify that both main and control voltages are turned "off."
    - Disconnect testing harness from the EPT transmitter or EPT testing module. Put it back in the small plastic bag and return to the drawing pocket.
    - Disconnect testing main, motor and control external cables.
    - Reconnect cables to the three voltage transformers.
    - Connect motor cables to the load-side terminals (T1, T2 and T3).
    - Reinstall the primary fuse for the control power transformer in the fuse holder.
    - Close the medium-voltage compartment door and secure latches.
    - Front panel cover is already opened, flip the display unit by about 180° toward you to access and set the three dip switches (dual-toggles) located on PC2055 to "on." Turn back the display at its initial position, reinstall the front panel of the control module and fasten the four screws.
    - Connect control voltage to the controller.
    - Enter test/maintenance options (press mode and ∨) and press select three times until "store now?" default settings shows. Press mode and store. Verify that "data saved ok" message appears.
    - Enter test/maintenance options (press mode and ∨) and press select four times until "clear now? statistical data" shows. Press reset and store. Verify that "data saved ok" message appears.
    - Enter test/maintenance options (press mode and ∨) and press select five times until the clock adjustment display is shown. Set the time and date correctly.

- Enter main and protection parameters set:
  a. Rated line voltage as indicated on the soft starter label
  b. Starter FLC as indicated on the soft starter label
  c. Motor FLA as indicated on the motor label
  d. Rated motor power as indicated on the motor label
  e. Service factor as indicated on the motor label
  f. Browse until the message: "store enable main & protect" shows
  g. Press the store button and wait for the message: "data saved ok."
- Enter start parameters, set the parameters as required for the motor. If no other data is available, leave all parameters in their default values.
- Enter stop parameters, set the parameters as required for the motor. If soft stop process is used, it is recommended to use same curve as for soft start.
- To ensure that there are no mistakes in storing the parameters, it is advised to turn off the control voltage and then turn it on after 10 seconds. Verify that all above parameters are properly stored. Verify that statistical data is erased ("No data" message is displayed when browsing the statistical data).
- Turn off control voltage.

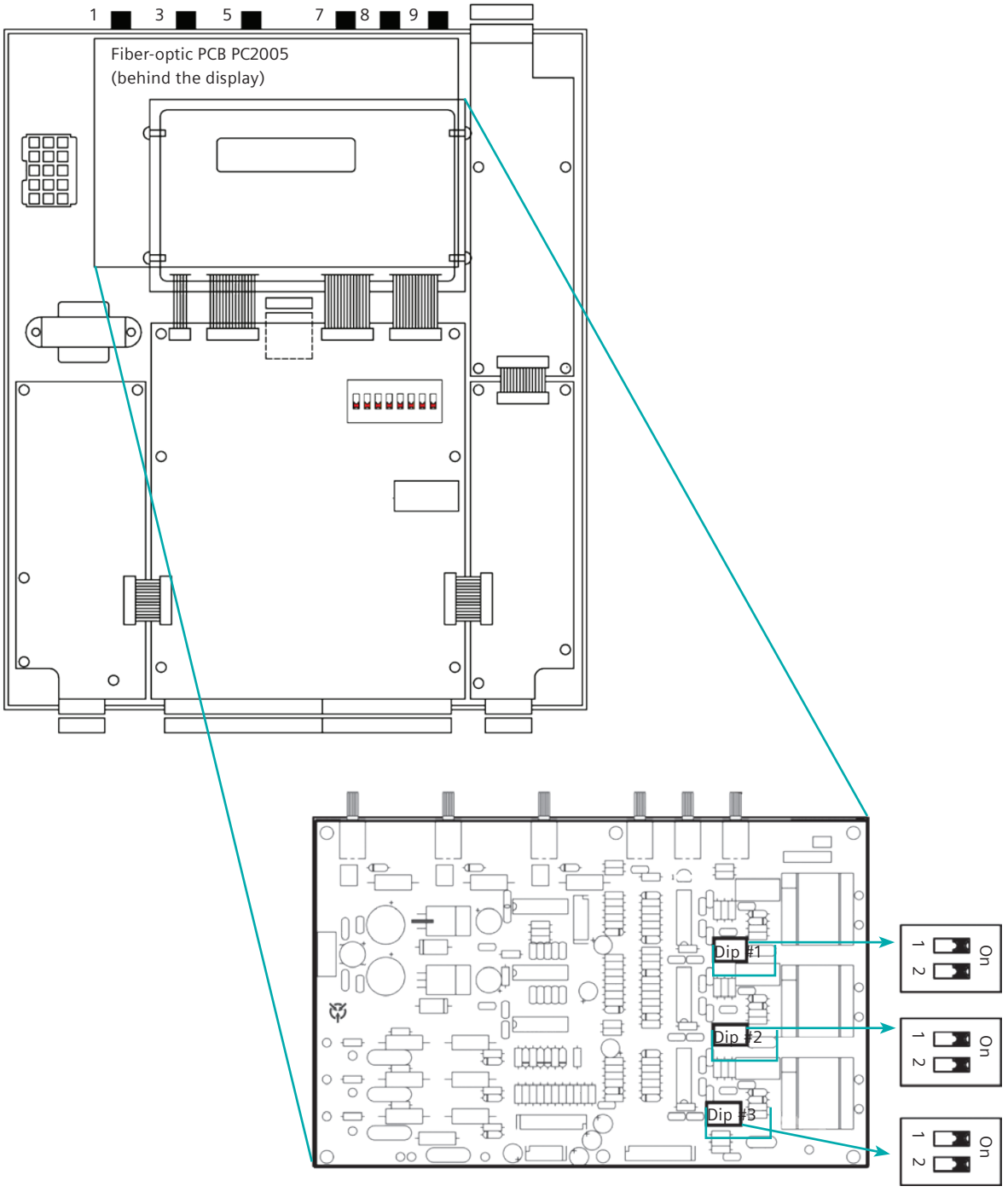
Current gain dip-switches setting

The unit is factory set for the rated current of the starter, for example 320 A. The rated current of the low-voltage motor used for testing is 6 A, for example. The ratio between these currents is 53. In order to enable testing with such a low level of current, additional gain should be added to the current path. To do so, loosen the four screws holding the display case that covers the upper printed circuit board (PCB). Slide out the top while the two bottom screws are used to support the metal cover. On the right side of the PCB, there are three dip switches (dual-toggles). Individual dip switch represent a phase. Note that all dip switch toggles are set to "on" (gain of 1). Dip switch #1 when set to "off" (for testing) sets a gain of 5. Dip switch #2 when set to "off", sets a gain of 13.4. By setting both to "off" a gain of 5 x 13.4 = 67 is introduced (refer to Table 32: Current gain dip switches - position and gain). Set the dip switches according to the ratio between rated starting current and low-voltage testing motor rated current. Dual toggles on all three dip switches must have matching settings. In the above example of 320 A versus 6 A, set both dip switch toggles on each phase to OFF (refer to Figure 23: Current gain dip switches location on page 80).

Table 32: Current gain dip switches - position and gain

Toggle 1	Toggle 2	Gain
Off	Off	67
Off	On	5
On	Off	13.4
On	On	1

Figure 23: Current gain dip switches location



NOTICE

The standard test harness is designed for testing with low-voltage test motor or load, rated 480 V. A special test harness is available for testing with voltage higher than 480 V, including internal resistors. Never test with higher (than 480 V) low voltage with the standard 480 V testing harness. Higher than the specified voltage may cause damage to the electronic potential transformer (EPT) transmitter.

EPT test harness installation

Test harness installation in soft starter

The testing harness includes three colored wires: blue, red and green.These wires are used to change the resistor voltage dividing ratio in the electronic potential transformer transmitter (EPT-TX).

At one end of each colored wire is a banana plug with the same color as of the wire. At the second end of the blue wire is an alligator clip. The second end of the red and green wires are clamped together and connected to a second alligator clip.

On the front side of the EPT-TX there are three colored round stickers: blue, red and green stickers.

