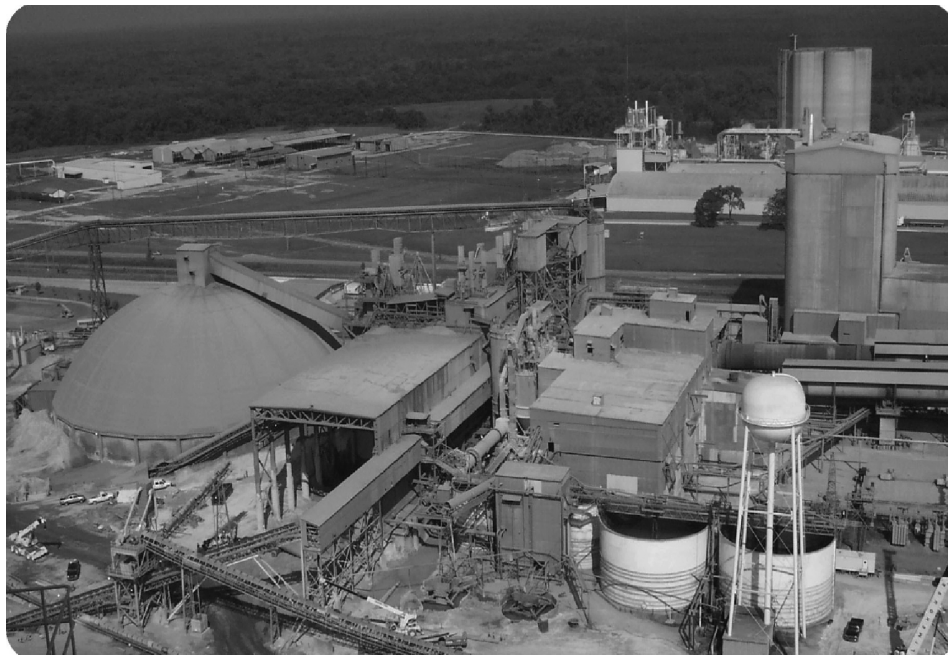


PowerFlex 7000 Medium Voltage AC Drive Air-Cooled ("B" Frame)—ForGe Control

Bulletin 7000



Important User Information

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

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

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

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

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

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.

IMPORTANT

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

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



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



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



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

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Notes:

This manual contains new and updated information as indicated in the following table.

Topic	Page
Changed standard IEEE 519-1992 to IEEE 519-1992	14
Added Safe Torque Off section	20
Added Arc Resistance Warning Labels section	25
Updated DC Link/Fan Cabinet with Fan Control Panel (Heat Sink Model)	38
Updated DC Link/Fan Cabinet CMC (Heat Pipe Model)	39
Updated DC Link/Fan Cabinet	40
The location of Shock indication label is changed	44
Updated Main and Choke Sections of 6600V Heat Pipe Drive Cabinetry	46
Updated Access to power Terminals (AFE (heat pipe model) illustration	59
Added Chapter 4 ArcShield Unit Information	77
Added Output Current Harmonics to Specifications Appendix	104

Notes:

About the Manual

This manual provides procedural information for installing the PowerFlex® 7000 Medium Voltage “B” Frame drives (heat sink and heat pipe models). This document also includes information regarding customer-responsibilities in advance of the commissioning process.

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 qualified engineering personnel to install the drive system.

What Is Not in the Manual

This manual provides information specific to the installation and configuration of the PowerFlex 7000 “B” Frame drive. These topics are covered in other manuals:

- Physical transportation or site requirements of the drive cabinetry.
- Commission-specific processes and configuration, as managed by a Rockwell Automation® commissioning-engineer.
- Details concerning the operator interface, or configuration of drive parameters.
- Dimensional and electrical drawings generated for each customer order.
- Spare parts list compiled for each customer order.
- Troubleshooting potential usage problems.

See these documents for additional product detail or instruction that is related to PowerFlex® 7000 “B” Frame drives:

- Drive-specific Technical Specifications.
- Transportation and Handling Procedures: instructions on how to receive and handle a Medium Voltage variable-frequency drive and related equipment.
- The Commissioning Guide: required procedures and checklists for Rockwell Automation field service engineers.
- Drive-specific User Manual: instructions for daily and recurrent drive usage or maintenance tasks.
- Drive-specific Technical Data: additional troubleshooting, parameters, and specification information for MV variable-frequency drives.

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, verify that 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.

See [About the Manual on page 9](#) for additional information.

Manual Conventions

See [Important User Information on page 2](#) for a list of the symbols and labels that are used throughout this manual. Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

General Precautions



ATTENTION: This drive contains ESD (electrostatic discharge) sensitive parts and assemblies. Static control precautions are required during install, test, service, or repair procedures for this assembly. Component damage can result if ESD control procedures are not followed. If you are not familiar with static control procedures, refer to 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, an undersized motor, incorrect or inadequate AC supply, or excessive ambient temperatures can result in malfunction of the system.



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

See [Arc Resistant Warning Labels on page 25](#) for specific warning labels concerning arc resistance.

Support for Commissioning

After installation, Rockwell Automation Medium Voltage Support is responsible for commission support and activities in the PowerFlex 7000 product line.

Phone: 519-740-4790

Option 1 for technical and option 4 for commission questions:

- MVSsupport_technical@ra.rockwell.com
- MVSsupport_services@ra.rockwell.com

Rockwell Automation support includes, but is not limited to these services.

- Quotation and management of product on-site start ups
- Quotation and management of field modification projects
- Variable-frequency quotation and management of customer in-house and on-site product training

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
PowerFlex 7000 Medium Voltage AC Drive Technical Data, publication 7000-TD002 for the latest Firmware Revision	Provides details and programming during commissioning or troubleshooting
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system
Product Certifications website, http://www.rockwellautomation.com/global/certification/overview.page	Provides declarations of conformity, certificates, and other certification details
PowerFlex 7000 Medium Voltage AC Drive Air-Cooled ("B" Frame)—ForGe Control Commissioning Manual, publication 7000-IN012	Provides procedures for commissioning
PowerFlex 7000 Medium Voltage AC Drive Air-Cooled ("B" Frame)—ForGe Control User Manual, publication 7000-UM202	Provides general information regarding the usage and programming of the operator interface after installation (before or after commissioning)
PowerFlex 7000 Medium Voltage AC Drive Transportation & Handling Procedures Installation Instructions, publication 7000-IN008	Provides receiving and handling instructions for Medium Voltage variable-frequency drive and related equipment
PowerFlex 7000 HMI Offering With Enhanced Functionality User Manual, publication 7000-UM201	Provides information for human machine interface (HMI) with enhanced functionality
PowerFlex 7000 Medium Voltage AC Drive Air-Cooled ("B" Frame)—ForGe Control (Using PanelView 550) User Manual, publication 7000-UM151	Provides information for drives equipped with the PanelView™ 550 HMI
Electrical Schematics and Diagrams	Shipped with the drive and list any additional manual necessary for configuring the drive lineup. The schematic that is titled "General Notes" identifies all required Rockwell Automation publications by publication number
PowerFlex 7000 Series Safe Torque Off User Manual, publication 7000-UM203	Provides information that is related to the functional safety option of safe torque off

Each drive ships with a service binder that contains all technical publications that are required to install, use, and troubleshoot the drive lineup. If the service binder is unavailable when pre-commissioning, or when additional information is required. You can view or download publications at <http://www.rockwellautomation.com/global/literature-library/overview.page>. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Notes:

PowerFlex 7000 Drive Overview

The PowerFlex® 7000 drive is a general-purpose, standalone, medium voltage drive. The drive controls speed, torque, direction, and the start and stops 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. It is used in industries such as petrochemical, cement, mining and metals, forest products, power generation, and water/waste water.

The PowerFlex 7000 drive meets most common standards from these organizations:

- National Electrical Code (NEC)
- International Electrotechnical Commission (IEC)
- National Electrical Manufacturers Association (NEMA)
- Underwriters Laboratories (UL)
- Canadian Standards Association (CSA)

The drive is available with most common supply voltages at medium voltage, from 2400...6600V.

Topology

The PowerFlex 7000 drive uses a pulse width modulated (PWM) – current source inverter (CSI) for the machine side converter as shown in [Figure 6](#). This topology applies to a wide voltage and power range. The power semiconductor switches used are easy-to-series for any medium voltage level. Semiconductor 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 minimal. For example, only six inverter devices for switching are required at 2400V, 12 at 3300...4160V, and 18 at 6600V.

The PowerFlex 7000 drive provides regenerative braking for applications where the load is overhauling the motor, for example downhill conveyors. Or where high inertia loads are quickly slowed down, for example, fans. The drive uses:

- Symmetrical gate commutated thyristors (SGCTs) for machine converter switches.
- Silicon-controlled rectifiers (SCRs) for 18-pulse rectifier configurations.

- SGCTs for active front-end [AFE] rectifier configurations for the line converter switches.

The PowerFlex 7000 drive provides a selectable option for enhanced torque control capabilities and increased dynamic control performance. This High-Performance Torque Control (HPTC) feature delivers 100 % torque at zero speed and provides torque control through zero speed with smooth direction transition.

Rectifier Designs

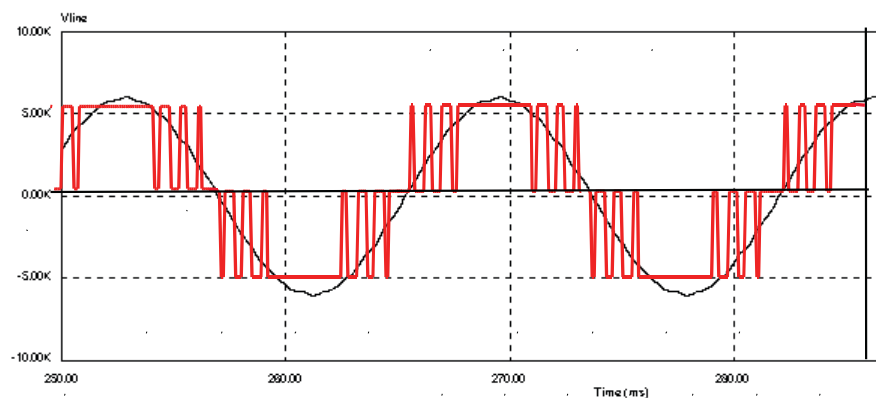
The PowerFlex 7000 drive offers three rectifier configurations for "B" Frame drives:

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

Direct-to-Drive Technology

Direct-to-Drive™ technology does not require an isolation transformer or multiple rectifier bridges. Instead of multiple uncontrolled rectifiers, an AFE rectifier bridge is supplied. The rectifier semiconductors that are used are symmetrical gate commutated thyristors (SGCTs). Unlike the diodes that are used in VSI (voltage source inverter) 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, similar to the control philosophy of the inverter. The gating algorithm uses a specific 42-pulse switching pattern ([Figure 1](#)) called selective harmonic elimination (SHE) to mitigate the 5th, 7th, and 11th harmonic orders.

Figure 1 - Typical PWM Switching Pattern, Line Voltage Waveform

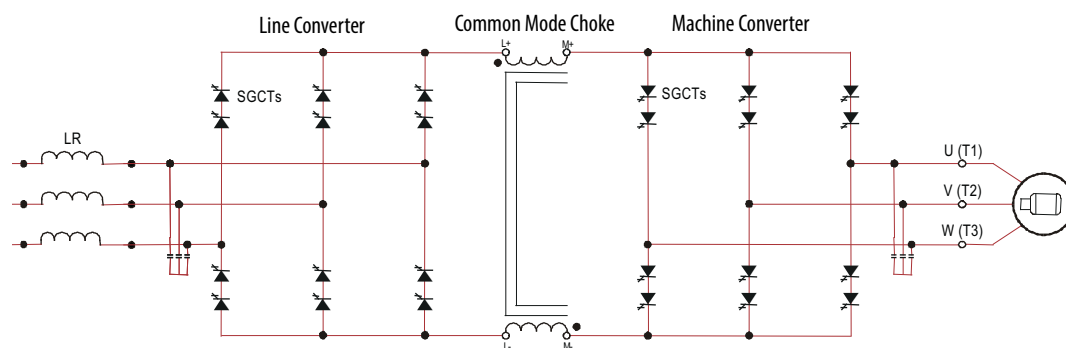


An integral line reactor and capacitor addresses the high harmonic orders (13th and above). It also provides sinusoidal voltage and current waveforms back to the distribution system. The capacitor delivers excellent line-side harmonic and power factor performance to meet IEEE 519-2014 requirements and other global harmonic standards. All while 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 that is seen at the motor terminals. Standard (non-inverter duty rated) motors and motor cables can be used. This technology is ideal for motor retrofit applications.

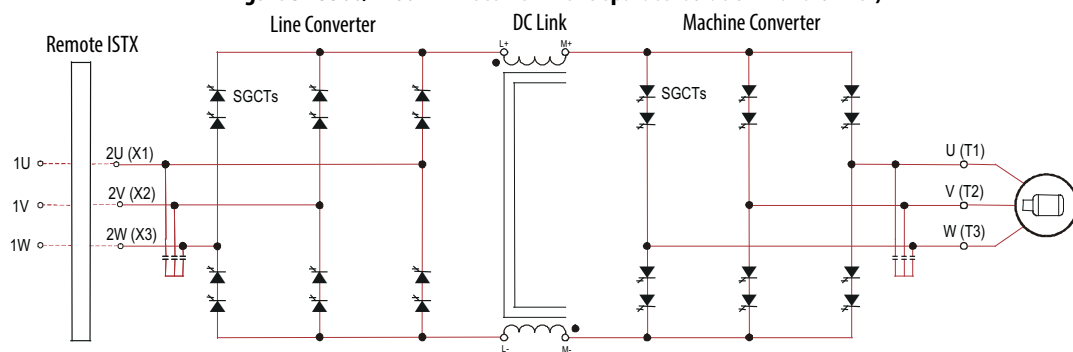
Figure 2 - 3300/4160V AFE Rectifier (Direct-to-Drive)



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. The isolation transformer provides the input impedance to replace the requirement for an integral line reactor. It also addresses the common mode voltage to replace 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.

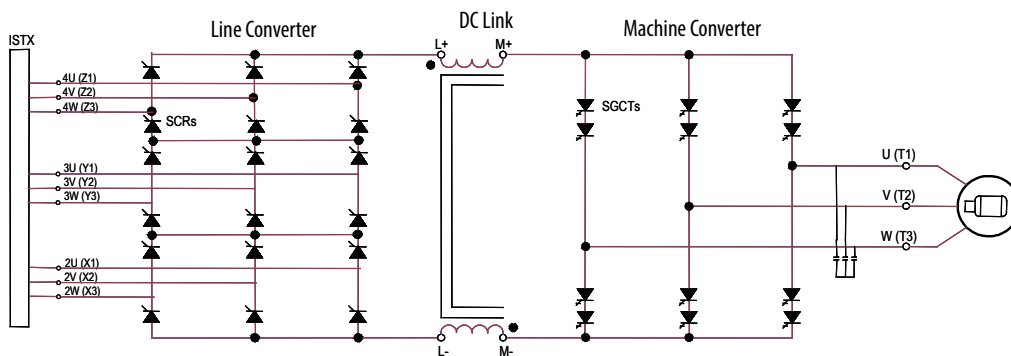
Figure 3 - 3300/4160 AFE Rectifier with Separate Isolation Transformer)



18-pulse Rectifier with Separate Isolation Transformer

A transformer is required for voltage matching for high power, constant torque applications. Also when the line voltage is higher than the motor voltage. The 18-pulse rectifier uses SCRs instead of the SGCTs used for an AFE rectifier. When used for high power and constant torque applications, the 18-pulse rectifier has lower losses than the AFE rectifier. This functionality makes it ideal for the highest power requirements. The 18-pulse isolation transformer provides the required input impedance and addresses common mode voltage just like the separate isolation transformer that is used with the AFE rectifier. However, instead of a PWM switching pattern and a rectifier bridge, the 18-pulse configuration mitigates line side harmonics. Harmonic current cancelation in the isolation transformer phase shifted secondary windings is used. The inverter is the same configuration for all available rectifier options.

Figure 4 - 3300/4160V 18-pulse Rectifier



Cooling Technology

Variable-frequency drives (VFD) are supplied with heat sinks for low and mid-power configurations and heat pipes for high-power configurations. While both configurations draw heat away from the semiconductors, heat pipes are bigger, more efficient, and require larger fans and airflow.

Information and graphics in this manual show both configurations.

Motor Compatibility

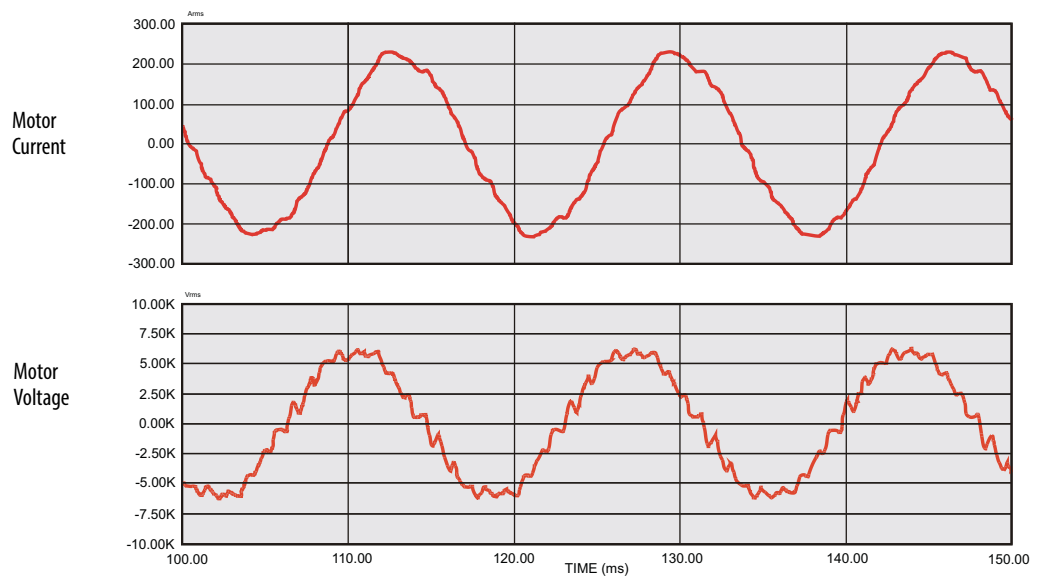
The PowerFlex® 7000 drive achieves near-sinusoidal current and voltage waveforms to the motor with no significant additional heating or insulation stress. The motor that is connected to the VFD is typically 3 °C (5.5 °F) higher compared to across-the-line operation. Voltage waveform has dv/dt of less than 10 V/ μ s. The peak voltage across the motor insulation is the rated motor RMS voltage that is divided by 0.707.

Reflected wave and dv/dt issues that are often associated with voltage source inverter (VSI) drives are a non-issue with the PowerFlex 7000 drive. [Figure 5](#) shows typical motor waveforms. The drive uses a selective harmonic elimination (SHE) pattern in the inverter. This SHE mitigates major order harmonics. A small output capacitor (integral to the drive) mitigates harmonics at higher speeds.

Standard motors are compatible without derating, even on retrofit applications.

Rockwell Automation® has tested the motor cable distance of this technology for controlling motors up to 15 km (9.3 miles) away from the drive.

Figure 5 - Motor Waveforms at Full Load, Full Speed



Simplified Electrical Diagrams

2400V

Figure 6 - 2400V – AFE Rectifier, Configuration #1 – Direct-to-Drive

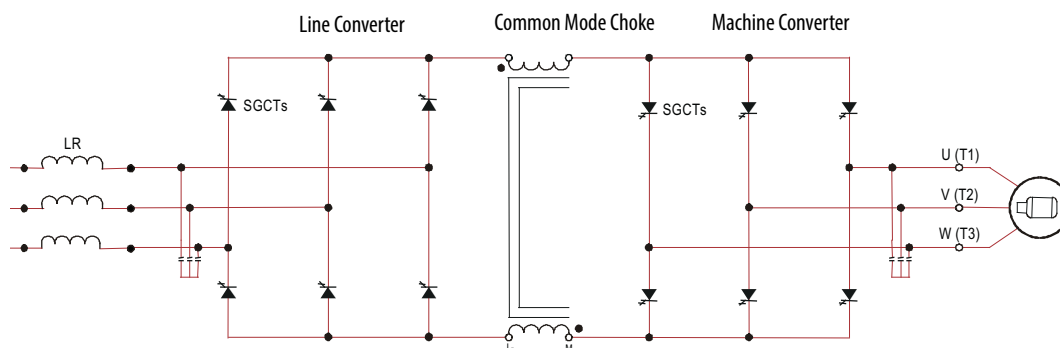


Figure 7 - 2400V – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

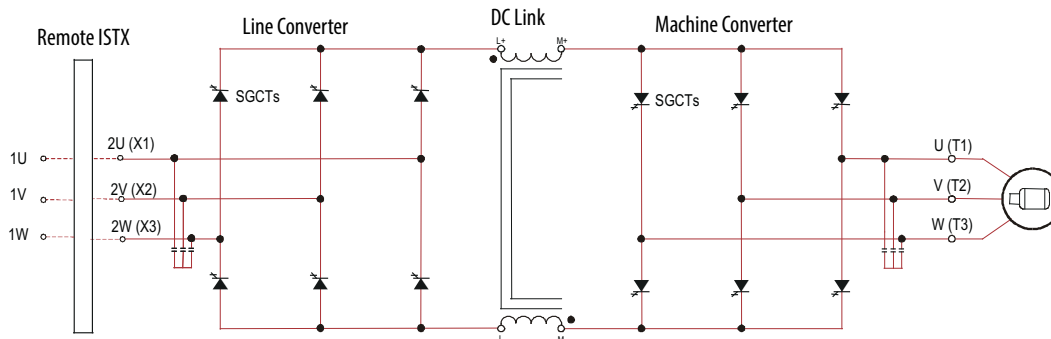
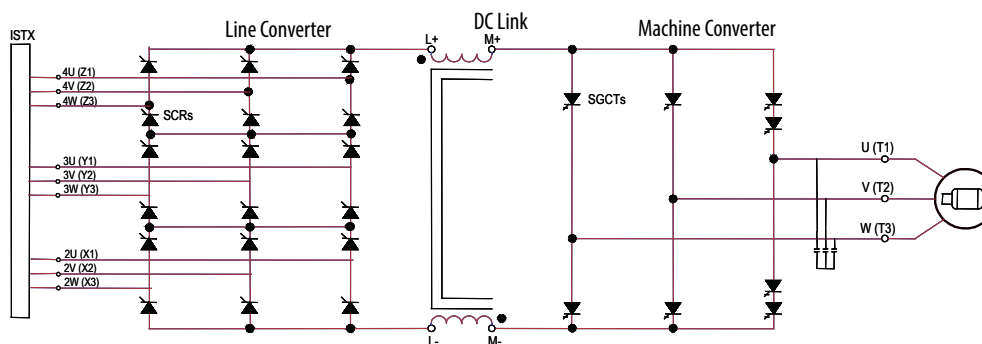
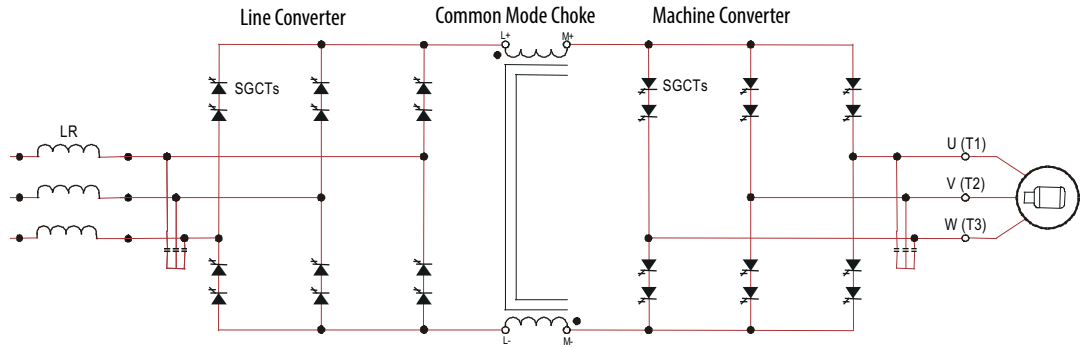
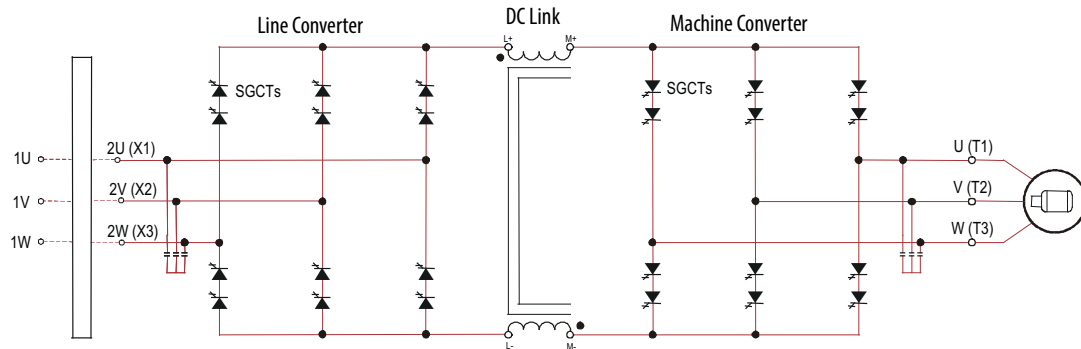
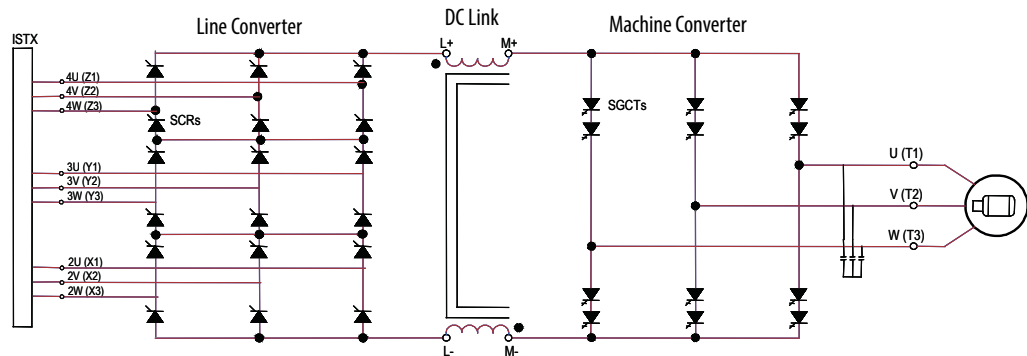


Figure 8 - 2400V - Configuration #3 - 18-pulse



3300/4160V**Figure 9 - 3300/4160V – AFE Rectifier, Configuration #1 – Direct-to-Drive****Figure 10 - 3300/4160V – AFE Rectifier, Configuration #2 – Separate Isolation Transformer****Figure 11 - 3300/4160V - Configuration #3 - 18-pulse**

6600V

Figure 12 - 6600V – AFE Rectifier, Configuration #1 – Direct-to-Drive

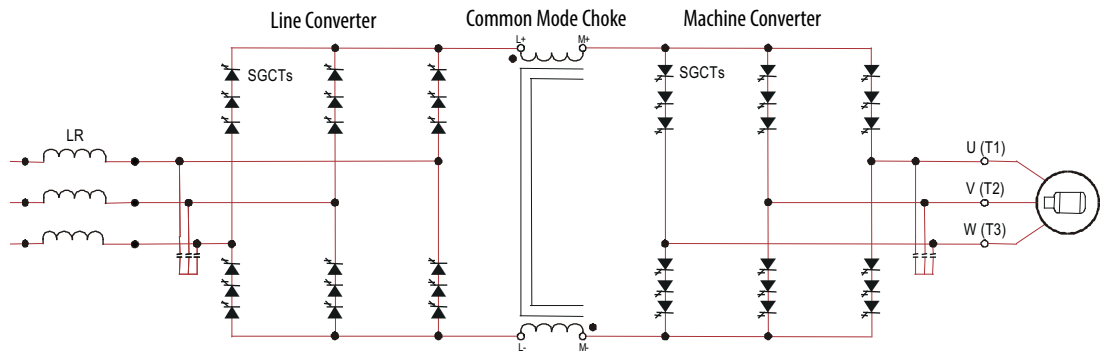


Figure 13 - 6600V – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

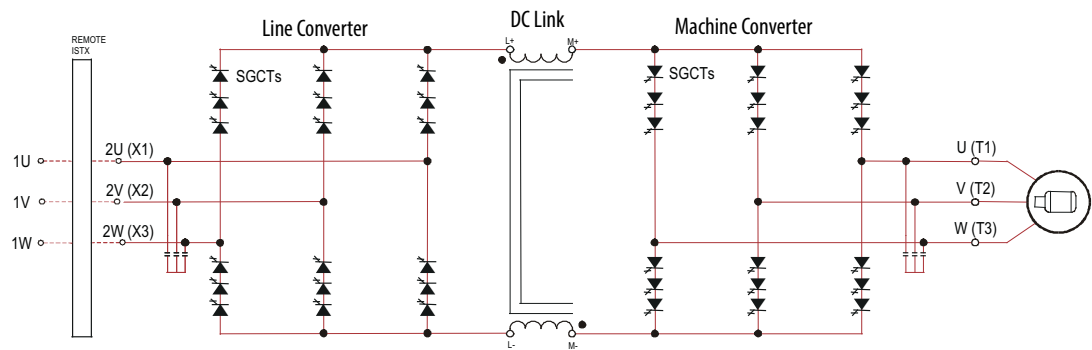
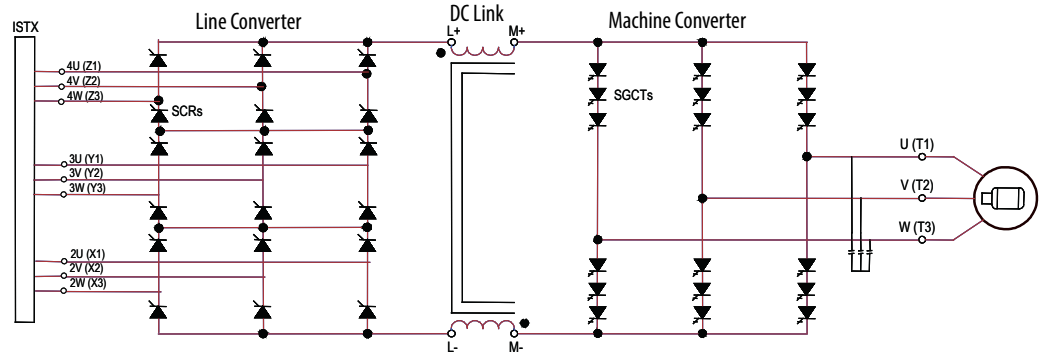
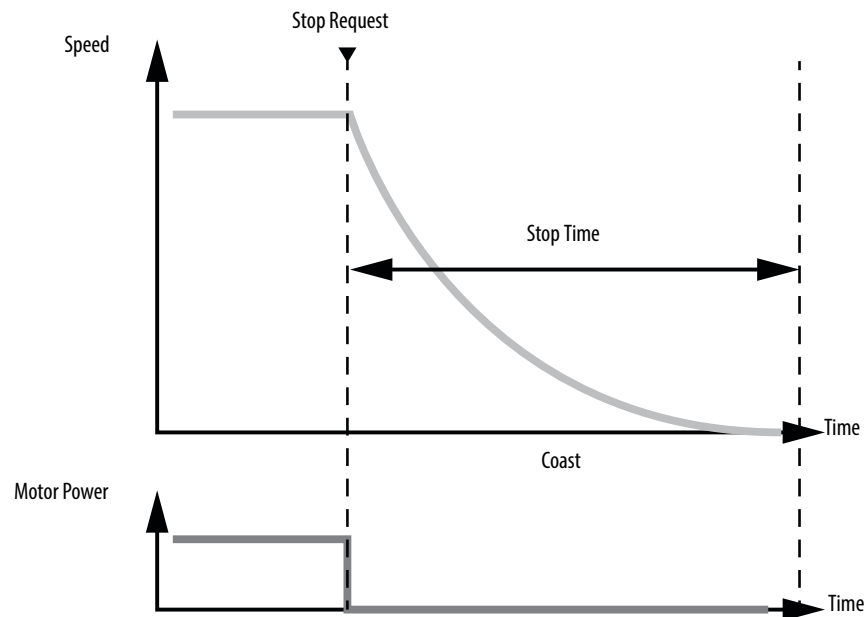


Figure 14 - 6600V - Configuration #3 - 18-pulse



Safe Torque Off

Safe Torque Off is a functional safety feature that is integrated into the PowerFlex 7000 drive, available for Active Front End (AFE) and Direct-to-Drive configurations. The drive can receive a safety input signal (for example, from an optical sensor or a safety gate) and remove rotational power from the motor. This action allows the motor to coast to a stop. After the Safe Torque Off command is initiated, the drive will declare it's in the safe state. The drive itself remains powered and the safe state is reliably monitored to make sure that no rotational torque can be delivered to the motor. The drive can return rotational power to the motor after Safe Torque Off condition has been reset.

Figure 15 - Safe Torque Off

An internal safety relay provides for the safety input and reset circuits.

Safe Torque Off can be used in Active Front End (AFE) and Direct-to-Drive rectifier drive configurations for A, B, and C frames. It cannot be used for parallel drives, N+1, N-1, synchronous transfer, and 18-pulse drive configurations.

This TÜV certified feature is for use in safety applications up to and including Safety Integrity Level 3 (SIL3) and Category 3, Performance Level e (Cat 3, PL_e). More information on functional safety and SIL and PL ratings can be found in the following standards:

- EN 61508
- EN 62061
- EN 61800-5-2
- EN 13849-1

See publication [7000-UM203](#) for more information that is related to the functional safety option.

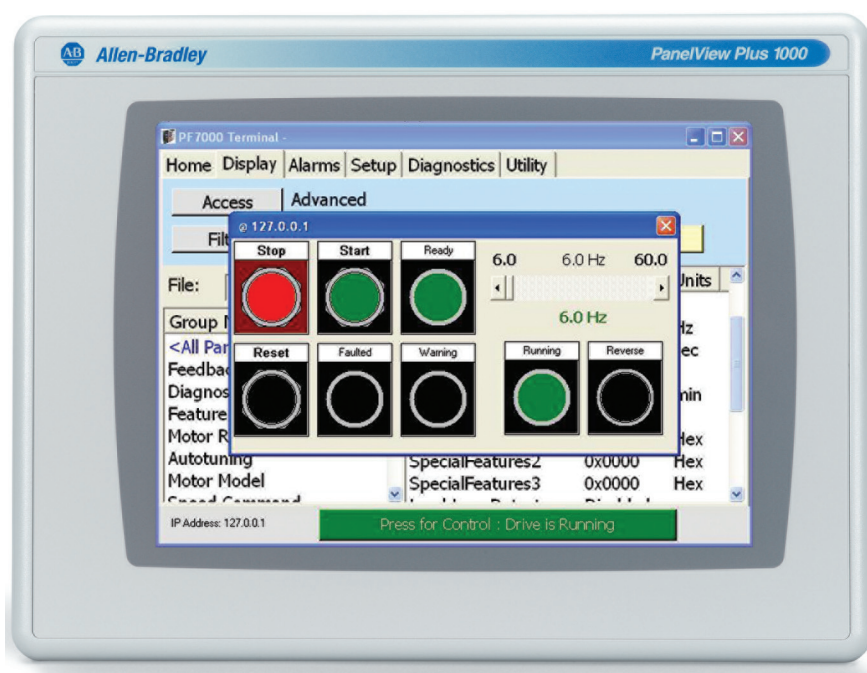
Operator Interface

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

With the HMI Interface Board, you can choose the style and size of the desired Windows-based operator terminal to interact with the drive. For example, PanelView™ CE terminal, laptop, or desktop computer. The HMI Interface Board has compatibility between the drive and configuration tools, as all necessary tools are acquired from the drive.

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

Figure 16 - Operator Interface



Basic Configurations

There are three basic configurations for the HMI interface board: remote-mounted HMI, locally mounted HMI, and no HMI supplied.

Remote-mounted HMI

The HMI is not mounted in the traditional location on the low voltage (LV) door of the variable-frequency drive (VFD). A remote mounting plate, 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 functional distance limitation.

This unlimited distance is ideal for non-PLC users wanting to control and monitor remotely. For example at the driven machine, control room. 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.

Locally Mounted HMI

Similar to the existing PanelView 550, the HMI is mounted on the low voltage (LV) door of the VFD. There is also a service access port (RJ45 connector) on the LV door.

No HMI Supplied

A service access port (RJ45 connector) is on the LV door of the VFD. Customers use their own laptop as the HMI. All programs that are 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. It is ideal for unmanned sites, where a dedicated HMI is not required.

See publication [7000-UM201](#) for detailed instruction for the HMI interface board.

Notes:

Drive Installation

This section details the processes for cabinet connection and component installation such as fan hoods, cables, the grounding, and the interlocking of units.

See the PowerFlex® 7000 Medium Voltage AC Drive Transportation & Handling Procedures, publication [7000-IN008](#), for drive cabinetry site and level requirements before continuing with the remaining installation tasks.

Where appropriate, separate diagrams and instructions are available for both the heat sink and the heat pipe “B” Frame models. Assume any “B” Frame diagram that is not identified as a heat pipe model represents a heat sink model.

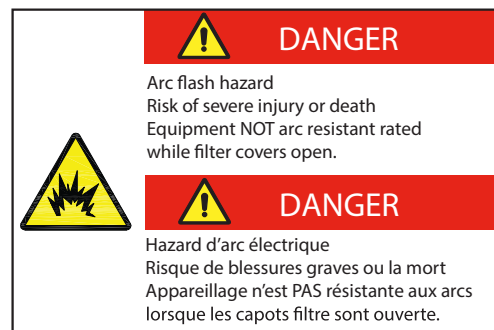
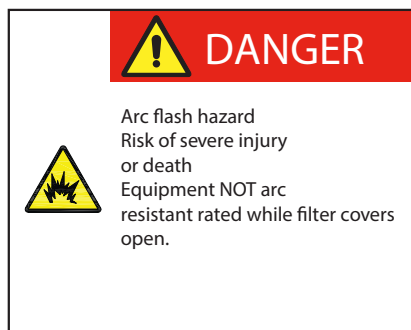
Safety and Codes



ATTENTION: The CEC, NEC, or local codes outline provisions for safely installing electrical equipment. Installation must comply with wire type specifications, conductor sizes, branch circuit protection, and disconnect devices. Failure to do so can result in personal injury and/or equipment damage.

