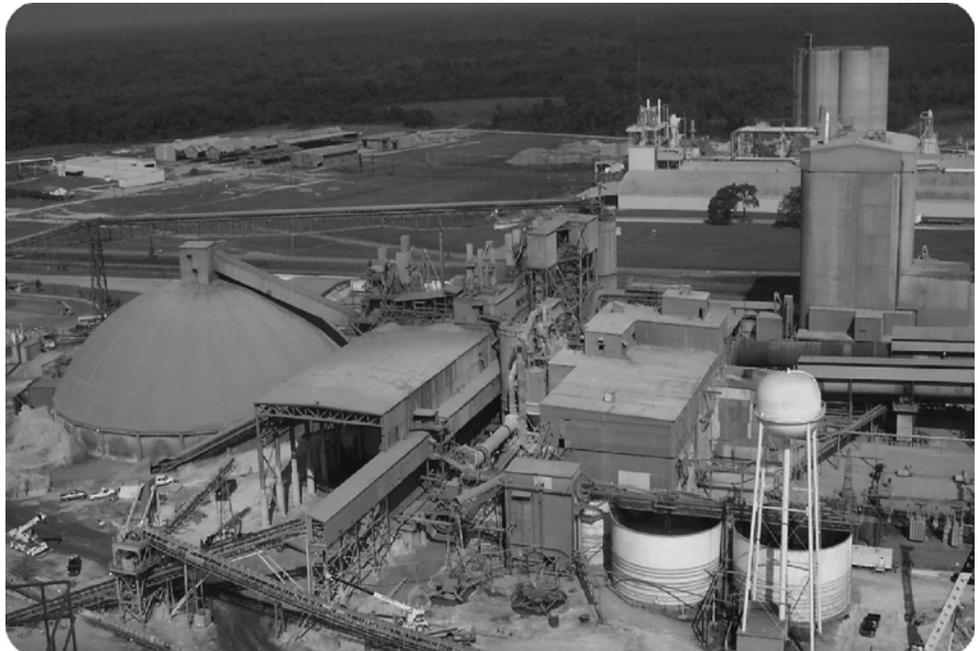


# PowerFlex 7000 Medium Voltage AC Drive Liquid-Cooled ("C" Frame) - ForGe Control

Publication 7000L-UM301D-EN-P



## Important User Information

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

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

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

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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).

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This manual contains new and updated information.

### New and Updated Information

This table summarizes the changes made to this revision.

Topic	Page
Changed all references of “tachometer” to “encoder”	Throughout
Added HPTC information to Topology section	<a href="#">17</a>
Updated Speed Regulator Bandwidth	<a href="#">24</a>
Updated Torque Regulator Bandwidth	<a href="#">24</a>
Inserted Torque Accuracy with HPTC	<a href="#">24</a>
Added Polish to list of available Languages	<a href="#">25</a>
Added “Dual-port Ethernet/IP” to Communications Protocols	<a href="#">25</a>
Replaced Control Overview block diagram	<a href="#">29</a>
Added “Pipe Materials and Layout” section	<a href="#">76</a>
Added dimensions and torque information to Pipe Flange detail images	<a href="#">77</a>
Inserted “External Piping to the Drive” section	<a href="#">77</a>
Inserted “Controlled Siphon into Open-top Reservoir” section	<a href="#">78</a>
Added Converter Cabinet Components (3300/4160V) image	<a href="#">212</a>
Added Converter Cabinet Components (6600V) image	<a href="#">213</a>
Changed graphic labels for valve locations	<a href="#">217</a>
Changed graphic labels for valve locations	<a href="#">218</a>
Inserted “System Fill and Air Venting” and “Normal Operation” section	<a href="#">218</a>
Replaced Cooling System Overview chart	<a href="#">328</a>
Inserted “Pump Cabinet with Ebara Pumps” image	<a href="#">331</a>
Added “Pump Replacement with Drive Running” section	<a href="#">331</a>
Replaced Pressure Indicator and Switch Locations image	<a href="#">333</a>
Replaced Temperature and Conductivity Sensors image	<a href="#">337</a>
Replaced Deionizer Reservoir Circuit image	<a href="#">338</a>
Inserted “Replacing the Mesh Filters” section	<a href="#">339</a>
Replaced Catalog Number Explanation	<a href="#">411</a>
Updated “When is an Encoder Required?” section and table	<a href="#">414</a>
Replaced Encoder Selection table	<a href="#">415</a>
Added HPTC information to Drive Torque Capabilities table	<a href="#">415</a>
Updated Typical Application Load Torque Profiles	<a href="#">416</a>

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## Overview of Drive

### Introduction

The PowerFlex® 7000 represents the third generation of medium voltage drives at Rockwell Automation. The PowerFlex 7000 medium voltage AC drive is part of the PowerFlex family of AC drive products. The Allen-Bradley PowerFlex® family of Drives incorporates leading-edge technology, embedded communications, and significant commonality across multiple platforms, networks, operator interface programming and hardware. Designed for end users, solution providers and OEMs, PowerFlex 7000 liquid-cooled drives meet applications ranging from 3000...9000 horsepower (2240...6715 kW).

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

The PowerFlex 7000L is a global product that adheres to the most common standards from NEC, IEC, NEMA, UL, and CSA. It is available with the world's most common supply voltages at medium voltage, from 2400...6600 volts.<sup>(1)</sup>

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

### Liquid Cooling

The PowerFlex 7000L “C” Frame liquid-cooled drive utilizes a closed loop system to cool the converter main power components and the integral DC link inductor.

#### Benefits of Liquid Cooling Include:

- Smaller drive dimension compared to air-cooled drives of similar rating
- Higher power rating capability
- Quiet operation in control room
- Low loss rejection to the control room reduces air conditioner loading
- Majority of losses rejected outside the control room via a liquid-to-air or liquid-to-liquid type heat exchanger

(1) For 2400V and 3300V designs, contact factory.

## Benefits of the 7000L “C” Frame Liquid-cooled Drive:

- Completely integrated MV drive package reduces customer installation costs and start-up time.
- Higher power rating capability (up to 9000 hp / 6715 kW)
- 18 Pulse and AFE rectifiers for low harmonic solutions that meet IEEE 519-1992 Harmonic Guidelines
- Motor friendly current and voltage output waveforms for use with standard new and existing motors
  - Inverter duty motors not required
  - Motor temperature derating not required
  - No additional dv/dt or peak voltage stress to motor insulation system
  - Tested up to 15 kilometers (9.3 miles) cable distance between drive and motor
- Spacious cable termination cabinet for ease of use by installation contractor
- Cable termination stabs accommodate:
  - 3 cables in / 3 cables out (Direct-to-Drive or AFE rectifier)
  - 9 cables in / 3 cables out (18 Pulse)
  - Top or bottom entry and exit of line and load cables
- 90% of drive losses are rejected outside the control room
- Integral liquid-cooled DC link inductor reduces overall dimension and eliminates external interwiring.
- Integral pumping panel includes:
  - Line supply c/w disconnect and fusing
  - Closed loop coolant system
  - Iron and chloride free liquid ethyl-glycol / deionized water mixture
  - Low conductivity coolant (1-2 micro-Siemens / cm<sup>3</sup>)
  - Isolated from medium voltage
  - Fully serviceable low voltage compartment isolated from medium voltage power
  - Monitors coolant temperature, flow, level, conductivity, and pressure
  - Redundant pumping system (optional)
  - Automatic pump change over on pump failure
  - 1/2 turn valves with quick disconnect couplers for pump replacement when drive is operating
  - Full drip tray to contain any spilled coolant
  - Drain and fill pump for convenient filling
  - Industrial schedule 80 CPVC piping for pump panel, headers and manifolds (no condensation possibility)
  - Control hardware for cycling of main / redundant cooling pumps and heat exchanger fans
- **“Plug and play” Power Cage concept**
  - Central location for easy access to all main power components

- Common modular design for rectifier / inverter
- Same concept as air-cooled drive for front access, easy component replacement, and no special tools
- 5...10 minutes to replace main power devices
- No need to remove any cooling lines for device replacement
- Reduced manufacturing time for faster delivery and lower cost
- **Keyed mechanical interlock**
  - Interlocked with main disconnect means to prevent unsafe access to medium voltage section

## Topology

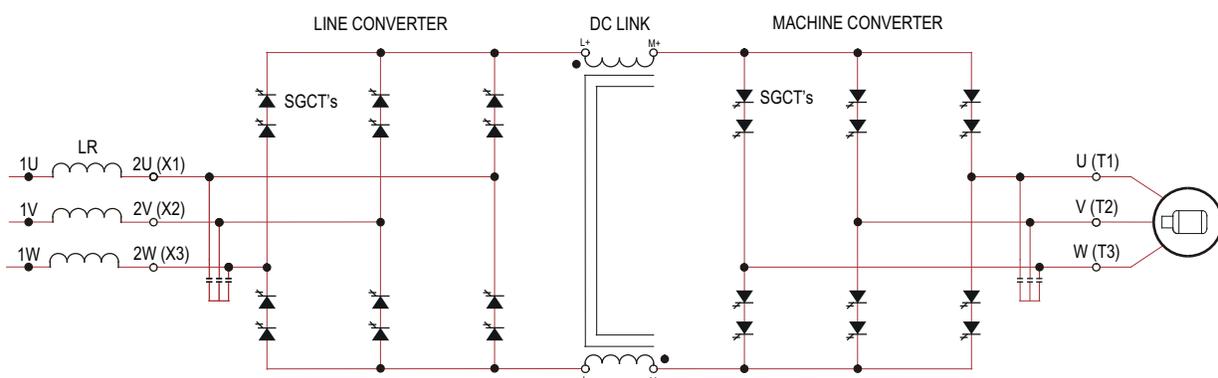
The PowerFlex 7000L utilizes a Pulse Width Modulated (PWM) – Current Source Inverter (CSI) for the machine side converter as shown in [Figure 1](#). This topology offers a simple, reliable, cost effective power structure that is easy to apply to a wide voltage and power range. The power semiconductor switches used are easy-to-series for any medium voltage level. Semiconductor fuses are not required for the power structure due to the current limiting DC link inductor.

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

The PowerFlex 7000L has the additional benefit of inherent regenerative braking for applications where the load is overhauling the motor (i.e. downhill conveyors, etc.), or where high inertia loads (i.e. fans, etc.) need to be slowed down quickly. Symmetrical Gate Commutated Thyristors (SGCTs) are used for machine converter switches. Silicon-controlled rectifiers (SCRs) (for 18 Pulse) or SGCTs (for AFE rectifiers) are used for the line converter switches. An AFE configuration is shown in [Figure 1](#).

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

**Figure 1 - AFE Rectifier (4160 Volt)**



## Rectifier Designs

There are two offered designs for the rectifier of the PowerFlex 7000L drive.

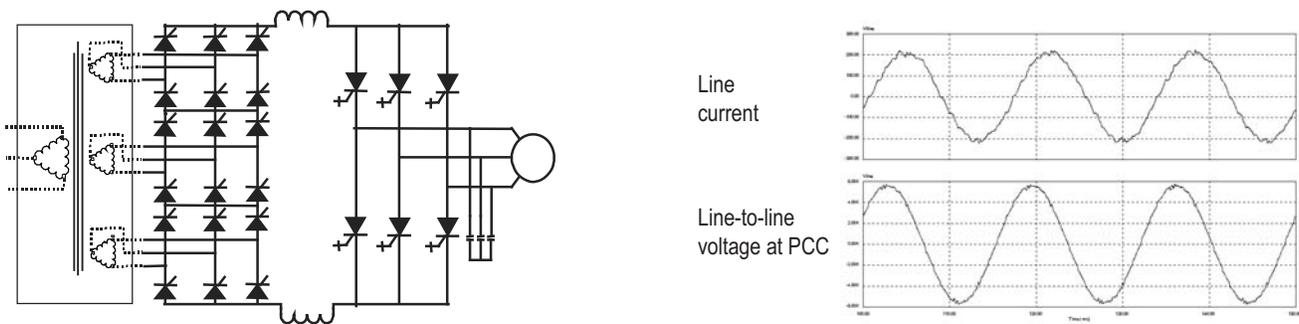
### 18 Pulse Rectifier

An 18 Pulse phase controlled rectifier is shown in [Figure 2](#). In an 18 Pulse configuration, the IEEE 519-1992 requirements are met in the majority of cases without the need for passive filters; however, a multi-winding isolation transformer is required to mitigate the low order harmonics by phase shifting principles. The 18 Pulse solution is superior to 6- or 12-pulse offerings in terms of lowering line side harmonics.

Isolation transformers are available in indoor dry type, cast coil, and outdoor oil-filled designs for maximum flexibility in dealing with floor space, installation costs, and control room air conditioner loading. (Refer to Specification 80001-005, Rectifier Duty Transformers, for more details on transformer requirements and features.)

Sample line current and voltage are also shown in [Figure 2](#). The THD of line current is approximately 5.6%, while the THD of line voltage (line-to-line) is approximately 2.0%. (THD of line voltage is a function of system impedance.) The 18 Pulse rectifier consists of one master bridge and two slave bridges and will always have a total of 18 SCR switching devices.

**Figure 2 - 18 Pulse Rectifier and its input waveforms**



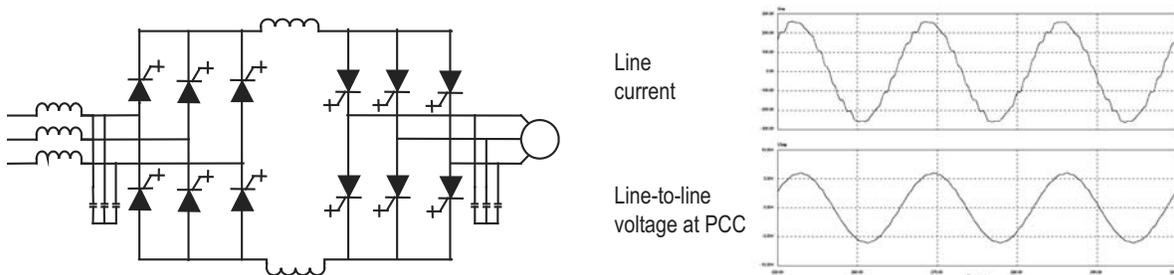
### Active Front End (AFE Rectifier)

An active front end (AFE rectifier) suitable for the PowerFlex 7000L topology is also commonly called a PWM rectifier. This is particularly attractive since it does not require an isolation transformer to meet IEEE 519-1992. Most available technologies in today's MV market require a multi-winding transformer to mitigate the unwanted harmonics by phase shifting the transformer secondary windings. Depending on the topology, the transformer can have up to 15 sets of secondary windings. Elimination of the isolation transformer reduces capital and installation costs, saves on valuable floor space, and increases overall system efficiency.

The AFE rectifier requires a switching pattern that complies with similar rules as the inverter. The pattern, used for the example shown in [Figure 3](#), is a 42-pulse selective harmonic elimination (SHE) pattern, which eliminates the 5th, 7th and 11th harmonics. The integral input capacitors are designed to reduce the current harmonics of the higher order. The filter transfer function technique is used to place the filter break frequency in a region where no harmonics are present. This prevents the excitation of system harmonic frequencies. Other factors that are considered when designing the filter are the input power factor and the requirement on Total Harmonic Distortion (THD) of input current and voltage waveforms.

The AFE rectifier is ideal when a distribution transformer is required to step down the distribution voltage to match the VFD and motor voltage. The rectifier input current, the rectifier terminal voltage and the line current and voltage waveforms are shown in [Figure 3](#). The line current THD is approximately 4.5%, while line-to-line voltage THD is approximately 1.5%. (THD of line voltage is a function of system impedance.) Input power factor with the AFE rectifier is equal to or greater than 0.98 for the typical speed and load range when applied to variable torque loads.

**Figure 3 - Active rectifier (PWM) and its input current/voltage waveforms**



## “Direct-to-Drive” Technology

The PowerFlex 7000L with “Direct-to-Drive” technology allows you to:

- connect supply power directly to the drive without an Isolation Transformer
- connect a new or existing motor directly to the drive without extra motor filtering.

Most Medium Voltage Drive Manufacturers use multi-winding isolation transformers to mitigate unwanted harmonics by phase shifting the transformer secondary windings. Depending on the topology, the transformer can have up to 15 sets of secondary windings. The disadvantages to this method are the high degree of drive and transformer complexity, a very high component count and many interconnecting cables and connection points. This leads to much higher maintenance requirements and lower reliability.

Manufacturers also use isolation transformers to protect motors from Common Mode Voltage stress. When transformers are used they allow the motor neutral point to be connected to ground, but with this method, the common mode voltage that would otherwise be impressed on the motor is impressed on the transformer. The disadvantage to this method is that increased transformer insulation and increased cable insulation is required between the transformer and the drive so it can withstand the common mode voltage stress.

Rather than use an Isolation Transformer, the “Direct-to-Drive” Active Front End uses the semiconductor switching pattern to reduce line current harmonics to levels that comply to the world’s most accepted harmonic standards. The Active Front End is the best method of harmonic cancellation because it does not suffer from complexity and high component count like multi-pulse drive topologies do.

“Direct-to-Drive” technology produces virtually no common mode voltage so it is suitable for new or existing motors and imposes no stress on the drive input. The advantage of “Direct-to-Drive” technology over an Isolation Transformer is that no extra insulation is required in the motor, in the motor cables or in the line cables.

In addition to mitigating Common Mode Voltage, “Direct-to-Drive” technology mitigates dv/dt or Reflected Wave Voltage Stress on motors.

The simplicity of its design results in a lower initial capital investment, lower operating cost, lower installation cost and lower maintenance cost relative to drives that require isolation transformers.

The PowerFlex 7000L with “Direct-to-Drive” technology is typically smaller and lighter than drive technologies that use Isolation Transformers. Isolation Transformers represent 30 to 50% of a drive system size and 50 to 70% of the system’s weight. This means that there is no interwiring between drive and transformer (for external transformer configurations). This makes the PowerFlex 7000L the simplest to install.

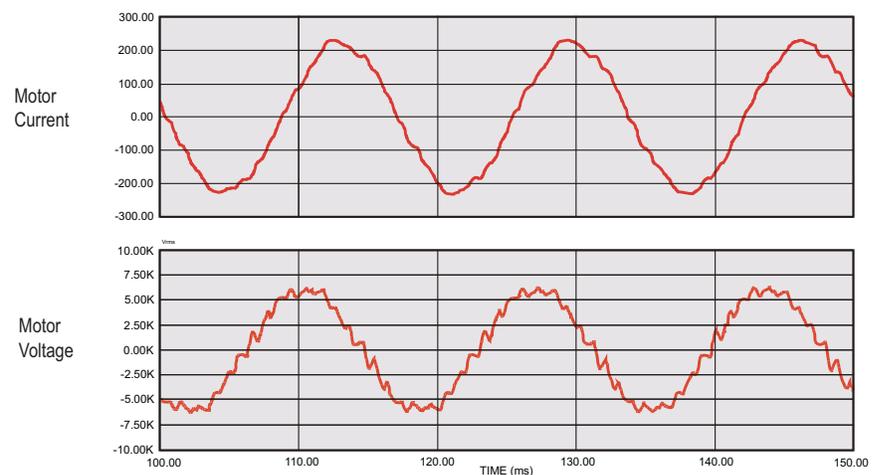
## Motor Compatibility

The PowerFlex 7000L achieves near sinusoidal current and voltage waveforms to the motor, resulting in no significant additional heating or insulation stress. Temperature rise in the motor connected to the VFD is typically 3°C (5.5°F) higher compared to across the line operation.  $Dv/dt$  in the voltage waveform is less than 10 volts / microsecond. The peak voltage that the motor insulation will see is the rated motor RMS voltage divided by 0.707. Reflected wave and  $dv/dt$  issues often associated with VSI (voltage source inverter) drives are a non-issue with the PowerFlex 7000L. Typical motor waveforms are shown in [Figure 4](#). These motor friendly waveforms are achieved by utilizing a selective harmonic elimination (SHE) pattern in the inverter to eliminate major order harmonics, in conjunction with a small output capacitor (integral to the drive) to eliminate harmonics at higher speeds.

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

Motor cable distance is virtually unlimited. This technology has been tested, controlling motors up to 15 km (9.3 miles) away from the drive.

**Figure 4 - Motor waveforms @ full load, full speed**



## SGCT Features and Benefits

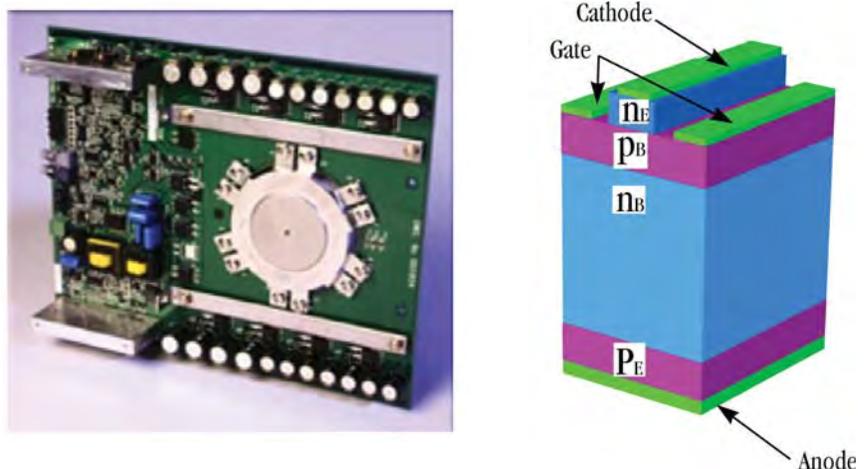
An SGCT is a Symmetrical Gate Commutated Thyristor with an integrated gate drive. Positioning the gate drive close to the SGCT as shown in [Figure 5](#), creates a low inductance path that provides more efficient and uniform gating of the device. As a result, the device is better suited than a conventional GTO to handle the fluctuating levels of voltage and current while it is switching on and off during gating.

An SGCT has similar characteristics to an IGCT (used on some VSI drives), including low conduction and switching losses, low failure rate, and double sided cooling for low thermal stress. However, the SGCT achieves voltage blocking capability in both forward and reverse directions up to 6500 volts by a NPT (Non-Punch-Through) structure and nearly symmetrical pnp transistor in the wafer, while the current is unidirectional. Unlike many VSI topologies that use IGBTs, the semiconductors used in the PowerFlex 7000L feature a non-rupture, non-arc failure mode. In the unlikely event of a device failure, the fault would be contained within the device.

Implementing SGCTs in the PowerFlex 7000L “B” Frame results in significant advantages including:

1. Simplification of the snubber design and a reduction in the size of the snubber capacitor by a factor of 10.
2. Operation at a higher switching frequency (420-540 Hz), hence reducing the size of passive components (DC link inductor and motor filter cap) by 50%.
3. Improving performance of the drive.
4. Reduction of component count, hence improving reliability, cost, and size of the drive.
5. Fail safe failure mode (non-rupture).

**Figure 5 - SGCT with integrated gate drive (left) and unit cell structure (right)**



## Specifications

**Table 1 - General Design Specifications**

Description			
Motor Type	Induction or Synchronous		
Input Voltage Rating	2400V, 3300V, 4160V, 6600V		
Input Voltage Tolerance	± 10% of Nominal		
Voltage Sag <sup>(1)</sup>	-30%		
Control Power Loss Ride-through	5 Cycles (Std) > 5 Cycles (Optional UPS)		
Input Protection <sup>(2)</sup>	Surge Arrestors (AFE/Direct-to-Drive) Metal Oxide Varistor (MOV) (18 Pulse)		
Input Frequency	50/60 Hz, +/- 0.2%		
Power Bus Input Short-circuit Current Withstand (2400...6600V <sup>(3)</sup> )	25 kA RMS SYM, 5 Cycle		
Basic Impulse Level <sup>(4)</sup>	45 kV (0...1000 m)		
Power Bus Design	Copper - Tin plated		
Ground Bus	Copper - Tin plated 6 x 51 mm (¼ x 2 in.)		
Customer Control Wire Way	Separate and Isolated		
Input Power Circuit Protection <sup>(5)</sup>	Vacuum Contactor with Fused Isolating Switch or Circuit Breaker		
Output Voltage	0...2400V 0...3300V 0...4160V 0...6000V, 0...6300V, 0...6600V		
Inverter Design	PWM		
Inverter Switch	SGCT		
Inverter Switch Failure Mode	Non-rupture, Non-arc		
Inverter Switch Failure Rate (FIT)	100 per 1 Billion Hours Operation		
Inverter Switch Cooling	Double Sided, Low Thermal Stress		
Inverter Switching Frequency	420...440 Hz		
Number of Inverter SGCTs	<b>Voltage</b>	<b>SGCTs (per phase)</b>	
	2400V	2	
	3300V	4	
	4160V	4	
	6600V	6	
Inverter PIV Rating (Peak Inverse Voltage)	<b>Voltage</b>	<b>PIV (each device)</b>	<b>Total PIV</b>
	2400V	6500V	6500V
	3300V	6500V	13,000V
	4160V	6500V	13,000V
	6600V	6500V	19,500V
Rectifier Designs	Direct-to-Drive (transformerless AFE rectifier) AFE with separate isolation transformer 18 Pulse with separate isolation transformer		
Rectifier Switch	SCR (18 Pulse), SGCT (AFE Rectifier)		
Rectifier Switch Failure Mode	Non-rupture, Non-arc		
Rectifier Switch Failure Rate (FIT)	50 (SGCT) 100 (SCR) per 1 Billion Hours Operation		

**Table 1 - General Design Specifications (Continued)**

<b>Description</b>			
Rectifier Switch Cooling	Double Sided, Low Thermal Stress		
Number of Rectifier Devices per phase	<b>Voltage</b>	<b>AFE</b>	<b>18 Pulse</b>
	2400V	2	6
	3300V	4	6
	4160V	4	6
	6600V	6	6
Output Current THD (1 <sup>st</sup> ...49 <sup>th</sup> )	< 5%		
Output Waveform to Motor	Sinusoidal Current / Voltage		
Medium Voltage Isolation	Fiber Optic		
Modulation techniques	Selective Harmonic Elimination (SHE) Synchronous Trapezoidal PWM Asynchronous or Synchronous SVM (Space Vector Modulation)		
Control Method	Digital Sensorless Direct Vector Full Vector Control with Encoder Feedback (Optional)		
Tuning Method	Auto Tuning via Setup Wizard		
Speed Regulator Bandwidth	1...10 rad/s with standard control 1...20 rad/s with HPTC (optional)		
Torque Regulator Bandwidth	15...50 rad/s with standard control 80...100 rad/s with HPTC (optional)		
Torque Accuracy with HPTC (optional)	+/- 5%		
Speed Regulation	0.1% without Encoder Feedback 0.01...0.02% with Encoder Feedback		
Acceleration/Deceleration Range	Independent Accel/Decel – 4 x 30 s		
Acceleration/Deceleration Ramp Rates	4 x Independent Accel/Decel		
S Ramp Rate	Independent Accel/Decel – 2 x 999 s		
Critical Speed Avoidance	3 x Independent with Adjustable bandwidth		
Stall Protection	Adjustable time delay		
Load Loss Detection	Adjustable level, delay, speed set points		
Control Mode	Speed or Torque		
Current Limit	Adjustable in Motoring and Regenerative		
Output Frequency Range	0.2...75 Hz (Standard) 75 Hz...85Hz (Optional - need specific Motor Filter Capacitor [MFC])		
Service Duty Rating	<b>Normal Duty</b>	<b>Heavy Duty</b>	
	110% Overload for 1 min. every 10 min. (Variable Torque Load)	150% Overload for 1 min. every 10 min. (Constant Torque Load)	
Typical VFD Efficiency	> 97.5% (AFE) > 98% (18 Pulse) Contact Factory for Guaranteed Efficiency of Specific Drive Rating		
Input Power Factor	<b>AFE Rectifier</b>		
	0.95 minimum, 10...100% Load		

**Table 1 - General Design Specifications (Continued)**

Description		
IEEE 519 Harmonic Guidelines <sup>(6)</sup>	IEEE 519 - 1992 Compliant	
VFD Noise Level	< 85 dB (A) per OSHA Standard 3074	
Regenerative Braking Capability	Inherent – No Additional Hardware or Software Required	
Flying Start Capability	Yes – Able to Start into and Control a Spinning Load in Forward or Reverse Direction	
Operator Interface	10" Color Touchscreen – Cat# 2711P-T10C4A9 (VAC) Built-in PDF viewer Redesigned PanelView Plus 6 Logic Module with 512 Mb of memory	
Languages	English, French, Spanish, Portuguese, German, Chinese, Italian, Russian, and Polish	
Control Power	220/240V or 110/120V, Single phase - 50/60 Hz (20 A)	
External I/O	16 Digital Inputs, 16 Digital Outputs	
External Input Ratings	50...60 Hz AC or DC 120...240V – 1 mA	
External Output Ratings	50...60 Hz AC or DC 30...260V – 1 A	
Analog Inputs	Three Isolated, 4...20 mA or 0...10V (250 Ω)	
Analog Resolution	Analog input 12 Bit (4...20 mA) Internal parameter 32 Bit resolution Serial Communication 16 Bit resolution (.1Hz) (Digital Speed Reference)	
Analog Outputs	One Isolated, Eight Non-isolated, 4...20 mA or 0...10V (600 Ω)	
Communication Interface	Ethernet IP/DPI	
Scan Time	Internal DPI – 2 ms min., 4 ms max.	
Communications Protocols (Optional)	DeviceNet                      ControlNet Ethernet I/P                      Lon Works Dual-port Ethernet I/P        Can Open Profibus                          RS485 HVAC Modbus                            RS485 DF1 Interbus                            RS232 DF1 USB	
Enclosure	NEMA 1 (standard)	IP21 (IEC)
	NEMA 12 (optional)	IP42 (IEC)
Lifting Device	Standard / Removable	
Mounting Arrangement	Mounting Sill Channels	
Structure Finish	Epoxy Powder – Paint Exterior Sandtex Light Grey (RAL 7038) – Black (RAL 8022) Internal – Control Sub Plates – High Gloss White (RAL 9003)	
Interlocking	Key provision for customer input Disconnecting Device	
Corrosion Protection	Unpainted Parts (Zinc Plated / Bronze Chromate)	
Ambient Temperature	0...40 °C (32...104 °F) / 0...50 °C (32...122 °F) - optional	
Fiber Optic Interface	Rectifier – Inverter – Cabinet (Warning / Trip)	
Door Filter	Painted Defuser with Matted Filter Media	

**Table 1 - General Design Specifications (Continued)**

<b>Description</b>	
Door Filter Blockage	Air Flow Restriction Trip / Warning
Storage and Transportation Temperature Range	-40...70 °C (-40...185 °F)
Relative Humidity	Max. 95%, non-condensing
Altitude (Standard)	0...1000 m (0...3300 ft)
Altitude (Optional)	1001...5000 m (0...16,400 ft)
Seismic (UBC Rating)	1, 2, 3, 4
Standards	NEMA, IEC, CSA, UL, ANSI, IEEE

- (1) Voltage Sag tolerance is reduced to -25% when control power is supplied from medium voltage via CPT.
- (2) MOVs are used for 18 Pulse. Surge arrestors are used for AFE/Direct-to-Drive configurations.
- (3) Short-circuit fault rating based on input protection device (contactor or circuit breaker).
- (4) BIL rating based on altitudes < 1000 m (3300 ft) Refer to factory for derating on altitudes >1000 m.
- (5) Optional.
- (6) Under certain conditions, power system analysis will be required.

## Simplified Electrical Drawings

Figure 6 - 3300 / 4160 Volt – 18 Pulse

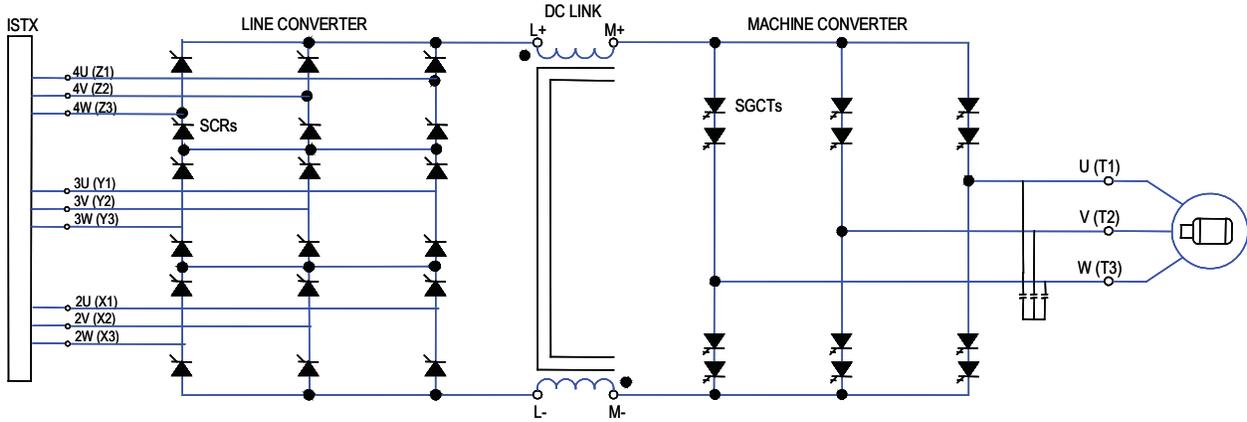


Figure 7 - 3300 / 4160 Volt – Active Front End

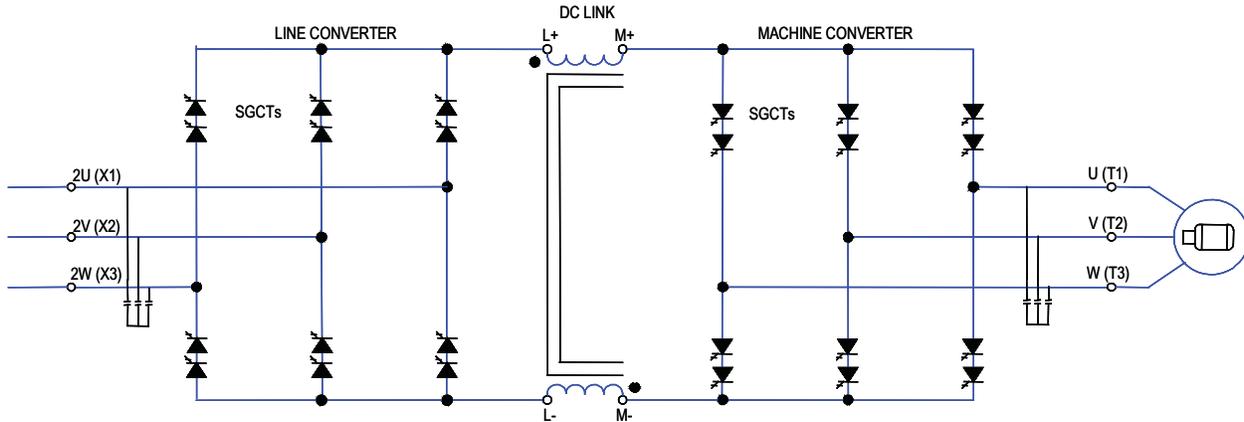


Figure 8 - 6000-6600 Volt – 18 Pulse

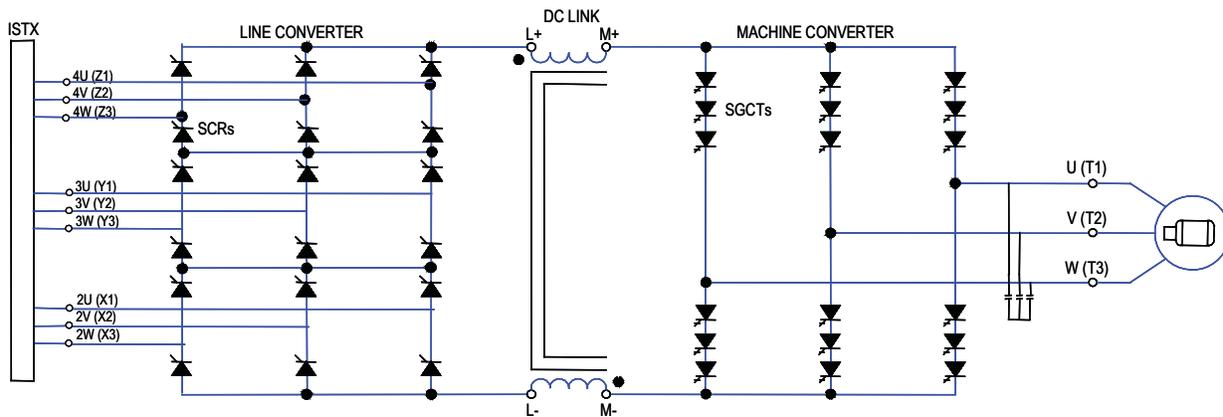
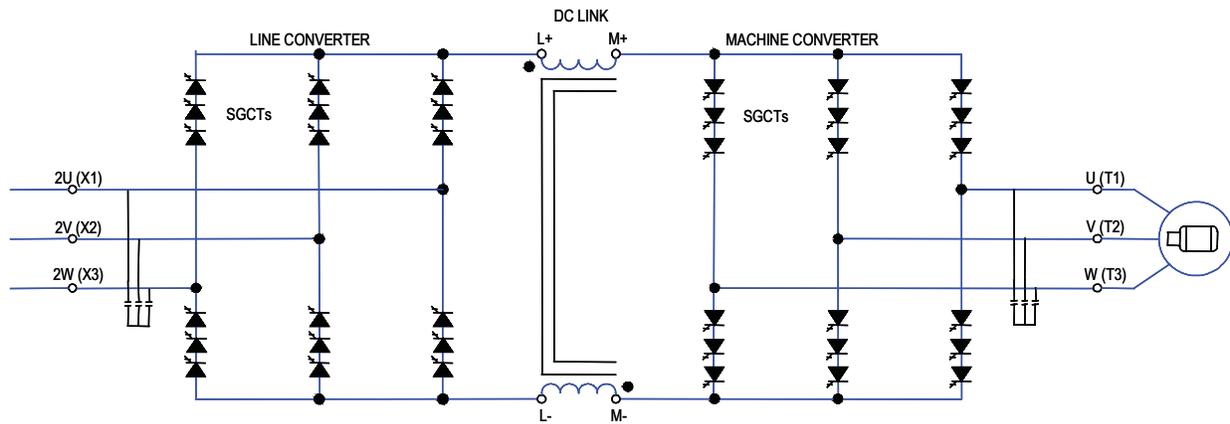
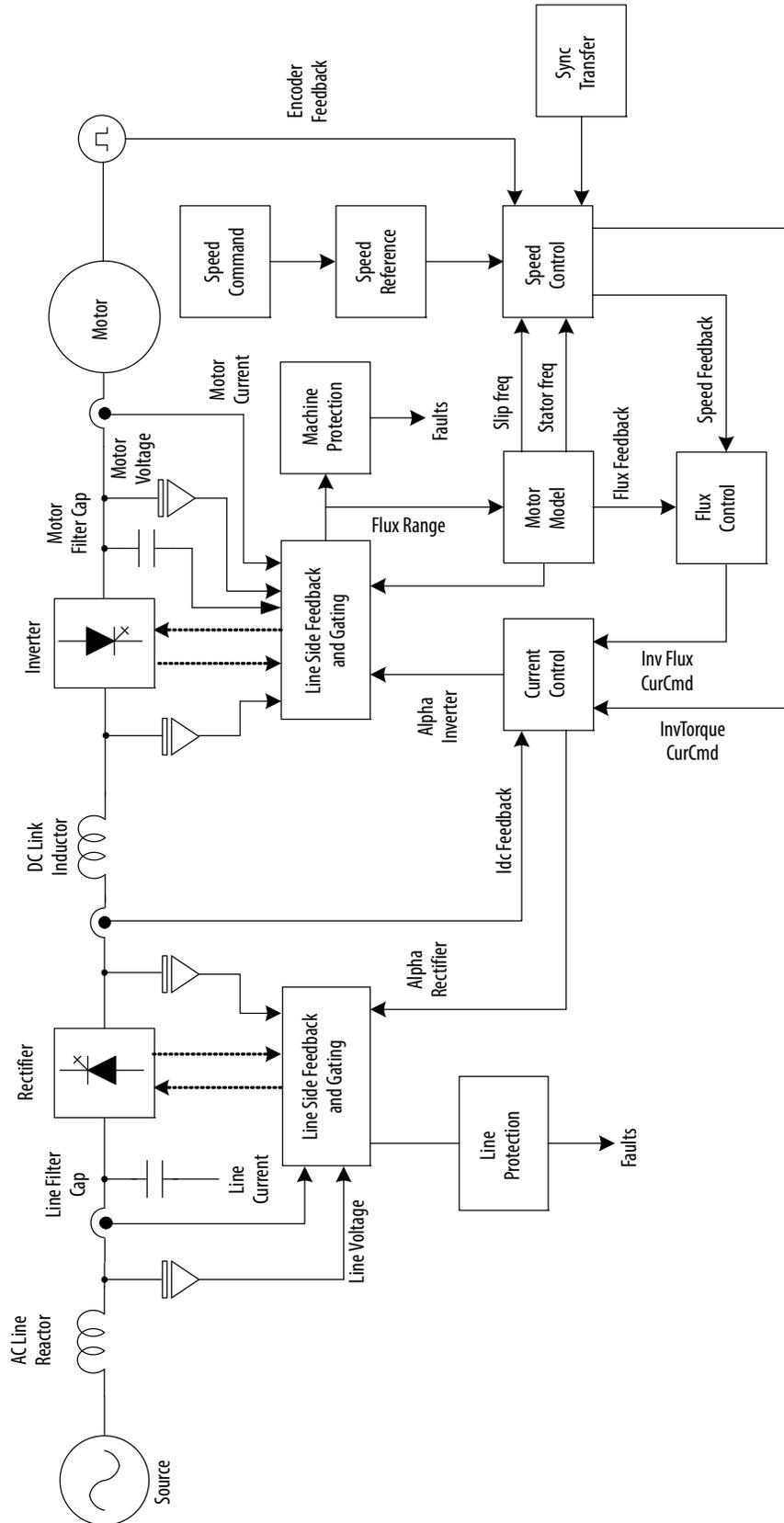


Figure 9 - 6000-6600 Volt – Active Front End



## Control Overview

Figure 10 - PowerFlex 7000L "C" Frame Function Block Diagram



## Direct Vector Control

The method of control in the PowerFlex 7000 “C” Frame medium voltage AC drive is called sensorless direct vector control, meaning that the stator current is divided into torque producing and flux producing components, allowing the motor torque to be changed quickly without affecting motor flux. This method of control is used without encoder feedback for applications requiring continuous operation above 6 Hz and less than 100% starting torque.

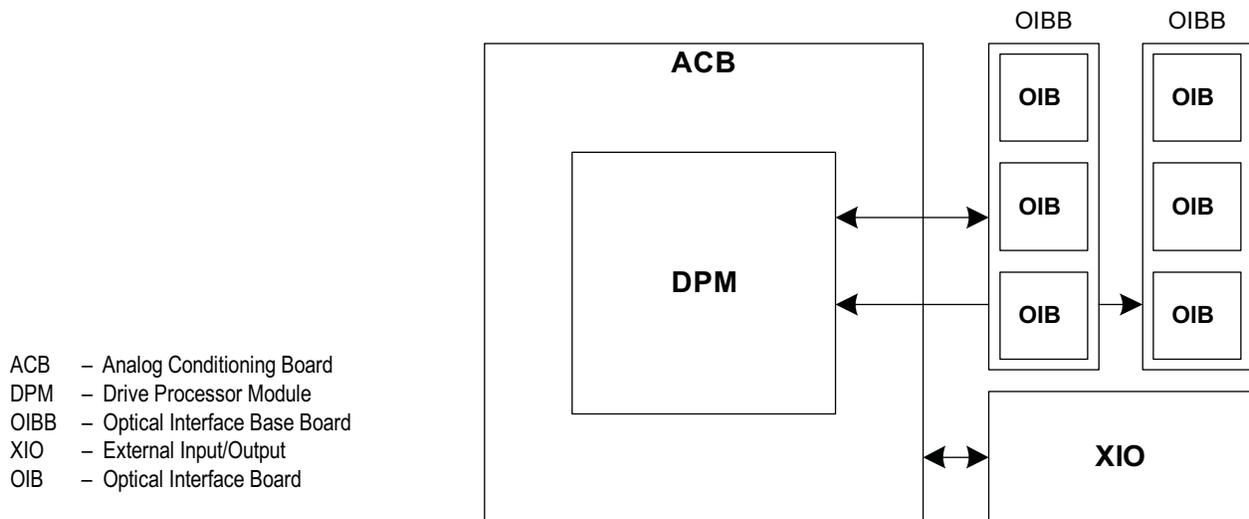
Full vector control can also be achieved with encoder feedback for applications requiring continuous operation down to 0.2 Hz with up to 150% starting torque. Vector control offers superior performance over volts/hertz type drives. The speed bandwidth range is 5...25 rad/s, while the torque bandwidth range is 15...50 rad/s.

## Control Hardware

The control hardware includes a processor board (DPM) with an interface to six fiber optic boards (depending on the voltage and number of switching devices) via OIBB, an analog conditioning board (ACB) and an external IO board (XIO). The control hardware is used for rectifier and inverter, induction or synchronous drive control and the two rectifier types (18 Pulse or Active Front End).

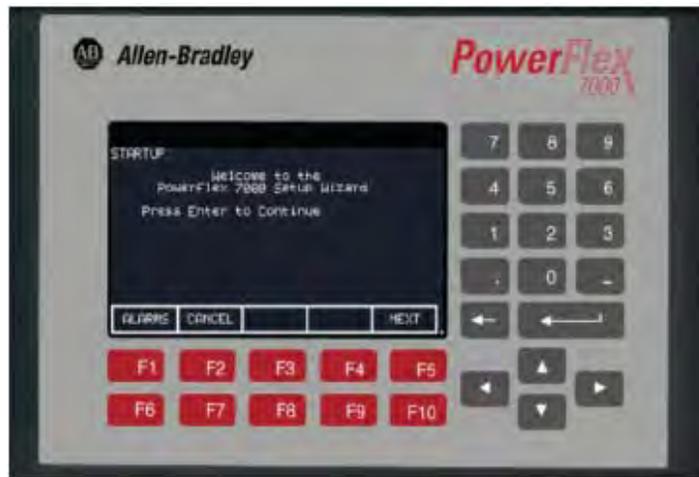
The DPM features two floating point DSPs (Digital Signal Processor) and a FPGA (Field Programmable Gate Array) for advanced functions such as gating and diagnostics, fault handling and drive synchronization control.

**Figure 11 - Control Hardware Layout for PowerFlex 7000 “C” Frame**



## Operator Interface

Figure 12 - PowerFlex 7000L Operator interface terminal



The operator interface terminal features a 16-line, 40-character, pixel based LCD display that makes text and graphics easy to read. Bar chart meters are configurable for common process variables including speed, voltage and load.

Everything is user friendly about the PowerFlex 7000L operator interface terminal including the greeting on the opening screen. The terminal is designed for the greatest ease of use for start-up, monitoring and troubleshooting. The setup wizard helps the user to set the required parameter menus by asking questions or prompting selections for desired operation. Warnings and comments appear complete with help text to keep the user on the right track. The setup wizard combined with the auto-tuning feature allows the drive to be tuned to the motor and load as quickly and accurately as possible, resulting in fast start-ups, smooth operation, and less down time.

Up to five test modes are available including low voltage gate check, and running at full current without motor connected.

Enhanced diagnostic functions are available on the operator interface terminal including separate fault and warning queues in non-volatile RAM (NVRAM), extended fault text strings and on line help, and trend buffers for 16 variables.

**Notes:**

## Drive Installation

### Safety and Codes



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

### Unpacking and Inspection

Before leaving the factory, all drives have been tested both mechanically and electrically. Immediately upon receiving the drive, remove the packing and check for possible shipping damage. Report any damage immediately to the claims office of the common carrier.

After unpacking the material, check the item(s) received against the bill of lading to assure that the nameplate description of each item agrees with the material ordered. Inspect the PowerFlex 7000 drive for physical damage, as stated in the Rockwell Automation Conditions of Sale.

**IMPORTANT** All claims for breakage and damage whether concealed or obvious must be made to the carrier by the Customer as soon as possible after receipt of the shipment. Rockwell Automation will be glad to give the Customer reasonable assistance in the securing of adjustment for such damage claims.

Remove all packing material, wedges, or braces from within the drive. Operate the contactors and relays manually to assure that they operate freely. If any part of the equipment will not be installed when it is unpacked, it should be stored in a clean, dry place. The storage temperature must be between -40°C (-40°F) and 70°C (185°F) with a maximum humidity of 95%, non-condensing, to guard against damage to temperature sensitive components in the controller.

### Transportation and Handling

The PowerFlex 7000 drive is shipped on a wooden skid, which is bolted to the underside of the cabinetry. The drive should remain bolted to the shipping skid until it is delivered to its final installation area. Lifting angles are supplied bolted to the top of the cabinetry. The drive must be kept in an upright position during any handling. Refer to General Handling Procedures, publication 7000-IN002\_-EN-P for a more detailed description.

The drive must be transported on a pallet or via use of the lifting beam supplied as part of all 2300 mm (91 in.) high cabinets.



**ATTENTION:** Ensure that the load rating of the lifting device is sufficient to safely raise the controller sections. Refer to the packing slip enclosed with shipment for shipping weights.

---

Round rollers can be used to assist in moving the drive to the installation site. Once at the final site, the pipe rolling technique can be used to place the cabinet in the desired position.



**WARNING:** Care must be exercised when using either a forklift or the pipe rolling technique for positioning purposes to ensure that the equipment is not scratched, dented or damaged in any manner. Always exercise care to stabilize the drive during handling to guard against tipping and injury to personnel.

---

**IMPORTANT** It is extremely important that the customer's installation duties are performed correctly. Any errors will cause damage to the Drive and delays in commissioning.

---

Never attempt to lift or move the drive by any means other than the methods listed, as structural damage or personal injury could result. The following methods of handling are recommended:

## Overhead Lifting

1. Attach rigging to the lifting angles on the top of the cabinetry.



**ATTENTION:** Ensure that the load rating of the lifting device and rigging is sufficient to safely raise the drive. Refer to shipping weights on the packing slip enclosed with the shipment.

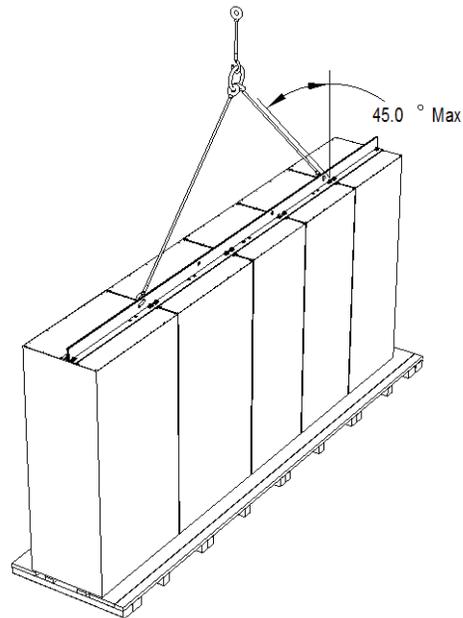
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2. Do not pass ropes or cables through the support holes in the lifting angles. Use slings with safety hooks or shackles.
3. Select or adjust the rigging lengths to compensate for an unequal weight distribution of load and maintain the drive in an upright position.
4. To reduce the tension on the rigging and the compressive load on the lifting device, do not allow the angle between the lifting cables/chains and vertical to exceed 45 degrees.



**ATTENTION:** Drives may contain heavy equipment that could be adversely affected by tilting.

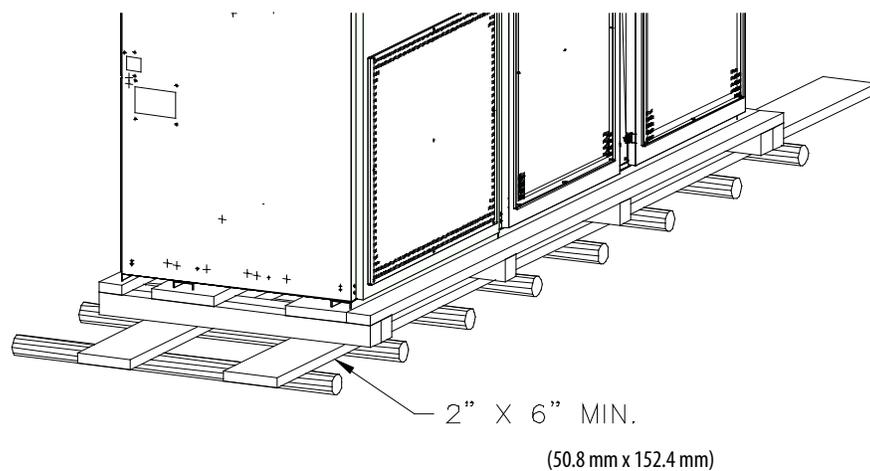
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**Figure 13 - Overhead Lifting**

## Rod or Pipe Rollers

This method is only suitable when there are no inclines and the drive is being moved on one floor level.

1. Boards 50.8 mm x 152.4 mm (2 in. x 6 in.) or equivalent and at least 300 mm (12 inches) longer than the drive must be placed under the shipping skid.
2. Carefully ease the shipping platform over the roller pipes until the drive weight is borne on the roller pipes.
3. The drive can be rolled to its designated location. Steady the load to prevent tipping.

**Figure 14 - Rod or Pipe Rollers**

## Fork Lift Trucks

A single fork lift truck may be used on drives not exceeding 3 m (120 inches) in length if the lift truck has sufficient lifting capacity. Larger drives can be moved with two forklift trucks operating in tandem.

1. Insert forks into openings of shipping skids from the rear of the drive.
2. Carefully balance the drive on the forks because the drives are usually heavier at one side.
3. Use safety straps when handling to steady the drive while moving.

## Storage

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

Storage temperature should be maintained between  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) and  $70^{\circ}\text{C}$  ( $185^{\circ}\text{F}$ ). If storage temperature fluctuates or if humidity exceeds 85%, space heaters should be used to prevent condensation. The drive should be stored in a heated building having adequate air circulation. The drive must never be stored outdoors.

## Siting of the Drive

### Site Considerations

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

- Elevation above sea level less than 1000 meters (3250 feet)
- Ambient air temperature between  $0^{\circ}\text{C}$  ( $32^{\circ}\text{F}$ ) and  $40^{\circ}\text{C}$  ( $104^{\circ}\text{F}$ )
- Relative humidity of the air not to exceed 95% non-condensing

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

The equipment requires the following site conditions:

- (A) Indoor installation only, no dripping water or other fluids
- (B) Clean air for cooling requirements
- (C) Level floor for anchoring the equipment. Refer to dimension drawings for the location of the anchoring points.
- (D) The room in which the equipment is located must allow for full opening of the doors of the equipment, typically 1200 mm (48 inches). Also, allowances have to be made for clearance for fan removal. This fan allowance must be greater than 700 mm (27.5 inches).

*or*

Dimension drawings can be obtained by contacting the local Rockwell Automation Sales office. The equipment does not require rear access for servicing.

- (E) Allowance must be made for the stream of cooling air which exits the drive at the top. The flow of cooling air into and out the drive must be kept clear and uninhibited.
- (F) The room in which the equipment is located must be large enough to accommodate the thermal losses of the equipment since air conditioning may be required; the ambient temperature must not exceed that for which the equipment is rated. The heat created by the drive is directly proportional to the power of the motor being driven and the efficiency of equipment within the room. If thermal load data is required contact the Rockwell Automation Sales office.
- (G) The area in which the drive is located should be free of radio frequency interference such as encountered with some welding units. This may cause erroneous fault conditions and shut down the drive.
- (H) The equipment must be kept clean. Dust in the equipment decreases system reliability and inhibits cooling.
- (I) Power cable lengths to the motor are virtually unlimited due to the near sinusoidal voltage and current waveforms. Unlike voltage source drives, there are no capacitive coupling,  $dv/dt$ , or peak voltage issues that can damage the motor insulation system. The CSI-PWM topology utilized in the PowerFlex 7000 medium voltage AC drive has been tested with motors located up to 15 km (9.3 miles) from the drive.
- (J) Only personnel familiar with the function of the drive should have access to the equipment.
- (K) The drive is designed for front access and should be installed with adequate and safe clearance to allow for total door opening. The back of the unit may be placed against a wall although some customers prefer back access also. If back access is desired, set drive 300 mm (12 inches) out from wall.



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

## Installation

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

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

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

Install and tighten the anchor bolts. (M12 or 1/2" hardware required).  
Engineered bolt systems are required for seismic requirements. Consult factory.

Remove the top lifting angles, retain the hardware.

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

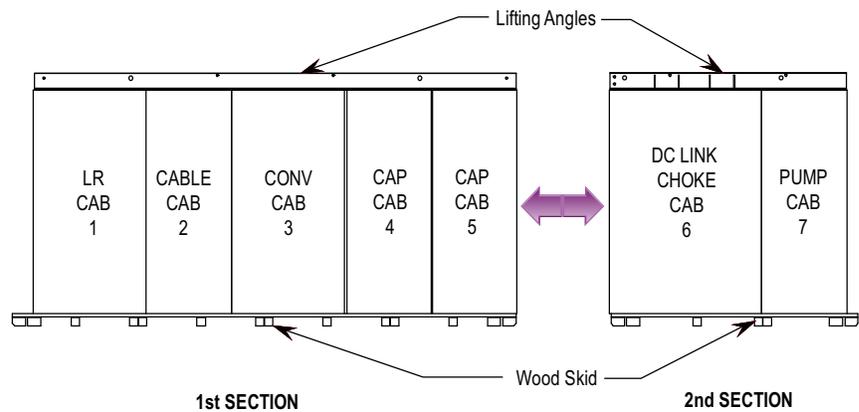
## Joining Shipping Splits

The Drive may have been shipped in two or more shipping sections which are to be connected at installation. It is essential that the surfaces are level. Arrange the sections per the information provided in the dimension drawings and move the sections together. Ground bus, power and control connections are to be made per the electrical diagrams provided. Side sheets of the enclosures are to be joined with thread forming screws using the available holes.

Liquid-cooled Drives may require joining of the coolant pipes. Some enclosure ratings may require the addition of silicone sealant where cabinets join together to prevent the possible ingress of dripping water.

For Direct-to-Drive liquid-cooled 6600V Drives (430A, 495A and 575A rated current) the Drive will be shipped in two sections as shown in [Figure 15](#).

**Figure 15 - Typical Split Drive**



The 1st section consists of 5 cabinets.

The 2nd section consists of 2 cabinets.

Final placement requires that the 1st and 2nd sections are joined at final installation site.



**WARNING:** Heavy Magnetic DC Link Chokes up to 4600 kg (10,000 lb) are shipped inside DC Link Choke cabinet. Professional Millwright/Rigging contractors are required for safe final placement of Drive sections.

---

## Connect the Sections

Field connect the following:

- CPVC pipe splices – 2 pieces
- Power Bus Splice Kit – 4 pieces
- Ground Bus Splice – 1 piece
- Control Wiring

### Tools Required (not supplied)

- Adjustable or socket wrenches for 6-, 10-, 12-mm and 5/8" bolt and nut hardware
- Strap wrench for tightening CPVC unions
- Screwdriver assortment
- Cable ties
- Wire cutters

### Install CPVC Piping Splices

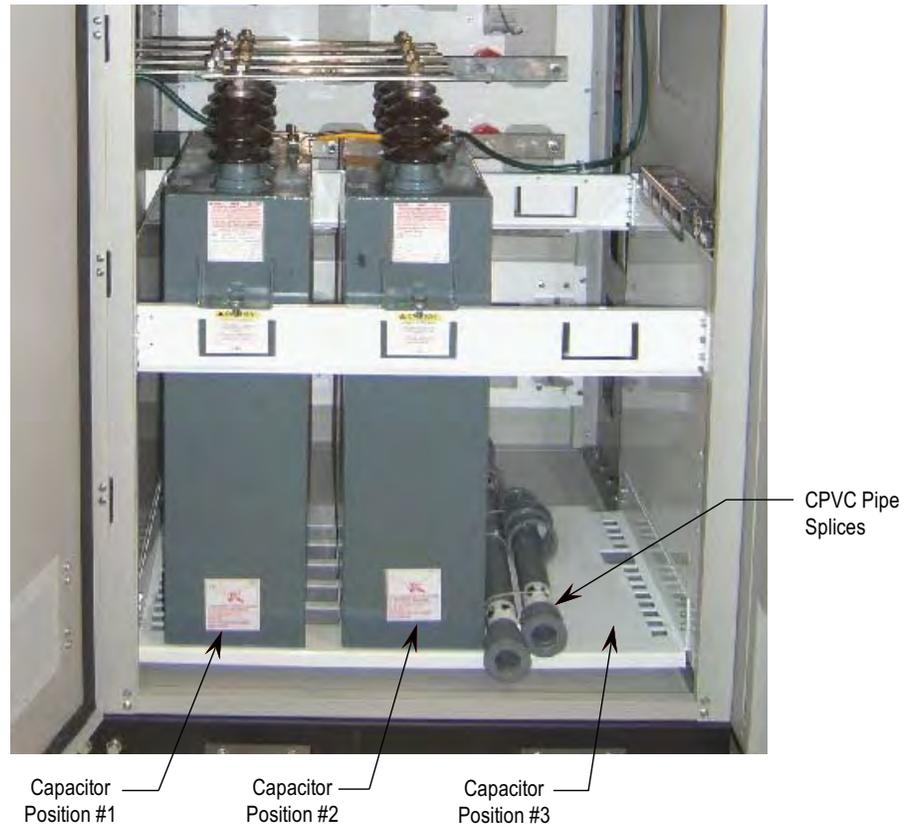
- Open doors of capacitor cabinet (Cabinet #5) next to DC Link Choke cabinet (Cabinet #6). Refer to [Figure 16](#).
- Remove capacitor from position #3, if installed (not all configurations have a capacitor in this location). It is not necessary to remove capacitor from position #2.



**ATTENTION:** Capacitors weigh up to 100 kg (220 lb). Use two people to remove the unit from the structure.

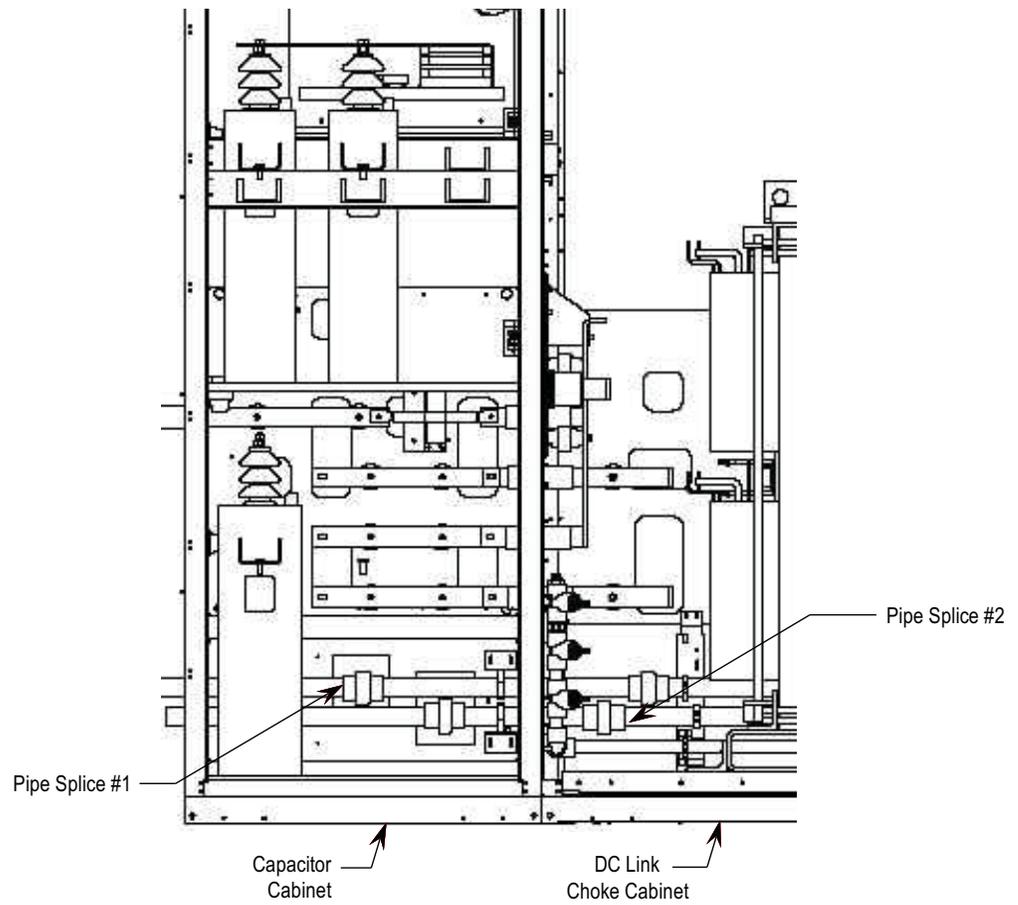
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Figure 16 - Capacitor Cabinet



- Remove CPVC pipe splices shipped in the capacitor cabinet. Install and tighten the 4 CPVC unions with strap wrench (1/4 to 1/2 turn past hand tight). Ensure O-ring is seated inside male end of union. Refer to [Figure 17](#), [Figure 18](#) and [Figure 19](#). Do not use CPVC primer or cement.

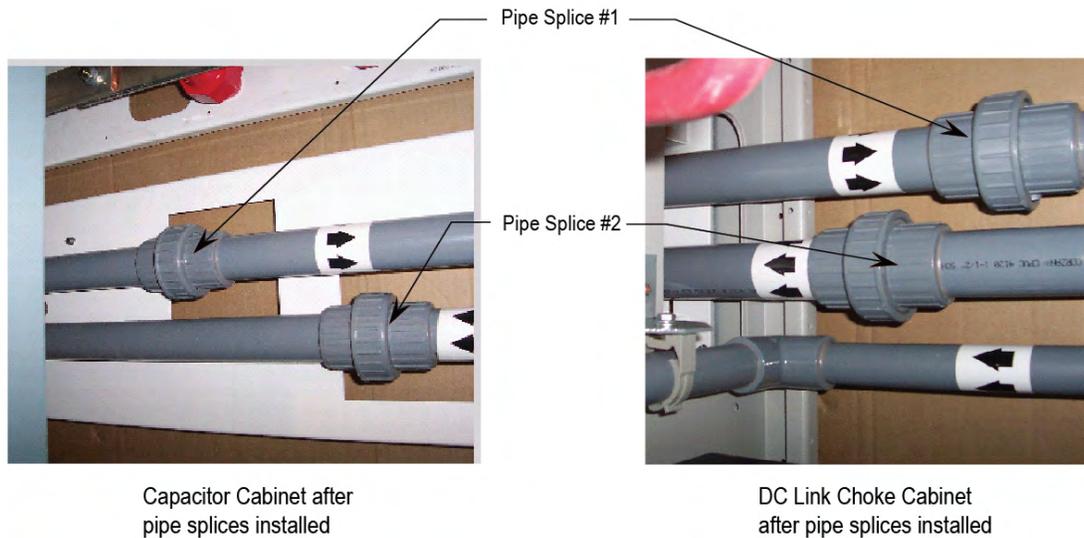
**Figure 17 - CPVC Pipe Splices (Capacitor #2 not shown for clarity)**



**Figure 18 - Typical Strap Wrench (not supplied) used to tighten unions on CPVC pipe splices**



**Figure 19 - Capacitor Cabinet and DC Link Choke Cabinet after Pipe Splices installed**

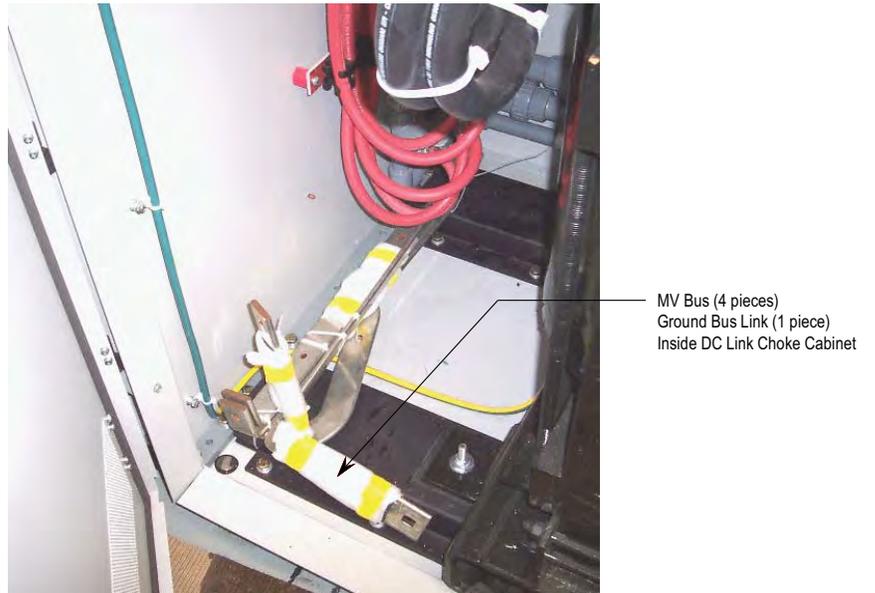


**TIP** Install according to flow direction labels as shown.

### Connect Power: M+, L+, M-, L- Power Bus

- Locate the four (4) Power Bus pieces of the splice kit in DC Link Choke cabinet and remove shipping wrapping. See [Figure 20](#).
- Connect Power Bus M+, L+, M-, L- on the red insulators in the DC Link Choke cabinet and mating bus pieces in the capacitor cabinet. Hardware required is pre-attached to bus connections, cabling, and insulators in the cabinet where the power bus splice kit will attach. Remove and attach as shown in [Figure 20](#) to [Figure 24](#).
- Torque M10 carriage bolts connecting bus to bus in the capacitor cabinet to 29 Nm (21 ft-lb). Torque M12 hardware supplied for cable to bus stab connections to 50 Nm (37 ft-lb).
- After cable connections have been made, ensure cable connections to choke stabs are torqued to 50 Nm (37 ft-lb).
- Ensure a minimum of 3" (75mm) clearance exists between Medium Voltage Bus field connections (including hardware) and all cabinet sidesheets.

**Figure 20 - DC Link Choke Cabinet**  
Power Bus (4) pieces; Ground bus (1) shipped disassembled



**Figure 21 - DC Link Choke Cabinet *before* field power bus connections**

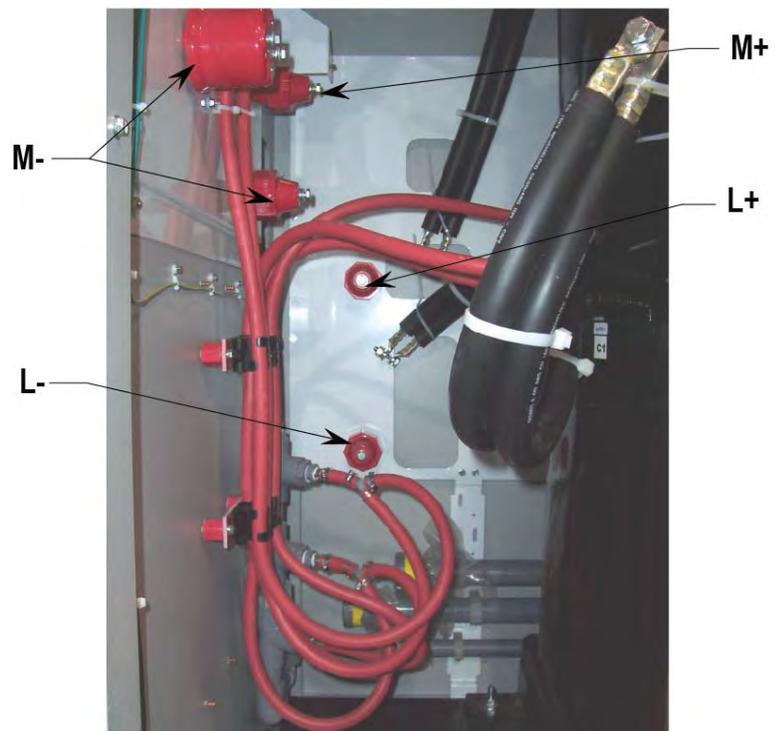


Figure 22 - DC Link Choke Cabinet *after* field connections of power bus

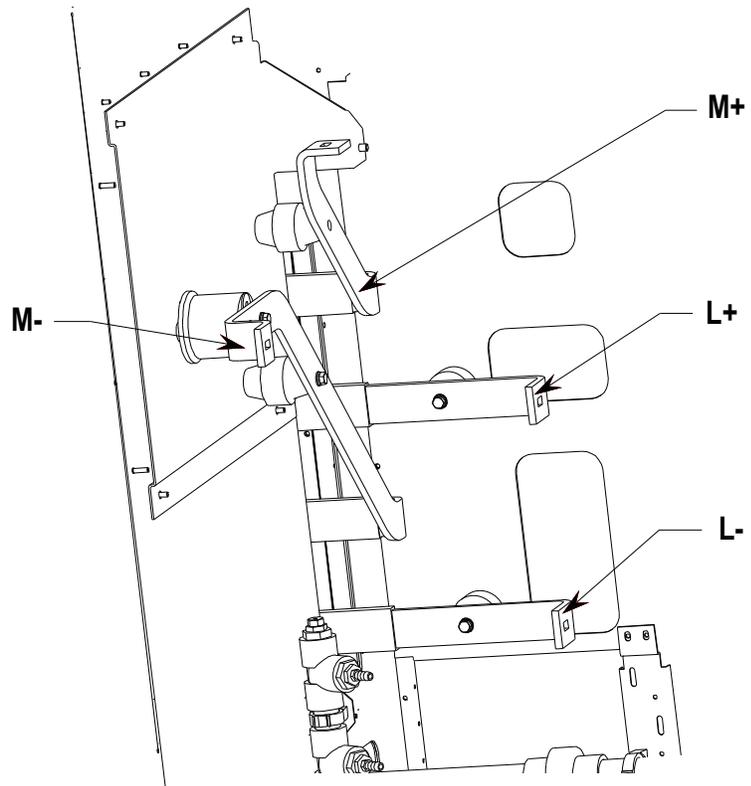
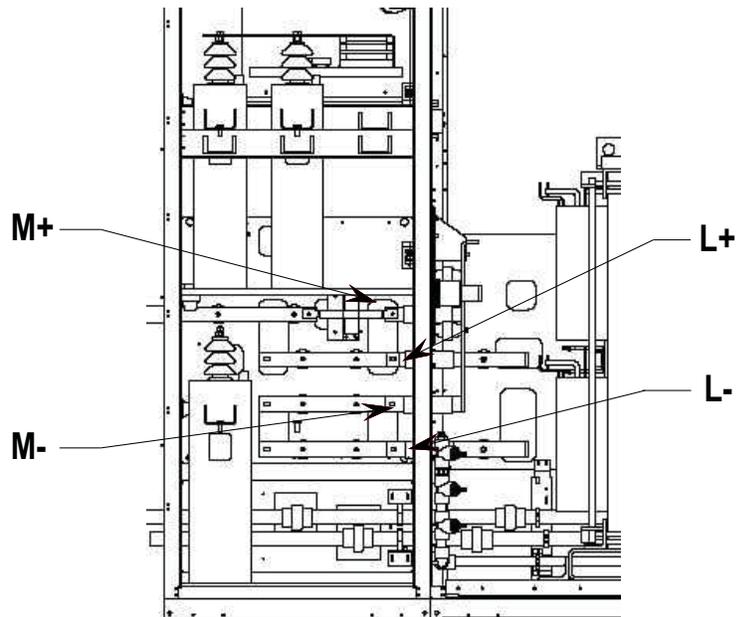
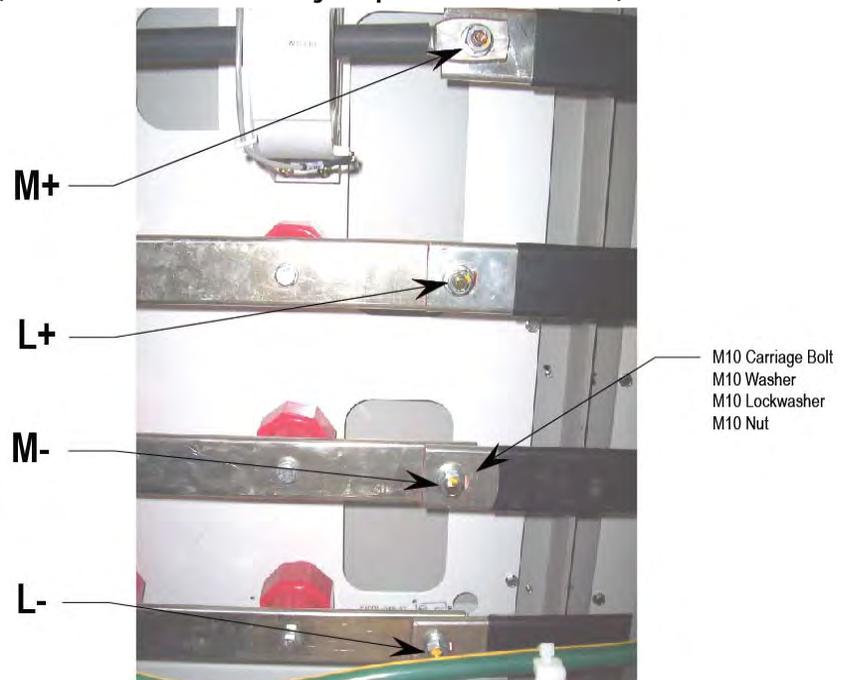


Figure 23 - Capacitor Cabinet *after* field connections of power bus

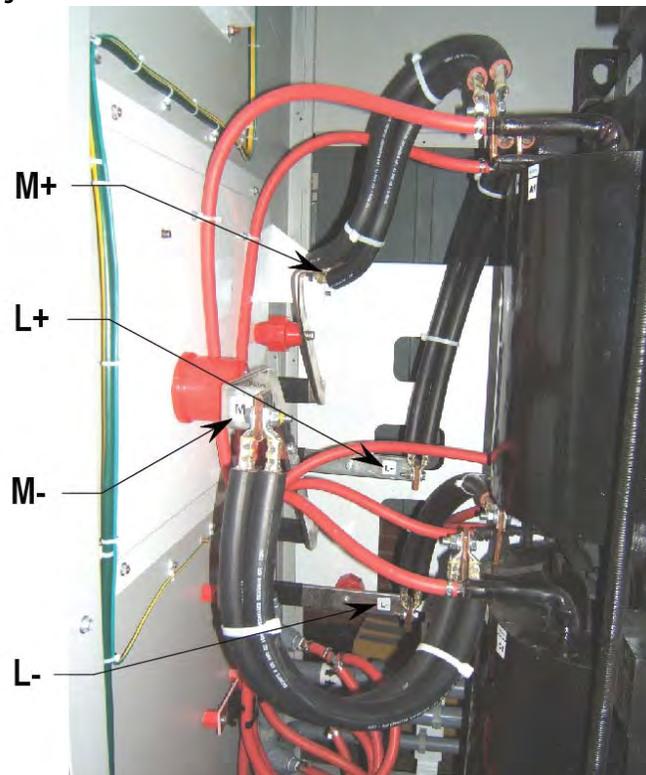


**Figure 24 - Capacitor Cabinet**  
 (Connect left side of Medium Voltage bus pieces with M10 hardware)



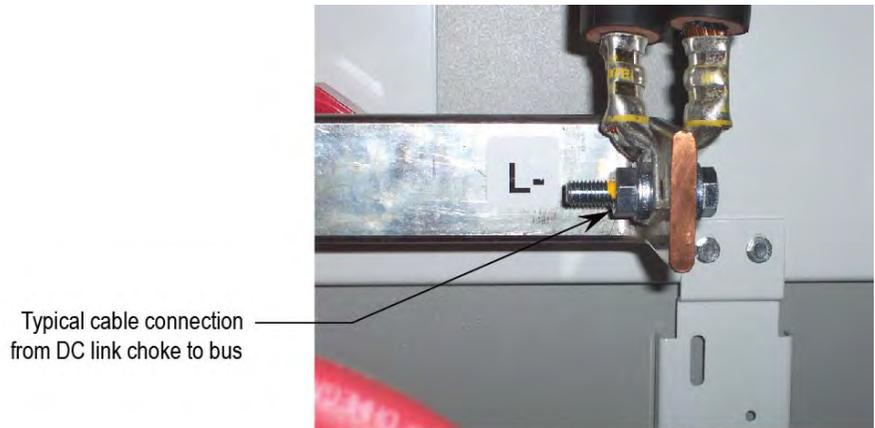
- Connect cables from DC Link Choke to MV Bus pieces using supplied M12 hardware.

**Figure 25 - DC Link Choke Cabinet after connection of cables from DC Link Choke to red insulators**



- Connection points are labeled on bus and DC Link Choke. Connect cables from labeled stabs M+, L+, L-, L+ on DC Link Choke to corresponding labeled stabs M+, L+, M-, L+ on bus.

Figure 26 - DC Link Choke Cabinet Typical Cable Connection



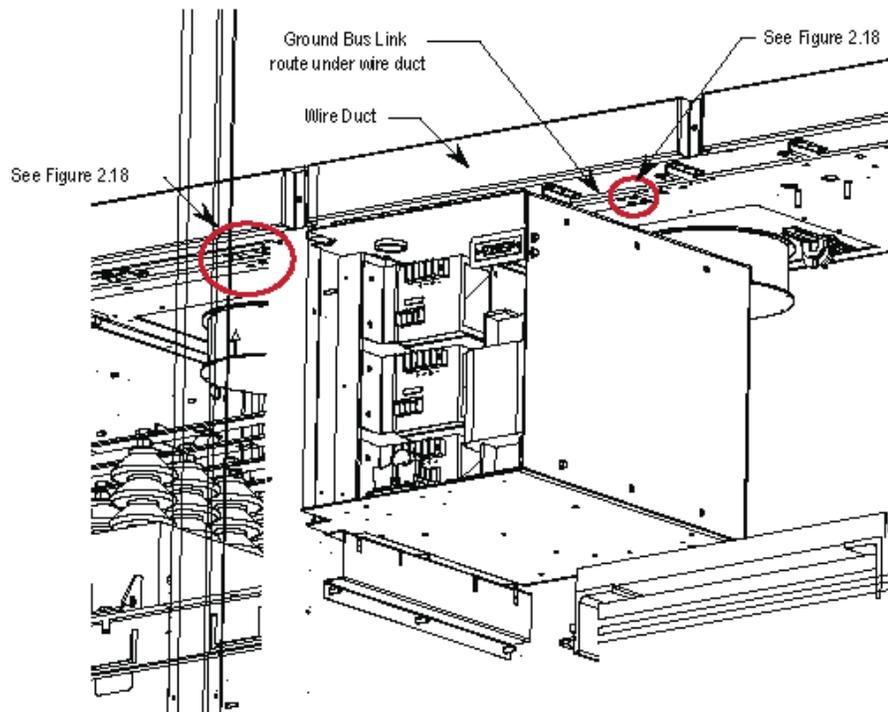
Typical cable connection from DC link choke to bus

- Connect Ground Bus Link from top left of DC Link Choke cabinet to ground bus in adjacent capacitor cabinet by sliding underneath wire duct. Use supplied hardware.

Figure 27 - Ground Bus Link



Figure 28 - Install Ground Bus Link



**Figure 29 - Ground Bus Connection Points  
(Install Ground Bus Link using Supplied Hardware)**

M6 Hardware (4 places)  
tighten to 6 Nm (4.4 ft-lbs)  
at each end of bus link

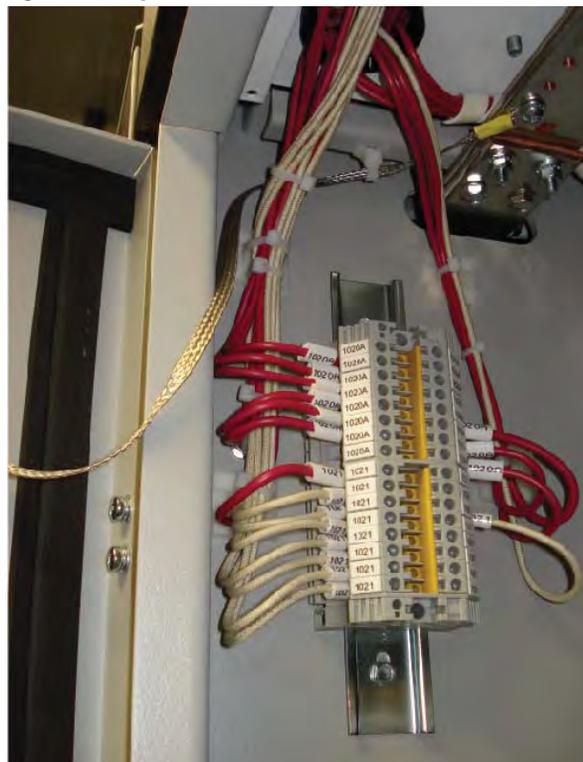


## Control Wiring Connections

Refer to EDs and wiring diagrams supplied with Drive. Contact Rockwell Automation representative for assistance. Final wiring connections to be performed by Rockwell Automation field service representative.

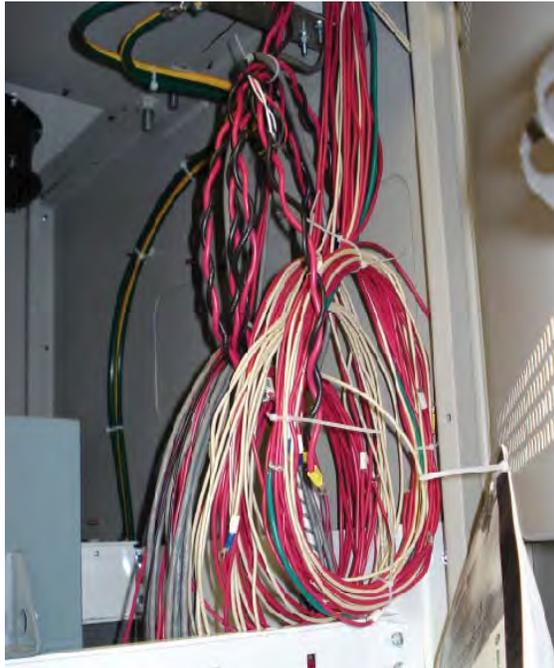
1. Remove the wireway covers located on top of the line and motor filter capacitor sections and the DC Link section.
2. If drive has strip heater wiring, it will be coiled up in the top wireway. Route these wires down through the grommeted cutout for connection on the terminal blocks located in the upper left side of the capacitor section.

**Figure 30 - Strip heater terminal block**



3. Route the control wiring which has been coiled up and left hanging in the upper area of the motor filter capacitor section, back up through the two grommets cutouts back into the wireway. There is a fiber optic cable in this bundle and care must be taken not to damage it. The fiber optic cable, control power wires and the “XIO link” cable will be required in the pump control cabinet.

**Figure 31 - Control Wiring**



4. Route the 8 gauge black and red twisted pairs of wire and the Belden shielded cables down through the grommets cutout into the AC\DC power supply section.

**Figure 32 - Belden Shielded Cables**



5. Route the 3-fan control wires, 2 cabinet over-temperature control wires down through the grommeted cutout into the center of the DC choke section ([Figure 33](#)).

**Figure 33 - Fan Thermostat Control Wires**



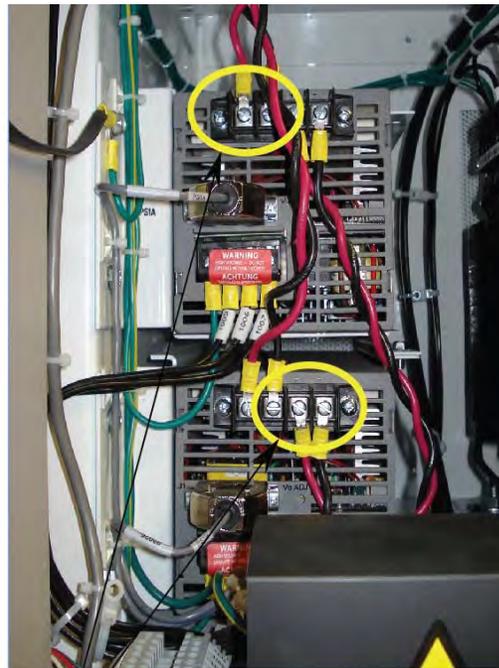
6. Route the control wires down through the grommeted cutout into the control power disconnect section ([Figure 34](#)).
7. Connect the numbered wires to the corresponding numbered terminal blocks ([Figure 35](#) to [Figure 38](#)).

**Figure 34 - Route control wires through grommeted cutout**



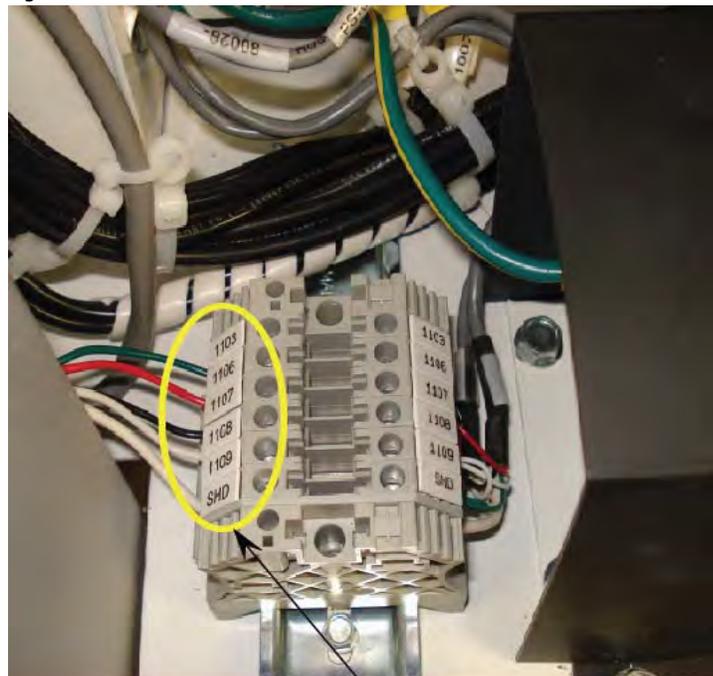
8. Refer to the electrical drawing and make the above control wiring connections.

**Figure 35 - 56V DC Connections**

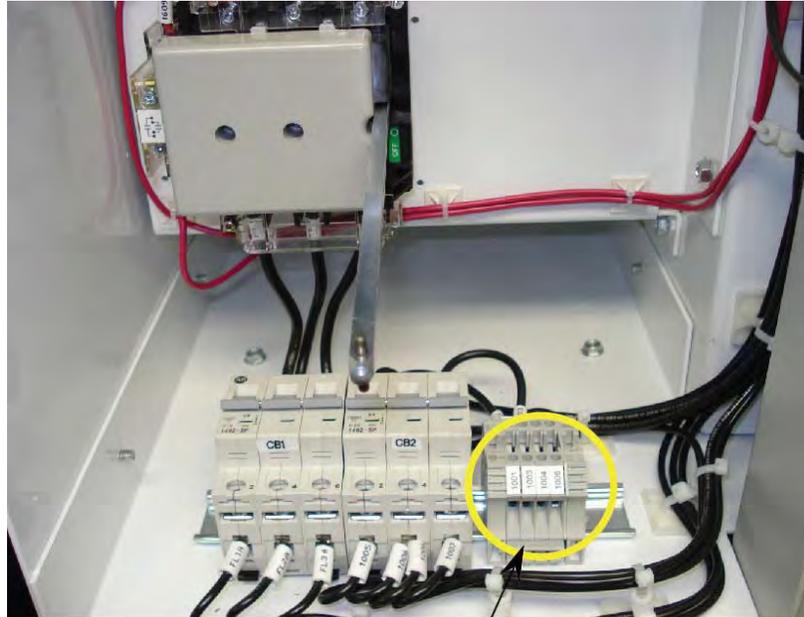


56V DC Connections  
Red – Positive  
Black – Negative

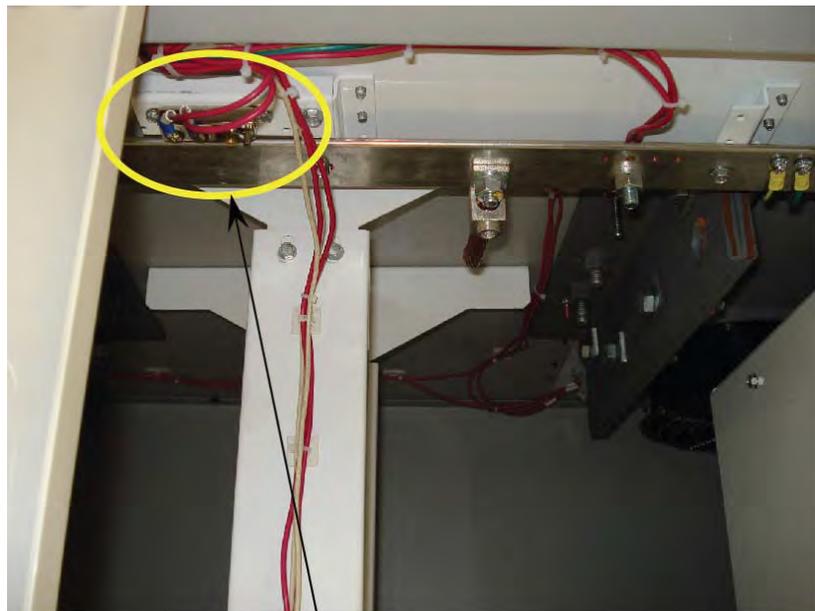
**Figure 36 - AC DC fails Belden Cable Connection**



AC DC fails Belden  
cable connections

**Figure 37 - Control Wire Power Connections**

Control Wire Power Connections

**Figure 38 - Thermostat and Fan Connections**

Thermostat and Fan Connections

9. Once all the connections have been made and neatly routed in each section, the excess control wires can be looped up in the top wireways.
10. Swing out the control section in the pump control cabinet.
11. Route the XIO link cable, control power wires and the fiber optic cable down through the wire ways grommeted cutout.
12. Route the XIO link cable, the control power wires into the pump control cabinet through the upper side grommeted cutout.

13. Route the fiber optic cable into the pump control cabinet through the lower side grommeted cutout.

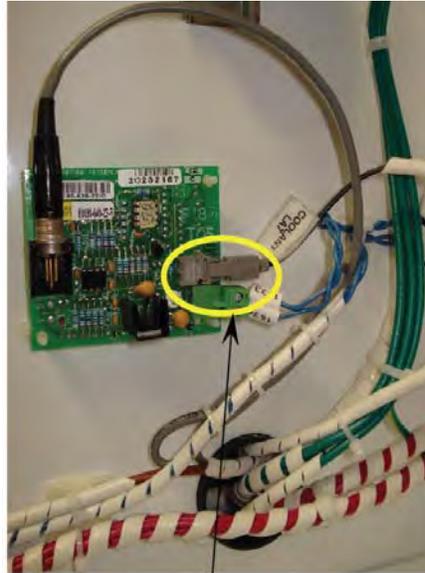
**Figure 39 - 120V and XIO cables through upper cutout**



14. Connect the XIO link cable to the XIO board “XIO link A” connector. (Figure 40)
15. Connect the control power wires to the control power terminal blocks. Refer to Electrical Drawings for corresponding wire numbers and terminal blocks.
16. Connect the fiber optic cable to the TFB board.

**Figure 40 - XIO link Cable**



**Figure 41 - TFB Fiber Optic connected**

TFB Fiber optic  
connected

- Use supplied silicone (see [Figure 42](#)) to seal between cabinets to prevent moisture or dirt from entering. Join sidesheets with M6 Taptite thread forming screws in holes provided.

**Figure 42 - Capacitor Cabinet**

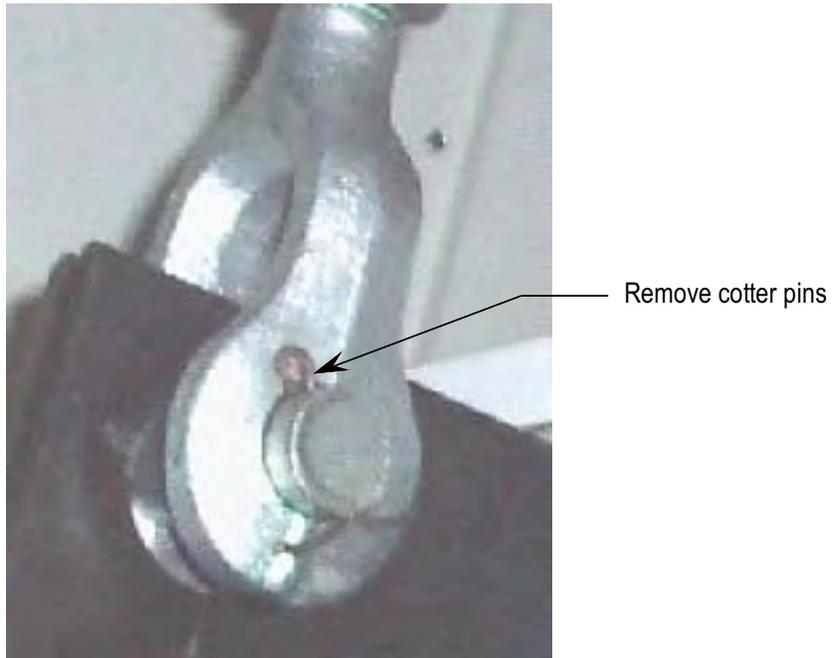
Silicone  
sealant

## Removal of DC Link Choke Turnbuckle Supports

Remove turnbuckles which attach choke to top lifting angle pair as follows:

- Remove cotter pins (see [Figure 43](#)) from bottom turnbuckle jaw then top. Carefully remove turnbuckles. Retain for future use.

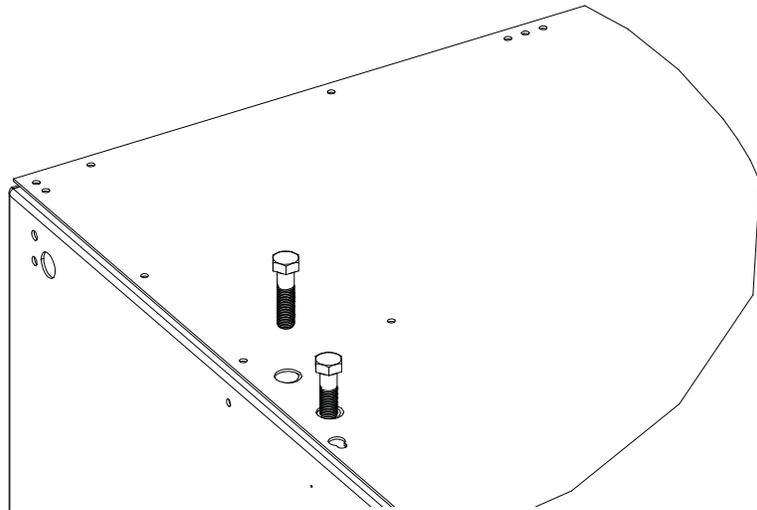
**Figure 43 - Choke Cabinet**



- Re-install any capacitors that were removed.
- Proceed with Removal of Lifting Angles.

## Removal of Lifting Angles

Lifting angles should be removed only when the Drive is in its final location. The lifting angles are retained with 5/8"-11 hardware. The 5/8" bolts need to be re-installed in their holes in the top of the Drive to prevent the ingress of foreign matter into the enclosures. See [Figure 44](#).

**Figure 44 - Insert bolts**

**ATTENTION:** Refer to the technical drawings and installation manual for your Drive mounting instructions. Failure to correctly anchor the cabinet may result in damage to the equipment or injury to personnel. Contact the area Rockwell Automation sales office if you do not have these documents.

## Shock Indication Labels

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

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

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

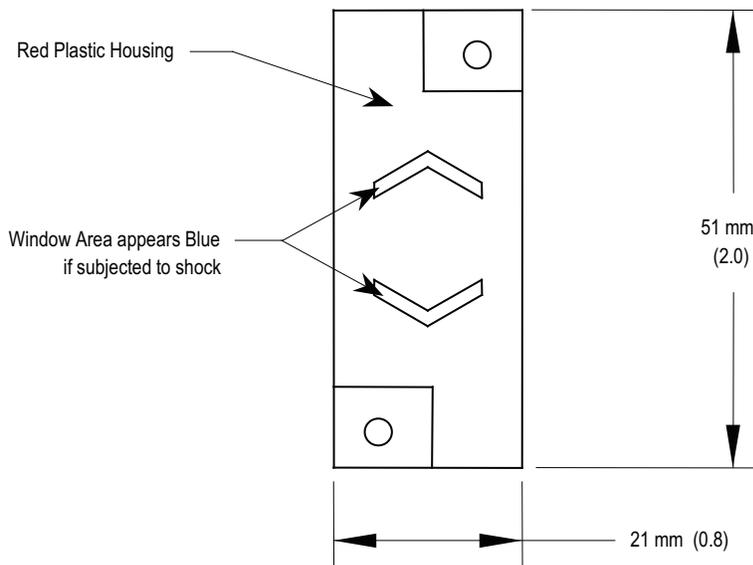
When the drive has been placed in its installation area, the converter door is to be opened and the shock indication labels inspected.

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

If these shock levels have been attained, record the values. There is a greater possibility of the drive having sustained internal damage if it has been subjected to physical shock during the shipping and installation process.

Even if the indicators show that no shock was attained, full inspection and verification in accordance with the Commissioning process outlined in Chapter 4 is still essential.

Figure 45 - Shock Indicator



## Installation of Exhaust Air Hood

Even though this is a liquid-cooled drive, some sections still require air circulation.

On the top of the cabinets with cooling fans, sheet metal exhaust hoods are to be installed. The components to make up the exhaust hood have been packaged and shipped with the drive and are to be found in the control/cabing cabinet.

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

Secondly, loosely assemble the two L-shaped panel components shipped with the drive.

**TIP** For AFE Rectifiers with a line reactor cabinet, there may be a provision for small fans in the roof of the cabinet. This cabinet will still have a full-size exhaust air hood.

Locate the exhaust hood on top of the cabinet per [Figure 46](#) and re-install the original cover plate previously set aside. (Care must be taken that the notches on the bottom flange are oriented toward the sides of the drive). Affix assembly to the drive top plate. Tighten all hardware.

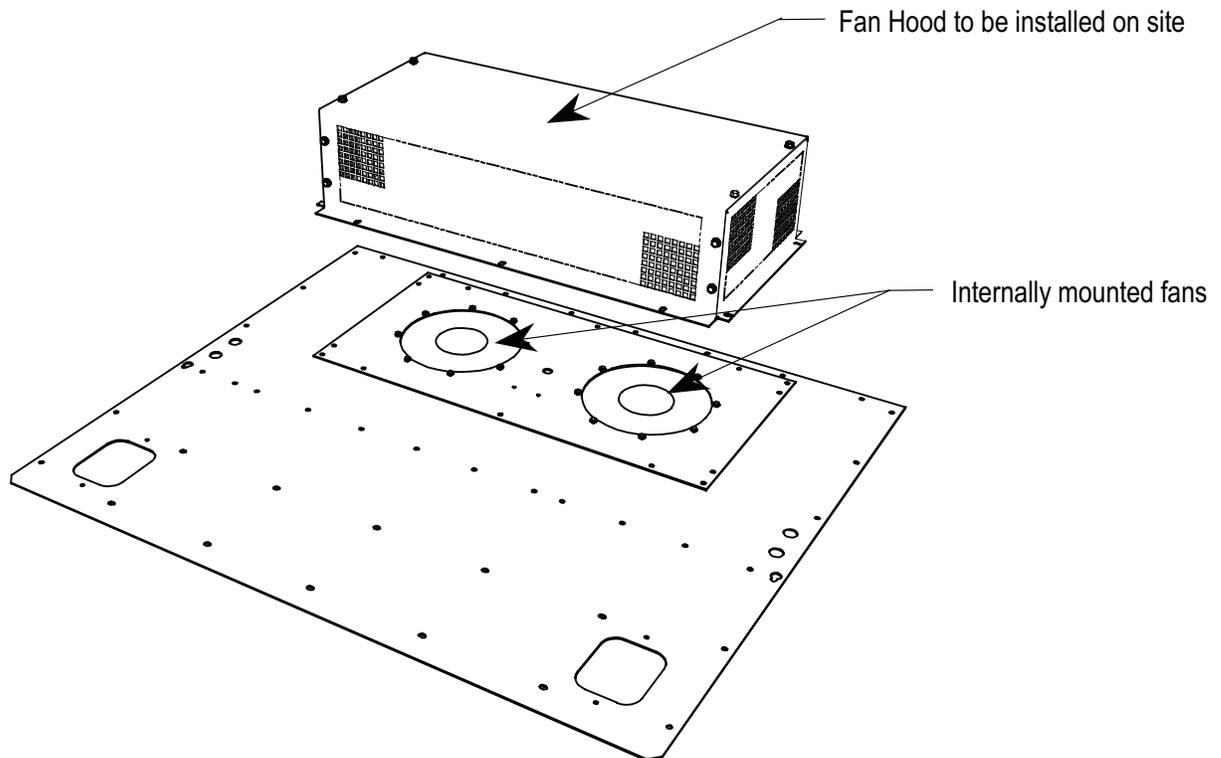


**ATTENTION:** Any screws that are accidentally dropped in the equipment must be retrieved as damage or injury may occur.

## Internally mounted fans

Capacitor cabinets have internally mounted fans which are installed and wired by Rockwell Automation (refer to [Figure 46](#)). The customer only needs to install the fan hood.

**Figure 46 - Fan Hood Installation (Internally Mounted Fans)**



## Externally mounted fans and fan hood

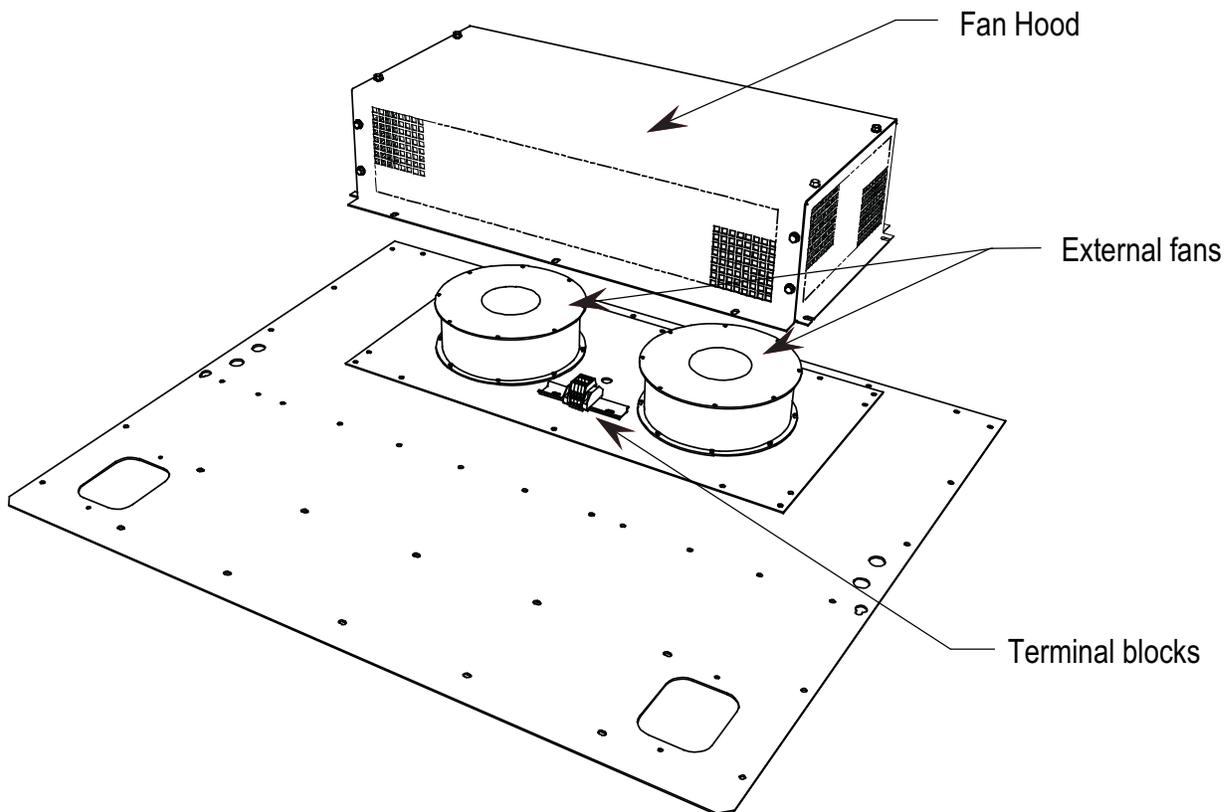
The converter has cooling fans that are externally mounted (refer to [Figure 47](#)). It is necessary to re-install and connect the fans, and install the fan hood.

Shipped with the drive is a plate with the fans mounted and wired to terminal blocks. On site, the fan assembly is to be mounted on the top plate of the converter cabinet as shown in [Figure 47](#).

Wiring for fan power is to be routed through the hole near the terminal blocks. The plate is fastened to the cabinet with M6 hardware. Connect wires to the terminal blocks per the electrical diagram.