On the rear side of the EPT-TX (most of models), exactly at same location as the stickers, are three small holes. These holes have internal banana jacks for the banana plugs.

Connect the three banana plugs into the banana jacks at the rear side of the EPT-TX. Ensure that the wire colors match the round sticker colors at the front of the
EPT-TX.

Connect the alligator clips marked "1" (with red and green wires) and "3" (with blue wire) to the bus bars to which the EPT-TX is connected as shown in Figure 24: Soft starter - EPT-TX and test harness.

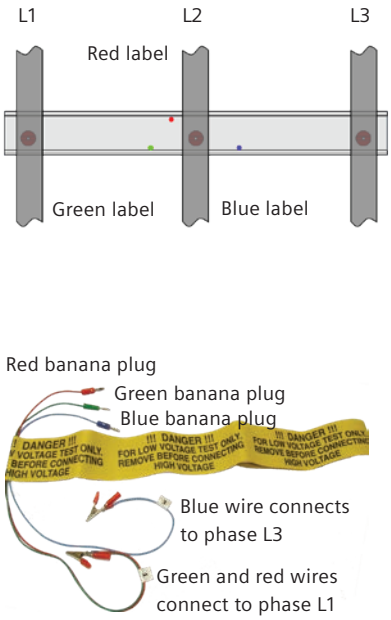


Figure 24: Soft starter - EPT-TX and test harness

The testing harness is equipped with a long warning band, intended to prevent forgetting that test harness is connected. Never cut the warning band. Leave the warning band unfolded for its full length and laid in such a way that the harness will not be forgotten and left connected after the low-voltage testing is completed.

Always disconnect the harness immediately after ending the low-voltage testing. The testing harness warning band should be rolled up, place inside the small plastic bag and stored into the drawing pocket of the soft starter (refer to Figure 24: Soft starter - EPT-TX and test harness).

Start procedure for medium-voltage motor
Special attention notes

NOTICE

- Prior to performing these tests, this instruction manual, instruction manual IC1000-F320-A105-XX-XXXX, as well as all project drawings must be fully understood.
- Be sure to know the stop button location, so you can stop the motor immediately if needed.
- Verify that the stop button is operative; depressing the stop button opens the main contactor and disconnects the motor from the main voltage.
- During starting time, you should continually check the three phase currents as shown on the soft starter LCD display. They should show approximately balanced currents.
- If the currents are significantly different - STOP IMMEDIATELY. Do not wait until the total start time is reached and a trip occurs.
- Verify that number of starts parameter is set to 1 and starts period is set to 20. Remember! Do not exceed the number of starts per hour for which the motor is designed. This will avoid damage to both motor and controller.
- When main voltage is connected to the soft starter, even if control voltage is disconnected, full voltage appears on the soft starter load terminals.
- Power factor correction capacitors must not be installed on the load side of the controller. When required, install capacitors on the line side of the soft starter.
- Do not interchange line and load connections. Verify correct connections to the soft starter terminals: L1, L2, L3, T1, T2 and T3.
- Before starting the motor at loaded condition, confirm the rotation direction. It is recommended to verify the correct direction of rotation on motor at unloaded condition.
- Prior to start-up procedure, verify that line voltage and control voltage match the values shown on the label of the controller.
- When the start signal is initiated and the motor is not connected to the load terminals, the s. scr or wr. con protection will be activated (refer to page 60).

Medium-voltage test procedure

1. Verify that insulation-resistance test was performed on the motor and the cables connecting the motor to the soft starter. This test should be carried when the soft starter is not connected to the motor.
2. Verify that low-voltage testing harness and cables are disconnected and removed.
3. Verify that all three gain dip switches (dual-toggles) on the PCB (PC2055) are set to "on" (refer to Current gain dip-switches setting on page 79).
4. Enter main and protection parameters set:
   - Rated line voltage as indicated on the controller label
   - Starter FLC as indicated on the controller label
   - Motor FLA as indicated on the motor label
   - Rated motor power as indicated on the motor label
   - Service factor as indicated on the motor label
   - Browse until the message: "store enable main & protect" is shown.
   - Press the store button and wait for the message: "data saved ok."

5. Enter start parameters, set the parameters as required for the medium-voltage motor. If no other data is available, leave all parameters in their default values.
    - Verify that number of starts parameter is set to 1. Remember! Do not exceed the number of starts per hour for which the motor is designed.
    - Browse until the message: "store enable start parameters" is shown.
    - Press the store button and wait for the message: "data saved ok."
6. Enter stop parameters.
    - If soft stop process is required it is recommended to use same soft start curve as soft start curve.
    - Set deceleration time (DEC. TIME).
    - If soft stop is not required, set DEC. TIME to minimum value (0).
    - Browse until the message: "store enable stop parameters" is shown.
    - Press the store button and wait for the message: "data saved ok."
7. Verify that all other parameters are set properly for the application.
8. Return the DCU screen to the current (amps) display (in % of motor FLA).
9. Be sure to know where the stop button or control is located, so the motor can be stopped immediately if needed.
10. It is strongly recommended that a person stand near the motor during initial starting event(s) to monitor events. A communication path should be clearly defined with the person standing close to the motor prior to releasing the start command.
11. During starting, check the three currents as shown on the starter display. They should show approximately balanced currents.
12. If the currents are significantly different - STOP IMMEDIATELY. Do not wait the total start time until a trip occurs.
13. In any case of problem, please refer to the Troubleshooting on page 89.
14. If any problems are encountered during the commissioning start process, the low-voltage test process (beginning on page 76) should be used to determine the cause of the problem so it can be rectified.
15. After successful starting with a loaded motor, set MAX START TIME (in START PARAMETERS page) to slightly longer than the actual time seen in the STATISTICAL DATA page. This precaution will prevent starter and motor overheating condition, as the load inertia could be higher than the level experienced during the initial start-up. Higher inertia will increase the acceleration time and motor heating.

