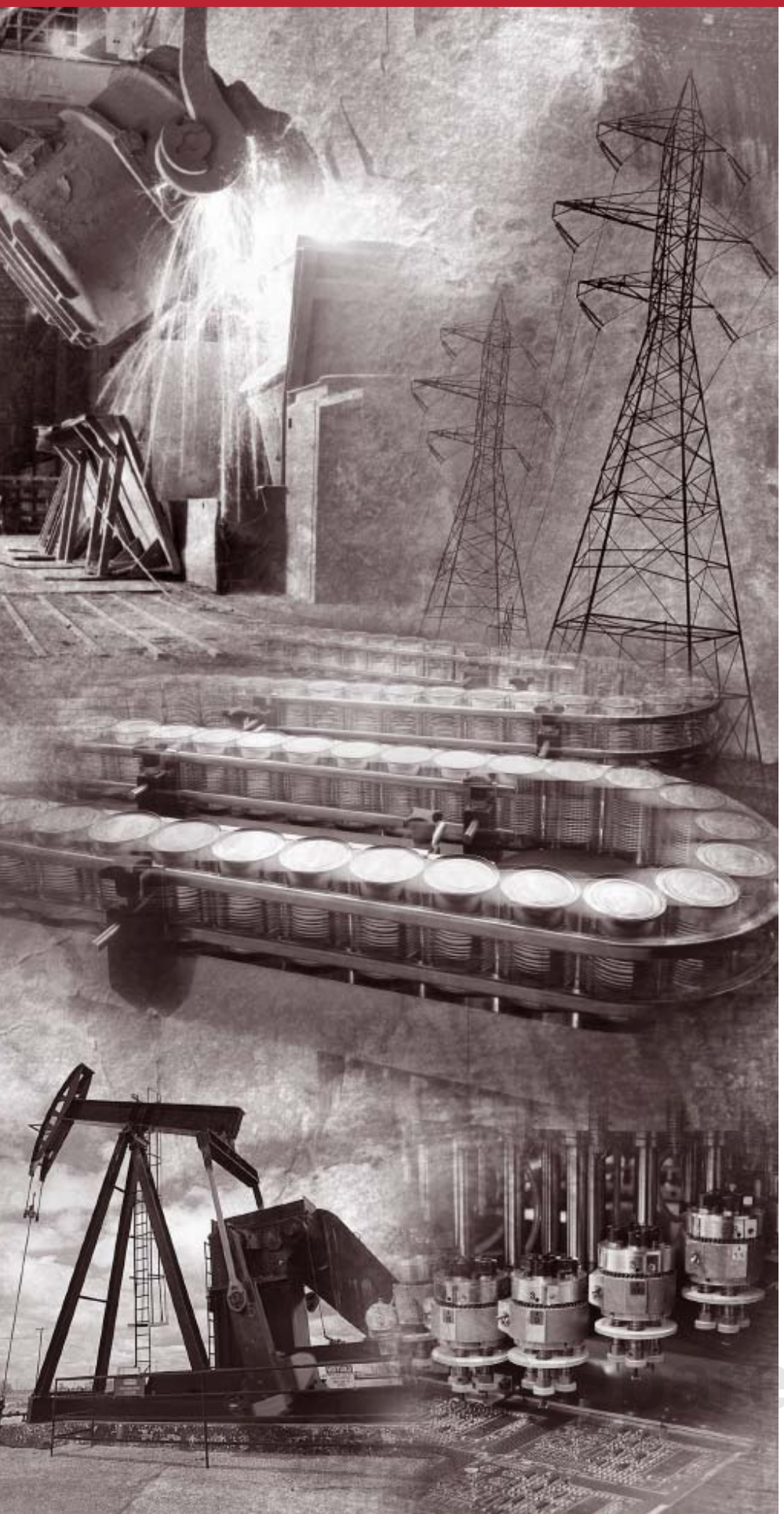

Allen-Bradley

Medium Voltage Smart Motor Controllers (SMC)

Bulletin 1560E, 1562E

Specification Guide

Rockwell Automation

1.0 General

Introduction

Rockwell Automation has produced quality medium voltage products to meet the requirements of all types of industries for well over six decades.

From the original oil-immersed contactor, to air break and vacuum contactors, to solid-state controllers such as Smart Motor Controllers and AC Variable Frequency Drives, Rockwell Automation has developed and built a medium voltage product line that satisfies those industries demanding more safety, less maintenance, longer life and reliability in motor control equipment.

Added to those demands is the need for smaller and more flexible medium voltage products that are more efficient and that enable a reduction in building and expansion costs.

MV SMC-Flex Solid-State Motor Controllers

Rockwell Automation has met industry demands with the MV SMC-Flex line of solid-state, reduced-voltage motor controllers. The MV SMC-Flex provides closed-loop microprocessor control to start and stop three-phase motors. Several standard modes of operation are available within a single controller:

- Soft Start with Selectable Kickstart
- Current Limit Start with Selectable Kickstart
- Linear Acceleration with Selectable Kickstart*
- Linear Deceleration*
- Soft Stop
- Dual Ramp Start
- Full Voltage Start
- Pump Control (optional), including start and stop control

*-requires motor tachometer

Additional Features:

- Solid-state motor protection
- Metering
- DPI (Drive Programming Interface) communication
- LCD display
- Keypad programming
- Fiber optic control of medium voltage SCRs (for isolation)
- Current loop gate driver boards
- Vacuum bypass contactor
- Starting optimized power stacks
- Centerline™ power bus

1.0 General (cont.)

MV SMC-Flex Solid-State Motor Controllers (cont.)

The MV SMC-Flex controller is available for motors rated up to 600 amp full load current, 2300 to 6900 volts AC, 50 and 60 Hz. Under certain conditions, higher motor full load current may be possible (consult factory).

The MV SMC-Flex is a solid-state reduced voltage controller utilizing the SMC-Flex digital control module. This is the same control module used in the 480/600 V Bulletin 150 SMC-Flex controller.

MV SMC-Flex Motor Controllers	Bulletin Number
OEM Components	1503E
Retrofit Controller	1560E
Combination Controller, non-reversing	1562E

Custom engineered units available upon request (i.e. reversing or multi-motor, etc.).

2.0 Scope

This specification outlines the overall fabrication, performance and functional requirements for a medium voltage solid-state, reduced-voltage motor controller for use with polyphase motors. The complete controller shall meet the overall design requirements as specified herein.

The solid state reduced voltage starter shall be _____ V, 3 phase, _____ hp or _____ kW rated, and used for the controlled starting and/or stopping of AC induction motors.

3.0 Codes and Standards

The Seller's equipment shall be designed, manufactured and tested to meet or exceed the applicable requirements of the latest standards published by the following organizations:

- Canadian Standards Association (CSA) *Industrial Control Equipment C22.2 No. 14*
- American National Standards Institute (ANSI) *Instrument Transformers C57.13*
- Institute of Electrical & Electronic Engineers (IEEE)
- National Electrical Code (NEC)
- Occupational Safety & Health Act (OSHA)
- Guide for Harmonic Control and Reactive Compensation of Static Power Converters (IEEE 519-1992)
- National Electrical Manufacturers Association (NEMA) *Medium Voltage Controllers Rated 1501 to 7200V AC ICS 3-2 (formerly ICS 2-324)*
- Underwriters Laboratories, Inc. (UL) *High Voltage Industrial Control Equipment 347*
- European Directives for Safety and EMC

Note: It shall be the responsibility of the user and/or installer to know and meet all local codes, standards, and OSHA requirements.

Environmental Conditions

The controller shall be offered in versions that accept nominal plant power of 2400V, 3300V, 4200V, 6600V or 6900V AC (±10%), 3 phase 50/60 Hz (± 3%).

The standard controller shall operate in an ambient temperature range of 0°C to 40°C (32°F to 104°F) with a relative humidity of up to 95% (non-condensing). Higher ambient temperature conditions are to be supported with factory assistance.

Rockwell Automation products are built using materials that comply with Class 1: Industrial Clean Air sulphur environments as defined in IEC Standard 60654-4 (Operating Conditions for Industrial-Process Measurement and Control Equipment), and G1 as defined in ISA-S71.04-1985 (Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants).

The equipment shall be capable of being stored in an environment with an ambient temperature range of -20°C to 65°C (-4°F to 149°F).

The equipment shall operate at altitudes from 0 to 1000 m (3,300 ft) above sea level, without derating. For applications above 1000 m (3,300 ft), the maximum current and Basic Impulse Levels (B.I.L.) of the controllers shall be derated, and vacuum contactors may be compensated for operation at the specified altitude (see page 30).

