PowerFlex Digital DC Drive – Frame B

Bulletin Number 20P

Allen-Bradley
by ROCKWELL AUTOMATION

Hardware Service Manual

Original Instructions

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).

Notes:

This manual contains component test and hardware replacement information for PowerFlex® DC frame B drives, 40...300 Hp (30...224 kW).

This manual is intended for qualified service personnel responsible for troubleshooting and repairing PowerFlex DC drives. You should have previous experience with, and basic understanding of, electrical terminology, procedures, required troubleshooting equipment, equipment protection procedures and methods, and safety precautions.

It is highly recommended that you obtain a copy of the PowerFlex Digital DC Drive User Manual, publication 20P-UM001, which contains fault/alarm and programming information to assist you in troubleshooting drive errors and determining if repairs are necessary. See Additional Resources on page 133 for information on related publications and how to obtain manuals.

Summary of Changes

This manual contains new and updated information.

Topic	Page
Added note to the procedure Troubleshoot an Armature Bridge Failure.	20
Changed the procedure Check the Field SCR/Dual Diode Module.	32
Added the Non-regenerative Drive Power Module Diagram.	107
Added the Regenerative Drive Power Module Diagram.	108

Notes:

Before You Begin Testing, Maintenance, or Repairs

This chapter provides information you should know before you begin tests, maintenance, or repairs on drive components.

General Safety Precautions

Read the following precautions before you begin testing components, performing maintenance or repairing the drive.

ATTENTION: Only qualified personnel familiar with DC drives and associated machinery should plan or implement the installation, startup, and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

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

ATTENTION: Severe injury or death can result from electrical shock, burn, or unintended actuation of controlled equipment. Hazardous voltages may exist in the drive enclosure even with the circuit breaker in the off position. Recommended practice is to disconnect and lock out control equipment from power sources. If it is necessary to work in the vicinity of energized equipment, the safety related work practices of NFPA 70E, Electrical Safety Requirements for Employee Workplaces, must be followed. DO NOT work alone on energized equipment.

ATTENTION: Potentially fatal voltages may result from improper usage of an oscilloscope and other test equipment. The oscilloscope chassis may be at a potentially fatal voltage if not properly grounded. If an oscilloscope is used to measure high voltage waveforms, use only a dual channel oscilloscope in the differential mode with X 100 probes. It is recommended that the oscilloscope be used in the A minus B Quasi-differential mode with the oscilloscope chassis correctly grounded to an earth ground.

ATTENTION: Remove power before making or breaking cable connections. When you remove or insert a cable connector with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field devices, causing unintended machine motion
- causing an explosion in a hazardous environment

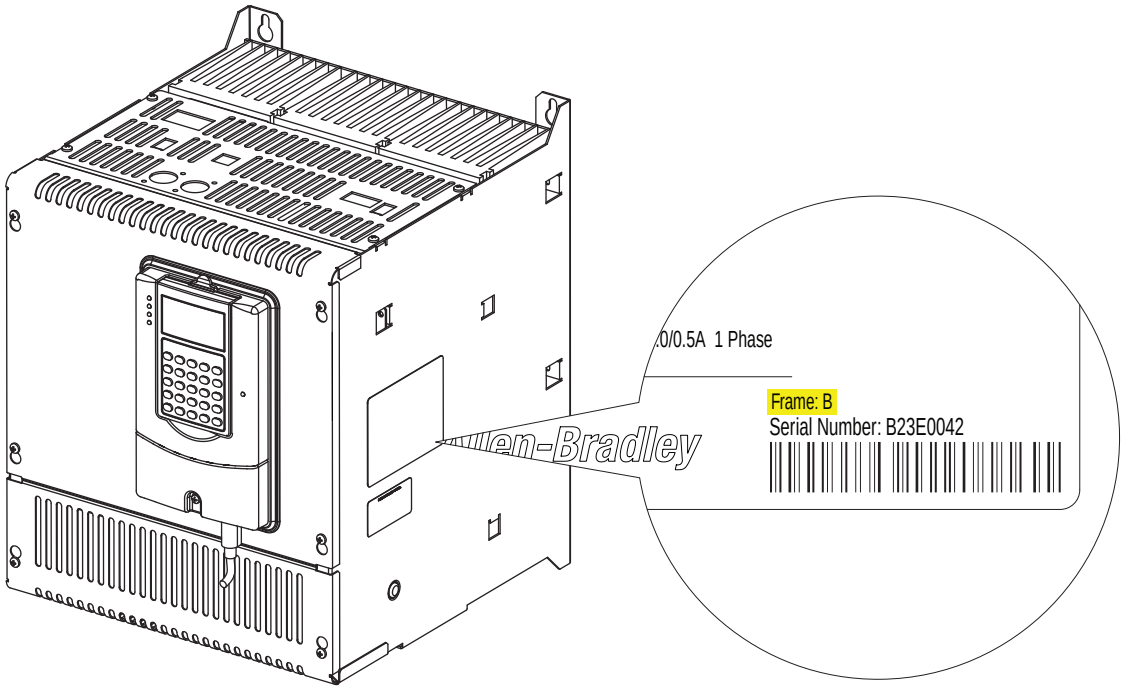
Electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance.

ATTENTION: HOT surfaces can cause severe burns. **Do not** touch the heatsink surface during operation of the drive. After disconnecting power allow time for cooling.

Hardware Description

The PowerFlex® DC drive contains a power structure that has an armature and field supply. The armature supply consists of a three–phase, full wave rectified, dual bridge, capable of two or four quadrant output. The field supply consists of single phase, full wave rectified bridge. Also associated with the power structure are incoming line protection devices and contactor and dynamic brake control circuits.

Verify that you are working on a frame B drive by checking the data nameplate located on the side of the drive. The frame size is printed just above the serial number in the lower right corner of the label.



Commonly Used Tools

Service Tools

This list of basic service tools which will cover needs of tools for repair and maintenance measurements.

Item	Details
Digital multimeter	Digital multimeter, capable of AC and DC voltage, continuity, resistance, and forward diode bias tests. Fluke model 87 III or equivalent (recommended).
Oscilloscope	Portable, digitizing, dual channel scope, with isolation
Current clamp	3x drive rated armature current output
Soldering station	Soldering / de soldering
Torque wrench	1…12 N•m
Torque wrench	6…50 N•m
Box wrench	7 mm, 8 mm, 10 mm, 13 mm, 17 mm, 19 mm, 22 mm
Socket extension	230 mm
Wrench	7 mm, 8 mm, 10 mm, 13 mm, 17 mm, 19 mm, 22 mm
Wire cutter	
Nose pliers	
Crimping tools	For cable terminals 1.5…240
Angle wrench	
Screw drivers:	
Flat nose	7 x 2 mm
Hexalobular	T15, T20, T25
Phillips	#1, 2, 3
Hexagonal wrench	#4, 5, 6
ESD-protected place of work	Working surface, floor covering, seat and ground connections
ESD-protective clothing	Wrist wrap, shoes, overall clothing (coat)

Software Tools

You can use Connected Components Workbench® software or DriveExecutive™ software to monitor, upload, or download system parameters. You can also view current alarm and fault information.

Component Test Procedures

This chapter provides general procedures for inspecting and testing the major components of the drive and includes recommendations for repairs. Due to the technical nature of this product and the variety of possible applications, not all possible fault conditions and troubleshooting solutions can be described in this manual.

IMPORTANT Using the diagnostic tests in this chapter should only be performed by qualified personnel and only when other corrective actions have failed. All tests assume that the control board connections have been properly made.

For common drive symptoms and corrective actions and fault troubleshooting information, see the Troubleshooting chapter in the PowerFlex Digital DC Drive User Manual, publication 20P-UM001.

Save the Parameter Configuration

It is recommended that you save the drive and communication adapter parameter configuration before performing any service. You can save the drive configuration in one of these ways:

- Upload the drive configuration to a HIM Set
- Upload the drive configuration to a DriveExecutive file (.dno)
- Export the drive configuration to Connected Components Workbench file (.iuux)

See the specific software online help for instructions on how to save or export the drive configuration to an offline file.

Save to a HIM Set

Complete these steps to save the drive and adapter parameters to a HIM set.

1. On the HIM, access the **Memory Storage** menu.
2. Select the **HIM CopyCat** menu and press  .
3. Select **Device** -> **HIM** and press  .
4. Do one of the following:
   - If there are no existing HIM Sets, enter a name using the  and  buttons to select the desired characters and press  .
   - If there is an existing HIM Set, press  to overwrite it, or select **No** using the  button and use the  and  buttons to select the desired characters. Then press  .

The HIM Set will be saved to nonvolatile memory.

Visual Component Inspection

Visually inspect the circuit boards and power components before energizing the drive for any of the component test procedures.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers (see page 43) and lower the control EMI shield (see page 58) when necessary.
4. Check components for burn marks, breakage or foil delamination on all circuit boards.

Replace any of these components without further testing if they show evidence of burn marks, breakage, or foil delamination.

Troubleshoot a Control Power Supply Failure

If a drive code F3 'Power Failure' fault has occurred and the drive is inoperable via the HIM or other means of control, compete the steps below to determine where the control power failure has occurred.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Measure the signal voltage at the testpoints on the control board as indicated in the following table.

Name	Testpoint	For Testpoint Location See…	Associated Connector-Pin	Description
+ 5V	XY5	Figure 1 on page 17	XA-1 / XA-3 / XA-5	+5V digital supply
GNDD	XY6	Figure 1 on page 17	XA-2 / XA-4 / XA-6	+5V digital supply ground
GNDD	XY7	Figure 2 on page 18	XA-2 / XA-4 / XA-6	+5V digital supply ground
+15V	XY12	Figure 1 on page 17	XA-9 / XA-10	+15V analog supply
GNDA	XY10	Figure 1 on page 17	XA-11 / XA-12	15V analog supply ground
-15 V	XY11	Figure 1 on page 17	XA-13 / XA-14	-15V analog supply
+24V	XY8	Figure 1 on page 17	XA-16	+24V terminal block
GNDV	XY9	Figure 1 on page 17	XA-15	+24V terminal block ground
+5VEXP	+5VEXP	Figure 2 on page 18	XP3-1 / XP3-2 / XP3-3	+5V for DPI expansion
+12VEXP	+12VEXP	Figure 2 on page 18	XP3-4 / XP3-5	+12V for DPI expansion
0VEXP	0VEXP	Figure 2 on page 18	XP3-7 / XP3-8 / XP3-9	DPI™ expansion ground

Note: For a flow chart version of the steps that follow, see Control Power Supply Failure on page 124.

4. If any of the signals in the table above is incorrect or missing, verify that either 115V AC or 230V AC voltage is present at terminals U2 and V2 (control circuit power input).
   - If the voltage is present and correct, continue with step 5 below.
   - If the voltage is incorrect or missing, remove control power and verify the wiring and power source to U2, V2 and correct any problems. Test the voltage level again to verify that it is correct. If the voltage is correct, but the drive is still inoperable, continue with step 5 below.

5. Remove AC control power from terminals U2 and V2 and remove and test the fuse (F1) at the top of the drive. See Remove the Fuses on the Switching Power Supply Circuit Board on page 60 for fuse location.
   - If the fuse is blown, continue with step 6 below.
   - If the fuse is not blown, replace the switching power supply board (see page 62).
6. Replace the fuse on the switching power supply board (see page 61).
7. Disconnect the cable at connector XA on the control board. See Figure 29 on page 121 for location of connector XA.
8. Apply AC control power to the drive.
   - If the fuse blows, continue with Testing the Switching Power Supply and Pulse Transformer Boards.
   - If the fuse does not blow, continue with Testing the Control and Field Board Connections on page 16.

Testing the Switching Power Supply and Pulse Transformer Boards

1. Remove power from the drive (see page 42).
2. Replace the fuses on the switching power supply board (see page 61).
3. Remove the switching power supply board from the drive (see page 62).
4. Reapply power to the switching power supply board only.
   - If the power supply fuses do not blow, continue with step 5 below.
   - If the power supply fuses blow, replace the switching power supply board (see page 62).
5. Remove all incoming AC voltage from the drive.
6. Check all external wiring connected to the pulse transformer board, including the motor PTC if used, for a possible short circuit condition. Repair any short circuit conditions if found.
7. If no short circuit conditions exist, replace the pulse transformer board (see page 62).

Testing the Control and Field Board Connections

1. Using an ohmmeter, check all input and output wiring on terminals 1...40 on terminal blocks TB1 and TB2 on the control board for a possible short circuit condition. Repair any short circuit conditions if found.
2. If an encoder and/or tachometer is used, use an ohmmeter to check all wiring on the respective terminals for a possible short circuit condition. Repair any short circuit conditions if found.

3. Remove the cables from connector XR and XFCD on the control board and use an ohmmeter to check between all voltage test points and common on the control board for possible short circuit conditions. The ohmmeter measurements should be greater than 200 kΩ. If any low resistance measurements are found, replace the control board.
4. Using an ohmmeter, measure between pins 1 and 2 and pins 3 and 2 on the XFCD cable connector. The resistance measurement for both tests should be greater than 200 kΩ. If a lower resistance value is measured, replace field board.

Figure 1 - Control Board Testpoints - Upper Left

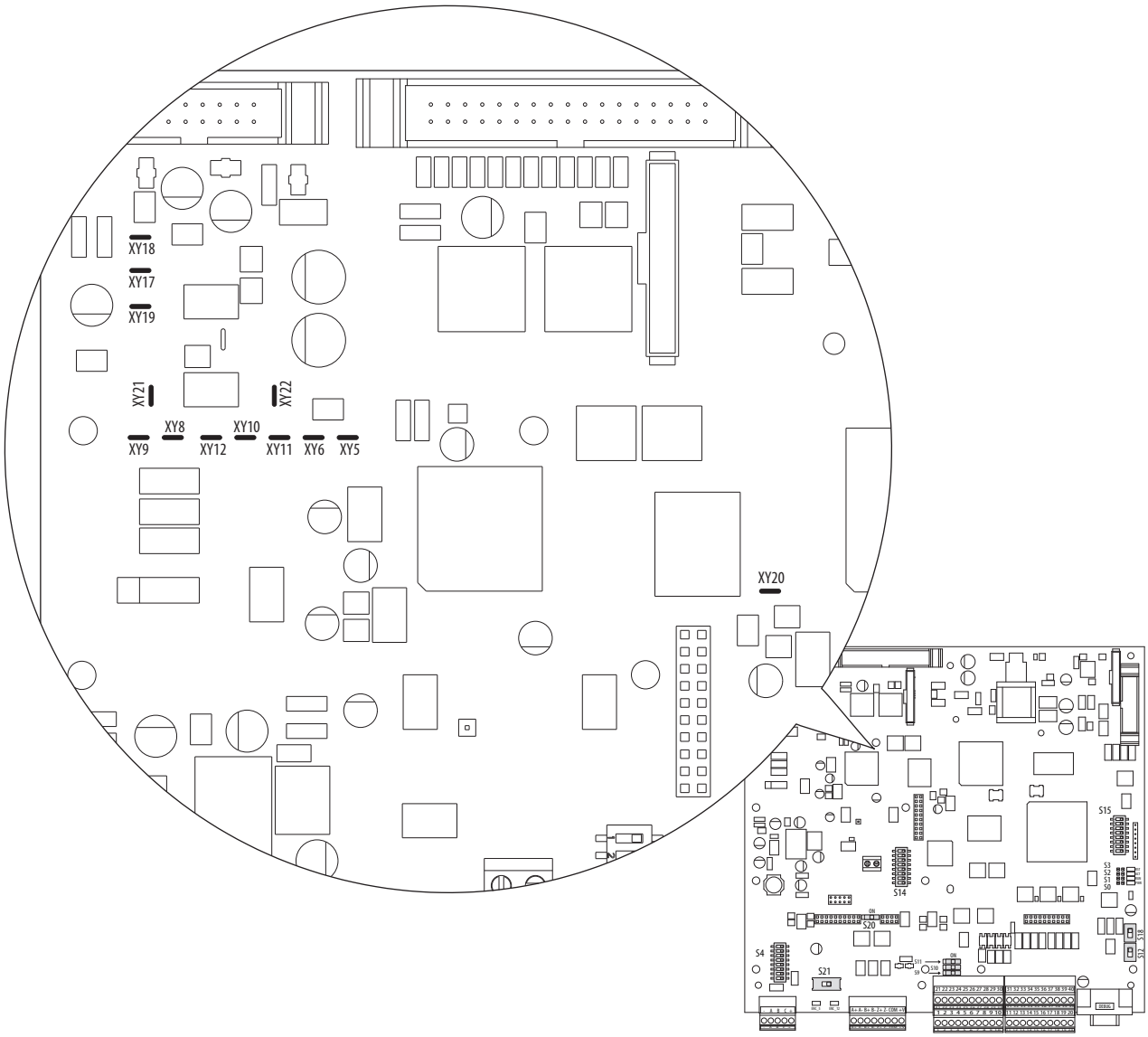
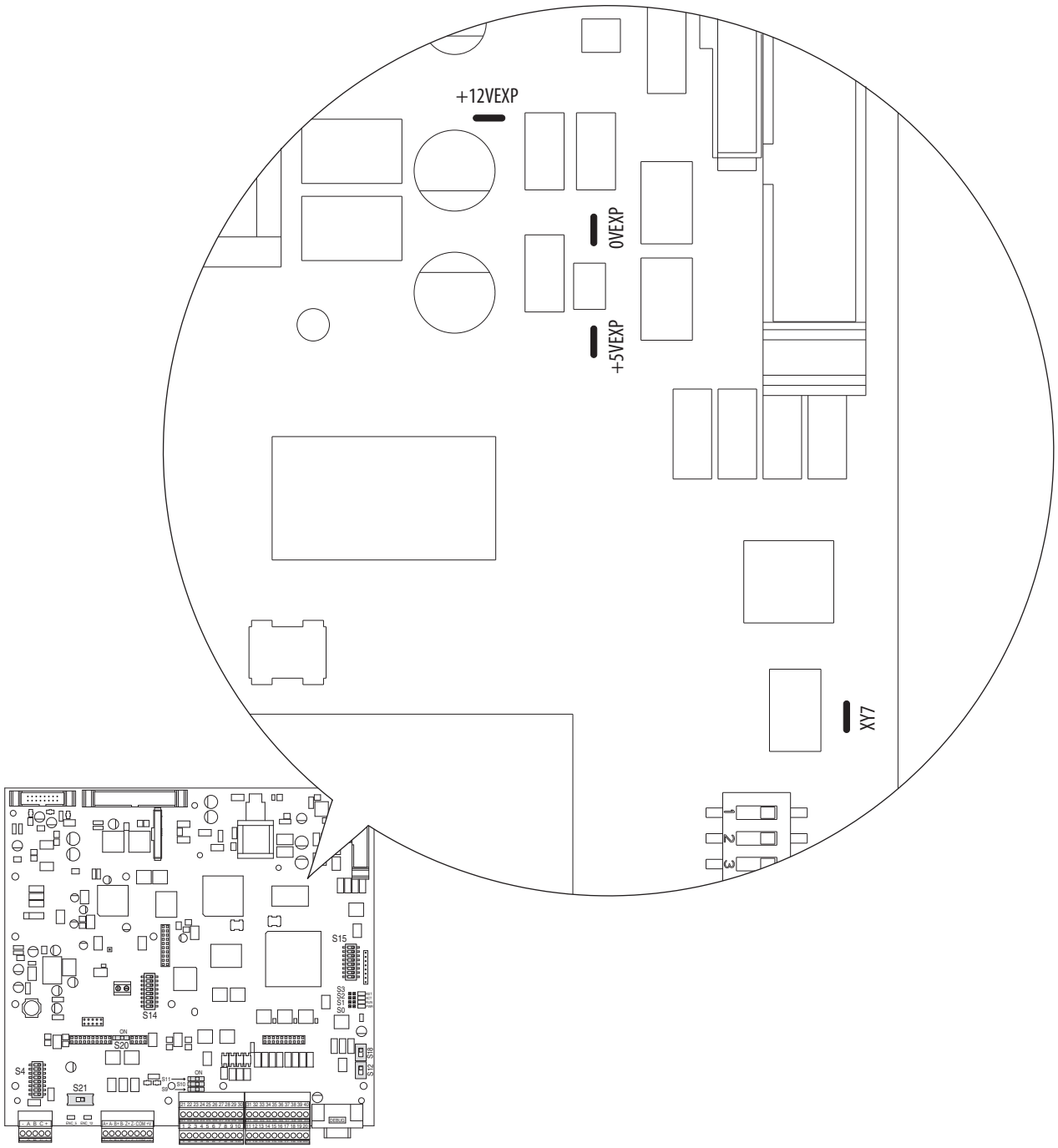


Figure 2 - Control Board Testpoints - Upper Right



Troubleshoot an AC Undervoltage Fault

If the drive faults with a code F4 'AC Undervoltage' fault, or parameter 466 [AC Line Voltage] does not equal the expected incoming AC line voltage, measure the AC line input signals as directed in the steps below.

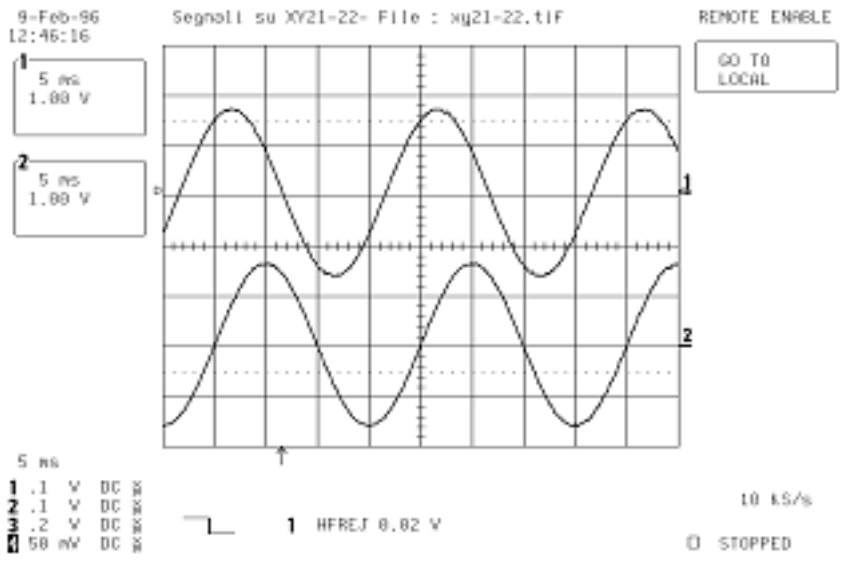
1. Read the General Safety Precautions on page 10.
2. Remove the protective covers (see page 43).
3. Using a voltmeter, measure the voltage at terminals U, V, and W of the drive.

   If an AC input contactor is used, the voltage must be measured on both the input and output sides of the contactor.

   If any of the voltage measurements is incorrect or missing, remove incoming AC power and verify the wiring to the drive and the power supply source and correct any problems.
4. Using a voltmeter, measure the combined voltages of the AC lines on the following testpoints on the control board (all waveforms have a 2.5V offset). See Figure 1 on page 17 and Figure 2 on page 18 for location of the testpoints. Also, see Figure 16 on page 109 for a schematic diagram.

Table 1 - Combined AC Line Input Signal Testpoints

Incoming AC Line Voltage	Phases	Measure from Testpoint	…	To Testpoint	Peak to Peak Measurement	RMS Measurement
240V AC	V and U	XY22	…	XY18	1.42V AC	0.500V
	V and W	XY21	…	XY18		
480V AC	V and U	XY22	…	XY18	2.95V AC	1.040V
	V and W	XY21	…	XY18		
575V AC	V and U	XY22	…	XY18	2.85V AC	1.007V
	V and W	XY21	…	XY18		
690V AC	V and U	XY22	…	XY18	3.45V AC	1.220V
	V and W	XY21	…	XY18		



- If any of the voltage measurements above are incorrect or missing, continue with step 5.
- If the voltage measurements above are correct but the value of parameter 466 [AC Line Voltage] is incorrect, replace the control board.

5. Remove the ribbon cable connected to XR on the control board and pulse transformer board and test the continuity of the cable using the measurements in Table 24 on page 118.

If the measurements on the XR cable are correct, replace the pulse transformer board.

Troubleshoot an Armature Bridge Failure

If the drive is running unstable or faults with a code F13 'Overcurrent' fault, an armature bridge failure may have occurred. All of the signals going to and coming from the SCR bridges are transmitted via the ribbon cable connected to XR on the control board and can be measured at these points. See Figure 29 on page 121 for location of the XR connector on the control board.

IMPORTANT These checks cannot be completed with an AC contactor in use.

1. Read the General Safety Precautions on page 10.
2. Remove the protective covers (see page 43).
3. If using a DC output contactor, disconnect the cable from XR on the control board and measure the signal for each SCR gate as indicated in this table:

Signal Name	XR Cable Pin	Gate		Note
		MP	MN	
IT1	27	G1	G04	
IT2	29	G2	G05	
IT3	31	G3	G06	
IT4	21	G4	G01	
IT5	23	G5	G02	
IT6	25	G6	G03	
MN	33	–	–	Negative bridge MN - active when high (+5V)
MP	34	–	–	Positive bridge MP - active when high (+5V)

Figure 3 and Figure 4 on page 21, and Figure 5 on page 22 are examples representing gate pulse, current and voltage signal measurements taken on an SCR. In the figures below:

- The current signal is taken on the testpoint XY17 (+2.5V offset; +0.6V=Drive size current).
- The voltage signal is taken on the testpoint XY19 (+2.5V offset).
- The ground signal is taken on either testpoint XY10 or XY18.

Figure 3 - Good SCR Gate Pulse and Armature Current Signals Example

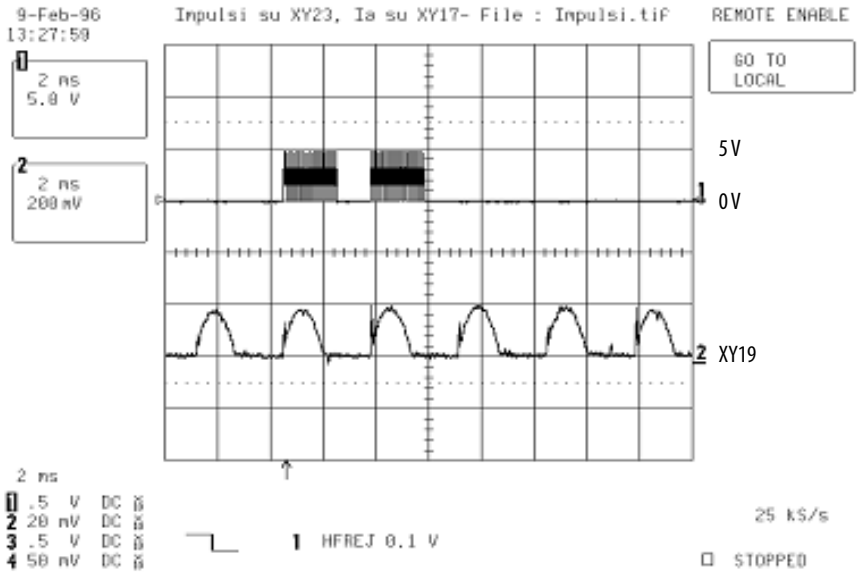
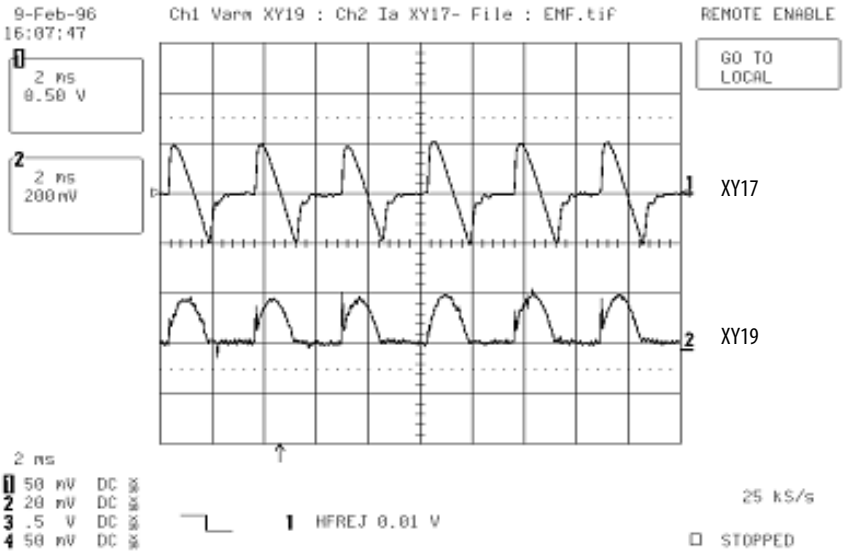
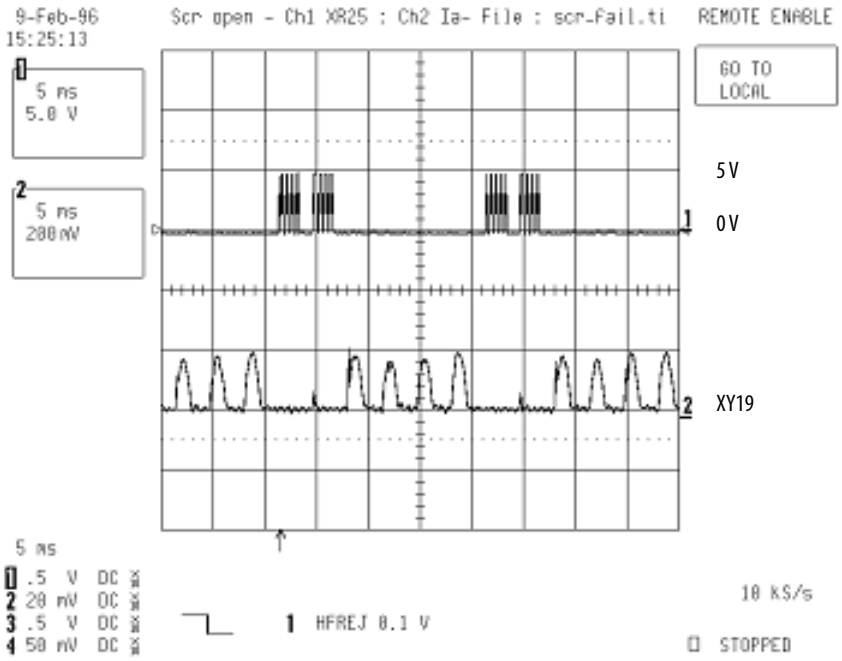


Figure 4 - Good SCR Armature Voltage and Motor Current Signal Example



A malfunctioning thyristor is connected to the relative gate. For example, if the tested signal is at XR25 and the positive bridge is active (MP high) from this figure you can deduce that SCR connected to gate G6 is open.

Figure 5 - Open Thyristor Example



Troubleshoot a Field Current Loss Fault

If the drive faults with a code F6 'Field Current Loss' fault, and there is low or incorrect field current present at the motor, as seen in parameter 351 [Field Current], complete the steps in Low or Incorrect Field Current. If the drive faults with a code F6 'Field Current Loss' fault, and there is no field current present at the motor, as seen in parameter 351 [Field Current], complete the steps in No Field Current on page 24.

Low or Incorrect Field Current

Note: For a flow chart version of these steps, see Low or Incorrect Field Current on page 126.

1. Read the General Safety Precautions on page 10.
2. Verify the actual value of parameter 351 [Field Current] by measuring the DC motor field current using a DC clamp.
3. Verify that the drive rated field bridge current is set correctly in parameter 374 [Drv Fld Brdg Cur] and DIP switch S14 is configured to correctly (according to the instructions in the PowerFlex Digital DC Drive User Manual, publication 20P-UM001) and make any necessary corrections. See Control Board on page 121 for DIP switch location.

4. Verify that the value of parameter 280 [Nom Mtr Fld Amps] matches the rated field current value on motor nameplate and make any necessary corrections.
5. Remove the protective covers (see page 43).
6. Measure the field current signal on the green LA-LB terminal located on the control board: LA is the ground and LB is field current signal. The measured value of the field current at LA-LB should be equal to the value of parameter 374 [Drv Fld Brdg Cur]. If these values are equivalent, the voltage across these terminals should be 1.66 VDC.

   Note: For lower field current values, the voltage will be proportional. For example, if the field is set up for 2 A and the motor is rated for 1.5 A, the measurement at LA-LB will be 1.245 VDC (1.5 / x = 2 / 1.66).
   - If the voltage measurement is incorrect, continue with step 7 below.
   - If the voltage measurement is correct, but the code F6 'Field Current Loss' fault still exists, replace the control board (see page 55).
7. Using an ohmmeter, measure the resistance across terminals LA-LB to verify that the value equals the equivalent resistance as indicated in the table below (set with DIP switch S14 on the control board).

Switch Ohms:		**168.5**	**333.3**	**182**	**36.4**	**845**	**1668**	**3333**	**–**	**Equivalent Resistance**
Field Current Scale	**Field Supply**	**S14-1**	**S14-2**	**S14-3**	**S14-4**	**S14-5**	**S14-6**	**S14-7**	**S14-8**	**Ohm**
1 A	10 A	OFF	OFF	OFF	OFF	OFF	ON	Not used (OFF)		1668
2 A		OFF	OFF	OFF	OFF	ON	OFF			845
3 A		OFF	OFF	OFF	OFF	ON	ON			560.9
5 A		OFF	ON	OFF	OFF	OFF	OFF			333.3
10 A		ON	OFF	OFF	OFF	OFF	OFF			168.5
13 A	14 A	ON	OFF	OFF	OFF	ON	ON			129.6
17 A	20 A	OFF	ON	ON	OFF	ON	ON			97.3
20 A		ON	OFF	ON	OFF	OFF	ON			83.1

   - If the resistance measurement is incorrect, replace the field board (see page 75).

No Field Current

Note: For a flow chart version of these steps, see No Field Current on page 125.

1. Read the General Safety Precautions on page 10.
2. Remove the protective covers (see page 43).
3. Verify that the correct AC voltage is present at terminals U1 and V1 at the top of the field fuse holder mounted on the control panel. See Figure 18 on page 110 for a schematic diagram.
   - If the voltage is correct, continue with step 4 below.
   - If the voltage is incorrect or missing, remove power from the drive and verify the wiring to the drive and the power supply source and correct any problems. Test the voltage level again to verify that it is correct. If the voltage is correct, but the fault persists or parameter 351 [Field Current] is incorrect, continue with step 4 below.
4. Remove AC power to the drive and check the fuses at FU1 and FV1. See Remove Power from the Drive on page 42.
   - If the fuses are blown, complete the steps in Test Field Wiring and Voltage Signals.
   - If the fuses are not blown, complete the steps in Test Field Control Signals.

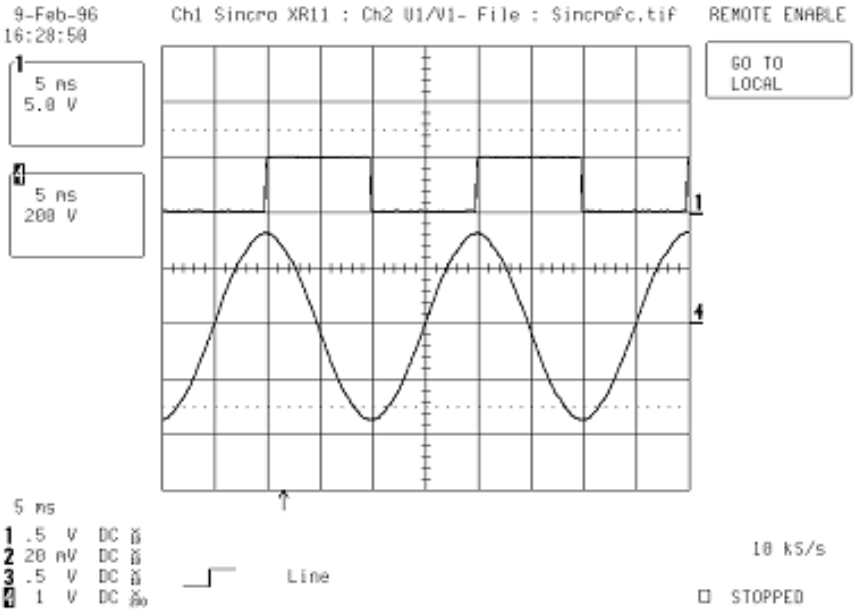
Test Field Wiring and Voltage Signals

1. Test the resistance of the motor field wiring and motor field for possible short circuits.
   - If there are no short circuits, continue with step 2 below.
   - If a short circuit exists, correct any problems.
2. Check the field SCR/dual diode module for a short circuit condition (see page 32).
   - If there are no short circuits, continue with step 3 below.
   - If a short circuit exists, replace the field SCR/dual diode module (see page 77).
3. Replace the field fuses at FU1 and FV1 and apply power to the drive.
4. If the field fuses blow, replace the field board (see page 75).

