Solcon USA

HRVS-DN

Ratings 2.3kV – 6.9kV

Medium Voltage Soft Starter

Typical Specification

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1.0 GENERAL

1.1 The starter shall provide smooth, step-less acceleration and deceleration, reducing inrush current and mechanical shock, providing motor protection, remote control and supervision, according to the technical specification shown here below.
1.2 Line voltage: 2.3 to 6.9kV +10% - 15% (see paragraph 19.0 for Voltage Selection, see also section 1.6 below for generator supplied systems).
1.3 Nominal Current: continuous (see paragraph 19.0 for Current Rating Selection).
1.4 Control voltage: 115V +10% / - 15% (other control voltages: 220VAC, 115 or 220VDC optional)
1.5 Frequency: 45-65Hz (See 1.6 below for Generator Supply Systems).
1.6 When starter is supplied from a stand-by diesel generator: The starter shall be capable of operating with a diesel generator supply where voltage and frequency may be unstable (voltage drop up to 35% and frequency range of 45-66Hz). Starting & stopping curves shall be designed for operating from a diesel generator supply. The supplier shall provide a reference list of operation with a diesel generator supply.
1.7 Ambient temperature: 0ºC - 50ºC, Relative humidity: 95% non-condensed.
1.8 Maximum number of starts: unit shall be selected and sized for operation at maximum current and temperature rating for no less than 2 starts per hour.
1.9 Altitude: up to 1000m without de-rating.
1.10 EMC Certificate – Starter shall have EMC certificate according to Article 10(2) of EMC directive 89/336/EEC.
1.11 UL/cUL – 2.3kV-4.16kV models up to 360A rating shall be UL /cUL listed.
1.12 Minimum SCR PIV Rating shall be 3 times system voltage.

2.0 SCOPE OF SUPPLY

2.1 Digital soft starter in NEMA12 cabinet with fault make/load break disconnect switch, line and bypass vacuum contactors.
2.2 When required, the starter shall include optional cabinet construction and features as listed in the specification.
2.3 The starter shall be supplied as a Class E2 type starter with a fault make/load break disconnect switch with grounding bar and power fuses or vacuum circuit breaker.
  2.3.1 BIL ratings:
    - Up to 3.6KV - BIL 45
    - Up to 7.2KV - BIL 60
  2.3.2 Short time current – 12KA
  2.3.3 Short circuit making capacity 31.5KA
  2.3.4 The disconnect switch shall incorporate a handle mechanism that can be padlocked in the Off position.
  2.3.5 Viewing window for viewing the main switch contacts shall be included.
2.4 Three phase MV fuse system with R type fuses shall be included.
2.5 The manufacturer shall supply 2 sets of instruction manuals with control diagrams "As Built“.
2.6 The manufacturer shall offer commissioning and training on site.
2.7 The manufacturer shall offer spare parts required for commissioning and 5 years operation.

3.0 STARTER CONSTRUCTION

3.1 Starter shall be designed for heavy duty applications and ambient temperature of 50ºC.
3.2 To ensure long term reliability and safety, each starter shall be tested for Partial Discharge (Corona Free) according to EN50178 & HD 625.1 S1:1996 Electronic Equipment for use in power installations.
3.3 SCR firing system shall be via fiber optics to provide complete isolation of the low voltage control from the Medium Voltage power circuitry.
3.4 The SCR firing system shall include LED indicators for easy trouble shooting.
3.5 Heat-sink over-temperature protection shall be provided for each of the 3 phases using fiber optic connections.
3.6 Each phase shall be protected on the sides and front by reinforced insulation material..
3.7 Each phase shall have the capability of being disassembled on site for maintenance.
3.8 All printed circuit boards shall be varnished (conformal coated) on both sides, to protect from harsh environmental conditions. Top spray only is not acceptable.

3.9 When required, preparation for connecting power factor capacitors (capacitors are not a part of the standard scope of supply) shall be made at starter input side, switched on by the Line Contactor and without the need for a separate capacitor contactor.
3.10 Three phase voltage measurement shall be via an Electronic Potential Transformer (EPT), with fiber-optic connection, to provide complete isolation of the low voltage control from the Medium Voltage power circuitry.
3.11 Selectable curves shall enable field setting of the starting characteristics - Voltage Ramp, Current Ramp or Torque Ramp for optimizing soft start and soft stop processes based on the line voltage, motor and load requirements.
3.12 All control inputs shall be via opto-couplers allowing isolation of the micro controller board and to meet EMC requirements.

