PROCUREMENT SPECIFICATION

SMC™-50 Reduced Voltage Solid-State Smart Motor Controllers

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PART 1 GENERAL

1.01 QUALIFICATIONS

A. Manufacturer

1. The manufacturer shall have a minimum of 25 years of experience in the manufacture of solid-state reduced-voltage controllers.
2. The approved manufacturers are:

    a) Rockwell Automation Allen-Bradley
    b) Substitutions: None permitted

B. Support

1. 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.
2. Support personnel are to be direct employees of the manufacturer and be available 24 hours per day through a toll-free number.
3. The manufacturer shall provide all required start-up and training services.
4. The approved manufacturers are:

    a) Rockwell Automation Customer Support & Maintenance
    b) Substitutions: None permitted

C. Certification

1. To ensure all quality and corrective action procedures are documented and implemented all manufacturing locations shall be certified to the ISO-9001 Series of Quality Standards.
2. Third party manufacturers and brand labeling shall not be allowed.

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.

1.02 REFERENCES

A. The controller shall be designed to meet or exceed the applicable requirements of the following agencies.

1. EN
2. UL
3. IEC
4. CSA
5. NEMA
6. IEEE

7. CCC

B. The following standards shall be met.

1. Creep distances and clearances 600V (UL/CSA) and 690V (IEC)
2. Power terminal markings per EN 50005 and EN 60947-4-2
3. Dielectric withstand per UL 508 and IEC 947
4. EMC Emission levels, Conducted Radio & Radiated: Class A per IEC60947-4-2
5. EMC Immunity levels: per EN/IEC60947-4-2
6. Surge withstand per IEEEC62.41 and IEC61000-4-5

1.03 ENVIRONMENTAL REQUIREMENTS

A. Confirm to specified service conditions during and after installation of products.
B. Maintain area free of dirt and dust during and after installation of products.

1.04 PRE-MANUFACTURE SUBMITTALS

A. Refer to Section _____ for submittal procedures.
B. Manufacturer Dimension Drawings
C. Product Data

1. Publications on solid-state reduced-voltage controller.
2. Data sheets and publications on all major components including but not limited to the following

a) Contactors
b) Circuit breakers and fuse information including time current characteristics
c) Control power transformers
d) Pilot devices
e) Relays

D. Specification Response

1. Detailed response to this specification showing where in the literature each requirement is satisfied.
2. All clarifications and exceptions must be clearly identified.

E. Installation Instructions

1. Provide a copy of the manufacturer’s installation instructions which includes the following:

a) Receiving, handling, and storage instructions

F. Testing and Test Reports

1. Testing shall be per manufacturer’s standard.
2. A copy of the test reports, if available, shall be provided as part of the final documentation.

1.05 FINAL SUBMITTALS

A. Refer to Section _____ for procedure on submittal of final documentation.
B. The contractor shall provide certification that the solid-state reduced-voltage controller has been installed in accordance with the manufacturer's instructions.
C. The contractor shall provide certification that the Contractor has properly adjusted any timing devices required in the starting circuitry.
D. Final Drawings

1. The manufacturer shall provide final drawings reflecting the "As-Shipped" state of the installed equipment.
2. Manufacturer drawings shall be provided in DWG format.
3. Manufacturer drawings do not need to be stamped if a drawing schedule is provided that lists the drawing numbers, revision levels, and status of drawings (Preliminary, Approval, Final, etc.)
4. The contractor shall be responsible for making any changes to the "As-Shipped" drawings from the manufacturer to reflect any field modifications.

E. Test reports, if available, indicating manufacturer's standard testing was performed.
F. Maintenance Data

1. Solid-state reduced-voltage controller installation instructions and User Manual.
2. Installation / Operation instructions for major components such as circuit
3. Parameter listing
4. Field service report from start-up service
5. Solid state reduced voltage controller spare parts listing and pricing
6. Include name and phone number for a local distributor for the spare parts.

