

SECTION 26 29 13.16 REDUCED-VOLTAGE SOLID STATE STARTERS

PART 1 - GENERAL

1.1 SCOPE

- A. This specification describes the performance, functional specifications and fabrication details for a digital reduced voltage, stepless, solid state motor starter that shall provide a selectable voltage ramp, current limit or torque ramp (all standard) method of soft starting 3-phase AC induction motors.
 - 1. The motor starter shall be self-contained and house the solid-state controller, motor overload protection (Class 10 through Class 30 selectable), an integral bypass contactor and a disconnect means as required on the drawings, in one enclosure.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract apply to this section.

1.3 SUBMITTALS

- A. Submit shop drawings and product data for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location and customer order number.
- B. Units shall be shipped with a complete set of documentation to include the following items:
 - 1. Complete schematics and wiring diagrams
 - 2. Enclosure outline drawings
 - 3. System instruction manuals
 - 4. Contactor and disconnect system data, if applicable
 - 5. All drawings shall be done in AutoCAD and shall be available on electronic medium.
 - 6. All of the above will be required at the time of **[Approval]** **[Close Out]**.

1.4 RELATED STANDARDS

- A. Codes and Standards
 - 1. Unit(s) must be manufactured to the codes listed below:
 - a. National Electrical Code
 - 2. Unit(s) must be approved and/or certified by, and carry the label(s) of one or more of the following organizations:
 - a. Underwriters Laboratories (UL)
 - b. Canada Standards Association (CSA) or cUL is acceptable
 - 3. Stand-alone units shall be Combination Starters with circuit breakers and shall be UL listed for use in combination with the specific associated circuit breaker per applicable UL-508 standards. If used in Motor Control Centers, the complete starter units will be UL listed under UL-845 as part of the MCC.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engage a firm with at least 60 years experience in manufacturing motor controllers.
 - 1. All incoming material shall be inspected and/or tested for conformance to quality assurance.
 - 2. Power semiconductors shall be fully tested for proper electrical characteristics (dv/dt, di/dt, etc.).
 - 3. All subassemblies shall be inspected and/or tested for conformance to vendors engineering and quality assurance specifications.
 - 4. Printed circuit boards shall be burned in for a minimum of 48 hours at 60°C.
 - 5. The complete unit shall be functionally tested under load before shipment to assure proper operation per specification. Complete test reports shall be available upon request

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver products in factory labeled packages.
- B. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations. Store so condensation will not form on or in controller and if necessary, apply temporary heat where required to obtain suitable service conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. *[The 3RW44 Reduced Voltage Solid State Starter shall be manufactured by Siemens or pre-approved equal. Approved manufacturers are as follows:*
 - 1. *Siemens*
 - 2. *.J*

2.2 FEATURES

- A. Design Specifications
 - 1. Power Ratings
 - a. Input: 200 – 460V ±15%, 3 phase 50 / 60Hz (selectable) ± 10%. Unit(s) will operate with any incoming phase sequence.
 - b. Output: Reduced voltage 3 phase AC derived from phase-angle fired inverse-parallel thyristors, ramped to full voltage.
 - c. Current Rating(s): Shall be, at a minimum, capable of the motor Full Load Amps for the Horsepower(s) indicated on the drawings, including any Service Factors.
 - 1.) Current ratings of starter chassis must be based on manufacturer's data showing they were tested at 50°C. Units with current ratings tested at 40°C will be sufficiently oversized to match this requirement and prospective alternate bidders will provide proof of this over sizing prior to receiving approval to bid.
 - d. Output Overload Capacity: Shall be as follows, based upon motors indicated on the drawings and specified elsewhere;
 - 1.) For units used on motors where Class 10 overload protection is required, the soft starter shall be callable of delivering 550% of the motor FLA for 10 seconds.
 - 2.) For units used on motors where Class 20 overload is required, the soft starter shall be capable 500% of motor FLA for 20 seconds
 - 3.) If the motor is capable of Class 30 protection, the soft starter shall be capable of delivering 550% current for 30 seconds.
 - 4.) Continuous duty rating shall be for the motor FLA plus + 15%.
 - 5.) Lighter duty rated starters are not acceptable
 - e. SCCR (Short Circuit Current Rating) Listing: Combination starter units shall be UL listed to withstand the Available Fault Current of the system as indicated on the drawings or as determined prior to installation. For retrofit applications, both the soft starter and circuit breaker shall be supplied so that the SCCR rating of the combination is capable of withstanding the Available Fault Current. SCCR ratings in combination with the Circuit Breaker shall be published and supplied by the manufacturer with submittals.
 - f. Control Power: 120VAC, 60Hz provided by a Control Power Transformer with primary and secondary fusing, adequate to operate all associated devices in each starter.
 - 2. Power Current Switching Devices (SCRs)
 - a. PIV Ratings: Minimum 2.5 times nominal line voltage.