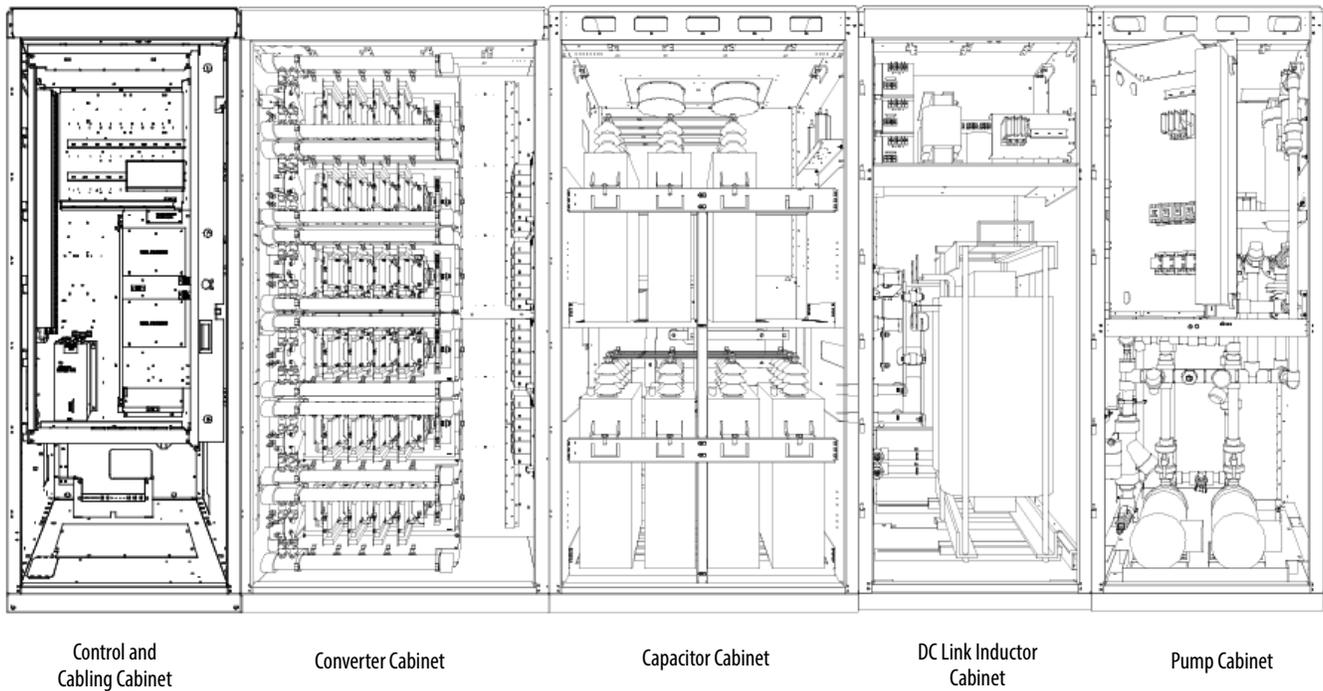
Position the fan hood over the fan assembly and fasten with M6 hardware.

**Figure 47 - Fan Hood Installation (Externally Mounted Fans and Fan Hood)**



## Typical PowerFlex 7000L Drive Structure Layout

Figure 48 - Typical PowerFlex 7000 "C" Frame Drive Structure Layout



### Control/Cabling Cabinet

Shows the medium voltage area located in the control/cabling cabinet behind the low voltage area compartment and with barriers removed.

**TIP** The control/cabling cabinet comes in two different configurations:

- AFE rectifier ([Figure 49](#))
- 18 Pulse rectifier ([Figure 50](#))

### Major Components

The following seven diagrams show the typical layout of each cabinet for PowerFlex 7000 "C" Frame Drives.

Figure 49 - Control and Cabling Cabinet (AFE Rectifier version shown) (with Control Panel removed)

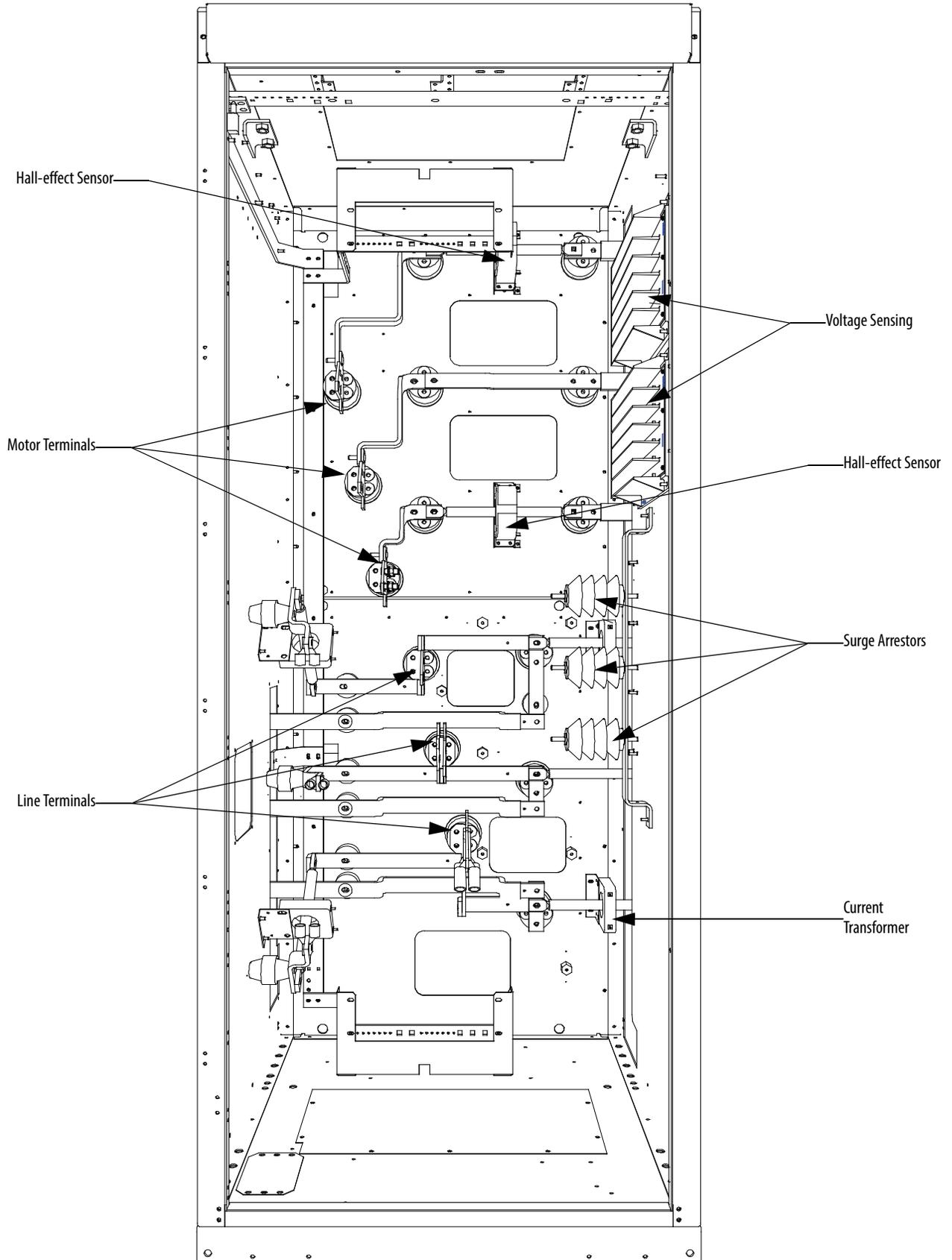


Figure 50 - Control and Cabling Cabinet (18 Pulse version shown) (with Control Panel removed)

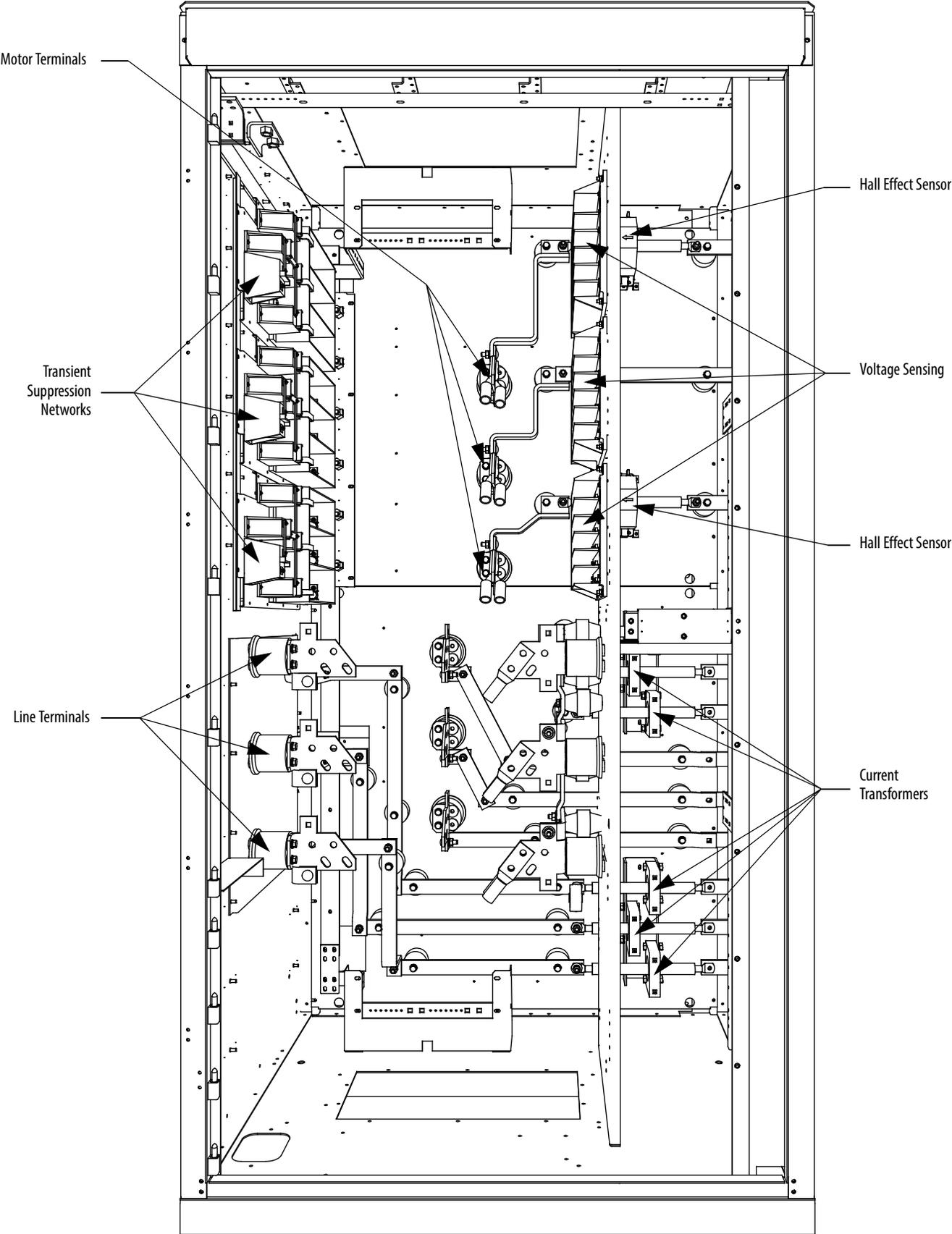


Figure 51 - Low Voltage Tub Compartment

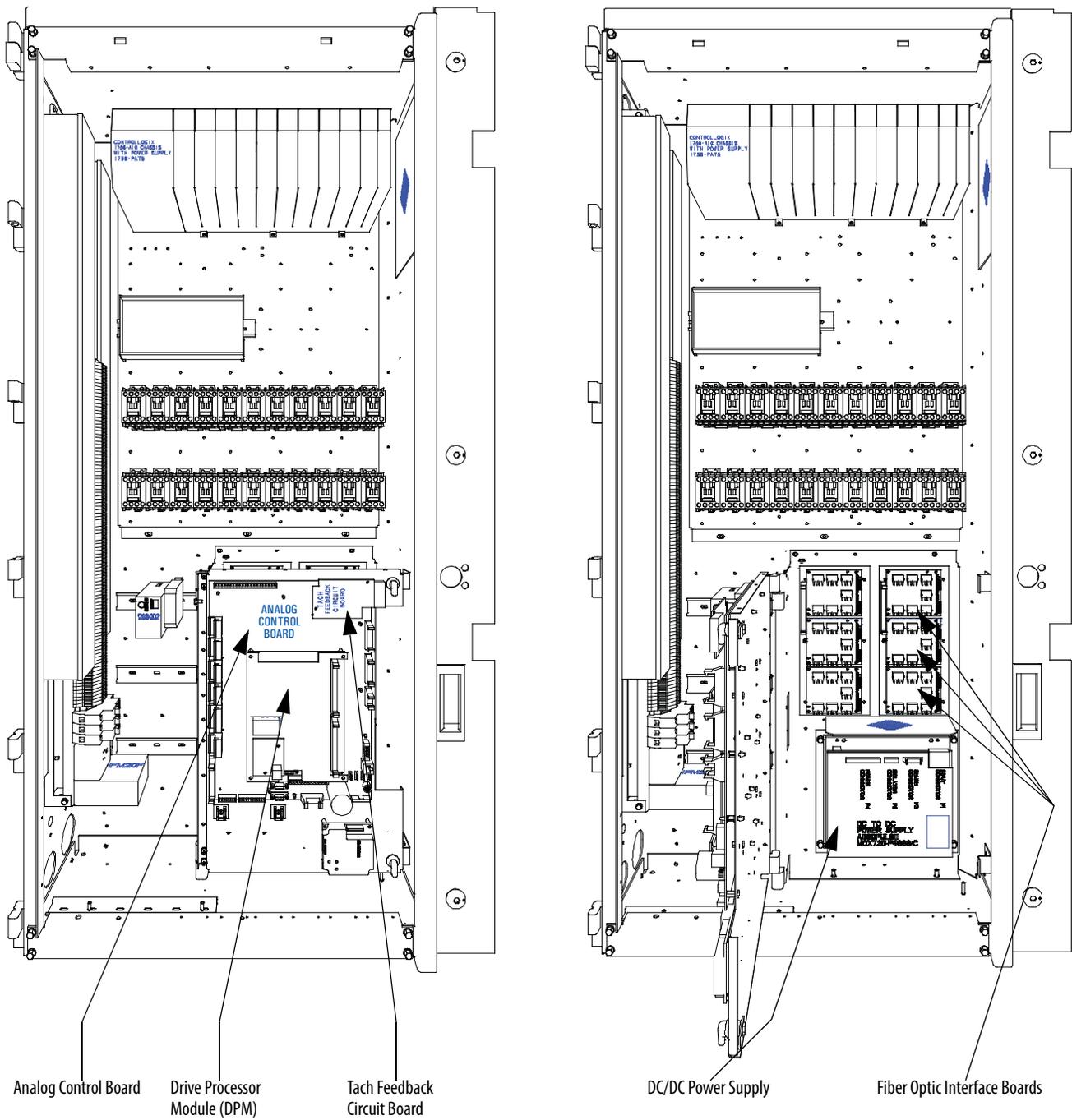


Figure 52 - Converter Cabinet Components (4160V AFE shown)

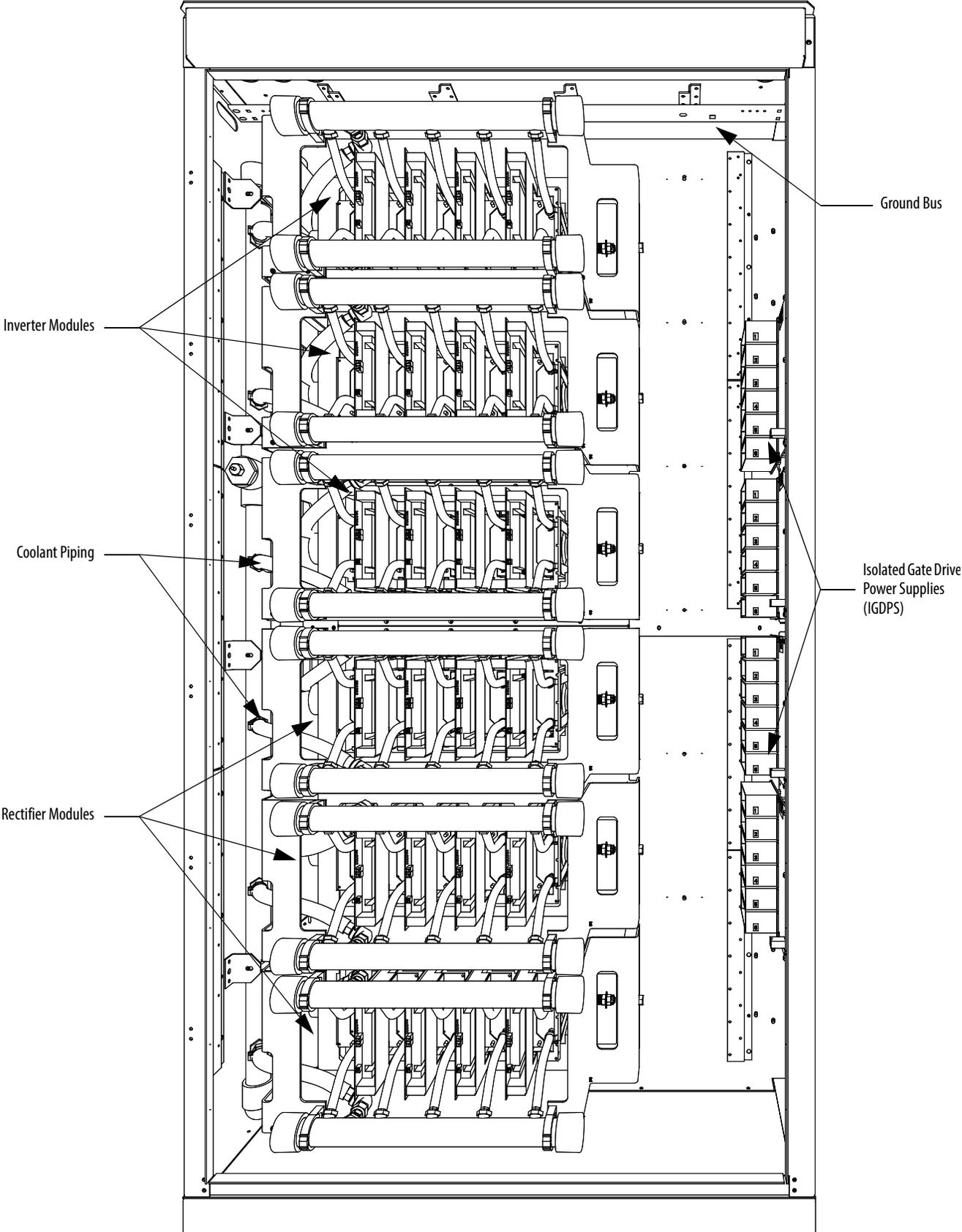


Figure 53 - Converter Cabinet Components (6600V AFE shown)

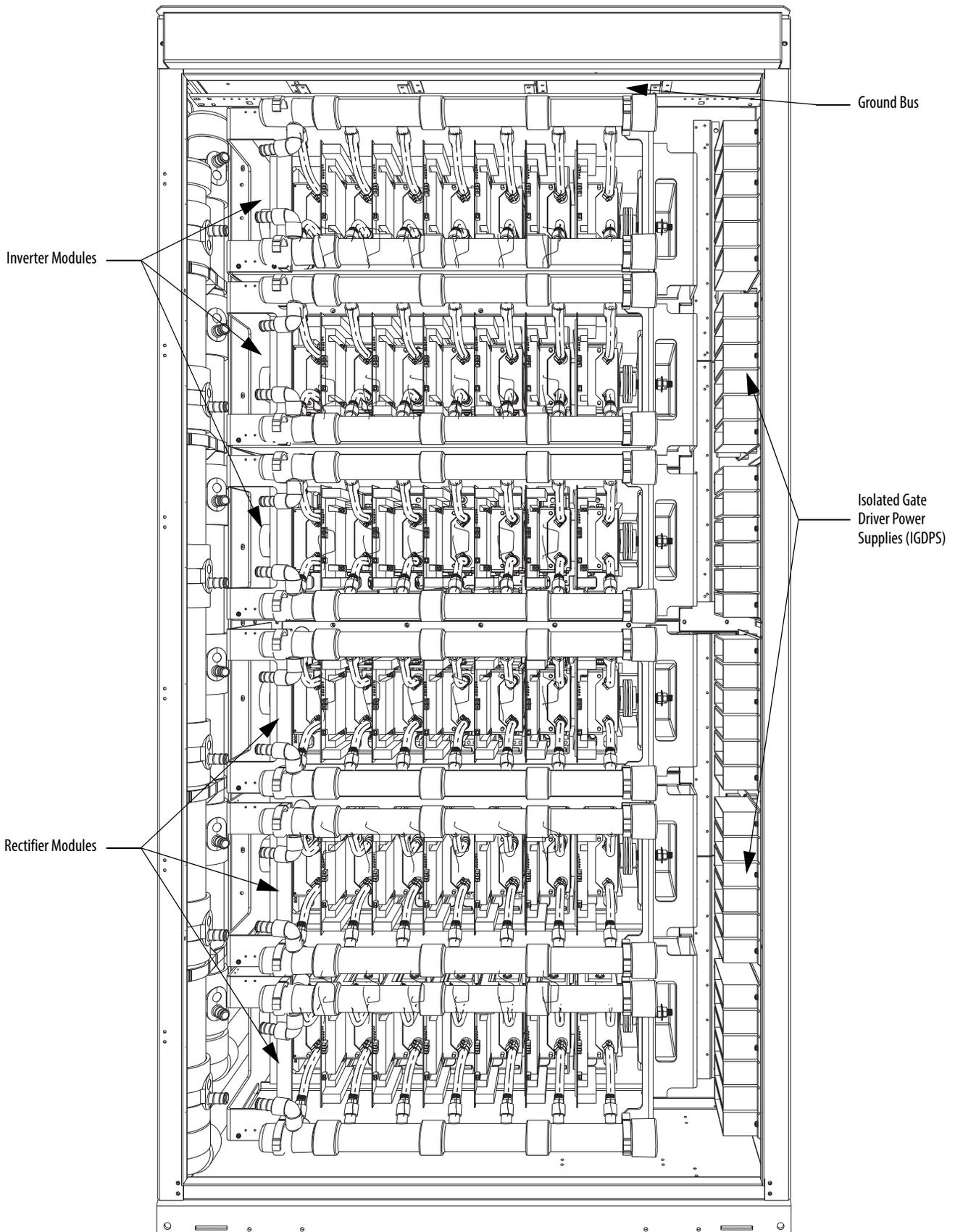


Figure 54 - Capacitor Cabinet

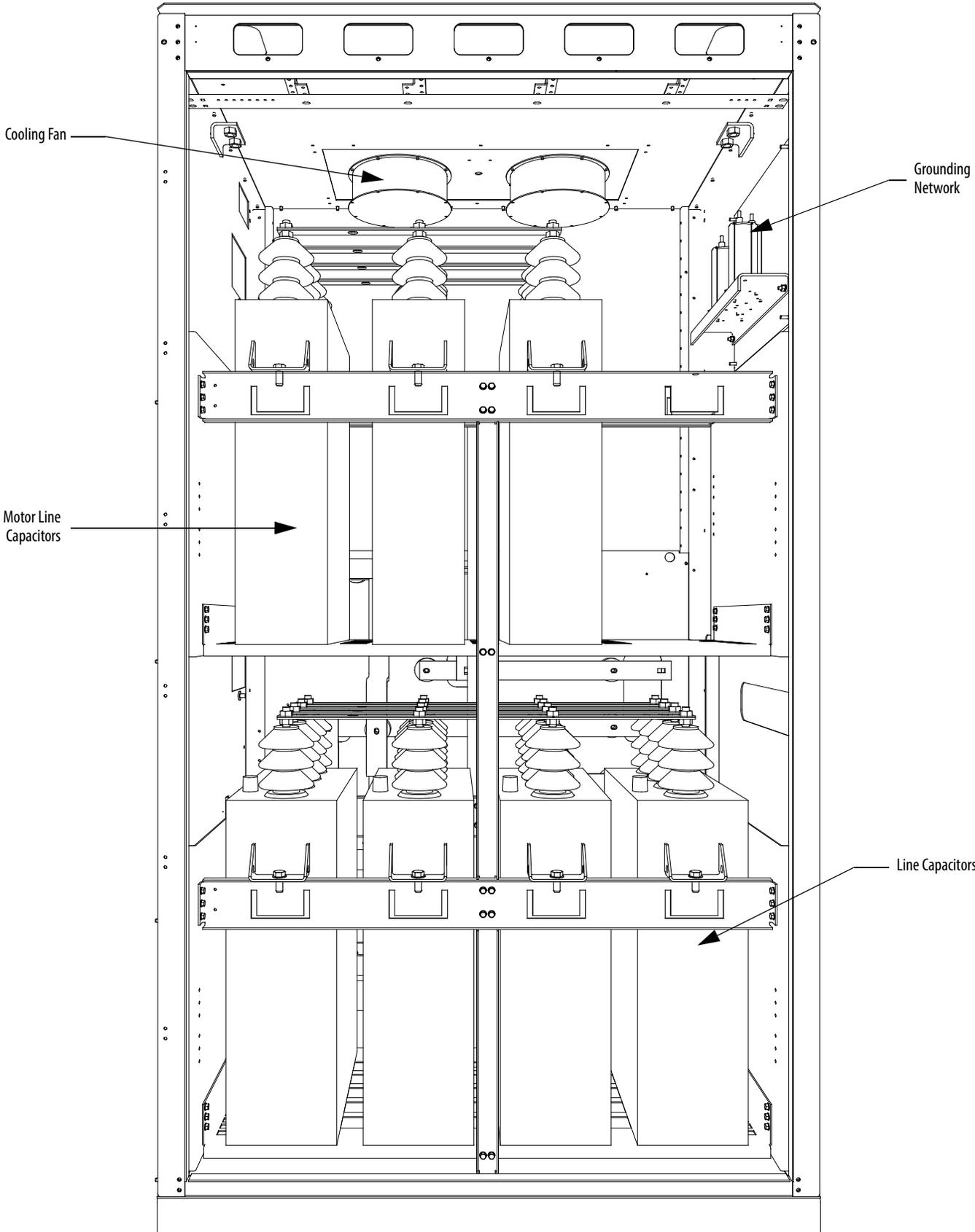


Figure 55 - DC Link Inductor Cabinet

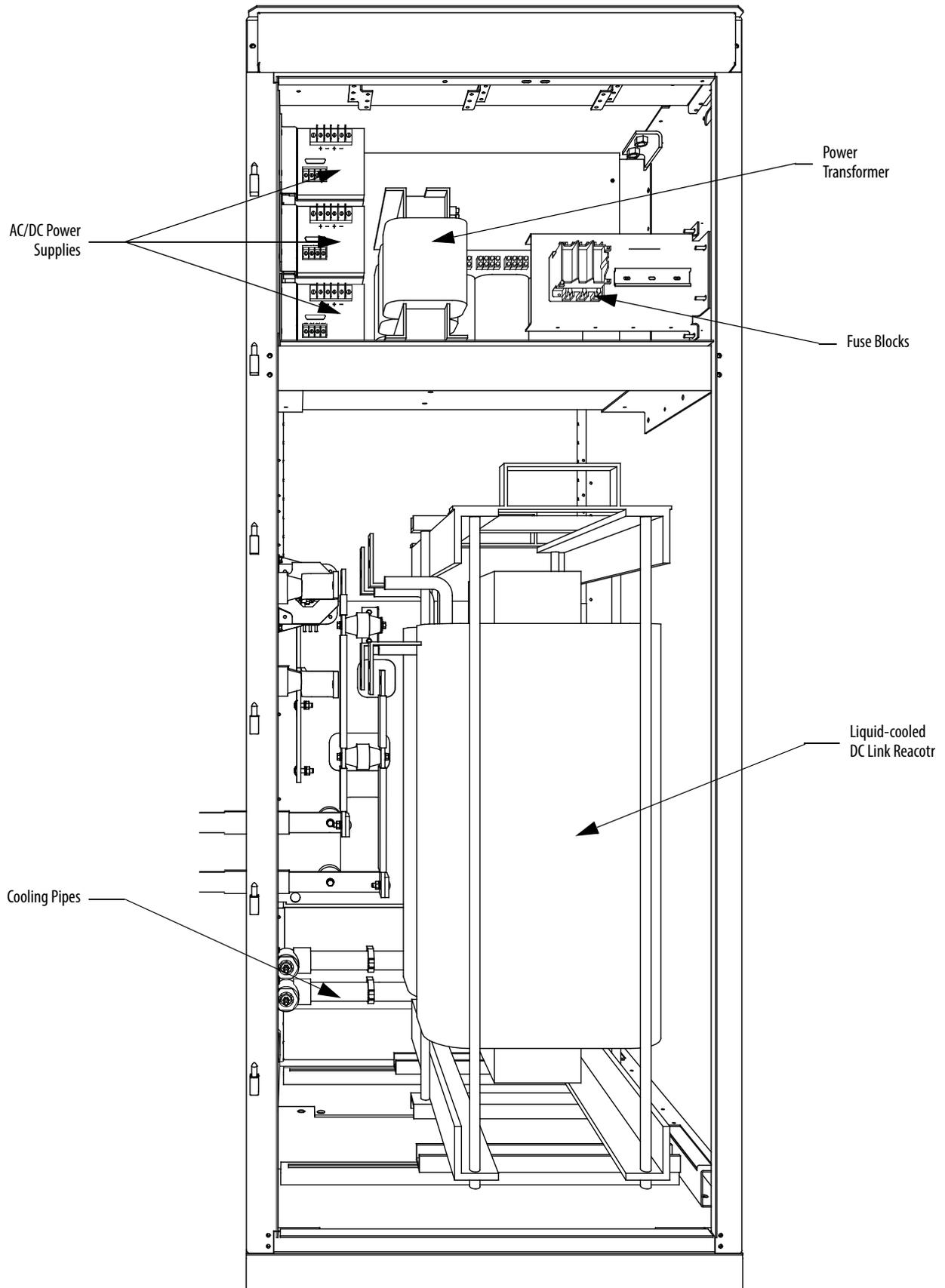
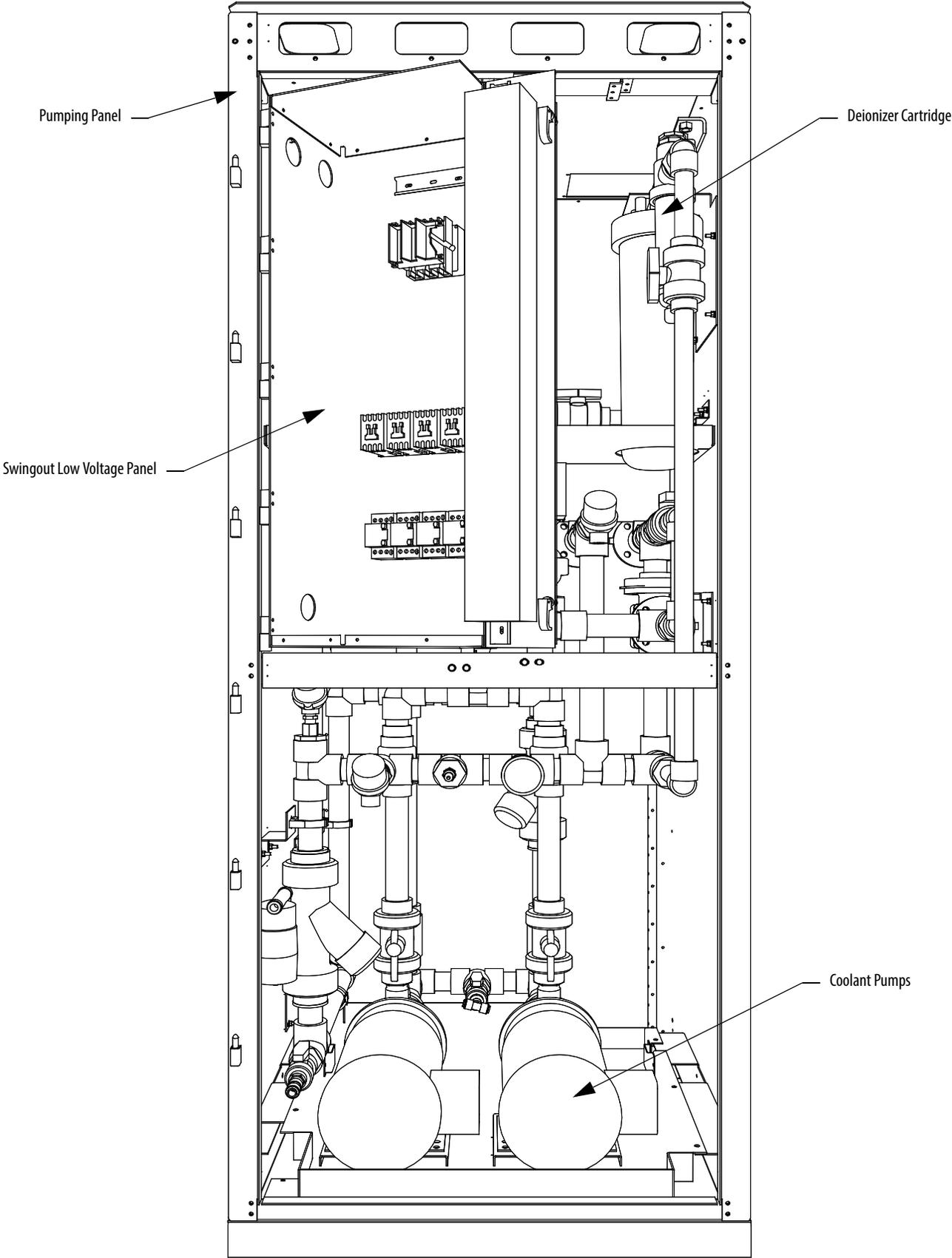


Figure 56 - Pump Cabinet (showing swing-out low voltage panel)



## IEC Component and Device Designation

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

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

## Power Wiring Selection

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

### General Notes

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

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

## Cable Insulation

The cable insulation requirements for the PowerFlex 7000 drive are given in the tables below.



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

**Table 2 - Cable Insulation Requirements for 18 Pulse and 6P / AFE Drives with Isolation Transformer**

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

**Table 3 - Cable Insulation Requirements for “Direct-to-Drive” Technology**

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

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

**Table 4 - Wire Group Numbers**

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

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

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

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

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

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

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

The wire sizes must be selected individually, observing all applicable safety and CEC or IEC / NEC regulations. The minimum permissible wire size does not necessarily result in the best operating economy. The minimum recommended size for the wires between the drive and the motor is the same as that used if a main voltage source connection to the motor was used. The distance between the drive and motor may affect the size of the conductors used.

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

## Power Cabling Access

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

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

### Access the Customer Power Cable Terminations:

- Open the door of the low voltage control compartment. The low voltage control compartment is hinged on its left side. The power terminals are behind the low voltage control compartment.
- Note that there is a key interlock to prevent swinging the low voltage control compartment open unless the medium voltage source is locked out.
- Turn each of the three latches on the right side of the low voltage compartment one-quarter turn using an 8-mm hexagonal key wrench. There is a pull handle provided on the right side of the low voltage compartment.
- Slowly pull the handle so that the low voltage compartment swings out. The power terminals are now visible.
- The installer is responsible for modifying the power cable access plates to suit the requirements.
- Note that appropriate connectors must be used to maintain the environmental rating of the enclosure.

Figure 57 - Swing-out of Low Voltage Compartment

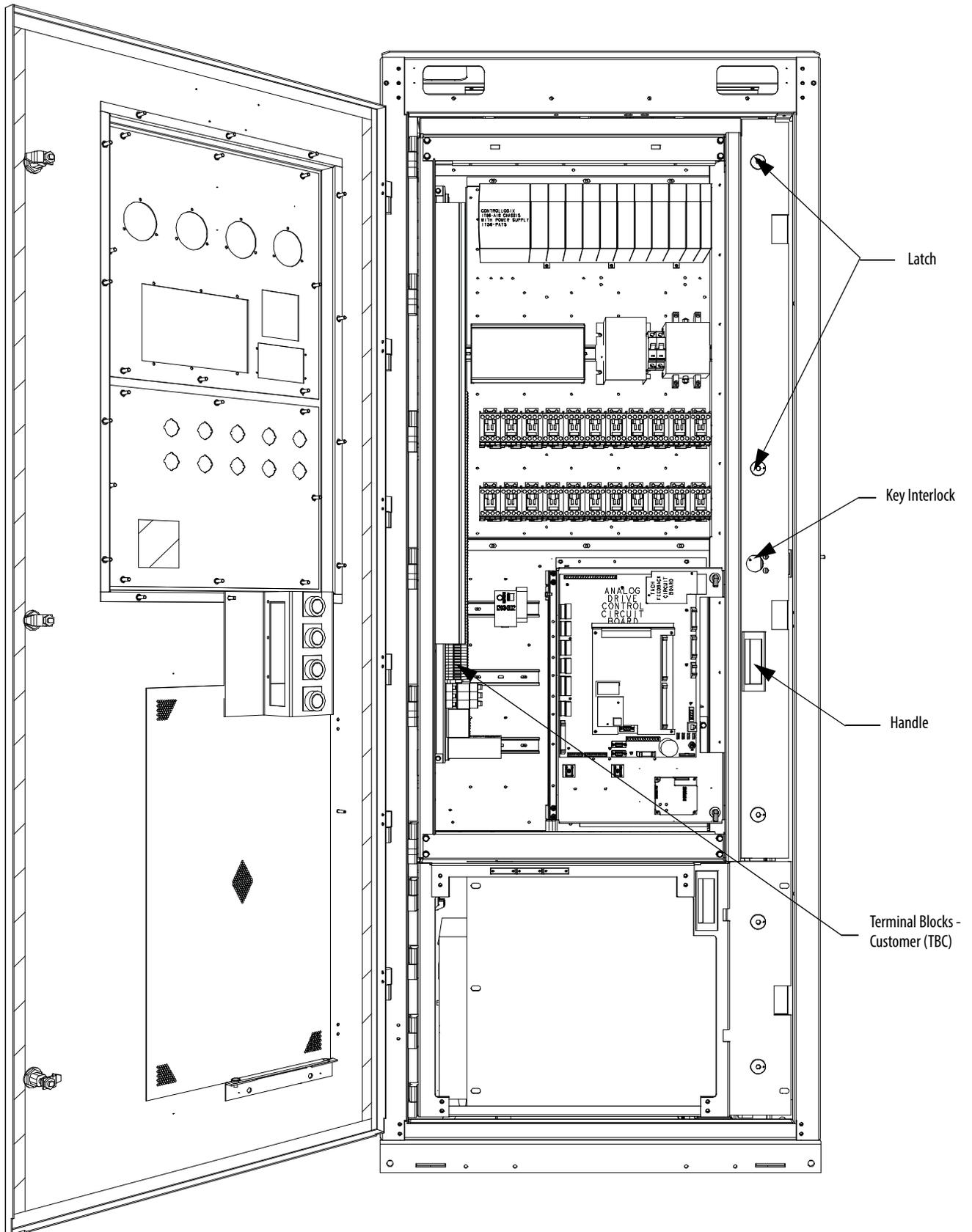
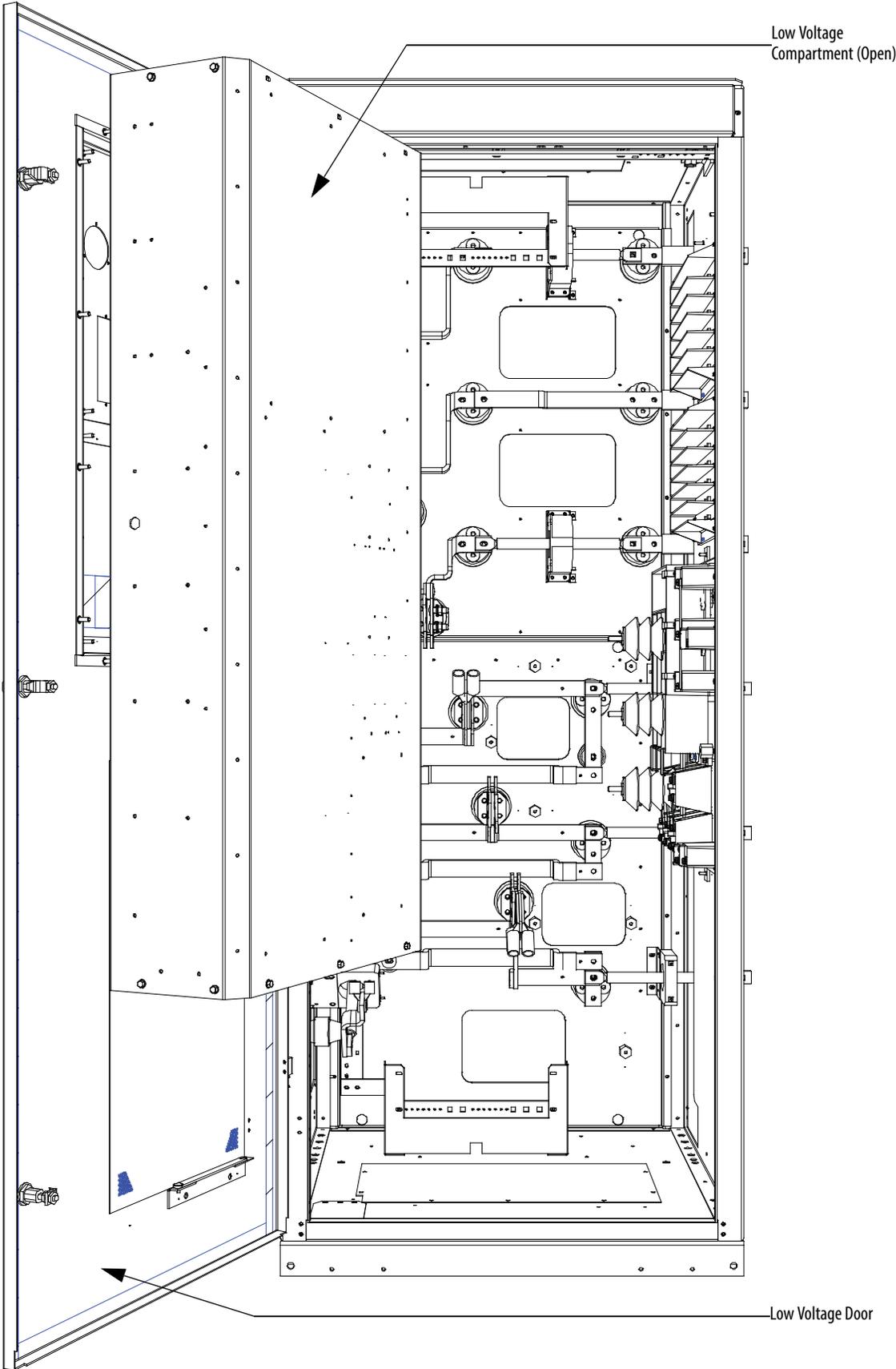


Figure 58 - Access to Power Terminals



## Power Connections

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

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

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

### Incoming Connections

- Drives with AFE Rectifiers: 2U, 2V, 2W
- Drives with 18 Pulse Rectifiers
  - Secondary (d0) 2U, 2V, 2W
  - Secondary (d-20) 3U, 3V, 3W
  - Secondary (d+20) 4U, 4V, 4W
- Motor Connections U, V, W

The installer is responsible for ensuring that power connections are made with appropriate torque. (Refer to [Torque Requirements for Threaded Fasteners on page 419 \(Appendix B\)](#).)

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

## Liquid Connections

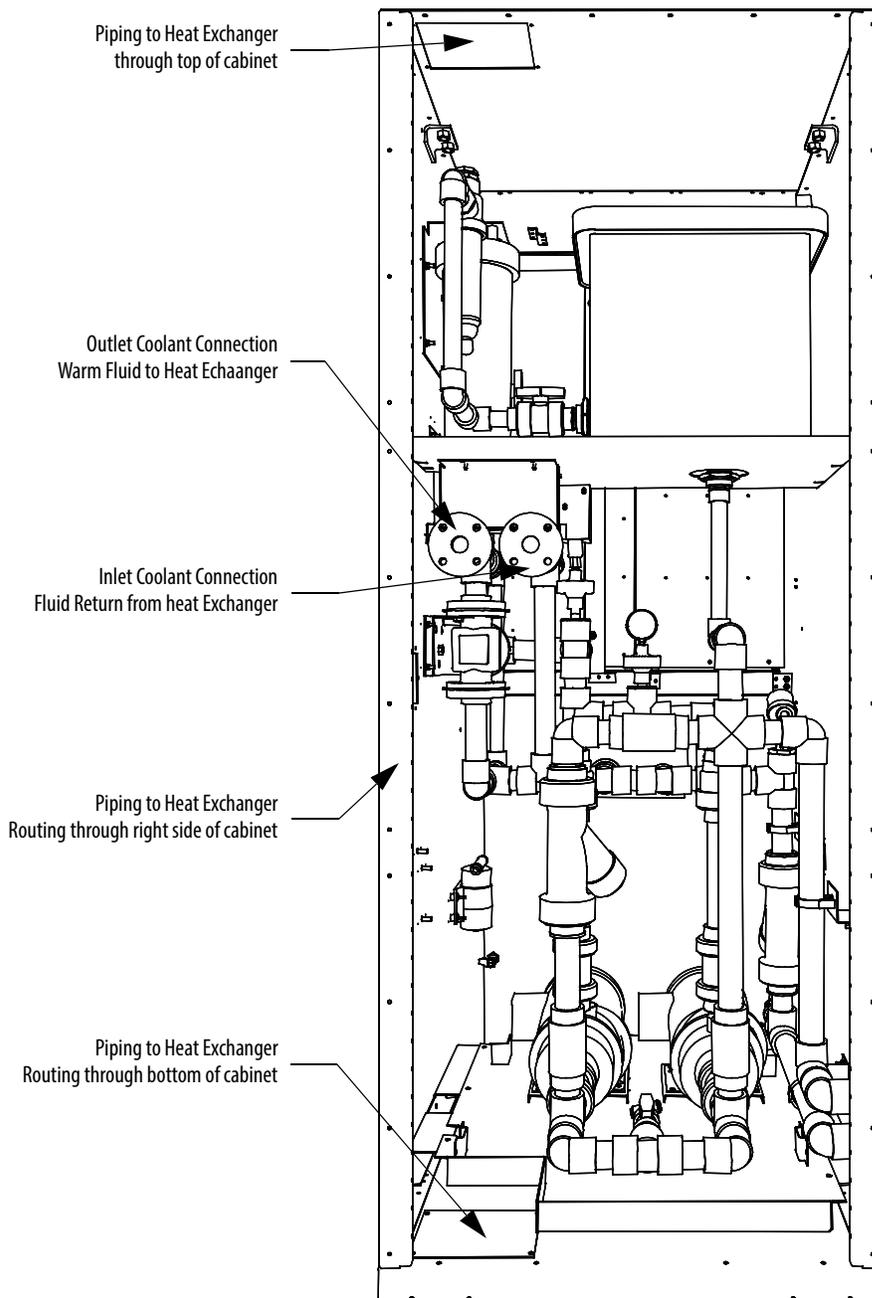
### Liquid-to-Air Heat Exchangers

There are three options for routing piping between the liquid-to-air heat exchanger and the pumping cabinet of the drive:

- Pipes through top plate of cabinet
- Pipes through bottom plate of cabinet
- Pipes through right side of cabinet

Removable plates are provided in each of these locations.

**Figure 59 - Connection to Liquid-to-Air Heat Exchanger (rear of pumping cabinet shown with back plates removed)**



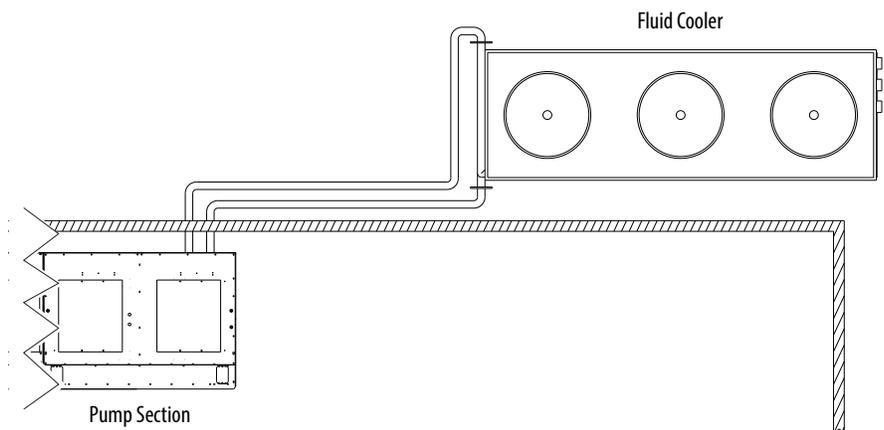
## Pipe Materials and Layout

All material that contacts fluid between the heat exchanger and drive must be either Schedule 80 CPVC or stainless steel. Rockwell Automation recommends using stainless steels AISI 304L or 316L to connect the drives to heat exchangers. Use 304L and 316L welding wire to avoid sensitization of the welded material. Sensitization due to incorrect welding causes localized corrosion of the welded area. Pressures expected within a drive are below 75 psi with test pressures of 110 psi.

Schedule 80 CPVC piping may be installed within a climate controlled building with any outside pipe of stainless steel. Shield CPVC from direct sunlight to prevent UV damage. Use expansion loops for long pipe runs.

See document CTS-3 "CPVC CTS Products Design and Installation Manual" from Spears Manufacturing Company ([www.spearsmfg.com](http://www.spearsmfg.com)) for more information.

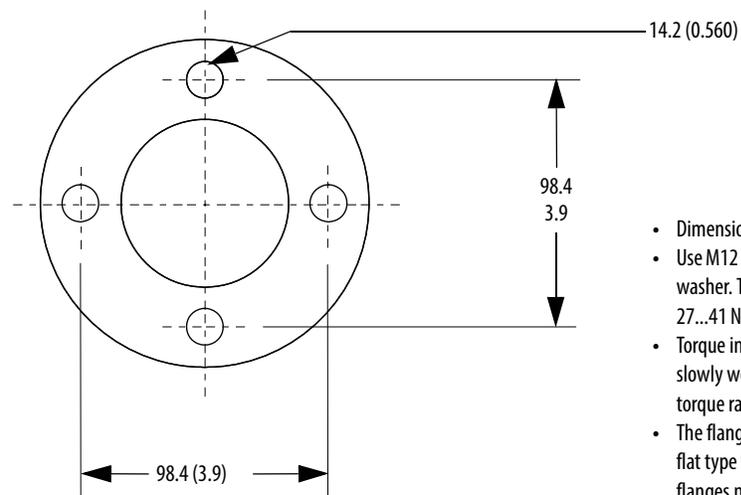
**Figure 60 - Plan View of Piping to Heat Exchanger (Piping may vary with exchanger)**



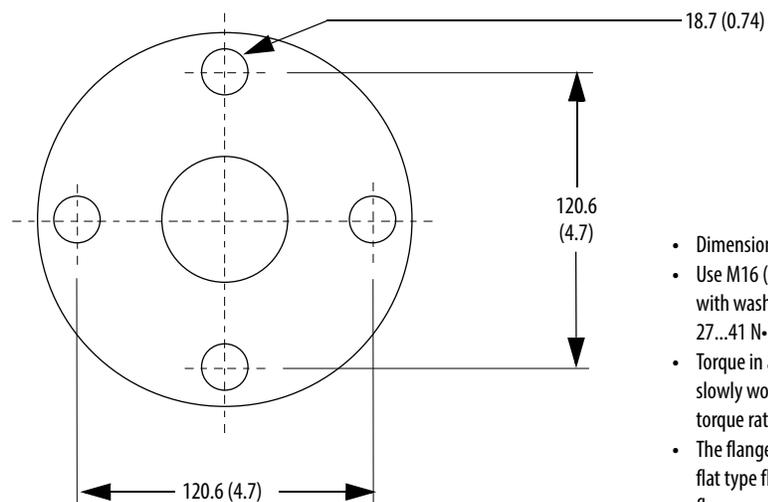
Ensure exit flow from the pump cabinet is routed to the inlet flange of the exchanger.

The estimated flow rate and pressure is printed on the cooling system schematic, which is posted on the inside of the pumping cabinet door.

The pipes to which connections are made are Schedule 80 CPVC: 38 mm (1.50 in.) or 50 mm (2.00 in.).

**Figure 61 - Drive CPVC Class 150 Flange, 1.5 in. (38.1 mm) (ANSI B16.5; ASTM D4024)**

- Dimensions in mm (in.)
- Use M12 (0.5 in.) bolt with washer. Torque to 27...41 N·m (20...30 lb·ft)
- Torque in a cross pattern, slowly working toward torque rating
- The flange used must be a flat type flange. Raised flanges may break.

**Figure 62 - Drive CPVC Class 150 Flange, 2 in. (50.8 mm) (ANSI B16.5; ASTM D4024)**

- Dimensions in mm (in.)
- Use M16 (5/8 in.) bolt with washer. Torque to 27...41 N·m (20...30 lb·ft)
- Torque in a cross pattern, slowly working toward torque rating
- The flange used must be a flat type flange. Raised flanges may break.

## External Piping to the Drive External Piping Cleaning

Rockwell Automation liquid-cooled drive piping and heat exchangers are flushed and cleaned at the factory and piping is capped to prevent contamination. Leave the drive pipe caps installed until final assembly.

Use stainless steel capped piping and valves to maintain cleanliness before welding or assembly. Parts must be stored in a clean, dry area.

All external piping must be cleaned and flushed before installation to ensure proper coolant system and drive pump operation.

*Before welding or assembly:*

- Remove debris, particulate, oils and greases from inside pipes and valves before welding.
- Use a high-pressure water spray to remove debris and particulate from pipes and valve.
- Remove oils and greases with solvents.

*Finished pipe system*

1. Circulate hot water with industrial detergent through external piping system only for at least 4...8 hours. Maintain a water temperature of 60...71 °C (140...160 °F). Do not circulate through the drive piping.
2. Circulate clean hot water until the effluent is clear.

Do not allow oils, greases, solvents, cleaning detergents or other cleaning agents to contact or enter the drive piping as this may cause stress cracking of CPVC piping.

Refer to ASTM A 380-06 "Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems" for additional information.

## Controlled Siphon into Open-top Reservoir

Rockwell Automation recommends this method of pipe routing for pipes and heat exchangers higher than the reservoir coolant level. The reservoir is located in the VFD pump cabinet. This method controls the siphoning of coolant into the open top reservoir when the coolant pumps are off for maintenance. It prevents the siphoning of all pipes higher than the reservoir liquid level causing reservoir overflow. Siphoning occurs only when both pumps are off.

1. Ensure vertical pipe from drive to vent valve is the same size (1-1/2" or 2.0") as the main VFD pipe. The rear outlet flanges may be 1-1/2" or 2.0" size. Keep the vertical pipe this exact size to maintain minimum coolant siphon flow into reservoir. Add 1-1/2" Ball Check Valve (Rockwell Part 80025-750-01, Flow Coefficient Cv 80 or equivalent) into vertical exit piping. Increase pipe size to 2.0" or 3.0" respectively for the remainder of the pipe circuit.
2. Vents to the top of the reservoir may be 1.0" CPVC pipe or PVC hose. The end shall not be immersed into the reservoir coolant. Cut a hole into the top of the reservoir to allow leakage flow.

Vent valve ARV100VS-CP may be obtained from [www.plastomatic.com](http://www.plastomatic.com).

3. Fill heat exchanger and pipe using fill line and main VFD piping before starting pump to purge air. Ensure pumps do not run dry as damage may occur. Follow priming and valve operation instructions located on pump cabinet door before operating pumps.

**Figure 63 - Controlled Siphon Method**

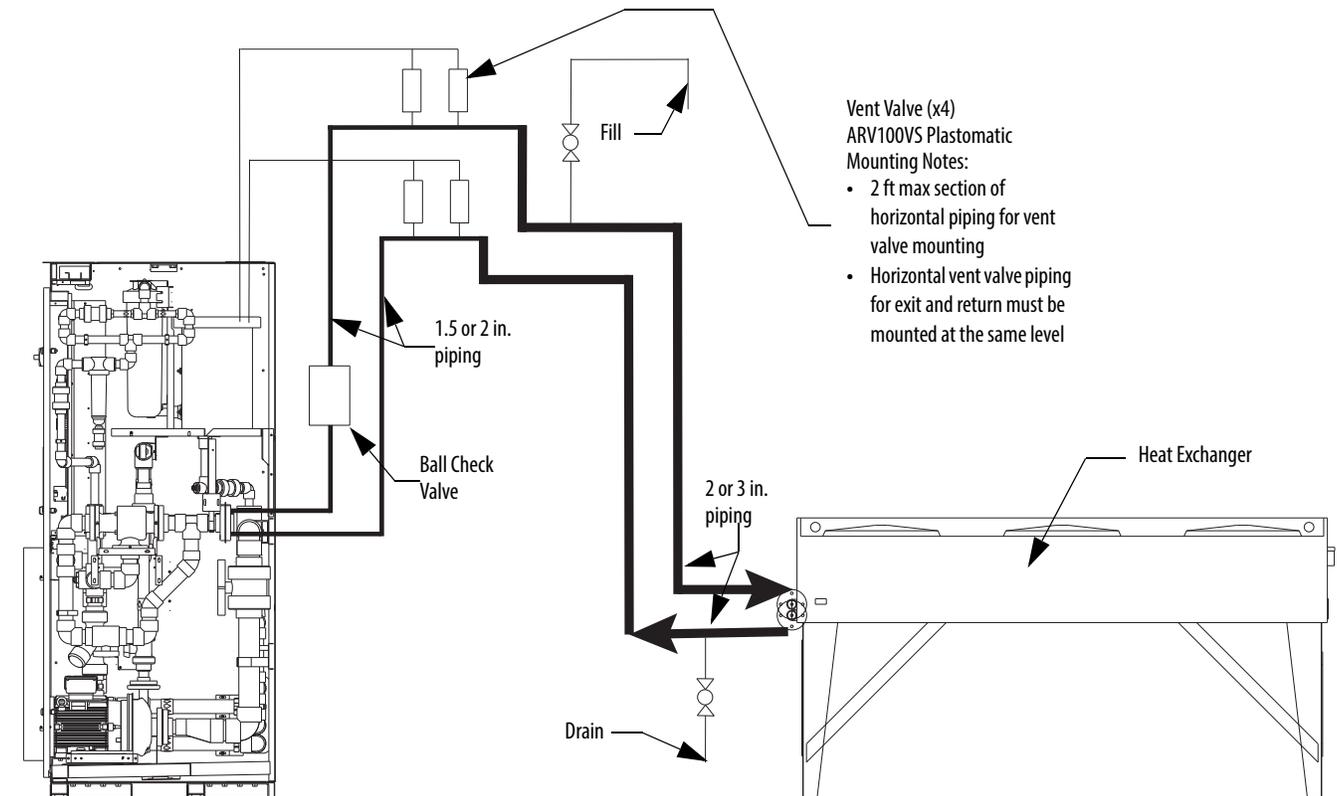
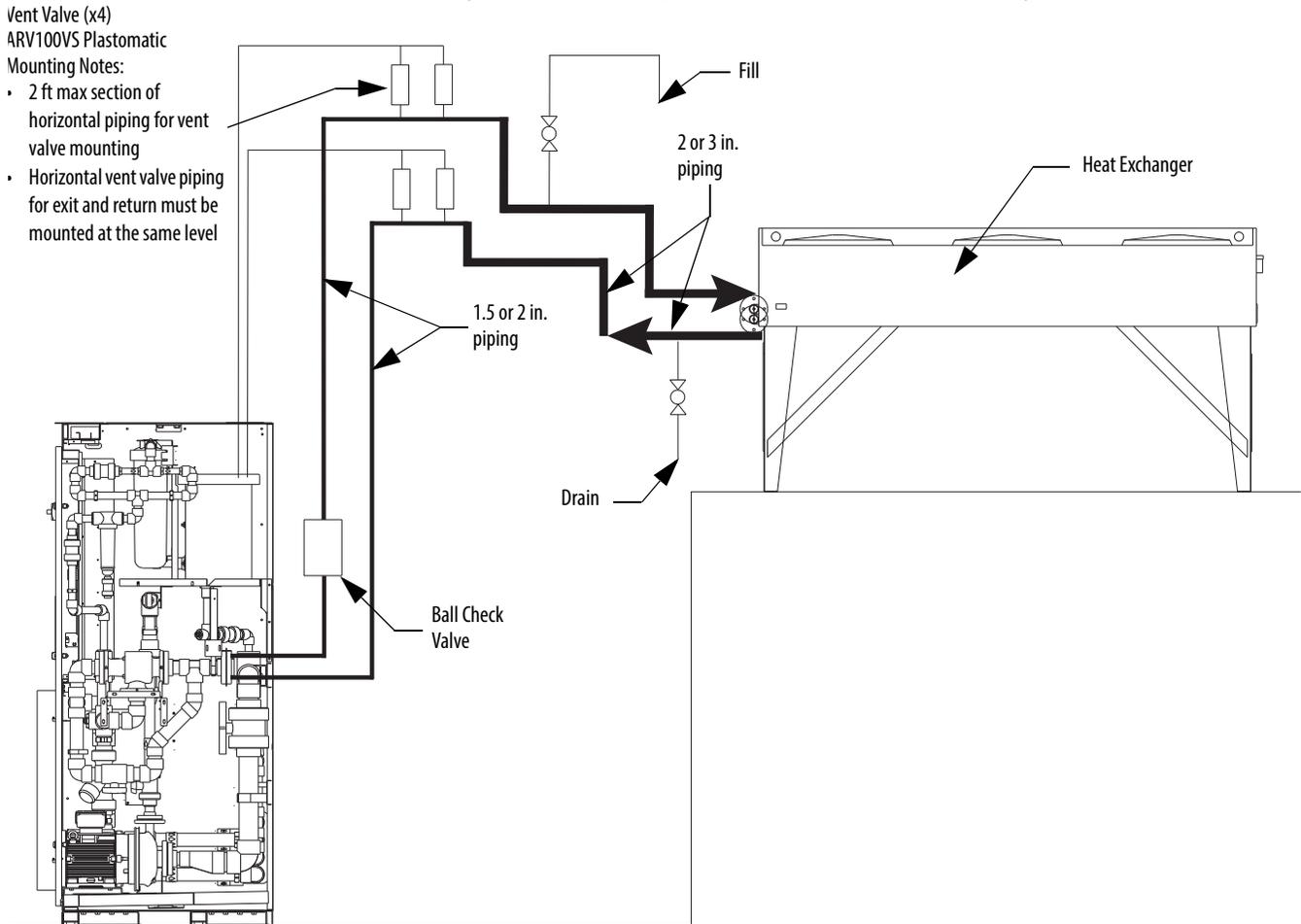


Figure 64 - Controlled Siphon Method with Elevated Heat Exchanger



## Liquid-to-Liquid Heat Exchangers

There are three options for routing piping between the liquid-to-liquid heat exchanger to the supply and return coolant:

- Pipes through top plate of cabinet
- Pipes through bottom plate of cabinet
- Pipes through right side of cabinet

Removable plates are provided in each of these locations.

**Figure 65 - Connection to Liquid-to-Liquid Heat Exchanger (rear of pumping cabinet shown with back plates removed)**

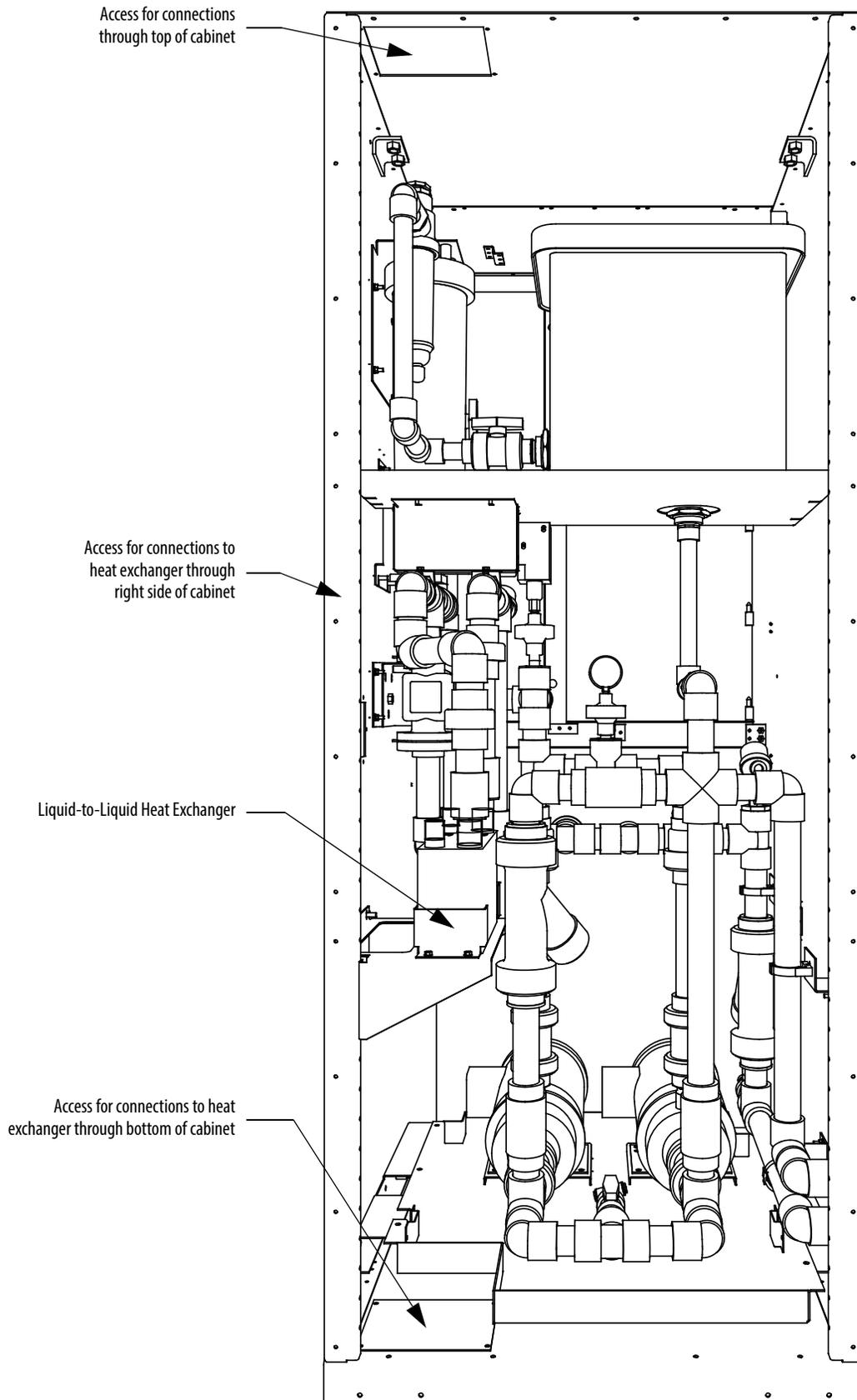


Figure 66 - Pipe Flange Detail

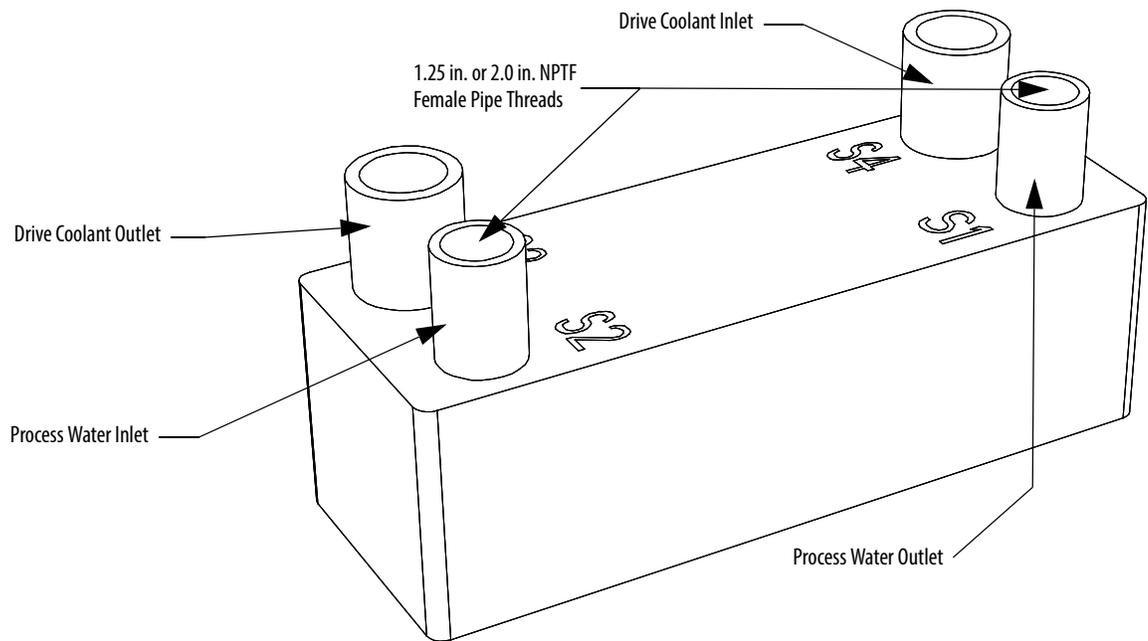


Table 5 - Customer Cooling Requirements for Liquid-to-Liquid Heat Exchangers

Drive			Min. Flow Rate		Max. Pressure (psig)	Pressure Drop (kPa)	Temperature (°C)	
Rectifier	Voltage	Amps	US Gpm <sup>(1)</sup>	L/m <sup>(2)</sup>			Min.	Max.
18 Pulse	4160	375	19.5	72	435	7	> 0	< 32
		430	21.5	80	435	8	> 0	< 32
		495	26.5	100	435	13	> 0	< 32
		575	29.0	109	435	15	> 0	< 32
		657	37.5	142	435	25	> 0	< 32
	6600	375	33.0	125	435	18	> 0	< 32
		430	44.5	167	435	34	> 0	< 32
		495	48.5	184	435	40	> 0	< 32
		575	54.5	206	435	43	> 0	< 32
		657	62.6	237	435	49	> 0	< 32
AFE	4160	375	19.5	74	435	7	> 0	< 32
		430	24.0	90	435	10	> 0	< 32
		495	26.5	100	435	13	> 0	< 32
		575	33.0	125	435	19	> 0	< 32
	6600	375	37.0	139	435	24	> 0	< 32
		430	44.5	167	435	34	> 0	< 32
		495	48.5	184	435	40	> 0	< 32
		575	54.5	206	435	43	> 0	< 32

(1) US Gpm = Gallons per minute (U.S.)

(2) L/m = Liters per minute

## Power and Control Wiring

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

### Control Cables

Control cable entry/exit should be located near the terminal block “TBC” – the customer’s connections are to be routed along the empty side of the TBC terminals. These terminals are sized to accept a maximum AWG #14 wire gauge. The low voltage signals (includes 4-20mA) are to be connected using twisted shielded cable, with a minimum AWG #18 wire gauge. (Based on using a W4 terminal block for customer connections, comparable wire sizes would be 0.5...4 mm<sup>2</sup> as equivalent to #22-#10 AWG.)

Of special concern is the encoder signal. Two encoder inputs are provided to accommodate a quadrature encoder (senses motor direction). The encoder power supply is isolated and provides +15V and a ground reference. Many encoder outputs have an open collector output, in which case a pull-up resistor must be added to ensure that proper signals are fed to the system logic. (Refer to [When is an Encoder Required? on page 414 \(Appendix A\)](#) to see if one needs to be supplied.)

---

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

---

### Encoder Installation Guidelines

The most frequent problems encountered when transmitting an encoder’s signal(s) to the drive are signal distortion and electrical noise. Either of these problems can result in a gain or loss of encoder data counts (quadrature encoders) or corrupt positional data (absolute encoders). Many of these problems can be avoided by applying good installation and wiring practices. This section is a general guideline and recommended practices for field installed equipment. It applies to either encoder board and both quadrature and absolute encoders.

#### *Protection from Radiated and Conducted Noise*

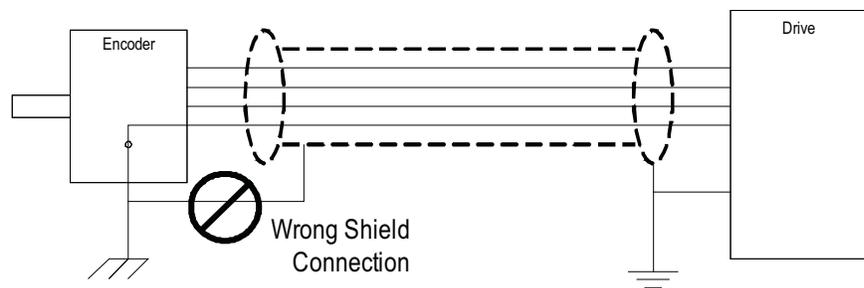
Reasonable care should be taken when connecting and routing power and signal wiring on a machine or system. Radiated noise from nearby relays, solenoids, transformers, non linear loads (such as motor drives) etc. can couple onto signal wires producing undesired pulses. In fact the encoder itself may induce noise into signal lines run adjacent to it.

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

Encoder wires and shields should maintain continuity throughout, from the encoder to the drive. Avoid the use of a terminal block in a junction box. This has the potential of creating radiated noise and ground loops.

The encoder case must be grounded to the building ground to insure proper and reliable operation. Most encoders have provision for a case ground connection through the connector/cable pair if a ground connection cannot be made through the mounting bracket/machine ground. **DO NOT** ground the encoder case through both the machine and cable wiring. Use low capacitance wires ( $\leq 40\text{pf/ft}$ ) with 100% shield coverage for long cable runs and connect the shield only at the drive end.

**Figure 67 - Detail Power Terminal Dimensions**



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

As a final precaution, ground the shield together with all other parts of the system that require grounding to a single point ground. This will reduce varying ground potentials caused by high current fluxes created by motors, remote control switches and magnetic fields.

### *Signal Distortion*

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

To reduce the effects of signal distortion at the encoder receiving electronics, the following guidelines should be considered:

1. Use a low capacitance cable. Purchase a cable that has a capacitance of <math>< 120\text{pf/m}</math> (40pf/ft). As an example Belden 1529A is an 18Awg 3pair cable having a capacitance of 114pf/m (35pf/ft).
2. Use twisted pair cabling with a shield that covers 100% of the cable. This is especially true in the case of quadrature encoders. It is still a better choice for absolute encoders, although the data in these encoders will not exhibit the same frequency spectrum as quadrature encoders and single wire cabling can be used. In either case, always check with the encoder manufacturer for the recommended cable.
3. Keep cable distances as short as is practically possible. Rockwell Automation's recommendation for cable distances are:
  - a. For the 20B-ENC encoders, the distance should be kept to a maximum of 65m (200 ft). Longer cable distances could cause excessive surge currents. The operating frequency of the encoder has no bearing on this recommended distance due to AC Termination used. However, if the frequency can be kept so that the cable's characteristic impedance is around 348ohms, this will improve the surge currents and may increase the maximum distance to 100m (330 ft).
  - b. For the Universal Encoder Interface, the distance can be extended out to 200 m (650 ft) @ 100 Khz. This distance can be increased to 500m at frequencies below 55 Khz. It is not recommended to exceed this distance since the voltage drop across the cable could cause a lower than expected power at the encoder.

### *Unused Inputs*

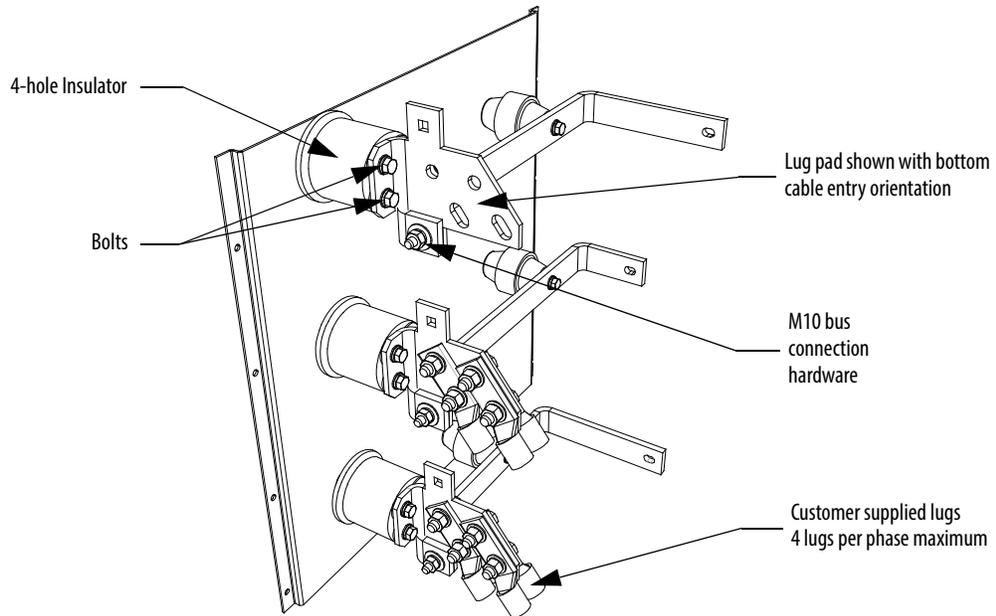
Not all inputs, in either the quadrature or absolute encoders, may be necessary. For example, the absolute encoder can accept a 12bit encoder but will work with a lower resolution. Likewise, quadrature encoders may not utilize the Z track. The following should be used for unused inputs:

1. 20B-ENC Board. Any unused input should be wired to the encoder power rail. This also includes the B and B' inputs if using a pulse encoder. Failure to do this will result in phase loss warnings and improper operation of the encoder feedback logic (i.e. missing counts).
2. Universal Encode Interface. When used as a quadrature encoder interface, the same rule applies as for the 20B-ENC Board. When operating as an absolute encoder interface, the wiring of unused inputs is dependent on the position of the POL\_QRDNT jumper. If the jumper is installed, then wire all unused inputs to ENC PWR, otherwise use ENC COM.

## Information Regarding Termination of Customer Cables

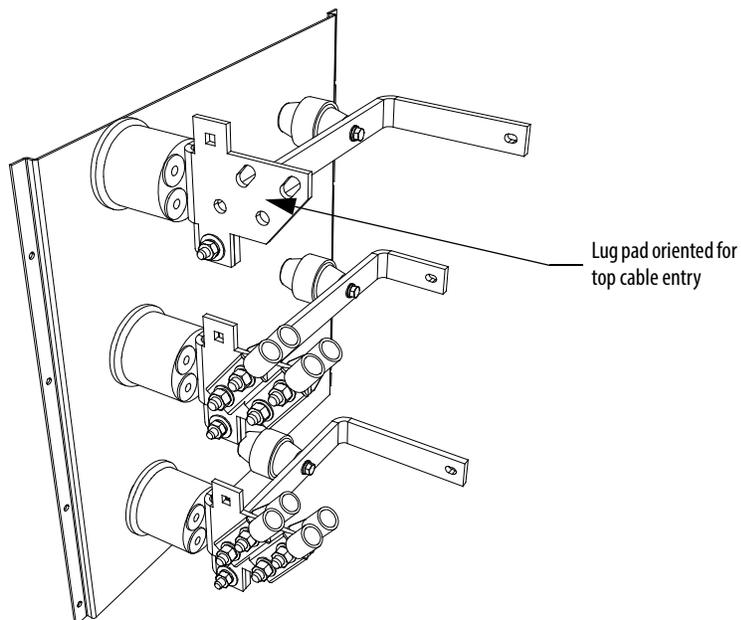
Customer termination assemblies can accommodate either top or bottom customer cable entry.

**Figure 68 - Typical Line Cable Termination (shown assembled for bottom cable entry – 18 Pulse)**



For top line cable entry, it is necessary to remove the lug pads and re-orient them as shown in [Figure 69](#). To remove the lug pads, disconnect the M10 bus connection hardware (17 mm hex tooling required). Remove the two bolts that secure the lug pad to the 4-hole insulator. Refer to [Torque Requirements for Threaded Fasteners on page 419 \(Appendix B\)](#) for Torque Values of electrical connections.

**Figure 69 - Typical Line Cable Terminal Assembly (modified for top cable entry – 18 Pulse)**



## Grounding Practices

The purpose of grounding is to:

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

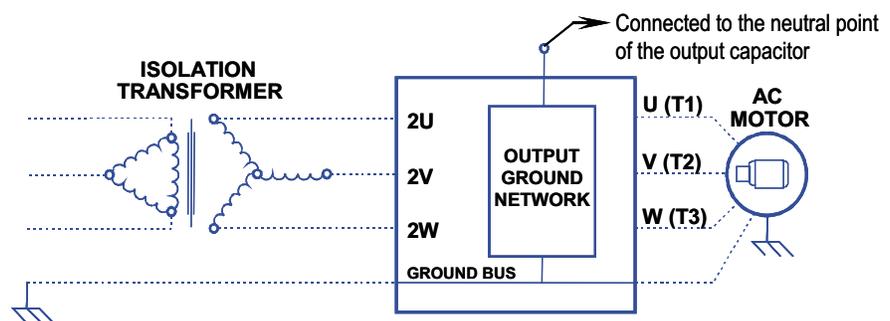
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**IMPORTANT** Generally, the means used for external grounding of equipment should be in accordance with the Canadian Electrical Code (CEC), C22.1 or the National Electrical Code (NEC), NFPA 70 and applicable local codes.

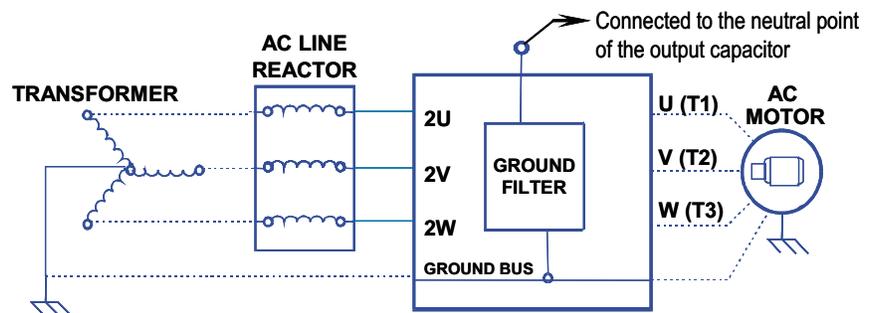
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Refer to the grounding diagrams that follow for ground connections. The drive's main ground bus must be connected to the system ground. This ground bus is the common ground point for all grounds internal to the drive.

**Figure 70 - Ground Connection Diagram with Isolation Transformer**



**Figure 71 - Ground Connection Diagram with Line Reactor**



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

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

Each AC motor frame must be bonded to grounded building steel within 6 m (20 feet) of its location and tied to the drive's ground bus via ground wires within

the power cables and/or conduit. The conduit or cable armor should be bonded to ground at both ends.

## Grounding Guidelines and Practices for Drive Signal and Safety Grounds

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

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

## Grounding Requirements and Grounding Specification for Customers and Power Integrators

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

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

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

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

## Identification of Types of Electrical Supplies – Grounded and Ungrounded Systems

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

### Ground Bus

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

## Interlocking

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

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

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

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

**Notes:**

## Operator Interface

### Chapter Objectives

This chapter describes how you use the operator interface to modify and obtain information contained within the drive. In this chapter you will learn how to:

- Modify information associated with the initial drive setup.
- View:
  - drive parameters
  - drive status
- View and Reset Alarm Conditions.
- Request printouts of the information in the drive.
- Perform diagnostic trending.
- Modify the operation of the operator interface.

The chapter deals only with the operation of the operator interface. Specific references to a particular parameter are only for illustrative purposes. Refer to Publication [7000-TD002\\_-EN-P](#) for information about the actual 'tags' within the drive and their use.

### Terminology

**Parameter** – A memory location within the drive to which data may be written to or read. Setting a parameter (i.e. writing to it) will modify how the drive behaves. Prior to using the drive a number of parameters must be set. Additional parameters may be changed while the drive is in use in order to adjust its operation, (i.e. the speed could be changed via a parameter).

**Read-only Parameter** – A memory location which can only be read. A read-only parameter contains real-time data and is used to read the current conditions within the drive, such as running speed.

**Tag** – A generic reference to either a parameter or a read-only parameter.

**PanelView 550** – The PanelView 550 is a product marketed by Rockwell Automation consisting of a hardware terminal and a software package, integrated into a single product. The Medium Voltage Drive only uses the hardware portion of the product and has replaced the software package.

**PowerFlex Operator interface** – References to the operator interface refer to the product consisting of the PanelView 550 interface hardware and the unique software contained within it, which allows it to function with the Medium Voltage Drive.

**Editing Field** – An area of a screen that is displayed in reverse video. When the field is in this state, data may be entered into it via the keypad.

**XIO** – the eXternal Inputs and Output adapters used by the drive to interface hardwired signals to the drive.

**Operation** – A task which is to be performed. In order to complete the task, a number of screens may be involved; i.e. selecting a parameter is an operation that requires at minimum two screens. This operation itself is an operation of modifying a parameter.

**NVRAM** – Non-Volatile Random Access Memory. This is memory that is not affected by loss of power. It is used for long term storage of data such as parameters and alarm queues.

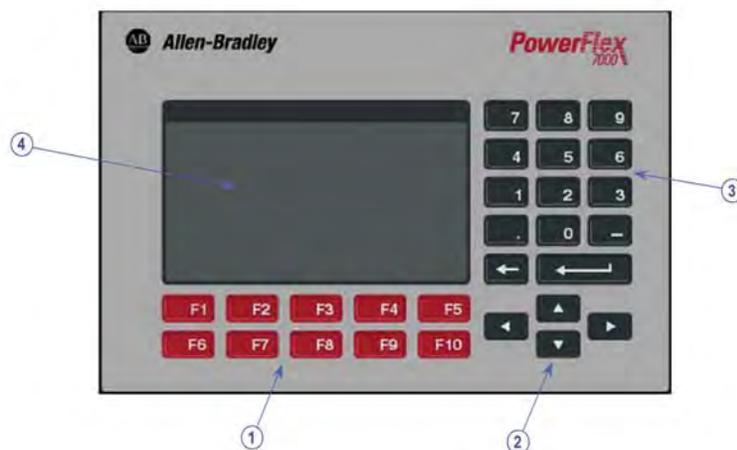
**Flash** – A type of memory technology which will indefinitely store information and is unaffected by power loss. It is used for storage of firmware, parameters and data files.

**PCMCIA** – A standard for flash memory cards. Personal Computer Memory Card International Association.

## Overview

The operator interface used on the PowerFlex 7000 Medium Voltage Drive is that of the PanelView 550 terminal ([Figure 72](#)). This terminal however does not behave as a PanelView, as only the hardware for the operator interface has been utilized. The PanelView software has been replaced with unique software to tailor it to the requirements of the Medium Voltage Drive, and its faceplate has been modified ([Figure 72](#)).

**Figure 72 - PowerFlex 7000 Drive Operator Interface Terminal**



## Keypad

The keypad of the operator interface consists of two rows of five function keys (item 1 of [Figure 72](#)) located below the operator interface display area (item 4 of [Figure 72](#)). In the lower right corner of the operator interface are four keys, which will be referred to as the cursor keys (item 2 of [Figure 72](#)). Above the cursor keys are data entry keys consisting of the numeric values 0..9, a decimal point (.), a negative (-), a backspace key and a data entry key (item 3 of [Figure 72](#)).

All keys are of a membrane type. The key is executed upon release.

### Function (Softkeys) Keys

Along the bottom of the display area is one or two rows of 'Softkeys'. These 'Softkeys' represent the physical function keys. The function of the actual keys will vary between displays. The bottom row of keys (i.e. F6 through F10) is always shown. The upper row is shown only if they are required for keys (F2 through F5). Thus a single row of 'Softkeys' always refers to the keys F6 through F10.

Even though the upper row of Softkeys (e.g. F1 through F5) may not be shown on some displays, the F1-HELP key is always active. (F2 through F5) are only active if shown.

### Cursor (Selection) Keys

The cursor keys are normally used to select an item on the display. When an item on the display is selected, that item will be displayed in reverse video. To change the selection, press the key in the desired direction.

On selection screens having more than one page, the page will automatically change when the cursor is moved beyond the displayed list.

Some displays, such as the Utility screen, use these keys to modify the data value. Pressing the [cursor up] and [cursor down] keys will change the value by a fine amount, e.g. one unit. Using the [cursor left] and [cursor right] keys will change the value by a course amount, e.g. 10 units.

For entries requiring a HEX value, the keys (cursor up/down) are used to scroll to the desired HEX value.

For parameters which contain an Enumeration string, pressing either the up or down key will provide a list of options to pick from. Using the cursor keys, make a selection and press enter. If more options exist than can be displayed on the screen, a triangle symbol or inverted triangle to the right of the list will show that there are more selections available in the indicated direction. Continue to use the up/down cursor keys to move to these additional selections.

For parameters that are comprised of bit fields, the left/right keys are used to move to the desired bit field. The up and down keys toggle the bit between its possible states.

All four cursor keys have an auto feature such that after holding the key for two seconds, the key will automatically repeat at a rate of five 'presses' per second.

## Data Entry Keys

As the name implies, these keys are used to enter data. Pressing the keys [0] through [9] will enter the corresponding value into the 'editing field'. Pressing the [-] key will change the value to a negative number. Pressing the [.] will allow a fractional value to be entered.

While entering a value, the value may be edited using the [backspace] key. This key will remove the right most digit (or decimal point or negative). The help screen uses the backspace key to return to the previous level of help.

The enter key varies depending on the screen. If you are in the process of a selection operation, the enter key will accept the selection and proceed to a different screen based on the selection in order to complete the operation. If you are in the process of entering data, the enter key will accept the edited data.

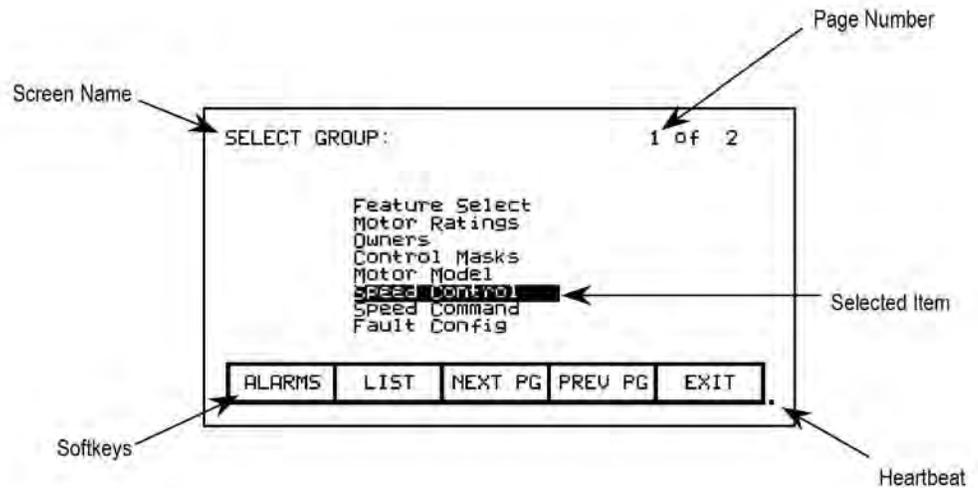
## What is a Screen?

The operator interface uses menu driven screens to perform various operations on the drive. You can think of a screen as a window or template, overlaying data from the drive. The operator interface combines a screen with the drive data, to formulate what you see on the display area of the operator interface. Individual screens display a particular type of data and allow selected operations to be performed on this data. A number of different screens may be used while performing a single operation.

## Components

Although the data displayed on any particular screen will vary, the general makeup of a screen is the same for all. [Figure 73](#) shows a typical screen and its components.

Figure 73 - Screen Components



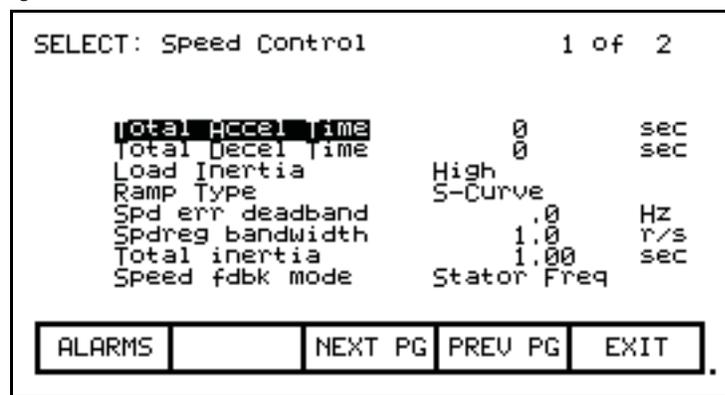
The upper left-hand corner contains the name of the screen (i.e. SELECT GROUP:). Knowing the name of the screen will assist you in the orientation of the menu system. On some screens to the right of the screen name, will be the name of the selected item from the previous screen as shown in [Figure 74](#).

Some screens have more than one page associated with them. The current page number and the number of pages which make up the data currently being displayed on the screen is shown in the upper right hand corner (e.g. showing page 1 of 2 pages).

Along the bottom of the screen are one or two rows of 'Softkeys' which represent the assignment to the actual function keys. In [Figure 73](#), Softkeys F6 through F10 are shown. Pressing F8 will display the next page of data.

In the very lower right-hand corner is a small dot. This dot indicates the healthy state of the operator interface terminal. Under normal conditions this dot will flash at a rate of .5 Hz. During communication errors, the dot will flash at a rate of .1 Hz.

Figure 74 - Screen Name &amp; Item



The remainder of the screen shows the data from the drive. The presentation of the data is dependent on the screen. Screens that allow an item to be selected show the current selection in reverse video. An example of this is shown in [Figure 73](#) in which the Speed Control group is selected.

## Information Windows

Numerous screens require communications with the drive in order to function. At times, the duration of this activity will be noticeable to you. During this activity, a special 'window' is used within the current screen to inform you of this activity. The time required for the activity will vary.

## Accessing/Writing to Drive

When first powered up, the operator interface knows very little about the information in the drive. As each screen is activated, the operator interface requests information from the drive, which it will store within the operator interface for future reference. When the operator interface requests information from the drive, a window is used to display a message "Accessing Drive ...". During this time, the operator interface will not respond to any user input, until the task at hand is completed. You will notice that subsequent activation of the same screen for the same data will be much quicker since the operator interface already has most or all of its required information.

You can selectively choose to download the complete database to the operator interface on command, thus eliminating the initial access delays. If uninterrupted, the operator interface will automatically download the database on power-up, or during periods of inactivity. Refer to [Database Download on page 162](#).

Some screens require that information be written to the drive. During this task, a window is used to display the message "Writing to Drive..." During this time, the operator interface will not respond to any user input, until the task at hand is completed.

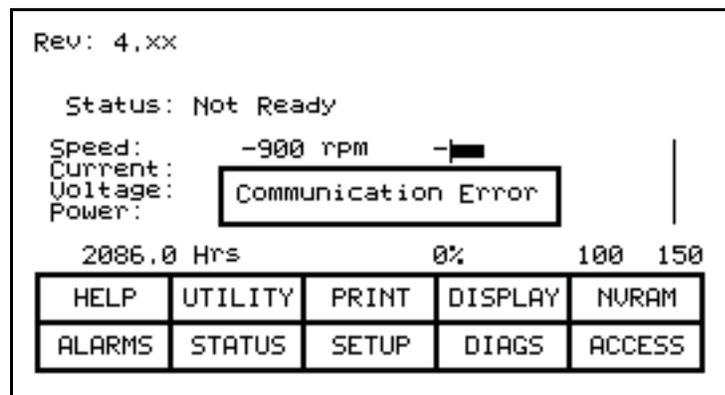
## Communication Error

While the operator interface is reading or writing to the drive, it is possible for communications to be disrupted for a number of reasons. If this were to occur, a special window is used to inform you of this. During this time, the operator interface will not respond to any user input, until the task at hand is completed.

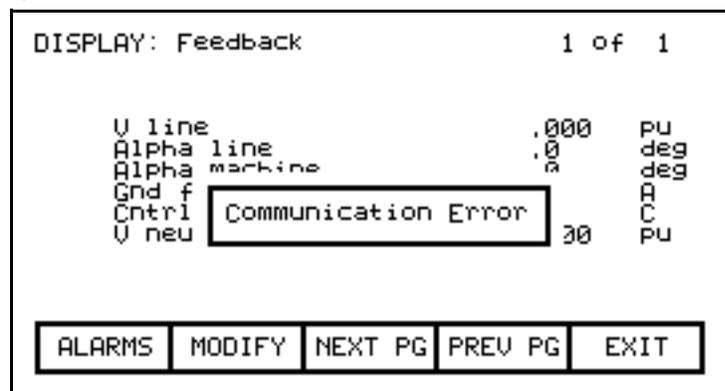
The window for the "Communication Error" can take on two forms. If a window has already been displayed showing "Accessing Drive" or "Writing to Drive", then the communication error message will be added to the window already in use. Some screens constantly read from the drive in order to show real-time data. An example of this is the 'Top Level Menu.' When a communication error occurs on a screen showing real-time data, a window is opened showing a box around the "Communication Error". Two examples of this are shown in [Figure 75](#) and [Figure 76](#).

In both cases, once communications has been re-established, the information window will be removed and the operator interface will return to normal operation.

**Figure 75 - Communications Error**



**Figure 76 - Communications Error**



## Language Changing

When the language used by the drive changes, (either via the operator interface or an external device), the operator interface must do considerable work. The database strings are all invalidated, the character set for the server is changed and all strings used by the operator interface are linked to the new language. During this possibly lengthy process, the "Language Changing ..." message is displayed.

## General Operation

The operations that can be performed on a screen vary depending on the actual screen being displayed. The majority of the operations are activated by the function keys located along the bottom of the screen. Although the meaning of these keys does change from one screen to the next, there are some functions which are available on most screens and always have the same assignment.

The operations for these latter keys will not be explained within the description of individual screen operations. They are explained here and apply equally to all screens.

### *F1 - Help*

This operation is active on every screen, even if the 'Softkey' is not displayed. Help is context sensitive and will display help that relates to the screen that you are currently viewing.

### *F6 - Alarms*

The F6 'Softkey' will always get you to the Alarm Summary Screen. A new alarm will cause this key to flash in reverse video.

### *F8 - Next Page*

When a screen is capable of displaying data that requires more than one page, this 'Softkey' will be active. The 'Softkey' will increment the page number being viewed.

### *F9 - Previous Page*

When a screen is capable of displaying data that requires more than one page, this 'Softkey' will be active. The 'Softkey' will decrement the page number being viewed.

### *F10 - Exit*

When you are viewing any screen other than the Top Level Menu, this 'Softkey' will return you to the previous screen.

## Operator Interface Power-up Sequence

When the operator interface is powered up or reset, it will go through two noticeable operations:

1. **Linking to Drive** - During this phase the operator interface is establishing communications with the drive communications board. The screen will also show information about the software product contained in the PowerFlex operator interface, such as:
  - a. software part number and revision level
  - b. date and time stamp of program creation
2. **Obtaining Drive Database** - During this phase, the database of information about the drive is obtained from the drive. Obtaining the database at this point in time is optional and may be aborted by pressing any key on the operator interface. Obtaining the entire database does however speed up subsequent operations since relevant portions of the database do not have to be obtained. (Without obtaining the entire database, the operator interface will access portions of the drive database as required. This slows down the first access to the operation that requires the data. Subsequent operations requiring the same data are not affected). Aborting the download will not affect portions of the database already obtained.

Once the database has been obtained, the operator interface will start up in one of two modes, depending on to what degree the drive has previously been configured:

1. On an unconfigured drive, the operator interface will enter the 'Setup Wizard' mode. Until the user has gone through the entire 'Setup Wizard', this will be the default mode to power up in. The 'Setup Wizard' can be cancelled at any time by pressing the appropriate softkey.
2. Once the drive has been configured through the 'Setup Wizard', the Top Level Menu, will be displayed from this point forward. The 'Setup Wizard' can be re-entered via the Setup Menu.

## Top Level Menu

This screen ([Figure 77](#)) represents the main menu from which all other screens (and the operations which they perform) are activated. To activate an operation, simply press the function key corresponding to the 'Softkey' shown on the screen. A screen for that operation will be displayed. Refer to the section entitled "How To:" for information about the various operations which may be performed.

The screen identifies the drive product to which the operator interface is attached and its overall state of operation. Four digital meters show four selected parameters located in the drive. A Hobbs meter displays the number of hours that the drive has been running.

The status of the drive will show one of the following:

NOT READY – drive is not ready to start

READY – drive will start when commanded

FORWARD RN – drive is running in the forward direction

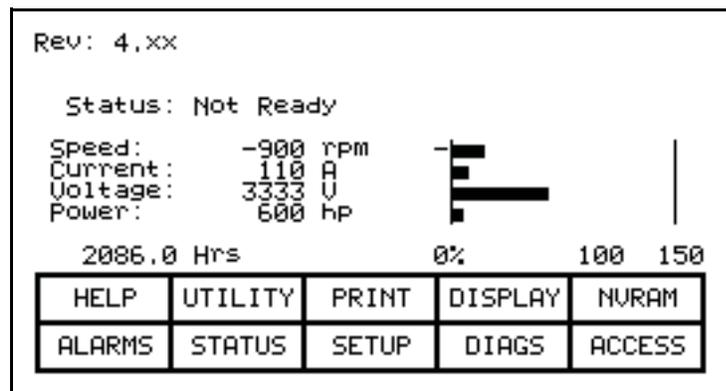
REVERSE RN – drive is running in the reverse direction

WARNING – drive has a warning

FAULTED – the drive is faulted

DISCHARGING – waiting for the input filter capacitor to discharge on an Active Front End drive before re-start

Figure 77 - Top Level Menu



## How To

The following sections describe how to perform the various operations on the drive, using the operator interface. Throughout the discussion, a number of screens will be used to achieve the desired operation. In many cases, the same screen will be used for more than one operation, however with possibly different data from the drive.

Throughout the section, you want to focus on how the operation is performed. The operator interface will take care of what screens are needed to perform the operation.

### Obtain Help

Help is obtained for any screen by pressing the [F1] function key. [Figure 78](#) shows the help screen, which is displayed for the Top Level Menu. After the name of the screen (i.e. HELP:) is the name of the screen for which help is being accessed. (In this case the name of the Top Level Menu is REV.) This particular help screen contains three pages. To view page two, press the [F8] key. Page 2 is displayed. To return to page 1, press the [F9] key.

You can return to the original screen from which you asked for help at any time by pressing the [F10] key.

**Figure 78 - Typical Help Screen**

```

HELP: Rev                               1 of 3
* This is the 'Top Level' screen or
'Main Menu'. From this screen, all
other screens may be accessed,
* To access a screen, press the 'soft'
function key which corresponds to the
desired screen. The active function
keys and their purpose are shown on
SOFTKEYS
ALARMS  NEXT PG  PREV PG  EXIT

```

## Related Topics

All of the help screens will have additional topics relating to the help currently being displayed. These topics are highlighted just above the Softkeys. Additional topics are selected via the [cursor left] and [cursor right] keys. [Figure 78](#) shows the additional topic of "SOFTKEYS" selected. To access this information, press the [enter] key.

The help for the additional topic will be displayed as in [Figure 79](#). As with the original help screen, the related topic help may also have related topics.

Press the [backspace] key to return to the previous level of help, (i.e. the previous related topic). To exit help completely press [F10] to return to the screen from which help was called.

**Figure 79 - Help on Related Topic (Softkey)**

```

HELP: Rev                               1 of 7
* F1:  HELP: Calls the help text for
the current screen,
* F2:  UTILITY: Selecting this screen
allows various operations of the
terminal to be viewed and/or
modified, such as:
- setting the clock,
I
ALARMS  NEXT PG  PREV PG  EXIT

```

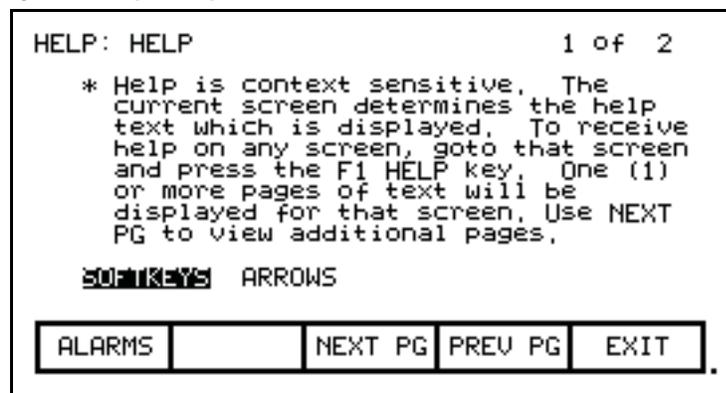
## Help on Help

The previous sections described how you can access help for a particular screen, by pressing the [F1] key while on that screen. This also applies while in any of the help screens.

Pressing [F1] while in a help screen will give you a help screen describing how to use the help system. An example of a screen giving help on the help system is shown in [Figure 80](#). As with the help screens previously described, the screens will contain related topics.

To return to a previous screen of help information, press the [backspace] key. To return to the screen from which help was originally accessed, press the [F10] key.

**Figure 80 - Help on Help**



## Modify Operator Interface Operation (Utility)

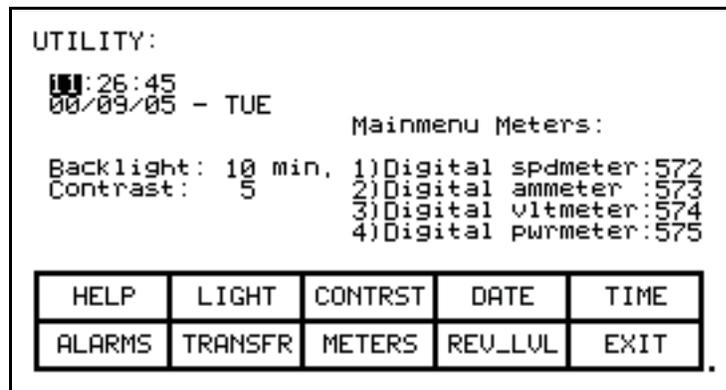
The utility operation of screens change the characteristics of the operator interface. Within this operation you will:

- Set the clock and calendar
- Change the delay for the display backlight shutoff
- Change the contrast of the display
- Define the meters that will be displayed on the Top Level Menu
- View the revision levels of all software in the drive line-up.
- Transfer data between the operator interface 'flash' memory, 'flash' memory card and the drive.
- Load a new language module.

You will access the Utility operation from the Top Level Menu by pressing the [F2] key. This results in the display of the screen shown in [Figure 81](#).

In all operations on this screen, the value currently being acted upon is shown in reverse video. Only when the value is in this state, may it be modified.

Figure 81 - Utility Operation Screen



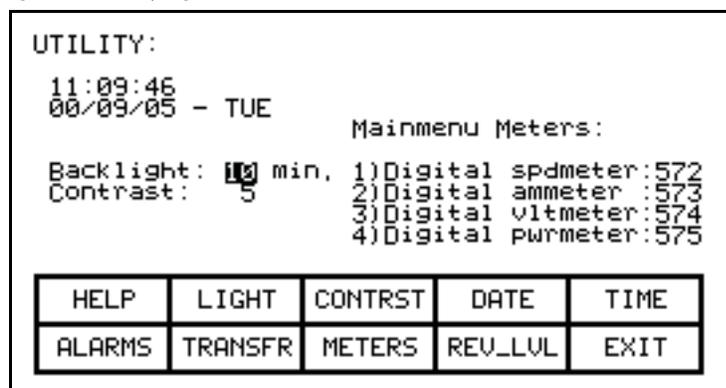
## Changing Backlight Delay

The display of the operator interface is only readable with the aid of a backlight. In order to preserve the life of the lamp that provides this, the backlighting is automatically shut off after a duration of inactivity on the keypad. The backlight is restored by pressing any key. The pressed key will not have any other affect on the operator interface when pressed with the backlight off.

To change the duration of the delay, press the [F2 key. The current backlight delay will be shown in reverse video (Figure 82). The value can be adjusted from 0...60 min. A value of zero (0) will disable the “delay, keeping the light on indefinitely. Press the [cursor up] or [cursor down] keys to change the value by a resolution of 1 minute. Press the [cursor left] and [cursor right] keys to change the value by a resolution of 10 minutes. To abort the change, press the [backspace] key and the setting will return to its original value. To accept the change press the [enter] key. The backlight delay has been saved.

The setting may also be aborted by pressing any of the assigned function keys (other than F1). The function associated with that key will be executed.

Figure 82 - Utility Light

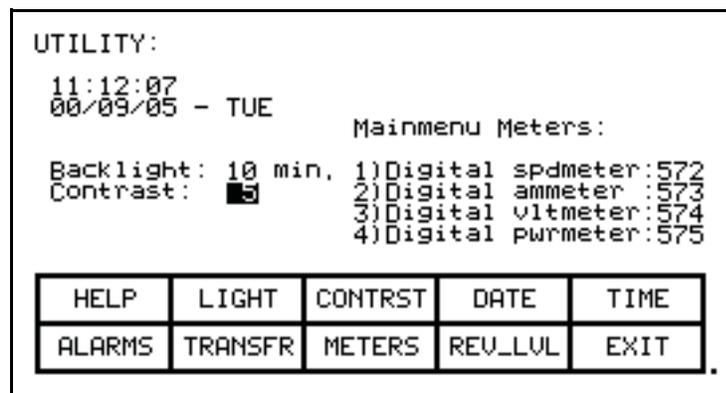


## Changing Contrast

The contrast controls the horizontal angle to which the display may be viewed. To change the contrast, press the [F3] key. The current value of the contrast will be shown in reverse video ([Figure 83](#)). Press the [cursor up] or [cursor down] keys to change the value of the contrast. The screen will change instantly to show the effect of the change. To abort the change, press the [backspace] key and the setting will return to its original value. To accept the change, press the [enter] key. The contrast setting has been saved.

