Hardware Service Manual

Original Instructions

Allen-Bradley

# PowerFlex Active Front End – Frame 13

Catalog Number 20Y
PowerFlex AFE/PowerFlex 700AFE
(400V/480V and 600V/690V)

## 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.

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

| | |
|---|---|
|  | **WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss. |
|  | **ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence. |
| **IMPORTANT** | Identifies information that is critical for successful application and understanding of the product. |

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

| | |
|---|---|
|  | **SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present. |
|  | **BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures. |
|  | **ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE). |

## Summary of Changes

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

| Topic | Page |
|---|---|
| Updated the basic one-line diagram for a Frame 13 AFE in IP20 2500 MCC style enclosure to include the factory-installed common mode core at the DC bus output. | Figure 1 on page 19 |
| Updated the system schematics for a Frame 13 AFE in IP20 2500 MCC style enclosure to include the factory-installed common mode core at the DC bus output. | Figure 21 on page 108 |

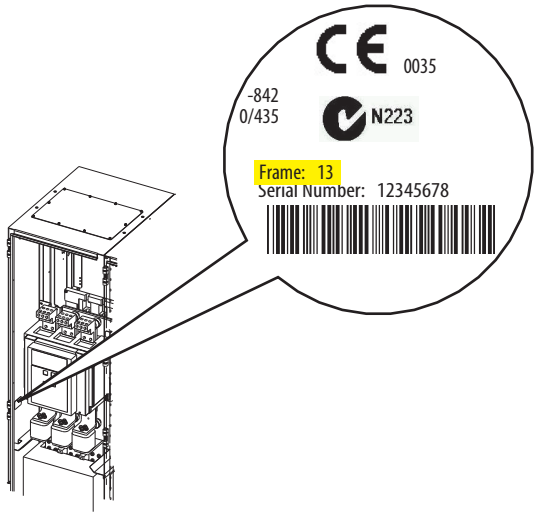
## Intended Audience

This manual is intended for qualified service personnel responsible for troubleshooting and repairing the PowerFlex® Active Front End (AFE). You must have previous experience with, and basic understanding of, electrical terminology, procedures, required troubleshooting equipment, equipment protection procedures and methods, and safety precautions. See safety-related practices that are in Standard for Electrical Safety in the Work Place, publication NFPA 70E.

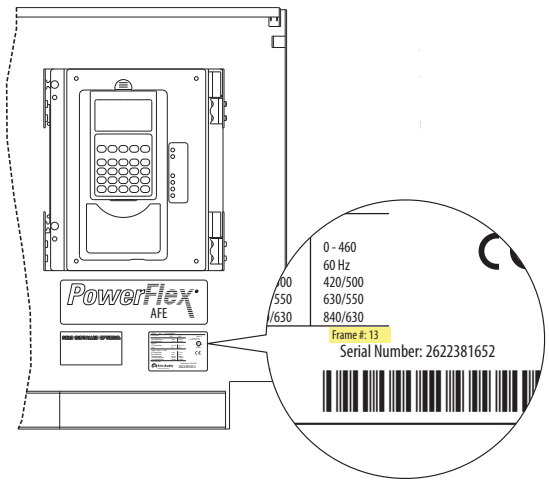
## What Is in This Manual

This manual contains hardware service information for the Frame 13 PowerFlex Active Front End. Verify that you are working on a Frame 13 by checking the data nameplate on the AFE. The frame number is printed just above the serial number.

Data Nameplate on AFE in IP20
2500 MCC Style Enclosure




Data Nameplate on AFE in IP21
Rittal Enclosure




## What Is Not in This Manual

This manual does not contain installation, start-up, and programming information. This information is available in the PowerFlex Active Front End User Manual, publication 20Y-UM001.

## Additional Resources

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

| Resource | Description |
|---|---|
| PowerFlex Active Front End User Manual, publication 20Y-UM001 | Provides information for installation, startup, and programming for the PowerFlex Active Front End units. |
| PowerFlex 700H, 700S, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029 | Provides information for drive fan system service and installation. |
| Drives in Common Bus Configurations Application Guidelines, publication DRIVES-AT002 | Provides guidelines, considerations, and limitations for the proper application of PowerFlex drives used in common bus configurations. |
| Wiring and Grounding Guidelines for pulse Width Modulated AC Drives, publication DRIVES-IN001 | Provides basic information to properly wire and ground Pulse Width Modulated (PWM) AC drives. |
| Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control, publication SGI-1.1 | Provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies with solid-state components. |
| Guarding Against Electrostatic Damage, publication 8000-4.5.2 | Provides an explanation of the causes of Electrostatic Damage, and how you can guard against its effects. |
| 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. |

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.

## Spare Parts

For spare parts information on PowerFlex 7-Class Architecture-Class Low-Voltage AC Drives, including the PowerFlex Active Front End, click this link:

http://www.ab.com/support/abdrives/powerflex70/PF7ReleasedParts.pdf

## Additional Support Available on the Internet

Additional troubleshooting information and software tools are available on the Allen-Bradley® Drives Service and Support website at http://www.ab.com/support/abdrives.

## General Precautions for Class 1 Light-emitting Diode Product

**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into module ports or fiber-optic cable connectors.

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC Board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

**ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

**ATTENTION:** Potentially fatal voltages can result from improper usage of an oscilloscope and other test equipment. The oscilloscope chassis can be at a potentially fatal voltage if not properly grounded. Use high-voltage differential voltage probes for all voltage measurements with the oscilloscope chassis that is correctly grounded to an earth ground.

**ATTENTION:** The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this unit. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

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

**ATTENTION:** Only qualified personnel familiar with adjustable frequency AC drives 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.

## Notes:

# Troubleshooting and Error Codes

**ATTENTION:** To avoid an electric shock hazard, verify that all power to the PowerFlex® Active Front End has been removed before you perform any service or repairs.

**ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

**ATTENTION:** Hot surfaces can cause severe burns. Do not touch the heatsink surface during operation of the PowerFlex Active Front End. After you disconnect power, allow time for cooling.

**ATTENTION:** The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

## Create Fault Reports

Complete fault reports are critical for analysis and repair of modules that are returned to the factory.

At a minimum, perform these tasks:

- Use an Allen-Bradley® drive configuration tool such as Connected Components Workbench™ software, DriveExplorer™ software, or DriveExecutive™ software, do perform these tasks:
  - Upload all parameters from the PowerFlex Active Front End.
  - Run the technical support wizard.
- Collect the AFE system application data that are shown in Appendix E.
- If possible, record the contents of the fault queue (faults and times of occurrence).
- Record the following information:
  - Any burn marks on the rectifying module, DC capacitors, inverter bridge, charging resistors, balancing/precharging resistors, printed circuit boards, bus bars, cabling, and fiber-optic cabling.
  - Any liquid and condensation marks on printed circuit boards, components, and mechanical parts.
  - Amount of dust and other additional particles on drive and drive components.
  - Any mechanical damage to the drive and drive components.
- Record the size and type of main fuses.
- Record any other important marks and damage.
- Note grounding type (solid, high resistance, or floating) and source impedance of the power distribution system.

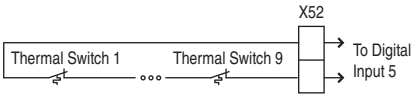
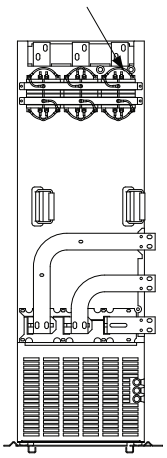
## Addressing PowerFlex Active Front End Faults

| No. | Name | Description | Action (if appropriate) |
|---|---|---|---|
| 1 | PrechargeActv | The AFE is still in precharge, because the charging switch is open:<br>• K20, K6, and K1 for AFE in IP20 2500 MCC Style enclosure<br>• K20, K6, and Q1 for AFE in IP21 Rittal enclosure<br>Faulty operation.<br>Component failure. | Reset the fault and restart.<br>If the fault reoccurs, contact technical support. |
| 2 | Auxiliary In | The AFE control digital input interlock is open. | Verify wiring to the digital inputs on the AFE control board is correct. |
| 4 | DC UnderVolt | The DC bus voltage fell below the minimum value of 333V for 400/480V units, or 461V for 600/690V units. You can enable/disable this fault with parameter 120 [Fault Config]. | Monitor the incoming AC line for low voltage or power interruption. |
| 5 | DC OverVolt | The DC bus voltage exceeded the maximum value of 911V for 400/480V units, or 1200V for 600/690V units. | Check if the AFE was in a regenerative current limit condition, which can indicate an excess regenerative load.<br>Adjust parameter 076 [Regen Power Lmt].<br>Monitor incoming AC line for high voltage or voltage transients. |

| No. | Name | Description | Action (if appropriate) |
|---|---|---|---|
| 7 | Overload | When input current exceeds 125% for 60 seconds or 150% for 30 seconds. The overload is a linear type in counting up. | Reduce the current consumption of the AFE or increase parameter 133 [Cnvrtr OL Factor]. |
| 8 | HeatsinkOvrTp | The power structure heatsink temperature has exceeded the maximum allowable value.<br>85 °C (185 °F) = Alarm<br>90 °C (194 °F) = Fault | Verify that the maximum ambient temperature has not been exceeded.<br>Check the fans (including the ASIC board on the converter).<br>Check for an excess load.<br>Verify that the airflow plate is installed. See page 46. |
| 9 | IGBT OverTemp | The output transistors have exceeded their maximum operating temperature due to an excessive load. | Verify that the maximum ambient temperature has not been exceeded.<br>Check the fans.<br>Check for an excess load. |
| 10 | System Fault | A hardware problem exists in the power structure. | Reset the fault and restart.<br>Verify the fiber-optic connections.<br>Verify ASIC board jumper connections from X9 to X15 (see Figure  on page 102).<br>Contact technical support.<br>If the problem persists, replace or repair the power structure. |
| 12 | AC OverCurr | The AC line current has exceeded the hardware current limit. | Check for an excessive load or other causes of excess current. |
| 13 | Ground Fault | A current path to earth ground exists that is greater than the parameter 082 [Ground I Lvl] value. The current must appear for 800 milliseconds before the unit will fault. | Use a digital voltmeter to check for low impedance to ground, and verify the bus cables/bars between the:<br>Disconnect and AC input lines<br>Power structure and LCL filter<br>For AFE in IP20 enclosure:<br>• Q0 input breaker and K1 input contactor, which includes the precharge disconnect<br>• LCL filter and K1 input cont.<br>For AFE in IP21 enclosure:<br>• Q1 (MCCB) and Q0 disconnect switch, which includes the precharge disconnect<br>• LCL filter and Q1 (MCCB) |
| 14 | Power Structure Fault | A hardware problem exists in the power structure. | Cycle the power.<br>Contact technical support.<br>If the problem persists, replace the converter unit. |
| 17 | LineSync Fail | One input of the known phase rotation is missing. | Check all user-supplied fuses.<br>Check the AC input line voltage. |
| 21 | Phase Loss | There are zero current in one of the three phases. | Check supply voltage, fuses, and cable. |
| 29 | Anlg In Loss | An analog input is configured to fault on a signal loss. A signal loss has occurred. Configure this fault with parameter 203 or 206 [Anlg In x Loss]. | Verify parameter 203 or 206 [Anlg In x Loss] setting. Verify that input signal levels are greater than or equal to 1.5V or 3 mA.<br>Check for broken/loose connections at the inputs. |
| 30 | MicroWatchdog | A microprocessor watchdog timeout has occurred. | Cycle the power.<br>Replace the control board. See page 39. |
| 31 | IGBT Temp Hw | The AFE input current has exceeded the 1 minute overload rating. | Check for an excess load. |

| No. | Name | Description | Action (if appropriate) |
|---|---|---|---|
| 32 | Fan Cooling | The power structure or LCL filter fans are not energized at start command. | If the LCL filter fan is not operating, check the fan DC power supply board in front of the LCL filter fan.<br>If the power structure fan is not operating, check the fan inverter board in back of the converter fan.<br>For additional information, see PowerFlex 700H, 700S, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029. |
| 33 | AutoReset Lim | The AFE unsuccessfully attempted to reset a fault and resumed running for the programmed number in parameter 053 [Auto Rstrt Tries]. You can enable/disable this fault with parameter 120 [Fault Config]. | Correct the cause and manually clear the fault. |
| 34 | CAN Bus Flt | A sent message was not acknowledged. | Cycle the power.<br>Replace the control board on the power structure. See page 39. |
| 35 | Application | Problem in application software with task overload. | Contact technical support. |
| 37 | HeatsinkUndTp | The ambient temperature around the power structure heatsink is too low. | Raise the ambient temperature. |
| 44 | Device Change | The new power unit or option board that is installed is a different type. | Clear the fault and verify the correct parameters for the new option board. |
| 45 | Device Add | A new option board was added. | Clear the fault. |
| 47 | NvsReadChksum | There was an error reading parameters 019 [Motoring MWh], 020 [Regen MWh], and 021 [Elapsed Run Time] from EEPROM. | Cycle the power.<br>Replace the control board.See page 39. |
| 58 | Start Prevent | Startup has been prevented. | Cancel prevention of startup if cancellation can be done safely.<br>Remove Run Request. |
| 65 | I/O Removed | An I/O option board has been removed. | Clear the fault. |
| 70 | Power Unit | Incorrect output power device operation. | Check the power structure for damaged components. Replace if defective.<br>Replace the power structure. |
| 71 | Periph Loss | The 20-COMM-x communication adapter has a fault on the network side. | Check the DPI™ device event queue and associated fault information for the device. |
| 81 | Port DPI Loss | The DPI port has stopped communicating. A SCANport™ device was connected to a drive operating DPI devices at 500k baud. | Check the HIM connection.<br>If the adapter was not intentionally disconnected, check the wiring to the port. Replace the wiring, port expander, adapters, control board, or complete AFE as required.<br>If an adapter was intentionally disconnected and the [Logic Mask] bit for that adapter is set to '1', this fault occurs. To disable this fault, set the bit in parameter 154 [Logic Mask] to '0' for the port in which the adapter is connected. |
| 94 | Hardware Enbl | An enable signal is missing from the control terminal block, only when jumper J5 is removed on the digital I/O board. | Check the control wiring.<br>Check the position of the J5 hardware enable jumper.<br>Check the digital input programming. |

| No. | Name | Description | Action (if appropriate) |
|---|---|---|---|
| 100 | Param Chksum | The checksum read from the control board does not match the checksum that is calculated. | Restore the AFE to the default configurations.<br>Cycle the power.<br>Replace the control board in the power structure. See page 39. |
| 104 | PwrBrd Chksum | The checksum read from the EEPROM does not match the checksum that is calculated from the EEPROM data. | Cycle the power.<br>Check the fiber optics between the fiber-optic adapter board and the ASIC board. See Table 9 on page 123, Table 10 on page 124, and Figure 36 on page 125 for connections.<br>Replace the fiber-optic adapter board (see page 40) and/or the ASIC board (see page 50) in the converter unit.<br>Contact technical support. |
| 106 | MCB-PB Config | The AFE rating information that is stored on the power board is incompatible with the control board. | Reset the fault<br>Cycle the power.<br>Replace the control board on the power structure. See page 39.<br>Contact technical support. |
| 107 | New IO Option | A new option board was added to the control board. | Clear the fault and verify the correct parameters for the new option board.<br>Reprogram parameters as necessary. |
| 113 | Fatal App | A Fatal Application error has occurred. | Cycle the power.<br>Replace the control board on the power structure. See page 39. |
| 120 | I/O Change | An option board has been replaced. | Reset the fault. |
| 121 | I/O Comm Loss | A defective option board or I/O board slot. | Check the control board-to-I/O option board connection.<br>Verify the ground integrity from the control board to the option board.<br>Replace the control board and/or I/O board. See page 39. |
| 125 | LCL OverTemp | The LCL filter has been overheated or the signal is not connected to input. | Check the LCL filter and signal connection or verify that digital input 5 is closed. See Chapter 7. |

| No. | Name | Description | Action (if appropriate) |
|---|---|---|---|
| | | There are nine total thermal switches that are connected in series to monitor temperature inside the coil of each filter inductor.<br>  <br><br>X52 is on the LCL Filter.<br>X52 Approximate Location<br>  <br>Frame 13 LCL Filter | |
| 126 | LCL Fan Stop | The LCL fan has been stopped. | Check the LCL fan. See Chapter 7.<br>**IMPORTANT:** This fault occurs only when a digital input is manually programmed as option '5'. |
| 128 | Contact Fdbk | The input of the acknowledge signal from the main contactor is missing. | Check for closure on the following devices:<br>• For AFE in IP20 enclosure, input contactor (K1)<br>• For AFE in IP21 enclosure, MCCB (Q1)<br>Check digital input 4 on the control board of the power structure. |
| 133 | DigInConflict | Digital input functions are in conflict. | Check the parameter settings of parameters 221…226. |
| 138 | DCRefLowLim | DC voltage reference is less than the limit in parameter 080 [DC Ref Lo Lmt]. | Check the parameter setting.<br>Verify the bus voltage to be above the parameter value.<br>Troubleshoot the cause of the low voltage condition. |
| 139 | DCRefHighLim | DC voltage reference exceeds the limit in parameter 081 [DC Ref Hi Lmt]. | Check the parameter setting.<br>Verify the bus voltage to be below the parameter value.<br>Troubleshoot the cause of the high voltage condition. |
| 140 | DCBusLoAlarm | DC voltage is less than the value set by parameter 078 [DC Bus Lo Alarm]. | Check the parameter setting. |
| 141 | DCBusHiAlarm | DC voltage exceeds the value set by parameter 079 [DC Bus Hi Alarm]. | Check the parameter setting. |

## Common Symptoms and Corrective Actions

AFE does not start from start or run inputs that are wired to the terminal block.

| Cause | Indication | Corrective Action |
|---|---|---|
| AFE is faulted | Flashing red status light | Clear the fault.<br>Press Stop.<br>Cycle the power.<br>Set parameter 121 [Fault Clear] to '1'.<br>'Clear Faults' on the HIM Diagnostic menu. |
| Incorrect input wiring. See the 'Control Wiring' section in the PowerFlex Active Front End User Manual, publication 20Y-UM001, for information.<br>**Important:** Jumper from terminal 17…20 is required when using the 24V DC internal supply. | None | Wire inputs correctly and/or install jumper. |
| Incorrect digital input programming. | None | Program parameters 221…226 [Digital Inx Sel] for correct inputs.<br>Run programming can be missing. |
| There is some other start inhibit. | Check status bits of parameter 100 [Start Inhibits]. | Correct the source of the inhibit. |

Instability in the AC line input current and DC bus voltage.

| Cause | Indication | Corrective Action |
|---|---|---|
| AC line voltage more than 5% above normal. | Instability in AC line current and DC bus voltage.<br>Can trip on fault F7 'Overload'. | Increase parameter 060 [DC Volt Ref] proportional to the percentage of the AC line voltage that is above nominal. |
| Negative reactive I Ref on parameter 065 [Reactive I Ref] with a soft (high impedance) AC line. | Instability in AC line current and DC bus voltage.<br>Can trip an F7 overload. | Change parameter 065 [Reactive I Ref] value to zero. Verify if the AFE is running on a soft line per the AC line source considerations. |

## Notes:

# Active Front End System Overview

This chapter describes AFE system main components. The chapter groups components that are used in an IP20 2500 MCC Style enclosure, an IP21Rittal enclosure, and main components for the AFE IP00 open chassis configuration.

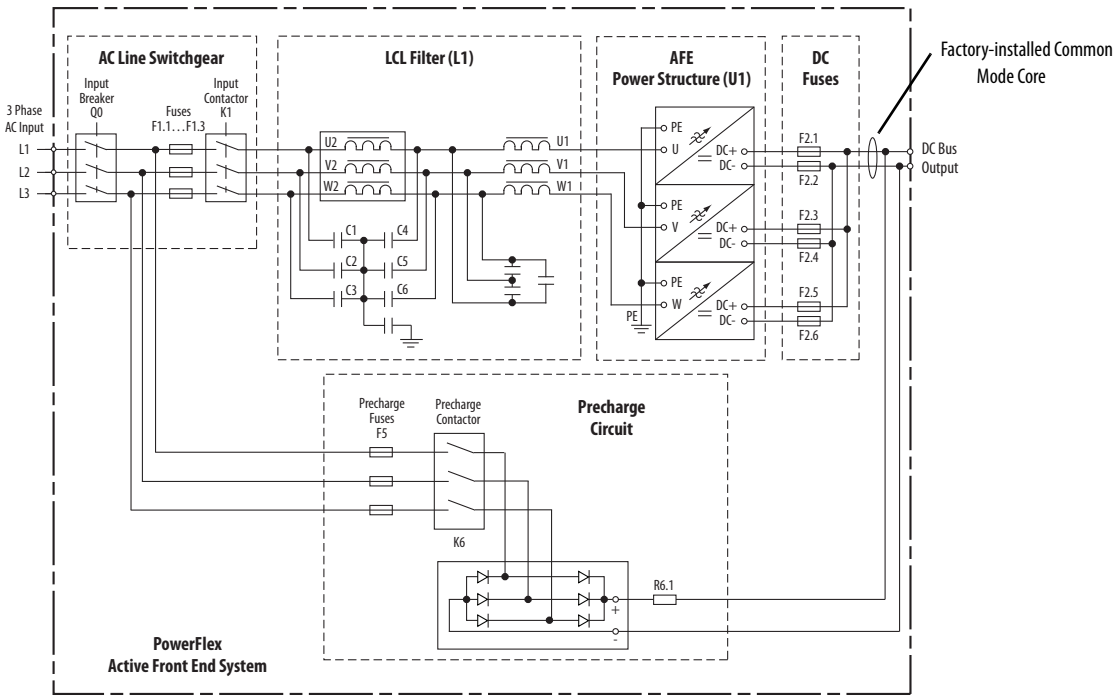
## AFE in IP20 2500 MCC Style Enclosure

### Main Component Sections

Figure 1 shows a basic one-line diagram for an AFE system in an IP20 2500 MCC Style enclosure. The main component sections consist of the following items:

- AC line switchgear consisting of the input circuit breaker (Q0), fuses (F1.1...F1.3), and input contactor (K1)
- LCL filter (L1)
- Precharge circuit
- AFE power structure (U1) with AFE control assembly
- DC fuses (F2.1...F2.6)

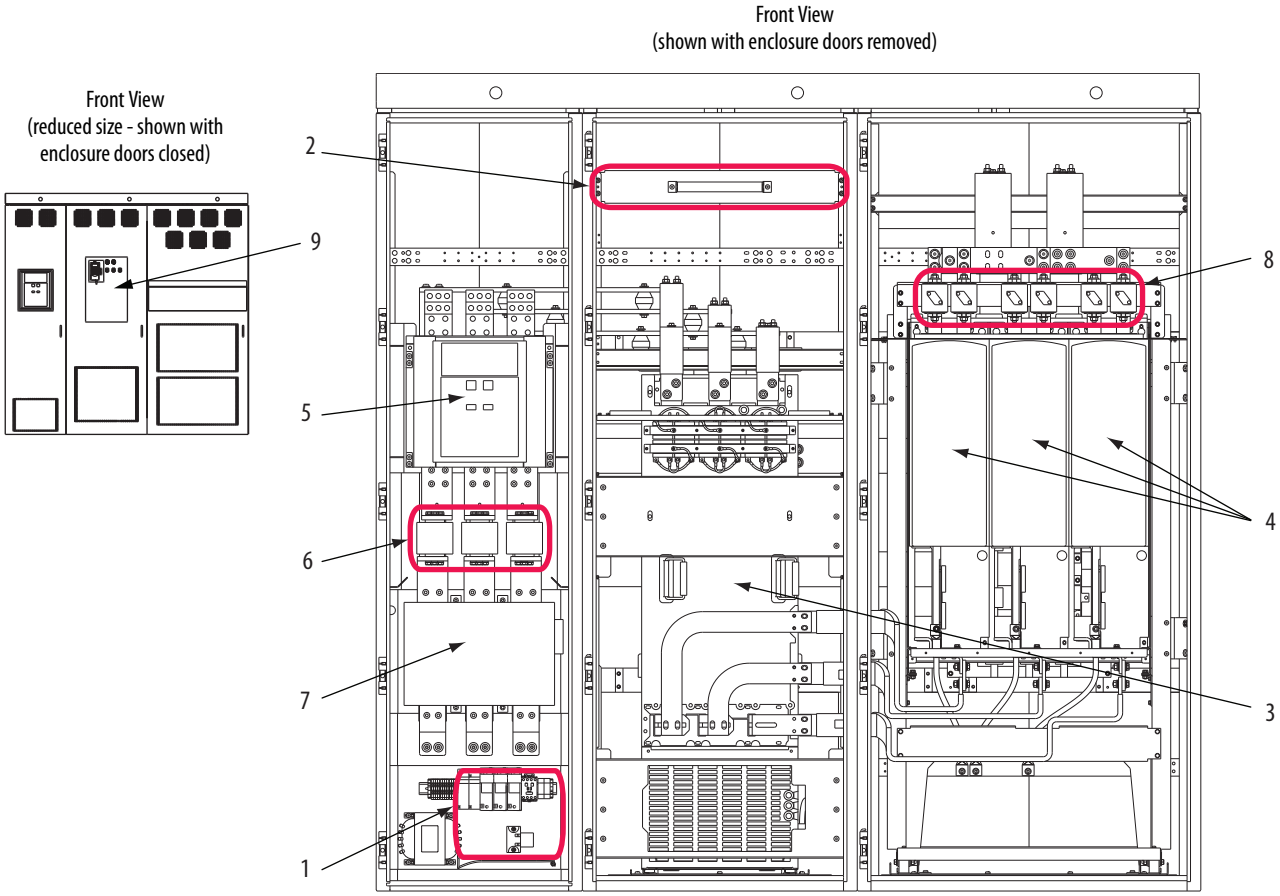
**Figure 1 - Basic One-line Diagram for an AFE Frame 13 in IP20 2500 MCC Style Enclosure**



## Main Component Locations

Figure 2 shows the main components of the AFE Frame 13 system in an IP20 2500 MCC Style enclosure.

**Figure 2 - AFE Frame 13 Main Component Locations in IP20 2500 MCC Style Enclosure**




| Item | Description | |
|---|---|---|
| 1 | Precharge circuit | |
| 2 | Precharge resistor (R6.1) | |
| 3 | LCL filter (L1) | |
| 4 | Active Front End power structure (U1) | |
| 5 | AC line switchgear | Input circuit breaker (Q0) |
| 6 | | Input fuses (F1.1…F1.3) |
| 7 | | Input contactor (K1) |
| 8 | DC fuses (F2.1…F2.6) | |
| 9 | AFE control box assembly (on the AFE door and shown with user-installed HIM) | |

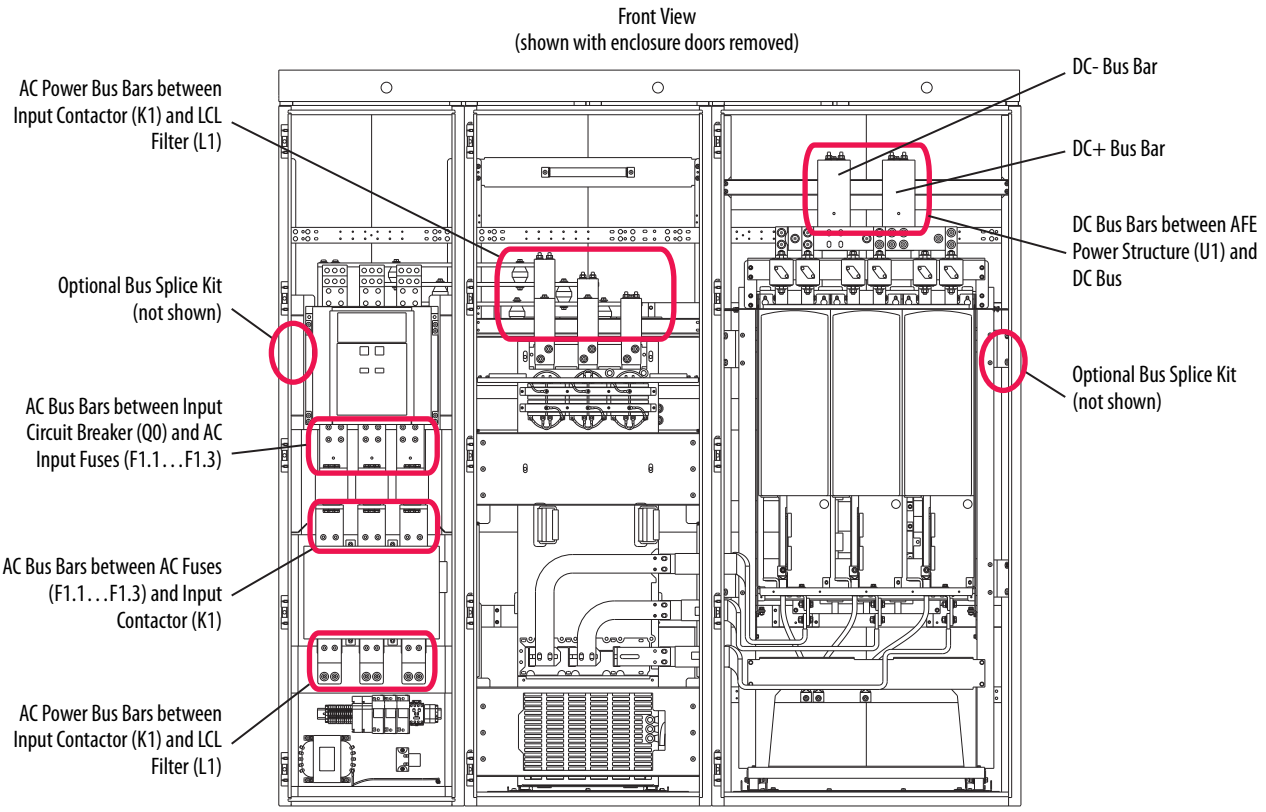
## Main Bus Bar Locations

There are several sets of bus bars in the AFE Frame 13 system that connect main system components:

- Bus bars between input breaker (Q0) and AC fuses (F1.1...F1.3)
- Bus bars between AC fuses (F1.1...F1.3) and input contactor (K1)
- Bus bars between input contactor (K1) and the LCL filter (L1)
- Bus bars between the AFE power structure (U1) and DC bus

Figure 3 shows these bus bar locations.

**Figure 3 - AFE Frame 13 Bus Bar Locations in IP20 2500 MCC Style Enclosure**



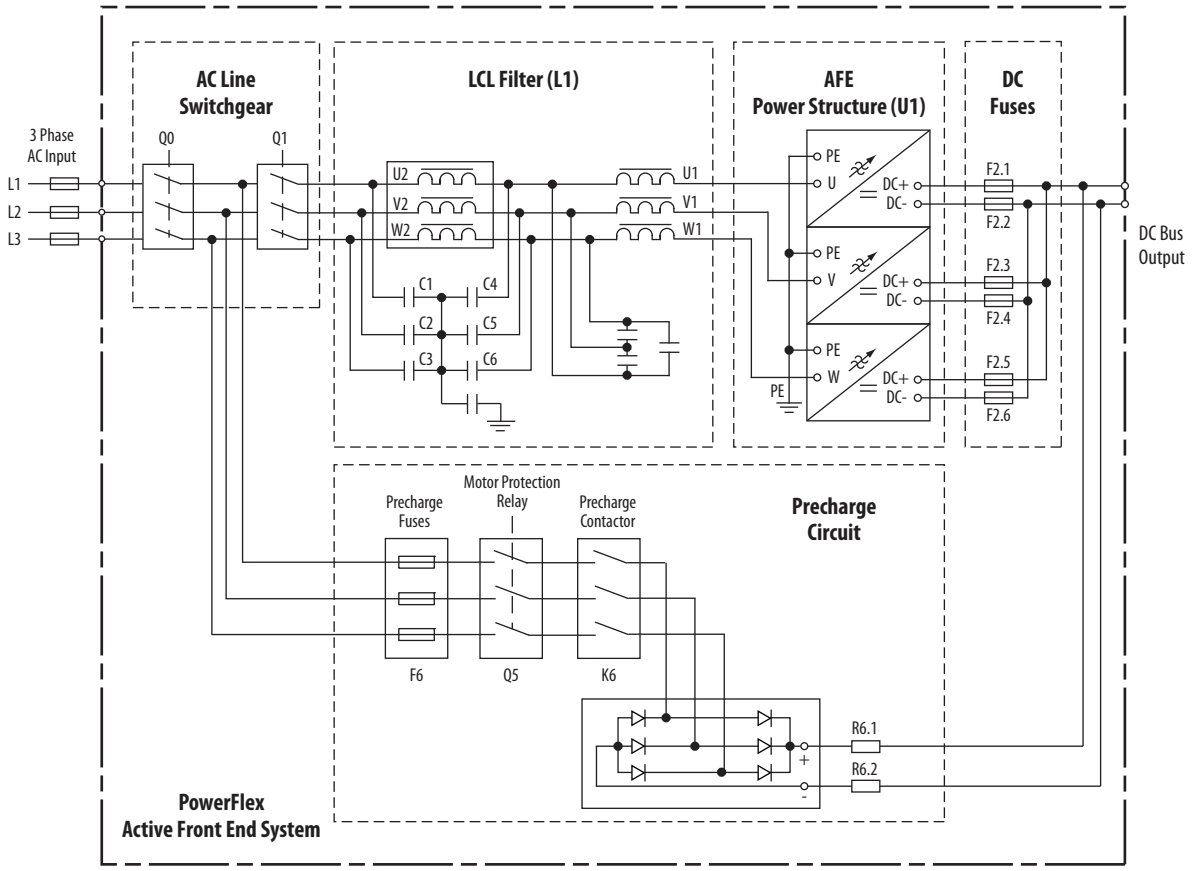
# AFE in IP21 Rittal Enclosure

## Main Component Sections

Figure 4 shows a basic one-line diagram for an AFE system in an IP21 Rittal enclosure. The main component sections consist of the following items:

- AC line switchgear consisting of the input disconnect (Q0) and MCCB motor-controlled circuit breaker (Q1)
- LCL filter (L1)
- Precharge circuit
- AFE power structure (U1) with AFE control assembly
- DC fuses (F2.1...F2.6)

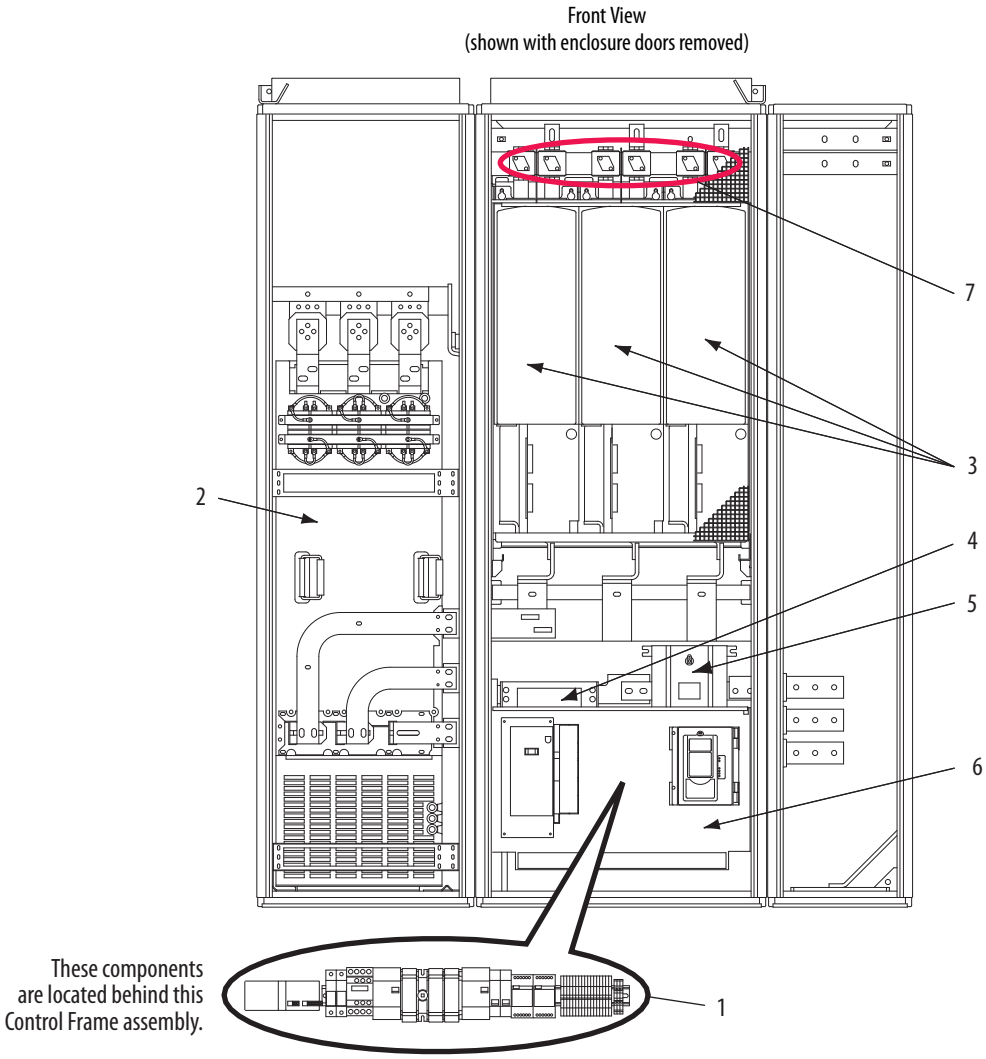
**Figure 4 - Basic One-line Diagram for AFE in IP21 Rittal Enclosure**



## Main Component Locations

Figure 5 shows the main components of the AFE Frame 13 system in an IP21 Rittal enclosure.

**Figure 5 - AFE Frame 13 Main Component Locations in IP21 Rittal Enclosure**




| Item | Description | |
|---|---|---|
| 1 | Precharge circuit and precharge resistors (R6.1 and R6.2) | |
| 2 | LCL filter (L1) | |
| 3 | Active Front End power structure (U1) | |
| 4 | AC line switchgear | Motor-controlled circuit breaker (Q1) |
| 5 | | Input disconnect (Q0) |
| 6 | AFE control assembly (shown with user-installed HIM | |
| 7 | DC fuses (F2.1…F2.6) | |

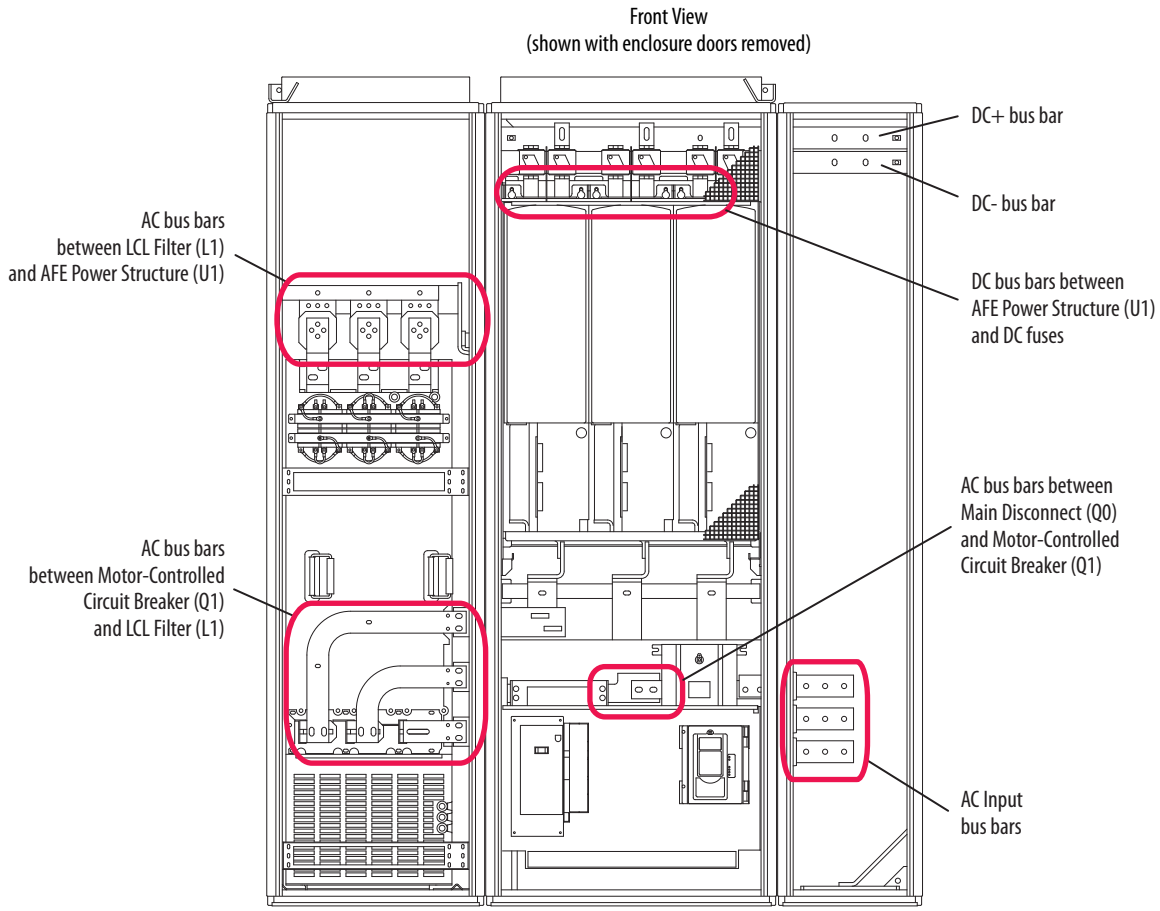
## Bus Bar Locations

There are several sets of bus bars in the AFE Frame 13 system that connect main system components:

- Bus bars between input disconnect (Q0) and MCCB (Q1)
- Bus bars between MCCB (Q1) and the LCL filter (L1)
- Bus bars between the LCL filter (L1) and AFE power structure (U1)
- Bus bars between the AFE power structure (U1) and DC bus bars

Figure 6 shows these bus bar locations.

