

PowerFlex® 7000 Medium Voltage AC Drive Liquid-Cooled ('C' Frame) – Fourth Generation (ForGe) Control



Bulletin 7000L (Marine)
User Manual



Important User Information

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

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

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

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

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

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

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



WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.



ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT

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

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



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



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



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

Overview

Who Should Use This Manual

This User Manual is intended for use by personnel familiar with medium voltage and variable speed solid-state drive equipment. The manual contains material that will allow the user to operate the drive system.

What Is Not in this Manual

This manual is designed to provide only information specific to the PowerFlex 7000 “C” Frame drive. Therefore customer specific topics are not presented. These customer specific topics include:

- Dimensional and Electrical Drawings generated for each customer specific order. (This manual does provide generic drawings for illustrative purposes only.)
- Spare Parts Lists compiled for each customer specific order. (This manual does provide a generic list of possible components and a description of their characteristics and functionality.)

The above information is provided to the customer during the order process cycle.

Three User Manuals address this product line:

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

If you have multiple drive types or power ranges, ensure you have the correct manual.

For detailed information on Troubleshooting, Parameters and Functional Description for MV variable frequency drives, please refer to Technical Data publication **7000-TD002_-EN-P**.

For detailed information on receiving and handling for Medium Voltage variable frequency drive and related equipment, please refer to General Handling Procedures, publication **7000-IN002_-EN-P**.

Reference Manuals (for “A”, “B” and “C” Frame drives) are also available. These manuals provide additional technical information about the drive components. Contact your local Rockwell Automation Sales office to order copies of these publications.

Please note: This manual deals specifically with the PowerFlex 7000 “C” Frame drive. Information on auxiliary cabinetry or special components we are contracted to supply with the drive will be contained within the Service Manual you will receive with your order.

Manual Conventions

Symbols are used throughout this manual to indicate specific types of information.

WARNING



Warnings tell readers where people may be hurt if procedures are not followed properly.

ATTENTION



Cautions tell readers where machinery may be damaged or economic loss can occur if procedures are not followed properly.

Both of the above could indicate:

- A possible trouble spot
- Tell what causes the trouble spot
- Give the result of an improper action
- Tell the reader how to avoid trouble

SHOCK HAZARD



This symbol alerts the user to a potential electrical shock hazard that exists on a component or printed circuit board.

General Precautions

ATTENTION

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

ATTENTION

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

ATTENTION

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

Who to Call for Commissioning

Rockwell Automation **Medium Voltage Support** group is responsible for Commissioning Support and activities for this product line.

They may be contacted at **519-740-4100**, request **Medium Voltage Support – Project Manager**.

The support they offer includes, but is not limited to:

- Quoting and Managing **Product On-site Start-ups**.
- Quoting and Managing **Field Modification projects**.
- Quoting and Managing **Customer in-house and on-site product training**.

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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 3,000 to 9,000 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. ⊇

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

⊇ For 2400V and 3300V designs, contact factory.

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.

The Main 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

The Main Benefits of the 7000L “C” Frame Liquid-cooled Drive Include:

- 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 / cm³)
 - 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 1.1. 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 6500 volt PIV rated power semiconductor devices, the number of inverter components is kept to a minimum. For example, only six inverter switching devices are required at 2400V, 12 at 3300-4160V, and 18 at 6600V.

The PowerFlex 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 1.1.

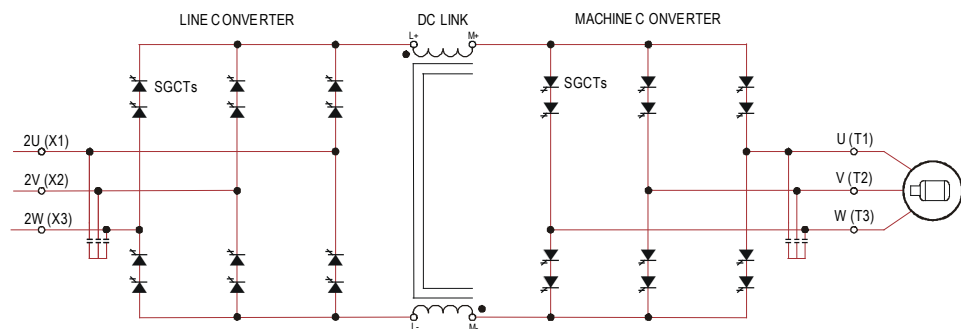


Figure 1.1 – AFE Rectifier (4160 Volt)

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 1.2. 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 1.2. 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.

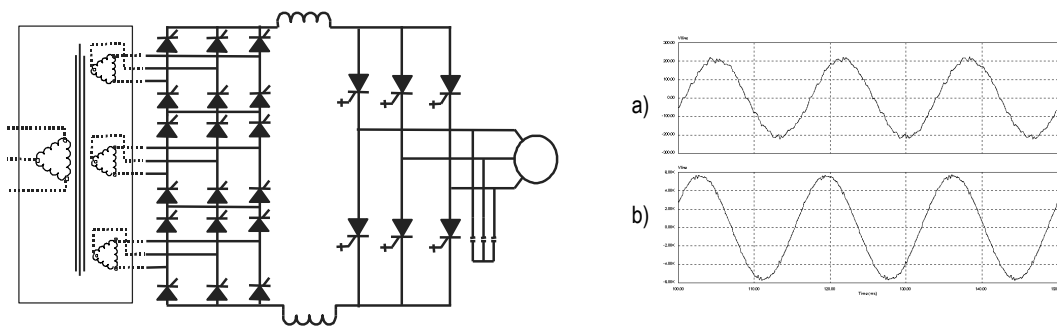


Figure 1.2 – 18-pulse Rectifier and its input waveforms

- a) Line current
- b) Line-to-line voltage at PCC

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 1.3, 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 1.3. 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.

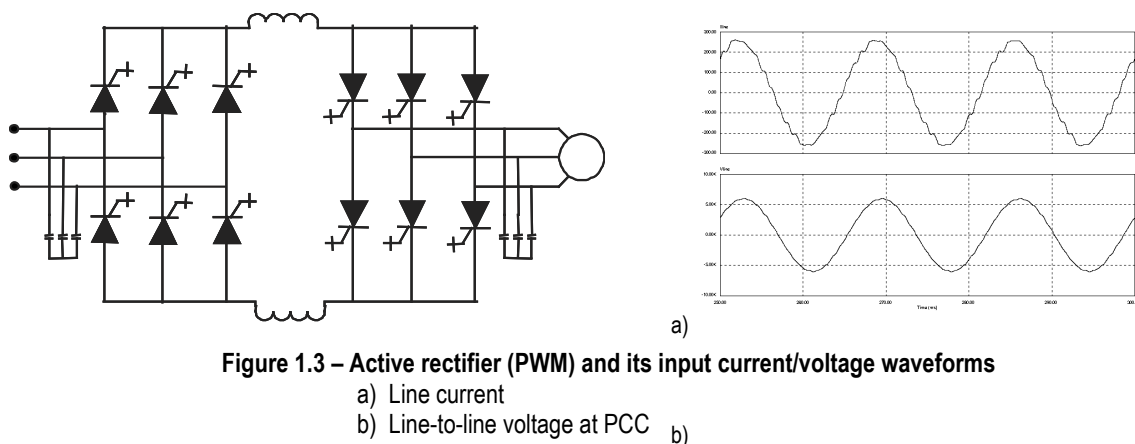


Figure 1.3 – Active rectifier (PWM) and its input current/voltage waveforms

- a) Line current
- b) Line-to-line voltage at PCC

“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 1.5. These motor friendly waveforms are achieved by utilizing a selective harmonic elimination (SHE) pattern in the inverter to eliminate major order harmonics, in conjunction with a small output capacitor (integral to the drive) to eliminate harmonics at higher speeds.

Standard motors are compatible without 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.

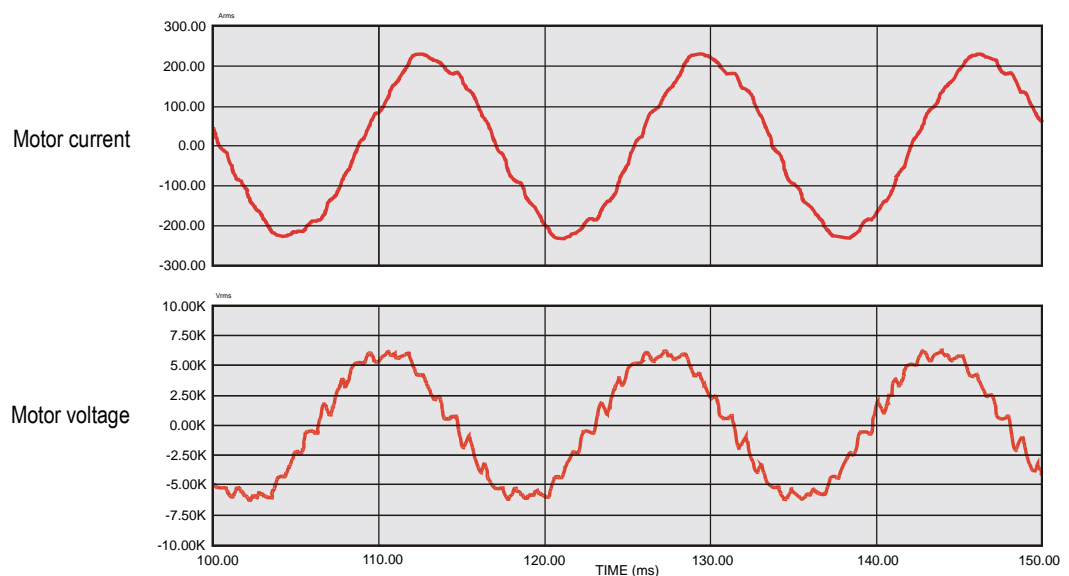


Figure 1.4 – Motor waveforms @ full load, full speed

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 1.5, 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).

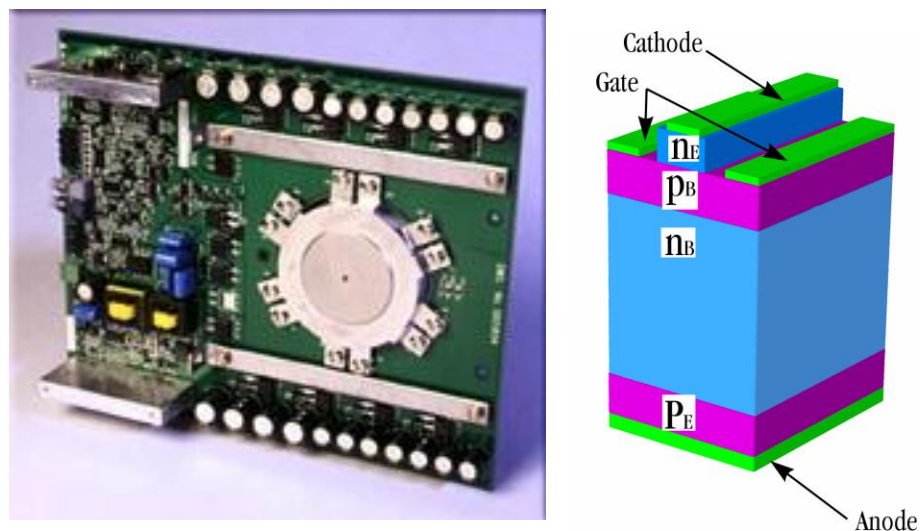


Figure 1.5 – SGCT with integrated gate drive (left) and unit cell structure (right)

Specifications

Description	Specifications	
Power Rating (Liquid Cooled)	NEMA:	3000 – 9000 hp
	IEC:	2240 – 6715 kW
Motor Type	Induction or Synchronous	
Input Voltage Rating \supseteq	2400V, 3300V, 4160V, 6600V	
Input Voltage Tolerance	\pm 10% of Nominal	
Voltage Sag Ⓜ	-30%	
Control Power Loss Ride-Through	5 Cycles (Std)	
Input Protection Ⓝ	Metal Oxide Varistor (MOV) – 18P Surge Arrestors (AFE/D2D)	
Input Frequency	50/60 Hz, +/- 5%	
Input Short-circuit Current Withstand 3300 V – 6000 V Ⓞ	5 Cycle 25 MVA RMS SYM	
Basic Impulse Level Ⓟ	50 kV (0 – 1000 m)	
Power Bus Design	Copper – Tin plated	
Ground Bus	Copper – Tin plated 6 x 51 mm (¼ x 2 in.)	
Customer Control Wireway	Separate and Isolated	
Input Power Circuit Protection Ⓠ	Vacuum Contactor with Fused Isolating Switch or Circuit Breaker	
Input Impedance Device	Isolation Transformer or AC Line Reactor	
Output Voltage	0 – 2300 V	
	0 – 3300 V	
	0 – 4160 V	
	0 – 6600 V	
Inverter Design	PWM	
Inverter Switch	Symmetrical Gate Commutated Thyristor (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	420-540 Hz	
Number of Inverter SGCTs	Voltage	SGCTs (per phase)
	2400 V	2
	3300 V	4
	4160 V	4
	6600 V	6
SGCT PIV Rating (Peak Inverse Voltage)	Voltage	PIV
	2400 V	6500 V
	3300 V	6500 V
	4160 V	6500 V
	6600 V	6500 V
Rectifier Designs	AFE (Active Front End), 18 Pulse Direct-to-Drive	
Rectifier Switch	SCR (18 Pulse) SGCT (AFE, Direct-to-Drive)	
Rectifier Switch Failure Mode	Non-rupture, Non-arc	
Rectifier Switch Failure Rate (FIT)	50 (SCR) 100 (SGCT) per 1 Billion Hours Operation	
Rectifier Switch Cooling	Double Sided, Low Thermal Stress	

Ⓢ For 2400V and 3300V configurations, contact factory.

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

Ⓤ MOVs are used for 18 Pulse. Surge Arrestors are used for AFE/D2D configurations.

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

Ⓢ BIL rating based on altitudes < 1000 m (3,300 ft.) Refer to factory for derating on altitudes >1000 m.

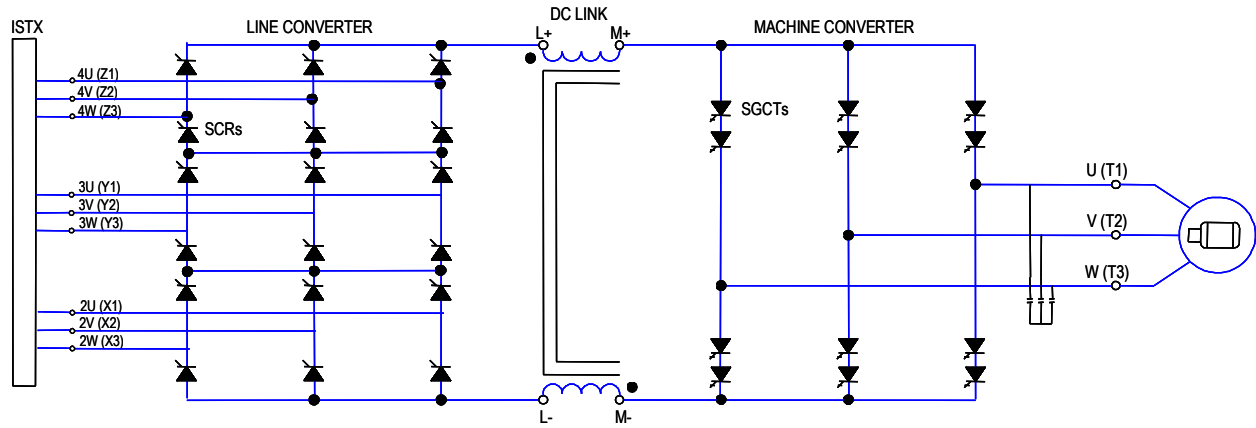
Ⓣ Optional

Specifications (cont.)

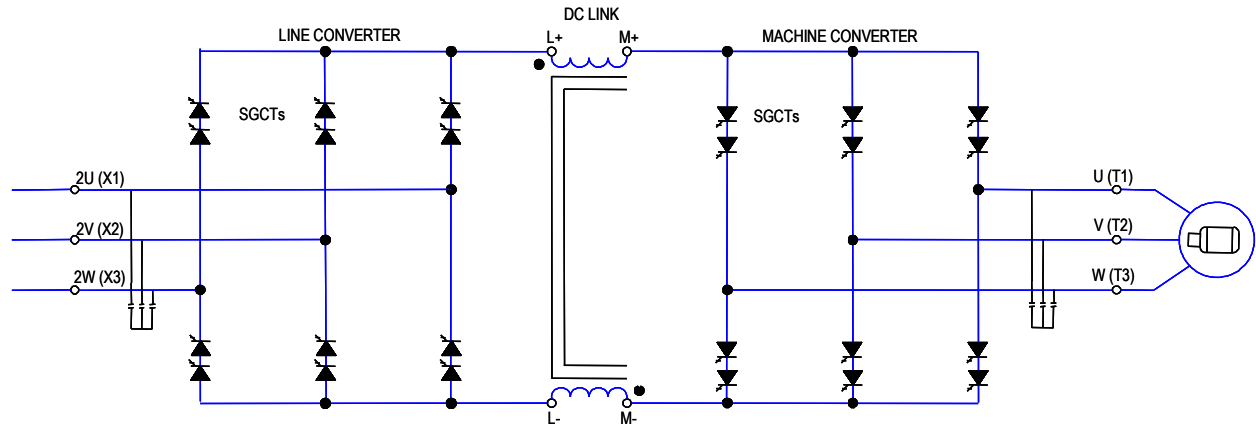
Description	Specifications		
Number of Rectifier Devices per phase	Voltage	18-Pulse	AFE / D2D
	2400 V	6	2
	3300 V	6	4
	4160 V	6	4
	6600 V	6	6
SCR PIV Rating (Peak Inverse Voltage)	Voltage	18-Pulse	AFE / D2D
	2400 V	4500 V	6500 V
	3300 V	4500 V	6500 V
	4160 V	4500 V	6500 V
	6600 V	6500 V	6500 V
Output Waveform to Motor	Sinusoidal Current / Voltage		
Medium Voltage Isolation	Fiber Optic		
Modulation Techniques	SHE (Selective Harmonic Elimination) Synchronous Trapezoidal PWM Asynchronous and Synchronous SVM (Space Vector Modulation)		
Control Method	Digital Sensorless Direct Vector Full Vector Control with Tach Feedback (Optional)		
Tuning Method	Auto Tuning via Setup Wizard		
Speed Regulator Bandwidth	5-25 Radians / Second		
Torque Regulator Bandwidth	15-50 Radians / Second		
Speed Regulation	0.1% without Tachometer Feedback 0.01-0.02% with Tachometer Feedback		
Acceleration/Deceleration Range	Independent Accel/Decel – 4 x 1200 sec.		
Acceleration/Deceleration Ramp Rates	4 x Independent Accel/Decel		
S Ramp Rate	Independent Accel/Decel – 2 x 1200 sec.		
Critical Speed Avoidance	3 x Independent with Adjustable Bandwidth		
Stall Protection	Delay / Speed		
Load Loss Detection	Adjustable level, delay, speed set points		
Control Mode	Speed or Torque		
Current Limit	Adjustable in Motoring and Regenerative		
Output Frequency Range	0.2-85 Hz		
Service Duty Rating Overload Rating	Normal Duty	Heavy Duty	
	110% Overload for 1 minute every 10 minutes (Variable Torque Load)	150% Overload for 1 minute every 10 minutes (Constant or Variable Torque Load)	
Typical VFD Efficiency	> 98% (18 Pulse) > 97.5% (AFE) Contact Factory for Guaranteed Efficiency of Specific Drive Rating		
Input Power Factor	AFE Rectifier		
	0.98 minimum, 30 – 100% Load		
IEEE 519 Harmonic Guidelines	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	40-character, 16-line formatted text		
Languages	English	German	
	French	Chinese (Mandarin)	
	Spanish	Portuguese	
	Italian		

Description	Specifications												
Control Power	220/240 V or 110/120 V, 1 phase – 50/60 Hz (20 Amp)												
External I/O	16 Digital Inputs, 16 Digital Outputs												
External Input Ratings	50/60 Hz AC or DC 120-240 V – 1 mA												
External Output Ratings	50-60 Hz AC or DC 30-260 V – 1 amp												
Analog Inputs	(3) Isolated, 4-20mA or 0-10 V												
Analog Resolution	<ul style="list-style-type: none"> Analog input 12 Bit (4-20 mA) Analog input 13 Bit (0-10V) 												
Analog Outputs	<ul style="list-style-type: none"> (1) Isolated, 4-20 mA (8) Non-isolated, 0-10 V 												
Communication Interface	DPI												
Scan Time	Internal DPI – 2 ms min., 4 ms max.												
Communications Protocols (Optional)	<table> <tr> <td>R I/O</td> <td>Lon Works</td> </tr> <tr> <td>DeviceNet</td> <td>Can Open</td> </tr> <tr> <td>Ethernet</td> <td>RS485 HVAC</td> </tr> <tr> <td>Profibus</td> <td>RS485 DF1</td> </tr> <tr> <td>Modbus</td> <td>RS232 DF1</td> </tr> <tr> <td>Interbus</td> <td>USB</td> </tr> </table>	R I/O	Lon Works	DeviceNet	Can Open	Ethernet	RS485 HVAC	Profibus	RS485 DF1	Modbus	RS232 DF1	Interbus	USB
R I/O	Lon Works												
DeviceNet	Can Open												
Ethernet	RS485 HVAC												
Profibus	RS485 DF1												
Modbus	RS232 DF1												
Interbus	USB												
Enclosure	NEMA 1 (IP21), NEMA 12 (IP42)												
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 Plates / Bronze Chromate)												
Fiber Optic Interface	Rectifier – Inverter – Cabinet (Warning/Trip)												
Door Filter	Painted Diffuser with Matted Filter Media												
Door Filter Blockage	Air Flow Restriction Trip/Warning												
Coolant	Iron and chlorine free ethylene glycol mixed with de-ionized water												
Coolant Conductivity	1-2 micro-Siemens/CM												
Heat Exchangers	Liquid-to-Air, Liquid-to-Liquid												
Ambient Temperature	0° to 45°C (32°F to 113°F)												
Storage and Transportation Temperature Range	-40°C to 70°C (-40°F to 185°F)												
Relative Humidity	95% Non-Condensing												
Altitude (Standard)	0 to 3300 ft. (0 to 1000 m)												
Altitude (Optional)	0 to 16400 ft. (1001 to 5000 m)												
Seismic (UBC Rating)	1, 2, 3, 4												
Standards	NEMA, IEC, CSA, UL, ANSI, IEEE												

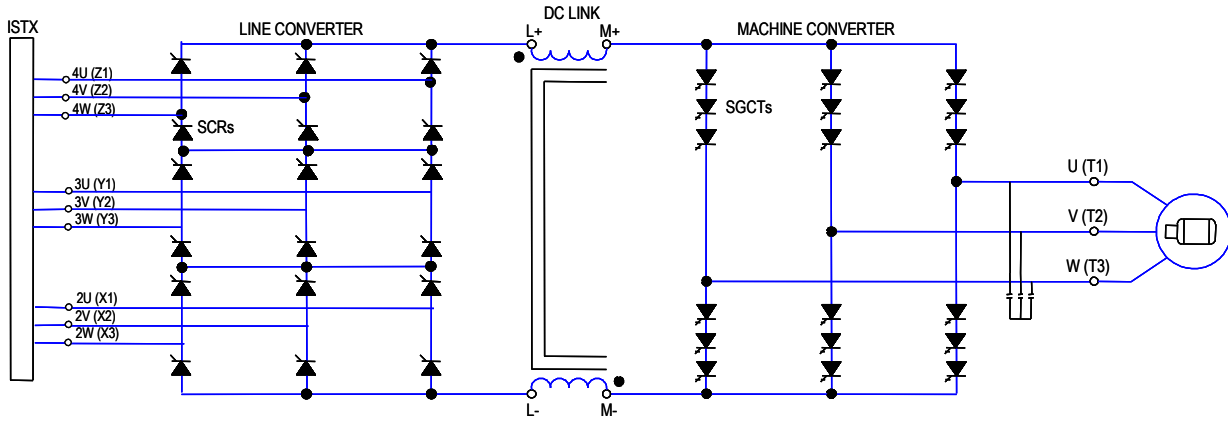
Simplified Electrical Drawings



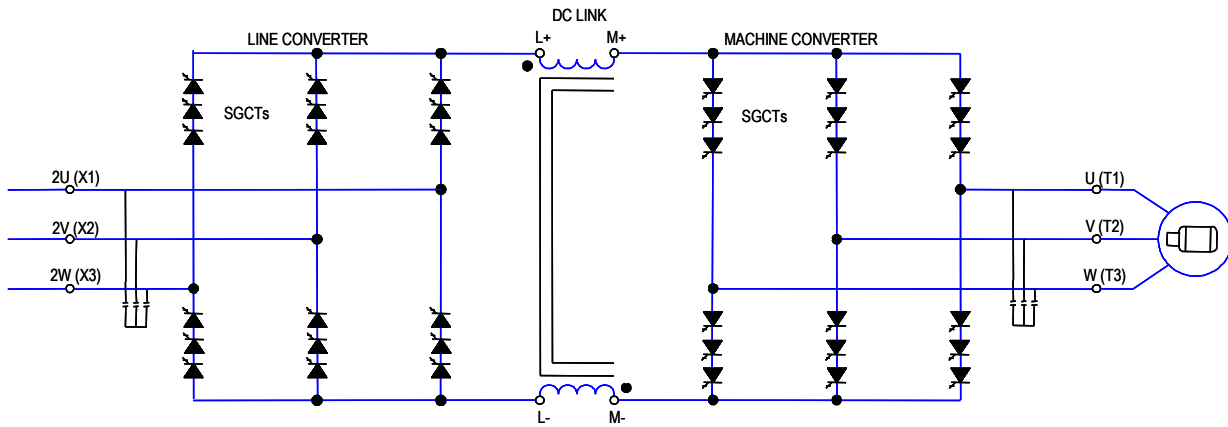
3300 / 4160 Volt – 18 Pulse



3300 / 4160 Volt – Active Front End



6000-6600 Volt – 18 Pulse



6000-6600 Volt – Active Front End

Control Overview

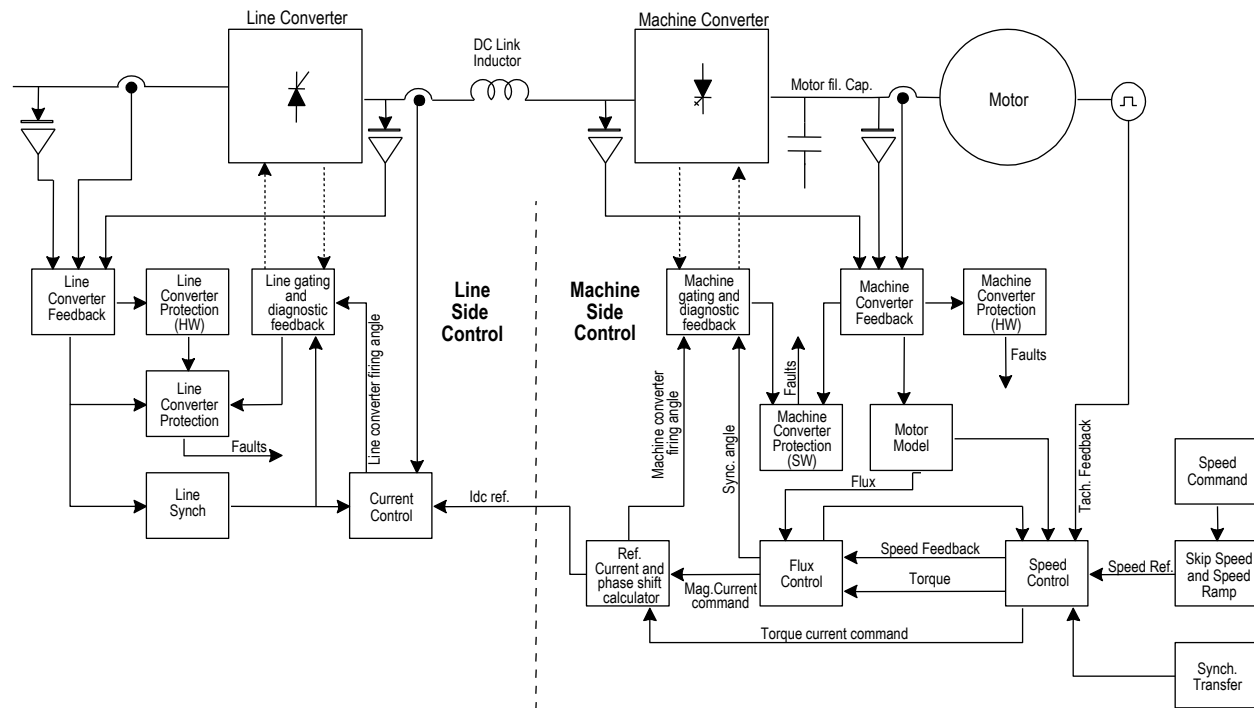


Figure 1.6 – PowerFlex 7000L 'C' Frame Function Block Diagram

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 tachometer feedback for applications requiring continuous operation above 6 Hertz and less than 100% starting torque.

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

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.

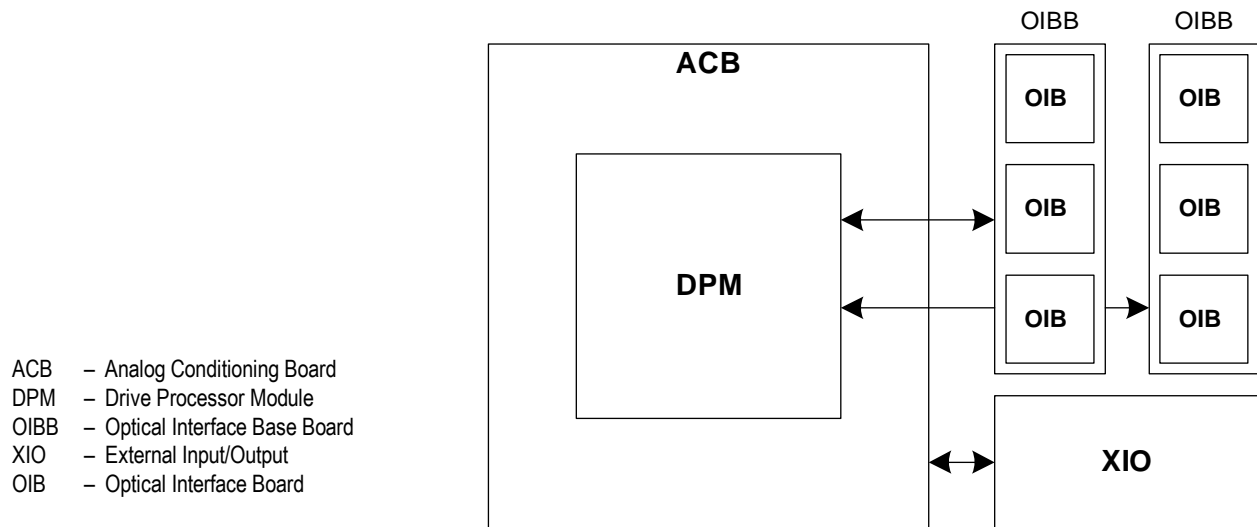


Figure 1.7 – Control Hardware Layout for PowerFlex 7000 “C” Frame

Operator Interface

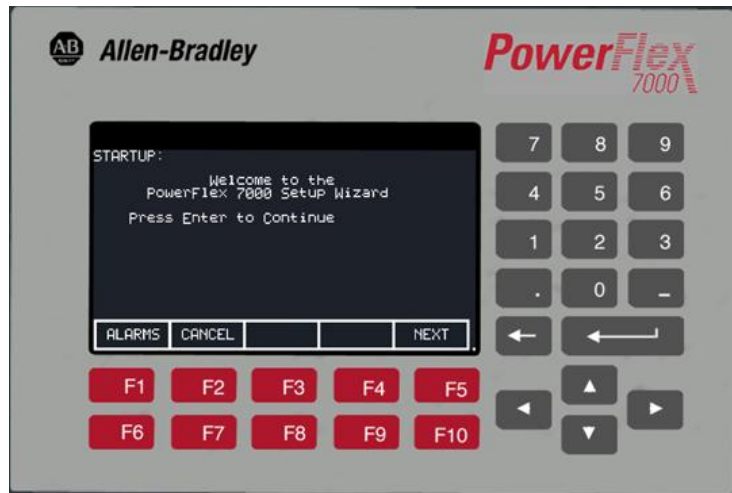


Figure 1.8 – PowerFlex 7000L Operator interface terminal

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.

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-inch) 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.

NOTE: 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.

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.

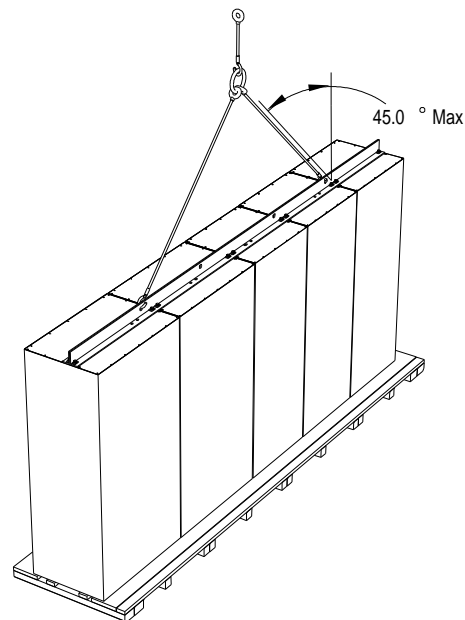



Figure 2.1 – Overhead Lifting

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 × 152.4 mm (2 in. × 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.



(50.8 mm × 152.4 mm)

Figure 2.2 – 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°C (-40°F) and 70°C (185°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°C (32°F) and 45°C (113°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.

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.
- (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 ½” hardware required). Engineered bolt systems are required for seismic requirements. Consult factory.

Remove the top lifting angles, retain the hardware.

An additional set of mounting brackets has been supplied by Rockwell Automation for securing the drive to the roof for roll and pitch concerns. The hardware removed for the lifting angles are to be used to secure these brackets to the drive. An additional mounting drawing, specific for the order, should be used to understand how to brace the drive to the vessel structure using these brackets. If this drawing cannot be located, please contact Rockwell Automation Sales office.

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 some Direct-to-Drive liquid-cooled Drives (6600V - 430A / 495A / 575A rated) the Drive will be shipped in two sections as shown in Figure 2.3.

Joining Shipping Splits (cont.)

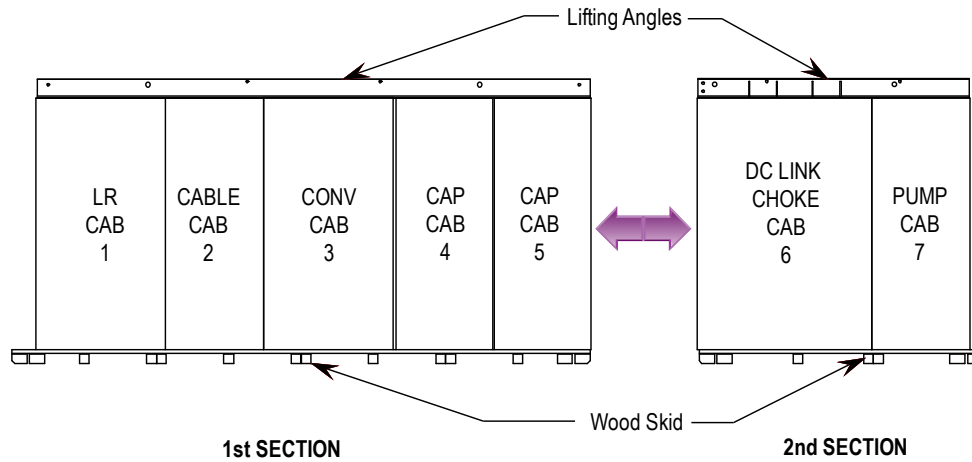


Figure 2.3 – Typical Split Drive

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 lbs) 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 2.4.
- 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 lbs). Use two people to remove the unit from the structure.

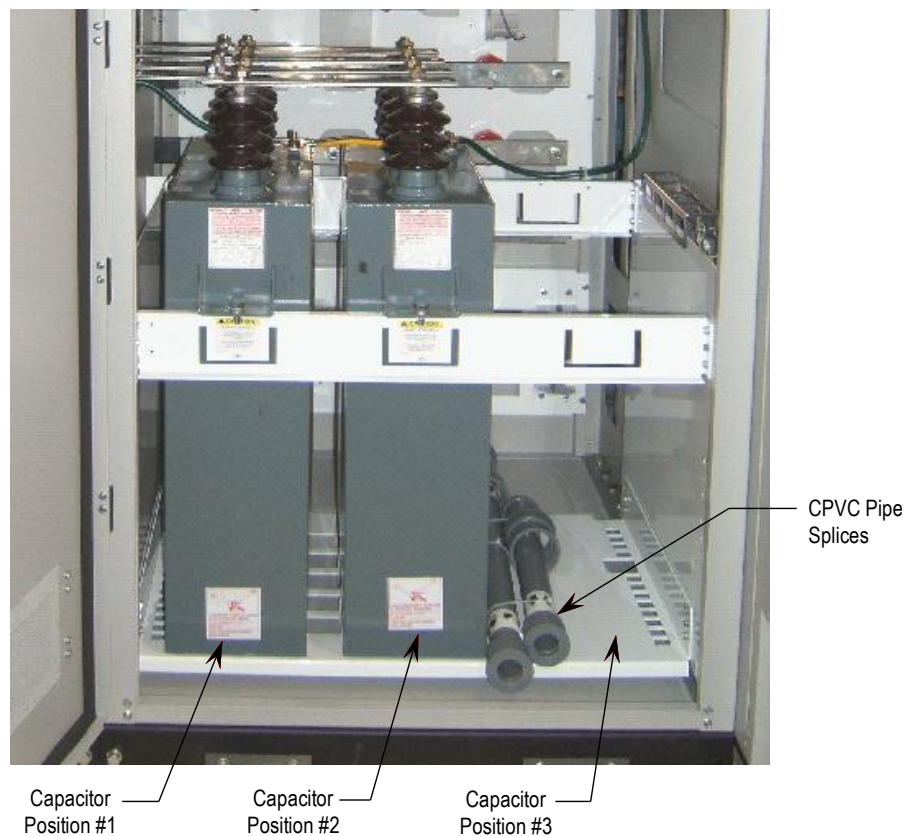


Figure 2.4 – Capacitor Cabinet

- Remove CPVC pipe splices shipped in the capacitor cabinet. Install and tighten the 4 CPVC unions with strap wrench ($\frac{1}{4}$ to $\frac{1}{2}$ turn past hand tight). Ensure O-ring is seated inside male end of union. Refer to Figures 2.5, 2.6, 2.7 and 2.8. Do not use CPVC primer or cement.

Connect the Sections (cont.)

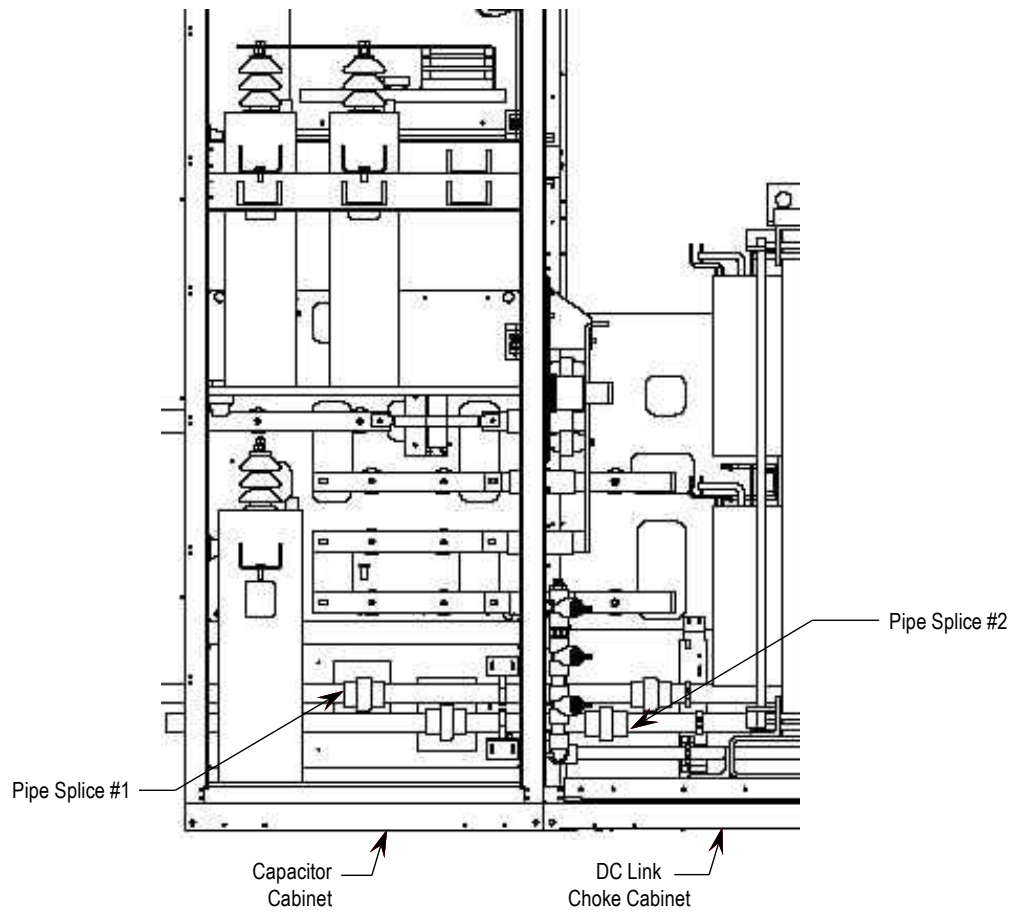


Figure 2.5 – CPVC Pipe Splices (Capacitor #2 not shown for clarity)



Figure 2.6 – Typical Strap Wrench (not supplied)
used to tighten unions on CPVC pipe splices

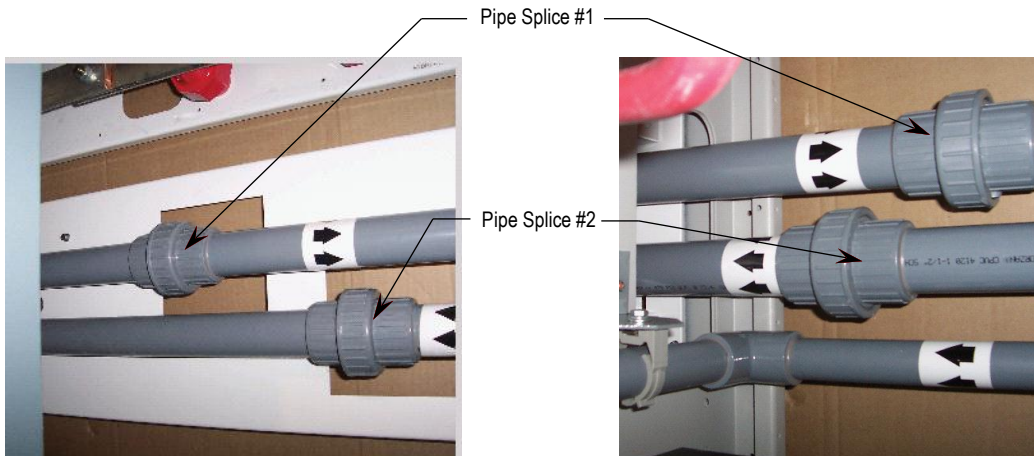


Figure 2.7 – Capacitor Cabinet after pipe splices installed

Figure 2.8 – DC Link Choke Cabinet after pipe splices installed

Note: 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 2.9.
- 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 Figures 2.9 to 2.13.
- Torque M10 carriage bolts connecting bus to bus in the capacitor cabinet to 29 Nm (21 ft-lbs). Torque M12 hardware supplied for cable to bus stab connections to 50 Nm (37 ft-lbs).
- After cable connections have been made, ensure cable connections to choke stabs are torqued to 50 Nm (37 ft-lbs)
- Ensure a minimum of 3” (75mm) clearance exists between Medium Voltage Bus field connections (including hardware) and all cabinet sidesheets.

Connect the Sections (cont.)

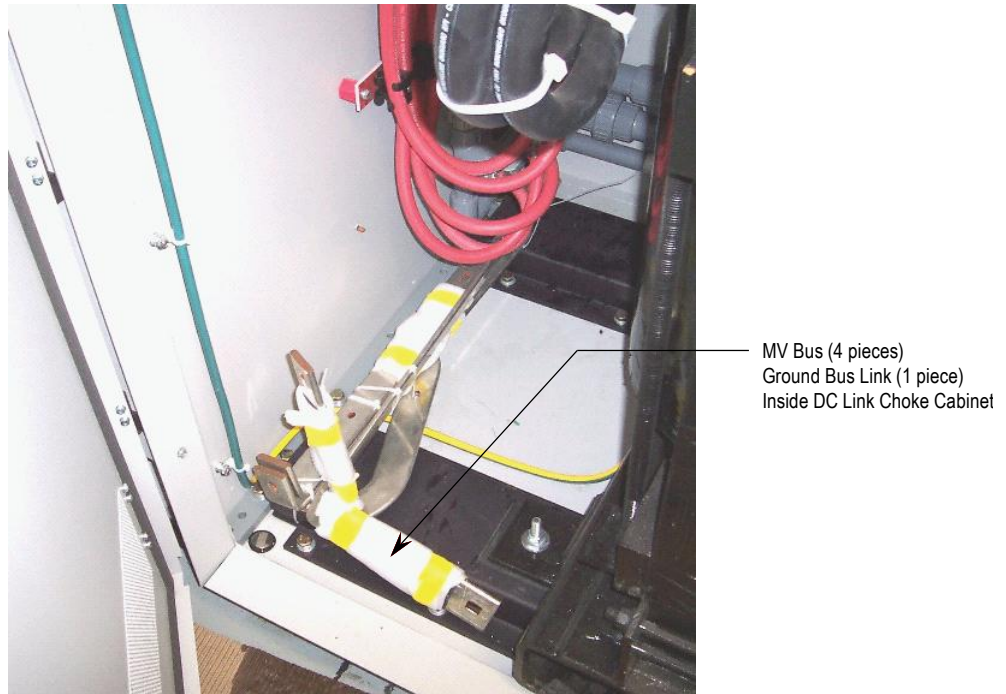


Figure 2.9 – DC Link Choke Cabinet
Power Bus (4) pieces; Ground bus (1) shipped disassembled

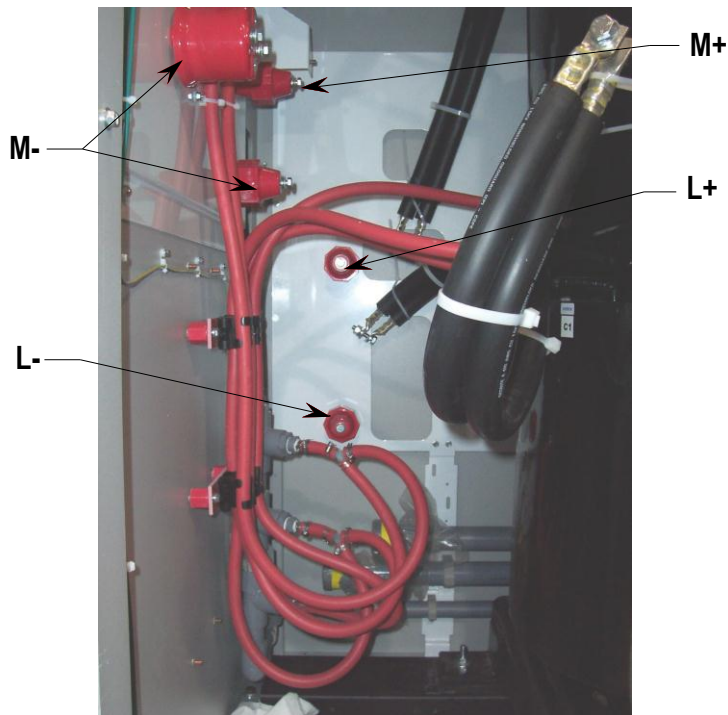


Figure 2.10 – DC Link Choke Cabinet *before* field power bus connections

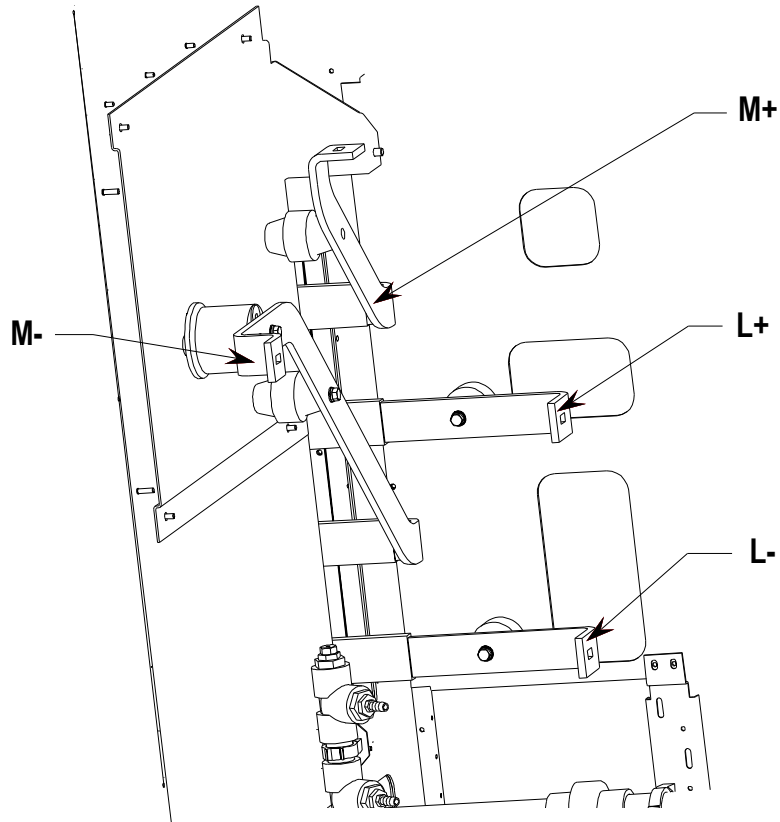


Figure 2.11 – DC Link Choke Cabinet *after* field connections of power bus

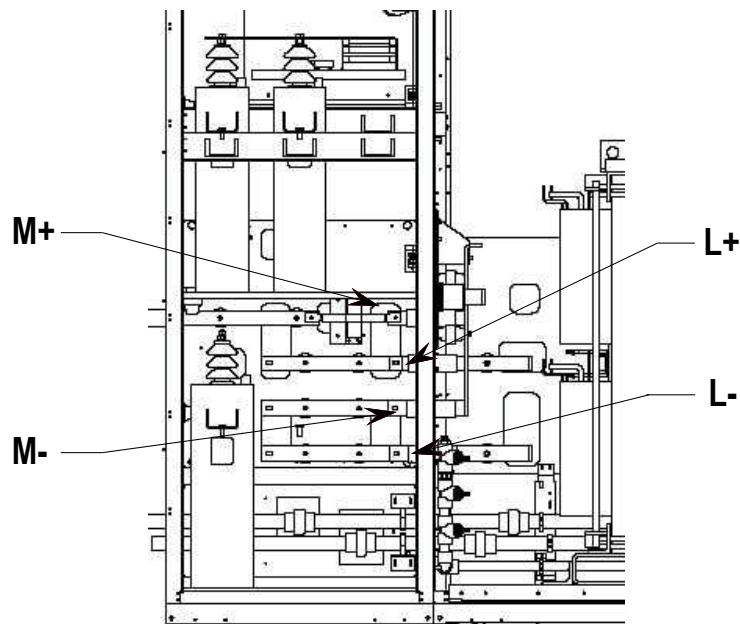


Figure 2.12 – Capacitor Cabinet *after* field connections of power bus

Connect the Sections (cont.)



Figure 2.13 – 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.

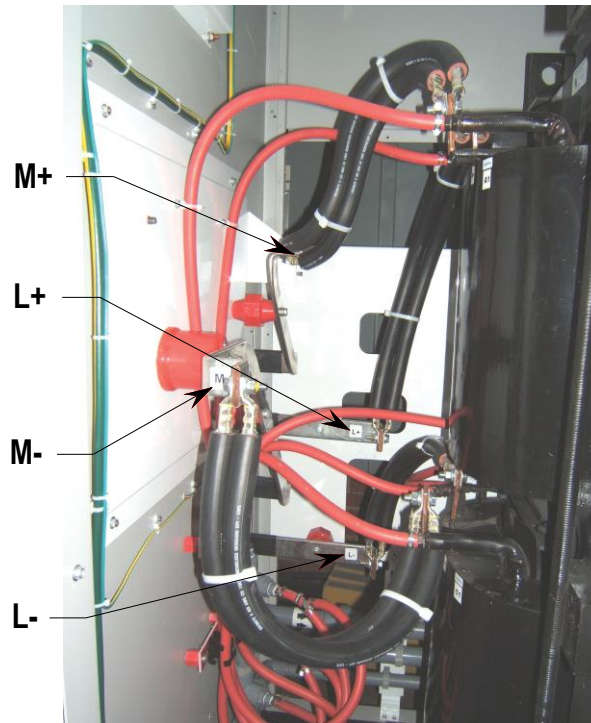


Figure 2.14 – DC Link Choke Cabinet after connection of cables from DC Link Choke to red insulators

- 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.

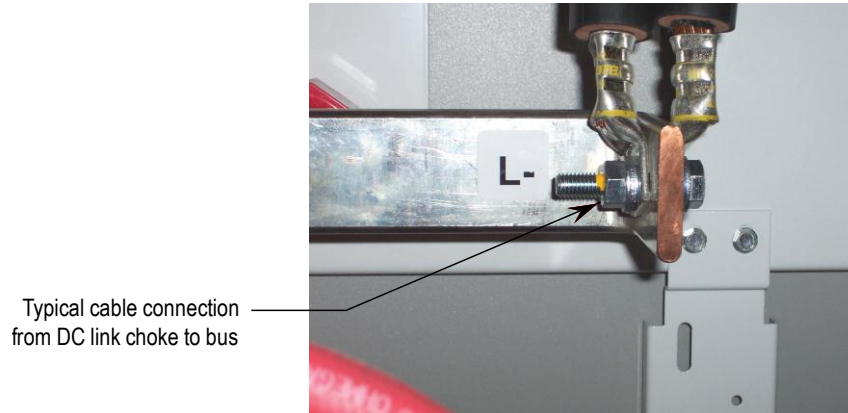


Figure 2.15 – DC Link Choke Cabinet Typical Cable Connection

- 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 2.16 – Ground Bus Link

Connect the Sections (cont.)

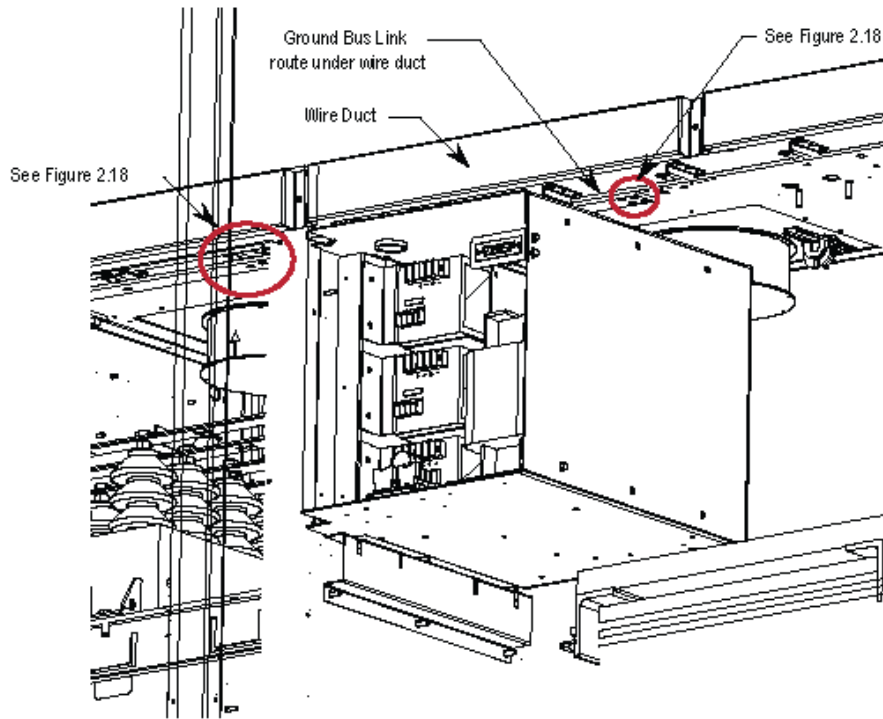


Figure 2.17 – Install Ground Bus Link

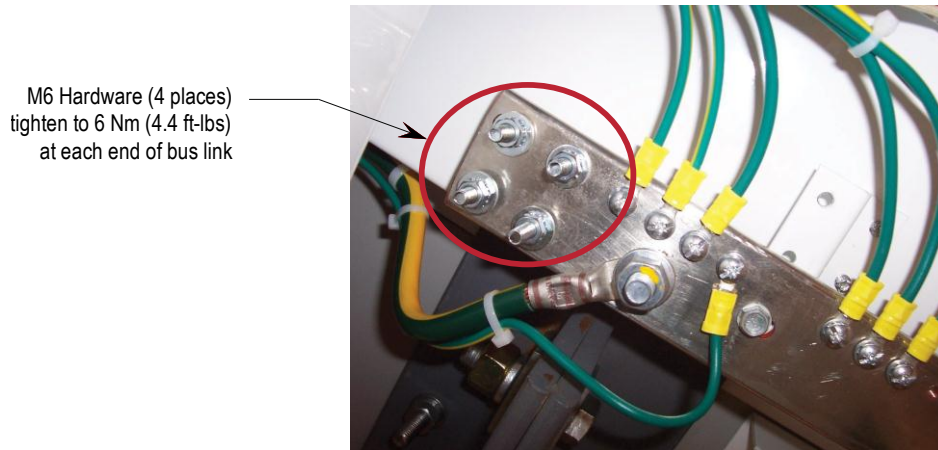


Figure 2.18 – Ground Bus Connection Points
(Install Ground Bus Link using Supplied Hardware)

Control Wiring Connections

Refer to Electrical Drawings 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 grommetted cutout for connection on the terminal blocks located in the upper left side of the capacitor section.

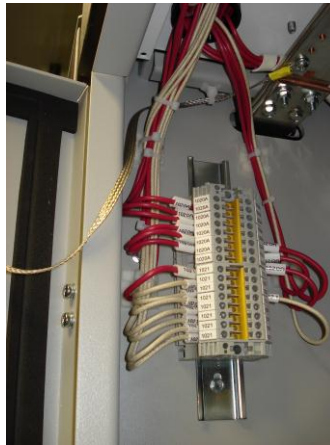


Figure 2.19 – Strip heater terminal block

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 grommetted 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.

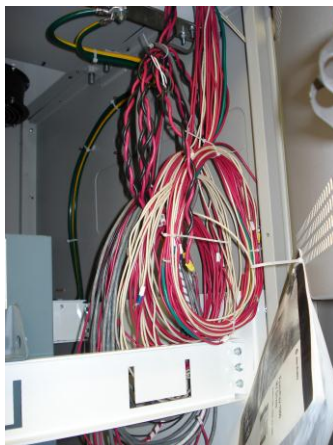


Figure 2.20 – Control Wiring

Control Wiring Connections (cont.)

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



Figure 2.21

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 2.22).



