MOTOR STARTERS – LOW VOLTAGE
SECTION 16481

PART 1   GENERAL

1.01   SCOPE
   A. The Contractor shall furnish and install the low voltage motor starters as specified herein and as shown on the contract drawings.

1.02   RELATED SECTIONS
   A. Section 16475 – Circuit Breakers and Fusible Switches
   B. Section 16902 – Electrical Control Devices

1.03   REFERENCES
   A. The motor starters shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA, ANSI and UL.

1.04   SUBMITTALS – FOR REVIEW/APPROVAL
   A. The following information shall be submitted to the Engineer:
      1. Master drawing index
      2. Dimensioned outline drawings
      3. Conduit entry/exit locations
      4. Cable terminal sizes
      5. Wiring diagrams
      6. Nameplate schedule
      7. Ratings including:
         a. Voltage
         b. Horsepower and/or continuous current
      8. Product data sheets

1.05   SUBMITTALS – FOR CONSTRUCTION
   A. The following information shall be submitted for record purposes:
      1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process.
      2. Wiring diagrams
      3. Seismic certification as specified
1.06 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. *Provide Seismic tested equipment as follows:

**Note to Spec. Writer:**

To help understand the 2006 IBC/2007 CBC seismic parameters for a specific location, the attached link to the US Geological Survey will be extremely helpful:

http://earthquake.usgs.gov/research/hazmaps/design/

Download the file “Java Ground Motion Parameter Calculator - Version 5.0.8 (4.6 MB)” and save it to your hard drive, then run the executable (.exe) that was downloaded.

Enter the latitude and longitude of your project location.

(To find exact Latitude and Longitude, go to http://geocoder.us/ and type in the address.)

The IBC seismic criteria for that location will then be displayed. It is simply a matter of verifying that the criteria shown for your specific building location is.

1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the 2006 International Building Code (IBC) Site Classification [Enter classification from above website]. The site coefficients $F_a = [Enter value from above website]$, and spectral response accelerations of $S_S = [Enter value from above website]g$, $S_1 = [Enter value from above website]g$ are used. The test response spectrum shall be based upon a 5% damping factor, and a peak $(S_{DS})$ of at least $[Enter value from above website]g$'s (3-12 Hz) applied at the base of the equipment in the horizontal direction. The forces in the vertical direction shall be at least 66% of those in the horizontal direction. The tests shall cover a frequency range from 1 to 100Hz. Guidelines for the installation consistent with these requirements shall be provided by the equipment manufacturer and based upon testing of representative equipment. Equipment certification acceptance criteria shall be based upon the ability for the equipment to be returned to service immediately after a seismic event within the above requirements without the need for repairs.

--- OR ---

1. The manufacturer shall certify the equipment based upon a dynamic and/or static structural computer analysis of the entire assembly structure and its components, provided it is based upon actual seismic testing from similar equipment. The analysis shall be based upon all applicable seismic requirements of the 2006 International Building Code (IBC) Site Classification [Enter classification from above website], site Coefficient $F_s = [Enter classification from above website]$, $F_V = [Enter classification from above website]$.

* Note to Spec. Writer – Optional
* Note to Spec. Writer – Select one
above website] and spectral response accelerations of $S_S = \text{[Enter classification from above website]}$g, $S_I = \text{[Enter classification from above website]}$g. The analysis shall be based upon a 5% damping factor, and a peak ($S_{DS}$) of at least $\text{[Enter classification from above website]}$g’s (3 -12 Hz), applied at the base of the equipment in the horizontal direction. The forces in the vertical direction shall be at least 66% of those in the horizontal direction. The analysis shall cover a frequency range from 1 to 100Hz.

Guidelines for the installation consistent with these requirements shall be provided by the equipment manufacture and based upon testing of representative equipment. Equipment certification acceptance criteria shall be based upon the ability for the equipment to be returned to service immediately after a seismic event within the above requirements without the need for repairs.

2. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
   
a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.

b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.

c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.07 REGULATORY REQUIREMENTS

1.08 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer’s instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton / Cutler-Hammer products

B. *__________

C. *__________

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.
2.02 MANUAL MOTOR CONTROL

A. Single-Phase Manual Starters
   1. Manual single-phase starters 1 hp or smaller shall be Cutler-Hammer type MS starters or approved equal. The starter shall have a quick-make/quick-break toggle mechanism. The overload shall have a field adjustment allowing up to +/- 10% variance in ratings of the nominal heater value.
   2. Manual single-phase starters above 1 hp shall be Cutler-Hammer type B100 or approved equal. The starter shall have quick-make/quick-break mechanism. The closure of the contacts shall be blocked while the line terminals are exposed. The operating handle or button shall clearly indicate whether the unit is ON, OFF or TRIPPED.
   3. The enclosure shall be [general purpose NEMA 1] [general purpose NEMA 1B – flush mounted] [watertight NEMA 3, 4, 5] [hazardous locations NEMA 7D: Class I, Group D] [hazardous locations NEMA 9E, F, G: Class II, Groups E, F, G] [as indicated on the contact drawings].

B. Three-Phase Manual Starters
   1. The starter shall have quick-make/quick-break operating mechanism.
   2. The operating handle or button shall clearly indicate whether the unit is ON, OFF or TRIPPED.
   3. The closure of the contacts shall be blocked while the line terminals are exposed.
   4. The enclosure shall be [general purpose NEMA 1] [general purpose NEMA 1B – flush mounted] [watertight NEMA 3, 4, 5] [hazardous locations NEMA 7D: Class I, Group D] [hazardous locations NEMA 9E, F, G: Class II, Groups E, F, G] [as indicated on the contact drawings].
   5. Manual three-phase motor starters shall be Cutler-Hammer type B100 or equal.

C. Three-Phase Manual Motor Starter and Protector
   1. The starter shall have an adjustable Class 10 ambient compensated integral overload relay and a fixed magnetic short-circuit trip mechanism designed to trip at twelve (12) times the maximum current rating of the starter.
   2. The starter shall be UL listed and CSA certified for group motor installations with 1200 ampere maximum fuse and circuit breaker ratings at 480 Vac.
   3. The starter shall have provisions for padlocking in the OFF position.
   4. The starter shall have accessories such as auxiliary contacts, trip alarm, undervoltage release, and shunt trip available for field installation.
   5. The enclosure shall be general purpose NEMA 1.
   6. Motor starter and protector shall be Cutler-Hammer type [A302], [A307], [A308], [A309] [or equal].

2.03 ELECTROMECHANICAL MOTOR CONTROL

A. Non-Reversing Starters

* Note to Spec. Writer – Select one
1. Magnetic starters through NEMA Size 9 shall be equipped with double-break silver alloy contacts. The starter must have straight-through wiring. Each starter shall have one (1) NO auxiliary contact.

2. Coils shall be permanently marked with voltage, frequency and part number.

3. Overload relays shall be self-powered electronic type with selectable trip class, phase unbalance and ground fault. Electrically isolated NO and NC contacts shall be provided on the relay. Visual trip indication shall be standard. An LED will provide overload health status. A test trip feature shall be provided for ease of troubleshooting and shall be conveniently operable without removing components or the motor starter. Overload to provide 5:1 FLA adjustability range, manual or automatic reset, and remote reset capabilities.