4.0 SETTINGS & SUPERVISION

4.1 The starter shall be programmed according to the driven load characteristic. Starting and stopping process shall be as specified here below.
4.2 Starter settings shall be made on a keypad and illuminated LCD. Illuminated LCD shall have 2 lines, 16 characters each for ease of use
4.3 Display language shall be English with additional languages: German, French, Spanish selectable as standard feature (optional languages: Chinese, Russian, Turkish and others available upon request).
4.4 The LCD shall display motor current, fault description and statistical data including: total run time, number of starts, last start current, last start time duration, description of last trip, last 10 trips data and total number of trips.
4.5 LCD shall enable selection between viewing of minimum parameters for basic applications and viewing full parameters for more demanding applications.
4.6 The following front panel LEDs shall enable quick status display: control voltage on, motor starting, motor running, motor soft stopping, motor stopped, test, operation using dual adjustment settings and fault.
4.7 Keys on the keypad shall be clearly marked and setting software shall have easy-to-use default parameters.
4.8 Software lock, preventing parameter changes shall be made via an internal dip switch.

5.0 STARTING & STOPPING CHARACTERISTICS

The starter shall have the following starting and stopping settings:

5.1 Initial voltage: adjustable 10-80% nominal voltage.
5.2 Current limit: adjustable 100-700%.
5.3 Ramp-up time: adjustable 1-90 seconds.
5.4 Ramp-down time: adjustable 1-90 seconds.
5.5 Pulse start: Selectable pulse of either 80% nominal voltage without current limit, for 0.1-1 seconds or 1-2 seconds at current limit setting.
5.6 Torque control for linear acceleration and deceleration with selectable torque curves.
5.7 Current ramp control with initial current adjustable from 100-400%, ramp-up time 1-90 seconds.
5.8 Pump control with selectable starting and stopping curves to prevent over pressure and water hammer. Separate settings shall be available for starting and stopping.
5.9 Dual adjustment with two start/stop and two FLA settings (used for varying loads and for two speed motors).

6.0 MOTOR & STARTER PROTECTION

The starter shall have the following protection functions:

6.1 Excessive starts with adjustable max. number of starts, time period and waiting time (time delay after exceeding maximum number of starts).
6.2 Long start time (stall protection).
6.3 Electronic shear-pin (jam protection) - trips instantaneously (in less than 1 cycle) when current reaches 850% FLA. An adjustable time delay shall be available for lower currents.
6.4 Electronic overload with selectable IEC or NEMA overload curves.
6.5 Under current with time delay

6.6 Ground fault current with adjustable time delay
6.7 Current imbalance - trip time will be related to motor load
6.8 Phase loss
6.9 Phase reversal
6.10 Starter over-temperature
6.11 Shorted SCR & wrong motor connection
6.12 External fault A – from a N.O. contact
6.13 External fault B – from a N.O. contact
6.14 Bypass contactor open - trips the starter if bypass contactor does not close after end of acceleration. When bypass is in a separate panel, Bypass Contactor Open protection can be disabled.
6.15 No start signal - trips the line contactor in the event power is connected to soft starter but start signal has not been received. This feature can be disabled.
6.16 Motor currents shall be measured via the soft starter current transformers (CTs) on all three phases. Upstream protection shall operate before and after bypass contactor closes.
6.17 Protection disable functions: protection functions (except for no-voltage protection) can be disabled once the bypass contactor has been closed. A special disable mode of “bypass contactor open” function can be set when the bypass contactor is mounted remotely.

7.0 **RESETTING AFTER FAULT**

7.1 Upon fault, the starter shall trip and lock in a fault mode, also if line voltage disappears (blown fuse or voltage outage).
7.2 For maximum safety, resetting shall be possible only after the start signal is removed.
7.3 Resetting shall be possible either via local reset key or remotely via hard wire or communications.
7.4 Auto-reset shall be possible for the following faults: Under-Voltage, Phase Loss, Under Current and Open Bypass Contactor.

8.0 **AUXILIARY CONTACTS**

The soft starter shall incorporate a minimum of three auxiliary relays, each with 1 change of state contact rated 8A, 250V, 2000VA, with the following functions:

Immediate Relay - shall operate upon start signal, with adjustable On and Off delays. The contact shall return to original position upon voltage outage, fault, stop signal and upon soft stop signal – at the end of soft stopping process. The Immediate Relay can be also programmed for over current shear-pin function.

8.1 End of Acceleration Relay - shall operate upon completion of starting process, with adjustable On-delay. The contact shall return to original position upon voltage outage, fault and upon stop and soft stop signals.
8.2 Fault Relay – shall be programmed either as:
8.2.1 Fault – changes position upon Fault and returns to original position upon Reset, after fault has been removed.
8.2.2 Fault-Fail-Safe - changes position when control voltage connection returns upon fault (can be used for "Control Voltage Disconnected” alarm).