1.06 DELIVERY, STORAGE, AND HANDLING

A. The contractor shall coordinate the shipping of equipment with the manufacturer.
B. The contractor shall store the equipment in a clean and dry space.
C. The contractor shall protect the units from dirt, water, construction debris and traffic.
D. During storage the contractor shall connect internal space heaters (if specified) with temporary power.

1.07 FIELD MEASUREMENTS

A. The contractor shall verify all field measurements prior to the fabrication of the solid state reduced voltage controller.

1.08 SPARE MATERIALS

A. Provide one (1) set of three (3) of each size power fuse utilized.
B. Provide spares equal to 10 percent of the installed quantity for primary and secondary control power fuses.
C. Provide one (1) spare control relay for each unique relay utilized on the project.

1.09 WARRANTY

A. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.
B. The manufacturer shall confirm this warranty as part of the submittal.
C. This warranty applies only to stand alone solid-state reduced-voltage controllers.

PART 2 PRODUCTS

2.01 RATINGS

A. The solid state reduced voltage controller shall accept an input voltage from 200…480V AC or 200…690V AC three-phase plus 10 percent or minus 15 percent.
B. The solid state reduced voltage controller shall have a short circuit current rating of 65 kA @ 480V with standard circuit breakers and 100 kA with type CC/J/L fuses (up to 600V).
C. Environmental Ratings

1. Storage ambient temperature range: -25…+75°C.
2. Operating ambient temperature range: -20…+40°C as standard and up to 65°C maximum with derating.
3. The relative humidity range: 5%…95% non-condensing.
4. Operating elevation: up to 2000 meters as standard and up to 4000 meters maximum with derating.
5. The manufacturer shall provide a tool for evaluating thermal capabilities of the solid state reduced voltage controller.

2.02 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 power structure shall include built-in electronic 3-phase current monitoring and overload protection.
2. The family of devices must be available from 1…520 A in a line motor connection
3. The family of devices must be available from 1…899 A when connected inside the delta

    a) The inside the delta mode must be auto configured by the controller

4. For devices rated 90…180 A, the power structure shall consist of three power poles with integral heat sinks in a single housing
5. For devices rated 210…520 A, the power structure shall consist of three power poles with integrated heatsinksand mounted separately for ease of maintenance
6. The power structure shall be modular in design and easily replaceable
7. Back-to-back SCR pairs shall be the only power switching semiconductor means acceptable. Diode-SCR (Silicon Controlled Rectifier) combinations shall not be acceptable.
8. SCRs shall have the following minimum repetitive peak inverse voltage ratings.

a) 1400V for units rated 200…480V
b) 1800V for units rated 200…690V

9. SCRs shall have built in temperature monitoring sensors.
10. Use of an External bypass must be an option
11. The manufacture must supply guidance on obtaining Type 2 coordination per IEC 60947 4-2

C. Logic Component / Control Module

1. The logic component shall be a self-contained control module, compatible with the full range of power structures.
2. The control module shall provide continuous 32-bit digital microprocessor control and supervision of all controller operation, including pulse firing of all 6 SCRs.
3. The control module shall consist of the following.

   a) Self-tuning power supply accepting control power input from 100…240V AC, 50/60 Hz.
   b) SCR firing circuitry that incorporates an RC snubber network to prevent false firing.
   c) Input / output circuitry (two 24V DC inputs and 2 relay outputs standard).
   d) Four (4) DPI communication ports
   e) Built in multi-color status LEDs
   f) A reset push button on solid state reduced voltage controller

4. The control terminals shall have the following characteristics

   a) The control terminal wiring connector shall be easily removable and located on the front top of the device for easy access.
   b) The terminals shall be UL rated for 500V, 7 mA maximum, and accept wires from #24 AWG…#14 AWG.
   c) The terminals are UL Recognized to accept a maximum of two (2) #16 AWG wires per terminal.

