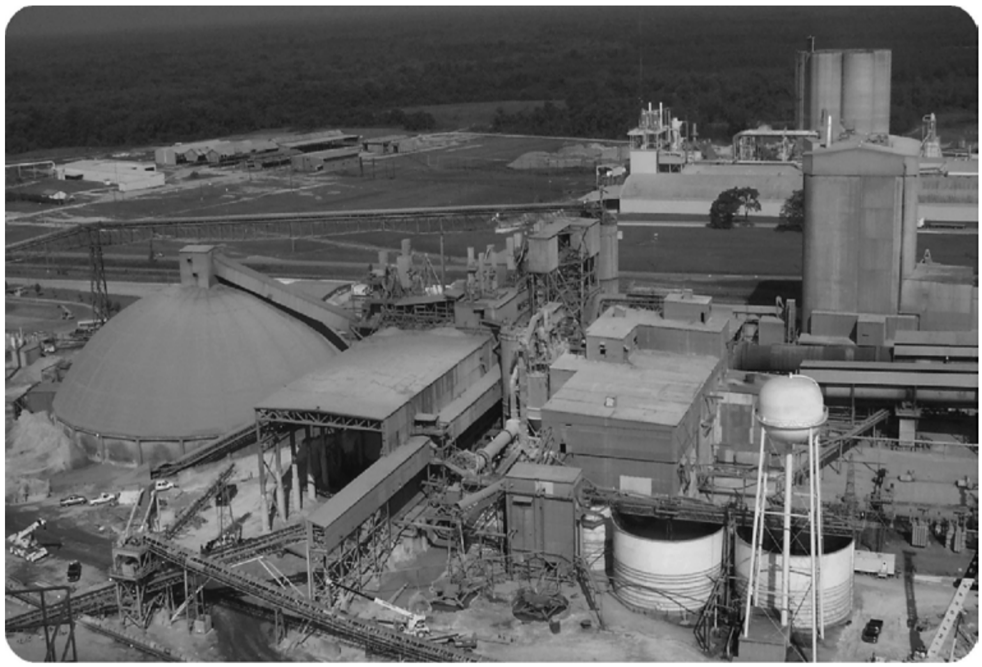
Installation Instructions

Medium Voltage SMC™ OEM Components (10…15 kV)

Publication 7703E-IN001E-EN-P



Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

This manual contains new and updated information. Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

New and Updated Information

This table contains the changes made to this revision.

Topic	Page
Migrated manual to FrameMaker	
Updated PowerBrick catalog numbers and removed footnotes about them	11
Added 580 A to PowerBrick specifications table	12
Updated PowerBrick dimension and arrangement diagrams	14, 15, 16
Removed 160/340 A description from power circuit wiring diagram	38
Added 580 A to component derating table	47
Added 580 A to PowerBrick replacements table	53
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Introduction

Scope

This document pertains to the Bulletin 7703E SMC OEM components for 10-15 kV. These components allow an OEM to fabricate a medium voltage soft starting solution.

Most of the components described herein are provided in various 7703E kits; however, some of the devices described are not provided. These must be acquired separately.

A key part of the Bulletin 7703E components is the power stack assembly which uses PowerBrick™ technology. PowerBricks are a superior means of packaging SCRs, heatsinks, passive devices (for circuit protection) and gate drive circuit boards. Each PowerBrick is a self-contained assembly with inherent insulation and flexible mounting features. PowerBricks are easily connected in series to service the required system voltage level.

PowerBricks are provided as a set of components used to create a three-phase assembly (refer to Figure 1 on page 11). Each form of PowerBrick assembly is applied with other Bulletin 7703E control components and power devices, in forming a complete solution.

Additional Publications

Please refer to Medium Voltage SMC Flex Motor Controller, Bulletin 1503E, 1560E, 1562E User Manual 1560E-UM051_-EN-P for additional information about the functionality of some of the Bulletin 7703E products. This document contains the following information for the MV SMC Flex:

- Commissioning
- Maintenance and Troubleshooting
- Parameter List

To order additional copies of Instruction Manuals for all Rockwell Automation medium voltage products, please contact a Rockwell Automation sales office or your local distributor.

Notes:

Receiving and General Information

Receiving

Refer to Getting Started, General Handling Procedures for Medium Voltage Controllers – Publication MV-QS050_-EN-P. This document is included with your shipment and contains information regarding receiving, unpacking, initial inspection, handling, storage, and site preparation.

Handling Procedures for Electrostatic Sensitive Devices

ATTENTION: Printed circuit boards contain components that can be damaged by electrostatic charges that build up on personnel during normal activities. Exercise the following precautions when handling electrostatic sensitive devices. Failure to do so may damage the device and render it inoperable.

To guard against electrostatic damage (ESD) to equipment, the following precautions should be observed when handling electrostatic sensitive devices.

1. Use a grounding wrist strap to minimize the build up of static charges on personnel.
2. Handle the module by the edges and avoid touching components or printed circuit paths.
3. Store devices with sensitive components in the conductive packaging that the module is shipped in.

These precautions are the minimum requirements for guarding against ESD. For more information refer to Guarding Against Electrostatic Damage – Publication ICCG-4.3. See the Additional Publications section for information on obtaining this document.

Standards and Codes

IMPORTANT	It is recommended that the user be familiar with the following safety and design standards and codes, and any additional local codes that a medium voltage controller must comply with:

- CEC (Canadian Electrical Code)
- CSA 22.2 No. 253 (Canadian Standards Association) – Medium Voltage AC Contactors, Controllers and Control Centers
- NEC (National Electrical Code)

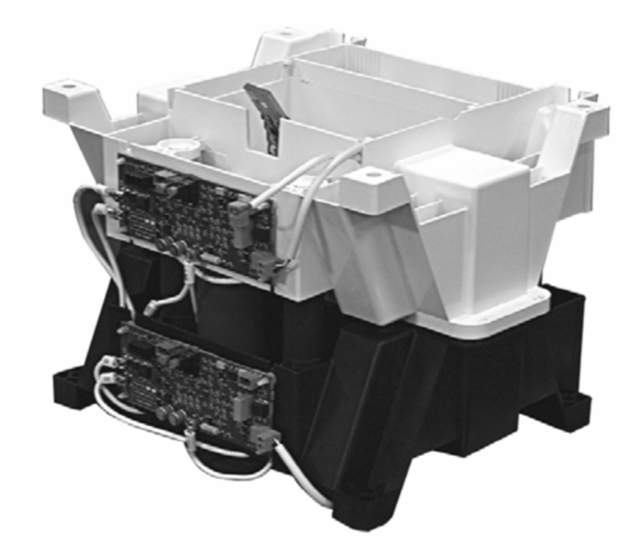
- NEMA ICS Standards (National Electrical Manufacturers' Association)
- OSHA (Occupational Safety and Health Administration)
- UL 50 (Underwriters Laboratories) – Enclosures for Electrical Equipment
- UL 347B (Underwriters Laboratories) – Medium Voltage Motor Controllers
- UL 508 (Underwriters Laboratories) – Industrial Control Equipment
- IEC 60204-1 – Safety of Machinery – Electrical Equipment of Machines, Part 1: General Requirements
- IEC 62271-200 – AC Metal Enclosed Switchgear and Control Gear for Rated Voltages Above 1kV and up to 52 kV (formerly IEC 60298)
- IEC 62271-106 – High Voltage Alternating Current Contactors (formerly IEC 604701
- IEC 60529 – Degrees of Protection Provided by Enclosures (IP Code)
- IEC 62271-1 – Common Clauses for High Voltage Switchgear and Control Gear Standards
- ICS1– Industrial Control and Systems General Requirements
- ICS3 Part 2 – Industrial Control and Systems - Medium Voltage Controllers Rated 2001-7200V AC

PowerBrick™ Installation

Identification

A PowerBrick is shown in Figure 1.

Figure 1 - Single-phase PowerBrick



Several PowerBricks are supplied as a loose set of components to service a particular voltage and current. Verify the voltage and current rating of the OEM power stacks by examining the shipping label and referencing it to the information in Table 1.

Table 1 - PowerBrick Options and Catalog Numbers

Catalog Number(1)	Voltage(2)		Current (Amps)
7703E-PPMT	12000V	3 phase, 50/60 Hz	160
7703E-PPMA			340
7703E-PPMC			580
7703E-PPNT	13800V		160
7703E-PPNA			340
7703E-PPNC			580

(1) The OEM is responsible for ordering and installing the correct format for the current loop gate drive conductor conduit/CT assembly (refer to the Installation Instructions, publication 7703E-IN008_-EN-P for additional details.)

(2) Voltage ranges : 12000 = 10000…12000V (5 PowerBricks in series per phase)
13800 = 12001…14400V (6 PowerBricks in series per phase)

In addition to the PowerBricks, a voltage sensing board is to be connected in the power circuit. Table 2 lists the voltage sensing board catalog numbers.

Table 2 - Voltage Sensing Board Catalog Number

Catalog Number	Voltage Sensing Board Input (3 phase, 50/60 Hz)
7703E-VSM	10,000…12,000V
7703E-VSN	12,001…14,400V

Sizing the Enclosure

ATTENTION: The enclosure for the power stack assemblies must be adequately sized to provide sufficient airflow to cool the units. Failure to provide adequate cooling may result in reduced duty cycles or component failure.

Use the data in Table 3 to assist in calculating the enclosure size.

Table 3 - PowerBrick Specifications

Description	160 A, 340 A				
Input Voltages (50/60 Hz)	10,000…12,000V 12,001…14,400V 3 phase, +10%, -15%				
Ambient Temperature	0 °C…40 °C (32 °F…104 °F)				
Power Section (for 3 phases)	30 SCR at 10…12 kV 36 SCR at 12.1…14.4 kV				
Repetitive Peak Inverse Voltage Rating	10 to12 kV…32,500 PIV 12.1…14.4 kV…39,000 PIV				
Thermal Capacity(1)	600% of FLA, 10 seconds 450% of FLA, 30 seconds				
dv/dt Protection	R.C. Snubber Network				
Maximum Heat Dissipation (kW)	Start or Stop Cycle (at 450% FLA)				
		160 A	340 A	580 A	Continuous(2)
	10,000…12,000V	27	57	98	0.5
	12,001…14,400V	32	69	117	0.5
Altitude	0…1000 m (0…3,300 ft) (See Controller Deratings Table on page 6, Publication 1503-BR010F-EN-P)				
Net Shipping Weight (3 phases)	Rating (kV)	10…12			12.1…14.4
Weight kg (lbs)	570 (1260)	684 (1512)			

(1) It may be possible to offer extended start times at reduced current or ambient temperature. Please consult Rockwell Automation factory for assistance.

(2) After bypass contactor/breaker is closed.

Dimensions

Refer to Figure 2, Figure 3, and Figure 4 for PowerBrick dimensions and mounting.

Torque Requirements

All electrical connections must be torqued to the specifications shown in Table 4.

ATTENTION: Ensure that all electrical connections are torqued to the correct specification. Failure to do so may result in damage to the equipment and/or injury to personnel.

Table 4 - Torque Requirements

Hardware	Recommended Torque
¼-20 thread cutting housing assembly screws	7 N•m [62 lb•in]
M5	3.4 N•m [30 lb•in]
Control Wire Terminals	0.2…0.4 N•m [2.0…3.3 lb•in]
CLGD Power Assembly Terminals	5.6 N•m [50 lb•in]
SMC Flex Control Module Terminals	0.6 N•m [5in•lb]
M8, Capacitor Lugs M8, All others	7.5 N•m [66 lb•in] 14 N•m [120 lb•in]
M10	29 N•m [250 lb•in]