3.0 Codes and Standards (cont.)

Seismic Qualifications

The controller can be provided such that it shall withstand certain horizontal and vertical accelerations (seismic zones 1, 2, 3 and 4) without overturning or lateral movement when bolted down (mounted) per the Seller's recommended installation instructions.

Note: The above seismic qualification does not indicate that the equipment will operate properly during or after a seismic event.

4.0 Obligations of Seller

Deviations

Any exceptions or deviations shall be defined in writing at the time of bid.

5.0 Drawings and Manuals

Information Drawings

Orders shall include a submittal of three (3) bond paper prints of the dimension drawing and electrical drawings (two for customer and one for Seller's local representative), at the time engineering is finalized. These drawings shall be suitable for photo copying.

Approval Drawings

If requested at the time of order entry, approval drawings shall be available at no charge. The approval submittal shall include (3) bond paper prints of the dimension drawing and electrical drawings supplied at the published lead time after order receipt by the Seller. Submittal of approval drawings requires an additional _____ weeks. Approval drawings can be sent electronically via the Internet, as an alternative to sending them by mail.

Note: Seller shall allow the customer two (2) weeks to review the drawings. This period starts on the date that the drawings are shipped to the customer and ends on the date that the drawings must be back to the Seller. If drawings are returned earlier than two (2) weeks, then lead-time may be adjusted accordingly.

Final Drawings and Manuals

Certified drawings, instruction and maintenance manuals shall be provided on CD (3 copies) and sent within 30 days of final product shipment. Final drawings shall be available in DXF format at no charge.

6.0 Spare Parts

Recommended spare parts list and prices shall be supplied with the bid. Also, the address of the manufacturer's closest parts stocking location to the user can be provided on request.

Critical Spares

Critical spare parts are those associated with long lead times and/or are critical to the unit's operation. These spares should be held in reserve by the customer to limit unforeseen downtime.

Maintenance Spares

Maintenance spare parts are those required by customers to regularly perform scheduled maintenance on their equipment. These spares include, but are not limited to, consumable spares that are required to be exchanged during scheduled customer maintenance periods.

Seller shall assist in determining an appropriate level of spare parts in conjunction with the customer's bill of material (which may include circuit breakers, full voltage starters, load break switches and other auxiliary equipment) and the customer's current installed base.

On-site Inventory Agreement (Optional)

Seller shall offer an on-site inventory agreement, in which the Seller will stock and supply as needed all of the spare parts required by the user in the closest stocking location. The user shall have a controlled/immediate access to this inventory 365 days a year.

7.0 Quality Assurance

All inspection and testing procedures shall be developed and controlled under the guidelines of the seller's quality system. This system must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.

All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.

All sub-assemblies shall be inspected and/or tested for conformance to vendor's engineering and quality assurance specifications.

All printed circuit boards with active components shall be burned-in for a minimum of 2 hours at 65ºC (149°F).

7.0 Quality Assurance (cont.)

Standard Testing

The following tests shall be carried out in accordance with applicable requirements and/or specifications of Canadian Standards Association (CSA), Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), European Standard (EN), and International Electrotechnical Commission (IEC).

Functional checks shall be performed wherever possible; otherwise, inspection and continuity checks shall be made.

A "HI-POT" dielectric withstand test shall be performed on all buswork and cables from phase to phase and phase to ground (except solid-state components, low voltage controls and instrument transformers). The voltage level used for this test depends on the product's nominal AC voltage.

Component devices shall be functionally operated in circuits as shown on electrical diagrams or as called for by specific test instructions.

Instruments, meters, protective devices and associated controls shall be functionally tested by applying the specified control signals, current and/or voltages.

Medium voltage solid-state controllers shall be inspected for the following:
- Electrical interlocking
- Motor protection and ground fault
- Motor start tests (under medium voltage load conditions)

Physical Inspection

The product must meet all applicable engineering and workmanship standards and specifications. All components shall be verified against engineering documentation to be present and correctly installed.

Warning plates, isolation barriers, and mechanical interlocks must provide sufficient safety/isolation for personnel and equipment.

- Warning labels and nameplates must be present and in their specified positions to advise personnel of possible hazards.
- Isolation barriers must be in place within the cabinet. Such barriers protect personnel from touching live medium voltage components in an area that otherwise does not have power supplied to it.
- Operation of isolation switch handle (if supplied) and door interlocks must be verified. The interlocking prevents the opening of any medium voltage door on a medium voltage cabinet when the isolation switch handle has been moved to the full ON position.

All bus and bus connections shall be checked for proper clearance, creepage, phasing and tightness (torque).

Factory Inspections (Optional)

Visual Inspection of Equipment

If requested, a review of the electrical and mechanical drawings for the purchased equipment will be done with the Applications Specialist or Project Manager prior to commencing the inspection.

The visual inspection consists of a customer visit to the factory, with prior notification and coordination with the Customer Service Coordinator or the Project Manager, with the intent to view the customer-specific equipment at the various stages of build. There is no special preparation of the equipment for this inspection. It is a means for the customer to verify the progress of the order without any disruption to the manufacturing cycle.

Witness Testing

A review of the electrical and mechanical drawings for the purchased equipment will be done with the Applications Specialist or Project Manager prior to commencing the tests. Any questions or clarifications prior to commencing the test will be addressed at this time. The Test Facility will then host the customer for the duration of the actual testing. At the conclusion of the test the customer will reconvene with the Applications Specialist or Project Manager to discuss any concerns or issues that arose during the test. The Project Manager or Applications Specialist will respond back to the customer at the earliest possible time with an outline of the financial and/or schedule impact of the changes.

The medium voltage solid-state, reduced-voltage testing consists of:

- demonstrating an AC high pot test to the customer;
- applying control power at the rated voltage to the equipment; then, a functional demonstration of customer-purchased options and control devices is completed with the starter in the TEST position.
- operation of the vacuum contactor .
- connection of equipment to a medium voltage input source and the test motor in the manufacturing facility. The motor starting functionality is demonstrated by starting and stopping the test motor.

Custom Testing

The Seller shall be prepared to provide custom testing of the equipment. The customer specifications for the customer test must be provided to the Seller at least two months prior to the testing date at which time the Seller will provide a cost and schedule impact for completing the testing requirements.

8.0 Equipment Design and Selection

General

The controller shall be manufactured by a single vendor.

The medium voltage, solid-state controller shall consist of a metal-enclosed, free-standing, dead front, vertical steel structure.

Each structure shall be suitable for future expansion at each end. Each structure shall also have two (2) non-removable base sill channels and removable lifting angles or brackets for ease of handling and installation.

The controller shall be of modular design to provide for ease and speed of maintenance. The modules are to be manufactured by one supplier, designed to allow ease of maintenance, including removal of medium voltage components and power electronic components.

The structure shall be divided into isolated compartments as follows:

- Main power bus and ground bus compartment
- Power cell compartment
- Low voltage compartment

Metal or glass polyester barriers shall be provided between the low voltage compartment and the power cell and/or main power bus compartment, and between the power cell and main power bus compartment. Personnel shall have access to the low voltage compartment, with the controller energized, without being exposed to any medium voltage.

Structure and Controller

Each structure shall contain the following items:

Retrofit Controller *(For use with existing isolating or full voltage controller)*

- Tin-plated copper horizontal power bus (optional)
- A continuous bare copper ground bus
- Power electronics
- A vacuum bypass contactor
- A low voltage control panel complete with microprocessor-based control module
- Three (3) current transformers
- Top and bottom plates to accommodate cable entry/exit

Structure and Controller (cont.)

Combination Starters *(Includes isolating controller)*

- Tin-plated copper horizontal power bus (optional)
- A continuous bare copper ground bus
- Power electronics
- A non-load-break isolation switch and operating handle, complete with ground connection when open
- A vacuum isolation contactor
- A vacuum bypass contactor
- Three (3) current limiting power fuses for NEMA Class E2 operation
- Three (3) current transformers
- A control power transformer
- A low voltage control panel complete with microprocessor-based control module
- Space for necessary auxiliary control and metering devices
- Top and bottom plates to accommodate cable entry/exit

Enclosure Types

The medium voltage product line shall be available in a NEMA Type 1 (IEC IP10) general purpose enclosure as standard. Optional enclosures are:

– NEMA Type 1 with door gasketing (IEC IP21)
– NEMA Type 12 dust tight and drip proof (IEC IP52)
– NEMA Type 3R outdoor (IEC IP34) non-walk-in

Each enclosure shall be properly sized to dissipate the heat generated by the controller within the limits of the specified environmental operating conditions.