Arc Resistant Warning Labels

These warning labels are affixed to areas of the PowerFlex 7000 drive where, if proper precautions are not followed, equipment is NOT arc resistant. You must follow all precautions for equipment to remain arc resistant.



NOTICE

ARC RESISTANT EQUIPMENT

Accessibility: IEEE C37.20.7 Type 2B
IEC 62271-200 IAC AFLR

Arcing Short Circuit Current : $\leq 50\text{kA}$

Arc Duration: Device Limited

Protective Devices:

Mersen A051B1DAR0 suffix 2R to 12R

Mersen A051B2DAR0 suffix 18R to 32R

Protect only with fuses specified.

Arc resistant functionality requires that:
Medium voltage doors must be bolted
and locked.

Covers must be fully secured.

AVIS

APPAREILLAGE RESISTANTE AUX ARC

Accessibilité: IEEE C37.20.7 Type 2B
IEC 62271-200 IAC AFLR

Courant d'arc court-circuit : $\leq 50\text{kA}$

Arc duration: limité par le dispositif

Fusibles acceptable

Mersen A051B1DAR0 suffix 2R à 12R

Mersen A051B2DAR0 suffix 18R à 32R

Protéger uniquement par des fusibles
indiqués.

Fonctionnalité résistante aux arcs exige que:
Portes de moyenne tension doivent être
boulonné et verrouillé.

Capots doivent être pleinement sécurisé.

Transporting and Siting the Drive

Follow all guidelines for siting the components before continuing with these installation procedures.

The process can vary depending on the type and number of drive components in your specific installation. Follow the procedures that are recommended for your particular components. Contact your Rockwell Automation sales or service representative with any questions during the installation process.

Cabinet Layout and Dimension Drawings of Drive

Generic dimension drawings for the “B” Frame drives are available in the PowerFlex 7000 Reference Manual. Drawings specific to your unit and your installation are available as a package with your unit. For additional copies, or if you have questions, contact your Rockwell Automation sales representative.

Control/Cabling Cabinet

[Figure 17](#) ... [Figure 31](#) illustrate the medium voltage area in the control/cabling cabinet behind the low voltage compartment. The barriers are removed.

IMPORTANT Heat pipes are only available within AFE rectifier “B” Frame models.

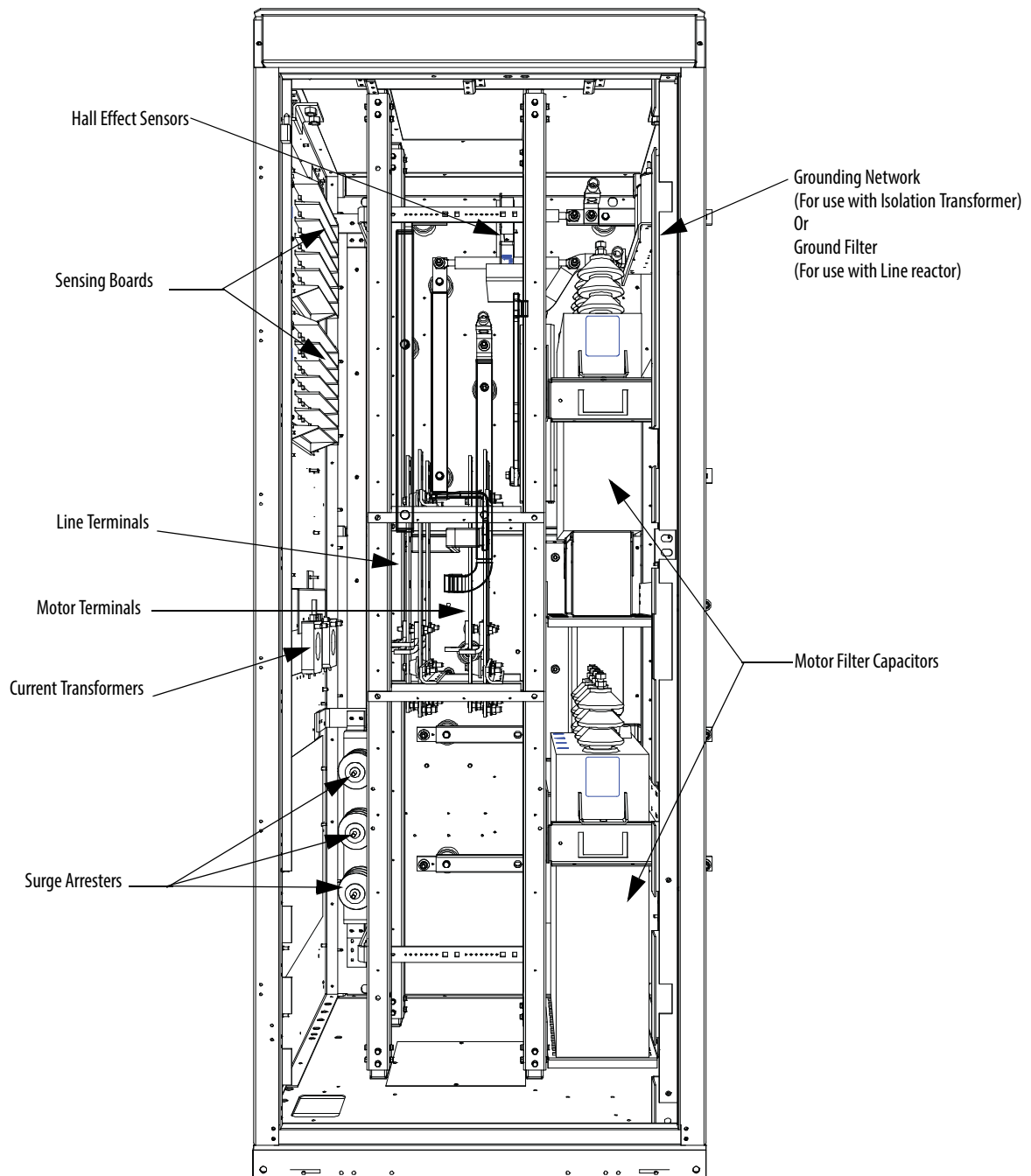
Figure 17 - Cabling Cabinet for AFE Rectifier (Heat Sink Model)

Figure 18 - Cabling Cabinet for AFE Rectifier (Heat Pipe Model)

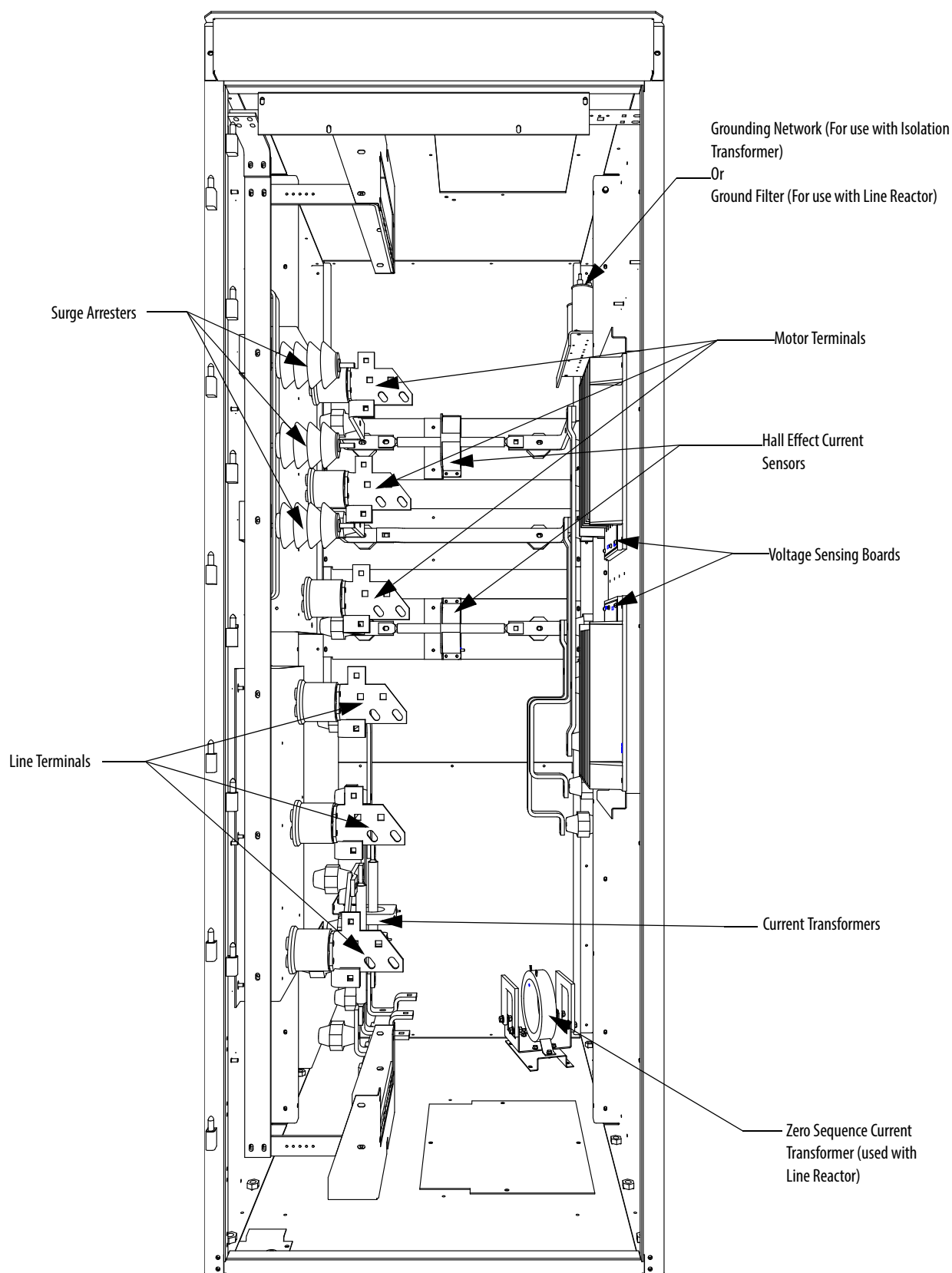


Figure 19 - Cabling Cabinet for AFE Rectifier (6600V Heat Pipe RPDTD)

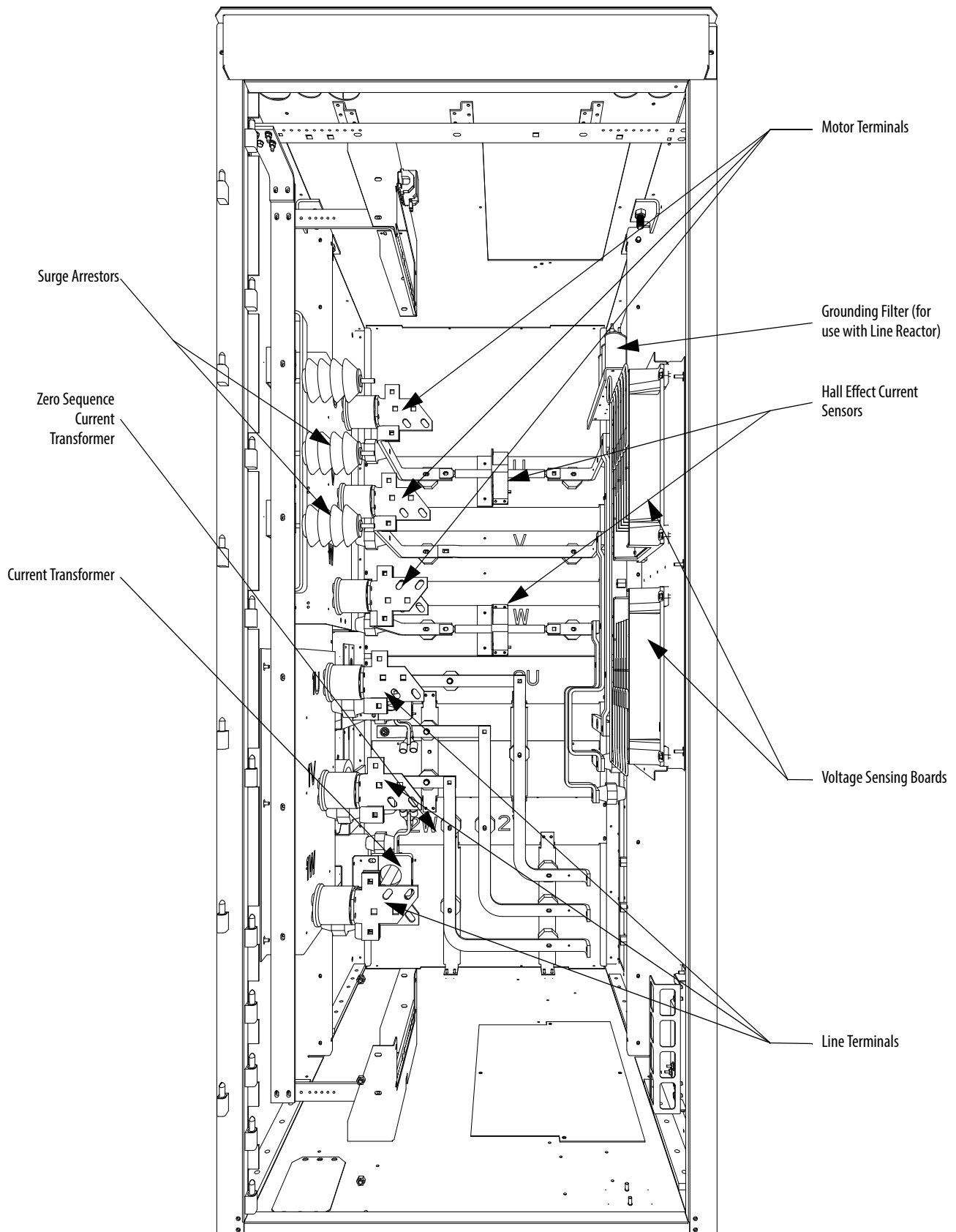


Figure 20 - Cabling Cabinet for 18-pulse Rectifier (Motor Filter Capacitors Not Shown)

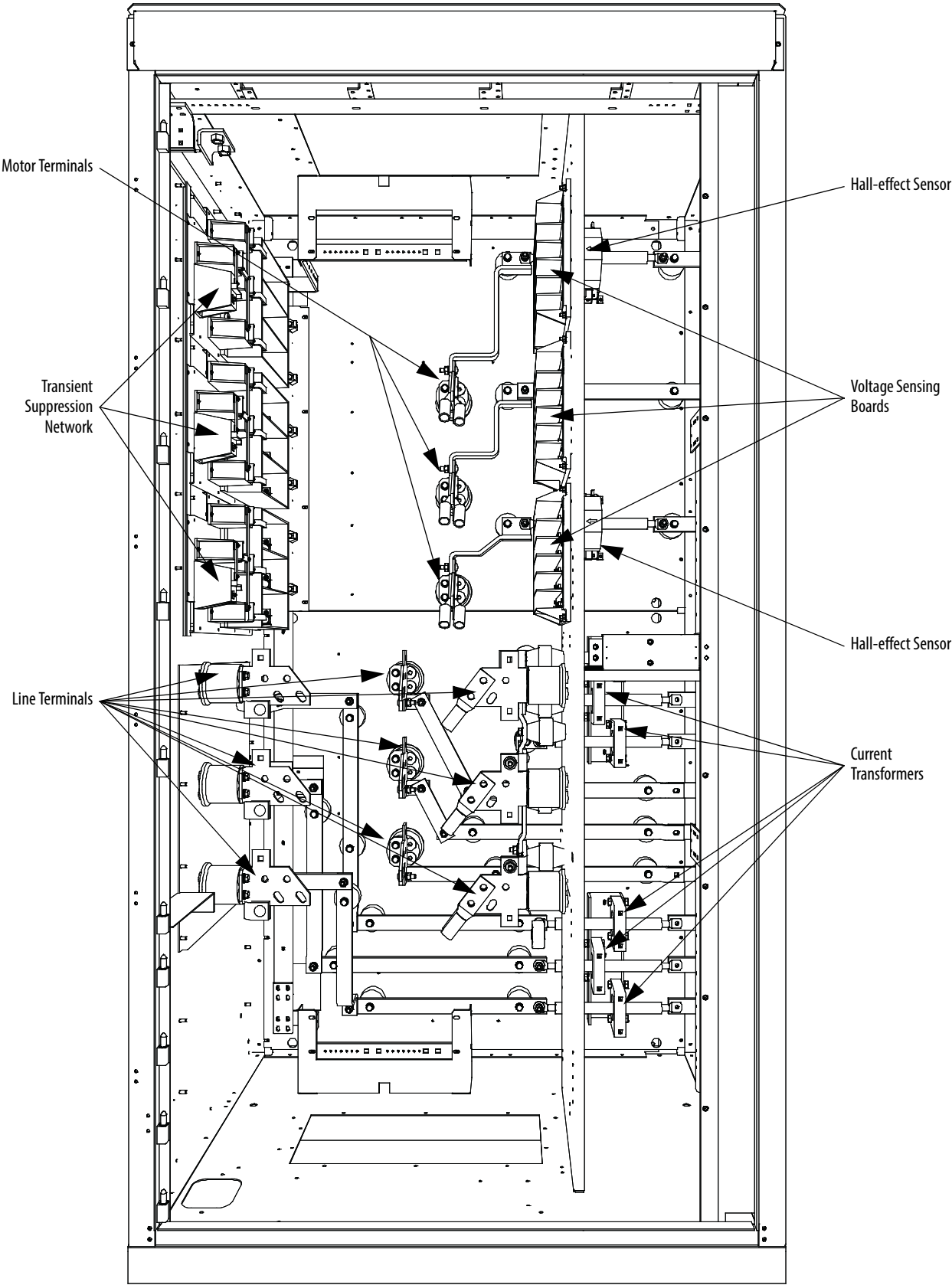


Figure 21 - AC Line Reactor for AFE Rectifier with Connection Cabinet (Heat Sink Model)

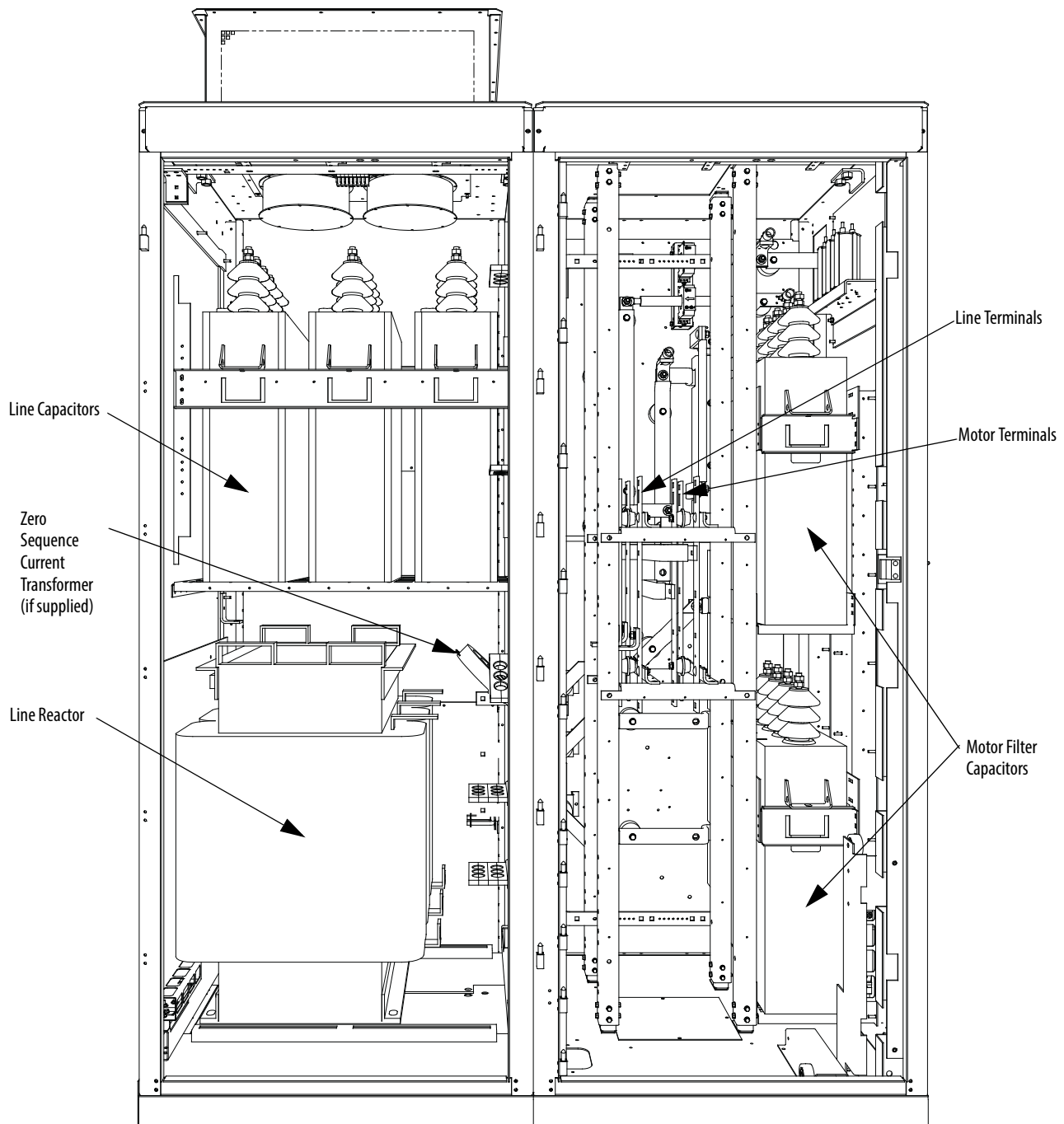


Figure 22 - AC Line Reactor Cabinet (6600V Heat Pipe RPDTD Model)

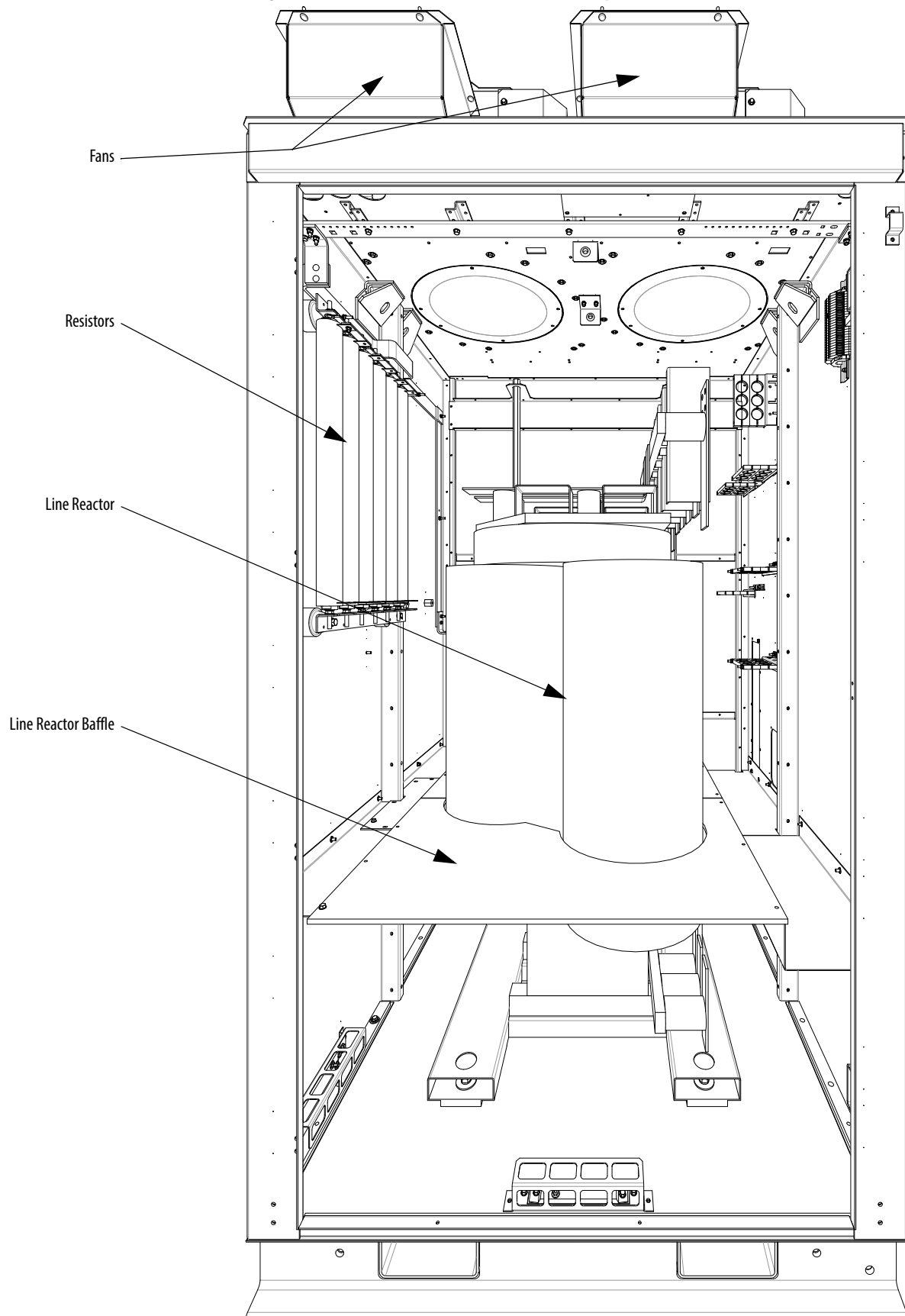


Figure 23 - AC Line Reactor with Connection Cabinet (Heat Pipe Model)

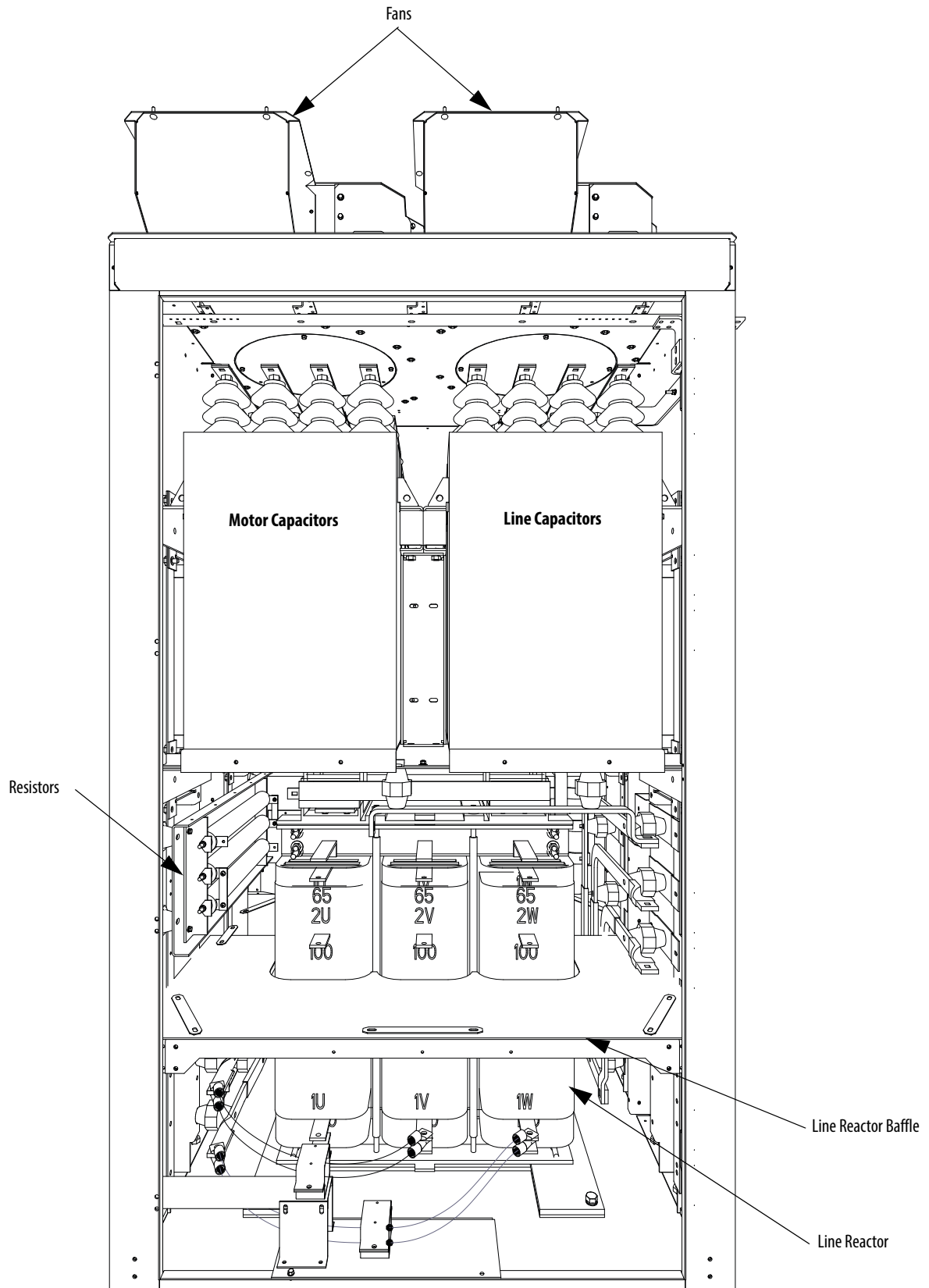
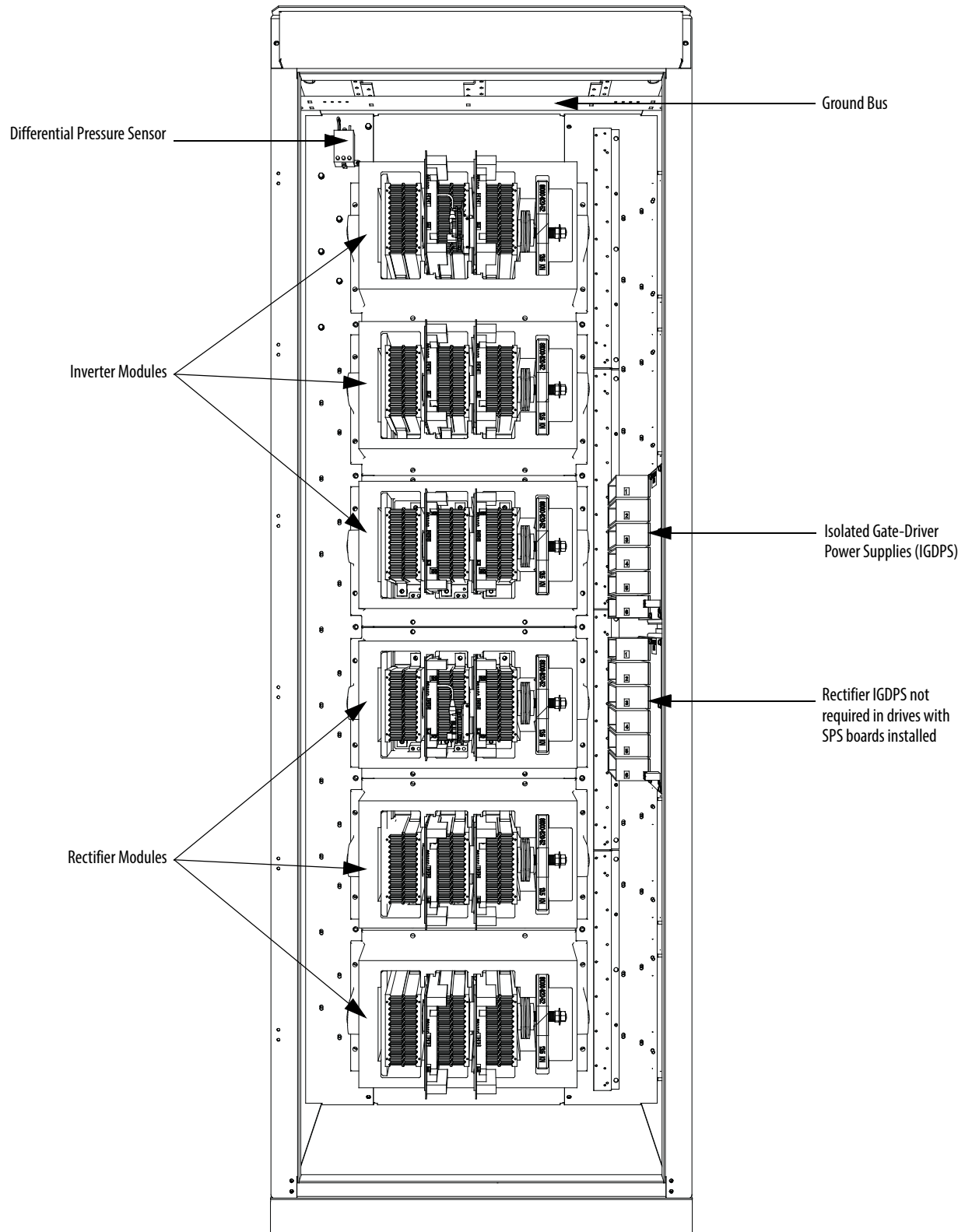


Figure 24 - Converter Cabinet (Heat Sink Model, 2400V Version Shown)



IMPORTANT There can be minor variations in the cabinet layout for different voltage classes. This installation manual does not show SPS boards that are installed.