Figure 25: Standard setting process flow

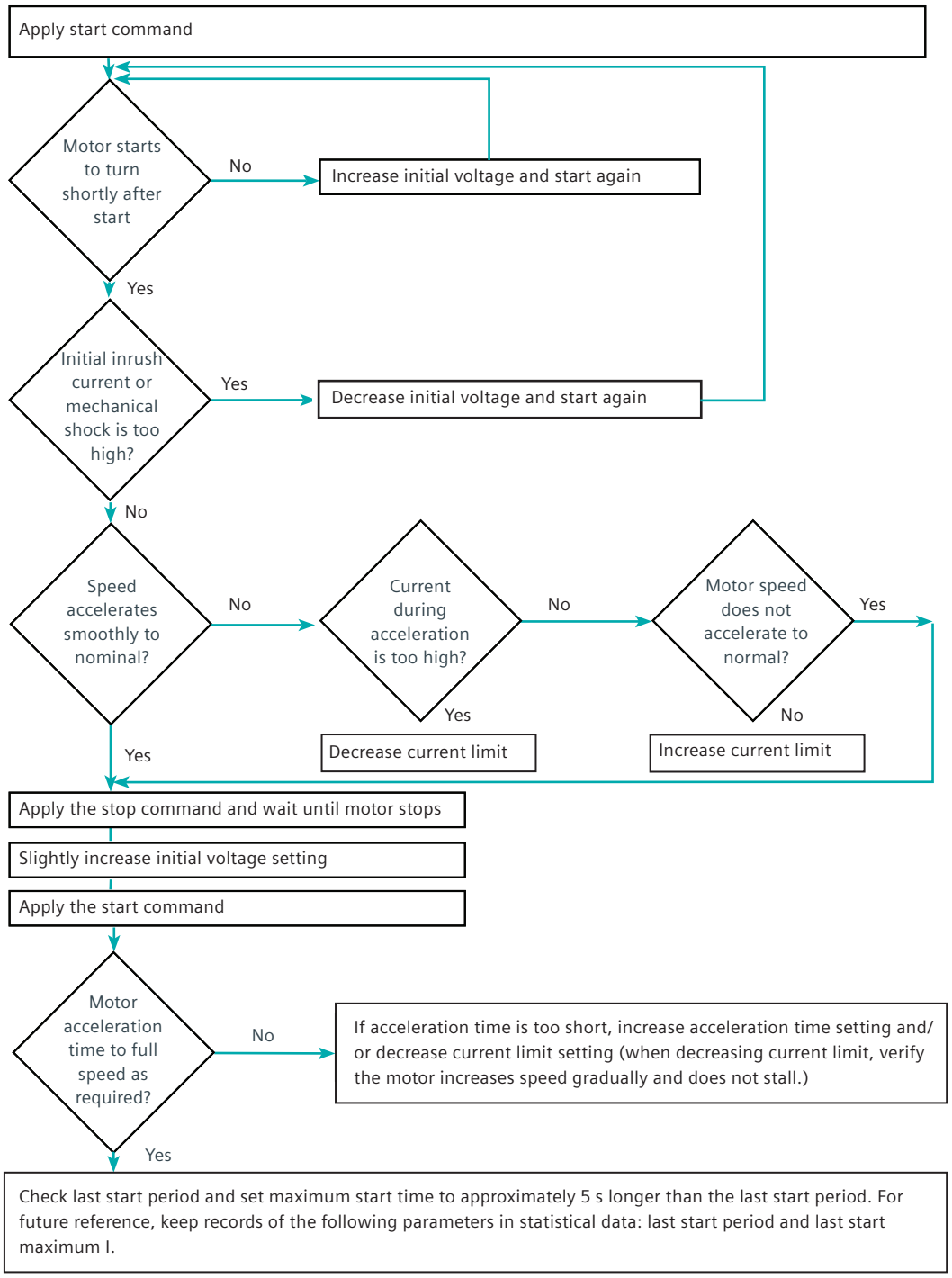


Figure 26: Light load - pump, etc.

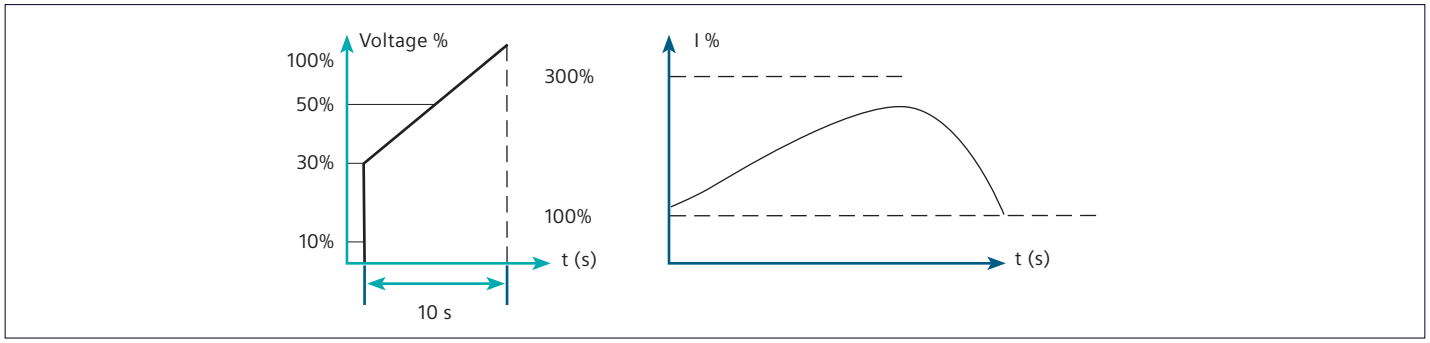
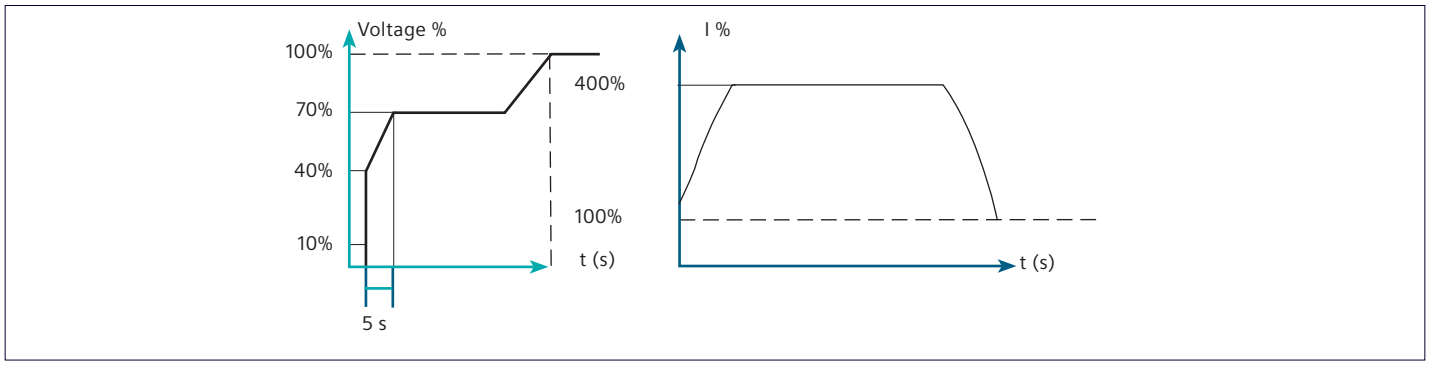


Figure 27: High-inertia loads - crushers, centrifuges, mixers, etc.



Examples of starting curves: Light load - pump, etc.
(In these cases the actual current is always lower than the current limit setting)

- Initial voltage set to 30 percent
- Current limit set to 300 percent
- Acceleration time set to 10 s.

Upon start, the voltage quickly increases to the initial voltage value (30-percent of supply voltage) and then gradually ramps up to nominal.

The current will simultaneously increase to peak current value (lower than the current limit setting), before smoothly decreasing to the operating current.

High-inertia loads - crushers, centrifuges, mixers, etc.
(In these cases, the actual current is at the current limit setting during part of the starting time)

- Initial voltage set to 40 percent
- Current limit set to 400 percent
- Acceleration time set to 30 s.

Upon start the voltage and current increase until the current reaches the current limit value. The voltage remains at this value until the motor reaches close to nominal speed, then the current begins to decrease and voltage continues to ramp up to nominal.

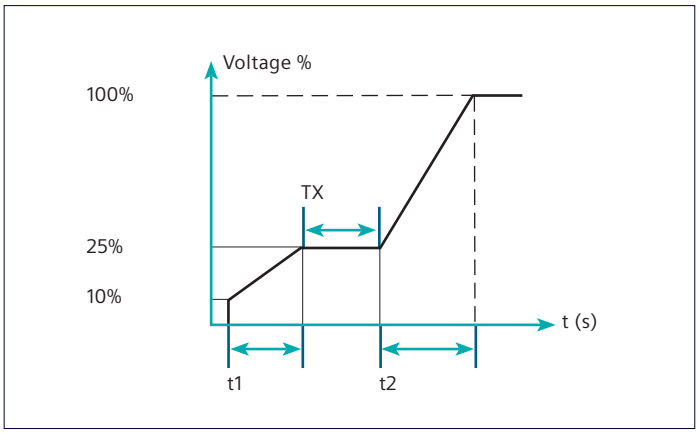


Figure 28: Special starting using dual adjustment

Table 33: Special starting using dual adjustment

Parameter	Main setting	Dual-adjustment setting
Initial voltage	10%	255
Acceleration time	t1 = 2 s to 30 s	t2 = 2 s to 30 s
Current limit	200%	300% to 400%
Relay on delay	TX = 1 s to 60 s	—