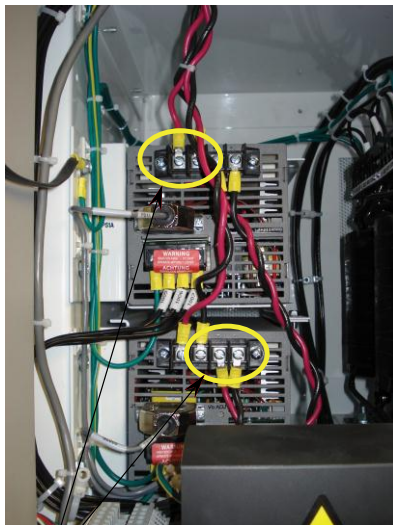
Figure 2.22 – Fan • Thermostat Control Wires

6. Route the control wires down through the grommeted cutout into the control power disconnect section (Figure 2.23).
7. Connect the numbered wires to the corresponding numbered terminal blocks (Figures 2.24 to 2.27).



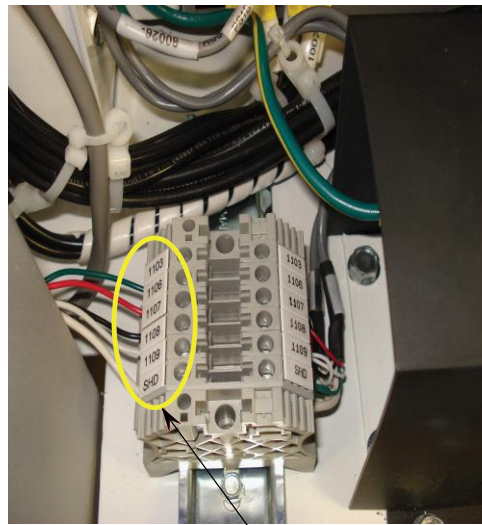
Figure 2.23

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



56V DC Connections
 Red – Positive
 Black – Negative

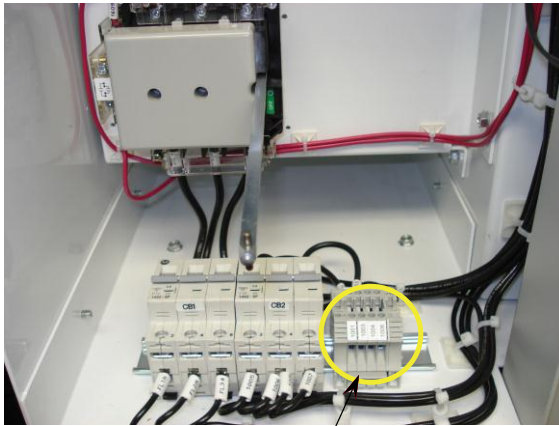
Figure 2.24



AC DC fails Belden
 cable connections

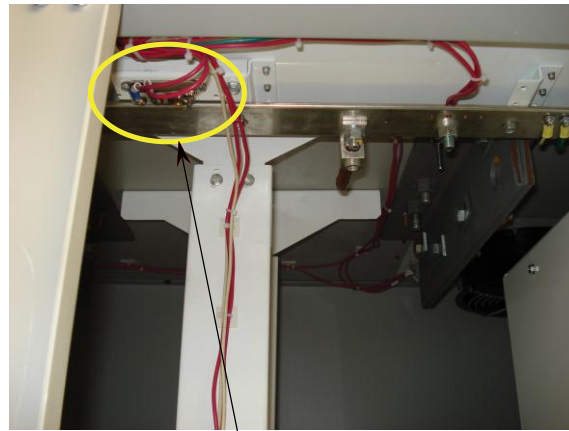
Figure 2.25

Control Wiring Connections (cont.)



Control Wire Power Connections

Figure 2.26



Thermostat and Fan Connections

Figure 2.27

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 2.28 — 120 volt and XIO cables through upper cutout

14. Connect the XIO link cable to the XIO board “XIO link A” connector. (Figure 2.29)

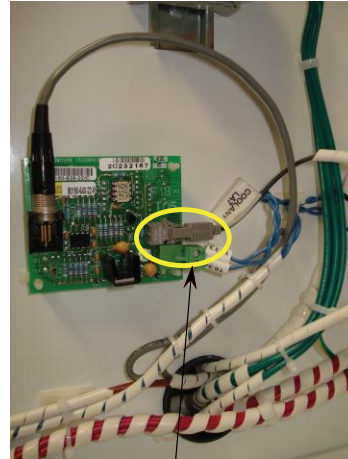
15. Connect the control power wires to the control power terminal blocks. Refer to Electrical Drawings for corresponding wire numbers and terminal blocks.

16 Connect the fiber optic cable to the TFB board.



XIO link cable connected to XIO link A

Figure 2.29



TFB Fiber optic connected

Figure 2.30

- Use supplied silicone (see Fig. 2.31) to seal between cabinets to prevent moisture or dirt from entering. Join sidesheets with M6 Taptite thread forming screws in holes provided.

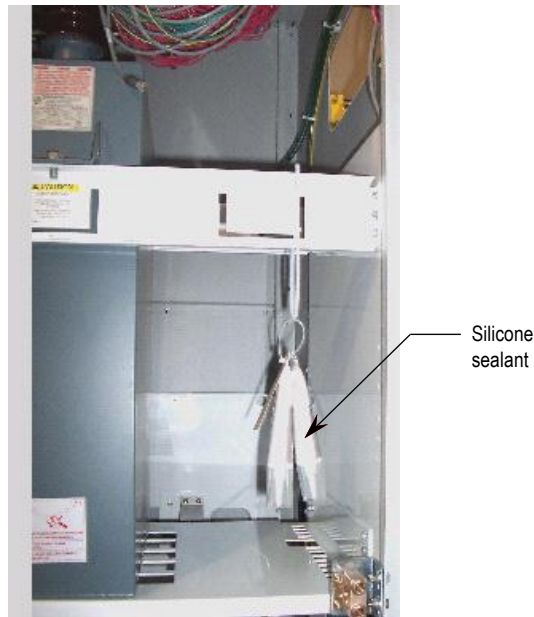


Figure 2.31 – Capacitor Cabinet

Removal of DC Link Choke Turnbuckle Supports (if used on design supplied)

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

- Remove cotter pins (see Fig. 2.32) from bottom turnbuckle jaw then top. Carefully remove turnbuckles. Retain for future use.



Figure 2.32 – 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 2.33.

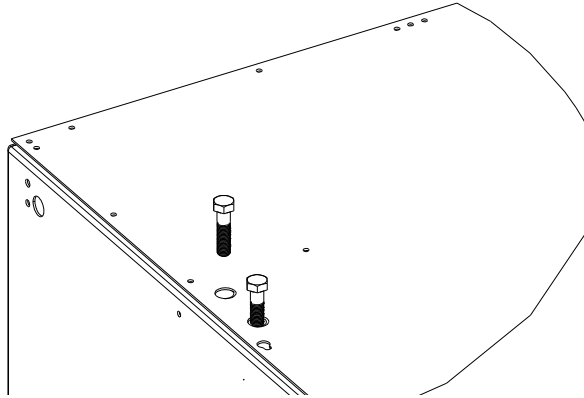


Figure 2.33 – Insert bolts.

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.

An additional set of mounting brackets has been supplied by Rockwell Automation for securing the drive to the roof for roll and pitch concerns. The hardware removed for the lifting angles are to be used to secure these brackets to the drive. An additional mounting drawing, specific for the order, should be used to understand how to brace the drive to the vessel structure using these brackets. If this drawing cannot be located, please contact Rockwell Automation Sales office.

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.

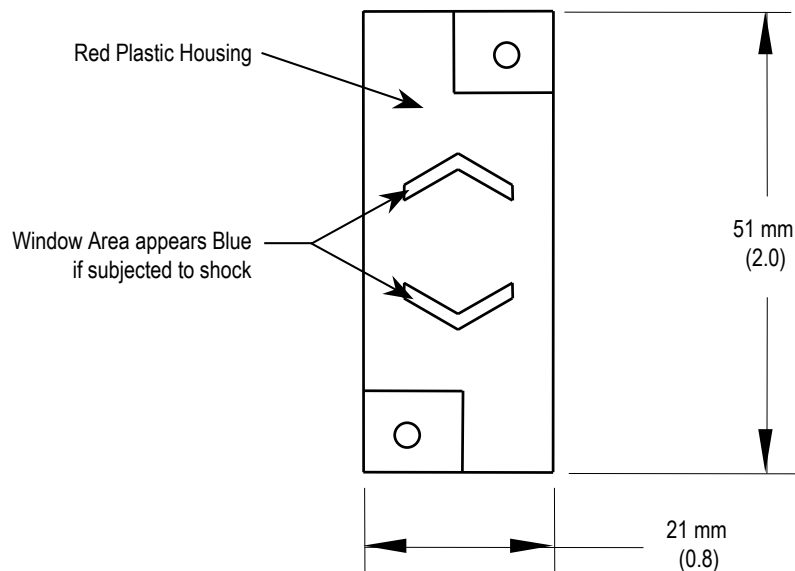


Figure 2.34 – Shock Indicator

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 on a separate skid marked with the same identifying tags on the skid.

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 keep the hardware for reuse.

Secondly, locate the fan hoods on the separate skid and lift these over the respective holes located on the top of the drive cabinet.

Locate the exhaust hood on top of the cabinet per Figure 2.35 and reuse the existing hardware set aside earlier. (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 2.35). The customer only needs to install the fan hood.

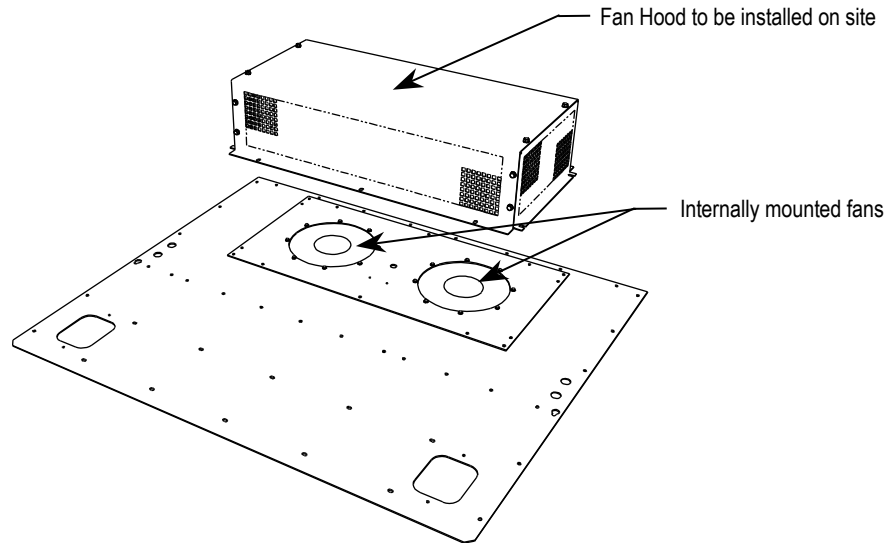


Figure 2.35 – Fan Hood Installation (Internally Mounted Fans)

Externally mounted fans and fan hood

The converter has cooling fans that are externally mounted (refer to Figure 2.36). 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 2.36.

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.

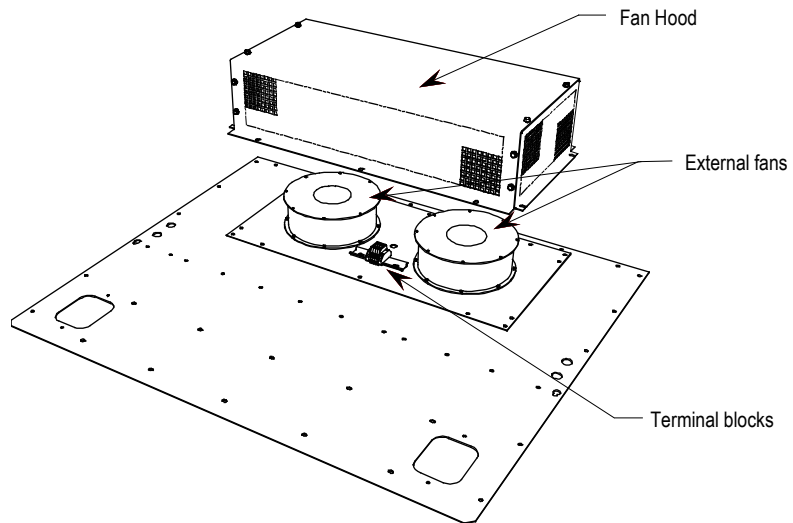


Figure 2.36 – Fan Hood Installation (Externally Mounted Fans and Fan Hood)

**Cabinet Layout and
Dimensional Drawings
of Drive**

Generic Dimensional Drawings have not been included in this user's manual. Please reference the order specific project drawings for detailed dimensions of conduit openings and mounting penetrations.

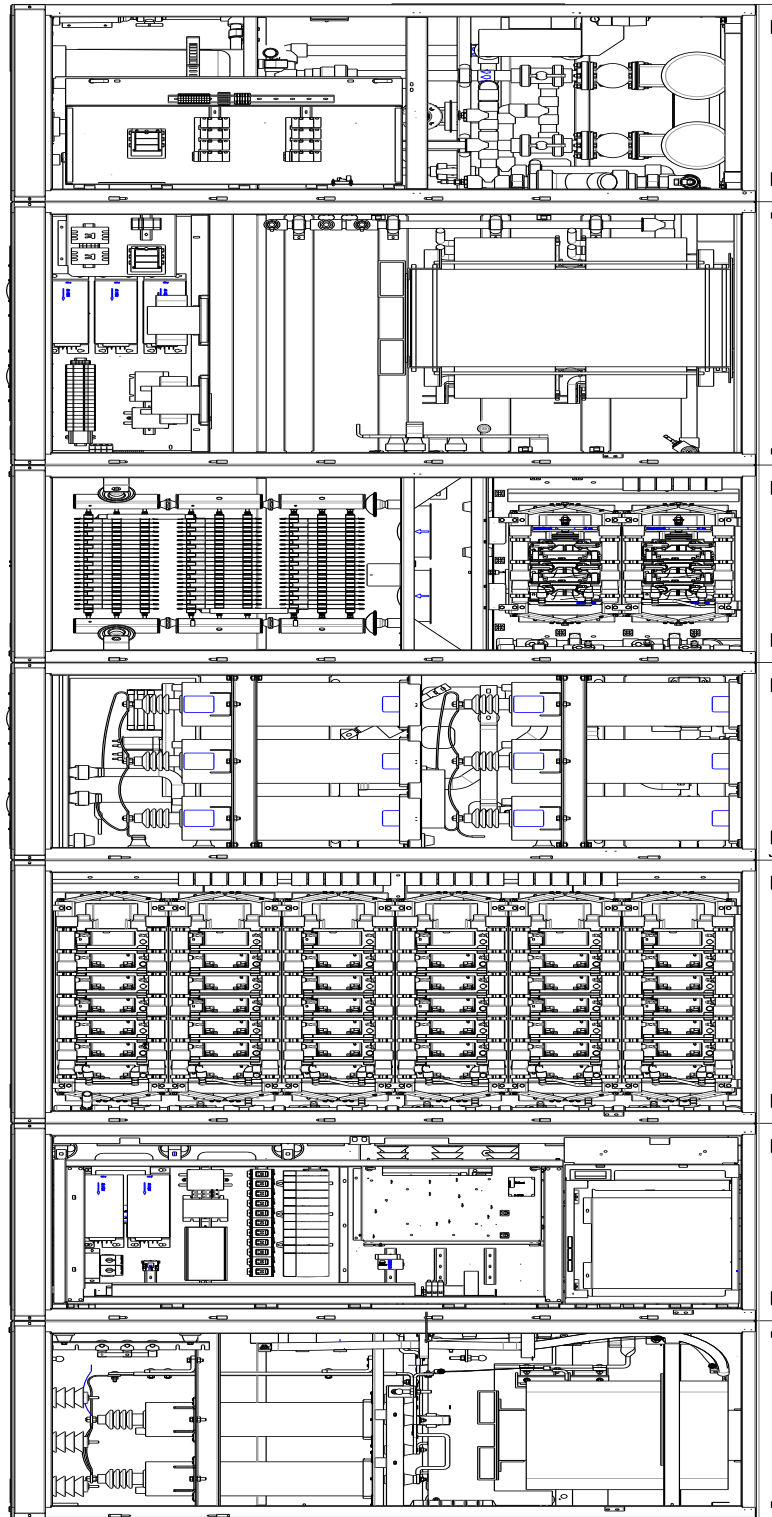


Figure 2.37 – Typical Footprint PowerFlex 7000 “C” Frame Marine Drive Structure Layout

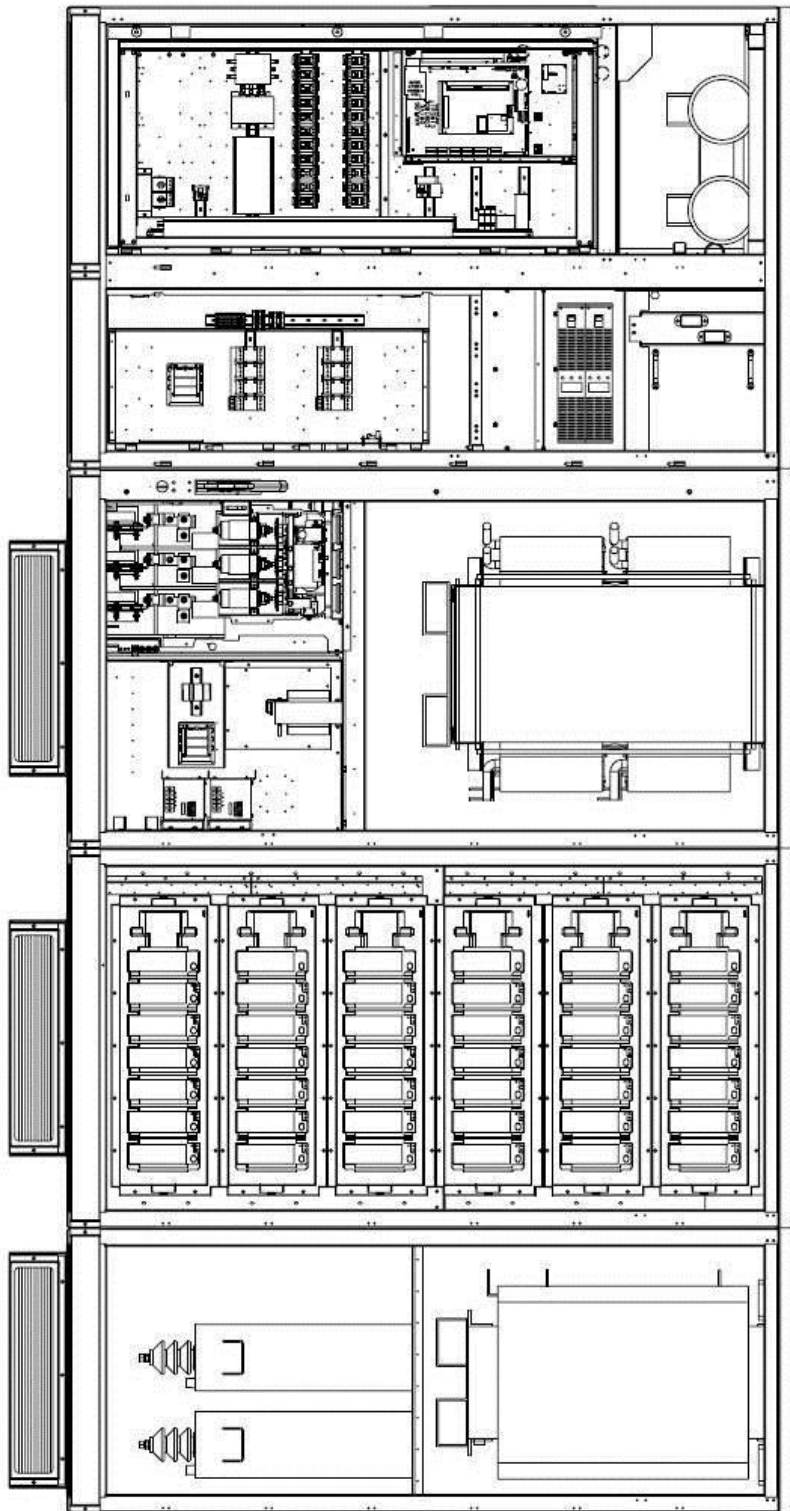


Figure 2.38 – Typical Footprint PowerFlex 7000 “C” Frame Marine Drive Structure Layout

Control/Cabling Cabinet

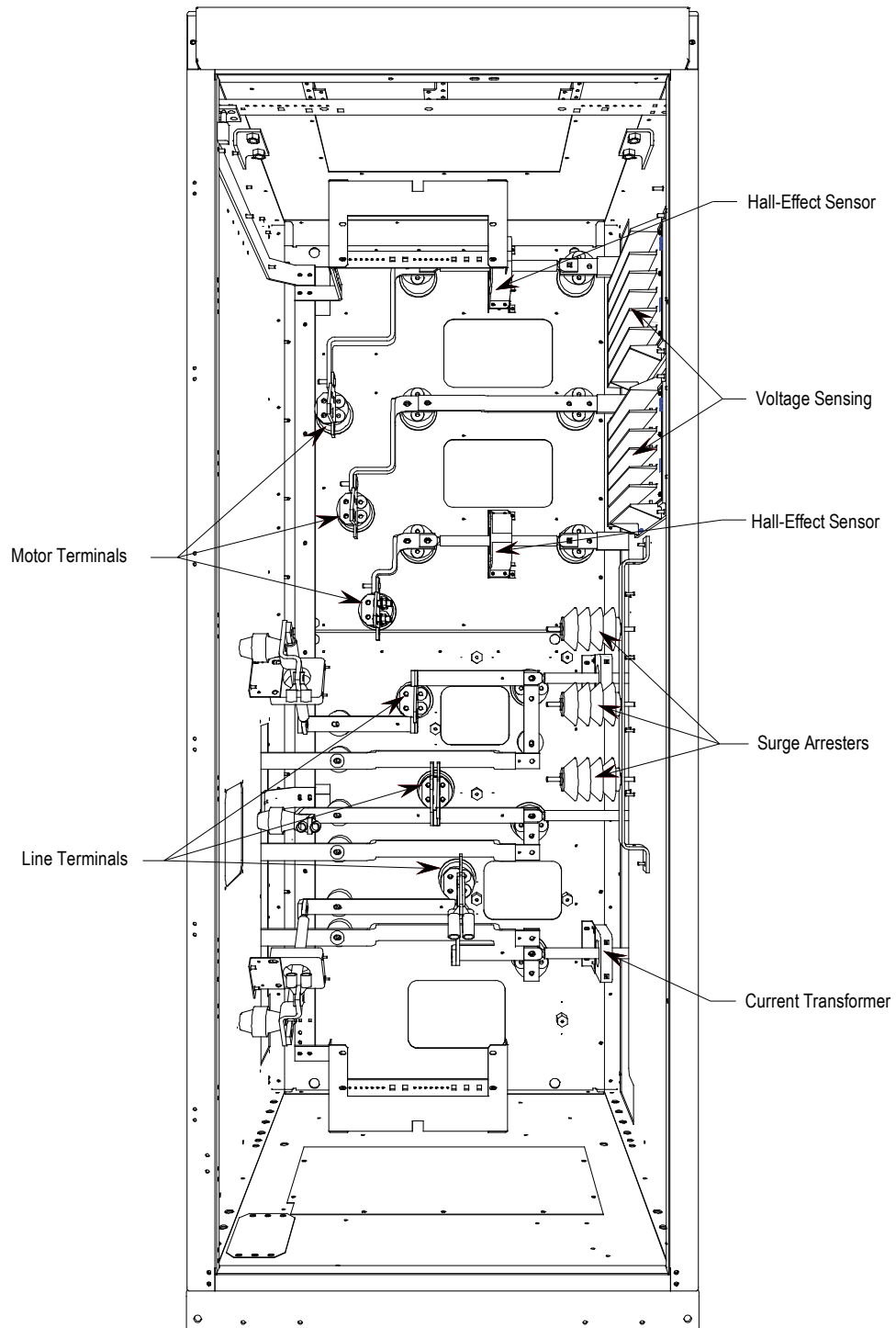
Shows the medium voltage area located in the control/cabling cabinet behind the low voltage compartment and with barriers removed.

Note: The control/cabling cabinet comes in two different configurations:

- Large Footprint AFE rectifier (Figure 2.37)
- Small Footprint AFE rectifier (Figure 2.38)

Major Components

The following diagrams are presented to show what the typical layout of each cabinet will be for the PowerFlex 7000 “C” Frame Marine Drive.



**Figure 2.39 – General Control and Cabling Cabinet
(with Control Panel removed)**

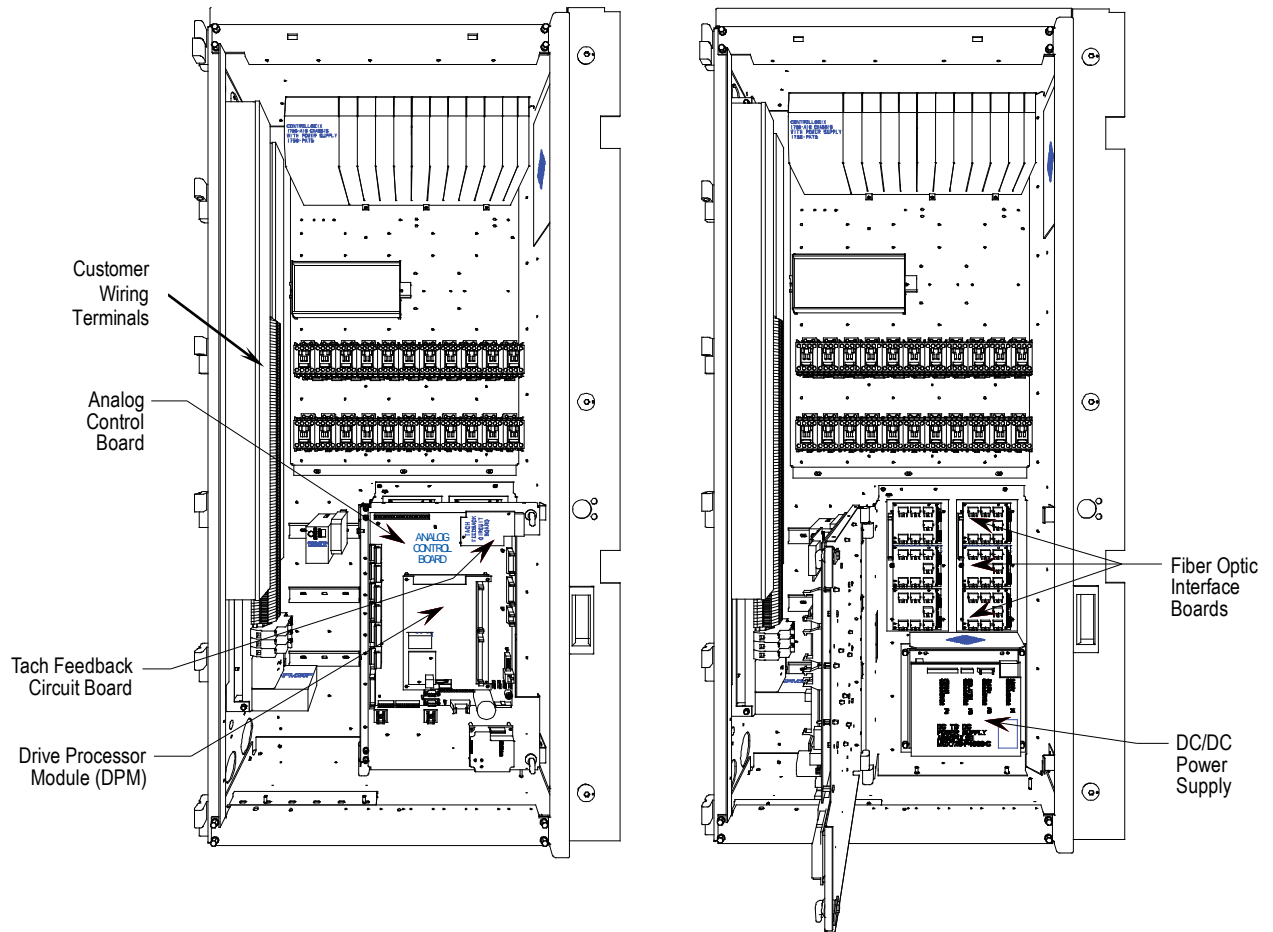


Figure 2.40 – Low Voltage Tub Compartment

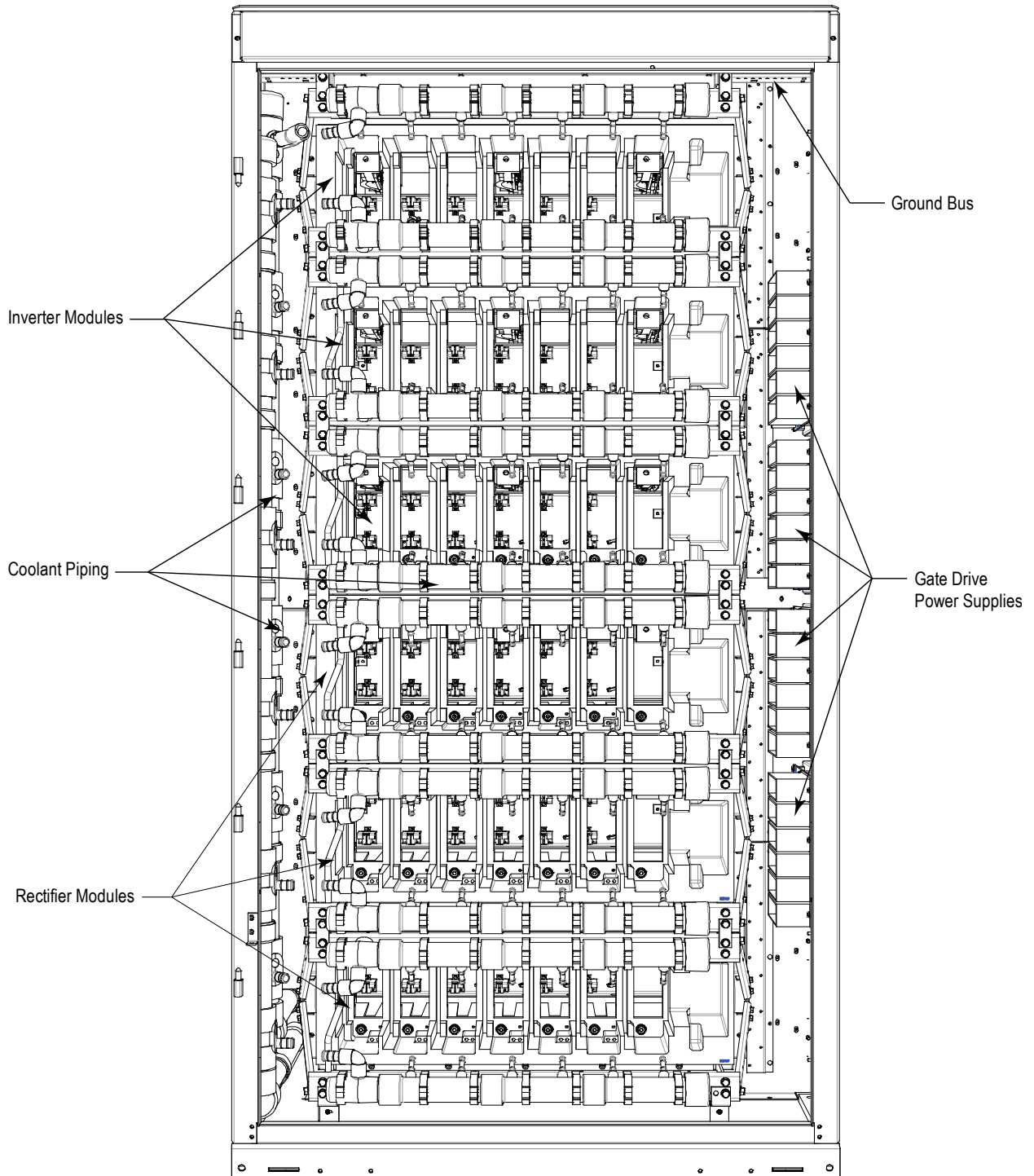


Figure 2.41 – Converter Cabinet

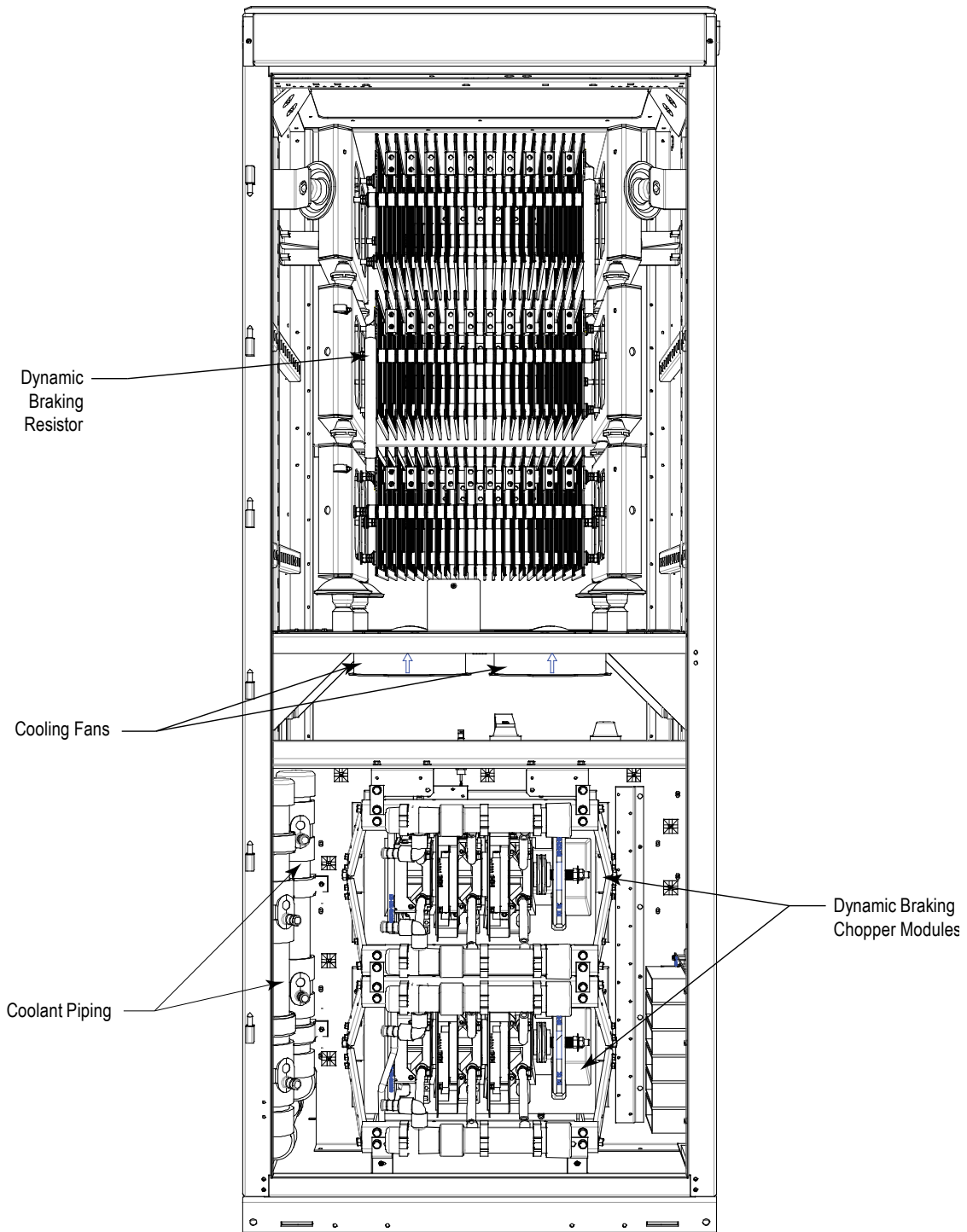


Figure 2.42 – Dynamic Braking Cabinet

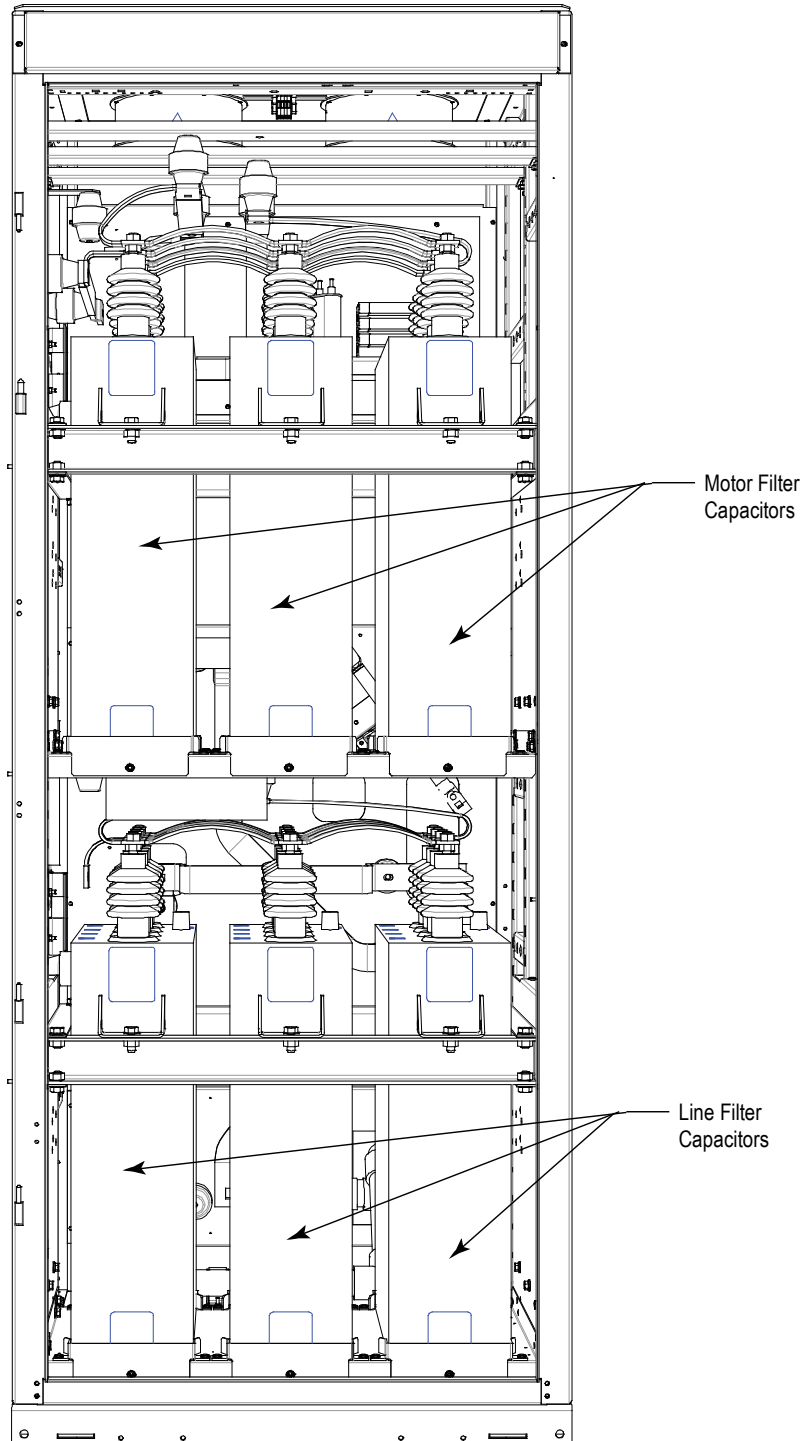


Figure 2.43 – Capacitor Cabinet

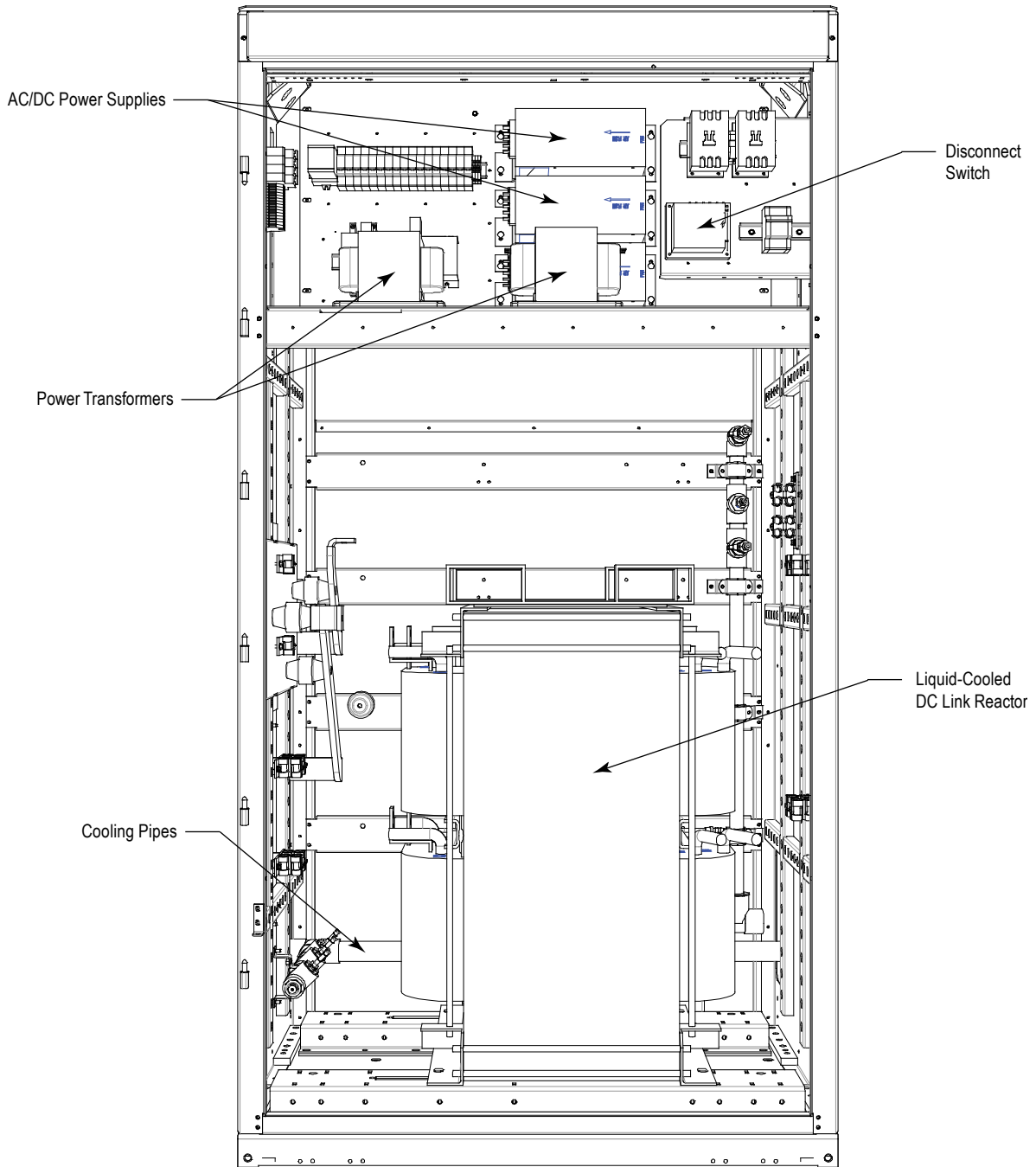


Figure 2.44 – DC Link Inductor Cabinet

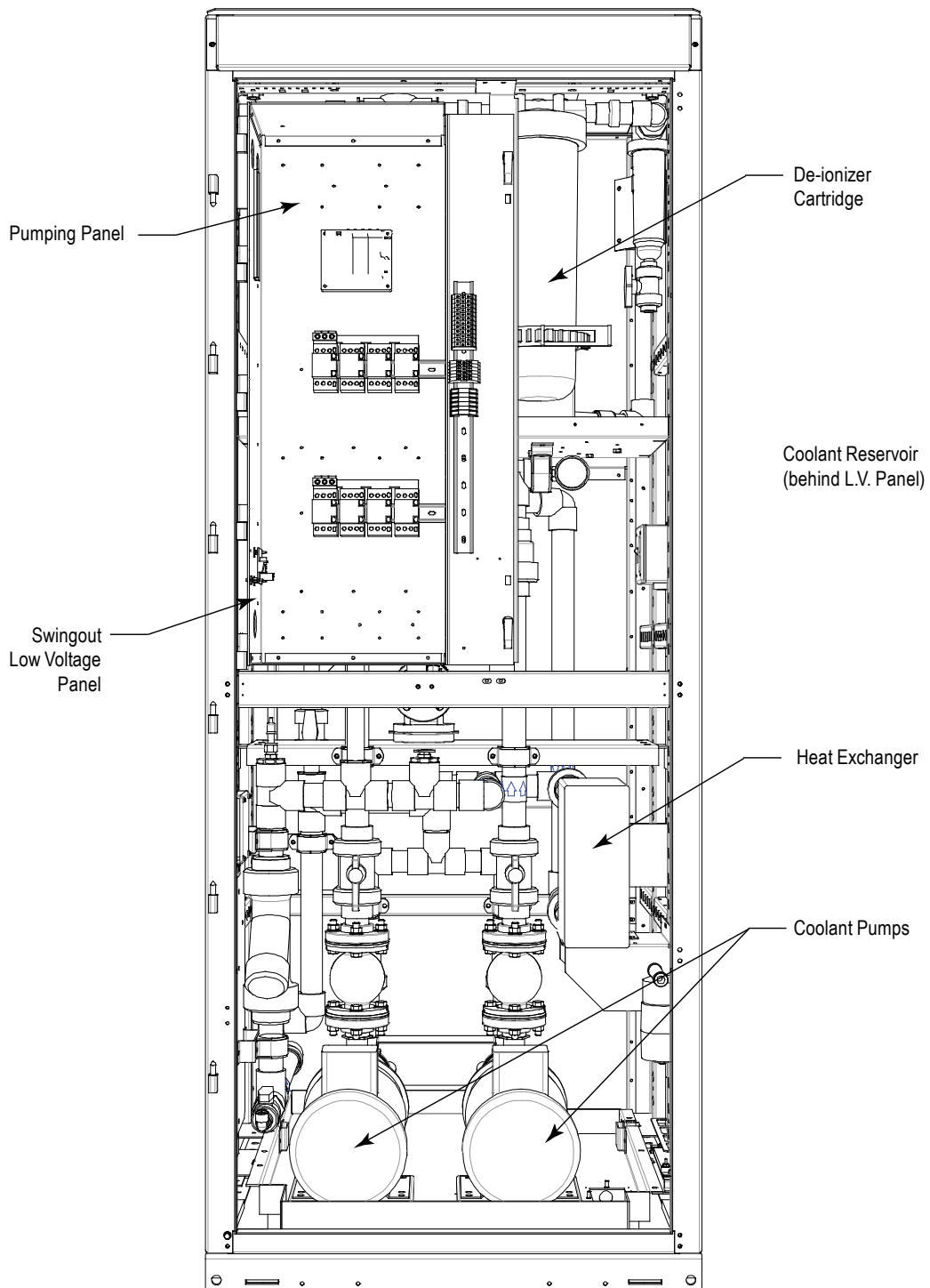


Figure 2.45 – Pump Cabinet (showing swing-out low voltage panel)

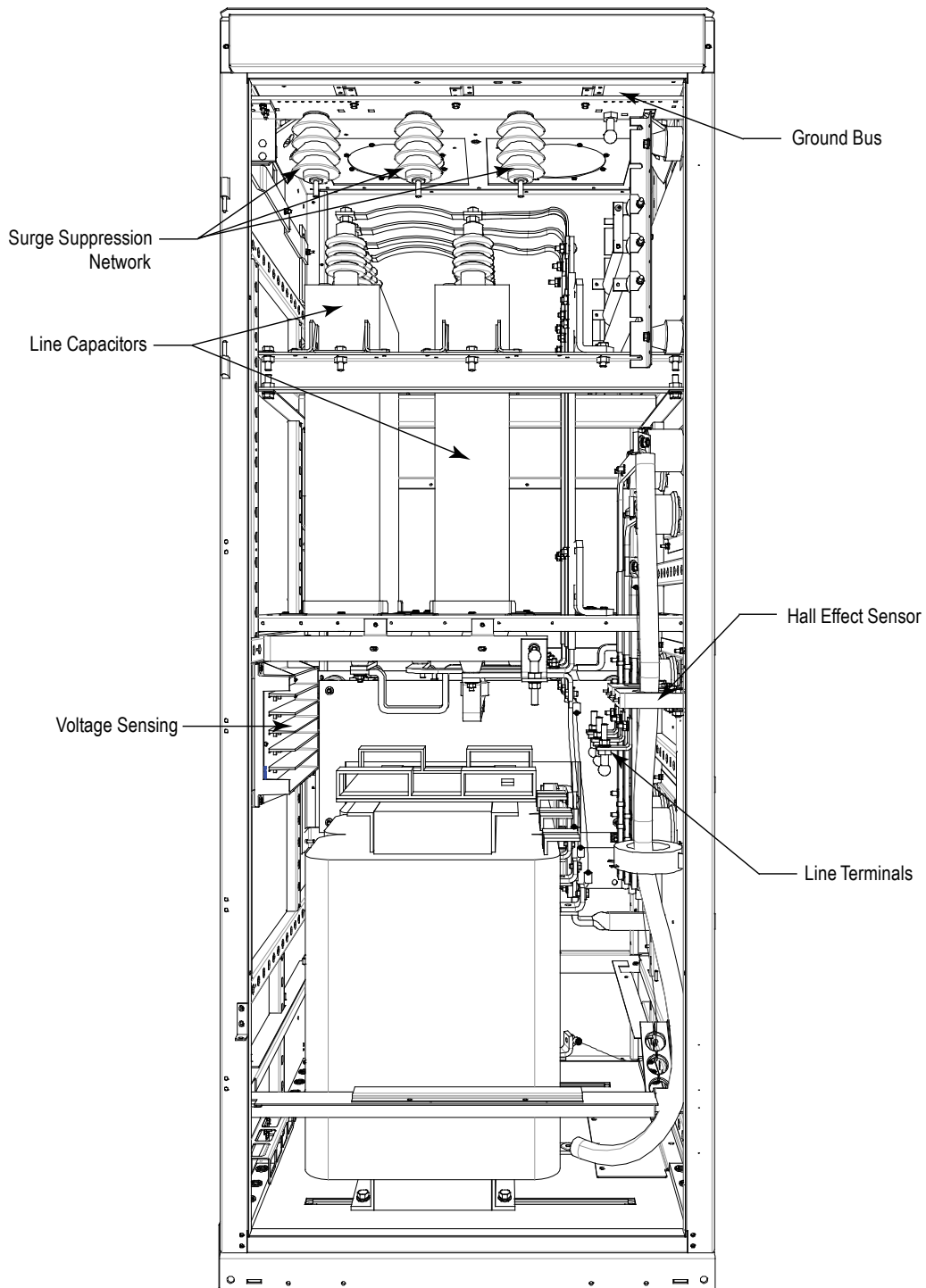


Figure 2.46 – Line Reactor and Incoming Cabling Cabinet

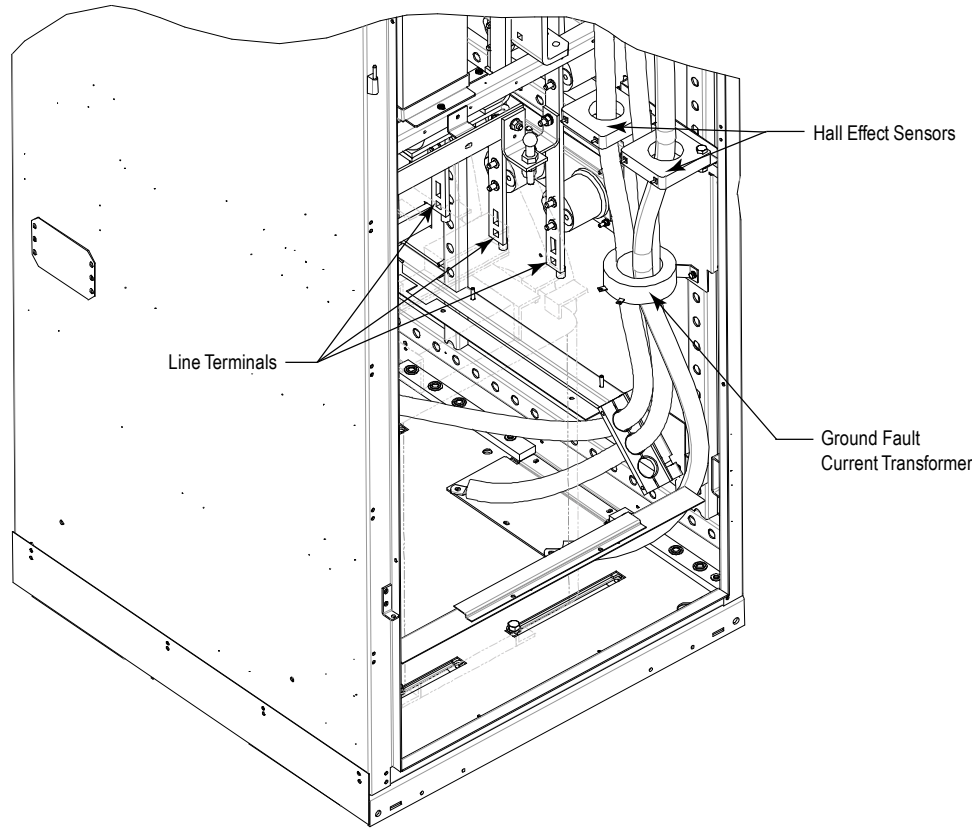


Figure 2.47 – General Incoming Cabling Location (Line Reactor section)

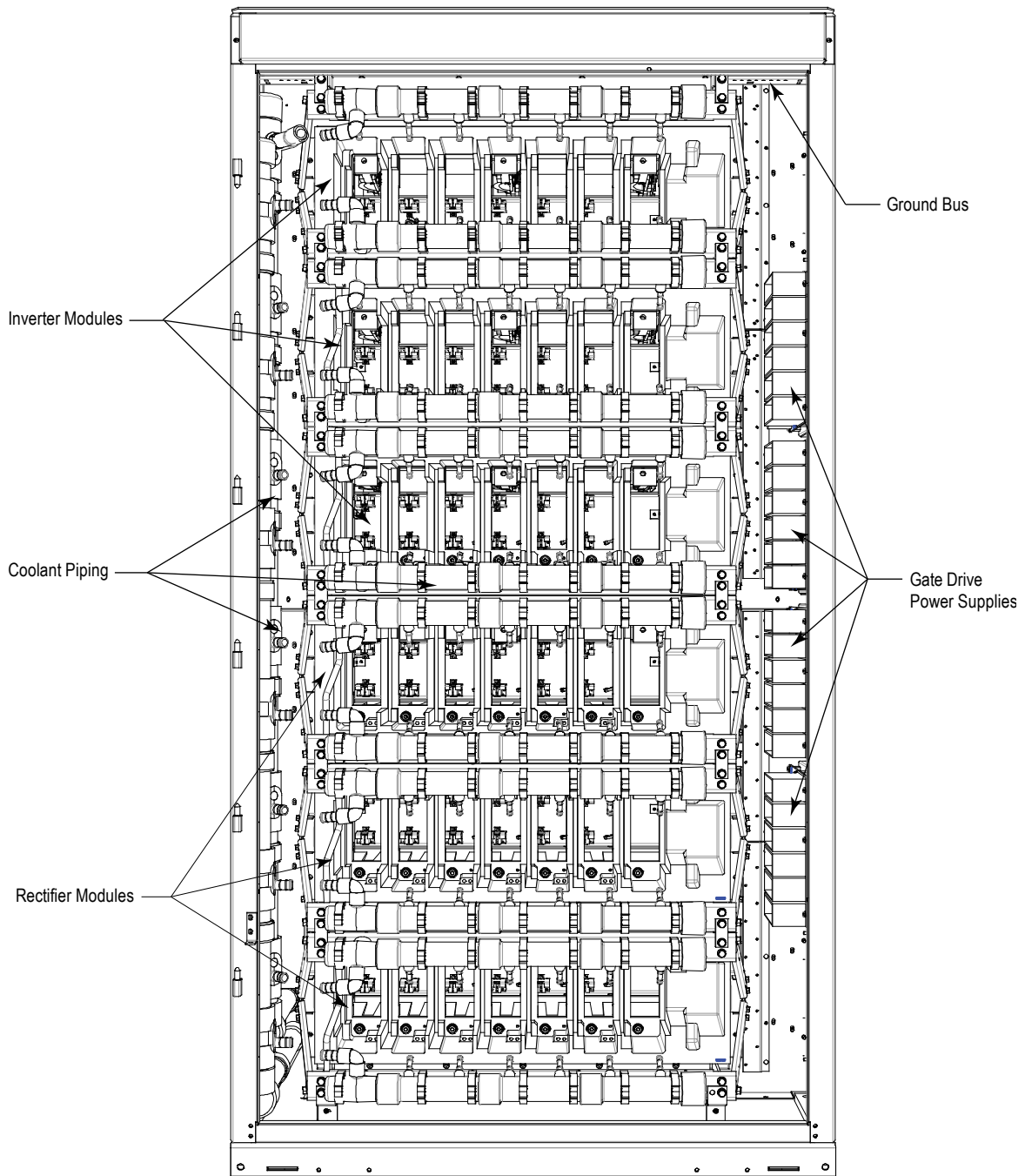


Figure 2.48 – Converter Cabinet

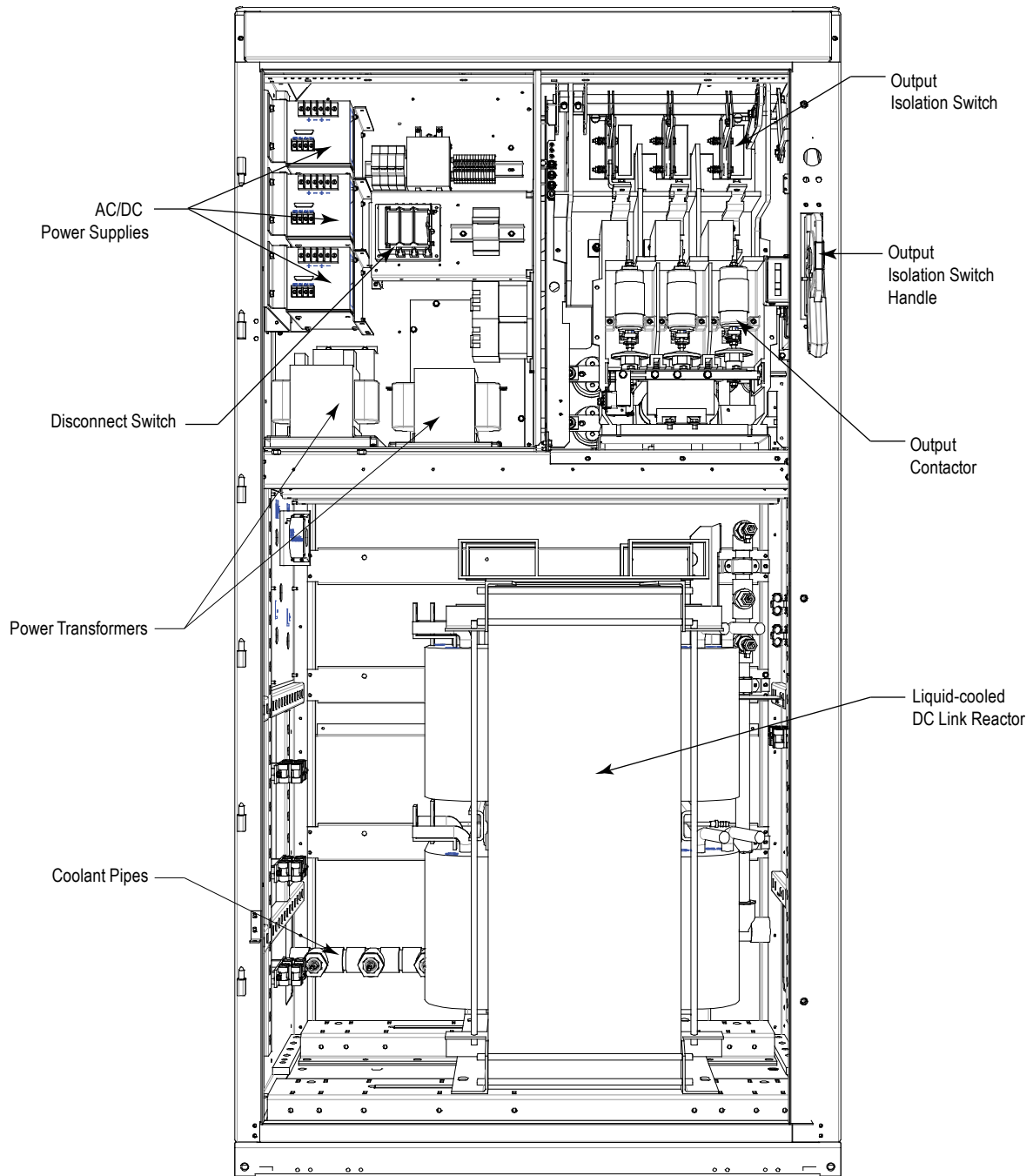


Figure 2.49 – Capacitor and CMC Cabinet

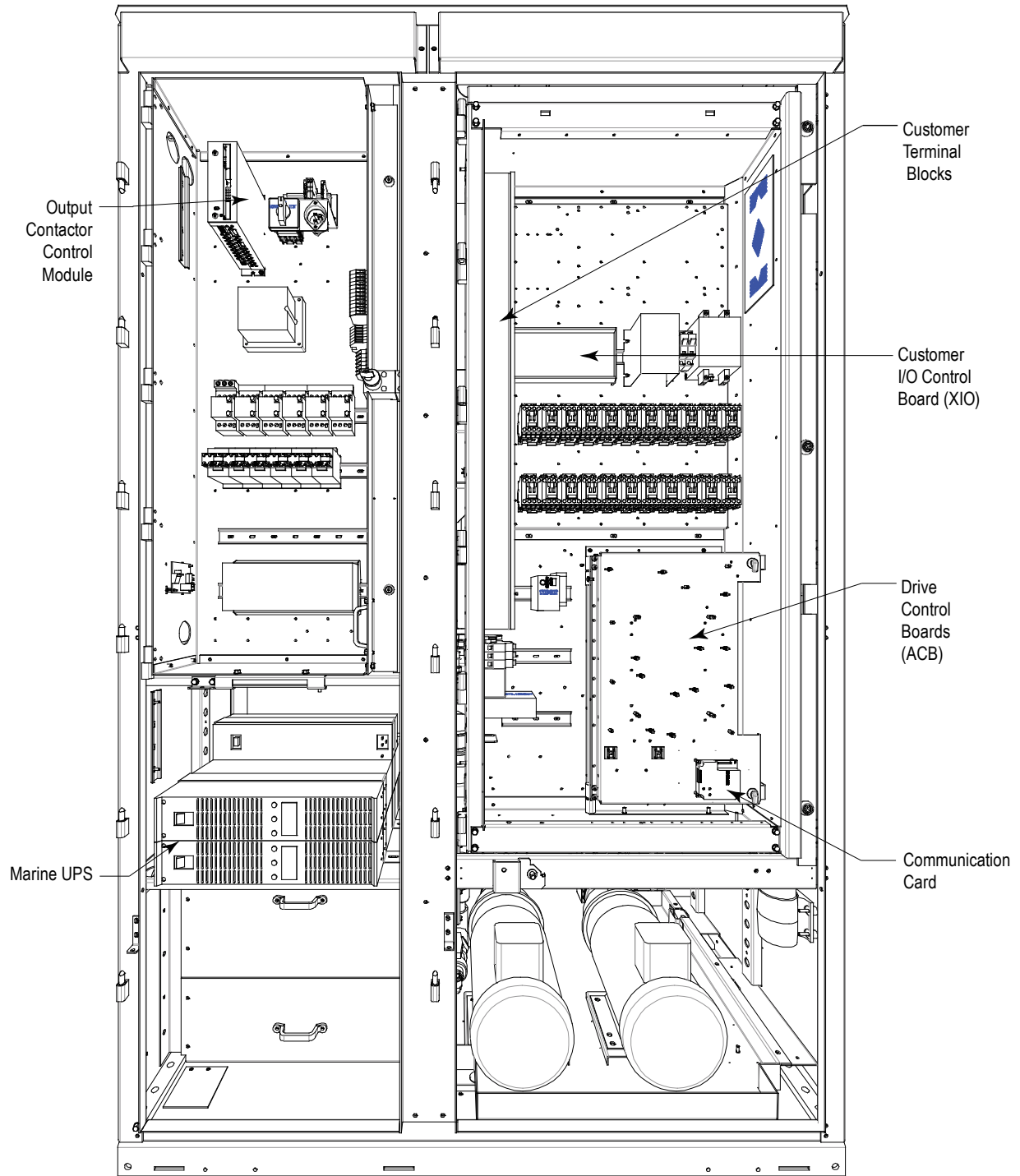


Figure 2.50 – Pump Cabinet (showing swing-out low voltage panel)