Figure 25 - Converter Cabinet (Heat Sink Model, 3300...4160V Version Shown)

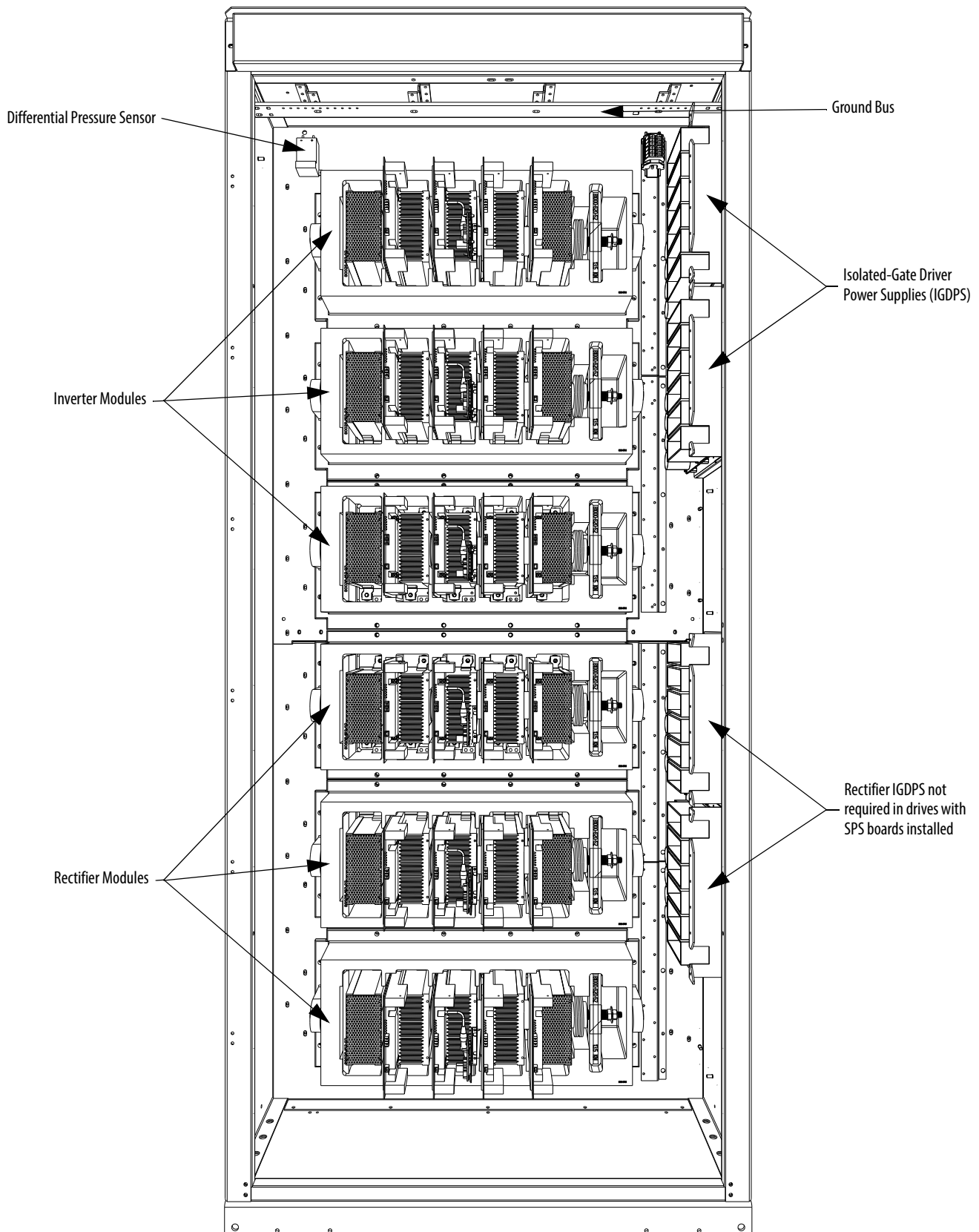


Figure 26 - Converter Cabinet (Heat Sink Model, 6600V Version Shown)

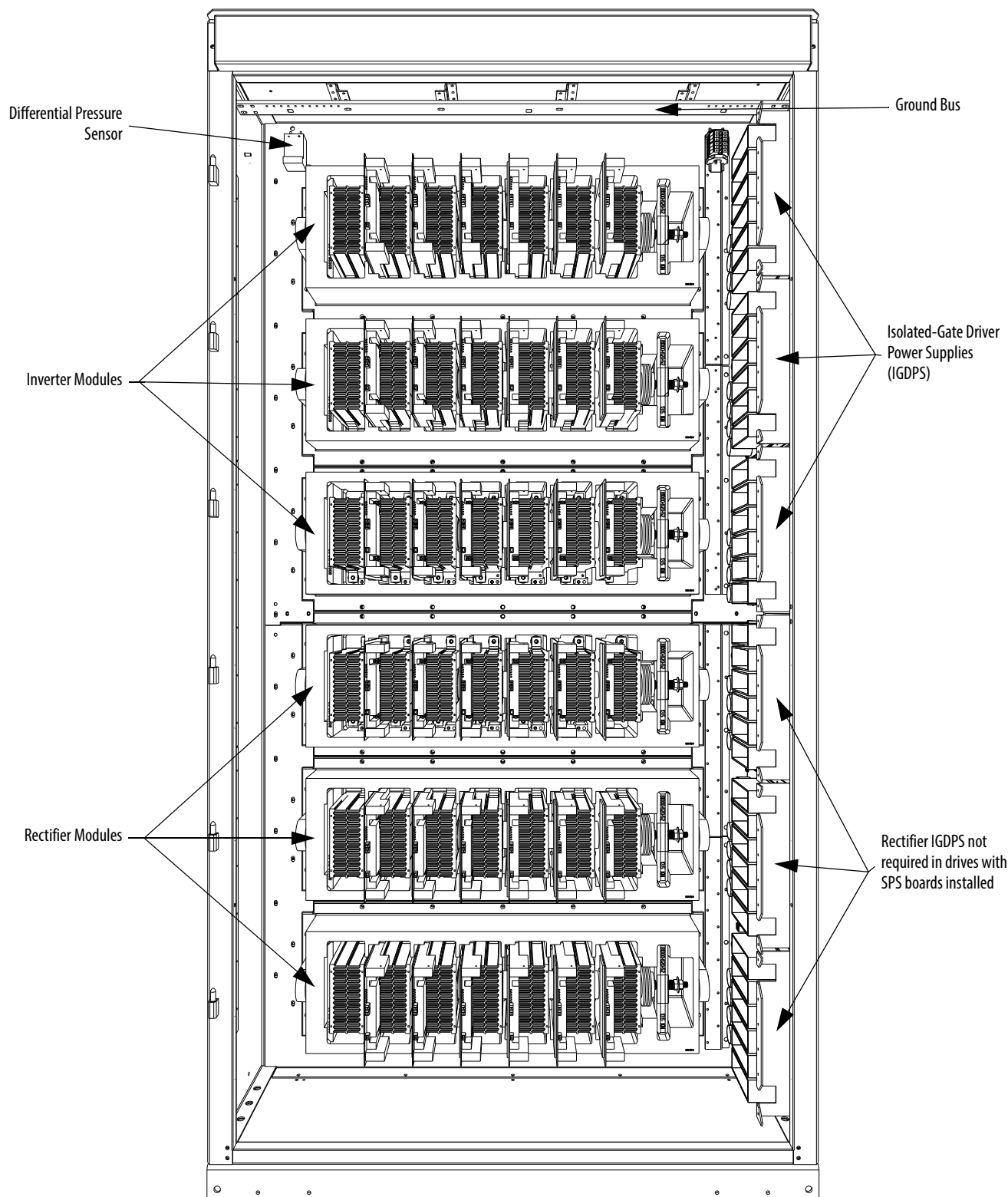


Figure 27 - Converter Cabinet, 3300...4160V (Heat Pipe Model)

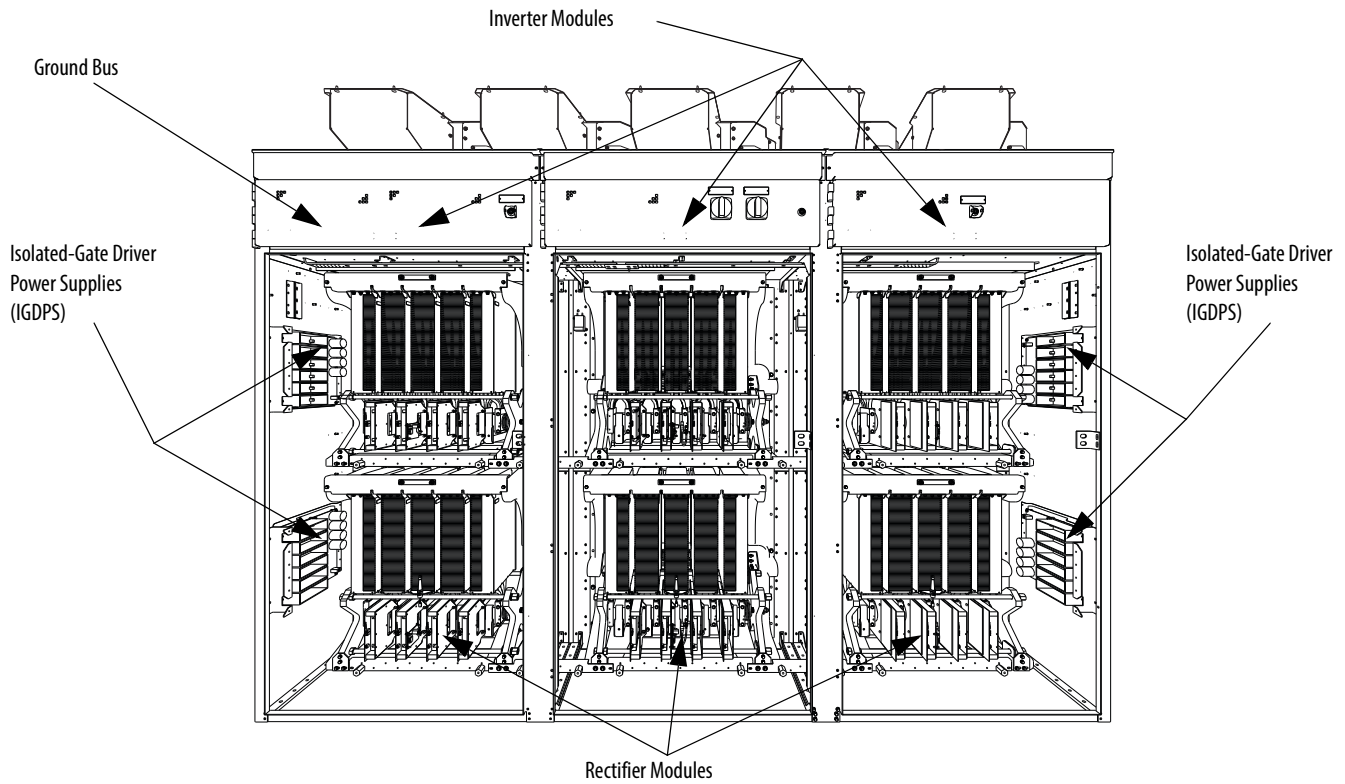


Figure 28 - Converter Cabinet, 6600V (Heat Pipe Model)

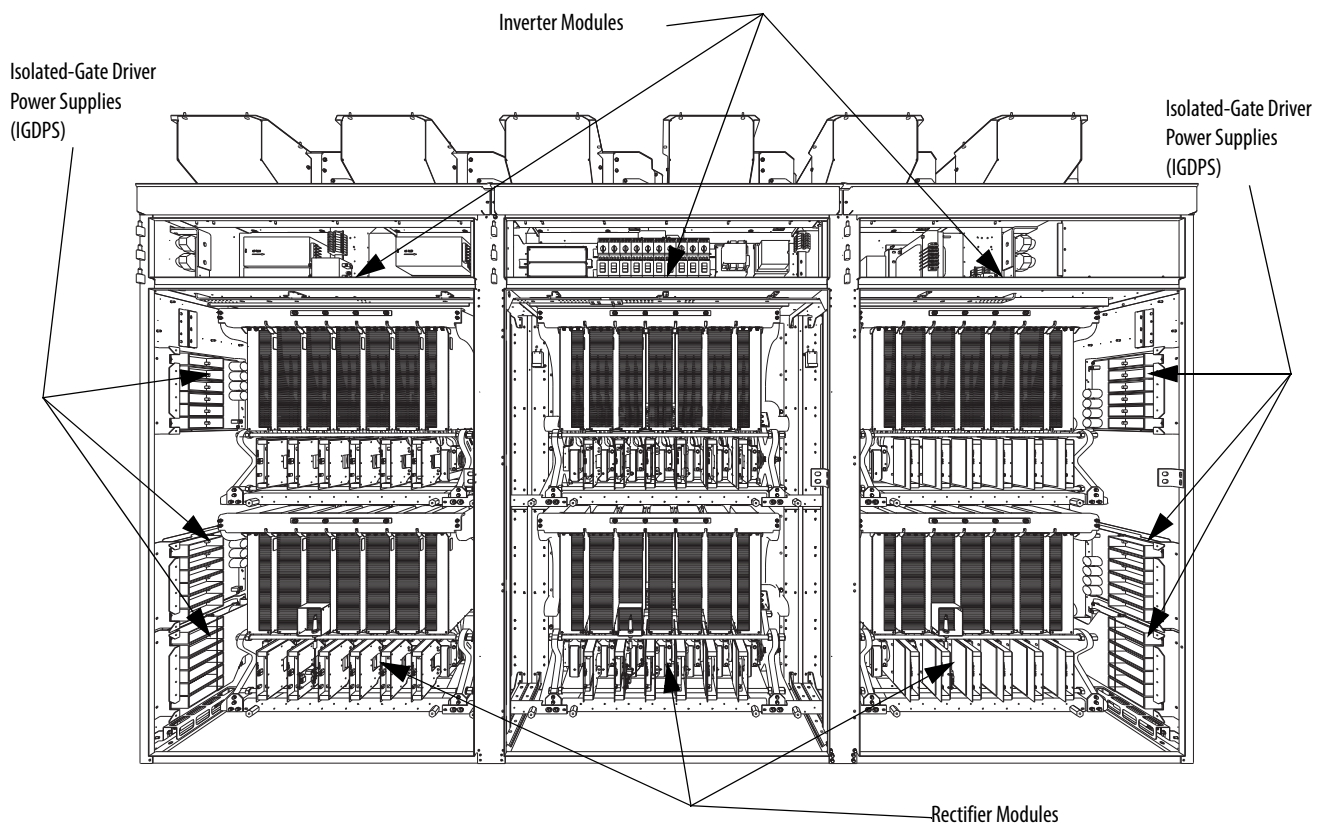


Figure 29 - DC Link/Fan Cabinet with Fan Control Panel (Heat Sink Model)

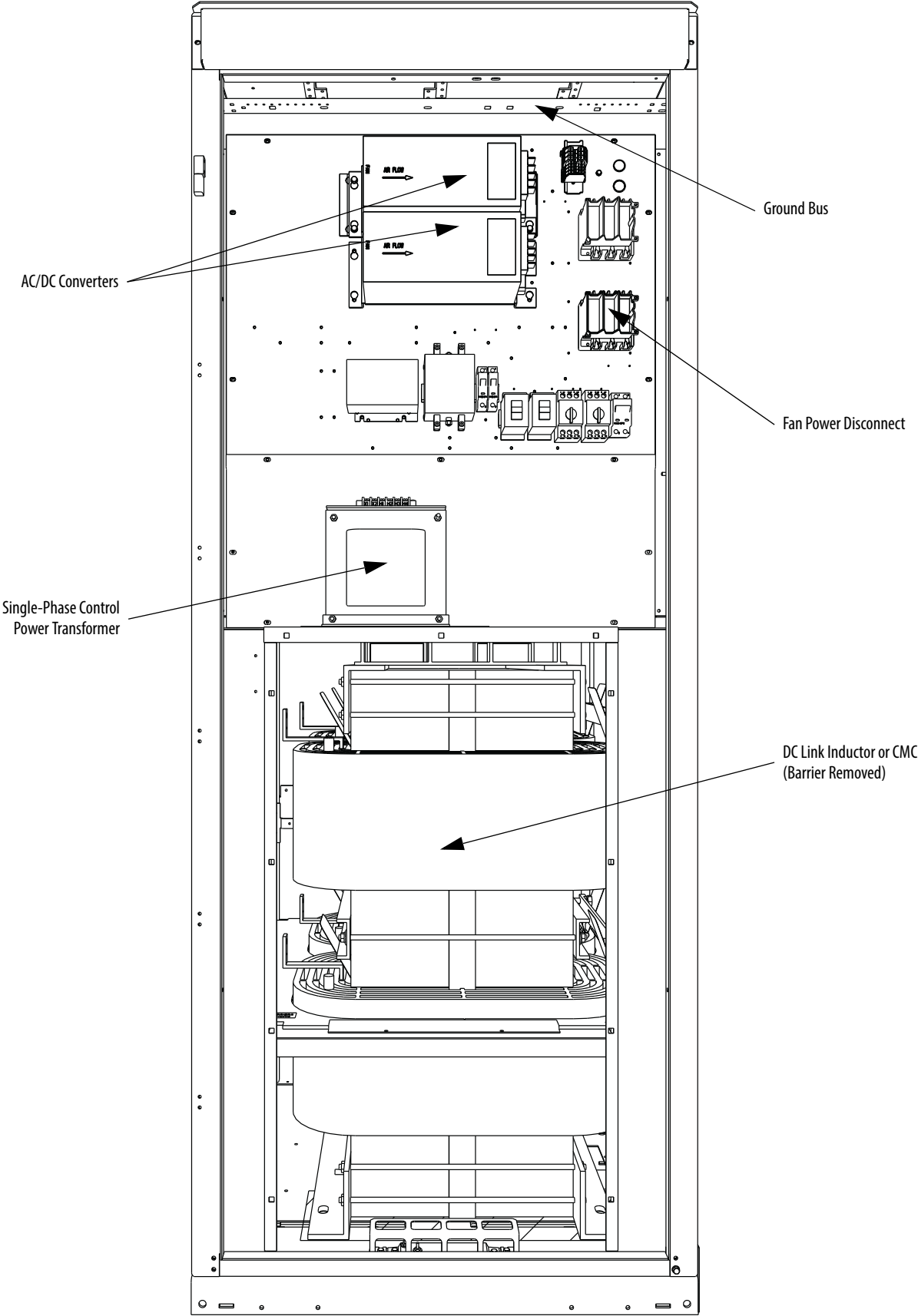


Figure 30 - DC Link/Fan Cabinet CMC (Heat Pipe Model)

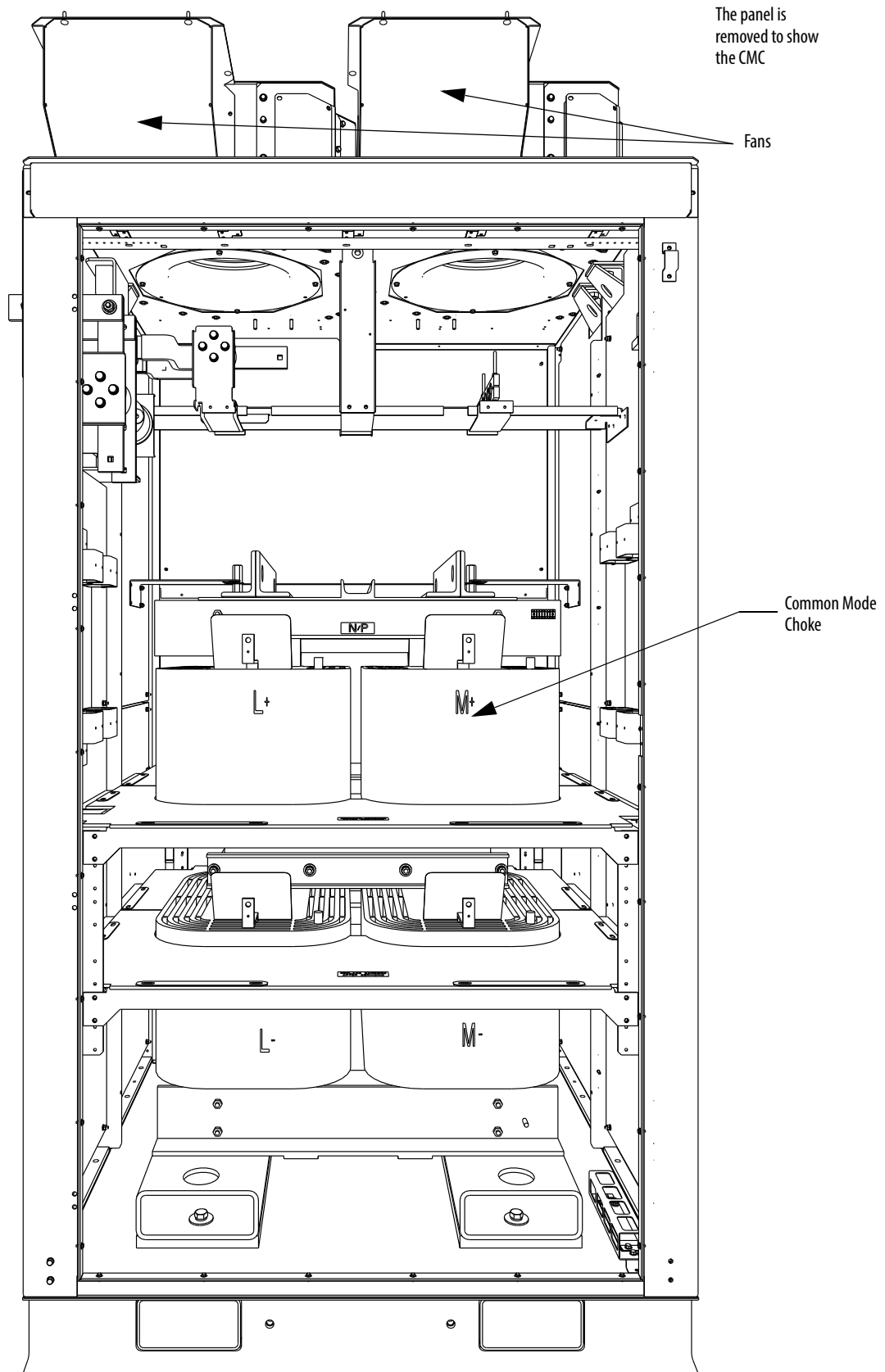
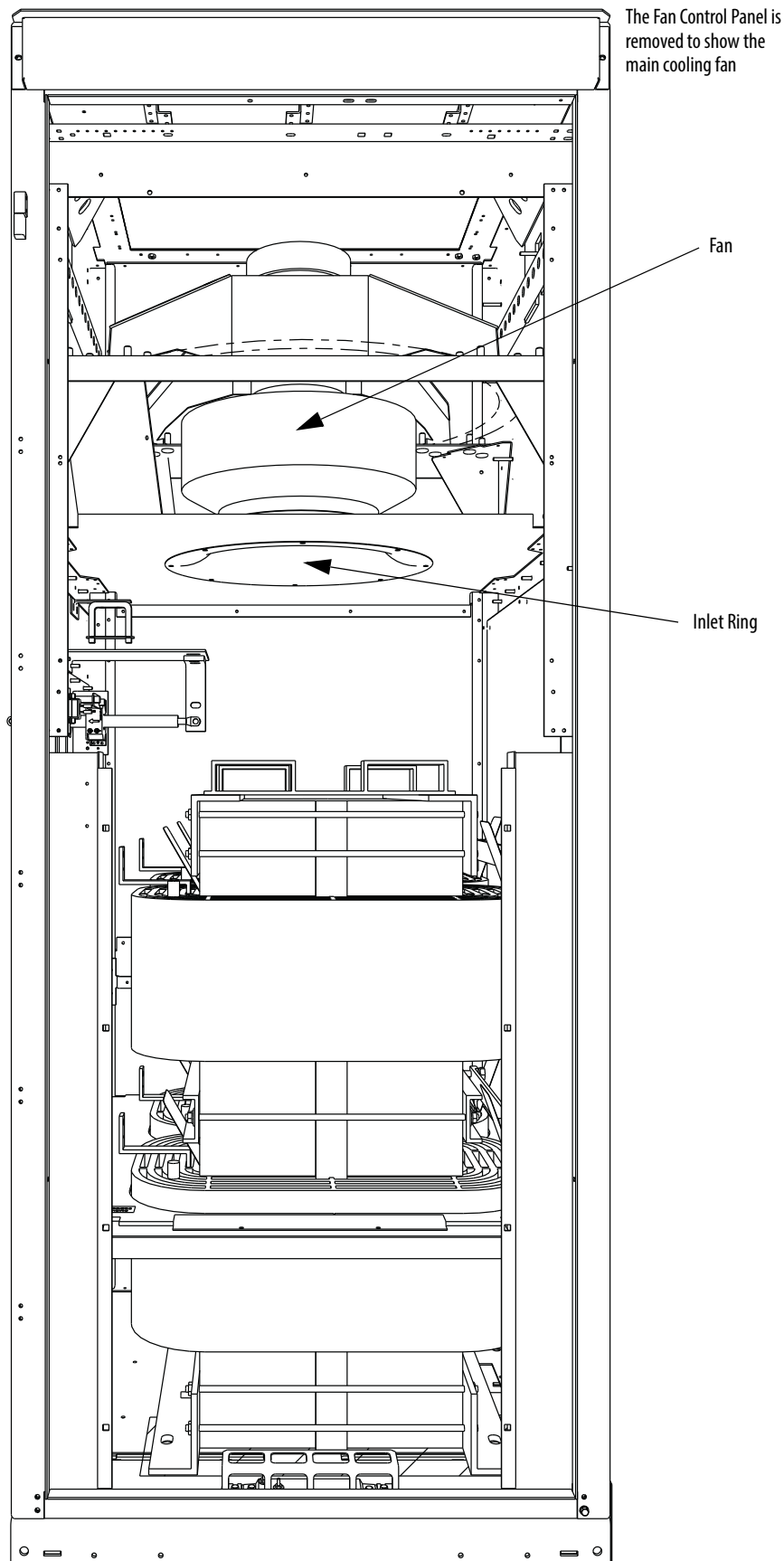


Figure 31 - DC Link/Fan Cabinet



IEC Component and Device Designations

PowerFlex 7000 drive electrical drawings use IEC-based conventions, while remaining compatible with ANSI (American National Standards Institute) standards. Component identification symbols on the drawings are international. PowerFlex 7000 drive elementary drawings (ED) set provides a full listing of these symbols. Each ED set also lists the device designations that are used on the drawings and labels with explanations.

The wiring identification uses a source/destination wire number convention on wiring that is point-to-point multi-conductor and elsewhere as warranted. The wire-numbering system of unique, single numbers for multi-drop and point-to-point wiring is common in general control and power wiring. When wiring connects between the sheets, or ends and continues on another a drawing, an arrow and reference is used in the drawing to indicate the ongoing connection.

The drawing reference indicates the sheet and the X/Y coordinates of the continuation point. Each drawing set contains a sheet with an explanation of the reference system. The wire-numbering system serves as confirmation that you are tracing the correct wire from sheet to sheet or across a drawing. Wires in multi-conductor cables are typically identified with color rather than by number. The abbreviations that are used to identify the colors on the drawings are fully identified on a sheet in the drawing set.

Selection of Power Wiring

These tables show general wire selections common to the PowerFlex 7000 drive installations.

IMPORTANT	Adherence to the recommended field-power cable insulation levels for medium voltage drives provides easier start-up and operation. Increase the cable insulation level over the default that is supplied for an across-the-line application with the same rated line-to-line voltage.
------------------	---

IMPORTANT	Use either shielded or unshielded cable, according to the requirements of the distribution system designer and local standards. However, NEC requires shielded cable for installations above 2 kV.
------------------	--

Cable Insulation

[Table 1](#) and [Table 2](#) provide cable insulation requirements for the PowerFlex® 7000 “B” Frame drive.



ATTENTION: Voltage ratings in [Table 1](#) and [Table 2](#) are peak line-to-ground. Some cable-manufacturers rate voltage line-to-line RMS. Verify that the cable meets the rating that is specified in [Table 1](#) and [Table 2](#).

Table 1 - Cable Insulation Requirements for AFE and 18-pulse Drives with Isolation Transformer

System Voltage (V, RMS)	Cable Insulation Rating (kV) (maximum peak line-to-ground)	
	Line Side	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

Table 2 - Cable Insulation Requirements for “Direct-to-Drive” Technology

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

[Table 3](#) identifies general wire categories common to the PowerFlex 7000 “B” Frame drive. Each category has an associated wire group number, which is used in the following sections to identify the appropriate wire to use. The table also provides:

- Application and signal examples.
- A recommended type of cable for each group.
- A matrix with the recommended minimum spacing between different wire groups that are run in the same tray or separate conduit.

Table 3 - 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 (in.)						
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								
	6	Digital (high speed)	Pulse Train, Input Encoder, PLC Communications	Belden 8760 Belden 9460 Belden 9463		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 in.).					

Wire Groups

1. 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

2. You can use steel conduit or cable tray for all PowerFlex 7000 Drive power or control wiring, and steel conduit is mandatory for all PowerFlex 7000 Drive signal wiring. Bring all input and output power wiring, control wiring, or conduit through the entry holes for the drive conduit of the enclosure. Use appropriate connectors to maintain the environmental rating of the enclosure. The steel conduit is MANDATORY for all control and signal circuits, when installing the drive in European Union countries. The connection of the conduit to the enclosure must be on full 360° and the ground bond at the junction must be less than 0.1 Ω. In EU countries, it is a usual practice to install the control and signal wiring.

3. The spacing between wire groups is the recommended minimum for parallel runs of 61 m (200 ft) or less.

4. The customer is responsible for the grounding of shields. On drives that are shipped after November 28/02, the shields are removed from the drive boards. On drives that are shipped before November 28/02, all shields are connected at the drive end. These connections must be removed before grounding the shield at the customer end of the cable. Ground shields for cables from one enclosure to another only at the source end cabinet. If you must splice shielded cables, the shield must remain continuous and insulated from the ground.

5. AC and DC circuits must run through separate conduits or trays.

6. Voltage drop in motor leads can adversely affect the motor start and run performance. Installation and application requirements can dictate that larger wire sizes than indicated in IEC / NEC guidelines are used.

Select the wire sizes individually, in accordance with all applicable safety and CEC or IEC/NEC regulations. The minimum acceptable wire-size does not necessarily result in operational economy. The minimum recommended size for the wires between the drive and the motor is the same as if it were a main voltage source-connection to the motor. The distance between the drive and motor can affect the size of the conductors used.

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

Installation

After the drive is placed at the installation site:

1. Remove the lag bolts that fasten the drive to the shipping skid.
2. Move the drive off the shipping skid and discard the skid.
3. Position the drive in its desired location.
4. Verify that the drive is on a level surface and that the position of the drive is vertical when you install the anchor bolts. The drive dimension-drawing shows the location of the provided anchor points.
5. Install and tighten the anchor bolts (M12 or 1/2in. hardware is required).

IMPORTANT Engineered bolt systems are mandatory for seismic requirements. Consult Rockwell Automation for further information, if necessary.

6. Remove the top lifting angles and retain the hardware.
7. Install the hardware from the lifting angles in the tapped holes at the top of drive. This blocks leakage of cool air and keeps dust out of the equipment.

Shock Indication Labels

Shock indication labels are devices that permanently record the physical shock occurring to the equipment.

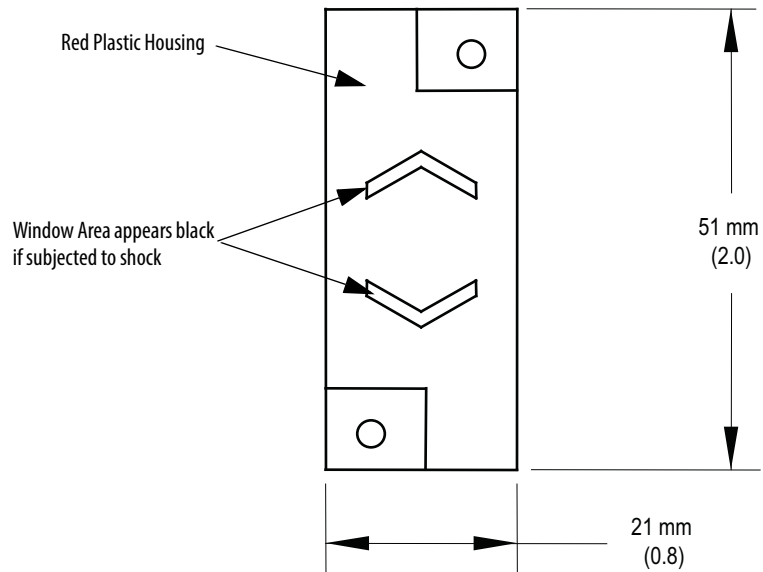
During final preparation for shipment, the factory applies a shock indication label that records shock levels in excess of 10G on the door of the converter cabinet.

During the shipping and installation process drives can inadvertently experience excess shock and vibration that can impair its functionality. When you have situated the drive in its installation area, inspect the shock indication labels on the converter door.

If sufficient shock levels occur, the chevron shaped window appears black in one of the two windows. Record the shock values. There is a greater possibility of the drive having sustained internal damage as the result of physical shock during the shipping and installation process.

Even if the shock indicators are clear, do a full equipment inspection and verification. See [Pre-Commissioning on page 71](#) for details on the inspection and verification process.

Figure 32 - Shock Indicator



Joining the Shipping Splits (3300...4160V and 6600V Heat Pipe)

IMPORTANT See publication [7000-IN008](#) for details regarding moving and siting the drive before continuing with these installation procedures.

The 3300...4160 and 6600V heat pipe drives are the “B” Frame models that ship in multiple sections (two for 3300...4160V and three for 6600V). All other “B” Frame models ship as one unit. For the 3300...4160V heat pipe model, the choke section ships separately from main section of the drive ([Figure 33](#)). For the 6600V heat pipe model, the choke cabinet and the line reactor section are shipped separately from the main section of the drive ([Figure 34](#)).



ATTENTION: Install the drive on a level surface (+/- 1 mm (0.039 in.) over the length of the drive). Use metal shims if necessary to level the cabinets before joining them. Do not attempt to level after joining as it twists the cabinets.

1. Arrange the sections as directed in the dimension drawings and move the sections together. Join the side sheets of the enclosure with thread-forming screws. Use the available holes.
2. Complete the ground bus, power, and control connections as directed in the electrical schematics and this installation guide.

3. Attach choke section to main section of the drive. See [Figure 33](#) and [Figure 34](#).

Figure 33 - Main and Choke Sections of 3300...4160V Heat Pipe Drive Cabinetry

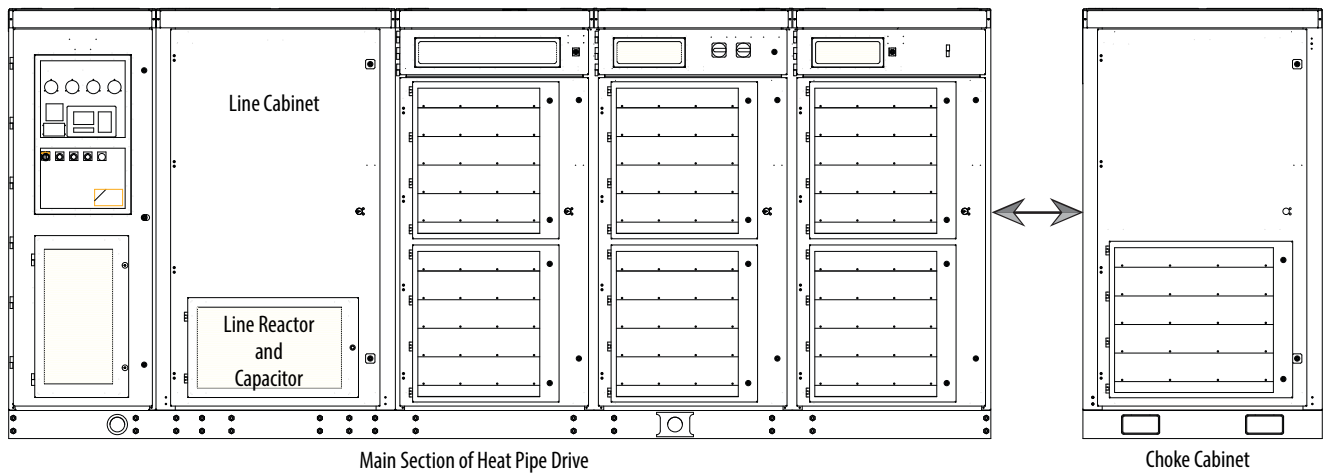
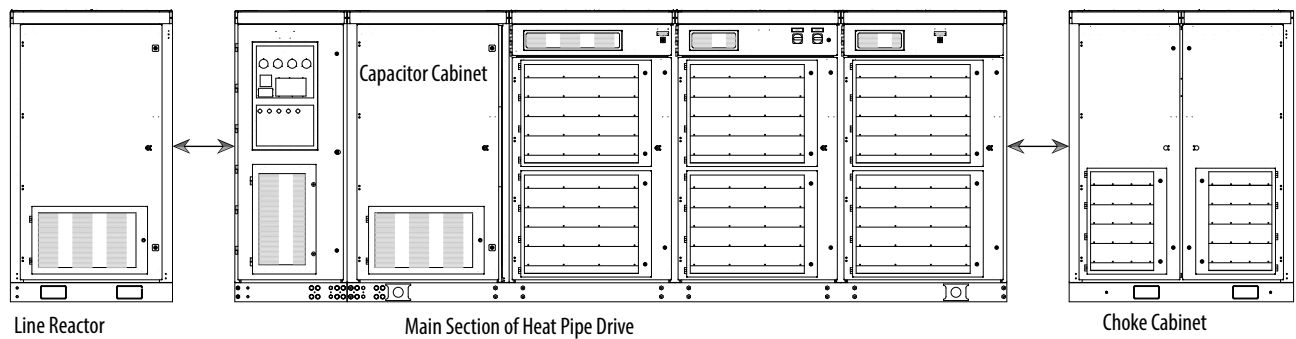
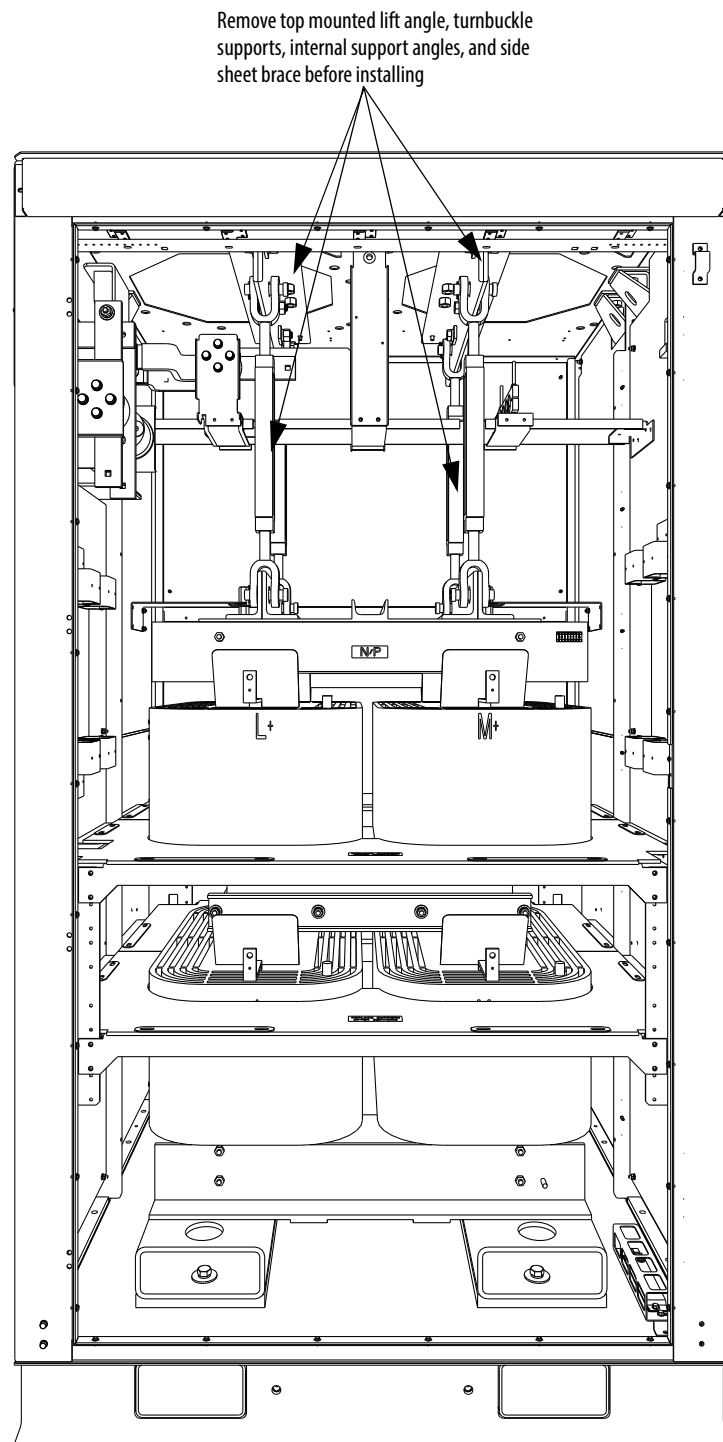


Figure 34 - Main and Choke Sections of 6600V Heat Pipe Drive Cabinetry



4. Remove the lift supports in the choke cabinet that is used for shipping and retain for future use. See [Figure 35](#).

Figure 35 - Heat Pipe Choke Cabinet (No Fans)

5. Join the choke cabinet side-sheet to the main drive cabinet side-sheet. Use the M10 hardware, see [page 107](#) for torque specifications.