Test Field Control Signals

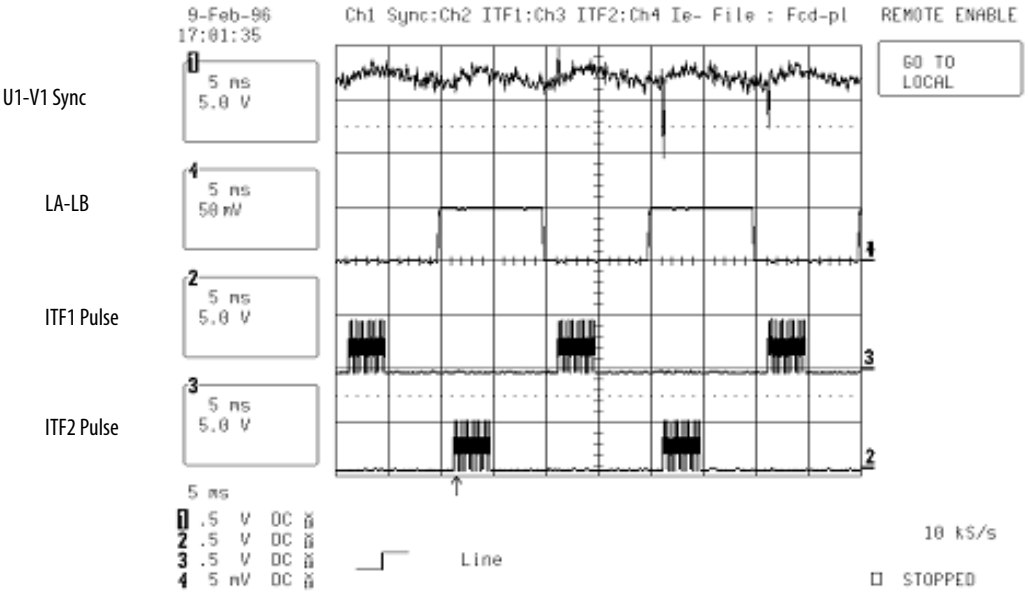
1. Disconnect the cable from connector XR on the control board and measure the U1-V1 voltage synchronization signal at pin 11 on the cable. See Figure 29 on page 121 for location of the XR connector on the control board.

This signal is a square wave signal with a 90° lag phase displacement compared to the AC voltage signal.



2. Measure the gate signals at pins XR-1 and XR-2 on the cable. The figure below displays the following signals from top to bottom:

Channel	Signal
1	U1-V1 Sync
4	Ie - LEM current feedback signal taken on LA-LB terminal
2	ITF1 pulse
3	ITF2 pulse



- If the gate signals are missing, replace the control board (see page 55).
- If the gate signals are present, replace the field board (see page 75).

Power Component Test Procedures

Check the Armature SCR Modules

The frame B PowerFlex® DC drive armature supply consists of three (non-regenerative drives) or six (regenerative drives) SCR modules mounted on heat sinks within the legs assemblies. A malfunction of any of these devices will be indicated by either a code F13 'Overcurrent' fault, blown or tripped incoming protection devices, or erratic motor operation. The following procedure can be used if an armature bridge component malfunction is suspected.

1. Read the General Safety Precautions on page 10.
2. Verify that contactor power (if used) is removed.
3. Verify that power to an external field supply (if used) is removed.
4. Check the anode to cathode junction of each SCR. With a digital multimeter set to Ohms, measure the resistance across the SCRs (lead orientation is not critical).
   - For regenerative drives, see Table 2 on page 26 and Figure 6 on page 27.
   - For non-regenerative drives, see Table 3 on page 28 and Figure 7 on page 28.

   If a low resistance is detected, determine which SCR module(s) is/are damaged based on the tables below and replace that module (see page 80).

Table 2 - SCR Anode to Cathode Junction Measurements for Regenerative Drives

On SCR Module	SCR	Measure from Terminal	To Terminal	Nominal Meter Reading
1	1	U	C	"open circuit" or "MΩ" range
	4	U	D	
2	2	V	C	
	5	V	D	
3	3	W	C	
	6	W	D	
01	01	U	C	
	04	U	D	
02	02	V	C	
	05	V	D	
03	03	W	C	
	06	W	D	

Figure 6 - Regenerative Drive SCR Module Layout

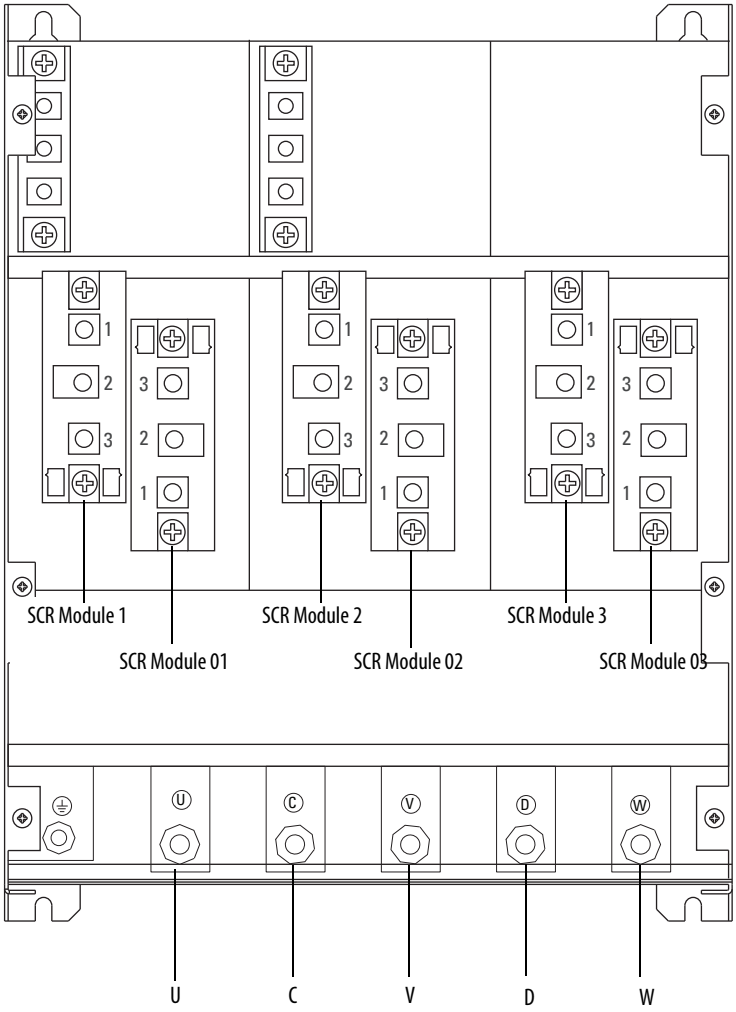
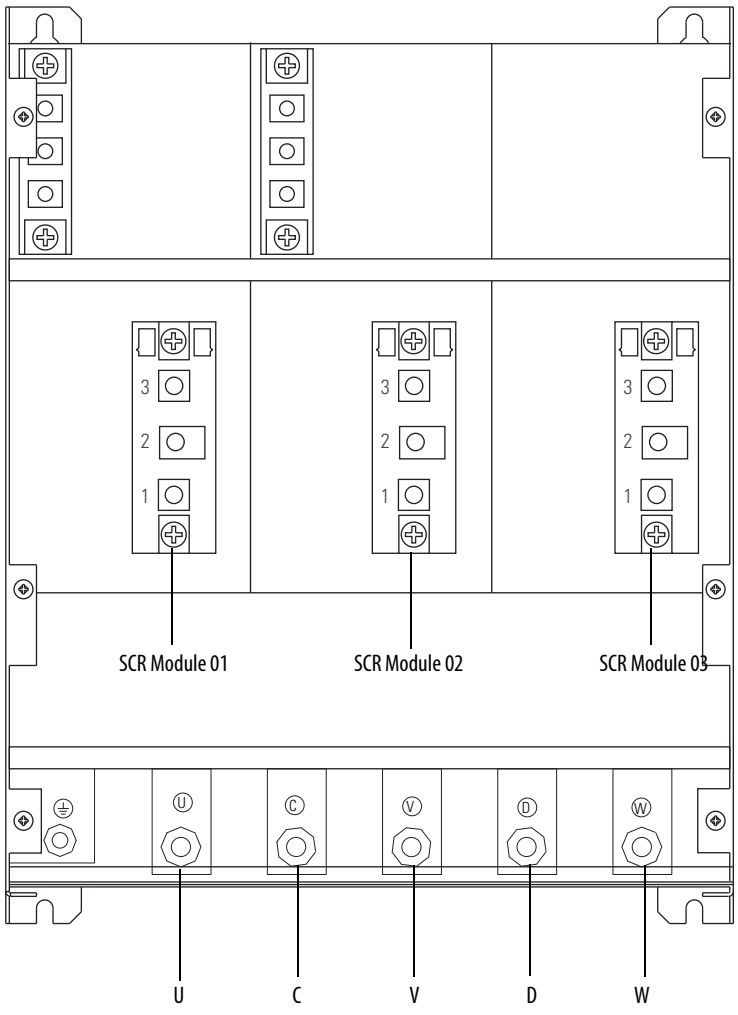


Table 3 - SCR Anode to Cathode Junction Measurements for Non-Regenerative Drives

On SCR Module	SCR	Measure from Terminal	To Terminal	Nominal Meter Reading
01	01	U	C	"open circuit" or "MΩ" range
	04	U	D	
02	02	V	C	
	05	V	D	
03	03	W	C	
	06	W	D	

Figure 7 - Non-Regenerative Drive SCR Module Layout



5. Check the gate to cathode junction of each SCR. With a digital multimeter set to Ohms, measure the resistance of each SCR junction.
   - For regenerative drives, see Table 4 on page 29 and Figure 8 on page 29.
   - For non-regenerative drives, see Table 5 on page 30 and Figure 9 on page 30.

If a measurement is outside of the range specified in the table, or if one reading deviates significantly from the majority, then module replacement may be necessary (see page 80).

Table 4 - SCR Gate to Cathode Junction measurements for Regenerative Drives

On SCR Module	SCR	Measure from	To	Nominal Meter Reading
1	1	Pin 5	Pin 4	5…20 Ω (1)
	4	Pin 6	Pin 7	
2	2	Pin 5	Pin 4	
	5	Pin 6	Pin 7	
3	3	Pin 5	Pin 4	
	6	Pin 6	Pin 7	
01	01	Pin 6	Pin 7	
	04	Pin 5	Pin 4	
02	02	Pin 6	Pin 7	
	05	Pin 5	Pin 4	
03	03	Pin 6	Pin 7	
	06	Pin 5	Pin 4	

(1) The actual reading varies depending upon the SCR manufacturer. Verify that the actual measured value is consistent for all SCRs.

Figure 8 - SCR Gate Lead Connection Pinouts for Regenerative Drives

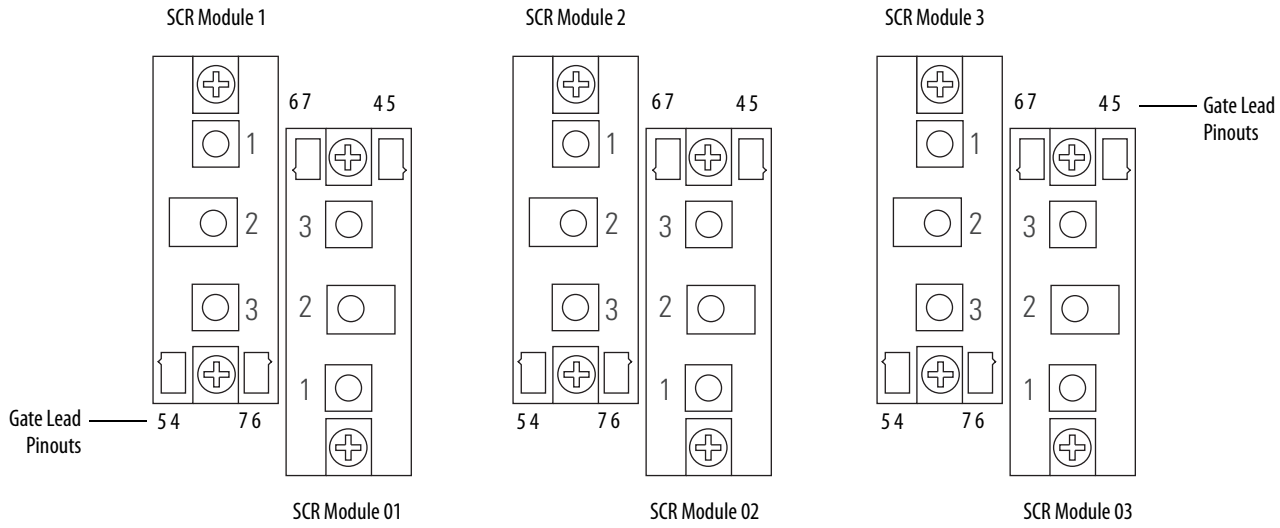
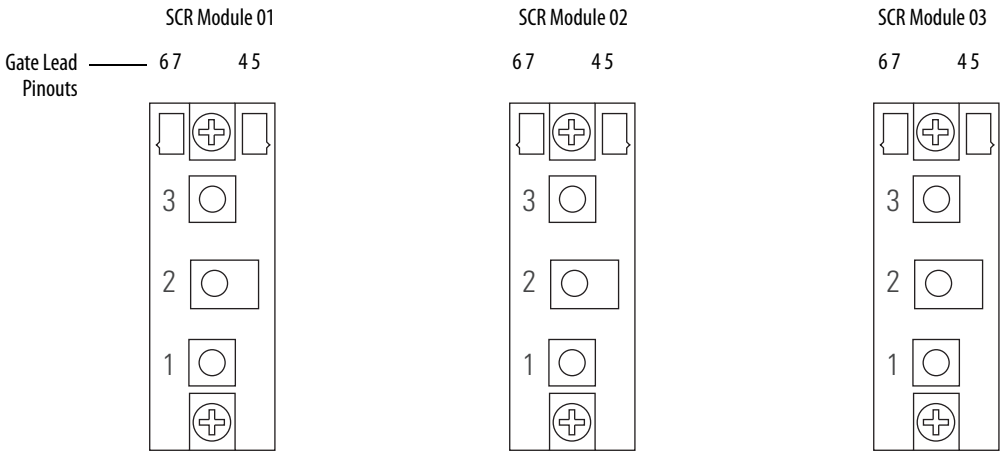


Table 5 - SCR Gate to Cathode Junction Measurements for Non-Regenerative Drives

On SCR Module	SCR	Measure from	To	Nominal Meter Reading
01	01	Pin 6	Pin 7	5…20 Ω (1)
	04	Pin 5	Pin 4	
02	02	Pin 6	Pin 7	
	05	Pin 5	Pin 4	
03	03	Pin 6	Pin 7	
	06	Pin 5	Pin 4	

(1) The actual reading varies depending upon the SCR manufacturer. Verify that the actual measured value is consistent for all SCRs.

Figure 9 - SCR Gate Lead Connection Pinouts for Non-Regenerative Drives



Check the Pulse Transformer Board

The armature pulse transformer circuit board contains an isolated gate firing circuit and also provides dv/dt protection for the armature SCR modules. A malfunction of these devices will be indicated by either a code F13 'Overcurrent' fault, blown or tripped incoming protection devices or erratic motor operation. Use the following procedure if a malfunction in this circuitry is suspected.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the pulse transformer board (see page 62).
4. With a digital multimeter set for a "continuity check", measure each connection point on the pulse transformer board listed in the tables below. See Figure 27 on page 116 for connector locations.

   If any of the actual measurements are out of tolerance, replace the pulse transformer board (see page 62).

Table 6 - Armature Pulse/Snubber Circuit Measurements for Regenerative Drives

For SCR	Measure From	To	Meter Reading	Connector XY Pinout
1	KG1	XY-4	"open circuit"	
4	KG4	XY-1		
2	KG2	XY-5		
5	KG5	XY-2		
3	KG3	XY-6		
6	KG6	XY-3		
01	KG01	XY-1		
04	KG04	XY-4		
02	KG02	XY-2		
05	KG05	XY-5		
03	KG03	XY-3		
06	KG06	XY-6		

Table 7 - Armature Pulse/Snubber Circuit Measurements for Non-Regenerative Drives

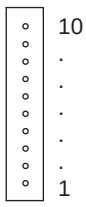
For SCR	Measure From	To	Meter Reading	Connector XY Pinout
01	KG01	XY-1	"open circuit"	
04	KG04	XY-4		
02	KG02	XY-2		
05	KG05	XY-5		
03	KG03	XY-3		
06	KG06	XY-6		

5. With the digital multimeter set to "diode test", measure each connection point on the pulse transformer board listed in the tables below. If any of the actual measurements are out of tolerance, replace the pulse transformer board (see page 62).

Table 8 - Armature Pulse Transformer Primary Measurements for Regenerative and Non-Regenerative Drives

For SCR	(+) Meter Lead	(-) Meter Lead	Meter Reading	Connector XY Pinout
1/01	XY-8	XY-1	0.41 Ω	
4/04	XY-8	XY-4		
2/02	XY-8	XY-2		
5/05	XY-8	XY-5		
3/03	XY-8	XY-3		
6/06	XY-8	XY-6		

Table 9 - Armature Pulse Transformer Primary Measurements for Regenerative Drives

For SCR	(+) Meter Lead	(-) Meter Lead	Meter Reading	Connector XY Pinout
1	XY-7	XY-1	0.41 Ω	
4	XY-7	XY-4		
2	XY-7	XY-2		
5	XY-7	XY-5		
3	XY-7	XY-3		
6	XY-7	XY-6		

Check the Field SCR/Dual Diode Module

The field supply consists of a dual pack SCR/dual diode module arranged in a single–phase full wave rectifier configuration. Malfunction of either of these components may cause various responses including field and velocity related faults, or blown fuses. The following procedures can be used if field bridge malfunctions are suspected.

1. Read the General Safety Precautions on page 10.
2. Remove and lock-out all incoming power to the drive (see page 42).
3. Remove the protective covers (see page 43).
4. Verify that contactor power (if used) is removed.
5. Verify that power to an external field supply (if used) is removed.
6. Disconnect the field wires from C1 and D1. See Figure 10 on page 33.
7. Check the anode to cathode junction of the field SCR/dual diode module. With the digital multimeter set to "diode test", measure the resistance across the modules. See Table 10 and Figure 10.

   If a low resistance is detected, replace the modules (see page 77).

   If a measurement results in an "infinity" reading, check the fuses at FU1 and FV1 on the control panel to determine if they are open. See Figure 11 on page 33.

Table 10 - Field SCR/Dual Diode Module Anode to Cathode Junction Measurements

(+) Meter Lead Terminal	(-) Meter Lead Terminal	Nominal Meter Reading
U1	C1	0.45V
U1	D1	open or infinity
V1	C1	open or infinity
V1	D1	open or infinity
C1	D1	open or infinity
C1	U1	open or infinity
C1	V1	open or infinity
D1	C1	0.9V
D1	U1	0.45V
D1	V1	open or infinity

Figure 10 - Field Terminal Block Location

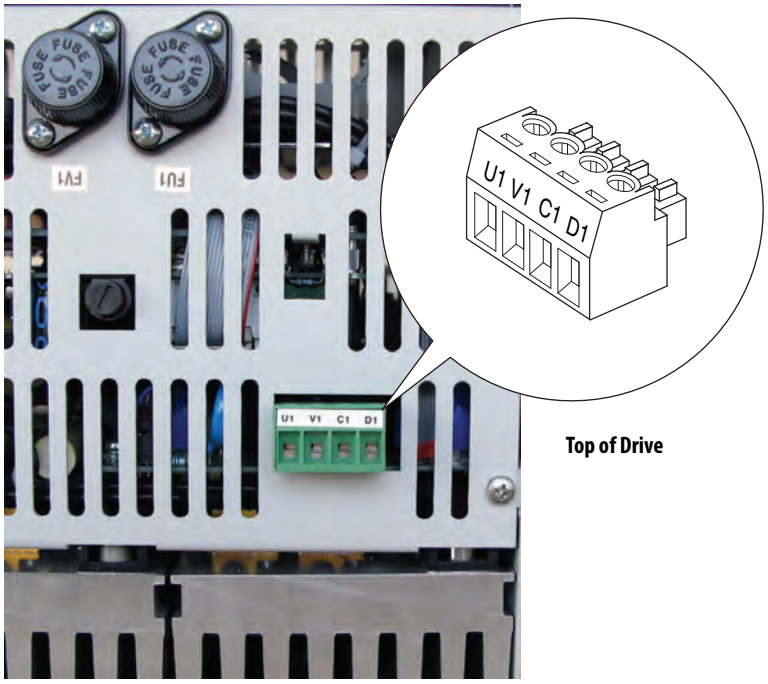
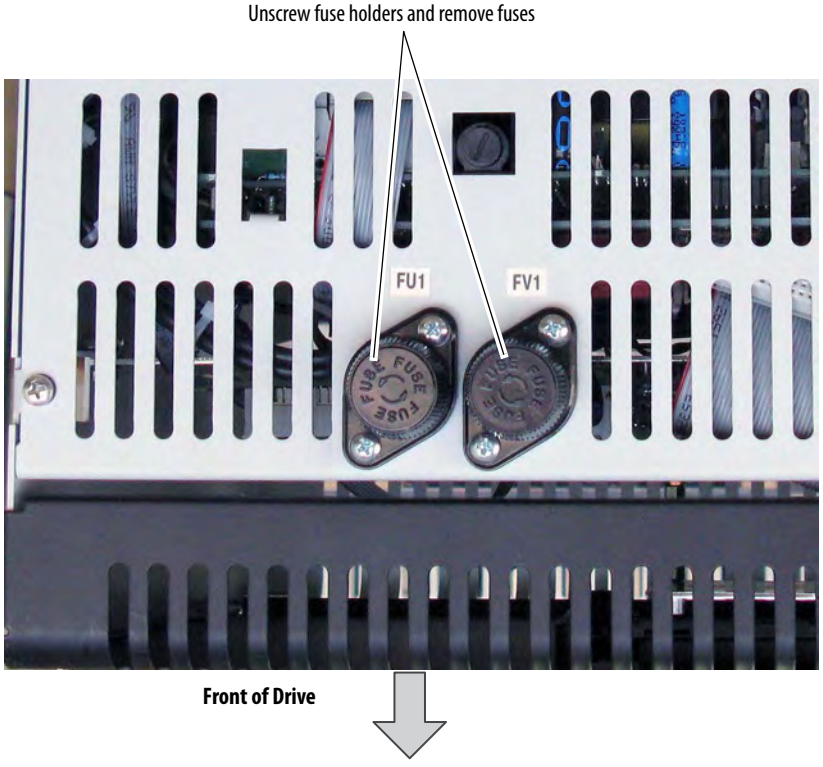


Figure 11 - Field Fuses Location

Top view of Drive



8. Remove the cable from connector XP on the pulse transformer circuit board. See Figure 27 on page 116 for connector location.

9. Check the gate cathode junction of the field SCR/dual diode module. With the digital multimeter set to "diode test" measure the resistance across the modules (lead orientation is not critical). See Table 11.

   If a low resistance is detected, replace the SCR/dual diode module (see page 77).

Table 11 - SCR/Dual Diode Module Gate Cathode Junction Measurements

Measure from	To	Nominal Meter Reading
XP1	XP2	10…20 Ω
XP3	XP4	

Speed Feedback Device Tests

Check the Encoder

The encoder feedback device provides a dual channel quadrature output waveform and requires that the output be differential line drivers at +5 or +12...15V signal levels. The encoder power supply voltage and input selection is controlled by DIP switch S21 on the control board (see "DIP Switch and Jumper Settings" in the PowerFlex Digital DC Drive User Manual, publication 20P-UM001). The encoder power supply from the drive can be measured from +V (+) to COM (-) with a digital multimeter. If S21 is set to ENC_5, the voltage level should be +2.5...5.4V. If S21 is set to ENC_12, the voltage level should be +5.4V...15.2V. For reference, see Figure 21 on page 112 for a schematic diagram.

The Channel A and Channel B are square wave type outputs that are 90 degrees out of phase. When rotating in the counter clockwise direction, as viewed from the commutator end, Channel A leads Channel B. Each differential channel has an inverted and non–inverted signal.

Power for the encoder is provided internally and is capable of 200mA of current with a current foldback feature that protects the power supply should the current draw exceed 200mA. If different power supply requirements exist for the chosen feedback device, the supply must be provided external to the drive.

The frequency is proportional to speed and the pulse rate of the encoder, referred to as the "Pulse/Rev" rating on the nameplate. The speed of the motor can be calculated by: Speed (RPM) = [Frequency (Hz) x 60]/[Pulses/Revolution].

Check the DC Tachometer

- Verify that DIP switch S4 on the control board is set to the correct input voltage of the DC analog tachometer. See "DIP Switch and Jumper Settings" in the PowerFlex Digital DC Drive User Manual, publication 20P-UM001. Also, see Figure 22 on page 112 for a circuit diagram.
- The analog tach signal is fine scaled using parameter 562 [Anlg Tach Gain].
- See "Drive Reference and Feedback Scaling" in Appendix C of the PowerFlex Digital DC Drive User Manual, publication 20P-UM001, for more information.

Check the Resolver Interface Board

The resolver feedback option module uses the resolver feedback board for resolver connections, and the resolver interface board for external power, status, feedback board reset, and encoder output connections.

If a code F93 `Resolver Error' fault occurs and the resolver wiring and configuration are correct, the following light-emitting diode indicators and testpoints on the resolver interface board can be used to verify that the board is not damaged.

- Verify that the following light-emitting diodes are functioning as expected. See Figure 12 on page 36 for light-emitting diodes locations and switch settings.

Light-emitting Diode Code	Light-emitting Diode Color	On State	Off State
D3	Red	24V overload (fuse F1 blown). This fuse is self-resetting when it returns to normal operating temperature.	24V supply is OK.
D10	Green	12V supply is OK.	Loss of 12V power.
D11	Green	Resolver feedback board voltage is OK.	Voltage error on resolver feedback board.
D12	Blue	Switch S1 is set to +24V for encoder signal output on TB2.	S1 is not set for +24V.
D16	Yellow	Switch S1 is set to +12V for encoder signal output on TB2.	S1 is not set for +12V.
D18	Green	Switch S1 is set to +5V for encoder signal output on TB2.	S1 is not set for +5V.
D26	Red	Resolver feedback board is in reset mode.	Resolver feedback board not in reset mode.

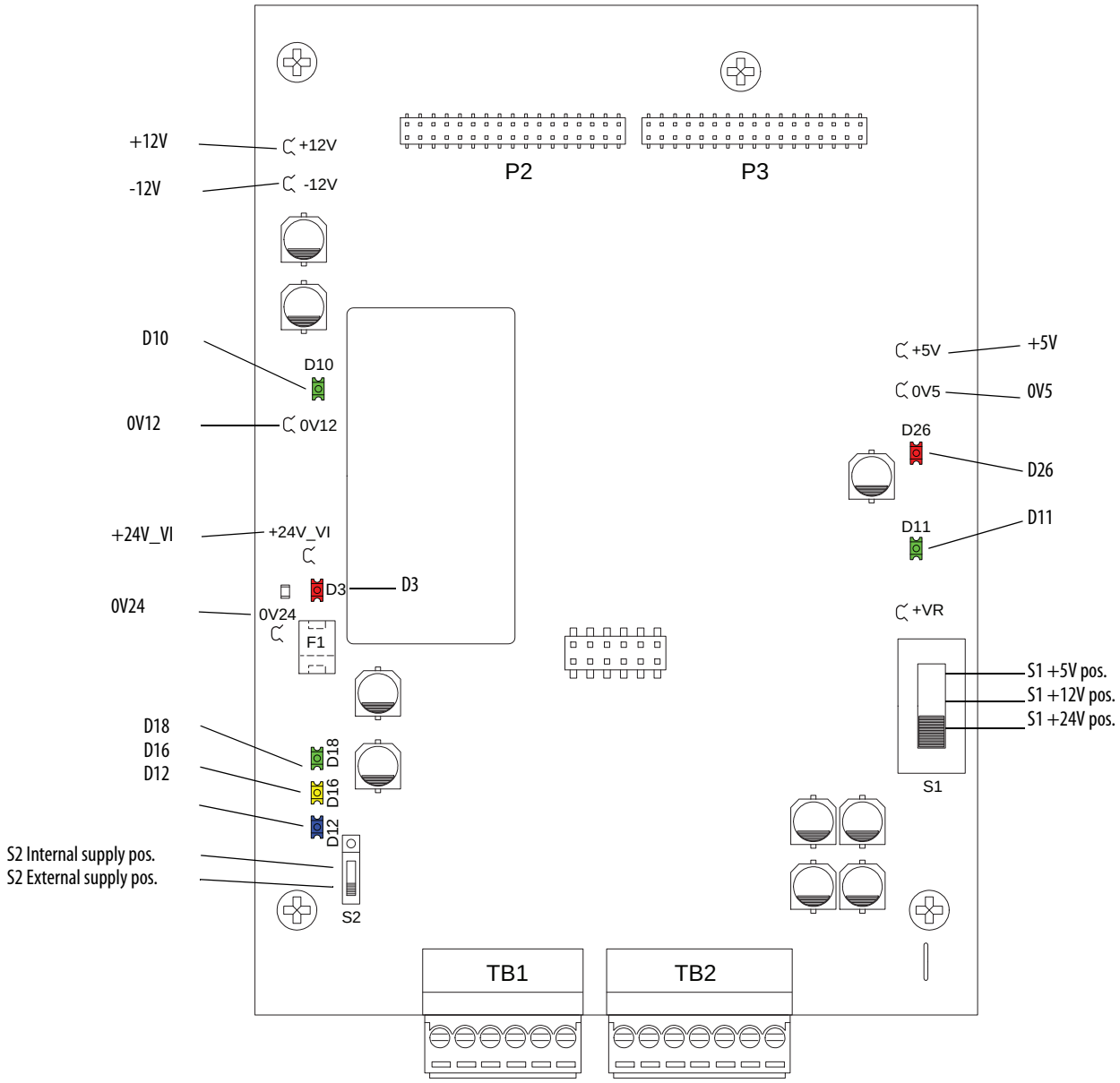
If any of the light-emitting diodes that should turn on when control power is applied fail to do so, verify that the resolver interface and resolver feedback boards are properly seated on the appropriate connectors (XRE, P2, P3). If problems persist, replace the resolver interface and/or resolver feedback board (see page 48).

- Measure the signal voltage at the testpoints as indicated in the following table. See Figure 12 on page 36 for testpoint locations.

Testpoint	to	Testpoint	Measurement
+12V	…	0V12	12V DC ±5%
-12V	…	0V12	-12V DC ±5%
+24V_VI	…	0V24	24V DC ±5%
+5V	…	0V5	5V DC ±5%

If any of the voltage measurements fails, replace the resolver interface board (see page 48).

Figure 12 - Resolver Interface Board Testpoint Locations



Thermistors and Thermal Switches

Motor overheating is detected by an external, user-supplied thermistor (PTC) or thermal switch connected to terminals 78 and 79 on the control power terminal block on the lower, right corner of the pulse transformer circuit board. See Figure 27 on page 116 for terminal block location.

Motor overheating is typically identified by a code F16 'Motor Over Temp' fault. See "Fault Descriptions" in Chapter 4 of the PowerFlex Digital DC Drive User Manual, publication 20P-UM001 for details. See Figure 23 on page 111 for a circuit diagram.

- If a thermal switch is used, a 1 kΩ resistor must be placed in series between the switch and either terminal 78 or 79.
- If neither a thermistor (PTC) or a thermal switch is installed, a 1 kΩ resistor must be connected between terminals 78 and 79.

The drive heatsink temperature is monitored by a bimetal thermostat connected directly to the heatsink. When the heatsink temperature is too high, a code F8"Heatsink OvrTemp" fault occurs. See "Fault Descriptions" in Chapter 4 of the PowerFlex Digital DC Drive User Manual, publication 20P-UM001 for details. See Figure 24 on page 113 for a circuit diagram.

During normal operation, 1.6V DC is present between terminal 78 and drive common. When an open circuit exists between terminals 78 and 79, 24V DC will be present at terminal 78 to drive common. If the 24V is missing, the pulse transformer board may need replacement.

Relay Outputs

Terminals 35 and 36 and 75 and 76 are N.O. relay outputs. The relay output between terminals 35 and 36 is configured with parameter 1392 [Relay Out 1 Sel]. The relay output between terminals 75 and 76 is configured with parameter 629 [Relay Out 2 Sel]. See "Using Contactors" in Chapter 1 of the PowerFlex Digital DC Drive User Manual, publication 20P-UM001, for more information.

The code F10 'Main Contactor' fault indicates a problem related to a contactor used with the drive. See "Fault Descriptions" in Chapter 4 of the PowerFlex Digital DC Drive User Manual, publication 20P-UM001 for details.

Create a Fault Report

A Technical Support wizard is available in the DriveExecutive and Connected Components Workbench software application. The wizard gathers information about the hardware, firmware, non-default parameters, and the fault and alarm queues, including time stamps. The logged data can be saved as a text (.txt) file.

Complete fault reports are critical for analysis and repair of modules returned to the factory. At a minimum, perform and record the following:

- Record the contents of the fault queue (faults and times of occurrence). See the PowerFlex Digital DC Drive User Manual, publication 20P-UM001, for detailed Fault and Alarm codes and descriptions.
- Make a record of any burn marks on the printed circuit boards, cabling, bus bars, and SCR modules.
- Make a record of any liquid and condensation marks on the printed circuit boards, components and mechanical parts.
- Make a record of the amount of dust and other additional particles on the drive and drive components.
- Make a record of any mechanical damage to the drive and drive components.
- Record the size and type of main fuses.
- Record any other important marks and damage.

What You Need When You Call Tech Support

When you contact Technical Support, please be prepared to provide the following information:

- Order number
- Product catalog number and drives series number (if applicable)
- Product serial number
- Firmware revision level
- Most recent fault code
- Your application

You can use the table below to record the data provided in each PowerFlex DC drive parameter listed.

Param(s)	Name	Description	Parameter Data
1349	Status1 at Fault	Captures and displays Par 381 [Drive Status 1] bit pattern at the time of the last fault.	
1350	Status2 at Fault	Captures and displays Par 382 [Drive Status 2] bit pattern at the time of the last fault.	
1351…1360	Fault x Code	A code that represents the fault that tripped the drive. The codes will appear in these parameters in the order they occur (for example, [Fault 1 Code] = the most recent fault).	
1361…1370	Fault x Time	The time between initial drive power up and the occurrence of the associated trip fault.	
1371	Fault Arm Amps	Captures and displays the armature current (as a percentage of rated current) at the time of the last fault.	
1372	Fault Speed	Captures and displays the output speed (rpm) of the drive at the time of the last fault.	
1373	Fault Field Amps	Captures and displays the field current (as a percentage of rated current) at the time of the last fault.	
1374	Fault Voltage	Captures and displays the armature voltage at the time of the last fault.	

Part Replacement Procedures

This chapter provides a list of spare parts and detailed procedures for removing and replacing drive components.

Replacement Parts Kits

Table 12 lists the spare parts kits available for PowerFlex DC frame B drives.

Table 12 - Spare Part Kits

Description	Kit Cat. No.	Instructions Page
Fuses/Fuse Holders		
Switching Power Supply Board (Revision H and Lower only) Fuse - Ferrule 5 x 20 mm, 3.15 A 250V (SW2-32) (1)	SK-20P-S7169	60
Switching Power Supply Board Fuse - Ferrule 5 x 20 mm, 2.5 A 250V (SW2-32) (2)	SK-20P-S8B29	
Switching Power Supply Board Fuse Holder	SK-20P-S7G84	60
Pulse Transformer Board (FIR1) Fuses (Qty 3) - Ferrule 6 x 32 mm, 16 A 500V	SK-20P-S824B	62
Field Circuit Fuses (Qty 2) - Ferrule 10 x 38 mm, 25 A 600V	SK-20P-S823B	74
Field Circuit Fuse Holder	SK-20P-S8N29	74
Accessories		
DPI / HIM Assembly	SK-DC1-CVR1-A1	42
Control Circuit Boards		
Resolver Feedback and Interface Boards	20P-RES-A0	48
I/O Expansion Board (TBO-32)	20P-S5V62	52
115V AC to 24V DC I/O Converter Board	20P-S520L	54
Control Circuit Board	SK-20P-S5RP1	55
Power Circuit Boards		
Pulse Transformer Board for 230V AC Regen. Drives, 146…434 A (FIR2-41)	SK-20P-S5N08	62
Pulse Transformer Board for 460/480V AC Regen. Drives, 167…412 A (FIR2-51)	SK-20P-S5N18	
Pulse Transformer Board for 575V AC Regen. Drives, 67…405 A (FIR2-61)	SK-20P-S5N421	
Switching Power Supply Board (SW2-32)	SK-20P-S5N10	62
Field Board (PFC2A-31)	SK-20P-S5N25	75
AC Line Snubber Board for 230V AC Regen. Drive (SN4-31)	SK-20P-S5N13	78
AC Line Snubber Board for 460/480V AC Regen. Drive (SN5-31)	SK-20P-S5N14	
AC Line Snubber Board 0.22 µF for 575V AC Regen. Drive (SN7-32)	SK-20P-S5N425	
AC Line Snubber Board 0.33 µF for 575V AC Regen. Drive (SN7-32)	SK-20P-S5N428	
Power Components		
AC Current Transducers (Qty 2), 600 A / 0.2 A	SK-20P-S777H	90
Field Dual Diode Module, 1K6V, 40 A	SK-20P-S799F	77
Field SCR Module, 1K6V, 25 A	SK-20P-S7F73	
Bimetal Thermostat, 80 °C ± 3 (Qty 2), 230V Regen. Drives, 360 and 434 A, 460/480V Regen. Drives, 330 and 412, or 575V Regen. Drive, 405 A	SK-20P-S7G29	94
Bimetal Thermostat, 85 °C ±3 (Qty 2), 230V Regen. Drives, 146…265 A, 460/480V Regen. Drives, 167…250 A, or 575V Regen. Drives, 67…270 A	SK-20P-S7G33	

Table 12 - Spare Part Kits (Continued)

Description	Kit Cat. No.	Instructions Page
SCR Modules (Qty 6) 1K2V 130 A, 230V AC Regen. Drives, 146 and 180 A	SK-20P-S7F48	80
SCR Modules (Qty 6) 1K2V 160 A, 230V AC Regen. Drive, 218 A	SK-20P-S7F49	
SCR Modules (Qty 6) 1K2V 210 A, 230V AC Regen. Drive, 265 A	SK-20P-S7F42	
SCR Modules (Qty 6) 1K2V 320 A, 230V AC Regen. Drives, 360 and 434 A	SK-20P-S727F	
SCR Modules (Qty 6) 1K6V 210 A, 460/480V AC Regen. Drive, 250 A	SK-20P-S7F41	
SCR Modules (Qty 3) 1K6V 210 A, 460/480V AC Non-Regen. Drive, 250 A		
SCR Modules (Qty 6) 1K6V 160 A, 460/480V AC Regen. Drive, 207 A	SK-20P-S7F79	
SCR Modules (Qty 3) 1K6V 160 A, 460/480V AC Non-Regen. Drive, 207 A		
SCR Modules (Qty 6) 1K2V 130 A, 460/480V AC Regen. Drive, 167A	SK-20P-S7F78	
SCR Modules (Qty 3) 1K2V 130 A, 460/480V AC Non-Regen. Drive, 167A		
SCR Modules (Qty 6) 1K6V 320 A, 460/480V AC Regen. Drives, 330 and 412 A	SK-20P-S737F	
SCR Modules (Qty 3) 1K6V 320 A, 460/480V AC Non-Regen. Drives, 330 and 412 A		
SCR Modules (Qty 6) 1K8V 130 A, 575V AC Regen. Drives, 67…135 A	SK-20P-S79F7	
SCR Modules (Qty 3) 1K8V 130 A, 575V AC Non-Regen. Drives, 67…135 A		
SCR Modules (Qty 6) 1K8V 250 A, 575V AC Regen. Drive, 270 A	SK-20P-S8HI6	
SCR Modules (Qty 3) 1K8V 250 A, 575V AC Non-Regen. Drive, 270 A		
SCR Modules (Qty 6) 1K8V 320 A, 575V AC Regen. Drive, 405 A	SK-20P-S79F9	
SCR Modules (Qty 3) 1K8V 320 A, 575V AC Non-Regen. Drive, 405 A		
Ventilation Components		
Cooling Fans, (Qty 2) 24V DC, 100 CFM, 230V AC Drives, 146…265 A, 460/480V AC Drives, 167…250 A, or 575V AC Drives, 67…270 A	SK-20P-S7G71	99
Cooling Fans, (Qty 2) 150 x 55 mm, 24V DC, 212 CFM, 230V AC Drives, 360 and 434 A 460/480V AC Drives, 320 and 412 A 575V AC Drives, 405 A	SK-20P-S7G78	

(1) This kit contains one fuse only. Order 1 kit for switching power supply circuit boards, revision "H" and lower.