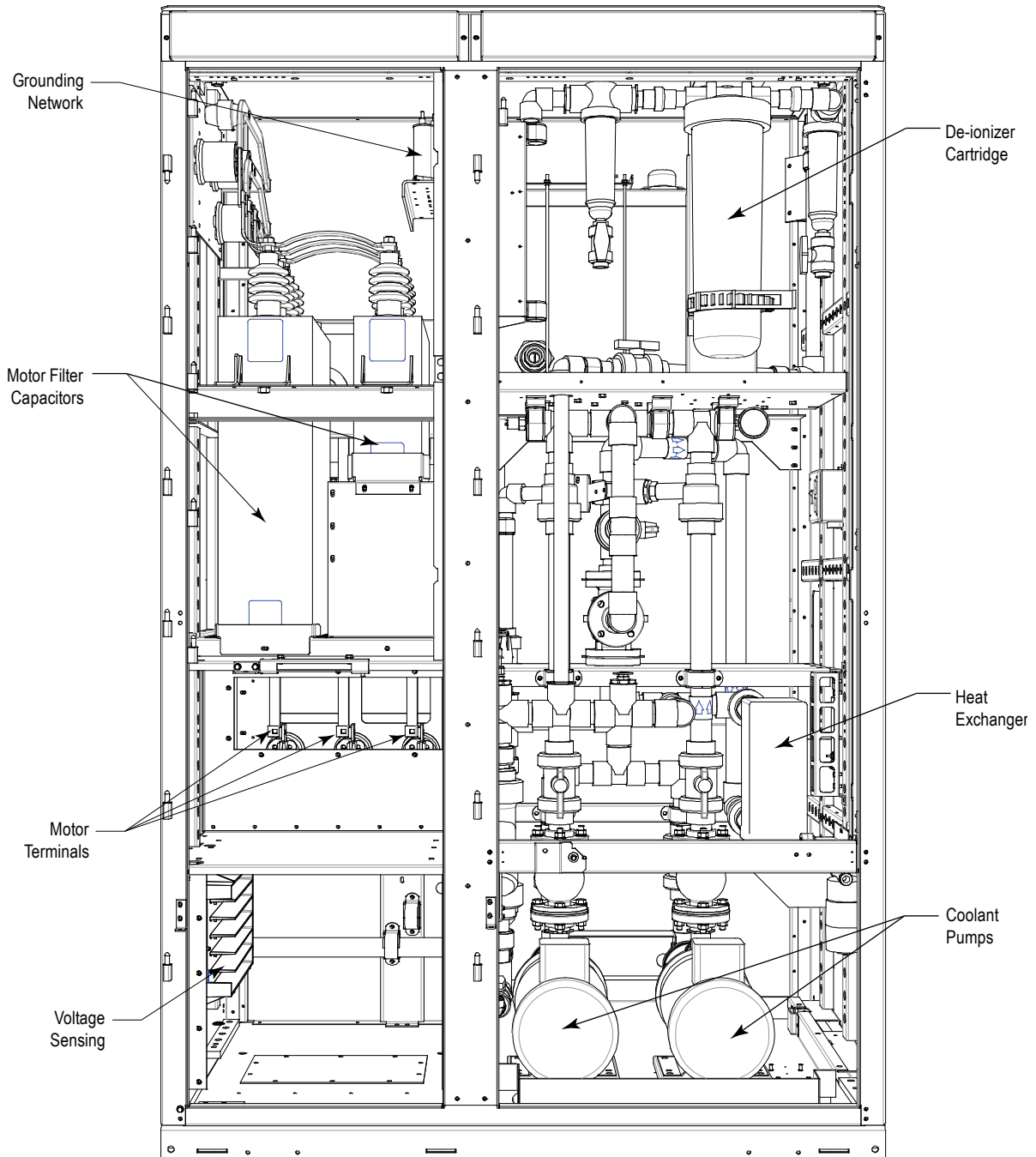


Figure 2.51 – Pump Cabinet (swing-out low voltage panel removed)

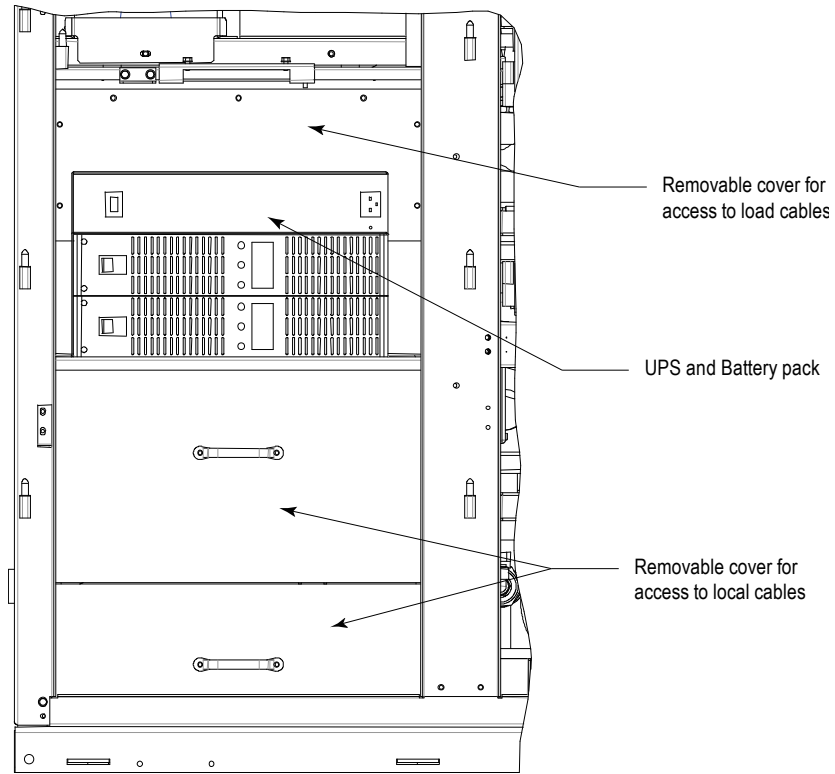


Figure 2.52 – Access to Load Terminals (components installed)

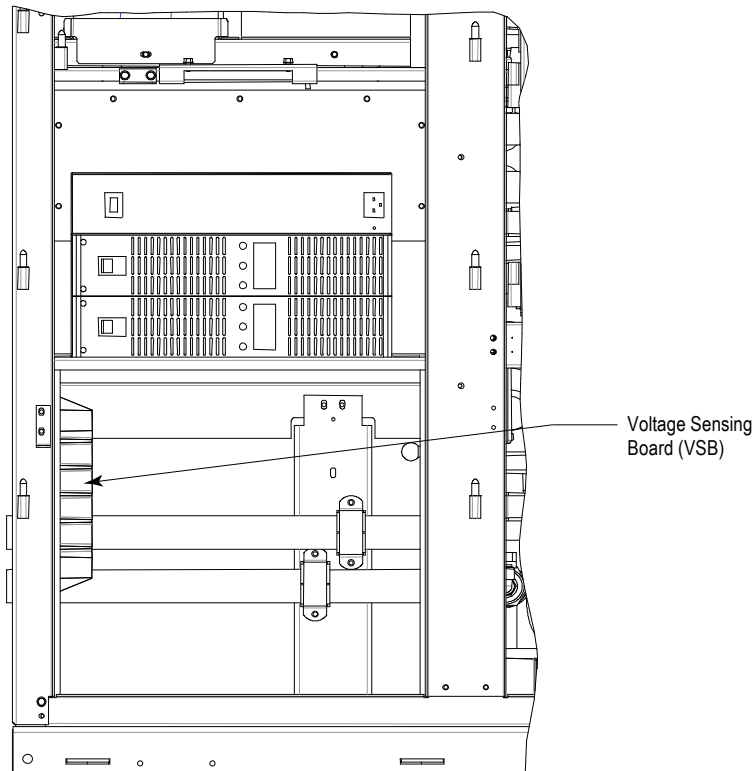


Figure 2.53 – Access to Load Terminals (bottom covers removed)

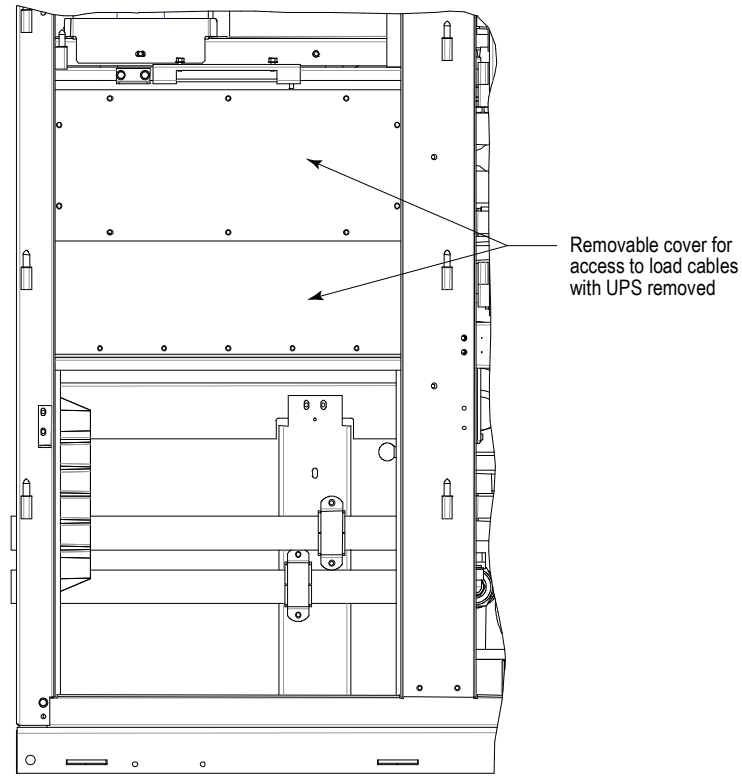


Figure 2.54 – Access to Load Terminals (bottom covers and UPS removed)

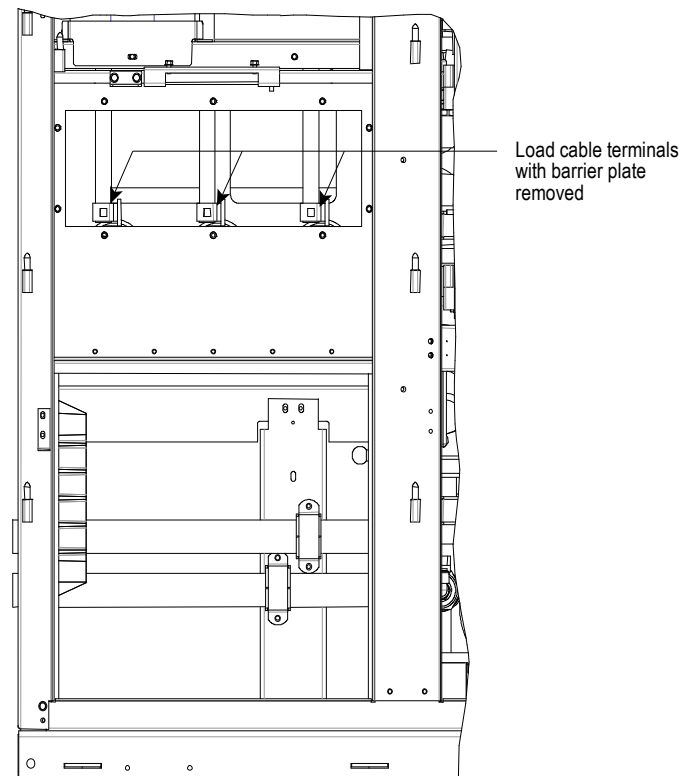


Figure 2.55 – Access to Load Terminals (bottom covers, UPS and terminal barrier removed)

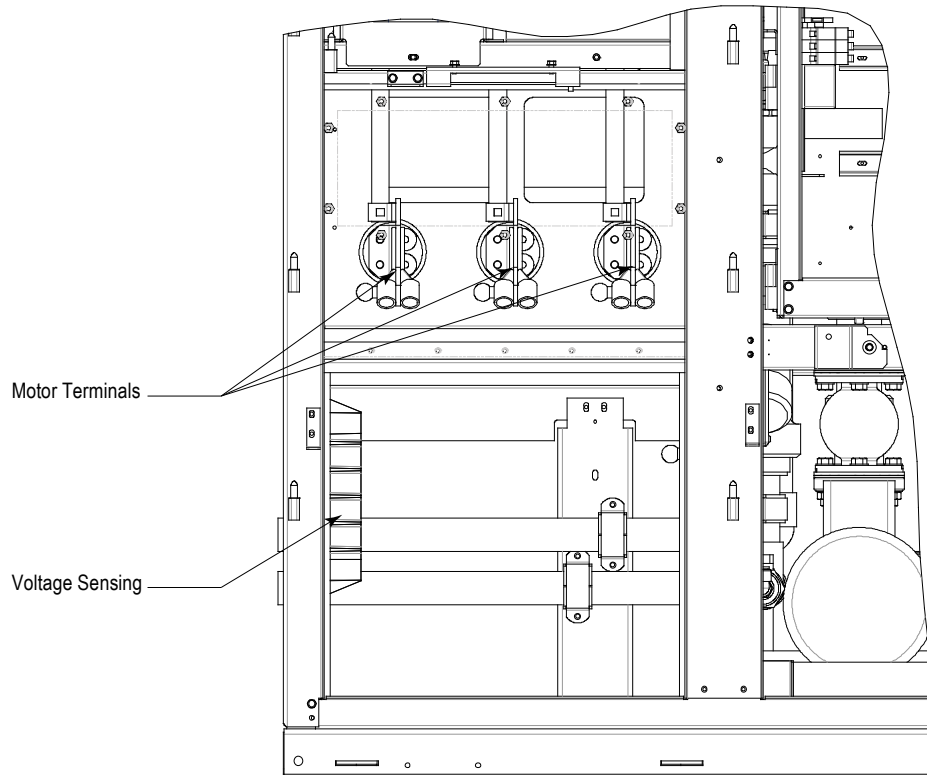


Figure 2.56 – Motor Cable termination point

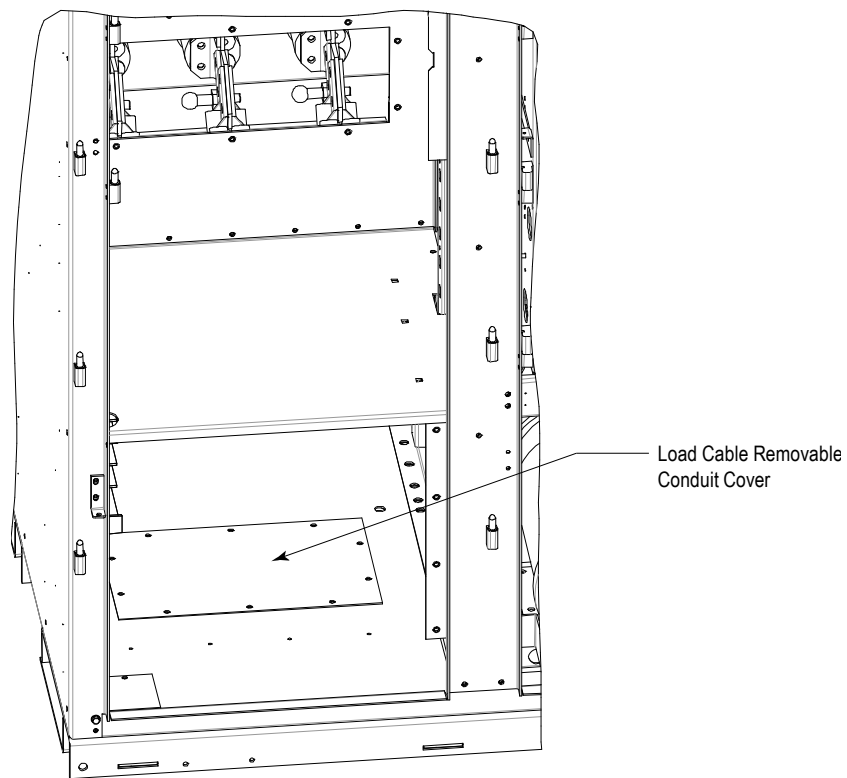


Figure 2.57 – Motor Cable termination point (Removable gland plate)

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, applicable marine standard(s) requirements 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.

Cable Insulation Requirements for 18P 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

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.

					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.

Table 2.A – Wire Group Numbers

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.

To 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.

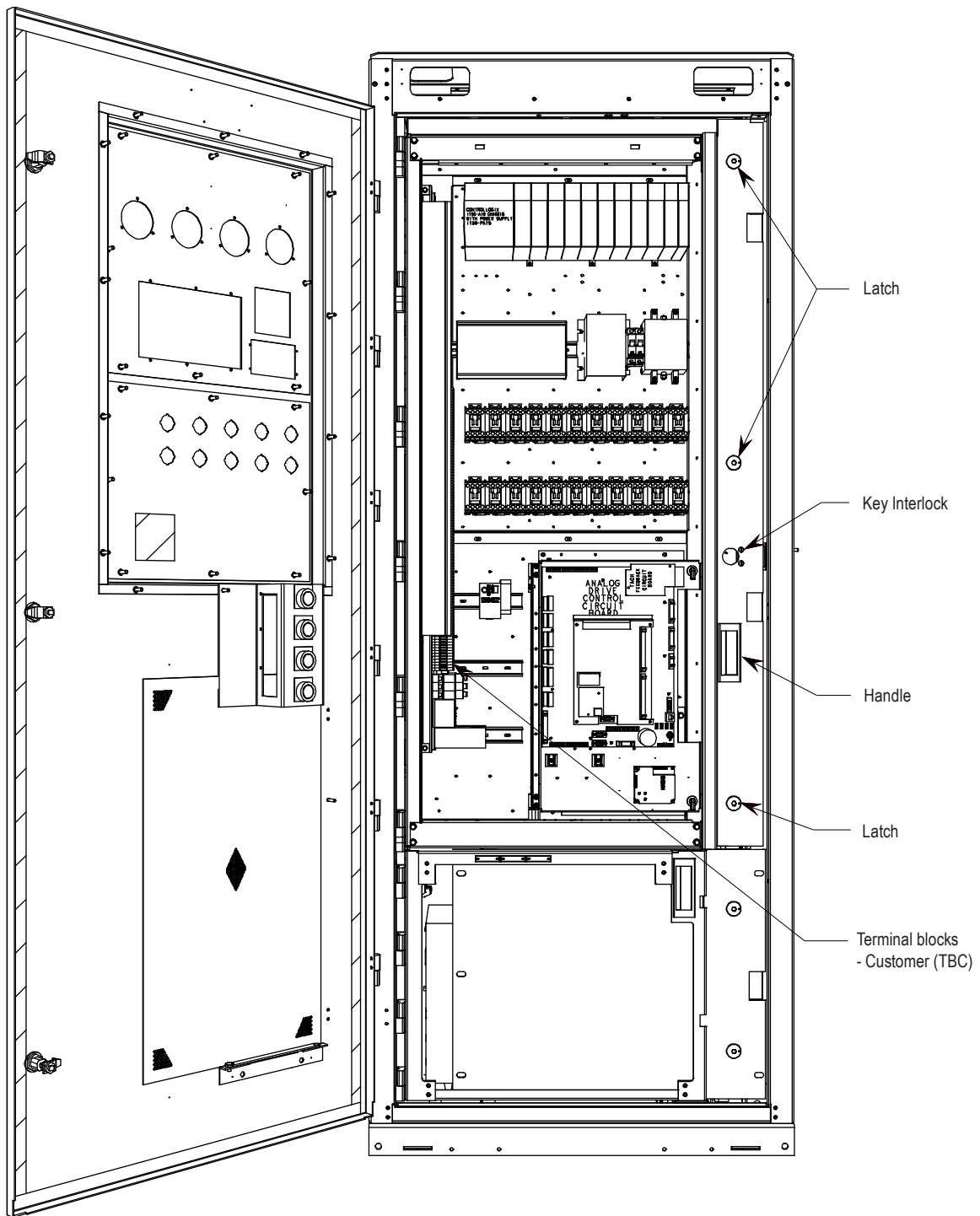


Figure 2.58 – Swing-out of Low Voltage Compartment

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 Appendix B "**Torque Requirements**" in back of manual.)

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

Liquid Connections

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.

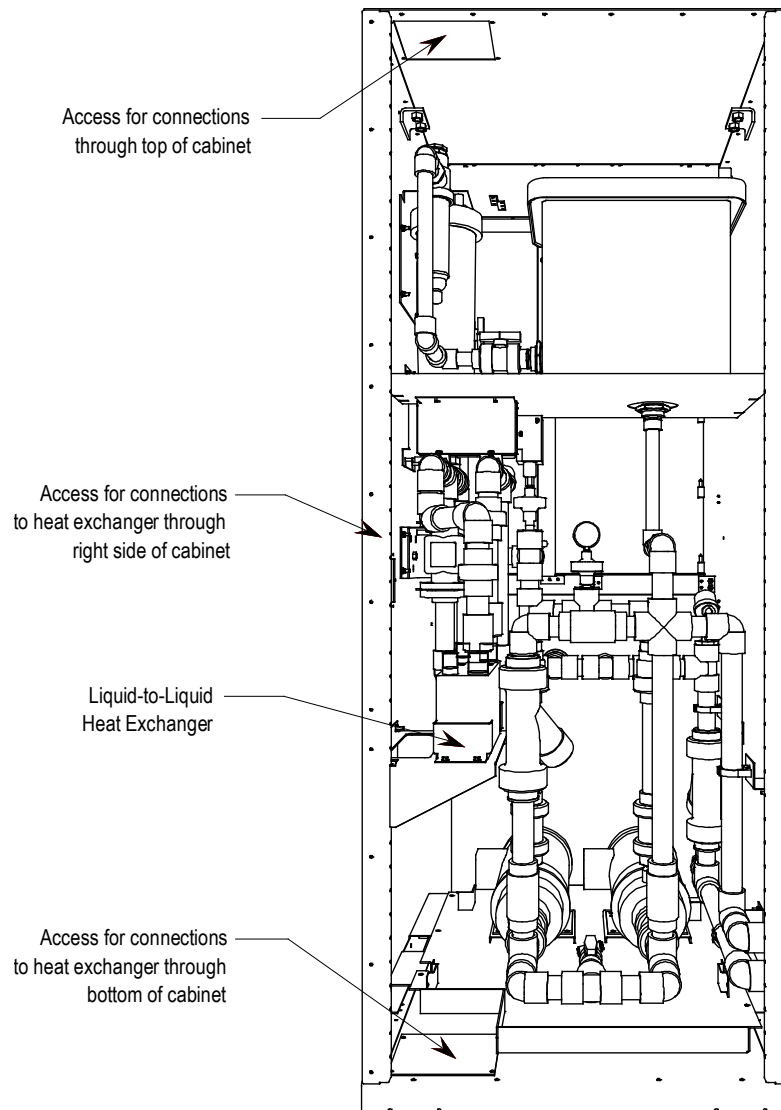


Figure 2.59 – Connection to Liquid-to-Liquid Heat Exchanger (rear of pumping cabinet shown with back plates removed)



Figure 2.60 – Conduit opening plate for bottom entry of plumbing from customer's coolant loop

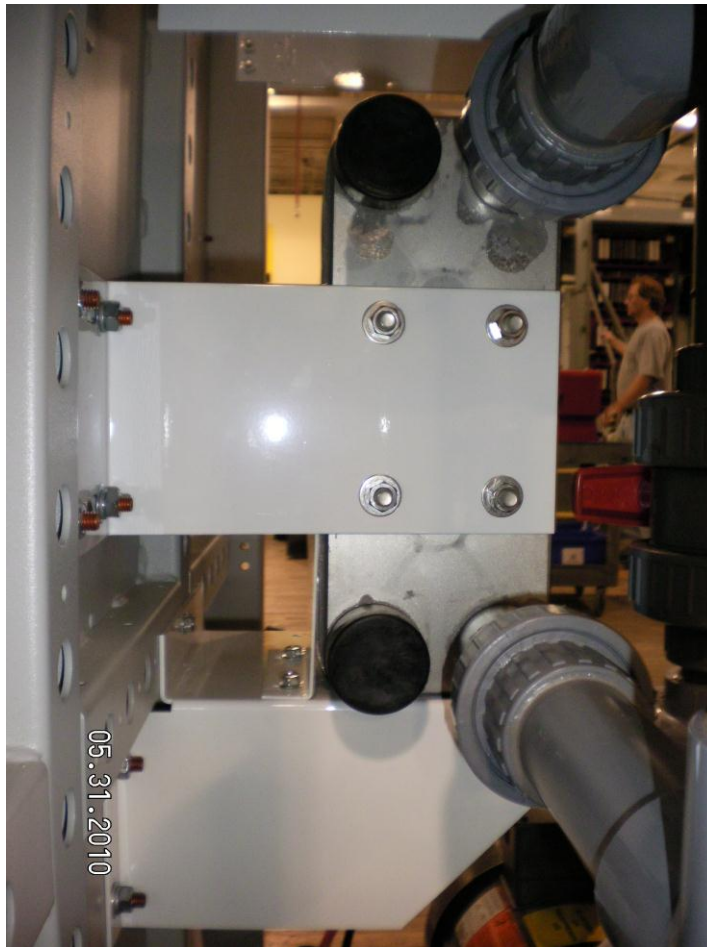


Figure 2.61 –Customer connection points to internal Heat Exchanger for external coolant loop

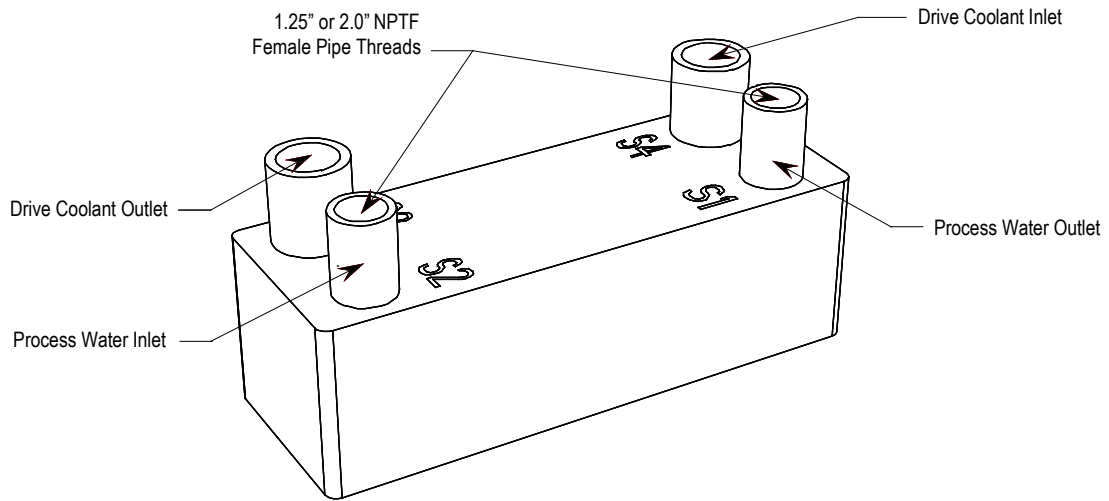


Figure 2.62 – Pipe Flange Detail

Please refer to project Specific drawings for detailed requirements for the coolant flow and pressures required.

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 mm² as equivalent to #22-#10 AWG.)

Of special concern is the tachometer signal. Two tachometer inputs are provided to accommodate a quadrature tachometer (senses motor direction). The tachometer power supply is isolated and provides +15 Volts and a ground reference. Many tachometer outputs have an open collector output, in which case a pull-up resistor must be added to ensure that proper signals are fed to the system logic. (Refer to Appendix A "**When is a Tachometer Required?**" 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.

Power and Control Wiring (cont.)

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.

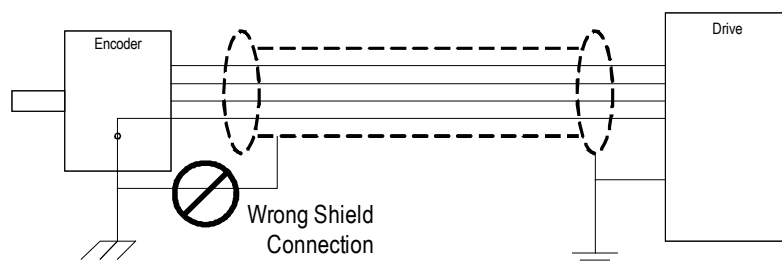


Figure 2.63 – Detail Power Terminal Dimensions

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 $< 120\text{pf/m}$ (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.

Power and Control Wiring (cont.)

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 (200ft). 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 55Khz. 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 tachometer. 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.

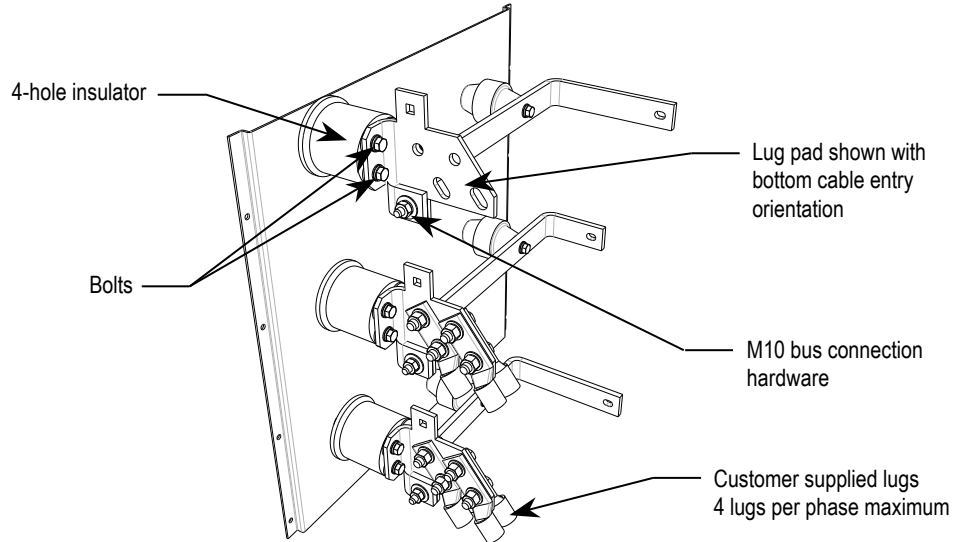


Figure 2.64 – Typical Line Cable Termination (shown assembled for bottom cable entry)

For top line cable entry, it is necessary to remove the lug pads and re-orient them as shown in Figure 2.65. To remove the lug pads, disconnect the M10 bus connection hardware (17 mm hex tooling required). Remove the two bolts that secure the lug pad to the 4-hole insulator. See **Appendix B** for Torque Values of electrical connections.

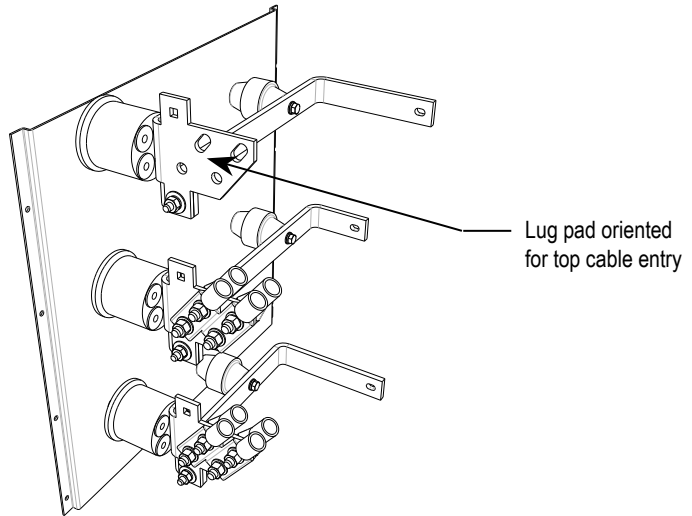


Figure 2.65 – Typical Line Cable Terminal Assembly (shown assembled for top cable entry)

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

IMPORTANT

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

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

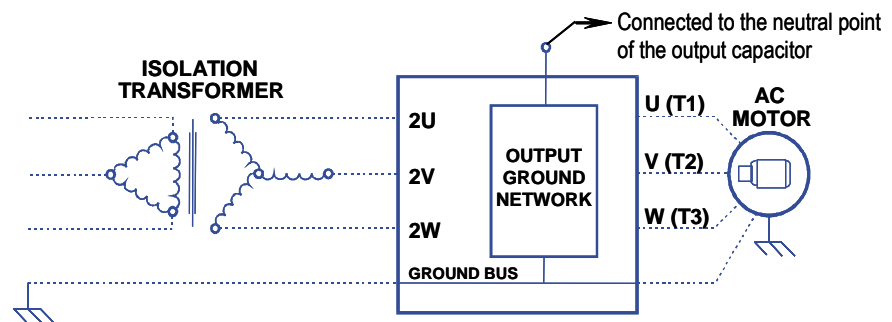


Figure 2.66 – Ground Connection Diagram with Isolation Transformer

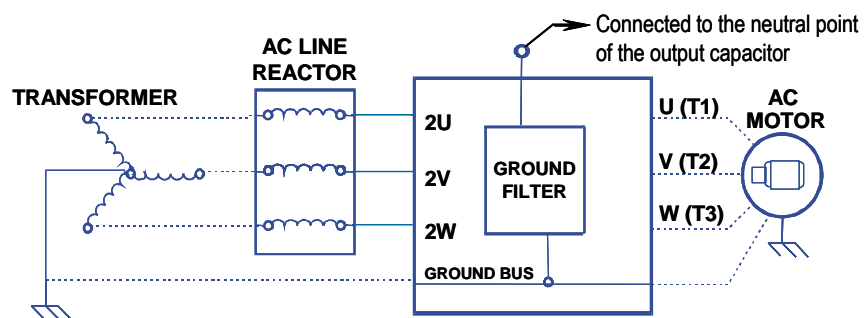


Figure 2.67 – Ground Connection Diagram with Line Reactor

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 Practices (cont.)

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.

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 **PowerFlex 7000 Medium Voltage AC Drive • Technical Data (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 “C” Frame Medium Voltage Drive is that of the PanelView 550 terminal (Figure 3.1). 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 3.1).

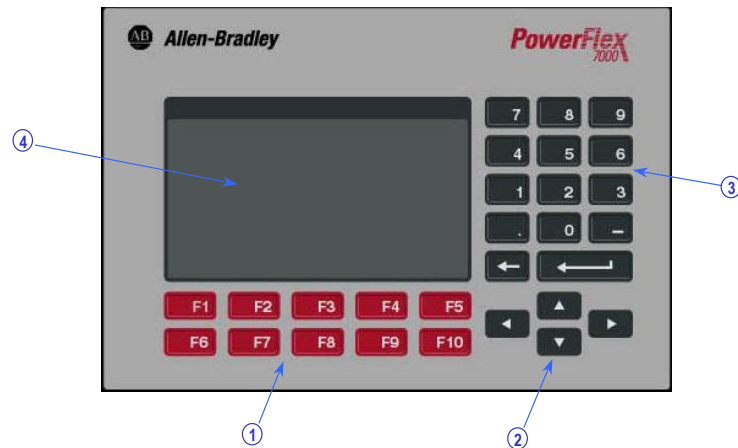


Figure 3.1– PowerFlex 7000 “C” Frame Operator Interface Terminal

Keypad

The keypad of the operator interface consists of two rows of five function keys (item 1 of Figure 3.1) located below the operator interface display area (item 4 of Figure 3.1). 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 3.1). 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 3.1).

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-F10) is always shown. The upper row is shown only if they are required for keys (F2-F5). Thus a single row of 'Softkeys' always refers to the keys F6-F10.

Even though the upper row of Softkeys (i.e. F1-F5) may not be shown on some displays, the F1-HELP key is always active. (F2-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, i.e. 1 unit. Using the [cursor left] and [cursor right] keys will change the value by a course amount, i.e. 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 2 seconds, the key will automatically repeat at a rate of 5 'presses' per second.

Data Entry Keys

As the name implies, these keys are used to enter data. Pressing the keys [0] to [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 3.2 shows a typical screen and its components.

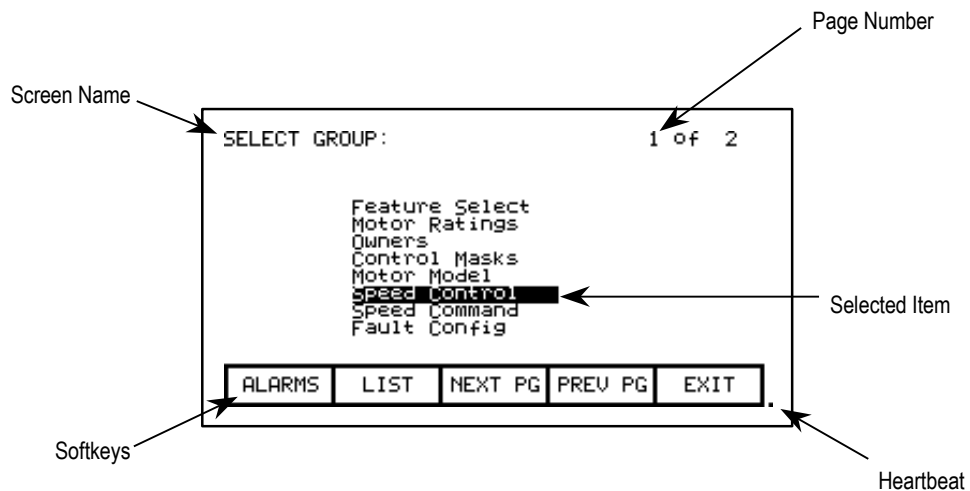


Figure 3.2 – Screen Components

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 3.3.

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, (i.e. 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 3.2, Softkeys F6-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.

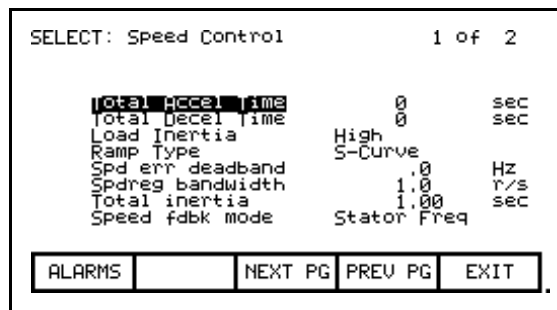


Figure 3.3 – Screen Name & Item

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 3.2 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 the section on "Advanced Screen Operations - Database Download".

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 Figures 3.4 and 3.5.

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

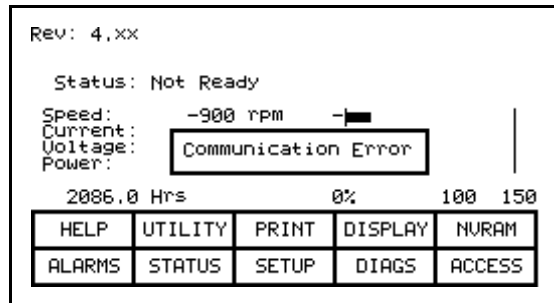


Figure 3.4 – Communications Error

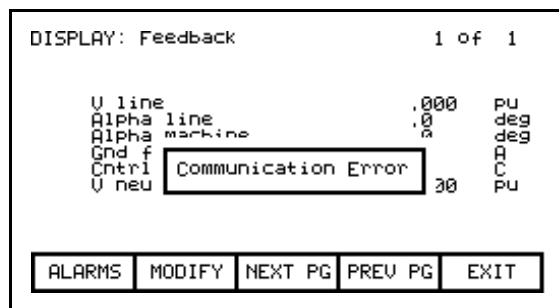


Figure 3.5 – Communications Error

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 do 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:

- a) **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:
 - software part number and revision level
 - date and time stamp of program creation

- b) **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:

- a) 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.
- b) 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 3.6) 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

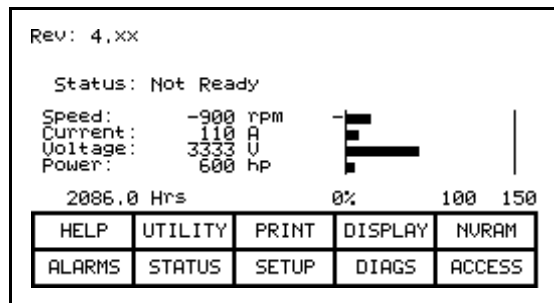


Figure 3.6 – Top Level Menu

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 3.7 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.

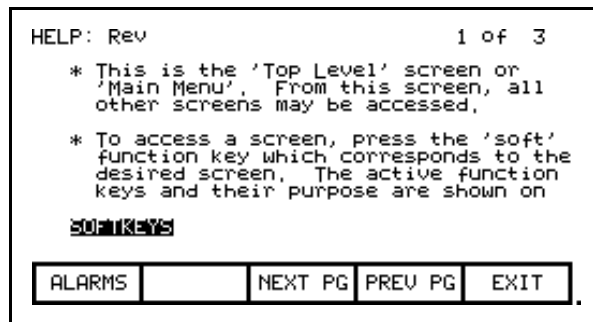


Figure 3.7 – Typical Help Screen

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 3.7 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 3.8 . 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.

```

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

```

Figure 3.8 – Help on Related Topic (Softkey)

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 3.9. 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.

```

HELP: HELP                               1 of 2
* Help is context sensitive. The
  current screen determines the help
  text which is displayed. To receive
  help on any screen, goto that screen
  and press the F1 HELP key. One (1)
  or more pages of text will be
  displayed for that screen. Use NEXT
  PG to view additional pages.

SOFTKEYS  ARROWS
ALARMS  NEXT PG  PREV PG  EXIT

```

Figure 3.9 – 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 3.10 .

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.

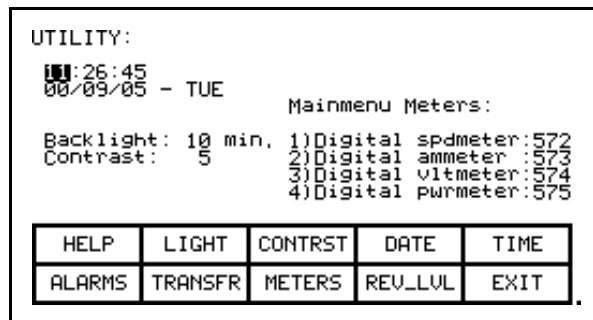


Figure 3.10 – Utility Operation Screen

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 3.11). The value can be adjusted from 0 to 60 minutes. 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.

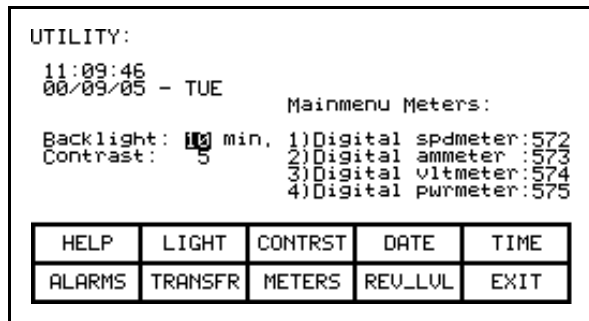


Figure 3.11 – Utility Light

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 3.12). 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.

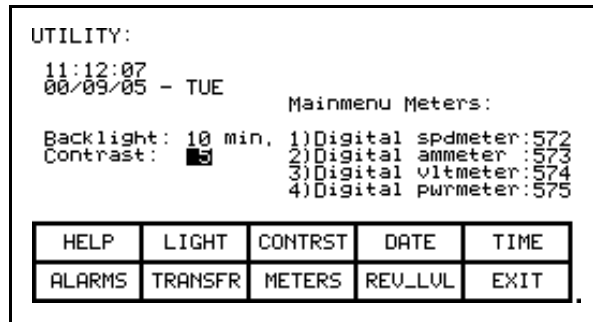


Figure 3.12 – Utility Contrast

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 3.13). 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.

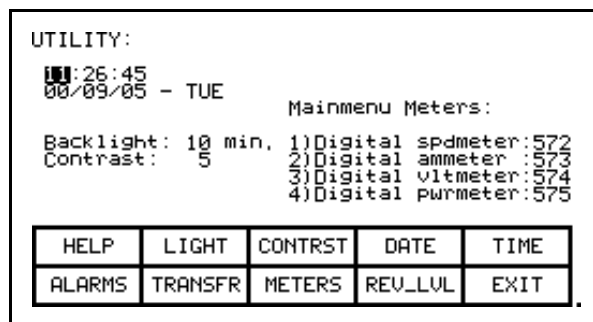


Figure 3.13 – Utility Time

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 3.14). 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.

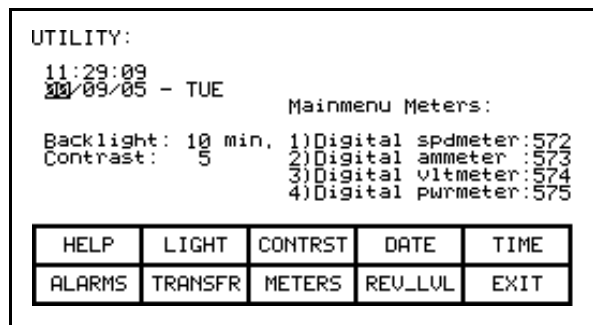


Figure 3.14 – Utility Date

Selecting Meters

The utility screen (Figure 3.10) 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 3.15) from which the selection and text associated with the meter is changed.

METERS:				
METER1	Speed	:	Digital spdmeter	:572
METER2	Current	:	Digital ammeter	:573
METER3	Voltage	:	Digital vltmeter	:574
METER4	Power	:	Digital purmeter	:575
HELP	DEFAULT	SET	DELETE	CASE
ALARMS	CANCEL	ACCESS		EXIT

Figure 3.15 – 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 the section entitled **Enter/Modify an Access Level** .

This will begin the selection process of a tag as described in the section entitled "**Select a Parameter**". 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 3.16 for meter 2.

METERS:				
METER1	Speed	:	Digital spdmeter	:572
METER2	-Meter2-	:	V line	:324
METER3	Voltage	:	Digital vltmeter	:574
METER4	Power	:	Digital purmeter	:575
HELP	DEFAULT	SET	DELETE	CASE
ALARMS	CANCEL	ACCESS		EXIT

Figure 3.16 – Utility Meter V Line

The text consists of 8 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 the section entitled **Enter/Modify an Access Level** .

The first character position of the string will be in reverse video as shown in Figure 3.17. Refer to the section entitled "Edit Text".

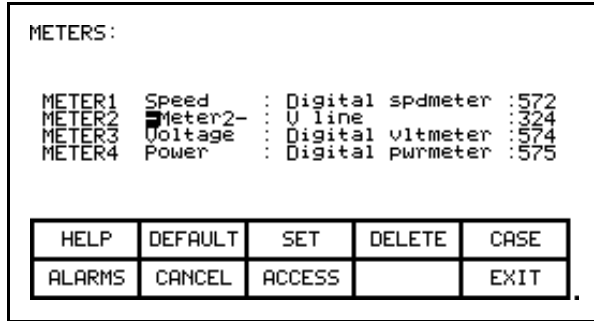


Figure 3.17 – Edit the Text

When editing is complete, the screen will appear as in Figure 3.18.

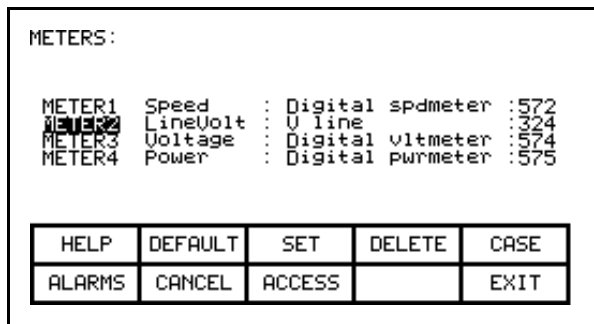


Figure 3.18 – Editing Completed

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 3.15.

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 3.19 after the METERS screen was exited.

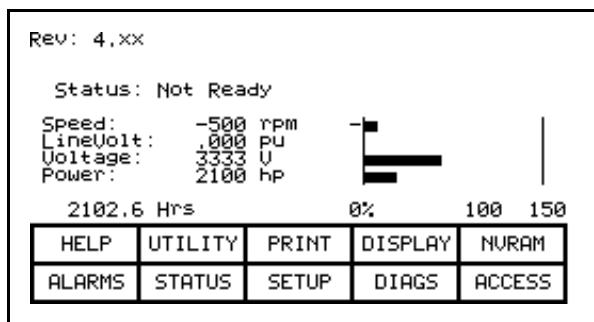


Figure 3.19 – Top Level Meter Modified

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 3.20 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.

REVISION LEVELS:		
DRIVE TYPE: PowerFlex 7000		
DRIVE NAME: PowerFlex 7000		
	SOFTWARE P/N	REV.
MUD Terminal	80189-xxx-01	4.xx
PV550 BootCode		2.06
Complete Drive		0.000
RCP Firmware		1.000
ICP Firmware		1.000
CIP Firmware		1.000
ALARMS		TEXT
		EXIT

Figure 3.20 – 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 the section entitled **Enter/Modify an Access Level**.)

A screen typical of Figure 3.21 will be displayed. To modify the text refer to the section entitled "Edit Text", noting the following exception. When the text has been entered (as in Figure 3.22) the enter key has no effect. Simply 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.

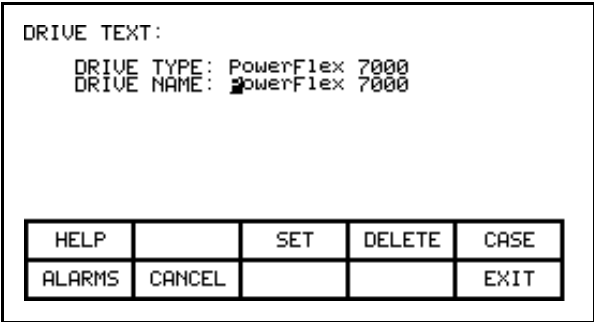


Figure 3.21 – Edit the Drive Name

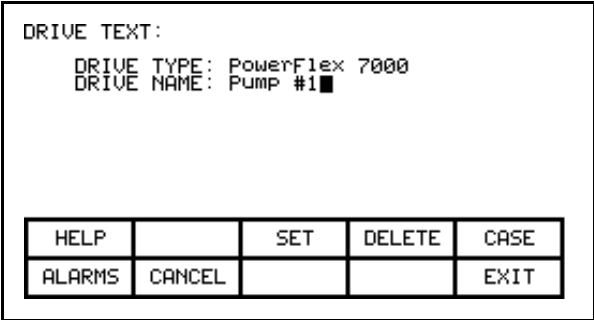


Figure 3.22 – Editing Completed

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 3.87) from which all flash memory operations are performed. Refer to the section entitled “Flash Memory Transfers” 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** 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 3.23) 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 3.24) 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.

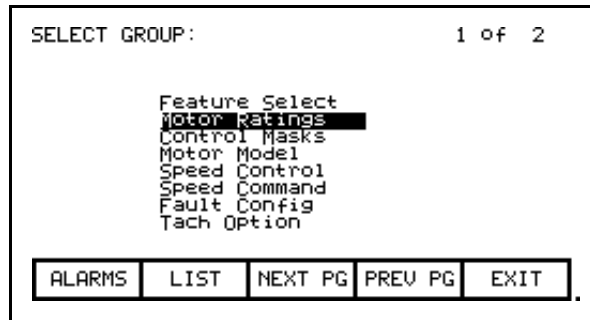


Figure 3.23 – Selecting a Group

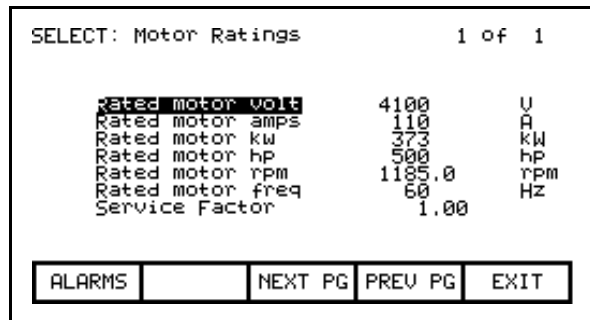


Figure 3.24 – Selecting a Member of a Group

From the SELECT GROUP screen (Figure 3.23), 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 3.23) by pressing the [F7] key. This displays the SELECT LETTER screen shown in Figure 3.25.

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 3.26. 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.

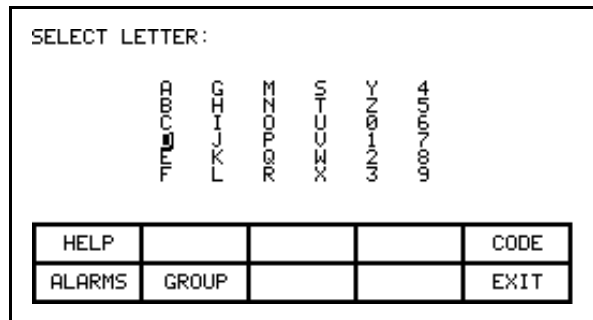


Figure 3.25 – Selecting via a Letter (Step 1)

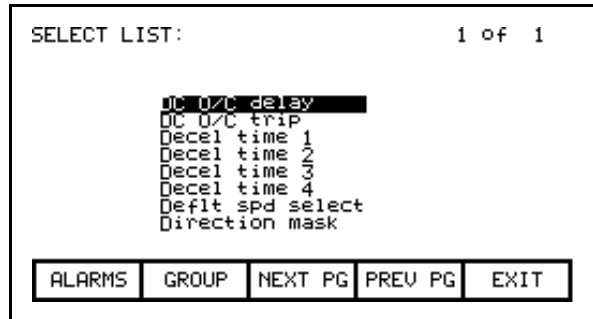


Figure 3.26 – Selecting Name via List (Step 2)

From the SELECT LETTER screen (Figure 3.25) the tag may also be selected via a code by pressing the [F5] key.

Via Code

This method of selecting a tag is initiated from the SELECT LETTER screen (Figure 3.25) by pressing the [F5] key. It allows you to select the tag, given that you know the tag code associated with the desired tag. Every parameter (i.e. tag) has a unique code associated to identify it to devices incapable of making decisions based on a name, such as a PLC for example.

Use the data entry keys [0]-[9] to enter the desired code on the SELECT CODE screen (Figure 3.27). The entered code may be edited using the [backspace] key. Press the [enter] key.

```

SELECT CODE:

|
Enter Tag Code:  22

ALARMS |   |   |   | EXIT
  
```

Figure 3.27 – Select via Code (Step 1)

The screen will display one of two formats. If the code you entered was valid, it will show the name of the tag associated with the code (Figure 3.28). This allows you to verify that this was the tag that you intended to select with the code before proceeding. If correct, press the [enter] key. If incorrect, immediately repeat the process by typing in another code. If the tag code was not valid, a message indicating such is displayed as in Figure 3.29.

```

SELECT CODE:

Rated motor volt
Enter Tag Code:  22

ALARMS |   |   |   | EXIT
  
```

Figure 3.28 – Valid Tag Code

```

SELECT CODE:

|
Enter Tag Code:  14
Invalid Tag Id Code

ALARMS |   |   |   | EXIT
  
```

Figure 3.29 – Invalid Tag Code

When the [enter] key is pressed for a valid tag code (i.e. Figure 3.28) the selected tag will be used to continue the operation for which the selection process was being used if that tag is appropriate for the operation. For example: if you are performing a parameter modification operation, but have selected a read-only parameter tag code, you will be unable to exit the screen with this read-only parameter. The screen will display this information, along with the tag's current value, such as shown in Figure 3.30. Re-enter a tag code for a parameter or press [F10] to return to the previous screen without making a selection.