Figure 36 - Aligning and Joining Heat Pipe Main and Choke Cabinets (for 3300...4160V and 6600V)

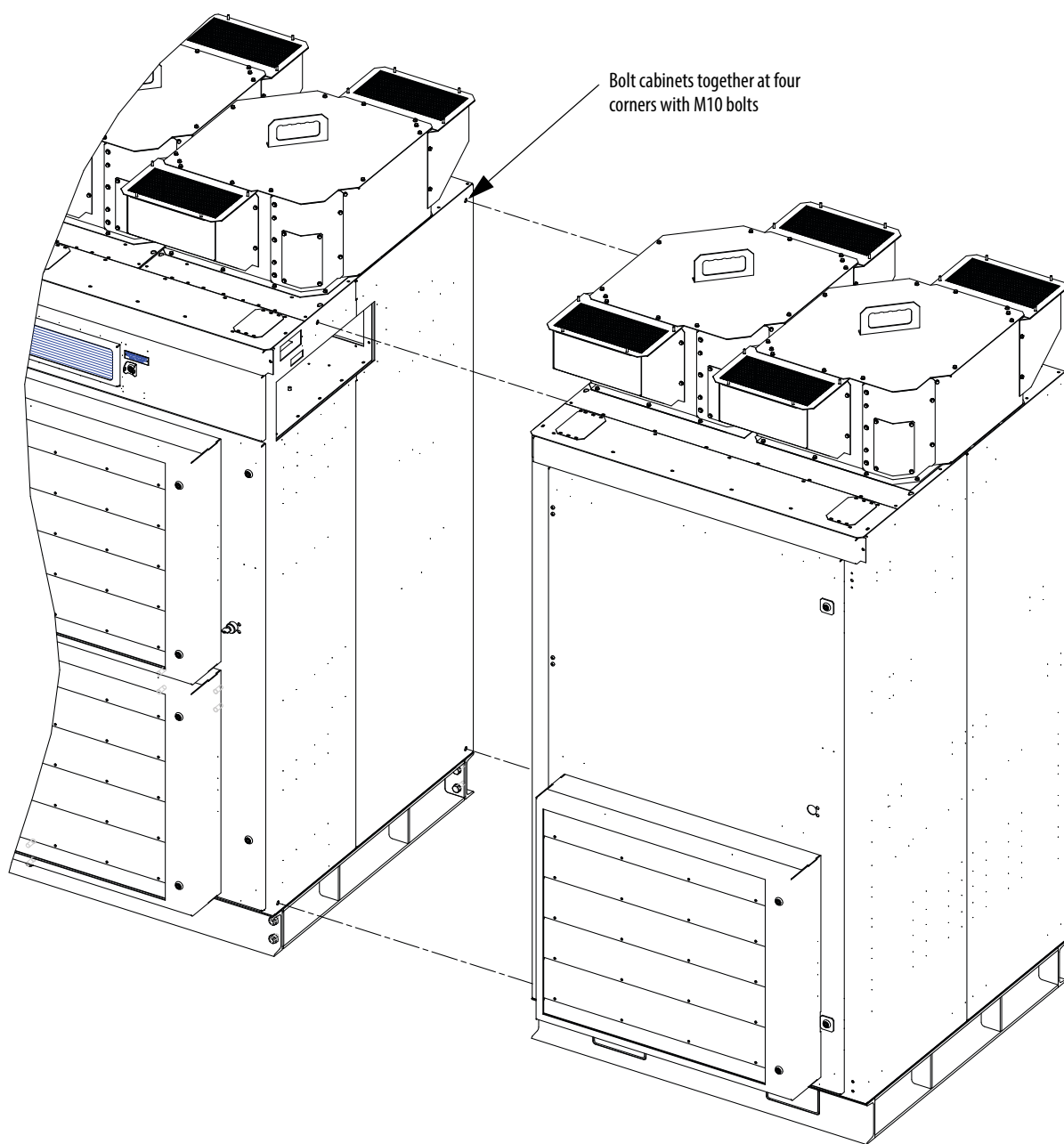
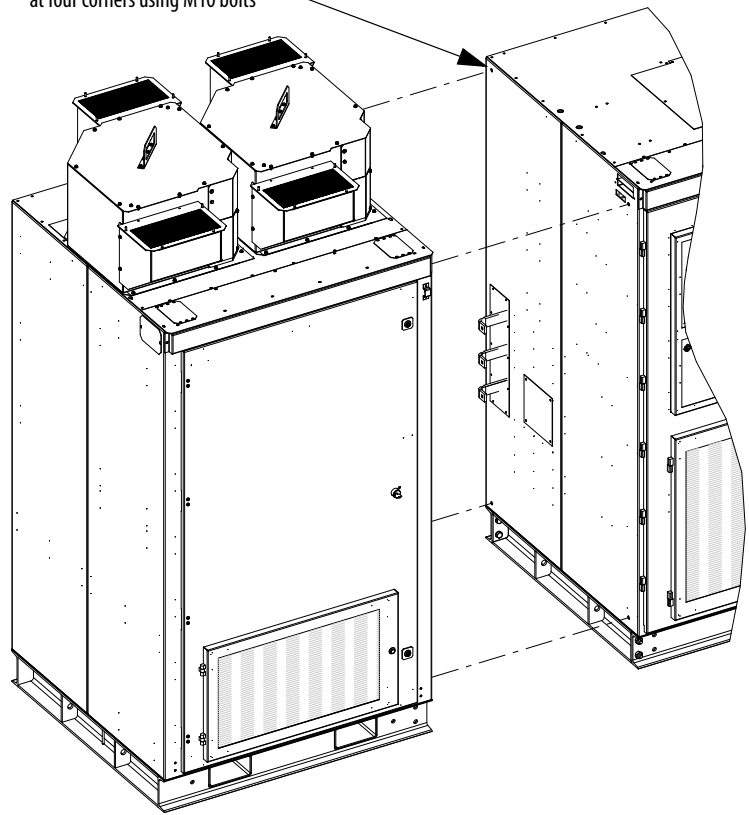


Figure 37 - Aligning and Joining Heat Pipe Main and Line Reactor (for 6600V only)

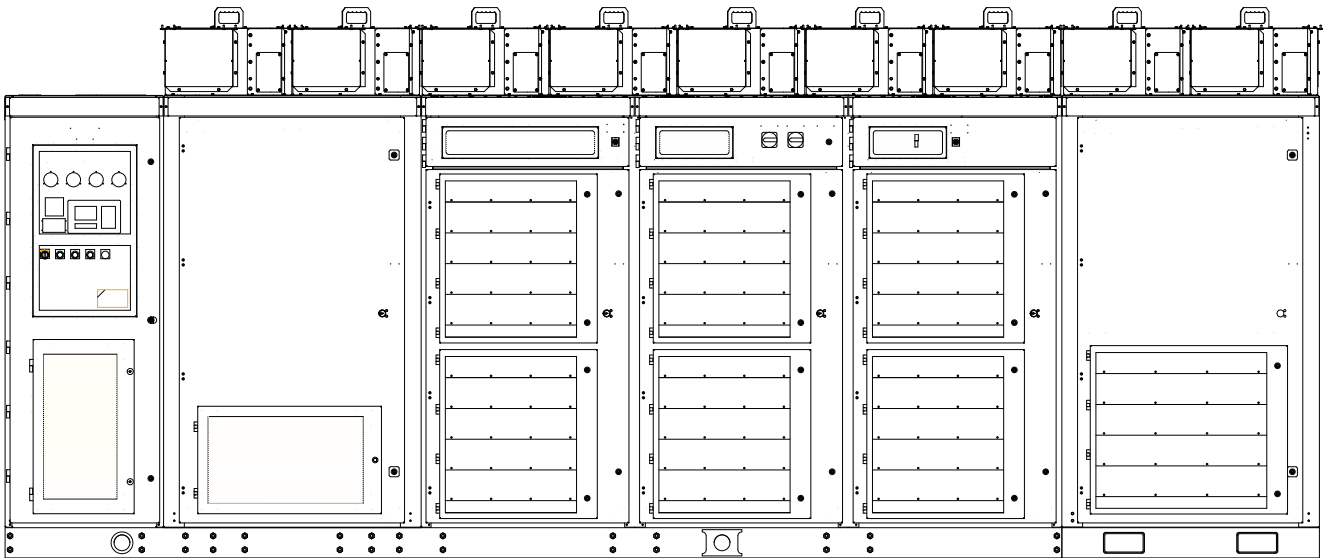
Cabinets that are bolted together
at four corners using M10 bolts



IMPORTANT There is no required order of operations for installing the fans and hoods, and joining the cabinets. Joining the cabinets first allows roof-top access to the upper bolts, but the bolts are also accessible from the front when the fans are installed first.

6. Install top mounted fans.

Figure 38 - 3300...4160V Heat Pipe Drive with Fans Attached



7. Connect the cables from the choke to M+, M-, L-, L+ bus connections at the top left corner of the choke cabinet.

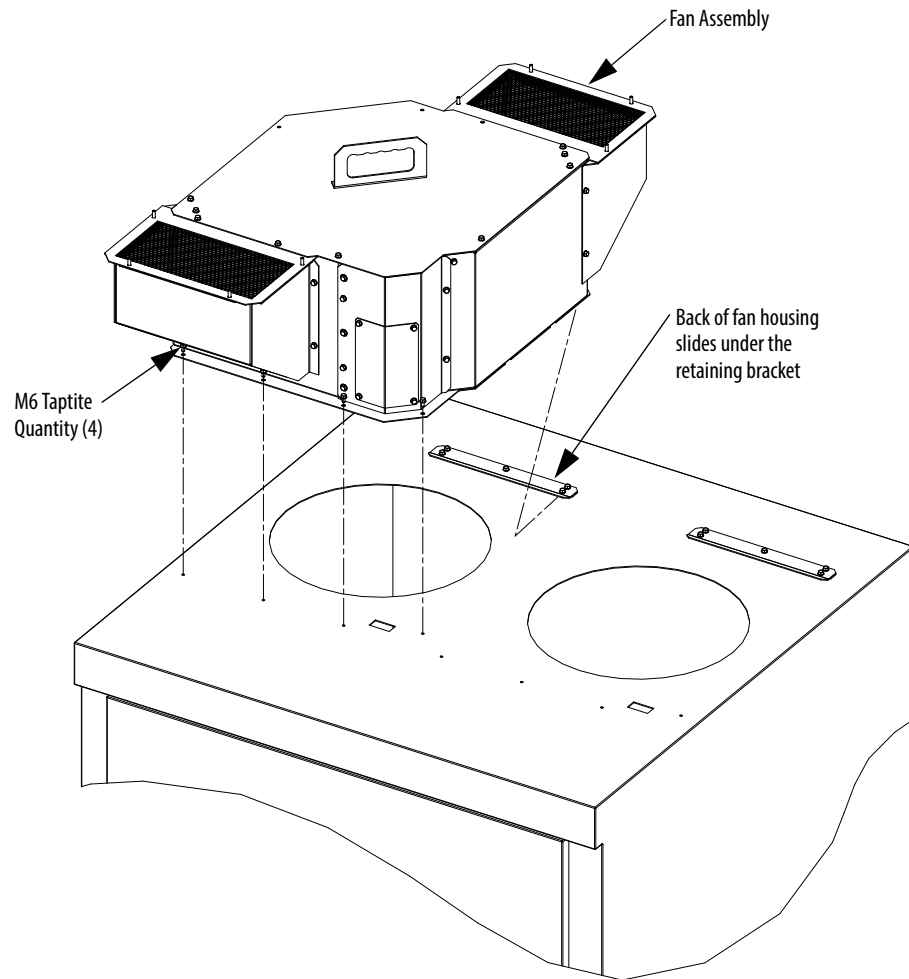
Installing Exhaust Fans and Air Hoods

Install an exhaust hood on the top of the cabinet with the cooling fan. The exhaust hood components ship with the drive, packed in the control/cabling cabinet. For drives with an acoustic hood, the components are shipped assembled, as shown in [Figure 41](#)).

1. Remove the protective plate that covers the fan opening on the drive. It is a flat cover plate that is bolted to the top plate. Remove the bolts and plate and retain for reuse.

Assembling Exhaust Fans

The cabinet-top fan assembly is similar to the model shown in [Figure 39](#).

Figure 39 - Fan Assembly (Heat Pipe Model Shown)

2. Slide the edge bottom edge of the fan housing under the retention bracket, and anchor the M6 hardware in the locations shown.

Assembling Fan Hoods

3. Assemble the two L-shaped panel components that are shipped with the drive as shown in [Figure 41](#).

Figure 40 - Fan hood Assembly

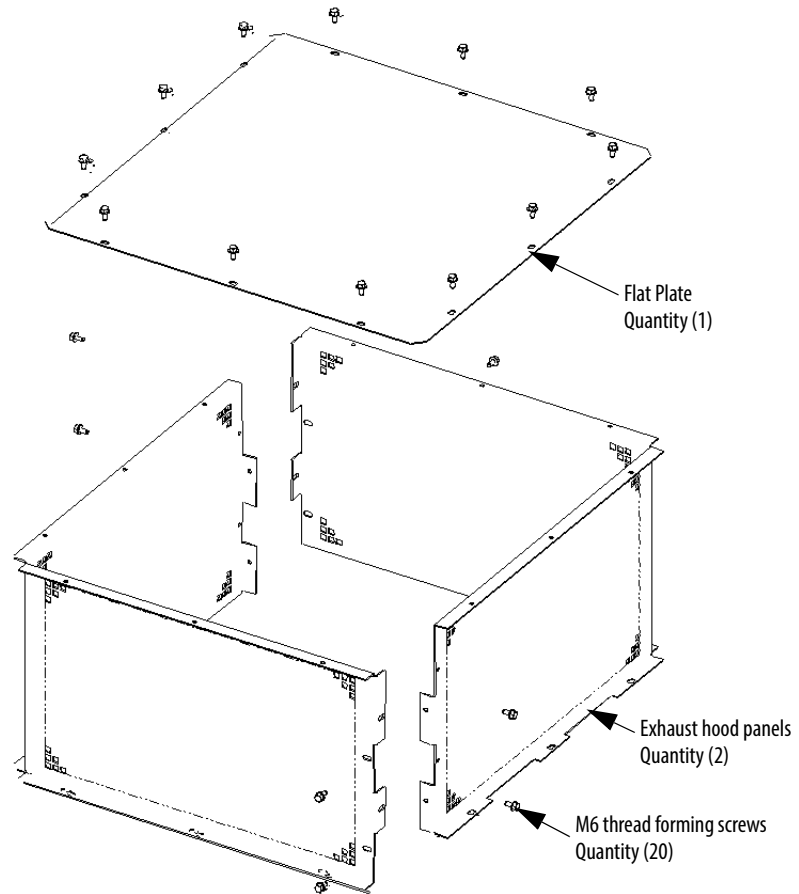
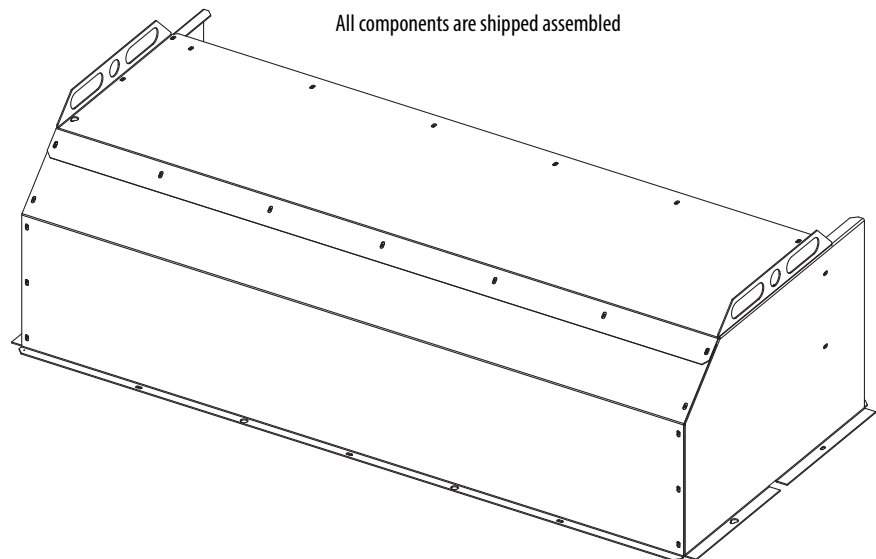


Figure 41 - Acoustic Fan hood Assembly



4. Locate the exhaust hood on top of the cabinet as show in [Figure 43](#), and install the original cover plate set aside in Step 1.

5. Align the notches on the bottom flange toward the sides of the drive. Affix the assembly to the drive top plate, and tighten all hardware. See [page 107](#) for torque specifications.

For drives with an acoustic hood (shown in [Figure 41](#)), locate the exhaust hood (see [Figure 43](#)).



ATTENTION: To avoid potential damage or injury retrieve any screws that accidentally fall into the equipment.

Figure 42 - Fan hood installation

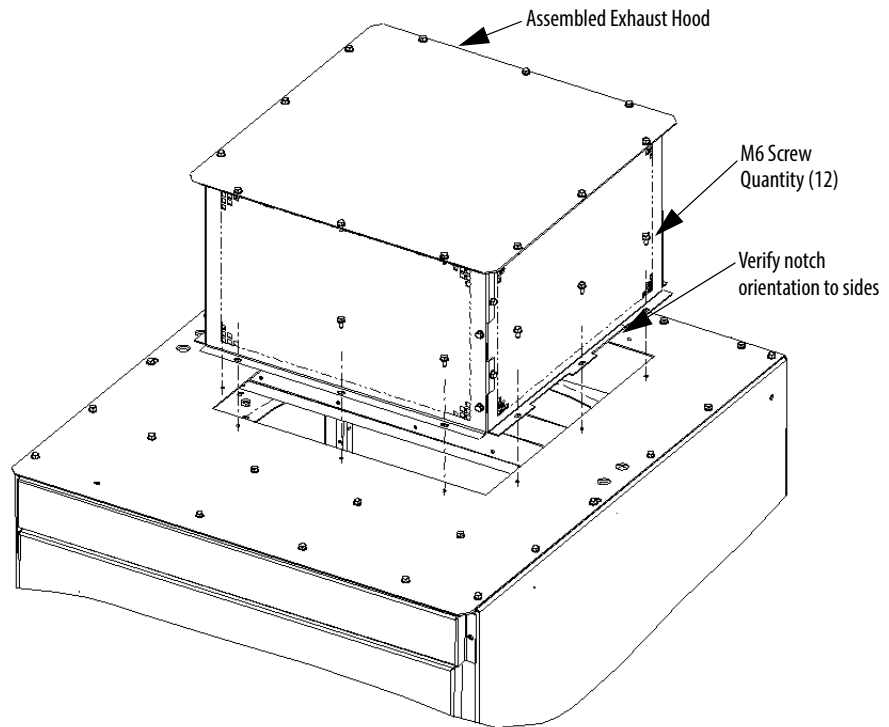
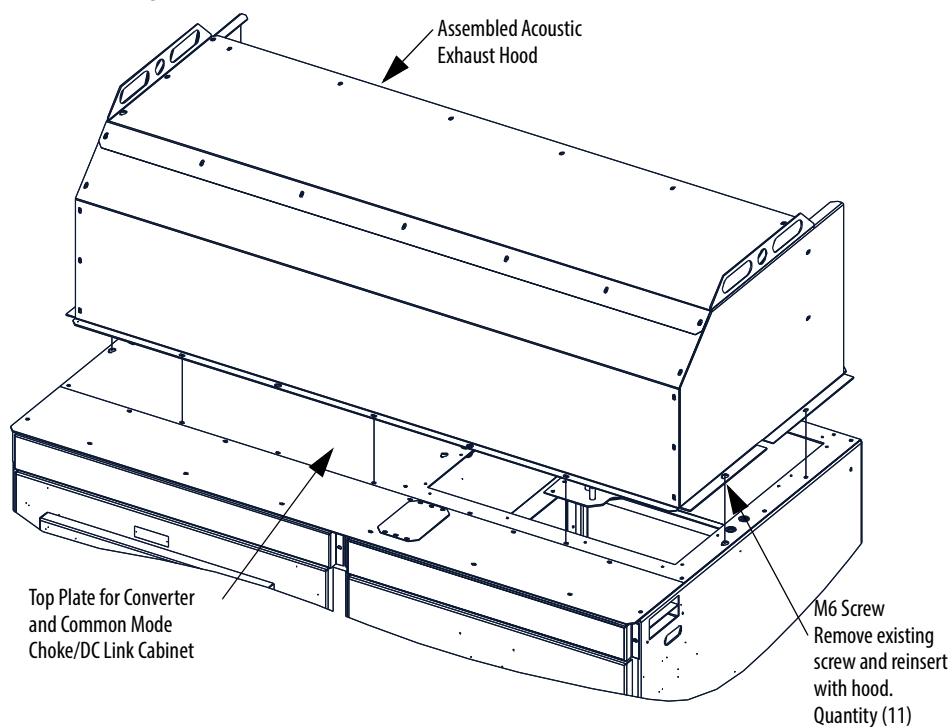


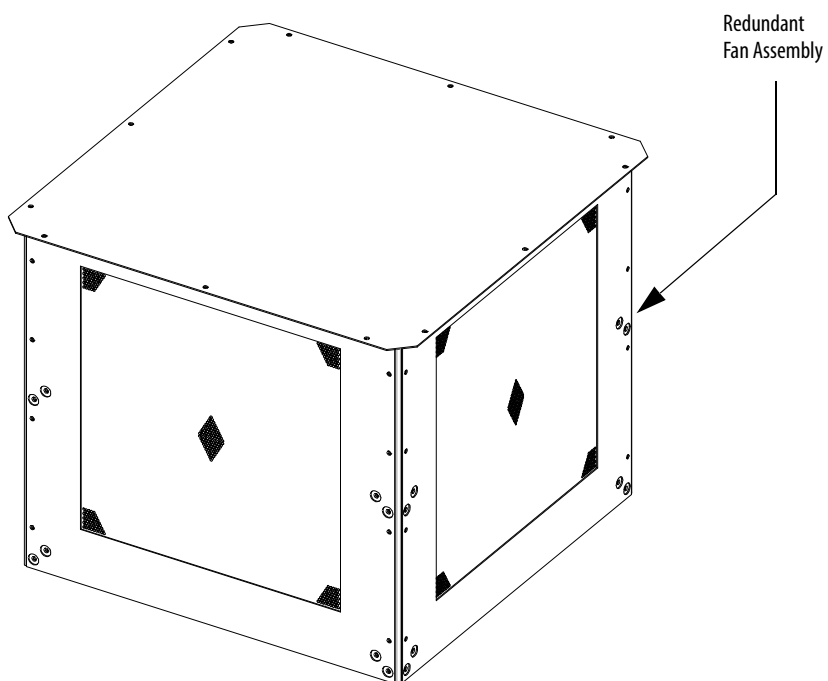
Figure 43 - Acoustic Fan hood Installation



Installation of Redundant Fan Assembly

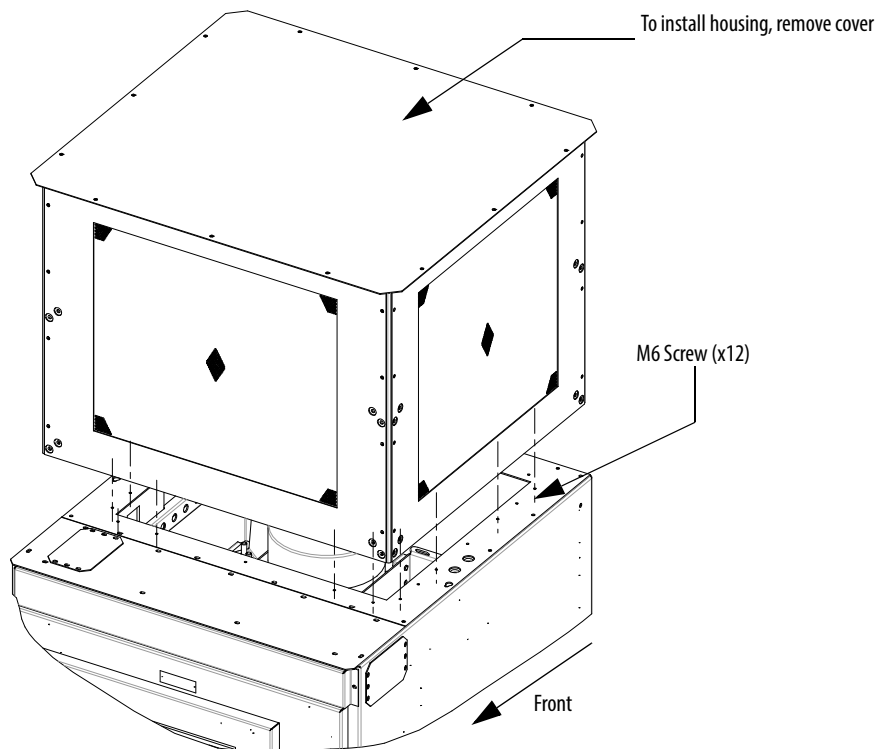
Redundant Fan components are shipped assembled ([Figure 44](#)).

Figure 44 - Redundant Fan Assembly



1. Remove the protective plate for the fan opening and discard all associated hardware.
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 that 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 45 - Redundant Fan Assembly Orientation



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

External Ducting

The PowerFlex 7000 design conducts exhaust air outside of the control room. Make special consideration for conditions present in the atmosphere outside the control room.



ATTENTION: If the drive configuration includes multiple exhaust outlets, duct each outlet separately to help prevent back-feeding hot exhaust into the drive. Heatpipe drives are excluded from this provision since each fan assembly is provided with back draft dampers.

These requirements are mandatory for systems that externally duct the exhaust air and draw clean outside air:

- An external duct with an external filtering system must not add more than 50 Pa (0.2 in.) of water pressure drop to the PowerFlex 7000 drive airflow system. A minimum 600 mm (24 in.) of clearance from an exhaust vent is required for heat pipe models.
- The control room must provide slightly more make-up air, to create a pressurized room. Pressurization keeps unfiltered air from being drawn into the room.
- The drive is intended to operate in conditions with no special precautions to minimize the presence of sand or dust, but not close to sand or dust sources. IEC 60721-1 defines the minimum as less than 0.2 mg/m³ of dust. If outside air does not meet this condition, filter the air to ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers) Standard 52.2 MERV 11 (Minimum Efficiency Reporting Value). This filtration reduces 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). Clean or change filters regularly to help maintain proper flow.
- The make-up air must be between 2...40 °C.
- Relative humidity must be less than 95% noncondensing.
- Approximately 10% of drive losses can still be rejected into the control room; address this issue, when required, to maintain the temperature in the control room within specification.
- Failure to maintain the proper flow of air for cooling into the control room can result in the drive stopping on low differential pressure across the heat sinks.

Power Cabling Access

The drive cabinetry provides for either the top, or bottom, power cable entry.

Cable access plates are available on the top and bottom plates of the connection cabinet; check your customer-specific dimension drawings for details.

To access the power cable terminations:

1. Open the door of the low voltage control compartment, which is hinged on its left side. The power terminals are behind the compartment.
The key interlock stops the compartment from swinging open unless the medium voltage source is locked out.
2. Turn each of the three latches on the right side of the compartment one-quarter turn, use an 8 mm hexagonal key wrench. There is a pull handle that is provided on the right side of the low voltage compartment.
3. Slowly pull the handle so the compartment swings out. The power terminals are now visible.

The access plates for power cables can require modification to suit the requirements. To maintain the environmental rating of the enclosure, use the appropriate connectors.

Figure 46 - Swing-out of Low Voltage Compartment (Heat Sink and Heat Pipe Models)

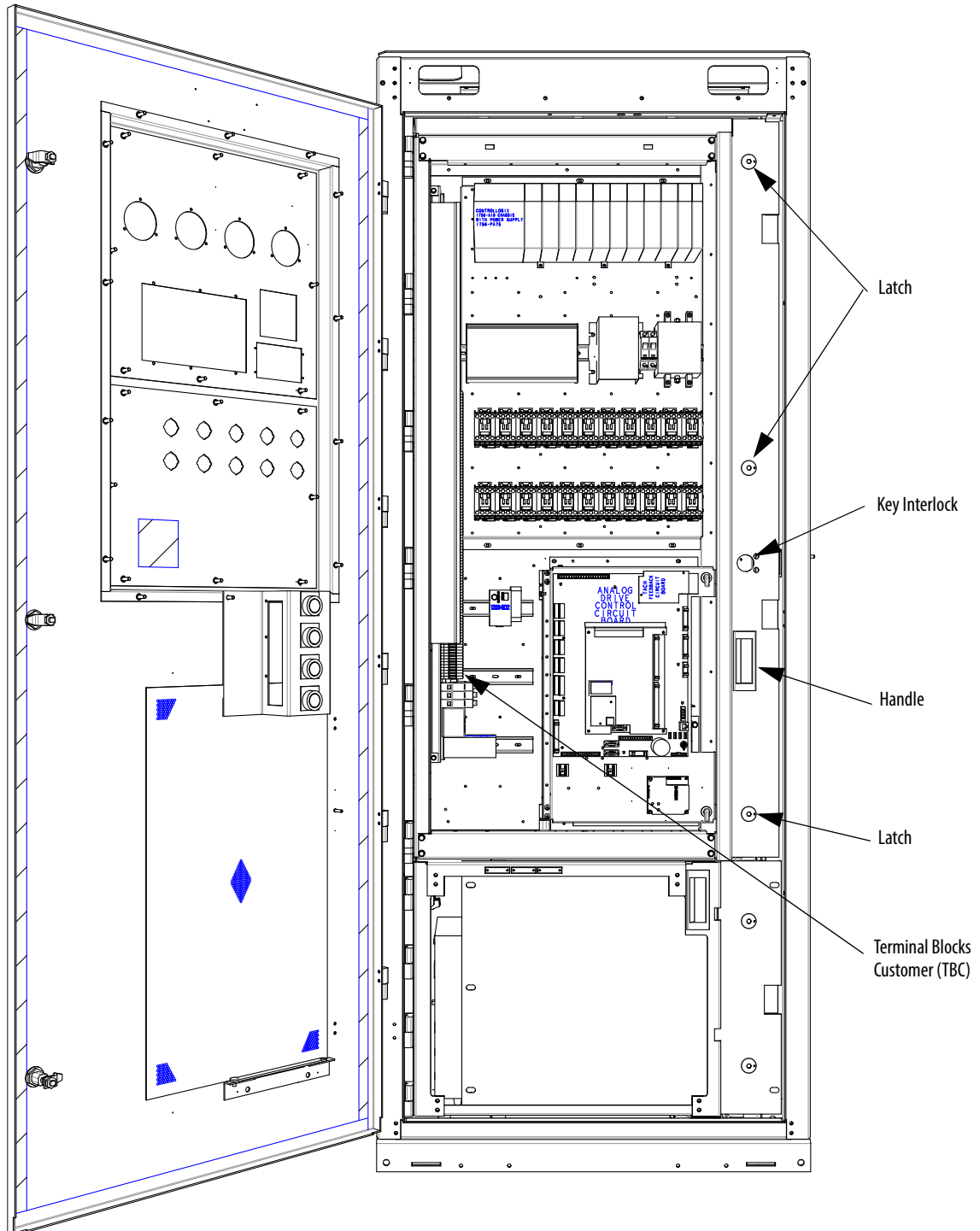


Figure 47 - Access to Power Terminals, AFE (Heat Sink Model)

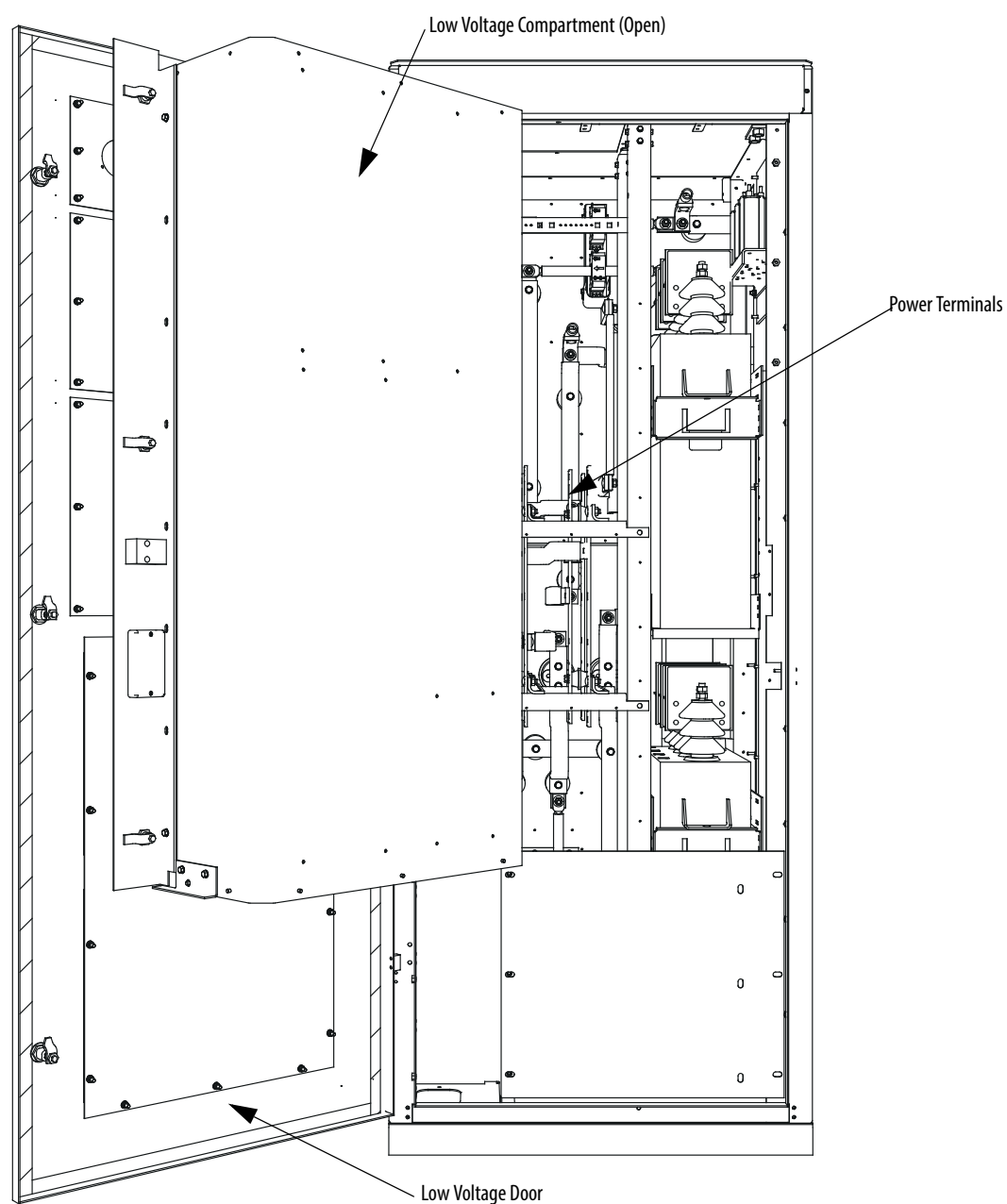
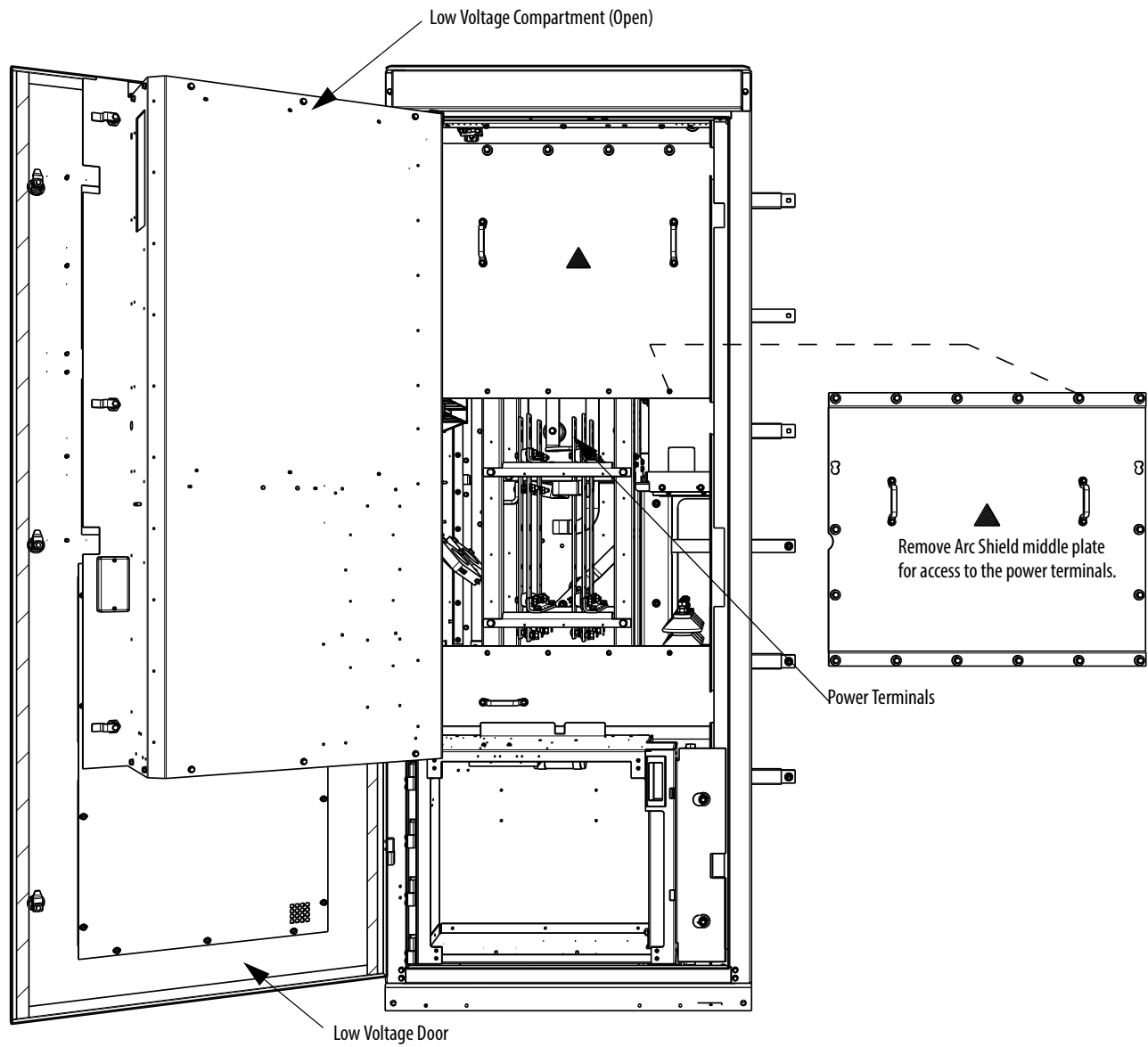


Figure 48 - Access to Power Terminals, AFE (Arc Resistant Heat Sink Model)



Power Connections

Verify that:

1. Interlocking with the upstream power source is installed and functioning correctly.
2. All equipment power connections meet with local electrical codes.

The drive provides for cable lugs, [Table 4](#) details the power terminals.

Table 4 - Incoming Connections

Drives with AFE Rectifiers:	2U, 2V, 2 W
Secondary (d0)	2U, 2V, 2 W
Secondary (d-20)	3U, 3V, 3 W
Secondary (d+20)	4U, 4V, 4 W
Motor Connections	U, V, W
Drives with AFE Rectifiers:	2U, 2V, 2 W

Installation Requirements for Power Cabling

These drawings illustrate:

- A front view of the 900 mm input cabinet for AFE drives.
- Typical line cable-termination assemblies (18-pulse).