PowerBrick Mounting

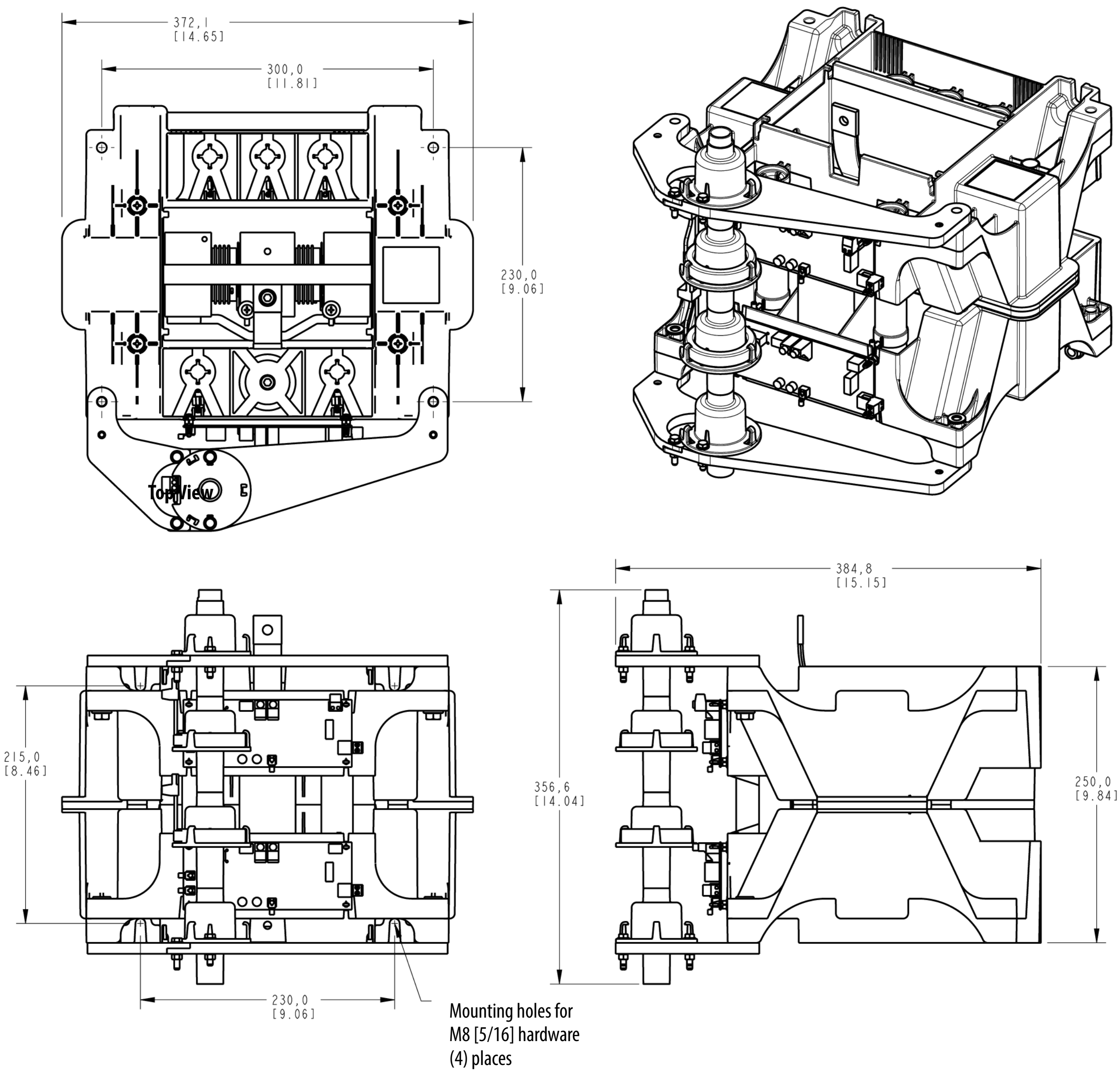
PowerBricks are to be mounted in a vertical orientation in order to provide adequate component cooling. Mount the PowerBricks in a suitable location using the mounting holes provided in the assembly (refer to Figure 2). Use M8 (5/16 in.) or similar hardware for the mounting hole dimensions of 10.7 x 15.9 mm (0.421 x 0.625 in.).

PowerBricks are provided with two methods for mounting (as shown in Figure 2). The PowerBricks can be mounted to a vertical surface using the four mounting locations on the rear face, or they can be mounted to a horizontal surface using the four mounting locations on the base.

Note: Using either mounting option requires space above and below each phase assembly (refer to Figure 3 and Figure 4).

ATTENTION: Maintain sufficient clearance between the power phases and between phases and grounded surfaces. Refer to local electrical codes to determine the required clearance. Failure to do so may result in injury to personnel or damage to the equipment.

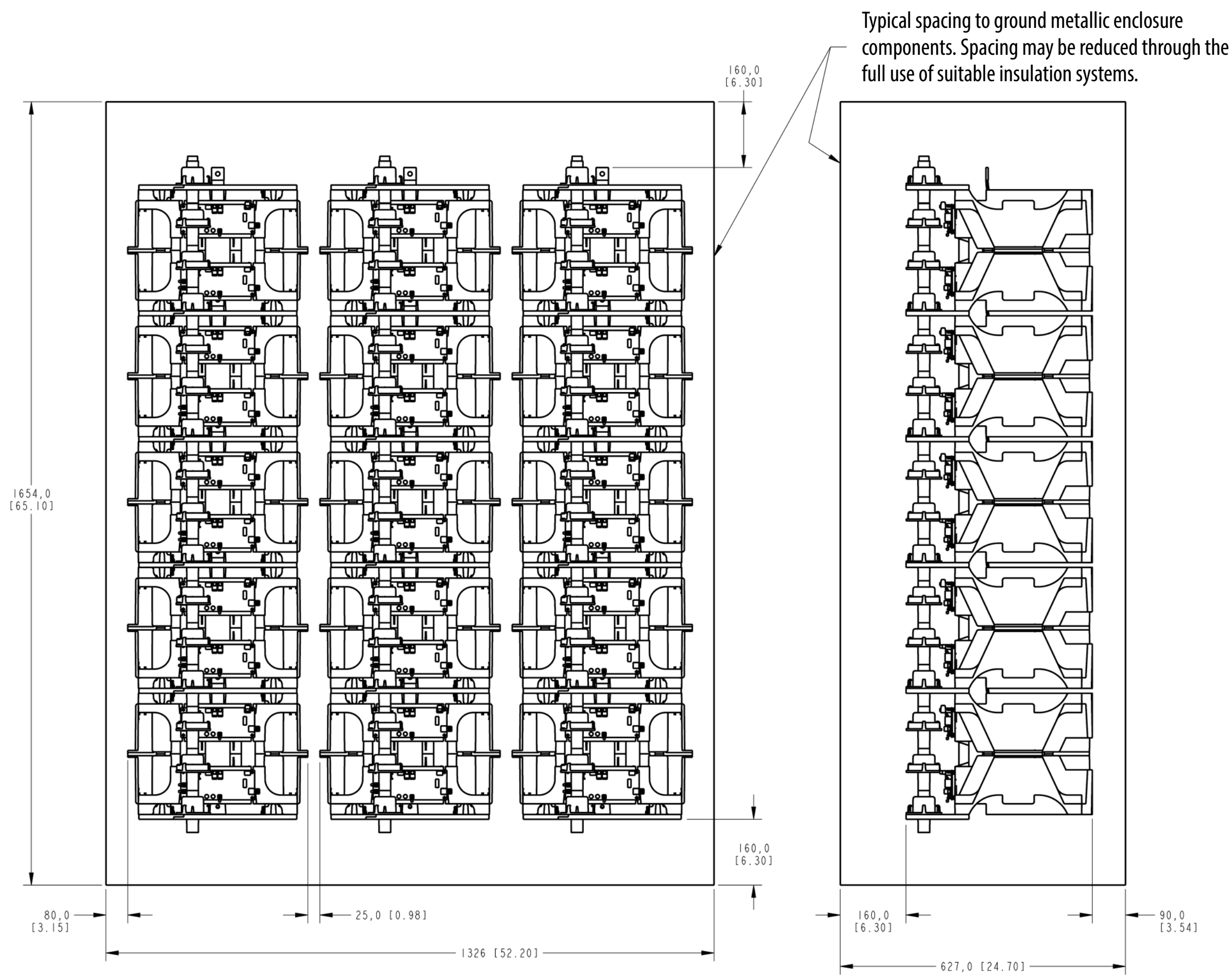
Figure 2 - Single PowerBrick Dimensions (1000/2400V)



Front View **Side View**

Typical Mounting Arrangement, 10…12 kV PowerBrick System

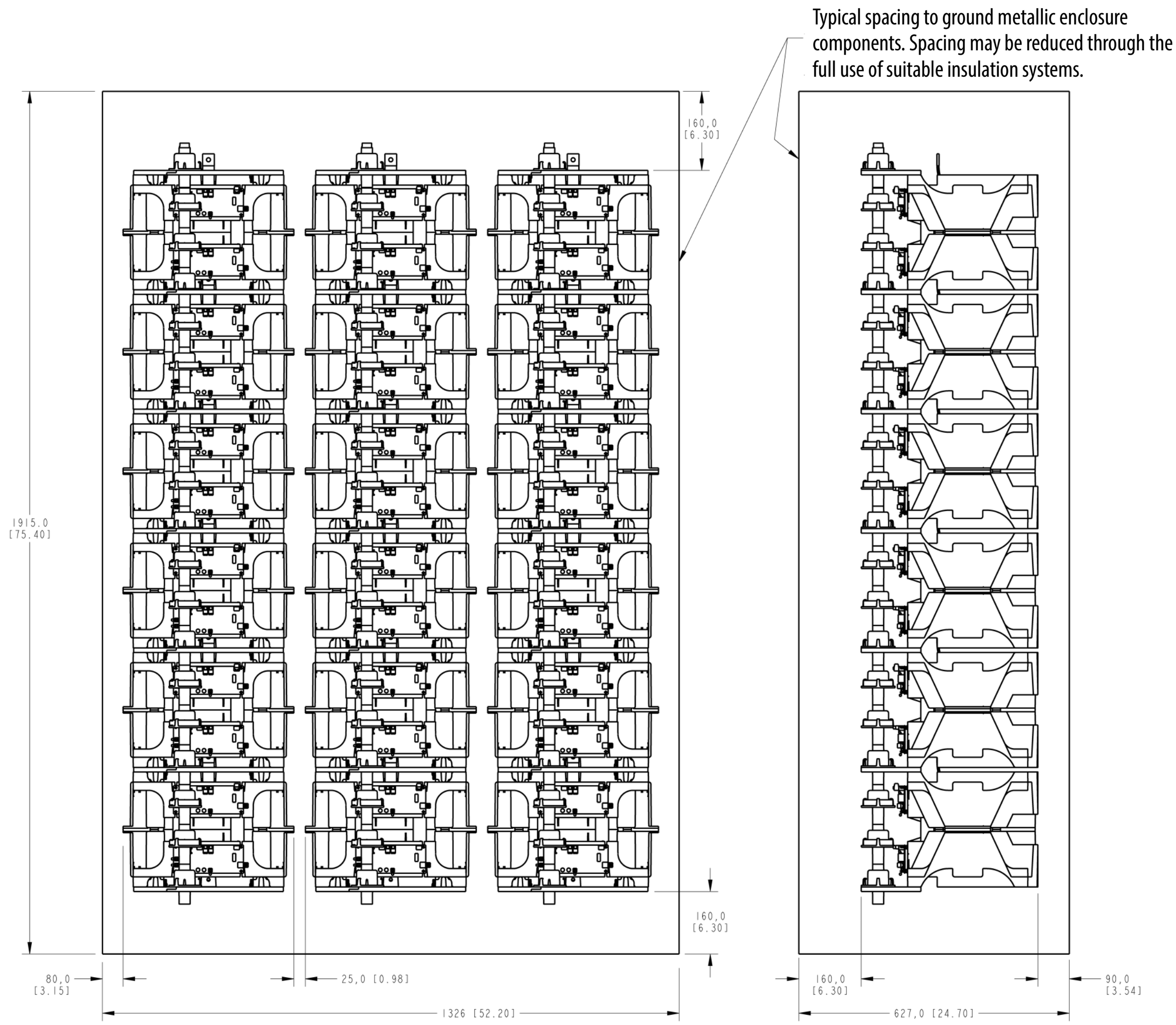
Figure 3 - Typical PowerBrick arrangement for 10…12 kV



Front View **Side View**

Typical Mounting Arrangement, 12.1…14.4 kV PowerBrick System

Figure 4 - Typical PowerBrick arrangement for 12.1…14.4 kV



Front View **Side View**

Power Connections

ATTENTION: To avoid shock hazard, lock out incoming power to power cables when completing connections. Failure to do so may result in severe burns, injury or death.

IMPORTANT It is the responsibility of the OEM to ensure that suitable line and load cables are used to satisfy the requirements of the equipment and meet local electrical codes.

1. The PowerBrick units are connected to each other in order to create a complete phase assembly. The flexible connector on the top of each PowerBrick is attached to the fixed connector on the bottom of the PowerBrick above.
2. The top PowerBrick should be connected to a suitable fixed terminal location. Use appropriate cable lugs to attach suitable line cables to the line cable terminal. Each PowerBrick can use M10 (3/8 in.) hardware. Refer to Figure 5 for the terminal location. Torque the fastening hardware to the specifications shown in Table 4.
3. Use cable lugs to attach suitable load cables to the load cable terminal (lower). Refer to Figure 5 for the terminal location. Torque the fastening hardware to the specifications shown in Table 4.
4. Refer to Chapter 5 and Chapter 6 for a typical wiring diagram to determine the required connections. Appendix B includes a typical schematic for a complete soft starter unit.