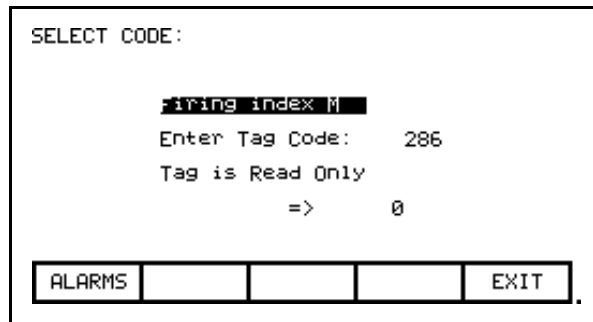


Figure 3.30 – Selected Tag Inappropriate

Edit Text

Various operations require a text string to be entered. Operations requiring this are:

- setting external faults
- adding text to selected Top Level Menu meters
- identifying the drive with a text string
- entering a filename

The operator interface's keypad does not contain any alpha keys to allow direct input of the characters. This section will describe the operation for which characters may be entered.

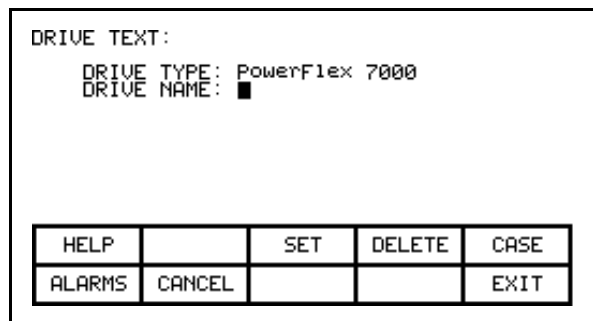


Figure 3.31 – Typical Text Edit Screen

The screen shown in Figure 3.31 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:

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

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

A special set consisting of A-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 and 65535. 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 3.32 is accessible from within a number of screens where the Access Level affects the operation of subsequent operations, such as:

- 1) [F10] key on the Top Level Menu,
- 2) [F8] key on the Modify Parameter screen,
- 3) [F8] key on the Setup Screen,
- 4) [F8] key on the Transfer Screen,
- 5) [F8] key on the Diagnostic Setup screen.

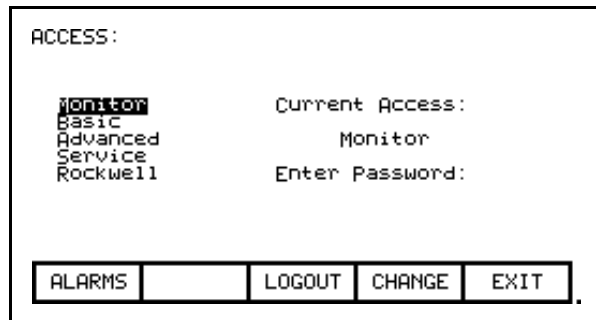


Figure 3.32 – Access Screen

The Current Access level is shown. To select a different access level, use the up/down cursor keys to select the desired the level. Then enter the password value (PIN) for that level using the data entry keys. The value can be any number between 0 and 65535. As the number is entered via the keys [0]-[9], the value will be shown by a placeholder (i.e. * in the editing field), as shown in Figure 3.33.

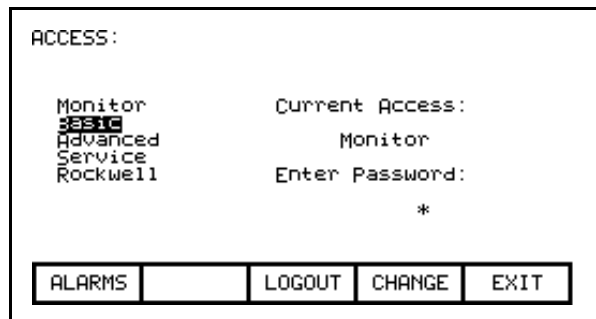


Figure 3.33 – Pin Entry

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 3.34 . If the incorrect value was entered, the operator interface will remain at the current access level.

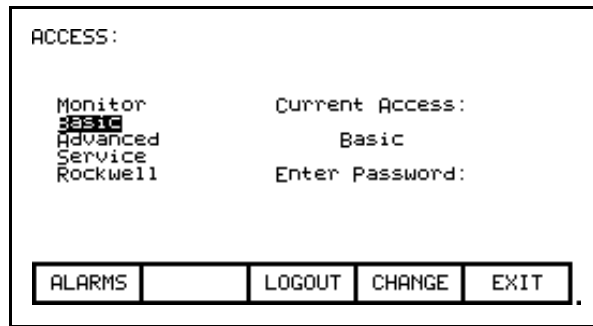


Figure 3.34 – Access Level Changed

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 3.32.

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 3.35 is displayed, showing the Access Level for which the new PIN will be applied to.

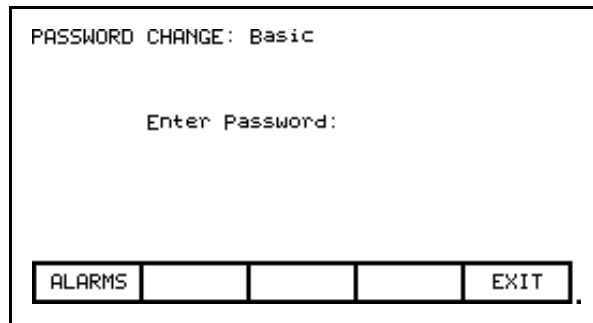


Figure 3.35 – PIN Change

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 3.36.

```

PASSWORD CHANGE: Basic

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

ALARMS | | | | | EXIT

```

Figure 3.36 – PIN Change Completed

At the end of the operation you will see a status as shown in either Figures 3.36, 3.37 or 3.38 depending on whether you successfully changed the PIN, incorrectly entered the existing PIN or incorrectly verified the new PIN.

```

PASSWORD CHANGE: Basic

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

ALARMS | | | | | EXIT

```

Figure 3.37 – Invalid PIN

```

PASSWORD CHANGE: Basic

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

ALARMS | | | | | EXIT

```

Figure 3.38 – Invalid PIN Verification

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 3.39 .

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 3.40). Refer to the section **Enter/Modify an Access Level** .



Figure 3.39 – Setup Screen

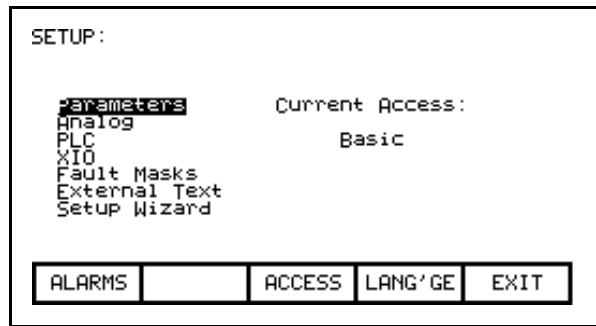


Figure 3.40 – Basic Access Level

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 3.41. 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.

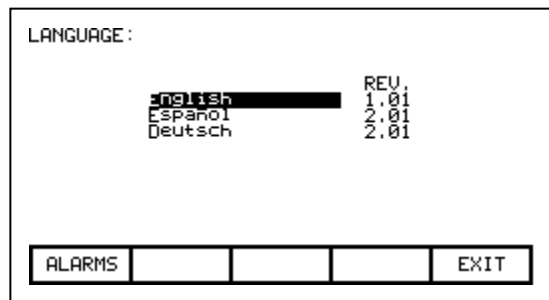


Figure 3.41 – Language Selection

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 3.68) 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 3.42 will be displayed. This screen shows:

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

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

Figure 3.42 – Parameter Data Entry

MODIFY PARAMETER: Rated motor volt			
	P: 22		
Min:	4000	U	
Actual:	4100		
New:	4000		
Max:	4150		
ALARMS	CANCEL	ACCESS	EXIT

Figure 3.43 – Modify Numerical 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** 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 (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 3.43. 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 3.44 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 (i.e. 4)
- the actual value of the parameter contained in the drive.

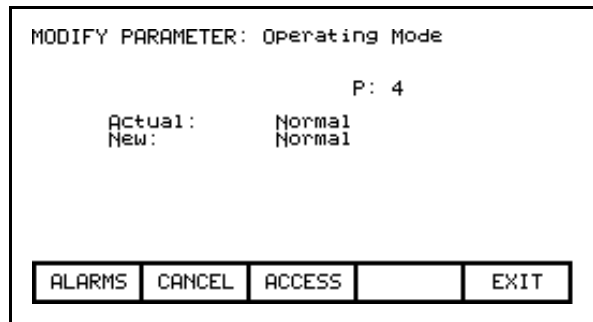


Figure 3.44 – Modify Enumerated Value

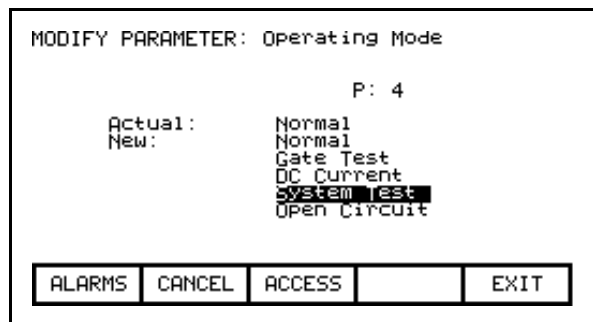


Figure 3.45 – Option List Viewed on Single Page

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** 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 3.45). 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 3.46).

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 3.47.

```

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 3.46 – Option List Viewed on Multiple Pages

```

MODIFY PARAMETER: Operating Mode

                                P: 4

Actual:      Normal
New:         System Test

ALARMS  CANCEL  ACCESS  EXIT

```

Figure 3.47 – Modification Completed

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 3.48 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 (i.e. 241)
- the name of the bit currently selected (Adapter 0)
- the actual value of the parameter bits contained in the drive.

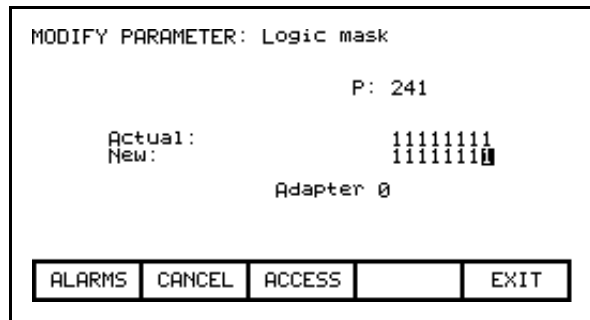


Figure 3.48 – Modify Bit Encoded Value

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** 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 3.49 . 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** to gain access).



Figure 3.49 – Analog Setup

This will begin the selection process of a tag as described in the section entitled "Select a Parameter". 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 3.50 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 3.51. (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** to gain access).

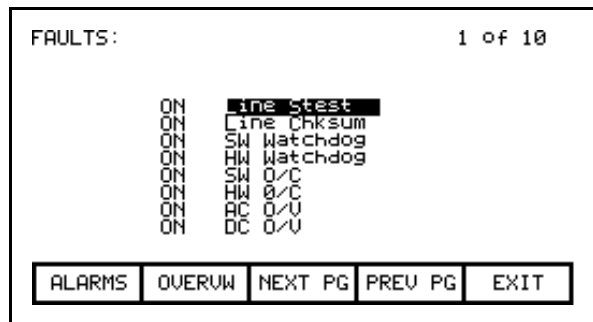


Figure 3.50 – Fault Screen

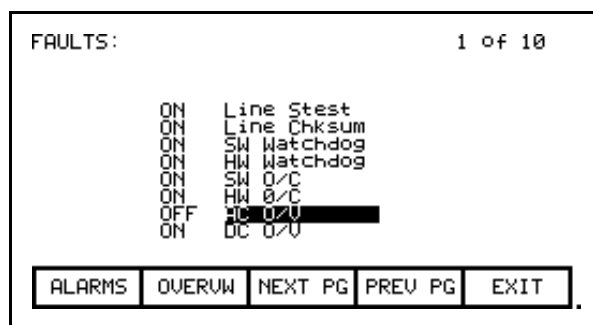


Figure 3.51 – Fault Mask OFF

Figures 3.50 and 3.51 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 Figures 3.52 and 3.53.

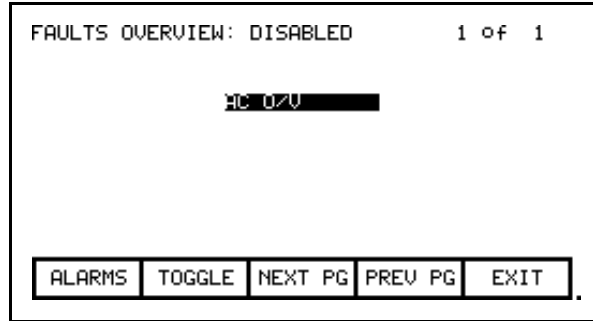


Figure 3.52 – AC O/V, Disabled

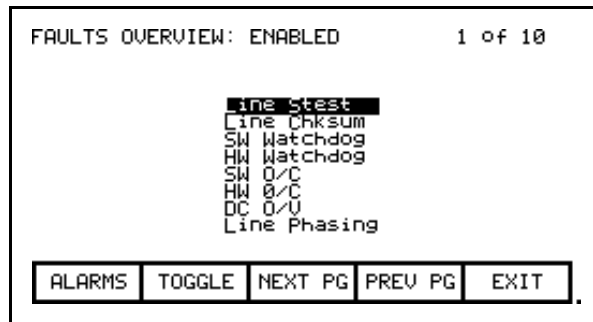


Figure 3.53 – Fault Overview, Enabled

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 3.52, 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 3.54. Pressing [F7] toggles the screen to show the enabled faults, which the AC O/V is one of (Figure 3.55). (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** to gain access).

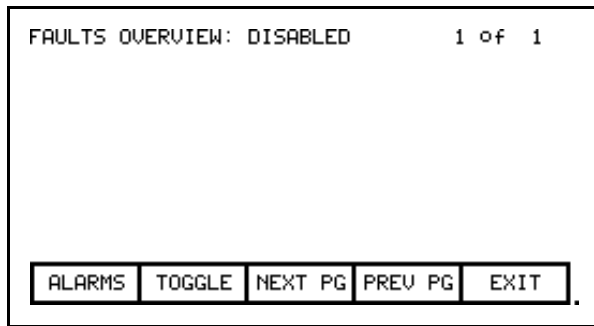


Figure 3.54 – AC O/V Removed From List

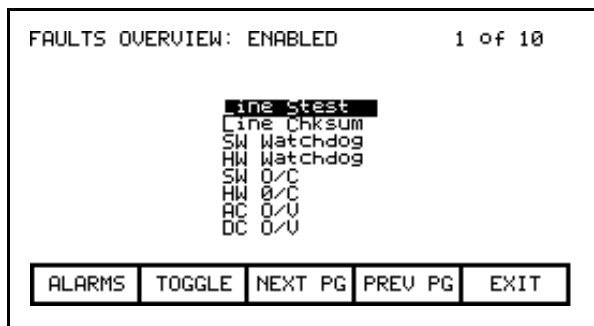


Figure 3.55 – AC O/V Now Enabled

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 3.56).

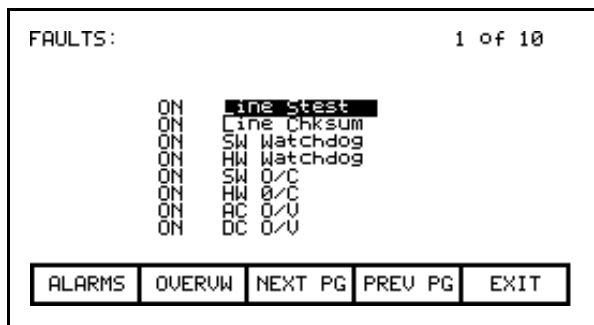


Figure 3.56 – AC O/V Mask is ON

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 3.57 will be seen.

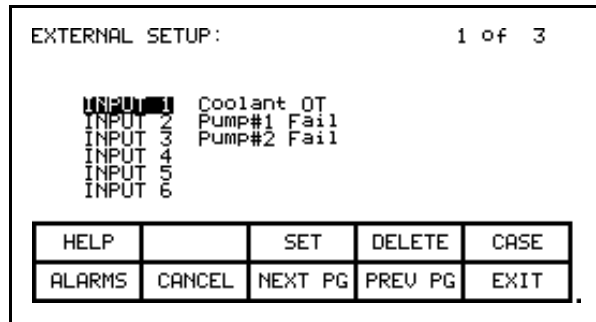


Figure 3.57 – External Setup Text

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** to gain access). The first character position of the string will be in reverse video as shown in Figure 3.58. Refer to the section entitled "Edit Text". When editing is complete, the screen will appear as in Figure 3.59.

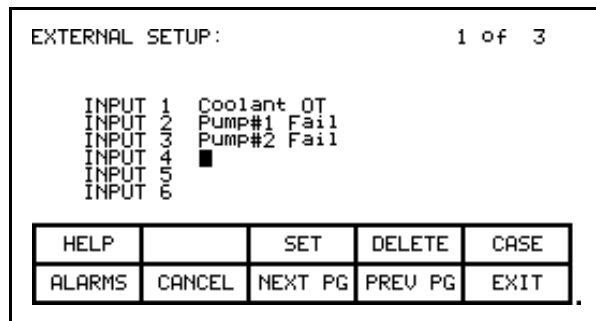


Figure 3.58 – Modify Text

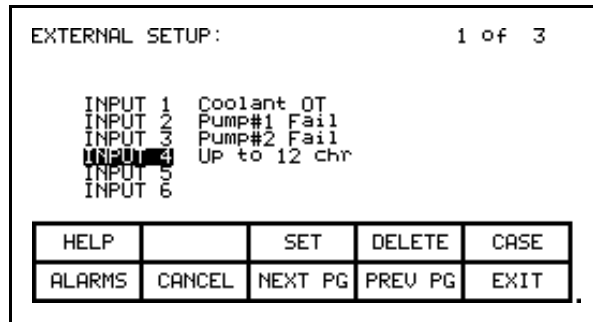


Figure 3.59 – Modification Completed

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.

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 3.60 or 3.61. 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** to gain access).

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 3.60 – PLC Input 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
--------	--------	--------	--	------

Figure 3.61 – PLC Output Links

This will begin the selection process of a tag as described in the section entitled "**Select a Parameter**". 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 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.

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 3.62 to save the data. If you wish to save the data, press [F8] 'Yes' and the NVRAM screen (refer to **Store/Retrieve Configuration**) will be entered (Figure 3.63). 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**.

MESSAGE:				
<p>You have changed the setup data in the drive's working RAM. If you wish the changes to be permanent, they must be SAVED in the drive NVRAM.</p> <p>Do you wish to save to NVRAM? [Yes/No]?</p>				
ALARMS		YES	NO	EXIT

Figure 3.62 – Message Prompt Screen

NVRAM:				
Operation:				
Operation Status:				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

Figure 3.63 – 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**.

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 3.64, 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.

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

Figure 3.64 – Initialize Operation

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 3.65).

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

Figure 3.65 – Save Operation

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 3.66).

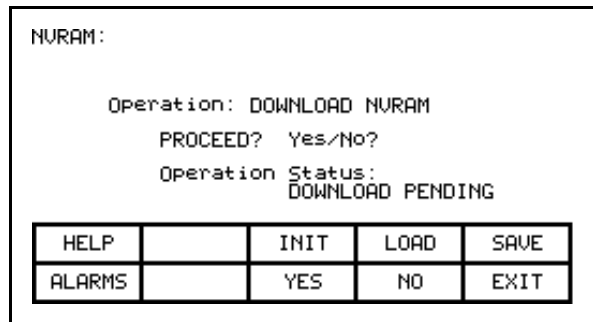


Figure 3.66 – Load Operation

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 3.67 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 3.68).

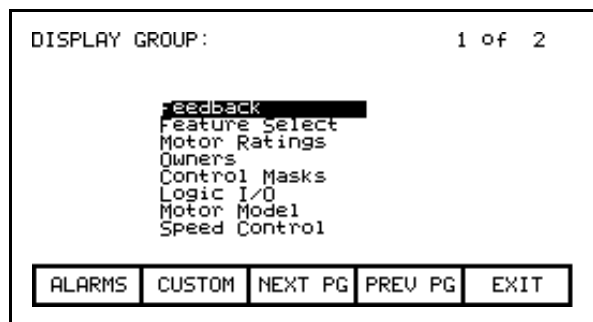


Figure 3.67 – Display Screen


```

DISPLAY: Feature Select          1 of 2

Auto restart dly                .000    sec
Coast Speed                     40.0    Hz
Deflt spd select                Local
Input ContCfg                  Not Running
IO configuration                 Config1
Operating Mode                  Gate Test
Output ContCfg                  Not Running
Passcode 0                      48059

ALARMS  MODIFY  NEXT PG  PREV PG  EXIT

```

Figure 3.68 – Feature Select Group Chosen

```

DISPLAY: Logic I/O             1 of 1

Logic command                   0      Hex
Logic status 1                  0      Hex
Logic status 2                  0      Hex
Local inputs                     0      Hex
Local outputs                    0      Hex
SCANport input                  0
SCANport output                  0      rpm

ALARMS  MODIFY  NEXT PG  PREV PG  EXIT

```

Figure 3.69 – Bit Encoded Parameter

```

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

```

Figure 3.70 – Bit Description for Local Outputs

The DISPLAY screen, typical of Figure 3.68, 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 (Figures 3.69 and 3.70). The VIEW PARAMETER screen will then show that parameter as it is decoded per bit as shown in Figure 3.70.

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 3.67) 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 3.71).

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**". When you have completed the selection process, the selected tag will be assigned to the item, as in Figure 3.72. To remove a tag from the highlighted item, press the [delete] (Backspace) key.

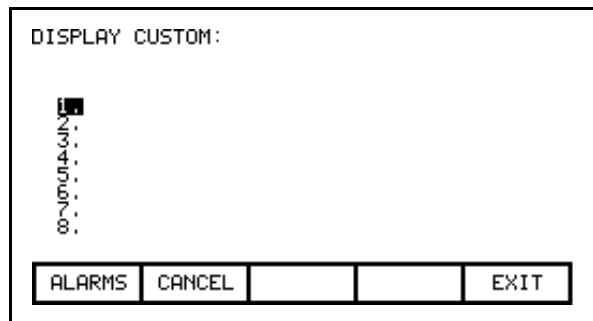


Figure 3.71 – Display Custom Screen

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 3.75 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.

FAULTS:		1 of 1						
Line self test	07/27	13:59:59						
Rect Adwr Overnt	07/27	12:59:59						
<table border="1" style="width: 100%;"> <tr> <td>ACK</td> <td>CLEAR</td> <td>NEXT PG</td> <td>PREV PG</td> <td>EXIT</td> </tr> </table>				ACK	CLEAR	NEXT PG	PREV PG	EXIT
ACK	CLEAR	NEXT PG	PREV PG	EXIT				

Figure 3.75 – 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 3.76 will be shown for that alarm. Not all alarms will have this additional help text. For those alarms the screen shown in Figure 3.77 is displayed.

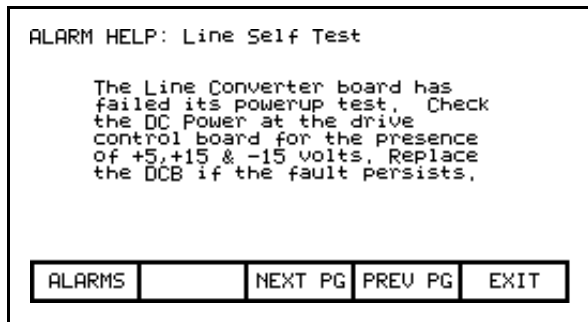


Figure 3.76 – Alarm Help

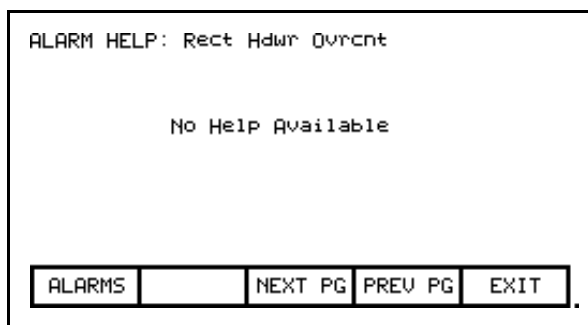


Figure 3.77 – No Alarm Help

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 3.78 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 the Figure 3.78, 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 3.78 – 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 3.79.

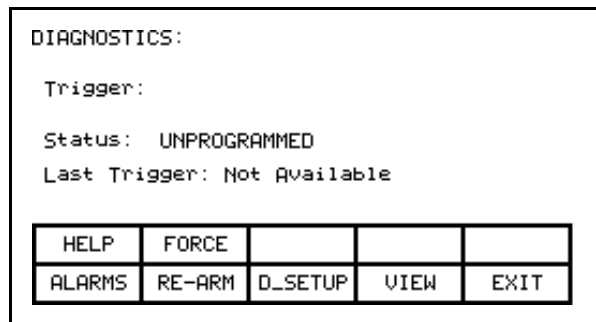


Figure 3.79 – Diagnostic Screen

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 3.80.

```

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 3.80 – Diagnostic Setup

```

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

Figure 3.81 – Assign a Trace

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** to gain access).

This will begin the selection process of a tag as described in the section entitled "**Select a Parameter**". When you have completed the selection process, the selected tag will be assigned to the trace, as in Figure 3.81. 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** 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 3.81). 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.

Trigger Conditions:

=	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 3.82. 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.

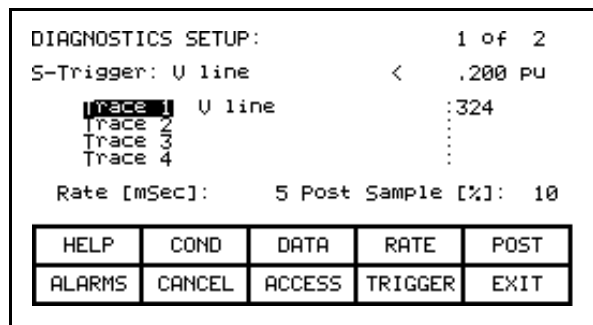


Figure 3.82 – Trigger Condition

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 3.83 will show the trigger condition and the status. Pressing the [F7] key on the DIAGNOSTICS screen may also start the trend.

DIAGNOSTICS:				
Trigger: U line = .200 pu				
Single				
Status: RUNNING				
Last Trigger: Not Available				
HELP	FORCE			
ALARMS	RE-ARM	D_SETUP	VIEW	EXIT

Figure 3.83 – Diagnostic Armed

DIAGNOSTICS:				
Trigger: U line = .000 pu				
Continuous				
Status: TRIGGERED				
Last Trigger: Not Available				
HELP	FORCE			
ALARMS	RE-ARM	D_SETUP	VIEW	EXIT

Figure 3.84 – Diagnostic Triggered

Once the data has started to be collected, the status will show 'triggered' as in Figure 3.84. When the buffer contains a complete capture, it will show "stopped" (if a single capture), as shown in Figure 3.85. 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.

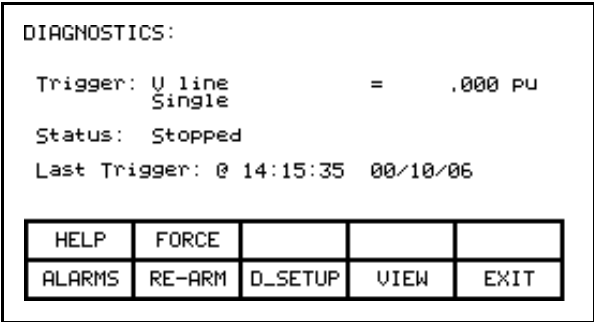


Figure 3.85 – Diagnostic Stopped

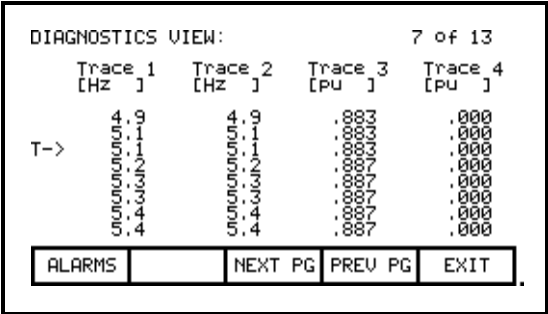


Figure 3.86 – View the Trend Buffer(s)

A screen such as Figure 3.86 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 3.79), you will be prompted to save the changes to NVRAM. Refer to the section "Message Prompting" 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 3.87.

TRANSFER:				
Current Access: Basic				
HELP	FORMAT	PROGRAM	PARAMTR	LANG'GE
ALARMS	DIR	ACCESS	SYSTEM	EXIT

Figure 3.87 – 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** .

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 3.88, 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** to gain access).

TRANSFER: FORMAT:				
FORMAT FLASH CARD				
PROCEED? Yes/No?				
Operation Status:				
FORMAT PENDING				
HELP	FORMAT			
ALARMS		YES	NO	EXIT

Figure 3.88 – 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 3.89 will be shown.

DIRECTORY:		1 of 1	
Filename:			
ENGLISH	.PAR	99/07/30	09:10
FRENCH	.LNG	98/02/25	16:39
SPANISH	.LNG	97/06/12	13:17
PUMP	.PAR	99/10/20	11:17
RUSSIAN	.LNG	97/12/09	09:06
BOILER	.PAR	00/02/17	13:30

HELP	EDIT		DELETE	
ALARMS	CANCEL	NEXT PG	PREV PG	EXIT

Figure 3.89 – 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 3.90.

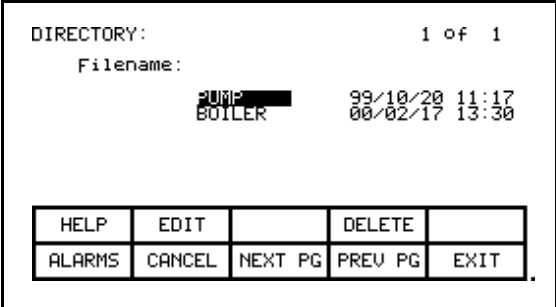


Figure 3.90 – Typical File Selection

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.

- a) If a 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.
- b) 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** to gain access).

When the filename has been obtained, the TRANSFER: PROGRAM screen such as that in Figure 3.91 will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

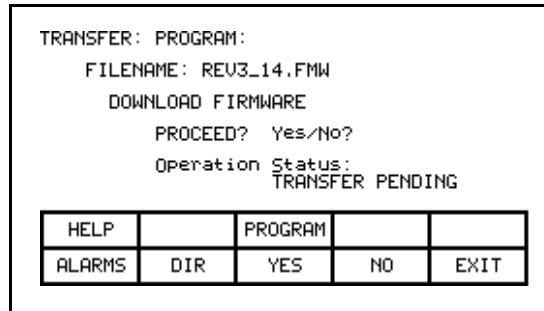


Figure 3.91 – Load New Firmware

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**.

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**. 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 3.92 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** to gain access). Within this screen it is possible to perform four different parameter transfers.

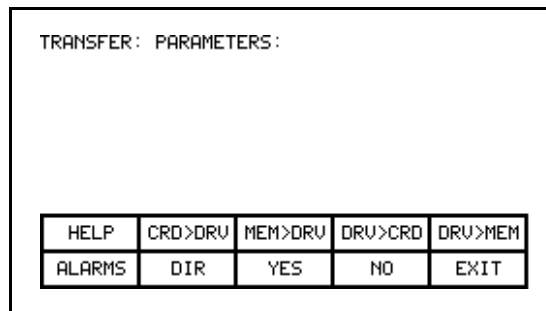


Figure 3.92 – Transfer Parameters Menu

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 3.93, 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.

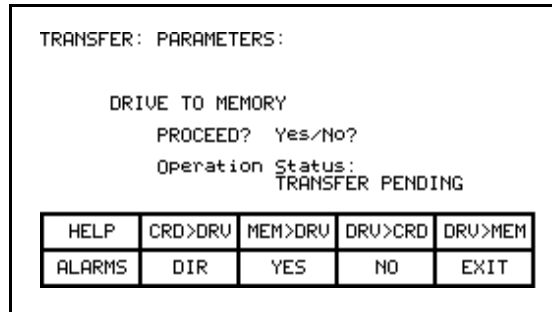


Figure 3.93 – Transfer Stored Parameters

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 3.93 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**”. When the filename has been obtained, the TRANSFER: PARAMETERS screen such as that in Figure 3.94 will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

TRANSFER: PARAMETERS:				
FILENAME: PUMP.PAR				
DRIVE TO FILE				
PROCEED? Yes/No?				
Operation Status:				
TRANSFER PENDING				
HELP	CRD>DRU	MEM>DRU	DRU>CRD	DRU>MEM
ALARMS	DIR	YES	NO	EXIT

Figure 3.94 – 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**” and “**Enter a filename**”. When the filename has been obtained, the TRANSFER: PARAMETERS screen similar to that shown in Figure 3.94 (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:

- a) First Line:
- a revision number followed by a semi-colon (;). Number is not important.
 - the date followed by a semi-colon, i.e. 01/01/1996. Date is not important.
 - the time followed by a semi-colon, i.e. 12:01:01. Time is not important.
- b) Remaining Lines:
- 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. i.e.
 - 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 3.95. 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** to gain access).

When the filename has been obtained, the TRANSFER: LANGUAGE screen such as that in Figure 3.96 will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

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 3.95 – Language Directory

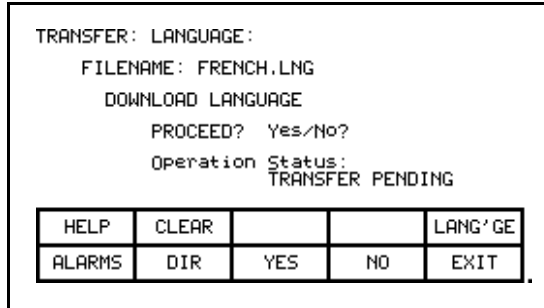


Figure 3.96 – Transfer Language Module

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 3.97 will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort.

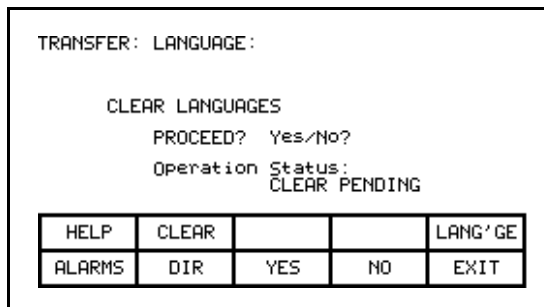


Figure 3.97 – Clear Languages

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 3.98 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.

```

COMMUNICATIONS:                               1 of 1
ERRORS:
Parity:  0 Framing:  0 Overrun:  0
Resends: 0 Timeouts: 0 Chksum:  0
Discard: 0 Control:  0 Seqnce:  0
BUFFERS:
TX: Psh0 0; Pop0 0;
   0 10 4 10 6 10 2 7 9A 0
   3 3C 2 1 E3 0 10 4 10 6
RX: Psh0 2; Pop0 2;
   10 4 1 0 0 A1 0 10 4 10
   6 10 2 7 9A 1 0 0 A2 0
ALARMS ANALYZE RESET EXIT

```

Figure 3.98 – 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 3.99)
- the data shown as a mixture (Figure 3.100) of:
 - a) control characters
 - b) printable ASCII characters
 - c) hexadecimal data.

```

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 3.99 – Hexadecimal Displayed

```

PROTOCOL ANALYZER:                1 of 13
RX:  01 DL ET
TX:  DL AK DL ST 07 F8 00

RX:  DL AK
TX:  01 00 00 AK AK 01 DL ET

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

```

Figure 3.100 – Mixed Format Displayed

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.

```

MEMORY:
SEGMENT: 0040
0000: AA 55 00 10 00 00 02 0A : .U.....
0008: 31 2E 30 30 00 31 2E 30 : 1.00.i.0
0010: 30 00 31 2E 30 30 00 45 : 0.1.00.E
0018: 6E 67 6C 69 73 68 00 31 : nglish.I
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.....E.
0038: 40 00 AC 00 82 12 40 00 : 0.....0.

```

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

Figure 3.101 – Data Segment Memory Dump

The initial screen, (Figure 3.101) 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 8 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 3.102 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.

```

MEMORY:
SEGMENT: 0040 New Address: A000: 1E
0000: AA 55 00 10 00 00 02 0A : U.....
0008: 32 2F 30 30 00 32 2F 30 : 2.00.2.0
0010: 30 00 32 2F 30 30 00 45 : 0.2.00.E
0018: 6F 67 6C 69 73 68 00 32 : nglsh.2
0020: 2F 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...U.0.
0038: 40 00 C0 00 56 14 40 00 : 0...U.0.

ALARMS ADDRESS NEXT PG PREV PG EXIT

```

Figure 3.102 – Edit the Segment: Offset

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 3.103.

```

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

ALARMS ADDRESS NEXT PG PREV PG EXIT

```

Figure 3.103 – Data at New Address

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 Figures 3.104 and 3.105.

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.

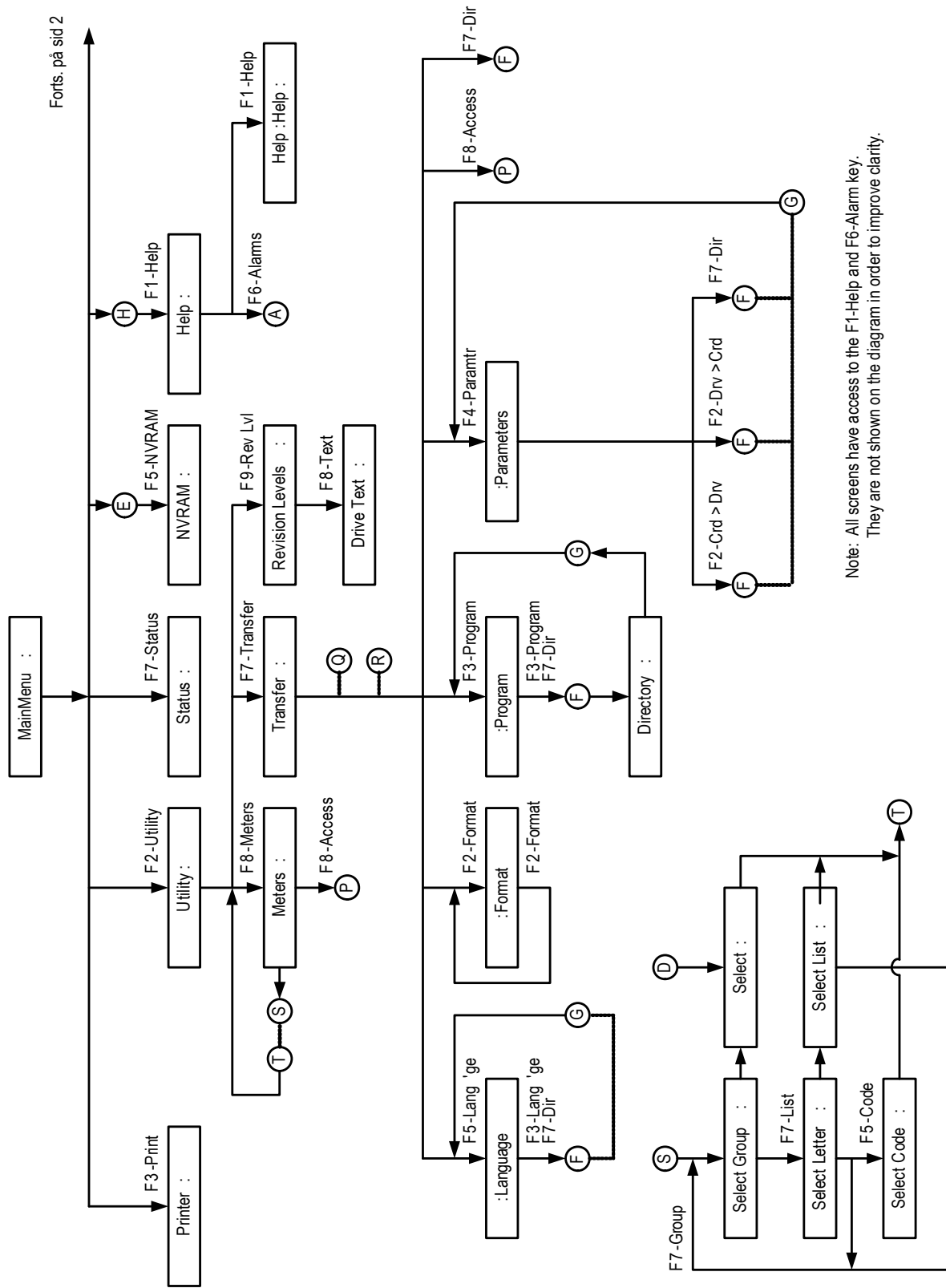


Figure 3.104 – Menu Hierarchy

PowerFlex 7000 Terminal Menu Tree

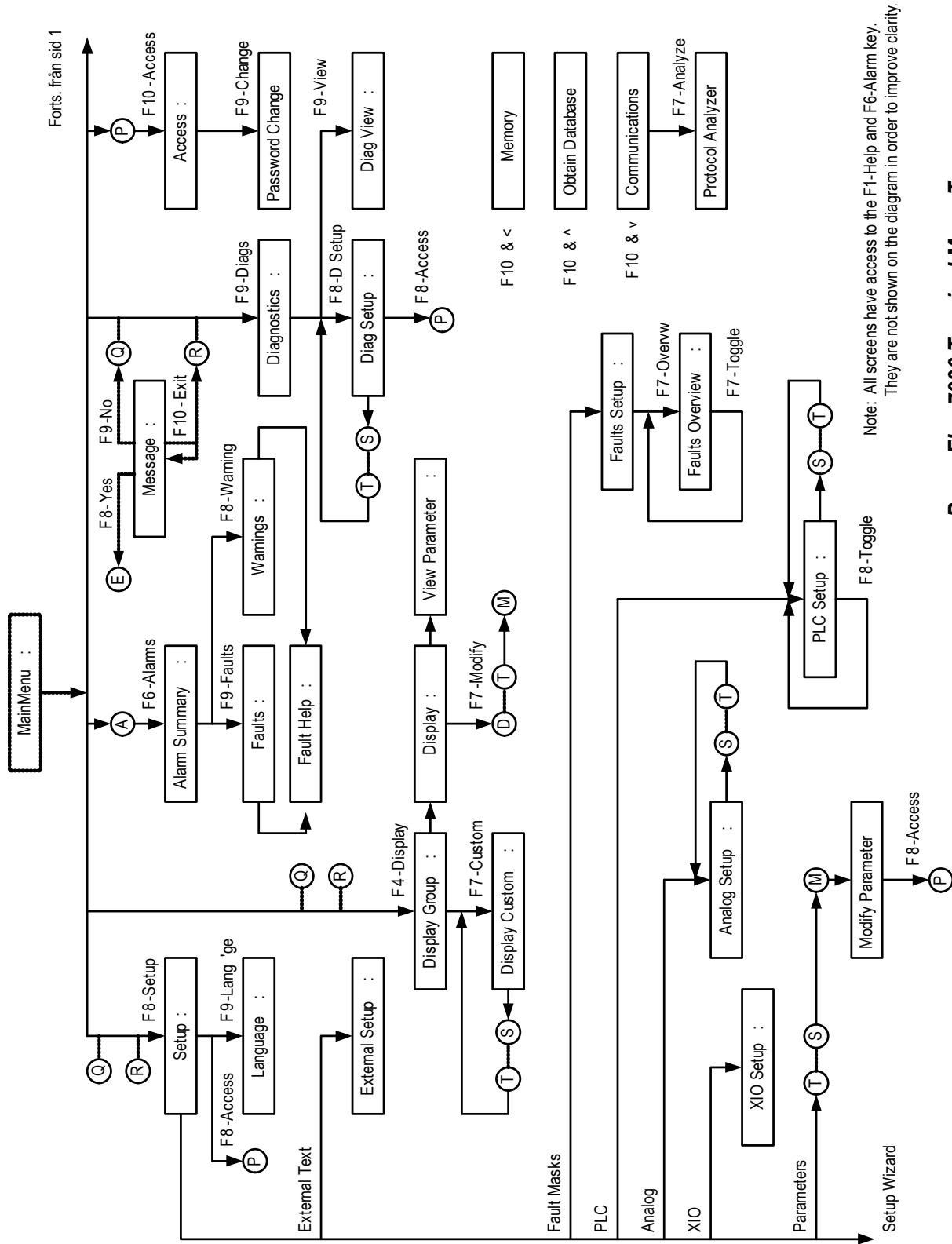


Figure 3.105 – Menu Hierarchy

PCMCIA Memory Card Installation Data

Description

The memory card slides into the card slot located on the backside of the PowerFlex 7000 “B” Frame 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 3.106.

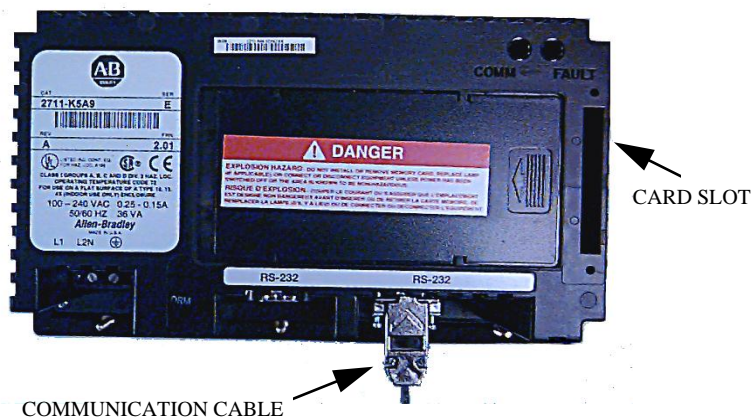


Figure 3.106 – Rear View of Operator Interface

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

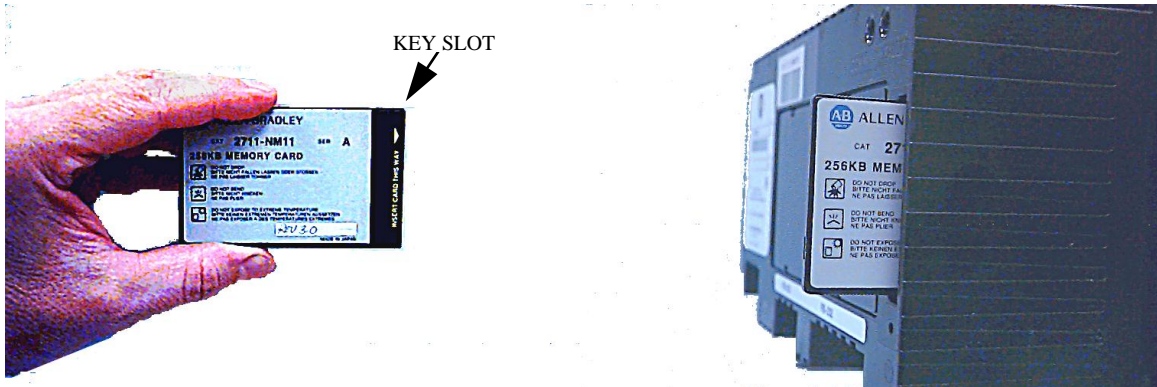


Figure 3.107 – Key Slot Orientation

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.

Component Definition and Maintenance

Control / Cabling Cabinet Components

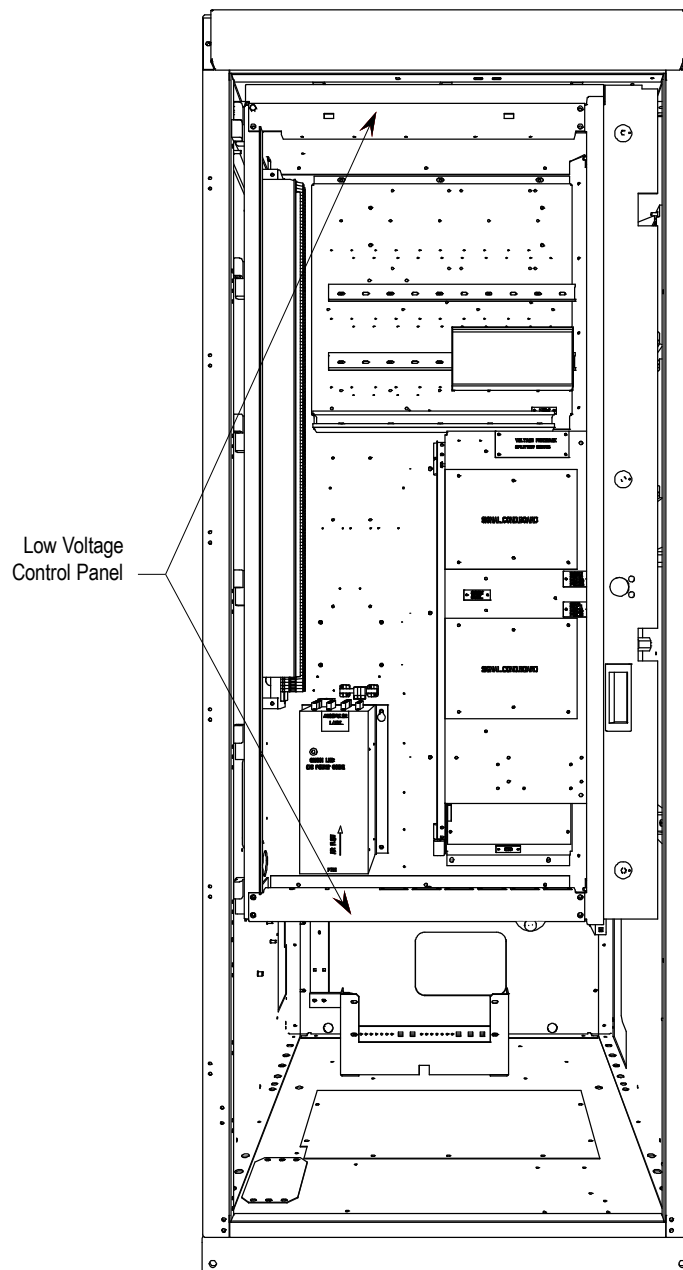


Figure 4.1 – Control and Cabling Cabinet showing LV Control Panel

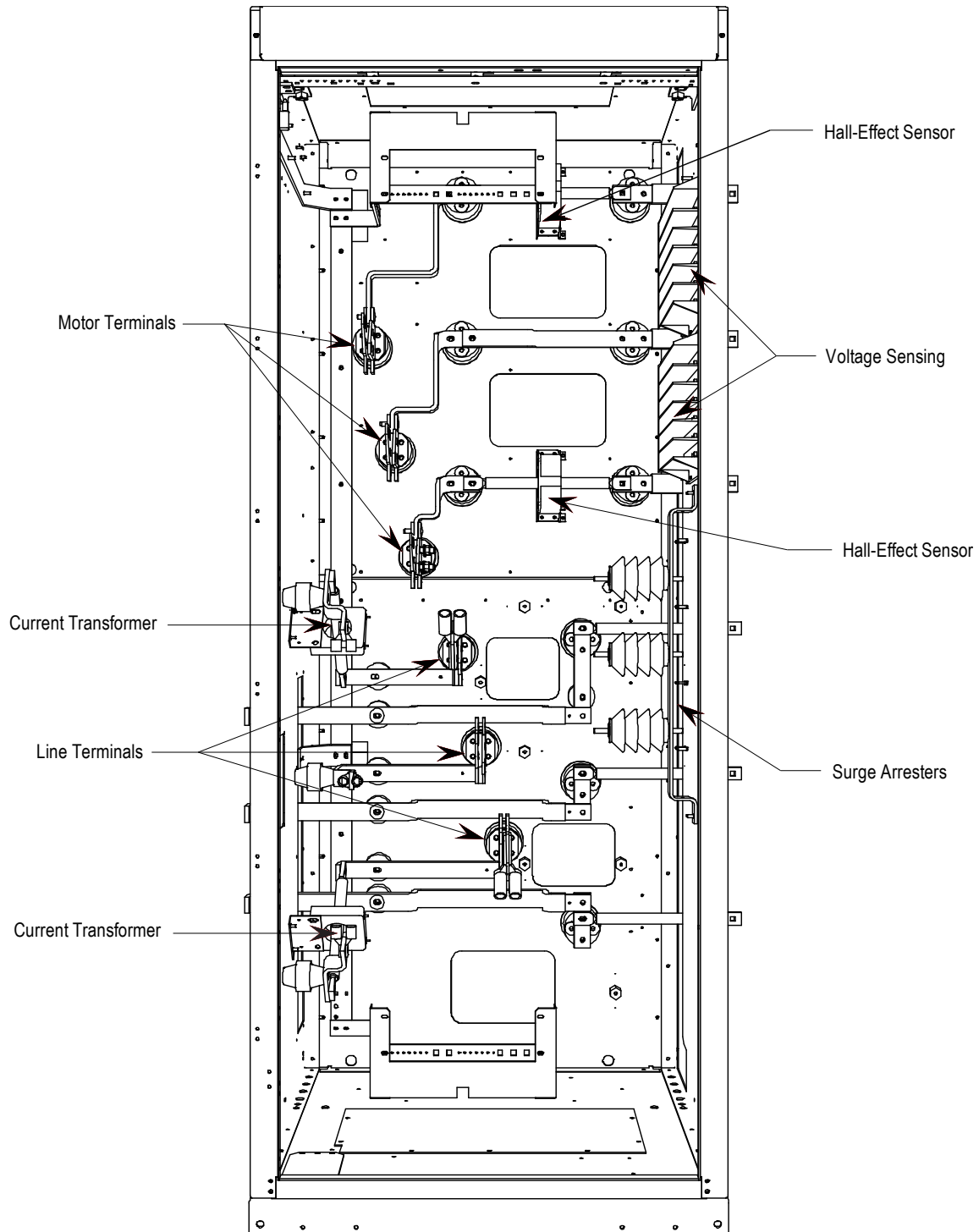


Figure 4.2 – Large Footprint AFE Control and Cabling Cabinet (with LV Control Panel removed)

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 4.A – 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.

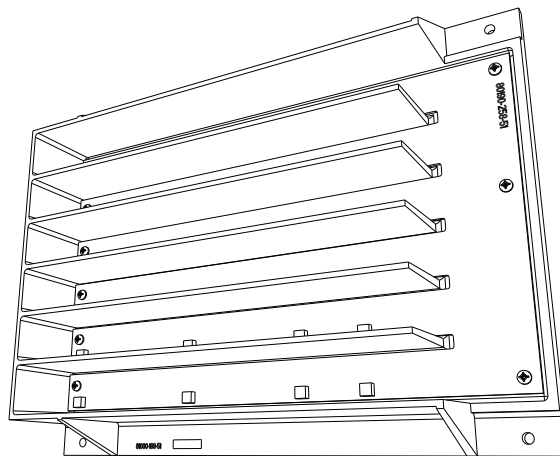


Figure 4.3 – Sensing Board with Mounting Hardware Placement

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 18P 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 4.5.

Transient Suppression Network – TSN (cont.)

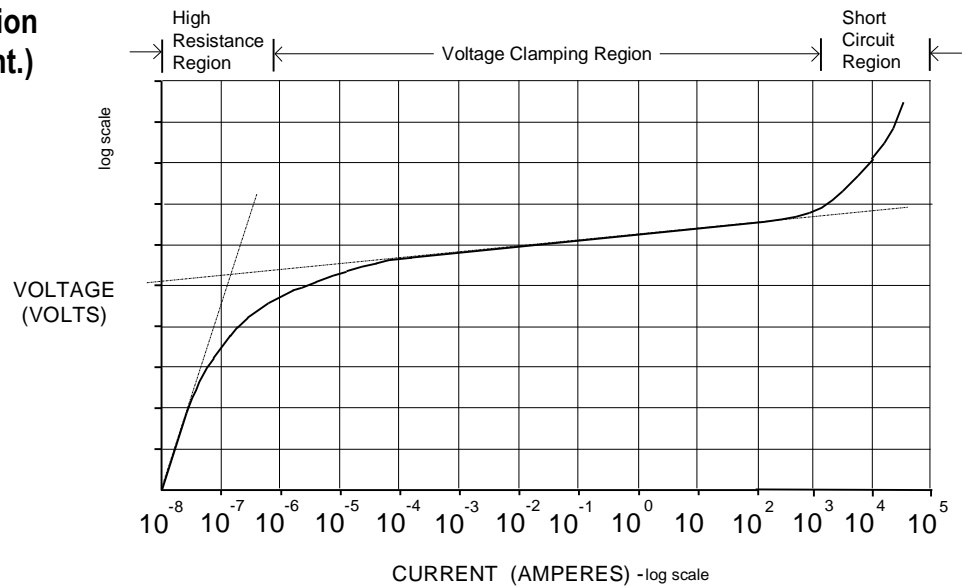


Figure 4.4 – Typical MOV V-I Characteristic Curve

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 4.5, 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.

Note: 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.

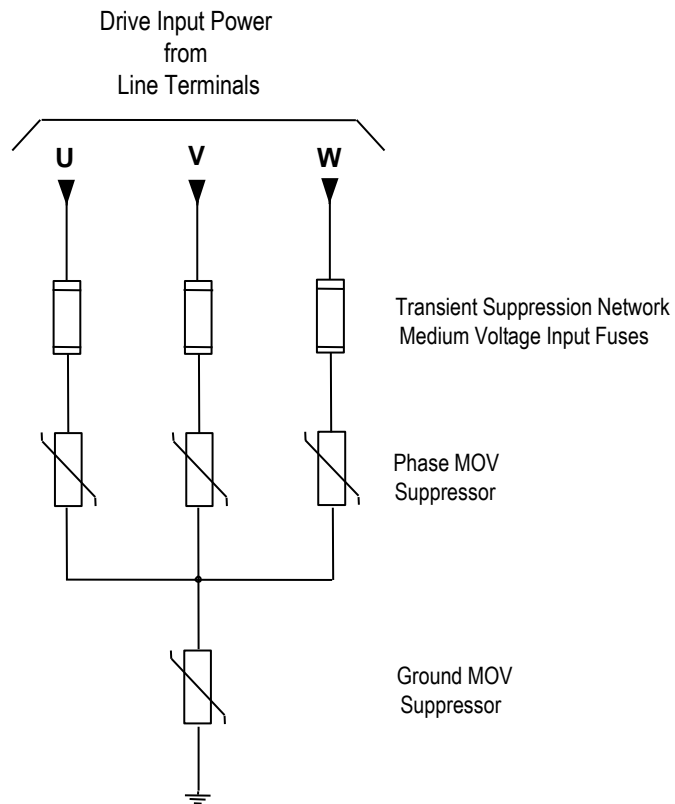


Figure 4.5 – Simplified Wiring Diagram

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 4.7 for location.)