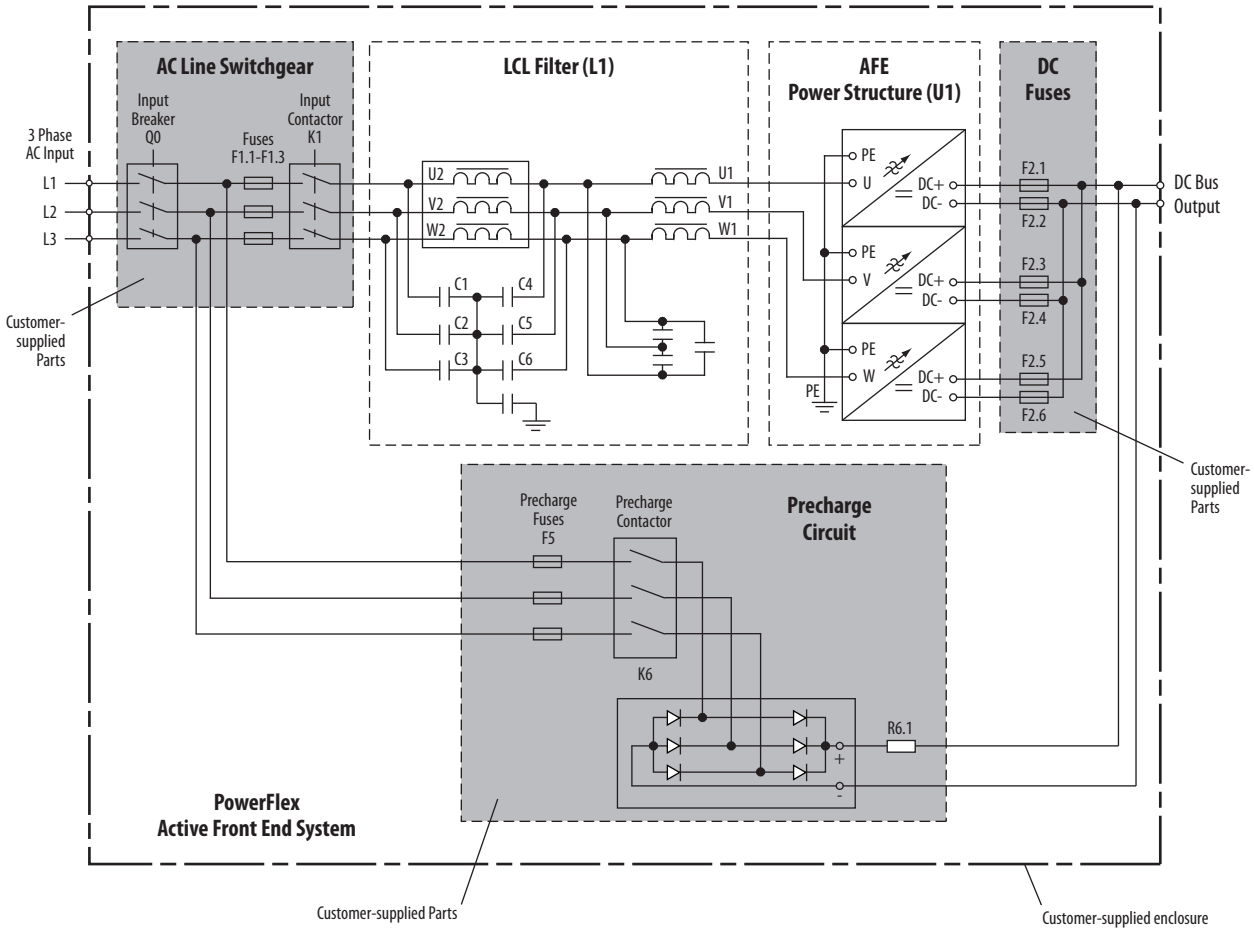
**Figure 6 - AFE Frame 13 Bus Bar Locations in IP21 Rittal Enclosure**



## AFE in IP00 Open Chassis Configuration

Figure 7 shows a basic one-line diagram for an AFE system in an IP00, NEMA/UL Open Chassis configuration, and the parts the customer must supply.

**Figure 7 - Basic One-line Diagram for AFE in IP00 Open Chassis Configuration**



## Notes:

# Component Test Procedures

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC Board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

**ATTENTION:** To avoid an electric shock hazard, verify that all power to the PowerFlex® Active Front End has been removed before you perform any service or repairs.

**ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

**ATTENTION:** Hot surfaces can cause severe burns. Do not touch the heatsink surface during operation of the PowerFlex Active Front End. After you disconnect power, allow time for cooling.

**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

**ATTENTION:** The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

## View the Status Indicators

This section describes the status indicators.

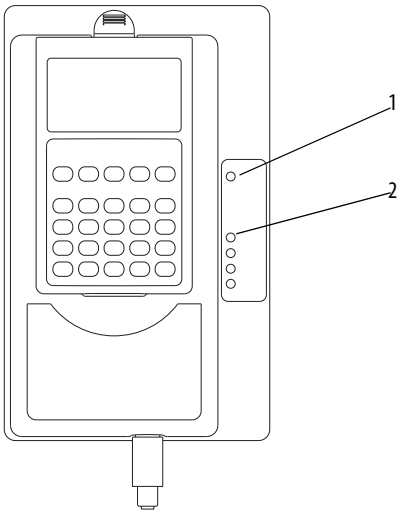



**Table 1 - AFE Status Indicator Descriptions**

| Item | Name | Color | State | Description |
|---|---|---|---|---|
| 1 | PWR (Power) | Green | Steady | Lights when power is applied to the AFE. |
| 2 | PORT (1) | See to the Communication Adapter User Manual, publication 20COMM-UM*xxx* | | Status of DPI™ port internal communication (if present). |
| | MOD (1) | | | Status of communication adapter (when installed). |
| | NET A (1) | | | Status of network (if connected). |
| | NET B (1) | | | Status of secondary network (if connected). |

(1) These indicators operate only when a 20-COMM-X communication adapter is installed in the AFE and operating on the connected network.

## Perform Visual Inspections

**IMPORTANT** Always remove power from the Active Front End before you perform visual inspections. See Remove Power from the AFE on page 37.

### Inspect the Cooling Tunnels

To inspect the cooling tunnels, follow these steps.

1. Remove the main cooling fans from the bottom of the power structure.

   See Remove and Install the Power Structure Fan System on page 53.
2. Inspect the tunnels.

   Clean the heatsinks and tunnels if necessary.

### Inspect the Power Structure

To inspect the power structure, follow these steps.

1. Remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.

2. Remove the protective front covers and terminal covers from the power structure for each phase (U, V, and W).

   See Remove Protective Covers from the Power Structure on page 47.

3. Check components for burn marks, breakage, or foil delamination on circuit boards.

   Check all boards on the power structure.

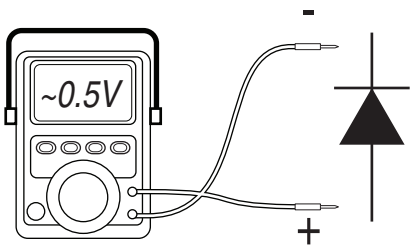
   Replace any of these components if they show evidence of burn marks, breakage, or foil delamination.

## Perform Forward and Reverse Biased Diode Tests for Power Structure

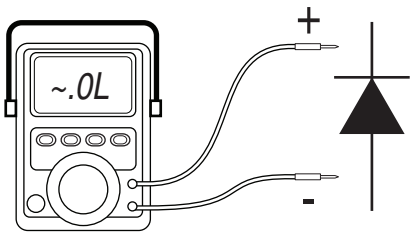
A forward biased diode test checks the semiconductor junctions between the terminals and measures the voltage drop across those junctions. To pass each test, the meter must display a voltage near 0.5V. If the test finds a short, the meter displays '.000'. If the test finds an open circuit or reversed polarity, the meter displays '.0L' (zero load).

**IMPORTANT** The actual voltage readings can vary depending upon your equipment. If your readings are not near the indicated values in the following tables, verify that the actual voltage that is measured is consistent for the Power module.

A reverse biased diode test finds an open circuit, and the meter displays '.0L' (zero load).




Forward biased test on PN-junction.




Reverse biased test on PN-junction.

To perform forward and reverse biased diode tests for the power structure, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

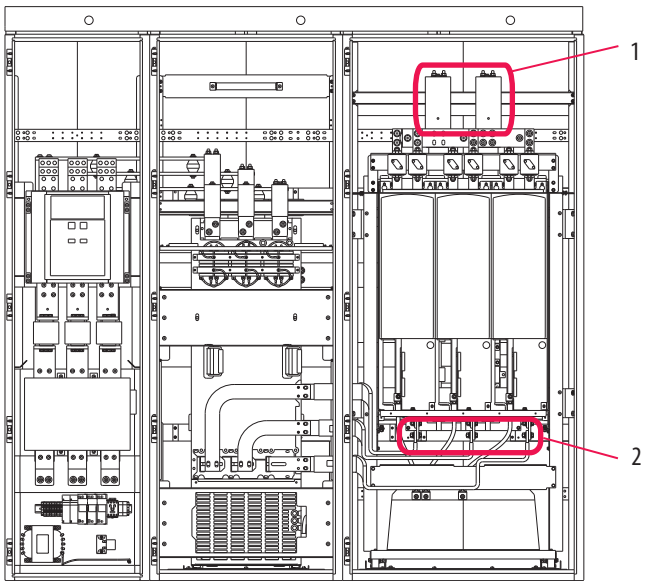
2. Remove the protective barriers.

See Remove AFE Protective Barriers on page 44.

3. Disconnect any drives that are connected to the DC bus from the DC bus, or remove the DC bus fuses from the AFE.
4. Conduct forward and reverse biased diode tests on the power structure.

**Figure 8 - Measurement Points for Forward and Reverse Diode Tests**

Front View
(AFE in IP20 2500 MCC Style Enclosure shown with doors removed)




Front View
(AFE in IP21 Rittal Enclosure shown with doors removed)

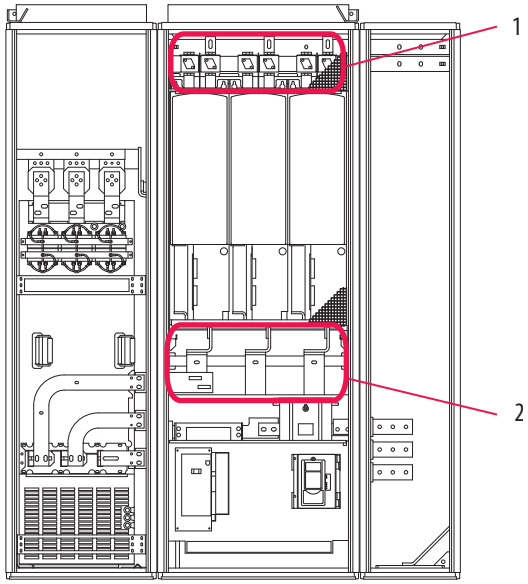



**Table 2 - Forward Biased Diode Tests on Power Structure**

| Meter Leads | | Location (see Figure 8) | Nominal Meter Reading |
|---|---|---|---|
| + | - | | |
| DC- | U/T1 | 1 | Value gradually rises to about 0.5V (1) |
| DC- | V/T2 | | |
| DC- | W/T3 | | |
| U/T1 | DC+ | 2 | |
| V/T2 | DC+ | | |
| W/T3 | DC+ | | |

(1) The actual voltage reading can vary depending upon your equipment. If your readings are not near 0.5V, verify that the actual voltage that is measured is consistent for the power structure.

**Table 3 - Reverse Biased Diode Tests on Power Structure**

| Meter Leads | | Location (see Figure 8) | Nominal Meter Reading |
|---|---|---|---|
| + | - | | |
| U/T1 | DC- | 1 | Meter displays '.0L' (zero load) |
| V/T2 | DC- | | |
| W/T3 | DC- | | |
| DC+ | U/T1 | 2 | |
| DC+ | V/T2 | | |
| DC+ | W/T3 | | |

If the AFE fails any of these measurements, replace all power modules for each line phase in the power structure, or the complete power structure. To replace the components, follow one of these options:

- Contact your local representative to schedule on-site services.
- Contact your local representative to make arrangements to return the power structure to the factory for repair by Remanufacturing Services.
- For an AFE not covered under factory warranty, a customer has the option of repairing the power structure using procedures that are described in this manual.

## Check the Fiber-optic Connections

Damaged or improperly connected fiber-optic cables can cause apparent gate driver board malfunctions. For fiber-optic cable connections, see Table 9 on page 123, Table 10 on page 124, and Figure 36 on page 125.

The check the fiber-optic connection, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

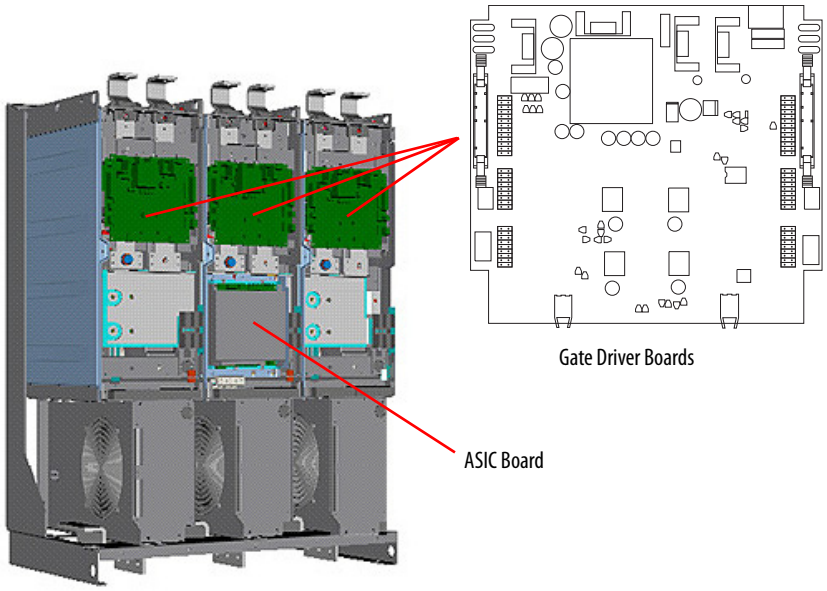
2. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.

3. Remove the protective front covers and terminal covers from the power structure.

   See Remove Protective Covers from the Power Structure on page 47.

4. Locate the three gate driver boards on the front of the power structure (right-side AFE enclosure).




5. Verify that the fiber-optic cables are properly connected between the gate driver boards and the ASIC board.

| | |
|---|---|
| **IMPORTANT** | The minimum inside bend radius for fiber-optic cable is 25.4 mm (1 in.). Any bends with a shorter inside radius can permanently damage the fiber-optic cable. Signal attenuation increases with decreased inside bend radii. |

6. Verify that the fiber-optic cables are properly connected between the ASIC board and the fiber-optic adapter circuit board.
7. Disconnect the cables and inspect them for scratches and cracks, and overall integrity.

| | |
|---|---|
| **IMPORTANT** | When mishandled, the ability of fiber-optic cables to transmit data is greatly diminished. |

8. Reconnect the cables, replacing any damaged cables.

## Perform Gate Driver Board Resistance Measurements

To measure the gate driver board resistance, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

2. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.

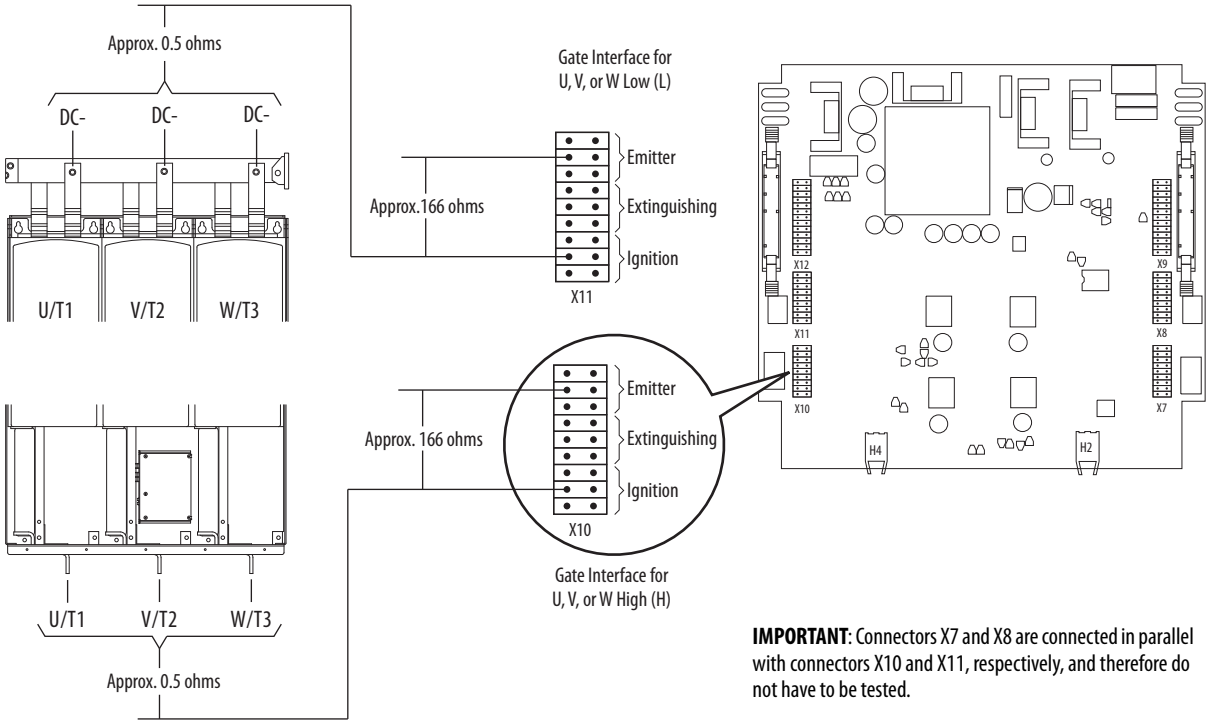
3. Remove the protective front covers and terminal covers from the power structure for each phase (U, V, and W).

   See Remove Protective Covers from the Power Structure on page 47.

   There are three gate driver boards on the power structure, one for each phase (U, V, and W).

4. Measure the power transistor gate interface resistance for each phase (U, V, and W):
   - The resistance from each ignition pin to the branch emitter pin (connectors X10 and X11) is approximately 166 Ω.
   - The resistance from the X10 branch emitter pin to the same branch power terminal (U/T1, V/T2, and W/T3) is approximately 0.5 Ω.
   - The resistance from the X11 branch emitter to the same branch DC-bus terminal is approximately 0.5 Ω.

   If any of the gate interfaces fails this test, replace the appropriate (left, middle, or right) power module. See Remove the Power Module from the U, V, or W Phase Assembly on page 62.




**IMPORTANT**: Connectors X7 and X8 are connected in parallel with connectors X10 and X11, respectively, and therefore do not have to be tested.

## Check the AFE Power Structure Fan Inverter Fuses

To check the AFE power structure fan inverter fuse, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

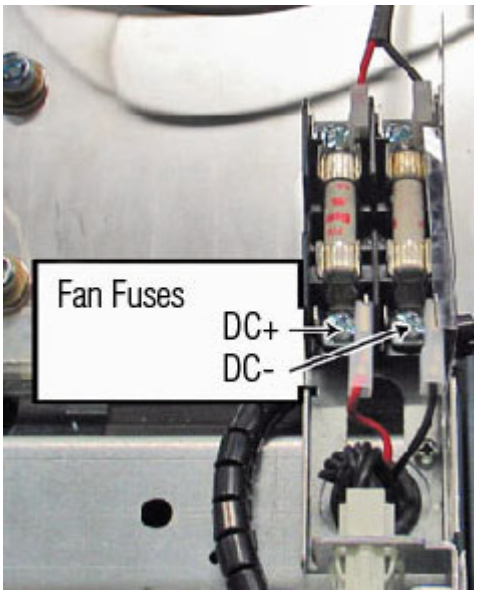
2. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.

3. Remove the protective front covers and terminal covers from the power structure for each phase (U, V, and W).

   See Remove Protective Covers from the Power Structure on page 47.

4. A pair of fuses (F1 and F2) feed DC bus power to each fan inverter.
   a. Locate these fuses (shown below) and remove them.
   b. Use a multi-meter to verify that the fuses are not open.




5. Reinstall the good fuses and replace any open fuse with an equivalent-rated fuse.

# AFE Power Structure Component Section

**ATTENTION:** To avoid an electric shock hazard, verify that all power to the PowerFlex® Active Front End has been removed before you perform any service or repairs.

**ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC Board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

**ATTENTION:** Hot surfaces can cause severe burns. Do not touch the heatsink surface during operation of the PowerFlex Active Front End. After you disconnect power, allow time for cooling.

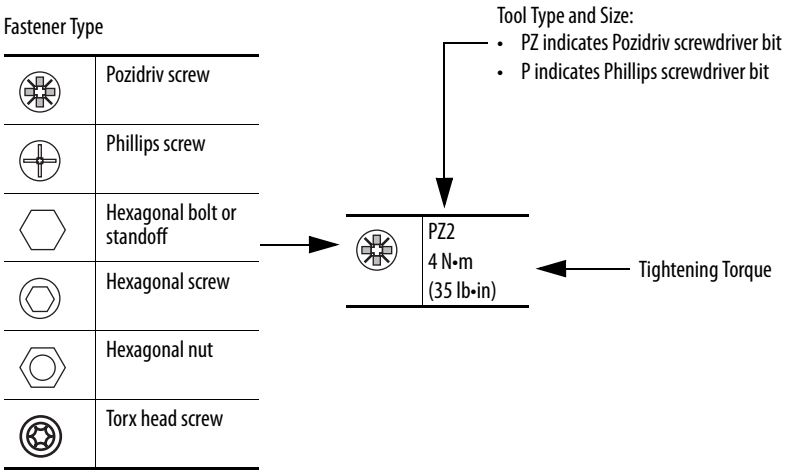
**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

**ATTENTION:** The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

Use the instructions in this chapter to remove and install components from the Active Front End. To remove and install components on the power structure and to remove a power module from the power structure, see Power Structure Access Procedures on page 44.

## Understand the Torque Figures in Assembly Diagrams

Icons and numbers in the assembly diagrams indicate how to tighten hardware.




## Torque Specifications

The following table lists fastener torque specifications for the circuit boards and main components of the Active Front End.

| Item | | Hardware | Final Torque |
|---|---|---|---|
| AC input terminals | | M10 nut | 40 N•m (354 lb•in) |
| ASIC circuit board (mounting) | | M4 x 8 Pozidriv screws | 0.9 N•m (8 lb•in) |
| ASIC circuit board cover | | M4 x 8 Pozidriv screws | 0.9 N•m (8 lb•in) |
| ASIC fan | | M4 x 16 Pozidriv screws | 0.4 N•m (3.5 lb•in) |
| Capacitor | | M4 x 8 self-tapping screws | 1 N•m (9 lb•in) |
| DC-/DC+ terminals | | M6 x 20 Pozidriv screws | 5 N•m (44 lb•in) |
| DC connective bus bars | | M10 x 20 hexagonal screws | 8 N•m (71 lb•in) |
| | | M8 x 25 hexagonal socket-head screws | 8 N•m (71 lb•in) |
| | | M6 x 12 Pozidriv screws | 4 N•m (35 lb•in) |
| DPI/HIM assembly door | | M3 x 6 Phillips screws | 0.9 N•m (8 lb•in) |
| DPI/HIM assembly (mounting) | | M3 x 6 Phillips screws | 0.9 N•m (8 lb•in) |
| Fan inverter assembly | | M5 x 10 Pozidriv screws | 4 N•m (35 lb•in) |
| Fan inverter fuse base | | M4 x 8 Pozidriv screws | 3 N•m (27 lb•in) |
| Fan inverter fuse holder | | M4 x 8 Pozidriv screws | 3 N•m (27 lb•in) |
| Gate driver circuit board (mounting) | | M4 x 8 Pozidriv screws | 1.35 N•m (12 lb•in) |
| Main cooling fan (mounting) | | M5 x 10 Pozidriv screws | 3 N•m (27 lb•in) |
| Precharge bridge assembly | Wire fasteners | M5 x 12 machine screws | 4.5 N•m (40 lb•in) |
| | Mounting | M5 nuts | 3.9 N•m (35 lb•in) |
| Precharge bridge resistor assembly | | M5 x 12 Torx self-tapping screws | 4.5 N•m (40 lb•in) |
| LCL filter upper front bracket | In IP20 enclosure | M8 x 20<br>M6 x 16 screws | 6.7 N•m (60 lb•in)<br>4.5 N•m (40 lb•in) |
| | In IP21 enclosure | M5 x 12 Torx self-tapping screws | 4.5 N•m (40 lb•in) |

| Item | | Hardware | Final Torque |
|---|---|---|---|
| Power structure input terminals (U, V, W) | In IP20 enclosure | M10 x 40 bolt | 37.9 N•m (336 lb•in) |
| | In IP21 enclosure | M8 x 20 bolt | 20 N•m (177 lb•in) |
| Power structure block (mounting) | | M10 x 12 hexagonal screw | 20 N•m (177 lb•in) |
| Power structure DC bus terminals | In IP20 enclosure | | |
| | In IP21 enclosure | M6 x 16 Pozidriv | |
| Protective covers on power structure | Front | M5 x 10 Pozidriv | 3 N•m (27 lb•in) |
| | Terminal | M5 x 16 Pozidriv | 3 N•m (27 lb•in) |

## Remove Power from the AFE

**ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

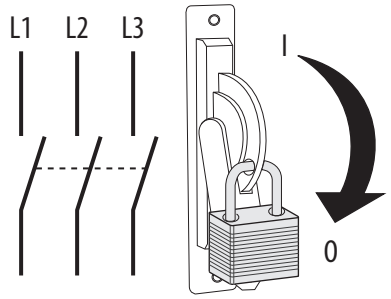
Remove power before you make or break cable connections. When you remove or insert a cable connector with power applied, an electric arc can occur. An electric arc can cause personal injury or property damage by these actions:

- Sends an erroneous signal to the system field devices, which causes unintended machine motion.
- Causes an explosion in a hazardous environment.

Electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts can create electrical resistance.

To remove power from the AFE, follow these steps.

1. Turn off and lockout input power.




2. Wait 5 minutes.
3. Verify that there is no voltage at the AFE input power terminals.
4. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis.

   The voltage must be zero for all three measurements before proceeding.

# Control Frame Access Procedures

## Remove the DPI Interface Assembly

To remove the DPI™ interface assembly, follow these steps.

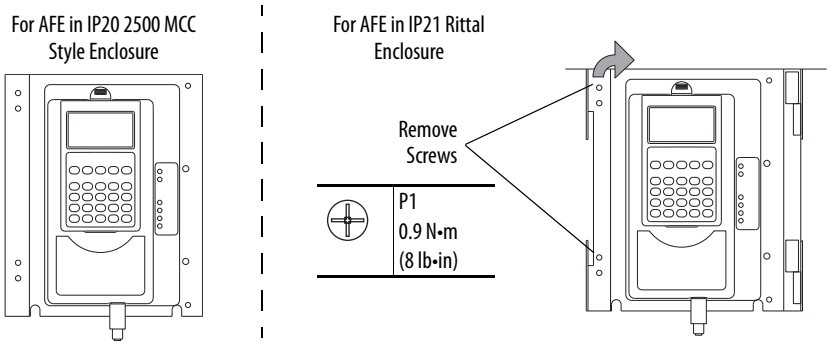
1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

   **IMPORTANT** Before you remove the connections and wires, mark them to avoid incorrect wiring during assembly.

2. For an AFE in an IP20 2500 MCC Style enclosure, disregard this step.

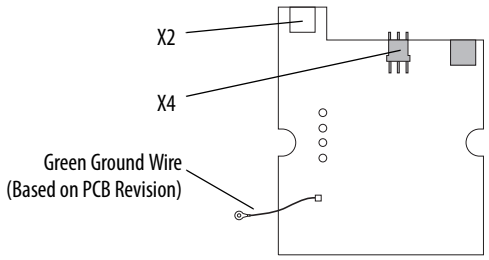
   For an AFE in an IP21 Rittal enclosure, locate the control assembly (item 6 in Figure 5 on page 23), and remove the two screws from the front of the DPI hinged assembly.




3. For an AFE in an IP20 2500 MCC Style enclosure, open the control box door to access the DPI interface board.

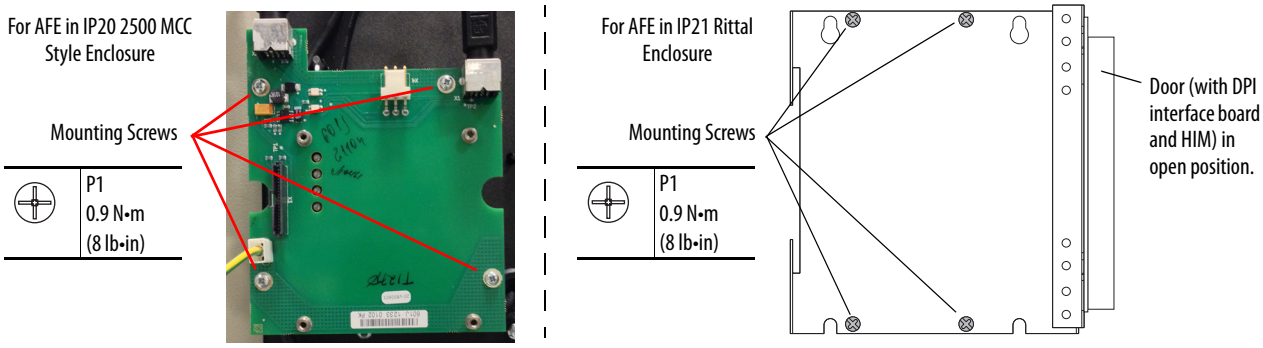
   For an AFE in an IP21 Rittal enclosure, open the hinged assembly that holds the DPI interface board.

4. Unplug the DPI cable from the X2 connector on the DPI interface board.




Back view of the DPI interface board that remains mounted on the back of the control frame.

5. Remove the four screws and the assembly from the control frame.




## Install the DPI Interface Assembly

Install the DPI interface assembly in the reverse order of removal, while referring to Torque Specifications on page 36.

## Remove the I/O Circuit Boards and Control Box

To remove the I/O circuit boards and control box, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

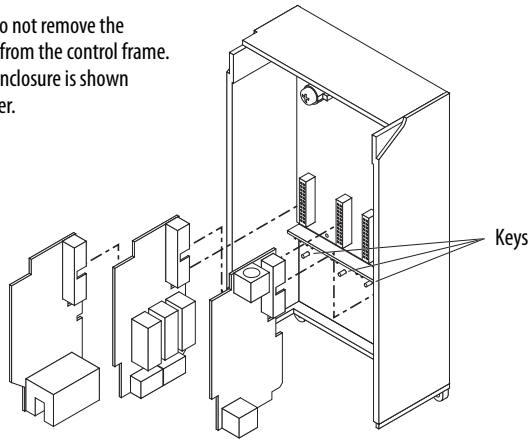
2. For an AFE in an IP20 2500 MCC Style enclosure, open the control box and carefully unplug the DPI cable and any I/O cables.

   For an AFE in an IP21 Rittal enclosure, open the enclosure that contains the control and I/O circuit boards and carefully unplug the DPI cable and any I/O cables.

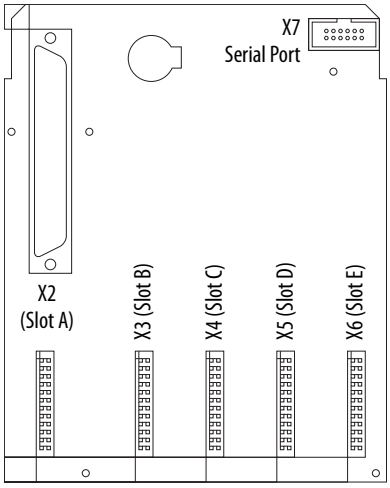
3. Remove the I/O boards from the control board and enclosure.

   Note the order of the boards and the keys that help prevent placement of boards in incorrect slots.

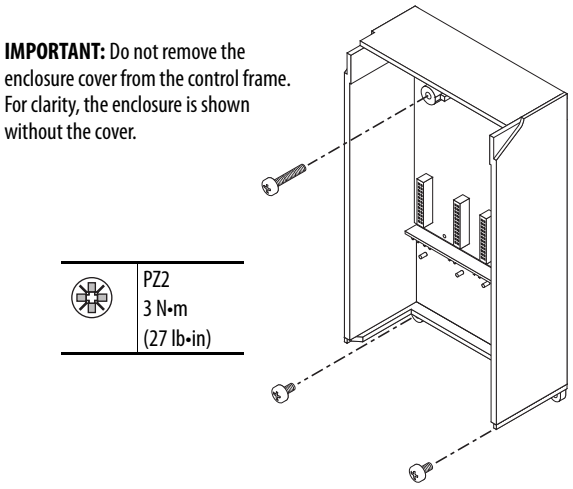
**IMPORTANT:** Do not remove the enclosure cover from the control frame. For clarity, the enclosure is shown without the cover.



4. Unplug the serial connection from X7 of the control board.




5. To remove the control box, remove the three screws that secure it to the control frame.




## Install the I/O Circuit Boards and Control Box

Install the control box and I/O circuit boards in reverse order of removal. See Torque Specifications on page 36.

## Remove the Fiber-optic Adapter Circuit Board

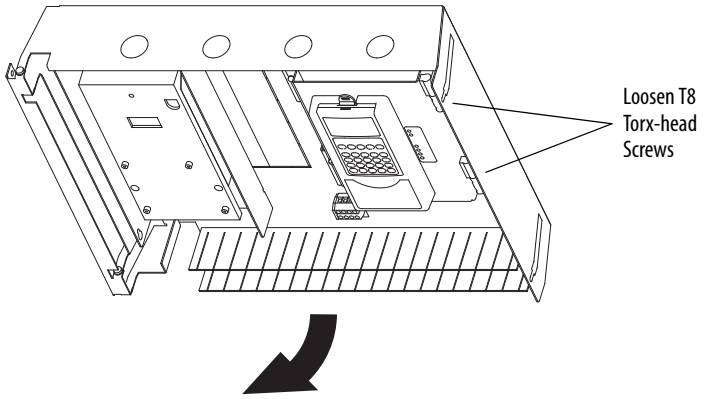
To remove the fiber-optic adapter circuit board, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

2. For an AFE in an IP20 2500 MCC Style enclosure, open the control box on the enclosure door to access the control assembly.

For an AFE in an IP21 Rittal enclosure, see the following drawing and do perform these substeps:



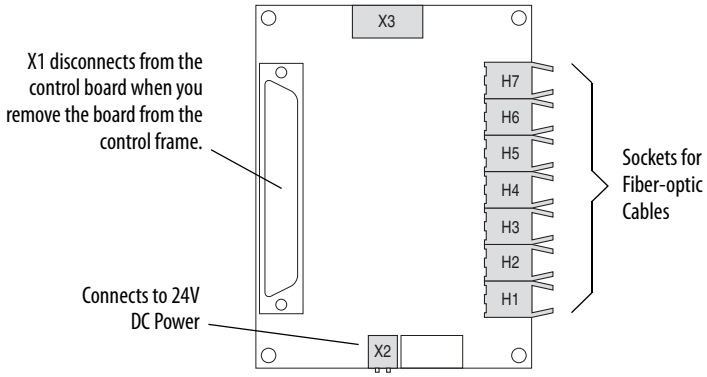

a. To access the control frame, open the enclosure door.

b. To open the control frame, loosen the T8 screws.

c. Open the control frame, which exposes the back of the control box to access the fiber-optic adapter board.

3. Disconnect the cables from X2 and X3 of the fiber-optic adapter board.

**IMPORTANT** Note polarity when removing X2 and X3 wires. If polarity is not maintained when reinstalling these wires, the ASIC board or fiber-optic board can be damaged.



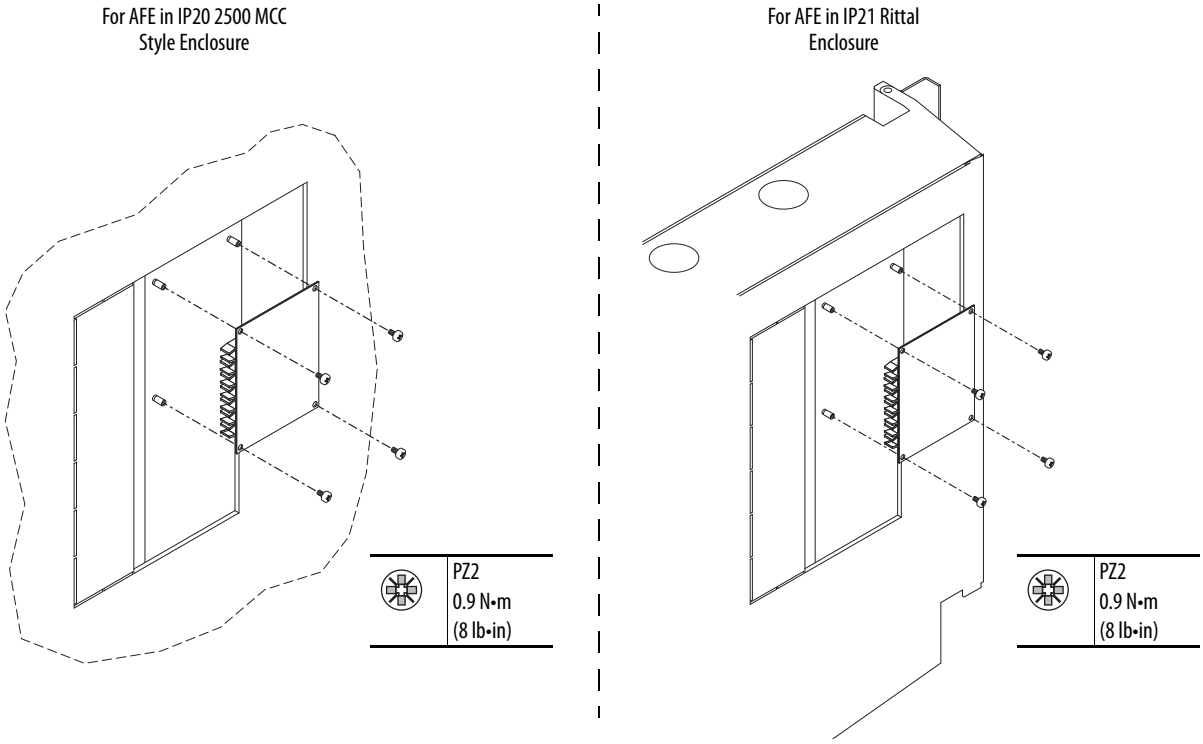

4. Carefully disconnect the fiber-optic cables from the right side of the circuit board, and carefully set them aside.

**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

**IMPORTANT** When mishandled, the ability of fiber-optic cables to transmit data is greatly diminished.

**IMPORTANT** The minimum inside bend radius for fiber-optic cable is 25.4 mm (1 in.). Any bends with a shorter inside radius can permanently damage the fiber-optic cable. Signal attenuation increases with decreased inside bend radii.