Figure 49 - Front View of 900 mm Control/Cabling Cabinet, AFE (Heat pipe Model)

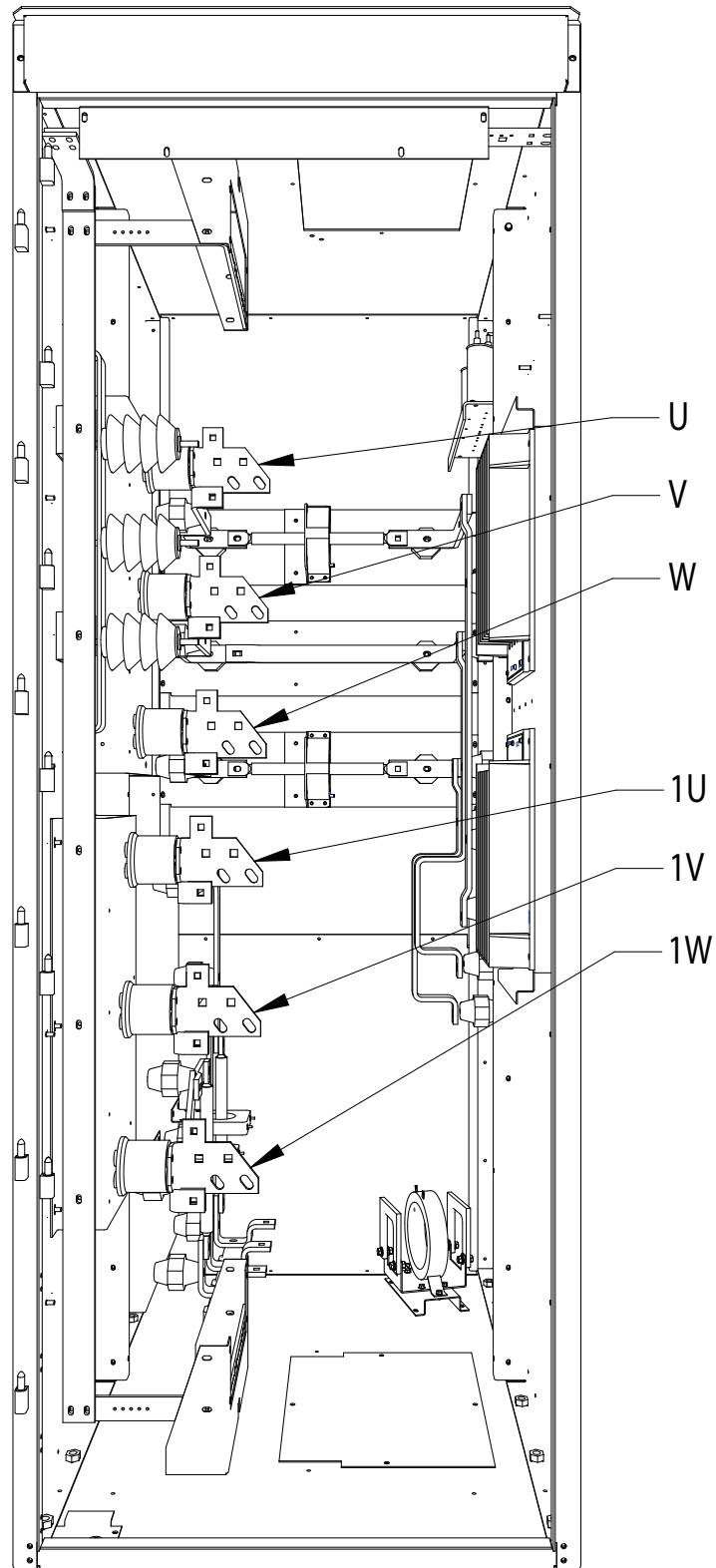
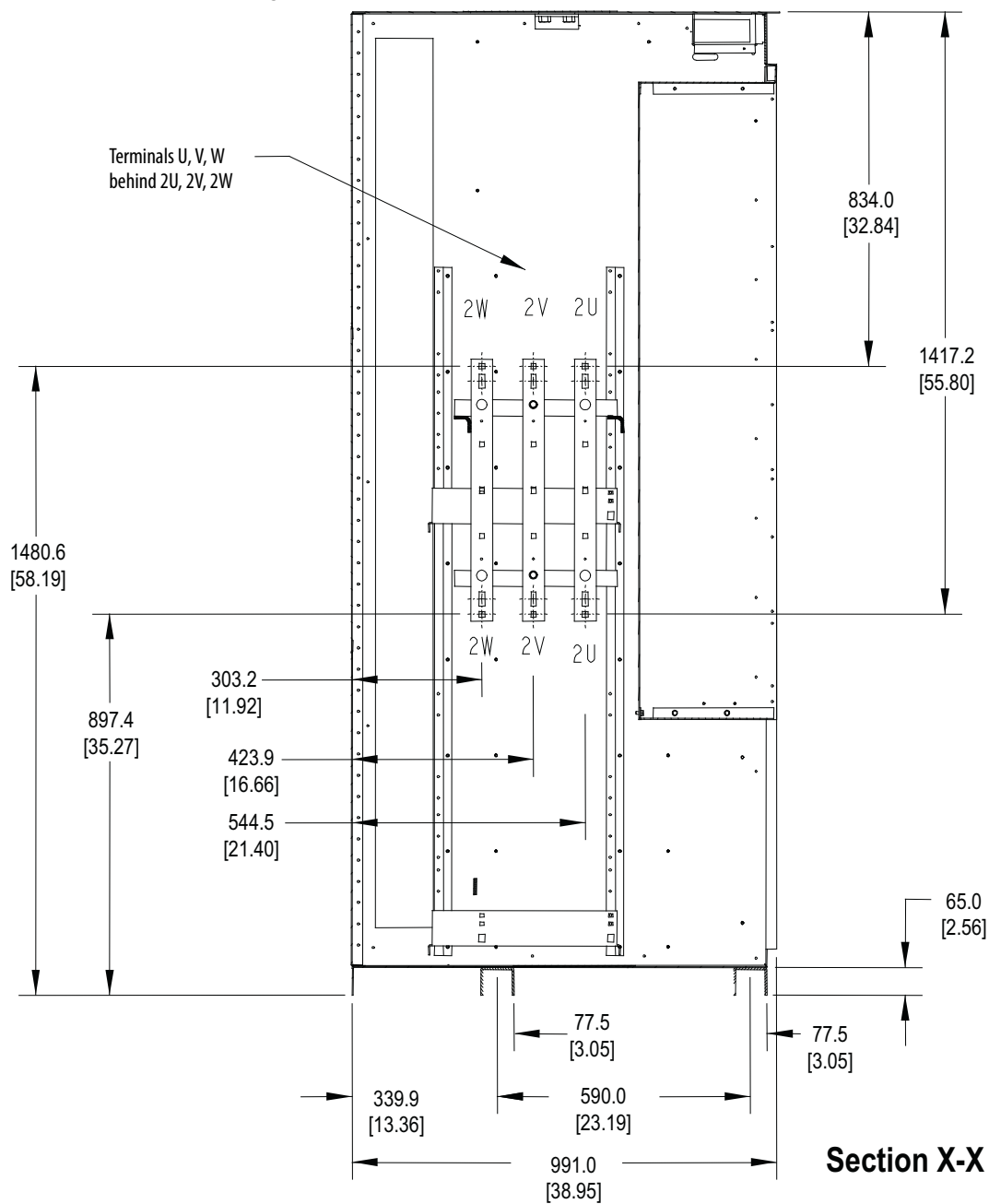


Figure 50 - Detail Power Terminal Dimensions (Heat Sink AFE Rectifier)



Confirm the torque that is applied on all power connections is correct. See [Torque Requirements for Threaded Fasteners on page 107](#) for more information.

The drive provides for grounding cable shields and stress cones near the power terminals.

Power and Control Wiring

Drive lineups (that is drive and input starter) shipped in two or more sections to make the require reconnection for power and control wiring easier. After joining the sections, reconnect the power and control wiring as shown in the schematic drawings that are provided with the drive.

Control Cables

1. Locate the control cable entry/exit near the terminal block 'TBC'.
2. Route connections along the empty side of the TBC terminals.

These terminals accept a maximum AWG #14 wire gauge.

3. Connect the low voltage signals (includes 4...20 mA) using twisted shielded cable, with a minimum AWG #18 wire gauge. Based on using a W4 terminal block for customer connections, comparable wire sizes would be 0.5...4 mm² as equivalent to #22-#10 AWG.

Two encoder inputs accommodate a quadrature encoder (senses motor direction). The encoder power supply is isolated and provides 15V and a ground reference. Many encoder outputs have an open collector output, which requires an additional pull-up resistor to feed proper signals to the system logic. See [Torque Requirements for Threaded Fasteners on page 107](#) to see if one is required.

IMPORTANT	Connect low voltage signals using twisted shielded cable, connecting the shield at the signal source end only. Wrap the shield at the other end with electrical tape and isolate it. Make connections as shown on the drawings provided.
------------------	--

Encoder Installation Guidelines

Transmission problems from the encoder to the drive include signal distortion and electrical noise. Either problem can result in a gain or loss of encoder data counts (quadrature encoders) or corrupt positional data (absolute encoders). This section provides general guidelines and recommended practices for field-installed equipment, and applies to either encoder board and both quadrature and absolute encoders.

Protection from Radiated and Conducted Noise

Take care when connecting and routing power and signal wiring on a machine or system. Radiated noise from nearby relays, solenoids, transformers, non-linear loads (such as motor drives) can couple onto signal wires to produce undesired pulses. The encoder itself can also induce noise into adjacent signal lines.

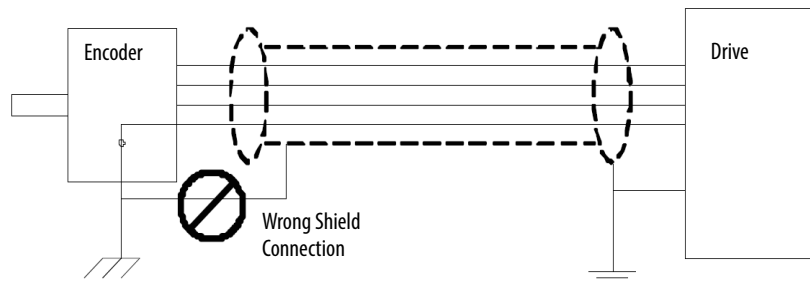
To avoid radiated or conducted noise, run power and signal lines separately with a minimum distance between them of at least 75 mm (3 in.). If they must overlap somewhere in the system, run the power lines at 90° to the signal lines. Signal lines must use twisted pair shielded cable and run in a separate conduit that is grounded to the building ground.

Encoder wires and shields must maintain continuity from the encoder to the drive. Avoid using a terminal block in a junction box as it has the potential to create radiated noise and ground loops.

Ground the encoder case to the building ground for proper operation. If you cannot make a ground connection through the mounting bracket/machine ground, most encoders provide for a case ground connection through the connector/cable pair.

IMPORTANT DO NOT ground the encoder case through the machine and cable wiring. Use low capacitance wires (≤ 40 pF/ft) with 100% shield coverage for long cable runs. Connect the shield ground only at the drive end, see [Figure 51](#).

Figure 51 - Detail Power Terminal Dimensions



For more protection against electrical noise, specify an encoder with complementary outputs and connect with twisted-pair cable. With this type of cabling, the induced currents self-cancel.

As a final precaution, ground the shield together with all other parts of the system that require grounding to one ground. The one ground reduces varying ground potentials, caused by high current fluxes from motors, remote control switches, and magnetic fields.

Signal Distortion

The primary causes of signal distortion are cable length and capacitance. The longer the cable, the greater chance of signal distortion at the receiving end. The receiving end responds to either a logical '0' or a logical '1'. Anywhere between those values are undefined and the transition through this region is $< 1.0 \mu\text{s}$. If the leading edge of the waveform is distorted, it causes the transition time through this region to increase. At some point, the receiver can become unstable and either gain or lose encoder counts.

To reduce the effects of signal distortion at the encoder that is receiving electronics, consider these guidelines:

1. Use a low capacitance cable ($< 120 \text{ pF/m}$ [40 pF/ft]). For example, Belden 1529 A is an 18Awg 3pair cable having a capacitance of 114 pF/m (35 pF/ft).
2. Use twisted-pair cabling with a shield that covers 100% of the cable. This guideline is especially true in the case of quadrature encoders and for absolute encoders. Although, the data in absolute encoders do not exhibit the same frequency spectrum as quadrature encoders so you can use single wire cabling. In either case, always check with the encoder manufacturer for the recommended cable.
3. Keep cable distances as short as possible. Rockwell Automation recommends the following cable lengths:
 - a. For the 20B-ENC encoders, maximum cable length is 65 m (200 ft). Longer cable distances could cause excessive surge currents. The operating frequency of the encoder has no bearing on this recommended distance due to the AC Termination. However, keeping the frequency so that the characteristic impedance of the cable is $\sim 348 \Omega$, improves the surge currents. It can also increase the maximum distance to 100 m (330 ft).
 - b. For the Universal Encoder Interface, maximum length is 200 m (650 ft) @ 100 KHz, or to 500 m (1600 ft) at frequencies below 55 KHz. Do not exceed this distance because the voltage drop across the cable can cause decreased power at the encoder.

Unused Inputs

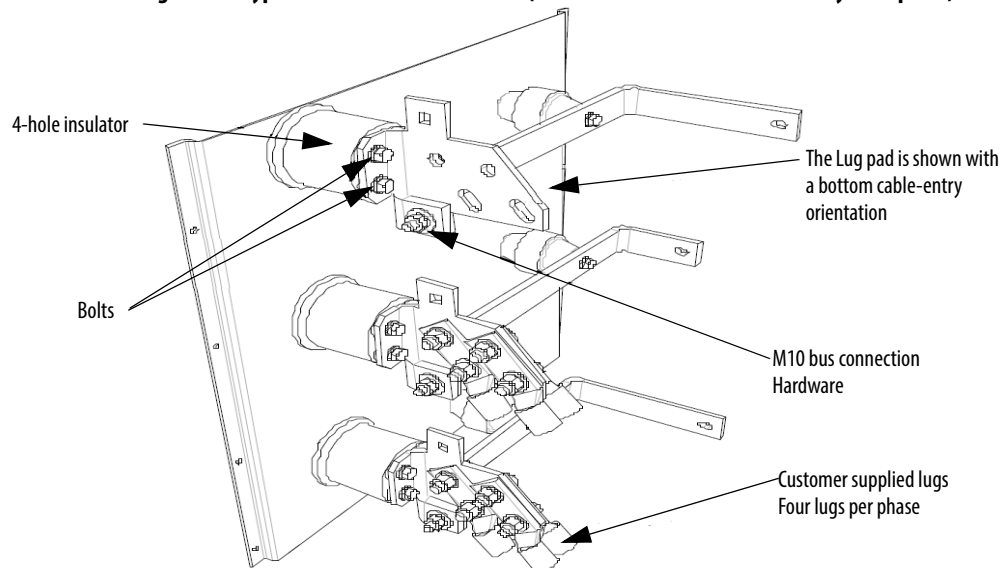
Sometimes not all inputs are required in either the quadrature or absolute encoders. For example, the absolute encoder accepts a 12-bit encoder but also works with a lower resolution. Likewise, sometimes quadrature encoders do not use the Z track. Follow these guidelines for unused inputs:

1. 20B-ENC Board. Wire any unused input to the encoder power rail, including the B and B' inputs if a pulse encoder is used. Failure to do so results in phase loss warnings and improper operation of the encoder feedback logic, for example missing counts.
2. Universal Encode Interface. When used as a quadrature encoder interface, the same rule applies as for the 20B-ENC Board. When operating as an absolute encoder interface, the wiring of unused inputs depends on the position of the POL_QRDNT jumper. If the jumper is installed, wire all unused inputs to ENC PWR, otherwise use ENC COM.

Terminating the Customer Cables

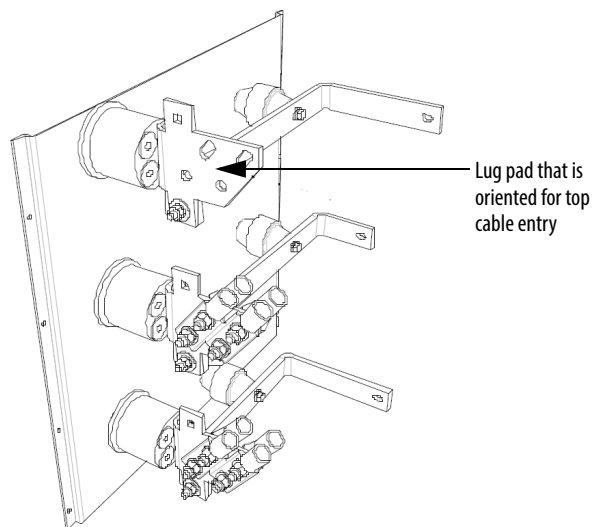
Customer termination assemblies can accommodate either top, or bottom, customer cable entry. For clarity, [Figure 52](#) and [Figure 53](#) show only one phase of three; there are a total of nine lug pads.

Figure 52 - Typical Line Cable Termination (assembled for bottom cable entry – 18-pulse)



For top-line cable entry, remove the lug pads and reorient them as shown in [Figure 53](#). To remove the lug pads, disconnect the M10 bus connection hardware (17 mm hex tooling required). Remove the two bolts that secure the lug pad to the 4-hole insulator. See [Torque Requirements for Threaded Fasteners on page 107](#) for more information regarding these electrical connections.

Figure 53 - Line Cable Terminal Assembly (modified for top cable entry – 18-pulse)



Grounding Practices

Grounding:

- Increases personnel safety.
- Limits dangerous voltages on exposed parts regarding ground.
- Facilitates proper over-current device operation under ground fault conditions.
- Provides electrical interference suppression.

Generally, all external equipment grounding must meet the Canadian Electrical Code (CEC) C22.1, or the NEC NFPA 70, and applicable local codes.

See these diagrams for ground connections. Do not connect the main ground bus of the drive to the system ground. This ground bus is the common ground point for all grounds internal to the drive.

Figure 54 - Ground Connection Diagram with Isolation Transformer

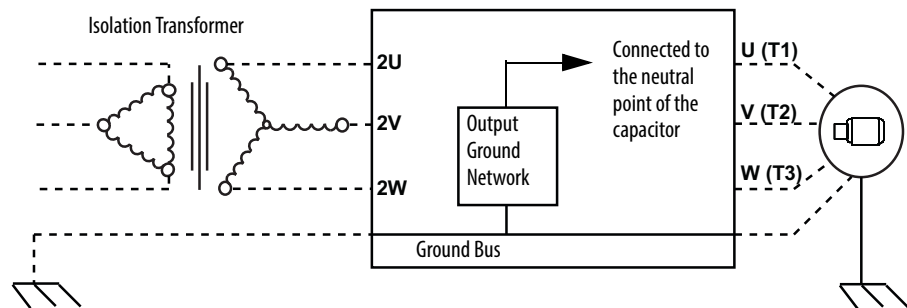
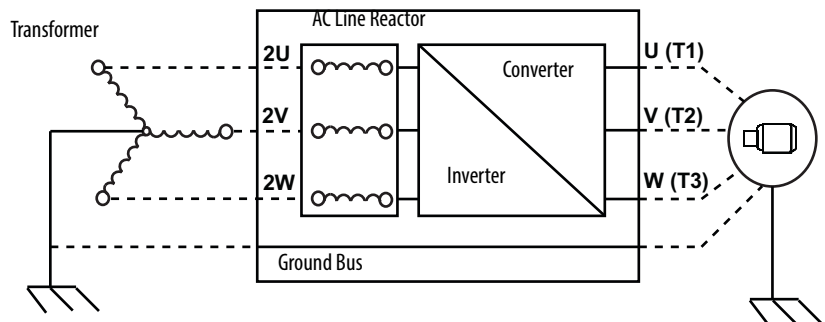


Figure 55 - Ground Connection Diagram with Line Reactor



Provide each power feeder from the substation transformer to the drive with properly sized ground cables. Using conduit or cable armor as a ground on its own is insufficient.

IMPORTANT If a drive isolation transformer is used, do not ground the WYE secondary neutral point.

Bond each AC motor frame to the buildings steel that is grounded and within 6 m (20 ft) of its location. Tie it to the ground bus of the drive via ground wires within the power cables or conduit. The conduit or cable armor must bond to ground at both ends.

Guidelines for Drive Signal and Safety Grounds

When using interface cables that carry signals (where the frequency does not exceed 1 MHz) for communications with the drive, follow these general guidelines:

- Ground screen mesh around the entire circumference, rather than forming a pigtail grounded only at one point.
- For coaxial cables with one conductor that is surrounded by a mesh screen, ground the screen at both ends.
- When using a multi-layer screened cable (that is, a cable with both a mesh screen and a metal sheath or some form of foil), there are two alternative methods:
 - Ground the mesh screen at both ends to the metal sheath or foil (known as the drain). The sheath must (unless otherwise specified) be grounded at one end only. The end is at the receiver end or the end that is physically closest to the main equipment ground bus.
 - Leave the metal sheath or foil insulated from ground, and ground the other conductors and the mesh cable screen at one end only.

Specifications for Customers and Power Integrators

Attach an external ground to the main ground bus, in compliance with applicable local codes and standards. As general guidelines, 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 must be no higher than 4V over ground potential.
- The current flowing into a ground fault is of sufficient magnitude to cause the protection to operate.

Run the main grounding conductor separately from power and signal wiring so that faults do not:

- Damage the grounding circuit.
- Interfere with or damage, protection and metering systems, or cause undue disturbance on power lines.

Electrical Supplies: Grounded and Ungrounded Systems

The cable insulation rating of an ungrounded, three-phase electrical supply system, must handle both the phase-to-phase voltage and the voltage-to-ground. This requirement is in case one of the other phases develops a ground fault.

The cable insulation must be rated for continuous voltage of root three (1.732) times (1.1) times the rated voltage of the supply ($1.732 \times 1.1 = 1.9$) times the rated line-to-line voltage).

Ground Bus

The drive ground bus runs along the top each of the drive enclosures at the front. The ground bus is accessible when the enclosure door is open and the low voltage compartment is hinged out (in the case of the incomer cabinet). Make sure the drive that is grounded, typically at the point on the ground bus in the incomer cabinet, is close to the incoming power terminations.

Interlocking

For safety reasons, access is restricted to the medium voltage areas of the drive by the use of key interlocking.

At installation, configure the key interlocking to enable access to the medium voltage compartments only when the upstream power is locked in the OFF position.

The key interlocking prohibits applying the upstream power until the access doors of the medium voltage drive are closed and locked.

The key interlocking must be properly installed to the upstream equipment.

Notes:

Pre-Commissioning

Rockwell Automation manages the start-up service for each installed drive at the customer site. There are a number of tasks that must be completed before Rockwell Automation personnel are scheduled for drive commissioning.

This chapter outlines the required pre-commissioning responsibilities. Review this information before commissioning the drive as a reference for drive lineup commissioning. Record the information in the data sheets provided; these sheets are useful during future procedures for maintenance and troubleshooting.



ATTENTION: Perform the pre-commissioning tasks in the order that is listed in this chapter. Failure to do so can result in equipment failure or personal injury.

IMPORTANT Rockwell Automation requests a minimum of four weeks notice to schedule each startup.

The Rockwell Automation standard work hours are 9:00 a.m.-5:00 p.m. EST (8 hours per day) Monday through Friday, not including observed holidays. Additional work hours are available on a time and material basis.

Inspection and Verification

Before the drive can be commissioned, Rockwell Automation recommends:

1. A meeting with Rockwell Automation personnel before installation to review the following.
 - a. Start-up plan
 - b. Start-up schedule
 - c. Drive installation requirements
2. Inspecting the mechanical and electrical devices of the drive.
3. Performance of a tug test on all internal connections within the drive and verification of the wiring.
4. Verifying critical mechanical connections for proper torque requirements.
5. Verifying and adjusting mechanical interlocks for permanent location.
6. Confirmation of all inter-sectional wiring connections.

7. Verifying the control wiring from any external control devices, such as PLCs.
8. Confirmation of the proper operation of the cooling system.
9. Verification of the proper phasing from isolation transformer to drive.
10. Confirming the cabling of the drive to motor, isolation transformer, and line feed.
11. Confirmation of the test reports that indicate the insulation resistance (IR) and high-potential tests are complete on line and motor cables.
12. Control power checks to verify all system inputs such as starts/stops, faults, and other remote inputs.
13. The application of medium voltage to the drive and performance of 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, uncouple the load before bumping the motor for a directional test.
15. The drive motor system is run throughout the operational range to verify proper performance.

IMPORTANT Customer personnel must be on-site to participate in the system start-up procedures.



ATTENTION: The servicing of energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages can exist in the cabinet even with the circuit breaker in the OFF position. Rockwell Automation recommends that control equipment is disconnected or locked out from power sources, and that discharge of stored energy in capacitors is confirmed. If it is necessary to work in the vicinity of energized equipment, follow the safety-related work practices of NFPA 70E, Electrical Safety Requirements for Employee Work Places.

Notwithstanding the safety references in this document, follow all local codes and safety practices when working on this product.



ATTENTION: The CMOS devices that are used on the control circuit boards are susceptible to damage or destruction by static charges. Personnel who work near static sensitive devices must be appropriately grounded.

Pre-Commissioning Responsibilities

To avoid complications during the commissioning process, verify that the drive lineup is ready for commissioning. This chapter has the pre-commissioning checklist on [page 74](#). To verify that all points are completed in the proper sequence, use the checklist before the process for commissioning the drive is started. Print and complete the checklist so that the start-up proceeds efficiently.

Pre-Commissioning Using the Checklist

1. Print a copy of the pre-commissioning checklist on [page 74](#).
2. Initial each task and provide the date as each task is completed.
3. When the checklist is complete, photocopy the checklist and fax the copy to Medium Voltage Support, along with the planned start-up date.
4. Upon receiving this checklist, the Medium Voltage Support contacts the site to finalize arrangements for a start-up engineer to travel to the site at your convenience.

Additional Required Resources

Before scheduling your drive commission, verify that you have the following:

- Self-powered gate driver board-test power cable wire-harness (SPGDB) (Part no. 80018-298-51) supplied with SCR rectifier drives only
- Rockwell Automation electrical and mechanical diagrams for each drive
- PLC program (if supplied with a PLC)
- Commissioning Data Sheets
- All required manuals (see [The Pre-commissioning Checklist](#) for the list)

If any of the previously mentioned information is unavailable before the time of commissioning, contact Rockwell Automation.

The Pre-commissioning Checklist

Medium Voltage Support	Name:	Date:
Rockwell Automation	Company:	
Fax: 1 (866) 465 0103 or Fax: 1 (519) 740 4756	Phone:	Pages:
	Fax:	

Drive Serial Number:	
CSM Service Engineer Requested (YES/NO):	
Scheduled Commissioning Date:	

Table 5 - Receiving and Unpacking

Initials	Date	Check	
			The drives are checked for shipment damage upon receiving.
			After unpacking, the items that are received are verified against the bill of materials.
			Any claims for breakage or damage, whether concealed or obvious, are made to the carrier by the customer as soon as possible after receipt of shipment.
			All packing material, wedges, or braces are removed from the drive.

Table 6 - Installation and Mounting

Initials	Date	Check	
			The drive is securely fastened in an upright position, on a level surface. Seismic zones require special fastenings. Consult factory.
			The lifting angles are removed.
			Bolts are inserted into original location on top of drive (helps prevent leakage of air for cooling).
			All contactors and relays are operated manually to verify free movement.

Table 7 - Safety

Initials	Date	Check	
			All mechanical interlocks and door Ram Interlocks are tested for proper functionality and are not defeated or damaged.
			All Kirk key interlocks are installed and tested for proper functionality.
			The grounding of the drive must be in accordance with CEC, NEC, or IEC regulations.
			If the drive has an isolation transformer, the transformer enclosure or frame must be bonded to system ground at a minimum of two locations.
			If the drive has an isolation transformer, the wye secondary neutral-point must not be grounded.
			If there are shipping splits in the lineup, the ground bus between cabinets is installed.
			Based on your local regulation, an ARC Flash study is complete.

Table 8 - Control Wiring

Initials	Date	Check	
			All low voltage wiring entering the drive is labeled, the appropriate wiring diagrams are available, and all customer interconnections are complete.
			If an encoder is used, the encoder must be isolated from the motor frame. The encoder cables must be routed in grounded steel conduit for electrical noise suppression. The conduit must be grounded at junction box but left isolated from the encoder with an insulated bushing.
			The encoder cable shield to the drive is connected to the ground bus at the drive end only.
			All AC and DC circuits are run in separate conduits.
			All wire sizes that are used are selected by observing all applicable safety and CEC / NEC / IEC regulations.
			Remote I/O Interface is properly configured / active.
			All 3-phase control wiring is within specified levels and is verified for proper rotation, UVW.
			All single-phase control wiring is within specified levels and has grounded neutrals.

Table 9 - Drive Lineup Status

Initials	Date	Check	
			The medium voltage and low voltage power is available for startup activities.
			The motor is uncoupled from the driven load.
			The load is available for full load testing.

Table 10 - Power Wiring

Initials	Date	Check	
			The power cable connections to the drive, motor, and isolation transformer adhere to CEC, NEC, IEC, or appropriate local standards.
			The cable terminations, if stress cones are used, adhere to the appropriate standards.
			Appropriate cable insulation levels are adhered to, as per Rockwell Automation specifications (see Cable Insulation on page 42).
			All shields for shielded cables must be grounded at the source end only.
			If shielded cables are spliced, the shield must remain continuous and insulated from ground.
			All wire sizes that are used are selected by observing all applicable safety and CEC / NEC / IEC regulations.
			All power connections are torqued as per Rockwell Automation specifications. See Torque Requirements for Threaded Fasteners on page 107 .
			All customer power cabling is insulation resistance or high potential tested before connecting to drive system.
			Power wiring phase-rotation is verified per the specific Electrical Schematics and drawings that are supplied by Rockwell Automation.

Notes

ArcShield Unit Information

Overview

This manual covers all drives; however, only the 7000B units are ArcShield™ protected. The arc-resistant (ArcShield) enclosure is an option for the "B" Frame PowerFlex 7000. This option cannot be retrofitted in the field. ArcShield™ units have a robust arc resistant enclosure design that has been tested per IEEE C37.20.7. The arc resistant drive was tested to withstand the effects of an arc flash at 50 kA for 0.5 seconds with current limiting fuses. ArcShield units provide an enhanced Type 2B Accessibility level.

ArcShield Design

ArcShield units typically include a pressure relief vent on the roof of the structure (some incoming units are without a pressure relief vent if top cable entry is required). Under arc flash conditions, the pressure relief vent opens to allow hazardous flames and gases to exit the enclosure via plenum or chimney system. The low voltage panel area is sealed to prevent flames and gases from entering. Regardless, suitable personal protective equipment (PPE) must be used whenever working on live circuits.



ATTENTION: To keep Arc resistant integrity, these rules must be followed:

- The pressure relief vent must not be tampered with. Do not use the pressure relief vent as a step.
 - No alterations can be made to the ArcShield structure.
 - All covers, plates, and hardware that are removed for installation or maintenance purposes must be reinstalled and properly secured. Failure to do so voids the arc resistant integrity.
 - Treat power cable entry points as the boundary to a hazardous location and sealed accordingly. Failure to do so voids the arc resistant integrity.
 - A plenum or chimney must be used to direct the arc flash energy to a suitable location. Failure to do so voids the arc resistant integrity. See [ArcShield Unit Information on page 77](#) for plenum and chimney installation instructions.
 - All wiring between the low voltage panel and the power cell must be routed through a suitable gland. This routing is to make sure that flames and gases are not transmitted into this area (as fitted from factory).
-

Exhaust Systems: Chimney or Plenum Option

A plenum can be provided for each unit. The plenum is then field-mounted on the top of the unit structure. Some incoming units do not have a plenum if it requires a top cable entry. The purpose of the plenum is to direct the hazardous flames and gases away from the top of the arc resistant enclosure. Unit plenums are secured to the top of the unit structure and to adjacent plenums. The continuous conduit that is created can direct the arc flash energy away from personnel. See [ArcShield Plenum Installation Instructions on page 83](#).

Each plenum-based ArcShield lineup includes a plenum exhaust piece that extends beyond the left end of the lineup. The other end of the plenums are capped with an end cover. Extensions can be added to the plenum to direct the arc flash energy to an area further away, where plasma gases can be safely vented.

Figure 56 - Elements of ArcShield Plenum

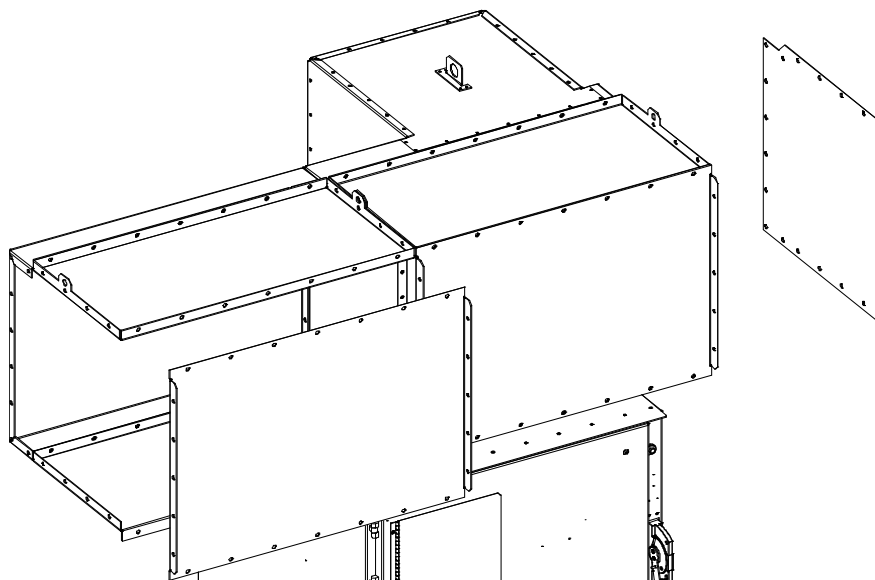
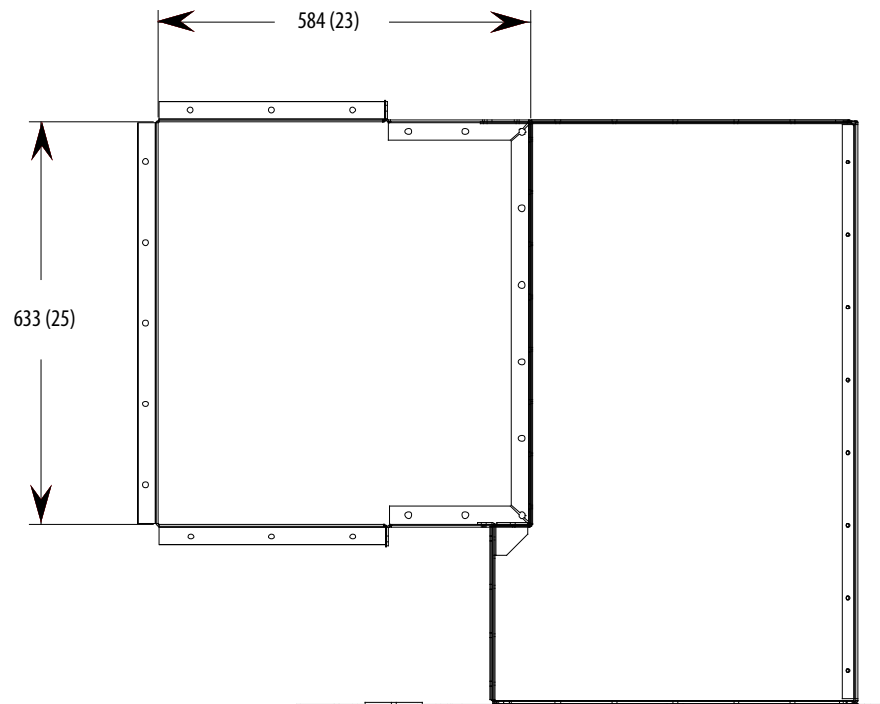


Figure 57 - Cross-section of Plenum Extension, Dimensions in mm [inches]

Plenum Exhaust Considerations

The following options for locating the plenum exhaust are presented:

1. Plenum ducted to an area of the control room where arc gases are permitted to escape, with plenum extensions (see [Figure 58](#), [Figure 59](#), and [Figure 60](#)).
2. Plenum duct to outside of control room (see [Figure 58](#) and [Figure 59](#)).

Plan the location where the plenum exhausts. Make sure that:

- There is no access to personnel while equipment is energized.
- Area is free of flammable material or vapors.

Make sure that adequate space is provided around the plenum exhaust, as outlined in [Figure 58](#) through [Figure 60](#).

IMPORTANT Damage or destruction can occur to equipment in the area of the plenum exhaust point.

