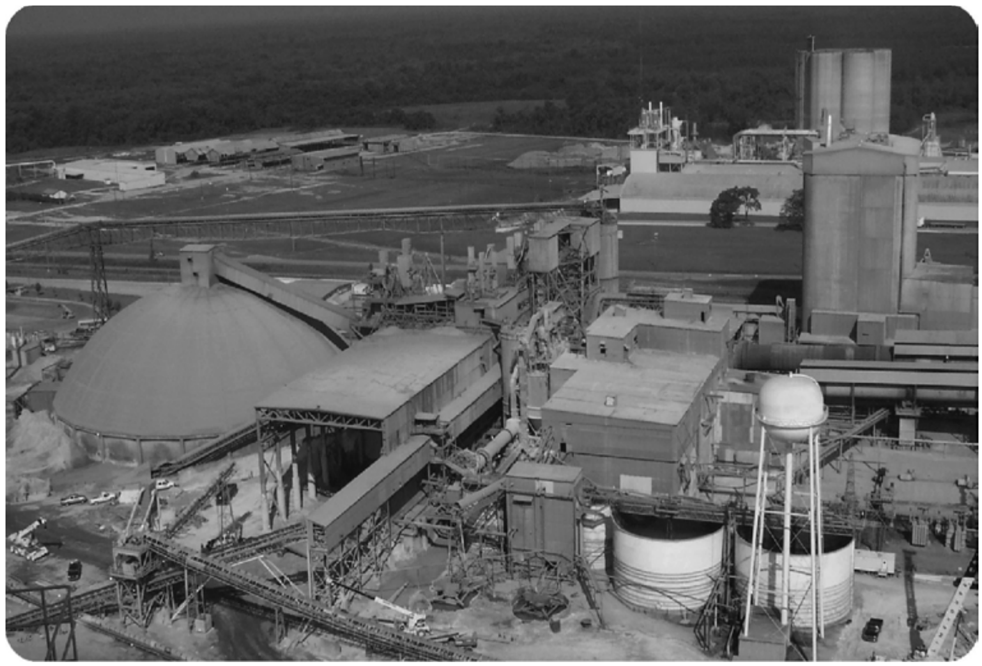
Bulletin 7000 User Manual

Allen-Bradley

PowerFlex® 7000 Medium Voltage AC Drive Air-Cooled ("A" Frame)—ForGe Control

Publication Number 7000A-UM200B-EN-P



Allen-Bradley • Rockwell Software

Rockwell Automation

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

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.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

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.

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).

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

Allen-Bradley, Rockwell Software, Rockwell Automation, and TechConnect are trademarks of Rockwell Automation, Inc.

Trademarks not belonging to Rockwell Automation are property of their respective companies.

This manual contains new and updated information.

New and Updated Information

This table summarizes the changes made to this revision.

Topic	Page
Added instructions to install Redundant Fan assembly	29
Updated Chromate Plating section	193
Updated Door Filter and Enclosure sections	198
Updated standard altitude information	198
Inserted History of Changes appendix	199

Changes made to this manual for previous revisions are included in the History of Changes on page 199.

Notes:

Component Definition and Maintenance

Chapter 3

Appendix A

Commissioning

Appendix B

Catalog Number Explanation

Appendix C

Preventative Maintenance Schedule

Appendix D

Torque Requirements

Appendix E

Meggering

Appendix F

Line & Load Cable Sizes

Appendix G

Environmental Considerations

Appendix H
Specifications

Appendix I
History of Changes

Index

This document provides procedural information for managing daily or recurring tasks involving the PowerFlex 7000 medium voltage “A” Frame drives.

Who Should Use This Manual

This manual is intended for use by personnel familiar with medium voltage and solid-state variable speed drive equipment. The manual contains material that enables regular operation and maintenance of the drive system.

What Is Not in this Manual

This manual provides information specific to maintaining the PowerFlex 7000 “A” Frame drive. It does not include topics such as:

- Dimensional and electrical drawings generated for each customer’s order
- Spare parts lists compiled for each customer’s order
- Human Machine Interface (HMI) operation and configuration

Please refer to the following documents for additional product detail or instruction relating to PowerFlex 7000 “A” Frame drives:

- Drive-specific Technical Data: additional troubleshooting, parameters, and specification information for MV variable frequency drives (7000-TD002_-EN-P).
- Operator Interface Guide: HMI Offering with Enhanced Functionality (7000-UM201_-EN-P).
- For drives equipped with the PanelView 550 HMI, see (7000-UM151_-EN-P).

Rockwell Automation provides the site- and installation-specific electrical and design information for each drive during the order process cycle. If they are not available on site with the drive, contact Rockwell Automation.

If you have multiple drive types or power ranges, ensure you have the correct documentation for each specific PowerFlex 7000 product:

- “A” Frame for lower power air-cooled configurations (up to approximately 1250 hp/933 kW)
- “B” Frame for higher-power, air-cooled configurations (heat sink or heat pipe models)
- “C” Frame for all liquid-cooled configurations

General Precautions

ATTENTION: This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference Allen-Bradley publication 8000-4.5.2, “Guarding Against Electrostatic Damage” or any other applicable ESD protection handbook.

ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as, undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures may result in malfunction of the system.

ATTENTION: Only personnel familiar with the PowerFlex 7000 Adjustable Speed Drive (ASD) and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

Additional Resources

These documents contain additional information concerning "A" Frame drives and related products from Rockwell Automation.

Resource	Description
Publication 7000-PP002_-EN-P	PowerFlex 7000 Air-Cooled Drives Product Profile
Publication 7000A-UM150_-EN-P	PowerFlex 7000 Medium Voltage AC Drive (A Frame) - Classic Control
Publication 7000A-UM151_-EN-P	PowerFlex 7000 Medium Voltage AC Drive (A Frame) - ForGe Control (Using PanelView 550)
Publication 7000-TD001_-EN-P	PowerFlex 7000 Medium Voltage AC Drive (Firmware Version 6.xxx) - Classic Control
Publication 7000-TD002_-EN-P	PowerFlex 7000 Medium Voltage AC Drive (Firmware Version 9.xxx) - ForGe Control
Publication 7000-UM201_-EN-P	PowerFlex 7000 HMI Offering with Enhanced Functionality
Publication 7000-QS002_-EN-P	HMI Interface Board Software Updater and Firmware Download Procedure
Publication 7000-IN010_-EN-P	Handling, Inspection, and Storage of Medium Voltage Line Filter Capacitors

You can view or download publications at http:/www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Overview of Drive

Introduction

The PowerFlex 7000 is a general purpose, stand-alone, medium voltage drive that controls speed, torque, direction, starting and stopping of standard asynchronous or synchronous AC motors. It works on numerous standard and specialty applications such as fans, pumps, compressors, mixers, conveyors, kilns, fan-pumps, and test stands in industries such as petrochemical, cement, mining and metals, forest products, power generation, and water/waste water.

The PowerFlex 7000 meets most common standards from the National Electrical Code (NEC), International Electrotechnical Commission (IEC), National Electrical Manufacturers Association (NEMA), Underwriters Laboratories (UL), and Canadian Standards Association (CSA). It is available with the world's most common supply voltages at medium voltage, from 2400…6600V.

The design focus is on high reliability, ease of use, and lower total cost of ownership.

Topology

The PowerFlex 7000 utilizes a Pulse Width Modulated (PWM) – Current Source Inverter (CSI) topology. This topology offers a simple, reliable, cost-effective power structure that is easy to apply to a wide voltage and power range. The power semiconductor switches used are easy-to-series for any medium voltage level. Semi-conductor fuses are not required for the power structure due to the current limiting DC link inductor.

With 6500V PIV rated power semiconductor devices, the number of inverter components is kept to a minimum. For example, only six inverter switching devices are required at 2400V, 12 at 3300…4160V, and 18 at 6600V.

The PowerFlex 7000 has the additional benefit of inherent regenerative braking for applications where the load is overhauling the motor, or where high inertia loads need to be slowed down quickly. Symmetrical Gate Commutated Thyristors (SGCTs) are used for machine converter switches and line converter switches.

Rectifier Designs

Configurations

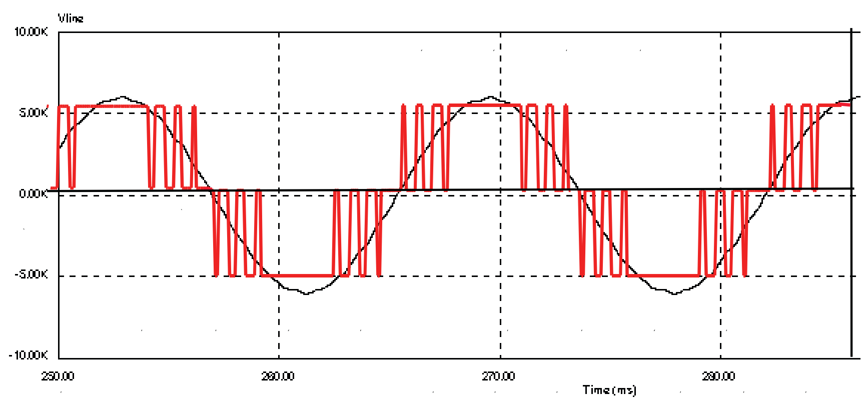
The PowerFlex 7000 offers three rectifier configurations for "A" Frame drives:

- Direct-to-Drive (Active Front End [AFE] rectifier with integral line reactor and Common Mode Choke)
- AFE rectifier with separate isolation transformer
- AFE rectifier with integral isolation transformer

Direct-to-Drive

Direct-to-Drive™ technology does not require an isolation transformer or multiple rectifier bridges as in Voltage Source Inverter (VSI) topologies offered by others. The approach is completely different. Instead of multiple uncontrolled rectifiers, a single AFE rectifier bridge is supplied. The rectifier semiconductors used are Symmetrical Gate Commutated Thyristors (SGCTs). Unlike the diodes used in VSI rectifier bridges, SGCTs are turned on and off by a gating signal. A Pulse Width Modulation (PWM) gating algorithm controls the firing of the rectifier devices, very similar to the control philosophy of the inverter. The gating algorithm uses a specific 42 pulse switching pattern called Selective Harmonic Elimination (SHE) to mitigate the 5th, 7th, and 11th harmonic orders.

Figure 1 - Typical PWM switching pattern, line voltage waveform

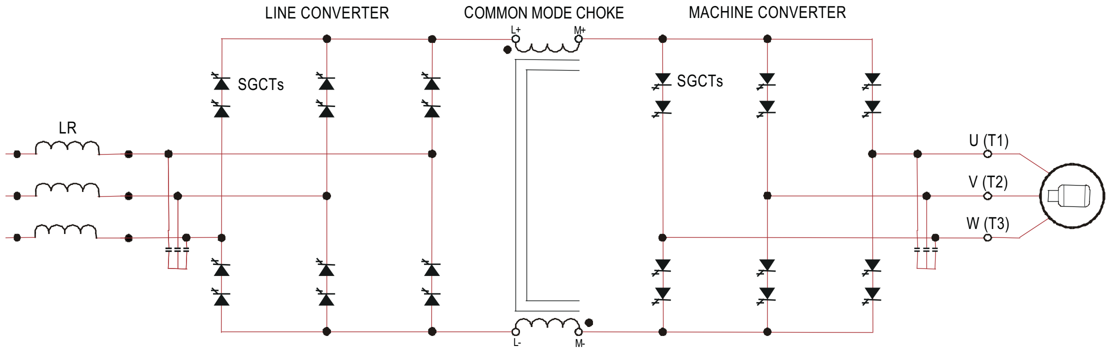


A small integral line reactor and capacitor addresses the high harmonic orders (13th and above) and provides virtually sinusoidal input voltage and current waveforms back to the distribution system. This delivers excellent line-side harmonic and power factor performance to meet IEEE 519-1992 requirements and other global harmonic standards in virtually all cases, while still providing a simple, robust power structure that maximizes uptime by minimizing the number of discrete components and the number of interconnections required.

A Common Mode Choke (CMC) mitigates the common mode voltage seen at the motor terminals, so standard (non-inverter duty rated) motors and motor cables can be used, making this technology ideal for retrofitting existing motor applications.

An integral starter is offered as an option.

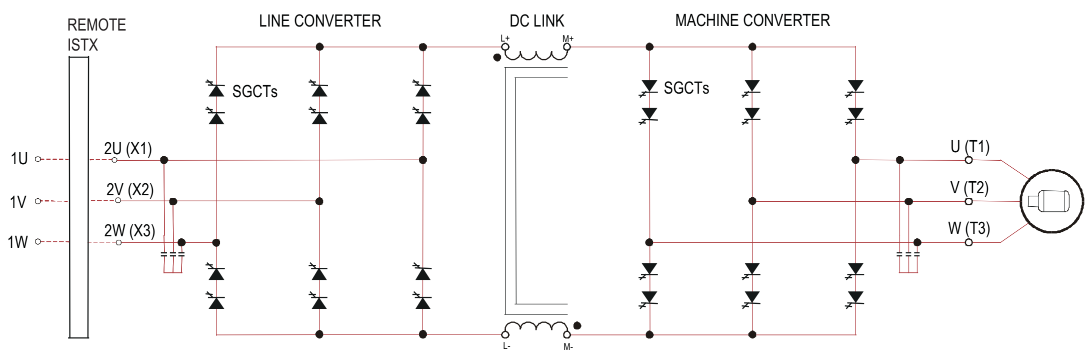
Figure 2 - 3300/4160V Direct-to-Drive (transformerless AFE rectifier)



AFE Rectifier with Separate Isolation Transformer

For applications when the line voltage is higher than the motor voltage, a transformer is required for voltage matching. In this case, providing an AFE rectifier with a separate isolation transformer is ideal (indoor and outdoor transformer versions are offered). The isolation transformer provides the input impedance (replaces the requirement for an integral line reactor) and addresses the common mode voltage (replaces the requirement for a CMC that is supplied in the Direct-to-Drive rectifier configuration). However, the AFE rectifier, its operation, and advantages are the same as the Direct-to-Drive configuration.

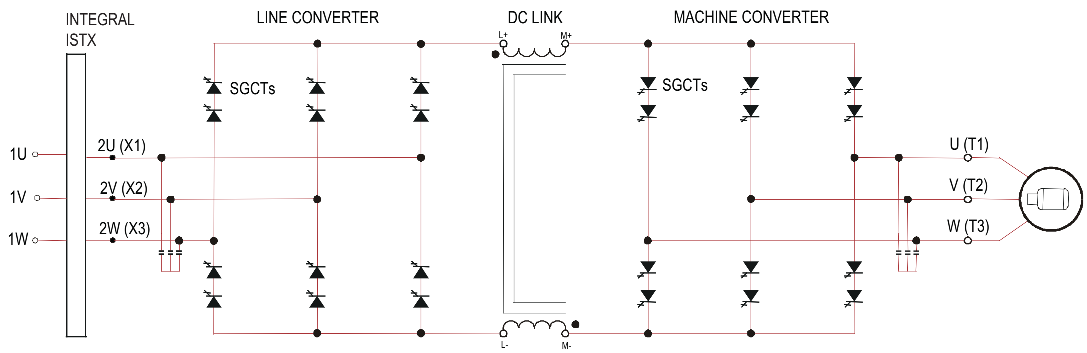
Figure 3 - 3300/4160 AFE Rectifier with separate isolation transformer



AFE Rectifier with Integral Isolation Transformer

For applications requiring a higher power rating than available with Direct-to-Drive, providing an AFE rectifier with an integral isolation transformer is ideal (indoor and outdoor transformer versions are offered). The isolation transformer provides the input impedance (replaces the requirement for an integral line reactor) and addresses the common mode voltage (replaces the requirement for a CMC that is supplied in the Direct-to-Drive rectifier configuration). However, the AFE rectifier, its operation, and advantages are the same as the Direct-to-Drive configuration.

Figure 4 - 3300/4160 AFE Rectifier with integral isolation transformer



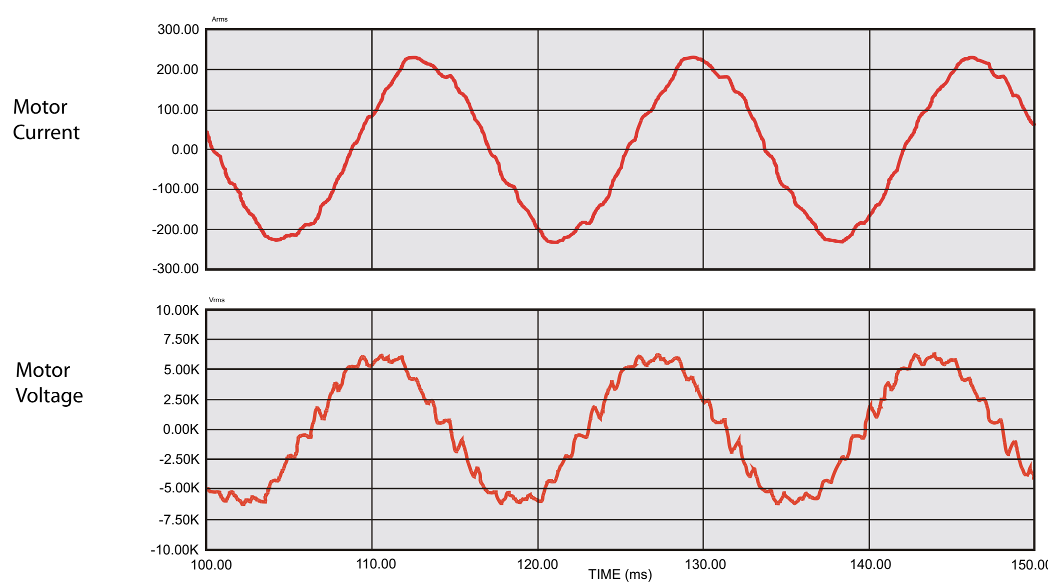
Motor Compatibility

The PowerFlex 7000 achieves near sinusoidal current and voltage waveforms to the motor, resulting in no significant additional heating or insulation stress. Temperature rise in the motor connected to the VFD is typically 3 °C (5.4 °F) higher compared to across-the-line operation. Voltage waveform has dv/dt of less than 50V/µs. Reflected wave and dv/dt issues often associated with VSI (voltage source inverter) drives do not exist with the PowerFlex 7000. Typical motor waveforms are shown in Figure 5. These motor friendly waveforms are achieved by utilizing a selective harmonic elimination (SHE) pattern in the inverter to eliminate major order harmonics, in conjunction with a small output capacitor (integral to the drive) to eliminate harmonics at higher speeds.

Standard motors are compatible without de-rating, even on retrofit applications.

Motor cable distance is virtually unlimited. This technology is capable of controlling motors up to 15 km (9.3 mi) away from the drive.

Figure 5 - Motor waveforms @ full load, full speed



Simplified Electrical Drawings

2400V

Figure 6 - 2400V - Direct-to-Drive (transformerless AFE rectifier)

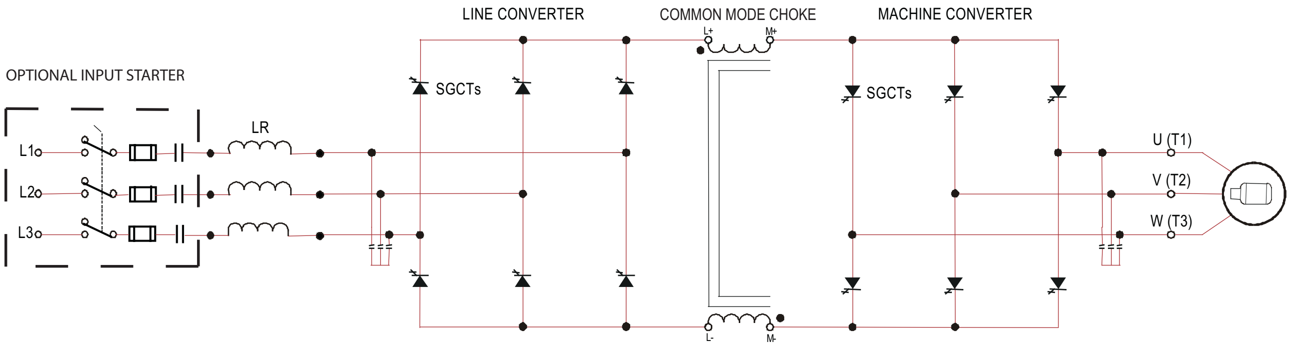


Figure 7 - 2400 Volt – AFE Rectifier with Separate Isolation Transformer

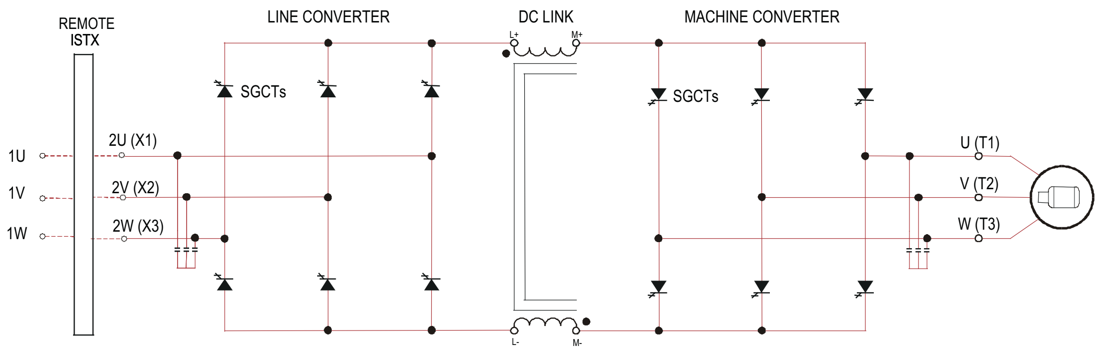
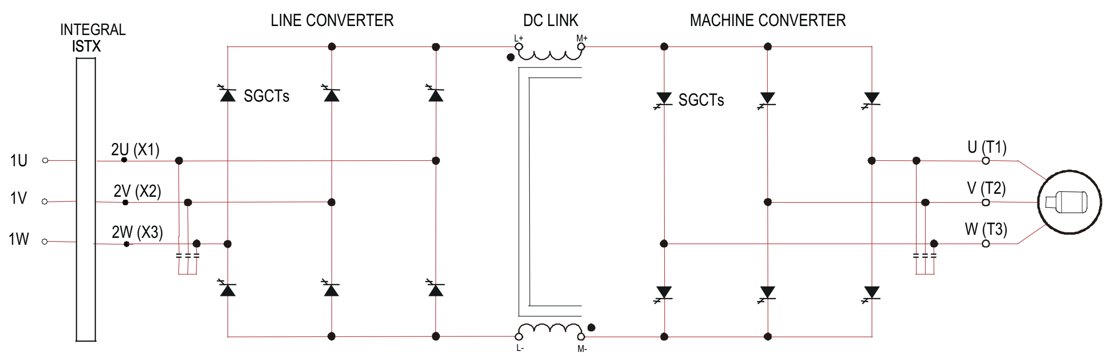


Figure 8 - 2400 Volt – AFE Rectifier with Integral Isolation Transformer



3300/4160V

Figure 9 - Direct-to-Drive (transformerless AFE rectifier)

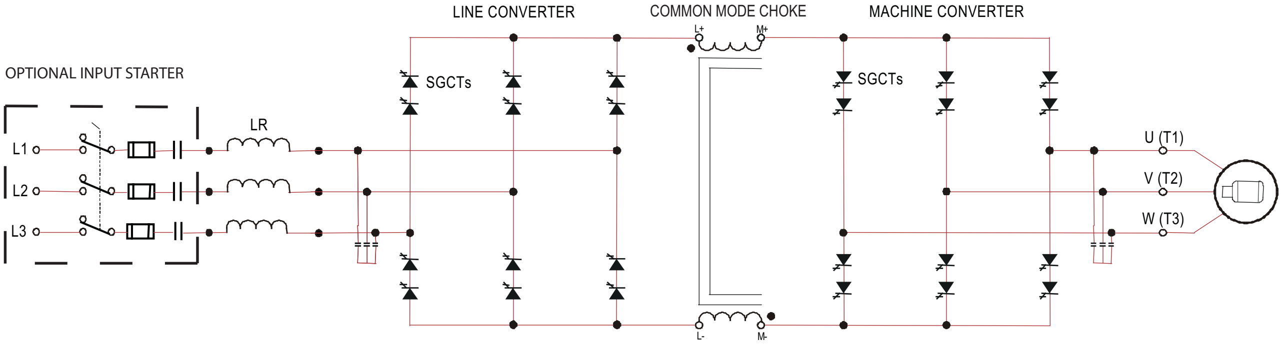


Figure 10 - AFE Rectifier with Separate Isolation Transformer

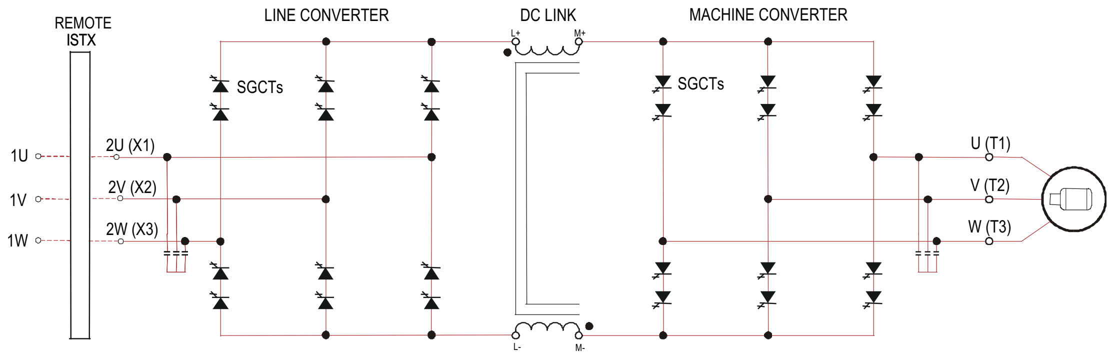
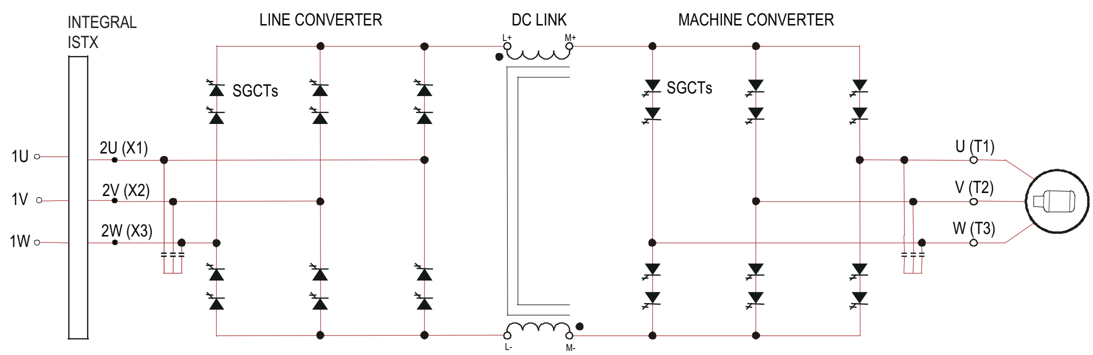


Figure 11 - AFE Rectifier with Integral Isolation Transformer



6600V

Figure 12 - Direct-to-Drive (transformerless AFE rectifier)

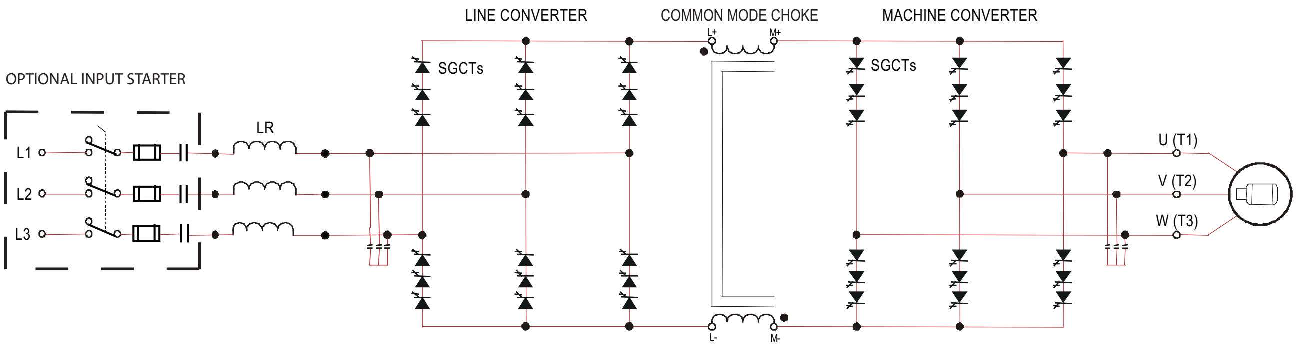


Figure 13 - AFE Rectifier with Separate Isolation Transformer

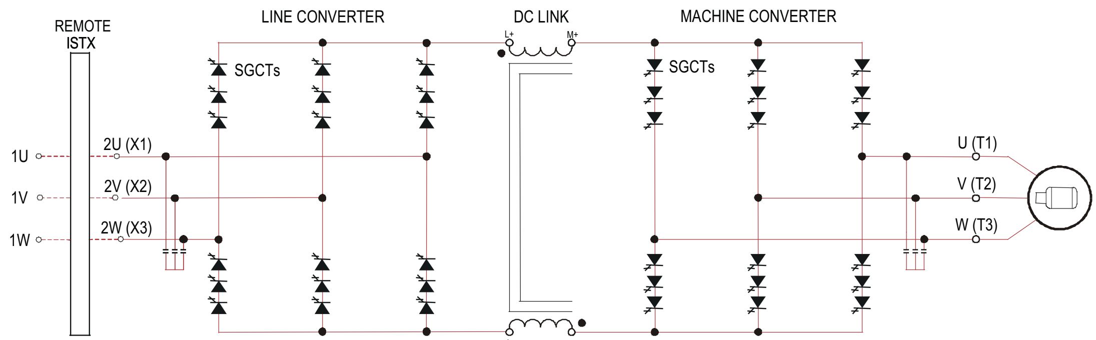
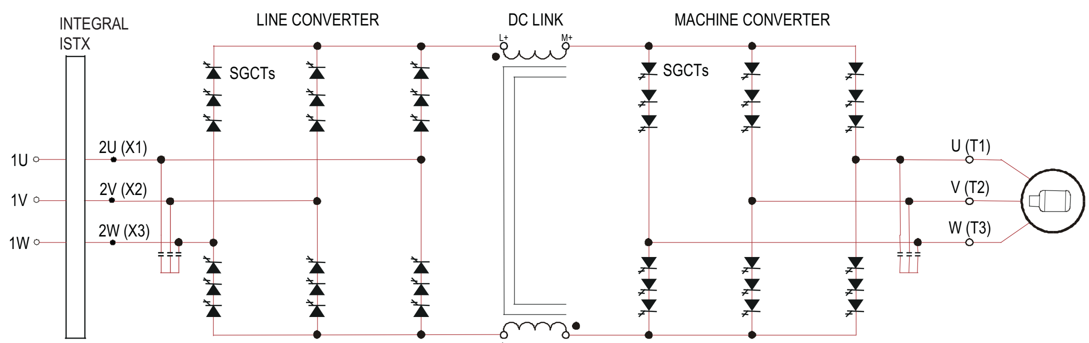


Figure 14 - AFE Rectifier with Integral Isolation Transformer



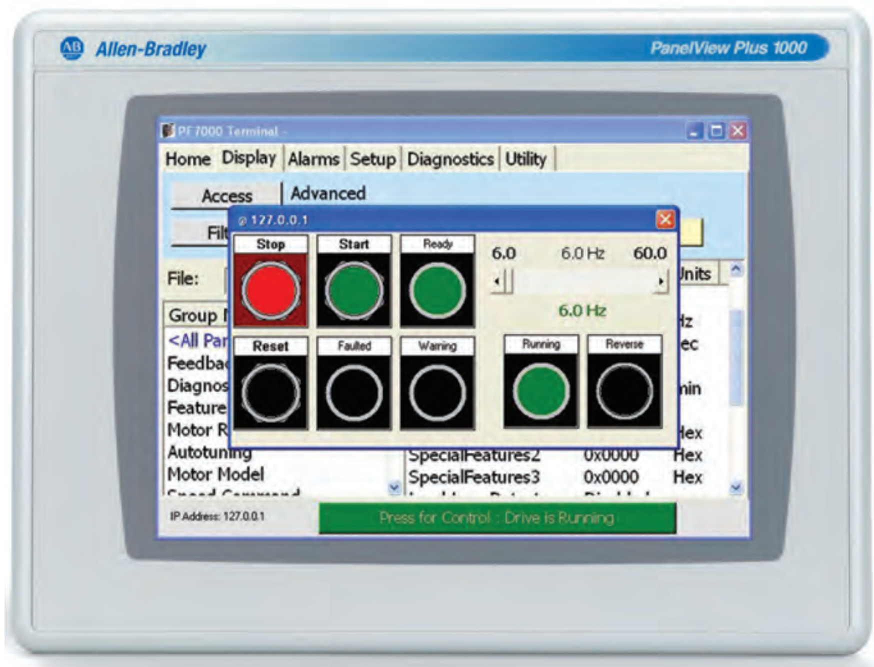
Operator Interface

The HMI Interface Board is an HMI-enabling device for the PowerFlex 7000 drive. It allows the user to acquire all the necessary executable tools, documentation and reports required to commission, troubleshoot and maintain the drive.

Via the HMI Interface Board, the user can choose the style and size of the desired Windows-based operator terminal to interact with the drive (e.g. PanelView CE terminal, laptop, or desktop computer). The HMI Interface Board removes past issues with compatibility between the drive and configuration tools, as all the necessary tools are acquired from the drive.

The HMI Interface Board is well suited for applications that require remote placement of the operator terminal and remote maintenance.

Figure 15 - Operator Interface



Basic Configurations

There are three basic configurations for the HMI.

Remote-mounted HMI

The HMI is not mounted in the traditional location on the low voltage door of the Variable Frequency Drive (VFD). A remote mounting plate, complete with E-Stop push button, and HMI is supplied loose for the customer to mount wherever desired. The HMI connects to the VFD via a hardwired Ethernet cable. There is no significant functional distance limitation.

This is ideal for non-PLC users wanting to control and monitor remotely (e.g. at the driven machine, control room, etc.). Also ideal for customers having policies in place to control access to medium voltage equipment and the associated requirements of PPE when using the operator interface at the VFD, etc.

Locally-mounted HMI

Similar to the previously offered PanelView 550, the HMI is mounted on the LV door of the VFD. There is also a service access port (RJ-45 connector) on the LV door.

No HMI supplied

A service access port (RJ-45 connector) is located on the LV door of the VFD. Customers use their own laptop as the HMI. All programs required to use the laptop as the HMI are stored in the VFD. Their laptop is connected to the VFD via a hardwired Ethernet cable, when required. This is ideal for unmanned sites, where a dedicated HMI is not required.

See Publication 7000-UM201_-EN-P for detailed instruction for the HMI.

See Publication 7000A-UM151_-EN-P for detailed instruction for "A" Frame drives using the PanelView 550 HMI.

Notes:

Drive Installation

Safety and Codes

WARNING: The Canadian Electrical Code (CEC), National Electrical Code (NEC), or local codes outline provisions for safely installing electrical equipment. Installation MUST comply with specifications regarding wire type, conductor sizes, branch circuit protection and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

Drive Storage

If it is necessary to store the drive, be certain to store in a clean dry dust free area.

Storage temperature should be maintained between -40…70 °C (-40…185 °F). If storage temperature fluctuates or if humidity exceeds 95%, space heaters should be used to prevent condensation. The drive should be stored in a heated building having adequate air circulation. The drive must never be stored outdoors.

Siting of the Drive

Site Considerations

The standard environment in which the equipment is designed to operate is:

- Elevation above sea level less than 1000 m (3250 ft)
- Ambient air temperature between 0…40 °C (32…104 °F)
- Relative humidity of the air not to exceed 95% non-condensing

For the equipment to operate in conditions other than those specified consult the local Rockwell Automation Sales office.

The equipment requires the following site conditions:

- Indoor installation only, no dripping water or other fluids
- Clean air for cooling requirements
- Level floor for anchoring the equipment. Refer to dimension drawings for the location of the anchoring points.
- The room in which the equipment is located must allow for full opening of the doors of the equipment, typically 1200 mm (48 in.). Also, allowances have to be made for clearance for fan removal. This fan allowance must be greater than 700 mm (27.5 in.) above the drive
- Allowance must be made for the stream of cooling air which exits the drive at the top. The flow of cooling air into and out the drive must be kept clear and uninhibited.

- The room in which the equipment is located must be large enough to accommodate the thermal losses of the equipment since air conditioning may be required; the ambient temperature must not exceed that for which the equipment is rated. The heat created by the drive is directly proportional to the power of the motor being driven and the efficiency of equipment within the room. If thermal load data is required contact the Rockwell Automation Sales office.
- The area in which the drive is located should be free of radio frequency interference such as encountered with some welding units. This may cause erroneous fault conditions and shut down the drive.
- The equipment must be kept clean. Dust in the equipment decreases system reliability and inhibits cooling.
- Power cable lengths to the motor are virtually unlimited due to the near sinusoidal voltage and current waveforms. Unlike voltage source drives, there are no capacitive coupling, dv/dt, or peak voltage issues that can damage the motor insulation system. The topology utilized in the PowerFlex 7000 medium voltage AC drive does not produce dv/dt or peak voltage problems, and has been tested with motors located up to 15 km from the drive.
- Only personnel familiar with the function of the drive should have access to the equipment.
- The drive is designed for front access and should be installed with adequate and safe clearance to allow for total door opening. The back of the unit may be placed against a wall although some customers prefer back access also.

ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Ambient conditions not within the specified ranges may result in malfunction of the drive.

Generator Note:

ATTENTION: Verify that the load is not turning due to the process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

Installation

When the drive has been placed at its installation area, the lag bolts that fasten the shipping skid to the drive must be removed. The drive is moved off the shipping skid and the shipping skid can be discarded.

Position the drive in its desired location. Verify that the drive is on a level surface and that the position of the drive will be vertical when the anchor bolts are installed.

The location of the anchor points is provided with the dimension drawing of the drive.

Install and tighten the anchor bolts. (M12 or ½" hardware required). Engineering bolt systems are required for seismic requirements. Consult factory.

Remove the top lifting angles, retain the hardware.

Install the hardware from the lifting angles in the tapped holes at the top of drive; this prevents leakage of cooling air as well as keeping dust out of the equipment.

Shock Indication Labels

Shock indication labels are devices that permanently record the physical shock to which equipment is subjected.

At the time of final preparation for shipment from the factory, a shock indication label is installed on the outside door of the converter cabinet.

During the shipping and installation process, drives may inadvertently be subjected to excess shock and vibration which may impair its functionality.

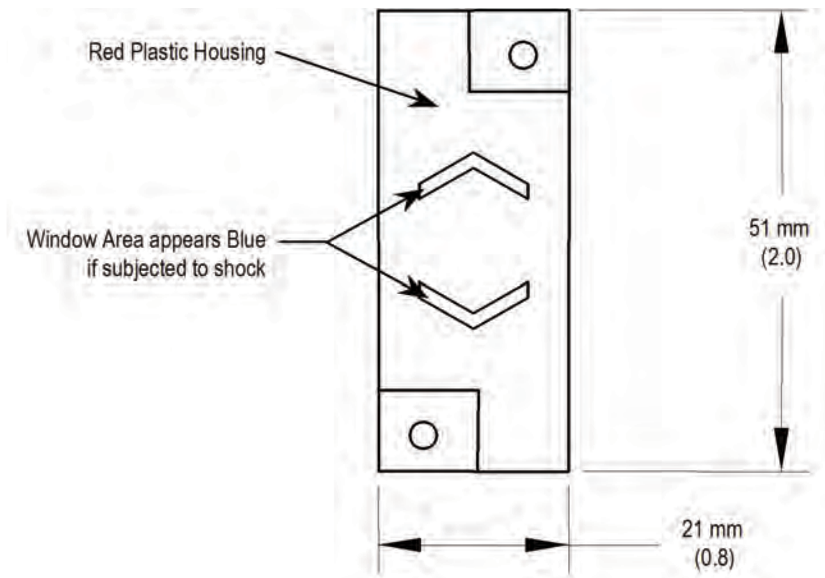
When the drive has been placed in its installation area, inspect the shock indication labels on the outside of the door.

The drive is shipped with a label that records shock levels in excess of 10G. If these shock levels have been attained, the chevron shaped window will appear blue in one of the two windows.

If the shock indicator is blue, contact Rockwell Automation Product Support Group in Cambridge, Ontario, Canada. The drive may have internal damage if it experienced physical shock during shipping or installation.

If the indicators show that no shock was attained, full inspection and verification in accordance with the Commissioning process outlined in page 159 is still essential.

Figure 16 - Shock Indicator



Installation of Exhaust Air Hood

On the top of the cabinet with the cooling fan, a sheet metal exhaust hood is to be installed. The components to make up the exhaust hood have been packaged and shipped with the drive. For drives with an acoustic hood, the components are shipped assembled. See Figure 18.

The first step is to remove the protective plate covering the fan opening on the drive. It is a flat cover plate bolted to the top plate. Remove the bolts and plate and set aside for re-use.

Secondly, loosely assemble the two L-shaped panel components shipped with the drive as per Figure 17.

Figure 17 - Fan Hood Assembly

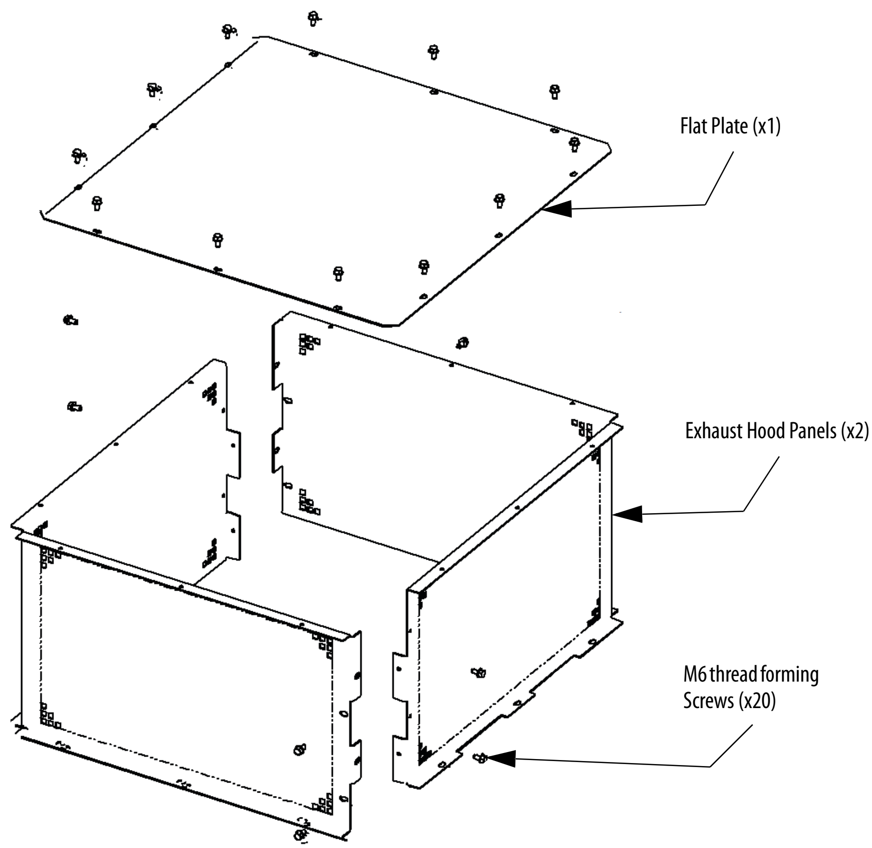
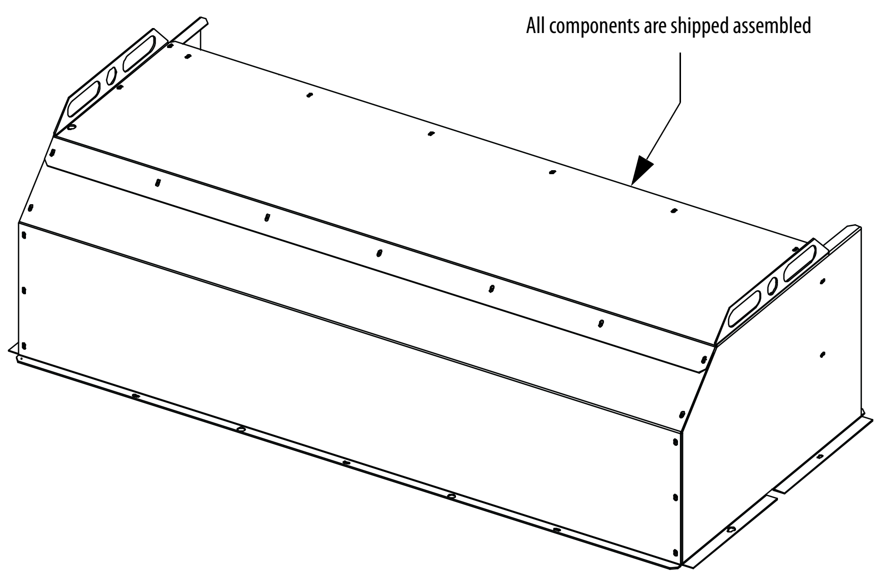


Figure 18 - Acoustic Fan Hood Assembly



Locate the exhaust hood on top of the cabinet per Figure 19 and re-install the original cover plate previously set aside. Care must be taken that the notches on the bottom flange are oriented toward the sides of the drive. Affix assembly to the drive top plate. Tighten all hardware.

For drives with an acoustic hood (shown in Figure 18), locate the exhaust hood (refer to Figure 20).

ATTENTION: Any screws that are accidentally dropped in the equipment must be retrieved as damage or injury may occur.

Figure 19 - Fan Hood Installation

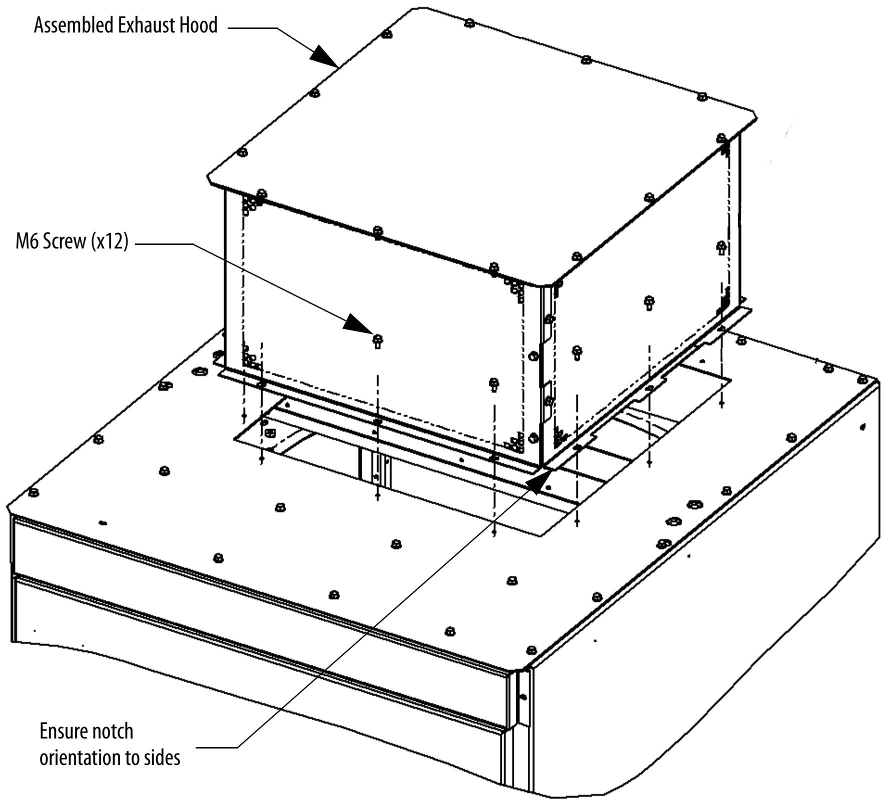
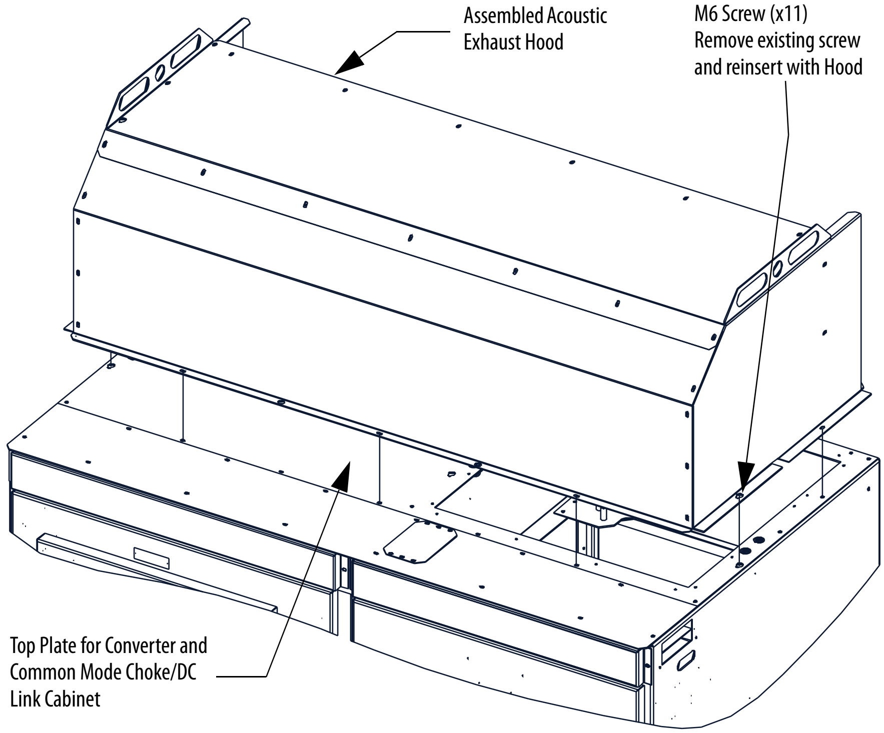


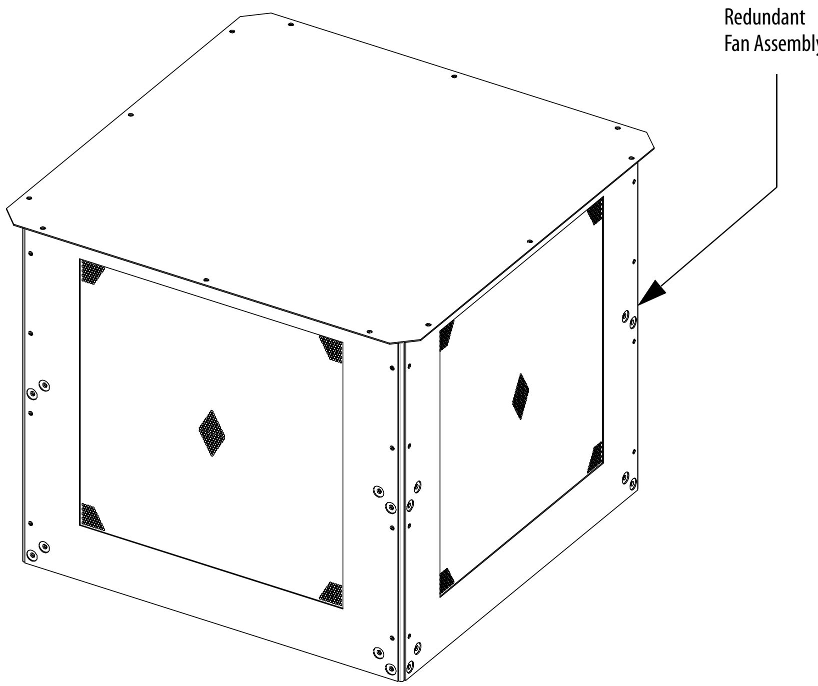
Figure 20 - Acoustic Fan Hood Installation



Installation of Redundant Fan Assembly

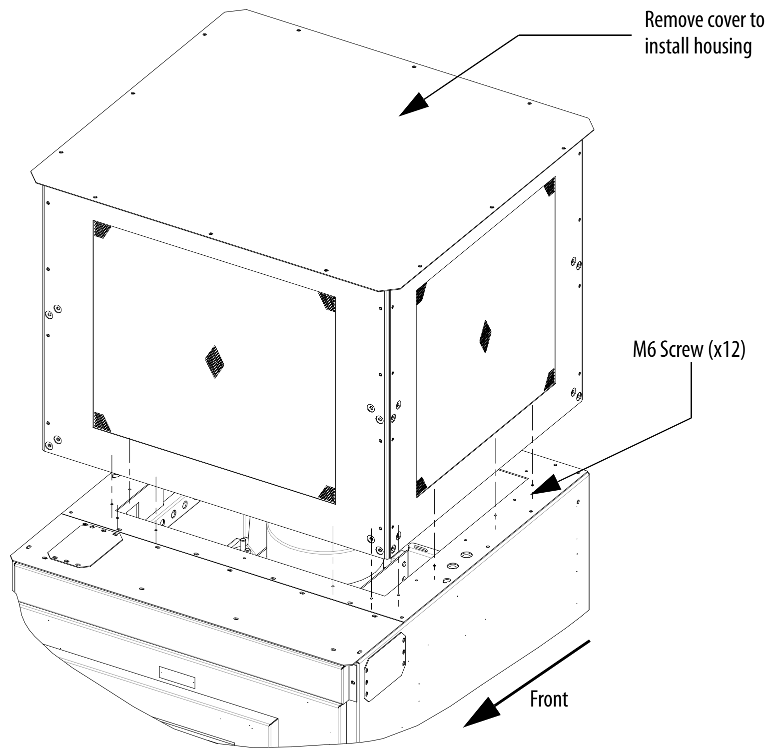
Redundant Fan components are shipped already assembled (Figure 21).

Figure 21 - Redundant Fan Assembly



1. Remove and discard the protective plate and associated hardware covering the fan opening on the cabinet.
2. Remove the top cover of the fan housing and set aside.
3. Remove the shipping cover plate on the bottom of the redundant fan assembly and discard.
4. Position the assembly over the opening, verifying the locating hole on the housing base aligns with the front right side of the cabinet.
5. Align the mounting holes and wire harness connections.

Figure 22 - Redundant Fan Assembly Orientation



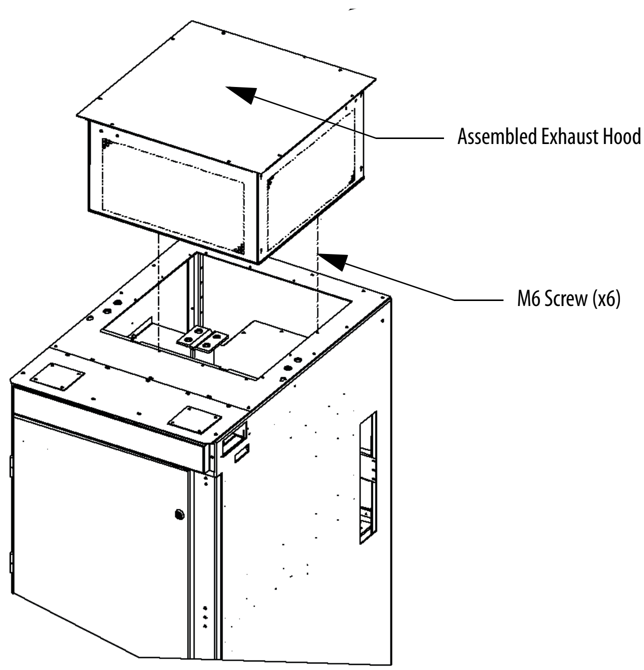
6. Affix the redundant fan assembly to the drive top plate with the M6 thread forming screws provided.
7. Connect the fan wire harness to fan.
8. Reinstall the top cover onto the fan housing and tighten all hardware.

Installation of Integral Transformer Cooling Fan

1. Remove the protective plate covering the fan opening on the top of Isolation Transformer cabinet and discard.
2. Locate the cooling fan on top of the cabinet. Position it over the opening and align the mounting holes and wire harness connections.
3. Affix the fan to the drive top plate with the M6 thread forming screws provided.

4. Connect the wire harness to fan.

Figure 23 - Fan Installation for Integral Isolation Transformer



Neutral Resistor Assembly

Figure 24 - Hood Assembly for Neutral Resistor

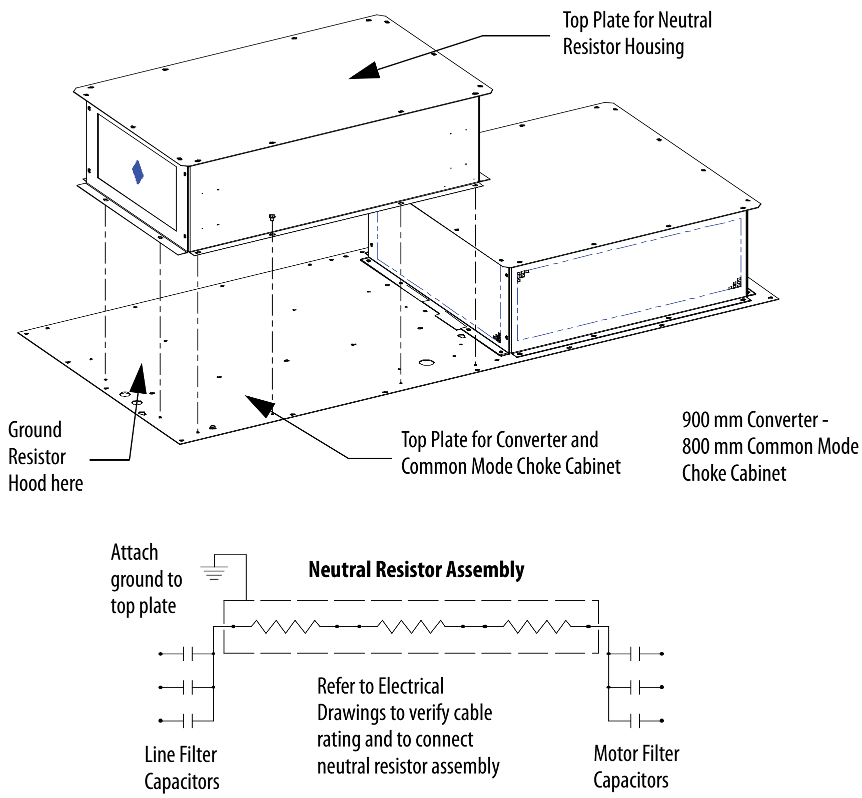
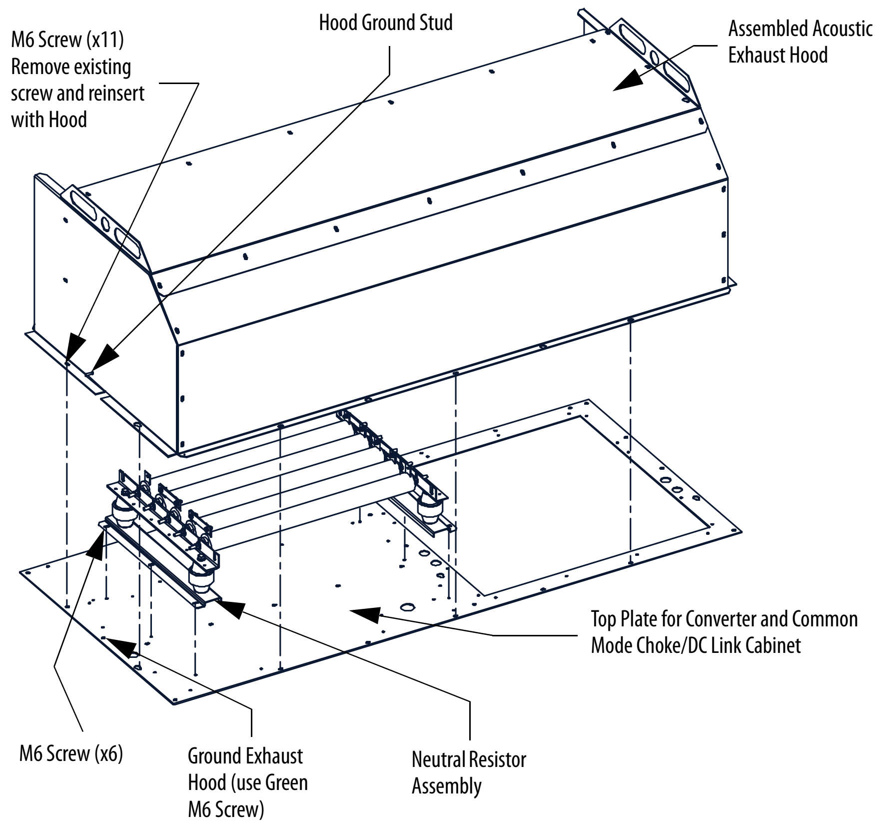


Figure 25 - Acoustic Hood Assembly for Neutral Resistor



Installation of Neutral Resistor Assembly (Direct-to-Drive)

On top of the converter cabinet, a sheet metal enclosure containing power resistors is to be installed.

1. Locate the resistor assembly on top of the cabinet as shown in Figure 24 (For acoustic hood assembly, refer to Figure 25).
2. Affix the assembly to the top plate using M6 thread forming screws provided.
3. Remove the top plate of the resistor assembly to permit access to the wiring connection points.
4. Connect the resistor wiring and per the electrical diagram provided with the drive, a typical connection diagram is shown in Figure 24. Ensure that the resistor wiring is routed through the hole having a plastic bushing to protect the wire insulation. The neutral resistor assembly housing has a ground connection that is to be connected to the top plate of the drive.
5. Re-install the top plate of the neutral resistor housing.

Cabinet Layout and Dimensional Drawings of Drive

The following dimension drawing is a sample and may not accurately detail your drive. It is provided here to give you a general overview of a typical drive.

The Dimensional Drawings are order specific and will show the information outlined.

The dimension drawing provides important information for the installation of the equipment.

The **FLOOR PLAN** shows:

- the locations for anchoring the equipment to the floor (balloon D)
- size and location of openings for bottom power cable entry (balloons A and B)
- size and location of openings for bottom control wiring entry (balloon C)

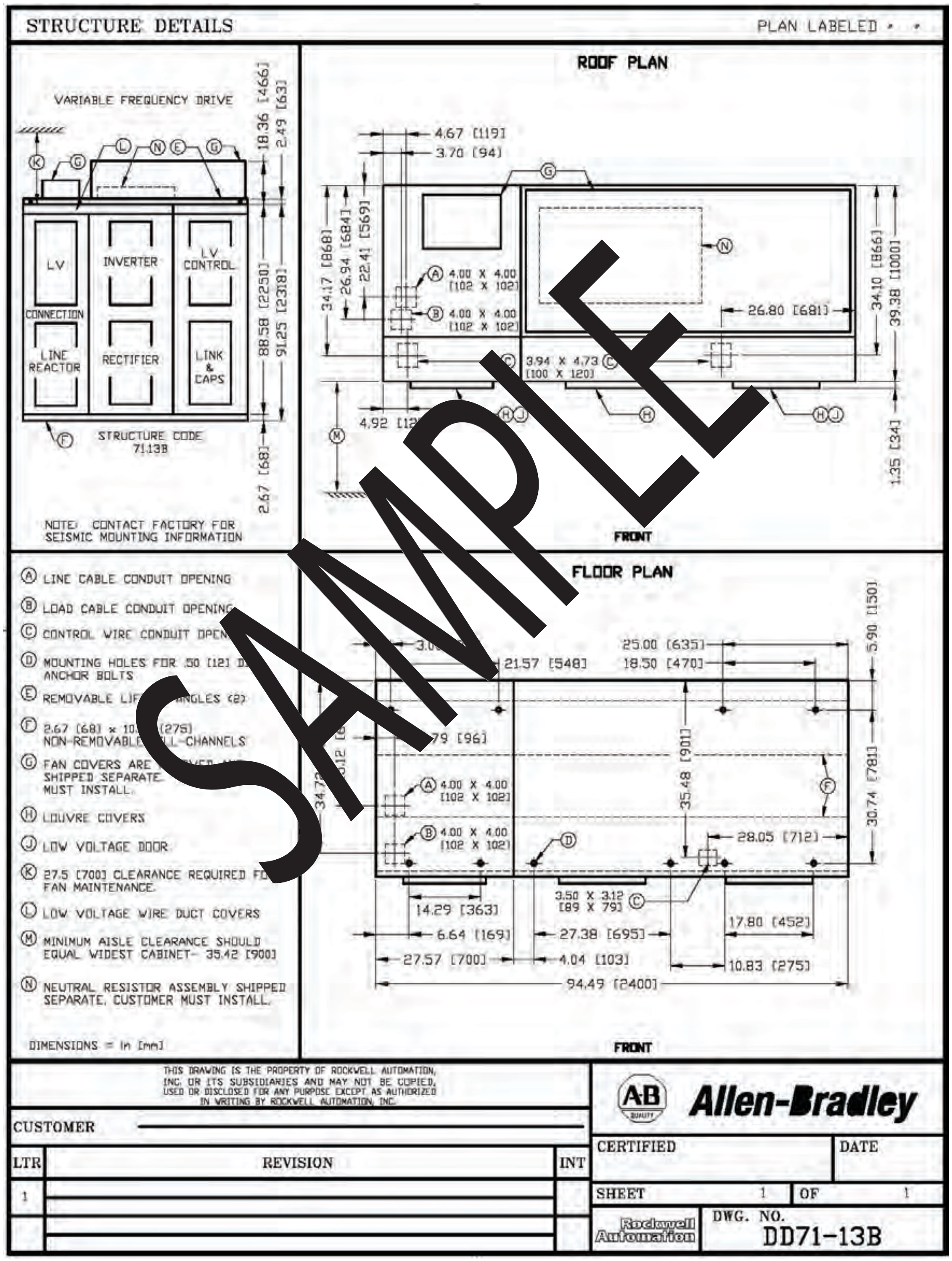
The **ROOF PLAN** shows:

- size and location of openings for top power cable entry (balloons A and B)
- size and location of openings for top control wiring entry (balloon C)
- minimum aisle clearance in front of equipment (balloon M)

The **FRONT VIEW** shows:

- minimum clearance required at top of drive for fan maintenance (balloon K)

Figure 26 - PowerFlex 7000 "A" Frame Dimensional Drawing



Note: Contact Factory for Seismic Mounting Information.