   -- OR --

3. Solid-State Overload Relay- C441
   a. Where indicated on the drawings, provide a definite-purpose, microprocessor-based Overload Relay (OLR) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors. The OLR shall be Eaton / Cutler-Hammer type C441 (Motor Insight) relay. The OLR shall meet UL 1053, CUL and CSA standards.
   b. The relay shall not require external current transformers for applications up to 150 amperes for motors rated less than 600 Vac. Where larger motors are involved, external current transformers shall be used. The relay shall include terminals for remote trip and remote reset.
   c. The OLR shall have the following motor control functions:
      1. 1—Fault relay, Form C, NO/NC contact with a rating code of B300 per UL 508.
      2. 1—Ground fault relay, Form A, NO contact with a rating code of B300 per UL 508.
      3. 1—External remote reset terminal
      4. 1—Trip status indicator
   d. The OLR shall be capable of accommodating external current transformers with ranges from 150:5, 300:5, and 600:5 amperes. Provide three (3) current transformers sized per manufacturer’s recommendations based on motor full-load amperes and service factor.
   e. The OLR shall draw its power from 120Vac control power. The OLR shall be suitable for either 50 Hz or 60 Hz.
   f. The OLR shall have selectable trip classes 5-30.
   g. The OLR shall be equipped with an operator-interface (OI)/ display interface panel. The OI shall have a seven-segment display for programming, monitoring, and alarming functions.
   h. The OLR shall annunciate the following conditions:
      1. Motor Protection consisting of:
         a. Thermal overload
         b. Jam protection
         c. Current unbalance
         d. Current phase loss
         e. Ground fault
         f. Phase reversal

* Note to Spec. Writer – Select one
2. Load protection consisting of:
   a. Under-current
   b. Low power (kW)
   c. High power (kW)
3. Line Protection consisting of:
   a. Over-voltage
   b. Under-voltage
   c. Voltage unbalance
   d. Voltage phase unbalance

i. The OLR shall have the following monitoring capabilities:
   1. Current—Average and Phase RMS
   2. Voltage—Average and Phase RMS
   3. Power—Motor kW
   4. Power Factor
   5. Frequency
   6. Thermal capacity
   7. Run hours
   8. Ground fault current
   9. Current unbalance %
   10. Voltage unbalance %

j. · The OLR shall have the following remote-mounted display/operator-interface option for use with enclosed control or motor control centers [Type 1 remote display] [Type 12 remote display] [Type 3R remote display].

k. · The OLR shall be equipped with the following optional communication module [Modbus] [Modbus with I/O] [DeviceNet with I/O] [PROFIBUS with I/O] [Ethernet IP with I/O].

-- OR --

4. Solid-State Motor Management Relay - C445
   a. Where indicated on the drawings, provide a microprocessor-based Overload Relay (OLR) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors. The OLR shall be Eaton type C445 (Power Xpert) relay. The OLR shall meet UL 60947-4-1, IEC/EN 60947-4-1, IEC/EN 60947-5-1, EN 60947-8, and CSA 22.2 #60947-4-1 standards
   b. The OLR shall offer a flexible modular form factor where sensing and protection are broken out in order to provide the most compact configuration possible
   c. The relay shall not require external current transformers for applications up to 136 amperes for motors rated less than 1000 Vac. Where larger motors are involved, external current transformers shall be used.
   d. The OLR shall provide both protection and control functionality. OLR shall provide pre-defined operation modes which define input and output behavior if used. The following functionality shall support protection and control.

1. 1— One primary Fault relay, NO contact with a rating code of B300 per UL 60947-4-1

* Note to Spec. Writer - Optional
* Note to Spec. Writer – Select one
* Note to Spec. Writer – Select one
to be used for both protection and optional control of motor contactor or MCCB
2. 1— A second output relay, NO contact with rating code of B300 per UL 60947-4-1 to be used in providing both protection and optional control of a second contactor or MCCB when used in wye/delta, two speed, auto-transformer and HMCP/MCCB applications. Output to be available for general purpose use if not required by application.
3.1— A third output relay, NO/NC Form C output contact with rating code of B300 per UL 60947-4-1 that can be used in providing both protection and optional control of a third contactor when used in wye/delta, two speed dahlender, and auto-transformer applications. Output to be available for general purpose use if not required by application
4. 1— An input able to accept 120Vac or 24Vdc run or start signal from local or remote fieldwire control source when required
5.1— An input able to accept 120Vac or 24Vdc permissive signal from local or remote fieldwire control source when required. Input to be available for general purpose use if 3-wire control is not used
6.1— An input able to accept 120Vac or 24Vdc reset signal from local or remote fieldwire control source when required
7.1— An input able to accept 120Vac or 24Vdc remote signal from local or remote fieldwire control source when required
8. 1— Trip status indicator
9.1— Ability to run 2-wire or 3-wire control schemes
10.1— Ability to accept local control signals from a user interface or fieldwiring
11.1— Ability to accept remote control signals from a fieldbus network or fieldwiring
e. The OLR shall be capable of accommodating external current transformers with ranges from 300:5, 600:5, and 800:5 amperes. Provide three (3) current transformers sized per manufacturer’s recommendations based on motor full-load amperes and service factor.
f. The OLR shall accept 120/240 Vac OR 24 Vdc control power. The OLR shall be suitable for application from 20-80 Hz.
g. The OLR shall have selectable trip classes 5-40.
h. *The OLR shall be equipped with an operator-interface (OI)/ display interface panel that is safely, remote mountable on the panel door. The OI shall have the following features for control, monitoring, programming and diagnostics
1.1— Status LEDs that indicate a FAULT or WARN condition
1.2— Monitoring window to display current, voltage, power, thermal and other motor system parameters with no network or setup required
1.3— Ability for customer to fully program and customize the device using only the user interface
1.4— Setup Wizard for fast commissioning
1.5— Running, Stopped and Auto Status LEDs with user selectable LED color schemes
1.6— Complete fault description on screen if fault event occurs
1.7— Access to 10 fault queue and trip snapshot
1.8— Dedicated Reset button, that may be disabled if desired
1.9—Optional Local Control functionality that is automatically customized based on operation mode without the need for multiple part numbers or user applied stickers, marking or programming

1.10—Powered off the base device, with no separate power source required

1.11—Optional local password protection

1.12—Micro-USB port for connection to PCs

i. The OLR shall protect and monitor the following conditions. Where applicable, all protection types will offer both trip and alarm settings with uniquely settable delays.

1. Motor Protection consisting of:
   a. Thermal overload
   b. Instantaneous overcurrent
   c. Jam
   d. Stall
   e. Undercurrent
   f. Current unbalance
   g. Current phase loss
   h. Ground fault (residual, zero sequencing and pulse detection)
   i. Allowed starts per hour
   j. Optional PTC protection (Positive Temperature Coefficient)

2. Load protection consisting of:
   a. Low power
   b. High power
   c. Power Factor Deviation

3. Line Protection consisting of:
   a. Phase Rotation
   b. Over-voltage
   c. Under-voltage
   d. Voltage unbalance
   e. Frequency deviation (fast and slow)
   f. Voltage loss restart algorithm providing automatic staggered restart of motors during a voltage loss conditions offering (3) user settable time intervals and individual re-start delays

j. The OLR shall have the following monitoring capabilities:
   a) Current—Average and phase RMS
   b) Current unbalance %
   c) Ground fault current
   d) Average motor current as % of FLA
   e) Maximum motor starting current
   f) Voltage—Average line-to-line and L1-L2, L2-L3, L3-L1
   g) Voltage unbalance %
   h) Power—Motor kW, VA, VARs, real energy, apparent energy, reactive energy, peak demand
   i) Power factor
The OLR shall record the following data on fault conditions:

- Active fault
- Active warning
- Active inhibit
- Fault Queue – A list of last 10 faults shown in the order they occurred
- Trip snapshot – 12 recorded parameters at time of trip for last trip (current and voltage each phase, ground current, frequency, thermal memory, VA, watts, power factor), optionally time stamped

Ground fault detection local and via network:

- Zero sequence for high resistive ground and direct connected grounds
- Ground fault pulse detection
- Residual ground detection

User logic and external I/O

- Onboard user defined logic for local control
- Function block programming
- Pass through via communications
- Onboard I/O 4 in and 3 out
- External I/O expandable to 64 in and 64 out, plus 8 analog I/O cards

The OLR shall provide the following communications without increasing the footprint of the device or requiring a separate power source. The OLR shall provide the user the option to configure communication loss behavior to trip or hold last state.