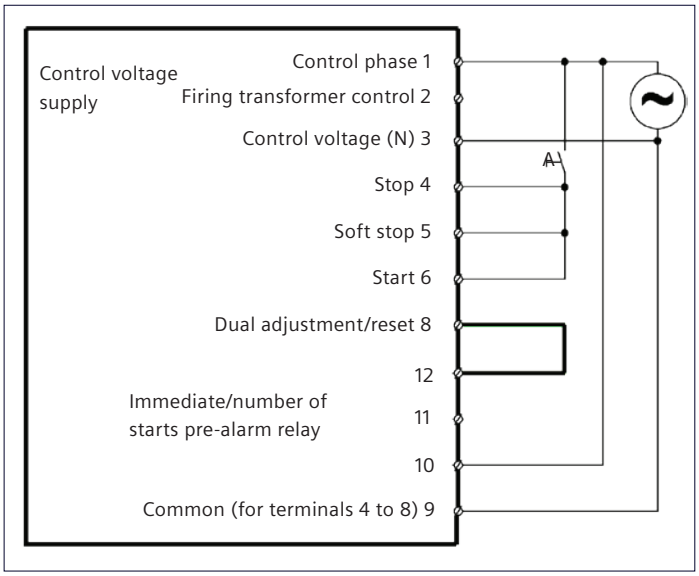


Figure 29: Special starting using dual adjustment

Special starting using dual adjustment

Using two starting characteristics, the soft starter will accelerate using standard characteristics (initial voltage, acceleration time and current limit). After transition (R/SS) (immediate relay delay), voltage to input terminal 8 is switched on using the dual-adjustment characteristic to complete acceleration.

Perform the following steps:

- To use dual adjustment automatically, connect immediate in series to input terminal 8 as shown in Dual-adjustment parameters - DCU display page 4 on page 50.
- Program immediate/shear-pin relay to immediate (default setting) and program relay on delay to TX.
- Program prog. input #8 to dual adjustment (default setting).
- Program standard parameters and dual-adjustment parameters as shown in the table below.

Using two starting characteristics, the soft starter will accelerate to reach the 200 percent current limit. After the voltage to prog. input #8 is switched "on", using the Dual-adjustment characteristic to complete acceleration.

Choosing a suitable pump curve (centrifugal pumps)

Starting curve

- Adjust main parameters as necessary (motor FLA, starter FLC, etc.).
- Set starting curve, acceleration time, current limit and initial voltage to their default values (soft start curve 1!, 10 s, 400 percent and 30 percent respectively).
- Start the pump while watching the pressure gauge as the pump starts and look for overshooting ("pressure surge") of the gauge needle above the target pressure. In case of over pressure, choose a peak torque reduction curve (soft start curve 2!).
- Set soft start curve 2!, increase acceleration time to 15 s and reduce current limit to 350 percent. Start the pump and watch the pressure gauge while the pump starts.
- In most cases, overshooting is reduced. if the overshoot persists, increase acceleration time to 25 s (confirm with motor manufacturer) and try again.
- If the overpressure persists, increase the soft start curve setting to 3! or 4!, if necessary. each increase in the soft start curve setting will reduce the peak torque, thus reducing the overpressure and preventing "pressure surge" during start.

Stopping curve

- Adjust main parameters as necessary (motor FLA, starter FLC, etc.)
- Set soft stop curve and deceleration time, to their default values (curve 1!,
  10 s, respectively).
- Stop the pump, watching the pressure gauge and check valve as the pump stops. Look for overshooting ("water hammer") on the gauge (application stopping abruptly).
- Select soft stop curve 2! and increase deceleration time to 15 s. Stop the pump and watch the pressure gauge and the rate of closing of the check valve as the pump stops. abrupt stopping of the pump and motor will cause a loud audible noise emitted from the check valve.
- In most cases, "water hammer" is reduced. If "water hammer" persists, increase the time to 25 s (confirm with motor manufacturer) and try again.
- If "water hammer" persists, increase the soft stop curve setting to 3!, or 4!. Each increase in the soft stop curve will reduce the abrupt stop of the pump, thus preventing the "water hammer" phenomenon.

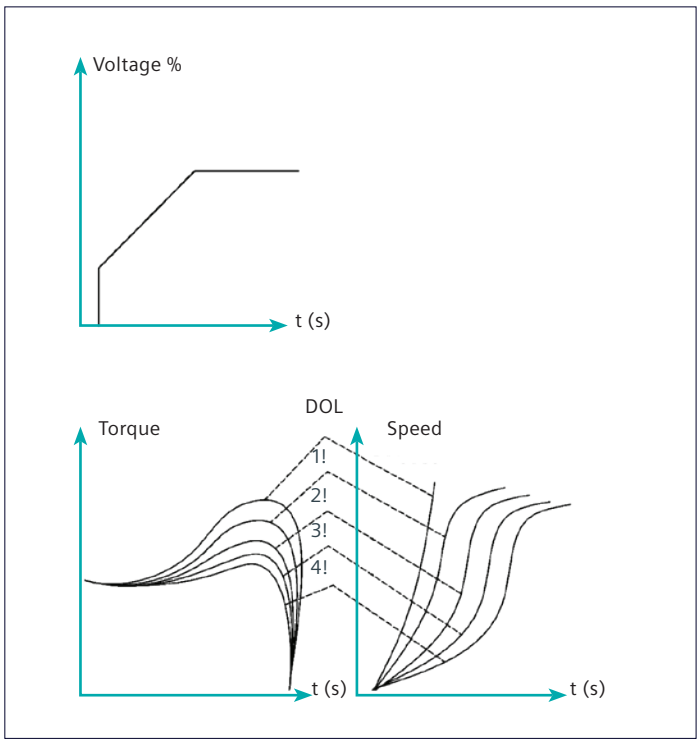


Figure 30: Starting curve

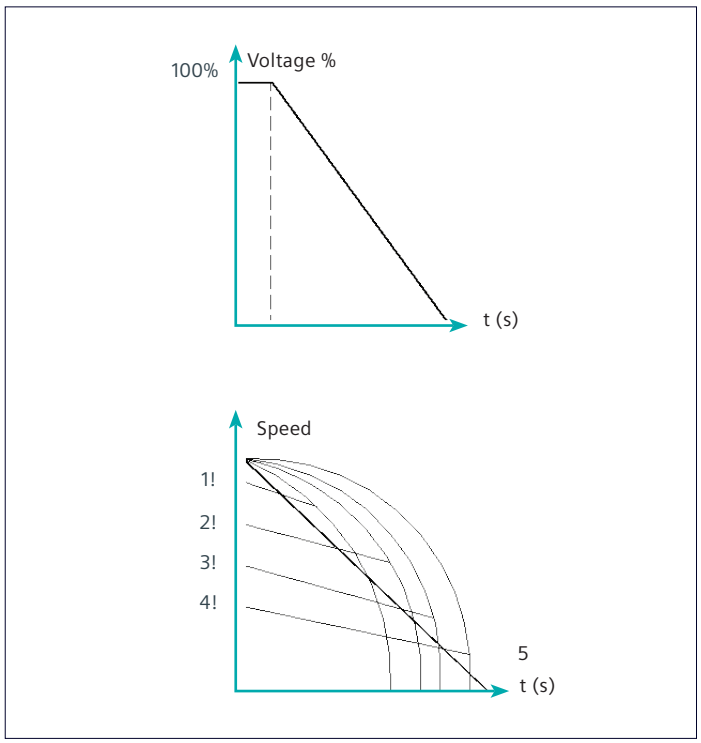


Figure 31: Stopping curve

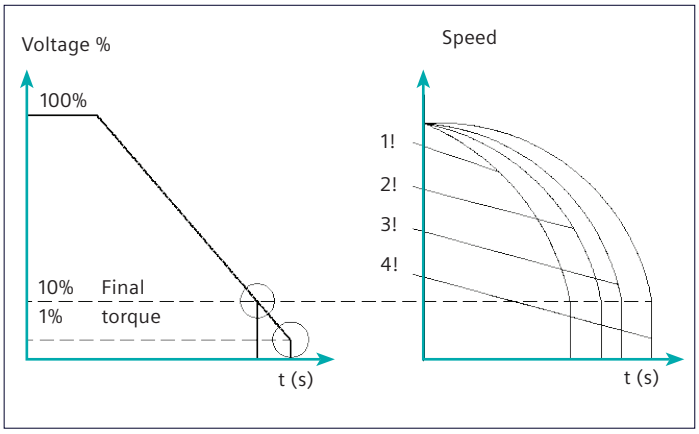


Figure 32: Final torque during soft-stopping a pump application

Final torque during soft-stopping a pump application
While decelerating, the check valve may close before deceleration time has elapsed, thus allowing current to flow through stator winding causing unnecessary heat. Select final torque sensitivity to 1 and stop the pump, then confirm that the current stopped flowing through the motor shortly after the check valve closed.