Figure 5 - Typical Single Phase 15 kV PowerBrick Assembly (side view)

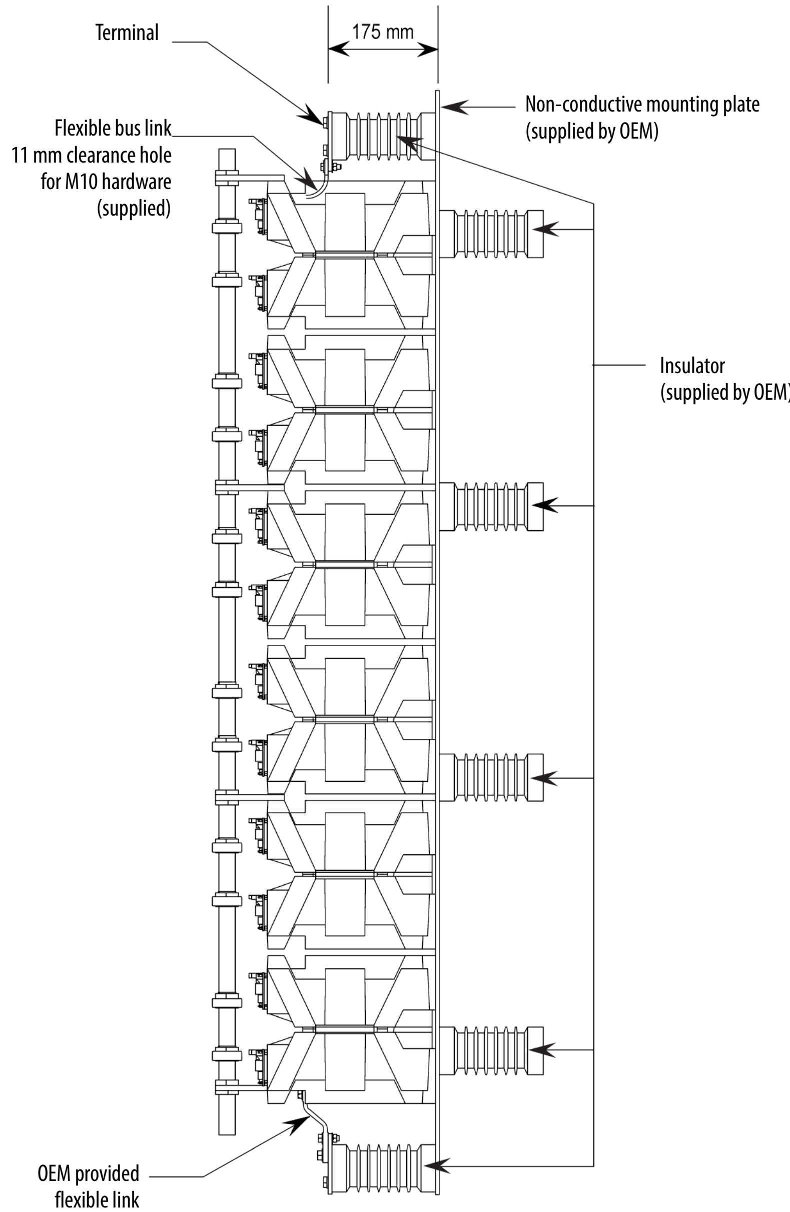
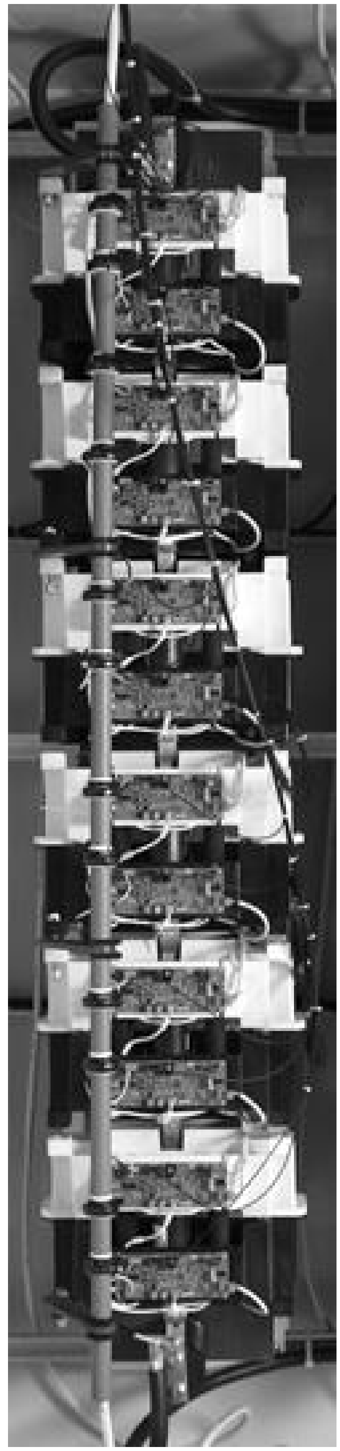


Figure 6 - Photo of Typical Single Phase PowerBrick Assembly (Front View)



Grounding

ATTENTION: It is the responsibility of the OEM to ensure that the final enclosure is suitably bonded to ground, and that provisions for grounding are made according to local electrical codes and standards.

PowerBrick Operating Restrictions

The SCRs in the power stacks are not intended for continuous operation. Observe the following operating restrictions for the SMC when operating at the thermal capacity limit and maximum ambient (40 °C). (Refer to Table 3.)

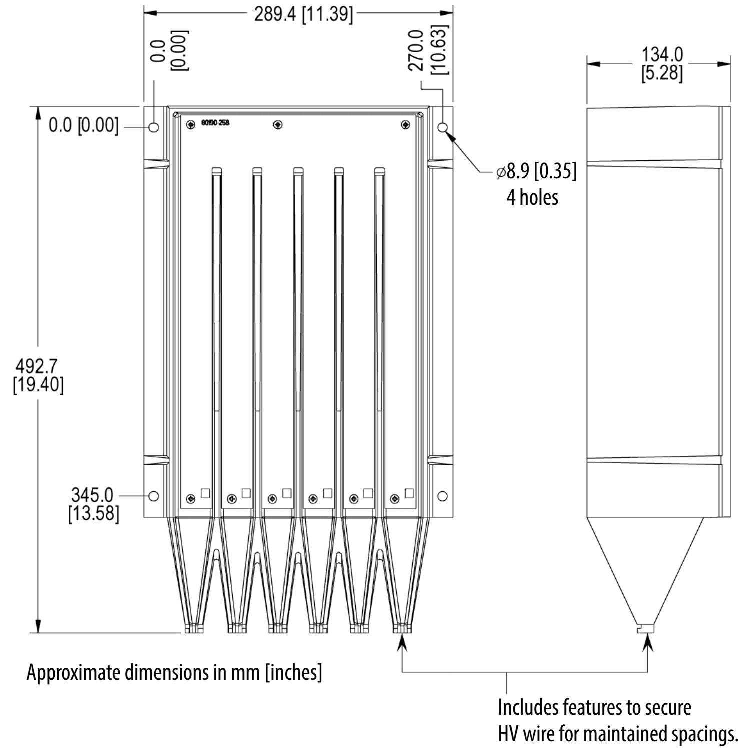
- Power stacks must be bypassed using a separate contactor or circuit breaker when the motor is up to speed.
- Do not operate the power stacks for more than 60 seconds in one hour.
- Do not exceed 30 seconds for any individual duty cycle of the power stacks.
- Do not operate the power stacks for at least five minutes between a start or a stop cycle.
- For repeated hourly operation, forced ventilation is required.

Note: It may be possible to exceed some of the above restrictions if all maximum ratings are not attained. For example, higher ambient conditions can be supported when the % FLC and/or start time are reduced. Please consult factory for details.

ATTENTION: The operating restrictions for the SMC must be adhered to. Failure to observe the recommended precautions may result in injury to personnel or damage to the equipment.

Voltage Sensing Board Dimensions

Figure 7 - Voltage Sensing Board Dimension Diagram



Mounting and Connecting the Voltage Sensing Board

The voltage sensing board (VSB) for the relevant voltage range (see table below) should be mounted adjacent to the PowerBrick (refer to Figure 7 for dimensions). All connection points are to be made accessible.

Description	Line Voltage (3 phase, 50/60 Hz)	MV Ratio	Catalog Number
Voltage Sensing Board	10,000…12,000V	126	7703E-VSM
	12,001…14,400V	97	7703E-VSN

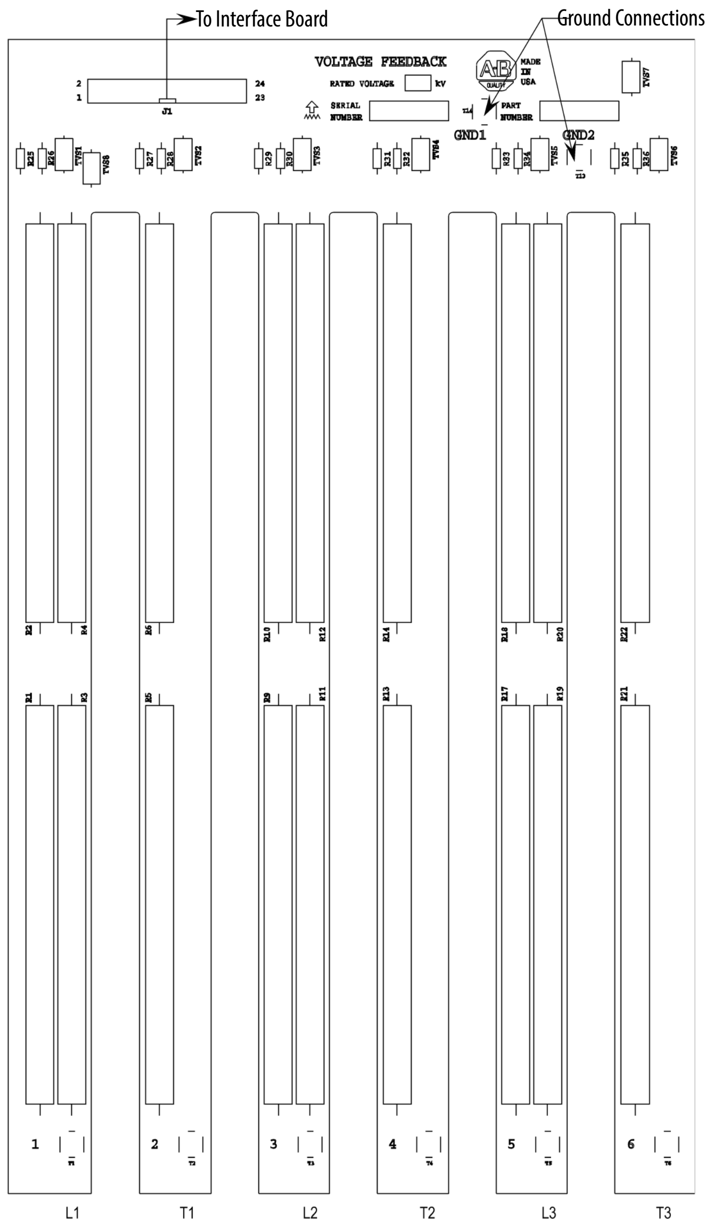
Connect the voltage sensing board to the L1 to L3 (Line) and T1 to T3 (Load) terminals of the power stack (refer to Figure 8 and Chapter 6).

Recommended specifications for wire used on medium voltage connections: UL style 3239, #18 AWG, 40 KVDC silicone rubber insulated wire, covered with PCV tubing or other suitable material.

IMPORTANT	The wires must be prevented from touching live or grounded metals, and low voltage wiring, or have supplemental insulation suitable for the application. Use the tapered features below the Lx and Tx terminals to maintain wire spacings in this area.

The MV ratios shown above are nominal values and may be fine tuned to achieve better accuracy on the display of the SMC Flex control module. While running the motor in bypass mode, compare the voltage displayed on the control module to a known accurate meter connected to the same source voltage as the motor the MV SMC Flex is controlling. Parameter 106, MV Ratio, may be changed up or down to match the Flex display to the external meter. A small change in ratio can make a large change in the display, so 5 units at a time are recommended. Increasing the ratio will decrease the displayed voltage, and visa versa.

Figure 8 - Voltage Sensing Board



Current Loop Gate Drive Power Assembly (CLGD)

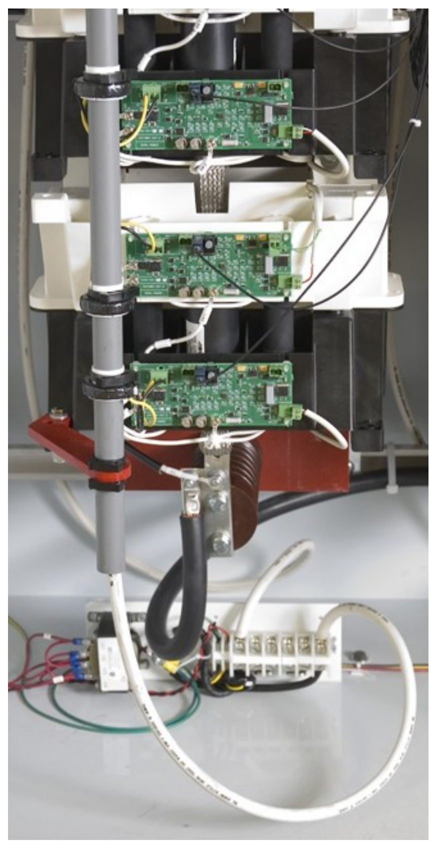
The CLGD power assembly is provided as a loose component with the PowerBricks. It should be mounted adjacent to the PowerBrick in a manner that allows the secondary cable assembly to be correctly installed (see below).