- On-board Modbus Serial
- * [PROFIBUS communication port with support for DVP0 and DVP1 messages] or [Ethernet communication ports with support for Ethernet/IP and ModbusTCP messaging and web pages. Ethernet will be in the form of a 2 port switch with port forwarding allowing configuration in star, redundant ring topologies, and redundant master topologies.]
- USB for connection to a PC for commissioning and monitoring
- Free software tool for commissioning and monitoring, which allows the user to save configuration files
- Embedded web pages (with Ethernet option)
The OLR shall provide the following optional functionality
a) Real time stamping
b) Memory backup module that saves all configuration data to non-volatile memory and copies that data to a new device in the event of device replacement
c) Four versions of optional password protection – Administrator, USB lockout, Running Lock and User Interface

NEMA Size 00 through 2 starters shall be suitable for the addition of at least six (6) external auxiliary contacts of any arrangement normally open or normally closed. Size 3 through 8 starters shall be suitable for the addition of up to eight (8) external auxiliary contacts of any arrangement normally open or normally closed.

Motor starters shall be Cutler-Hammer Freedom Series or approved equal

B. Reversing Starters
1. Reversing starters shall consist of two (2) contactors and a single overload relay assembled together. The contactors shall be mechanically and electrically interlocked to prevent line shorts and the energizing of both contactors simultaneously.
2. Magnetic starters through NEMA Size 8 shall be equipped with double-break silver alloy contacts. The starter must have straight-through wiring.
3. Coils shall be permanently marked with voltage, frequency and part number.
4. Overload relays shall be self-powered electronic type with selectable trip class, phase unbalance and ground fault. Electrically isolated NO and NC contacts shall be provided on the relay. Visual trip indication shall be standard. An LED will provide overload health status. A test trip feature shall be provided for ease of troubleshooting and shall be conveniently operable without removing components or the motor starter. Overload to provide 5:1 FLA adjustability range, manual or automatic reset, and remote reset capabilities.

--- OR ---

Solid-State Overload Relay- C441
a. Where indicated on the drawings, provide a definite-purpose, microprocessor-based Overload Relay (OLR) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors. The OLR shall be Eaton / Cutler-Hammer type C441 (Motor Insight) relay. The OLR shall meet UL 1053, CUL and CSA standards.
b. The relay shall not require external current transformers for applications up to 150 amperes for motors rated less than 600 Vac. Where larger motors are involved, external current transformers shall be used. The relay shall include terminals for remote trip and remote reset.
c. The OLR shall have the following motor control functions:
   1. 1—Fault relay, Form C, NO/NC contact with a rating code of B300 per UL 508.
   2. 1—Ground fault relay, Form A, NO contact with a rating code of B300 per UL 508.
   3. 1—External remote reset terminal
   4. 1—Trip status indicator

* Note to Spec. Writer – Select one
d. The OLR shall be capable of accommodating external current transformers with ranges from 150:5, 300:5, and 600:5 amperes. Provide three (3) current transformers sized per manufacturer’s recommendations based on motor full-load amperes and service factor.

e. The OLR shall draw its power from 120 Vac control power. The OLR shall be suitable for either 50 Hz or 60 Hz.

f. The OLR shall have selectable trip classes 5-30.

g. The OLR shall be equipped with an operator-interface (OI)/ display interface panel. The OI shall have a seven-segment display for programming, monitoring, and alarming functions.

h. The OLR shall annunciate the following conditions:
   1. Motor Protection consisting of:
      a. Thermal overload
      b. Jam protection
      c. Current unbalance
      d. Current phase loss
      e. Ground fault
      f. Phase reversal

   2. Load protection consisting of:
      a. Under-current
      b. Low power (kW)
      c. High power (kW)

   3. Line Protection consisting of:
      a. Over-voltage
      b. Under-voltage
      c. Voltage unbalance
      d. Voltage phase unbalance

i. The OLR shall have the following monitoring capabilities:
   1. Current—Average and Phase RMS
   2. Voltage—Average and Phase RMS
   3. Power—Motor kW
   4. Power Factor
   5. Frequency
   6. Thermal capacity
   7. Run hours
   8. Ground fault current
   9. Current unbalance %
   10. Voltage unbalance %

j. The OLR shall have the following remote-mounted display/operator-interface option for use with enclosed control or motor control centers * [Type 1 remote display] [Type 12 remote display] [Type 3R remote display].

k. The OLR shall be equipped with the following optional communication module * [Modbus] [Modbus with I/O] [DeviceNet with I/O] [PROFIBUS with I/O] [Ethernet IP with I/O].

* Note to Spec. Writer - Optional
* Note to Spec. Writer – Select one
4. Solid-State Motor Management Relay - C445
   a. Where indicated on the drawings, provide a microprocessor-based Overload Relay (OLR) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors. The OLR shall be Eaton type C445 (Power Xpert) relay. The OLR shall meet UL 60947-4-1, IEC/EN 60947-4-1, IEC/EN 60947-5-1, EN 60947-8, and CSA 22.2 #60947-4-1 standards.
   b. The OLR shall offer a flexible modular form factor where sensing and protection are broken out in order to provide the most compact configuration possible.
   c. The relay shall not require external current transformers for applications up to 136 amperes for motors rated less than 1000 Vac. Where larger motors are involved, external current transformers shall be used.
   d. The OLR shall provide both protection and control functionality. OLR shall provide pre-defined operation modes which define input and output behavior if used. The following functionality shall support protection and control:
      1. One primary Fault relay, NO contact with a rating code of B300 per UL 60947-4-1 to be used for both protection and optional control of motor contactor or MCCB.
      2. A second output relay, NO contact with rating code of B300 per UL 60947-4-1 to be used in providing both protection and optional control of a second contactor or MCCB when used in wye/delta, two speed, auto-transformer and HMCP/MCCB applications. Output to be available for general purpose use if not required by application.
      3. A third output relay, NO/NC Form C output contact with rating code of B300 per UL 60947-4-1 that can be used in providing both protection and optional control of a third contactor when used in wye/delta, two speed dahlander, and auto-transformer applications. Output to be available for general purpose use if not required by application.
      4. An input able to accept 120Vac or 24Vdc run or start signal from local or remote fieldwire control source when required.
      5. An input able to accept 120Vac or 24Vdc permissive signal from local or remote fieldwire control source when required. Input to be available for general purpose use if 3-wire control is not used.
      6. An input able to accept 120Vac or 24Vdc reset signal from local or remote fieldwire control source when required.
      7. An input able to accept 120Vac or 24Vdc remote signal from local or remote fieldwire control source when required.
      8. Trip status indicator.
      9. Ability to run 2-wire or 3-wire control schemes.
      10. Ability to accept local control signals from a user interface or fieldwiring.
      11. Ability to accept remote control signals from a fieldbus network or fieldwiring.
   e. The OLR shall be capable of accommodating external current transformers with ranges from 300:5, 600:5, and 800:5 amperes. Provide three (3) current transformers sized per manufacturer’s recommendations based on motor full-load amperes and service factor.
   f. The OLR shall accept 120/240 Vac or 24 Vdc control power. The OLR shall be suitable for application from 20-80 Hz.

* Note to Spec. Writer – Select one
g. The OLR shall have selectable trip classes 5-40.

h. The OLR shall be equipped with an operator-interface (OI)/ display interface panel that is safely, remote mountable on the panel door. The OI shall have the following features for control, monitoring, programming and diagnostics
1.1—Status LEDs that indicate a FAULT or WARN condition
1.2—Monitoring window to display current, voltage, power, thermal and other motor system parameters with no network or setup required
1.3—Ability for customer to fully program and customize the device using only the user interface
1.4—Setup Wizard for fast commissioning
1.5—Running, Stopped and Auto Status LEDs with user selectable LED color schemes
1.6—Complete fault description on screen if fault event occurs
1.7—Access to 10 fault queue and trip snapshot
1.8—Dedicated Reset button, that may be disabled if desired
1.9—Optional Local Control functionality that is automatically customized based on operation mode without the need for multiple part numbers or user applied stickers, marking or programming
1.10—Powered off the base device, with no separate power source required
1.11—Optional local password protection
1.12—Micro-USB port for connection to PCs

i. The OLR shall protect and monitor the following conditions. Where applicable, all protection types will offer both trip and alarm settings with uniquely settable delays.

