HRVS-DN

MV Soft Starter

Typical Specification

10-13.8kV

200A-1200A Ratings

Overview: This specification guide assist Plant and Consulting Engineers to specify and describe Solcon's HRVSDN Series 15kV Class, Digital Reduced Voltage Solid State Starters. This equipment is provided as a superior method of providing control and protection for AC motors. It also solves performance control and reliability problems typical of electro-mechanical reduced voltage motor starting methods (including Part Winding, Auto Transformer and Primary Reactor). Advantages include solid state construction, advanced motor protection, step-less acceleration, reduced inrush current, minimal maintenance and long-term, reliable operation. Applications include, but are not limited to: pumps, fans, blowers, grinders, compressors, bow thrusters, wood and aggregate processing, conveyors and mixers.

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1. GENERAL

This specification describes the performance, functional specifications and fabrication details for a 15kV Class digital reduced voltage, solid state medium voltage starter that shall provide a selectable voltage ramp, current ramp or torque ramp methods (all standard) of soft starting 3-phase AC induction motors or synchronous motors (synchronous controller sold as an option adder). Each motor controller shall be a complete Class E-2 combination starter and include a fused disconnect switch, in-line isolation contactor or breaker, digital controller unit with built in motor overload protection and bypass contactor or breaker.

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: 10-13.8kV +10% - 15% (see section 1.6 below for Generator Supplied Systems).
1.3 Nominal Current: up to 1200A continuous (see paragraph 0 for Current Rating Selection).
1.4 Control voltage: 115VAC +10% - 15% standard (other control voltages: 230VAC, 115 or 220VDC)
1.5 Frequency: 50/60Hz ± 2% (see also section 1.6 below for Generator Supply Systems).
1.6 When the 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: 0°C - 50°C, Relative humidity: 95% non-condensed
1.8 Maximum number of starts: minimum 2 per hour based on maximum operating conditions (See paragraph 0 for de-rating factor for frequent starting, may also require forced air cooling).
1.9 Altitude: 3300ft (1000m) maximum without derating (See paragraph 0 for de-rating factor for higher altitudes).
1.10 EMC Certificate – Starter shall have EMC certificate according to Article 10(2) of the EMC directive 89/336/EEC.
1.11 Minimum SCR PIV Rating shall be about 3 times system voltage.

2. SCOPE OF SUPPLY

2.1 Digital soft starter cabinet is comprised of a set of 3 adjoining cabinets containing integral parts of the total assembly. The basis for the structures will be 15kV Metal-Enclosed Interrupter Switchgear (Metal Clad type construction optional) and consist of the following:

A. Incoming terminals, Main Disconnect Switch and Fuses:
   a. Disconnect Switch: A “Fault-Make / Load-Break” rated disconnect switch shall be provided in the incoming power section of the starter assembly. Disconnect switch design voltage shall be 13.8kV. The Load-Break rating is to protect against any possible vacuum contactor or breaker failure. Isolation switches relying on the vacuum contactor or breaker to interrupt the load shall not be used.
   b. Power Fuses: As a NEMA Class E2 controller, current limiting primary power fuses shall be provided for each incoming phase. Fuses shall be ANSI class “E”, sized according to motor locked rotor current and coordinated with the overload protection. Fuse and overload coordination shall be designed to allow the controller and contactor or breaker to clear low and medium level faults without blowing and without exceeding the contactor or breaker interrupt ratings. Fuses shall be used to interrupt high level faults exceeding those ratings.

B. Isolation and Bypass Contactor or Breaker:
   Vacuum contactor or breaker designed for a minimum of 11kV or up to 15kV shall be provided for both In-Line Isolation and SCR Bypass.
   a. A sequencing feature shall control the contactor or breakers to maximize life. Under normal operating conditions, it will ensure that contactor or breakers always make and break under no-load conditions.
   b. Vacuum contactor or breakers shall be rated for maximum starting current of the starter design and capable of across-the-line (DOL) emergency start. Interrupt rating shall be in coordination with the primary fuses.

C. SCR Power Section:
   Shall contain the SCR heatsink assemblies and load terminals. SCR assemblies shall be designed as modular assemblies for ease of removal and service.

2.2 When required, the starter shall include optional features as listed in this specification (see paragraphs 15, 16, **Error! Reference source not found.**, 17, 18, **Error! Reference source not found.**, 0 for available options).