The CLGD power assembly consists of three parts:

1. Power supply (transformer with secondary terminal blocks and sensing CT)
2. Current Transformer (CT) assembly (plastic tubing with two current transformers per PowerBrick)
3. Loop Cable (white, silicone insulated, 50 kV DC, #6 AWG)

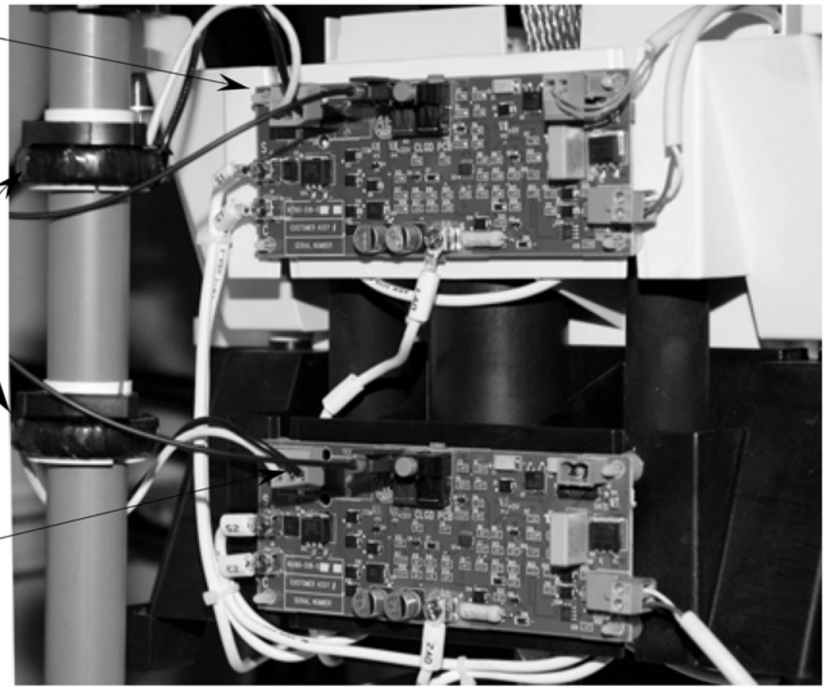
The CT assembly is mounted with hardware to the left side of the PowerBrick stack, and can be pivoted to the left by loosening the mounting hardware to allow removal of individual PowerBricks without removing the CT assembly. The current transformer secondary leads plug into the gate driver board directly behind each CT, and must all be unplugged to pivot the assembly.

Figure 9 - PowerBrick Current Loop Gate Drive Cable Assembly and Power Supply



ATTENTION: Check that all CT leads are plugged into each gate driver board before putting the SMC into service. Failure to do so may result in erratic operation and/or equipment damage during option stop maneuvers.

Figure 10 - Connection of CLGD CTs to Gate Driver Board



The CT assembly has a loop cable which passes through the tube and connects to terminal blocks above and/or below the assembly (depending on how the assembly is implemented). The three phases of loop cables are connected in series and to the secondary of the power supply transformer. The transformer rating and secondary voltage are selected to provide 40 or 50 amps in the loop cable. See Table 5 for matching the loop length to the power supply transformer rating. See Appendix C for part numbers.

Table 5 - Matching Loop Length to Power Supply Transformer Rating

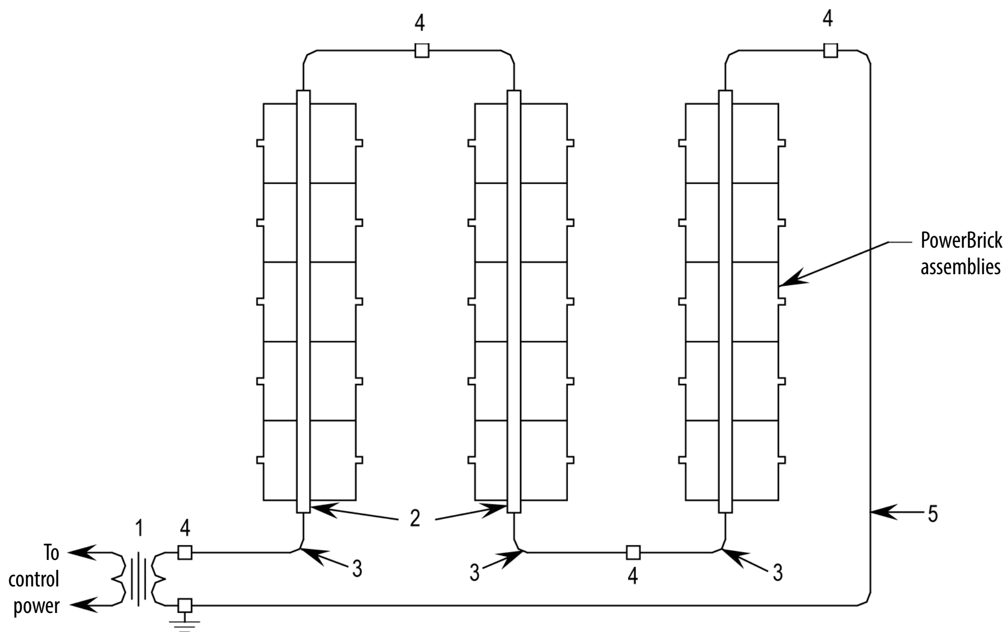
Power Supply Transformer Rating	Total Loop Length for #6 AWG Cable
50 VA, 115/230:0.6V	21 feet ± 4 in. (6.4 m ± 10 cm)
100 VA, 115/230:1.5V	50 feet ± 8 in. (15.2 m ± 20 cm) (1)

(1) The 50-foot length is 3 x 14 ft HV wire plus 8 ft LV wire.

ATTENTION: The loop cable length must be as specified above. The loop cable is the load for the transformer and establishes the loop current. If it is not correct, a longer length will not provide sufficient power to the gate driver boards, and a shorter length will overload the cable or transformer.

A sensing CT is supplied to monitor the current in the loop. It provides a signal to the Interface Board to inform the SMC Flex control module that the power supply is operating. If the current loop is not operating, option stop maneuvers will be inhibited. An Alarm will be generated in the SMC Flex control module if the signal is lost after control power has been applied. If control power is applied without the signal, the controller will not provide option stop maneuvers until the module is powered up with the signal present.

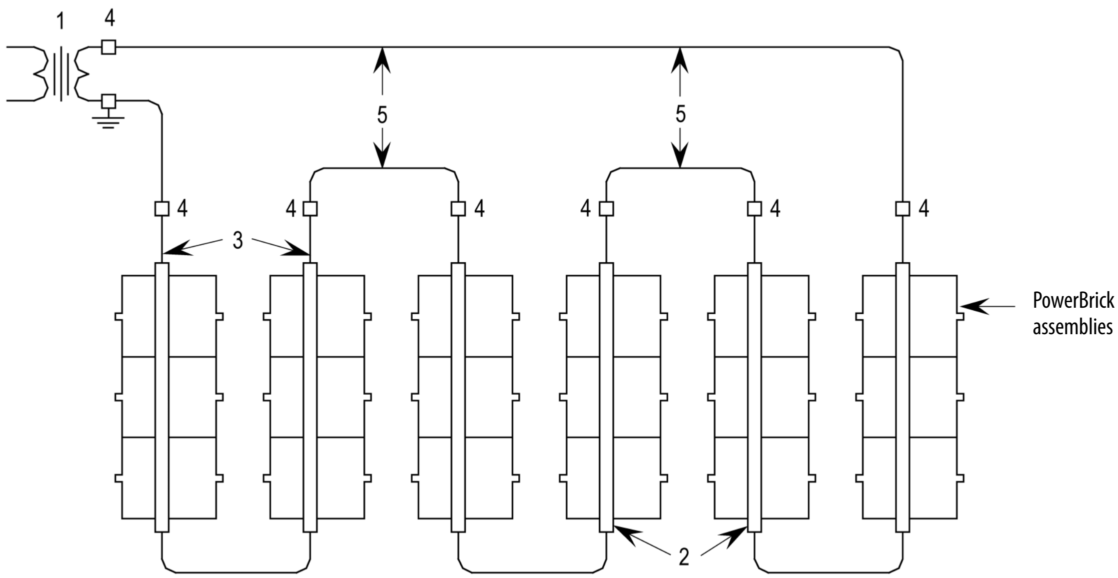
Figure 11 - Typical 12 kV Implementation for Current Loop



1. Power Supply
2. Current Transformer Assembly
3. Loop Cable
4. Terminal
5. Return Cable #6 AWG (13 mm²)

NOTE: The total length of the three loop cables and the return cable must be 50 feet ± 8 in. (152. m ± 20 cm).

Figure 12 - Typical 15 kV Implementation for Current Loop



1. Power Supply
2. Current Transformer Assembly
3. Loop Cable
4. Terminal
5. Return Cable #6 AWG (13 mm²)

NOTE: The total length of the three loop cables and the return cable must be 50 feet ± 8 in. (152. m ± 20 cm).

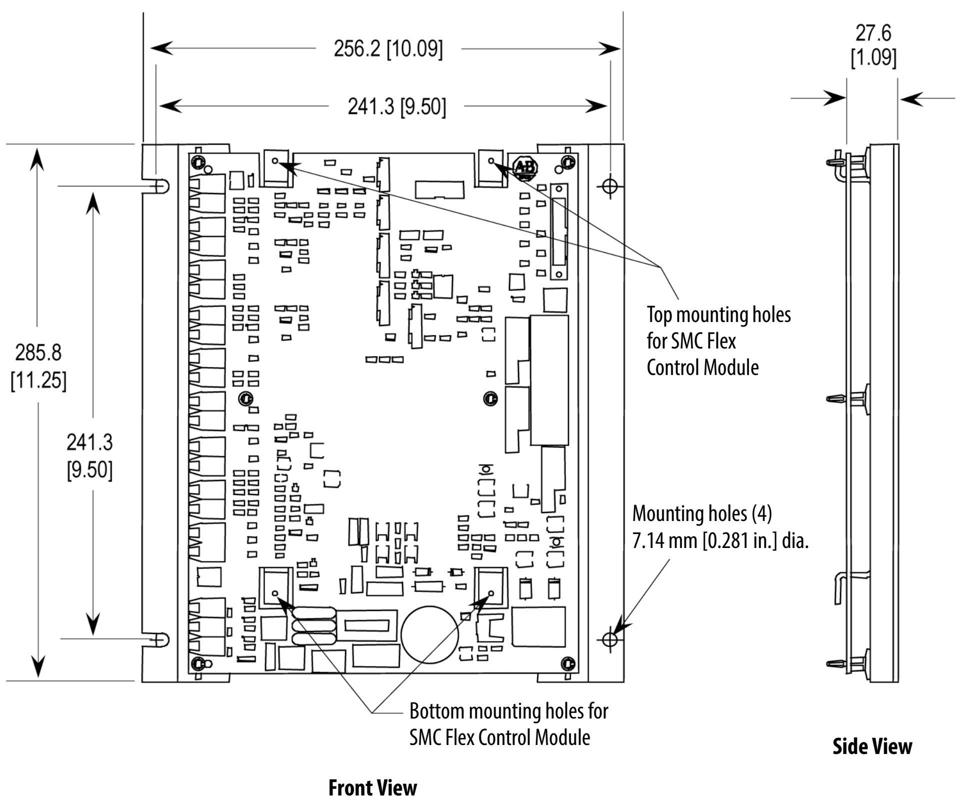
Control Component Installation

Interface Board Installation

Mount the 7703E-INTB Interface Board in a suitable location within a low voltage compartment, using the appropriate hardware. Use the interface board mounting bracket (refer to Figure 13).

ATTENTION: Do not mount the interface board in the same compartment as high voltage components. Ensure that barriers are provided in the final application to prevent access to any live high-voltage parts, including insulated conductors located in enclosures with low voltage parts and wiring. Failure to do so may result in severe burns, injury or death.