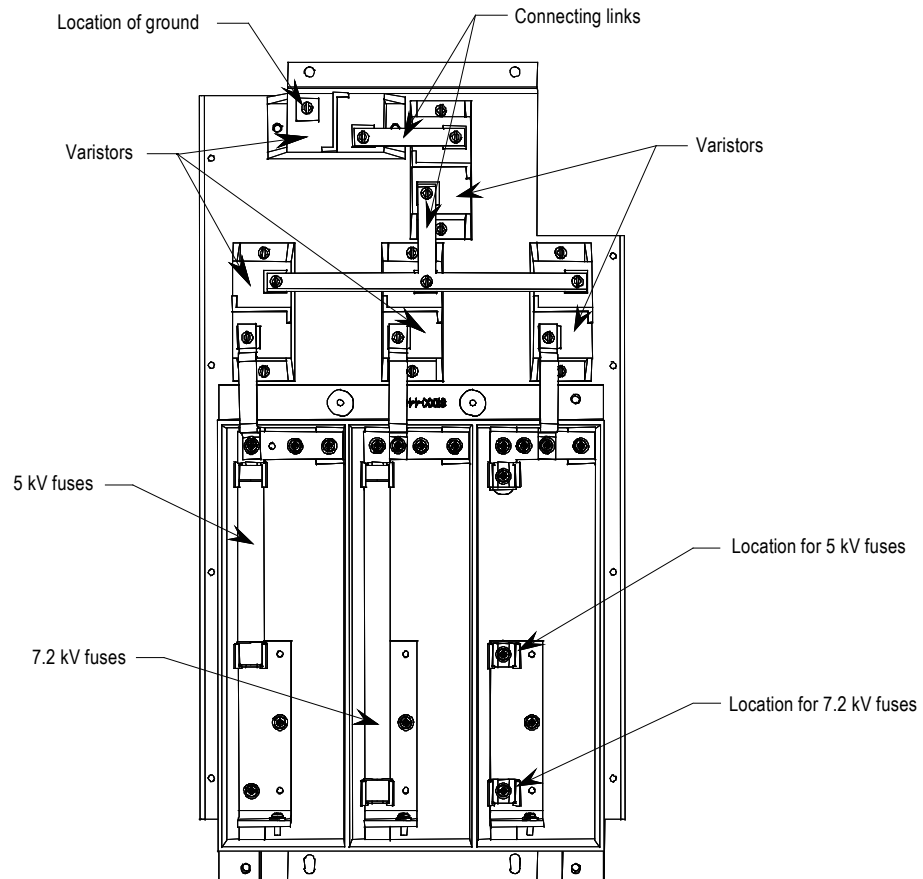


Figure 4.6–Transient Suppression Network

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 4.8 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.

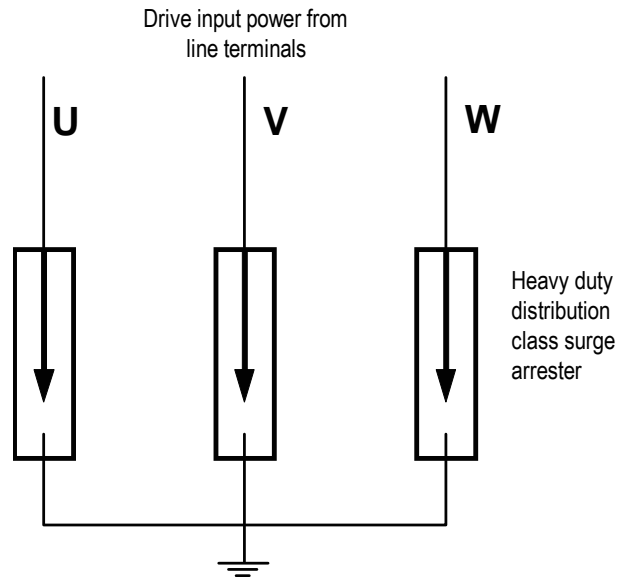
There are 3 types of surge arresters depending on the voltage class of the drive as shown in the table below:

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.

Surge Arresters (cont.)

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.



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 PF7000 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/lbs).

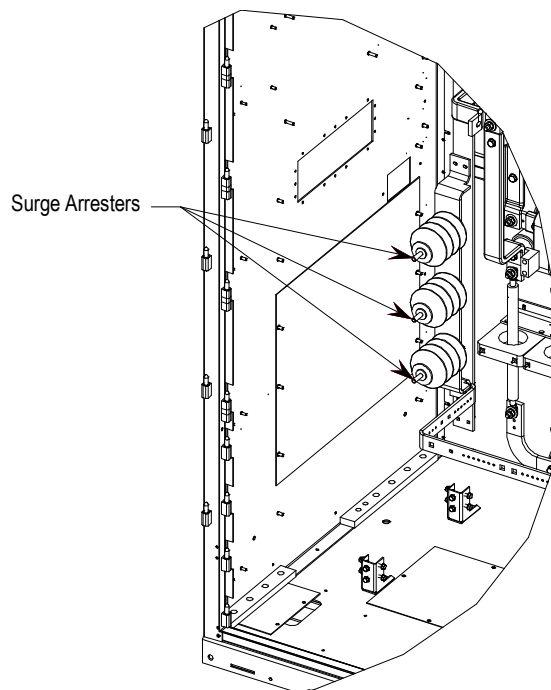


Figure 4.7 – Surge Arresters

Note: 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 (¼ 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 (¼ inch) hardware.
(See Figure 4.9)

IMPORTANT

The maximum torque for the capacitor terminal is 3.4 Nm (30 lb-in).

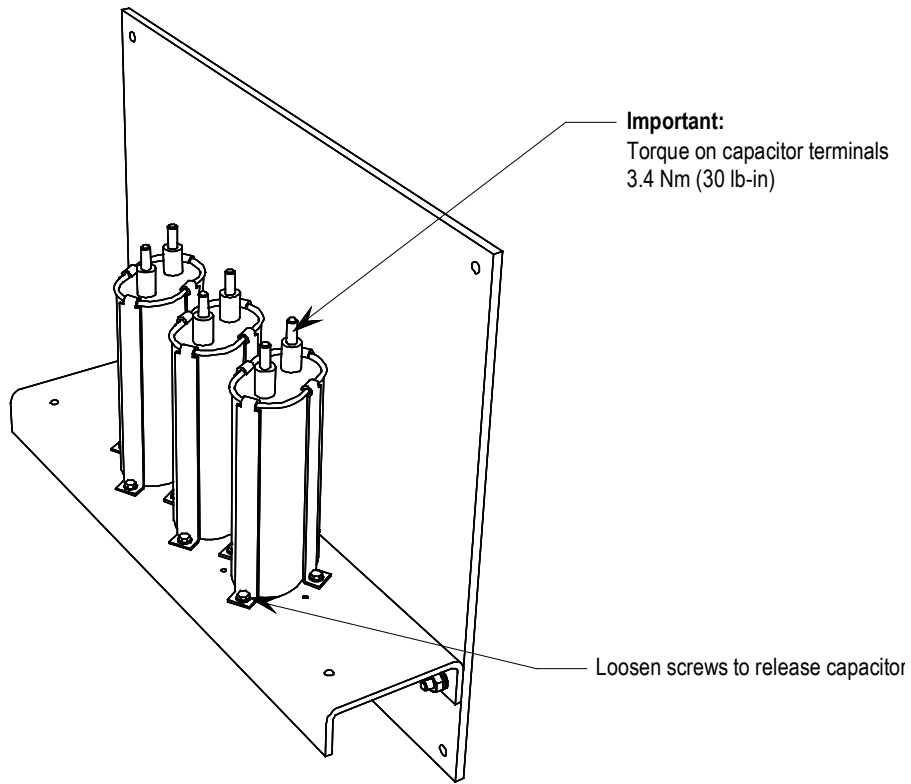


Figure 4.8 – Capacitor in Grounding Network

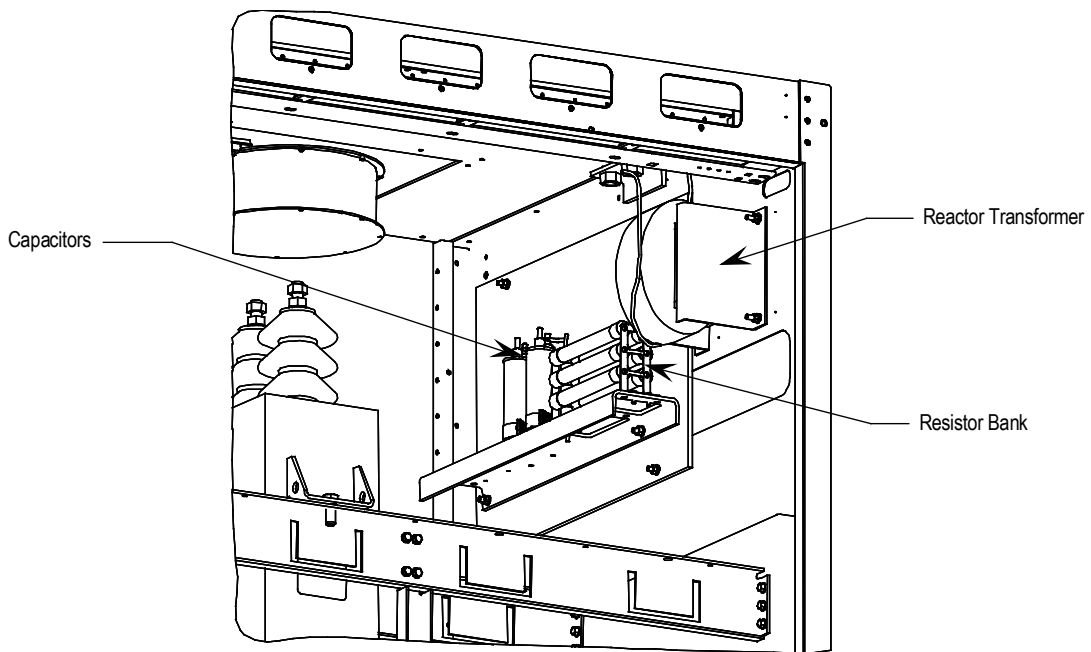


Figure 4.9 – Location of Ground Filter in 'C' Frame Drive

Output Grounding Network Capacitor Replacement (cont.)

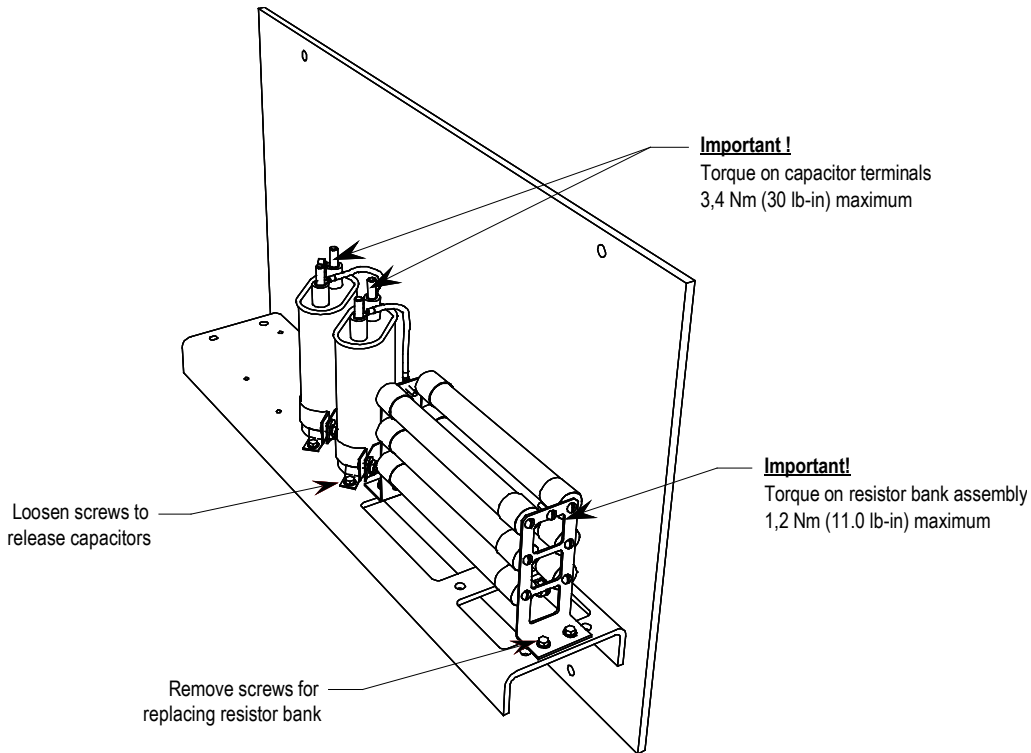


Figure 4.10 – Torque Values for Ground Filter Assembly

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 4.11 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 4.8)

IMPORTANT

The maximum torque for the capacitor terminal is 3.4 Nm (30 lb-in).

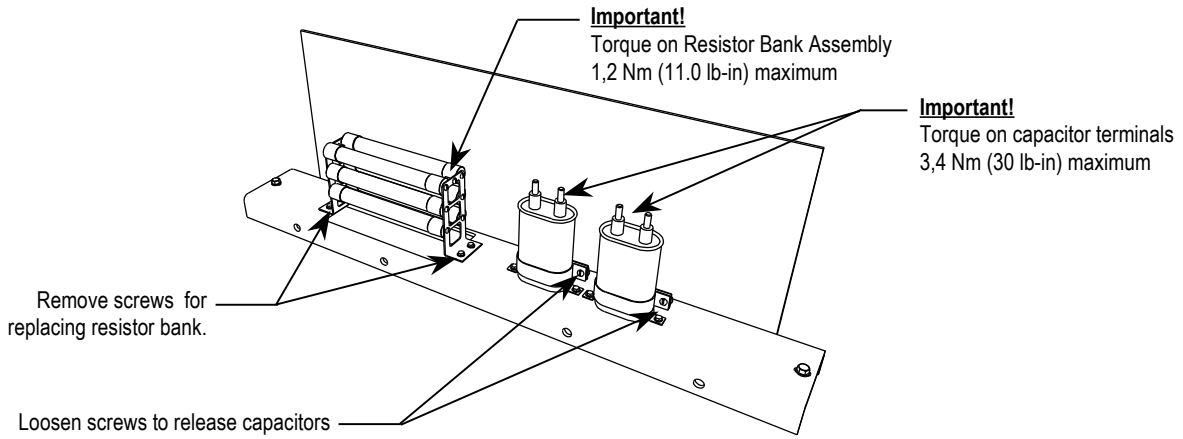


Figure 4.11 – Ground Filter Capacitor/Resistor

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, look for the white arrow.

IMPORTANT

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

3. The 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 the illustration below.
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.

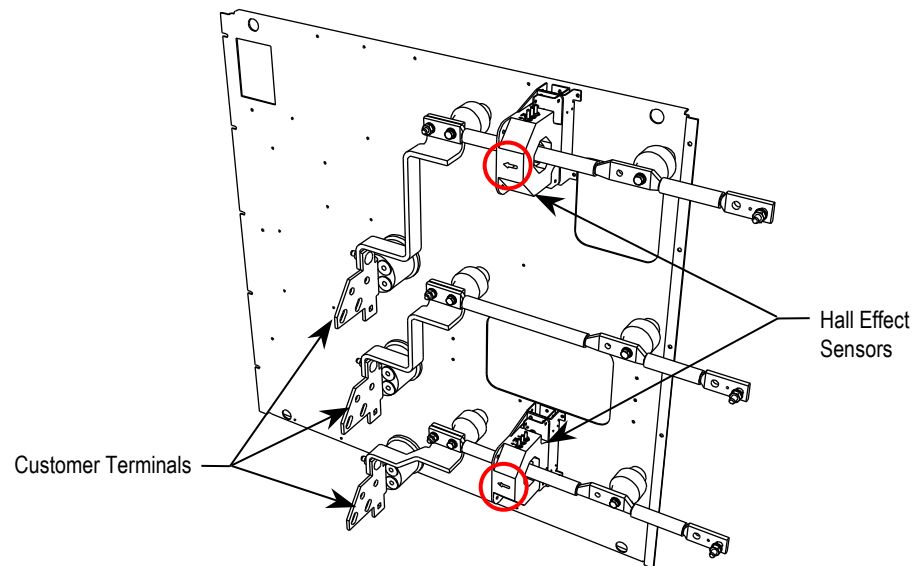


Figure 4.12 – Motor Terminal Assemblies

Note: 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.

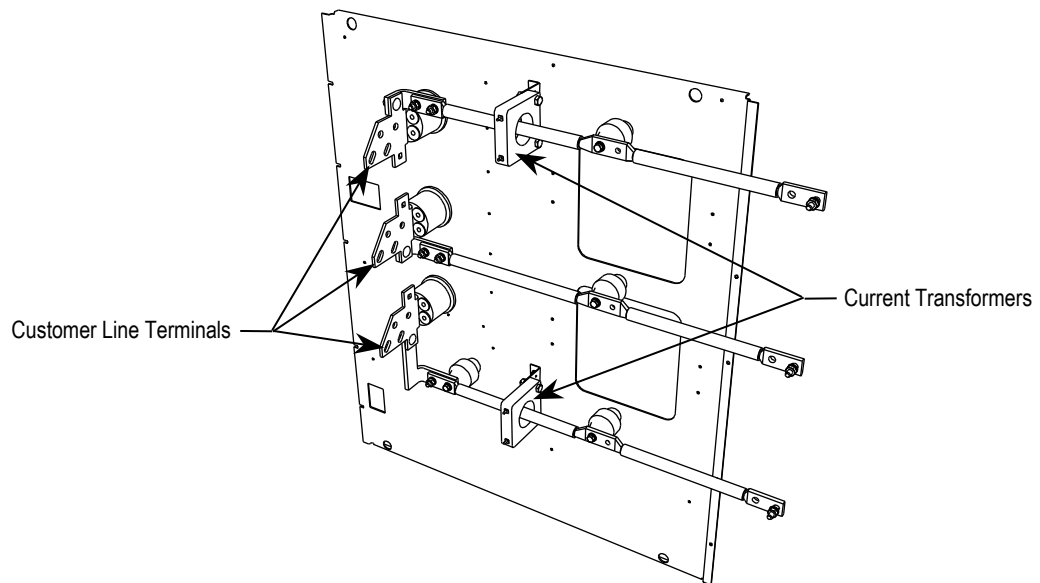


Figure 4.13 – Line Terminals

Note: 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 4.1 (Cabling Cabinet for 18-pulse Rectifier), and Figure 4.2 (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 below:

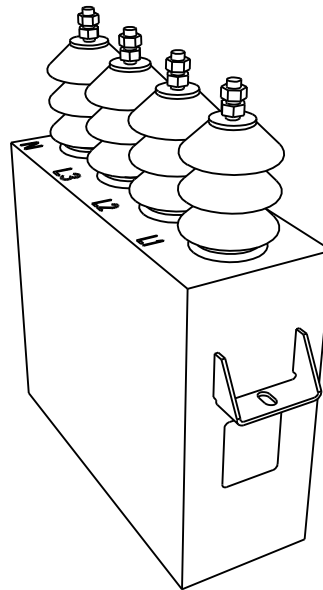


Figure 4.14 – Motor Filter Capacitor

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 lbs), 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-lbs.) 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.

Filter Capacitor Cabinet (cont.)

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 μ 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:

$$V = 200V, I = 1.87 \text{ for L1-N}$$

$$X_c = V/I = 200/1.87 = 106.95$$

$$C = \frac{1}{2\pi f X_c}$$

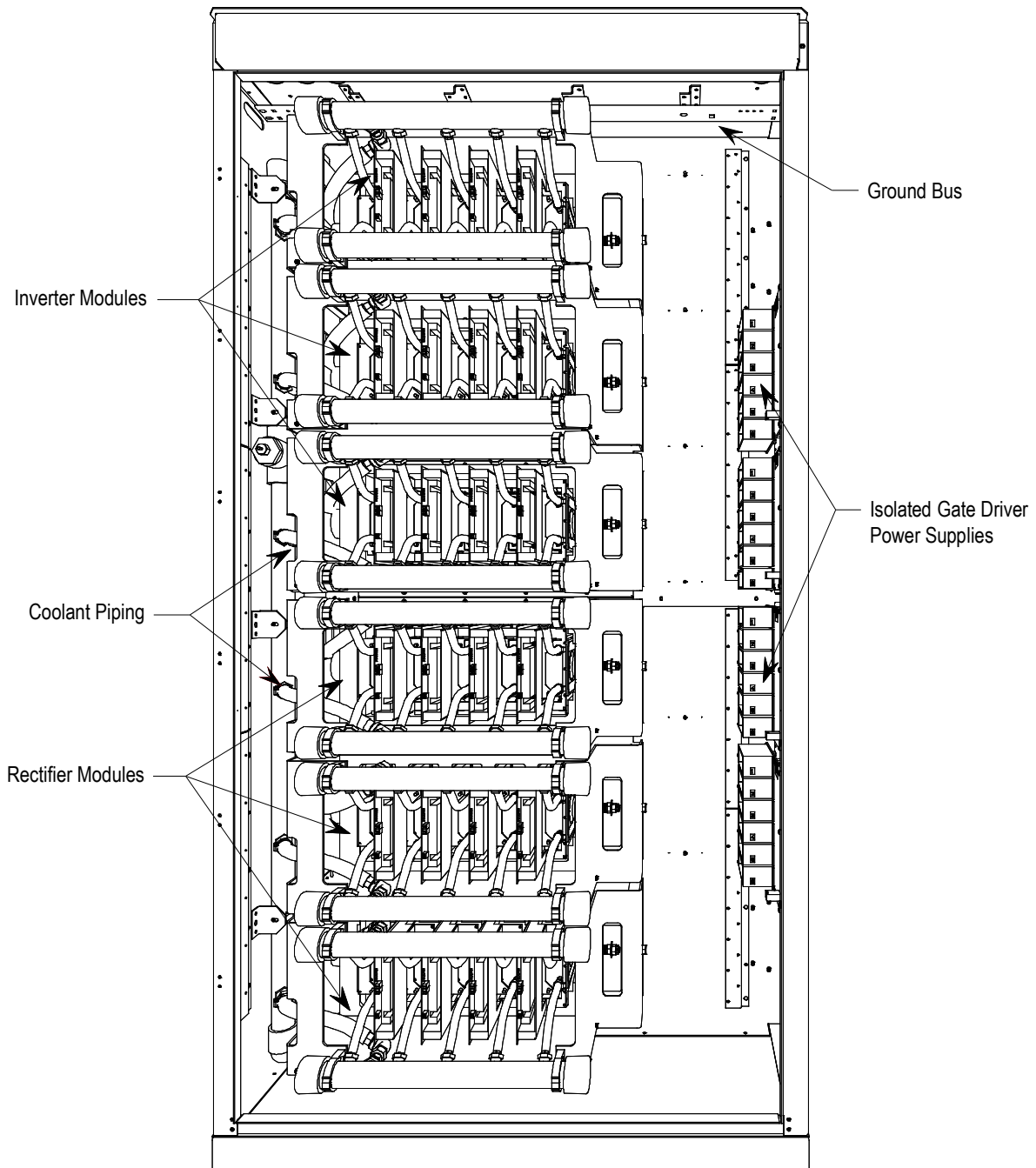
$$C = \frac{1}{2 \times 3.14 \times 50 \times 106.95}$$

$$C = 29.7 \mu F$$

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 4.15 – Converter Cabinet Components
(standard 4160V AFE design shown)**

Converter Cabinet

The converter cabinet contains three rectifier modules and three inverter modules. Figure 4.15 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, 18P	12	0	18
6600V, 18P	18	0	18
6600V, PWM rectifier	18	18	0

Power Cage (cont.)

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.

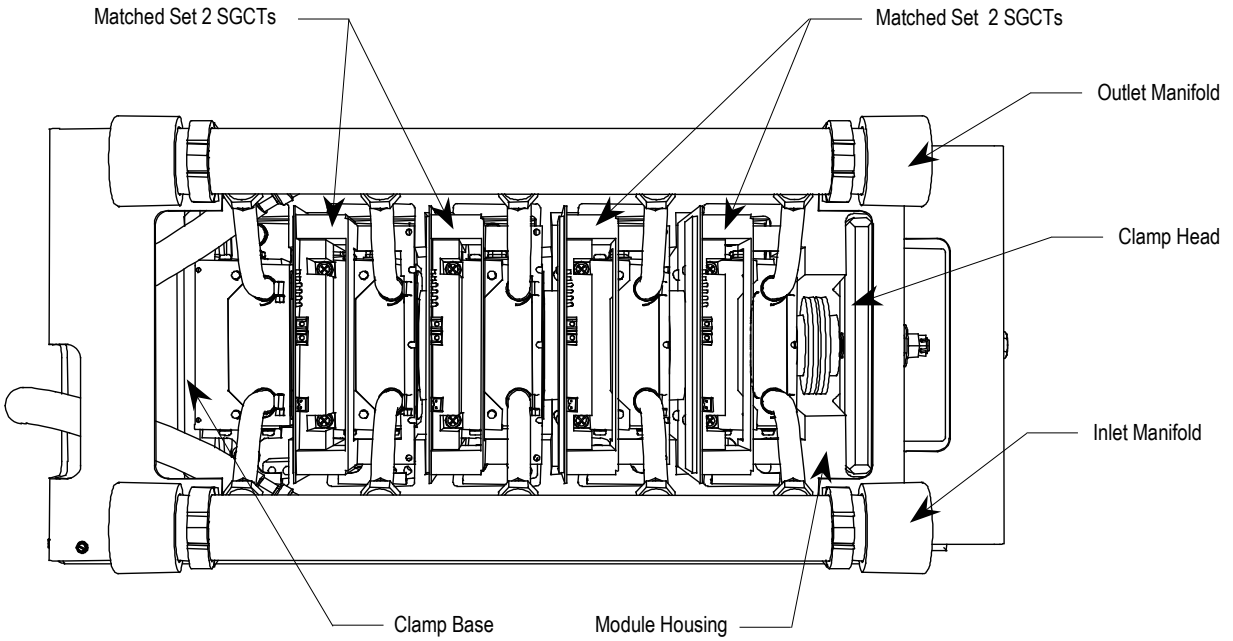


Figure 4.16 – 4-Device PowerCage

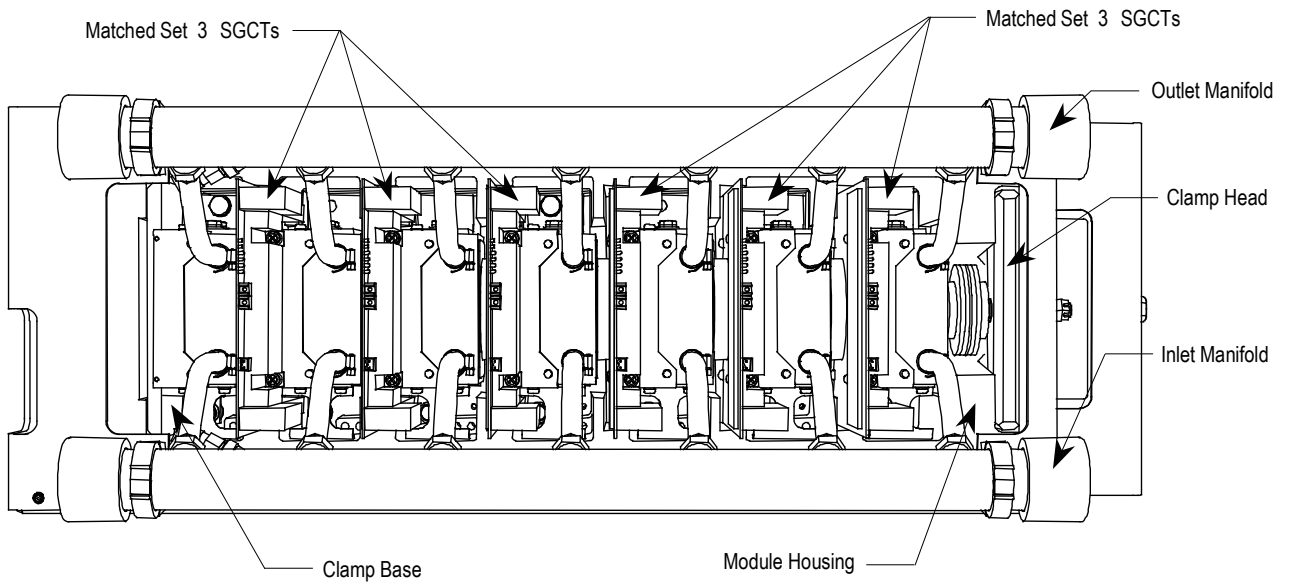


Figure 4.17 – 6-Device PowerCage

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.

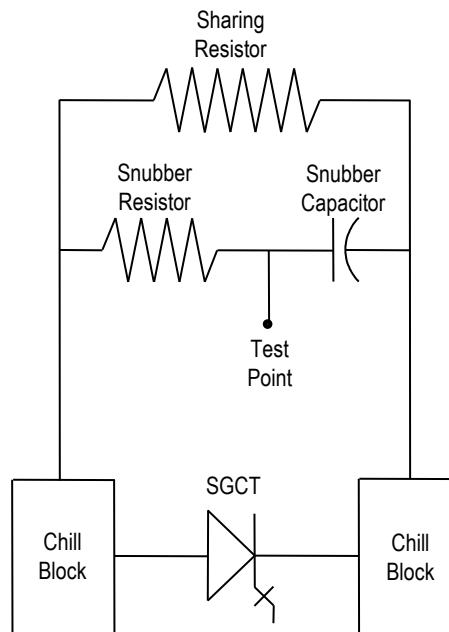


Figure 4.18 – SGCT and Snubber Circuit

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.

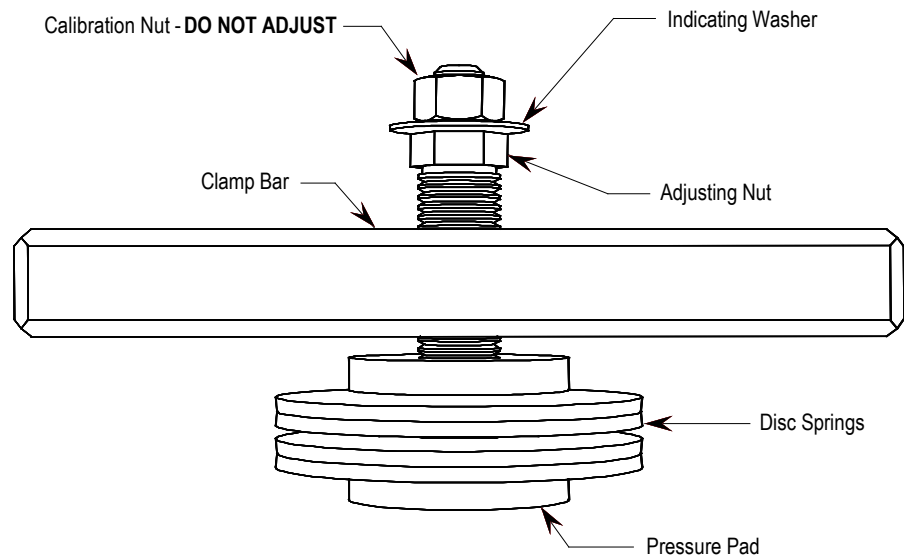


Figure 4.19 – Clamp Head Illustration

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.**

Checking Clamping Pressure (cont.)

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 4.20.)

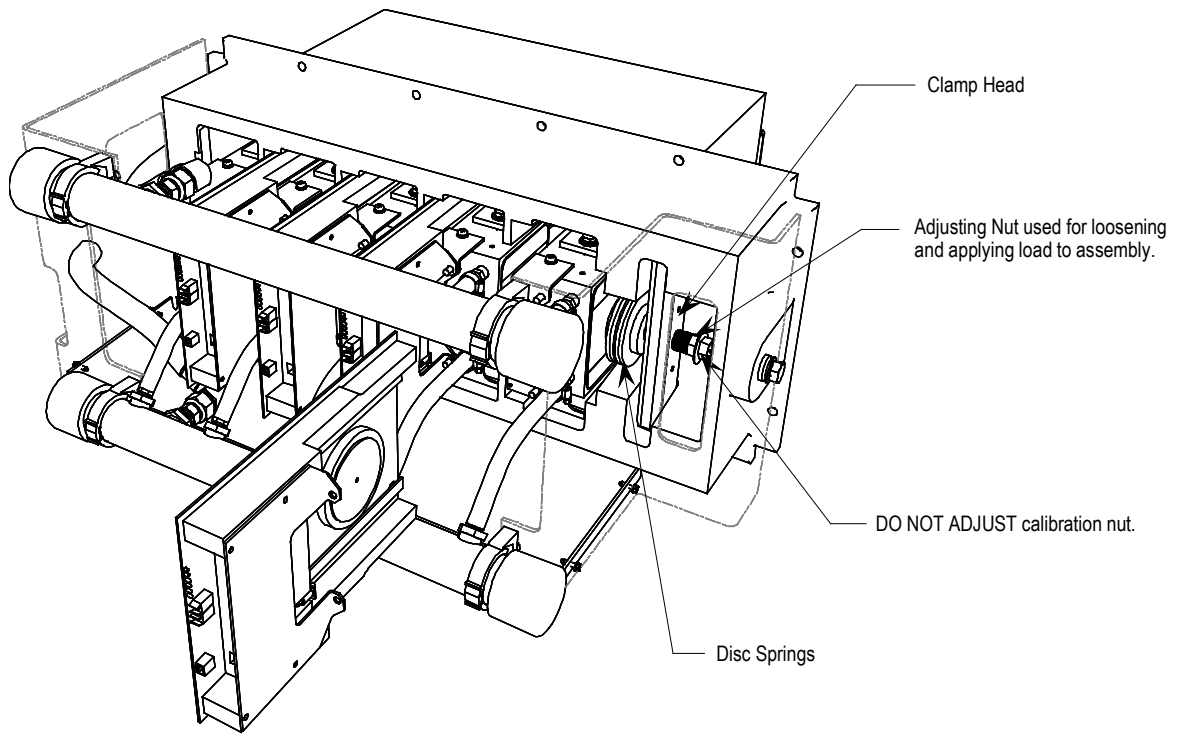


Figure 4.20 – Detail of the clamping assembly

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:

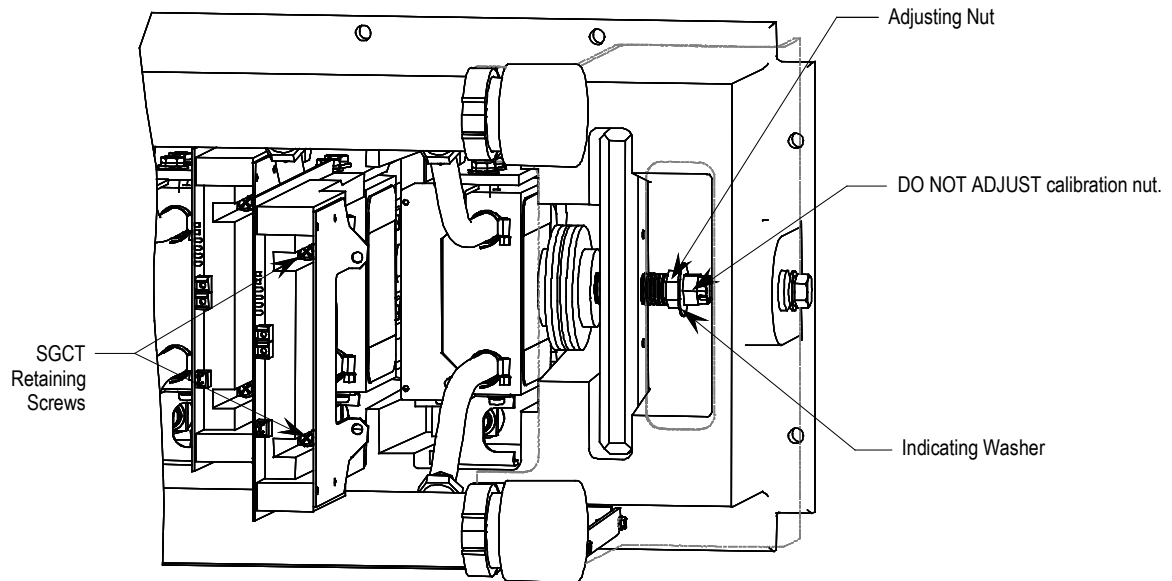


Figure 4.21 – Replacing the SGCT

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:

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

Symmetrical Gate Commutated Thyristor Replacement (cont.)

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 on page 5-26.
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.

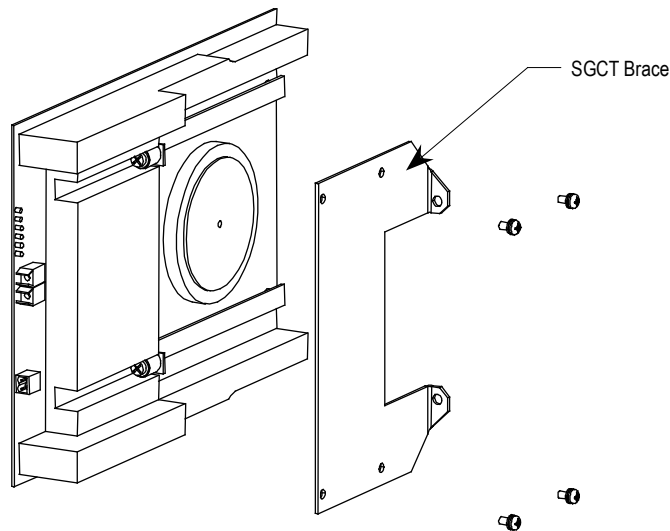


Figure 4.22 – Replacing the SGCT – Brace Angle

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”.
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.

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 assembly as described on page 5-26.
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.

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.

Silicon Controlled Rectifier and SCR Self-Powered Gate Driver Board Replacement (cont.)

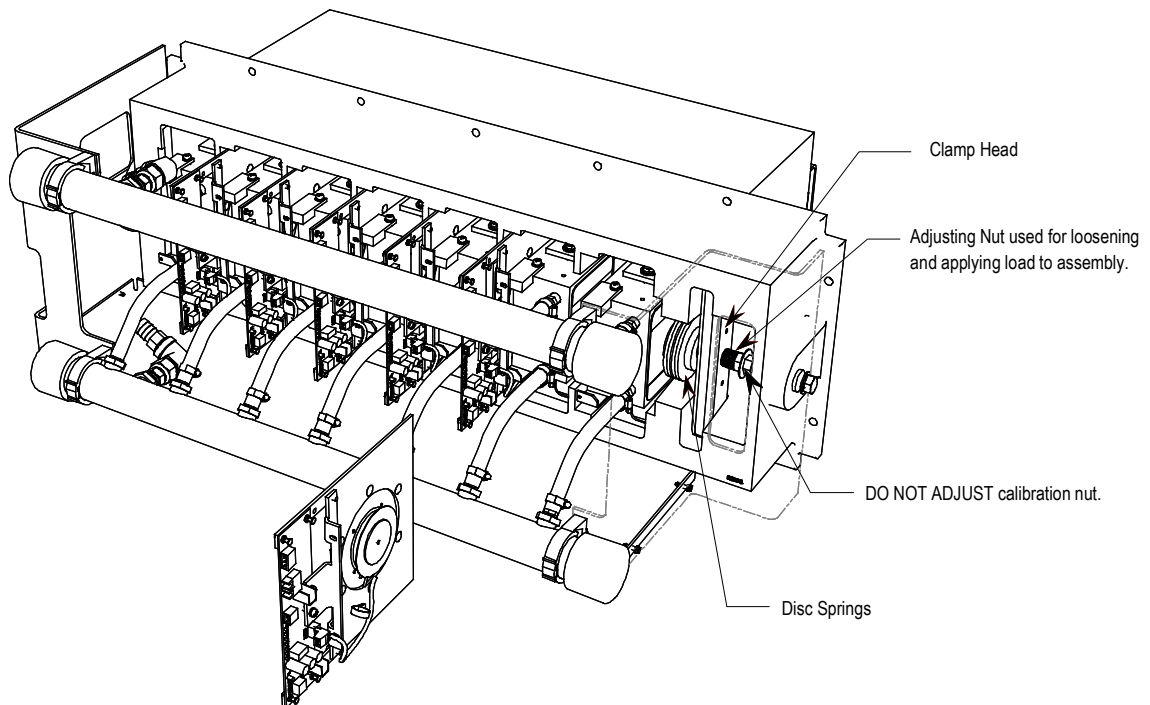


Figure 4.23 – SCR Removal

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”.
18. Connect the control power cable and the fiber optic cables, ensuring that the bend radius is not exceeded.

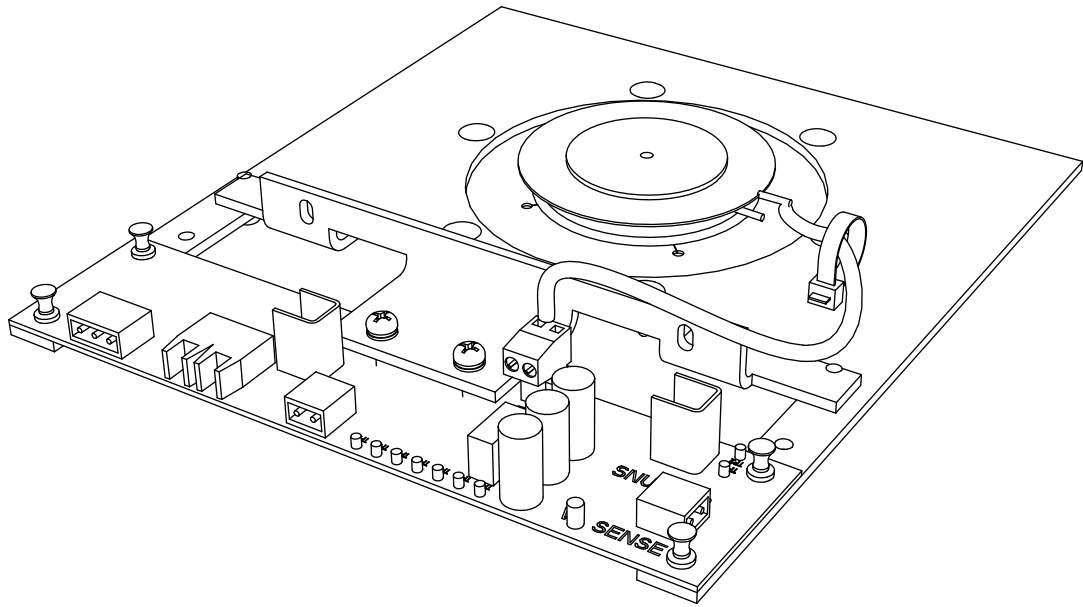


Figure 4.24 – SCR and SPGDB assembly

Detachment of Coolant System from PowerCage Modules

In the event that service is required to snubber components, it will be necessary to extract a chillblock 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 “Replacing the Silicon Controlled Rectifier” and “SGCT Replacement”.
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 4.25 are provided with the spare parts kit of each drive.

Detachment of Coolant System from PowerCage Modules (cont.)

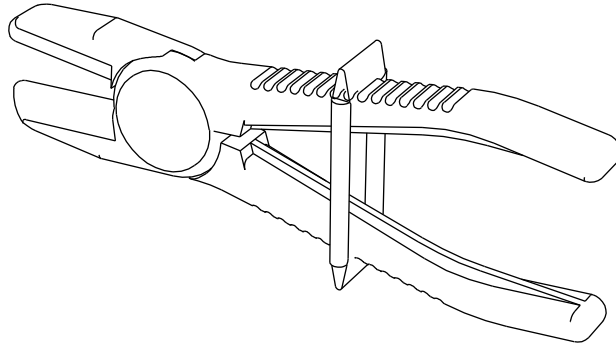


Figure 4.25 – Flow Restrictor Clamp

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 4.25. M10 bolts must be clean.

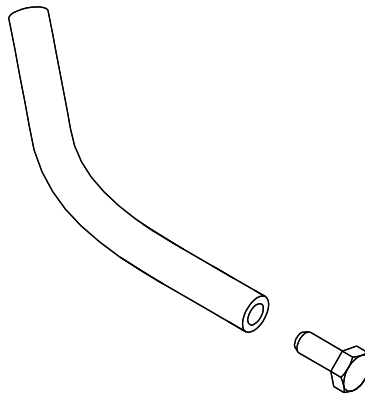


Figure 4.26 – Flow Stopper for Servicing (2 required)

6. Insert the 2 clamps per Figure 4.26 on the 3/4-inch (19-mm) silicon hoses to isolate flow between the vertical manifolds and the horizontal manifolds of the converter modules.

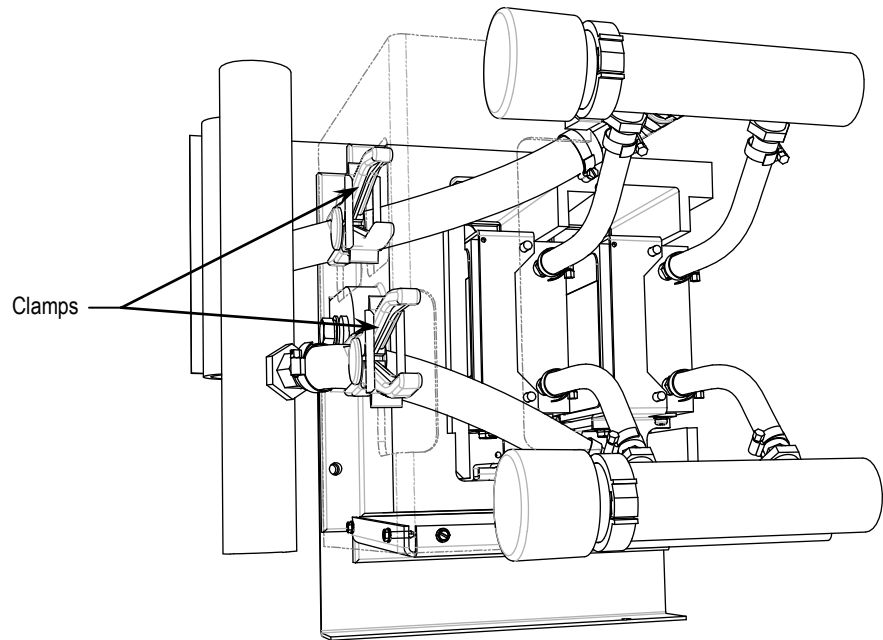


Figure 4.27 – Converter PowerCage Module (Service – per Step 6)

Loosen the hose clamp of the top hose of the outlet manifold of the chillblock to be serviced. Slide the hose clamp toward the chillblock.

7. Have a hose plug assembly and a M10 bolt ready. Per Figure 4.27, pull the hose from the upper manifold hose barb and collect the fluid in a container.

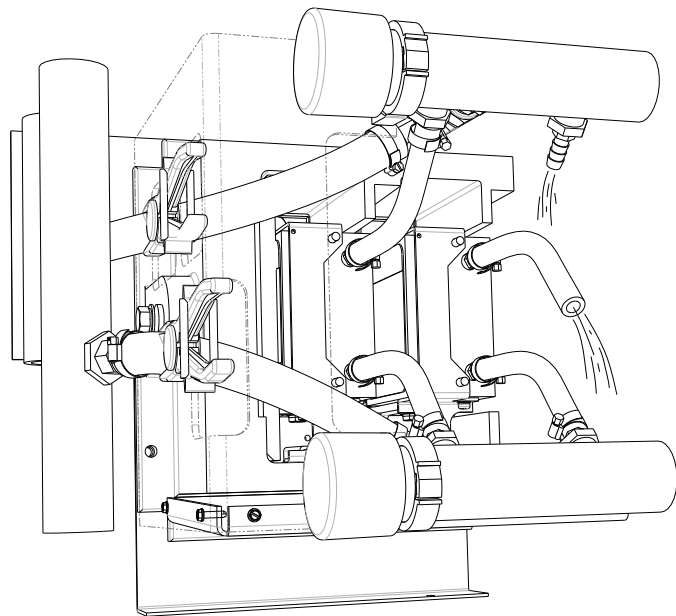


Figure 4.28 – Converter PowerCage Module (Service – per Step 7)

Detachment of Coolant System from PowerCage Modules (cont.)

- Per Figure 4.29, insert the hose plug on the hose barb of the upper manifold. Insert a M10 bolt in the end of the chillblock hose. Note that there may still be limited fluid leakage during this procedure.

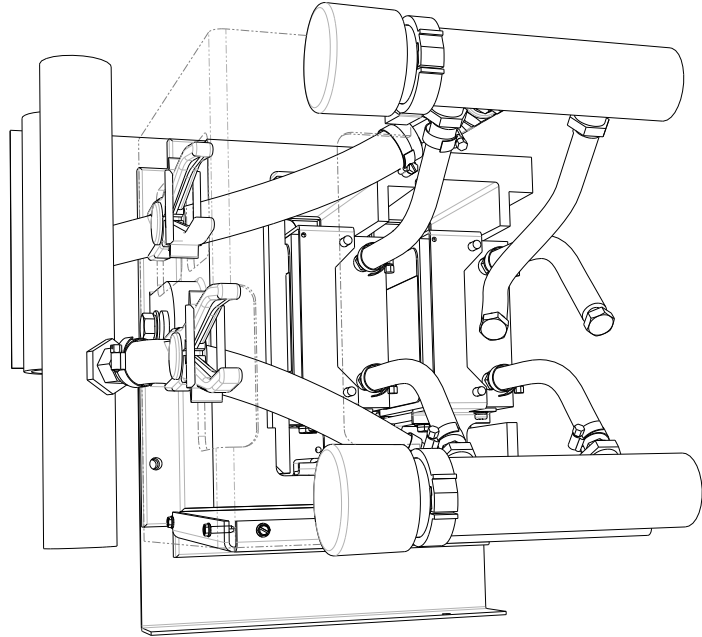


Figure 4.29 – Converter PowerCage Module (Service – per Step 8)

Shows flow plugs installed.

Repeat this procedure for the lower manifold connection point. The chillblock can be extracted from the PowerCage per “Instructions for removing Chillblock assembly”.

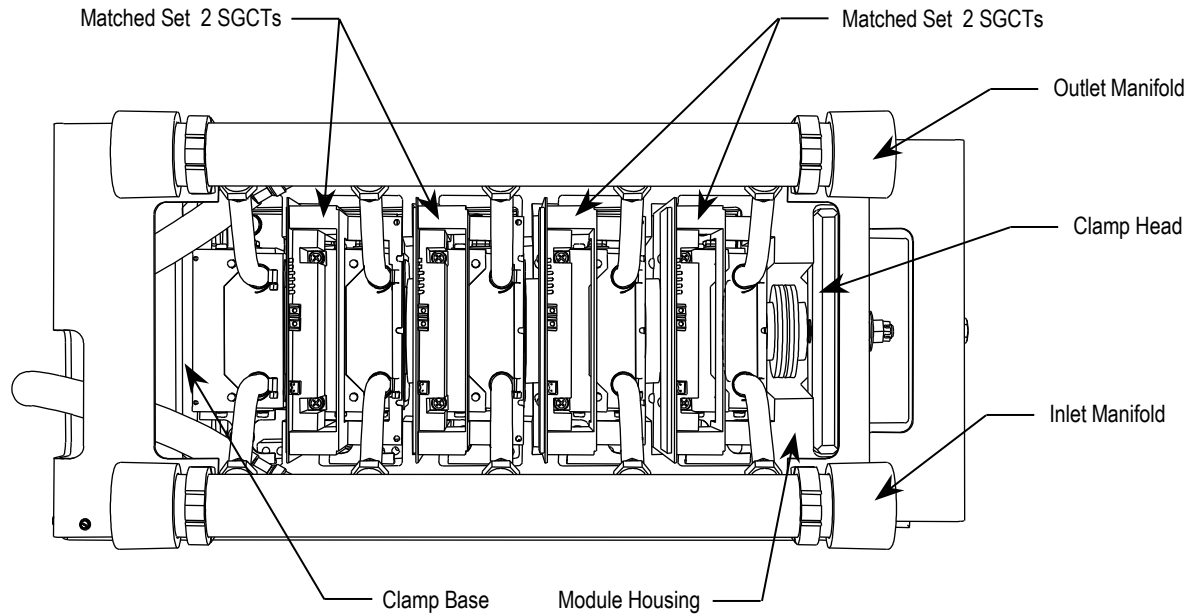


Figure 4.30 – Cooling System

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 “Replacing the Silicon Controlled Rectifier” and “SGCT Replacement”.
6. Check coolant levels to ensure there is still enough coolant in the system. If coolant must be added, see “Adding Coolant” in the “Cooling Cabinet Components” section.

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 “SGCT Replacement Procedure” and “Replacing the Silicon Controlled Rectifier”.

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. Detach coolant hoses from upper and lower manifolds. This procedure is more clearly explained in “Detachment of Coolant System from PowerCage Modules”.
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.

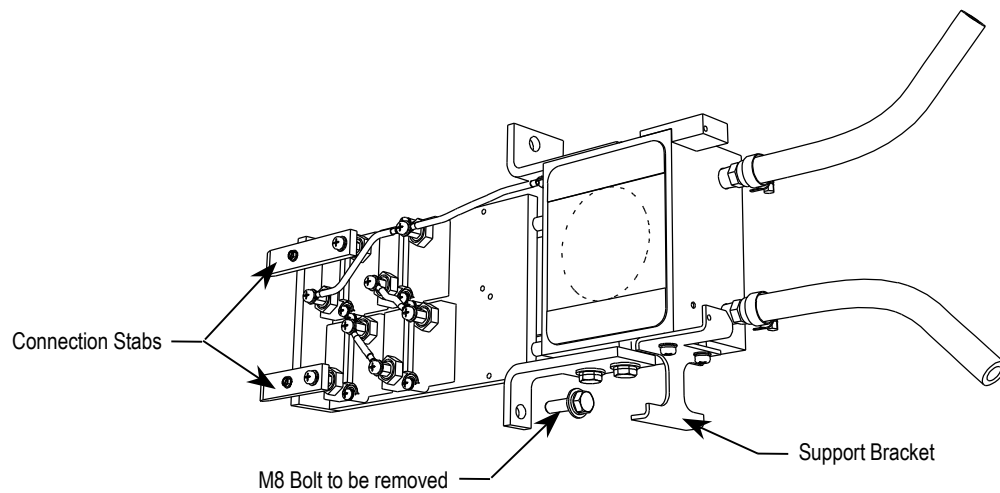


Figure 4.31 – Chill Block Removal and Replacement

Instructions for inserting Chill Block assembly

1. Ensure all power is disconnected.
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.

Note: 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 “SGCT Replacement Procedure” and “Replacing the Silicon Controlled Rectifier”.
6. Readjust the clamping load as described in “Checking Clamping Pressure”.

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 4.32.

IMPORTANT

When replacing the PowerCage, always be sure all the PowerCage components are removed.

5. After the PowerCage is securely fastened to the backplane refer to the appropriate sections to replace all other components.

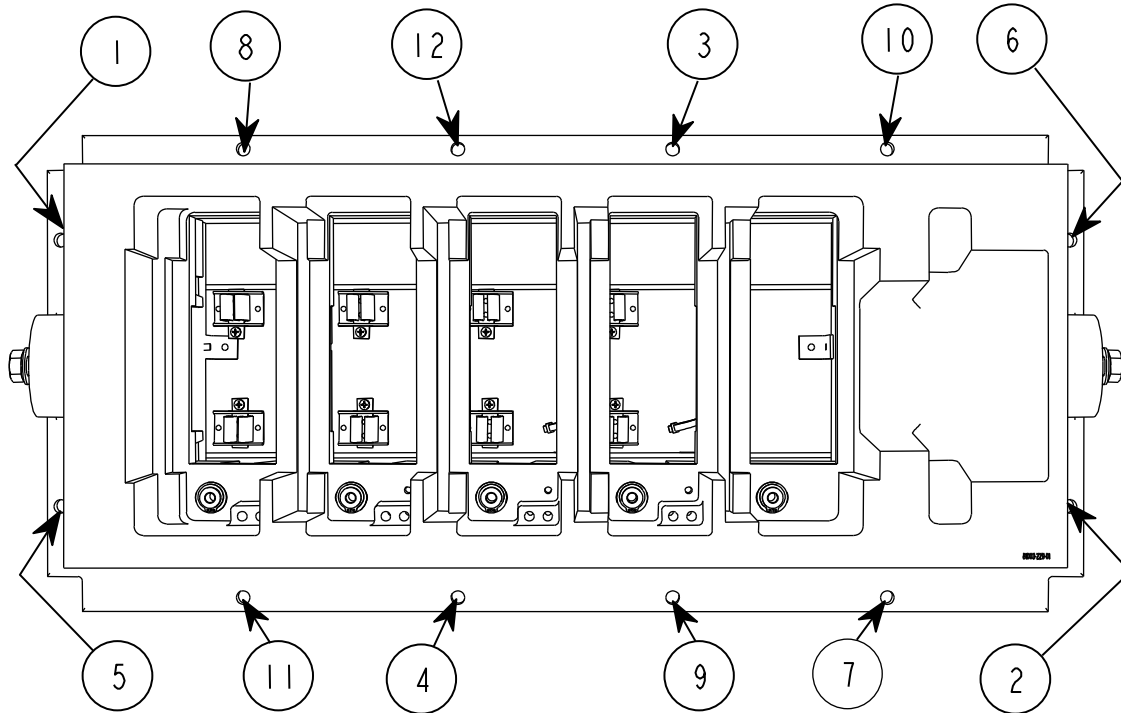


Figure 4.32 – Typical Torque Sequence

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.

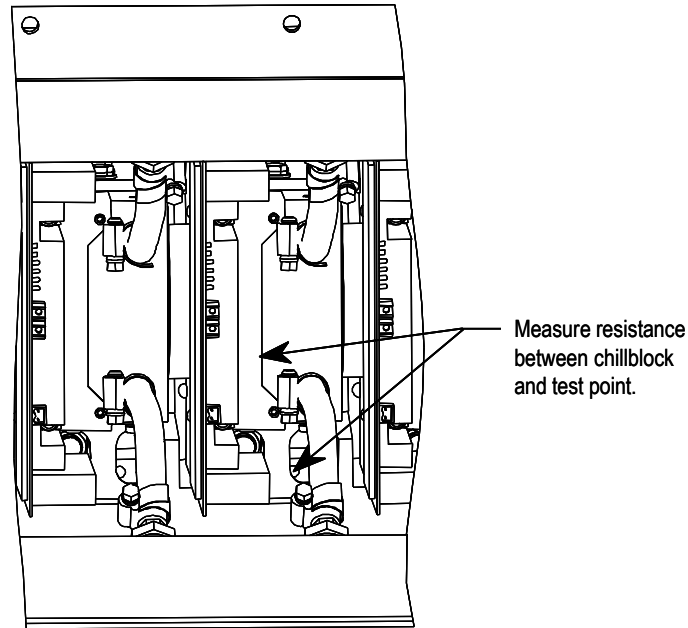


Figure 4.33 – Testing the Snubber Resistor

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 Ω and 75 k Ω 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 Ω 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.

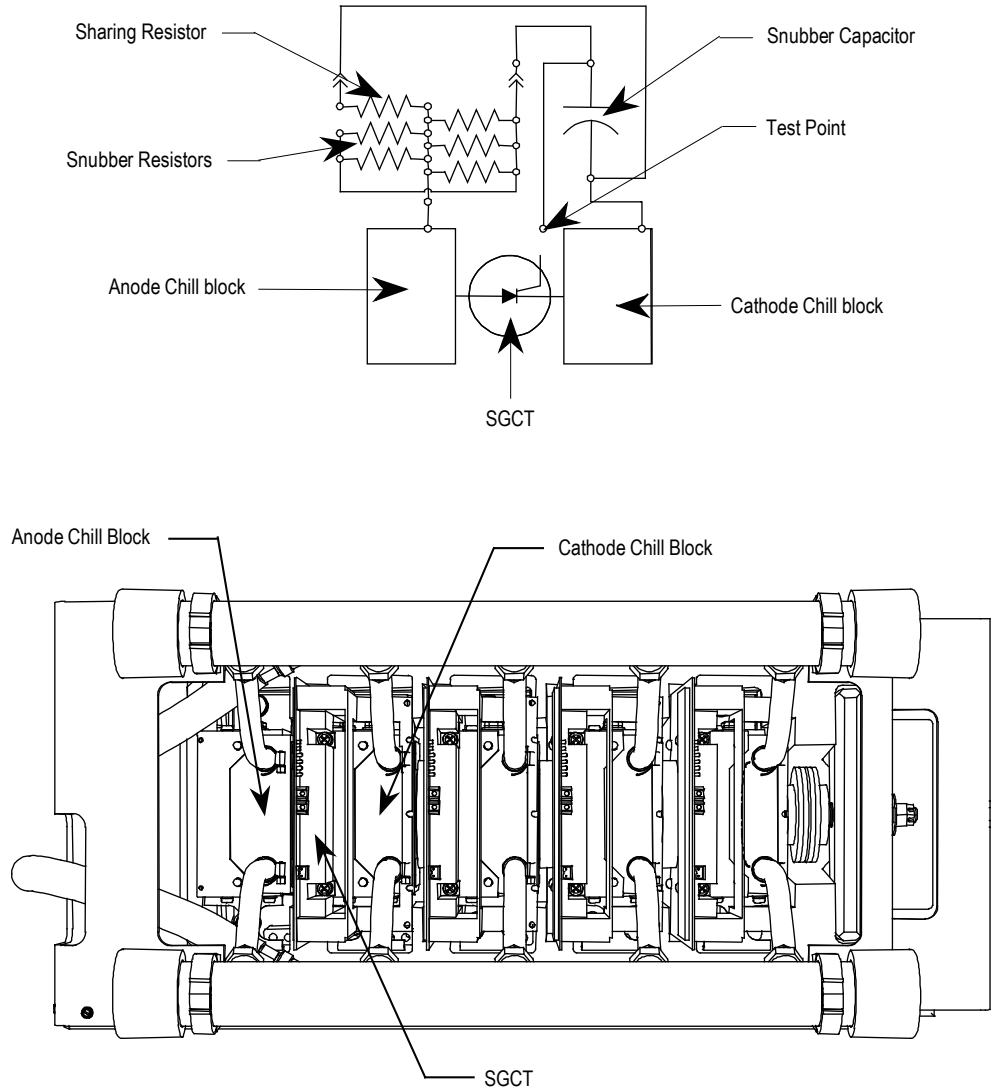


Figure 4.34 – SGCT Power Cage

Sharing Resistors (cont.)

