

PowerFlex 7000 Medium Voltage AC Drive Air-Cooled ('B' Frame) – Classic Control

Bulletin Number 7000



Important User Information

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

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

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

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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.

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



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



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

IMPORTANT

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

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



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



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



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

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Overview

Summary of Changes

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Added warning for motor filter capacitors and indicative fault codes	6-16
Added additional information around non-operational MFCs to fault codes 21, 23, 24, 33, 44, 67, 171, 173, 203, 206	7-7, 7-10, 7-15, 7-16, 7-17, 7-19, 7-20, 7-21, 7-22

Who Should Use This Manual

This 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, maintain, and troubleshoot the drive system.

What Is Not in this Manual

This manual is designed to provide only general information on the PowerFlex® 7000 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.

Please note: This manual deals specifically with the PowerFlex 7000 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

The Medium Voltage Support provides customer support for our product line.

They may be contacted at 519-740-4747 and 519-740-4746.

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

- Quoting and Managing Product On-site Start-ups.
- Ongoing Preventative Maintenance Planning for our products.
- Parts Management and on site inventory agreements.
- Customer in-house and on-site product training.

Notes:

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 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 air-cooled drives meet applications ranging from fractional to 5500 horsepower.

The PowerFlex 7000 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 7000 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.

Topology

The PowerFlex 7000 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. Semi-conductor 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 7000 has the additional benefit of inherent regenerative braking for applications where the load is overhauling the motor, or where high inertia loads need to be slowed down quickly. Symmetrical Gate Commutated Thyristors (SGCTs) are used for machine converter switches. Silicon-controlled rectifiers (SCRs) (for 6/18 pulse) or SGCTs (for AFE rectifiers) are used for the line converter switches.

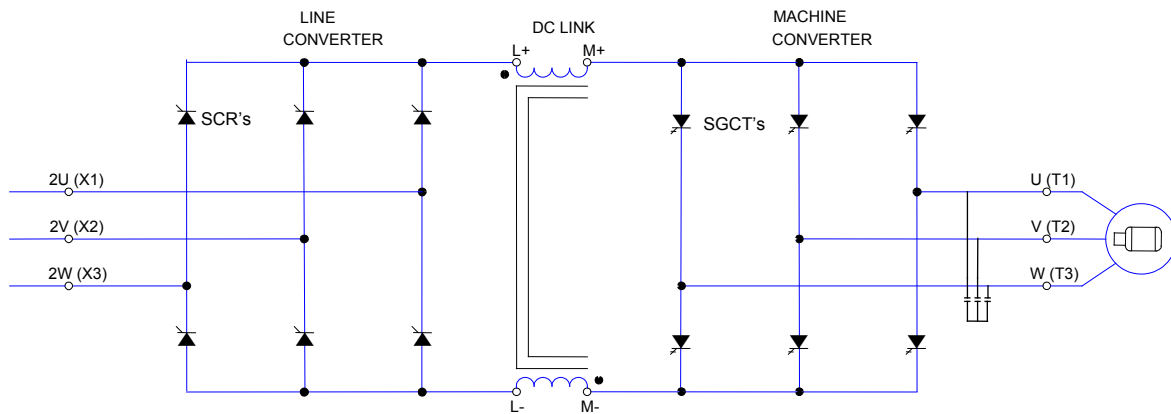


Figure 1.1 – PWM-CSI AC Drive

Rectifier Designs

There are three offered designs for the rectifier of the PowerFlex drive.

6-Pulse Rectifier

A 6-pulse thyristor phase controlled rectifier (with optional passive tuned filters) is shown in Figure 1.2. The line current before and after the filter is shown. It can be seen that the current before the filter contains the 5th, 7th and 11th harmonics, however, the current after the filter is more sinusoidal since these harmonics are redirected through the tuned filters. The tuned filters also serve to improve input power factor to near unity. The total harmonic distortion (THD) of line current with the 6-pulse rectifier and tuned filters is approximately 5.2%. The THD of line voltage (line-to-line) is approximately 2.6%. (THD of line voltage is a function of system impedance.)

The 6-pulse rectifier can be used in conjunction with a rectifier duty isolation transformer as shown or with an AC line reactor. A rectifier duty isolation transformer is required when the drive is being applied to existing or retrofit motors or when the supply voltage is higher than the drive rated voltage. (Refer to Specification 80001-005, Rectifier Duty Transformers for more details on transformer requirements and features.)

An AC line reactor can be used in front of the 6-pulse rectifier when the drive is being applied to new motors. (Refer to Specification 80001-004, Requirements for Medium Voltage Motors Without Common Mode Voltage Elimination). Elimination of the isolation transformer reduces capital and installation costs, saves on valuable floor space, and increases overall system efficiency.

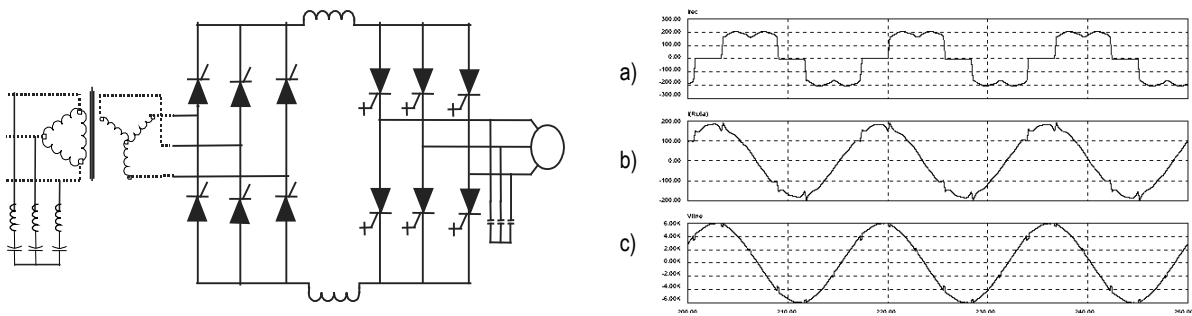


Figure 1.2 – 6-pulse Rectifier with input waveforms

- a) Line current without filter
- b) Line current with filter
- c) Line-to-line voltage at point of common coupling (PCC)

18-Pulse Rectifier

An 18-pulse phase controlled rectifier is shown in Figure 1.3. 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 both indoor dry type 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 1.3. 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.

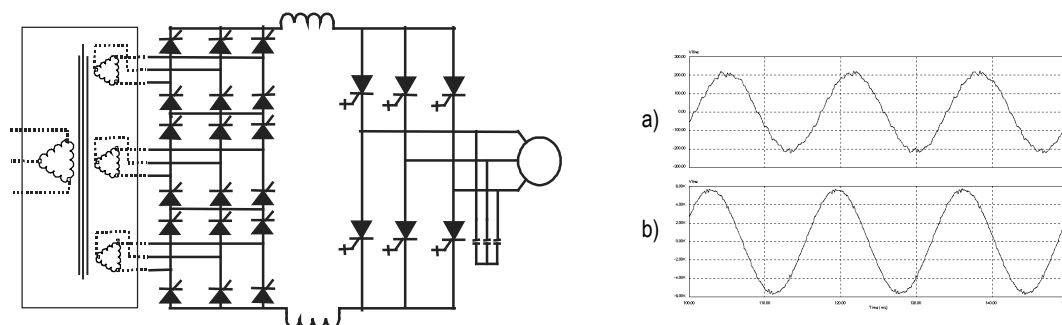


Figure 1.3 – 18-pulse Rectifier and its input waveforms

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

Active Front End (PWM Rectifier)

An active front end (AFE rectifier) suitable for the PowerFlex 7000 topology is also commonly called a PWM rectifier. This is particularly attractive for applications with new motors since it does not require an isolation transformer to meet IEEE-519. (See Specification 80001-004, Requirements for Medium Voltage Motors Without Common Mode Voltage Elimination). Most available technologies in today's MV market require a multi-winding transformer to mitigate the unwanted harmonics through cancellation 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 1.4 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 small integral AC line reactor (see Fig. 1.4) provides additional filtering and current limiting features to a line side short circuit fault. The rectifier input current, the rectifier terminal voltage and the line current and voltage waveforms are shown in Figure 1.4. 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 entire speed and load range when applied to variable torque loads.

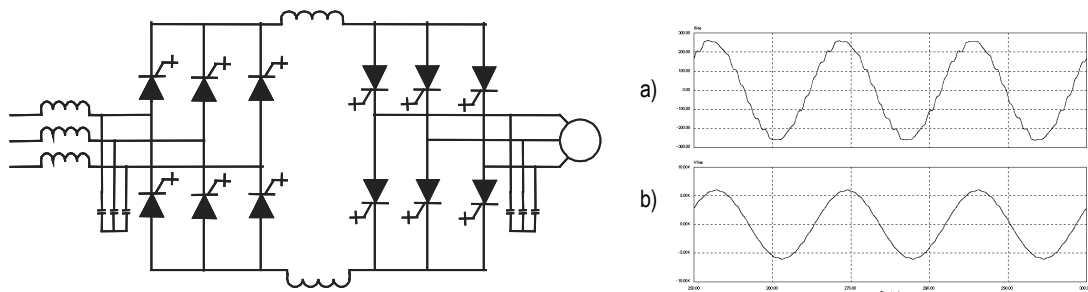


Figure 1.4 – Active rectifier (PWM) and its input current/voltage waveforms

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

“Direct-to-Drive” Technology

The PowerFlex 7000 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 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.

**“Direct-to-Drive” Technology
(cont.)**

Rather than use an Isolation Transformer, the “Direct-to-Drive” Active Front End uses the semi-conductor 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 almost 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 does not generate 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.

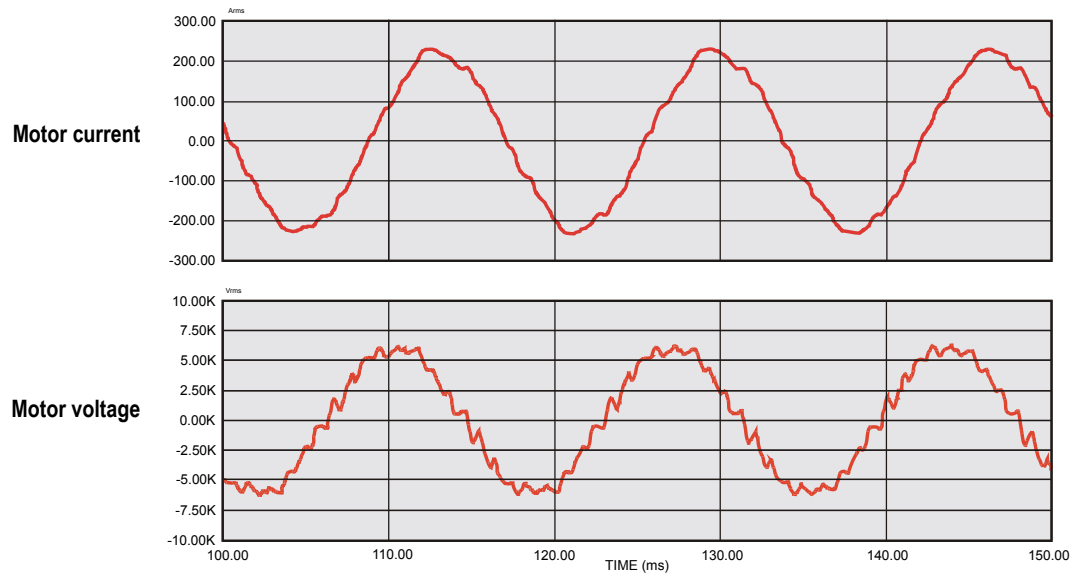
The PowerFlex 7000 with “Direct-to-Drive” technology is typically smaller and lighter than drive technologies that use Isolation Transformers. Isolation Transformers represent 30 to 50% of a drive system size and 50 to 70% of the system’s weight. This means that there is no interwiring between drive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

Motor Compatibility

The PowerFlex 7000 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 (37 °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 7000. 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 de-rating, 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 1.5 – Motor waveforms @ full load, full speed
4160V, 933 kW, 60 Hz**

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 1.6, 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.

The IGCT only blocks voltage in one direction and allows current flow in both forward and reverse direction, thus needs a built-in anti-parallel diode.

Implementing SGCTs in the PowerFlex 7000 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).

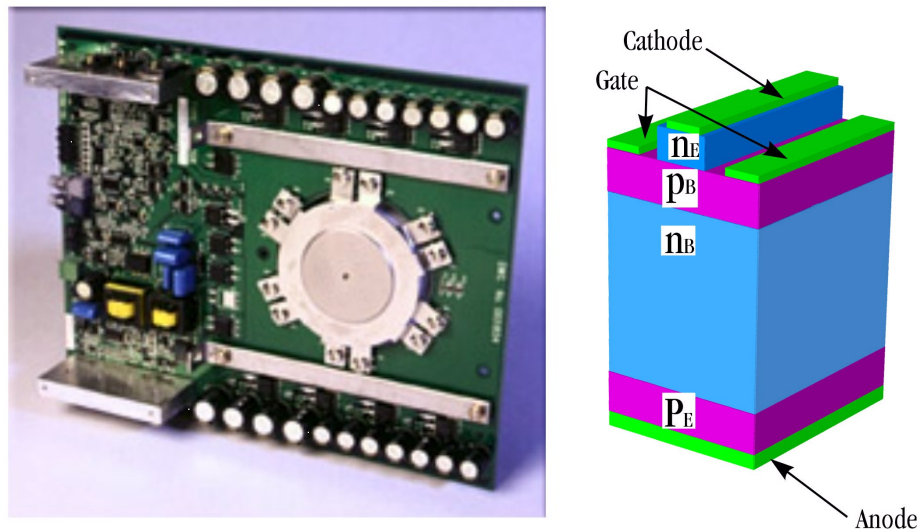


Figure 1.6 – SGCT with integrated gate drive (left) and unit cell structure (right)

Specifications

Description	NEMA	IEC
Power Rating (Air Cooled)	200 to 5,500 hp	150 to 4,100 kW
Motor Type	Induction or Synchronous	
Input Voltage Rating	2400V, 3300V, 4160V, 6600V	
Input Voltage Tolerance	± 10% of Nominal	
Voltage Sag	-30%	
Power Loss Ride-Through	5 Cycles (Std) > 5 Cycles (Optional UPS)	
Input Protection	Metal Oxide Varistor (MOV)	
Input Frequency	50/60 Hz, +/- 5%	
Input Short-circuit Current Withstand	5 Cycle	
2400 V – 6600 V ❶	25 MVA RMS SYM	
Basic Impulse Level ❷	50 kV (0 – 1000m)	
Power Bus Design	Copper – Tin plated	
Ground Bus	Copper – Tin plated 6 x 51 mm (¼ x 2 in.)	
Customer Control Wire Way	Separate and Isolated	
Input Power Circuit Protection	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 -6000 V, 0 – 6300 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 SGCT's	Voltage	SGCT's (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	6 Pulse 18 Pulse Active Front End (PWM)	
Rectifier Switch	SCR (6/18 Pulse), SGCT (Active Rectifier)	
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	

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

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

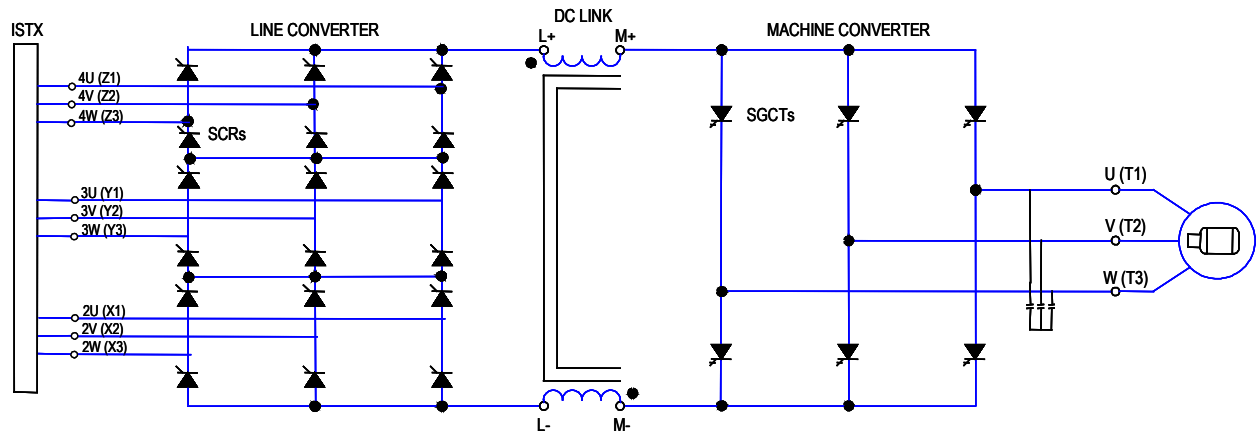
Specifications (cont.)