Arc Resistant Enclosure (optional for selected units)

The medium voltage solid-state motor controller(s) shall be provided with an arc resistant enclosure design (select units – consult factory for availability).

The arc resistant units shall be tested per IEEE C37.20.7™, Type 2 Accessibility, and provide the following benefits:

- Reinforced structure, to contain arc flash material, at faults up to 40 kA, 0.5 seconds
- Arc vent to exhaust arc flash material
- Plenum to redirect arc flash material
- Reinforced low voltage panel, sealed to prevent entry of arc flash material

8.0 Equipment Design and Selection (cont.)

Structure and Controller (cont.)

Structure Finish

As standard, all exterior and interior metal parts (except for the power cell back plates and low voltage panel) shall be painted ANSI 49 medium light gray (3R shall be ANSI 61). All metal back plates in the power cell and low voltage compartments shall be painted high gloss white for high visibility. Optional field touch-up spray can(s), matching the enclosure color, shall be supplied when requested.

Description.....	Hybrid epoxy powder paint
Standard color.....	ANSI 49 medium light gray (optional ANSI 61 light gray)
Procedure	Continuous paint line. All parts are painted before assembly.
Preparation.....	Alkaline wash/rinse/iron phosphate rinse/iron-chrome sealer rinse/recirculated de-ionized water rinse and virgin de-ionized water rinse.
Painting.....	Air-atomized electrostatic spray. Total paint thickness - 0.002” (0.051 mm) minimum
Baking.....	Natural gas oven at 179°C (355°F) minimum.

Notes:

1. When optional custom paint color is specified (including ANSI 61), all external surfaces shall be painted to the custom color requirement, except for the external isolating switch handle assembly, lifting angles and lifting brackets .
2. All unpainted steel parts shall be plated with a zinc plate/bronze chromate process for corrosion resistance.

Structure and Controller (cont.)

Main Power Bus (Optional)

The main horizontal power bus shall be located at the center rear of the structure to provide optimum heat distribution, ease of maintenance and splicing. The power bus shall be mounted on edge to a molded bus support insulator in a common vertical plane. This provides better short circuit withstand capability and protection against tracking between phases and the accumulation of dust. The power bus shall be made of tin-plated copper and be available in one of the following continuous current ratings: 1200, 2000 or 3000 amps. Optimal silver-plated power bus shall be available.

Access shall be provided to the bus compartment from the front or the rear of the structure to allow for installation and regular maintenance of the power and ground bus splice connections.

The horizontal buswork, the cabling/bus from the main power cell shall be braced and tested in accordance with NEMA ICS 3-2 and UL 347 (paragraph 30).

When optional insulated power bus is specified for the main horizontal bus, a sleeve-type, heat shrink insulating material with good flame resistance and self-extinguishing properties, shall be used. This material shall have a minimum wall thickness of 1.4 mm (0.055 in.)

Vertical Bus (Combination Controller only)

Vertical power bus risers shall be provided from the main horizontal power bus to the unit isolating switch line terminals. It shall be made of tin-plated copper and rated according to the unit size.

Bus Bracing

The horizontal/vertical buswork and the cabling/bus in the main power cell(s) shall be braced and tested in accordance with NEMA ICS 3-2 and UL 347.

The buswork and cabling shall be braced to withstand the let-through energy allowed by the largest fuse during a short circuit fault.

Ground Bus

A continuous copper ground bus shall be provided along the entire length of the controller line-up. A mechanical lug for #8 to #1/0 AWG or #6 to 250 MCM cable shall be supplied at the incoming end of the line-up. The ground bus shall be 6.4 x 51 mm (1/4 in. x 2 in.) bare copper. Optional tin plating shall be available.

8.0 Equipment Design and Selection (cont.)

Vacuum Contactor Specifications (Input and Bypass)

The electrically held medium voltage contactor shall be the Allen-Bradley Bulletin 1502 vacuum type.

The following current ratings shall be available:
- 400 A
- 800 A

The contactor shall have visual contact wear indicators. No special tools are required for checking contact wear.

Vacuum bottle and coil maintenance shall be performed on the contactor while it is mounted. Removal of contactor is not required.

Vacuum Input Contactor (Combination Controller Only)

The vacuum input contactor shall be fixed mounted inside the power cell. Fixed mounting provides solid, continuous contact, lowering maintenance requirements considerably. The contactor shall be interlocked with the non-load-break isolating switch, both electrically and mechanically, which shall provide the following safety features:

- Prevent the isolating switch from being opened or closed when the contactor is in the closed position.
- Prevent the opening of the medium voltage door when the isolating switch is in the closed position.
- Prevent the closing of the isolating switch when the medium voltage door of the controller is open.
- Remove control power from the control power transformer (CPT), power transformers (PTs) or external power source to the control circuit when the isolating switch and contactor are in the open position.

Vacuum Bypass Contactor

A contactor shall be provided to bypass the SCRs once the motor is up to full speed. When a stop option is selected, the bypass contactor will open, bringing the SCRs back into the power circuit. It shall be fixed mounted in the main power cell.

The bypass contactor shall be capable of providing a full voltage start in case of emergency bypass.

Control Wire Specification

The control wire shall be an insulated (with a flame retarding thermoplastic compound), flexible stranded, tinned copper wire supported and neatly bundled. Red wire shall indicate AC power, blue wire shall indicate DC power and green wire shall indicate ground. Other colors or combinations may be used for specific applications. The control wire shall be isolated from high voltage components in the power cell (whenever possible), and wire markers which are numbered according to the electrical diagram, shall be provided at each end of the wire.

All of the control wire terminations shall be a screw-type, copper-compression-type terminal block or connector which firmly grips the conductor. Non-insulated, locking-type, fork tongue lugs shall be provided on the control wire terminating on the control power transformer(s) and current transformers.

Low Voltage Wireway

An optional low voltage wireway shall be available across the top of the structure. There are two (2) sizes of low voltage wireway available:

- 51 mm x 102 mm (2 in. x 4 in.)
- 152 mm x 152 mm (6 in. x 6 in.)

The low voltage wireway shall allow a convenient method of interconnecting control wire from one controller to another, when interfacing with a master panel or with programmable controller circuits.

Low Voltage Control Panel

Each controller shall have a separate, front accessible, low voltage control compartment. The compartment shall be completely isolated, using metal barriers between the low voltage compartment and the power cell and/or main power bus compartments for utmost safety.

Optional meters, motor protection relays, selector switches, operators, indicating lights, etc., shall be mounted on the front of the low voltage control panel, and arranged in a logical and symmetrical manner. The low voltage panel shall provide the following features:

- Space shall be provided for low voltage control devices, transducers and metering.
- Necessary terminal blocks shall be supplied. Extra terminal blocks can be supplied as an option.

8.0 Equipment Design and Selection (cont.)

Low Voltage Control Panel (cont.)

- There shall be low voltage control panel access from the front, without turning the controller “OFF”.
- All remote low voltage cables shall be able to enter the low voltage control panel from the top or bottom of the structure. Access shall be by means of removable entry plates on the top and bottom of the structure.
- As standard, the combination controllers shall incorporate a swing-out low voltage panel which provides easier access to the power cell to make bus splicing and load cable connections. All products shall have a swing-out low voltage panel, which is interlocked with the power cell compartment (the panel shall not have the ability to swing open until the power cell is “OFF” and isolated from the main power bus) to allow easy access to medium voltage equipment, i.e. power stacks, power bus, power factor correction capacitor, or other similar equipment.
- Pilot control relays shall be used to operate and economize the vacuum contactor.
- The control panel supply voltage shall be 120 V AC or 240 V AC, 50/60 Hz. It shall be rectified to provide a DC operating voltage for the vacuum contactor coils and economizing relay.
- There shall be a two-pole, three-conductor (with a grounding prong) male plug to provide a means for connecting a two-pole, three-conductor receptacle from a remote 120 V AC, 50/60 Hz supply to operate the control circuit when it is in the TEST position (combination controllers only).
- The low voltage control panel door shall have a viewing window, allowing the user to monitor the MV SMC-Flex controller operation via the built-in display.