1. Motor Protection consisting of:
   a. Thermal overload
   b. Instantaneous overcurrent
   c. Jam
   d. Stall
   e. Undercurrent
   f. Current unbalance
   g. Current phase loss
   h. Ground fault (residual, zero sequencing and pulse detection)
   i. Allowed starts per hour
   j. Optional PTC protection (Positive Temperature Coefficient)

2. Load protection consisting of:
   a. Low power
   b. High power
   c. Power Factor Deviation

3. Line Protection consisting of:
   a. Phase Rotation
   b. Over-voltage
   c. Under-voltage

* Note to Spec. Writer - Optional
d. Voltage unbalance

d. Phase loss

e. Frequency deviation (fast and slow)
f. Voltage loss restart algorithm providing automatic staggered restart of motors during a voltage loss conditions offering (3) user settable time intervals and individual re-start delays

j. The OLR shall have the following monitoring capabilities:

1. Current—Average and phase RMS
2. Current unbalance %
3. Ground fault current
4. Average motor current as % of FLA
5. Maximum motor starting current
6. Voltage—Average line-to-line and L1-L2, L2-L3, L3-L1
7. Voltage unbalance %
8. Power—Motor kW, VA, VARs, real energy, apparent energy, reactive energy, peak demand
9. Power factor
10. Motor speed in RPM
11. Motor torque
12. Thermal memory %
13. Frequency
14. Motor state
15. Operating seconds (total and resettable)
16. Time to trip and reset
17. PTC status
18. Motor run time (total and resettable)
19. Last measured starting time
20. Number of starts (total and resettable)
21. Number of contactor operations last hour
22. Latest run time

k. The OLR shall record the following data on fault conditions

1. Active fault
2. Active warning
3. Active inhibit
4. Fault Queue – A list of last 10 faults shown in the order they occurred
5. Trip snapshot – 12 recorded parameters at time of trip for last trip (current and voltage each phase, ground current, frequency, thermal memory, VA, watts, power factor), optionally time stamped

l. Ground fault detection local and via network:

1. Zero sequence for high resistive ground and direct connected grounds
2. Ground fault pulse detection
3. Residual ground detection

m. User logic and external I/O

1. Onboard user defined logic for local control
2. Function block programming
3. Pass through via communications
4. Onboard I/O 4 in and 3 out
5. External I/O expandable to 64 in and 64 out, plus 8 analog I/O cards

n. The OLR shall provide the following communications without increasing the footprint of the device or requiring a separate power source. The OLR shall provide the user the option to configure communication loss behavior to trip or hold last state.
   1. On-board Modbus Serial
   2. * [PROFIBUS communication port with support for DVP0 and DVP1 messages] or [Ethernet communication ports with support for Ethernet/IP and ModbusTCP messaging and web pages. Ethernet will be in the form of a 2 port switch with port forwarding allowing configuration in star, redundant ring topologies, and redundant master topologies.]
   3. USB for connection to a PC for commissioning and monitoring
   4. Free software tool for commissioning and monitoring, which allows the user to save configuration files
   5. Embedded web pages (with Ethernet option)

O. The OLR shall provide the following optional functionality
   1. Real time stamping
   2. Memory backup module that saves all configuration data to non-volatile memory and copies that data to a new device in the event of device replacement
   3. Four versions of optional password protection – Administrator, USB lockout, Running Lock and User Interface
   5. Motor contactor shall be Cutler-Hammer Freedom Series or approved equal

B. Two-Speed Starters
4. Magnetic starters through NEMA Size 6 shall be equipped with double-break silver alloy contacts. The starter must have straight-through wiring
5. Coils shall be permanently marked with voltage, frequency and part number
6. Overload relays shall be self-powered electronic type with selectable trip class, phase unbalance and ground fault. Electrically isolated NO and NC contacts shall be provided on the relay. Visual trip indication shall be standard. An LED will provide overload health status. A test trip feature shall be provided for ease of troubleshooting and shall be conveniently operable without removing components or the motor starter. Overload to provide 5:1 FLA adjustability range, manual or automatic reset, and remote reset capabilities.

--- OR ---

3. Solid-State Overload Relay- C441
a. Where indicated on the drawings, provide a definite-purpose, microprocessor-based Overload Relay (OLR) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors. The OLR shall be Eaton / Cutler-Hammer type C441 (Motor Insight) relay. The OLR shall meet UL 1053, CUL and CSA standards
b. The relay shall not require external current transformers for applications up to 150 amperes for motors rated less than 600 Vac. Where larger motors are involved, external current transformers shall be used. The relay shall include terminals for remote trip and remote reset.

c. The OLR shall have the following motor control functions:
   1. Fault relay, Form C, NO/NC contact with a rating code of B300 per UL 508.
   2. Ground fault relay, Form A, NO contact with a rating code of B300 per UL 508.
   3. External remote reset terminal
   4. Trip status indicator

d. The OLR shall be capable of accommodating external current transformers with ranges from 150:5, 300:5, and 600:5 amperes. Provide three (3) current transformers sized per manufacturer’s recommendations based on motor full-load amperes and service factor.

e. The OLR shall draw its power from 120 Vac Control Power. The OLR shall be suitable for either 50 Hz or 60 Hz.

f. The OLR shall have selectable trip classes 5-30.

g. The OLR shall be equipped with an operator-interface (OI)/display interface panel. The OI shall have a seven-segment display for programming, monitoring, and alarming functions.

h. The OLR shall annunciate the following conditions:
   1. Motor Protection consisting of:
      a. Thermal overload
      b. Jam protection
      c. Current unbalance
      d. Current phase loss
      e. Ground fault
      f. Phase reversal
   2. Load protection consisting of:
      a. Under-current
      b. Low power (kW)
      c. High power (kW)
   3. Line Protection consisting of:
      a. Over-voltage
      b. Under-voltage
      c. Voltage unbalance
      d. Voltage phase unbalance

i. The OLR shall have the following monitoring capabilities:
   1. Current—Average and Phase RMS
   2. Voltage—Average and Phase RMS
   3. Power—Motor kW
   4. Power Factor
   5. Frequency
   6. Thermal capacity
   7. Run hours
   8. Ground fault current
   9. Current unbalance %
   10. Voltage unbalance %
MOTOR STARTERS – LOW VOLTAGE
SECTION 16481

j. The OLR shall have the following remote-mounted display/operator-interface option for use with enclosed control or motor control centers: [Type 1 remote display] [Type 12 remote display] [Type 3R remote display].

k. The OLR shall be equipped with the following optional communication module: [Modbus] [Modbus with I/O] [DeviceNet with I/O] [PROFIBUS with I/O] [Ethernet IP with I/O].

Solid-State Motor Management Relay- C445

a. Where indicated on the drawings, provide a microprocessor-based Overload Relay (OLR) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors. The OLR shall be Eaton type C445 (Power Xpert) relay. The OLR shall meet UL 60947-4-1, IEC/EN 60947-4-1, IEC/EN 60947-5-1, EN 60947-8, and CSA 22.2 #60947-4-1 standards.

b. The OLR shall offer a flexible modular form factor where sensing and protection are broken out in order to provide the most compact configuration possible.

c. The relay shall not require external current transformers for applications up to 136 amperes for motors rated less than 1000 Vac. Where larger motors are involved, external current transformers shall be used.

d. The OLR shall provide both protection and control functionality. OLR shall provide pre-defined operation modes which define input and output behavior if used. The following functionality shall support protection and control.

1. One primary Fault relay, NO contact with a rating code of B300 per UL 60947-4-1 to be used for both protection and optional control of motor contactor or MCCB.

2. A second output relay, NO contact with rating code of B300 per UL 60947-4-1 to be used in providing both protection and optional control of a second contactor or MCCB when used in wye/delta, two speed, auto-transformer and HMCP/MCCB applications. Output to be available for general purpose use if not required by application.

3. A third output relay, NO/NC Form C output contact with rating code of B300 per UL 60947-4-1 that can be used in providing both protection and optional control of a third contactor when used in wye/delta, two speed dahlander, and auto-transformer applications. Output to be available for general purpose use if not required by application.

4. An input able to accept 120Vac or 24Vdc run or start signal from local or remote fieldwire control source when required.