5. The control module shall mount directly to the power structure.
6. The control module shall be easily removed from the power structure, without the need to disassemble associated printed circuit board assemblies.
7. The control module shall have conformal coated printed circuit boards as standard.
8. The control module shall have a battery backed time of day clock

D. Optional Logic Components

1. The controller shall have a dedicated bezel used to house an optional human interface module (HIM) for parameter configuration and monitoring. The HIM shall have the following capabilities:

   a) Full numeric tactile feedback keypad with integrated navigation.
   b) Multi-language support.
   c) Multi-line LCD display.
   d) Dynamic soft keys that change function based on the display.

2. The controller shall have 4 option ports used to house user selectable option modules. These shall include the following:

    a) Parameter configure module used to provide limited control parameter configuration using rotary position and SIP switches.
    b) Digital input / output module: the module shall provide four (4) 120/240V AC inputs and three (3) relay outputs.
    c) Motor PTC, ground fault, and external current transformer module. This module shall provide interface capability to all three (3) of the sensors.

2.03 SOLID STATE REDUCED VOLTAGE CONTROLLER UNIT MODES

A. Initial and Pre-Starting Modes

1. Start Delay pre-start

    a) Shall be programmable from 0…30 seconds.

2. Integral motor winding heater pre-start

    a) The selectable start option will begin at the end of this option.
    b) Programmable time from 0…1000 seconds.
    c) Programmable current from 0…100% of full load current

3. Motor tuning function (initial start)

    a) Either automatically initiated by the controller on the initial start sequence of the motor or manually initiated by user.

B. Starting Modes

1. Soft start

    a) Programmable initial torque value of 0…90% of locked rotor torque.
    b) Programmable acceleration ramp time from 0…1000 seconds.
    c) Current limit 50…600% of full load current.

2. Current limit start

    a) Adjustable from 50…600% of motor full load current.
    b) Adjustable ramp time from 0…1000 seconds.

3. Linear speed acceleration start

    a) Programmable ramp time from 0…1000 seconds
    b) Programmable initial torque value of 0…90% of locked rotor torque.
    c) Programmable current limit from 50…600% of full load current.

4. Full voltage start

    a) Provides across the line starting.
    b) Ramp time shall be less than 0.1 seconds.

5. Selectable kickstart

a) A selectable kickstart, or boost, shall be provided at the beginning of the voltage ramp.
b) The kickstart shall provide an adjustable pulse of 0…90% of locked rotor torque.
c) The kickstart time shall be adjustable from 0…2 seconds.
d) Kickstart shall be available for soft start, current limit start, torque control start, pump start, and dual ramp start.

6. Pump start

a) Pump start and stop parameters are typically configured together.
b) Initial torque programmable from 0…90% of locked rotor torque.
c) Backspin timer programmable from 0…999 seconds.
d) Ramp time programmable from 0…1000 seconds.

7. Torque control start

a) Starting torque programmable from 0…300 percent of rated motor torque.
b) Maximum torque programmable from 0…300 percent of rated motor torque.
c) Ramp time programmable from 0…1000 seconds.

8. Dual ramp start

a) Provides two (2) separate start profiles with separately adjustable ramp times, current limit level, initial torque, starting and max torque, and kickstart time and level.
b) Ramp times programmable from 0…1000 seconds.
c) Current limit level programmable from 50…600% full load current.
d) Initial torque programmable from 0…90% of locked rotor torque.
e) Starting and maximum torque programmable from 0…300% of locked rotor torque.

9. Timed start

a) Forces the starting profile to complete the entire user-configured ramp time before applying full voltage.

10. Start delay

a) User configurable start delay of 0…30 seconds from the point when the start command is enabled until the start sequence actually occurs.
b) Applies to any start mode.

11. Backspin

a) Provided in order to avoid starting a motor into a backspin condition.
b) The user-configured time begins to count down after a stop maneuver is complete
c) All start inputs are ignored until the backspin timer has timed out.