IntelliVAC Control (Optional)

- Optional IntelliVAC contactor control shall be available with the following features:
  - Universal input voltage (110-240 V AC, 50/60 Hz or 110-250 VDC)
  - Consistent vacuum contactor pick-up time
  - Selectable and repeatable vacuum contactor drop-out time (eight settings)
  - Altitude compensation
  - Power loss ride-through (TDUV) for up to 2 seconds
  - Temporary motor jog function
  - Delayed motor re-start
  - Anti-kiss and anti-plugging protection
  - Status indication (LEDs and relay outputs)

Main Isolating Switch (Combination Controller Only)

The main power cell shall have an externally operated, three-pole, gang-operated, fixed-mounted, non-load-break isolating switch providing the following features:

- The isolating switch shall isolate the power bus compartment from the power cell by means of a positively driven shutter mechanism to prevent accidental contact with line terminals in the power bus compartment.
- The main power cell door shall have a viewing window through which the operator can verify that the isolating switch is open.
- The isolating switch shall only have the ability to interrupt the no-load (magnetizing) current of the control power transformer(s) (CPT) and/or potential transformers (PTs) supplied inside the controller power cell.
- In the OFF position, the isolating switch shall provide a means of grounding appropriate medium voltage power cell components, discharging stored energy, thus providing safer operation and maintenance.
- Three rating sizes shall be available: 400 amp, 600 amp, and 800 amp. (some 600A units may use an 800A isolation switch).
- One or more normally open (N-O) and normally closed (N-C) auxiliary contacts shall be arranged to open the secondary circuit of the control power transformer (CPT) and/or potential transformers (PTs), to de-energize the control circuit. This is to ensure there is no load on the isolating switch when it is opened or closed. The contacts shall also prevent backfeeding through the CPT and/or PTs and isolate the power cell when the control circuit is in the TEST mode. It shall only be possible to operate the TEST control circuit when the isolating switch is in the open position. The auxiliary contacts shall have NEMA contact ratings of A600 (quantity 2) and P600 (quantity 2).
- The isolating switch shall remain connected to the external operating handle at all times.
- The isolating switch must be mechanically and electrically interlocked with the main contactor.
- The external isolating switch operating handle shall have provisions to be padlocked, with up to three (3) padlocks in the open position and one (1) padlock in the closed position. The closed position shall be located and marked, but shall be drilled out by the USER to allow insertion of the padlock.
- The power cell door on each controller shall be interlocked with the isolating switch such that the door(s) cannot be opened when the isolating switch is fully closed, and the isolating switch cannot be closed with the door(s) open (without circumventing the interlock using a tool).

8.0 Equipment Design and Selection (cont.)

Main Isolating Switch (Combination Controller Only) (cont.)

Interlocking

Mechanical interlocking, including cable interlocks, horizontal and vertical ram interlocks, shall be provided to prevent the opening of any power cell door or medium voltage compartment until the non-load-break isolating switch is fully in the open position and power is removed (the external operating handle must be in the OFF position).

Optional key interlocks configured to operate with the operating handle or power cell door shall be available when interlocking is required with another specified device, i.e. main breaker, load-break switch, starter, etc.

Power Fuses and Fuse Holders (Combination Controller Only)

R-rated current limiting power fuses shall be provided. R-rated fuses shall be used for the short circuit protection of medium voltage motors and motor controllers.

The medium voltage controller shall have fixed power fuse holders that are separately mounted in the power cell, not on the contactor, and be located to allow easy inspection and replacement without any disassembly. The power fuses shall have a spring actuated blown fuse indicator. The power fuse size shall be selected when motor data and the protective device characteristics are known.

Control Power Transformer (Combination Controller Only)

The control power shall be 110/120 or 220/240 V AC, and shall be obtained from a control power transformer (CPT) located in each controller power cell, or from a separate control source. As standard, the dry-type CPT shall be 500 VA in size with approximately 350 VA extra capacity for the customer's use when the standard control circuit is supplied. Appropriately sized primary and secondary fuses will be supplied. Optional sizes of 1000 VA, 2000 VA and 3000 VA control power transformers shall also be available.

The secondary circuit of the transformer(s) shall be disconnected from the control circuit by means of the isolating switch auxiliary contacts. This is to prevent backfeeding through the transformer(s) and to isolate the power cell when the control circuit is in the TEST mode.

The standard control power transformers used in the controller shall be a compensated type with an output accuracy of approximately 4% over nominal at no load. They shall be designed to maintain voltage at in-rushes of up to 600%, which results in a 2% overvoltage at full load.

Primary Fuses

The primary side of the control power transformers and/or potential transformers shall be protected by current limiting fuses sized according to requirements. The interrupting rating of the primary fuses shall be 50 kA symmetrical.

Secondary Fuses

The secondary side of the control power transformer and/or potential transformers shall be fused appropriately to protect the transformer(s) from overloads. The standard control circuit shall have one leg of the secondary grounded.

8.0 Equipment Design and Selection (cont.)

Current Transformer

The medium voltage power cell shall include three (3) current transformers of sufficient VA capacity to meet the requirements of all the devices connected to them.

Each current transformer shall have the primary rating sized appropriately in relation to the full load current rating of the motor or feeder. The secondary of the current transformers shall have a five (5) amp output and an accuracy suitable for the type and quantity of protection or metering devices connected to it. All current transformer control wiring shall be terminated on the current transformer with locking type, fork tongue lugs.

An appropriate load termination location shall be provided to accommodate lugs with single or two-hole mounting, for connection of the load cables, when either bar or donut type current transformers are supplied.

The power cell shall have provisions to locate a toroid (donut) style, ground fault sensing current transformer, when the zero sequence ground fault protection feature is required (Combination Controller only).

Control Module • Logic Design Feature

Mechanical

The control module shall be designed for mounting within the low voltage panel (for safety reasons) and shall be compatible with the full range of current and voltage ratings.

The control module shall consist of a power supply, logic control circuitry, silicon controlled rectifier (SCR) firing circuitry, I/O circuitry, a digital programming keypad, a backlit LCD display, and a serial communication port.

Programming and Display

Digital parameter adjustment shall be provided through a standard built-in keypad. Analog potentiometer adjustments are not acceptable. A built-in backlit LCD display shall be provided for controller set-up, diagnostics, status, and monitoring. The display shall be three-line, 16-characters minimum.

The display shall be capable of depicting alphanumeric characters in any of the following languages, by adjustment of a single parameter:

- English
- French
- Spanish
- German
- Portuguese
- Mandarin

Communications

A serial communications port DPI (Drive Programming Interface), shall be provided as standard. Optional communications protocol interface modules shall be available for connection to Remote I/O, DeviceNet™, ControlNet™, Ethernet, RS-485, ModBus RTU and Profibus-DP.

8.0 Equipment Design and Selection (cont.)

Control Module • Logic Design Feature (cont.)

Electrical

The control module shall provide closed-loop digital microprocessor control and supervision of all controller operations, including SCR pulse firing control.

The control module shall be the same as used for the SMC-Flex low voltage product family.

The control module shall offer the following functions:

- Soft Start – with Selectable Kickstart
- Soft Stop
- Current Limit Start – with Selectable Kickstart
- Linear Speed Acceleration* – with Selectable Kickstart
- Linear Speed Deceleration*
- Dual Ramp – with Selectable Kickstart
- Full Voltage
- Preset Slow Speed
- Pump Control (Optional)

*-requires motor tachometer

The standard start ramp time shall be programmable from 0 to 30 seconds. The standard stop time shall be programmable from 0 to 30 seconds. Extended start or stop times may be made available, upon consultation with qualified factory personnel.

Kick-start, selectable with soft start, current limit and linear acceleration, shall provide an adjustable time pulse of current prior to the normal start mode. The current shall be controlled to provide 0-90 % of locked rotor torque for a time between 0.0 and 2.0 seconds. This feature shall be field selectable.

SCR Pulse Firing Control

The SCRs shall be protected from voltage transients with an R-C snubber network to prevent false SCR firing.

The SCRs shall be protected from overvoltage with voltage threshold gating circuitry.

The SCR firing circuitry shall be fully isolated from the control circuits. Fiber optic cables shall be used for isolation from the logic circuits.

Control Module • Logic Design Feature (cont.)

SCR Pulse Firing Control (cont.)

Current loop gate driver boards shall be utilized to increase efficiency of the controller, reducing power consumption and heat.

Monitoring

The controller shall provide the following monitoring functions indicated though the built-in LCD display; or remotely via the communication port:

- Phase-to-phase supply voltage
- Three-phase line current
- Three-phase power (MW, MWh, power factor)
- Elapsed time
- Motor thermal capacity usage
- Motor speed (with optional use of tachometer input)

Protection and Diagnostics

The following protection and diagnostics shall be provided as standard with the controller:

- Power loss (with phase indication; pre-start)
- Line fault (with phase indication; pre-start) advising:
  – Shorted SCR
  – Missing load connection
- Line fault (running protection) advising:
  – Power loss
  – Shorted SCR
  – Missing load connection
- Voltage unbalance ❶
- Phase reversal ❶
- Undervoltage ❶
- Overvoltage ❶
- Stall ❶
- Jam ❶
- Overload ❶
- Underload ❶
- Excessive starts/hour ❶
- Open gate (with phase indication)
- Overtemperature (power stack, with phase indication)
- Communication loss
- Motor temperature (via PTC input)
- Ground fault (with GFCT option)

❶ These protective features shall be defeatable.