Drive Layout

The following diagrams show the typical layout of the three main configurations of the PowerFlex 7000 "A" Frame Drive.

Figure 27 - Direct-to-Drive (AFE with DTD DC Link)

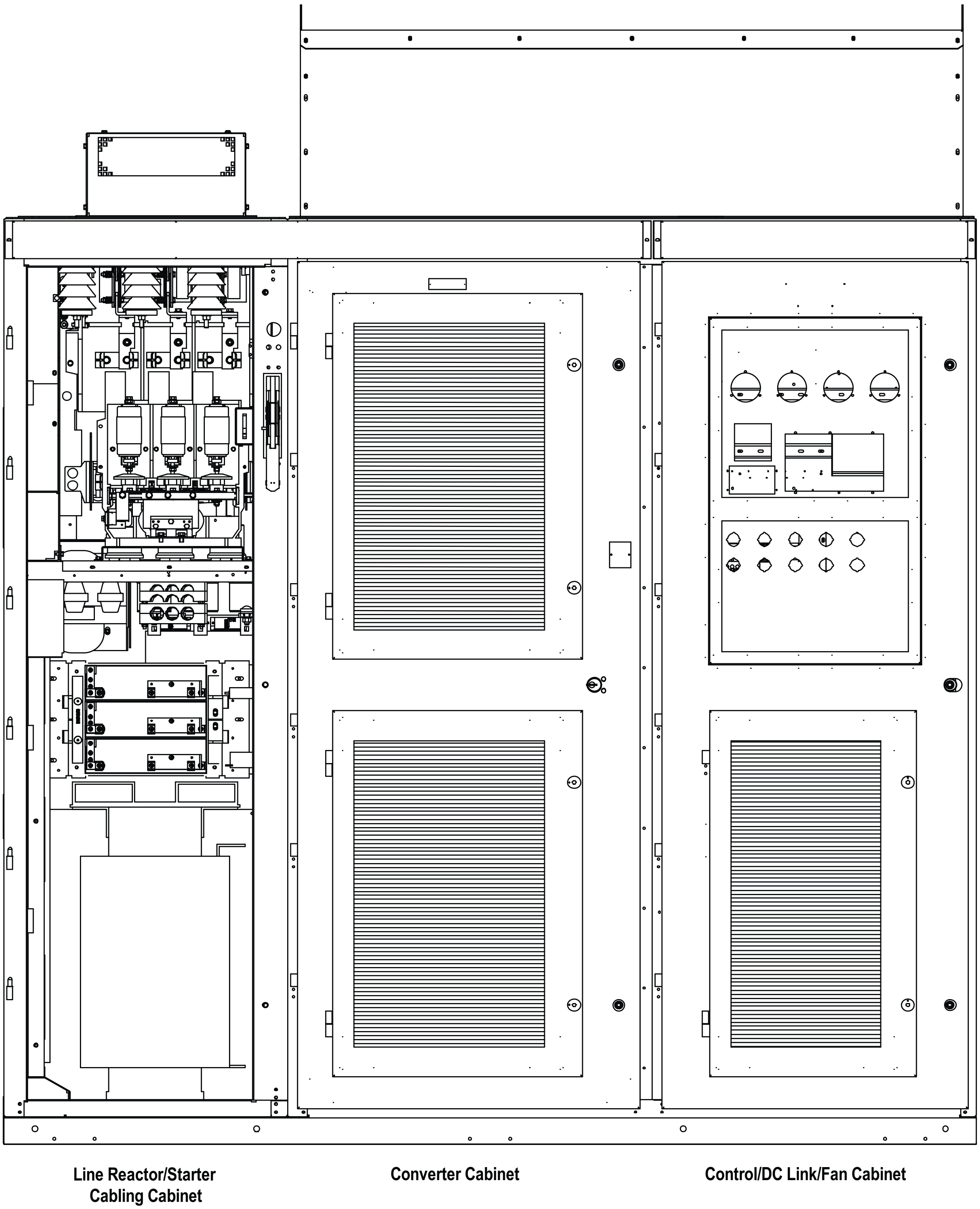


Figure 28 - AFE Rectifier (Separate Isolation Transformer)

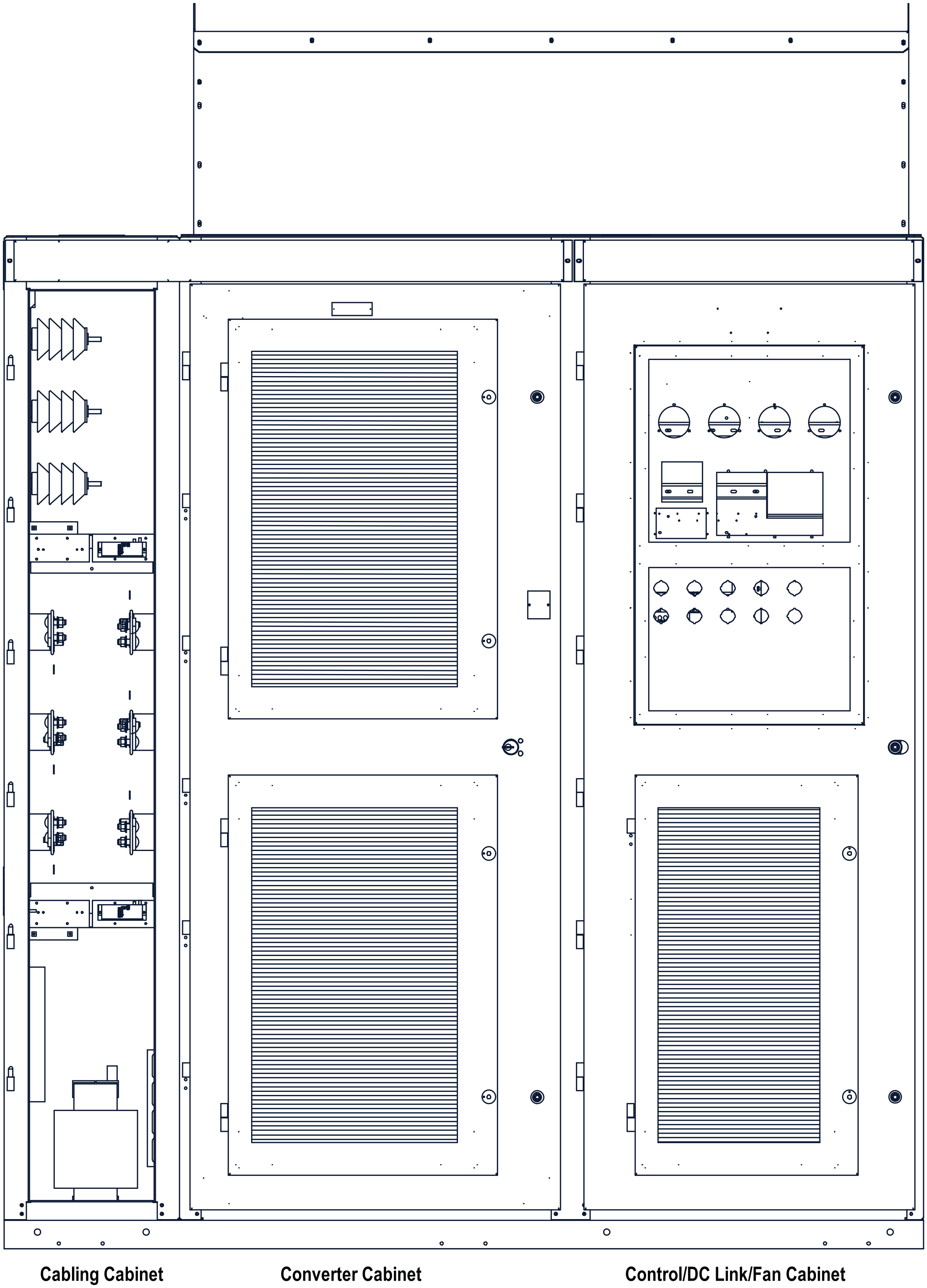
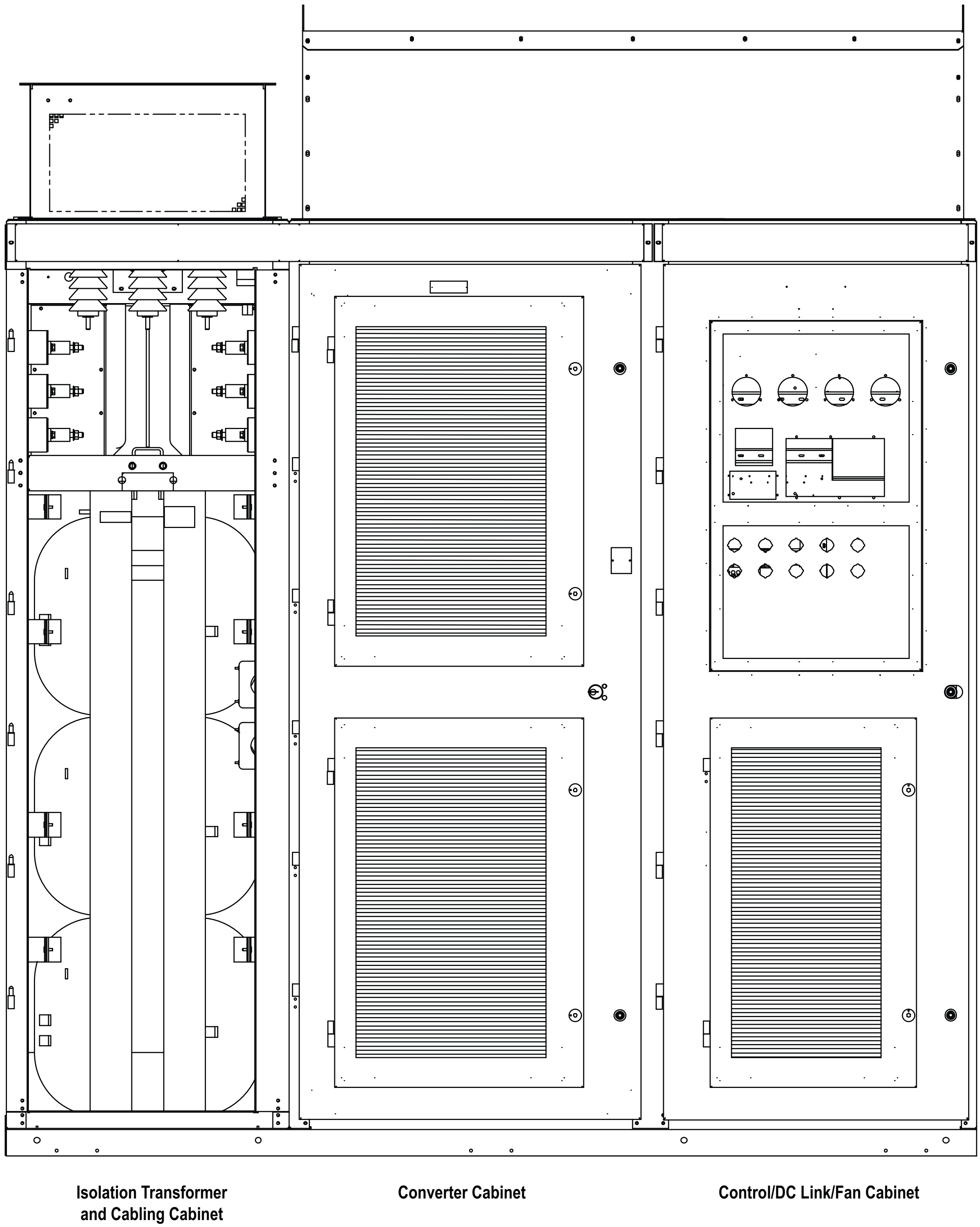


Figure 29 - AFE Rectifier (Integral Isolation Transformer)



IEC Component and Device Designations

PowerFlex 7000 electrical drawings use conventions that are based on IEC (International Electrotechnical Commission) standards, while remaining basically compatible with North American ANSI (American National Standards Institute) standards. The symbols used to identify components on the drawings are international and a full listing of the symbols is given as part of each PowerFlex 7000 electrical drawing (ED) set. The device designations used on the drawings and labeling are also listed with explanations on each drawing set.

Wiring identification uses a source/destination wire number convention on point to point multi-conductor wiring and in situations where the system is warranted. The wire-numbering system of unique, single numbers for multi-drop and point to point wiring continues to be used for general control and power wiring. Wiring that connects between the sheets or that ends at one point and starts at another point on a drawing has an arrow and drawing reference to indicate the ongoing connection. The drawing reference indicates the sheet and the X/Y coordinates of the continuation point. The reference system is explained on a sheet in each drawing set. The unique wire numbering system serves as confirmation that the correct wire is being traced from sheet to sheet or across a drawing. Wires in multi-conductor cables are typically identified by color rather than by number. The abbreviations used to identify the colors on the drawings are fully identified on a sheet in the drawing set.

Power Wiring Selection

The following tables identify general wire selections that will be encountered when installing the PowerFlex 7000 "A" Frame drive line-up.

General Notes

Adherence to the following recommended field power cabling insulation levels for medium voltage drives will help to ensure trouble-free start-up and operation. The cable insulation level must be increased over that which would be supplied for an Across-the-line application with the same rated line-to-line voltage.

Either shielded or unshielded cable may be used based on the criteria considered by the distribution system designer. However, NEC requires shielded cables for installations above 2 kV.

Cable Insulation

The cable insulation requirements for the PowerFlex 7000 "A" Frame drive are given in the following tables.

ATTENTION: Voltage ratings shown in the following tables are peak line-to-ground. Some cable manufacturers rate voltage line-to-line RMS. Ensure the cable meets the rating specified in the following tables.

Cable Insulation Requirements for AFE Drives with Separate Isolation Transformer

System Voltage (V, RMS)	Cable Insulation Rating (kV) (Maximum Peak Line-to-Ground)	
	(1)	Machine Side
2400	≥ 4.1	≥ 2.2
3000	≥ 5.12	≥ 2.75
3300	≥ 5.63	≥ 3.0
4160	≥ 7.1	≥ 3.8
6000	≥ 10.8	≥ 5.5
6300	≥ 11.4	≥ 5.8
6600	≥ 11.8	≥ 6.0

(1) Cabling from secondary side of Isolation Transformer to input of VFD

Cable Insulation Requirements for "Direct-to-Drive" Technology or Integral Isolation Transformer

System Voltage (V, RMS)	Cable Insulation Rating (kV) (Maximum Peak Line-to-Ground)	
	Line Side	Machine Side
2400	≥ 2.2	≥ 2.2
3000	≥ 2.75	≥ 2.75
3300	≥ 3.0	≥ 3.0
4160	≥ 3.8	≥ 3.8
6000	≥ 5.5	≥ 5.5
6300	≥ 5.8	≥ 5.8
6600	≥ 6.0	≥ 6.0

The following table identifies general wire categories that will be encountered when installing the PowerFlex 7000 "A" Frame Drive. Each category has an associated wire group number that is used in the following sections to identify the wire to be used. Application and signal examples along with the recommended type of cable for each group are provided. A matrix providing the recommended minimum spacing between different wire groups run in the same tray or separate conduit is also provided.

Table 1 - Wire Group Numbers

					For Tray: Recommended spacing between different wire groups in the same tray. For Conduit: Recommended spacing for wire groups in separate conduit – mm (inches)						
Wire Category	**Wire Group**	**Application**	**Signal Example**	**Recommended Cable**	**Wire Group**	**Power 1**	**Power 2**	**Control 3**	**Control 4**	**Signal 5**	**Signal 6**
Power	1	AC Power (> 600V AC)	2.3 kV, 3Ø AC Lines	Per IEC / NEC Local Codes and Application Requirements	In Tray	228.6 (9.00)	228.6 (9.00)	228.6 (9.00)	228.6 (9.00)		
					Between Conduit	76.2 (3.00) Between Conduit					
	2	AC Power (TO 600V AC)	480V, 3Ø	Per IEC / NEC Local Codes and Application Requirements	In Tray	228.6 (9.00)	228.6 (9.00)	152.4 (6.00)	152.4 (6.00)		
					Between Conduit	76.2 (3.00) Between Conduit					
Control	3	115V AC or 115V DC Logic	Relay Logic PLC I/O	Per IEC / NEC Local Codes and Application Requirements	In Tray	228.6 (9.00)	152.4 (6.00)	228.6 (9.00)	152.4 (6.00)		
		115V AC Power	Power Supplies Instruments		Between Conduit	76.2 (3.00) Between Conduit					
	4	24V AC or 24V DC Logic	PLC I/O	Per IEC / NEC Local Codes and Application Requirements	In Tray	228.6 (9.00)	152.4 (6.00)	152.4 (6.00)	228.6 (9.00)		
					Between Conduit	76.2 (3.00) Between Conduit					
Signal	5	Analog Signals DC Supplies	5-24V DC Supplies	Belden 8760 Belden 8770 Belden 9460							
		Digital (Low Speed)	Power Supplies TTL Logic Level				All signal wiring must be run in separate steel conduit. A wire tray is not suitable. The minimum spacing between conduits containing different wire groups is 76.2 mm (3 inches).				
	6	Digital (High Speed)	Pulse Train Input Tachometer PLC Communications	Belden 8760 Belden 9460 Belden 9463							

Belden 8760 - 18 AWG, twisted pair, shielded
Belden 8770 - 18 AWG, 3 conductor, shielded
Belden 9460 - 18 AWG, twisted pair, shielded
Belden 9463 - 24 AWG, twisted pair, shielded

Note 1: Steel conduit or cable tray may be used for all PowerFlex 7000 Drive power or control wiring, and steel conduit is required for all PowerFlex 7000 Drive signal wiring. All input and output power wiring, control wiring or conduit should be brought through the drive conduit entry holes of the enclosure. Use appropriate connectors to maintain the environmental rating of the enclosure. The steel conduit is REQUIRED for all control and signal circuits, when the drive is installed in European Union countries. The connection of the conduit to the enclosure shall be on full 360 degree and the ground bond at the junction shall be less than 0.1 ohms. In EU countries this is a usual practice to install the control and signal wiring.

Note 2: Spacing between wire groups is the recommended minimum for parallel runs of 61 m (200 ft) or less.

Note 3: The customer is responsible for the grounding of shields. On drives shipped after November 28/02, the shields are removed from the drive boards. On drives shipped prior to November 28/02, all shields are connected at the drive end and these connections must be removed before grounding the shield at the customer end of the cable. Shields for cables from one enclosure to another must be grounded only at the source end cabinet. If splicing of shielded cables is required, the shield must remain continuous and insulated from ground.

Note 4: AC and DC circuits must be run in separate conduits or trays.

Note 5: Voltage drop in motor leads may adversely affect motor starting and running performance. Installation and application requirements may dictate that larger wire sizes than indicated in IEC / NEC guidelines are used.

The wire sizes must be selected individually, observing all applicable safety and CEC, IEC or NEC regulations. The minimum permissible wire size does not necessarily result in the best operating economy. The minimum recommended size for the wires between the drive and the motor is the same as that used with an across-the-line starter. The distance between the drive and motor may affect the size of the conductors used.

Consult the wiring diagrams and appropriate CEC, IEC or NEC regulations to determine correct power wiring. If assistance is needed, contact your local Rockwell Automation Sales Office.

Power Cabling Access

The drive is built with provision for either the top or bottom power cable entry.

Cable access plates are provided on the top and bottom plates of the connection cabinet identified by the customer specific dimension drawing (DD).

Access the Customer Power Cable Terminations

Cable connections are located behind the medium voltage door of the Connection/Cabling cabinet. Location of power terminals for various drive configurations are as indicated in Figure 30 through Figure 33.

In the case of the cabling cabinet with starter, the removal of internal barriers and duct covers located on the left side of the cabinet may be required to facilitate the routing of line cables. This can be accomplished by removing the hardware securing the barrier/cover and sliding it toward the front of the cabinet for removal. In addition the fan housing and cover plate (if already installed) located on the top of the cabinet must be removed to allow routing and termination of line cables. All barriers/covers must be replaced, by reversing the above sequence, before applying medium voltage.

The installer is responsible for modifying the power cable access plates to suit their requirements.

Note that appropriate connectors must be used to maintain the environmental rating of the enclosure.

Power Connections

The installer must ensure that interlocking with the upstream power source has been installed and is functioning.

The installer is responsible for ensuring that power connections are made to the equipment in accordance with local electrical codes.

The drive is supplied with provision for cable lugs. The power terminals are identified as follows:

Line/Motor Terminations

- Drives with Connection to remote transformers: 2U, 2V, 2W
- Drives with integral transformers: 1U, 1V, 1W
- Drives with integral line reactor and input starter: L1, L2, L3
- Motor Connections: U, V, W
- Drives with integral line reactor, no input starter: 1U, 1V, 1W

Power Cabling Installation Requirements

To determine cable distance from top or bottom of input cabinet to termination points, refer to Figure 30, Figure 32 and Figure 33.

The installer is responsible for ensuring that power connections are made with appropriate torque (see page 177).

The drive is supplied with provision for grounding of cable shields and stress cones near the power terminals.

Figure 30 - Dimension Views of Direct-to-Drive (AFE with DC Link) *with* Input Starter

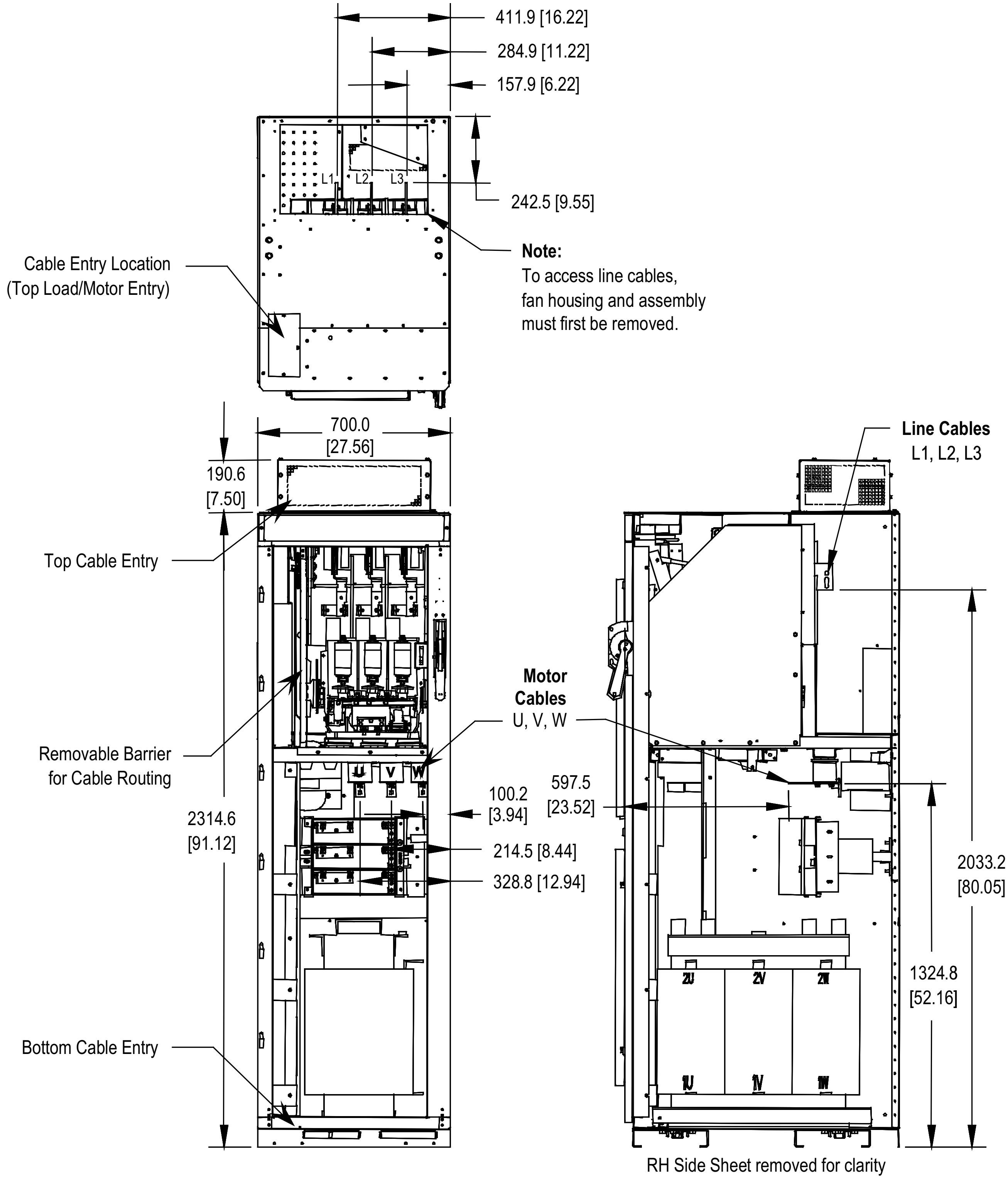


Figure 31 - Dimension Views of Direct-to-Drive (AFE with DC Link) *without* Input Starter

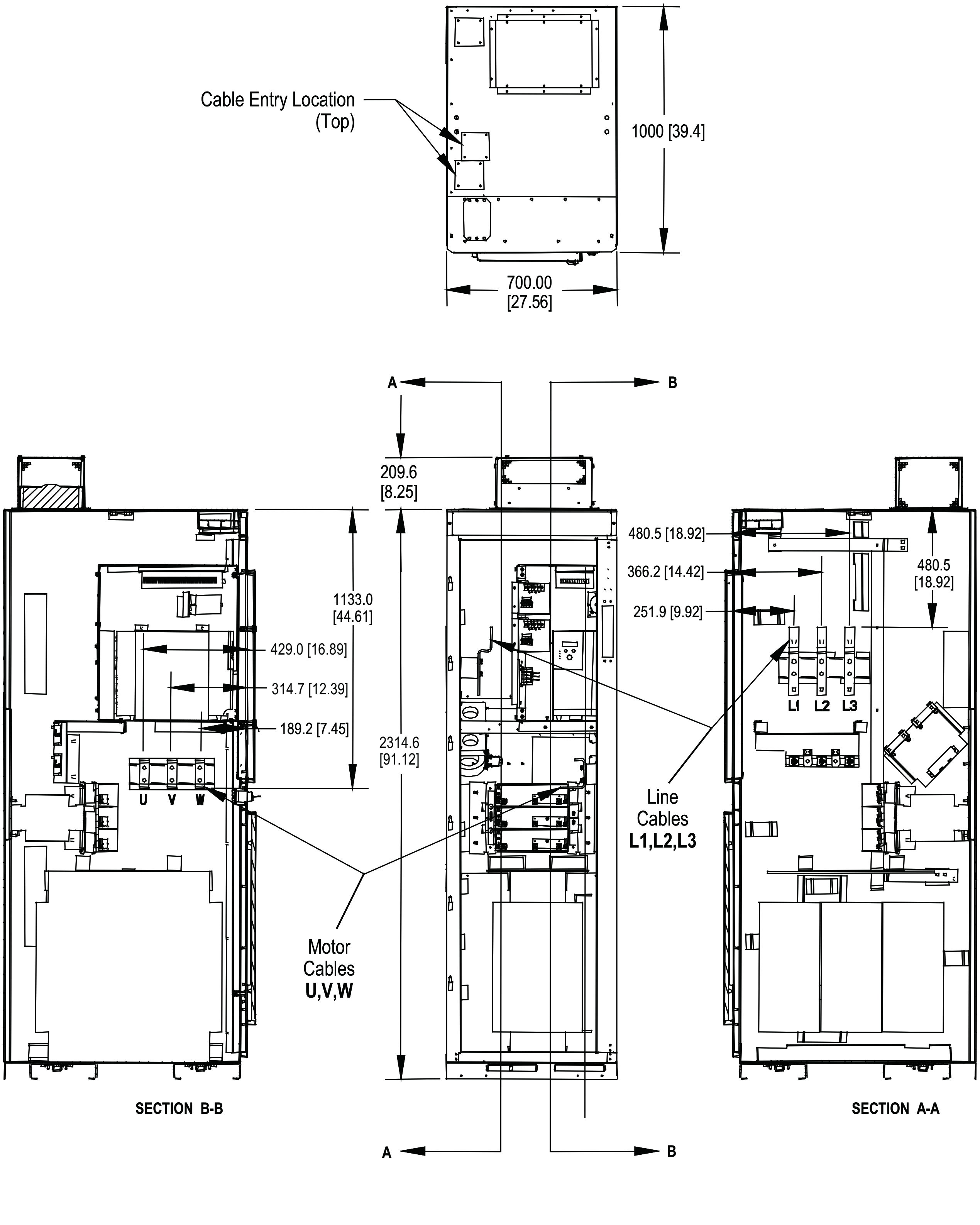


Figure 32 - Dimension Views of AFE Rectifier with Separate Isolation Transformer

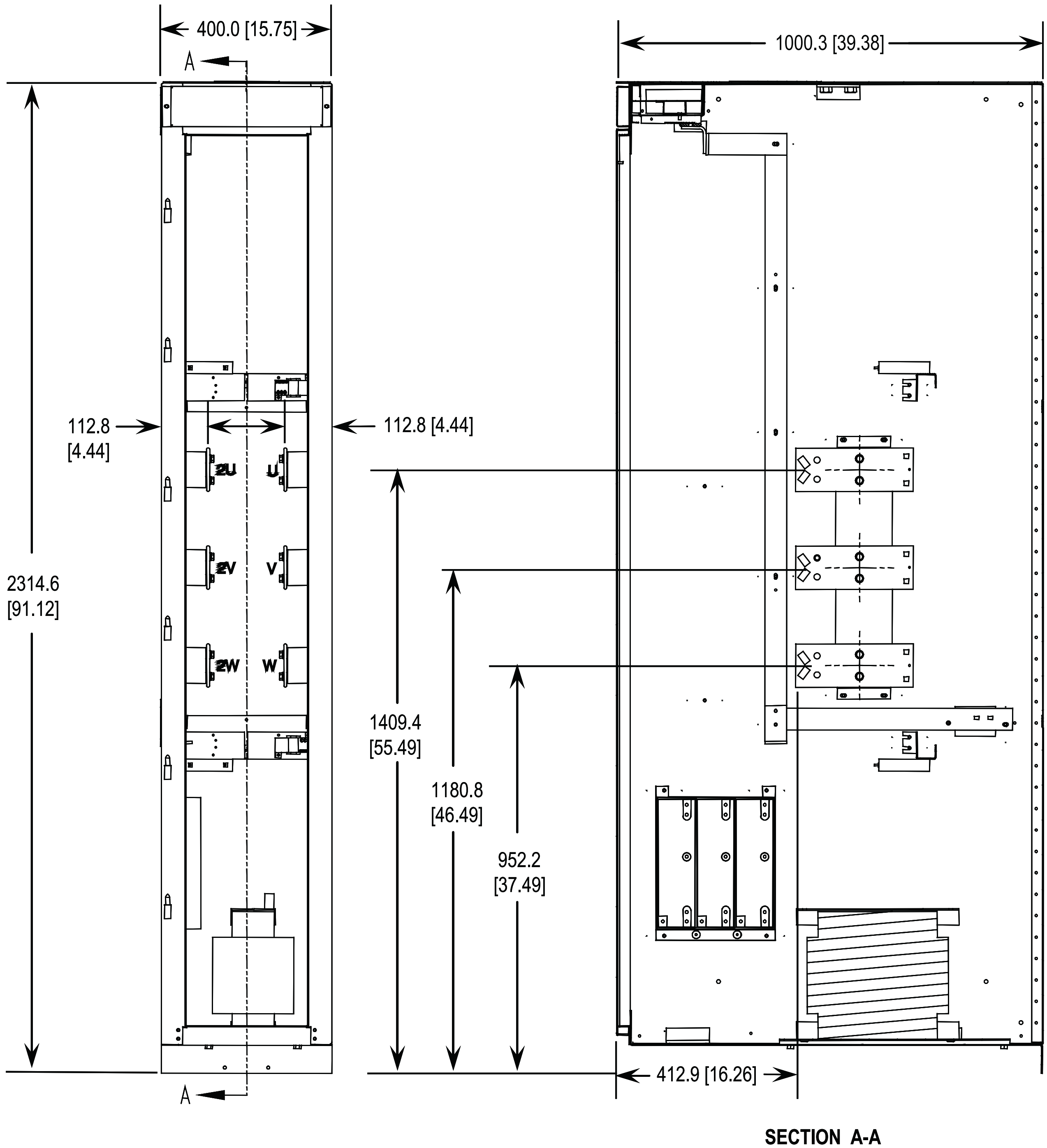
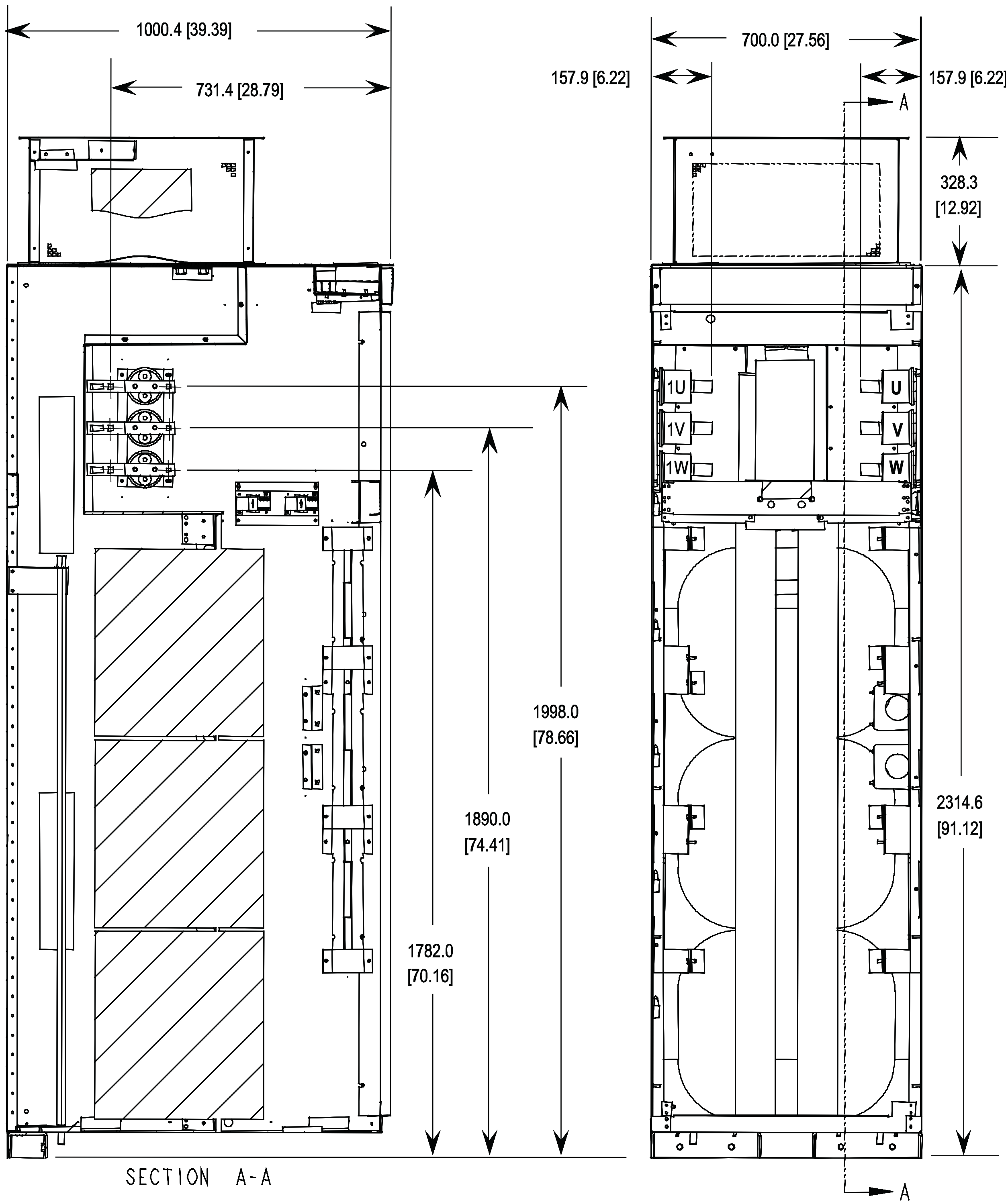


Figure 33 - Dimension Views of AFE Rectifier with Integral Isolation Transformer



Power and Control Wiring

Drive line-ups (i.e. Drive and Input Starter) which are delivered in two or more sections, for ease of handling, will require that the power and control wiring be re-connected. After the sections are brought together, the power and control wiring is to be re-connected as per the schematic drawings provided.

Control Cables

Control cable entry/exit should be located near the terminal block 'TBC' – the customer's connections are to be routed along the empty side of the TBC terminals. These terminals are sized to accept a maximum #14 AWG. The low voltage signals (includes 4…20 mA) are to be connected using twisted shielded cable, with a minimum #18 AWG.

Of special concern is the tachometer signal. Two tachometer inputs are provided to accommodate a quadrature tachometer (senses motor direction). The tachometer power supply is isolated and provides 15V and a ground reference. Many tachometer outputs have an open collector output, in which case a pull-up resistor must be added to ensure that proper signals are fed to the system logic (see page 162).

IMPORTANT	Low voltage signals are to be connected using twisted shielded cable with the shield connected at the signal source end only. The shield at the other end is to be wrapped with electrical tape and isolated. Connections are to be made as shown on the electrical drawings (ED) provided.

Grounding Practices

The purpose of grounding is to:

- provide for the safety of personnel
- limit dangerous voltages on exposed parts with respect to ground
- facilitate proper over current device operation under ground fault conditions, and
- provide for electrical interference suppression

IMPORTANT	Generally, the means used for external grounding of equipment should be in accordance with the Canadian Electrical Code (CEC), C22.1 or the National Electrical Code (NEC), NFPA 70 and applicable local codes.

Refer to the grounding diagrams that follow for ground connections. The drive's main ground bus must be connected to the system ground. This ground bus is the common ground point for all grounds internal to the drive.

Figure 34 - Ground Connection Diagram with Isolation Transformer

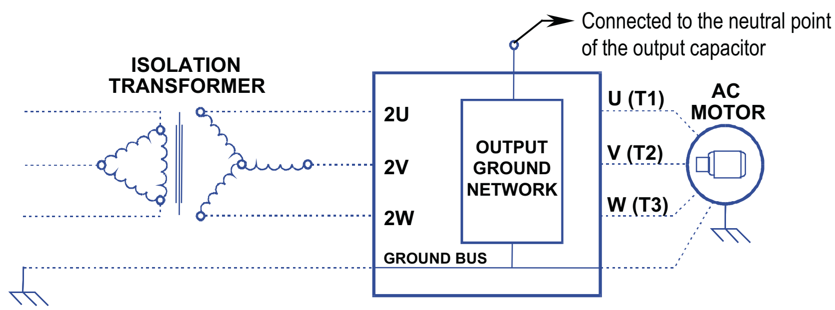
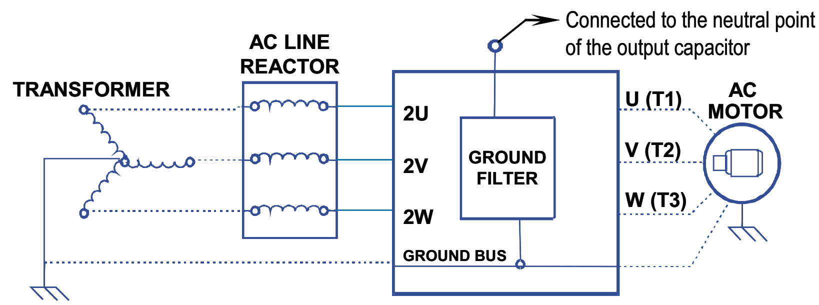


Figure 35 - Ground Connection Diagram with Line Reactor



Each power feeder from the substation transformer to the drive must be provided with properly sized ground cables. Utilizing the conduit or cable armor as a ground is not adequate.

Note that if a drive isolation transformer is used, the WYE secondary neutral point should not be grounded.

Each AC motor frame must be bonded to grounded building steel within 6 m (20 ft) of its location and tied to the drive's ground bus via ground wires within the power cables and/or conduit. The conduit or cable armor should be bonded to ground at both ends.

Grounding Guidelines and Practices for Drive Signal and Safety Grounds

When interface cables carrying signals where the frequency does not exceed 1 MHz are attached for communications with the drive, the following general guidelines should be followed:

- It is good practice for the mesh of a screen to be grounded around its whole circumference, rather than forming a pigtail that is grounded at one point.
- Coaxial cables with a single conductor surrounded by a mesh screen should have the screen grounded at both ends.
- Where a multi-layer screened cable is used (that is, a cable with both a mesh screen and a metal sheath or some form of foil), there are two alternative methods:
  - The mesh screen may be grounded at both ends to the metal sheath. The metal sheath or foil (known as the drain) should, unless otherwise specified, be grounded at one end only, again, as specified above, at the receiver end or the end which is physically closest to the main equipment ground bus, or
  - The metal sheath or foil may be left insulated from ground and the other conductors and the mesh cable screen grounded at one end only as stated above.

Grounding Requirements and Grounding Specification for Customers and Power Integrators

An external ground must be attached to the main ground bus. The grounding means must comply with applicable local codes and standards. As general guidelines, for information only, the ground path must be of sufficiently low impedance and capacity that:

- the rise in potential of the drive ground point when subjected to a current of twice the rating of the supply should be no higher than 4V over ground potential.
- the current flowing into a ground fault will be of sufficient magnitude to cause the protection to operate.

The main grounding conductor(s) should be run separately from power and signal wiring so that faults:

- do not damage the grounding circuit, or
- will not cause undue interference with or damage to protection or metering systems, or cause undue disturbance on power lines.

Identification of Types of Electrical Supplies - Grounded and Ungrounded Systems

When dealing with an ungrounded, three-phase electrical supply system, the cable insulation must be capable of handling not only the phase to phase voltage, but also the voltage to ground if one of the other phases develops a ground fault. In practice, the cable insulation of an ungrounded, three-phase system must be good for at least a continuous voltage of root three (1.732) times (1.1) times the rated voltage of the supply. (1.732 x 1.1 = 1.9 times the rated line-to-line voltage)

Ground Bus

The drive ground bus runs along the top of the drive at the front. The ground bus is accessible at the top of each of the drive enclosures when the enclosure door is opened (and the low voltage compartment hinged out in the case of the DC link/fan cabinet). It is the responsibility of the installer to ensure that the drive is grounded properly, typically at the point on the ground bus in the cabling cabinet, close to the line cable terminations.

Interlocking

Access to the medium voltage areas of the drive is restricted by the use of key interlocking for safety.

At installation the key interlocking is set up so that access to the medium voltage compartments of the equipment can only be made when the upstream power is locked in the off position.

Additionally, the key interlocking prohibits the upstream power being applied until the medium voltage drive's access doors have been closed and locked shut.

It is the responsibility of the installer to ensure that the key interlocking is installed properly to the upstream equipment.

Component Definition and Maintenance

Cabling Cabinet Components

Figure 36 - Direct-to-Drive with UPS option

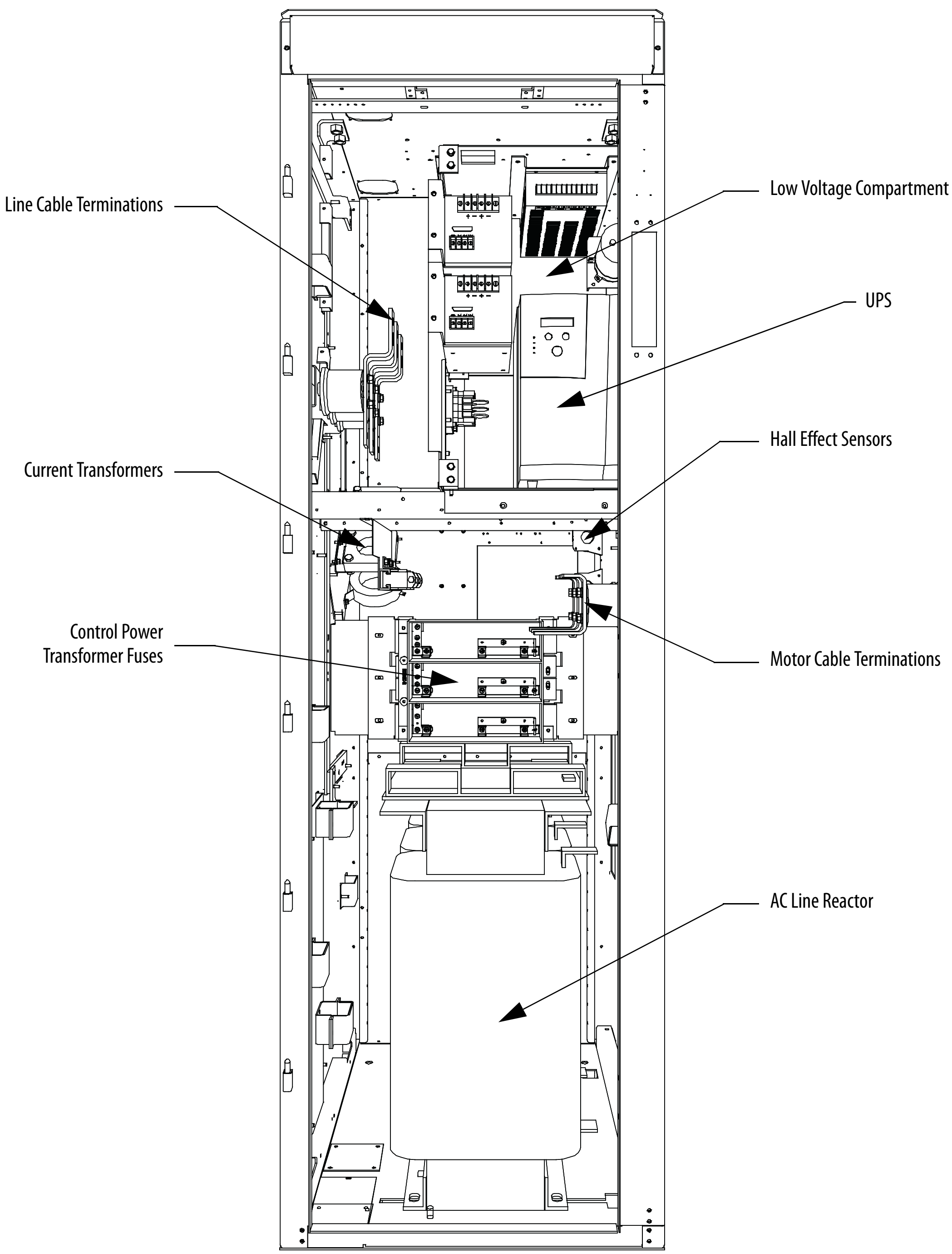


Figure 37 - Direct-to-Drive with Optional Input Starter

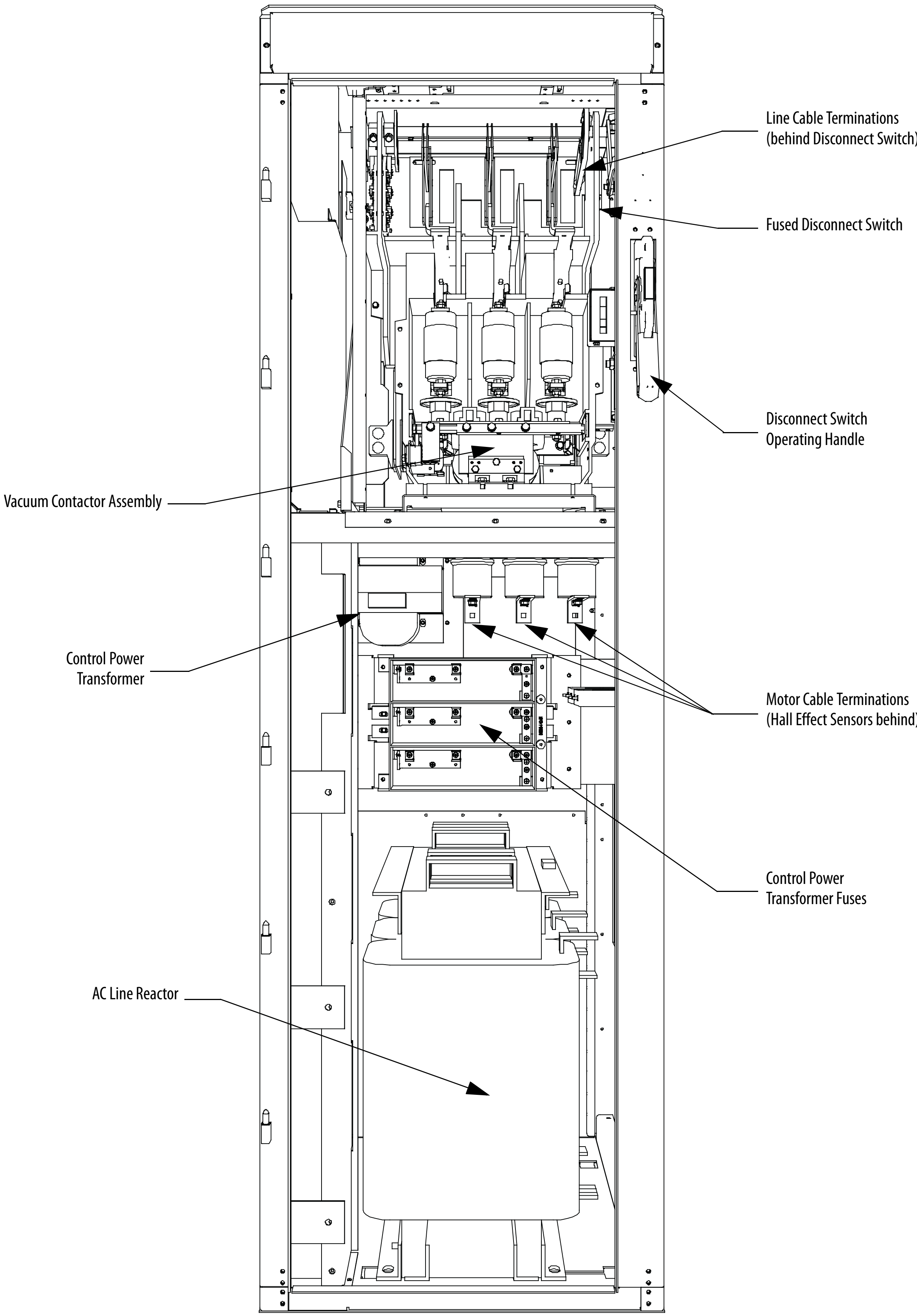


Figure 38 - AFE Rectifier with Isolation Transformer

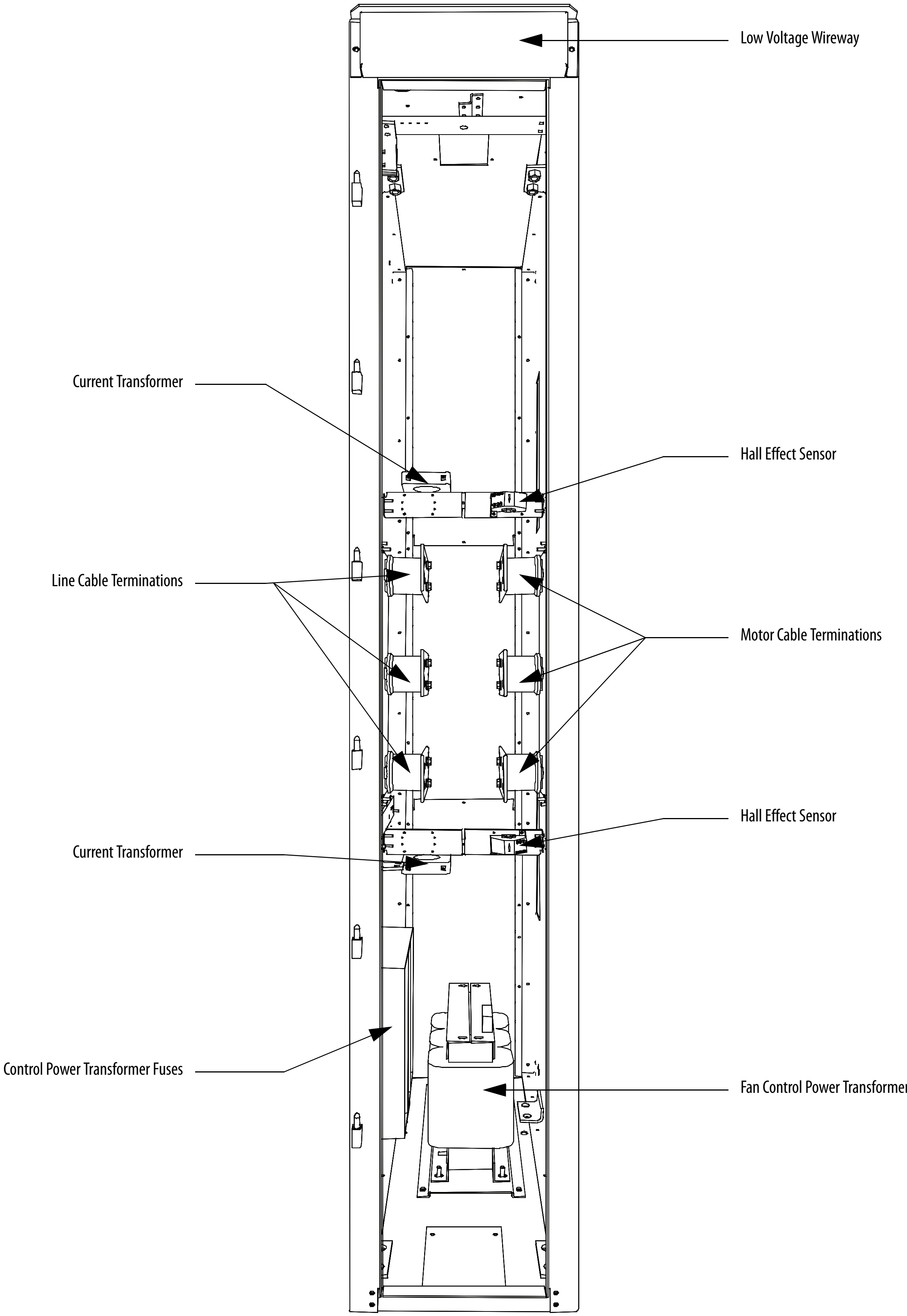
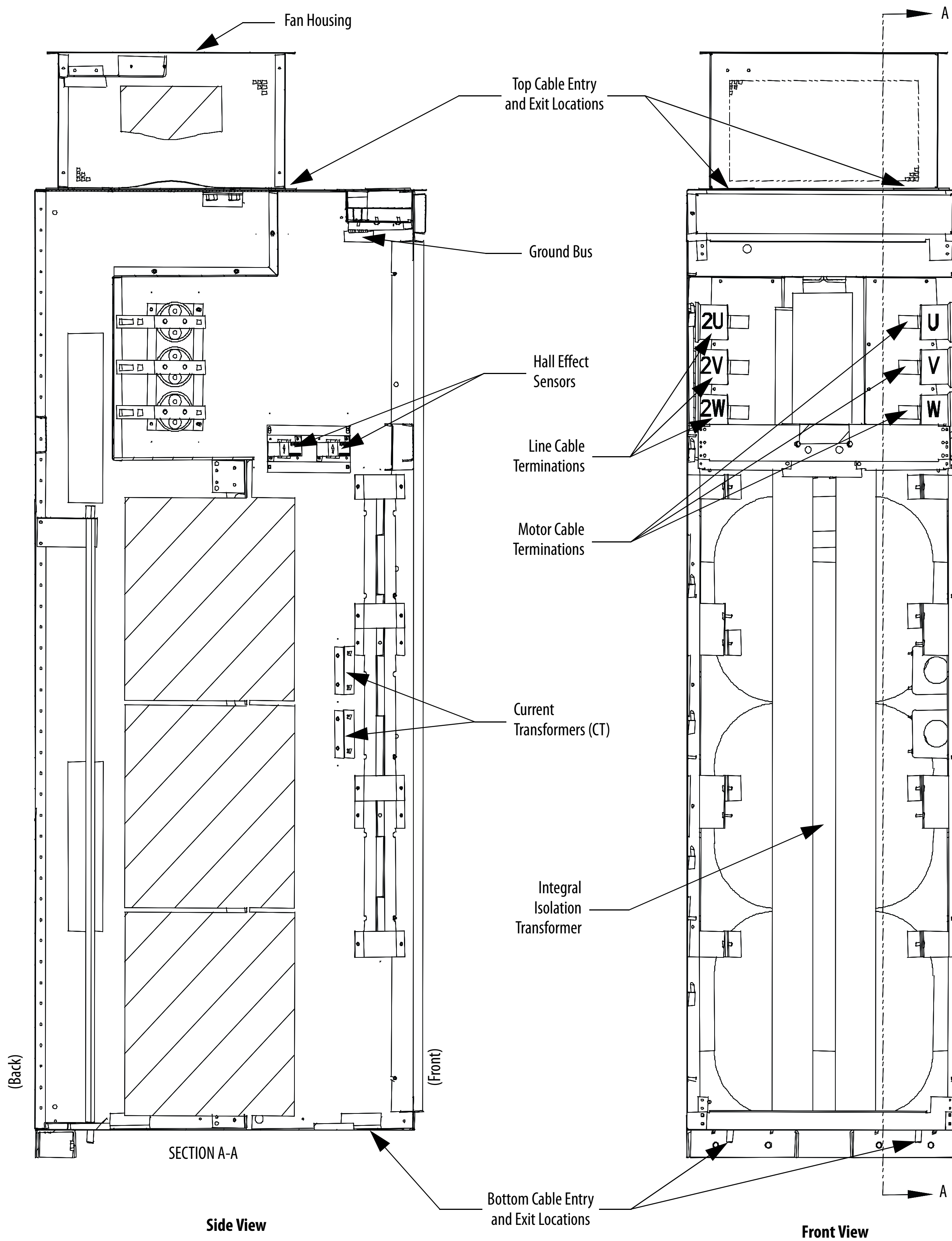


Figure 39 - AFE Rectifier with Integral Isolation Transformer



Hall Effect Sensor Replacements

1. Ensure there is no power to the equipment.

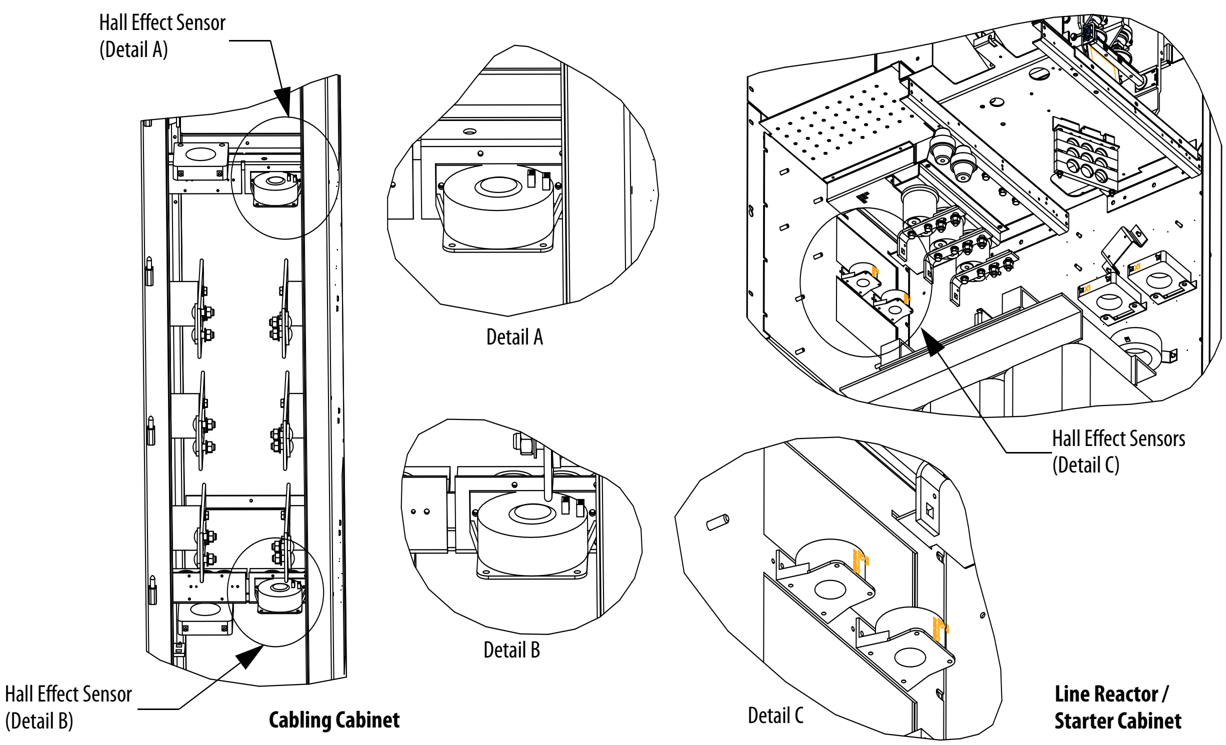
ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the Hall Effect sensor. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

2. Note the location of all wires and the orientation of the Hall Effect sensor. For quick reference when checking the orientation of the Hall Effect sensor, look for the white arrow.

IMPORTANT The Hall Effect sensor and wires must be in the proper orientation. Note the position before disassembly.

3. The load cable must be disassembled to allow removal of the Hall Effect sensor. Remove the hardware to allow the cable to slide out.
4. Remove the plug connecting the sensing wire to the Hall Effect sensor.
5. Remove the four screws on the base of the Hall Effect sensor, and remove the Hall Effect sensor.
6. Replace the Hall Effect sensor. Note the arrow must be oriented as shown in the illustration below.
7. Slide the load cable back into place and secure the hardware.
8. Plug the connector back into the sensor. The plug is keyed so that it cannot be plugged in incorrectly.