Description	NEMA		IEC	
	Voltage	6-Pulse	18-Pulse	AFE
Number of Rectifier Devices per phase	2400 V	2	6	2
	3300 V	4	6	4
	4160 V	4	6	4
	6600 V	6	6	6
SCR PIV Rating (Peak Inverse Voltage)	Voltage	6-Pulse	18-Pulse	AFE
	2400 V	6500 V	4500 V	6500 V
	3300 V	6500 V	4500 V	6500 V
	4160 V	6500 V	4500 V	6500 V
6600 V	6500 V	6500 V	6500 V	
Output Current THD (1 st – 49 th)	< 5%			
Output Waveform to Motor	Sinusoidal Current / Voltage			
Medium Voltage Isolation	Fiber Optic			
Modulation techniques	SHE (Selective Harmonic Elimination) PWM (Pulse Width 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 30 sec.			
Acceleration/Deceleration Ramp Rates	4 x Independent Accel/Decel			
S Ramp Rate	Independent Accel/Decel – 2 x 999 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 \supseteq	0.2-75 Hz			
Service Duty 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 Torque Load)	
Typical VFD Efficiency	> 98% (6/18 Pulse) > 97.5% (AFE) Contact Factory for Guaranteed Efficiency of Specific Drive Rating			
VFD Noise Level $\not\leq$	< 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 0.1 Hz Display speed resolution			
Languages	English French		Spanish Chinese	

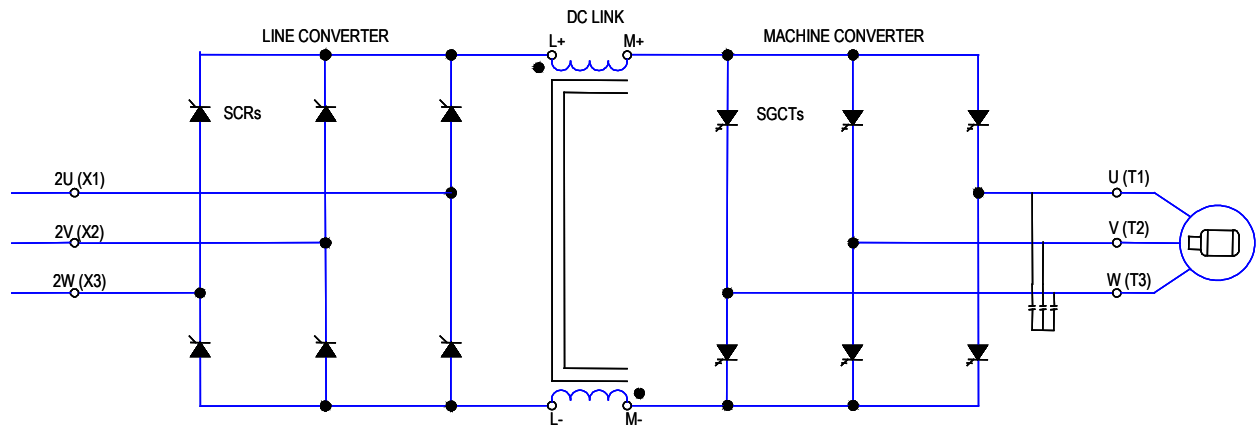
\supseteq Based on a motor 50 or 60 Hz base frequency
 $\not\leq$ Redundant fan and fan exhaust ducting options will affect noise level

Description	NEMA	IEC
Control Power	208-575 V, 3 Phase, 50/60 Hz	
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	(1) Isolated, (1) Non-isolated, 4-20 mA or 0-10 V (250 ohm)	
Analog Resolution	<ul style="list-style-type: none"> • Analog input 12 Bit (4-20 mA) • Internal parameter 32 Bit resolution • Serial Communication 16 Bit resolution (.1Hz) (Digital Speed Reference) 	
Analog Outputs	(1) Isolated, (7) Non-isolated, 4-20 mA or 0-10 V (600 ohm)	
Communication Interface	SCANPort /DPI	
Scan Time	Internal ScanPort – 10 ms Internal DPI – 5 ms	
Communications Protocols (Optional)	RS232/422/485 DH485 Remote I/O DeviceNet ControlNet Modbus/Modbus Plus Johnson Controls	Ethernet Interbus LON Works Can Open Profibus
Enclosure	NEMA 1	IP21
Lifting Device	Standard / Removable	
Mounting Arrangement	Mounting Sill channels	
Structure Finish	Epoxy Power – Paint Exterior Sandtex Light Grey (RAL 7038) – Black (RAL 8022) Internal – Control Sub Plates – High Gloss White (RAL 9003)	
Interlocking	Key provision for customer input Disconnecting Device	
Corrosion Protection	Unpainted Parts (Zinc Plated / Bronze Chromate)	
Ambient Temperature	0° to 40°C (32°F to 104°F)	
Fiber Optic Interface	Rectifier – Inverter – Cabinet (Warning / Trip)	
Door Filter	Painted Diffuser with Matted Filter Media	
Door Filter Blockage	Air Flow Restriction (Trip / Warning)	
Storage and Transportation Temperature Range	-40°C to 70°C (-40°F to 185°F)	
Relative Humidity	Max. 95% Non-Condensing	
Altitude (Standard)	0 to 1000 m (0 to 3300 ft.)	
Altitude (Optional)	1001 to 5000 m (0 to 16400 ft.)	
Seismic (UBC Rating)	1, 2, 3, 4	

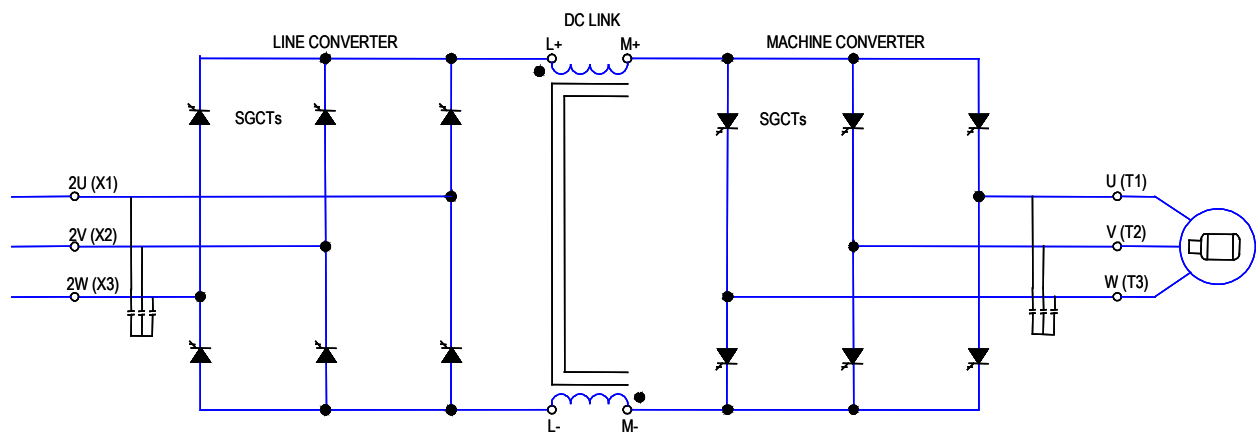
Simplified Electrical Drawings



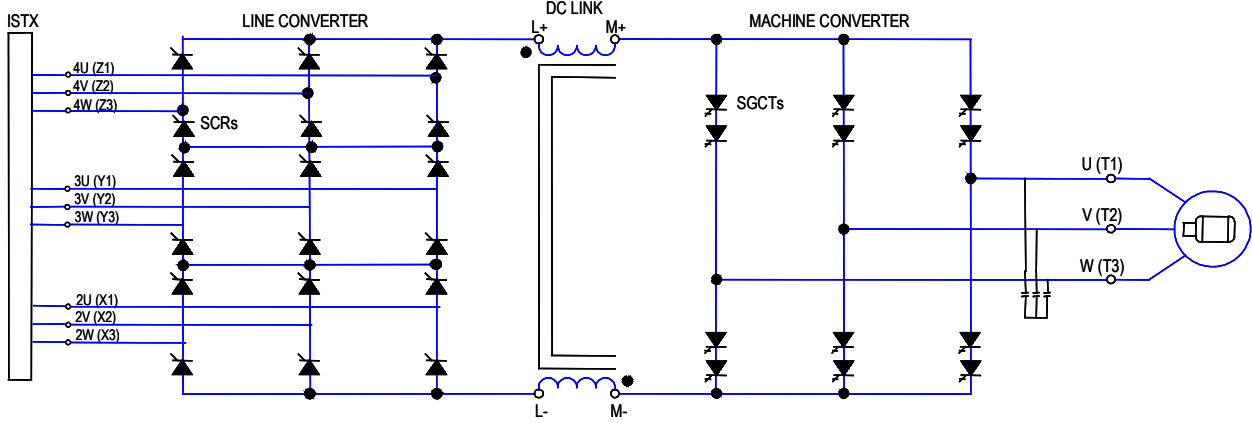
2400 Volt – 18 Pulse



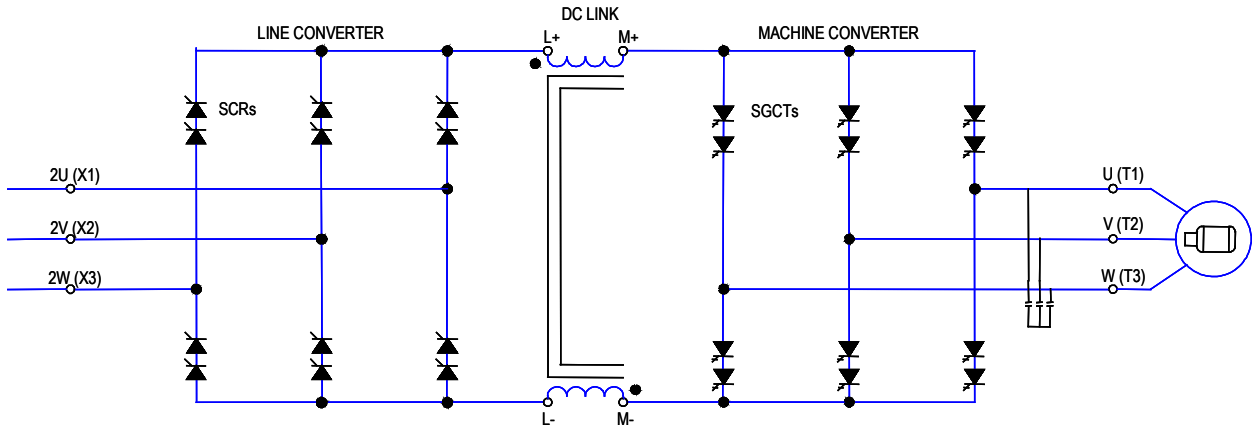
2400 Volt – 6 Pulse



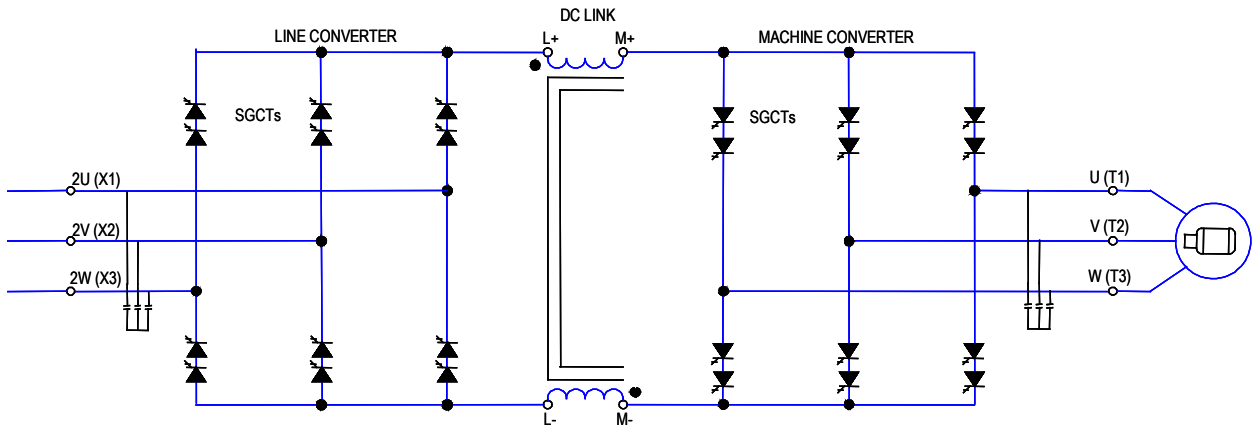
2400 Volt – Active Front End



3300 / 4160 Volt – 18 Pulse

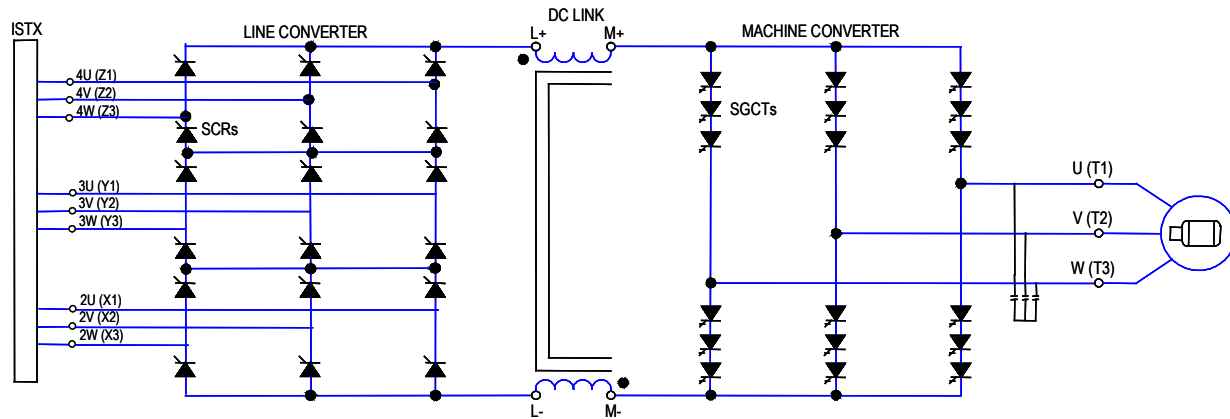


3300 / 4160 Volt – 6 Pulse

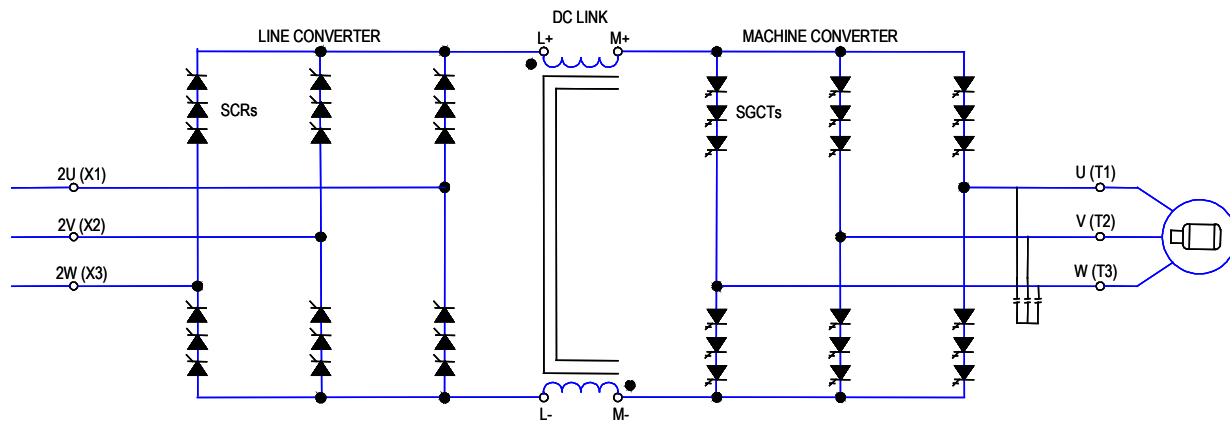


3300 / 4160 Volt – Active Front End

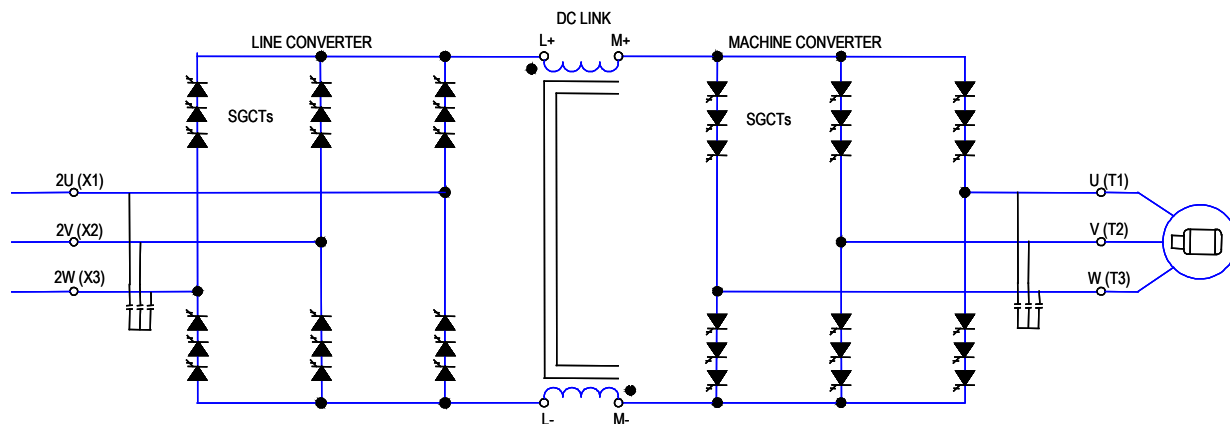
Simplified Electrical Drawings (cont.)