9.0 **TEST MODE**

Full functional test of all starter circuits shall be possible using a standard low voltage motor (typically 3HP-10HP rating). A special testing harness for the low voltage test shall be provided. Special warning signs preventing connection of high voltage to the starter during low voltage test shall be provided.

10.0 **LINE & BY-PASS CONTACTORS**

Line and bypass contactors shall be vacuum type. For system voltages higher than 7200V with currents higher than 600A, a fixed type motor operated circuit breaker shall be used. Contactors or circuit breakers shall be fixed mounted, rated according to motor current and voltage, having a minimum of 2 N.O & 2 N.C auxiliary contacts. Draw-out vacuum breakers may be supplied as an option.

11.0 **CABINET**

11.1 The cabinet shall be designed and constructed according to UL and NEMA standards with soft starter keypad mounted behind a transparent window.
11.2 All exterior and interior metal parts shall be coated and painted under the following procedure:
11.2.1 Preparation - Alkaline wash / rinse / iron phosphates / rinse/non chrome sealer rinse / re-circulated de-ionized water rinse and distilled de-ionized water rinse.
11.2.2 Painting – Air atomized electrostatic spray, Hybrid Epoxy Polyester powder paint.
11.2.3 Semi-matt. Paint thickness shall be at least 0.07 mm.
11.2.4 Color shall be ANSI-61 or other ANSI or RAL color as specified.
11.3 Field “touch-up” spray can(s), matching the enclosure color, shall be available if required.
11.4 Cabinet doors shall be provided with heavy duty hinges and locks.
11.5 Ground Bus - A continuous bare copper ground bus, 5 X 50 mm, shall be provided along the entire width of the enclosure, at the bottom.
11.6 Cable access shall be from bottom with a minimum of 30 cm available space for cable connections. No components shall be mounted in this space. Top entry option shall be available upon request.
11.7 An optional door switch with 1 N.O. + 1 N.C. contacts shall be mounted on the MV door, operated when the door is opened and wired to the terminal blocks. When indicated – the Door switch shall be wired so as to trip open the line contactor when door is opened.
11.8 Cabinet Heater - A 250W heater supplied from a dedicated miniature C.B. shall be optional.
11.9 Enclosure shall be equipped with top lifting hooks, capable of supporting 1.5 times cabinet weight.

12.0 **L.V. CONTROL**

The starter shall have a separate, completely segregated, front accessible low voltage compartment. This compartment shall include at least the following components:

12.1 Soft starter control module, with fiber optic wires.
12.2 Selector switch - Local / Remote (for door mounted Start/Stop buttons or Remote by hard wires).
12.3 Selector switch - Soft Starter / DOL starting (enabling DOL starting in case of a fault in the soft starter).
12.4 Interposing relays shall be used for starters built-in output relays.
12.5 Holding relay shall be provided when external Start / Stop push buttons are used.
12.6 All control components mounted in the L.V. compartment shall be wired to terminal blocks.
12.7 Control copper wires shall be insulated, flexible stranded, flame retarding thermoplastic compound, 690V, 70ºC (Standard), Halogen free 90ºC (optional), neatly bundled.
12.8 Each wire shall be marked with cable marking sleeves or direct printing on the wires, numbered according to the electrical diagram. Control wire terminations shall be screw-type, copper compression type, non-insulated, locking type, fork tongue lugs shall be provided on the current transformers.
12.9 Optional RF filter shall be supplied for the control circuit.

13.0 **DOOR MOUNTED CONTROL COMPONENTS**

The following components shall be mounted on L.V. door:

13.1 Motor protection relay (when specified)
13.2 Motor insulation protection (when specified)
13.3 Digital power meter (when specified)
13.4 Start / Stop pushbuttons.
13.5 Emergency Stop pushbutton.
13.6 Indication lights: Line Contactor Closed, Line Contactor Open, Bypass Contactor Closed, Remote Operation and Fault. Indicating lamp test feature is available upon request.

14.0 **COMMUNICATIONS**

The starter shall be equipped with one of the following protocols, as specified:

14.1 MODBUS RTU RS 485 half duplex (standard), enabling parameter settings, control (start/stop, etc.) and supervision.
14.2 PROFIBUS DP (optional) enabling control (start/stop, etc.) and supervision, non-bridge type.
14.3 DeviceNet (optional) enabling control (start/stop, etc.) and supervision, non-bridge type.