Figure 40 - Hall Effect Sensor (located within cabinet with detail)



Current Transformer Replacement

1. Ensure there is no power to the equipment.

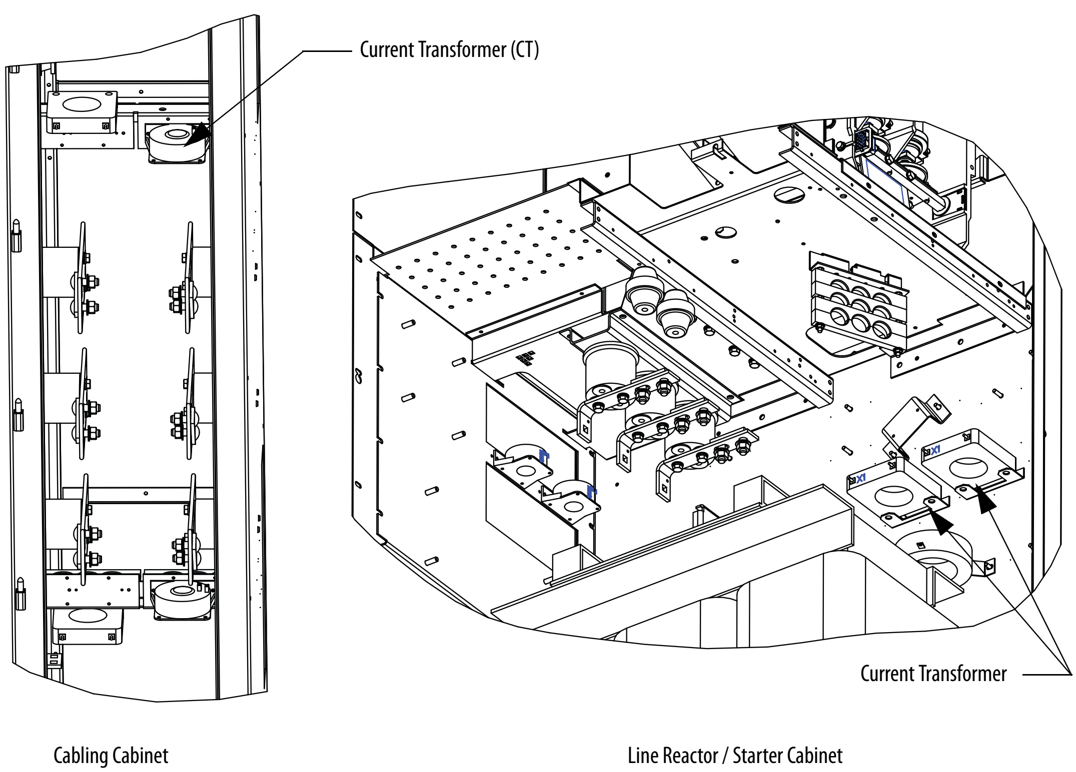
ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the current transformer. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

2. Note the location of all wires and the orientation of the CT. For quick reference when checking the orientation of the CT, look for the white dot.

IMPORTANT	The CT and wires must be in the proper orientation. Note the position before disassembly.

3. Disconnect the wires.
4. The line cable must be disassembled to allow removal of the CT. Remove the hardware to allow the cable to slide out.
5. Remove the two screws located in the base of the CT and remove the CT.
6. Replace the CT, ensuring the proper orientation. Fasten the CT securely with the two screws in the base.
7. Reconnect the ring lugs.
8. Slide the line cable back into place and secure the hardware.

Figure 41 - Replacement of Current Transformer



Converter Cabinet Components

Figure 42 - Converter Cabinet Components (2400V version)

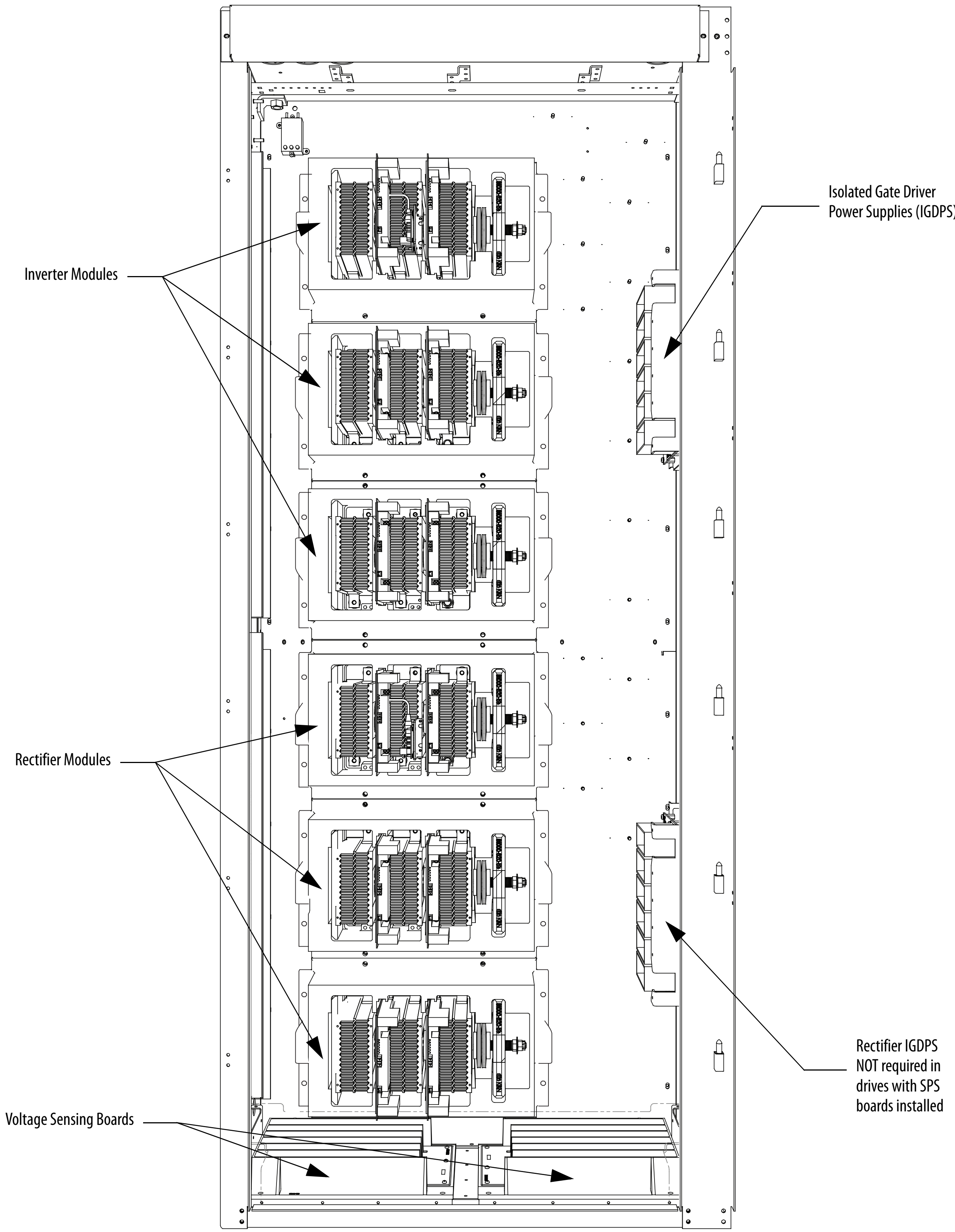


Figure 43 - Converter Cabinet Components (3300/4160V version)

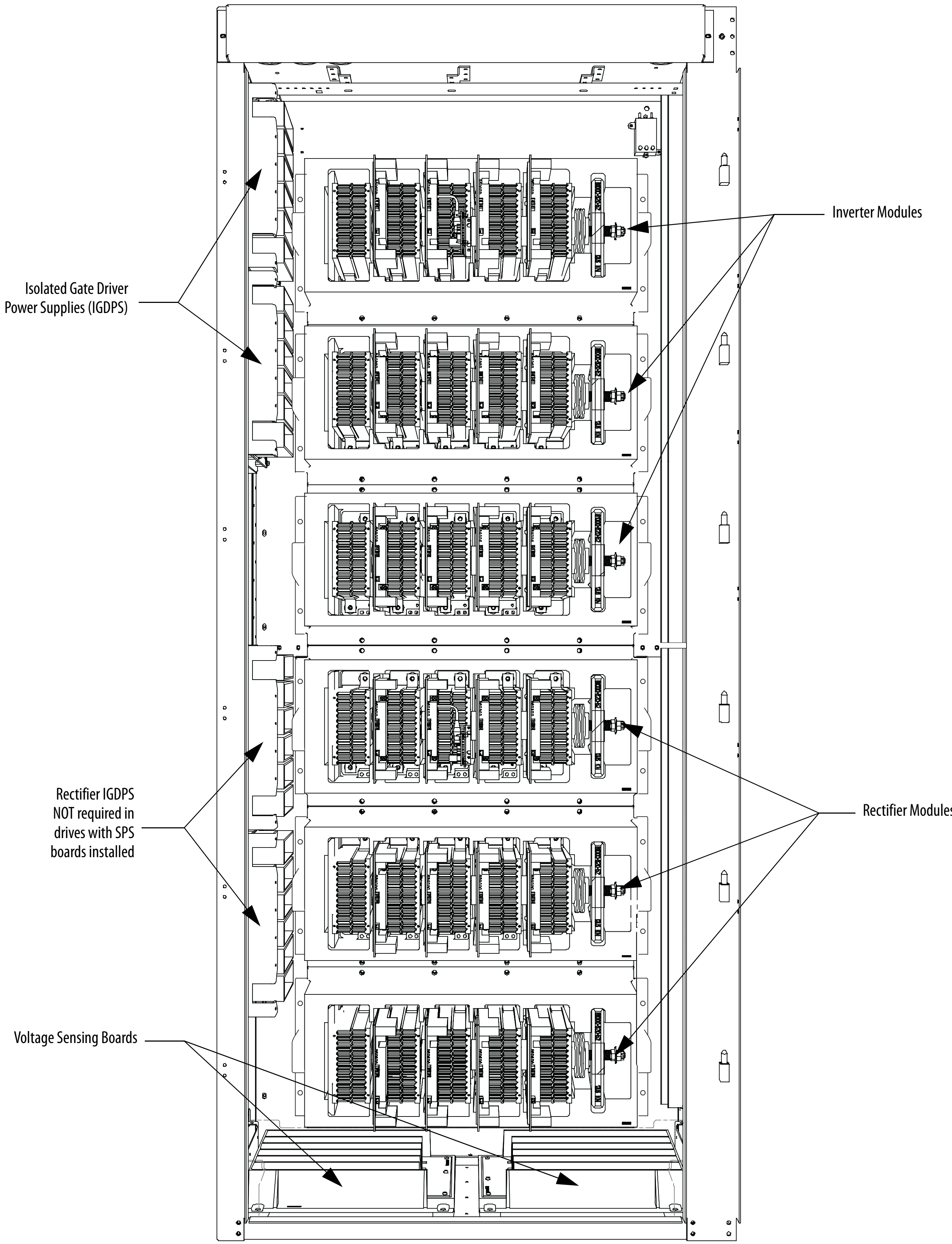
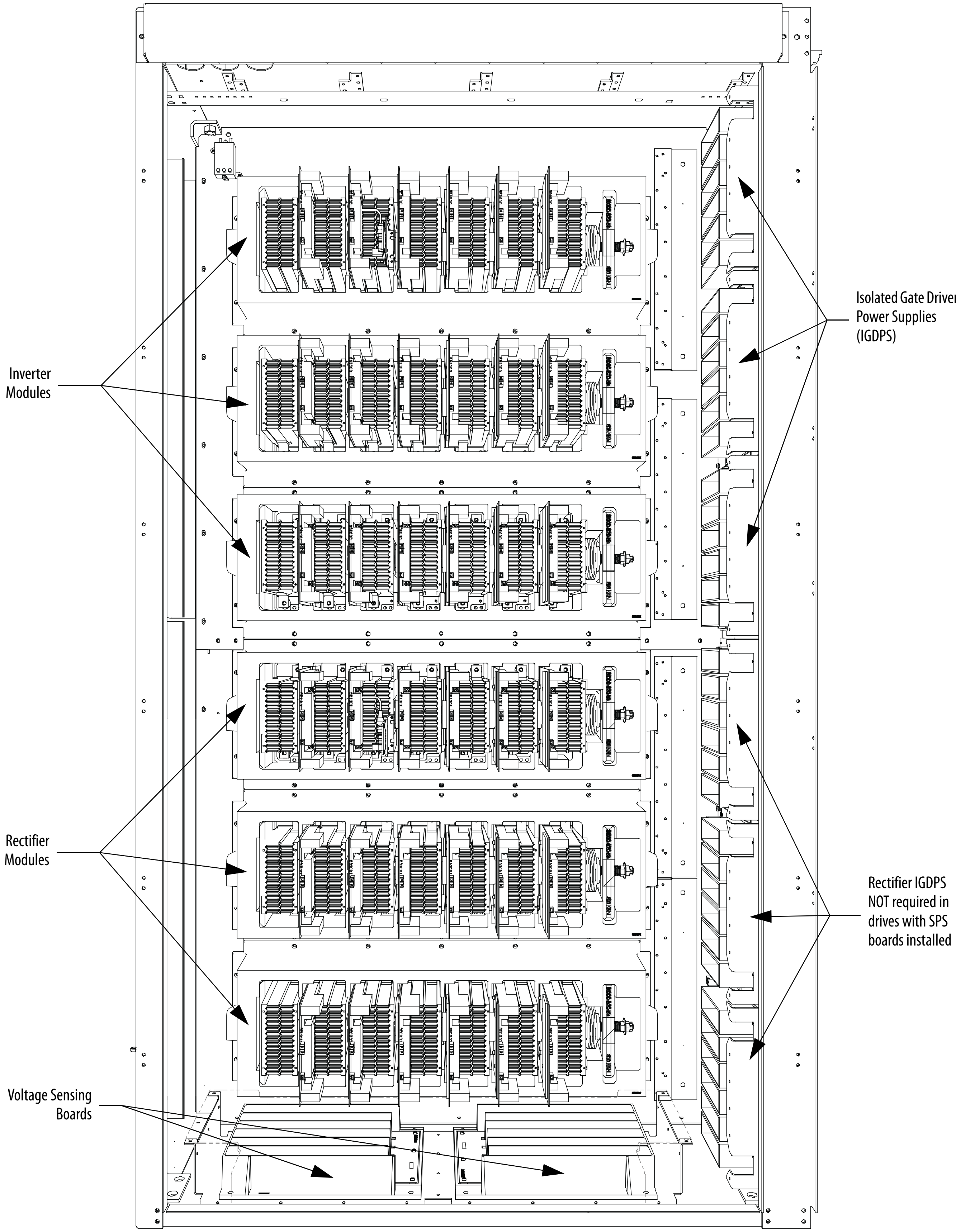


Figure 44 - Converter Cabinet Components (6600V version)



Converter Cabinet

The converter cabinet contains three rectifier modules and three inverter modules. Figure 42 shows a 3300/4160V converter with a PWM Rectifier.

Isolated Gate Driver Power Supplies (IGDPS) are mounted on the cabinet's right side sheet (6600V, 2400V Drives) and on the cabinet's left side sheet (3300V, 4160V Drives).

Thermal sensors are installed on the top module of the inverter and rectifier. The exact location depends on the drive configuration.

Voltage-Sensing Assembly

The voltage-sensing assembly consists of two voltage sensing boards, mounting plate and protective cover. Each voltage sensing assembly has six independent channels which convert voltages up to 10,800V (7.2 kV @ 1.5 pu) down to low voltage levels which can be used by the PowerFlex 7000 control logic. For drives that require the synchronous transfer option, one extra assembly is used. This extra assembly uses a separate connector to output the transfer voltages directly to the ACB board.

Below is a table of the input voltage ranges for each of the input terminals on the voltage-sensing board. There are four separate inputs taps for each of the six independent channels. This assembly has been designed to operate at a nominal input voltage of up to 7200V with a continuous 40% overvoltage. The output voltages are scaled to provide close to 10V peak for a 140% input voltage at the high end of each of the voltage ranges.

Each of the channels has only four taps, thus they must be used to provide a range of input voltages and software will be used to provide a given amount of gain so that 140% will correspond to the maximum numerical value of the analogue to digital converter.

Table 2 - Input Voltage Range

Tap	Voltage Range
D	800...1449V
C	1450...2499V
B	2500...4799V
A	4800...7200V

ATTENTION: Grounds must be reconnected on the voltage sensing boards. Failure to do so may result in injury, death or damage to equipment.

Voltage-Sensing Circuit Board Assembly Replacement

1. Ensure there is no power to the equipment.

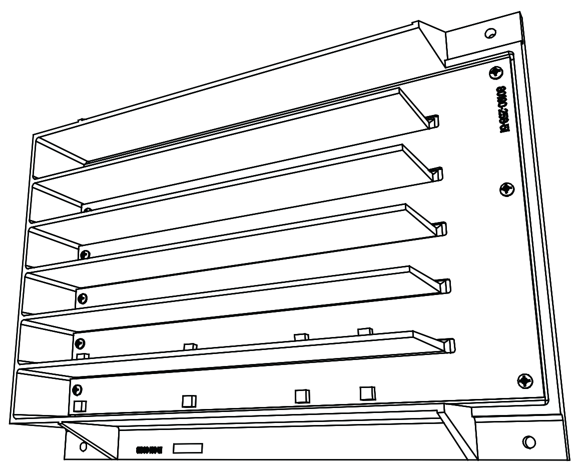
ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the sensing board. Verify that all circuits are voltage free using a hot stick or appropriate high voltage-measuring device. Failure to do so may result in injury or death.

2. Remove clear plastic cover.
3. Mark the position of the ribbon cables and wires.
4. Remove the screws and lift the ring lugs from the terminals to remove the wires.
5. Release the locking mechanism located on each side of the ribbon cable connector and pull the ribbon cable straight out to prevent bending the pins.
6. Remove the four nuts and washers that secure the assembly to the studs welded to the frame.
7. Remove the old VSB and replace the new VSB on the studs, using the existing hardware to secure the assembly.

IMPORTANT	Do not overtorque the connections or you may break the studs.

8. Replace all ring lugs on terminals. Plug in ribbon cables making sure that cables are positioned properly and fitting is secure (locking mechanism is engaged).
9. For personnel and equipment safety, ensure both grounding connections are re-connected to the sensing board.
10. Replace clear plastic cover and re-fasten in place.

Figure 45 - Sensing Board with mounting hardware placement



Surge Arresters

Description

Heavy duty distribution class surge arresters are used for transient overvoltage protection in the drives with AFE rectifiers. The arresters are certified as per ANSI/IEEE Std C62.11-1993.

The surge arresters are basically MOVs, with or without an air gap in series, packed in sealed housing. They provide overvoltage protection similar to what the TSN module does. They differ from the TSN in that fusing is not required for the operation of surge arresters.

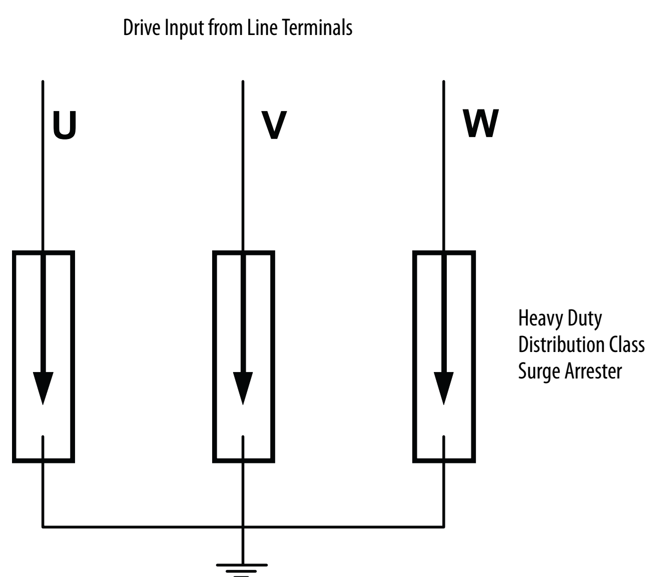
There are three types of surge arresters depending on the voltage class of the drive as shown in the following table:

Drive voltage	2.4kV	3.3kV	4.16, 4.8 kV	6.0…6.9kV
Arrester rating (RMS)	3 kV	6 kV		9 kV
Arrester MCOV (RMS)	2.55	5.10		7.65

The most severe temporary overvoltage occurs when one phase is grounded in an ungrounded system. The full line-to-line voltage is applied to the arrester in this case. The arresters are designed to operate under this condition continuously without any problems as shown by their Maximum Continuous Operating Voltage (MCOV) rating.

There are three Y-connected surge arresters attached to the incoming MV lines. The neutral point of the arresters is connected to the ground bus.

Figure 46 - Surge Arresters



Operation

The operation of arresters without a gap is the same as that of MOVs. Depending on design, the arrester may also be gapped. Both gapped and un-gapped arresters provide adequate overvoltage protection.

The arresters are able to withstand or ride through most commonly seen bus transients within their capability. However, caution should be taken if there is a harmonic filter on the MV bus to which PowerFlex 7000 is connected. The filter should satisfy relevant international or local standards, such as IEEE Std 1531—Clause 6.4, to avoid high inrush currents.

The surge arrester is certified as per ANSI/IEEE Std C62.11-1993. Certification tests include high current short duration tests, low current long duration tests and fault current withstand tests. The fault current withstand tests consist of different combinations of kA and number of cycles, including a 20 kA 10-cycle test, under which the arresters are non-fragmenting and without expelling any internal components.

When the incoming energy exceeds the handling capability of the arrester and causes arrester failure, the housing is designed to split open to vent without causing damage to any adjacent components.

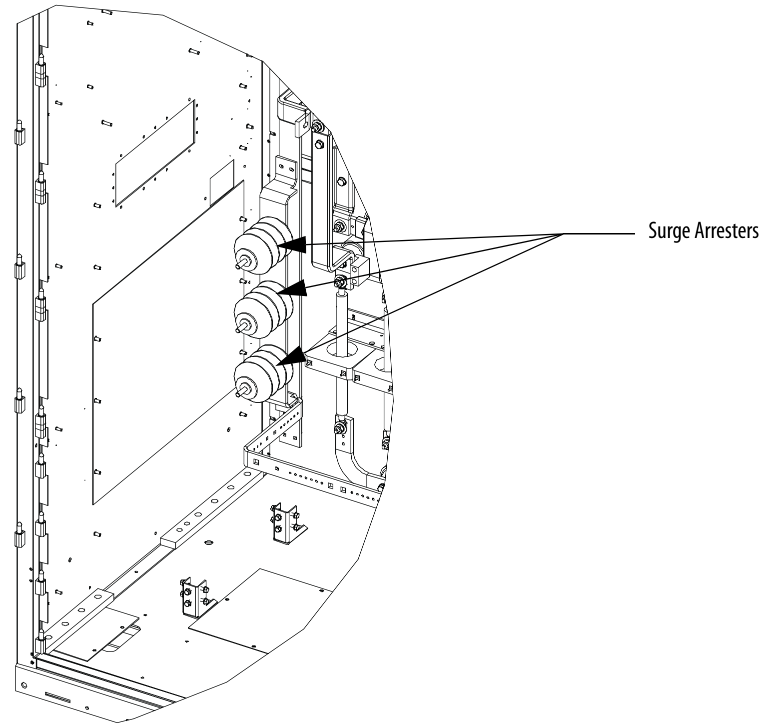
Surge Arrester Replacement

1. Ensure there is no power to the equipment. Isolate the drive by lock out/tag out.

ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the surge arrester. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

2. Wait for a minimum of 10 minutes to allow the stored energy in the drive to be discharged.
3. Observe the location of the connecting leads.
4. Using proper method to ensure the leads are at ground potential. Use temporary ground when necessary.
5. Detach the connecting leads.
6. Loosen the bolt that attaches the surge arrester to the ground bus. Remove the arrester. Remove temporary ground when applicable.
7. Replace the surge arrester with an equivalent one (make sure that the voltage rating is the same).
8. Connect the leads to the surge arrester.
9. Surge arrester hardware to be torqued to 28 N•m (21 lb•ft).

Figure 47 - Surge Arresters



When the surge arrester is disconnected from MV, it is possible that a small amount of static charge is retained by the arrester. As a precautionary measure, install a temporary ground on the line-end of the arrester and discharge the stored energy. Remove temporary ground before the arrester is reinstalled. To avoid electrical shock when removing the arrester from service, consider it to be fully energized until both the line and ground leads are disconnected.

Field Test and Care

No field testing is necessary. The arresters do not require special care. However at very dusty sites, it is suggested to clean the arrester when the whole drive is cleaned.

PowerCage™ Overview

A PowerCage is a converter module, consisting of the following elements:

- epoxy resin housing
- power semiconductors with gate driver circuit boards
- heatsinks
- clamp
- snubber resistors
- snubber capacitors
- sharing resistors (2400V drives do not have a sharing resistor)

Each drive consists of three PowerCage rectifier modules and three PowerCage inverter modules.

AFE type rectifiers use SGCTs as semi-conductors.

All inverter modules use SGCTs as semi-conductors.

The size of the PowerCage will vary depending on the system voltage.

The power semi-conductor usage in the converter section is as follows:

Configuration	Rectifier SGCTs	Inverter SGCTs
2400V, AFE	6	6
3300/4160V, AFE	12	12
6600V, AFE	18	18

Some PowerFlex 7000 configurations contain Self-Powered SGCT Power Supply (SPS) boards. These boards are applicable on all "A" Frame drives and all AFE "B" Frame drives with heat sinks. See Self-Powered SGCT Power Supply - SPS on page 90 for more information.

ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the converter cabinet. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

ATTENTION: The SGCT circuit board is sensitive to static charges. It is important that these boards should not be handled without proper grounding.

ATTENTION: Some circuit boards can be destroyed by static charges. Use of damaged circuit boards may also damage related components. A grounding wrist strap is recommended for handling sensitive circuit boards.

The inverter module is the module that contains the SGCT power device necessary for producing the motor voltages and currents. There are three inverter modules in each drive; the number of SGCTs per module depends on the voltage rating of the motor. To understand a module, a description of a single SGCT and its peripheral equipment is all that is required.

Resistance Checks

Prior to applying control power to the drive, power semiconductor and snubber circuit resistance measurements must be taken. Doing so will ensure that no damage has occurred to the converter section during shipment. The instructions provided below detail how to test the following components:

- Inverter or AFE Rectifier Bridge
  - Anode-to-Cathode Resistance Test (Sharing Resistor and SGCT)
  - Snubber Resistance Test (Snubber Resistor)
  - Snubber Capacitance Test (Snubber Capacitor)

ATTENTION: Before attempting any work, verify that the system has been locked out and tested to have no potential.

Snubber Resistors

Snubber resistors connect in series with the snubber capacitors. Together they form a simple RC snubber that connects across each thyristor (SGCT). The snubber circuit reduces the dv/dt stress on the thyristors and reduces the switching losses. The snubber resistors connect as sets of various wire-wound resistors connected in parallel. The number of resistors in parallel depends on the type of the thyristor and the configuration and frame size of the drive.

Snubber Capacitors

Snubber capacitors are connected in series with the snubber resistors. Together they form a simple RC snubber that is connected across each thyristor (SGCT). The purpose of the snubber circuit is to reduce the voltage stress (dv/dt and peak) of the thyristor and to reduce the switching loss.

Sharing Resistors

Sharing resistors provides equal voltage sharing when using matched devices in series. SGCT PowerCages for 2400V systems do not need matched devices and have no sharing resistor.

SGCT and Snubber Circuit

As with all power semi-conductors or thyristors, the SGCT must have a snubber circuit. The snubber circuit for the SGCT is comprised of a snubber resistor in series with a snubber capacitor.

The snubber circuit is shown in Figure 48. The physical locators of the same circuit are shown in Figure 56. Measure the resistance across two adjacent heatsinks. A value between 60 kΩ and 75 kΩ indicates a good sharing resistor.

Figure 48 - Snubber Circuit for SGCT module

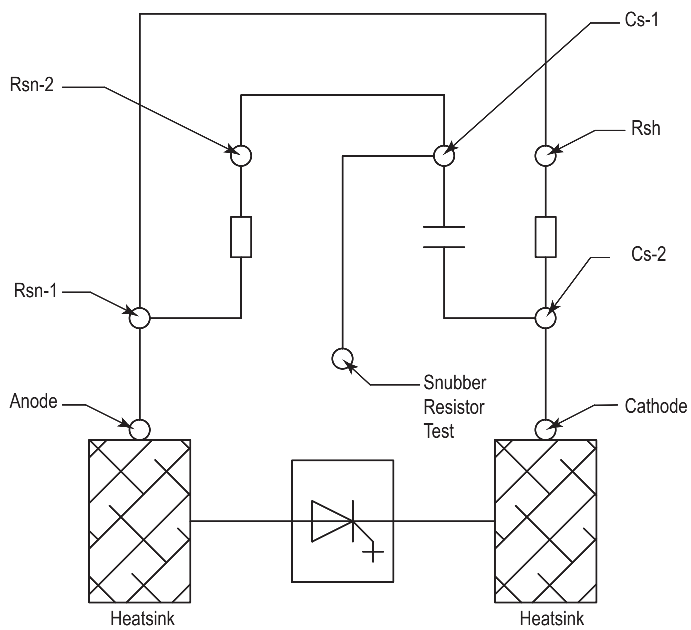


Figure 49 - Snubber Circuit for SGCT module (with SPS board)

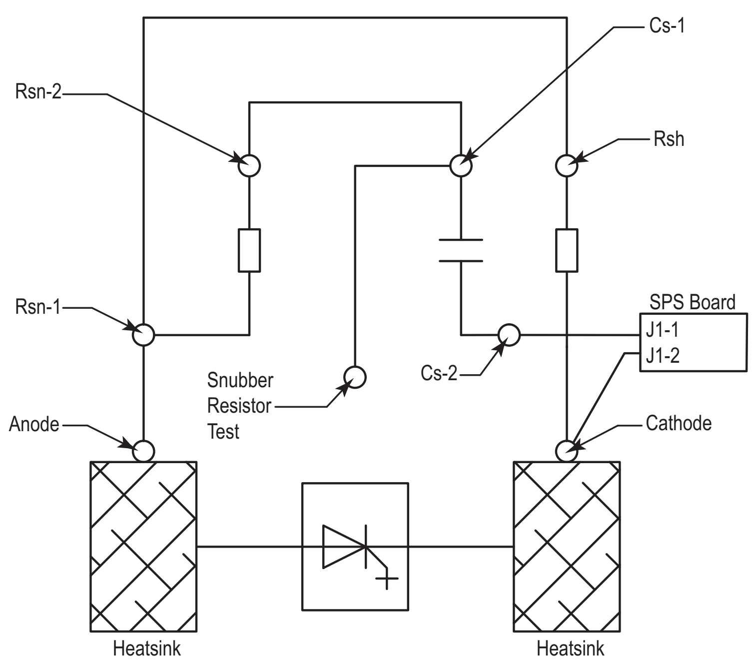


Figure 50 - 2400V Two Device PowerCage (heat sink model)

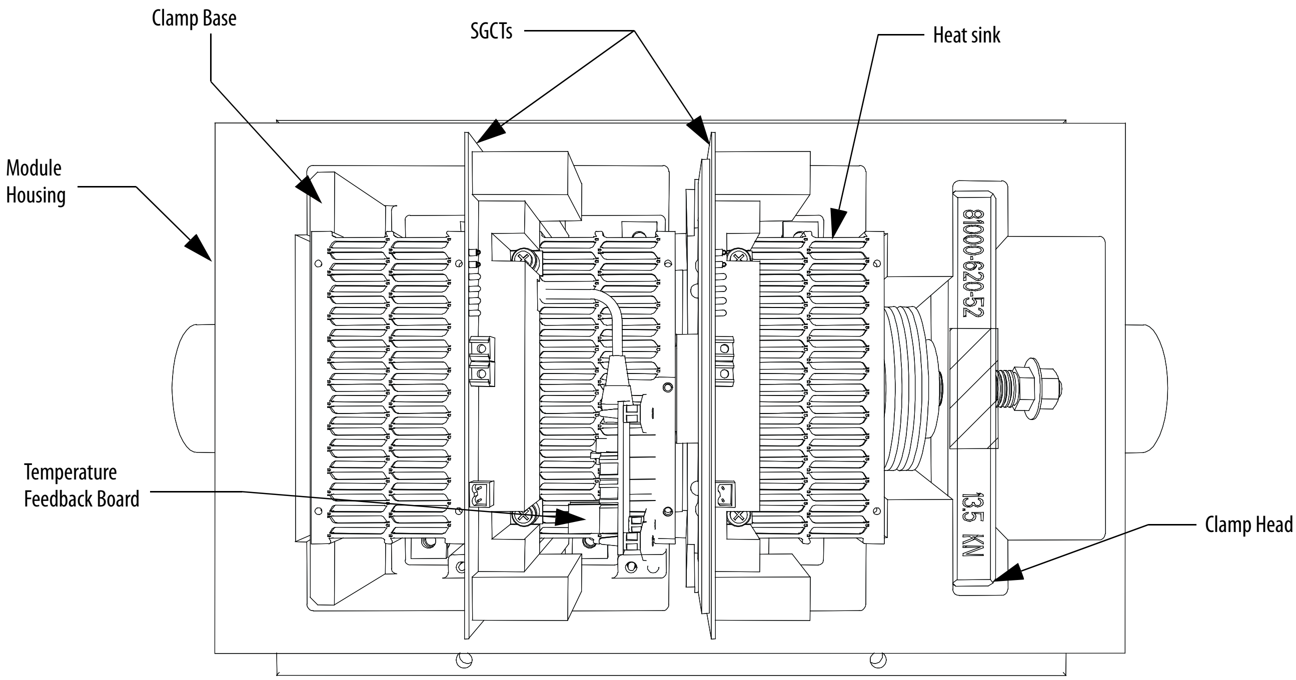


Figure 51 - 2400V Two Device PowerCage (with SPS Boards installed)

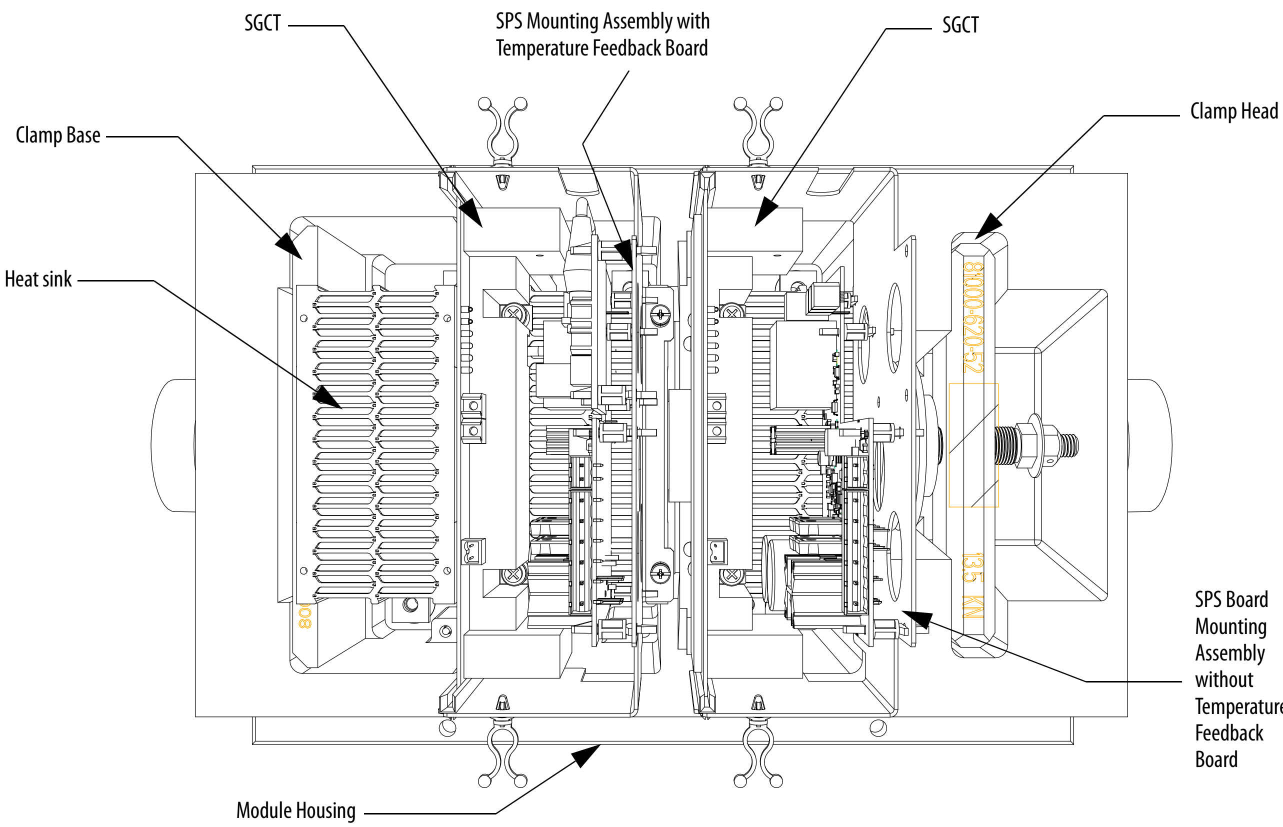


Figure 52 - 3300/4160V Four Device PowerCage (heat sink model)

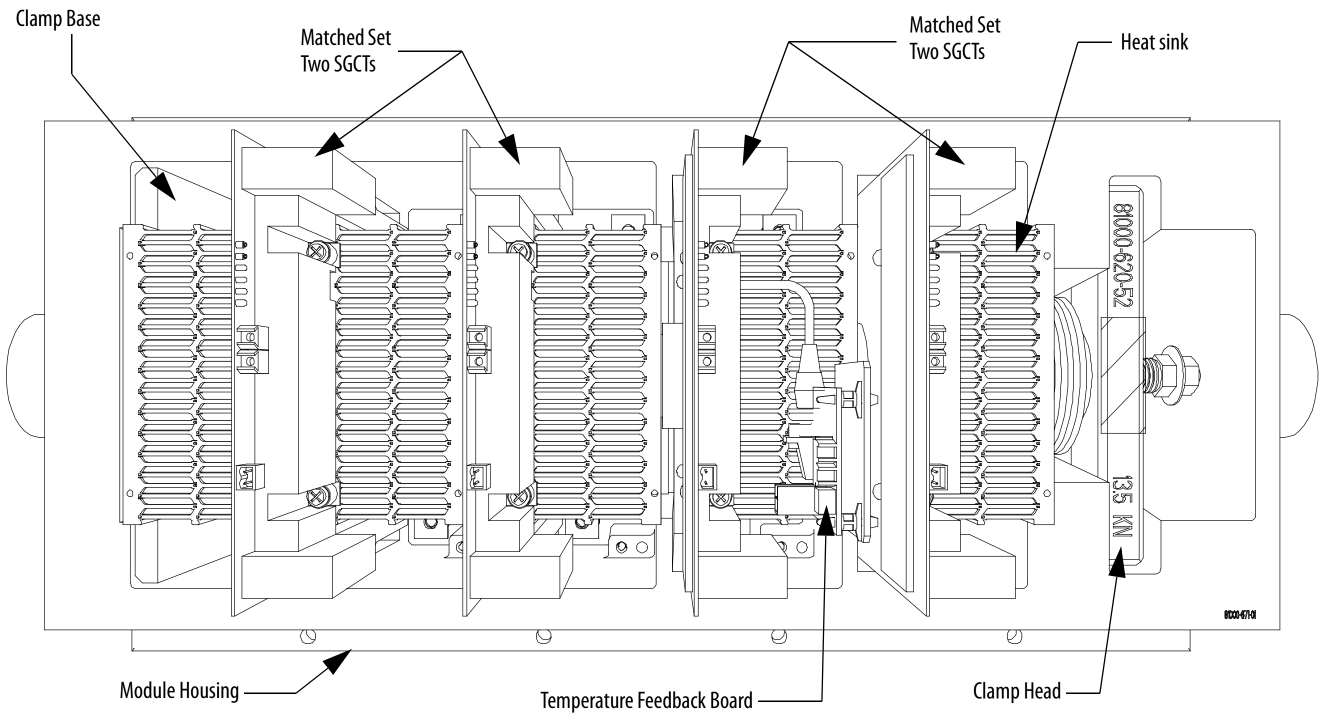


Figure 53 - 3300/4160V Four Device Rectifier PowerCage (with SPS Boards installed)

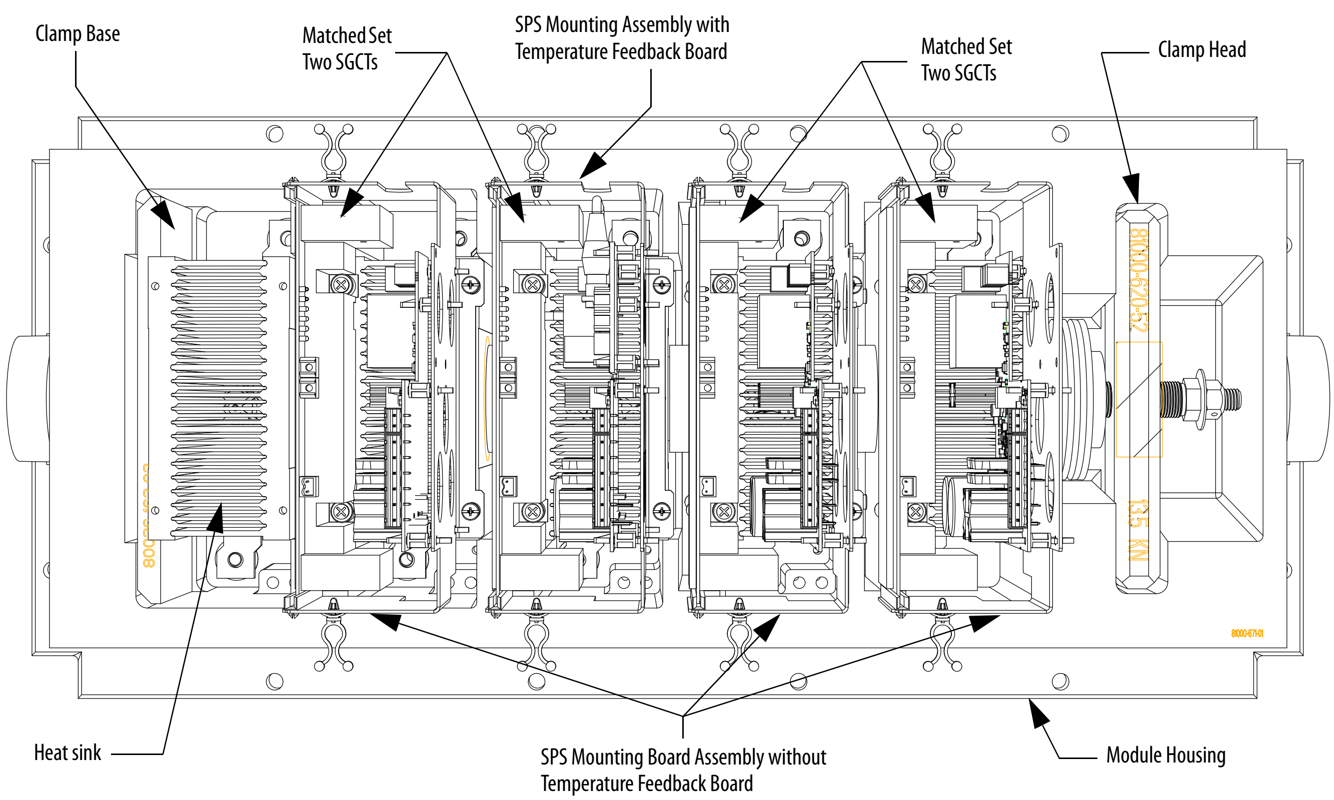


Figure 54 - 6600V Six Device PowerCage

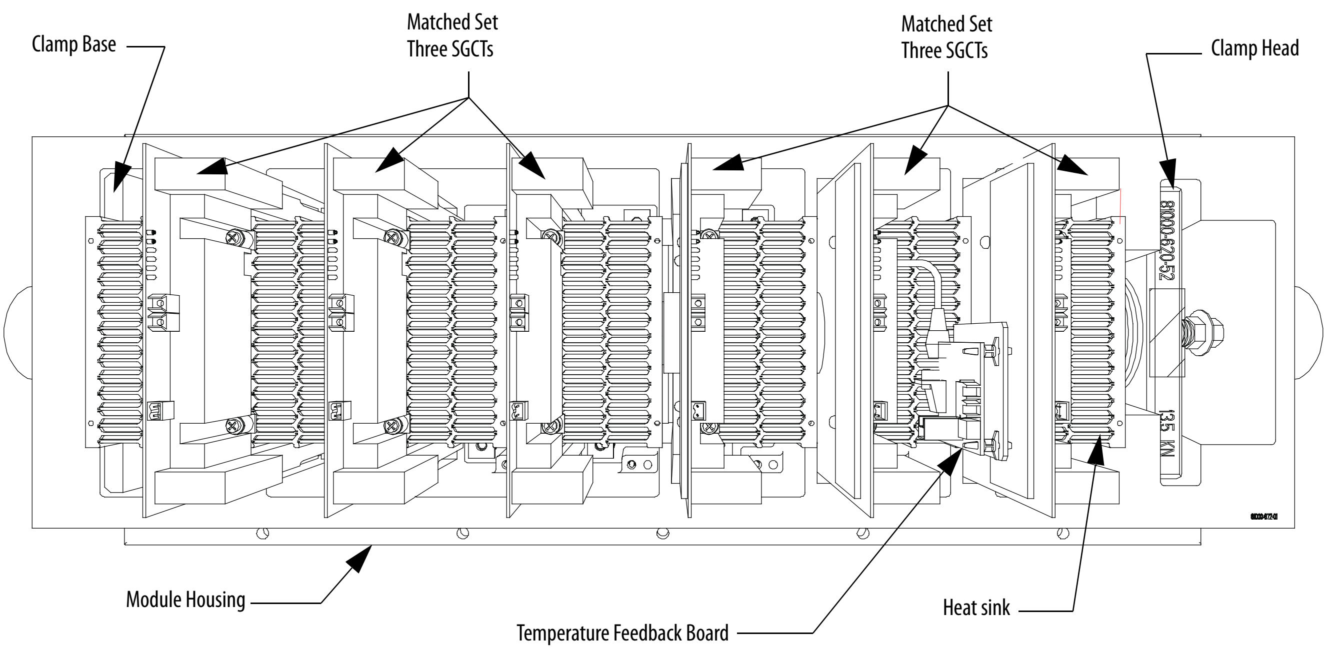


Figure 55 - 6600V Six Device PowerCage (with SPS Boards installed)

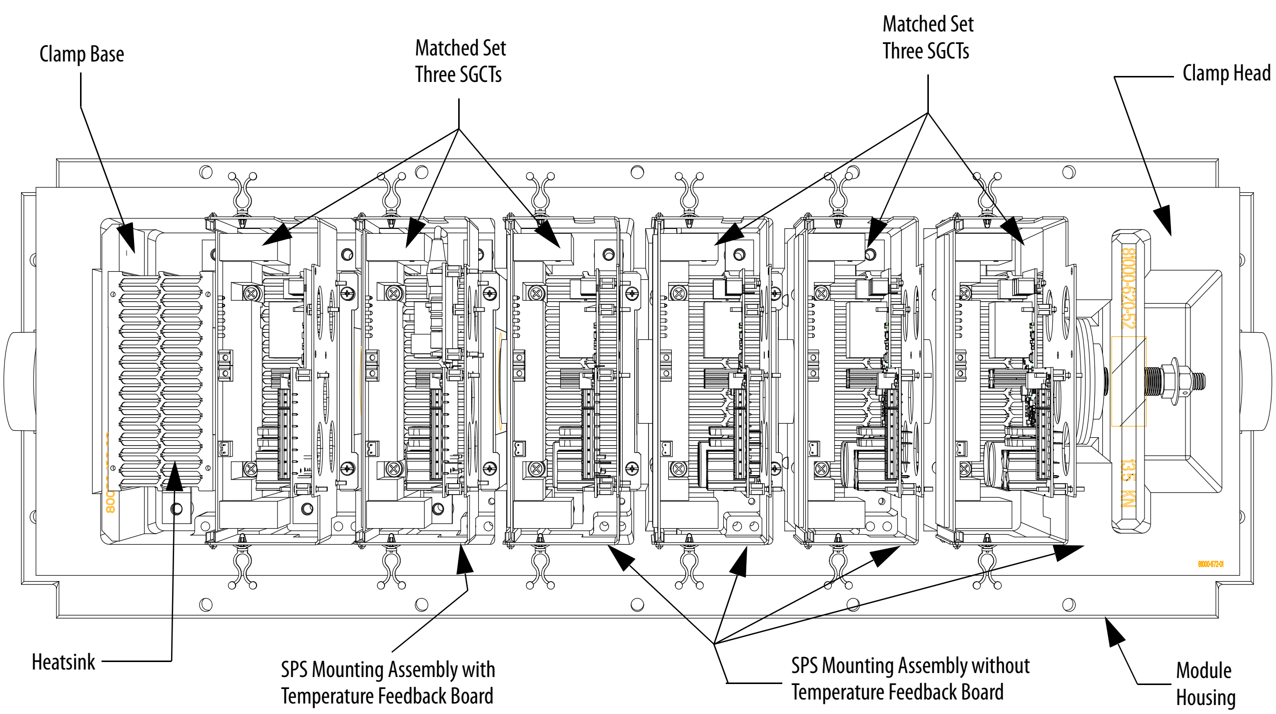
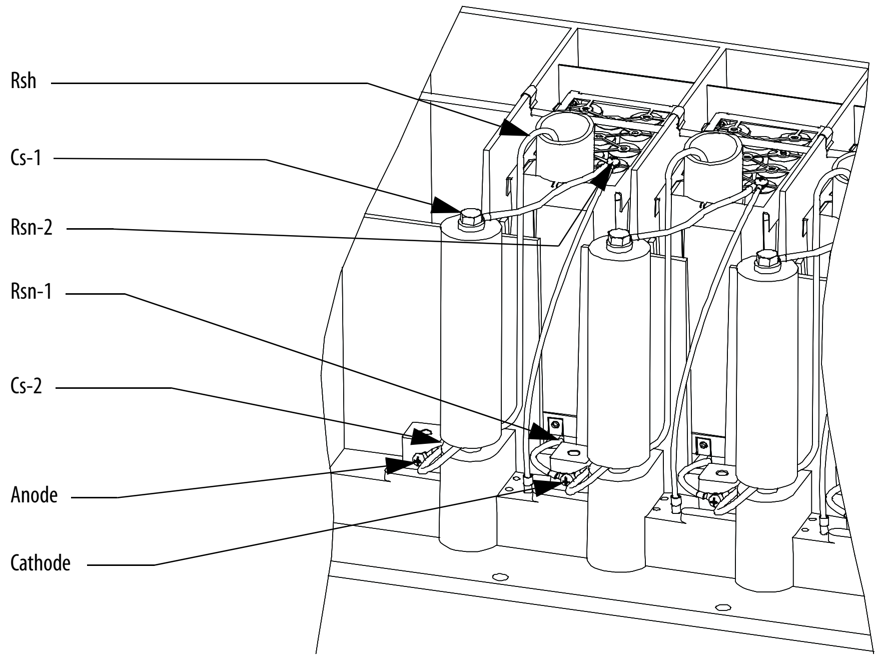


Figure 56 - Snubber Circuit Assembly for SGCT module



In addition to the snubber circuit, a sharing resistor is connected in parallel with the SGCT. The function of the sharing resistor is to ensure the voltage is shared equally among the SGCTs when connected in series. SGCTs are connected in series to increase the total reverse voltage blocking (PIV) capacity as seen by the electrical circuit. A single SGCT has a PIV rating of 6500V. This single device will provide sufficient design margin for electrical systems with 2400V medium voltage supply. At 4160V, two SGCTs must be connected in series to provide a net PIV of 13,000V to achieve the necessary design margin. Similarly, three SGCTs must be connected in series at 6600V, providing a net PIV of 19,500V to achieve the necessary design margin.

The cooling requirements of the SGCT are achieved by placing the SGCT between two forced air-cooled heatsinks, one heatsink on the anode and the other heatsink on the cathode. The clamp assembly on the right hand side of the inverter module generates these forces.

SGCT	Device Diameter	Clamp Force
400 A SGCT	38 mm	8.6 kN
800 A SGCT	47 mm	13.5 kN
1500 A SGCT	63 mm	20 kN

Pressure on the SGCTs must be uniform to prevent damage and to ensure low thermal resistance. Uniform pressure can be achieved by loosening the heatsink mounting bolts, tightening the clamp and then tightening the heatsink bolts.

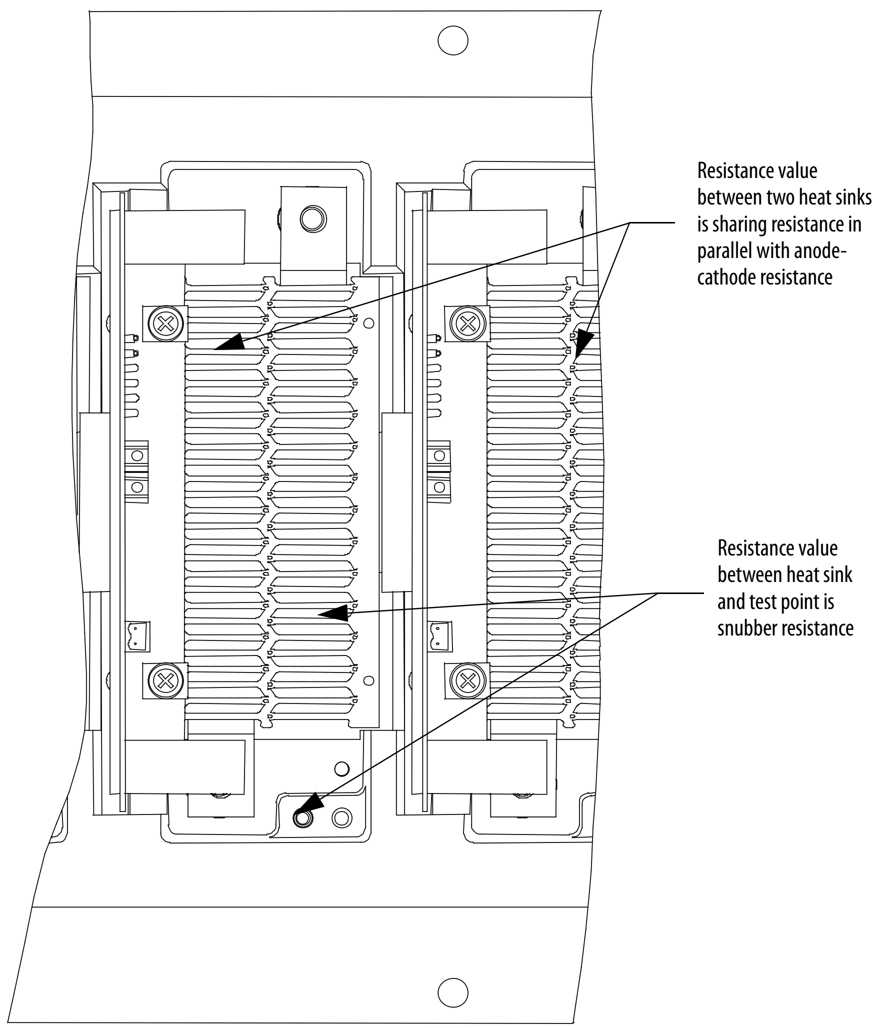
External filtered air will be directed through the slots of the heatsinks to carry away the generated heat from the SGCTs. The door filter is necessary to ensure the slots on the heatsinks do not get plugged with dust particles.

SGCT Anode-to-Cathode Sharing Resistance

The anode-cathode resistance check will measure the parallel combination of the sharing resistor and SGCT anode-cathode resistance. The sharing resistor has a resistance much lower than that of a good SGCT, thus the measurement will be slightly less than the resistance of the sharing resistor. A measurement between 60 kΩ and 75 kΩ indicates the SGCT is in good condition and that wiring to the SGCT is correct. If the SGCT fails, it will be in the shorted mode, 0 Ω. The anode to cathode resistance check will be 0 Ω.

A test point is provided inside the PowerCage to measure the resistance of the snubber resistor and capacitance of the snubber capacitor. The test point is the electrical connection between the snubber resistor and snubber capacitor. The procedure is to place one probe of the multi-meter on the test point, and the other probe on the anode heatsink in order to measure the snubber resistor value and the snubber capacitor (Figure 57). Remove the snubber terminal connection to TB1 of the SPGD board and measure between the test point and the wire that is connected to pin 1 of the TB1 female connector. Replace the snubber terminal connection once the measurement is complete.

Figure 57 - Resistance Measurements SGCT PowerCage (SPS Board removed for clarity)



Snubber Resistance

Access to the snubber resistor is not required to test its resistance. Located within the PowerCage under the heatsink is a snubber circuit test point. For each device, there is one test point. To verify the resistance, measure the resistance between the test point and the heat sink above.

Figure 58 - Testing the Snubber Resistor

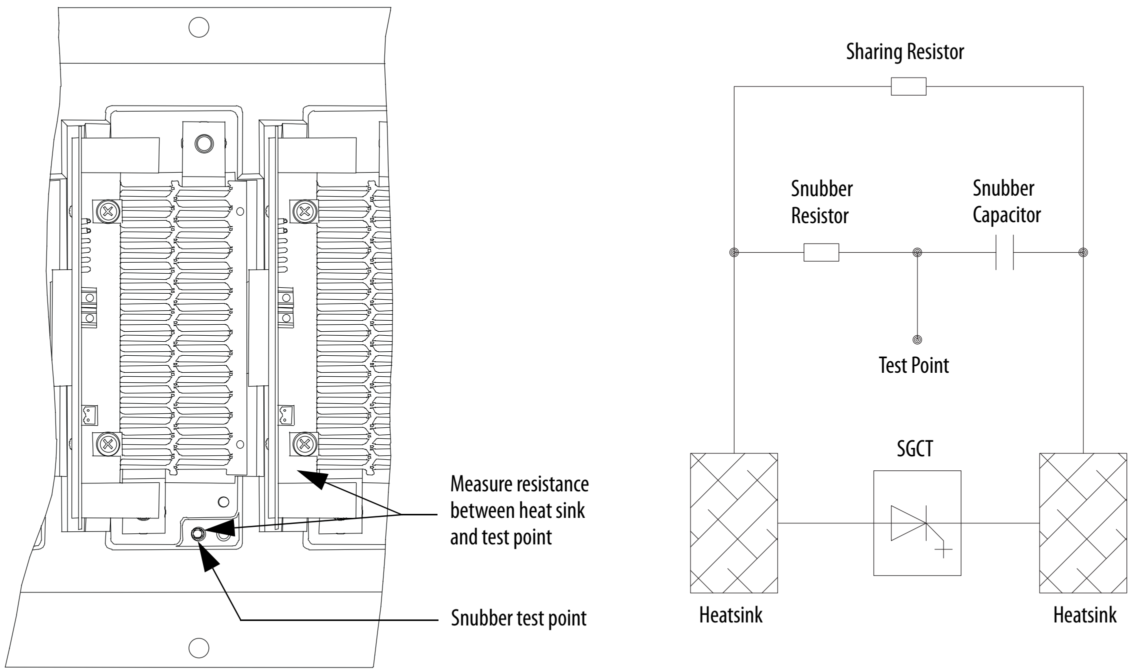
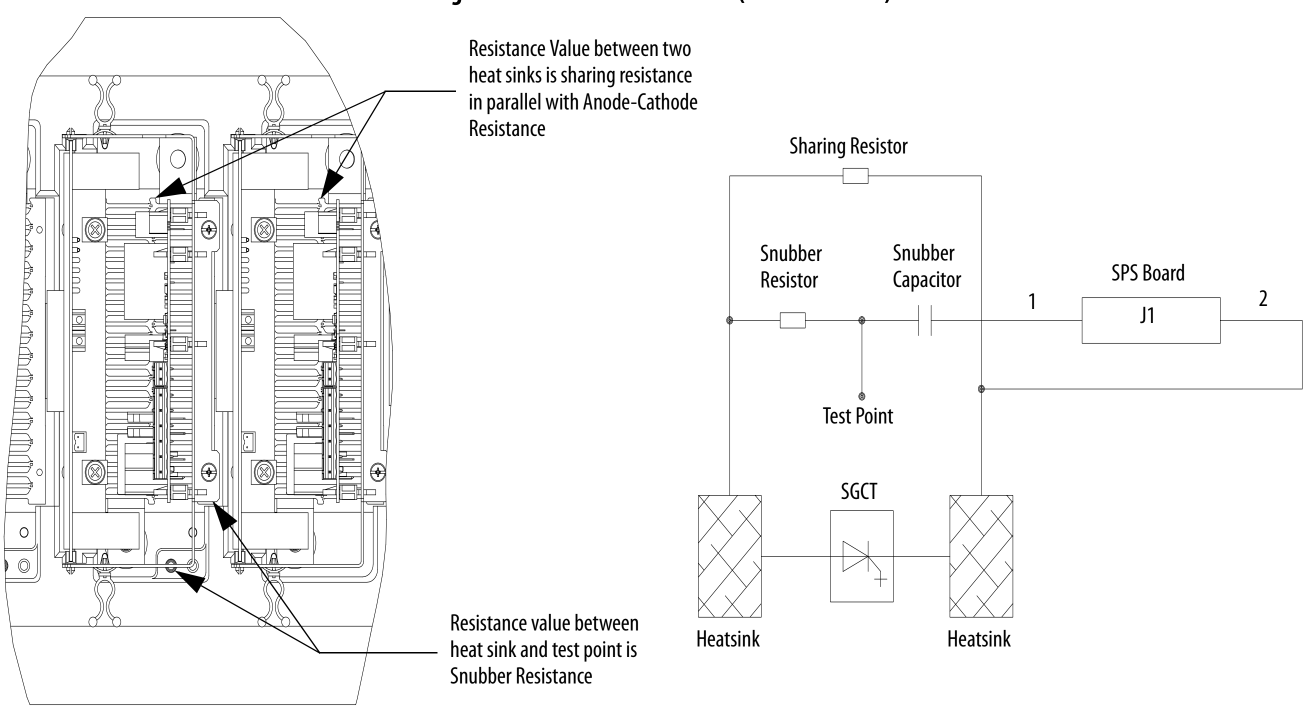


Figure 59 - Snubber Resistor Test (with SPS Board)



Snubber Capacitance

Turn the multimeter from the resistance to capacitance measurement mode. Verify the snubber capacitor by measuring from the test point to the heat sink adjacent to the right for standard rectifiers, or from heat sink to heat sink. For SPS rectifiers, measure from the test point to pin 1 of the Phoenix connector that plugs into J1 of the SPS board (disconnect the J1 connector from the SPS board first).