5. Remove the four screws that secure the fiber-optic adapter board to the stand-offs on the back of the control box (IP20) or control frame (IP21) and remove the fiber-optic adapter board.




## Install the Fiber-optic Adapter Circuit Board

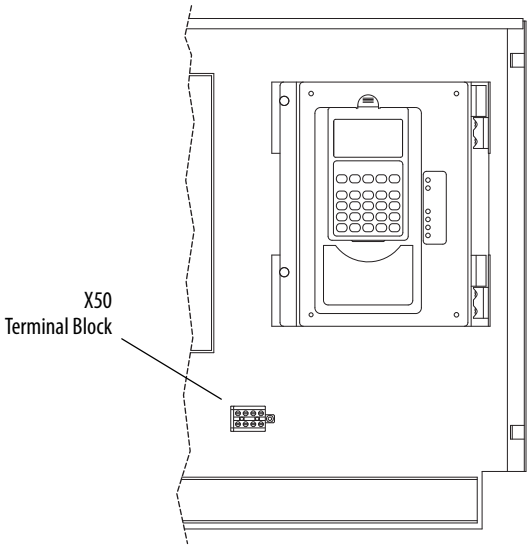
Install the fiber-optic adapter circuit board in reverse order of removal. See Torque Specifications on page 36 .

## Remove the Control Frame (only for AFE in IP21 Rittal enclosure)

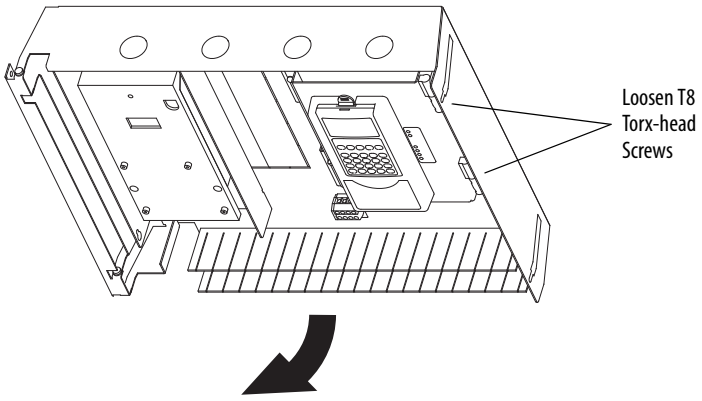
To remove the control frame for an AFE in an IP21 Rittal enclosure, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.




2. Loosen the T8 Torx-head screws, which secure the control frame to the AFE enclosure.
3. Swing the control frame out and away from the power structure.
4. Lift the control frame from the hinges and remove it.




## Replace the Control Frame

Replace the control frame in reverse order of removal. See Torque Specifications on page 36 .

# Power Structure Access Procedures

Follow these instructions to remove and install components on the power structure, and to remove power modules from the power structure.

**IMPORTANT** To replace power modules, you must remove the power structure from the AFE enclosure.

## Remove AFE Protective Barriers

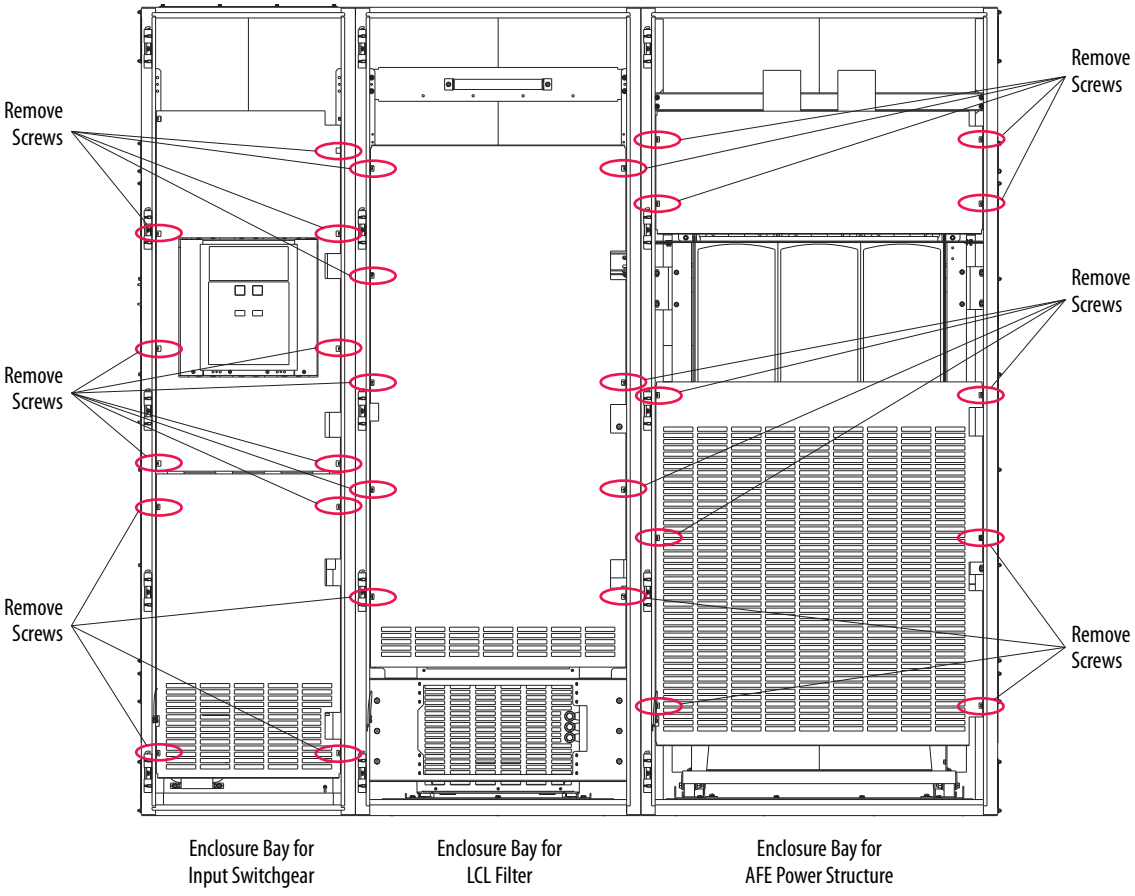
To remove the AFE protective barriers, follow these steps.

1. Remove power from the AFE.

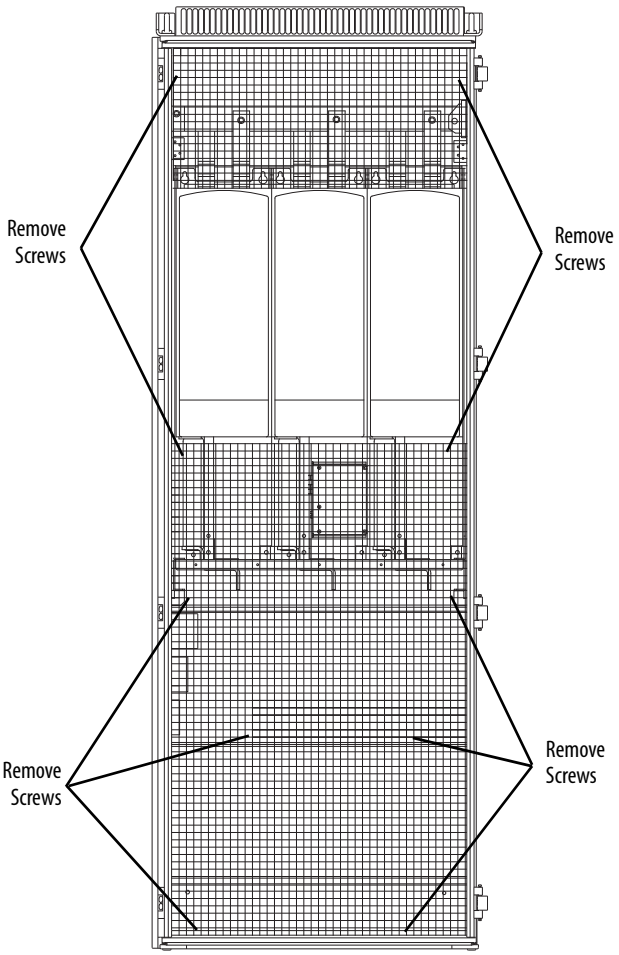
   See Remove Power from the AFE on page 37.

2. Remove the screws that secure the protective barriers to the AFE enclosure.
3. Remove the protective barriers.

Removing Protective Barriers for AFE in IP20 2500 MCC Style Enclosure



Removing Protective Barriers for AFE in IP21 Rittal Enclosure




## Install AFE Protective Barriers

Install the protective barriers in reverse order of removal.

## Remove the AFE Airflow Plate

You must remove the airflow plate to remove the power structure from the AFE.

To remove the AFE airflow plate, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

2. If present, remove the protective barriers.

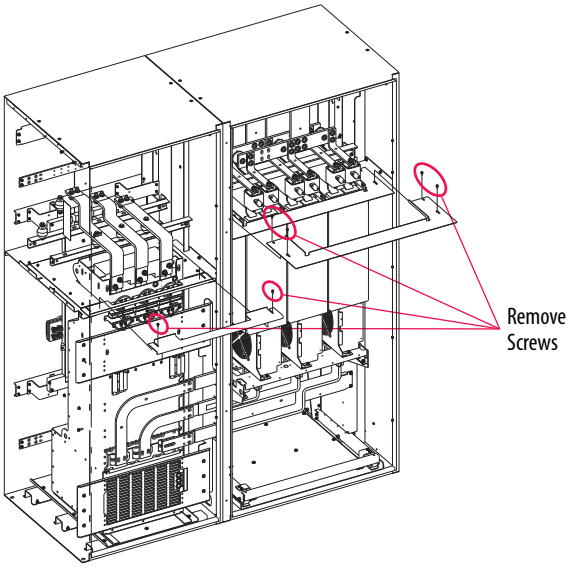
   See Remove AFE Protective Barriers on page 44.

3. For an AFE in an IP20 2500 MCC Style enclosure, remove the four M6 x 16 screws that secure the airflow plate to the AFE, and remove the two M6 x 16 screws that secure the airflow plate to the LCL filter.

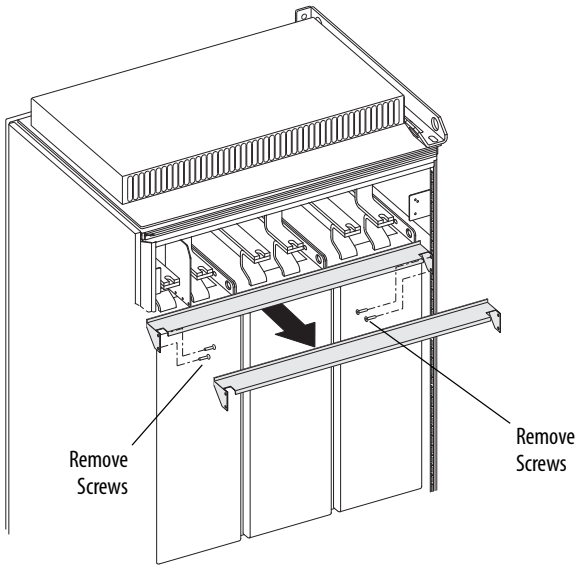
   For an AFE in an IP21 Rittal enclosure, remove the four T8 Torx-head screws that secure the airflow plate to the AFE.

4. Slide the airflow plate from the AFE.

Removing Airflow Plate for AFE in IP20 2500 MCC Style Enclosure




Removing Airflow Plate for AFE in IP21 Rittal Enclosure




## Install the AFE Airflow Plate

Install the airflow plate in reverse order of removal.

## Remove Protective Covers from the Power Structure

You must remove the protective covers to access internal components of the power structure.

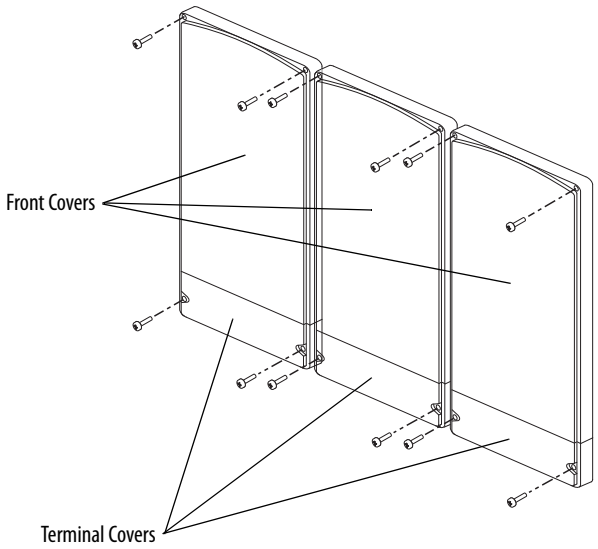
To remove the protective covers from the power structure, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.
2. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.
3. Remove the four M5 Pozidriv screws that secure the protective front covers and terminal covers to the power structure.
4. Remove the covers.

**IMPORTANT** Remove only the terminal covers to gain access to the cooling fan connections.




## Install Protective Covers on the Power Structure

Install the protective covers on the power structure in reverse order of removal. See Torque Specifications on page 36 for torque specifications.

## Remove the Gate Driver Circuit Boards

There are three gate driver circuit boards on the front of the power structure.

To remove the gate driver circuit boards, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

2. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.

3. Remove the airflow plate.

   See Remove the AFE Airflow Plate on page 46.

4. Remove the protective front covers and terminal covers from the power structure.

   See Remove Protective Covers from the Power Structure on page 47.

5. Unscrew the terminals for the DC +/- supply from X1 of the first gate driver board.

   Observe polarity when removing for later reattachment.

6. Carefully unplug the fiber-optic cables from sockets along the bottom of the gate driver board, and carefully set them aside.

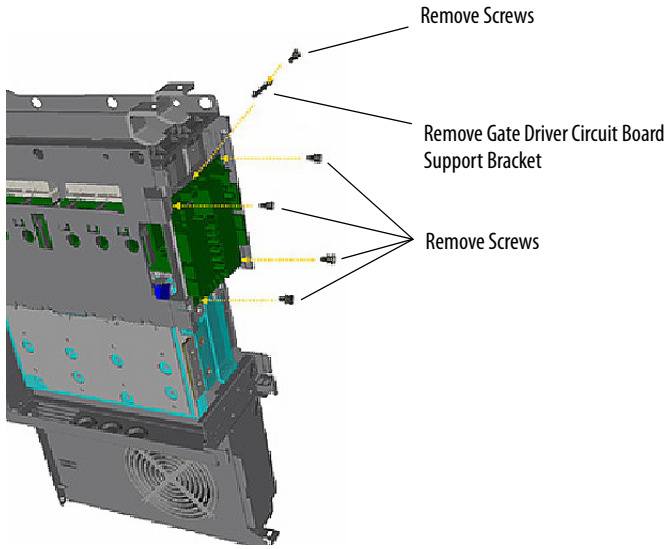
**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

**IMPORTANT** When mishandled, the ability of fiber-optic cables to transmit data is greatly diminished.

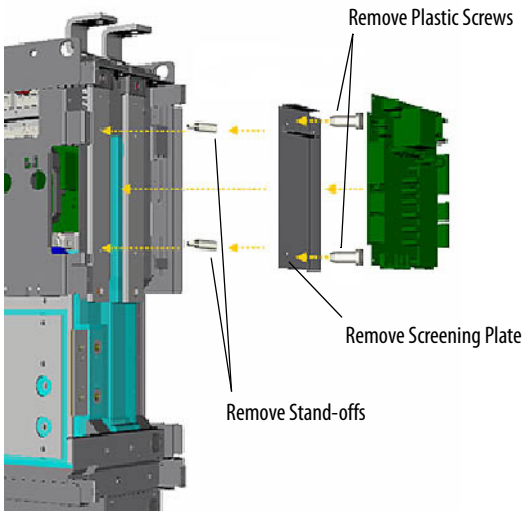
**IMPORTANT** The minimum inside bend radius for fiber-optic cable is 25.4 mm (1 in.). Any bends with a shorter inside radius can permanently damage the fiber-optic cable. Signal attenuation increases with decreased inside bend radii.

7. Disconnect the X13, X14, and X15 cables from sockets of the gate driver board, and set them aside.

8. Remove the five screws that secure the gate driver board and support bracket to the power structure.




9. Carefully remove the gate driver board and the board support bracket.
10. Carefully remove the two plastic screws that secure the gate driver board screening plate to the power structure and remove the screening plate.
11. Remove the two stand-offs that support the gate driver board.




12. Repeat step 5 through step 11 for each of the remaining gate driver boards.

## Install the Gate Driver Circuit Boards

Install the gate driver circuit boards in the reverse order of removal.

## Remove the ASIC Circuit Board

To remove the ASIC circuit board, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

2. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.

3. Remove the airflow plate.

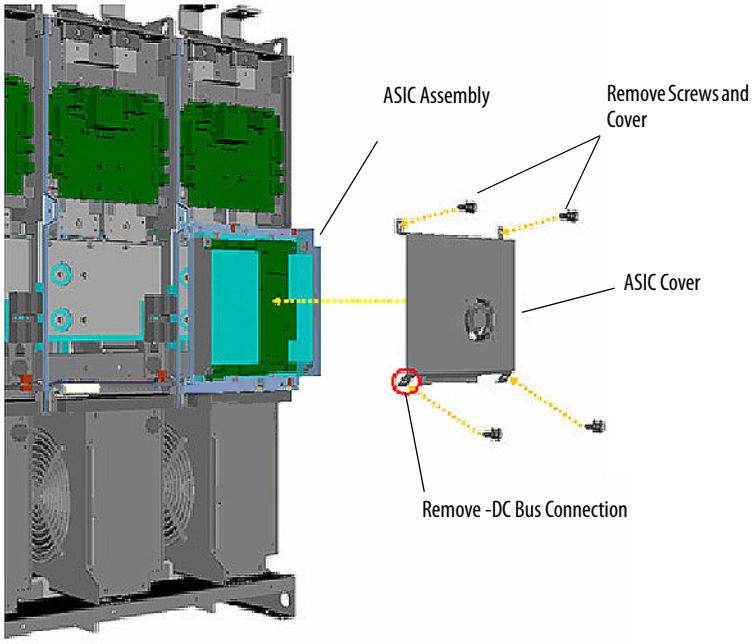
   See Remove the AFE Airflow Plate on page 46.

4. Remove the protective front covers and terminal covers from the power structure.

   See Remove Protective Covers from the Power Structure on page 47.

> **ATTENTION:** The sheet metal cover and mounting screws on the ASIC circuit board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

5. Remove the four screws that secure the ASIC cover to the ASIC assembly, remove the -DC bus connection from the ACSIC cover, and remove the ASIC cover.




6. Unplug the fan, which mounts on the cover, from connector X11 of the ASIC circuit board.

7. Carefully unplug the fiber-optic cables H1 through H7 from sockets on the ASIC board, and carefully set them aside.

**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

**IMPORTANT** When mishandled, the ability of fiber-optic cables to transmit data is greatly diminished.

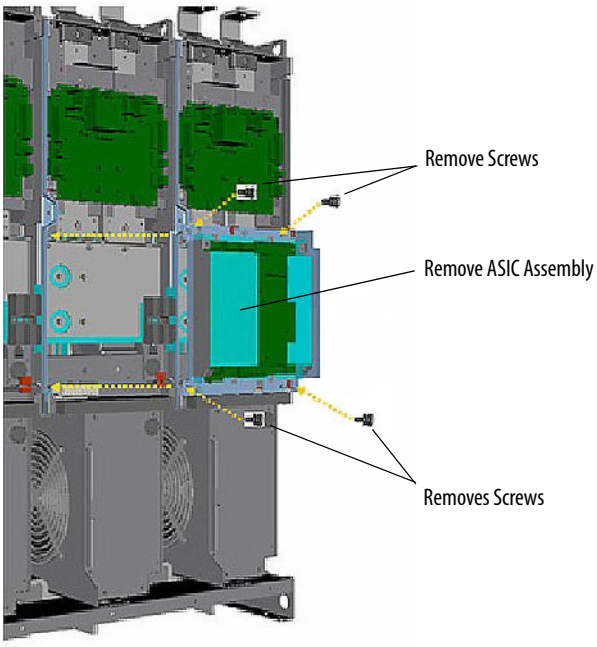
**IMPORTANT** The minimum inside bend radius for fiber-optic cable is 25.4 mm (1 in.). Any bends with a shorter inside radius can permanently damage the fiber-optic cable. Signal attenuation increases with decreased inside bend radii.

8. Disconnect the X9 terminal block and the X15 terminal connectors.

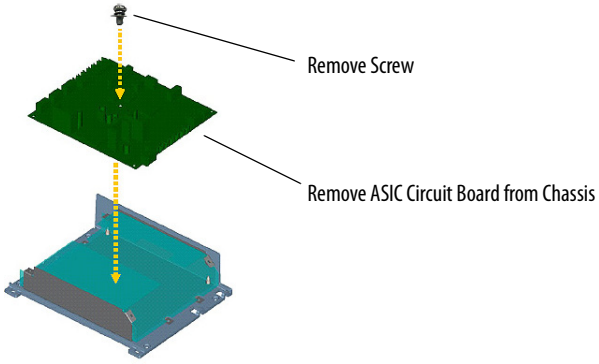
**IMPORTANT** When replacing the existing ASIC board with a new board, the X9 and X15 connectors must be transferred and connected to the new board before installation.

9. Disconnect the X3, X4, X5, X6, and X10 cables from sockets on the front of the ASIC board, and set them aside.

10. Remove the four screws that secure the ASIC assembly to the power structure and remove the ASIC assembly.

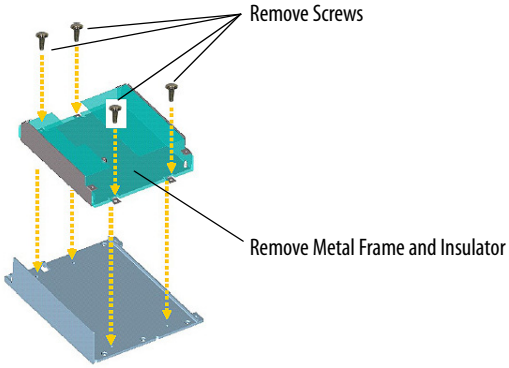



11. Remove the screw and detach the four plastic standoffs that secure the ASIC board to the ASIC chassis, and remove the ASIC board.

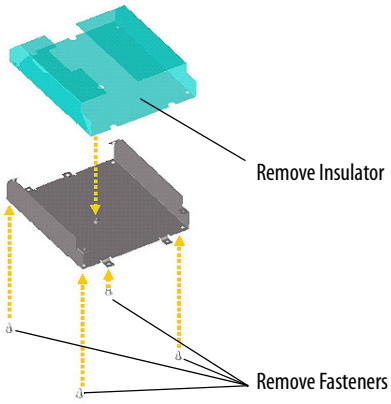



If the plastic insulator requires replacement, follow these steps:

a. Remove the four screws that secure the board holder to the metal frame, and remove the metal frame and insulator.



b. Carefully remove the four fasteners that secure the insulator to the metal frame, and remove the insulator.




c. Replace the insulator.

## Install the ASIC Circuit Board

Install the ASIC circuit board in reverse order of removal. See Torque Specifications on page 36 . Reconnect cables and jumpers to the ASIC board, while referring to Figure  on page 102.

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC circuit board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly. Verify that the -DC bus wire is properly connected to the ASIC chassis cover.

## Remove and Install the Power Structure Fan System

There are three main cooling fans on the power structure. For complete details on all fan system-related information, see the PowerFlex 700S, 700H, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029, including removal and installation of the following items:

- AC fan inverters
- AC fan capacitors
- AC main cooling fans
- DC fan power supplies
- DC main cooling fans
- Fan fusing

## Remove the Power Structure from the Enclosure

**IMPORTANT** Power structure removal is required only when the power structure, or its internal components (power module, DC bus capacitors, balancing resistors, and so forth) are replaced.

To remove the power structure from the enclosure, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

2. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.

3. Remove the airflow plate.

   See Remove the AFE Airflow Plate on page 46.

4. Remove the DC+ and DC- wires from the Fan Inverter Fuse assemblies.
5. Disconnect the seven fiber-optic cables that are connected to the fiber-optic adapter board located behind the control assembly (for AFE in IP20 2500 MCC Style enclosure) or the control frame (for AFE inIP21 Rittal enclosure).

   For location of connections, see Remove the Fiber-optic Adapter Circuit Board on page 40.

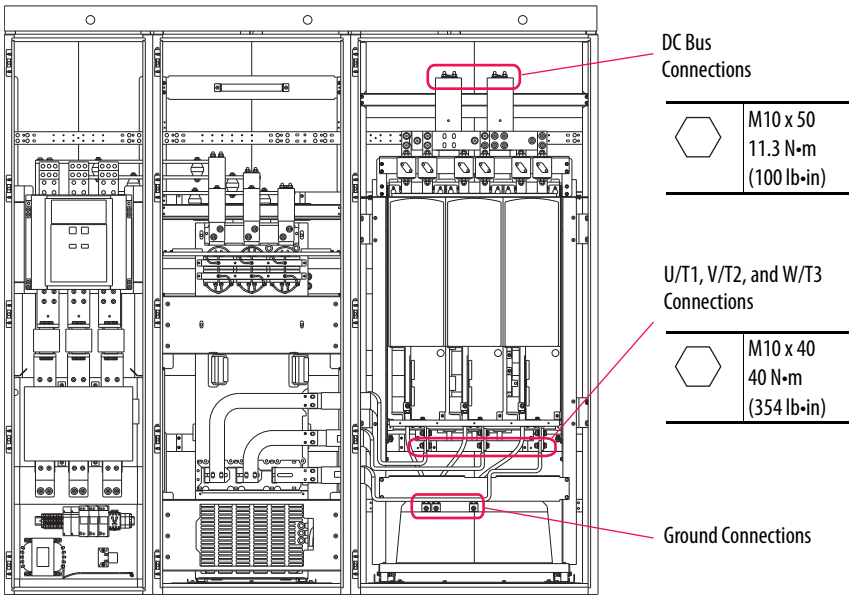
6. Depending on the enclosure in which the AFE is installed, follow the appropriate procedure to remove the power structure from the enclosure.
   - AFE in IP20 2500 MCC Style Enclosure on page 54.
   - AFE in IP21 Rittal Enclosure on page 57.

### *AFE in IP20 2500 MCC Style Enclosure*

If your AFE is in an IP20 2500 MCC enclosure, continue to remove the power structure with these steps.

a. Disassemble the four M10 x 50 bolts and associated hardware that secure the DC+ and DC- bus bars of the AFE power structure to the MCC bus.

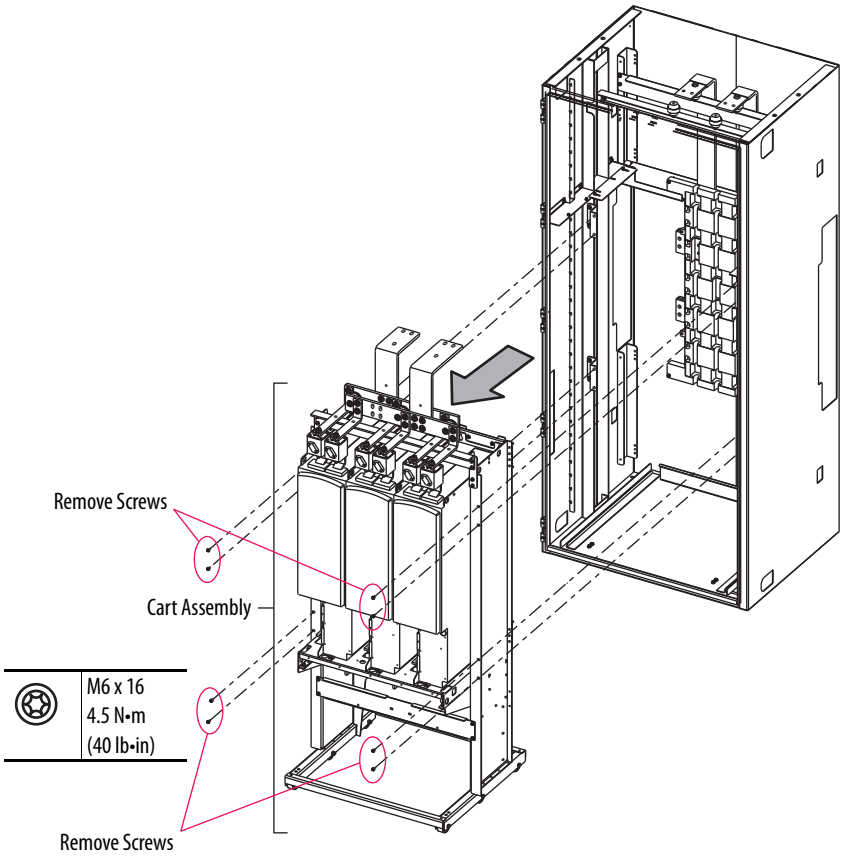
AFE in IP20 2500 MCC Style Enclosure
(shown with enclosure doors removed)




b. Remove the U/T1, V/T2, and W/T3 connections from the power structure at the bottom front of the power structure.

c. Remove the ground connections of the power structure from the enclosure PE terminals.

d. Remove eight M6 x 16 screws that secure the cart assembly to the enclosure.




**ATTENTION:** The cart assembly is heavy. To avoid personal injury or damage to the equipment, use caution when removing the cart assembly from the enclosure.

e. Roll the cart assembly that contains the power structure outward from the enclosure.

**IMPORTANT** Ramps can be required due to floor mismatch.

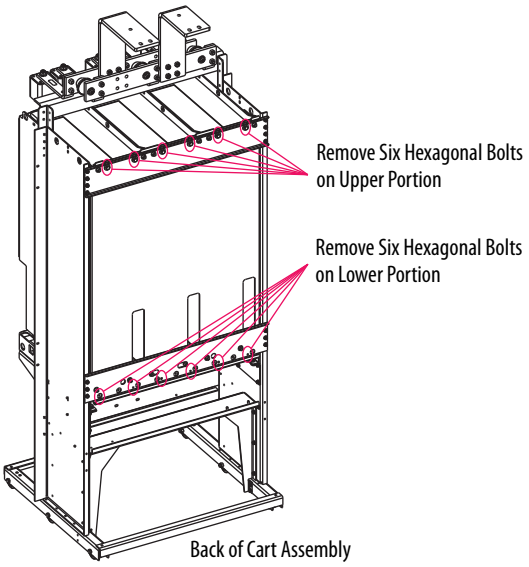
When replacing the complete power structure, continue with the following substeps. When replacing components within an individual phase assembly, see Remove the U, V, or W Phase Assembly from the Power Structure on page 59.

f. Secure appropriate cables or chains to the recommended lift points on the power structure, and tighten the cables or chains.

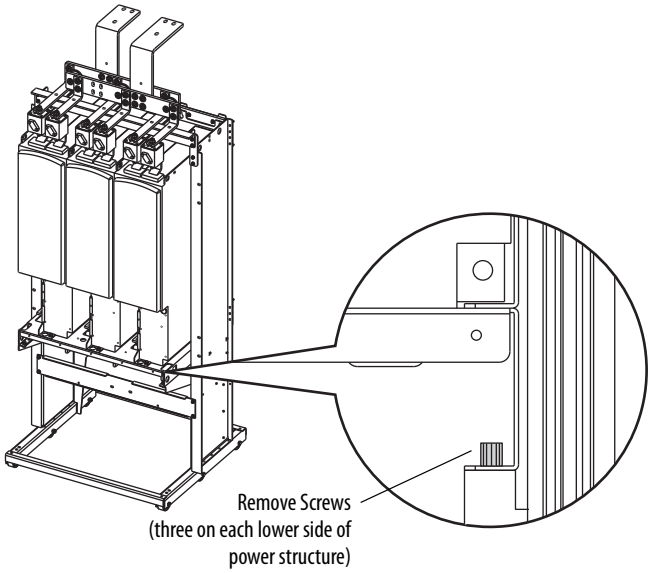
For details, see Lifting and Mounting the PowerFlex Active Front End (AFE)—Frames 10 and 13, publication 20Y-IN001.

g. To detach the power structure from its cart assembly, remove the six hexagonal bolts from the upper portion of the chassis backside.

h. Remove the six hexagonal bolts from the lower portion of the chassis backside.




i. To detach the power structure from its cart assembly, remove the six hexagonal screws (three on each lower side).




j. Remove the six DC output fuses (two per phase) from the power structure bus bars.

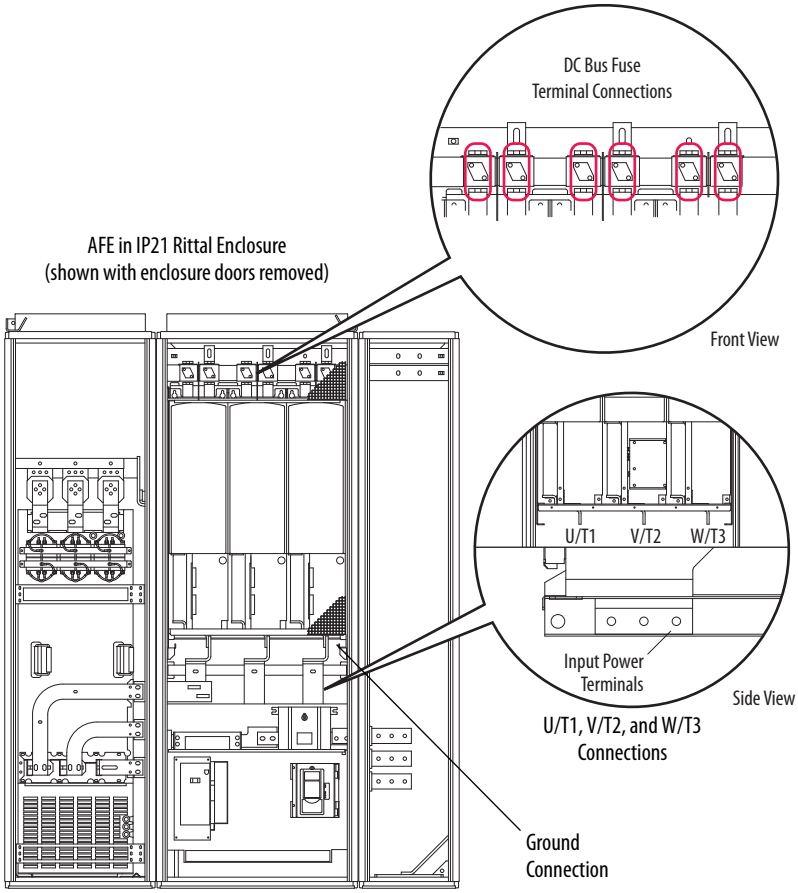
   For DC fuse removal instructions, see Fuse Replacement Guidelines on page 94.

k. Separate the power structure from its cart assembly, and remove the power structure by using appropriate lifting equipment.

### *AFE in IP21 Rittal Enclosure*

If your AFE is in an IP21 Rittal enclosure, continue to remove the power structure with these steps.

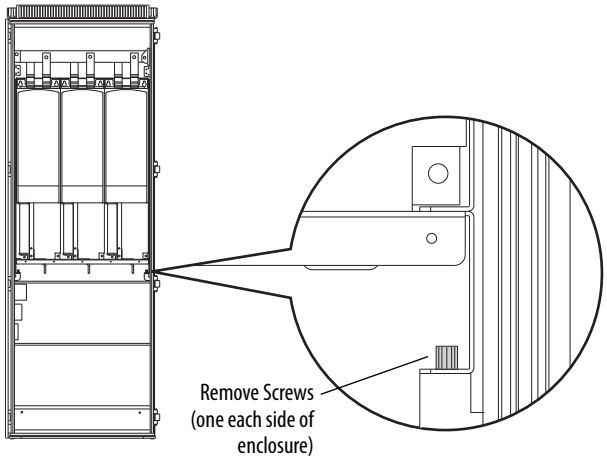
a. Remove the six DC bus fuses from the terminal connections at the top of the power structure.




b. Remove the U/T1, V/T2, and W/T3 connections from the power structure at the front of the power structure.

c. Remove the ground connections of the power structure from the enclosure PE terminals.

d. Remove the output cable screws, and the two hexagonal screws that secure the power structure to the AFE frame.




e. Install the maintenance stand (catalog number 20-MAINSTD) onto the power structure rails.

See PowerFlex 700S and 700H Frame 10...14 Drives Maintenance Stand Installation Instructions, publication PFLEX-IN014.

**ATTENTION:** The power structure is heavy. To avoid personal injury or damage to the equipment, use caution when removing the power structure from the enclosure.

f. Slide the power structure outward onto the rails of the optional Maintenance Stand.

## Install the Power Structure in the Enclosure

Install the power structure in reverse order of removal. See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for fastener torques of AC supply, DC bus input, and ground connection terminations.

## Remove the U, V, or W Phase Assembly from the Power Structure

**IMPORTANT** Do not attempt to disassemble the power module within the U, V, or W phase assembly.

To remove the U, V, or W phase assembly from the power structure, follow these steps.

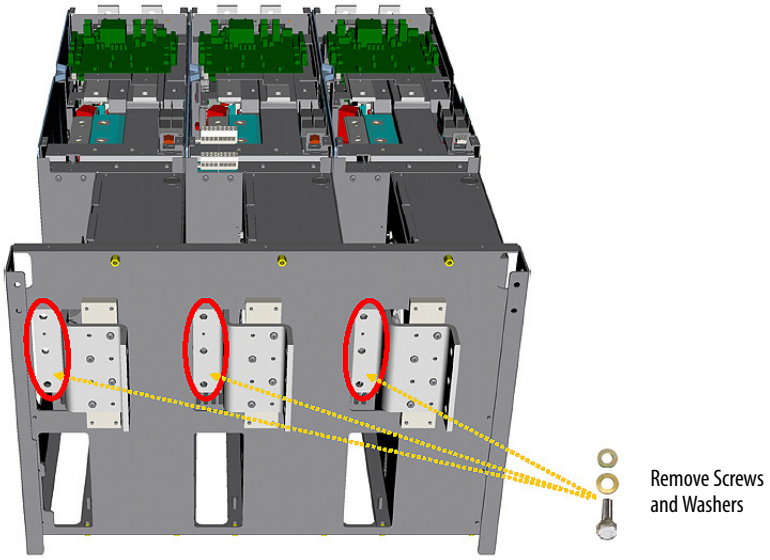
1. Remove the power structure from the AFE enclosure.

   See Remove the Power Structure from the Enclosure on page 54.

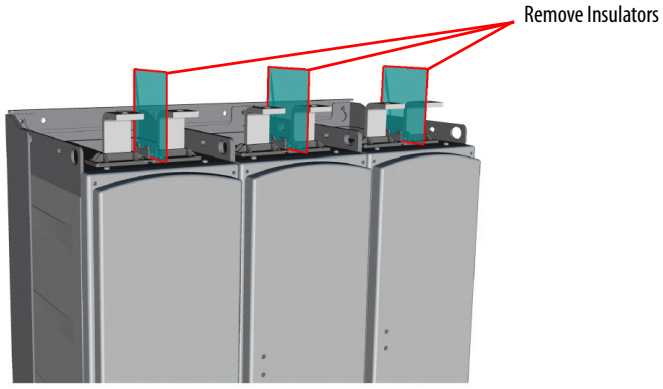
2. Remove the ASIC Circuit board.

   See Remove the ASIC Circuit Board on page 50.