8.0 Equipment Design and Selection (cont.)

Control Module • Logic Design Feature (cont.)

Overload Protection

- The control module shall meet applicable standards as a motor overload protective device
- Three-phase current sensing shall be utilized; the use of two current transformers shall be unacceptable.
- Overload trip classes of 10, 15, 20 and 30 shall be provided and user-programmable.
- Electronic thermal memory shall be provided for enhanced motor protection
- Protection shall be available through the controller while in bypass configuration
- Separate overload relay shall be provided for emergency bypass operation

Pump Control (Optional)

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

Tachometer Signal Conditioner (Optional)

- A panel-mounted tachometer signal conditioner (TSC) shall be made available for use with acceleration/deceleration applications.
- A suitable power supply will be provided with the TSC.
- The TSC shall be used to convert the motor speed feedback signal (in pulse format) to a 0 to 4.5 VDC level.

DeviceNet and IntelliCENTER Options

General

The MV motor controller (MVMC) shall have DeviceNet cabling integrated throughout the sections.

Each Motor Starter and Soft Starter in the MVMC line-up shall be supplied with a means to communicate via DeviceNet, and have the capability of monitoring at least 2 devices in each starter.

DeviceNet Cable

The DeviceNet cable used for the trunk line and drop lines shall be *flat* cable rated 8 amperes, 600V, Class 1.

The DeviceNet cable used to connect a DeviceNet unit to a DeviceNet port shall be round cable rated 8 amperes, 600V, Class 1.

The addition or removal of a unit from the DeviceNet system shall not interrupt the operation of other units within the system.

DeviceNet Cable Layout

A DeviceNet trunkline shall be routed through the low voltage wireway, located on the top of each MVMC section to prevent accidental mechanical damage during MVMC installation.

A DeviceNet dropline shall be routed into the low voltage control panel of each MVMC unit.

Two (2) DeviceNet ports shall be provided in the low voltage control panel of each unit to simplify installation of DeviceNet products.

Power Supplies

The MVMC manufacturer shall check the user's design to ensure adequate power supplies have been specified to conform with DeviceNet requirements. The power supply shall provide 24Vdc for the DeviceNet system and be rated no less than 8.0 amperes.

8.0 Equipment Design and Selection (cont.)

DeviceNet System Performance

The DeviceNet system shall be designed to operate at 500k Baud to maximize the system performance, unless precluded by the cumulative length of the trunk and drop lines.

The DeviceNet system is to be qualified to communicate and perform under normal and adverse MVMC electrical environments, e.g. vacuum contactor electrical operation and unit short circuit fault.

Solid-State Controllers

Each solid-state controller unit shall have a DeviceNet communication module to communicate the status over DeviceNet. The DeviceNet communication module shall have 4 input points.

Programming of Parameters

The DeviceNet MAC ID number (node address) shall be loaded into each unit per the drawings. All other parameters shall be left at the factory default setting.

The DeviceNet System components shall be preconfigured to operate at the appropriate baud rate.

DeviceNet and IntelliCENTER Options (cont.)

Software

The DeviceNet MVMC shall be provided with pre-configured software. The software shall be capable of viewing multiple MVMC line-ups. The software communication driver shall allow the software to be installed and located on Ethernet, ControlNet, or DeviceNet. The software shall be capable of displaying the following:

- *System View*
  - Dynamically configured based on reading data from devices in MVMC line-up
  - Sizeable view to allow ease of viewing multiple MVMC line-ups
  - Unit nameplate information
  - Unit status indicators (ready, running, warning, fault, no communication)
- *Unit Monitor View*
  - Pre-configured for specific unit
  - Real time monitoring via analog dials and trending
  - Data configurable for customized monitoring
  - Modifying device parameters
- *Speadsheet View*
  - User configurable for customized monitoring
  - Sorting and cascading functions
  - Custom user fields
- *Event Log*
  - Track history of MVMC unit
  - Automatic logging of trips, alarms, and changes
  - Manual entry of events
- *Documentation*
  - Front elevation drawings
  - One-line drawings
  - Unit wiring diagrams
  - User manuals
  - Spare parts lists

Testing

The interwired DeviceNet MVMC shall be powered up, configured and tested in an ISO9001 facility to ensure each unit communicates properly prior to shipment.

9.0 Transportation and Equipment

Delivery Times

Estimated drawing and shipment delivery times are based on receipt of all information at time of order.

Shipment of equipment will commence approximately ____ weeks after the Seller receives a written purchase order. Actual on-site delivery will depend on the site location.

Unless specified, transportation is determined by the Seller based on shipment by the lowest cost carrier, and charged to Buyer.

Loading Equipment

As standard, the Seller must utilize tractors and trailers equipped with air-ride features, reducing the chance of damage and the need for extra packaging. All trailers shall have logistic posts allowing the most secure loading.

Special Packaging Requirements (Optional)

The Seller must use custom-designed crates to reduce the possibility of air or sea transit damage, and offer vacuum shrink-wrap to eliminate moisture or humidity damages.

10.0 Commissioning

Start-Up Commissioning Services (Optional)

Start-up will be performed at the User's site.

The Seller will provide the following:

- A pre-installation meeting with the User to review:
  - The start-up plan
  - The start-up schedule
  - The controller’s installation requirements
- Inspect the starter's mechanical and electrical devices enclosed.
- Perform a tug test on all internal connections within the controller and verify wiring.
- Verify critical mechanical connections for proper torque requirements.
- Verify and adjust mechanical interlocks for permanent location.
- Confirm all sectional wiring is connected properly.
- Re-verify control wiring from any external control devices.
- Set up auxiliary equipment with customer supplied parameters.
- Exercise the controller in Test Mode (combination controllers).
- Confirm cabling of controller to Motor and Line Feed.
- Apply medium voltage to the controller and perform operational checks.
- Run the controller motor system throughout the operational range to verify proper performance.
- User's personnel shall be required on-site to participate in the start-up of the system.

Start-up service is to be quoted at a per diem rate with an estimate of time required for commissioning.

On-Site Training (Optional)

The Seller shall provide a qualified instructor to provide the User's personnel with training that is specific to the MV controller system installed at the User's facility. The training session will be one (1) day in duration and will be customized for the User's needs. Manuals and documentation are provided for each participant, to a maximum of eight participants per class.

The training will cover the following topics:

- Basic motor theory
- Starter hardware
- Contactor hardware
- Hardware replacement procedures
- Power device replacement procedures
- Fault analysis and troubleshooting
- Preventative maintenance procedures

Time will be spent on lecture and hands-on training if user's equipment is available. Demos are not provided.

11.0 Basic Data Sheets

Table 11.A – Electrical Ratings

Electrical Ratings	UL/CSA/NEMA	IEC
Power Circuit		
Method of Connection	Motor in delta or star; SCRs between windings and supply	
Number of Poles	Equipment designed for three phase loads only	
Rated Voltage (Ur)	2400 V AC (-15%, +10%) 3300 V AC (-15%, +10%) 4200 V AC (-15%, +10%) 6900 V AC (-15%, +10%)	3.6 kV 7.2 kV
Rated Insulation Voltage (Ui)	2500 V 5000 V 7200 V	3.6 kV 7.2 kV
Rated Impulse Voltage (Uimp)	60 kV	(3.6 kV) 40 kV (7.2 kV) 60 kV
Dielectric Withstand	(2500 V) 7,625 V AC (5000 V) 13,250 V AC (7200 V) 18,200 V AC	(3.6 kV) 10 kV (7.2 kV) 20 kV
Repetitive Peak Inverse Voltage Rating	2500 V max. 6,500 V (2 SCRs per phase) 5000 V max. 13,000 V (4 SCRs per phase) 7200 V max. 19,500 V (6 SCRs per phase)	
Output Rating	100 to 7500 hp	75 to 5600 kW
Semi-Conductor Isolation	Fiber optic	
Operating Frequency	50/60 Hz	50/60 Hz
dv/dt Protection	RC Snubber Network	
Transient Protection	Integrated overvoltage trigger circuit	
Rated Current	180 A 360 A 600 A	
dv/dt	180 A 1000 V/µs 360/600 A 2000 V/µs	
di/dt	180/360/600 A 200 A/µs	
Voltage Drop (Line to Output Terminals)	2.5 V per SCR without bypass; Less than 1.0 V with bypass, total	
Overall Efficiency	99.95% with bypass	
Initial Torque	0 to 90% of motor locked rotor torque	
Thermal Capacity	600%, 10 seconds 450%, 30 seconds	
Ramp Time	0 to 30 seconds (Consult Factory for Longer Time)	
Kickstart	0 to 90% of motor locked rotor torque for 0.0 to 2.0 seconds	
Approvals	UL E102991 CSA LR12235 (pending)	Safety : 92/59/EEC (Directive) Ref : BSEN 61010-1 :1993 BSEN 60204-1 :1997 EMC : 89/336/EEC, 92/31/EEC, 93/68/EEC (Directives) Ref : EN 61000-6.4 :2001 EN 61000-6.2 :2001

Table 11.A – Electrical Ratings (cont.)