Figure 60 - Snubber Capacitor Test

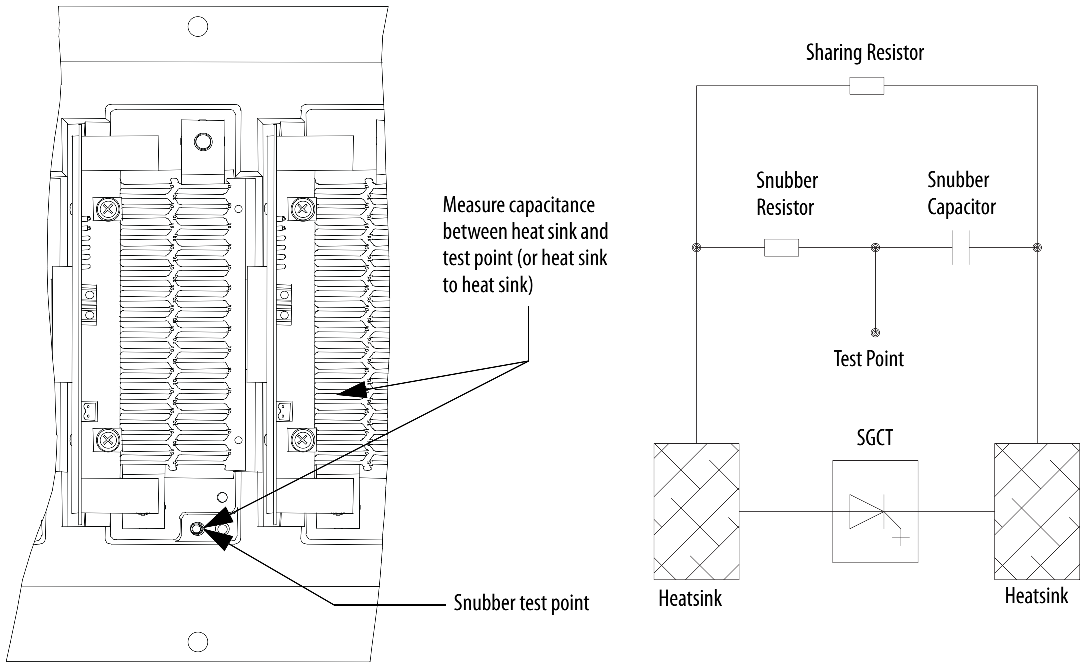
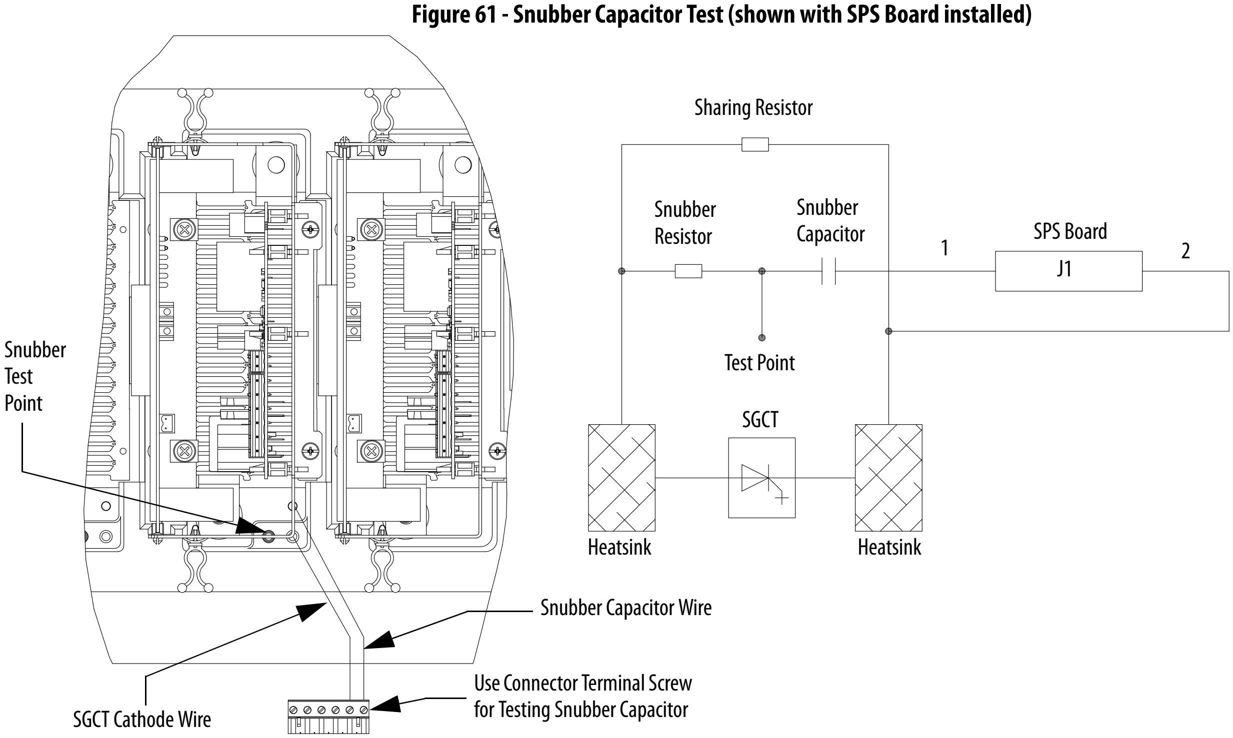


Figure 61 - Snubber Capacitor Test (shown with SPS Board installed)



Replacing the SGCT

The Symmetrical Gate Commutated Thyristor (SGCT or device) with attached circuit board is located within the PowerCage assembly.

SGCTs must be replaced in matched sets:

- 3300V and 4160V systems use sets of two
- 6600V systems use sets of three

The SGCT and associated control board are a single component. There will never be a time when the device or the circuit board will be changed individually. There are four LEDs on the SGCT; the following table describes their functions:

LED 4	Green	Solid Green indicates that the Power Supply to the Card is OK
LED 3	Green	Solid Green indicates that the Gate-Cathode resistance is OK
LED 2	Yellow	LED ON indicates the gate is ON, and Flashes alternately with LED 1 while gating
LED 1	Red	LED ON indicates the gate is OFF, and Flashes alternately with LED 2 while gating

1. Ensure there is no power to the equipment.

ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the drive. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

Note the position of the fiber optic cables for assembly.

2. To remove the SGCT, it is necessary to remove the gate driver power cable and fiber optic cables. Exceeding the minimum bend radius (50 mm [2 in.]) of the fiber optic cables may result in damage.

   If installed, remove the SPS snubber connector (J1 on the SPS board) and remove the SPS mounting bracket with the SPS board.

ATTENTION: The fiber optic cables can be damaged if struck or bent sharply. The minimum bend radius is 50 mm (2 in.). The connector has a locking feature that requires pinching the tab and gently pulling straight out. The component on the printed circuit board should be held to prevent damage

3. Remove the load on the clamp head assembly as described on page 83.
4. Two brackets secure the board to the heatsink. Loosen the captive screws until the circuit board is free. It may be necessary to adjust the position of the heatsinks to allow free movement of the SGCT.

5. Slide the circuit board straight out.

ATTENTION: The SGCT can be destroyed or damaged by static charges. Personnel must be properly grounded before removing the replacement SGCT from the protective anti-static bag that it is supplied in. Use of damaged circuit boards may also damage related components. A grounding wrist strap is recommended for handling sensitive circuit boards.

IMPORTANT	Replacement SGCTs will be supplied, grouped in matched sets. This means that all of the SGCTs in a leg have been grouped together based on their electrical performance. Grouping similarly matched devices ensures balanced load sharing of a leg of devices. When replacing the device, it is necessary to replace all the SGCTs in a matched set, even if only one has failed.

6. Clean the heatsink with a soft cloth and rubbing alcohol.
7. While grounded, remove the SGCT from the anti-static bag in which it is supplied.
8. Apply a thin layer of Electrical Joint Compound (Alcoa EJC No. 2 or approved equivalent) to the contact faces of the new SGCTs to be installed. The recommended procedure is to apply the compound to the pole faces using a small brush, and then gently wipe the pole face with an industrial wipe so that a thin film remains. Examine the pole face before proceeding to ensure that no brush bristles remain.

IMPORTANT	Too much joint compound may result in contamination of other surfaces leading to system damage.

9. Slide the SGCT into place until the mounting brackets contact the surface of the heatsink.
10. Tighten the captive screws located in the brackets.
11. Follow procedure Uniform Clamping Pressure on page 82 to ensure the heatsinks are clamped to a uniform pressure.

    If equipped, re-install the SPS board and mounting bracket, and reconnect the snubber connection to J1 of the SPS board.
12. Connect the power cable and fiber optic cables (ensure the bend radius is not exceeded)

Figure 62 - Replacing the SGCT

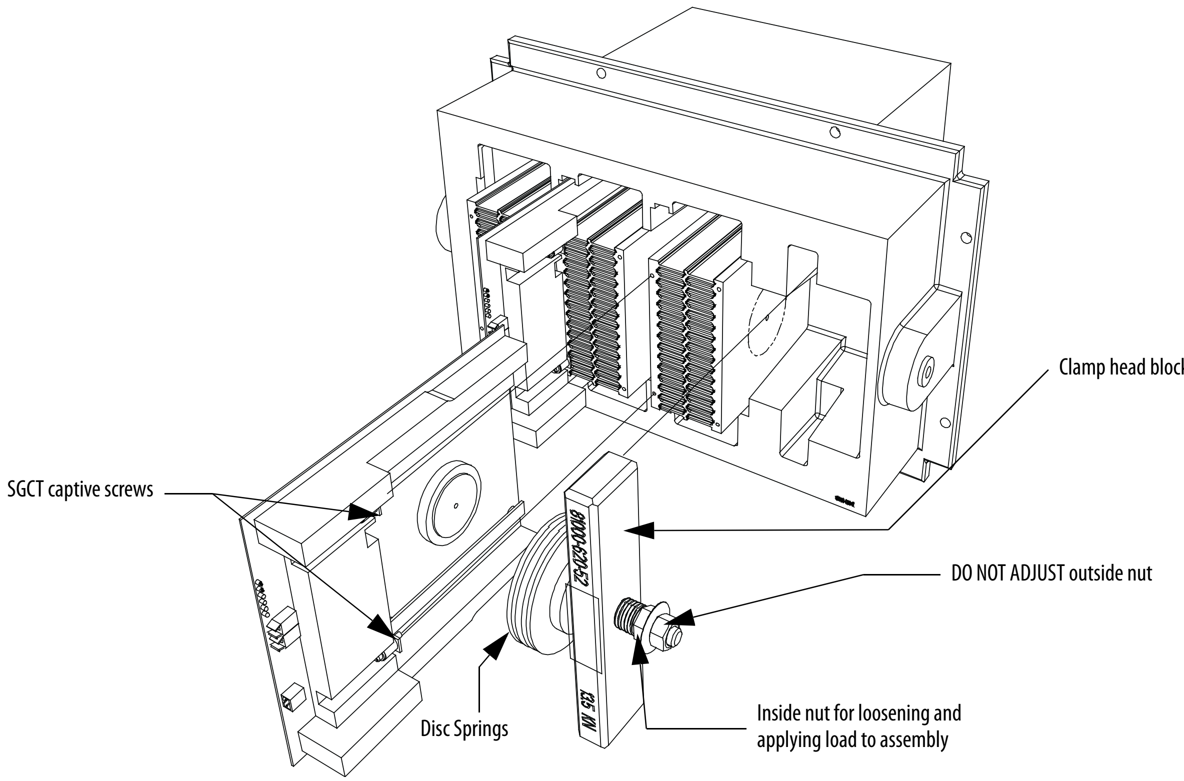
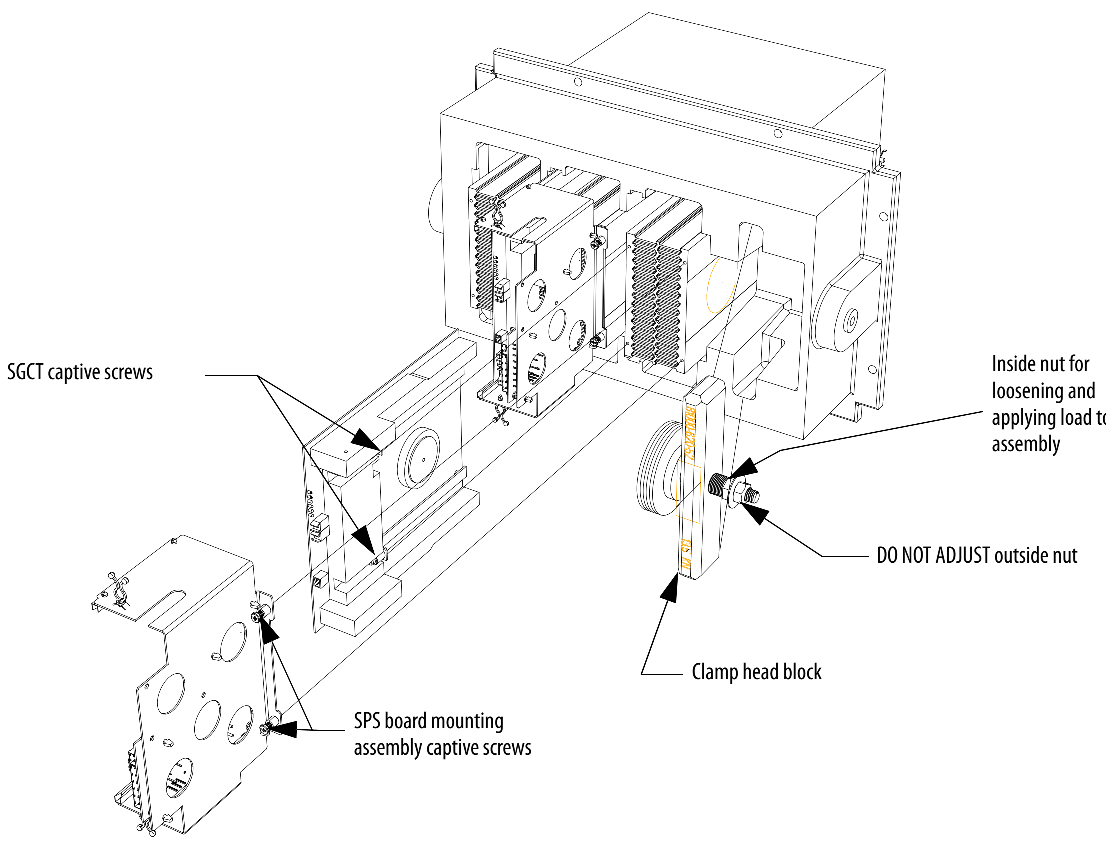


Figure 63 - Replacing the SGCT (if SPS board is installed)

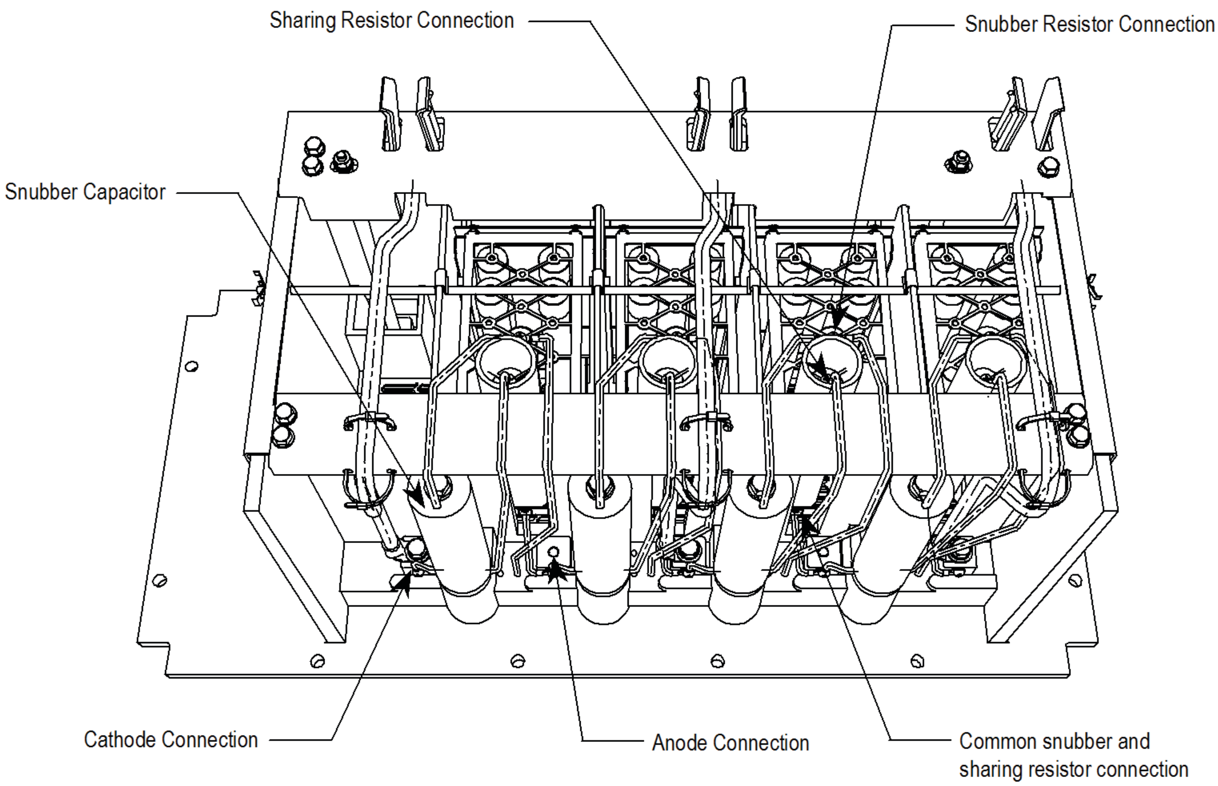


Replacing Snubber and Sharing Resistor

The snubber and sharing resistors are part of the resistor assembly located behind the PowerCage.

1. Remove the PowerCage as outlined in PowerCage Removal on page 88.
2. Note the connection of the leads for correct replacement.
3. Detach the leads located on the bottom of the resistor assembly.

Figure 64 - Removal of the PowerCage



4. Remove the push nuts on the end of the retaining rod. Pinch the clip together and pull off. Pull out the retaining rod.
5. Remove two bolts and swing out the PowerCage plug-in stab assembly.

Figure 65 - Snubber and Sharing Resistor Replacement

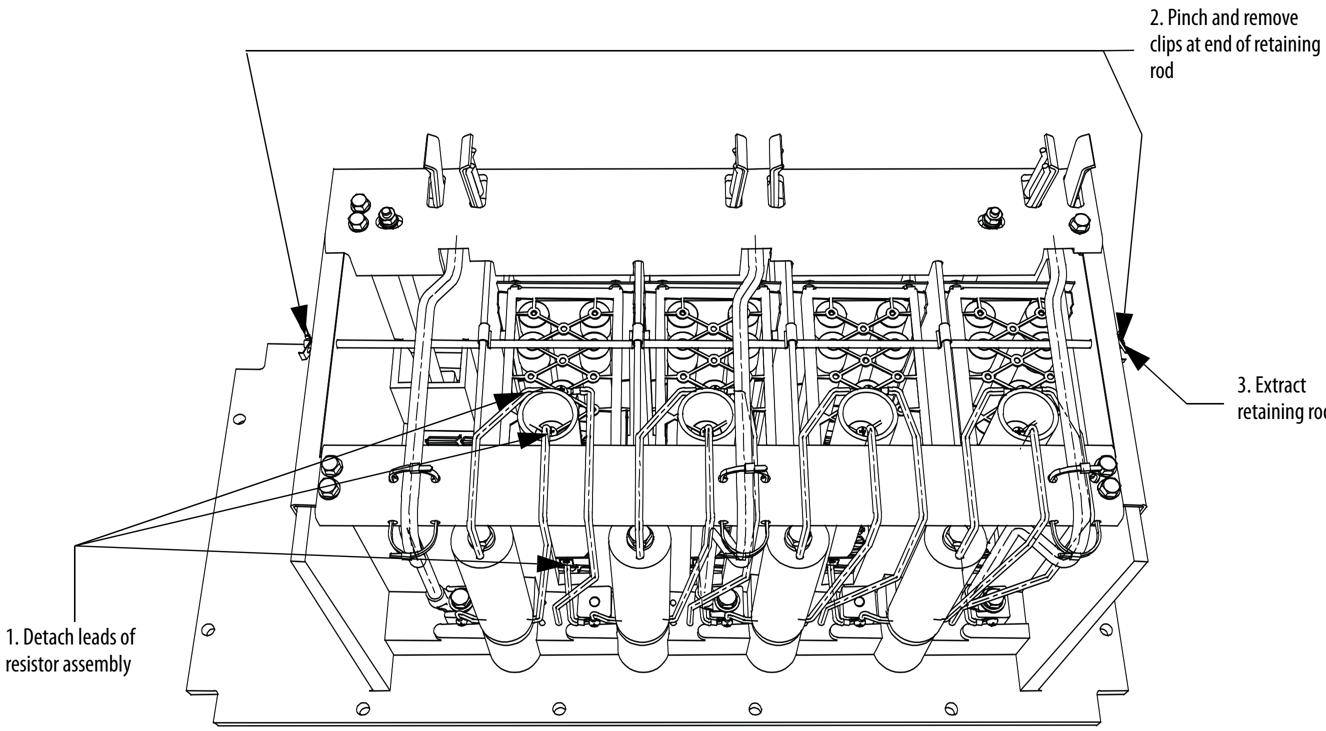
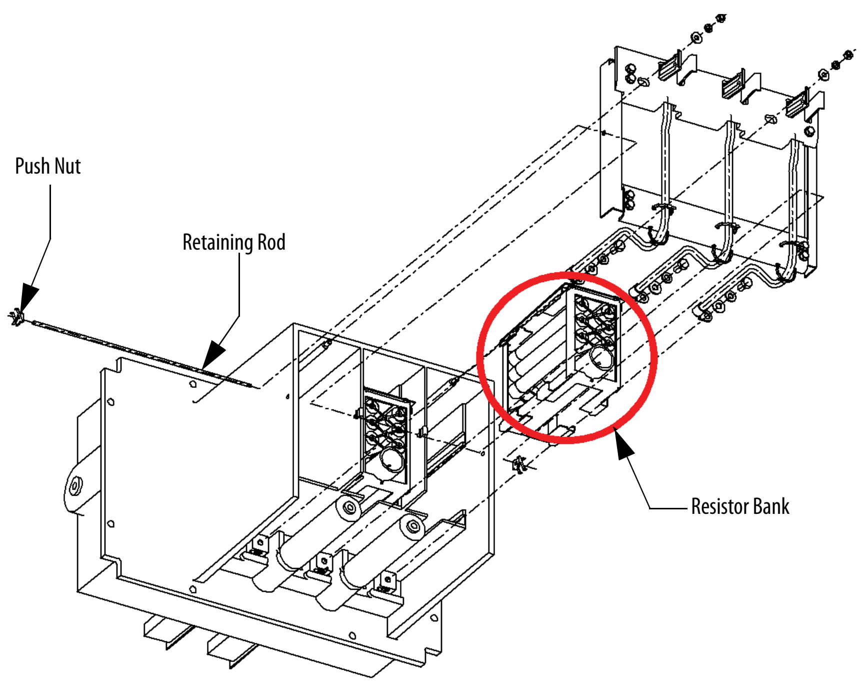


Figure 66 - Removing resistor bank from PowerCage



6. Remove the resistor bank from the Power Cage.
7. Place the new resistor bank assembly back into the PowerCage.
8. Slide the retaining rod into place and push the clips back into place.

9. Connect the leads to the resistor bank.
10. Install the PowerCage as outlined in PowerCage Removal on page 88.

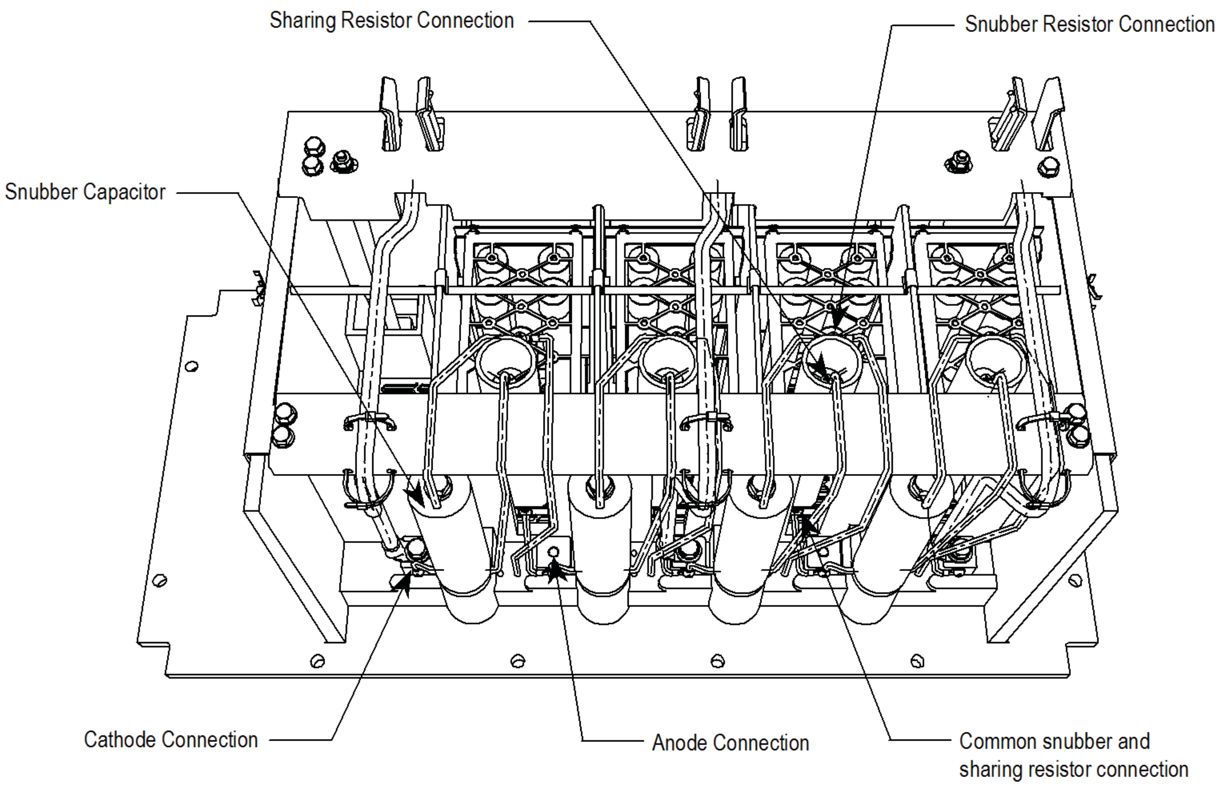
Replacing Snubber Capacitor

The snubber capacitors are part of the capacitor assembly located behind the PowerCage.

1. Remove the PowerCage as outlined in PowerCage Removal on page 88.

   Note the connection of the leads for correct replacement.
2. Detach the lead located on the top of the capacitor.

Figure 67 - Removal of the PowerCage



3. Remove the push nuts on the end of the retaining rod. Pinch the clip together and pull off. Pull out the retaining rod.
4. Remove two bolts and swing out PowerCage plug-in stab assembly.

Figure 68 - Snubber Capacitor Replacement

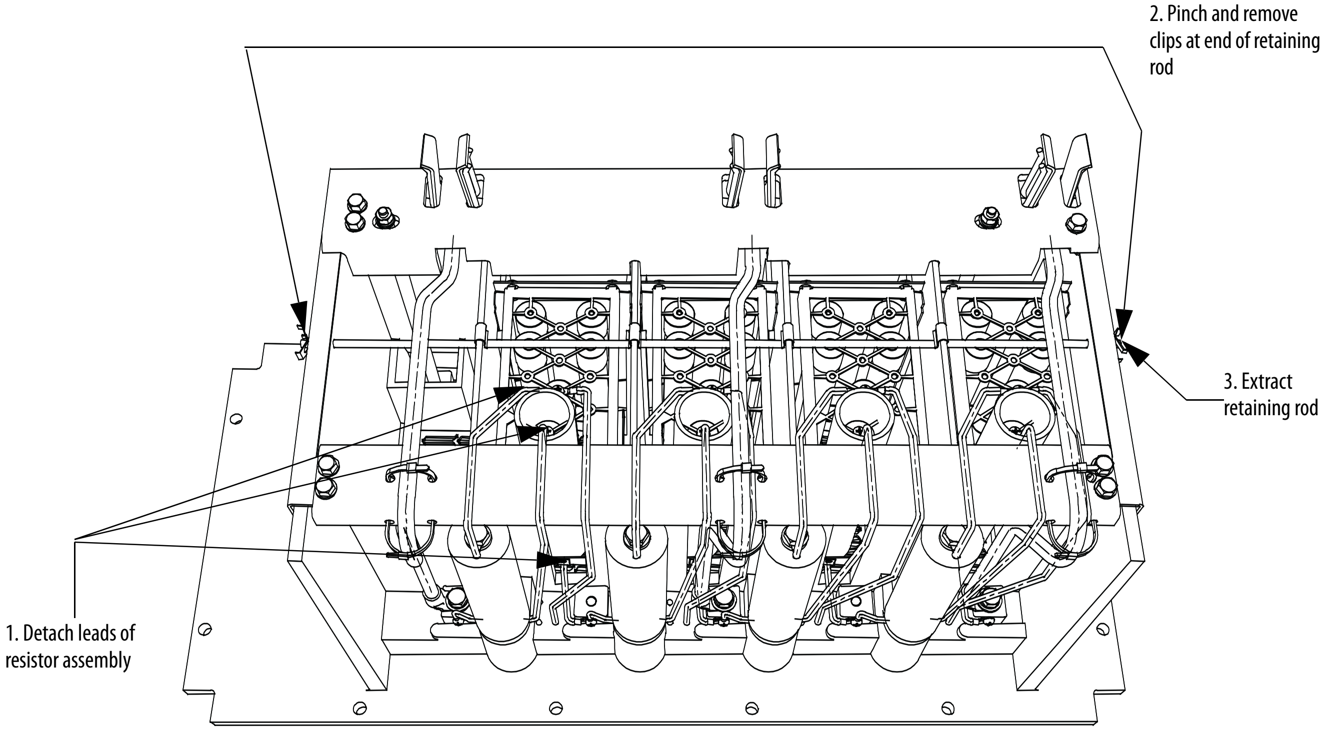
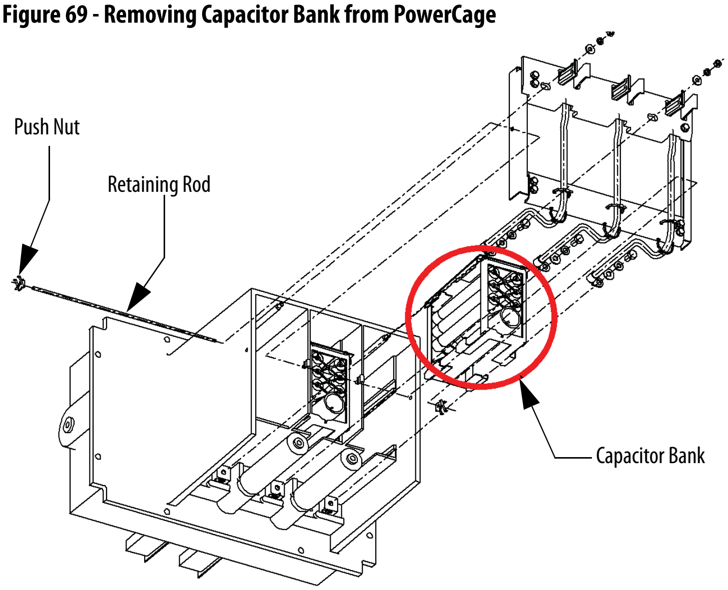


Figure 69 - Removing Capacitor Bank from PowerCage



5. Remove the capacitor from the PowerCage.
6. Place the new capacitor back into the PowerCage.

   Ensure the bottom lead of the capacitor is on the stud.
7. Slide the retaining rod into place and push the clips back into place.
8. Connect the top lead to the capacitor.
9. Install the PowerCage as outlined in PowerCage Removal on page 88.

Replacing Sharing Resistors

Normally the sharing resistor is part of the snubber resistor assembly. Replacement of the sharing resistor also requires replacing the snubber resistor.

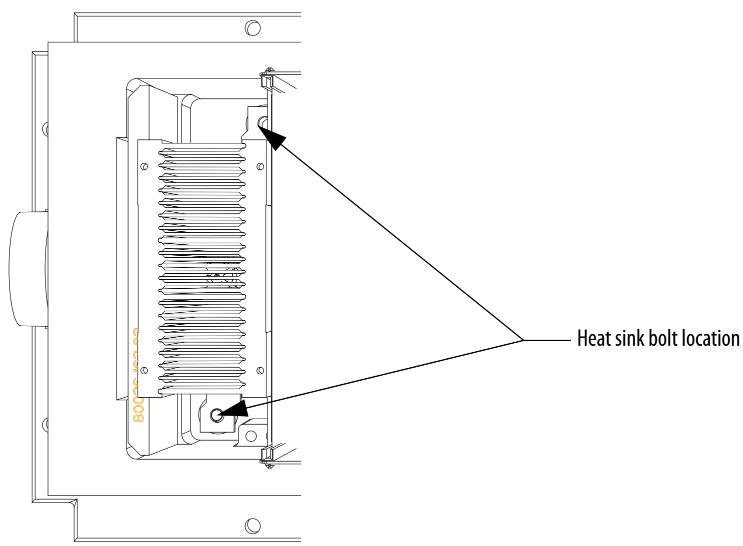
The sharing and snubber resistors are normally located on the backside of the PowerCage. See Replacing Snubber and Sharing Resistor.

Uniform Clamping Pressure

Always maintain proper pressure on the thyristors. Follow this procedure whenever changing devices or loosening the clamp completely.

1. Apply a thin layer of Electrical Joint Compound (Alcoa EJC No. 2 or approved equivalent) to the clamp head pressure pad face (Figure 71). Apply the compound using a small brush, and gently wipe the pad face with an industrial wipe until a thin film remains. Ensure no brush bristles remain.
2. Torque the heat sink bolts to 13.5 N•m (10 lb•ft.), then loosen each bolt two complete turns.

Figure 70 - Location of Heat sink bolts



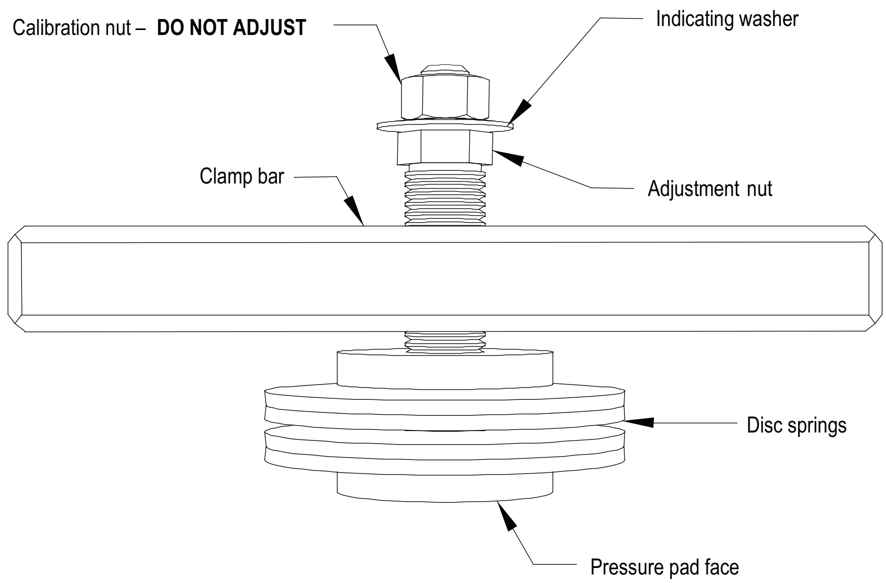
3. Tighten the clamp to the proper force until you can turn the indicating washers by the fingers with some resistance.
4. Torque the heat sink bolts to 13.5 N•m (10 lb•ft.) starting with the center heat sink and moving outward alternating left to right.
5. Check the clamp indicating washer.

Checking Clamping Pressure

Periodically, the clamping force in the PowerCage should be inspected. Ensure there is no power to the equipment.

ATTENTION: Main power must be disconnected before working on the drive. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

Figure 71 - Clamp Head Illustration



If proper force (as designated on the clamp head block) is applied to the clamping assembly, the indicating washer should just be able to rotate with fingertip touch. The indicating washer should not rotate freely. Some force will need to be applied with your fingertips.

Clamping Pressure Adjustment

1. Ensure that all power to the drive is off.
2. Do not loosen the adjustment nut. If the clamping pressure is let off, the assembly procedure must be carried out to ensure uniform pressure on the thyristors.
3. Tighten with a 21 mm wrench on the adjustment nut (upward motion) until the indicating washer can be turned by fingers with some resistance. IT SHOULD NOT SPIN FREELY.

IMPORTANT	Never rotate the calibration nut located outside the indicating washer at the end of the threaded rod. The rotation of the outer nut will affect the torque calibration, which is factory set. Only adjust the inside nut (see Figure 71 and Figure).

Temperature Sensing

Thermal sensors are located on heatsink(s) in the converter. The thermal sensor is mounted on the heatsink with the temperature feedback board.

Replacing the Thermal Sensor

1. Ensure there is no power to the equipment.

ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the drive. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

2. Remove the SPS bracket first, if installed. The heatsink with the thermal sensor must be removed from the PowerCage. Remove clamp load (refer to Figure 71).
3. Remove the device (SGCT) that is secured to the heatsink with the thermal sensor.
4. Disconnect the fiber optic cable to the temperature feedback board.
5. Remove two M8 screws holding the heatsink in place.
6. Remove the heatsink with the temperature feedback board from the PowerCage. If SPS is equipped, the heatsink is on the SPS mounting bracket.
7. Disconnect the plug that connects the thermal sensor to the circuit board.
8. Remove the screw that attaches the thermal sensor to the heatsink.
9. Replace with the new thermal sensor and cable assembly.
10. Note there is a small voltage difference between the thermal sensor and its heatsink. For proper function, it is essential to mount the small insulating pad between the thermal sensor and the heatsink and the insulating bushing between the thermal sensor mounting screw and the thermal sensor (see Figure 72).
11. Replacement of the heatsink with the new thermal sensor is in the reverse order of removal.
12. Follow procedure Uniform Clamping Pressure on page 82 to ensure the heatsinks are clamped to a uniform pressure.

Figure 72 - Replacing the Thermal Sensor

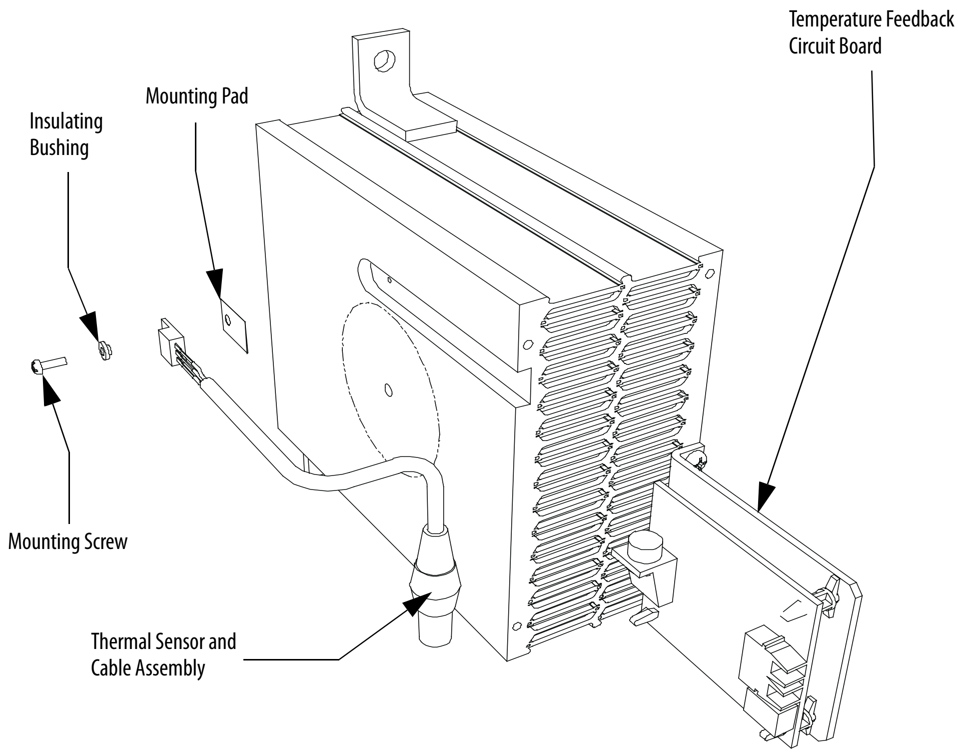
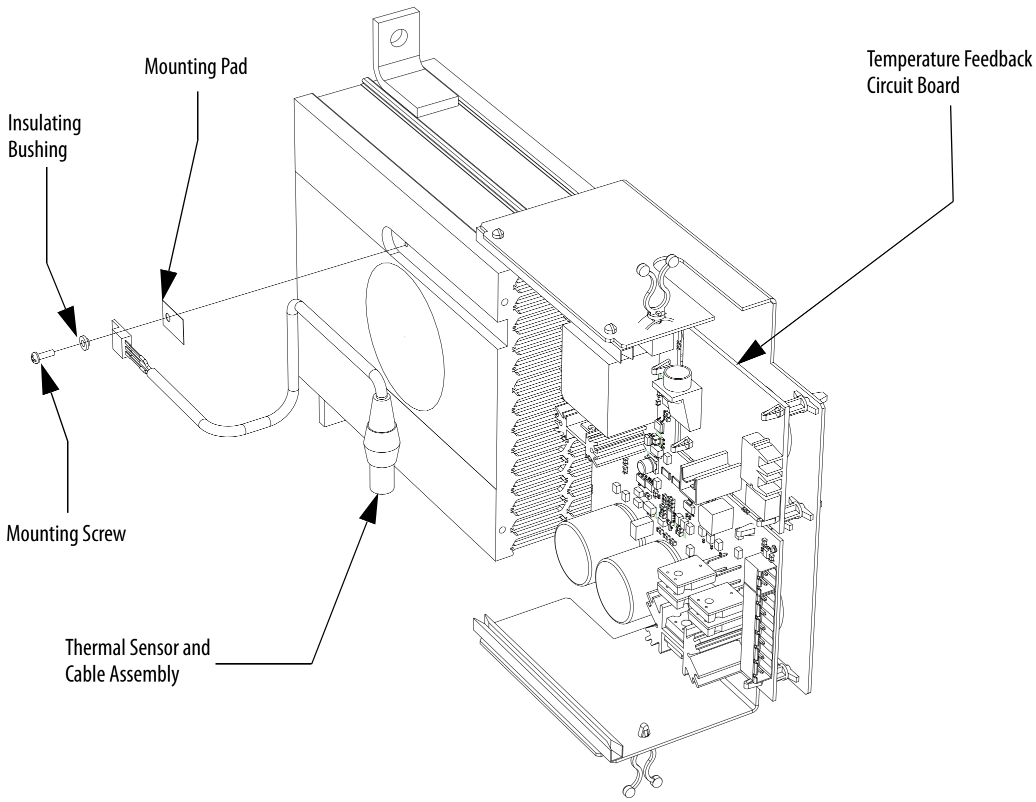


Figure 73 - Replacing the Thermal Sensor (if SPS board is installed)

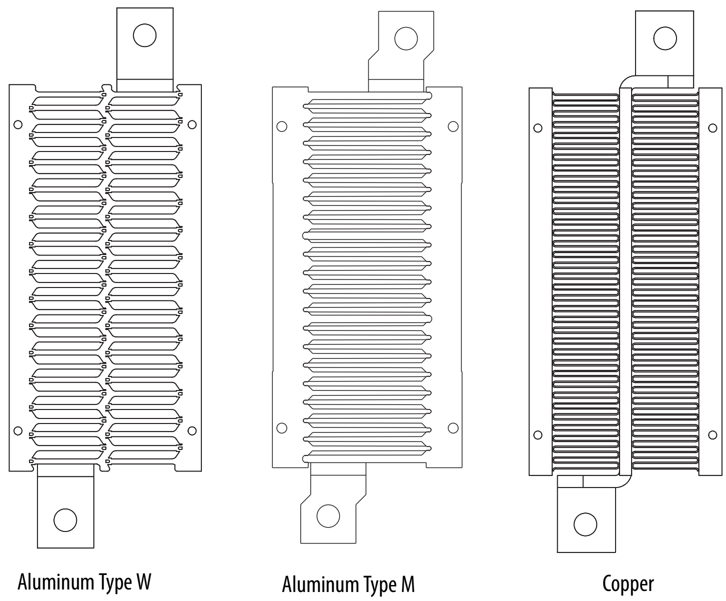


Heatsink Replacement

There are three different styles of heat sinks in PowerFlex air-cooled drives, depending on thermal requirements:

- Aluminum Type W heat sinks have a plurality of short internal fins along the internal surfaces
- Aluminum Type M heat sinks have internal fins with flat surfaces.
- Copper heat sinks have internal fins made from folded copper foil

Figure 74 - Heatsinks



1. Ensure there is no power to the equipment.

ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the drive. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

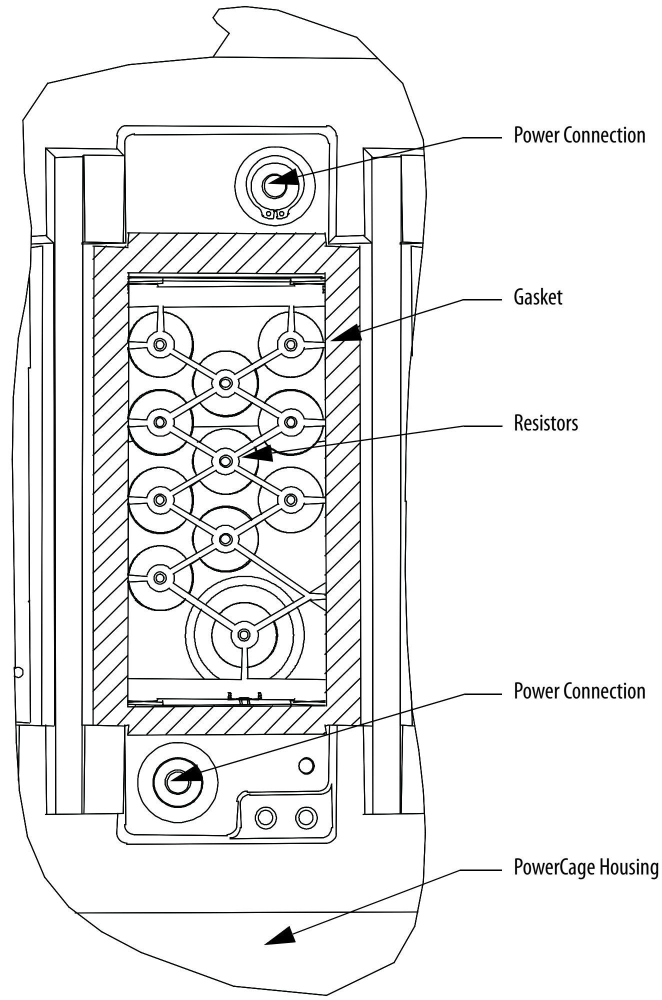
2. Remove the load from the clamp head per the procedure on page 83.
3. Completely remove the SGCT from the heatsink that is being replaced per the instructions on page 75.
4. There are two bolts that secure the heatsink to the PowerCage. They are 13 mm bolts, and should be removed using several extenders to get the socket wrench out past all the sensitive gate driver boards.
5. Loosen the two bolts and carefully remove the heatsink from the PowerCage.
6. Install the new heatsink and hand-tighten the bolts.
7. Replace the SGCT per the instructions on page 75.

   Refer to page 82 to ensure the heatsinks are clamped to a uniform pressure.

PowerCage Gasket

To ensure all air movement is through the slots of the heatsinks, all possible air leaks have been sealed with a rubber gasket. This gasket is placed between the surface of the PowerCage and heatsink module. It is necessary to have the gasket in place to ensure proper cooling of the SGCTs is maintained.

Figure 75 - PowerCage Gasket Location



Replacement of PowerCage Gaskets

The gaskets do not normally require replacement, but in the event that they become damaged, they may require replacement.

Removal of old Gasket Material

Pull all the material possible off by hand. Scrape off as much material as possible with a sharp knife. Do not score the PowerCage with the knife. All the material will not come off! Remove as much as possible to leave an even surface to bond to. Clean away any loose pieces of gasket. Then proceed with installation of the gasket.

The PowerCage must be cleaned with an all purpose household cleaner.

IMPORTANT	Do not spray onto the PowerCage as it promotes electrical tracking.

Apply the cleaner to a paper towel and wipe the surface of the PowerCage where the gasket will be applied. Liberally spray the surface with distilled water. Wipe the surface with a clean paper towel.

Apply a thin bead of Loctite 454 adhesive to the PowerCage surface in a zigzag pattern using the original nozzle size. Use the tip to spread the adhesive around to cover at least 50% of the area. There should be sufficient quantity of adhesive to remain wet long enough for the gasket to be applied. The adhesive uses the moisture in the air as it cures. The higher the humidity the faster the adhesive will cure.

IMPORTANT	This adhesive will bond anything quickly, including fingers!

Position the gaskets ensuring the gasket is oriented correctly. The gasket should be centered over the opening for the heatsinks with the narrow end positioned closest to the test points. The porous surface of the gasket should be applied to the PowerCage. The gasket will bond almost immediately. Apply some pressure to the gasket for 15…30 seconds.

PowerCage Removal

After all the gaskets have been placed check to see that the gasket has bonded properly. Repair any loose areas.

1. Ensure there is no power to the equipment.

ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the sensing board. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

2. Before removing the PowerCage, all the components located within the PowerCage need to be removed to avoid any damage to the components. Consult the required sections to remove clamping pressure, as well as remove the SGCT, circuit boards, and thermal sensor.

ATTENTION: The SGCT can be destroyed or damaged by static charges. Personnel must be properly grounded before removing circuit boards from the PowerCage. Use of damaged circuit boards may also damage related components. A grounding wrist strap is recommended for handling.

3. Remove the M8 bolts in the two flanges that connect the heatsink to the PowerCage, then remove the heatsink from the PowerCage. This will reduce the weight of the PowerCage making it easier to handle.

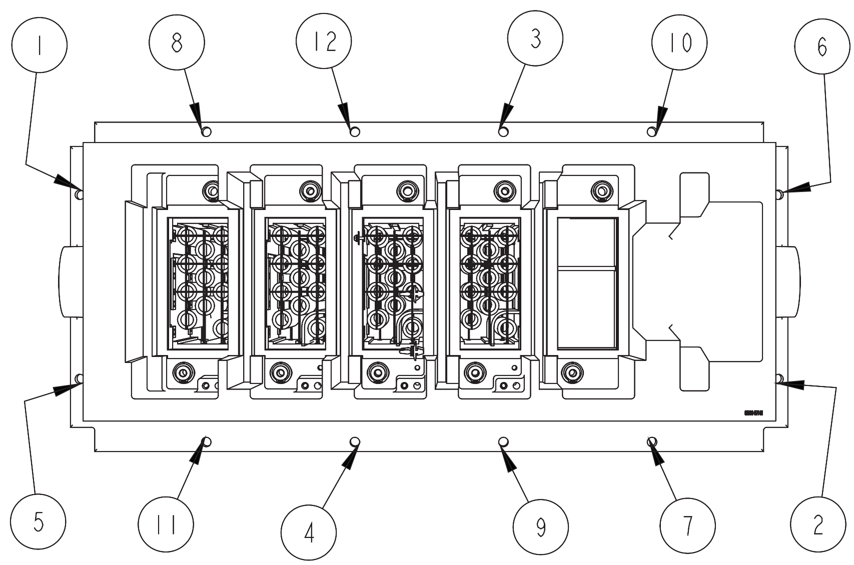
4. To detach the PowerCage itself, the bolts on the outer flange need to be removed. Carefully lift the PowerCage down, placing the forward face down. Do not overtorque these bolts when replacing the PowerCage.

IMPORTANT	The PowerCage can be heavy and it is preferred that two people should extract the PowerCage from the drive to prevent injury or damage to the module.

5. Refer to appropriate section for component replacement.
6. When replacing the PowerCage, it is important to place the bolts on the outer flange in loosely. Torque bolts alternately on one flange and then the opposite flange to ensure even tightening of the module. A suggested sequence for torquing PowerCage bolts is shown in Figure 76.

Note: The PowerCage is shown with switching components, heatsinks and clamps removed for ease of lifting.

Figure 76 - Typical Torque Sequence



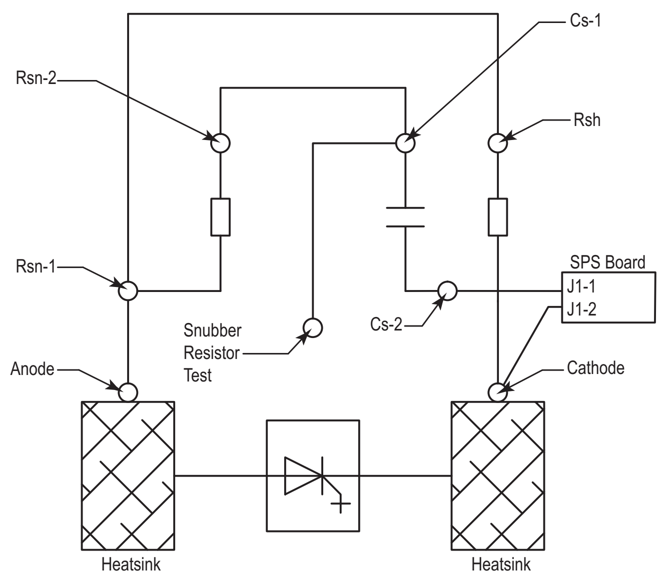
7. Replace interior assembly in the reverse order of removal.

Self-Powered SGCT Power Supply - SPS

This board is a component in drives that does not use the IGDPS module to power the rectifier SGCTs. The SPS board extracts energy from the associated SGCT snubber circuitry to provide the 20V DC required to power the SGCT device.

The SPS Board has two snubber connection inputs and two 20V DC outputs. Snubber connection inputs are derived from opening the snubber capacitor to SGCT cathode connection and bringing these connections to the SPS board (Figure 77).

Figure 77 - Snubber Circuit for SGCT module (with SPS board)



Board Calibration

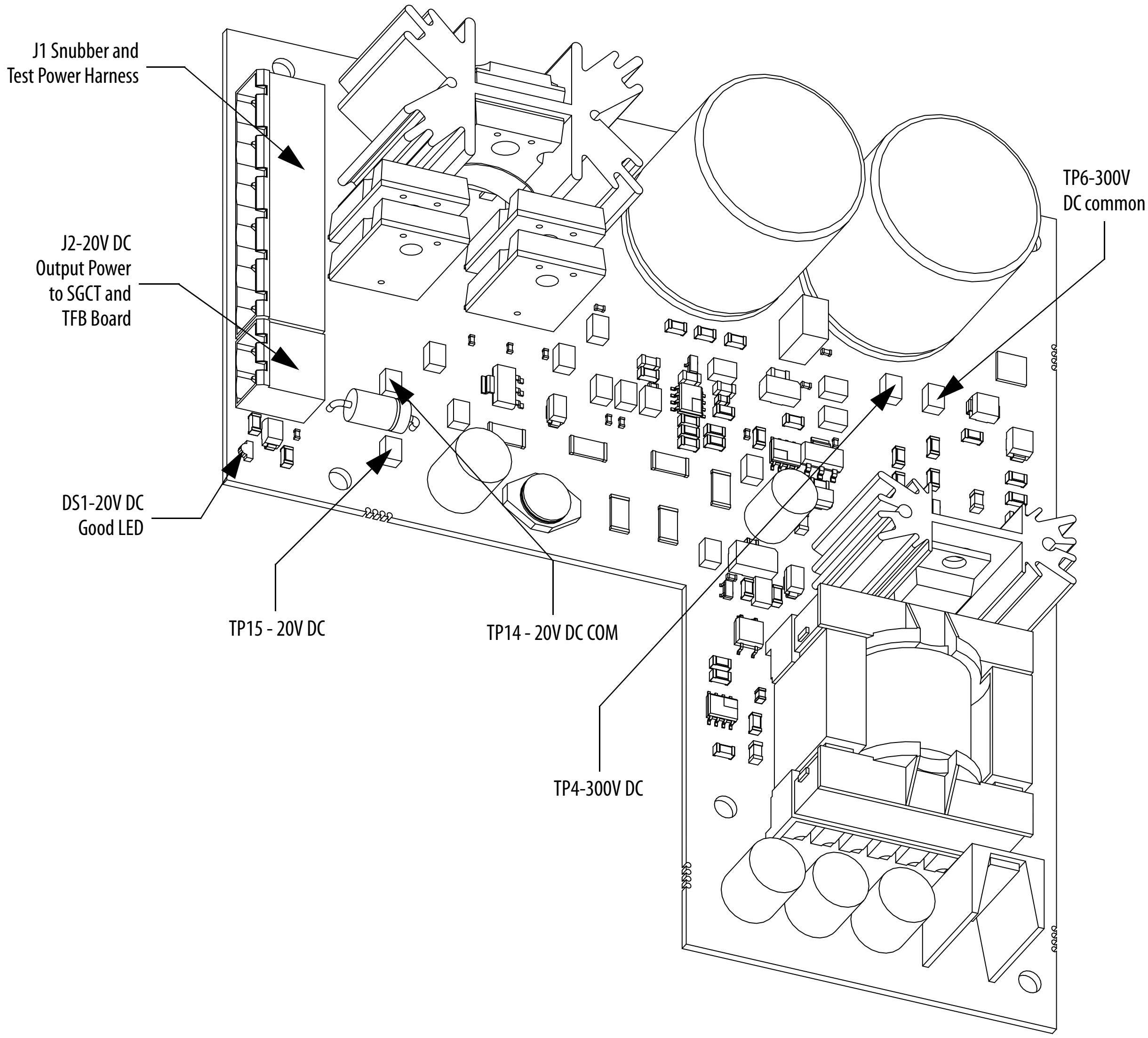
This board requires no field calibration.

Test Points

TP4	300V DC bus
TP6	300V DC bus common
TP15	20V DC output
TP14	20V DC output common

The green LED (DS1) on the SPS board indicates that the 20V DC output is within operating specification range.

Figure 78 - SPS Board Test Points



Terminal	Connections
J1 – 1	Connection to the SGCT snubber capacitor at CS-2 location
J1 – 2	Connection to SGCT cathode terminal
J1 – 3	Connection to input attenuated feedback (Short J1-3 to J1-4 to disable input SCR clamp stage for test power usage)
J1 – 4	Connection to 300V DC common connection (Short J1-3 to J1-4 to disable input SCR clamp stage for test power usage)
J1 – 5	Connection to 300V DC internal bus (Short J1-5 to J1-6 to allow input to operate from 90V AC)
J1 – 6	Connection to TOPSwitch programming resistor (Short J1-5 to J1-6 to allow input to operate from 90V AC)

Testing Equipment

Ensure you have the following equipment available in order to perform testing tasks.

- SPS test power harness (80018-695-51)
- Digital multimeter

1. Disconnect the snubber connection to J1 of the SPS board.
2. Connect one of the SPS test power harness connectors to the SPS J1 connector.
3. Plug the AC input end of the SPS test power harness into the appropriate drive receptacle.

   The green LED (DS1) at the front of the board should be on.
4. Measure between the TP4 and TP6 on the SPS board. It should be at a level of $\sqrt{2} \text{ x } VIN_{RMS}$.

   This can range from 120V (85V input) to 375V (265V input).
5. Measure between TP15 and TP14 on the SPS board. It should be at a level of 20V DC, +/- 400 mV.

   If these readings are not correct, replace the tested SPS board with a new board and return the faulty board to the factory.

WARNING: When the SPS test harness is installed and powered, there are lethal voltages on the SPS board. Always connect multimeter test leads to the SPS test points before applying input power to the SPS test harness.

Always connect the SPS test harness connectors to the SPS board before applying input power to the SPS test harness.

Certain shorted components on the SPS board, such as any of the input diode bridge diodes D10, D11, D13 or D14, will cause the input breaker to the SPS test power harness to trip. In this situation, replace with a new unit and return the faulty board to the factory.

Fiber Optic Cabling

The equipment is provided with fiber optic cabling as a means of interfacing the low voltage control to the medium voltage circuits. The user of the equipment should never need to change the routing of the fiber optic cables.

Each end of a fiber optic cable is provided with a connector that plugs and latches into its respective location on a circuit board. To disconnect a fiber optic cable, depress the ridged plastic tab at the end connector and pull. To install a fiber optic cable insert the fiber optic port of the circuit board so that the plastic tab latches into place.

If the user finds it necessary to replace fiber optic cables, great care must be taken to prevent the cables from becoming strained or crimped as a resulting loss in light transmission will result in loss in performance.

The minimum bend radius permitted for the fiber optic cables is 50 mm (2.0 in.).

When installing the fiber optic cable, the color of the connector at the end of the cable must match the color of the connector socket on the circuit board.

Lengths of fiber optic cables used in the product include:

Duplex	Simplex
5.0 m	5.0 m
5.5 m	6.0 m
6.0 m	10.0 m
6.5 m	
7.0 m	

There is one duplex fiber optic for each thyristor, which manages gating and diagnostic functions. The healthy status of the thyristor is determined by the circuitry on the respective driver boards. This information is then sent to the main processor via a fail-safe light signal in the fiber optic. The firing command for the thyristor is initiated by the main processor and transmitted to the appropriate gate driver board via the gating fiber optic.

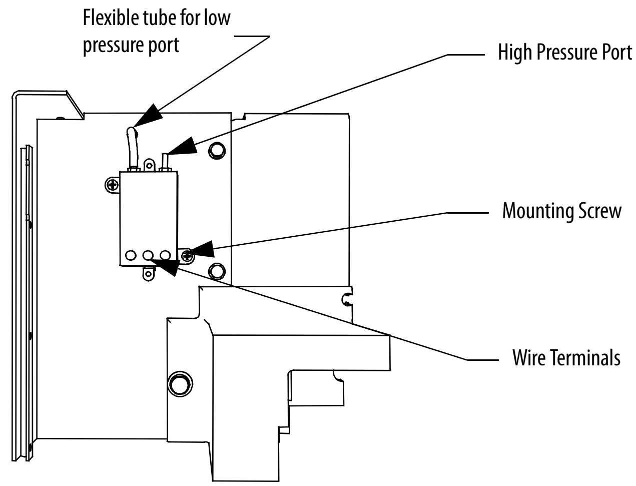
The color codes of the connectors are:

- BLACK or GREY – is the transmitting end of the fiber optic.
- BLUE – is the receiving end of the fiber optic.

Air Pressure Sensor

An air pressure sensor is located in both the converter cabinet and the integral rectifier transformer cabinet (if applicable). In both cases, it is located in the upper left-hand quadrant of the cabinet.

Figure 79 - Air Pressure Sensor



The air pressure sensor measures the difference in air pressure between the front and rear of the converter modules/integral rectifier transformer. A small direct current voltage signal is transmitted to the control circuits.

In the event of reduced fan performance or air blockage for either the converter or the transformer, the measured differential pressure will be reduced and a warning message will appear on the console. A likely cause of the warning message would be laden filters at the inlet.

If, as a result of blockage or fan failure, flow becomes so reduced that there is a risk of thermal damage for either the converter or transformer, a fault signal will cause drive shutdown.

Air Pressure Sensor Replacement

1. Remove the wires at the sensor and note their designation.
2. Disconnect the clear tube on the low pressure port. Remove the two mounting screws of the sensor.
3. Check the integrity of the sealant that has been applied where the clear tubing passed through the sheet metal barrier.
4. Installation of the replacement airflow sensor is in the reverse order of its removal.

D.C. Link / Fan / Control Components

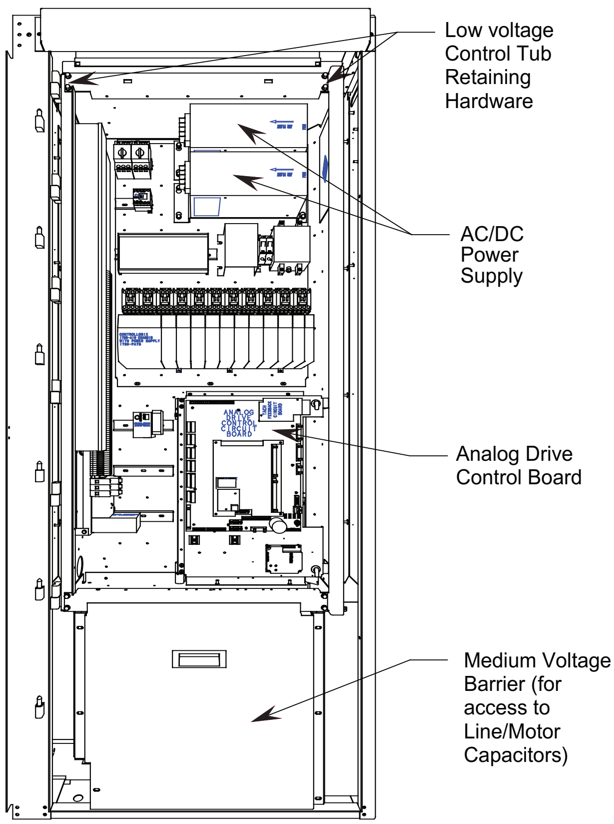


Figure 80 - DC Link and Fan Cabinet w/ low voltage control tub shown

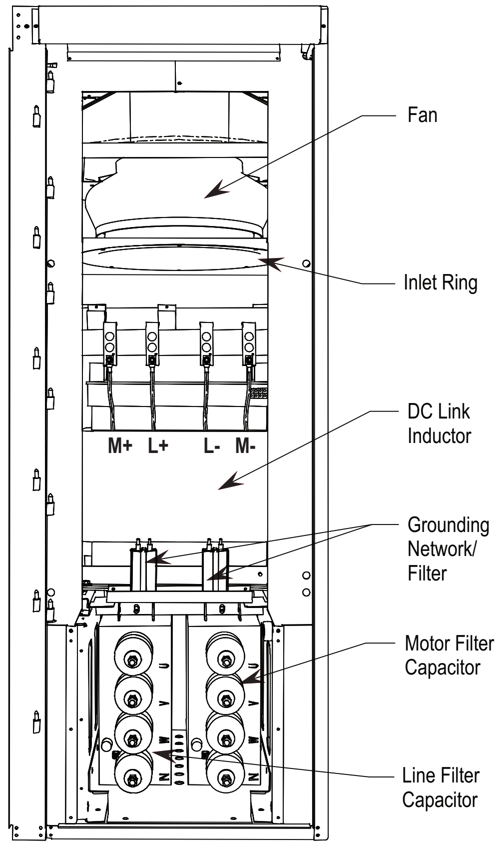


Figure 81 - DC Link and Fan Cabinet w/ low voltage control tub removed

When the door is opened, control components are accessible. Behind the low voltage swing-out panel is the medium voltage compartment where the DC link and fan are located. The D.C. link is mounted on the floor plate of the cabinet above the capacitors.