3. STARTER CONSTRUCTION

3.1 Starter shall be designed for heavy duty applications and ambient temperature of 50°C.
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 Fault Indication LEDs for easy commissioning and trouble shooting.
3.5 Heat-sink over-temperature protection shall be provided for each of the 3 phases, with fiber-optic connections.
3.6 Each phase shall be protected on the sides and front by reinforced insulation material. Double insulation sheets shall be used between phases.
3.7 Each phase shall have the capability of being disassembled on site for maintenance.
3.8 All printed circuit boards shall be conformal coated to protect against harsh environmental conditions.
3.9 When required, preparation for connecting power factor capacitors (capacitors are not a part of this scope of supply) shall be made at starter's input side, switched on by the Line Vacuum Breaker or Contactor, without the need for a special 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 All cable connections shall be to bus-bars, supported by isolators. Care should be given to Cu/Al connections.
3.12 Selectable curves shall enable field setting of the starting characteristic - Voltage Ramp, Current Ramp or Torque Ramp, optimizing soft start and soft stop processes based on the line voltage, motor and load requirements.
3.13 All control inputs shall be via opto-couplers, to isolate the micro controller board from external noice and meet EMC requirements.

4. SETTINGS & SUPERVISION

4.1 The starter shall be programmed according to the driven load characteristics. Starting and stopping process shall be as specified here below.
4.2 Starter settings shall be made via a keypad and illuminated LCD display. Illuminated LCD display shall have 2 lines, 16 characters each for ease of use.
4.3 Display language shall be selectable as English (default), German, French or Spanish (additional languages including Russian, Chinese and others shall be available as options).
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 9 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 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, operation using Dual Adjustment settings and Fault.
4.7 Keys on the keypad shall be clearly marked and software shall have easy-to-use Default Parameters.
4.8 Software lock, preventing parameters change shall be via an internal dip switch.

5. 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 (C.L.): adjustable 100-440% x (Starter FLC / Motor FLA)
5.3 Ramp-up Time: adjustable 1-90 sec.
5.4 Ramp-down Time: adjustable 1-90 sec.

5.5 Pulse Start: Selectable pulse of either 80% nominal voltage, without current limit, for 0.1-1 sec. or 1-2 Sec when set at C.L.
5.6 Torque Control, for linear acceleration and deceleration with selectable Torque Curves.
5.7 Current Ramp Control with Initial Current adjusts 100-400%, Ramp-up time 1-90 sec.
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 for varying loads for two speed motors.

6. MOTOR & STARTER PROTECTION

The starter shall have the following protection functions:

6.1 Excessive starts protection 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 both NEMA and IEC selectable curves (Class 5-30).
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.
6.15 No start signal - trips the Line Contactor in case power is connected to soft starter and no start command is given. No start signal protection can be disabled.
6.16 Motor currents shall be measured by soft starter's C/Ts on all three phases. Upstream protection shall operate before and after bypass contactor closes.
6.17 All protection features, with the exception of No-Voltage Protection, can be disabled after the Bypass Contactor closes.

7.0 METERING

Metering functions shall be available through the standard digital controller unit (DCU) for indicating the following: Output current, line voltage, power factor, kW, kW demand, kVA, kVA deman, kVAR, kVAR demand, Motor Load % of FLA, Line Frequency and Ground Fault (when included). Statistical data shall be recorded and viewable via the operator interface.

8. RESETTING AFTER FAULT

8.1 Upon fault or if line voltage is not present (blown fuse or voltage outage) the starter shall trip and lock in Fault Mode.
8.2 For maximum safety, resetting shall be possible only after start command is removed.
8.3 Resetting shall be possible either via local Reset Key or remotely via hard wire or communications.
8.4 Auto-Reset shall be possible for Under-Voltage, Phase Loss, Under Current and Open Bypass Contactor Faults.

9. AUXILIARY CONTACTS

The soft starter shall incorporate a minimum of three auxiliary relays, each with 1 change-over contact rated 8A, 250V, 1800VA, with the following functions:

9.1 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.

9.2 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.

9.3 Fault Relay – shall be programmed either as:

A. Fault – changes position upon Fault, returns to original position upon Reset after fault condition has been removed.
B. Fault-Fail-Safe - changes position upon control voltage connection returns upon fault, can be used for "Control Voltage Disconnected" alarm).