14.4 TCP/IP (optional) enabling control (start/stop, etc.) and supervision
14.5 Motor can be remotely controlled – start, stop, via communication.
14.6 Configuration software shall be provided for parameter setting and actual data reading.

15.0 **ANALOG OUTPUT (WHEN SPECIFIED)**

The starter shall be equipped with analog output, proportional to motor current, 0–10VDC or 0/4–20mA as standard.

16.0 **REMOTE SUPERVISION SYSTEM (WHEN SPECIFIED)**

Remote supervision system enables the user to control and monitor all parameters of the soft starter from a remote location.

The system incorporates the following features:
16.1 Parameter setup
16.2 Remote start and stop
16.3 Remote monitoring of actual parameters such as current, power, statistical data etc.
16.4 Remote fault analysis
16.5 Communication with up to 28 local stations using one transmitter
16.6 Communication to remote location using LAN, GSM (GPRS), satellite
16.7 Security levels
16.8 No need for special control servers
16.9 Operate from normal windows based PC and handheld computer based on windows CE
16.10 Customized comprehensive, friendly user active user interface
16.11 Plug and play system – easy to install and commission
16.12 Internal, on-line, messaging system (ICQ style)

17.0 **MOTOR INSULATION PROTECTION (WHEN SPECIFIED)**

Motor insulation protection monitors the insulation level of the motor. This protective device consists of a resistance box on the medium voltage side and a factory pre-installed PCB in the main control module of the starter.

17.1 Monitoring is implemented using up to 48 VDC for maximum safety.
17.2 Microprocessor based control
17.3 Monitors while motor is de-energized
17.4 Two distinct levels can be set for Alarm and Trip functions:
  17.4.1 Alarm level, Range: 0.1(OFF) – 10 MΩ
  17.4.2 Trip level, Range : 0.1 (OFF) – 10 MΩ
17.5 When insulation decreases below Alarm Level set point for more than 120 seconds, the LCD displays an alarm message and the insulation level can be read in MΩ on the display. The Fault LED flashes and the Insulation Alarm Relay is activated. Alarm signal will disappear automatically 60 seconds after insulation level returns to normal.
17.6 Trip does not reset automatically.

18.0 **MOTOR PROTECTION RELAY (WHEN SPECIFIED)**

The starter shall incorporate a digital, microprocessor based Motor Protection System (MPS) as a full motor protection package in addition to the motor protection and metering features in the soft starter. Upon fault that is not cleared by the soft starter, the MPS shall trip open the line contactor. In case of a high current fault, above the maximum opening current of the vacuum contactor, the MPS shall not trip the line contactor but shall let the fuses clear the fault, thereafter opening the contactor.

The MPS shall have the following protection and settings:
18.1 Under-current alarm with adjustable time delay
18.2 Maximum start time (stall protection)
18.3 Under current trip with adjustable time delay
18.4 Load increase alarm
18.5 Low set over-current (overload) with adjustable time delay

18.6 High set over-current (short circuit) with adjustable time delay
18.7 Thermal alarm (modeling motor heating, with adjustable time to trip at 6xIn, hot/cold ratio, cool time factor, stall time factor)
18.8 Thermal trip with adjustable time delay
18.9 Unbalance current alarm with adjustable time delay (negative – positive sequence)
18.10 Unbalance trip with adjustable time delay
18.11 Ground fault alarm with adjustable time delay
18.12 Ground fault trip with adjustable time delay
18.13 Under voltage with adjustable time delay
18.14 Over voltage alarm with adjustable time delay
18.15 Over voltage trip with adjustable time delay
18.16 Under power trip with adjustable time delay
18.17 Phase loss
18.18 Phase sequence
18.19 Motor over temp – input from thermistor PTC / NTC or RTD (Pt100), as shown in drawing.
18.20 External Fault 1 (entry from a N.O. contact)
18.21 External Fault 2 (entry from a N.O. contact)
18.22 Internal fault
18.23 Serial communication fault
18.24 Function shall be programmable for each fault as: Disable, Alarm Only, Trip Only, Alarm & Trip
18.25 Authorization key: preventing unauthorized parameter changing
18.26 Trip contact shall be 5A, 250VAC/DC
18.27 Four analog inputs, selectable 0/4-20mA
18.28 Four analog outputs, selectable 0/4-20mA, proportional to selectable actual values
18.29 Settings and supervision shall be by a LCD, 2 line, 16 characters each
- 18.29.1 Displays measured data: phase voltage, line voltage, line current, ground current, frequency, real power, active power, reactive power, power factor, each RTD sensor temperature, analog inputs 1-4 value.
- 18.29.2 Displays calculated data: motor current (% of motor FLC), equivalent current (calculated according to unbalance K factor), unbalance current, thermal capacity, time to trip via overload, time to start (after trip).
- 18.29.3 Displays discrete input status: status of each digital input (open or closed)
- 18.29.4 Displays statistical data: total run time, total number of starts, total number of trips, last start period, last start maximum current, total energy, minimum voltage, maximum voltage, minimum current, maximum current.
- 18.29.5 Displays fault data: last trip, last alarm, trip 3 line current values, trip ground current, trip phase voltage, last 10 trips with time stamp, external fault with time stamp, RTD value before last trip, over-current level 2 (short circuit).