The setting may also be aborted by pressing any of the assigned function keys (other than F1). The function associated with that key will be executed.

**Figure 83 - Utility Contrast**



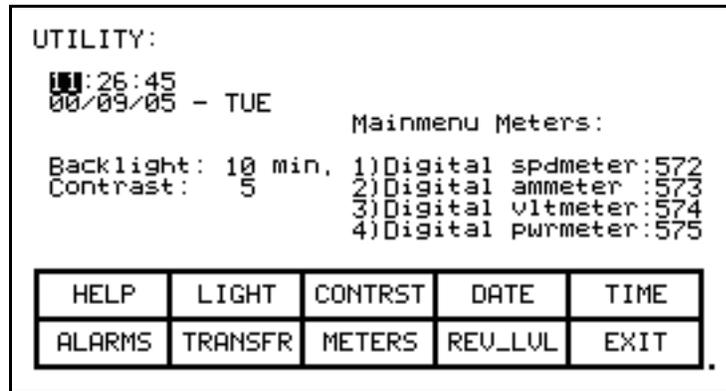
## Setting Time

The clock setting controls the time stamp that the drive uses on the information contained on the alarm summary screen. To change the time, press the [F5] key. The hour's position of the clock will be in reverse video ([Figure 84](#)). Press the [cursor up] or [cursor down] keys to change the value by a resolution of 1 unit. Press the [cursor left] and [cursor right] keys to change the value by a resolution of 10 units. To change the minutes press the [F5] key again and repeat the procedure. Likewise to change the seconds press the [F5] key again. Each press of the [F5] key will highlight the next position of the clock. The highlighted position may be modified via the cursor keys.

To abort the change, press the [backspace] key and the clock will return to its original time. To accept the change, press the [enter] key. The new clock setting has been recorded.

The setting may also be aborted by pressing any of the assigned function keys (other than F1 and F5). The function associated with that key will be executed.

Figure 84 - Utility Time



## Setting Date

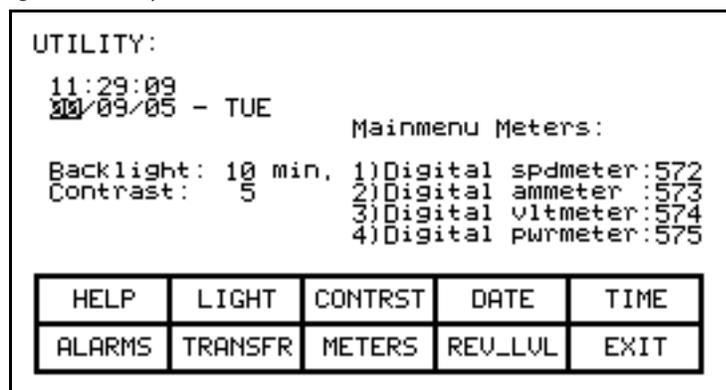
The calendar setting controls the date stamp that the drive uses on the information contained on the alarm summary screen. To change the date, press the [F4] key. The year position of the calendar will be in reverse video ([Figure 85](#)). Press the [cursor up] or [cursor down] keys to change the value by a resolution of 1 unit. Press the [cursor left] and [cursor right] keys to change the value by a resolution of 10 units. To change the month press the [F4] key again and repeat the procedure. Likewise, to change the day, press the [F4] key again. Each press of the [F4] key will highlight the next position of the calendar. The highlighted position may be modified via the cursor keys.

To abort the change, press the [backspace] key and the calendar will return to its original date. To accept the change, press the [enter] key. The new calendar setting has been recorded.

The setting may also be aborted by pressing any of the assigned function keys (other than F1 and F4). The function associated with that key will be executed.

You can not set the day of the week. The operator interface will determine the day of the week based on the date that you set in the calendar.

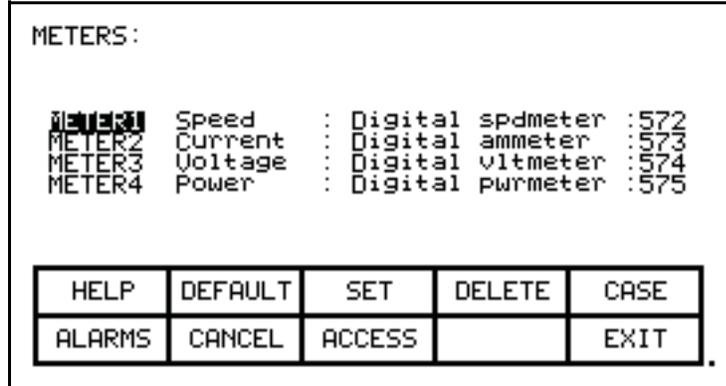
Figure 85 - Utility Date



## Selecting Meters

The utility screen (Figure 81) shows the four tags assigned to the four meters on the 'Top Level Menu'. These can be changed by pressing the [F8] key. This displays a new screen (Figure 86) from which the selection and text associated with the meter is changed.

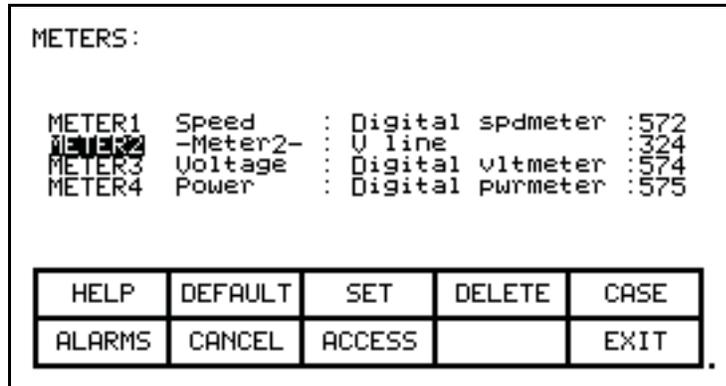
Figure 86 - Utility Meter



To change the tag attach to a meter, use the [cursor up] and [cursor down] keys to highlight the desired meter and press the [enter] key. (If nothing happens then you have not gained the required access to make changes.) Press the [F8] key in order to gain access and refer to [Enter/Modify an Access Level on page 116](#).

This will begin the selection process of a tag as described in the section entitled [Select a Parameter on page 110](#). When you have completed the selection process, the selected tag will be assigned to the meter (i.e. V Line). The name of the meter will have been changed to a default string as shown in [Figure 87](#) for meter 2.

Figure 87 - Utility Meter V Line



The text consists of eight characters. This text is displayed on the Top Level Menu along with the value and units of the tag. Select the meter that you wish to modify via the [cursor up] and [cursor down] keys. To modify the text, press the [cursor right] key. (If nothing happens then you have not gained the required access to make changes. Press the [F8] key in order to gain access and refer to [Enter/Modify an Access Level on page 116](#)

The first character position of the string will be in reverse video as shown in [Figure 88](#). Refer to the section entitled [Edit Text on page 114](#).

**Figure 88 - Edit the Text**

METERS :				
METER1	Speed	:	Digital spdmeter	:572
METER2	<b>Meter2-</b>	:	U line	:324
METER3	Voltage	:	Digital vltmeter	:574
METER4	Power	:	Digital pwrmeter	:575
HELP	DEFAULT	SET	DELETE	CASE
ALARMS	CANCEL	ACCESS		EXIT

When editing is complete, the screen will appear as in [Figure 89](#).

**Figure 89 - Editing Completed**

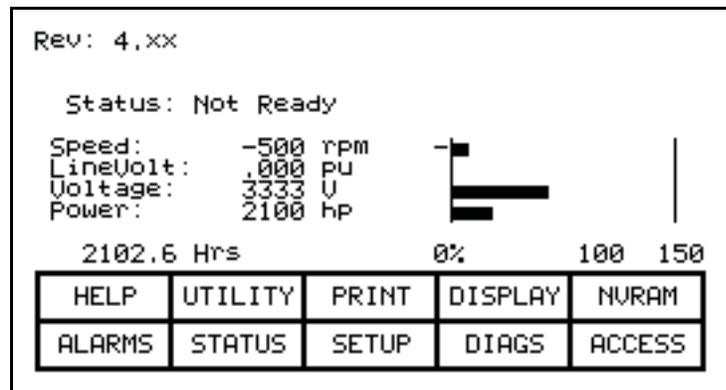
METERS :				
METER1	Speed	:	Digital spdmeter	:572
<b>METER2</b>	LineVolt	:	U line	:324
METER3	Voltage	:	Digital vltmeter	:574
METER4	Power	:	Digital pwrmeter	:575
HELP	DEFAULT	SET	DELETE	CASE
ALARMS	CANCEL	ACCESS		EXIT

The operator interface contains a default set of meters. This default set is selected by pressing the [F2] key any time the 'Meters' screen is displayed. This results in the default text and tags as shown in [Figure 86](#).

The changes made do not take affect until you press [F10] and exit the screen. Any time prior to this you may cancel all of the changes made after coming to the screen by pressing the [F7] key.

The result of selecting the V Line tag for meter 2 (in our example) is shown in [Figure 90](#) after the METERS screen was exited.

Figure 90 - Top Level Meter Modified



### Viewing Revision Levels

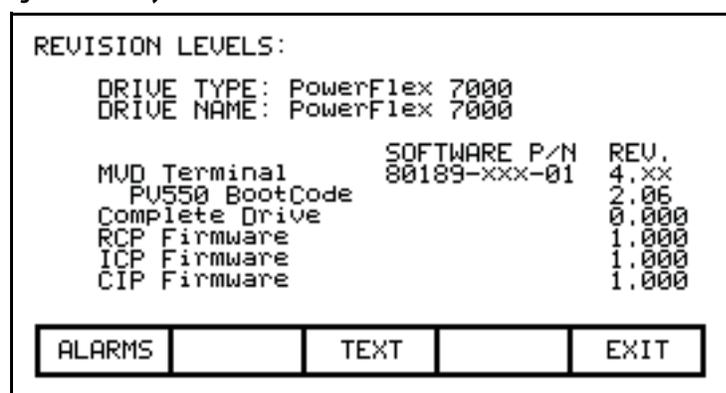
For the purpose of maintenance or upgrading of software, the revision levels of all the software contained in the terminal and the drive may be viewed. To access this screen, press the [F9] key.

A screen typical of [Figure 91](#) shows:

- the type of drive
- a 16-character, user definable string to uniquely identify a drive
- revision level of the terminal software and its part number
- revision level of the bootcode contained in the terminal
- revision level of various boards contained in the drive

These are identified by name.

Figure 91 - Utility Rev Level



To modify the user definable text string, press the [F8] key. (If nothing happens then you have not gained the required access to make changes. Exit to the Top Level Menu screen and refer to [Enter/Modify an Access Level on page 116.](#))

A screen typical of [Figure 92](#) will be displayed. To modify the text refer to the section entitled [Edit Text on page 114](#), noting the following exception. When the text has been entered (as in [Figure 93](#)) the enter key has no effect. Press the exit key [F10] to accept the edited string.

Prior to exiting the screen, the string can be returned to its state upon entry to the screen by pressing the [F7] key.

**Figure 92 - Edit the Drive Name**

DRIVE TEXT:				
DRIVE TYPE: PowerFlex 7000				
DRIVE NAME: PowerFlex 7000				
HELP		SET	DELETE	CASE
ALARMS	CANCEL			EXIT

**Figure 93 - Editing Complete**

DRIVE TEXT:				
DRIVE TYPE: PowerFlex 7000				
DRIVE NAME: Pump #1				
HELP		SET	DELETE	CASE
ALARMS	CANCEL			EXIT

## Transfer Data in Memory

The operator interface contains long term storage in two forms. Flash memory contained in the operator interface is used to store the firmware and optionally language modules and parameters used in the drive. This information can also be stored on a removable flash card that can be taken to another drive.

In order to transfer information from the two forms of memory, press the [F7] key. This displays a new screen ([Figure 158](#)) from which all flash memory operations are performed. Refer to the section entitled [Flash Memory Transfers on page 148](#) for instructions on these features.

## Picking an Access Level

Access Levels are used in the drive to protect parameters from unauthorized changes and to filter out the amount of information viewed. Each access level takes on the parameters and permissions of the lower access levels.

The default access level is 'Monitor'. In this level, only a small subset of the parameter database is viewable. No changes are allowed to any configuration information.

The next level is 'Basic'. This level and all levels above it allow changes to be made to any parameter that can be viewed. The number of parameters viewable increases from the previous level. This level will be sufficient for configuring and maintaining the drive for the majority of applications.

The last level intended for normal operation is the 'Advanced' level. From this level, the drive can be configured in its entirety.

Two additional levels are used for trained service personal and are only used when physical hardware changes are made to the drive.

Individual PIN numbers protects all levels, except the first. Use the up/down cursor keys to select the desired access level. Then enter the PIN value for the given access level and press [enter]. If the correct PIN was entered, the access level will change.

Refer to [Enter/Modify an Access Level on page 116](#) for complete information on the use of Access Levels.

## Select a Parameter

Various operations require that a parameter be selected. All selection operations are done via one of three methods described in this section. All parameters are organized into groups. Selecting via groups is the default method.

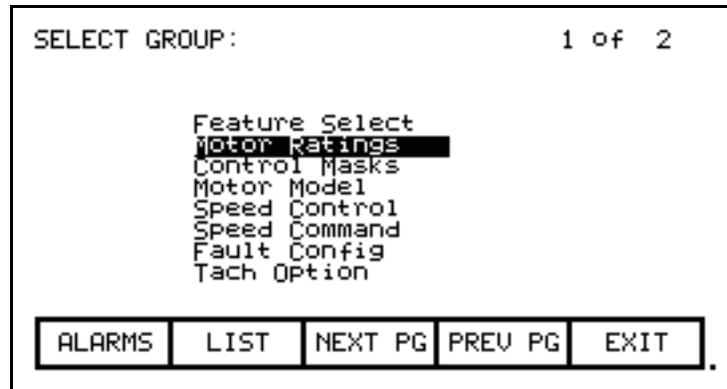
The screens associated with the selection process are called automatically as part of the operation from other screens.

### Via Groups

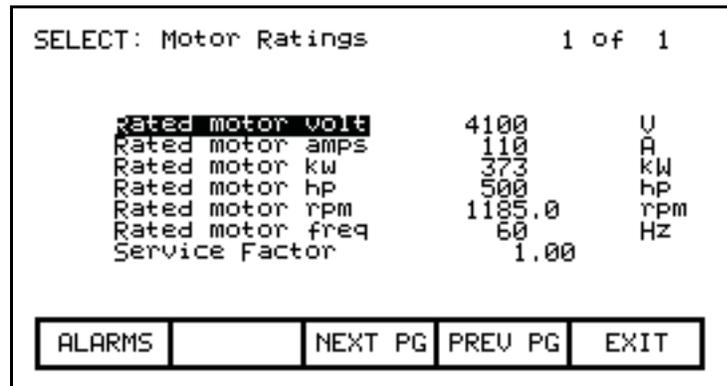
This is the default screen ([Figure 94](#)) used in the selection of a parameter. It shows all the groups that are accessible for the operation currently being performed. For example: if you are selecting a parameter, any groups that are showing read-only parameters only will not be shown. The current access level will also affect the number of groups that are currently viewable, and can be selected from. If more than one page of groups exist, press the [F8] and [F9] keys to view the other pages.

Press the [cursor up] or [cursor down] keys to select the desired group, (i.e. reverse video the group name). Press the [enter] key. The SELECT screen (Figure 95) is displayed showing the members of the selected group. The name of the selected group currently being displayed is shown after the screen name, i.e. Motor Ratings. Again using the [cursor up] or [cursor down] keys, and if required the [F8] and [F9] keys to change the page, select the desired tag. Press the [enter] key and the selected tag will be used to continue the operation for which the selection process was being used.

**Figure 94 - Selecting a Group**



**Figure 95 - Selecting a Member of a Group**



From the SELECT GROUP screen (Figure 94), the tag can also be selected via its name by pressing the [F7] key.

## Via Name

When you know the name of the tag that you wish to select but do not know what group it belongs to or are unsure of the full name, this method of selection may be appropriate.

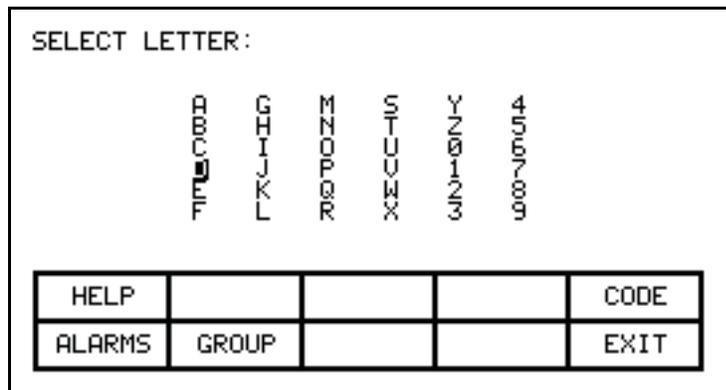
Selecting via a name is initiated from the SELECT GROUP screen (Figure 94) by pressing the [F7] key. This displays the SELECT LETTER screen shown in Figure 96.

Using the cursor keys, select (i.e. reverse video) the letter with which the desired tag starts with. The [cursor up] and [cursor down] keys move vertically within a column, the [cursor left] and [cursor right] key move laterally within the rows. When the appropriate letter has been selected, press the [enter] key.

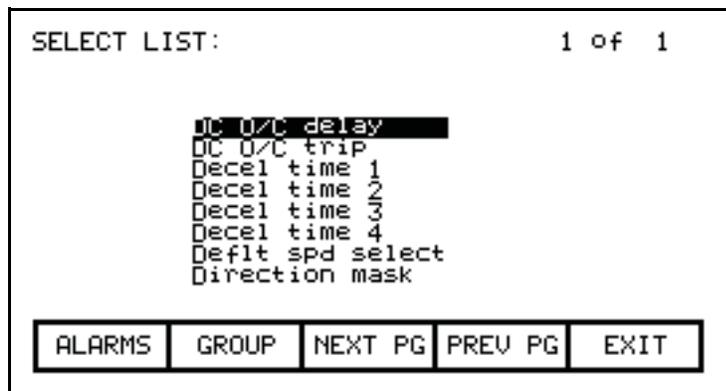
All tags which begin with that letter, and are appropriate for the operation on which the selection is being performed, will be displayed as in [Figure 97](#). Using the [cursor up] or [cursor down] keys, and if required the [F8] and [F9] keys to change the page, select the desired tag. Press the [enter] key and the selected tag will be used to continue the operation for which the selection process was being used.

From either of these two screens (SELECT LETTER or SELECT LIST) you can return directly to the default selection method via groups by pressing the [F7] key.

**Figure 96 - Selecting via a Letter (Step 1)**



**Figure 97 - Selecting Name via List (Step 2)**

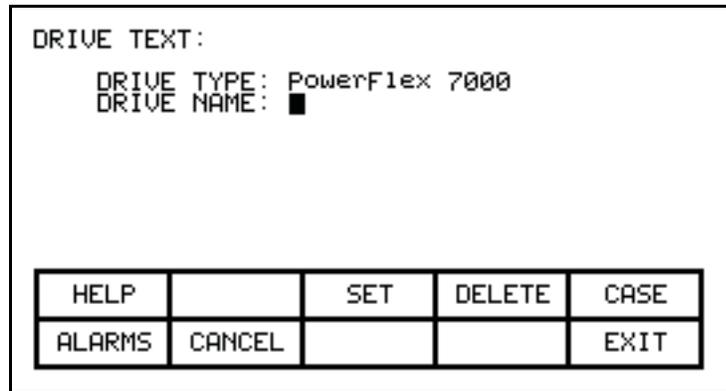


From the SELECT LETTER screen ([Figure 96](#)) the tag may also be selected via a code by pressing the [F5] key.





Figure 102 - Typical Text Edit Screen



The screen shown in [Figure 102](#) is typical of all screens using the edit text operation. All screens have the F3, F4 and F5 keys in common (if applicable). Once in the 'editing field' all operations are performed on the character in reverse video.

Pressing the [cursor left] and [cursor right] keys will move to the next character position in the string. Pressing the [cursor up] and [cursor down] keys will cycle through the characters contained in a set, each time the key is pressed. Note that when the first member of a set is displayed, pressing [cursor down] will wrap around to the last member of the set.

There are four sets of characters available. Press the [F3] key to cycle among the sets. The sets consist of:

- the upper case letters A through Z
- the lower case letters a through z
- the numbers 0...9 and the characters " and '-'
- the characters: space \_ ( ) [ ] { } < > | @ # \$ % & \* ! ^ + = ; : ?

**Note:** these character set may vary depending on the language selected.

A special set consisting of A through Z, 0...9 and the underscore character are used for filenames and cannot be selected via the [F3] key or modified by the [F5] key.

When a letter is in the editing field, pressing the [F5] key may change its case.

To delete the entire string (i.e. fill it with spaces), press the [F4] key.

To abort the changes to the string being edited press the [backspace] key. This will restore the string to its contents when the screen was first entered.

The editing operation is completed by pressing the [enter] key. Changes are not permanently made until the screen is exited via the [F10] key.

**Note:** The characters entered may only be valid for the currently selected language. Any characters used which are unique for a given language (i.e. other than the four sets defined above) can only be meaningfully displayed in the selected language, because other languages do not contain the appropriate display characters.

## Configure the Drive

In order to tailor the drive to your motor and application, a number of elements must be defined in the drive. The section describes how you will set or 'configure' these elements of the drive, via this operator interface. You will learn how to:

- Change a parameter setting.
- Assign a parameter to an Analog Port.
- Selectively enable or disable (i.e. Mask) certain faults.
- Define your own faults attached to external inputs.
- Configure the XIO
- Define the information sent to your optional PLC connection.
- Save and Restore your settings in the drive.
- Select an alternate language (if previously loaded in operator interface)

There are two methods to configure the drive. This section defines the more complete method to configure the drive for any application. The drive may also be configured for the majority of applications by using the Setup Wizard. The Setup Wizard can be entered from the "SETUP" screen by selecting the 'Setup Wizard' from the list of options and pressing [enter].

Regardless of the method used for configuration, the default factory parameters will be obtained from the Drive Identity Module (DIM). The use of the DIM allows each drive to be customized at the factory to the intended application, using all known information at the time of building the drive.

## Enter/Modify an Access Level

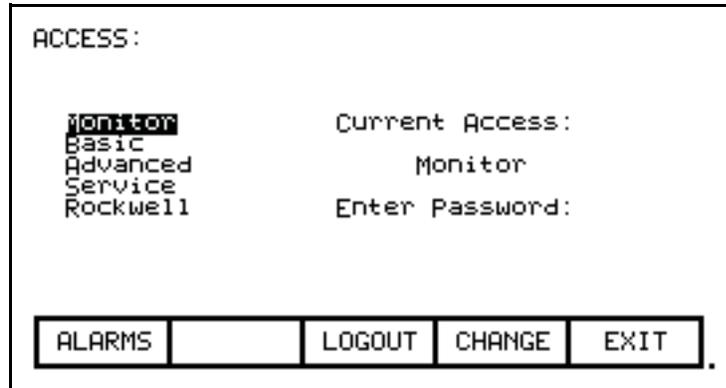
The drive is protected from unauthorized changes via passwords consisting of a number between 0....65,535. These passwords are associated with Access Levels. Each Access Level, (except for the first one 'Monitor') has its own password number (PIN). These values can be unique or all can be set to the same value.

The default level, 'Monitor' does not have a PIN associated with it. With this Access Level, the drive configuration can be viewed, but no changes are allowed to the parameters. In addition to providing the protection, the Access Levels also filter out the amount of information that can be viewed at each level. On any level, other than 'Monitor', any information that can be viewed may also be modified.

The screen shown in [Figure 103](#) is accessible from within a number of screens where the Access Level affects the operation of subsequent operations, such as:

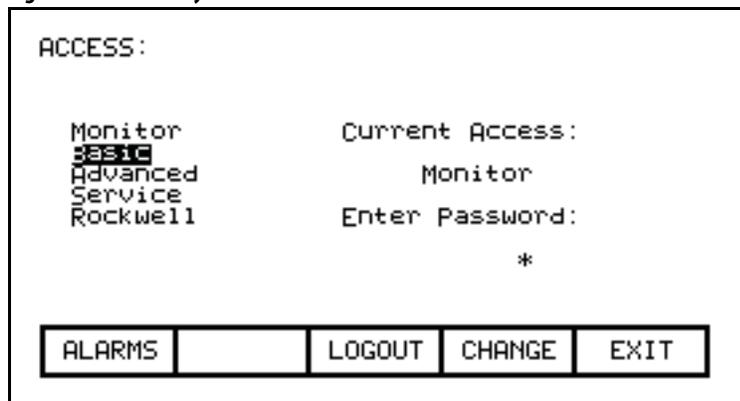
- [F10] key on the Top Level Menu
- [F8] key on the Modify Parameter screen
- [F8] key on the Setup Screen
- [F8] key on the Transfer Screen
- [F8] key on the Diagnostic Setup screen

**Figure 103 - Access Screen**



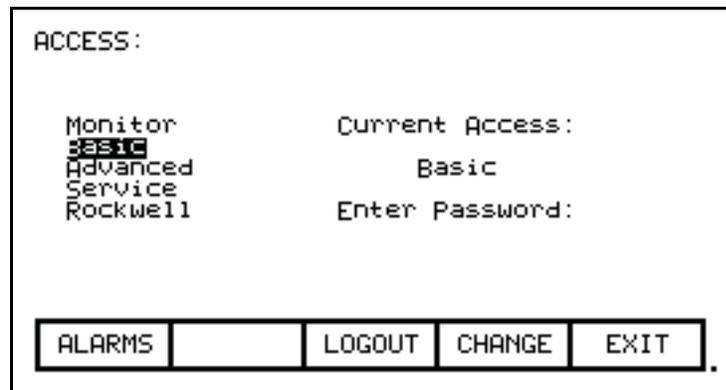
The Current Access level is shown. To select a different access level, use the up/down cursor keys to select the desired level. Then enter the password value (PIN) for that level using the data entry keys. The value can be any number between 0 through 65,535. As the number is entered via the keys [0]...[9], the value will be shown by a placeholder (e.g. \* in the editing field), as shown in [Figure 104](#).

**Figure 104 - Pin Entry**



The value may be edited by using the [backspace] key. When the value has been typed in, press the [enter] key. If the correct PIN was entered, the access level of the operator interface will change as shown in [Figure 105](#). If the incorrect value was entered, the operator interface will remain at the current access level.

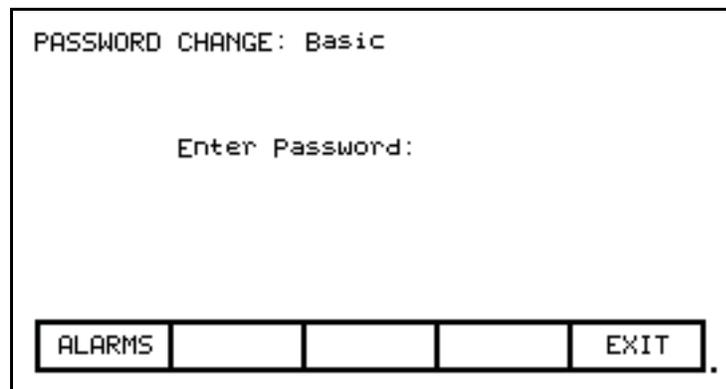
Figure 105 - Access Level Changed



When the desired operations have been completed, the operator interface should be placed back to the 'Monitor' level in order to protect against unauthorized modifications. From this screen press the [F8] key. The level will change back to 'Monitor' as shown in [Figure 103](#).

The default value for the password (PIN) of the 'Basic' and 'Advanced' levels is zero (0), or simply pressing the [enter] key. This value can be changed from the ACCESS screen. First use the up/down cursor keys to select the level for which you wish to modify the PIN. Press the [F9] key. The typical PASSWORD CHANGE screen shown in [Figure 106](#) is displayed, showing the Access Level for which the new PIN will be applied to.

Figure 106 - PIN Change



Enter the current PIN value via the data keys [0]...[9] and press the [enter] key. As in the ACCESS screen, the entered value is shown via placeholders and may be edited with the [backspace] key.

If you entered the correct PIN, the screen now asks you for the new PIN. Type in the new PIN value using the data entry keys [0]...[9] followed by the [enter] key. The screen now asks you to verify the new PIN. Type in the new PIN again followed by the [enter] key as shown in [Figure 107](#).

Figure 107 - PIN Change Completed

```

PASSWORD CHANGE: Basic

      Enter Password:
Enter New Password: ****
Verify New Password: ****
                Status: Password Changed

ALARMS  [ ] [ ] [ ] [ ] EXIT

```

At the end of the operation you will see a status as shown in either [Figure 107](#), [Figure 108](#) or [Figure 109](#), depending on whether you successfully changed the PIN, incorrectly entered the existing PIN or incorrectly verified the new PIN.

Figure 108 - Invalid PIN

```

PASSWORD CHANGE: Basic

      Enter Password: ****
Enter New Password:
Verify New Password:
                Status: Invalid Password

ALARMS  [ ] [ ] [ ] [ ] EXIT

```

Figure 109 - Invalid PIN Verification

```

PASSWORD CHANGE: Basic

      Enter Password:
Enter New Password: *
Verify New Password: *
                Status: Invalid Verify

ALARMS  [ ] [ ] [ ] [ ] EXIT

```

If you were not successful in changing the password, simply start over again by typing in the current password value.

## Drive Setup

This section describes how to:

- select an alternate language
- enter data to a drive parameter
- assign a tag to an analog port
- enable and disable a fault via a mask
- assign text to be associated with optional external fault inputs
- re-enter Setup Wizard
- configure the XIO link
- define the tags to be accessible by a PLC.

You will access the "SETUP" screen from the Top Level Menu by pressing the [F8] key. This will result in the typical screen shown in [Figure 110](#).

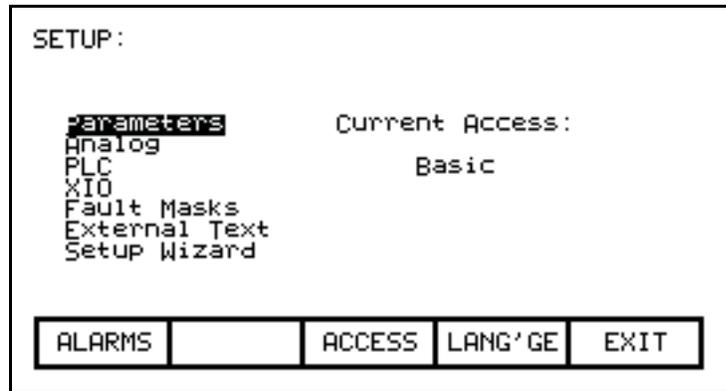
The Current Access level is shown. If it states 'Monitor' then you are restricted to only viewing the basic drive setup. You cannot make any changes. You must be in at least the 'Basic' access level in order to modify any of the drive parameters, and you may only modify the parameters for which you can view at the given access level.

At power-up, the operator interface access level is 'Monitor'. If this is the current mode and you wish to change any of the setup data, press the [F8] key now in order to change the access level before proceeding into any of the other setup operations available from this screen ([Figure 111](#)). Refer to [Enter/Modify an Access Level on page 116](#).

**Figure 110 - Setup Screen**



Figure 111 - Basic Access Level



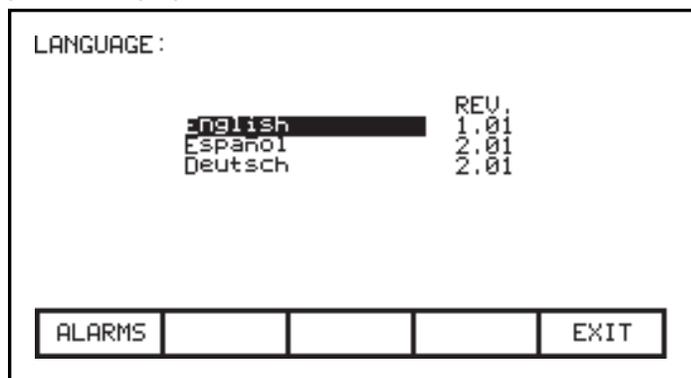
## Language Selection

The drive is capable of supporting multiple languages. The operator interface supports these languages via language modules which must initially be loaded via the flash card (refer to the section Flash Memory Transfers).

To select an alternate language, press the [F9] key on the SETUP screen. The screen will show all language modules currently loaded as in [Figure 112](#). Associated with each language is a module revision level. Use the [cursor up] and [cursor down] keys to select the desired language and press the [enter] key.

The operator interface will switch to the new language selected. It is possible for other devices attached to the drive to request a language change. If this occurs, the operator interface will switch to the new language, if the required language module is loaded.

Figure 112 - Language Selection



## Modify Parameters

To change a parameter, Use the up/down arrow keys on the SETUP screen to select the 'Parameters' option and press the [enter] key. This will begin the selection process of a parameter as described in the section entitled "Select a Parameter". The selection process to change a parameter can also be initiated while displaying the members of a parameter group on the DISPLAY screen ([Figure 138](#)) by pressing the [F7] key.

When you have successfully selected a parameter, one of three possible screens will be displayed depending on the type of parameter.

### Numerical Value

When the parameter is a numerical value, the MODIFY PARAMETER screen typical of [Figure 113](#) will be displayed. This screen shows:

- the name of the parameter for which you are making the changes (e.g. Rated motor volt)
- the tag code for the parameter, (e.g. 22)
- the minimum and maximum allowable limits to which the parameter must be set, (e.g. 4000...4160)
- the units in which the parameter data is being displayed
- the actual value of the parameter contained in the drive

**Figure 113 - Parameter Data Entry**

MODIFY PARAMETER: Rated motor volt			
	P:	22	
Min:	4000		U
Actual:	4100		
New:	4100		
Max:	4160		
ALARMS	CANCEL	ACCESS	EXIT

Figure 114 - Modify Numerical Value

MODIFY PARAMETER: Rated motor volt			
	P:	22	
Min:	4000		U
Actual:	4100		
New:	4000		
Max:	4160		
ALARMS	CANCEL	ACCESS	EXIT

To be allowed to make changes to the parameter, the operator interface must be set to an Access Level other than 'Monitor'. (You will be able to view the screen; however, pressing the data entry keys will have no effect). If you are not in the correct level, press the [F8] key in order to gain access to the parameter. Refer to the section entitled [Enter/Modify an Access Level on page 116](#) for further information on the operation to change the level.

Having gained access, use the data entry keys [0]...[9] to enter the new value. The [-] key can be typed at any time to enter a negative value. The [.] key is used to enter a decimal point for fractional values. The entered new value can be edited by pressing the [backspace] key. This key will delete the right most character (e.g. number, decimal point or negative sign) shown on the screen. Press the [enter] key to accept the new value as shown in [Figure 114](#). If the new value that you entered is outside the limits defined, the new value will not change. For example: If you entered 900 when the minimum value was 4000, the new value will still show 4100.

Some data must be entered in HEX. To accomplish this, use the cursor up/down keys to scroll through the values 0...F for the right most digit. To accept the digit and enter to the right of the current digit, press the right cursor key. Press the [Enter] key to accept the value.

The value may be edited the same as a value entered from the numeric keypad.

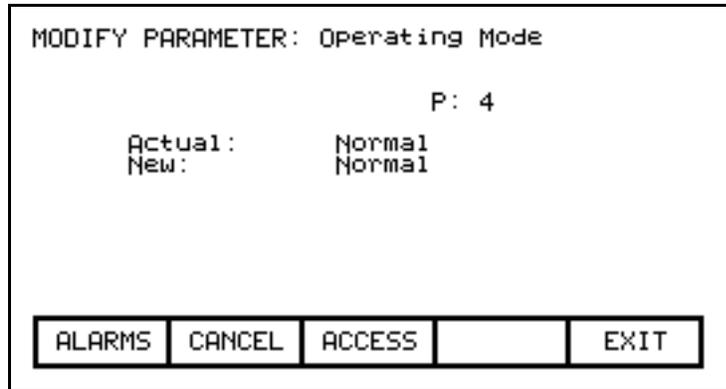
The new value is not sent to the drive until you exit the screen with the [F10] key. Prior to this you can modify the new value by repeating the above procedure, or you can cancel the change by pressing the [F7] key. The CANCEL operation returns the new value to that of the actual value.

## Enumerated Value

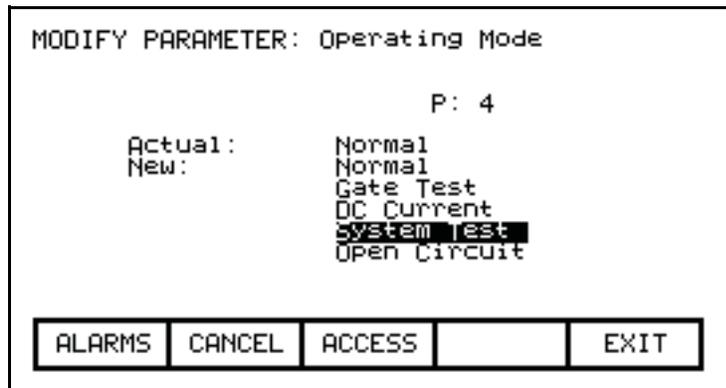
When the parameter is an enumerated value, the MODIFY PARAMETER screen typical of [Figure 115](#) will be displayed. This screen shows:

- the name of the parameter for which you are make the changes (i.e. Operating Mode)
- the tag code for the parameter (e.g. 4)
- the actual value of the parameter contained in the drive

**Figure 115 - Modify Enumerated Value**



**Figure 116 - Option List Viewed on Single Page**



To be allowed to make changes to the parameter, the operator interface must be set to an Access Level other than 'Monitor'. (You will be able to view the screen; however, pressing the data entry keys will have no effect). If you are not in the correct level, press the [F8] key in order to gain access to the parameter. Refer to the section entitled [Enter/Modify an Access Level on page 116](#) for further information on the operation to change the level.

Having gained access, press the up or down cursor keys to obtain a list of possible options to select from. Use the up/down arrow keys to move the highlighting to the desired option ([Figure 116](#)). If more options exist than what can be displayed on a single screen, a triangle or inverted triangle symbol will indicate in which direction the list can be expanded ([Figure 117](#)).

Use the up/down cursor keys to scroll onto these additional options. Press the [enter] key to accept the new value as shown in [Figure 118](#).

**Figure 117 - Option List Viewed on Multiple Pages**

```

MODIFY PARAMETER: XIO General IO

                                P: 592

Actual:      unassigned
New:         unassigned
            Slot 1
            Slot 2
            Slot 3
            Slot 4
            Slot 5
            ▼

ALARMS  CANCEL  ACCESS  [ ]  EXIT
  
```

**Figure 118 - Modification Completed**

```

MODIFY PARAMETER: Operating Mode

                                P: 4

Actual:      Normal
New:         System Test

ALARMS  CANCEL  ACCESS  [ ]  EXIT
  
```

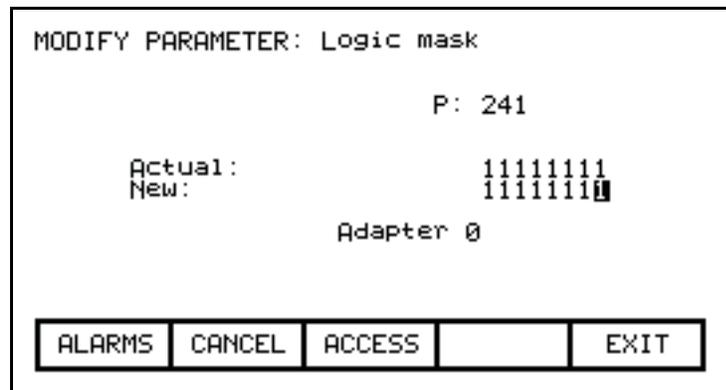
The new value is not sent to the drive until you exit the screen with the [F10] key. Prior to this you can modify the new value by repeating the above procedure, or you can cancel the change by pressing the [F7] key. The CANCEL operation returns the new value to that of the actual value.

## Bit Encoded Value

When the parameter is a bit encoded value, the MODIFY PARAMETER screen typical of [Figure 119](#) will be displayed. This screen shows:

- the name of the parameter for which you are make the changes (i.e. Logic Mask)
- the tag code for the parameter (e.g. 241)
- the name of the bit currently selected (Adapter 0)
- the actual value of the parameter bits contained in the drive.

Figure 119 - Modify Bit Encoded Value



To be allowed to make changes to the parameter, the operator interface must be set to an Access Level other than 'Monitor'. (You will be able to view the screen; however, pressing the data entry keys will have no effect). If you are not in the correct level, press the [F8] key in order to gain access to the parameter. Refer to the section entitled [Enter/Modify an Access Level on page 116](#) for further information on the operation to change the level.

Having gained access, press the left/right cursor keys to move to the various bits within the parameter. As each bit is selected, the name of the bit is displayed. Use the up/down arrow keys to toggle the state of the bit.

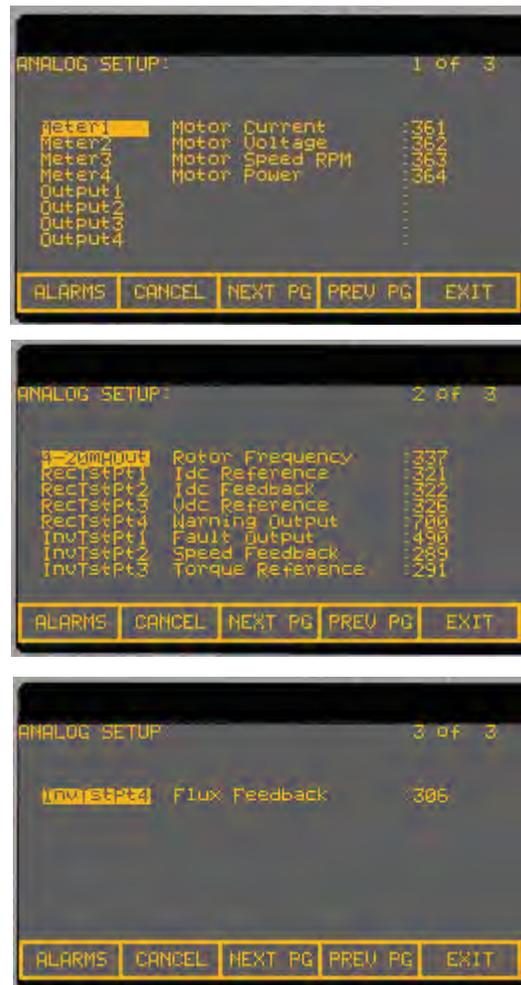
The new value is not sent to the drive until you exit the screen with the [F10] key. Prior to this you can modify the new value by repeating the above procedure, or you can cancel the change by pressing the [F7] key. The CANCEL operation returns the new value to that of the actual value.

## Analog Ports

The drive contains a number of external analog ports to which you can assign any parameter. To setup an analog port, use the up/down arrow keys on the SETUP screen to select the 'Analog' option and press the [enter] key.

This will display a series of screens as shown in [Figure 120](#). The screen shows the current tags and their tag code, which are associated with each of the analog ports. To change the tag attached to a port, use the [cursor up] and [cursor down] keys to highlight the desired port and press the [enter] key. (If nothing happens then you have not gained the required access to make changes. Exit to the SETUP screen and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access).

Figure 120 - Analog Setup



This will begin the selection process of a tag as described in the section entitled [Select a Parameter on page 110](#). When you have completed the selection process, the selected tag will be assigned to the port. To remove an assignment to the highlighted port, press the [delete] (Backspace) key.

The changes made do not take affect until you press [F10] and exit the screen. Any time prior to this you may cancel all of the changes made after coming to the screen by pressing the [F7] key.

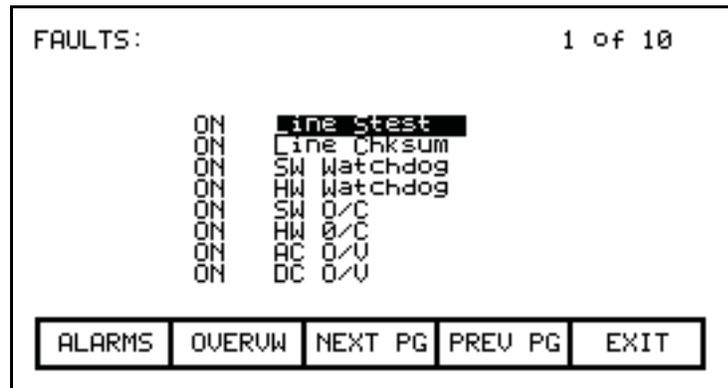
## Fault Masks

A number of the faults within the drive may be selectively enabled or disabled by you. To view or modify the current fault mask settings, use the up/down arrow keys on the SETUP screen to select the 'Fault Masks' option and press the [enter] key.

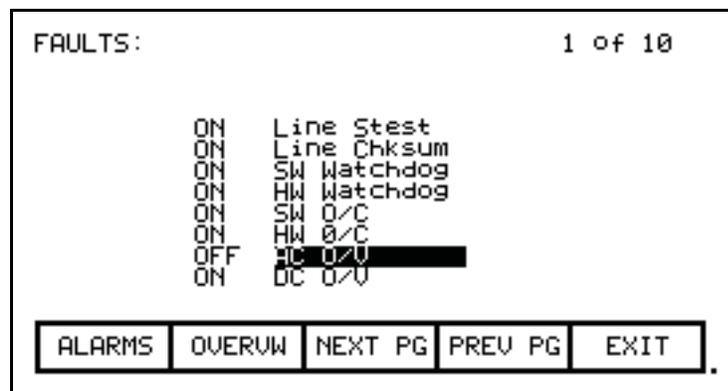
A typical screen as shown in [Figure 121](#) shows all of the user maskable faults. Associated with each fault is the state of the mask. If OFF, it means the fault is disabled and will not occur. The normal state is ON or enabled.

To change the state of the mask, use the [cursor up] or [cursor down] keys to select the desired fault and press the [enter] key. Each press of the [enter] key will toggle the state of the mask as shown in [Figure 122](#). (If nothing happens, you do not have proper access to the drive. Exit to the SETUP screen and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access).

**Figure 121 - Fault Screen**



**Figure 122 - Fault Mask OFF**



[Figure 121](#) and [Figure 122](#) show all fault masks regardless of their current state. The fault masks can be viewed according to their state by pressing the [F7] key on the FAULTS SETUP screen. This will display the FAULTS OVERVIEW screen, typical of [Figure 123](#) and [Figure 124](#).

Figure 123 - AC O/V, Disabled

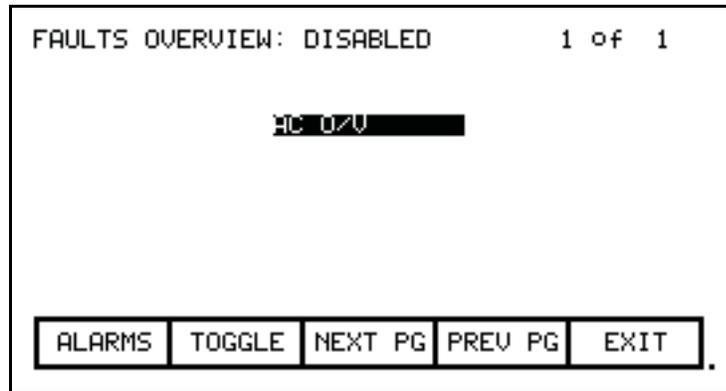
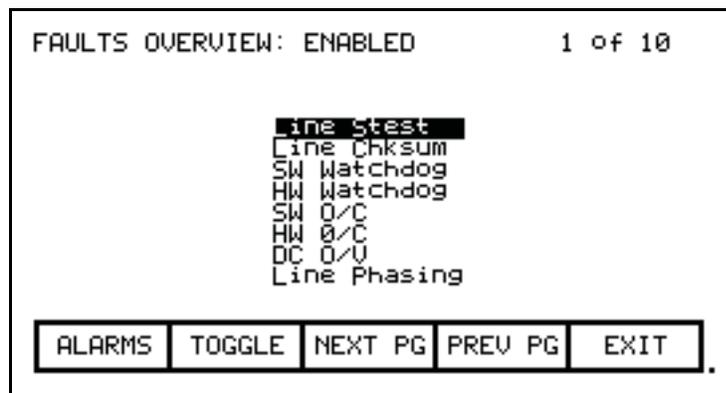


Figure 124 - Fault Overview, Enabled



The state of the fault masks which you are currently viewing is defined to the right of the screen name, i.e. FAULTS OVERVIEW: DISABLED or FAULTS OVERVIEW: ENABLED. To change the state of fault masks currently displayed, press the [F7]. Each press of the [F7] key will toggle the screen to show the masks in the other state.

To change the state of a mask on the FAULTS OVERVIEW screen, use the [cursor up] and [cursor down] keys to select the desired mask and press the [enter] key. In the example of [Figure 123](#), the “AC O/V” is currently disabled and is selected. When [enter] is pressed its mask is enabled, thus removing the fault from this screen as shown in [Figure 125](#). Pressing [F7] toggles the screen to show the enabled faults, which the AC O/V is one of ([Figure 126](#)). (If nothing happens, you do not have proper access to the drive. Exit to the SETUP screen and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access).

Figure 125 - AC O/V Removed From List

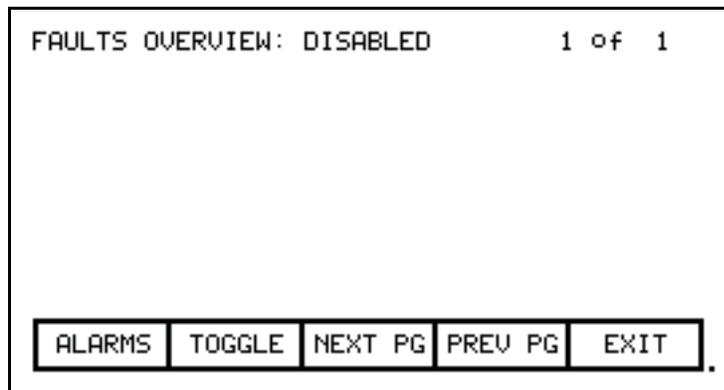
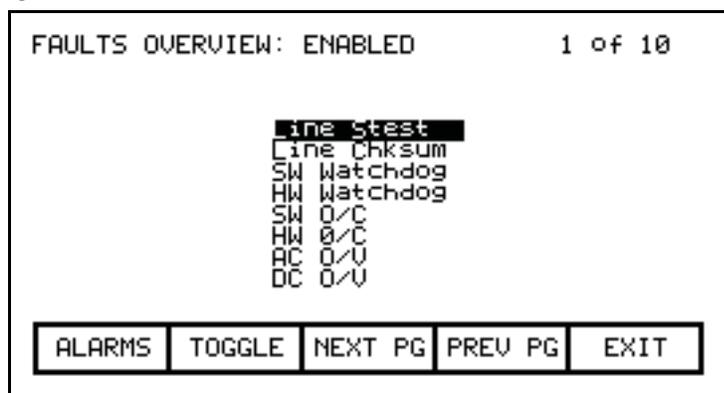
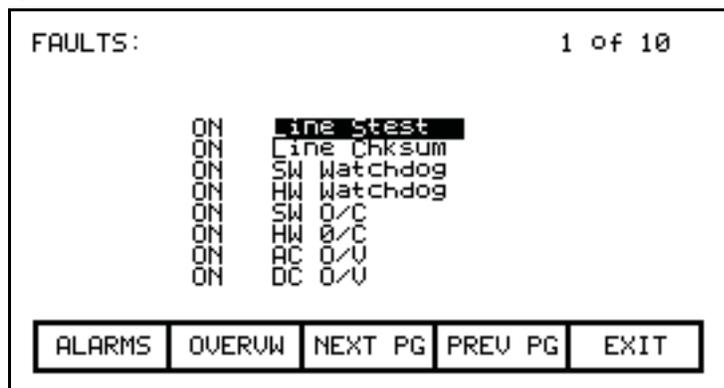


Figure 126 - AC O/V Now Enabled



The changes to the fault masks do not take effect until the screen is exited via the [F10] key, i.e. exiting the FAULTS OVERVIEW will change the masks in the drive as will exiting the FAULTS SETUP screen. In our example, exiting the FAULTS OVERVIEW screen and returning to the FAULTS SETUP screen now shows the “AC O/V” mask as being ON (Figure 127).

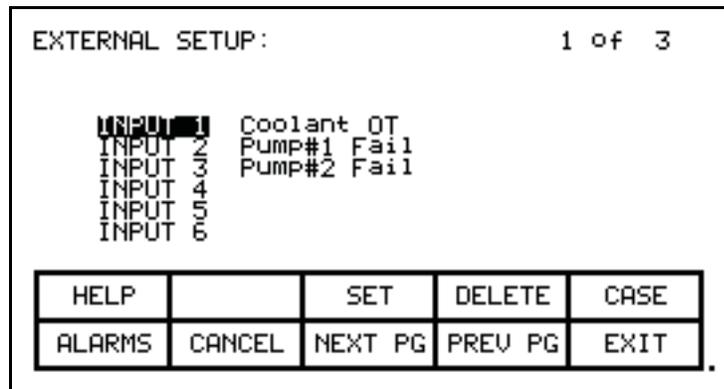
Figure 127 - AC O/V Mask is ON



## User Definable External Text

The drive contains a number of external fault inputs. You can custom define the text associated with these inputs, which will be used on the alarm screen and the fault mask screens. To define the text, use the up/down arrow keys on the SETUP screen to select the 'External Text' option and press the [enter] key. A screen typical of [Figure 128](#) will be seen.

**Figure 128 - External Setup Text**



To modify the text attached to a particular fault input, use the [cursor up] and [cursor down] keys to select the desired input. To modify the text, press the [cursor right] key. (If nothing happens then you have not gained the required access to make changes. Exit to the SETUP screen and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access). The first character position of the string will be in reverse video as shown in [Figure 129](#). Refer to the section entitled [Edit Text on page 114](#). When editing is complete, the screen will appear as in [Figure 130](#).

**Figure 129 - Modify Text**

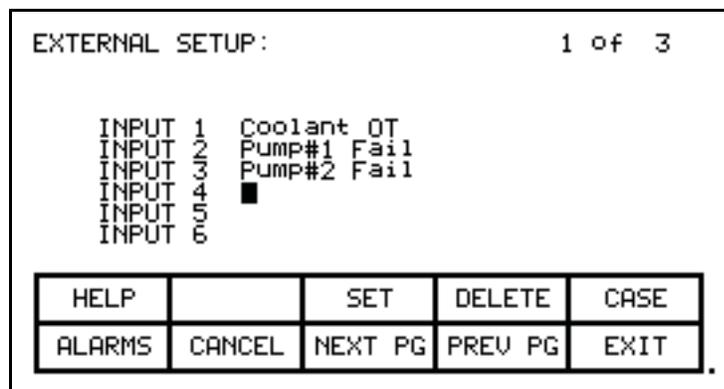


Figure 130 - Modification Completed

EXTERNAL SETUP:		1 of 3		
INPUT 1	Coolant OT			
INPUT 2	Pump#1 Fail			
INPUT 3	Pump#2 Fail			
INPUT 4	UP to 12 chr			
INPUT 5				
INPUT 6				
HELP		SET	DELETE	CASE
ALARMS	CANCEL	NEXT PG	PREV PG	EXIT

The changes made do not take effect until you press [F10] and exit the screen. Any time prior to this you may cancel all of the changes made after coming to the screen by pressing the [F7] key.

## PLC

The drive can be optionally connected to a PLC via a RIO (Remote Input/Output) adapter. The drive appears to the PLC as a rack of information. The tags that are associated with each of the words within a rack can be defined. To setup the PLC link, use the up/down arrow keys on the SETUP screen to select the 'PLC' option and press the [enter] key.

This will display a screen as shown in [Figure 131](#) or [Figure 132](#). The PLC setup consists of eight words of input and eight words of output.

These are shown on separate screens. The type of PLC word being viewed is defined to the right of the screen name, i.e. PLC SETUP: INPUTS or PLC SETUP: OUTPUTS. To switch to the other screen, press the [F8] key. Each press of the [F8] key will toggle the screen to show the other set of words.

The layout of the PLC 'rack' is dependent on the DIP switch settings on the RIO adapter, (refer to the appropriate manual for information on the following adapters and their use: 1203-GD1, 1203-GK1, 1203-CN1, 1203-GD2, 1203-GK2, 1203-GK5, 1203-GU6, 1203-SM1 and 1203-SSS). Tags are assigned to rack module locations in pairs. These pairs are referred to as links and consist of two input and two output words. There are a total of four links that can be assigned to the RIO adapter.

The screens show the current tags and their tag code, which are associated with each of the links. To change the tag attached to a link, use the [cursor up] and [cursor down] keys to highlight the desired link and press the [enter] key. (If nothing happens then you have not gained the required access to make changes. Exit to the SETUP screen and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access).

Figure 131 - PLC Input Links

PLC SETUP: INPUTS		
Link A1	U line	:324
Link A2	Alpha line	:327
Link B1	Cntrl board temp	:368
Link B2	U neutral motor	:347
Link C1	Current meter	:361
Link C2	Voltage meter	:362
Link D1	Speed meter	:363
Link D2	Power meter	:364

ALARMS	CANCEL	TOGGLE		EXIT
--------	--------	--------	--	------

Figure 132 - PLC Output Links

PLC SETUP: OUTPUTS		
Link A1	Stop Mode	:77
Link A2	Total Decel Time	:62
Link B1	Rated motor volt	:22
Link B2	Rated motor hp	:25
Link C1	Speed cmd max	:48
Link C2	Tach Select	:237
Link D1	Ext flt 1 class	:200
Link D2	Input ContCfg	:1

ALARMS	CANCEL	TOGGLE		EXIT
--------	--------	--------	--	------

This will begin the selection process of a tag as described in the section entitled [Select a Parameter on page 110](#). When selecting a tag for the output words, only parameters will be allowed. Both parameters and read-only parameters are allowed for the selection of input words. When you have completed the selection process, the selected tag will be assigned to the link. To remove an assignment to the highlighted link, press the [delete] (Backspace) key.

The changes made do not take effect until you press [F10] and exit the screen. Any time prior to this you may cancel all of the changes made after coming to the screen by pressing the [F7] key.

## XIO

The drive uses XIO adapters to hardwire to discrete inputs and outputs. Each drive contains one or more of these modules. Each module contains a unique address that is assigned automatically according to where it is attached on the link. This address value can be seen on the LED display of the module. The drive must be configured with these address values to link them to a parameter in the drive. To setup the XIO configuration, use the up/down arrow keys on the SETUP screen to select the 'XIO' option and press the enter key

**Note:** This feature is currently inactive and is reserved for future enhancements.

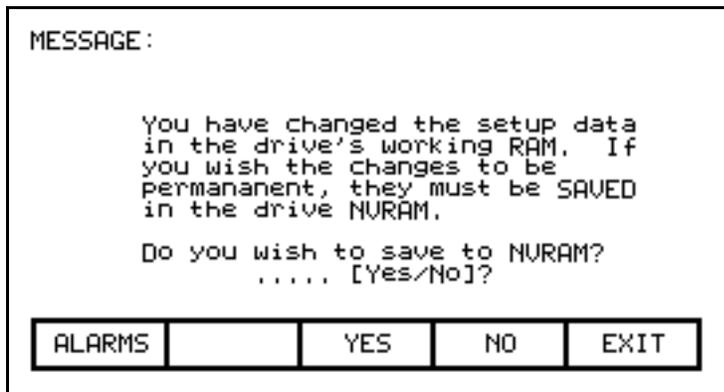
## Message Prompting

All the changes you made while you were configuring the drive are stored in volatile memory of the drive. This means that when power to the drive is lost, so will be the changes. To permanently store the changes, the contents of the memory must be stored to NVRAM memory.

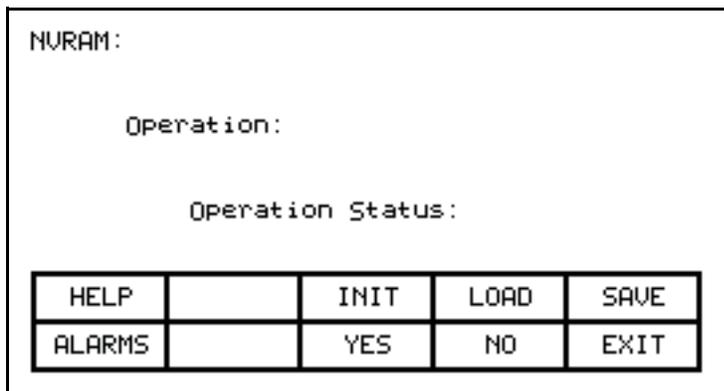
When you exit a group of screens on which you have changed the drive data, you will be prompted as in [Figure 133](#) to save the data. If you wish to save the data, press [F8] 'Yes' and the NVRAM screen (refer to [Store/Retrieve Configuration \(NVRAM\) on page 135](#)) will be entered ([Figure 134](#)). If you wish the data to reside as temporary data in RAM only, press [F9] 'No'. Pressing [F10] Exit will return you to the screen from which you previously exited.

Note that the data can still be saved at a later time by accessing the NVRAM screen directly from the Top Level Menu. Refer to [Store/Retrieve Configuration \(NVRAM\) on page 135](#).

**Figure 133 - Message Prompt Screen**



**Figure 134 - NVRAM Screen**



## Store/Retrieve Configuration (NVRAM)

To access the memory functions, press [F5] on the Top Level Menu. Within this screen it is possible to perform three operations on the memory of the drive. To perform these operations you must have the proper access to the drive. Refer to the section entitled [Enter/Modify an Access Level on page 116](#).

### Initialize

The drive contains a default set of parameters and setup information. This can form a basis for configuring the drive. To initialize the drive with the default set of data, press the [F3] key. The screen will appear as in [Figure 135](#), indicating the operation you are about to perform.

The screen then will ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Performing an initialization will overwrite the data currently in the drive. Previous changes that were saved to NVRAM will not be affected.

**Figure 135 - Initialize Operation**

NVRAM:				
Operation: INITIALIZE				
PROCEED? Yes/No?				
Operation Status: INITIALIZE PENDING				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

### Save

The changes that you have made to the drive data must be saved if you do not want to lose the data when the drive is powered off. To save the changes, press the [F5] key ([Figure 136](#)).

Figure 136 - Save Operation

NVRAM:				
Operation: SAVE TO NVRAM				
PROCEED? Yes/No?				
Operation Status: SAVE PENDING				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

To confirm the operation, press the [F8] key to proceed, or the [F9] key to abort. Saving the data will overwrite the previously stored data in the NVRAM.

## Load

The changes that you stored in NVRAM are automatically used each time the drive is powered up. If you make changes to the data in the drive (without saving) and then wish to use the previously stored data, press the [F4] key ([Figure 137](#)).

Figure 137 - Load Operation

NVRAM:				
Operation: DOWNLOAD NVRAM				
PROCEED? Yes/No?				
Operation Status: DOWNLOAD PENDING				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

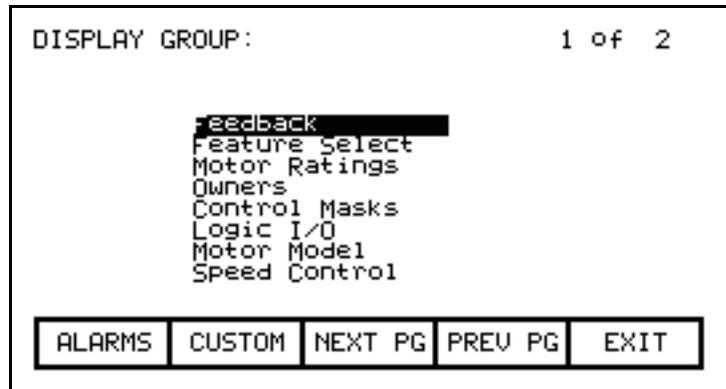
To confirm the operation, press the [F8] key to proceed, or the [F9] key to abort. Loading the data will overwrite the data currently being used by the drive.

## Display Parameters

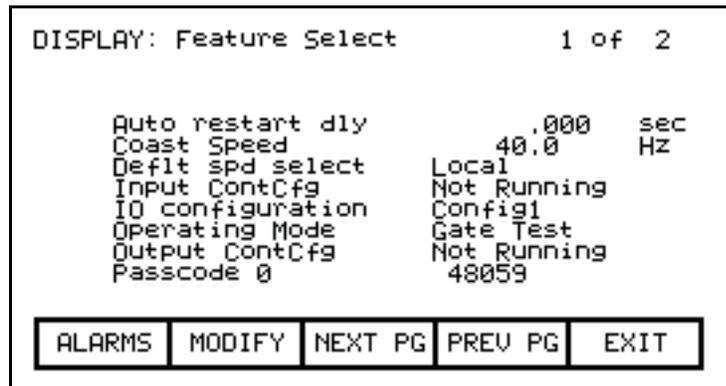
The parameters of the drive can be displayed, continually showing the value contained in the drive. From the Top Level Menu, press the [F4] key. The DISPLAY GROUP screen of [Figure 138](#) is displayed.

The screen shows one or more pages of groups that can be displayed. The number of groups displayed depends on the current access level. Using the [cursor up] and [cursor down] keys select the group you wish to display and press the [enter] key ([Figure 139](#)).

**Figure 138 - Display Screen**



**Figure 139 - Feature Select Group Chosen**



**Figure 140 - Bit Encoded Parameter**

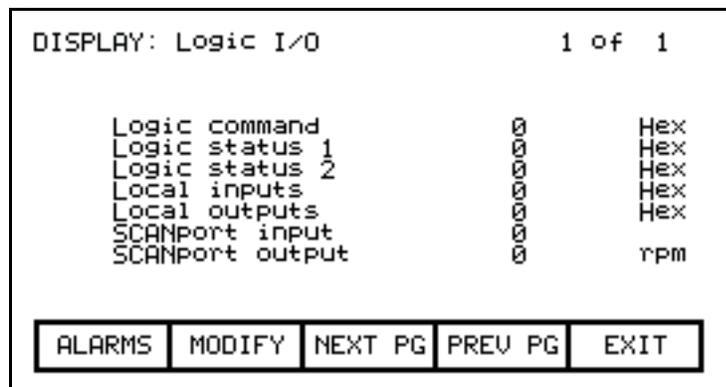


Figure 141 - Bit Description for Local Outputs

VIEW PARAMETER: Local outputs			
Ready	0	Close Bypass	0
Running	0	At speed	0
Rev Rot'tn	0	Torque Lmt	0
Fault	0	Test Mode	0
Warning	0	Synching	0
Start Fans	0	Start Field	0
Close Input	0	Enable Field	0
Close Output	0	Reset Faults	0

ALARMS				EXIT
--------	--	--	--	------

The DISPLAY screen, typical of [Figure 139](#), is displayed. The screen shows the name of the group being displayed to the right of the screen name ("FEATURE SELECT"). One or more pages of the members in the group are displayed along with the value for this tag in the drive and its unit of measurement. Values that are bit encoded will show a hex value for the parameter value. Use the up/down cursor keys to select the parameter which is bit encoded and then press the [enter] key ([Figure 140](#) and [Figure 141](#)). The VIEW PARAMETER screen will then show that parameter as it is decoded per bit as shown in [Figure 141](#).

The left side of the pair shows the name of the bit, while the right side shows the current value of the bit within the parameter.

All of these values are updated from the drive on a continual basis.

From the DISPLAY screen, it is possible to modify a parameter. If the group you are currently viewing contains parameters, press the [F7] key. The operator interface then allows you to select the parameter you wish to modify. Refer to the section entitled "Modify Parameters" for further details.

If you have modified any parameters in the drive, you will be prompted to make the changes permanent. This prompt will occur upon exiting the DISPLAY GROUP screen. Refer to "Message Prompting" for further details.

## Custom Group

From the DISPLAY GROUP screen ([Figure 138](#)) you can select a group which you have custom defined by pressing the [F7] key. This custom group contains selected tags from one or more other groups, arranged by you onto a single screen for more convenient viewing ([Figure 142](#)).

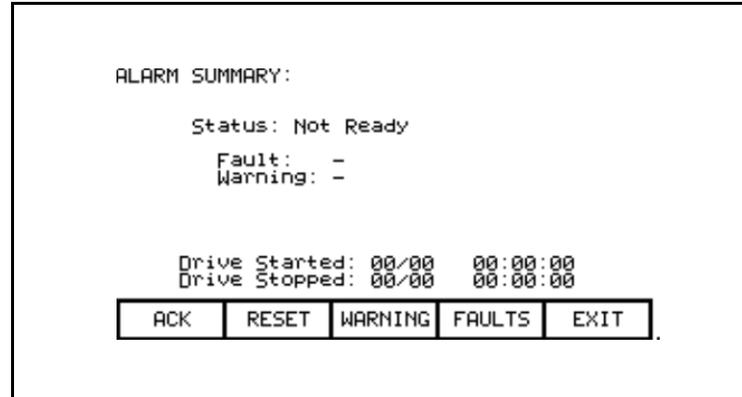
To assign a tag to the display, use the [cursor up] and [cursor down] keys to highlight the desired item position and press the [enter] key. This will begin the selection process of a tag as described in the section entitled [Select a Parameter on page 110](#). When you have completed the selection process, the selected tag will be assigned to the item, as in [Figure 143](#). To remove a tag from the highlighted item, press the [delete] (Backspace) key.



## View and Reset Alarms

All drive faults and warnings are logged to their respective queues. Collectively the faults and warnings are referred to as "Alarms". When a new alarm occurs, the F6 key on any screen will begin to flash in reverse video. Pressing the [F6] key on any screen will bring you to the screen as shown in [Figure 145](#).

**Figure 145 - Alarm Summary Screen**



The screen shows the current status of the drive, as well as the last active Fault that tripped the drive and any pending warning. (The screen only shows a fault and/or warning if the drive is still in the fault and/or warning state. This is independent of the content of the queues.) **Note:** Terminal FRN > 4.005.

To aid in troubleshooting, a time and date stamp is also provided, indicating the last time the drive was started and stopped for any reason.

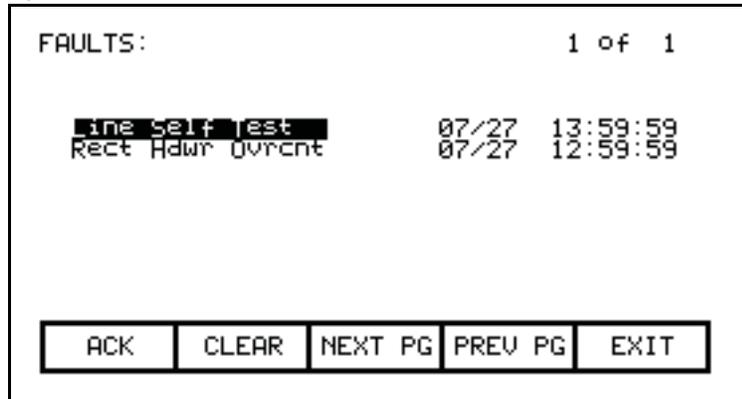
To acknowledge the alarm(s), press the [F6] key. This will cause the F6 key to cease flashing and return to normal video. (If a new alarm were to occur, the F6 key would again flash in reverse video).

To reset the drive, press the [F7] key. This operation will reset any latched faults in the drive. This has no action upon either the Fault or Warning queues. If some faults still exist, they will return as new faults.

Faults and Warnings are stored into separate queues. Both work similar, thus only the fault queue will be discussed. To access the fault queue, press the [F9] softkey from the ALARM SUMMARY screen.

A screen typical of [Figure 146](#) will be shown. The screen shows all faults in chronological order as they have occurred. A timestamp gives the date and time that the fault occurred. The most recent fault occurs at the top of the list. Use the [F8] and [F9] keys to shift to other pages if required. Entries are not removed from the queue until the queue is cleared with the [F7] key. If the queue becomes full, the oldest entries are discarded to make room for newer faults.

Figure 146 - Fault Queue



## Help for Alarms

When viewing the fault or warning queue, help text may be associated with the alarm entry. Use the up/down cursor keys to highlight the alarm in question and press the [enter] key. An ALARM HELP screen, typical of that shown in [Figure 147](#) will be shown for that alarm. Not all alarms will have this additional help text. For those alarms the screen shown in [Figure 148](#) is displayed.

Figure 147 - Alarm Help

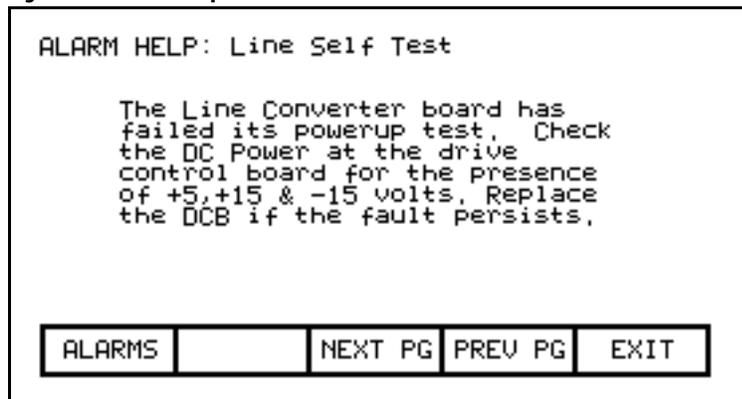
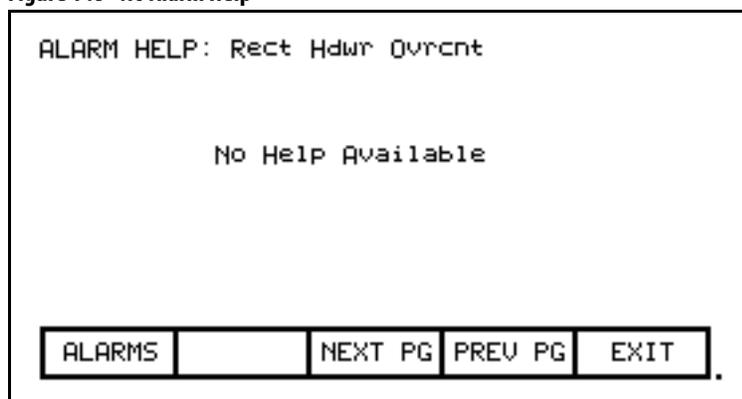


Figure 148 - No Alarm Help



## Request Printouts

When the drive contains the optional printer, you can obtain hard copies of the data that you are able to view on the terminal. The printouts are requested from the PRINTER screen. Press [F3] while displaying the Top Level Menu.

The screen typical of [Figure 149](#) is displayed. It shows the current status of the printer (A-B part #80025-290-01) and the type of reports that are available. (Refer to the “Syntest SP401 Thermal Printer User Manual” for information regarding the use of the printer hardware and a description of the various reports available.) Using the [cursor up] and [cursor down] keys, select the desired report and press the [enter] key. The report will be sent to the printer.

The printer can automatically print out the alarms as they occur. This feature is selected as one of the report formats. In [Figure 149](#), the “AUTO - ON” indicates that this feature is currently enabled. To disable the feature, use the [cursor down] key to select the text, and press the [enter] key. The text will change to “AUTO - OFF” (if a printer is attached). The automatic alarm printout feature is now disabled. Pressing the [enter] key again while selected will enable the feature.

**Figure 149 - Typical Printer Screen**



## Perform Diagnostic Trending

The diagnostic trending operation of screens allows you to capture the relationships of a number of parameters over a period of time. Within this operation you will:

- Define the Parameters to which the Trend Apply
- Define the Trigger Condition to Begin the Trend
- Define the Sampling Rate and position of the Trigger
- View the results of the Trend

You will access the Diagnostic Trend operation from the Top Level Menu by pressing the [F9] key. This results in the display of the screen shown in [Figure 150](#).

Figure 150 - Diagnostic Screen

```

DIAGNOSTICS:

Trigger:

Status: UNPROGRAMMED
Last Trigger: Not Available

```

HELP	FORCE			
ALARMS	RE-ARM	D_SETUP	VIEW	EXIT

From this screen, additional screens are accessible to perform the diagnostic trending functions. The screen shows the current status of the trend, (Unprogrammed, Running, Triggered, Stopped). If a trigger has been defined, the trigger parameter, its trigger condition and the type of trigger will be displayed.

If data has already been captured, a time stamp indicating the last time the given trigger has occurred. This captured data can be viewed by pressing the [F9] softkey.

When a trigger has been defined, and is currently "Stopped", it can be re-started by pressing the [F7] key. If the status is "Running", the user can force the trigger to occur by pressing the [F2] key. Note that in doing so, that the trigger condition did not actually occur, but all data buffers can be viewed as if the condition had occurred.

To define a trend, press the [F8] key to display the setup screen, shown in [Figure 151](#).

Figure 151 - Diagnostic Setup

```

DIAGNOSTICS SETUP:                               1 of 2

Trigger:

Trace 1
Trace 2
Trace 3
Trace 4

```

Rate [mSec]:      0 Post Sample [%]:      0

HELP	COND	DATA	RATE	POST
ALARMS	CANCEL	ACCESS	TRIGGER	EXIT

Figure 152 - Assign a Trace

```

DIAGNOSTICS SETUP:                1 of 2
S-Trigger: U line                 = .000 PU
Trace 1 U line                     :324
Trace 2                             :
Trace 3                             :
Trace 4                             :
Rate [mSec]:                       0 Post Sample [%]: 0

```

HELP	COND	DATA	RATE	POST
ALARMS	CANCEL	ACCESS	TRIGGER	EXIT

From this screen, the tags to be monitored are assigned to a trace. The tag which you assign to the first trace 'Trace 1' is used as the trigger parameter. By default, when assigning a tag to Trace 1, the trigger value (i.e. data) will be set to the tag's minimum value and the trigger condition will be 'equal to'. A tag must be assigned to Trace 1 before the trigger value or condition can be set. From this screen you may also set the interval between samples (i.e. Rate), and the location of the trigger point within the view buffer. By default, the trigger will occur in the middle of the buffer, however you may change this by indicating the percentage of samples which will follow (i.e. Post) the trigger point.

## Assigning a Trace

To assign a tag to a trace, use the [cursor up] and [cursor down] keys. Highlight the desired trace and press the [enter] key. Since there are more traces than can be seen on a single screen, use the up/down arrow keys to extend the list to the additional traces on the screen. (If nothing happens then you have not gained the required access to make changes. Press the [F8] key and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access).

This will begin the selection process of a tag as described in the section entitled [Select a Parameter on page 110](#). When you have completed the selection process, the selected tag will be assigned to the trace, as in [Figure 152](#). To remove a tag from the highlighted trace, press the [delete] (Backspace) key.

## Setting the Trigger

Once you have assigned a tag to Trace 1, you may proceed to set the trigger value. Three items of information are required, the trigger type, the trigger condition and the trigger value. These are selected for modification by pressing the [F9], [F2] and [F3] keys respectively. (If nothing happens then you have not gained the required access to make changes. Press the [F8] key and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access).

There are two types of triggers possible. A Single trigger occurs once and stops. The trigger must then be manually re-armed. This is the default type of trigger. A Continuous trigger will re-arm itself and continue to collect new trends until viewing the contents of the captured data stops it. The current type of trigger is shown by either a 'C' or 'S' in front of the Trigger label (refer to [Figure 152](#)). To switch between the two types, press the [F9] key.

The trigger condition and trigger value are set with the [F2] and [F3] keys respectively. When the respective field is in reverse video, that field may be modified.

The condition is set to one of the conditions listed below by pressing the [cursor up] or [cursor down] keys to scroll through the conditions. Pressing [enter] ends the editing and accepts the shown condition.

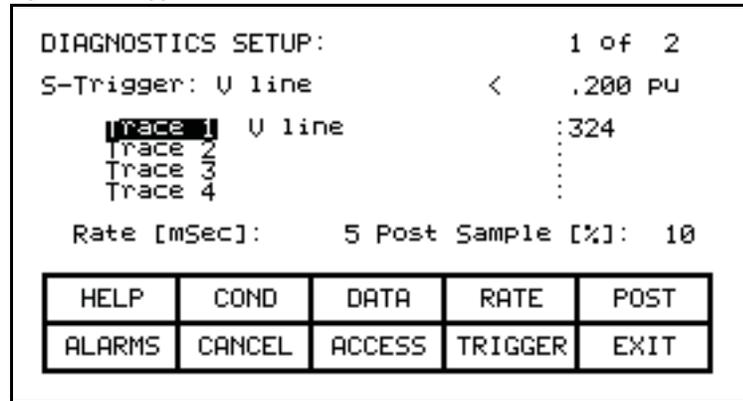
<b>Trigger Conditions</b>	
=	Equal to
N=	Not Equal to
>	Greater than
<	Less than
+	Boolean OR
N+	Boolean NOR
&	Boolean AND
N&	Boolean NAND

The value (data) is set through the use of the numerical keypad. Use the data entry keys [0]-[9] to enter the new value. The [-] key can be typed at any time to enter a negative value. The [.] key is used to enter a decimal point for fractional values. The entered new value can be edited by pressing the [backspace] key. This key will delete the right most character (i.e. number, decimal point or negative sign) shown on the screen. Press the [enter] key to accept the new value as shown in [Figure 153](#). If the new value that you entered is outside the limits defined, the new value will be pegged at the closest limit. For example: If you entered 900 when the minimum value was 1000, the new value will show 1000.

Some data must be entered in HEX. To accomplish this, use the cursor up/down keys to scroll through the values 0-F for the right most digit. To accept the digit and enter to the right of the current digit, press the right cursor key. Press the [Enter] key to accept the value.

The value may be edited the same as a value entered from the numeric keypad.

Figure 153 - Trigger Condition



### Defining Sample Rate and Positioning

Pressing the [F4] key sets the rates at which the samples are taken. This data field is then modified in the same manner as the trigger data is entered. Rates can be set from 0 msec (collect as fast as possible) to 20.000 seconds.

When samples are collected, part of the buffer will store values prior to the trigger point and the remainder of the buffer will store values after the trigger. Pressing the [F5] key will allow you to set the percentage of the trend buffer, allocated to values collected, after the trigger has occurred. This data field is modified in the same manner as the trigger data is entered.

### Starting the Trace

The changes do not take affect, and the trend is not started until you press [F10] and exit the screen. Any time prior to this you may cancel all the changes made after coming to the screen by pressing the [F7] key.

When you exit the screen, the trend is started and the screen such as [Figure 154](#) will show the trigger condition and the status. Pressing the [F7] key on the DIAGNOSTICS screen may also start the trend.

Figure 154 - Diagnostic Armed

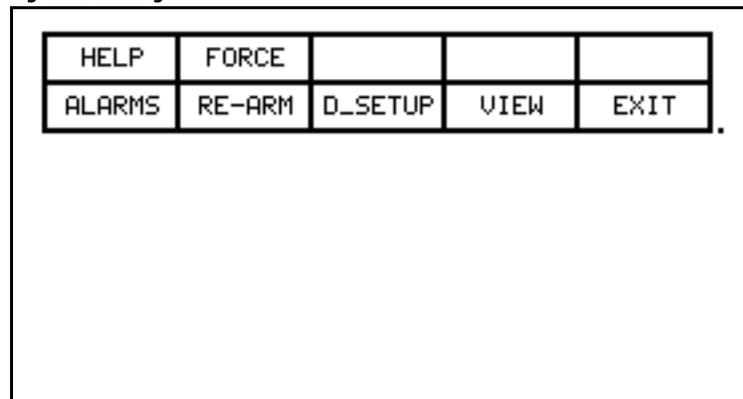


Figure 155 - Diagnostic Triggered

```

DIAGNOSTICS:

Trigger: U line          =    .000 PU
        Continuous

Status:  TRIGGERED

Last Trigger: Not Available

```

HELP	FORCE			
ALARMS	RE-ARM	D_SETUP	VIEW	EXIT

Once the data has started to be collected, the status will show 'triggered' as in [Figure 155](#). When the buffer contains a complete capture, it will show "stopped" (if a single capture), as shown in [Figure 156](#). The time and date at which the trigger occurred is displayed. The trend buffers may only be viewed when their status is 'stopped'. If in continuous mode, the capture will stop when the buffers are viewed. To view the trend buffers, press the [F9] key.

Figure 156 - Diagnostic Stopped

```

DIAGNOSTICS:

Trigger: U line          =    .000 PU
        Single

Status:  Stopped

Last Trigger: @ 14:15:35  00/10/06

```

HELP	FORCE			
ALARMS	RE-ARM	D_SETUP	VIEW	EXIT

Figure 157 - View the Trend Buffer(s)

```

DIAGNOSTICS VIEW:                                7 of 13

```

	Trace 1 [Hz ]	Trace 2 [Hz ]	Trace 3 [PU ]	Trace 4 [PU ]
	4.9	4.9	.883	.000
T->	5.1	5.1	.883	.000
	5.1	5.1	.883	.000
	5.2	5.2	.887	.000
	5.4	5.4	.887	.000
	5.4	5.4	.887	.000
	5.4	5.4	.887	.000
	5.4	5.4	.887	.000

ALARMS		NEXT PG	PREV PG	EXIT
--------	--	---------	---------	------

A screen such as [Figure 157](#) will be shown. Upon initial entry, the screen will be positioned to the trigger point, shown by the "T ->". To view data either side of the trigger point, press the [F8] and [F9] keys.

Changes made to the diagnostic list setup are not permanent unless they are saved to the NVRAM in the drive. Upon exiting the DIAGNOSTICS screen ([Figure 150](#)), you will be prompted to save the changes to NVRAM. Refer to the section [Message Prompting on page 134](#) for further details.

## Flash Memory Transfers

Flash memory is used to store data in a non-volatile environment that is it is not lost when power is removed. The operator interface contains flash memory in two forms. The first is built into the operator interface. This form of flash is used to store the operator interface's firmware and parameters from the drive. This information can also be stored on a removable flash memory card.

This second form of flash allows the data from one drive to be physically transferred to another drive for loading. All files on the flash card use a DOS format thus can be read or written by any PC that contains a PCMCIA drive. Flash memory cards which are supported are those that contain the following memory chips from INTEL:

- 28F010
- 28F020
- 28F008SA
- 28F016SA

These chips are used in the following memory cards available from Rockwell Automation:

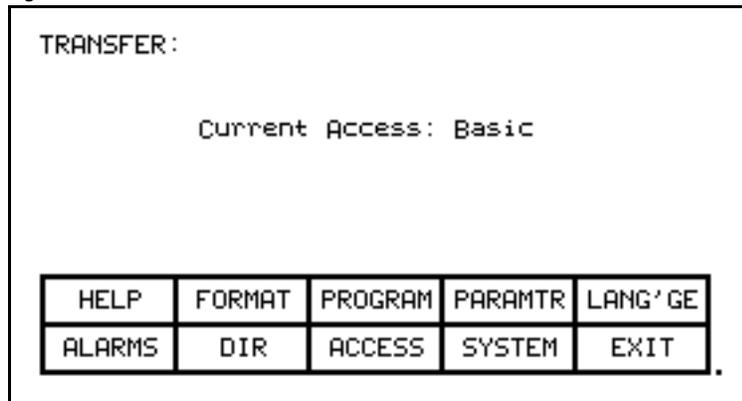
- 2711-NM11
- 2711-NM24
- 2711-NM12
- 2711-NM28
- 2711-NM14
- 2711-NM216

This section describes how you will transfer information between these two forms of flash memory and the drive. You will learn how to:

- Format a flash card.
- Look at the directory of files on a flash card containing the DOS file format.
- Select a program (firmware) from the flashcard and load it into the operator interface.
- Save the parameters from the drive on the flash card or in the operator interface.
- Download parameters to the drive from a flash card or that previously saved in the operator interface.
- Load a language module from the flash card.

You will access the Transfer operations from the Utility screen by pressing the [F7] key. This results in the display of the screen shown in [Figure 158](#).

**Figure 158 - Transfer Main Menu**



From this screen, additional screens are used to perform the various functions involving the flash memory. The screen shows the current access level of the operator interface. Any operation that will alter the contents of the flash memory or of the drive requires the access level to be something other than 'Monitor'. At the 'Monitor' level you may view the contents of the flash card. To change the access level, press the [F8] key. Refer to the section [Enter/Modify an Access Level on page 116](#).

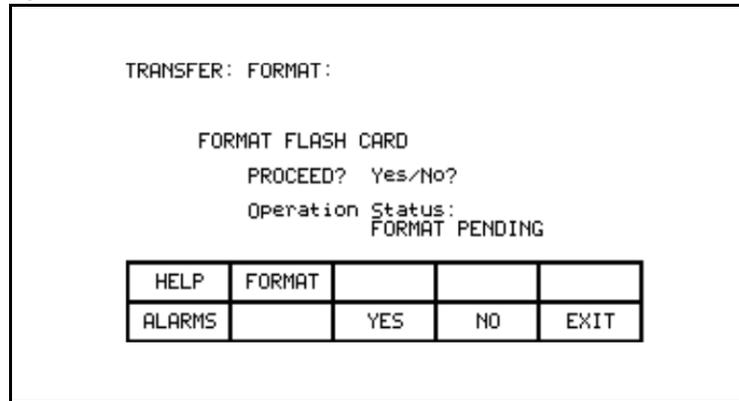
## Format Flash Card

Flash card files have a characteristic unlike normal DOS files. They can not be modified once written. New files can be added to the card; however they cannot be selectively removed.

When a new flash card is to be used or all the files removed from an existing card, the card must first be formatted. Formatting erases all data on the card and creates a DOS file structure.

To format a card press the [F2] key on the TRANSFER screen. The screen will appear as in [Figure 159](#), indicating the operation you are about to perform and showing the current status of the operation. (If nothing happens then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access).

**Figure 159 - Format the Flash Card**



The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Performing a format will overwrite all existing data on the flash card.

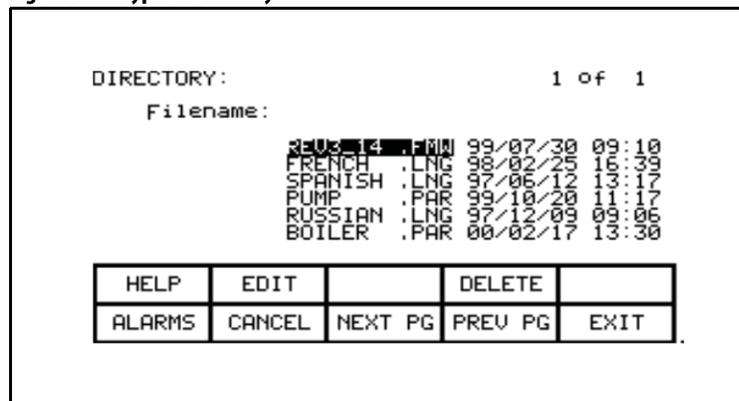
Formatting can take up to several minutes depending on the card involved. The status will indicate when the formatting is complete or if an error occurred.

Additional cards may be formatted from this screen by pressing the [F2] key.

### View a Directory

The directory of a flashcard is shown by pressing the [F7] key on the TRANSFER screen. The directory shows the filename and extension, along with a date and time stamp of when the file was created. A screen typical of [Figure 160](#) will be shown.

**Figure 160 - Typical Directory**



Any screen or operation that requires a filename to be entered or picked from the directory uses this DIRECTORY screen. It is always obtainable from the [F7] key on any applicable screen.

When the directory is entered from the TRANSFER screen, all files will be shown. When entered from one of the operations screens, only the files that are relevant to the operation being performed will be shown.

Only the root directory of the card is used, as sub directories are not supported in the operator interface.

## Select a Filename

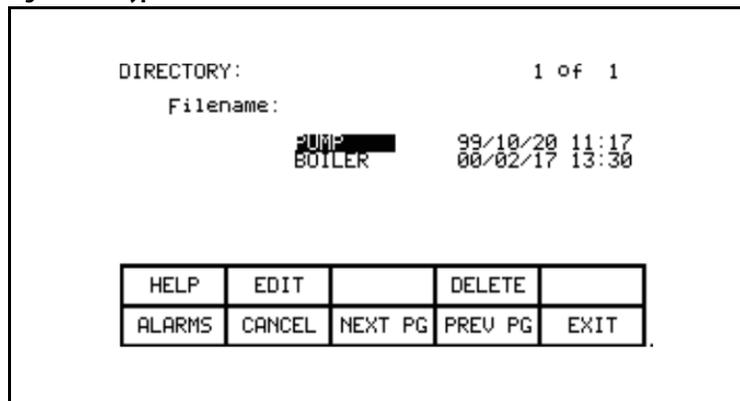
When working with existing files on the flash card, it is necessary to pick a file from the directory in order to use in the operation being performed. When the DIRECTORY screen is entered, all files that are relevant to the operation are displayed. The [cursor up] and [cursor down] keys are then used to select the desired file. Pressing [Enter] will select the file and proceed with the operation.

Press the [F10] key to abort the selection operation and return to the previous screen without continuing with the operation.

## Enter a Filename

When a new file is being created, the DIRECTORY screen is used to enter the new filename. Upon entering the screen all existing files relevant to the operation are shown as shown in [Figure 161](#).

**Figure 161 - Typical File Selection**



An existing filename can be used as a basis for the new filename by first selecting that filename. Press the [F2] key. The filename can now be edited. Refer to the section entitled “Edit Text” for further details. When complete, pressing the [Enter] key will proceed with the operation.

## Loading Programs (Firmware)

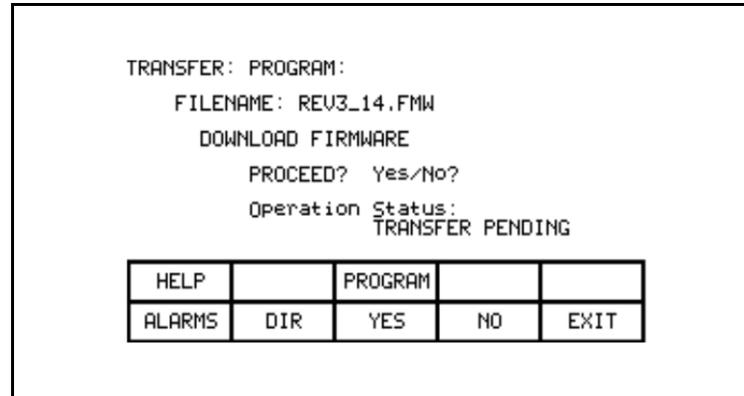
Firmware is the program that is run in the operator interface to provide all the functionality described in this manual. Firmware is loaded from the flash card in one of two ways:

1. If an operator interface has a memory card inserted when it is powered up or rebooted, and that card has a valid firmware file with the extension of .FMW, the operator interface will automatically load the first .FMW file it encounters on the card.
2. The user can select from one or more .FMW files on the card and load the selected firmware into the operator interface. This is the method that will be described here.

From the TRANSFER screen, press the [F3] key. The operator interface will enter the DIRECTORY screen from which an existing firmware filename can be selected or entered. Refer to the sections entitled “Select a filename” and “Enter a filename”. (If nothing happens then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access).

When the filename has been obtained, the TRANSFER: PROGRAM screen such as that in [Figure 162](#) will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

**Figure 162 - Load New Firmware**



The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Performing a DOWNLOAD FIRMWARE operation will overwrite the existing firmware that is currently running.

Pressing the [F3] key may restart an aborted download or one that failed prior to starting the download. To select or enter a different filename, press the [F7] key.

Due to the nature of this operation, all other operator interface functions will cease during a download. Once the download begins, the operator interface’s screen will be unable to show any status information. For this reason the two LEDs on the back of the operator interface are used as such:

- **Flashing Green** - indicates that all is healthy and the transfer is proceeding.

- **Solid Red** - the transfer has failed. Firmware must be loaded via the method described in a) above. This is achieved by cycling power to the operator interface or simultaneously pressing the [cursor left] [cursor right] and [Enter] key at the same time while the flash card is inserted. If more than one firmware file exists on the card, the first one will be loaded and this process will need to be repeated in order to select the firmware file you desire. When the transfer completes successfully, the new firmware will automatically begin operation. Refer to the section [Operator Interface Power-up Sequence on page 99](#).



**WARNING:** Any time the operator interface is powered up with a flash card inserted which contains a valid firmware \*.FMW file, the operator interface will attempt to load new firmware (note item 'a' above). For this reason, it is not advisable to leave a memory card containing a firmware file in the operator interface, after the firmware has been downloaded.

## Parameter Transfers

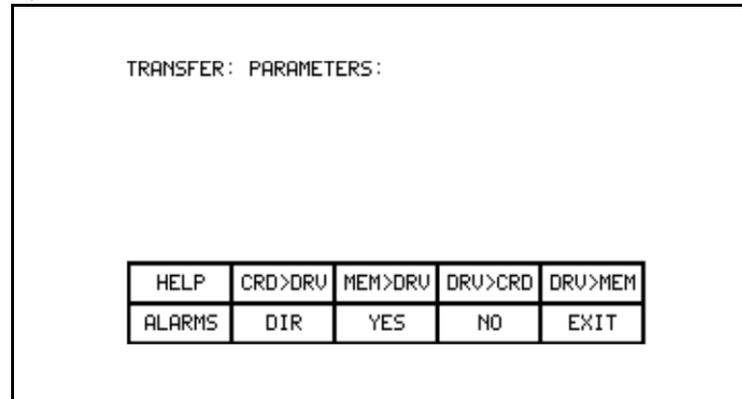
The parameters used by the drive are stored within the drive itself. The operator interface is used to review and modify these parameters. When a Drive Control Board is changed, it is necessary to re-enter the parameters into the new board. The operator interface can simplify this process by reading all the parameters from the old Drive Control Board and storing them either in the operator interface or on a flash card. When the new board has been installed, the previously stored parameters are then downloaded to the new board.

The flash card provides an added benefit when more than one drive is using the same set of parameters. Parameters can be entered on the first drive, then uploaded and stored on the flash card. The flash card may then be taken to the remaining drives and the parameters downloaded to those drives.

**Note:** This feature does not replace the saving of parameters to the Drive NVRAM, refer to section Store/Retrieve Configuration (NVRAM). After downloading parameters, they must still be saved within the drive in order to make them permanent.

To transfer parameters, press the [F4] key from the TRANSFER screen. The screen shown in [Figure 163](#) will be displayed. (If nothing happens, then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access). Within this screen it is possible to perform four different parameter transfers.

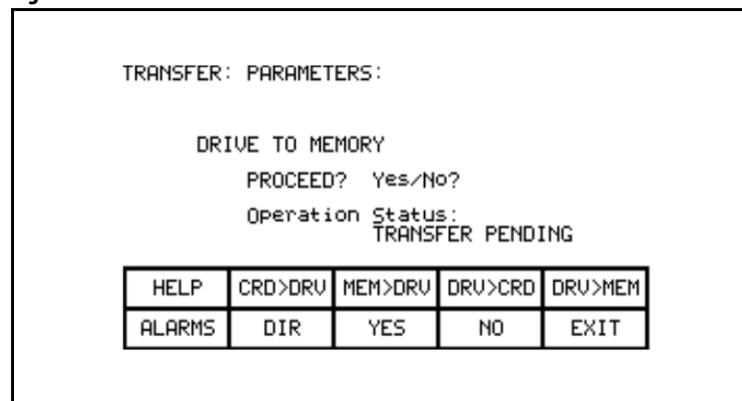
Figure 163 - Transfer Parameters Menu



## Upload to Operator Interface

The parameters are read from the drive and stored in the operator interface by pressing the [F5] key. The screen will appear as in [Figure 164](#), indicating the operation you are about to perform. The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Performing a “DRIVE TO MEMORY” transfer will overwrite any previous parameters stored within the operator interface.

Figure 164 - Transfer Stored Parameters



## Download from Operator Interface

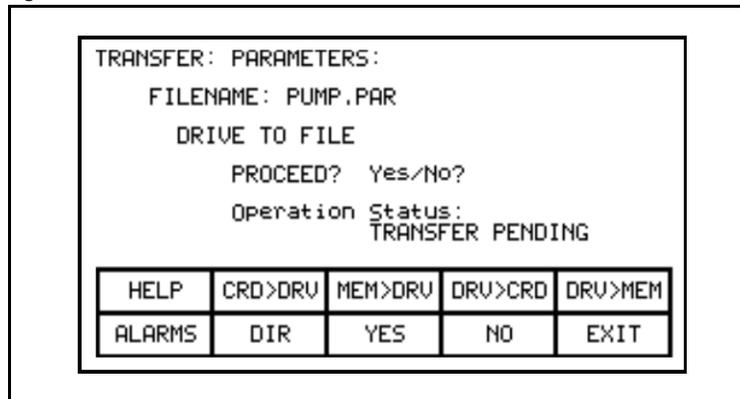
The parameters stored in the operator interface are downloaded to the drive by pressing the [F3] key. A screen similar to that shown in [Figure 164](#) will be shown (except the operation will show “MEMORY TO DRIVE”). To confirm the operation, press the [F8] key to proceed, or the [F9] key to abort. Performing a “MEMORY TO DRIVE” transfer will overwrite the active parameters in the drive. It will not affect the parameters stored within the drive’s NVRAM.

After parameters have been downloaded you will be prompted to make the new parameters downloaded to the drive permanent. Refer to section “Message Prompting” for further details.

## Upload to Memory Card

The parameters are read from the drive and stored on a memory card by pressing the [F4] key. The operator interface will enter the DIRECTORY screen in which a parameter filename can be entered. Refer to the section entitled [Enter a Filename on page 151](#). When the filename has been obtained, the TRANSFER: PARAMETERS screen such as that in [Figure 165](#) will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

**Figure 165 - Transfer File Parameters**



The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Pressing the [F4] key may restart an aborted transfer or one that failed. To select or enter a different filename, press the [F7] key.

## Download from Memory Card

The parameters are read from a memory card and written to the drive by pressing the [F2] key. The operator interface will enter the DIRECTORY screen from which an existing parameter filename can be selected or entered. Refer to the sections entitled [Select a Filename on page 151](#) and [Enter a Filename on page 151](#). When the filename has been obtained, the TRANSFER: PARAMETERS screen similar to that shown in [Figure 165](#) (except the operation will show “FILE TO DRIVE”) will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Pressing the [F4] key may restart an aborted transfer or one that failed. To select or enter a different filename, press the [F7] key.

## Parameter File Format

The parameter file stored on the flash card is in a DOS file format. This parameter file can be created off-line on a PC using any ASCII text editor and then written to the memory card via a PCMCIA Card Drive.

Information in this section is not needed to operate the operator interface. It is required knowledge if you wish to create a parameter file off-line and then download into a drive. The filename must have the extension of \*.PAR in order to be recognized as a parameter file. The format of the file is as follows:

1. First Line:
  - a. a revision number followed by a semi-colon (;). Number is not important.
  - b. the date followed by a semi-colon, i.e. 01/01/1996. Date is not important.
  - c. the time followed by a semi-colon, i.e. 12:01:01. Time is not important.
2. Remaining Lines:
  - a. each line contains one parameter. The line consists of the linear parameter number followed by a semi-colon, and the parameter value followed by a semi-colon. For example:  
1;0;  
2;0;  
5;2;

## Loading Language Modules

In order to use a language in the operator interface, it must first be loaded into the operator interface from the flash card.

From the TRANSFER screen, press the [F5] key. The operator interface will enter the DIRECTORY screen, from which an existing language module filename can be selected or entered, [Figure 166](#). Refer to the sections entitled [Select a Filename on page 151](#) and [Enter a Filename on page 151](#). (If nothing happens then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled [Enter/Modify an Access Level on page 116](#) to gain access).

When the filename has been obtained, the TRANSFER: LANGUAGE screen such as that in [Figure 167](#) will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

Figure 166 - Language Directory

DIRECTORY:		1 of 1		
Filename:				
	FRENCH	98/02/25	16:39	
	SPANISH	97/06/12	13:17	
	RUSSIAN	97/12/09	09:06	
HELP	EDIT		DELETE	
ALARMS	CANCEL	NEXT PG	PREV PG	EXIT

Figure 167 - Transfer Language Module

TRANSFER: LANGUAGE:				
FILENAME: FRENCH.LNG				
DOWNLOAD LANGUAGE				
PROCEED? Yes/No?				
Operation Status:				
TRANSFER PENDING				
HELP	CLEAR			LANG'GE
ALARMS	DIR	YES	NO	EXIT

The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. If an attempt to download a language module that already exists is made, the transfer will fail.

In order to download a newer version of a language, all languages in the operator interface must first be cleared (this is a characteristic of flash memory) by pressing the [F2] key on the TRANSFER:LANGUAGE screen. The screen as in [Figure 168](#) will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort.

Figure 168 - Clear Languages

TRANSFER: LANGUAGE:				
CLEAR LANGUAGES				
PROCEED? Yes/No?				
Operation Status:				
CLEAR PENDING				
HELP	CLEAR			LANG'GE
ALARMS	DIR	YES	NO	EXIT

Pressing the [F5] key may restart an aborted download or one that failed. To select or enter a different filename, press the [F7] key.

## System Programming

The firmware for the complete drive system may be updated via serial port #2 on the Customer Interface Board. Pressing the [F9] key from the transfer screen will place the drive system into download mode.

## Advanced Screen Operations

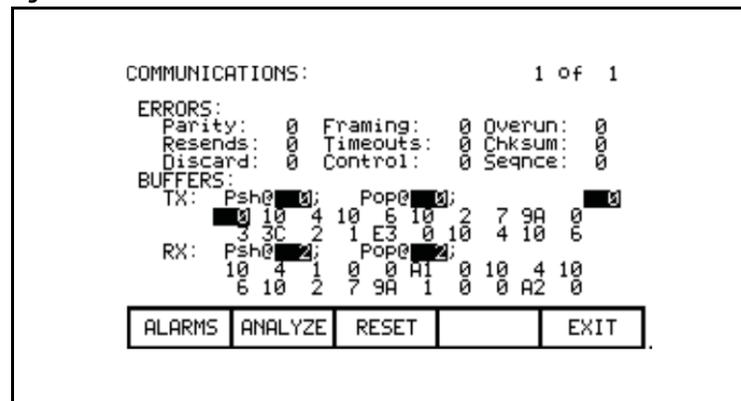
A number of advanced functions have been incorporated into the operator interface. These operations are not required to operate the drive. They are meant as service tools for trained technicians and have been included here only for completeness.

All operations are accessed via a two key sequence.

## Communications Statistics

The screen, depicted in [Figure 169](#) shows statistics involving the serial communications between the operator interface and the drive as well as the contents of the transmit and receive buffers. It is called from any screen (except the PRINTER screen), by pressing the [F10] key and the [cursor down] key at the same time.

**Figure 169 - Communications Statistics & Buffer**



The ERRORS show the number of occurrences of a particular error since the last time the counters were reset.

- **Parity:** number of parity errors in characters received.
- **Framing:** number of framing errors in the characters received.
- **Overrun:** number of characters received that were not read prior to accepting the next character.
- **Resends:** number of times the operator interface had to resend data due to a NACK being sent by the drive.
- **Timeouts:** number of times the operator interface did not receive data from the drive within a specified time period.

- **Chksum:** number of times the operator interface detected a checksum error in the data it received from the drive.
- **Discard:** number of characters discarded by the operator interface, as they were not what was anticipated.
- **Control:** number of control codes that did not conform to the anticipated ACK or NACK. The operator interface will have assumed ACK, which if wrong will result in a time-out error.
- **Seqnce:** number of responses from the drive that did not correspond to the last request sent.

To reset the above counters, press the [F8] key.

The BUFFERS show the current contents (in hexadecimal) of the Transmit (TX) and Receive (RX) buffers contained in the operator interface. These buffers are circular in nature. The Psh (push) and Pop values indicate the location in the buffer where the next character will be loaded or unloaded respectively. If the values are equal, then the buffer is empty. To aid in viewing the buffer locations, the cursor keys can be used to highlight the buffer contents. The current location of the cursor is shown in reverse video in the mid-right screen.

## Protocol Analyzer

The protocol analyzer is accessed from the COMMUNICATIONS screen by pressing the [F7] key. The screen shows the data and the relationship of the data exchanged between the operator interface and the drive board. This data can be displayed in either one of two formats:

- the data shown in hexadecimal ([Figure 170](#))
- the data shown as a mixture ([Figure 171](#)) of:
  - control characters
  - printable ASCII characters
  - hexadecimal data

**Figure 170 - Hexadecimal displayed**

```

PROTOCOL ANALYZER:                               1 of 13
RX:  01 10 04
TX:  10 06 10 02 07 F8 00
RX:  10 06
TX:  01 00 00 06 06 01 10 04
RX:  10 02 00 F8 01 4E 6F 74 20 52
TX:
RX:  65 61 64 79 20 20 20 9F 04 10
TX:
ALARMS TOGGLE NEXT PG PREV PG EXIT

```

Figure 171 - Mixed Format Displayed

```

PROTOCOL ANALYZER:                               1 of 13
RX:  01 DL ET
TX:                                DL AK DL ST 07 F8 00
RX:
TX:                                01 00 00 AK AK 01 DL ET DL AK
RX:  DL ST 00 F8 01 N o t R
TX:
RX:  e a d y                                9F ET DL
TX:
ALARMS TOGGLE NEXT PG PREV PG EXIT

```

Pressing the [F7] key changes the format of the displayed data. When data is shown as a mixture, a particular value is displayed based on the priority defined above, (control characters is highest).

The RX row displays data received by the operator interface. The TX row displays the data transmitted by the operator interface.

## Print Screen

The print screen operation allows a screen dump of the operator interface's display. This requires the use of a second RS232 port communicating at 9600 Baud to an external computer. Special software is required in the computer to receive the data and to interpret the data.

The operation is initiated from any screen by pressing the [F10] key and the [cursor right] key at the same time. The screen will clear and a message will indicate that the screen is being printed as well as the percentage completed. When complete, the original screen will return.

## Memory Dump

The memory dump allows any directly accessible memory (i.e. memory which is directly addressable and does not require access through a port) to be monitored. It is called from any screen (except the PRINTER screen), by pressing the [F10] key and the [cursor left] key at the same time.