(2) This kit contains one fuse only. Order 1 kit for switching power supply circuit boards, revision "H" and lower. Order 2 kits for switching power supply circuit boards, revision "I" and higher.

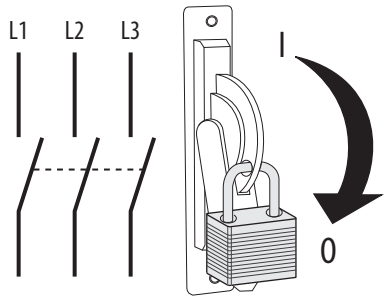
Remove Power from the Drive

ATTENTION: Remove power before making or breaking cable connections. When you remove or insert a cable connector with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field devices, causing unintended machine motion
- causing an explosion in a hazardous environment

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

Remove and lock-out all incoming power to the drive.



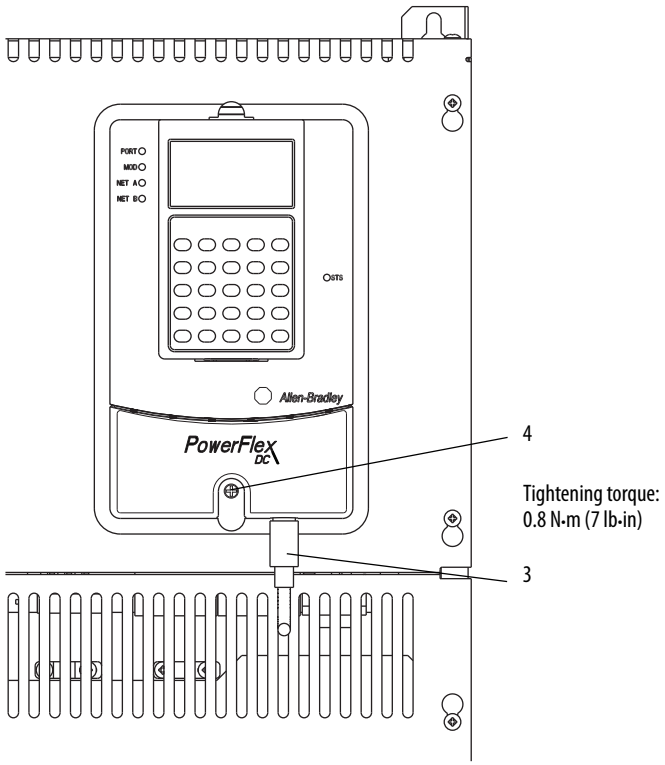
DPI / HIM Assembly Replacement

Remove the DPI / HIM Assembly

Follow these steps to remove the device peripheral interface (DPI) / human interface module (HIM) assembly.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).

3. Disconnect the DPI cable from the HIM assembly.
4. Remove the screw that secures the DPI / HIM assembly to the drive.
5. Carefully remove the DPI / HIM assembly from the cover and disconnect the cable from the DPI connector on the back side of the assembly.



Install the DPI / HIM Assembly

Install the DPI / HIM assembly in reverse order of removal.

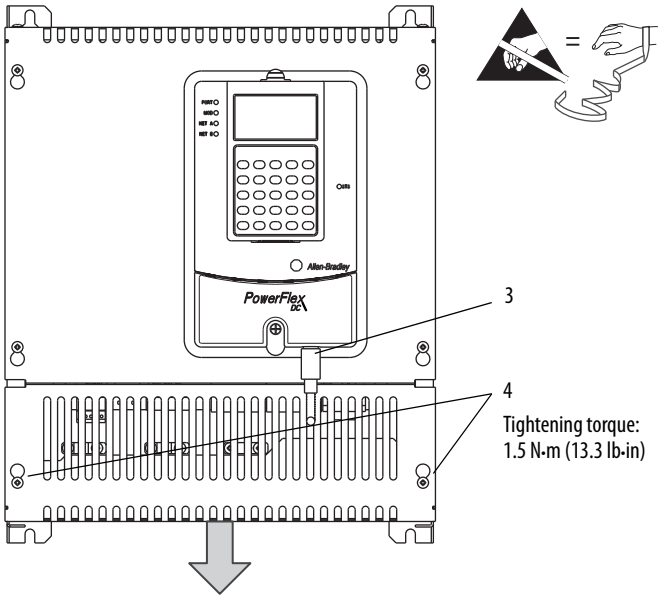
Protective Cover Replacement

Remove the Protective Covers

Follow these steps to remove the protective covers.

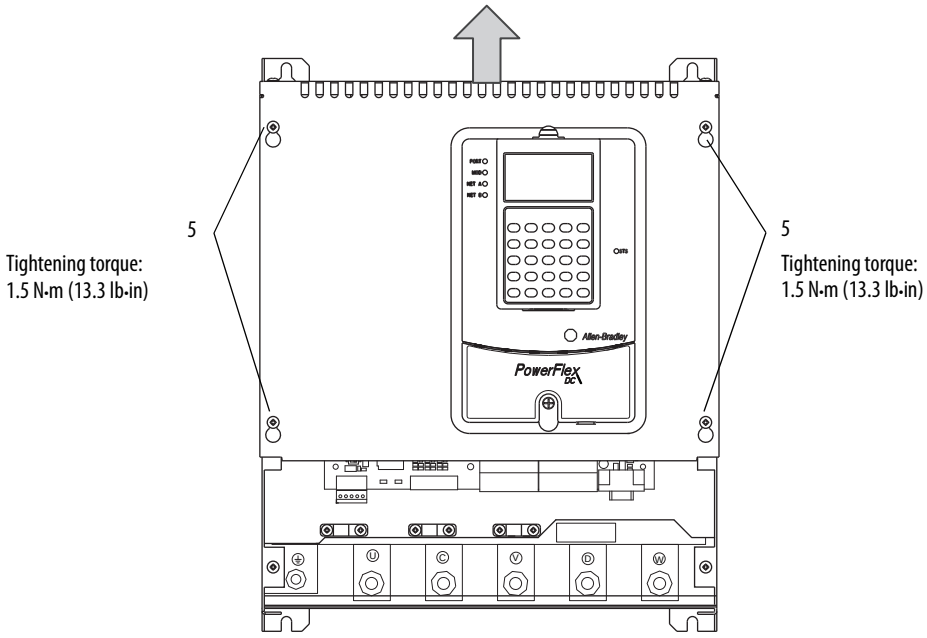
1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).

3. Disconnect the DPI cable from the HIM assembly.
4. Loosen, but do not remove, the screws that secure the bottom cover to the drive, then slide the cover down and off the drive chassis.

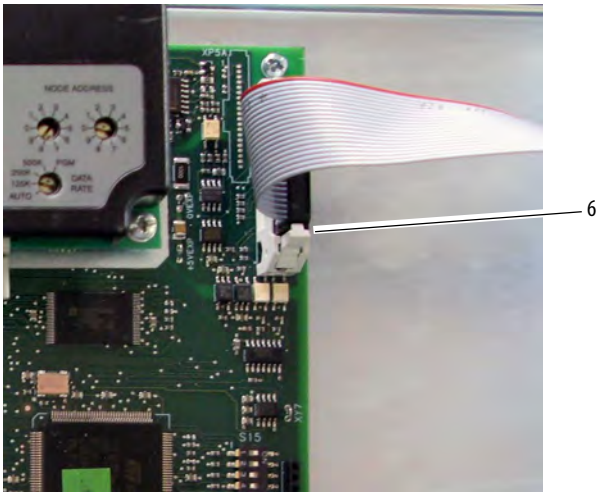


5. Loosen, but do not remove, the screws that secure the top cover to the drive, then slide the cover up and off the drive chassis.

IMPORTANT The HIM assembly is connected via a cable to the Control board and therefore will not pull free from the drive until disconnected.



6. Disconnect the HIM communication cable from the connector on the upper right corner of the control board and set the cover aside.



Install the Protective Covers

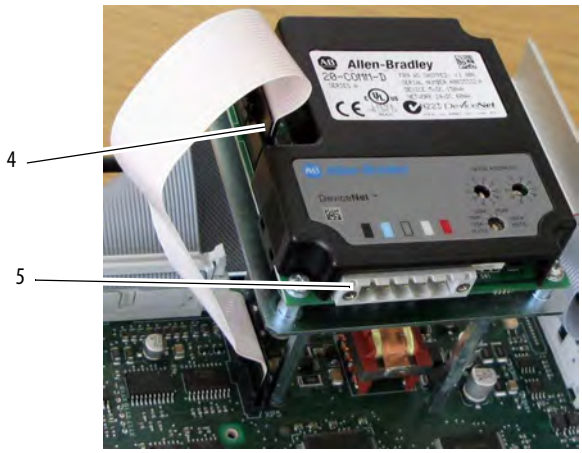
Install the protective covers in the reverse order of removal.

Communication Adapter and Electromagnetic Interference Shield Replacement

Remove the Communication Adapter and Electromagnetic Interference Shield

Follow these steps to remove the communication adapter and electromagnetic interference (EMI) shield.

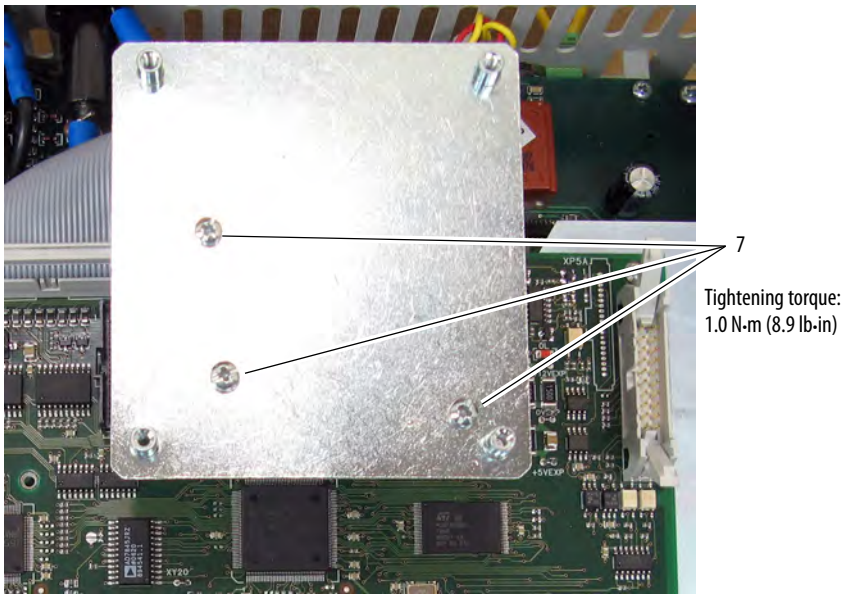
1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers from the drive (see page 43).
4. Disconnect the interface cable from the communication adapter and set it aside.
5. Disconnect any network cables from the adapter and set them aside.



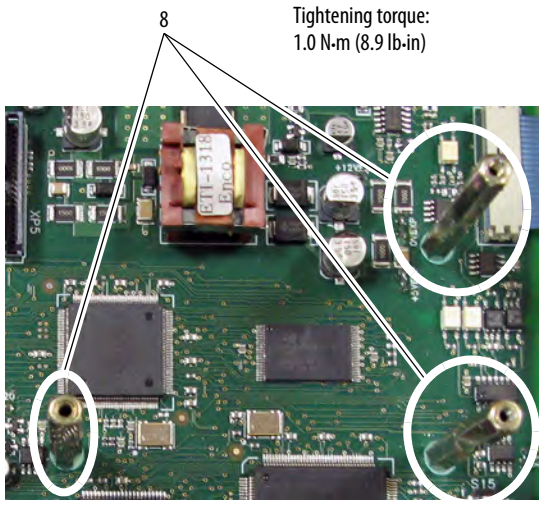
6. Remove the four screws that secure the communication adapter to the electromagnetic interference (EMI) shield and remove the adapter.

Tightening torque:
0.9 N•m (8.0 lb•in)

7. Remove the three screws that secure the EMI shield to the standoffs on the control board and remove the EMI shield.



8. Remove the three standoffs from the control board.



Install the Communication Adapter and EMI Shield

Install the communication adapter and EMI shield in reverse order of removal.

Resolver Feedback and Interface Circuit Board Replacement

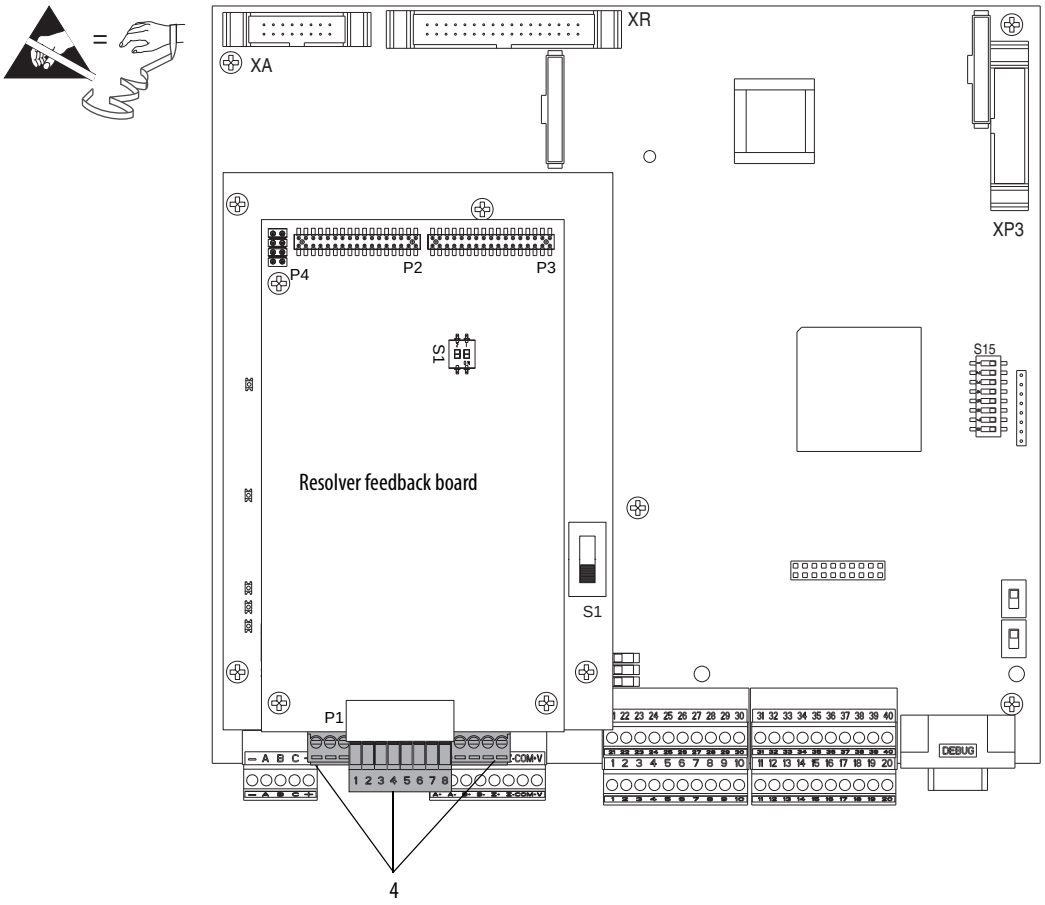
Remove the Resolver Feedback and Interface Circuit Boards

Follow these steps to remove the resolver feedback and interface circuit boards.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers from the drive (see page 43).

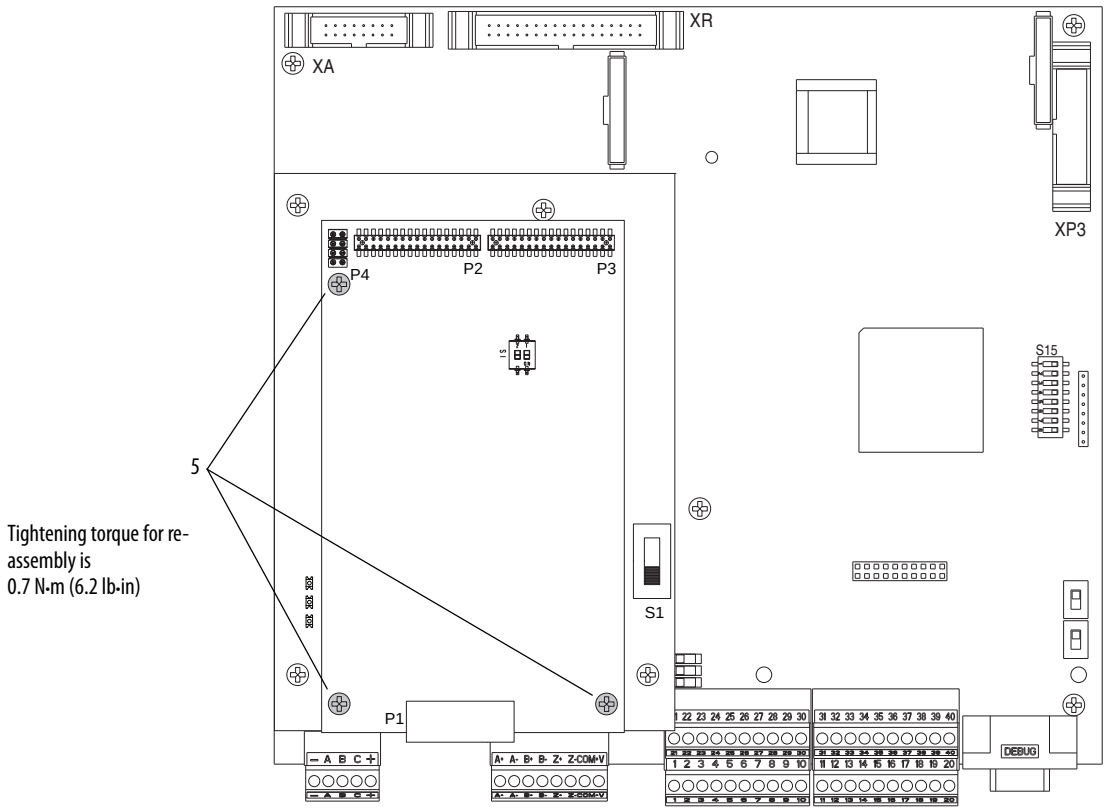
IMPORTANT Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

4. Disconnect the plug-in terminal blocks from the resolver feedback and resolver interface boards.

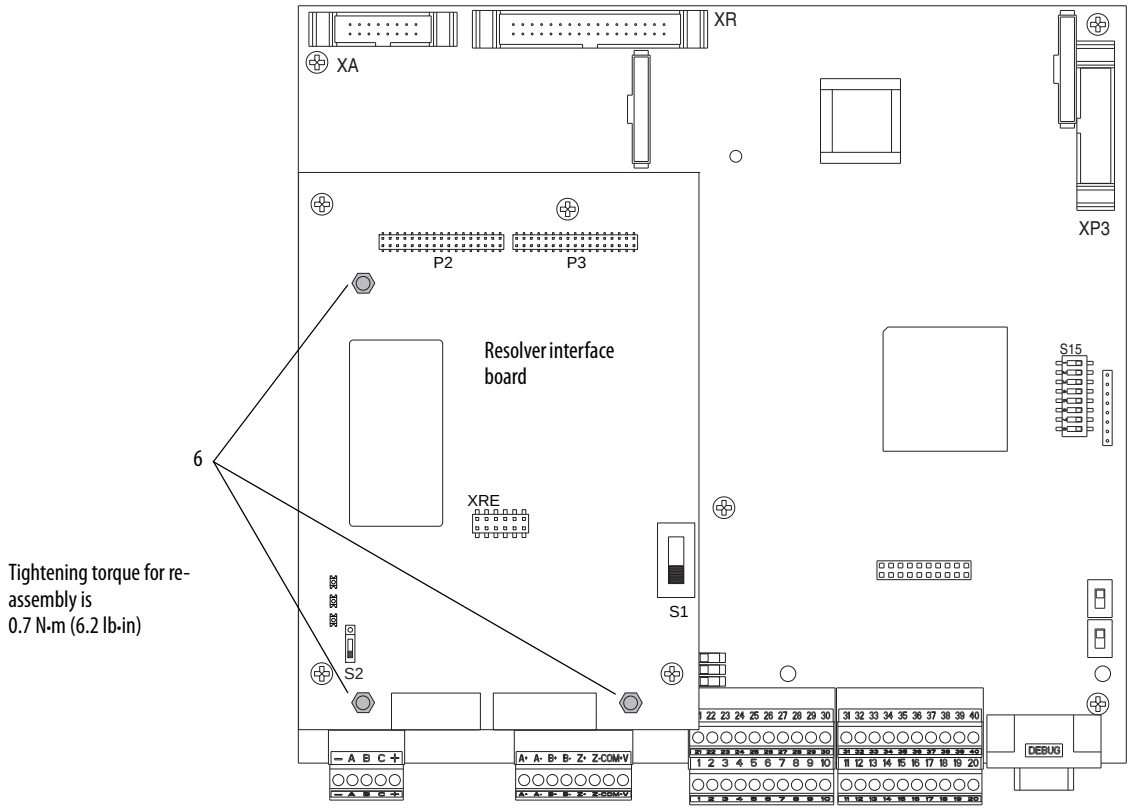


5. Remove the three hexalobular screws that secure the resolver feedback board to the stand-offs on the resolver interface board and carefully remove the resolver feedback board.

IMPORTANT The resolver feedback board is connected to the resolver interface board below it via stacker connector pins at connectors P2 and P3. Lift the resolver feedback board straight up during removal to avoid any damage to the connector pins.



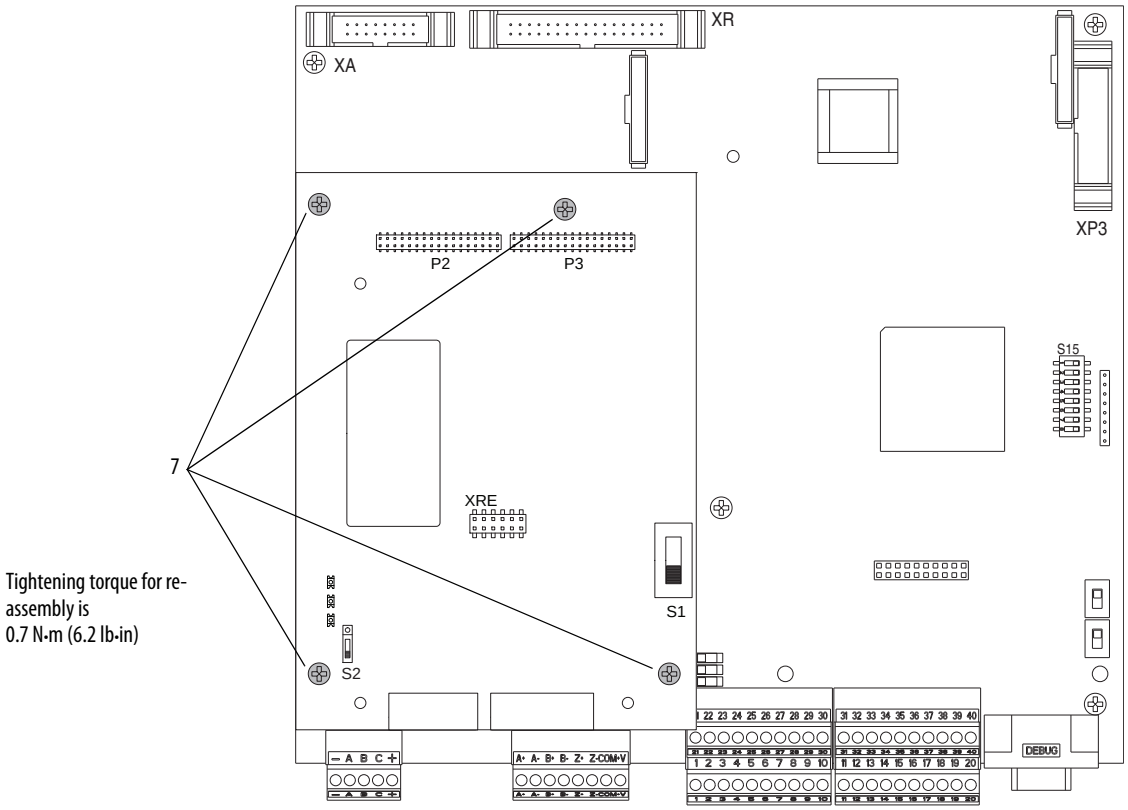
6. Remove the three stand-offs from the resolver interface board.



Tightening torque for re-assembly is 0.7 N•m (6.2 lb•in)

7. Remove the four hexalobular screws that secure the resolver interface board to the control board and remove the resolver interface board.

IMPORTANT The resolver interface board is connected to the control board below it via a stacker connector pin at connector XRE. Lift the resolver interface board straight up during removal to avoid any damage to the connector pin.



Install the Resolver Feedback and Interface Circuit Boards

Install the resolver feedback and interface boards in reverse order of removal.

I/O Expansion Circuit Board Replacement

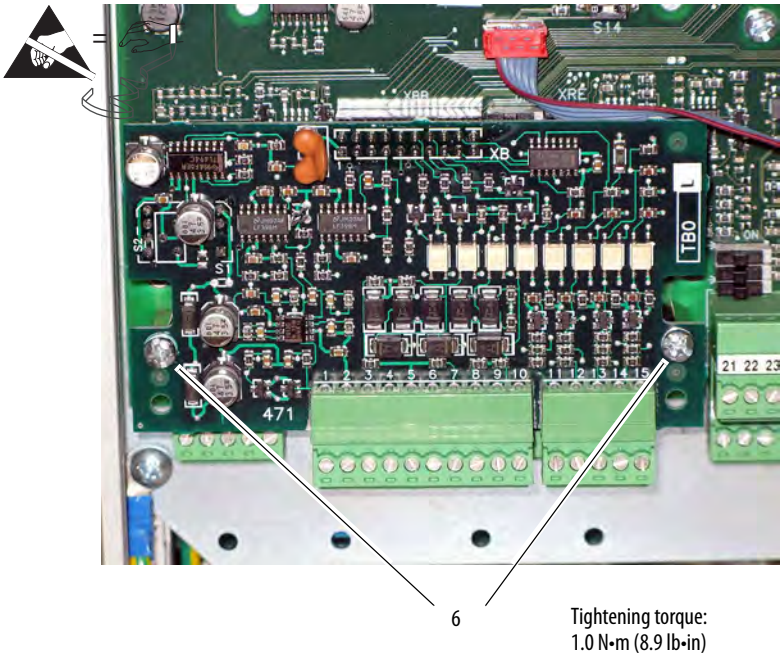
Remove the I/O Expansion Circuit Board

Follow these steps to remove the I/O expansion circuit board.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers from the drive (see page 43).

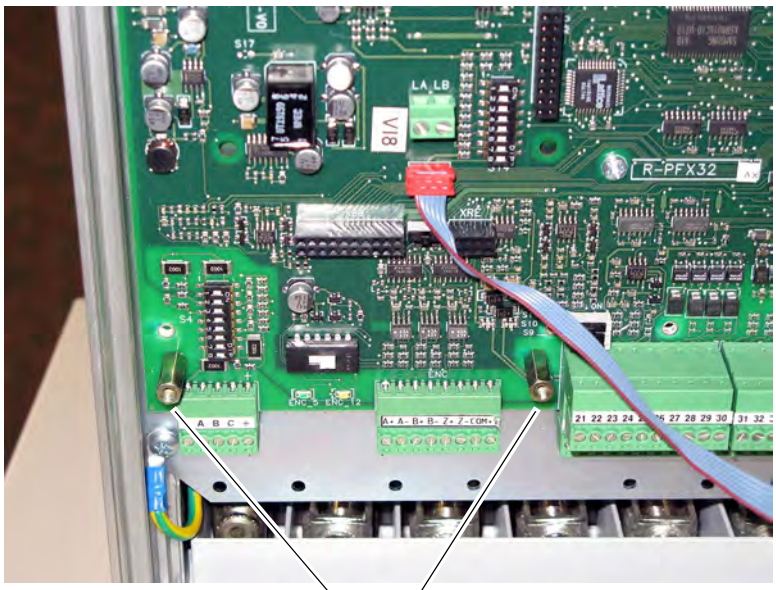
IMPORTANT Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

4. If installed, remove the resolver feedback option board (see page 48).
5. Remove the plug-in I/O terminal blocks with the wiring kept in place.
6. Remove the two M3 x 6 mm screws and washers that secure the I/O expansion board to the stand-offs on the control board.

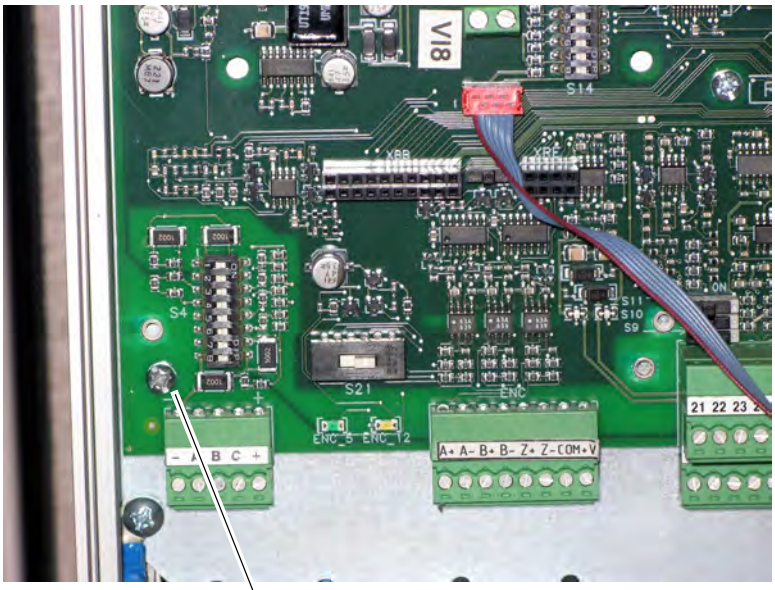


7. Carefully pull the I/O expansion board off connector XBB on the control board.

8. Remove the two stand-offs from the control board.



9. Install one screw in the lower left corner of the control board.



Install the I/O Expansion Circuit Board

Install the I/O expansion board in reverse order of removal.

115V AC to 24V DC I/O Converter Circuit Board Replacement

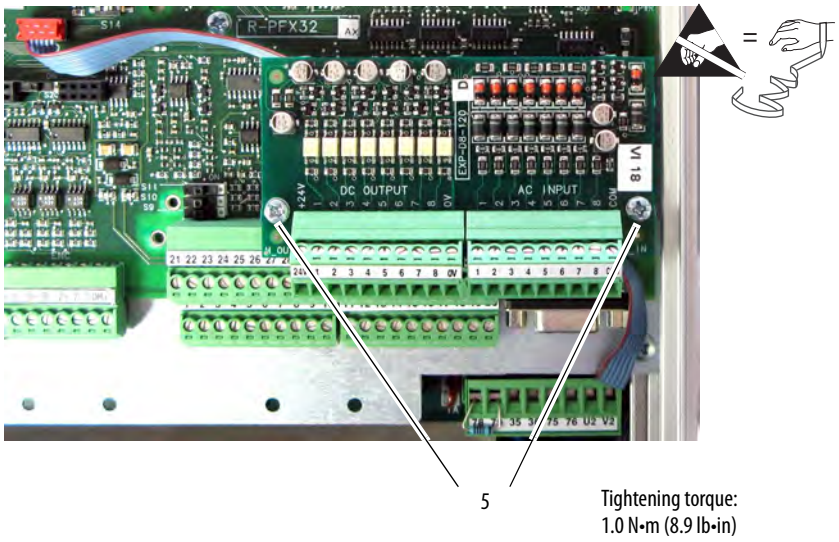
Remove the 115V AC to 24V DC I/O Converter Circuit Board

Follow these steps to remove 115V AC to 24V DC I/O converter circuit board.

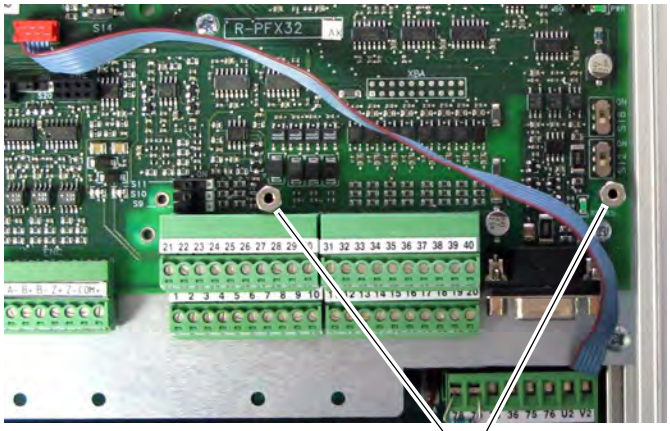
1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers from the drive (see page 43).

IMPORTANT Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

4. Remove the plug-in I/O terminal blocks with the wiring kept in place.
5. Remove the two M3 x 6 mm screws and washers that secure the I/O converter board to the stand-offs on the control board and remove the I/O converter board.



6. Remove the two stand-offs from the control board.



Tightening torque:
1.0 N•m (8.9 lb•in)

Install the 115V AC to 24V DC I/O Converter Circuit Board

Install the 115V AC to 24V DC I/O converter board in reverse order of removal.

Control Circuit Board Replacement

Remove the Control Circuit Board

Follow these steps to remove the control circuit board.

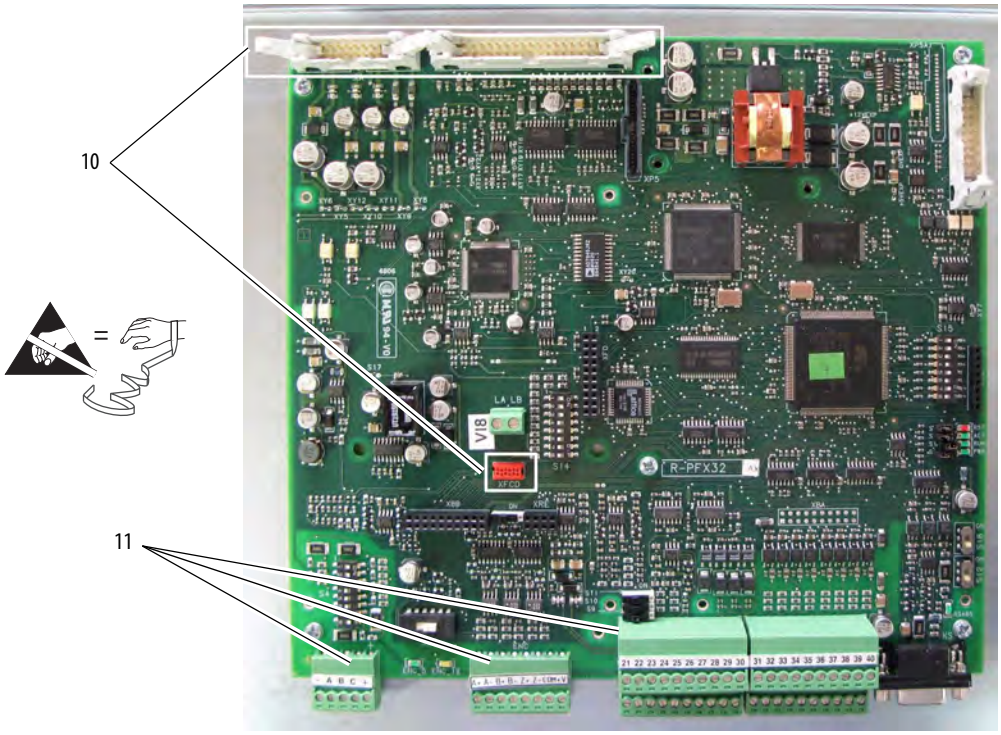
1. Read the General Safety Precautions on page 10.
2. Save the drive and adapter parameter configuration to a HIM Set or by down loading the drive and adapter parameters to an offline database file using DriveExecutive™. See to the PowerFlex DC Digital Drive User Manual, publication 20P-UM001, for information on using the HIM or the on-line Help provided with DriveExecutive for more information on HIM Sets or using the HIM.
3. Remove power from the drive (see page 42).
4. Remove the protective covers from the drive (see page 43).
5. Remove the communication adapter and EMI shield from the control board (see page 46).
6. If installed, remove the resolver feedback option board (see page 48).
7. If installed, remove the I/O expansion circuit board (see page 52).
8. If installed, remove the 115V AC to 24V DC I/O converter circuit board (see page 54).