6000-6600 Volt – 18 Pulse



6000-6600 Volt – 6 Pulse



6000-6600 Volt – Active Front End

Control Overview

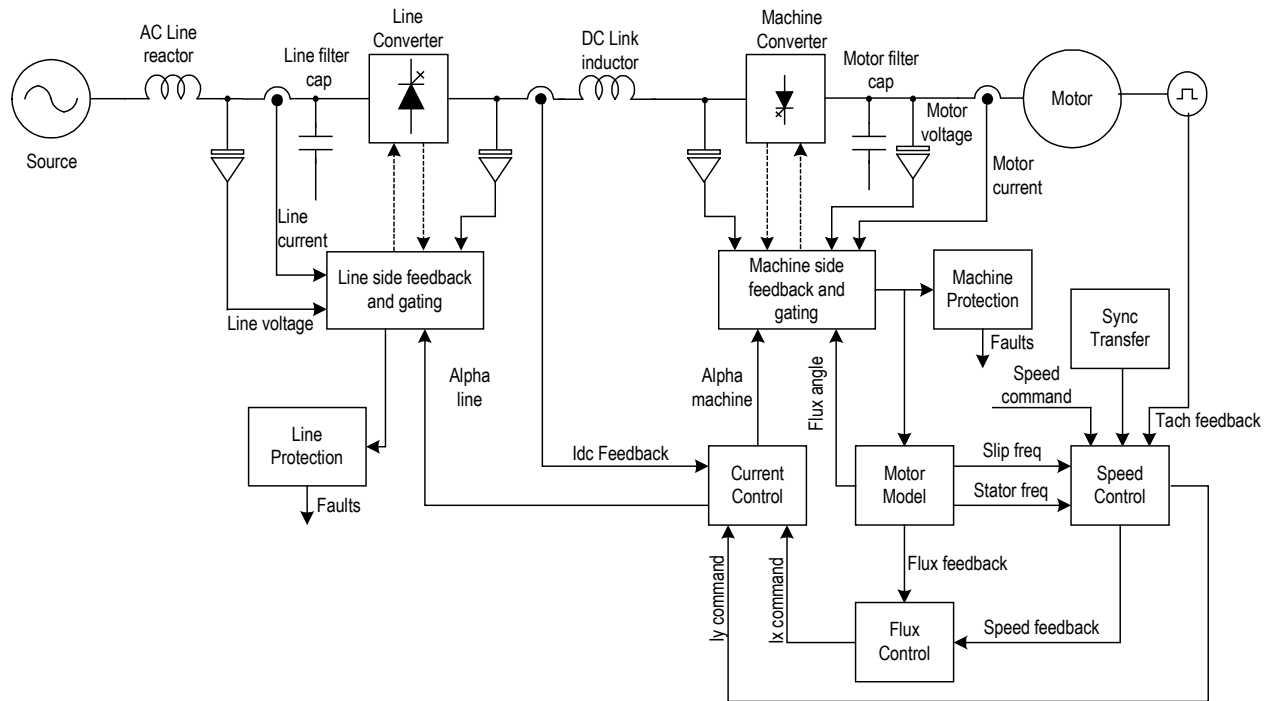


Figure 1.7 – PowerFlex 7000 Function Block Diagram

Direct Vector Control

The method of control in the PowerFlex 7000 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 .1-15 radians per second, while the torque bandwidth range is 20-100 radians per second.

Control Hardware

The control hardware includes identical drive control boards for machine and line side complete with up to three fiber optic interface boards (depending on the voltage and number of switching devices), signal conditioning boards for machine and line side, customer interface board and external I/O board. The common drive control boards are used for the rectifier and inverter, induction or synchronous drive control, and the three rectifier types (6-pulse, 18-pulse, or Active Rectifier).

The drive control boards feature a floating point digital signal processor and field programmable gate arrays for advanced functions such as gating and diagnostics, fault handling, and drive synchronization control.

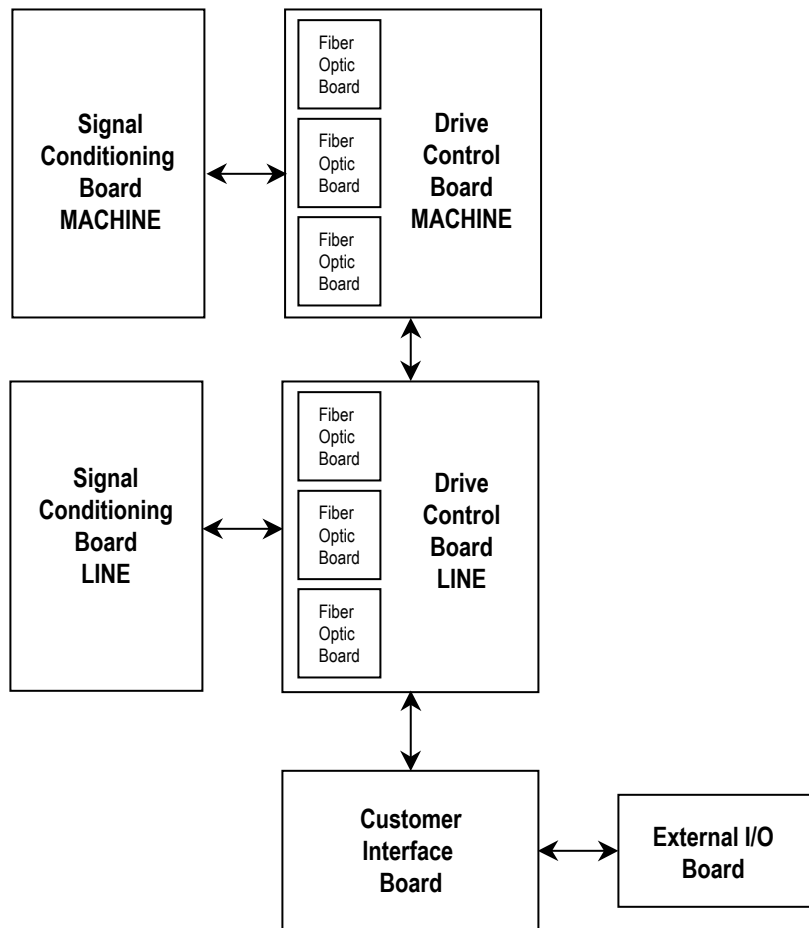


Figure 1.8 – Control Hardware Layout for PowerFlex 7000

Operator Interface

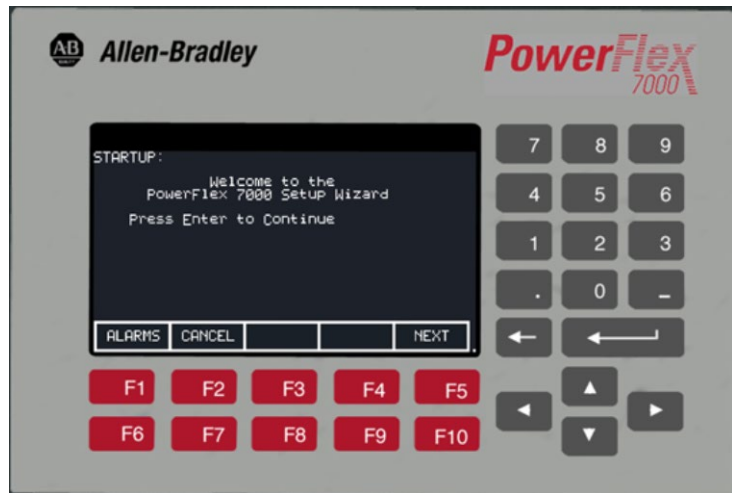


Figure 1.9 – PowerFlex 7000 Operator interface terminal

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 7000 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 8 variables.

Notes:

Drive Installation

Safety and Codes

ATTENTION

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 render 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 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 cannot be sufficiently stressed how important it is that the customer installation duties are performed correctly. Any errors will certainly cause delays in the drive commissioning, if not damage as well.

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.

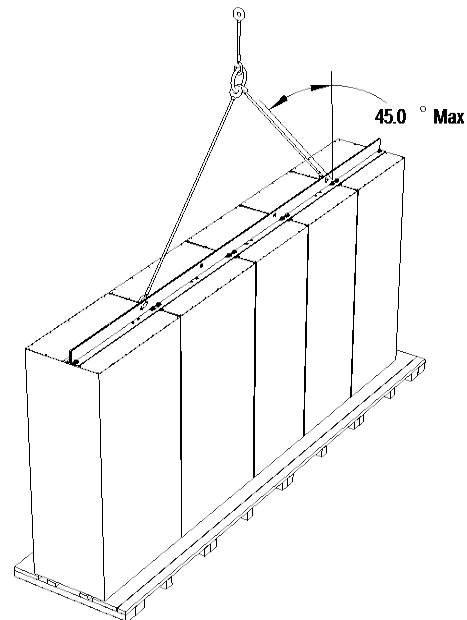


Figure 2.1 – Overhead Lifting

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.

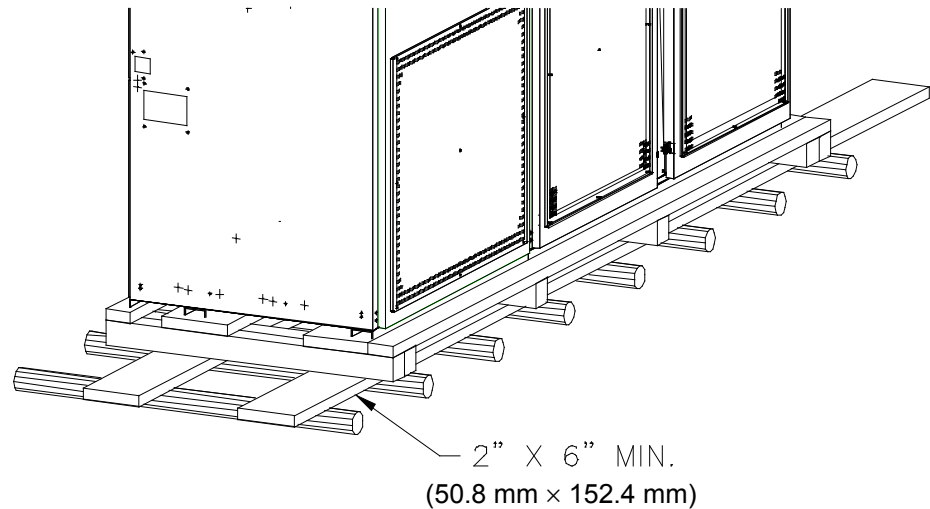


Figure 2.2 – Rod or Pipe Rollers

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 -20°C and 65°C (-4°F and 149°F). If storage temperature fluctuates or if humidity exceeds 85%, space heaters should be used to help 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 40°C (104°F)
- Relative humidity of the air not to exceed 95% non-condensing

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

The equipment requires the following site conditions:

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

or

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

- (E) Allowance must be made for the stream of cooling air which exits the drive at the top. The flow of cooling air into and out the drive must be kept clear and uninhibited.

- (F) The room in which the equipment is located must be large enough to accommodate the thermal losses of the equipment since air conditioning may be required; the ambient temperature must not exceed that for which the equipment is rated. The heat created by the drive is directly proportional to the power of the motor being driven and the efficiency of equipment within the room. If thermal load data is required contact the Rockwell Automation Sales office.
- (G) The area in which the drive is located should be free of radio frequency interference such as encountered with some welding units. This may cause erroneous fault conditions and shut down the drive.
- (H) The equipment must be kept clean. Dust in the equipment decreases system reliability and inhibits cooling.
- (I) Power cable lengths to the motor are virtually unlimited due to the near sinusoidal voltage and current waveforms. Unlike voltage source drives, there are no capacitive coupling, dv/dt , or peak voltage issues that can damage the motor insulation system. The CSI-PWM topology utilized in the PowerFlex 7000 medium voltage AC drive has been tested with motors located up to 15 kilometers 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.

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

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.

Installation (cont.)

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.

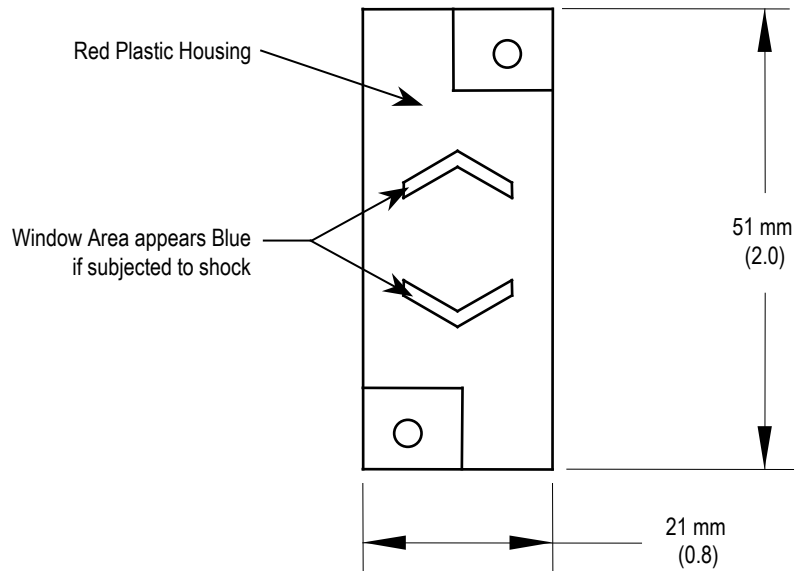


Figure 2.3 – Shock Indicator

Installation of Exhaust Air Hood

On the top of the cabinet with the cooling fan, a sheet metal exhaust hood is to be installed. The components to make up the exhaust hood have been packaged and shipped with the drive and are to be found in the control/cabling cabinet.

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

Secondly, loosely assemble the two L-shaped panel components shipped with the drive as per Figure 2.4.