5. An input able to accept 120Vac or 24Vdc permissive signal from local or remote fieldwire control source when required. Input to be available for general purpose use if 3-wire control is not used.

6. An input able to accept 120Vac or 24Vdc reset signal from local or remote fieldwire control source when required.

7. An input able to accept 120Vac or 24Vdc remote signal from local or remote fieldwire control source when required.

--- OR ---

* Note to Spec. Writer - Optional
* Note to Spec. Writer – Select one
* Note to Spec. Writer – Select one
8. 1—Trip status indicator
9.1—Ability to run 2-wire or 3-wire control schemes
10.1—Ability to accept local control signals from a user interface or fieldwiring
11.1—Ability to accept remote control signals from a fieldbus network or fieldwiring
e. The OLR shall be capable of accommodating external current transformers with ranges from 300:5, 600:5, and 800:5 amperes. Provide three (3) current transformers sized per manufacturer’s recommendations based on motor full-load amperes and service factor.
f. The OLR shall accept 120/240 Vac OR 24 Vdc control power. The OLR shall be suitable for application from 20-80 Hz.
g. The OLR shall have selectable trip classes 5-40.
h. The OLR shall be equipped with an operator-interface (OI)/display interface panel that is safely, remote mountable on the panel door. The OI shall have the following features for control, monitoring, programming and diagnostics
1.1—Status LEDs that indicate a FAULT or WARN condition
1.2—Monitoring window to display current, voltage, power, thermal and other motor system parameters with no network or setup required
1.3—Ability for customer to fully program and customize the device using only the user interface
1.4—Setup Wizard for fast commissioning
1.5—Running, Stopped and Auto Status LEDs with user selectable LED color schemes
1.6—Complete fault description on screen if fault event occurs
1.7—Access to 10 fault queue and trip snapshot
1.8—Dedicated Reset button, that may be disabled if desired
1.9—Optional Local Control functionality that is automatically customized based on operation mode without the need for multiple part numbers or user applied stickers, marking or programming
1.10—Powered off the base device, with no separate power source required
1.11—Optional local password protection
1.12—Micro-USB port for connection to PCs

i. The OLR shall protect and monitor the following conditions. Where applicable, all protection types will offer both trip and alarm settings with uniquely settable delays.

1. Motor Protection consisting of:
   a. Thermal overload
   b. Instantaneous overcurrent
   c. Jam
   d. Stall
   e. Undercurrent
   f. Current unbalance
   g. Current phase loss
   h. Ground fault (residual, zero sequencing and pulse detection)
   i. Allowed starts per hour

* Note to Spec. Writer - Optional
j. Optional PTC protection (Positive Temperature Coefficient)

2. Load protection consisting of:
   a. Low power
   b. High power
   c. Power Factor Deviation

3. Line Protection consisting of:
   a. Phase Rotation
   b. Over-voltage
   c. Under-voltage
   d. Voltage unbalance
   d. Phase loss
   e. Frequency deviation (fast and slow)
   f. Voltage loss restart algorithm providing automatic staggered restart of motors during a voltage loss conditions offering (3) user settable time intervals and individual re-start delays

j. The OLR shall have the following monitoring capabilities:
   1. Current—Average and phase RMS
   2. Current unbalance %
   3. Ground fault current
   4. Average motor current as % of FLA
   5. Maximum motor starting current
   6. Voltage—Average line-to-line and L1-L2, L2-L3, L3-L1
   7. Voltage unbalance %
   8. Power—Motor kW, VA, VARs, real energy, apparent energy, reactive energy, peak demand
   9. Power factor
   10. Motor speed in RPM
   11. Motor torque
   12. Thermal memory %
   13. Frequency
   14. Motor state
   15. Operating seconds (total and resettable)
   16. Time to trip and reset
   17. PTC status
   18. Motor run time (total and resettable)
   19. Last measured starting time
   20. Number of starts (total and resettable)
   21. Number of contactor operations last hour
   22. Latest run time

k. The OLR shall record the following data on fault conditions
   1. Active fault
   2. Active warning
   3. Active inhibit
4. Fault Queue – A list of last 10 faults shown in the order they occurred
5. Trip snapshot – 12 recorded parameters at time of trip for last trip (current and voltage each phase, ground current, frequency, thermal memory, VA, watts, power factor), optionally time stamped

l. Ground fault detection local and via network:
   1. Zero sequence for high resistive ground and direct connected grounds
   2. Ground fault pulse detection
   3. Residual ground detection

m. User logic and external I/O
   1. Onboard user defined logic for local control
   2. Function block programming
   3. Pass through via communications
   4. Onboard I/O 4 in and 3 out
   5. External I/O expandable to 64 in and 64 out, plus 8 analog I/O cards

n. The OLR shall provide the following communications without increasing the footprint of the device or requiring a separate power source. The OLR shall provide the user the option to configure communication loss behavior to trip or hold last state.
   1. On-board Modbus Serial
   2. [PROFIBUS communication port with support for DVP0 and DVP1 messages] or [Ethernet communication ports with support for Ethernet/IP and ModbusTCP messaging and web pages. Ethernet will be in the form of a 2 port switch with port forwarding allowing configuration in star, redundant ring topologies, and redundant master topologies.]
   3. USB for connection to a PC for commissioning and monitoring
   4. Free software tool for commissioning and monitoring, which allows the user to save configuration files
   5. Embedded web pages (with Ethernet option)

o. The OLR shall provide the following optional functionality
   1. Real time stamping
   2. Memory backup module that saves all configuration data to non-volatile memory and copies that data to a new device in the event of device replacement
   3. Four versions of optional password protection – Administrator, USB lockout, Running Lock and User Interface

7. NEMA Size 00 through 2 starters shall be suitable for the addition of at least six (6) external auxiliary contacts of any combination of normally open or normally closed contacts. Sizes 3 through 6 starters shall be suitable for the addition of up to eight (8) external auxiliary contacts of any combination of normally open or normally closed contacts

8. Two-speed magnetic starters for motors up to 400 hp, 600 volts shall be Cutler-Hammer Freedom Series type AN700 or approved equal

C. Vacuum Starters
4. Vacuum starters shall incorporate “low-chop” interrupters and limit chop currents to less than 0.5 amperes. Contact material to be silver tungsten carbide.

5. Interrupters shall have contact wear detection indicators.

6. Vacuum starters shall have front removable coil and auxiliaries.

7. The contactor coil shall utilize rectified ac current.

8. Provide a “push-to-test” button for Sizes 5 and 6.


10. Overload relays shall be self-powered electronic type with selectable trip class, phase unbalance and ground fault. Electrically isolated NO and NC contacts shall be provided on the relay. Visual trip indication shall be standard. An LED will provide overload health status. A test trip feature shall be provided for ease of troubleshooting and shall be conveniently operable without removing components or the motor starter. Overload to provide 5:1 FLA adjustability range, manual or automatic reset, and remote reset capabilities.

--- OR ---

7. Solid-State Overload Relay- C441
   a. Where indicated on the drawings, provide a definite-purpose, microprocessor-based Overload Relay (OLR) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors. The OLR shall be Eaton / Cutler-Hammer type C441 (Motor Insight) relay. The OLR shall meet UL 1053, CUL and CSA standards.
   b. The relay shall not require external current transformers for applications up to 150 amperes for motors rated less than 600 Vac. Where larger motors are involved, external current transformers shall be used. The relay shall include terminals for remote trip and remote reset.
   c. The OLR shall have the following motor control functions:
      1. 1—Fault relay, Form C, NO/NC contact with a rating code of B300 per UL 508.
      2. 1—Ground fault relay, Form A, NO contact with a rating code of B300 per UL 508.
      3. 1—External remote reset terminal
      4. 1—Trip status indicator
   d. The OLR shall be capable of accommodating external current transformers with ranges from 150:5, 300:5, and 600:5 amperes. Provide three (3) current transformers sized per manufacturer’s recommendations based on motor full-load amperes and service factor.
   e. The OLR shall draw its power from the line-voltage input for the motor. The OLR shall be suitable for either 50 Hz or 60 Hz.
   f. The OLR shall have selectable trip classes 5-30.
   g. The OLR shall be equipped with an operator-interface (OI)/ display interface panel. The OI shall have a seven-segment display for programming, monitoring, and alarming functions.
   h. The OLR shall annunciate the following conditions:
      1. Motor Protection consisting of:
         a. Thermal overload
         b. Jam protection
c. Current unbalance
d. Current phase loss
e. Ground fault
f. Phase reversal