If current still flowing more than 3 s to 5 s after check valve closure, increase final torque (up to a maximum value of 10) to stop current flow earlier. Refer to DCU display page 3 on page 48.

Disposal

⚠ WARNING

Stored energy.

Can cause death, serious injury, or property damage.

Mechanisms contain stored energy, which may be released during disassembly.

Wear suitable protection and take appropriate precautions when disconnecting and removing moving parts.

⚠ WARNING

Heavy objects.

Can cause death or serious injury.

Disassembly may cause an unbalanced load, and could result in falling objects.

Take appropriate precautions in a properly designated workspace to maximize support and stability.

Siemens equipment is environmentally friendly product predominantly consisting of recyclable materials. For disposal, some disassembly, separation, and professional services handling may be required.

Materials to be handled include but are not limited to:

- Metals: Should be transferred and recycled as mixed scrap metals.
- Plastics: Plastic containing a recycle symbol should be recycled. Plastic lacking the recycle symbol should be discarded as industrial waste.
- Small electronics, insulated cables, and motors: Should be recycled via electronics scrap disposal companies specialized in separating and sorting as described above.
- Batteries: Should be recycled via a recycling company.

Disposal regulations vary from locality to locality and may be modified over time. Specific regulations and guidelines should be verified at the time of waste processing to ensure that current requirements are being fulfilled. For specific assistance in understanding and applying regional regulations and policies or manufacturer's recommendations, refer to the local Siemens service representative for additional information.

Troubleshooting

Troubleshooting

The following procedures should be performed only upon occurence of a fault or when troubleshooting is required for other reasons.

Power SCR verification

In-out resistance and cathode-cathode resistance

- Verify that motor is disconnected.
- Open the isolating switch.

In-out resistances should be the same for all three phases in each model. Cathode-cathode resistances are indicated in Table 34: Cathode-cathode resistances.

Refer to Figure 33: Firing PCB – SCR #1 gate-cathode testing in order to identify the terminals on all SCRs on the firing PCB. Figure 33 shows an example with six SCRs, but units with differing numbers of SCRs are similar in concept. A number is located on the firing PCB to identify the SCRs controlled by the firing PCB.

The measurement of cathode-cathode resistances varies by the number of SCRs in the unit.

For units with one SCR stack and four SCRs, measure cathode-cathode resistances as follows (refer to Figure 35 Item A):

- Cathode SCR#1 to cathode SCR#2 – should be ½ of in-out resistance in Table 34
- Cathode SCR#1 to cathode SCR#3 – should be equal to in-out resistance in Table 34.

For units with one SCR stack and six SCRs, measure cathode-cathode resistances as follows (refer to Figure 35 Item B):

- Cathode SCR#1 to cathode SCR#2 – should be ⅓ of in-out resistance in Table 34
- Cathode SCR#2 to cathode SCR#3 – should be ⅓ of in-out resistance in Table 34
- Cathode SCR#3 to cathode SCR#4 – should be ⅓ of in-out resistance in Table 34
- Cathode SCR#1 to cathode SCR#4 – should be equal to in-out resistance in Table 34.

Table 34: Cathode-cathode resistances

Soft starter rated voltage	L1 - U/L2 - V/L3 - W in-out resistance
2.3 kV	1,200 kΩ±10%
3.3 kV	135 kΩ±10%
4.16 kV	120 kΩ±10%
6.6 kV	300 kΩ±10%

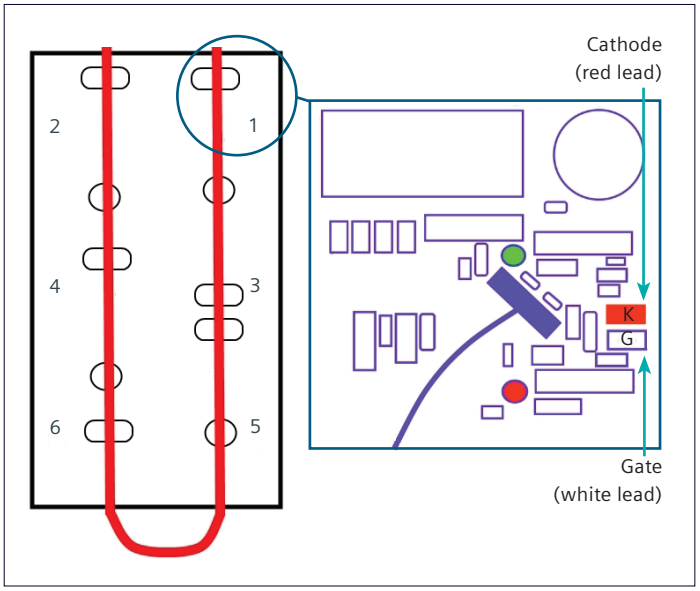


Figure 33: Firing PCB - SCR #1 gate-cathode testing

For units with two SCR stacks, top and bottom stacks identical, with six SCRs in each stack, measure for each stack (top and bottom) cathode-cathode resistances as follows (refer to Figure 35 Item C):

- Cathode SCR#1 to cathode SCR#2 – should be ⅙ of in-out resistance in Table 34
- Cathode SCR#2 to cathode SCR#3 – should be ⅙ of in-out resistance in Table 34
- Cathode SCR#3 to cathode SCR#4 – should be ⅙ of in-out resistance in Table 34
- Cathode SCR#1 to cathode SCR#4 – should be ½ of in-out resistance in Table 34.

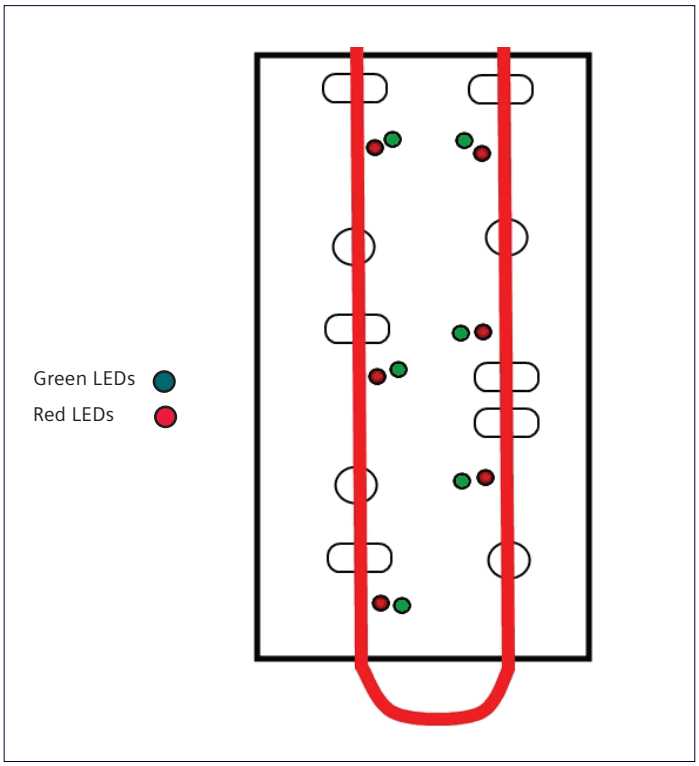


Figure 34: Firing test disconnect mains and red and green LEDs

For units with two SCR stacks, top stack (six SCRs) and bottom stack (four SCRs) not identical, measure cathode-cathode resistances are follows (refer to Figure 35 Item D on page 93):

For top stack (six SCRs), measure cathode-cathode resistances as follows:

- Cathode SCR#1 to cathode SCR#2 – should be 1/5 of in-out resistance in Table 34
- Cathode SCR#2 to cathode SCR#3 – should be 1/5 of in-out resistance in Table 34
- Cathode SCR#3 to cathode SCR#4 – should be 1/5 of in-out resistance in Table 34
- Cathode SCR#1 to cathode SCR#4 – should be 3/5 of in-out resistance in Table 34.