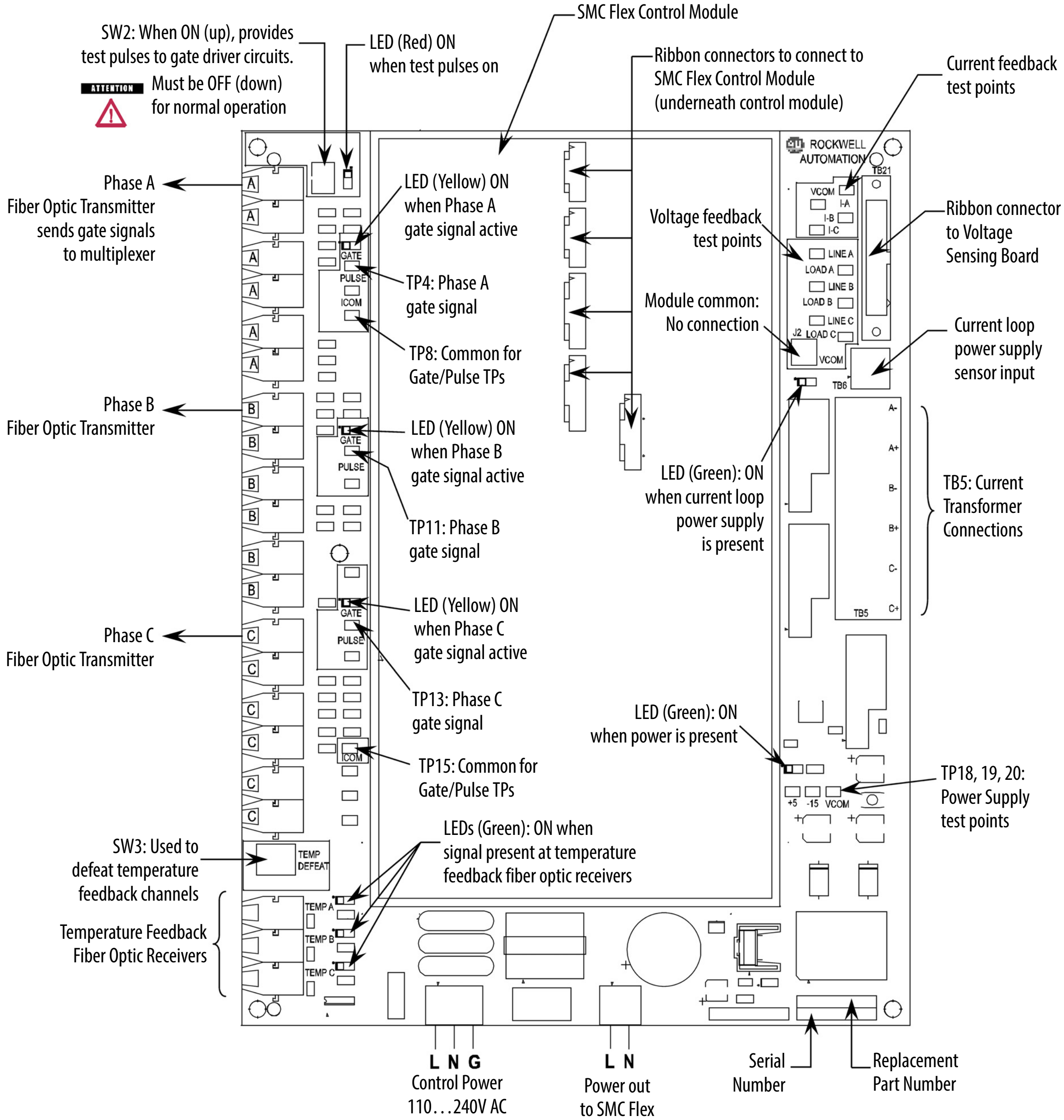
Figure 13 - Mounting the Interface Board



Approximate dimensions in mm [inches]

ATTENTION: Do not touch or bend the connectors on the Interface Board when handling it. Damage to the connectors may result in loss of communication signals from the MV SMC Flex to other components.

Figure 14 - Interface Board Layout



Notes:
1. ICOM is the common connection for Gate and Pulse test points.
2. VCOM is the common connection for Current and Voltage feedback test points. **Do not** connect to earth ground. **Do not** connect ICOM and VCOM together, either directly or through test probes, meter or scope common.

IMPORTANT	**10…12 kV and 12.1…15 kV** Two fiber optic devices per phase are used. One connects to the temperature feedback in the upper PowerBrick, and the other connects to the fiber optic multiplexer board (see below).

Interface Board Connections

Connect control power to the interface board. Use a grounded supply source from 110...240 +10, -15% VAC, 50/60 Hz, 15 VA.

Connect 5A current transformer (CT) secondary signals to the interface board, noting the required CT polarity. Three-phase CTs are required.

WARNING: Do not connect to Interface Board Vcom terminal.

SMC Flex Control Module

1. Connect the ribbon cables (5) to the back of the SMC Flex control module.
2. Align the ribbon cables (5) from the SMC Flex Control Module with the connectors on the Interface Board. Push the ribbon connectors into the mating connectors on the interface board.
3. Use the supplied screws to securely fasten the module to the board mounting bracket.
4. Supply power to the SMC Flex control module and make the required control connections.

Please refer to User Manual, MV SMC Flex Motor Controller Bulletins 1503E, 1560E and 1562E – Publication 1560E-UM051_-EN-P for detailed instructions on wiring and programming the unit.

EMC Compliance

ATTENTION: This product has been designed for Class A equipment. Use of the product in domestic environments may cause radio interference, in which case, the installer may need to employ additional mitigation methods.

The following guidelines are provided for EMC installation compliance.

Enclosure

Install the product in a grounded metal enclosure.

Wiring

Wire in an industrial control application can be divided into three groups: power, control, and signal. The following recommendations for physical separation between these groups are provided to reduce the coupling effect.

- Different wire groups should cross at 90° inside an enclosure.
- Minimum spacing between different wire groups in the same tray should be 16 cm (6 in.).
- Wire runs outside an enclosure should be run in conduit or have shielding/armor with equivalent attenuation.
- Different wire groups should be run in separate conduits.
- Minimum spacing between conduits containing different wire groups should be 8 cm (3 in.).
- For additional guidelines, please refer to Wiring and Ground guidelines, publication DRIVES-IN001M-EN-P.
- Wire earth ground to control terminal 14 of the SMC Flex control module.
- Use shielded wire for:
  - PTC Input
  - Tach Input
  - Ground Fault Input
- Terminate shield wires to terminal 14.
- Ground fault CT must be inside or within 3 m of metal enclosure.
- To meet product susceptibility requirements, ferrite cores need to be added to the communication lines. All cores specified below are split core type, so they can be added to existing connections.
  - When using an external HIM (or DPI interface), a core should be added to the HIM cable near the SMC Flex control module. The recommended core is Fair-Rite no. 0431167281 or equivalent.
  - When using DeviceNet, two cores need to be added to the DeviceNet cable near the SMC Flex control module. The recommended cores are TDK ZCAT2033 0930H and TDK ZCAT2035 0930 or equivalent.

Control Power

Control Voltage

The SMC Flex controller will accept a control power input of 100…240V AC, (-15 / +10%), 1 phase, 50/60 Hz. Refer to the product nameplate to verify the control power input voltage.

Connect control power to the controller at terminals 11 and 12. The control power requirement for the control module is 75 VA. Depending on the specific application, additional control circuit transformer VA capacity may be required.

Control Wiring

Table 6 provides the control terminal wire capacity and the tightening torque requirements. Each control terminal will accept a maximum of two wires.

Table 6 - Control Wiring and Tightening Torque

Wire Size	Torque
0.75…2.5 mm^2 (#18…#14 AWG)	0.6 N•m (5 lb•in.)

Control Terminal Designations

As shown in Figure 15, the SMC Flex controller contains 24 control terminals on the front of the controller.

Figure 15 - SMC Flex Controller Control Terminals

Table 7 - Terminal Descriptions

Terminal Number	Description	Terminal Number	Description
11	Control Power Input C	23	PTC Input
12	Control Power Common C	24	PTC Input
13	Control Enable Input(1)	25	Tach Input (-)
14	Control Module Ground	26	Tach Input (+)
15	Option Input #2	27	Ground Fault Transformer Input
16	Option Input #1	28	Ground Fault Transformer Input
17	Start Input	29	Aux. Contact #2
18	Stop Input	30	Aux. Contact #2
19	Aux. Contact #1 (Ext. Bypass)(2)	31	Aux. Contact #3
20	Aux. Contact #1 (Ext. Bypass)	32	Aux. Contact #3
21	Not Used	33	Aux. Contact #4 (Normal)(3) (4)
22	Not Used	34	Aux. Contact #4 (Normal)

(1) Do not connect any additional loads to these terminals. These "parasitic" loads may cause problems with operation, which may result in false starting and stopping.

(2) Aux. Contact #1 is always programmed for Ext. Bypass (N.O.) to control the bypass contactor in MV applications.

(3) Aux. Contact #4 is always programmed for "Normal" (N.O.) to control the isolation contactor in MV applications.

(4) RC snubbers are required on inductive loads connected to auxiliary.

Note: The OFF state leakage current for a solid-state device connected to an SMC Flex input must be less than 6 mA.

Connecting Interface Board to Voltage Sensing Board

Use the wire harness provided to connect the Voltage Sensing Board and the Interface Board. Refer to Figure 14 for the location of the connector on the interface board, and Figure 8 on page 22 for the connector on the voltage sensing board.

Connecting Fiber Optic Multiplexer Board to Gate Driver Board

The 7703E-MUXB Fiber Optic Multiplexer board accepts fiber gate drive signals from the interface board (7703E-INTB) and splits them into the required fiber optic gate drive signals for 10…15 kV.

Figure 16 - Fiber Optic Multiplexer Board

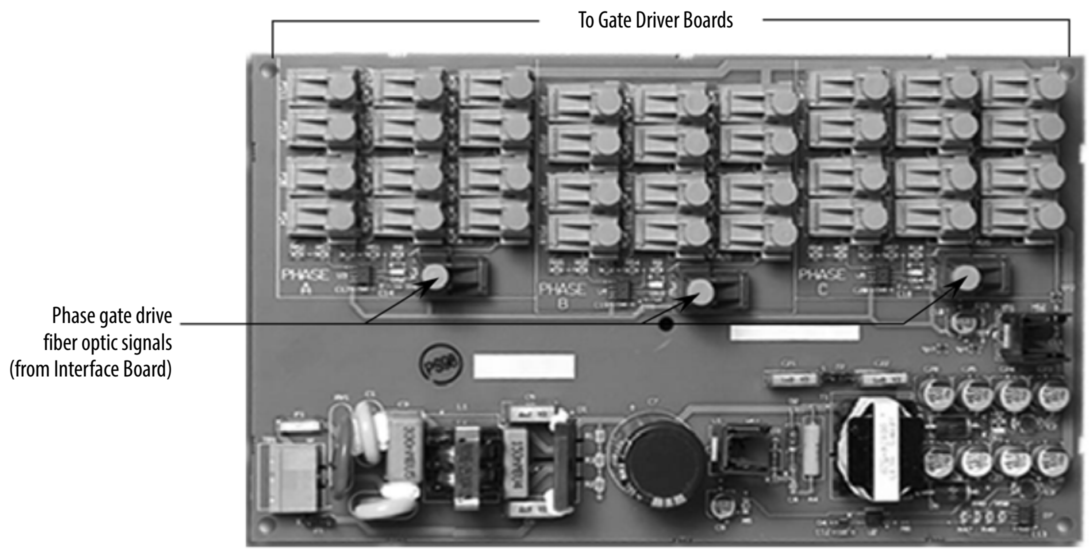


Figure 17 - Fiber Optic Multiplexer Board Dimensions and Connections

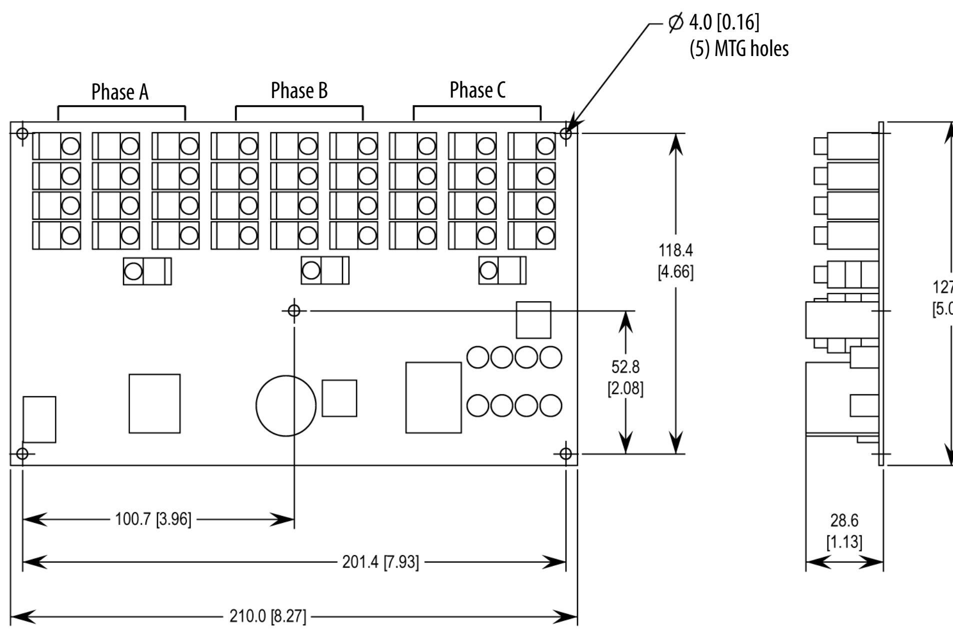


Table 8 - Fiber Optic Multiplexer Board Specifications

Control Voltage	110/120V…220/240V at 50/60 Hz, 30 VA
Gate Drive (In/Out)	Via Fiber Optics

1. Use the fiber optic cables (Cat. No. 7703E-XXFOXX) to connect each fiber optic receiver from the gate driver boards to the fiber optic multiplexer board (refer to Figure 16 and Figure 17). Ensure that the gate driver boards of each power phase are connected to the correct terminals on the fiber optic multiplexer board. Observe the minimum bend radius of at least 45 mm (1.75 in.) for the fiber optic cables.