2. Load protection consisting of:
   a. Under-current
   b. Low power (kW)
   c. High power (kW)

3. Line Protection consisting of:
   a. Over-voltage
   b. Under-voltage
   c. Voltage unbalance
   d. Voltage phase unbalance

i. The OLR shall have the following monitoring capabilities:
   1. Current—Average and Phase RMS
   2. Voltage—Average and Phase RMS
   3. Power—Motor kW
   4. Power Factor
   5. Frequency
   6. Thermal capacity
   7. Run hours
   8. Ground fault current
   9. Current unbalance %
   10. Voltage unbalance %
j. The OLR shall have the following remote-mounted display/operator-interface option for use with enclosed control or motor control centers: [Type 1 remote display] [Type 12 remote display] [Type 3R remote display].

k. The OLR shall be equipped with the following optional communication module: [Modbus] [Modbus with I/O] [DeviceNet with I/O] [PROFIBUS with I/O] [Ethernet IP with I/O].

--- OR ---

--- OR ---

4. Solid-State Motor Management Relay - C445

a. Where indicated on the drawings, provide a microprocessor-based Overload Relay (OLR) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors. The OLR shall be Eaton type C445 (Power Xpert) relay. The OLR shall meet UL 60947-4-1, IEC/EN 60947-4-1, IEC/EN 60947-5-1, EN 60947-8, and CSA 22.2 #60947-4-1 standards.

b. The OLR shall offer a flexible modular form factor where sensing and protection are broken out in order to provide the most compact configuration possible.

c. The relay shall not require external current transformers for applications up to 136 amperes for motors rated less than 1000 Vac. Where larger motors are involved, external current transformers shall be used.

d. The OLR shall provide both protection and control functionality. OLR shall provide pre-defined operation modes which define input and output behavior if used. The following functionality shall support protection and control.

1. 1—One primary Fault relay, NO contact with a rating code of B300 per UL 60947-4-1 to be used for both protection and optional control of motor contactor or MCCB.

2. 1—A second output relay, NO contact with rating code of B300 per UL 60947-4-1 to be used in providing both protection and optional control of a second contactor or MCCB when used in wye/delta, two speed, auto-transformer and HMCP/MCCB applications. Output to be available for general purpose use if not required by application.

3. 1—A third output relay, NO/NC Form C output contact with rating code of B300 per UL 60947-4-1 that can be used in providing both protection and optional control of a third contactor when used in wye/delta, two speed dahlander, and auto-transformer applications. Output to be available for general purpose use if not required by application.

4. 1—An input able to accept 120Vac or 24Vdc run or start signal from local or remote fieldwire control source when required.

5. 1—An input able to accept 120Vac or 24Vdc permissive signal from local or remote fieldwire control source when required. Input to be available for general purpose use if 3-wire control is not used.

* Note to Spec. Writer - Optional
* Note to Spec. Writer – Select one
* Note to Spec. Writer – Select one
* Note to Spec. Writer – Select one
6.1— An input able to accept 120Vac or 24Vdc reset signal from local or remote fieldwire control source when required
7.1— An input able to accept 120Vac or 24Vdc remote signal from local or remote fieldwire control source when required
8. 1— Trip status indicator
9.1— Ability to run 2-wire or 3-wire control schemes
10.1— Ability to accept local control signals from a user interface or fieldwiring
11.1— Ability to accept remote control signals from a fieldbus network or fieldwiring
e. The OLR shall be capable of accommodating external current transformers with ranges from 300:5, 600:5, and 800:5 amperes. Provide three (3) current transformers sized per manufacturer’s recommendations based on motor full-load amperes and service factor.
f. The OLR shall accept 120/240 Vac OR 24 Vdc control power. The OLR shall be suitable for application from 20-80 Hz.
g. The OLR shall have selectable trip classes 5-40.
h. The OLR shall be equipped with an operator-interface (OI)/ display interface panel that is safely, remote mountable on the panel door. The OI shall have the following features for control, monitoring, programming and diagnostics
1.1— Status LEDs that indicate a FAULT or WARN condition
1.2— Monitoring window to display current, voltage, power, thermal and other motor system parameters with no network or setup required
1.3— Ability for customer to fully program and customize the device using only the user interface
1.4— Setup Wizard for fast commissioning
1.5— Running, Stopped and Auto Status LEDs with user selectable LED color schemes
1.6— Complete fault description on screen if fault event occurs
1.7— Access to 10 fault queue and trip snapshot
1.8— Dedicated Reset button, that may be disabled if desired
1.9— Optional Local Control functionality that is automatically customized based on operation mode without the need for multiple part numbers or user applied stickers, marking or programming
1.10— Powered off the base device, with no separate power source required
1.11— Optional local password protection
1.12— Micro-USB port for connection to PCs
i. The OLR shall protect and monitor the following conditions. Where applicable, all protection types will offer both trip and alarm settings with uniquely settable delays.
1. Motor Protection consisting of:
   a. Thermal overload
   b. Instantaneous overcurrent
   c. Jam
   d. Stall
   e. Undercurrent
f. Current unbalance

g. Current phase loss

h. Ground fault (residual, zero sequencing and pulse detection)
i. Allowed starts per hour

j. Optional PTC protection (Positive Temperature Coefficient)

2. Load protection consisting of:
   a. Low power
   b. High power
   c. Power Factor Deviation

3. Line Protection consisting of:
   a. Phase Rotation
   b. Over-voltage
   c. Under-voltage
   d. Voltage unbalance
   e. Frequency deviation (fast and slow)
   f. Voltage loss restart algorithm providing automatic staggered restart of motors during a voltage loss conditions offering (3) user settable time intervals and individual re-start delays

j. The OLR shall have the following monitoring capabilities:

1. Current—Average and phase RMS
2. Current unbalance %
3. Ground fault current
4. Average motor current as % of FLA
5. Maximum motor starting current
6. Voltage—Average line-to-line and L1-L2, L2-L3, L3-L1
7. Voltage unbalance %
8. Power—Motor kW, VA, VARs, real energy, apparent energy, reactive energy, peak demand
9. Power factor
10. Motor speed in RPM
11. Motor torque
12. Thermal memory %
13. Frequency
14. Motor state
15. Operating seconds (total and resettable)
16. Time to trip and reset
17. PTC status
18. Motor run time (total and resettable)
19. Last measured starting time
20. Number of starts (total and resettable)
21. Number of contactor operations last hour
22. Latest run time
The OLR shall record the following data on fault conditions:
1. Active fault
2. Active warning
3. Active inhibit
4. Fault Queue – A list of last 10 faults shown in the order they occurred
5. Trip snapshot – 12 recorded parameters at time of trip for last trip (current and voltage each phase, ground current, frequency, thermal memory, VA, watts, power factor), optionally time stamped

Ground fault detection local and via network:
1. Zero sequence for high resistive ground and direct connected grounds
2. Ground fault pulse detection
3. Residual ground detection

User logic and external I/O:
1. Onboard user defined logic for local control
2. Function block programming
3. Pass through via communications
4. Onboard I/O 4 in and 3 out
5. External I/O expandable to 64 in and 64 out, plus 8 analog I/O cards

The OLR shall provide the following communications without increasing the footprint of the device or requiring a separate power source. The OLR shall provide the user the option to configure communication loss behavior to trip or hold last state.
1. On-board Modbus Serial
2. [PROFIBUS communication port with support for DVP0 and DVP1 messages] or [Ethernet communication ports with support for Ethernet/IP and ModbusTCP messaging and web pages. Ethernet will be in the form of a 2 port switch with port forwarding allowing configuration in star, redundant ring topologies, and redundant master topologies.]
3. USB for connection to a PC for commissioning and monitoring
4. Free software tool for commissioning and monitoring, which allows the user to save configuration files
5. Embedded web pages (with Ethernet option)

The OLR shall provide the following optional functionality:
1. Real time stamping
2. Memory backup module that saves all configuration data to non-volatile memory and copies that data to a new device in the event of device replacement
3. Four versions of optional password protection – Administrator, USB lockout, Running Lock and User Interface

1.02 MICROPROCESSOR-BASED MOTOR CONTROL
A. Motor Starters – IT Design
4. Provide electromechanical type motor starters with coil control and overload integrated into a single or dual microcontroller
5. The motor starter shall operate over a temperature range of -40 to 149 degrees F (-40 to 65 degrees C) and shall meet or exceed the following Standards and Certifications: UL, CSA, NEMA ICS1, ICS2, ICS5, IEC 60947-4-1, CE, and KEMA where applicable. Devices shall meet Electromagnetic Compatibility (EMC) Requirements per EMC IEC 61000-4.