Figure 58 - Plenum Exit Left with Extensions to Internal Controlled Access Area (Top View)

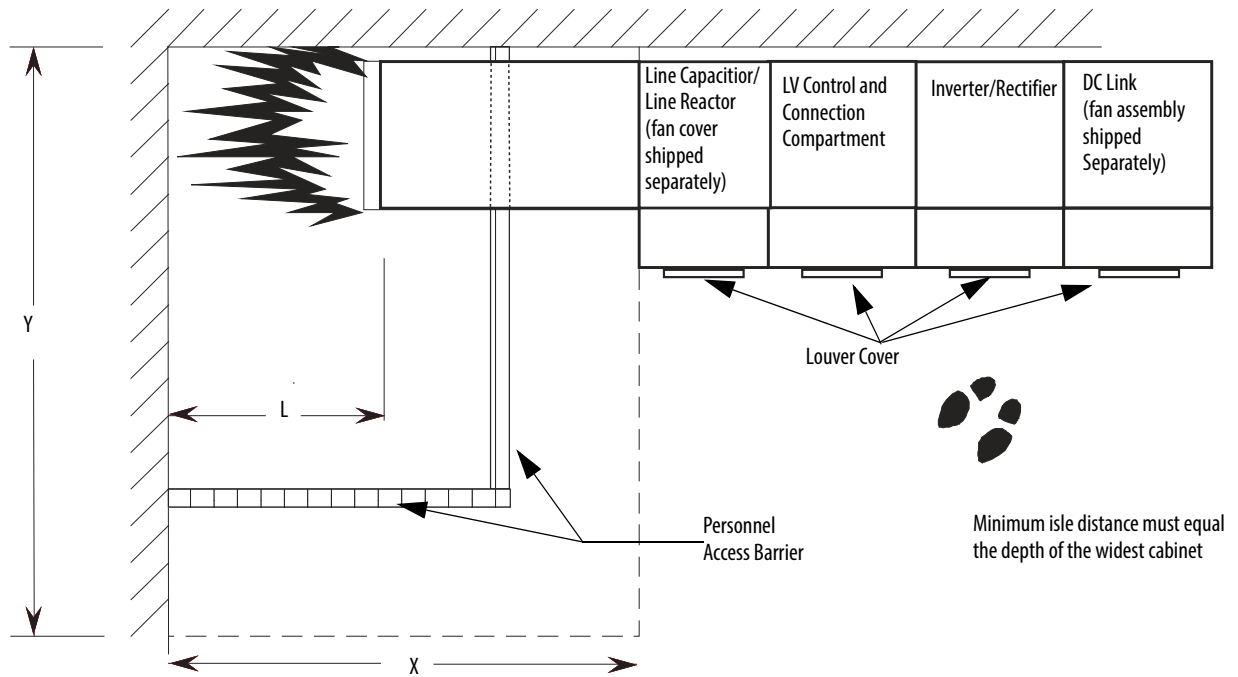
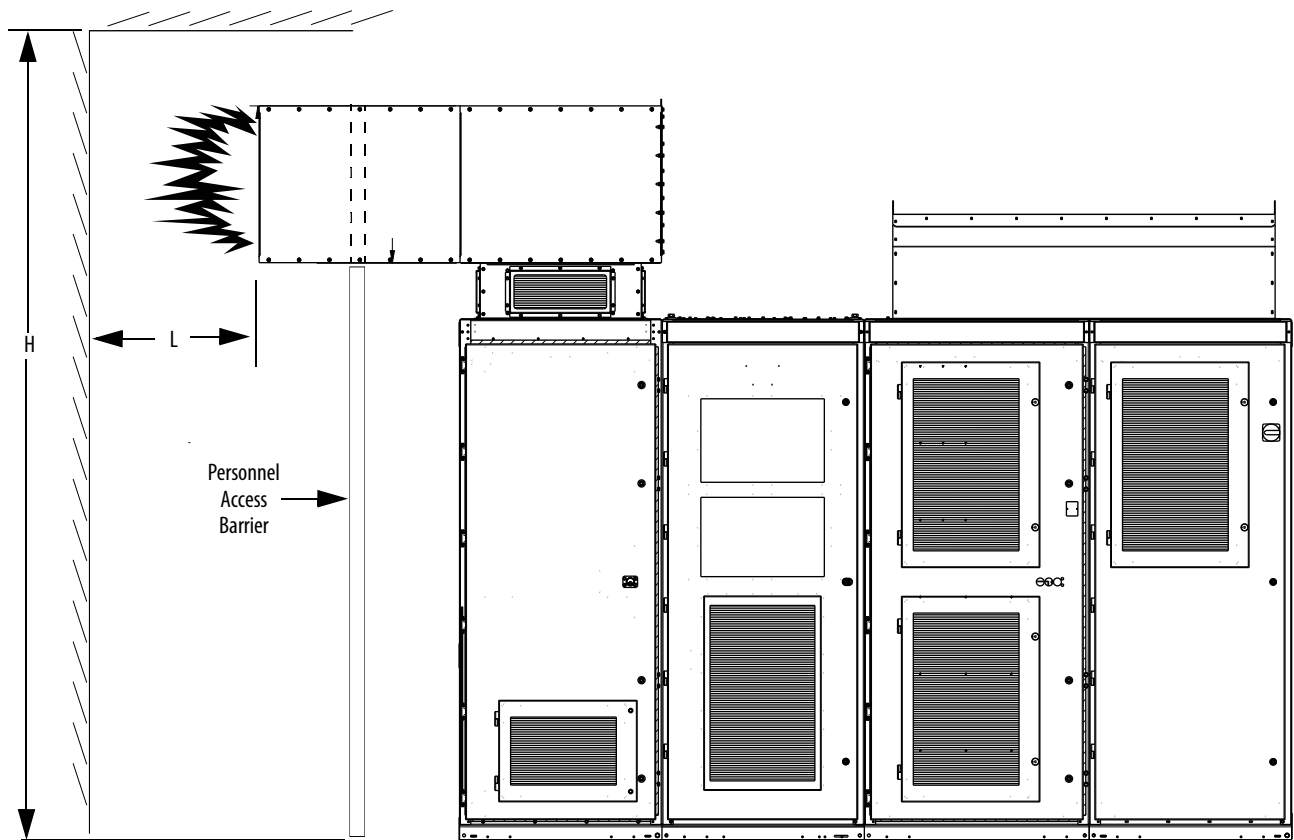


Figure 59 - Plenum Exit Left with Extension to Internal Controlled Access Area (Front View)

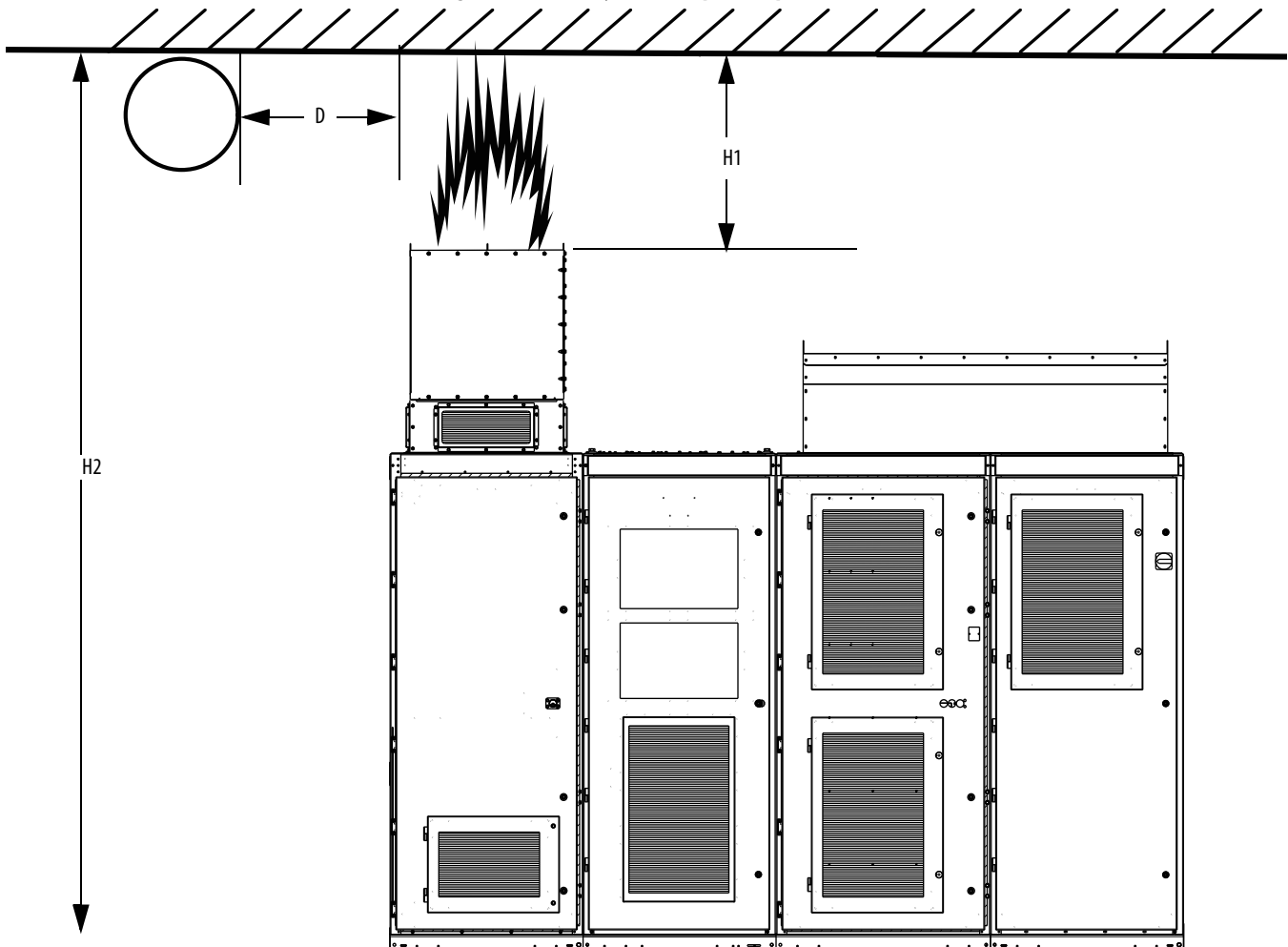


Minimum H = 3.5 m (138 in.)

Minimum L = 1.2 m (47 in.)

Minimum Volume of space that is required for safe pressure relief: $X * Y * H = 11 \text{ m}^3$ (390 cubic feet)

Figure 60 - Chimney Exhaust Space Requirements



Minimum H1: 0.4 m (16 in.)
 Minimum D (distance): 1 m (39 in.)
 Minimum H2: 3.494 m (137.54 in.)

Additional Notes

- Any painted surfaces, which face direct contact with the arc products, can ignite. Flame suppression is recommended.
- The exit point can also be outside the building. Make sure that ice, snow, or vermin nest cannot block the exit area.
- Access barriers are recommended to restrict access by personnel while the equipment is energized. A chain link fence is a suitable barrier material.

Chimney Information

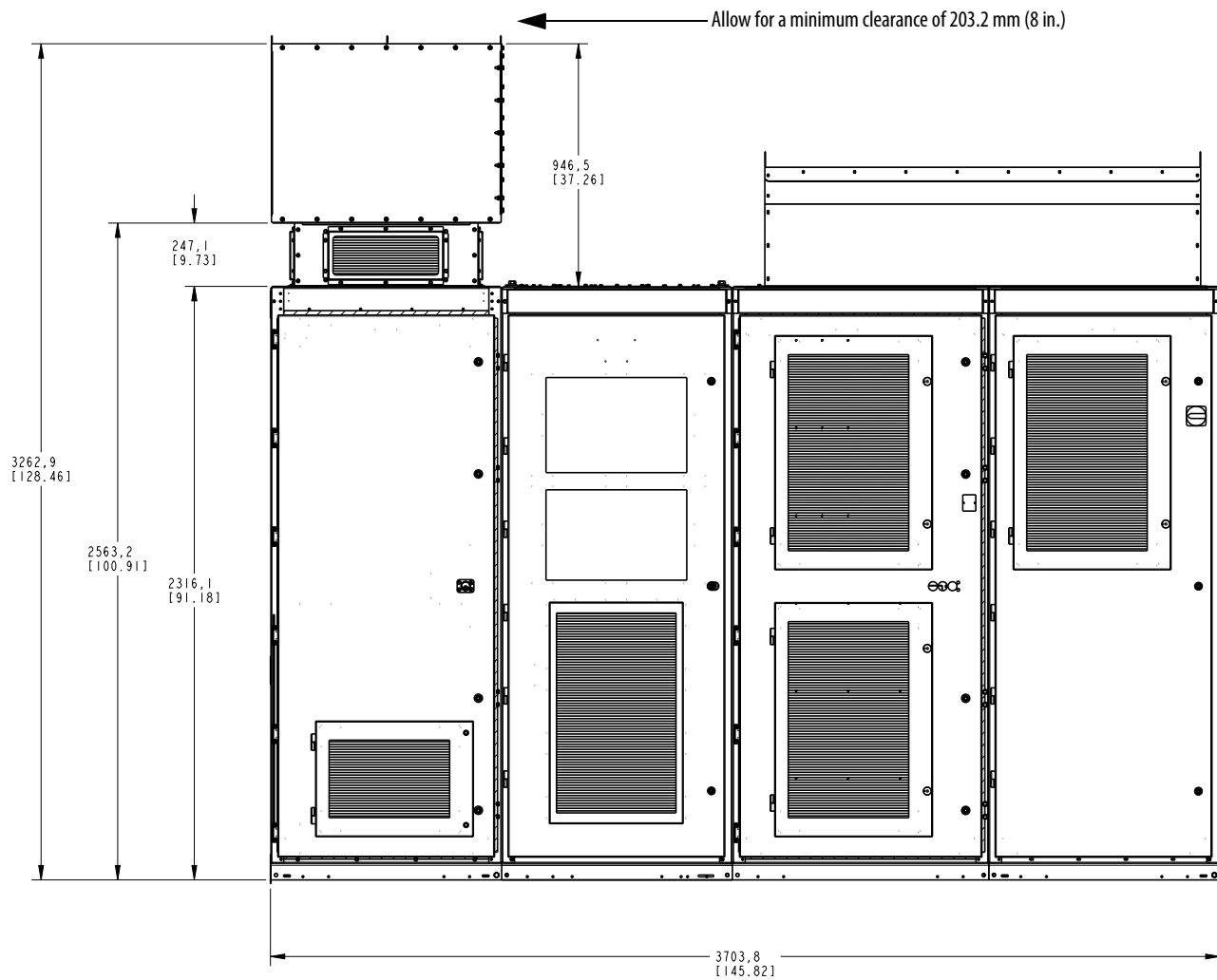
Where adequate clearance height (space) is available, chimney can be provided for each unit in place of the plenum system. Field-mount the chimney on top of the unit structure. The purpose of the chimney is to direct the hazardous flames and gases away from the top of the resistant enclosure. The chimney is secured to the top of each unit structure. See [ArcShield Plenum Installation Instructions on page 83](#) for chimney installation instructions.

Chimney Exhaust Considerations

1. For the medium voltage motor-control center, there must be a minimum distance of 1.7 m (67 in.) from the top outlet of the chimney to the ceiling. And a minimum of 1 m (39 in.) on each side.
2. No obstructions (for example, Piping) can be in the path of the exhaust within this 1.7 m (67 in.) height requirement.

Plan the location where the chimney exhausts. Make sure that:

- There is no access to personnel while equipment is energized.
- Area is free of flammable material or vapors.
- Make sure that adequate space is provided around the chimney exhaust as outlined in [Figure 60](#).

Figure 61 - Arc Shield Lineup Dimensions

ArcShield Plenum Installation Instructions

The following instructions are provided to make sure that the proper installation and function of plenum components that are supplied with ArcShield™ enclosures. See [ArcShield Design on page 77](#) for additional information that is related to ArcShield™ plenums before attempting to follow these instructions.

Plenum Bracing

The bracing of the plenum must be able to withstand the dynamic forces of the arc fault and any other vibration or seismic effects that are associated with the installation. Most of this force is in the direction opposite to where the relief vent exits. The amount of the bracing depends on how the plenum is supported at its exit and the distance from the end of the cabinets to the exit vent.

- A flange is available for the installation of hangers to support the plenum weight.
- The plenum extension has holes for mechanical support.
- Weight per unit length of Rockwell supplied plenum = 28 kg/m (19 lb/ft).
- Installer is responsible for ensuring that the plenum extension has sufficient support to resist the effect of vibrations and seismic effects.

IMPORTANT Plan the location where the plenum exhausts. See [ArcShield Design on page 77](#). Equipment in the area of the plenum exhaust point can be damaged or destroyed. Mark the plenum exhaust area as a Hazardous Zone ([Figure 62](#)).

Figure 62 - Plenum Exhaust Label

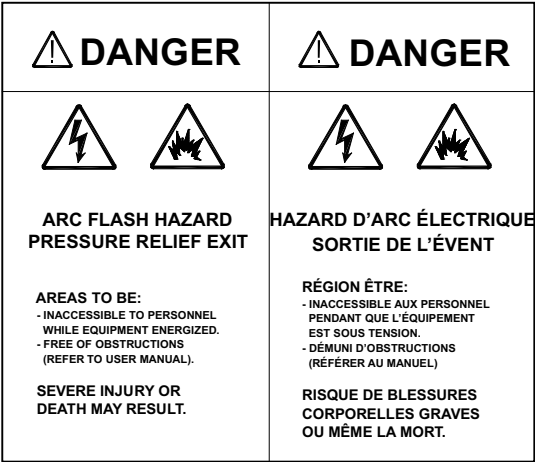
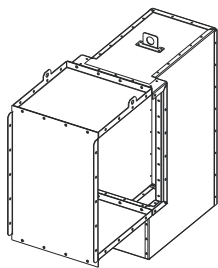
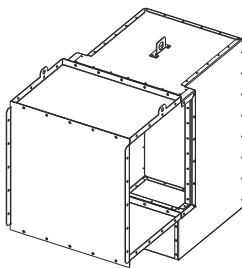


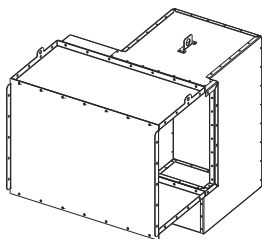
Figure 63 - Various Plenum Components Available



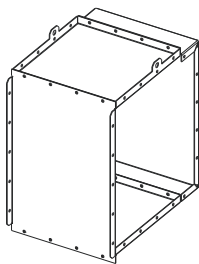
18" wide Plenum
Fastened directly over the 0.5 m (18 in.) wide cabinet



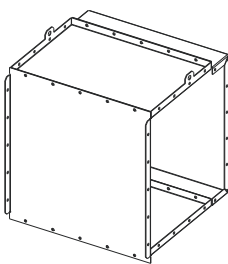
26" wide Plenum
Fastened directly over the 0.7 m (26 in.) wide cabinet



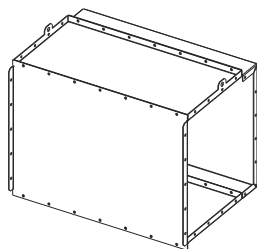
36" wide Plenum
Fastened directly over the 0.9 m (36 in.) wide cabinet



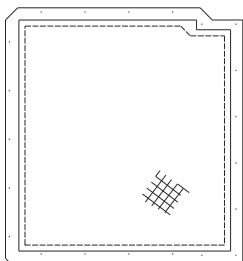
18" long Extension
Connected to the last Plenum on the exhaust end of the "lineup"



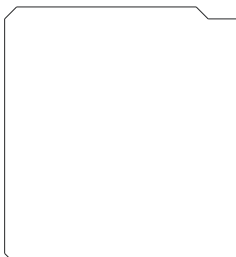
26" long Extension
Connected to the last plenum on the exhaust end of the "lineup"



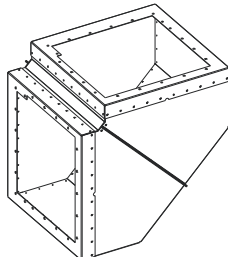
36" long Extension
Connected to the last plenum on the exhaust end of the "lineup"



Screen Cover Plate
Fastened at the opening of the last component on the exhaust end



End Cover Plate
Fastened at the opening of the last Plenum in the "lineup" opposite the exhaust end to seal plenum end



90° Elbow Section
Connected at the exhaust end of the plenum (or Extension)

General Plenum Layout for ArcShield Lineup

An example of a general plenum assembly configuration is shown in [Figure 64](#). Plenums of various widths are mounted directly over the MV enclosures of the corresponding width. A 0.9 m (36 in.) Exhaust extension assembly is shown mounted on the extreme right side plenum of the equipment "Lineup" (can alternatively exhaust to the left). Engineered systems can be made site specific.

Figure 64 - ArcShield Lineup (Left-hand Exhaust)

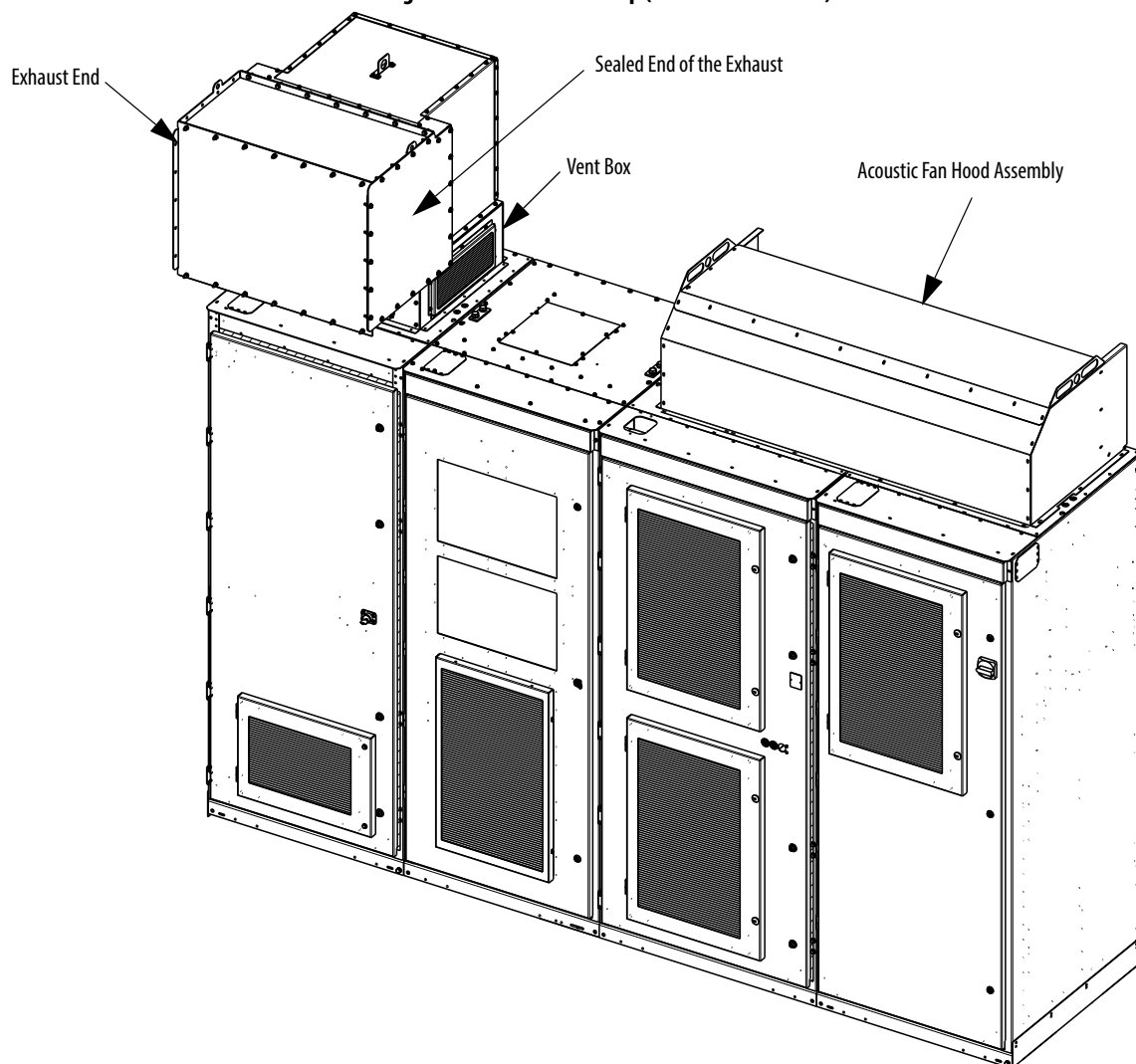
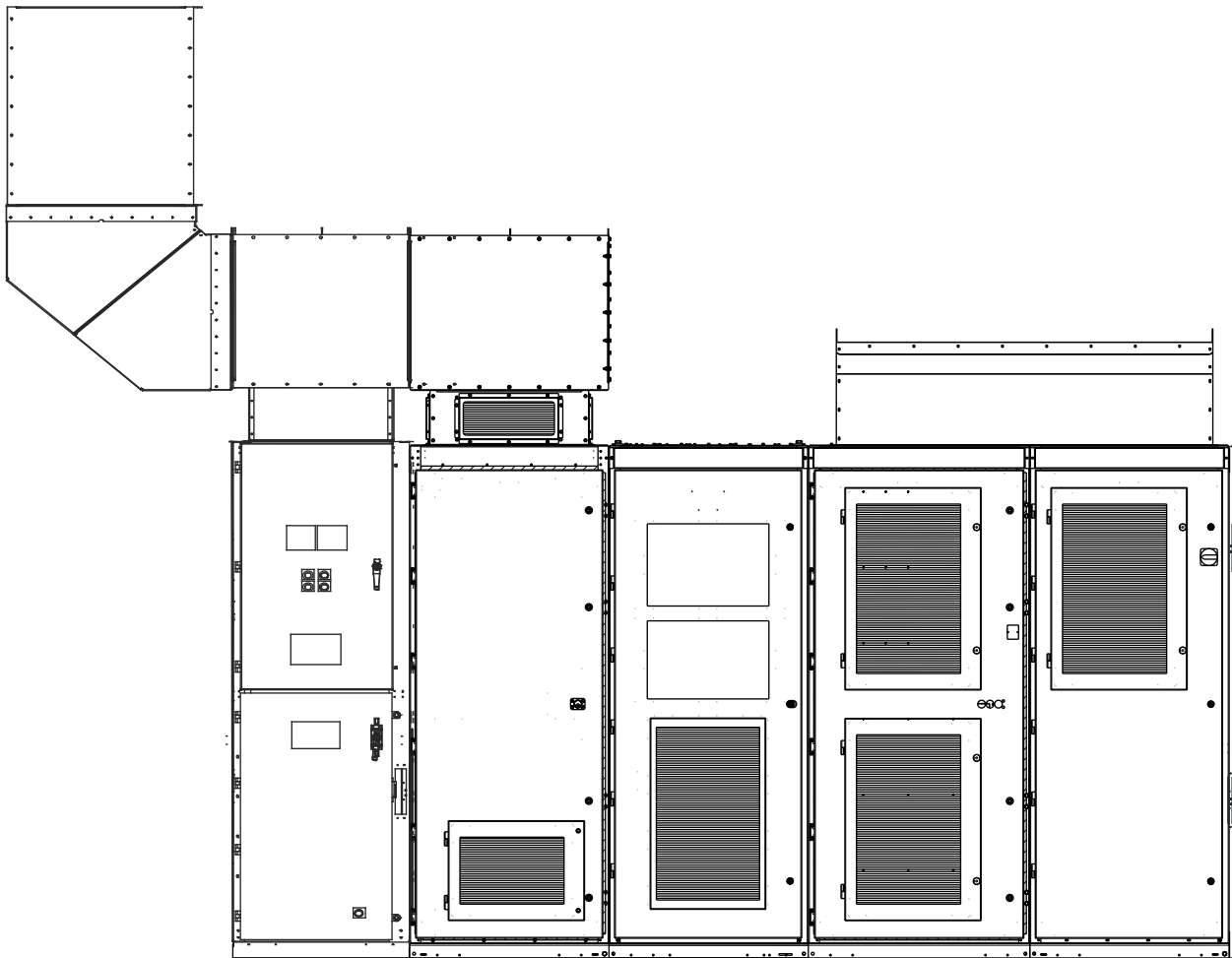


Figure 65 - Arc Shield Line up with Starter and Left Plenum Exhaust

Plenum exhaust is on the left end of the lineup. Pictures and figures in this procedure are shown with a left-hand exhaust exit direction.

[Figure 64](#) shows an example of a left-hand exhaust.

Also shown is an optional vertical (top) direction exhaust extension (see [Figure 75](#)).

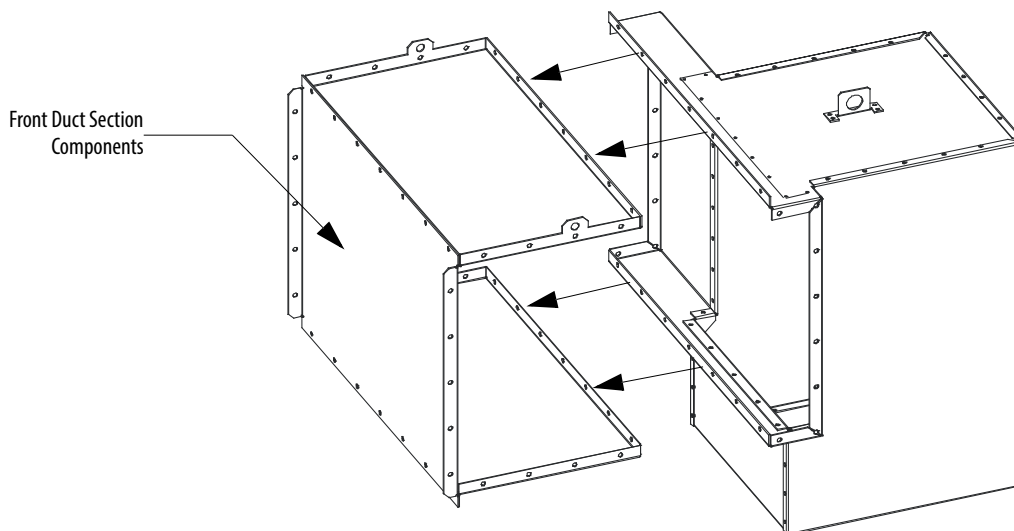
IMPORTANT Plenum components that are not directly mounted to the tops of the MV enclosures, must have additional mounting support. This restriction includes the Extension components and 90° Elbow Sections (refer to [STEP 5 – Additional Mounting Support on page 94](#)).

For dimensional requirements of the Arc Shield lineup, see [Arc Shield Lineup Dimensions on page 83](#).

STEP 1 – Mounting a Single Plenum

Before mounting a plenum over an MV enclosure, the front duct section must first be removed, as shown in [Figure 66](#).

Figure 66 - Remove the Front Duct Section



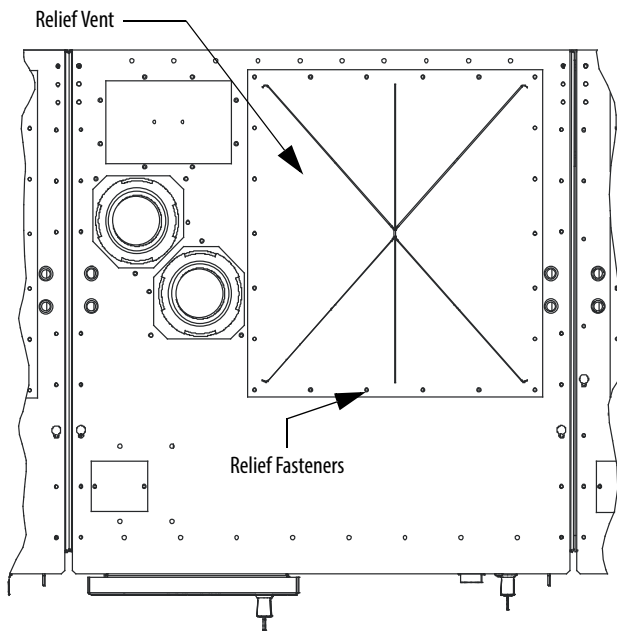
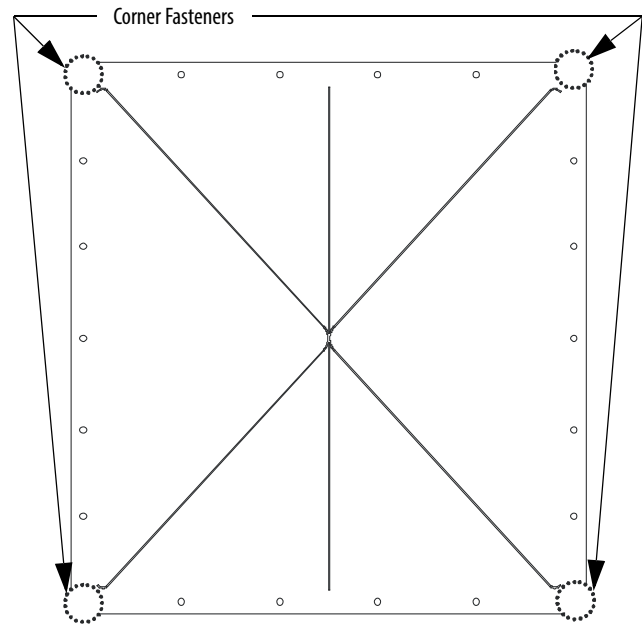
Cabinet Preparation

In preparation for mounting plenum, the cabinet lifting means (the lifting angles) must be removed. The bolts retaining the lifting means must be replaced in the holes from where they came. Failure to reinstall removes the cabinets ability to control any arc gases properly. Once the lifting angles or clips are removed, remove 1/4-20 fasteners from the Relief vent on the top of the MV enclosure.



ATTENTION: Hardware that is used to retain the lifting provision hardware must be reinstalled in the same holes. Failure to replace this hardware makes the arc resistance of the cabinet ineffective and could subject personnel to the possibility of severe burns, injury, or death.

IMPORTANT Do not remove the four corner fasteners ([Figure 68](#)).

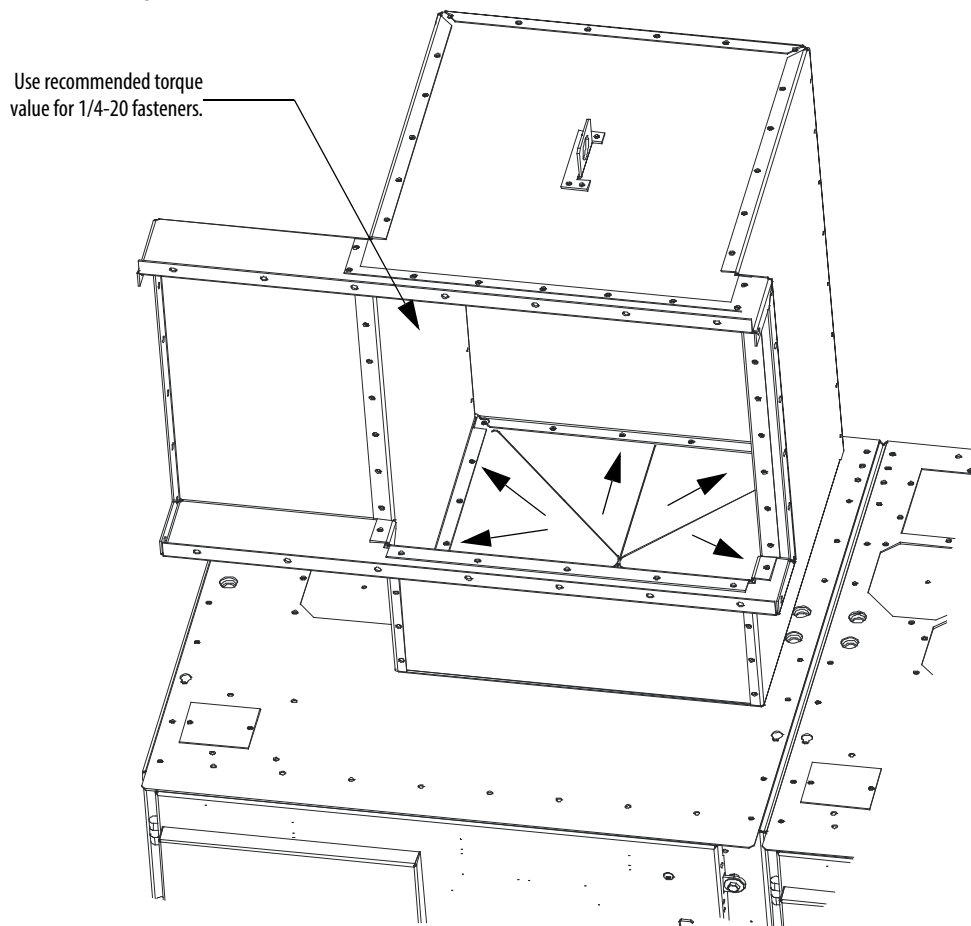
Figure 67 - Typical Relief Vent Fasteners (top view)**Figure 68 - Relief Vent**

The plenums are designed to fit over the fastener heads at the four corners of the Relief vent. The corner fasteners are required to secure the Relief vent during installation.

Plenum Placement on Structure

Lift the plenum in place directly over the relief vent (shown in [Figure 69](#)). Attach the plenum to the top of the enclosure. Use all 1/4-20 fasteners that are removed in the [Cabinet Preparation](#) procedure. Use hand tools only.

Figure 69 - Plenum Placement



IMPORTANT Any unused holes must be filled with thread forming screws. For example, the lifting lug holes must be filled after the lugs are removed.

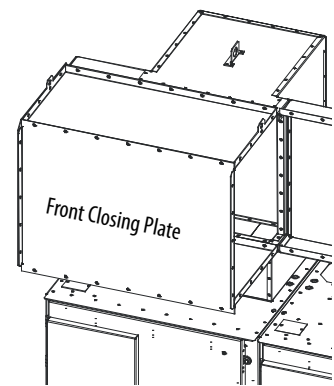
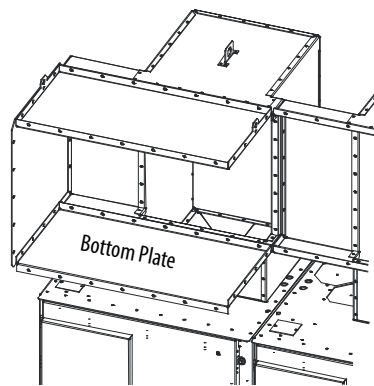
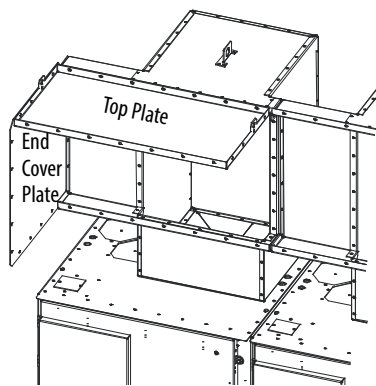
STEP 2— Closing the Front of the Plenum Sections

All plenums in a lineup must be mounted to the top of each enclosure. And to the plenum directly beside it before the front duct sections are reattached (see [Figure 66](#)).

Mount the “End Cover Plate” on the closed end of the lineup by using 5/16 inch hardware (see [Figure 70](#) left side).

After the first stage of the plenum assemblies have been mounted, the plenums can then be “closed-up” by replacing the front duct sections as shown in [Figure 70](#).

Figure 70 - Plenum Sections



IMPORTANT Do not reinstall the front duct section of the last plenum on the exhaust side of the lineup. See [STEP 4— Mounting Extension/Elbow to Plenum Lineup on page 93](#) for more information.

STEP 3— Extension and Elbow Assembly

Attach the 36" Extension components and 90° Elbow Section using 5/16-inch hardware in the following sequence:

Step 5A – See [Figure 71](#)

Step 5B – See [Figure 72](#)

Step 5C – See [Figure 73](#)

TIP The Screen Cover Plate is attached in [Figure 72](#).