9. Record all switch and jumper settings on the control board. See the PowerFlex DC Digital Drive User Manual, publication 20P-UM001, for more information.

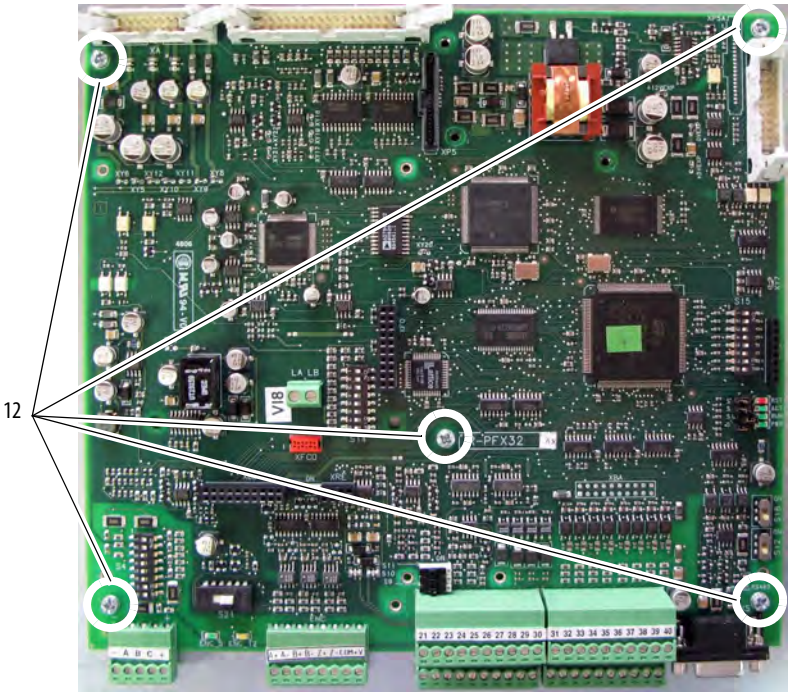
Jumper /Switch	Function		Setting
S4	Configures the input voltage of the DC analog tachometer.		
S9	Configures the input signal of analog input 1 (terminals 1 and 2):		
	Par 71 [Anlg In1 Config] must be programmed to match the input signal type selected with this switch.		
S10	Configures the input signal of analog input 2 (terminal 3 and 4):		
	Par 76 [Anlg In2 Config] must be programmed to match the input signal type selected with this switch.		
S11	Configures the input signal of analog input 3 (terminals 5 and 6):		
	Par 81 [Anlg In3 Config] must be programmed to match the input signal type selected with this switch.		
S14	Field current resistors settings. The value that is selected with switch S14 must be entered in Par 374 [Drv Fld Brdg Cur] when the drive is commissioned.		S14-1 = S14-2 = S14-3 = S14-4 = S14-5 = S14-6 = S14-7 = (not used) S14-8 = (not used)
S15	Configures the control circuit board to the appropriate drive size.		S15-1 = S15-2 = S15-3 = S15-4 = S15-5 = S15-6 = S15-7 = S15-8 =
S20	Monitoring (reported by Par 652 [Encoder Err Chk]) of the Z channel of the Digital Encoder on connector XE2.		
	Off Position	Z-channel monitored	
	On Position	Z-channel not monitored	
S21	Encoder power supply voltage and input adaptation selection: This switch setting determines both the power supply (input) and feedback level (output) voltage of the connected encoder. Note: When control power is supplied to the drive, the appropriate light-emitting diode lights to indicate the selection of the switch.		
	ENC_5	+5V encoder (+2.5…5.4V input range)	
	ENC_12	+12…15V encoder (+5.4V…15.2V input range)	

IMPORTANT Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

10. Carefully disconnect the cables from connectors XFCD, XA and XR on the control board.
11. Remove the plug-in I/O and control terminal blocks with the wiring kept in place.



12. Remove the five screws that secure the control board to the control EMI shield and remove the board.



Install the Control Circuit Board

Install the control board in reverse order of removal.

- Verify that all DIP switches are set to the correct configuration based on your recorded settings.

Control Electromagnetic Interference Shield Removal and Closure

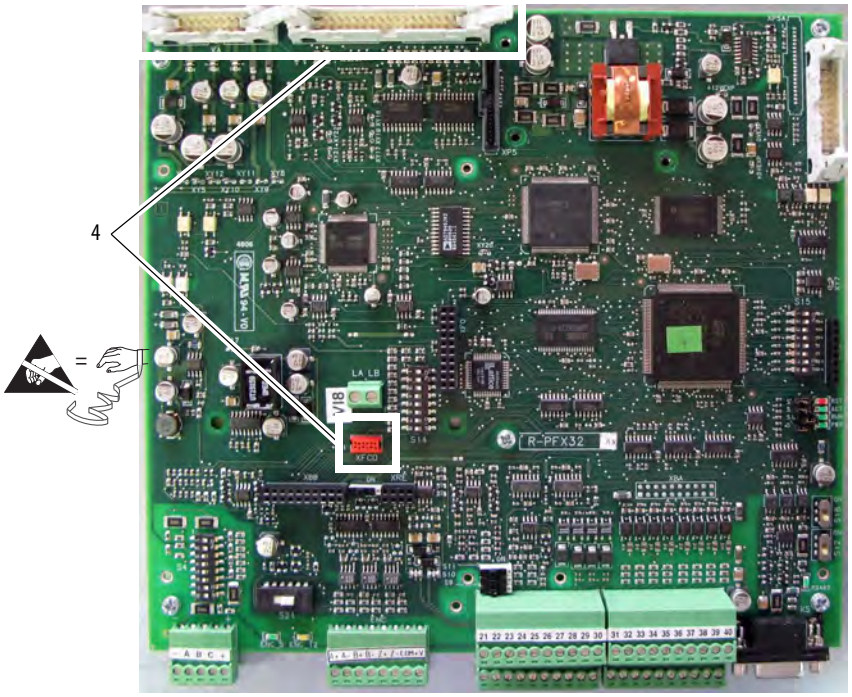
Move the Control Electromagnetic Interference Shield

You must move (lower) the control electromagnetic interference (EMI) shield that holds the control board in order to access other components within the drive. Follow these steps to remove the control electromagnetic interference (EMI) shield.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers from the drive (see page 43).

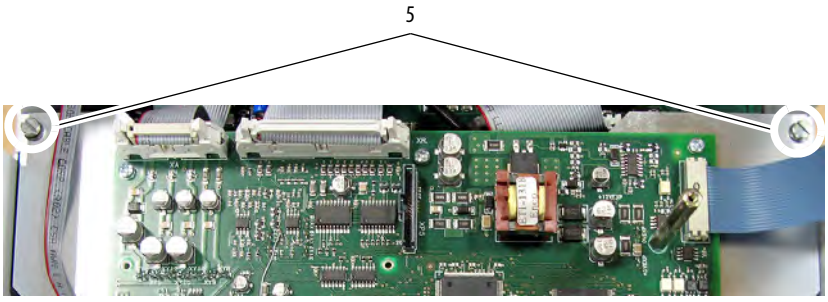
IMPORTANT	Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

4. Carefully disconnect the cables from connectors XA, XR and XFCD on the control board.



5. Loosen the two captive screws at the top of the control EMI shield and lower shield.

IMPORTANT If the drive is not in a vertical position, the control EMI shield will not remain open without a means of restraint.



Close the Control EMI Shield in the Service Position

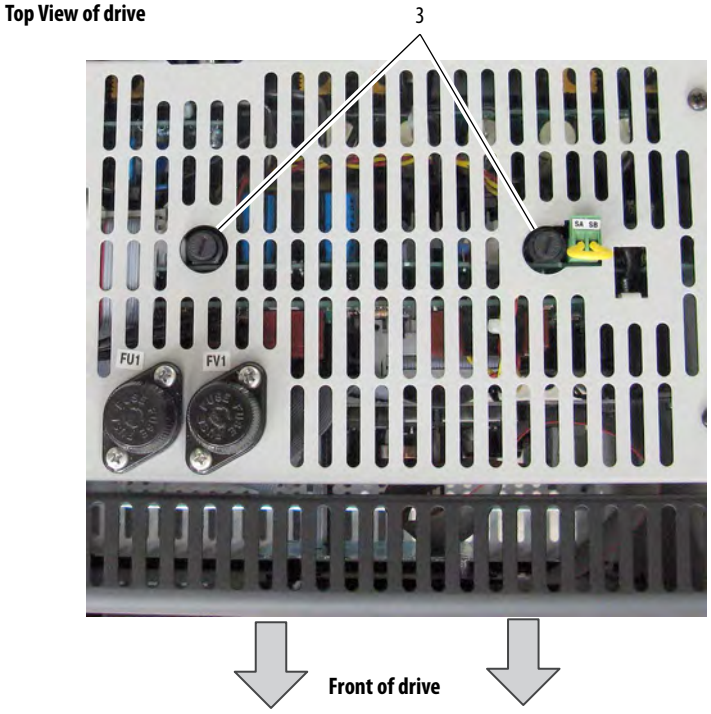
Close the control EMI shield in reverse order.

Switching Power Supply Board Fuse Replacement

Remove the Fuses on the Switching Power Supply Circuit Board

Follow these steps to remove the switching power supply circuit board.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. At the top of the drive, remove the two fuses by inserting a screwdriver in the slot on the top of the fuse holder, carefully pushing down and turning the fuse counterclockwise. When the fuse holder releases, remove the holder and fuse.



Install the Fuses on the Switching Power Supply Circuit Board

Install the fuses identified in this table on the switching power supply board in reverse order of removal.

Circuit Board ID / Revision	Fuse Designation	Fuse (5 x 20 mm)
SW2-32 / H and below	F1	3.15 A, 250V fast
	F2	2.5 A, 250V slow
SW2-32 / I and above	F1	2.5 A, 250V slow
	F2	

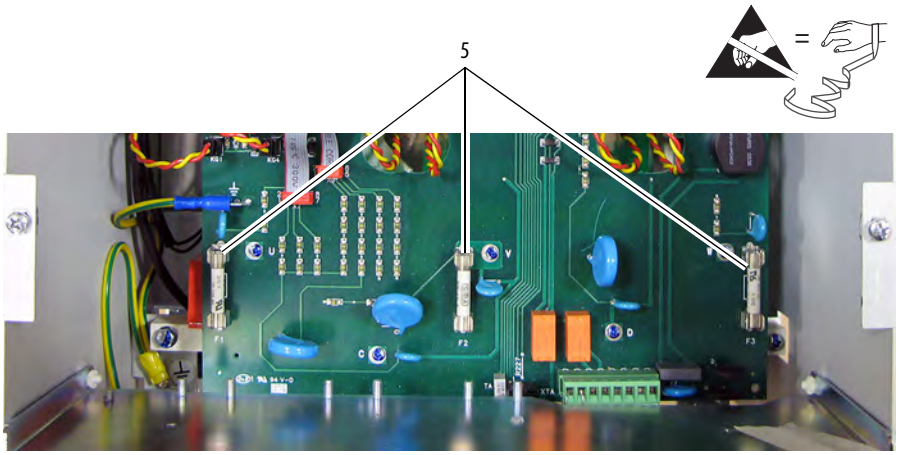
Top View of drive

Pulse Transformer Circuit Board Fuse Replacement

Remove the Fuses on the Pulse Transformer Circuit Board

Follow these steps to remove the fuses on the pulse transformer circuit board.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers from the drive (see page 43).
4. Move the control EMI shield (see page 58).
5. Using a fuse puller, carefully remove the three fuses from the fuse holders on the pulse transformer board.



Install the Fuses on the Pulse Transformer Circuit Board

Install the fuses on the pulse transformer circuit board in reverse order of removal.

Pulse Transformer and Switching Power Supply Circuit Boards Replacement

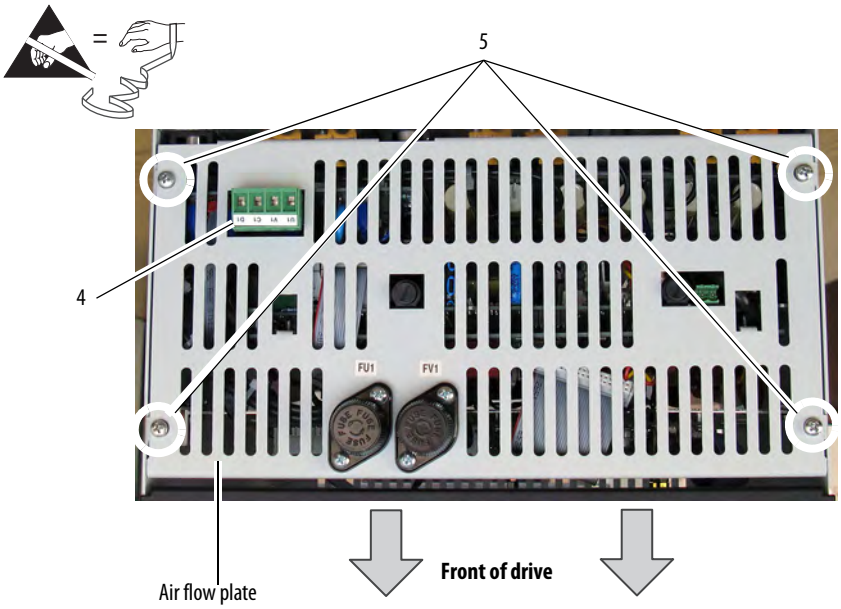
Remove the Pulse Transformer and Switching Power Supply Circuit Boards

Note: The switching power supply circuit board is located on the back of the pulse transformer circuit board. You must remove both boards in order to replace either board. Follow these steps to remove the pulse transformer and switching power supply circuit boards.

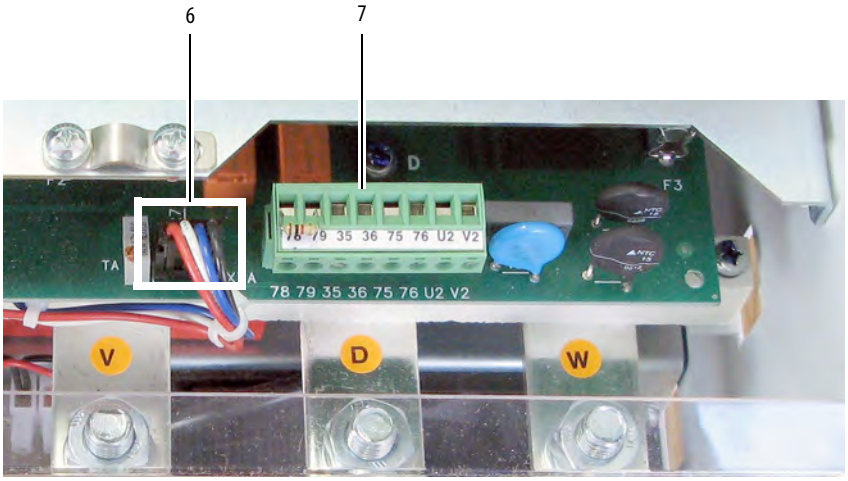
1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers from the drive (see page 43).

4. Remove the plug-in terminal from the field input block at the top of the drive.
5. Remove the four screws that secure the slotted air flow plate to the top of the drive chassis.

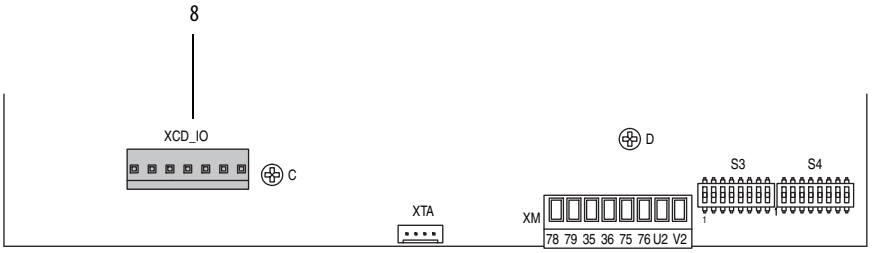
IMPORTANT The air flow plate is also secured to the pulse transformer circuit board and therefore cannot yet be removed. Instructions for doing so are included later in this procedure.



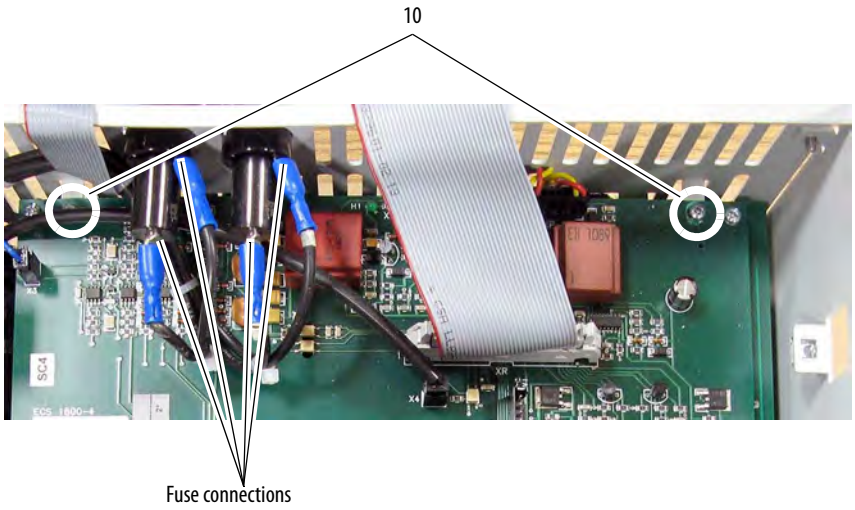
6. Remove the cable from connector XTA at the bottom of the pulse transformer board.
7. Remove the plug-in terminals from the control power block at the bottom of the pulse transformer board.



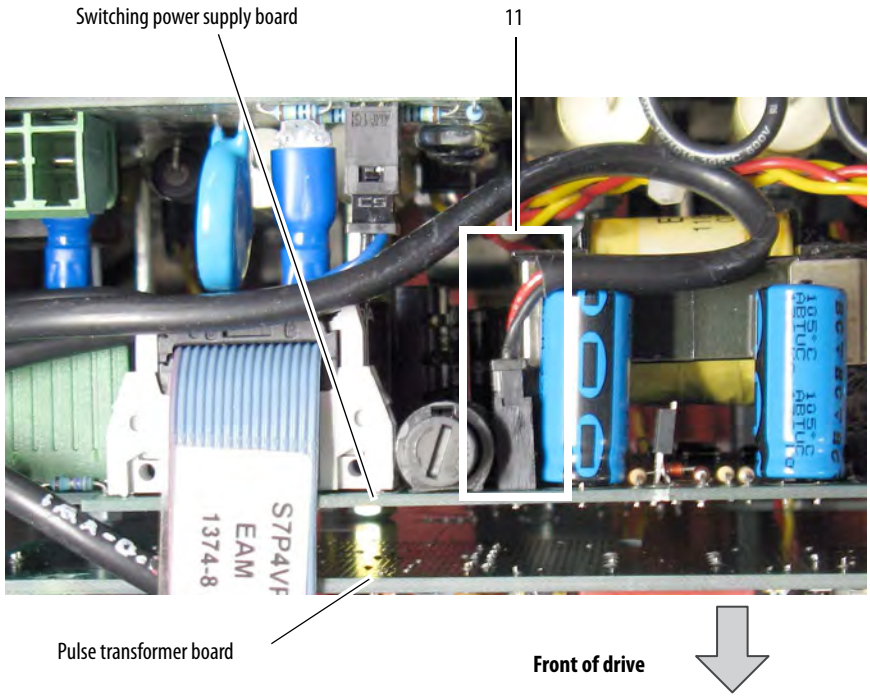
8. For Pulse Transformer boards with an armature voltage feedback terminal block, FIR2-XX, rev. "N" and higher, remove the connector from XCD_IO on the lower left corner of the board.



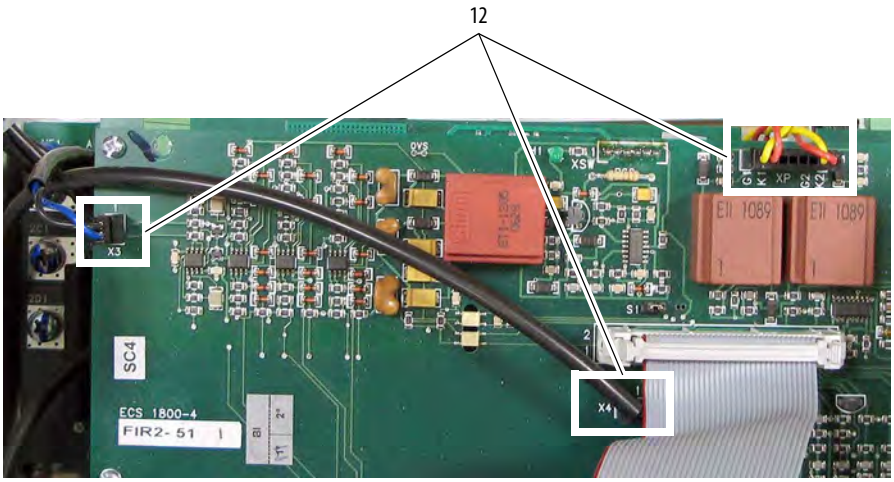
9. Move the control EMI shield (see page 58).
10. Remove the two screws that secure the air flow plate to the top of the pulse transformer board and lift the plate off the drive chassis. Note that the air flow plate cannot be completely removed due to the fuse connections at FU1 and FV1.



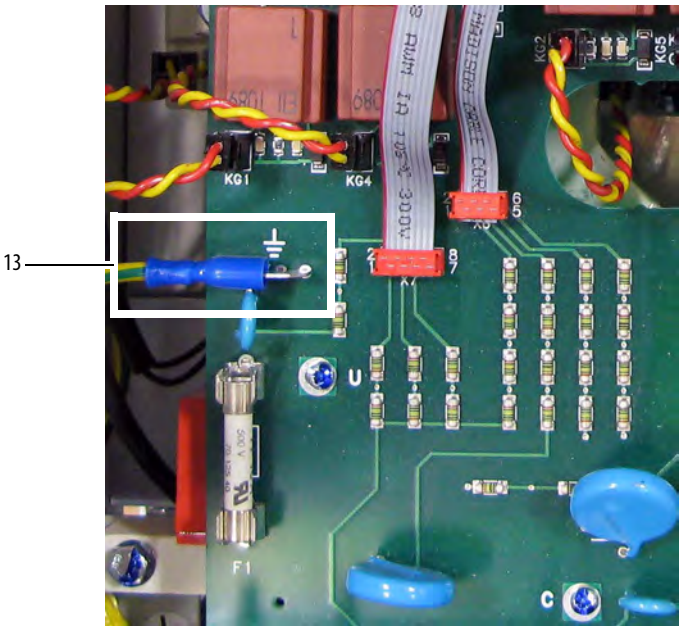
11. Remove the cable from connector XV on the switching power supply board.



12. Remove the cables from connectors X3, X4, and XP on the pulse transformer board.



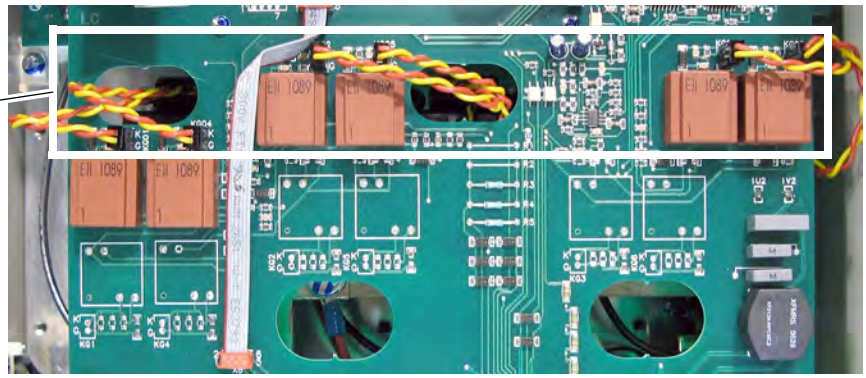
13. Remove the ground connection at the left side of the pulse transformer board.



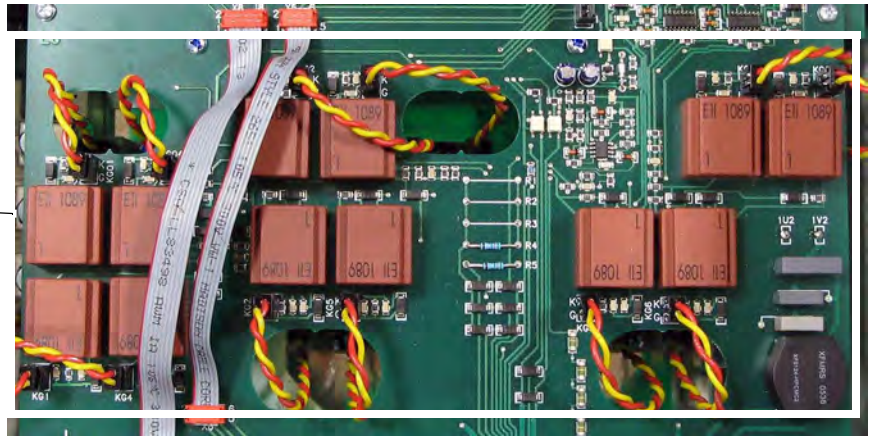
14. Remove the appropriate gate leads:
    - For non-regenerative drives, remove each pair of (orange and yellow) gate lead cables from connectors KG01...KG06 and push each lead through the appropriate opening in the board.
    - For regenerative drive, remove each pair of (orange and yellow) gate lead cables from connectors KG01...KG06 and KG1...KG6 and push each lead through the appropriate opening in the board.

IMPORTANT Carefully remove the gate leads by grasping the connector. DO NOT pull the gate leads off by pulling on the wires.

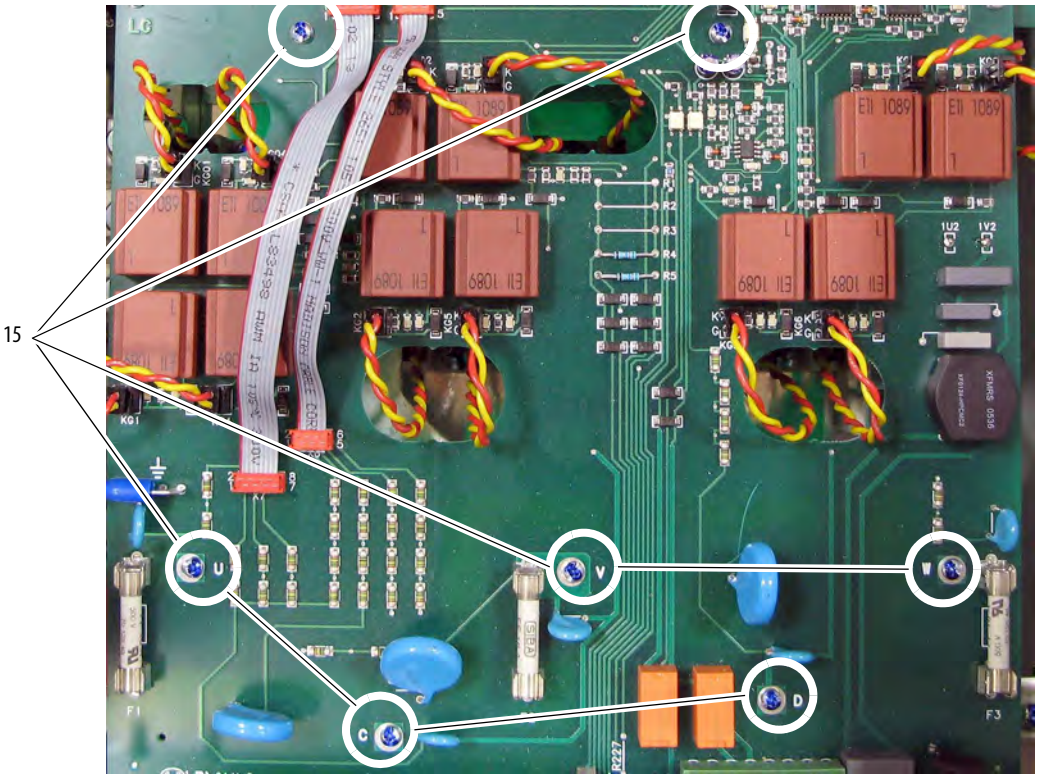
14 (**non-regenerative** drives)



14 (**regenerative** drives)

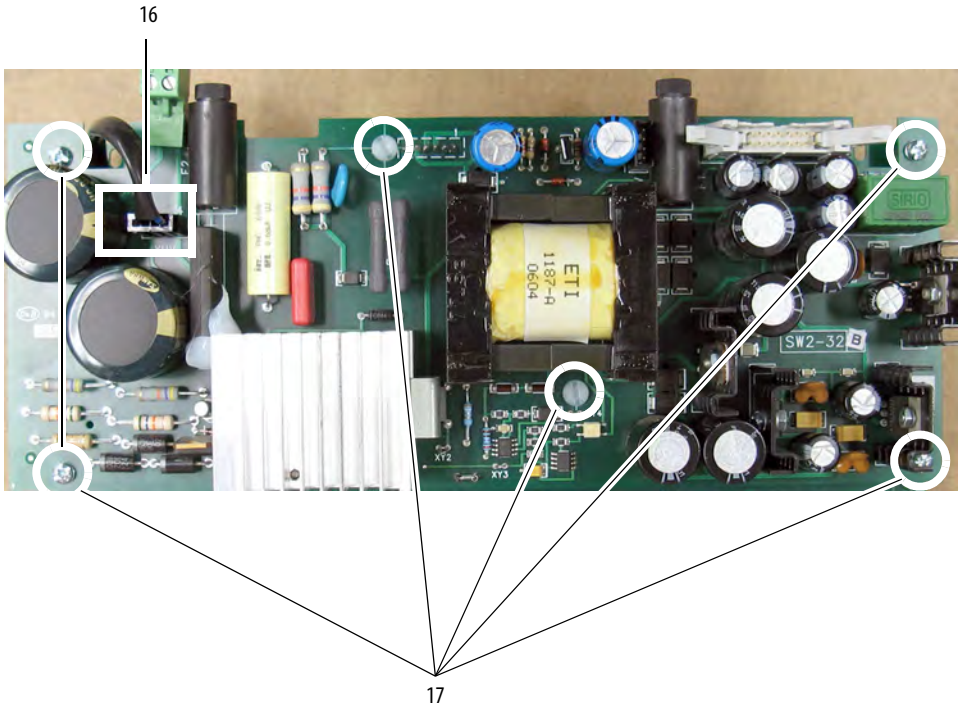


15. Remove the seven screws that secure the board to the stand-offs on the drive chassis and remove the boards from the drive.



Note: Regenerative drive shown.

16. Remove the cable from connector XUV on the switching power supply board.
17. Remove the six screws and washers that secure the switching power supply board to the stand-offs on the back of the pulse transformer board and remove the switching power supply board.



Configure the Pulse Transformer Circuit Board

The steps required to configure the pulse transformer board are different based on the revision code of the pulse transformer board. See one of these procedures:

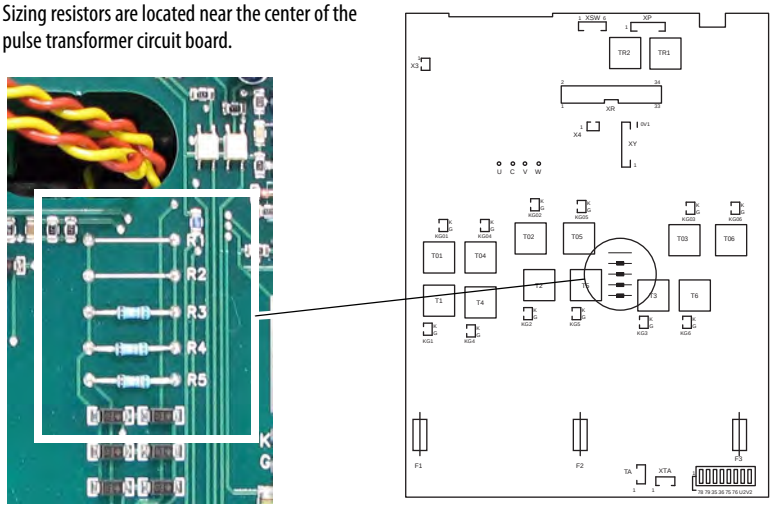
- Configure a Pulse Transformer Board FIR2-xx Rev. "M" and Lower on page 69
- Configure a Pulse Transformer Board FIR2-xx Rev. "N" and Higher on page 72

Configure a Pulse Transformer Board FIR2-xx Rev. "M" and Lower

IMPORTANT This procedure requires a multimeter that measures resistance to thousandths of an ohm.

1. Cut and remove the appropriate sizing resistor(s) (if necessary) from the pulse transformer board based on the drive size. See Table 13 or Table 14 for the appropriate configuration.

Sizing resistors are located near the center of the pulse transformer circuit board.



Sizing Resistor Configuration

Table 13 and Table 14 indicate the value of the designated resistor (R1 - R5) when left in place on the pulse transformer board, or indicate "Remove" when the resistor should be cut off and removed from the board. "–" indicates that this resistor is not contained on the pulse transformer board for the designated drive size.

Table 13 - 230V AC Input Drives

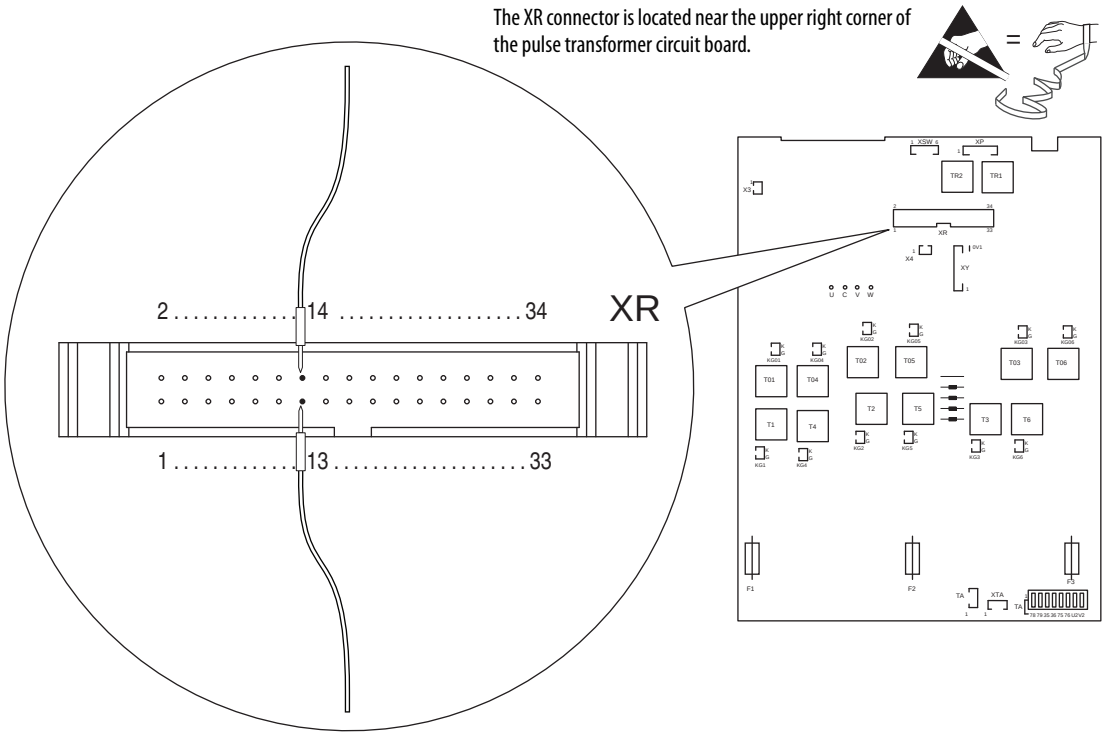
Drive Current Rating Code	DC Amps	AC Line Amps	Hp	R1	R2	R3	R4	R5
146	146	119	40	–	Remove	Remove	5.36 Ω	Remove
180	180	147	50	–	Remove	Remove	5.36 Ω	Remove
218	218	178	60	–	Remove	Remove	5.36 Ω	Remove
265	265	217	75	–	Remove	Remove	5.36 Ω	5.36 Ω
360	360	294	100	–	Remove	5.36 Ω	5.36 Ω	5.36 Ω
434	434	355	125	–	Remove	5.36 Ω	5.36 Ω	5.36 Ω

Table 14 - 460V AC Input Drives

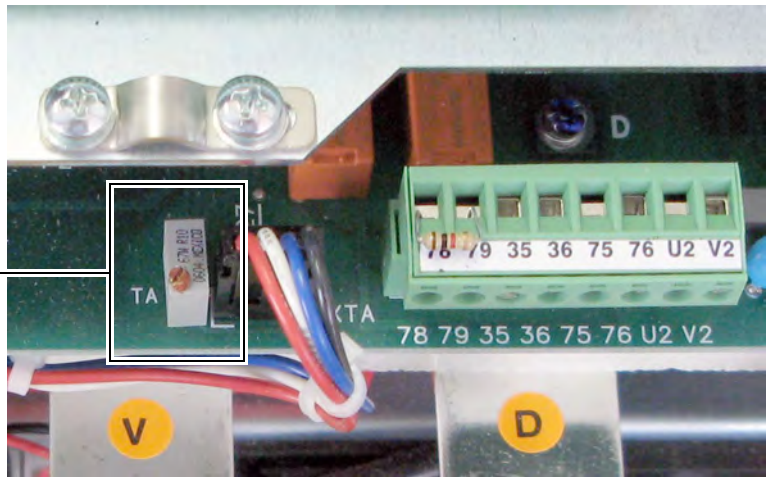
Drive Current Rating Code	DC Amps	AC Line Amps	Hp	R1	R2	R3	R4	R5
167	167	136.4	100	–	Remove	5.36 Ω	Remove	Remove
207	207	169.1	125	–	Remove	Remove	5.36 Ω	Remove
250	250	204.3	150	–	Remove	Remove	5.36 Ω	5.36 Ω
330	330	269.6	200	–	Remove	5.36 Ω	5.36 Ω	5.36 Ω
412	412	336.6	250	–	Remove	5.36 Ω	5.36 Ω	5.36 Ω

2. Connect the leads of the multimeter to pins 13 and 14 of connector XR on the pulse transformer board (polarity is not important) and, using the TA potentiometer on the lower right corner of the pulse transformer circuit board, set the total resistance (RTA) to the appropriate value as indicated in Table 15 or Table 16 in the Total Resistance Values section on page 72.