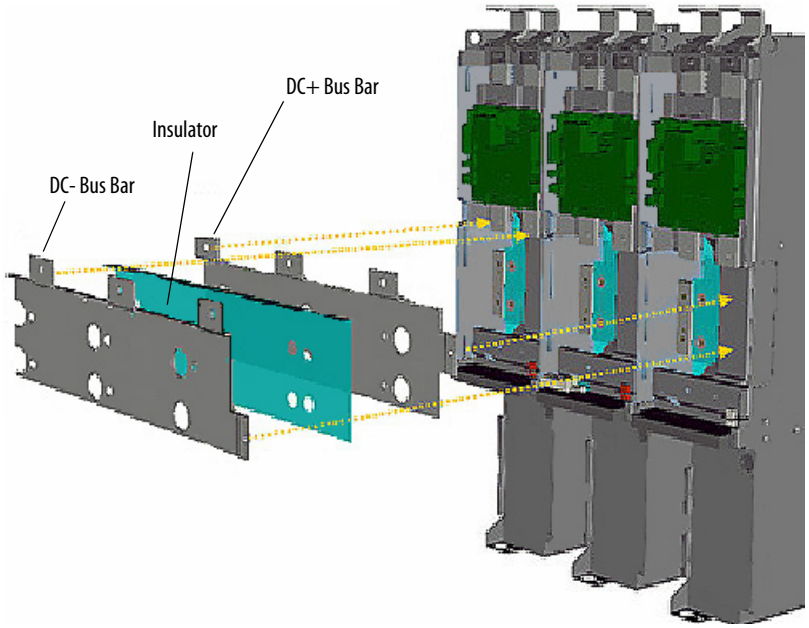
3. Remove the M10 x 25 hexagonal screws that secure the input power cables to the input power terminals on the power structure.



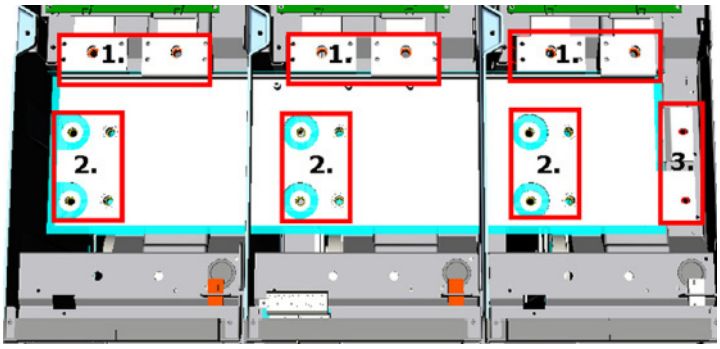

4. Remove the insulators from between the DC+ and DC- bus bars.



5. Remove the M6 x 12 screws that secure the connective DC bus bars and insulators to the phase assembly.

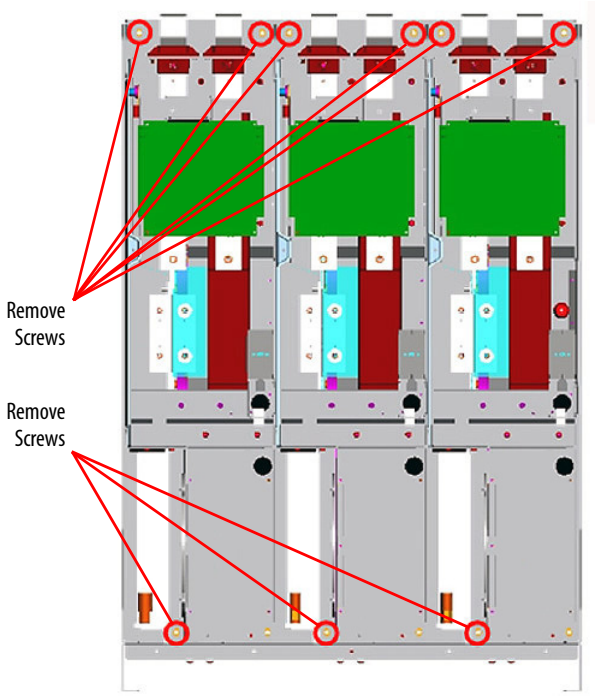



| Location | Fasteners | Qty | Torque |
|---|---|---|---|
| 1 | M10 x 20 hexagonal screws, M10 spring washers and M10 washers | 6 | 8 N•m (70 lb•in) |
| 2 | M8 x 25 hexagonal screws, M8 spring washers and M8 washers | 6 | 8 N•m (70 lb•in) |
| 3 | M6 x 12 screws | 2 | 4 N•m (35 lb•in) |




6. Remove the three M8 x 20 hexagonal screws from the top section of each phase assembly (U, V, or W) that you want to remove.

**IMPORTANT** Only two screws are shown for each phase assembly in the top section of the drawing.




7. Remove three M8 x 20 hexagonal screws from the bottom section of each phase assembly (U, V, or W) that you want to remove.

| | |
|---|---|
| **IMPORTANT** | Only one screw is shown for each phase assembly in the bottom section of the drawing. |

8. Disconnect the three input power cables from the lower section of the phase assembly that you want to remove.
9. Remove the phase assembly by using appropriate lifting equipment.

## Remove the Power Module from the U, V, or W Phase Assembly

| | |
|---|---|
| **IMPORTANT** | Do not attempt to disassemble the power module within the U, V, or W phase assembly. |

| | |
|---|---|
| **IMPORTANT** | When replacing a damaged power module, it is recommended to replace all three power modules to avoid potential failure on the remaining power modules due to residual damage. |

The following procedure describes removing the power module from one phase assembly. Repeat this procedure for each phase assembly.

To remove the power module from the U, V, or W phase assembly, follow these steps.

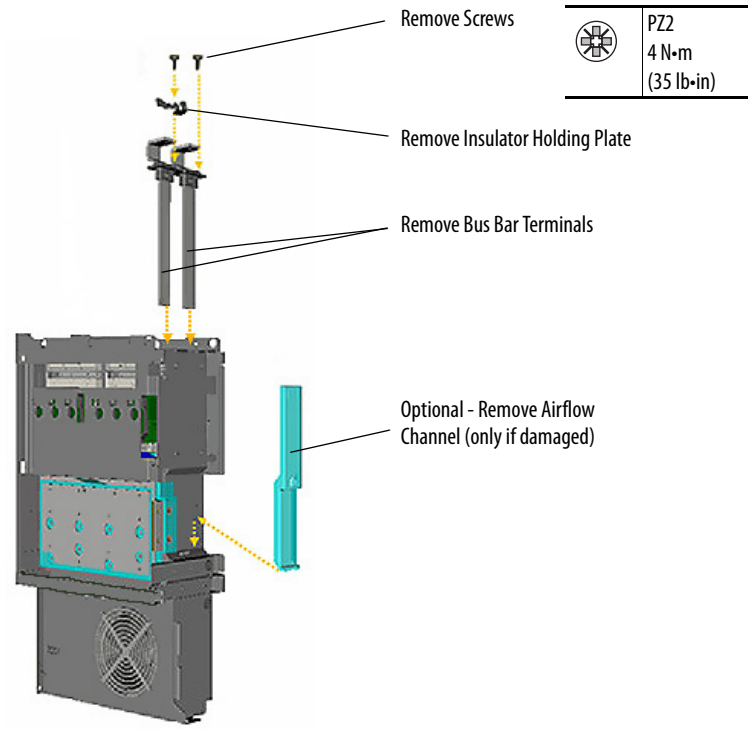
1. Remove the power structure from the AFE enclosure.

   See Remove the Power Structure from the Enclosure on page 54.

2. Remove the U, V, or W phase assembly from the power structure.

   See Remove the U, V, or W Phase Assembly from the Power Structure on page 59.

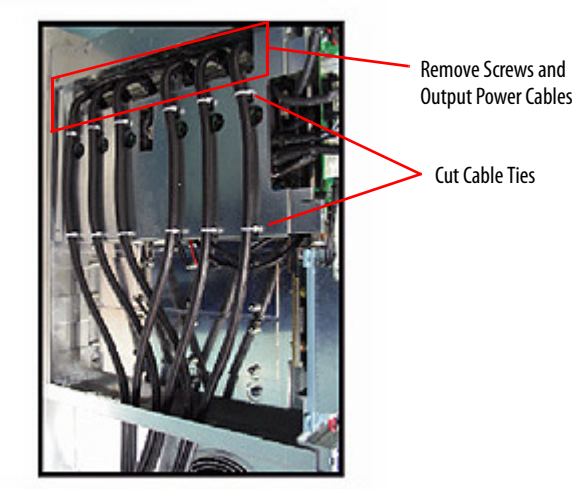
3. Remove the insulator holding plate from between the bus bar terminals.
4. Remove the M5 Pozidriv screws that secure the bus bar terminals to the power structure.
5. Slide the bus bar terminals out of the phase assembly.
6. If the bus bar airflow channel is damaged, remove and replace it.



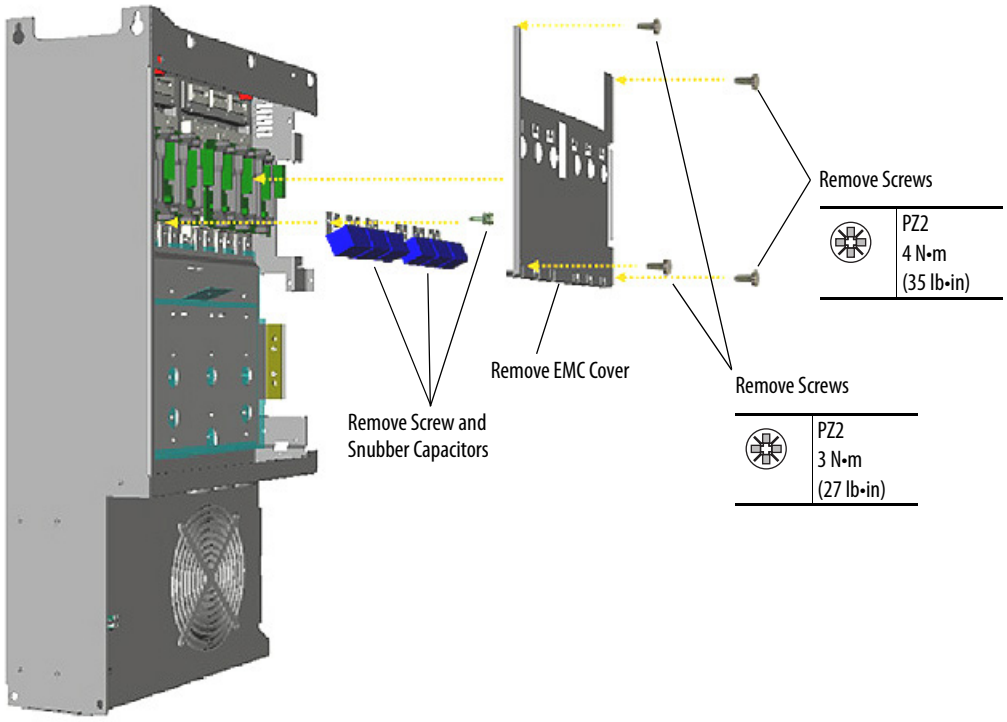

7. Remove the M8 x 20 hexagonal screws that secure the input power cables to the input power bus bar.

   Tightening torque for reassembly is 14 N•m (124 lb•in).

8. Cut and remove the cable ties that secure the input power cables to the EMC cover plate and remove the cables.

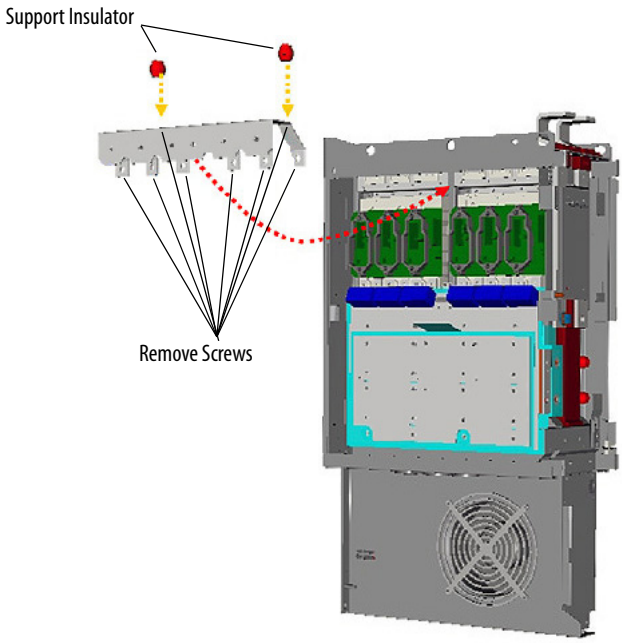



9. Remove the M5 x 10 Pozidriv and M4 x 8 Pozidriv screws that secure the EMC cover to the AFE, and remove the cover.
10. Remove the screws that secure the snubber capacitors to the U, V, or W phase assembly, and remove the snubber capacitors.

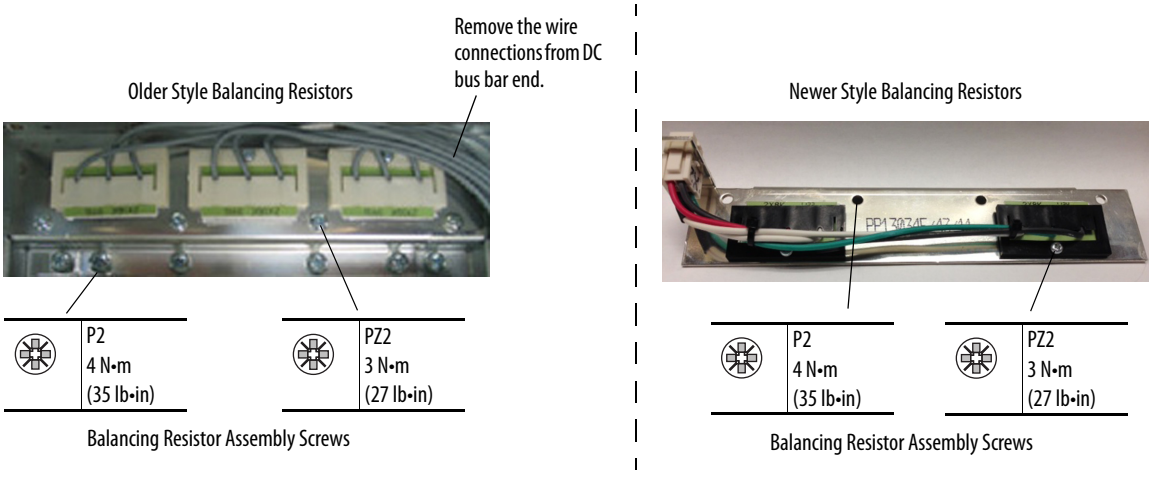


11. Remove the screws that secure the power bus bar and support insulators to the power structure.
12. Remove the power bus bar and insulators.

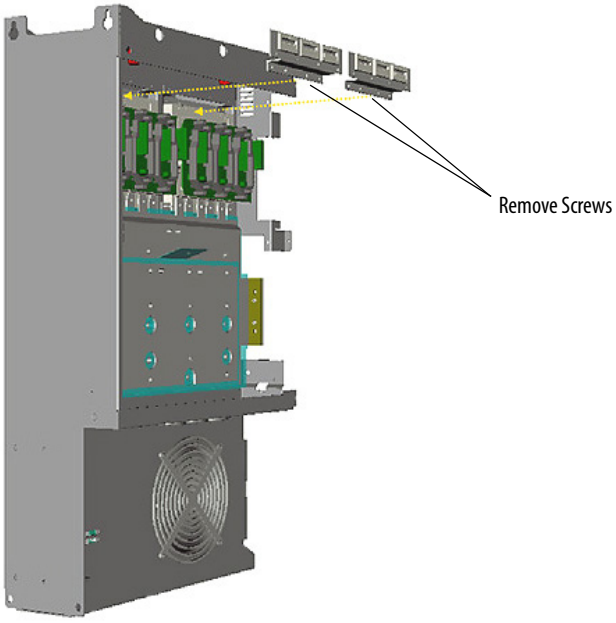
    Tightening torque for reassembly is 14 N•m (124 lb•in).




13. Disconnect the balancing resistor wires from the DC bus bars.

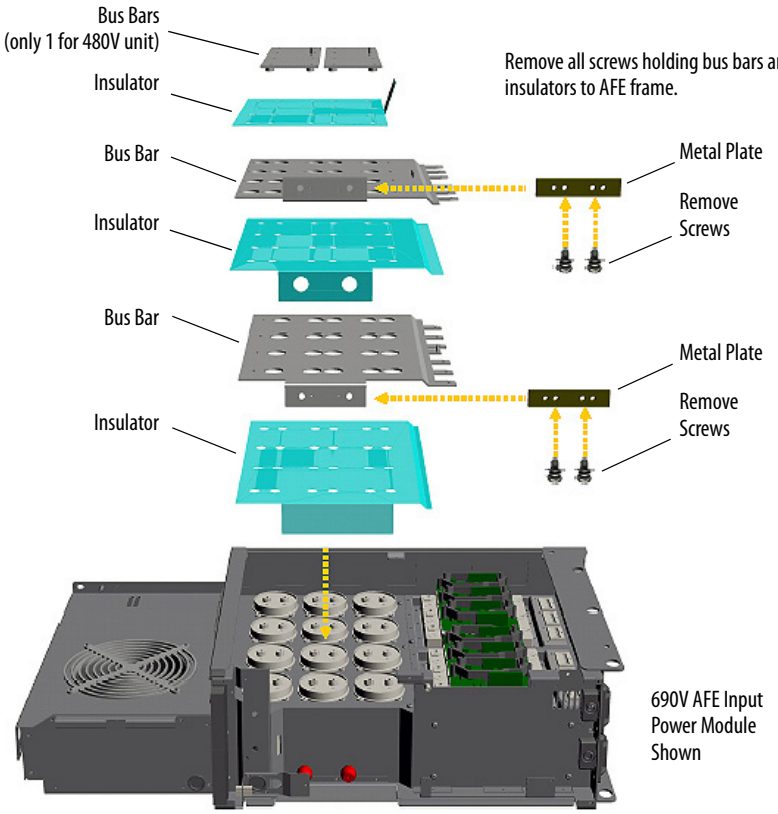


14. Remove the screws that secure the balancing resistor assemblies to the U, V, or W phase assembly.

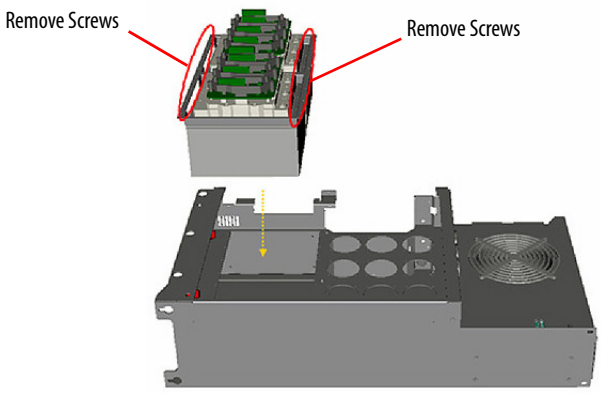



15. Remove the balancing resistor assemblies (see step 13 picture for screw locations).
16. Remove the connective DC bus bars and insulators.

    Tightening torque for reassembly is 4 N•m (35 lb•in).



17. Remove the M4 x 8 screws that secure the power module to the U, V, or W phase assembly.
18. Remove the power module.




19. Repeat step 10 through step 18 for each remaining phase assembly.

## Install the Power Module on the U, V, or W Phase Assembly

Install the power module in reverse order of removal. See Torque Specifications on page 36 .

## Remove the U, V, or W Phase Assembly DC Bus Capacitors

To remove the U, V, or W phase assembly DC bus capacitors, follow these steps.

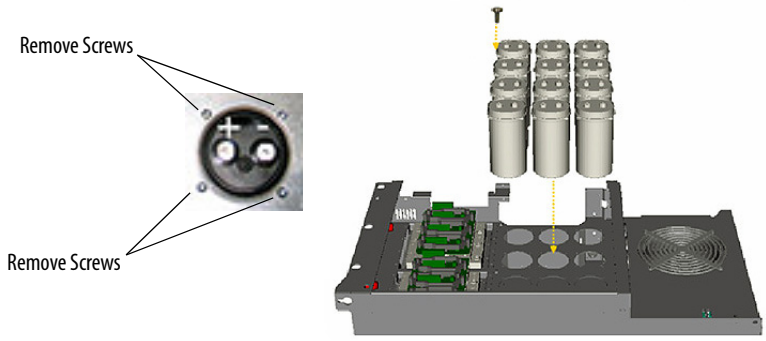
1. Remove the power structure from the AFE enclosure.

   See Remove the Power Structure from the Enclosure on page 54.
2. Remove the U, V, or W phase assembly from the AFE.

   See Remove the U, V, or W Phase Assembly from the Power Structure on page 59.
3. Remove the power module from the U, V, or W phase assembly—but do not perform the last three steps (step 17 through step 19) in that procedure.

   See Remove the Power Module from the U, V, or W Phase Assembly on page 62.
4. Note the polarity of the capacitors.

5. Remove the four M4 x 8 screws that secure the capacitor to the power structure.




6. Remove the capacitor.

   Tightening torque for reassembly is 1.35 N•m (12 lb•in). We recommend replacing all capacitors at the same time.

7. Repeat step 5 and step 6 for each remaining DC bus capacitor being removed.

## Install the U, V, or W Phase Assembly DC Bus Capacitors

Install the capacitors in reverse order of removal. Make sure to observe the polarity of the capacitors as noted in removal step 4 above.

## Replace the Existing Power Structure with a New Power Structure

**IMPORTANT** When replacing the existing AFE Frame 13 power structure with a new power structure, (SK-Y1-PWRMOD-D1K3 for 400/480V, or SK-Y1-PWRMOD-E1K0 for 600/690V), you must perform these tasks to avoid possible equipment malfunction:

- Remove the common mode capacitors in the new power structure.
- Remove the power supply voltage feedback board from the new power structure.

To replace the existing power structure with a new power structure, follow these steps.

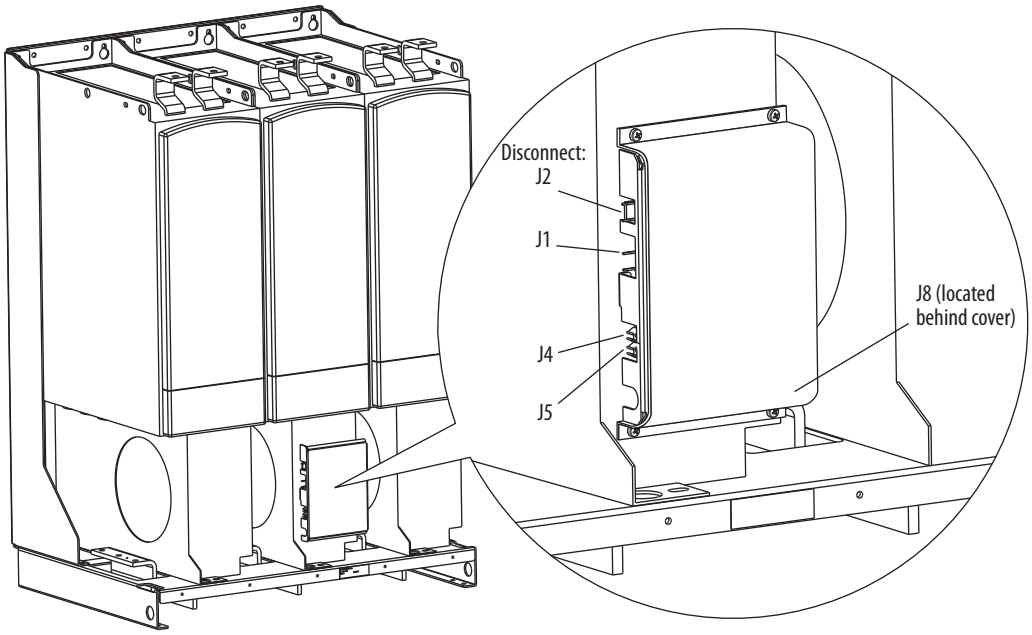
1. Remove the old power structure from the enclosure.

   See Remove the Power Structure from the Enclosure on page 4-54.

2. Remove the common mode capacitors from the new Frame 13 power structure that is replacing the old power structure.

For the procedure to remove the common mode capacitors, see the PowerFlex Active Front End User Manual, publication 20Y-UM001. See Chapter 2, section 'Disconnect Common Mode Capacitors', and subsection 'Frame 13 Power Structure'. These instructions apply to an AFE in an IP20 2500MCC Style enclosure or an AFE in an IP21 Rittal enclosure.

3. To remove the power supply voltage feedback board from the new Frame 13 power structure that is replacing the old power structure, follow the steps.
   a. Disconnect the DC bus connection cable from connector J2, and the motor feedback connection cable from connector J1 at the top of the power supply voltage feedback board.




   b. Carefully disconnect the fiber-optic cables from sockets J4 and J5 on the side of the power supply voltage feedback board.
   c. Secure the cables to the adjacent fan housing so that they are out of the way.

**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

   d. Remove the four screws that secure the power supply voltage feedback board and cover to the V phase assembly module fan housing.
   e. Carefully remove the power supply voltage feedback board and cover.
   f. Disconnect the cable from connector J8 on the power supply voltage feedback board.

g. Secure the cable to the adjacent fan housing so that it is out of the way.

4. Install the new (replacement) power structure.

   See Install the Power Structure in the Enclosure on page 59.

# AC Line Switchgear Component Section

**ATTENTION:** To avoid an electric shock hazard, verify that all power to the PowerFlex® Active Front End has been removed before you perform any service or repairs.

**ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC Board on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

**ATTENTION:** Hot surfaces can cause severe burns. Do not touch the heatsink surface during operation of the PowerFlex Active Front End. After you disconnect power, allow time for cooling.

**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

**ATTENTION:** The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

## AFE in IP20 2500 MCC Style Enclosure

For a PowerFlex AFE system in the IP20 2500 MCC Style enclosure, the AC line switchgear components are the input circuit breaker (Q0), AC input fuses (F1.1...F1.3), and input contactor (K1).

The input circuit breaker either connects or disconnects the AFE system to the AC line. The input contactor connects the internal AFE system AC line to the AFE power structure through the LCL filter. The AFE power structure contains the control logic that opens or closes the input contactor.

See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for the AC input fusing and circuit breaker protection recommendations.

## AFE in IP21 Rittal Enclosure

For a PowerFlex AFE system in the IP21 Rittal enclosure, the AC line switchgear components are the input disconnect (Q0) and MCCB (Q1).

The input disconnect either connects or disconnects the AFE system to the AC line. The MCCB connects the internal AFE system AC line to the AFE power structure through the LCL filter. The AFE power structure contains the control logic that enables or disables the resettable trip mechanism that is integrated into the MCCB. The trip mechanism controls the MCCB functionality.

See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for the AC input fusing and MCCB protection recommendations.

# Precharge Component Section

**ATTENTION:** To avoid an electric shock hazard, verify that all power to the PowerFlex® Active Front End has been removed before you perform any service or repairs.

**ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC Board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

**ATTENTION:** Hot surfaces can cause severe burns. Do not touch the heatsink surface during operation of the PowerFlex Active Front End. After you disconnect power, allow time for cooling.

**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

**ATTENTION:** The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

## Precharging Functions

The precharge circuitry has two main functions:

- It provides AFE system enclosure control power.
- It provides the precharge circuitry to charge the DC bus.

The AFE system is available in both 400/480V AC and 600/690V AC system voltage configurations. Control logic voltages are as follows:

- For an AFE in an IP20 2500 MCC Style enclosure, it is 120V AC single phase and also 24V DC power.
- For an AFE in an IP21 Rittal enclosure, it is 230V AC single phase and also 24V DC power.

The precharge circuitry lets the DC capacitors, which are located in the AFE power structure, to be properly charged with in-line current limiting resistors to DC bus voltage magnitudes.

See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for the minimum and maximum system capacitance requirements.

## Replace the Precharge Fuse

The precharge fuse assembly for an AFE in an IP20 enclosure is located in the Input Power enclosure. For an AFE in an IP21 enclosure, the precharge fuse assembly is located in the power structure enclosure.

To replace the precharge fuse, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.
2. Open the appropriate enclosure door.
3. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.
4. Slide the fuse sleeve out from the fuse holder.
5. Remove the fuse from the sleeve and appropriately discard the old fuse.
6. See Table 4 and Table 5 for the recommended new replacement fuse, and install the fuse in reverse order of removal.

**Table 4 - 400/480 Volt Precharge Fuse Rating**

| Frame Size | Enclosure Style | Fuse | | Fuse Holder (3) |
|---|---|---|---|---|
| | | Amps | Type | Type |
| 13 | IP20 2500 MCC | 50 | Bussmann DFJ-50 (1) | Bussmann CH60J3 |
| | IP21 Rittal | 32 | ABB OFAF000H32 (2) | ABB 0540D12000 |

(1) Precharge fuse designation is F5 for AFE in IP20 2500 MCC style enclosure.
(2) Precharge fuse designation is F6 for AFE in IP 21 Rittal enclosure.
(3) Precharge fuse holder holds a quantity of three fuses.

**Table 5 - 600/690 Volt Precharge Fuse Rating**

| Frame Size | Enclosure Style | Fuse | | Fuse Holder (3) |
|---|---|---|---|---|
| | | Amps | Type | Type |
| 13 | IP20 2500 MCC | 50 | Bussmann DFJ-50 (1) | Bussmann CH60J3 |
| | IP21 Rittal | 32 | ABB OFAA000GG32 (2) | ABB 0540D12000 |

(1) Precharge fuse designation is F5 for AFE in IP20 2500 MCC style enclosure.
(2) Precharge fuse designation is F6 for AFE in IP 21 Rittal enclosure.
(3) Fuse holder holds a quantity of three fuses.

# Test the Control Transformer (T4) and 24V DC Power Supply (T10)

## For AFE in IP20 2500 MCC Style Enclosure

To test the control transformer (T4) and 24V DC power supply (T10) in an IP20 2500 MCC enclosure, follow these steps.

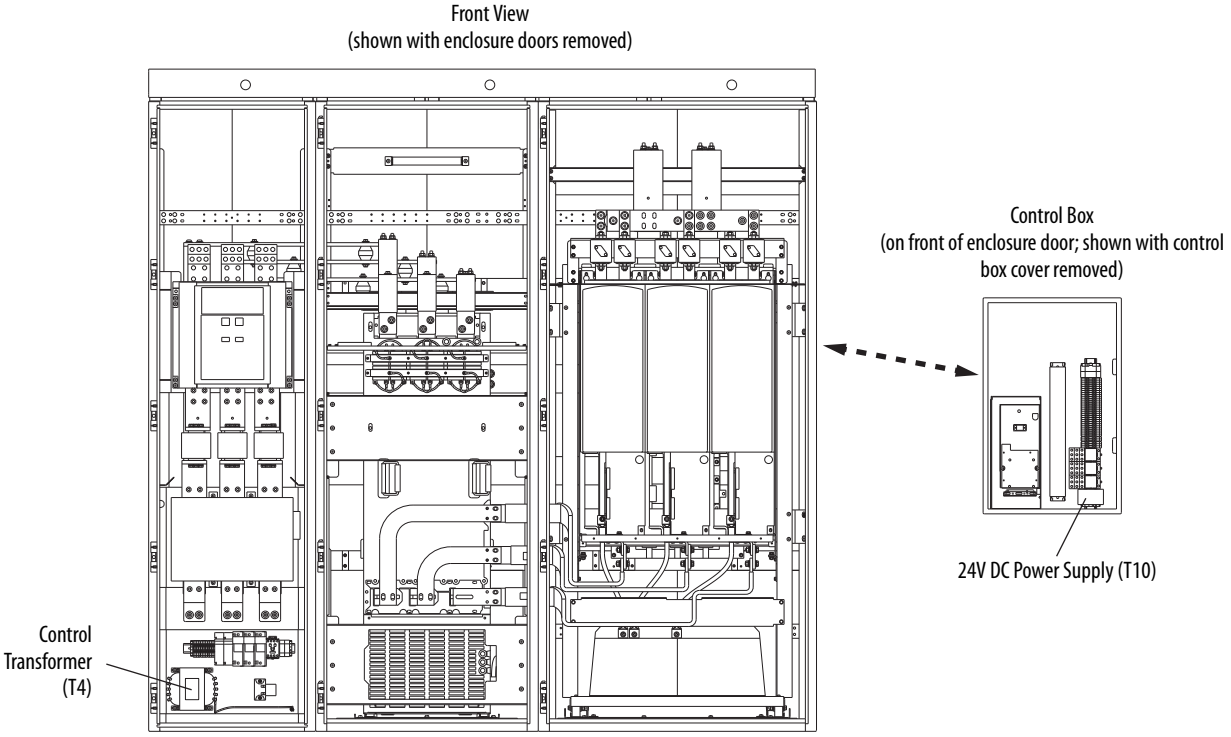
1. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.

   **ATTENTION:** Perform these tests only with qualified personnel. During these tests, the AFE is powered. Take proper precautions to avoid injury from electric shock.

2. Locate the control transformer (T4) and 24V DC power supply (T10).

The control transformer (T4) is at the bottom of the left-most enclosure (AC input switchgear). The 24V DC power supply (T10) is located in the bottom of the control box.




3. Use a digital voltmeter to test the control transformer (T4).
   a. Measure the primary AC line voltage, which is at the 400...480V AC or 600...690V AC system voltage.
   b. Measure the control transformer (T4) output voltage, which is approximately 120V AC.

      If these measurements are not within ±10%, perform these other steps.
   c. Power down the AFE.
   d. Remove the output (secondary) wires.
   e. Power up the AFE and retest by repeating step a and step b.

      The control transformer (T4) can require replacement if these measurements continue to be outside of the ±10% tolerance.
4. Use a digital voltmeter to test the 24V DC power supply (T10).
   a. Measure the primary voltage, which is 120V AC.
   b. Measure the power supply (T10) output voltage, which is approximately 24V DC.

      If these measurements are not within ±10%, perform these other steps.
   c. Power down the AFE.
   d. Remove the 24V DC output wires of the power supply (T10).
   e. Power up the AFE and retest by repeating step a and step b.

The 24V DC power supply (T10) can require replacement if these measurements continue to be outside of the ±10% tolerance.

## For AFE in IP21 Rittal Enclosure

To test the control transformer (T4) and 24V DC power supply (T10) in an IP21 Rittal enclosure, follow these steps.

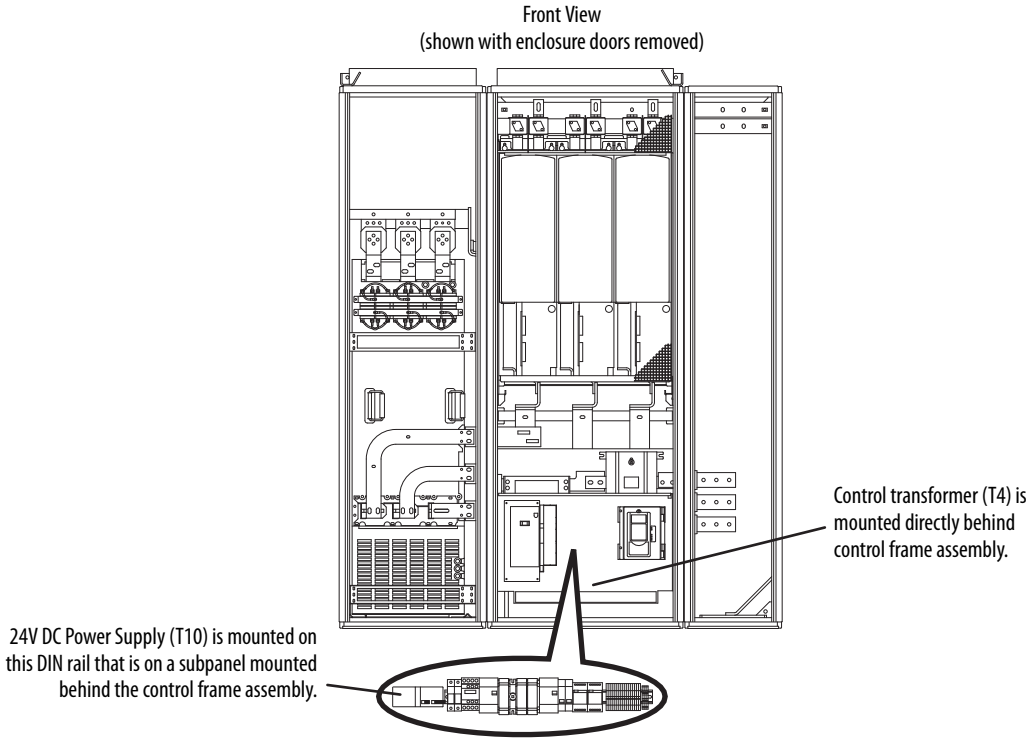
1. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.

> **ATTENTION:** Perform these tests only with qualified personnel. During these tests, the AFE is powered. Take proper precautions to avoid injury from electric shock.

2. Locate the control transformer (T4) and 24V DC power supply (T10).

   The control transformer (T4) is located behind the control frame. The 24V DC power supply (T10) is on a subpanel in front of the components that are shown in the front view.




3. Use a digital voltmeter to test the control transformer (T4).
   a. Measure the primary AC line voltage, which is at the 400...480V AC or 600...690V AC system voltage.
   b. Measure the control transformer (T4) output voltage, which is approximately 230V AC.

If these measurements are not within ±10%, perform these steps.

c. Power down the AFE.

d. Remove the output (secondary) wires.

e. Power up the AFE and retest by repeating step a and step b.

The control transformer (T4) can require replacement if these measurements continue to be outside of the ±10% tolerance.

4. Use a digital voltmeter to test the 24V DC power supply (T10).

a. Measure the primary voltage, which is 230V AC.

b. Measure the power supply (T10) output voltage, which is approximately 24V DC.

If these measurements are not within ±10%, perform these steps.

c. Power down the AFE.

d. Remove the 24V DC output wires of the power supply (T10).

e. Power up the AFE and retest by repeating step a and step b.

The 24V DC power supply (T10) can require replacement if these measurements continue to be outside of the ±10% tolerance.

## Test the Precharge Bridge Using the Power Structure Terminals

1. Remove power from the AFE.

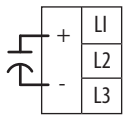
See Remove Power from the AFE on page 37.

2. If present, remove the protective barriers.

See Remove AFE Protective Barriers on page 44.

3. To test the precharge bridge, measure the points on the power structure that is listed in Table 6.

**Table 6 - Precharge Bridge Tests on Power Structure**

| Meter Leads | | Nominal Meter Reading | Test Point Locations |
|---|---|---|---|
| + | - | | |
| DC- | L1 | Value gradually rises to about 0.48V (1) |  |
| DC- | L2 | | |
| DC- | L3 | | |
| L1 | DC+ | | |
| L2 | DC+ | | |
| L3 | DC+ | | |
| L1 | DC- | Meter displays charging voltage. | |
| L2 | DC- | | |
| L3 | DC- | | |
| DC+ | L1 | | |
| DC+ | L2 | | |
| DC+ | L3 | | |



(1) The actual voltage reading can vary depending upon your equipment. If your readings are not near 0.48V, verify that the actual voltage that is measured is consistent for the power structure.

## Replace the Precharge Bridge

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.
2. Open the power structure enclosure door.
3. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.
4. Remove the protective front covers and terminal covers from the power structure.

   See Remove Protective Covers from the Power Structure on page 47.
5. Remove the four POZIDRIVE screws that secure the bridge protective cover.
6. Remove the bridge protective cover.
7. Before removal, note the locations of the DC+, DC–, L1, L2, and L3 wires, and then disconnect these wires.
8. Remove the precharge bridge mounting nuts.
9. Remove and appropriately discard the old precharge bridge.
10. Install the new precharge bridge in reverse order of removal. See Torque Specifications on page 36 .

## Test the Precharge Resistor

To test the precharge resistor, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 4-37.
2. Open the LCL filter enclosure door.
3. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 4-44.
4. Measure the resistance between the following two points with an ohmmeter:
   - Between the (+) side of the precharge resistor R6.1 and the (+) terminal on the TB of the precharge circuit.

     **IMPORTANT** This measurement applies to an AFE in either an IP20 2500 MCC Style enclosure or an AFE in an IP21 Rittal enclosure.

   - Between the (–) side of the precharge resistor R6.2 and the (–) terminal on the TB of the precharge circuit.

     **IMPORTANT** This measurement only applies to an AFE in an IP21 Rittal enclosure.

The precharge resistance is approximately 11 Ω for each measurement for an AFE in an IP20 2500 MCC Style enclosure, or 20 Ω for each measurement for an AFE in an IP21 Rittal enclosure. If the measured value is not correct, disconnect a resistor wire and remeasure again. If the measured value is still not correct, replace the precharge resistor.