10. TEST MODE

Full functional test of all starter circuits shall be possible using a standard low voltage motor (typically 3-10HP or 3-15kW rated motor). A special low voltage test harness shall be provided with each starter.
Special Warning signs, preventing connection of high voltage to the starter during low voltage test will be provided.

11. LINE & BY-PASS

Line and Bypass shall be fixed mount type vacuum contactor or motor operated circuit breaker, rated according to motor current and voltage and having a minimum of 2 N.O & 2 N.C auxiliary contacts.

12. CABINET CONSTRUCTION

12.1 NEMA type 1 Metal Enclosed constructed cabinets shall contain the disconnect, solid state soft starter and other components as required. Structure design shall be as follows (with Metal Clad type construction as optional):

A. Welded steel with a minimum thickness of 11 gauge to form rigid free-standing dead front structures. Enclosure design shall be in accordance with NEMA ICS 3-2 and UL 347.
B. Isolated compartments shall be provided: a Main Incoming Power Section housing the main disconnect switch and horizontal power bus bars, one or more Starter Chassis compartments containing all other medium voltage devices, and an isolated Low Voltage compartment hosing the digital controller unit (DCU) and all other low voltage devices or controls.
    a. Compartment doors shall be rolled and formed so they are capable of containing maximum fault forces. Doors shall open at a minimum of 120 degrees and include means for holding them open during testing or service.
C. Enclosure finish shall be suitable for indoor use in non-corrosive environments. Paint shall be ANSI61 grey polyurethane powder over a zinc phosphate pre-treatment, minimum 2-mil thickness.
D. Lifting eyes or angles capable of supporting the maximum weight of each shipping split shall be provided on the top of the enclosure.
E. Seismic Qualifications: The entire starter assembly and installation procedures shall withstand vertical and horizontal accelerations typical of seismic Zones 1 thru 4 as defined in the UBC. The assembly will not overturn or show significant lateral movement, but shall not be expected ot continue operating during or after a seismic event.

12.2 Bus Bars: Where indicated on the drawings, provide 600 or 1200A main horizontal phase bus bars extending the entire length of the starter lineup. Bus bar material shall be tin or silver-plated copper. Bus ratings shall be per UL Standard 347. Splice kits for each shipping split shall be provided. Bus connections shall use 2 bolts minimum with Belleville spring washers to ensure tightness.

A. Bracing: bus bars shall be braced with non-tracking fire resistant non-hygroscopic insulation supports and shall have a minimum fault current rating of 40,000 amps for 600A bus and 61,000 amps for 1200A bus.
B. Ground Bus: A continuous bare copper ground bus with a minimum rating of 600 amps shall extend the entire length of the starter lineup near the bottom of each cabinet. A grounding strap shall connect each vertically adjacent compartment and also tie the grounding arm of the disconnect switch to the main ground bus bar.

13. LOW VOLTAGE CONTROL

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

13.1 Soft starter Digital Control Module (DCU), with fiber optic wires.

13.2 Selector Switch - Local / Remote (for door mounted Start/Stop buttons or Remote via hard wires).
13.3 Selector Switch - Soft Starter / DOL starting (enabling DOL starting in case of a fault in the soft starter).
13.4 Interposing relays shall be used for starters built-in output relays.
13.5 A Holding Relay shall be provided when external Start / Stop push buttons are used.
13.6 All control components mounted in the low voltage compartment shall be wired to terminal blocks, which shall be wired to Customer Terminal blocks.
13.7 Customer connection terminal blocks shall be located in separate, fully segregated section. Remote control cables shall be from the top or bottom of the structure. Control cable inputs and outputs shall be through removable entry plates on top or bottom of the structure.
13.8 Control copper wires shall be insulated, flexible stranded, flame retarding thermoplastic compound, 690V, 70ºC (Standard), Halogen free 90ºC (optional), neatly bundled.
13.9 Each wire shall be marked with cable marking sleeves, 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.
13.10 Whenever two wires are connected to the same terminal, they shall be crimped together.
13.11 Optional RF filter shall be supplied for the control circuit.

14. DOOR MOUNTED CONTROL COMPONENTS

The following components shall be mounted on L.V. door:
14.1 Motor Protection Relay
14.2 Motor Insulation protection (when specified)
14.3 Digital power meter (when specified)
14.4 Start / Stop Pushbuttons.
14.5 Emergency stop push button.
14.6 Indication light LED type: Line Contactor Closed, Line Contactor Open, Bypass Contactor Closed, Remote Operation and Fault. Indicating lamp test feature is available upon request.