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 k Ω indicates a healthy sharing resistor.

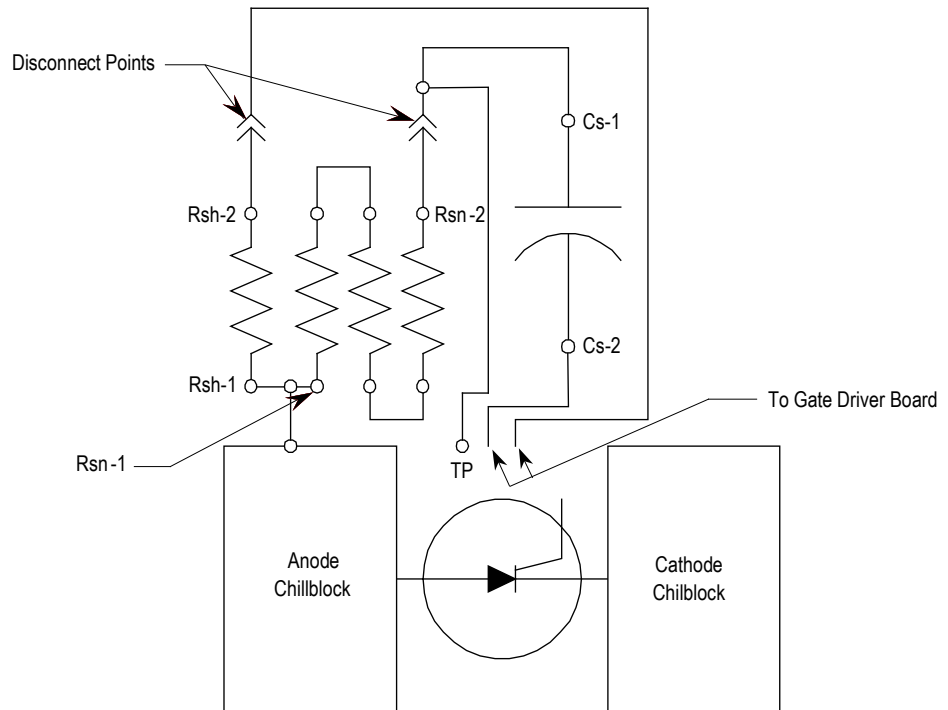


Figure 4.35 – SCR PowerCage Snubber Circuit Connections

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. See “Chill block Removal and Replacement”.

1. Remove the chill block outlined in “Chill Block Removal and Replacement”
2. Note all connections for correct replacement.

- 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.

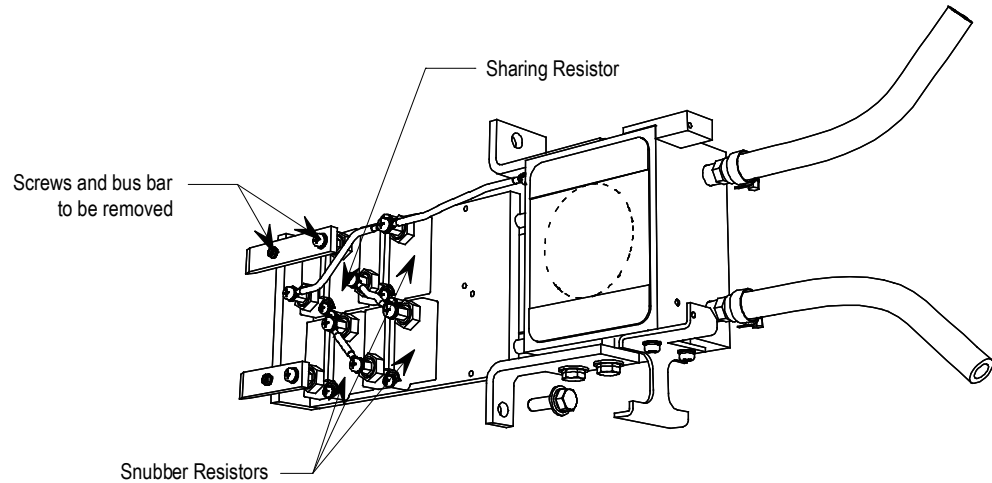


Figure 4.36 – Snubber and Sharing Resistor Replacement

- 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.
- 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.
- Install the new resistor(s) on the chill plate and replace the M4 mounting screws.
- When all damaged snubber resistors have been replaced, re-assemble the bus bars with the original hardware.
- Re-connect any leads that were removed.
- Install the chill block assembly as described in “Chill Block Removal and Replacement”. Readjust the clamping load as described in “Checking Clamping Pressure”.
- 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 SPGDB indicates that the SCR being controlled has a gating current flowing which is used to turn the SCR on.

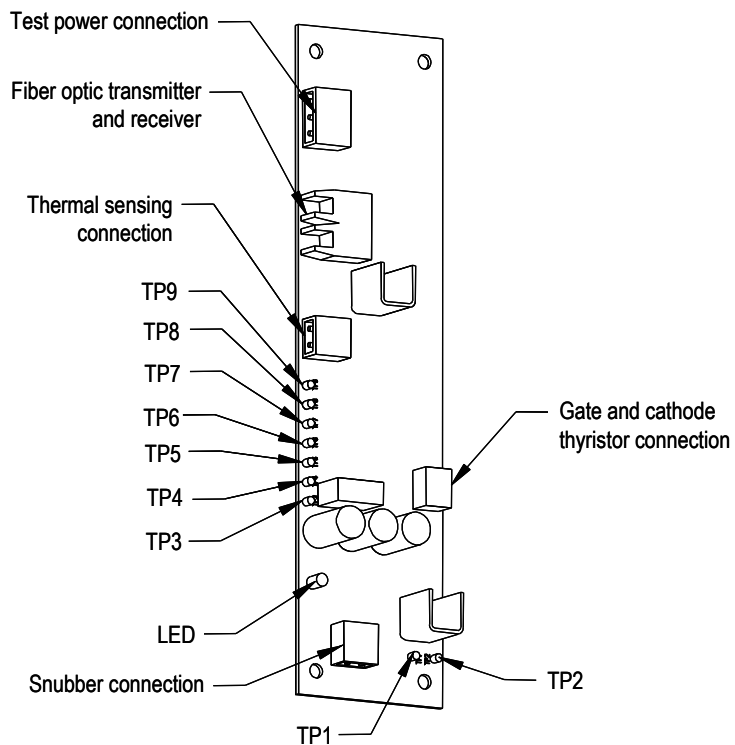


Figure 4.37 – Self-Powered Gate Driver Board

Self-Powered Gate Driver Board – SPGDB (cont.)**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, +/-100mV.
5. Measure TP5 to TP3, which should be +5.0V, +/- 250mV.
6. Measure TB2-1 to TB2-2, which should be +14.4V, +/-100mV.
7. Measure the voltage at U4-pin2 to COM, which should be +1.0V, +/- 100mV.
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, +/- 100mV.
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, +/- 250mV.
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, +/-100mV.
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 Fig. 4.38.
19. Verify that the signal between TP1 and TP2 is as shown in Figures 4.39 and 4.40.
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 Figures 4.41 and 4.42. Note that in Figure 4.42 there should be a 220 μ S, +/-20 μ S time between the rising edge of the U4-pin7 pulse and the falling edge of the TP7 signal.

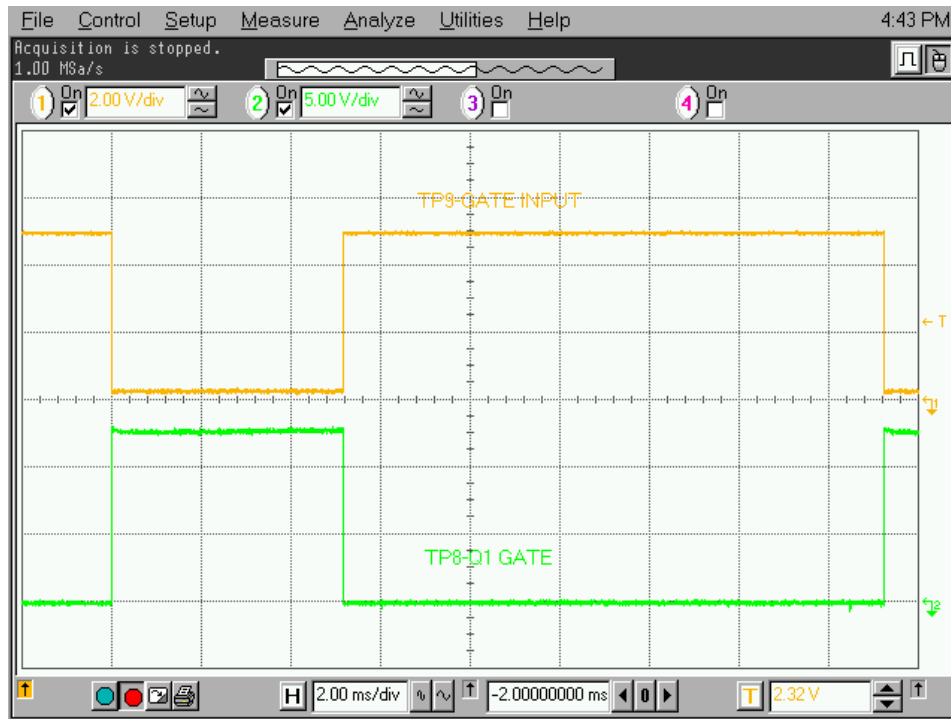


Figure 4.38 – Gating pulses

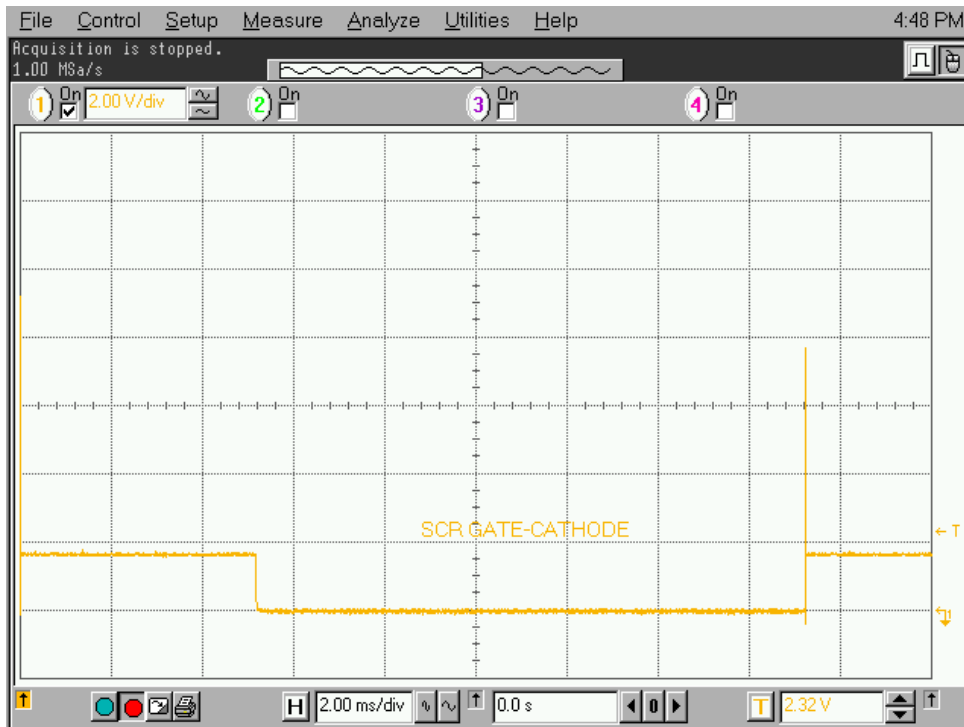


Figure 4.39 – SCR gating pulse

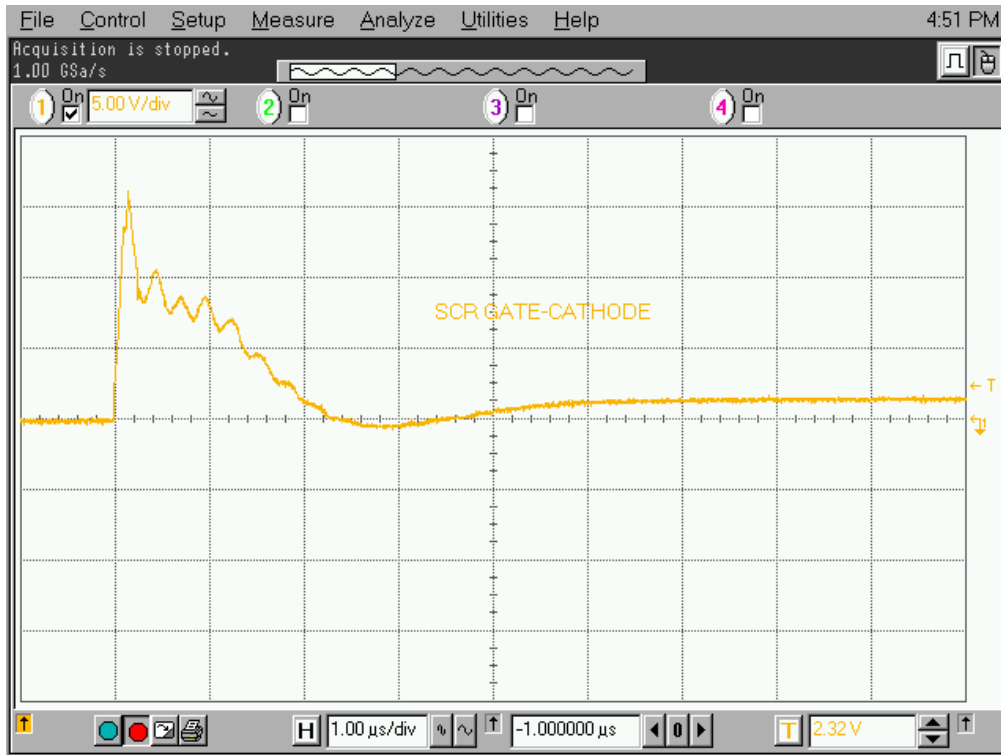


Figure 4.40 – Expanded SCR gating pulse

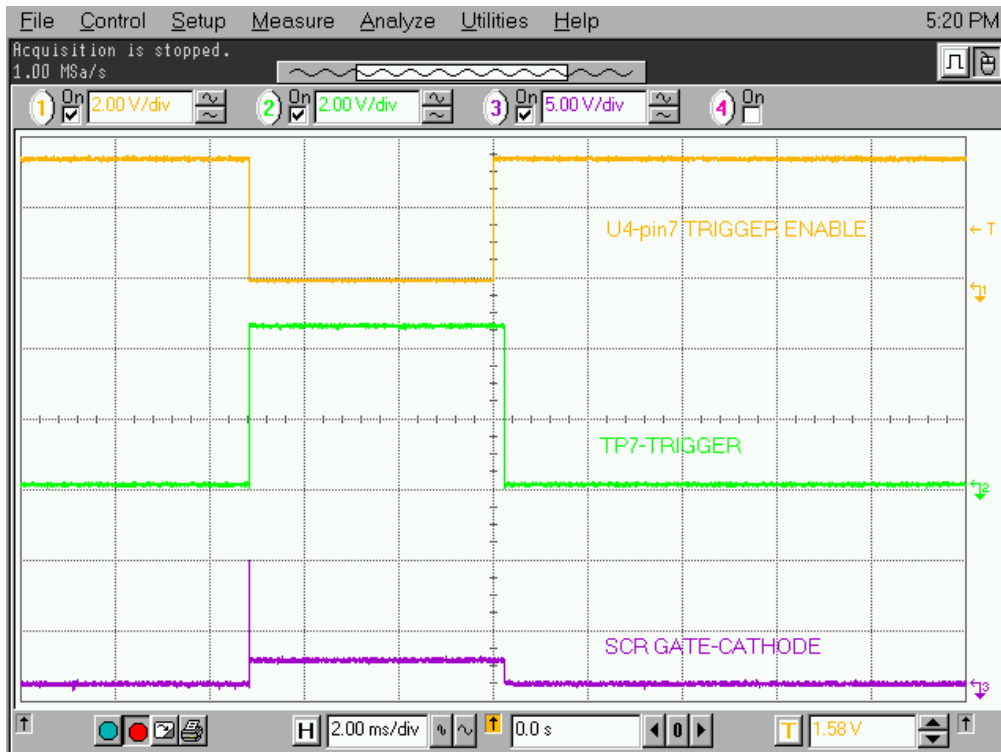


Figure 4.41 – V Sense Trigger to SCR gating pulse

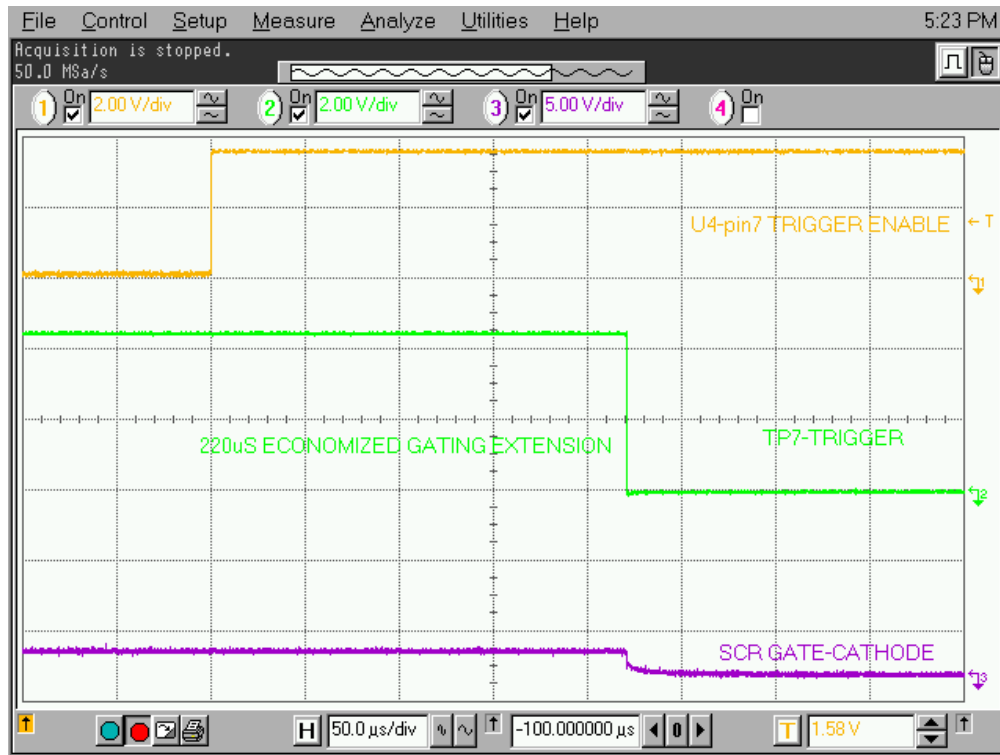


Figure 4.42 – Expansion of V Sense Trigger to SCR gating pulse

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:

Duplex	Simplex
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.

DC Link and Control Power Section

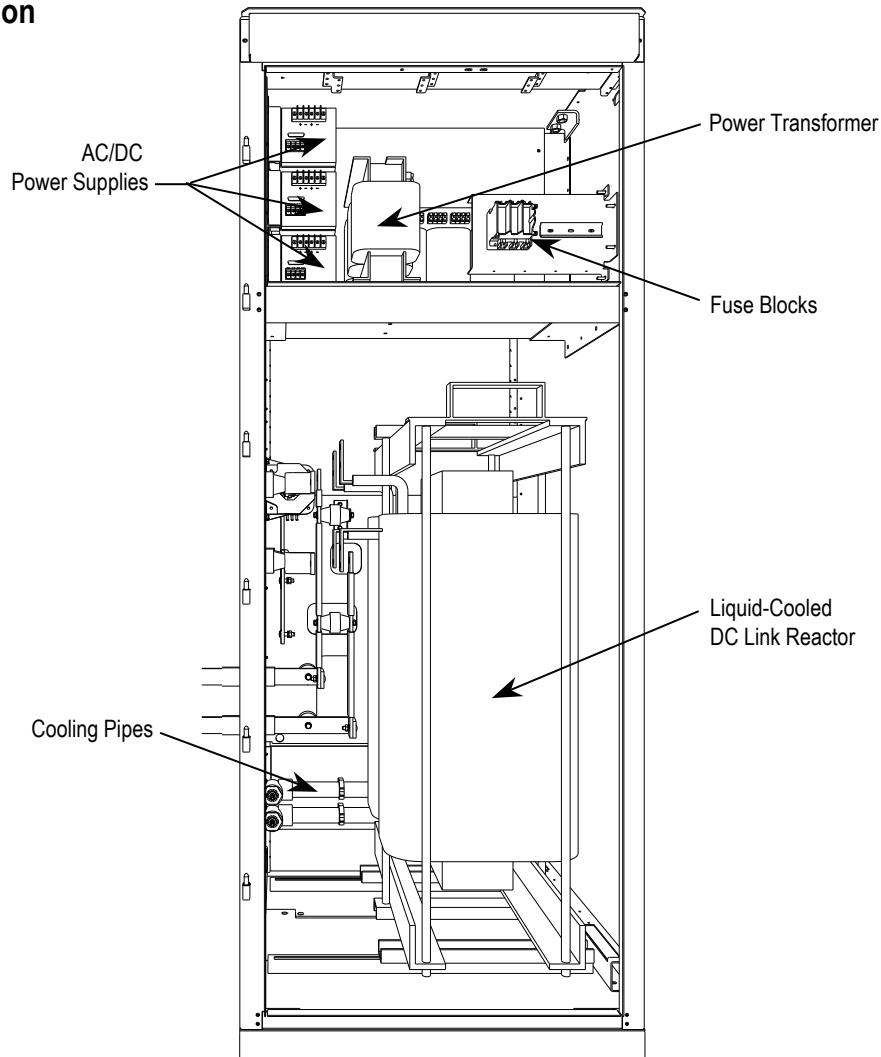


Figure 4.43 – DC Link and Control Power Cabinet

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 4.44 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.

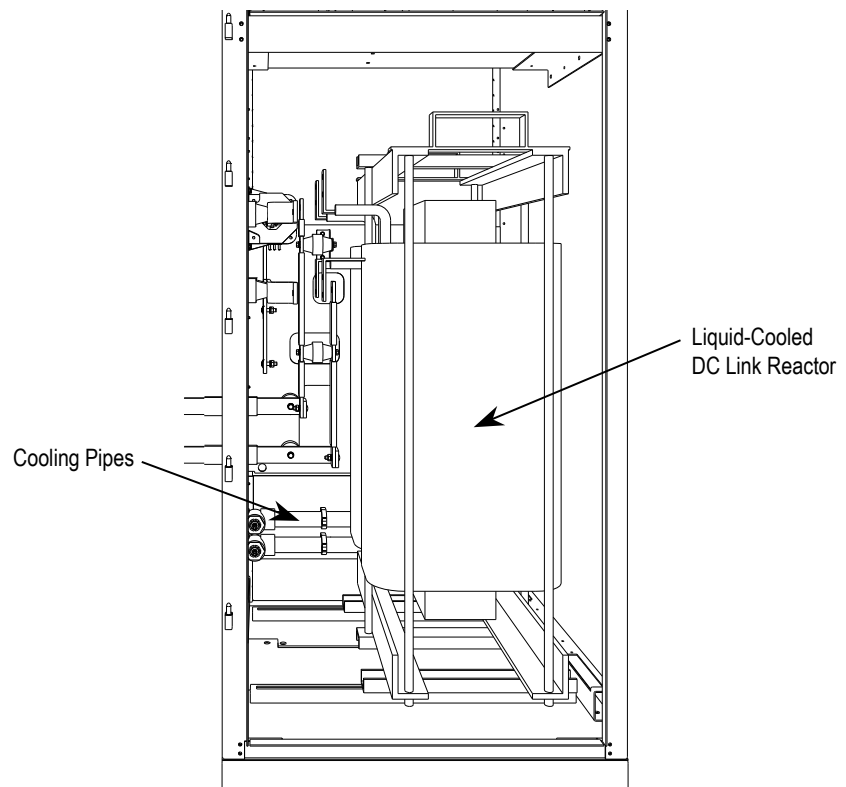


Figure 4.44 – DC Link Reactor

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 4.45)
2. Remote Transformer and Starter (refer to Figure 4.46)

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 4.45 illustrates the control power distribution for 6-pulse and PWM drives with integral starter/line reactor.

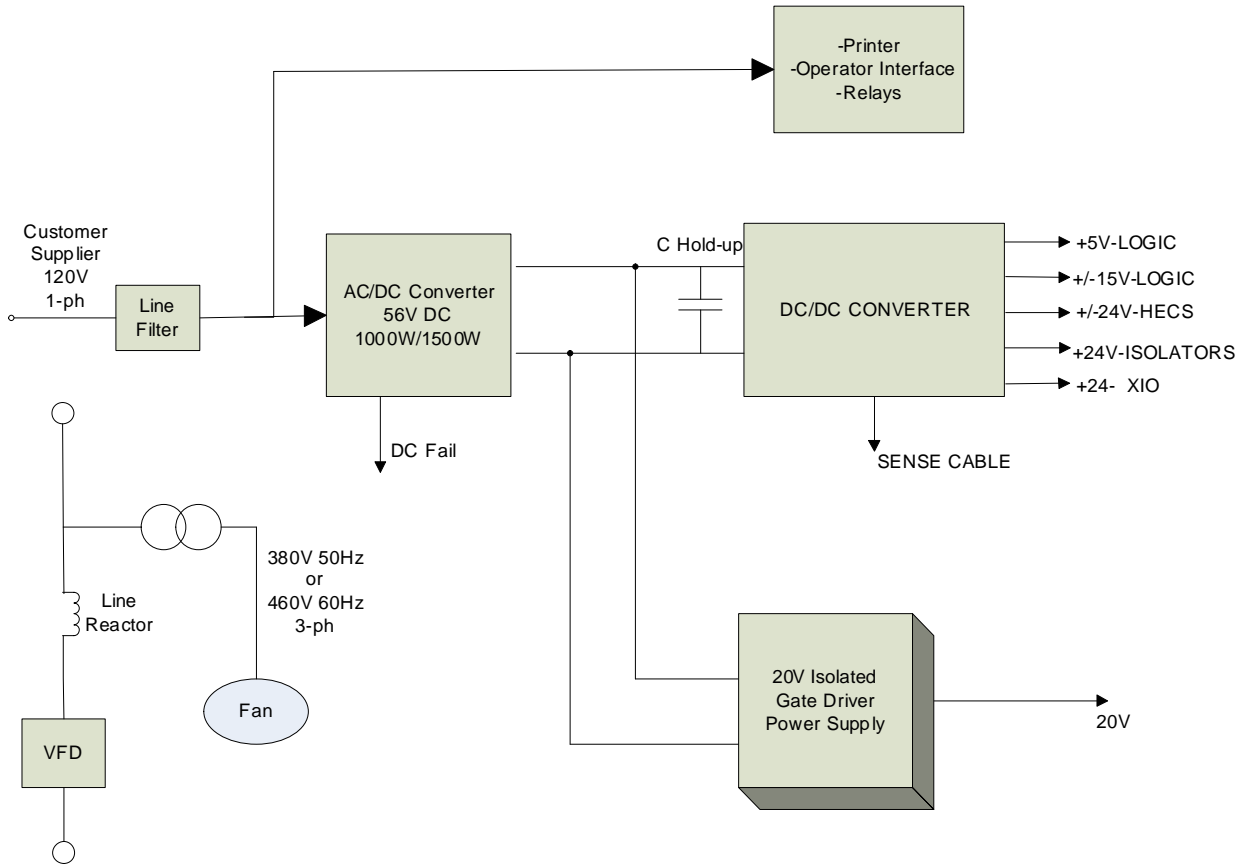


Figure 4.45 – AFE Line Reactor Drives

Figure 4.46 illustrates the control power distribution for 6-pulse and AFE drives with remote transformer/starter or integrated line reactor with remote starter.

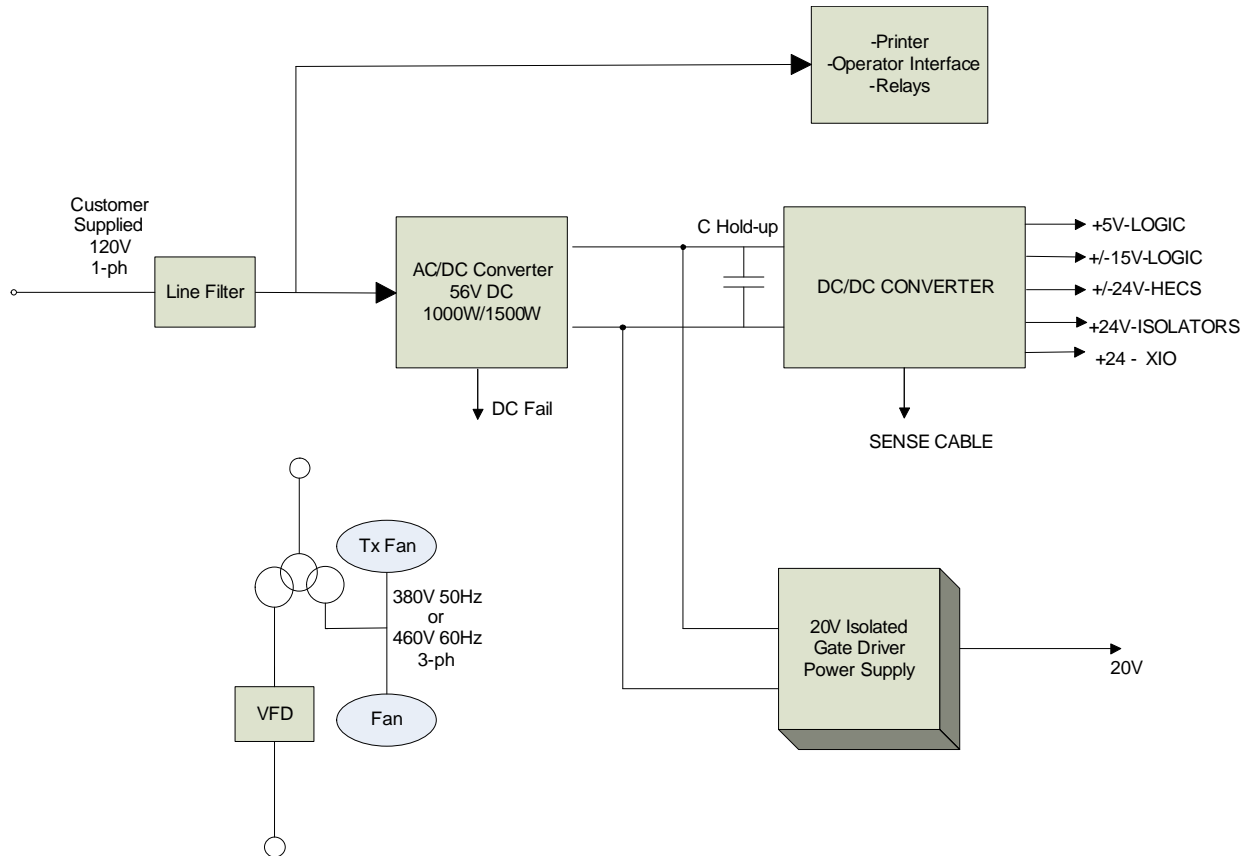


Figure 4.46 – 6-pulse / AFE Remote Transformer / Starter

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.

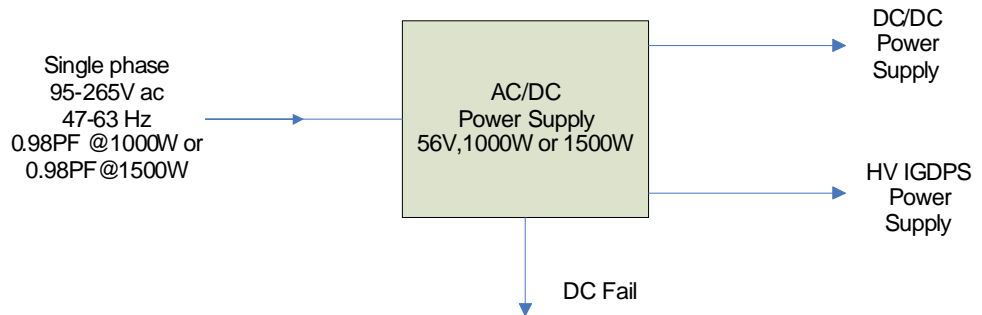


Figure 4.47 – AC/DC Converter Power Supply

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

**AC/DC Power Supply
(cont.)**

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 4.48.

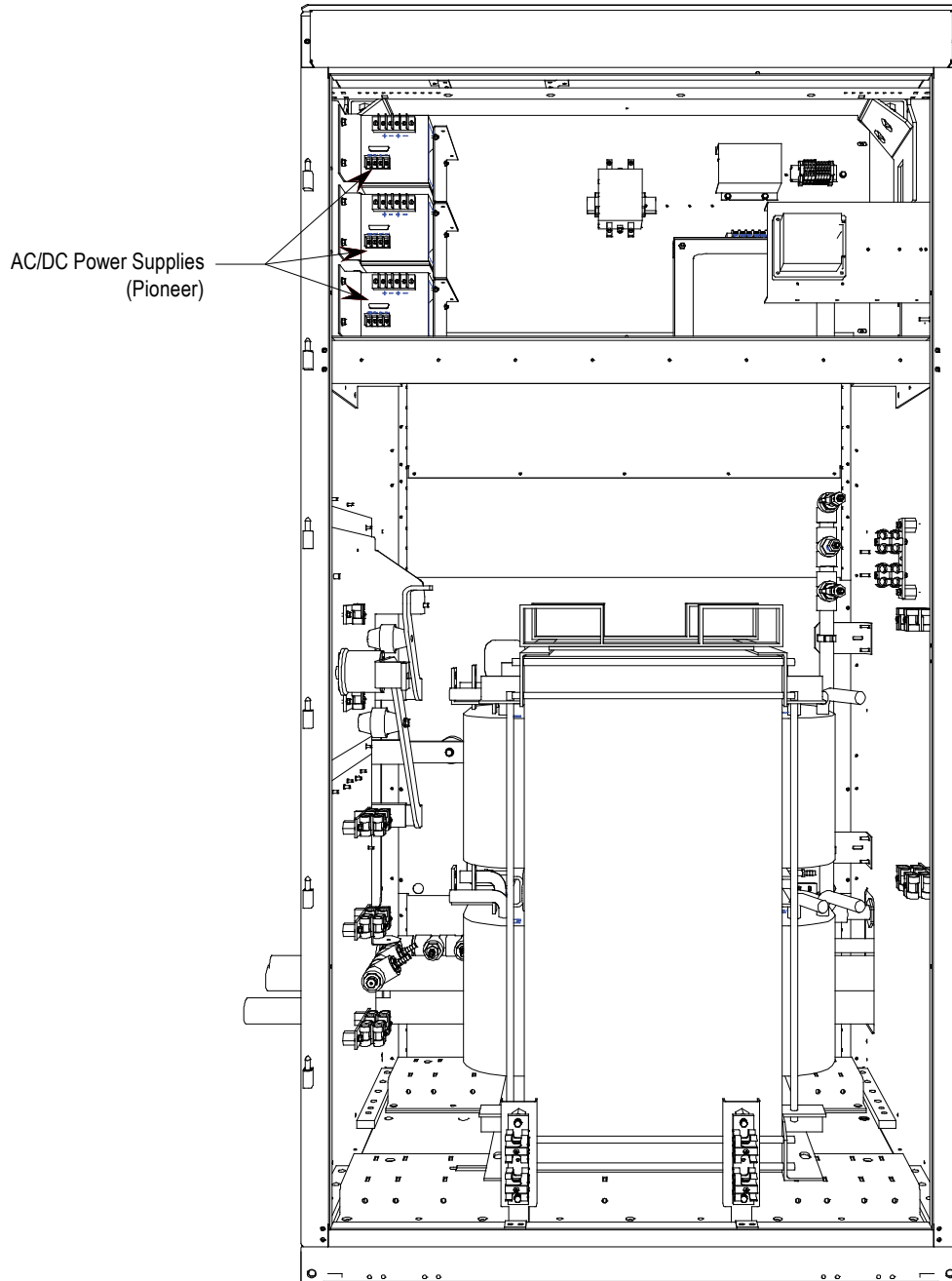


Figure 4.48 – Location of AC/DC Pioneer Power Supply on Low Voltage Panel

Terminal / Connections Descriptions

The terminal connections are shown in Figure 4.50.

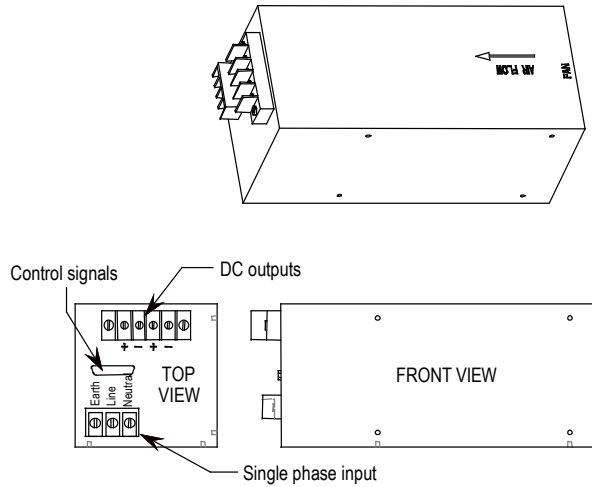


Figure 4.49 – Terminal locations on AC/DC Pioneer power supply

P1-AC input

PIN#	LABEL
1	EARTH
2	LINE
3	NEUTRAL

P2-DC output

PIN#	LABEL
1	+56V
2	+56V COMM
3	+56V
4	+56V COMM

P3-FAIL output

PIN#	LABEL
3	DC POWER FAIL (OUTPUT POWER GOOD)
15	CURRENT SHARING
14	DC POWER FAIL COMMON

AC/DC Power Supply (cont.)

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 re-measure 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 4.50.
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.

Note: 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 4.50).
8. Reapply control power and verify voltage levels.

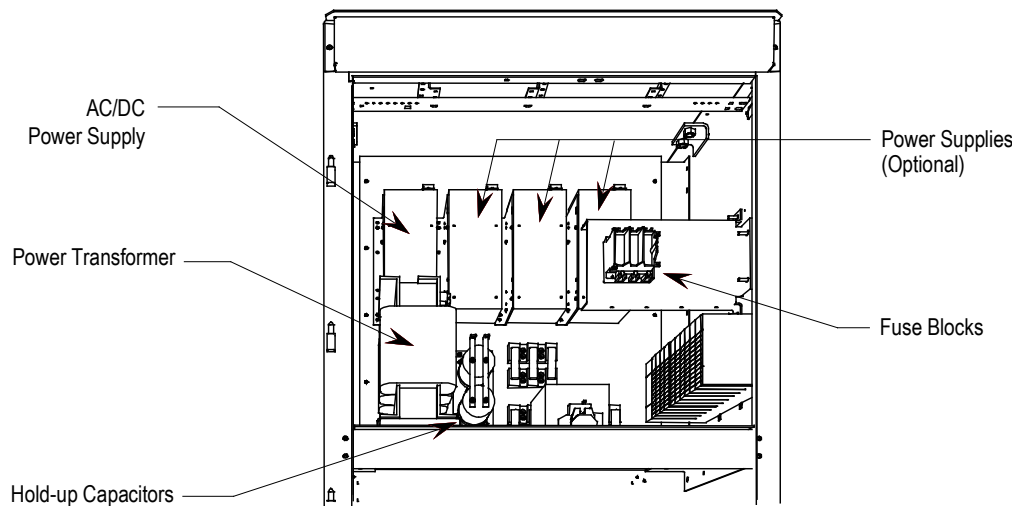


Figure 4.50 – Replacement of AC/DC Power Supply on Low Voltage Panel

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:

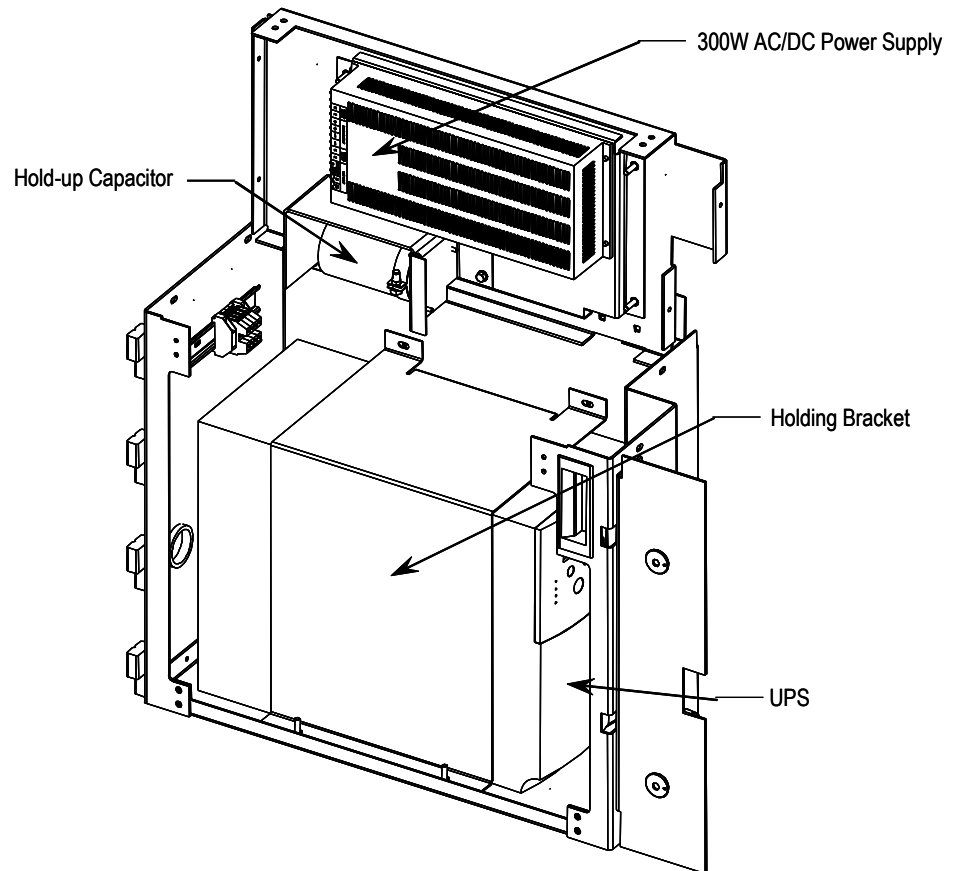


Figure 4.51 – 300W AC/DC Power Supply

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.

UPS Option (cont.)

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 System

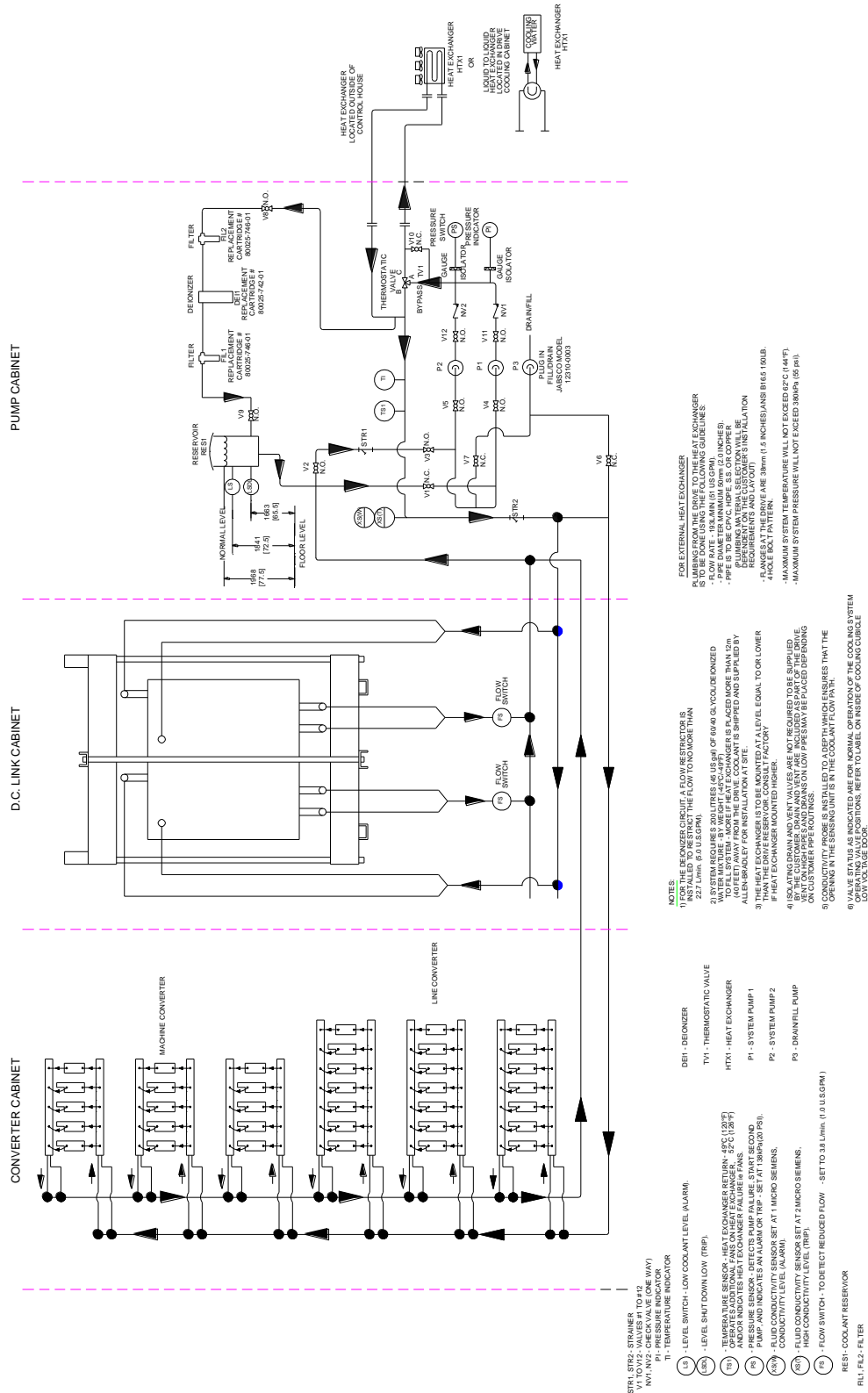


Figure 4.52 – Generic Cooling System Overview

Cooling System (cont.)

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.

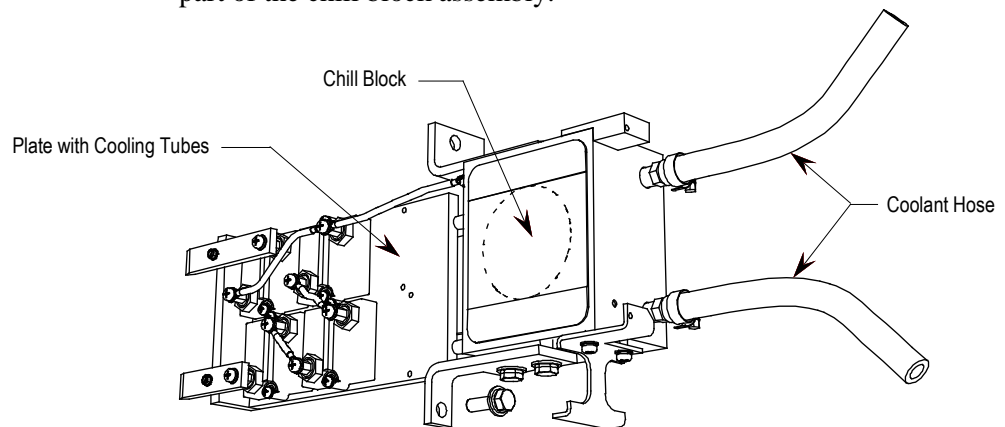


Figure 4.53 – Chill Block Assembly

Coolant Pumps

Two pumps (P1 and P2) are used to move coolant through the system (Figure 4.54). One of the pumps is used as a backup. The control logic alternates the primary and secondary pump once every eight (8) hours. Ensure that the pumps never run dry, as this will damage the pump seals. Ensure the pumps don't cavitate (pumping air pockets) when filling the system.

Pump Maintenance and Replacement

Pump Seal Replacement

ATTENTION


Do not run the pumps without coolant. Ensure coolant is present in the system. Damage to the pump seals may result.

Isolate the pump by closing valve V4 and V11 or V5 and V12. Note that the non-return valve NV1 or NV2 will stop coolant from flowing back to the pump being serviced. Follow the pump seal replacement instructions from the pump manufacturer.

Refer to pump nameplate for manufacturer's model information. Typical pump seal replacement information is provided at www.goulds.com/pdf/SST-C,SST-F%20IOM.pdf

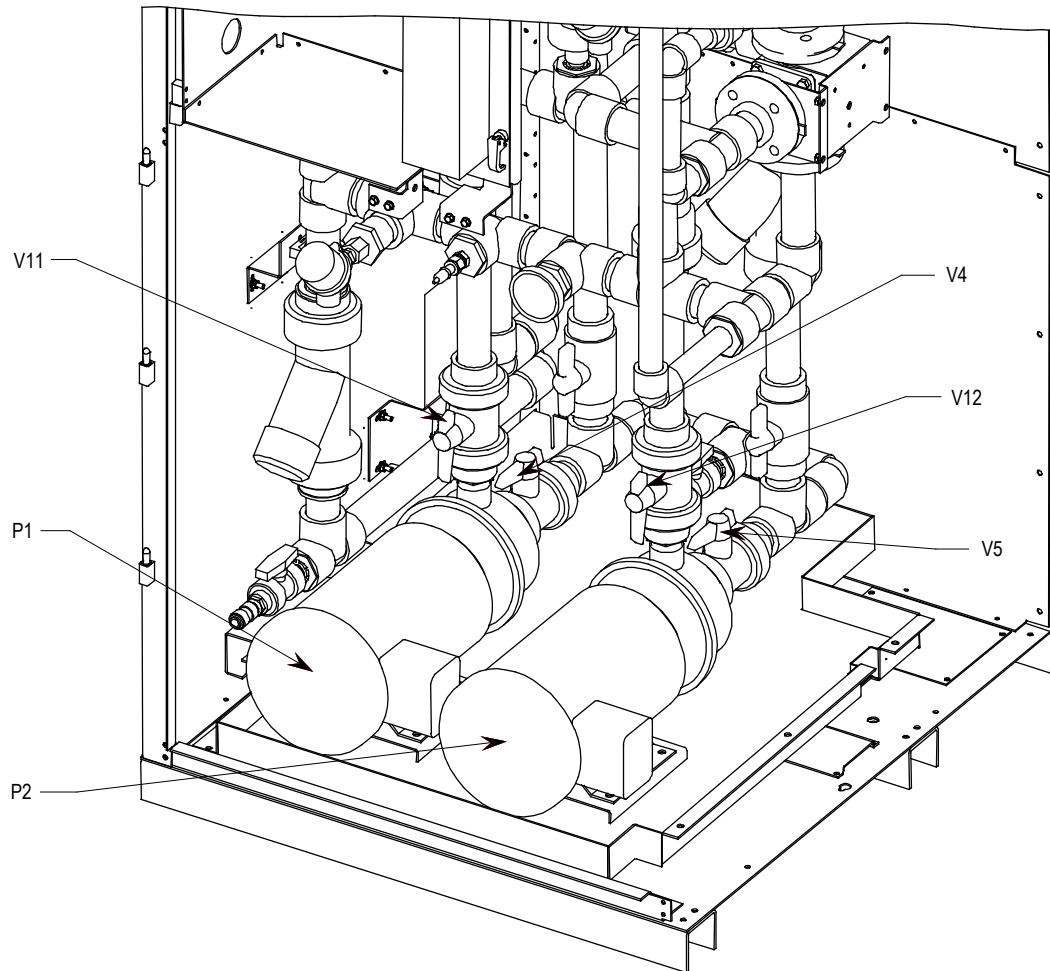


Figure 4.54 – Drain/Fill Pump

Pump Maintenance and Replacement (cont.)

Pump Replacement

While the drive is running, one of the pumps must be in operation. Two pumps run alternatively. The switching from one pump to another pump depends upon the Control Program setup. If the drive is running and you need to replace one pump, it is important to select the pump in operation by changing the pump selector switch position from auto to the pump number which is in operation.

Perform the following steps to replace the pump ON LINE.

1. Select the running pump by changing the pump selector switch.
2. Open the overload relay of the pump to be replaced by pressing the RED button of the overload relay.
3. Check voltages at terminal T1, T2 and T3 of the pump contactor (PC) make sure that there is no voltage.
4. Disconnect wire T1, T2 and T3 at pump.
5. Close Valve V4 and V11 if pump # 1 is to be replaced OR V5 and V12 if pump # 2 is to be replaced.
6. Loosen only bottom and front true union connector of the two valves (Valves V4 and V11 are for Pump #1 and Valves V5 and V12 are for Pump #2).
7. Unbolt the pump from its foot-plate.
8. Take the pump out and replace it with another.
9. **MAKE SURE THAT CORRECT VOLTAGE IS TAPPED FROM THE NEW PUMP WINDING. ENSURE THE THREE-PHASE SUPPLY IS TERMINATED IN THE ORIGINAL SEQUENCE TO KEEP THE SAME PUMP ROTATION DIRECTION.**

Piping, Tubing and Connectors

The piping is schedule 80-type made from chlorinated polyvinyl chloride (CPVC) which has good high and low temperature properties; it 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 flexible tubing for the coolant path from the manifolds to the various hose barbs throughout the drive is 3/8 inch (10 mm) inside diameter silicon. The manifolds, just as the chill blocks, use hose barbs to provide easy connectivity of the hoses.

Non-Return Valves

The non-return valves (NV1 & NV2) shown in Figure 4.55 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.

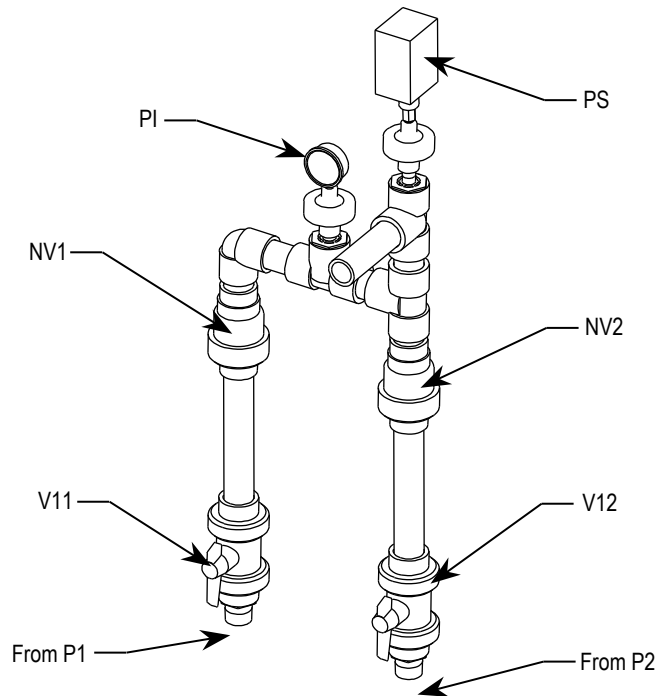


Figure 4.55 – Pressure Indicator and Switch Locations

Pressure Indicator

The pressure indicator (PI) shown in Figure 4.55 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 4.55 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.

The pressure trip setting is set at the factory and varies with the construction of the drive.

Pump Maintenance and Replacement (cont.)

Thermostatic Valve

The thermostatic valve (TV1) shown in Figure 4.56 is similar to an automobile thermostat. When the fluid is cool, the valve bypasses the flow away from the heat exchanger to re-circulate 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 chill block near room temperature to prevent condensation.

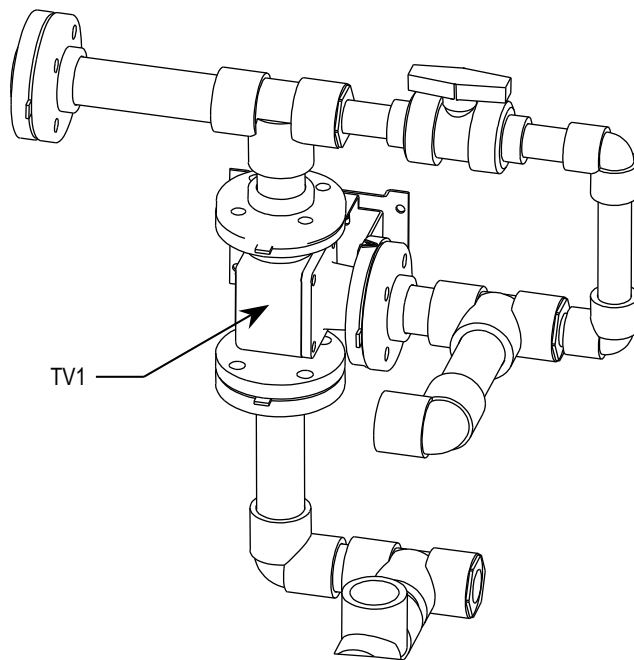


Figure 4.56 – Thermostatic Valve

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.

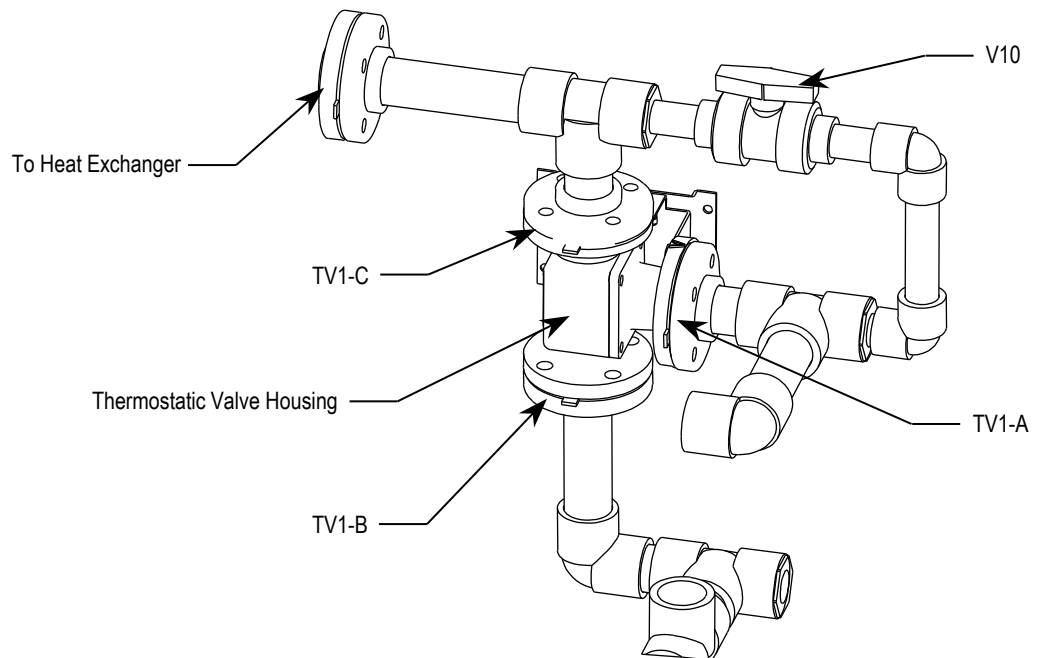


Figure 4.57 – Thermostatic Valve Replacement

Pump Maintenance and Replacement (cont.)