Electrical Ratings	UL/CSA/NEMA	IEC
Short Circuit Protection		
The power electronics unit must be protected by current-limiting fuses (to be included by customer in existing starter with 1560E). The combination controller includes appropriate fusing (coordinated with motor).		
Fault Level Withstand as a Fused (E2) Controller according to NEMA	5000 V 7200 V	350 MVA Sym 500 MVA Sym
Control Circuit		
Rated Operation Voltage	120/240 V AC (-15%, +10%)	110/230V ~ (-15%, +10%)
Dielectric Withstand	1600 V AC	2000 V ~
Operating Frequency	50/60 Hz	50/60 Hz
Enclosure		
Enclosure Type	NEMA Type 1, 1G, 12 and 3R	IP 10, 21, 52 and 34
Overload Characteristics (Control Module)		
Type	Solid-state thermal overload with phase loss	
Current Range	1.0 – 1,000 Amps	
Trip Classes	10, 15, 20 and 30	
Trip Current Rating	120% of Motor FLC	
Number of Poles	3	
Power Requirements		
Control Module	75 VA	
Gate Driver Boards ❶	30 VA (total)	
Contactor	See Contactor Specifications (page 35)	
Auxiliary Contacts (Control Module)		
Rated Operation Voltage (Max.)	20-265 V AC 5-30 V DC (resistive)	20-265 V ~ 5-30 V DC (resistive)
Rated Insulation Voltage	N/A	277 V ~
Operating Frequency	50/60 Hz, DC	
Utilization Category	AC-15/DC-12	
Mechanical Ratings (Control Module)		
Terminals	Control Terminals : M 3.5 x 0.6 Pozidriv screw with self-lifting clamp plate	
SCPD Performance	Type 2	
SCPD List	Class CC 8A @ 1000 A Available Fault Current	
DPI Communication (Control Module)		
Maximum Output Current	280 mA	
Metering Functionality (Control Module)		
Voltage, Current, MW, MWh, Displacement Power Factor	Yes	
Tachometer Input (Control Module)		
Voltage	0 – 4.5 VDC	
Current	1.0 mA	

❶ Power requirements for the gate driver boards are the same for all voltages.

11.0 Basic Data Sheets (cont.)

Table 11.B – Environmental Ratings

Environmental Ratings	UL/CSA/NEMA	IEC
Operating Temperature Range	0°C to 40°C (32°F to 104°F)	
Storage and Transportation Temperature Range	-20°C to +75°C (-4°F to 149°F)	
Altitude	0 - 1000 meters (3,300 feet) without derating ❷	
Humidity	5% to 95% (non condensing)	
Pollution Degree	2	
Seismic (UBCRating) ❶	1, 2, 3, 4	

❶ Some units may require special bracing. Contact factory for more information.

❷ Controller Deratings

Altitude Range	Power Cell Rating			Reduce B.I.L. Withstand Rating By:
	180 A	360 A	600 A	
	❸ Reduce Max. Continuous Current Rating By:			
1000 to 2000 m (3,300 to 6,600 ft.)	10 A	10 A	15 A	6.0 kV
2001 to 3000 m (6,601 to 9900 ft.)	20 A	20 A	30 A	12.0 kV
3001 to 4000 m (9,901 to 13,200 ft.)	30 A	30 A	45 A	18.0 kV
4001 to 5000 m (13,201 to 16,500 ft.)	40 A	40 A	60 A	24.0 kV

❸ Current deratings shown are the minimum levels. Additional derating may be required due to power fuse limitations. Please consult factory for additional details.

Table 11.C – Area Available for Cable Entry/Exit

Structure Code	Voltage	Top		Bottom	
		Line	Load	Line	Load
14.60	2300 – 4160 V	5.68 X 9.00 (144 X 229)	Combined with line	5.68 X 9.00 (144 X 229)	Combined with line
14.62	6900 V	5.68 X 12.55 (144 X 319)	Combined with line	5.68 X 12.55 (144 X 319)	5.68 X 12.55 (144 X 319)
14.64	All	5.68 X 12.55 (144 X 319)	Combined with line	NA	NA
14.66	All	5.68 X 12.55 (144 X 319)	Combined with line	15.00 x 15.00 (381 x 381)	Combined with line
14.70	2300 – 4160 V	5.68 X 5.68 (144 X 144)	5.68 X 9.00 (144 X 229)	5.68 X 9.00 (144 X 229)	5.68 X 9.00 (144 X 229)
14.70XP	2300 – 4160 V	5.68 X 5.68 (144 X 144)	5.00 x 9.00 (144 x 229)	5.68 X 9.00 (144 X 229)	5.68 X 9.00 (144 X 229)
14.72	6900 V	5.68 X 9.00 (144 X 229)	5.68 X 9.00 (144 X 229)	5.68 X 5.68 (144 X 144)	5.68 X 9.00 (144 X 229)
14.74	2300 – 4160 V	5.68 X 9.00 (144 X 229)	5.68 X 9.00 (144 X 229)	5.68 X 9.00 (144 X 229)	5.68 X 9.00 (144 X 229)
14.76	All	5.68 X 9.00 (144 X 229)	7.25 X 15.88 (184 X 403)	5.68 X 9.00 (144 X 229)	7.25 X 15.88 (184 X 403)

Dimensions are in inches (mm).

11.0 Basic Data Sheets (cont.)

Table 11.D – Shipping Weights and Dimensions ❶

Current Rating	Horsepower (kW)					Dimensions in inches (mm)			Shipping Weight	
	2400 V	3300 V	4200 V	6600 V	6900 V	Width	Depth	Height	lb	kg
Bulletin 1560E										
200 A	800 (600)	1000 (746)	1250 (933)	–	–	26 (660)	36 (915)	91 (2315)	800	363
400 A	1500 (1119)	2250 (1679)	2750 (2051)	–	–					
Bulletin 1560E										
200 A	–	–	–	2250 (1678)	2500 (1865)	36 (915)	36 (915)	91 (2315)	1220	554
400 A	–	–	–	4500 (3357)	5000 (3730)					
600A (top exit)	2750 (2051)	4000 (2984)	4500 (3357)	7500 (5595)	7500 (5595)	44 (1117)	36 (915)	36 (915)	1330	590
600 A (bottom exit)	2750 (2051)	4000 (2984)	4500 (3357)	7500 (5595)	7500 (5595)	70 (1778)	36 (915)	91 (2315)	2100	951
Bulletin 1562E										
200 A	800 (600)	1000 (746)	1250 (932)	–	–	36 (915)	36 (915) or 46 ❷ (1168)	91 (2315) or 128.5 ❷ (3264)	1400 or 1950 ❷	636 or 886 ❷
400 A	1500 (1119)	2250 (1679)	2750 (2051)	–	–					
Bulletin 1562E										
200 A	–	–	–	2250 (1676)	2500 (1865)	62 (1575)	36 (915)	91 (2315)	2325	1056
400 A	–	–	–	4500 (3357)	5000 (3730)					
Bulletin 1562E										
600 A	2750 (2051)	4000 (2984)	4500 (3357)	7500 (5600)	7500 (5600)	80 (2032)	36 (915)	91 (2315)	2700	1227
	>2750 (2051)	>4000 (2984)	>4500 (3357)	>7500 (5600)	>7500 (5600)	100 (2540)	36 (915)	91 (2315)	4000	1816

❶ Weights and dimensions are approximate. Certain options (such as PFCC) will change weight and dimensions. Contact factory for certified dimensions and weights.

❷ Additional dimensions/weights shown are for arc resistant version.