C. Stopping Modes

1. Coast-to-stop

    a) No further parameters needed.

2. 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) Stop time programmable from 0…999 seconds.
    d) The load shall stop when the motor voltage drops to a point where the load torque is greater than the motor torque

3. Linear speed deceleration

    a) Stop time programmable from 0…999 seconds.
    b) Current limit level programmable from 50…600% of full load current.

4. Pump stop

    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
    b) This shall aid in eliminating the phenomena commonly referred to as “water hammer.”
    c) Stop time programmable from 0…999 seconds.
    d) Pump pedestal programmable from 0…50%.
    e) See section 2.03 B 6 for more information.

D. Braking Control Modes

1. Smart Motor Braking, SMB

    a) Stop time programmable from 0…999 seconds.
    b) Braking current programmable from 0…400% of full load current

2. Accu-Stop

    a) Provide a brake from full speed to a present slow speed and then a brake or coast to stop.
    b) Requires four (4) settings:

        i. SMB setting
        ii. A control input that is set for stop
        iii. A second input that is set for start
        iv. A third input that is set for slow speed

3. External Braking Control

    a) Will remove power from the motor and enable an external mechanism to brake the motor during the user configured stop time from 0…999 seconds.
    b) When the stop time is complete, the unit will open the auxiliary output and switch to the stopped state.

4. 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.

E. Running Modes

1. SCR Control – Normal Run Operation

    a) The unit shall run at full voltage when the unit is at full speed and no external bypass contactor is provided.

2. SCR Control – Energy Saver Run Operation

    a) Only applies during light motor load situations when enabled by user
    b) The controller reduces current to the motor and thereby saves energy

3. External Bypass – Optional Run Operation

    a) An external bypass contactor may be configured to operate the motor while running at full voltage and speed.
    b) The controller shall control the external bypass contactor by using one of the auxiliary relay outputs configured to Ext. Bypass using the output's configuration parameter
    c) For units rated 90…180 A operation in external bypass mode will require current feedback through the optional PTC/Ground Fault/External Current Transformer Expansion Module (150-SMC2) and an 825 MCMxx current sensor.
    d) For units rated 210…520 A operation in external bypass mode with current feedback can be accomplished using the internal current sensors and an optional current feedback mounting kit.

4. Emergency Run

    a) A control terminal or network input can be configured as the Emergency Run command input.
    b) When this input is active all faults are disabled.

2.04 SOLID STATE REDUCED VOLTAGE CONTROLLER UNIT FEATURES

A. 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. Make available selectable trip class settings from 5…30 in increments of 1 as standard.
4. Electronic thermal memory shall provide enhanced motor protection.
5. Shall provide alternative overload capabilities based on Over Power conditions

B. Digital Outputs

1. A minimum of two (2) auxiliary contacts shall be provided, as standard, for customer use
2. The contacts shall be rated for 240V AC maximum.
3. Functional operation of the contacts shall be programmable for: normal, up-to-speed, Ext. bypass, Ext brake, aux control, network 1-4.
4. The relay contacts shall be programmable for normally open (N.O.) or normally closed (N.C.) operation.
5. The controller shall be scalable to enable adding up to nine (9) outputs.

C. DPI Serial Communication Port

1. Four (4) DPI serial communication ports shall be provided as standard.
2. Port #4 supports optional communication protocol interface modules that shall be available for connection to DH485, ControlNet, DeviceNet, RS485, Profibus, InterBus, EtherNet/IP, RS485 HVAC, CAN open, and Control Net (Fiber).
3. Refer to the system specification for the options (if any) required.

D. Metering – the controller shall provide the following motor and/or power system metering functions indicated through the optional LCD display.