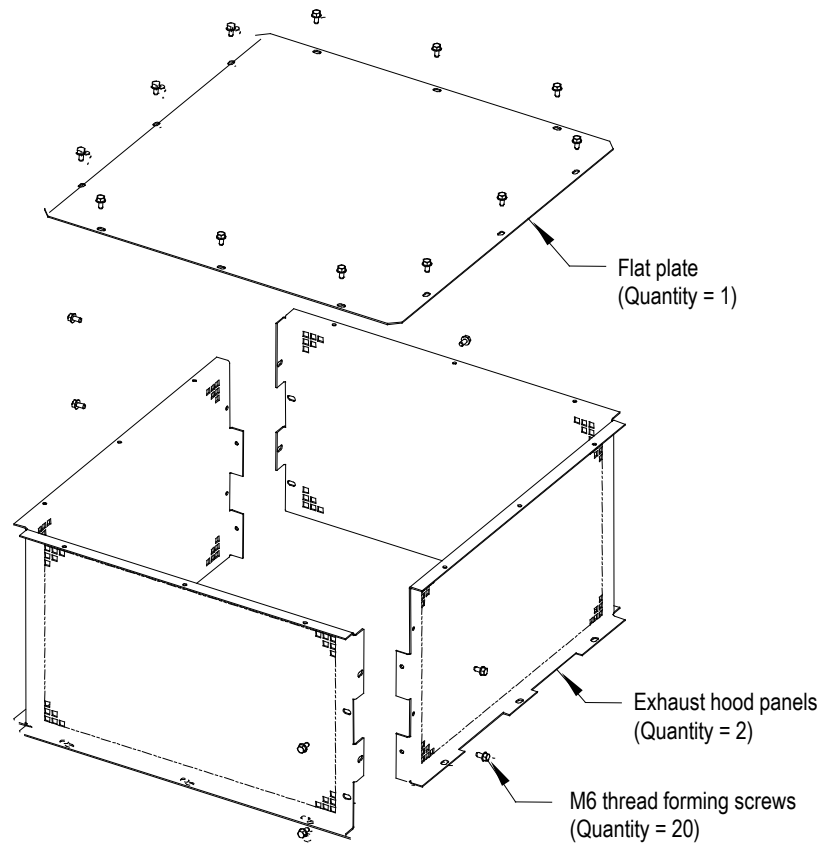


Figure 2.4 – Fan Hood Assembly

Locate the exhaust hood on top of the cabinet per Figure 2.5 and re-install the original cover plate previously set aside. (Care must be taken that the notches on the bottom flange are oriented toward the sides of the drive). Affix assembly to the drive top plate. Tighten all hardware.

ATTENTION



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

Installation (cont.)

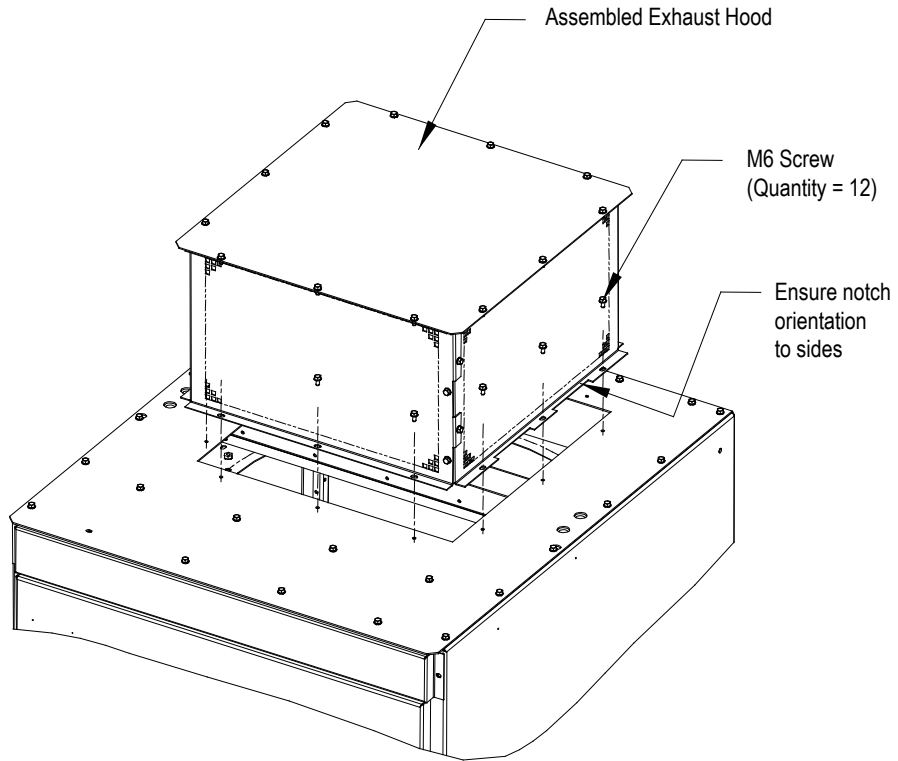


Figure 2.5 – Fan Hood Installation

Cabinet Layout and Dimensional Drawings of Drive

The following drawings are generic in nature and will not accurately detail your drive. They are provided here to give you a general overview of a typical drive.

The Dimensional Drawings are order specific and will show the information outlined.

The dimension drawing provides important information for the installation of the equipment.

The **FLOOR PLAN** shows:

- the locations for anchoring the equipment to the floor (balloon D)
- size and location of openings for bottom power cable entry (balloons A and B)
- size and location of openings for bottom control wiring entry (balloon C)
- size and location of openings for bottom fan power wiring entry (balloon J)

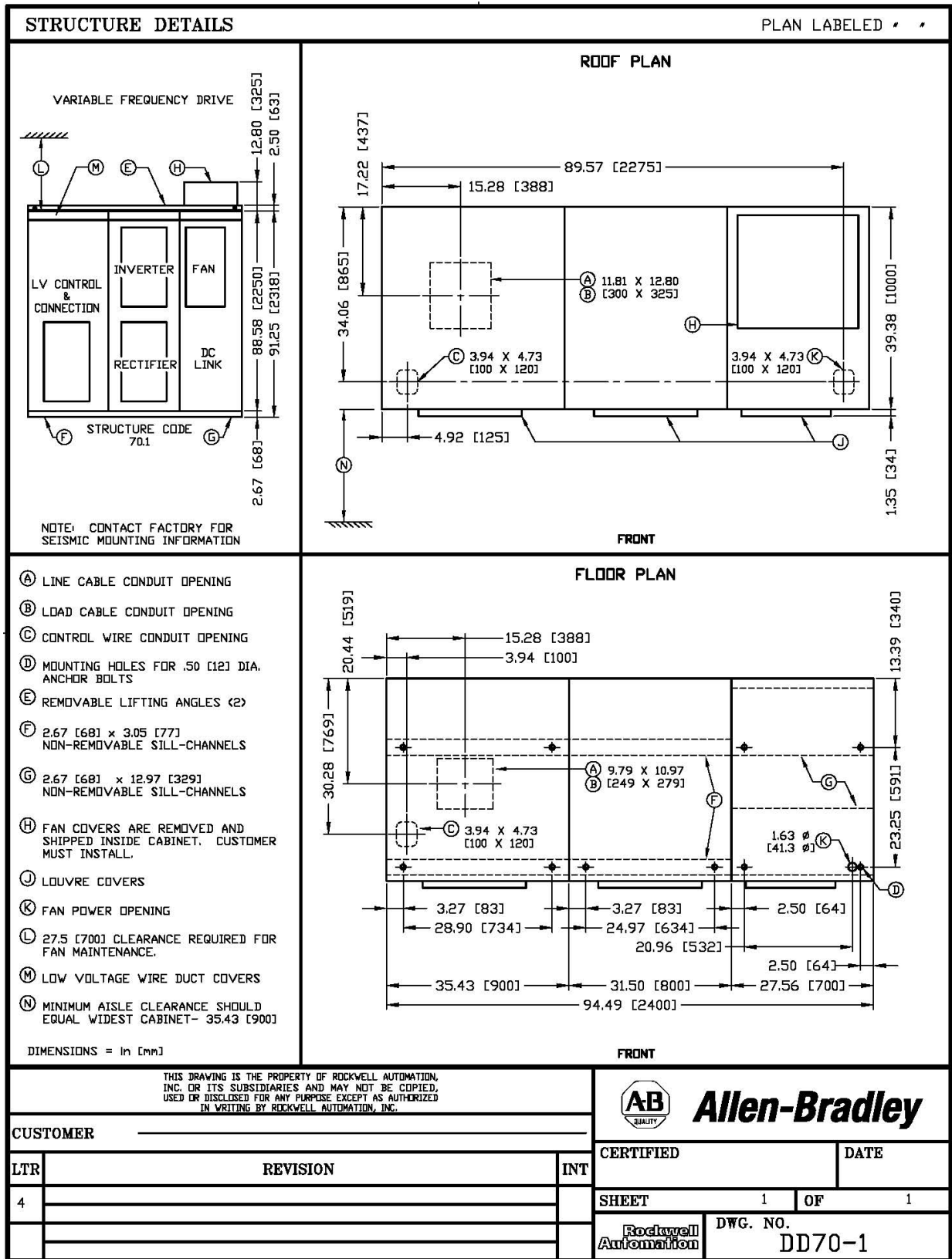
The **ROOF PLAN** shows:

- size and location of openings for top power cable entry (balloons A and B)
- size and location of openings for top control wiring entry (balloon C)
- size and location of openings for top fan power wiring entry (balloon J)
- minimum aisle clearance in front of equipment (balloon M)

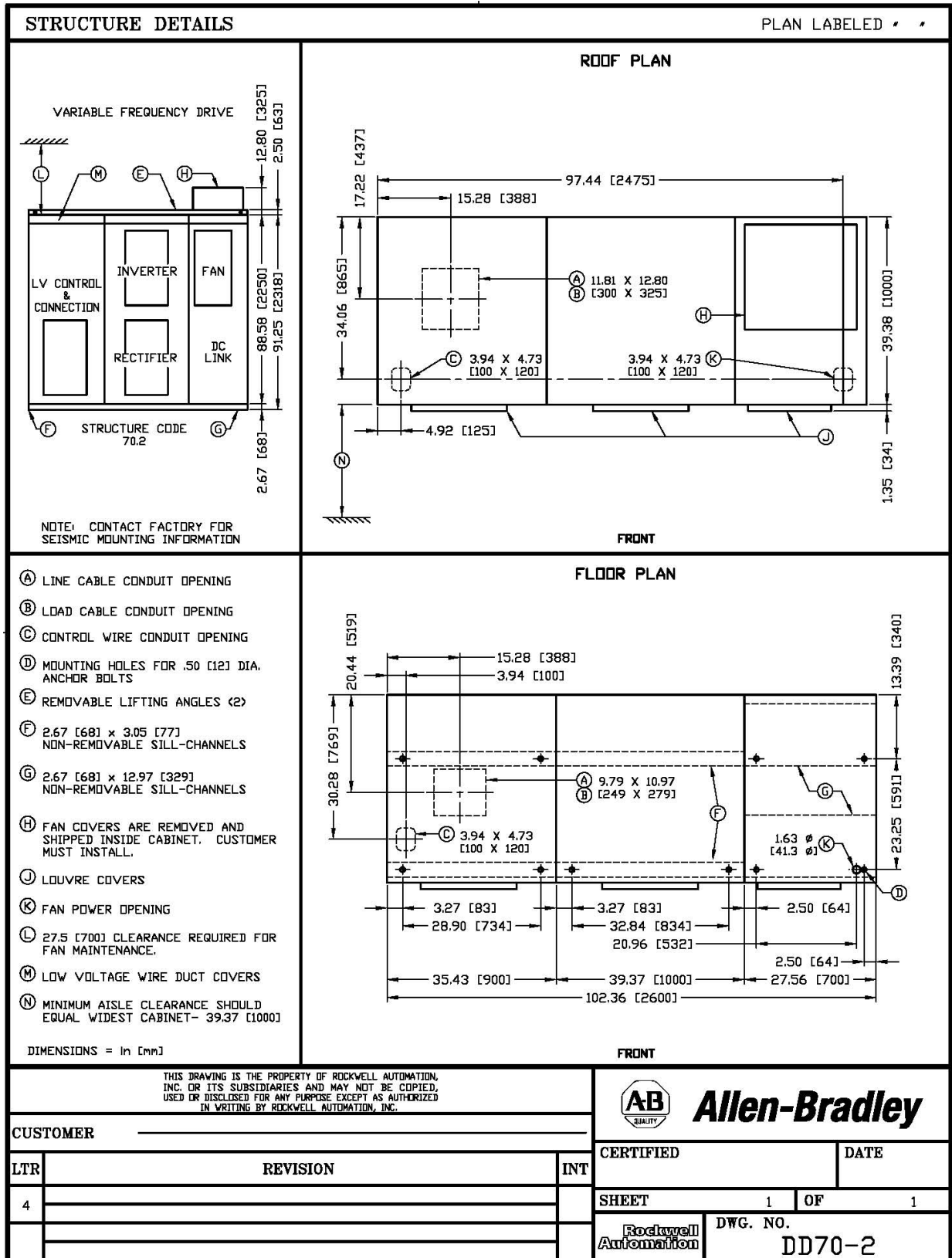
The **Front View** shows:

- minimum clearance required at top of drive for fan maintenance (balloon K)