Figure 172 - Data Segment Memory Dump

```

MEMORY:
SEGMENT: 0040
0000: AA 55 00 10 00 00 02 0A : U.....
0008: 31 2E 30 30 00 31 2E 30 : 1.00.1.0
0010: 30 00 31 2E 30 30 00 45 : 0.1.00.E
0018: 6E 67 6C 69 73 68 00 31 : nglsh.1
0020: 2E 30 30 00 40 01 40 00 : .00.0.0.
0028: 44 01 40 00 FF FF 45 01 : 0.0...E.
0030: 40 00 00 00 00 00 06 11 : 0.....:
0038: 40 00 AC 00 82 12 40 00 : 0.....0.

ALARMS ADDRESS NEXT PG PREV PG EXIT

```

The initial screen, (Figure 172) shows the data segment by default. Each screen shows the segment (in hex) which is being viewed. In the left column is the starting address (in hex) for the row of data. Eight bytes of data are shown in Hex, followed by the equivalent eight ASCII characters (if relevant). Additional data within the segment is viewed by pressing the [F8] and [F9] keys.

To change the segment and/or offset being viewed, press the [F7] key. A display similar to Figure 173 will be shown. Each successive press of the [F7] key toggles between highlighting the segment and offset value. The highlighted value is the field that is currently being edited.

Figure 173 - Edit the Segment: Offset

```

MEMORY:
SEGMENT: 0040 New Address: A000: 18
0000: AA 55 00 10 00 00 02 0A : U.....
0008: 32 2E 30 30 00 32 2E 30 : 2.00.2.0
0010: 30 00 32 2E 30 30 00 45 : 0.2.00.E
0018: 6E 67 6C 69 73 68 00 32 : nglsh.2
0020: 2E 30 30 00 4C 01 40 00 : .00.L.0.
0028: 50 01 40 00 FF FF 51 01 : P.0...0.
0030: 40 00 00 00 00 00 96 13 : 0.....:
0038: 40 00 C0 00 56 14 40 00 : 0...U.0.

ALARMS ADDRESS NEXT PG PREV PG EXIT

```

The segment:offset address is edited via the numeric keypad and the arrow keys. All values of [0...9] can be entered directly via the numeric keypad. To enter a value of [A...F], the [cursor up] and [cursor down] keys must be used to cycle through the possible values. Note that the value [0...9] can also be entered via this method. Once a digit has been entered via the arrow keys, it must be accepted by means of the [cursor right] key.

The value may be edited via the [cursor left] key, which acts as a backspace to remove the last digit entered. The value is accepted by pressing either the [enter] or [F7] key. The edited segment:offset can be aborted by pressing the [delete] key. To accept the segment:offset value entered, press the [enter] key. The screen will show the data at the entered address, as shown in Figure 174.

Figure 174 - Data at New Address

```

MEMORY:
SEGMENT: A000
0018: 00 00 00 00 00 00 58 4B : .....XK
0020: 40 00 01 00 14 00 88 4B : @.....K
0028: 40 00 E6 26 40 77 18 05 : @..&Mw..
0030: 40 00 01 00 00 00 56 14 : @.....U.
0038: 40 00 00 00 00 00 00 00 : @.....
0040: 00 00 60 00 5A 14 40 00 : ..\Z.@.
0048: 0C 01 EB 82 2A 01 64 A0 : .....*.d.
0050: 62 00 56 14 40 00 00 00 : b.U.e...

```

ALARMS	ADDRESS	NEXT PG	PREV PG	EXIT
--------	---------	---------	---------	------

## Database Download

The database download operation allows the operator interface to obtain the majority of the information it requires on your command (instead of as needed). The operation is initiated from any screen by pressing the [F10] key and the [cursor up] key at the same time.

Obtaining the entire drive database is a lengthy process. As the operator interface is receiving the database, it will display what portion of the database it is currently obtaining, and the percent done. If the operator interface is successful in obtaining the complete database, it will display a message indicating such and wait for a key press from you. If unsuccessful, it will immediately return to the screen from which this call was made. The download may be aborted at any time by pressing any key on the operator interface. The portion of the database already obtained will be valid. A subsequent request to download the database will continue from where the previous download had terminated.

This screen will always return to the screen from which the download was requested.

## Operator Interface Menu Hierarchy Chart

The screens of the operator interface are used to form a menu driven system to access the various operations in the drive. The hierarchy of this menu system is shown in [Figure 175](#) and [Figure 176](#).

## What Does It Show?

The chart shows the relationship between screens and a particular operation. It also shows the path to reach a particular screen. This chart does not introduce you to the use of the operator interface, however is useful as a reference to the preceding material.

## How Do You Read It?

Each of the boxes represents a screen and contains the screen name. From a particular screen, a downward arrow shows what other screens can be displayed and which function key is required to move to that screen. Pressing exit [F10] on the screen will move you in the opposite direction, returning you to the screen from which you came.

A lateral arrow shows to which screen you can move by pressing the [enter] key while making a selection. Again pressing exit [F10] on the screen will move you in the opposite lateral direction, returning you to the screen from which you came.

Some of the operations have screens in common. These are shown only once on the diagram. Their use is indicated by symbols inserted into a circle. For example: The ACCESS screen is displayed from the MAINMENU by pressing the [F10] key. In this location (marked by an \*), the operation of the screens ACCESS and PASSWORD CHANGE are shown in their entirety. These operations are also available from the MODIFY PARAMETER screen and SETUP screens by pressing the [F8] key. At these locations, the operation of screens is represented by the symbol 'P', which represents the same flow as previously defined.

For sake of clarity, the soft function key calls to the HELP operation and the ALARMS screen have not been shown. It is implied that all screens have this ability via the F1 and F6 keys respectively.

## Example

As an example of using the chart, we will modify a parameter while displaying it, starting from the Top Level Menu referred to in the chart as the MAINMENU screen. This example assumes you have read the previous sections of this manual. The example will concentrate more on the flow of screens and how it relates to the chart, rather than the actual operations being performed by each screen. The symbols refer to those of the chart. Descriptions of movement, i.e. lateral, refer to flow depicted on the chart.

Displaying the MAINMENU, press the [F4] key. The DISPLAY GROUP screen is now shown. Cursor to a parameter group and press the [enter] key. This laterally moves us to the DISPLAY screen. Since you selected a parameter group, pressing the [F7] key takes us into a selection operation (symbol 'D') in which the SELECT screen is displayed. This allows us to use the cursor keys to select the desired parameter.

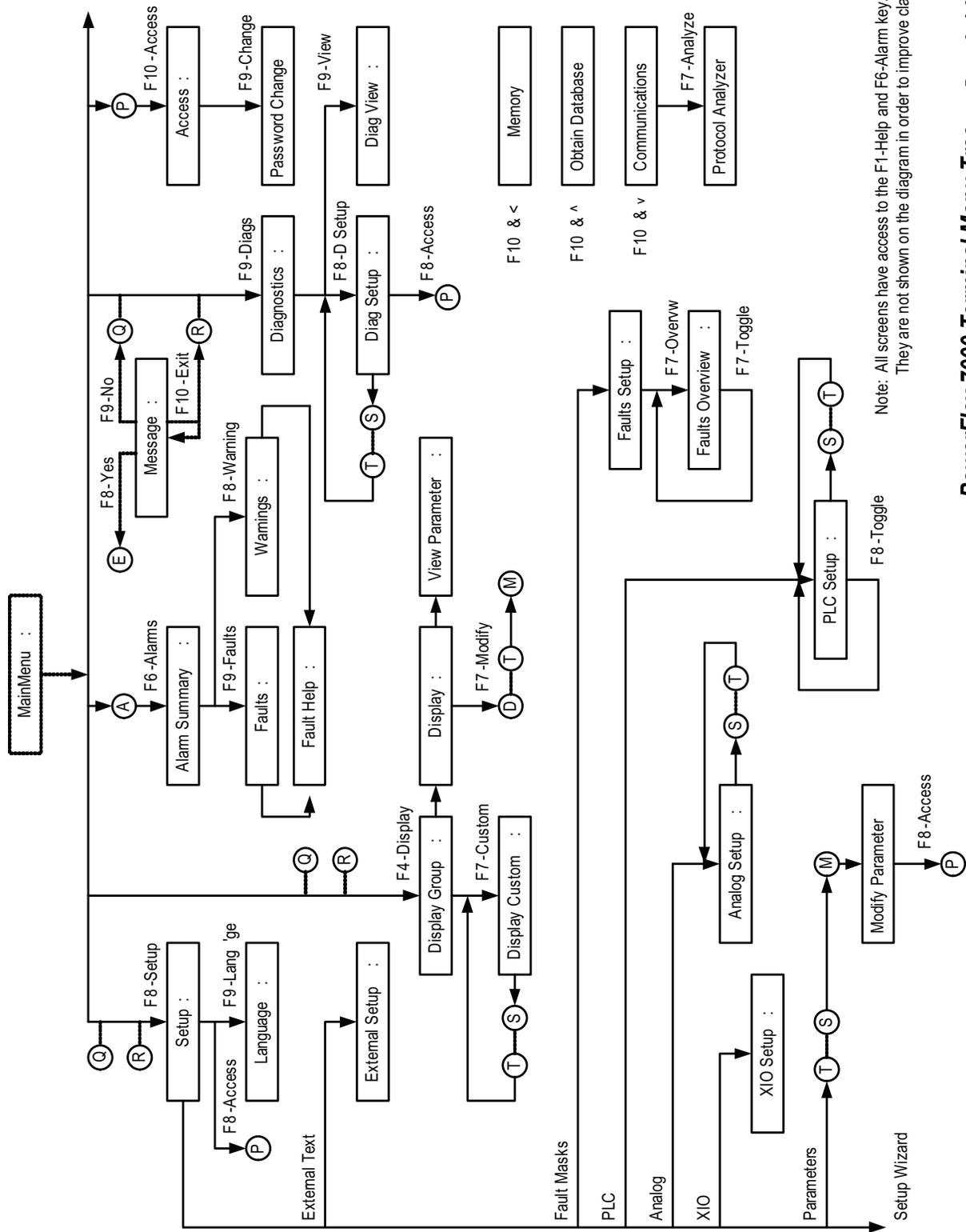
Pressing the [enter] key laterally moves us to the symbol T which ends the selection process. For this example, the symbol T laterally moves to the symbol M that defines a new process in which the selected parameter can be modified. The MODIFY PARAMETER screen is now displayed.

To change the parameter, you must have the proper access to it. If required press the [F8] key to display the ACCESS screen, as represented by the symbol P. Obtain the access from this screen and press [F10] to exit. This will return you to the MODIFY PARAMETER screen. When you are finished with this screen, press [F10] exit and you will be returned to the SELECT screen (via symbols M and T). Pressing [F10] again will return you to the DISPLAY screen (via the symbol D). Successive presses of the [F10] key will return you to the DISPLAY GROUP and finally to either the MAINMENU or the MESSAGE screens.

If you have changed any data in the drive, the [F10] Exit key will bring up the MESSAGE screen. The message will remind you that the changes made in the drive are only temporary, unless saved to NVRAM. If you desire the data to be temporary, press [F9] 'No' and you will continue onto the MAINMENU. If you press [F8] 'Yes', the NVRAM screen is entered, from which you can save the data. Exiting the NVRAM screen returns you to the MAINMENU. Pressing the [F10] Exit key on the MESSAGE screen will return you to the DISPLAY GROUP screen.



Figure 176 - Menu Hierarchy (cont'd)



## PCMCIA Memory Card Installation Data

### Description

The memory card slides into the card slot located on the backside of the PowerFlex 7000 drive operator interface. These instructions show how to insert the card in the Operator interface.



**WARNING:** The memory card should be kept free from moisture, extreme temperatures, and direct sunlight. Failure to observe this caution could result in damage to the card.

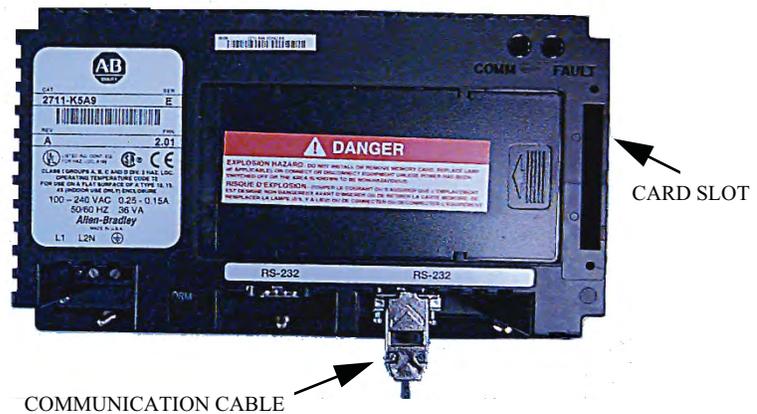


**WARNING:** Do not subject memory card to flexing or extreme shock. Failure to observe this caution could result in damage to the card.

### Installing the Memory Card

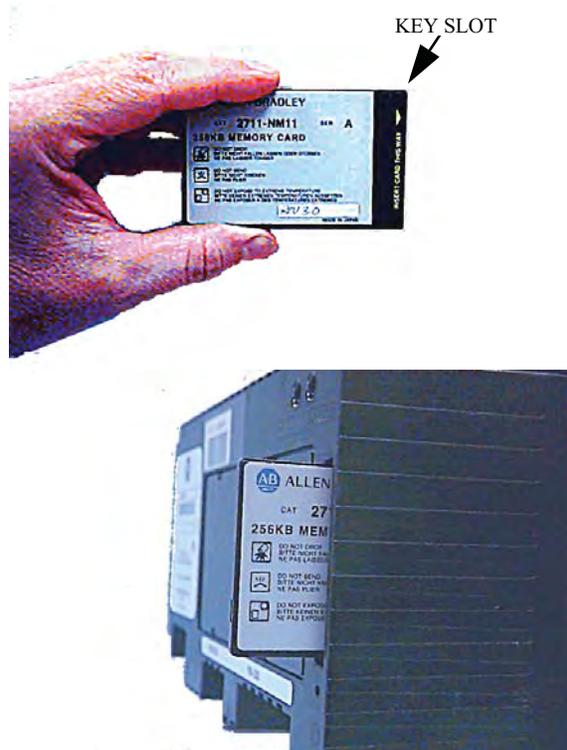
1. Locate the vertical card slot on the back of the operator interface. See [Figure 177](#).

**Figure 177 - Rear View of Operator Interface**



2. Position the card vertically so the key slot is facing the right side of the operator interface.

Figure 178 - Key Slot Orientation



3. Insert the card into the card slot and push until the card is firmly seated.



**WARNING:** Do not force the card into the slot. Forcing the card into the slot may damage the connector pins.

---

## Commissioning

### Start-up Commissioning Services

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

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

Rockwell Automation recommends the following:

### Drive Commissioning

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

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

**TIP** Customer personnel will be required on-site to participate in the start-up of the system.

## Commissioning the Drive

**Information contained in this chapter will assist in commissioning a PowerFlex liquid-cooled medium voltage AC drive. This chapter contains reference material with information including:**

- Recommended Tools and Equipment
- Safety Checks
- Drive line-up Data Sheets
- Pre-Power Checks
- Control Power Checks

Review the information contained in this chapter prior to commissioning the drive. It will be used as a reference while the drive line-up commissioning is performed. **Record all the information requested in the data sheets. The information recorded on the data sheets will be useful during future maintenance and troubleshooting exercises.**

Perform the commissioning checks illustrated in this chapter in the sequence that they have been presented. Failure to do so may result in equipment failure or personal injury.



**ATTENTION:** Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Recommended practice is to disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. 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 Work places, must be followed.

---

Notwithstanding the safety references here, all local codes and safety practices are to be utilized when working on this product.



**ATTENTION:** The CMOS devices used on the control circuit boards can be destroyed or damaged by static charges. If personnel will be working near static sensitive devices, they must be appropriately grounded.

---

## Pre-Commissioning Responsibilities

In order to avoid complications during commissioning, it is important to ensure that the drive line-up is ready to be commissioned. Included in this chapter is a seven-point Pre-Commissioning Checklist. It is necessary that the checklist be reviewed to ensure that all points are completed in the order that they have been presented prior to beginning the drive commissioning. Completing the items in the checklist prior to commencing drive commissioning will help to ensure that the start-up is performed in an organized and efficient manner.

Please print the following information:

Medium Voltage - Center of Expertise Fax: 1 (866) 465-0103, or 1 (519) 740-4756	Name:	Date:
	Company:	
	Phone:	Pages:
	Fax:	

## PowerFlex 7000 'C' Frame Pre-Commissioning Checklist

Once all points of the checklist are complete, initial each check box and provide the date. Photocopy the checklist and fax the copy to Medium Voltage Center of Expertise (MV COE), along with the planned start-up date. Upon receiving this checklist, the MV COE will contact the site to finalize arrangements for a start-up engineer to travel to site if so desired by the end user.

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

## Receiving and Unpacking

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

## Installation / Mounting

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

## Safety

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

## Control Wiring

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

## Power Wiring

Initials	Date	
		The power cable connections to the drive, motor and isolation transformer adhere to CEC, NEC, IEC or appropriate local standards.
		The cable terminations, if stress cones are used, adhere to the appropriate standards.
		Appropriate cable insulation levels are adhered to, as per Rockwell Automation specifications (refer to tables in Chapter 2 of User Manual for Cable Insulation Requirements).
		All shields for shielded cables must be grounded at the source end only.
		If shielded cables are spliced, the shield must remain continuous and insulated from ground.
		All wire sizes used are selected by observing all applicable safety and CEC / NEC / IEC regulations.
		All power connections are torqued as per Rockwell Automation Specifications. (See <a href="#">page 419</a> ).
		All customer power cabling has been Meggered or Hi-Pot tested before connecting to drive system.
		Power wiring phase rotation has been verified per the specific electrical diagrams supplied by Rockwell Automation.

## Drive Line-up Status

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

## Cooling System Status

Initials	Date	
		The barrel of coolant is present. (Glycol and de-ionized water may not be used in the future).
		The liquid-to-air heat exchanger has been installed and wired (if necessary).
		For liquid-to-liquid heat exchangers, the source of cooling water has been connected and testing.
		Piping from the drive to the heat exchanger has been completed. The piping should be copper, CPVC, HDPE, or stainless steel. Do not use lead solder for connections.
		Piping is clear from construction debris.



## Commissioning Preparation

The following section identifies all the tools and resources required to successfully commission a PowerFlex 7000 “C” Frame drive line-up. In addition, it identifies how to obtain the required equipment in the event that it is not readily available prior to commissioning the drive. It is recommended that all items listed below be obtained prior to attempting to commission the drive. Ensure that the contents of this section are reviewed and that the uses of the equipment described within are understood prior to commencing commissioning of the drive. If further support or additional information is required, contact your local Rockwell Automation service office or Medium Voltage Support at (519) 740-4790.

## Recommended Tools and Equipment

### *Hand Tools*

- Metric and Imperial wrenches, sockets, and Hex keys
- Torque wrench
- Assortment of screw drivers
- Assortment of electrical tools (wire strippers, electrical tape, crimpers, etc.)

### *Electrical Equipment*

- High voltage gloves – 10 kV insulation rating (minimum)
- Approved high voltage potential tester – 10 kV rating (minimum)
- Anti-static strap

### *Test Equipment*

- 100 MHz oscilloscope with at least two channels and memory
- 600V (1000V rating) digital multimeter with assorted clip leads
- 5000V megohmmeter

### *Computer Requirements and Software*

- Laptop computer (486 or higher installed with Microsoft (MS) Windows)
- Microsoft HyperTerminal (Provided with MS Windows)
- Rockwell Automation Software (RS) drive tools (Optional)
- RS Logix<sup>(1)</sup>
- Required computer cables
  - 9-Pin Null Modem<sup>(2)</sup>
  - 9-Pin Serial<sup>(2)</sup>
  - Remote I/O (SCANport DeviceNet...)<sup>(3)</sup>
  - PLC Communications Cable<sup>(1)</sup>

(1) Only required when PLC has been provided with the drive.

(2) Refer to Publication 7000-UM151\_-EN-P, Chapter 5 – Component Definition and Maintenance.

(3) Only required when Remote I/O has been provided with the drive.

## Technical Publications

Each drive is shipped with a service binder containing all technical publications required to commission and troubleshoot the drive line-up. This section describes how to determine what technical publications are required and how to obtain them in the event that the service binder is not available at the time of commissioning or additional information is required.

## PowerFlex 7000 “C” Frame Manual

The PowerFlex 7000 “C” Frame manual will be required during drive commissioning to guide you through each commissioning procedure. Copies of the manual or new revisions of the manual can be requested from your local Rockwell Automation Office.

## PowerFlex 7000 Parameters

The PowerFlex 7000 Technical Data publication for Parameters is also required for Commissioning and Troubleshooting. Refer to [7000-TD002\\_-EN-P](#) for the latest firmware revision.

## Additional Manuals

Any additional manual required to configure the drive line-up can be identified on the Electrical Schematics. The Schematic titled “General Notes” identifies all required Rockwell Automation Publications by publication number.

## Resources Required to Complete Drive Commissioning

Prior to attempting to commission the drive ensure you have the following:

- Self powered gate driver board test power cable wire harness (Part no. 80018-298-51) supplied with SCR rectifier drives only
- Rockwell Automation electrical and mechanical diagrams
- PLC program (if supplied with a PLC)
- Commissioning data sheets
- All required manuals

If any of the above information is not available prior to the time of commissioning, please contact the factory.

## Important Note for Commissioning Engineer

The Commissioning Engineer is advised to go through this commissioning package and follow the steps outlined herein to commission PowerFlex 7000 drive(s). It is the responsibility of the commissioning engineer to complete all datasheets included in this package and collect any other relevant information that may not have been included in the package.

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**IMPORTANT** Important guidelines for capturing waveforms are also included in the package for quick reference. These must be reviewed and followed properly by the commissioning engineer.

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Anything that is not clear, please contact MV Tech Support for assistance:

Phone: **519-740-4790**

**Option 1** for technical and **Option 4** for commissioning questions

[MVSupport\\_technical@ra.rockwell.com](mailto:MVSupport_technical@ra.rockwell.com) or  
[MVSupport\\_services@ra.rockwell.com](mailto:MVSupport_services@ra.rockwell.com)

After successful commissioning of the drive, the commissioning engineer is required to return the completed commissioning package along with his field service reports to the project manager within one week after completion of job. If job is not completed and some data collected it must be sent to project manager within one week after leaving the site. The items listed below **MUST** be included when submitting the commissioning package.

1. All checklists and tables in this document (commissioning checklist, customer data, motor data, daily service summary, etc.)
2. Harmonics waveforms must be captured on AFE drives under drive-not-running and full-load conditions
3. DC current test waveforms (dc voltage and dc current) and variables while running DC test
4. Load Test waveforms (line and load voltage and current waveforms at 50% and 100% load or whatever maximum load and speed allowed by the customer)
5. Final drive parameter settings and variables (running motor at max speed and load) captured at *SERVICE LEVEL ACCESS*.
6. Modified PLC program (if applicable)
7. Synchronous transfer waveforms (for synchronous transfer applications)
8. Marked-up drawings
9. Summary of issues/failures encountered during commissioning

All documents and data files (waveforms, parameter settings, variables, trend data, etc.) submitted by the commissioning engineer must be properly named, labeled and organized.

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**IMPORTANT** If the commissioning datasheets submitted by the commissioning engineer are incomplete and/or the required commissioning data, such as harmonic waveforms, dc test waveforms, sync xfer waveforms etc., are not captured correctly or the required data is missing, then it can delay the processing of expense invoices submitted by the engineer.

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**IMPORTANT** While the FSE is still at the site, he MUST send the following information to MV Tech Support for review via e-mail at [mvsupport\\_service@ra.rockwell](mailto:mvsupport_service@ra.rockwell).

- Drive setup after completing the auto-tuning.
- Drive variables captured in running condition (at load or no load or uncoupled or with load).
- Line voltage and line current waveforms for harmonics on AFE drives when drive is energized.

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## Key Steps to Commissioning a PowerFlex 7000 Drive

As a guide for a commissioning engineer, the major steps involved in the commissioning of medium voltage PowerFlex 7000 drives are outlined below in a sequential order. For detailed instructions, always refer to PowerFlex 7000 User Manual.

- Review the drawings and identify all sources of energy that apply to the drive system and get better understanding of the application to which the drive system is applied.
- Follow Safety Procedures and apply LOTO before working on the equipment
- Complete all Power Off checks and note down motor and drive nameplate data
- Apply control power and perform Power On checks
- Perform Gating Test
- Program the drive after verifying the information on EDs and DDs against the equipment nameplate data.
- Perform System Test and verify operation of the drive and the associated controls
- Remove any jumpers used during system test
- Inspect the drive line-up and ensure that no tools are left inside the cabinets before closing them.
- Apply medium voltage and complete incoming line phasing checks and take harmonic measurements
- Perform DC Test. Ensure that the Diagnostic Trend is setup and ready before attempting the DC Test
- Perform Stationary Autotune tests (first two autotune tests)
- Bump the motor for rotation check
- Complete Rotating Autotune tests (last autotune test)
- Save the parameters in NVRAM and also transfer them from Drive to Memory and also print the Drive Setup to your laptop
- Start the drive in normal operation, print variables and capture waveforms
- Complete commissioning documentation

## PowerFlex 7000 “C” Frame Commissioning Datasheets

It is imperative for Medium Voltage Product Support division to have the following information filled-out and returned to Rockwell Automation Canada, Cambridge office immediately upon completion of the drive system commissioning. It is the responsibility of the Field Service Engineer to fill-out the required information and submit the completed documents along with the Field Service Report. The Field Service Engineer must endeavor to fill these forms out as accurately and legibly as possible.

Please refer to the PowerFlex 7000 User Manual for the Commissioning Procedure and necessary guidelines.

### POWERFLEX 7000 MEDIUM VOLTAGE DRIVE

Drive Firmware Revision Level	
Terminal Firmware Revision Level	
Job Number	
Customer Name	

#### ROCKWELL AUTOMATION CANADA

135 Dundas Street  
Cambridge, Ontario, N1R 5X1  
Canada

#### **MV Support Contact Info:**

Office Hours: 9:00am - 5:00pm EST, Monday to Friday

Phone: 1-519-740-4790, (Option 1 for Tech Support, Option 2 for MV Parts)

After Hours Support: 5:00pm – 9:00am EST, 365 days

Digital Pager: 1-519-654-5616

## PowerFlex 7000 “C” Frame Drive Commissioning Checklist

A commissioning check list has been provided as a quick reference to assist in starting up the drive system. This checklist should not be used as a detailed instruction or in no way includes all necessary steps to commission every possible drive configuration. Refer to the procedures in the PowerFlex 7000 “C” Frame user manual for detailed commissioning instructions or contact either the local Rockwell Automation office or Medium Voltage Support directly for assistance if necessary.

### Drive Application Review

	Study Rockwell Automation prints provided with the Drives System
	Study the system one-line diagram and identify all sources of power
	Verify one-line diagram. Trace power cables back to their sources and verify that equipment tag ID numbers agree with the customer's one-line diagram
	Inspect the process for hazards. Verify that the load is not turning due to process (A freewheeling motor will generate voltage)

### Safety Tests

	Lock out and tag all sources of power as per OSHA guidelines
	Test for voltage potential in the cabinet with appropriate safety equipment
	Remove step down CPT or PT fuses and place them in a safe place outside of the drive cabinet <b>(Control power must be off)</b>
	Check fuse and O/L values and compare them to the values specified on the schematic diagrams

### Installation Review

	Examine the drive for shipping damage
	Inspect cabinets for debris
	Ensure that protective barriers removed for drive commissioning have been re-installed
	Verify that the drive line-up and all associated equipment have system power grounding cable installed
	Power cabling is appropriately rated and stress-coned, if required
	Power cabling has been Hi-potted or Meggered
	Power cabling has been torqued per table on <a href="#">page 419</a>
	Control reactor wiring has been correctly installed as shown on the Rockwell Automation electrical diagrams
	Control wiring routing has been examined to ensure that AC, DC and fiber optic wiring are separated from each other
	All additional controls not shown on the prints has been identified, documented and forwarded to the factory for future reference
	Verify that all low voltage cables in the medium voltage cabinet have sufficient clearance from power components [3 in. (76.2 mm) minimum for 4160V]
	Verify that all connectors, cables and components are secure
	Verify encoder wiring (if supplied with encoder)
	Verify that fan hood has been assembled and mounted properly

<b>Service Data</b>	
	Record customer name, location, date and drive ID number
	Record drive nameplate data
	Record motor nameplate data and compare it to the dimensional drawings
	Record encoder nameplate data, if applicable
	Record harmonic filter nameplate data, if applicable
	Record source of control power, auxiliary cooling information, environmental conditions, drive password
	Record all Dip switch settings, jumper settings and revision levels on printed circuit boards, power supplies, communication modules and protective relays
<b>Control Power Off Tests</b>	
	Verify mechanical interlocks
	Perform a resistance check on all devices and snubber circuits
	Verify that the 3-phase control power coming into the control section is within specification. Most drives will not have this option
	Verify that all additional sources of low voltage power are within specification and have grounded neutrals
<b>Control Power On Tests</b>	
Power Supply Tests	
	Apply control power and verify that AC voltages are within specifications
	Verify the AC/DC output is 56V DC at the input of the DC/DC converter and at the input to gate driver power supplies. Adjust if necessary
	Verify the 20V output of SGCT IGDPs boards
	Verify that all of the DC outputs in the DC/DC converter are at rated value
	Verify that healthy lights are on for all control boards and firing boards (Use wire harness with power supply adapter to test SCR gate driver boards or use the test power harness [part no. 80018-695-51; one for 2kV drives, two for 3 and 4 kV drives and three for 6 kV drives] with the appropriate standard IEC line cord to test the rectifier SGCT devices using the SPS power supply boards)
Converter Tests	
	Confirm that SCR and SGCT gating pulse sequence are correct for all devices
Programming the Operator Interface	
	Verify preliminary parameter settings
	Calibrate signal conditioners
	Set analog outputs
	Fault masks / External faults
	Analog I/O
	PLC In/Out
System Tests	
	Perform a system test with low voltage control/test power
	Prove all protection functions as desired
	Verify that all emergency stop devices are functioning correctly
	Calibrate the analog I/O
	Verify that the drive cooling fan(s) is/are operating properly
	Measure input contactor drop out time (2-cycle advance warning needed if input contactor is not part of drive line-up)

<b>Medium Voltage Tests</b>	
Pre-Power Tests	
	Inspect cabinets for debris (tools, hardware, metal shavings, etc.)
	Re-install control fuses (to be done with control power off)
Power Tests	
	Verify that line voltage is at rated value
	Perform a phasing check ( <i>18 Pulse drives only</i> )
	Verify input line harmonic by checking line voltage and current waveforms at ACB board ( <i>only for AFE rectifier drive</i> ); save the waveforms
	Perform IDC Test and verify dc current and voltage waveforms
	Autotune the drive
	Review parameters settings for operating the drive with unloaded motor
	Program the drive for operation at full load
	Run the drive at rated load and rated speed, and record variables
	Capture line side and load side voltage and current waveforms under running condition
<b>Paperwork</b>	
	Print <b>DRIVE SETUP</b> , which gives all parameters, firmware revisions, PLC links, etc.
	Complete the Commissioning Datasheets
	Mark up EDs with modifications or corrections done in the control circuit
	Add revision notes to modified PLC program
	Have the customer sign sign-off documents
	Provide customer with parameter settings, marked-up drawings, commissioning package, PLC program and Field Report
	Forward Waveforms, PLC program, modified drawings, Commissioning Package and Field report to Medium Voltage Support group

## Drive Application Review

In order to ensure trouble free commissioning, it is necessary for all involved in the start-up to familiarize themselves with the drive line-up and application. Service on the equipment should not be performed without a clear understanding of how the equipment has been designed to function and how the equipment has been applied. If questions arise that have not been addressed within this manual, they can be addressed by contacting your local GMS office or by contacting Medium Voltage Support directly.

## Rockwell Automation Drive Line-up Drawings

Prior to performing any service work on the drive line-up, the electrical and dimensional drawings provided with the equipment must be studied and understood. Within these drawings is detailed information and instructions required for commissioning and installation of the equipment including the following:

### *Dimensional Drawings*

- Power cable termination locations
- Ground bus locations
- Shipping split locations
- Control and medium voltage power ratings
- Drive options
- Remote I/O protocol
- PLC options
- Motor and load specifications
- Drive power component selection ratings
- Heat exchanger ratings, connections

### *Electrical Drawings*

- Contactor locations (electrically)
- Drive topology
- General notes
- Cable isolation ratings
- Symbol table
- Component designations

Device Designations	Color Designations	Wire No. Designations	SGCT Designations
Ribbon Cable Designations	Location of Relay and Contactor Contacts	Location of Relays	Drawing Location References

- Customer power and control wiring locations (electrically)
- Control and medium voltage power ratings
- Fuse ratings and locations (electrically)

If the dimensional and electrical prints are not available, a copy can be sent from the factory. In addition, if the drawings require changes to accurately suit the installation and application of the system, please fax or e-mail them to the factory so they may be revised.

## Electrical System One-line Diagram

Once the Rockwell Automation electrical and dimensional drawings are clearly understood, a copy of the electrical system one-line drawing should be obtained. In studying this drawing, all relevant equipment tag Identification names and number should be identified. The system should be studied for sources of power and parallel paths of medium voltage power to the drive. A copy of the one-line diagram should be retained for the drive commissioning and if possible sent to the Medium Voltage division where it will be archived and used in the event that future customer assistance is required.

## Verify One-line Diagram on Site

Once all documentation has been reviewed, an on site inspection of the drive line-up is required. While referencing the one-line diagram and Rockwell Automation prints, identify all the locations of the components within the drive line-up by their Tag Identification name or number. Trace the power cables from point to point while following the electrical diagrams. Any discrepancy between the physical installation and the electrical prints should be reviewed prior to commencing the drive commissioning.

## Inspect Process

Before commencing commissioning on the drive line-up it is important to inspect the process which the drive has been applied to. This step is not only important as a means of identifying and understanding how the equipment is designed to adapt to the customer's application, but it will also be used to identify any potential hazards. Review the process and determine what measures need to be taken to ensure that commissioning the equipment will not expose anyone to hazardous situations or in any way do damage to the equipment involved in the application.



**ATTENTION:** Verify that the load is not turning due to the process. A freewheeling motor can generate voltage that will be back-fed to the equipment being serviced. Take all action necessary to ensure that motor regeneration into the drive does not occur while the equipment is being serviced.

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## Safety Tests

The information contained in this section of the commissioning chapter must be completed in order to ensure that the commissioning continues in an environment safe to all those involved in servicing the drive line-up. Every point included in this section must be completed prior to continuing with the drive commissioning. Ensure that commissioning of this drive line-up is performed in accordance with local safety standards.



**ATTENTION:** Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Recommended practice is to disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. 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 Work places, must be followed.

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

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### Lockout Tagout

Prior to opening the doors to the drive line-up cabinets, proper lockout tagout procedures must be performed to ensure that the working environment is safe. In addition, the equipment must be tested for potential prior to servicing the equipment. Even though the input to the drive may be open, it is still possible for potential to be present.



**ATTENTION:** Live capacitors in circuit. Before touching anything, ensure that the drive is isolated from medium voltage and wait five minutes for the capacitors to discharge. Test the circuit for potential before servicing the equipment. Failure to do so can result in severe injury or death.

---



**ATTENTION:** Ensure that the motor is not spinning due to a driven load. A spinning motor can generate a high potential into the drive's motor filter capacitors, which can result in severe injury or death.

---

Refer to local safety guidelines for detailed procedures on how to safely isolate the equipment from hazards.

The door to the medium voltage cabinets can only be opened after the lockout and tagout are successfully completed.

## Step Down Transformer Fusing

Transformers are used in the drive to step down medium voltage to low voltage. With all sources of power removed from the drive (Medium Voltage and Control Power), remove the step down transformer fuses from the fuse clips and place them in a safe place outside of the drive cabinet. Removing the control power fuses will prevent a separate source of control power from being stepped up to Medium Voltage in the event that the safety interlocks fail to function.

## Fuse and O/L Protection

While referencing the electrical diagrams, locate all fuses and overload relays within the drive line-up. Verify that all installed fuses and overload are the same as indicated by Rockwell Automation. Fuses and overload settings are also identified by stickers located on the cabinet structure in close proximity to the fuse or overload. Ensure the settings match the rating identified on the sticker.

Replacement fuses have been shipped with the drive in the event that a fuse opens during commissioning.

## Installation Review

Prior to commencing the commissioning of the drive line-up it is recommended that the installation of the equipment be re-inspected. Identifying errors in the drive installation prior to commencing the commissioning as opposed to mid way through the commissioning process will greatly reduce the amount of time required to commission the drive line-up.

## Inspect for Shipping Damage

Prior to continuing verifying the installation of the equipment, open the cabinets to all equipment supplied by Rockwell Automation and inspect each component installed for signs of damage. Any damage claim should be made back to the Medium Voltage Business as soon as it is identified so the damaged components can be replaced as quickly as possible.

## Inspect Cabinets for Debris

Once the safety checks have been completed and the drive line-up has been successfully isolated, inspect all cabinets in the drive line-up for foreign material left behind during the installation. Ensure that no tools, hardware or wiring debris have been left in the drive. Note that some electric components used within the drive create magnetic fields that may attract metal shavings left behind if drilling or metal cutting was required during the installation process. Ensure that all metal shavings have been removed from the cabinet and take care not to get shavings into the cabinets if drilling or cutting is required during drive installation.

## Protective Barriers

In confined spaces, it is common for the electricians responsible for the installation to remove protective barriers to allow for more space within the cabinets. Ensure that all protective barriers removed during the installation have been re-installed. Failure to re-install a protective barrier may result in equipment damage or personal injury.

## Component Grounding

Verify that the drive and all its associated equipment have system power ground cabling installed and that the cables are terminated at both ends. Power cable shield grounds to be terminated at both ends. Ensure that all grounding hardware is sufficiently torqued (refer to [Torque Requirements for Threaded Fasteners on page 419 \(Appendix B\)](#)). All drive line-up components (Drives, Switcher, Motors, Transformers and Reactors) must be grounded to the installations ground grid.

In drive line-ups supplied with Isolation Transformers, it is important to leave the secondary of the isolation transformer floating so the drive line-up can reference system ground from the upstream distribution transformer. Failure to do so may result in unreliable drive operation.

## Information on Splice Kits

The drive line-up may have been shipped in sections. Verify that the bus splice kits provided in this circumstance are installed and properly torqued at shipping split locations.

## Power Cabling

All customer power and control wiring required for drive line-up installation have been identified on the electrical drawings by a dashed line (See electrical drawing – General Notes, for additional information).



**ATTENTION:** Power cabling should be installed in accordance with local codes and guidelines. The information in this section is to be used as reference only and is not intended to replace practices outlined in the electrical code.

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Trace the power cabling from termination point to termination point while examining the cable and its routing for mechanical damage, sharp bend radiuses and sources of induced noise and heat. Ensure that the power cabling is sufficiently braced so as to contain the cabling in the event of a ground fault situation.

Verify that all cables are terminated on each end and are sufficiently torqued (refer to [Torque Requirements for Threaded Fasteners on page 419 \(Appendix B\)](#)).

Verify that the cable installed meets the recommended power rating outlined in the electrical drawings and installation section of the manual. Ensure that the cable terminations are stress coned if required.

Verify that the customer power cables have been Hi-Potted or Meggered and read a sufficient insulation value.

## Control Wiring

Identify all customer-required control wiring detailed on the electrical diagram and located within the terminal blocks in the drive. Examine it to verify that the cable insulation has not been tightened into the terminal. Verify that all connections have proper continuity.

Ensure factory jumpers installed and marked with notes “to remove if remote equipment installed” have been removed.

Inspect the control cable routing to ensure that DC Control wiring and AC control wiring are separated from each other. Routing them together in the same bundle, wire-way or panduit may result in unwanted noise being induced in the drive control. In the overhead cable tray provided at the front of the drive, ensure that the AC Control, DC control and Fiber optic cables remain isolated from each other by the dividers provided.

Inspect for additional control not shown on the electrical diagram. Determine its purpose, mark the changes on the electrical diagram and send the prints to the factory for future reference.

Perform a tug test on all control cables to ensure that they are securely fastened, and check each plug and connector to ensure it is properly seated in its socket.



**ATTENTION:** Ensure that there is sufficient clearance between the installed control wiring to the control cabinet and components carrying medium voltage. Verify that closing the low voltage door does not swing the low voltage cables into the medium voltage cabling section.

## Liquid-Cooling Connections

Drives with a Liquid-to-Air Heat Exchanger will require external piping from the heat exchanger to be connected to the inlet and outlet pipe fittings on the back of the cooling section. See [Pipe Materials and Layout on page 76](#).

[Figure 61](#) and [Figure 62](#) show the drive flange connections and required bolt torque. Use the 1/8 in. Elastomer gasket supplied.

The rear view of the cooling cabinet shown in [Figure 59](#) shows the location of the inlet and outlet for the drive cooling system. It is very important to connect the outlet of the drive to the inlet of the heat exchanger, and the outlet of the heat exchanger to the inlet of the drive. Reversing these connections will limit the heat exchanger efficiency.

Drives with a Liquid-to-Liquid Heat Exchanger will require external piping from the heat exchanger to be connected to the inlet and outlet pipe fittings on the internal heat exchanger in the cooling cabinet.

[Figure 66 on page 82](#) shows the cross-section of the internal connections, and the external connection needs to be compatible with a 1.00 inch NPT female connector. The drawing clearly indicates that the S1 connection is the inlet, and the S2 connection is the outlet.

Please refer to [page 214](#) to [page 220](#) when commissioning the drive cooling system.

## Service Data

This section of the commissioning chapter has been included in this manual so that all of the system nameplate data and variable set points can be captured as commissioned.

### Why this Information is Needed

When a PowerFlex 7000 “C” Frame medium voltage AC drive is commissioned, the start-up sometimes occurs in an artificial environment. There’s usually no actual process being performed, and no load, at least not a full load. Therefore, the application situation is artificial and this isn’t an ideal time to establish parameter baselines to signature the drive. After commissioning is complete, the drive is at full capacity and realistic load conditions occur; parameters such as speed regulation may begin to drift and the drive will not perform as designed to meet processing requirements.

It is important that the information required on the following pages is completed in a detailed and accurate manner and that immediately after their completion, the following data sheets are submitted to the customer and to the factory. They will be required to perform modifications on the drive line-up once production commences.

It is common for modifications to be made to the drive’s program some time during the two-month period following the drive commissioning. This is done to ensure that speed control, direction, starting and stopping functions are all performing with precision.

In addition to system modifications, the factory will use the data sheet as an indication that the system is running. The date on the commissioning data sheets will indicate to the factory the date that the system has been started and will be used to commence the product warranty.

In the unlikely event the system is not operating as designed, it will be possible to trend performance between similar applications and topologies. In the event a product notification or recall is required, the datasheets will be used to identify if the customer falls under the definition for an update.

These data sheets will be archived at the factory for future reference.

**Customer Information**

<b>Company Name</b>	
Address	
City	Postal/Zip Code
Province/State/Country	
<b>Service Contact</b>	
Application	Serial No.
Drive Tag ID No.	
Commissioning Engineer	Commissioning Date

**Motor Nameplate Data**

Motor Type (Induction OR Synchronous):		
Manufacturer	Model No.	Serial No.
HP / KW:	Volts:	Current:
KVA:	Power Factor:	Frequency:
RPM:	Service Factor:	Efficiency:
Code:	Type:	Frame:
NEMA Type:	RTD Type:	
	Bearing:	Stator:
Excitation (For Synchronous Motors only)		
Exciter Type:	Volts:	Current:

**Tachometer/Encoder Nameplate Data**

Tachometer:	Position Encoder:	Stator Feedback (None):
Manufacturer:	Model No.:	Serial No.:
PPR:	Gear Ratio:	

<b>Drive Nameplate Data</b>				
Catalog No.:		Schematic Diagram:		
<b>Control Cell</b>				
Max Volts:		Hz:		
<b>Power Cell</b>				
Unit Series:	Hz:	BIL (kV):	Current (Amp):	Rectifier Type:
Max Volts:	MVA:	NEMA Type:	Service Factor:	
<b>Motor Filter Capacitors</b>				
Manufacturer:		Model No.:	Number of Capacitors:	
			Each Cap KVAR:	
Volts:		Hz:		
<b>Line Filter Capacitors (AFE Rectifier Only)</b>				
Manufacturer:		Model No.:	Number of Capacitors:	
			Eac Cap KVAR:	
Volts:		Hz:		
<b>DC Link</b>				
Manufacturer:		Serial No.:	Model:	
Current (Amp):	Inductance (mH):	Insulation Class:		Temp. Rise:
<b>Input Reactor</b>				
Configuration		Manufacturer:	Model No.:	Serial No.:
Line Reactor ____	Isolation Transformer ____			
Voltage		mH/KVA/Current:	Temp. Rise:	Impedance:
Primary ____	Secondary ____			
<b>Heat Exchanger</b>				
Manufacturer:		Model No.:	<b>Type</b>	
Volts:		Current:	Liquid-to-Liquid ____ Liquid-to-Air ____	



<b>Drive Circuit Boards</b>			
<b>Acronym</b>	<b>Production Assembly Part Number</b>	<b>Hardware Revision</b>	<b>Firmware Revision</b>
ACB	80190-560-		—
DPM	80190-580-		
OIB L (A,B,C)	80190-099-		—
OIBB	80190-600-		—
OIB M (A,B,C)	80190-099-		—
XIO <sup>(1)</sup>	80190-299-		—
VSBL 1	81000-199-		—
VSBL 2	81000-199-		—
VSBM 1	81000-199-		—
<b>Operator Interface</b>	2711-KASL11		PV Firmware <sup>(2)</sup>
			PV Software <sup>(3)</sup>
TFB L	80190-639- or 80190-539-		—
TFB M	80190-639- or 80190-539-		—
SCR SPGDB <sup>(1)</sup>	80190-219-		—
SPS <sup>(1)</sup>	80190-799-		
IGDPS L (1-3)	80026-044-		—
IGDPS M (1-3)	80026-044-		—
PS1 (A-F) <sup>(1)</sup> [AC/DC Converter]	80026-520 or 524 -		—
PS2 [DC/DC Converter]	81002-440-		—
PS4 [24V DC Power supply]			—
CPT	80022-069-		—
UPS			—
Printer			—

(1) The drive can have more than one of this circuit board.

(2) PV Firmware is located on a sticker on the back of the unit.

(3) PV Software is located on the main display screen (top-left corner).

## Control Power Off Tests

The following checks listed in this section of the chapter should be performed prior to applying control power to the drive. It is recommended that these checks be completed in the sequence that they have been presented in this chapter.

### Interlocking

When the input contactor option is purchased a key interlock is provided to prevent access to the medium voltage compartments of the drive unless the input isolation switch is locked in the open position.

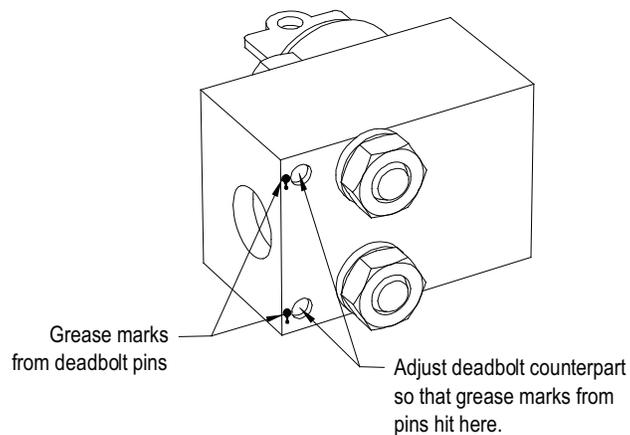
Where the input switching device is provided by others, Rockwell Automation will provide a key interlock on the medium voltage compartment of the drive, and a matching interlock for installation by others on the upstream device. The interlock shall be installed in a manner that ensures the power to the drive is off and the drive is electrically isolated whenever the key is freed.

Although Key interlocks shipped with all medium voltage equipment are aligned in the factory, they often move out of position during shipping or are often misaligned when the cabinet is set down on an uneven floor. The following instructions will assist the field engineers in quickly and accurately aligning the deadbolt key interlock with its counterpart.



**ATTENTION:** Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Recommended practice is to disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. If it is necessary to work in the vicinity of energized equipment, the safety related work practices of NFTA 70E, Electrical Safety requirements for Employee Work places, must be followed.

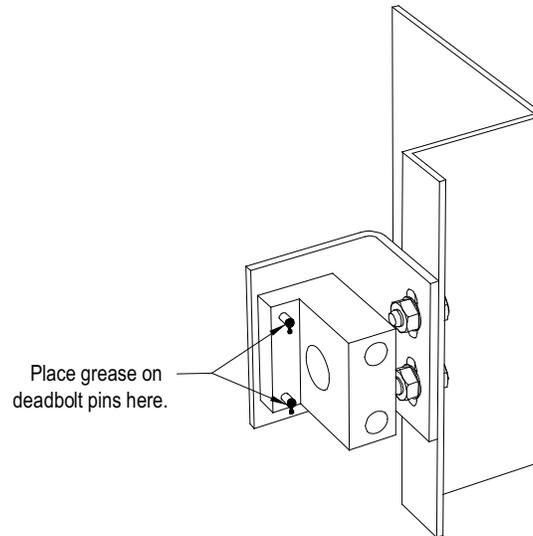
**Figure 179 - Deadbolt Assembly Mounted to Door**



1. Lock out and isolate the drive from medium voltage. Verify with a hot stick that there is no medium voltage present.

2. Determine that the key interlock is correctly aligned by securely bolting the medium voltage doors of the cabinet closed and removing the key from the lock. The key should turn easily; if any force is required to turn the key, the deadbolt alignment requires adjustment.
3. Open the doors of the cabinet and inspect the key assembly. Place high visibility grease on the pins of the deadbolt counterpart. The factory recommends using yellow torque sealant, however if it is unavailable almost any grease will do. (See [Figure 179](#))

**Figure 180 - Deadbolt Counterpart Mounted to Cabinet**



4. Bolt the cabinet door closed so the pins on the dead bolt counterpart make contact with the deadbolt assembly. Doing so should leave two marks of torque sealant or grease on the assembly where the pins made contact ([Figure 179](#) – Deadbolt Assembly).
5. Slightly loosen the adjustment bolts on the counterpart and make the necessary movements on the counterpart to ensure that the pins align with the landing plates on the deadbolt assembly. As the amount of counterpart movement required is an estimate, it may take a couple attempts to properly align the assembly.
6. Clean the torque seal/grease from the key interlock once finished aligning the counterpart.

Once properly aligned, the key should turn freely when the cabinet door is fully bolted shut. If the key does not function when the door is tightly bolted closed, adjustments will have to be made to the depth of the counterpart. This can be done by adding shims on the landing plate where the counterpart is mounted.

## Resistance Checks

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

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



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

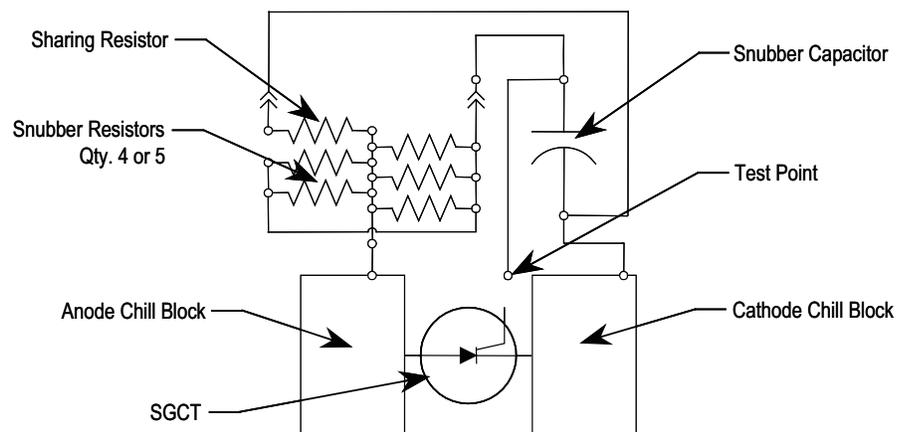
## SGCT Testing

The following instructions outline the procedure to be taken when verifying SGCT semiconductors and all snubber components. Expected SGCT Snubber Circuit Resistance and Capacitance values are listed in [Table 6](#).

**Table 6 - SGCT Snubber Circuit Resistance and Capacitance Values**

	Drive Rating	Sharing Resistance	Snubber Resistance	Snubber Capacitance
Inverter	3300 to 6600 V	80 k $\Omega$	7.5 $\Omega$	0.5 $\mu\text{f}$
AFE Rectifier	3300 to 6600 V	80 k $\Omega$	6.0 $\Omega$	0.5 $\mu\text{f}$

**Figure 181 - SGCT Snubber Circuit Connections**



SGCT Resistance Measurement		Measured Resistance			
		Inverter		Rectifier (AFE only)	
SGCT Anode-Cathode Resistance (Heatsink to Heatsink)	k-Ω	(Lowest)	(Highest)	(Lowest)	(Highest)
Snubber Resistance (Test Point – Heatsink above)	Ω	(Lowest)	(Highest)	(Lowest)	(Highest)
Snubber Capacitance (Test Point – Heatsink on Right)	μF	(Lowest)	(Highest)	(Lowest)	(Highest)

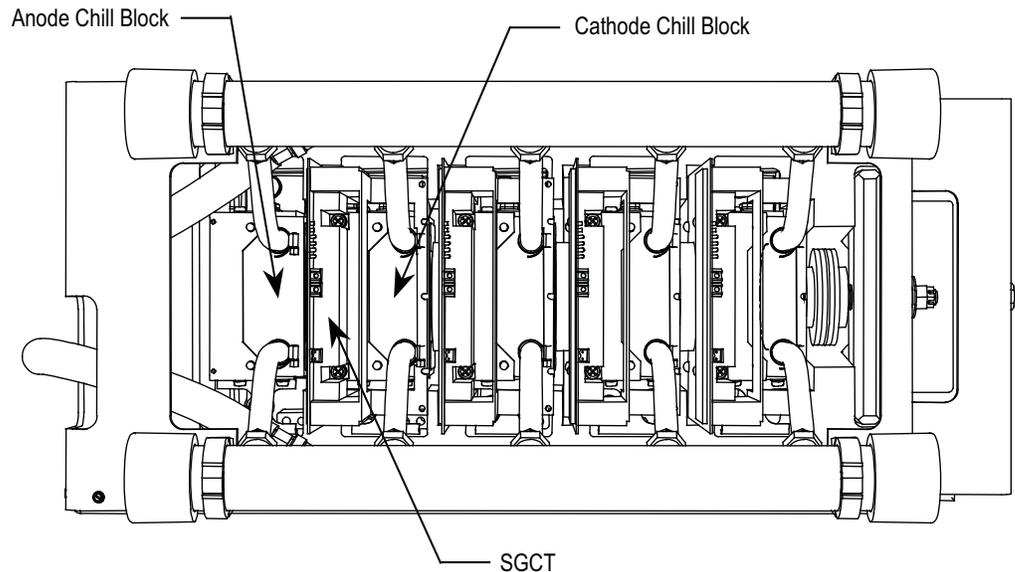
If a device or snubber component is found to be damaged, it must be replaced using the detailed procedures in Component Definition and Maintenance.

### SGCT Anode-to-Cathode Resistance

Performing an Anode-to-Cathode resistance test not only tests the integrity of the SGCT but also the integrity of the sharing resistor. An abnormal device resistance measurement will indicate either a shorted device or damaged sharing resistor.

Using an ohmmeter, measure the anode-to-cathode resistance each SGCT, looking for similar resistance values across each device. Easy access from the anode-to-cathode is available by going from chill block to chill block as shown in [Figure 182](#):

**Figure 182 - Anode-to-Cathode Resistance Test Points**



An SGCT when not gated on is an open circuit. A healthy device resistance value should be close to the value-sharing resistor, however due to parallel resistances in the firing card, the resistance value will be slightly lower.

**Example:**

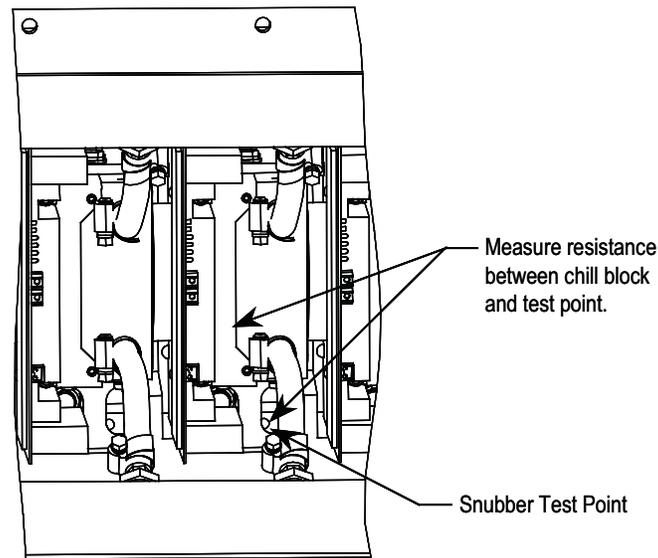
The resistance across the anode-to-cathode of a 1500 amp device may be 57 k $\Omega$  even though the sharing resistor is 80 k $\Omega$ .

A failure of an SGCT can be detected by measuring a lower than normal resistance value; one device in the converter may read 15 k $\Omega$  whereas the rest of the devices in the converter measured close to 60 k $\Omega$ . This indicates a partially shorted device. A fully shorted device will read closer to 0  $\Omega$  and will be quickly identified. If the SGCT is found to be out of tolerance, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#) for detailed instructions on how to replace the SGCT assembly.

Damage to a sharing resistor is easily detected if the SGCT is replaced and the anode-to-cathode resistance remains abnormal. If the resistor is found to be out of tolerance, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#) for detailed instructions on how to replace the snubber/sharing resistor assembly.

**Snubber Resistance (SGCT Device)**

Access to the snubber resistor is not required to test the resistance. The snubber circuit test point is located within the PowerCage under the chill blocks. For each device, there is one test point. To verify the resistance, measure the resistance between the test point and the chill block directly above the test point.

**Figure 183 - Snubber Resistor Test**

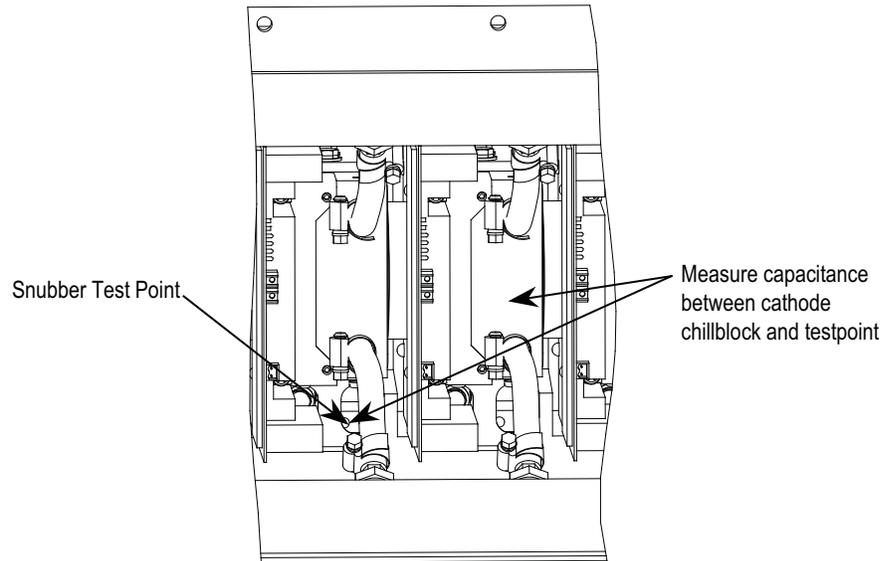
Refer to [Table 6](#) to determine the appropriate snubber resistance value for the SGCT used in either the AFE Rectifier or the inverter.

If the resistor is found to be out of tolerance, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#) for detailed instructions on how to replace the snubber resistor assembly.

## Snubber Capacitance (SGCT Device)

Turn the multimeter from the resistance to capacitance measurement mode. Proceed to verify the snubber capacitor by measuring from the test point to the chill block adjacent to the right.

**Figure 184 - Snubber Capacitor Test**



The capacitance measured is actually affected by the snubber capacitor and other capacitance in the circuit, including capacitance from the Gate Driver circuit. You are actually looking for a consistent reading for all devices.

If the capacitor is found to be out of tolerance, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#) for detailed instructions on how to replace the snubber capacitor.

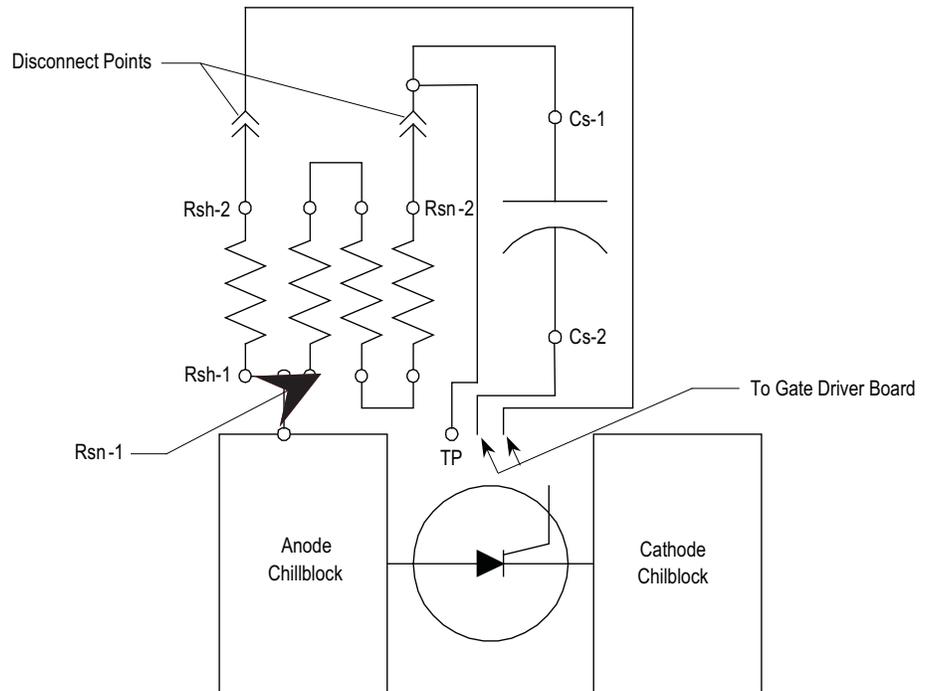
## SCR Testing

The following steps outline how to verify SCR semiconductors and all associated snubber components. A quick reference to the expected resistance and capacitance values as well as a simple schematic diagram is located below:

**Table 7 - SCR Snubber Circuit Resistance and Capacitance Values**

Drive Rating	Sharing Resistance	Snubber Resistance	Snubber Capacitance
3300 to 6600V	80 k $\Omega$	90 $\Omega$	0.5 $\mu$ f

**Figure 185 - SCR Snubber Circuit Connections**



If a device or snubber component is found to be damaged, a detailed replacement procedure is located in Chapter 5 – refer to [Component Definition and Maintenance on page 265](#).

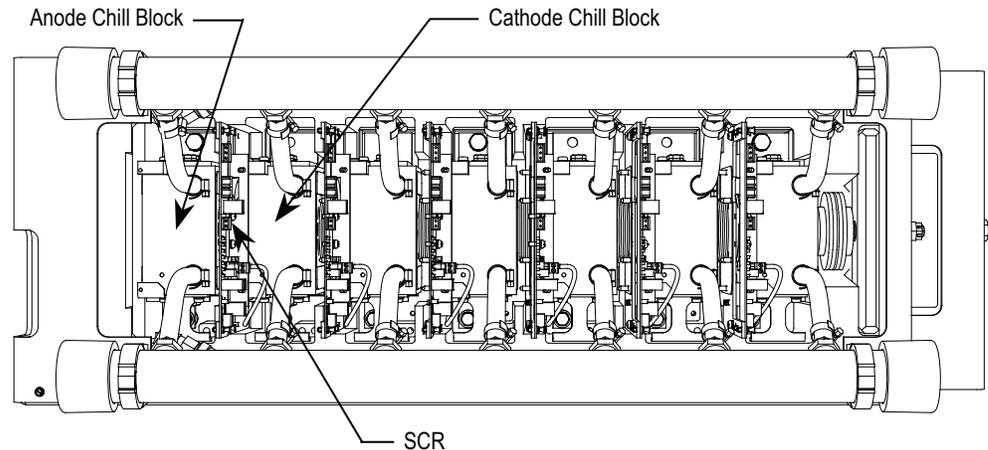
SCR Resistance Measurement		Measured Resistance	
SCR Anode-Cathode Resistance (Heatsink to Heatsink)	<b>k-Ω</b>	(Lowest)	(Highest)
		(Lowest)	(Highest)
SCR Gate-Cathode Resistance (Across SCR Phoenix Connector)	<b>Ω</b>	(Lowest)	(Highest)
		(Lowest)	(Highest)
Snubber Resistance (Test Point – Heatsink on Left)	<b>Ω</b>	(Lowest)	(Highest)
		(Lowest)	(Highest)
Snubber Capacitance (Test Point – White Wire from Snubber Phoenix connector on Right)	<b>μF</b>	(Lowest)	(Highest)
		(Lowest)	(Highest)
Sharing Resistance (Red Wire from Snubber Phoenix connector – Heatsink on Right)	<b>k-Ω</b>	(Lowest)	(Highest)
		(Lowest)	(Highest)

### SCR Anode-to-Cathode Resistance

Performing an Anode-to-cathode resistance test verifies the integrity of the SCR. Unlike the SGCT, the SCR uses the snubber circuit to power the self-powered gate driver boards. The resistance measurement taken across each SCR should be consistent; an inconsistent value may indicate a damaged sharing resistor, self-powered gate driver board or SCR.

Using an ohmmeter, measure the anode-to-cathode resistance across each SCR in the rectifier bridge, while looking for similar resistance values across each device. Easy access from the anode-to-cathode is available by going from chill block to chill block as shown in [Figure 186](#):

**Figure 186 - Anode-to-cathode Test**

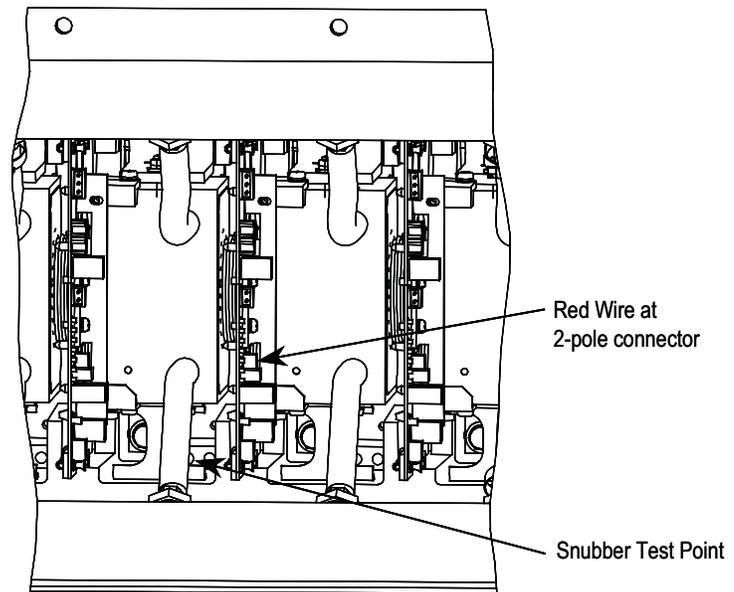


A good SCR and circuit should read between 22 k $\Omega$  and 24 k $\Omega$ .

An SCR that has failed from anode-to-cathode will commonly produce a resistance value of 0 for a shorted device or  $\infty \Omega$  for an opened device. Unlike the SGCT, it is highly irregular for an SCR to have a partially shorted device. If an SCR is found to be out of tolerance, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#) for detailed instructions on how to replace the SCR assembly.

### SCR Sharing Resistance Test

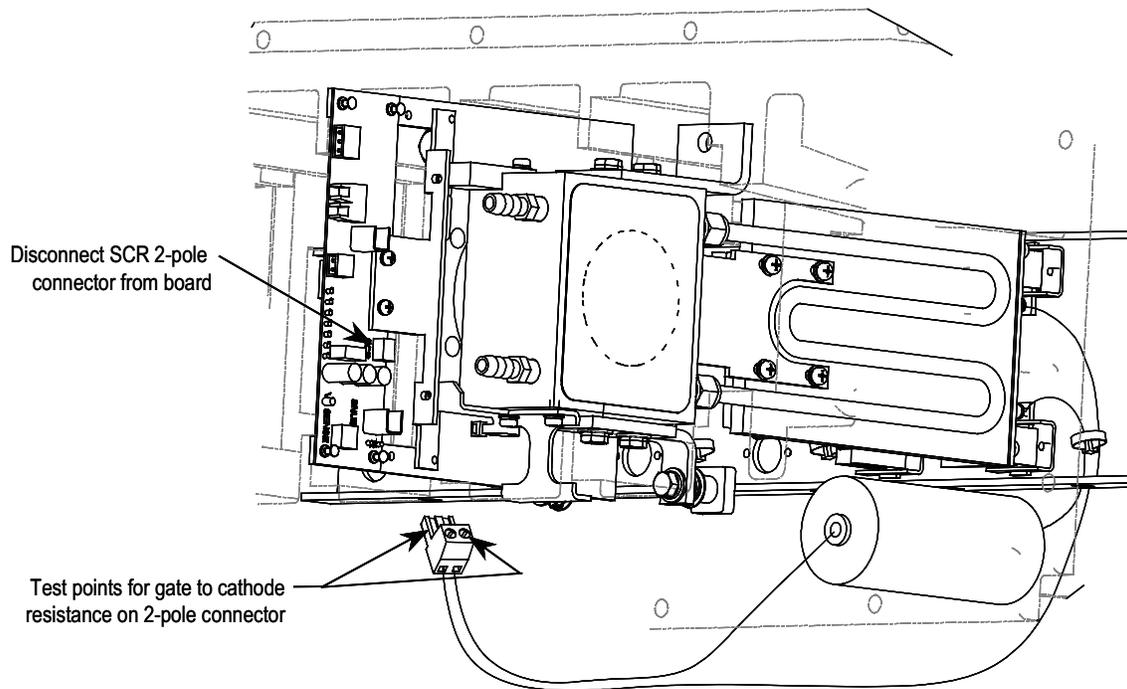
To test the sharing resistor of an SCR module, disconnect the 2-pole plug of the self-powered gate driver board labeled SHARING and SNUBBER on the circuit board. The red wire of the plug is the sharing resistor. Measure the resistance between the red wire of the plug and the chill block to the left. A value of 80 k-ohms indicates a healthy sharing resistor.

**Figure 187 - SCR Sharing Resistance Test**

### SCR Gate-to-cathode Resistance

One test that can be performed on SCRs that cannot be performed on SGCTs is a Gate-to-cathode Resistance Test. Performing a Gate-to-cathode resistance measurement will identify damage to a SCR by revealing either an open or shorted gate-to-cathode connection. To test an SCR from gate-to-cathode, disconnect the SCR gate leads from the self powered gate driver board and measure the gate-to-cathode resistance on the SCR firing card Phoenix connector as shown in [Figure 188](#).

Figure 188 - SCR Gate-to-cathode Test

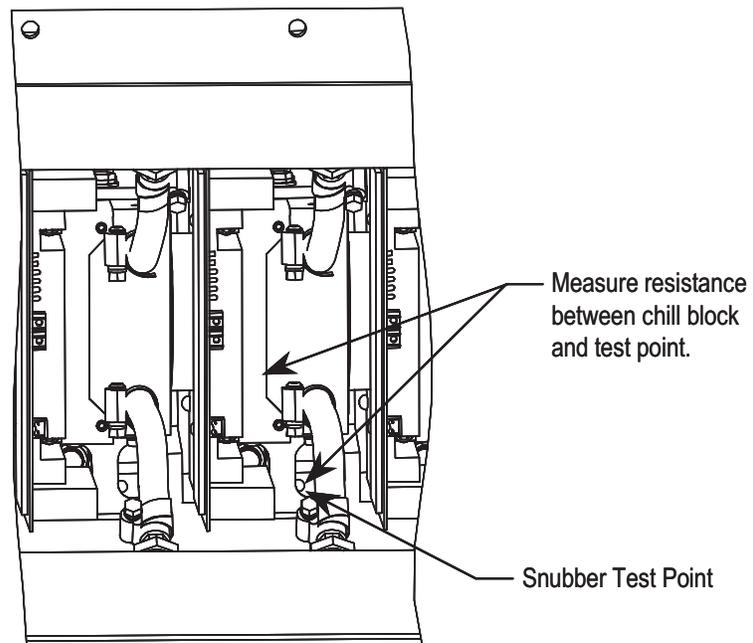


The resistance value from gate-to-cathode should be between  $10\ \Omega$  to  $20\ \Omega$ . A value close to  $0\ \Omega$  indicates that there is an internal short in the SCR. An extremely high value indicates that the gate connection in the device has broken.

If a Gate-to-cathode test reveals a damaged SCR, a detailed replacement procedure is located in Chapter 5 – refer to [Component Definition and Maintenance on page 265](#).

### Snubber Resistance (SCR Device)

Access to the snubber resistor is not required to test the resistance. The snubber circuit test point is located within the PowerCage under the chill blocks. For each device, there is one test point. To verify the resistance, measure the resistance between the test point and the chill block above.

**Figure 189 - Snubber Resistance Test**

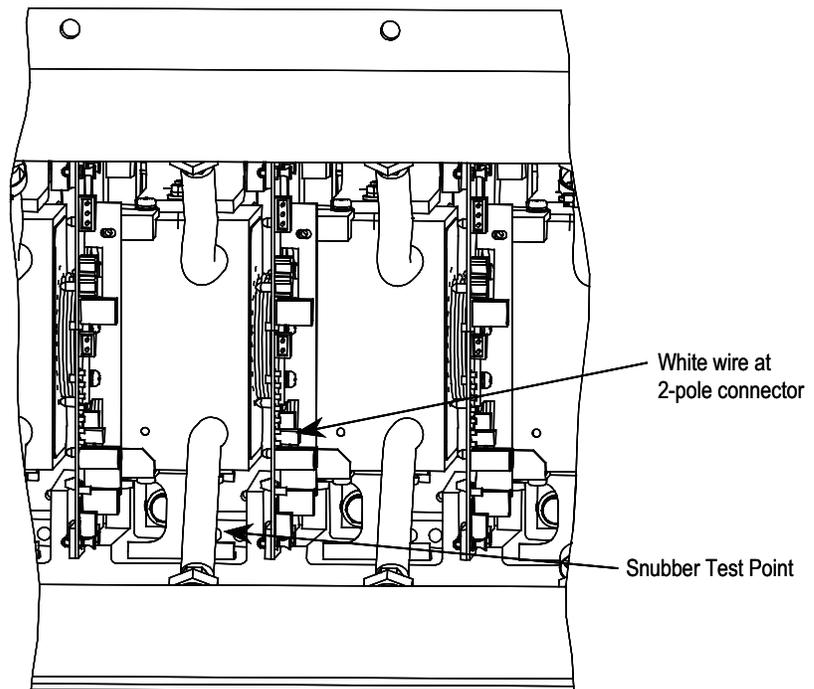
Refer to [Table 7](#) to determine the appropriate snubber resistance value for the current rating of the SCR used.

If the resistor is found to be out of tolerance, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#) for detailed instructions on how to replace the snubber resistor assembly.

### **Snubber Capacitance (SCR Device)**

Turn the multimeter from the resistance to capacitance measurement mode. Proceed to verify the snubber capacitor by measuring from the test point and the white wire at the 2-pole device snubber plug (labeled snubber).

Figure 190 - Snubber Capacitance Test



To test the snubber capacitance, disconnect the plug of the self-powered gate driver board labeled SHARING and SNUBBER. The resistance between the white wire of the plug and the Test Point to its left is the snubber capacitance.

Refer to [Table 7](#) to determine the appropriate snubber capacitance value for the current rating of the SCR used. You should read the actual snubber capacitor value shown in the table.

If the capacitor is found to be out of tolerance, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#) for detailed instructions on how to replace the snubber capacitor.

## Control Power Tests

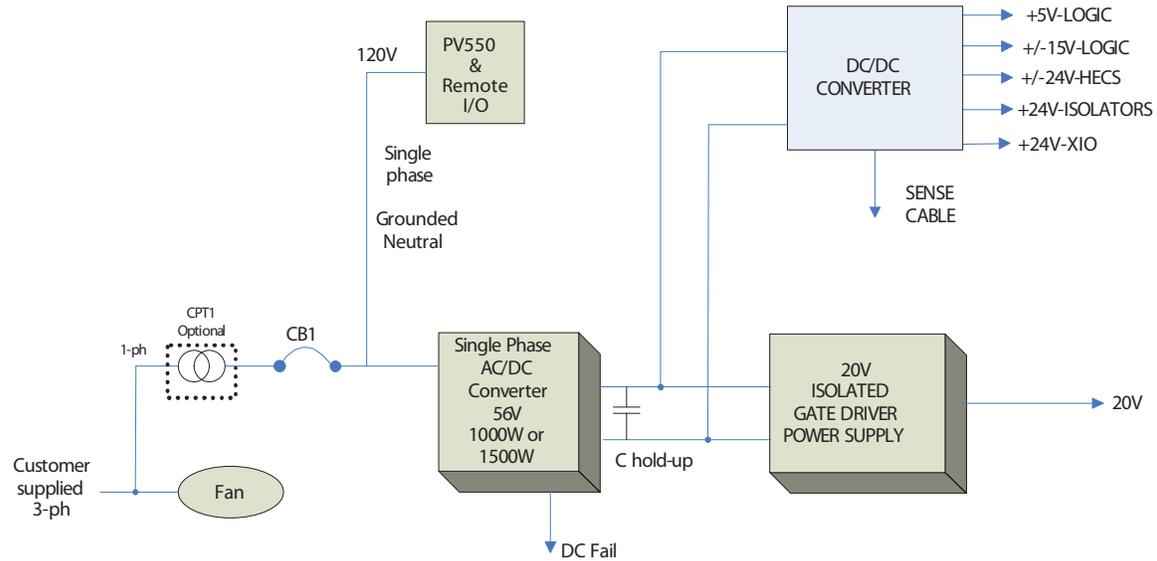
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**IMPORTANT** Prior to energizing the drive, verify that the control power being fed into the input breakers is rated as designated on the electrical diagram.

---

Although there are a variety of options available to customers that will effect the control power distribution within the drive, the input will always be as illustrated in [Figure 191](#).

Figure 191 - Control Power Distribution



### Three-Phase Input

In the 3-phase input configuration, the customer supplies 3-phase control power into the Disconnect Switch (Labeled DS1 on the Electrical Schematics). From that point, the power is distributed to the 3-phase fan and to the power supplies through a single phase CPT. The output of the single phase CPT powers all the power supplies and controls within the drive. The 3-phase control should be measured at the input to DS1. If the rating matches the designation on the electrical schematic, it is acceptable to apply control power to the drive. Take necessary measures to rectify the control power level in the event that it does not meet the design specifications.

### Three-Phase Input / Single Phase Input

This configuration has one source of control power:

- Three-phase control power for fan operation which is also converted to single-phase control power to operate the Interface, power supplies, I/O and additional auxiliaries.

Similar to the three-phase configuration, the input power for the fan and control must be verified at the primary of DS1.

If the ratings match the designation on the electrical schematic, it is acceptable to apply control power to the drive by closing CB1 and DS1. Take necessary measures to rectify the control power levels in the event that they do not meet the design specifications.

## Power Supply Tests

The variety of components installed within the PowerFlex 7000 “B” Frame requires a versatile control distribution design. As a result there are many power supplies incorporated within the drive design. The following section describes how to verify that all power supplies installed within the drive are functioning as designed.

## Circuit Board Healthy Lights

Once all sources of control power have been verified and proven to be within specified levels, close the low voltage input breaker (CB1) and Disconnect Switch (DIS); doing so will apply control power to the drive.

Observe the healthy lights on all drive control boards to ensure that the unit has passed all power-up self-tests. The following table identifies the LEDs that should be illuminated, assuming the drive passes all self-tests and is in a ready state:

Component	LED Activated
AC/DC Converter Power Supply	No Healthy LEDs Provided
DC/DC Converter Power Supply	No Healthy LEDs provided
SGCT Power Supplies <sup>(1)</sup>	1 Green LED per section of Power Supply (No Label)
SGCT Integrated Firing Card	LED 4 (Green) LED 3 (Green) LED 1 (Red)
Analog Control Board (ACB)	2 Green LEDs – Healthy
DPM	LED 6 (Green)      LED 9 (Green) LED 7 (Green)      LED 11 (Green)
External I/O	Various YELLOW Surface Mounted LEDs based on I/O status
Remote I/O Adapter	LED configuration will change based on adapter. Refer to the adapter user's manual to identify the state the adapter is in.
Operator Interface Terminal	Displays Boot Sequence. Communications Error will occur in a fault situation. A small flashing indicator in bottom right corner indicates good communication.

(1) Number of supplies varies based on drive configuration.

Failure of LED to illuminate indicates a problem with the power-up self-test. Refer to Publication 7000-TD002\_-EN-P for information on troubleshooting.

## Control Power Transformer (CPT)

A control power transformer (CPT) is supplied only in certain drive configurations. If there is no control transformer supplied in the drive being commissioned, please disregard the following information on setting the control voltage output level.

Measure the control voltage level at the secondary of the control power transformer located in the DC link low voltage cabinet of the drive. Ensure that the output of the transformer matches the specification on the electrical schematics.

The value of the output can be adjusted by changing the taps on the control transformer. Ensure that the power is disconnected in the Disconnect Switch prior to attempting to change the control transformer tap setting.

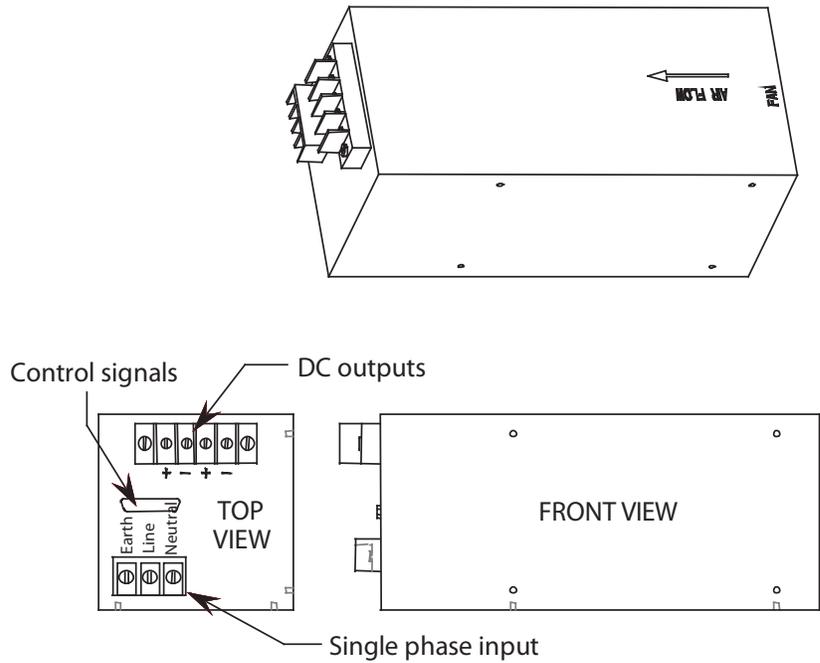
Input Control Voltage ( $V_{L-L}$ )	U-V	V
	V-W	V
	W-U	V
Control Power Transformer Installed?	Yes <input type="checkbox"/>	No <input type="checkbox"/>
CPT Secondary Voltage ( $V_{L-L}$ )	U-V	V
	V-W	V
	W-U	V
CPT Secondary Voltage ( $V_{L-N}$ ) <i>or</i> , if no CPT: Input Control Voltage ( $V_{L-N}$ )	U-N	V
	V-N	V
	W-N	V

## AC/DC Converter (PS1)

Every PowerFlex 7000 “C” Frame drive will be supplied with at least one AC/DC power supply. As the number of devices increases OR to provide a redundant power supply, the number of AC/DC power supplies installed may be more than one. The electrical schematics provided by Rockwell Automation will identify how many AC/DC power supplies have been installed in the application being commissioned.

**Ensure the output of the AC/DC power supply is 56V DC.** If any adjustment is required, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#) of the drive User Manual.

Figure 192 - Location of AC/DC Power Supply on Low Voltage Panel



### DC/DC Converter (PS2)

The DC/DC converter has no provision for output power adjustments. A green LED on front case of the power supply indicates that the power supply is functioning properly. Using a digital multimeter, measure each of the outputs of the DC/DC converter to ensure that they meet the values specified on the electrical schematics. Compare these measured values to those displayed on the Operator Terminal under the Metering group.

Table 8 - Plug 1 (P1) – INPUT

Terminal Numbers	Description	Value
1 → 2	Input Power (+56 V)	

Table 9 - Plug 2 (P2) – SENSE SIGNAL

Terminal Numbers	Description	Value

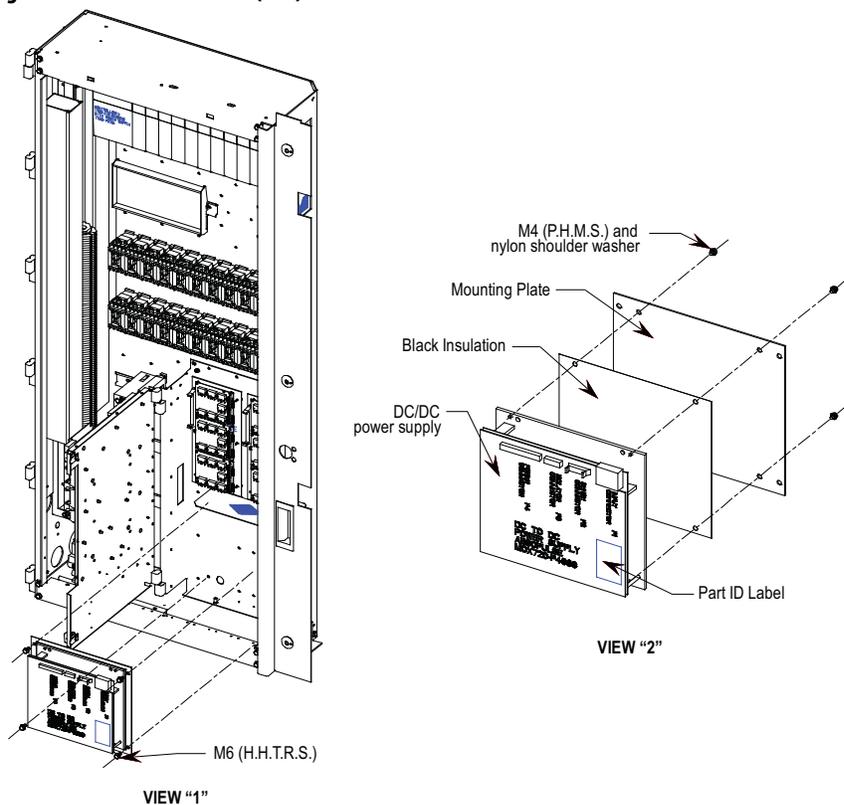
Table 10 - Plug 3 (P3) – ISOLATOR

Terminal Numbers	Description	Value
1 → 2	ISOLATOR (+24V,1A)--ISOL_COMM (COM4) ±5%	

**Table 11 - Plug 4 (4) – PWR**

Terminal Numbers	Description	Value
1 → 2	+24V_XIO (+24V,2A)–XIO_COMM (COM3) $\pm 5\%$	
3 → 4	+HECSPWR (+24V,1A)–LCOMM (COM2) $\pm 1\%$	
5 → 4	-HECSPWR (-24V,1A)–LCOMM (COM2) $\pm 1\%$	
6 → 7	+15V_PWR (+15V,1A)–ACOMM (COM1) $\pm 0.5V$	
8 → 7	-15V PWR (-15V,1A)–ACOMM (COM1) $\pm 0.5V$	
9 → 10	+5V PWR (+5V,5A)–DGND (COM1) 5.1-5.5V	

If any values are out of the expected range, a bad DC/DC converter is suspect.

**Figure 193 - DC/DC Converter (PS2)**

## SGCT Power Supplies (IGDPS)

**Note:** Refer to [Figure 194](#) and [Figure 195](#) for location of IGDPS.

Figure 194 - Converter Cabinet Components (3300/4160V)

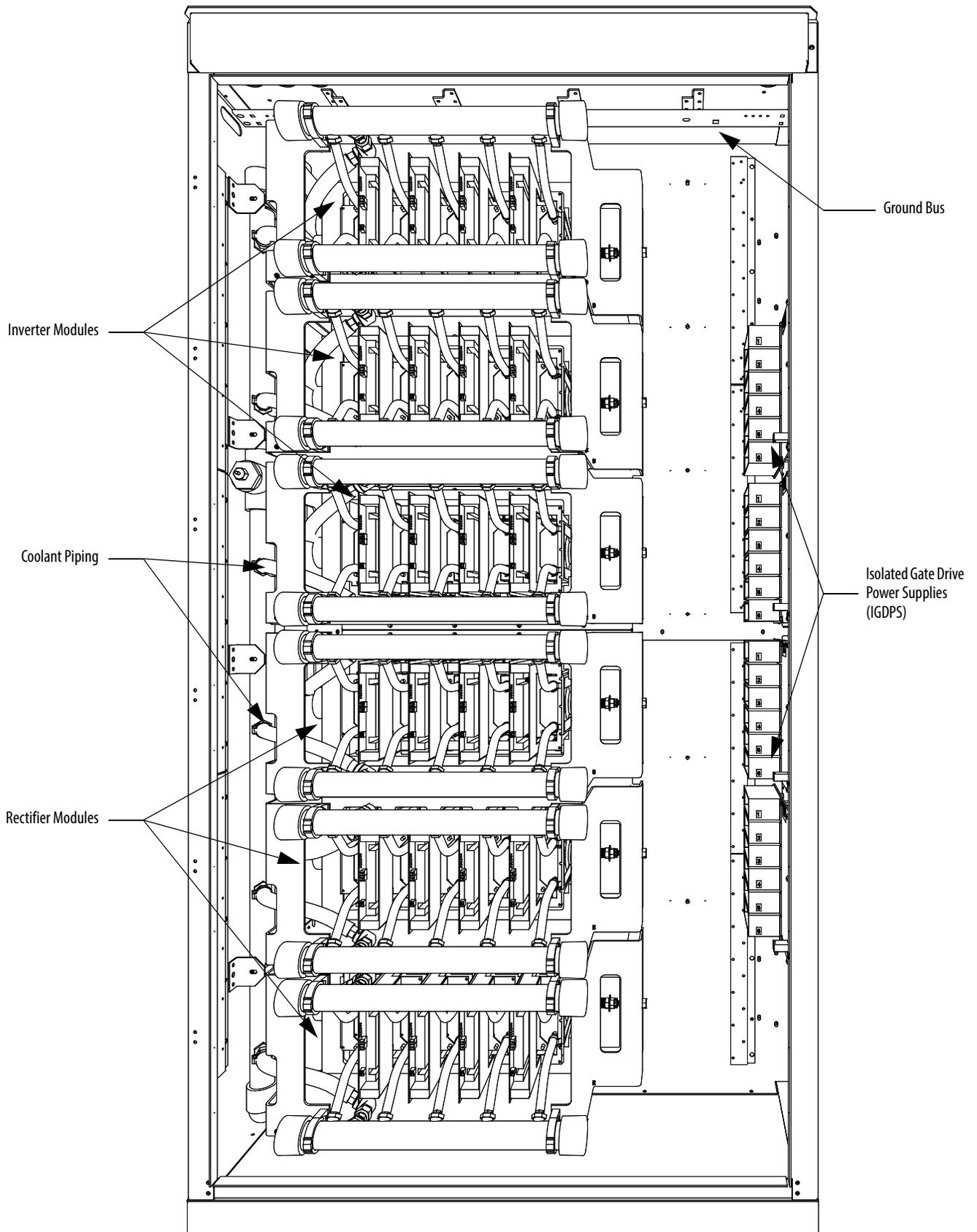
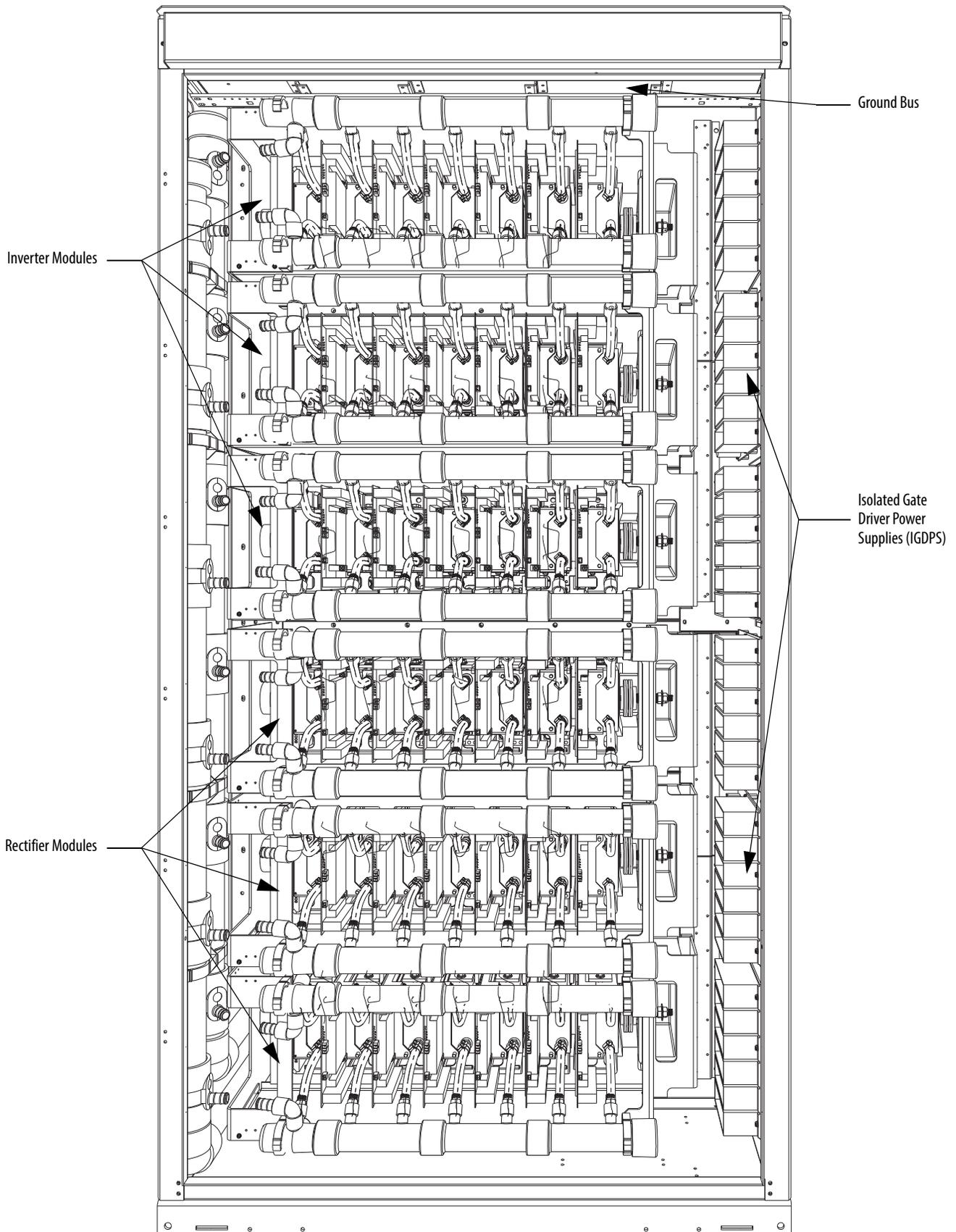


Figure 195 - Converter Cabinet Components (6600V)



The circuitry for the IGDPS is encapsulated in epoxy. As a result the module cannot be field repaired and there are no test points or adjustments available on this board. If one of the six isolated 20 V outputs fails, the entire board must be replaced.

### IGDPS Board LEDs

There is one green LED on each of the 6 output channels of IGDPS. If the IGDPS is healthy, then all six LEDs will be illuminated. If any of the LEDs is not ON, then the IGDPS might be defective and must be replaced.

Record the following measurements to ensure all 6 outputs in each IGDPS are functioning. The output voltage should be within  $20V \pm 1\%$ . There may be more than one IGDPS in the drive.

Test Points	Expected Value	Measured Value					
		IGDPS #1	IGDPS #2	IGDPS #3	IGDPS #4	IGDPS #5	IGDPS #6
Plug 8 Pin 1 → Pin 2	+20 V DC						
Plug 9 Pin 1 → Pin 2	+20 V DC						
Plug 10 Pin 1 → Pin 2	+20 V DC						
Plug 11 Pin 1 → Pin 2	+20 V DC						
Plug 12 Pin 1 → Pin 2	+20 V DC						
Plug 13 Pin 1 → Pin 2	+20 V DC						

### Commissioning the Cooling System

The liquid cooling system is tested for leaks at the factory, but shipping damage can create leaks in the liquid cooling system. All leaks must be repaired prior to start up.



**ATTENTION:** The E-Stop button on the drive does not interrupt the 3-phase control power. E-Stop only opens the input contactor providing the Medium Voltage on the drive input. This means that the cooling system will continue to run.

## Heat Exchanger Checks

The PowerFlex “C” Frame drive requires a heat exchanger to transfer heat from the drive coolant to an external medium. There should be connections from the drive pumping cabinet to the heat exchanger. Ensure that these connections are completed and attached to the proper locations (inlet / outlet) on both the drive and the heat exchanger.

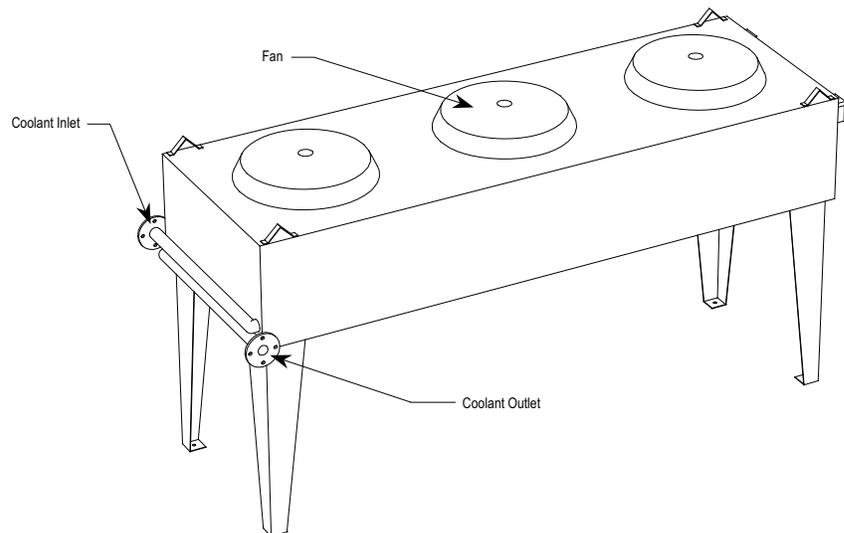
These connections should be made from stainless steel.

The customer should not be using lead solder with the connections, as the coolant will deteriorate this connection over time.

When making connections to the drive from the heat exchanger, ideally the connections or the heat exchanger should not be at an elevation higher than the internal drive piping (below inlet of reservoir). This allows the drive to remove any trapped air in the system. If the heat exchanger is at a higher elevation, then air release valves should be installed at the highest point.

**TIP** The largest heat exchanger is 287 cm (113 inches) tall.

**Figure 196 - Typical Liquid-to-air Heat Exchanger**



The tubing to the heat exchanger should have been cleaned by the installation personnel. If they are still in the process of installation you should verify that the piping will be cleaned. Otherwise the filling process will probably produce a lot of debris in the first mesh filter and may require several cleanings.

On a liquid-to-air heat exchanger, there will be fans on the heat exchanger to move the air over the cooling tubes within the exchanger. Ensure these fans are wired properly per the electrical print.

On a liquid-to-liquid heat exchanger, process water will be required to transfer heat from the drive coolant. The water temperature, pressure and flow rate are as

specified by the factory on the piping schematic drawing mounted inside the pump cabinet.

### **Pumping Cabinet Control Power Checks**

There will be 3 phase power brought into the control power cabinet and jumpered to the pumping control cabinet. This determines the direction of rotation of the pumps. There will be arrows on the pump showing the proper direction of rotation, and it can be visually verified by looking at the non-drive end shaft. Manually activate the pump control relays and verify the rotation.

Manually activate the fan control relays and ensure each of the fans on the heat exchanger is rotating. Also ensure that the fans have been wired to the correct relays (as specified by factory).

## System Fill

There should be a 200 L (55 U.S. gallon) drum of coolant provided with the drive. The drive takes approximately 170 L (45 U.S. gallons) to fill the system. The drum **SHOULD NEVER BE DISCARDED**. In the event that you need to drain the system, you will want to have this handy to store the coolant so that it can be reused.

**Figure 197 - Cooling Cabinet Overview showing Valve Locations – 1**

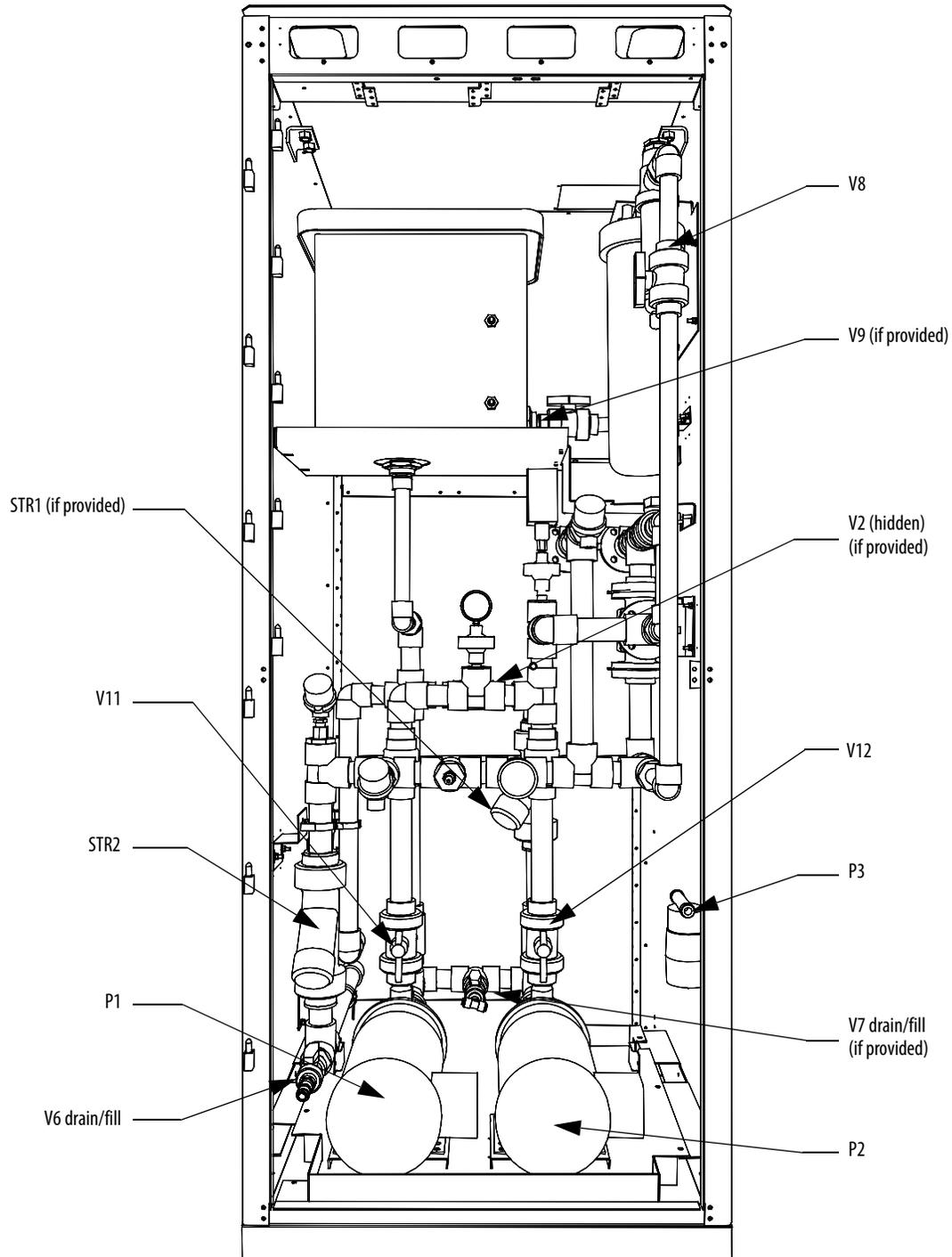
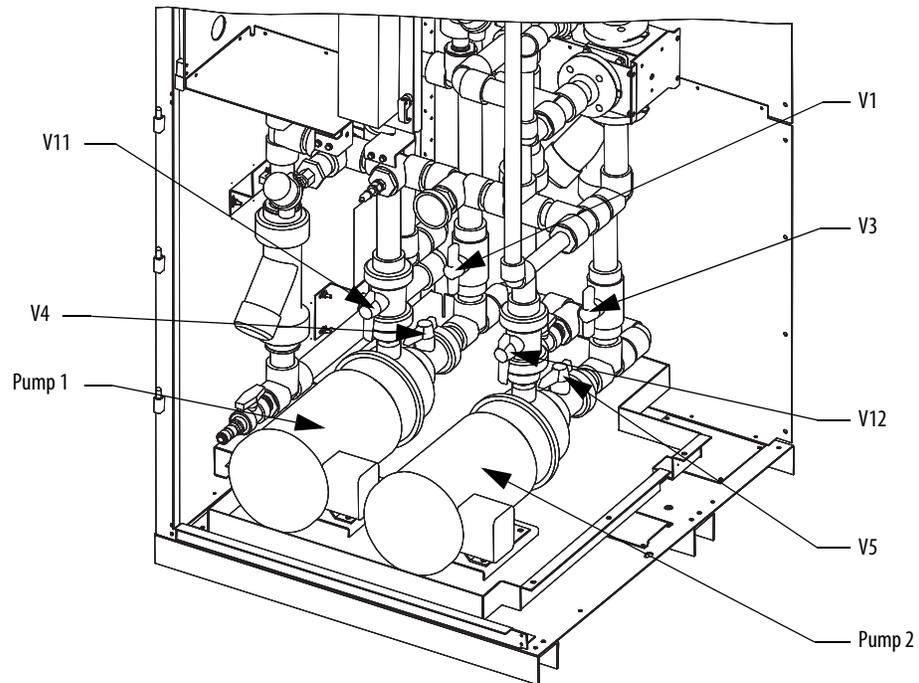


Figure 198 - Cooling Cabinet Overview showing Valve Locations – 2



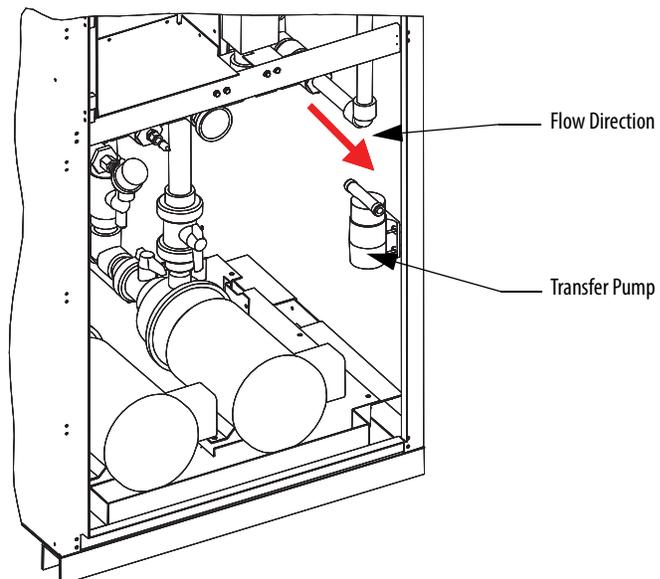
## System Fill and Air Venting



**WARNING:** Do not allow main pumps P1 and P2 to turn when dry. Damage to seals can result.

1. Attach transfer pump to drain/fill line (see drain/fill pump in [Figure 2](#)). Ensure flow arrow on pump is in correct direction.

Figure 199 - Drain/Fill Pump



2. Open valves V1, V2, V3, V4, V5, V6, V7, V10, V11, V12, V13, V14.

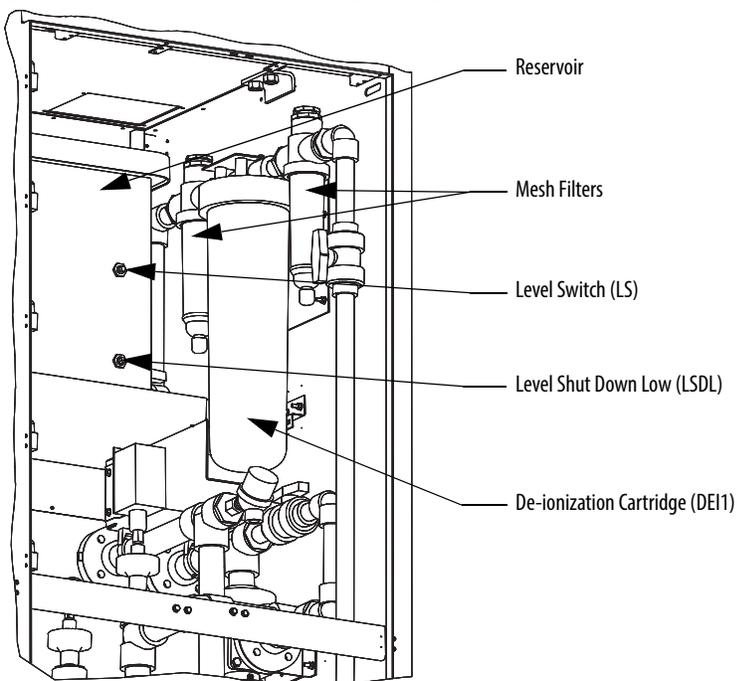
**TIP** Some drives may not have all valves.