Figure 71 - 90° Elbow Section Assembly, Step 5A (Front View)

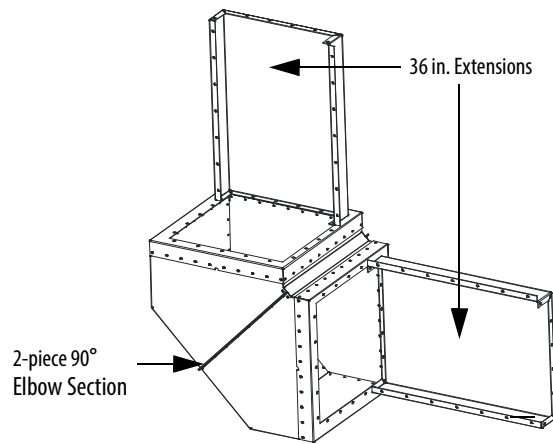


Figure 72 - 90° Elbow Section Assembly, Step 5B (Front View)

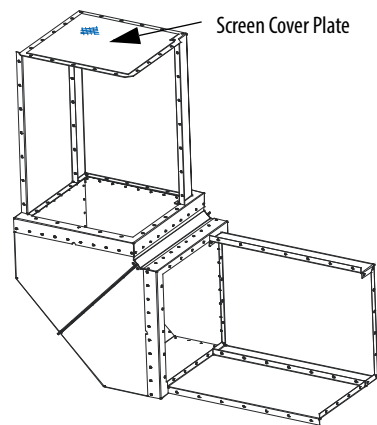
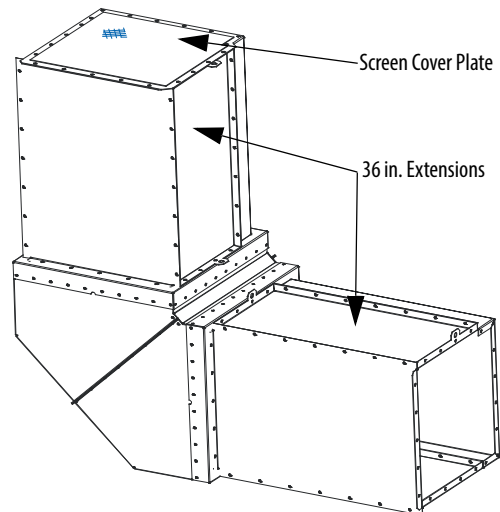


Figure 73 - 90° Elbow Section Assembly, Step 5C (Front View)

The Extension components are attached to the Elbow Section using 5/16-in. Hardware.

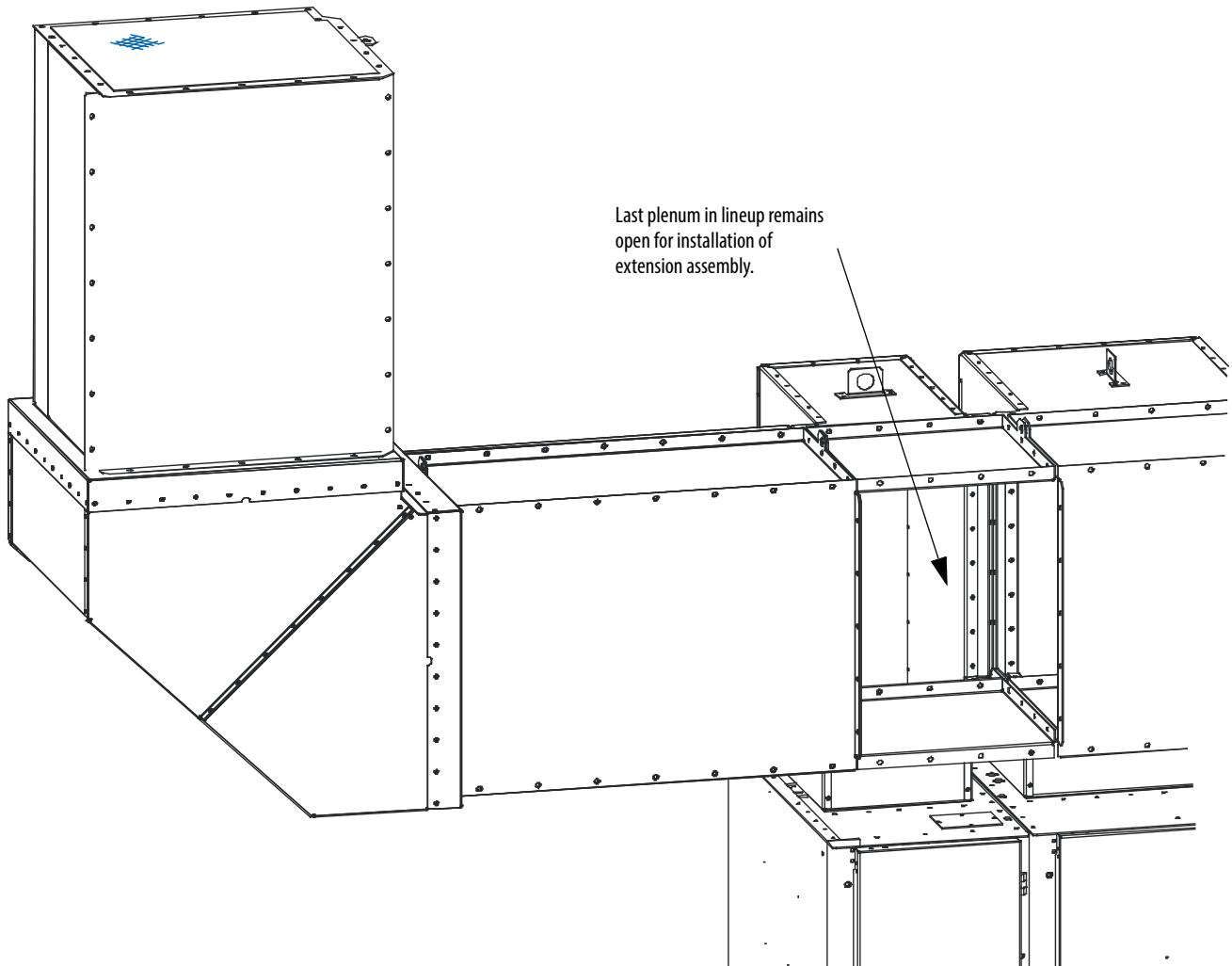
[Figure 73](#) illustrates what the Extension/Elbow Assembly resembles when finished.



STEP 4– Mounting Extension/Elbow to Plenum Lineup

In [STEP 2– Closing the Front of the Plenum Sections on page 91](#), the last plenum at the exhaust side of the lineup has the front duct section removed. The removed section allows access to fastener holes to mount the extension/elbow components (see [Figure 74](#)).

Figure 74 - Optional Extension/Elbow with Vertical Extension (left side exit)



After the Extension/Elbow assembly is attached through the fastener holes on the inside flange of the plenum, replace the front duct section. Fasten the section through the holes on the outside flanges.

STEP 5 – Additional Mounting Support

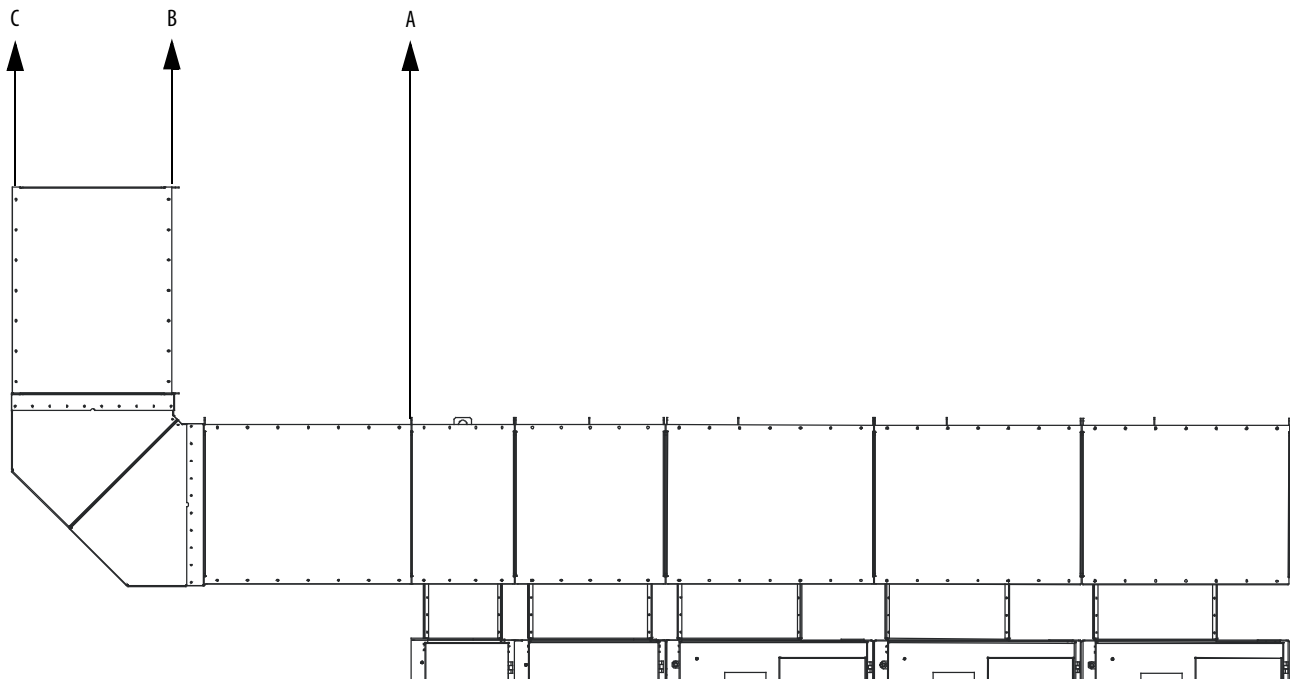
The Extension/Elbow Assembly must have additional mounting support.

90° Elbow Section: Approximate weight 64 kg (142 lb)

36 inch Extension Assembly: Approximate weight 51 kg (112 lb)

[Figure 75](#) shows an example of how to support the Extension/Elbow Sections by suspension from a high ceiling. Points A, B & C show where chains or high tension cables can be connected.

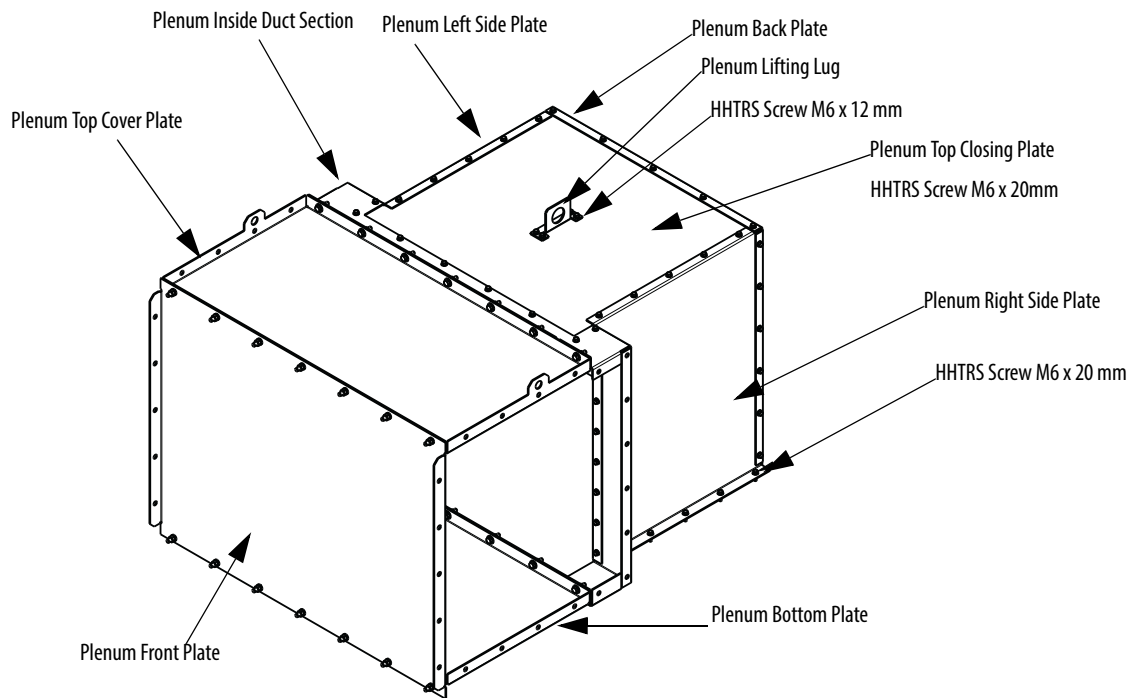
Figure 75 - Completed Assembly for optional vertical exit plenum (Left-hand exit)



TIP During an arc fault, the plenum is subjected to a brief high-pressure shock wave. The Extension/Elbow assembly can experience dynamic loading. It is important to account for dynamic loading when selecting a supporting means and materials.

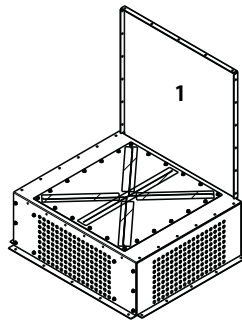
Assembling the Plenum

Figure 76 - The Arc Shield Plenum Assembly

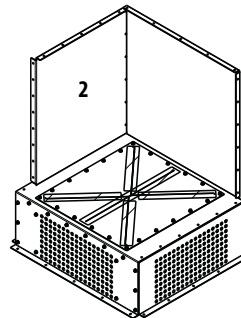


Installing the Plenum Plates

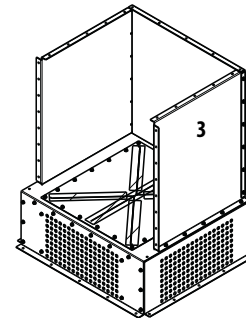
1. Install the plenum back, left, and right side plates in sequence.



Plenum Back Plate

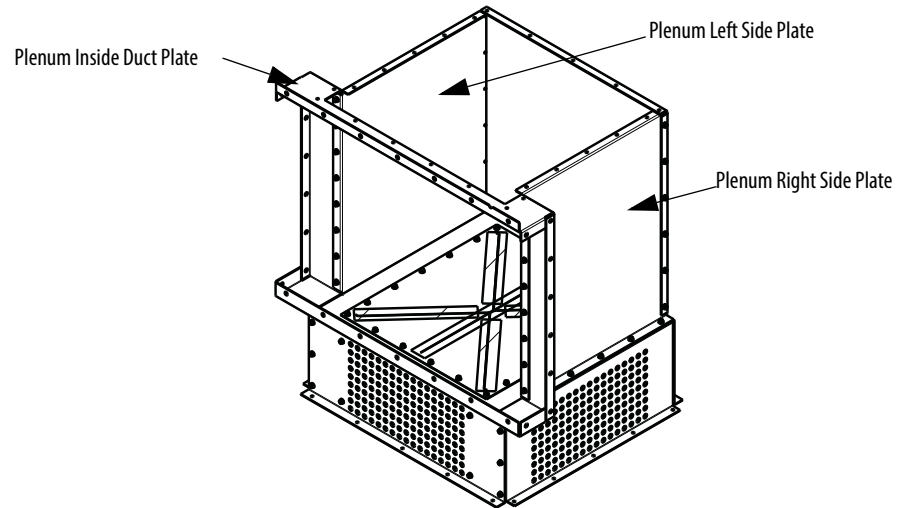


Plenum Left Side Plate

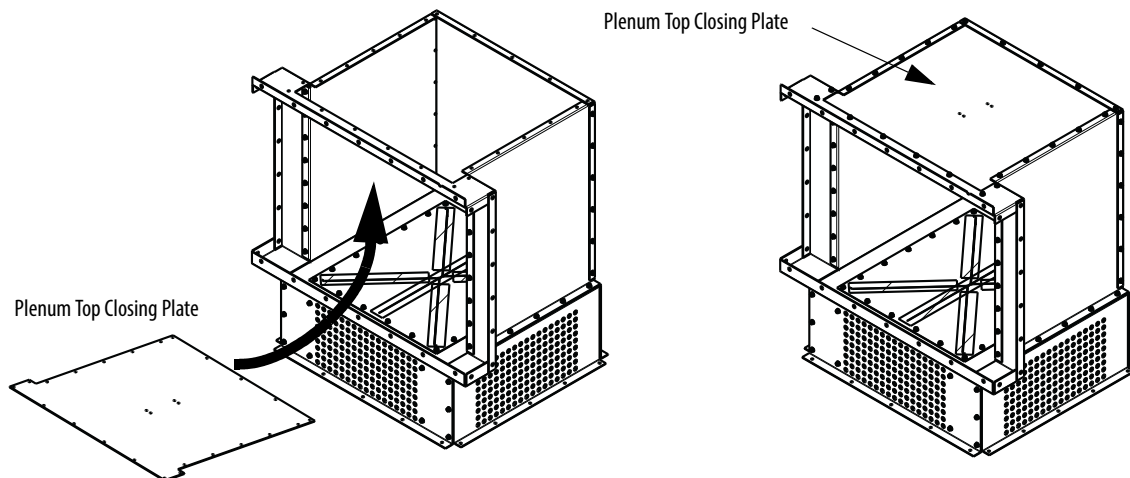


Plenum Right Side Plate

2. Align the bottom flange of the plates to match the installation holes of the ventilation box assembly. Insert the M6 x 20 mm tapites through the bottom flange of the plate.
3. Install the plenum inside duct plate. Insert the flanges of the left and right side plates into the duct cutout.

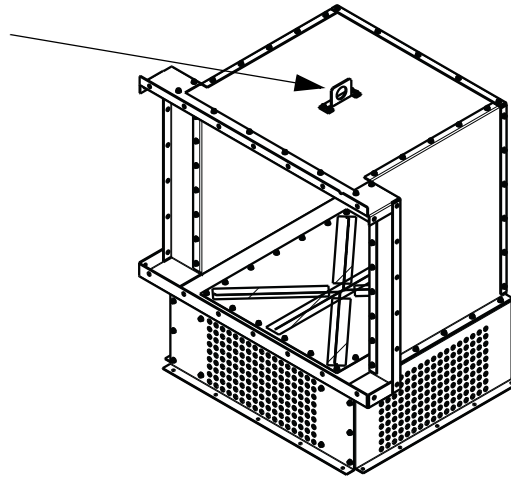


4. Insert M6 x 12 mm taptites.
5. Insert the plenum top closing plate into the plenum.

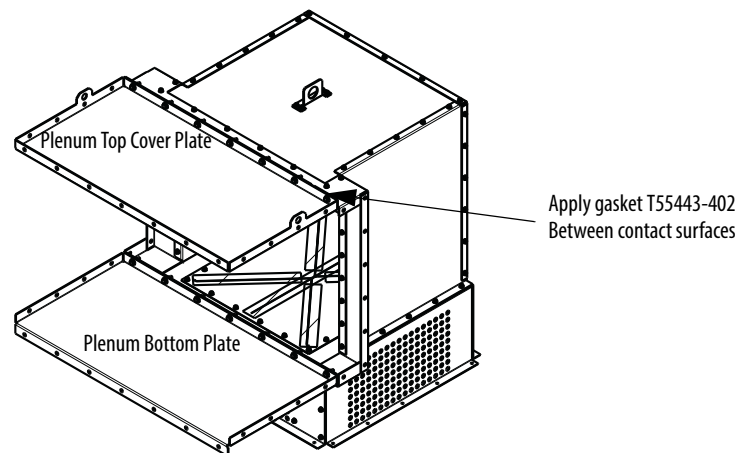


6. Move the plate to the top flange of the plenum sides.
7. Insert M6 x 12 mm taptites to attach the plate to the plenum sides.
8. Install the lifting lug to the plenum top cover plate using M6 x 12 mm taptites.

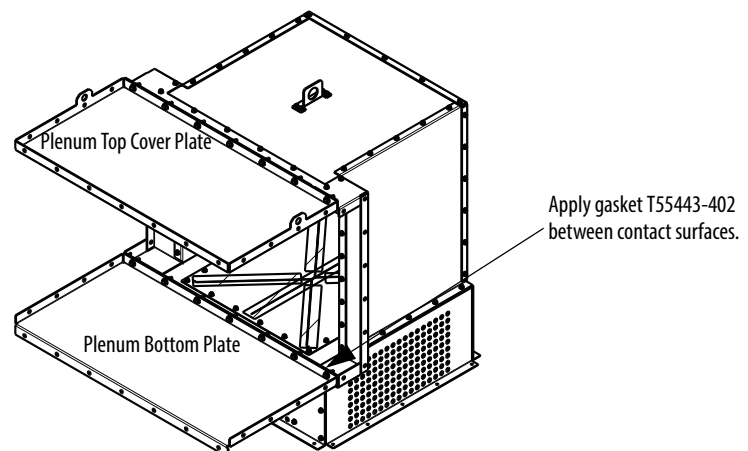
Equipment in the area of the plenum exhaust point can be damaged or destroyed. inchLifting



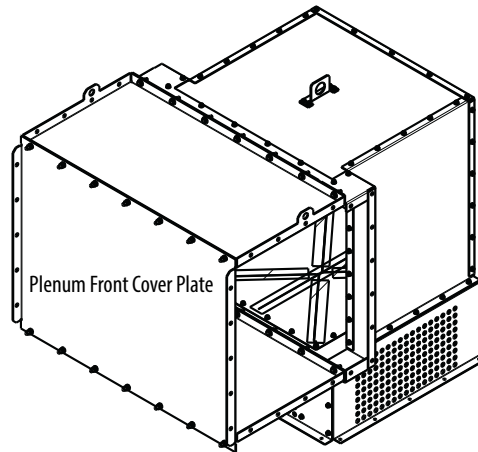
9. Install the plenum top cover plate.



10. Apply the supplied gasket material (T55443-402) between the contact surface.
11. Attach the plate to the plenum using M8 x 28 mm bolts with 5/16 inch flat washers and lockwashers.
12. Install the plenum bottom plate.



13. Apply the supplied gasket material (T5443-402) between the contact surface.
14. Attach the plate to the plenum using M8 x 28 mm bolts with 5/16 inch flat washers and lockwashers.
15. Attach the plenum front cover plate to the plenum using M8 x 28 mm bolts with 5/16 inch flat washers and lockwashers.



ArcShield Chimney and Plenum Assembly Instructions with Vent Box

ArcShield Chimney Installation Instructions







The following instructions are provided for the proper installation and function of the chimney that is supplied with ArcShield™ enclosures.

See [ArcShield Design on page 77](#) for additional information that is related to ArcShield™ chimney before attempting these instructions.

See [Torque Requirements for Threaded Fasteners on page 107](#).

IMPORTANT	Plan the location where the plenum exhausts (refer to ArcShield Design on page 77). Mark the plenum exhaust area as a Hazardous Zone, and labeled per Figure 77 .
------------------	--

Figure 77 - Chimney Exhaust Label

 DANGER	 DANGER
  <p>ARC FLASH HAZARD PRESSURE RELIEF EXIT</p> <p>AREAS TO BE:</p> <ul style="list-style-type: none"> - INACCESSIBLE TO PERSONNEL WHILE EQUIPMENT ENERGIZED. - FREE OF OBSTRUCTIONS (REFER TO USER MANUAL). <p>SEVERE INJURY OR DEATH MAY RESULT.</p>	  <p>HAZARD D'ARC ÉLECTRIQUE SORTIE DE L'ÉVENT</p> <p>RÉGION ÊTRE:</p> <ul style="list-style-type: none"> - INACCESSIBLE AUX PERSONNEL PENDANT QUE L'ÉQUIPEMENT EST SOUS TENSION. - DÉMUNI D'OBSTRUCTIONS (RÉFÉRER AU MANUEL) <p>RISQUE DE BLESSURES CORPORELLES GRAVES OU MÊME LA MORT.</p>

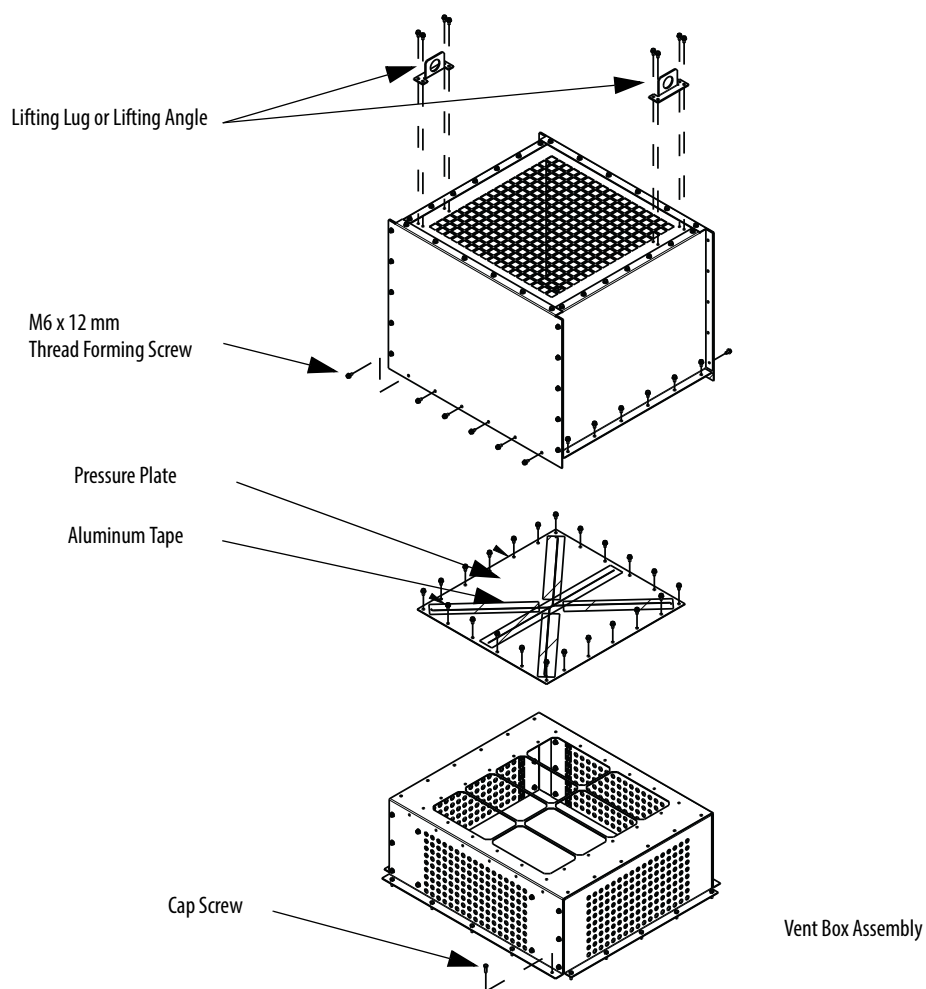
Cabinet Preparation

In preparation for mounting a chimney, the lifting lugs (the lifting angles) of the cabinet must be removed. The bolts retaining the lifting means must be replaced in the holes from where they came. Failure to replace the bolts removes the cabinets ability to control any arc gases properly.



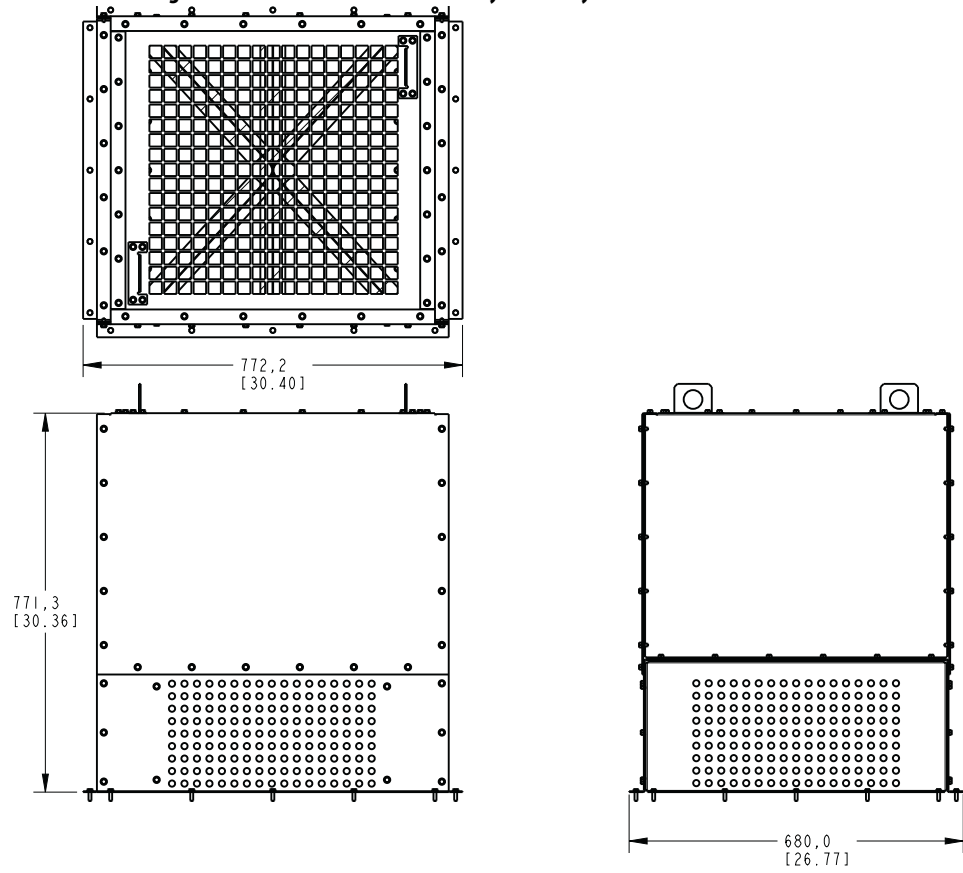
ATTENTION: Hardware that is used to retain the lifting provision hardware must be reinstalled in the same holes. Failure to replace this hardware makes the arc resistance of the cabinet ineffective and could subject personnel to the possibility of severe burns, injury, or death.

Figure 78 - Chimney Placement



Vent Box Dimensions

Figure 79 - Vent Box with Arc Chimney Assembly



Specifications



ATTENTION: See customer drawings when there is a discrepancy between the generic manual specifications and the specific design or electrical drawings.

Table 11 - General Design Specifications

Attribute	
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) Metal Oxide Varistor (MOV) (18-pulse)
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 Wireway	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 11 - General Design Specifications

Attribute			
Number of Inverter SGCTs	Voltage	SGCTs (per phase)	
	2400V	2	
	3300V	4	
	4160V	4	
	6600V	6	
Inverter PIV Rating (Peak Inverse Voltage)	Voltage	PIV (each device)	Total PIV
	2400V	6500V	6500V
	3300V	6500V	13,000V
	4160V	6500V	13,000V
	6600V	6500V	19,500V
Rectifier Designs	Direct-to-Drive™ (transformerless AFE rectifier) AFE with separate isolation transformer 18-pulse with separate isolation transformer		
Rectifier Switch	SCR (18-pulse), SGCT (AFE Rectifier)		
Rectifier Switch Failure-Mode	Non-rupture, Non-arc		
Rectifier Switch Failure-Rate (FIT)	50 (SGCT) 100 (SCR) per 1 Billion Hours Operation		
Rectifier Switch Cooling	Double Sided, Low Thermal Stress		
Number of Rectifier Devices per phase	Voltage	AFE	18-pulse
	2400V	2	6
	3300V	4	6
	4160V	4	6
	6600V	6	6
Output Current Harmonics (1 st ...49 th)	< 5% full load and full (rated) speed		
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 through Setup Wizard		
Speed Regulator Bandwidth	1...10 rad/s with standard control 1...20 rad/s with HPTC (optional)		
Torque Regulator Bandwidth	15...50 rad/s with standard control 80...100 rad/s with HPTC (optional)		
Torque Accuracy with HPTC (optional)	+/- 5%		
Speed Regulation	0.1% without Encoder Feedback 0.01...0.02% with Encoder 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		

Table 11 - General Design Specifications

Attribute		
Load Loss Detection	Adjustable level, delay, speed set points	
Control Mode	Speed or Torque	
Current Limit	Adjustable in Motoring and Regenerative	
Output Frequency Range	0.2...75 Hz (Standard) 75 Hz...85 Hz (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) > 98% (18-pulse) 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 - 2014 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 Touch Screen – 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, Russian, and Polish	
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...240V – 1 mA	
External Output Ratings	50...60 Hz AC or DC 30...260V – 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 (.1 Hz) (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...4 Ms	

Table 11 - General Design Specifications

Attribute		
Communication Protocols (Optional)	DeviceNet	ControlNet
	EtherNet/IP	Lon Works
	Dual-port EtherNet/IP	Can Open
	PROFIBUS	RS-485 HVAC
	Modbus	RS-485 DF1
	Interbus	RS-232 DF1
	USB	
Enclosure	Type 1 IP21 (with door gaskets)	
	IP42	
Lifting Device	Standard / Removable	
Mounting Arrangement	Mounting Sill Channels	
Structure Finish	Epoxy Powder – Paint Exterior Sandtex Light Gray (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 (Zn 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 Defuser with Matted Filter Media	
Door Filter Blockage	Airflow Restriction Trip / Warning	
Storage and Transportation Temperature Range	-40...+70 °C (-40...+185 °F)	
Relative Humidity	Max. 95%, Noncondensing	
Altitude (Standard)	0...1000 m (0...3300 ft)	
Altitude (Optional)	1001...5000 m (3301...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 through CPT.
- (2) MOVs are used for 18-pulse. Surge arrestors are used for AFE/Direct-to-Drive configurations.
- (3) Short-circuit fault rating that is based on input protection device (contactor or circuit breaker).
- (4) BIL rating that is based on altitudes < 1000 m (3300 ft). See factory for derating on altitudes > 1000 m (3280 feet).
- (5) Optional.
- (6) Under certain conditions, power system analysis is required.

General Reference

This section contains general reference information that can be used in conjunction with instructions and information throughout this manual.

Torque Requirements for Threaded Fasteners	107
Preventative Maintenance Schedule	108
Encoder Usage	108
PowerFlex 7000 Drive Performance (Torque Capabilities)	110
Application Load Profiles	111

Torque Requirements for Threaded Fasteners

Unless otherwise specified, use these torque values when maintaining the equipment.

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
1/4 in.	20	Steel S.A.E. 5	12	9
5/16 in.	18	Steel	14	11
3/8 in.	16	Steel S.A.E. 2	27	20

Preventative Maintenance Schedule

By rigorously following this maintenance schedule, it improves the performance and operational lifespan of the drive with the highest possible uptime. Annual maintenance includes the following:

- Visual inspection of all drive components visible from the front of the unit.
- Resistance checks on the power components.
- Voltage level checks of the power supply.
- General cleaning and maintenance.
- Checking of all accessible power connections for tightness, and other tasks.

These tasks are described in detail in publication [7000-UM202](#).

I – Inspection	Indicates that the component must be inspected for signs of excessive accumulation of dust, dirt, or external damage. For example, examination of Filter Capacitors for bulges in the case, inspection of the heat sinks for debris that clogs the airflow path.
M – Maintenance	Indicates a maintenance task that is not a normal maintenance, and can include an inductance test of Line Reactors/DC Links, or the full testing of an isolation transformer.
R – Replacement	Indicates that the component has reached its mean operational life, and must be replaced to decrease the chance of component failure. It is likely that components exceed the design life in the drive, and that is dependent on many factors such as usage, heat.
C – Cleaning	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	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.

Encoder Usage

When Is an Encoder Required?

An encoder is required under the following conditions:

1. When speed regulation accuracy must be between 0.01...0.02% of nominal speed.
2. When the zero speed breakaway torque is greater than 90% of continuous running-torque.
3. When continuous running-speed is greater than or equal to 0.1 Hz, but less than 6 Hz.
4. For minimizing restart times by using the flying start capability in forward or reverse direction.
5. At any time, when high performance torque or speed control mode (HPTC) is enabled.

Table 12 - PowerFlex Speed Regulation

Encoder	Frequency Output		
	<6 Hz	6...15 Hz	>15 Hz
Without Encoder	Not applicable	0.1%	0.1%
With Encoder	0.02%	0.01%	0.01%
With Encoder and HPTC mode enabled	0.01%	0.01%	0.01%

Notes:

- Speed regulation is based on a percentage of motor synchronous speed.
- Encoder to be mounted on the AC machine.
- Operational 15V DC Power Supply mounted in drive to power the encoder as a standard option with the encoder feed back card.
- Customer is responsible for providing and the mounting of encoder.
- Sleeve bearing motors require the encoder to have an axial movement tolerance.
- Recommended encoder types are shaft mounting.
- Magneto resistive models are more adaptable to harsh environments.
- When installing, the encoder body and electronics must be isolated from ground (options available from the encoder manufacturers).
- There are usually limits on encoder cable lengths. Verify that the maximum length is suitable for the application.

Table 13 - Encoder Selection

(HPTC) Mode	Motor RPM	Minimum Tach PPR	Recommended Tach PPR
	3600	1024	1024
	3000	1024	1024
	1800	1024	2048
	1500	1024	2048
	1200	2048	2048
	1000	2048	2048
	900	2048	4096
	720	4096	4096
	600	4096	4096
	450	4096	8192
	360	8192	8192
	300	8192	8192

Table 13 - Encoder Selection (continued)

Standard Control Mode	3600	—	600
	3000	—	600
	1800	—	1024
	1500	—	1024
	1200	—	2048
	1000	—	2048
	900	—	2048
	720	—	2048
	600	—	2048

PowerFlex 7000 Drive Performance (Torque Capabilities)

The PowerFlex 7000 drives are tested on a dynamometer to verify performance under locked rotor, accelerating, and low speed-high torque conditions.

[Table 14](#) shows the PowerFlex 7000 drive torque capabilities as a percent of motor rated torque, independent of the momentary overload conditions of the drive.

Table 14 - PowerFlex 7000 Drive Torque Capabilities

Parameter	7000 Torque Capability without Encoder (% of Motor Rated Torque)	7000 Torque Capability with Encoder (% of Motor Rated Torque)	7000 Torque Capability with Encoder and (HPTC)
Breakaway Torque (1)	90%	150%	150%
Accelerating Torque (2)	90% (0...8 Hz)	140% (0...8 Hz)	150% (0...75 Hz)
	125% (9...75 Hz)	140% (9...75 Hz)	
Steady State Torque (3)	125% (9...75 Hz) ⁽¹⁾	100% (1...2 Hz)	150% (0...60 Hz) ⁽¹⁾
		140% (3...60 Hz) ⁽⁵⁾	
Max. Torque Limit (4)	150%	150%	150%

(1) Torque required to start a machine from standstill.