Power connections are made to the inductor via its flexible leads. There are four power connection points labeled L+, L-, M+, and M-.

The D.C. link is equipped with thermal protection for the windings.

There is a current sensor on the M+ conductor.

The fan is located above the D.C. link; the primary elements of the fan are the inlet ring, impeller and motor.

IMPORTANT	The inlet ring is stationary and must not contact the rotating impeller.

Mounted on top of the cabinet is an air exhaust hood. The exhaust hood must be installed to prevent foreign objects from entering the drive.

Output Grounding Network Replacement

PowerFlex 7000 drives may have either a grounding network or a ground filter in place of the grounding network.

The number of capacitors will vary depending on the system voltage.

1. Ensure there is no power to the equipment.

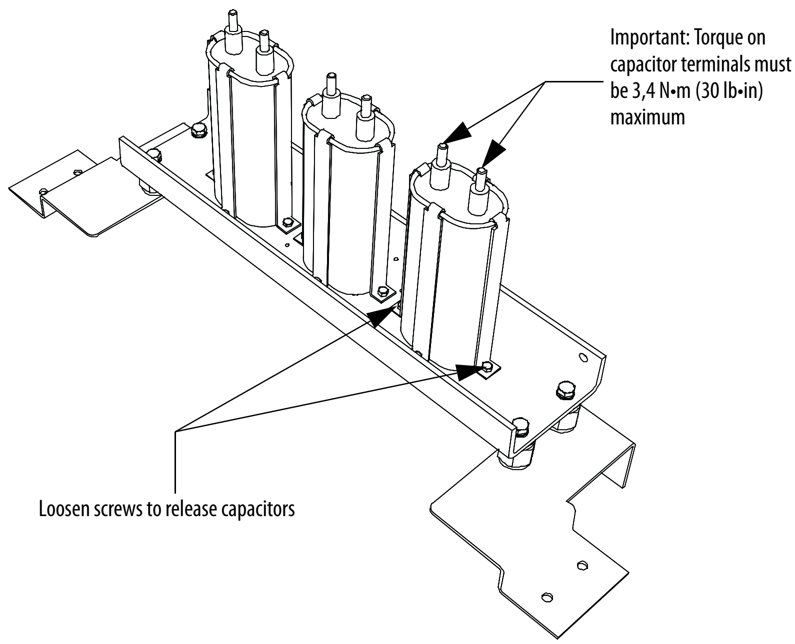
ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the capacitor. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

Note the position of the leads.

2. Remove the 6.4 mm (¼ inch) hardware and disconnect the leads connected to the terminals.
3. Four brackets are used to secure the capacitor. Loosen the four screws at the base of the brackets and lift the capacitor out.
4. Place the new capacitor and tighten the screws securely.
5. Replace the ring lugs and 6.4 mm (¼ inch) hardware (Figure 82).

IMPORTANT	The maximum torque for the capacitor terminal is 3.4 N•m (30 lb•in.).

Figure 82 - Output Grounding Network



Ground Filter Component Replacement

The number of capacitors will vary depending on the system voltage.

1. Ensure there is no power to the equipment.

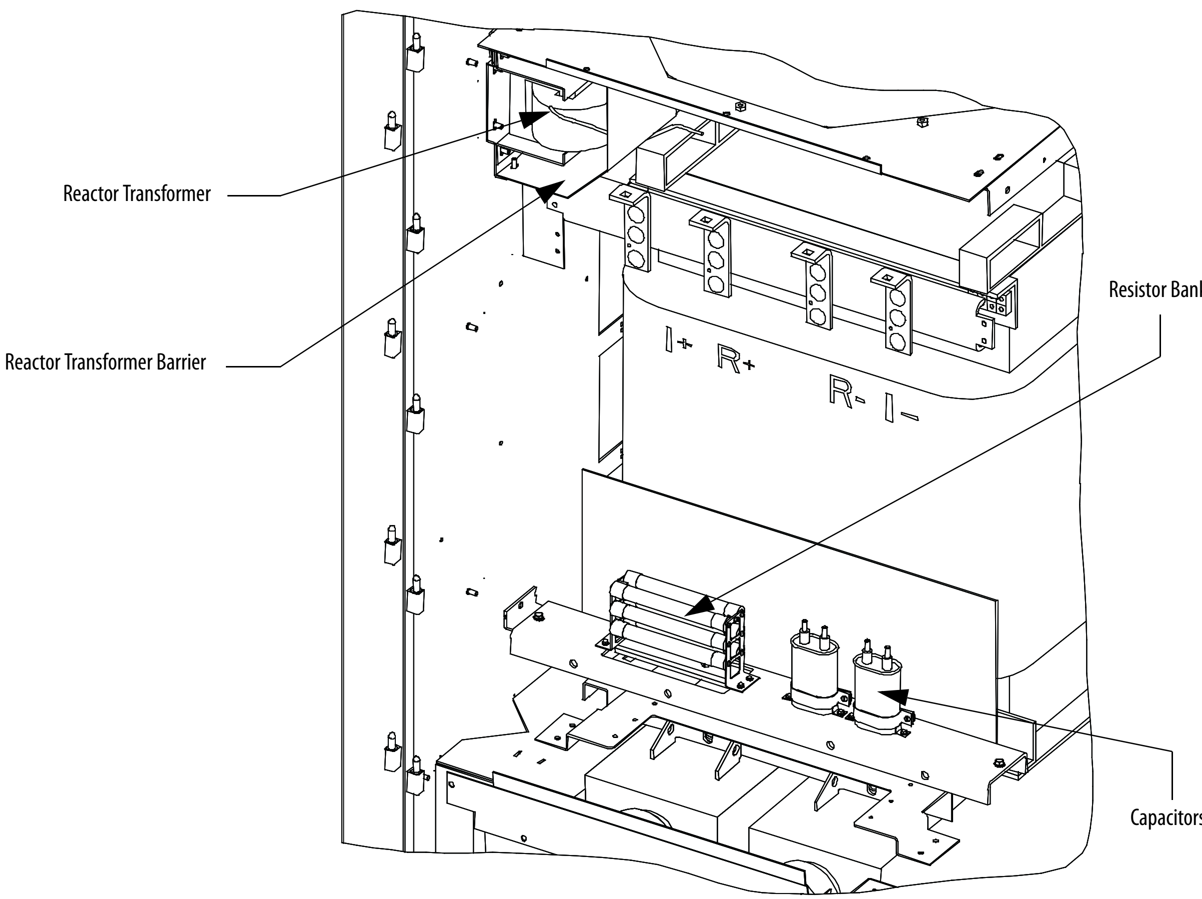
ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the capacitor. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

Note the position of the leads.

2. Disconnect the leads connected to the failed capacitor/resistor bank.
3. Loosen and remove mounting screws as indicated in Figure 83 and remove the failed component.
4. Assemble the new component in the reverse order of disassembly.
5. Reattach the leads strictly adhering to the torque requirements outlined below.

IMPORTANT	The maximum torque for the capacitor terminal is 3.4 N•m (30 lb•in.).

Figure 83 - Ground Filter Component Replacement



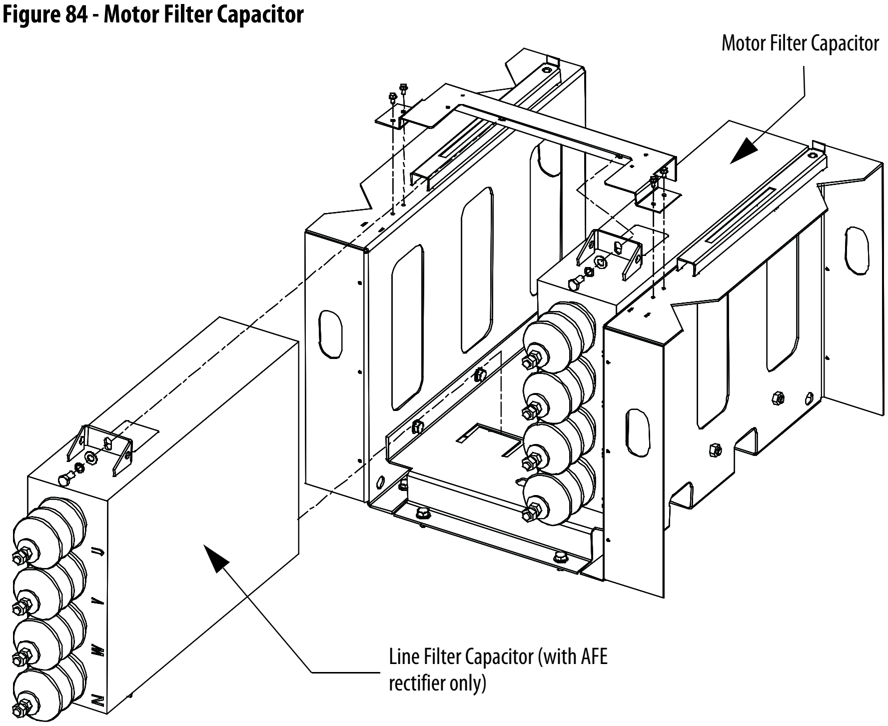
Filter Capacitors

Filter capacitors are used on the motor side for all drives. The AFE rectifier also includes filter capacitors on the line side (see Figure 81).

The filter capacitors are three-phase four-bushing units and "oil-filled". The three-phase capacitors are comprised of internal single-phase units that are connected in a Y configuration. The neutral point of the Y is connected to the fourth bushing, which is accessible and can be used for neutral point voltage measurement or other protection/diagnostics purposes. Depending on the drive configuration, the fourth bushing may or may not be connected to circuitry. The metal cases of the capacitors are grounded through a stud on the capacitor housing.

The capacitors are equipped with internal "bleeding resistors" to discharge the capacitor and reduce its voltage below 50V in five minutes when left disconnected. A typical three-phase capacitor is shown in Figure 84.

Figure 84 - Motor Filter Capacitor



WARNING: Allow 5...10 minutes for motor capacitors to safely discharge voltage prior to opening cabinet doors.

WARNING: Verify that the load is not turning due to the process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

Replacing Filter Capacitors

See Publication 7000-IN010_-EN-P, “Handling, Inspection, and Storage of Medium Voltage Line Filter Capacitors”.

1. Isolate and lock out all power to the drive.

ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the capacitor. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

ATTENTION: Verify the load is not turning due to the process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

2. Remove medium voltage barrier below the low voltage panel to access capacitor (Figure 80).
3. Short all four bushings together and to ground on both capacitors before handling the connections. Note the location of all the cables and mark them accordingly.
4. Remove the four power connections to the terminals, and the single ground connector from the drive to the capacitor frame.
5. Remove the grounding network and top bracket that holds the capacitor in place. At the bottom of the capacitor, there is no hardware securing the capacitor; it fits into a slot in the assembly.
6. Remove the capacitor from the drive. The capacitors can weigh up to 100 kg (200 lb); two people may be required to remove them.

IMPORTANT	Do not lift capacitor by bushings. Doing so may damage bushings and result in oil leakage.

ATTENTION: The porcelain bushings are extremely fragile and any force applied to the bushings can damage the seal between the bushing and the body causing potential leaks or chipping.

7. Install the new capacitor, sliding it back until it fits into the slot. Fasten the top bracket and grounding network.
8. Reconnect all the power cables and the ground connection. These use M14 hardware, but should only be tightened to 30 N•m (22 lb•ft) due to capacitor mechanical constraints.
9. Remove any shorting/grounding conductors.
10. Reinstall the sheet metal that was removed, and complete one final check to ensure connections are secure and correct.

Testing Filter Capacitors

There are two ways to test line filter capacitors. Rockwell Automation recommends the first method as it reduces the chance of re-torque issues because the capacitors are not disconnected. If the readings are unsatisfactory, the second method is more accurate, but involves disconnecting and testing them individually.

First Method

1. Ensure there is no power to the equipment.

ATTENTION: To prevent electrical shock, disconnect the main power before working on the drive. Verify that all circuits are voltage-free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

ATTENTION: Verify the load is not running due to process. A freewheeling motor can generate voltage that feeds back to the equipment.

2. Follow appropriate safety steps to isolate the equipment from medium voltage.
3. Verify that there is no voltage present on the capacitor by using a hot stick or any other appropriate voltage-measuring device.
4. Perform visual inspection to ensure there is no oil leak or bulge in any of the capacitors.

ATTENTION: Capacitors that appear bulged or are leaking oil indicate potential problems with the internal elements. DO NOT USE. These units must be replaced. Failure to do so may lead to personal injury or death, property damage, or economic loss.

5. Using a DMM measure the capacitance across each phase-to-neutral of capacitors without removing any connections.

   If the difference between the highest and the lowest readings is below 15%, then all capacitors are in good condition. If the difference between the highest and the lowest readings is off by 15% or more, then you might have a bad capacitor. If more than one capacitor is used in the circuit, then you would need to isolate each of them and check them separately to identify which one is defective.
6. Before disconnecting the capacitors, note the location of all the cables and mark them accordingly.
7. Disconnect power cables from the capacitor terminals on all four bushings and isolate them from the capacitor (see Replacing Filter Capacitors on page 99).

8. Repeat step 5 to check each capacitor separately to confirm which is defective.

Second Method

1. Ensure there is no power to the equipment.

ATTENTION: To prevent electrical shock, disconnect the main power before working on the drive. Verify that all circuits are voltage-free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

ATTENTION: Verify the load is not running due to process. A freewheeling motor can generate voltage that feeds back to the equipment.

2. Perform visual inspection to ensure there is no oil leak or bulge in any of the capacitors.

ATTENTION: Capacitors that appear bulged or are leaking oil indicate potential problems with the internal elements. DO NOT USE. These units must be replaced. Failure to do so may lead to personal injury or death, property damage, or economic loss.

3. Note the location of all the cables and mark them accordingly.
4. Disconnect power cables from the capacitor terminals on all four bushings and isolate them from the capacitor (see Replacing Filter Capacitors on page 99).
5. Connect a low voltage single-phase test power, for instance 110V or 220V, across a phase and the neutral of the capacitor. Switch on the test power and measure the test voltage and current drawn by the capacitor. Repeat the test for all three phases and note down the test voltage and current.

ATTENTION: The capacitor will charge during this test so take care to prevent a shock or injury. When moving the test connections from one phase to the next, wait five minutes minimum for the capacitor to discharge.

6. Calculate the capacitance from the measured values of test voltage and current. For a good capacitor, the calculated capacitance value for each of the three readings should be within ±15% of the capacitor nameplate micro-Farad. If it is outside this range, the capacitor must be replaced.

This example demonstrates the calculation for capacitance value.

Suppose a capacitor under test is rated at 400 kVAR, 6600V, 50 Hz, 29.2 μF. Assume you are using 200V, 50 Hz test power with the recorded voltage and current values for each test as shown in the table below.

Phase - Neutral	L1-N	L2-N	L3-N
Test Voltage	200V	200V	200V
Measured Current	1.87 A	1.866 A	1.861 A

Calculate the capacitance using the first reading. In this case:

V = 200V, I = 1.87 for L1-N
Xc = V/I = 200/1.87 = 106.95
C= 1/ (2 π *F* Xc)
C= 1/(2 x 3.14 x 50 x 106.95
C=29.7μ *F*

Where:
F = frequency of the applied voltage.

Similarly, you can calculate the capacitance for the remaining two measurements for L2-N and L3-N.

DC Link Reactor Replacement

The DC Link maintains a low ripple current between the rectifier and the inverter.

ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the current transformer. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

The DC link reactor does not normally require service. In the event of its replacement, it must be ensured that Rockwell Automation approves the replacement link.The link has been constructed to ensure that it is cooled by air drawn through its coils.

To service the DC link, see Figure 85.

WARNING: The DC Link may be hot.

1. Ensure that source power to the drive is locked out and that the filter caps are fully discharged.
2. Open the door to the DC link cabinet and remove the screws that retain the vertical sheet metal barrier and low voltage panel.

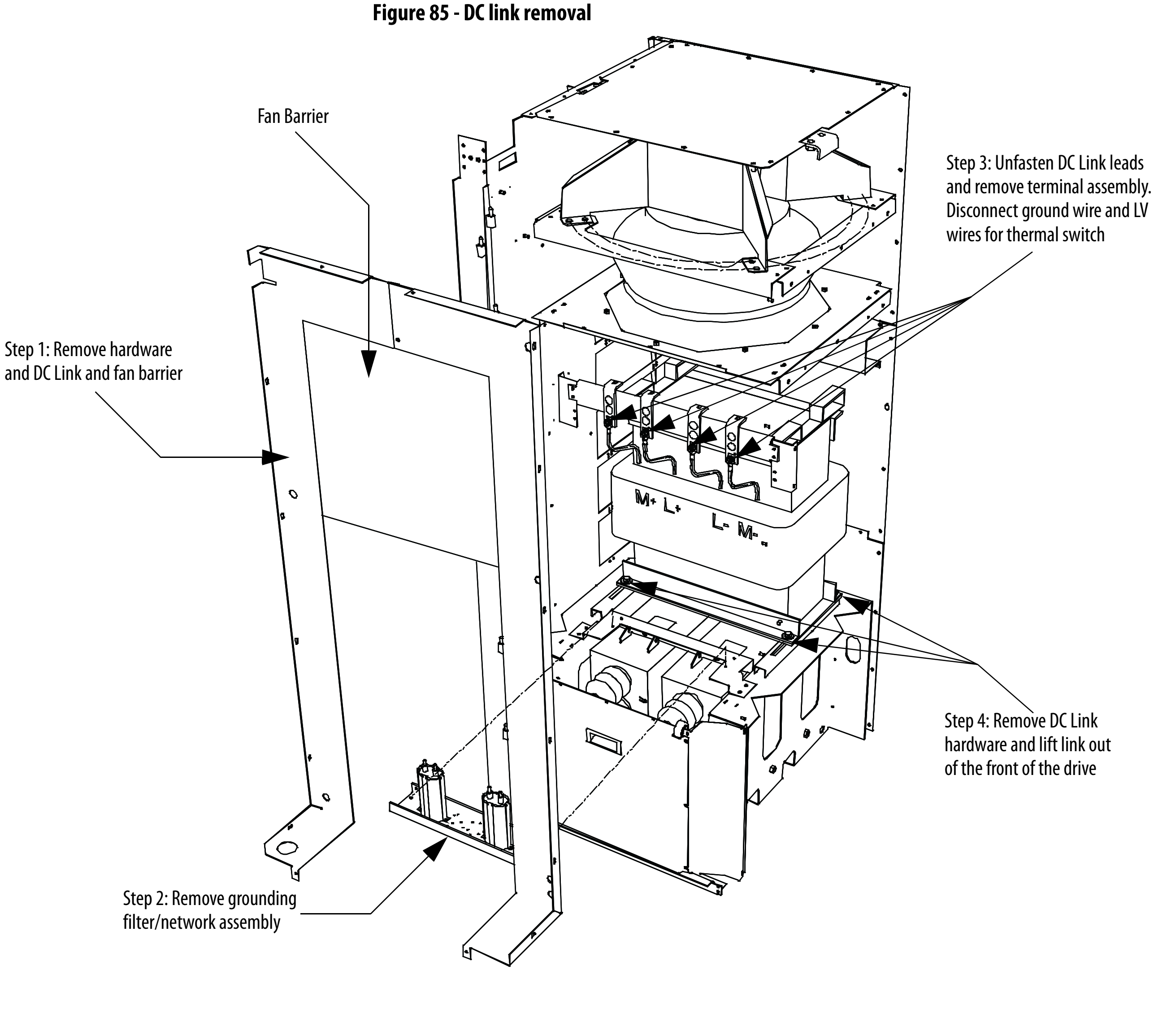
3. Swing the low voltage panel to the left and disassemble the closing barriers located on the left and right-hand side of the panel by removing the nuts and washers which secure them to the sides of the structure.

   In some instances, depending on the size of the DC link, it may be necessary to completely remove the low voltage panel from the drive cabinet. This can be accomplished by lifting the panel off its hinges and shifting or rotating it to a position where it does not obstruct the opening to the DC link cabinet. Ensure that equipment used to lift and support the panel during DC link replacement is adequate for this purpose.

4. Disconnect the four power connections. The DC link is equipped with flexible power leads.
5. Disconnect wires at terminal block on DC link for thermal switch.
6. Remove the hardware that secures the DC link.
7. Disconnect the ground connection.

The DC link is heavy and has provision for lifting with forks of a lift truck.

Figure 85 - DC link removal



Installation of the replacement DC link is performed in the reverse order of its removal.

The installer must ensure that the flexible DC link leads are connected to the appropriate terminal and routed so that electrical clearances are maintained. Verify the nameplate ratings are the same or appropriate for the drive system. A different DC link will require different parameter settings.

Thermal protection of the DC link reactor is provided by two normally closed contacts wired to the I/O module. These contacts will open at 190 °C and cause a fault/alarm message to be displayed.

Fan Replacement

There are several models of cooling fans used in PowerFlex drives. Differing fan types may be used in the various locations throughout the drive.

DC Link Section

The fan consists of a motor impeller assembly. To replace the fan, it is necessary to remove the fan exhaust hood Figure 86.

ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working on the current transformer. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

Safety Notes

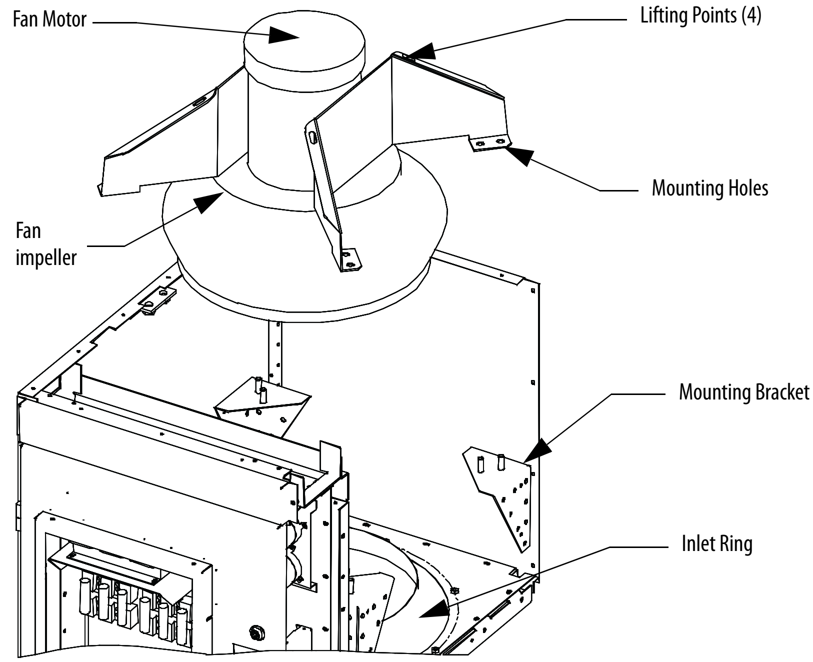
Fan replacement requires working at a significant height from the floor. Care should be taken to make a suitable platform from which to work.

The fan motor weighs approximately 45 kg (100 lb) and will require suitable lifting provision. Ensure that fan power is locked out during fan maintenance.

Remove the eight nuts that secure the motor frame to the side sheets of the cabinet. Disconnect the power leads to the motor. Note the terminal locations so that proper fan rotation is maintained.

To extract the fan, lifting hooks are placed in the holes of the motor mounting brackets and the assembly is withdrawn vertically from the cabinet. Do not support the assembly on the impeller or damage may result.

Figure 86 - Fan Removal



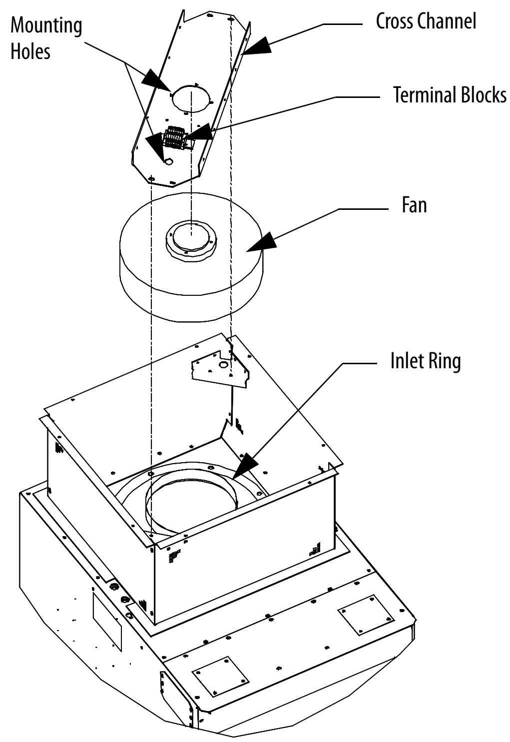
Fan Installation

Care must be taken in handling of the fan as its balance could be affected by poor handling.

Fan installation is performed in the reverse order of its removal. Upon completion of installation, rotate the impeller by hand to ensure that there is no contact with the inlet ring.

Top of Integral Isolation Transformer Section

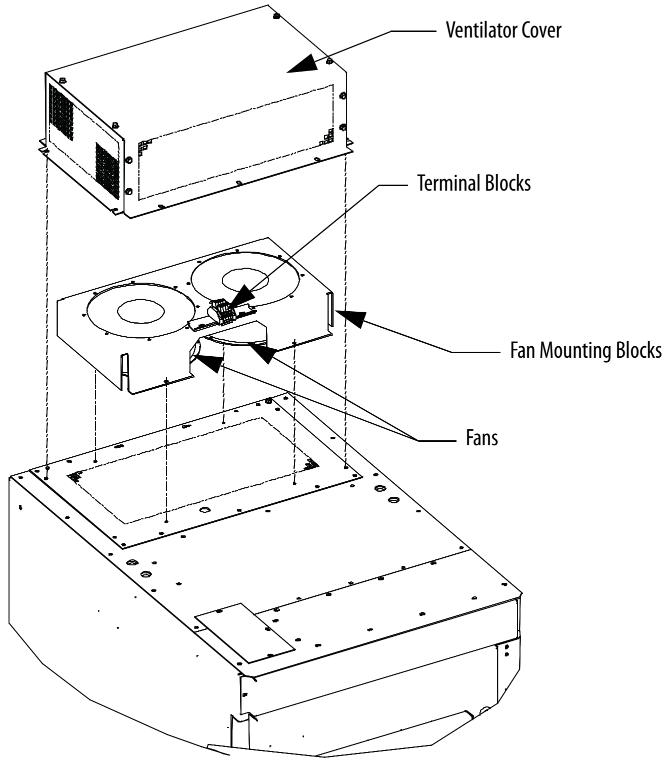
Figure 87 - Isolation Transformer Fan Removal



1. Remove the top plate of the ventilation housing and label fan supply leads before disconnecting.
2. Remove the bolts retaining the cross channel and withdraw the fan and channel from housing.
3. Disassemble and replace the fan.
4. Reassemble in the reverse order of removal.

Top of Integral Line Reactor and Input Starter Section

Figure 88 - Starter/Line Reactor Cabinet Fan Removal



1. Remove the top ventilation cover from the exterior of the cabinet.
2. Remove mounting screws and invert fan mounting bracket to expose fan mounting hardware.
3. Unplug or disconnect fan leads from terminal blocks and replace fan.
4. Reassemble in the reverse order of removal.

Impeller Removal from Motor Shaft

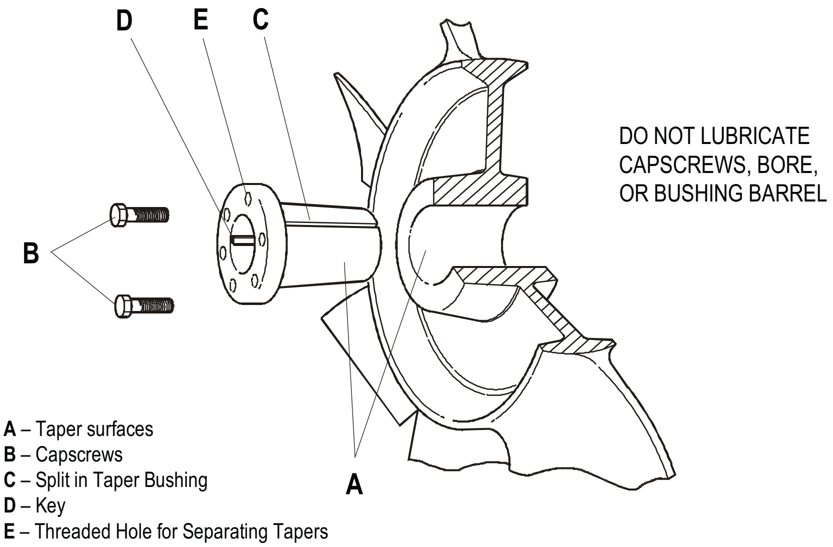
The fan impeller is held onto the motor shaft with a split tapered bushing. This bushing is positioned on the motor shaft and through the center of the impeller. Two cap screws, when tightened to 10.2 N•m (7.5 lb•ft), lock the bushing onto the motor shaft and the impeller to the bushing.

Safety Notes

The impeller is fragile. Do not allow the impeller to support the weight of the motor.

If vertical, the impeller and bushing may fall when loosening cap screws. Physical injury or component damage may result.

Figure 89 - Cutaway View of Fan Impeller and Bushing



1. Record the distance from the end of the motor shaft to the bushing. The new impeller must be installed in the same location. Failure to do so will result in gaps between the impeller and the intake ring resulting in loss of air flow, or rubbing of the impeller against the inlet ring or motor assembly during operation.
2. Remove both cap screws from the bushing. The impeller or bushing may fall as screws are loosened.
3. Thread the cap screws by hand into the two threaded holes in the bushing flange.
4. Tighten each bolt part of a turn successively, to push the impeller off the bushing. Screwing down the cap screws into these holes will force the bushing away from the impeller hub, releasing the compression on the shaft. Be careful that the impeller does not fall as the clamping force is released.
5. Pull the bushing off the shaft and remove the impeller. If the assembly has been in place for some time, it may be necessary to use a wheel puller to remove the bushing. Never use a wheel puller on the impeller.

ATTENTION: Do not lubricate capscrews, bore, or bushing barrel, as this will hinder clamping force of the bushing on the shaft and impeller bore.

Installation of Impeller Assembly onto Motor Shaft

The fan impeller is held onto the motor shaft with a split tapered bushing. This bushing is positioned on the motor shaft and through the center of the impeller. Cap screws, when tightened to 10.2 N•m (7.5 lb•ft), lock the bushing onto the motor shaft and the impeller to the bushing.

The bushing barrel and the bore of the impeller are tapered which assures concentric mounting and keeps the impeller running evenly.

The cap screws, when tightened, lock the bushing in the impeller and over the motor shaft.

The bushing is split down the middle, so that when the locking cap screws force the bushing into the tapered bore in the impeller assembly, the bushing will grip the shaft with a positive clamping fit.

The impeller and bushing assembly have keyways that line up with the shaft and are held in place with compression.

To Assemble:

1. Make sure the shaft and keyway are clean and smooth. Clean the shaft and bore with rubbing alcohol or non oily solvent. Check the key size with both the shaft and bushing keyways.
2. Put the cap screws through the clearance holes in the bushing and put the bushing loosely into the impeller, lining up the screws with the threaded holes on the impeller hub.

IMPORTANT	Do not press, drive or hammer the bushing into the bore.

3. Start the cap screws by hand, turning them just enough to engage the threads. Do not use a wrench at this time. The bushing should be loose enough in the impeller to move freely.
4. Slide the impeller and bushing assembly onto the motor shaft, ensuring the same distance from the end of the shaft to the bushing as in step 1 of impeller removal.
5. Fit the key into keyway. Do not force impeller and bushing onto shaft. If they do not fit easily, check the shaft, bushing and key sizes.
6. Tighten the cap screws progressively with a wrench. Do this evenly as though mounting an automobile wheel. Turn one a quarter turn, then the next a quarter turn, then go back and turn the other a quarter turn and so on. Torque to 10.2 N•m (7.5 lb•ft).
7. Peen the end of the motor shaft at the keyway with a chisel or center punch to prevent the key from falling out of position.

Fan Balance

Fan impellers are statically and dynamically balanced within acceptable tolerances at the factory. Damage in shipping or from poor handling or installation may upset the unit's balance. An impeller that is not properly balanced can lead to excessive vibration causing undue wear on the entire unit.

If vibration is excessive, shut down the fan and determine the cause.

Common causes of excessive vibration

- Support structure not sufficiently rigid or level.
- Vibration amplified by resonance in duct work or support structure.
- Bearing locking collar or mounting bolts loose.
- Loose impeller or bushing.
- Material accumulation on impeller.
- Wheel rubbing on inlet ring.

Impeller Maintenance

Isolation Transformer Cooling Fan

The isolation transformer fan motor and impeller is an integral unit and cannot be serviced separately.

Inlet Ring Removal and Replacement

The inlet ring is the large circular part located beneath the fan impeller. It is positioned such that the impeller sits outside but does not touch the ring. The ring sits inside the impeller 10 mm (0.40 in.). Refer to the cutaway view of fan impeller and bushing (Figure 89).

This procedure will require coming in contact with the internal electrical connectors and devices.

WARNING: All power MUST be removed from the drive. Failing to do so may result in serious injury or death.

Precautions must be taken to prevent the inlet ring from falling after all of the bolts have been removed.

ATTENTION: To prevent electrical shock, ensure the main power has been disconnected before working within the DC Link and Fan Area. Verify all circuits are voltage free using a hot stick or appropriate high voltage-measuring device. Failure to do so may result in injury or death.

DC Link / Fan Section

If rear panel access is possible, remove rear middle panel of the DC link / fan portion of the cabinet and remove the inlet ring from the back.

Procedure

If rear panel access is not possible, follow this procedure:

1. Remove bolts and swing-out low voltage panel (see Figure 80).
2. Remove bolts from the inlet ring being careful not to allow the ring to fall.
3. Remove inlet ring via the bottom access panel by moving it around the DC link and diagonally out the door. Shifting of the DC link may be required.
4. To install the new ring, reverse the above procedure. Rotate the fan impeller by hand to ensure that there is no contact with the inlet ring. Move the ring and retighten bolts to eliminate interference.
5. Replace all panels and barriers opened or removed during inlet ring replacement.

Top of Integral Isolation Transformer Section

1. Remove fan as described in "Fan Replacement".
2. Disassemble bolts and remove inlet ring.
3. To install new ring, reverse the above procedure. Rotate the fan impeller by hand to ensure that there is no contact with the inlet ring. Move the ring and retighten bolts to eliminate interference.
4. Replace all panels and barriers opened or removed during inlet ring replacement.

Replacement of Air Filters

Air filters are located at the cooling air intake grille mounted on the door in front of the converter, line reactor and transformer cabinets.

It is necessary to periodically remove and clean, or remove and replace the filter material. The frequency with which the filters are renewed depends on the cleanliness of the supplied cooling air.

It is possible to renew the filters while the drive is running, but the procedure is easier to perform while the drive is shut down.

1. Using an 8 mm (5/16") Hex key, loosen the ¼ turn fasteners and swing open the hinged grill assembly.
2. Remove filter material.

If the drive is running, the filter must be replaced as soon as possible so foreign material is not drawn into the drive.

Care must be taken in removing the filter, to prevent dirt that has accumulated on the inlet side of the filter from being sucked into the drive. It may be difficult to remove the filter material without tearing it due to the suction at the air inlet.

Recommended cleaning method of filters:

- **Vacuum Clean** – A few passes of a vacuum cleaner on the inlet side of the filter will remove accumulated dust and dirt in seconds.
- **Blow with Compressed Air –** point compressed air nozzle in opposite direction of operating air flow. Blow from exhaust side toward intake side.
- **Cold Water Rinse –** Under normal conditions the foam media used in the filters, require no oily adhesives. Collected dirt is washed away quickly and easily using just a standard hose nozzle with plain water. (**Ensure filter is completely dry before reinstalling**).
- **Immersion in Warm Soapy Water** – Where stubborn air-borne dirt is present, the filter may be dipped in a solution of warm water and mild detergent. Then simply rinse in clear clean water, **let stand until completely dry and free of moisture, and return to service.**

When replacing with a new filter, the filter must be provided by Rockwell Automation or approved for use by Rockwell Automation. Replacement of the filters is performed in the reverse order of its removal. Check that there are no openings that would allow foreign matter to enter the drive.

Figure 90 - Filter Replacement

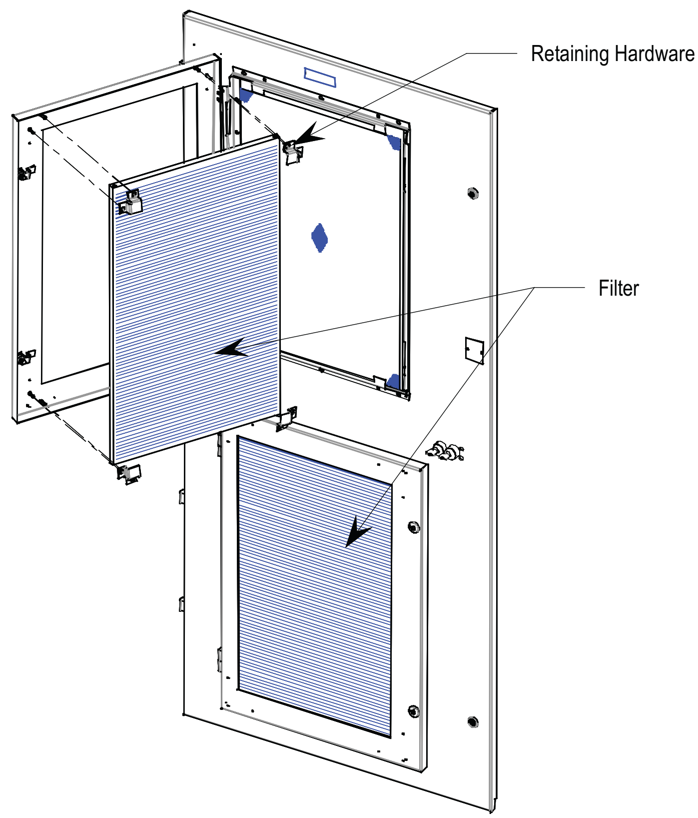


Figure 91 - Air Flow Pattern for Drive Cooling

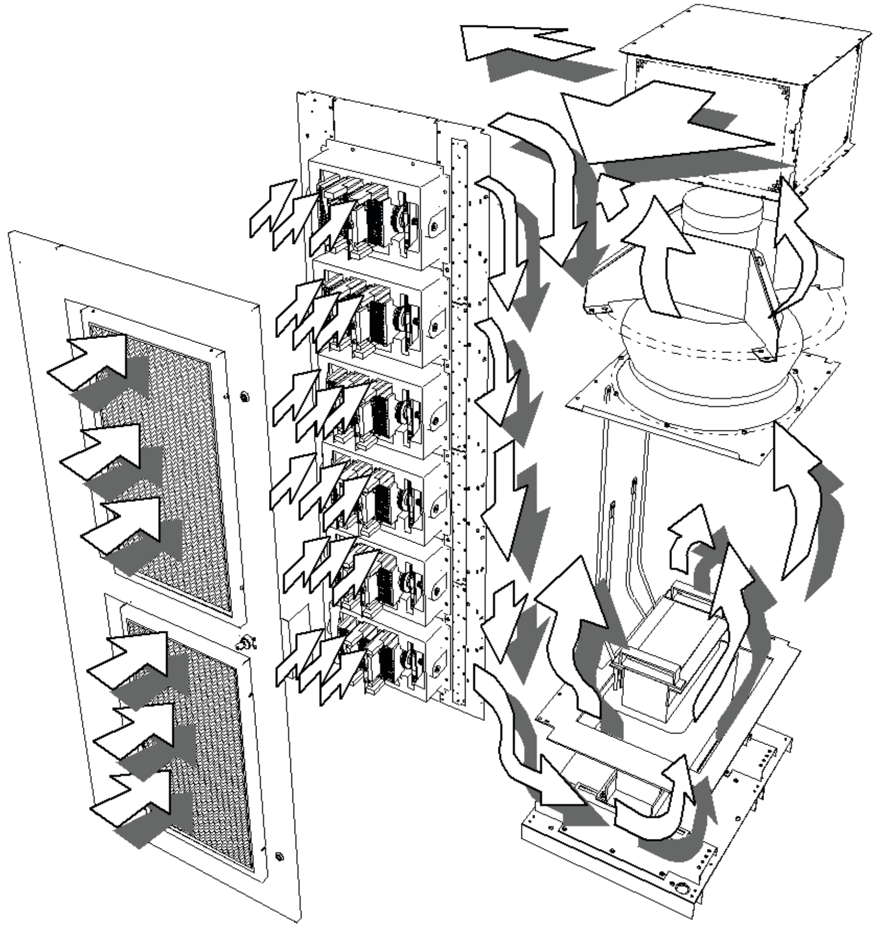
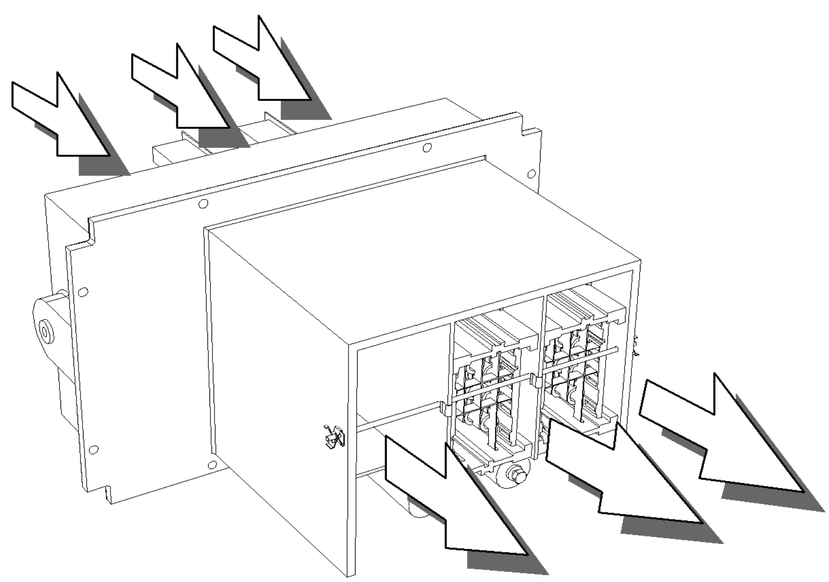


Figure 92 - Air flow through PowerCage



Control Power Components

There are two configurations in which control power will be distributed for the drive. The different methods are dependent on what drive option the customer has chosen:

1. Direct-to-Drive (transformerless AFE rectifier) (Figure 93)
2. AFE rectifier with separate isolation transformer (Figure 94).
3. AFE rectifier with integral isolation transformer (Figure 95).

Ride-Through

Standard controls with 5 cycle ride-through – The drive main control boards will remain energized for a total of 5 cycles after control power is interrupted. If control power is not restored during the 5 cycles, a controlled shutdown will occur.

Figure 93 illustrates the control power distribution for AFE drives with integral starter/line reactor.

Figure 93 - Direct-to-Drive (transformerless AFE rectifier)

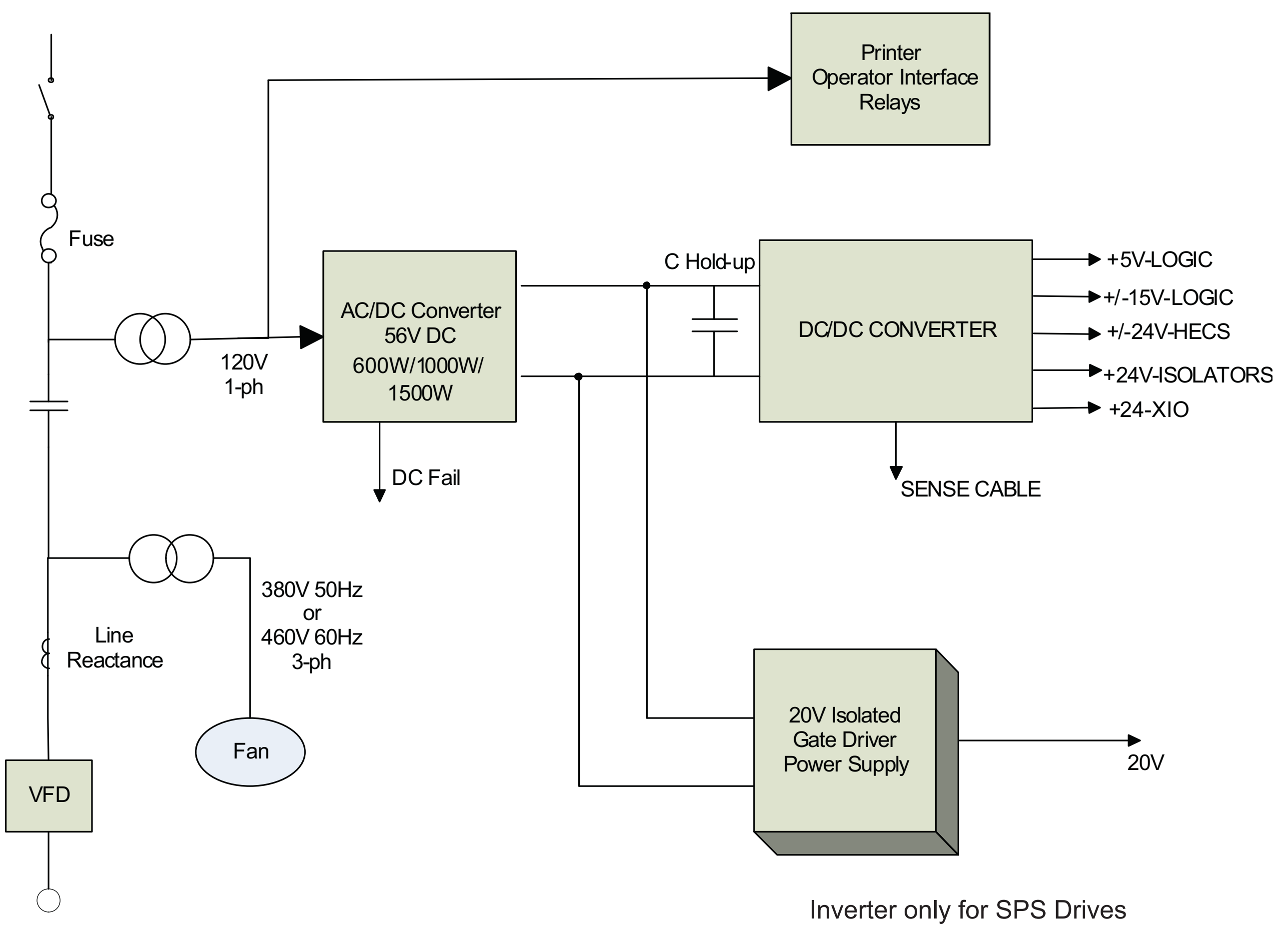


Figure 94 illustrates the control power distribution for AFE drives with remote transformer/starter (A) or integrated line reactor with remote starter (B).

Figure 94 - AFE rectifier with separate isolation transformer

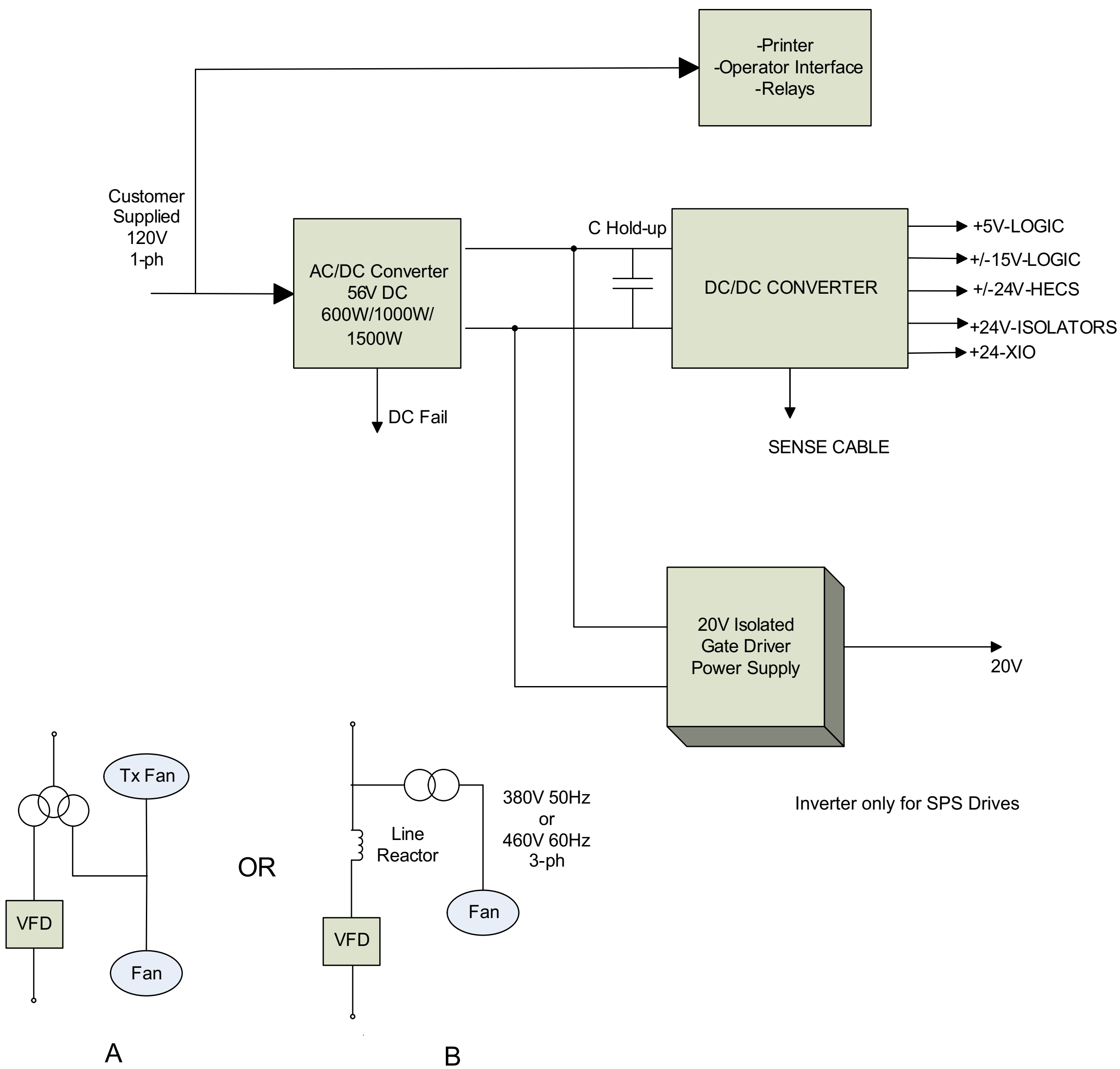
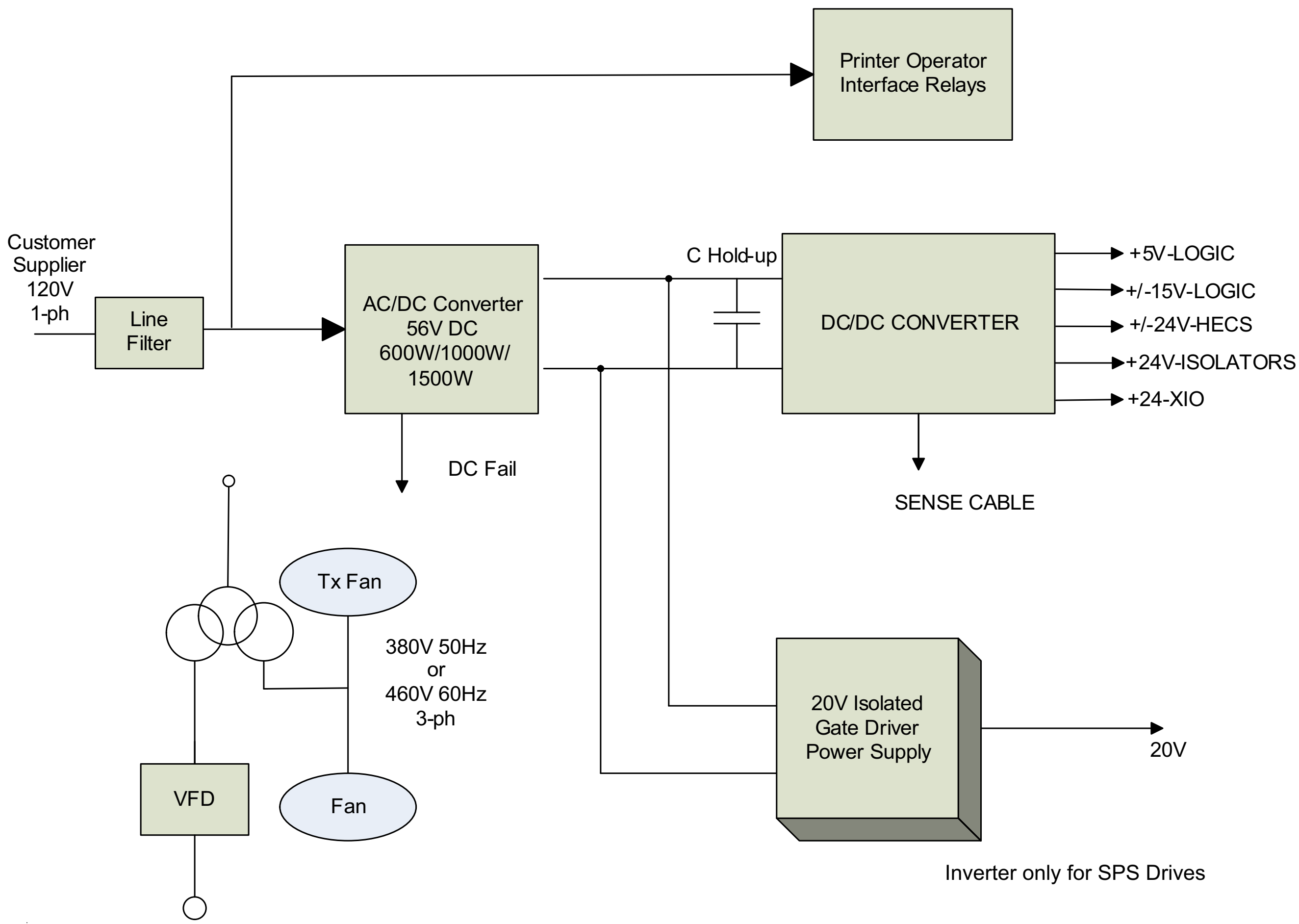


Figure 95 illustrates the control power distribution for AFE drives with integral transformer and remote starter.

Figure 95 - AFE rectifier with integral isolation transformer



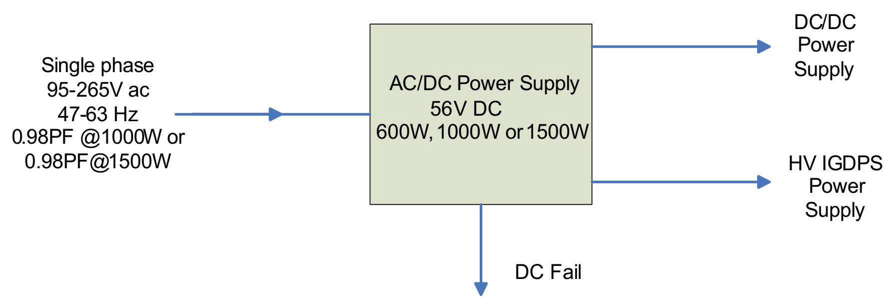
AC/DC Power Supply

The load demands on the AC/DC converters are the DC/DC converter and up to six IGDPS modules (up to three IGDPS modules for SPS drives). The DC/DC is a fixed load; however, the quantity of IGDPS modules will vary depending upon the drive configuration and whether SPS modules are used.

Description

The AC/DC power supply accepts single phase voltage and produces a regulated 56V DC output for the DC/DC power supply and the HV IGDPS modules that power the SGCTs. The input and output voltages are monitored and fail signals are annunciated upon either voltage going below a pre-set level.

Figure 96 - AC/DC Converter Power Supply



DC FAIL: Upon loss of DC output (V outputs ≤ 49V DC) this output goes from low to high.

Location

The AC/DC power supply is located in the low voltage panel at the top right-hand section of the drive. A typical low voltage compartment is shown in Figure 97.

Figure 97 - Location of AC/DC Pioneer Power Supply on Low Voltage Panel

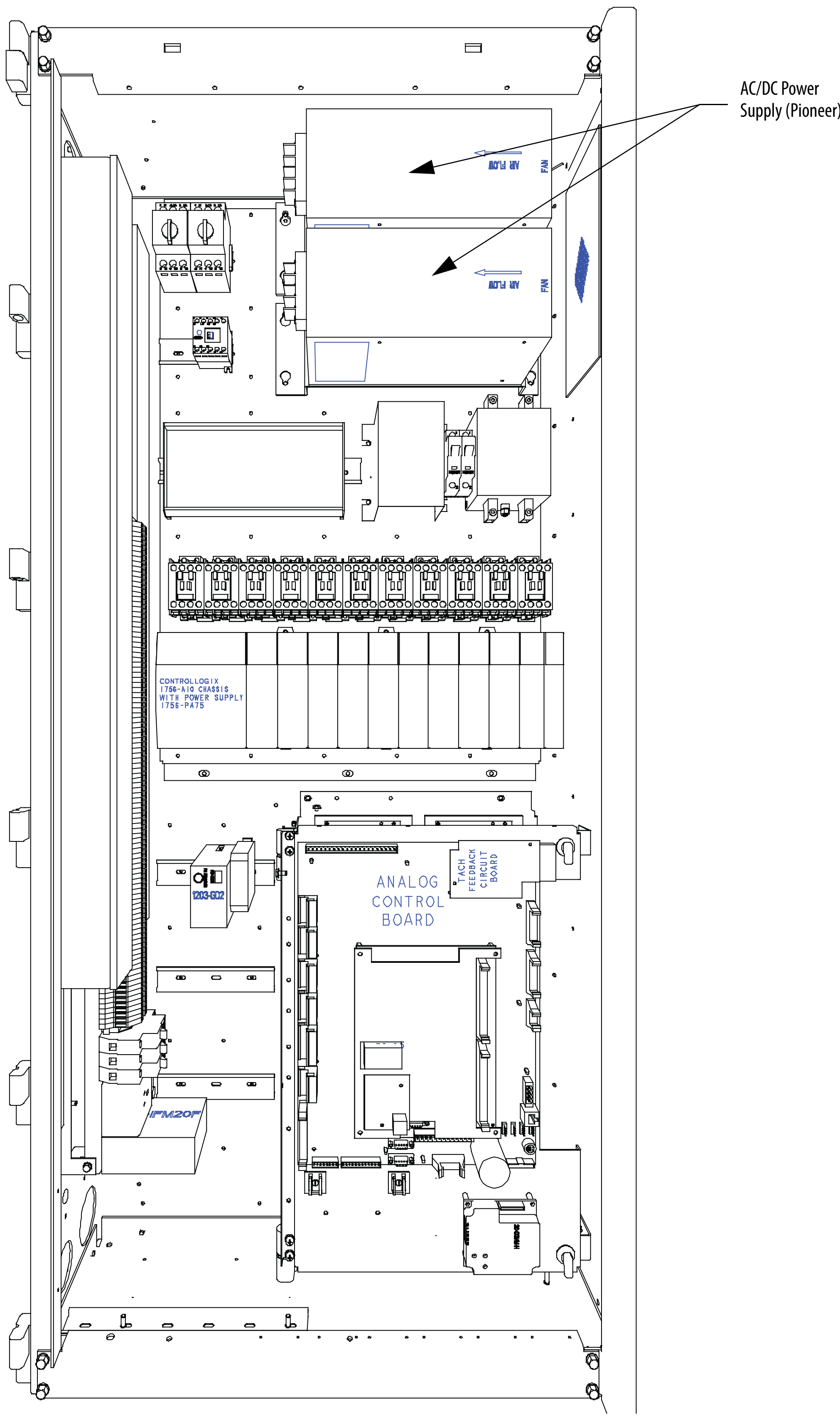
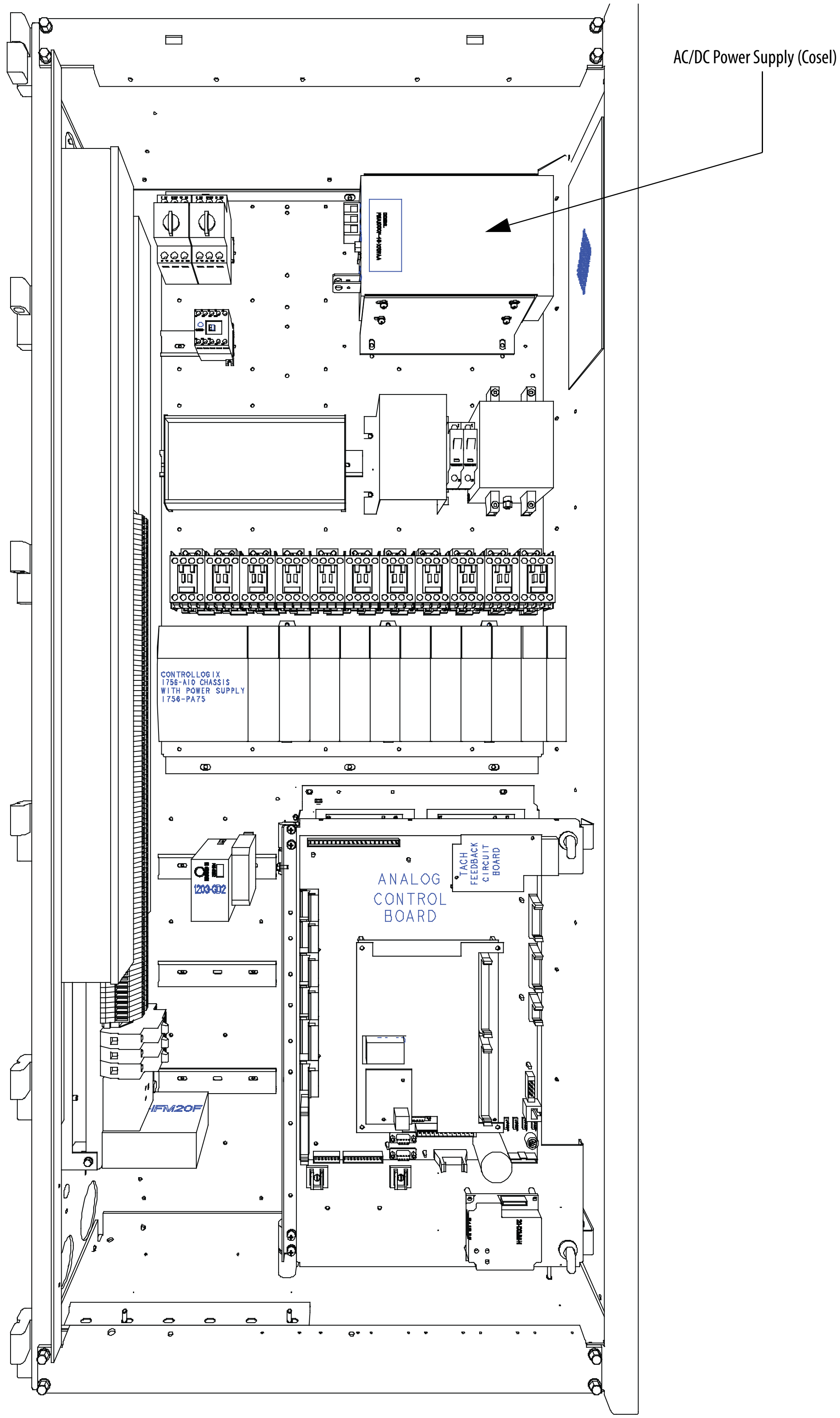


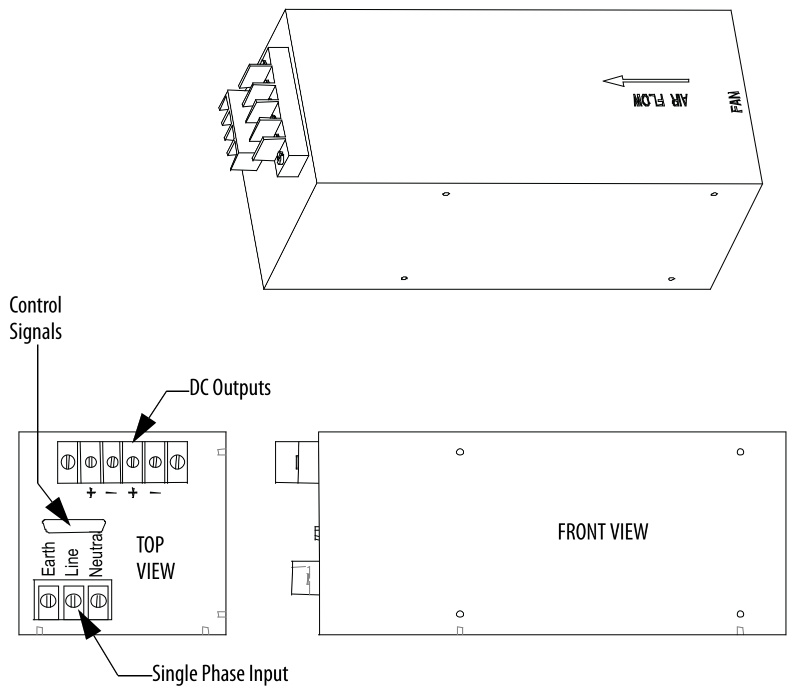
Figure 98 - Location of AC/DC Cosel Power Supply on Low Voltage Panel



Terminal / Connections Descriptions (Pioneer Power Supply)

The terminal connections are shown below in Figure 99.