18.30 Maintenance options: run test, simulation test.
18.31 Reset function shall be programmable for each fault as auto reset, local reset and remote reset.
18.32 The MPS shall be equipped with RS 485 communications, with Modbus protocol. Other protocols shall be optional.
18.33 Configuration software shall be provided for parameter setting and actual data reading

19.0 **STARTER SELECTION & AVAILABLE OPTIONS**

19.1 Mains Voltage Selection: 2300, 3300, 4160, 5500, 6000, 6600, 6900, 7200 (10000, 11000 & 13800 also available. Refer to separate specification guide for these higher voltage rated products).
19.2 Current Rating Selection:
System voltages: 4160V and below – 100, 200, 400, 600, 800, 1000A (above this, consult factory).
For system voltages: 6kV and above – 70, 140, 250, 300, 400, 500, 700, 800, 1000, 1200A (above this, consult factory)
19.3 Re-rating factor for frequent starting (check motor data sheet to verify the number of starts per hour allowed by the motor manufacturer). Soft starter manufacturer shall provide a detailed starting analysis (including starts per hour recommendations) based on the motor and load speed/torque curves and application requirements. This starting analysis shall be supplied at no additional charge.
19.4 Cabinet protection: Standard cabinet is rated NEMA12 (indoor use). Optional NEMA4, NEMA3R and MetalClad type construction are also available. Contact factory.

19.5 De-rating factor for higher altitudes: The starter is designed to operate at altitudes of up to 1000m above sea level. Contact factory for installations at higher altitudes.

19.6 Synchronous Motors: for synchronous motor applications, add the following paragraph:
The starter shall be equipped with an "At Speed Contact" to initiate the excitation system.

19.7 Multi-start system: multi-motor starting (sequential starting) design is available – contact factory for detailed specifications.

19.8 Marine applications: Marine duty features are available - contact factory for "Specification Guide – Marine Applications" and available Type test certifications.

19.9 Other available options

In the L. V. Section	* 220VDC Control Supply * Synchronization card – for synchronous motors * MPS 3000C motor protection relay (with Control functions) * Additional Signal light, Control Relays, Push buttons, Selector switches, etc.
In the MV Section	* Exhaust fan + filter + timer + fan duct (required for frequent starting like multi-start applications or higher ambient temperatures) * Humidity control, heater + control + miniature C/B
General	* Door stoppers * Cabinet light * Rear access – via rear doors with hinges and locks or panels with screws. * Non-standard painting (standard is ANSI 61 grey) * Special thick painting * Bus bars

20.0 **APPLICABLE IEC & UL STANDARDS**

1. IEC 62271-200	High Voltage switchgear and control gear.
2. IEC 60061-1	High Voltage test techniques, General definitions and test requirements.
3. IEC 60694	Common specifications for high voltage switchgear and control gear standard.
4. IEC 71-1	Insulation coordination.
5. IEC 71-2	Insulation coordination.
6. EN 50178:1998	Electronic equipment for use in power installation.
7. IEC 664	Insulated coordination within low voltage systems including clearances and creepage distances for equipment.
8. EN 60265-1	Load break switch.
9. EN 60420	Load break switch.
10. IEC 129	Double section rotary disconnects.
11. IEC 129	Earthing/ground switch.
12. IEC 60470, UL 347	Vacuum contactors.
13. IEC 282-1	Vacuum contactors + fuses.
14. IEC 60282-1	Medium voltage fuse
15. IEC 420	Medium voltage fuse
16. DIN 43624	Fuse base for indoor mounting
17. DIN 46234	Cable lugs
18. DIN 0472+IEC 754	Medium voltage cables
19. EN 61000-6-2	Electromagnetic compatibility (EMC) - Immunity
20. EN 61000-6-4	Electromagnetic compatibility (EMC) - Emission
21. EEC/72/23	Electrical safety - Council Directive
22. UL347	