**IMPORTANT** Verify that the precharge resistor has not been engineered to another value by the system engineer to accommodate a larger system capacitance. The engineered value can change the value of the precharge resistance. See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for total DC bus capacitance limits for the precharging circuit.

# Replace the Precharge Resistor Assembly

## AFE in IP20 2500 MCC Style Enclosure

To replace the precharge resistor assembly in an IP20 2500 MCC enclosure, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.
2. Open the LCL filter enclosure door.
3. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.
4. Disconnect the R6.1 precharge resistor wires from the resistor terminals on the precharge resistor assembly.
5. Remove the two precharge resistor assembly mounting screws that secure the assembly to the bracket on the LCL enclosure bay.
6. Remove the mounting screws from the failed precharge resistor, and appropriately discard the resistor.
7. Install the new precharge resistor in reverse order of removal. See Torque Specifications on page 36.

## AFE in IP21 Rittal Enclosure

To replace the precharge resistor assembly in an IP21 Rittal enclosure, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.
2. Open the LCL filter enclosure door.
3. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.
4. Disconnect the wires from the (+) and (-) terminals on the precharge resistor assembly.
5. Verify that the capacitor on the bridge (+) and (-) terminals is still in the circuit.
6. Disconnect the white wires from the terminal block by the bridge.
7. Remove the mounting screws from the failed precharge resistor, and appropriately discard the resistor.
8. Install the new precharge resistor in reverse order of removal. See Torque Specifications on page 36.

## Notes:

# LCL Filter Component Section

**ATTENTION:** To avoid an electric shock hazard, verify that all power to the PowerFlex® Active Front End has been removed before you perform any service or repairs.

**ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC Board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

**ATTENTION:** Hot surfaces can cause severe burns. Do not touch the heatsink surface during operation of the PowerFlex Active Front End. After you disconnect power, allow time for cooling.

**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

**ATTENTION:** The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

## Remove the LCL Filter Protective Barriers and Vented Cover

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

2. Remove the protective barriers from the LCL filter enclosure.

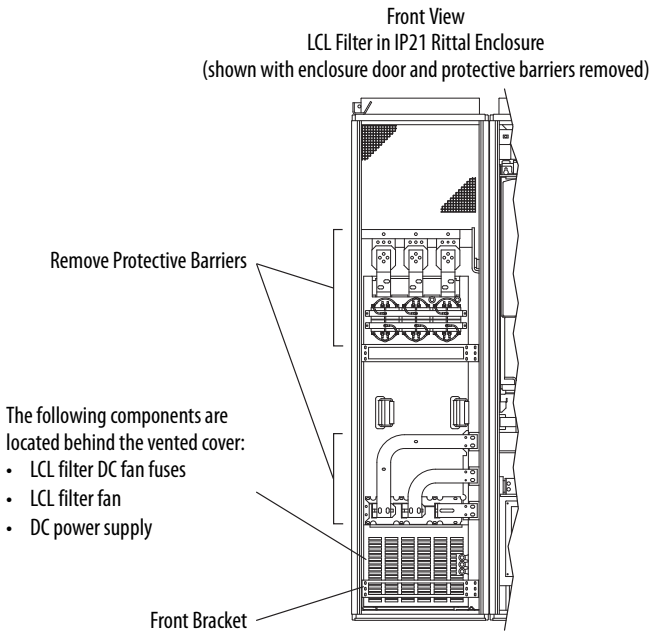
   For an AFE in an IP20 MCC Style enclosure, see Remove AFE Protective Barriers on page 44. For an AFE in an IP21 Rittal enclosure, see Figure 9.

3. Remove the four T25 Torx self-tapping screws that secure the front bracket that is shown in the Figure 9.

   This bracket holds the LCL filter in the enclosure.

4. To access the DC fan fuses, fan, and DC power supply, remove the vented cover from the bottom of the LCL filter.

**Figure 9 - Removing Protective Barriers and Vented Cover from LCL Filter**




## Install the LCL Filter Protective Barriers and Vented Cover

Reinstall the protective barriers and vented cover in reverse order of removal. See Torque Specifications on page 36.

## Replace the LCL Filter DC Fan Fuses

The LCL filter DC fan fuses are located behind the vented cover at the bottom of the LCL filter.

**IMPORTANT** Replace LCL filter fan fuses with only ATQ8 (Ferraz Shawmut) fuses.

For complete details on LCL fan system information, see PowerFlex 700H, 700S, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029.

## Remove the LCL Filter Fan DC Power Supply

The following figures show the LCL filter fan DC Power Supply wiring diagram with the connections to the AFE power structure and DC bus.

For complete details on LCL fan system information, see the PowerFlex 700H, 700S, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029.

**Figure 10 - LCL Filter Fan DC Power Supply Wiring Diagram (older version)**

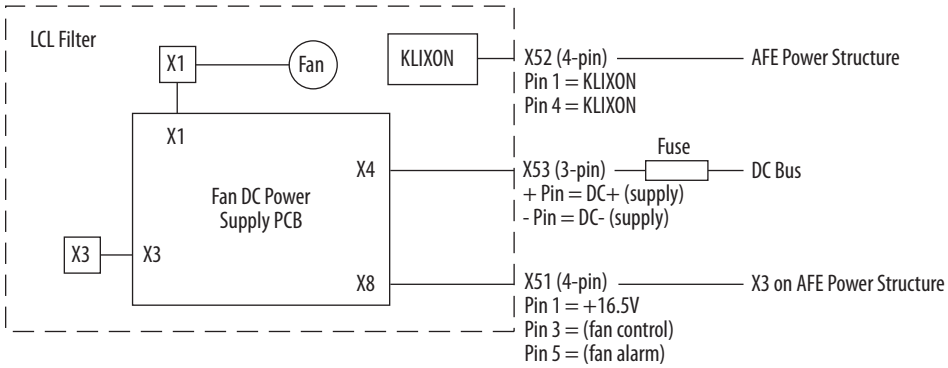
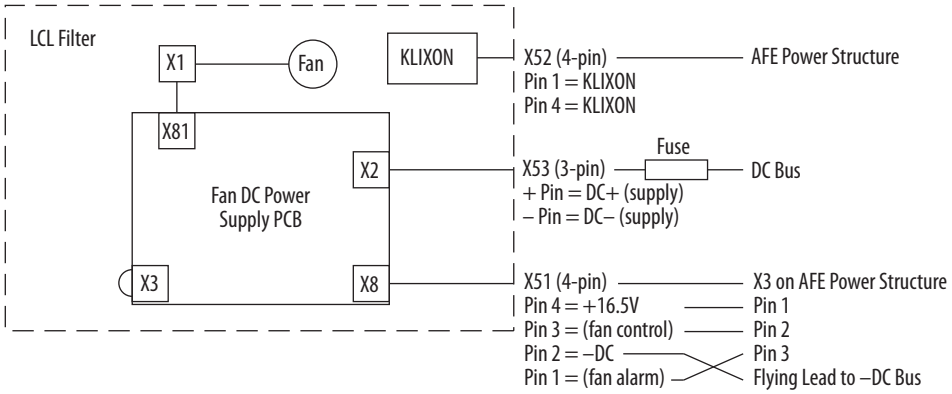
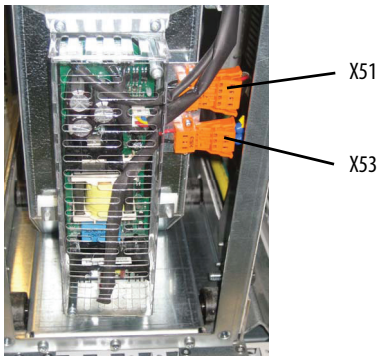



**Figure 11 - LCL Filter Fan DC Power Supply Wiring Diagram (newer version)**




**IMPORTANT** Before doing any work, disconnect the AFE power structure from the AC supply, and wait until the fan stops and the indicators on the keypad turn off. (If a keypad is not attached, see the indicator through the keypad base.) Wait 5 more minutes before doing any work on the DC-to-DC power supply to let it completely discharge. Do not open the cover until after this time has expired.




To remove the LCL filter fan DC power supply, follow these steps.

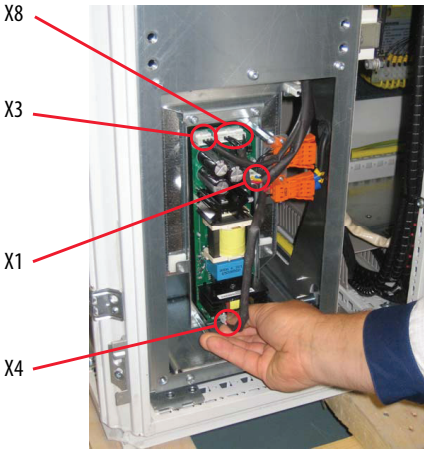
1. Remove the LCL filter protective barriers.

   See Remove the LCL Filter Protective Barriers and Vented Cover on page 7-84.

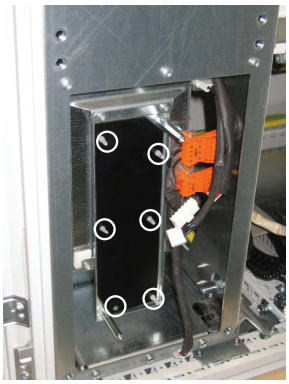
2. Remove the two M4 x 10 mm Pozidriv screws that secure the cover.

3. Remove the cover.

4. Remove the connectors X1, X3, X4, and X8.




5. Remove the six fasteners that secure the DC-to-DC power supply.



## Install the LCL Filter Fan DC Power Supply

Install the DC-to-DC power supply in reverse order of removal. See Torque Specifications on page 36.

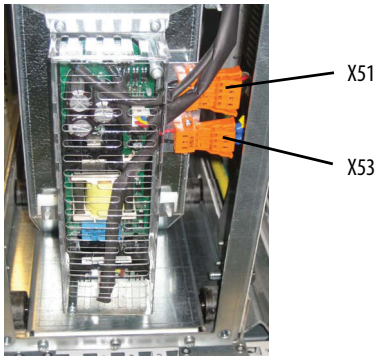
## Replace the LCL Filter Fan

To replace the LCL filter fan, follow these steps.

1. Remove the LCL filter protective barriers.

   See Remove the LCL Filter Protective Barriers and Vented Cover on page 84.

2. Disconnect terminal blocks X51 and X53.




3. Lower the front fan sheet metal edge and slide it forward to remove the alignment studs from their respective holes in the fan frame sheet metal.
4. Slide out the fan assembly.
5. Remove the LCL filter fan DC power supply.

   See Remove the LCL Filter Fan DC Power Supply on page 85.
6. Reinstall the LCL filter fan in reverse order of removal. See Torque Specifications on page 36.

Note the following LCL filter airflow cooling requirements.

| LCL Filter | Required Airflow |
|---|---|
| LCL 460 | 1100 $m^3$/hr |
| LCL 1300 | 1300 $m^3$/hr |

## Remove the LCL Filter

The procedures to remove the LCL filter are different depending on the enclosure in which it is installed.

### From the IP20 2500 MCC Style Enclosure

To remove the LCL filter from an IP20 2500 MCC enclosure, follow these steps.

1. Remove power from the AFE.

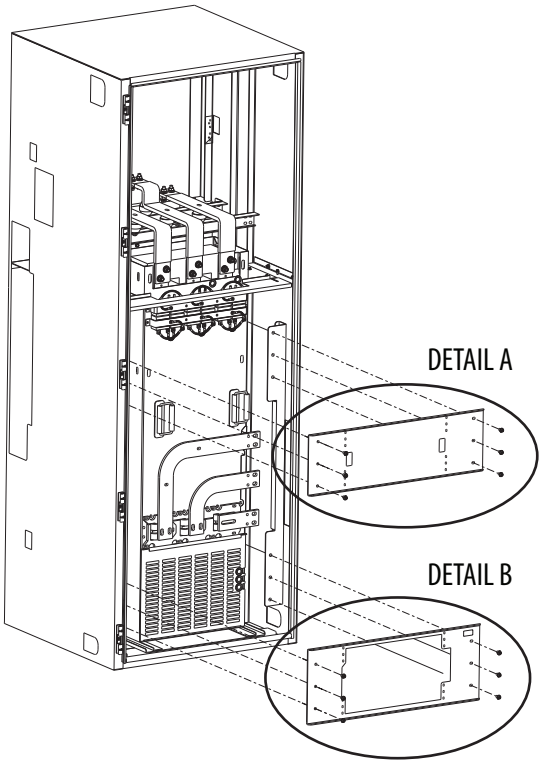
   See Remove Power from the AFE on page 37.
2. Remove the LCL filter protective barriers.

   See Remove the LCL Filter Protective Barriers and Vented Cover on page 84.
3. Remove the airflow plate.

   See Remove the AFE Airflow Plate on page 46.
4. Remove the X51 and X53 terminal blocks from the LCL fan assembly.

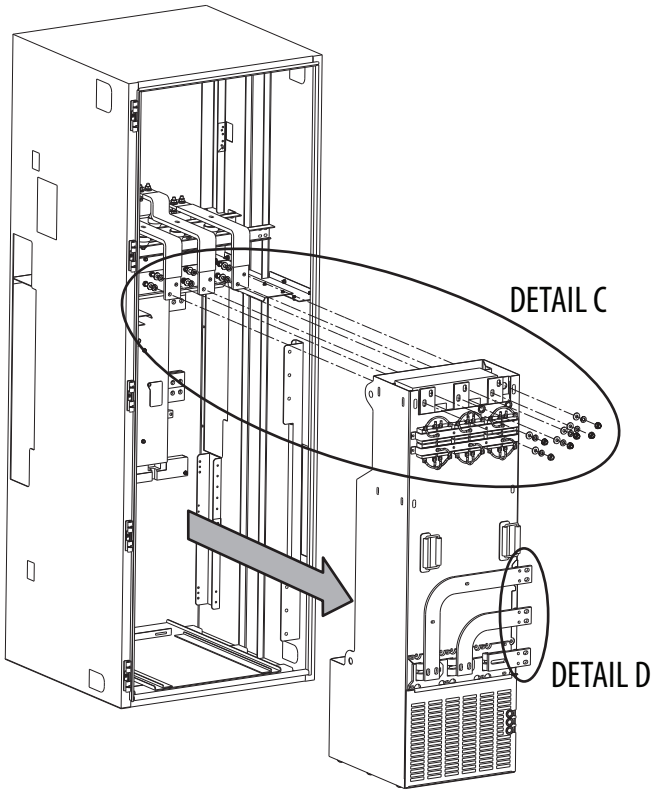
5. Remove the X52 terminal block from the LCL filter assembly (upper-right side).
6. Remove the top and bottom brackets that hold the LCL filter in the enclosure (see Figure 12).
   a. See Detail A and remove the six M8 x 20 screws.
   a. See Detail B and remove the six M8 x 20 screws.

**Figure 12 - Remove LCL Filter from AFE in IP20 2500 MCC Style Enclosure**




7. See Figure 13 on page 90, Detail C, and remove the six M10 x 10 washer hex nuts and associated hardware that secure the input bus bars to the LCL filter.

**Figure 13 - Remove Input Bus Bar Connections**




8. See Figure 13, Detail D and remove the 12 M6 x16 screws that secure the LCL filter output bus bars to the AFE power structure.

**ATTENTION:** The LCL filter is heavy. To avoid personal injury or damage to the equipment, use caution when removing the LCL filter from the enclosure.

9. See Figure 13 and slide the LCL filter out of the enclosure.

**IMPORTANT** Ramps can be required due to enclosure floor mismatch.

## From the IP21 Rittal Enclosure

To remove the LCL filter from an IP21 Rittal enclosure, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.

2. Remove the LCL filter protective barriers.

   See Remove the LCL Filter Protective Barriers and Vented Cover on page 84.

3. Remove the X51 and X53 terminal blocks from the LCL fan assembly.

4. Remove the X52 terminal block from the LCL filter assembly (upper right side).
5. Remove the four T25 Torx self-tapping screws that secure the front bracket that is shown in Figure 9 on page 84.

   This bracket holds the LCL filter in the enclosure.
6. Remove the MCCB-to-LCL filter bus bars (L1, L2, L3).

   For bus bar locations, see Figure 6 on page 24.
7. Remove the LCL filter-to-AFE power structure bus bars (U, V, W).

   For bus bar locations, see Figure 6 on page 24.
8. Disconnect the ground wire from the LCL filter chassis.

**ATTENTION:** The LCL filter is heavy. To avoid personal injury or damage to the equipment, use caution when removing the LCL filter from the enclosure.

9. Slide the LCL filter out of the enclosure.

**IMPORTANT** Ramps can be required due to enclosure floor mismatch.

## Install the LCL Filter in the Enclosure

Install the LCL filter in reverse order of removal. See Torque Specifications on page 36.

## Notes:

# DC Fuses Component Section

**ATTENTION:** To avoid an electric shock hazard, verify that all power to the PowerFlex® Active Front End has been removed before you perform any service or repairs.

**ATTENTION:** To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC Board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

**ATTENTION:** Hot surfaces can cause severe burns. Do not touch the heatsink surface during operation of the PowerFlex Active Front End. After you disconnect power, allow time for cooling.

**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

**ATTENTION:** The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

## Overview

An AFE system in an IP20 2500 MCC Style enclosure or IP21 Rittal enclosure contains the protective DC bus fuses.

**IMPORTANT** For PowerFlex AFE systems in the IP00 open chassis configuration, you must supply the output fuses.

See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for the DC bus output fusing recommendations.

## Fuse Replacement Guidelines

DC bus fuses are required for short circuit protection. Table 7 and Table 8 list the recommended DC bus fuses.

**Table 7 - 400/480 Volt DC Fusing**

| Frame Size | AFE Enclosure Style | Fuse | | |
|---|---|---|---|---|
| | | Amps | Bussman Type | Ferraz Shawmut Type |
| 13 | IP20 2500 MCC | 1100 | 170M6499 | — |
| | IP21 Rittal | 1100 | — | PC73UD95V11CTF |
| | | 1250 | 170M6566 | — |

**Table 8 - 600/690 Volt DC Fusing**

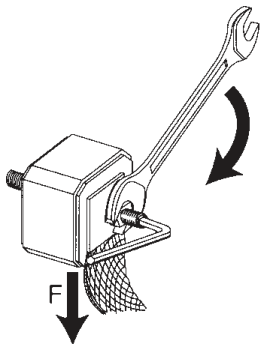
| Frame Size | AFE Enclosure Style | Fuse | | |
|---|---|---|---|---|
| | | Amps | Bussman Type | Ferraz Shawmut Type |
| 13 | IP20 2500 MCC | 630 | 170M6454 | — |
| | IP21 Rittal | 630 | — | PC73UD13C630TF |
| | | 700 | 170M6305 | — |

To replace the fuses, follow these steps.

1. Remove power from the AFE.

   See Remove Power from the AFE on page 37.
2. Open the power structure enclosure door.
3. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.
4. Remove and discard the blown fuse.
5. Insert the fuse body between the bus bars.
6. Turn the threaded rod into the fuse body.
7. Place the Belleville (domed) washer and hexagonal nut on the threaded rod and hand tighten.
8. Hold the threaded rod with the hex key while tightening the nut to the specified torque.




| Stud Type | Stud Tightening Torque, Max | Nut Tightening Torque, Max |
|---|---|---|
| M8 x 30<br>M8 x 35 | 10 N•m<br>(88.5 lb•in) | 13.5 N•m<br>(132.8 lb•in) |
| M10 x 30<br>M10 x 50 | 15 N•m<br>(132.8 lb•in) | 26 N•m<br>(230.1 lb•in) |
| M12 x 35<br>M12 x 50 | 15 N•m<br>(132.8 lb•in) | 46 N•m<br>(407.1 lb•in) |
| M12 x 40 | 15 N•m<br>(132.8 lb•in) | 46 N•m<br>(407.1 lb•in) |

**IMPORTANT** Do not apply torque or twisting force to the fuse body. Too much force can damage the fuse.

For information about Bussmann fuses, click this link:

http://www.cooperindustries.com.

For information about Ferraz Shawmut fuses, click this link:

http://www.ferrazfuses.com.

## Notes:

# Startup After Repair

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC Board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

**ATTENTION:** Power must be applied to the PowerFlex® Active Front End to perform the following start-up procedure. Some of the voltages present are at incoming line potential.

To avoid electric shock hazard or damage to equipment, only qualified service personnel can perform the following procedure.

Thoroughly read and understand the procedure before beginning.

During startup, if one of these pre-powerup checks reveals a concern, do not proceed. Remove power, including user-supplied control voltages.

User-supplied voltages can exist even when main AC power is not applied to the PowerFlex Active Front End. Correct the malfunction before continuing.

## Technical Support

See the back cover for Rockwell Automation support contact information.

Be prepared to provide the following information when you contact Allen-Bradley® drives technical support:

- Product catalog number
- Product serial number
- Firmware revision level

## Before Applying Power to the AFE

1. Open the power structure enclosure door.
2. If present, remove the protective barriers.

   See Remove AFE Protective Barriers on page 44.
3. Check for zero volts between DC+ and DC-.
4. Use a digital multimeter to perform forward and reverse biased diode tests.

   See Perform Forward and Reverse Biased Diode Tests for Power Structure on page 29.
5. Confirm that all wiring to the AFE (AC input, ground, DC bus, and I/O) is connected to the correct AFE terminals, and is secure.

6. Verify that AC line power at the disconnect device is within the rated value of the AFE.
7. Verify that the control power voltage is correct.
8. Whenever possible, isolate the AFE from the rest of the DC bus system to enable the AFE to be powered separately.

# Service Tools and Equipment

## Software Tools

Connected Components Workbench™ software, DriveExecutive™ software, or DriveExplorer™ software are tools that can be used to upload, download, and monitor system parameters

## Service Tools

This table lists the basic tools that are needed for repair and maintenance.

| Item | Description | Details |
|---|---|---|
| 1 | Oscilloscope | Portable, digitizing, dual-channel scope with isolation |
| 2 | Current clamp | 1000 A (AC, rms), signal output |
| 3 | High-voltage differential probe | P5210 or equivalent |
| 4 | Soldering station | Soldering / de-soldering |
| 5 | Flash light | — |
| 6 | Multi-meter | Digital multimeter, capable of AC and DC voltage, continuity, resistance, capacitance measurements, and forward diode bias tests. Fluke Model 87 III or equivalent. |
| 7 | Insulation tester | 1000V DC |
| 8 | Torque wrench | 1…12 N•m |
| 9 | Torque wrench | 6…50 N•m |
| 10 | Box wrench | 7 mm, 8 mm, 10 mm, 13 mm, 17 mm, 19 mm, 22 mm |
| 11 | Socket extension | 230 mm |
| 12 | Wrench | 7 mm, 8 mm, 10 mm, 13 mm, 17 mm, 19 mm, 22 mm |
| 13 | Allen wrench | — |
| 14 | Wire cutter | — |
| 15 | Needle-nose pliers | — |
| 16 | Crimping tools | For cable terminals 1, 5…240 |
| 17 | Angle wrench | — |
| 18 | Screwdriver | 7 x 2 mm |
| 19 | Pozidriv screwdriver | #1, #2, #3 |
| 20 | Phillips screwdriver | #1, #2, #3 |
| 21 | Torx screwdriver | #25 |
| 22 | Hexagonal wrench | #4, #5, #6 |
| 23 | ESD-protected place of work | Working surface, floor covering, seat, and ground connections |
| 24 | ESD-protective clothing | Wrist wrap, shoes, overall clothing (coat) |
| 25 | Power supply (service) | Capacity of three-phase service 400/500/690V AC, 30 A |
| 26 | 20-MAINSTND maintenance stand | Maintenance stand for removing power structure from AFE enclosure |
| 27 | Fiber-optic repair kit | Agilent HFBR-4593 Polishing Kit, consisting of a Polishing Fixture, 600 grit abrasive paper, and 3 mm pink lapping film (3M Company, OC3-14).<br>For Agilent HFBR-4532 latching connectors and HFBR-RL cable. See Agilent publications 5988-9777EN and 5988-3625EN. |

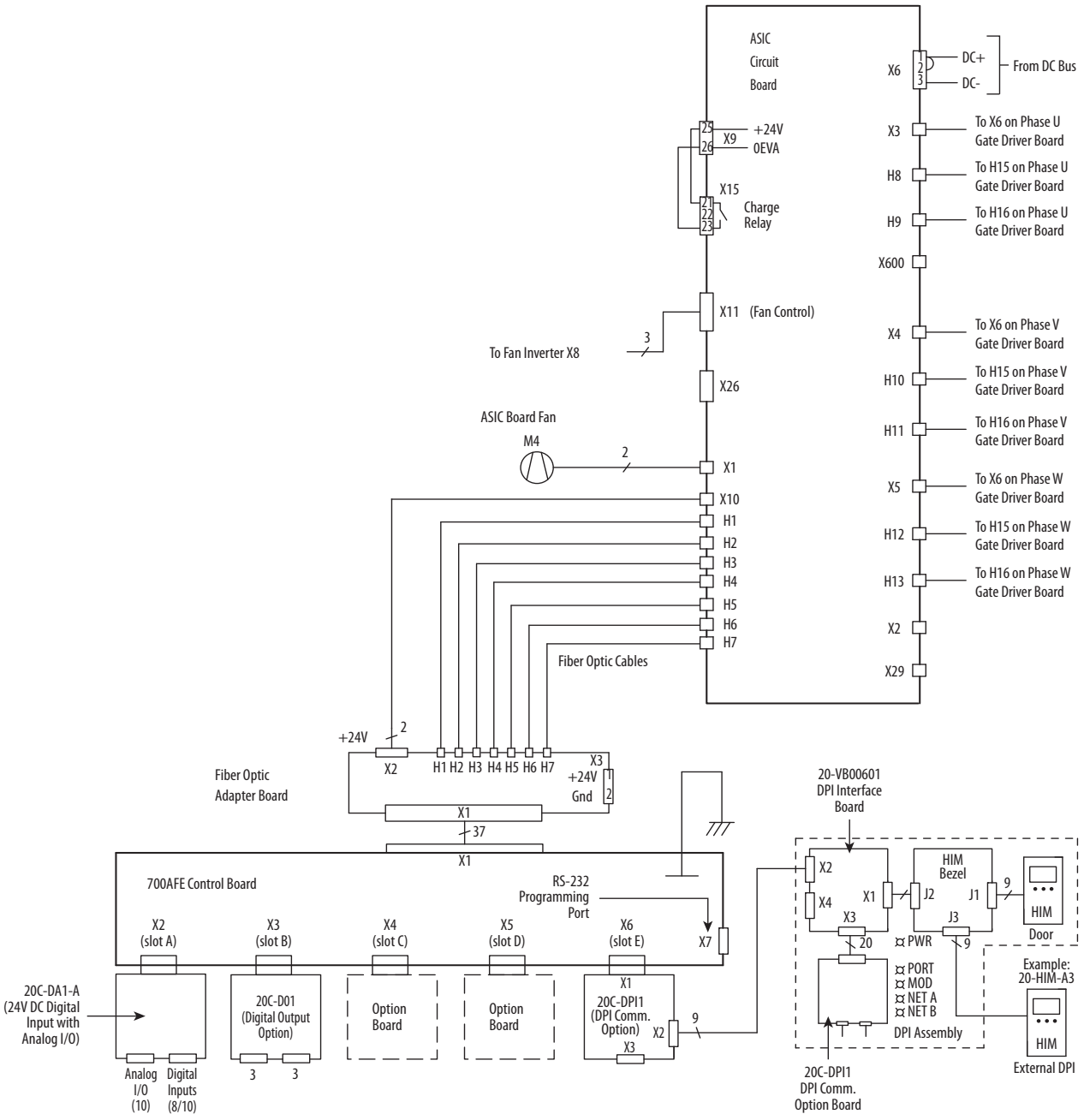
## Notes:

# Schematic Diagrams

## Frame 13 Circuit Board Connections

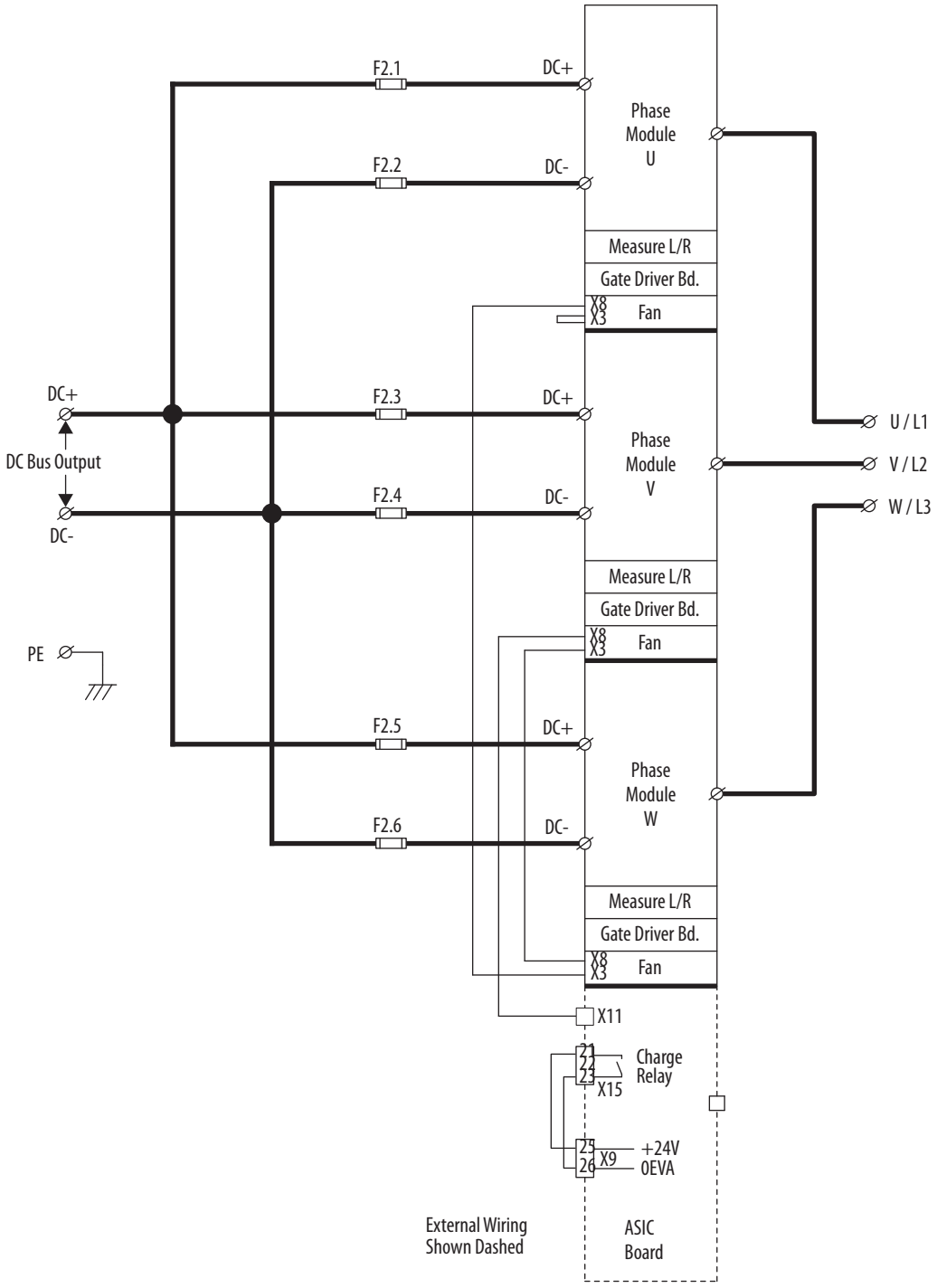
This section provides schematic diagrams.