ATTENTION: Do not sharply bend or strike the fiber optic cables when handling them. A minimum bend radius of at least 45 mm (1.75 in.) should be maintained throughout the system. Damaging the cables may result in signal loss to the components and improper functioning of the unit.

IMPORTANT Fiber optic components are color coded for easier connections. Receiver terminals are dark blue, and transmitter terminals are grey or black. The cables have a grey connector at one end and a blue one at the other. When connecting to the gate driver boards, the dark blue connector must plug into the dark blue receiver and the grey connector must plug into the grey or black transmitter.

Refer to the appropriate wiring diagram in Chapter 6.

IMPORTANT It is acceptable to connect the fiber optic transmitter cables to any port within a particular power phase. Note that the cables for the temperature feedback ports should be connected to the correct phase. Refer to Figure 14 for the Interface Board layout.

2. Connect a single fiber optic cable between the interface board transmitter (one per phase) to the corresponding receiver on the fiber optic multiplexer board.
3. Connect the temperature feedback fiber optic receivers for each phase from the interface board to the appropriate gate driver board transmitter. Refer to Chapter 6 for the appropriate diagram for the temperature feedback fiber optic connections.

Additional Control Components

Additional control components are required to complete the circuit, depending on the application. Some of these control components are outlined in Chapter 5 and Appendix B.

It is the responsibility of the OEM to ensure that all required power and control components are supplied and functional.

Main and Bypass Switching Device Installation

Introduction

The MV SMC components are designed for intermittent starting duty. A bypass contactor or circuit breaker must be used to bypass the PowerBrick assemblies once the motor is at full speed.

Main Contactor or Circuit Breaker

A line switch is required in order to isolate the power stacks from line voltage.

- If a line contactor is used, suitable short-circuit protection must be provided in compliance with relevant standards and/or local codes (refer to Section 2).
- If a circuit breaker is used for the line switch, it must be rated to handle normal load and short-circuit conditions.

Bypass Contactor or Circuit Breaker

A bypass contactor or circuit breaker must be used in the SMC configuration to bypass the SCRs once the motor is up to speed. The bypass must have an opening time of 100 ms or less.

ATTENTION: A bypass contactor or circuit breaker must be installed to complete the SMC configuration. SCRs are not rated for continuous duty. The duty cycle is limited to 60 seconds per hour. This can be a combination of starting and stopping cycles that does not exceed 30 seconds per cycle. Failure to install a bypass contactor or circuit breaker may result in damage to components from overheating.

Notes:

Typical Wiring Diagrams

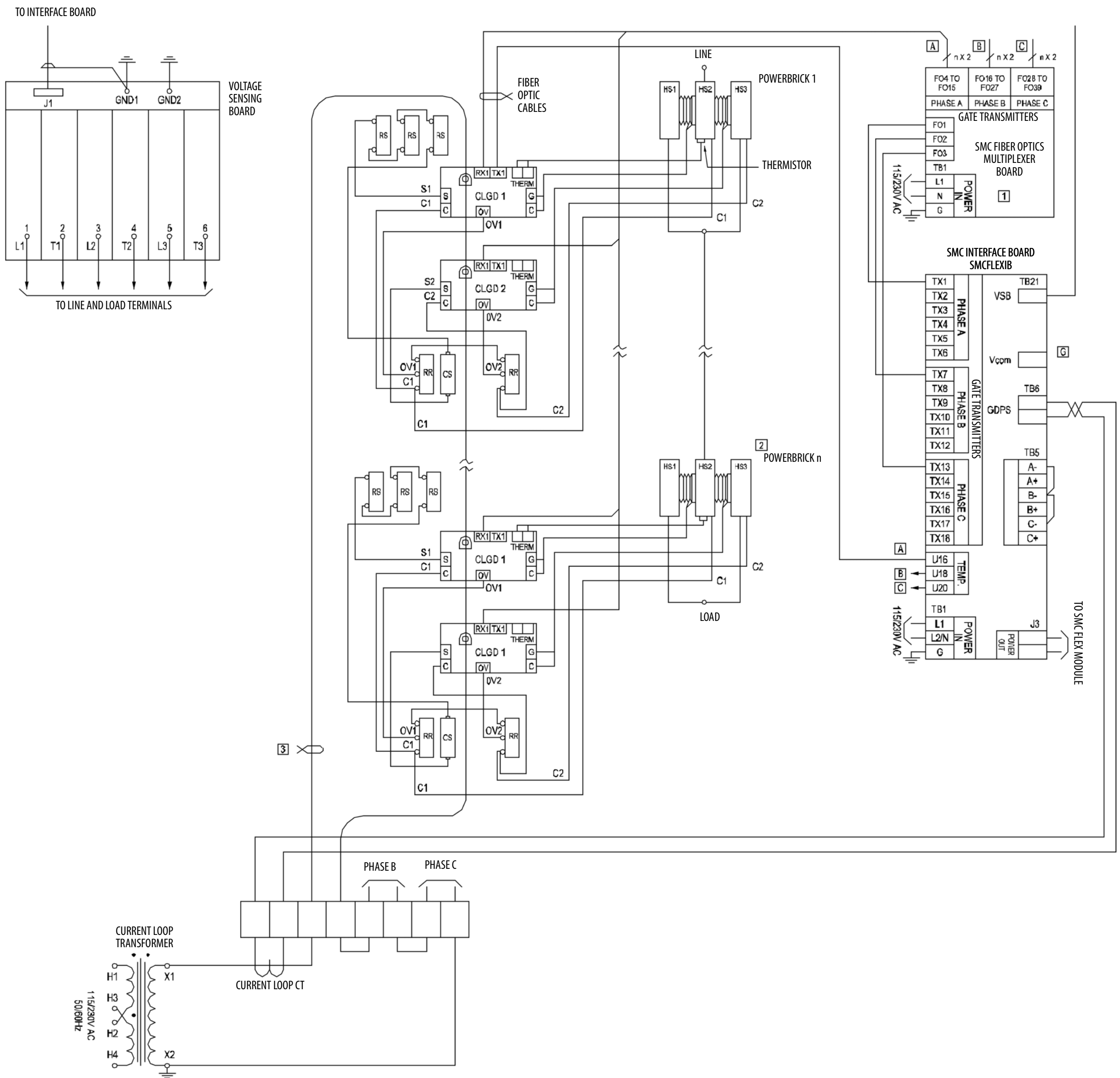
Wiring Diagrams

The following wiring diagrams illustrate the connections between the main components of the MV SMC OEM components.

Additional components are typically required to complete the MV SMC. Refer to Appendix B for examples of how these additional components can be implemented to form a complete solution.

ATTENTION: Wires used for connecting the components must be sufficiently insulated to withstand system voltage. Refer to the appropriate wiring diagram for the wire insulation requirements. Failure to use adequately insulated wiring may cause injury to personnel and/or damage to the equipment.

Figure 18 - Typical Power Circuit Wiring Diagram (10-15 kV)



NOTE: Only devices supplied by Rockwell Automation are shown. Additional devices are required to form a complete solution (refer to Appendix B for a typical schematic showing other devices).

LEGEND

- A CONNECTIONS SHOWN FOR PHASE A
- B WIRE CONNECTIONS FOR PHASE B
- C WIRE CONNECTIONS SHOWN FOR PHASE C
- G DON'T CONNECT
- 1 USED ONLY FOR 4 OR MORE POWERBRICKS IN SERIES
- 2

VOLTAGE	NUMBER OF POWERBRICKS (n)
9.6 kV	4
10 - 12 kV	5
12.1 - 14.4 kV	6

- 3 SEE CHAPTER 3, Current Loop Gate Drive Power Assembly (CLGD) on page 23, FOR CABLE REQUIREMENTS

Final Test Procedures

Final Test Procedures

- Verify that the enclosure is properly grounded.
- Verify that phase-to-phase and phase-to-ground clearances meet the requirements of the local electrical code.
- Visually check for sufficient electrical clearances, creepage allowances and bend radii. Refer to the applicable local electrical codes.
- Check the tightness of all power and control connections. Refer to Table 4 on page 13 for recommended torque values. Gently tug on all wires to ensure that they are properly connected.

ATTENTION: All hardware for electrical connections must be torqued to the above specifications. Failure to do so may result in electrical faults causing personal injury or damage to the equipment.

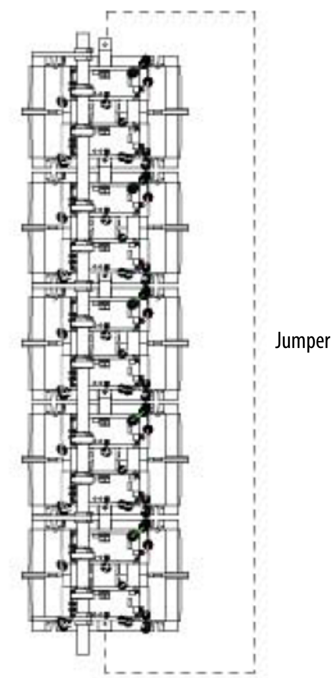
- Check for cross-threaded hardware. In addition to the regular power connections, check the connections and wiring to the voltage sensing board.
- The high voltage silicone-insulated wires must be identified with tube markers. Avoid routing the wires over any components. If the wires are routed near live parts or ground, there must be enough slack in the wire to allow at least 15 cm (6 in.) of creep or clearance between the wire and other parts. Tie wraps must not tightly squeeze the high voltage wires, and must not be put on with a tie-wrap gun.
- Do not remove the plastic plugs from unused fiber optic transmitters on the circuit boards.
- Verify that the fiber optic cables between the interface board, fiber optic multiplexer board, and the gate driver boards are connected to the correct power phase.
- Check the routing of the twisted pair of red and white cathode and gate wires from the SCRs. They can safely touch the heatsink on the side of the SCR that they are exiting; however, they must not touch the heatsink on the other side of the SCR. The wires must be properly supported to ensure this condition is met. See wiring diagrams in Appendix B for the sequences.
- Wiring to the voltage sensing board from the power stacks must be rated for the line voltage. Rockwell Automation recommends UL style 3239, #18 AWG, 40 kV DC silicone rubber insulated wire covered with PVC tubing or other suitable material for this application. These wires must not touch live parts, grounded metal or low voltage wiring.

- The bypass vacuum contactor or breaker (and capacitor contactor if applicable) must have a fast drop-out time (typically 100 milliseconds or less).

Dielectric Test

1. Remove the ribbon cable and ground wires from the voltage sensing board, and isolate the ends to prepare for the Hi-Pot test.
2. Jumper the line and load terminals together within each phase as shown in Figure 19.

Figure 19 - Example of Jumper Positioning for Hi-pot Test



3. Measure the resistance between the line and load sides of each PowerBrick phase assembly to make sure there is zero resistance. This indicates that the jumpers are properly set.
4. Perform a Hi-Pot test as required by the applicable local codes and standards. Typical levels for field testing are two times the rated voltage of the equipment.
5. After the Hi-Pot remove the heatsink jumpers. Re-connect the feedback board wires.
6. Perform a resistance check for each SCR. The SCR resistance can be checked directly at the device or at the leads on the gate driver board.
   a. The gate-to-cathode resistance should range from 10…40 ohms for all styles.
   b. The cathode-to-cathode resistance can also be checked and should be between 20…32 ks per brick.

7. Check all line and load resistances to ground at the interface board voltage feedback test points. The measurement for all voltages should be within 11…13 kΩ.

Additional Tests

Perform additional tests, as outlined in Chapter 3 of User Manual, MV SMC Flex Motor Controller, Bulletins 1503E, 1560E and 1562E, Publication 1560E-UM051_-EN-P.

Programming

MV SMC Flex Module

Refer to Chapter 4[1] for programming procedures.

The default (factory) parameter settings are as shown in Appendix B[1].

IMPORTANT	The module should be programmed with an understanding of how the SMC functions, and the characteristics of the motor and driven load. Inappropriate settings may elicit unexpected results such as lack of acceleration torque or full-voltage starting. For Pump Control applications, refer to Application Considerations in publication 1560E-UM051_-EN-P.[1]

If the factory settings are not suitable for the application, program the module to meet the application requirements.