15. COMMUNICATIONS

The starter shall be equipped with MODBUS RTU RS 485 communications as standard (half duplex, enabling parameter settings, start/stop control, supervision, etc). Optional communications protocols shall be as follows:
15.1 PROFIBUS DP enabling Control (Start/Stop, etc.) and Supervision.
15.2 DEVICENET enabling Control (Start/Stop, etc.) and Supervision.
15.3 Configuration software shall be provided for parameter setting and actual data reading

16. ANALOG OUTPUT (WHEN SPECIFIED)

Analog output, proportional to motors current, 0–10VDC or 0/4–20mA as specified.

17. MOTOR INSULATION PROTECTION (WHEN SPECIFIED)

Motor insulation protection monitors the insulation level of the motor. The protection 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 controlling.
17.3 Monitoring while motor is de-energized.
17.4 Two distinct levels can be set for Alarm and Trip functions:
Alarm level, Range: 0.1(OFF) – 10 MΩ
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 massage 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. MOTOR PROTECTION RELAY (WHEN SPECIFIED)

The starter shall incorporate a digital, microprocessor based Motor Protection System (MPS) as a full motor protection package. Upon fault that is not cleared by the soft starter, the MPS shall trip open the Line Contactor or Breaker.

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 Authorized key: preventing unauthorized parameter changing.
18.26 Trip contact shall be 5A, 250VAC/DC.
18.27 Four analogue inputs, selectable 0/4-20mA.
18.28 Four analogue 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.
18.30 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 communication RS 485, with Modbus Protocol.
18.33 Configuration software shall be provided for parameter setting and actual data reading

19. STARTER SELECTION & AVAILABLE OPTIONS

19.1 Line Voltage Selection: 10000, 11000, 13800

19.2 Current Rating Selection:
At system voltages: 10kV and above – 70, 140, 200, 250, 300, 400, 500, 700, 800, 1000, 1200A (Consult factory for higher ratings)

19.3 De-rating for higher altitude
The starter is designed to operate at altitudes of up to 3300ft (1000m) above sea level.
Contact factory for de-rate requirements above this.

19.4 Synchronous Motors: For synchronous motor add the following as paragraph: *The starter shall be equipped with an "At Speed Contact" to initiate the excitation system*.

19.5 Multi-start System: Multi-start application is available – contact factory for detailed specifications.

19.6 Marine Applications: Marine certifications are available - contact factory for details.

20. APPLICABLE IEC & UL STANDARDS

ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronic Engineers
UL347	Underwriters Laboratories Inc.
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
OSHA	Occupational Safety and Health Act
IEC 62271-200	High Voltage switchgear & control gear
IEC 60061-1	High Voltage test techniques, general definitions & test requirements
IEC 60694	Common specifications for high voltage switchgear & control gear
IEC 71-1	Insulation co-ordination
IEC 71-2	Insulation co-ordination
EN 50178:1998	Electronic equipment for use in power installation
IEC 664	Insulated coordination within low-voltage systems
EN 60265-1	Load break switch
EN 60420	Load break switch
IEC 60470, UL 347	Vacuum contactors.
IEC 282-1	Vacuum contactors + fuses.
IEC 60282-1	Medium voltage fuse
IEC 420	Medium voltage fuse
DIN 43624	Fuse base for indoor mounting
DIN 46234	Cable lugs
DIN 0472+IEC 754	Medium voltage cables
EN 61000-6-2	Electromagnetic compatibility (EMC)- Immunity
EN 61000-6-4	Electromagnetic compatibility (EMC)- Emission
EEC/72/23	Electrical safety-Council Directive

21. DOCUMENTATION

Units shall be shipped with a complete set of documentation to include the following:

A. Complete schematics and wiring diagrams
B. Enclosure outline drawings
C. System instruction manuals
D. Contactor or breaker and disconnect system data, as applicable
E. All drawings shall be done in AutoCAD and shall be available in electronic format.

22. SPARE PARTS

A recommended spare parts list required for commissioning and 5 years operation.

23. COMMISSIONING AND TRAINING

The manufacturer shall offer commissioning and training on site. A minimum of 1 day on-site shall be necessary for each unit.