For bottom stack (four SCRs), measure cathode-cathode resistances as follows:

- Cathode SCR#1 to cathode SCR#5 – should be 2/5 of in-out resistance in Table 34
- Cathode SCR#1 to cathode SCR#2 – should be 1/5 of in-out resistance in Table 34
- Cathode SCR#2 to cathode SCR#5 – should be 1/5 of in-out resistance in Table 34.

Verify that cathode-cathode resistances agree with the listing above, as related to the in-out resistances in Table 34.

Rgk (SCR gate-cathode) resistances

Thyristors gate-cathode resistances can easily be measured from the firing PCBs.

In order to access the testing points, the medium-voltage door must be opened.

Gate-cathode connection points of SCR #1 are illustrated in Figure 33: Firing PCB - SCR #1 gate-cathode testing on page 89. Measure all SCRs Rgk resistances in each of the phases.

Rgk values should be about the same for all SCRs in the phase, and in the range of 7Ω to 20 Ω.

Firing test

The purpose of this test is to check that the firing system of all SCR functions properly.

This procedure requires control supply voltage only (no need for main three- phases voltage).

- Open the isolating switch.
- Verify the LEDs status by accessing the medium-voltage compartment.
- Identify six green LEDs and six red LEDs as shown in Figure 34. Number of LEDs varies for different voltage models.
- Program input #7 to test. (Remember to store the parameter!). Refer to I/O programming parameters - DCU display page 6 on page 53.
- Connect control input voltage to terminal #7. The test LED on the control keypad will light. Refer to I/O programming parameters - DCU display page 6 on page 53.

Press mode key until the display shows:

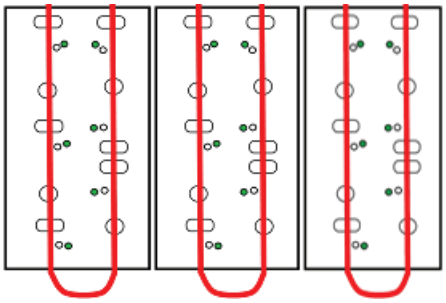
FIRING TEST

DISCONNECT MAINS

Press select button. The display will show:

FIRING PWR SUPPLY

CHECK GREEN LEDS



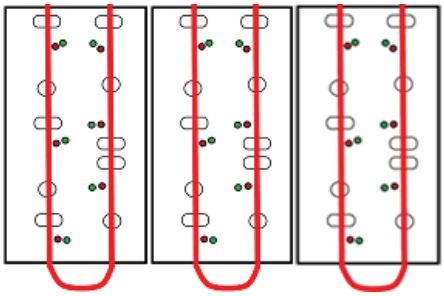
Green LEDs should be lit

Press select button second time.

The display will show:

FIRING NOW CHECK

GREEN & RED LEDS

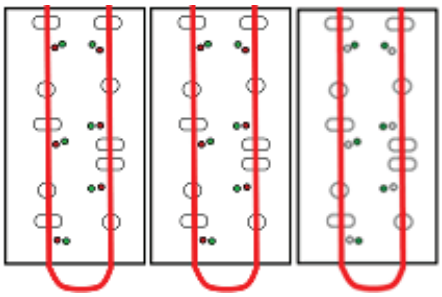


Red and green LEDs should be lit

Press select button a third time. The display will show:

FIRING NOW CHECK

ALL LEDS OF R&S



Red and green LEDs of phases 1 and 2 should be lit. Phase 3 LEDs should not be lit.

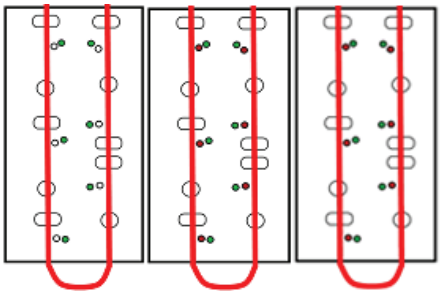
Phases A and B

Press select button a fourth time. The display will show:

FIRING NOW CHECK

ALL LEDS OF S&T

Phases B and C



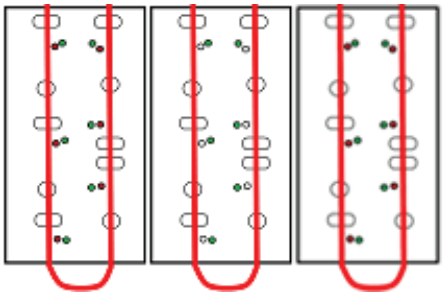
Red and green LEDs of phases 2 and 3 should be lit. Phase 1 LEDs should not be lit.

Press select button a fifth time. The display will show:

FIRING NOW CHECK

ALL LEDS OF R&T

Phases A and C



Red and green LEDs of phases 1 and 3 should be lit. Phase 2 LEDs should not be lit.

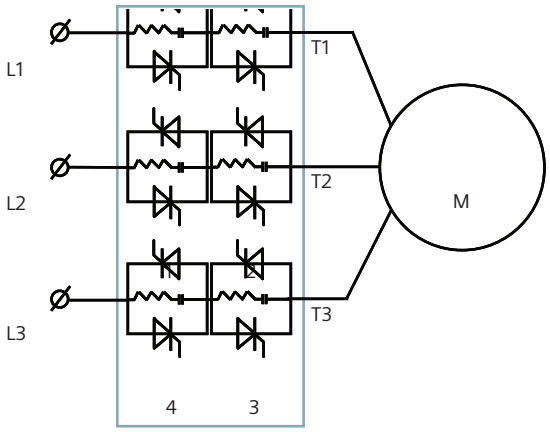
Notes: Firing test is limited to 30 s. If the test did not conclude in the allowed testing period of time, perform the test again until the testing five stages has been completed.

If the firing test fails:

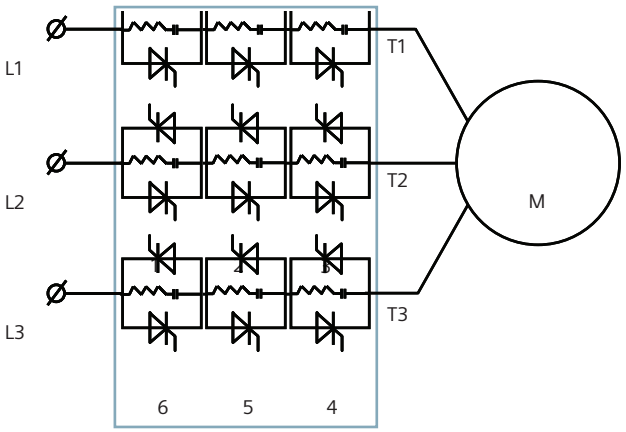
- Check fuses in switch mode power supplies (PC2075 for ac control voltage, PC2076 for dc control voltage). dc control voltage uses all three fuses in series, so if one fuse fails to operate, all firing LEDs will be off.
- Check that fiber-optic wires #1, 3 and 5 (firing of phases 1, 2 and 3) are properly connected according to markings on the control module.
- Check that the fiber-optic wires are inserted properly into the connectors (full depth) and that the fiber-optic wires are not damaged.
- Check that individual fiber-optic wires connected between the individual power supplies (PC2075 or PC2076) and the firing PCBs are properly inserted.
- When control voltage is turned on, the green LEDs in the power modules may blink rapidly and this is normal.