3. Open V8 30° rotation to prevent water hammer during air purging.
4. Fill system to above reservoir upper float switch.
5. Close valves V1, V6, V7 to ensure coolant is cleaned through strainer STR1 (if provided).
6. Vent pumps by opening vent plugs on top of each pump. Open carefully to prevent excess coolant leakage. Close vent plugs.
7. Jog each pump for 1 second by manually pushing in contactor located on panel above pumps. Ensure direction is clockwise when viewed from motor side of pump. Check motor electrical connections if not clockwise.
8. Start Pump 2 to circulate coolant and eliminate air in the system. If the pump is noisy and sounds like gravel is being pumped, the pump may be cavitating. Ensure V2 and V3 are open and strainer STR1 (if provided) is not plugged.
9. Continue to fill system to maintain level in reservoir. Eliminate air by running Pump 2 for several hours. Air in the system can be observed in the deionizer filter DEI 1 and strainer STR1 (if provided). Surging or bubbling within the reservoir when pump is turned off indicates air is in the system.



**WARNING:** Air must be purged from the coolant before drive startup or damage to thyristors can result.

**Figure 200 - Mesh Filters and De-ionizing Cartridge**



10. If necessary, purge air at heat exchanger by opening heat exchanger vent valves with pump on or slightly opening the top most flange of the heat exchanger with pump on.
11. Stop pump 2.
12. Close V10 and open V1 (if provided).
13. Open vent plug on Pump 1. Open carefully to prevent excess coolant leakage. Close vent plug.
14. Run Pump 1 for several minutes.
15. Place pump selector switch to Auto.

### Normal Operation

1. Open valves V1, V2, V3, V4, V5, V8, V11, V12, V13, and V14.
2. Close valves V6, V7, and V10.

## Gating Tests

Once the drive converters have been tested without Medium Voltage and all the power supply output values have been verified, it is necessary to test the SCRs and SGCTs under low voltage control power.

The following procedures will describe how to perform the next level of device testing:

- Gating Test Mode
- SCR Firing Test
- SGCT Firing Test

If the results of the tests are not as described in the section below, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#), for detailed information on how to troubleshoot problems in the converter section of the drive.

### Gating Test Mode

The following procedure explains how to enter gating test mode. This feature will simulate drive operation by applying gate signals to the SCRs and SGCTs while isolated from medium voltage. Prior to starting the drive for the first time, a gating test should be performed to ensure that each device is functional.

Some drive status I/O will be active while performing tests in Gating Test Mode. If the drive I/O is monitored remotely, process control should be notified in advance to avoid confusion.



**ATTENTION:** Ensure that the drive is isolated from medium voltage prior to starting this test.

The PV550 display screens are given as an example. The actual screen data may differ.

From the main screen, press the ACCESS [F10] key and use the down arrow until you highlight ADVANCED. Press Enter and then EXIT [F10].

**Figure 201 - Access Advanced Screen**

SETUP :

```

Parameters          Current Access:
Analog              Advanced
PLC
XIO
Fault Masks
External Text
Setup Wizard

```

ALARMS		ACCESS	LANG'GE	EXIT
--------	--	--------	---------	------

Now press SETUP [F8] to get to Parameters, and then Enter. You should be on Feature Select, the first group.

SETUP :

```

Parameters          Current Access:
Analog              Advanced
PLC
XIO
Fault Masks
External Text
Setup Wizard

```

ALARMS		ACCESS	LANG'GE	EXIT
--------	--	--------	---------	------

Press Enter, and then use the down arrow to get to Operating Mode.

```

SELECT: Feature Select          1 of 2

Operating Mode      Normal
Speed Ref Select   Local
Speed Cmd Loss     Fault
Coast Speed        2.0      Hz
Auto Restart Dly   .0      sec
Input Ctctr Cfg    All Faults
InpCtctr OpenDly  .0      min
Output Ctctr Cfg   Not Running

ALARMS  NEXT PG  PREV PG  EXIT
  
```

Press Enter and use the down arrow to get to Gating Test. Press Enter, and you will now be in gating test mode.

```

MODIFY PARAMETER: Operating Mode

P: 4

Actual: Normal
New:     Normal
        Gate Test
        DC Current
        System Test
        Open Circuit
        Open Loop

ALARMS  CANCEL  ACCESS  EXIT
  
```



**ATTENTION:** Ensure that the drive is no longer running in test mode prior to applying medium voltage to the drive line-up. Failure to do so may result in equipment damage.

### SCR Firing Test

In normal operation, the SCR firing cards derive their power from a voltage divider network that steps down the medium voltage to 20 V DC maximum. As it is necessary to perform this test while isolated from medium voltage, a secondary source of power has to be provided to power the firing cards.

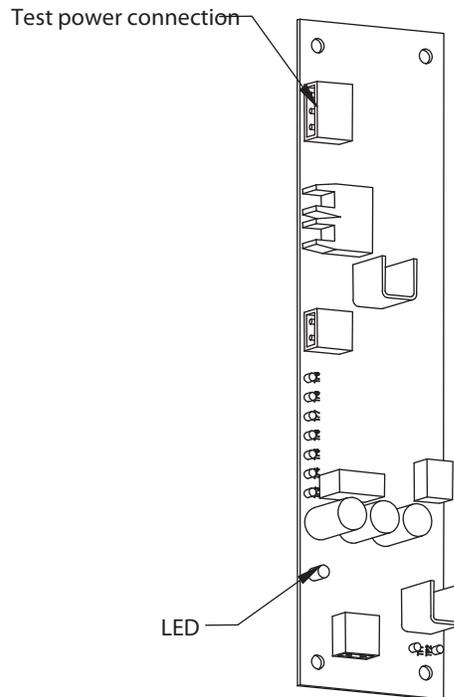
Supplied with each drive is a power cable which supplies 15 V DC from an AC/DC power supply to the firing cards (SPGDB). This cable has one input to be connected to an AC source (120/240V, 50/60 Hz) and 18 sets of outputs that can be connected to the SCR self powered gate driver boards.

The procedure is as follows:

Plug the AC power connector on the test cable into an appropriate AC source. The other eighteen 3-pin connectors plug into the SCR SPGDB board terminals labeled TB3 – Test Power (see [Figure 202](#) – Self-Power Gate Driver Board Test

Power Terminal). The number of eighteen 3-pin connectors used will depend on the voltage and configuration of the drive rectifier section.

**Figure 202 - Self-Powered Gate Driver Board Test Power Terminal**



Put the drive in Gating Test Mode and the rectifier will automatically go into Test Pattern gating mode.

LED 1 – Gate Pulse (Yellow) should light up and pulsate at the frequency that the device is firing. All the other LEDs will light up as the firmware sends a gating signal to every SCR.

There is also a Gating Test that fires the individual devices one at a time, in what is described as a Z-pattern. Basically, for each section, the Top Left device will turn on for 2 seconds, then turn off. The next device to the right will turn on for 2 seconds, and the pattern will continue. When you reach the end of the first stack of devices, the right device in the middle stack down will fire and the pattern continues right to left until the end of the middle stack is reached. Then the left device in the bottom stack will fire and the pattern will continue to the last device, where it will then return to the top. This is a test to show that the correct fiber optic cables are connected to the corresponding devices.

During commissioning, it is not necessary to use an oscilloscope for SCR firing tests, although it will be required if SCR firing problems occur.

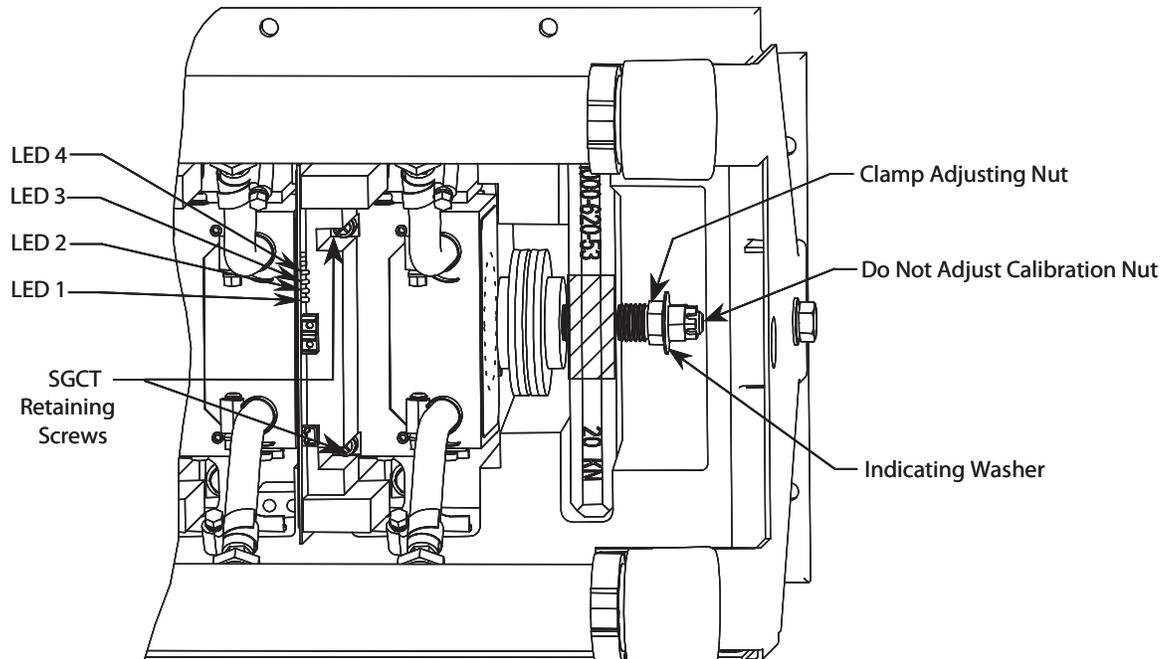


**ATTENTION:** Ensure that the test cable is removed from the drive and that it is taken out of Test Mode prior to applying Medium Voltage. Failure to do so may result in personal injury or equipment damage.

## SGCT Firing Test

Unlike the SCR Self-powered gate Driver Board, the SGCT has an integrated firing circuit mounted on the device. The power for this circuit is derived from the SGCT Power Supplies (IGDPS), and preliminary observations are possible by monitoring the healthy lights on the firing circuit without putting the drive into gating test mode. There are 4 LEDs on the firing card. The following diagram illustrates the location of the LEDs:

**Figure 203 - SGCT Healthy LEDs**



While the drive is sitting idle, without gating LEDs 4 (Green), 3 (Green), and 1 (RED) should be illuminated while LED 2 (Yellow) is off. If any other combinations of LEDs are illuminated, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#), for instructions on how to troubleshoot the SGCT firing cards.

Put the drive in Gating Test Mode and the inverter will automatically go into the Test Pattern gating mode.

Monitor the SGCT LEDs and ensure that LEDs 4 (Green) and 3 (Green) remain illuminated, while LEDs 1 (Red) and 2 (Yellow) toggle on an off alternately at the frequency that the converter is operating at.

There is also a Gating Test that fires the individual devices one at a time, in what is described as a Z-pattern. Basically, for each section, the Top Left device will turn on for 2 seconds, then turn off. The next device to the right will turn on for 2 seconds, and the pattern will continue. When you reach the end of the first stack of devices, the right device in the middle stack down will fire and the pattern continues right to left until the end of the middle stack is reached. Then

the left device in the bottom stack will fire and the pattern will continue to the last device, where it will then return to the top.

This is a test to show that the correct fiber optic cables are connected to the corresponding devices.

Normal Gating Test mode will fire the inverter at the output frequency corresponding to the active reference (speed) command.

## System Test

Prior to applying medium voltage, it is necessary to verify the entire low voltage control circuit to ensure the drive operates as desired. Failure to perform this test may result in damage to the drive or process in the event that the control does not operate as expected. This section of the manual provides instruction for the following five tests:

- System Test Mode
- Start/Stop Contactor Control
- Status Indicators
- Analog I/O
- Configurable Alarms

### System Test Mode

The following procedure explains how to enter System Test Mode. This allows the drive to operate the drive's low voltage control circuit without medium voltage present.

Drive status I/O will be active while performing tests in System Test Mode. If the drive I/O is monitored remotely, process control should be notified in advance to avoid confusion.



**ATTENTION:** Ensure that the drive is isolated from medium voltage prior to starting this test.

---

**The PV550 display screens are given as an example. The actual screen data may differ.**

Ensure you have Advanced access.

Now, from the main screen, press SETUP [F8] to get to Parameters, and then Enter. You should be on Feature Select, the first group.

SELECT GROUP: 1 of 3

```

Feature Select
Motor Ratings
Autotuning
Motor Model
Speed Command
Speed Control
Speed Profile
Current Control
    
```

ALARMS	LIST	NEXT PG	PREV PG	EXIT
--------	------	---------	---------	------

Press Enter, Operating Mode is highlighted on the first line.

SELECT: Feature Select 1 of 2

```

Operating Mode      Normal
Speed Ref Select    Local
Speed Cmd Loss      Fault
Coast Speed          2.0      Hz
Auto Restart Dly    .0       sec
Input Cctr Cfg      All Faults
InpCctr OpenDly     .0       min
Output Cctr Cfg     Not Running
    
```

ALARMS		NEXT PG	PREV PG	EXIT
--------	--	---------	---------	------

Press Enter and use the down arrow to get to System Test. Press Enter, and then EXIT and you will be in System Test mode. From this point you can completely check the entire system without medium voltage. As long as you have test power to all your contactors, you can start, stop, E-Stop, trigger faults, check remote IO, check PLC inputs, and verify other functionality.



**ATTENTION:** Ensure that the drive is no longer running in system test mode prior to applying medium voltage to the drive line-up. Failure to do so may result in equipment damage.

## Start/Stop Control Circuit

Once the drive is in System Test mode, ensure that the stop/start circuit functions as desired. It may be necessary to study the electrical schematic drawings, prior to performing this test, in order to understand the control circuit.

Start the drive in local control while observing the system vacuum contactors or customer supplied circuit breakers. If troubleshooting is required in Rockwell Automation medium voltage switchgear, additional information is available in the following publications:

- Publication **1500-UM055\_-EN-P**, Medium Voltage Controller, Bulletin 1512B, Two-High Cabinet, 400 Amp • User Manual

- Publication **1503-IN050\_-EN-P**, OEM Starter Frame and Components • Installation Manual
- Publication **1502-UM050\_-EN-P**, Medium Voltage Contactor, Bulletin 1502, 400 Amp (Series D) • User Manual
- Publication **1502-UM052\_-EN-P**, Medium Voltage Contactor, Bulletin 1502, 400 Amp (Series E) • User Manual
- Publication **1502-UM051\_-EN-P**, Medium Voltage Contactor, Bulletin 1502, 800 Amp • User Manual

If the Medium Voltage contactors or circuit breakers perform as desired, stop the drive and perform the same test while operating in remote control.

Start the drive again and verify that all emergency stops installed in the system function as desired. Ensure that all electrical interlocks installed in the system function as desired. Make any necessary control wiring modifications at this time and re-test the system if necessary.

## Status Indicators

Drive status is often feedback to a plant's process control either digitally through the PLC input/output feature (see Chapter 3 – Operator Interface, PLC page 3-43) or through relay logic. The following relays are provided with the drive as standard:

Relay Name	Relay Designation
Run Contact	RUN
Fault Contact	FLT
Warning Contact	WRN
Ready Contact	RDY

It is necessary to activate each status indicator used by the customer to ensure that they have connected their control to the drive correctly. This can be achieved by changing the drive status (ready, faulted, warning etc.).

## Analog I/O

It is possible to configure all of the drive's analog inputs and outputs without running the motor. The following information describes how to set up the following drive features:

- Analog Inputs
  - Analog Reference Command Input Scaling (Local, Remote)
  - Minimum Setting
  - Maximum Setting
  - Digital Reference Command Input Scaling (Digital)
- Analog Outputs

All of the Analog I/O connections are made on the ACB.

### *Analog Inputs*

- Analog Command Input Scaling
  - Prior to commencing the reference command input scaling it is necessary to ensure that the reference command input selection has been configured as desired. This requires setting Reference Select [P7] to the appropriate input source.
  - Set the utilized Reference Command minimum (SpdCmd Pot(L), SpdCmd Anlg Inp(R) and SpdCmd DPI ( D)) to the desired value. The minimum reference command input setting on a drive without an encoder is 6 Hz. Without encoder control, do not set the reference command minimum parameter below 6 Hz. A control with encoder feedback will allow a minimum speed of 1 Hz. With encoder control, do not set the reference command minimum parameter below 1 Hz.
  - Set the utilized Reference command (L, R and D) Maximum parameters so that with full reference command inputs, the associated Reference command Variables read the desired maximum value.
  - The various reference command maximums usually have to be increased above the desired maximum value to compensate for the loading down of their 10 volt input rails by the attached potentiometer or isolator.

### **Example:**

- **SpdCmd Anlg Inp (4-20mA) Reference command Input Scaling**

The customer 4-20 mA speed input is coming to the Current Loop Receiver on the ACB, and they want the maximum input to represent 60 Hz.

1. Reference Command Remote Maximum (Ref Cmd R Max) should be set for 60 Hz.
2. The Reference Select parameter should be set to “Remote 4-20 mA”.
3. Have the source supply 20 mA to the drive. This should be verified with a multimeter connected in series with the current source. Ensure that you are in Remote mode with the selector switch, and look at the parameter Speed Command In, which will represent that 20 mA signal.
4. Ensure that it reads 60 Hz. If it does not, you can increase the Ref Cmd R Max value until this parameter reads 60 Hz.

- **SpdCmd DPI (Digital) Reference command Input Scaling**

The maximum value for a digital reference command is 32767; the minimum value is 0. Values that are negative or out of bounds will result in the drive slowing down to minimum speed.

### *Analog Outputs*

Review the electrical schematics to understand which meters or signals the user expects out of the analog output ports on the ACB Board.

The PV550 display screens are given as an example. The actual screen data may differ.

To assign a parameter to an analog output, ensure that you are at least in Advanced access. From the main screen, press SETUP [F8], and use the down arrow to highlight Analog. Press Enter.

SETUP :

```

Parameters          Current Access:
Analog              Advanced
PLC
XIO
Fault Masks
External Text
Setup Wizard

```

ALARMS		ACCESS	LANG'GE	EXIT
--------	--	--------	---------	------

Use the down arrow to highlight the output you wish to assign. When you press Enter, you will be brought to the entire list of parameters in the Select Group screen. Use the arrow and enter keys to find the parameter you wish to assign, and press Enter. This will take you back to the Analog screen and you will see the new parameter name beside your selected output.

ANALOG SETUP: 1 of 3

```

Meter1      Motor Current      :361
Meter2      Motor Voltage     :362
Meter3      Motor Speed RPM   :363
Meter4      Motor Power       :364
Output1
Output2     Idc Test Command   :119
Output3
Output4

```

ALARMS	CANCEL	NEXT PG	PREV PG	EXIT
--------	--------	---------	---------	------

Press EXIT [F10], go up to Parameters. Press Enter, and then scroll down the list until you reach Analog Outputs. Press Enter, and you will see the same list of available ports and the assigned parameter number, but not the name.

SELECT GROUP: 3 of 3

```

Datalinks
Analog Outputs
XIO
Security
Parallel Drive
Drv Application
Process Control

```

ALARMS	LIST	NEXT PG	PREV PG	EXIT
--------	------	---------	---------	------

If you scroll down, you will reach the scaling factors for the 4 Meter Port and the 3 ACB Port outputs. All parameters are scaled to 0-10V, with 0 representing the minimum value given in Chapter 5 under Parameter Descriptions, and 10V representing the maximum value given in Chapter 5. These Scaling parameters (i.e. Anlg Port2 Scl) can be used to change the scaling.

```

SELECT: Analog Outputs                2 of 3

Anlg 4-20mAOut                337
AnlgMeter1 Scale                1.00
AnlgMeter2 Scale                1.00
AnlgMeter3 Scale                1.00
AnlgMeter4 Scale                1.00
Anlg Out1 Scale                1.00
Anlg Out2 Scale                1.00
Anlg Out3 Scale                1.00
    
```

ALARMS		NEXT PG	PREV PG	EXIT
--------	--	---------	---------	------

**TIP** There are certain parameters whose minimum value is a negative number. In that case, the minimum value of the parameter (-10V) is scaled to 0V output, and the maximum value is scaled to 10V output.

Highlight the appropriate Analog Scale parameter and press Enter. You can enter your new value, and then press Enter, and EXIT [F10]. Ensure you save to NVRAM when you are finished.

```

MODIFY PARAMETER: Anlg Out2 Scale

P: 184

Min:                .00
Actual:              1.00
New:                2.73
Max:                655.35
    
```

ALARMS	CANCEL	ACCESS		EXIT
--------	--------	--------	--	------

The analog outputs from the customer interface boards are stated as 0 to 10 volts, but in actual fact their outputs are typically 0.025 to 9.8 or 9.9 V. This is due to the rails being loaded down by an attached speed potentiometer or signal conditioner impedance. Incorporated signal conditioners usually have 0 to 10-volt inputs and 4 to 20 mA outputs. An additional error is incorporated in the signal conditioners, so if they are calibrated for 0 to 10 volts input, there will not be exactly 4 to 20 mA out.

It is now necessary to calibrate the external 4 to 20 mA signal conditioners.

1. Set a digital multimeter to mA and place it in line with the signal conditioners. If the output of the conditioner is terminated, the meter can be used as a load.

2. Assign a parameter to the Analog Output port that we wish to calibrate. This parameter should be one that we can change from minimum to maximum for test purposes only. IDC Command Test is a good example. See previous page on assigning an output.
3. Set IDC Command Test to 0.000 pu. This is the minimum. Adjust the Zero adjustment screw on the isolator to read 4 mA.
4. Set IDC Command Test to 1.500 pu. This is the maximum. Adjust the Span adjustment screw on the isolator to read 20 mA.
5. Repeat the process until no more adjustments are required.
6. Set IDC Command Test to 0.750 pu to ensure you read 12 mA (Half-scale). Set IDC Command Test to 0.000 pu.
7. Assign the required parameter to the Analog Output port we have calibrated.
8. Save all changes to NVRAM.

## Configurable Alarms

Ensure that the configurable alarms have been programmed in the drive control. Instructions on where to locate the following External Fault related tasks in the manual are listed below:

- **Setting Fault Masks:** Refer to [Fault Masks on page 128 \(Chapter 3\)](#)
- **Setting External Fault Text:** Refer to [User Definable External Text on page 131 \(Chapter 3\)](#)
- **Setting Fault Classes:** Refer to [Drive Commissioning on page 169](#)

The external faults can be tested by lifting the wires to all external warning / fault inputs while running in system test mode. These wires are terminated at the Digital I/O boards. Opening the circuit at any point will verify the external fault's configuration and functionality. However, it is preferable to actually force the trips from the source. If that is not possible, then an acceptable alternative is to lift the wire at the protective device.



**ATTENTION:** Do not short the lifted wire to ground when testing the circuit or damage will occur to the Digital I/O board and possibly weld the equipment's trip contact.

## 18 Pulse Phasing Test

Prior to applying medium voltage and running the drive, it is important to verify the phase rotation on the input of all 18 Pulse drives. The following tests do not need to be performed on AFE rectifier drives unless they incorporate synchronous transfer:

- Line Terminal Resistance Measurements
- Application of Medium Voltage Power

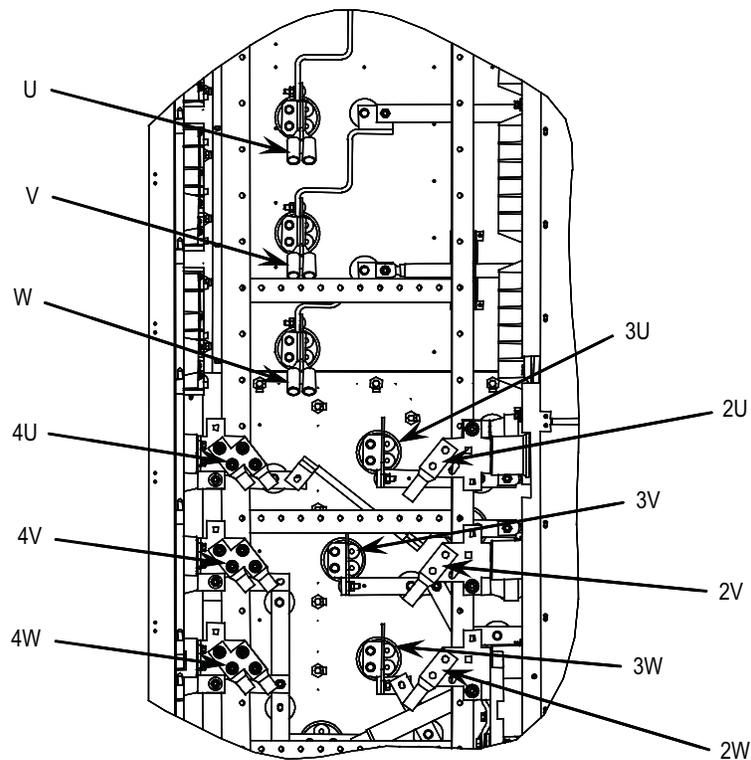
- Compare the voltage feedback from all 9 test points in the ACB board to ensure proper phasing.

Failure to perform the recommended tests will result in poor drive performance and may result in drive converter damage.

### Line Terminal Resistance Measurements

Measuring the resistance between the drive line cable terminals will quickly identify if there is interwiring between the 0°, +20°, and -20° bridges in the isolation transformer.

Figure 204 - 18 Pulse Terminals



There are low resistances between phases through a transformer winding and a high resistance between transformer windings. Therefore, the expected resistance measurements are listed in the table below:

Terminal Measurement Points	Expected Resistance
2U → 2V → 2W	Approximately 0 Ω
3U → 3V → 3W	Approximately 0 Ω
4U → 4V → 4W	Approximately 0 Ω
#U → #V → #W	Approximately ∞ Ω

If the measurement results are not as described above, the interwiring between the isolation transformer and drive needs to be re-inspected.

## Application of Medium Voltage

Before running the drive on Medium Voltage, it is a good idea to set up the diagnostic trending feature to capture any information in the event of a fault during commissioning. **REMEMBER TO RESET THE TRENDING BEFORE LEAVING THE DRIVE IN PRODUCTION.**

The diagnostic trending operation of the drive allows you to capture the relationships of 8 parameters over a period of time. Trending is a valuable tool for trouble shooting the drive.

Refer to [Chapter 5](#) for instructions on setting up the Diagnostic Trending.

The next test required to test phase rotation requires that medium voltage be applied to the drive input. Ensure that the drive is thoroughly inspected for debris and tools prior to energizing the drive. Furthermore, ensure that all protective barriers have been re-installed before continuing. Ensure that you have taken the drive out of System Test mode, and have returned to Normal operating mode.

## Input Phasing Check

There are 9 voltage test points on the ACB board that will allow you to look at each voltage level individually.

These test points are labeled as follows:

**Table 12 - ACB Test Points and Associated Voltage Signals**

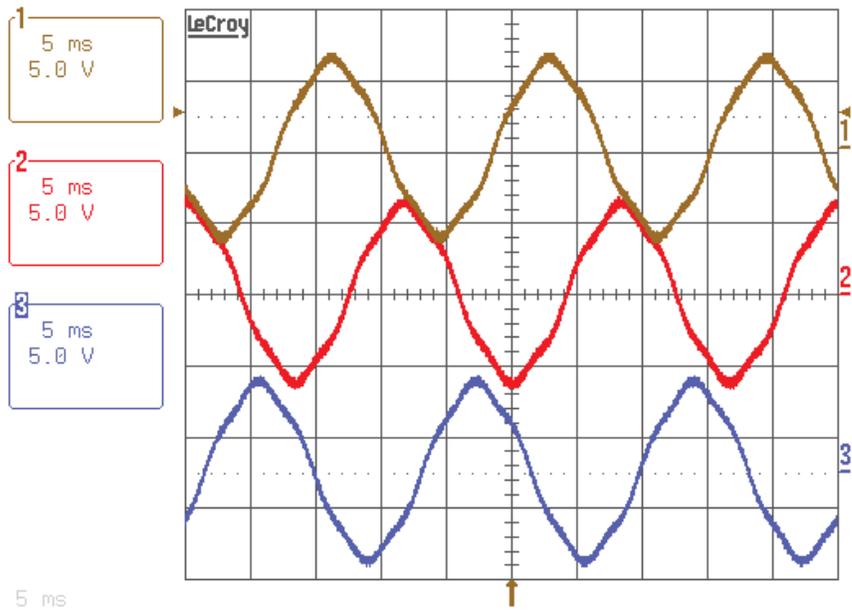
Test Point Description	Isolation Transformer: Secondary Phasing and Bridge		Phase Relationship with respect to V2uv (2U)
V2uv	2U	Master	0°
V2vw	2V	Master	-120°
V2wu	2W	Master	-240°
V3uv	3U	Slave 1	-20°
V3vw	3V	Slave 1	-140°
V3wu	3W	Slave 1	-260°
V4uv	4U	Slave 2	+20°
V4vw	4V	Slave 2	-100°
V4wu	4W	Slave 2	-220°

All of these test points can be measured to either the Analog Ground (AGND) on the board or the TE ground in the low voltage section. You can use V2uv as your reference (trigger on this waveform) and verify all the other test points using the table above. It is easier to use zero crossings on your oscilloscope as the reference points when checking the phase shifts.

Essentially, you are verifying the following relationships:

1. V and W in each bridge should be lagging U by 120° and 240°, respectively.
2. 3U, 3V, and 3W should be **lagging** 2U, 2V, and 2W by 20° (-20°), respectively.
3. 4U, 4V, and 4W should be **leading** 2U, 2V, and 2W by 20° (+20°), respectively.

Figure 205 - CH1 is 2Vuv, CH2 is 2Vvw, CH3 is 2Vwu

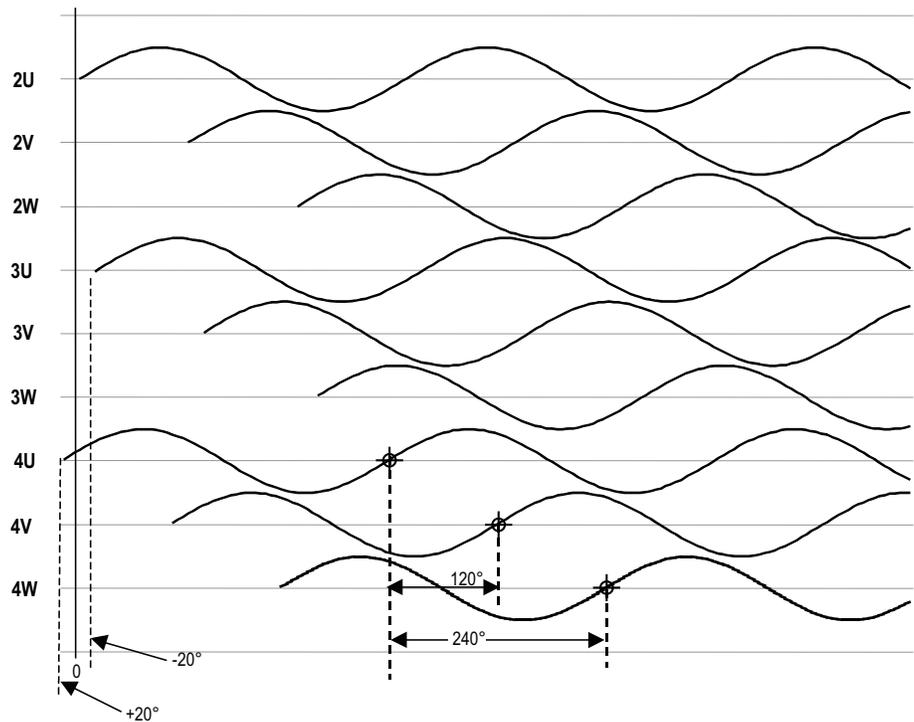


For 60 Hz systems,  $360^\circ = 16.7 \text{ ms}$ .

For 50 Hz systems,  $360^\circ = 20 \text{ ms}$ .

Refer to [Figure 206](#) for a visual representation of the phasing checks.

Figure 206 - 18 Pulse Phase Sequence



## DC Current Test

The following test will assist in verifying the isolation transformer phasing, as well as verifying DC Link connections. It involves putting the drive in DC Current Test and monitoring variable Alpha Line and Idc feedback while increasing the DC current through the drive rectifier. The following instructions detail how to DC current test:

**The PV550 display screens are given as an example. The actual screen data may differ.**

Ensure that you have Service access.

From the main screen press SETUP [F8], then press Enter, and press Enter again to access the Feature Select parameter group.

SELECT GROUP: 1 of 3

```

feature select
Motor Ratings
Autotuning
Motor Model
Speed Command
Speed Control
Speed Profile
Current Control

```

ALARMS	LIST	NEXT PG	PREV PG	EXIT
--------	------	---------	---------	------

Operating Mode is highlighted on the first line. Press Enter. Scroll down to the DC Current option, highlight it, and press Enter. Then press EXIT [F10], until you make it out to the main screen. There is no need to save to NVRAM when the prompt appears.

```

MODIFY PARAMETER: Operating Mode

                                P: 4

Actual:      Normal
New:         Normal
            Gate Test
            DC Current
            System Test
            Open Circuit

ALARMS  CANCEL  ACCESS  .  EXIT
    
```

Press DISPLAY [F4] and scroll down until you reach the group Current Control. Press Enter and then press MODIFY [F7]. Scroll down to Idc Test Command and press Enter. Enter the number 0.1 pu and then press Enter. Press EXIT [F10] twice and press PREV PG. The value of Alpha Rectifier will be displayed on this screen, as shown below.

DISPLAY GROUP: 2 of 4

```

Refernce Command
Speed Command
Speed Control
Speed Profile
Current Control
Torque Control
Flux Control
Flux Command
    
```

```

ALARMS  CUSTOM  NEXT PG  PREV PG  EXIT
    
```

DISPLAY: Feedback 1 of 3

```

Alpha Line          .0      deg
Alpha Machine       .0      deg
Cabinet Temp c      .0      C
Cabinet Temp f      .0      F
Gnd flt Current     .0      A
IHeatsink Temp C    .0      C
IHeatsink Temp F    .0      F
RHeatsink Temp C    .0      C
    
```

```

ALARMS  MODIFY  NEXT PG  PREV PG  EXIT
    
```

Press the start button and the drive should start running, pumping 0.1 pu (10%) of rated current through the DC link. Alpha Rectifier should be approximately 90°– 92°.

We can also check the Idc Reference and Idc Feedback on this same screen. Idc reference should be at 0.100 pu and Idc Feedback should be around that same number. Ensure that Idc error stays around 0.

The Idc waveform can be observed from T21 (Idc1) on the ACB board. The test point should show 6 ripples per cycle for a 6-pulse drive. The waveform should have an offset of 0.5V for each 0.1pu of Idc Test Command. The waveform should also never have any of the low points between ripples go to 0V. This would indicate a problem with the DC Link cabling. See the troubleshooting section for sample waveforms.

Press MODIFY [F7], and increase Idc to .2 pu, and repeat the process. Go as high as 0.7 pu in 0.1pu steps for 18 Pulse, and 0.3 pu in 0.1pu steps for AFE, verifying each level as you increase the current. For AFE, the Idc test is limited to 0.3 Idc reference. If there is a current meter somewhere on the input to the transformer/ drive, check the current to ensure that it matches up with what you think we are pumping.

```

SELECT: Current Control          1 of 1

Currreg Bandwidth                200.0    r/s
Idc Command Test                 .800    pu
Idc Ref Step                    .000    pu
T DC Link                       .040    sec

```

ALARMS		NEXT PG	PREV PG	EXIT
--------	--	---------	---------	------

When we are satisfied everything is OK, bring the IDC current down in steps of .1 pu to 0, and then stop the drive. Return to the Feature Select parameter group and change Operating Mode back to Normal.

```

SELECT: Feature Select          1 of 2

Auto Restart Dly                 .0      sec
Coast Speed                      2.0    Hz
Ctrl DC Power                    Fault
Input ContCfg                   All Faults
Input Open Delay                 .0      min
Operating Mode                   Normal
Output ContCfg                  Not Running
Reference Select                 Remote 4-20a

```

ALARMS		NEXT PG	PREV PG	EXIT
--------	--	---------	---------	------

## Tuning Procedure

The PowerFlex 7000 “C” Frame medium voltage drive must be tuned to the motor and load to which it is connected. There are three drive functions that require tuning. These are listed below in the order in which they are usually performed:

1. Rectifier
2. Mtr Impedance
3. FluxSpeedReg

The first two functions can be tuned with the motor stationary, but third function requires the motor to rotate. In case the drive cannot complete the tuning, it should be carried out manually.

---

**IMPORTANT** You will need to have a minimum of SERVICE level access to complete manual tuning. If you do not have SERVICE level access, please contact the factory.

---

**TIP** Make sure the following tuning parameters are set to default values:

- Input Impedance (P#140)
- T DC Link (P#115)
- R Stator (P#129)
- L Total Leakage (P#130)
- Lm Rated (P#131)
- T rotor (P#132)
- Total Inertia (P#82)
- Lmd (P#418)

### 1. Rectifier

The Rectifier tuning function calculates parameter *Input Impedance* (140) and *T DC Link* (115) in Current Control group.

#### *Input Impedance*

*Input Impedance* is used in the software reconstruction of the line voltage to compensate for the drop in the line impedance. It is also used in the calculation of the line converter retard limit (for SCR rectifiers) to ensure proper operation under all conditions of line voltage and load current. If the *Input Impedance* parameter is not correctly adjusted, the resulting error in the reconstructed line voltage may cause line synchronization faults and incorrect reading of the incoming line voltage.

The *Input Impedance* parameter is tuned with the drive operating in the dc current test mode. Although the *Input Impedance* was tuned during factory test, it must be retuned during commissioning because its value is determined by the impedance of the input transformer and harmonic filter (if present).

### *TDC Link*

The tuning of the current regulator is controlled by three parameters – two in the *Current Control* group, and one in the *Drive Hardware* group:

1. Current regulator bandwidth *CurReg Bandwidth*
2. DC Link time constant *TDC Link*
3. DC Link inductance in per unit *DCLnk Induct pu*

Of these three parameters, inductance *DCLnk Induct pu* is calculated from its nameplate rating, the current regulator bandwidth should be set to its default value of 200 rad/sec, and only *TDC link* is unknown and must be measured. Although the current regulator was tuned during factory test, it should be retuned during commissioning because the dc link time constant is affected by the impedance of the drive input transformer.

The following auto-tune procedure is used to complete the rectifier side tuning:

### *Rectifier Auto-tuning*

1. Ensure that the parameters in the *Drive Hardware* and *Motor Ratings* groups have been set to the correct values.
2. Set parameter *Autotune Select* in the Autotuning parameter group to *Rectifier*. The drive will go into DC Current test mode. The current regulator bandwidth is set to *Autotune Idc BW* (212).
3. Start the drive. The dc current will increase to 0.2pu and stay at that level for couple of seconds. The drive records the data under this condition and then ramps up to approximately rated current. After staying at the level for couple of seconds, the drive will again record the measured data and then ramp the current to zero. The current regulator bandwidth is set back to the original value. From the recorded data, the drive will calculate the *Autotune L Input* (P217) and *Autotune TDC Link* (218). At the end of the tuning *Input Impedance* is set to *Autotune L Input* and *TDC Link* is set to *Autotune TDC Link*. During tuning if the values are determined to be out of range, the drive will issue warnings indicated below. Try to tune the drive again, but if the warnings persist, verify the result by tuning the drive manually.

Warnings during Rectifier tuning and their interpretation:

**L Input Low** - indicates that the measured L Input is less than 0.02 pu. The L Input must be tuned using the manual method described below.

**L Input High** - indicates that the measured L Input is greater than 0.5 pu. The L Input must be tuned using the manual method described below.

**TDC Link Low** - indicates that the measured dc link time constant is less than 0.020 second. The step response of the current regulator should be checked using the manual method described below.

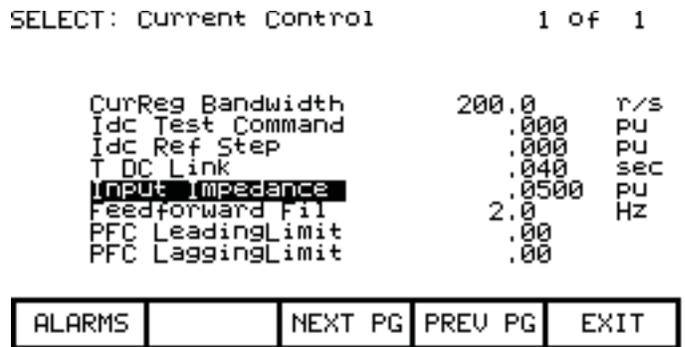
**T DC Link High** - indicates that the measured dc link time constant is greater than 0.150 second. The step response of the current regulator should be checked using the manual method described below.

**TIP** The display screens are given as an example. The actual screen data may differ.

*Input Impedance Manual Tuning*

1. Set parameter *Operating Mode* in *Feature Select* to *DC Current* to enter dc current test mode.
2. If not already at default value, set parameter *Input Impedance* in “Current Control” to an initial value of 0.05 pu.

**Figure 207 - Current Control Parameter Screen**



3. Energize the drive by closing the input contactor.
4. Record the value of the rectifier input voltage by looking at parameter *Rec Input Voltage* (P696). Let this value be  $V_{in0}$ .
5. For SCR drives set parameter *Idc Command Test* in Current Control to 0.800 pu. For AFE drives set the parameter to 0.300 pu. Let this value be  $I_{dc}$ .
6. Start the drive and wait for a few seconds for steady state conditions to be established.
7. Record the value of the rectifier input voltage by looking at parameter *Rec Input Voltage* (P696). Let this value be  $V_{in1}$ .

**TIP** This section is not applicable to ForGe.

8. The value of input impedance for AFE drives is calculated as follows:

$$L_{in} = \frac{V_{in0} - V_{in1}}{I_{dc} + C_{in}(V_{in0} - V_{in1})} \Rightarrow \text{for PWM drives}$$

$C_{in}$  is the value of input filter capacitor given by *Line Filter Cap* (P133)

9. The value of input impedance for SCR drives is calculated as follows:

$$L_{in} = \frac{3(V_{in0} - V_{in1})}{I_{dc}} \Rightarrow \text{for SCR drives}$$

10. Stop the drive. Set parameters *Operating Mode* to *Normal* and *Idc Command Test* to zero.

### TDC Link (P#115) Manual Tuning

An appropriate value for the *TDC Link* parameter can be determined from the current regulator step response while operating in *DC Current* test mode. The following procedure should be followed:

1. Be sure that all the parameters in the *Drive Hardware* and *Motor Ratings* groups have been set to the correct values. Otherwise, the calculated value of parameter *TDC Link* in *Current Control* will not be correct.
2. Set parameter *Operating Mode* in the *Feature Select* to *DC Current* to enter dc current test mode.

**Figure 208 - Current Control Parameter Screen**

```

SELECT: Current Control           1 of 1

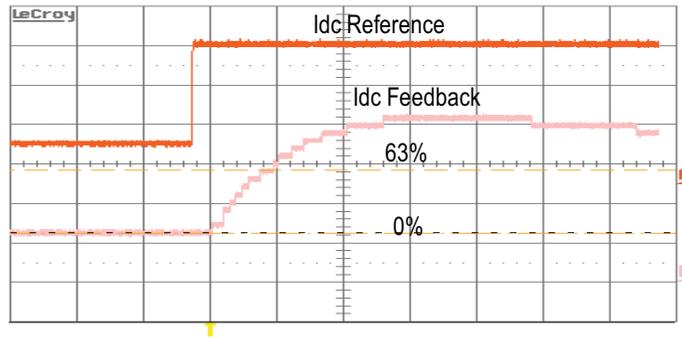
CurReg Bandwidth                200.0    r/s
Idc Test Command                 .000    pu
Idc Ref Step                     .000    pu
TDC Link                         .040    sec
Input Impedance                  .0500   pu
Feedforward Fil                  2.0    Hz
PFC LeadingLimit                 .00
PFC LaggingLimit                 .00
  
```

ALARMS		NEXT PG	PREV PG	EXIT
--------	--	---------	---------	------

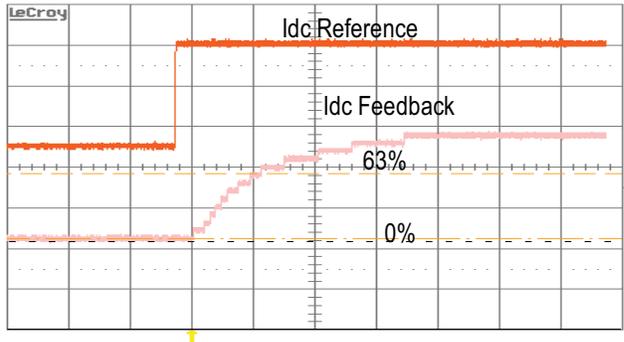
3. Set parameter *Idc Test Command* in *Current Control* to 0.225 pu for AFE rectifier drives and 0.400 pu for SCR drives.
4. Set parameter *CurReg Bandwidth* in *Current Control* to 100 rad/sec. A lower than the normal bandwidth makes the step response easier to measure.
5. Set parameter *TDC Link* in *Current Control* to 0.020 sec, which is at the low end of the normal range of values and should produce an under-damped response.
6. Assign parameters *Idc Reference* and *Idc Feedback* in the *Current Control* group to 2 DPM test points e.g. RTP1 and RTP2. This can be done similarly to the way that the meter assignments were described earlier in the chapter. Then they can be displayed on the oscilloscope.
7. Start the drive. Set parameter *Idc Ref Step* in *Current Control* to 0.075 pu for AFE rectifier drive and 0.200 pu for SCR drives. The dc link current will step up and down by this amount at regular intervals.

8. Adjust the scope to trigger on the rising edge of the dc current reference and observe the dc current feedback on the other channel. The step response will probably have noticeable overshoot, indicating that the dc link time constant is set too low.
9. Adjust parameter *TDC Link* until the current feedback rises to about 63% of its final value in 10 ms as shown in [Figure 210](#). The overshoot should now be quite small. Increasing *TDC Link* causes the rise time to increase. Since the desired step response is slightly under-damped, *TDC Link* should not be increased beyond the value at which the overshoot disappears.

**Figure 209 - Current Regulator Tuned Incorrectly**



**Figure 210 - Current Regulator Tuned Correctly**



10. Set parameter *CurReg Bandwidth* to the normal value of 200 rad/sec. Confirm that the rise time of the current feedback is now approximately 5 ms and that the overshoot is not excessive.
11. Set parameter *Idc Ref Step* to zero. The dc link current will return to a steady level given by *Idc Test Command*.
12. Stop the drive. Set parameters *Operating Mode* to *Normal*, and *Idc Test Command* to 0.000pu.

## 2. Motor Impedance

The motor impedance tuning function calculates stator resistance  $R_{Stator}$  (129) and total leakage inductance  $L_{Total Leakage}$  (130) in Motor model Group. These parameters are used in the reconstruction of the rotor flux. If these parameters are not adjusted correctly, the resulting distortion in the flux feedback may cause speed feedback or motor synchronization errors. These parameters must be tuned during commissioning because it is affected not only by motor parameters, but also by cable length. The tuning should be done with the motor stationary.



**ATTENTION:** In the following steps, the rotation of the motor in an undesirable direction may occur. To guard against possible equipment damage, it is recommended that the motor is disconnected from the load and tested for direction prior to proceeding, should the equipment be sensitive to reverse direction rotation.

The following auto-tune procedure can be followed.

### *Motor Impedance Auto-tuning*

1. Ensure that the motor is stationary. If the motor is turning, the results of the test may be invalid. It is not necessary to lock the rotor.
2. Set parameter *Autotune Select* in *Auto-tuning* to *Motor Impedance*.
3. Start the drive. In the first half of the test the output frequency is zero and the dc current is ramped to 0.6pu for a few seconds. This step will calculate  $R_{Stator}$ . After this the current is ramped down to zero.
4. In the second half of the step the output frequency ramps up to rated frequency with the dc current equal to 1.0pu for a few seconds. This test may produce a small amount of motor torque and some rotation may occur. This step will calculate the  $L_{Total Leakage}$ . The current is ramped down and parameter *Autotune Select* is set to *Off*.

Parameter *Autotune RStator* (219) is set to the measured Stator resistance.  $R_{Stator}$  (129) in *Motor Model* is set equal to *Autotune R Stator*. If the test fails or the values are out of range, a warning is issued indicating the cause of the failure.

Parameter *Autotune LLeakage* (220) is set to the measured leakage inductance.  $L_{total leakage}$  (P130) in *Motor Model* is set equal to *Autotune LLeakage*. If the test fails, a warning is issued indicating the cause of the failure.

Following warnings can occur during this test:

**R stator High** - this is probably caused by extremely long motor cables increasing the apparent stator resistance of the motor. The drive cannot operate with stator resistance greater than 0.50 pu.

**L Leakage Low** - indicates that the measured leakage inductance is less than 0.10 pu. Possible causes are:

1. The motor is much larger than the drive and the motor nameplate parameters do not correspond to the actual motor ratings.
2. Because of the design of the motor, this method of measuring leakage inductance does not produce a valid result. The leakage inductance will have to be obtained from the motor data sheet, or if this is not possible, parameter *L Total Leakage* should be set to its default value of 0.20 pu.

**L Leakage High** - indicates that the measured leakage inductance is greater than 0.35 pu. Possible causes are:

1. The inductance of long motor cables is increasing the apparent leakage inductance of the motor. In this case, the measured leakage inductance is probably correct.
2. The motor is very small (leakage inductance generally increases with decreasing motor size).
3. Because of the design of the motor, this method of measuring leakage inductance does not produce a valid result. The leakage inductance will have to be obtained from the motor data sheet. If this is not possible, parameter *L Total Leakage* should be set to its default value of 0.20 pu.

### 3. FluxSpeed Regulator [INDUCTION MOTORS]

**TIP** For synchronous motors, please refer FluxSpeed Regulator for Synchronous motor.

This method combines the auto-tuning of the Flux and Speed regulator in a single step. It calculates parameters, *Lm Rated* (P131), *T Rotor* (P132) in *Motor Model* Group and *Total Inertia* (82) in *Speed Control* group.

**TIP** During this auto-tune step the motor will run at speed set in *Autotune Spd Cmd*. The default setting is 30Hz. Make sure the motor rotates during this auto-tune. Motor rotation must be verified either physically or monitoring *FlxFbk VoltModel* (342). It is possible that stall condition may calculate wrong tuning parameters. If it happens, make sure the tuning parameters *Lm Rated*, *T Rotor*, *Total Inertia* are set to default before starting this tuning again.

#### *Flux Regulator*

The tuning of the flux regulator for an induction motor is determined by three parameters:

1. FlxReg Bandwidth in Flux Control
2. Lm Rated in Motor Model

### 3. T Rotor in Motor Model

*FlxReg Bandwidth* should be set to the default value of 10 r/s for almost all applications. *Lm Rated* and *T Rotor* are usually unknown and must be measured. Both of these motor parameters change substantially with different operating conditions, but the variations do not significantly affect the operation of the flux regulator.

The other aspect of flux control is the variation of motor flux with speed. This is determined by two parameters:

1. *Base Speed in Flux Control*
2. *FlxCmd RatedLoad in Flux Control*

In most applications, the motor runs at constant flux below rated speed and constant voltage above rated speed. The motor flux is normally set to a level that provides rated voltage at rated speed and full load. The flux level required to achieve this is a function of the motor parameters. The flux regulator auto-tuning determines a value of rotor flux that should provide rated motor voltage at full load and rated speed, and sets the flux command parameter to this value.

#### *Speed Regulator*

The tuning of the speed regulator is determined by two parameters in the *Speed Control* group:

1. *SpdReg Bandwidth*
2. *Total Inertia*

Parameter *SpdReg Bandwidth* is set to a value determined by the requirements of the application, but parameter *Total Inertia* is usually unknown and must be measured. The auto-tuning determines the total inertia by measuring the change in speed that occurs when a low frequency sinusoidal torque perturbation is applied to the motor. The inertia measurement is not affected by the load torque as long as the drive does not hit torque limit. Do not disconnect the driven load from the motor, as it is the total inertia of motor and load that is being measured.

#### *FluxSpeed Reg Auto-tuning [Induction Motor]*

The following procedure should be used to perform FluxSpeed Reg auto-tuning:

1. Ensure that parameters *Rated Motor RPM* in *Motor Ratings* and *L Total Leakage* in *Motor Model* are set to the correct value. Ensure that parameters *Autotune Spd Cmd* and *Autotune Trq Stp* in *Autotune* are set to default values.
2. Set parameter *Autotune Select* in *Autotuning* to *FluxSpeed Reg*.

3. Start the drive. The motor accelerates normally up to the speed specified by parameter *Autotune Spd Cmd*. The motor magnetizing inductance is calculated from the measured current and flux feedback and parameter *Autotune L Magn* is set to this value. The flux command is then set to a value that should produce rated voltage at rated speed and load. The resulting change in the flux level may cause the magnetizing inductance to change. This process is repeated until the magnetizing inductance and flux commands stabilise.
4. After completing the flux regulator tuning, the drive waits for a few seconds and adds a sinusoidal perturbation specified by parameter *Autotune Trq Stp* to the torque command, causing the speed to vary. After the initial transient has decayed (this usually takes a few seconds), the variation in torque and speed are measured and used to calculate the *Total Inertia*. The torque perturbation is then removed and the drive performs a normal stop.

Parameter *Autotune L Magn* (221) is set to the measured magnetizing inductance. Parameter *FlxCmd RatedLoad* in Flux Control Group is set to a value which is intended to produce rated voltage at rated speed and load. The value of parameter *Autotune T Rotor* is calculated from parameters *Lm Rated* and *Rated Motor RPM* (which gives the rated slip). If the auto-tuning is successful, then parameter *Lm Rated* (131) in *Motor Model* is set equal to *Autotune L Magn*, parameter *T Rotor* (P132) in *Motor Model* is set equal to *Autotune T Rotor*, and the flux regulator gains are recalculated, parameter *Total Inertia* (82) in Speed Control is set equal to *Autotune Inertia* and the regulator gains are calculated.

If the auto-tuning fails then a warning is issued indicating the cause of the failure. Following are the list of possible warnings:

**L Magnetize Low** - indicates that the measured value of magnetizing inductance is less than 1.0 pu. This warning is intended to draw attention to an unusually low value of magnetizing inductance. This may occur if the motor is much larger than the drive and the nameplate parameters do not correspond to the actual motor ratings.

**L Magnetize High** - indicates that the measured value of magnetizing inductance is greater than 10.0 pu. This warning is intended to draw attention to an unusually high value of magnetizing inductance. This may occur if the motor is much smaller than the drive, and the nameplate parameters do not correspond to the actual motor ratings. The flux regulator should be tuned using the manual method described below.

**T Rotor Low** - indicates that the calculated value of rotor time constant is less than 0.2 seconds. This is caused by a value of *Lm Rated* or *Rated Motor RPM* which is too low.

**T Rotor High** - indicates that the calculated value of rotor time constant is greater than 5.0 seconds. This is caused by a value of *Lm Rated* or *Rated Motor RPM* which is too high.

**Regulator Limit** - indicates that the torque command was greater than *Trq Limit Motoring* or *Trq Limit Braking*. The measured inertia value is invalid. Parameter *Autotune Trq Stp* or parameter *Autotune Spd Cmd* must be set to a lower value and the test repeated.

**Tuning abort** - indicates that the deviation in motor speed was greater than 10 Hz. The measured inertia value is invalid. Parameter *Autotune Trq Stp* must be set to a lower value and the test repeated.

**Inertia high** - indicates that the measured total inertia is greater than 20 seconds. This warning is intended to draw attention to an unusually high inertia value. For a very high inertia load such as a large fan, this may be a valid result and parameter *Total Inertia* should be manually set equal to *Autotune Inertia*. However, a high inertia measurement could also be produced by a value of *Autotune Trq Stp* which is too low.

#### *Flux Regulator Manual Tuning [Induction Motor]*

1. Adjust the reference command to a value between 20 and 30 Hz.
2. Start the drive and wait for it to accelerate to the commanded speed.
3. Record the value of parameter *Lm Measured* (134) in *Motor Model*.
4. Stop the drive.
5. Set parameter *Lm Rated* in *Motor Model* to the recorded value of *Lm Measured*.
6. Calculate an approximate value of the rotor time constant using the following formula:

$$T_{rotor} = \frac{LmRated}{RatedSlip}$$

Where

$$Rated\ Slip = (2\pi Freq_{motor}) \times \frac{(Sync\ RPM - Rated\ RPM)}{Sync\ RPM}$$

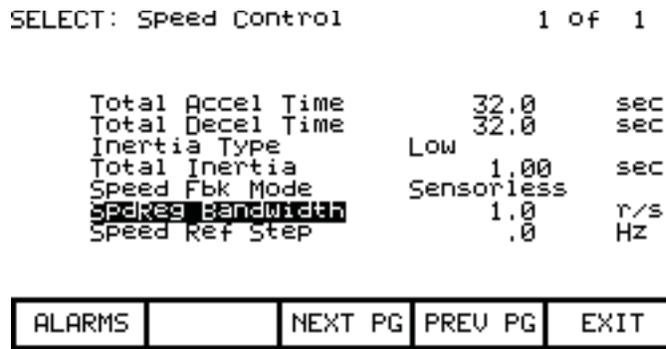
Set the parameter *T Rotor* in *Motor Model* to the calculated value.

#### *Speed Regulator Manual Tuning [Induction Motor]*

If it is not possible to tune the speed regulator using the auto-tune function, then the step response of the speed regulator can be tuned manually using the following procedure. To obtain accurate results, the load torque must be steady.

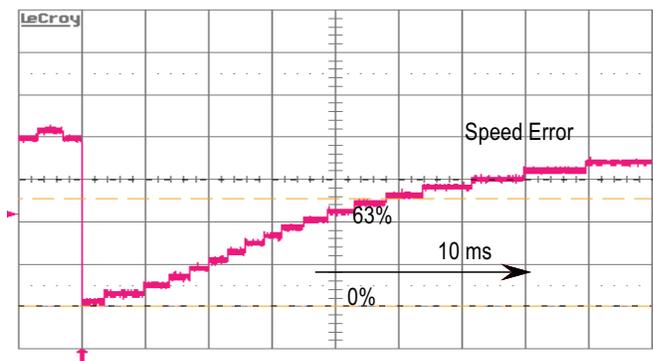
1. Set parameter *SpdReg Bandwidth* in *Speed Control* to 1.0 rad/sec.

Figure 211 - Speed Control Parameter Screen



2. Set parameter *Total Inertia* in *Speed Control* to an initial value of 1.0 sec if it is a low inertial application (pumps etc). Set the parameter to 5.0 seconds if it is a high inertia application (e.g. ID Fans).
3. Assign parameter *Speed Error* in the *Speed Control* group to a test point e.g. ITP1 on the DPM. This can be done similarly to the way that the meter assignments were described earlier in the chapter. Then it can be displayed on your oscilloscope.
4. Adjust the reference command to a value around the middle of the operating speed range.
5. Start the drive and wait for it to accelerate to the commanded speed.
6. Set parameter *Speed Ref Step* in *Speed Control* to 0.8 Hz. The drive speed will step up and down by this amount at regular intervals. The step of 0.8 Hz corresponds to 0.8V or 800mV on the test point. To capture the error set the scope at 200mV/division and 200msec/division. Trigger the scope on negative edge as shown in [Figure 212](#).
7. Adjust the value of parameter *Total Inertia* until the speed rises to approximately 63% of its final value in 1 second as shown in the figure. If the response time is too fast, it indicates that *Total Inertia* is set too high and should be decreased. If the response is too slow, then *Total Inertia* is set too low and should be increased.

Figure 212 - Correctly Tuned Speed Regulator



8. Set parameter *SpdReg Bandwidth* to the normal operating value. Confirm that the response time is equal to the inverse of the speed regulator bandwidth and that there is minimal overshoot. For example, if the speed regulator bandwidth is set to 2 rad/sec, the speed should rise to 63% of its final value in 0.5 second.
9. Set parameter *Speed RefStep* to zero and stop the drive.

#### Calculating Total Inertia

If the system inertia cannot be measured, it can be calculated if the moment of inertia of the motor and load are known. The value of parameter *Total Inertia* is defined as the time required to accelerate the motor and load to rated speed when rated torque is applied. It can be calculated using the following formula:

$$\text{Total inertia} = \frac{\text{total inertia of motor \& load in kg-m}^2 \times (\text{rated speed in rad / sec})^2}{\text{rated power in watts}}$$

or

$$\text{Total inertia} = 6.21 \times 10^{-7} \frac{\text{total inertia of motor \& load in lb-ft}^2 \times (\text{rated speed in rpm})^2}{\text{rated power in hp}}$$

If there is a gearbox between the motor and load, the inertia of the load must be referred to the motor side of the gearbox.

## 4. FluxSpeed Regulator [SYNCHRONOUS MOTORS]

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**IMPORTANT** Before the FluxSpeed regulator can be tuned, the analog output for the field current reference must be set up.

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#### Configuring the Field Current Reference

Excitation for the synchronous motor is provided by a current regulated field supply, either a dc supply for a slip ring or dc brushless machine, or a three phase ac supply for an ac brushless machine. The drive provides an analog current reference as an input to the field supply. The analog current reference has a range of 0–10V, where 0V corresponds to zero field current and 10V corresponds to maximum field current. The scaling of the analog current reference must be adjusted to achieve a linear relationship between the current reference and the actual field current. If this is not done, the flux regulator may be unstable. The scaling of the analog output can be adjusted using the following procedure:

1. Temporarily assign variable *Autotune Lmd* in Autotuning to the analog output used to control the field supply e.g. ACB Port 1.
2. Set the analog output scale parameter e.g. Anlg Out1 Scale in *Analog Output* to:

**Analog Scale = maximum analog input of field supply / 10V**

3. Set *Autotune Lmd* to a value of 10.00. Confirm that the reference input of the field supply is at its maximum value. Adjust the analog output scaling parameter if necessary.
4. Start the field supply and confirm that the field current goes to its maximum value. If necessary, adjust the field supply to achieve a field current slightly above rated.



**ATTENTION:** Applying maximum field current to a stationary machine for an extended period may damage the exciter. Adjust the current as quickly as possible.

5. Stop the field supply. Assign variable *I Field Command* in “Flux Control” to the analog output used to control the field supply (e.g. ACB Port 1). The setup of the field current reference is complete and you can proceed with the tuning of the FluxSpeed regulator.

#### *FluxSpeed Reg Auto-tuning [Synchronous Motor]*

The tuning of the FluxSpeed regulator for a synchronous machine is determined by following parameters:

1. FlxReg Bandwidth in Flux Control
2. Lm Rated in Motor Model
3. T Rotor in Motor Model
4. Lmd in Motor Model
5. SpdReg Bandwidth in Speed Control
6. Total Inertia in Speed Control

The FluxSpeed Regulator tuning function calculates parameters, *Lm Rated* (131), *T Rotor* (132) in *Motor Model* Group and *Total Inertia* (82) in *Speed Control* group. This is combined Auto-tuning for Flux and Speed regulator.

**TIP** *During this Autotune step the motor will run at speed set in auto tune speed Cmd. The default setting is 30HZ. Make sure the motor rotates during this Autotune. Motor rotation must be verified either physically or monitoring “FlxFbk VoltModel” (P#342). It is possible that stall condition may calculate wrong tuning parameters. If it happens, make sure the tuning parameters (Lm rated, T Rotor, Total Inertia) are set to default before starting this tuning again.*

#### *Flux Regulator*

Flux Regulator Bandwidth should be set to the default value for almost all applications. *Lm Rated*, *Lmd*, *T Rotor* and *Total Inertia* are usually unknown and must be measured. Although these motor parameters change with different

operating conditions, the variations do not significantly affect the operation of the flux regulator.

The other aspect of flux control is the variation of motor flux with speed. This is determined by two parameters:

1. Base Speed in Flux Control
2. FlxCmd RatedLoad in Flux Control

In most applications, the motor runs at constant flux below rated speed and constant voltage above rated speed. The motor flux is normally set to a level that provides rated voltage at rated speed and full load. The flux level required to achieve this is a function of the motor parameters. The flux regulator auto-tuning determines a value of rotor flux that should provide rated motor voltage at full load and rated speed and sets the flux command parameter to this value.

### *Speed Regulator*

Refer details given for Induction motor section.

**TIP** If a position encoder is fitted to the motor, the FluxSpeed regulator auto-tuning is performed with the encoder feedback turned off because it is assumed that the encoder has not been aligned with the rotor axis yet. Since less starting torque is produced with the encoder feedback off, this test should be performed with reduced load. The encoder offset measurement is also most accurate with no load on the motor.

### *FluxSpeed regulator Auto-tuning [Synchronous Motor]*

The FluxSpeed regulator is tuned with the motor running at constant speed using the following procedure:

1. Ensure that the analog reference for the field current has been set up as described previously, and that parameter *L Total Leakage* has been set to the correct value.
2. Set parameter *Autotune Select* in Autotuning to *FluxSpeed Reg.*
3. Start the drive. The motor accelerates normally up to the speed specified by parameter *Autotune Spd Cmd*. The motor magnetizing inductance is calculated from the magnetizing current reference and the flux feedback and parameter *Autotune Lm* is set to this value. The flux command is then set to a value that should produce rated voltage at rated speed and load. The resulting change in the flux level may cause the magnetizing inductance to change. This process is repeated until the magnetizing inductance and flux command stabilize. If a position encoder is fitted to the motor, the angle between the measured flux and the encoder zero is measured and parameter *Encoder offset* is adjusted to align the encoder with the motor flux.

The field current reference is then held constant and the response of the flux to changes in stator magnetizing current is measured by stepping “Ix command” up and down at regular intervals. The size of the step in the stator current is specified by parameter *Autotune Isd Step*. The step response measurement takes about 3 minutes. During this step parameter *Lmd*, *T Rotor*, *Lm Rated* will be calculated.

When the motor speed has settled at the commanded value, a sinusoidal perturbation specified by parameter *Autotune Trq Stp* is added to the torque command, causing the speed to vary. After the initial transient has decayed (this usually takes a few seconds), the variation in torque and speed are measured and used to calculate the total inertia. The torque perturbation is then removed and the drive performs a normal stop.

Parameter *FlxCmd RatedLoad* in *Flux Control* is set to a value calculated to produce rated voltage at rated speed and load. The value of parameters *Autotune T Rotor* and *Autotune Lmd* are calculated from the step response data.

If the flux regulator auto-tuning is successful, then parameter *Lm Rated* in *Motor Model* is set equal to *Autotune L Magn*, parameter *T Rotor* in *Motor Model* is set equal to *Autotune T Rotor*, and parameter *Lmd* in *Motor Model* is set equal to *Autotune Lmd*. Parameter *Total Inertia(63)* in *Speed Control* is set equal to *Autotune Inertia*. If the flux regulator auto-tuning fails a warning is issued indicating the cause of the failure.

**L Magnetize Low** – indicates that the measured value of magnetizing inductance is less than 1.0 pu. This warning is intended to draw attention to an unusually low value of magnetizing inductance. The most likely cause is incorrect scaling of the analog field current reference.

**L Magnetize High** – indicates that the measured value of magnetizing inductance is greater than 15.0 pu. This warning is intended to draw attention to an unusually high value of magnetizing inductance. The most likely cause is incorrect scaling of the analog field current reference.

**T Rotor Low** – indicates that the calculated value of rotor time constant is less than 0.2 seconds

**T Rotor High** – indicates that the calculated value of rotor time constant is greater than 5.0 seconds.

**Regulator Limit** - indicates that the torque command was greater than *Trq Lmt Motoring* or *Trq Lmt Braking*. The measured inertia value is invalid. Parameter *Autotune Trq Stp* or parameter *Autotune Spd Cmd* must be set to a lower value and the test repeated.

**Tuning Abort** - indicates that the deviation in motor speed was greater than 10 Hz. The measured inertia value is invalid. Parameter *Autotune Trq Stp* must be set to a lower value and the test repeated.

**Inertia High** - indicates that the measured total inertia is greater than 20.0 seconds. This warning is intended to draw attention to an unusually high inertia

value. For a very high inertia load such as a large fan, this may be a valid result and parameter *Total Inertia* should be manually set equal to *Autotune Inertia*. However, a high inertia measurement could also be produced by a value of *Autotune Trq Stp* which is too low.

## Running the Load

### Motor Starting Torque

When starting without an encoder, the drive operates in an open loop mode below approx. 3 Hz at which point the drive switches to closed loop speed control. The starting currents are set by three parameters; Torque Command 0 sensorless (P86), 1 (P87), Torque Command 0 sensorless sets the breakaway torque and Torque Command 1 sensorless is the torque at the transition point from open to closed loop. Torque Command Minimum operates in conjunction with Torque Command 1 to minimize speed overshoot at the transition point. If you are starting an uncoupled motor, or simply auto-tuning, the default starting torque values may be sufficient to run the motor. But the defaults are generally not high enough to start a loaded motor.

Be prepared to have to increase starting torque and ensure Motor Stall faults during initial operation.

### Reaching Specific Load Points

Verify the drive can reach rated speed and load. Monitor the Torque Reference (P291) and the displayed value of the motor current. If you are running into a torque limit the Torque Reference will be running near the Torque Limit Motoring (P84) limit. If you are not realizing rated motor current you may increase the Torque Limit Motoring slightly. If increasing the Torque Limit Motoring does not help to increase the motor amps and speed then the drive is most likely running out of input voltage.

Monitor the Line Voltage pu (P135), and increase the tap setting on the drive feed if the measured value is less than 1.03 pu. It is desirable to have Line Voltage pu read in the 1.03 to 1.07 pu range. Alpha Rectifier (P327) should be greater than 15° while running at rated speed and load, indicating how far forward the rectifier is phased. The input voltage should be increased by tapping up the transformer.

Fill in the following table with data from the various load points. If possible, capture the running parameters with the printer, DriveTools, or Hyperterminal as a substitute for recording the data in the table below. This should be forwarded with all commissioning data back to Product Support for future reference.

TEST #	MOTOR/DRIVE OPERATING POINT		DRIVE VARIABLES										
	%SPEED / RPM	AMPS	VOLTS (Vline)	Speed Ref (Hz)	Speed Fdbk (Hz)	Flux Ref (pu)	Torque Ref (pu)	I DC Ref (pu)	I DC Fdbk (pu)	Alpha Machine (degrees)	Alpha Line (degrees)	Inverter Heatsink Temp (°C)	Rectifier Heatsink Temp (°C)
1	25%/ ____												
2	50%/ ____												
3	75%/ ____												
4	100%/ ____												
5	____%/ ____												
6	____%/ ____												
7	____%/ ____												
8	____%/ ____												
9	____%/ ____												
10	____%/ ____												
11	____%/ ____												
12	____%/ ____												

## Capturing Data

When all of the final commissioning procedures are completed and the drive is running, it is VERY IMPORTANT TO CAPTURE ALL THE DRIVE DATA for future reference.

The last step should be to **PRINT DRIVE SETUP**. This will print all the parameters (regardless of the user access level), the various firmware revisions, the exploded fault masks, the PLC links, and the Analog configuration.

All of this information is required to address future customer issues.

### GUIDELINES FOR DATA CAPTURE

*This section provides some guidelines for capturing required commissioning data and setting up oscilloscope to capture the waveforms. For detailed instructions, always refer to PowerFlex 7000 user manual. Some sample waveforms have been included for reference purpose.*

## Drive Input Voltage Phasing Checks

After applying medium voltage to the drive, perform an input voltage phasing check.

### Summary:

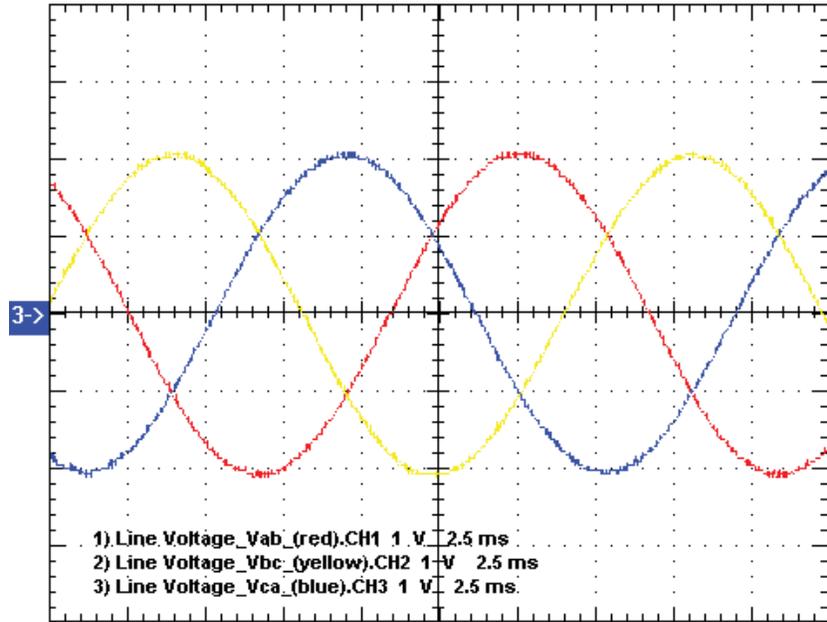
- Drive input contactor should be closed. If the drive input contactor configuration is set to NOT RUNNING, you will have to temporarily change it to ALL FAULTS.
- Ensure that the drive is not running when capturing these waveforms.
- Capture the three line voltage waveforms at ACB test points
  - Master winding: V2uv, V2vw & V2wu
- In the case of 18 Pulse drive, verify 20 deg phase shift between the Master and two Slave windings for each phase voltage and capture the waveforms at ACB test points:
  - Slave 1 winding: V3uv, V3vw, V3wu
  - Slave 2 winding: V4uv, V4vw, V4wu
- Label the waveforms as “V2uv”, “V2vw” and “V2wu”, etc.
- Save the worksheet as “Input Phasing”.

**Table 13 - Oscilloscope Setting**

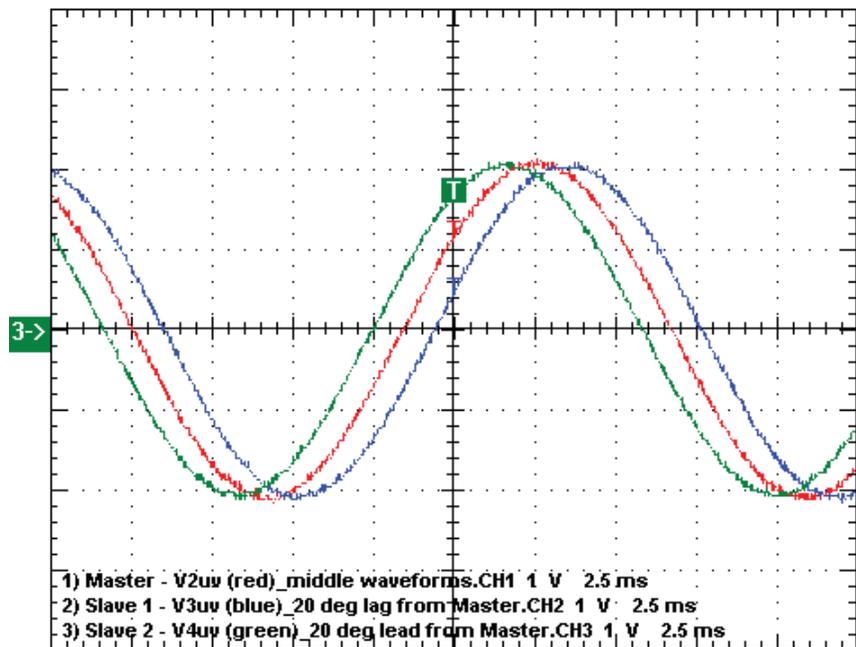
Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label	Sheet Name
Ch. 1	10ms/div.	2U Line Voltage	V2uv	V2uv	Input Phasing
Ch. 2		2V Line Voltage	V2vw	V2vw	
Ch. 3		2W Line Voltage	V2wu	V2wu	

**TIP** Use the same settings on the oscilloscope when capturing waveforms for the two Slave bridges. If you are using a 2-channel oscilloscope, then first capture two waveforms and move them onto a wavestar worksheet and after that capture the remaining waveforms and move them onto the same wavestar worksheet.

**Figure 213 - Sample Waveforms**



Sample Waveforms captured on ACB test points showing incoming line voltage phasing [Ch1: V2uv (red), Ch2: V2vw (yellow), Ch3: V2wu (blue)]



Sample waveforms captured on ACB test points showing 20 deg Phase Shift between Master and two Slave Bridges [Ch1-Master: V2uv (red), Ch2-Slave 1: V3uv (yellow), Ch3-Slave 2: V4uv (blue)]

## Harmonic Analysis (required for AFE drives only)

Measure the harmonic (resonance) levels at the input to the drive.

**TIP** Please refer to tech note PowerFlex 7000\_GEN-15 to compare the waveforms for harmonic distortion. If you notice considerable distortion in the waveforms then you **MUST** send those waveforms to MV Support via e-mail at [mvsupport\\_technical@ra.rockwell.com](mailto:mvsupport_technical@ra.rockwell.com) and then call at 519-740-4790 (option 1) to discuss the issue and action plan. During after-hours, you can call MV Support pager (Pager # 519-654-5616) to talk with MV Tech Support Specialist. If you are out side North America, then call at 1-440-646-3434 and ask for MV Tech Support.

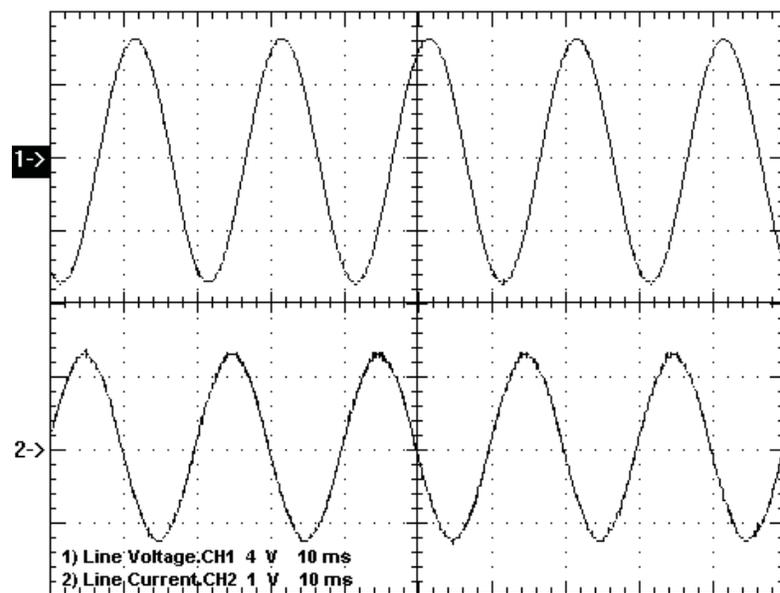
### Summary:

- Drive input contactor should be closed. If the drive input contactor configuration is set to NOT RUNNING, you will have to temporarily change it to ALL FAULTS.
- Ensure that the drive is not running when capturing these waveforms.
- Capture line voltage at ACB test point “V2uv” and line current at ACB test point “I2u”.
- Label the waveforms as “V2uv”, and “I2u”.
- Save the worksheet as “Harmonics (Drive Not Running)”.

**Table 14 - Oscilloscope Setting**

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label	Sheet Name
Ch. 1	10ms/div.	Line Voltage	V2uv	V2uv	Harmonics (Drive Not Running)
Ch. 2		Line Current	I2u	I2u	

**Figure 214 - Sample Waveforms**



Sample waveforms captured on SCBL test points under Drive Not Running  
Condition [Ch1: V2uv (red), Ch2: I2u (yellow)]

## DC Current Test

Perform DC Test. Refer to the commissioning section of the PowerFlex 7000 user manual for a more detailed procedure.

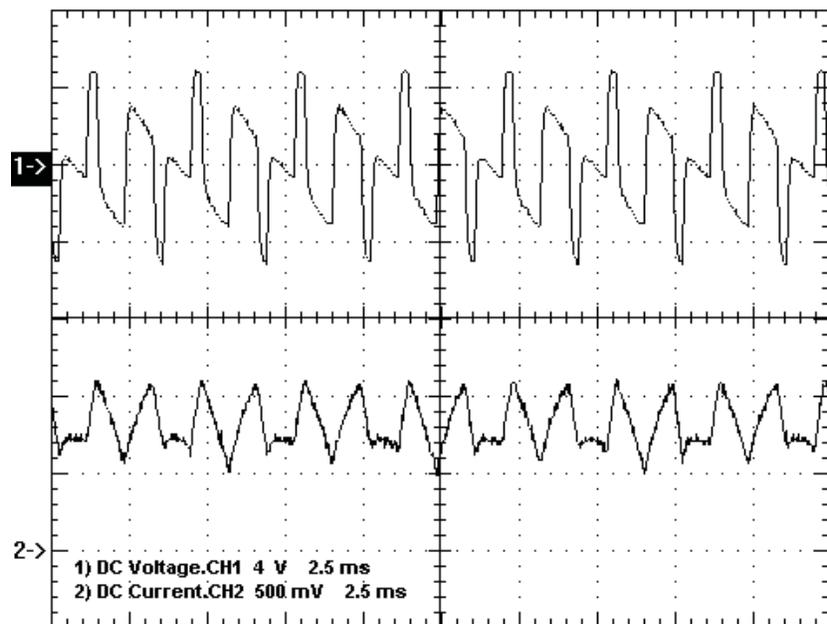
### Summary:

1. Make sure the Diagnostic Trend has been setup and is armed.
2. Run the DC Test with Idc Command Test (P119) set to 0.1pu. Increase Idc Command Test from 0.1 → 0.3pu (**for AFE drives**) or from 0.1 → 0.7pu (**for 18 Pulse drives**) in steps of 0.1pu. At each step, verify DC link current regulation by monitoring Idc Error (P323) and Alpha Line (P327).
3. Capture DC link voltage waveform at ACB test point “**Vdcr1**” and DC link current waveform at ACB test point “**Idc1**” at 0.3pu (for AFE drives) or at 0.7pu (for 18 Pulse drives).
4. Label the waveforms as “Vdcr1”, and “Idc1”.
5. Save the worksheet as “DC Test @ 0.3pu” (for AFE drives) or “DC Test @ 0.7pu” (for 18 Pulse drives).

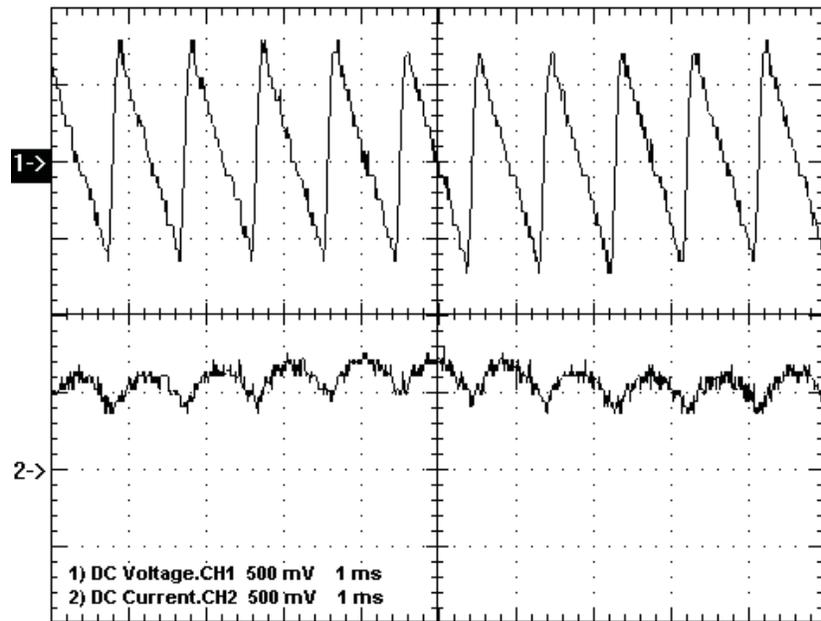
**Table 15 - Oscilloscope Setting**

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label	Sheet Name
Ch. 1	2ms/div.	DC Link Voltage	Vdcr1	Vdcr1	DC Test
Ch. 2		DC Link Current	Idc1	Idc1	

**Figure 215 - Sample Waveforms:**



Sample waveforms of DC Test recorded on a **AFE Drive**  
 Idc Cmd Test = 0.2pu [Ch1- **Vdcr1** (yellow) Ch2 – **Idc1** (blue) at ACB test points]



Sample waveforms of DC Test recorded on **18 Pulse Drive**  
 Idc Cmd Test = 0.5pu [Ch1- **Vdcr1** (yellow) Ch2 - **Idc1** (blue) at ACB test points]

## Load Test

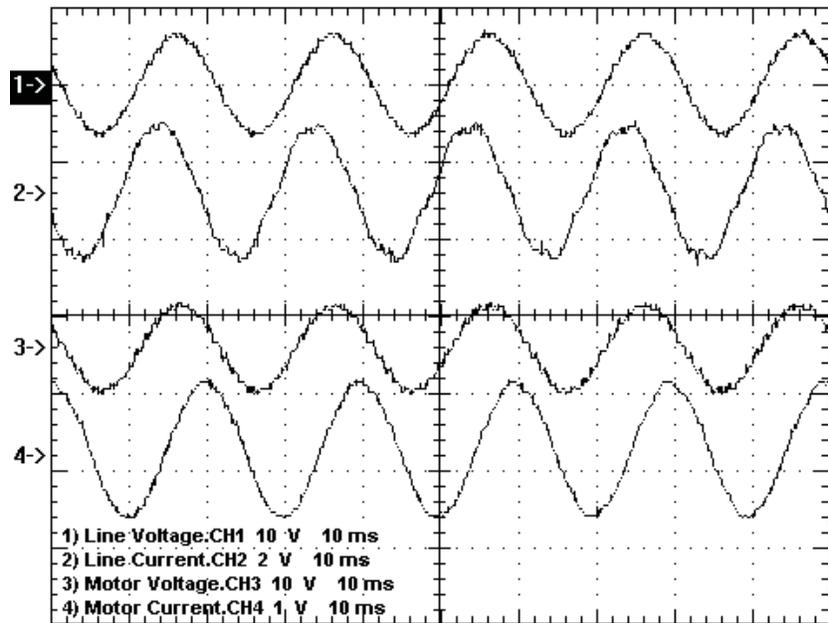
After autotuning of the drive, run the motor on load and capture the following waveforms at 50% load and at 100% load. If the system is not ready for 100% load test, then capture the waveforms at the max load you are allowed to run the drive at. Also, print variables at 50% and 100% load points. Before printing variables make sure the drive Access Level is at SERVICE.

1. Capture line voltage & current waveforms at ACB test points “V2uv” & “I2u”.
2. Label the waveforms as “V2uv” and “I2u”.
3. Capture motor voltage & current waveforms at ACB test points “Vuv” & “Iu”
4. Label the waveforms as “Vuv” and “Iu”.
5. Save the worksheet as “Line and Load Voltage and Current Waveforms at 1048 rpm, 31 A”, for example.

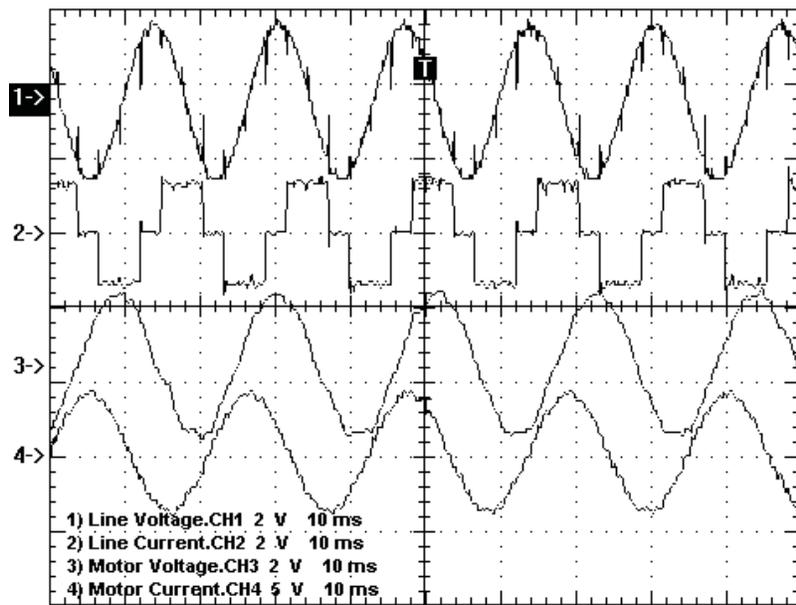
**Table 16 - Oscilloscope Setting**

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label	Sheet Name
Ch. 1	10ms/div.	Line Voltage	V2uv	V2uv	[see above]
Ch. 2		Line Current	I2u	I2u	
Ch. 3		Motor Voltage	Vuv	Vuv	
Ch. 4		Motor Current	Iu	Iu	

Figure 216 - Sample Waveforms:



Sample waveforms recorded on a **AFE Drive** running under full load condition  
(Ch1: Line Voltage, Ch2 - Line Current, Ch3 - Motor Voltage, Ch4 - Motor Current)



Sample waveforms recorded on **18 Pulse Drive** running at 75% load  
(Ch1: Line Voltage, Ch2 - Line Current, Ch3 - Motor Voltage, Ch4 - Motor Current)

## Synchronous Transfer

When commissioning a drive employing synchronous transfer, the following waveforms should be captured and submitted with the commissioning package. Refer to the “*Synchronous Transfer Commissioning Guidelines*” for a detailed commissioning procedure.

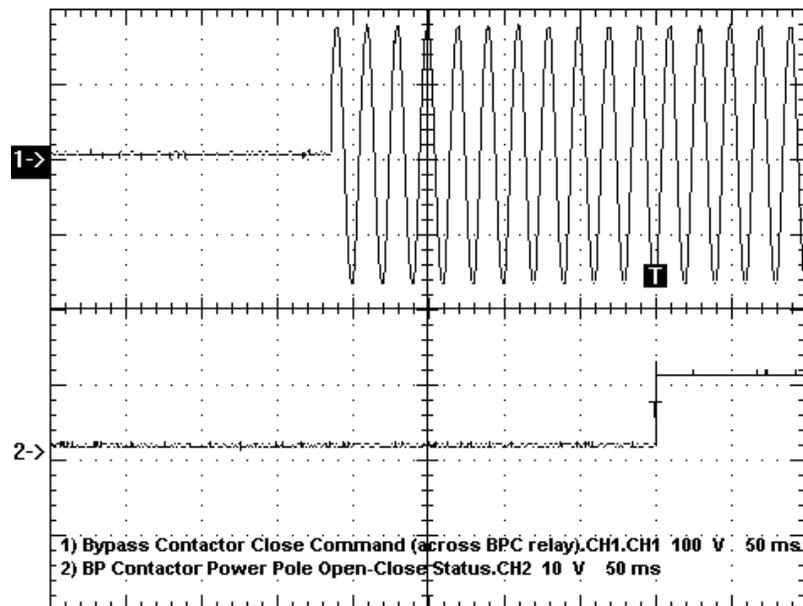
### *While measuring the bypass (BP) contactor closing time:*

- Capture 120V bypass close command from the BP Contactor Close output (J1-12) at the ACB (refer to electrical drawing for specific wire/terminal number).
- Capture the 9V signal across the bypass contactor vacuum bottles (refer to the tech note PowerFlex 7000\_GEN-78 for details).
- Label the waveforms as “BP\_Close\_Cmd” and “Actual\_Closure”.
- Save the worksheet as “Bypass Contactor Close Delay”.

**Table 17 - Oscilloscope Setting**

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label
Ch. 1	25ms/div.	BP Contactor Close Command	BP Contactor Close Cmd	BP_Close_Cmd
Ch. 2		Actual Closure of BP	Across 2K-Ohm resistor connected in series with 9V battery	Actual_Closure

**Figure 217 - Sample Waveforms**



Ch1: Bypass Contactor Close Command (BPC output at ACB, J1-12 & 402)

Ch2: Actual Closure of Bypass Contactor (using 9V battery across contactor vacuum bottles)

### *While simulating a synchronous transfer to determine the best lead angle:*

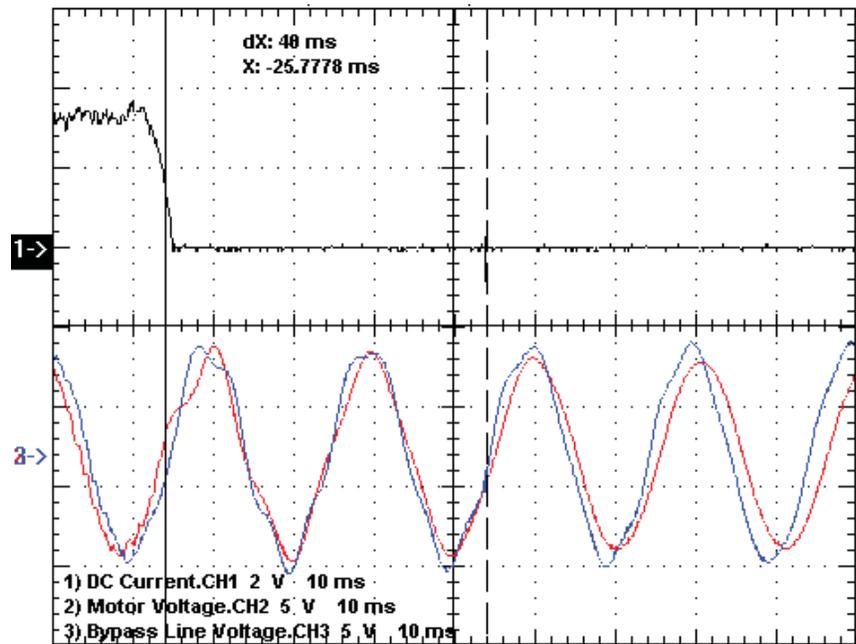
- Make sure the Diagnostic Trend has been setup and is armed.
- Capture motor voltage at ACB test point “**Vuv**” & bypass voltage at ACB test point “**Vuvs**”.

- Capture and trigger on falling edge of the DC Link current waveform at ACB test point “**Idc1**”.
- Label the waveforms as “Vuv”, “Vuvs” and “Idc1”.
- Save the worksheet as “Drift @ 15 Degree Lead Angle”, for example.

**Table 18 - Oscilloscope Setting**

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label
Ch. 1	10ms/div.	DC Link Current	Idc1	Idc1
Ch. 2		Motor Voltage	Vuv	Vuv
Ch. 3		Bypass Line Voltage	Vuvs	Vuvs

**Figure 218 - Sample Waveforms**



Synchronous Transfer Test to verify Sync Lead Angle (50Hz System)  
 Ch1: **Idc1** (yellow), Ch2: **Vuv** (blue), Ch3: **Vuvs** (red)

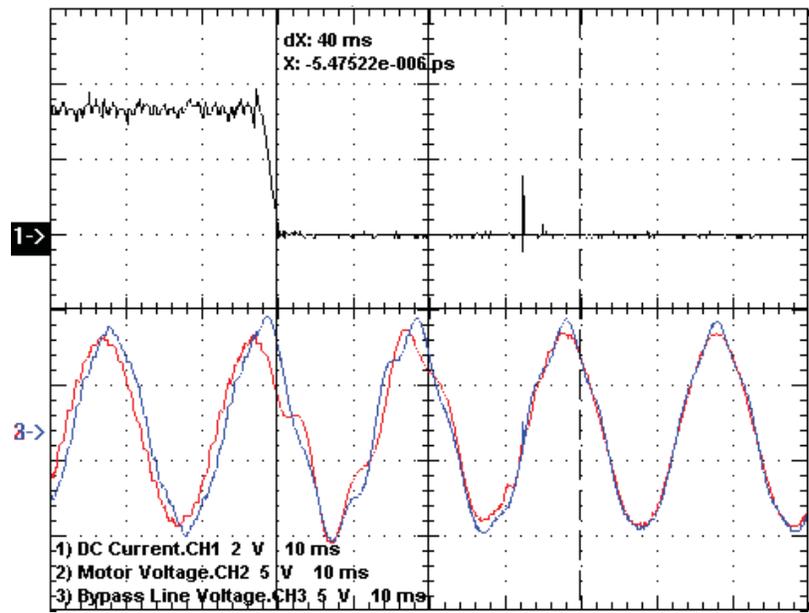
**While performing a live synchronous transfer:**

- Capture motor voltage at ACB test point “**Vuv**” & bypass voltage at ACB test point “**Vuvs**”.
- Capture and trigger on falling edge of the DC Link current waveform at ACB test point “**Idc1**”.
- Label the waveforms as “Vuv”, “Vuvs” and “Idc1”.
- Save the worksheet as “Synch on Motor 01”, for example.

**Table 19 - Oscilloscope Setting**

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label
Ch. 1	10ms/div.	DC Link Current	Idc1	Idc1
Ch. 2		Motor Voltage	Vuv	Vuv
Ch. 3		Bypass Line Voltage	Vuvs	Vuvs

Figure 219 - Sample Waveforms



Live Synchronous Transfer Capture (50Hz System)  
Ch1: **Idc1** (yellow), Ch2: **Vuv** (blue), Ch3: **Vuvs** (red)

**Notes:**

## **Component Definition and Maintenance**

# Control / Cabling Cabinet Components

Figure 220 - Control and Cabling Cabinet showing LV Control Panel (AFE Rectifier version shown)

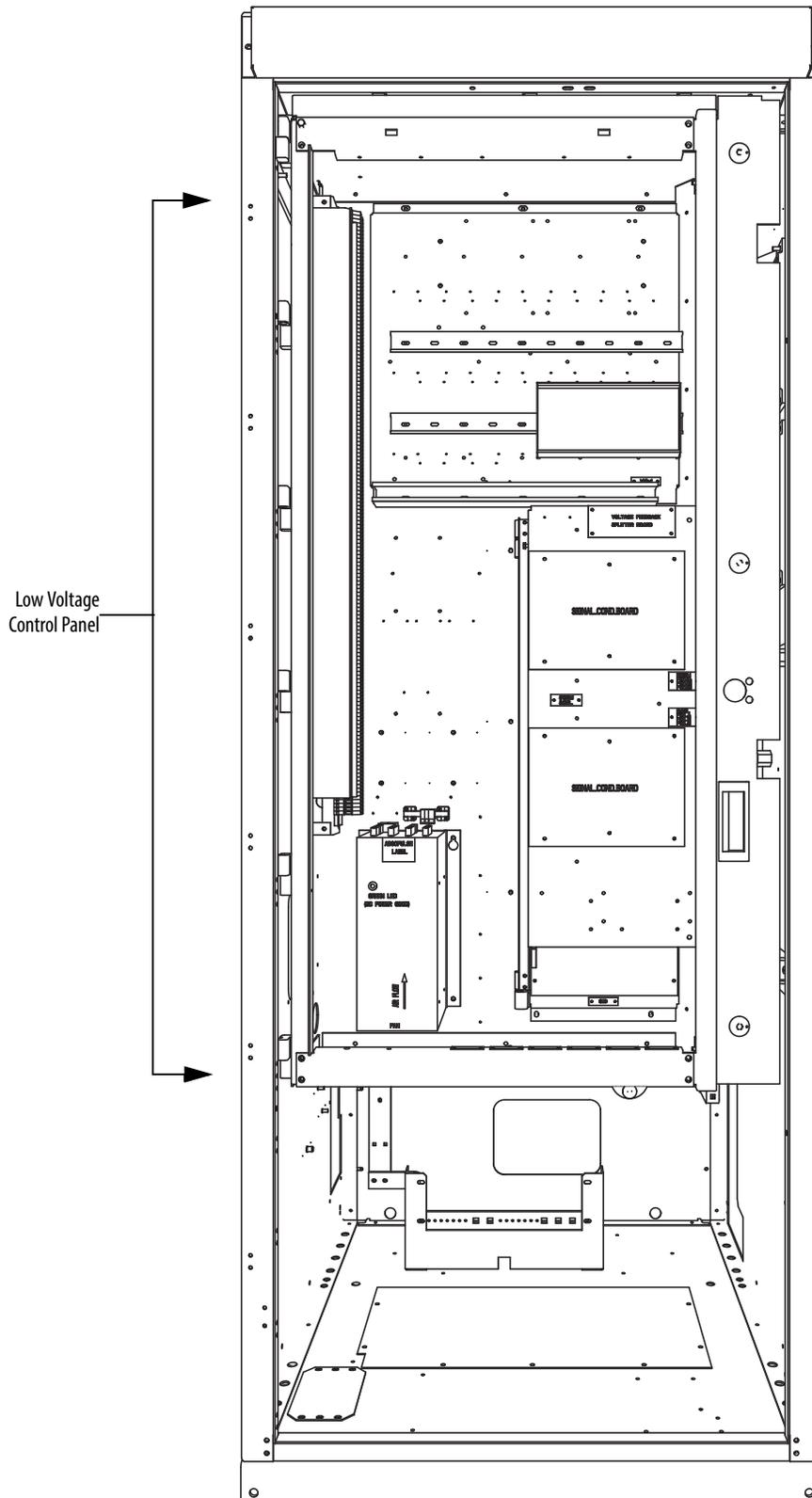


Figure 221 - AFE Control and Cabling Cabinet (with LV Control Panel removed)

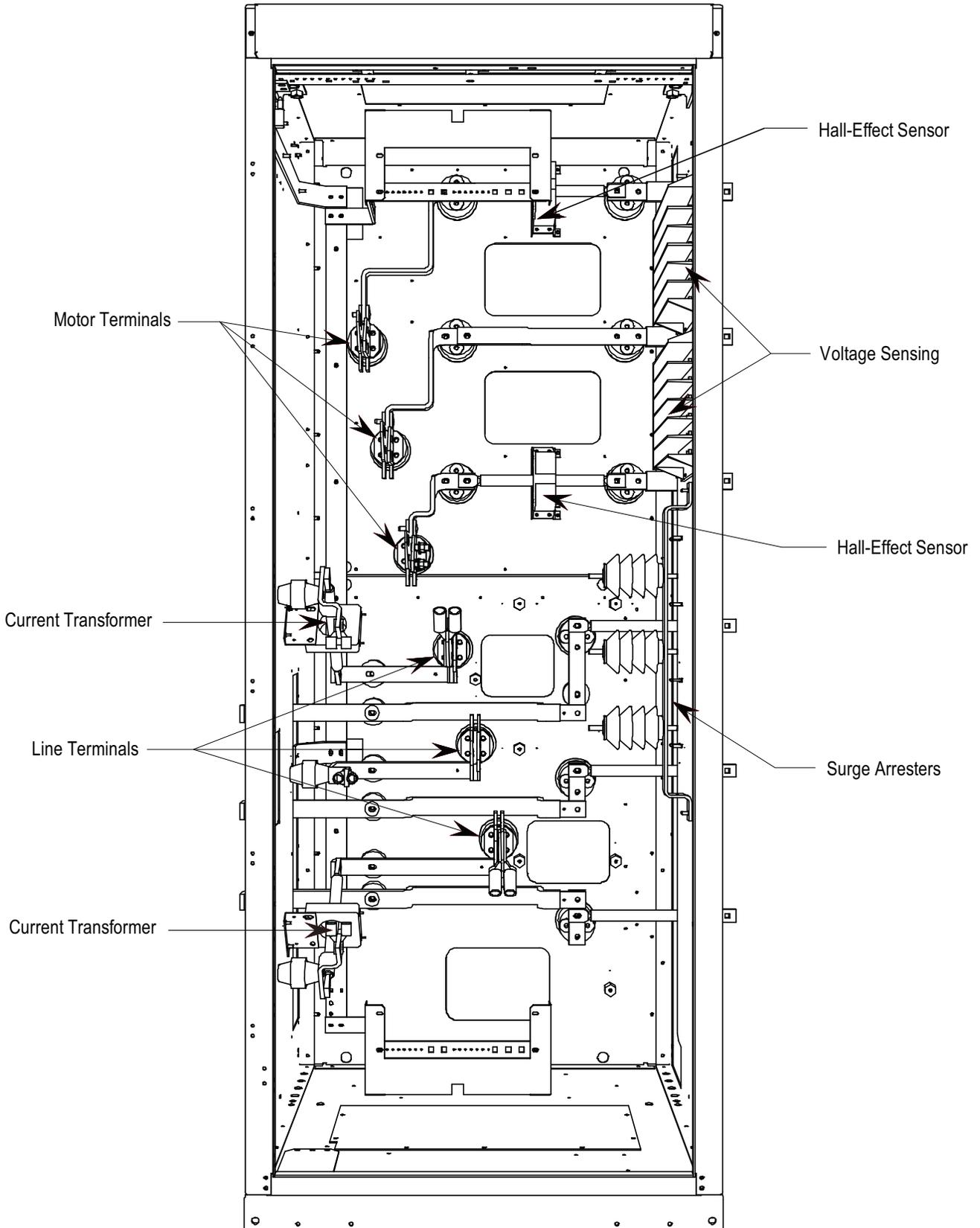
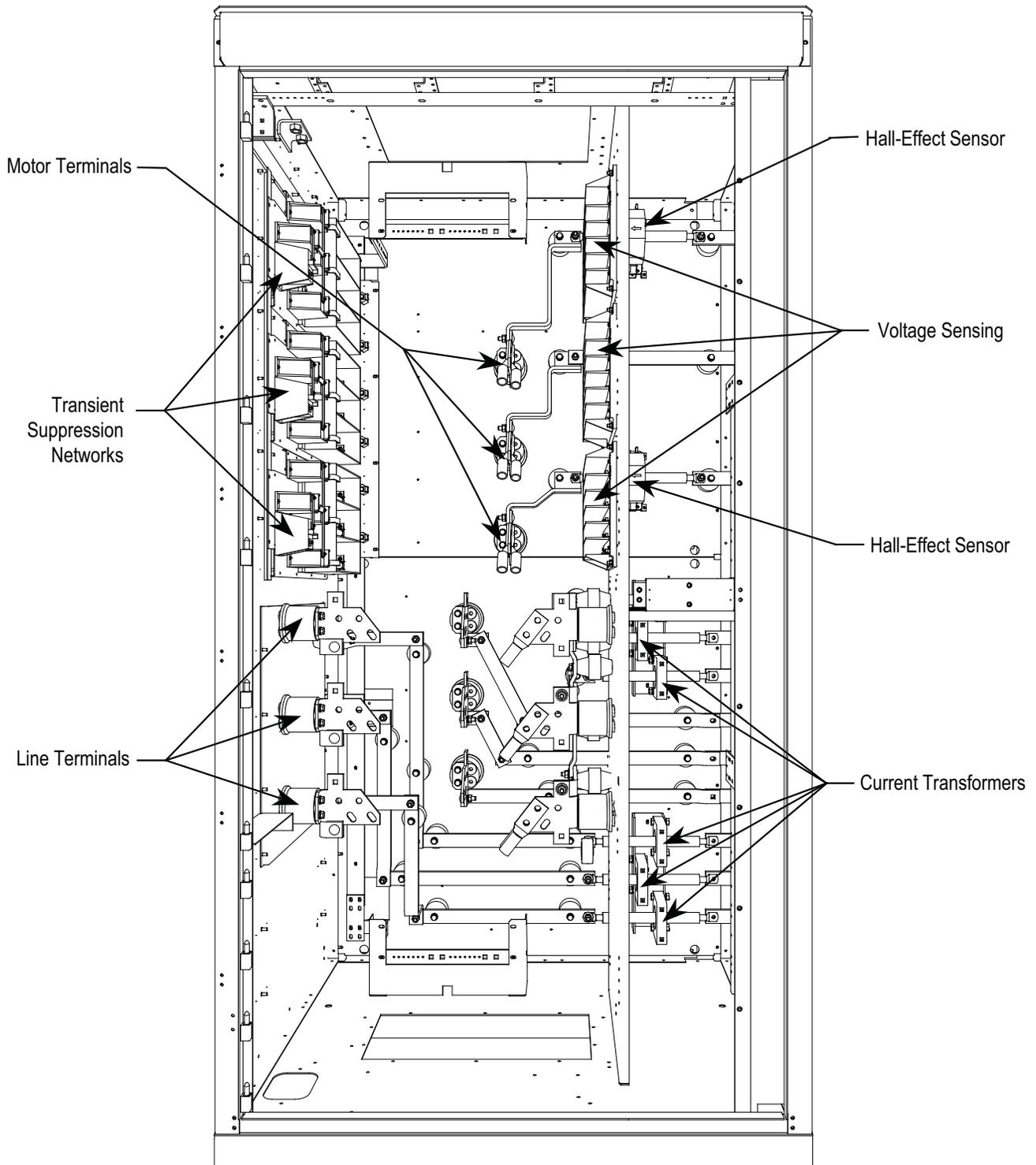


Figure 222 - 18 Pulse Control and Cabling Cabinet (with LV Control Panel removed)



## Voltage-Sensing Assembly

The voltage-sensing assembly consists of the voltage sensing board and the mounting plate. The voltage sensing board has six independent channels which convert voltages up to 10800V (7.2kV x 1.5 pu) down to low voltage levels which can be used by the PowerFlex 7000 control logic (i.e. Signal Conditioning Board - SCB). Two of these assemblies can be linked together where one assembly acts as the master assembly, and the second assembly acts as the slave assembly. In this manner, up to twelve independent voltage channels can be measured. When two assemblies are linked together, the master assembly is used to send the twelve voltage signals to the SCB board. For drives that require the synchronous transfer option, one additional module is used. This assembly uses a separate connector to output the transfer voltages directly to the SCB board.