6. Provide one toroidal current sensor per phase accurate to 2% providing input to analog circuitry and software which yields a time-current curve paralleling actual motor heating. Motor FLA shall be set via a potentiometer for 1.0 or greater Service Factor settings.

7. Provide user selectable overload Trip Class of 10, 20 and 30 on each Overload Relay. To adjust factory defaults, Trip Class shall be manually changed using the Test button and FLA dial.

8. Provide phase loss and phase current unbalance protection. If the phase unbalance of any phase is greater than or less than approximately 50% of the average, the device trips. This feature is user enabled/disabled and manually changed using the Test button and FLA dial.

9. Provide each motor starter with a lockable cover that prevents unwanted tampering of FLA dial settings once installed.

10. Provide a microcontroller with the following features:
   a. Monitor the nominal 24 Vdc and adjust the Pulse Width Modulation (PWM) accordingly to minimize utilized power and maximize contact sealed force.
   b. Energizes coil at full voltage and then applies Pulse Width Modulation.
   c. Monitors user control inputs (i.e., permissive {stop}, forward, reverse, local reset, remote reset, test/test to trip. Control inputs shall be rated are 24 Vdc (3-5 mA) with a plug and unplug lockable control connector.
   d. Operates an LED indicator which displays a flash sequence for thermal capacities over 70%, test button depression, trip indication, class setting, phase enablement/disablement, and microcontroller reset condition.
   e. Monitors 3-phase current into a common node.
   f. Sweeps the current waveform to avoid synchronizing with the current waveform.
   g. Provides Thermal Memory (in addition, Thermal Pile, Thermal Capacity) which shall be saved to non-volatile memory for safety purposes in the event of a power loss or removal and restore event.
   h. Controls an alarm output which is a solid-state open collector or emitter type output at 24 Vdc 250 mA.
   i. Shall solve a first order differential equation for an actual motor heating model to calculate trip points.
   j. Provides an “alarm only” or “alarm without trip” mode for critical must run applications.
   k. Provides built-in logic to provide either 2- or 3-wire control, eliminating the need to provide and wire auxiliary contacts to seal-in and interlock the contactor coil.
   l. Starter can be easily networked with the appropriate SNAP device communicating to a factory bus.

11. Control Voltages:

* Note to Spec. Writer – Optional
The starter voltage shall be nominal 24 Vdc from 20 to 28 Vdc

Motor starters shall have replaceable fixed and movable contacts, Size 1 through 5.

Motor starters shall have no laminations, shading coils, or magnet noise.

Accessories:

a. Motor starters shall accommodate auxiliary contacts per various maximum combinations of single and dual auxiliaries. Maximum number of circuits shall be six (6) for Size 1 through 4 and twelve (12) for Size 5 starters. Contacts shall be rated ten (10) amperes continuous, 7200 VA make, 720 VA break for 120 Vac, 3600 VA make, 360 VA break for 240 Vac, 1800 VA make, 180 VA break for 480 Vac, 1440 VA make, 144 VA break for 600 Vac, and 137.5 VA make and break for 125 through 250 Vdc. No seal-in auxiliary contacts are required.

b. Provide mechanical interlock on reversing contactors of a pivot-type mechanism to prevent closing of one contactor when the other is closed. Coil controller energizes both forward and reverse contactors providing one control point for wiring.

c. Provide control modules to perform the indicated input/output control functions shown on the drawings. Module shall incorporate faceplates having membrane type pushbuttons and LEDs. All pushbutton and LED functions shall be provided with clearly written identification. Modules shall be provided with the ability to replace conventional start, stop, hand, auto control functions, and overload reset function. Modules shall be provided with the ability to replace conventional indicating light status of run, off, selector switch pushbutton position, and overload trip and circuit breaker trip.

Microprocessor-based motor starters shall be Cutler-Hammer IT. Series or approved equal.

All printed wiring boards shall be conformally coated to provide environmental robustness.

Motor starters shall provide *[Manual] [Remote Reset] [Auto Reset] capability

* [Provide] [Make provisions for] a DeviceNet Starter Network Adapter addressable communication card capable of providing communication capability, control, and monitoring. All data, including trip data, shall be transmitted over the DeviceNet network. The adapter shall serve as a single node on the DeviceNet network. The adapter shall be designed for use with the same 24 Vdc power as the starter. A starter power sensing circuit shall indicate to the network that the starter does not have 24 Vdc power, signaling a fault or an emergency stop. The adapter MAC ID and baud rate shall be manually set. Configuration software shall not be required for normal operation. Configuration software shall be available for configuring advanced features. The adapter shall connect to the starter via an interconnection cable and terminal adapter. The following data shall be transmitted over the network:

a. RMS average current
b. Percent of operating full load current
c. Percent thermal memory
d. Integral contact position detection

* Note to Spec. Writer – Select one
* Note to Spec. Writer – Select one
Operating status and fault codes
Start/Stop control
Run/Forward-Reverse control
Trip reset
Fault log
Current level warning (adjustable)
Underload warning (adjustable)

OR

[Provide] [Make provisions for] a QCPort Starter Network Adapter addressable communication card capable of providing communication capability, control and monitoring. All data, including trip data, shall be transmitted over the QCPort network. The adapter shall consume a single QCPort ID. The adapter shall be designed for use with the same 24 Vdc power as the starter. A starter power sensing circuit shall indicate to the network that the starter does not have 24 Vdc power, signaling a fault or an emergency stop. The adapter Group ID shall be manually set. Configuration software shall not be required for normal operation. Configuration software shall be available for configuring advanced features. The adapter shall connect to the starter via an interconnection cable and terminal adapter. The following data shall be transmitted over the network:

- RMS average current
- Percent of operating full load current
- Percent thermal memory
- Integral contact position detection
- Operating status and fault codes
- Start/Stop control
- Run/Forward-Reverse control
- Trip reset
- Fault log
- Current level warning (adjustable)
- Underload warning (adjustable)

OR

SOLID-STATE REDUCED-VOLTAGE MOTOR CONTROL

A. Reduced Voltage Motor Starter Type S801
   1. Controller shall be Cutler-Hammer type S801
   2. The solid-state reduced-voltage starter shall be UL and CSA listed. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing