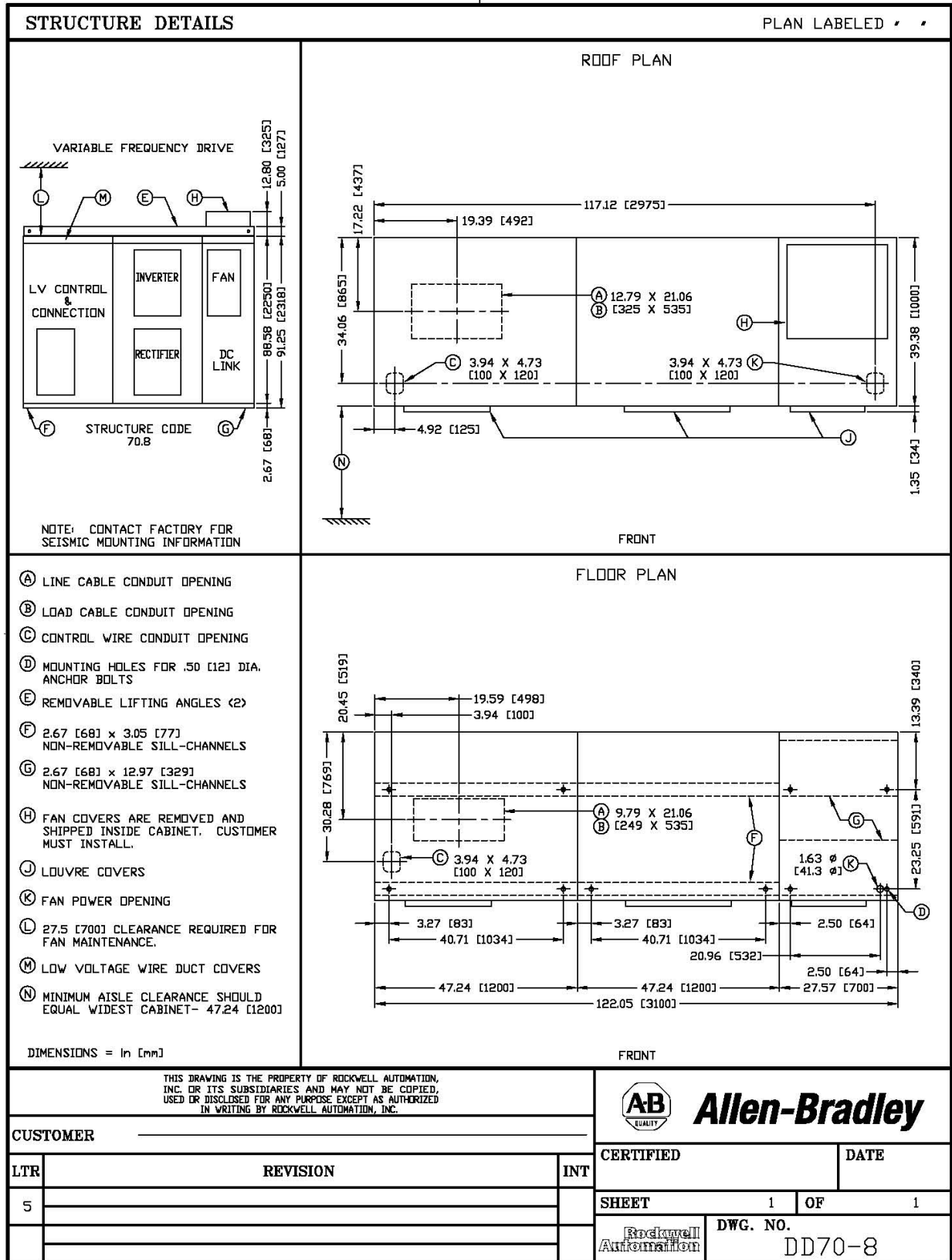
PowerFlex 7000 Dimensional Drawings



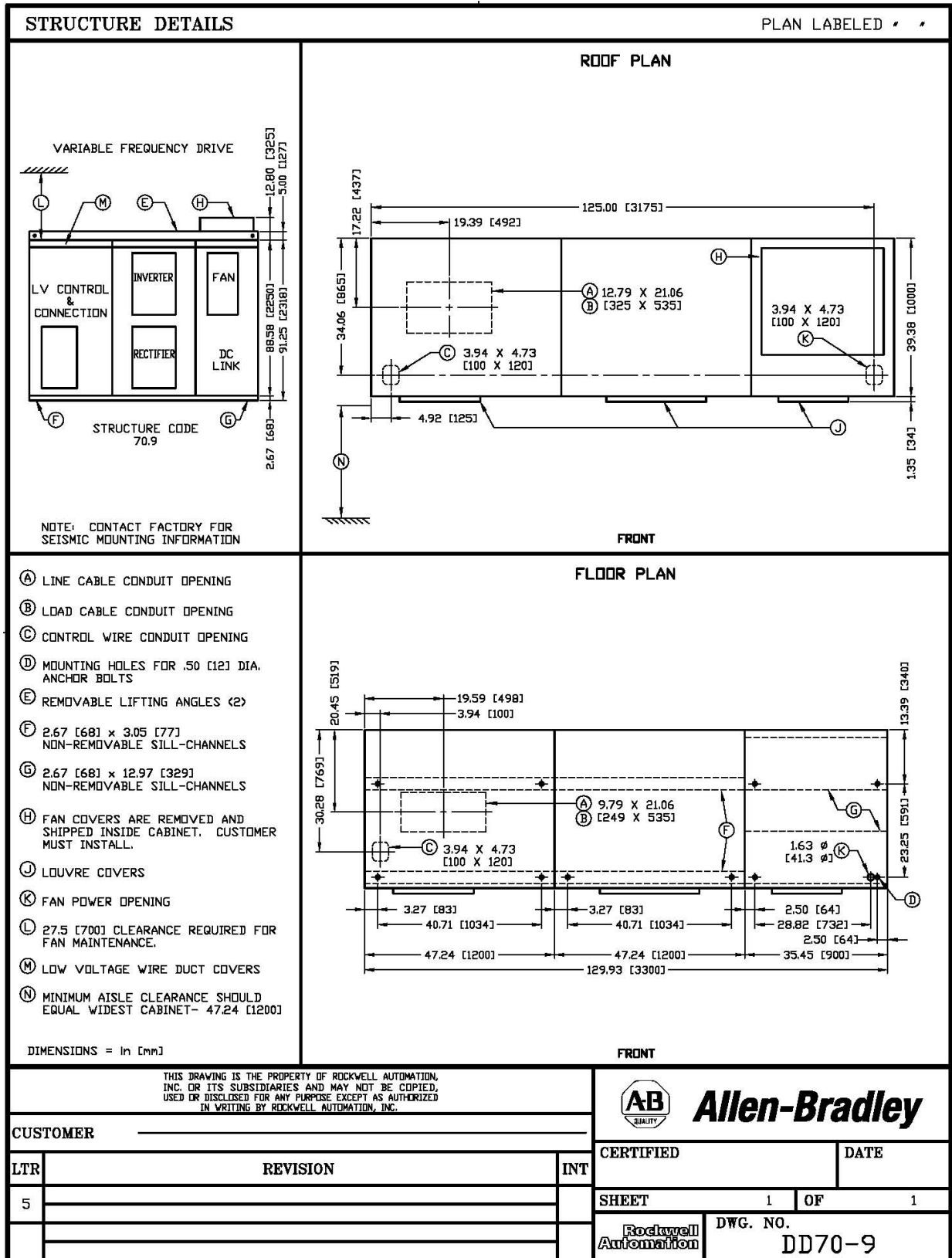
Note: Contact Factory for Seismic Mounting Information.



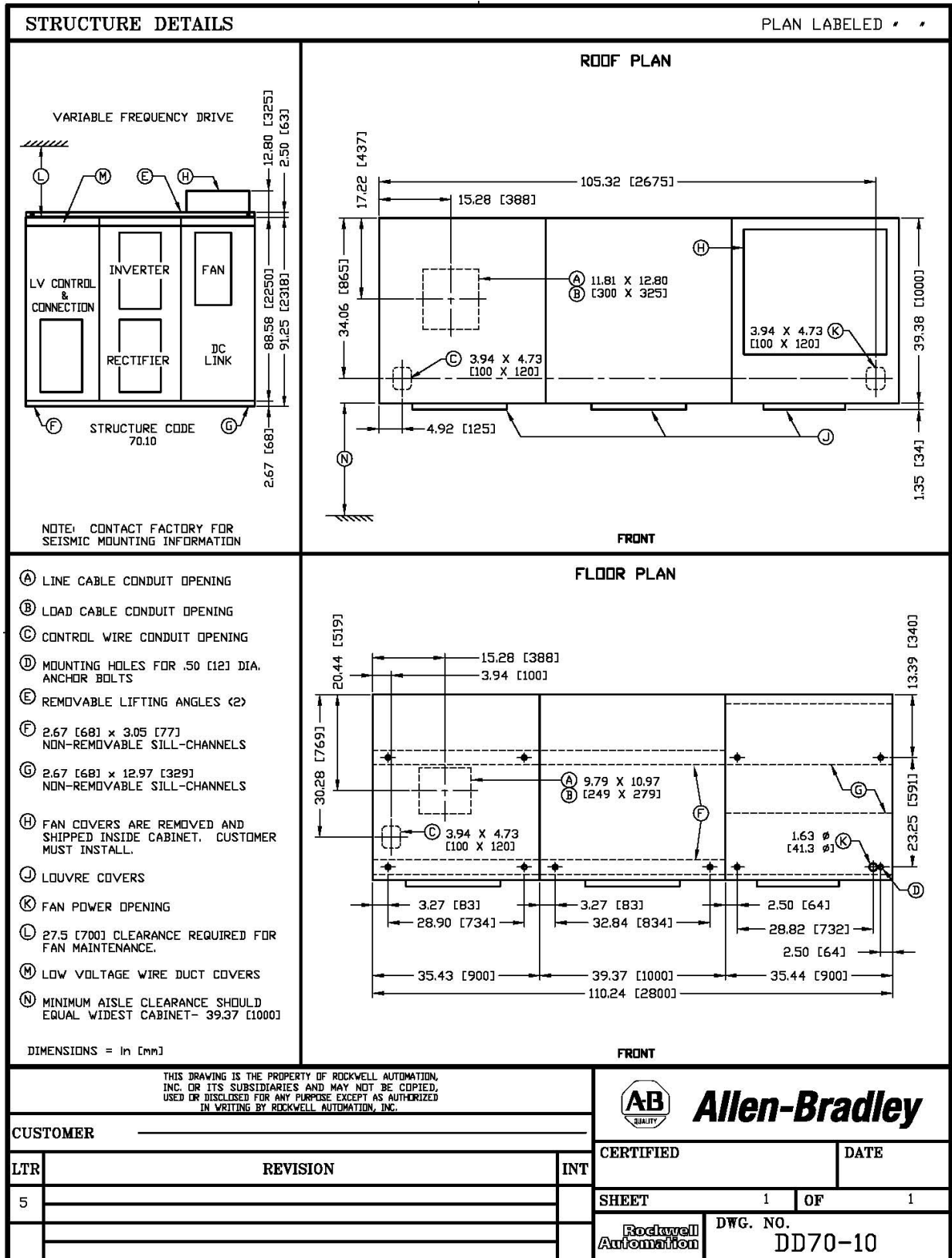
Note: Contact Factory for Seismic Mounting Information.



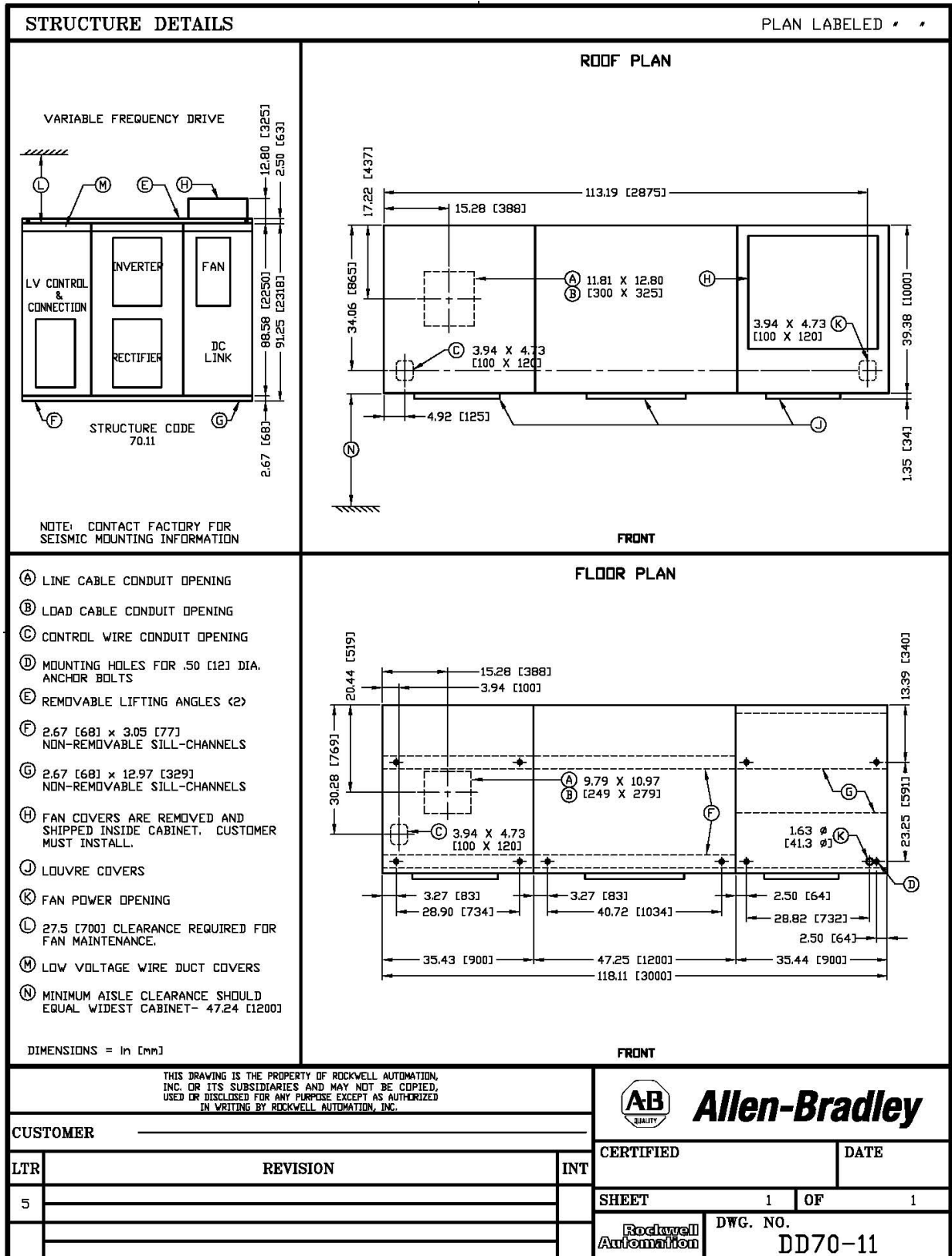
Note: Contact Factory for Seismic Mounting Information.



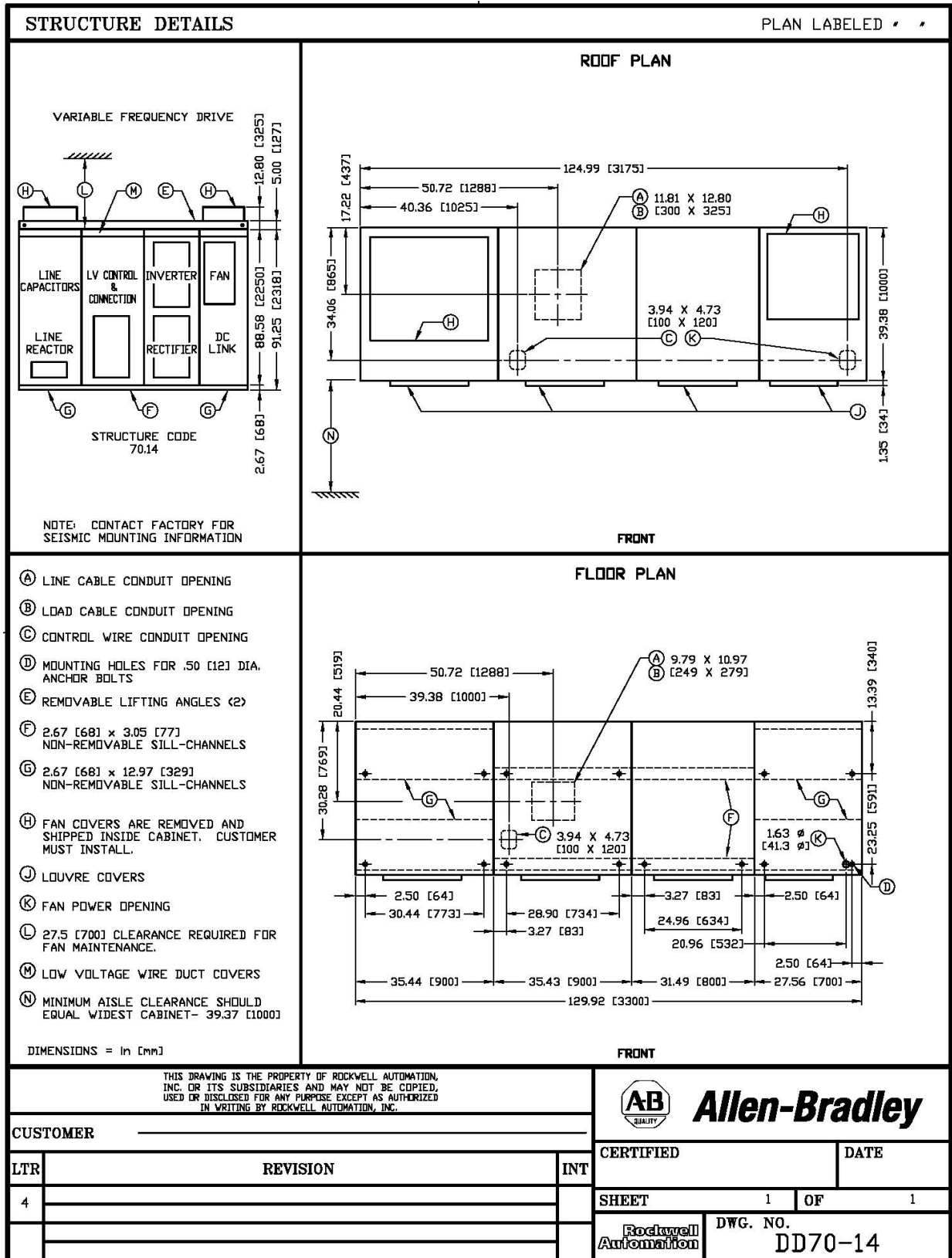
Note: Contact Factory for Seismic Mounting Information.