- b. Protection: RC snubber network circuits on each phase assembly and MOV protective devices on the gate circuits.
 - c. Efficiency: 98.5% through SCRs, 99.97% when bypass is engaged.
 - 3. Bypass Contactor: All units shall have an integral Bypass Contactor to shunt motor power around the SCRs when at full speed. The soft starter shall include all necessary control circuitry to accomplish this without the need for external timers and engage the Bypass Contactor only when the microprocessor has determined that the motor has reached speed.
 - a. Overload Protection shall be integral and continuous so that it is in the motor circuit at all times, even when the Bypass Contactor is engaged.
 - b. Decel Interlocking shall be integral to allow the soft starter to automatically disengage the Bypass Contactor when a Decel command is given.
 - c. Units which use external Bypass Contactors will be considered, but shall still meet the all of the above control and protection conditions. They shall also meet the SCCR ratings as required above.
 - 4. Ambient Conditions
 - a. Temperature: As a standard of unit design quality, starter shall be documented to show that the open chassis design has been tested for 0 – 50° C (-32 to 122° F) operation. Enclosed units shall be designed for 0 – 40° C ambient unless indicated elsewhere.
 - b. Altitude: 3300 ft (1000 m) without derating, 16,500ft (5000m) maximum.
 - c. Humidity: 0 – 95% RH, non-condensing.
- B. Product Features
 - 1. Solid state reduced voltage motor starters shall be Siemens 3RW44 Series (sized as indicated on the drawings), or pre-approved equal modified to meet the requirements of this specification. The starter shall be complete with the following standard features and adjustments.
 - 2. Acceleration Control shall be fully adjustable in programming to match any application. As a minimum, starter shall come complete with the following settings:
 - a. Ramp Type: To ensure maximum flexibility in matching any unforeseen load conditions in the field, the starter shall provide all of the following methods of closed loop acceleration ramp control: Voltage Ramp, Current Limit Only (Current Step) or Closed Loop Torque. In addition, the soft starter shall be capable of being programmed to start the motor Across-the-Line for testing purposes. To avoid problems in commissioning once the field application conditions are known, any starter that has limited ramp choices will not be acceptable.
 - b. Starting Torque: Initial torque output shall be programmable as either Voltage or Torque output depending on the selected ramp profile, and adjustable between 50-200% of motor Full Load Torque.
 - c. Maximum Current Limit: To ensure acceptability to power conditions and reliability of starting under any circumstance that the motor can function in, a Current Limit function shall be available in all starting ramp modes, adjustable between 150 and 550% of the unit rating. Starters which do not provide Current Limit in all starting modes will not be acceptable.
 - d. Ramp Time: The time between Initial Torque and Full Output shall adjustable between 1 and 360 seconds.
 - e. Kick Start: To provide for starting of difficult loads, the starter shall include a Breakaway Pulse (Kick Start) feature that will apply a high output for a short time on initial start command. The Kick Start voltage level shall be adjustable from 40 – 100% voltage, for 0.1-2 seconds max.
 - f. Motor heating function that will maintain motor above dew point when a run signal is not applied. Functions by passing a small amount of DC current through the motor windings on motors which include a thermistor or PTC temperature device.
 - g. Slow Speed Jog: For checking rotation at start-up or other testing procedures, the starter shall provide a programmable Slow Speed Jog feature, initiated by the

Operator Interface or via input. The Slow Speed Jog output shall be programmable as a percentage of the base motor speed, not exceeding 21%.