Table 11.E – Power Bus Specifications

Description	Specifications	
Main Horizontal Power Bus		
Bus Bar Material	Tin-plated copper	
Optional Bus Bar Material	Silver-plated copper	
Continuous Current Rating at 40°C (104°F)	1200, 2000 and 3000 A	
Maximum Full Load Temperature Rise	65°C (149°F)	
Maximum Full Load Temperature	105°C (221°F)	
Fault Withstand Current Rating (10 cycles)	60 kA RMS SYM (96 kA ASYM)	
Type of Bus Bracing	Molded glass polyester Anti-hygroscopic	
Dimensions per Phase	1200 A	Qty 1 – 6 x 100 mm (1/4 x 4 in)
	2000 A	Qty 2 – 6 x 100 mm (1/4 x 4 in)
	3000 A	Qty 2 – 9.5 x 127 mm (3/8 x 5 in)
Cross Sectional Area per Phase	1200 A	65 mm^2 (1.0 in^2) total
	2000 A	129 mm^2 (2.0 in^2) total
	3000 A	242 mm^2 (3.75 in^2) total
Insulating Material Between Phases and Ground	Air (Standard)	
Optional Insulation Material for Main Horizontal Bus	Type :	Sleeve, heat shrink
	Material :	Polyolefin
	Thickness :	1.4 mm (0.055 in. / 55 mils)
	Anti-hygroscopic :	0.5 to 1%
	Electrical Strength :	900 V/mil (49.5 kV total)
Vertical Power Bus		
Bus Bar Material	Tin-plated copper	
Continuous Current Rating at 40°C (104°F)	400, 600 and 800 A	
Fault Withstand Current Rating (½ cycle)	50 kA RMS SYM (80 kA ASYM)	
Insulation Material for Vertical Bus	Type :	Sleeve, heat shrink
	Material :	Polyolefin
	Thickness :	1.14 mm (0.045 in. / 45 mils)
	Anti-hygroscopic :	0.5 to 1%
	Electrical Strength :	900 V/mil (40.5 kV total)
Ground Bus		
Ground Bus Material	Bare copper	
Optional Ground Bus Material	Tin-plated copper	
Continuous Current Rating at 40°C (104°F)	600 A	
Dimensions per Phase	600 A	6 x 51 mm (1/4 x 2 in)
Cross Sectional Area	600 A	32 mm^2 (0.5 in^2) total

11.0 Basic Data Sheets (cont.)

Table 11.F – Power Fuse Specifications

Description	Specifications
Power Fuses and Fuse Holders	
This section details the power fuse and fuse holder technical information that each medium voltage product conforms to. It includes information on R-rated fuses, as well as mounting dimensions.	
Fuse Types	
R Rated : 2R to 12R	A480R – 5.0 kV
19R to 38R, 48X, 57X	A051B – 5.0 kV
2R to 38R, 48X, 57X	A072 – 7.2 kV
Interrupting Ratings : 5.5 kV to 8.25 kV	50 kA RMS SYM (80 kA RMS ASYM)
Mounting (Center) Dimensions	
Clip-On	304.8 mm (12.0 in)
Bolt-On	454.2 mm (17.88 in) *or* 511.6 mm (20.14 in.)

Maximum Heat Dissipation (kW) (Convection)

Controller Rating	Start or Stop Cycle (@ 450% Starting Duty)			Continuous
	180 A	**360 A**	**600 A**	
2500 V	13.5	19.2	45.3	.250
5000 V	27.0	38.5	90.5	.250
7200 V	40.5	57.7	136.0	.250

Power Losses

	Current (A)	Fuse Size	Losses (kW) ± 10%
Power Cell Losses	90	6R	.125
	180	12R	.350
	240	18R	.510
	360	24R	1.000
	600	48X	1.500

	Bus Rating (A)	Fully Loaded Bus Losses per 915 mm (36 in.) Section (Watts) ±%
Power Bus Losses	1200	150
	2000	200
	3000	200
Control Power Transformer Losses	The losses from a 500 VA control power transformer fully loaded is approximately 50 W per controller.	
Low Voltage Panel Losses	The losses from the standard control circuit is approximately 25 W per controller.	

Table 11.G – Bulletin 1502 Medium Voltage 400 Amp Contactor Ratings

Description			Specification
Voltage Ratings ❶			
Maximum Rated Voltage			7200
System Voltages			2400 3300 4160 4800 6600 6900
Dielectric Voltage Withstand Rating	For 60 seconds (kV)		18.2 / 20 (IEC)
Basic Impulse Level (B.I.L.) Withstand	Phase to Ground, Phase to Phase (kV)		60
Frequency Ratings	Hertz		50 / 60
Current Ratings ❶			
Rated Continuous Current (Amps)			400
Maximum Interrupting Current Rating	2400 V (RMS Sym Amps)		6300
	5000 V (RMS Sym Amps)		6300
	7200 V (RMS Sym Amps) ❷		6000
Maximum Interrupting MVA Rating	2400 V (Sym MVA)		25
	5000 V (Sym MVA)		50
	7200 V (Sym MVA) ❷		75
Short-Circuit Withstand at Rated Voltage	Current Peak ½ cycle (kA)		60
Short Time Current Rating Capability	For 1 second (kA)		6.0
	For 30 seconds (kA)		2.4
Chop Current (Average RMS Amps)			0.5
Make and Break Capability at Rated Voltage (kA)			4.0
Ambient Temperature	°C		40
Contactor Coil Data (Series E)			
Control Voltage (V_{CTL})	Coil Voltage (V_{CL})		
Electro-Mechanical (Relay) Control (Mechanical Latch Only)			
120 VAC	110 VDC	Close Current (A_{DC})	5.6
		Trip Current (A_{DC})	6.0
		Pick-up Voltage	102
		Trip Voltage	84
IntelliVAC Control (Electrically Held & Mechanical Latch)			
110 to 240 VAC or 110 to 250 VDC ❸	VAC: $V_{CL} = \sqrt{2} \times V_{CTL}$ (Max.)	Close Current (A_{DC}, 200 milliseconds)	4.3
		Hold Current (A_{DC})	0.48
		Pick-up Voltage ❸	95
		Drop-out Voltage ❸	75
	VDC: $V_{CL} = V_{CTL}$	Trip Current (A_{DC}, 200 milliseconds)	5.5
		Trip Voltage ❸	70

❶ The voltage and current ratings listed are valid up to 1,000 m (3,300 feet). Please refer to - Controller Derating chart on page 30 for ratings above this altitude.

❷ The IEC rating at 7200 V (RMS Sym.) is 5300 Amps / 66 MVA.

❸ Control voltage, as measured at the input of the IntelliVAC control module.

❹ Provided that regular maintenance is performed.

❺ A contactor drop-out delay may be configured with the IntelliVAC control module (refer to publication 1503-UM051B-EN-P).

❻ The full Altitude range is available with the IntelliVAC control module only, and the IntelliVAC is to be configured accordingly (refer to publication 1503-UM051B-EN-P). The standard mechanical latch contactors, if used with electro-mechanical control, are designed for -1000 to 1000 meters (-3300 to 3300 feet). Higher altitudes are possible by changing the contactor return springs.

❼ The number of contactor auxiliary contacts depends on the contactor type. Some of the contacts are used in the typical control schemes used.

11.0 Basic Data Sheets (cont.)

Table 11.G – Bulletin 1502 Medium Voltage 400 Amp Contactor Ratings (cont.)

Description			Specifications
Contactor Coil Data (Series D)			
Control and Coil Voltage	120 VAC / 110 VDC	Coil Inrush Current (A) – Electrically Held	7.3
		Coil Inrush Current (A) – Mechanical Latch	11.5
		Coil Inrush Current (A) – Mechanical Latch Trip	5.1
		Coil Continuous Current (A)	0.13
		Coil Pick-up Voltage (VAC)	102
		Coil Drop-out Voltage (VAC)	75
	230 VAC / 210 VDC	Coil Inrush Current (A) – Electrically Held	8.3
		Coil Inrush Current (A) – Mechanical Latch	NA
		Coil Inrush Current (A) – Mechanical Latch Trip	NA
		Coil Continuous Current (A)	0.11
		Coil Pick-up Voltage (VAC)	190
		Coil Drop-out Voltage (VAC)	140
Operational Characteristics			
Mechanical Life (Operations) x 1000 ❹		Electrically Held	2500
		Mechanical Latch	100
Electrical Life (Operations) x 1000 ❹			1000
Switching Frequency (Operations per hour)		Electrically Held	600
		Mechanical Latch	150
Opening and Closing Times (Series E)			
Electro-Mechanical (Relay) Control (Mechanical Latch Only)			
Maximum Closing Time (120 VAC)		50 or 60 Hz (milliseconds)	160
Maximum Opening Time (120 VAC)		50 or 60 Hz (milliseconds)	50
IntelliVAC Control (Electrically Held & Mechanical Latch)			
Maximum Closing Time		50/60 Hz or DC (milliseconds)	100 / 70
Maximum Opening Time (without delay) ❺		50/60 Hz or DC (milliseconds)	60
Opening and Closing Times (Series D)			
Maximum Closing Time		50 or 60 Hz (milliseconds)	160
Maximum Opening Time (Normal Drop Out)		50 or 60 Hz (milliseconds)	130
Maximum Opening Time (Fast Drop Out and Mechanical Latch)		50 or 60 Hz (milliseconds)	50
Capacitor Switching (max. KVAR)			
System Voltage		2400 V	800
		4160 V	1400
		6900 V	2000
General			
Standard Altitude Capability (meters / feet) ❶ ❻			-1000 to 5000 / -3300 to 16500
Contactor Weight (kg / lbs)			21.8 / 48
Auxiliary Contact Rating			A600
Auxiliary Contacts on the Vacuum Contactor (Max.) ❼			3 N.O. / 3 N.C.