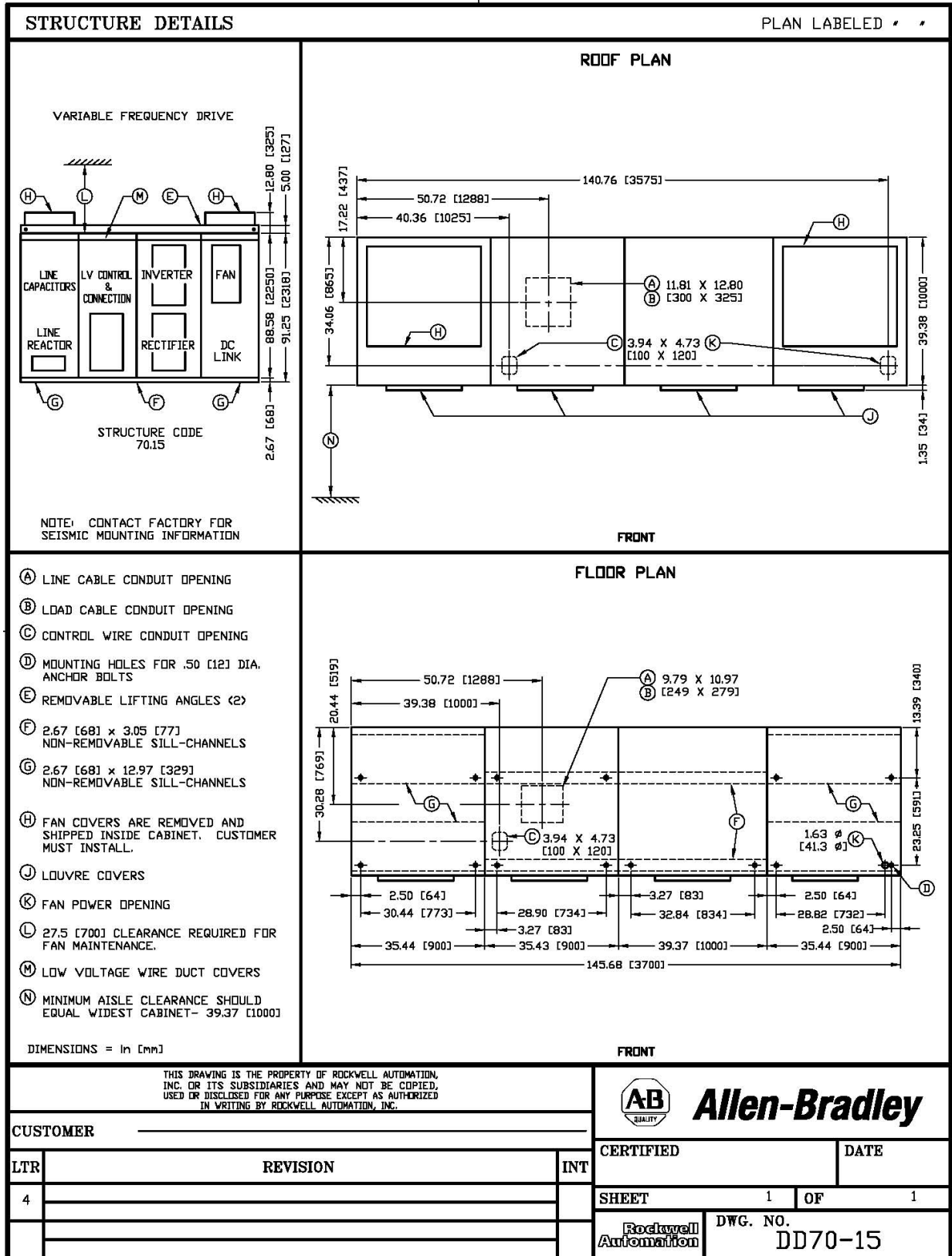
Note: Contact Factory for Seismic Mounting Information.



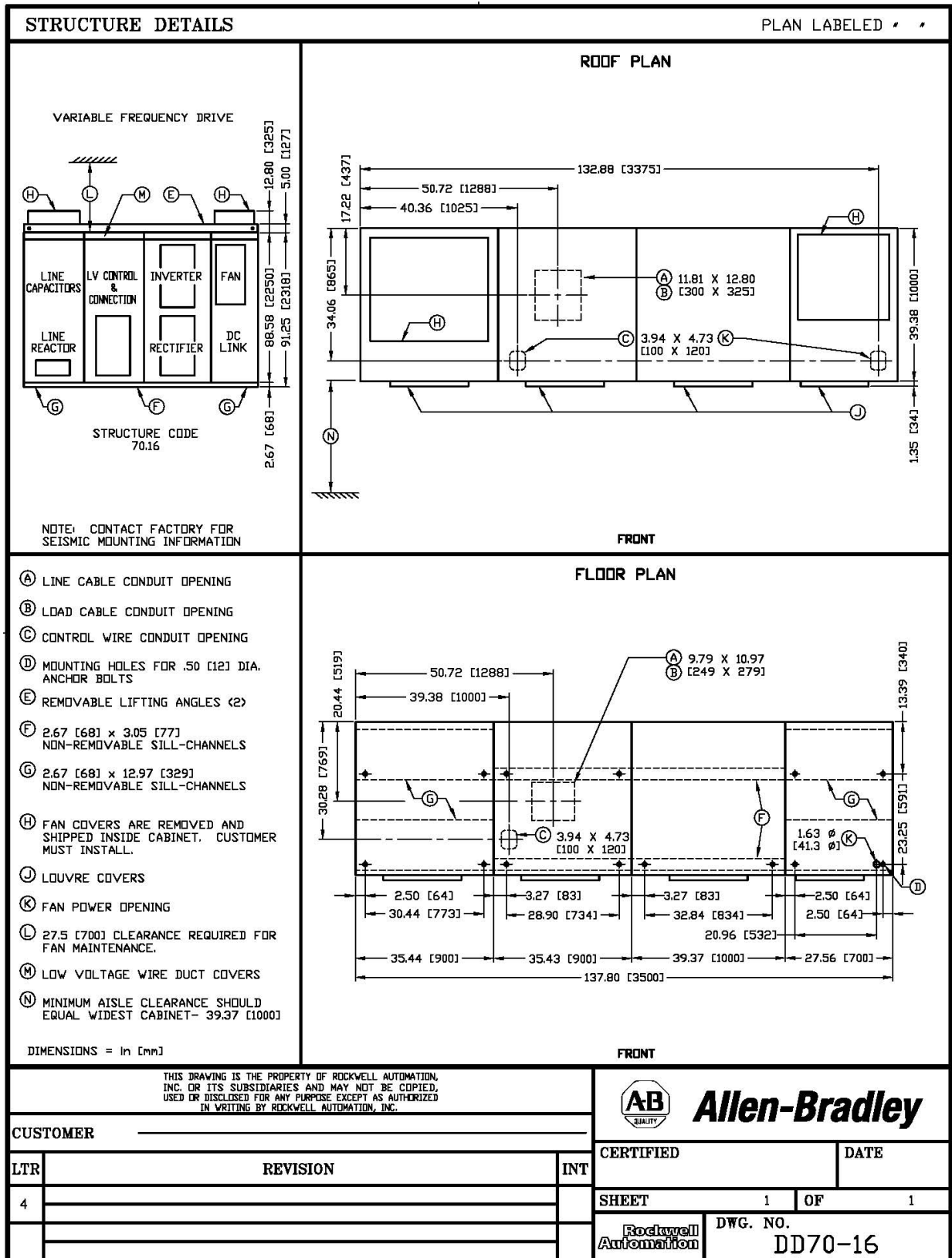
Note: Contact Factory for Seismic Mounting Information.



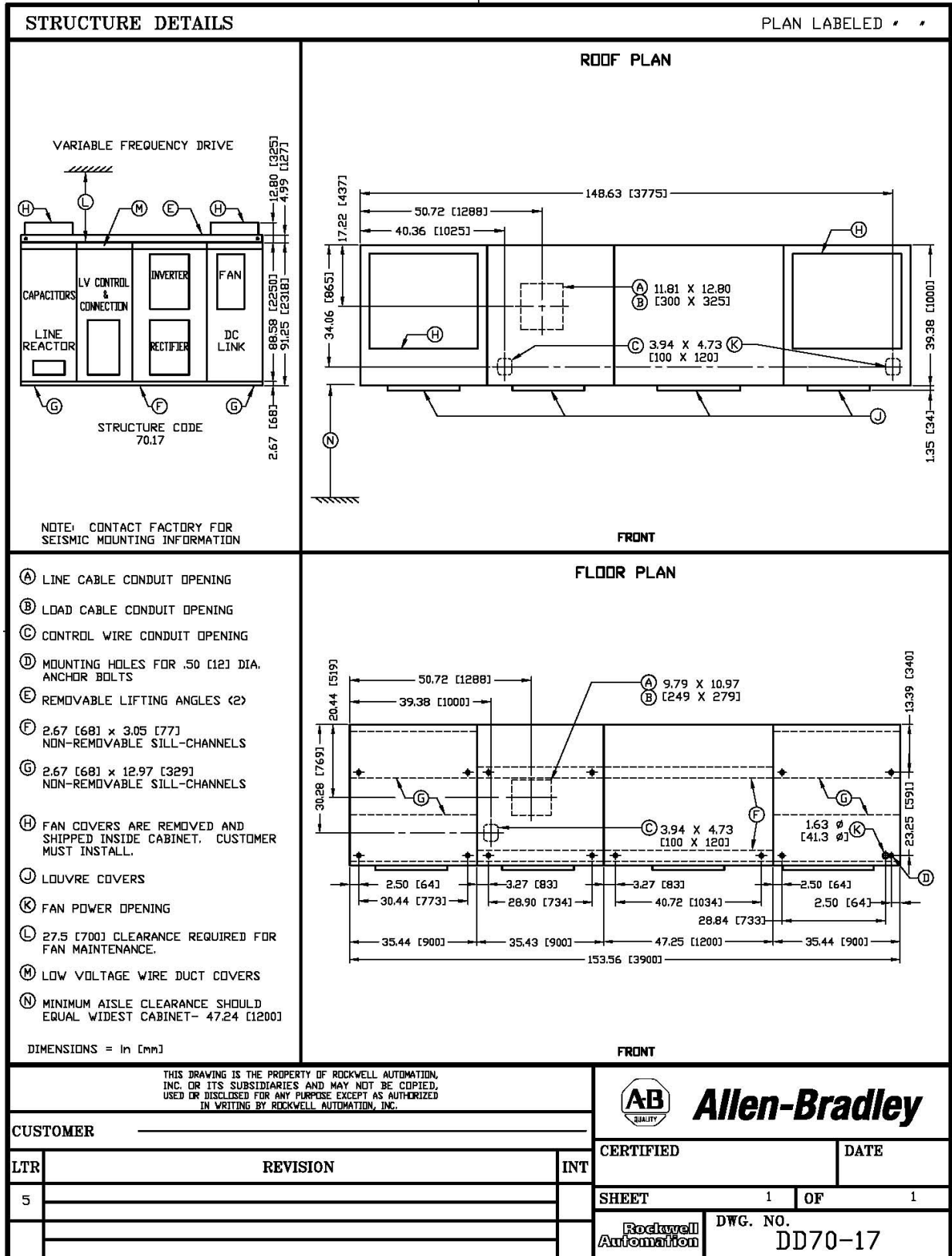
Note: Contact Factory for Seismic Mounting Information.



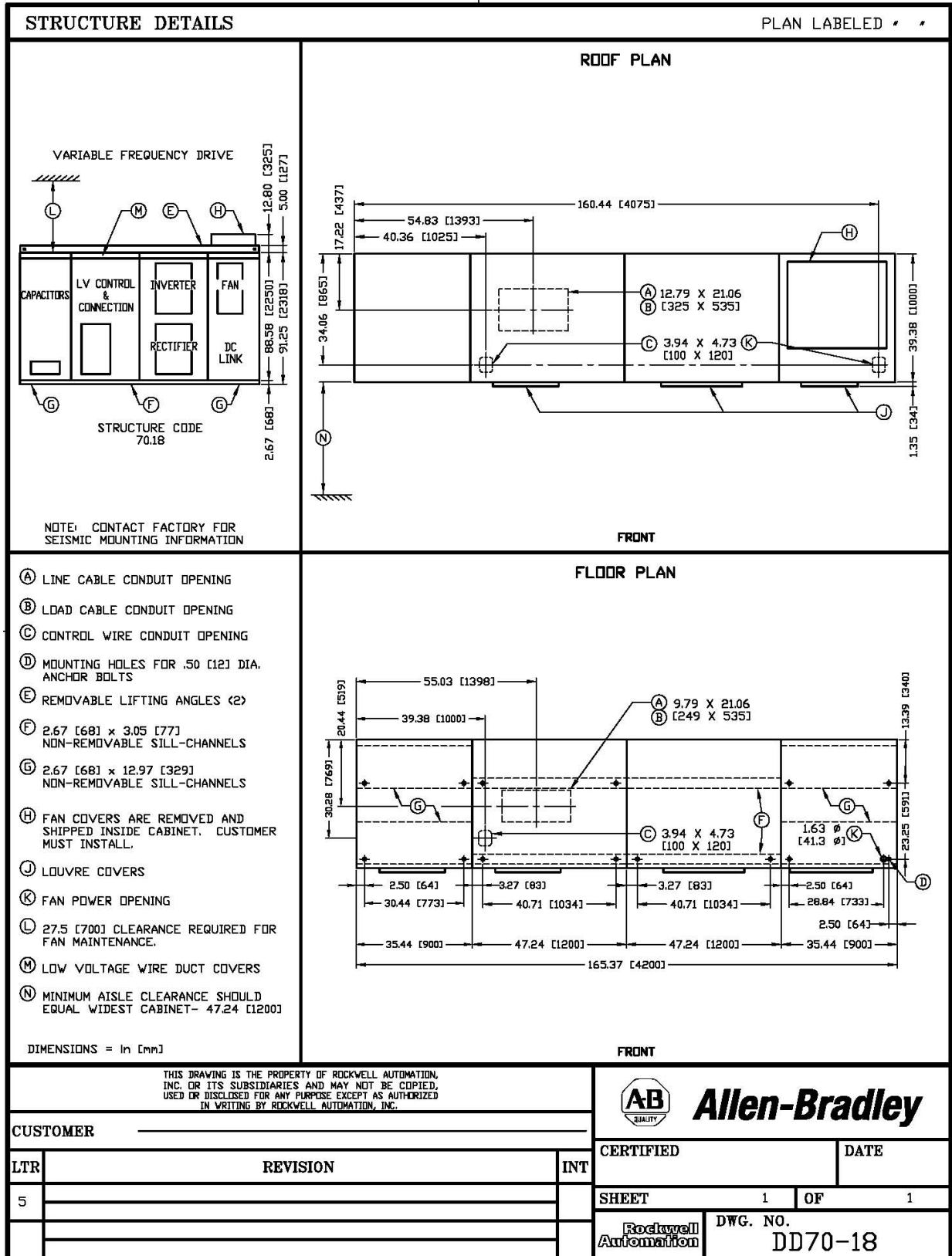
Note: Contact Factory for Seismic Mounting Information.



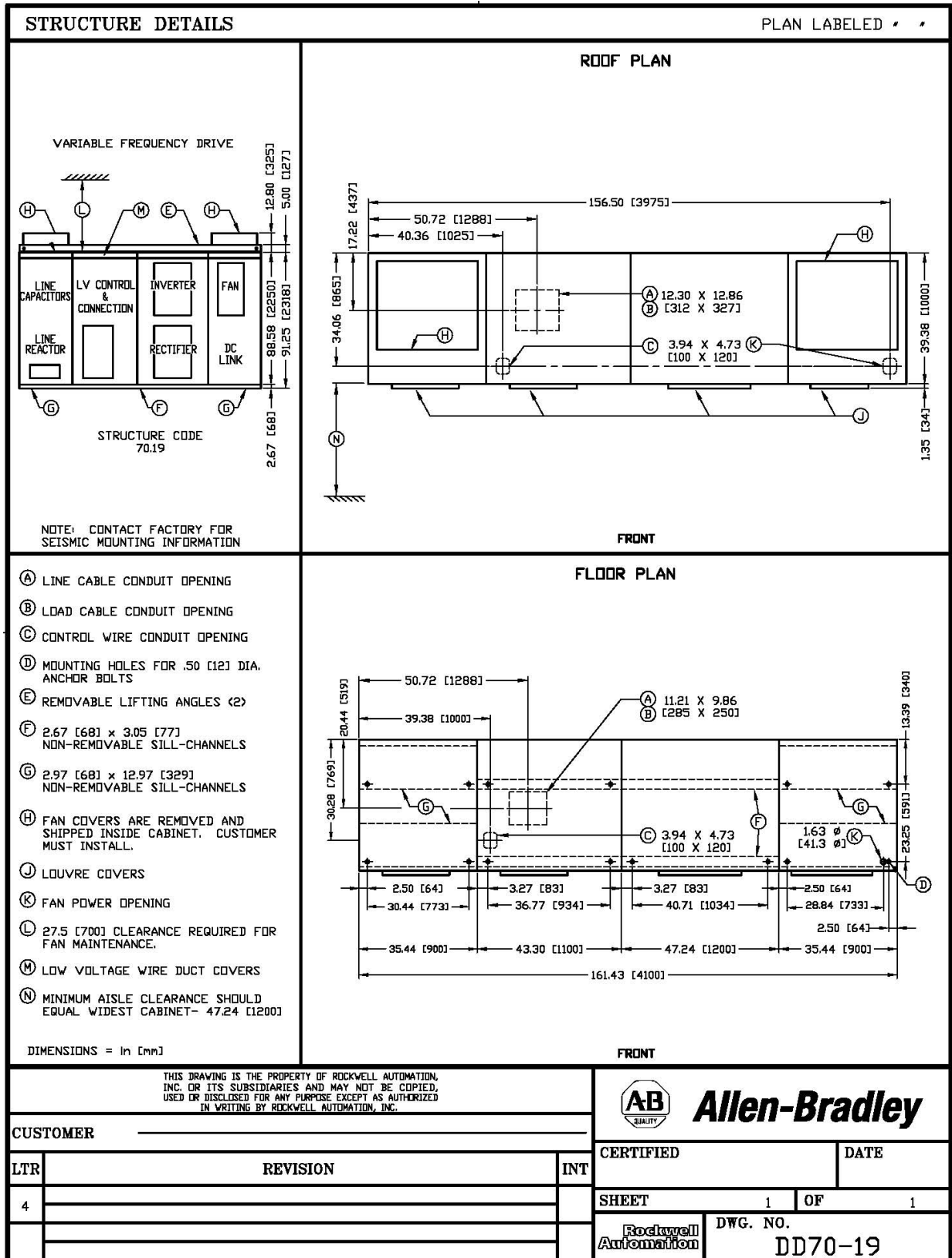
Note: Contact Factory for Seismic Mounting Information.