- 1.) Slow Speed Reverse: For testing purposes or to provide for special applications as indicated on the drawings, the soft starter shall be capable of rotating the motor in the reverse direction upon command from the operator interface or via inputs. This feature shall be integral to the soft starter or modifications shall be provided to accommodate it.
3. Deceleration Control (Controlled Ramp Down): To facilitate the controlled deceleration of pumps and other loads, Decel Torque Control and/or Pump Control shall be built in and selectable with the following adjustments, all of which are independent of any Acceleration Ramp settings:
 - a. Deceleration Ramp Time: adjustable from 0 – 360 seconds to allow gentle controlled deceleration in excess of the natural coast-to-stop time of the load.
 - b. Stop Torque Level, adjustable from 10-100% to automatically turn off the starter when the output torque has reached a desired level, i.e. when a check valve has closed.
4. Selectable Ramp Profiles: To accommodate changeable conditions, the starter shall provide 3 separately adjustable ramp profiles, selectable via a dry contact closure. Each ramp will provide all of the above features.
5. Motor and Load Protection shall be integral to the starter assembly. All current referenced protection features shall be automatically calculated from the motor nameplate FLA as entered by the user. All time based protection features shall have retentive memory so that they remain active should the power fail and be restored. Starter shall provide the following functions:
 - a. I²t Thermal Overload shall be provided by the on-board microprocessor control based on inverse time-current trip curves as defined by NEMA trip curve Classes. The trip curves classes shall be programmable from between Class 5 and Class 30 and the starter shall be UL listed to provide each individual class. As the most important protection feature of a starter, the overload protection shall be based on a Motor Thermal Model retained in memory and provide the following features:
 - 1.) Retentive Thermal Memory shall be used to ensure that the overload protection does not lose track of motor temperature after the power is lost or shut down. Upon reapplication of power, the microprocessor shall be updated as to the motor thermal state. This feature shall be capable of being overridden for emergency re-start applications.
 - 2.) Manual or Automatic Reset shall be selectable in programming to provide for automatic reset in unattended remote applications.
 - 3.) Thermistor Input shall be provided in case the motor or equipment arrives with integral Thermistors to monitor temperature. The Thermistor input shall provide for a motor thermal temperature monitoring that will bias the Motor Thermal Model mentioned above based on actual motor temperature.
 - a.) The Thermistor monitoring circuit shall detect broken or shorted field devices or wiring.
 - b.) Units without this feature shall provide external Thermistor Protection Relays if necessary and provide a way for the soft starter to display a Thermistor Trip independently of a Motor Overload trip.
 - b. Phase-Loss Protection shall be standard and shut down the starter if current through any leg drops to 20% of the programmed motor FLA or less, independent of line voltage levels.
 - 1.) For purposes of testing with smaller motors, each starter shall be capable of having the motor FLA adjusted down to 20% of the unit Max Amp rating so that this feature will not trip if a load less than 20% of that setting is connected (i.e. 4% of unit max. rating).