The XR connector is located near the upper right corner of the pulse transformer circuit board.



The TA potentiometer is located on the lower right corner of the pulse transformer circuit board next to the control power terminal block.



Total Resistance Values

Table 15 - 230V AC Input Drives

Drive Current Rating Code	DC Amps	AC Line Amps	Hp	Set RTA Value Using TA Potentiometer (Ohms)
146	146	119	40	12.575
180	180	147	50	10.2
218	218	178	60	8.422
265	265	217	75	6.928
360	360	294	100	5.1
434	434	355	125	4.23

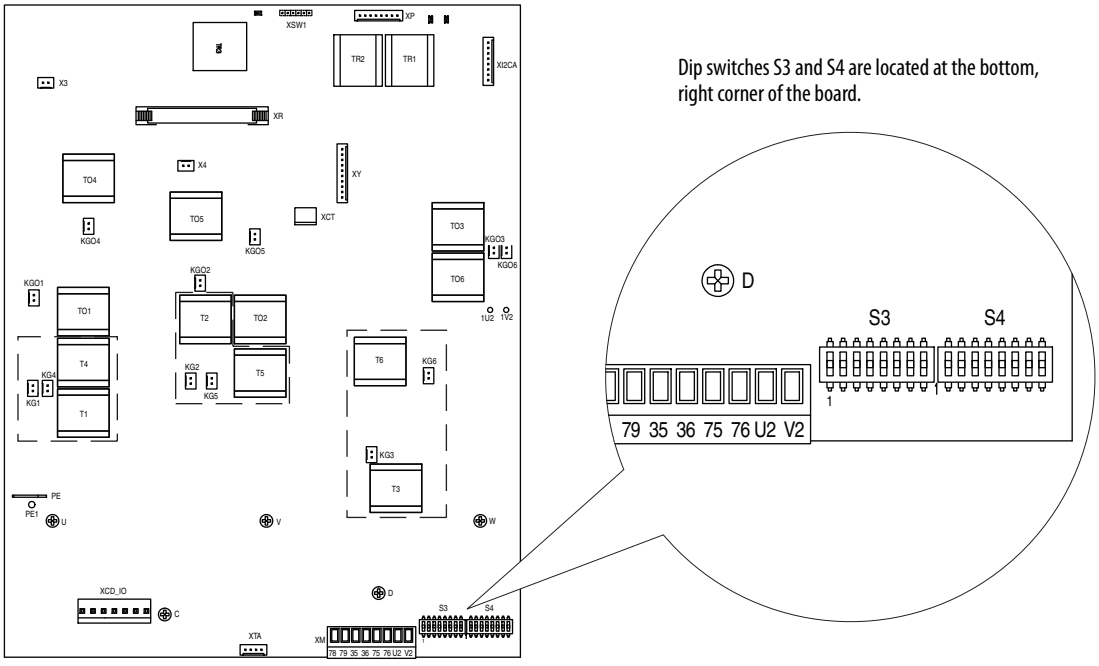
Table 16 - 460V AC Input Drives

Drive Current Rating Code	DC Amps	AC Line Amps	Hp	Set RTA Value Using TA Potentiometer (Ohms)
167	167	136.4	100	10.994
207	207	169.1	125	8.87
250	250	204.3	150	7.344
330	330	269.6	200	5.564
412	412	336.6	250	4.456

3. Seal the TA potentiometer in place using RV (silicon).
4. Continue with Install the Pulse Transformer and Switching Power Supply Boards on page 74.

Configure a Pulse Transformer Board FIR2-xx Rev. "N" and Higher

Set DIP switches S3 and S4, located at the bottom right corner of the pulse transformer board (shown below), to the correct settings based on the appropriate table below.



IMPORTANT A blank cell below a switch in Table 17, Table 18, and Table 19 indicates that the setting is "OFF".

Table 17 - 230V AC Input Drives

Drive Current Rating Code	DC Amps	AC Line Amps	Hp	DIP Switch S3								DIP Switch S4							
				S3-1	S3-2	S3-3	S3-4	S3-5	S3-6	S3-7	S3-8	S4-1	S4-2	S4-3	S4-4	S4-5	S4-6	S4-7	S4-8
146	146	119	40				ON								ON	ON			
180	180	147	50								ON	ON			ON	ON			
218	218	178	60	ON	ON								ON				ON		
265	265	217	75								ON	ON			ON		ON		
360	360	294	100	ON									ON					ON	
434	434	355	125					ON					ON		ON			ON	

Table 18 - 460V AC Input Drives

Drive Current Rating Code	DC Amps	AC Line Amps	Hp	DIP Switch S3								DIP Switch S4							
				S3-1	S3-2	S3-3	S3-4	S3-5	S3-6	S3-7	S3-8	S4-1	S4-2	S4-3	S4-4	S4-5	S4-6	S4-7	S4-8
167	167	136.4	100					ON		ON					ON	ON			
207	207	169.1	125	ON									ON				ON		
250	250	204.3	150				ON			ON					ON		ON		
330	330	269.6	200	ON						ON								ON	
412	412	336.6	250							ON	ON				ON			ON	

Table 19 - 575V AC Input Drives

Drive Current Rating Code	DC Amps	AC Line Amps	Hp	DIP Switch S3								DIP Switch S4							
				S3-1	S3-2	S3-3	S3-4	S3-5	S3-6	S3-7	S3-8	S4-1	S4-2	S4-3	S4-4	S4-5	S4-6	S4-7	S4-8
67	67	55.1	50		ON		ON				ON	ON							
101	101	82.7	75		ON						ON	ON	ON						
135	135	110.3	100							ON	ON		ON	ON					
270	270	220.6	200								ON		ON	ON			ON		
405	405	330.9	300		ON								ON	ON				ON	

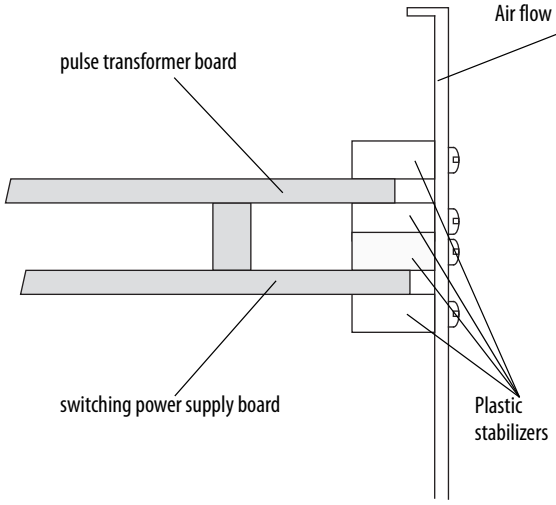
Install the Pulse Transformer and Switching Power Supply Boards

Install the new pulse transformer board in reverse order of removal.

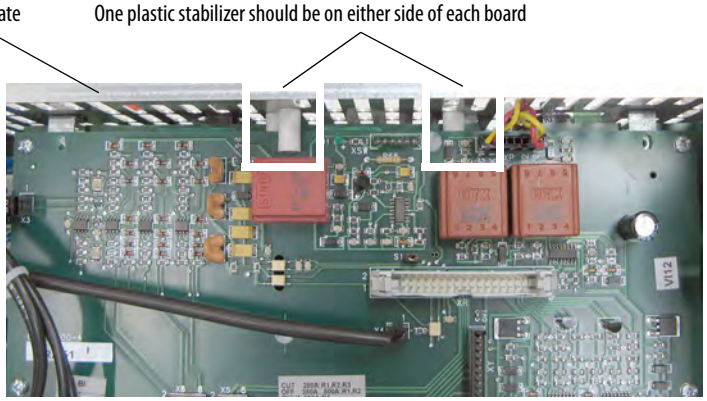
ATTENTION: Each gate lead cable must be connected to the exact connector from which it was removed on the pulse transformer circuit board or damage to the drive may occur.

- Verify that the four plastic board stabilizers mounted on the top air flow plate are placed one on either side of each board.

Side cut-away view



Top view of pulse transformer board



Field Circuit Fuses Replacement

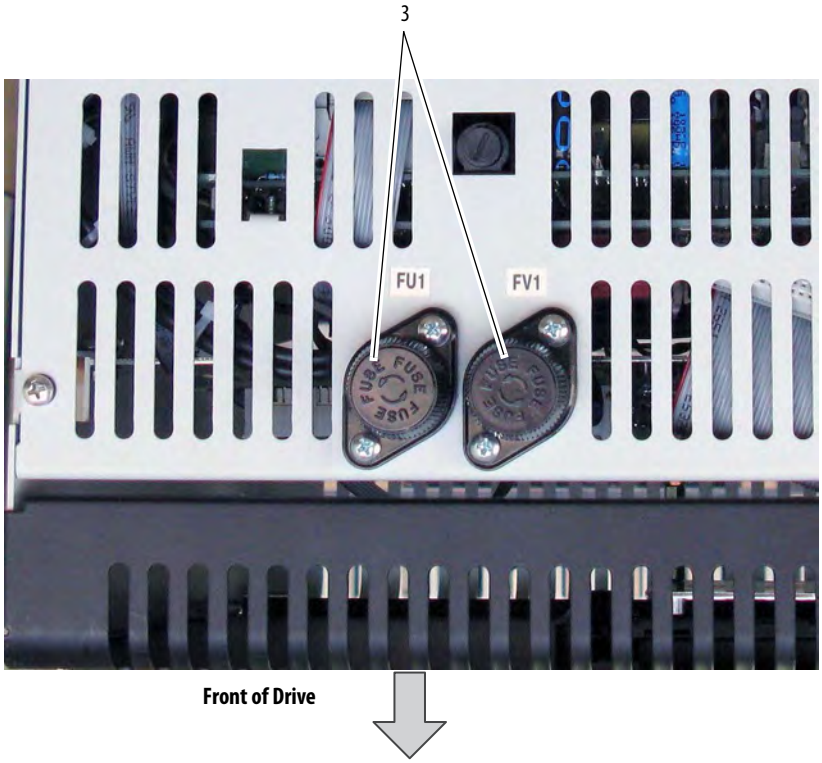
Remove the Field Circuit Fuses

Follow these steps to remove the field circuit fuses.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).

3. On the top of the drive, unscrew the fuse holders and remove the fuses from the holders.

Top view of Drive



Install the Field Circuit Fuses

Install the field circuit fuses in the reverse order of removal.

Field Circuit Board Replacement

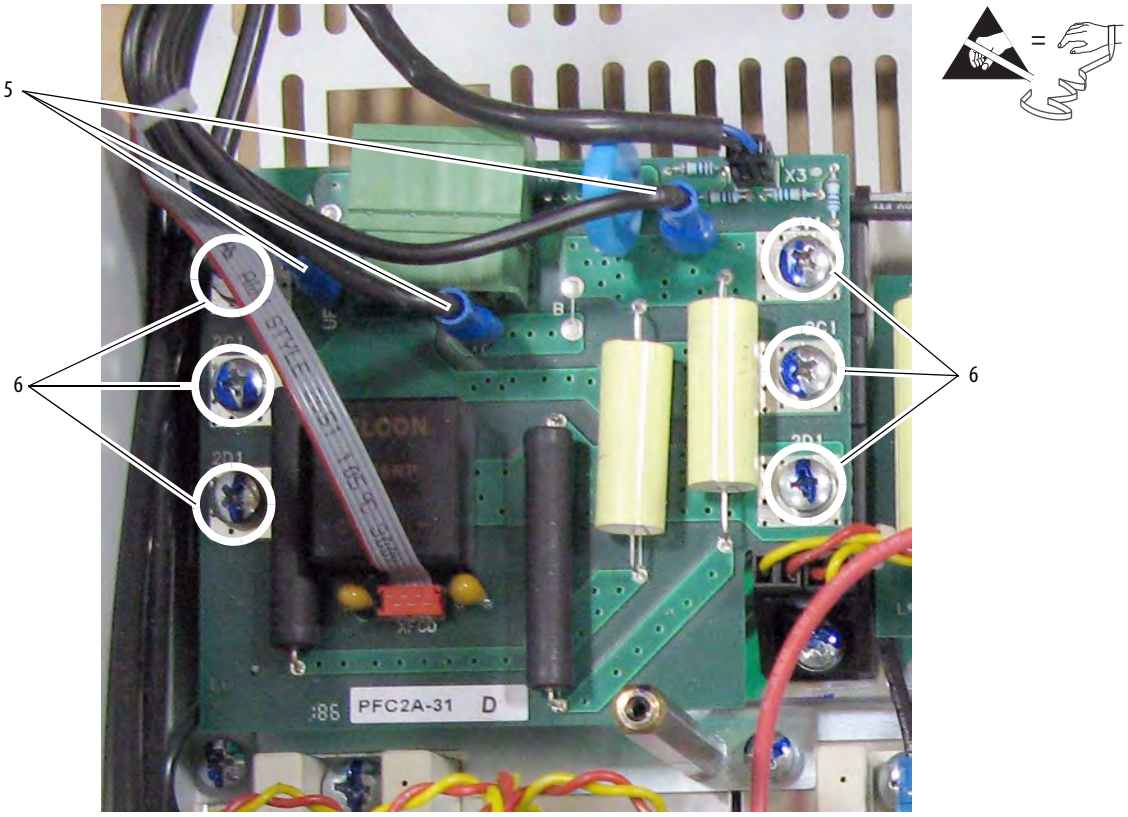
Remove the Field Circuit Board

Follow these steps to remove field circuit board.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers from the drive (see page 43).

IMPORTANT Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

4. Remove the pulse transformer and switching power supply boards from the drive (see page 62). You do not need to remove the switching power supply board from the back of the pulse transformer board for this procedure.
5. Remove the wires from connectors UF, UF1, VF, and VF1.
6. Remove the six screws and washers that secure the field board to the field SCR and dual diode modules and remove the field board.



Install the Field Circuit Board

Install the field board in reverse order of removal.

- Inspect the existing X3 and XFCD cables for burn marks, cracks or loose connectors. If necessary, replace the cables on the field board with the new cables provided.

Field SCR and Dual Diode Modules Replacement

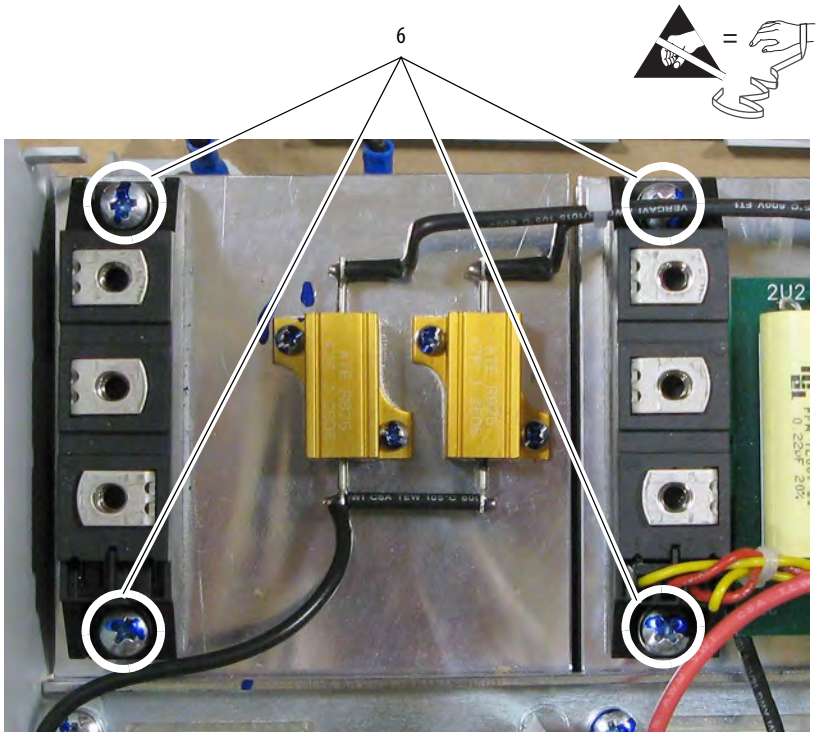
Remove the Field SCR and Dual Diode Modules

It is recommended that you replace both modules at the same time. Follow these steps to remove field SCR and dual diode modules.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers from the drive (see page 43).

IMPORTANT Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

4. Remove the pulse transformer and switching power supply boards from the drive (see page 62). You do not need to remove the switching power supply board from the back of the pulse transformer board for this procedure.
5. Remove the field circuit board (see page 75).
6. Remove the two screws and washers that secure each module to the heatsink and remove the modules from the drive.



Install the Field SCR and Dual Diode Modules

Install the field SCR and dual diode modules in reverse order of removal.

- Apply thermal grease to the bottom of the SCR and dual diode modules before securing it to the heatsink.

ATTENTION: Thermal grease must be applied to the bottom of the SCR and dual diode modules before securing them to the heatsink or damage to the drive may occur.

- Tightening torque for the screws connecting the SCR and dual diode modules to the heatsink and the screws connecting the field circuit board to the SCR and dual diode modules is 2.5...4.0 N•m (22...35 lb•in).

AC Line Snubber Circuit Board and Resistors Replacement

Remove the AC Line Snubber Circuit Board and Resistors

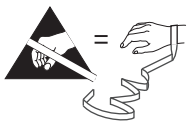
Follow these steps to remove the AC line snubber circuit board and resistors.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the protective covers from the drive (see page 43).

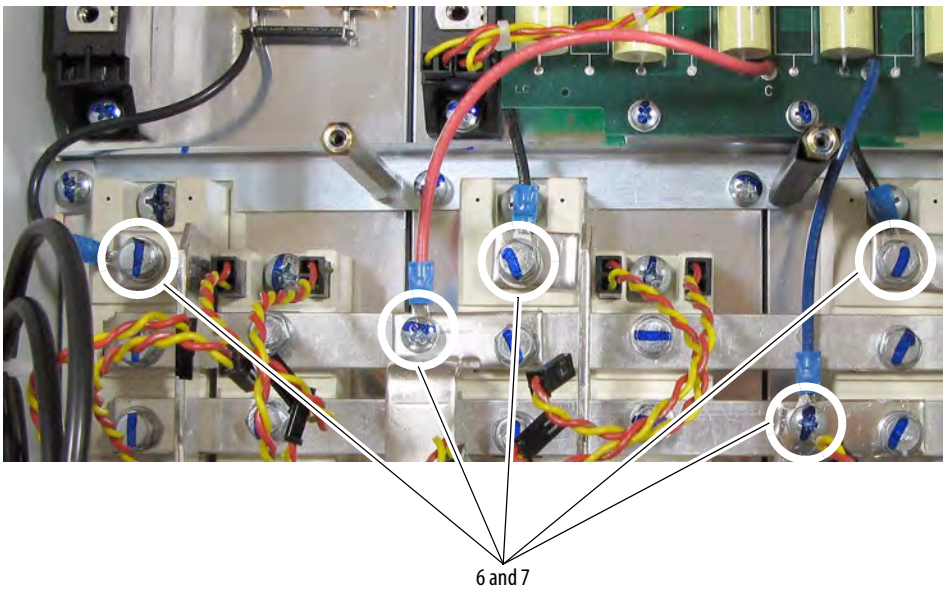
IMPORTANT Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

4. Remove the pulse transformer and switching power supply boards from the drive (see page 62). You do not need to remove the switching power supply board from the back of the pulse transformer board for this procedure.
5. Remove the field circuit board (see page 75).
6. Remove the two screws and washers that secure the (red and blue) wires from the AC line snubber board to the bus bars and remove the wires.

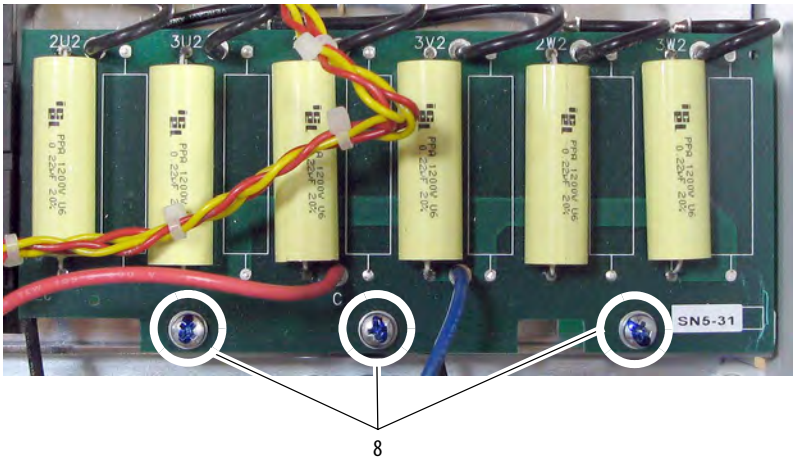
7. Remove the three screws and washers that secure the (black) wires from the resistors to the bus bars and remove the wires.



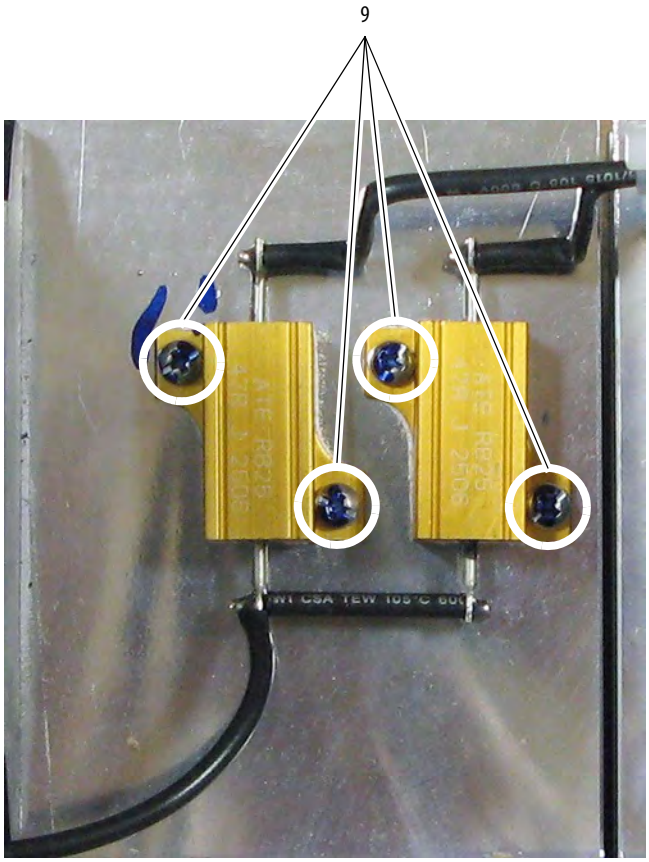
Regenerative Drive Shown



8. Remove the three screws and washers that secure the AC line snubber board to the drive frame and lift the board. Note: The wires from the resistors are connected to the board. Therefore, the board cannot be removed until the resistors are removed.



9. Remove the two screws that secure each resistor (six total) to the drive heatsink and remove the resistors and AC line snubber board from the drive.



Install the AC Line Snubber Circuit Board and Resistors

Install the AC line snubber board and resistors in reverse order of removal.

IMPORTANT Thermal grease must be applied to the bottom of the resistors before securing them to the heatsink.

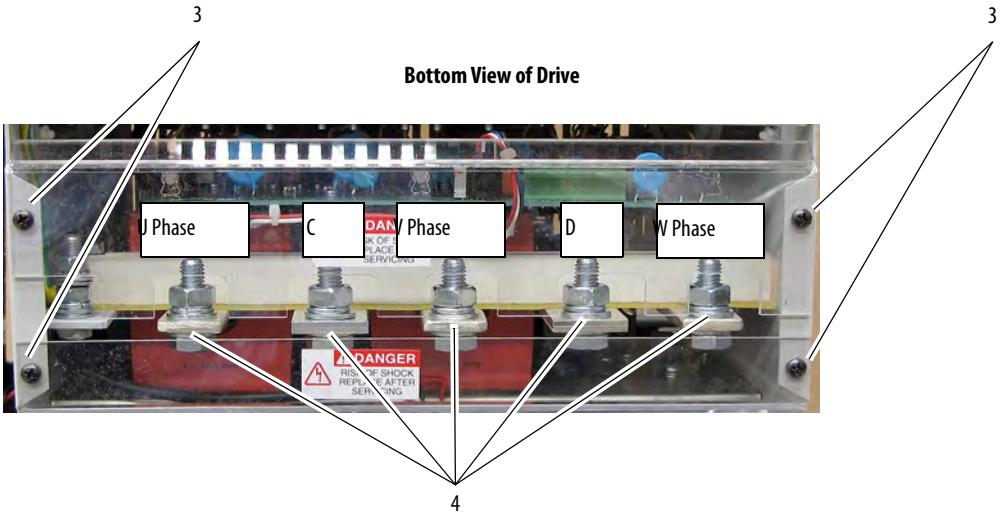
SCR Modules Replacement

Remove the SCR Modules

Follow these steps to remove SCR modules.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the screws and washers that secure the plastic shields to the bottom of the drive and remove the shields.

4. Remove the bolts, washers and wiring from the power terminals (U, V, W, C, and D).



5. Remove the protective covers from the drive (see page 43).

IMPORTANT Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

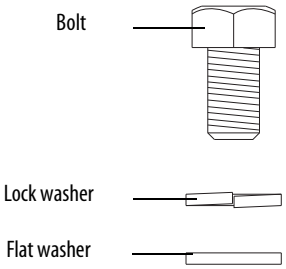
6. Remove the pulse transformer and switching power supply boards from the drive (see page 62). You do not need to remove the switching power supply board from the back of the pulse transformer board for this procedure.

7. Remove the bus bars in order to access the SCR modules in the drive:
   - For a regenerative drive, see Remove the Bus Bars from a Regenerative Drive on page 82.
   - For a non-regenerative drive, see Remove the Bus Bars from a Non-Regenerative Drive on page 85.

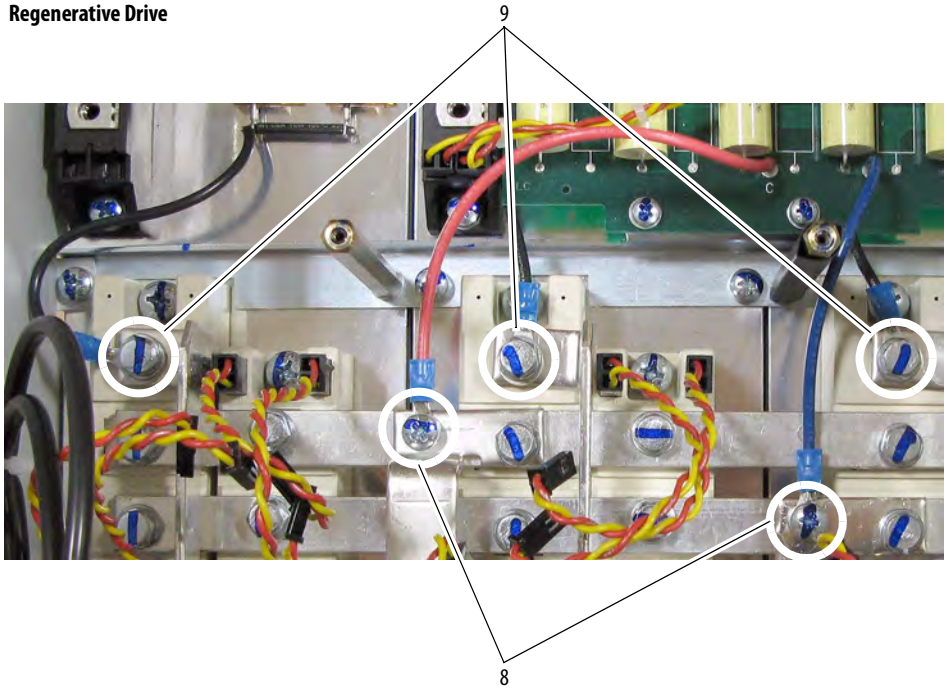
Remove the Bus Bars from a Regenerative Drive

8. Remove the two screws or bolts and washers that secure the (red and blue) wires from the AC line snubber board to the terminal bus bars (C and D) and remove the wires.
9. Remove the three bolts and washers that secure the (black) wires from the resistors to the terminal bus bars (U, V, and W) and remove the wires.

Note proper order of washers for installation.

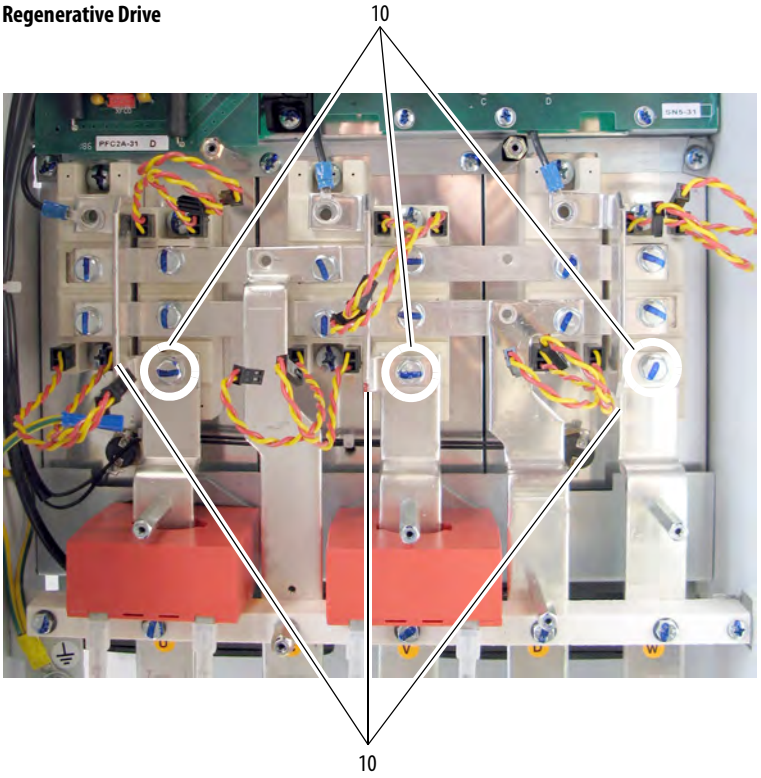


Regenerative Drive



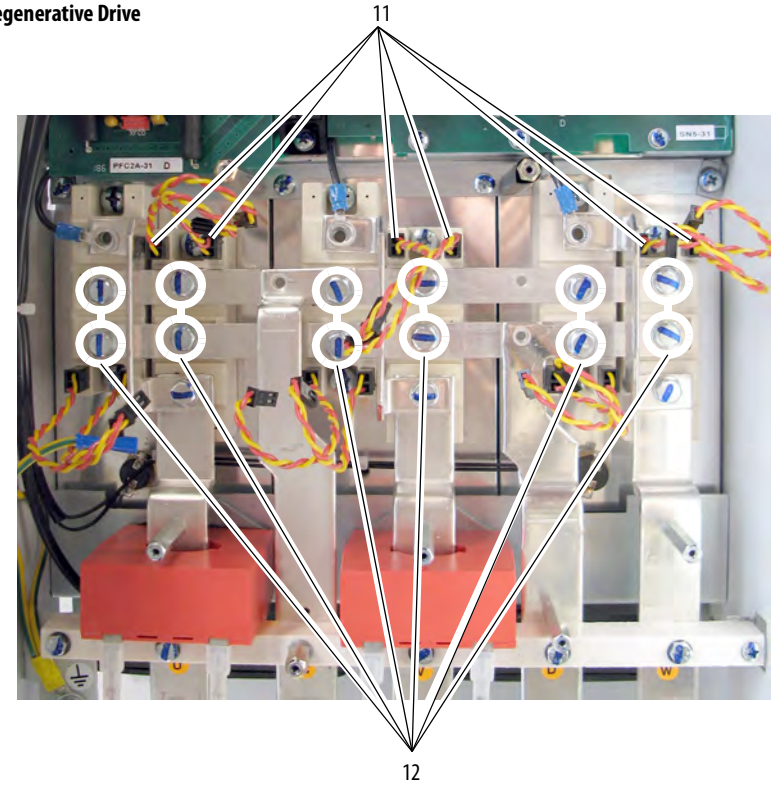
10. Remove the three remaining bolts and washers that secure the AC input bus bars (U, V, and W phases) to the anode of the SCR modules and remove the bus bars.

Regenerative Drive



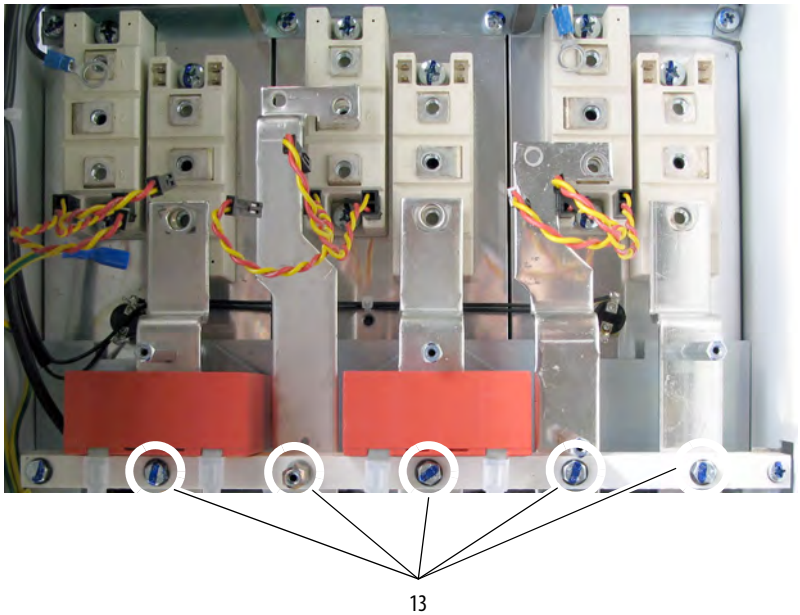
11. Remove the three pairs of upper gate leads from the SCR modules.
12. Remove the bolts and washers that secure the DC bus bars to the SCRs and remove the bus bars.

Regenerative Drive



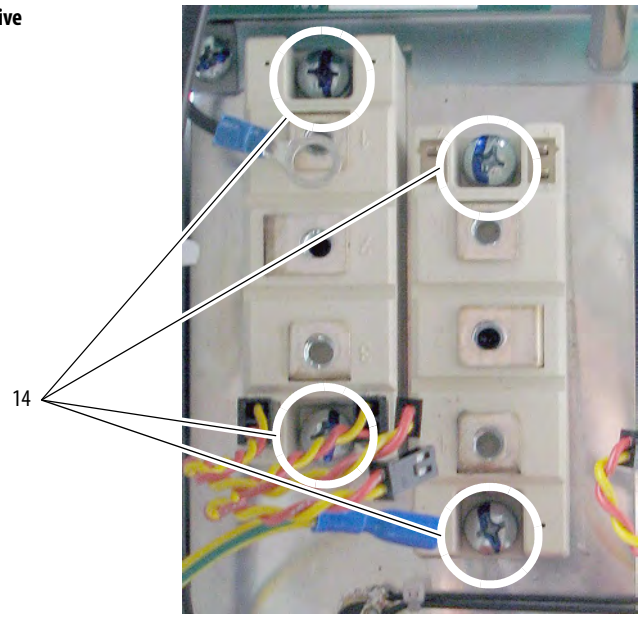
13. Remove the four bolts and washers and stand-off that secure the power terminal bus bars to the isolation bar and slide the bus bars up and out of the drive.

Regenerative Drive



14. Remove the two screws and washers that secure each SCR module to the heatsink and remove the SCR module.

Regenerative Drive

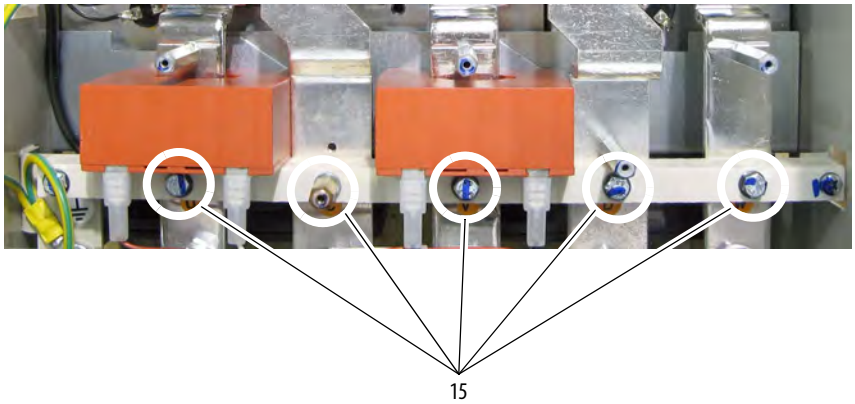


Continue with Install the SCR Modules on page 88.