Note: Contact Factory for Seismic Mounting Information.



Note: Contact Factory for Seismic Mounting Information.



Note: Contact Factory for Seismic Mounting Information.

Control/Cabling Cabinet

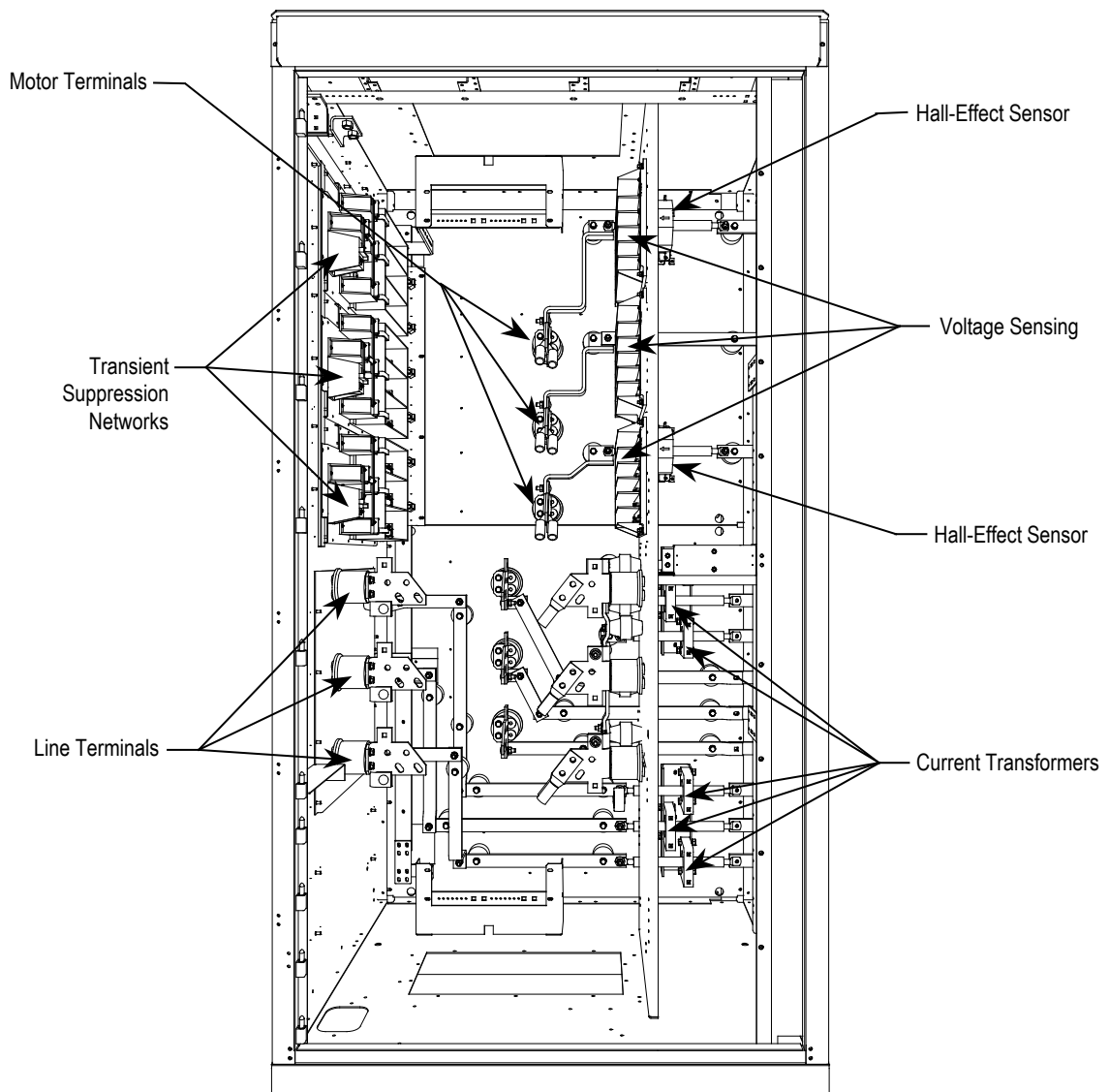
Shows the medium voltage area located in the control/cabling cabinet behind the low voltage compartment and with barriers removed.

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

- 18-pulse rectifier (Figure 2.6)
- 6-pulse/PWM (Figure 2.7)

Major Components

The following four diagrams are presented to show what the typical layout of each cabinet will be for the PowerFlex 7000 Drive.



**Figure 2.6 – Cabling Cabinet for 18-Pulse Rectifier
(Motor Filter Capacitors Not Shown)**

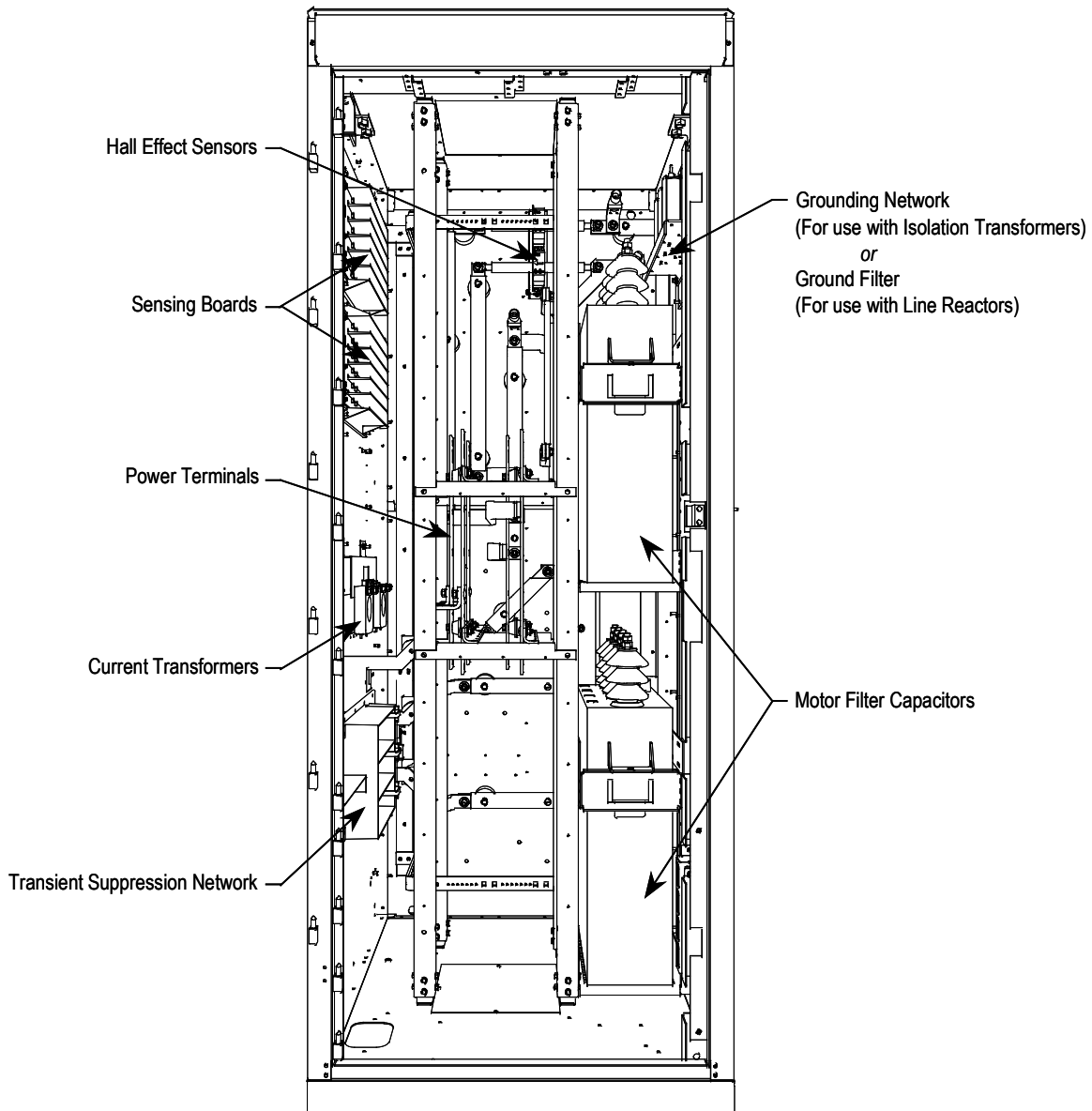


Figure 2.7 – Cabling Cabinet for 6-Pulse/PWM Rectifier

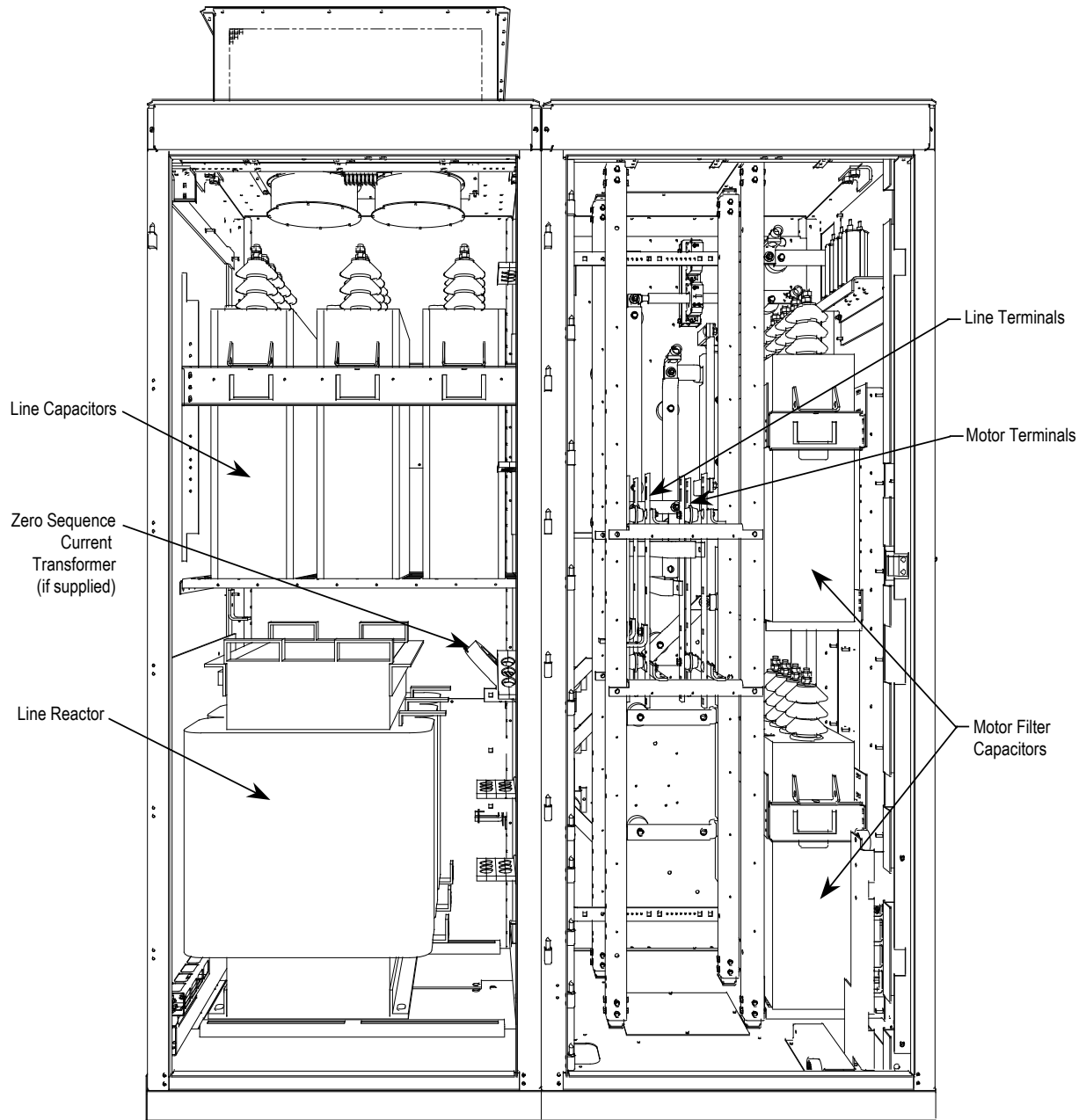
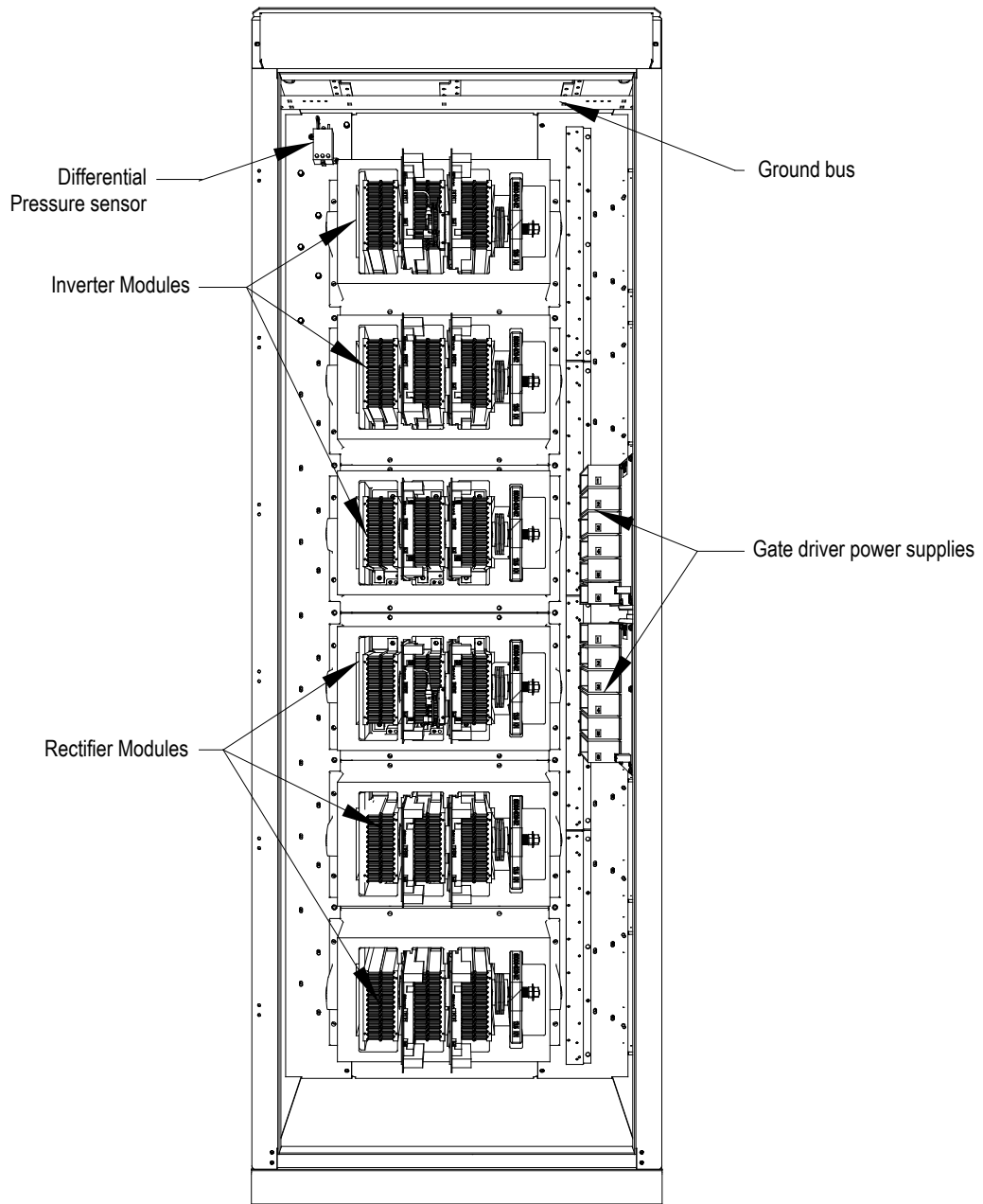