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

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

**Table 20 - Nominal Input Voltage Ranges**

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



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

## Voltage-Sensing Circuit Board Assembly Replacement

The number of sensing boards is dependent upon the drive rectifier configuration.

1. Ensure there is no power to the equipment.

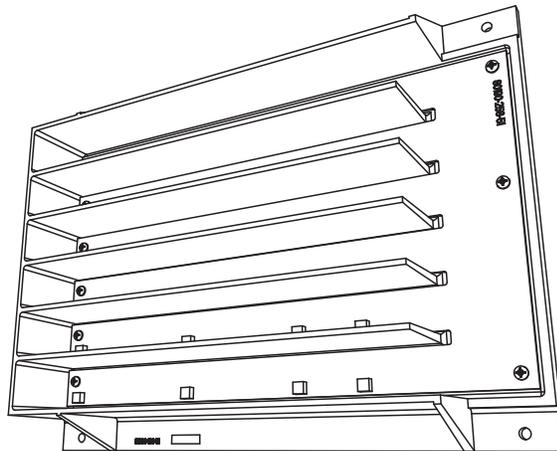


**ATTENTION:** To prevent electrical shock, ensure the main power has been disconnected before working on the sensing board. Verify that all circuits are voltage free using a hot stick or appropriate high voltage-measuring device. Failure to do so may result in injury or death.

2. Mark the position of the ribbon cables and wires.

3. Remove the screws and lift the ring lugs from the terminals to remove the wires.
4. Release the locking mechanism located on each side of the ribbon cable connector and pull the ribbon cable straight out to prevent bending the pins.
5. Remove the four nuts and washers that secure the assembly to the studs welded to the frame.
6. Remove the old VSB and replace with the new VSB on the studs, using the existing hardware to secure the assembly. **Do not overtorque the connections or you may break the studs.**
7. Replace ring lugs on terminals. Plug in ribbon cables making sure that cables are positioned properly and fitting is secure (locking mechanism is engaged).
8. For personnel and equipment safety, ensure both grounding connections are re-connected to the sensing board.

**Figure 223 - Sensing Board with Mounting Hardware Placement**



## Input Transient Protection

### Overview

Input transient protection is provided in two forms:

- Transient Suppression Network (TSN), or
- Surge Arresters

The TSN is optimized for 6P and 18 Pulse rectifier designs. Surge Arresters are optimized for AFE and D2D rectifier designs.

## Transient Suppression Network (TSN)

### Description

The Transient Suppression Network Module consists of an assembly of suppressors that are connected to each of the three phase input lines and the structure's ground bus. There are three assemblies for an 18 Pulse drive.

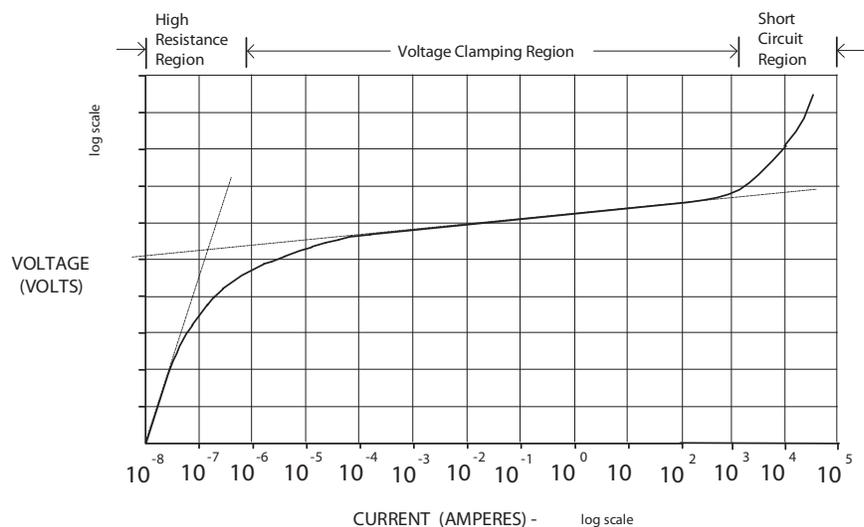
A transient voltage spike in excess of the semiconductor rating will destroy or shorten the lifespan of the device. The Transient Suppression Network Module provides suppression of transient overvoltages appearing on the input of the drive and is a standard feature of the drive. The two basic blocks of the TSN module are the MOV suppressor and the MOV fuse.

### MOV Suppressor

The transient suppressors used in the module are heavy-duty metal oxide varistors or MOVs. Varistors are voltage dependent, nonlinear resistors. They have symmetrical voltage/current characteristics similar to back-to-back connected Zener Diodes. The varistor has very high resistance below its voltage rating and appears as an open circuit.

The leakage current through the device would be very small in this region. When a voltage transient occurs in which the voltage exceeds the “knee” in the curve, the varistor resistance changes from its high state by several orders of magnitude to a very low level. The voltage will be essentially clamped for a change in current of several orders of magnitude. This can be seen in [Figure 224](#).

**Figure 224 - Typical MOV V-I Characteristic Curve**



When the MOV is clipping the voltage transient, the energy of the transient is being absorbed by the MOV. The varistor has a limited energy absorbing capability and generally there is not enough time for the heat generated to be conducted out of the device. The MOV is sized based on the steady-state voltage rating, the energy in the transient, and the repetition rate of the transients. A critical element in the MOV selection and protection offered is the impedance in the line supplying the transient. This impedance will be mainly that provided by the Isolation Transformer or the AC Line Reactor on the input of the drive. That is why an impedance level is specified for these input devices.

## MOV Fuse

In series with each of the Phase MOVs is a medium voltage fuse. As seen in [Figure 225](#), these fuses may be located on the assembly or remote from the assembly (on the Line Terminal Module). Check the part number on your module and the information in this documentation to determine which assembly you should have in your case.

The fuses provide overload protection for the conductors feeding the suppression network (and overcurrent protection if a short circuit occurs on the downstream side of the fuse). These conductors will normally have a much smaller current carrying capacity than the drive input conductors and thus will not be protected by the drive input fuses. The fuses also serve to isolate a failed MOV. Varistors initially fail in a short-circuited condition. The high follow-through current will open the fuse and remove the MOV from the circuit.

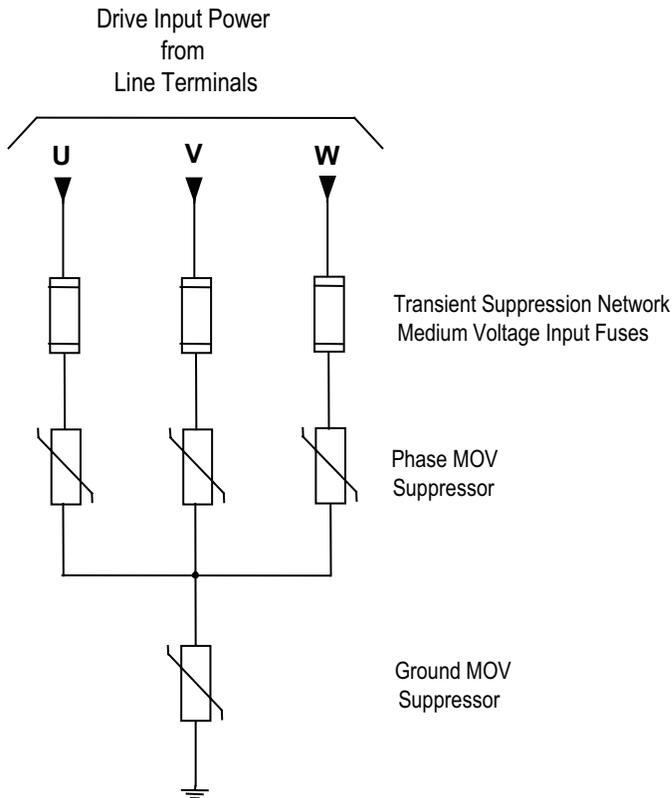
The fuses used are E-rated current limiting fuses with a high interrupting rating. Because they are current limiting, they will limit both the magnitude and duration of fault currents. They are small dimension, ferrule-type fuses with a fiberglass body, and mount in standard fuse clips.

---

**IMPORTANT** The fuses sent with the Transient Suppression Network have been selected based on their characteristics (including internal resistance). This is necessary for optimum MOV performance and protection. Do not substitute other fuses without contacting the factory first.

---

**TIP** Voltage sensing occurs after the MOV fuse, and as a result open fuses will be detected in drive control as a Master or Slave Undervoltage or Unbalance.

**Figure 225 - Simplified Wiring Diagram**

## Transient Suppression Network Fuse Replacement

Two sizes of fuses (5 kV, 7.2 kV) are available within the Transient Suppression Network (TSN) located inside the connection cabinet. The 18 Pulse drive contains three TSNs.

1. Ensure there is no power to the equipment.

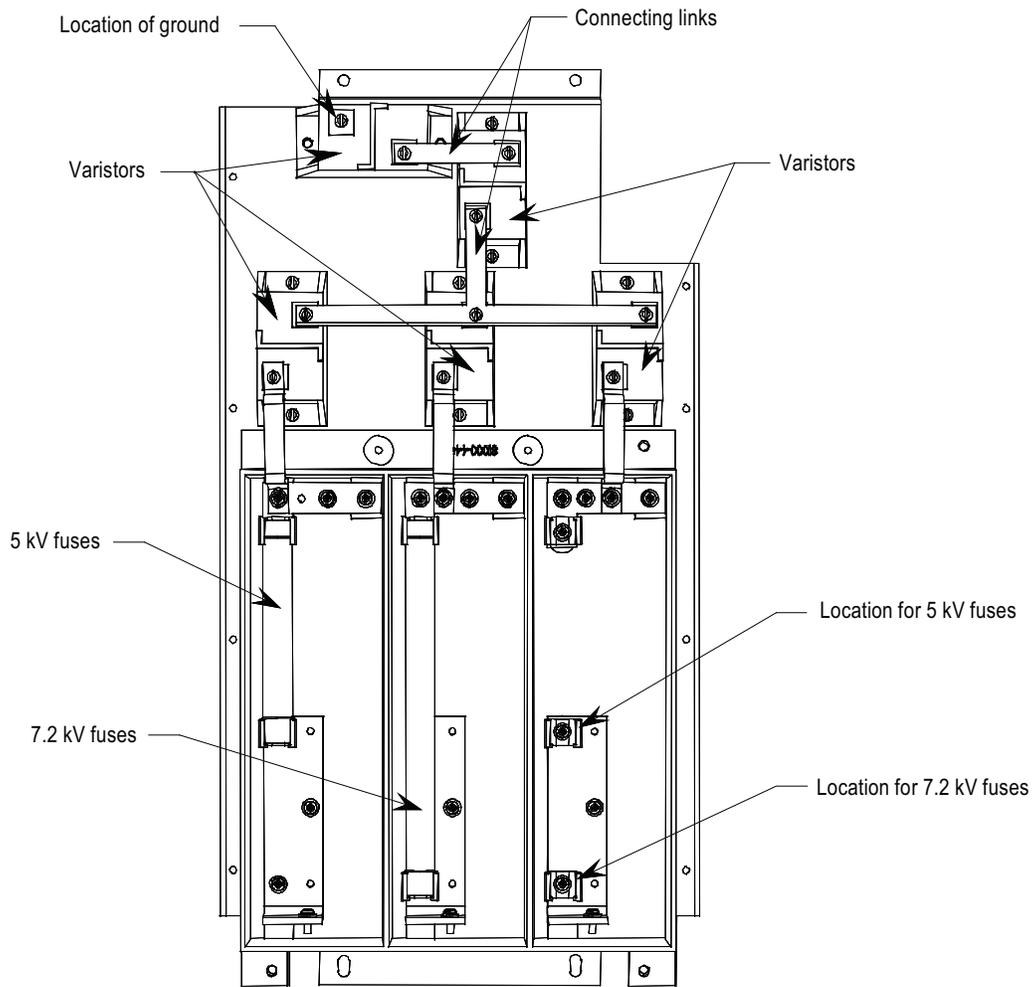


**ATTENTION:** To prevent electrical shock, ensure the main power has been disconnected before working on the drive. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

2. Fuses are held in a place with a fuse clip. To remove the fuse pull firmly.
3. To replace the fuse, hold it in position and push firmly until the fuse is seated within the fuse clip. Install fuses so that the rating is visible.

**IMPORTANT** Make sure to replace the fuse with another of the same rating. (See [Figure 226](#) for location.)

Figure 226 - Transient Suppression Network



## Metal-Oxide Varistor Replacement

Metal-oxide varistors (MOV) are part of the Transient Suppression Network located within the connection cabinet.

1. Ensure there is no power to the equipment.



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

2. Observe the locations of the connecting links.
3. Detach the connecting links by removing the screws.
4. Using a screwdriver remove the screws at the base.

5. Replace the MOV (polarity is not an issue).
6. Continue by replacing the screws and connecting links.

---

**IMPORTANT** Each MOV panel is grounded. Ensure that one MOV (see [Figure 226](#) for location) is connected to the grounding lead.

---

## Surge Arresters

### Description

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

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

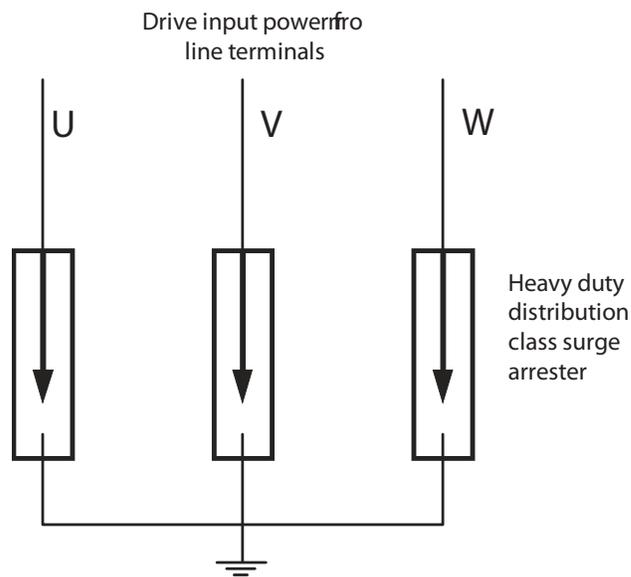
There are 3 types of surge arresters depending on the voltage class of the drive as shown in the table below:

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

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

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

Figure 227 - Surge Arresters



## Operation

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

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

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

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

## Surge Arrester Replacement

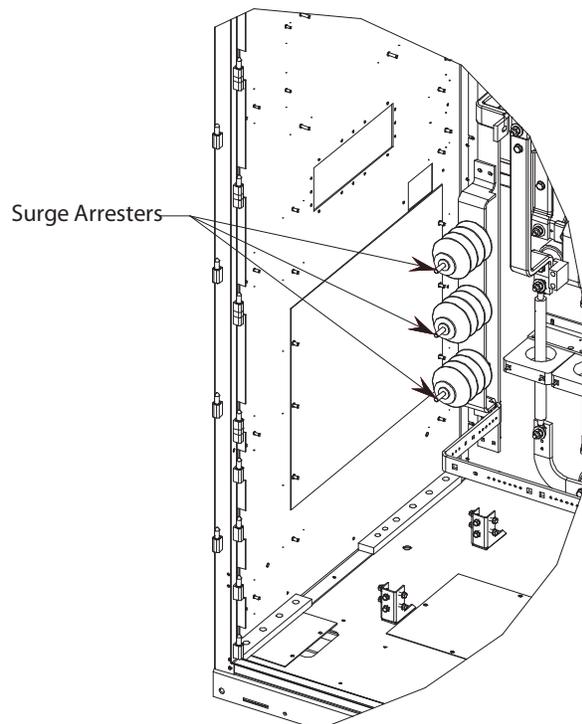
1. Ensure there is no power to the equipment. Isolate the drive by lock out / tag out.



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

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

**Figure 228 - Surge Arresters**



**TIP**

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

**Field Test and Care**

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

**Output Grounding Network Capacitor Replacement**

PowerFlex 7000 18 Pulse and some AFE drives will come with a grounding network installed.

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

1. Ensure there is no power to the equipment.



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

2. Note the position of the leads.
3. Remove the 6.4-mm (1/4 inch) hardware and disconnect the leads connected to the terminals.
4. Four brackets are used to secure the capacitor. Loosen the four screws at the base of the brackets and lift the capacitor out.
5. Place the new capacitor and tighten the screws securely.
6. Replace the ring lugs and 6.4-mm (1/4 inch) hardware. (See [Figure 229](#))

**IMPORTANT** The maximum torque for the capacitor terminal is 3.4 Nm (30 lb-in).

Figure 229 - Capacitor in Grounding Network

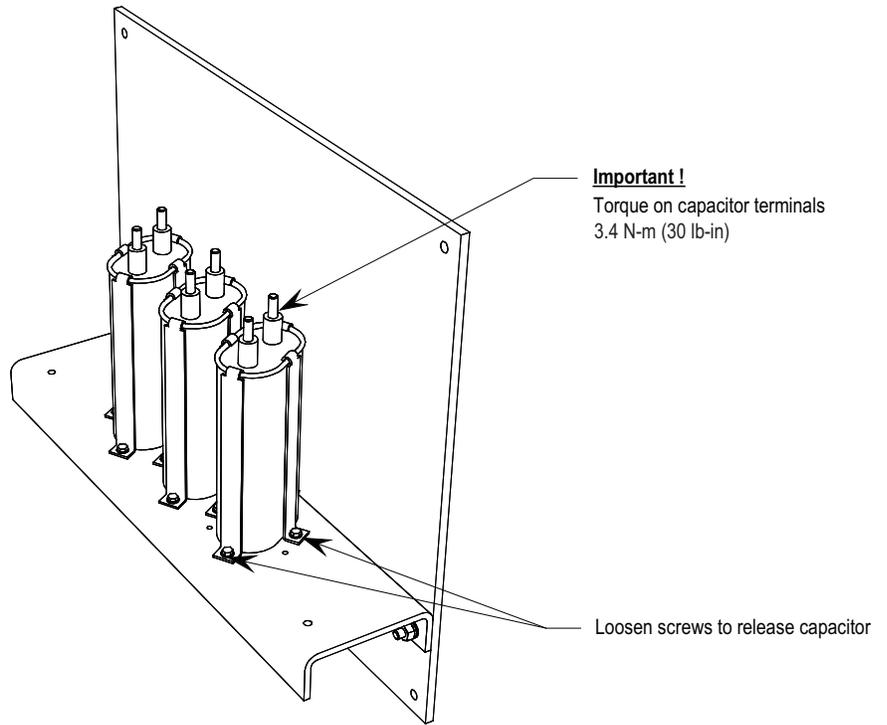
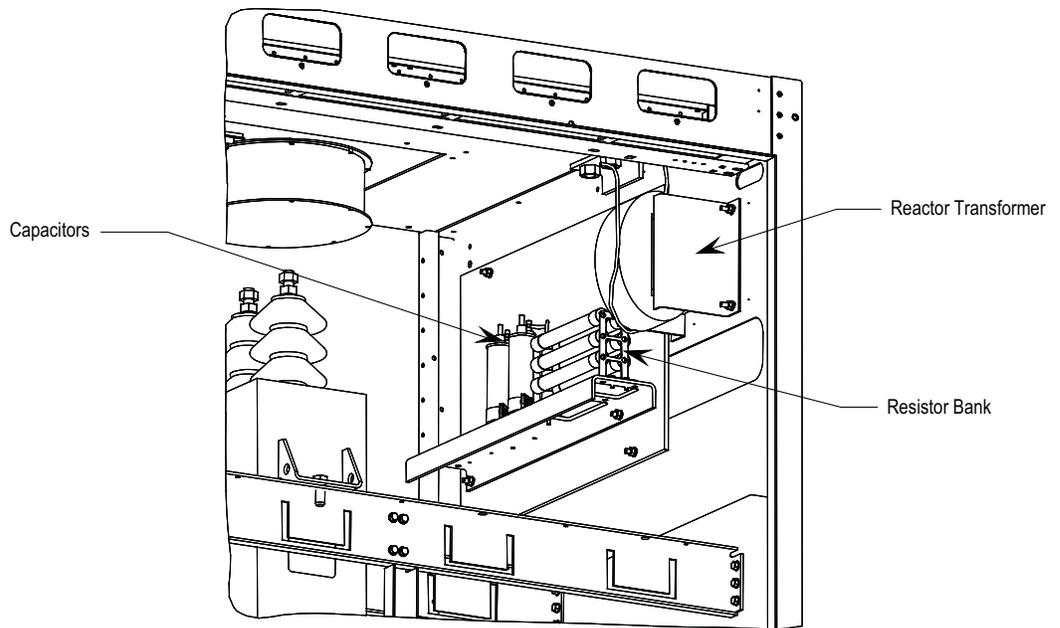
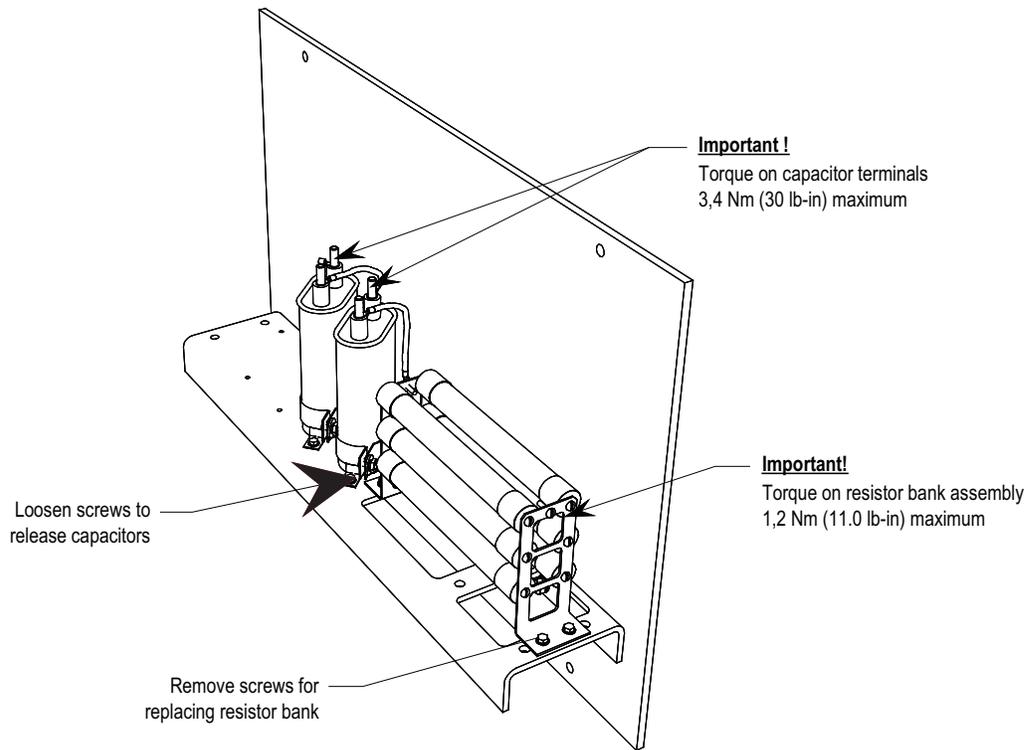


Figure 230 - Location of Ground Filter in "C" Frame Drive



**Figure 231 - Torque Values for Ground Filter Assembly**



## Ground Filter Replacement

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

1. Ensure there is no power to the equipment.

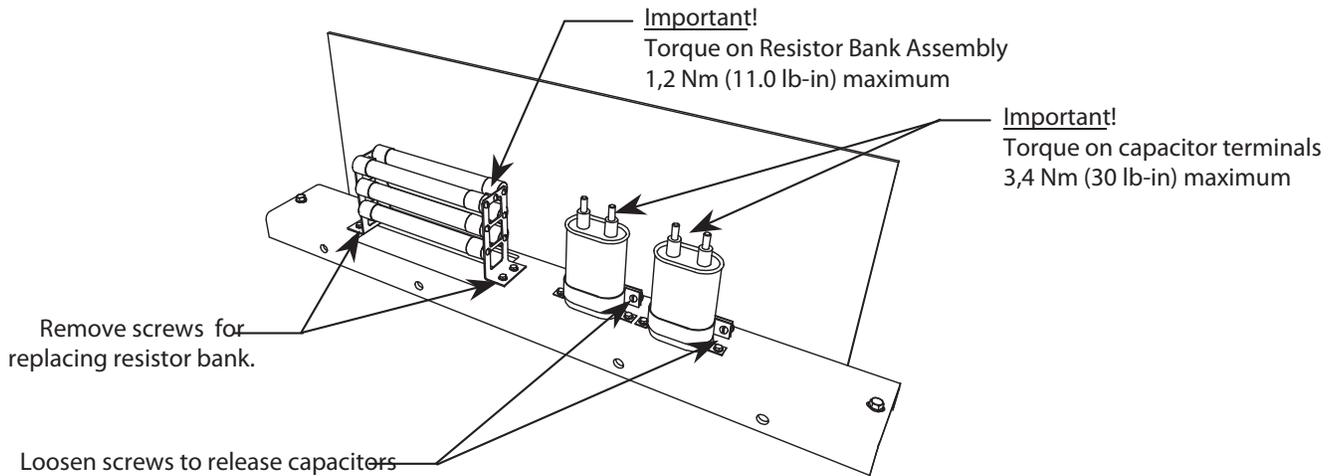


**ATTENTION:** To prevent electrical shock, ensure the main power has been disconnected before working on the capacitor. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

2. Note the position of the leads.
3. Disconnect the leads connected to the capacitor/resistor bank.
4. Loosen and remove mounting screws as indicated in [Figure 232](#) and remove the component.
5. Assemble the new component in the reverse order of disassembly.
6. Reattach the leads strictly adhering to the torque requirements outlined in [Figure 229](#)

**IMPORTANT** The maximum torque for the capacitor terminal is 3.4 Nm (30 lb-in).

Figure 232 - Ground Filter Capacitor/Resistor



## Hall Effect Sensor Replacement

1. Ensure there is no power to the equipment.



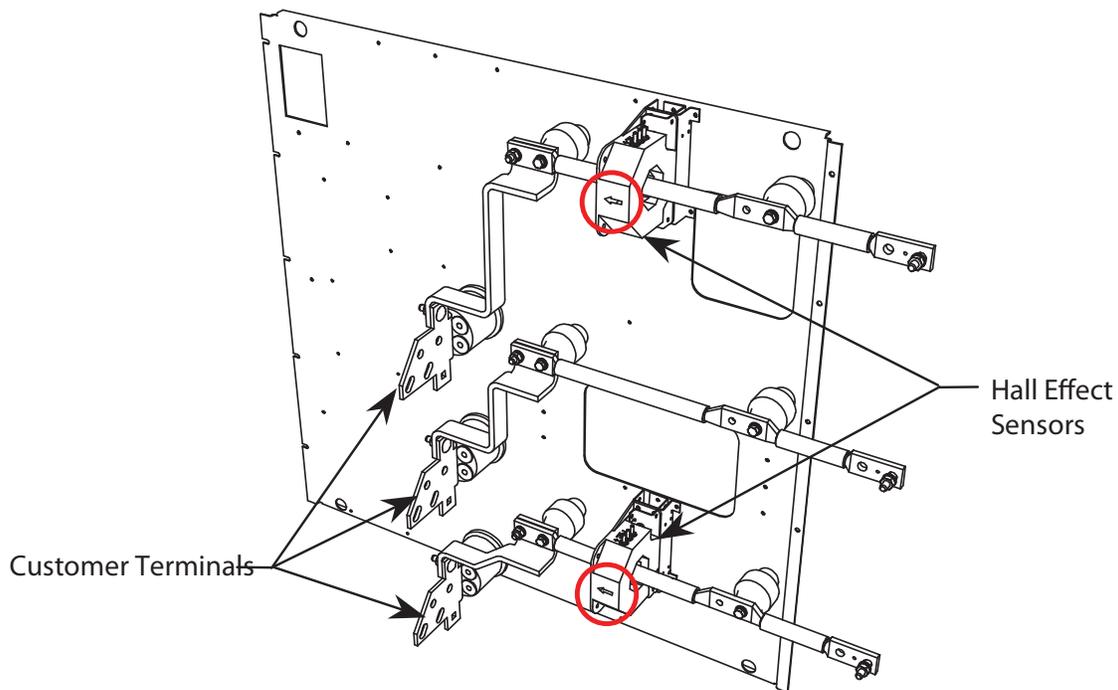
**ATTENTION:** To prevent electrical shock, ensure the main power has been disconnected before working on the Hall Effect sensor. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

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

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

3. The round bus bar must be removed. Remove the M10 hardware and slide the bar out.
4. Remove the screws from the three terminals to allow removal of the ring lugs.
5. Remove the four screws on the base of the Hall Effect sensor.
6. Replace the Hall Effect sensor. Note the arrow must be oriented as shown in [Figure 233](#).
7. Slide the bus bar back into place and secure with the M10 hardware.
8. Fasten the ring lugs on the wires back into place in the correct position. Do not overtighten or you will break the threaded stud.

Figure 233 - Motor Terminal Assemblies



**TIP** Arrows on Hall Effect sensors indicate direction of current flow. Customer Terminals shown for bottom cable entry. Customer must remove and re-orient terminals if top entry is required.

## Current Transformer Replacement

1. Ensure there is no power to the equipment.



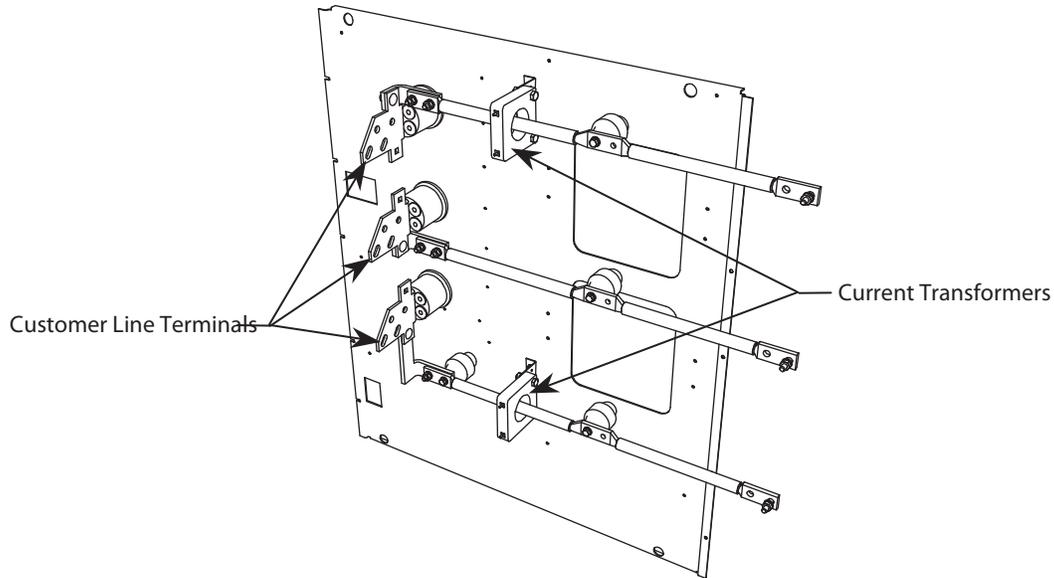
**ATTENTION:** To prevent electrical shock, ensure the main power has been disconnected before working on the current transformer. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

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

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

3. Disconnect the wires.
4. The bus bar must be disassembled to allow removal of the CT. Remove the M10 hardware to allow the bus bar to slide out.
5. Remove the four screws located in the base of the CT and remove.
6. Replace the CT, ensuring the proper orientation. Fasten the CT securely with the four screws in the base.

7. Reconnect the ring lugs.
8. Replace the bus bar and tighten into place.

**Figure 234 - Line Terminals****TIP**

Customer terminals shown for bottom cable entry. Terminals can be removed and re-installed with orientation for top cable entry.

## Filter Capacitor Cabinet

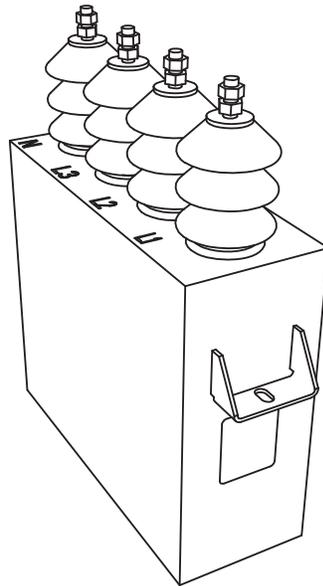
### Filter Capacitors

Filter capacitors are used on the motor side for all drives. The AFE Rectifier option also includes filter capacitors on the line side. Refer to [Figure 222](#) (Cabling Cabinet for 18 Pulse Rectifier), and [Figure 221](#) (Cabling Cabinet for AFE Rectifier).

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

The capacitors are equipped with internal “bleeding resistors” to discharge the capacitor and reduce its voltage below 50V in 5 minutes when left disconnected. A typical three-phase capacitor is shown in [Figure 235](#):

Figure 235 - Motor Filter Capacitor



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

---

## Filter Capacitor Replacement

1. Ensure there is no power to the equipment.



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

---

2. Note the location of all the cables and mark them accordingly.
3. Remove the 4 power connections to the terminals, and the single ground connector from the drive to the capacitor frame. This is located at the back top right corner of the capacitor.
4. Remove the front bracket that holds the capacitor in place. At the rear of the capacitor, there is no hardware securing the capacitor; it fits into a slot in the assembly.
5. Remove the capacitor from the drive.

---

**IMPORTANT THESE CAPACITORS CAN WEIGH AS MUCH AS 100 kg (220 lb), SO YOU WILL REQUIRE AT LEAST TWO PEOPLE TO REMOVE A CAPACITOR.**

---

6. Install the new capacitor, sliding it back until it fits into the slot. Fasten the front bracket.
7. Reconnect all the power cables and the ground connection. These use M14 hardware, but should only be tightened to 30 Nm (22 ft-lb.) due to capacitor mechanical constraints. You may want to fasten these connections before fully sliding the capacitor into place depending on the available space.
8. There are instruction labels on each capacitor detailing how to tighten the terminal connections. Please refer to these labels.
9. Reinstall the sheet metal that was removed, and complete one final check to ensure connections are secure and correct.

## Testing Filter Capacitors

1. Ensure there is no power to the equipment before testing the capacitor.



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

---



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

---

2. Follow appropriate safety steps to isolate the equipment from medium voltage.
3. Verify that there is no voltage present on the capacitor by using a hot stick or any other appropriate voltage-measuring device.
4. Perform visual inspection to ensure there is no oil leak or bulge in any of the capacitors.
5. Note the location of all the cables and mark them accordingly.
6. Disconnect power cables from the capacitor terminals on all four bushings and isolate them from the capacitor.
7. Connect a low voltage single-phase test power, for instance 110V or 220V, across a phase and the neutral of the capacitor. Switch on the test power and measure the test voltage and current drawn by the capacitor. Repeat the test for all three phases and note down the test voltage and current.



**ATTENTION:** The capacitor will charge during this test so care must be taken to prevent a shock or injury. When moving the test connections from one phase to the next, wait for at least five minutes until the capacitor is discharged. Using a hot stick.

---

8. Now, calculate the capacitance from the measured values of test voltage and current. For a good capacitor, the calculated capacitance value for each of the three readings should be within  $\pm 10\%$  of the capacitor nameplate micro-Farad. If it is outside this range then the capacitor must be replaced.

**Example:**

An example is given below to demonstrate how the capacitance value is calculated.

Suppose a capacitor under test is rated at 400kVAR, 6600V, 50Hz, 29.2  $\mu$ F. Let us say, you are using 200V, 50Hz test power and have recorded the values of voltage and current for each test as given in the table below.

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

Let us calculate the capacitance using the first reading. In this case:

$$V = 200V, I = 1.87 \text{ for L1-N}$$

$$X_c = V \div I = 200 \div 1.87 = 106.95$$

$$C = 1 \div 2\pi f X_c$$

$$C = 1 \div 2 \times 3.14 \times 50 \times 106.95$$

$$C = 29.7 \mu F$$

Where,  $f$  = frequency of the applied voltage.

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

## Converter Cabinet Components

Figure 236 - Converter Cabinet Components (4160V AFE shown)

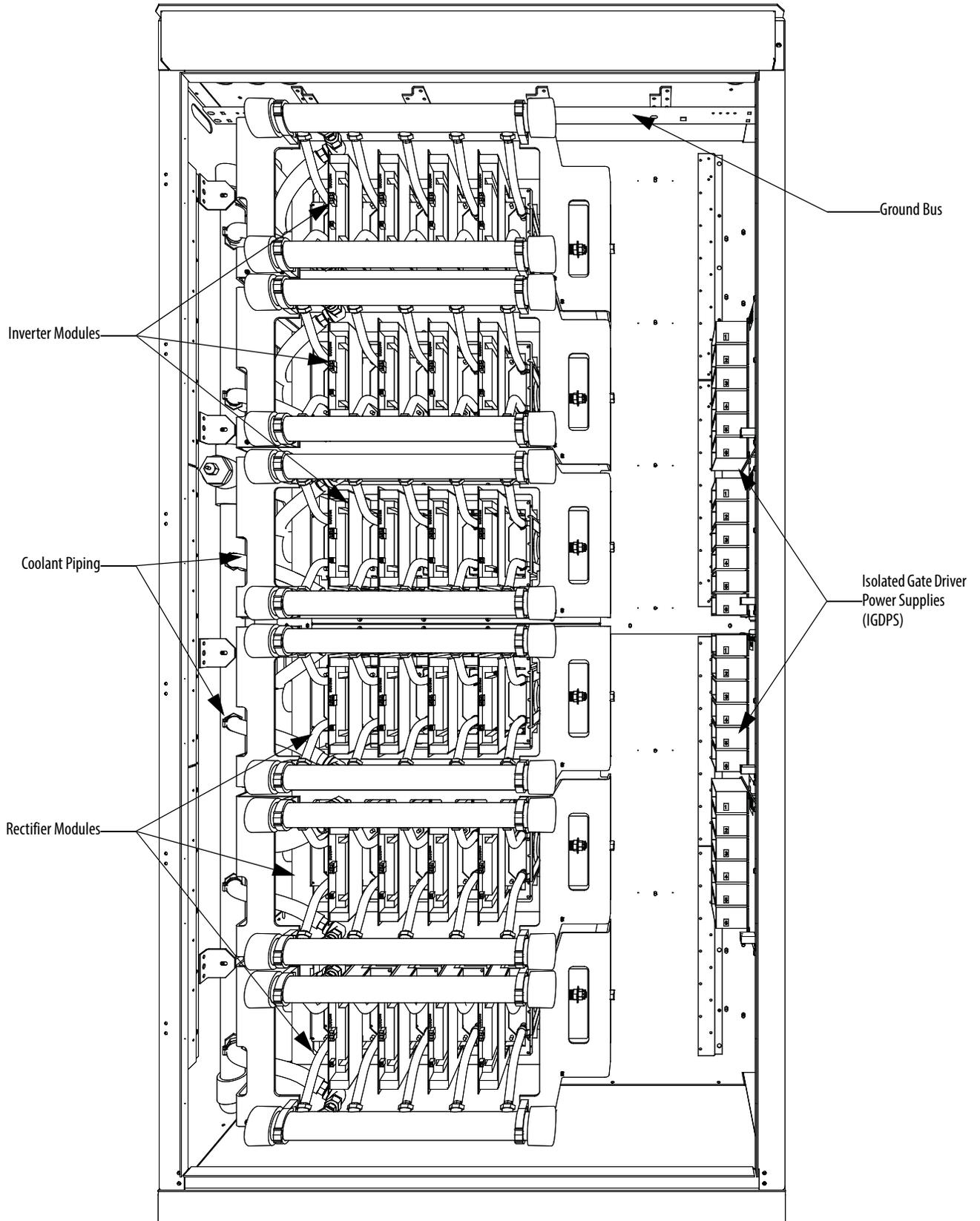
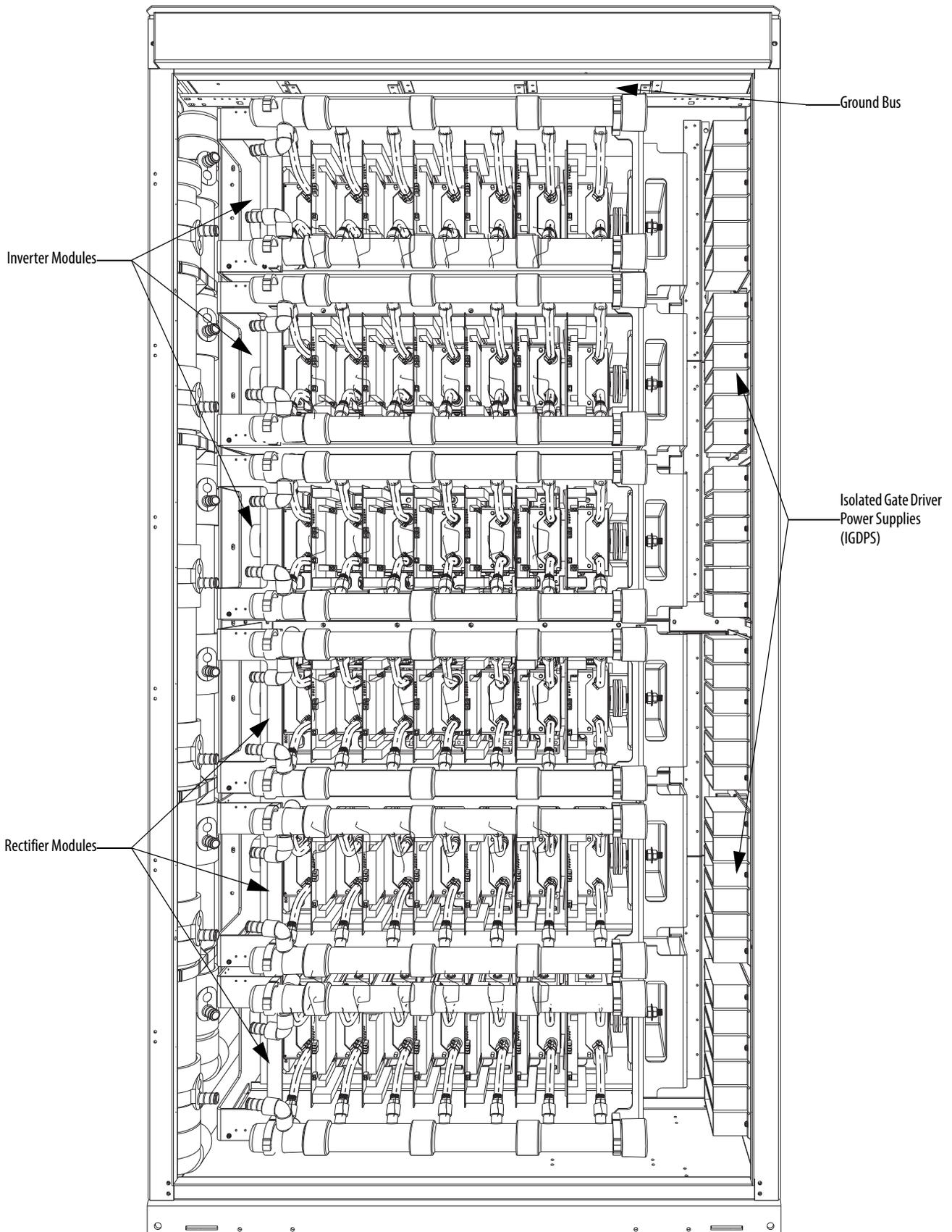


Figure 237 - Converter Cabinet Components (6600V AFE shown)



## Converter Cabinet

The converter cabinet contains three rectifier modules and three inverter modules. [Figure 236](#) shows a 4160-volt converter with a Pulse Width Modulation Rectifier (PWMR).

Isolated Gate Driver Power Supplies (IGDPS) are mounted on the cabinet's right side sheet.

Cooling pipes are throughout the cabinet and are connected to each chill block. Unlike the air-cooled drive, thermal sensors are not installed on the chill block. The thermal sensor is located in the pump cabinet.

## PowerCage™

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

- Epoxy resin housing
- Power semi-conductors with gate driver circuit boards
- Chill blocks
- Clamp
- Snubber resistors
- Snubber capacitors
- Sharing resistors
- Piping for coolant to flow to each chill block

All drives have six PowerCages, three rectifiers and three inverter modules. The liquid-cooled drive has two types of rectifiers – the 18 Pulse SCR and the PWM rectifier.

All inverter modules use SGCTs as semi-conductors.

The size of the PowerCage will vary depending on the system voltage, and the components will also vary depending on the system current.

All PWMR modules use SGCTs as semi-conductors.

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

Configuration	Inverter SGCTs	Rectifier SGCTs	Rectifier SCRs
3300/4160V PWM rectifier	12	12	0
3300/4160V, 18 Pulse	12	0	18
6600V, 18 Pulse	18	0	18
6600V, PWM rectifier	18	18	0



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



**ATTENTION:** The PowerCage can house either SCRs or Silicon Gate Commutated Thyristors (SGCT). The SGCT circuit board is sensitive to static charges. It is important that these boards should not be handled without proper grounding.



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

Figure 238 - 4-Device PowerCage

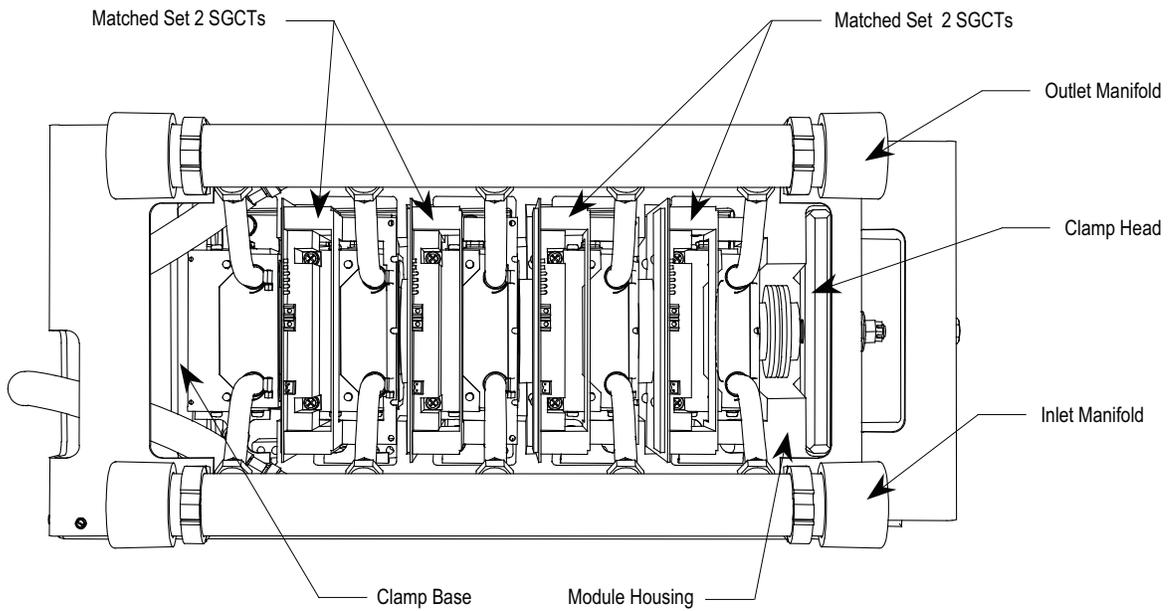
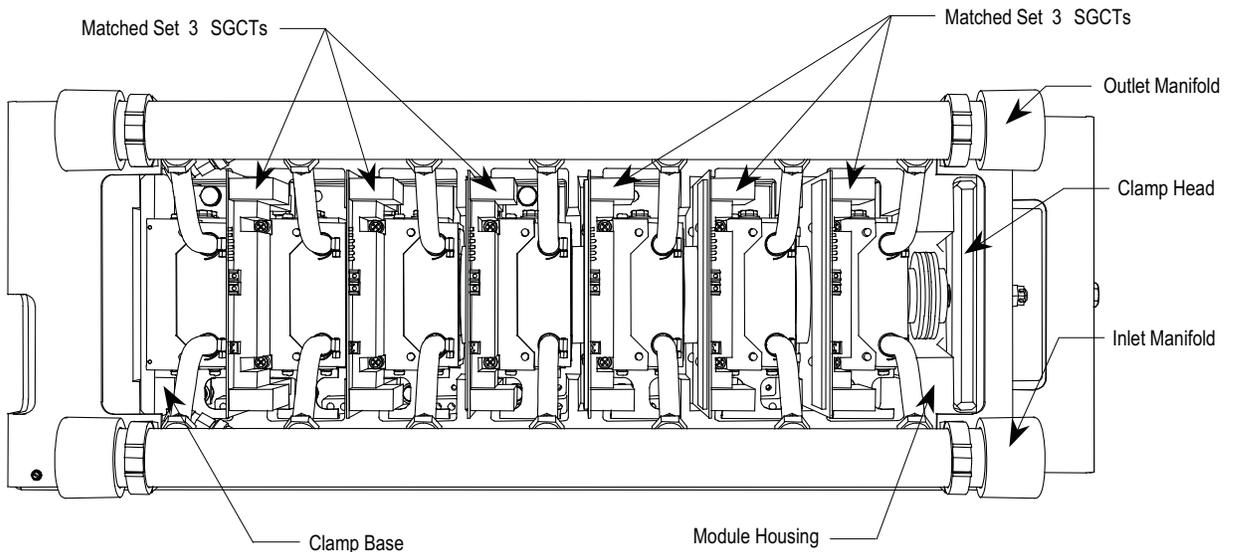


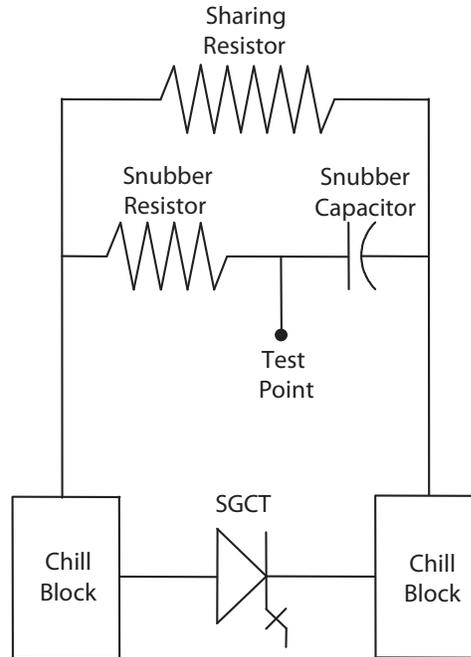
Figure 239 - 6-Device PowerCage



## SGCT and Snubber Circuit

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

**Figure 240 - SGCT and Snubber Circuit**



In addition to the snubber circuit, a sharing resistor is connected in parallel with the SGCT. The function of the sharing resistor is to ensure the voltage is shared equally among the SGCTs when connected in series. SGCTs are connected in series to increase the total reverse voltage blocking (PIV) capacity as seen by the electrical circuit. A single SGCT has a PIV rating of 6.5 kV. At 4.16 kV, 2 SGCTs must be connected in series to provide a net PIV of 13 kV to achieve the necessary design margin. Similarly, three SGCTs must be connected in series at 6.6 kV.

The cooling requirements of the SGCT are achieved by placing the SGCT between two liquid cooled chill blocks – one chill block on the anode and the other chill block on the cathode. The force placed on the SGCTs differs with the size of the device. A 63-mm device (1500A) requires 20 kN. The clamp assembly on the right hand side of the inverter module generates these forces.

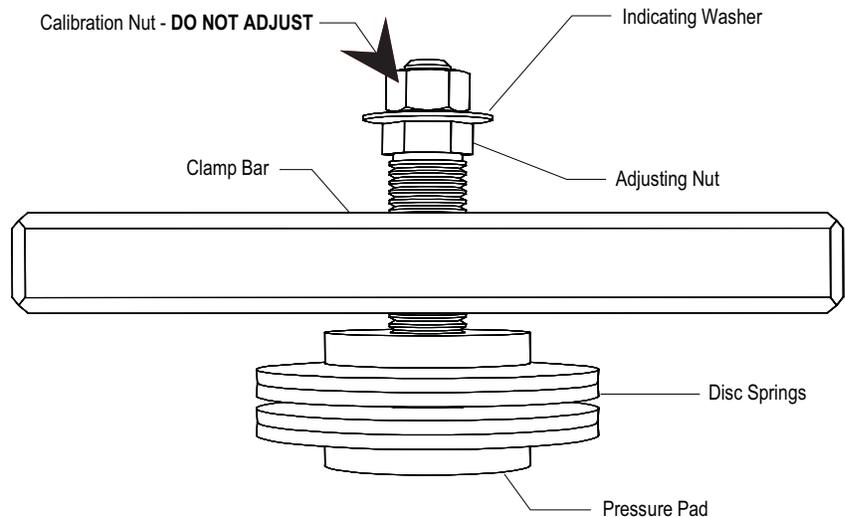
## Checking Clamping Pressure

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



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

**Figure 241 - Clamp Head Illustration**

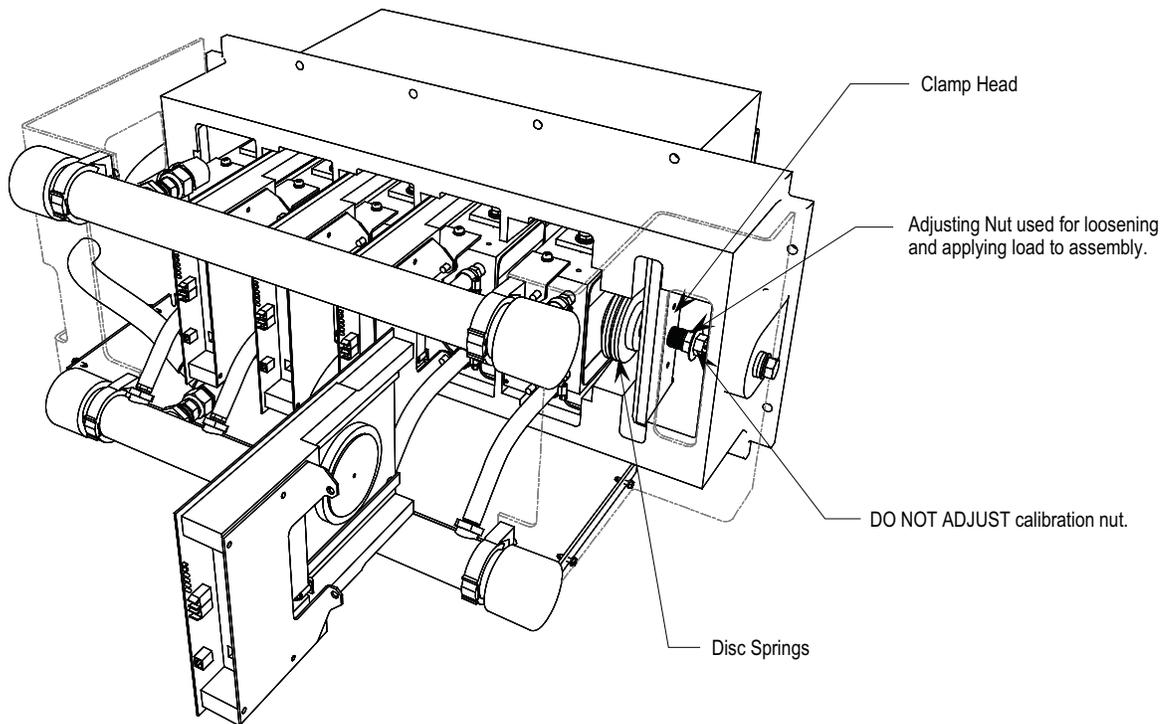


If proper force (as designated on the clamp head block) is applied to the clamping assembly, the indicating washer should just be able to rotate with fingertip touch. The disc should not rotate freely. Some force will need to be applied with your fingertips.

## Clamping Pressure Adjustment

1. Ensure that all power to the drive is off.
2. Do not loosen the adjustment nut completely.
3. Tighten with a 21-mm (13/16-inch) open-ended wrench on the adjusting nut (upward motion) until the indicating washer can be turned by fingers with some resistance. IT SHOULD NOT SPIN FREELY.

**IMPORTANT** Never rotate the calibration nut located outside the indicating washer at the end of the threaded rod. The rotation of the calibration nut will affect the torque calibration, which is factory set. Only adjust the adjusting nut. (See [Figure 242](#).)

**Figure 242 - Detail of the clamping assembly**

## Symmetrical Gate Commutated Thyristor Replacement

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

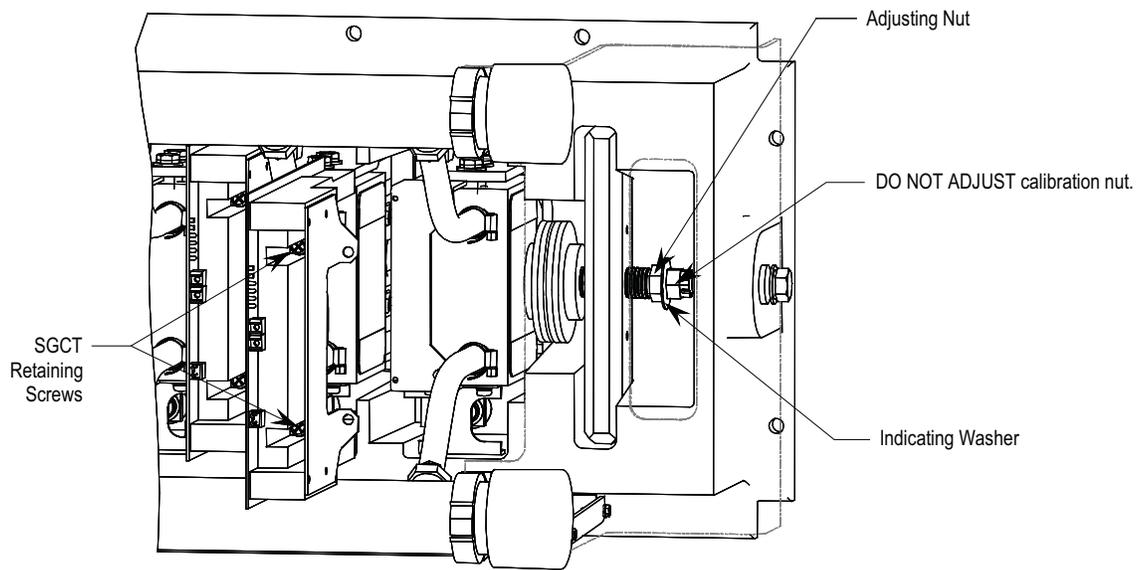
SGCTs must be replaced in matched sets:

- 4160V systems use sets of 2
- 6600V systems use sets of 3

SGCTs can be removed and replaced without interrupting the cooling fluid path.

To remove SGCTs, the following procedure is to be employed:

Figure 243 - Replacing the SGCT



The SGCT and associated control board are a single component. There will never be a time when the device or the circuit board will be changed individually. There are 4 LEDs on the SGCT, and the following table describes their functions:

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

1. Ensure there is no power to the equipment.



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

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



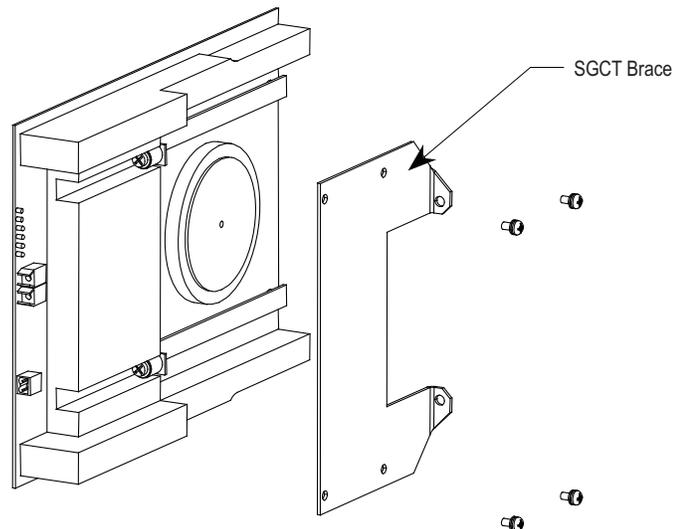
**ATTENTION:** The fiber optic cables can be damaged if struck or bent sharply. The minimum bend radius is 50 mm (2 inches). The connector has a locking feature that requires pinching the tab and gently pulling straight out. The component on the printed circuit board should be held to prevent damage.

4. Remove the load on the clamp head assembly as described in [Checking Clamping Pressure on page 292](#).
5. Two screws secure the board to the chill block. Loosen the captive screws with a long Phillips screwdriver until the circuit board is free. It may be necessary to adjust the position of the chill blocks to allow free movement of the SGCT.
6. SGCTs can now be extracted by pulling the Gate Driver board forward between the upper and lower manifolds. Use a Phillips screwdriver to remove the brace angle of the SGCT. Retain the brace angle and its hardware.



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

**Figure 244 - Replacing the SGCT – Brace Angle**



**IMPORTANT** SGCTs come in matched sets in systems with more than one device per leg. When replacing the device, it is necessary to replace all devices in the matched set even if only one has failed.

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

---

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

---

10. Slide the SGCT into place until the mounting brackets contact the surface of the chill block. **Do not force SGCT when inserting into place. Make sure it slides in with little resistance.** Use a Phillips screwdriver to tighten the captive screws to the cathode side of the chill block.
11. Readjust the clamping load as described in [Checking Clamping Pressure on page 292](#).
12. Connect the control power cable and fiber optic cables (ensure the bend radius is not exceeded).

## Silicon Controlled Rectifier and SCR Self-Powered Gate Driver Board Replacement

The method for replacing the Silicon Controlled Rectifier (SCR) is almost identical to that of the SGCT. The one exception is that the SCR and circuit board can be replaced independently of one another.

1. Ensure there is no power to the equipment.




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

---

2. Note the position of the Fiber Optic Cables for reassembly.
3. To Remove the SCR and SCR SPGD Board, it is necessary to remove the Gate Driver Power Supply connector (from snubber circuit), the fiber optic cable, and the SCR gate-cathode connection. Exceeding the minimum bend radius (50 mm/2 in.) of the fiber optic cables may result in damage.



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

4. Remove the load on the clamp head as described in [Checking Clamping Pressure on page 292](#).
5. Loosen the 2 captive screws with a long Phillips screwdriver until the circuit board is free. It may be necessary to adjust the position of the chill blocks to allow free movement of the SCR.
6. Slide the SCR and SCR SPGD Board straight out.
7. While grounded, unplug the Gate-Cathode phoenix connector from the SCR SPGD Board.



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

**IMPORTANT** Never adjust the orientation of the SCR by pulling the Gate and Cathode Leads. These connections are sensitive and the device orientation should only be adjusted by turning the device itself.

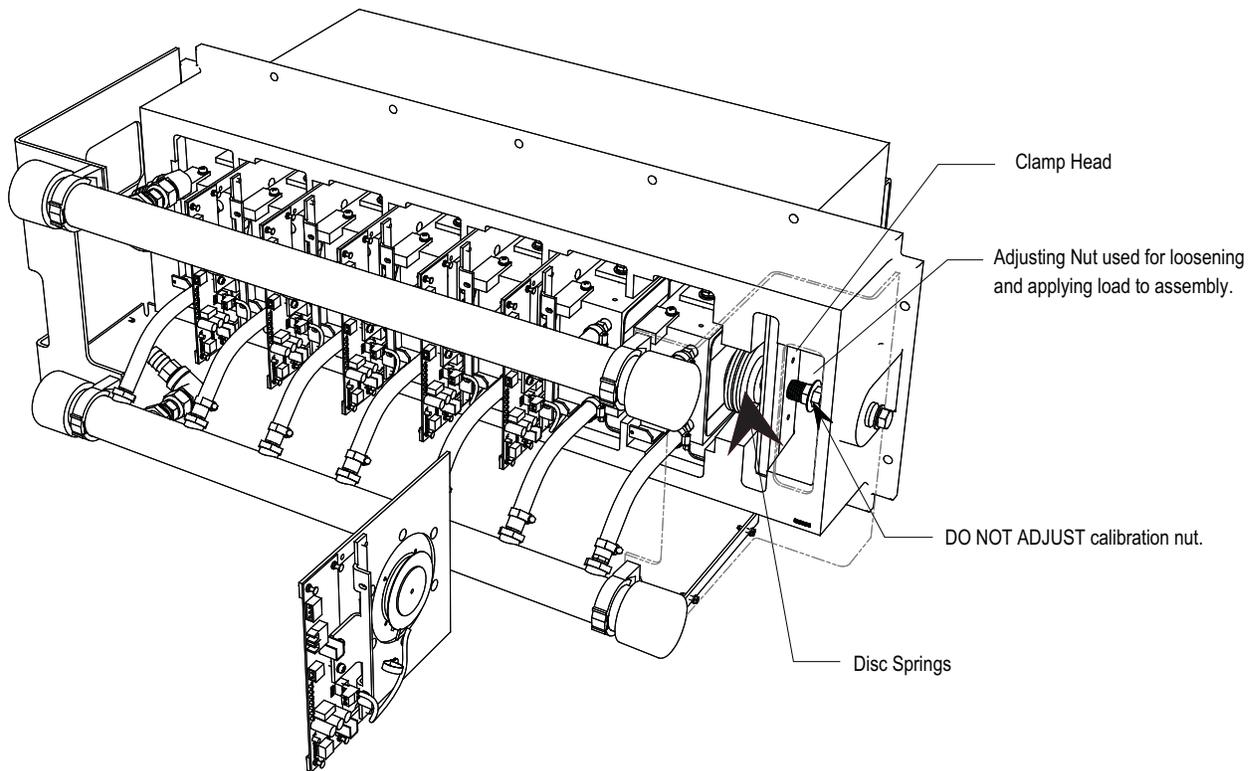
**IMPORTANT** TO REPLACE THE SCR, FOLLOW STEPS 8-11, and 16-18.

**IMPORTANT** TO REPLACE THE SCR SPGD BOARD, FOLLOW STEPS 12-15, and 16-18.

8. Remove the tie wrap holding the G-C wire in place, and remove the device from the assembly.
9. Install the new device in the same position and using the same orientation as the original SCR, and firmly secure the G-C wires with a tie wrap.
10. Connect the Gate-Cathode phoenix connector to the Gate Driver Board.
11. Apply a thin layer of Electrical Joint Compound (Alcoa EJC No. 2 or approved equivalent) to the contact faces of the new SCRs to be installed. The recommended procedure is to apply the compound to the pole faces using a small brush and then gently wiping the pole face with an industrial wipe so that a thin film remains. Examine the pole face before proceeding to ensure that no brush bristles remain.

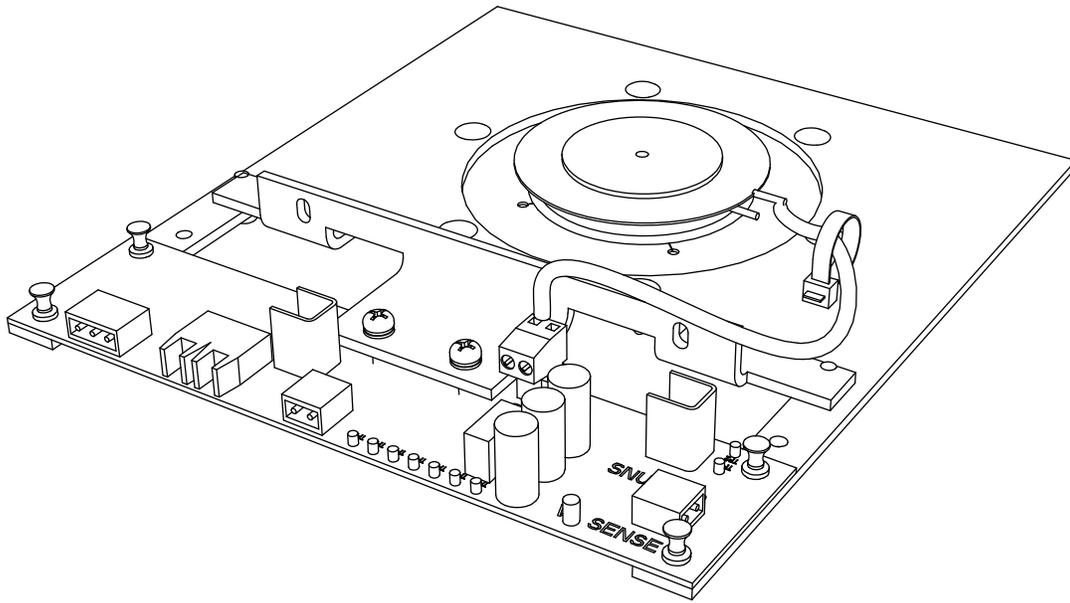
**IMPORTANT** Too much joint compound may result in contamination of other surfaces leading to system damage.

Figure 245 - SCR Removal



12. While grounded, use a long Phillips screwdriver to remove the 2 screws that hold the SCR SPGD Board to the metal bracket on the red glastic assembly. Retain the hardware.
13. Pull the 4 plastic clips that secure the SCR SPGD Board to the glastic assembly. Retain the hardware.
14. Install the new SCR SPGD Board in the assembly with the 4 plastic clips and use the screws to secure the board to the metal bracket.
15. Connect the Gate-Cathode phoenix connector to the Gate Driver Board.
16. Slide the SCR and SCRGD Board back into place until the mounting bracket makes contact with the chill block. Use the Phillips screwdriver to tighten the assembly to the chill block.
17. Readjust the clamping load as described in [Checking Clamping Pressure on page 292](#).
18. Connect the control power cable and the fiber optic cables, ensuring that the bend radius is not exceeded.

Figure 246 - SCR and SPGDB assembly

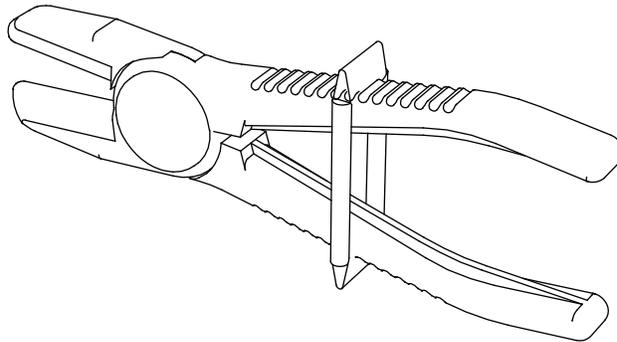


## Detachment of Coolant System from PowerCage Modules

In the event that service is required to snubber components, it will be necessary to extract a chill block assembly from a converter PowerCage module in order to access the snubber and sharing resistors. To avoid draining coolant from the entire converter, it is possible to isolate the fluid path of one converter module from the remainder of the drive using the following technique:

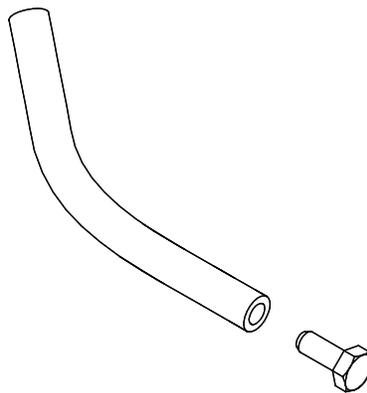
1. Ensure that power has been disconnected.
2. Ensure all pumps have been turned off. Allow the system to cool down before servicing any components in the coolant system.
3. Remove all SCR/SGCT devices and their circuit boards as outlined in [Silicon Controlled Rectifier and SCR Self-Powered Gate Driver Board Replacement on page 296](#) and [Symmetrical Gate Commutated Thyristor Replacement on page 293](#).
4. Drape a waterproof plastic sheet over all the devices under the PowerCage being serviced. Personnel must wear suitable protective personal gear to avoid direct contact with the coolant (ethylene glycol – water mixture).
5. Two flow restrictor clamps per [Figure 247](#) are provided with the spare parts kit of each drive.

**Figure 247 - Flow Restrictor Clamp**

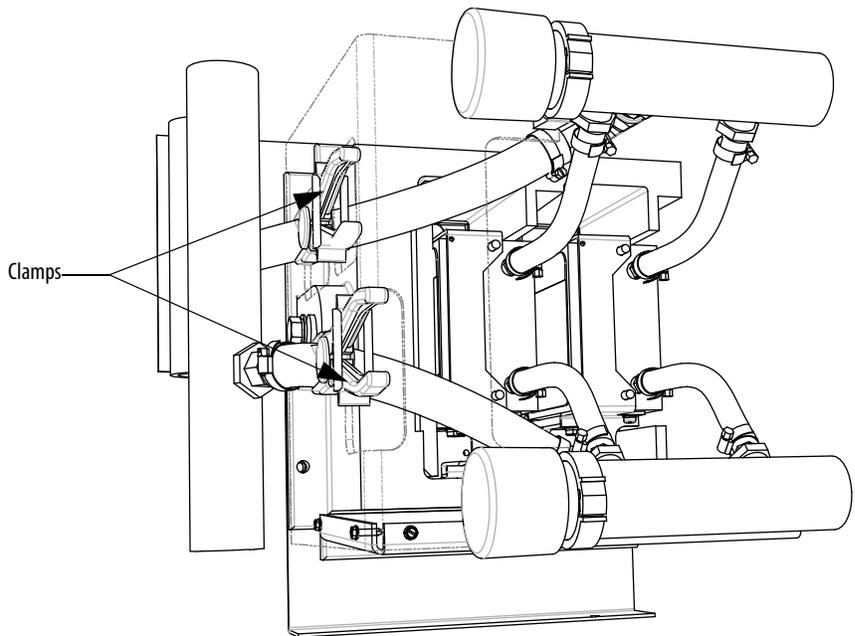


Also required are two (2) pieces of 3/8" hose (included) in spare parts kit and four (4) M10 bolts with a length from 10 to 30 mm for use as plugs in the 3/8" hose (not included). See [Figure 248](#). M10 bolts must be clean.

**Figure 248 - Flow Stopper for Servicing (2 required)**

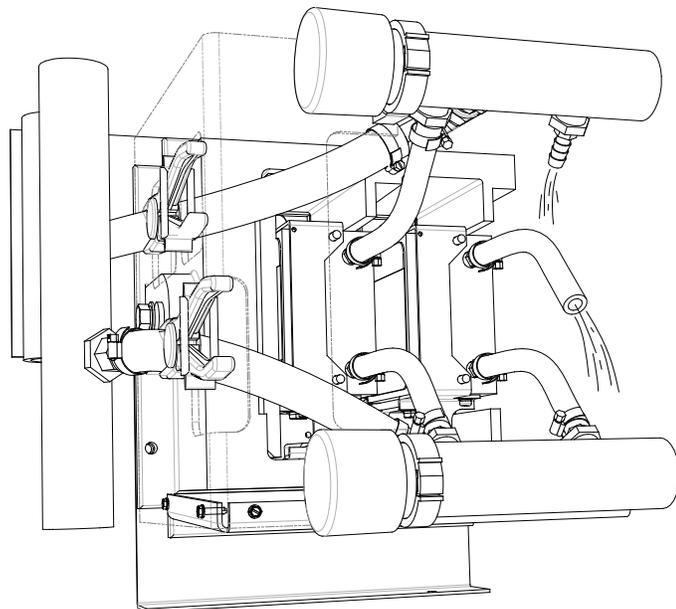


6. Insert the 2 clamps per [Figure 249](#) on the 3/4-inch (19-mm) silicon hoses to isolate flow between the vertical manifolds and the horizontal manifolds of the converter modules.

**Figure 249 - Converter PowerCage Module (Service – per Step 6)**

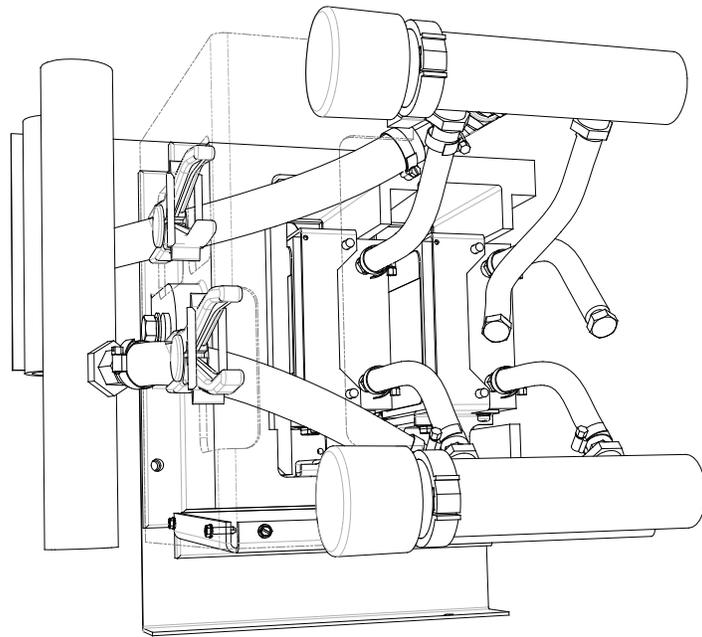
Loosen the hose clamp of the top hose of the outlet manifold of the chill block to be serviced. Slide the hose clamp toward the chill block.

7. Have a hose plug assembly and a M10 bolt ready. Per [Figure 250](#), pull the hose from the upper manifold hose barb and collect the fluid in a container.

**Figure 250 - Converter PowerCage Module (Service – per Step 7)**

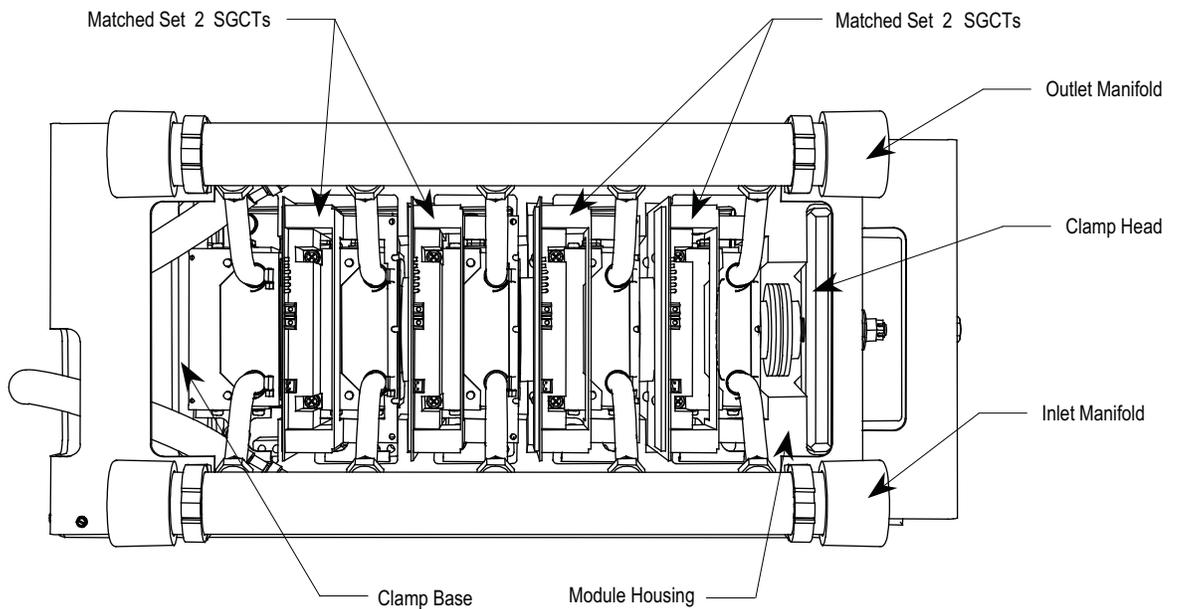
8. Per [Figure 251](#), insert the hose plug on the hose barb of the upper manifold. Insert a M10 bolt in the end of the chill block hose. Note that there may still be limited fluid leakage during this procedure.

Figure 251 - Converter PowerCage Module (Service – per Step 8)



Repeat this procedure for the lower manifold connection point. The chill block can be extracted from the PowerCage per [Chill Block Removal and Replacement on page 303](#).

Figure 252 - Cooling System



## Reconnecting the Coolant System to a PowerCage Module

1. Ensure all power is off and locked-out, including the pumping system.
2. Ensure a blanket or plastic sheet is covering the devices below the PowerCage being serviced. Face shield and full arm chemical resistant gloves should be worn at all times when performing this task.
3. Attach both the inlet and outlet manifolds to their bracketry, be sure to close all the pipe clamps.
4. If necessary, remove the device blocking the left outlet hose and reconnected it to the lower nipple on the chill block to the extreme left. Make sure to tighten the hose clamp. Repeat this step for all outlet hoses and than all inlet hoses.
5. Replace all SGCT/SCR devices and circuit boards as described in [Silicon Controlled Rectifier and SCR Self-Powered Gate Driver Board Replacement on page 296](#) and [Symmetrical Gate Commutated Thyristor Replacement on page 293](#).
6. Check coolant levels to ensure there is still enough coolant in the system. If coolant must be added, refer to [Fluid Top-up on page 340](#).

## Chill Block Removal and Replacement

### Instructions for removing Chill Block assembly

1. Ensure all Power has been disconnected.



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

---

2. Remove SCR/SCGT(s) and circuit board(s) outlined in [Symmetrical Gate Commutated Thyristor Replacement on page 293](#) and [Silicon Controlled Rectifier and SCR Self-Powered Gate Driver Board Replacement on page 296](#).



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

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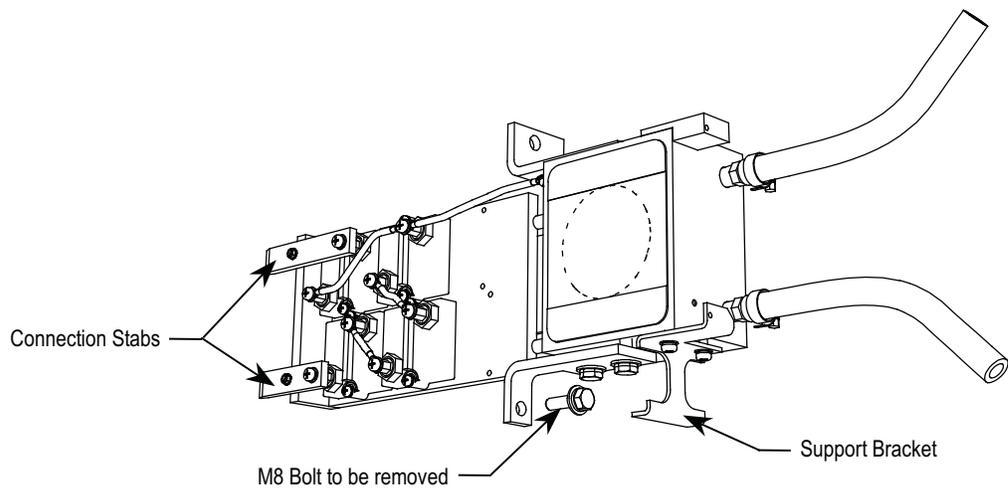
3. Detach coolant hoses from upper and lower manifolds. This procedure is more clearly explained in [Detachment of Coolant System from PowerCage Modules on page 299](#).

4. Using a 14-mm socket with an extension of at least 40 cm, remove the M8 bolt on the bottom flange of the chill block, which connects the chill block assembly to the PowerCage.
5. If present, remove the M10 bolt at the top of the chill block using a 17-mm socket with an extension of at least 40 cm.
6. Slowly and carefully pull the assembly out of the PowerCage.



**ATTENTION:** The chill block assembly is heavy and it is recommended that two people pull the assembly out to avoid damage.

**Figure 253 - Chill Block Removal and Replacement**



### Instructions for inserting Chill Block assembly

1. Ensure all power is disconnected.



**ATTENTION:** Remove plastic film from chill block before installation. Failure to remove the film will result in device failure.

2. Slowly push the chill block assembly into the PowerCage. Ensure that the stabs are aligned with their connectors at the back of the PowerCage. This is difficult to see. When the stabs are properly aligned and in place, the chill block assembly will be seated squarely and the support bracket should be resting on the PowerCage base when positioned correctly.

**TIP**

If the stabs are not seated properly in the brackets, damage can occur. Measure the snubber resistance and sharing resistance to ensure that contact has been made. If rear access to the drive is available, remove backplates and visually verify.

3. When sure that the chill block stabs are properly positioned replace the M8 and M10 bolts and tighten. Magnetized sockets are recommended with 40 cm extensions.
4. Re-connect the coolant system to the chill blocks. Reconnecting the coolant system before re-installing the SCR/SGCTs ensures no coolant is spilled on the devices or circuit boards.
5. Replace SCR/SGCT and circuit boards explained in [Symmetrical Gate Commutated Thyristor Replacement on page 293](#) and [Silicon Controlled Rectifier and SCR Self-Powered Gate Driver Board Replacement on page 296](#).
6. Readjust the clamping load as described in [Checking Clamping Pressure on page 292](#).

## PowerCage Removal and Replacement

1. Ensure there is no power to the equipment.



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

---

2. Before removing the PowerCage, all the components located within the PowerCage need to be removed to avoid any damage to the components. Consult the required sections to remove clamping pressure, SGCT and SCR boards, detachment of cooling system, and chill block removal.



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

---

3. With all the components removed, detach the manifold assembly by removing the bolts on the outer flange. Carefully lift the PowerCage down, placing the front face down. Do not overtorque these bolts when replacing the PowerCage.

---

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

---

4. When replacing the PowerCage, it is important to place the bolts on the outer flange loosely. Torque bolts alternately on one flange and then the opposite flange to ensure even tightening of the module. A suggested sequence for torquing PowerCage bolts is shown in [Figure 254](#).

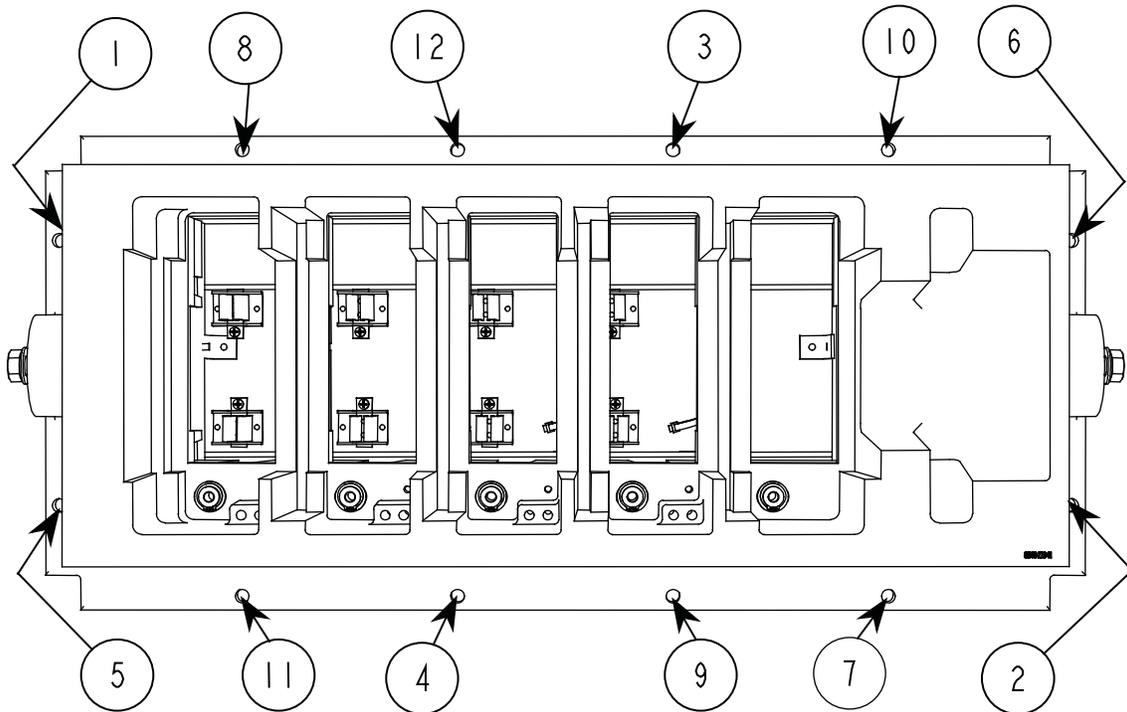
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**IMPORTANT** When replacing the PowerCage, always be sure all the PowerCage components are removed.

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- After the PowerCage is securely fastened to the backplane refer to the appropriate sections to replace all other components.

**Figure 254 - Typical Torque Sequence**



## Snubber Resistors

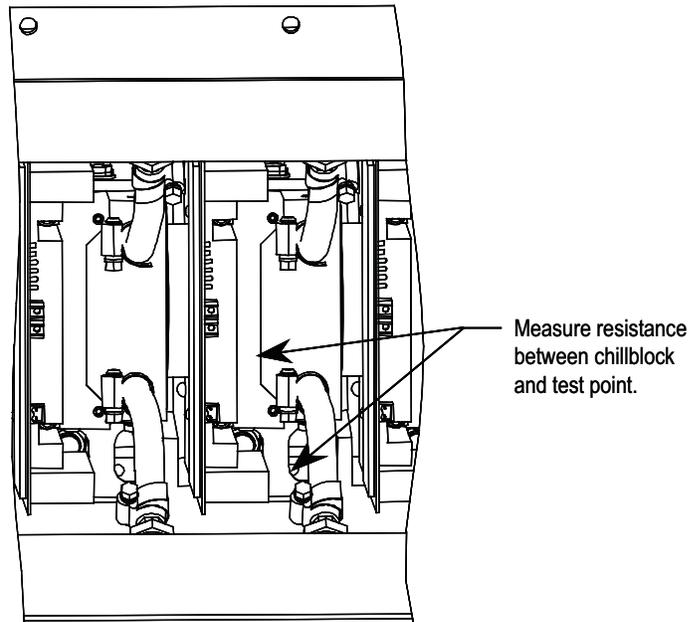
A test point is provided inside the PowerCage to measure the resistance of the snubber resistor and capacitance of the snubber capacitor. The test point is the electrical connection between the snubber resistor and snubber capacitor. The procedure is to place one probe of the multi-meter on the test point and the other probe on the appropriate chill block to determine the value of the resistor or capacitor.

Snubber resistors are connected in series with the snubber capacitors. Together they form a simple RC snubber that is connected across each semiconductor (SCR or SGCT). The purpose of the snubber circuit is to reduce the  $dv/dt$  stress on the semiconductors and to reduce the switching losses. The snubber resistors are connected as sets of thick film resistors. The number of resistors depends on the type of the semiconductor and the configuration and frame size of the drive.

## Testing Snubber Resistors

Access to the snubber resistor is not required to test the resistance. Located within the PowerCage under the chill block is a snubber resistor test point. For each device, there is one test point. To verify the resistance, follow the procedures outlined in Chapter 4.

**Figure 255 - Testing the Snubber Resistor**



## Sharing Resistors

The anode-cathode resistance check will measure the parallel combination of the sharing resistor and SGCT anode-cathode resistance. The sharing resistor has a resistance much lower than a good SGCT, thus the measurement will be slightly less than the resistance of the sharing resistor. A measurement between 60 k $\Omega$  and 75 k $\Omega$  indicates the SGCT is in good condition and that wiring to the SGCT is correct. If the SGCT fails, it may be shorted. The anode to cathode resistance check will be 0  $\Omega$  for a complete short, but SGCT can fail when partially shorted.

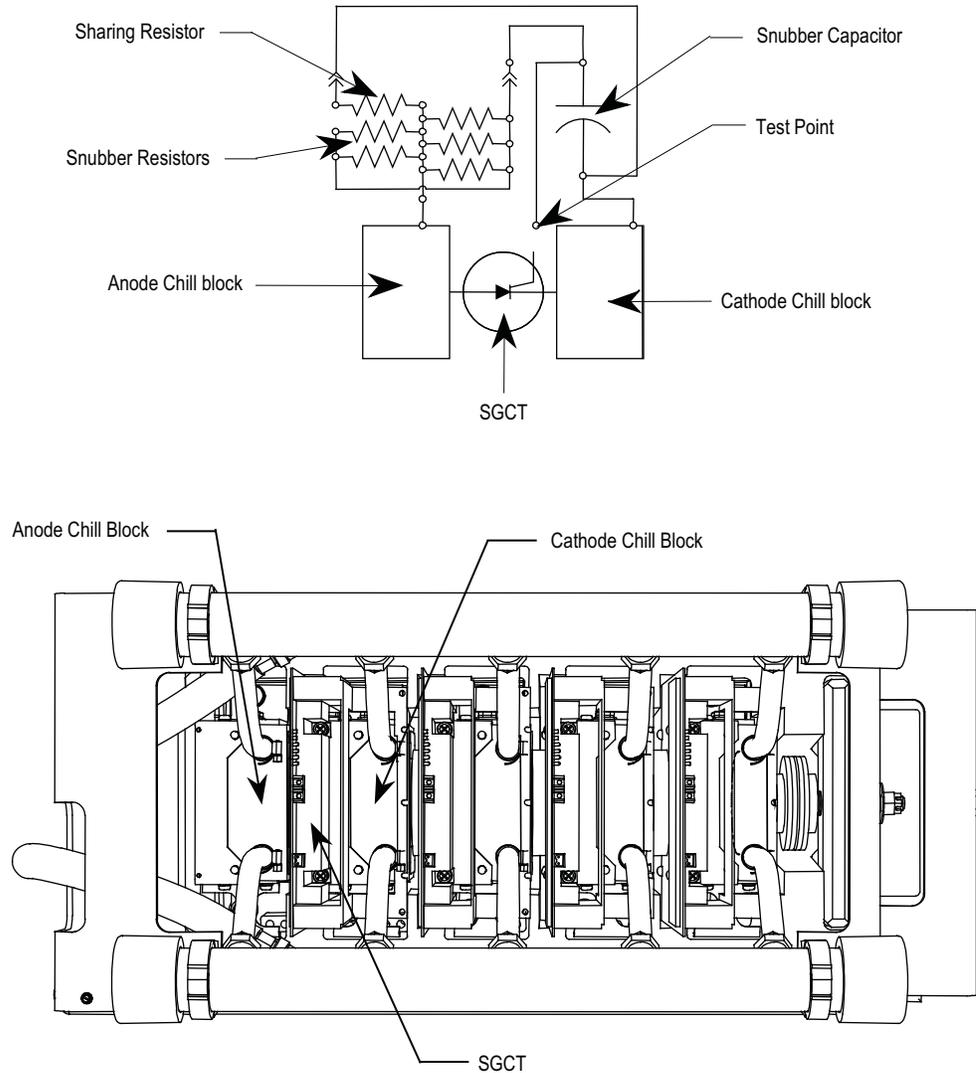
Sharing resistors provide equal sharing of the voltage when matched devices are used in series. Sharing resistors in SCR PowerCages provide a diagnostic function.

## Testing Sharing Resistors

### SGCT PowerCages

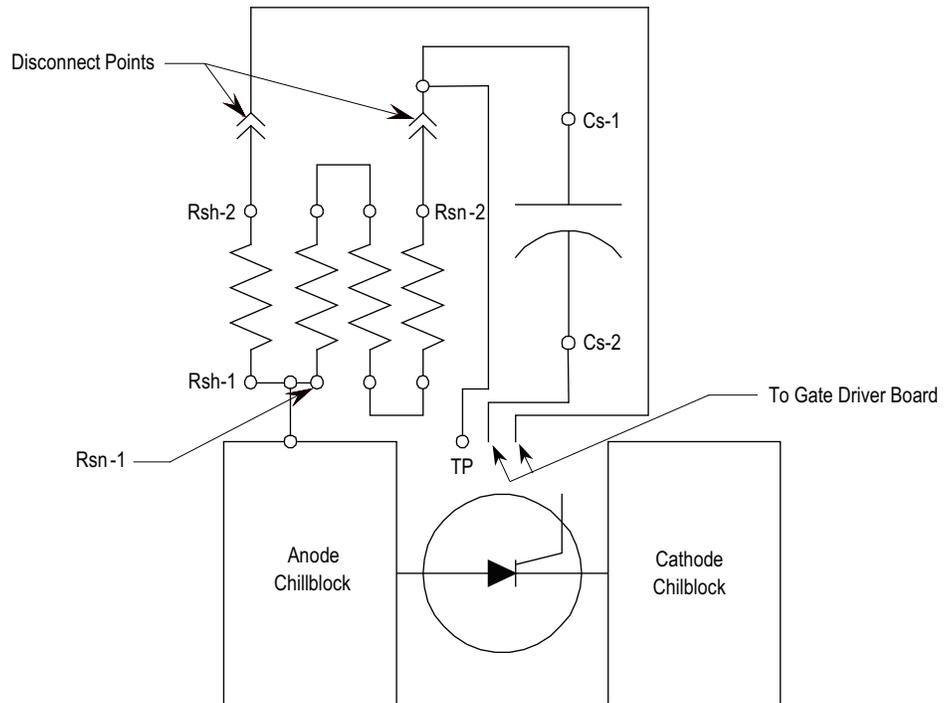
To determine the sharing resistor value, simply measure the resistance between the anode and cathode chill blocks. A value between 60 kΩ and 75 kΩ indicates a good sharing resistor.

**Figure 256 - SGCT Power Cage**



### SCR PowerCages

To obtain the sharing resistor value, disconnect the 2-pole plug of the self-powered gate driver board labeled SHARING and SNUBBER on the circuit board. The red wire of the plug is the sharing resistor. Measure the resistance between the red wire of the plug and the chill block to the left (the anode chill block). A value of approximately 80 kΩ indicates a healthy sharing resistor.

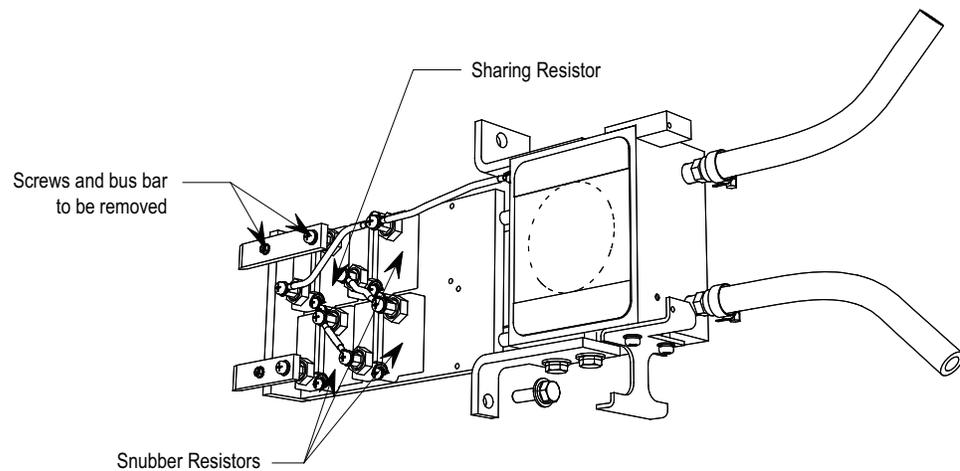
**Figure 257 - SCR PowerCage Snubber Circuit Connections**

## Snubber and Sharing Resistor Replacement

In the liquid cooled drive the sharing and snubber resistors can be replaced independently. The sharing resistor is located in the same spot on every chill block assembly, and the number of snubber resistors can vary with the drive rating. The snubber and sharing resistors are part of the chill block assembly. Servicing of resistors requires that the chill block be removed from the PowerCage. Refer to [Chill Block Removal and Replacement on page 303](#).

1. Remove the chill block outlined in [Chill Block Removal and Replacement on page 303](#).
2. Note all connections for correct replacement.
3. Remove the screws holding the bus bars to the resistor terminals. The position of the sharing resistor is common on all drive sizes. The number of snubber resistors varies with the size of drive and application. Shown below is a three-snubber resistor configuration. There can be up to 5 snubber resistors on each chill block.

Figure 258 - Snubber and Sharing Resistor Replacement



4. After removing the bus bars, unscrew the two screws holding each resistor in place. Measure each resistor on the assembly to verify which resistors are damaged.
5. Apply a thin layer of Electrical Joint Compound (Alcoa EJC No.2 or approved equivalent) to the contact faces of the new resistors to be installed. The recommended procedure is to apply the compound to the pole faces using a small brush and then gently wiping the pole face with an industrial wipe so that a thin film remains. Examine the pole face before proceeding to ensure that no brush bristles remain.
6. Install the new resistor(s) on the chill plate and replace the M4 mounting screws.
7. When all damaged snubber resistors have been replaced, re-assemble the bus bars with the original hardware.
8. Re-connect any leads that were removed.
9. Install the chill block assembly as described in [Chill Block Removal and Replacement on page 303](#). Readjust the clamping load as described in [Checking Clamping Pressure on page 292](#).
10. Verify the snubber and sharing resistances.

## Self-Powered Gate Driver Board – SPGDB

### Description

This board is used in drives where SCRs are used as the rectifying device on the input of the drive. The SCRs require a gating pulse in order to turn on, and this is achieved by using the SPGDB.

The SPGDB receives its command from the drive processor, via a light signal, which is transmitted through a fiber optic cable. The power source for the SPGDB is from the snubber network of the SCR, a patent pending design of Rockwell Automation. This unique design gives the SPGDB the ability to conserve the amount of energy that it supplies to the SCR. This reduces the amount of energy required by the drive to operate, thus making the drive more efficient.

Also, this board will determine the health of the SCR. It has the hardware necessary to diagnose the condition of the SCR. This status is relayed to the processor via a fail-safe light signal transmitted through a fiber optic cable.

### Board Calibration

No field calibration is required for this board.

### Test points description

**TP1** – SCR gate output (attach oscilloscope between TP1 and TP2 to see gating pulses).

**TP2** – SCR cathode output.

**TP3** – Common reference point for all other test point measurements, except for TP1, which uses TP2 as its reference point.

**TP4** – The positive 20 V rail used for the SPGDB operation.

**TP5** – The positive 5 V rail used for the SPGDB operation.

**TP6** – The sense voltage taken from the sense resistor across the SCR being controlled.

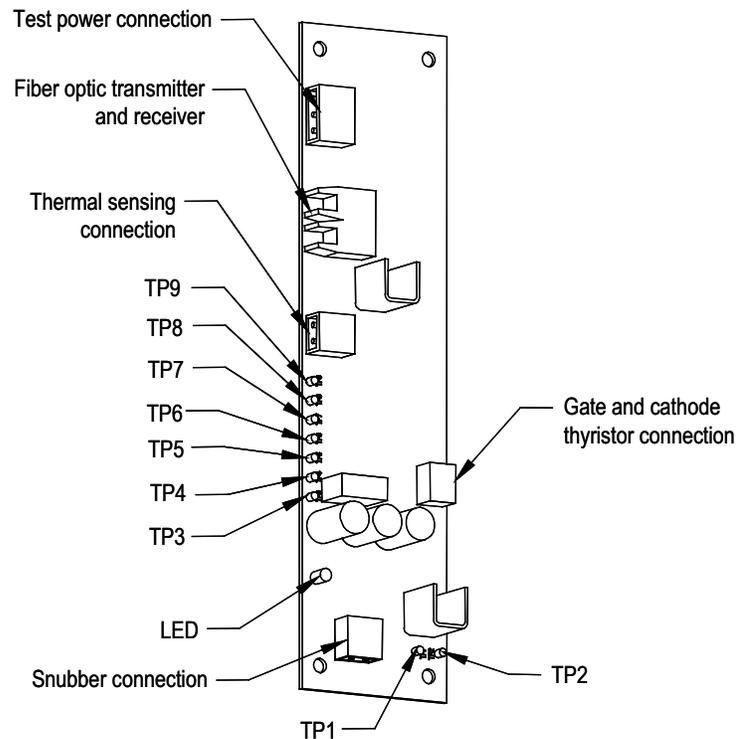
**TP7** – Trigger signal, which remains active for a fixed period of time after the SCR being controlled, has turned on and the voltage across it has collapsed.

**TP8** – Internal gating signal that indirectly turns on the SCR that is being controlled.

**TP9** – Gating signal received from the commanding drive control board, through the appropriate fiber optic cable.

The yellow LED (LED 1) on the SGPDB indicates that the SCR being controlled has a gating current flowing which is used to turn the SCR on.

**Figure 259 - Self-Powered Gate Driver Board**



### Terminal/connections description

**TB1-1** – Connection to SCR snubber circuit used to extract energy from the snubber for SPGDB operation

**TB1-2** – Connection to SCR sensing resistor which indicates conduction status of SCR being operated

**TB2-1** – Positive 20V power supply connection to temperature sensor board. Provides power to temperature sensor board.

**TB2-2** – Common connection of positive 20V power supply to temperature sensor board

**TB3-1** – Positive 15V power supply connection for test power used when commissioning drive or testing SPGDB

**TB3-2** – Provides artificial sense voltage signal to allow SPGDB to gate the SCR when in test mode. When the appropriate test power cable is used, P/N 81001-262-51, this input is shorted to TB3-1 to obtain the sense voltage.

**TB3-3** – Common connection of positive 15V power supply used for test power

**TB4-2** – Cathode connection to SCR being controlled

**TB4-1** – Gate connection to SCR being controlled

**OP1** – Blue fiber optic cable receptacle – Firing pulse command from the processor

**OT1** – Grey fiber optic cable receptacle – Diagnostic status of the SCR

## Testing procedure for SCR self-powered gate driver board

### Equipment needed:

- Digital oscilloscope
- Function generator w/duty cycle control
- DC power supply (+15V @ 300 mA required)
- Digital multimeter
- Temperature sensor board (80190-639-02)

### Procedure:

1. Connect a clamped ABB #5STP03D6500 SCR to the gate-cathode leads of the SPGDB board (TB4-1/TB4-2).
2. Attach a temperature sensor board to the TB2-1/TB2-2 terminals.
3. Apply +15V test power to terminals TB3-1 and TB3-3 (TB3-1 is at +15V while TB3-3 is the +15V return). Leave TB3-2 open.
4. Measure TP4 to TP3, which should be +14.4V,  $\pm 100\text{mV}$ .
5. Measure TP5 to TP3, which should be +5.0V,  $\pm 250\text{mV}$ .
6. Measure TB2-1 to TB2-2, which should be +14.4V,  $\pm 100\text{mV}$ .
7. Measure the voltage at U4-pin2 to COM, which should be +1.0V,  $\pm 100\text{mV}$ .
8. Measure the voltage at U4-pin3 to COM, which should be 0V.
9. Measure the voltage at U4-pin7 to COM, which should be +3.6V,  $\pm 100\text{mV}$ .
10. Verify that the OT1 LED is off.
11. Measure TP7 to TP3, which should be 0V.
12. Measure TP9 to TP3, which should be +5.0V,  $\pm 250\text{mV}$ .
13. Measure TP8 to TP3, which should be 0V.
14. Measure TP1 to TP2, which should be 0V.
15. Connect a jumper between TB3-1 and TB3-2 and verify that the voltage at TP6 is +2.2V,  $\pm 100\text{mV}$ .

16. Apply a 60Hz, 33% duty cycle signal to the OP1 fiber optic input.
17. Verify that the diagnostics transmitter LED, OT1, is on.
18. Verify that the signals at TP9 and TP8 are as shown in [Figure 260](#).
19. Verify that the signal between TP1 and TP2 is as shown in [Figure 261](#) and [Figure 262](#).
20. Remove the jumper between TB3-1 and TB3-2.
21. Apply a constant fiber optic signal to the OP1 input.
22. Apply a 60 Hz, 33% duty cycle signal, at a 0 to +2V level, between the TB1-2 input and COM. Verify the signals in [Figure 263](#) and [Figure 264](#). Note that in [Figure 264](#) there should be a  $220 \mu\text{s}$ ,  $\pm 20 \mu\text{s}$  time between the rising edge of the U4-pin7 pulse and the falling edge of the TP7 signal.