Repair Instructions - Element Testing

Place element in water at a temperature 8°C to 1°C (15°F to 2°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°C to 8°C (10°F to 15°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°C (5°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°C (5°F) below the start to open temperature.

Element Replacing (Refer to Figure 4.58)

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.

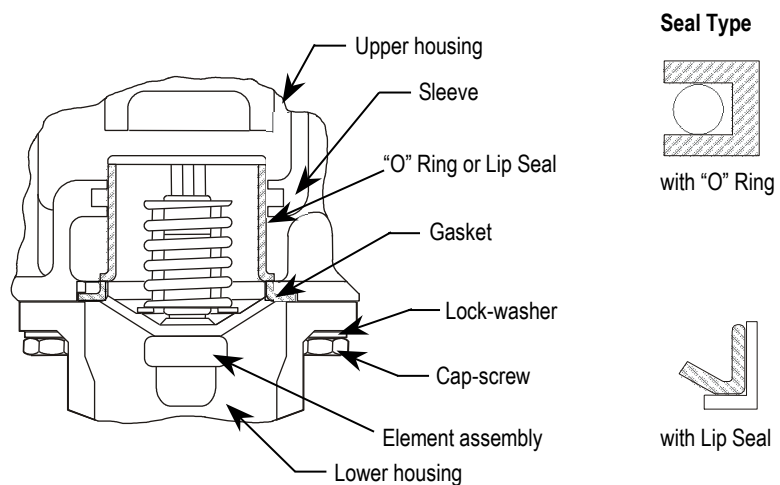


Figure 4.58 – Element Assembly Cross-Section

Temperature Gauge

Temperature is indicated by the temperature gauge (T1) as shown in Figure 4.59.

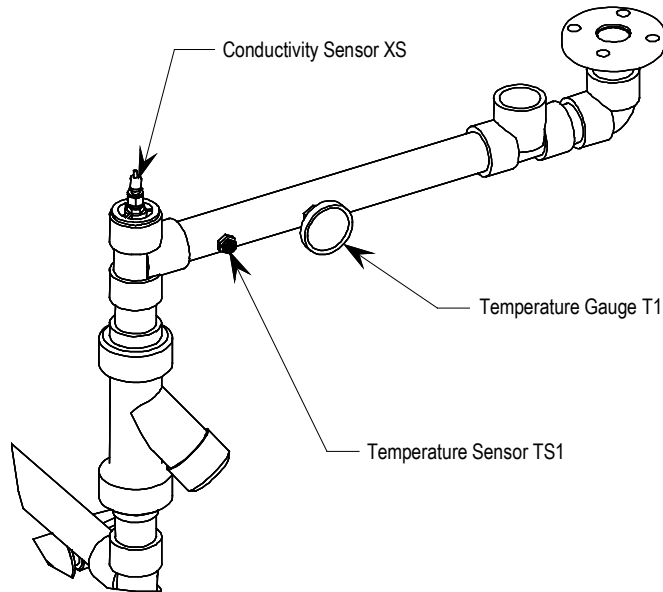


Figure 4.59 – Temperature and Conductivity Sensors

Fluid Conductivity

An in-line conductivity sensor (XS) as shown in Figure 4.59 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.

Temperature Sensor

This temperature sensor (TS1), shown in Figure 4.59, 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.

Pump Maintenance and Replacement (cont.)

The following are the temperature values for alarm and trip signal:

1. When coolant temperature is greater than 48°C (120°F), an alarm signal is initiated. It can only be reset when temperature reaches 38°C (100°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 circuit shown in Figure 4.60 filters and de-ionizes the stream at a rate of about 0.3 L/second (5 U.S. gallons per minute). This stream can be isolated for cleaning and maintenance by closing the incoming and outgoing valves. 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.

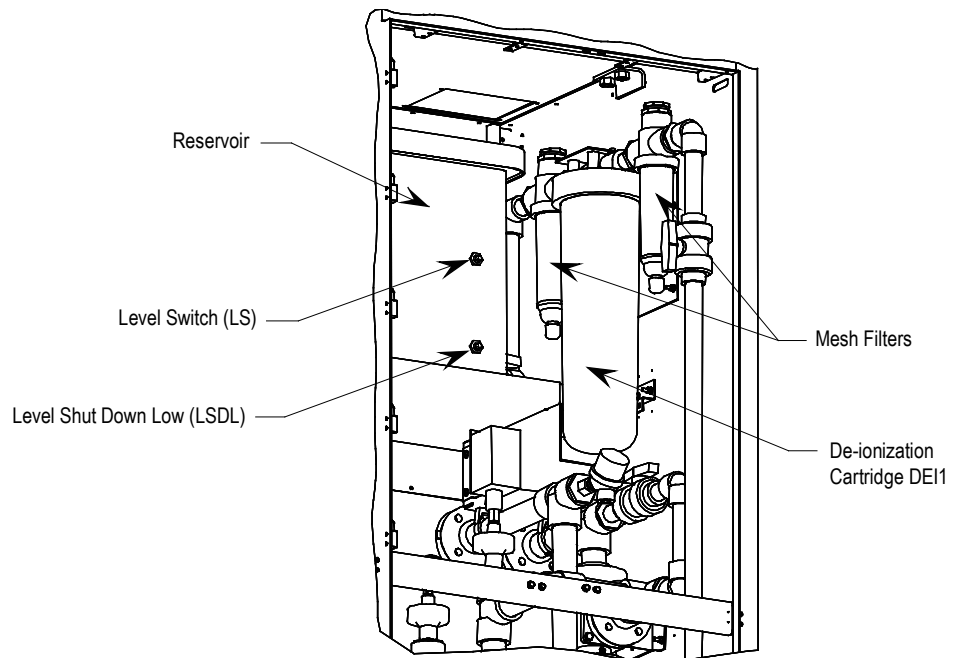


Figure 4.60 – De-ionizing Filter DEI1 (Rear View)

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 4.60) 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 4.61).
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 fifteen-gallon container. Level switch LS (see Figure 4.60) is a warning switch that annunciates when the fluid drops down below the first level switch.

Level switch LSDL (see Figure 4.60) triggers the drive and cooling pumps to shut down when the fluid drops below critical level.

Pump Maintenance and Replacement (cont.)

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-litre (55-gallon) 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.

IMPORTANT

Pour the coolant slowly into the reservoir to avoid disturbing the coolant level switches and causing a trip fault.

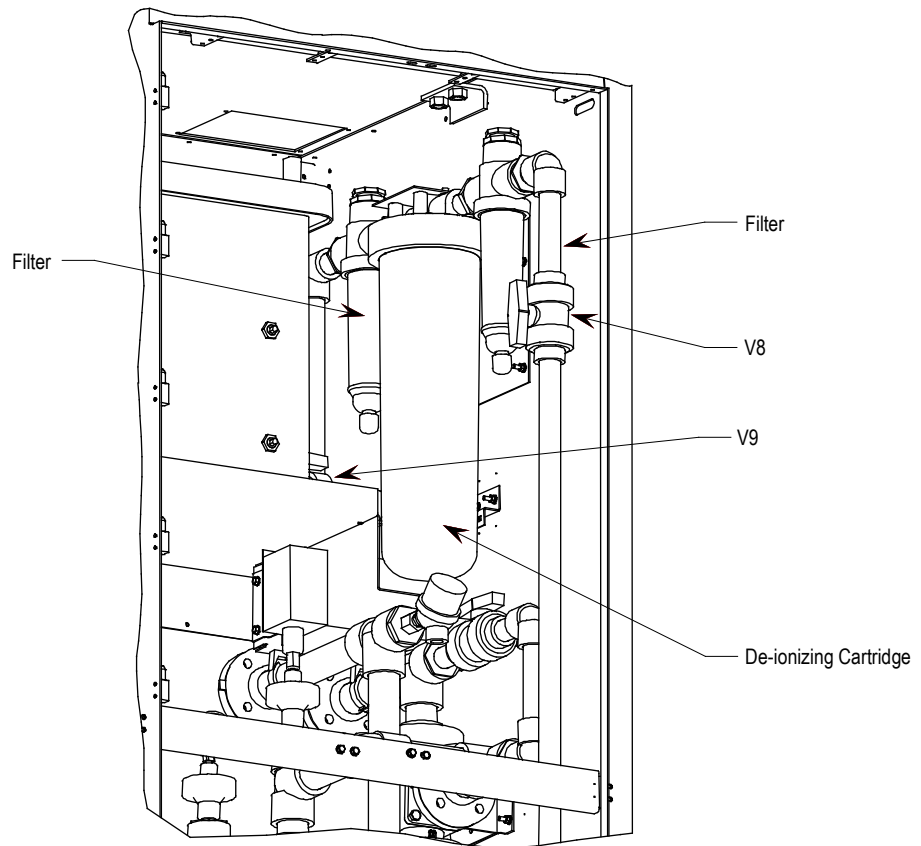


Figure 4.61 – Reservoir Circuit

Strainers

Cleaning the Strainer

1. Open valve V1, shown in Figure 4.62, 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.

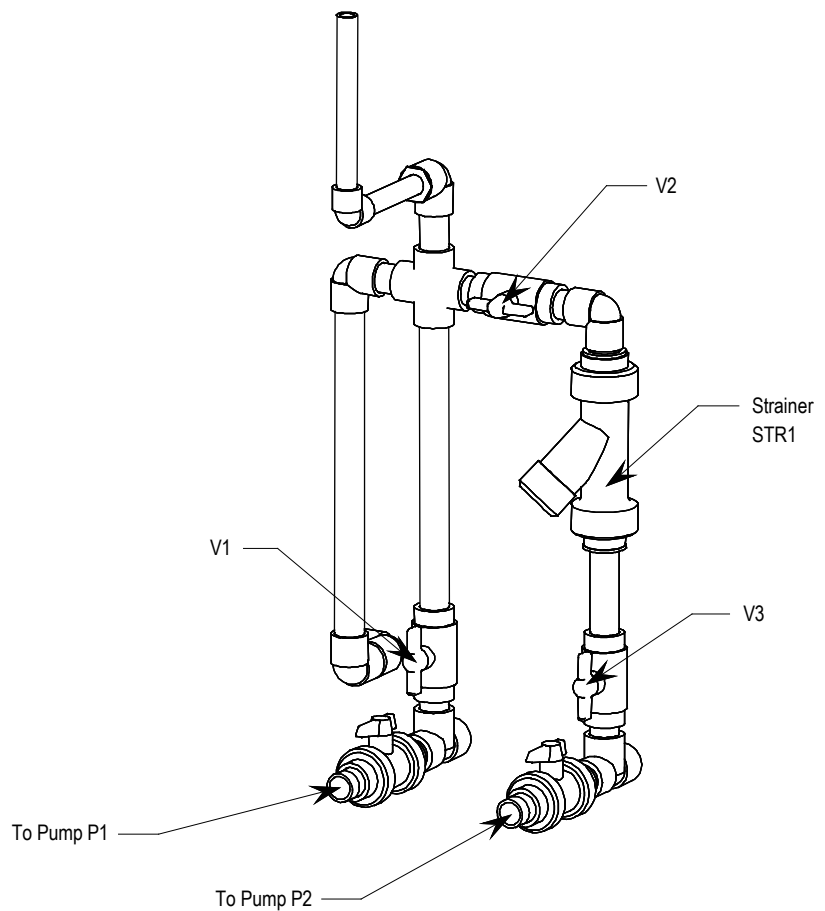


Figure 4.62 – Cleaning the Strainer

Pump Maintenance and Replacement (cont.)

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 (Na^+), Calcium (Ca^{+2}) and chloride (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 (Cl_2) and carbon dioxide (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.

NOTE: 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 instructions 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-litre (5-gallon) container (Part # 80025-784-60)
 - Pure ethylene glycol, 19-litre (5-gallon) 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°C (-50°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°C (32°F) and pure ethylene glycol freezes at -13°C (8.6°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°C (-33°F). The addition of ethylene glycol to the mixture will lower the freezing point. Adjust the freeze temperature of the coolant mixture to -45°C (-50°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.

Pump Maintenance and Replacement (cont.)

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 inch)
3/8 inch NPT	9,5 N-m (7.0 lb-ft)	19 mm (3/4 inch) and 26 mm (1 inch)
1/2 inch NPT	27 N-m (20 lb-ft)	29 mm (1-1/8 inch)

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 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 4.63 for a generic representation of a low voltage tub arrangement.

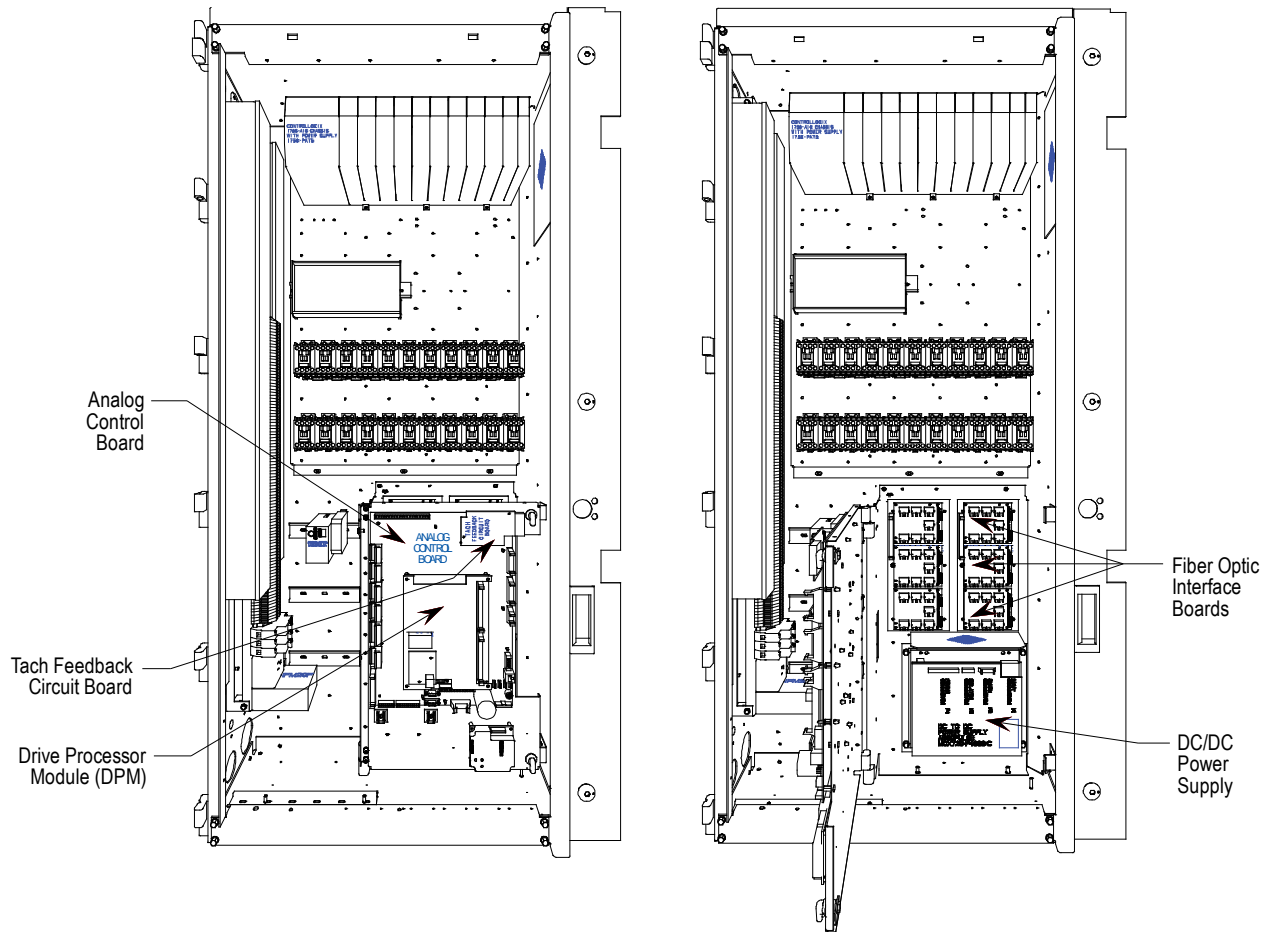


Figure 4.63 – Low Voltage Compartment

DC/DC Power Supply

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.

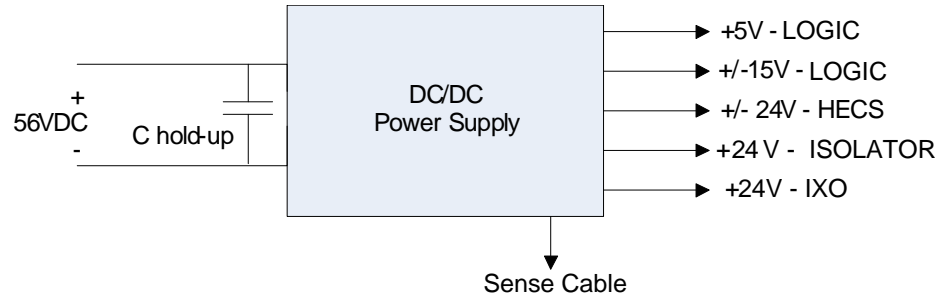


Figure 4.64 – DC/DC Converter Power Supply

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

DC/DC Power Supply (cont.)

Replacement Procedure for DC/DC Power Supply

(Refer to Figure 4.65)

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 (4) 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 (4) **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

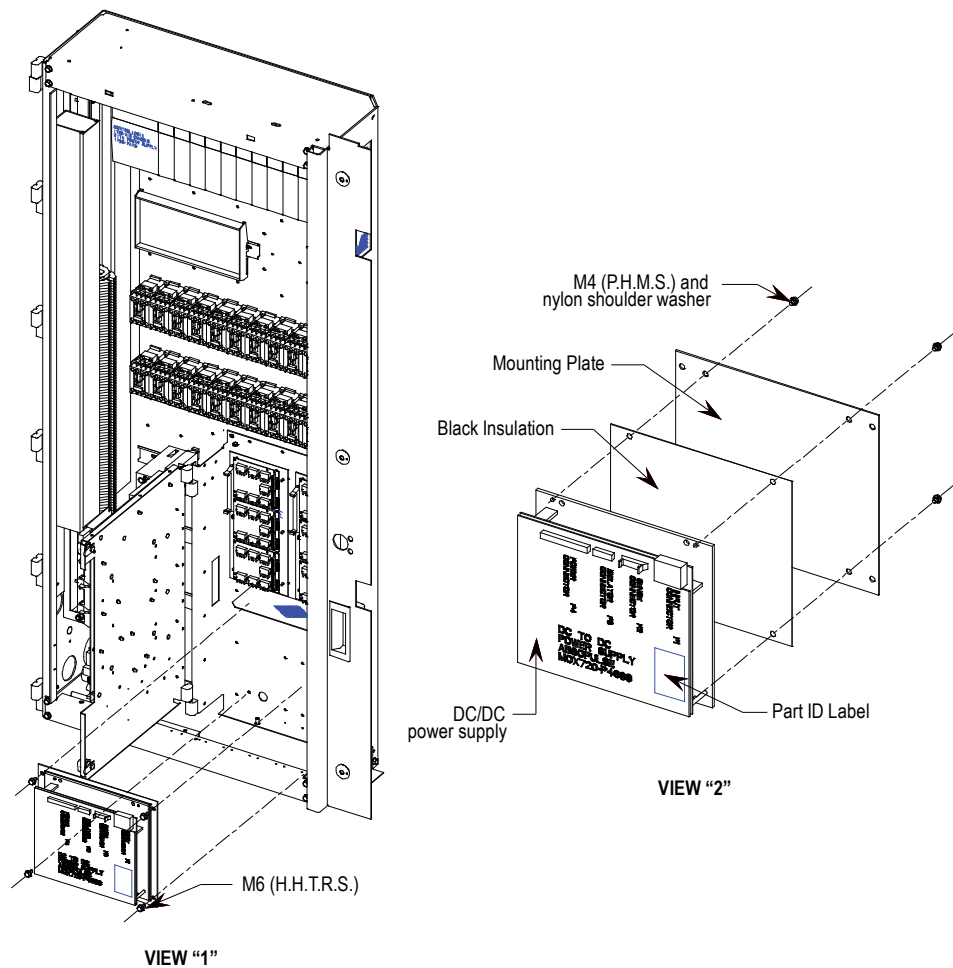


Figure 4.65 – Replacement of DC/DC Power Supply

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

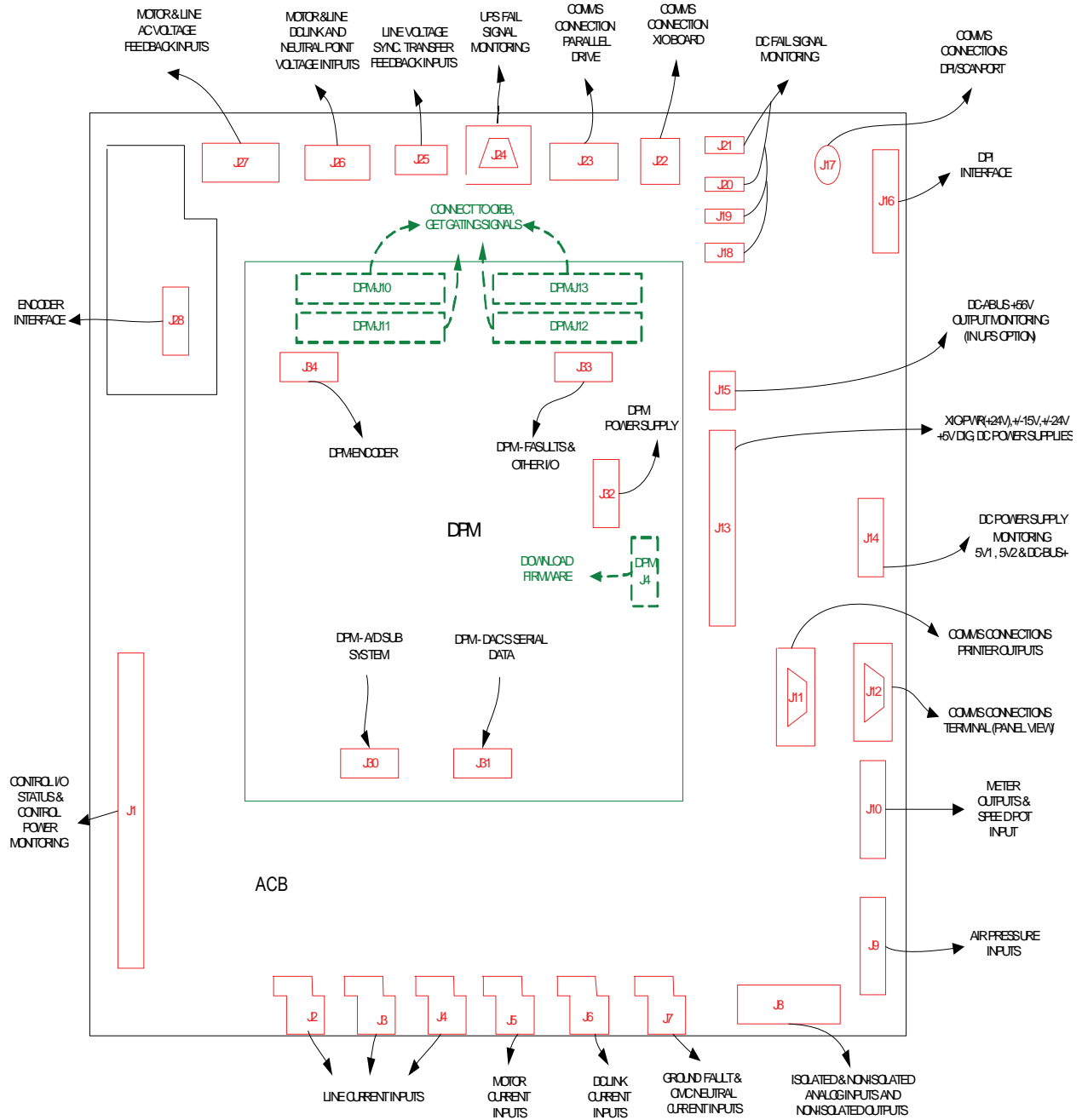


Figure 4.66 – IO Connectors on Control Boards

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.

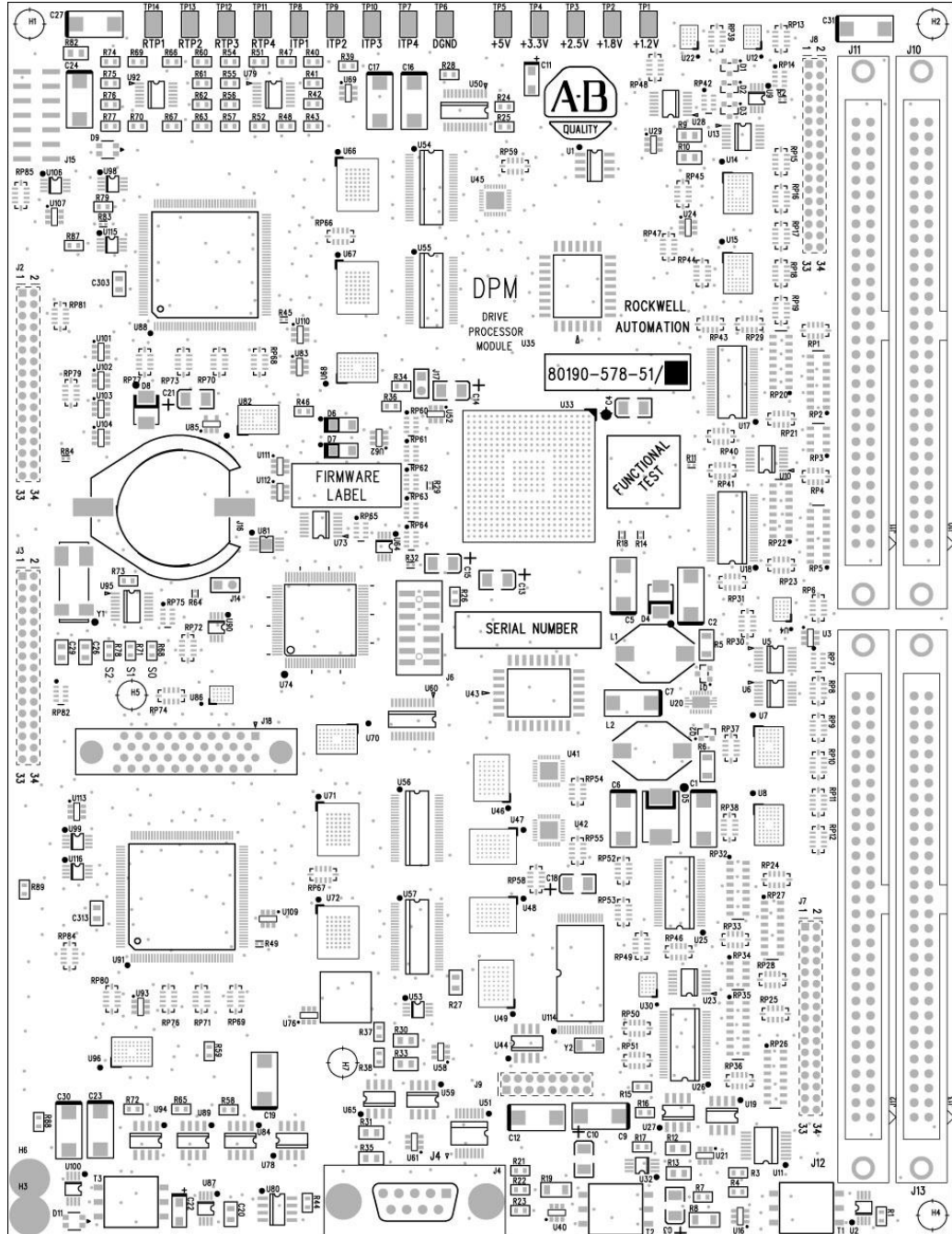


Figure 4.67 – Drive Processor Module (DPM)

Drive Processor Module (cont.)

The following is the list of test points on the DPM.

NOTE: Diagnostic Test Points on the DPM have a voltage output range of -5 to +5V.

Table 4.B – 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 4.C – 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
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 in ‘Installing Firmware’.

**Drive Processor Module
(cont.)**

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.

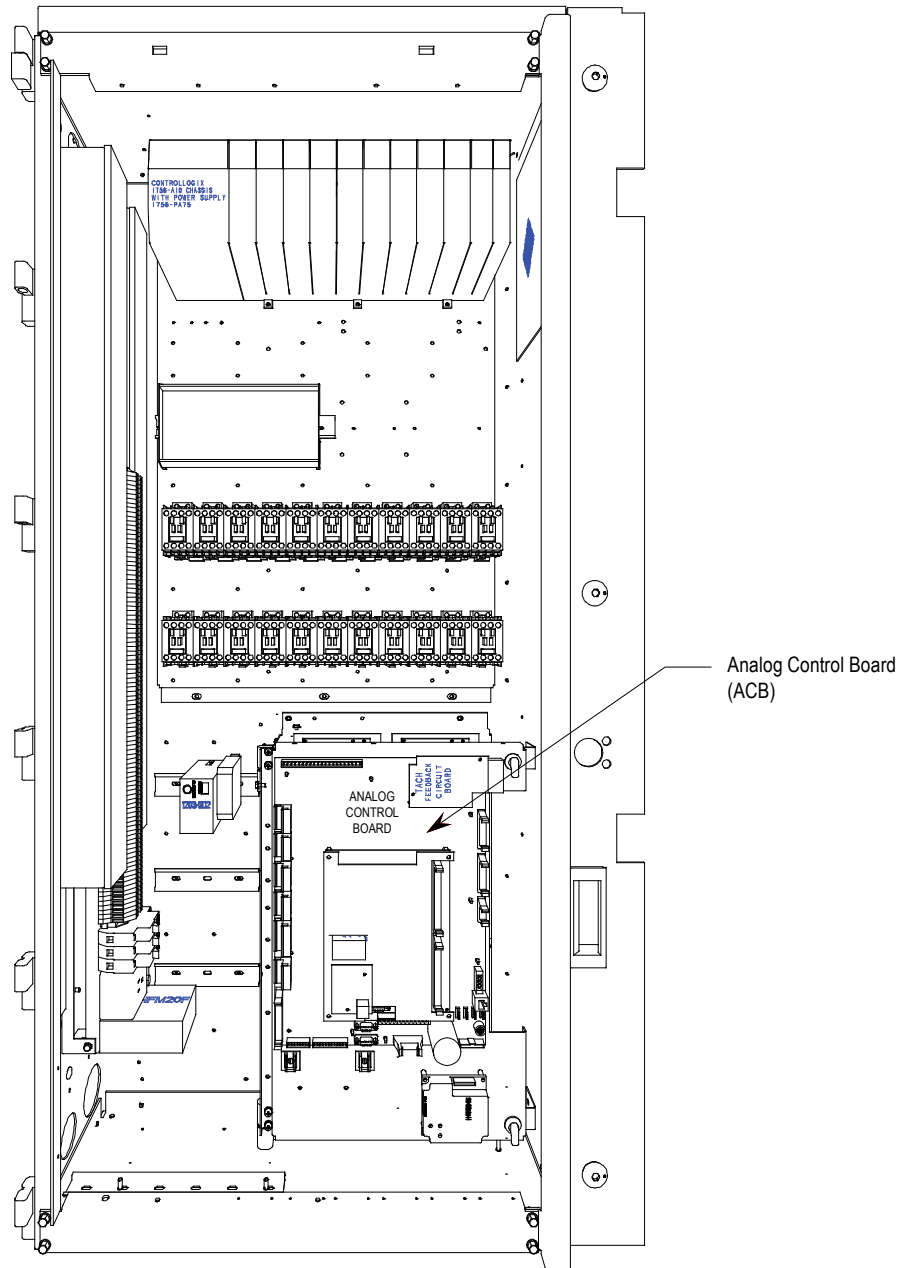


Figure 4.68 – ACB and DPM Replacement

ACB Analog Control Board

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

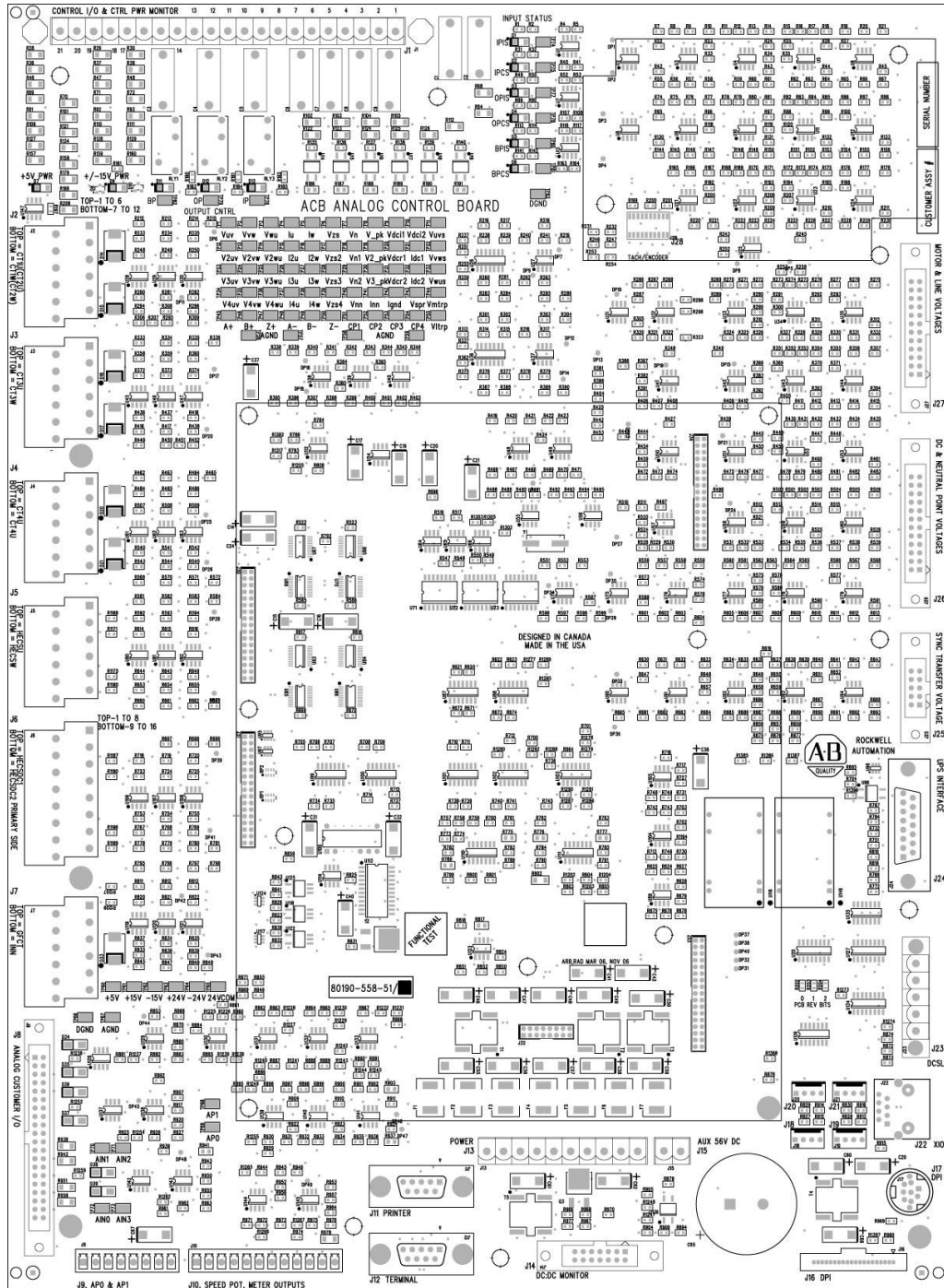


Figure 4.69 – ACB Analog Control Board

ACB Analog Control Board (cont.)

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 4.D – 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, HECDC2
ACB-J7	Ground fault & CMC Neutral current inputs, GFCT, INN
ACB-J8	Isolated & Non-isolated analog inputs, AIN1,AIN2,AIN3 and Non-isolated outputs, AOUT1AOUT2,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 4.E – 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	Vwus	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)
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

ACB Analog Control Board (cont.)

Table 4.E – Test Points on Analog Control Board (cont.)

Test points	Name	Description
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	Vltp	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
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.

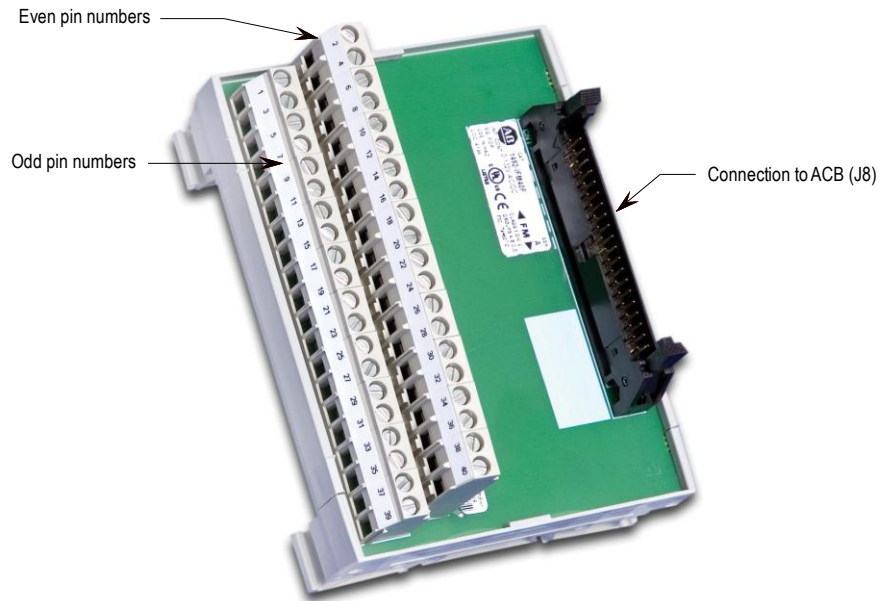


Figure 4.70 – Interface Module (IFM)

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. The figure below shows a block diagram of the transmitter.

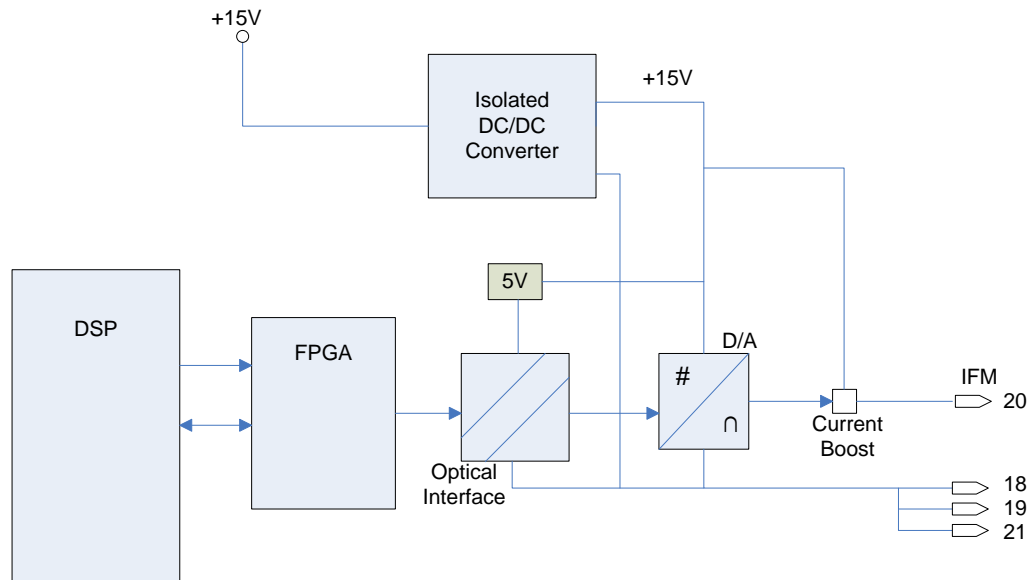


Figure 4.71 – Process Loop Transmitter Block Diagram

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 $\pm 100\text{V DC}$ or 70V RMS AC .

A block diagram of the receiver is shown below.

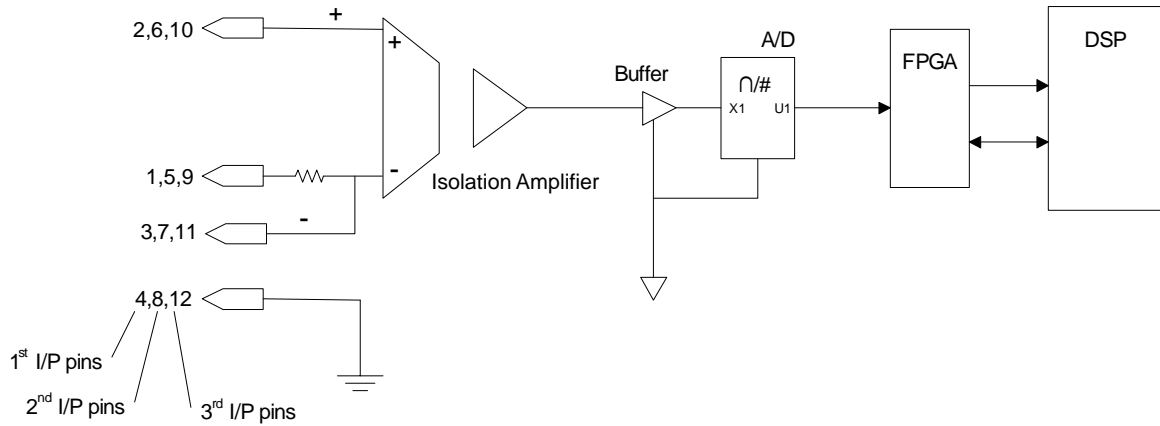


Figure 4.72 – Process Loop Receiver Block Diagram

Current Loop Transmitter (cont.)

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.

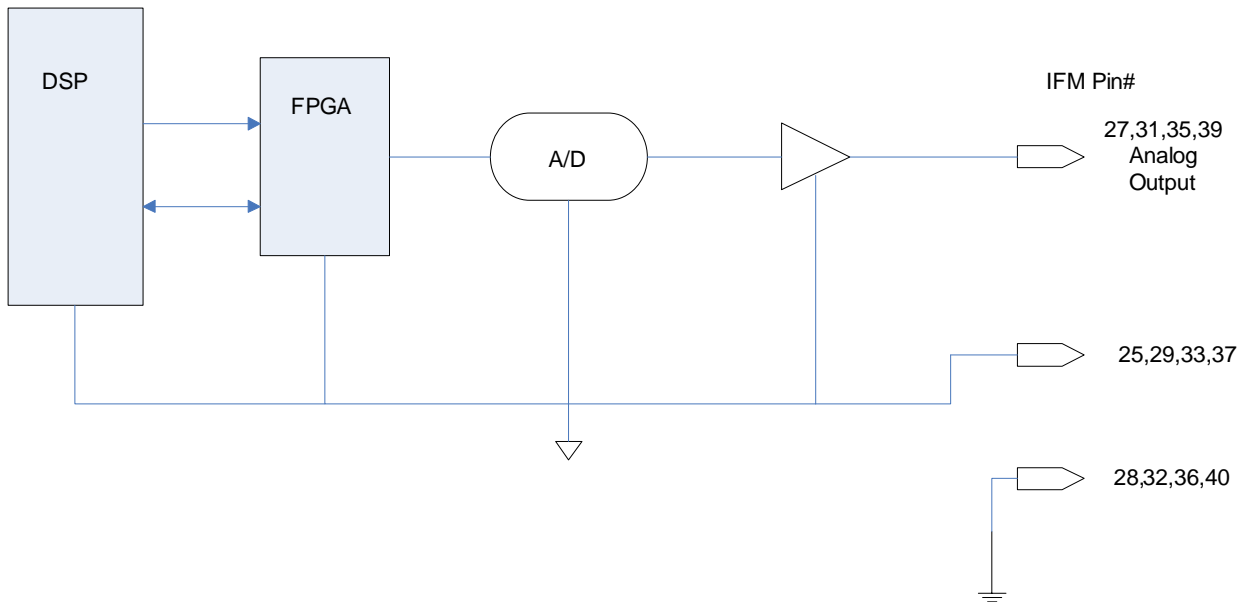


Figure 4.73 – Non-Isolated Configurable Analog Outputs on ACB

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.

<u>PIN NO.</u>	<u>DESCRIPTION</u>
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.

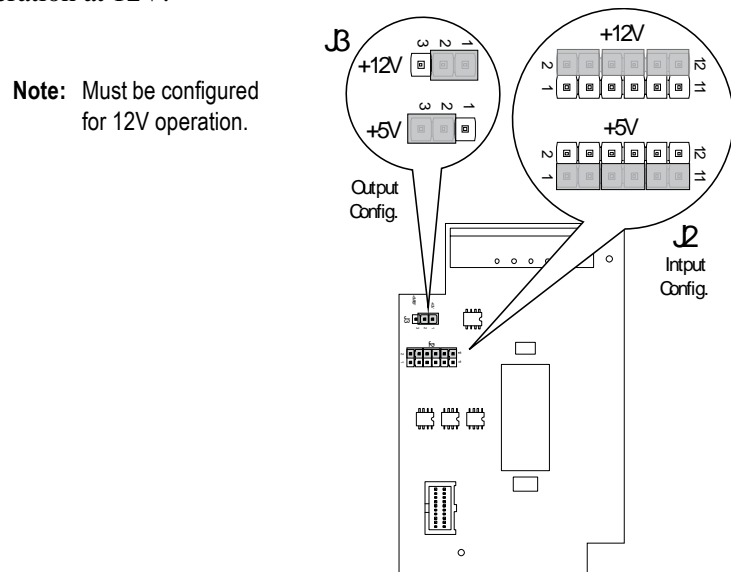


Figure 4.74 – Encoder Interface (20B-ENC-1 and 20B-ENC-1-MX3)

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. Fig xxx 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.

Tachometer Feedback Board (cont.)

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 4.F – 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

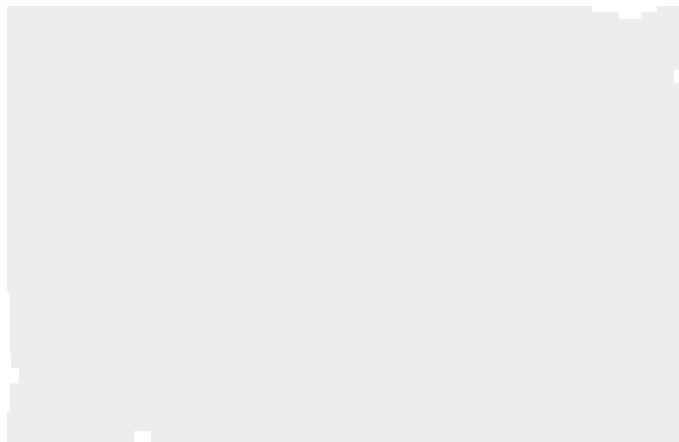


Figure 4.75 – Universal Encoder Board

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

Table 4.G – Encoder Functions

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

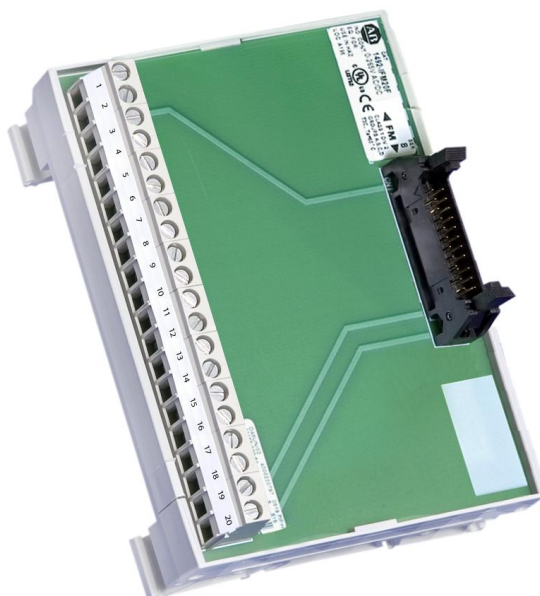


Figure 4.76 – 20-pin Interface Module (IFM)

Tachometer Feedback Board (cont.)

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. ❶

For dual encoder configurations, the primary encoder is wired to pins 1 to 7 on the 1492-IFM20 module. (See table below).

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.

❶ Consult factory for availability of dual Quadrature Encoder options.

ATTENTION

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

Positional Encoder Operations ②

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.

② Consult factory for availability of Positional Encoders.

Tachometer Feedback Board (cont.)

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 256, 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 000000000. Whereas a Low/True encoder the zero position is 111111111. 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 111111111 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).

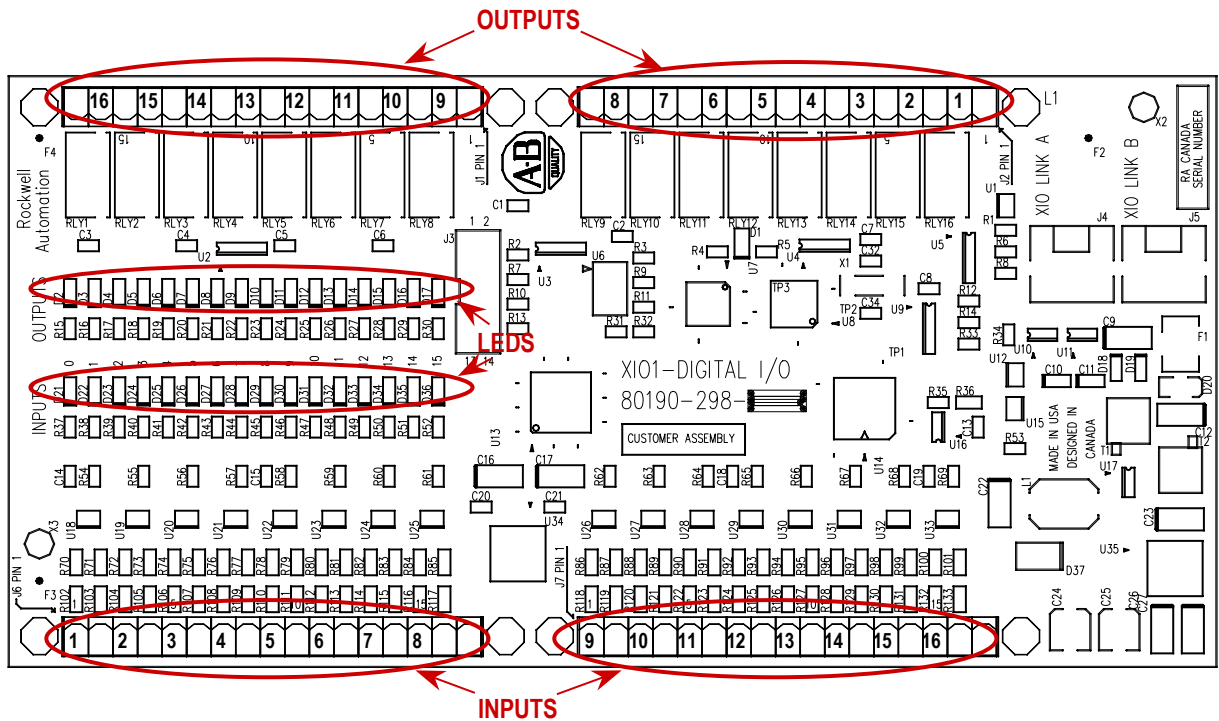


Figure 4.77 – XIO Board

External Input/Output Boards (cont.)

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 4.F – Status of U6 Display

Display	Description	Explanation
—	No valid address found	<ul style="list-style-type: none"> – More than 6 XIO cards on network – XIO cable failure – XIO card failure – ACB failure
0	Card in "Master" mode	<ul style="list-style-type: none"> – Rockwell Use Only – Remove connection to J3 and recycle power
1 – 6	Valid address	– Normal
Decimal point ON	Indicates network activity	– Normal
Decimal point OFF	No activity on the network	– Normal at Power on, during firmware download and with unprogrammed drive

External Input/Output Board Replacement

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.

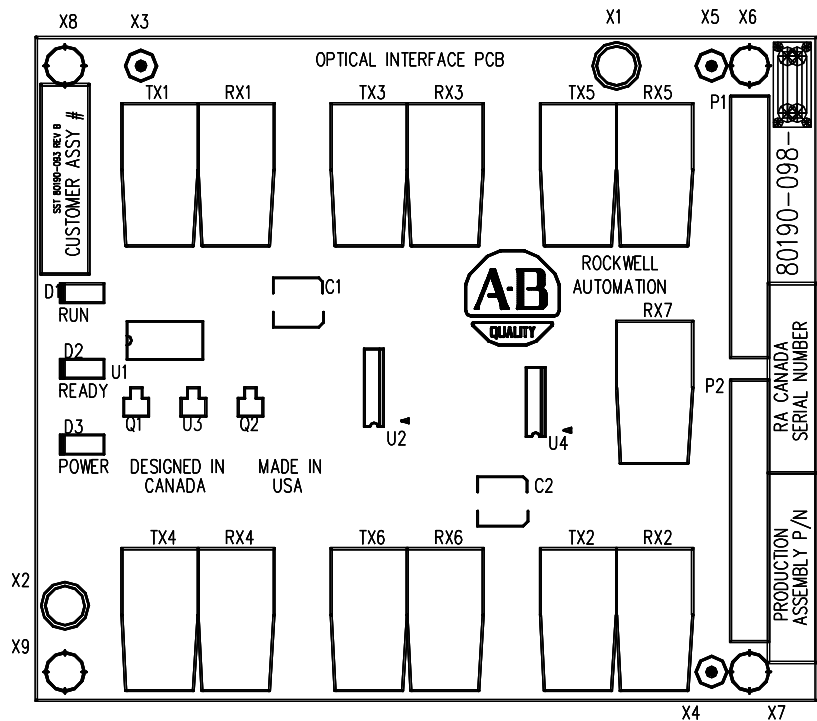


Figure 4.78 – Optical Interface Board

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.

Optical Interface Boards (OIB) (cont.)

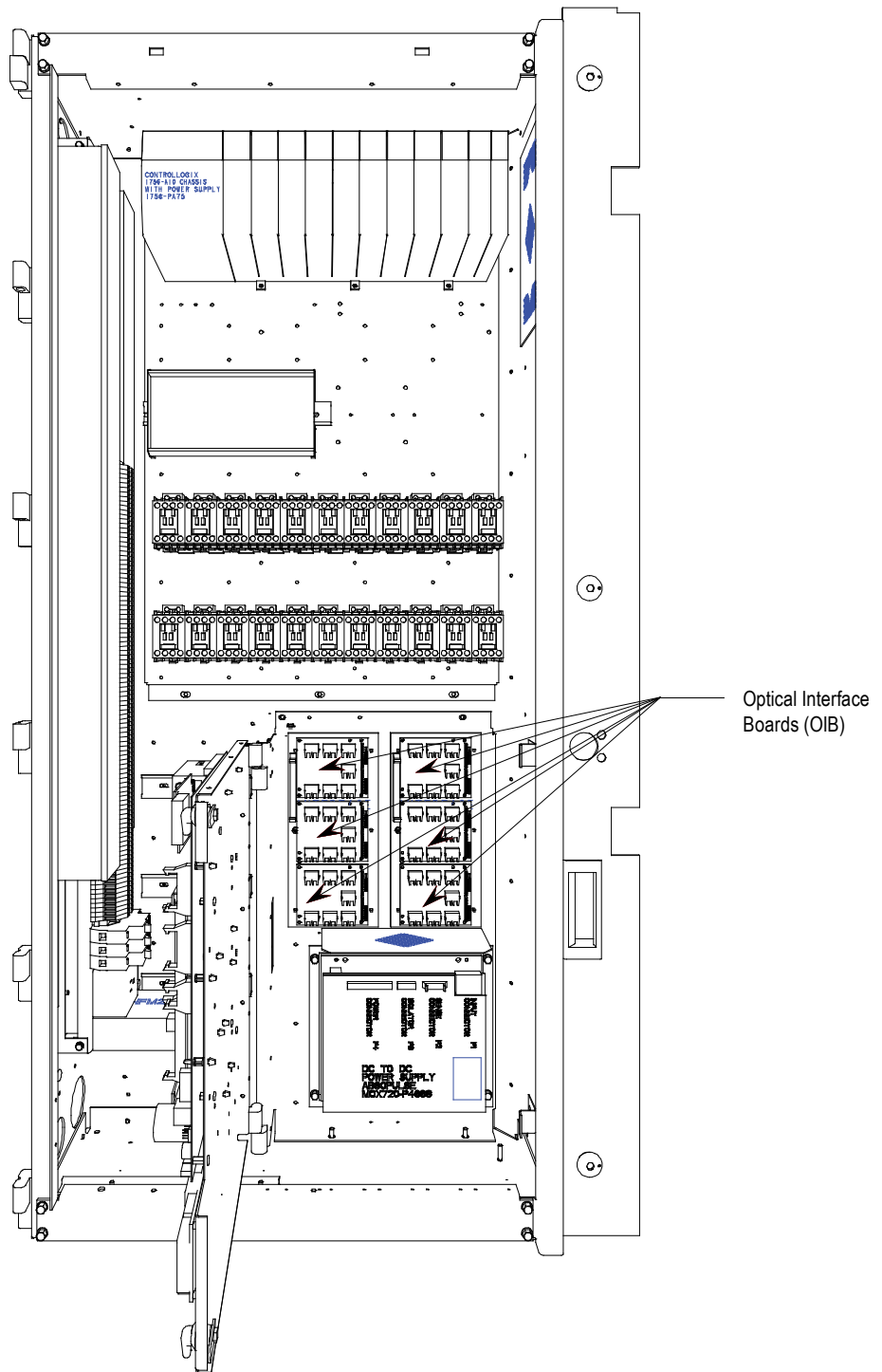


Figure 4.79 – OIB Replacement (Mounting Plate Accessible)

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.

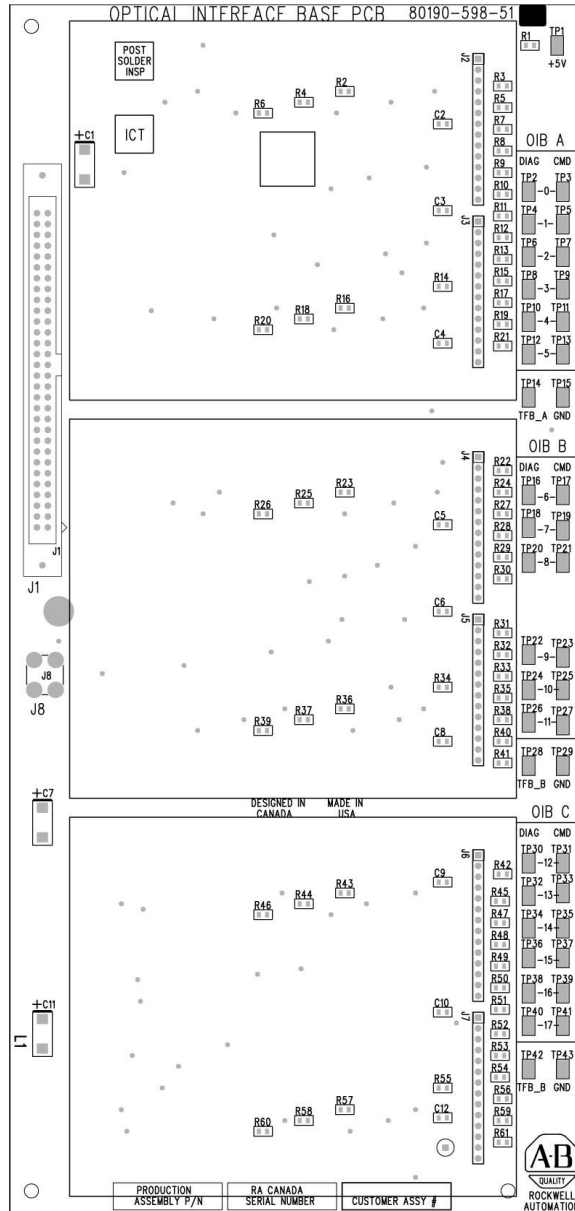


Figure 4.80 – Optical Interface Base Board (OIBB)

Optical Interface Base Board (OIBB) (cont.)