Figure 35: SCR stacks/SCR numbering

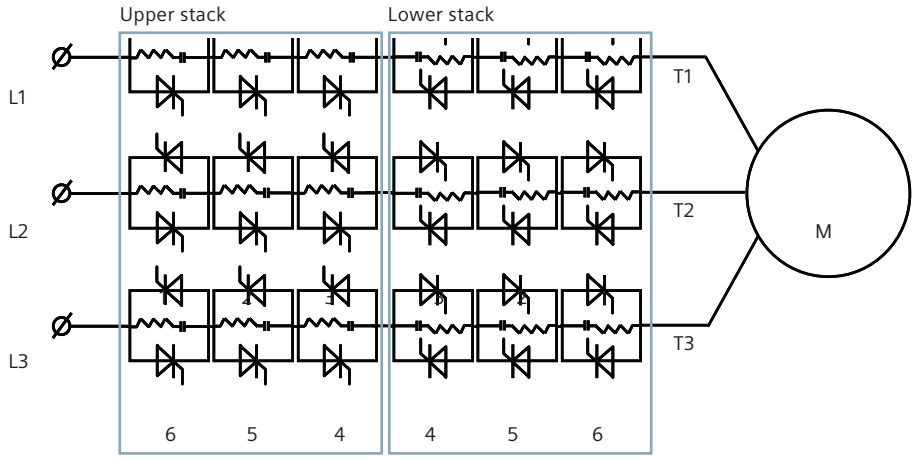
Item A: Units with one SCR stack and four SCRs



Item B: Units with one SCR stack and six SCRs



Item C: Units with two SCR stacks (top and bottom stacks identical)



Item D: Units with two SCR stacks (top and bottom stacks not identical)

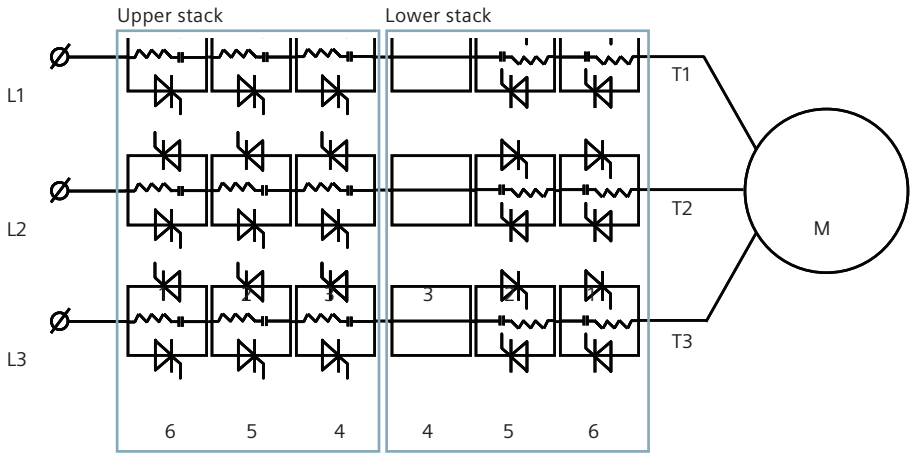


Table 35: Low-voltage test troubleshooting

Problem	Troubleshooting
Control module is not powered after external control voltage is connected.	• Verify that cabinet MCBs are set to "on" position, or that control power disconnects are closed. • Verify that the stop pushbutton is released. • Verify that customer terminals 5 and 6 are connected together with a jumper. • Verify that DOL/soft start selector switch is set to soft start. • Verify that rated control voltage is connected to customer terminals 1 and 2. • Verify correct polarity for DC control voltage.
Upon control voltage connection the control module trips immediately.	• Disconnecting control voltage from the control module and reconnecting the control voltage does not reset the soft starter which has tripped. • Reset the soft starter by pressing the reset key.
Power on and no start trip occurs before starting.	• Occurs when the main voltage is connected to the soft starter more than 30 s without a start signal. • Can be disabled for special applications.

Local start command does not cause any action.	• Verify that local/remote/off selector switch (optional) is set to local position.
	• Verify that fault light is not active on the front panel or on the starter control panel or on the MPR panel.
	• If fault light is lit:
	  • Verify that there are no fault messages on soft starter and MPR displays.
	  • Reset if necessary.
	  • Check setting of the trip relay logic (fault/fault fail-safe), of the soft starter and MPR. Improper setting de-energizes fault relays FT and FT/1.

Remote start command does not cause any action.	• Verify that local/remote/off selector switch (optional) is set to remote position. • Verify that fault indication light is not active on door and starter and MPR panels. • If trip indication light is lit: • Verify that there are no fault messages on starter and MPR displays. • Reset if necessary. • Check setting of the trip relay logic (fault/fault fail-safe) of the soft starter and MPR. Improper setting de-energizes fault relays FT and FT/1.
Under/no voltage trip occurs immediately after starting.	• Verify all medium-voltage connections. • In low-voltage testing, a missing phase can cause under/no voltage trip. • Verify that test harness is connected to the EPT-TX while testing at low-voltage. • Verify that the main contactor closes, even if only for few moments, at the beginning of the start process. • Verify that the main contactor auxiliary contact is wired back to the controller terminal 5 (in series with RS relay contact) to initiate the start command. Refer to DCU display page 1 on page 39. • Check undervoltage trip setting level in main and protection page. • Verify that the electronic potential transformer receiver (EPT-RX) fuse located in the receiver auxiliary supply plug is undamaged. • Verify that the fiber-optic wires connecting the EPT-TX and EPT-RX are properly connected. • Disconnect fiber-optic wires 11 and 13 from the EPT-RX, they should emit red light with same intensity. • Check that the 15-pin white connector is properly connected, at the back of the control module (Refer to pages 23-25).

Table 35: Low-voltage test troubleshooting (continued)

Problem	Troubleshooting
Overvoltage trip occurs immediately after starting.	• Make sure that the main testing voltage is 480 V or as indicated as on the test harness. • If it is higher, disconnect the main voltage immediately. • Check overvoltage trip setting level in main and protection page.

Phase sequence trip occurs immediately after starting.	• Phase sequence of the main lines is wrong.
	• Two options are available:
	  • Swap two input lines.
	  • Set phase sequence setting in fault parameters as required. Refer to DCU display page 4 on page 50.

Too many starts trip occurs immediately after starting.	• The default setting allows for one start per 20 minutes. • To reset the fault find the number of starts setting at the end of start parameters page, increase setting to off, then reset. Refer to DCU display page 2 on page 43. • Store at the end of the page. • Be sure to set for medium-voltage operation after end of testing.

S.SCR OR WR CON. trip occurs after starting.	• Verify that test motor current time gain dip switches equal to a minimum value of 30% of starter FLC. Refer to Current gain dip-switches setting on page 79.
	• Verify that fiber-optic wires 1, 3 and 5 are properly connected.
	• Verify that current gain dip switches are set equally for the three phases and according to the ratio between starter rated current and testing motor rated current. Refer to Current gain dip-switches setting on page 79.
	• Try to start using soft start curve 0, the basic curve. If the motor is not loaded and has no inertia, the motor may vibrate after reaching full speed. This is normal and should not occur with the loaded medium-voltage motor.
	  • If the low-voltage test motor starts properly, then the current transformers and their wiring should be checked.
	  • If test motor does not start properly, the measured current may be too low.
	• Perform a firing test as described in Firing test on page 90.
	• Check fuses and fuse holders in phase firing power supplies. Refer to Control fuses location on page 9.
	• Soft start curve 0 enables the starting condition properly, even if a CT or its wiring is problematic. Use the soft start curve 0 when testing conditions are not ideal or with non-standard motor. Current in every phase must be above 5% of starter FLC, or the same trip might occur.

Set curve to 0 trip occurs after starting.	• Check that gain dip switches pairs are set identically for the three phases. Refer to Current gain dip-switches setting on page 79. • Try soft start curve 0.
O/C-shear pin trip occurs immediately after starting.	• Verify that current gain dip switches are set according to the ratio between the rated current of the starter and the testing motor rated current. • The trip can occur if added (dip switches) gain is too high. • Try to start with soft start curve 0 and stop with soft stop curve 0. If problem is solved the CTs and their wiring should be checked. • Check that all fiber-optic wires are properly connected.
Phase loss trip occurs after starting.	• Verify that all three phases are within range. • Verify that EPT-TX and EPT-RX fiber-optic wires are properly connected. • During low-voltage testing, if the 480 Vac test voltage is provided by a generator, check that the frequency is within the range of 46 Hz to 65 Hz.