Remove the Bus Bars from a Non-Regenerative Drive

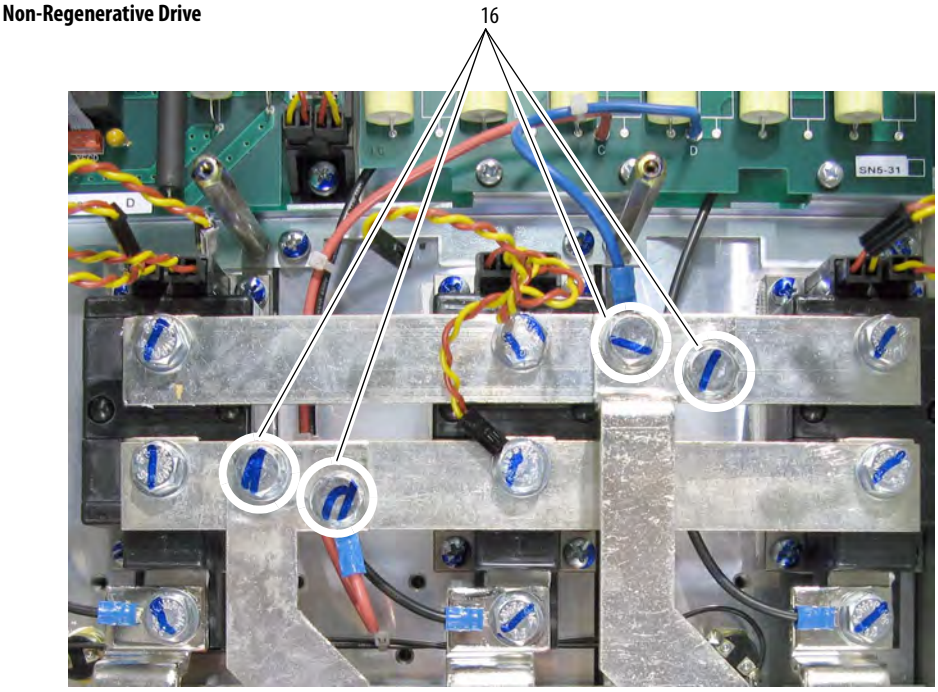
15. Remove the bolts and washers and stand-off and washer that secure the power terminal bus bars to the isolation bar.

Non-Regenerative Drive

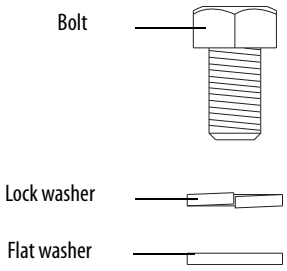


16. Remove the bolts and washers that secure the C and D terminal bus bars to the horizontal bus bars.

Non-Regenerative Drive

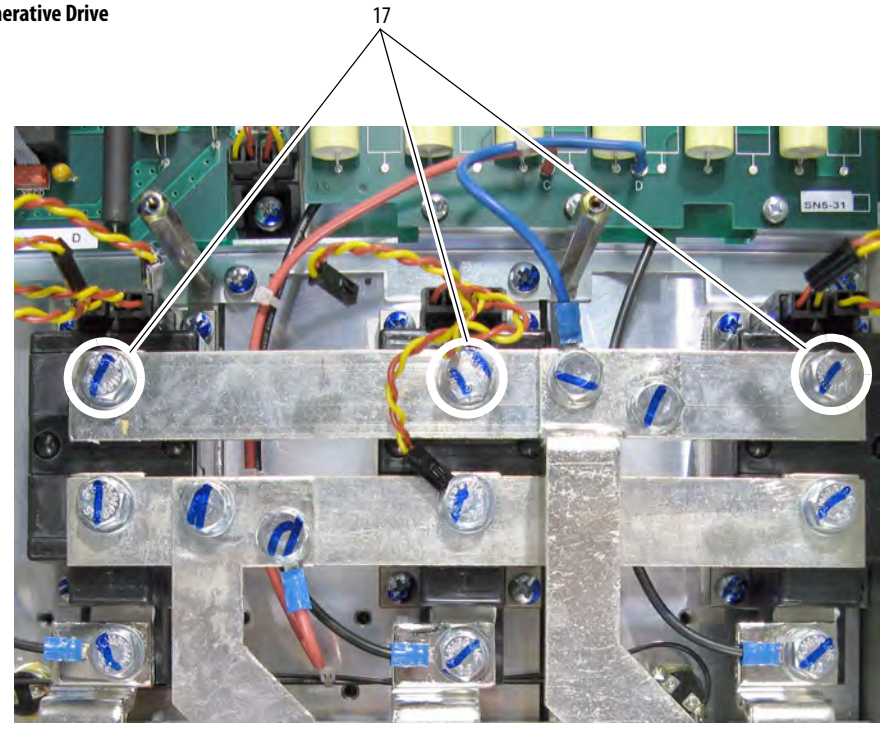


Note proper order of washers for installation.



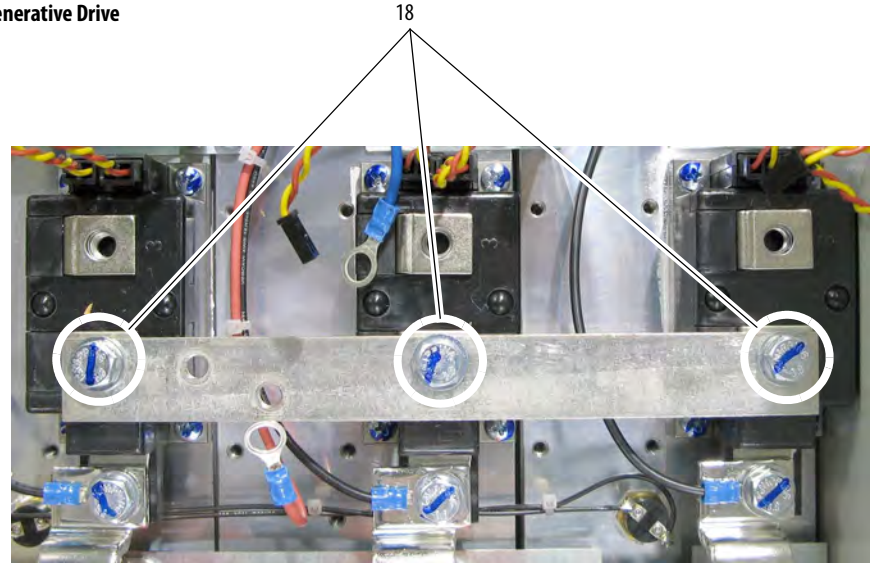
17. Remove the bolts and washers that secure the upper horizontal bus bar to the SCR modules and remove the bus bars.

Non-Regenerative Drive



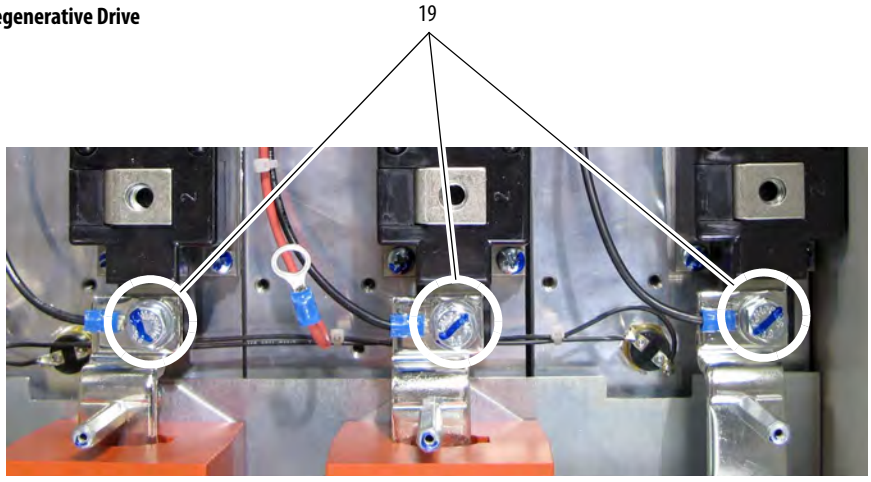
18. Remove the bolts and washers that secure the lower horizontal bus bar to the SCR modules and remove the bus bar.

Non-Regenerative Drive



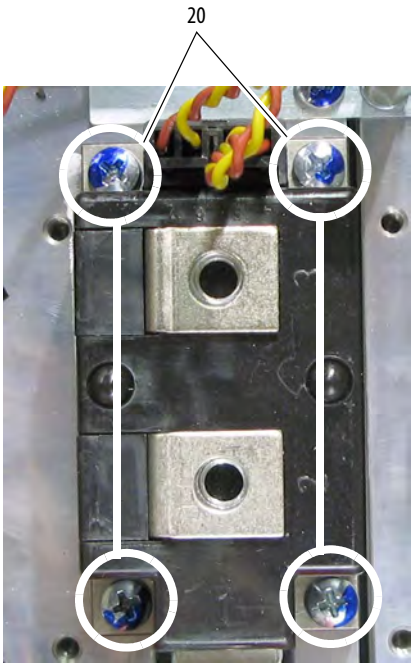
19. Remove the bolts, washers and wires that secure the U, V and W phase power terminals to the SCR modules.

Non-Regenerative Drive



20. Remove the screws and washers that secure each SCR module to the heatsink and remove the SCR module from the drive.

Non-Regenerative Drive



Install the SCR Modules

Install the SCR modules in reverse order of removal.

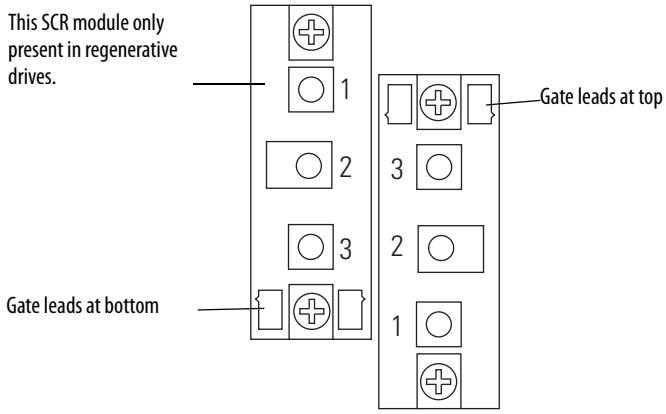
IMPORTANT Thermal grease must be applied to the bottom of each SCR module before securing it to the heatsink.

- Use the following table to determine the proper tightening torque for the SCR modules installed on the heatsink.

230V AC Input	
Part Number	**Final Torque**
SK-20P-S7F48	2.5…4.0 N•m (22…35.4 lb•in)
SK-20P-S7F49	4.5…5.5 N•m (40…48.7 lb•in)
SK-20P-S7F42	4.5…5.5 N•m (40…48.7 lb•in)
SK-20P-S727F	4.5…5.5 N•m (40…48.7 lb•in)

460V AC Input	
Part Number	**Final Torque**
SK-20P-S7F78	2.5…4.0 N•m (22…35.4 lb•in)
SK-20P-S7F79	4.5…5.5 N•m (40…48.7 lb•in)
SK-20P-S7F41	4.5…5.5 N•m (40…48.7 lb•in)
SK-20P-S737F	4.5…5.5 N•m (40…48.7 lb•in)

- Use the following orientation for installing the SCR modules:

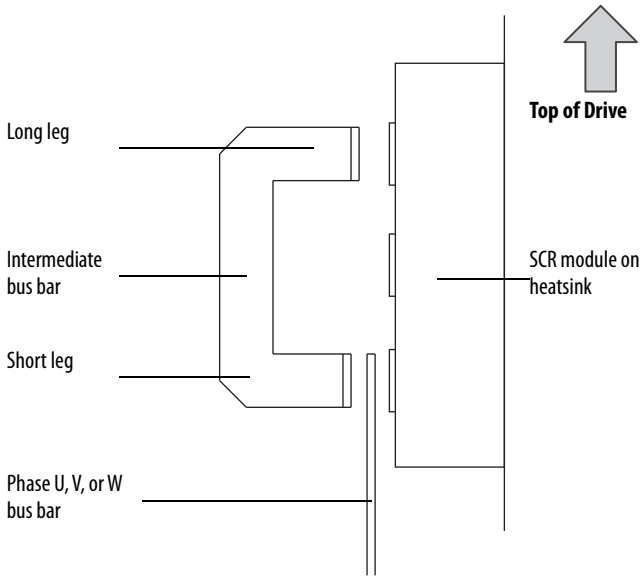


- Use the following table to determine the proper tightening torque for the bus bars connected to the SCR modules:

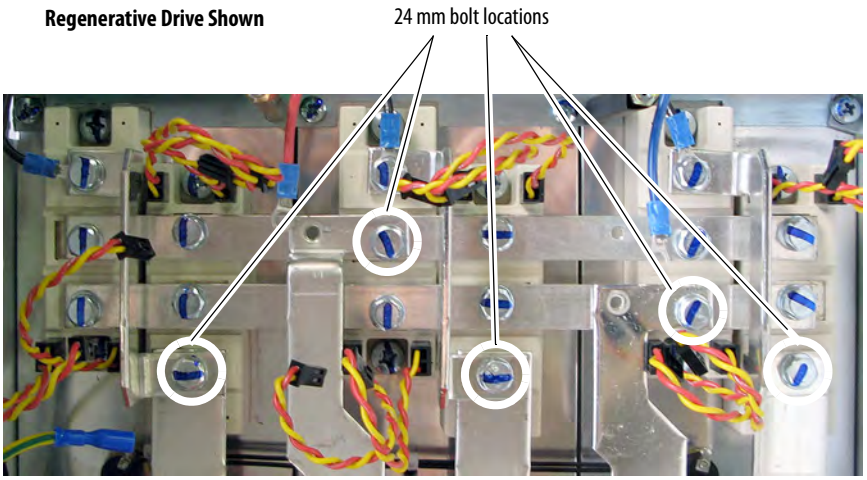
230V AC Input	
Part Number	**Final Torque**
SK-20P-S7F48	4.5…5.5 N•m (40…48.7 lb•in)
SK-20P-S7F49	4.5…5.5 N•m (40…48.7 lb•in)
SK-20P-S7F42	11…13 N•m (97.4…115 lb•in)
SK-20P-S727F	11…13 N•m (97.4…115 lb•in)

460V AC Input	
Part Number	**Final Torque**
SK-20P-S7F78	4.5…5.5 N•m (40…48.7 lb•in)
SK-20P-S7F79	4.5…5.5 N•m (40…48.7 lb•in)
SK-20P-S7F41	11…13 N•m (97.4…115 lb•in
SK-20P-S737F	11…13 N•m (97.4…115 lb•in)

- For regenerative drives, the longer leg of the intermediate AC input bus bars connect to the top of the SCR modules:



- For regenerative drives, five of the bolts are 24 mm long and the rest are 20 mm long. For non-regenerative drives, two of the bolts are 24 mm long and the rest are 20 mm long. Install the 24 mm bolts in the following locations:

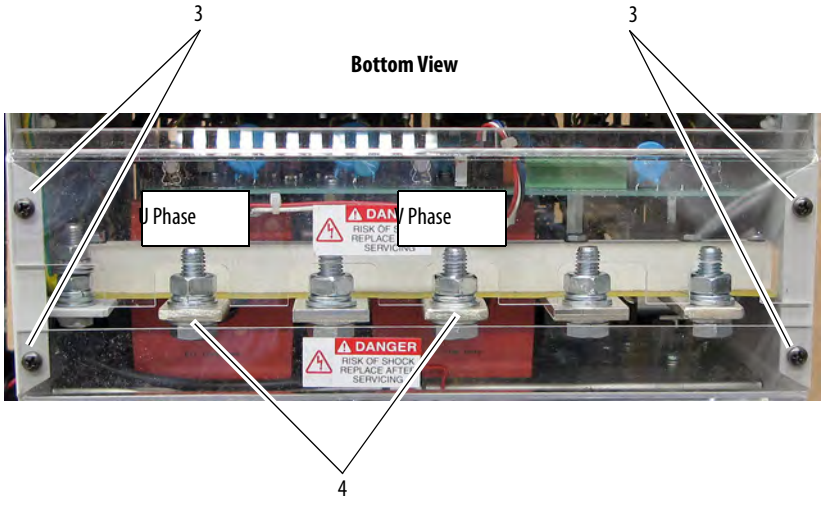


AC Current Transducers Replacement

Remove the AC Current Transducers

Follow these steps to remove the AC current transducers.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the screws and washers that secure the plastic shields to the bottom of the drive and remove the shields.
4. Remove the bolts, washers and wiring from the U and V phase AC input power terminals.

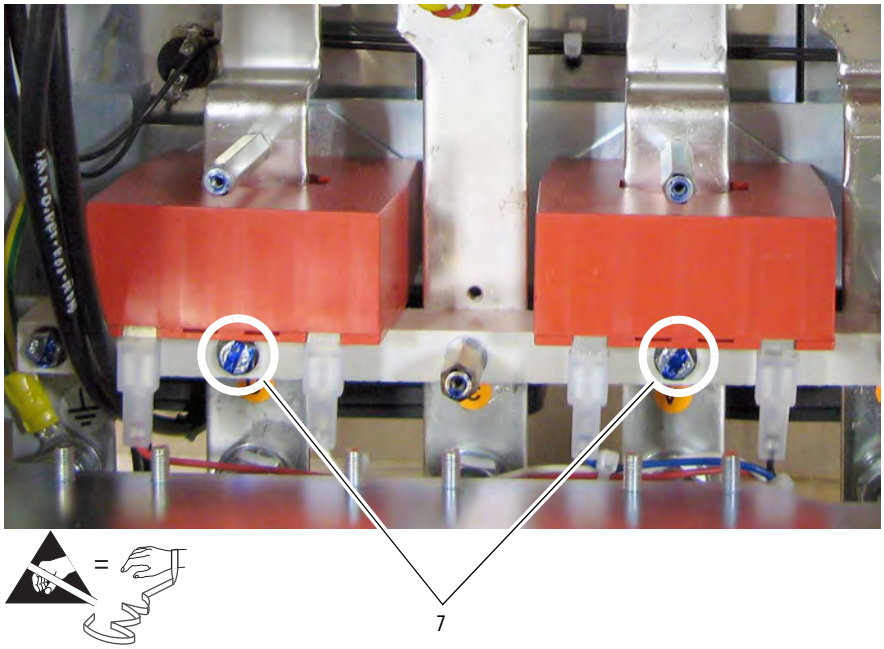


5. Remove the protective covers from the drive (see page 43).

IMPORTANT Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

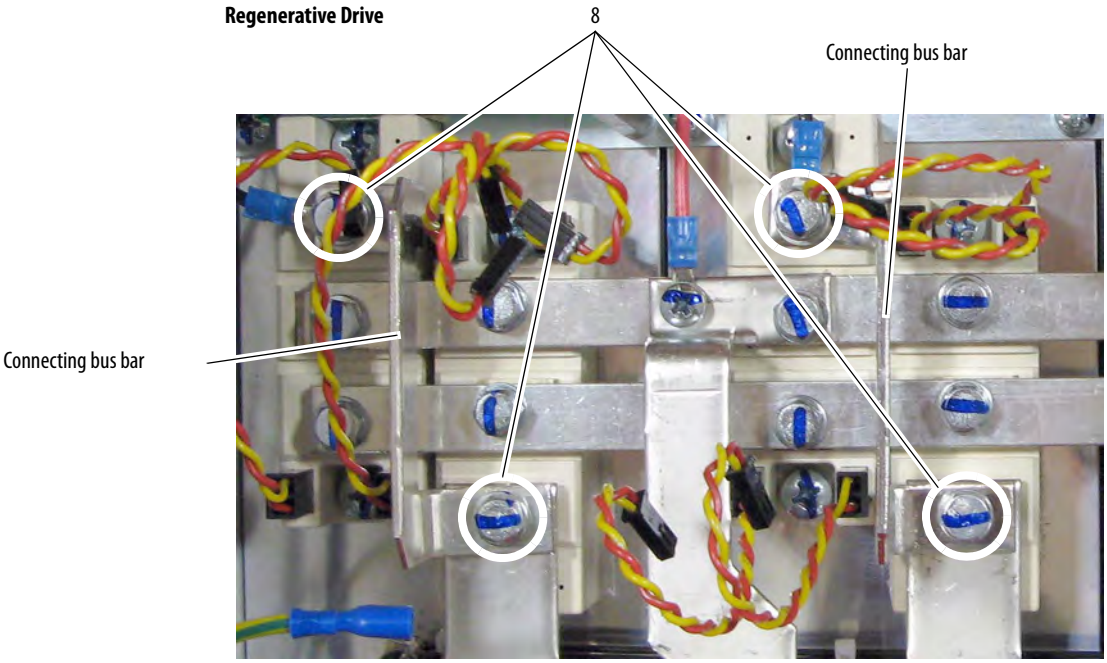
6. Remove the pulse transformer and switching power supply boards from the drive (see page 62). You do not need to remove the switching power supply board from the back of the pulse transformer board for this procedure.
7. Remove the bolts and washers that secure the U and V phase AC input bus bars to the isolation bar.

Regenerative Drive Shown



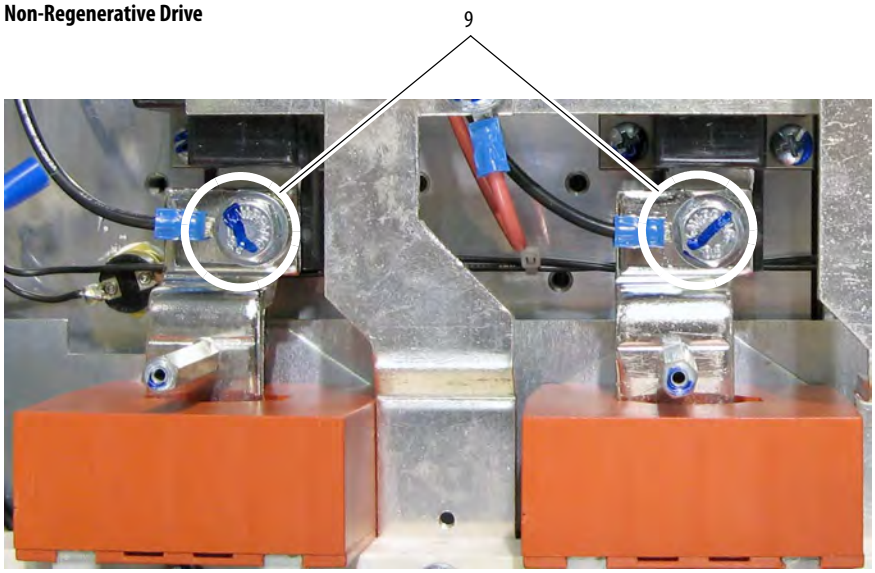
8. For **regenerative drives only**, remove the bolts and washers that secure the resistor wires and the connecting bus bars to the U and V Phase SCR modules and remove the wires and bus bars.

Regenerative Drive



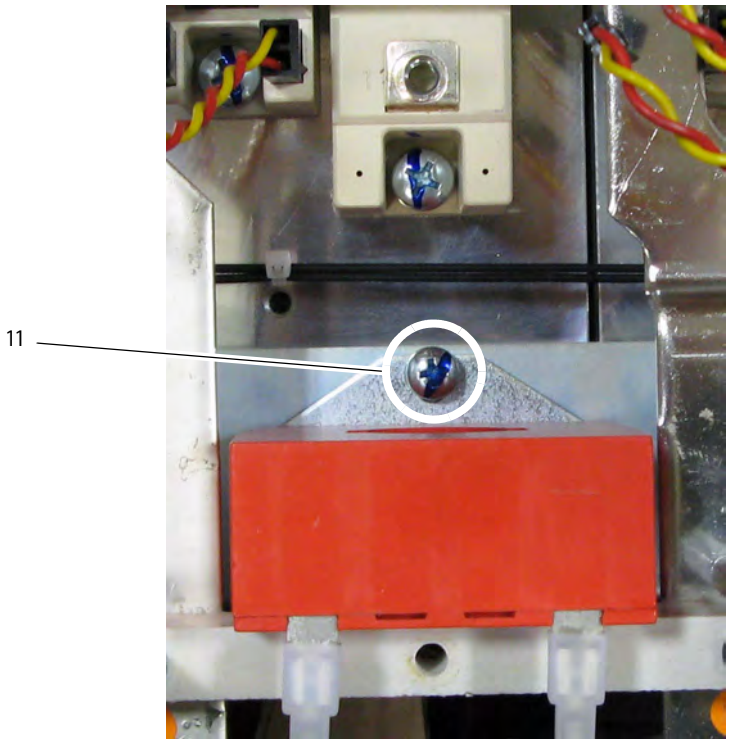
9. For **non-regenerative drives only**, remove the bolts and washers that secure the resistor wires and bus bars to the U and V Phase SCR modules and remove the wires and bus bars.

Non-Regenerative Drive



10. Slide the U and V phase bus bars that pass through the AC current transducers up and out of the drive.

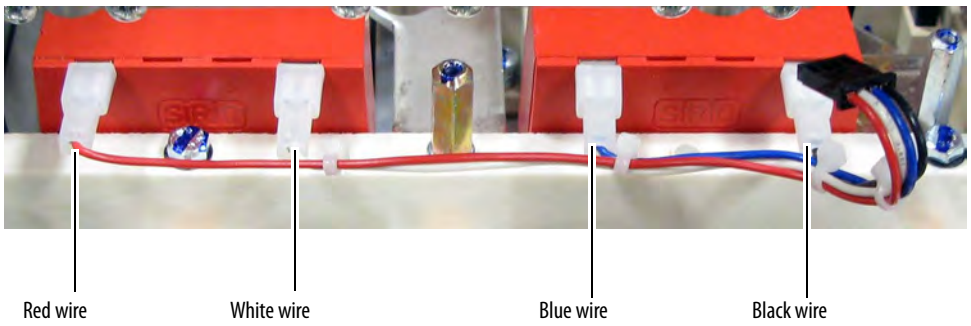
11. Remove the screw and washer that secures each of the AC current transducers to the drive frame and remove the AC current transducers.



Install the AC Current Transducers

Install the AC current transducers in reverse order of removal.

- Note the color and location of each of the four wires connected to the AC current transducers to ensure that each wire is properly connected during installation. Use cable ties to bundle wires as shown below.



- Use the following table to determine the proper tightening torque for the bus bars connected to the SCR modules:

230V AC Input				
Drive Current Rating Code	**DC Amps**	**AC Line Amps**	**Hp**	**Final Torque**
146	146	119	40	4.5…5.5 N•m (40…48.7 lb•in)
180	180	147	50	
218	218	178	60	
265	265	217	75	11…13 N•m (97.4…115 lb•in)
360	360	294	100	
434	434	355	125	

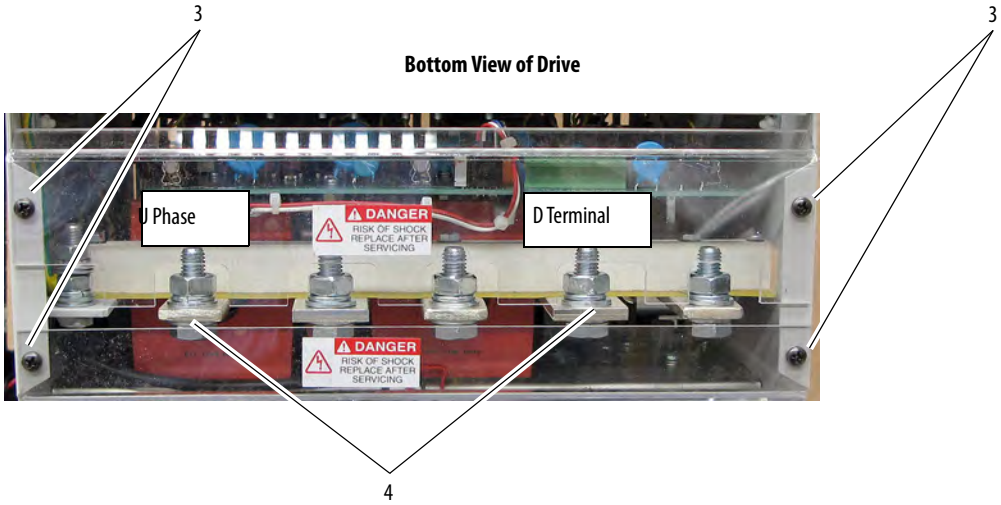
460V AC Input				
Drive Current Rating Code	**DC Amps**	**AC Line Amps**	**Hp**	**Final Torque**
167	167	136.4	100	4.5…5.5 N•m (40…48.7 lb•in)
207	207	169.1	125	
250	250	204.3	150	11…13 N•m (97.4…115 lb•in)
330	330	269.6	200	
412	412	336.6	250	

Bimetal Thermostats Replacement

Remove the Bimetal Thermostats

Follow these steps to remove the bimetal thermostats.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).
3. Remove the screws and washers that secure the plastic shields to the bottom of the drive and remove the shields.
4. Remove the bolts, washers and wiring from the U phase AC input power terminal and the D power terminal.



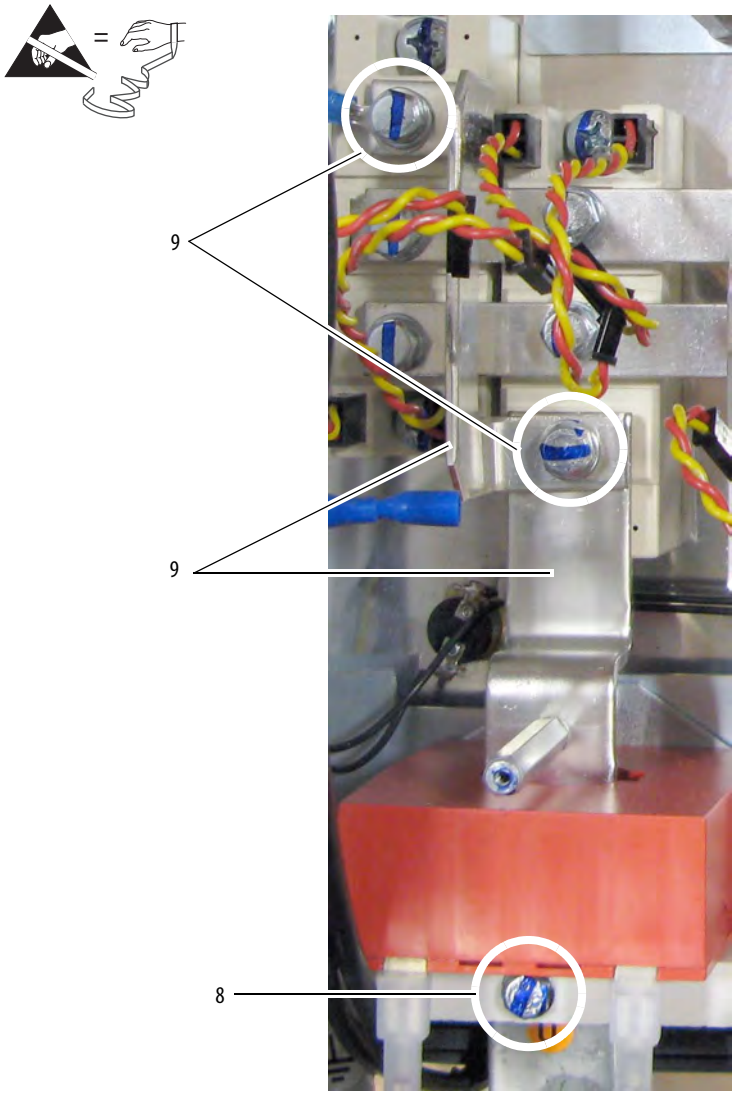
5. Remove the protective covers from the drive (see page 43).

IMPORTANT Mark all connections and wires before removal to avoid incorrect wiring during reassembly.

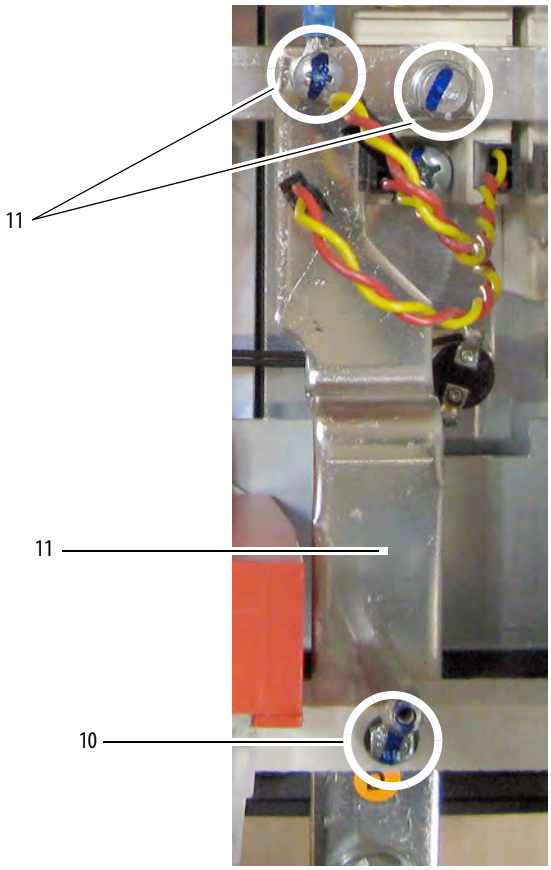
6. Remove the pulse transformer and switching power supply boards from the drive (see page 62). You do not need to remove the switching power supply board from the back of the pulse transformer board for this procedure.
7. Remove the appropriate bus bars in order to access the bimetal thermostats.
   - For a regenerative drive, see Remove the Bus Bars from a Regenerative Drive on page 96.
   - For a Non-Regenerative drive, see Remove the Bus Bars from a Non-Regenerative Drive on page 98.

Remove the Bus Bars from a Regenerative Drive

8. Remove the bolt and washer that secures the U phase terminal bus bar to the terminal isolation bar.
9. Remove the bolts and washers that secure the connecting bus bar to the U phase SCR modules and remove the bus bars.



10. Remove the bolt and washers that secure the D terminal bus bar to the terminal isolation bar.
11. Remove the screw and washer that secures the wire to the bus bar and the bolt and washer that secures the U phase bus bar to the SCR module and remove the bus bar.

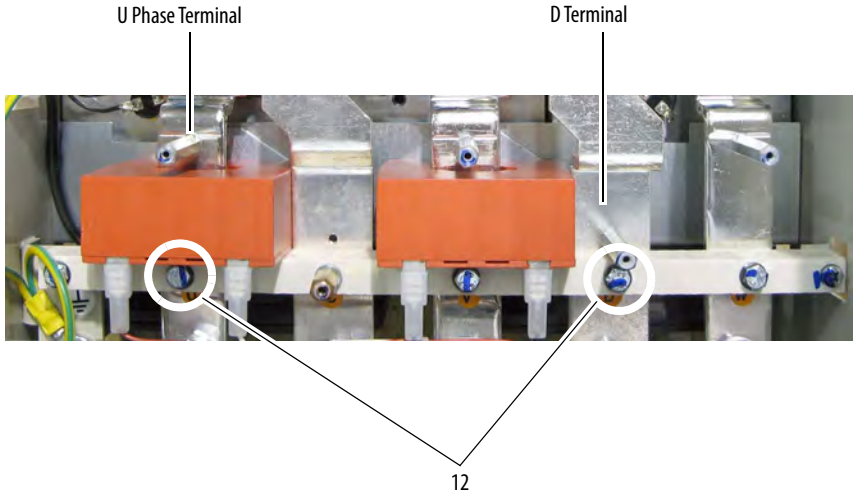


Continue with Remove the Bimetal Thermostats on page 99.

Remove the Bus Bars from a Non-Regenerative Drive

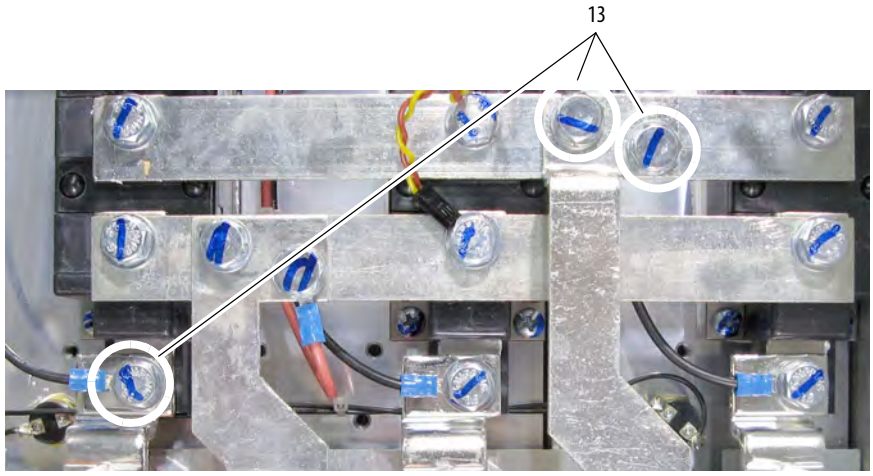
12. Remove the three bolts and washers that secure the U Phase and D power terminals to the isolation bar.

Non-Regenerative Drive



13. Remove the bolts and washers that secure the wires and bus bars to the U phase SCR Module and D power terminal and remove the bus bars.

