

SECTION 26 29 13.16 – SOLID-STATE REDUCED VOLTAGE STARTERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. General: The CONTRACTOR shall provide solid-state reduced voltage motor starters, complete and operable, in accordance with the Contract Documents.
- B. Single Manufacturer
 - 1. Like products shall be the end product of one manufacturer in order to standardize appearance, operation, maintenance, spare parts, and manufacturer's services. However, the CONTRACTOR shall remain responsible to the OWNER for the WORK of the Contract.
 - 2. The manufacturer shall maintain factory-trained and authorized service facilities within 100 miles of the project and shall have a demonstrated record of service for at least the previous ten years.
 - 3. Support personnel are to be direct employees of the manufacturer and be available 24 hours per day through a toll-free number.
 - 4. The manufacturer shall provide all required start-up and training services
- C. Coordination: Equipment provided under this Section shall operate the electric motor and the driven equipment indicated under other equipment specifications. The CONTRACTOR's attention is specifically directed to the need for proper coordination of the WORK under this Section with the WORK under the equipment section.

1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with MASS Section 10.05 Article 5.6, except that Shop Drawing information for the drives shall be submitted as part of the information for the driven equipment.
- B. Shop Drawings
 - 1. Equipment information
 - a. Name of drive manufacturer
 - b. Type and model
 - c. Assembly drawing and nomenclature
 - d. Maximum heat dissipation capacity (kW)
 - 2. Written description of ladder diagram operation. Custom schematics shall be furnished. Diagrams shall include all remote devices.
 - 3. System block diagram and interconnection diagrams.
 - 4. Replacement parts list and operation and maintenance instructions.

PART 2 - PRODUCTS

2.1 GENERAL

The CONTRACTOR shall provide solid-state starters, in quantity and type as indicated below or as shown on the Contract Drawings.

Qty.	Equipment	Location	Description	HP	Volt	Drawing

- A. The solid state reduced voltage controller shall accept an input voltage from 200...480V AC, 200...600V AC, or 230...690V AC three-phase plus 10 percent or minus 15 percent.
- B. The solid-state reduced-voltage controller shall have a minimum short-circuit current rating of 65 kA when protected with a type CC/J/L fuses (up to 600V).
- C. Environmental Ratings
 - 1. Storage ambient temperature range: -25...+75°C.
 - 2. Operating ambient temperature range: 0...50°C.
 - 3. The relative humidity range: 5% ...95% non-condensing.
 - 4. Operating elevation: up to 2000 meters.
- D. Definitions
 - 1. The Solid-State Reduced-Voltage Controller Unit shall refer to the actual controller unit that will be mounted within the specified enclosure.
 - 2. The Solid-State Reduced-Voltage Controller System shall refer to the controller unit and all items specified under Controller System Options.

2.2 SOLID-STATE REDUCED-VOLTAGE CONTROLLER UNIT DESIGN

- A. The open-type controller device shall be modular, consisting of a power structure and a logic component.
- B. Power Structure
 - 1. The family of devices must be available from 1...1250 A in a line connection
 - 2. The family of devices must be available from 1...1600 A when connected inside the delta

3. The inside the delta mode must be enabled with a parameter setting on the device
4. The power structure shall include an electro-mechanical SCR bypass device.
5. The power structure shall include built-in 3-phase current monitoring and overload protection.
6. The power structure shall consist of three power poles with integral heatsinks.
7. The power poles are to be modular in design that each is easily replaceable
8. Back-to-back SCR pairs shall be the only power switching semiconductor means acceptable. Diode-SCR (Silicon Controlled Rectifier) combinations shall not be acceptable.
9. SCRs shall have the following minimum repetitive peak inverse voltage ratings.
10. 1400V for units rated 200...480V
11. 1600V for units rated 200...600V
12. 1800V for units rated 230...690V
13. SCRs shall have built in temperature monitoring sensors.
14. Use of an External bypass must be an option
15. The manufacture must supply guidance on obtaining SCR protection

C. Logic Component

1. The logic component shall be a self-contained control module, compatible with the full range of power structures. The control module shall mount directly to the power structure.
2. The control module shall provide digital microprocessor control and supervision of all controller operation, including pulse firing of the SCRs.
3. The control module shall consist of the following.
 - a. Self-tuning power supply accepting control power input from 100...240V AC or 24V AC/DC, 50/60 Hz.
 - b. Logic control circuitry incorporating a latch circuit for three-wire control.
 - c. SCR firing circuitry that incorporates an RC snubber network to prevent false firing.
 - d. Input / output circuitry
 - e. Digital programming keypad
 - f. Backlit LCD display with multi-lingual capabilities
 - g. DPI communication port
4. The control terminals shall have the following characteristics
 - a. The control terminal wiring connector shall be easily accessible and located on the front top of the device.
 - b. The terminals shall be UL rated for 300V, 10 A maximum.
 - c. The terminals are UL Recognized to accept a maximum of two (2) wires rated #8...#14 AWG.
5. The control module shall be easily removed from the power structure, without the need to disassemble associated printed circuit board assemblies.