1. Three-phase current

    a) Current per phase
    b) Current average

2. Three-phase voltage

    a) Volts per phase, phase to phase
    b) Volts, average phase to phase
    c) Volts, phase to neutral
    d) Volts, average phase to neutral

3. Torque in percent of maximum
4. Power in Mega Watts (MW)

    a) Real power per phase
    b) Real power
    c) Real demand
    d) Maximum real demand

5. Reactive power in Mega VAR (MVAR)

    a) Reactive power per phase
    b) Reactive power

c) Reactive demand
d) Maximum reactive demand

6. Apparent power in Mega VA (MVA)

a) Apparent power per phase
b) Apparent power
c) Apparent demand
d) Maximum apparent demand

7. Energy in Mega Watt hours (MWh)

a) Real energy
b) Real demand

8. Reactive energy in Mega VAR hours (MVARh)

a) Reactive energy C
b) Reactive energy P
c) Reactive energy

9. Apparent energy in Mega VA hours (MVAh)
10. Power factor

a) Power factor per phase
b) Power factor

11. Energy savings in percent
12. Elapsed time in hours

a) Elapsed time, resettable
b) Elapsed time 2, not resettable

13. Running time in hours
14. Motor speed in percent of full speed
15. Actual start time (last 5 starts) in seconds
16. Peak start current (last 5 starts) in Amps
17. Total starts
18. Total Harmonic Distortion (THD)

a) THD of voltage per phase in percent
b) THD of current per phase in percent

19. Line frequency in Hertz
20. Current imbalance in percent
21. Voltage unbalance in percent
22. Event log of last 100 events including start, stops, faults, alarms, and parameter changes

E. 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) Current imbalance
    f) Voltage unbalance
    g) Phase reversal
    h) High and low line frequency
    i) Stall
    j) Jam
    k) Real power

        i. Motor over power real
        ii. Motor under power real

    l) Reactive power

        i. Motor over power reactive + motor generated
        ii. Motor under power reactive + motor generated
        iii. Motor over power reactive – motor generated
        iv. Motor under power reactive – motor generated

    m) Apparent power

        i. Motor over power apparent
        ii. Motor under power apparent

    n) Power factor
    o) Excessive starts per hour
    p) Preventive maintenance

        i. Preventive maintenance hours
        ii. Preventive maintenance starts

    q) Line loss
    r) Silicon-Controller Rectifier (SCR) Specific protection

        i. SCR shorted
        ii. SCR overtemperature
        iii. Open SCR gate

7. When fault conditions are detected, the controller shall inhibit starting or shutting down SCR pulse firing.
8. A Snapshot record maintains historical data that describes certain conditions that existed prior to a protection fault. The following instantaneous values should be available:

a) Volts Phase A-B
b) Volts Phase B-C
c) Volts Phase C-A
d) Current Phase A
e) Current Phase B
f) Current Phase C
g) Power Factor
h) MtrTherm Usage
i) Motor Speed
j) THD Vave
k) THD Iave
l) Product Status
m) Board Temp
n) Line Frequency
o) Peak Vline A-N (for Shorted SCR faults)
p) Peak Vline B-N (for Shorted SCR faults)
q) Peak Vline C-N (for Shorted SCR faults)
r) Peak I A (for Shorted SCR faults)
s) Peak I B (for Shorted SCR faults)
t) Peak I C (for Shorted SCR faults)

9. Fault diagnostics shall be indicated by a multi-color LED as standard, four (4) diagnostic LEDs on the option module, or by descriptive text on the optional LCD display. (The exclusive use of fault codes is unacceptable.)
10. An auxiliary contact that is user programmable for fault indication shall be provided for customer use.
11. Meter accuracy for diagnostics shall be accurate to 3% over nominal sensing range for current and 1% over entire range for voltage.

2.05 HIM OPTION

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.

PART 3 EXECUTION

3.01 MANUFACTURER'S SERVICES

A. The service division of the manufacturer shall perform all start-up services.
B. Start-up personnel shall be direct employees of the manufacturer and shall be degreed engineers.
C. 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

3.02 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.

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