Voltage Sensing Module

The MV ratios shown above are nominal values and may be fine tuned to achieve better accuracy on the display of the SMC Flex control module. While running the motor in bypass mode, compare the voltage displayed on the control module to a known accurate meter connected to the same source voltage as the motor the MV SMC Flex is controlling. Parameter 106, MV Ratio, may be changed up or down to match the Flex display to the external meter. A small change in ratio can make a large change in the display, so 5 units at a time are recommended. Increasing the ratio will decrease the displayed voltage, and visa versa.

Table 9 - MV Ratio

Voltage	MV Ratio
12000V	126
14400V	97

(1) References apply to publication 1560E-UM051_-EN-P.

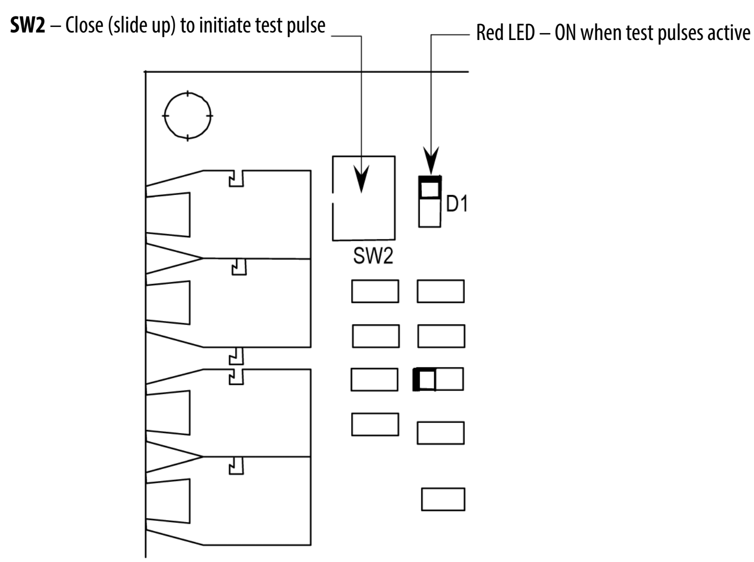
Power Supply Test

ATTENTION: Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of controlled equipment. Before proceeding, ensure that all sources of power are isolated and locked out. Verify that all circuits are voltage free using a hot stick or appropriate voltage measuring device. Any covers or barriers removed during this procedure must be replaced and securely fastened before energizing equipment. Where appropriate, the case of test equipment should be connected to ground.

1. Isolate incoming power
2. Open the door(s) providing access to the SCR/heatsink assemblies. You will be touching components which are connected to the high voltage power circuit, so be sure to isolate power as stated above.
3. Apply rated control voltage to the control circuits from a separate control source, or by plugging into the test source connector, and selecting the TEST position of the control switch.
4. Check voltage on each gate-driver board by connecting a DC voltmeter at TP4(+) and TP3(-). (See Figure 21.) The voltage should be 18…22V DC.
5. Locate the SMC Flex Interface board in the control section (See Figure 20). This circuit board has the control module mounted on it. Locate the switch labeled **SW2** at the upper left corner of the board. Close the switch by sliding the toggle up. This starts a pulse generator to supply simulated gate-pulse signals via fiber optic cables to the gate driver boards. A red LED beside the switch, and the three yellow LEDs on the left side of the Interface board should be lit.

   Note: They may appear dim, depending on ambient light conditions.

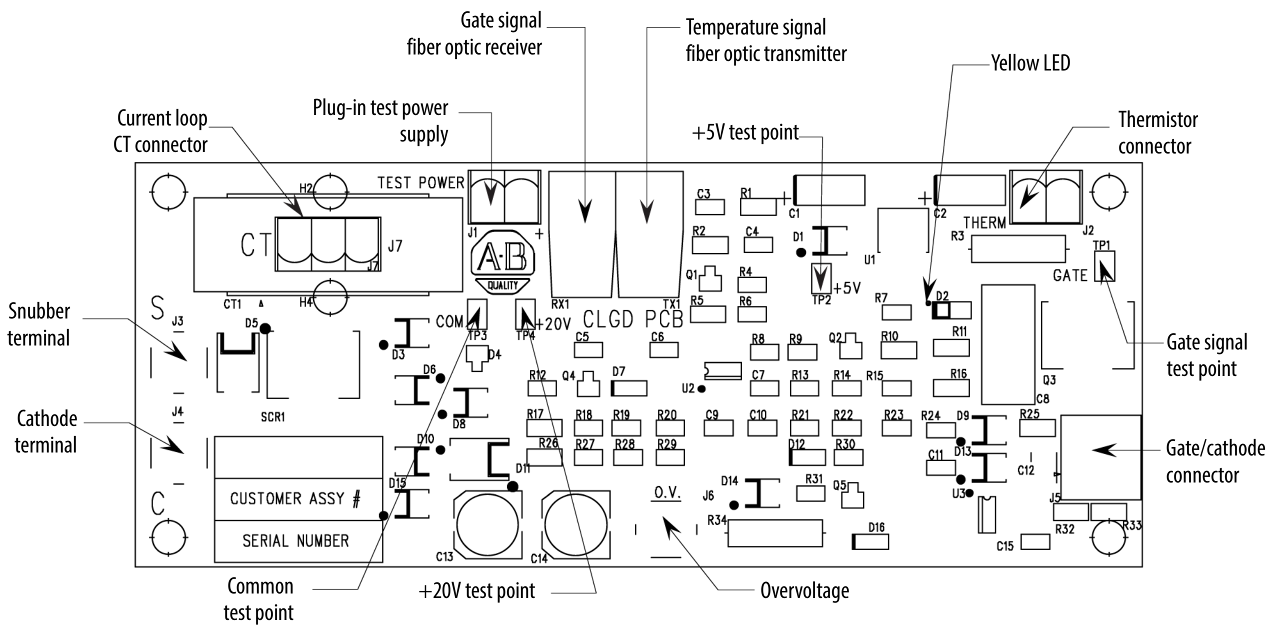
Figure 20 - Interface PCB



6. With the gate pulses on, check the voltage again on each gate-driver board as described in step 4 above. The voltage should be 4…5V DC.

7. Locate the Portable Test Power Supply that was included with the equipment, and verify that the rating corresponds to the available power system (i.e., 110/120V AC or 220/240V AC). Plug the unit into the power source, and plug the green connector into J1 on each of the gate driver boards (see Figure 21).

Figure 21 - Test Power Application on Gate Driver Board



8. The yellow LED on the upper right-hand side of the energized gate driver circuit should be lit (it may appear dim, depending on ambient light conditions). While the gate pulses are still on, check the voltage on each gate driver board as described in step 4 above. The voltage should be 10…12V DC. If the voltage is less than 5V, then you have a bad gate drive board. Do not leave the Portable Test Power Supply connected to a bad gate driver board. The power supply adapter will burn up if the gate driver board is shorted.

9. A more detailed check is performed by verifying the actual gate pulses by connecting an oscilloscope between TP1 and TP3 (-) (see Figure 4 on page 16). To check gate pulses, the pulse generator must be enabled (i.e. SW2 toggled up) and the Portable Test Power Supply should be connected to J1. The pulse should appear as shown in Figure 22 and Figure 23.

Figure 22 - Gate Pulse Detail – Typical SCR (ABB)

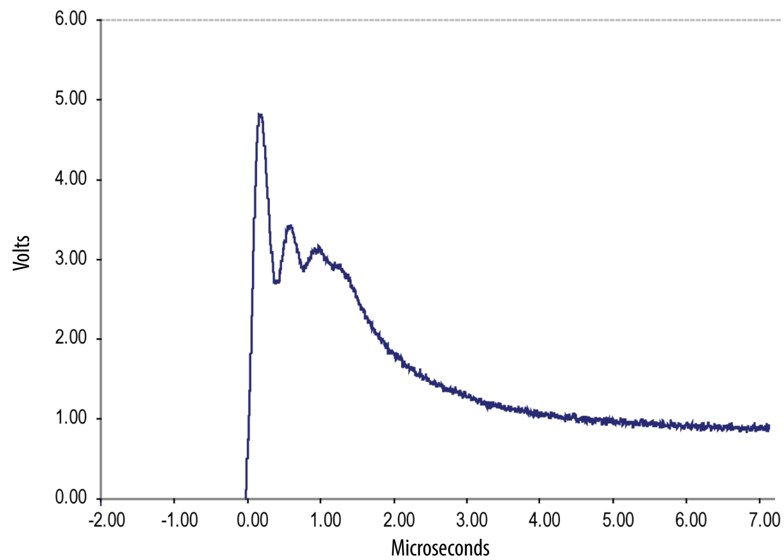
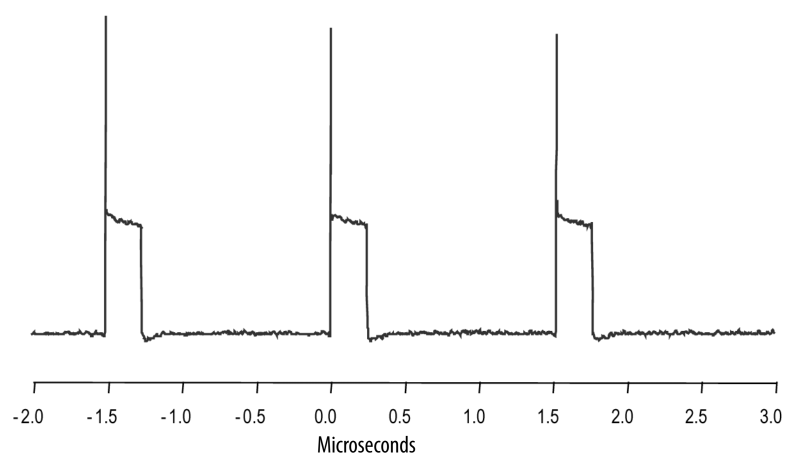


Figure 23 - Gate Pulse Test Waveform



10. If no pulse is observed, and the yellow LED is lit, check for a shorted gate on the SCR by removing the green plug and connecting an ohmmeter to the gate leads. If the LED is not lit, and the circuit voltage is as specified in step 8 (above), pinch the tab on the blue fiber-optic connector and carefully pull it straight out of the receiver. The end of the connector should glow red to indicate the presence of a gate signal.

ATTENTION: Do not look directly into the end of the fiber optic cable.

If it does not, remove the other end of the cable from the interface board and check that the grey transmitter is emitting red light. If it is, the fiber-optic cable must be replaced. If it isn't, the interface board should be replaced.

11. When each gate driver circuit has been checked, disconnect the power supply and remove it from the cabinet.

ATTENTION: The gate-drive circuits operate at high voltage when the SMC is energized. Failure to remove the portable test power supply will result in equipment damage and may cause severe injury or death.

12. Open the switch SW2 on the interface board (see Figure 21) before returning the unit to service. Ensure the red LED is off.

ATTENTION: If the SW2 switch is not in the open position when the SMC is energized, the motor will start in an uncontrolled manner and may cause severe damage.

13. 13.Check that all plugs and connectors are secure. Retrieve all hardware and tools from the equipment. Replace and secure any barriers removed during servicing and close all doors before applying power.

ATTENTION: Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of controlled equipment. Recommended practice is to disconnect and lock out control equipment from power sources, and allow any stored energy in capacitors to dissipate. The safety related work practices of NFPA 70E, Electrical Safety Requirements for Employee Workplaces, must be followed if it is necessary to work in the vicinity of energized equipment.

1. Apply rated control voltage to the control circuit.
2. Using the control schematic, apply control signals to cause relays and contactors to energize, to verify operation.
3. Remove any jumpers used in the test and restore all circuits to normal when finished.

Start-Up

1. Remove any temporary jumpers or grounding devices used during commissioning.
2. Check that all tools are removed from the equipment. Any tools or hardware used or dropped during installation and commissioning must be retrieved and accounted for.
3. Check that all barriers or covers removed during installation or commissioning have been securely mounted.
4. Close and secure all doors, and verify function of all interlocks that prevent access to medium voltage compartments when the unit is energized.
5. The controller is ready to power the motor.

Spare Parts

For a complete listing of spare parts, refer to Appendix C.

Component Deratings

Deratings Specifications

The components described in this publication may be applied in a wide variety of situations. Some applications may require component derating. For example, at altitudes above 1000 m (3300 ft), the maximum current and basic impulse level (BIL) are reduced as shown in Table 10.

Table 10 - Component Derating Table

Altitude Rating	Reduce Max. Continuous Current Rating by:			B.I.L. Withstand Rating	
	160 A c	340 A	580 A	12 kV	15 kV
0…1000 m (0…3300 ft)	—	—		75 kv	95 kV
1001…2000 m (3301…6600 ft)	5 A	10 A	15 A	66 kV	84 kV
2001…3000 m (6601…9900 ft)	10 A	20 A	30 A	59 kV	74 kV
3001…4000 m (9901…13,200 ft)	15 A	30 A	45 A	52 kV	66 kV
4001…5000 m (13,201…16,500 ft)	20 A	40 A	60 A	46 kV	58 kV

Notes:

Typical Schematic Diagrams

Introduction

This Appendix contains a typical schematic for a complete MV SMC Flex controller (refer to Figure 24).