**Figure 14 - Frame 13 Circuit Board Connections**



# Frame 13 Power Structure Power Circuitry Block Diagram

**Figure 15 - Frame 13 Power Structure Power Circuitry Block Diagram**



# Frame 13 Power Module Circuitry

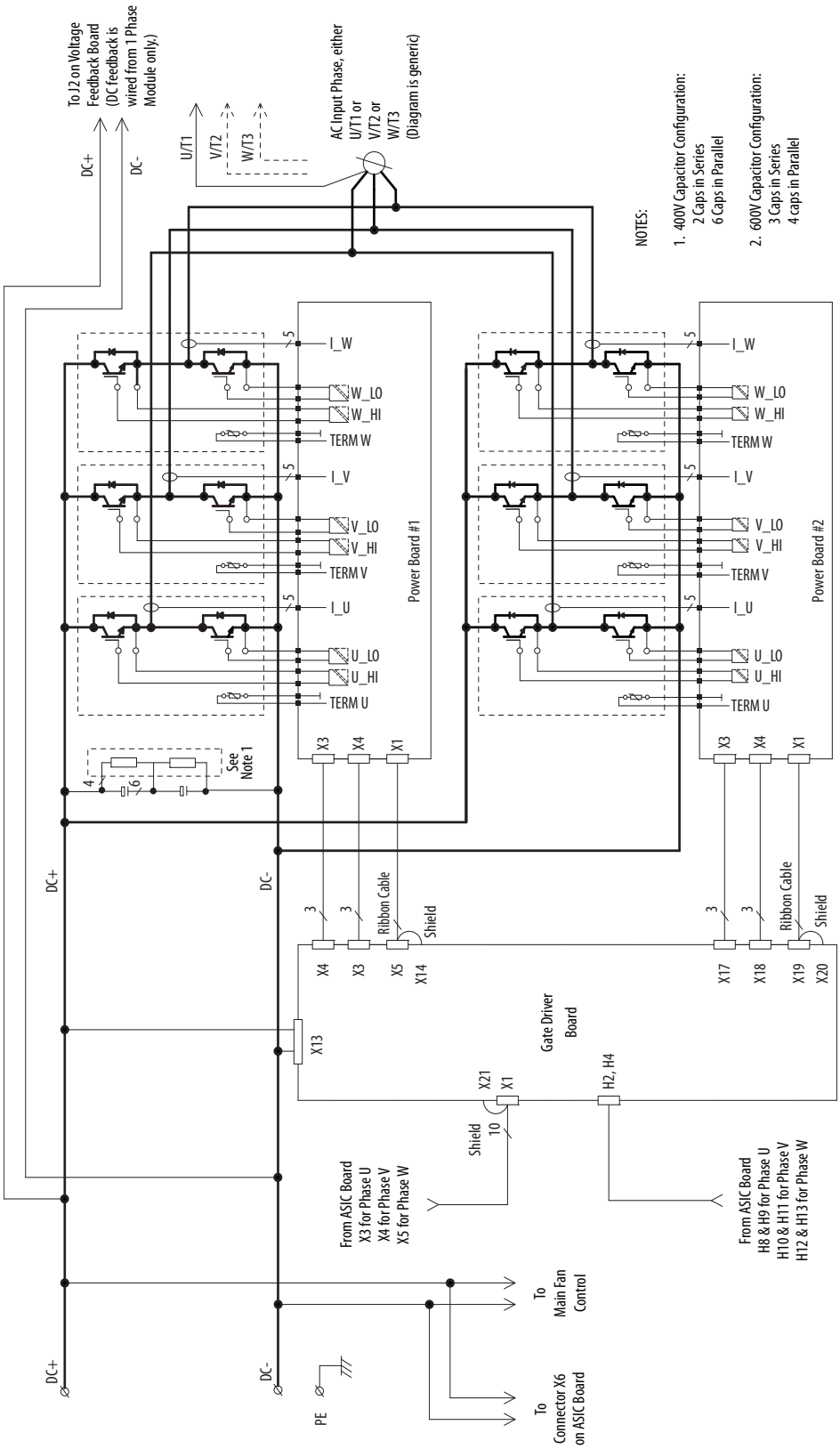



**Figure 16 - Frame 13 Power Module Circuitry**

# Frame 13 Power Structure Main Fan Connections

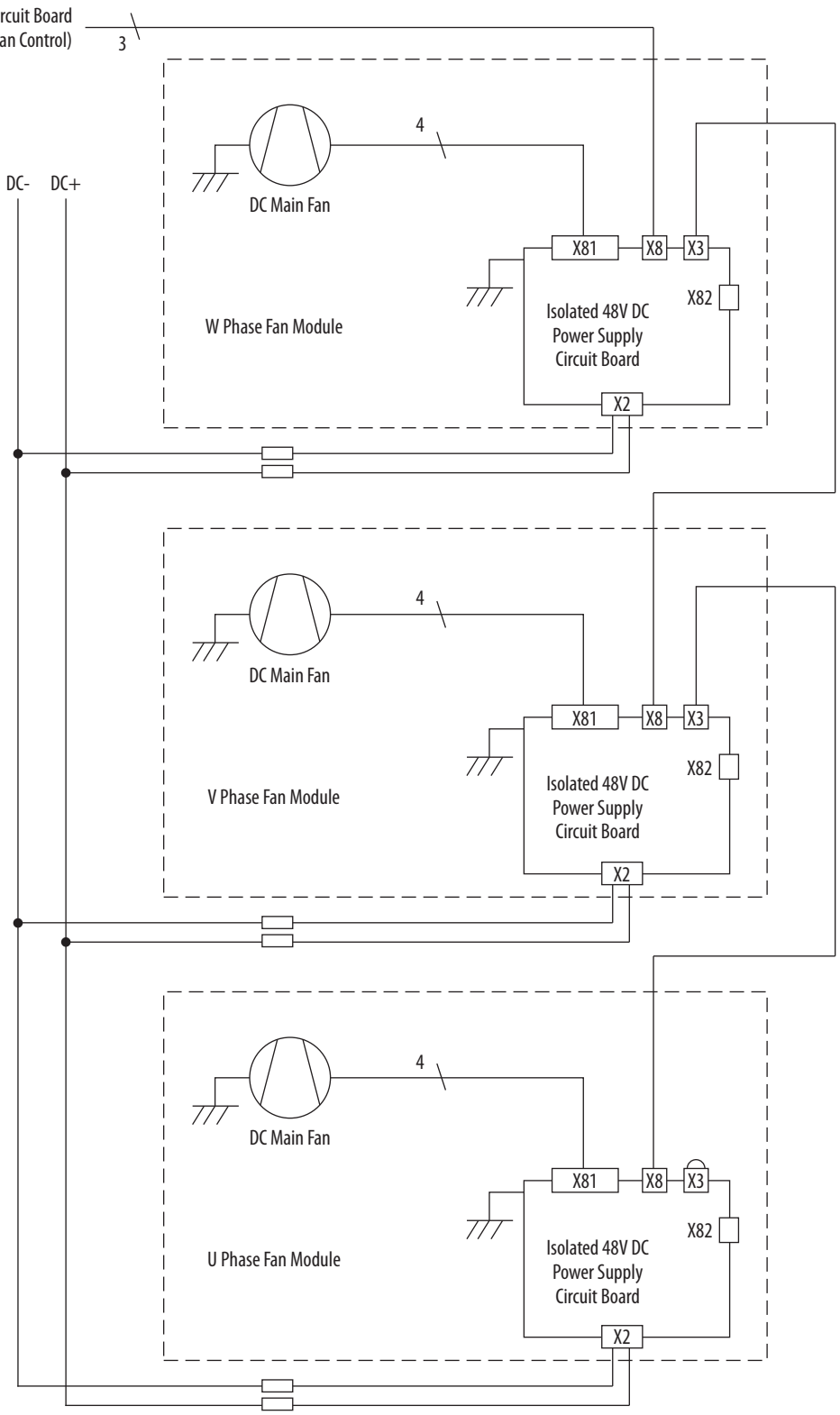



**Figure 17 - Frame 13 Power Structure Main DC Fan Connections – newer version**

# Frame 13 Power Structure Main Fan Connections

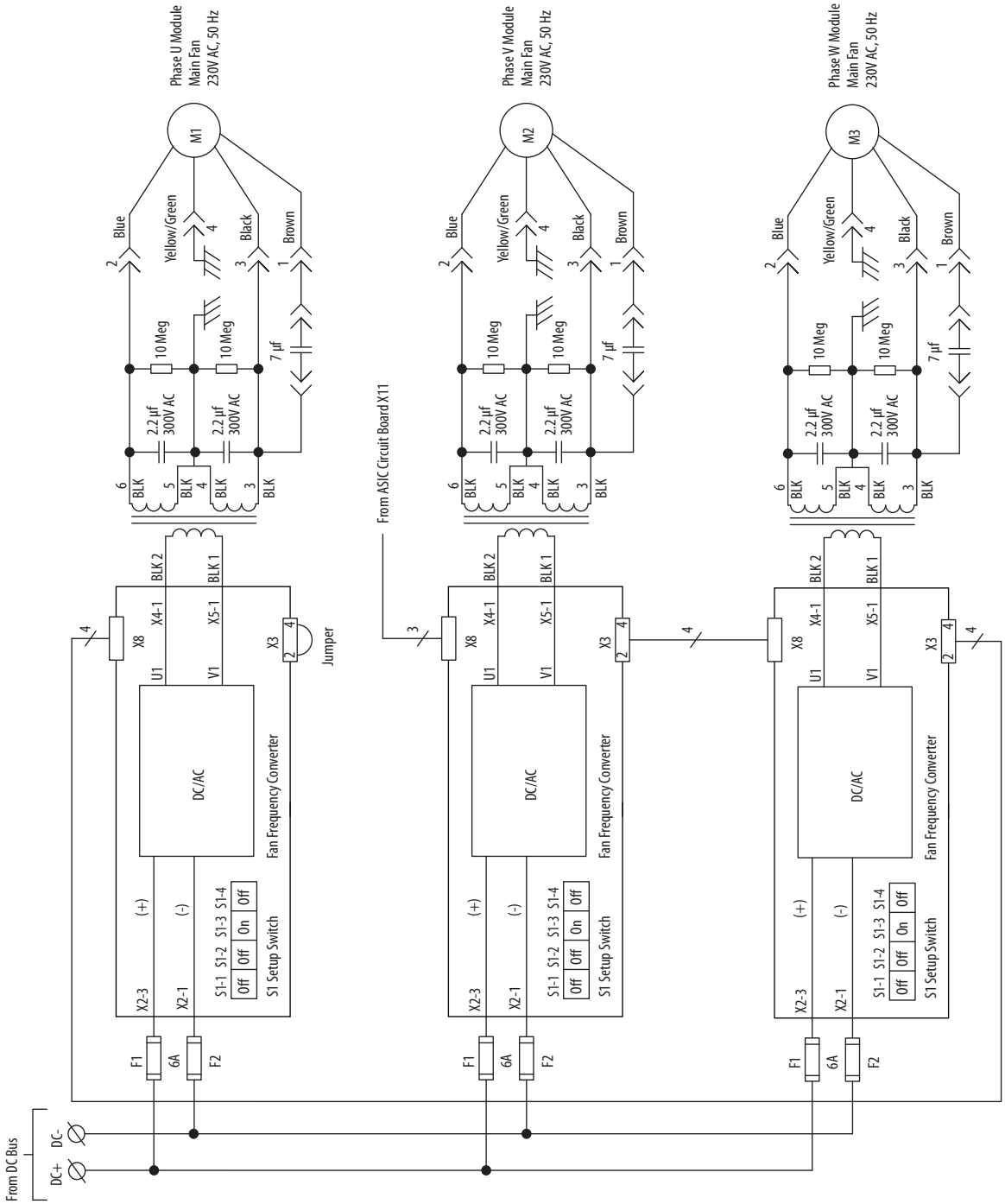



**Figure 18 - Frame 13 Power Structure Main AC Fan Connections – older version**

# Control Wiring Diagram for Frame 13 in IP20 2500 MCC Style Enclosure

**Figure 19 - Control Wiring Diagram for Frame 13 in IP20 2500 MCC Style Enclosure**

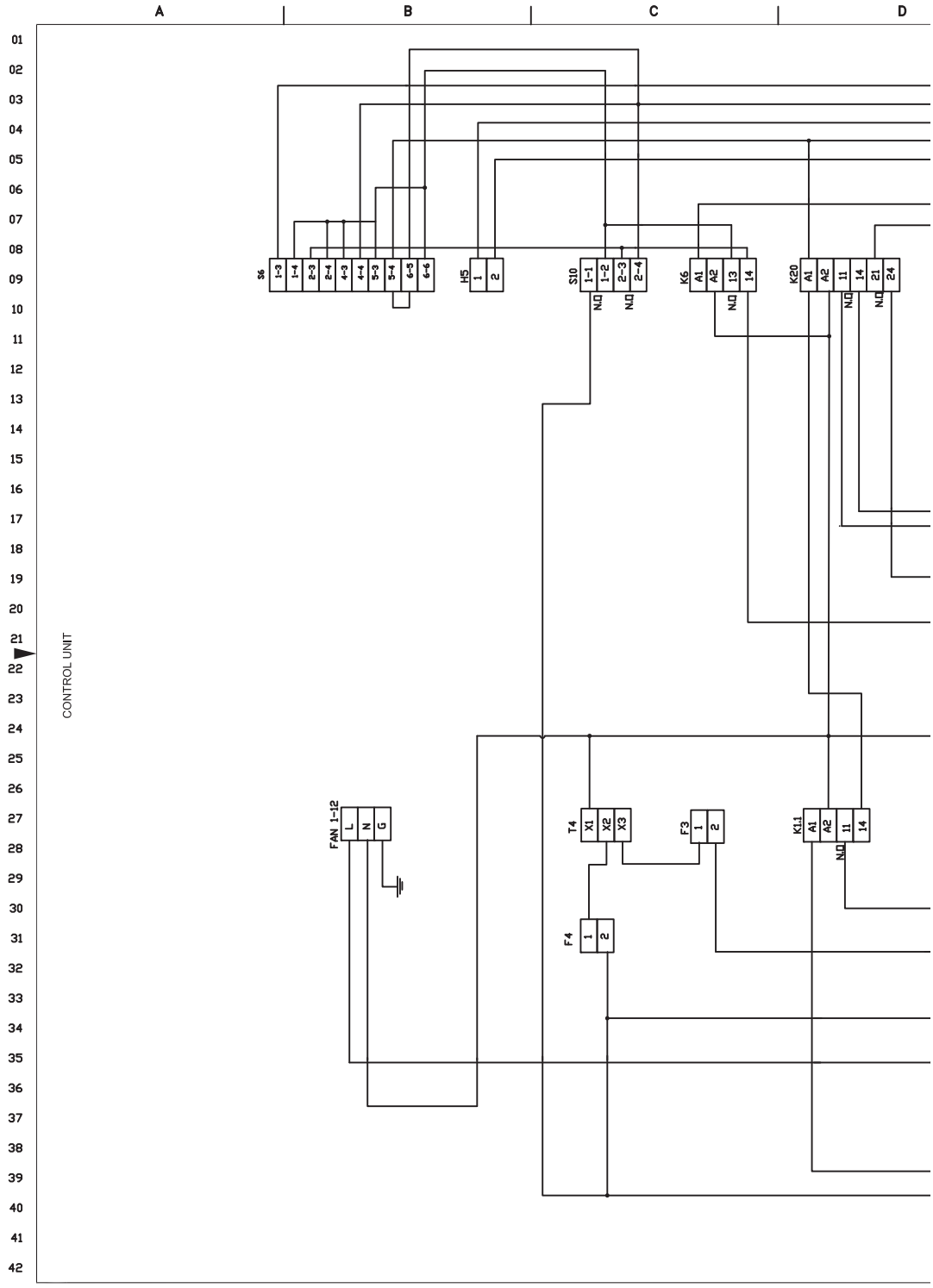
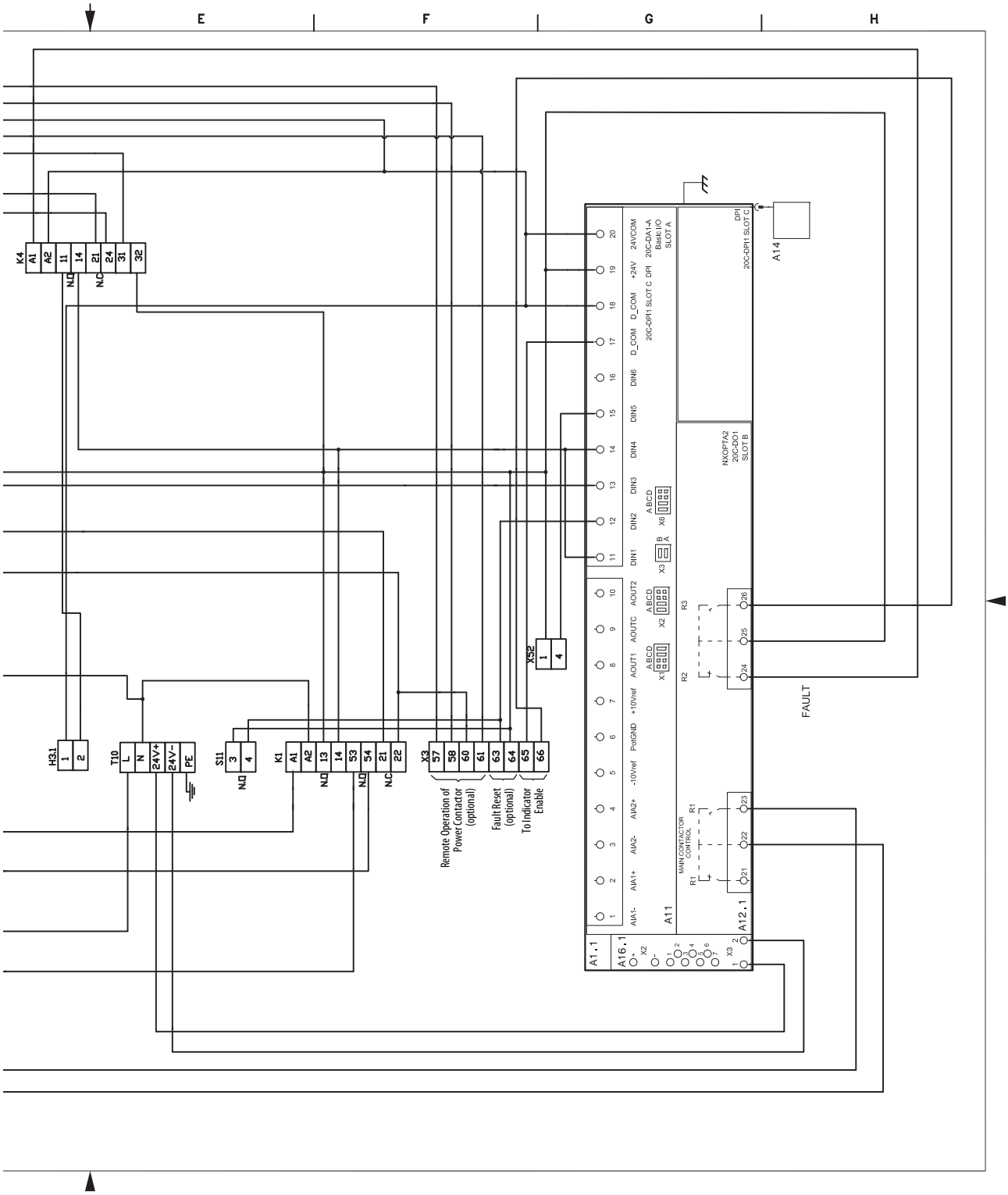


**Figure 20 - Control Wiring Diagram for Frame 13 in IP20 2500 MCC Style Enclosure (continued)**



## System Schematics for Frame 13 in IP20 2500 MCC Style Enclosure

The following system schematics are for the AFE Frame 13 in an IP20 2500 MCC Style enclosure. The PowerFlex® AFE catalog number has an enclosure code of P for standard color (or W for optional gray color) as shown in the example catalog string. For other enclosure designs, contact the supplier of the system for the system schematics.

| | Position | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1…3 | 4 | 5…7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| **20Y** | **D** | **1K3** | **P** | **0** | **A** | **N** | **N** | **A** | **N** | **A** | **0** |
| *a* | *b* | *c* | *d* | *e* | *f* | *g* | *h* | *i* | *j* | *k* | *l* |

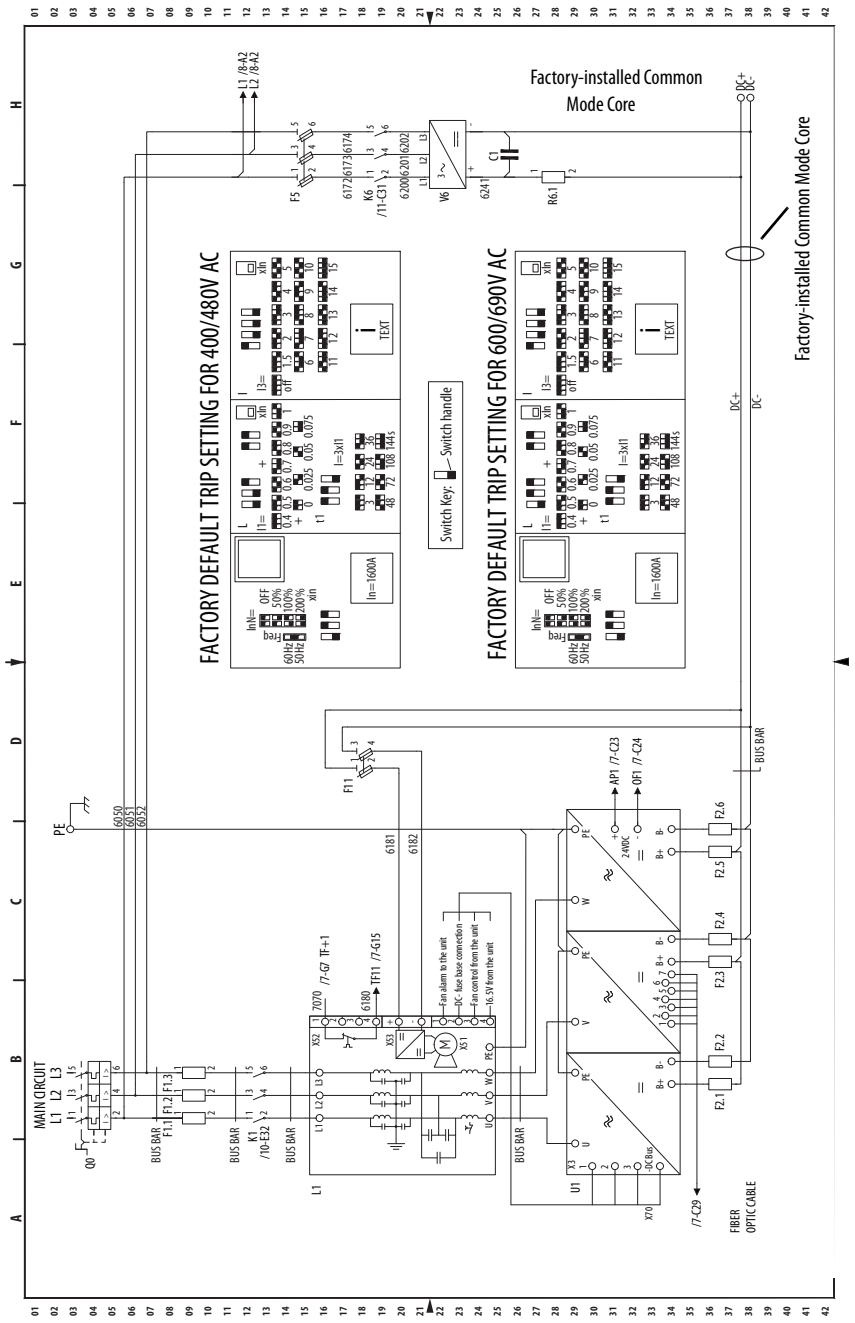



**Figure 21 - Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 6 (400/480V and 600/690V)**

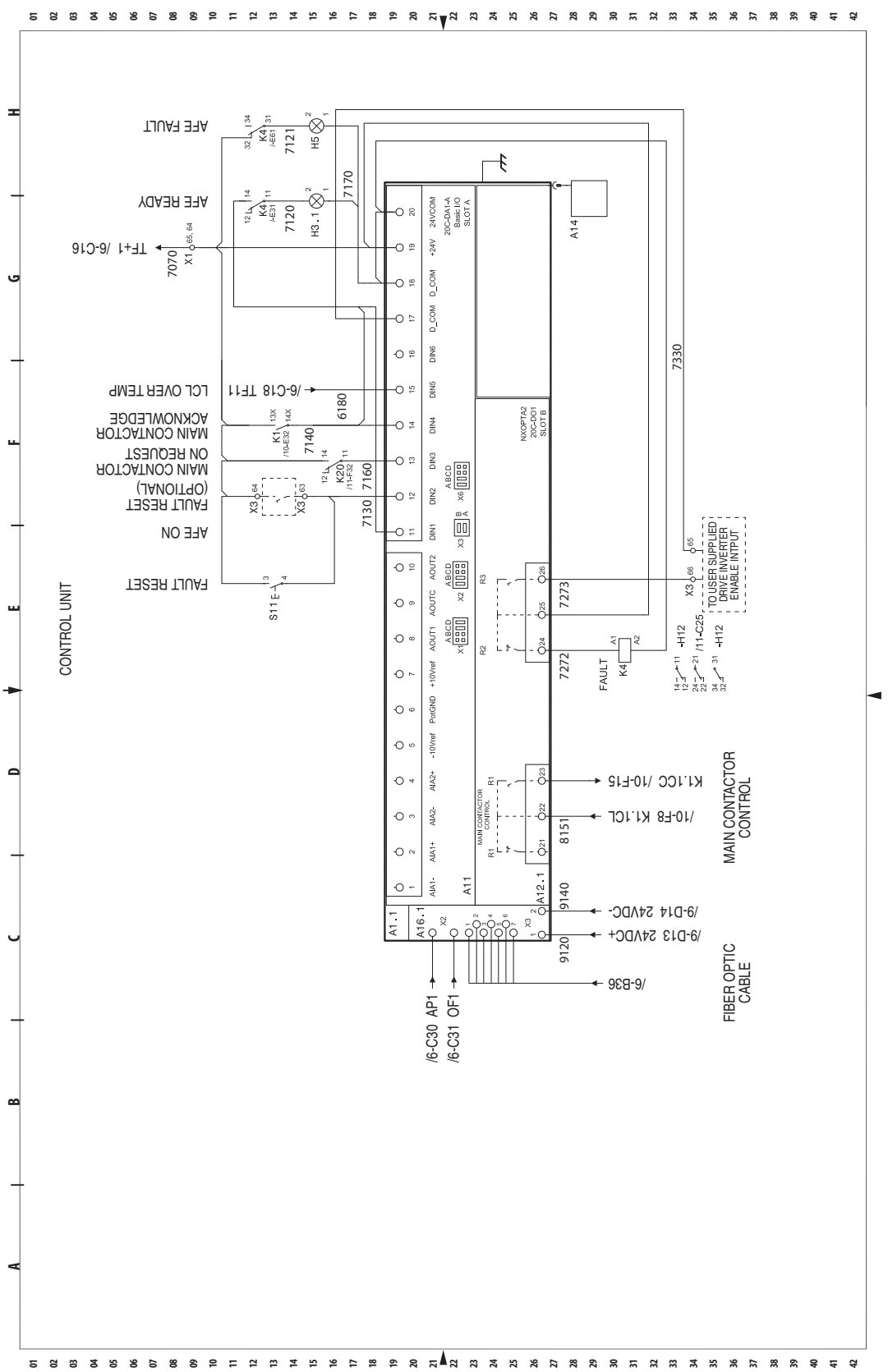



**Figure 22 - Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 7 (400/480V and 600/690V)**

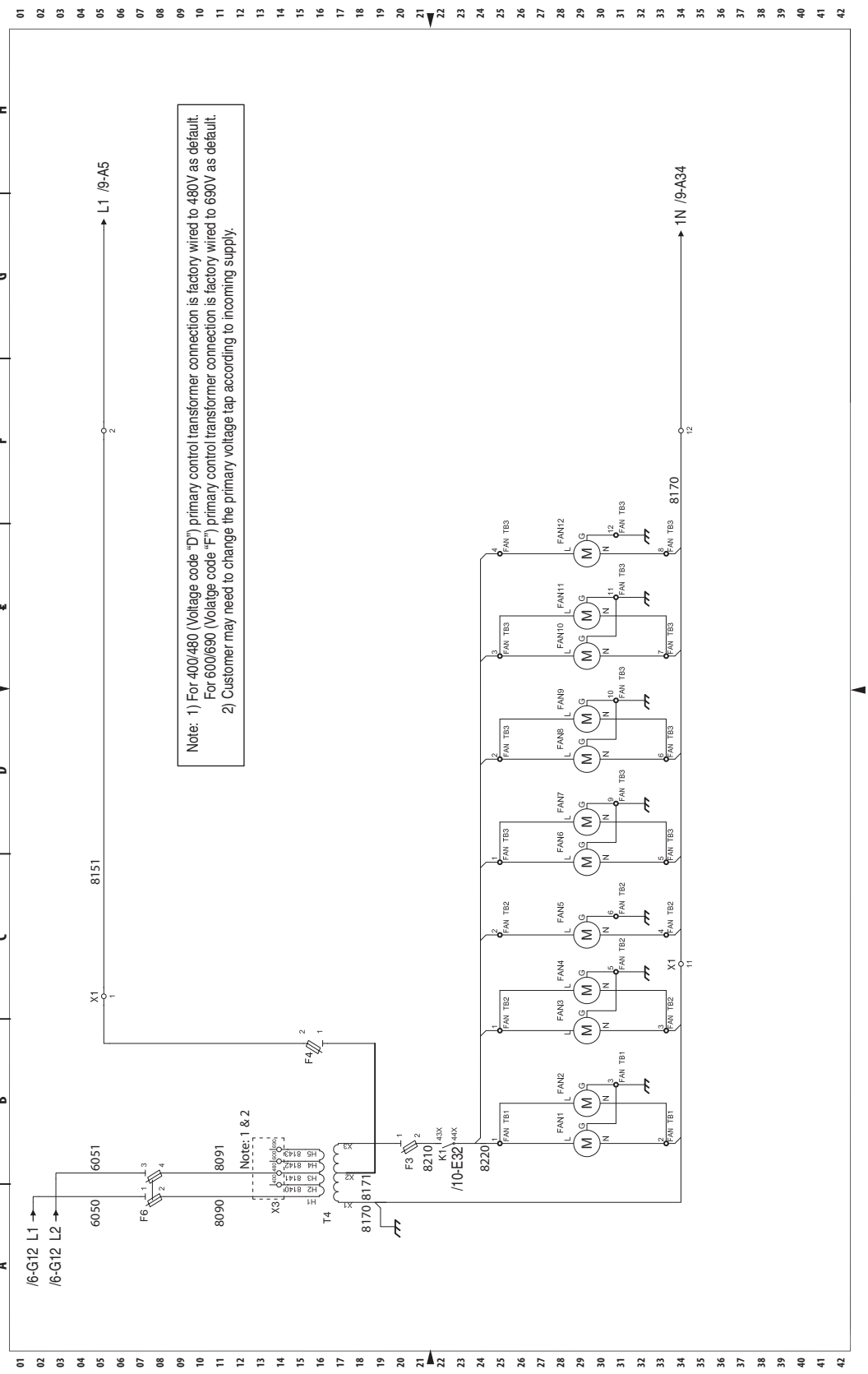



**Figure 23 - Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 8 (400/480V and 600/690V)**

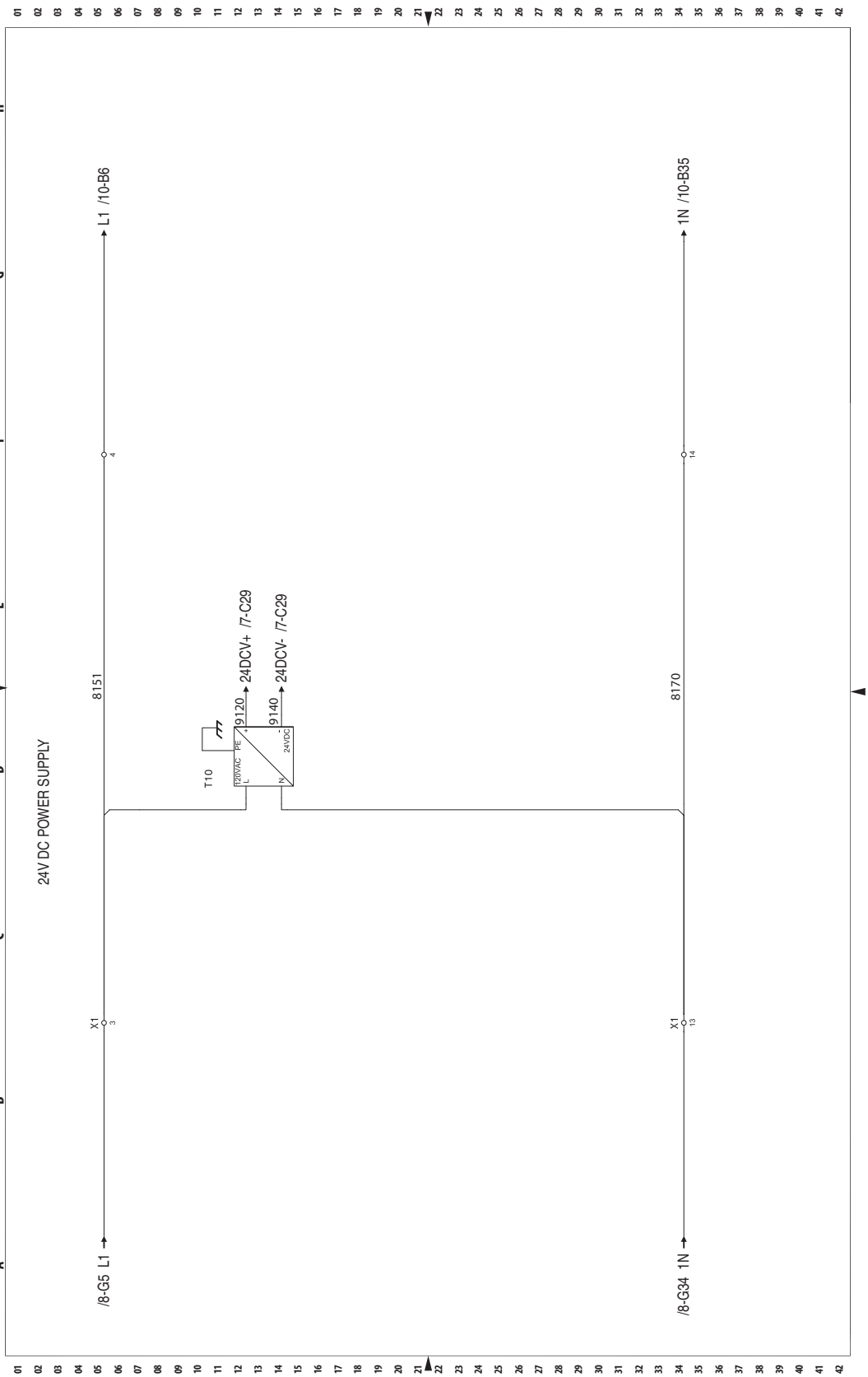



**Figure 24 - Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 9 (400/480V and 600/690V)**

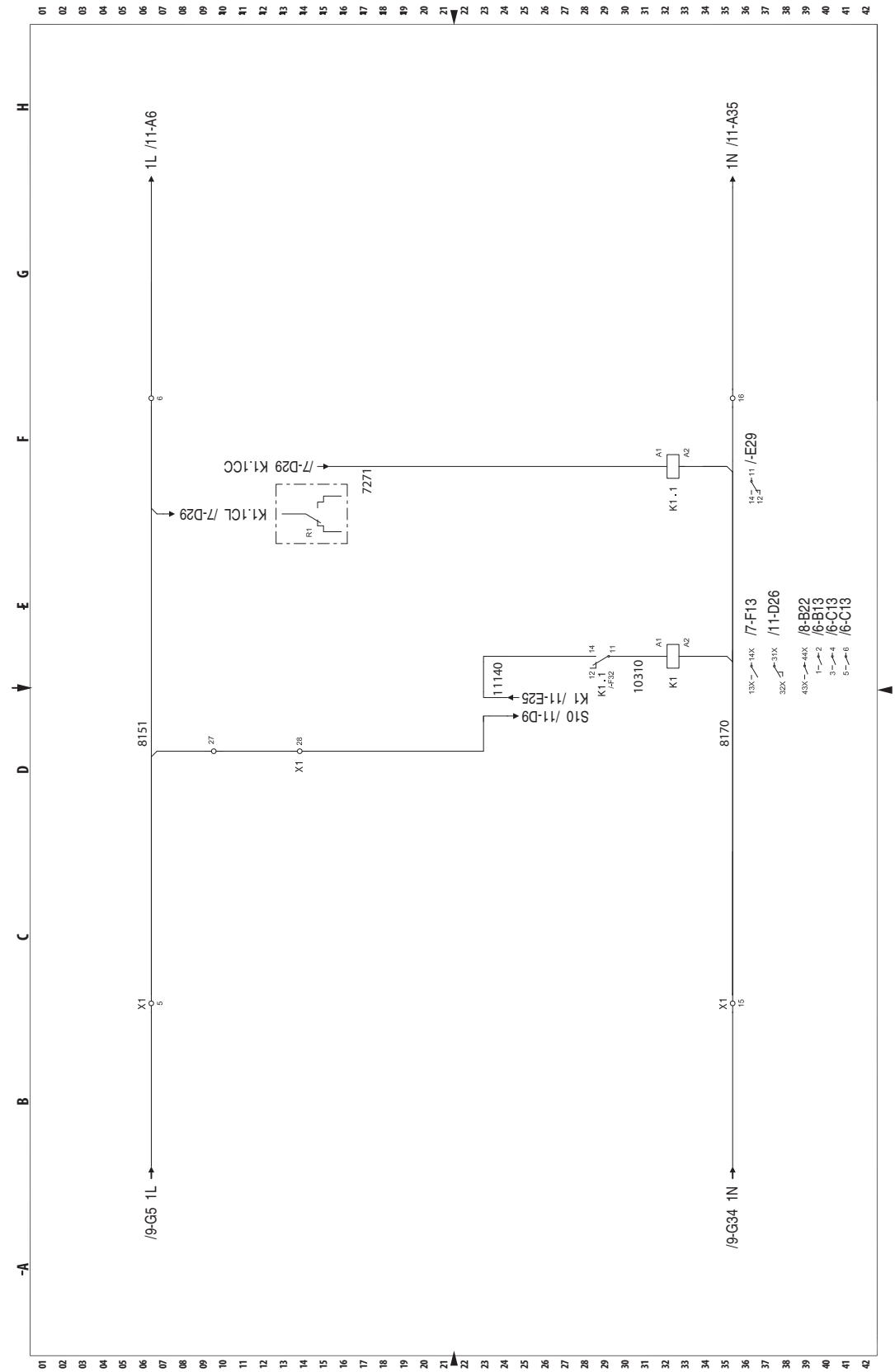



**Figure 25 - Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 10 (400/480V and 600/690V)**

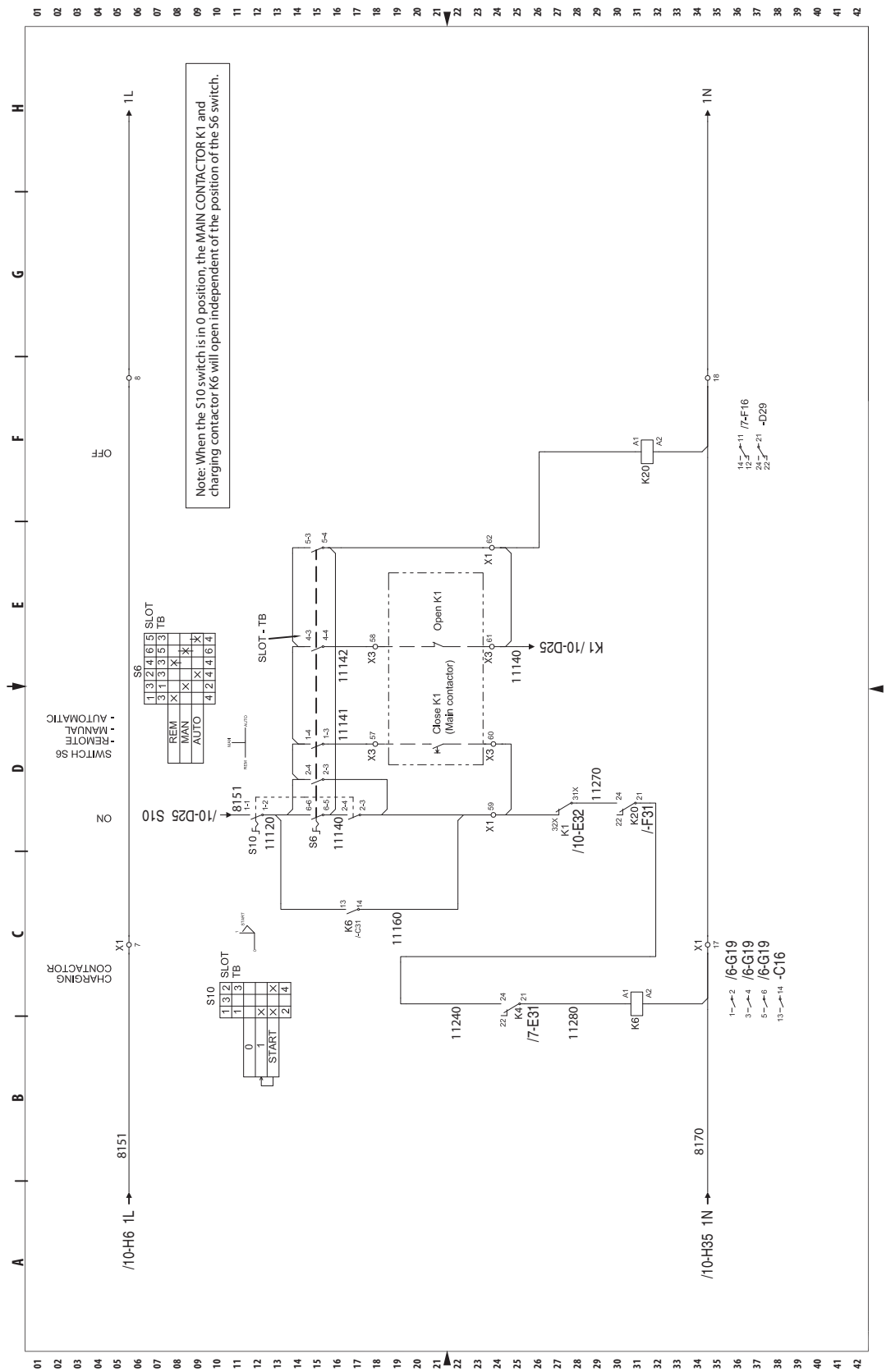



**Figure 26 - Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 11 (400/480V and 600/690V)**

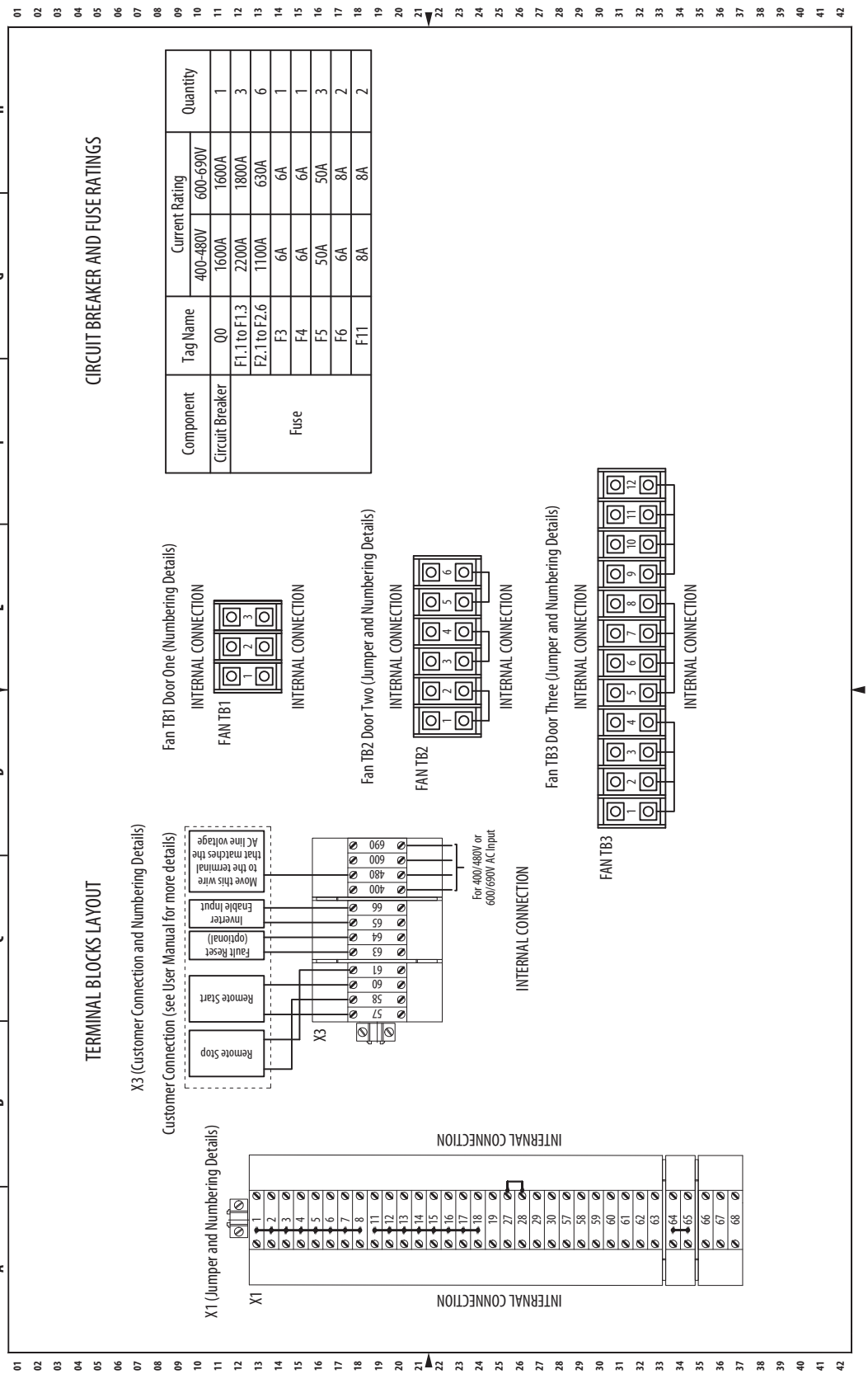
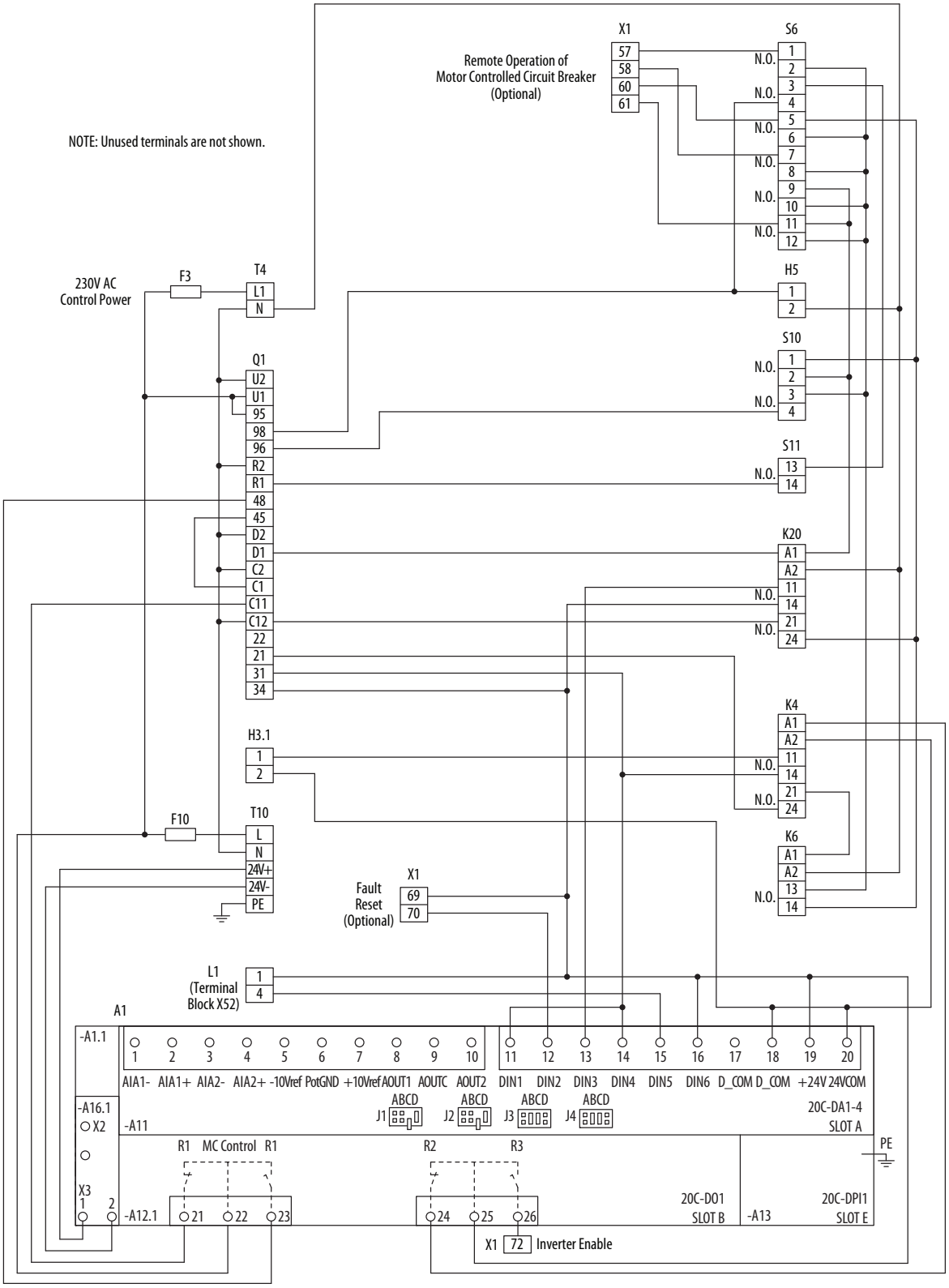