2.3 SOLID-STATE REDUCED-VOLTAGE CONTROLLER UNIT MODES

A. Starting Modes

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1. Soft start with Selectable Kickstart
 - a. Programmable initial torque value of 0...90% of locked rotor torque.
 - b. Programmable acceleration ramp time from 0...30 seconds.
 - c. A selectable kickstart, or boost, shall be provided at the beginning of the voltage ramp. The kickstart shall provide a current pulse of 550 percent of the full load current. The kickstart time shall be adjustable from 0...2 seconds.
 - d. Current limit start
 - e. Provides means of limiting the maximum starting current
 - f. Adjustable from 50...600% of motor full load current.
2. Full-voltage start
 - a. Provides across the line starting.
 - b. Ramp time shall be less than 0.25 seconds.
3. Dual ramp start
 - a. Provides two (2) separate start profiles with separately adjustable ramp times and initial torque, settings.
 - b. Programmable acceleration times from 0... 30 seconds.
 - c. Current limit level programmable from 50...600% full load current.
 - d. Programmable initial torque values from 0...90% of locked rotor torque.

B. Stopping Modes

1. Soft stop
 - a. The soft stop option shall provide a voltage ramp-down for an extended motor stopping time.
 - b. Soft stop shall be initiated by a dedicated Soft Stop input. A coast-to-rest stop shall still be possible with a separate stop input.
 - c. Programmable voltage ramp down time from 0...60 seconds.
 - d. The load shall stop when the motor voltage drops to a point where the load torque is greater than the motor torque
2. Preset Slow Speed
 - a. Provides a slow speed for applications requiring a slow speed.
 - b. The Preset Slow Speed option shall provide two jog speeds in the forward direction: high (15% of base speed) and low (7% of base speed).
 - c. The Preset Slow Speed option shall provide two jog speeds in the reverse direction: high (20% of base speed) and low (10% of base speed). Reverse operation of the motor shall be available in the jog mode without the use of a reversing contactor
 - d. The starting current for the slow speed operation shall be user adjustable from 0...450% of the motor's full load current rating.
 - e. The running current for the slow speed operation shall be user adjustable from 0... 450% of the motor's full load current rating.

C. Mutually exclusive starting and stopping modes. Refer to the system specifications for the option (if any) required

1. Pump Control

- a. The Pump Control option shall be implemented to provide closed loop control of a motor to match the specific torque requirements of centrifugal pumps for both starting and stopping. This shall aid in eliminating the phenomena commonly referred to as “water hammer.” Methods utilizing Soft Start with Soft Stop shall not be acceptable.
- b. Closed loop control shall be achieved without using external sensors or feedback devices.
- c. Pump Stop shall be initiated by a dedicated Pump Stop input. A coast-to-rest stop shall still be possible with a separate stop input.
- d. Programmable starting time from 0...30 seconds.
- e. Programmable stopping time from 0...120 seconds.

2.4 SOLID-STATE REDUCED-VOLTAGE CONTROLLER UNIT FEATURES

A. LCD Display

1. An alphanumeric, backlit LCD display shall be provided for controller set-up, diagnostics, status and monitoring. The display shall be four-line, 16 characters minimum.
2. Digital parameter adjustment shall be provided through a keypad. Analog potentiometer adjustments are not acceptable.

B. Overload Protection

1. Shall meet applicable standards as a motor thermal protective device.
2. Shall utilize three-phase current sensing. The use of two current transformers shall be unacceptable.
3. Selectable trip classes of 10, 15, 20, and 30 shall be provided as standard.
4. Electronic thermal memory shall provide enhanced motor protection.

C. Digital I/O

1. A minimum of four (4) auxiliary contacts shall be provided for customer use
2. The contacts shall be rated for 240V AC maximum.
3. Contact configuration shall be programmable and contain the following configurations:
 - a. Normal Operation (N.O. or N.C.)
 - b. Up-to-Speed indication (N.O. or N.C.)
 - c. External bypass
 - d. Fault indication (N.O. or N.C.)
 - e. Alarm indication (N.O. or N.C.)
 - f. Network controlled output (N.O. or N.C.)

D. DPI Serial Communication Port

1. A DPI serial communication ports shall be provided as standard.
2. Optional communication protocol interface modules that shall be available for connection to EtherNet/IP, Remote I/O, DH485, ControlNet, DeviceNet and RS232/422/485. Provide DeviceNet module.

3. DeviceNet Bridge: The RVSS starter signal circuits shall be isolated from the power circuits and be designed to accept a DeviceNet interface. The RVSS starter supplier shall provide an EDS file to allow the Allen-Bradley DeviceNet programming software to address the starter. The starter shall follow the setting of a local control when in the hand mode. The following operator monitoring and control devices for the starter shall be provided on the face of its enclosure, either as discrete devices, or as part of a multi-function microprocessor-based keypad access device. Access to set-up and protective adjustments shall be protected by key-lockout or password.
 - a. All available programming parameters must be addressable from RSNetwork over DeviceNet without the use of protocol convertors or bridges.
 - b. Auto/Hand selection from the operator interface. In "Auto", the starter shall operate from the DeviceNet input, and in "Hand" control, shall operate on Devicenet from the local keypad.
 - c. RVSS starter fault trip indication and output alarm contacts
 - d. Trip reset pushbutton
 - e. Electronic overload protection.