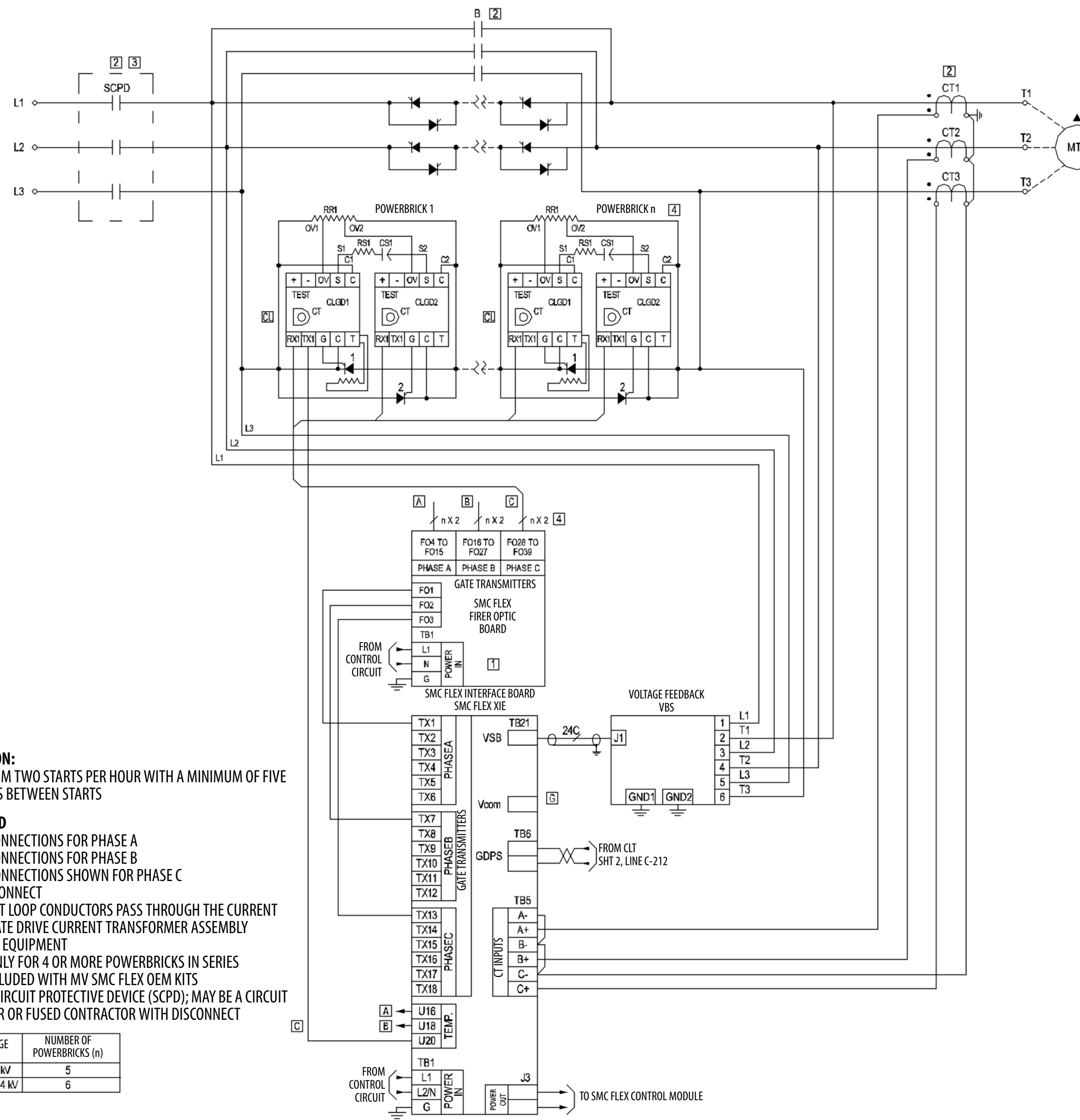
Refer to publication 1560E-UM051_-EN-P for additional samples of control wiring configurations. The examples shown are not a recommendation for the correct wiring configurations, nor is the OEM required to follow this design exactly.

The OEM must ensure that all wiring for the unit meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

Rockwell Automation does not assume any responsibility or liability for loss or damages caused by failures in the unit manufactured by the OEM.

For more information, see the Warranty section in General Terms and Conditions of Sale, Publication 6500-CO001_-EN-P.

Figure 24 - Typical Power System Diagram (10-15 kV)



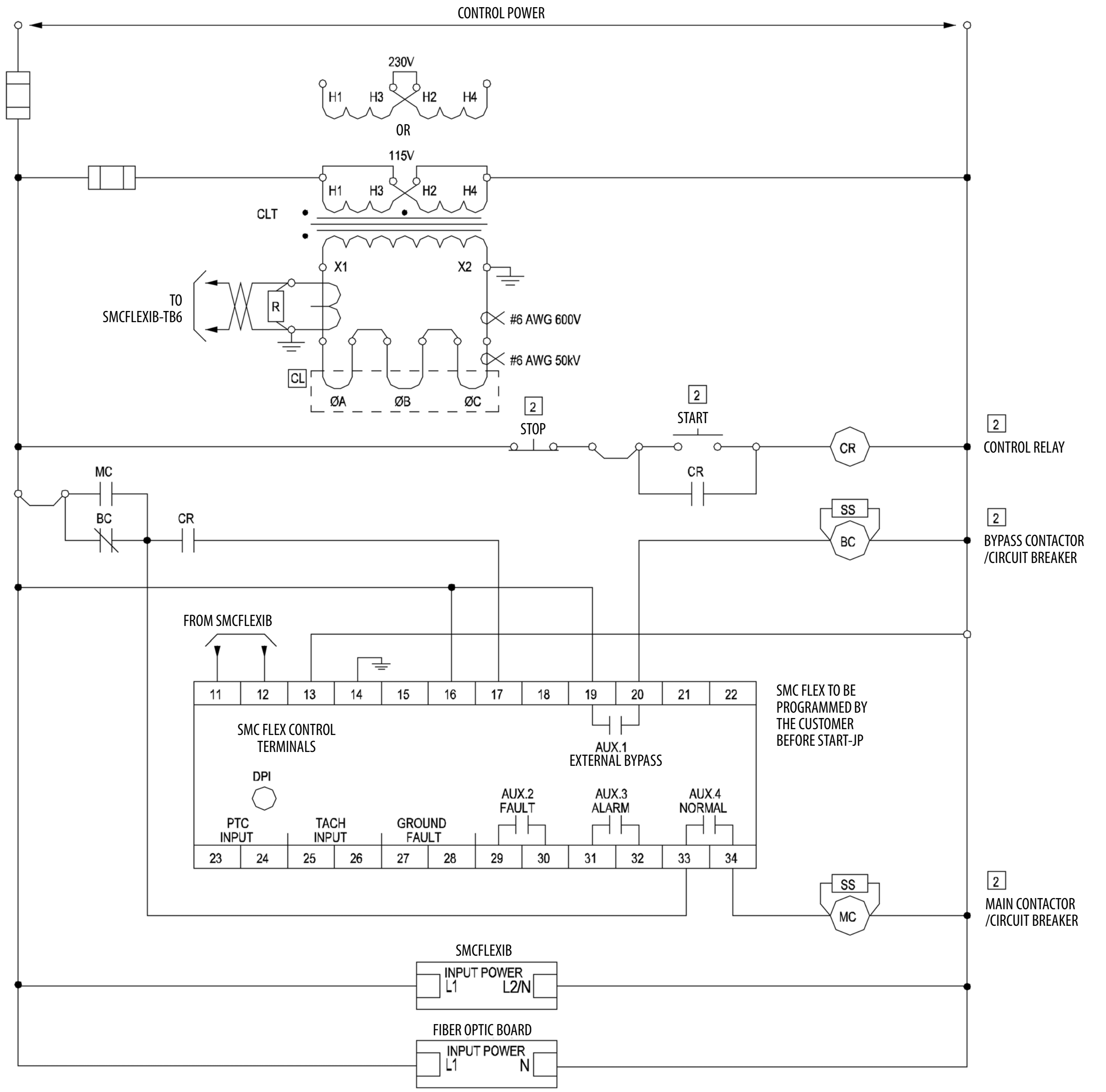
CAUTION:
MAXIMUM TWO STARTS PER HOUR WITH A MINIMUM OF FIVE MINUTES BETWEEN STARTS

LEGEND
- A WIRE CONNECTIONS FOR PHASE A
- B WIRE CONNECTIONS FOR PHASE B
- C WIRE CONNECTIONS SHOWN FOR PHASE C
- G DON'T CONNECT
- CL CURRENT LOOP CONDUCTORS PASS THROUGH THE CURRENT LOOP GATE DRIVE CURRENT TRANSFORMER ASSEMBLY
- ▲ REMOTE EQUIPMENT
- 1 USED ONLY FOR 4 OR MORE POWERBRICKS IN SERIES
- 2 NOT INCLUDED WITH MV SMC FLEX OEM KITS
- 3 SHORT CIRCUIT PROTECTIVE DEVICE (SCPD); MAY BE A CIRCUIT BREAKER OR FUSED CONTRACTOR WITH DISCONNECT
- 4

VOLTAGE	NUMBER OF POWERBRICKS (n)
10 - 12 kV	5
12.1 - 14.4 kV	6

Note: Requires input disconnection (optional), as well as main and bypass vacuum contactors.

Figure 25 - Typical Control Circuit, Standard Module (10-15 kV)



LEGEND

CL CURRENT LOOP CONDUCTORS PASS THROUGH THE CURRENT LOOP GATE DRIVE CURRENT TRANSFORMER ASSEMBLY

2 NOT INCLUDED WITH MV SMC FLEX OEM KITS

Note: Requires optional Main and Bypass control panels, as well as control relays and pilot devices.

Notes:

Spare Parts

PowerBricks

Table 11 - PowerBrick Replacements

Part Number	Description	Match Designator	PowerBrick Current Rating
81020-232-51-R	Heatsink Assembly only	W	160 A
81020-753-51-R		IJ	
81020-230-51-R	Complete PowerBrick	W	
81020-752-51-R		IJ	
81020-232-57-R	Heatsink Assembly only	Y	340 A
81020-232-58-R		Z	
81020-230-57-R	Complete PowerBrick	Y	
81020-230-58-R		Z	
81020-753-85-R	Heatsink Assembly only	DM	580 A
81020-753-86-R		DN	
81020-752-85-R	Complete PowerBrick	DM	
81020-752-86-R		DN	

Table 12 - Snubber Capacitor / Snubber Resistor

Snubber Capacitor	Part Number
	200/400 Amp
All voltages	80026-508-02 (0.68 µF)

Snubber Resistor(1)	Part Number(2)
	200/400 Amp
3 per PowerBrick	80026-561-02-R (20 Ω, 120 W)

(1) All parts are ceramic, wirewound, non-inductive winding.

(2) Resistors are series connected for a total of 60 ? per snubber for 180/360A assemblies and 30 ? per snubber for 600A assemblies. A PowerBrick has one snubber per pair of SCRs.

Table 13 - Common Parts

Part Number	Description		Quantity
80026-562-01-R	Sharing resistor 16.25 kS, 112W, 2.5 k, tap		2 per SCR pair(1)
80190-519-02-R	Current loop self-powered gate driver board (CLGD)		1 per SCR(1)
81020-237-52-R	Voltage Sensing Board (VSB)	10-12 kV	1 per controller
81020-237-53-R		12.1-15 kV	
80190-440-03-R	Interface Board		1 per controller

Part Number	Description		Quantity
80190-679-01-R	Fiber optic multiplexer Board		1 per controller
80025-549-03-R	Fiber Optic Cable	2.5 m (8.2 ft)	(1 per SCR) + 6(1)
80025-549-01		5 m (16.4 ft)	
80187-051-51-R	Test Power Supply	120V AC for North America	1 per controller
80187-245-51-R		Universal	
80022-133-01	Current loop transformer	50 VA, 115/230 : 0.6V	1 per controller
80022-133-02		100 VA, 115/230:1.5V	
80018-246-56	Current loop cable	(4.3 m) 14 ft	(2)
80018-246-57		(6.4 m) 21 ft	
80022-163-01	Current loop sense CT		1 per controller
80026-146-56	Ribbon cable from VSB to Interface Board		1 per controller
80174-201-01	Ribbon cable from control module to Interface board	6-pin	2 per controller
80174-201-02		8-pin	3 per controller

(1) Refer to table C.1 for an explanation of the number of SCRs per controller, which is voltage dependent.

(2) Different lengths may be used for various configurations. The current loop total length must conform to the requirements of Section 3, Current Loop Gate Drive Power Assembly.

Table 14 - Accessories

Part Number	Description	Quantity
41391-454-01-S1FX	Control Module (Standard)	1
41391-454-01-B1FX	Control Module (Pump Control)	

Notes:

1.Reference only.

2. 7703E – For OEM products, refer to OEM-supplied documentation for specific spare parts list.

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