Table 35: Low-voltage test troubleshooting (continued)

Problem	Troubleshooting
Motor makes abnormal noise while starting.	• Verify that motor is not too small. Try to use bigger motor, with inertia or loaded, if possible. • If vibration occurs at the beginning of start process with soft start curve 1!, 2!, 3!, 4! or 5, try soft start curve 0. • If vibration occurs at the beginning of start process with soft start curve 0, check low-voltage test harness installation, fiber-optic wires 11 and 13 and EPT-RX outputs. • Vibration occurs while approaching full speed at start soft start curve 0 are normal with unloaded motor and does not indicate any problem. With other soft start curves, it may occur with a small/unloaded motor that accelerates too fast. Try reducing initial voltage to minimum. • Verify that current gain dip switches are set according to the ratio between the rated current of the soft starter and the testing motor rated current. Refer to current gain dip-switches setting on page 79. • If test motor is loaded or has some inertia, try to start the low-voltage motor with soft start curve 0 (basic curve). If the problem is solved, then test the CTs and the CT wiring. Soft start curve 0 should function properly with a loaded motor, even if a CT or its wiring are faulty or with a problematic main voltage (for example, weak low-voltage testing transformer). • Check that all fiber-optic wires are properly connected according to their numbers.

Unbalance current trip occurs after starting.	• Verify, by reading currents on the display, that the three current readings are essentially equal (before the trip).
	• Check that fiber-optic wires 1, 3 and 5 are properly connected to the control module.
	• Check that the current gain dip switches are set identically in the three phases. Refer to current gain dip-switches setting on page 79.
	• Verify that current flows in all three phases.
	• If there is no current display on one phase:
	  • Change to soft start curve 0 (basic).
	  • Try to start.
	• If the problem persists, perform a firing test. Refer to firing test on page 90.

Ground fault trip occurs after starting.	• View the three currents on starter's display. • Check that the current gain dip switches are set identically in the three phases. Refer to current gain dip-switches setting on page 79. • Verify that an output cable to the motor is not short-circuited to the ground. • Verify that CT polarities and connections are correct. • Disconnect the low-voltage motor. Check motor insulation with an insulation-resistance test.
Motor vibrates mechanically at the end of starting process or at the beginning of soft stop current fluctuates.	• The phenomena may occur with unloaded or lightly loaded motor, if soft start curve 0 is used. • Use standard curve soft start curve 1! and soft stop curve 1!.
Open bypass trip occurs after end of start process.	• Verify that current gain dip switches are set according to the ratio between the rated current of the starter and the testing motor rated current. • Check the bypass contactor wiring. Refer to current gain dip-switches setting on page 79.
Undercurrent trip occurs after bypass is closed.	• Reduce setting of Undercurrent setting in the MAIN & PROTECT Parameters settings.

Table 35: Low-voltage test troubleshooting (continued)

Problem	Troubleshooting
MPR does not respond to current during low voltage motor starting.	This is normal. The MPR (Motor Protection Relay) does not have extra gain for testing. Its current reading may be very low, below the minimum threshold.
Current reading displayed on DCU is not correct.	Verify that starter FLC setting parameter is set according to the rated current of the starter. Current gain dip switches gain current reading as follows: Both dip switch toggles on each phases set to "On -> gain = 1" Dip switch toggle #1 on each phases set to "Off -> gain = 5" Dip switch toggle #2 on each phases set to "Off -> gain = 13.4" Both dip switch toggles on each phases set to "Off -> gain = 67". Use clamp-on ammeter to measure testing motor current. Starter current reading should be approximately actual current multiplied by the gain ratio set by the dip switches. Set parameters to default parameters and re-program the soft starter.
Overload trip occurs after bypass is closed.	Verify that current gain dip switches are set according to the testing motor rated current versus rated current of the starter. Overload trip can occur if gain (dip-switches settings) is too high. Verify that starter FLC setting parameter is set according to the rated current of the soft starter. Set motor FLA equal to starter FLC. Reset, start again and read currents on screen. Check if current readings after start are higher than starter rated current.
Motor is started immediately after resetting a trip.	Might occur when local/remote switch is set to remote, and remote start contact is closed. **Note: It is the responsibility of the user to open the remote start/stop contact immediately upon trip.**

Motor and soft starter tripping condition troubleshooting

Refer to motor and soft starter protection in Table 18 starting on page 39 for a description about settings, functionality and possible cause for trip conditions and remedies.

Annex A

Table 36: Mode pages overview and application settings record

DCU display page 1 (refer to page 39)		**DCU display page 2 (refer to page 43)**		**DCU display page 3 (refer to page 48)**
MAIN & PROTECT _****_		START PARAMETERS _****_		STOP PARAMETERS _****_
Display and default values	**Display and default values**	**Display and default values**	**Display and default values**	**Display and default values**
RATED LINE VOLT.	OVERLOAD PROTECT	SOFT START CURVE	STARTS PERIOD	SOFT STOP CURVE
STARTER FLC	UNBALANCE TRIP	START TACHO.GAIN	START INHIBIT	STOP TACHO. GAIN
MOTOR FLA	UNBALANCE DELAY	PULSE LEVEL	RUN CONTACT DLY	DEC. TIME
RATED MOTOR PWR	GND FAULT TRIP	PULSE TIME	STORE ENABLE	FINAL TORQUE
SERVICE FACTOR	GND FAULT DELAY	INITIAL VOLTAGE		STORE ENABLE
UNDERCURR. TRIP	UNDERVOLT. TRIP	INITIAL CURRENT		
UNDERCURR. DELAY	UNDERVOLT. DELAY.	CURRENT LIMIT		
O/C - SHEAR PIN	OVERVOLT. TRIP	ACC. TIME		
O/C DELAY	OVERVOLT. DELAY	MAX. START TIME		
OVERLOAD CLASS	STORE ENABLE	NUMBER OF STARTS		

Table 36: Mode pages overview and application settings record (continued)

DCU display page 4 (refer to page 50)	DCU display page 5 (refer to page 51)	DCU display page 6 (refer to page 53)	DCU display page 7 (refer to page 55)	
DUAL ADJUSTMENT PARAMETERS	FAULT PARAMETERS - **** -	I/O PROGRAMMING PARAMETERS	COMM. PARAMETERS - **** -	
Display and default values	**Display and default values**	**Display and default values**	**Display and default values**	**Display and default values**
DA: INIT. VOLT.	UV & PL AUTO RST	PROG. INPUT #7	Applicable when Modbus optional PCB installed	Applicable when Profibus optional PCB installed
DA: INIT. CURRENT	UNDER CUR. RESET	PROG. INPUT #8	COMM. PROTOCOL	COMM. PROTOCOL
DA: CUR. LIMIT	BYPASS OPEN TRIP	FAULT RELAY TYPE	BAUD RATE	BAUD RATE
DA: ACC. TIME	TRIP AFTER BYPASS	IMM/# STRT	PARITY CHECK	PROFI.NETWORK ID
DA: DEC. TIME	BYPASS AUTO RST	RELAY ON DELAY	SERIAL LINK NO.	S. LINK PAR. SAVE
DA: MOTOR FLA	SET CURVE 0 FLT	RELAY OFF DELAY	S. LINK PAR. SAVE	SER. LINK CONTROL
STORE ENABLE	PWR ON & NO STRT	ANALOG OUTPUT	SER. LINK CONTROL	FRONT COM ADDRESS
	INSULATION ALARM	STORE ENABLE	FRONT COM ADDRESS	STORE ENABLE
	INSULATION TRIP		STORE ENABLE	
	PHASE SEQUENCE			
	STORE ENABLE			

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