Figure 99 - Terminal locations on AC/DC (Pioneer) power supply



P1-AC Input	**PIN#**	**LABEL**
	1	Earth
	2	Line
	3	Neutral
P2-DC Output	**PIN#**	**LABEL**
	1	+56V
	2	+56V COMM
	3	+56V
	4	+56V COMM
P3-Fail Output	**PIN#**	**LABEL**
	3	DC Power Fail (Output Power Good)
	15	Current Sharing
	14	DC Power Fail Common

Terminal / Connections Descriptions (Cosel Power Supply)

The terminal connections are shown in Figure 100.

Figure 100 - Terminal locations on 1000W AC/DC Power Supply (Cosel)

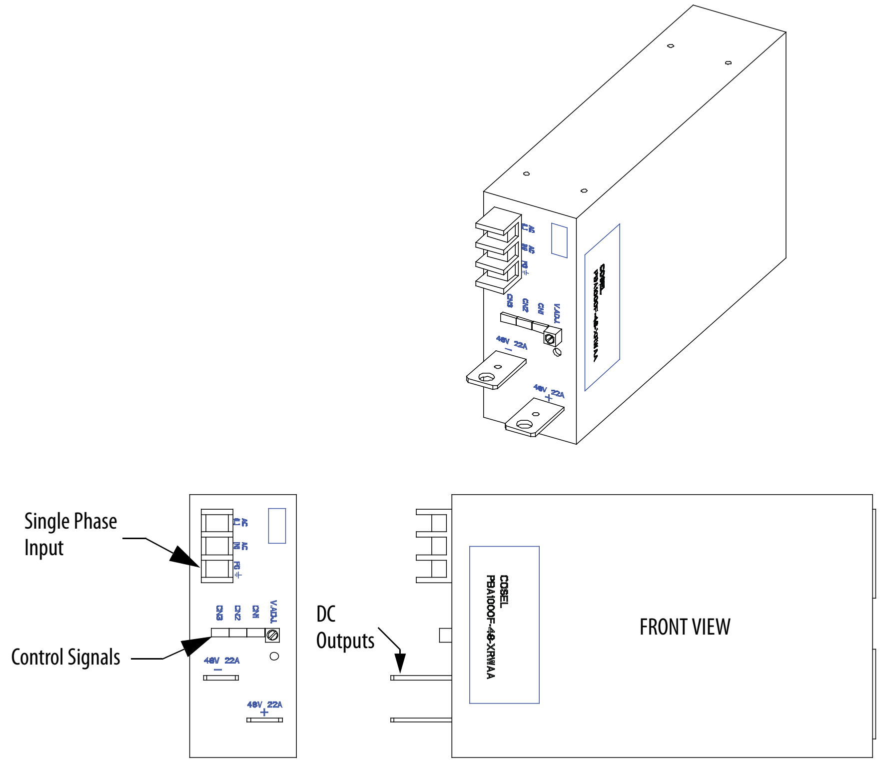
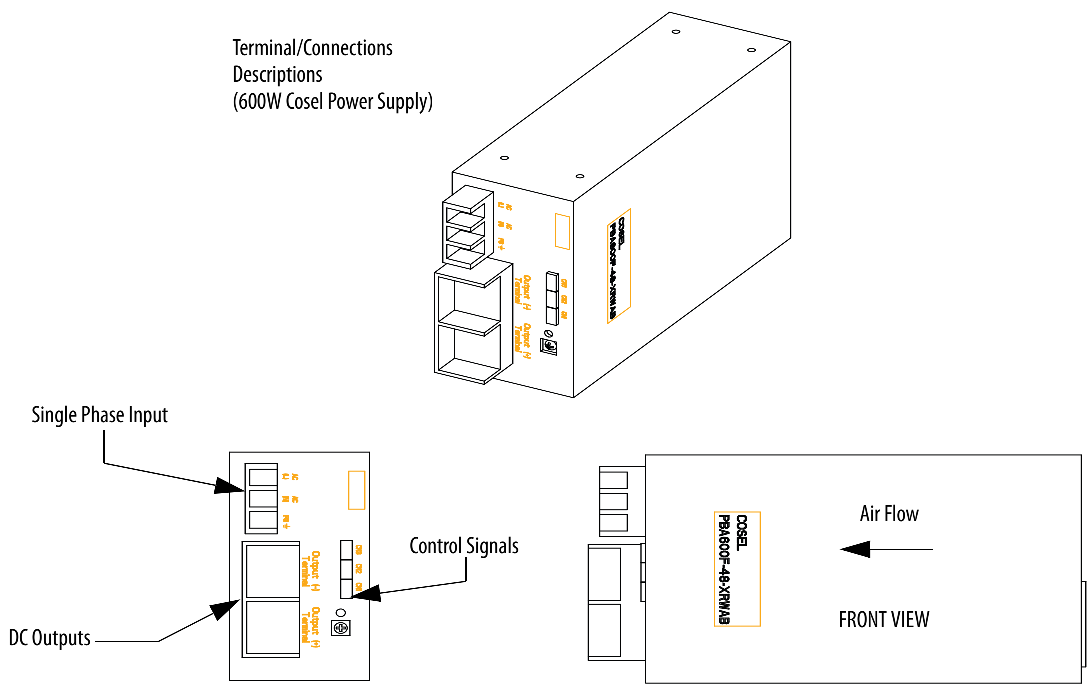


Figure 101 - Terminal locations on 600W AC/DC Power Supply (Cosel)



P1-AC Input	PIN#	LABEL
	AC (L)	Live
	AC (N)	Neutral
	NC	No Connection
	FG	Earth
P2-DC Output	PIN#	LABEL
	+	+56V
	–	+56V COMM
P3-Fail Output	PIN#	LABEL
	CN1	1-2 Connected 3-4 Connected 5, 6, 7, 8, 9, 10 N/C
	CN2	N/C
	CN3	7 - Alarm 8 - Alarm GND

Output Calibration

Ensure the output of the supply is 56V DC.

There is a potentiometer on the top of the power supply that adjusts the 56 V DC output for the power supply. Isolate the output of the power supplies; multiple supplies in series will affect your measurements. With the control power on and the output of the AC/DC Converter isolated from the drive control, adjust the potentiometer until the output equals 56V DC. Perform this test on each power supply. When all adjustments are complete, re-connect the power supply to the circuit and re-measure the output. Readjust if necessary.

If it is not possible to maintain 56V DC, the power supply may be faulty.

Power Supply Replacement

1. Ensure control power has been isolated and locked out.
2. Disconnect the terminals at the unit.
3. Remove the four M6 bolts per Figure 102 or Figure 103.
4. Extract the power supply complete with bracket from the drive.
5. Remove the bracket(s) from the failed power supply (four M4 screws and nylon shoulder washers).
6. Attach bracket to replacement power supply. The Black Insulation(s) must be between the AC/DC power supply and the mounting plate(s).
7. Repeat Steps 5 through 1 in this order to replace the unit (Figure 102 or Figure 103).
8. Reapply control power and verify voltage levels.

Figure 102 - Replacement of Pioneer AC/DC Power Supply on Low Voltage Panel

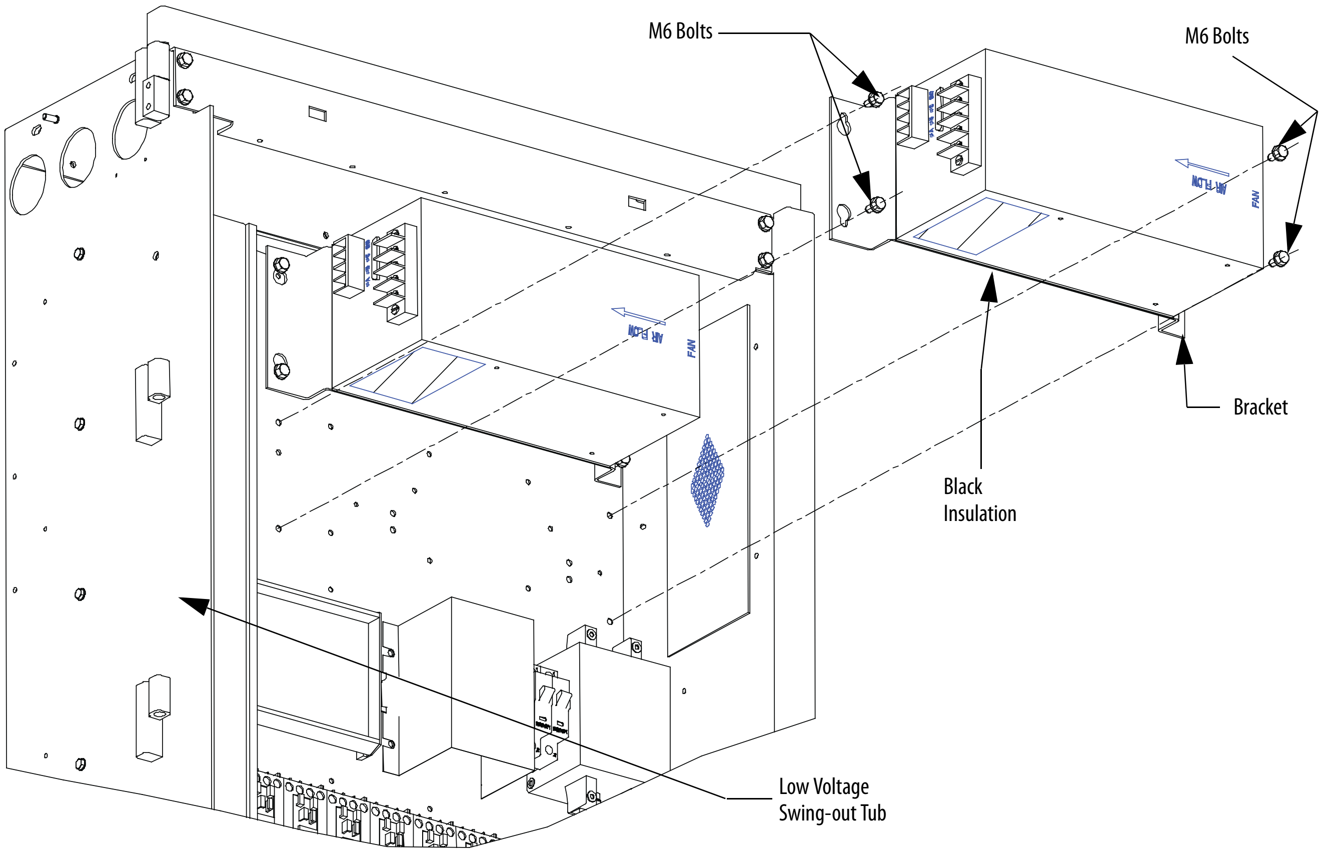
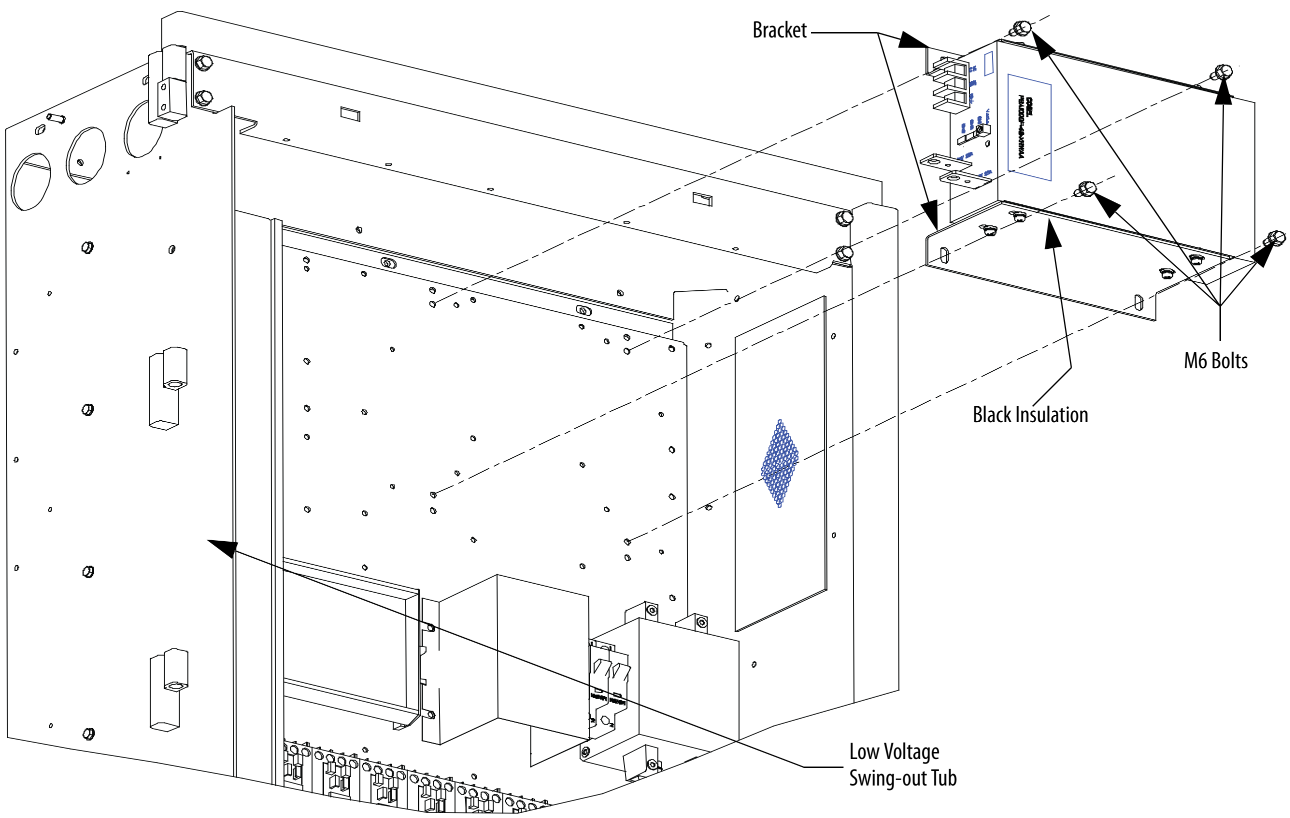


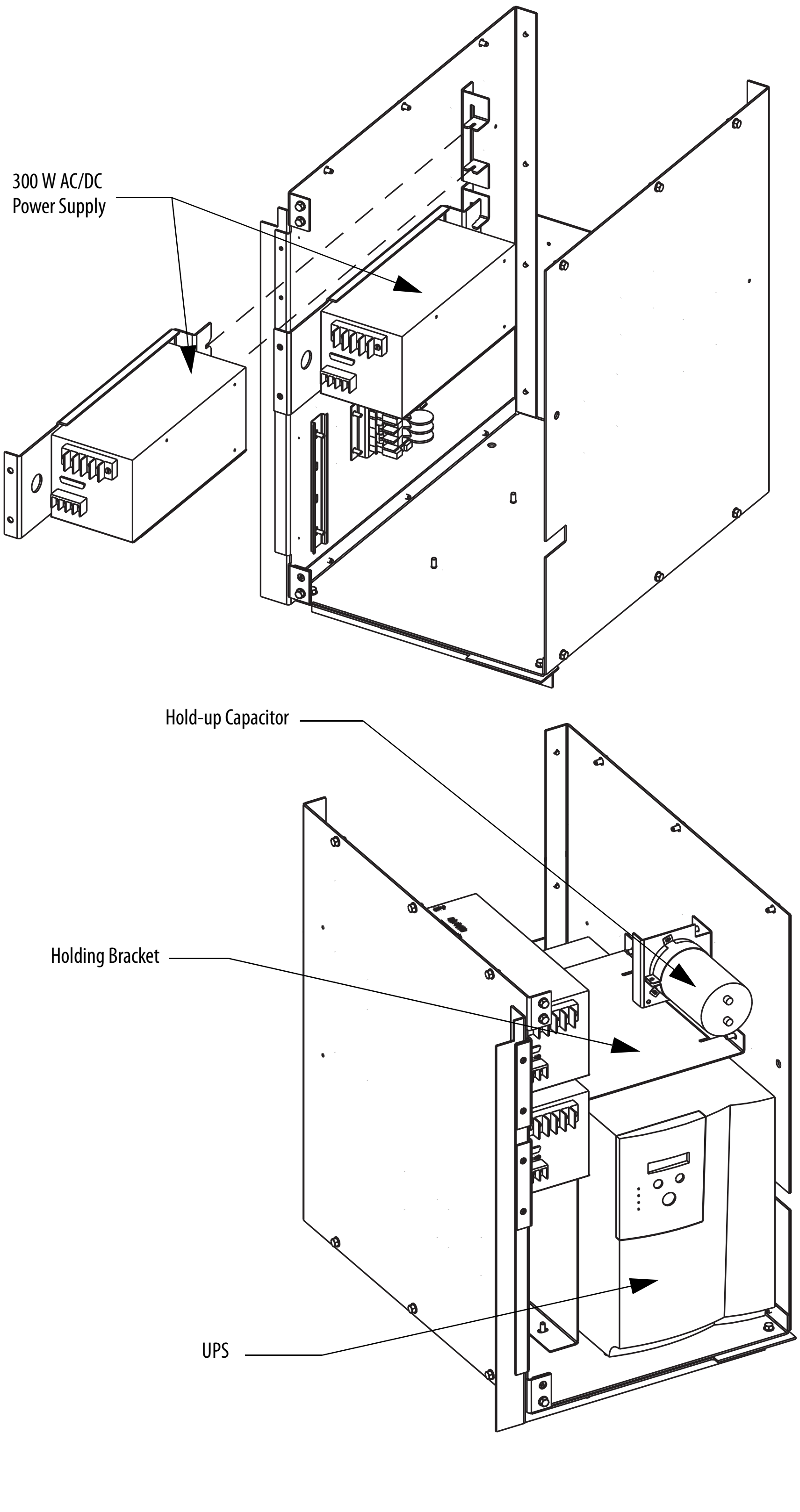
Figure 103 - Replacement of Cosel AC/DC Power Supply on Low Voltage Panel



UPS Option

The PowerFlex 7000 “A” Frame drive has the option for internal and external UPS power to keep the control power active within the drive in the event of a control power loss. The following diagram shows the current configuration of the internal UPS option.

Figure 104 - 300W AC/DC power supply



The UPS is installed in the incoming cabling section in the UPS LV control section.

The UPS will keep control power to all the critical 120VAC loads and an extra AC/DC power supply that feeds the DC/DC power supply for powering all the drive control components. The main drive cooling fan is not powered from this UPS.

The UPS uses the AS400 communication protocol, and feeds several status signals back to the ACB to control responses to various conditions including low batteries, loss of input power, UPS on bypass, etc.

If the customer has an external UPS, the firmware will not expect any of the signals mentioned in the above section, and will not display any information relating to the UPS status. The firmware will operate in the same manner with respect to the operation of the drive with an internal or external UPS.

The output of the UPS feeds a 300W AC/DC power supply. This is 20% of the standard AC/DC power Supply used in the drive because the load represented by the DC/DC power Supply is much smaller than the load of the IGDPS boards, and we are able to reduce the size accordingly. We still use the standard AC/DC power supply to feed the IGDPS boards. The 300W AC/DC power supply has its AC input monitored by the UPS, and the DC output is monitored by the ACB board for fault conditions.

There is also a hold-up capacitor on the output of the 300W AC/DC power supply to maintain the 56VDC in the event of a failure of the power supply.

Replacing the UPS

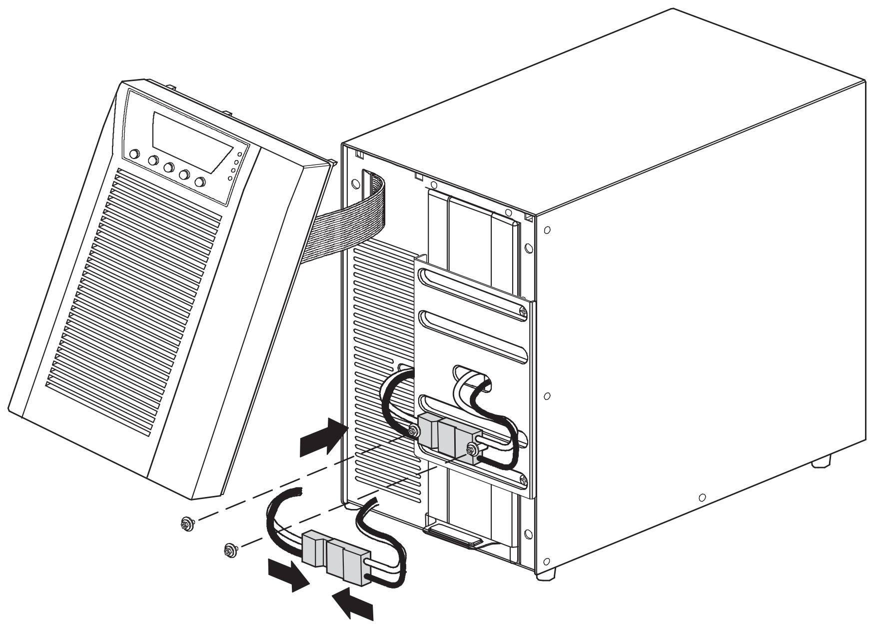
IMPORTANT To replace the UPS battery, refer to the UPS user manual that was shipped with the drive.

1. Isolate and lock out the control power.
2. Remove the hardware that fastens the holding bracket to the cabinet assembly and remove the holding bracket.
3. Disconnect the input and output wiring connected to and from the UPS.
4. Disconnect the 15-pin status plug and remove the UPS.

ATTENTION: Before installing the new UPS, check the battery recharge date on the shipping carton label. If the date has passed and the batteries were never recharged, do not use the UPS. Contact Rockwell Automation.

5. Before installing the new UPS, the internal battery must be connected.(1)
   a. Remove the UPS front cover. Push down on the top of the cover and pull the cover towards you to unclip it from the cabinet.
   b. Connect the white connectors together, connecting red to red, and black to black. Verify there is a proper connection.
   c. Remove and retain the two screws from the screw mounts.
   d. Place the battery connector between the screw mounts. Reinstall the two screws to hold the connector in place.
   e. Replace the UPS front cover.

Figure 105 - Connect the internal UPS battery



6. Reconnect all the connections removed in the previous steps.
7. Before reconnecting the mounting bracket, apply control power to the unit and ensure the UPS is configured for the AS400 communication protocol. Refer to the manual that comes with the UPS for instructions.
8. Once this has been confirmed, install the mounting bracket.

(1) Reprinted from 700-3000 VA User's Guide by permission of Eaton Corporation.

Low Voltage Control Section

The low voltage control section houses all of the control circuit boards, relays, Operator Interface Terminal, DC/DC power supply, and most other low voltage control components. Refer to Figure 106 for a generic representation of a low voltage tub arrangement.

Figure 106 - Low Voltage Tub Compartment (Pioneer Power Supply)

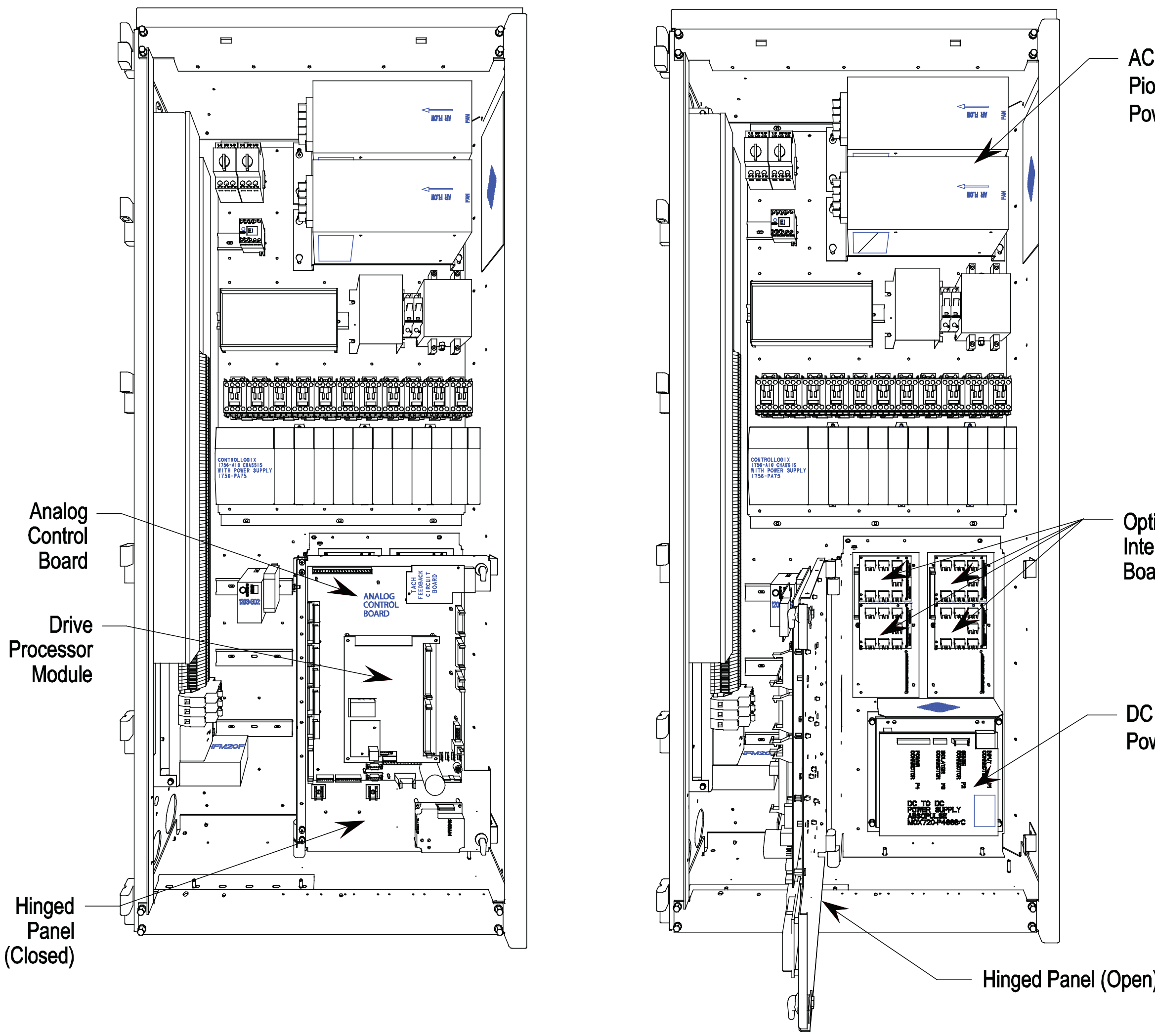
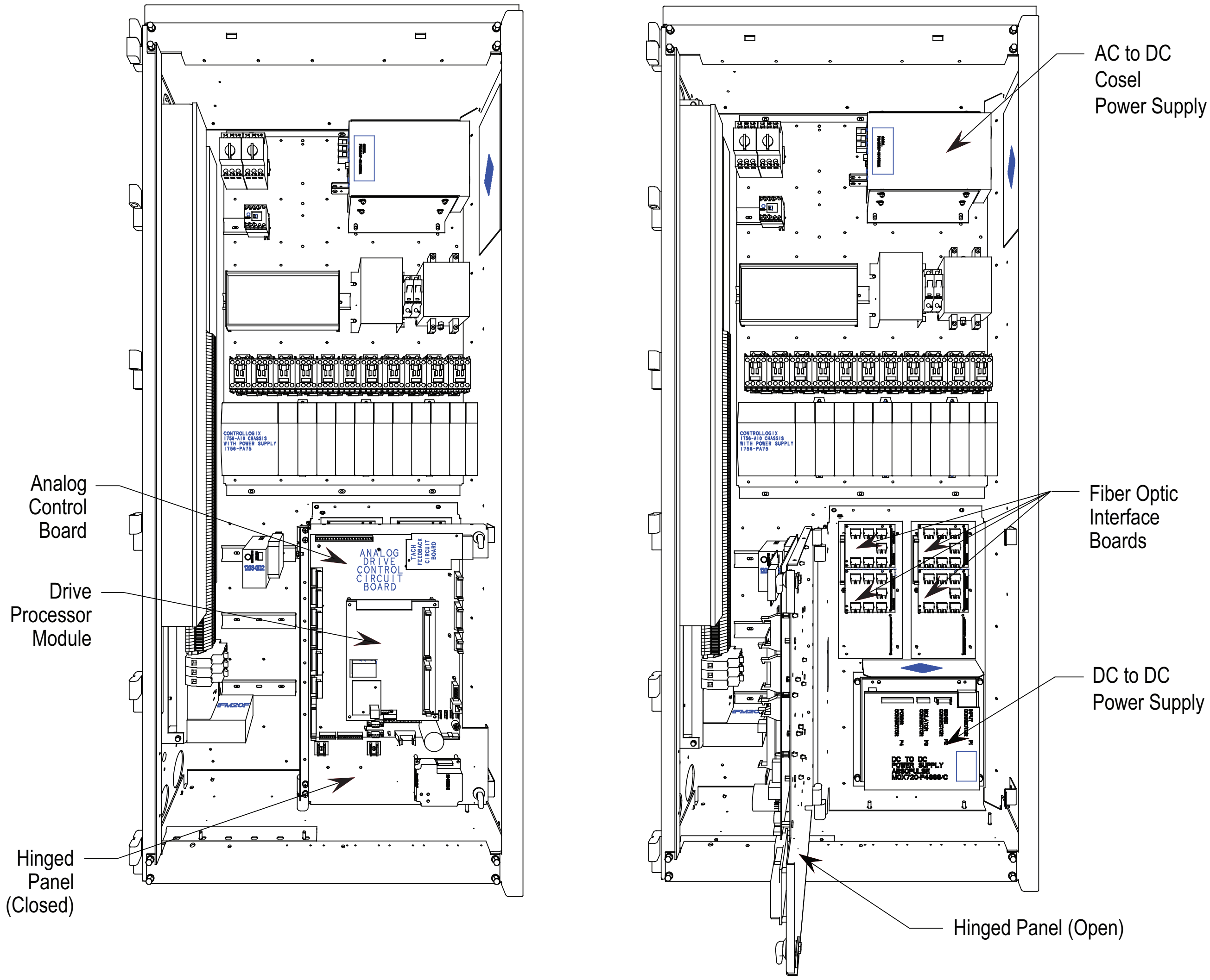


Figure 107 - Low Voltage Tub Compartment (Cosel Power Supply)

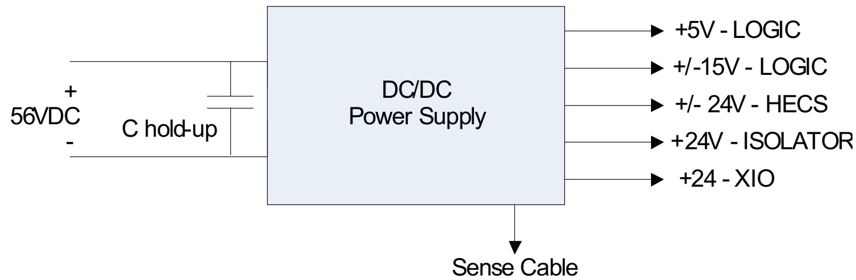


DC/DC Power Supply

Description

The DC/DC power supply is used as a source of regulated DC voltages for various logic control boards and circuits. The input to this power supply is from a regulated 56V DC source.

Figure 108 - DC/DC Converter Power Supply



The capacitor at the input terminals is for power dip ride-through purposes. Upon loss of the 56V input, the capacitors (C hold-up) will maintain the voltage level. This component is not required in all configurations.

Due to the critical nature of the ACB/DPM Logic power source, the DC/DC power supply has been designed to provide redundancy for the +5V rail. There are two separate +5V outputs, each capable of powering the logic boards. In the event of one failing, the other power supply will be automatically switched in to provide the output power.

Terminal/Connections Descriptions

P1 – DC Input	PIN NO.	LABEL	DESCRIPTION ONLY
	1	+56V	+56V input
	2	+56V COMM	+56V common
	3	EARTH	earth ground

P2 – SENSE (To ACB)	PIN NO.	LABEL	DESCRIPTION ONLY
	1	+56V	+56V input supply
	2	+56V RTN	+56V input supply return
	3	NC	Not Connected
	4	NC	Not Connected
	5	+24V	Isolated +24V Supply
	6	+24V RTN	Isolated +24V Supply return
	7	NC	Not Connected
	8	NC	Not Connected
	9	+5VA	Primary +5V supply, before OR'ing diode
	10	DGND (com1)	+5V, +/-15V Common
	11	+5VB	Secondary +5V supply, before OR'ing diode
	12	DGND (com1)	+5V, +/-15V Common
	13	ID0	Power Supply ID Pin 0
	14	ID1	Power Supply ID Pin 1

P3 – ISOLATOR (To Isolator Modules)	PIN NO.	LABEL	DESCRIPTION ONLY
	1	ISOLATOR (+24V,1A)	+24V, 1A/com4
	2	ISOL_COMM (com4)	0V/com4
	3	EARTH	EARTH

P4 – PWR (To ACB)	PIN NO.	LABEL	DESCRIPTION ONLY
	1	+24V_XIO (+24V,2A)	+24V, 2A/com3
	2	XIO_COMM (com3)	0V/com3
	3	+HECSPWR (+24V,1A)	+24V, 1A/com2
	4	LCOMM (com2)	0V/com2
	5	–HECSPWR (-24V,1A)	-24V, 1A/com2
	6	+15V_PWR (+15V,1A)	+15V, 1A/com1
	7	ACOMM (com1)	0V/com1

	8	-15V_PWR (-15V,1A)	-15V, 1A/com1
	9	+5V_PWR (+5V,5A)	+5V, 10A/com1
	10	DGND (com1)	0V/com1
	11	EARTH	earth ground

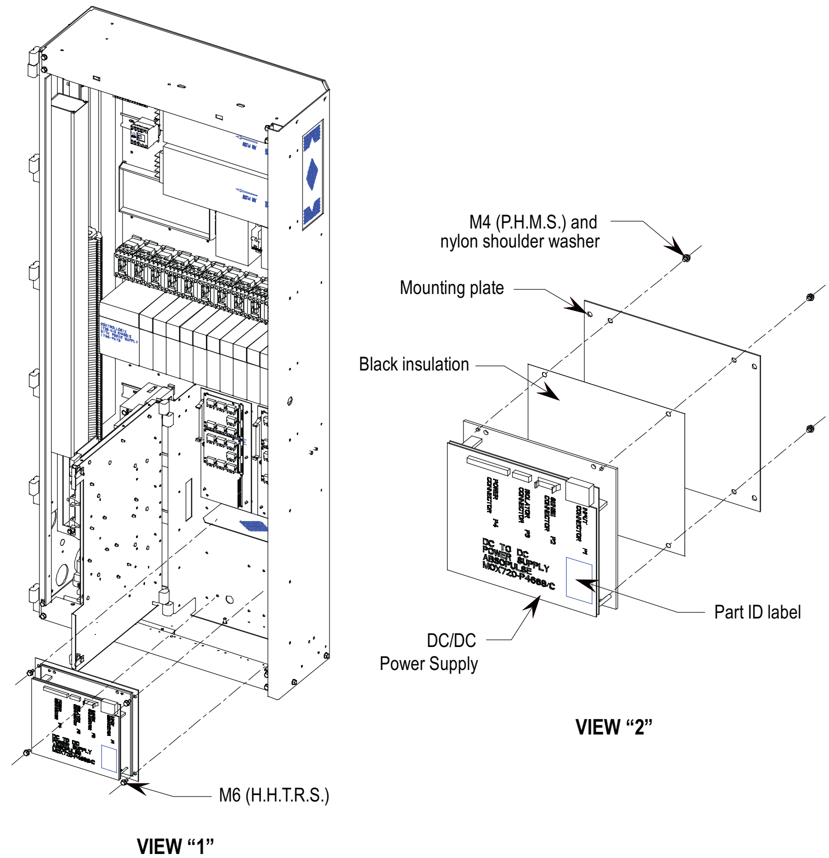
Replacement Procedure for DC/DC Power Supply

(Refer to Figure 109).

1. With the drive energized, check that all output voltages are present (View 1).
2. De-energize the drive, isolate and lock out the control power, and remove all wire connections from the unit (View 1).
3. Remove quantity of four M6 (H.H.T.R.S.) that will allow the DC/DC Power Supply Assembly to be removed from the Low Voltage Panel. (View 1).
4. Remove quantity of four **M4 (P.H.M.S.)** and **Nylon Shoulder Washers** from the back of the Mounting Plate (View 2).
5. Replace old DC/DC Power Supply with the new one.

   Ensure the **Black Insulation** is between the DC/DC Power Supply and the Mounting Plate. Repeat steps 4 through 1 in this order to replace unit (View 2).
6. Ensure the ground wire of P4 plug is connected to the ground by M10 bolt.

Figure 109 - Replacement of DC/DC power supply



Printed Circuit Board Replacement

The replacement of printed circuit boards should be handled in a careful manner.

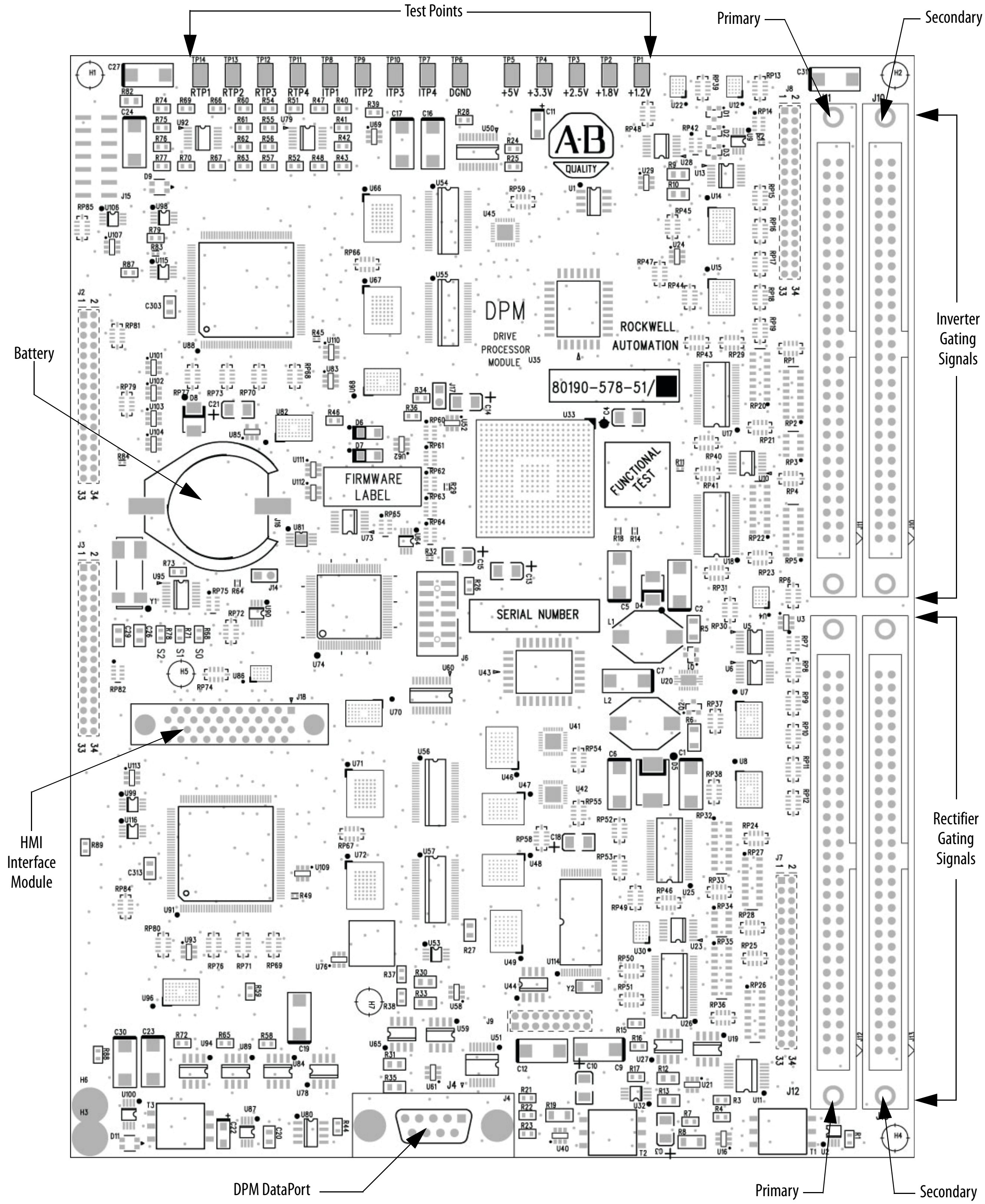
IMPORTANT	Remove all power to the drive. Do not remove the replacement board from the anti-static bag until necessary. Use anti-static wrist strap, grounded in the Low Voltage Control Section.

There are no direct screw/terminal connections on any of the Low Voltage circuit boards. All wire/terminal connections are made with plugs that plug into the circuit boards. This means that changing boards only requires the removal of the plugs, minimizing the chance of mistakes when reconnecting all of the wiring.

Drive Processor Module

This board contains the control processors. It is responsible for all the drive control processing and stores all of the parameters used for the drive control.

Figure 110 - Drive Processor Module (DPM)



Diagnostic test points on the DPM have a voltage output range of -5 to +5V. The following is the list of test points on the DPM:

Table 3 - Test Points on Drive Processor Module

Test points	Name	Description
DPM-TP1	+1.2V	+1.2V DC power supply
DPM-TP2	+1.8V	+1.8V DC power supply
DPM-TP3	+2.5V	+2.5V DC power supply
DPM-TP4	+3.3V	+3.3V DC power supply
DPM-TP5	+5V	+5V DC power supply
DPM-TP6	DGND	Digital ground
DPM-TP8	ITP1	Digital to Analog output – Assignable diagnostic test point
DPM-TP9	ITP2	Digital to Analog output – Assignable diagnostic test point
DPM-TP10	ITP3	Digital to Analog output – Assignable diagnostic test point
DPM-TP7	ITP4	Digital to Analog output – Assignable diagnostic test point
DPM-TP11	RTP4	Digital to Analog output – Assignable diagnostic test point
DPM-TP12	RTP3	Digital to Analog output – Assignable diagnostic test point
DPM-TP13	RTP2	Digital to Analog output – Assignable diagnostic test point
DPM-TP14	RTP1	Digital to Analog output – Assignable diagnostic test point

This table defines the states of LEDs D9 and D11 on the DPM board. D9 is used for the Inverter side processor and D11 is for the Rectifier side processor. The other two LEDs (D6 and D7) are the watchdogs for the Inverter and Rectifier code respectively.

Table 4 - Description of D9 and D11 Function

Color	Rate of Count (Pulse)	Meaning
Green	10 Count	PreExecution OK
Red	0.25 Hz	No Bootcode
Green	0.25 Hz	No Application
Green	0.5 Hz	Downloading via Serial Port
Green	2 Hz	Serial Port Active – i.e. Terminal
Green	1 Hz	Waiting/Loading Application
Green	Solid	Operation Running or Successful
Red	Solid	Operation Failed
Red	2 Count	POST – RAM Failed
Red	3 Count	POST – NVRAM Failed
Red	4 Count	POST – DPRAM Failed
Red	8 Count	FPGA Loading Failed
Red	9 Count	POST – USART Failed: 1 Green Count = Port 1 2 Green Count = Port 2
Red	10 Count	End of Code Reached
Red	11 Count	Download – CRC Error
Red	14 Count	Download – Overflow Error

Drive Processor Module Replacement

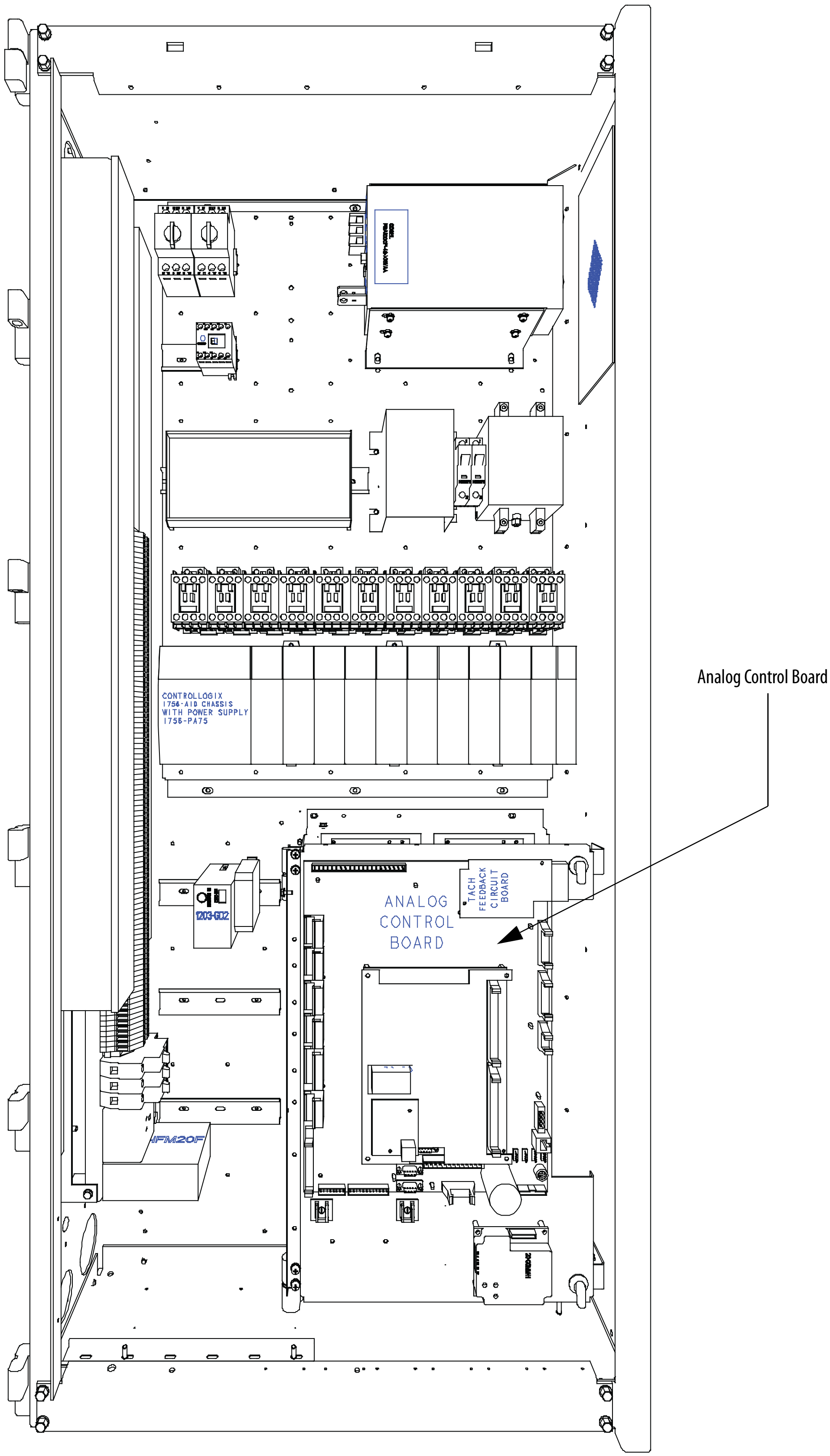
Before replacing the Drive Processor Module, it is important to record all of the programmed drive parameters and settings. Specifically, the parameters, fault masks, fault descriptions, and PLC links are critical. This information is stored in NVRAM on each, and as a result you may lose your settings with a new board. The best method to record parameters is to use the memory on the terminal. Other options include a flashcard, HyperTerminal, the door-mounted printer, or DriveTools™ to record the parameters to a file. The printer and HyperTerminal options allow you to print all of the drive setup information. Otherwise, recording information by hand is the only option left. In the situation where a board has failed, you probably will not be able to save parameters after the failure. That is why it is important to save all parameters when you are finished commissioning or servicing the drive. In this case you should contact the customer to see if they have a copy of the last parameters, or contact Product Support to check if they have a copy.

1. Record all drive setup information using any of the options above, if possible.
2. Ensure that all medium voltage and control voltage power to the drive is isolated and locked out.
3. It is required to first remove the transparent sheet on top of the Drive Processor Module by removing the four screws.
4. Use static strap before removing any connectors.
5. Remove the connectors J4, J11 and J12 after proper identification and marking if necessary. Use the electrical drawing as the reference.
6. Remove the four screws on the corners of the board fastening the board to the standoffs on the Analog Control Board ACB.
7. Gently remove the Drive Processor Module from the four, 34-pin female connectors and one, 16-pin female connector on the ACB.

IMPORTANT	Remove the DIM module from the DPM and plug it on the new DPM before the replacement of DPM.

8. Follow steps 7 through 3 in this order to re-install the boards back into the low voltage control cabinet.
9. Apply control power to the drive. The DPMs are shipped with no firmware installed, so the drive will automatically go into download mode. Install firmware in the drive following the guidelines in publication 7000-UM201A-EN-P.
10. Program the drive. Refer to Technical Data “Medium Voltage AC Drive Parameters” – Publication **7000-TD002_-EN-P**.

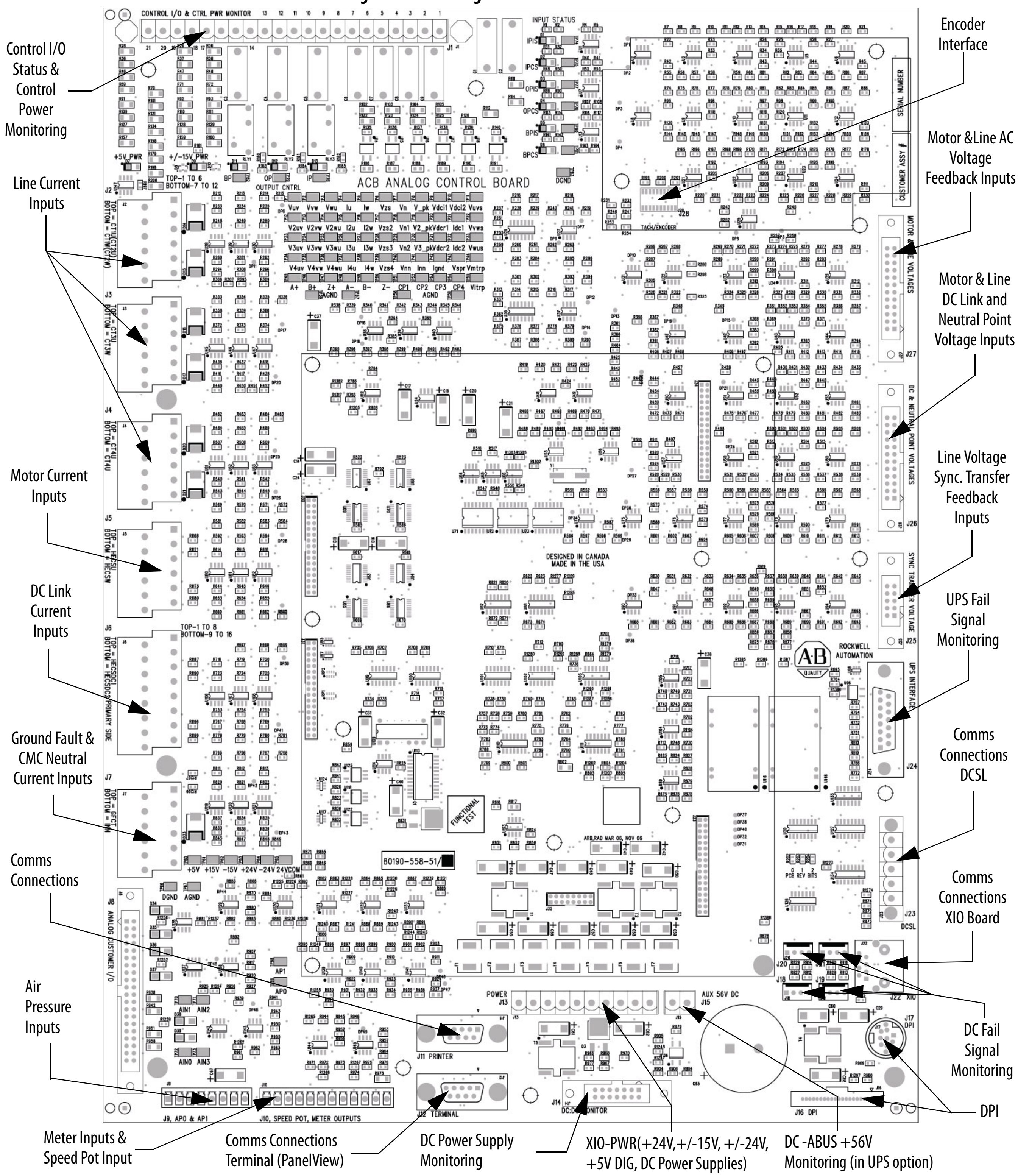
Figure 111 - ACB and DPM Replacement



Analog Control Board

The Analog Control Board (ACB) is the hub for all control-level signals external to the drive. Analog I/O, External Fault signals (through the XIO board), SCANport/DPI communication modules, Remote I/O, terminal interface, printers, modem, and other external communication devices are routed through this board.

Figure 112 - Analog Control Board



The ACB receives all of the Analog Signals from the drive's internal components. This includes the current and voltage feedback signals. The boards also have isolated Digital I/O for fan status, e-stops, and contactor control and status feedback. All of the test points for the currents, system voltages, control voltages, and flux are on these boards.

Table 5 - Connectors on Analog Control Board

ACB Connectors	Description
ACB-J1	Control I/O & Control Power Monitor
ACB-J2	Line current inputs, CT2U, CT2W
ACB-J3	Line current inputs, CT3U,CT3W
ACB-J4	Line current inputs, CT4U,CT4W
ACB-J5	Motor current inputs, HECSU, HECSW
ACB-J6	DC Link current inputs, HECSDC1, HECSDC2
ACB-J7	Ground fault & CMC Neutral current inputs, GFCT, INN
ACB-J8	Isolated & Non-isolated analog inputs, AIN1,AIN2,AIN3 and Non-isolated outputs, AOUT1, AOUT2, AOUT3, AOUT4
ACB-J9	Air pressure inputs, AP0, AP1
ACB-J10	Meter outputs, AOUT5, AOUT6, AOUT7, AOUT8 and Speed Pot input, AIN0
ACB-J11	Communication connections, printer outputs
ACB-J12	Communication connections, Terminal
ACB-J13	DC power supplies, XIO(+24V),+/-15V,+/-24V,+5V
ACB-J14	DC power supply monitoring, 5V1, 5V2, DC-BUS
ACB-J15	DC-ABUS +56V output monitoring (UPS option)
ACB-J16	DPI interface
ACB-J17	Communication connections, scan port
ACB-J18	DC fail signal monitoring
ACB-J19	DC fail signal monitoring
ACB-J20	DC fail signal monitoring
ACB-J21	DC fail signal monitoring
ACB-J22	Communication connection, XIO link CAN interface
ACB-J23	Communication connection, parallel drive
ACB-J24	UPS fail signal monitoring
ACB-J25	Line voltage synchronous transfer feedback voltage inputs VSA,VSB,VSC
ACB-J26	Motor & line DC link and Neutral Point Voltage inputs
ACB-J27	AC Motor & Line voltage feedback inputs
ACB-J28	Encoder interface
ACB-J30	DPM connection, A/D SUB system
ACB-J31	DPM connection, DACs serial data
ACB-J32	DPM power supply, +5V
ACB-J33	DPM connection, Faults & other I/O
ACB-J34	DPM connection, Encoder

Table 6 - Test Points on Analog Control Board

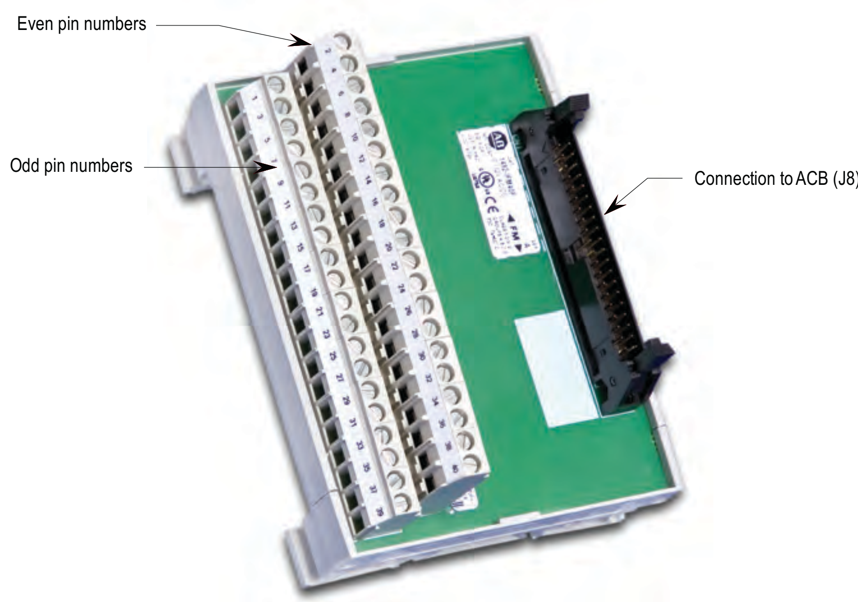
Test points	Name	Description
ACB-TP1	Vuv	Motor Voltage Feedback, UV
ACB-TP2	Vvw	Motor Voltage Feedback, VW
ACB-TP3	Vwu	Motor Voltage Feedback, WU
ACB-TP4	Iu	Motor Current, HECSU
ACB-TP5	Iw	Motor Current, HECSW
ACB-TP6	Vzs	Zero Sequence Generation Motor side, VZS
ACB-TP7	Vn	Motor Side Filter CAP Neutral Voltage, MFCN
ACB-TP8	V_pk	Motor Over Voltage Detection for UVW
ACB-TP9	Vdci1	Motor Side DCLINK Voltage for Bridge #1, VMDC1
ACB-TP10	Vdci2	Motor Side DCLINK Voltage for Bridge #2, VMDC2
ACB-TP11	Vuvs	Line Voltage Synchronous Feedback, VSAB
ACB-TP12	V2uv	Line Voltage Feedback, 2UV
ACB-TP13	V2vw	Line Voltage Feedback, 2VW
ACB-TP14	V2wu	Line Voltage Feedback, 2WU
ACB-TP15	I2u	Line current, CT2U
ACB-TP16	I2w	Line current, CT2W
ACB-TP17	Vzs2	Zero Sequence Generation Line side, VZS2
ACB-TP18	Vn1	Line Filter CAP Neutral Voltage for Bridge #1, LFCN1
ACB-TP19	V2_pk	AC over voltage detection for 2UVW
ACB-TP20	Vdcr1	Line side DCLINK Voltage for Bridge#1,VLDC1
ACB-TP21	Idc1	DCLINK current, HECSDC1
ACB-TP22	Vvws	Line Voltage Synchronous Feedback, VSBC
ACB-TP23	V3uv	Line Voltage Feedback, 3UV
ACB-TP24	V3vw	Line Voltage Feedback, 3VW
ACB-TP25	V3wu	Line Voltage Feedback, 3WU
ACB-TP26	I3u	Line current, CT3U
ACB-TP27	I3w	Line current, CT3W
ACB-TP28	Vzs3	Zero Sequence Generation Line side, VZS3
ACB-TP29	Vn2	Line Filter CAP Neutral Voltage for Bridge #2, LFCN2
ACB-TP30	V3_pk	AC over voltage detection for 3UVW
ACB-TP31	Vdcr2	Line side DCLINK Voltage for Bridge#2, VLDC2
ACB-TP32	Idc2	DCLINK current,HECSDC2
ACB-TP33	Vwus	Line Voltage Synchronous Feedback, VSCA
ACB-TP34	V4uv	Line Voltage Feedback, 4UV
ACB-TP35	V4vw	Line Voltage Feedback, 4VW
ACB-TP36	V4wu	Line Voltage Feedback, 4WU
ACB-TP37	I4u	Line current, CT4U
ACB-TP38	I4w	Line current, CT4W
ACB-TP39	Vzs4	Zero Sequence Generation Line side, VZS4 (spare one)
ACB-TP40	Vnn	CMC Neutral Voltage, VNN
ACB-TP41	Inn	CMC Neutral current, INN
ACB-TP42	Ignd	Ground Fault current, GFCT

ACB-TP43	Vspr	Spare channel for inputs
ACB-TP44	Vmtrp	Motor Over Voltage Detection set point
ACB-TP45	A+	Encoder A+ input
ACB-TP46	B+	Encoder B+ input
ACB-TP47	Z+	Encoder Z+ input
ACB-TP48	A-	Encoder A-input
ACB-TP49	B-	Encoder B- input
ACB-TP50	Z-	Encoder Z- input
ACB-TP51	CP1	Control Power monitoring for channel 1
ACB-TP52	CP2	Control Power monitoring for channel 2
ACB-TP53	CP3	Control Power monitoring for channel 3
ACB-TP54	CP4	Control Power monitoring for channel 4
ACB-TP55	Vltrp	AC Over Voltage Detection set point for 2UVW&3UVW
ACB-TP56	AGND	Analog ground
ACB-TP57	AGND	Analog ground
ACB-TP58	AGND	Analog ground
ACB-TP59	AGND	Analog ground
ACB-TP60	+5V	+5V DC power supply
ACB-TP61	+15V	+15V DC power supply
ACB-TP62	-15V	-15V DC power supply
ACB-TP63	+24V	+24V DC power supply
ACB-TP64	-24V	-24V DC power supply
ACB-TP65	24VCOM	+/- 24V common
ACB-TP66	DGND	Digital ground
ACB-TP67	AGND	Analog ground
ACB-TP68	AP1	Analog Control Inputs, Air pressure input, AP1
ACB-TP69	AP0	Analog Control Inputs, Air pressure input, AP0
ACB-TP70	AIN1	Analog Control Input, AIN1
ACB-TP71	AIN2	Analog Control Input, AIN2
ACB-TP72	AIN0	Analog Control Input, AIN0
ACB-TP73	AIN3	Analog Control Input, AIN3
ACB-TP74	IPIS	Input Isolating Switch
ACB-TP75	IPCS	Input Contactor Status
ACB-TP76	IP	Input Contactor Command
ACB-TP77	OPIS	Output Isolating Switch
ACB-TP78	OPCS	Output Contactor Status
ACB-TP79	OP	Output Contactor Command
ACB-TP80	BPIS	Bypass Isolating Switch
ACB-TP81	BPCS	Bypass Contactor Status
ACB-TP82	BP	Bypass Contactor Command
ACB-TP83	DGND	Digital Ground Return

Interface Module (IFM)

The Interface Module is used to make all customer useable connections to the ACB. The pin numbers listed on the following pages refer to IFM pin numbers.