Non-Regenerative Drive

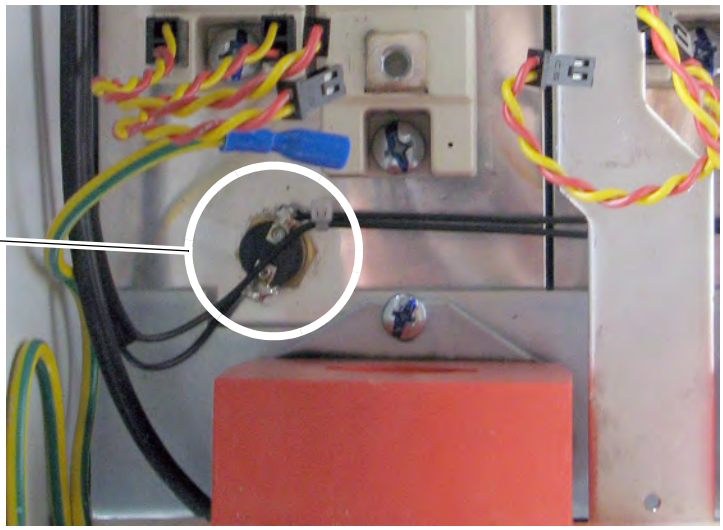


Continue with Remove the Bimetal Thermostats on page 99.

Remove the Bimetal Thermostats

1. Remove the solder from the connections on the two leads of the bimetal thermostats.
2. Remove the bimetal thermostats from the heatsinks by unscrewing them at the base.

Regenerative Drive Shown



Install the Bimetal Thermostats

Install the bimetal thermostats in reverse order of removal.

IMPORTANT Thermal grease must be applied to the bottom of the bimetal thermostats before securing them to the heatsink.

Cooling Fan Replacement

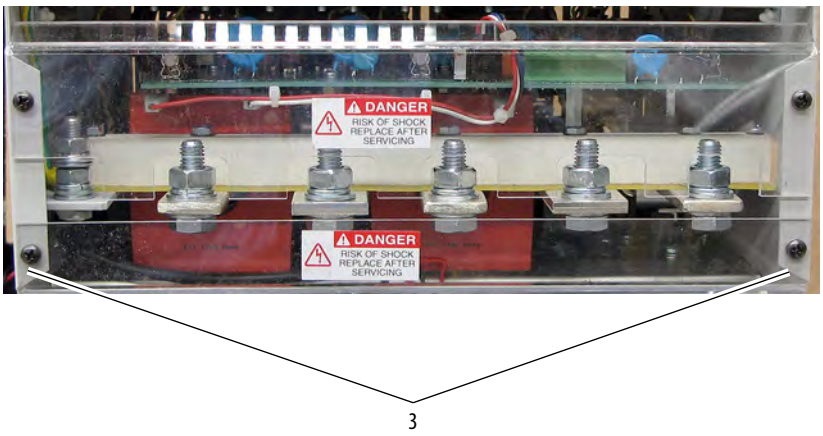
Remove the Cooling Fans

Follow these steps to remove the cooling fans.

1. Read the General Safety Precautions on page 10.
2. Remove power from the drive (see page 42).

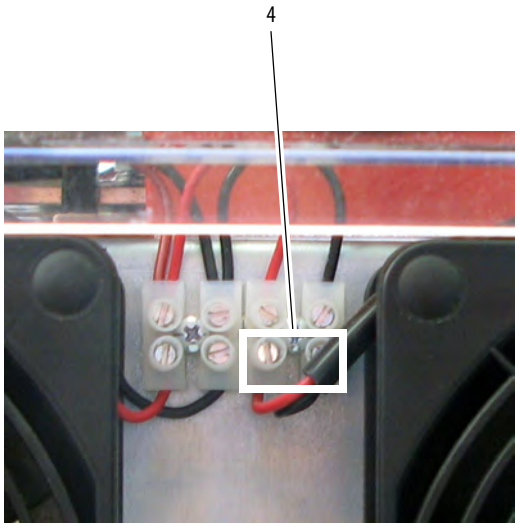
3. Remove the two screws that secure the rear plastic shield to the bottom of the drive and remove the shield.

Bottom View

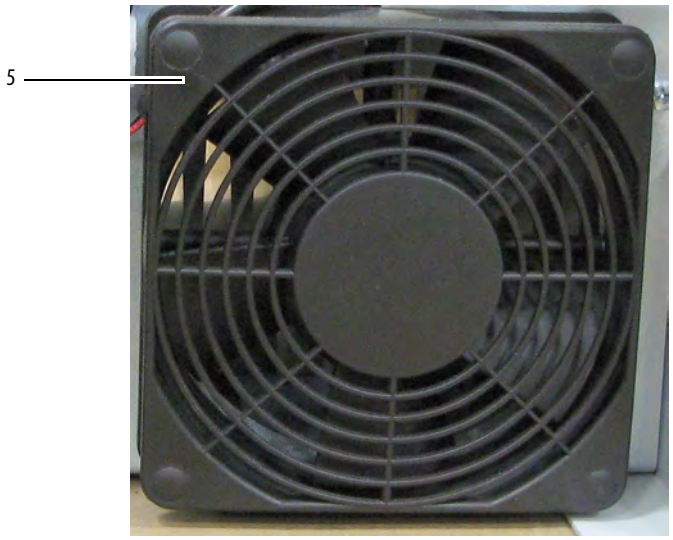


4. Locate the cooling fan terminal block on the bottom of the drive and loosen the screws that secure the fan power supply wires (red and black) to the terminal block and remove the wires.

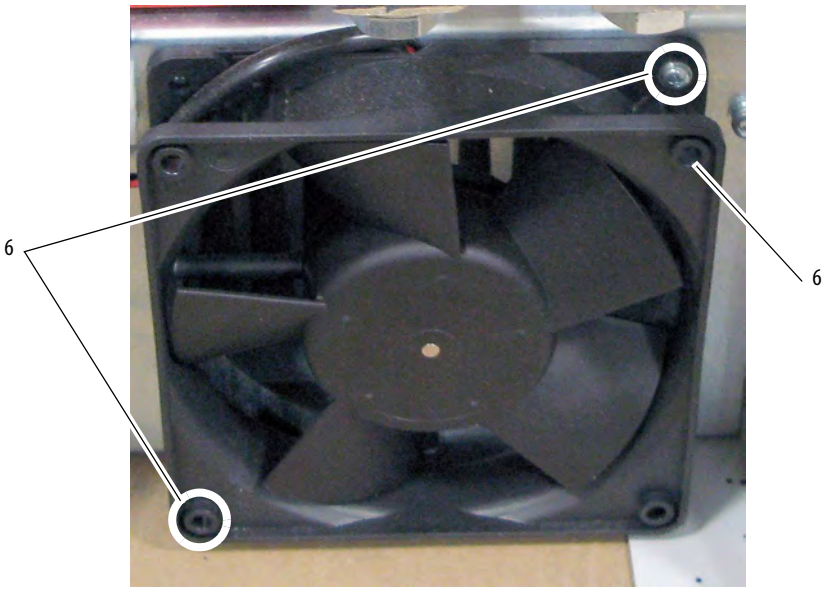
IMPORTANT	Note the color and location of each of the wires connected to the cooling fan to ensure that each wire is properly connected during installation.



5. Using a flathead screwdriver, carefully pry the fan cover plate off of the fan housing.



6. Remove the two screws that secure the fan to the drive frame. You must insert a Phillips head screwdriver through the hole in the front of the fan housing to reach and remove the screws. Remove the fan from the drive.



Install the Cooling Fans

Install the cooling fans in reverse order of removal.

- Verify that the air flow direction arrow on the fans is pointing toward the heatsink on the drive.

Notes:

Start Up After Repair

Before applying power to a repaired drive, perform the following tests:

- Check the Armature SCR Modules on page 26
- Check the Field SCR/Dual Diode Module on page 32
- Complete the Test With the Motor, Without a Mechanical Load

Test With the Motor, Without a Mechanical Load

This test allows you to measure several operating parameters and diagnose problems without connecting the motor to its mechanical load.

This procedure requires a HIM to configure and autotune the drive. If you prefer, you can use the DriveExecutive™ software.

ATTENTION: Power must be applied to the drive 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 should perform the following procedure. Thoroughly read and understand the procedure before beginning. If an event does not occur while performing this procedure, **Do Not Proceed. Remove Power** including user supplied control voltages. User supplied voltages may exist even when main AC power is not applied to then drive. Correct the malfunction before continuing.

1. Verify that the input power wiring and grounding is connected.
2. Verify that the motor cables are connected.
3. Verify that the motor load is disconnected.
4. Verify that the control board DIP switches are set correctly. See Install the Control Circuit Board on page 58 for more information.
5. Apply power to the control circuits (terminals U2 and V2) of the drive.
6. Verify that the following parameter values are set correctly:
   - 45 [Max Ref Speed] is set to the motor nameplate base speed.
   - 162 [Max Feedback Spd] is set to the motor nameplate base speed.
   - 175 [Rated Motor Volt] is set to the motor rated nameplate armature voltage.

- 179 [Nom Mtr Arm Amps] is set to the rated motor nameplate armature current.
- 280 [Nom Mtr Fld Amps] is set to the rated motor nameplate field current.
- 374 [Drv Fld Brdg Amps] is set to the rated current of the field bridge regulator

7. Energize the drive.
8. Measure the field current and verify that the value is reflected in parameter 234 [Fld Current Pct].
9. Run the following applicable Autotune procedures detailed in Chapter 2 of the PowerFlex Digital DC Drive User Manual, publication 20P-UM001.
   - Tune the Current Regulator
   - Verify Motor Rotation Direction and Run Feedback Polarity Checks. If parameter 414 [Fdbk Device Type] is set to 3 "Armature", set parameter 107 [Speed Zero Level] to a minimum value of 10% of base motor speed.
   - Configure the Speed Feedback Parameters
   - Tune the Speed Regulator
10. Make configuration changes that allow the HIM to issue start and speed commands.
11. Start the drive, by pressing  (the start button).

    If the drive will not start, verify that you have correctly installed any replacement components.

    If any faults are displayed on the HIM, see Chapter 4 - Troubleshooting in the PowerFlex Digital DC Drive User Manual, publication 20P-UM001.
12. Increase the speed command from zero to base speed, by pressing  (the up button).
13. Measure the output voltage and verify that it is reflected in parameter 233 [Output Voltage].
14. Measure the armature current and verify that the value is reflected in parameter 199 [Arm Current Pct].
15. Stop the drive, by pressing  (the stop button).
16. If these measurements are correct, re-configure the drive to suit the application. See Chapters 1 and 2 of the PowerFlex Digital DC Drive User Manual, publication 20P-UM001 for assistance.

    If any of these measurements are incorrect, repeat steps 8...15. If the measurements are still incorrect, repeat the appropriate procedures in Chapter 2 - Component Test Procedures beginning on page 13.