- c. Phase Current Imbalance shall be used to bias the Motor Thermal Model so that the tripping curve reflects the additional motor heating caused by the imbalance.
 - 1.) The “Pick-up Point” of this feature shall be programmable or able to be defeated so that nuisance tripping can be avoided.
 - d. Ground Fault Protection shall be included which will prevent a start-up if any phase is connected to Ground or trip while running.
 - e. Over Current / Shear Pin Protection shall be provided. This Over Current trip shall be adjustable at lower levels than the Thermal Overload protection for the purpose of protecting mechanical components from undue shock when rapid unexpected load changes occur.
 - 1.) Adjustment level shall be from 50% to 150% of the programmed motor FLA
 - f. Under Current / Load Loss Protection shall shut down the starter on an adjustable Under Current condition. This shall be programmable as follows:
 - 1.) Adjustment level shall be from 19% to 100% of the programmed motor FLA
 - g. Multiple motors (2) shall be capable of being accommodated in case the soft starter is temporarily connected to a spare motor where the motor protection parameters differ and the primary motor will be used again. Selection between the motor profiles shall be via the Operator Interface or communications port.
 - h. Over and Under Voltage Protection will cause a trip if the voltage dips or surges beyond the unit tolerance limits for both the line voltage and the control voltage, differentiating the trip cause between the two systems on the Operator Interface Display.
6. Starter Protection shall be provided to maintain reliability of both the equipment and the circuit components, with the following features:
 - a. Shorted SCR / Welded Contactor Detection shall be standard. This function must automatically prevent the next start when at least one SCR is shorted or the Bypass Contactor is welded.
 - b. Starter Overtemp Trip shall be built-in and protect the SCRs from excessive heat build-up in the heat sink. This function shall also detect a broken wire or defective sensor.
 7. Conformal coatings shall be factory applied to all circuit boards and circuit board components that allow and/or benefit from such treatments.
 8. Control Location shall be programmable to be any of the following choices: Control (Digital) Inputs, Operator Interface / keypad, PC via serial comm. port., PLC via Profibus or Profinet or Profinet interface or PC via Profibus or Profinet interface. The Operator Interface display shall graphically indicate which control point being used.
 - a. When remote control via the Profibus or Profinet interface is being used, the ability to override that control point via digital input will be provided for testing or troubleshooting
 9. Input / Output features shall be as follows:
 - a. Four (4) Inputs shall be provided for the control and option selection of the starter as follows. All input and control devices shall be 24VDC control from a built-in power supply, requiring only dry contact closures. All I/O termination points shall incorporate easily removable terminal blocks to facilitate quick change-out or troubleshooting isolation in the field.
 - 1.) Input commands shall be programmable for any one of the following functions; Motor Right (Fwd), Motor Left (Rev), Parameter Set 1, 2 or 3, Trip Reset, Quick Stop, Slow Speed, Emergency Restart, and Local Override for allowing local control when using Serial Communications as the control point.
 - b. Four (4) Output Relays shall be provided; three outputs shall be Form A (SPST), the fourth shall be Form C (SPDT), all rated for 240VAC, 3 Amps max.
 - 1.) Each relay shall be fully programmable for any one of the following functions; PIO Output 1, PIO Output 2, Input Status (1-4), Run up (Accelerating), Operation/bypass, Coasting down, On time motor (Running), Motor-on commanded, DC braking Contactor, Group warning (no trip),

Group error (Fault trip), Bus error, Device (starter) error, Power on, Ready to start.

10. Operator Interface panel shall be included which provides simple to use adjustment and status indication on a dead-front shroud of the starter. This panel shall be capable of being remotely mounted up to 10ft (3 meters) away from the starter chassis, such as on the front door of the enclosure.
 - a. Adjustments shall be made by keypad with tactile feedback keys for high noise environments. No binary coded dials shall be used for programming. Pass code protection shall be available to prevent unauthorized changes to the programming.
 - b. Graphical User Display shall be backlit LCD for long life and visibility in low contrast environments. Display shall have a minimum of 4 lines of alpha-numeric characters, programmable in 4 languages and capable of displaying all digits in displayed parameter so that operators do not need to calculate current values over 999A.
11. Metering functions shall be provided through the Alpha-Numeric Display for indicating the following;
 - a. Output Current for each individual phase. Indicating range to be 0.0 – 9999 amps
 - b. Voltage: Phase-to-phase and Phase-to-ground voltages shall be available for display
 - c. Frequency, for use in generator operation diagnostics.
 - d. Motor Thermal Status to indicate heat build-up in the motor. Range shall be 0 – 100% of the motor thermal capacity and count up towards 100% while heating.
 - e. Elapsed Time shall indicate the number of hours that the starter has been in a Run condition, maximum 100,000 hours.
 - f. Start Counter, indicating the number of Run commands given.
12. Serial Communications shall be available as an optional feature and supplied as indicated on the drawings.
 - a. Communications protocol shall be Profibus or Profinet.
 - b. PC interface and software shall be available either through the local programming port via USB connection, or over the Profibus or Profinet connection (if installed)
13. Historical Data shall be recorded and displayed, plus made available for communication. It shall be retained in non-volatile memory for viewing by service personnel later.
 - a. History shall include fault conditions experienced by the starter and peak running details