❶ The voltage and current ratings listed are valid up to 1,000 m (3,300 feet). Please refer to Table - Controller Derating Chart on page 30 for ratings above this altitude.

❷ The IEC rating at 7200 V (RMS Sym.) is 5300 Amps / 66 MVA.

❸ Control voltage, as measured at the input of the IntelliVAC control module.

❹ Provided that regular maintenance is performed.

❺ A contactor drop-out delay may be configured with the IntelliVAC control module (refer to publication 1503-UM051B-EN-P).

❻ The full Altitude range is available with the IntelliVAC control module only, and the IntelliVAC is to be configured accordingly (refer to publication 1503-UM051B-EN-P). The standard mechanical latch contactors, if used with electro-mechanical control, are designed for -1000 to 1000 meters (-3300 to 3300 feet). Higher altitudes are possible by changing the contactor return springs.

❼ The number of contactor auxiliary contacts depends on the contactor type. Some of the contacts are used in the typical control schemes used.

Table 11.H – Bulletin 1502 Medium Voltage 800 Amp Contactor Ratings

Description			Specification
Voltage Ratings ❶			
Maximum Rated Voltage			7200
System Voltages			2400 3300 4160 4800 6600 6900
Dielectric Voltage Withstand Rating		For 60 seconds (kV)	18.2 / 20 (IEC)
Basic Impulse Level (B.I.L.) Withstand		Phase to Ground, Phase to Phase (kV)	60
Frequency Ratings		Hertz	50 / 60
Current Ratings ❶			
Rated Continuous Current (Amps)			800
Maximum Interrupting Current Rating		2400 V (RMS Sym Amps)	12,500
		5000 V (RMS Sym Amps)	12,500
		7200 V (RMS Sym Amps)	12,500
Maximum Interrupting MVA Rating		2400 V (Sym MVA)	50
		5000 V (Sym MVA)	100
		7200 V (Sym MVA)	150
Short-Circuit Withstand at Rated Voltage		Current Peak ½ cycle (kA)	85
Short Time Current Rating Capability		For 1 second (kA)	12.0
		For 30 seconds (kA)	4.8
Chop Current (Average RMS Amps)			0.5
Make and Break Capability at Rated Voltage (kA)			8.0
Ambient Temperature		°C	40
Contactor Coil Data (Series E)			
Control Voltage (V_{CTL})	Coil Voltage (V_{CL})		
110 to 240 VAC or 110 to 250 VDC ❷	VAC: $V_{CL} = \sqrt{2} \times V_{CTL}$ (Max.) VDC: $V_{CL} = V_{CTL}$	Close Current (A_{DC}, 200 milliseconds)	12
		Hold Current (A_{DC})	0.7
		Pick-up Voltage ❷	95
		Drop-out Voltage ❷	75
		Trip Current (A_{DC}, 200 milliseconds)	5.2
		Trip Voltage ❷	70
Contactor Coil Data (Series D)			
Control Voltage (V_{CTL})	Coil Voltage (V_{CL})		
120 VAC	110 VDC	Coil Inrush Current (A) – Electrically Held	13.1
		Coil Inrush Current (A) – Mechanical Latch	13.1
		Coil Inrush Current (A) – Mechanical Latch Trip	5.6
		Coil Continuous Current (A)	0.24
		Coil Pick-up Voltage (VAC)	102
		Coil Drop-out Voltage (VAC)	75

❶ The voltage and current ratings listed are valid up to 1,000 m (3,300 feet). Please refer to - Controller Derating chart on page 30 for ratings above this altitude.
❷ Control voltage, as measured at the input of the IntelliVAC control module.
❸ Provided that regular maintenance is performed.
❹ A contactor drop-out delay may be configured with the IntelliVAC control module (refer to publication 1503-UM051B-EN-P).
❺ The number of contactor auxiliary contacts depends on the contactor type. Some of the contacts are used in the typical control schemes used.

11.0 Basic Data Sheets (cont.)

Table 11.H – Bulletin 1502 Medium Voltage 800 Amp Contactor Ratings (cont.)

Description		Specifications
Operational Characteristics		
Mechanical Life (Operations) x 1000 ❸	Electrically Held	250
	Mechanical Latch	100
Electrical Life (Operations) x 1000 ❸		250
Switching Frequency (Operations per hour)	Electrically Held	600
	Mechanical Latch	150
Opening and Closing Times (Series E)		
Maximum Closing Time	50/60 Hz or DC (milliseconds)	150
Maximum Opening Time (without delay) ❹	50/60 Hz or DC (milliseconds)	60
Opening and Closing Times (Series D)		
Maximum Closing Time	50 or 60 Hz (milliseconds)	200
Maximum Opening Time (Normal Drop Out)	50 or 60 Hz (milliseconds)	240
Maximum Opening Time (Fast Drop Out and Mechanical Latch)	50 or 60 Hz (milliseconds)	60
Capacitor Switching (max. KVAR)		
System Voltage	2400 V	2000
	4160 V	3000
	6900 V	4000
General		
Standard Altitude Capability (meters / feet) ❶		0 – 1000 / 3300
Contactor Weight (kg / lbs)		45 / 100
Auxiliary Contact Rating		A600
Auxiliary Contacts on the Vacuum Contactor (Max.) ❺		3 N.O. / 3 N.C.

❶ The voltage and current ratings listed are valid up to 1,000 m (3,300 feet). Please refer to - Controller Derating chart on page 30 for ratings above this altitude.
❷ Control voltage, as measured at the input of the IntelliVAC control module.
❸ Provided that regular maintenance is performed.
❹ A contactor drop-out delay may be configured with the IntelliVAC control module (refer to publication 1503-UM051B-EN-P).
❺ The number of contactor auxiliary contacts depends on the contactor type. Some of the contacts are used in the typical control schemes used.

Table 11.J – Control and Power Wire Specifications

Description	Specifications
Control Wire	
All Medium Voltage structures shall be equipped with control wire which meets the following specifications:	
Type	TEW, Stranded Copper Wire (Tinned)
AWG Size (Control Circuit)	#14 AWG – 1.5 mm^2
AWG Size (Current Transformer Circuit)	#12 AWG – 2.5 mm^2
Number of Strands	19
Maximum Voltage Rating	600 V
Maximum Rated Temperature	105°C (221°F)
Power Wire	
Power wire used to feed the primary of the control power transformer or potential transformers is as follows :	
AWG Size	PT – #8 AWG / CPT – #12 AWG
Type	Belden EPDM 37508
Insulation Rating	8.0 kV
Maximum Temperature Rating	150°C (302°F)

The controller shall be wired with the following non-shielded, stranded wire type, based on the current ratings :

Controller Rating (Amps)	AWG Size	Type	Insulation Rating	Maximum Temperature Rating
200	#2	EP-CSPE MV90	8.0 kV	90°C (194°F)
400	#4/0	EP-CSPE MV90	8.0 kV	90°C (194°F)
600	(2) x #4/0	EP-CSPE MV90	8.0 kV	90°C (194°F)

12.0 References

Publication Number	Title
1500-SR020_-EN-P	Specification Guide • Medium Voltage Motor Starters
1500-TD220_-EN-P	Test Procedures for Medium Voltage Products
1560E-PP001_-EN-P	Product Profile • MV SMC-Flex
150-1.9	Utilizing Solid-State Reduced Voltage Starters for Electrical Pump Control
150-2.6	Starting Solutions – Solid-State vs. Electromechanical Starters
QES-BR001A-EN-D	Rockwell Automation Control Systems
6500-CO001_-EN-P	Terms and Conditions
Internet	www.ab.com/mvb

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