- E. Monitoring – the controller shall provide the following motor and/or power system monitoring functions indicated through the optional LCD display.
 1. Three-phase current
 2. Three-phase voltage
 3. Power in kW
 4. Power usage in kWh or MWh
 5. Power factor
 6. Motor thermal capacity usage
 7. Elapsed time

- F. Protection and Diagnostics
 1. Pre-start line fault advising of shorted SCR or missing load connection with phase indication.
 2. Running line fault advising power loss, shorted SCR, or missing load connection.
 3. Pre-start power loss with phase indication.
 4. Over temperature
 5. Open gate with phase indication.
 6. The following programmable protection shall be provided as standard with the controller.
 - a. Overload
 - b. Underload
 - c. Undervoltage
 - d. Overvoltage
 - e. Voltage unbalance
 - f. Phase reversal
 - g. Stall
 - h. Jam
 - i. Excessive starts per hour

7. When fault conditions are detected, the controller shall inhibit starting or shutting down SCR pulse firing.
8. Fault diagnostics shall be indicated in descriptive text on the LCD display. The exclusive use of fault codes is unacceptable.
9. An auxiliary contact that is user programmable for fault indication shall be provided for customer use.

2.5 SOLID-STATE REDUCED-VOLTAGE CONTROLLER SYSTEM MISCELLANEOUS

- A. Control Power Transformer
 1. Provide a control power transformer mounted and wired inside of the system enclosure.
 2. The transformer shall be rated for an additional 100 VA for customer use.
 3. The transformer shall be provided with fused primary and secondary protection.
- B. Hand-Off-Auto Selector Switch
 1. Provide a "Hand/Off/Auto" selector switch for start-stop control
 2. Provide pilot lights for indication of the "Hand" and "Auto" modes
 3. The devices shall be Allen-Bradley Bulletin 800E pilot devices (22.5 mm, NEMA Type 4/4X/13) mounted on the enclosure door.
- C. Pilot Lights
 3. Provide pilot lights, mounted on the enclosure door, for indication of On (Green), and Fault (Red).
 4. Pilot lights shall be transformer type
 5. The devices shall be Allen-Bradley Bulletin 800E (22.5 mm, NEMA Type 4/4X/13) pilot devices mounted on the enclosure door.
- D. Pump Control Option
 1. Provide the Pump Control option.
- E. Human Interface Module (HIM)
 1. Provide a door mounted Human Interface Module with integral display and programming keys.
 2. The display shall show operating conditions, adjustments and fault indications.
 3. The display shall be backlit LCD and shall consist of four lines of 16 characters alphanumeric.

2.6 MANUFACTURERS, OR EQUAL

- A. Solid-state reduced voltage starters shall be **Allen-Bradley SMC with pump control option**, or equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. The CONTRACTOR shall install the solid-state reduced voltage starters in accordance with the manufacturer's published instructions.
- B. The CONTRACTOR shall
 - 1. Verify that the overload devices are properly adjusted for the equipment installed.
 - 2. After the equipment is installed, touch up scratches and verify that nameplate and other identification is accurate.
- C. The service division of the manufacturer shall perform all start-up services.
- D. Start-up personnel shall be direct employees of the manufacturer and shall be degreed engineers.
- E. At a minimum, the start-up service shall include:
 - 1. Pre-power check
 - a. Megger motor resistance: phase-to-phase and phase-to-ground
 - b. Verify system grounding per manufacturer's specifications
 - c. Verify power and signal grounds
 - d. Check connections
 - e. Check environment
 - 2. Power-up and commissioning
 - a. Measure incoming power phase-to-phase and phase-to-ground
 - b. Measure DC bus voltage
 - c. Measure AC current unloaded and loaded
 - d. Measure output voltage phase-to-phase and phase-to-ground
 - 3. Recording of all measurements
 - 4. Tuning for system operation
 - 5. Providing a parameter list

3.2 TRAINING

- A. Manufacturer to provide a quantity of one (1) session of on-site instruction.
- B. The service engineer shall perform training.
- C. The instruction shall include the operational and maintenance requirements of the controller
- D. The basis of the training shall be the installed controller, the engineered drawings and the user manual. At a minimum, the training shall do the following:
 - 1. Review of the engineered drawings identifying the components shown on the drawings.
 - 2. Review starting / stopping options for the controller.
 - 3. Review operation of the Human Interface for programming and monitoring of the controller.
 - 4. Review the maintenance requirements of the controller.
 - 5. Review safety concerns with operating the controller.

END OF SECTION 26 29 13.16