**Figure 27 - Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 12 (Terminal Block Layout, and Circuit Breaker and Fuse Ratings**

# Control Wiring Diagram for Frame 13 in IP21 Rittal Enclosure

**Figure 28 - Control Wiring Diagram for Frame 13 in IP21 Rittal Enclosure**



## System Schematics for Frame 13 in IP21 Rittal Enclosure

The following system schematics are for the Frame 13 AFE in an IP21 Rittal enclosure. The PowerFlex AFE catalog number has an enclosure code of A as shown in the example catalog string. For other enclosure designs, contact the supplier of the system for the system schematics.

| | | | Position | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1…3 | 4 | 5…7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| **20Y** | **D** | **1K3** | **A** | **0** | **A** | **N** | **N** | **A** | **N** | **A** | **0** |
| *a* | *b* | *c* | *d* | *e* | *f* | *g* | *h* | *i* | *j* | *k* | *l* |

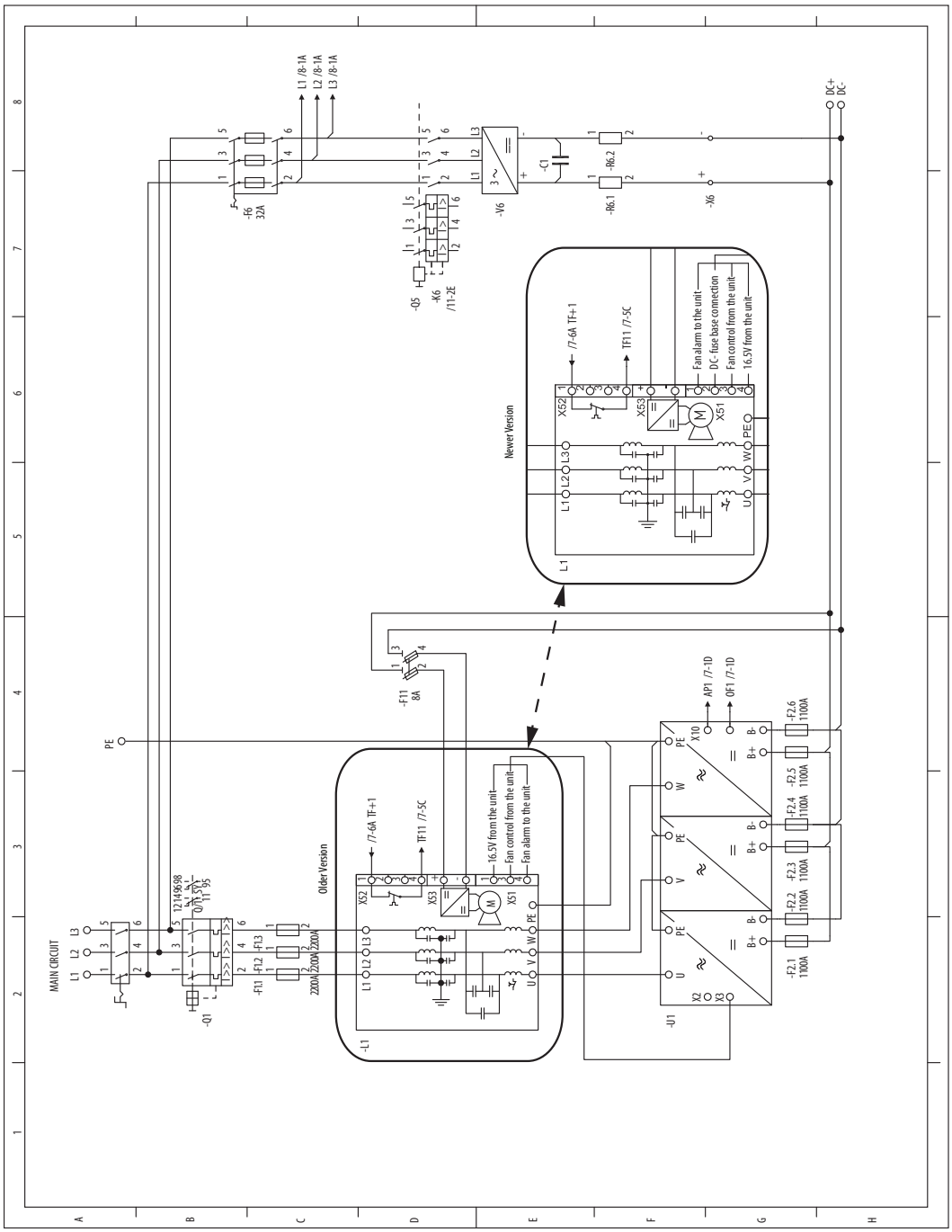



**Figure 29 - Frame 13 in IP21 Rittal Enclosure – Sheet 6 (400/480V and 600/690V)**

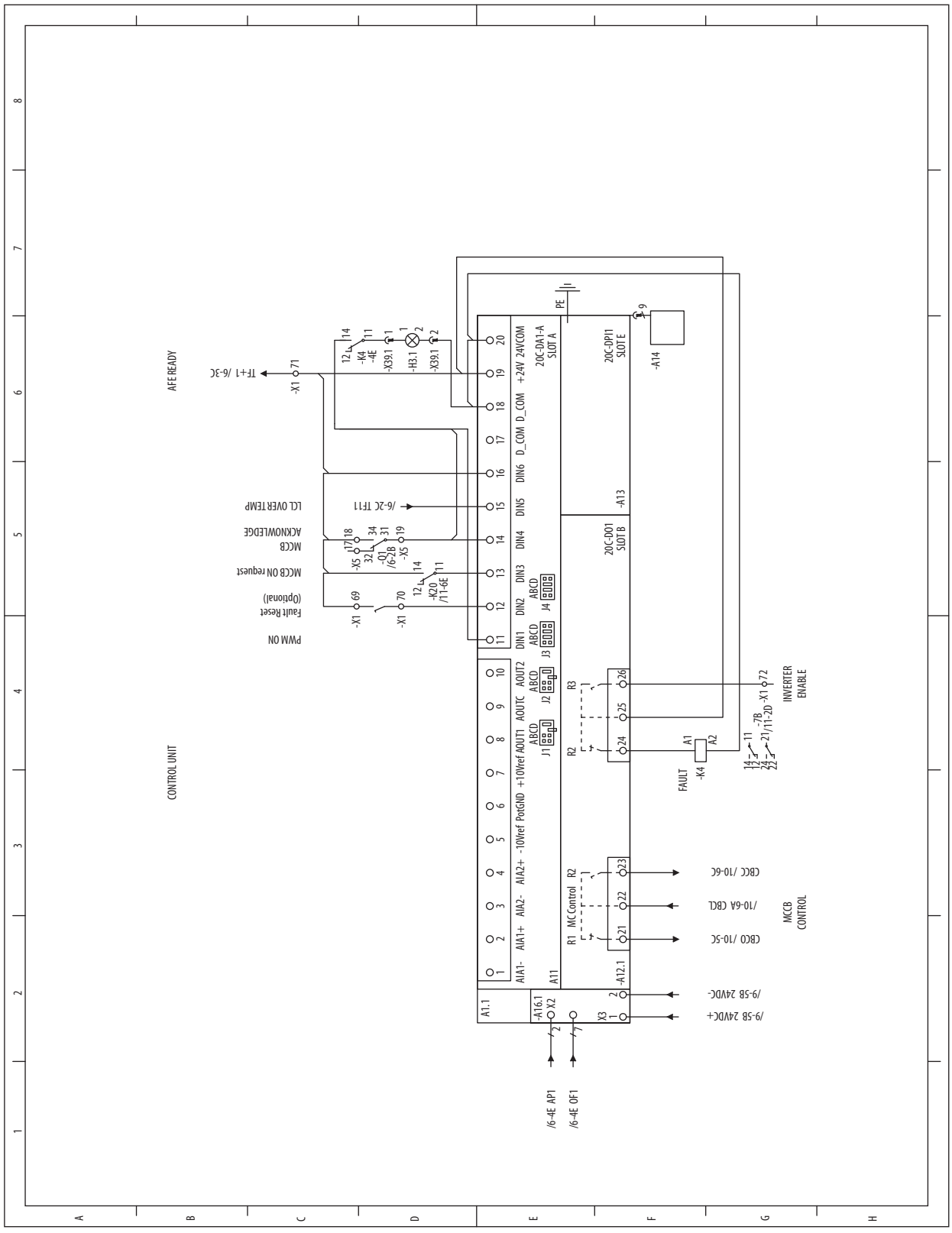



**Figure 30 - Frame 13 in IP21 Rittal Enclosure – Sheet 7 (400/480V and 600/690V)**

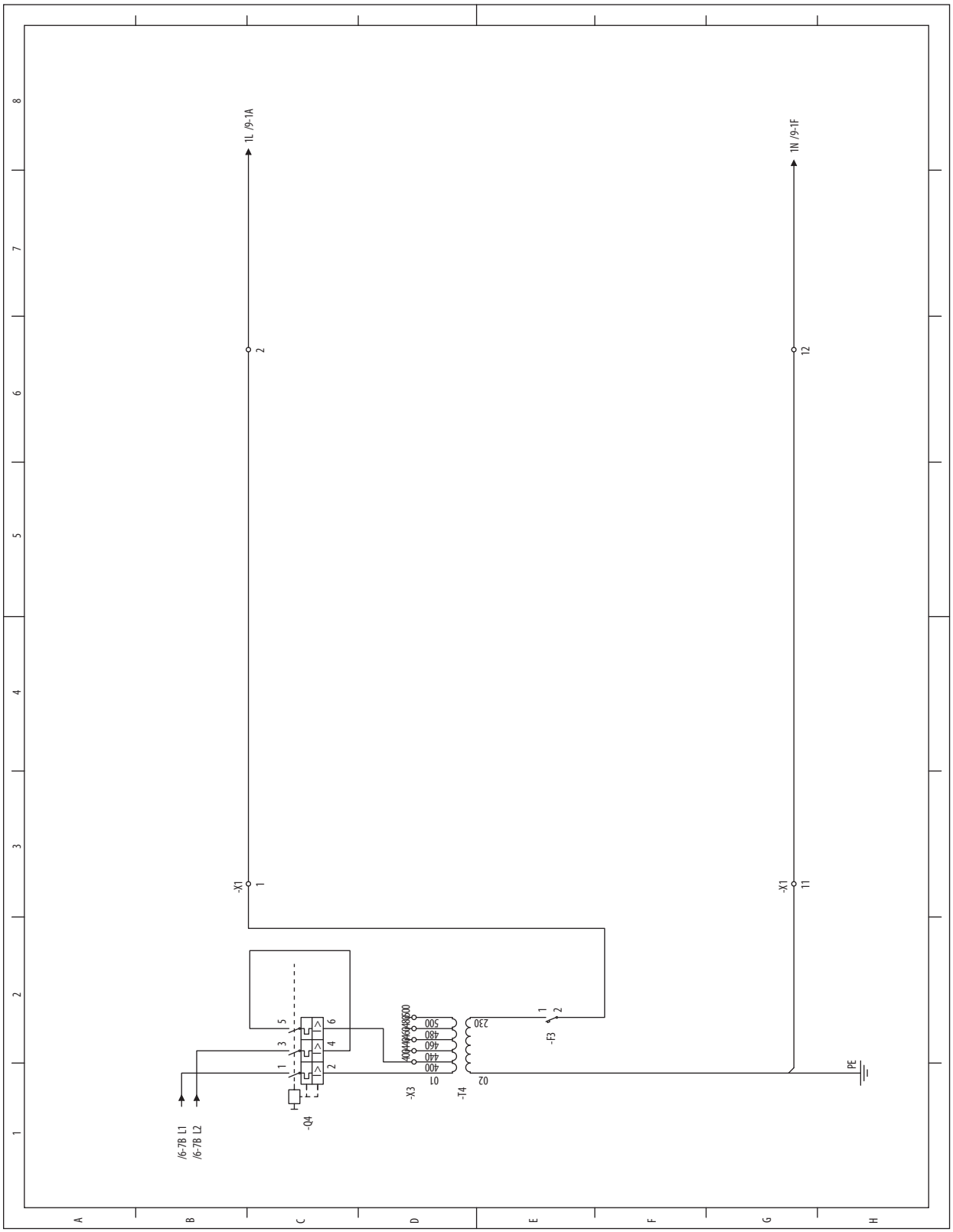



**Figure 31 - Frame 13 in IP21 Rittal Endosure – Sheet 8A (only 400/480V)**

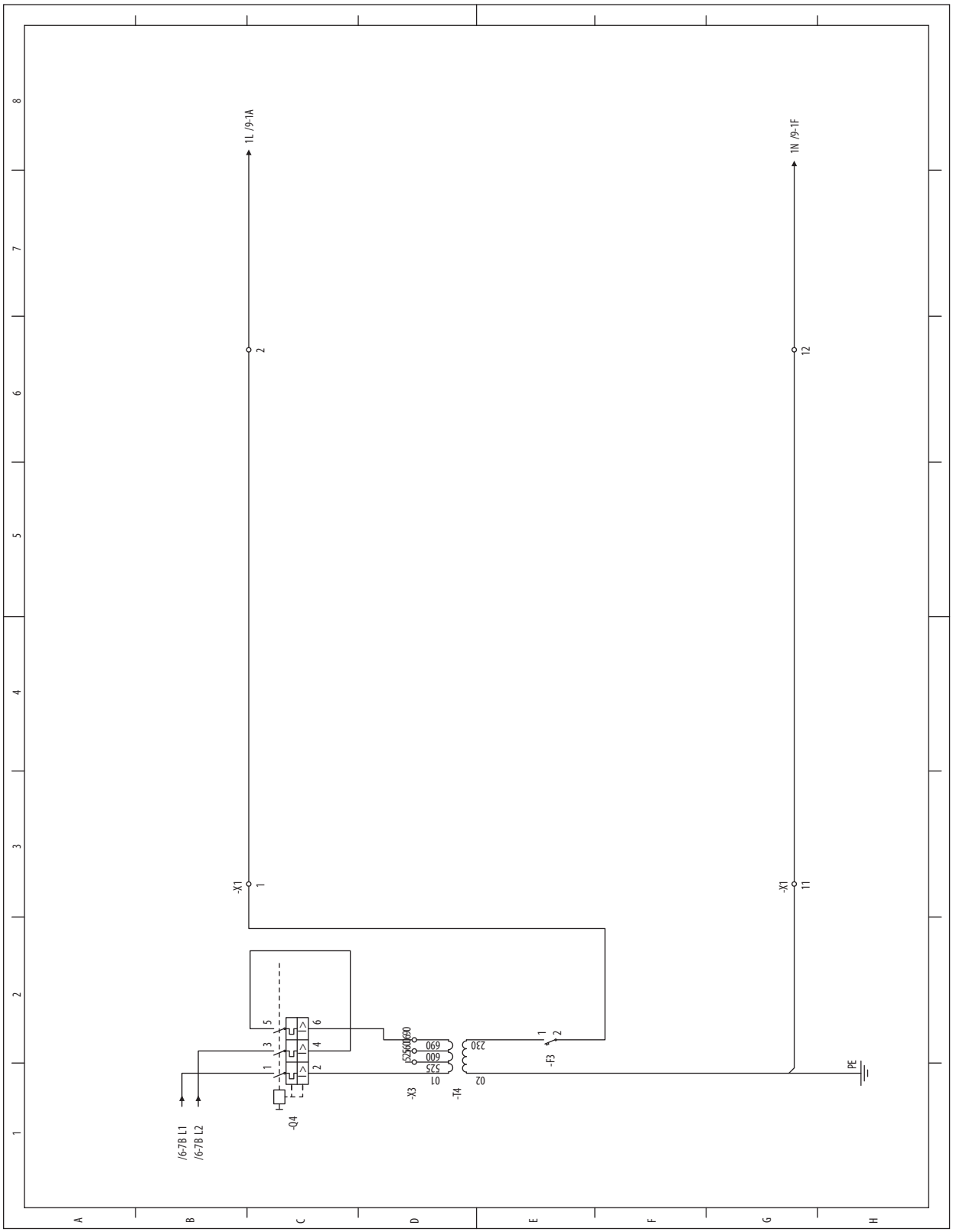



**Figure 32 - Frame 13 in IP21 Rittal Enclosure – Sheet 8B (only 600/690V)**

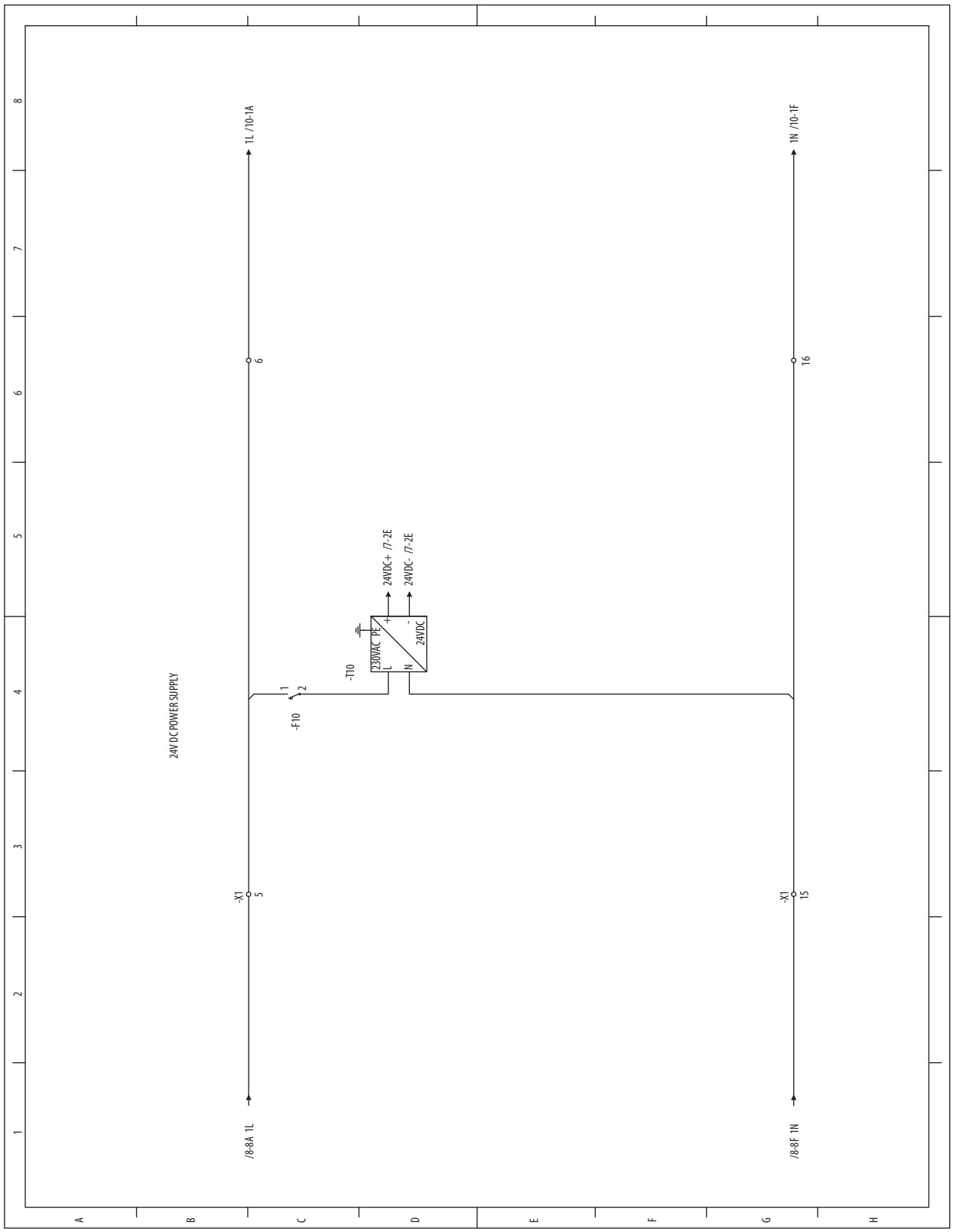



**Figure 33 - Frame 13 in IP21 Rittal Enclosure – Sheet 9 (400/480V and 600/690V)**

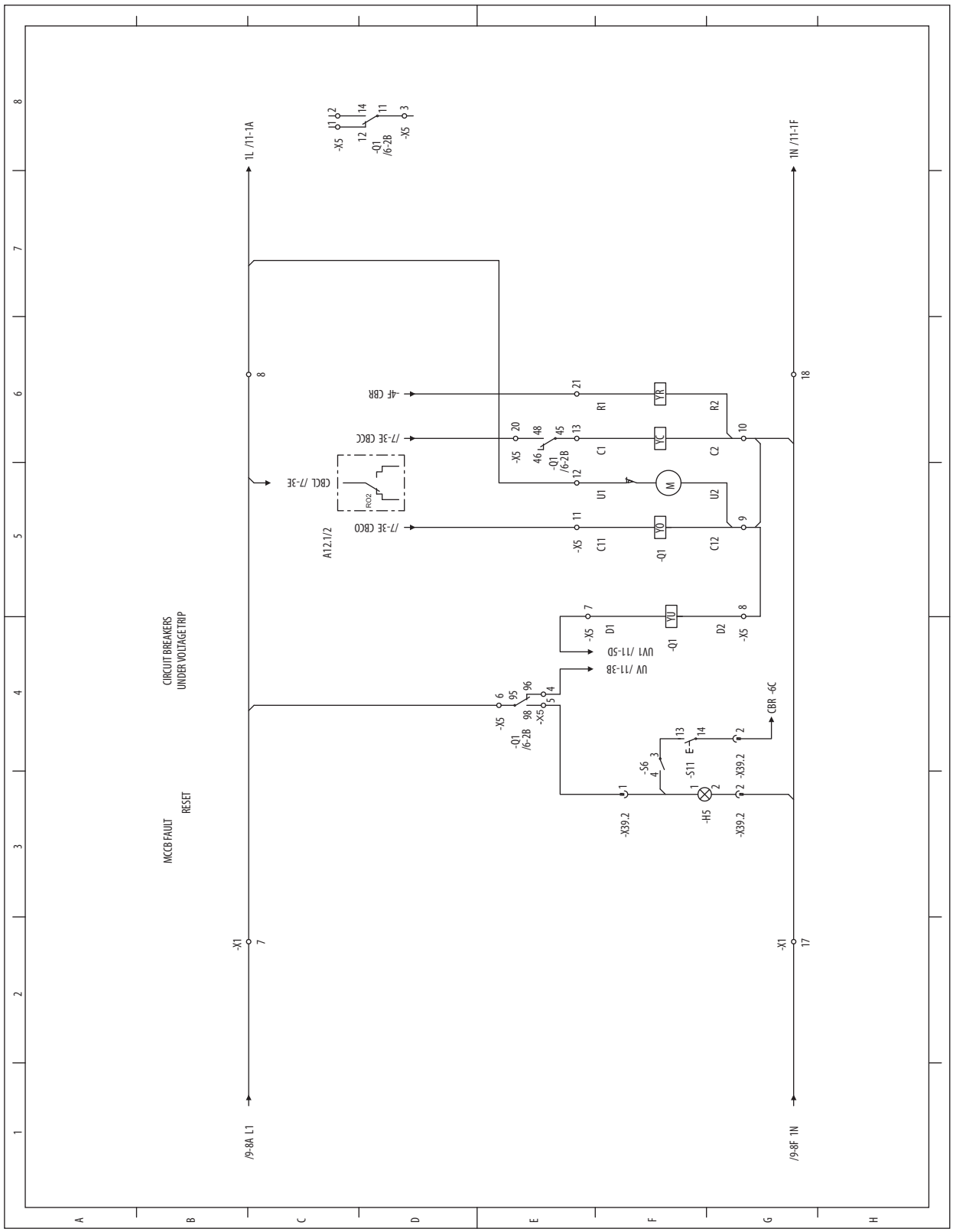



**Figure 34 - Frame 13 in IP21 Rittal Enclosure – Sheet 10 (400/480V and 600/690V)**

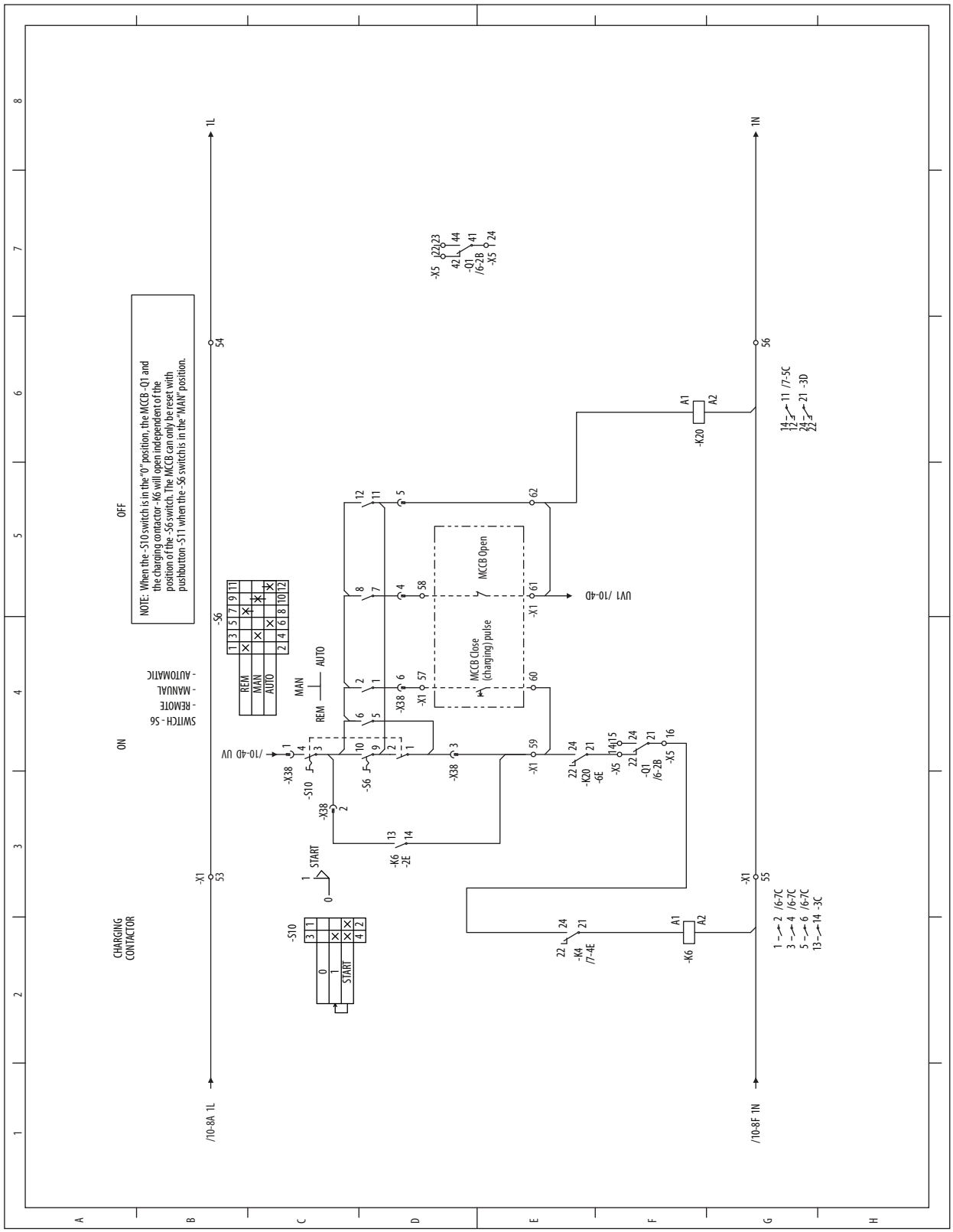



**Figure 35 - Frame 13 in IP21 Rittal Enclosure – Sheet 11 (400/480V and 600/690V)**

# Connector Descriptions

## Circuit Board Connections

The following tables detail the connection points for the Frame 13 PowerFlex® Active Front End circuit boards and components.

**Table 9 - Fiber-optic Adapter Board-to-ASIC Circuit Board Connections**

| Fiber-optic Adapter Connector | Type | Signal Description: Reference to ASIC Board | Type | ASIC Board Fiber Connector (1) |
|---|---|---|---|---|
| H1 | TX | Gate_Enable | RX | H1 |
| H2 | TX | U_Gate | RX | H2 |
| H3 | TX | V_Gate | RX | H3 |
| H4 | TX | W_Gate | RX | H4 |
| H5 | TX | A/D Convert | RX | H5 |
| H6 | TX | VBUS_RX | RX | H6 |
| H7 | RX | VBUS_TX | TX | H7 |
| X2 | From | +24V DC Power | To | X10 |
| X3 | From | Auxiliary 24V DC Power Supply | To | T10 power supply on control panel |

(1) See Figure 36 on page 125 for ASIC board Fiber-optic connectors.

**ATTENTION:** Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber-optic ports or fiber-optic cable connectors.

**IMPORTANT** When mishandled, the ability of fiber-optic cables to transmit data is greatly diminished.

**IMPORTANT** The minimum inside bend radius for fiber-optic cable is 25.4 mm (1 in.). Any bends with a shorter inside radius can permanently damage the fiber-optic cable. Signal attenuation increases with decreased inside bend radii.

**Table 10 - ASIC Board-to-Gate Driver Board Connections**

| ASIC Board | Gate Driver Board | Signal Description |
|---|---|---|
| X3 | X1 | 'U' phase |

| Ribbon Cable | Signal Description |
|---|---|
| Pin 1 | U_Feedback |
| Pin 2 | U_Power_OK |
| Pin 3 | U_DTR (1) |
| Pin 4 | U_ETR (2) |
| Pin 5 | U_ITR (3) |
| Pin 6 | U_DC- |
| Pin 7 | UI |
| Pin 8 | U_DC-_I |
| Pin 9 | U_TEMP |
| Pin 10 | U_DC-T |

| ASIC Board | Gate Driver Board | Signal Description |
|---|---|---|
| X4 | X1 | 'V' phase |

| Ribbon Cable | Signal Description |
|---|---|
| Pin 1 | V_Feedback |
| Pin 2 | V_Power_OK |
| Pin 3 | V_DTR (1) |
| Pin 4 | V_ETR (2) |
| Pin 5 | V_ITR (3) |
| Pin 6 | V_DC- |
| Pin 7 | VI |
| Pin 8 | V_DC-_I |
| Pin 9 | V_TEMP |
| Pin 10 | V_DC-T |

| ASIC Board | Gate Driver Board | Signal Description |
|---|---|---|
| X5 | X1 | 'W' phase |

| Ribbon Cable | Signal Description |
|---|---|
| Pin 1 | W_Feedback |
| Pin 2 | W_Power_OK |
| Pin 3 | W_DTR (1) |
| Pin 4 | W_ETR (2) |
| Pin 5 | W_ITR (3) |
| Pin 6 | W_DC- |
| Pin 7 | WI |
| Pin 8 | W_DC-_I |
| Pin 9 | W_TEMP |
| Pin 10 | W_DC-T |

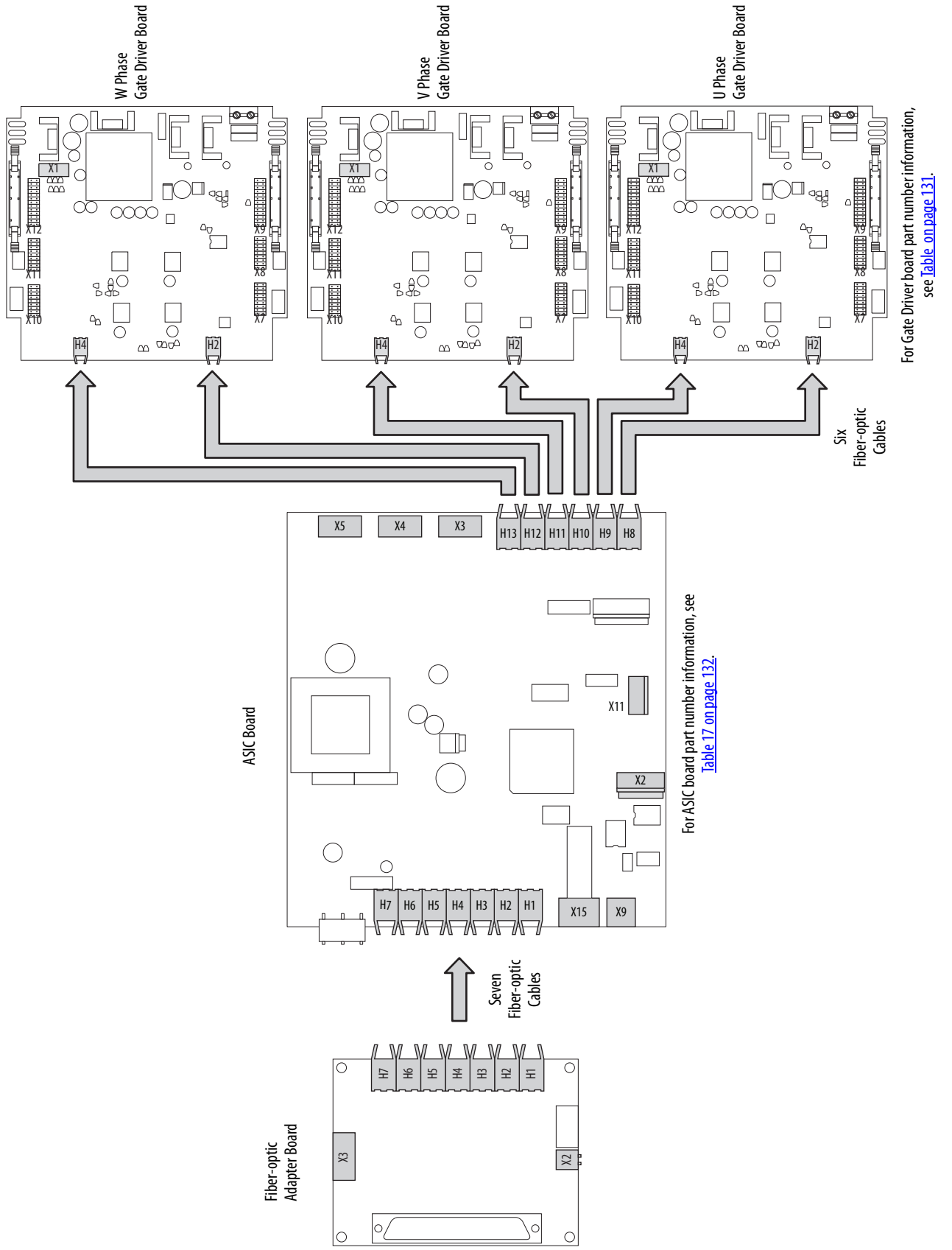
| | | |
|---|---|---|
| H13 (WL)<br>H12 (WH)<br>H11 (VL)<br>H10 (VH)<br>H9 (UL)<br>H8 (UH) | (WL) H4<br>(WH) H2<br>(VL) H4<br>(VH) H2<br>(UL) H4<br>(UH) H2 | Fiber-optic gate signals<br>(connect UH to UH, UL to UL, and so forth) |

(1) DTR = N Desat

(2) ETR = Phase $I^2T$

(3) ITR = Phase overcurrent

**Figure 36 - Fiber-optic Cable Routing**



## Hardware Connections

**Figure 37 - AFE Power Structure Fan Inverter Circuit Board Connectors**

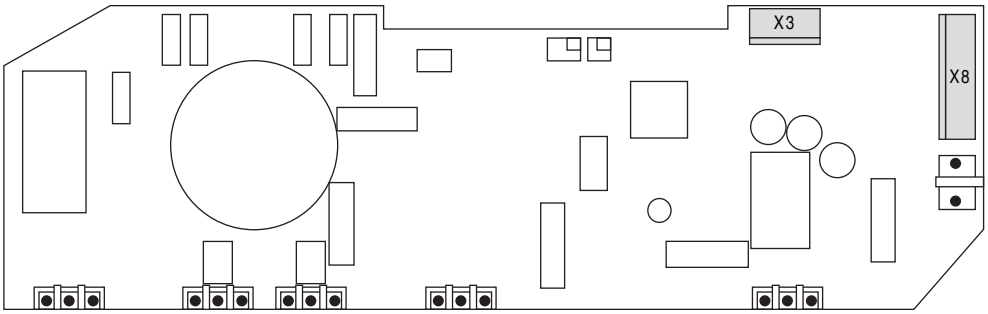



**Table 11 - ASIC Board - AFE Power Structure V Phase Fan Inverter Board Connections**

| ASIC Board Connector (1) | | Pin | Signal Description | | Pin | Phase V Fan Inverter Board Connector |
|---|---|---|---|---|---|---|
| X11 | From | 2 | ASIC_+15V | To | 2 | X8 |
| | From | 3 | FAN_CONTROL | To | 3 | |
| | To | 4 | FAN_ALARM | From | 7 | |

(1) See Figure 36 on page 125 for ASIC board connectors.

**Table 12 - Phase V Fan Inverter Board - W Phase Fan Inverter Board Connections**

| Phase V Fan Inverter Board Connector | | Pin | Signal Description | | Pin | Phase W Fan Inverter Board Connector |
|---|---|---|---|---|---|---|
| X3 | From | 2 | +15V | To | 2 | X8 |
| | From | 3 | FAN_CONTROL NEXT | To | 3 | |
| | To | 4 | FAN_ALARM | From | 7 | |

**Table 13 - Phase W Fan Inverter Board - U Phase Fan Inverter Board Connections**

| Phase W Fan Inverter Board Connector | | Pin | Signal Description | | Pin | Phase U Fan Inverter Board Connector |
|---|---|---|---|---|---|---|
| X3 | From | 2 | +15V | To | 2 | X8 |
| | From | 3 | FAN_CONTROL NEXT | To | 3 | |
| | To | 4 | FAN_ALARM | From | 7 | |

For part number information, see the PowerFlex 700H, 700S, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029.