(2) Torque required to accelerate a load to a given speed, in a certain time. This formula can be used to calculate the average torque to accelerate a known inertia (WK^2):

$$T = (WK^2 \times \text{change in RPM}) / 308t.$$

Where:

T = acceleration torque in N·m (lb·ft).

W = force N or kg f (lb).

K = gyration radius m (ft).

WK^2 = total system inertia (kg f x m² [lb·ft²]) that the motor must accelerate, including motor, gearbox, and load.

t = time to accelerate total system load.

(3) Continuous operating torque that is required to control the load, without instability.

(4) An electronic method of limiting the maximum torque available from the motor. The software in a drive typically sets the torque limit to 150% of motor rated torque.

(5) Drive requires over-sizing to achieve greater than 100% continuous torque.

Application Load Profiles

Table 15 - Typical, Application Load Torque Profiles ⁽¹⁾

Application	Load Torque Profile	Load Torque as Percent of Full-Load Drive Torque			Required Drive Service Duty Rating	Encoder Required for Extra Starting Torque?
		Break-away	Accelerating	Peak Running		
AGITATORS						
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	100	100	Heavy	Yes
BLOWERS (centrifugal)						
Damper closed	VT	30	50	40	Normal	No
Damper opened	VT	40	110	100	Normal	No
CHIPPER (WOOD)—starting empty	CT	50	40	200	Contact factory	No
COMPRESSORS						
Axial-vane, loaded	VT	40	100	100	Normal	No
Reciprocating, starting unloaded	CT	100	100	100	Contact factory	Yes
CONVEYORS						
Armored face	CT	175	150	200	Contact factory	Yes
Belt type, loaded	CT	150	130	100	Heavy	Yes
Drag type	CT	175	150	100	Contact factory	Yes
Screw type, loaded	CT	200	100	100	Contact factory	Yes
DRAG LINE	CT	100	200	200	Contact factory	Yes
EXTRUDERS (rubber or plastic)	CT	150	150	100	Contact factory	Yes
FANS (centrifugal, ambient)						
Damper closed	VT	25	60	50	Normal	No
Damper open	VT	25	110	100	Normal	No
FANS (centrifugal, hot gases)						
Damper closed	VT	25	60	100	Normal	No
Damper open	VT	25	200	175	Contact factory	No
FANS (propeller, axial flow)	VT	40	110	100	Normal	No
GRINDING MILL (Ball/Sag Mill)	CT	175	180	100	Contact factory	Yes
HOISTS	CT	100	200	200	Contact factory	Yes
KILNS (rotary, loaded)	CT	250	125	125	Contact factory	Yes
MIXERS						
Chemical	CT	175	75	100	Contact factory	Yes
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	125	100	Heavy	Yes
Solids	CT	175	125	175	Contact factory	Yes
PULPER	VT	40	100	150	Contact factory	No
PUMPS						

Table 15 - Typical, Application Load Torque Profiles (continued)⁽¹⁾

Application	Load Torque Profile	Load Torque as Percent of Full-Load Drive Torque			Required Drive Service Duty Rating	Encoder Required for Extra Starting Torque?
		Break-away	Accelerating	Peak Running		
Centrifugal, discharge open	VT	40	100	100	Normal	No
Oil field Flywheel	CT	150	200	200	Contact Factory	Yes
Propeller	VT	40	100	100	Normal	No
Fan Pump	VT	40	100	100	Normal	No
Reciprocating / Positive Displacement	CT	175	30	175	Contact factory	Yes
Screw type, started dry	VT	75	30	100	Normal	No
Screw type, primed, discharge open	CT	150	100	1000	Heavy	Yes
Slurry handling, discharge open	CT	150	100	100	Heavy	Yes
Turbine, Centrifugal, deep-well	VT	50	100	100	Normal	No
Vane-type, positive displacement	CT	150	150	175	Contact factory	Yes
SEPARATORS, AIR (fan type)	VT	40	100	100	Normal	No

(1) PowerFlex 7000 "A" Frame suitable only for normal service duty rating.

Insulation Resistance (IR) Testing

Drive IR Testing

When a ground fault occurs, there are three zones in which the problem can appear: input to the drive, the drive, and output to the motor. The ground fault condition indicates that a phase conductor has found a path to ground. A current with a magnitude that ranges from leakage to fault level exists that is dependent on the resistance of the path to ground. The drive itself rarely is a source of a ground fault when it is properly installed. Ground fault problems that are associated with the drive rarely occur. Normally the source of the fault exists in either the input or output zone.

Since the procedure for an IR test on the drive is more complex, it is recommended to first IR test the input and output zones when encountering a ground fault. If the location of the ground fault cannot be located outside the drive, IR test the drive.



ATTENTION: The IR test of the drive must be done with caution. Avoid hazards to drive by following the safety precautions in the [IR Testing the PowerFlex 7000 Drive](#) procedure. The [IR Testing Procedures](#) apply high voltage to ground. All control boards in the drive are grounded and if not isolated, the high potential that is applied to them can cause immediate damage.

IR Testing the PowerFlex 7000 Drive



ATTENTION: Use caution when performing the IR test. High-voltage testing is potentially hazardous and can cause severe burns, injury, or death. Where appropriate, connect the test equipment to Ground.

Check the insulation levels before power equipment is energized. IR tests provide a resistance measurement from the phase-to-phase and phase-to-ground by applying a high voltage to the power circuitry. Perform this test to detect Ground faults without damaging any drive equipment.



ATTENTION: There are risks of serious or fatal injury to personnel if you do not follow safety guidelines.

IR Testing Procedures

Follow this procedure to perform IR tests on the PowerFlex® 7000 drive.



ATTENTION: Failure to comply with this procedure can result in poor IR test readings and damage to drive control boards.

Required Equipment:

- Torque wrench and 7/16 in. socket.
 - Phillips screwdriver.
 - 2500/5000V insulation resistance tester.
1. Isolate and lockout the drive system from any high-voltage source.
 - a. Disconnect any incoming power sources.
 - b. Isolate and lockout medium-voltage sources.
 - c. Turn off all control power sources at their respective circuit breakers.
 - d. Verify with a potential indicator that power sources are disconnected, and that the control power in the drive is de-energized.
 2. Isolate the power circuit from system ground (“float the drive”).

Remove the grounds on these components within the drive (refer to the electrical diagrams provided with the equipment to determine the points to disconnect):

- Voltage sensing boards (VSB)
- Output grounding network (OGN)

Voltage Sensing Boards

3. Remove all ground connections, at the screw terminals on the VSB, from all VSBs in the drive. There are two grounds on each board marked “GND 1”, and “GND 2”.



ATTENTION: Disconnect the terminals on the boards rather than from the ground bus as the grounding cable is only rated for 600V. The Injection of a high voltage on the ground cable degrades 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.

Disconnect Output Grounding Network

4. Remove the ground connection on the OGN (if installed). Lift this connection at the OGN capacitor rather than the grounding bus, as the grounding cable is only rated for 600V.



ATTENTION: The Injection of a high voltage on the ground cable during an IR test degrades the cable insulation.

5. Disconnect connections between power circuit and low voltage control.

Disconnect Voltage Sensing Boards

The connections between the low voltage control and the power circuit are made through ribbon cable connectors. The cables are plugged into connectors on the voltage sensing board that is marked “J1”, “J2”, and “J3”, and terminate on the signal conditioning boards. Every ribbon cable connection that is made on the VSBs is marked for identification.

6. Confirm the marking matches the connections, and disconnect the ribbon cables and move them clear of the VSB. If the ribbon cables are not removed from the VSB, then high potential applies directly to the low voltage control through the SCBs and damages those boards.



ATTENTION: The VSB ribbon cable insulation is not rated for the potential that is applied during an IR test. You must disconnect the ribbon cables at the VSB rather than the SCB to avoid exposing the ribbon cables to high potential.

Removing Potential Transformer Fuses

A IR test can exceed the rating of potential transformer fusing. To avoid damage:

7. Remove the primary fuses from all potential and control power transformers in the system. It also removes a path from the power circuit back to the drive control.

Isolate Transient Suppression Network

A path to ground exists through the TSN network as it has a ground connection that dissipates high energy surges in normal operation. This ground path must be isolated. If this ground connection is not isolated, the IR test indicates a high leakage current through this path and falsely indicates a problem in the drive.

8. Remove all fuses on the TSN before proceeding with the IR test.

Surge Arrestors

Drives that are supplied after 2009 have surge arrestors instead of a TSN. Surge arrestors can remain in the circuit during the IR test procedure.

9. IR test the drive.

IMPORTANT Verify the drive and any connected equipment is clear of personnel and tools before starting the IR test. Barricade 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 connect through the DC Link and snubber network. A test from any one of the input or output terminals to ground sufficiently tests the drive.



ATTENTION: Discharge the IR tester before it is disconnected from the equipment.

- a. Connect the IR tester to the drive. Follow the specific instructions for that drive model.
- b. If the IR tester has a lower voltage setting (normally 500V or 1000V), apply that voltage for 5 seconds. Do the test as a precursor for a higher voltage rating. If you forgot to remove any grounds, it can limit the damage. If the reading is high, apply 5 kV from any drive input or output terminal to ground.
- c. Perform an IR test at 5 kV for 1 minute and record the result.

The test readings must be greater than the minimum values listed in [Table 16 on page 117](#).

Low Test Results

10. If the test results are lower than the listed values, segment the drive system into smaller components. Repeat the test on each segment until the source of the ground fault is identified.
 - a. Isolate the line side of the drive from the machine side by removing the appropriate cables on the DC Link reactor.
 - b. Isolate the DC Link reactor from the drive by disconnecting the four power cables.
 - c. Verify that all electrical components being IR tested are electrically isolated from ground.

Items that produce lower than expected readings are surge capacitors at the motor terminals and motor filter capacitors at the output of the drive. The IR test procedure must follow a systematic segmentation of electrical components to isolate and locate a ground fault.

Table 16 - Test Readings

Type of Drive	Minimum IR Tester Value
Liquid-cooled Drive	200 MΩ
Air-cooled Drive	1k MΩ
Drive with input/output Caps Disconnected	5k MΩ
Isolation Transformer	5k MΩ
Motor	5k MΩ

The motor filter capacitors and line filter capacitors (if applicable) can skew the IR test result as being lower than expected. The capacitors have internal discharge resistors that discharge the capacitors to ground. If the IR test results are skewed, disconnect the output capacitors.

IMPORTANT Humidity and dirty standoff insulators can cause leakage to ground because of tracking. Clean a 'dirty' drive before starting the IR test.

11. Reconnect connections between power circuit and low voltage control.
Reconnect the ribbon cables “J1”, “J2” and “J3” in all VSBs. Do not cross the cable connections.



ATTENTION: Incorrect placement of the feedback cables can result in serious damage to the drive. Make sure that they are connected to the proper location

12. Reconnect the power circuit to the system ground.

Reconnect Voltage Sensing Boards

13. Reconnect the two ground conductors on the VSBs.

The conductors provide a reference point for the VSB and enable the low voltage signal to be fed to the SCBs. If the ground conductors are not connected, the monitored low voltage signal rises to medium voltage potential, which is a serious hazard.

Make sure that 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 results in high potential in the low voltage cabinet within the drive. This high potential can damages the drive control and could cause injury or death to personnel.

Reconnect Output Grounding Network

14. Reconnect the ground connection on the OGN capacitor. Torque the bolt connection to 3.4 N•m (30 lb•in.). Do Not Exceed the torque rating of this connection, it results in damage to the capacitor.



ATTENTION: Failure to reconnect the OGN ground can result in impressing the neutral voltage offset on the motor cables and stator, which can result in equipment damage.

For drives that did not originally have the OGN connected (or installed), there is no need for concern.

Enable Transient Suppression Network

- d. Reinstall the fuses on the TSN.

Line and Load Cable Sizes

Maximum Line Cable Sizes

Table 17 - Max. Line Cable Sizes

PRODUCT					INPUT (LINE SIDE)			
Bulletin		Description (V/Freq./Rect.)	Drive Rating (A)	Drive Structure Code	Drive Enclosure Opening mm (inches) ¹	Max. Size and No. Incoming Cables: NEMA 2-4-5-6-8-9	Max. Size and No. Incoming Cables: IEC 2-4-5-6-8-9	Vertical Space Avail. for Stress Cones mm (inches)
'A' Frame (Air-Cooled)	PF7000A	2400V/60Hz/RPDTD	46...140	71.9 w/ starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	478 (18.8)
	PF7000A	2400V/60Hz/RPDTD	46...140	71.13, 71.18 w/o starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	435 (17.1)
	PF7000A	3300V/50Hz/RPDTD	46...140	71.9 w/ starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	478 (18.8)
	PF7000A	3300V/50Hz/RPDTD	46...140	71.13, 71.18 w/o starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	435 (17.1)
	PF7000A	4160V/50Hz/RPDTD	46...140	71.9 w/ starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	478 (18.8)
	PF7000A	4160V/50Hz/RPDTD	46...140	71.13, 71.18 w/o starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	435 (17.1)
	PF7000A	4160V/60Hz/RPDTD	46...140	71.9 w/ starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	467 (18-3/8)
	PF7000A	4160V/60Hz/RPDTD	46...140	71.13, 71.18 w/o starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	435 (17.1)
	PF7000A	6600V/50Hz/RPDTD	40...93	71.10 w/ starter	102x102 (4.00x4.00)	(1) #4/0 8 kV or 15 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	478 (18.8)
	PF7000A	6600V/50Hz RPDTD	40...93	71.14, 71.19 w/o starter	102x102 (4.00x4.00)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 8 kV or 15 kV/phase	435 (17.1)
	PF7000A	2400V/60Hz/RPTX	46...160	71.7	102x204 (4.00x8.00) ¹	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 5 kV or 8 kV/phase	860 (33.8)
	PF7000A	3300V/50Hz/RPTX	46...160	71.7	102x204 (4.00x8.00) ¹	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 8 kV or 15 kV/phase	860 (33.8))
	PF7000A	4160/50Hz/RPTX	46...160	71.7	102x204 (4.00x8.00) ¹	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 8 kV or 15 kV/phase	860 (33.8)
	PF7000A	4160/60Hz/RPTX	46...160	71.7	102x204 (4.00x8.00) ¹	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 8 kV or 15 kV/phase	860 (33.8)
	PF7000A	6600/50Hz/RPTX	40...105	71.8	102x204 (4.00x8.00) ¹	(1) 350MCM 15 kV/phase	(1) 177 mm ² 15 kV/phase	860 (33.8)
	PF7000A	2400V/60Hz/RPTXI	46...160	71.3	102x102 (4.00x4.00)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 5 kV or 8 kV/phase	508 (20.0) ³
	PF7000A	3300V/50Hz/RPTXI	46...160	71.3	102x102 (4.00x4.00)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 5 kV or 8 kV/phase	508 (20.0) ³
	PF7000A	4160V/50Hz/RPTXI	46...140	71.3	102x102 (4.00x4.00)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 5 kV or 8 kV/phase	508 (20.0) ³
	PF7000A	4160V/60Hz/RPTXI	46...160	71.3	102x102 (4.00x4.00)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 5 kV or 8 kV/phase	508 (20.0) ³
	PF7000A	6600V/50Hz/RPTXI	40...105	71.6, 71.15	102x102 (4.00x4.00)	(1) #4/0 8 kV or 15 kV/phase	(1) 177 mm ² 8 kV or 15 kV/phase	508 (20.0) ³

Table 17 - Max. Line Cable Sizes (continued)

PRODUCT				INPUT (LINE SIDE)				
Bulletin	Description (V/Freq./Rect.)	Drive Rating (A)	Drive Structure Code	Drive Enclosure Opening mm (inches) ¹	Max. Size and No. Incoming Cables: NEMA 2-4-5-6-8-9	Max. Size and No. Incoming Cables: IEC 2-4-5-6-8-9	Vertical Space Avail. for Stress Cones mm (inches)	
'B' Frame (Air-Cooled)	PF7000	2400V/60Hz/RPDTD	46...430	70.40, 70.41, 70.44, 70.45	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	2400V/60Hz/RPDTD	46...375	70.40C, 70.41C, 70.44C w/close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 5 kV or 8 kV/phase	(1) 253 mm ² 5 kV or 8 kV/phase	874 (34.4)
	PF7000	3300V/50Hz/RPDTD	46...430	70.43, 70.44, 70.45, 70.47	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	3300V/50Hz/RPDTD	E495-E625, G285, G325, N720	70.32	300x412 (11.81x16.22) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	421 (16.5)
	PF7000	3300V/50Hz/RPDTD	46...375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 5 kV or 8 kV/phase	(1) 253 mm ² 5 kV or 8 kV/phase	874 (34.4)
	PF7000	4160V/50Hz/RPDTD	46...375	70.43, 70.44, 70.45, 70.47	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	4160V/50Hz/RPDTD	46...375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 5 kV or 8 kV/phase	(1) 253 mm ² 5 kV or 8 kV/phase	874 (34.4)
	PF7000	4160V/60Hz/RPDTD	46...430	70.43, 70.44, 70.45, 70.47	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 8 kV or 15 kV/phase	725 (28.5)
	PF7000	4160V/60Hz/RPDTD	E495-E625, G285, G325 N720	70.32	300x412 (11.81x16.22) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	421 (16.5)
	PF7000	4160V/60Hz/RPDTD	46...375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 5 kV or 8 kV/phase	(1) 253 mm ² 8 kV or 15 kV/phase	874 (34.4)
	PF7000	6600V/50Hz/RPDTD	46...285	70.46, 70.47, 70.48, 70.49	249x279 (9.79x10.97) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 8 kV or 15 kV/phase	725 (28.5)
	PF7000	6600V/50Hz/RPDTD	E325-E575 G215, G250 N625	70.34, 70.35	325x500 (12.79x19.68) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 8 kV or 15 kV/phase	421 (16.5)
	PF7000	6600V/50Hz/RPDTD	40...285	70.46C, 70.47C, 70.49C w/close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 8 kV or 15 kV/phase	(1) 253 mm ² 8 kV or 15 kV/phase	874 (34.4)
	PF7000	6600V/60Hz/RPDTD	40...285	70.46, 70.47, 70.48, 70.49	249x279 (9.79x10.97) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	6600V/60Hz/RPDTD	40...285	70.46C, 70.47C, 70.49C w/close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 8 kV or 15 kV/phase	(1) 253 mm ² 5 kV or 8 kV/phase	874 (34.4)
	PF7000	2400V/60Hz/RPTX	46...430	70.1, 70.2, 70.25, 70.26	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	3300V/50Hz/RPTX	46...430	70.10, 70.27, 70.28, 70.30	249x279 (9.79x10.97) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	3300V/50Hz/RPTX	E495-E625 G285, G325 N720	70.32	300x412 (11.81x16.22) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	421 (16.5)
	PF7000	4160V/50Hz/RPTX	46...430	70.10, 70.27, 70.29, 70.30	249x279 (9.79x10.97) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 5kV or 8kV/phase	725 (28.5)
	PF7000	4160V/60Hz/RPTX	46...430	70.2, 70.26, 70.27, 70.28, 70.29, 70.31	249x279 (9.79x10.97) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)

Table 17 - Max. Line Cable Sizes (continued)

PRODUCT				INPUT (LINE SIDE)			
Bulletin	Description (V/Freq./Rect.)	Drive Rating (A)	Drive Structure Code	Drive Enclosure Opening mm (inches) ¹	Max. Size and No. Incoming Cables: NEMA 2-4-5-6-8-9	Max. Size and No. Incoming Cables: IEC 2-4-5-6-8-9	Vertical Space Avail. for Stress Cones mm (inches)
'B' Frame (Air-Cooled)	PF7000	4160V/60Hz/RPTX	E495-E625 G285, G325 N720	70.32	300x412 (11.81x16.22) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase
	PF7000	6600V/50Hz/RPTX	40...285	70.11, 70.28, 70.30, 70.31	249x279 (9.79x10.97) ¹	(2) 500MCM 15 kV/phase	(2) 127 mm ² 5 kV or 8 kV/phase
	PF7000	6600V/50Hz/RPTX	E325-E575 G215, G250 N625	70.36, 70.37	325x500 (12.79x19.68) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 8kV or 15kV/phase
'C' Frame (Liquid-Cooled)	PF7000	2400V/60Hz/RP18TX ⁷	46...430	70.8	249x535 (9.79x21.06) ¹	(2) 500MCM 5 kV or 8 kV/sec. Winding	(2) 253 mm ² 5 kV or 8 kV/sec. Winding
	PF7000	3300V/50Hz/RP18TX ⁷	46...430	70.9	249x535 (9.79x21.06) ¹	(2) 500MCM 8 kV or 15 kV/sec. Winding	(2) 253 mm ² 8 kV or 15 kV/sec. Winding
	PF7000L	4160V/50Hz/RPDTD	375...575	70.71(L-A), 70.72 (L-L), 70.76 (L-A), 70.77 (L-L), 70.89 (L-A), 70.94 (L-L)	285x600 (11.22x23.62) ¹	(4) 500MCM 5 kV or 8 kV/phase	(4) 253mm ² 5 kV or 8 kV/phase
	PF7000L	4160V/60Hz/RPDTD	375...625	70.71(L-A), 70.72 (L-L), 70.76 (L-A), 70.77 (L-L)	285x600 (11.22x23.62) ¹	(4) 500MCM 5 kV or 8 kV/phase	(4) 253mm ² 5 kV or 8 kV/phase
	PF7000L	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)	285x600 (11.22x23.62) ¹	(4) 500MCM 8 kV or 15 kV/phase	(4) 253mm ² 5 kV or 8 kV/phase
	PF7000L	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)	285x600 (11.22x23.62) ¹	(4) 500MCM 8 kV or 15 kV/phase	(4) 253mm ² 5 kV or 8 kV/phase
	PF7000L	4160V/50Hz/R18TX	375...657	70.50 (L-A), 70.55 (L-L)	249x535 (9.79x21.06) ¹	(2) 500MCM 8 kV or 15 kV/s Winding	(2) 253mm ² 5 kV or 8 kV/s Winding
	PF7000L	4160V/60Hz/R18TX	375...657	70.50 (L-A), 70.55 (L-L)	249x535 (9.79x21.06) ¹	(2) 500MCM 8 kV or 15 kV/s Winding	(2) 253mm ² 5 kV or 8 kV/s Winding
	PF7000L	6600V/50Hz/R18TX	375...657	70.50 (L-A), 70.53 (L-A), 70.55 (L-L), 70.58 (L-L)	249x535 (9.79x21.06) ¹	(2) 500MCM 15 kV/s Winding	(2) 177mm ² 15 kV/s Winding
	PF7000L	6600V/60Hz/R18TX	375...657	70.50 (L-A), 70.53 (L-A), 70.55 (L-L), 70.58 (L-L)	249x535 (9.79x21.06) ¹	(2) 500MCM 15 kV/s Winding	(2) 177mm ² 15 kV/s Winding
	PF7000L	6600V/60Hz/R18TX	375...657	70.50 (L-A), 70.53 (L-A), 70.55 (L-L), 70.58 (L-L)	249x535 (9.79x21.06) ¹	(2) 500MCM 15 kV/s Winding	(2) 177mm ² 15 kV/s Winding

Notes:

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

- Some 'A' Frames, most 'B' Frames, and all 'C' Frames have one enclosure aperture provision for both line and load cables (designated by ¹). Most 'A' Frames and some 'B' Frames have separate aperture provisions for line and load cables. All cabling capacities that are shown in this table are "worst case" conditions when both line and load cabling enters and exits in the same direction.
- Cable sizes are based on overall dimensions of compact-stranded three-conductor shielded cable (common for industrial cable tray installations). Maximum size stated accounts for minimum rated cable insulation requirements and the next higher-rated cable (that is, 8 kV) is not commercially available in many areas of the world. Rockwell Automation provides an 8 kV (minimum rating) and a 15 kV rating, when applicable. Enclosure openings accommodate the thicker insulation on the higher-rated cable. IEC ratings show the equivalent to the NEMA sizes. The exact cable mm² size that is shown is not commercially available in many cases; use the next smaller standard size.
- Cable enters termination point horizontally in this case, therefore orient space for the stress cones horizontally also.
- 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 (for example, if the cable diameter is 2.54 cm [1 in.] the minimum bend radius could range between 18.8...30.48 cm [7...12 in.]).
- For 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 cablings that are based on RMS line-to-line.
- 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).
- 18-pulse VFDs (R18TX) have nine line-side connections from the secondary, isolation transformer windings that enter 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).
- Maximum cable size for "B" Frame (two per phase) and "C" Frame (four per phase) is 500 MCM (253 mm²). Cable size is limited by the size of the lug pad assembly and by clearance requirements.
- Maximum cable sizes that are shown do not account for the size of the conduit hub. Verify size of conduit hubs against the "Drive enclosure openings" shown.

Maximum Load Cable Sizes

Table 18 - Max. Load Cable Sizes

PRODUCT					OUTPUT (MOTOR SIDE)			
Bulletin		Description (V/Freq./Rect.)	Drive Rating (A)	Drive Structure Code	Drive Enclosure Opening mm (inches) ¹	Max. Size and No. Incoming Cables: NEMA 2-4-5-6-8-9	Max. Size and No. Incoming Cables: IEC 2-4-5-6-8-9	Vertical Space Avail. for Stress Cones mm (inches)
'A' Frame (Air-Cooled)	PF7000A	2400V/60Hz/RPDTD	46...140	71.9 w/ starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	467 (18.4)
	PF7000A	2400V/60Hz/RPDTD	46...140	71.13, 71.18 w/o starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	424 (16.7)
	PF7000A	3300V/50Hz/RPDTD	46...140	71.9 w/ starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	467 (18.4)
	PF7000A	3300V/50Hz/RPDTD	46...140	71.13, 71.18 w/o starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	424 (16.7)
	PF7000A	4160V/50Hz/RPDTD	46...140	71.9 w/ starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	467 (18.4)
	PF7000A	4160V/50Hz/RPDTD	46...140	71.13, 71.18 w/o starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	424 (16.7)
	PF7000A	4160V/60Hz/RPDTD	46...140	71.9 w/ starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	467 (18.4)
	PF7000A	4160V/60Hz/RPDTD	46...140	71.13, 71.18 w/o starter	102x102 (4.00x4.00)	(1) #4/0 5 kV or 8 kV/phase	(1) 107 mm ² 5 kV or 8 kV/phase	424 (16.7)
	PF7000A	6600V/50Hz/RPDTD	40...93	71.10 w/ starter	102x102 (4.00x4.00)	(1) #4/0 8 kV or 15 kV/phase	(1) 107 mm ² 8 kV or 15 kV/phase	467 (18.4)
	PF7000A	6600V/50Hz/RPDTD	40...93	71.14, 71.19 w/o starter	102x102 (4.00x4.00)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 8 kV or 15 kV/phase	524 (20.6)
	PF7000A	2400V/60Hz/RPTX	46...160	71.7	102x204 (4.00x8.00) ¹	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 5 kV or 8 kV/phase	860 (33.8)
	PF7000A	3300V/50Hz/RPTX	46...160	71.7	102x204 (4.00x8.00) ¹	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 8 kV or 15 kV/phase	860 (33.8)
	PF7000A	4160/50Hz/RPTX	46...160	71.7	102x204 (4.00x8.00) ¹	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 8 kV or 15 kV/phase	860 (33.8)
	PF7000A	4160/60Hz/RPTX	46...160	71.7	102x204 (4.00x8.00) ¹	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 8 kV or 15 kV/phase	860 (33.8)
	PF7000A	6600/50Hz/RPTX	40...105	71.8	102x204 (4.00x8.00) ¹	(1) 350MCM 15 kV/phase	(1) 177 mm ² 15 kV/phase	860 (33.8)
	PF7000A	2400V/60Hz/RPTXI	46...160	71.3	102x102 (4.00x4.00)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 5 kV or 8 kV/phase	524 (20.6) ³
	PF7000A	3300V/50Hz/RPTXI	46...160	71.3	102x102 (4.00x4.00)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 5 kV or 8 kV/phase	524 (20.6) ³
	PF7000A	4160V/50Hz/RPTXI	46...140	71.3	102x102 (4.00x4.00)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 5 kV or 8 kV/phase	524 (20.6) ³
	PF7000A	4160V/60Hz/RPTXI	46...160	71.3	102x102 (4.00x4.00)	(1) 350MCM 8 kV or 15 kV/phase	(1) 177 mm ² 5 kV or 8 kV/phase	524 (20.6) ³
	PF7000A	6600V/50Hz/RPTXI	40...105	71.6, 71.15	102x102 (4.00x4.00)	(1) #4/0 8 kV or 15 kV/phase	(1) 177 mm ² 8 kV or 15 kV/phase	524 (20.6) ³
'B' Frame (Air-Cooled)	PF7000	2400V/60Hz/RPDTD	46...430	70.40, 70.41, 70.44, 70.45	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	2400V/60Hz/RPDTD	46...375	70.40C, 70.41C, 70.44C w/ close-coupled starter	168x251 (6.52x9.88)	(1) 500MCM 5 kV or 8 kV/phase OR (2) 250MCM 5 kV or 8 kV/phase	(1) 253 mm ² 5 kV or 8 kV/phase OR (2) 127mm ² 5kV or 8kV/phase	411 (16.2)
	PF7000	3300V/50Hz/RPDTD	46...430	70.43, 70.44, 70.45, 70.47	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	3300V/50Hz/RPDTD	E495-E625 G285, G325 N720	70.32	300x412 (11.81x16.22) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	430 (16.9)

Table 18 - Max. Load Cable Sizes (continued)

PRODUCT				OUTPUT (MOTOR SIDE)				
Bulletin	Description (V/Freq./Rect.)	Drive Rating (A)	Drive Structure Code	Drive Enclosure Opening mm (inches) ¹	Max. Size and No. Incoming Cables: NEMA 2-4-5-6-8-9	Max. Size and No. Incoming Cables: IEC 2-4-5-6-8-9	Vertical Space Avail. for Stress Cones mm (inches)	
'B' Frame (Air- Cooled)	PF7000	3300V/50Hz/RPDTD	46...375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 5 kV or 8 kV/phase OR (2) 250MCM 5 kV or 8 kV/phase	(1) 253 mm ² 5 kV or 8 kV/phase OR (2) 127mm ² 5 kV or 8 kV/phase	411 (16.2)
	PF7000	4160V/50Hz/RPDTD	46...375	70.43, 70.44, 70.45, 70.47	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	4160V/50Hz/RPDTD	46...375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 5 kV or 8 kV/phase OR (2) 250MCM 5 kV or 8 kV/phase	(1) 253 mm ² 5 kV or 8 kV/phase OR (2) 127mm ² 5 kV or 8 kV/phase	411 (16.2)
	PF7000	4160V/60Hz/RPDTD	46...430	70.43, 70.44, 70.45, 70.47	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 8 kV or 15 kV/phase	725 (28.5)
	PF7000	4160/60Hz/RPDTD	E495-E625 G285, G325 N720	70.32	300x412 (11.81x16.22) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	430 (16.9)
	PF7000	4160V/60Hz/RPDTD	46...375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 5 kV or 8 kV/phase OR (2) 250MCM 5 kV or 8 kV/phase	(1) 253 mm ² 5 kV or 8 kV/phase OR (2) 127mm ² 5 kV or 8 kV/phase	411 (16.2)
	PF7000	6600V/50Hz/RPDTD	46...285	70.46, 70.47, 70.48, 70.49	249x279 (9.79x10.97) ¹	(1) 500MCM 8 kV/ phase	(1) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	6600V/50Hz/RPDTD	40...285	70.46C, 70.47C, 70.49C w/ close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 5 kV OR (2) 250MCM 8 kV or 15 kV/phase	(1) 253 mm ² OR (2) 127mm ² 8 kV or 15 kV/phase	411 (16.2)
	PF7000	6600V/50Hz/RPDTD	E325-E575 G215, G250 N625	70.34, 70.35	325x500 (12.79x19.68) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 8 kV or 15 kV/phase	430 (16.9)
	PF7000	6600V/60Hz/RPDTD	40...285	70.46, 70.47, 70.48, 70.49	249x279 (9.79x10.97) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	6600V/60Hz/RPDTD	40...285	70.46C, 70.47C, 70.49C w/ close-coupled starter	142x183 (5.61x7.19)	(1) 500MCM 5 kV OR (2) 250MCM 8 kV or 15 kV/phase	(1) 253 mm ² OR (2) 127mm ² 8 kV or 15 kV/phase	411 (16.2)
	PF7000	2400V/60Hz/RPTX	46...430	70.1, 70.2, 70.25, 70.26	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	3300V/50Hz/RPTX	46...430	70.10, 70.27, 70.28, 70.30	249x279 (9.79x10.97) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	3300V/50Hz/RPTX	E495-E625 G285, G325 N720	70.32	300x412 (11.81x16.22) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	430 (16.9)
	PF7000	4160V/50Hz/RPTX	46...430	70.10, 70.27, 70.29, 70.30	249x279 (9.79x10.97) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	4160V/60Hz/RPTX	46...430	70.2, 70.26, 70.27, 70.28, 70.29, 70.31	249x279 (9.79x10.97) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	725 (28.5)
	PF7000	4160V/60Hz/RPTX	E495-E625 G285, G325 N720	70.32	300x412 (11.81x16.22) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	430 (16.9)
	PF7000	6600V/50Hz/RPTX	40...285	70.11, 70.28, 70.30, 70.31	249x279 (9.79x10.97) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 8 kV or 15 kV/phase	725 (28.5)
	PF7000	6600V/50Hz/RPTX	E325-E575 G215, G250 N625	70.36, 70.37	325x500 (12.79x19.68) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 8 kV or 15 kV/phase	430 (16.9)

Table 18 - Max. Load Cable Sizes (continued)

PRODUCT				OUTPUT (MOTOR SIDE)				
Bulletin		Description (V/Freq./Rect.)	Drive Rating (A)	Drive Structure Code	Drive Enclosure Opening mm (inches) ¹	Max. Size and No. Incoming Cables: NEMA 2-4-5-6-8-9	Max. Size and No. Incoming Cables: IEC 2-4-5-6-8-9	Vertical Space Avail. for Stress Cones mm (inches)
'C' Frame (Liquid-Cooled)	PF7000	2400V/60Hz/RP18TX ⁷	46...430	70.8	249x535 (9.79x21.06) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	415 (16.4)
	PF7000	3300V/50Hz/RP18TX ⁷	46...430	70.9	249x535 (9.79x21.06) ¹	(2) 500MCM 5 kV or 8 kV/phase	(2) 253 mm ² 5 kV or 8 kV/phase	415 (16.4)
	PF7000L	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)	285x600 (11.22x23.62) ¹	(4) 500MCM 5 kV or 8 kV/phase	(4) 253 mm ² 5 kV or 8 kV/phase	415 (16.4)
	PF7000L	4160V/60Hz/RPDTD	375...625	70.71(L-A), 70.72 (L-L), 70.76 (LA), 70.77 (L-L)	285x600 (11.22x23.62) ¹	(4) 500MCM 5 kV or 8 kV/phase	(4) 253 mm ² 5 kV or 8 kV/phase	415 (16.4)
	PF7000L	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)	285x600 (11.22x23.62) ¹	(4) 500MCM 8 kV or 15 kV/phase	(4) 253 mm ² 8 kV or 15 kV/phase	415 (16.4)
	PF7000L	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)	285x600 (11.22x23.62) ¹	(4) 500MCM 8 kV or 15 kV/phase	(4) 253 mm ² 8 kV or 15 kV/phase	415 (16.4)
	PF7000L	4160V/50Hz/R18TX	375...657	70.50 (L-A), 70.55 (L-L)	249x535 (9.79x21.06) ¹	(2) 500MCM 5 kV or 8V/phase	(2) 253 mm ² 5 kV or 8 kV/phase	415 (16.4)
	PF7000L	4160V/60Hz/R18TX	375...657	70.50 (L-A), 70.55 (L-L)	249x535 (9.79x21.06) ¹	(2) 500MCM 5 kV or 8V/phase	(2) 253 mm ² 5 kV or 8 kV/phase	415 (16.4)
	PF7000L	6600V/50Hz/R18TX	375...657	70.50 (L-A), 70.53 (L-A), 70.55 (L-L), 70.58 (L-L)	249x535 (9.79x21.06) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 8 kV or 15 kV/phase	415 (16.4)
	PF7000L	6600V/60Hz/R18TX	375...657	70.50 (L-A), 70.53 (L-A), 70.55 (L-L), 70.58 (L-L)	249x535 (9.79x21.06) ¹	(2) 500MCM 8 kV or 15 kV/phase	(2) 253 mm ² 8 kV or 15 kV/phase	415 (16.4)

Notes:

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

- Some 'A' Frames, most 'B' Frames, and all 'C' Frames have one enclosure aperture provision for both line and load cables (designated by ¹). Most 'A' Frames and some 'B' Frames have separate aperture provisions for line and load cables. All cabling capacities that are shown in this table are "worst case" conditions when both line and load cabling enters and exits in the same direction.
- Cable sizes are based on overall dimensions of compact-stranded three-conductor shielded cable (common for industrial cable tray installations). Maximum size stated accounts for minimum rated cable insulation requirements and the next higher-rated cable (that is, 8 kV) is not commercially available in many areas of the world. Rockwell Automation provides an 8 kV (minimum rating) and a 15 kV rating, when applicable. Enclosure openings accommodate the thicker insulation on the higher-rated cable. IEC ratings show the equivalent to the NEMA sizes. The exact cable mm² size that is shown is not commercially available in many cases; use the next smaller standard size.
- Cable enters termination point horizontally in this case, therefore orient space for the stress cones horizontally also.
- 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. For example, if the cable diameter is 2.54 cm [1 in.] the minimum bend radius can range between 18.8...30.48 cm [7...12 in.].
- For 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 cablings that are based on RMS line-to-line.
- 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).
- 18-pulse VFDs (R18TX) have nine line-side connections from the secondary, isolation transformer windings that enter 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).
- Maximum cable size for "B" Frame (two per phase) and "C" Frame (four per phase) is 500 MCM (253 mm²). Cable size is limited by the size of the lug pad assembly and by clearance requirements.
- Kv Maximum cable sizes that are shown do not account for the size of the conduit hub. Verify size of conduit hubs against the "Drive enclosure openings" shown.

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