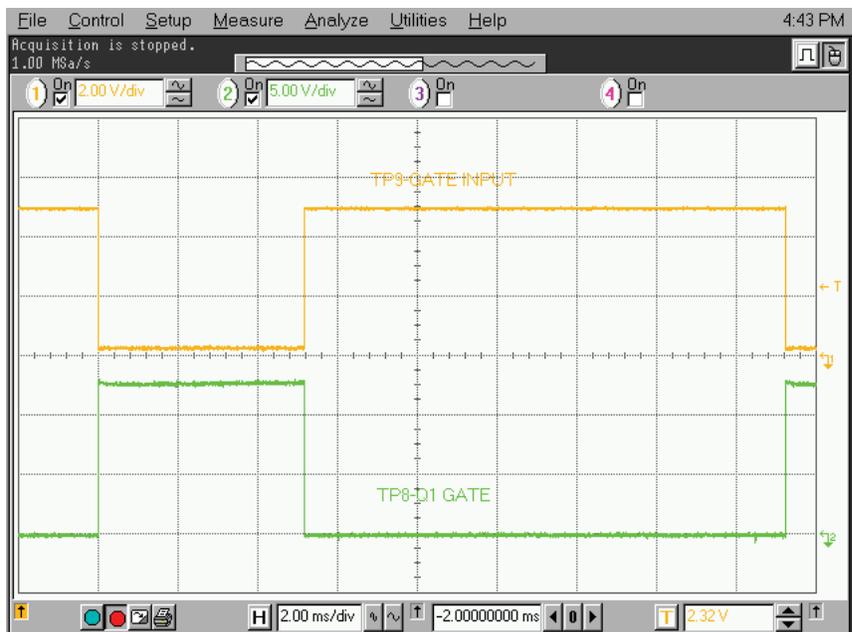
**Figure 260 - Gating pulses**

Figure 261 - SCR gating pulse

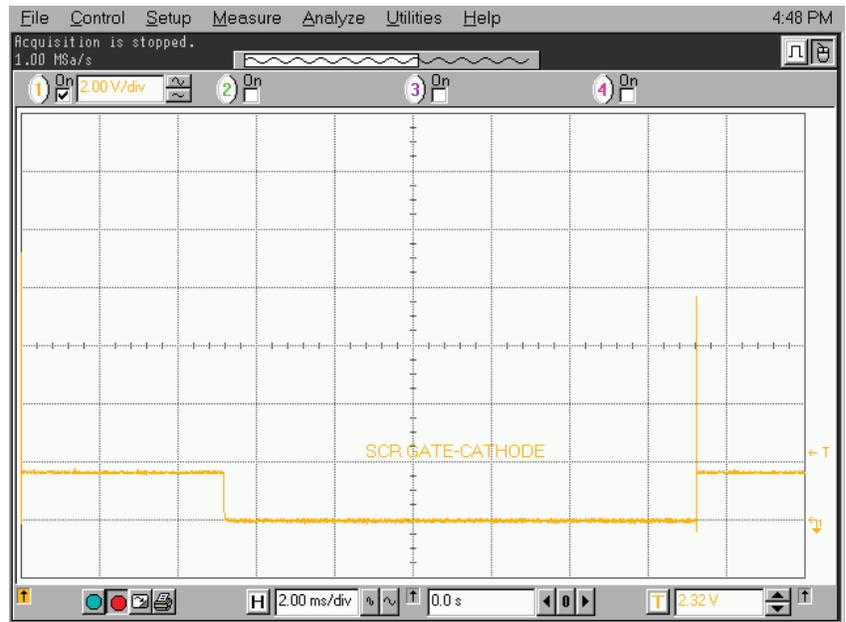


Figure 262 - Expanded SCR gating pulse



Figure 263 - V Sense Trigger to SCR gating pulse

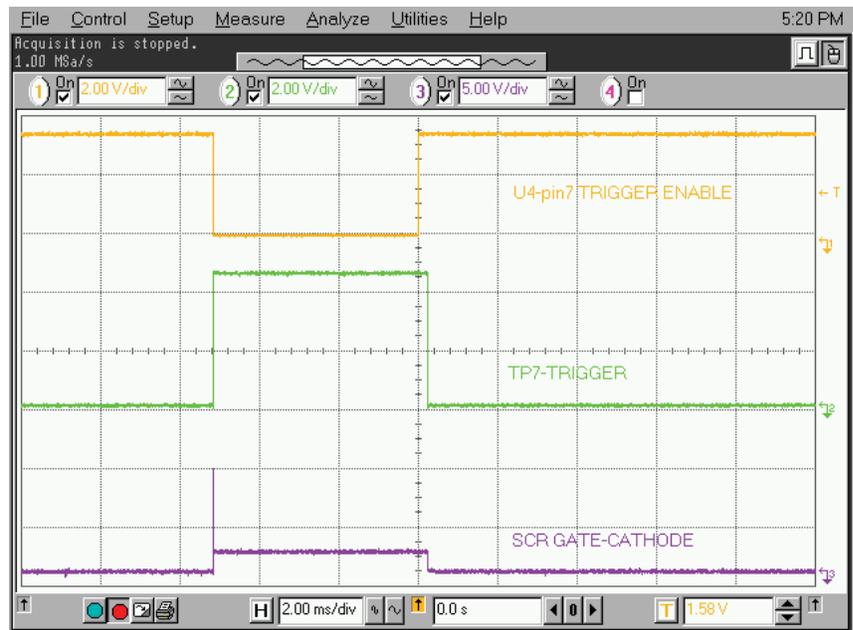
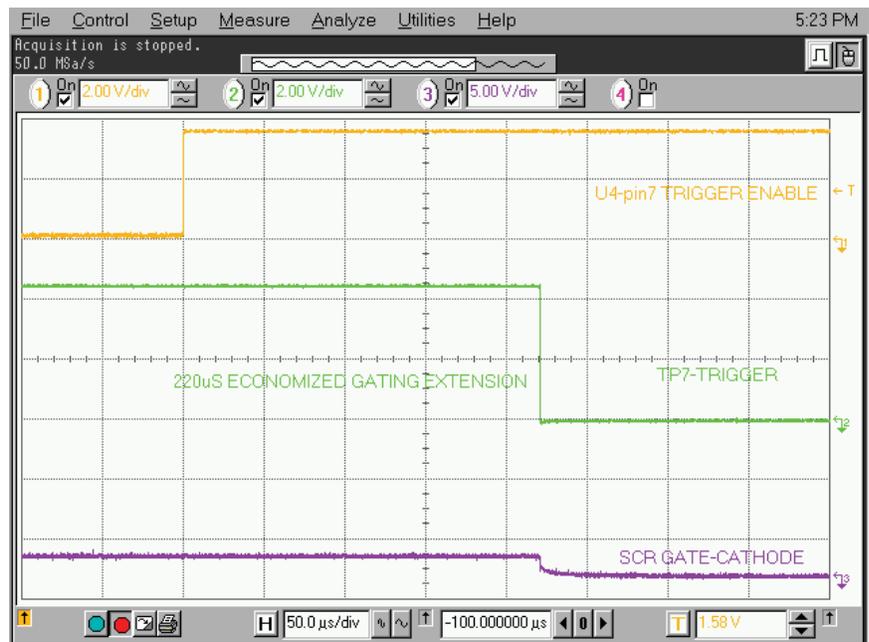


Figure 264 - Expansion of V Sense Trigger to SCR gating pulse



## Fiber Optic Cabling

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

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

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

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

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

Lengths of fiber optic cables used in the product include:

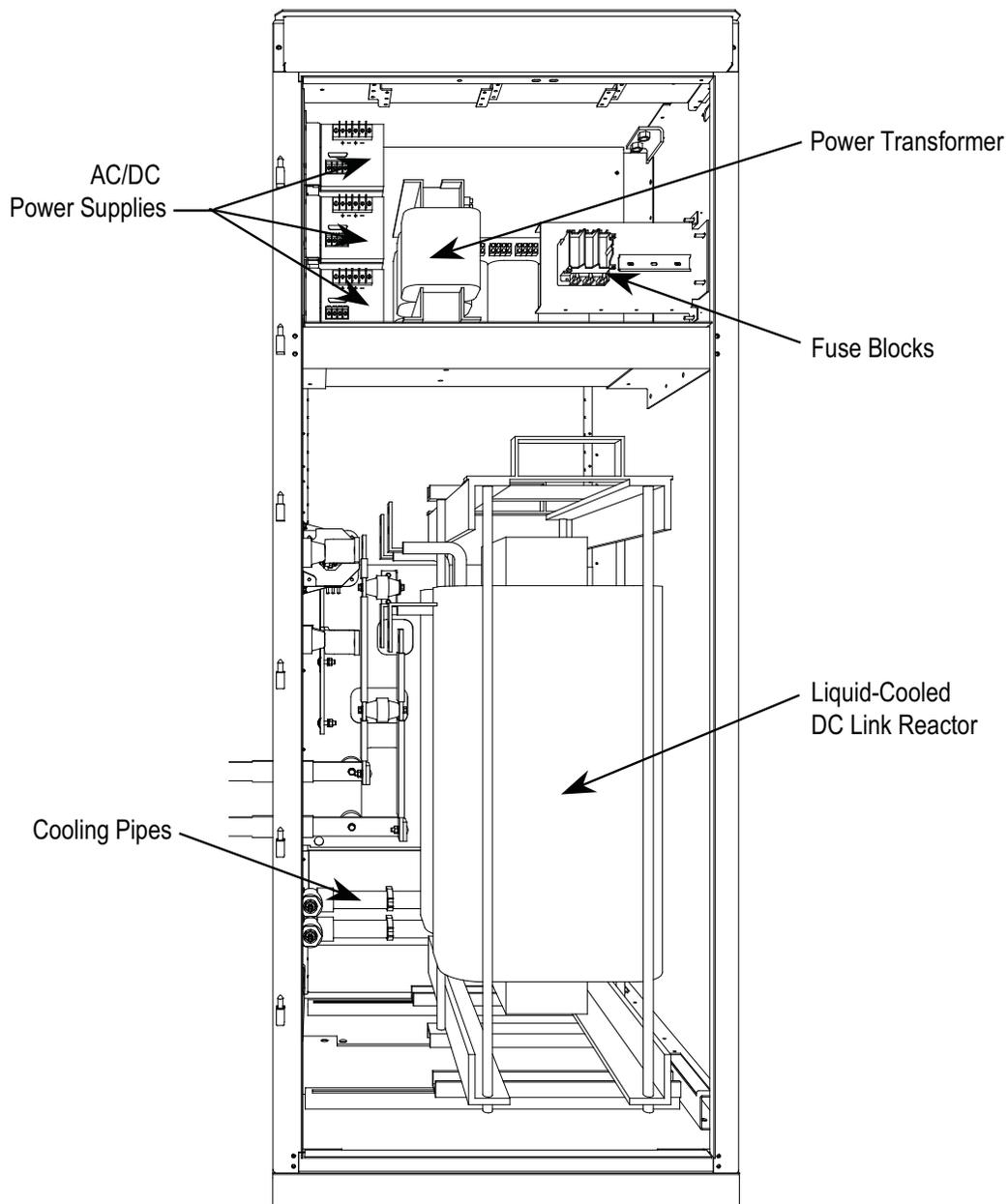
<b>Duplex</b>	<b>Simplex</b>
5.0 meter	5.0 meter
5.5 meter	6.0 meter
6.0 meter	10.0 meter
6.5 meter	
7.0 meter	

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

The color codes of the connectors are:

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

Figure 265 - DC Link and Control Power Cabinet



The door of the Control Power Panel is interlocked so that it cannot be opened unless the 3-phase control power is disconnected. When the door is opened, the AC Control Power transformer and the AC/DC power supplies are accessible. This is the section where the customer 3-phase power is brought into the drive.

The DC Link is mounted on the floor beneath the control power section. The larger door is interlocked with the rest of the system and cannot be opened unless the MV power is locked-out. The DC Link is part of the cooling circuit for the PowerFlex 7000L “C” Frame drive, and has 2 inlets and 2 outlets for coolant flow.

Power Connections are made to the DC Link through flexible leads, and they are labeled L+, L-, M+, and M-. There is a Hall Effect current sensor on the M+ connection to the DC Link.

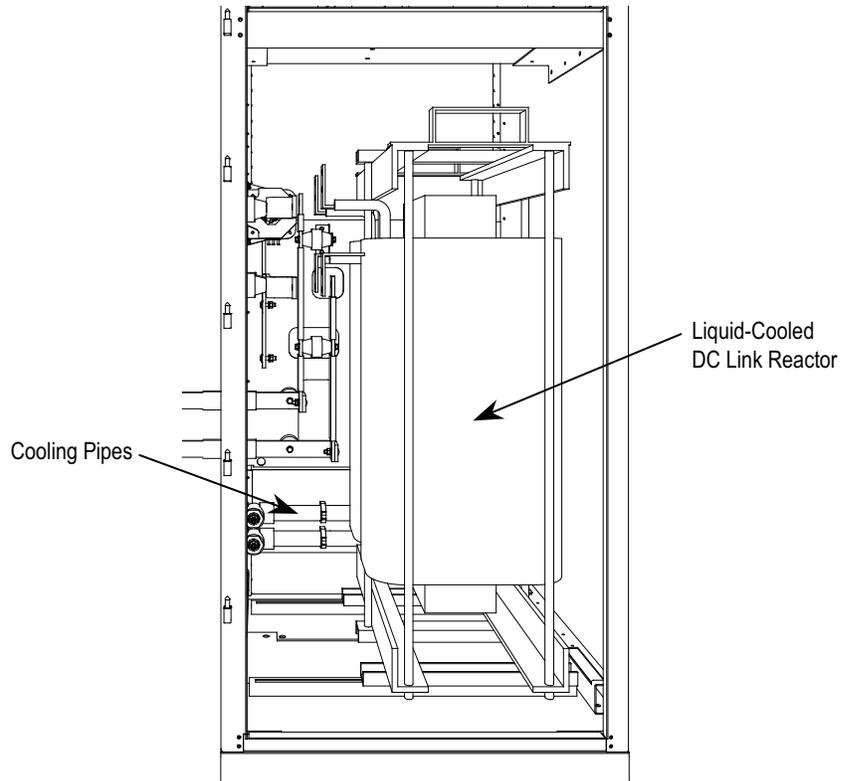
## **DC Link Reactor**

The DC Link maintains a ripple-free current between the rectifier and the inverter. Thermal levels in the DC Link are achieved through cooling water.

The DC Link Reactor does not normally require service. To replace the DC Link, refer to [Figure 266](#) and complete the following steps.

1. Ensure the MV source power to the drive is locked out.
2. Drain the coolant from the drive system.
3. Lock out the control power.
4. Access the DC Link cabinet and remove the cooling connections to the DC Link.
5. Disconnect the 4 power connections to the DC Link. Remember to note the location for each of the cables on the DC Link.
6. Remove the hardware that secures the DC Link to the ground channels.
7. Remove the DC Link frame ground connection.
8. Using a lift truck, remove the DC Link from the cabinet.
9. Install the replacement in the reverse order.

Figure 266 - DC Link Reactor



The installer needs to verify that the DC Link power connectors go to the proper locations. You must also ensure that they are routed the same way so that electrical clearances are not compromised.

The nameplate data must be compared to the old DC Link to ensure that the ratings are appropriate for the drive system. Any changes in the nameplate should be noted since the parameters within the drive will need to be changed.

## Control Power Components

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

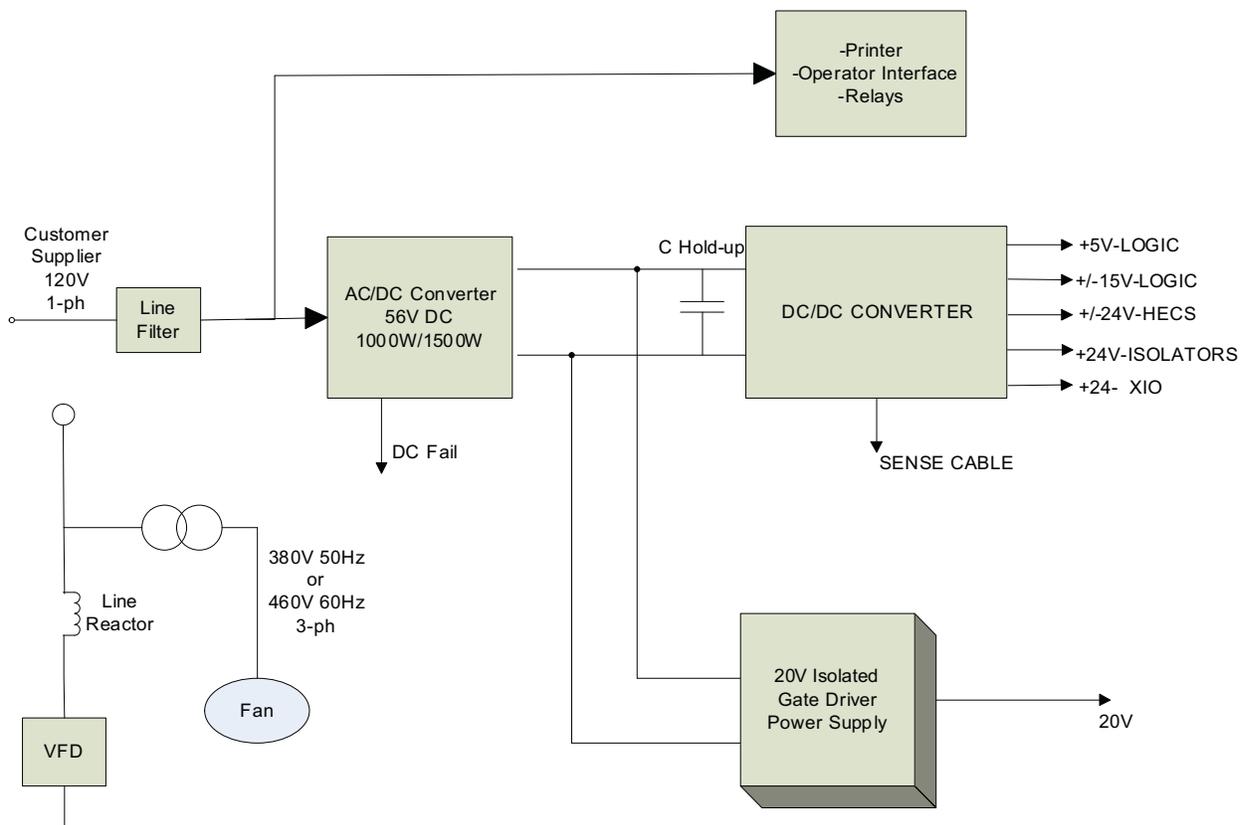
1. Line Reactor Drive (refer to [Figure 267](#))
2. Remote Transformer and Starter (refer to [Figure 268](#))

## Ride-Through

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

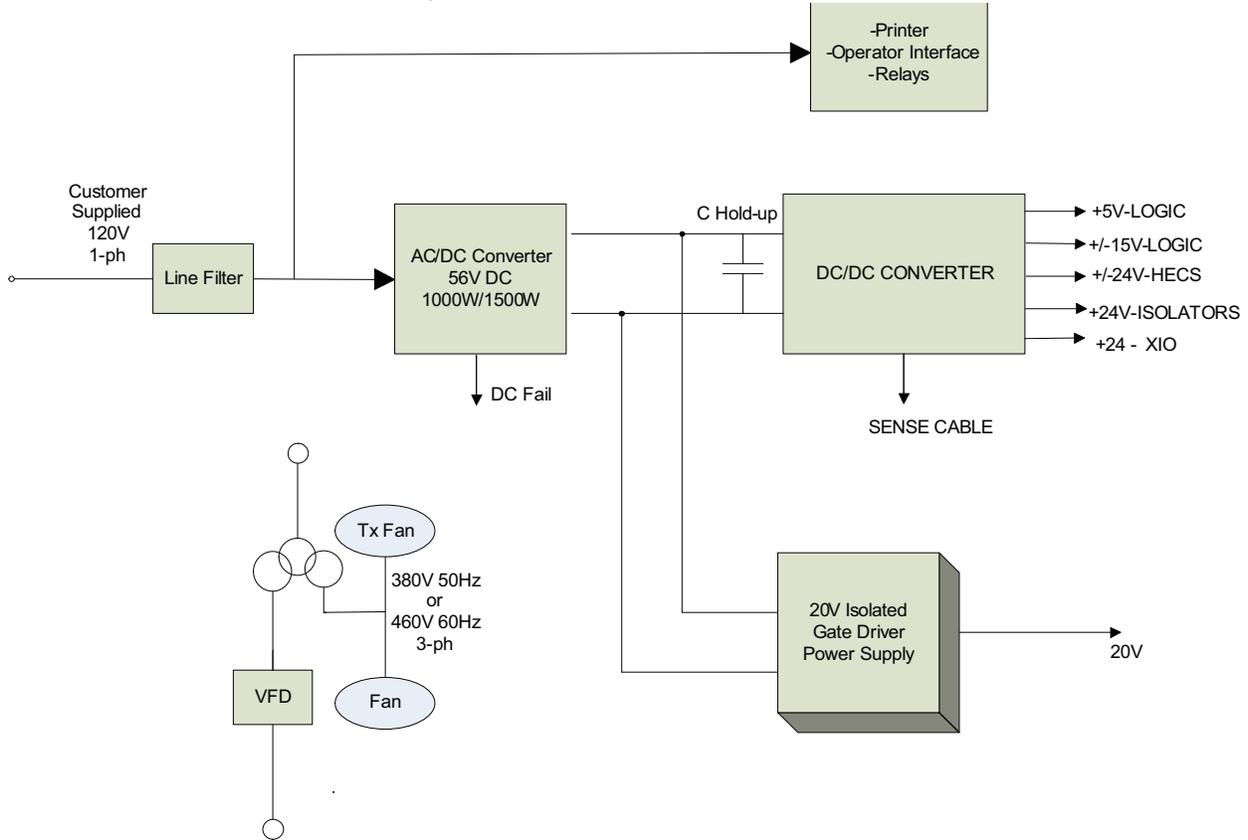
[Figure 267](#) illustrates the control power distribution for 6-pulse and PWM drives with integral starter/line reactor.

**Figure 267 - AFE Line Reactor Drives**



[Figure 268](#) illustrates the control power distribution for 6-pulse and AFE drives with remote transformer/starter or integrated line reactor with remote starter.

Figure 268 - 6-pulse / AFE Remote Transformer / Starter



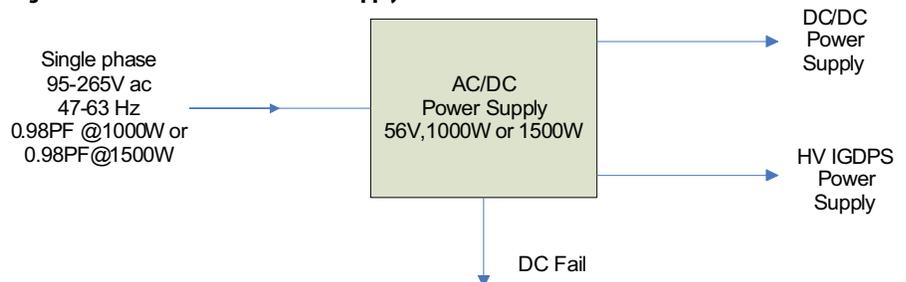
## AC/DC Power Supply

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

### Description

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

Figure 269 - AC/DC Converter Power Supply

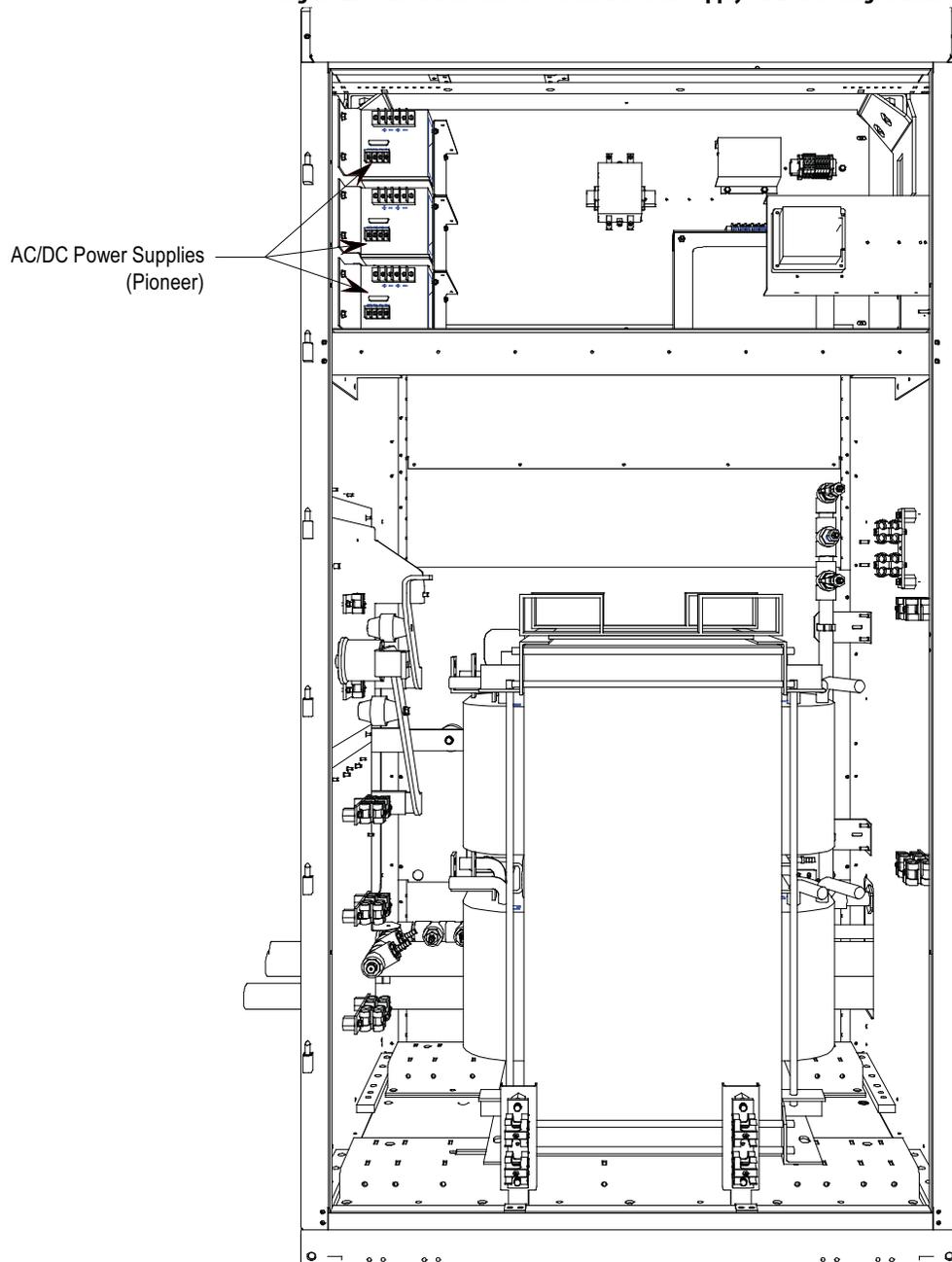


**DC FAIL:**

Upon loss of DC output ( $V$  outputs  $\leq 49$  VDC) this output goes from low to high.

**Location**

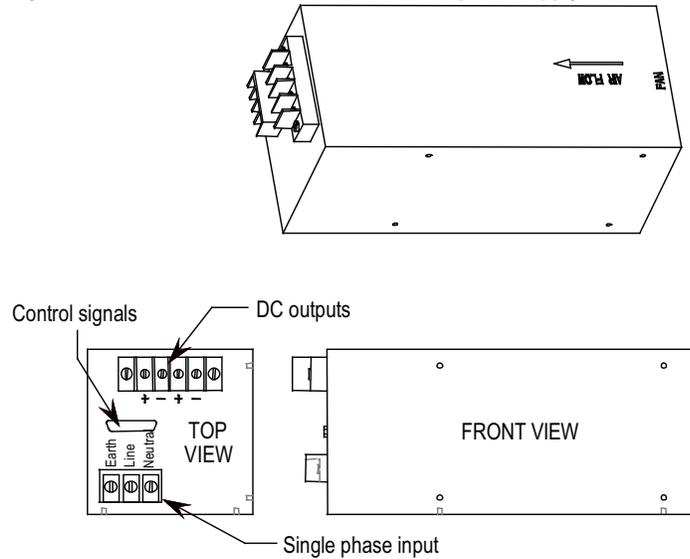
The AC/DC power supply is located in the low voltage panel in the far right-hand section of the drive. A typical low voltage compartment is shown in [Figure 270](#).

**Figure 270 - Location of AC/DC Pioneer Power Supply on Low Voltage Panel**

## Terminal / Connections Descriptions

The terminal connections are shown in [Figure 271](#).

**Figure 271 - Terminal locations on AC/DC Pioneer power supply**



<b>P1-AC input</b>	<b>PIN#</b>	<b>LABEL</b>
	1	EARTH
	2	LINE
	3	NEUTRAL
<b>P2-DC output</b>	<b>PIN#</b>	<b>LABEL</b>
	1	+56V
	2	+56V COMM
	3	+56V
	4	+56V COMM
<b>P3-FAIL output</b>	<b>PIN#</b>	<b>LABEL</b>
	3	DC POWER FAIL (OUTPUT POWER GOOD)
	15	CURRENT SHARING
	14	DC POWER FAIL COMMON

Ensure the output of the supply is 56V DC.

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

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

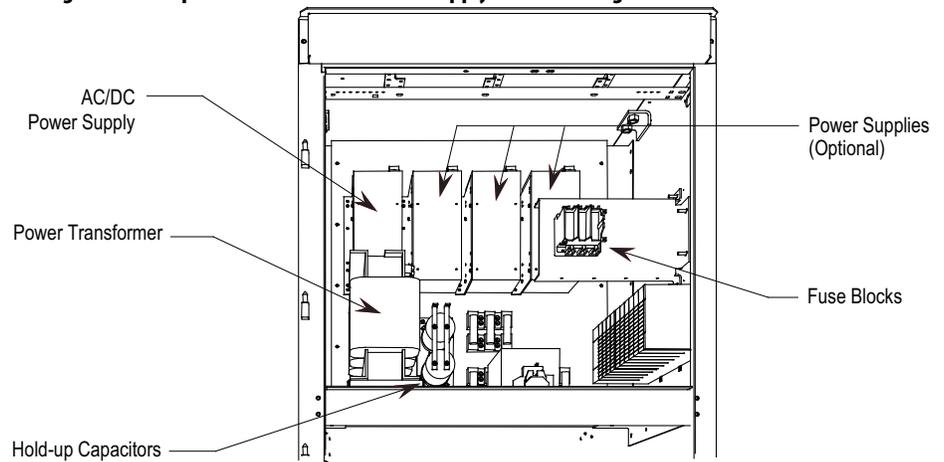
## Replacement Procedure

1. Ensure control power has been isolated and locked out.
2. Disconnect the terminals at the unit.
3. Remove the two M6 bolts per [Figure 272](#).
4. Extract the power supply complete with bracket from the drive.
5. Remove the bracket from the failed power supply (four M4 screws and nylon shoulder washers).
6. Attach bracket to replacement power supply.

**TIP** Make sure the Black Insulation is between the AC/DC power supply and the mounting plate.

7. Repeat Steps 5, 4, 3, 2 and 1 in this order to replace the unit (see [Figure 272](#)).
8. Reapply control power and verify voltage levels.

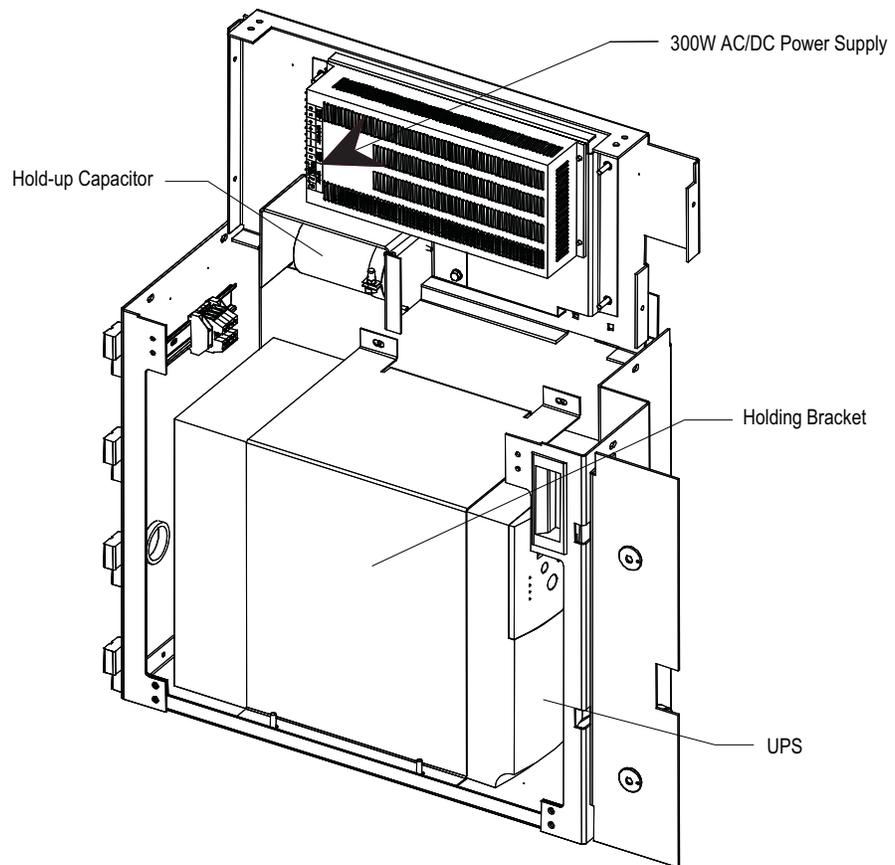
**Figure 272 - Replacement of AC/DC Power Supply on Low Voltage Panel**



## UPS Option

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

**Figure 273 - 300W AC/DC Power Supply**



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

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

The UPS is configured for the AS400 communication protocol, and has several status signals that are fed back to the Customer Interface Board to allow the control to respond to various conditions including low batteries, loss of input power, UPS on bypass, etc.

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

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

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

## **UPS Replacement Procedure**

1. Ensure Control Power has been isolated and locked-out.
2. Remove the hardware that fastens the holding bracket to the cabinet assembly and remove the holding bracket.
3. Disconnect the input and output wiring connected to and from the UPS.
4. Disconnect the 15-pin status plug from the UPS.
5. Remove the UPS, and install the new UPS.
6. Reconnect all the connections removed in the previous steps.
7. Before reconnecting the mounting bracket, apply control power to the unit and ensure the UPS is programmed for AS400 communication protocol. Refer to the manual that comes with the UPS for instructions.
8. Once this has been confirmed, install the mounting bracket.



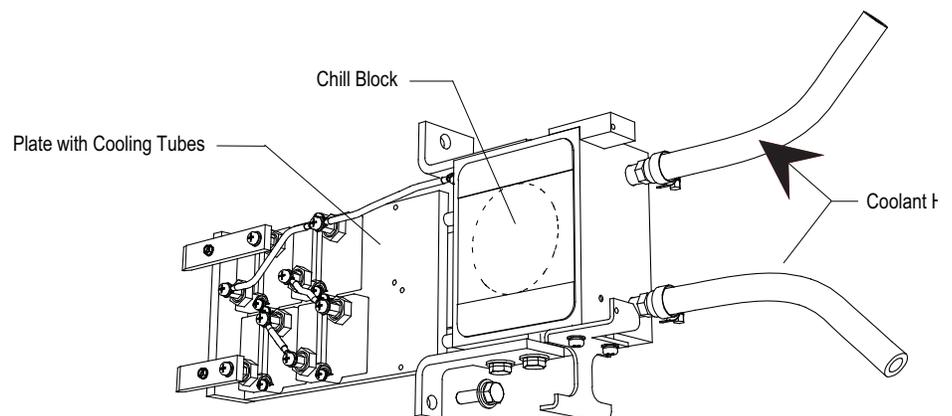
## Cooling Circuit

This circuit is required to cool such devices as Silicon Controlled Rectifier (SCR), Symmetrical Gate Commutated Thyristor (SGCT), snubber resistors and sharing resistors. The SCRs and SGCTs are positioned between two chill blocks in an alternating fashion to create a horizontal stack. The sharing and snubber resistors are mounted on a plate with cooling tubes embedded within. As cool liquid flows through the cooling tubes the entire plate is cooled, which in turn cools the resistors.

## Chill Blocks

The chill blocks are constructed of highly conductive copper machined parts that are silver soldered together. The parts are machined to a fine surface finish. The copper chill block provides good heat transfer from the electrical device to the chillblock. The coolant system is connected to each chill block with flexible 10 mm (3/8-in.) hose which fits onto stainless steel hose barbs which are part of the chill block assembly.

**Figure 275 - Chill Block Assembly**



## Coolant Pumps

Two pumps (P1 and P2) are used to move coolant through the system ([Figure 276](#)). One of the pumps is used as a backup. The control logic alternates the primary and secondary pump to ensure equal time of operation. Ensure that the pumps never run dry, as this will damage the pump seals. Ensure the pumps are not excessively noisy (pumping air pockets) when filling the system.

## Pump Maintenance and Replacement

### Pump Seal Replacement



**ATTENTION:** Do not run the pumpFs without coolant. Ensure coolant is present in the system. Damage to the pump seals may result.

Refer to pump nameplate for manufacturer's model information. Typical pump seal replacement information is provided at manufacturers websites.

**Figure 276 - Pump Cabinet**

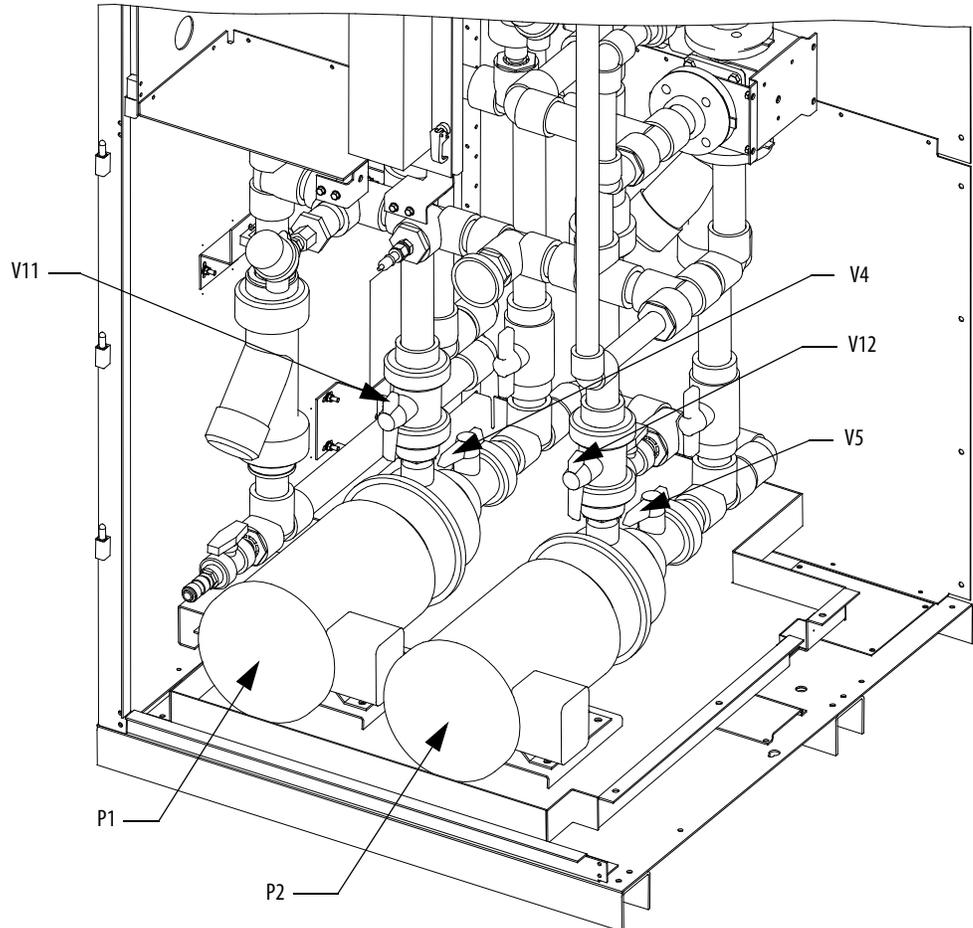
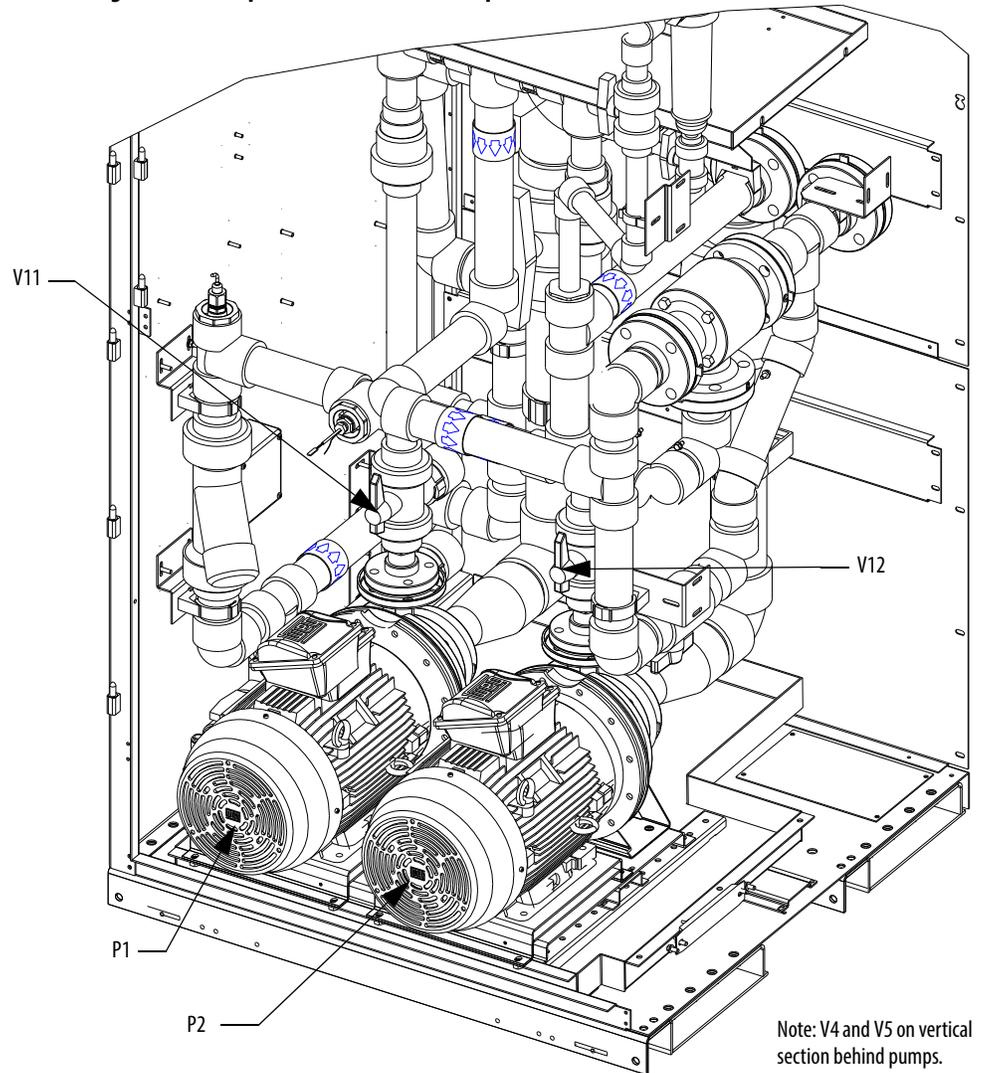


Figure 277 - Pump Cabinet with Ebara Pumps



### Pump Replacement with Drive Running

During drive operation, one of the pumps must be running. Two pumps run alternately switching from one pump to another after a preset time. This switching time is dependent on the Control Program setup. A pump may be replaced during drive operation by following the instruction sheet PowerFlex 7000C LIQUID COOLED SYSTEM OPERATION attached to the inside of the pump cabinet door.

### *Pump Removal*

1. Set pump selector switch located on pump cabinet door to the pump that must run to cool the drive.
2. Open V1 (if provided).
3. Close V4 and V11 if removing pump P1 or close V5 and V12 if removing pump P2.
4. Isolate power to the pump motor to ensure there is no voltage at pump motor leads.
5. Check voltages at terminal T1, T2, and T3 at pump to ensure there is no voltage.
6. Disconnect wires T1, T2 and T3 at pump.
7. Loosen true union connectors or flanges to disconnect pump from piping.
8. Unbolt pump from the foot plate and remove.
9. Repair pump as per manufacturers repair procedure supplied with the drive.

### *Pump Installation*

1. Isolate power to pump motor wires ensuring no voltage at pump motor leads.
2. Install pump and reattach wires to motor.
3. Open V1 (if provided).
4. Open V4 for pump P1 or V5 for pump P2.
5. To prime pump, carefully unscrew vent plug on top of pump casing. Close vent plus when coolant is seen.
6. Open V11 for Pump P1 or V12 for Pump P2.
7. Clear warnings in drive.
8. Jog pump by manually closing repaired pump contactor for 1 second. Ensure direction is clockwise when viewed from motor side of pump. Isolate power to motor and interchange two motor leads to reverse motor direction.
9. Operate pump for 5 seconds. Ensure pressure gauge shows an increase of pressure with two pumps operating.
10. Place pump selector switch to Auto.

## Piping, Tubing and Connectors

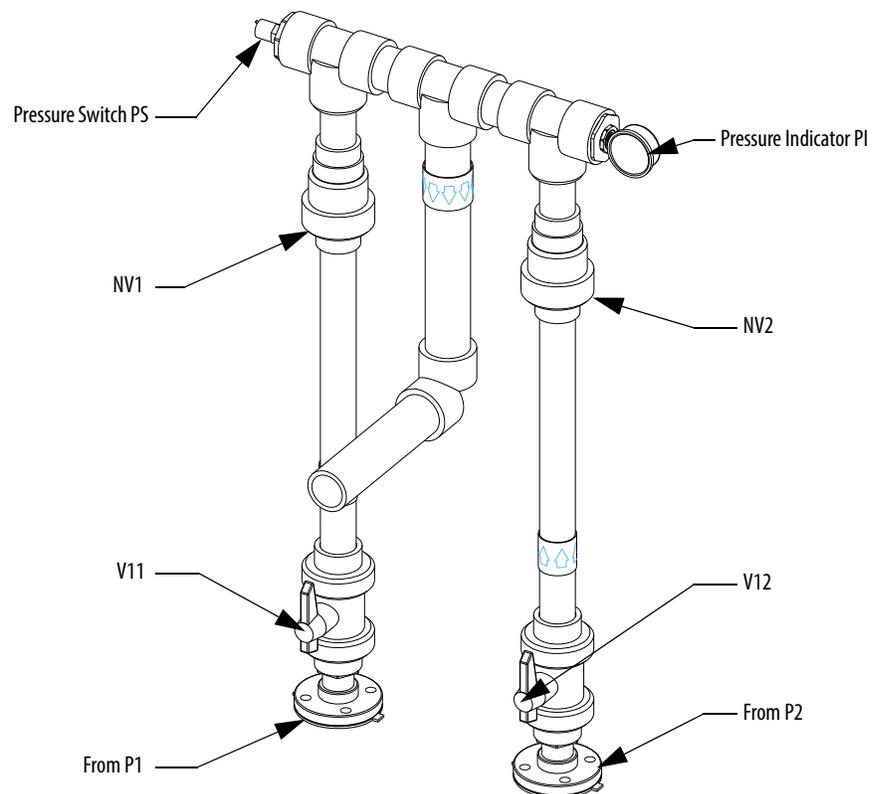
The piping is schedule 80 made from chlorinated polyvinyl chloride (CPVC) which has good high and low temperature properties and is unaffected by de-ionized water or ethylene glycol. The main piping is either 1.5 inch (38 mm) or 2.0 inch (50 mm) diameter.

The coolant hose connecting chill blocks to manifolds and Common Mode Chokes or DC Links to piping is made of 10 mm (3/8") EPDM. The hose is pushed onto hose barbs of stainless steel or CPVC. Hose clamps are used at the hose barbs.

## Non-Return Valves

The non-return valves (NV1 & NV2) shown in [Figure 278](#) are ball-type valves made from CPVC. These can not be changed with the drive on-line. All coolant must be drained to replace these parts.

**Figure 278 - Pressure Indicator and Switch Locations**



## Pressure Indicator

The pressure indicator (PI) shown in [Figure 278](#) indicates the discharge pressure of the pumps. Refer to Piping diagram supplied for the expected pressure value. Diagram is pasted in the pump cabinet.

## Pressure Switch

The pressure switch (PS) shown in [Figure 278](#) detects the drop in pressure if a pump fails or if there is a major pipe break. When low pressure is detected, the backup pump will start, but if the pressure does not reach operating levels within a set period of time, the drive will shut down.

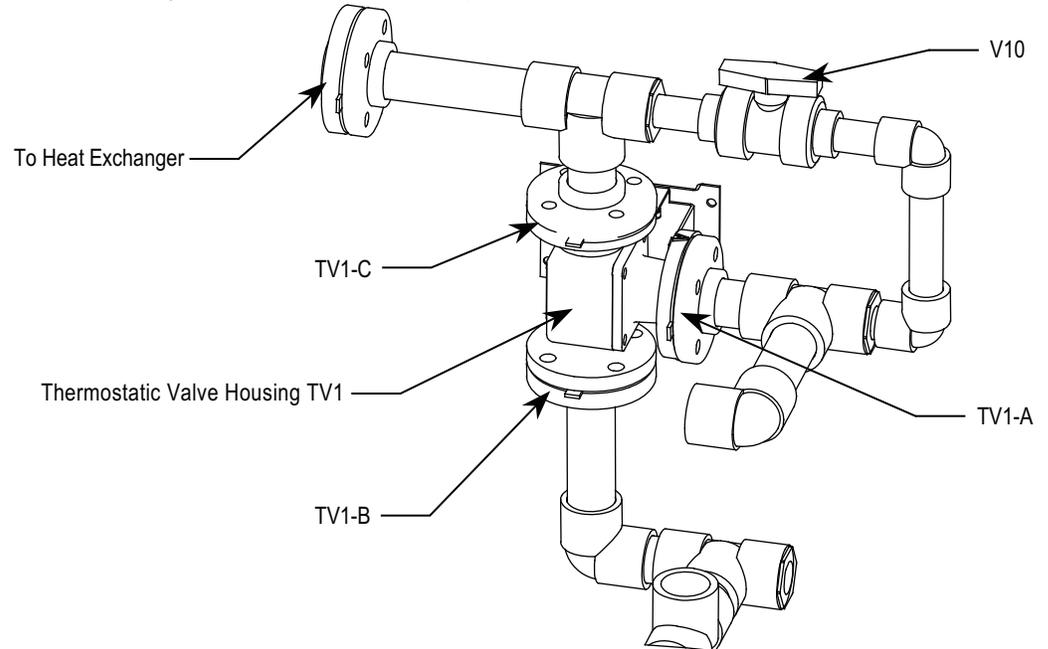
## Thermostatic Valve

The thermostatic valve (TV1) is similar to an automobile thermostat. When the fluid is cool, the valve bypasses the flow away from the heat exchanger to recirculate within the drive. As the fluid increases in temperature, the valve gradually opens, letting a trickle of fluid flow through the heat exchanger. The thermostatic element is set to begin opening at 29°C (85°F) and is fully open at 38°C (100°F). All flow then travels to the heat exchanger. The thermostatic valve keeps the semiconductor devices from getting too cold, and it keeps the near room temperature to prevent condensation.

## Thermostatic Valve Replacement

Drive must be shut down while replacing the thermostatic valve.

1. Open valve 10 and drain all coolant before replacing the thermostatic valve.
2. Note three flanges A, B and C on thermostatic valve. If you cannot see the marks A, B and C on thermostatic valve, you should mark three flanges. This is very important to put the thermostatic valve in correct position. The mark C flange will be in upper direction, and mark B flange will be in the bottom direction.
3. First unbolt flange A and B. Unbolt flange C, which is in upper direction, at the end.

**Figure 279 - Thermostatic Valve Replacement**

## Repair Instructions - Element Testing

Place element in water at a temperature  $8\text{ }^{\circ}\text{C} \dots 1\text{ }^{\circ}\text{C}$  ( $15\text{ }^{\circ}\text{F} \dots 2\text{ }^{\circ}\text{F}$ ) above its nominal setting and stir water vigorously with the element for five minutes. The temperature stamped on the side of the element is not the nominal temperature; it is the temperature at which the element is set to open. The stamped temperature is usually  $6\text{ }^{\circ}\text{C} \dots 8\text{ }^{\circ}\text{C}$  ( $10\text{ }^{\circ}\text{F} \dots 15\text{ }^{\circ}\text{F}$ ) higher than the nominal. After stirring vigorously, immediately place the element in the housing. If the element is fully stroked, the seating and over-travel spring can be felt as it is pushed down. To determine if the element will close at a specific temperature, place the element in a bath of water approximately  $3\text{ }^{\circ}\text{C}$  ( $5\text{ }^{\circ}\text{F}$ ) below the start to open temperature. This is the number stamped on the element. Due to the effect of hysteresis, the element will close  $3\text{ }^{\circ}\text{C}$  ( $5\text{ }^{\circ}\text{F}$ ) below the start to open temperature.

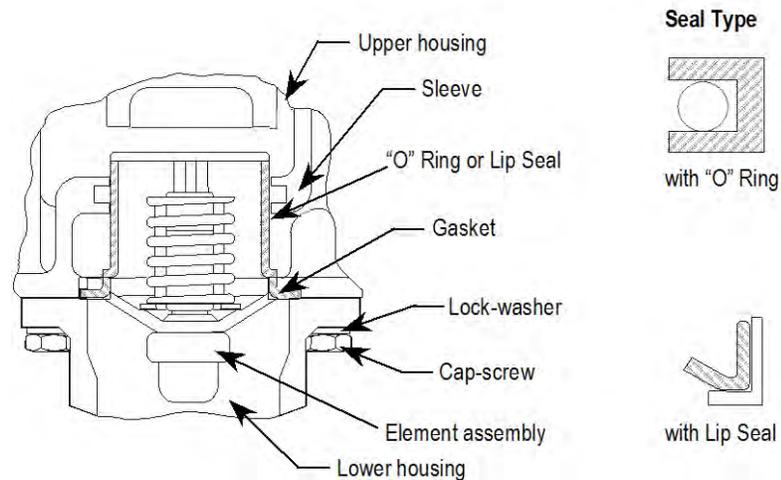
## Element Replacing

Refer to [Figure 280](#).

1. Remove four cap screws, lock-washers and separate upper housing and lower housing.
2. Remove element assembly and seal.
3. Remove housing gasket. Clean housing sections and remove any scale or foreign material from seal faces.
4. Lubricate the new element seal and slide it in place over top of the element assembly into position shown in section view.
5. Place new housing gasket in recess of upper housing.

6. Insert element into upper housing to position shown in section view.
7. Place lower housing over exposed section of element against face of upper housing.
8. Secure housings with cap screws and lock-washers.

**Figure 280 - Element Assembly Cross-Section**

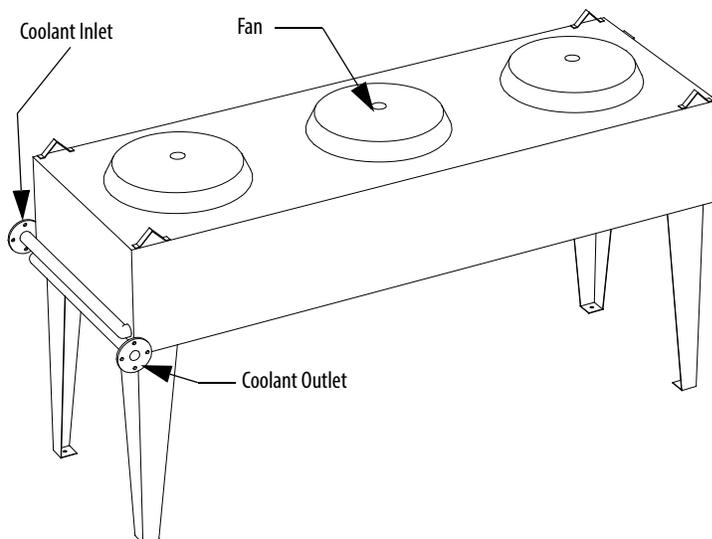


## Heat Exchanger

The heat exchanger (HTX1) is normally a liquid-to-air unit made of copper tubing and copper headers. There are primary and secondary fans to cool the unit. The fans are controlled by temperature sensor TS1 (shown in [Figure 282](#)). A stainless steel liquid-to-liquid plate type exchanger is also available.

If the temperature is less than 32 °C (90 °F), the fans will not run. The primary fan will start when the temperature reaches 38 °C (100 °F). The secondary fan will start when the temperature reaches 44 °C (110 °F).

**Figure 281 - Typical Liquid-to-Air Heat Exchanger**

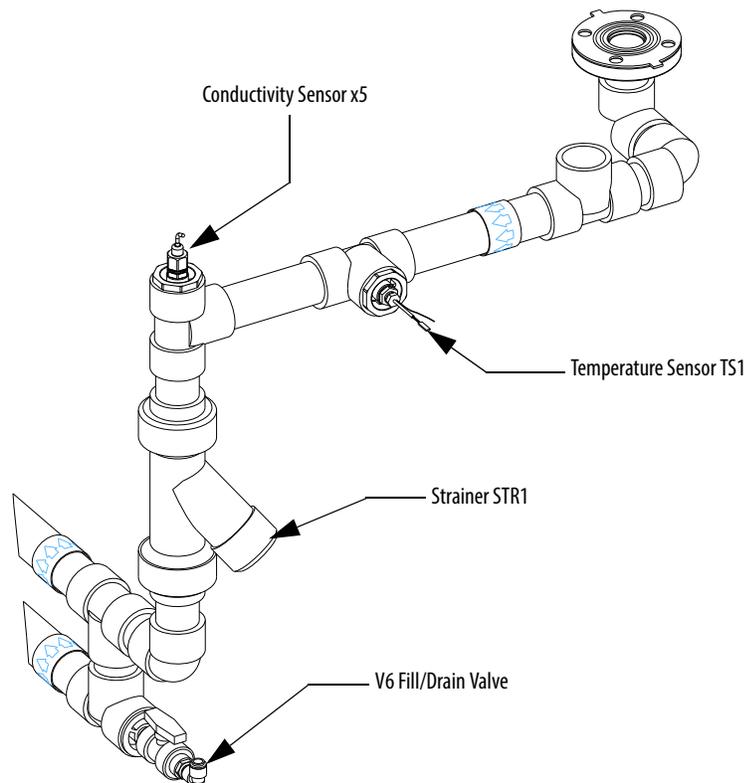


## Fluid Conductivity

An in-line conductivity sensor (XS) ([Figure 282](#)) measures the fluid conductivity. The sensor sends a signal to a meter mounted on the pump cabinet door. Two conductivity switches are part of the meter. They are set at conductivity of  $1 \mu\text{S}/\text{cm}^3$  for the annunciation warning and  $2 \mu\text{S}/\text{cm}^3$  for the trip value.

Change the deionization cartridge when the conductivity rises to the warning level.

**Figure 282 - Temperature and Conductivity Sensors**



## Temperature Sensor

This temperature sensor (TS1), shown in [Figure 282](#), triggers the drive to shut down when the fluid temperature entering the converter cabinet is too high. This situation could occur if the air cooling of the heat exchanger is cut off due to fan failure, plugging of the air paths, or failure of the thermostatic valve.

The following are the temperature values for alarm and trip signal:

1. When coolant temperature is greater than  $48 \text{ }^\circ\text{C}$  ( $120 \text{ }^\circ\text{F}$ ), an alarm signal is initiated. It can only be reset when temperature reaches  $38 \text{ }^\circ\text{C}$  ( $100 \text{ }^\circ\text{F}$ ).

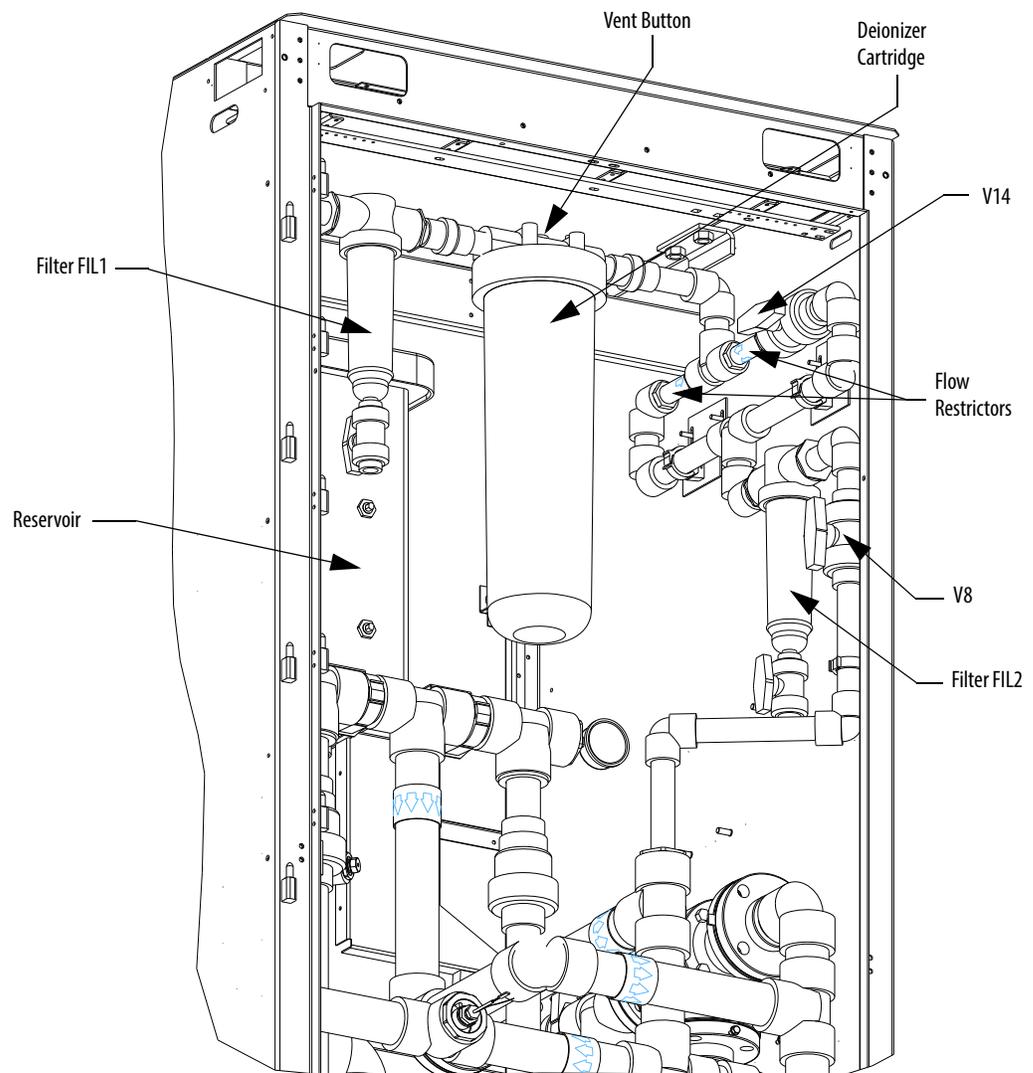
2. When coolant temperature is greater than 62 °C (144 °F), a trip signal is initiated. It can only be reset when the temperature reaches 48 °C (120 °F).
3. When coolant temperature is less than 4 °C (40 °F), a trip signal is initiated. It can only be reset when the temperature reaches 10 °C (50 °F).

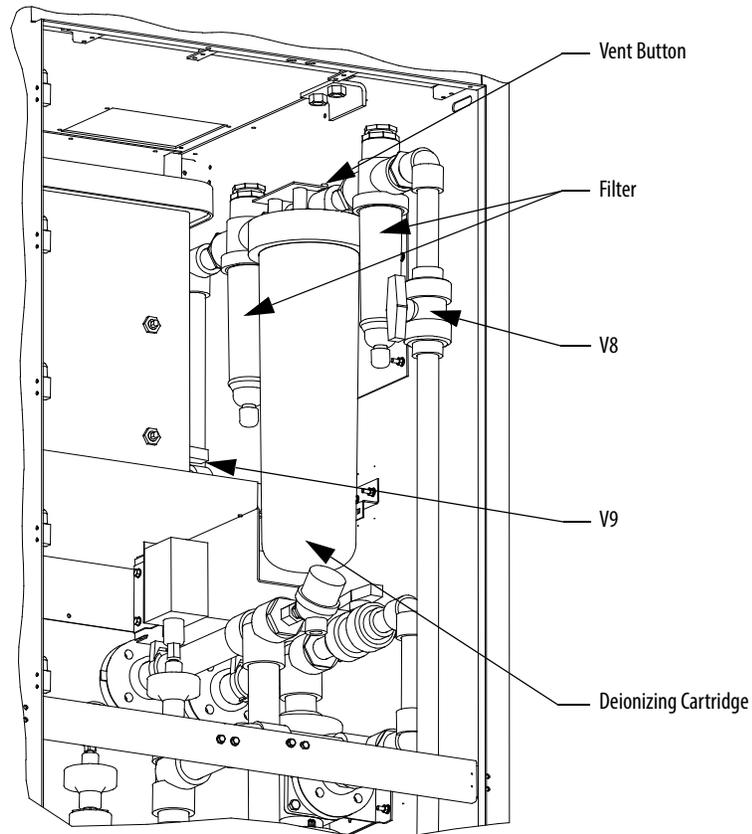
## De-ionizing Cartridge and Mesh Filter

The flow circuits shown in [Figure 283](#) filters and de-ionizes coolant at a rate of about 19 L/minute (5 gpm). Valve V14 may be closed only if the coolant mixture in the drive has a freeze temperature colder than -40 °C. This allows a decreased flow to 5.3 L/minute (1.4 gpm)

This stream can be isolated for cleaning and maintenance by closing the incoming valve V8. The filter is a 500-micron fine-mesh type, which can be cleaned many times by rinsing in clean water. The de-ionizing cartridge is a mixed-bed cartridge type, which can be disassembled easily for de-ionizing cartridge replacement.

**Figure 283 - Deionizer Reservoir Circuit**



**Figure 284 - Reservoir Circuit**

## Replacing the Mesh Filters

When the conductivity of the coolant approaches the alarm level of 1.0 microSiemen, a conductivity alarm and/or fault occurs. To correct the problem, first clean the fine mesh filters (see [Figure 283](#)) and put the purification system back online. The filters should be checked periodically and replaced when worn out. If the conductivity does not decrease after cleaning the filters, the de-ionization cartridge should be replaced. Note that if the filters are clogged, coolant conductivity will increase even if the de-ionization cartridge is still functioning properly. The filters and the de-ionization cartridge can be changed while the drive is running.

1. Close valves V8 and V9 (if provided) and unscrew the housing (see [Figure](#)).
2. Drain some of the coolant by loosening the drain at the base of the filter. Some spillage may occur so a pail should be placed underneath.
3. The filter may be cleaned or replaced, however the de-ionizing cartridge must be discarded and replaced with a new one.

**Do not recycle the resin cartridge. It has been contaminated with ethylene glycol.**

4. Open valves V8 and V9 (if provided) after cleaning. The high conductivity warning will stop once the conductivity decreases to its normal level.

## Reservoir Circuit

The reservoir is a cross-linked, polyethylene 57 L(15 gal) container. Level switch LS (see [Figure 283](#)) is a warning switch that annunciates when the fluid drops down below the first level switch.

Level switch LSDL (see [Figure 283](#)) triggers the drive and cooling pumps to shut down when the fluid drops below critical level.

## Fluid Top-up

Keep the coolant at the proper level in the reservoir. There are two float switches within the reservoir: one indicates a low coolant level (LS-alarm) and requires a top-up of the fluid, and the other indicates a very low coolant level (LSDL-trip) and triggers a shut down of the drive. De-ionized water and chloride-free ethylene glycol or a mixture of the two may be added to the reservoir. Use the 200 L(55 gal) barrel to mix coolant and/or to premix the de-ionized water and glycol. Check the freeze protection concentration with a glycol tester and add fluid accordingly. Add coolant by pouring it into the top of the reservoir.

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**IMPORTANT** Pour the coolant slowly into the reservoir to avoid disturbing the coolant level switches and causing a trip fault.

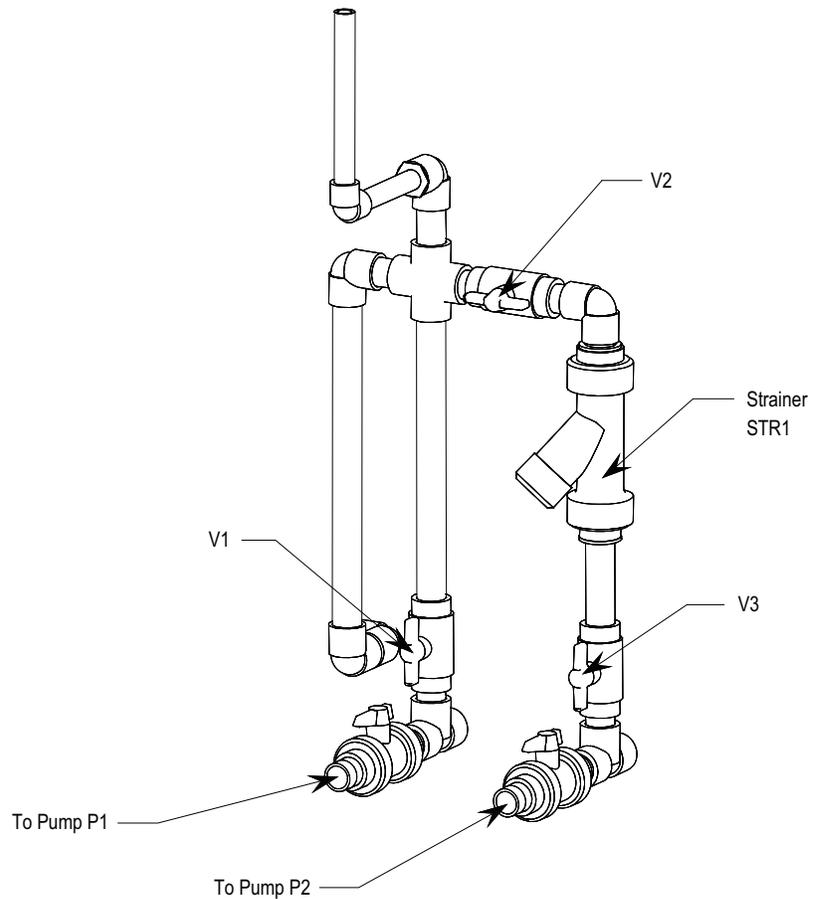
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## Strainers

### *Cleaning the Pump Suction Strainer (if provided)*

1. Open valve V1, shown in [Figure 285](#), to ensure flow to the pumps.
2. Close valve V2 and V3. Loosen strainer by hand. Clean it properly in water and dry it before putting it back.
3. Open V2 and V3 slowly to avoid a rush of air into the pumps. The air will gradually be purged from the system by flowing through the reservoir.
4. Close valve V1.

Figure 285 - Cleaning the Strainer



## Coolant

The cooling fluid is a mixture of de-ionized water and ethylene glycol. De-ionized water has been purified of most ionized solids and has very low conductivity. The ethylene glycol is an iron- and chloride-free type and also has low conductivity.

Water is an active solvent and gathers contaminants from everything it contacts. In nature, ionized solids such as Sodium ( $\text{Na}^+$ ), Calcium ( $\text{Ca}^{+2}$ ) and chloride ( $\text{Cl}^-$ ) are stripped from rocks and soil by water. Also found in water are organic molecules from decaying debris, bacteria and microbes that normally grow in water, and dissolved ionized gases such as chlorine ( $\text{Cl}_2$ ) and carbon dioxide ( $\text{CO}_2$ ).

Conductivity is primarily the result of ionized solids and gases in water. The other materials in water contribute very little to electric current flow. When a voltage is impressed on water, current flows by using the ionic molecules as stepping stones for the current. Most bacteria and organic materials offer few stepping stones for current, so if the ionized solids and gases are removed, the water becomes relatively non-conductive.

Dissolved ionized solids and gases can be removed by using ion exchange resins. Such resins attract ions in the water replacing them with  $H^+$  and  $OH^-$  ions, which ultimately join to form water. Ion exchange resins are synthetic polymers with several ion exchange sites attached to the surface. The ion exchange resins gradually lose their effectiveness and need to be replaced or recharged.

**TIP** Do not recycle the de-ionizing cartridge because it has been contaminated by ethylene glycol and would contaminate the recycling facility.

It is **imperative** that iron- and chloride-free ethylene glycol is used. This is pure ethylene glycol without corrosion inhibitors and other additives, which increase the conductivity of the coolant. In addition, de-ionized water may be added to the system for top up. Distilled water can only be used when no de-ionized water is available, and when it is necessary to run the drive on line. Using distilled water will significantly reduce the life of the ion exchange resin, and also reduce the life of mesh filters.

## Maintaining Coolant Ratio

Mixing pure ethylene glycol and de-ionized water produces the coolant used as the cooling medium in the liquid-cooled PowerFlex 7000L Medium Voltage “C” Frame drive. During operation, the concentration of pure ethylene glycol and de-ionized water may change due to fluid leakage or evaporation; therefore, the freezing point of the coolant may not be correct. The following instruction detail the steps required to record and correct the freezing point of the coolant mixture.

Required items:

- Glycol and battery tester (Part No. 80025-862-01)
- De-ionized water, 19 L (5 gal) container (Part # 80025-784-60)
- Pure ethylene glycol, 19 L(5 gal) container (Part # 80025-784-61)

1. Measure and record the reservoir coolant freeze point using the Glycol and Battery Tester.
2. If the freezing point of the coolant is at  $-45^{\circ}\text{C}$  ( $-50^{\circ}\text{F}$ )  $\pm 2^{\circ}\text{C}$ , correction is not required.
3. If correction is required, then follow the remaining steps.
4. Water freezes at  $0^{\circ}\text{C}$  ( $32^{\circ}\text{F}$ ) and pure ethylene freezes at  $-13^{\circ}\text{C}$  ( $8.6^{\circ}\text{F}$ ), but mixtures of the two freeze at lower temperatures. For example, a 50/50 mixture by weight of ethylene glycol and water freezes at  $-36^{\circ}\text{C}$  ( $-33^{\circ}\text{F}$ ). The addition of ethylene glycol to the mixture will lower the freezing point. Adjust the freeze temperature of the coolant mixture to  $-45^{\circ}\text{C}$  ( $-50^{\circ}\text{F}$ ) using this method.
5. Add either substance in small quantities and measure the freezing temperature after each addition until desired freezing temperature is achieved.

---

**IMPORTANT** It is better to have more water than glycol in the mixture because water is a better thermal conductor than glycol.

---

There are two possible causes of water loss in the drive:

**Evaporation** – Up to 99.5% of liquid lost to evaporation is water because of the chemical properties of the substances in the mixture.

**Leaks** – Glycol and water are lost proportionally depending on the concentration of the substances in the mixture. For example, if the mixture is 60% glycol and 40% water, then any leakage will contain the same proportions of the liquids.

To rectify the problem, add small quantities of water. Measure the freeze temperature of the coolant after each addition and continue adding until the desired freezing temperature is achieved.

## Leakage Checks

When repairing leaks or working on the stack assemblies, it is highly recommended that several layers of industrial-grade absorbent pads be placed on top of the middle and lower stacks to prevent any coolant spills from falling down on to the lower components, specifically the printed circuit boards.

Most leaks will be visible in the first 30 minutes, and once the system begins to fill and pressurize, you should be constantly inspecting all fittings and connections for drips. It is best to have help in checking the inverter and rectifier section, and the DC Link cabinet. An absorbent cloth is ideal for checking that the coolant is actually leaking and is not just remnants of the repair.

If a leak is visible at the threaded joint of a stainless steel fitting and a CPVC (plastic) pipe, the leak can often be repaired by tightening the joint.

Use the following values of torque when tightening stainless threaded fittings into CPVC.

Thread Size	Torque N·m (lb·ft)	Typical Wrench Size
1/4 inch NPT	9,5 N·m (7.0 lb·ft)	15 mm (9/16 in.)
3/8 inch NPT	9,5 N·m (7.0 lb·ft)	19 mm (3/4 in.) and 26 mm (1 in.)
1/2 inch NPT	27 N·m (20 lb·ft)	29 mm (1-1/8 in.)

If a leak persists, it will be necessary to drain the system, disassemble the threaded joint, clean the threads and reassemble with a generous amount of Teflon paste applied to the threads.

No matter how well you drain the system with the pumps, be aware that there will be liquid in the tubes, manifolds, and chill blocks. This requires special care in

removing connections, as there will definitely be liquid leaking out. Use absorbent pads or containers to catch the liquid.

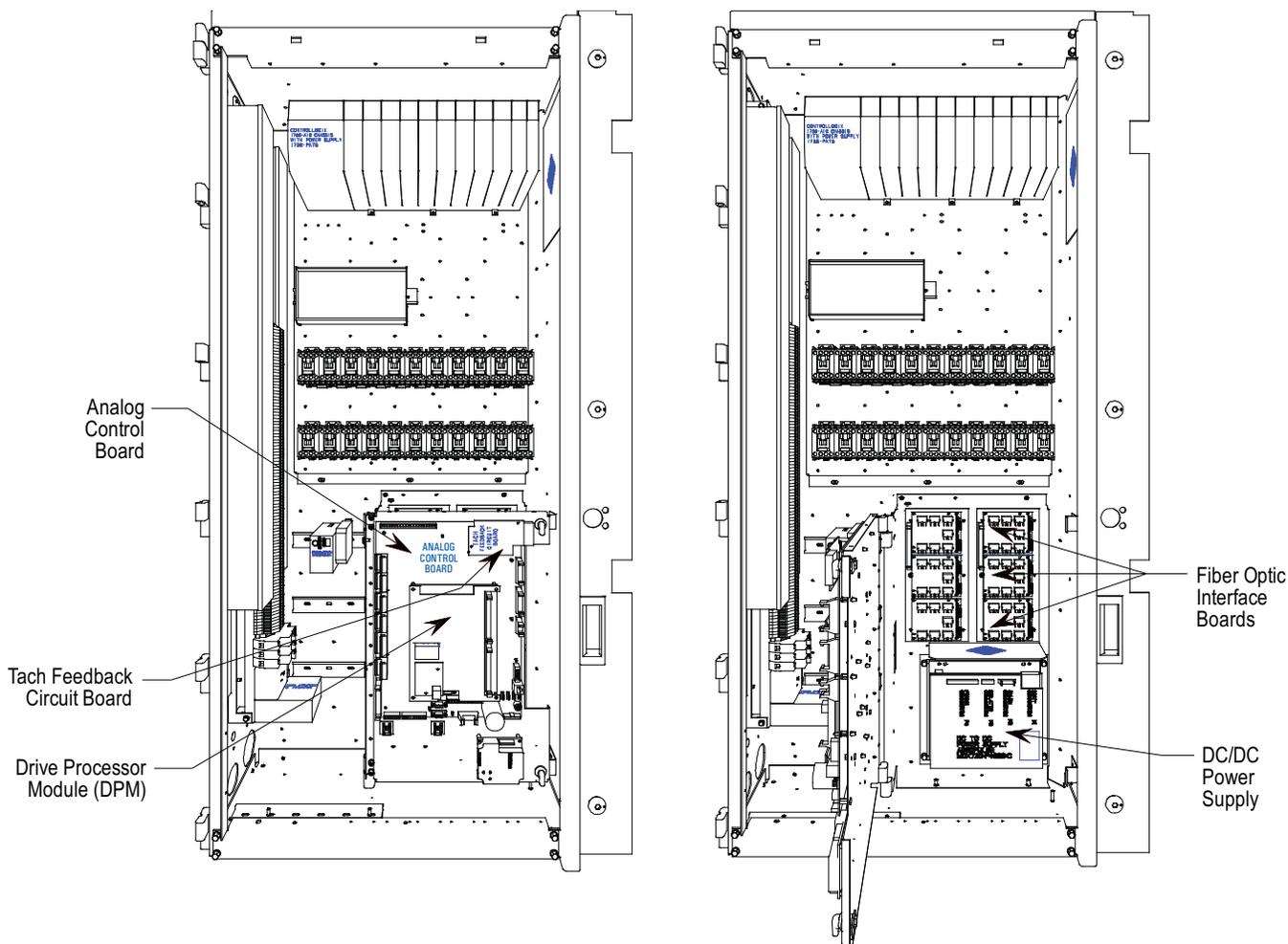
### System Drain

Turn off the pumping system and disconnect the switch on the cabinet door. Attach the transfer pump to Drain/Fill line. Ensure that the flow arrow on pump is in the correct direction. Open valve V6 and V7 (if provided) to pump coolant out.

### Low Voltage Control Section

The low voltage control section panel houses all of the control circuit boards, relays, Operator Interface Terminal, DC/DC power supply, and most other low voltage control components. Refer to [Figure 286](#) for a generic representation of a low voltage tub arrangement.

Figure 286 - Low Voltage Compartment

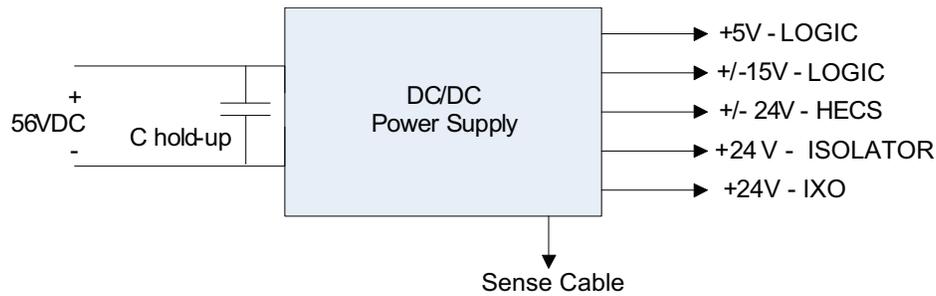


## DC/DC Power Supply Description

### Description

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

**Figure 287 - DC/DC Converter Power Supply**



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

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

## Terminal/Connections Descriptions

### P1 – DC Input

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

### P2 – SENSE (To ACB)

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

### P3 – ISOLATOR (To Isolator Modules)

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

### P4 – PWR (To ACB)

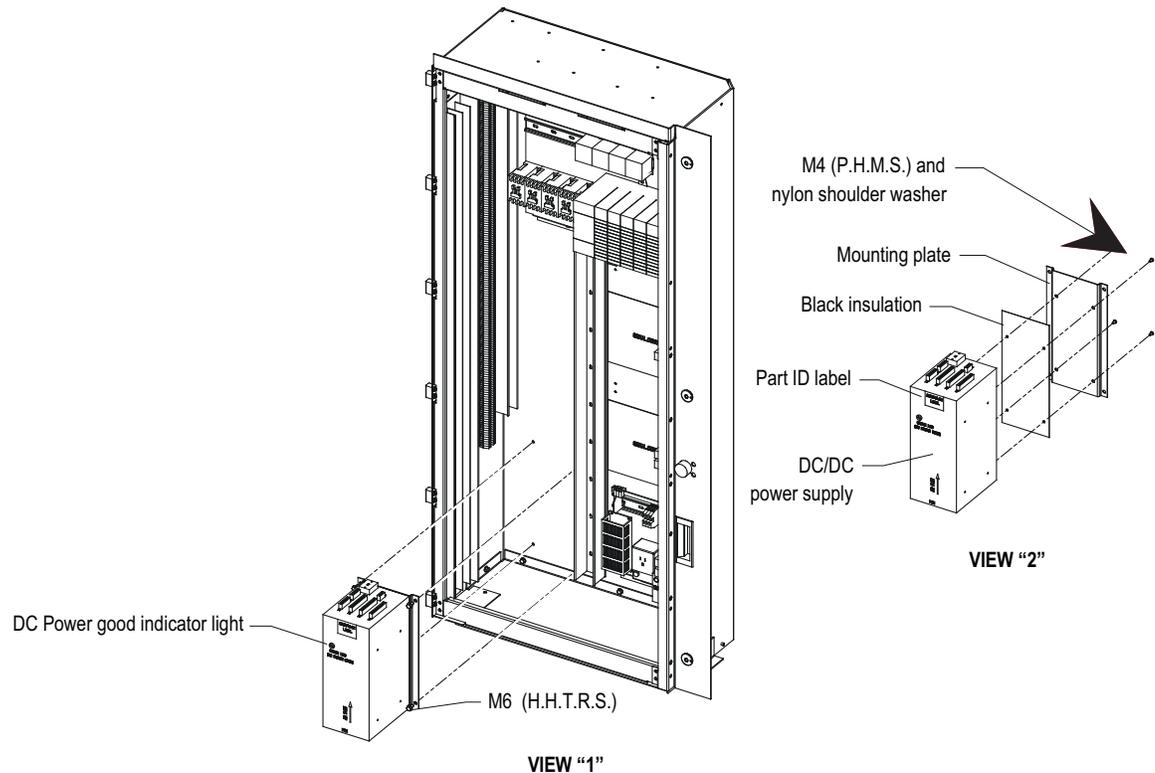
PIN NO.	LABEL	DESCRIPTION ONLY
1	+24V_XIO (+24V,2A)	+24V,2A/com3
2	XIO_COMM (com3)	0V/com3
3	+HECSPWR (+24V,1A)	+24V,1A/com2
4	LCOMM (com2)	0V/com2
5	-HECSPWR (-24V,1A)	-24V,1A/com2
6	+15V_PWR (+15V,1A)	+15V,1A/com1
7	ACOMM (com1)	0V/com1
8	-15V_PWR (-15V,1A)	-15V,1A/com1
9	+5V_PWR (+5V,5A)	+5V,10A/com1
10	DGND (com1)	0V/com1
11	EARTH	earth ground

## Replacement Procedure for DC/DC Power Supply

(Refer to [Figure 288](#))

1. With the drive energized, check that all output voltages are present. (View 1)
2. De-energize the drive, isolate and lock out the control power, and remove all wire connections from the unit. (View 1)
3. Remove quantity of four M6 (H.H.T.R.S.) that will allow the DC/DC Power Supply Assembly to be removed from the Low Voltage Panel. (View 1)
4. Remove quantity of four M4 (P.H.M.S.) and Nylon Shoulder Washers from the back of the Mounting Plate. (View 2)
5. Replace old DC/DC Power Supply with the new one. NOTE: Make sure the Black Insulation is between the DC/DC Power Supply and the Mounting Plate. Repeat Steps 4, 3, 2, 1 in this order to replace unit. (View 2)
6. Ensure the ground wire of P4 plug is connected to the ground by M10 bolt.

**Figure 288 - Replacement of DC/DC Power Supply**



# Printed Circuit Board Replacement

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

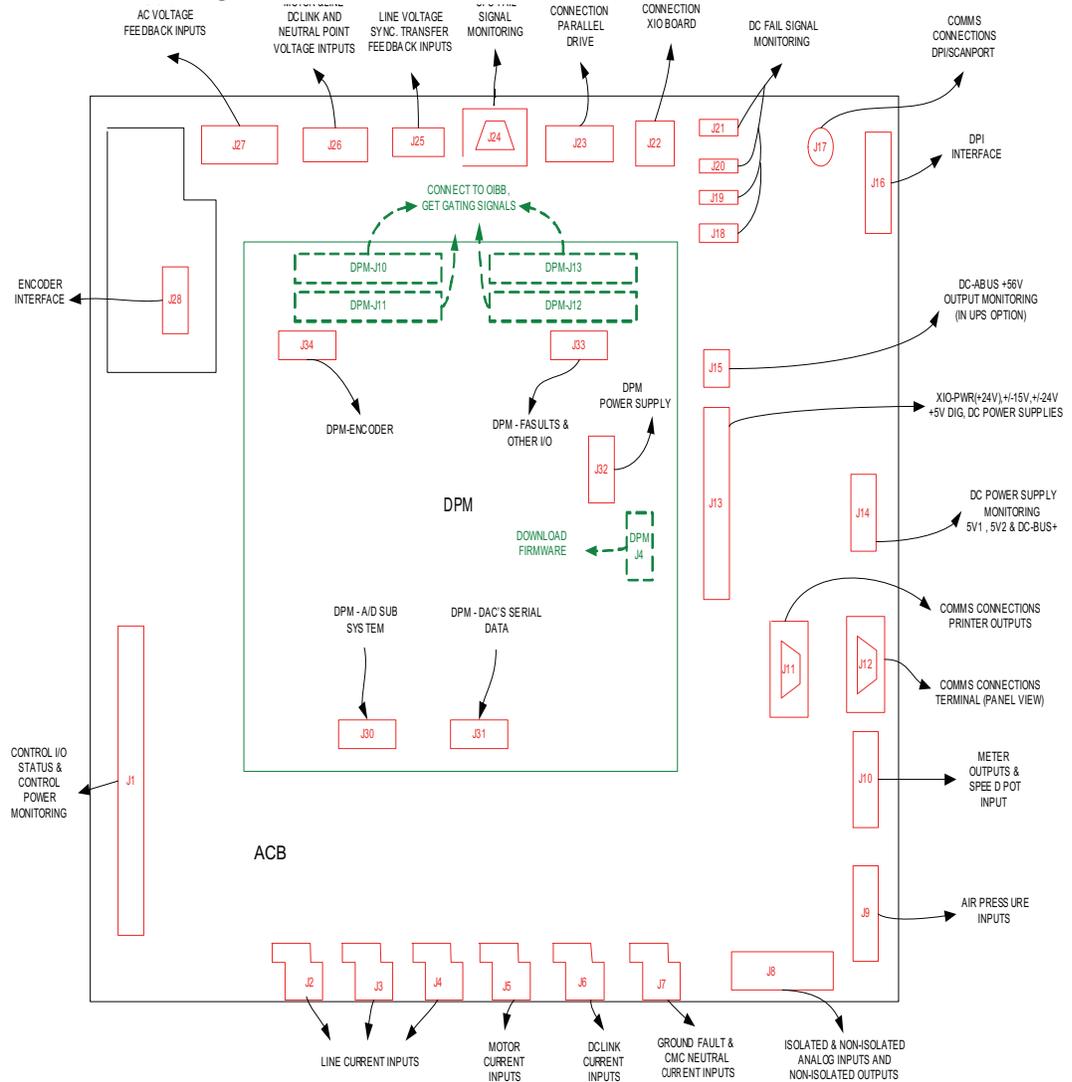
There are some basic precautions that should be taken. They include the following:

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

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

## IO Connectors on Control Boards

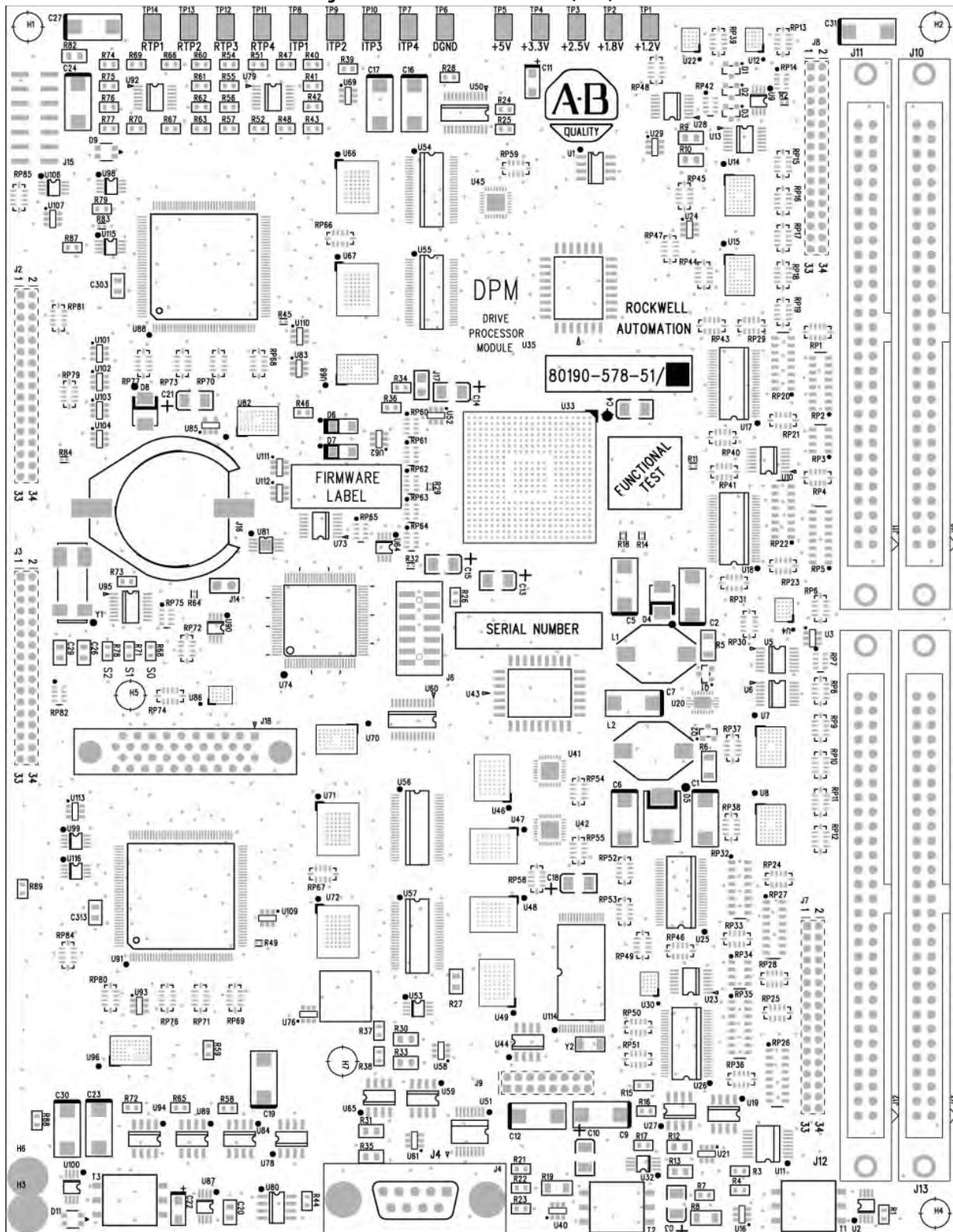
Figure 289 - IO Connectors on Control Boards



# Drive Processor Module

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

**Figure 290 - Drive Processor Module (DPM)**



The following is the list of test points on the DPM.

**TIP** Diagnostic Test Points on the DPM have a voltage output range of -5 to +5V.

**Table 21 - Test Points on Drive Processor Module**

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

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

**Table 22 - Description of D9 and D11 Function**

Color	Rate or Count (Pulse)	Meaning
Green	10 Count	PreExecution OK
Red	.25 Hz	No Bootcode
Green	.25 Hz	No Application
Green	.5 Hz	Downloading via Serial Port
Green	2 Hz	Serial Port Active – ie. Terminal
Green	1 Hz	Waiting/Loading Application
Green	Solid	Operation Running or Successful
Red	Solid	Operation Failed
Red	2 Count	POST – RAM Failed
Red	3 Count	POST – NVRAM Failed
Red	4 Count	POST – DPRAM Failed
Red	8 Count	FPGA Loading Failed
Red	9 Count	POST – USART Failed: 1 Green Count = Port 1 2 Green Count = Port 2

Color	Rate or Count (Pulse)	Meaning
Red	10 Count	End of Code Reached
Red	11 Count	Download – CRC Error
Red	14 Count	Download – Overflow Error

## Drive Processor Module Replacement

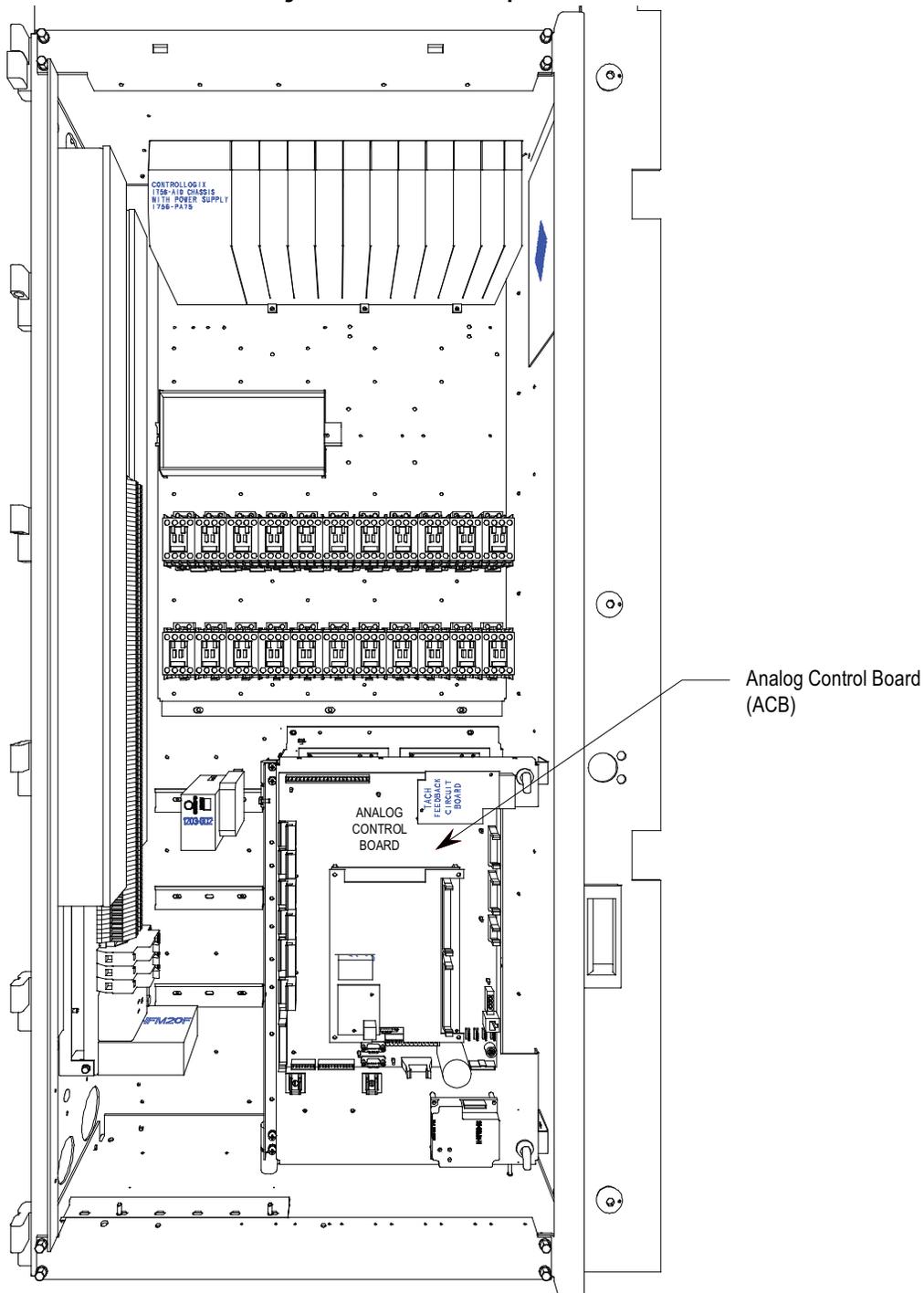
Before replacing the Drive Processor Module, it is important to record all of the programmed drive parameters and settings. Specifically, the parameters, fault masks, fault descriptions, and PLC links are critical. This information is stored in NVRAM on each, and as a result you may lose your settings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

## Instructions to Replace the Drive Processor Module

1. Record all drive setup information using any of the options above, if possible.
2. Ensure that all medium voltage and control voltage power to the drive is isolated and locked out.
3. It is required to first remove the transparent sheet on top of the Drive Processor Module by removing the 4 screws.
4. Use static strap before removing any connectors.
5. Remove the connectors J4, J11 and J12 after proper identification and marking if necessary. Use the electrical drawing as the reference.
6. Remove the 4 screws on the corners of the board fastening the board to the standoffs on the Analog Control Board ACB.
7. Gently remove the Drive Processor Module from the four, 34 pin female connectors and one, 16 pin female connector on the ACB.
8. **Remove the DIM module from the DPM and plug it on the new DPM before the replacement of DPM.**
9. Follow Steps 7 – 3 in reverse to re-install the boards back into the low voltage control cabinet.

10. Apply control power to the drive. The DPMs are shipped with no firmware installed, so the drive will automatically go into download mode. Install firmware in the drive following the guidelines on [page 382](#).
11. Program the drive. Refer to Technical Data “Medium Voltage AC Drive Parameters” – Publication 7000-TD002\_-EN-P. The parameters should also be saved to NVRAM and then externally to the drive using the options described earlier in this section.

Figure 291 - ACB and DPM Replacement





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

**Table 23 - Connectors on Analog Control Board**

ACB Connectors	Description
ACB-J1	Control I/O & Control Power Monitor
ACB-J2	Line current inputs, CT2U, CT2W
ACB-J3	Line current inputs, CT3U, CT3W
ACB-J4	Line current inputs, CT4U, CT4W
ACB-J5	Motor current inputs, HECSU, HECSW
ACB-J6	DClink current inputs, HECSDC1, HECD2
ACB-J7	Ground fault & CMC Neutral current inputs, GFCT, INN
ACB-J8	Isolated & Non-isolated analog inputs, AIN1, AIN2, AIN3 and Non-isolated outputs, AOUT1, AOUT2, AOUT3, AOUT4
ACB-J9	Air pressure inputs, AP0, AP1 (input from TSP)
ACB-J10	Meter outputs, AOUT5, AOUT6, AOUT7, AOUT8 and Speed Pot input, AINO
ACB-J11	Communication connections, printer outputs
ACB-J12	Communication connections, PanelView
ACB-J13	DC power supplies, XIO(+24V), +/-15V, +/-24V, +5V
ACB-J14	DC power supply monitoring, 5V1, 5V2, DC-BUS
ACB-J15	DC-ABUS +56V output monitoring in UPS option
ACB-J16	DPI interface
ACB-J17	Communication connections, scan ports
ACB-J18	DC fail signal monitoring
ACB-J19	DC fail signal monitoring
ACB-J20	DC fail signal monitoring
ACB-J21	DC fail signal monitoring
ACB-J22	Communication connection, XIO link CAN interface
ACB-J23	Communication connection, parallel drive
ACB-J24	UPS fail signal monitoring
ACB-J25	Line voltage synchronous transfer feedback voltage inputs VSA, VSB, VSC
ACB-J26	Motor & line DC link and Neutral Point Voltage inputs
ACB-J27	AC Motor & Line voltage feedback inputs
ACB-J28	Encoder interface
ACB-J30	DPM connection, A/D SUB system
ACB-J31	DPM connection, DACs serial data
ACB-J32	DPM power supply, +5V
ACB-J33	DPM connection, Faults & other I/O
ACB-J34	DPM connection, Encoder

**Table 24 - Test Points on Analog Control Board**

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

Test points	Name	Description
TP40	Vnn	CMC Neutral Voltage, VNN
TP41	Inn	CMC Neutral current, INN
TP42	Ignd	Ground Fault current, GFCT
TP43	Vspr	Spare channel for inputs
TP44	Vmtrp	Motor Over Voltage Detection set point
TP45	A+	Encoder A+ input
TP46	B+	Encoder B+ input
TP47	Z+	Encoder Z+ input
TP48	A-	Encoder A-input
TP49	B-	Encoder B- input
TP50	Z-	Encoder Z- input
TP51	CP1	Control Power monitoring for channel 1
TP52	CP2	Control Power monitoring for channel 2
TP53	CP3	Control Power monitoring for channel 3
TP54	CP4	Control Power monitoring for channel 4
TP55	Vltrp	AC Over Voltage Detection set point for 2UVW & 3UVW
TP56	AGND	Analog ground
TP57	AGND	Analog ground
TP58	AGND	Analog ground
TP59	AGND	Analog ground
TP60	+5V	+5V DC power supply
TP61	+15V	+15V DC power supply
TP62	-15V	-15V DC power supply
TP63	+24V	+24V DC power supply
TP64	-24V	-24V DC power supply
TP65	24VCOM	+/- 24V common
TP66	DGND	Digital ground
TP67	AGND	Analog ground
TP68	AP1	Analog Control Inputs, Air pressure input, AP1
TP69	AP0	Analog Control Inputs, Air pressure input, AP0
TP70	AIN1	Analog Control Input, AIN1
TP71	AIN2	Analog Control Input, AIN2
TP72	AIN0	Analog Control Input, AIN0
TP73	AIN3	Analog Control Input, AIN3
TP74	IPIS	Input Isolating Switch
TP75	IPCS	Input Contactor Status
TP76	IP	Input Contactor Command
TP77	OPIS	Output Isolating Switch
TP78	OPCS	Output Contactor Status
TP79	OP	Output Contactor Command

Test points	Name	Description
TP80	BPIS	Bypass Isolating Switch
TP81	BPCS	Bypass Contactor Status
TP82	BP	Bypass Contactor Command
TP83	DGND	Digital Ground Return

## LEDs

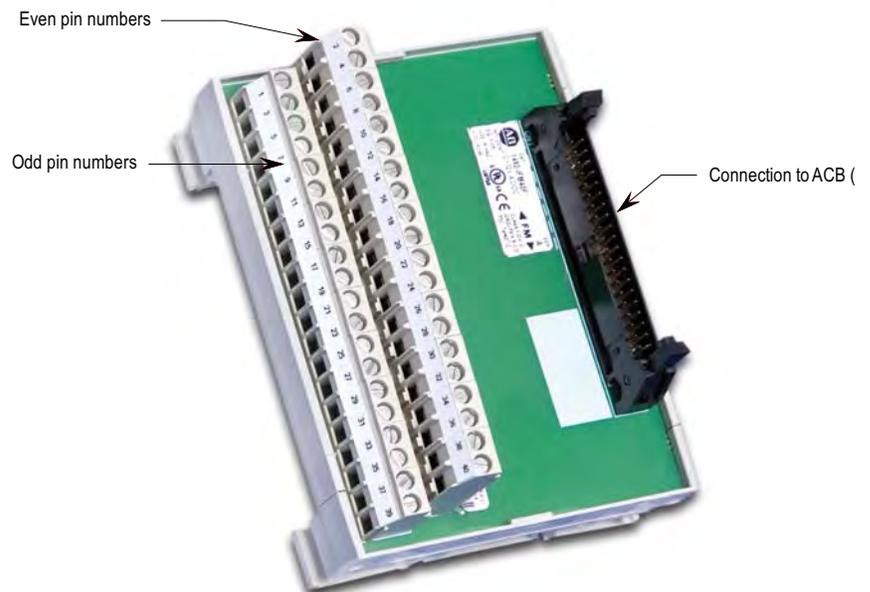
There are two power LEDs on the ACB labeled D7 and D9:

- D9 is the  $\pm 15V$  DC voltage-OK signal
- D7 is the +5V DC voltage present signal.

## Interface Module (IFM)

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

**Figure 293 - Interface Module (IFM)**



## Analog Inputs and Outputs

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

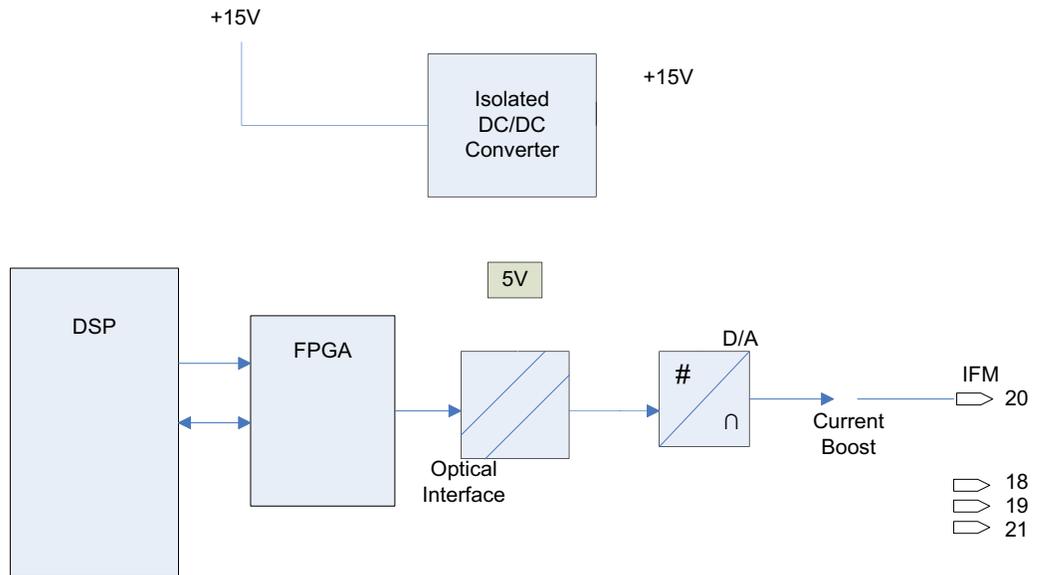
The isolated Process Output is configured as 4-20 mA. The three isolated process inputs are individually configurable for either a range of -10/0/+10V or 4-20 mA (Refer to Programming Manual).

The following information will show the connections for each.

## Current Loop Transmitter

The current loop transmitter will transmit a 4-20mA output to an external receiver. The loop compliance on the transmitter is 12.5V. Loop compliance is the maximum voltage at which a transmitter can generate to achieve the maximum current and is usually a function of the power supply voltage. Therefore, the PowerFlex 7000 “C” Frame transmitter can drive a receiver with an input resistance up to 625 ohms. [Figure 294](#) shows a block diagram of the transmitter.

**Figure 294 - Process Loop Transmitter Block Diagram**



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

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

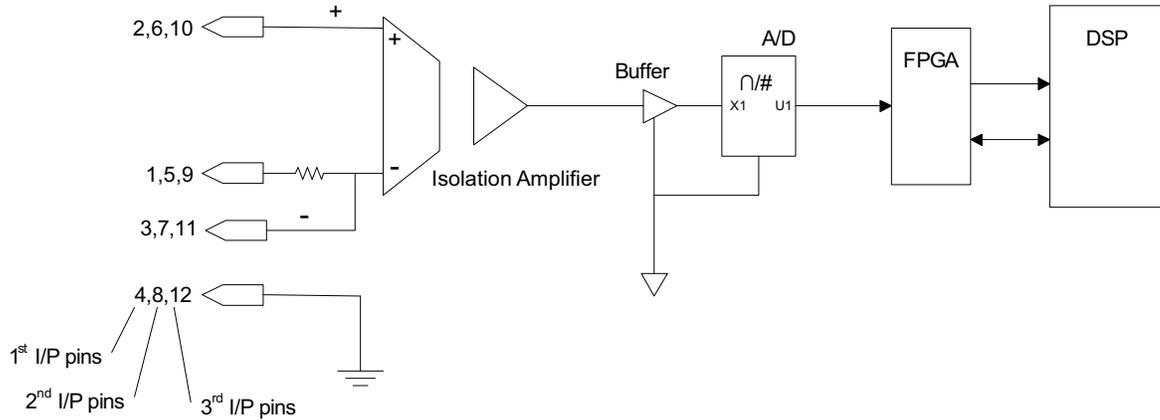
## Isolated Process Receiver

These inputs are individually configurable to accept either a -10/0/+10V input signal or a 4-20 mA signal. When configured for voltage input, each channel has an input impedance of 75 Kohms. When used as a current loop input, the transmitter must have a minimum loop compliance of 2 volts to satisfy the 100

ohm input impedance. Regardless of input configuration, each input is individually isolated to  $\pm 100V$  DC or  $70V$  RMS AC.