* Note to Spec. Writer – Optional
* Note to Spec. Writer – Optional
* Note to Spec. Writer – Select one
3. The SCR-based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1500 volts PIV
4. Units using triacs or SCR/diode combinations shall not be acceptable
5. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dV/dt effects
6. The logic board shall be mounted for ease of testing, service and replacement. It shall have quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits
7. The logic board shall be identical for all ampere ratings and voltage classes and shall be conformally coated to protect environmental concerns
8. The paralleling run bypass contactor shall energize when the motor reaches 90% of full speed and close/open under one (1) times motor current
9. The paralleling run bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions
10. Starter shall be provided with electronic overload protection as standard and shall be based on inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via a DIP switch setting on the device keypad
11. Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter
12. Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting on the device keypad
13. Starter shall be capable of either an electronic or mechanical reset after a fault
14. Units using bimetal overload relays are not acceptable
15. Overtemperature protection (on heat sink) shall be standard
16. Starters shall provide protection against improper line-side phase rotation as standard. Starter will shut down if a line-side phase rotation other than A-B-C exists. This feature can be disabled via a DIP switch on the device keypad
17. Starters shall provide protection against a phase loss or unbalance condition as standard. Starter will shut down if a 50% current differential between any two phases is encountered. This feature can be disabled via a DIP switch on the device keypad
18. Start shall provide protection against a motor stall condition as standard. This feature can be disabled via a DIP switch on the device keypad
19. Starter shall provide protection against a motor jam condition as standard. This feature can be disabled via a DIP switch on the device keypad
20. Starter shall be provided with a Form C normally open (NO), normally closed (NC) contact that shall change state when a fault condition exists. Contacts shall be rated 60 VA (resistive load) and 20 VA (inductive load). In addition, an LED display on the device keypad shall indicate type of fault (Overtemperature, Phase Loss, Jam, Stall, Phase Reversal and Overload)
21. The following control function adjustments on the device keypad are required:
a. Selectable Torque Ramp Start or Current Limit Start
b. Adjustable Kick Start Time: 0–2 seconds

c. Adjustable Kick Start Torque: 0–85%

d. Adjustable Ramp Start Time: 0.5–180 seconds

e. Adjustable Initial Starting Ramp Torque: 0–85%

f. Adjustable Smooth Stop Ramp Time: 0–60 seconds.

22. Units enclosed in motor control centers shall be of the same manufacturer as that of the circuit breaker and motor control center for coordination and design issues

23. Maximum continuous operation shall be at 115% of continuous ampere rating

Pump Control Option – Provide control algorithm for pump start-up and shut down sequences. Control algorithm shall reduce the potential for water hammer in a centrifugal pump system. Upon a start command, the speed of the motor is increased, under the control of the IT. Soft Starter microprocessor, to achieve a gentle start. After the speed has reached its nominal value, the bypass contactors close and the pump. Upon a stop command, the bypass contactors are opened and the motor speed is decreased in a tapered manner, to gradually slow the flow until the motor is brought to a stop. The start and stop ramp times are user adjustable and are to be set for the application requirements. The pump control option shall be factory installed.

-- OR --

A. Reduced Voltage Motor Starter Type S811

1. Controller shall be Cutler-Hammer type S811

2. The solid-state reduced-voltage starter shall be UL and CSA listed. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing

3. The SCR-based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1500 volts PIV

4. Units using triacs or SCR/diode combinations shall not be acceptable

5. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dV/dT effects

6. The logic board shall be mounted for ease of testing, service and replacement. It shall have quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs and SCR gate firing output circuits

7. The logic board shall be identical for all ampere ratings and voltage classes and shall be conformally coated to protect environmental concerns

8. The paralleling run bypass contactor shall energize when the motor reaches 90 of full speed and close/open under one (1) times motor current

9. The paralleling run bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions

10. Digital interface module mounted on the face of the S811 shall be used to program the soft starter. Display shall include six line LED readout. Monitoring

* Note to Spec. Writer – Select one
parameters shall include line currents, pole currents, pole voltages, number of starts, and DC control voltage. Soft starter shall display motor status and the previous 5 fault conditions

11. Starter shall be provided with electronic overload protection as standard and shall be based on inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via digital interface module

12. Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter

13. Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting on the device keypad

14. Starter shall be capable of either an electronic or mechanical reset after a fault

15. Units using bimetal overload relays are not acceptable

16. Overtemperature protection (on heat sink) shall be standard

17. Starters shall provide protection against improper line-side phase rotation as standard. Starter will shut down if a line-side phase rotation other than A-B-C exists. This feature can be disabled via digital interface module

18. Starters shall provide protection against a phase loss or unbalance condition as standard. Starter will shut down if a 50% current differential between any two phases is encountered. This feature can be disabled via digital interface module

19. Start shall provide protection against a motor stall condition as standard. This feature can be disabled via digital interface module

20. Starter shall provide protection against a motor jam condition as standard. This feature can be disabled via digital interface module

21. Starter shall be provided with a Form C normally open (NO), normally closed (NC) contact that shall change state when a fault condition exists. Contacts shall be rated 60 VA (resistive load) and 20 VA (inductive load). In addition, an LED display on the device keypad shall indicate type of fault (Overtemperature, Phase Loss, Jam, Stall, Phase Reversal and Overload)

22. The following control function adjustments from digital interface module are required:
   a. Selectable Torque Ramp Start or Current Limit Start
   b. Adjustable Kick Start Time: 0–2 seconds
   c. Adjustable Kick Start Torque: 0–85%
   d. Adjustable Ramp Start Time: 0.5–180 seconds
   e. Adjustable Initial Starting Ramp Torque: 0–85%
   f. Adjustable Smooth Stop Ramp Time: 0–60 seconds.

23. Units enclosed in motor control centers shall be of the same manufacturer as that of the circuit breaker and motor control center for coordination and design issues

24. Maximum continuous operation shall be at 115% of continuous ampere rating

Pump Control Option – Provide control algorithm for pump start-up and shut down sequences. Control algorithm shall reduce the potential for water hammer in a centrifugal
pump system. Upon a start command, the speed of the motor is increased, under the control of the IT. Soft Starter microprocessor, to achieve a gentle start. After the speed has reached its nominal value, the bypass contactors close and the pump. Upon a stop command, the bypass contactors are opened and the motor speed is decreased in a tapered manner, to gradually slow the flow until the motor is brought to a stop. The start and stop ramp times are user adjustable and are to be set for the application requirements. The pump control option shall be factory installed.

2.05 ELECTROMECHANICAL REDUCED VOLTAGE MOTOR CONTROL

A. Autotransformer Type
   1. The starter shall utilize an autotransformer for a reduced voltage start. The autotransformer shall have adjustable voltage taps at 50%, 65% and 80%
   2. The starter shall be [an open] [a closed] transition type
   3. The autotransformer shall use [electromechanical] [microprocessor-based] type starters

B. Part-Winding Type
   1. The starter shall utilize a part winding connection for a reduced voltage start
   2. The part-winding starter shall use [electromechanical] [microprocessor-based] type starters

C. Wye-Delta Type
   1. The starter shall utilize a wye-delta connection for a reduced voltage start
   2. The starter shall be [an open] [a closed] transition type
   3. The wye-delta starter shall use [electromechanical] [microprocessor-based] type starters

* Note to Spec. Writer – Select one

16481-33
8/8/2018
2.06 ENCLOSURES
   A. The enclosure shall be *[general purpose NEMA 1] [NEMA 3R] [NEMA 12] [NEMA 4X] [as indicated on the contract drawings].
   B. *Starters shall have [an adjustable instantaneous motor circuit protector (HMCP) type] [a thermal-magnetic circuit breaker type] [a fusible type] [a non-fused type] disconnect device.

2.07 OPTIONS
   A. Each starter shall be equipped with *[a fused control power transformer (100 VA minimum)] [HOA selector switch] [start-stop pushbutton] [red “run” pilot light] [green “stop” pilot light] [2 NO/2 NC auxiliary contacts] [options as indicated on the contract drawings].

PART 3 EXECUTION

3.01 FACTORY TESTING
   A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
   B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 FIELD QUALITY CONTROL
   A. Provide the services of a qualified factory-trained manufacturer’s representative to assist the Contractor in installation and start-up of the equipment specified under this section. The manufacturer’s representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained herein.
   B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer’s service representative.
      1. Inspection and final adjustments
      2. Operational and functional checks of starters and spare parts.
   C. The Contractor shall provide three (3) copies of the manufacturer’s field startup report.

3.03 MANUFACTURER’S CERTIFICATION
   A. A qualified factory-trained manufacturer’s representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations.
   B. The Contractor shall provide three (3) copies of the manufacturer’s representative’s certification.

3.04 TRAINING
   * Note to Spec. Writer – Select one
   * Note to Spec. Writer – Optional
The Contractor shall provide a training session for up to five (5) owner’s representatives for _____ normal workdays at a job site location determined by the owner.

B. The training representative shall be conducted by a manufacturer’s qualified representative.

C. The training program shall consist of the following:
   1. Instructions on the proper maintenance and operation of the equipment.