Figure 113 - Interface Module



Analog Inputs and Outputs

The PowerFlex 7000 offers one isolated process current loop transmitter and three isolated process current loop receivers, embedded into the control. These are accessible on the ACB.

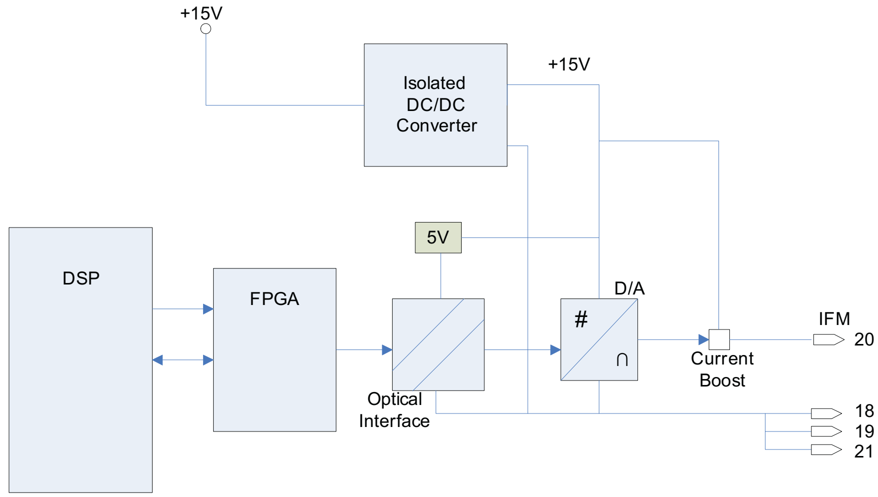
The isolated Process Output is configured as 4…20 mA. The three isolated process inputs are individually configurable for either a range of -10/0/+10V or 4…20 mA (Refer to Programming Manual).

The following information shows the connections for each input and output.

Current Loop Transmitter

The current loop transmitter will transmit 4…20mA output to an external receiver. The loop compliance on the transmitter is 12.5V. Loop compliance is the maximum voltage at which a transmitter can generate to achieve the maximum current and is usually a function of the power supply voltage. Therefore, the PowerFlex 7000 transmitter can drive a receiver with an input resistance up to 625 Ω. Figure 114 shows a block diagram of the transmitter.

Figure 114 - Process Loop Transmitter Block Diagram



This type of transmitter is known as a 4-wire transmitter, and will "sink" current from a receiver. The receiver is connected by two wires only from pins 20 (+ connection) and either pins 18, 19, 21 (- connection).

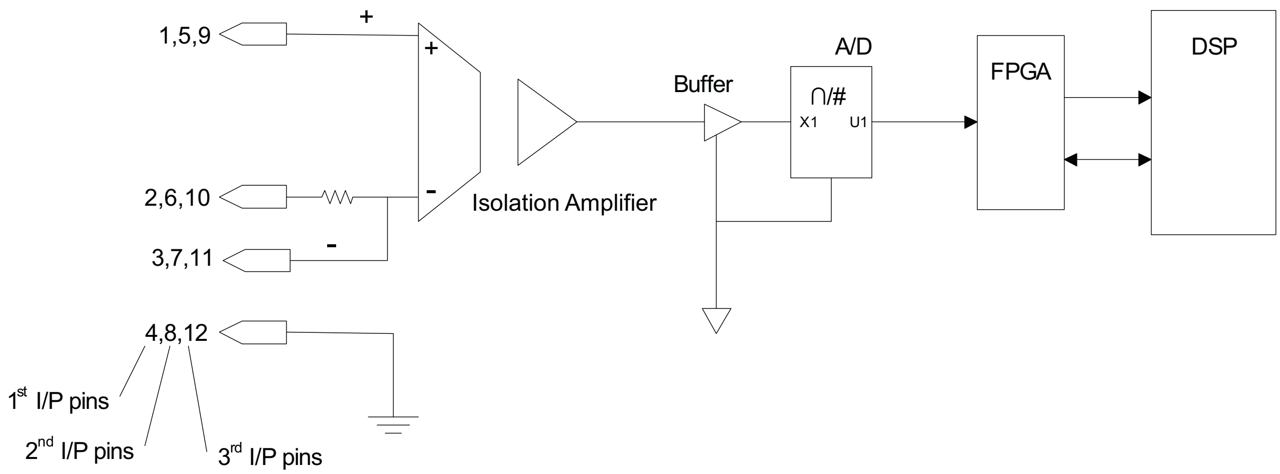
The recommended connection is shown above. The type of shielded cable used is application specific and is determined by the length of the run, the characteristic impedance and the frequency content of the signal.

Isolated Process Receiver

These inputs are individually configurable to accept either a -10/0/+10V input signal or a 4…20 mA signal. When configured for voltage input, each channel has an input impedance of 75 kΩ. When used as a current loop input, the transmitter must have a minimum loop compliance of 2V to satisfy the 100 Ω input impedance. Regardless of input configuration, each input is individually isolated to ± 100V DC or 70V RMS AC.

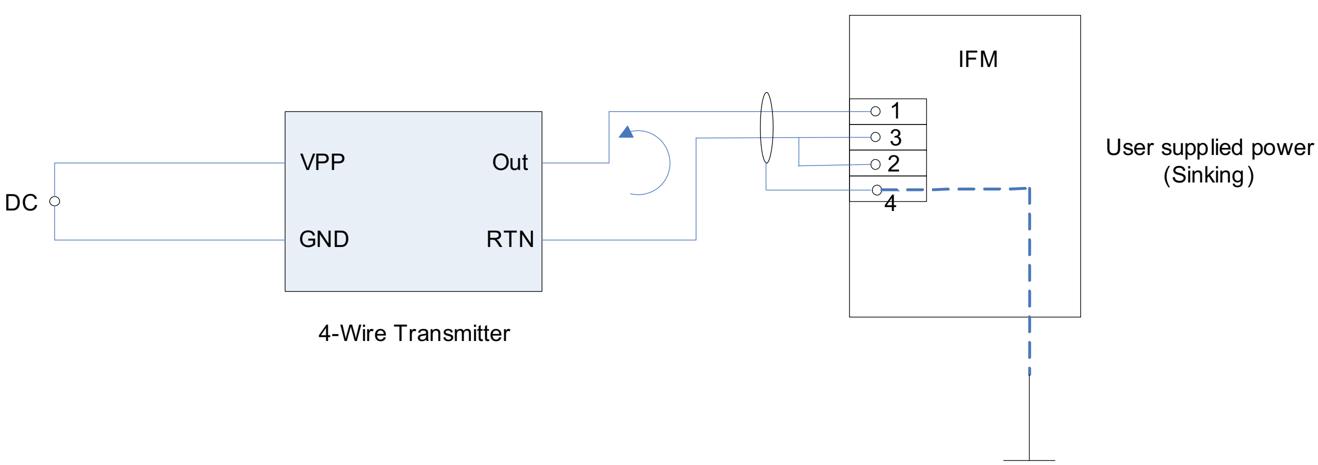
Figure 115 shows a block diagram of the receiver.

Figure 115 - Process Loop Receiver Block Diagram



The receiver can accept 4-wire transmitters. Figure 116 shows the recommended connections. Again, the type of shielded cable used is application specific as per the transmitter. Pin numbers shown are for connection to the first of three isolated process receivers.

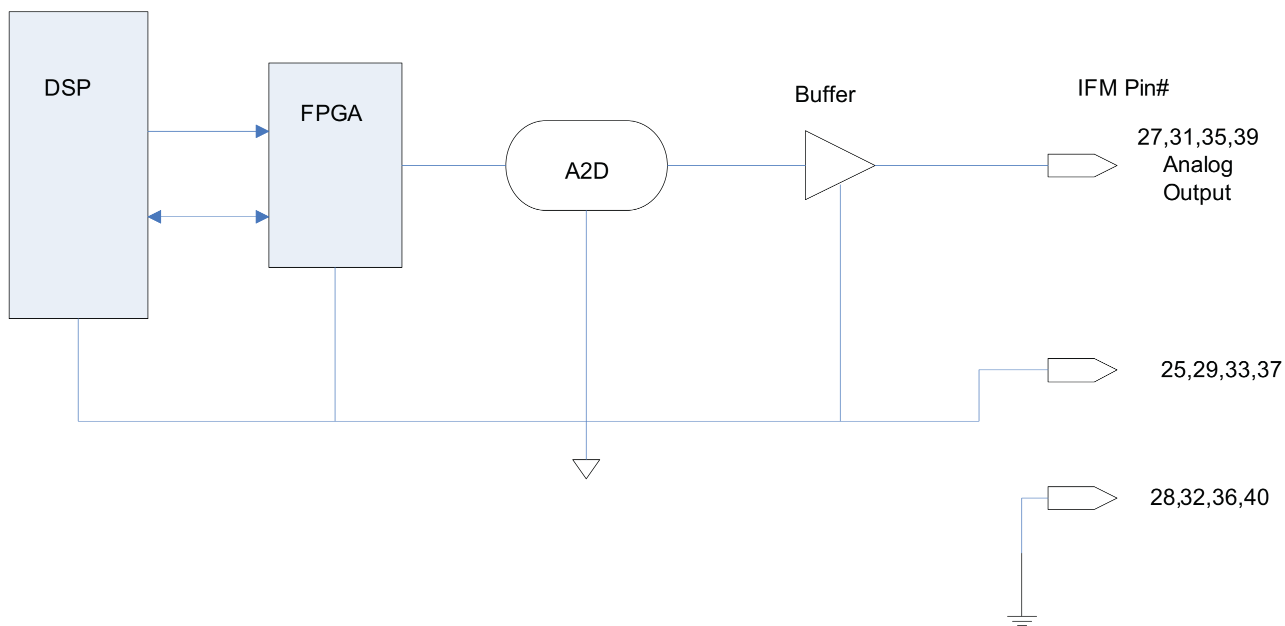
Figure 116 - Process Loop Receiver Connections



Non-Isolated Process Outputs

The drive supplies four non isolated -10/0/+10V outputs for customer use. These outputs can drive loads with impedances as low as 600 Ω. These outputs are all referenced to the Drive AGND and therefore should be isolated if they are required to drive outside the PowerFlex 'A' frame enclosure.

Figure 117 - Non-isolated Configurable Analog Outputs on ACB



Auxiliary +24V Power Supply

An Isolated 24V Power Supply is built into the DC/DC converter (Connector P3). This supply may be used for any customer supplied equipment requiring up to 24 W at 24V. This supply may also be used to power any custom drive options, such as isolation modules for additional Process Control Outputs. The health of this power supply is monitored in the drive.

PIN NO.	DESCRIPTION
1	ISOLATOR (+24V, 1A)
2	ISOL_COMM (com4)
3	EARTH

The ACB is common for both the line and motor side current feedbacks. Different scaling resistors are mounted on the terminal block for line side and machine side

There are two LEDs on the ACB labeled D7 and D9. D9 is the ±15V DC voltage-OK signal, and D7 is the +5V DC voltage-OK signal.

Analog Control Board Replacement

To replace the Analog Control Boards,

1. Ensure that all medium voltage and control voltage power to the drive is isolated and locked out.
2. It is required to remove the transparent sheet on top of the Drive Processor Module and the Drive Processor Module also before removing the ACB. Remove the transparent sheet on top of the DPM by removing the four screws.
3. Use static strap before removing any connectors.
4. Remove the connectors J4, J11 and J12 on DPM after proper identification and marking if necessary. Use the electrical drawing as the reference. Remove the four screws holding it on the standoffs above the ACB.
5. Gently remove the DPM mounted on the four, 34-pin connectors.
6. Remove the screws holding encoder interface board and gently remove the board mounted on the 8-pin connector
7. Remove the connectors J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J12, J13, J14, J16, J22, J24, J25, J26, J27 on ACB after proper identification and marking if necessary. Use the electrical drawing as the reference.
8. Remove the ACB board by removing the four screws, and six standoffs screwed to support the DPM & encoder interface board.
9. Follow steps 8 through 2 in that order to re-install the boards back into the low voltage control cabinet.
10. Apply Low Voltage power and complete a System Test and Medium Voltage tests to ensure the new board functions properly.

Encoder Feedback Board

Encoder Options

There are two positional encoder interface boards that may be used with the PowerFlex 7000 Forge Control. The encoder interface boards do not have any user accessible test points; however, buffered and isolated versions of each of the signals A+, A-, B+, B-, Z+ and Z- are available on the ACB at test points TP45-TP50.

Regardless of which type of encoder board, the following conditions should be adhered to:

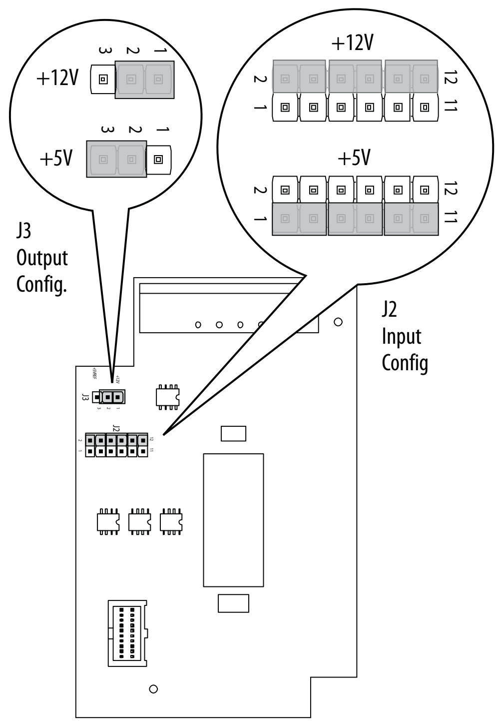
1. Do not attach encoders with open collector outputs to the drive. Acceptable outputs are Analog Line Driver or Push Pull.

2. The drive will not operate properly if using single ended Quadrature encoders. Rockwell Automation recommends using differential inputs only for these types of encoders. Single ended outputs are only acceptable for Positional Encoders.

20B-ENC-1 & 20B-ENC-1-MX3 Encoder Interface

This encoder interface allows the drive to be connected to a standard Quadrature Encoder. The 20B-ENC encoder interface provides three optically isolated differential encoder inputs for A and B phases as well as a Z track. These inputs cannot be configured for use with a single ended Encoder. Differential encoders only are supported. The board also provides a galvanically isolated 12V/3 W supply to power the attached encoder. The 20B-ENC-1 Encoder interface may be configured for 5V operation, however Rockwell recommends operation at 12V.

Figure 118 - Encoder Interface (20B-ENC-1 and 20B-ENC-1-MX3)



Must be configured for 12V operation.

Operation at 5V does not allow for long cable lengths. The reason for this is that it requires the power to be regulated within 5% at the encoder. Due to the resistance and capacitance of the cable it would be very hard to keep the power regulated at the encoder to 4.75V. With longer runs of cable this could drop below the 4.75V and the encoder would not operate properly. As a general rule, using 18Avg cabling with an Rdc of 19.3 Ω/km the longest cable distance from the board to the encoder is limited to 12 m (42 ft).

The 20B-ENC-1-MX3 encoder option is functionally identical to the 20B-ENC-1 encoder with the addition of conformal coating. Figure 118 shows the recommended jumper positions for use with the PowerFlex 7000 Drive.

Input Connections

All encoder interface Connections are made to J1. The connections are as follows:

- J1 Pin 1 A+
- J1 Pin 2 A-
- J1 Pin 3 B+
- J1 Pin 4 B-
- J1 Pin 5 Z+
- J1 Pin 6 Z-
- J1 Pin 7 Encoder Power Return
- J1 Pin 8 Encoder Power (+12V @ 3 Watts)

80190-759-01, 80190-759-02 Universal Encoder Interface

The Universal Encoder Interface allows the drive to be connected to an absolute position encoder or a standard quadrature encoder and also provides the option for dual or redundant quadrature encoders. The Universal Encoder Interface provides 12 single ended or 6 differential, optically isolated inputs as well as a 12V/3 W galvanically isolated encoder power source. When using absolute encoders the 12 single ended inputs are used. For quadrature encoders, the six differential inputs are used.

Either type of encoder with frequencies up to 200 KHz, can be interfaced to the Universal Encoder Interface.

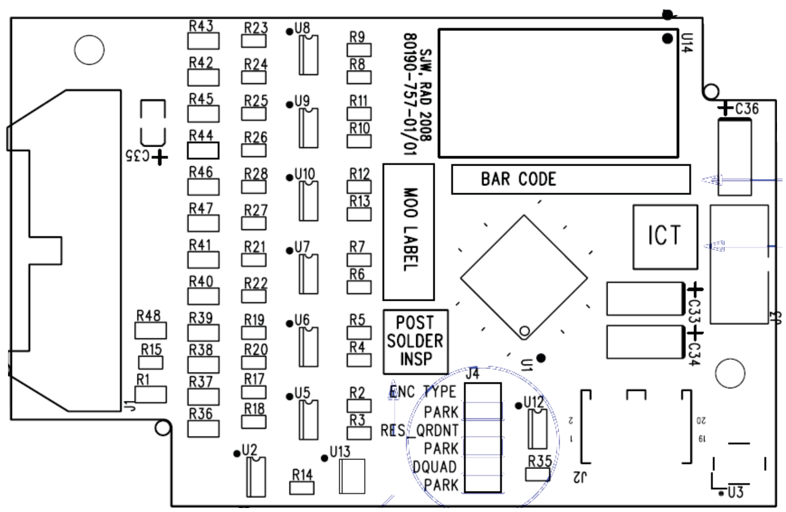
The 80190-759-02 Universal Encoder Interface is functionally identical to the 80190-759-01 with the addition of conformal coating. The Universal Encoder interface is configured via jumpers installed on the 12-position header J4. The header has three positions labeled 'Park' and used to store the jumpers when indicated as "Removed" in the table below. Each function is selected by moving its corresponding jumper from the 'park' location to the selected function location if labeled "Installed". The following table describes the functions available.

ATTENTION: Removing the Universal Encoder Interface while control power is applied may result in damage to the board. Only remove the board when the control power is off.

Table 7 - Encoder Configurations

ENC_TYPE	POL_QRDNTS	CD_DQUAD	CONFIGURATIONS
Installed	Installed	Installed	Single Quadrature Encoder Option (Factory Default)
Installed	Installed	Removed	Dual Quadrature Encoder Option without Redundancy
Installed	Removed	Removed	Dual Quadrature Encoder Option with Redundancy
Installed	Removed	Installed	Single Quadrature Option (CDSEL/DQUAD) must be removed for Redundancy
Removed	Installed	Installed	Gray Code Absolute Encoder Low True
Removed	Installed	Removed	Natural Binary Absolute Encoder Low True
Removed	Removed	Installed	Gray Code Absolute Encoder High True
Removed	Removed	Removed	Natural Binary Absolute Encoder High True
Installed	Installed	Installed	Single Quadrature Encoder Option (Factory Default)

Figure 119 - Universal Encoder Board



Connections to the Universal Encoder Interface are made via a 1492-IFM20F interface module. The connections to the IFM are as follows:

Table 8 - Encoder Functions

IFM Pin #	Quadrature Encoder Function	Absolute Encoder Function
1	A1+	E0
2	A1-	E1
3	B1+	E2
4	B1-	E3
5	ENC_COM	ENC_COM
6	Z1+	E4
7	Z1-	E5
8	A2+ (Redundant or Dual ENC)	E6
9	A2- (Redundant or Dual ENC)	E7
10	ENC_COM	ENC_COM
11	B2+ (Redundant or Dual ENC)	E8
12	B2- (Redundant or Dual ENC)	E9
13	Z2+ (Redundant or Dual ENC)	E10
14	Z2- (Redundant or Dual ENC)	E11
15	ENC_COM	ENC_COM
16	ENC_COM	ENC_COM
17	ENC_COM	ENC_COM
18	ENC PWR (+12V)	ENC PWR (+12V)
19	ENC PWR (+12V)	ENC PWR (+12V)
20	ENC PWR (+12V)	ENC PWR (+12V)

Figure 120 - 20-pin Interface Module (IFM)

Quadrature Encoder Operation

The Universal Encoder Interface will accept either single or dual quadrature encoders. Configuration of the board to accept the encoders is done through jumpers on J4.

Boards shipped from the factory come defaulted to single quadrature encoder configuration (Consult factory for availability of dual Quadrature Encoder options).

For dual encoder configurations, the primary encoder is wired to pins 1 through 7 on the 1492-IFM20 module.

To select the dual encoder option, remove the CD_QUAD jumper and place it in PARK. This will configure the board to accept two individual quadrature encoders. In this mode, the drive can switch between encoders for applications such as Synchronous Transfer between two motors with each having their own encoder.

For redundant encoder option, remove both the CD_QUAD and POL_QRDNT jumpers and place them in PARK. With this configuration, the drive will switch over to the redundant encoder when it detects a problem with the primary encoder.

ATTENTION: When the drive switches over to the redundant encoder, it cannot switch back without recycling control power.

Positional Encoder Operations[1]

Besides quadrature encoders, the Universal Encoder Interface will also accept positional (absolute) encoders. Parallel positional data is converted to a serial stream and transmitted to the DPM when requested by the drive. The board will also generate "pseudo" quadrature differential signals, including a zero position mark, derived from the binary data to the DPM.

There are three different positional encoder configurations available. For all of these configurations remove the ENC_TYPE jumper. The other jumpers configure the board for the type of positional data (Gray Code or Natural Binary) set by CD_DQUAD and High or Low True data set by POL_QRDNT.

1. **Gray code, Low True**. In this configuration the board will invert the incoming gray code data and then convert it to binary for transmission to the DPM.
2. **Natural Binary, Low True**. No conversion is done on the incoming data but it is inverted.

(1) Consult factory for availability of Positional Encoders.

3. **Gray code, High True**. In this configuration, the incoming gray code data is simply converted to binary. No inversion is done on the input data.
4. **Natural Binary, High True**. The positional data is simply converted to the serial stream. No inversion or conversion is done on the data.

Positional Encoder Guidelines

When selecting a positional encoder, certain guidelines must be followed for optimal performance.

1. **Code Selection:** Absolute encoders can be purchased with either Gray code or Binary output format. Gray code is a form of binary code where only a single bit changes at a time for each sequential number or position. The fact that only a single bit changes at a time make it easier for the Universal Encoder Interface to read valid positional data and not ambiguous data. If we compare the Natural Binary code to Gray code for the transition from 255 to 2556, here is what we get:

	Binary Code	Gray Code
255	011111111	010000000
256	100000000	110000000

   All nine bits changed in the Binary Code while only the MSB of the Gray code changed. In the Universal Encoder Interface there are delays created by the frequency filter components and input hysteresis. Differences in these delays could cause errors due to reading a bit as ON when it is actually transitioning to OFF or vice versa. In the case of Gray code since only one bit ever changes the ambiguity error is never more than one count. For this reason and to reduce inrush currents, Rockwell Automation recommends using Gray code Positional Encoders.

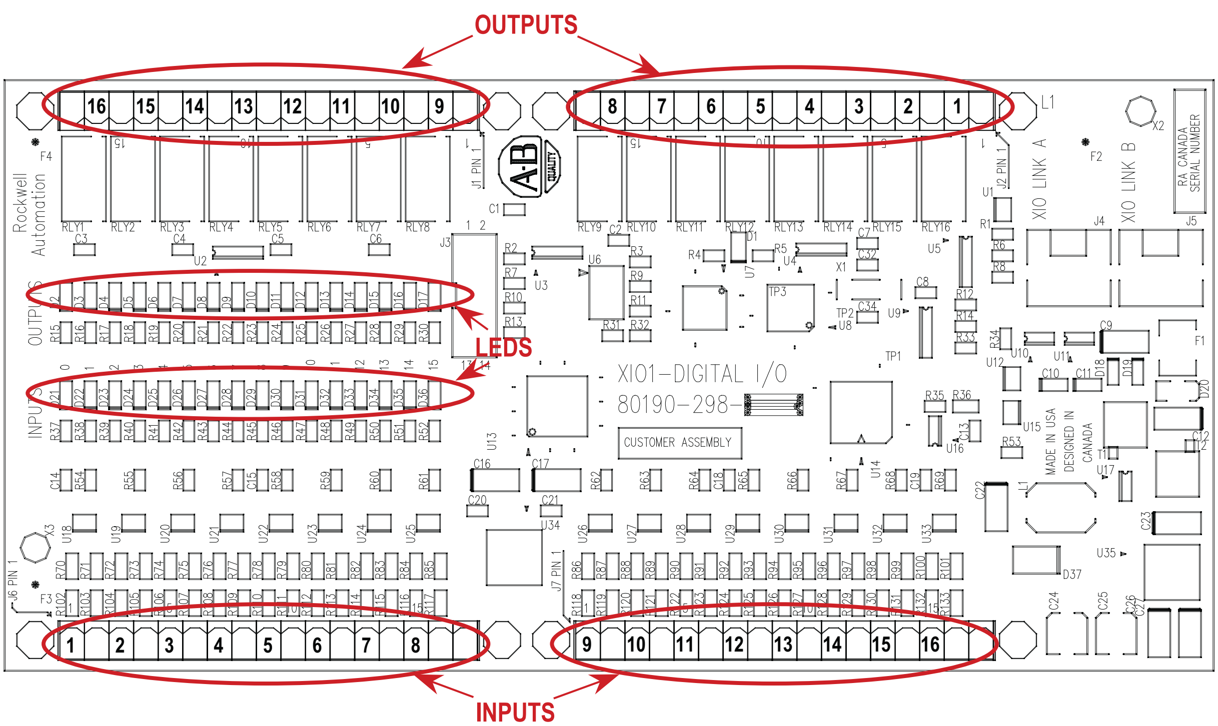
2. **Data Polarity**: Absolute encoders typically have a High True output. If the encoder model does not have a High/True (or Non Inverted/Inverted) option you should assume it to be High True. In the case of a 10bit High True encoder the zero position is represented by 0000000000. Whereas a Low/True encoder the zero position is 1111111111. On the Universal Encoder Interface the position data is inverted in hardware. That is a '1' will turn on an Optocoupler producing a '0'. Therefore a High True encoder would produce 1111111111 for the zero position. With the POL_QRDNT jumper you can control the polarity of the input. With the jumper installed (factory default) it is setup to accept High True encoders and an extra inversion is done in the Universal Encoder Interface. If you are using a Low True encoder then this jumper needs to be removed so that the zero position is inverted by the optocouplers alone.

The other role of the POL_QRDNT jumper is to correct the data in the event the encoder was mounted so that a CCW rotation produced decrementing counts. If this is the case the POL_QRDNT jumper should be configured to the opposite of what it should normally be for the data polarity. For example if the Universal Encoder Interface is configured to operate with High True encoders (POL_QRDNT installed), remove it to correct for encoder mounting.

External Input/Output Boards

The External Input/Output (XIO) Boards are connected through a network cable (CAN Link) to the Analog Control Board (ACB). This cable may be connected to either XIO Link A (J4) or XIO Link B (J5). The XIO board handles all external Digital Input and Output signals and sends them to the ACB through the cable. There are 16 Isolated Inputs and 16 Isolated Outputs on the card, and they are used for Runtime I/O including Start, Stop, Run, Fault, Warning, Jog, and External Reset signals. The boards also handle the standard drive fault signals (Transformer/Line Reactor Overtemperature, DC Link Overtemperature, etc.) and several spare configurable fault inputs. There is an option in software to assign each XIO a specific function (General IO, External IO or Liquid Cooling).

Figure 121 - XIO Board



The standard drive comes with one XIO board; additional boards (up to five) can be daisy chained together from XIO Link B (J5) on the first board to XIO Link A (J4) on the second board, for a total of six XIO cards. However, at this time the drive only supports the use of addresses 1 to 3, depending on the drive's features and application. U6 on the XIO board displays the board's address which is automatically calculated from the XIO board's position in the network.

XIO Link A and B ports are interchangeable but it may make wiring easier to follow if Link A is used for "upstream", that is, closest to the ACB, and Link B is used for "downstream" or farthest from the ACB.

LED D1 and display U6 indicate the status of the board. Table 9 shows the possible status for D1.

Table 9 - D1 Display Status

LED Status	Description
Solid Green	Normal Operation
Solid Red	Board Failure
Alternate Flashing of Red and Green	No Communication Available to ACB board (Normal during boot-up or unprogrammed)

Table 10 - U6 Display Status

Display	Description	Explanation
—	No valid address found	• More than 6 XIO cards on network • XIO cable failure • XIO card failure • ACB failure
0	Card in "Master" mode	• Rockwell Use Only • Remove connection to J3 and recycle power
1 – 6	Valid address	• Normal
Decimal point ON	Indicates network activity	• Normal
Decimal point OFF	No activity on the network	• Normal at Power on, during firmware download and with unprogrammed drive

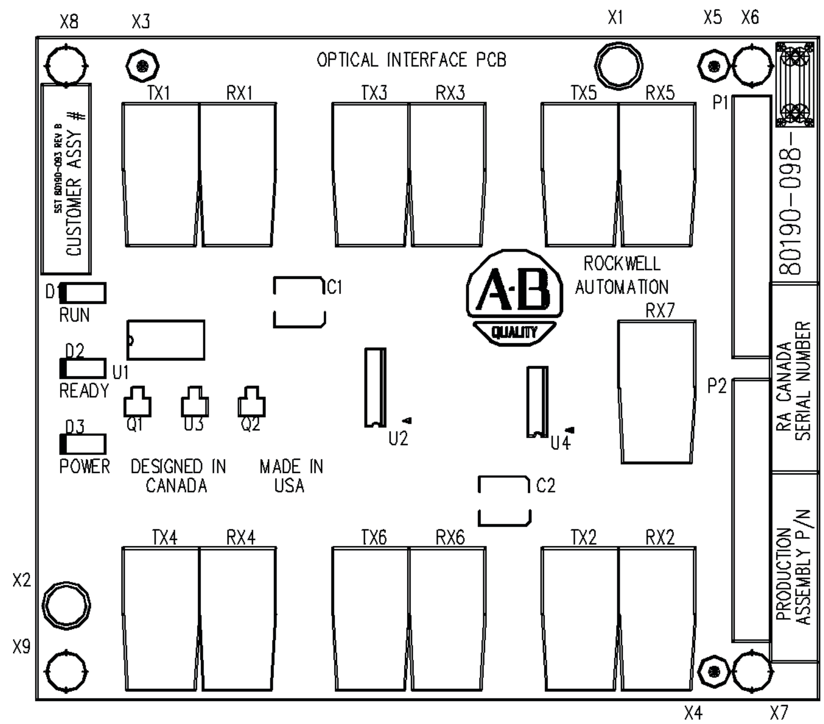
External Input/Output Board Replacement

1. Ensure that all medium voltage and control voltage power to the drive is isolated and locked out.
2. Note and Mark the location and orientation of all the plugs, cables, and connectors into the XIO board. Use the electrical drawing as a reference.
3. Using your static strap, disconnect all of the connections.
4. Remove the XIO board assembly from the low voltage control cabinet. The XIO board mounts on a DIN rail, so a special 3-piece assembly is used to secure the board. The assembly does not come with the new board, so the old board needs to be removed from the assembly and the new board installed in its place.
5. Install the new XIO board assembly in the low voltage control cabinet.
6. Reconnect all connections and verify the locations.
7. Apply Low Voltage power and complete a System Test and Medium Voltage tests to ensure the new board functions properly.

Optical Interface Boards

The Optical Interface (OIB) Boards are the interface between the DPM and the Gate Driver circuitry. The drive control decides which device to fire, and sends an electrical signal to the OIB boards. The OIB board converts that electrical signal to an optical signal, which is transmitted via fiber optics to the gate driver cards. Typically, the Transmit ports are Grey and the Receive ports are Blue. The gate driver accepts that signal and turns the device on and off accordingly. The diagnostic fiber optic signals work the same way, but the source is the gate driver boards and the destination is the drive control boards. Each OIB contains one extra fiber optic receiver (RX7), which is used for temperature measurement.

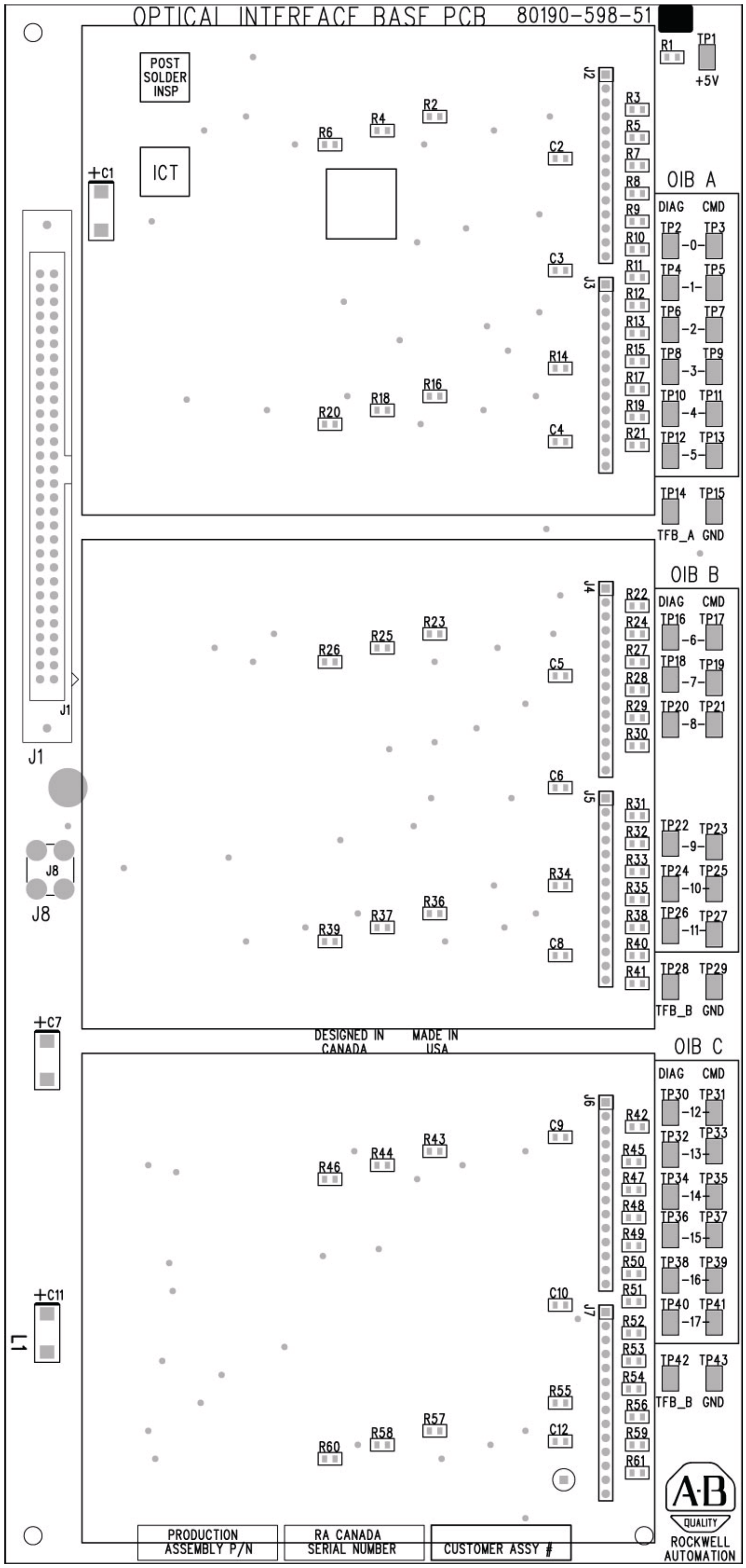
Figure 122 - Optical Interface Board



The OIB boards are mounted directly on the Optical Interface Base Board (OIBB) using two parallel 14-pin connectors for the electrical connection, and plastic clips to provide the mechanical strength. There is one OIBB for the inverter, and one OIBB for the rectifier device. The OIBBs are interfaced to the DPM using two ribbon cables to connect to J11 and J12.

Each OIB board can handle the Firing and Diagnostic duplex fiber optic connector for six devices. Physically, on the OIBBs, there is provision for 18 devices for the inverter and the rectifier. This is enough capacity to handle the highest rated drive that we currently produce. The top OIB board on the OIBB is for the 'A' devices, the middle OIB board on the OIBB is for the 'B' devices, and the bottom OIB board on the OIBB is for the 'C' devices.

Figure 123 - Optical Interface Base Board (OIBB)



Each OIB also has input RX7 for a signal from a Temperature Feedback Board. The quantity and location of thermistor connections is dependent on the drive configuration. Typically there is one temperature sensor from the Line Converter and one temperature sensor from the Machine Converter, each going into the respective OIB in the 'A' position. However some drive configurations only require one thermistor feedback connection. The temperature feedback connection on OIBC is not implemented on the OIBB and is never used. For more information, see the drawings supplied with your drive. The alarm and trip set points for each of these signals is programmable in software.

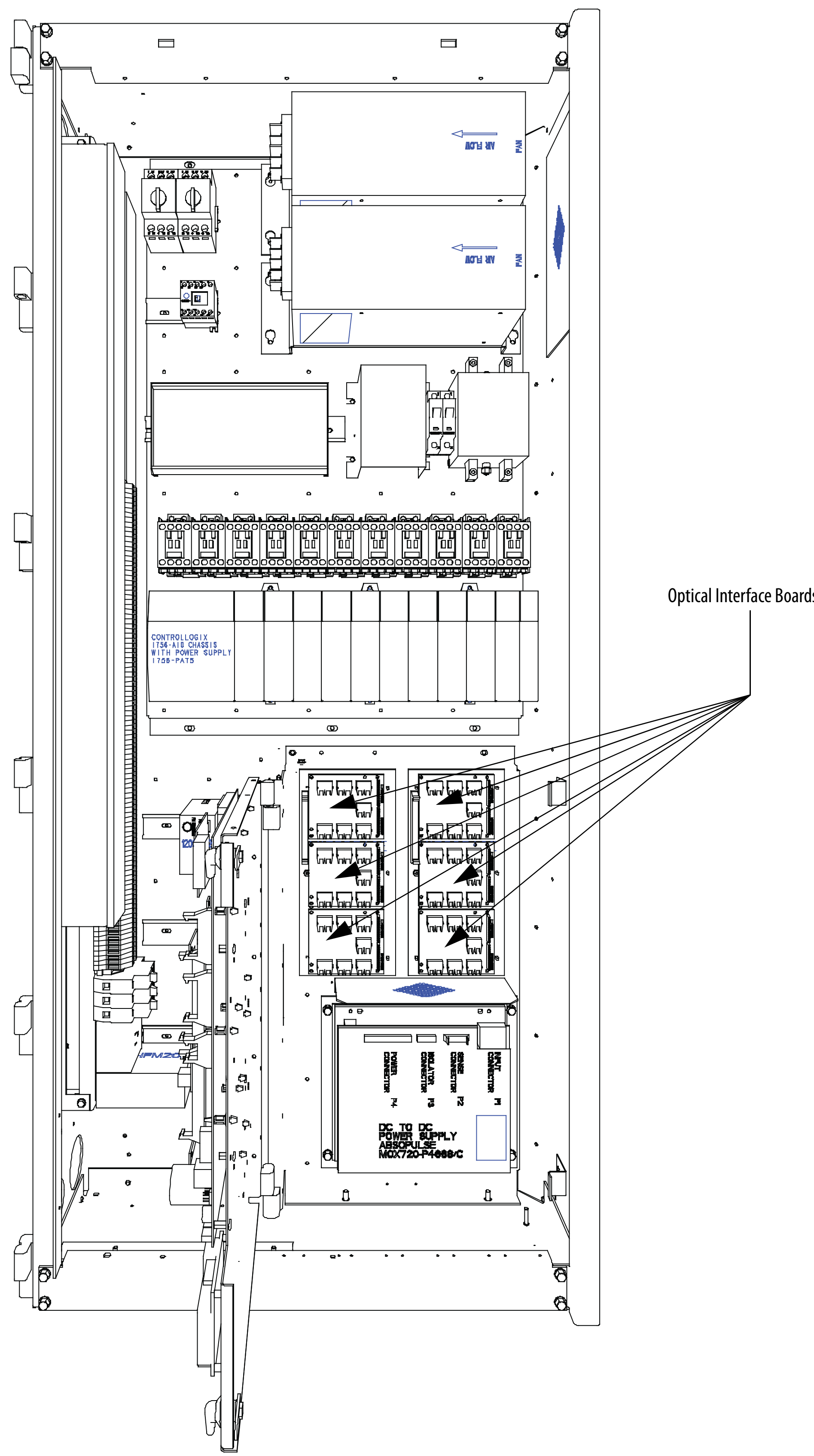
There are three LEDs on the OIB, and the following table illustrates the status and description for the LED states:

LED	Status	Description
D1	Red – On	Run – The OIB has received an Enable signal. The drive control software is in control of all gating.
D2	Yellow – On	Ready –The OIB power supply is sufficient for proper operation.
D3	Green – On	Power – The OIB has received a voltage signal greater than 2V.

Optical Interface Board Replacement

1. Ensure that all medium voltage and control voltage power to the drive is isolated and locked out.
2. Note and mark the location and orientation of all the fiber optic cables. Use the electrical drawing for reference.
3. Using your static strap, disconnect all of the connections. It may be necessary to remove the 60 core cable connectors on the Optical interface base and the ground connection for access to the standoffs
4. Remove the OIB board from the OIBB. There are four standoffs that snap into place on the OIB, and they need to be carefully handled when disconnecting the boards. There is also the 28-pin connection between the boards, and this connection should be handled carefully as you do not want to bend the pins.
5. Install the new OIB on the OIBB. Ensure the standoffs snap into place.
6. Reconnect all fiber optic connections and verify the locations.
7. Apply Low Voltage power and complete a Gating Test, System Test and Medium Voltage tests to ensure the new board functions properly.

Figure 124 - OIB Replacement (Mounting Plate Accessible)



Notes:

Commissioning

Start-up Commissioning Services

Start-up will be performed at the customer's site. Rockwell Automation requests a minimum of four weeks notice to schedule each start-up.

The standard Rockwell Automation work hours are between 9:00 AM to 5:00 PM EST, (8 hr/day) Monday through Friday, not including observed holidays. Additional working hours are available on a time and material basis.

Rockwell Automation recommends the following:

Drive Commissioning

1. A pre-installation meeting/conference call with the customer to review:
   - The Rockwell Automation Start-up Plan
   - The Start-up Schedule
   - The Drive(s) installation requirements
2. Inspect the drive's mechanical and electrical devices.
3. Perform a tug test on all internal connections within the drive and verify wiring.
4. Verify critical mechanical connections for proper torque requirements.
5. Verify and adjust mechanical interlocks for permanent location.
6. Confirm all inter-sectional wiring is connected properly.
7. Re-verify control wiring from any external control devices such as PLCs, etc.
8. Confirm cooling system is operational.
9. Verification of proper phasing from isolation transformer to drive.
10. Confirm cabling of drive to motor, isolation transformer and line feed.
11. Collect test reports indicating megger / hipot test has been performed on line and motor cables.
12. Control power checks to verify all system inputs such as starts/stops, faults, and other remote inputs.
13. Apply medium voltage to the drive and perform operational checks.
14. Bump motor and tune drive to the system attributes. (If the load is unable to handle any movement in the reverse direction the load should be uncoupled prior to bumping the motor for directional testing).

15. Run the drive motor system throughout the operational range to verify proper performance.

Please Note: Customer personnel will be required on-site to participate in the start-up of the system.

Catalog Number Explanation

			Position			
1	2	3	4	5	6	7
7000A	A	40	D	A	RPDTD	1–...etc.
a	b	c	d	e	f	Refer to Price List.

a

Bulletin Number

Code	Description
7000A	"A" Frame (Air-cooled)
7000	"B" Frame (Air-cooled)
7000L	"C" Frame (Liquid-cooled)

b

Service Duty/Altitude Code

Code	Description
A	Normal Duty, 0...1000 m Altitude. Maximum 40 °C Ambient
B	Normal Duty, 1001...5000 m Altitude Reduced Ambient (from 40 °C offering) 1001...2000 m = 37.5 °C 2001...3000 m = 35 °C 3001...4000 m = 32.5 °C 4001...5000 m = 30 °C
C	Heavy Duty, 0...1000 m Altitude. Maximum 40 °C Ambient
D	Heavy Duty, 0...5000 m Altitude. Reduced Ambient (from 40 °C offering) – same as "B" code above
E	Normal Duty, 0...1000 m Altitude. Maximum 35 °C Ambient
F	Normal Duty, 1001...5000 m Altitude Reduced Ambient (from 35 °C offering) 1001...2000 m = 32.5 °C 2001...3000 m = 30 °C 3001...4000 m = 27.5 °C 4001...5000 m = 25 °C
G	Heavy Duty, 0...1000 m Altitude. Maximum 35 °C Ambient
J	Normal Duty, 0...1000 m Altitude. Maximum 50 °C Ambient
L	Heavy Duty, 0...1000 m Altitude. Maximum 50 °C Ambient
N	Normal Duty, 0...1000 m Altitude. Maximum 20 °C Ambient
Z	Custom Configuration (Contact Factory)

c

Current Rating[1]

Code	Desc.	Code	Desc.	Code	Desc.
40	40 Amp	70	70 Amp	120	120 Amp
46	46 Amp	81	81 Amp	140	140 Amp
53	53 Amp	93	93 Amp	160	160 Amp
61	61 Amp	105	105 Amp	185	185 Amp

c (cont'd)

Current Rating[1]

Code	Desc.	Code	Desc.	Code	Desc.
215	215 Amp	375	375 Amp	625	625 Amp
250	250 Amp	430	430 Amp	657	657 Amp
285	285 Amp	495	495 Amp	720	720 Amp
325	325 Amp	575	575 Amp		

(1) Not all amperages are available at all ambient/altitude configurations. Refer to Price List for exact offering.

d

Enclosure Type

Code	Description
D	Type 1 w/gasket (IP21)
T	Type 1 w/gasket (IP21) – Seismic rated
K	Type 12 w/vents and filters (IP42)
U	Type 12 w/vents and filters (IP42) – Seismic rated

e

Line and Control Voltages

See Table 11 on page 162.

f

Rectifier Configuration/Line Impedance Type

Code	Description
RPDTD	AFE Rectifier with Integral Line Reactor and Direct-to-Drive DC Link
RPTX	AFE Rectifier with provision for connection to separate Isolation Transformer (standard DC Link)
RPTXI	AFE Rectifier with integral Isolation Transformer (standard DC Link)
R18TX	18 Pulse Rectifier with provision for connection to separate Isolation Transformer (standard DC Link)

Table 11 - Supply Voltage, Control Voltage, Frequency and Control Power Transformer Selection

Voltage		Frequency (Hz)	Modification Number	
Nominal Line	Control		With a C.P.T. (1)	Without a C.P.T. (2)
2400	120	60	A	AD
	120…240		AA	—
3300	110	50	CY	CDY
	220		CP	CDP
4160	110	50	EY	EDY
	220		EP	EDP
	120	60	E	ED
	120…240		EA	—
6600	110	50	JY	JDY
	220		JP	JDP
	110…220		JAY	—

(1) A Control Power Transformer modification must be selected (6, 6B…etc.) to size the transformer

(2) A Control Circuit Power is supplied to separate/external source.

PowerFlex 7000 Drive Selection Explanation

The PowerFlex 7000 medium voltage AC drive selection tables are based on two types of drive service duty ratings:

1. **Normal Duty (110% overload for one minute, once every ten minutes)** – used for Variable Torque (VT) applications only.

   Drives with this rating are designed for 100% continuous operation, with 110% overload for one minute, once every ten minutes.

2. **Heavy Duty (150% overload for one minute, once every ten minutes)** – used for Constant Torque (CT) applications only.

   Drives with this rating are designed for 100% continuous operation with 150% overload for one minute, once every ten minutes.

Service Duty Rating, Continuous Current Rating and Altitude Rating Code

There are different codes that define service duty and altitude in the drive catalog number (see Catalog Number Explanation on page 161).

EXAMPLE	Catalog number 7000A – A105DED-RPDTD, has a continuous current rating of 105 A, with a "normal duty" service rating up to 1000 m altitude. Catalog number 7000A – B105DED-RPDTD has a continuous rating of 105 A with a "normal duty" service rating up to 5000 m altitude. The ambient temperature rating is reduced at higher altitudes. If 40 °C ambient is required at 1001…5000 m altitude, a rating code of Z is required.

Preventative Maintenance Schedule

Preventative Maintenance Checklist

The preventive maintenance activities on the PowerFlex 7000 Air-Cooled Drive ("A" Frame or "B" Frame) can be broken down into two categories:

- Operational Maintenance – can be completed while the drive is running.
- Annual Maintenance – should be completed during scheduled downtime.

Refer to the Tools/Parts/Information Requirements at the end of this section for a list of documentation and materials needed to properly complete the preventive maintenance documents.

Operational Maintenance

This process really involves only one task: Changing or Cleaning the Air Filters. The PowerFlex 7000 drives require consistent, unrestricted airflow to keep the power devices cool. The air filter is the main source of blockage in the air path.

The drive will provide an air filter alarm whenever the pressure differential across the devices drops to a drive-specific level. Referring to the Air Filter Block parameter, this can be anywhere from 7…17% blocked, depending on the heat sink and device configuration. This may seem like a small number, but it takes significant blockage to begin to lower the voltage from the pressure sensor. The percentage is a measure of voltage drop, and should not be viewed as a percentage of the opening that is covered. They are not related linearly.

Once you receive an Air Filter Warning, you should immediately make plans to change or clean the filter. You should still have days or weeks until the drive reaches an Air Filter Fault, but this is dependent on site-specific particle conditions.

Annual Maintenance

These maintenance tasks should be performed on an annual basis. These are recommended tasks, and depending on the installation conditions and operating conditions, you may find that the interval can be lengthened. For example, we do not expect that torqued power connections will require tightening every year. Due to the critical nature of the applications run on MV drives, the key word is preventive. Investing approximately 8.0 hr/yr on these tasks is time well spent in adding insurance against unexpected downtime.

Initial Information Gathering

Some of the important information to be recorded includes:

- Print Drive Setup
- Print Fault/Warning Queues
- Save Parameters to NVRAM
- Save Parameters to Operator Interface
- Circuit Board Part Numbers / Serial Numbers / Revision Letters (This only needs to be recorded if parts have been modified or changed since the last Preventive Maintenance activities)

WARNING: To prevent electrical shock, ensure the main power has been disconnected before working on the drive. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

Physical Checks (NO Medium Voltage and NO Control Power)

1. Power Connection Inspection
   - Inspect PowerFlex 7000 drive, input/output/bypass contactor sections, and all associated drive components for loose power cable connections and ground cable connections: torque them to the required torque specifications.
   - Inspect the bus bars and check for any signs of overheating / discoloration and tighten the bus connections to the required torque specifications.
   - Clean all cables and bus bars that exhibit dust build-up.
   - Use torque sealer on all connections.
2. Carry out the integrity checks on the signal ground and safety grounds.
3. Check for any visual/physical evidence of damage and/or degradation of components in the low voltage compartments.
   - This includes Relays, Contactors, Timers, Terminal connectors, Circuit breakers, Ribbon cables, Control Wires, etc.; Causes could be corrosion, excessive temperature, or contamination.
   - Clean all contaminated components using a vacuum cleaner (DO NOT use a blower), and wipe clean components where appropriate.
4. Check for any visual/physical evidence of damage and/or degradation of components in the medium voltage compartments (inverter/rectifier, cabling, DC Link, contactor, load break, harmonic filter, etc).
   - This includes main cooling fan, power devices, heatsinks, circuit boards, insulators, cables, capacitors, resistors, current transformers, potential transformers, fuses, wiring, etc.; Causes could be corrosion, excessive temperature, or contamination.

- Verify torque on heatsink bolts (electrical connections to bullet assemblies) is within specifications (13.5 N•m).
- Clean all contaminated components using a vacuum cleaner and wipe clean components where appropriate.

IMPORTANT	Do not use a blower.

- Note: An important component to check for contamination is the heatsink. The fine grooves in the aluminum heatsinks can capture dust and debris.

5. Carry out the physical inspection and verification for the proper operation of the contactor/isolator interlocks, and door interlocks.
   - Carry out the physical inspection and verification for the proper operation of the key interlocks.
   - Physical verification of the additional cooling fans mounted in the AC Line Reactor cabinet, Harmonic Filter cabinet for mounting and connections.
   - Carry out the cleaning of the fans and ensure that the ventilation passages are not blocked and the impellers are freely rotating without any obstruction.
   - Carry out the insulation meggering of the drive, motor, isolation transformer/line reactor, and the associated cabling.
   - Refer to page 179 for meggering procedure.
   - Check clamp head indicator washers for proper clamp pressure, and adjust as necessary.

     Refer to page 82 and page 83 for details on proper clamp pressure.

Control Power Checks (No Medium Voltage)

1. Apply Control power to the PowerFlex drive, and test power to all of the vacuum contactors (input, output, and bypass) in the system, verifying all contactors can close and seal in.
2. Refer to Publication 1502-UM050_-EN-P for a detailed description of all contactor maintenance.
3. Verify all single-phase cooling fans for operation.
4. This includes the cooling fans in the AC/DC Power supplies and the DC/DC converter.
5. Verify the proper voltage levels at the CPT (if installed), AC/DC Power Supplies, DC/DC converter, isolated gate power supply boards.
   - Refer to page 159 for appropriate procedures/voltage levels for the above checks.

6. Verify the proper gate pulse patterns using Gate Test Operating Mode.

   For drives with SPS boards installed, use the Test Power Harness (80018-695-51) to power the rectifier SGCT boards.

7. If there have been any changes to the system during the outage, place the drive in System Test Operating Mode and verify all functional changes.

Final Power Checks before Restarting

1. Ensure all cabinets are cleared of tools, and all component connections are back in place and in the running state.
2. Put all equipment in the normal operating mode, and apply medium voltage.
3. If there were any input or output cables removed, verify the input phasing, and bump the motor for rotation.
4. If there were any changes to the motor, input transformer, or associated cabling, you will have to re-tune the drive to the new configuration using Autotuning.
5. Save all parameter changes (if any) to NVRAM.
6. Run the application up to full speed/full load, or to customer satisfaction.
7. Capture the drive variables while running, in the highest access level if possible.

Additional Tasks During Preventive Maintenance

1. Investigation of customer's concerns relating to drive performance
   - Relate any problems found during above procedures to customer issues.
2. Informal instruction on drive operation and maintenance for plant maintenance personnel
   - Reminder of safety practices and interlocks on MV equipment, and on specific operating concerns
   - Reminder of the need to properly identify operating conditions
3. Recommendation for critical spare parts which should be stocked in-plant to reduce production downtime
   - Gather information on all spare parts on site, and compare that with factory-recommended critical spares to evaluate whether levels are sufficient.
   - Contact MV Spare Parts group for more information.
4. Vacuum Bottle Integrity Testing using a Vacuum Checker or AC Hipot
   - Refer to Publication 1502-UM050_-EN-P for a detailed description of all contactor maintenance.

Final Reporting

1. A complete, detailed report on all steps in the Preventive Maintenance procedures should be recorded to identify changes.
   - A completed copy of this checklist should be included.
   - A detailed description of all adjustments and measurements that were taken during the process should be included in an addendum (Interlock Adjustments, Loose Connections, Voltage Readings, Megger Results, Parameters, etc.).
2. This information should be communicated to MV Product Support so future support activities have the latest site information available.
   - This can be faxed to (519) 740-4756 or
     e-mailed to MVSupport_Technical@ra.rockwell.com.

Time Estimations

Operational Maintenance	0.5 hours per filter
Annual Maintenance	
• Initial Information Gathering	0.5 hours
• Physical Checks	
– Torque Checks	2.0 hours
– Inspection	2.0 hours
– Cleaning(1)	2.5 hours(1)
– Meggering	1.5 hours
• Control Power Checks	
– Contactor Adjustments(1)	2.0 hours(1)
– Voltage Level Checks	1.0 hour
– Firing Check	0.5 hours
– System Test(1)	2.0 hours(1)
• Medium Voltage Checks	
– Final Inspection	0.5 hours
– Phasing Check(1)	1.5 hours(1)
– Autotuning(1)	2.0 hours(1)
– Operation to Maximum Load	Site Dependent
• Additional Tasks(1)	
– Investigation	Varies with nature of Problem
– Informal Training/Refresher	2.0 hours
– Spare Parts Analysis	1.0 hour
– Vacuum Bottle Integrity Check	3.0 hours
• Final Report	3.0 hours

(1) Time may not be required depending on the nature of the maintenance and the condition of the drive system. These times are only estimations.

Tool / Parts / Information Requirements

The following is a list of the tools recommended for proper maintenance of the PowerFlex 7000 drives. Not all of the tools may be required for a specific drive preventive procedure, but if we were to complete all of the tasks listed above the following tools would be required.

Tools

- 100 MHz Oscilloscope with minimum 2 Channels and memory
- 5 kV DC Megger
- Digital Multimeter
- Torque Wrench
- Laptop Computer with Relevant Software and Cables

- Assorted Hand Tools (Screwdrivers, Open Ended Metric Wrenches, Metric Sockets, etc.)
- 5/16 Allen Keys
- Speed Wrench
- Feeler Gauge
- Vacuum Bottle Checker or AC-Hipot
- Minimum of 15 kV Hotstick / Potential Indicator
- Minimum of 10 kV Safety Gloves
- Vacuum Cleaner with Anti-static hose
- Anti-static Cleaning Cloth
- No. 30 Torx Driver

Documentation

- PowerFlex 7000 Parameters Manual – Publication 7000-TD002_-EN-P
- 400A Vacuum Contactor Manual – Publication 1502-UM050_-EN-P
- Drive-Specific Electrical and Mechanical Prints
- Drive-Specific Spare Parts List

Materials

- Torque Sealer (Yellow) Part number --- RU6048
- Electrical Joint Compound ALCOA EJC No. 2 or approved equivalent (For Power Devices)
- Aeroshell no. 7 Part number 40025-198-01 (for Vacuum Contactors)

PowerFlex 7000 Maintenance Schedule

Rockwell recognizes that following a defined maintenance schedule will deliver the maximum product availability. By rigorously following this maintenance schedule, the Customer can expect the highest possible uptime. This Annual Preventative Maintenance Program includes a visual inspection of all drive components visible from the front of the unit, resistance checks on the power components, power supply voltage level checks, general cleaning and maintenance, checking of all accessible power connections for tightness, and other tasks. For more details, please refer to Chapter 5 (Component Definition and Maintenance) of this User Manual.

I – Inspection

This indicates that the component should be inspected for signs of excessive accumulation of dust/dirt/etc. or external damage (e.g. looking at Filter Capacitors for bulges in the case, inspecting the heatsinks for debris clogging the air flow path, etc.).

M – Maintenance

This indicates a maintenance task that is outside the normal preventative maintenance tasks, and can include the inductance testing of Line Reactors/DC Links, or the full testing of an isolation transformer.

R – Replacement

This indicates that the component has reached its mean operational life, and should be replaced to decrease the chance of component failure. It is very likely that components will exceed the design life in the drive, and that is dependent on many factors such as usage, heating, etc.

C – Cleaning

This indicates the cleaning of a part that can be reused, and refers specifically to the door-mounted air filters in the liquid-cooled drives and some air-cooled drives.

Rv – Review

This refers to a discussion with Rockwell Automation to determine whether any of the enhancements/changes made to the Drive Hardware and Control would be valuable to the application.

RFB/R – Refurbishment/Replacement

The parts can be refurbished at lower cost OR the parts can be replaced with new ones.

PowerFlex 7000 Preventative Maintenance Service Schedule

	Interval Period (in years)	0	1	2	3	4	5	6	7	8	9	10
	Commissioning Activities	S										
Air-Cooling System ❶	Door Mounted Air Filters ❷❽	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R
	Main Cooling Fan Motor		I	I	I	I	I	I	RFB/R	I	I	I
	Redundant Cooling Fan Motor (if supplied)		I	I	I	I	I	I	RFB/R	I	I	I
	Small Aux. Cooling Fans “Caravel”		I	I	I	I	R	I	I	I	I	R
Liquid-Cooling System ❸	Mesh Filters ❽	C	C	C	C	C	C	C	C	C	C	C
	De-ionizing Filter Cartridge ❽	R	R	R	R	R	R	R	R	R	R	R
	All Fittings/Connections/Hose Clamps		I	I	I	I	I	I	I	I	I	I
	Redundant Cooling Pump Motors/Pumps		I	I	I	I	I	I	I	I	I	I
	Redundant Cooling Pump Motor Seals		I	I	I	I	I	I	I	I	I	R
	Thermostatic Valve Element		I	I	I	I	I	I	R	I	I	I
Power Switching Components	Power Devices (SGCTs/SCRs)		I	I	I	I	I	I	I	I	I	I
	Snubber Resistors/Sharing Resistors/HECS		I	I	I	I	I	I	I	I	I	I
	Rectifier Snubber Capacitors		I	I	I	I ❹	I	I	I	I ❹	I	Rv/R ❹
	Inverter Snubber Capacitors		I	I	I	I	I	I	I	I	I	R
	Integrated Gate Driver Power Supply		I	I	I	I	RFB/R	I	I	I	I	RFB/R
	Self-Powered SGCT Power Supply (SPS)		I	I	I	I	RFB/R	I	I	I	I	RFB/R
Integral Magnetics/Power Filters	Isolation Transformer/Line Reactor		I	I	I	I	M	I	I	I	I	M
	DC Link/Common Mode Choke		I	I	I	I	M	I	I	I	I	M
	Line/Motor Filter Capacitors		I	I	I	I	M	I	I	I	I	M
Control Cabinet Components	AC/DC and DC/DC Power Supplies		I	I	I	I	RFB/R	I	I	I	I	RFB/R
	Control Boards		I	I	I	I	I	I	I	I	I	I
	Batteries (DCBs and CIB)		I	I	R	I	I	R	I	I	R	I
	Battery Module (UPS) ❺		I	I	I	I	R	I	I	I	I	R
Connections	Low Voltage Terminal Connections/ Plug-in Connections		I	I	I	I	I	I	I	I	I	I
	Medium Voltage Connections		I	I	I	I	I	I	I	I	I	I
	Heatsink Bolted Connections		I	I	I	I	I	I	I	I	I	I
	Medium Voltage Connections (Rectifier) ❻		–	–	–	I ❹	–	–	–	I ❹	–	I ❹
	Medium Voltage Connections (Inverter) ❼		–	–	–	–	–	–	–	–	–	I
Enhancements	Firmware		–	–	Rv	–	–	Rv	–	–	Rv	–
	Hardware		–	–	Rv	–	–	Rv	–	–	Rv	–
Operational Conditions	Parameters		I	I	Rv	I	I	Rv	I	I	Rv	I
	Variables		I	I	Rv	I	I	Rv	I	I	Rv	I
	Application Concerns		I	I	Rv	I	I	Rv	I	I	Rv	I
Spare Parts	Inventory/Needs		I	I	Rv	I	I	Rv	I	I	Rv	I

❶ Only applies to air-cooled VFDs (i.e. ‘A’ Frame and ‘B’ Frame)
❷ If filter supplied is not a washable type, replace filter. If filter supplied is a washable type, wash or replace (depending on state of filter).
❸ Only applies to liquid-cooled VFDs (i.e. ‘C’ Frame)
❹ A 4 year replacement interval applied to all 6-pulse and 18-pulse rectifier versions with previously available rectifier snubber capacitors. Snubber capacitors now available extend the replacement period of “B” and “C” frames to 10 years (replacement period for “A” Frames remain at 4 years) – contact Cambridge for details and to purchase extended life snubber capacitors. Active Front End rectifiers have a 10 year rectifier snubber capacitor replacement interval.
❺ Replace UPS battery module yearly for 50°C rated VFDs.
❻ When rectifier snubber capacitors are replaced, the MV connections for rectifier need to be inspected.
❼ When inverter snubber capacitors are replaced, the MV connections for inverter need to be inspected.
❽ These components may be serviced while the VFD is running.