**Figure 38 - LCL Filter Fan Inverter Circuit Board Connectors**

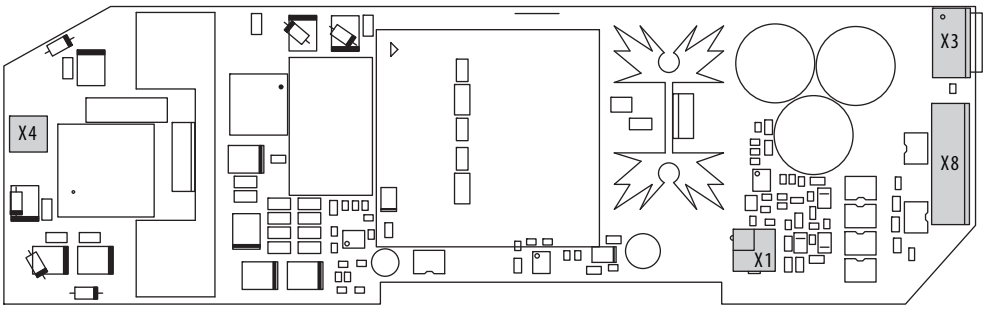



**Table 14 - LCL Filter Fan Inverter Circuit Board Connections**

| LCL Filter DC Fan Inverter Board | LCL Filter DC Fan Assembly |
|---|---|
| X1 | X1 |
| X3 | X3 |
| X8 | X51 |
| X4 | X53 |

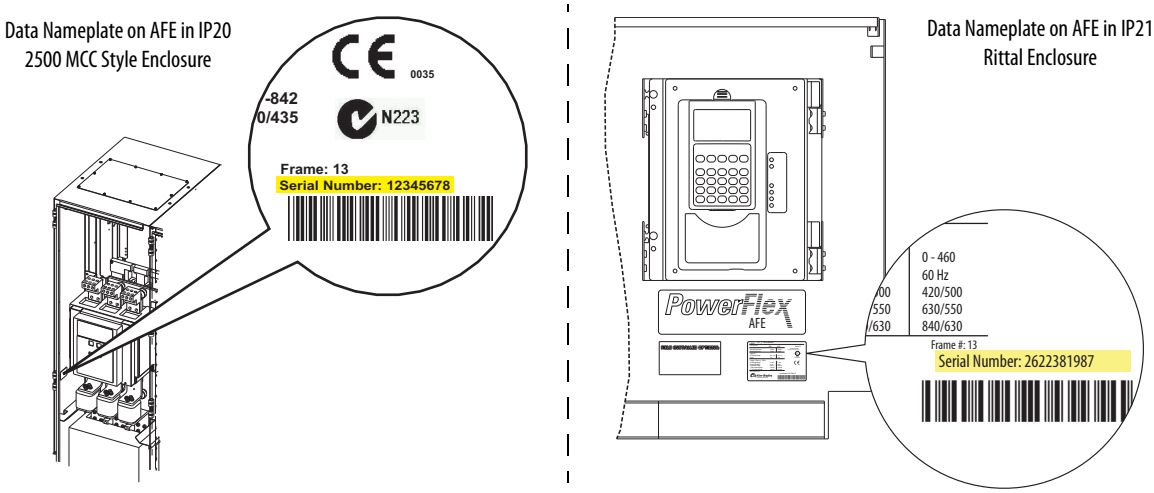
## Notes:

# Disassembly/Assembly Diagrams and Spare Parts

| Diagram | Figure and Page |
|---|---|
| AFE Power Structure Assembly External Components | Figure 39 on page 130 |
| AFE Power Structure Internal Components (U, V, or W Phase Assembly) | Figure 40 on page 131 |
| AFE Power Structure ASIC Assembly | Figure 41 on page 132 |
| LCL Filter Assembly | Figure 42 on page 133 |
| LCL Filter Power Supply Assembly | Figure 43 on page 134 |
| LCL Filter Fan Assembly | Figure 44 on page 134 |
| Precharge Assembly for AFE in IP20 2500 MCC Style Enclosure | Figure 45 on page 135 |
| Precharge Assembly for AFE in IP21 Rittal Enclosure | Figure 46 on page 136 |
| AC Line Switchgear Components for AFE in IP20 2500 MCC Style Enclosure | Figure 47 on page 137 |
| AC Line Switchgear Components for AFE in IP21 Rittal Enclosure | Figure 48 on page 138 |

Diagrams in this section illustrate disassembly and assembly of the AFE and its subsystems, and include a list of spare part numbers, where applicable.

When ordering spare parts, you must provide the serial number of the PowerFlex® Active Front End. The serial number is on the data nameplate on the control frame just above the bar code.




A complete list of spare parts for the Frame 13 PowerFlex Active Front End is available on the Allen-Bradley website at http://www.ab.com/support/abdrives/powerflex70/PF7ReleasedParts.pdf.

# AFE Power Structure Assembly

**Figure 39 - AFE Power Structure Assembly External Components**

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC Board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

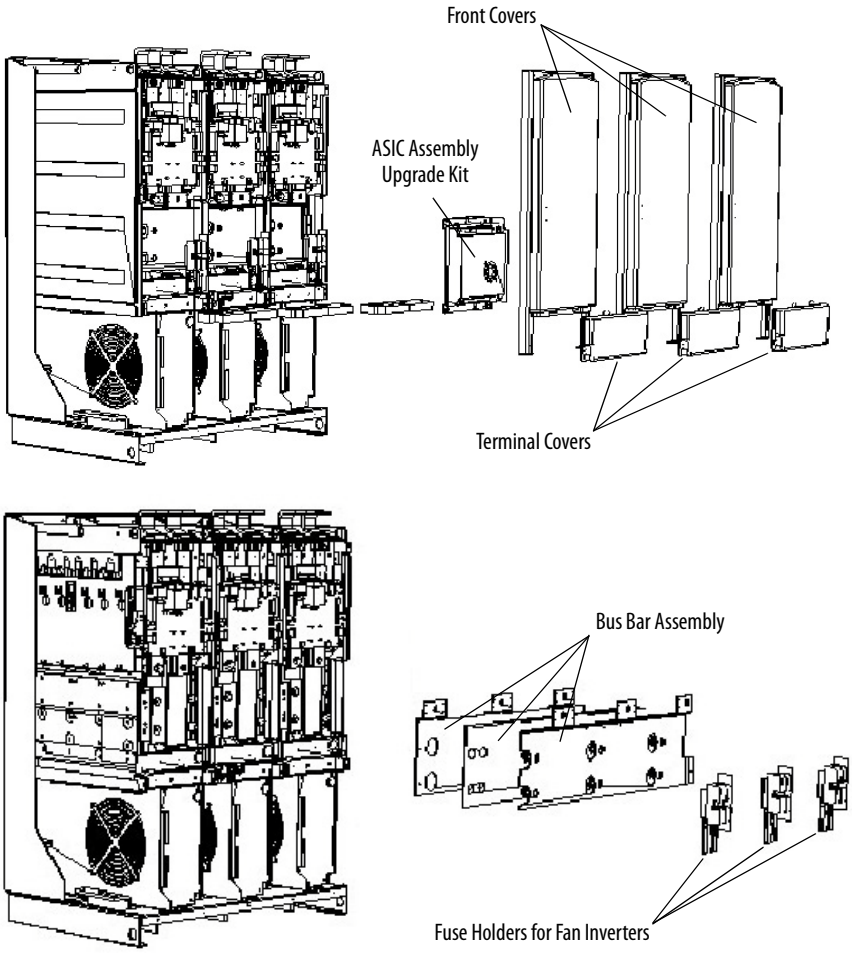



**Table 15 - AFE Power Structure Assembly External Component Part Numbers**

| Part Name | | Part No. |
|---|---|---|
| ASIC assembly upgrade kit (without ASIC board) | | 20-FR10850 |
| Bus bar assembly | | N/A |
| Fuse holders for fan inverters (only AC fan system) | | 20-PP01094 (1) |
| Fan inverter fuse (only AC fan system) | | 20-PP20202 (1) |
| Terminal covers | | N/A |
| Front covers | | N/A |
| Power structure | 400/480V (1300 A) | SK-Y1-PWRMOD-D1K3 |
| | 600/690V (1030 A) | SK-Y1-PWRMOD-E1K0 |
| Maintenance stand | | 20-MAINSTD |

(1) For additional AC fan system information, see publication PFLEX-IN029.

**Figure 40 - AFE Power Structure Internal Components (U, V, or W Phase Assembly)**

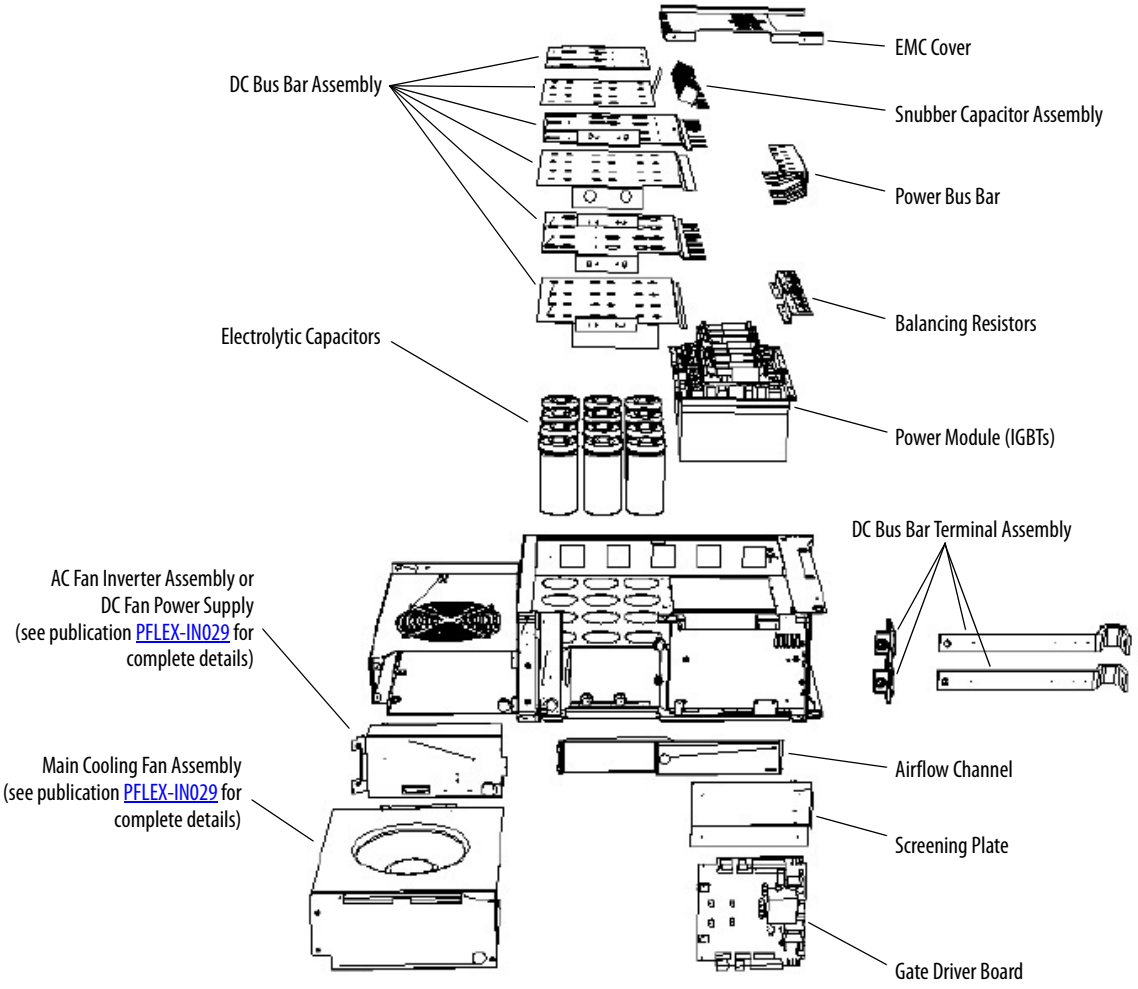



**Table 16 - AFE Power Structure Internal Component Part Numbers for U, V, or W Phase Assembly**

| Part Name | | Cat. No. |
|---|---|---|
| Airflow channel | | N/A |
| Balancing resistors | | N/A |
| DC bus bar assembly | | N/A |
| DC bus bar terminal assembly | | N/A |
| Electrolytic capacitors | ELKO 3300 µF 420V for 400/480V AFE | 20-PP01005 |
| | ELKO 5600 µF 420V for 600/690V AFE | 20-PP01099 |
| EMC cover | | N/A |
| Gate driver board | 400/480V | SK-H1-GDB1-F1314D |
| | 600/690V | SK-H1-GDB1-F1314E |
| Power module | 400/480V | SK-H1-QOUT-D1K3 |
| | 600/690V | SK-H1-QOUT-E1K0 |

**Table 16 - AFE Power Structure Internal Component Part Numbers for U, V, or W Phase Assembly (Continued)**

| Part Name | Cat. No. |
|---|---|
| Power bus bar | N/A |
| Screening plate (for gate driver board) | N/A |
| Snubber capacitor assembly | N/A |

**ATTENTION:** The sheet metal cover and mounting screws on the ASIC Board that is on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

**Figure 41 - AFE Power Structure ASIC Assembly**

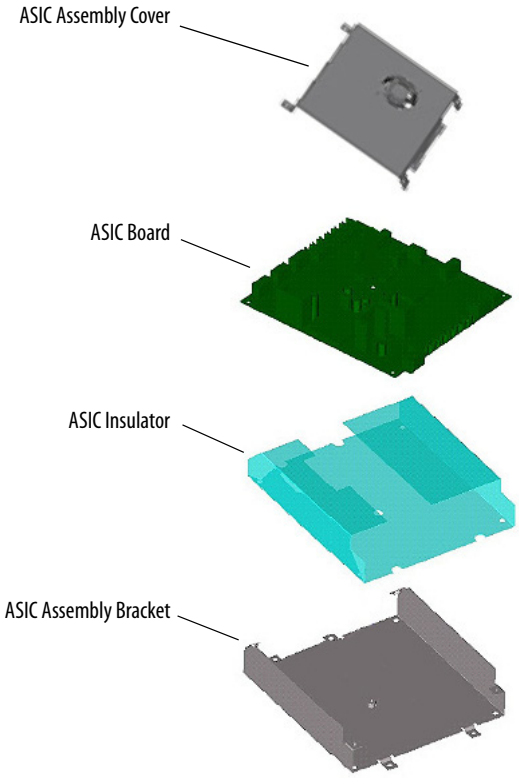



**Table 17 - AFE Power Structure ASIC Assembly Part Numbers**

| Part Name | | Cat. No. |
|---|---|---|
| ASIC assembly bracket | | Included in 20-FR10850 |
| ASIC assembly cover | | |
| ASIC assembly insulator | | |
| ASIC board (1) | 400/480V AFE | SK-H1-ASICBD-D1300 |
| | 600/690V AFE | SK-H1-ASICBD-E1030 |
| Fiber-optic cable set | | 20-PP09017 |

(1) The ASIC board is unprogrammed.

# LCL Filter Assembly (used in IP20 and IP21 enclosures)

**Figure 42 - LCL Filter Assembly**

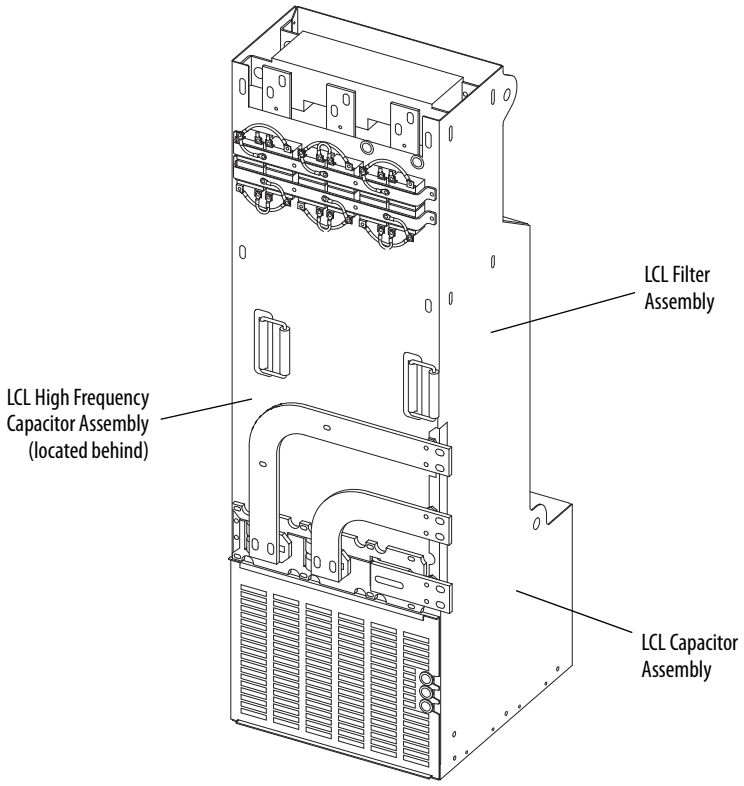



**Table 18 - LCL Filter Assembly Catalog Numbers**

| Part Name | | Cat. No. |
|---|---|---|
| LCL filter assembly | 400/480V | SK-Y1-LCL1-D1K3 |
| | 600/690V | SK-Y1-LCL1-E1K0 |
| LCL high-frequency capacitor assembly | 25 µF 400/480V | SK-Y1-CAPHF3-DF |
| | 20 µF 600/690V | SK-Y1-CAPHF2-DF |
| LCL capacitor assembly | 120 µF 400/480V | SK-Y1-CAPLCL1-D1K3 |
| | 53 µF 600/690V | SK-Y1-CAPLCL1-F1K0 |
| LCL filter inverter fan fuse | | SK-Y1-F11-F10 |

**Figure 43 - LCL Filter Power Supply Assembly**

**Table 19 - LCL Filter Power Supply Assembly Catalog Numbers**

| Part Name | | Cat. No. | |
|---|---|---|---|
| | | Universal Kit | Discontinued July 2014 (2) |
| LCL filter power supply | 400/480V | SK-Y1-DCPS2-F10 (1) | SK-Y1-DCPS1-D460 |
| | 600/690V | | SK-Y1-DCPS1-F325 |
| LCL fan wire kit | | SK-Y1-HF1-DF | |

(1) This kit can be used for either voltage class.
(2) These discontinued kits are no longer available, but spares inventory is applicable.

**Figure 44 - LCL Filter Fan Assembly**

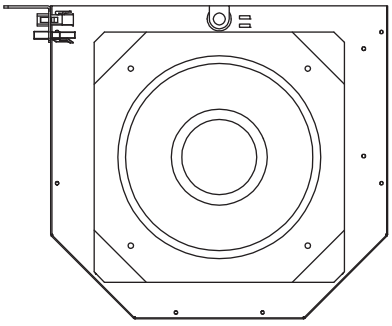


**Table 20 - LCL Filter Fan Assembly Catalog Number**

| Part Name | Cat. No. |
|---|---|
| Main fan, 48V DC | SK-Y1-DCFAN1 |

# Precharge Assembly

**Figure 45 - Precharge Assembly for AFE in IP20 2500 MCC Style Enclosure**

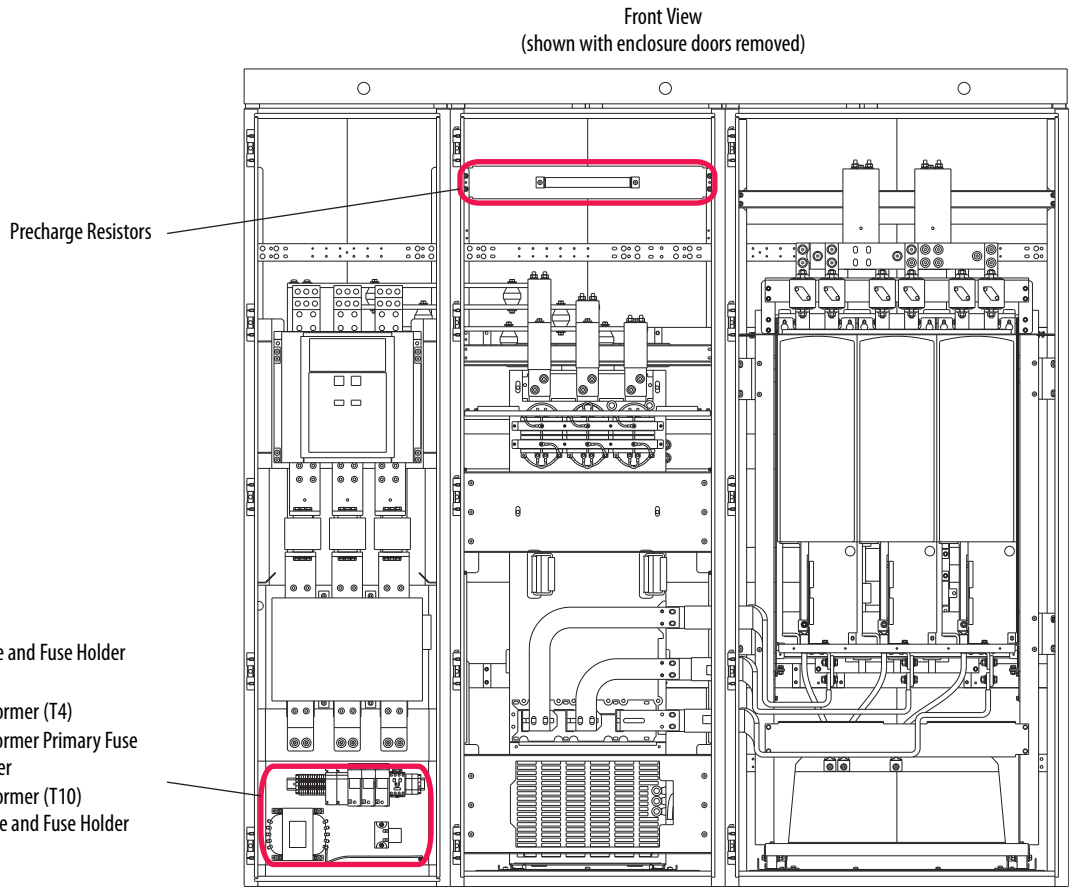



**Table 21 - Precharge Assembly Part Numbers for AFE in IP20 2500 MCC Style Enclosure**

| Part Name | | Part No. |
|---|---|---|
| Precharge fuse | | SK-Y1-MCCF5-F13 |
| Precharge fuse holder | | SK-Y1-MCCF5FUSEHOLDER-F13 |
| Precharge kit (1) | | SK-Y1-PRE2-F13 |
| Control transformer (T4), 1500VA | | SK-R1-OFANXFMR-F13 |
| Control transformer primary fuse | 400/480V | SK-Y1-MCCF6-D |
| | 600/690V | SK-Y1-MCCF6-F |
| Control transformer primary fuse holder | | SK-Y1-MCCF6FUSEHOLDER |
| Control transformer (T10) secondary fuse/holder | | SK-Y1-MCCF3F4 |

(1) Kit includes diode bridge (V6), one resistor (R6.1), and a snubber capacitor (C1).

**Figure 46 - Precharge Assembly for AFE in IP21 Rittal Enclosure**

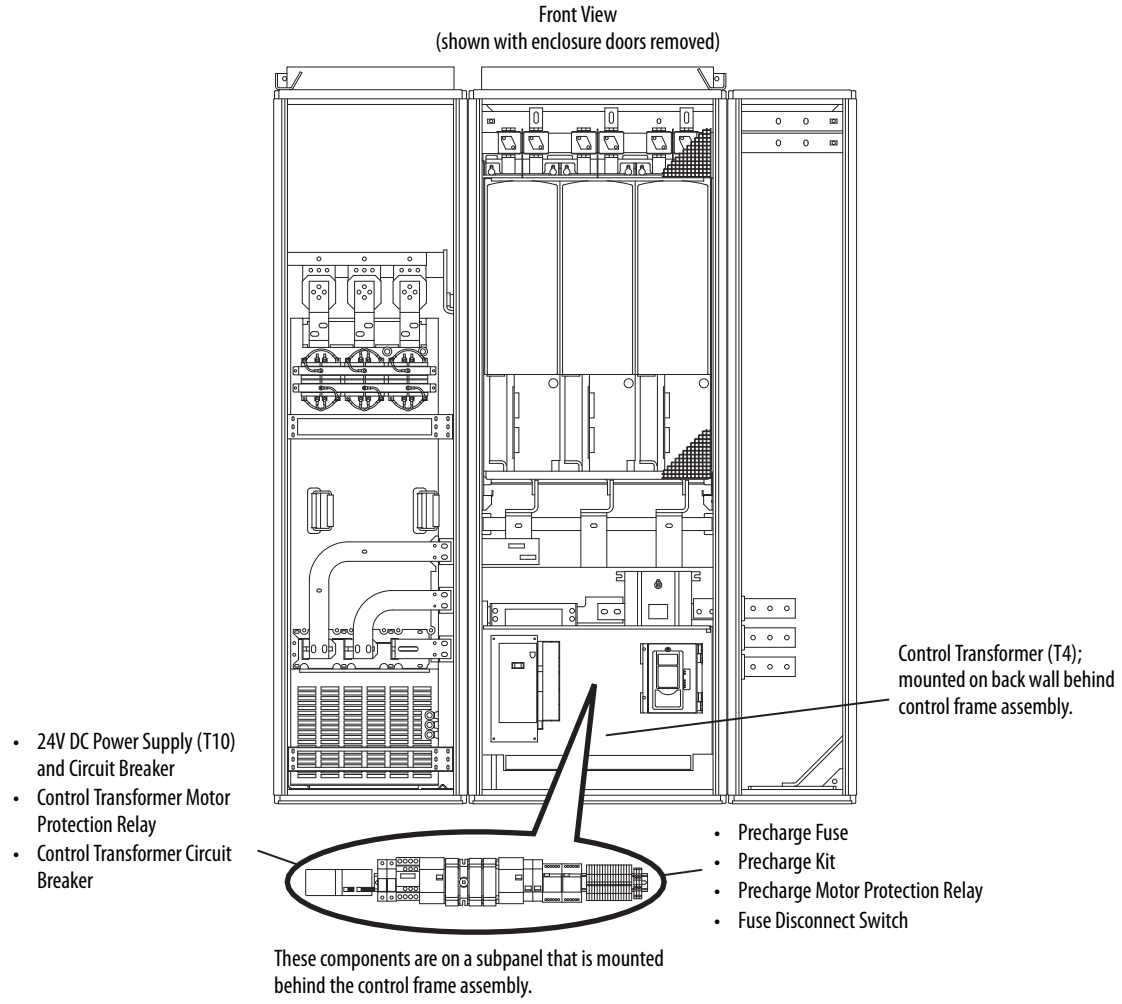



**Table 22 - Precharge Assembly Part Numbers for AFE in IP21 Rittal Enclosure**

| Part Name | | Part No. |
|---|---|---|
| Precharge fuse | 400/480V | SK-Y1-F6-D |
| | 600/690V | SK-Y1-F6-F |
| Fuse disconnect switch | | SK-Y1-F6-DISC-DF |
| Precharge kit (1) | | SK-Y1-PRE1-F13DF |
| Control transformer (T4), 750VA | 400/480V | SK-Y1-T4-D |
| | 600/690V | SK-Y1-T4-F |
| Control transformer motor protection relay | | SK-Y1-Q4-DF |
| Control transformer circuit breaker, 4 A | 400/480V | SK-Y1-F3-D |
| | 600/690V | SK-Y1-F3-F |
| 24V DC power supply (T10) | | SK-Y1-T10-DF |
| 24V DC power supply circuit breaker, 2 A | | SK-Y1-F10-DF |
| Precharge motor protection relay | | SK-Y1-Q5-F13 |

(1) Kit includes diode bridge (V6), contactor (K6), two resistors (R6.1 and R6.2), and a snubber capacitor (C1).

# AC Line Switchgear

**Figure 47 - AC Line Switchgear Components for AFE in IP20 2500 MCC Style Enclosure**

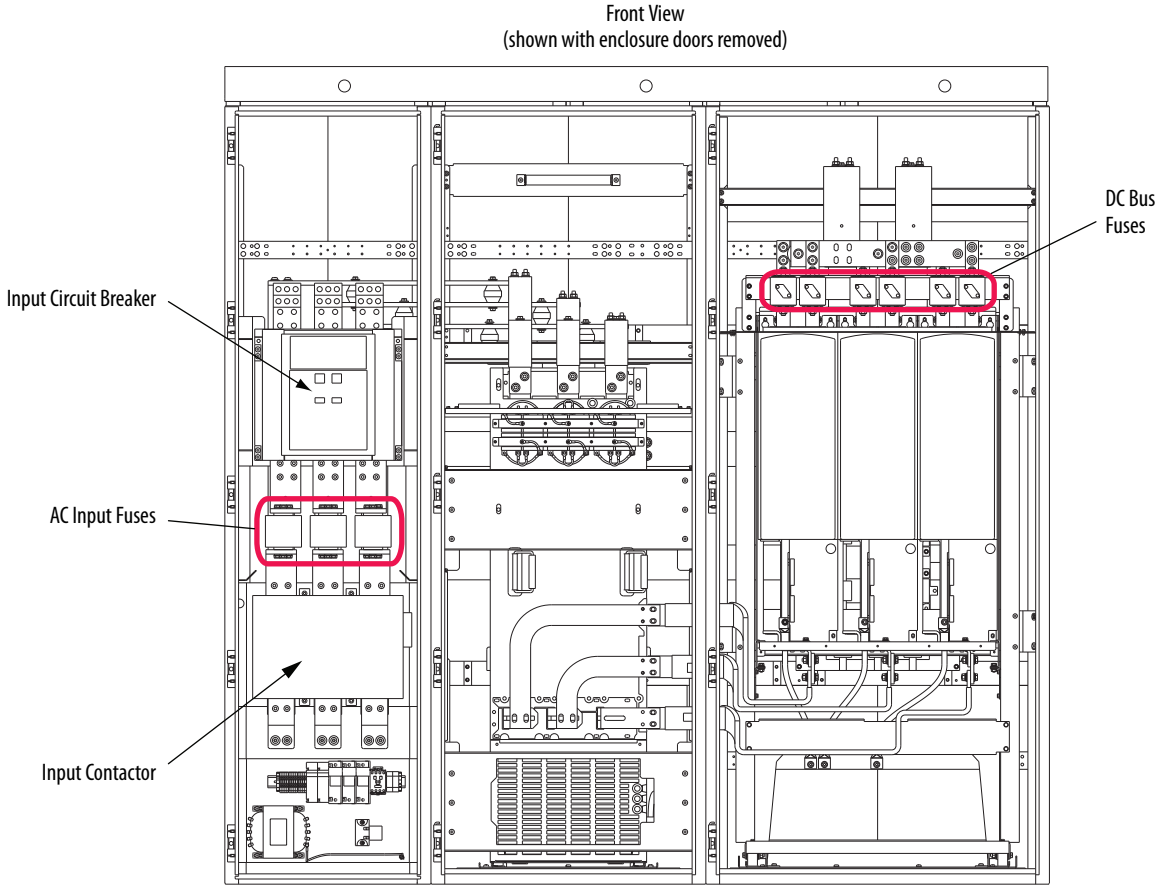



**Table 23 - AC Line Switchgear Part Numbers for AFE in IP20 2500 MCC Style Enclosure**

| Part Name | | Part No. |
|---|---|---|
| AC input fuses | 400/480V | SK-Y1-MCCF1-F13D |
| | 600/690V | SK-Y1-MCCF1-F13F |
| DC bus fuses | 400/480V | SK-Y1-MCCF2-D |
| | 600/690V | SK-Y1-MCCF2-F |
| Input circuit breaker | 400/480V | SK-Y1-MCCQ0-F13 |
| | 600/690V | |
| Input contactor | | SK-Y1-MCCK1-F13 |
| LCL filter bay door fan kit (two at top of door; not shown) | | 20-750-FAN3-F8 |
| Right-side bus splice kit (not shown; optional) | | SK-Y1-BUSSPLICE-F13R |
| Left-side bus splice kit (not shown; optional) | | SK-Y1-BUSSPLICE-F13L |
| MCC bus splice barrier kit (not shown; optional) (1) | | SK-Y1-MCCBARRIER |

(1) The MCC bus splice barrier kit must be used when installing a right-side bus splice kit (SK-Y1-BUSSPLICE-F13R) or a left-side bus splice kit (SK-Y1-BUSSPLICE-F13R).

**Figure 48 - AC Line Switchgear Components for AFE in IP21 Rittal Enclosure**

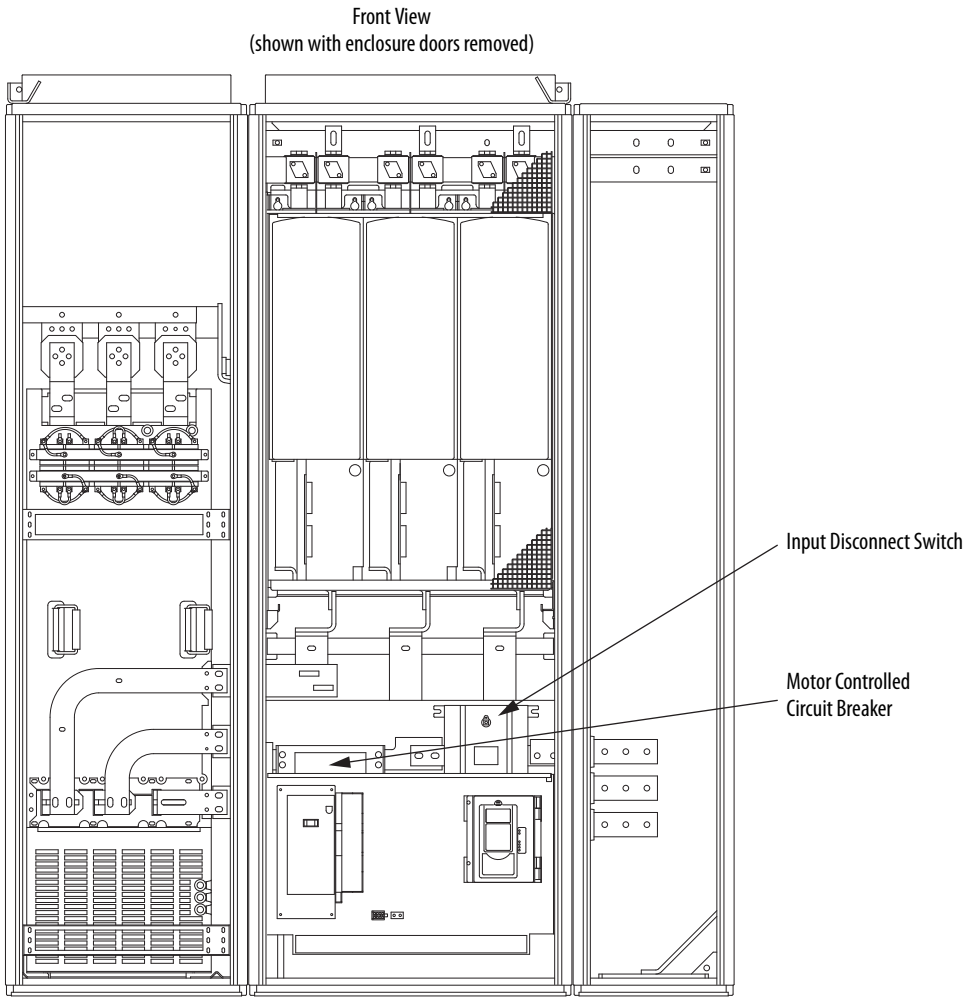


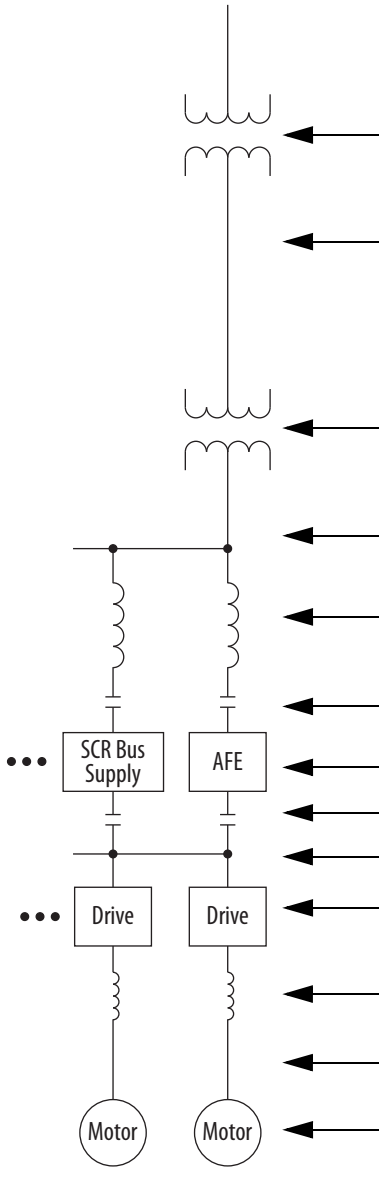

**Table 24 - AC Line Switchgear Part Numbers for AFE in IP21 Rittal Enclosure**

| Part Name | | Part No. |
|---|---|---|
| Control circuit relay | 230V AC | SK-Y1-K20-DF |
| | 24V DC | SK-Y1-K4-DF |
| Input disconnect switch | | SK-Y1-Q0-F13 |
| Motor controlled circuit breaker | | SK-Y1-Q1-F13 |

# AFE Power One-line System Application Data

## Data to Collect

Collect the following AFE system data before contacting Allen-Bradley technical support.




| Utility | Transformer | |
|---|---|---|
| Type | | Delta-Delta, Delta-Wye, or Other |
| Input Volts | | |
| Output Volts | | |
| kVA | | |
| Z | | None, Solid, High Resistive |
| Ground | | |

Cable Length:_____ Cable Type:_____

| Secondary | Transformer | |
|---|---|---|
| Type | | |
| Input Volts | | |
| Output Volts | | |
| kVA | | |
| Z | | None, Solid, High Resistive |
| Ground | | |

Cable Length:_____ Cable Type:_____

☐ Line Reactor Mfgr./Cat. No.:_____ % Impedance:_____

☐ Isolation Xfmr Mfgr./Cat. No.:_____ % Impedance:_____

☐ Input Contactor

AFE Cat. No.:_____ SCR Cat. No.:_____

☐ Output Contactor

Cable Length:_____ Cable Type:_____

Drive Cat. No.:_____

☐ Output Reactor Mfgr./Cat. No.:_____

☐ Terminator Mfgr./Cat. No.:_____

Cable Length:_____ Cable Type:_____

| Motor Manufacturer | |
|---|---|
| Volts | |
| Amps | |
| RPM | |
| Hz | |
| Power | |
| Design No. | |
| Encoder | |
| Brake | |
| Motor Heater | |

## Typical Transformer Winding Types

The following diagrams show typical transformer winding types.

**Figure 49 - Delta-Wye with Grounded Wye Neutral**

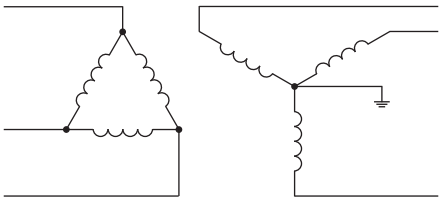


**Figure 50 - Delta-Delta with Grounded Leg or Four-Wire Connected Secondary Delta**

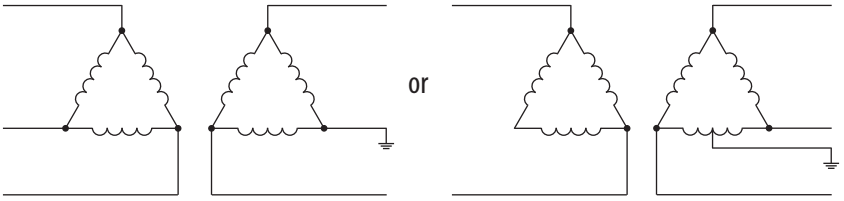
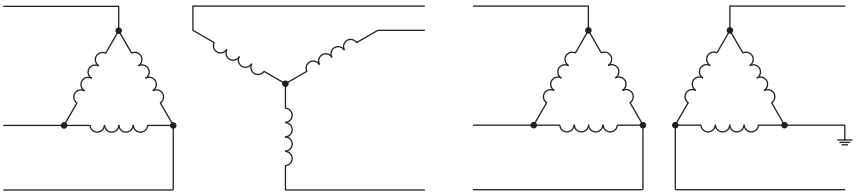



**Figure 51 - Ungrounded Secondary**



## O



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## W

## Rockwell Automation Support

Use the following resources to access support information.

| | | |
|---|---|---|
| **Technical Support Center** | Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates. | https://rockwellautomation.custhelp.com/ |
| **Local Technical Support Phone Numbers** | Locate the phone number for your country. | http://www.rockwellautomation.com/global/support/get-support-now.page |
| **Direct Dial Codes** | Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer. | http://www.rockwellautomation.com/global/support/direct-dial.page |
| **Literature Library** | Installation Instructions, Manuals, Brochures, and Technical Data. | http://www.rockwellautomation.com/global/literature-library/overview.page |
| **Product Compatibility and Download Center (PCDC)** | Get help determining how products interact, check features and capabilities, and find associated firmware. | http://www.rockwellautomation.com/global/support/pcdc.page |

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