C. Mechanical Construction

1. Enclosure shall contain the digital solid state controller and disconnect means (optional) as required.
 - a. Rating shall be as indicated on the drawings.
 - 1.) NEMA 1 enclosed units shall be ventilated, with fan forced cooling where necessary. Cooling fans shall be impedance protected and ball bearing construction for continuous use.
 - 2.) NEMA 3R enclosed units shall be either ventilated or provided with an external enclosure and any necessary cooling accessories as determined by the manufacturer, depending on sizing, to meet the ambient operating conditions as indicated elsewhere.
 - 3.) 4/12 enclosed units shall be sealed to prevent ingress of contaminants and supplied with any necessary cooling accessories as determined by the manufacturer, to meet the ambient operating conditions as indicated elsewhere.
2. Power Terminations shall be made on factory supplied mechanical lugs of sufficient size to accommodate the required wire for the line and load. Lugs are to be clearly marked as Line (L1, L2, L3) and Load (T1, T2, T3) and with appropriate tightening torque specifications.

3. Control Terminations to the soft start main unit shall be on terminal strips that can be removed easily without the need to special tools.
- D. Spare Parts
1. A recommended spare parts list, and associated pricing, will be supplied with each different solid state reduced voltage starter. The manufacturer will provide representation and local support to the job site. A list of authorized service centers will also be provided upon request.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall install all equipment in accordance with the contract drawings and manufacturers recommendations and manuals.
1. Install enclosed controllers where indicated, in accordance with manufacturer's instructions.
 2. Install fuses in fusible switches.
 3. Select and install overload heater elements in motor controllers to match installed motor characteristics.
 4. The FLA motor amps shall be input into the starter memory via the keypad
 5. Adjust all circuit breakers, switches, access doors and operating handles for free mechanical and electrical operation as described in manufacturer's instructions.
 6. Clean interiors of all enclosed electrical equipment to remove construction debris, dirt and shipping materials.
 7. Repaint scratched or marred exterior surfaces to match original finish.

3.2 ADJUSTMENT AND CLEANING

- A. Start Up Procedures
1. All starters will come with a "Quick Start" feature to allow simple commissioning for general applications so that only minor adjustments are necessary in the field to match specific conditions. Start up procedures shall be intuitive and simple enough so as not to require factory assistance or training. Basic start up shall include entering of motor data and Overload selection, then basic application data such as load type. Additional features will only be activated when necessary.
- B. Adjustments
1. To facilitate ease of initial setup, all necessary adjustments shall be capable of being made without the need for pass codes. Pass code use shall be optional at users discretion. All settings and adjustments shall not require a battery back-up for retention.
- C. Training
1. All necessary training for operator personnel shall be simple enough to be performed by local factory representatives if desired.
- D. Software
1. A software package shall be available for full programming via a PC running under MS Windows OS, connectable via a USB cable to the soft starter. Advanced versions that allow on-line monitoring and programming across the Profibus or Profinet connection shall also be available or supplied if indicated elsewhere.
- E. The Contractor shall perform necessary field adjustments of the equipment to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device coordination study or as directed by the Engineer.

3.3 TESTING

- A. Perform factory and installation tests in accordance with applicable NEC, NEMA and UL requirements.

3.4 WARRANTY

- A. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of invoice.

END OF SECTION