A block diagram of the receiver is shown in [Figure 295](#).

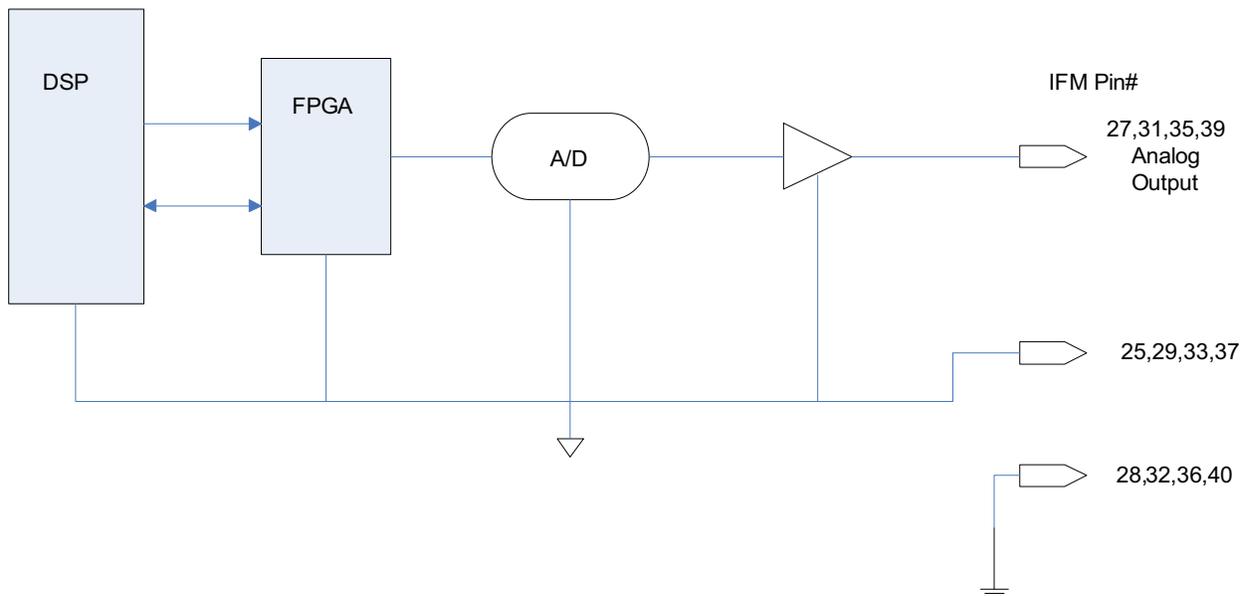
**Figure 295 - Process Loop Receiver Block Diagram**



### Non-Isolated Process Outputs

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

**Figure 296 - Non-Isolated Configurable Analog Outputs on ACB**



## Auxiliary +24V Power Supply

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

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

## ACB Analog Control Board Replacement

To replace the ACB Analog Control Boards:

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

## Tachometer Feedback Board Encoder Options

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

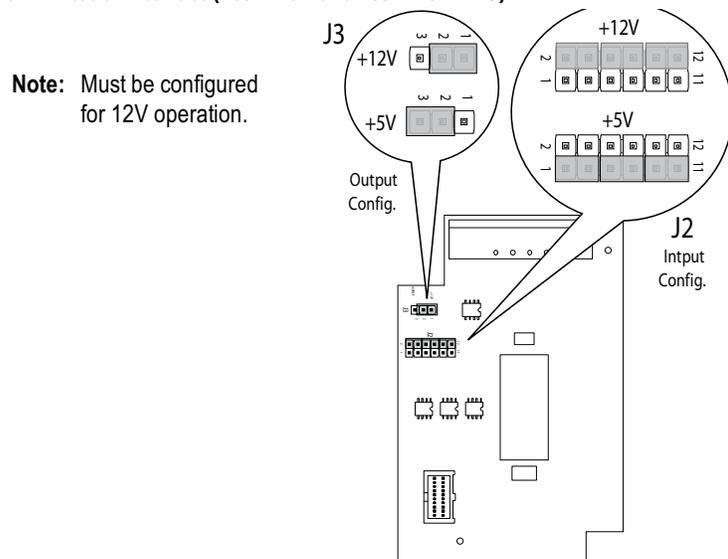
Regardless of which type of encoder board, the following conditions should be adhered to:

1. Do not attach encoders with open collector outputs to the drive. Acceptable outputs are Analog Line Driver or Push Pull.
2. The drive will not operate properly if using single ended Quadrature encoders. Rockwell Automation recommends using differential inputs only for these types of encoders. Single ended outputs are only acceptable for Positional Encoders.

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

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

**Figure 297 - Encoder Interface (20B-ENC-1 and 20B-ENC-1-MX3)**



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

The 20B-ENC-1-MX3 encoder option is functionally identical to the 20B-ENC-1 encoder with the addition of conformal coating. [Figure 297](#) shows the recommended jumper positions for use with the PowerFlex 7000 Drive.

#### Input Connections:

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

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

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

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

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

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

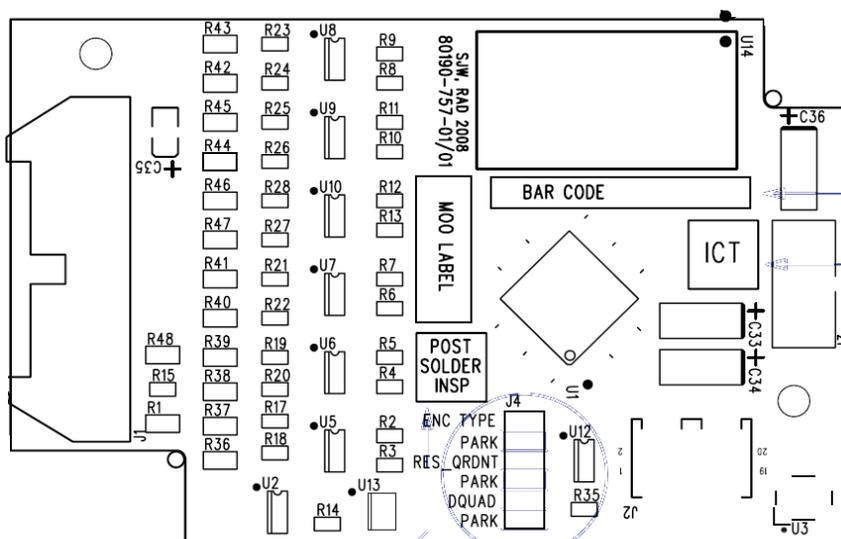


**ATTENTION:** Removing the Universal Encoder Interface while control power is applied may result in damage to the board. Only remove the board when the control power is Off.

**Table 25 - Encoder Configurations**

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

**Figure 298 - Universal Encoder Board**



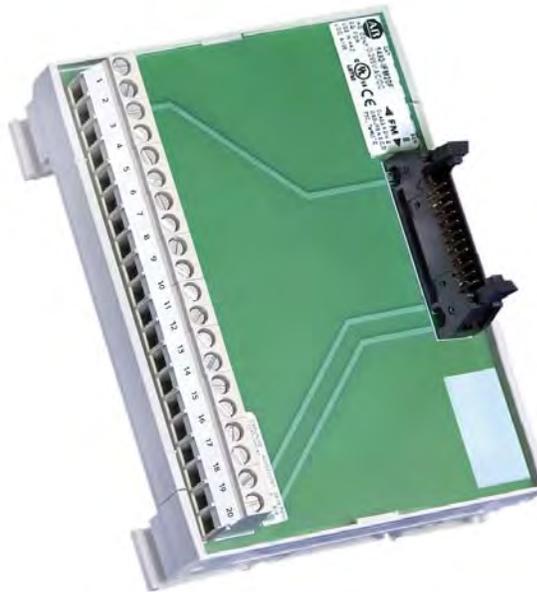
Connections to the Universal Encoder Interface are made via a 1492-IFM20F interface module. The connections to the IFM are as follows:

**Table 26 - Encoder Functions**

IFM Pin #	Quadrature Encoder Function	Absolute Encoder Function
1	A1+	E0
2	A1-	E1
3	B1+	E2
4	B1-	E3
5	ENC_COM	ENC_COM
6	Z1+	E4
7	Z1-	E5
8	A2+ (Redundant or Dual ENC)	E6
9	A2- (Redundant or Dual ENC)	E7
10	ENC_COM	ENC_COM

IFM Pin #	Quadrature Encoder Function	Absolute Encoder Function
11	B2+ (Redundant or Dual ENC)	E8
12	B2- (Redundant or Dual ENC)	E9
13	Z2+ (Redundant or Dual ENC)	E10
14	Z2- (Redundant or Dual ENC)	E11
15	ENC_COM	ENC_COM
16	ENC_COM	ENC_COM
17	ENC_COM	ENC_COM
18	ENC PWR (+12V)	ENC PWR (+12V)
19	ENC PWR (+12V)	ENC PWR (+12V)
20	ENC PWR (+12V)	ENC PWR (+12V)

**Figure 299 - 20-pin Interface Module (IFM)**



### Quadrature Encoder Operation

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

Boards shipped from the factory come defaulted to single quadrature encoder configuration.<sup>(1)</sup>

For dual encoder configurations, the primary encoder is wired to pins 1 to 7 on the 1492-IFM20 module. (See [Table 26](#)).

(1) Consult factory for availability of dual Quadrature Encoder options.

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

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



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

---

## Positional Encoder Operations<sup>(1)</sup>

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

There are three different positional encoder configurations available. For all of these configurations remove the ENC\_TYPE jumper. The other jumpers configure the board for the type of positional data (Gray Code or Natural Binary) set by CD\_DQUAD and High or Low True data set by POL\_QRDNT.

- 1. Gray code, Low True.** In this configuration the board will invert the incoming gray code data and then convert it to binary for transmission to the DPM.
- 2. Natural Binary, Low True.** No conversion is done on the incoming data but it is inverted.
- 3. Gray code, High True.** In this configuration, the incoming gray code data is simply converted to binary. No inversion is done on the input data.
- 4. Natural Binary, High True.** The positional data is simply converted to the serial stream. No inversion or conversion is done on the data.

(1) Consult factory for availability of Positional Encoders

## Positional Encoder Guidelines

When selecting a positional encoder there are certain guidelines that should be followed for optimal performance.

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

	Binary Code	Gray Code
255	011111111	010000000
256	100000000	110000000

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

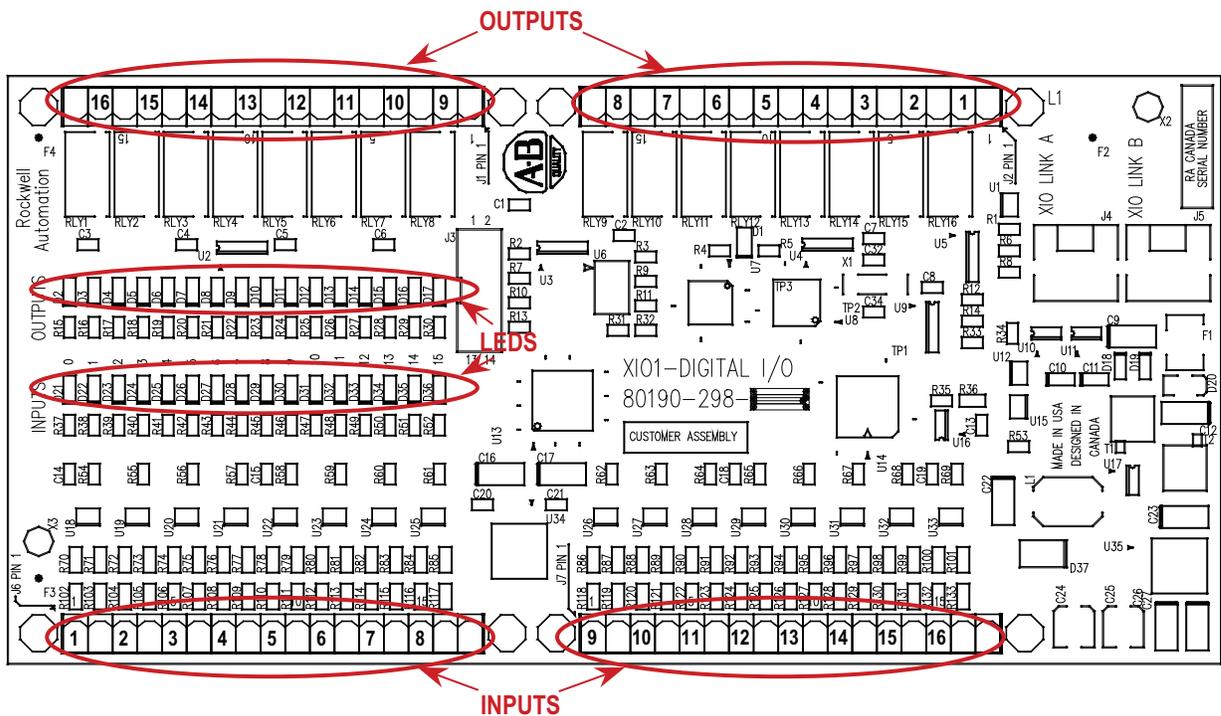
2. **Data Polarity:** Absolute encoders typically have a High True output. If the encoder model does not have a High/True (or Non Inverted/Inverted) option you should assume it to be High True. In the case of a 10bit High True encoder the zero position is represented by 0000000000. Whereas a Low/True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

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

## External Input/Output Boards

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

Figure 300 - XIO Board



The standard drive comes with one XIO board; additional boards (up to 5) can be daisy chained together from XIO Link B (J5) on the first board to XIO Link A (J4) on the second board, for a total of 6 XIO cards. However, at this time the drive only supports the use of addresses 1 to 3, depending on the drive’s features and application. U6 on the XIO board displays the board’s address which is automatically calculated from the XIO board’s position in the network.

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

LED D1 and display U6 indicate the status of the board. The following table illustrates the possible states for D1.

LED Status	Description
Solid Red	Board Failure
Alternate Flashing of Red and Green	No Communication Available to ACB board (Normal at Power on, during firmware download and with unprogrammed drive)

Table 27 - Status of U6 Display

Display	Description	Explanation
—	No valid address found	<ul style="list-style-type: none"> <li>– More than 6 XIO cards on network</li> <li>– IO cable failure</li> <li>– IO card failure</li> <li>– CB failure</li> </ul>
0	Card in “Master” mode	<ul style="list-style-type: none"> <li>– Rockwell Use Only</li> <li>– Remove connection to J3 and recycle power</li> </ul>
1 – 6	Valid address	– Normal
Decimal point ON	Indicates network activity	– Normal
Decimal point OFF	No activity on the network	– Normal at Power on, during firmware download and with unprogrammed drive

## External Input/Output Board Replacement

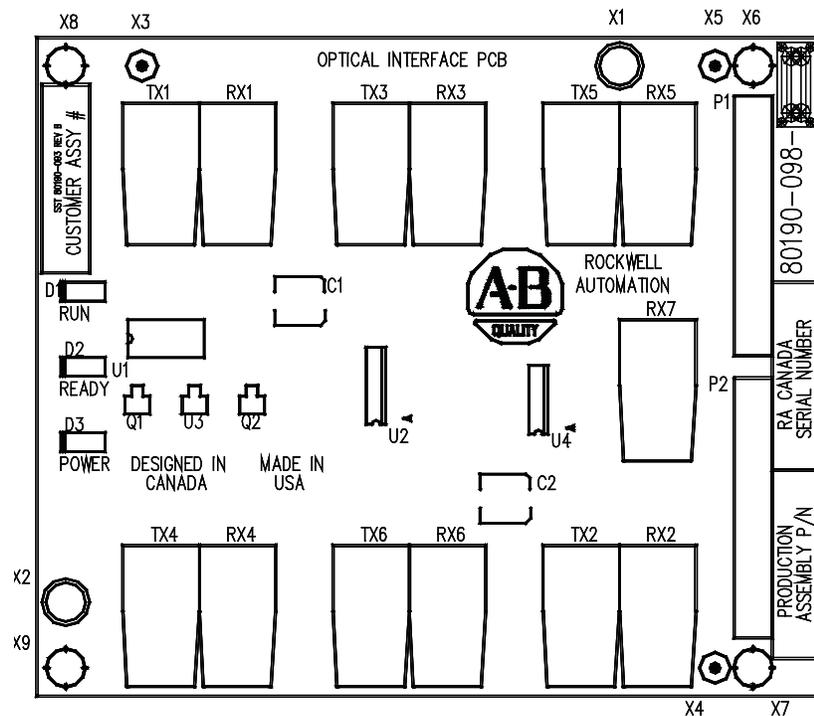
To replace the External Input/Output Boards:

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

## Optical Interface Boards (OIB)

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

**Figure 301 - Optical Interface Board**



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

Each OIB board can handle the Firing and Diagnostic duplex fiber optic connector for 6 devices, whether they are SCRs or SGCTs. Physically, on the OIBBs, there is provision for 18 devices for the inverter and the rectifier. The top OIB board on the OIBB is for the “A” devices, the middle OIB board on the OIBB is for the “B” devices, and the bottom OIB board on the OIBB is for the “C” devices. Test points for the OIB gating diagnostic and temperature feedback signals are on the OIBB.

Each OIB board also has input RX7 for a signal from a Temperature Feedback Board. The quantity and location of thermistor connections is dependant on the drive configuration. Typically there is one temperature sensor from the Line

Converter and one temperature sensor from the Machine Converter, each going into the respective OIB board in the “A” position. However some drive configurations only require one thermistor feedback connection. The temperature feedback connection on OIBC is not implemented on the OIBB and is never used. For more information, see the drawings supplied with your drive. The alarm and trip setpoints for each of these signals are programmable in software.

There are 3 LEDs on the OIB board, and the following table illustrates the status and description for the LED states:

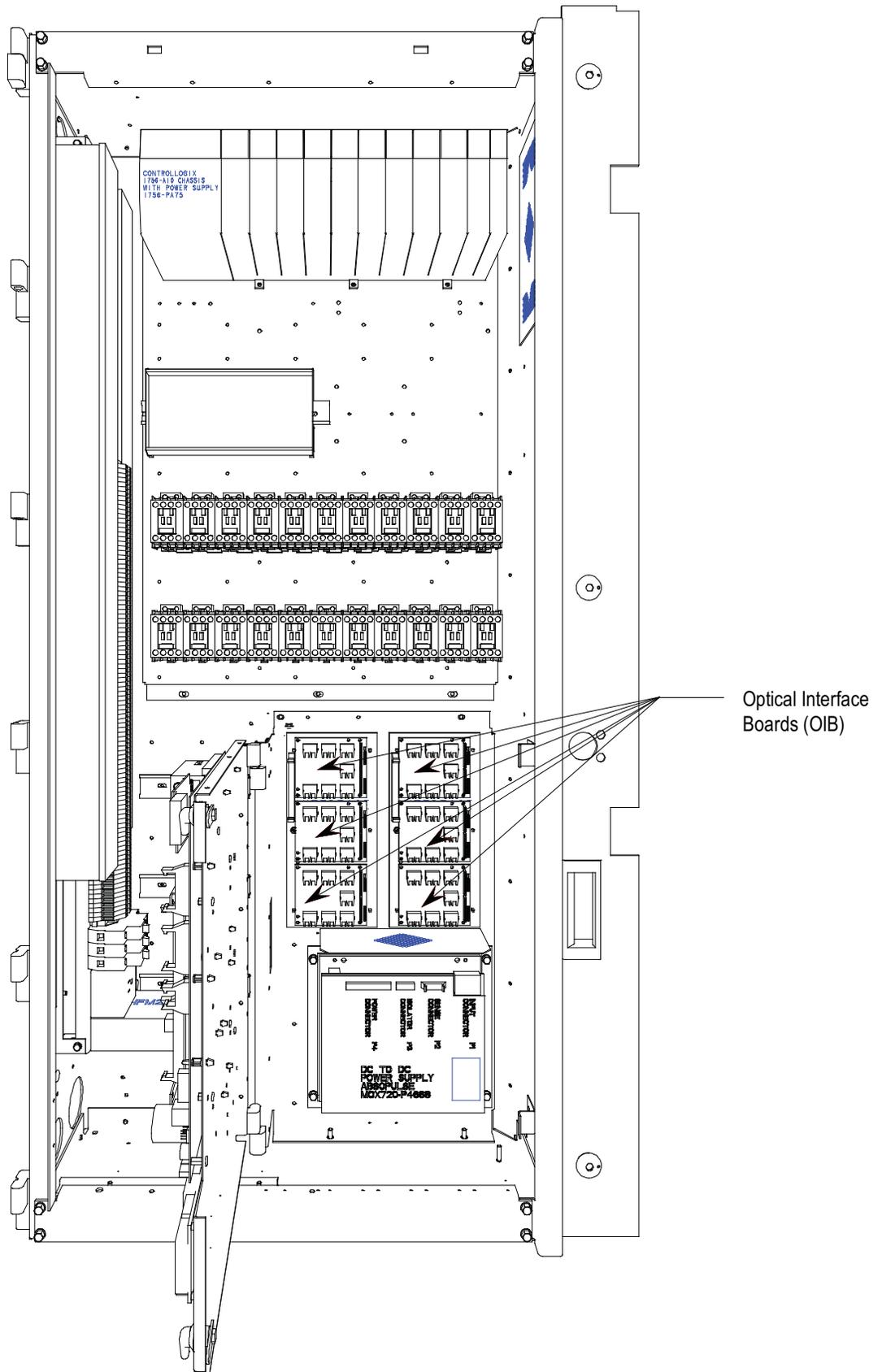
LED	Status	Description
D1	Red – On	Run – The OIB has received an Enable signal and is enabled to send and receive gating commands.
D2	Yellow – On	Ready – The OIB has received sufficient power for all transmit ports.
D3	Green – On	Power – The OIB has received a voltage signal greater than 2V.

## Optical Interface Board Replacement

To replace the Optical Interface Boards:

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

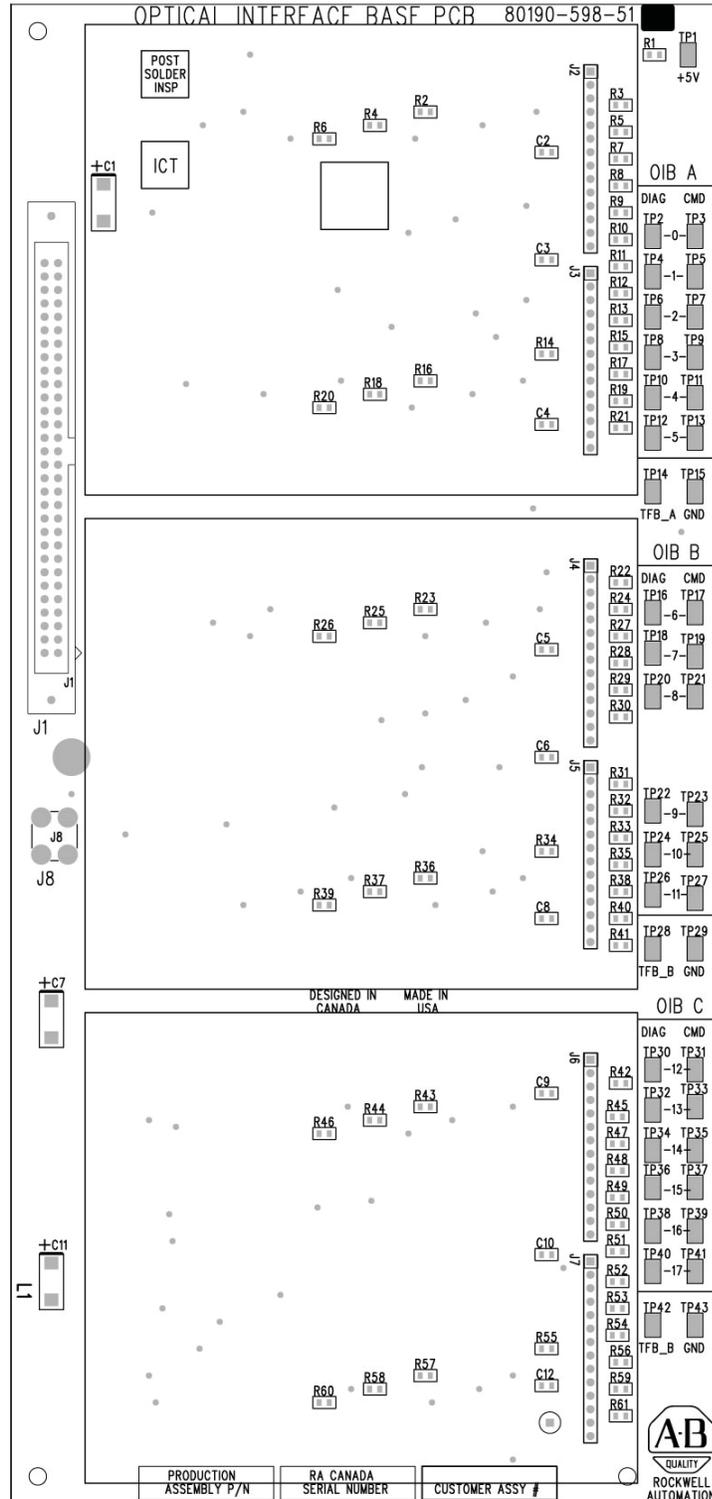
Figure 302 - OIB Replacement (Mounting Plate Accessible)



## Optical Interface Base Board (OIBB)

This board provides the mechanical and electrical interconnections between the OIBs and the DPM. It connects to either J11 or J12 on the DPM via a 60 Conductor shielded ribbon cable. The drain wire for this cable must be attached to the screw terminal J8. The remaining connectors on the board complete the electrical connection of the installed OIBs to the DPM. Each OIB can support from one to three OIBs.

Figure 303 - Optical Interface Base Board (OIBB)



## Optical Interface Base Board Test Points

In addition to the command and diagnostic test points, there are three ground reference test points. These reference points are electrically identical, but are physically placed to facilitate easy connection of Oscilloscope or Chart recorder test leads.

**Table 28 - Test Points on Optical Interface Base Board (OIBB)**

Test Point	Signal Name	Description
TP1	+5V	Positive 5V Power Supply
TP2	DIAG_0	OIB A, RX1 Diagnostic Feedback
TP3	CMD_0	OIB A, TX1 Firing Command Signal
TP4	DIAG_1	OIB A, RX2 Diagnostic Feedback
TP5	CMD_1	OIB A, TX2 Firing Command Signal
TP6	DIAG_2	OIB A, RX3 Diagnostic Feedback
TP7	CMD_2	OIB A, TX3 Firing Command Signal
TP8	DIAG_3	OIB A, RX4 Diagnostic Feedback
TP9	CMD_3	OIB A, TX4 Firing Command Signal
TP10	DIAG_4	OIB A, RX5 Diagnostic Feedback
TP11	CMD_4	OIB A, TX5 Firing Command Signal
TP12	DIAG_5	OIB A, RX6 Diagnostic Feedback
TP13	CMD_5	OIB A, TX6 Firing Command Signal
TP14	TFB_A	OIB A Temperature Feedback Signal
TP15	GND	Ground Reference for TP1 – TP14
TP16	DIAG_6	OIB B, RX1 Diagnostic Feedback
TP17	CMD_6	OIB B, TX1 Firing Command Signal
TP18	DIAG_7	OIB B, RX2 Diagnostic Feedback
TP19	CMD_7	OIB B, TX2 Firing Command Signal
TP20	DIAG_8	OIB B, RX3 Diagnostic Feedback
TP21	CMD_8	OIB B, TX3 Firing Command Signal
TP22	DIAG_9	OIB B, RX4 Diagnostic Feedback
TP23	CMD_9	OIB B, TX4 Firing Command Signal
TP24	DIAG_10	OIB B, RX5 Diagnostic Feedback
TP25	CMD_10	OIB B, TX5 Firing Command Signal
TP26	DIAG_11	OIB B, RX6 Diagnostic Feedback
TP27	CMD_11	OIB B, TX6 Firing Command Signal
TP28	TFB_B	OIB B Temperature Feedback Signal
TP29	GND	Ground Reference for TP16 – TP28
TP30	DIAG_12	OIB C, RX1 Diagnostic Feedback
TP31	CMD_12	OIB C, TX1 Firing Command Signal
TP32	DIAG_13	OIB C, RX2 Diagnostic Feedback
TP33	CMD_13	OIB C, TX2 Firing Command Signal

Test Point	Signal Name	Description
TP34	DIAG_14	OIB C, RX3 Diagnostic Feedback
TP35	CMD_14	OIB C, TX3 Firing Command Signal
TP36	DIAG_15	OIB C, RX4 Diagnostic Feedback
TP37	CMD_15	OIB C, TX4 Firing Command Signal
TP38	DIAG_16	OIB C, RX5 Diagnostic Feedback
TP39	CMD_16	OIB C, TX5 Firing Command Signal
TP40	DIAG_17	OIB C, RX6 Diagnostic Feedback
TP41	CMD_17	OIB C, TX6 Firing Command Signal
TP42	TFB_C	OIB C Temperature Feedback Signal – There is no provision in the drive for the use of this signal, it is only provided for Rockwell internal testing.
TP43	GND	Ground Reference for TP30 – TP42

## Downloading Firmware

### Introduction

With the introduction of the PowerFlex 7000 Medium Voltage Drive, all drive control functions are loaded on the Drive Processor Module (DPM) with firmware via a serial connection on the Drive Processor Module data port J4. The firmware is packaged into a single executable file (with the extension .exe).

This document describes how to download new or updated firmware to the drive using the DPM data port. All firmware downloaded via this means is stored in non-volatile Flash memory.

The latest firmware and the associated release notes are available on the Medium Voltage intranet site, or can be obtained from Medium Voltage Product Support.

### Overview

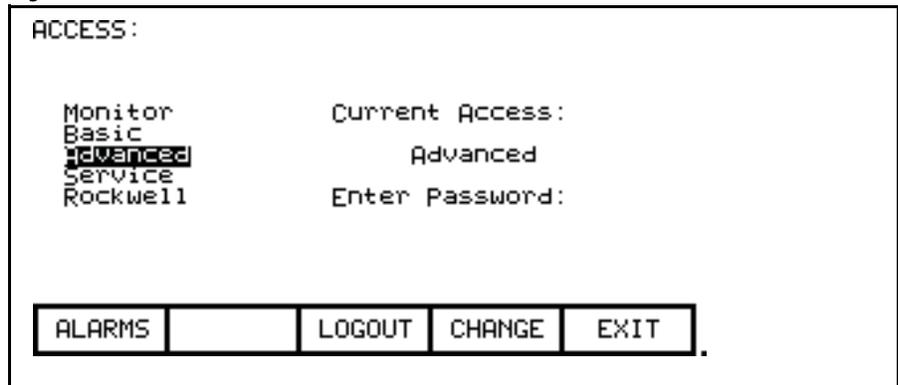
When the system is powered up, the drive executes the Application Code contained in the on-board flash memory. If it does not have valid firmware, then the entire system will drop into a download mode. In the download mode the system is waiting to receive a firmware download via the serial data port J4 on the DPM.

The system may also be placed into download mode from the Drive Terminal. This can only be accomplished if you have obtained a minimum of 'ADVANCED' level access. Once that has been obtained, from the main screen selecting UTILITY-TRANSFER-SYSTEM will place the drive into download mode.

Ensure the parameters are saved to NVRAM, and saved to the Operator Interface Terminal, and saved to any other external source such as the Flash Card, DriveTools, or printed to a hardcopy.

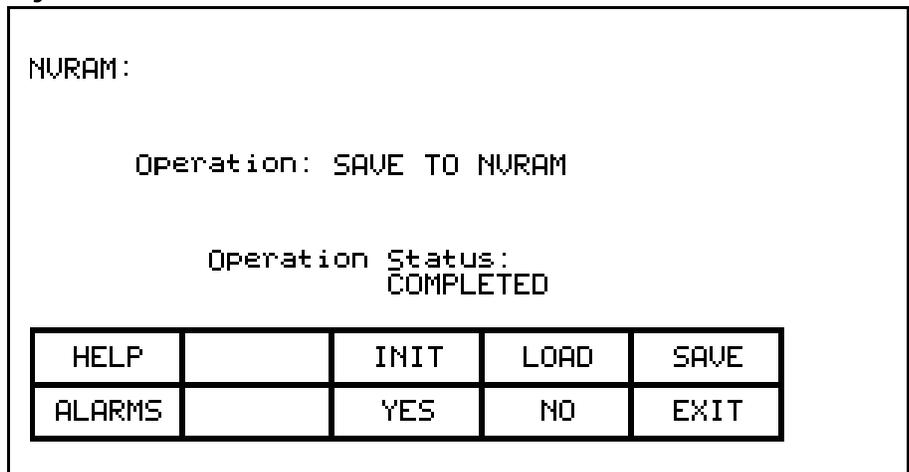
Hit F10 (Access), and highlight Advanced. Press Enter, or enter the password value (if password required) and you should have Advanced level access.

**Figure 304 - Advanced Screen**



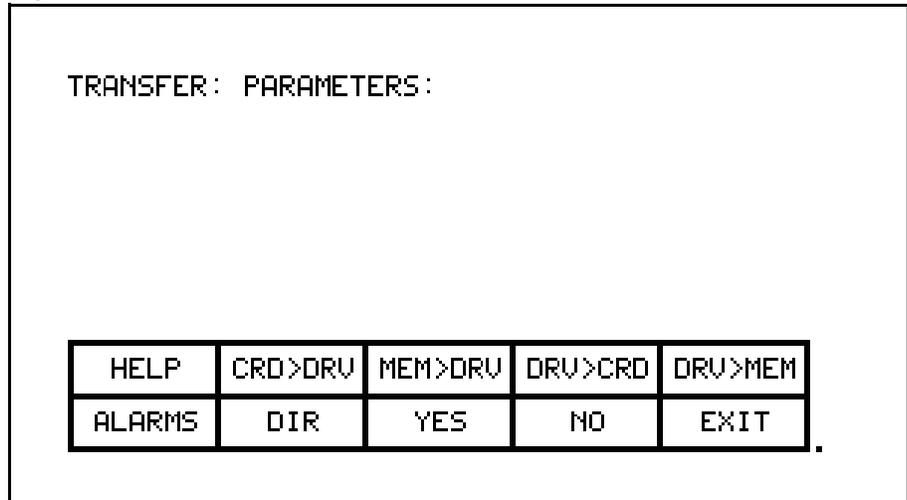
Hit F10 to Exit, and then F5 for NVRAM. Press F5 for SAVE, and F8 for YES. The parameters should now be saved to NVRAM. Press F10 again to EXIT.

**Figure 305 - Save to NVRAM**



To save to the Operator Interface Terminal and Flash Card, Press F2 (UTILITY), F7 (TRANSFER), and F4 (PARAMETERS). You should now be on the following screen:

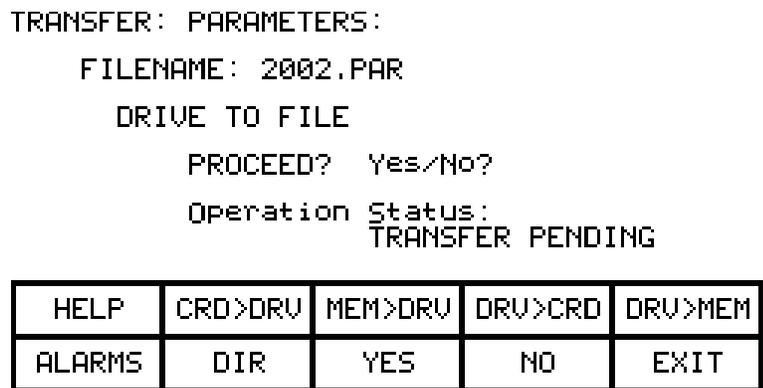
**Figure 306 - Transfer: Parameters**



In order to save parameters to the Operator Interface Terminal, press F5 (DRV>MEM). To save to the Flash Card, you must first insert the card in the terminal. Remove the back cover and insert the card in the slot on the terminal. It can only go in one way. Then press F4 (DRV>CRD).

Saving to the card means that you will have to choose a file name. Use the Up and Down arrows to select the character, and then use the Right arrow to go to the next character. Press the Enter key when finished.

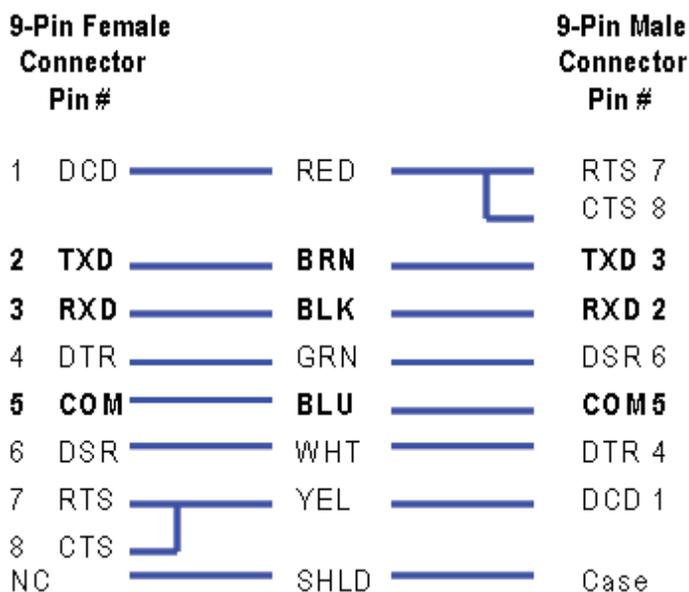
**Figure 307 - Transfer pending**



Press F8 for YES, and the parameters will be transferred to the card. Press F10 to EXIT.

Here is a typical pin out of a complete null-modem cable. Essentially, only 3 pins (2, 3 and 5) are all that is required.

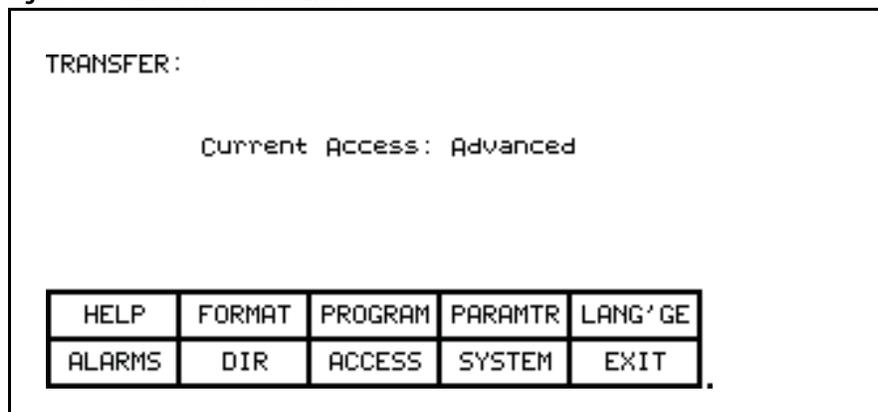
**Figure 308 - Null-modem pin out**



### PowerFlex 7000 in Download Mode

To place the drive in download mode, you should be in the UTILITY – TRANSFER screen. You will not be able to do this if the drive is running. Ensure the drive is stopped, and the E-Stop is pressed. This is just a precaution, as all versions of firmware 7.xxx and later will not allow you to attempt a download while running.

**Figure 309 - Current Access: Advanced**



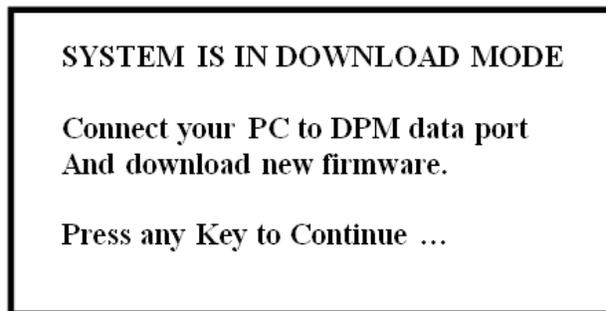
This time press F9 for SYSTEM, and a screen will appear telling you that you are in download mode, and to recycle control power once the download is complete.

There are two status LEDs (D9 and D11) on the DPM, which provides indication of the programming process. The following illustrates the states of the LED:

- **Solid Green** – when both LEDs are solid green, the Application firmware is running.
- **Flashing Green** – when either D9 or both LEDs are flashing, the board is in download mode. (If the DPM bootcode is  $\geq 1.005$ , then only D9 will be flashing and D11 will stay solid. But if the bootcode is  $\leq 1.005$ , then both LEDs will be flashing.)

After putting the drive in download mode, the following is the display on the drive terminal:

**Figure 310 - System in Download Mode**



If you press any Key after this message the PanelView will show “Communication Error”.

Connect your PC to the DPM data port J4. Locate the PowerFlex 7000 Medium Voltage Drive firmware file “PF7KFirmware7001\_G.exe” and double-click to download the file.

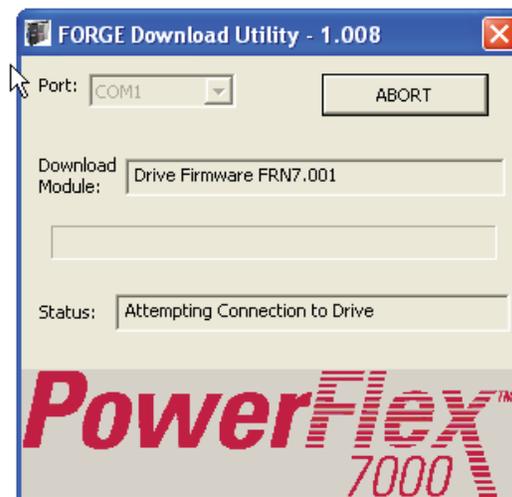
The executable program opens the following screen:

**Figure 311 - Modules Available for Download Window**



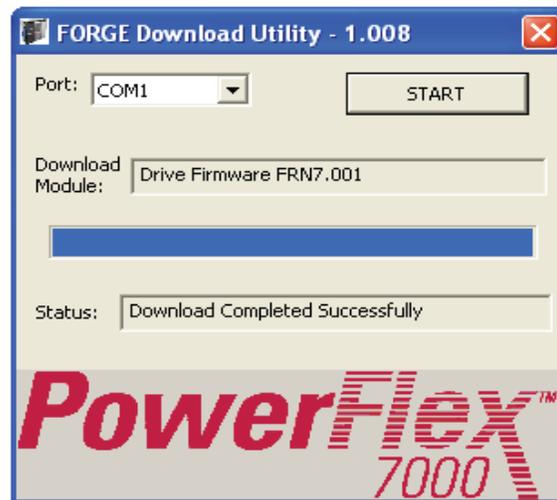
The DPM are preloaded with Bootcode and select the Firmware by clicking in the checkbox against Firmware and click OK. This will start the process of the downloading of firmware, attempting connection to the drive. The following screen is displayed:

**Figure 312 - FORGE Download Utility**



The completion of the download is displayed on the screen as shown.

**Figure 313 - Download Successful**



If the DPM does not have bootcode or needs an upgrade, then first select the Bootcode by clicking in the checkbox against Bootcode and click OK. After downloading the bootcode proceed with the drive firmware download as explained earlier.

After downloading new firmware, the DPM resets automatically.

## Reloading the Parameters

For major revision level upgrades, the majority of the parameters that were stored in the Operator Interface or other external means can still be used, but there may be things such as new parameters, changed scaling on an existing parameter, or added functionality to existing parameters that may have to be addressed.

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**IMPORTANT** Refer to the release notes before upgrading firmware.

---

To reload the parameters from the Operator Interface, once again obtain ADVANCED level access.

Then follow the same steps to get to the UTILITIES – TRANSFER – PARAMETERS screen. Then choose F3 (MEM>DRV). This will prompt you for confirmation, and you can press F8 for YES.

The parameters will then be transferred. There are differences between parameters for different revision levels, so you may get some errors, and a Transfer Incomplete message.

You can also transfer from the Card to the Drive using F2 (CRD>DRV), and the difference is that you will first get a screen asking you to choose from all the available parameter listings on the card. Select the one you want using the arrow keys, and press Enter. Then you can press F8 for Yes and transfer the parameters. Once the parameters are transferred, press the F10 (EXIT) key to get back to the main screen.

It is important to go through the parameters and ensure the settings are proper for the drive. New parameters may need to be changed for the specific drive application, and this should be understood from reviewing the release notes beforehand. You should also correct any information such as the drive name, the operating hours, or the external fault text, if present.

You should then press F5 (NVRAM), and save the parameters to NVRAM.

Then cycle control power one more time, and the drive should come up with no faults or warnings, and the drive will be ready to run. At this point you may also want to save the parameters to the Operator Interface terminal, the Flash Card, via software, or as a hardcopy. This will provide a record of the new settings.

## Setting Elapsed Time

When you replace the existing DPM board in the drive with a new board, the operating hours counter will start from zero. Therefore, if you want to keep the actual operating hours in the drive, you can restore them by running a utility program (Sethobb.exe), which is usually supplied with the firmware package. A copy of the program can be requested by e-mail at **MVSupport\_Technical@ra.rockwell.com**.

To set elapsed time in the drive:

1. Turn off control power to the drive control boards and the Terminal.
2. Remove the Terminal serial connector from Analog Control Board, ACB (Port-J12).
3. Connect your laptop to ACB (Port-J12) using a null-modem cable.
4. Turn on control power and wait until the boards are powered up and the LEDs on the boards become steady green.
5. Run **Sethobb.exe** program on your laptop.
6. When prompted to "**Specify a COMM port to use <1, 2, 3, 4>**", enter the correct port number and then press the **Enter** key.
7. When prompted to "**Specify the time preset including the 1/10 Hr:**", enter actual operating hours (e.g., if the actual operating hours = 146.5 hr, then enter 1465), and then press the **Enter** key. The Sethobb.exe will be closed automatically.
8. Remove the laptop and reconnect the Terminal to ACB (Port-J12) and turn on power to the Terminal.
9. After the Terminal is powered up, you should be able to see the actual operating hours on the main screen.

## Downloading the Terminal Firmware

The Operator Terminal is an interface used to interact with a PowerFlex7000 drive. In order to communicate with the drive, the Terminal needs a valid firmware. If it lacks the software, it does not have the necessary information to communicate with the Analog Control Board (ACB).

There are two methods of downloading the firmware into the Terminal, which are described below.

### Using Flash Memory Card

If using a Flash Memory Card (2711-NM4 or 2711-NM8 or 2711-NM16), copy the appropriate file to the Flash Card in the root directory. Ensure that there are no other files on the card containing the .FMW extension.

Power off the Terminal and insert the memory card. Apply power to the terminal. The terminal on power-up will sense new firmware and download it from the card. You will see a series of codes on the screen (2 – 20 – 21 ...) and then the drive application firmware will start. The process may take several minutes. When the download is finished, remove the card from the Terminal. (If you leave the card in the terminal, it will reload the firmware each time the terminal is powered up).

### DOSFWDL

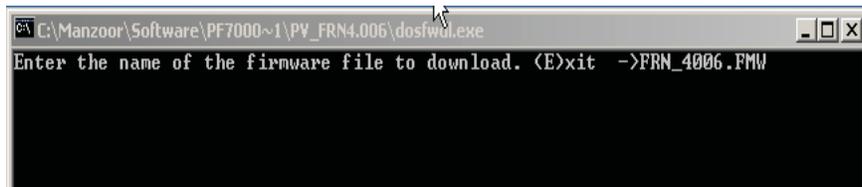
This is a DOS program which copies the .FMW file out the serial port of the laptop to the serial port of the terminal. The program is usually included in the firmware package. The method is described below. In this example, we are using firmware file **FRN\_4006.FMW**.

**Note:** If you are using a newer firmware, just make sure the filename is at maximum eight characters. You can rename the file, but keep the filename extension as **.FMW**. Also, when you are prompted to enter the filename, make sure you enter the correct filename as illustrated in the following example.

## Method

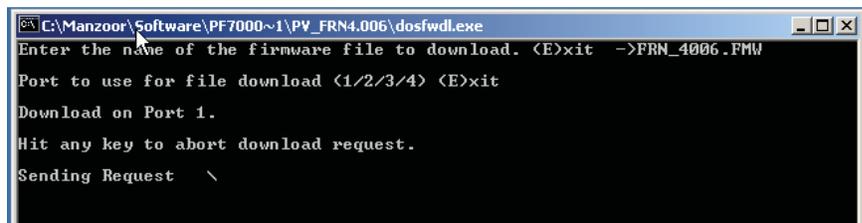
1. Ensure the Terminal is powered off. Disconnect Terminal's serial cable connector from Analog Processor Board (ACB) and connect it to the serial port on your laptop. (You may need a gender changer.)
2. Turn on your laptop and run **dosfwdl.exe** program. .
3. Type in the firmware filename (e.g., **FRN\_4006.FMW**) as shown in the screen below and then hit **Enter** key.

**Figure 314 - Download Firmware File**



4. Choose a correct port address and then hit **Enter** key.
5. Turn on control power to the terminal when a screen similar to [Figure 315](#) appears.

**Figure 315 - Download Terminal Firmware**



As soon as control power is applied to the Terminal, the firmware download will start automatically.

6. Once the firmware download is complete, the message “**Download successfully completed!**” will appear on your laptop screen. Press any key to close the **DOSFWDL** program.
7. Remove the serial cable from the laptop and connect it to ACB board port J12.

The Terminal will now start communicating with the drive.

## Setting up Diagnostic Trending

The diagnostic trending is a valuable tool for troubleshooting faults in the drive. It is a method of capturing the variation in the values of different variables over a period of time prior to and after a fault or warning condition. In the PowerFlex 7000 drive with ForGe control, the maximum number of parameters that can be assigned for trending is 16. The length of the trend buffer is 100 samples.

## Diagnostic Setup

The diagnostic setup is used to define the source of the diagnostic trigger. Information that must be programmed in the diagnostic setup is listed in [Table 29](#).

**Table 29 - Diagnostic Setup**

<b>Trace</b>	The Read-Only Parameter which is assigned to a particular list. The item linked to <b>Trace 1</b> is used as the trigger value. There are 16 traces in total, although not all have to be active.								
<b>Rate</b>	The time delay between sample periods. Any value between 0...20,000 msec can be set. Use numeric keypad to enter the value and press the enter key to accept.								
<b>Post</b>	The percentage of the list which will occur after the after the trigger point. Any value between 0...100% may be used.								
<b>Trigger</b>	<p>Defines whether you want a continuous or a single-shot trigger. Pressing this key will place an S or a C in front of the trigger parameter. You will almost always want a Single-Shot (S) trigger.</p> <p><b>S</b> = Single shot. The trigger occurs only once and stops. The trigger must be manually re-armed. The Re-Arm function clears the memory buffer, which contains the data stored from the previous trend. It is necessary to reset the trending feature in order for a second trigger to occur, unless you have continuous trigger enabled.</p> <p><b>C</b> = Continuous capture. Auto re-arm is enabled to collect new trends until stopped by viewing contents of captured data.</p>								
<b>Cond</b>	<p>Defines the condition that will cause the trigger. Possible options are:</p> <table style="width: 100%; border: none;"> <tr> <td>= Equal to</td> <td>+ Boolean OR</td> </tr> <tr> <td><b>N</b>= Not equal to</td> <td><b>N</b>+ Boolean NOR</td> </tr> <tr> <td>&gt; Greater than</td> <td><b>&amp;</b> Boolean AND</td> </tr> <tr> <td>&lt; Less than</td> <td><b>N&amp;</b> Boolean NAND</td> </tr> </table>	= Equal to	+ Boolean OR	<b>N</b> = Not equal to	<b>N</b> + Boolean NOR	> Greater than	<b>&amp;</b> Boolean AND	< Less than	<b>N&amp;</b> Boolean NAND
= Equal to	+ Boolean OR								
<b>N</b> = Not equal to	<b>N</b> + Boolean NOR								
> Greater than	<b>&amp;</b> Boolean AND								
< Less than	<b>N&amp;</b> Boolean NAND								
<b>Data</b>	Defines the trigger value with respect to the read-only parameter in Trace 1.								

## Setting up the Trend

The Access level must be *Basic* or higher level before programming the drive's trending feature. To change Access level to *Basic*, press **F10** [Access] key on the main screen. The display will change to 'Access' screen. Select *Basic* by pressing down-arrow key and then press *Enter* key. The Access level will change to *Basic*. Press **F10** [*EXIT*] key again to exit to the main screen.

**Note:** The parameter assigned to **Trace1** is used for trigger purpose. The **Condition** and **Data** defined in steps 11 and 12 must be satisfied for the trend to trigger. In most cases the parameter **569** "*DrvStatus Flag1*" is assigned to Trace1 for trigger purpose. A value of **18 Hex** for **Data** (Step-12 below) is used to capture the trend when the drive detects either an Alarm or a Fault condition. If you are interested in the fault condition only then set **Data** as **8 Hex**. If you are interested in Alarm condition only then set **Data** as **10 Hex**.

You can reset the Alarm or Fault in the drive, but don't Re-Arm the trend until you print (upload) the trend data into your laptop. Print the Alarm Queue as well, so that you know which alarm or fault condition was detected by the drive.

1. Press **F9** [*DIAGS*] key on the main screen to display '*Diagnostics*' screen as shown in the picture below.

**Figure 316 - Diagnostics screen**



2. Press **F8** [*D\_SETUP*]. The display will change to '*Diagnostics Setup*' screen as shown in the picture below.

**Figure 317 - Diagnostics Setup**



3. With **Trace-1** selected, press **Enter** key as shown in the picture below.

**Figure 318 - Trace-1**



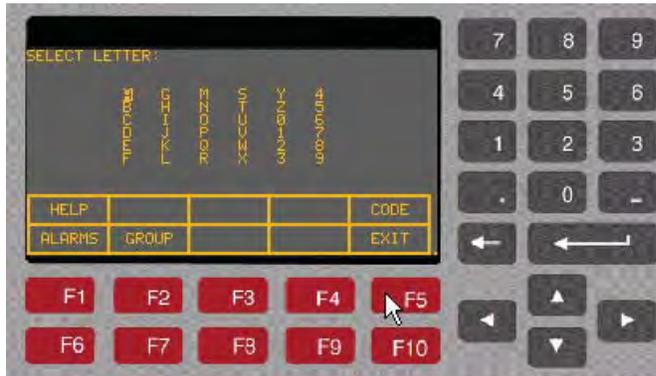
4. The display will change to *'Select Group'* screen as shown in the picture below. Now there are three ways to find the desired a parameter, (i) search by group (select the group by pressing up or down arrow keys and then press Enter key), (ii) search by Alphabetical order (press F7 key to move to the letters screen from there you can search the parameter by highlighting the first letter of the parameter and then pressing the Enter key), (iii) by entering the parameter linear number (press F7 and then F5 for the Code). In the following example we will select the parameter by using a Linear number (i.e., we will enter the Code). For this follow the steps outlined below.

Figure 319 - Select Group



5. Press F7 [*LIST*]. The display will change to *'Select Letter'* screen as shown in the picture below.

Figure 320 - Select Letter



- Press **F5** [*CODE*]. The display will change to '*Select Code*' screen as shown in the picture below.

Figure 321 - Select Code



- Enter the parameter linear number (in our example we have entered **569**) and then press **Enter** key. Once you press the **Enter** key, the parameter description will appear on the screen as shown in the picture below.

Figure 322 - Parameter Description



- Press **Enter** key again. The display will change to the '*Diagnostics Setup*' screen and the desired parameter gets assigned to **Trace 1**. Now, press the down arrow key to move the cursor to **Trace 2** and repeat steps 3 – 8 above to assign a parameter to **Trace 2**.

Figure 323 - Diagnostics Setup with Parameters



9. Repeat above steps until you have assigned the desired parameters to all the traces from Trace1 to Trace16.
10. Now press **F9** [**TRIGGER**] key. The first letter in the second line on the screen will toggle between **C** and **S**. The letter **C** stands for Continuous and **S** stands for Single shot. Select **S** for single shot.
11. Press **F2** [**CONDITION**] key. The cursor will move to the “=” equal sign. This defines the trigger condition. Press up or down arrow keys to select + sign as the trigger condition for our example.

**Figure 324 - Trigger Condition**



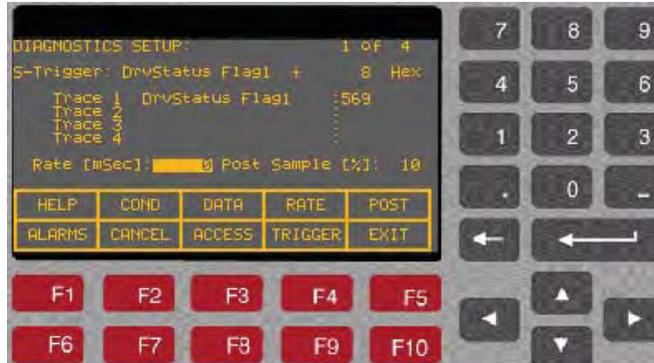
12. Press **F3** [**DATA**] key. The cursor moves to the data field. In our example we will enter **8** and then press **Enter** key.

**Figure 325 - Data Screen**



13. Press **F4** [**RATE**] key. The cursor moves to the rate field. Here we will enter **0**, which is the fastest sample rate (1 msec/sample) and then press **Enter** key.

**Figure 326 - Rate Option**



14. Press **F5** [**POST**] key and enter **10** (this is the percentage of post-trigger samples) and then press the *Enter* key.

**Figure 327 - Post Option**



15. Now, press **F10** [**EXIT**] key to exit to 'Diagnostic' screen. On the 'Diagnostics' screen, verify that the Status is 'Running', which means the Diagnostic Trend is ready and will capture the data whenever the trigger condition is satisfied. If the Status shows 'Stopped' then press **F7** [Re-Arm] key. This will change the Status to **Running**.

Figure 328 - Status Running



16. Now press **F10** [*EXIT*] to exit to the main screen.

## Printing (Uploading) Data from the Drive

### Overview

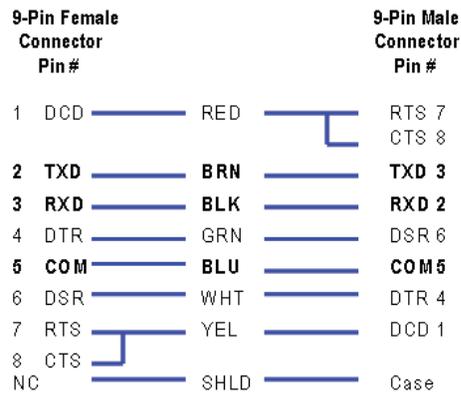
The data from the drive; such as drive setup, parameters, variables, trend data, fault masks, alarm queues etc., can be uploaded and saved into laptop using HyperTerminal program. When using the HyperTerminal program to upload the data, you will be prompted to select a file to store this data. Therefore, you need to open an empty Notepad file and then save that file on your pc before uploading the data from the drive. The following example illustrates the method to create an empty **.txt** file (example1.txt) and upload (or print) the data from drive into laptop.

Required:

- Laptop with Windows HyperTerminal program
- A null-modem cable with a 9-pin female connector for the laptop serial port, and a 9-pin male connector for the ACB Printer Port (**J11**). (*A serial cable with pins 2-3 swapped at one end will also work*)

Here is a typical pin out of a complete null-modem cable. Essentially, only 3 pins (2, 3 and 5) are all that is required.

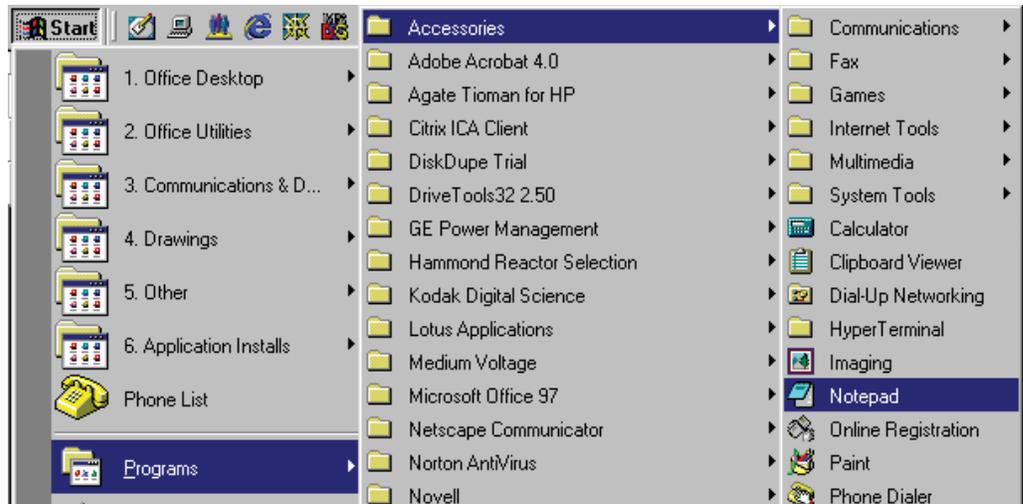
**Figure 329 - Null-modem Cable**



### Creating an empty notepad (.txt) file

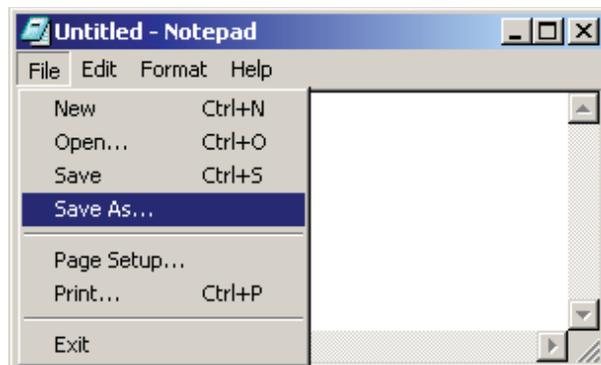
1. Run NotePad Program (Start → Program → Accessories → Notepad)

**Figure 330 - Opening Notepad**



2. From the File menu select **Save As**, as shown below.

**Figure 331 - Saving in Notepad**



3. On the **Save As** window, enter a filename (for instance, *example.txt*) in the field next to **File name** and select the directory from the dropdown list next to **Save in** at the top of the window. In this example the selected directory is C:\temp. Now, click on **Save** button.

Figure 332 - Enter Filename in Notepad

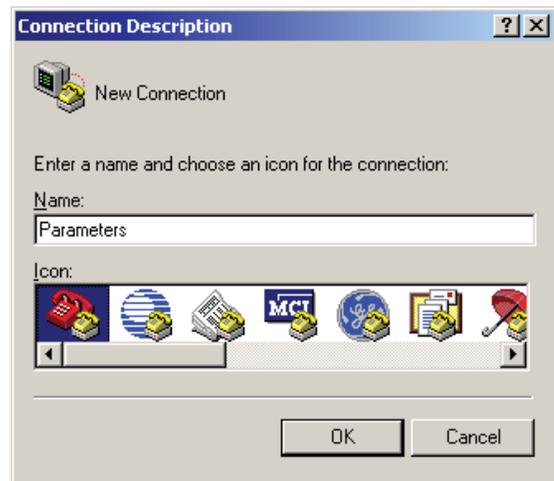


4. An empty notepad file has been created. So, now close the Notepad program.

## Setting up HyperTerminal Connection

1. Run **HyperTerminal** program
2. On the '**Connection Description**' window, enter a name (for instance, *Parameters*) for the New Connection under the *Name* field as shown below and then click **OK**.

Figure 333 - Connection Description



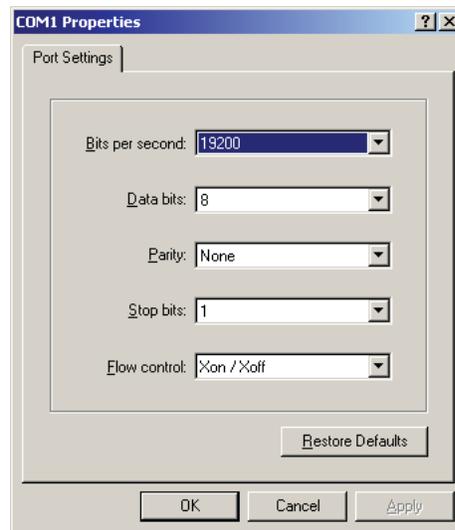
3. Select **COM1** from the dropdown list next to '*Connect Using*' and then click **OK**, as shown below.

Figure 334 - Connect Using Com1



4. The 'COM1 Properties' window will appear. Set the port settings as shown below and then click **OK**.

Figure 335 - COM1 Properties



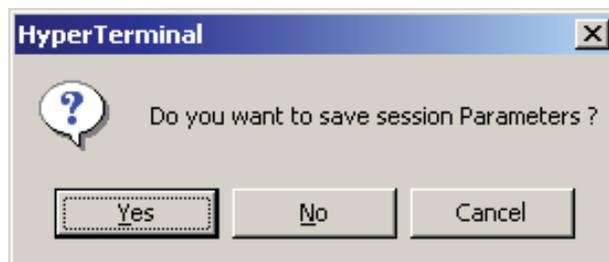
5. Close the HyperTerminal program. The following message box will appear.

Figure 336 - Disconnect from HyperTerminal



6. Click **Yes**. At this point, you will be prompted to save the session.

Figure 337 - Save Session Parameters



7. Click **Yes** to terminate the HyperTerminal program.

## Uploading the Data from the drive

Now that you have created an empty notepad file and setup HyperTerminal connection, you are ready to upload the data from the drive.

1. Connect a null-modem cable between your computer's serial port and the serial port 'J11' on the **Analog Control Board (ACB)**.
2. Restart HyperTerminal program. On the 'Connection Description' window click **Cancel**.

**Figure 338 - Connection Description - New Connection**



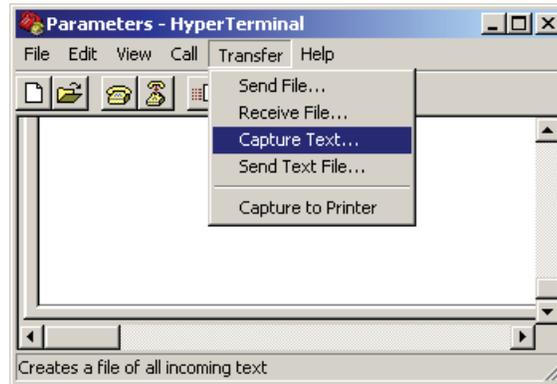
3. From the **File** menu, click **Open....** At the *Open* dialog box, locate the HyperTerminal connection you just created in step 2, (e.g. **Parameters**) and click **Open**.

**Figure 339 - Open Parameters file**



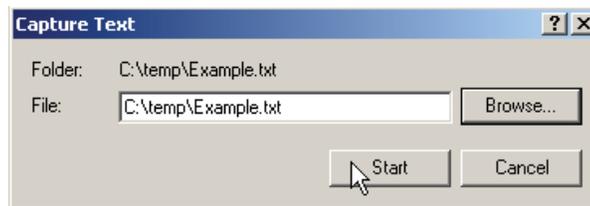
- From the **Transfer** menu, select *Capture Text...* as shown below.

Figure 340 - Capture Text



- The **Capture Text** dialog box will appear. Click on **Browse** button and search the file **Example.txt** that you created in step 1 above.

Figure 341 - Open Text File

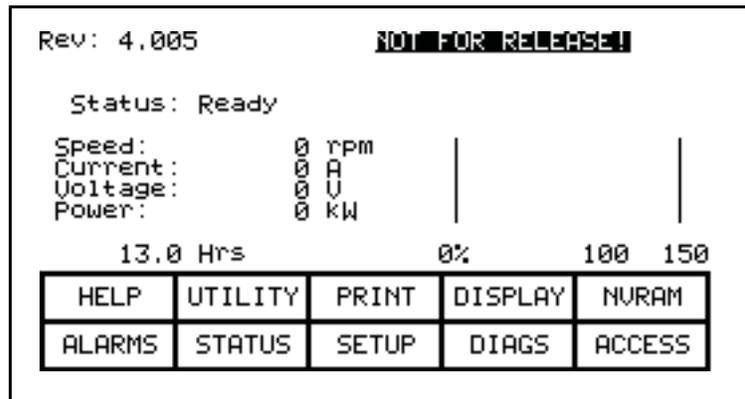


- Click **Start**.

HyperTerminal now acts as a dummy printer and is waiting for the information to be transmitted from the drive to the laptop.

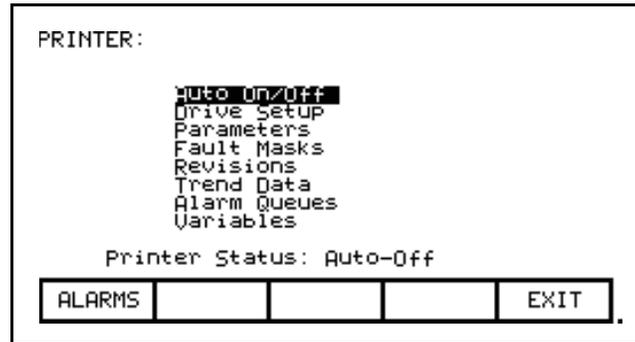
- From the drive **Terminal**, hit **F3 (PRINT)** at the main screen as shown below:

Figure 342 - Terminal Screen



The Terminal screen will change and display Printer options, as shown below.

**Figure 343 - Printer Options**



Now, using Up or Down (↕) arrow keys on the Terminal keypad select the item you want to print (i.e., upload the info into laptop) and press **Enter** key (↵). The required information will be transferred to your laptop and stored in the file C:\temp\Example.txt. Repeat this step to upload other data into your laptop.

The most desirable selections are:

- **Drive Setup:** for complete setup, which include Parameters, Fault Masks and Revisions
- **Trend Data:** for analyzing the drive trending
- **Variables:** snapshot of real-time data while the drive running.

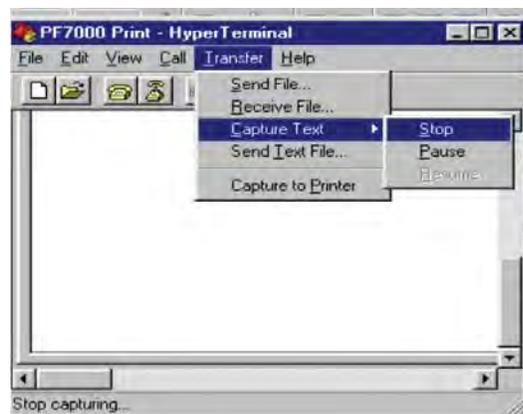
---

**IMPORTANT** Note that while the data is being transferred, the Printer Status will show Transfer in Process. Once the data transfer is complete, the Printer Status changes to either Auto-Off or Auto-On.

---

8. The last step is to stop the communication between your laptop and the drive and close the file Example.txt. At your laptop, click on **Transfer** menu and select **Stop** option under *Capture Text ...* as shown in the screenshot below.

**Figure 344 - Stop Capture Text**



Close the HyperTerminal program and disconnect the laptop from the drive.

## Printing (Uploading) Control Data

In PowerFlex 7000 drives with ForGe control, a specific memory location has been set aside to capture and store critical data in the event of a fault condition. This data is referred to as "Control Data". There are total 8 buffers where the data is stored sequentially on first-in first-out basis, which ensures the data of 8 most recent faults is always available. The data can be retrieved for analysis.

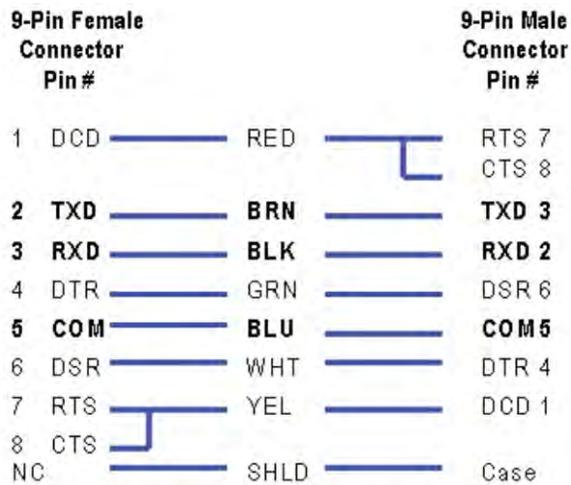
The method of retrieving Control Data is explained below.

Required:

- Laptop with Windows HyperTerminal program
- A null-modem cable with a 9-pin female connector for the laptop serial port, and a 9-pin male connector for Drive Processor Module (DPM) data port (J4). *(A serial cable with pins 2-3 swapped at one end will also work)*

Here is a typical pin out of a complete null-modem cable. Essentially, only 3 pins (2, 3 and 5) are all that is required.

**Figure 345 - Complete Null-Modem Cable**

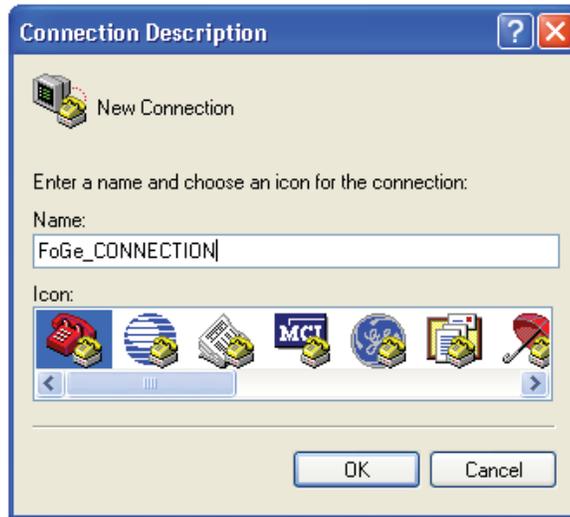


Connect your laptop to the drive using a 9-pin null-modem cable to DPM data port (J4).

## Set up HyperTerminal connection

1. Run HyperTerminal program
2. At the '*Connection Description*' window, enter any name for new connection under the *Name* field as shown below and then click **OK**.

**Figure 346 - Enter Name for New Connection**



3. The '*Connect to*' window will appear as shown below. Select **COM1** from the dropdown list next to '*Connect using*' and then click **OK**.

**Figure 347 - Connect to Window**



4. The '*COM1 Properties*' window will appear. Set the port settings as shown below and then click **OK**.

Figure 348 - Select Port Settings



5. Close HyperTerminal program. Click Yes to disconnect and Yes again to save.

## Printing Control Data

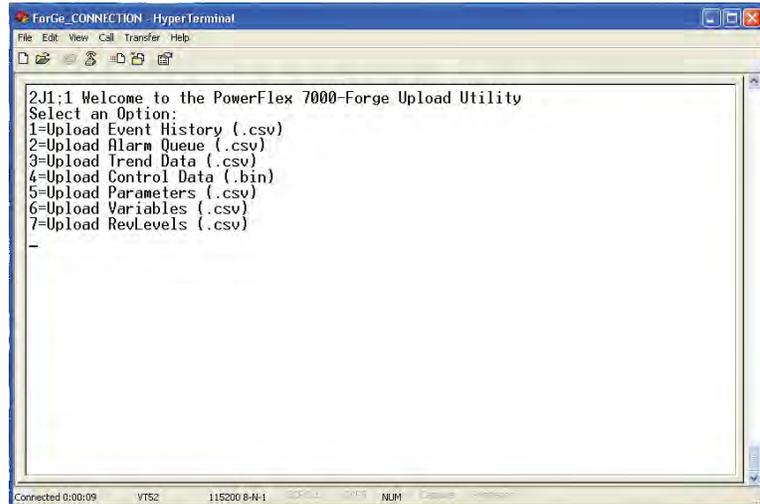
1. Restart HyperTerminal program.
2. At the '**Connection Description**' window as shown below, click **Cancel**.

Figure 349 - Connection Description, New Connection



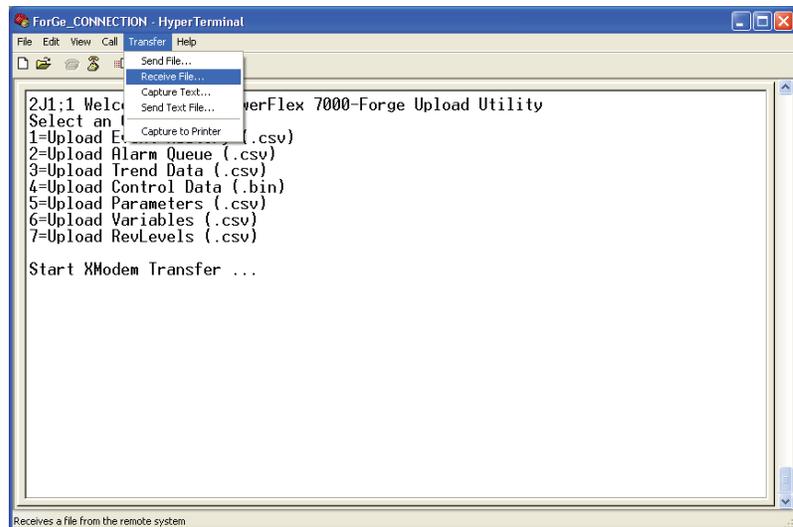
3. From the **File** menu, click **Open...** The **Open** window will appear. Locate the HyperTerminal connection that you just created in step 2 above (**ForGe\_CONNECTION** in this example) and then click **Open**.
4. Press the **ENTER** key. This should bring up the following options menu in the HyperTerminal window.

**Figure 350 - HyperTerminal Window**



5. From the above menu select the desired option by pressing the corresponding number to upload (print) the data. To upload **Control Data**, select option 4.
6. After selecting the desired option, you need to start the transfer by selecting **Receive File ...** from the **Transfer** menu as shown below.

**Figure 351 - Receive File**



The **Receive File** window will pop. Click **Browse** button and select the directory where you want to save the data file. Make sure the **Receiving Protocol** is set to **Xmodem**, then click **Receive**.

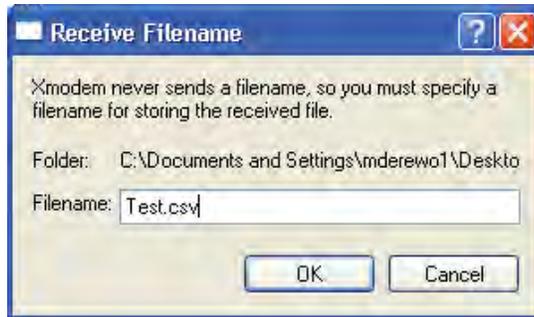
Figure 352 - Receive File Window



The **Receive Filename** dialog appears.

7. Enter the file name, but make sure you also enter a correct extension as given in the options menu. For **Control Data** use **.bin** extension. For all other data use **.csv** extension. Click **OK**.

Figure 353 - Receive Filename



8. When the data transfer is complete, you can select any option you want to print (upload). Once you have printed all the data files, you can then shutdown the HyperTerminal program and unplug the null-modem cable from the DPM board.

## Environmental Considerations

## Hazardous Materials

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

Please be assured that Rockwell Automation is actively seeking alternatives to potentially hazardous materials for which no feasible alternatives exist today in the industry. In the interim, the following precautionary information is provided for your protection and for the protection of the environment. Please contact the

factory for any environmental information on any material in the drive or with any general questions regarding environmental impact.

### *Capacitor Dielectric Fluid*

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

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

### *Printed Circuit Boards*

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

### *Lithium Batteries*

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

### *Chromate Plating*

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

### *In Case Of Fire*

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

individuals involved in extinguishing the fire or anyone in close proximity should wear a self-contained breathing apparatus to protect against any inhalation of toxic gases.

## Disposal

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

## Preventive Maintenance Check List

The preventive maintenance activities on the PowerFlex 7000 Liquid-Cooled Drive (C-Frame) can be broken down into two categories:

- **Operational Maintenance** – can be completed while the drive is running. These checks should be done periodically depending on operating conditions; the time between maintenance should not exceed three months.
- **Annual Maintenance** – should be completed during scheduled downtime.

Refer to [Tool / Parts / Information Requirements on page 409](#) at the end of this section for a list of documentation and materials needed to properly complete the preventive maintenance documents.

## Operational Maintenance

The PowerFlex 7000 “C” frame drive uses a mixture of de-ionized water and Glycol to cool down the devices. One of the desired qualities of this mixture is the low conductivity; a second is the low freezing point. The latter is required in climates where the temperature can drop below 0°C. The maintenance on the system can be done with the drive running by closing valve # V8 and V9. They must be re-opened when the changes are done.

The maintenance includes the following tasks:

- **Changing the DI Cartridge** – The DI cartridge keeps the conductivity low by removing positive ions from the DI water/glycol solution. It needs to be changed whenever the conductivity warning appears. This occurs when the conductivity increase above 1µS. **The DI cartridge cannot be cleaned, it must be replaced.**

- **Changing or Cleaning the Mesh Filters** – The DI Cartridge require clean DI water/Glycol solution to prevent damage. There are two Mesh filters, one before and one after the DI Cartridge. These should be changed or cleaned whenever they become dirty or the DI Cartridge is changed. The loose particles on the outside Mesh Filter can be removed by opening the tap on the bottom of the clear plastic container. The loose particle and the liquid should be collected in a small container and then discarded. The filter can then be removed and cleaned or changed. When the Mesh Filters are cleaned/changed, they should be thoroughly checked for damage before they are re-installed.
- **Maintenance of the Water pumps** – The two water pumps should be greased and checked for leaks whenever preventive maintenance is scheduled or every 3 months which ever comes first.
- **Check Coolant Levels in the reservoir** – The level of coolant should be measured or marked on the side reservoir. Masking tape placed vertically on the side of the reservoir can be marked with a pen or pencils for future level references.

The coolant level will go down due to evaporation. Significant change in coolant levels could be sign of leak in the drive or heat exchanger and should be checked thoroughly.

Percentage of Glycol in coolant should also be checked periodically. Since Water will evaporate faster than Glycol, the percentage could change as the liquid evaporates. The heat transfer quality changes as the percentages changes. A correct Glycol content should be maintained to balance the heat transfer quality and freezing point of the liquid.

- **Maintenance of the heat exchanger** – The liquid to air exchangers have fans, chiller fins and tubing. They should be checked for debris and cleaned periodically. Make sure all inspection opening cover plates are re installed after inspection.

## Annual Maintenance

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

## Initial Information Gathering

Some of the important information to be recorded includes:

- Print Drive Setup
- Print Fault/Warning Queues
- Save Parameters to NVRAM

- Save Parameters to Operator Interface
- Circuit Board Part Numbers / Serial Numbers / Revision Letters<sup>(1)</sup>



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

## Physical Checks (NO Medium Voltage and NO Control Power)

- **Power Connection Inspection**
    - Inspect PowerFlex 7000 drive, input/output/bypass contactor sections, and all associated drive components for loose power cable connections and ground cable connections: torque them to the required torque specifications.
    - Inspect the bus bars and check for any signs of overheating / discoloration and tighten the bus connections to the required torque specifications.
    - Clean all cables and bus bars that exhibit dust build-up.
    - Use torque sealer on all connections.
  - **Carry out the integrity checks on the signal ground and safety grounds.**
  - **Check for any visual/physical evidence of damage and/or degradation of components in the low voltage compartments.**
    - This includes Relays, Contactors, Timers, Terminal connectors, Circuit breakers, Ribbon cables, Control Wires, etc.; Causes could be corrosion, excessive temperature, or contamination.
    - Clean all contaminated components using a vacuum cleaner (DO NOT use a blower), and wipe clean components where appropriate.
  - **Check for any visual/physical evidence of damage and/or degradation of components in the medium voltage compartments (inverter/rectifier, cabling, DC Link, contactor, load break, harmonic filter, etc.).**
    - This includes main cooling fan, power devices, heatsinks, circuit boards, insulators, cables, capacitors, resistors, current transformers, potential transformers, fuses, wiring, etc.; Causes could be corrosion, excessive temperature, or contamination.
    - Verify that torque on heatsink bolts (electrical connections to bullet assemblies) is within specifications (13.5 N-m).
    - Clean all contaminated components using a vacuum cleaner (DO NOT use a blower), and wipe clean components where appropriate.
- TIP** An important component to check for contamination is the heatsink. The fine grooves in the aluminum heatsinks can capture dust and debris.

(1) This only needs to be recorded if parts have been modified/changed since the last PM activities.

- **Carry out the physical inspection and verification for the proper operation of the contactor/isolator interlocks, and door interlocks.**
  - Carry out the physical inspection and verification for the proper operation of the key interlocks.
  - Physical verification of the additional cooling fans mounted in the AC Line Reactor cabinet, Harmonic Filter cabinet for mounting and connections.
  - Carry out the cleaning of the fans and ensure that the ventilation passages are not blocked and the impellers are freely rotating without any obstruction.
  - Carry out the insulation meggering of the drive, motor, isolation transformer/line reactor, and the associated cabling.
  - Refer to [Meggering on page 421 \(Appendix C\)](#), for meggering procedure.
  - Check clamp head indicator washers for proper clamp pressure, and adjust as necessary.
  - Refer to [Checking Clamping Pressure on page 292](#) for details on proper clamp pressure.

### **Control Power Checks (No Medium Voltage)**

- Apply 3 Phase Control power to the PowerFlex 7000 drive, and test power to all of the vacuum contactors (input, output, and bypass) in the system, verifying all contactors can close and seal in.
  - Refer to Publication [1502-UM050 -EN-P](#) for a detailed description of all contactor maintenance
- Verify all single-phase cooling fans for operation.
  - This includes the cooling fans in the AC/DC Power supplies and the DC/DC converter.
- Verify the proper voltage levels at the CPT (if installed), AC/DC Power Supplies, DC/DC converter, isolated gate power supply boards.
  - Refer to [Commissioning on page 169 \(Chapter 4\)](#) for appropriate procedures/voltage levels for the above checks.
- Verify the proper gate pulse patterns using Gate Test Operating Mode.
- If there have been any changes to the system during the outage, place the drive in System Test Operating Mode and verify all functional changes.

### **Final Power Checks before Restarting**

- Ensure all cabinets are cleared of tools, and all component connections are back in place and in the running state.
- Put all equipment in the normal operating mode, and apply medium voltage.
- If there were any input or output cables removed, verify the input phasing, and bump the motor for rotation.

- If there were any changes to the motor, input transformer, or associated cabling, you will have to retune the drive to the new configuration using autotuning.
- Save all parameter changes (if any) to NVRAM.
- Run the application up to full speed/full load, or to customer satisfaction.
- Capture the drive variables while running, in the highest access level if possible.

### **Additional Tasks During Preventive Maintenance**

- Investigation of customer's concerns relating to drive performance
  - Relate any problems found during above procedures to customer issues.
- Informal instruction on drive operation and maintenance for plant maintenance personnel
  - Reminder of safety practices and interlocks on MV equipment, and on specific operating concerns
  - Reminder of the need to properly identify operating conditions
- Recommendation for critical spare parts which should be stocked in-plant to reduce production downtime
  - Gather information on all spare parts on site, and compare that with factory-recommended critical spares to evaluate whether levels are sufficient.
  - Contact MV Spare Parts group for more information.
- Vacuum Bottle Integrity Testing using a Vacuum Checker or AC Hipot
  - Refer to Publications **1502-UM050\_EN-P** (Series D) and **1502-UM052\_-EN-P** (Series E) for a detailed description of all 400A contactor maintenance.

### **Final Reporting**

- A complete, detailed report on all steps in the Preventive Maintenance procedures should be recorded to identify changes.
  - A completed copy of this checklist should be included.
  - A detailed description of ALL ADJUSTMENTS AND MEASUREMENTS that were taken during the process should be included in an addendum (Interlock Adjustments, Loose Connections, Voltage Readings, Megger Results, Parameters, etc.)
- THIS INFORMATION SHOULD BE COMMUNICATED TO MV PRODUCT SUPPORT SO THAT FUTURE SUPPORT ACTIVITIES WILL HAVE THE LATEST SITE INFORMATION AVAILABLE.
  - This can be faxed to (519) 740-4756

## Time Estimations

- Operational Maintenance 0.5 hours per filter
- Annual Maintenance
  - Initial Information Gathering 0.5 hours
  - Physical Checks
    - Torque Checks 2.0 hours
    - Inspection 2.0 hours
    - Cleaning \*\* 2.5 hours \*\*
    - Meggering 1.5 hours
  - Control Power Checks
    - Contactor Adjustments \*\* 2.0 hours \*\*
    - Voltage Level Checks 1.0 hours
    - Firing Check 0.5 hours
    - System Test \*\* 2.0 hours \*\*
  - Medium Voltage Checks
    - Final Inspection 0.5 hours
    - Phasing Check \*\* 1.5 hours \*\*
    - Autotuning\*\* 2.0 hours \*\*
    - Operation to Maximum Load Site Dependent
  - Additional Tasks
    - Investigation \*\* of the Problem \*\* Depends on Nature
    - Informal Training/Refresher \*\* 2.0 hours \*\*
    - Spare Parts Analysis \*\* 1.0 hours \*\*
    - Vacuum Bottle Integrity Check \*\* 3.0 hours \*\*
  - Final Report 3.0 hours

\*\* indicates that the time may not be required depending on the nature of the maintenance and the condition of the drive system. These times are only estimations.

## Tool / Parts / Information Requirements

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

### *Tools*

- 100 MHz Oscilloscope with minimum 2 Channels and memory
- 5kV DC Megger
- Digital Multimeter
- Torque Wrench

- Laptop Computer with Relevant Software and Cables
- Assorted Hand Tools (Screwdrivers, Open Ended Metric Wrenches, Metric Sockets, etc.)
- 5/16 Allen Keys
- Speed Wrench
- Feeler Gauge
- Vacuum Bottle Checker or AC-Hipot
- Minimum of 7.5 kV Hotstick / Potential Indicator
- Minimum of 10 kV Safety Gloves
- Vacuum Cleaner with Anti-static Hose
- Anti-static Cleaning Cloth
- No. 30 Torx Driver

#### *Documentation*

- PowerFlex 7000 User Manual – Publication [7000-UM151 -EN-P](#)
- PowerFlex Technical Data (Parameters, Troubleshooting) – Publication [7000-TD002 -EN-P](#)
- PowerFlex MV Drives Transportation and Handling Procedures – Publication [7000-IN008 -EN-P](#)
- MV 400A Vacuum Contactor, Series D User Manual – Publication [1502-UM050 -EN-P](#)
- MV 400A Vacuum Contactor, Series E User Manual – Publication [1502-UM052 -EN-P](#)
- Drive-Specific Electrical and Mechanical Prints
- Drive-Specific Spare Parts List

#### *Materials*

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

## Catalog Number Explanation

*Position*

1	2	3	4	5	6	7
<b>7000L</b>	<b>A</b>	<b>40</b>	<b>D</b>	<b>A</b>	<b>RPDTD</b>	<b>1-...etc.</b>
<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	

**a**

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

**b**

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

**c**

Drive Current Rating <sup>(1)</sup>			
Code	Description	Code	Description
40	40 Amp	215	215 Amp
46	46 Amp	250	250 Amp
53	53 Amp	285	285 Amp
61	61 Amp	325	325 Amp
70	70 Amp	375	375 Amp
81	81 Amp	430	430 Amp
93	93 Amp	495	495 Amp
105	105 Amp	575	575 Amp
120	120 Amp	625	625 Amp
140	140 Amp	657	657 Amp
160	160 Amp	720	720 Amp
185	185 Amp		

(1) Not all amperages are available at all ambient/altitude configurations.

**d**

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

Position

1                      2                      3                      4                      5                      6                      7  
**7000L**                      **A**                      **40**                      **D**                      **A**                      **RPDTD**                      **1-...etc.**  
*a*                      *b*                      *c*                      *d*                      *e*                      *f*

**e**

**f**

Supply Voltage/Control Voltage/Frequency/CPT Selection						
Frame Size	Voltage		Frequency (Hz)	Code		
	Nominal Line	Control		With a C.P.T. <sup>(1)</sup>	Without a C.P.T. <sup>(2)</sup>	
"A" Frame	2400	120	60	A	AD	
		120...240		AA	—	
	3300	110	50	CY	CDY	
		220		CP	CDP	
	4160	110	50	EY	EDY	
		220		EP	EDP	
		120	60	E	ED	
		120...240		EA	—	
	6600	110	50	JY	JDY	
		220		JP	JDP	
		110...220		JAY	—	
		120	60	J	JD	
		240		JA	—	
		208		AHD		
	"B" and "C" Frames <sup>(3)</sup>	2400	480	60	ABD	
			600		ACD	
230			CPD			
3300		380	50	CND		
		400		CKD		
		230		EPD		
4160		380	50	END		
		400		EKD		
		208	60	EHD		
		480		EBD		
		600		ECD		
6600		230	50	JPD		
		380		JND		
		400		JKD		
		208	60	JHD		
	480	JBD				
	600	JCD				

Rectifier Configuration/Line Impedance Type	
Code	Description
RPDTD	AFE Rectifier with Integral Line Reactor and Direct-to-Drive DC Link
RPTX	AFE Rectifier with provision for connection to separate Isolation Transformer (standard DC Link)
RPTXI	AFE Rectifier with integral Isolation Transformer (standard DC Link) <sup>(1)</sup>
R18TX	18 Pulse Rectifier with provision for connection to separate Isolation Transformer (standard DC Link) <sup>(2)</sup>

(1) RPTXI configuration is only available for "A" Frame configurations.

(2) R18TX configuration is only available for "B" and "C" Frame configurations.

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

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

(3) Three-phase Control Circuit Power is supplied from separate/external source.

## PowerFlex 7000 Drive Selection Explanation

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

- **Normal Duty (110% overload for one (1) Minute, once every 10 minutes)** – used for Variable Torque (VT) applications only.

Drives with this rating are designed for 100% continuous operation, with 110% overload for one (1) minute, once every 10 minutes.

- **Heavy Duty (150% for one (1) Minute, once every 10 minutes)** – used for Constant Torque (CT) or Variable Torque (VT) applications.

Drives with this rating are designed for 100% continuous operation, with 150% overload for one (1) minute, once every 10 minutes.

### Service Duty Rating, Continuous Current Rating & Altitude Rating Code

There are five different codes that define service duty and altitude in the drive catalog number per the table on [page 411](#).

#### For example:

Catalog number 7000 – **A105**DEHD-R18TX, has a continuous current rating of 105 amps, with a “normal duty” service rating up to 1000 meters altitude.

Catalog number 7000 – **B105**DEHD-R18TX has a continuous rating of 105 amps with a “normal duty” service rating up to 5000 meters altitude. Please note that the ambient temperature rating of the drive is reduced at higher altitudes. If 40°C ambient is required at 1001-5000 meters altitude, then a rating code of **Z** is required.

Catalog number 7000 – **C105**DEHD-R18TX, has a continuous current rating of 105 amps, with a “heavy duty” service rating up to 1000 meters altitude.

**TIP** The factory should be contacted for assistance sizing air-cooled drives that require greater than 150% overload. Refer to [Table 32](#) for typical application load torque profiles, to determine which drive overload rating is best suited for your application.

## When is an Encoder Required?

An encoder is required under the following conditions:

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

**Table 30 - Power Flex Speed Regulation**

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

### Notes:

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

**Table 31 - Encoder Selection**

<b>High Performance Torque Control (HPTC) Mode</b>	<b>Motor RPM</b>	<b>Minimum Tach PPR</b>	<b>Recommended Tach PPR</b>
	3600	1024	1024
	3000	1024	1024
	1800	1024	2048
	1500	1024	2048
	1200	2048	2048
	1000	2048	2048
	900	2048	4096
	720	4096	4096
	600	4096	4096
	450	4096	8192
	360	8192	8192
	300	8192	8192
<b>Standard Control Mode</b>	3600	—	600
	3000	—	600
	1800	—	1024
	1500	—	1024
	1200	—	2048
	1000	—	2048
	900	—	2048
	720	—	2048
	600	—	2048

## PowerFlex 7000 Drive Performance (Torque Capabilities)

The PowerFlex 7000 drives have been tested on a dynamometer to verify performance under locked rotor, accelerating, and low speed-high torque conditions. [Table 32](#) below shows the PowerFlex 7000 drive torque capabilities as a percent of motor rated torque, independent of the drive’s momentary overload conditions.

**Table 32 - PowerFlex 7000 Drive Torque Capabilities**

<b>Parameter</b>	<b>7000 Torque Capability without Encoder (% of Motor Rated Torque)</b>	<b>7000 Torque Capability with Encoder (% of Motor Rated Torque)</b>	<b>7000 Torque Capability with Encoder and High Performance Torque Control (HPTC)</b>
Breakaway Torque	90%	150%	150%
Accelerating Torque	90% (0...8 Hz)	140% (0...8 Hz)	150% (0...75 Hz)
	125% (9...75 Hz)	140% (9...75 Hz)	
Steady State Torque	125% (9...75 Hz) <sup>(1)</sup>	100% (1...2 Hz)	150% (0...60 Hz) <sup>(1)</sup>
		140% (3...60 Hz) <sup>(1)</sup>	
Max. Torque Limit	150%	150%	150%

(1) Drive will require over-sizing to achieve greater than 100% continuous torque.

## Glossary of Terms

### *Breakaway Torque*

Torque required to start a machine from standstill.

### *Accelerating Torque*

Torque required to accelerate a load to a given speed, in a certain period of time. The following formula may be used to calculate the average torque to accelerate a known inertia ( $WK^2$ ):

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

where,  $T$  = acceleration torque in (lb-ft).  
 $WK^2$  = total system inertia (lb-ft<sup>2</sup>) that the motor must accelerate, including motor, gear box, and load.  
 $t$  = time (seconds) to accelerate total system load.

### *Steady State Torque*

Continuous operating torque required to control the load, without instability.

### *Torque Limit*

An electronic method of limiting the maximum torque available from the motor.

The software in a drive typically sets the torque limit to 150% of motor rated torque.

**Table 33 - Typical Application Load Torque Profiles** <sup>(1)</sup>

Application	Load Torque Profile	Load Torque as Percent of Full-Load Drive Torque			Required Drive Service Duty Rating	Encoder Required for Extra Starting Torque?
		Break-away	Accelerating	Peak Running		
<b>AGITATORS</b>						
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	100	100	Heavy	Yes
<b>BLOWERS (centrifugal)</b>						
Damper closed	VT	30	50	40	Normal	No
Damper opened	VT	40	110	100	Normal	No
<b>CHIPPER (WOOD)—starting empty</b>	CT	50	40	200	Contact factory	No
<b>COMPRESSORS</b>						
Axial-vane, loaded	VT	40	100	100	Normal	No
Reciprocating, starting unloaded	CT	100	100	100	Contact factory	Yes
<b>CONVEYORS</b>						
Armored face	CT	175	150	200	Contact factory	Yes
Belt type, loaded	CT	150	130	100	Heavy	Yes
Drag type	CT	175	150	100	Contact factory	Yes

**Table 33 - Typical Application Load Torque Profiles (Continued)<sup>(1)</sup>**

Application	Load Torque Profile	Load Torque as Percent of Full-Load Drive Torque			Required Drive Service Duty Rating	Encoder Required for Extra Starting Torque?
		Break-away	Accelerating	Peak Running		
Screw type, loaded	CT	200	100	100	Contact factory	Yes
<b>DRAG LINE</b>	CT	100	200	200	Contact factory	Yes
<b>EXTRUDERS (rubber or plastic)</b>	CT	150	150	100	Contact factory	Yes
<b>FANS (centrifugal, ambient)</b>						
Damper closed	VT	25	60	50	Normal	No
Damper open	VT	25	110	100	Normal	No
<b>FANS (centrifugal, hot gases)</b>						
Damper closed	VT	25	60	100	Normal	No
Damper open	VT	25	200	175	Contact factory	No
<b>FANS (propeller, axial flow)</b>	VT	40	110	100	Normal	No
<b>GRINDING MILL (Ball/Sag Mill)</b>	CT	175	180	100	Contact factory	Yes
<b>HOISTS</b>	CT	100	200	200	Contact factory	Yes
<b>KILNS (rotary, loaded)</b>	CT	250	125	125	Contact factory	Yes
<b>MIXERS</b>						
Chemical	CT	175	75	100	Contact factory	Yes
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	125	100	Heavy	Yes
Solids	CT	175	125	175	Contact factory	Yes
<b>PULPER</b>	VT	40	100	150	Contact factory	No
<b>PUMPS</b>						
Centrifugal, discharge open	VT	40	100	100	Normal	No
Oil field Flywheel	CT	150	200	200	Contact Factory	Yes
Propeller	VT	40	100	100	Normal	No
Fan Pump	VT	40	100	100	Norma	No
Reciprocating / Positive Displacement	CT	175	30	175	Contact factory	Yes
Screw type, started dry	VT	75	30	100	Normal	No
Screw type, primed, discharge open	CT	150	100	1000	Heavy	Yes
Slurry handling, discharge open	CT	150	100	100	Heavy	Yes
Turbine, Centrifugal, deep-well	VT	50	100	100	Normal	No
Vane-type, positive displacement	CT	150	150	175	Contact factory	Yes
<b>SEPARATORS, AIR (fan type)</b>	VT	40	100	100	Normal	No

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

**Notes:**

## Torque Requirements for Threaded Fasteners

### Torque Requirements

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

Diameter	Pitch	Material	Torque (N·m)	Torque (lb·ft)
M2.5	0.45	Steel	0.43	0.32
M4	0.70	Steel	1.8	1.3
M5	0.80	Steel	3.4	2.5
M6	1.00	Steel	6.0	4.4
M8	1.25	Steel	14	11
M10	1.50	Steel	29	21
M12	1.75	Steel	50	37
M14	2.00	Steel	81	60
1/4"	20	Steel S.A.E. 5	12	9.0
3/8"	16	Steel S.A.E. 2	27	20

**Notes:**

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## Meggering

### Drive Meggering

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

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

### Meggering the PowerFlex 7000



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

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

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



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

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

## Equipment Required

- Torque Wrench and 7/16 inch socket
- Phillips Screwdriver
- 2500/5000 Volt Megger

## Procedure

### 1. Isolate and Lock Out the Drive System from High Voltage

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

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

### 2. Isolate the Power Circuit from System Ground (Float the drive)

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

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

#### Voltage Sensing Boards

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

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

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

#### Output Grounding Network

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

**TIP** Injecting a high voltage on the ground cable during a Megger test will degrade the cable insulation.

### 3. Disconnect Connections between Power Circuit and Low Voltage Control

#### Voltage Sensing Boards

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

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

#### Potential Transformer Fuses

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

#### Transient Suppression Network

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

### 4. Meggering the Drive

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

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

**TIP** Be sure the Megger is discharged prior to disconnecting it from the equipment.

Connect the Megger to the drive following the specific instructions for that model. If the Megger has a lower voltage setting (normally 500V or

1000V), apply that voltage for 5 seconds as a precursor for the higher voltage rating. This may limit the damage if you forgot to remove any grounds. If the reading is very high, apply 5kV from any drive input or output terminal to ground. Perform a Megger test at 5 kV for 1 minute and record the result.

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

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

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

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

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

## 5. Reconnecting Connections between Power Circuit and Low Voltage Control

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

## 6. Reconnect the Power Circuit to the System Ground

### Voltage Sensing Boards

Securely reconnect the two ground conductors on the VSBs.

The two ground connections on the VSB provide a reference point for the VSB and enable the low voltage signal to be fed to the SCBs. If the ground

conductor was not connected, the monitored low voltage signal could then rise up to medium voltage potential which is a serious hazard that must be avoided at all times. You must always ensure the ground conductors on the VSB are securely connected before applying medium voltage to the drive.



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

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### **Output Grounding Network**

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



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

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### **Transient Suppression Network**

Re-install the fuses on the TSN.

**Notes:**

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## Preventative Maintenance Schedule

### PowerFlex 7000 Maintenance Schedule

Rockwell recognizes that following a defined maintenance schedule will deliver the maximum product availability. By rigorously following this maintenance schedule, the Customer can expect the highest possible uptime. This Annual Preventative Maintenance Program includes a visual inspection of all drive components visible from the front of the unit, resistance checks on the power components, power supply voltage level checks, general cleaning and maintenance, checking of all accessible power connections for tightness, and other tasks. For more details, refer to [Component Definition and Maintenance on page 265 \(Chapter 5\)](#) of this User Manual.

#### **I – Inspection**

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

#### **M – Maintenance**

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

#### **R – Replacement**

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

#### **C – Cleaning**

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

### **Rv – Review**

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

### **RFB/R – Refurbishment/Replacement**

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

## Rockwell Automation PowerFlex 7000 Preventative Maintenance Schedule

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

(1) Only applies to air-cooled VFDs (i.e. "A" Frame and "B" Frame).

(2) Only applies to liquid-cooled VFDs (i.e. "C" Frame).

(3) If filter supplied is not a washable type, replace filter. If filter supplied is a washable type, wash or replace (depending on state of filter).

(4) These components may be serviced while the VFD is running.

(5) Replace UPS batteries yearly for 50°C rated VFDs.

(6) When rectifier snubber capacitors are replaced, the MV connections for rectifier need to be inspected.

(7) When inverter snubber capacitors are replaced, the MV connections for inverter need to be inspected.

(8) A 4-year replacement interval applies to 6-pulse or 18 Pulse versions. Active Front End rectifiers have a 10-year rectifier snubber capacitor replacement interval.

## Rockwell Automation PowerFlex 7000 Preventative Maintenance Schedule

		11	12	13	14	15	16	17	18	19	20
<b>Commissioning Activities</b>											
Air-Cooling System <sup>(1)</sup>	Door Mounted Air Filters <sup>(3) (4)</sup>	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R
	Main Cooling Fan Motor	I	I	I	RFB/R	I	I	I	I	I	I
	Redundant Cooling Fan Motor (if supplied)	I	I	I	RFB/R	I	I	I	I	I	I
	Small Aux. Cooling Fans "Caravel"	I	I	I	I	R	I	I	I	I	R
Liquid-Cooling System <sup>(2)</sup>	Mesh Filters <sup>(4)</sup>	C	C	C	C	C	C	C	C	C	C
	De-ionizing Filter Cartridge <sup>(4)</sup>	R	R	R	R	R	R	R	R	R	R
	All Fittings/Connections/Hose Clamps	I	I	I	I	I	I	I	I	I	I
	Redundant Cooling Pump Motors/Pumps	I	I	I	I	I	I	I	I	I	I
	Redundant Cooling Pump Motor Seals	I	I	I	I	I	I	I	I	I	R
	Thermostatic Valve Element	I	I	I	R	I	I	I	I	I	I
Power Switching Components	Power Devices (SGTs/SCRs)	I	R	I	I	I	I	I	I	I	I
	Snubber Resistors/Sharing Resistors/ HECS	I	I	I	I	I	I	I	I	I	I
	Rectifier Snubber Capacitors	I	I <sup>(8)</sup>	I	I	I	I <sup>(8)</sup>	I	I	I	Rv/R <sup>(8)</sup>
	Inverter Snubber Capacitors	I	I	I	I	I	I	I	I	I	R
	Integrated Gate Driver Power Supply	I	I	I	I	RFB/R	I	I	I	I	RFB/R
Integral Magnetics/ Power Filters	Isolation Transformer/Line Reactor	I	I	I	I	M	I	I	I	I	M
	DC Link/Common Mode Choke	I	I	I	I	M	I	I	I	I	M
	Line/Motor Filter Capacitors	I	I	I	I	M	I	I	I	I	M
Control Cabinet Components	AC/DC and DC/DC Power Supplies	I	I	I	I	RFB/R	I	I	I	I	RFB/R
	Control Boards	I	I	I	I	I	I	I	I	I	I
	Batteries (DCBs and CIB)	I	R	I	I	R	I	I	R	I	I
	Batteries (UPS) <sup>(5)</sup>	I	I	I	I	R	I	I	I	I	R
Connections	Low Voltage Terminal Connections/Plug-in Connections	I	I	I	I	I	I	I	I	I	I
	Medium Voltage Connections	I	I	I	I	I	I	I	I	I	I
	Heatsink Bolted Connections	I	I	I	I	I	I	I	I	I	I
	Medium Voltage Connections (Rectifier) <sup>(6)</sup>	-	I <sup>(8)</sup>	-	-	-	I <sup>(8)</sup>	I <sup>(8)</sup>	-	-	I <sup>(8)</sup>
	Medium Voltage Connections (Inverter) <sup>(7)</sup>	-	-	-	-	-	-	-	-	-	I
Enhancements	Firmware	-	Rv	-	-	Rv	-	-	Rv	-	-
	Hardware	-	Rv	-	-	Rv	-	-	Rv	-	-
Operational Conditions	Parameters	I	Rv	I	I	Rv	I	I	Rv	I	I
	Variables	I	Rv	I	I	Rv	I	I	Rv	I	I
	Application Concerns	I	Rv	I	I	Rv	I	I	Rv	I	I
Spare Parts	Inventory/Needs	I	Rv	I	I	Rv	I	I	Rv	I	I

- (1) Only applies to air-cooled VFDs (i.e. "A" Frame and "B" Frame).
- (2) Only applies to liquid-cooled VFDs (i.e. "C" Frame).
- (3) If filter supplied is not a washable type, replace filter. If filter supplied is a washable type, wash or replace (depending on state of filter).
- (4) These components may be serviced while the VFD is running.
- (5) Replace UPS batteries yearly for 50°C rated VFDs.
- (6) When rectifier snubber capacitors are replaced, the MV connections for rectifier need to be inspected.
- (7) When inverter snubber capacitors are replaced, the MV connections for inverter need to be inspected.
- (8) A 4-year replacement interval applies to 6-pulse or 18 Pulse versions. Active Front End rectifiers have a 10-year rectifier snubber capacitor replacement interval.



## Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products.

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

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

## Installation Assistance

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

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

## New Product Satisfaction Return

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

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

## Documentation Feedback

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

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