	Interval Period (in years)	11	12	13	14	15	16	17	18	19	20
	Commissioning Activities										
Air-Cooling System ❶	Door Mounted Air Filters ❷❽	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R
	Main Cooling Fan Motor	I	I	I	RFB/R	I	I	I	I	I	I
	Redundant Cooling Fan Motor (if supplied)	I	I	I	RFB/R	I	I	I	I	I	I
	Small Aux. Cooling Fans "Caravel"	I	I	I	I	R	I	I	I	I	R
Liquid-Cooling System ❸	Mesh Filters ❽	C	C	C	C	C	C	C	C	C	C
	De-ionizing Filter Cartridge ❽	R	R	R	R	R	R	R	R	R	R
	All Fittings/Connections/Hose Clamps	I	I	I	I	I	I	I	I	I	I
	Redundant Cooling Pump Motors/Pumps	I	I	I	I	I	I	I	I	I	I
	Redundant Cooling Pump Motor Seals	I	I	I	I	I	I	I	I	I	R
	Thermostatic Valve Element	I	I	I	R	I	I	I	I	I	I
Power Switching Components	Power Devices (SGCTs/SCRs)	I	R	I	I	I	I	I	I	I	I
	Snubber Resistors/Sharing Resistors/HECS	I	I	I	I	I	I	I	I	I	I
	Rectifier Snubber Capacitors	I	I ❹	I	I	I	I ❹	I	I	I	Rv/R ❹
	Inverter Snubber Capacitors	I	I	I	I	I	I	I	I	I	R
	Integrated Gate Driver Power Supply	I	I	I	I	RFB/R	I	I	I	I	RFB/R
	Self-Powered SGCT Power Supply (SPS)	I	I	I	I	RFB/R	I	I	I	I	RFB/R
Integral Magnetics/Power Filters	Isolation Transformer/Line Reactor	I	I	I	I	M	I	I	I	I	M
	DC Link/Common Mode Choke	I	I	I	I	M	I	I	I	I	M
	Line/Motor Filter Capacitors	I	I	I	I	M	I	I	I	I	M
Control Cabinet Components	AC/DC and DC/DC Power Supplies	I	I	I	I	RFB/R	I	I	I	I	RFB/R
	Control Boards	I	I	I	I	I	I	I	I	I	I
	Batteries (DCBs and CIB)	I	R	I	I	R	I	I	R	I	I
	Battery Module (UPS) ❺	I	I	I	I	R	I	I	I	I	R
Connections	Low Voltage Terminal Connections/ Plug-in Connections	I	I	I	I	I	I	I	I	I	I
	Medium Voltage Connections	I	I	I	I	I	I	I	I	I	I
	Heatsink Bolted Connections	I	I	I	I	I	I	I	I	I	I
	Medium Voltage Connections (Rectifier) ❻	–	I ❹	–	–	–	I ❹	–	–	–	I ❹
	Medium Voltage Connections (Inverter) ❼	–	–	–	–	–	–	–	–	–	I
Enhancements	Firmware	–	Rv	–	–	Rv	–	–	Rv	–	–
	Hardware	–	Rv	–	–	Rv	–	–	Rv	–	–
Operational Conditions	Parameters	I	Rv	I	I	Rv	I	I	Rv	I	I
	Variables	I	Rv	I	I	Rv	I	I	Rv	I	I
	Application Concerns	I	Rv	I	I	Rv	I	I	Rv	I	I
Spare Parts	Inventory/Needs	I	Rv	i	I	Rv	I	I	Rv	I	I

❶ Only applies to air-cooled VFDs (i.e. 'A' Frame and 'B' Frame)
❷ If filter supplied is not a washable type, replace filter. If filter supplied is a washable type, wash or replace (depending on state of filter).
❸ Only applies to liquid-cooled VFDs (i.e. 'C' Frame)
❹ A 4 year replacement interval applied to all 6-pulse and 18-pulse rectifier versions with previously available rectifier snubber capacitors. Snubber capacitors now available extend the replacement period of "B" and "C" frames to 10 years (replacement period for "A" Frames remain at 4 years) – contact Cambridge for details and to purchase extended life snubber capacitors. Active Front End rectifiers have a 10 year rectifier snubber capacitor replacement interval.
❺ Replace UPS battery module yearly for 50°C rated VFDs.
❻ When rectifier snubber capacitors are replaced, the MV connections for rectifier need to be inspected.
❼ When inverter snubber capacitors are replaced, the MV connections for inverter need to be inspected.
❽ These components may be serviced while the VFD is running.

General Notes

Maintenance of Medium Voltage Motor Control Equipment

ATTENTION: Servicing energized Medium Voltage Motor Control Equipment can be hazardous. Severe injury or death can result from electrical shock, bump, or unintended actuation of controlled equipment. Recommended practice is to disconnect and lockout control equipment from power sources, and release stored energy, if present.

For countries following NEMA standards, refer to National Fire Protection Association Standard No. NFPA70E, Part II and (as applicable) OSHA rules for Control of Hazardous Energy Sources (Lockout/Tagout) and OSHA Electrical Safety Related Work Practices safety related work practices, including procedural requirements for lockout-tagout, and appropriate work practices, personnel qualifications and training requirements, where it is not feasible to de-energize and lockout or tagout electric circuits and equipment before working on or near exposed circuit parts.

For countries following IEC standards, refer to local codes and regulations.

Periodic Inspection

Medium Voltage Motor control equipment should be inspected periodically. Inspection intervals should be based on environmental and operating conditions and adjusted as indicated by experience. An initial inspection within 3 to 4 months after installation is suggested. Refer to the following standards for general guidelines for setting-up a periodic maintenance program.

For countries following NEMA standards, refer to National Electrical Manufacturers Association (NEMA) Standard No. ICS 1.1 (Safety Guidelines for the Application, Installation, and Maintenance of Solid-Sate Control) for MV Drives and ICS 1.3 (Preventive Maintenance of Industrial Control and Systems Equipment) for MV Controllers.

For countries following IEC standards, refer to IEC 61800-5-1 Sec. 6.5 for MV Drives and IEC 60470 Sec. 10, IEC 62271-1 Sec. 10.4 for MV Controllers.

Contamination

If inspection reveals that dust, dirt, moisture or other contamination has reached the control equipment, the cause must be eliminated. This could indicate unsealed enclosure openings (conduit or other) or incorrect operating procedures. Replace any damaged or embrittled seals and repair or replace any other damaged or malfunctioning parts (e.g., hinges, fasteners, etc.). Dirty, wet or contaminated control devices must be replaced unless they can be cleaned effectively by vacuuming or wiping. Compressed air is not recommended for cleaning because it may displace dirt, dust, or debris into other parts or equipment, or damage delicate parts.

High Voltage Testing

High voltage insulation resistance (IR) or dielectric withstanding voltage (megger) tests should not be used to check solid-state control equipment. When meggering electrical equipment such as transformers or motors, solid-state devices must be bypassed before performing the test. Even though no damage may be readily apparent after a megger test, the solid-state devices are degraded and repeated application of high voltage can lead to failure.

Maintenance after a Fault Condition

Opening of the short circuit protective device (such as fuses or circuit breakers) in a properly coordinated motor branch circuit is an indication of a fault condition in excess of operating overload. Such conditions can cause damage to medium voltage motor control equipment. Before restoring power, the fault condition must be corrected and any necessary repairs or replacements must be made to restore the medium voltage motor control equipment to good working order. Refer to NEMA Standards Publication No. ICS-2, Part ICS2-302 for procedures. Use only replacement parts and devices recommended by Allen-Bradley to maintain the integrity of the equipment. Ensure the parts are properly matched to the model, series and revision level of the equipment. After maintenance or repair of the equipment, always test the control system for proper functioning under controlled conditions (that avoid hazards in the event of a control malfunction). For additional information, refer to NEMA ICS 1.3, PREVENTIVE MAINTENANCE OF INDUSTRIAL CONTROL AND SYSTEMS EQUIPMENT, published by the National Electrical Manufacturers Association, and NFPA70B, ELECTRICAL EQUIPMENT MAINTENANCE, published by the National Fire Protection Association.

Part-specific Notes

Cooling Fans

Inspect fans used for forced air cooling. Replace any that have bent, chipped, or missing blades, or if the shaft does not turn freely. Apply power momentarily to check operation. If unit does not operate, check and replace wiring, fuse, or fan motor as appropriate. Clean or change air filters as recommended in the Users Manual.

Operating Mechanisms

Check for proper functioning and freedom from sticking or binding. Replace any broken, deformed or badly worn parts or assemblies according to individual product User Manuals. Check for and securely re-tighten any loose fasteners. Lubricate, if specified in individual product instructions. Many devices are factory lubricated. If lubrication during use or maintenance of these devices is needed, it will be specified in their individual product instructions and/or User Manual. Note: Allen-Bradley magnetic starters, contactors and relays are designed to operate without lubrication. Do not lubricate these devices, because oil or grease on the pole faces (mating surfaces) of the operating magnet may cause the device to stick in the "ON" mode.

Contacts

Check contacts for excessive wear and dirt accumulations. Vacuum or wipe contacts with a soft cloth if necessary to remove dirt. Contacts are not harmed by discoloration and slight pitting. Contacts should never be filed, as dressing only shortens contact life. Contact spray cleaners should not be used as their residues on magnet pole faces or in operating mechanisms may cause sticking and can interfere with electrical continuity. Contacts should only be replaced after contact face material has become badly worn. Always replace contacts in complete sets to avoid misalignment and uneven contact pressure.

Vacuum Contactors

Contacts of vacuum contactors are not visible, so contact wear must be checked indirectly. Vacuum bottles should be replaced when:
1. The contactor wear indicator line shows need for replacement, or
2. The vacuum bottle integrity tests show need for replacement.

Replace all vacuum bottles in the contactor at the same time to avoid misalignment and uneven contact wear. If the vacuum battles do not require replacement, check and adjust over-travel to the value listed in the product User Manual.

Power Cable and Control Wire Terminals

Loose connections in power circuits can cause overheating that can lead to equipment malfunction or failure. Loose connections in control circuits can cause control malfunctions. Loose bonding or grounding connections can increase hazards of electrical shock and contribute to electromagnetic interference (EMI). Check the tightness of all terminals and bus bar connections and tighten securely any loose connections. Replace any parts or wiring damaged by overheating, and any broken wires or bonding straps. Refer to the User Manual for torque values required for power cable and bus hardware connections.

Coils

If a coil exhibits evidence of overheating (cracked, melted or burned insulation), it must be replaced. In that event, check for and correct overvoltage or undervoltage conditions, which can cause coil failure. Be sure to clean any residue of melted coil insulation from other parts of the device or replace such parts.

Batteries

Replace batteries periodically as specified in product manual or if a battery shows signs of electrolyte leakage. Use tools to handle batteries that have leaked electrolyte; most electrolytes are corrosive and can cause burns. Dispose of the old battery in accordance with instructions supplied with the new battery or as specified in the product manual.

Pilot Lights

Replace any burned out lamps or damaged lenses. Do not use solvents or cleaning agents on the lenses.

Solid-State Devices

ATTENTION: Use of other than factory recommended test equipment for solid-state controls may result in damage to the control or test equipment or unintended actuation of the controlled equipment. Refer to paragraph titled HIGH VOLTAGE TESTING.

Solid-state devices require little more than a periodic visual inspection. Discolored, charred or burned components may indicate the need to replace the component or circuit board. Necessary replacements should be made only at the PC board or plug-in component level. Printed circuit boards should be inspected to determine whether they are properly seated in the edge board connectors. Board locking tabs should also be in place. Solid-state devices must also be protected from contamination, and cooling provisions must be maintained – refer to paragraphs titled CONTAMINATION and COOLING DEVICES. Solvents should not be used on printed circuit boards.

Locking and Interlocking Devices

Check these devices for proper working condition and capability of performing their intended functions. Make any necessary replacements only with Allen-Bradley renewal parts or kits. Adjust or repair only in accordance with Allen-Bradley instructions found in the product User Manuals.

Torque Requirements

Torque Requirements for Threaded Fasteners

Unless otherwise specified the following values of torque are to be used in maintaining the equipment.

Table 12 - Torque Requirements

Diameter	Pitch	Material	Torque (N•m)	Torque (lb•ft)
M2.5	0.45	Steel	0,43	0.32
M4	0.70	Steel	1,8	1.3
M5	0.80	Steel	3,4	2.5
M6	1.00	Steel	6,0	4.4
M8	1.25	Steel	14	11
M10	1.50	Steel	29	21
M12	1.75	Steel	50	37
M14	2.00	Steel	81	60
¼ “	20	Steel S.A.E. 5	12	9.0
3/8”	16	Steel S.A.E. 2	27	20

Notes:

Meggering

Drive Meggering

When a ground fault occurs, there are three zones in which the problem may appear: input to the drive, the drive, output to the motor. The ground fault condition indicates a phase conductor has found a path to ground. Depending on the resistance of the path to ground, a current with magnitude ranging from leakage to fault level exists.   Based on our experiences in drive systems, the highest probability for the source of the fault exists in either the input or output zones. The drive itself rarely has been a source of a ground fault when it is properly installed. This is not to say there will never be any ground fault problems associated with the drive, but the chances are the fault is outside of the drive. Also, the procedure for meggering the drive is more complex than meggering outside the drive.

With these two factors, it is recommended to first megger the input and output zones when encountering a ground fault. If the location of the ground fault can not be located outside the drive, the drive will need to be meggered. This procedure must be performed with due care as the hazards to drive exist if the safety precautions in the procedure are not followed. This is due to the fact the megger procedure applies high voltage to ground: all the control boards in the drive have been grounded and if not isolated, they will have high potential applied to them causing immediate damage.

Meggering the PowerFlex 7000A

ATTENTION: Use caution when performing a Megger test. High voltage testing is potentially hazardous and may cause severe burns, injury or death. Where appropriate, the cause of the test equipment should be connected to ground.

It is recommended that the insulation levels be checked before energizing power equipment. Performing a Megger test will provide a resistance measurement from the phase to phase and phase to ground by applying a high voltage to the power circuitry. This test is performed to detect ground faults without damaging any equipment.

This test is performed by floating the drive and all connected equipment to a high potential while measuring the leakage current to ground. Floating the drive implies temporary removal of any existing paths to ground necessary for normal operation of the drive.

ATTENTION: There exists the possibility of serious or fatal injury to personnel if safety guidelines are not followed.

The following procedure details how the Megger test on the PowerFlex 7000A is to be performed. Failure to comply with this procedure may result in poor Megger reading and damage to drive control boards.

Equipment Required

- Torque Wrench and 7/16 in. socket
- Phillips Screwdriver
- 2500/5000V Megger

Isolate and Lock Out the Drive System from High Voltage

Disconnect any incoming power sources, medium voltage sources should be isolated and locked out and all control power sources should be turned off at their respective circuit breaker(s).

Verify with a potential indicator that power sources have been disconnected, and that the control power in the drive is de-energized.

Isolate the Power Circuit from System Ground (Float the drive)

It is necessary to remove the grounds on the following components within the drive (Refer to the electrical diagrams provided with the equipment to assist in determining the points which need to be disconnected):

- Voltage Sensing Boards (VSB)
- Output Grounding Network (OGN)

Voltage Sensing Boards

Remove all ground connections from all of the VSBs in the drive. This has to be done at the screw terminals on the VSB rather than the ground bus. There are two grounds on each board marked “GND 1”, and “GND 2”.

Note: It is important to disconnect the terminals on the boards rather than from the ground bus as the grounding cable is only rated for 600 V. Injecting a high voltage on the ground cable will degrade the cable insulation. Do not disconnect the white medium voltage wires from the VSBs. They must be included in the test.

The number of VSBs installed in each drive varies depending on the drive configuration.

Output Grounding Network

Remove the ground connection on the OGN (if installed). This connection should be lifted at the OGN capacitor rather than the grounding bus as the grounding cable is only rated for 600V.

Note: Injecting a high voltage on the ground cable during a Megger test will degrade the cable insulation.

Disconnect Connections between Power Circuit and Low Voltage Control

Voltage Sensing Boards

The connections between the low voltage control and the power circuit are made through ribbon cable connectors. The cables will be plugged into connectors on the Voltage Sensing Board marked "J1", "J2", and "J3", and terminate on the Signal Conditioning Boards. Every ribbon cable connection made on the VSBs should be marked for identification from the factory. Confirm the marking matches the connections, and disconnect the ribbon cables and move them clear of the VSB. If these ribbon cables are not removed from the VSB, then high potential will be applied directly to the low voltage control through the SCBs, and cause immediate damage to those boards.

Note: The VSB ribbon cable insulation is not rated for the potential applied during a Megger test. It is important to disconnect the ribbon cables at the VSB rather than the SCB to avoid exposing the ribbon cables to high potential.

Potential Transformer Fuses

A Megger test may exceed the rating of potential transformer fusing. Removing the primary fuses from all potential and control power transformers in the system will not only protect them from damage but remove a path from the power circuit back to the drive control.

Transient Suppression Network

A path to ground exists through the TSN network as it has a ground connection to dissipate high energy surges in normal operation. If this ground connection is not isolated the Megger test will indicate a high leakage current reading through this path, falsely indicating a problem in the drive. To isolate this ground path, all fuses on the TSN must be removed before proceeding with the Megger test.

Meggering the Drive

Verify the drive and any connected equipment is clear of personnel and tools prior to commencing the Megger test. Barricade off any open or exposed conductors. Conduct a walk-around inspection before commencing the test.

All three phases on the line and machine sides of the drive are connected together through the DC Link and Snubber Network. Therefore a test from any one of the input or output terminals to ground will provide all the sufficient testing required for the drive.

The Megger must be discharged prior to disconnecting it from the equipment.

Connect the Megger to the drive following the specific instructions for that model. If the Megger has a lower voltage setting (normally 500V or 1000V), apply that voltage for five seconds as a precursor for the higher voltage rating. This may limit the damage if you forgot to remove any grounds. If the reading is very high, apply 5 kV from any drive input or output terminal to ground. Perform a Megger test at 5 kV for one minute and record the result.

The test should produce a reading greater than the minimum values listed below. If the test results produced a value lower than these values start segmenting the drive system down into smaller components and repeat the test on each segment to identify the source of the ground fault. This implies isolating the line side of the drive from the machine side by removing the appropriate cables on the DC Link reactor.

The DC Link reactor may have to be completely isolated from the drive, at which point all four of its power cables must disconnected. It is imperative to ensure the electrical components to be meggered are electrically isolated from ground. Items that may produce lower than expected readings are surge capacitors at the motor terminals, motor filter capacitors at the output of the drive. The meggering procedure must follow a systematic segmentation of electrical components to isolate and locate a ground fault.

Table 13 - Minimum Megger Values

Type of Drive	Minimum Megger Values
Liquid Cooled Drive	200 M Ohms
Air Cooled Drive	1k M Ohm
Drive with input/output Caps Disconnected	5k M Ohm
Isolation Transformer	5k M Ohm
Motor	5k M Ohm

Note: The motor filter capacitors and line filter capacitors (if applicable) may result in the Megger test result being lower than expected. These capacitors have internal discharge resistors designed to discharge the capacitors to ground. If you are uncertain of the Megger test results disconnect the output capacitors.

IMPORTANT	Humidity and dirty standoff insulators may also cause leakage to ground because of tracking. You may have to clean a 'dirty' drive prior to commencing the Megger test.

Reconnecting Connections between Power Circuit and Low Voltage Control

Reconnect the ribbon cables "J1", J2" and "J3" in all the VSBs. Do not cross the cable connections. Mixing the feedback cables may result in serious damage to the drive.

Reconnect the Power Circuit to the System Ground

Voltage Sensing Boards

Securely reconnect the two ground conductors on the VSBs.

The two ground connections on the VSB provide a reference point for the VSB and enable the low voltage signal to be fed to the SCBs. If the ground conductor was not connected, the monitored low voltage signal could then rise up to medium voltage potential which is a serious hazard that must be avoided at all times. You must always ensure the ground conductors on the VSB are securely connected before applying medium voltage to the drive.

ATTENTION: Failure to connect both ground connections on the voltage sensing board will result in high potential in the Low Voltage cabinet within the drive which will result in damage to the drive control and possible injury or death to personnel.

Output Grounding Network

Reconnect the ground connection on the OGN capacitor. The bolt connection should be torque down to 3.4 N•m (30 lb•in). Exceeding the torque rating of this connection may result in damage to the capacitor.

ATTENTION: Failure to reconnect the OGN ground may result in the neutral voltage offset being impressed on the motor cables and stator, which may result in equipment damage. For drives that did not originally have the OGN connected (or even installed), this is not a concern.

Notes:

Line & Load Cable Sizes

Max. Line Cable Sizes

PRODUCT					INPUT (LINE SIDE)			
Bulletin		Description (V/Freq./Rect.)	Drive rating (A)	Drive Structure Code	Drive Enclosure Opening Inches (mm) [1]	Max. Size & No. Incoming Cables: NEMA [2-4-5-6-8-9]	Max. Size & No. Incoming Cables: IEC [2-4-5-6-8-9]	Vertical Space Avail. for Stress Cones Inches (mm)
'A' Frame (Air-Cooled)	PowerFlex 7000A	2400V/60Hz/RPDTD	46...140	71.9 w/ starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	18.8 (478)
	PowerFlex 7000A	2400V/60Hz/RPDTD	46...140	71.13, 71.18 w/o starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	17.1 (435)
	PowerFlex 7000A	3300V/50Hz/RPDTD	46...140	71.9 w/ starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	18.8 (478)
	PowerFlex 7000A	3300V/50Hz/RPDTD	46...140	71.13, 71.18 w/o starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	17.1 (435)
	PowerFlex 7000A	4160V/50Hz/RPDTD	46...140	71.9 w/ starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	18.8 (478)
	PowerFlex 7000A	4160V/50Hz/RPDTD	46...140	71.13, 71.18 w/o starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	17.1 (435)
	PowerFlex 7000A	4160V/60Hz/RPDTD	46...140	71.9 w/ starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	18-3/8 (467)
	PowerFlex 7000A	4160V/60Hz/RPDTD	46...140	71.13, 71.18 w/o starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	17.1 (435)
	PowerFlex 7000A	6600V/50Hz/RPDTD	40...93	71.10 w/ starter	4.00x4.00 (102x102)	(1) #4/0 8 kV or 15 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	18.8 (478)
	PowerFlex 7000A	6600V/50Hz RPDTD	40...93	71.14, 71.19 w/o starter	4.00x4.00 (102x102)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 8 kV or 15 kV/phase	17.1 (435)
	PowerFlex 7000A	2400V/60Hz/RPTX	46...160	71.7	4.00x8.00 (102x204) [1]	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 5 kV or 8 kV/phase	33.8 (860)
	PowerFlex 7000A	3300V/50Hz/RPTX	46...160	71.7	4.00x8.00 (102x204) [1]	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 8 kV or 15 kV/phase	33.8 (860)
	PowerFlex 7000A	4160/50Hz/RPTX	46...160	71.7	4.00x8.00 (102x204) [1]	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 8 kV or 15 kV/phase	33.8 (860)
	PowerFlex 7000A	4160/60Hz/RPTX	46...160	71.7	4.00x8.00 (102x204) [1]	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 8 kV or 15 kV/phase	33.8 (860)
	PowerFlex 7000A	6600/50Hz/RPTX	40...105	71.8	4.00x8.00 (102x204) [1]	(1) 350MCM 15 kV/phase	(1) 177mm² 15 kV/phase	33.8 (860)
	PowerFlex 7000A	2400V/60Hz/RPTXI	46...160	71.3	4.00x4.00 (102x102)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 5 kV or 8 kV/phase	20.0 (508) [3]
	PowerFlex 7000A	3300V/50Hz/RPTXI	46...160	71.3	4.00x4.00 (102x102)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 5 kV or 8 kV/phase	20.0 (508) [3]
	PowerFlex 7000A	4160V/50Hz/RPTXI	46...140	71.3	4.00x4.00 (102x102)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 5 kV or 8 kV/phase	20.0 (508) [3]
	PowerFlex 7000A	4160V/60Hz/RPTXI	46...160	71.3	4.00x4.00 (102x102)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 5 kV or 8 kV/phase	20.0 (508) [3]
	PowerFlex 7000A	6600V/50Hz/RPTXI	40...105	71.6, 71.15	4.00x4.00 (102x102)	(1) #4/0 8 kV or 15 kV/phase	(1) 177mm² 8 kV or 15 kV/phase	20.0 (508) [3]

PRODUCT					INPUT (LINE SIDE)			
Bulletin		Description (V/Freq./Rect.)	Drive rating (A)	Drive Structure Code	Drive Enclosure Opening Inches (mm) [1]	Max. Size & No. Incoming Cables: NEMA [2-4-5-6-8-9]	Max. Size & No. Incoming Cables: IEC [2-4-5-6-8-9]	Vertical Space Avail. for Stress Cones Inches (mm)
'B' Frame (Air-Cooled)	PowerFlex 7000	2400V/60Hz/RPDTD	46…430	70.40, 70.41, 70.44, 70.45	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/ phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	2400V/60Hz/RPDTD	46…375	70.40C, 70.41C, 70.44C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/ phase	(1) 253mm^2 5kV or 8kV/phase	34.4 (874)
	PowerFlex 7000	3300V/50Hz/RPDTD	46…430	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/ phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	3300V/50Hz/RPDTD	E495-E625, G285, G325, N720	70.32	11.81x16.22 (300x412) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	16.5 (421)
	PowerFlex 7000	3300V/50Hz/RPDTD	46…375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/ phase	(1) 253mm^2 5kV or 8kV/phase	34.4 (874)
	PowerFlex 7000	4160V/50Hz/RPDTD	46…375	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/ phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	4160V/50Hz/RPDTD	46…375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/ phase	(1) 253mm^2 5kV or 8kV/phase	34.4 (874)
	PowerFlex 7000	4160V/60Hz/RPDTD	46…430	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/ phase	(2) 253mm^2 8kV or 15kV/phase	28.5 (725)
	PowerFlex 7000	4160V/60Hz/RPDTD	E495-E625, G285, G325 N720	70.32	11.81x16.22 (300x412) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	16.5 (421)
	PowerFlex 7000	4160V/60Hz/RPDTD	46…375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/ phase	(1) 253mm^2 8kV or 15kV/phase	34.4 (874)
	PowerFlex 7000	6600V/50Hz/RPDTD	46…285	70.46, 70.47, 70.48, 70.49	9.79x10.97 (249x279) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 8kV or 15kV/phase	28.5 (725)
	PowerFlex 7000	6600V/50Hz/RPDTD	E325-E575 G215, G250 N625	70.34, 70.35	12.79x19.68 (325x500) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 8kV or 15kV/phase	16.5 (421)
	PowerFlex 7000	6600V/50Hz/RPDTD	40…285	70.46C, 70.47C, 70.49C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 8kV or 15kV/phase	(1) 253mm^2 8kV or 15kV/phase	34.4 (874)
	PowerFlex 7000	6600V/60Hz/RPDTD	40…285	70.46, 70.47, 70.48, 70.49	9.79x10.97 (249x279) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	6600V/60Hz/RPDTD	40…285	70.46C, 70.47C, 70.49C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 8kV or 15kV/phase	(1) 253mm^2 5kV or 8kV/phase	34.4 (874)
	PowerFlex 7000	2400V/60Hz/RPTX	46…430	70.1, 70.2, 70.25, 70.26	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/ phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	3300V/50Hz/RPTX	46…430	70.10, 70.27, 70.28, 70.30	9.79x10.97 (249x279) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	3300V/50Hz/RPTX	E495-E625 G285, G325 N720	70.32	11.81x16.22 (300x412) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	16.5 (421)
	PowerFlex 7000	4160V/50Hz/RPTX	46…430	70.10, 70.27, 70.29, 70.30	9.79x10.97 (249x279) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	4160V/60Hz/RPTX	46…430	70.2, 70.26, 70.27, 70.28, 70.29, 70.31	9.79x10.97 (249x279) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	4160V/60Hz/RPTX	E495-E625 G285, G325 N720	70.32	11.81x16.22 (300x412) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	16.5 (421)
	PowerFlex 7000	6600V/50Hz/RPTX	40…285	70.11, 70.28, 70.30, 70.31	9.79x10.97 (249x279)[1]	(2) 500MCM 15kV/phase	(2) 127mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	6600V/50Hz/RPTX	E325-E575 G215, G250 N625	70.36, 70.37	12.79x19.68 (325x500)[1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 8kV or 15kV/phase	16.5 (421)

PRODUCT					INPUT (LINE SIDE)			
Bulletin		Description (V/Freq./Rect.)	Drive rating (A)	Drive Structure Code	Drive Enclosure Opening Inches (mm) [1]	Max. Size & No. Incoming Cables: NEMA [2-4-5-6-8-9]	Max. Size & No. Incoming Cables: IEC [2-4-5-6-8-9]	Vertical Space Avail. for Stress Cones Inches (mm)
'C' Frame (Liquid-Cooled)	PowerFlex 7000	2400V/60Hz/RP18TX [7]	46...430	70.8	9.79x21.06 (249x535) [1]	(2) 500MCM 5kV or 8kV/ sec. Winding	(2) 253mm² 5kV or 8kV/sec. Winding	17.7 (449)
	PowerFlex 7000	3300V/50Hz/RP18TX [7]	46...430	70.9	9.79x21.06 (249x535) [1]	(2) 500MCM 8kV or 15kV/sec. Winding	(2) 253mm² 8kV or 15kV/sec. Winding	17.7 (449)
	PowerFlex 7000L	4160V/50Hz/RPDTD	375...575	70.71(L-A), 70.72 (L-L), 70.76 (LA), 70.77 (L-L), 70.89 (L-A), 70.94 (L-L)	11.22x23.62 (285x600) [1]	(4) 500MCM 5 kV or 8 kV/phase	(4) 253mm² 5 kV or 8 kV/phase	18.0 (457)
	PowerFlex 7000L	4160V/60Hz/RPDTD	375...625	70.71(L-A), 70.72 (L-L), 70.76 (LA), 70.77 (L-L)	11.22x23.62 (285x600) [1]	(4) 500MCM 5 kV or 8 kV/phase	(4) 253mm² 5 kV or 8 kV/phase	18.0 (457)
	PowerFlex 7000L	6600V/50Hz/RPDTD	325...575	70.80 (L-A), 70.85 (L-L), 70.86 (L-L), 70.87 (L-L), 70.88 (L-L), 70.91 (L-A), 70.92 (L-A), 70.93 (L-A)	11.22x23.62 (285x600) [1]	(4) 500MCM 8 kV or 15 kV/phase	(4) 253mm² 5 kV or 8 kV/phase	18.0 (457)
	PowerFlex 7000L	6600V/60Hz/RPDTD	325...575	70.80 (L-A), 70.85 (L-L), 70.86 (L-L), 70.87 (L-L), 70.88 (L-L), 70.91 (L-A), 70.92 (L-A), 70.93 (L-A), 70.93 (L-A)	11.22x23.62 (285x600) [1]	(4) 500MCM 8 kV or 15 kV/phase	(4) 253mm² 5 kV or 8 kV/phase	18.0 (457)
	PowerFlex 7000L	4160V/50Hz/R18TX	375...657	70.50 (L-A), 70.55 (L-L)	9.79x21.06 (249x535) [1]	(2) 500MCM 8 kV or 15 kV/s Winding	(2) 253mm² 5 kV or 8 kV/s Winding	17.7 (449)
	PowerFlex 7000L	4160V/60Hz/R18TX	375...657	70.50 (L-A), 70.55 (L-L)	9.79x21.06 (249x535) [1]	(2) 500MCM 8 kV or 15 kV/s Winding	(2) 253mm² 5 kV or 8 kV/s Winding	17.7 (449)
	PowerFlex 7000L	6600V/50Hz/R18TX	375...657	70.50 (L-A), 70.53 (L-A), 70.55 (L-L), 70.58 (L-L)	9.79x21.06 (249x535) [1]	(2) 500MCM 15 kV/s Winding	(2) 177mm² 15 kV/s Winding	17.7 (449)
	PowerFlex 7000L	6600V/60Hz/R18TX	375...657	70.50 (L-A), 70.53 (L-A), 70.55 (L-L), 70.58 (L-L)	9.79x21.06 (249x535) [1]	(2) 500MCM 15 kV/s Winding	(2) 177mm² 15 kV/s Winding	17.7 (449)

Notes:

This data is informative only; do not base final design criteria solely on this data. Follow national and local installation codes, industry best practices, and cable manufacturer recommendations.

1. Some 'A' Frames, most 'B' Frames, and all 'C' Frames have a single enclosure opening provision for both line and load cables (designated by [1]). Most 'A' Frames and some 'B' Frames have separate opening provisions for line and load cables. All cabling capacities shown in this table are "worst case" conditions when both line and load cabling enters and exits in the same direction.
2. Cable sizes are based on overall dimensions of compact-stranded three-conductor shielded cable (common for industrial cable tray installations). Maximum sizing stated accounts for minimum rated cable insulation requirements and the next higher-rated cable (i.e., 8 kV is not commercially available in many areas of the world, therefore Rockwell Automation provides an 8 kV (minimum rating) as well as a 15 kV rating, when applicable. Enclosure openings will accommodate the thicker insulation on the higher-rated cable. IEC ratings show the equivalent to the NEMA sizes. The exact cable mm² size shown is not commercially available in many cases; use the next smaller standard size.
3. Cable enters termination point horizontally in this case, therefore orient space for the stress cones horizontally also.
4. Minimum cable bend radius recommendations vary by national codes, cable type, and cable size. Consult local codes for guidelines and requirements. General relationship of cable diameter to bend radius is typically between 7x...12x (e.g., if the cable diameter is 1 in. [2.54 cm] the minimum bend radius could range between 7...12 in. [18.8...30.48 cm]).
5. For minimum cable insulation requirements, refer to the "PowerFlex 7000 Medium Voltage AC Drive User Manual" for your particular frame ('A', 'B', or 'C' Frame). Stated voltages are peak line-to-ground. Note: Some cable manufacturers rate cabling based on RMS line-to-line.
6. Ground lug capabilities: 'A' Frame—two mechanical range lugs for ground cable connections; 'B', or 'C' Frame—up to ten mechanical range lugs for ground cable connections are available, typically these frames supply four. Mechanical range lugs can accommodate cable size #6-250MCM (13.3...127 mm²).
7. 18 Pulse VFDs (R18TX) have nine line-side connections from the secondary isolation transformer windings entering the VFD. Lug pads are available for each connection. The lug pad and enclosure can generally accommodate two cables per connection, 18 cables in total (applies to all "B" and "C" configurations).
8. Maximum cable size for "B" Frame (two per phase) and 'C' Frame (four per phase) is 500 MCM (253 mm², limited by lug pad assembly size and clearance requirements.
9. As cabling methods can vary widely, maximum cable sizes shown do not account for the size of the conduit hub. Verify size of conduit hub(s) against the "Drive enclosure openings" shown.

Max. Load Cable Sizes

PRODUCT					OUTPUT (MOTOR SIDE)			
Bulletin		Description (V/Freq./Rect.)	Drive rating (A)	Drive Structure Code	Drive Enclosure Opening Inches (mm) [1]	Max. Size & No. Incoming Cables: NEMA [2-4-5-6-8-9]	Max. Size & No. Incoming Cables: IEC [2-4-5-6-8-9]	Vertical Space Avail. for Stress Cones Inches (mm)
'A' Frame (Air-Cooled)	PowerFlex 7000A	2400V/60Hz/RPDTD	46…140	71.9 w/ starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	18.4 (467)
	PowerFlex 7000A	2400V/60Hz/RPDTD	46…140	71.13, 71.18 w/o starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	16.7 (424)
	PowerFlex 7000A	3300V/50Hz/RPDTD	46…140	71.9 w/ starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	18.4 (467)
	PowerFlex 7000A	3300V/50Hz/RPDTD	46…140	71.13, 71.18 w/o starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	16.7 (424)
	PowerFlex 7000A	4160V/50Hz/RPDTD	46…140	71.9 w/ starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	18.4 (467)
	PowerFlex 7000A	4160V/50Hz/RPDTD	46…140	71.13, 71.18 w/o starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	16.7 (424)
	PowerFlex 7000A	4160V/60Hz/RPDTD	46…140	71.9 w/ starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	18.4 (467)
	PowerFlex 7000A	4160V/60Hz/RPDTD	46…140	71.13, 71.18 w/o starter	4.00x4.00 (102x102)	(1) #4/0 5 kV or 8 kV/phase	(1) 107mm² 5 kV or 8 kV/phase	16.7 (424)
	PowerFlex 7000A	6600V/50Hz/RPDTD	40…93	71.10 w/ starter	4.00x4.00 (102x102)	(1) #4/0 8 kV or 15 kV/phase	(1) 107mm² 8 kV or 15 kV/phase	18.4 (467)
	PowerFlex 7000A	6600V/50Hz/RPDTD	40…93	71.14, 71.19 w/o starter	4.00x4.00 (102x102)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 8 kV or 15 kV/phase	20.6 (524)
	PowerFlex 7000A	2400V/60Hz/RPTX	46…160	71.7	4.00x8.00 (102x204) [1]	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 5 kV or 8 kV/phase	33.8 (860)
	PowerFlex 7000A	3300V/50Hz/RPTX	46…160	71.7	4.00x8.00 (102x204) [1]	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 8 kV or 15 kV/phase	33.8 (860)
	PowerFlex 7000A	4160/50Hz/RPTX	46…160	71.7	4.00x8.00 (102x204) [1]	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 8 kV or 15 kV/phase	33.8 (860)
	PowerFlex 7000A	4160/60Hz/RPTX	46…160	71.7	4.00x8.00 (102x204) [1]	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 8 kV or 15 kV/phase	33.8 (860)
	PowerFlex 7000A	6600/50Hz/RPTX	40…105	71.8	4.00x8.00 (102x204) [1]	(1) 350MCM 15 kV/phase	(1) 177mm² 15 kV/phase	33.8 (860)
	PowerFlex 7000A	2400V/60Hz/RPTXI	46…160	71.3	4.00x4.00 (102x102)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 5 kV or 8 kV/phase	20.6 (524) [3]
	PowerFlex 7000A	3300V/50Hz/RPTXI	46…160	71.3	4.00x4.00 (102x102)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 5 kV or 8 kV/phase	20.6 (524) [3]
	PowerFlex 7000A	4160V/50Hz/RPTXI	46…140	71.3	4.00x4.00 (102x102)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 5 kV or 8 kV/phase	20.6 (524) [3]
	PowerFlex 7000A	4160V/60Hz/RPTXI	46…160	71.3	4.00x4.00 (102x102)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177mm² 5 kV or 8 kV/phase	20.6 (524) [3]
	PowerFlex 7000A	6600V/50Hz/RPTXI	40…105	71.6, 71.15	4.00x4.00 (102x102)	(1) #4/0 8 kV or 15 kV/phase	(1) 177mm² 8 kV or 15 kV/phase	20.6 (524) [3]

PRODUCT					OUTPUT (MOTOR SIDE)			
Bulletin		**Description (V/Freq./Rect.)**	**Drive rating (A)**	**Drive Structure Code**	**Drive Enclosure Opening Inches (mm)** [1]	**Max. Size & No. Incoming Cables: NEMA** [2-4-5-6-8-9]	**Max. Size & No. Incoming Cables: IEC** [2-4-5-6-8-9]	**Vertical Space Avail. for Stress Cones Inches (mm)**
	PowerFlex 7000	2400V/60Hz/RPDTD	46…430	70.40, 70.41, 70.44, 70.45	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	2400V/60Hz/RPDTD	46…375	70.40C, 70.41C, 70.44C w/ close-coupled starter	6.52x9.88 (168x251)	(1) 500MCM 5kV or 8kV/phase **OR** (2) 250MCM 5kV or 8kV/phase	(1) 253mm^2 5kV or 8kV/phase **OR** (2) 127mm^2 5kV or 8kV/phase	16.2 (411)
	PowerFlex 7000	3300V/50Hz/RPDTD	46…430	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	3300V/50Hz/RPDTD	E495-E625 G285, G325 N720	70.32	11.81x16.22 (300x412) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	16.9 (430)
	PowerFlex 7000	3300V/50Hz/RPDTD	46…375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/phase **OR** (2) 250MCM 5kV or 8kV/phase	(1) 253mm^2 5kV or 8kV/phase **OR** (2) 127mm^2 5kV or 8kV/phase	16.2 (411)
	PowerFlex 7000	4160V/50Hz/RPDTD	46…375	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	4160V/50Hz/RPDTD	46…375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/phase **OR** (2) 250MCM 5kV or 8kV/phase	(1) 253mm^2 5kV or 8kV/phase **OR** (2) 127mm^2 5kV or 8kV/phase	16.2 (411)
	PowerFlex 7000	4160V/60Hz/RPDTD	46…430	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 8kV or 15kV/phase	28.5 (725)
	PowerFlex 7000	4160/60Hz/RPDTD	E495-E625 G285, G325 N720	70.32	11.81x16.22 (300x412) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	16.9 (430)
	PowerFlex 7000	4160V/60Hz/RPDTD	46…375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/phase **OR** (2) 250MCM 5kV or 8kV/phase	(1) 253mm^2 5kV or 8kV/phase **OR** (2) 127mm^2 5kV or 8kV/phase	16.2 (411)
'B' Frame (Air-Cooled)	PowerFlex 7000	6600V/50Hz/RPDTD	46…285	70.46, 70.47, 70.48, 70.49	9.79x10.97 (249x279) [1]	(1) 500MCM 8kV/ phase	(1) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	6600V/50Hz/RPDTD	40…285	70.46C, 70.47C, 70.49C w/ close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV **OR** (2) 250MCM 8kV or 15kV/phase	(1) 253mm^2 **OR** (2) 127mm^2 8kV or 15kV/phase	16.2 (411)
	PowerFlex 7000	6600V/50Hz/RPDTD	E325-E575 G215, G250 N625	70.34, 70.35	12.79x19.68 (325x500) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 8kV or 15kV/phase	16.9 (430)
	PowerFlex 7000	6600V/60Hz/RPDTD	40…285	70.46, 70.47, 70.48, 70.49	9.79x10.97 (249x279) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	6600V/60Hz/RPDTD	40…285	70.46C, 70.47C, 70.49C w/ close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV **OR** (2) 250MCM 8kV or 15kV/phase	(1) 253mm^2 **OR** (2) 127mm^2 8kV or 15kV/phase	16.2 (411)
	PowerFlex 7000	2400V/60Hz/RPTX	46…430	70.1, 70.2, 70.25, 70.26	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	3300V/50Hz/RPTX	46…430	70.10, 70.27, 70.28, 70.30	9.79x10.97 (249x279) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	3300V/50Hz/RPTX	E495-E625 G285, G325 N720	70.32	11.81x16.22 (300x412) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	16.9 (430)
	PowerFlex 7000	4160V/50Hz/RPTX	46…430	70.10, 70.27, 70.29, 70.30	9.79x10.97 (249x279) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	4160V/60Hz/RPTX	46…430	70.2, 70.26, 70.27, 70.28, 70.29, 70.31	9.79x10.97 (249x279) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	28.5 (725)
	PowerFlex 7000	4160V/60Hz/RPTX	E495-E625 G285, G325 N720	70.32	11.81x16.22 (300x412) [1]	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	16.9 (430)
	PowerFlex 7000	6600V/50Hz/RPTX	40…285	70.11, 70.28, 70.30, 70.31	9.79x10.97 (249x279) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 8kV or 15kV/phase	28.5 (725)
	PowerFlex 7000	6600V/50Hz/RPTX	E325-E575 G215, G250 N625	70.36, 70.37	12.79x19.68 (325x500) [1]	(2) 500MCM 8kV or 15kV/phase	(2) 253mm^2 8kV or 15kV/phase	16.9 (430)

PRODUCT					OUTPUT (MOTOR SIDE)			
Bulletin		Description (V/Freq./Rect.)	Drive rating (A)	Drive Structure Code	Drive Enclosure Opening Inches (mm) 1	Max. Size & No. Incoming Cables: NEMA 2-4-5-6-8-9	Max. Size & No. Incoming Cables: IEC 2-4-5-6-8-9	Vertical Space Avail. for Stress Cones Inches (mm)
'C' Frame (Liquid-Cooled)	PowerFlex 7000	2400V/60Hz/RP18TX 7	46…430	70.8	9.79x21.06 (249x535) 1	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	16.4 (415)
	PowerFlex 7000	3300V/50Hz/RP18TX 7	46…430	70.9	9.79x21.06 (249x535) 1	(2) 500MCM 5kV or 8kV/phase	(2) 253mm^2 5kV or 8kV/phase	16.4 (415)
	PowerFlex 7000L	4160V/50Hz/RPDTD	375…575	70.71(L-A), 70.72 (L-L), 70.76 (LA), 70.77 (L-L), 70.89 (L-A), 70.94 (L-L)	11.22x23.62 (285x600) 1	(4) 500MCM 5 kV or 8 kV/phase	(4) 253mm^2 5 kV or 8 kV/phase	16.4 (415)
	PowerFlex 7000L	4160V/60Hz/RPDTD	375…625	70.71(L-A), 70.72 (L-L), 70.76 (LA), 70.77 (L-L)	11.22x23.62 (285x600) 1	(4) 500MCM 5 kV or 8 kV/phase	(4) 253mm^2 5 kV or 8 kV/phase	16.4 (415)
	PowerFlex 7000L	6600V/50Hz/RPDTD	325…575	70.80 (L-A), 70.85 (L-L), 70.86 (L-L), 70.87 (L-L), 70.88 (L-L), 70.91 (L-A), 70.92 (L-A), 70.93 (L-A)	11.22x23.62 (285x600) 1	(4) 500MCM 8 kV or 15 kV/phase	(4) 253mm^2 8 kV or 15 kV/phase	16.4 (415)
	PowerFlex 7000L	6600V/60Hz/RPDTD	325…575	70.80 (L-A), 70.85 (L-L), 70.86 (L-L), 70.87 (L-L), 70.88 (L-L), 70.91 (L-A), 70.92 (L-A), 70.93 (L-A), 70.93 (L-A)	11.22x23.62 (285x600) 1	(4) 500MCM 8 kV or 15 kV/phase	(4) 253mm^2 8 kV or 15 kV/phase	16.4 (415)
	PowerFlex 7000L	4160V/50Hz/R18TX	375…657	70.50 (L-A), 70.55 (L-L)	9.79x21.06 (249x535) 1	(2) 500MCM 5 kV or 8V/phase	(2) 253mm^2 5 kV or 8 kV/phase	16.4 (415)
	PowerFlex 7000L	4160V/60Hz/R18TX	375…657	70.50 (L-A), 70.55 (L-L)	9.79x21.06 (249x535) 1	(2) 500MCM 5 kV or 8V/phase	(2) 253mm^2 5 kV or 8 kV/phase	16.4 (415)
	PowerFlex 7000L	6600V/50Hz/R18TX	375…657	70.50 (L-A), 70.53 (L-A), 70.55 (L-L), 70.58 (L-L)	9.79x21.06 (249x535) 1	(2) 500MCM 8 kV or 15 kV/phase	(2) 253mm^2 8 kV or 15 kV/phase	16.4 (415)
	PowerFlex 7000L	6600V/60Hz/R18TX	375…657	70.50 (L-A), 70.53 (L-A), 70.55 (L-L), 70.58 (L-L)	9.79x21.06 (249x535) 1	(2) 500MCM 8 kV or 15 kV/phase	(2) 253mm^2 8 kV or 15 kV/phase	16.4 (415)

Notes:

This data is informative only; do not base final design criteria solely on this data. Follow national and local installation codes, industry best practices, and cable manufacturer recommendations.

1. Some 'A' Frames, most 'B' Frames, and all 'C' Frames have a single enclosure opening provision for both line and load cables (designated by 1). Most 'A' Frames and some 'B' Frames have separate opening provisions for line and load cables. All cabling capacities shown in this table are "worst case" conditions when both line and load cabling enters and exits in the same direction.
2. Cable sizes are based on overall dimensions of compact-stranded three-conductor shielded cable (common for industrial cable tray installations). Maximum sizing stated accounts for minimum rated cable insulation requirements and the next higher-rated cable (i.e., 8 kV is not commercially available in many areas of the world, therefore Rockwell Automation provides an 8 kV (minimum rating) as well as a 15 kV rating, when applicable. Enclosure openings will accommodate the thicker insulation on the higher-rated cable. IEC ratings show the equivalent to the NEMA sizes. The exact cable mm^2 size shown is not commercially available in many cases; use the next smaller standard size.
3. Cable enters termination point horizontally in this case, therefore orient space for the stress cones horizontally also.
4. Minimum cable bend radius recommendations vary by national codes, cable type, and cable size. Consult local codes for guidelines and requirements. General relationship of cable diameter to bend radius is typically between 7x…12x (e.g., if the cable diameter is 1 in. [2.54 cm] the minimum bend radius could range between 7…12 in. [18.8…30.48 cm]).
5. For minimum cable insulation requirements, refer to the "PowerFlex 7000 Medium Voltage AC Drive User Manual" for your particular frame ('A', 'B', or 'C' Frame). Stated voltages are peak line-to-ground. Note: Some cable manufacturers rate cabling based on RMS line-to-line.
6. Ground lug capabilities: 'A' Frame—two mechanical range lugs for ground cable connections; 'B', or 'C' Frame—up to ten mechanical range lugs for ground cable connections are available, typically these frames supply four. Mechanical range lugs can accommodate cable size #6-250MCM (13.3…127 mm^2).
7. 18 Pulse VFDs (R18TX) have nine line-side connections from the secondary isolation transformer windings entering the VFD. Lug pads are available for each connection. The lug pad and enclosure can generally accommodate two cables per connection, 18 cables in total (applies to all "B" and "C" configurations).
8. Maximum cable size for "B" Frame (two per phase) and 'C' Frame (four per phase) is 500 MCM (253 mm^2, limited by lug pad assembly size and clearance requirements.
9. As cabling methods can vary widely, maximum cable sizes shown do not account for the size of the conduit hub. Verify size of conduit hub(s) against the "Drive enclosure openings" shown.

Environmental Considerations

Air Quality Requirements

Air cleanliness for PowerFlex 7000 drives is important for two reasons:

1. Airborne particulate that settles on heat sinks and heat-producing components increases the thermal resistance of the components, resulting in an increase in the temperature of the part. The internal fins of the hockey puck thyristor heat sinks must be kept clean; the dust on the surface of the heat sinks interferes with the boundary layer air flow which inhibits cooling of the part.
2. Particulate can decrease the tracking insulation of electrical insulation materials within the drive. Electrically conductive dusts (such as coal dust and metallic dusts) can be severe, however other particulates such as cement dust moist from high ambient relative humidity may prove destructive as well. Dusts coating low voltage circuit boards can cause failures too.

Air presented to the PowerFlex 7000 must be of a cleanliness expected in a typical industrial control room environment. The drive is intended to operate in conditions with no special precautions to minimize the presence of sand or dust, but not in close proximity to sand or dust sources. This is defined by IEC 721(1) as being less than 0.2 mg/m3 of dust.

If outside air does not meet the conditions described above (0.2 mg / m3), the air must be filtered to ASHRAE (American Association of Heating, Refrigeration and Air-Conditioning Engineers) Standard 52.2 MERV 11 (Minimum Efficiency Reporting Value). This filtration eliminates from 65…80% of the particulate in Range 2 (1.0…3.0 μm) and 85% of the particulate in Range 3 (3.0…10.0 μm). This filter system must be cleaned or changed regularly.

This environment is accomplished by placing the drive in a pressurized room with adequate air conditioning to maintain the ambient temperature. The drive exhaust air is circulated within the control room. Five to ten percent cooled/heated and filtered make-up air is usually provided to keep the room pressurized.

(1) IEC 721-3-3 "Classification of Environmental Conditions - Part 3: Classification of Groups of Environmental Parameters and their Severities - Section 3: Stationary Use at Weather Protected Locations".

Hazardous Materials

Environmental protection is a top priority for Rockwell Automation. The facility that manufactured this medium voltage drive operates an environmental management system that is certified to the requirements of ISO 14001. As part of this system, this product was reviewed in detail throughout the development process to ensure that environmentally inert materials were used wherever feasible. A final review has found this product to be substantially free of hazardous material.

Rockwell Automation is actively seeking alternatives to potentially hazardous materials for which no feasible alternatives exist today in the industry. In the interim, the following precautionary information is provided for your protection and for the protection of the environment. Please contact the factory for any environmental information on any material in the drive or with any general questions regarding environmental impact.

Capacitor Dielectric Fluid

The fluids used in the filter capacitors and the snubber capacitors are generally considered very safe and are fully sealed within the capacitor housings. Shipping and handling of this fluid is typically not restricted by environmental regulations. In the unlikely event that capacitor fluid leaks out, avoid ingestion or contact with skin or eyes as slight irritation could result. Rubber gloves are recommended for handling.

To clean up, soak into an absorbent material and discard into an emergency container, or, if significant leakage occurs, pump fluid directly into the container. Do not dispose into any drain or into the environment in general or into general landfill refuse. Dispose of according to local regulations. If disposing of an entire capacitor, the same disposal precautions should be taken.

Printed Circuit Boards

Printed circuit boards may contain lead in components and materials. Circuit boards must be disposed of according to local regulations and must not be disposed of with general landfill refuse.

Lithium Batteries

This drive contains four small lithium batteries. Three are mounted on the printed circuit boards and one is located in the PanelView user interface. Each battery contains less than 0.05g of lithium, which is fully sealed within the batteries. Shipping and handling of these batteries is typically not restricted by environmental regulations, however, lithium is considered a hazardous substance. Lithium batteries must be disposed of according to local regulations and must not be disposed of with general landfill refuse.

Chromate Plating

Some sheet steel and fasteners are plated with zinc and sealed with a chromate-based dip. Shipping and handling of the chromate plating parts is typically not restricted by environmental regulations, however, chromate is considered a hazardous substance. Dispose of chromate plated parts according to local regulations, not with general landfill refuse.

In Case Of Fire

This drive is highly protected against arcing faults and therefore it is very unlikely the drive would be the cause of a fire. In addition, the materials in the drive are self-extinguishing (i.e. they will not burn without a sustained external flame). If, however, the drive is subjected to a sustained fire from some other source, some of the polymer materials in the drive will produce toxic gases. As with any fire, individuals involved in extinguishing the fire or anyone in close proximity should wear a self-contained breathing apparatus to protect against any inhalation of toxic gases.

Disposal

When disposing of the drive, it should be disassembled and separated into groups of recyclable material as much as possible (i.e. steel, copper, plastic, wire, etc.). These materials should then be sent to local recycling facilities. In addition, all disposal precautions mentioned above must also be taken for those particular materials.

Notes:

Specifications

ATTENTION: In the event of discrepancies between information published in generic manual specifications and those included with your specific design or electrical drawings, take the DD or EE ratings as correct values.

Drive Specifications

Table 14 - General Design Specifications

Description	
Motor Type	Induction or Synchronous
Input Voltage Rating	2400V, 3300V, 4160V, 6600V
Input Voltage Tolerance	± 10% of Nominal
Voltage Sag(1)	-30%
Control Power Loss Ride-through	5 Cycles (Std) > 5 Cycles (Optional UPS)
Input Protection(2)	Surge Arrestors (AFE/Direct-to-Drive)
Input Frequency	50/60 Hz, +/- 0.2%
Power Bus Input Short-circuit Current Withstand (2400…6600V(3))	25 kA RMS SYM, 5 Cycle
Basic Impulse Level(4)	45 kV (0…1000 m)
Power Bus Design	Copper - Tin plated
Ground Bus	Copper - Tin plated 6 x 51 mm (¼ x 2 in.)
Customer Control Wire Way	Separate and Isolated
Input Power Circuit Protection(5)	Vacuum Contactor with Fused Isolating Switch or Circuit Breaker
Output Voltage	0…2400V 0…3300V 0…4160V 0…6000V, 0…6300V, 0…6600V
Inverter Design	PWM
Inverter Switch	SGCT
Inverter Switch Failure Mode	Non-rupture, Non-arc
Inverter Switch Failure Rate (FIT)	100 per 1 Billion Hours Operation
Inverter Switch Cooling	Double Sided, Low Thermal Stress
Inverter Switching Frequency	420…440 Hz

Table 14 - General Design Specifications

Description			
Number of Inverter SGCTs	**Voltage**	**SGCTs (per phase)**	
	2400V 3300V 4160V 6600V	2 4 4 6	
Inverter PIV Rating (Peak Inverse Voltage)	**Voltage**	**PIV (each device)**	**Total PIV**
	2400V 3300V 4160V 6600V	6500V 6500V 6500V 6500V	6500V 13,000V 13,000V 19,500V
Rectifier Designs	Direct-to-Drive (transformerless AFE rectifier) AFE with separate isolated transformer AFE with integrated transformer		
Rectifier Switch	SGCT (AFE Rectifier)		
Rectifier Switch Failure Mode	Non-rupture, Non-arc		
Rectifier Switch Failure Rate (FIT)	50 (SGCT) per 1 Billion Hours Operation		
Rectifier Switch Cooling	Double Sided, Low Thermal Stress		
Number of Rectifier Devices per phase	**Voltage**	**AFE**	
	2400V 3300V 4160V 6600V	2 4 4 6	
Output Current THD (1^{st}…49^{th})	< 5%		
Output Waveform to Motor	Sinusoidal Current / Voltage		
Medium Voltage Isolation	Fiber Optic		
Modulation techniques	Selective Harmonic Elimination (SHE) Synchronous Trapezoidal PWM Asynchronous or Synchronous SVM (Space Vector Modulation)		
Control Method	Digital Sensorless Direct Vector Full Vector Control with Encoder Feedback (Optional)		
Tuning Method	Auto Tuning via Setup Wizard		
Speed Regulator Bandwidth	1…10 rad/s		
Torque Regulator Bandwidth	15…50 rad/s		
Speed Regulation	0.1% without Tachometer Feedback 0.01…0.02% with Tachometer Feedback		
Acceleration/Deceleration Range	Independent Accel/Decel – 4 x 30 s		
Acceleration/Deceleration Ramp Rates	4 x Independent Accel/Decel		
S Ramp Rate	Independent Accel/Decel – 2 x 999 s		
Critical Speed Avoidance	3 x Independent with Adjustable bandwidth		
Stall Protection	Adjustable time delay		
Load Loss Detection	Adjustable level, delay, speed set points		
Control Mode	Speed or Torque		

Table 14 - General Design Specifications

Description		
Current Limit	Adjustable in Motoring and Regenerative	
Output Frequency Range	0.2…75 Hz (Standard) 75 Hz...85Hz (Optional - need specific Motor Filter Capacitor [MFC])	
Service Duty Rating	**Normal Duty**	**Heavy Duty**
	110% Overload for 1 min. every 10 min. (Variable Torque Load)	150% Overload for 1 min. every 10 min. (Constant Torque Load)
Typical VFD Efficiency	> 97.5% (AFE) Contact Factory for Guaranteed Efficiency of Specific Drive Rating	
Input Power Factor	**AFE Rectifier**	
	0.95 minimum, 10...100% Load	
IEEE 519 Harmonic Guidelines(6)	IEEE 519 - 1992 Compliant	
VFD Noise Level	< 85 dB (A)) per OSHA Standard 3074	
Regenerative Braking Capability	Inherent – No Additional Hardware or Software Required	
Flying Start Capability	Yes – Able to Start into and Control a Spinning Load in Forward or Reverse Direction	
Operator Interface	10" Color Touchscreen – Cat# 2711P-T10C4A9 (VAC) Built-in PDF viewer Redesigned PanelView Plus 6 Logic Module with 512 Mb of memory	
Languages	English, French, Spanish, Portuguese, German, Chinese, Italian, and Russian	
Control Power	220/240V or 110/120V, Single phase - 50/60 Hz (20 A)	
External I/O	16 Digital Inputs, 16 Digital Outputs	
External Input Ratings	50…60 Hz AC or DC 120…240 V – 1 mA	
External Output Ratings	50…60 Hz AC or DC 30…260 V – 1 A	
Analog Inputs	Three Isolated, 4…20 mA or 0…10V (250 Ω)	
Analog Resolution	Analog input 12 Bit (4…20 mA) Internal parameter 32 Bit resolution Serial Communication 16 Bit resolution (.1Hz) (Digital Speed Reference)	
Analog Outputs	One Isolated, Eight Non-isolated, 4…20 mA or 0…10V (600 Ω)	
Communication Interface	Ethernet IP/DPI	
Scan Time	Internal DPI – 2 ms min., 4 ms max.	
Communications Protocols (Optional)	R I/O DeviceNet Ethernet I/P Profibus Modbus Interbus ControlNet	Lon Works Can Open RS485 HVAC RS485 DF1 RS232 DF1 USB

Table 14 - General Design Specifications

Description		
Enclosure	NEMA 1 (standard)	IP21 (IEC)
		IP42 (IEC) (optional)
Lifting Device	Standard / Removable	
Mounting Arrangement	Mounting Sill Channels	
Structure Finish	Epoxy Powder – Paint Exterior Sandtex Light Grey (RAL 7038) – Black (RAL 8022) Internal – Control Sub Plates – High Gloss White (RAL 9003)	
Interlocking	Key provision for customer input Disconnecting Device	
Corrosion Protection	Unpainted Parts (Zinc Plated / Bronze Chromate)	
Ambient Temperature	0…40 °C (32…104 °F) / 0…50 °C (32…122 °F) - optional	
Fiber Optic Interface	Rectifier – Inverter – Cabinet (Warning / Trip)	
Door Filter	Painted Diffuser with Matted Filter or Washable Foam Media	
Door Filter Blockage	Air Flow Restriction Trip / Warning	
Storage and Transportation Temperature Range	-40…70 °C (-40…185 °F)	
Relative Humidity	Max. 95%, non-condensing	
Altitude (Standard)	2400...4160V: 1001...5000m (3301...16,400 ft) ≥6000V: 1001...2000m (3301...6600 Ft)	
Altitude (Optional)	1001…5000 m (0…16,400 ft)	
Seismic (UBC Rating)	1, 2, 3, 4	
Standards	NEMA, IEC, CSA, UL, ANSI, IEEE	

(1) Voltage Sag tolerance is reduced to -25% when control power is supplied from medium voltage via CPT.

(2) Surge arrestors are used for AFE/Direct-to-Drive configurations.

(3) Short-circuit fault rating based on input protection device (contactor or circuit breaker).

(4) BIL rating based on altitudes < 1000 m (3300 ft). Refer to factory for derating on altitudes >1000 m.

(5) Optional.

(6) Under certain conditions, power system analysis will be required.

History of Changes

This appendix summarizes the revisions to this manual. Reference this appendix to determine what changes have been made across multiple revisions.

7000A-UM200A-EN-P, March 2013

Change
Converted document from Word to FrameMaker
Removed all PanelView 550 content
Added and linked additional resources
Updated Rectifier Design configurations
Add Shock Indication Label section
Inserted new operator interface information
Updated Hall Effect Sensor section
Added 2400V Converter Cabinet drawing
Added 6600V Converter Cabinet drawing
Added Voltage Sensing section
Added Surge Arrester replacement procedure
Inserted new PowerCage drawings with SPS boards installed
Consolidated all resistance checks section
Updated SGCT and Snubber Circuit section to reflect SPS boards
Added Clamping Pressure graphic showing bolt location
Updated Temperature Sensing section to reflect SPS boards
Added new image in Replacing SGCT section to account for SPS board
Added graphic showing all heatsink types
Updated Snubber Resistor testing section to reflect SPS board
Added Snubber and Sharing Resistor Replacement procedure
Updated Snubber Capacitor testing section to reflect SPS board
Added Snubber Capacitor Replacement procedure
Added Self-Powered SGCT Power Supply - SPS section
Updated section to use consistent rectifier terminology
Added Terminal and Connections power supply information
Modified UPS section to include connecting internal UPS battery
Inserted Air Requirements information
Updated and reformatted Catalog Number Explanation
Added SPS boards to Preventative Maintenance Schedule
Added Line and Load Cable sizes
Updated all Specifications for A Frame drive
Added Index

Notes:

A

C

D

E

F

Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support, you can find technical manuals, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools. You can also visit our Knowledgebase at http://www.rockwellautomation.com/knowledgebase for FAQs, technical information, support chat and forums, software updates, and to sign up for product notification updates.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect[SM] support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

Medium Voltage Products, 135 Dundas Street, Cambridge, ON, N1R 5X1 Canada, Tel: (1) 519.740.4100, Fax: (1) 519.623.8930
Online: www.ab.com/mvb

Allen-Bradley, Rockwell Software, Rockwell Automation, and TechConnect are trademarks of Rockwell Automation, Inc.

Trademarks not belonging to Rockwell Automation are property of their respective companies.

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Publication 7000A-UM200B-EN-P - May 2013
Supersedes Publication - 7000A-UM200A-EN-P - March 2013

Copyright © 2013 Rockwell Automation, Inc. All rights reserved. Printed in Canada.