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 4.F – 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
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.

Preparation for Downloading Firmware

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.

ACCESS:				
Monitor		Current Access:		
Basic		Advanced		
Advanced		Enter Password:		
Service				
Rockwell				
ALARMS		LOGOUT	CHANGE	EXIT

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.

NVRAM:				
Operation: SAVE TO NVRAM				
Operation Status: COMPLETED				
HELP		INIT	LOAD	SAVE
ALARMS		YES	NO	EXIT

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:

TRANSFER: PARAMETERS:				
HELP	CRD>DRU	MEM>DRU	DRV>CRD	DRV>MEM
ALARMS	DIR	YES	NO	EXIT

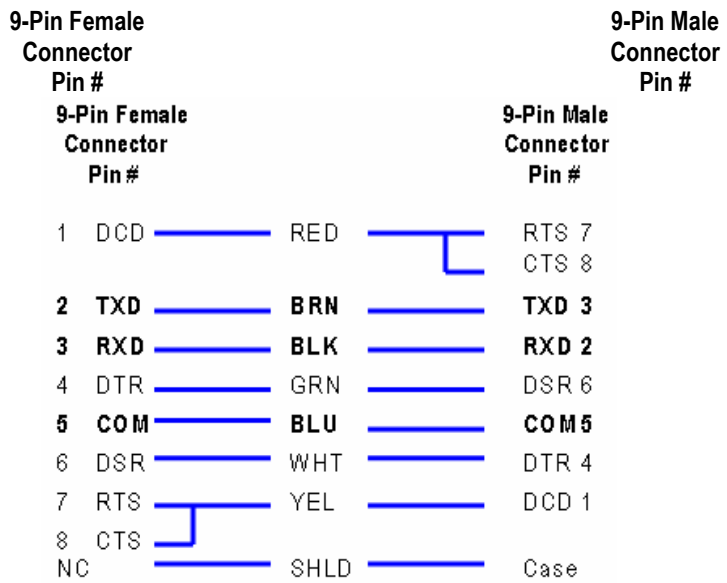
In order to save parameters to the Operator Interface Terminal, press F5 (DRV>MEM). To save to the Flash Card, you must first insert the card in the terminal. Remove the back cover and insert the card in the slot on the terminal. It can only go in one way. Then press F4 (DRV>CRD).

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.

TRANSFER: PARAMETERS:				
FILENAME: 2002.PAR				
DRIVE TO FILE				
PROCEED? Yes/No?				
Operation Status:				
TRANSFER PENDING				
HELP	CRD>DRU	MEM>DRU	DRU>CRD	DRU>MEM
ALARMS	DIR	YES	NO	EXIT

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.



Preparation for Downloading Firmware (cont.)

PF7000 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.

TRANSFER:				
Current Access: Advanced				
HELP	FORMAT	PROGRAM	PARAMTR	LANG' GE
ALARMS	DIR	ACCESS	SYSTEM	EXIT

This time press F9 for SYSTEM, and a screen will appear telling you that you are in download mode.

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 ≥ 1.006 , then only D9 will be flashing and D11 will stay solid. If the bootcode ≤ 1.005 , then both LEDs will be flashing.)

After putting the drive in download mode, the following is the display on the drive terminal:

<p>SYSTEM IS IN DOWNLOAD MODE</p> <p>Connect your PC to DPM data port And download new firmware.</p> <p>Press any Key to Continue ...</p>
--

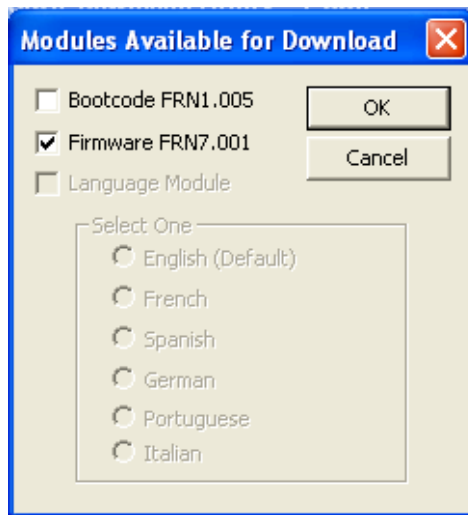
If you press any Key after this message the PanelView will show:

COMMUNICATION ERROR

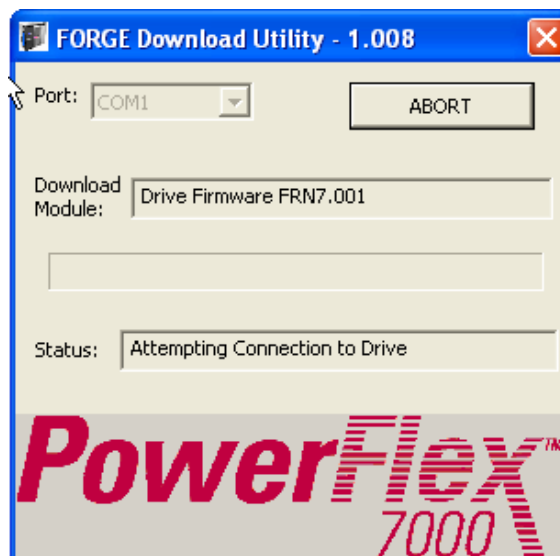
Connect your PC to the DPM data port J4. Locate the PowerFlex 7000 Medium Voltage Forge Drive firmware an executable file



Double click on the file to download the firmware.
The executable program will open the following screen:

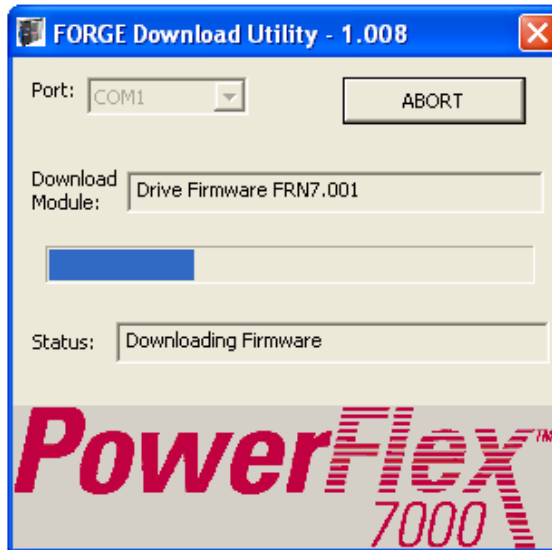


The DPM are preloaded with Bootcode and select the Firmware by clicking in the checkbox against Firmware and click OK. This will start the process of the downloading of firmware, attempting connection to the drive. The following screen will be displayed:

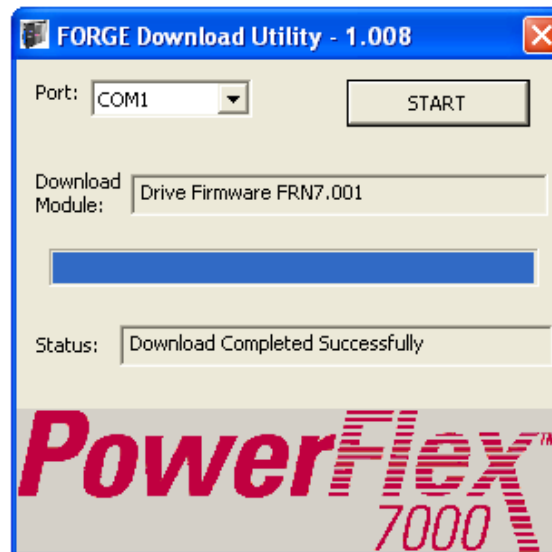


Preparation for Downloading Firmware (cont.)

The progress of the download is continuously displayed on the screen as shown.



The completion of the download is displayed on the screen as shown.



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. **IT IS IMPORTANT TO 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. You can also request a copy of the program by e-mail at MVSupport_Technical@ra.rockwell.com. Follow the steps below to set the elapsed time in the drive.

- Turn off control power to the drive control boards and the Terminal.
- Remove the Terminal serial connector from Analog Control Board, ACB (Port-J12).
- Connect your laptop to ACB (Port-J12) using a null-modem cable.
- Turn on control power and wait until the boards are powered up and the LEDs on the boards become steady green.
- Run **Sethobb.exe** program on your laptop.
- When prompted to "**Specify a COMM port to use <1, 2, 3, 4>**", enter the correct port number and then press the **Enter** key.
- When prompted to "**Specify the time preset including the 1/10 Hr:**", enter actual operating hours (eg., if the actual operating hours = 146.5 Hrs, then enter 1465), and then press the **Enter** key. The Sethobb.exe will be closed automatically.
- Now, remove your laptop and reconnect the Terminal to ACB (Port-J12) and turn on power to the Terminal.
- 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

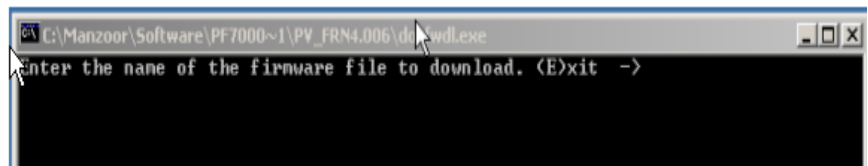
This is a DOS program which copies the .FMW file out the serial port of the laptop to the serial port of the terminal. The program is usually included in the firmware package. The method is described below. In this example, we are using firmware file

FRN_4006.FMW.

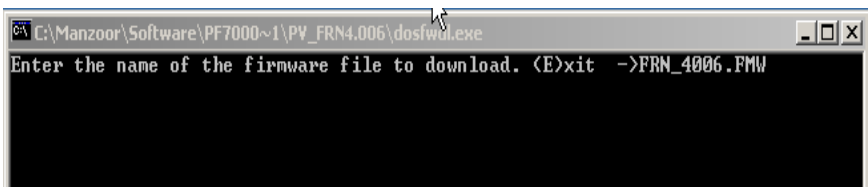
Note: If you are using a newer firmware, just make sure the filename is max 8 character long. You can rename the file, but keep the filename extension as **.FMW**. Also, when you are prompted to enter the filename, make sure you enter the correct filename as illustrated in the following example.

Method

1. Make sure 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. On your laptop, you should see the screen similar to one shown below.

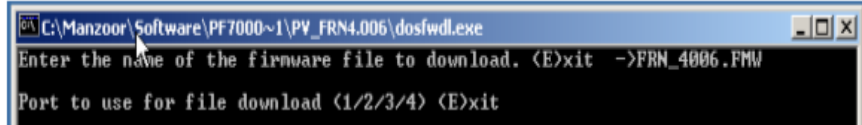


3. Type in the firmware filename (e.g., **FRN_4006.FMW**) as shown in the screen below and then hit **Enter** key.



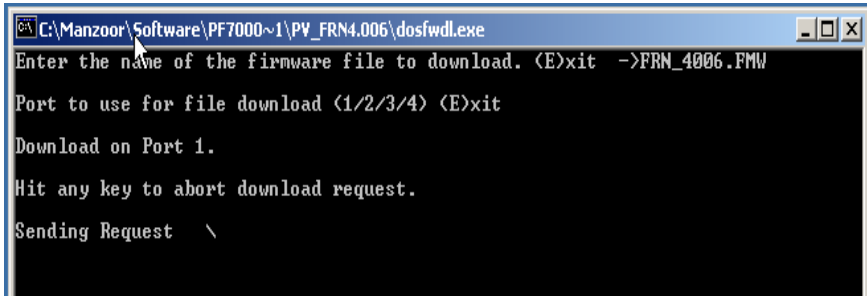
Downloading the Terminal Firmware (cont.)

- Now, you will be prompted to enter **Port** address of your laptop. Choose a correct port address and then hit **Enter** key.



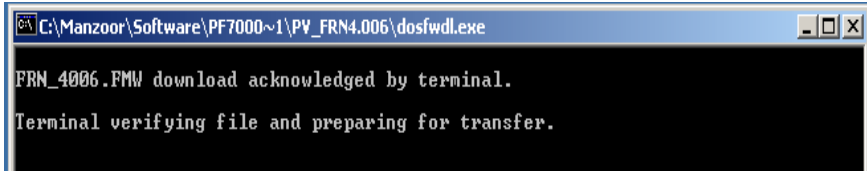
```
C:\Manzoor\Software\PF7000~1\PV_FRN4.006\dosfwd.exe
Enter the name of the firmware file to download. (E)xit ->FRN_4006.FMW
Port to use for file download (1/2/3/4) (E)xit
```

- When you see the screen similar to one shown below then at that moment **turn on control power** to the Terminal.



```
C:\Manzoor\Software\PF7000~1\PV_FRN4.006\dosfwd.exe
Enter the name of the firmware file to download. (E)xit ->FRN_4006.FMW
Port to use for file download (1/2/3/4) (E)xit
Download on Port 1.
Hit any key to abort download request.
Sending Request \
```

- As soon as control power is applied to the Terminal, the firmware download will start automatically, and the following message will appear on your laptop screen.

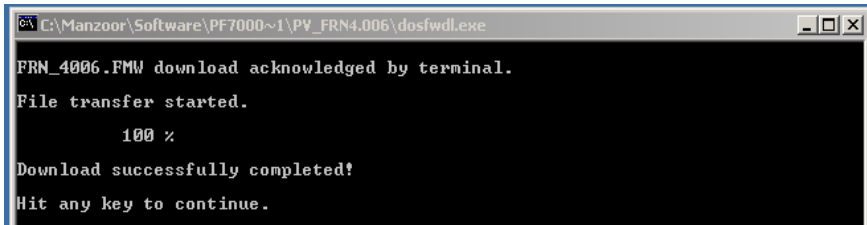


```
C:\Manzoor\Software\PF7000~1\PV_FRN4.006\dosfwd.exe
FRN_4006.FMW download acknowledged by terminal.
Terminal verifying file and preparing for transfer.
```

- The screens shots copied below show the progress status of firmware file transfer.



```
C:\Manzoor\Software\PF7000~1\PV_FRN4.006\dosfwd.exe
FRN_4006.FMW download acknowledged by terminal.
File transfer started.
34 %
```



```
C:\Manzoor\Software\PF7000~1\PV_FRN4.006\dosfwd.exe
FRN_4006.FMW download acknowledged by terminal.
File transfer started.
100 %
Download successfully completed!
Hit any key to continue.
```

8. Once the firmware download is complete, the message “**Download successfully completed!**” will appear on your laptop screen. At this point, press any key to close the **DOSFWDL** program.
9. Now, remove the serial cable from your 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 PF7000 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 has to be programmed in the diagnostic setup is listed below:

- | | |
|----------------|--|
| Trace | The Read-Only Parameter which is assigned to a particular list. The item linked to Trace 1 is used as the trigger value . There are 16 traces in total, although not all have to be active. |
| Rate | The time delay between sample periods. Any value between 0 and 20,000 msec can be set. Use numeric keypad to enter the value and press the enter key to accept. |
| Post | The percentage of the list which will occur after the after the trigger point. Any value between 0 and 100% may be used. |
| Trigger | 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. |

S = 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.

Setting up Diagnostic Trending (cont.)

C = Continuous capture >> auto re-arm is enabled to collect new trends until stopped by viewing contents of captured data.

Cond Defines the condition that will cause the trigger. The possible options are:

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

Data 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.

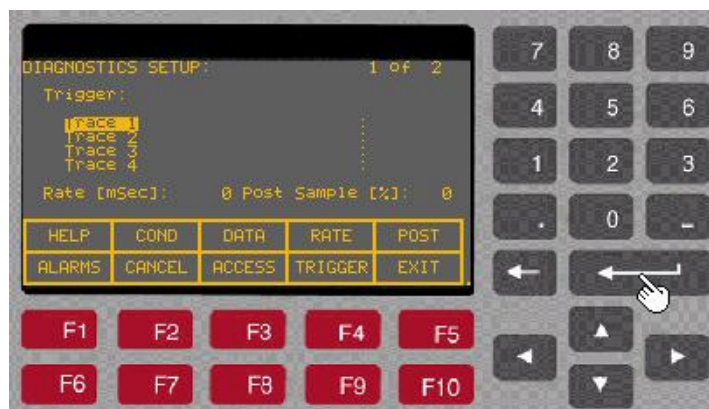
1. Press **F9** [DIAGS] key on the main screen to display 'Diagnostics' screen as shown in the picture below.



2. Press **F8** [*D_SETUP*]. The display will change to '*Diagnostics Setup*' screen as shown in the picture below.



3. With **Trace-1** selected, press *Enter* key as shown in the picture below.

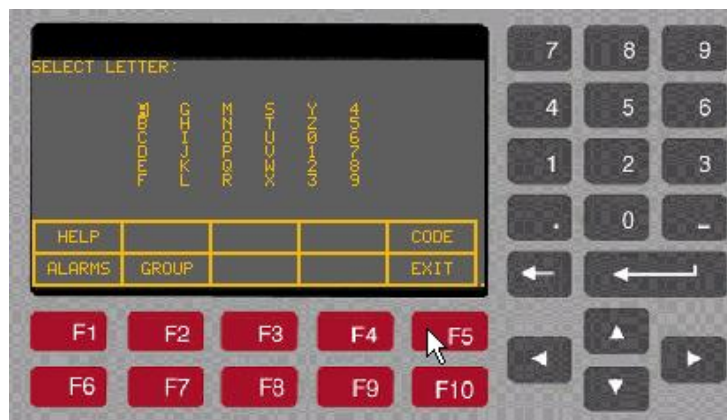


Setting up Diagnostic Trending (cont.)

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.



5. Press **F7 [LIST]**. The display will change to ‘*Select Letter*’ screen as shown in the picture below.



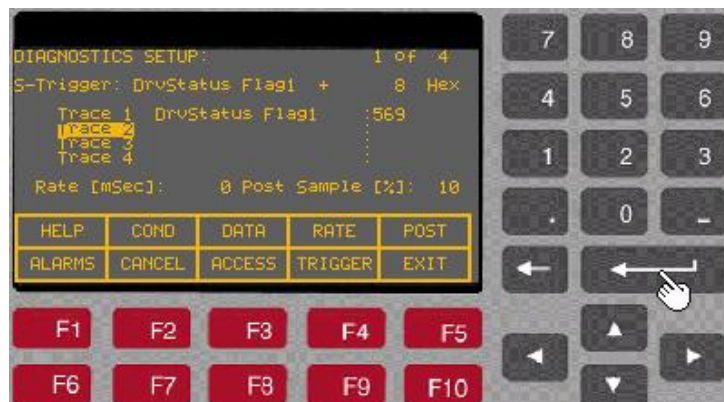
6. Press **F5 [CODE]**. The display will change to ‘*Select Code*’ screen as shown in the picture below.



- 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.

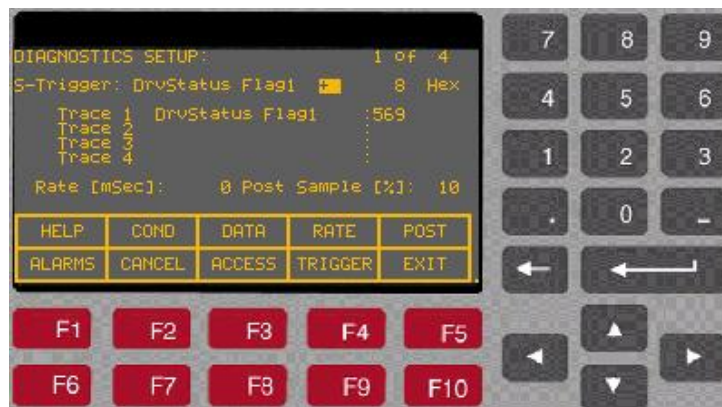


- Press **Enter** key again. The display will change to the 'Diagnostics Setup' screen and the desired parameter gets assigned to **Trace 1**. Now, press the down arrow key to move the cursor to **Trace 2** and repeat steps 3 – 8 above to assign a parameter to **Trace 2**.

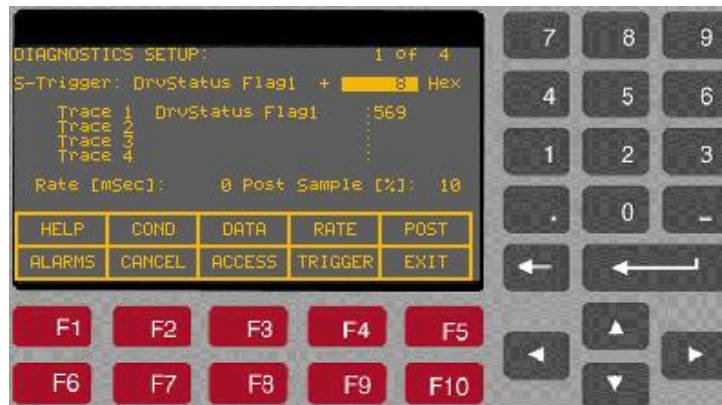


Setting up Diagnostic Trending (cont.)

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 **C**ontinuous and **S** stands for **S**ingle 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.



12. Press **F3 [DATA]** key. The cursor moves to the data field. In our example we will enter **8** and then press **Enter** key.



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.



14. Press **F5 [POST]** key and enter **10** (this is the percentage of post-trigger samples) and then press the **Enter** key.



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**.



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)

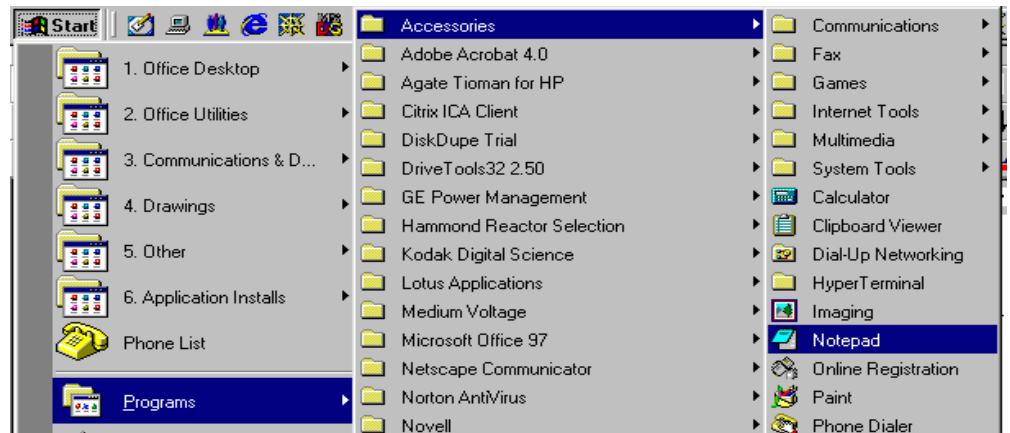
Here is a typical pin out of a complete null-modem cable.
Essentially, only 3 pins (2, 3 and 5) are all that is required.

9-Pin Female Connector				9-Pin Male Connector	
Pin #				Pin #	
1	DCD	RED	_____	RTS 7	
			_____	CTS 8	
2	TXD	BRN	_____	TXD 3	
3	RXD	BLK	_____	RXD 2	
4	DTR	GRN	_____	DSR 6	
5	COM	BLU	_____	COM 5	
6	DSR	WHT	_____	DTR 4	
7	RTS	YEL	_____	DCD 1	
8	CTS		_____		
NC		SHLD	_____	Case	

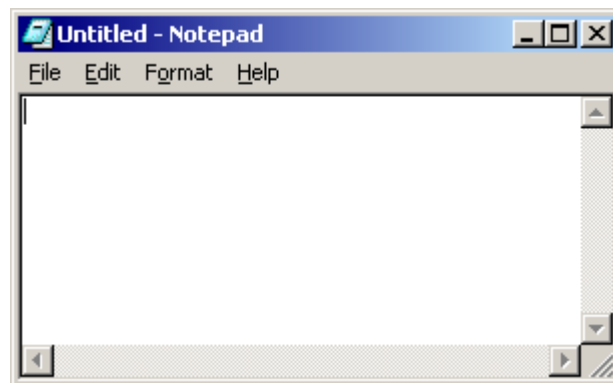
Method

Step-1: Creating an empty notepad (.txt) file

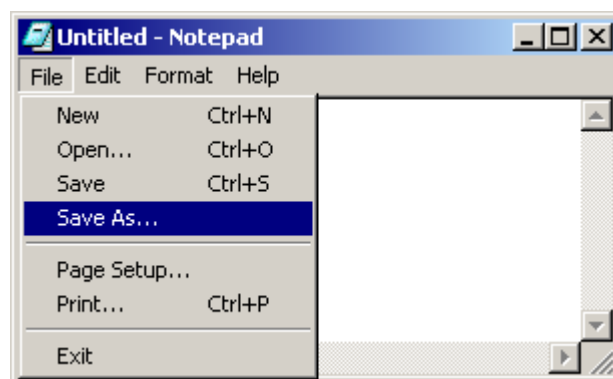
- Run NotePad Program (**Start** → **Program** → **Accessories** → **Notepad**)



- A blank Notepad window will appear as shown below.

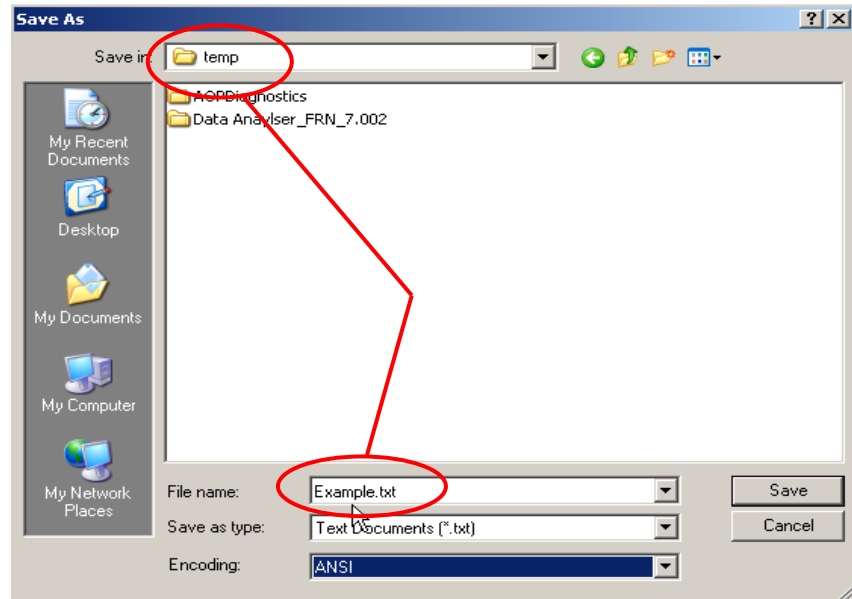


- From the File menu select **Save As**, as shown below.



Printing (Uploading) Data from the Drive (cont.)

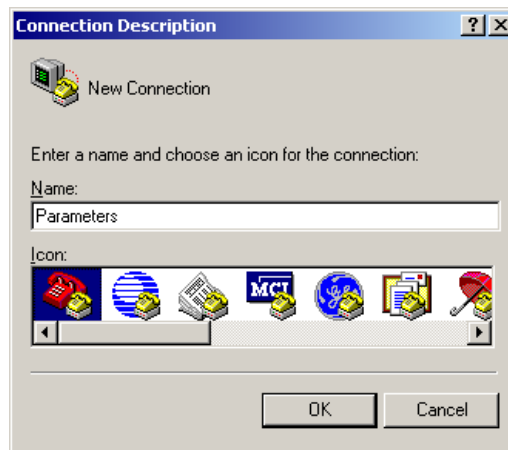
- On the **Save As** window, enter a filename (for instance, *example.txt*) in the field next to **File name** and select the directory from the dropdown list next to **Save in** at the top of the window. In this example the selected directory is C:\temp. Now, click on **Save** button.



- An empty notepad file has been created. So, now close the Notepad program.

Step-2: Setting up HyperTerminal Connection

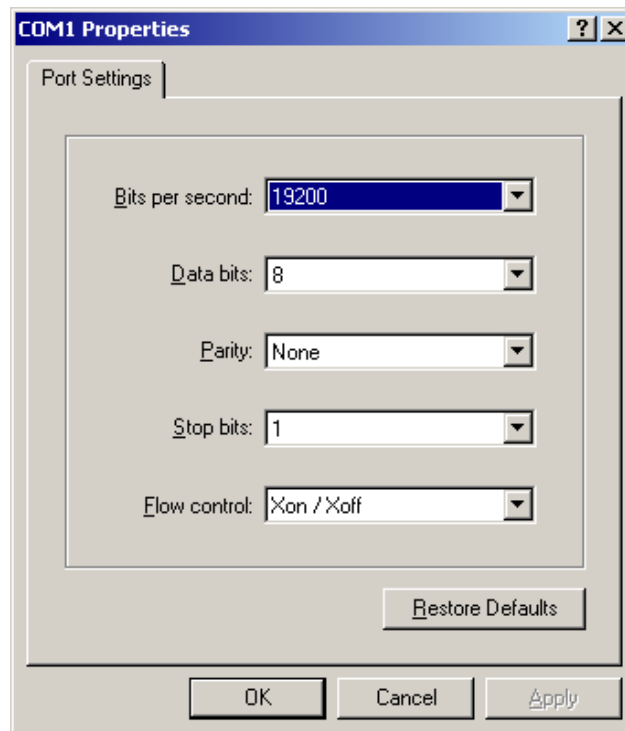
- Run **HyperTerminal** program
- On the '**Connection Description**' window, enter a name (for instance, *Parameters*) for the New Connection under the **Name** field as shown below and then click **OK**.



- Now, the 'Connect to' window will appear. Select **COM1** from the dropdown list next to 'Connect Using' and then click **OK**, as shown below.

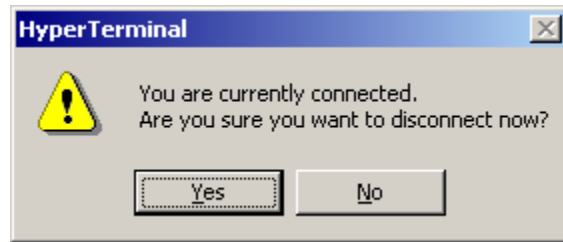


- Now, the 'COM1 Properties' window will appear. Set the port settings as shown below and then click **OK**.

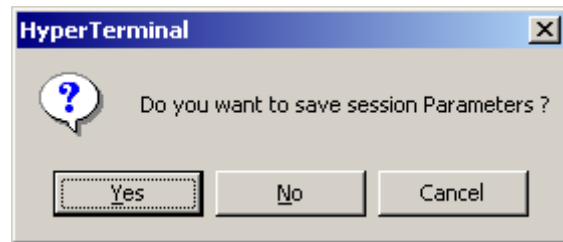


- Now, close the HyperTerminal program. Following message box will appear.

Printing (Uploading) Data from the Drive (cont.)



- Click **Yes**. At this point, you will be prompted to save the session.

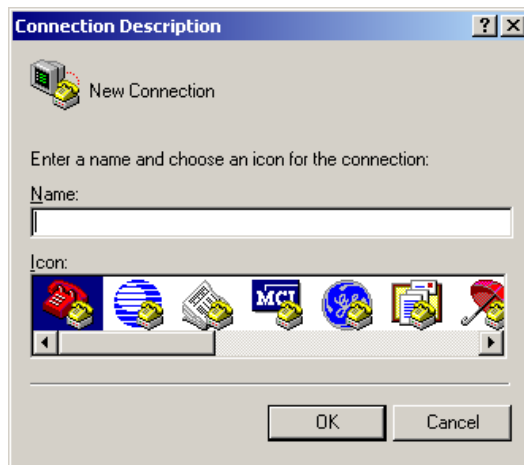


- Click **Yes** to terminate the HyperTerminal program.

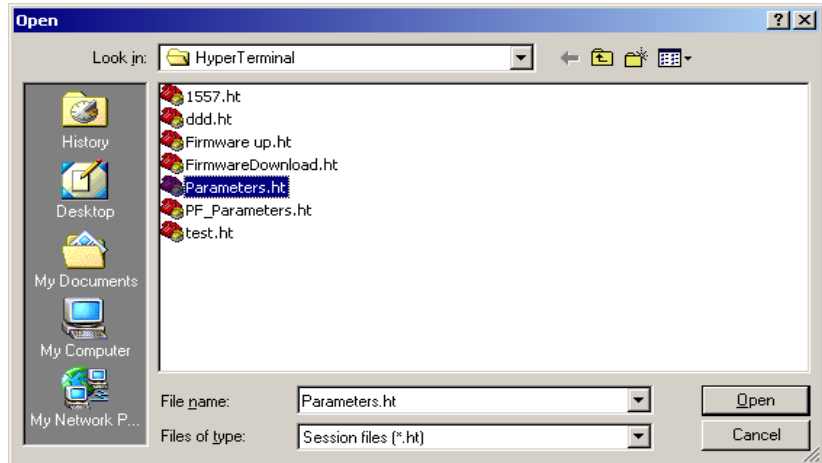
Step-3: Uploading the Data from the drive

Now, that you have created an empty notepad file and setup HyperTerminal connection, you are ready to upload the data from the drive.

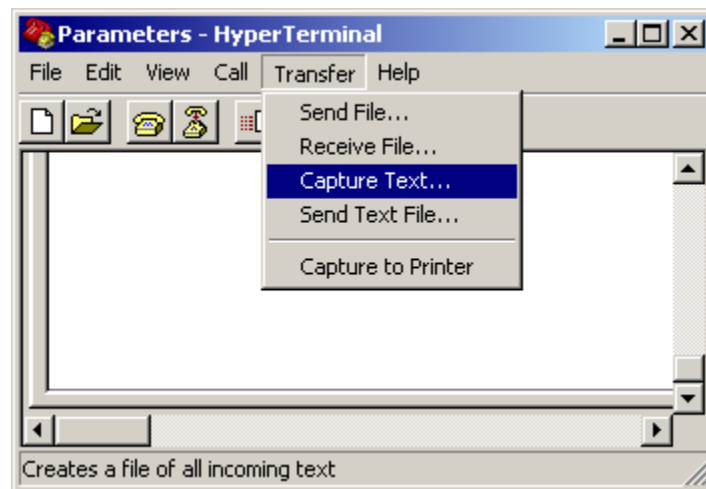
- Connect a null-modem cable between your computer's serial port and the serial port '**J11**' on the **Analog Control Board (ACB)**.
- Restart HyperTerminal program. On the '**Connection Description**' window click **Cancel**.



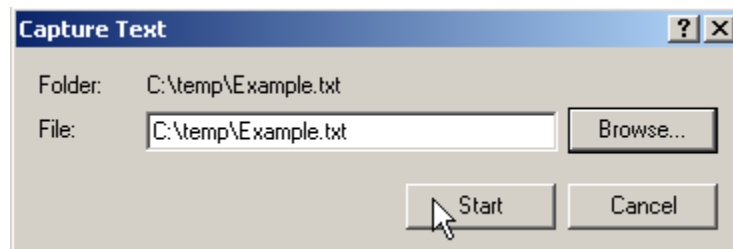
- From the **File** menu, click **Open**... At the *Open* dialog box, locate the HyperTerminal connection you just created in step-2, (eg. **Parameters**) and then click **Open**.



- From the **Transfer** menu, select *Capture Text...* as shown below.



- The **Capture Text** dialog box will appear. Click on **Browse** button and search the file **Example.txt** that you created in Step-1 above.



- Now click **Start** button.

Printing (Uploading) Data from the Drive (cont.)

- HyperTerminal will now act 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:

```

REV: 4.005                NOT FOR RELEASE!

Status: Ready

Speed:           0 rpm
Current:         0 A
Voltage:         0 U
Power:           0 kW

13.0 Hrs                0%                100 150

HELP  UTILITY  PRINT  DISPLAY  NVRAM
ALARMS STATUS  SETUP  DIAGS   ACCESS

```

- The Terminal screen will change and display Printer options, as shown below.

```

PRINTER:

Auto On/Off
Drive Setup
Parameters
Fault Masks
Revisions
Trend Data
Alarm Queues
Variables

Printer Status: Auto-Off

ALARMS  EXIT

```

- Now, using Up or Down (↕) arrow keys on the Terminal keypad select the item you want to print (ie., 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.

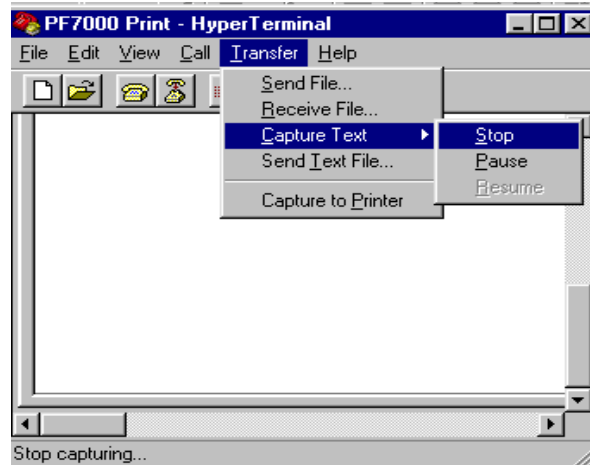
Note: The most desirable selections are:

- **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.

- 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.



Now close the HyperTerminal program and disconnect the laptop from the drive.

Printing (Uploading) Control Data

Overview

In PF7000 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.

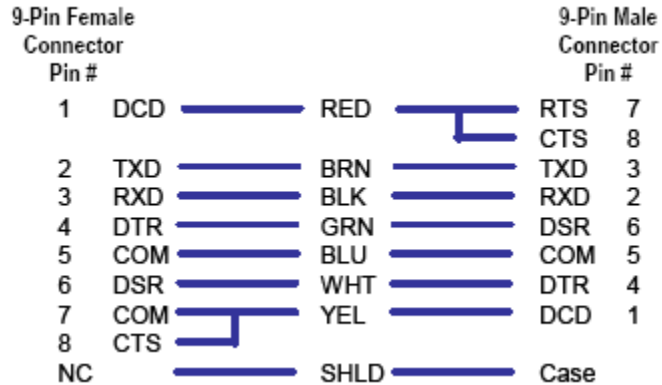
The method of retrieving Control Data is explained below.

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)

Printing (Uploading) Control Data (cont.)

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.



Method

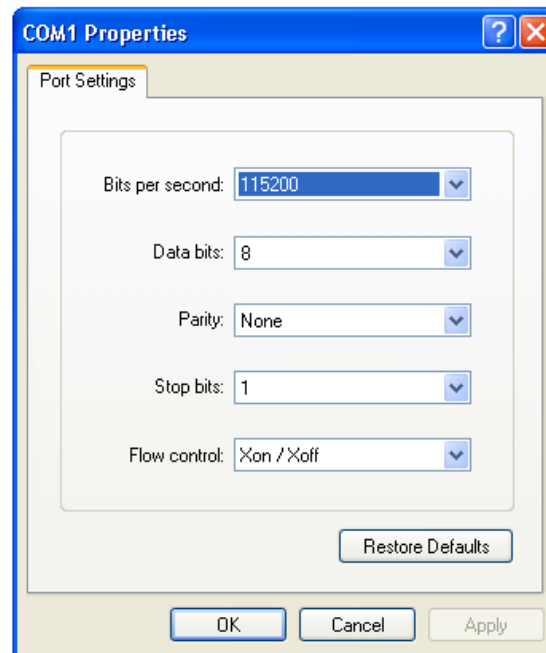
1. Connect your laptop to the drive using a 9-pin null-modem cable to DPM data port (J4).
2. *Set up HyperTerminal connection*
 - Run HyperTerminal program
 - At the '*Connection Description*' window, enter any name for new connection under the *Name* field as shown below and then click **OK**.



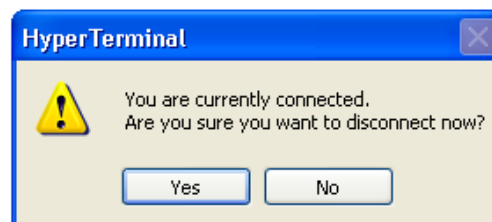
- The '*Connect to*' window will appear as shown below. Select **COM1** from the dropdown list next to '*Connect using*' and then click **OK**.



- Now, the '*COM1 Properties*' window will appear. Set the port settings as shown below and then click **OK**.

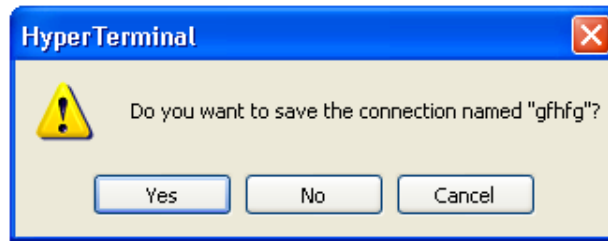


- Now close HyperTerminal program. At this point following message box will appear.



Printing (Uploading) Control Data (cont.)

- Click **Yes**, and you will be prompted to save the connection.



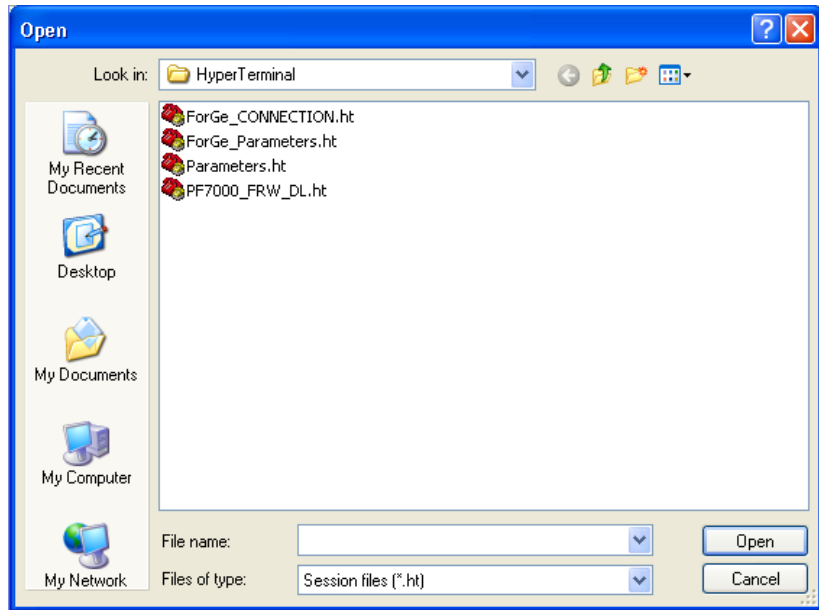
- Click **Yes** to terminate the HyperTerminal Program.

3. *Printing Control Data*

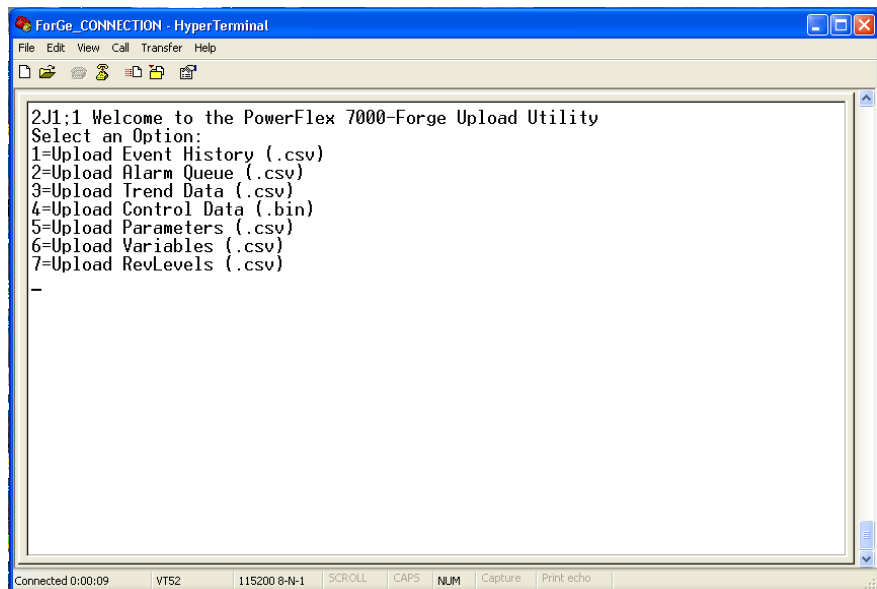
- Restart HyperTerminal program.
- At the '**Connection Description**' window as shown below, click **Cancel**.



- 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**.

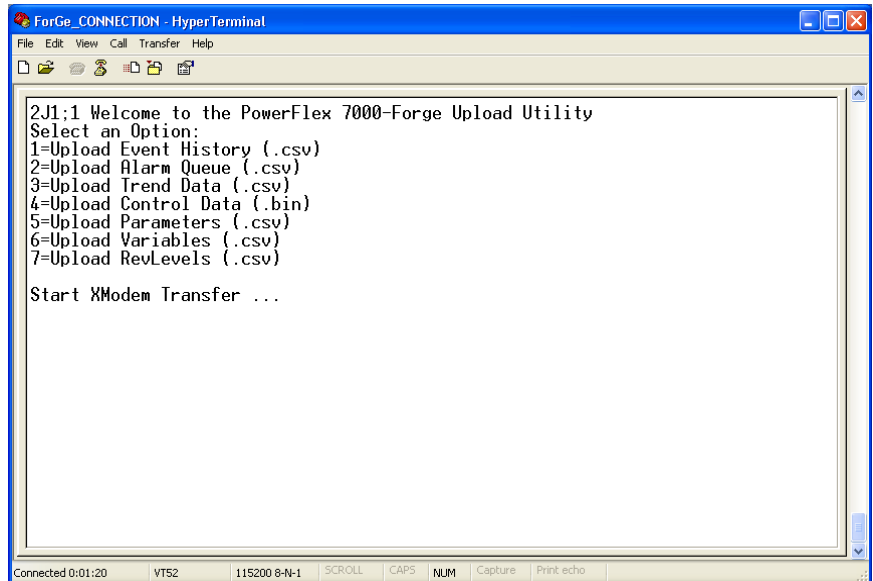


- Press the **ENTER** key. This should bring up the following options menu in the HyperTerminal window.

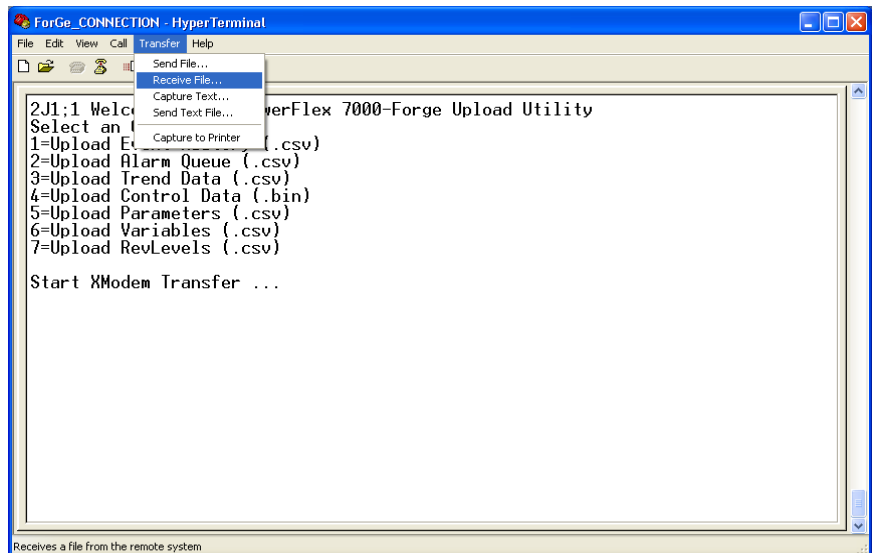


- From the above menu select the desired option by pressing the corresponding number to upload (print) the data. To upload **Control Data**, select option **4**.

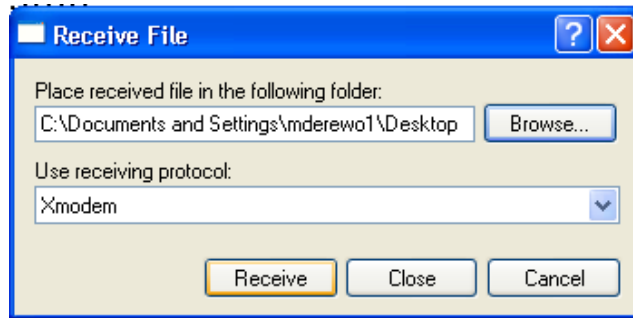
Printing (Uploading) Control Data (cont.)



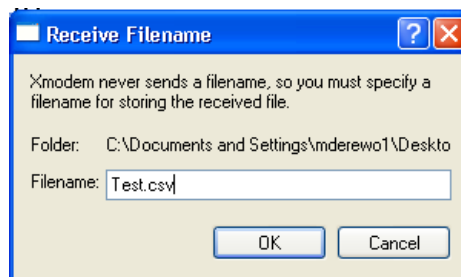
- After selecting the desired option, you need to start the transfer by selecting **Receive File ...** from the **Transfer** menu as shown below.



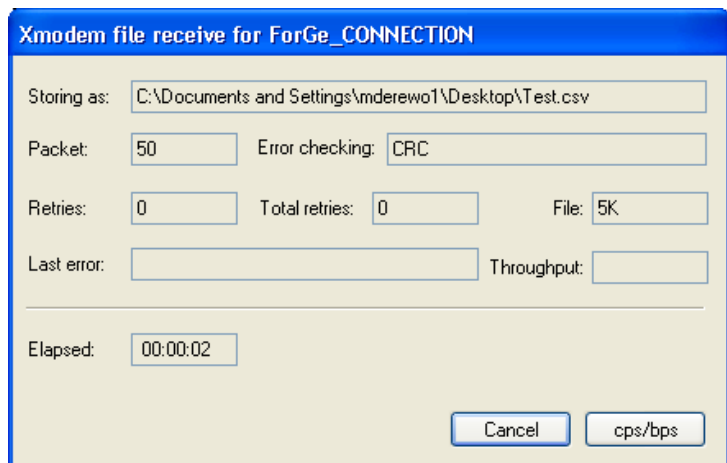
- The **Receive File** window will pop. Click **Browse** button and select the directory where you want to save the data file. Make sure the **Receiving Protocol** is set to **Xmodem**, then click **Receive**.



- Now, the **Receive Filename** dialog will appear. Here you need to 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**.



- Now, the following dialog box will appear where you can see the file transfer progress.



- When the data transfer is complete, the above dialog box will close automatically. This way use 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 PF7000 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 the Tools/Parts/Information Requirements at the end of this section for a list of documentation and materials needed to properly complete the preventive maintenance documents.

Operational Maintenance

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 cooling system 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 whichever 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*
(* This only needs to be recorded if parts have been modified/changed since the last PM activities)

WARNING



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

Physical Checks (NO Medium Voltage and NO Control Power)

- **Power Connection Inspection**
 - Inspect PF7000 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.
 - NOTE: An important component to check for contamination is the heatsink. The fine grooves in the aluminum heatsinks can capture dust and debris.
- **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 User Manual, Appendix D – Meggering, for meggering procedure.
 - Check clamp head indicator washers for proper clamp pressure, and adjust as necessary.
 - Refer to User Manual, Chapter 5 – Component Definition and Maintenance for details on proper clamp pressure.

Annual Maintenance (cont.)

Control Power Checks (No Medium Voltage)

- Apply 3 Phase Control power to the PF7000 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 Chapter 4 – Commissioning 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

Annual Maintenance (cont.)

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 ** Depends on Nature of the Problem **
 - Informal Training/Refresher ** 2.0 hours **
 - Spare Parts Analysis ** 1.0 hours **
 - Vacuum Bottle Integrity Check ** 3.0 hours **
 - Final Report 3.0 hours

Note: ** 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 PF7000 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

- PF7000 User Manual – Publication 7000-UM151_-EN-P
- PF7000 Technical Data (Parameters, Troubleshooting) – Publication 7000-TD002_-EN-P
- PF7000 MV Drives General Handling Procedures – Publication 7000-IN002_-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 for PowerFlex 7000 MV Drives

7000 - A105 D EHD - R18TX - 1 - 1DD - 3LL - 760A

First Position	Second Position	Third Position	Fourth Position	Fifth Position	Sixth Position
Bulletin Number (Refer to TABLE A-1)	Service Duty / Continuous Current Rating / Altitude Rating Code (Refer to TABLE A-2)	Enclosure Type D = NEMA Type 1 w/gaskets and vents (IEC IP42)	Nominal Line Voltage Control Voltage System Frequency (Reference TABLE A-3)	Rectifier Type Code R6TX R18TX RPTX RPDTD ❶	Options

- ❶ **R6TX** – 6-pulse rectifier for connection to remote transformer
- R18TX** – 18-pulse rectifier for connection to remote transformer
- RPTX** – AFE rectifier for connection to remote transformer
- RPDTD** – Direct-to-Drive Technology

Table A-1
Catalog Number Descriptions

Catalog Number	Description
7000A	PowerFlex 7000 “A” Frame Variable Frequency AC Drive, Air-cooled
7000	PowerFlex 7000 “B” Frame Variable Frequency AC Drive, Air-cooled
7000L	PowerFlex 7000 “C” Frame Variable Frequency AC Drive, Liquid-cooled

Table A-2
Service Duty Rating, Continuous Current Rating and Altitude Rating Code

Service Duty Rating and Altitude Rating Code		Continuous Current Capability	
		Code	Rating
A = Normal Duty 0-1000 m Altitude (@ 40°C Ambient)		40	40 Amp
		46	46 Amp
		53	53 Amp
B = Normal Duty 1001-5000 m Altitude (2000 m Altitude @ 37.5°C Ambient) (3000 m Altitude @ 35.0°C Ambient) (4000 m Altitude @ 32.5°C Ambient) (5000 m Altitude @ 30.0°C Ambient)		61	61 Amp
		70	70 Amp
		81	81 Amp
		93	93 Amp
		105	105 Amp
		120	120 Amp
		140	140 Amp
C = Heavy Duty 0-1000 m Altitude		160	160 Amp
		185	185 Amp
		215	215 Amp
D = Heavy Duty 1001-5000 m Altitude (2000 m Altitude @ 37.5°C Ambient) (3000 m Altitude @ 35.0°C Ambient) (4000 m Altitude @ 32.5°C Ambient) (5000 m Altitude @ 30.0°C Ambient)		250	250 Amp
		285	285 Amp
		325	325 Amp
		375	375 Amp
		430	430 Amp
Z = Custom Configuration (Contact Factory)			

Table A-3
Nominal Line Voltage, Control Voltage, System Frequency

Voltage		Frequency (Hz)	Modification Number (Externally Supplied Control Power)
Nominal Line	Control (3 phase)		
2400	208	60	AHD
	480		ABD
	600		ACD
3300	230	50	CPD
	380		CND
	400		CKD
4160	230	50	EPD
	380		END
	208	60	EHD
	480		EBD
	600		ECD
6600	230	50	JPD
	380		JND
	400		JKD

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 Table A-2.

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.

Note: The factory should be contacted for assistance sizing air-cooled drives that require greater than 150% overload. Refer to Table A-5 for typical application load torque profiles, to determine which drive overload rating is best suited for your application.

When is a Tachometer Required?

A tachometer 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.

Power Flex Speed Regulation

Tachometer	Frequency Output		
	< 6 Hertz	6 – 15 Hertz	Above 15 Hertz
Without Tachometer	Not applicable	0.1 %	0.1 %
With Tachometer	0.02 %	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 tachometer as a standard option with the tachometer feed back card.
- Customer is responsible for providing and mounting of tachometer
- Sleeve bearing motors require the tachometer to have an axial movement tolerance.
- Recommended tachometers are shaft mounting type.
- Magneto resistive models are more adaptable to harsh environments.
- When installing, the tachometer body and electronics must be isolated from ground (options available from the tachometer manufacturer to accomplish this).
- There are usually limits on tachometer cable lengths. Ensure the maximum length is suitable for the application.

Tachometer Selection

Recommended Tach PPR	
Motor RPM	Tach ppr
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 A-5 below shows the PowerFlex 7000 drive torque capabilities as a percent of motor rated torque, independent of the drive’s momentary overload conditions.

**Table A-5
PowerFlex 7000 Drive Torque Capabilities**

Parameter	7000 Torque Capability Without Tachometer (% of Motor Rated Torque)	7000 Torque Capability With Tachometer (% of Motor Rated Torque)
Breakaway Torque	90%	150%
Accelerating Torque	90% (0-8 Hertz)	140% (0-8 Hertz)
	125% (9-75 Hertz)	140% (9-75 Hertz)
Steady State Torque	125% (9-75 Hertz) **	100% (1-2 Hertz)
		140% (3-60 Hertz) **
Maximum Torque Limit	150%	150%

** 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).
WK² = total system inertia (lb-ft²) 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 A-6
Typical Application Load Torque Profiles**

Application	Load Torque Profile	Load Torque as Percent of Full-Load Drive Torque			Required Drive Service Duty Rating	Tachometer Required for Extra Starting Torque?
		Break-away	Accelerating	Peak Running		
Agitators						
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	100	100	Heavy	Yes
Blowers (Centrifugal)						
Damper Closed	VT	30	50	40	Normal	No
Damper Open	VT	40	110	100	Normal	No
Chipper (Wood) Starting Empty	CT	50	40	200	Contact Factory	No
Compressors						
Axial-vane, Loaded	VT	40	100	100	Normal	No
Reciprocating, start unloaded	CT	100	100	100	Contact Factory	Yes
Conveyors						
Belt type, loaded	CT	150	130	100	Heavy	Yes
Drag type	CT	175	150	100	Contact Factory	Yes
Screw type, loaded	CT	200	100	100	Contact Factory	Yes
Extruders (Rubber or Plastic)	CT	150	150	100	Contact Factory	Yes
Fans (Centrifugal, ambient)						
Damper closed	VT	25	60	50	Normal	No
Damper open	VT	25	110	100	Normal	No
Fans (Centrifugal, hot gases)						
Damper closed	VT	25	60	100	Normal	No
Damper open	VT	25	200	175	Contact Factory	No
Fans (Propeller, axial flow)	VT	40	110	100	Normal	No
Kilns (Rotary, loaded)	CT	250	125	125	Contact Factory	Yes
Mixers						
Chemical	CT	175	75	100	Contact Factory	Yes
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	125	100	Heavy	Yes
Solids	CT	175	125	175	Contact Factory	Yes
Pulper	VT	40	100	150	Contact Factory	No
Pumps						
Centrifugal, Discharge open	VT	40	100	100	Normal	No
Oil field Flywheel	CT	150	200	200	Contact Factory	Yes
Propeller	VT	40	100	100	Normal	No
Fan Pump	VT	40	100	100	Normal	No
Reciprocating / Positive Displacement	CT	175	30	175	Contact Factory	Yes
Screw type, started dry	VT	75	30	100	Normal	No
Screw type, primed, discharge open	CT	150	100	100	Heavy	Yes
Slurry handling, discharge open	CT	150	100	100	Heavy	Yes
Turbine, Centrifugal, deep-well	VT	50	100	100	Normal	No
Vane-type, positive displacement	CT	150	150	175	Contact Factory	Yes
Separators, air (fan type)	VT	40	100	100	Normal	No

Torque Requirements for Threaded Fasteners

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

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.

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

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

ATTENTION

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

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

Equipment Required

- Torque Wrench and 7/16 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”.

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

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

Output Grounding Network

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

Note: 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.

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

Potential Transformer Fuses

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

Transient Suppression Network

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

4. Meggering the Drive

Note: 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.

Note: 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

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

Note: 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.

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.

Transient Suppression Network

Re-install the fuses on the TSN.

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