Schematics

List of Schematic Diagrams

Figure 13 - Circuit Board Interconnection Diagram

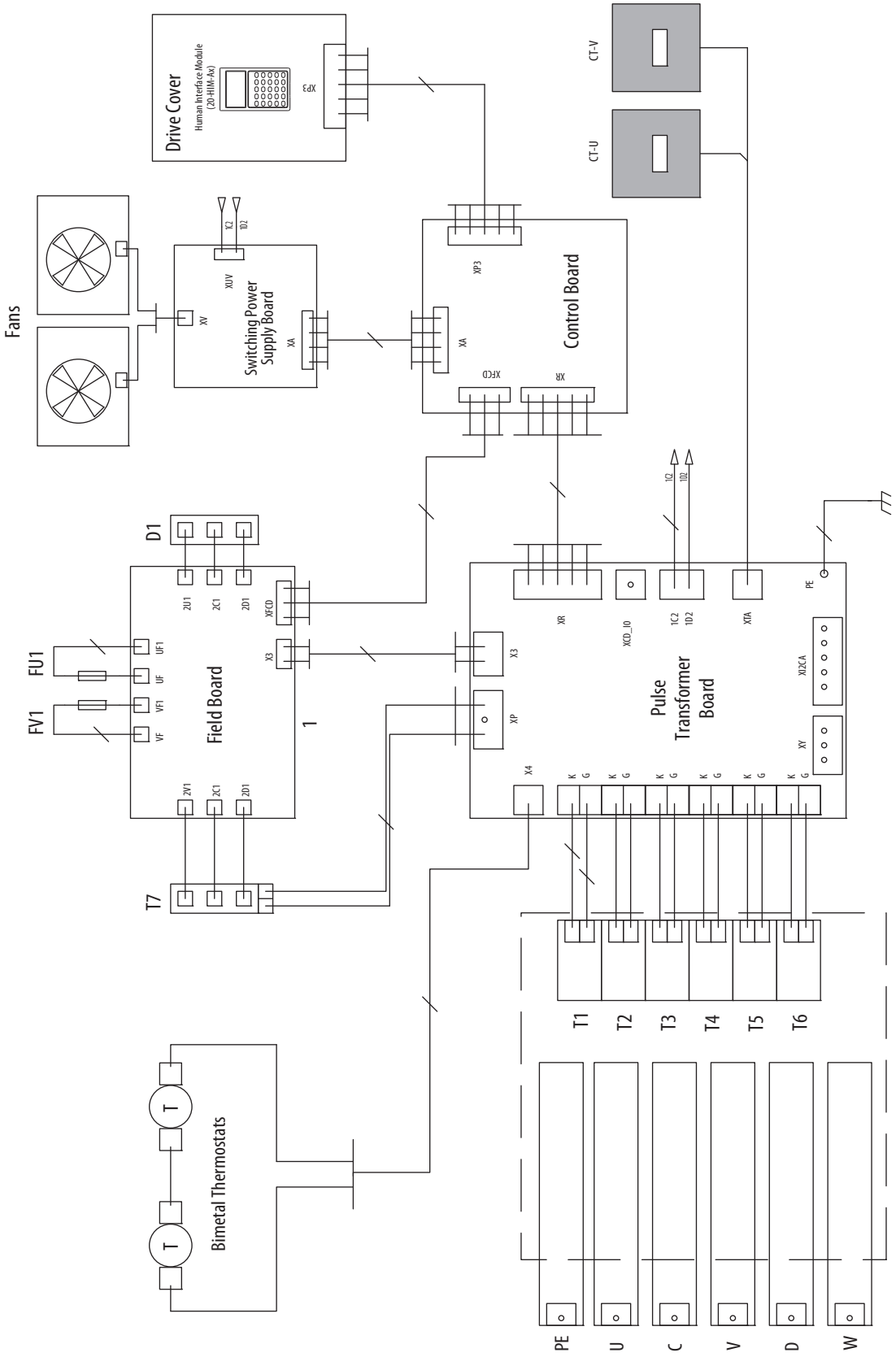


Figure 14 - Non-regenerative Drive Power Module Diagram

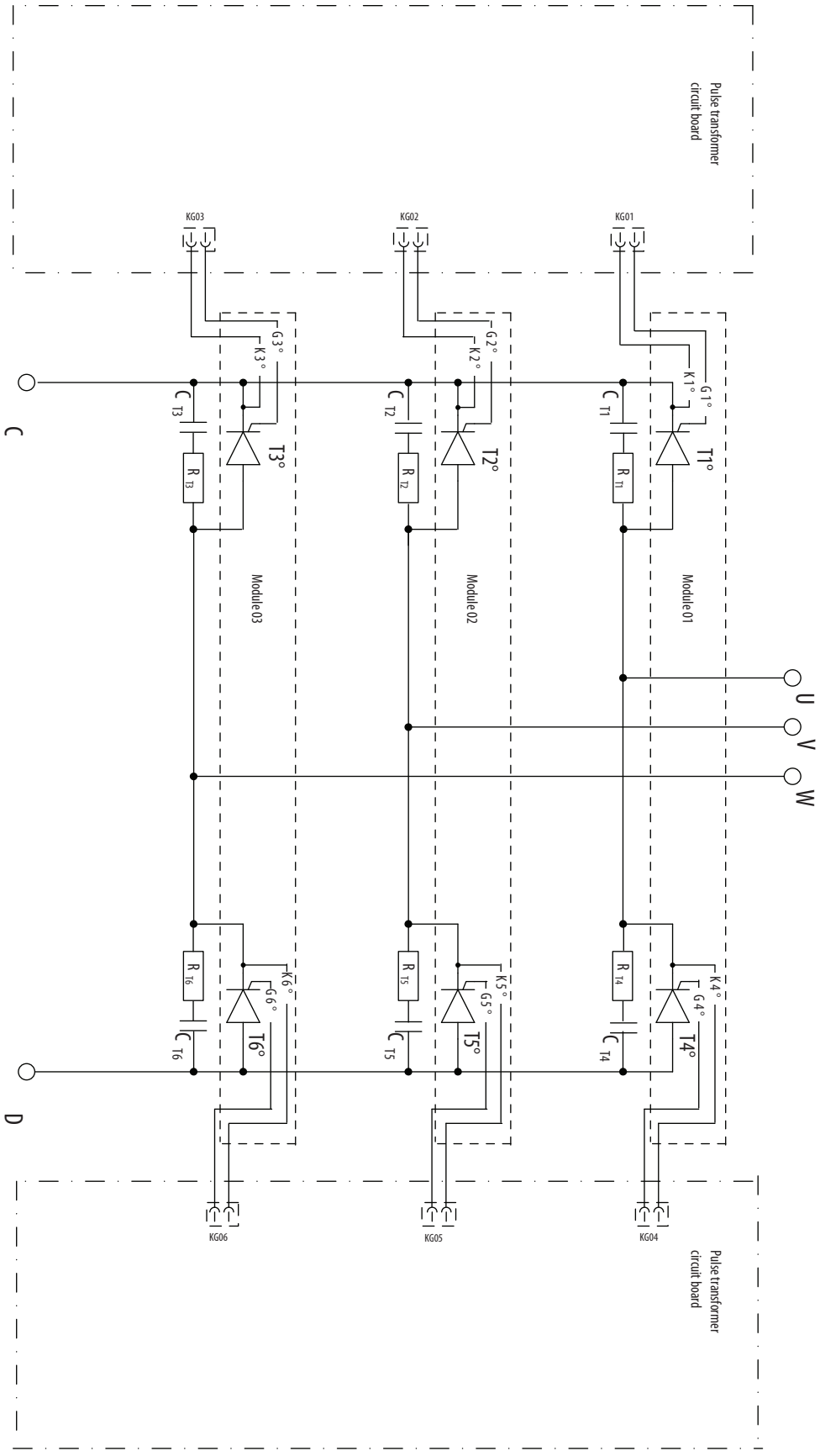


Figure 15 - Regenerative Drive Power Module Diagram

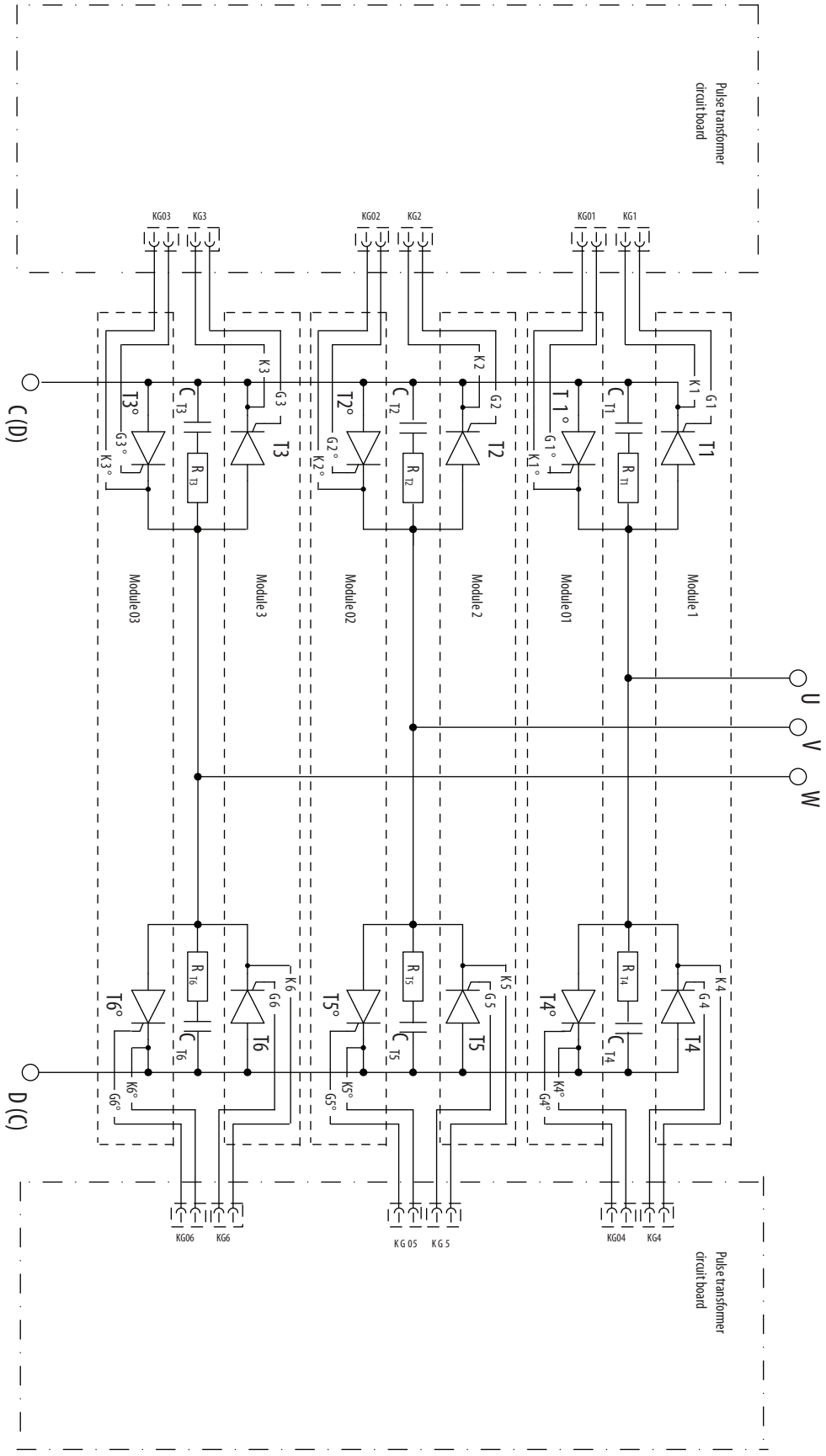


Figure 16 - AC Line Measurement Points Diagram

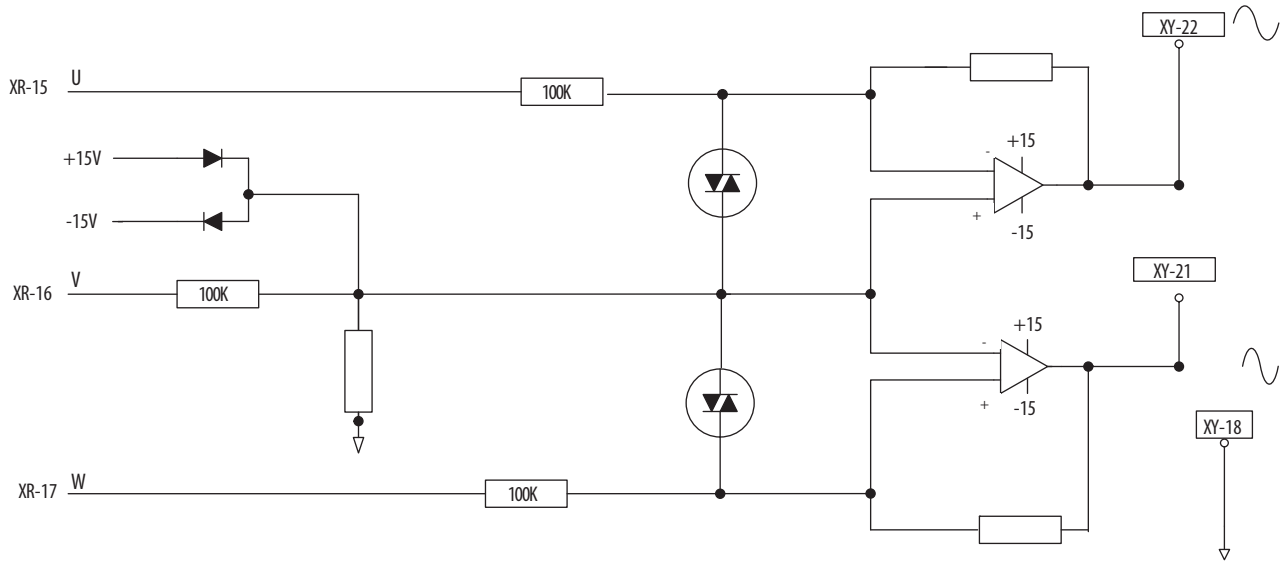


Figure 17 - Frame B Power Feedback Connections Diagram

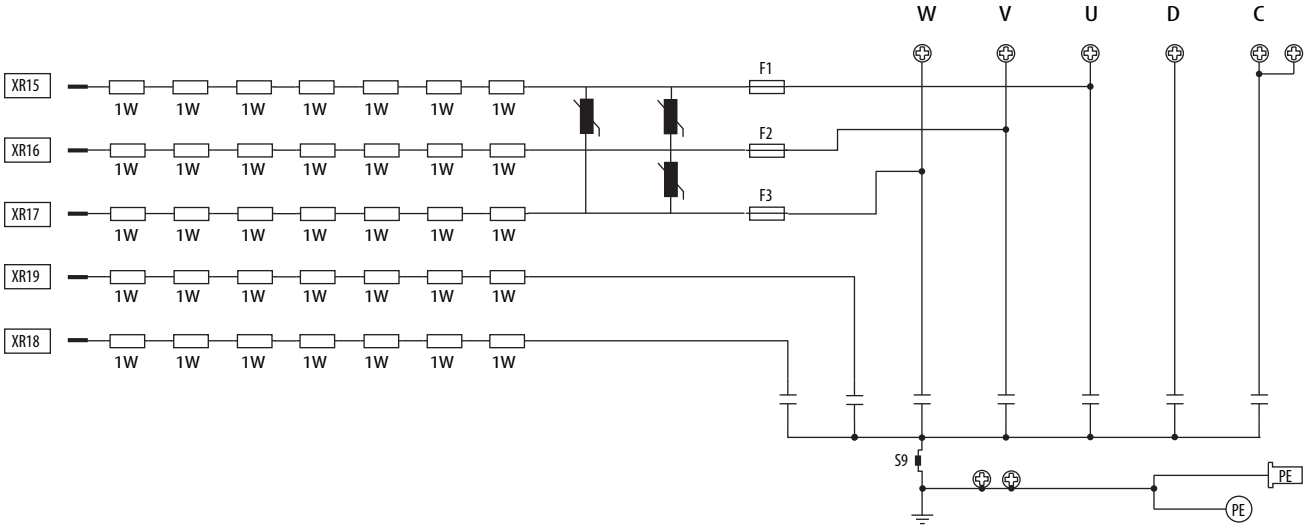


Figure 18 - Field Board and SCR/Dual Diode Module Connections Diagram

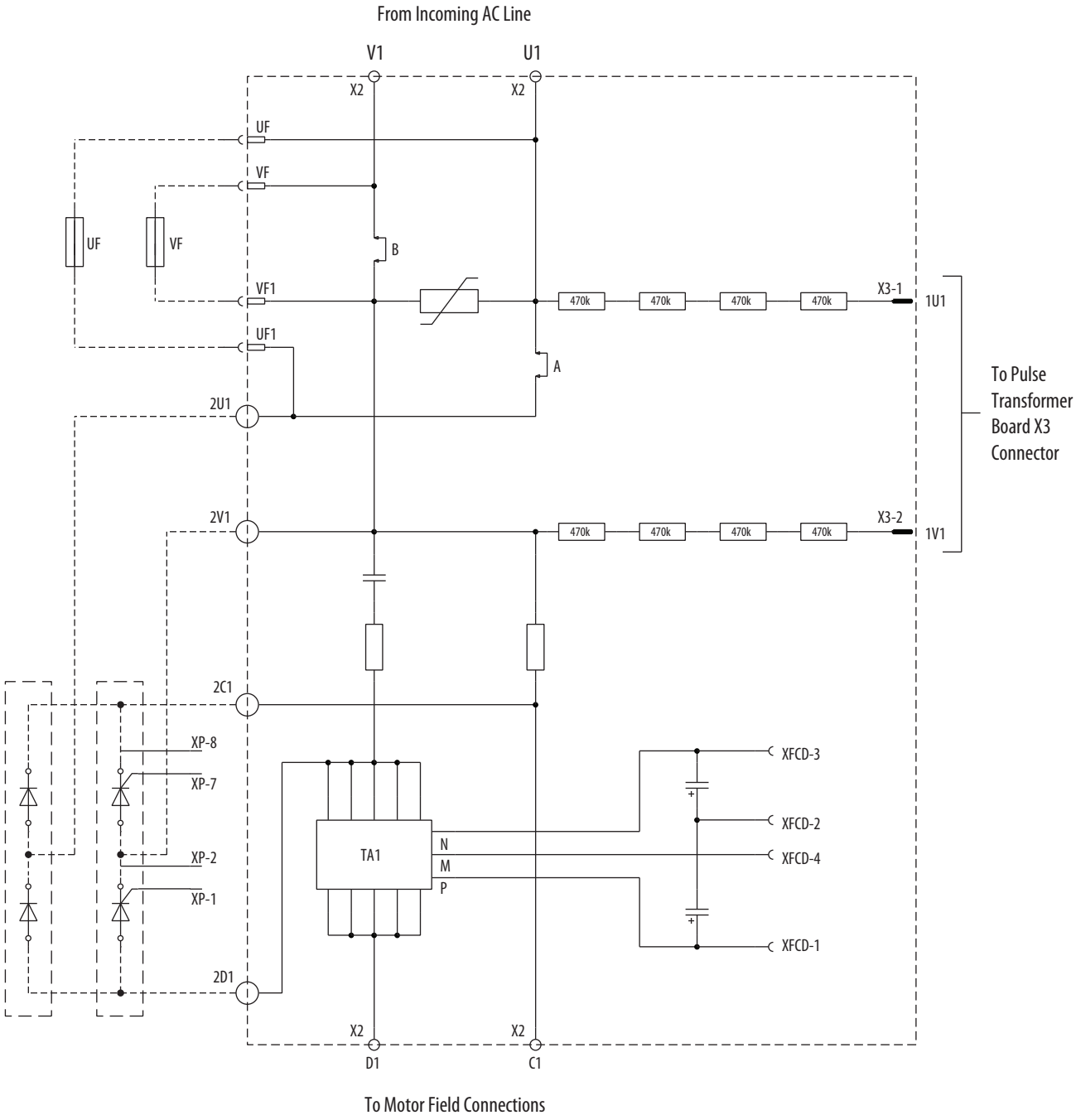


Figure 19 - Field Control Circuit Diagram

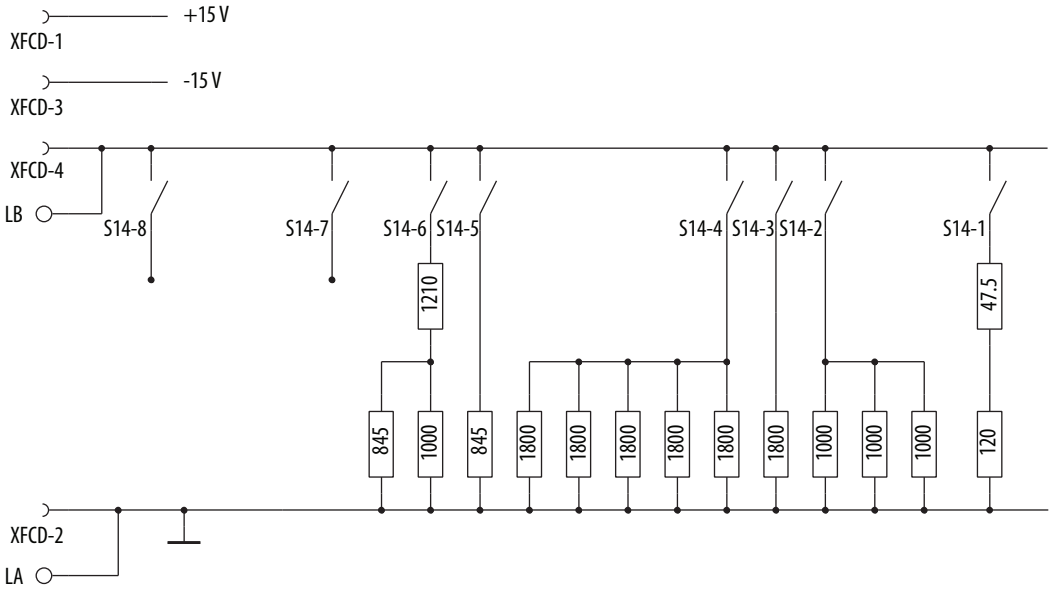


Figure 20 - Control Circuit Input Power Diagram

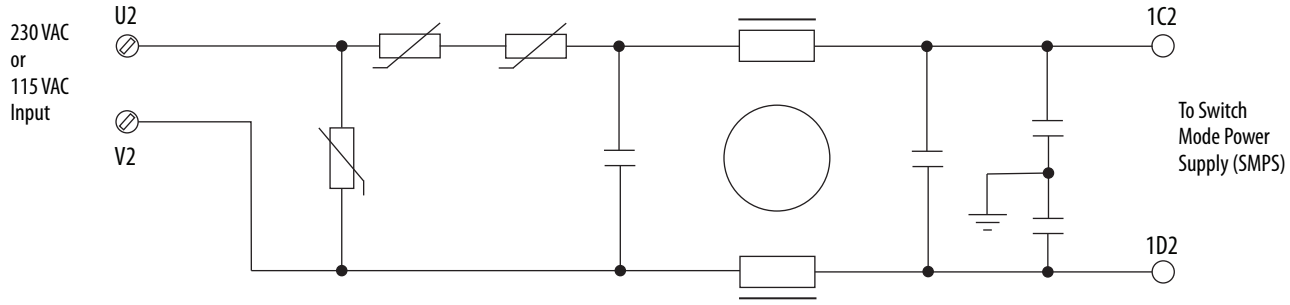


Figure 21 - Encoder Control Circuit Diagram

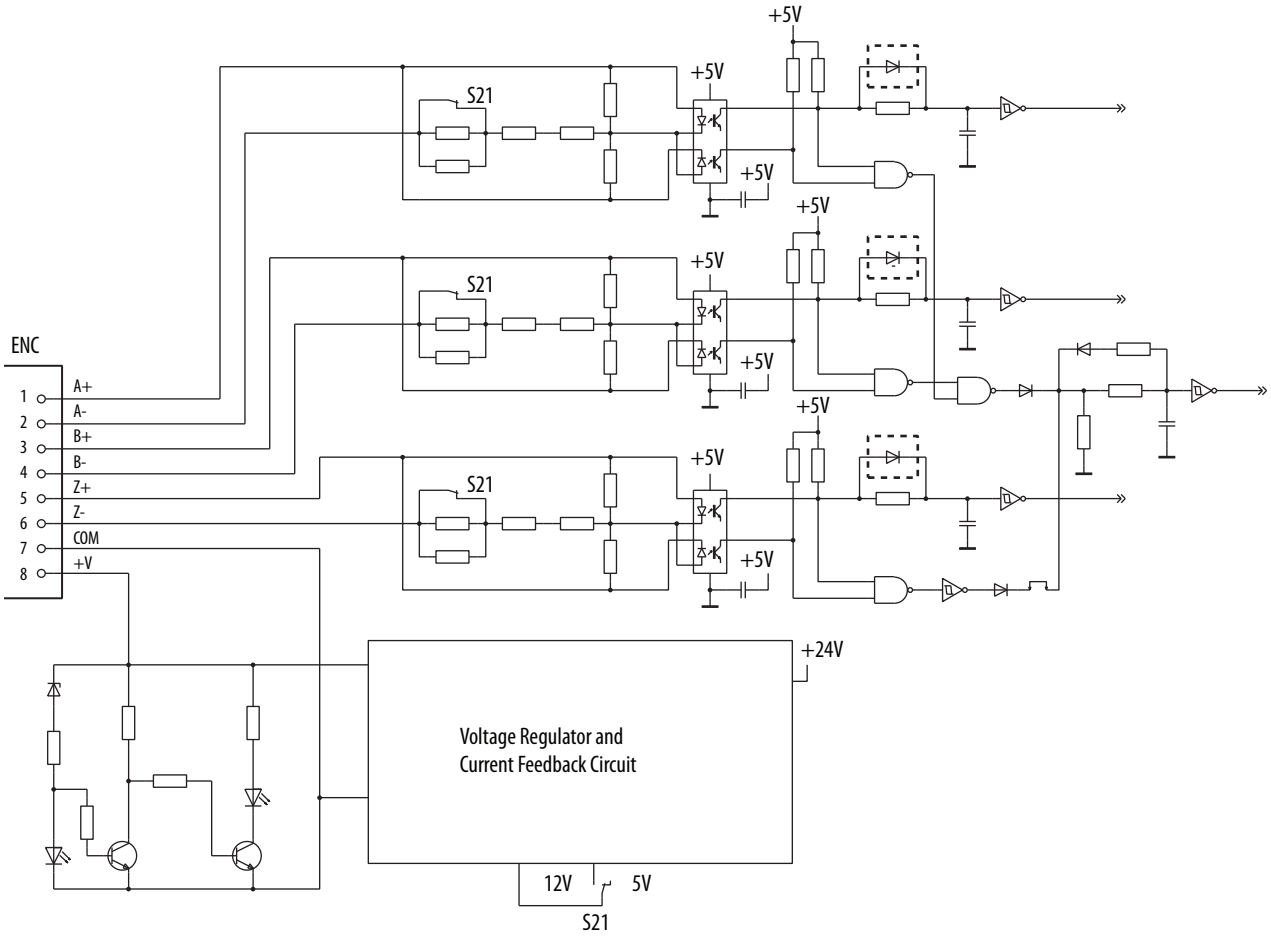


Figure 22 - DC Tachometer Control Circuit Diagram

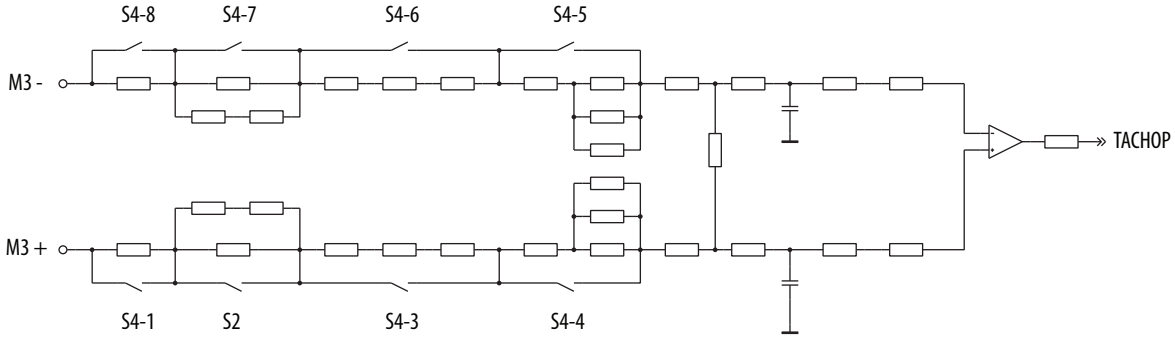


Figure 23 - Motor Thermal Protection Control Circuit Diagram

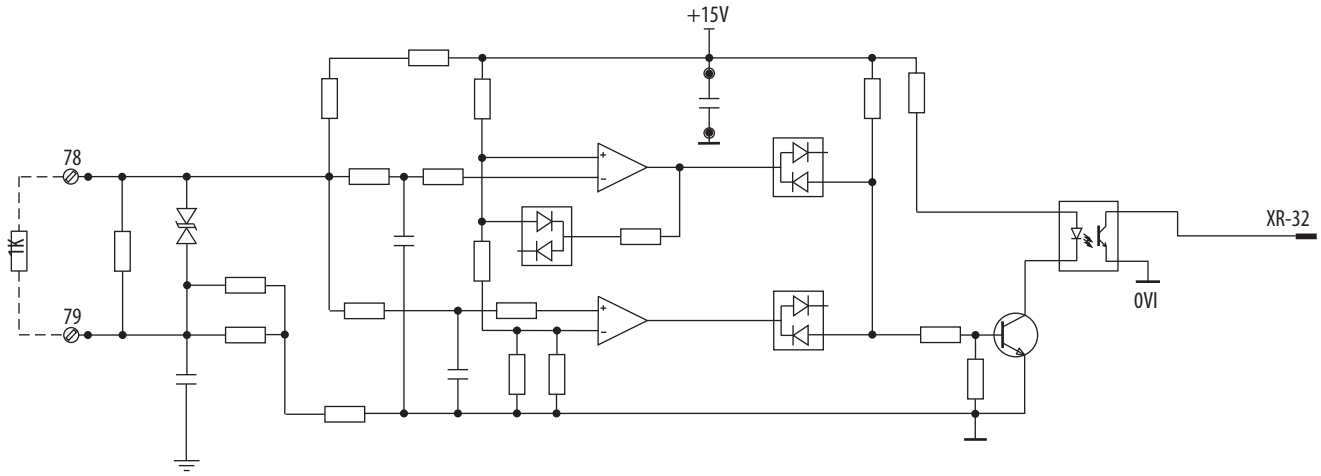


Figure 24 - Drive Heatsink Monitoring Control Circuit Diagram

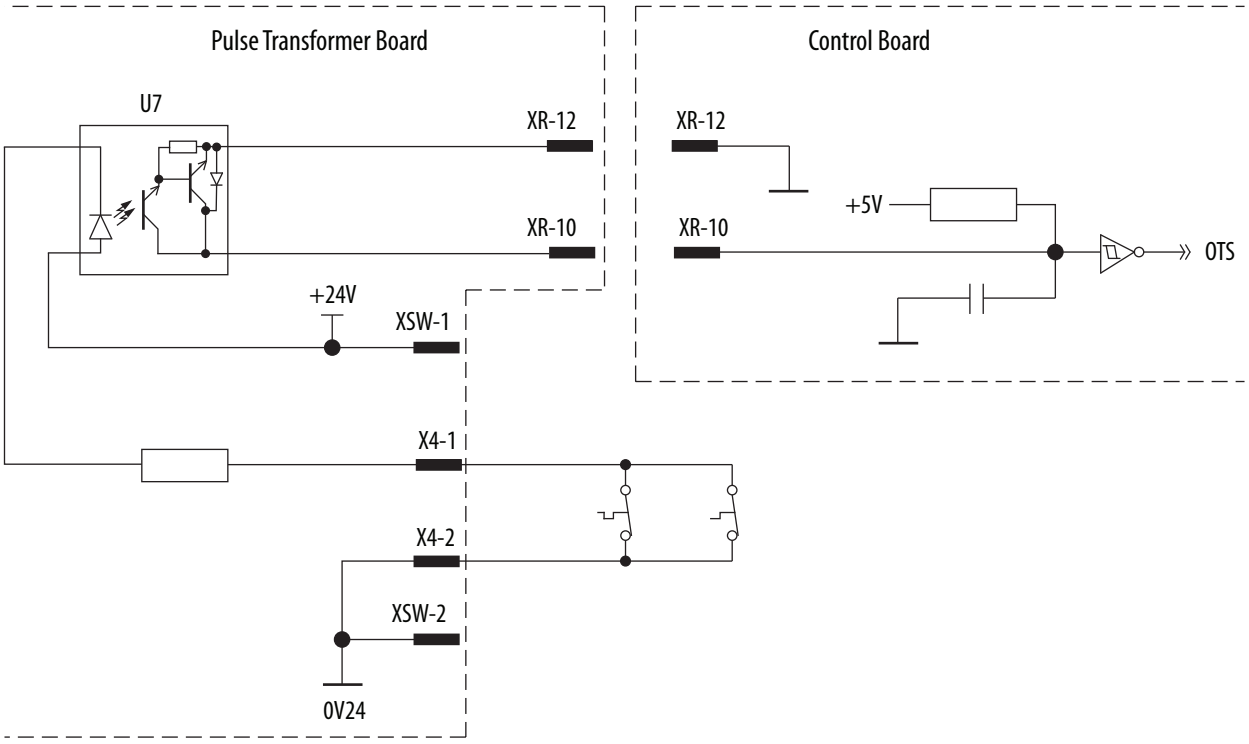


Figure 25 - Contactor Control Relays Control Circuit Diagram

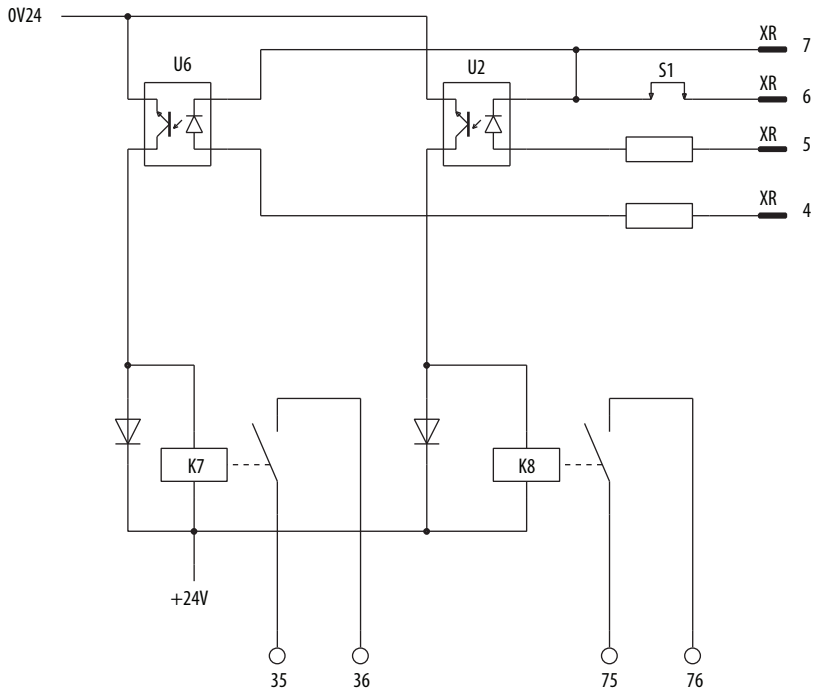
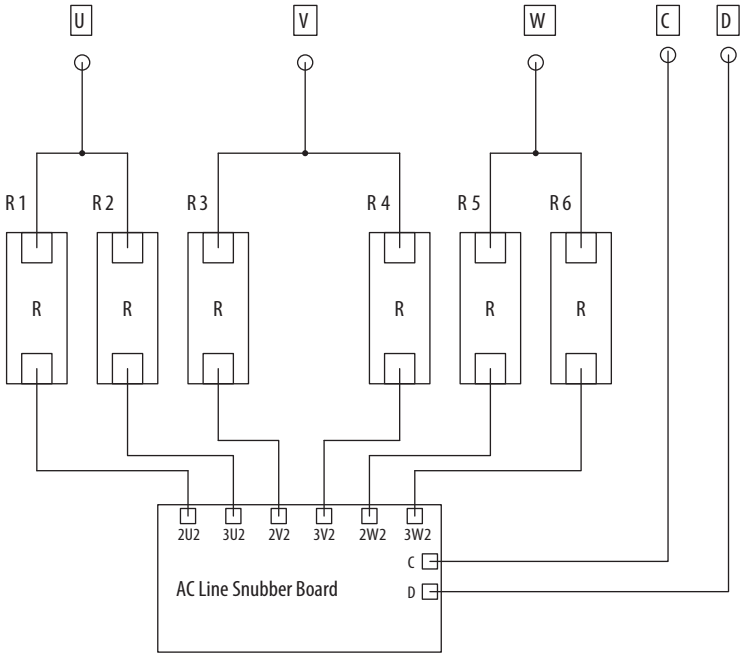


Figure 26 - AC Line Snubber Circuit Diagram



Circuit Board Layouts and Connections

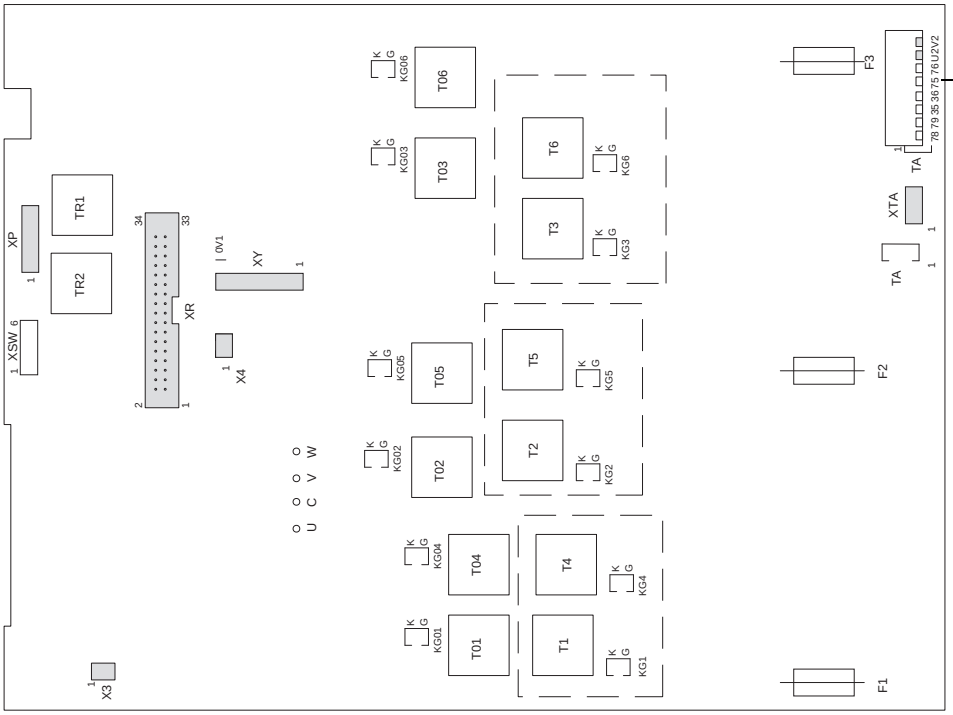
List of Circuit Board Layouts

The following images and tables detail the connection points for the frame B PowerFlex DC drive circuit boards and components.

Pulse Transformer Board

Figure 27 - Pulse Transformer Board Layout

Components shown within dashed lines are only on the pulse transformer board for regenerative drives.



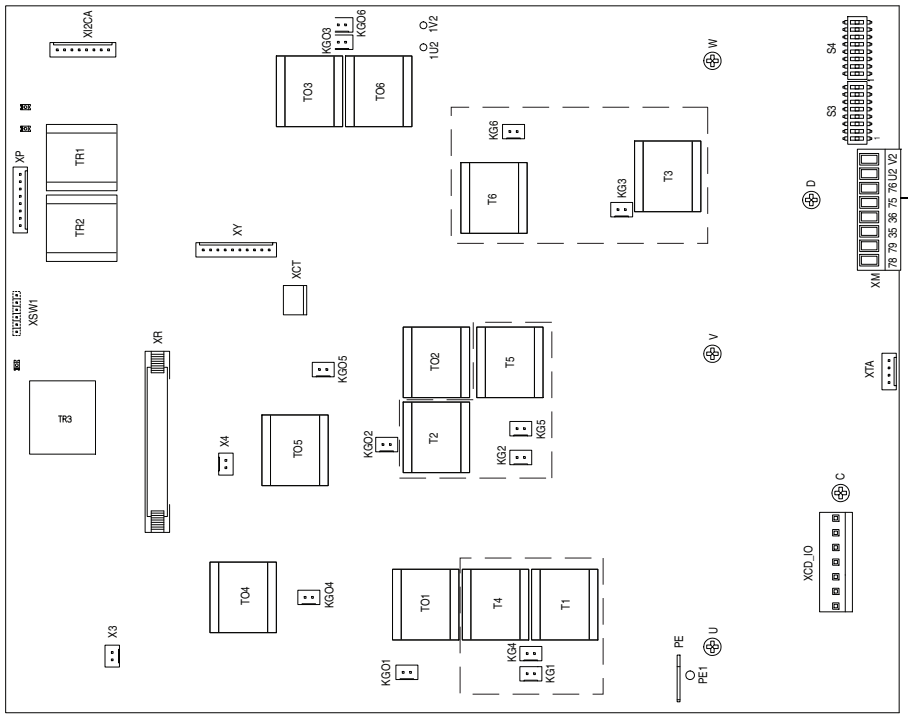


Table 20 - Pulse Transformer Board to Field Board Connections

Pulse Transformer Board Connector	Pin Number	to	Pin Number	Field Board Connector	Description
X3	1	…	1	X3	1U1 field sync signal (from U1)
	2	…	2		1V1field sync signal (from V1)

Table 21 - Pulse Transformer Board to Switching Power Supply Connections

Pulse Transformer Board Point	to	Pin Number	Switching Power Supply Board Connector	Description
1U2	…	4	XUV	Rectified U2-V2 voltage (approx. 150/300V DC)
	…	3		not used
1V2	…	2		not used
	…	1		Common

Table 22 - Pulse Transformer Board to Bimetal Thermostat Connections

Pulse Transformer Board Connector	Pin Number	to	Pin Number	Bimetal Thermostat Connector	Description
X4	1	…	1	X4	+24V supply through resistor
	2	…	2		24V common

Table 23 - Pulse Transformer Board to Field SCR/Dual Diode Module Connections

Pulse Transformer Board Connector	Pin Number	to	Pin Number	Field SCR/Dual Diode Module Connector	Description
XP	1	…	3	Fastons	Gate signal G1
	2	…	2		Common cathode (K1 and K2) for both field SCRs
	3	…	2		
	4	…	1		Gate signal G2

Table 24 - Pulse Transformer Board to Control Board Connections

Pulse Transformer Board Connector	Pin Number	to	Pin Number	Control Board Connector	Description
XR	1	…	1	XR	Gate signal G1 field SCR1
	2	…	2		Gate signal G2 field SCR2
	3	…	3		0V (GNDP)
	4	…	4		Relay output 35-36 command
	5	…	5		Relay output 75-76 command
	6	…	6		2Q/4Q selection signal
	7	…	7		0V (GNDP)
	8	…	8		I armature = 0 signal
	9	…	9		0V (GNDP)
	10	…	10		Heatsink overtemperature
	11	…	11		Digital U1-V1 sync signal
	12	…	12		0V (GNDP)
	13	…	13		CT burden signal
	14	…	14		0V (GND)
	15	…	15		Reduced U sync signal
	16	…	16		Reduced V sync signal
	17	…	17		Reduced W sync signal
	18	…	18		Reduced C (armature) signal
	19	…	19		Reduced D (armature) signal
	20	…	20		0V (GNDP)
	21	…	21		Gate signal SCR 4/01
	22	…	22		0V (GNDP)
	23	…	23		Gate signal SCR 5/02
	24	…	24		0V (GNDP)
	25	…	25		Gate signal SCR 6/03
	26	…	26		WH1 (not used, grounded)
	27	…	27		Gate signal SCR 1/04
	28	…	28		WL1 (not used, grounded)
	29	…	29		Gate signal SCR 2/05
	30	…	30		0V (GNDP)
	31	…	31		Gate signal SCR 3/06
	32	…	32		Motor overtemperature
	33	…	33		Enable reverse (MN) power bridge
	34	…	34		Enable forward (MP) power bridge

Table 25 - Pulse Transformer Board to Current Transducer Connections

Pulse Transformer Board Connector	Pin Number	to	Pin Number	Current Transducer	Description
XTA	1	…	Black	CT on Phase U	Secondary side CT phase U
	2	…	Brown		
	3	…	Black	CT on Phase V	Secondary side CT phase V
	4	…	Brown		

Switching Power Supply Board

Figure 28 - Switching Power Supply Board Layout

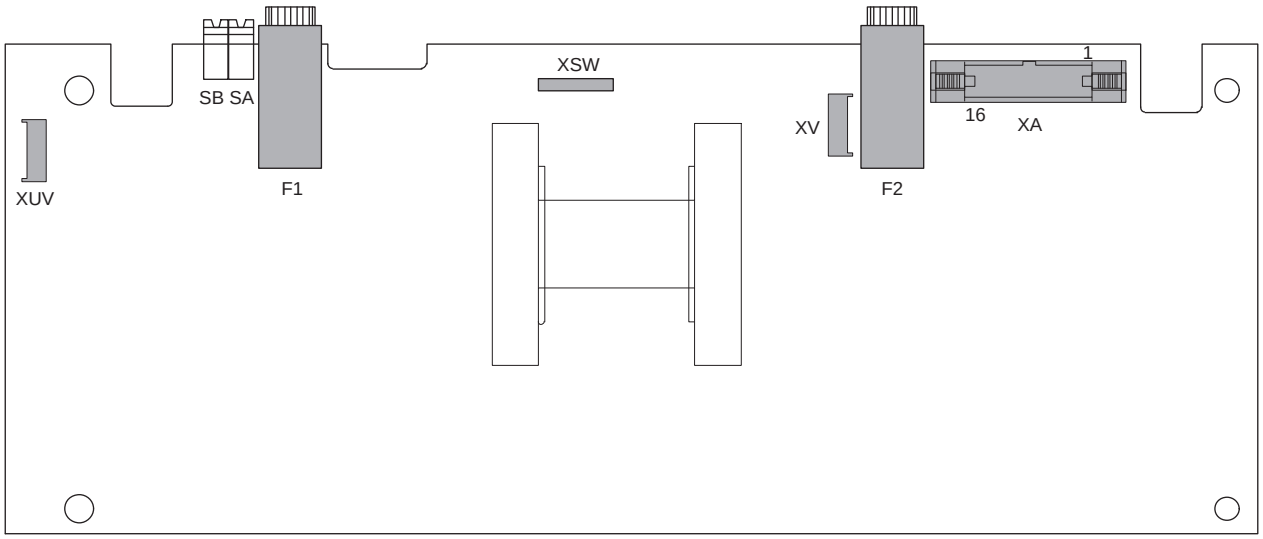


Table 26 - Switching Power Supply Board to Control Board Connections

Switching Power Supply Board Connector	Pin Number	to	Pin Number	Control Board Connector	Description
XA	1	…	1	XA	+5V
	2	…	2		5V common
	3	…	3		+5V
	4	…	4		5V common
	5	…	5		+5V
	6	…	6		5V common
	7	…	7		SMPS supply input undervoltage
	8	…	8		
	9	…	9		+15V
	10	…	10		
	11	…	11		15V common
	12	…	12		
	13	…	13		-15V
	14	…	14		
	15	…	15		24V common
	16	…	16		+24V

See Pulse Transformer Board to Switching Power Supply Connections on page 117.

Control Board

Figure 29 - Control Board Layout

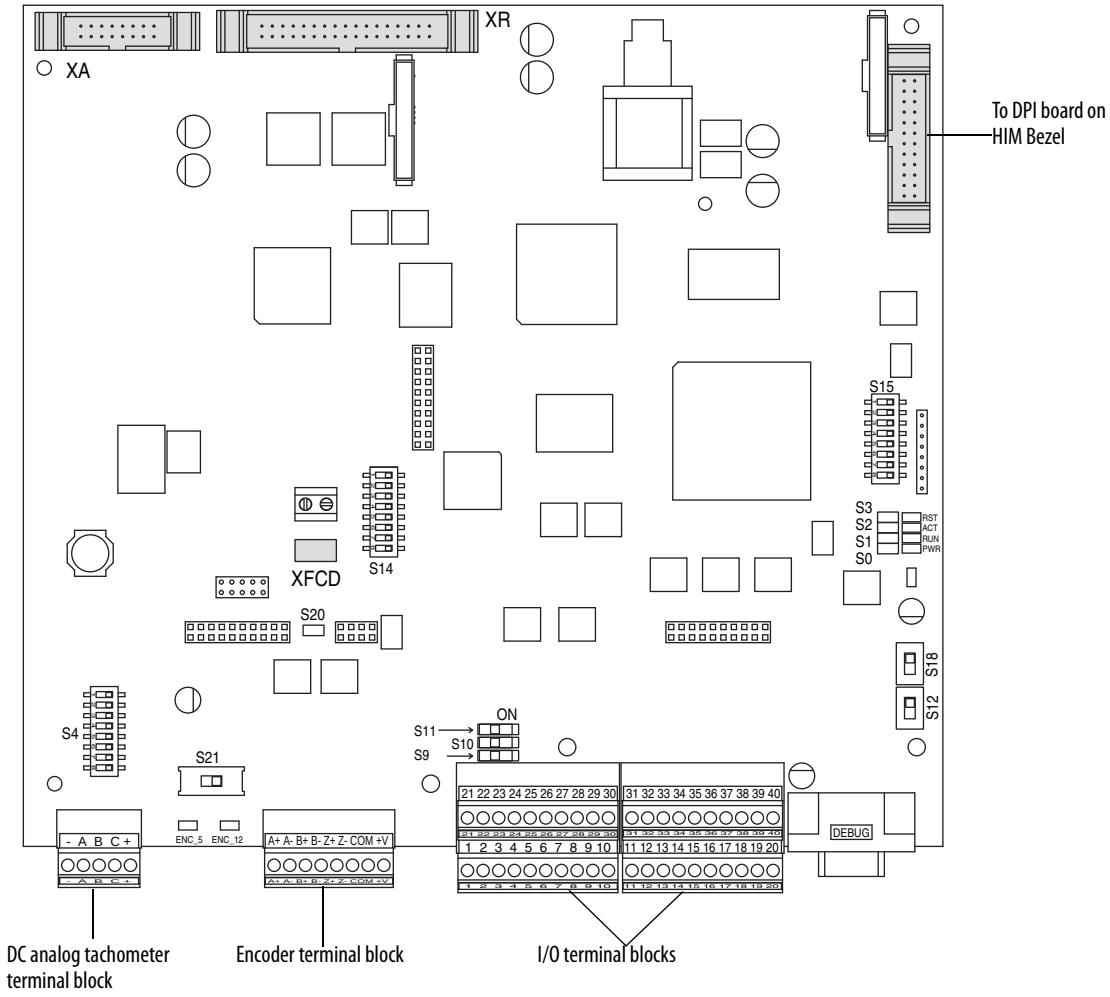


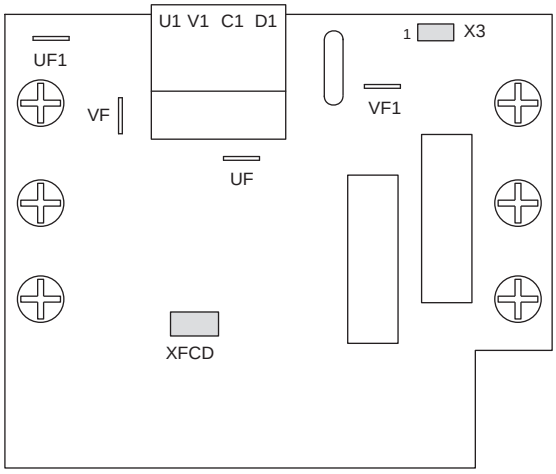
Table 27 - Control Board to Field Board Connections

Control Board Connector	Pin Number	to	Pin Number	Field Board Connector	Description
XFCD	1	…	1	XFCD	+15V
	2	…	2		15V Common
	3	…	3		-15V
	4	…	4		Field CT burden resistors

See Pulse Transformer Board to Control Board Connections on page 118 and Switching Power Supply Board to Control Board Connections on page 120.

Field Board

Figure 30 - Field Board Layout



See Control Board to Field Board Connections on page 121 and Pulse Transformer Board to Field Board Connections on page 117.

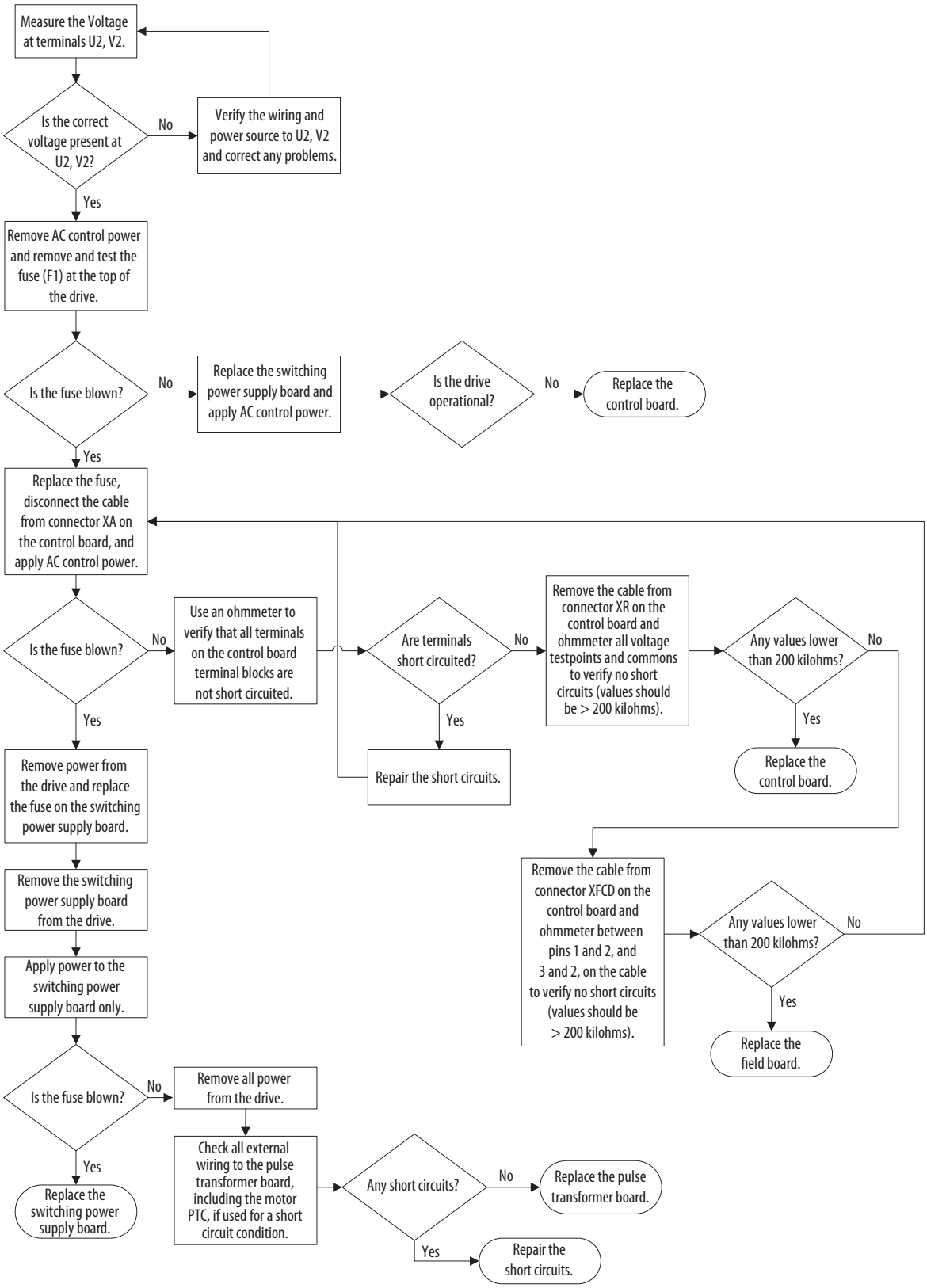
Flow Charts

List of Flow Charts

The following pages contain flow chart versions of troubleshooting procedures contained in Chapter 2 - Component Test Procedures on page 13.

Control Power Supply Failure

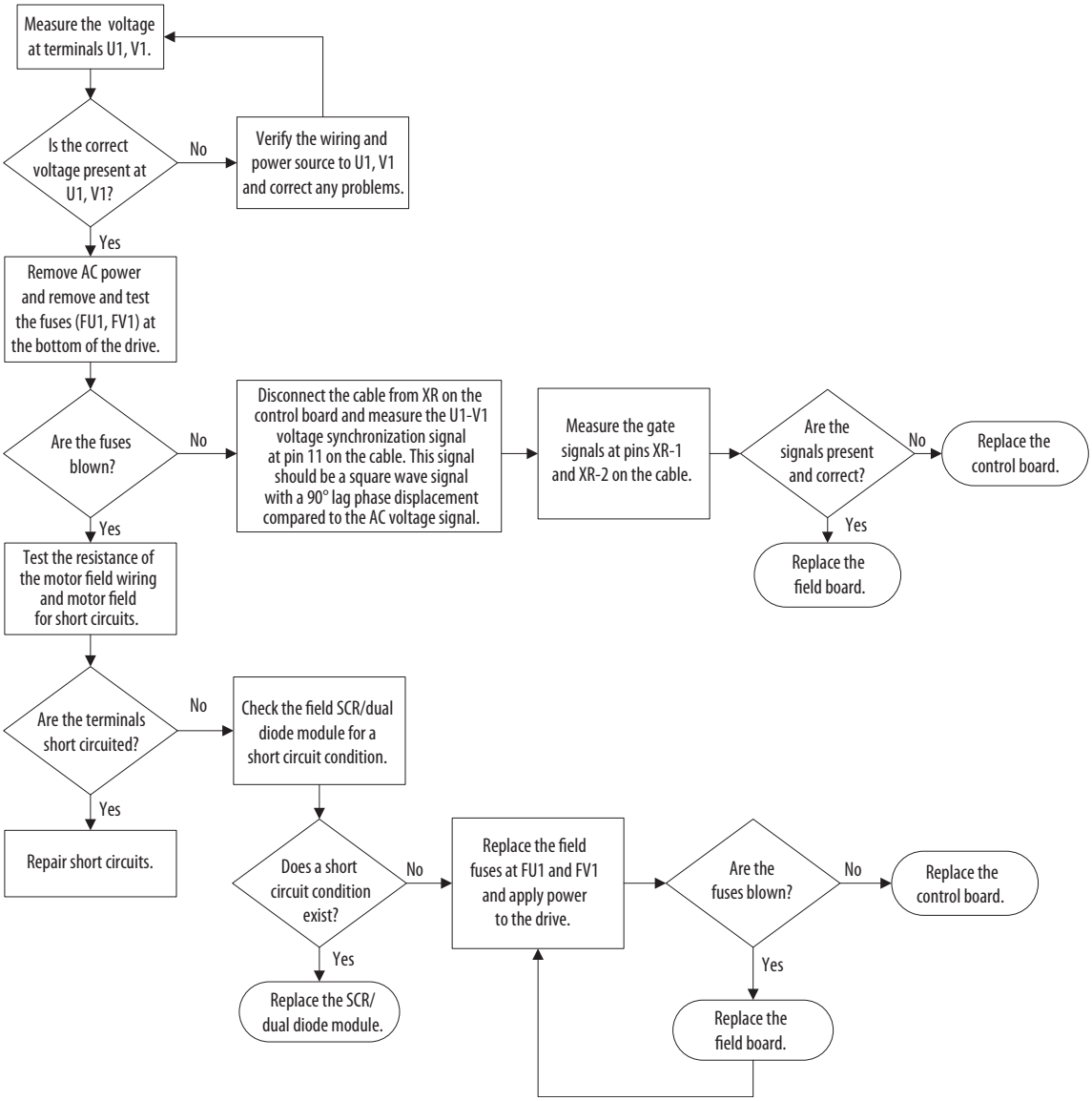
This chart shows the steps for troubleshooting a code F3 'Power Failure' fault.



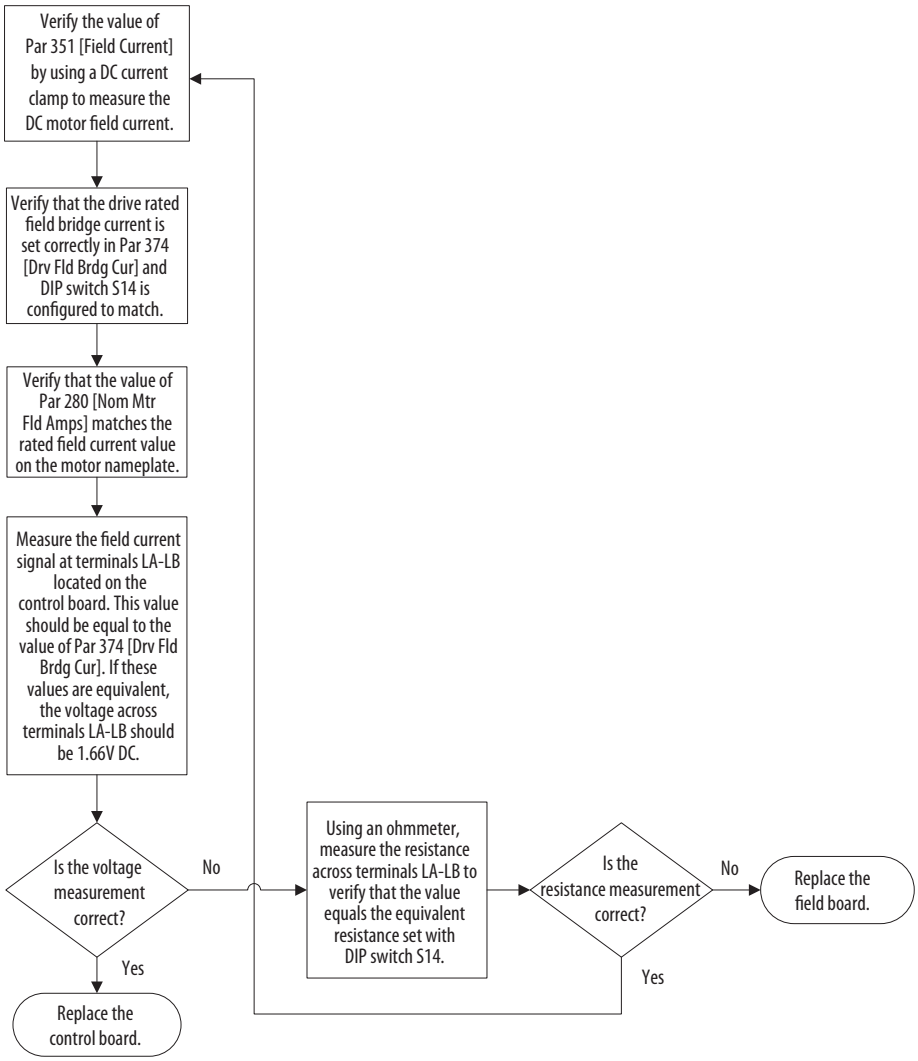
Field Current Loss Failure

The charts below present the steps for troubleshooting a code F6 'Field Current Loss' fault.

No Field Current



Low or Incorrect Field Current



History of Changes

This appendix contains the new or updated information for each revision of this publication. These lists include substantive updates only and are not intended to reflect all changes. Translated versions are not always available for each revision.

20P-TG002C-EN-P, September 2021

Change
Added note to the procedure Troubleshoot an Armature Bridge Failure.
Changed the procedure Check the Field SCR/Dual Diode Module.
Added the Non-regenerative Drive Power Module Diagram.
Added the Regenerative Drive Power Module Diagram.

20P-TG002B-EN-P, February 2018

Change
Updated the list of Additional Resources to include a link to the PowerFlex DC drive spare parts list.
Added a table of spare parts kits to Chapter 3.

Notes:

L

M

O

P

R

S

T

V

Additional Resources

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

Resource	Description
PowerFlex Digital DC Drive User Manual, publication 20P-UM001	Provides basic information that is required to install, start up, and troubleshoot the PowerFlex DC drive.
PowerFlex DC Drive Spare Parts List, publication PFLEX-SB003	Provides a current list of spare parts available for the PowerFlex DC field controller.
EtherNet/IP Network Devices User Manual, ENET-UM006	Describes how to configure and use EtherNet/IP™ devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
System Security Design Guidelines Reference Manual, SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	rok.auto/support
Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	rok.auto/pcdc

Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental information on its website at rok.auto/pec.

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