Figure 2.8 – AC Line Reactor with Connection Cabinet



**Figure 2.9 – Major Components of the Converter Cabinet
(2400V version shown)**

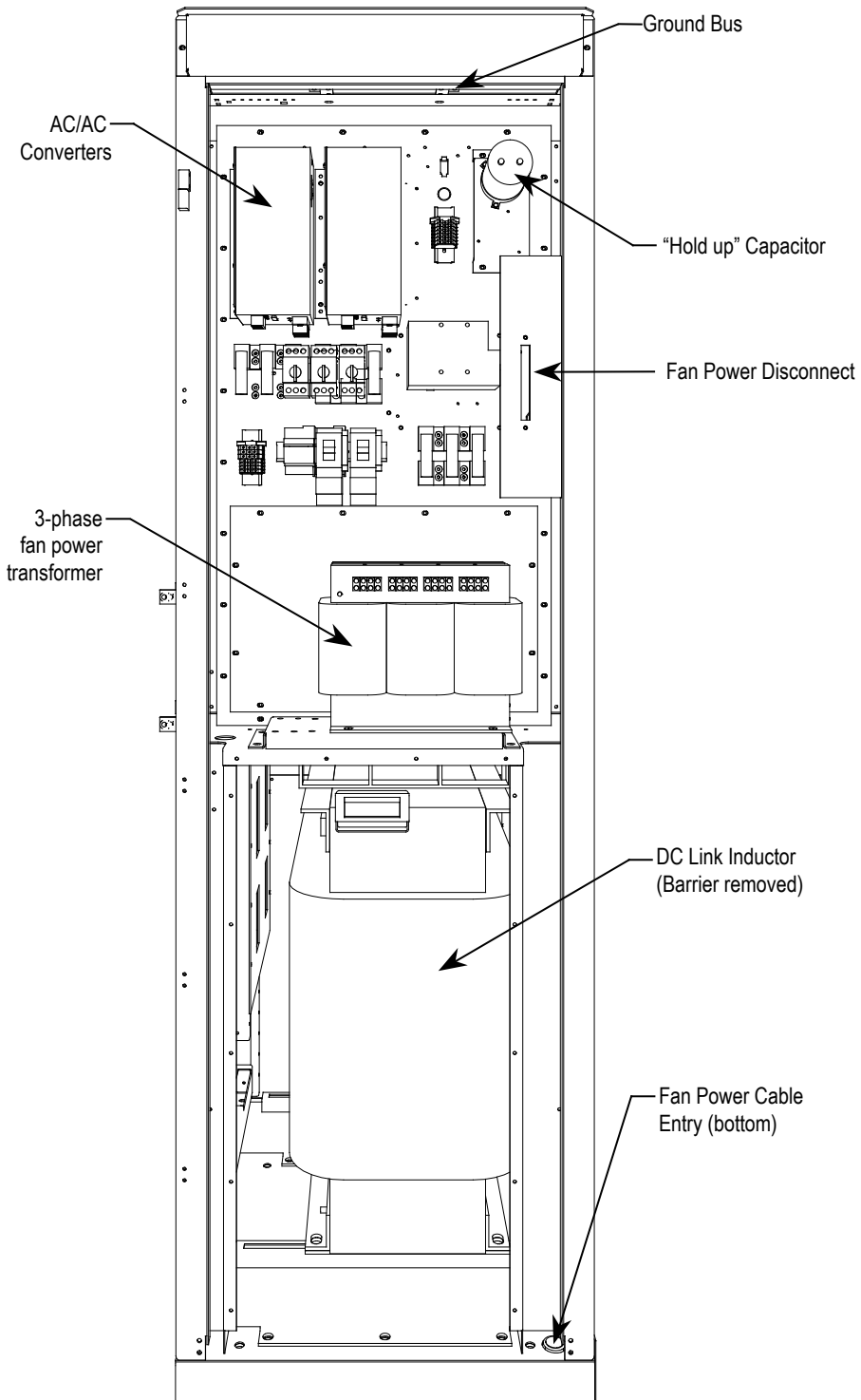


Figure 2.10 – Major Components of DC Link/Fan Cabinet

IEC Component and Device Designations

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 colour rather than by number. The abbreviations used to identify the colours 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.

Power Wiring Selection (cont.) 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 6P / PWM Drives with Line Reactor

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

Cable Insulation Requirements for 18P and 6P / PWM 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

Power Wiring Selection (cont.) 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.

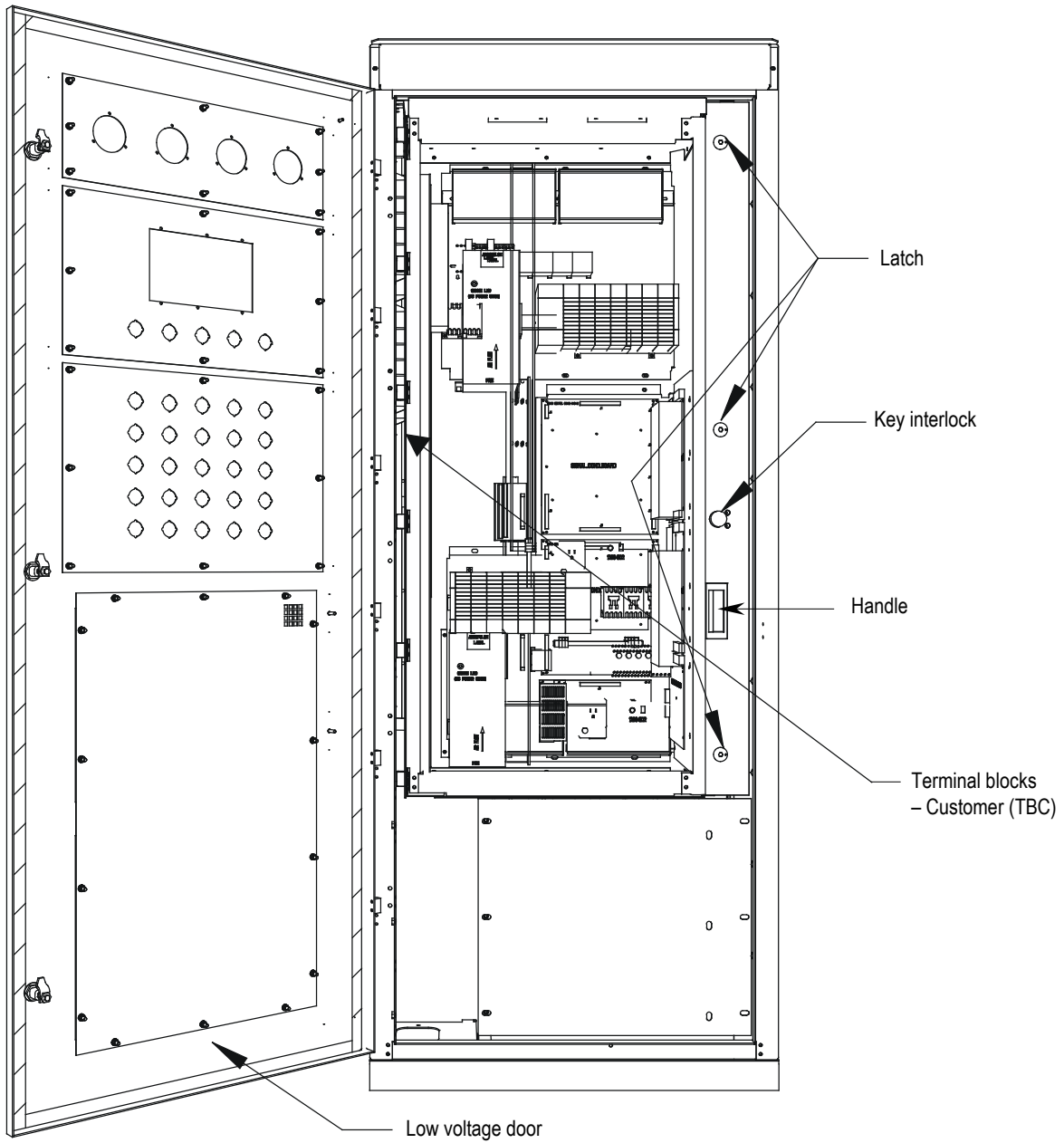


Figure 2.11 – Swing-out of Low Voltage Compartment

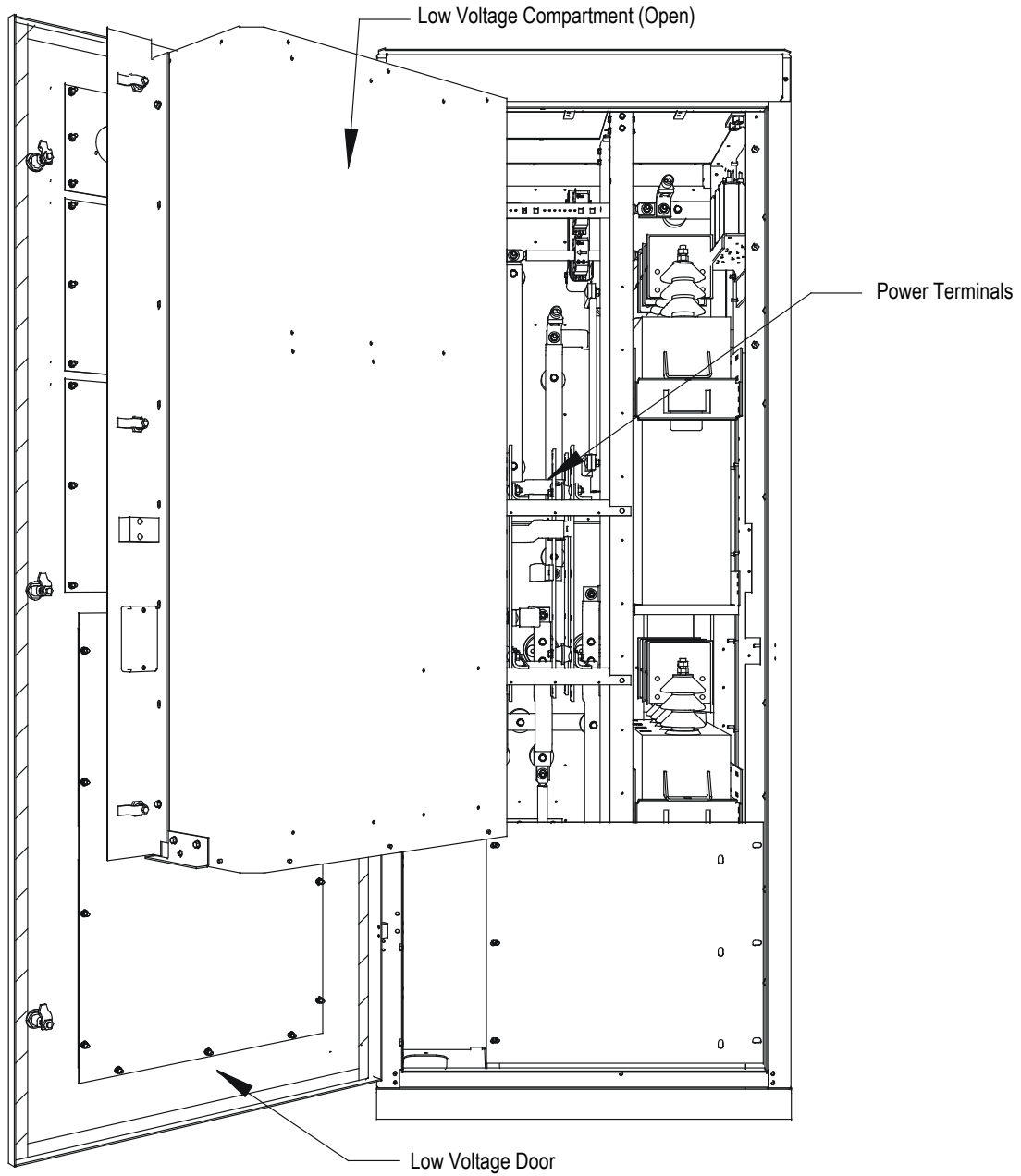


Figure 2.12 – Access to Power Terminals

Power Connections

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

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

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

Incoming Connections

- Drives with 6-Pulse / PWM 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

Power Cabling installation requirements

The following drawings are:

- A front view of the 900 mm input cabinet for 6-pulse and PWMR drives.
- Typical line cable termination assemblies (18-pulse)

To determine cable distance from top or bottom of input cabinet to termination points, refer to Figure 2.14 .

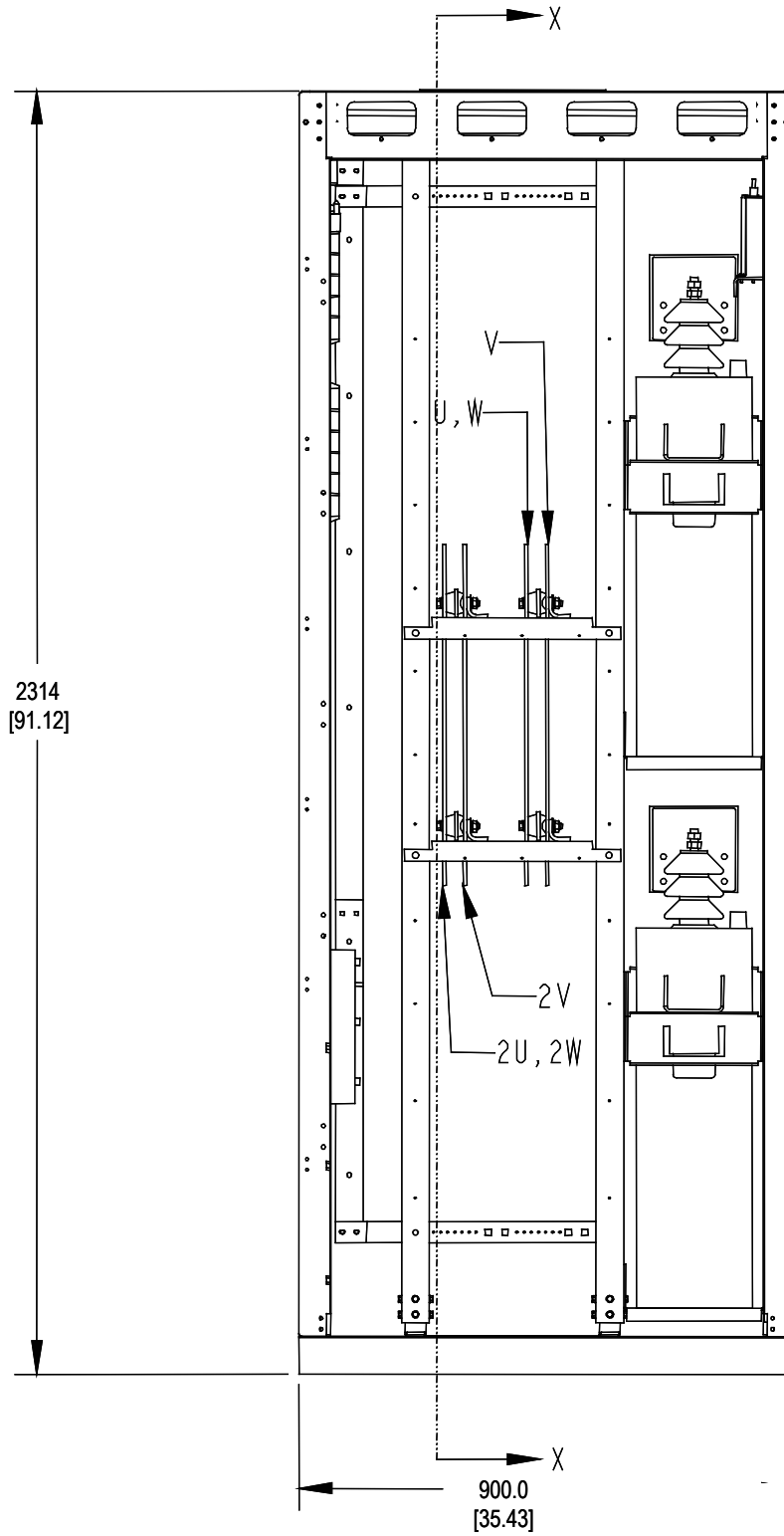
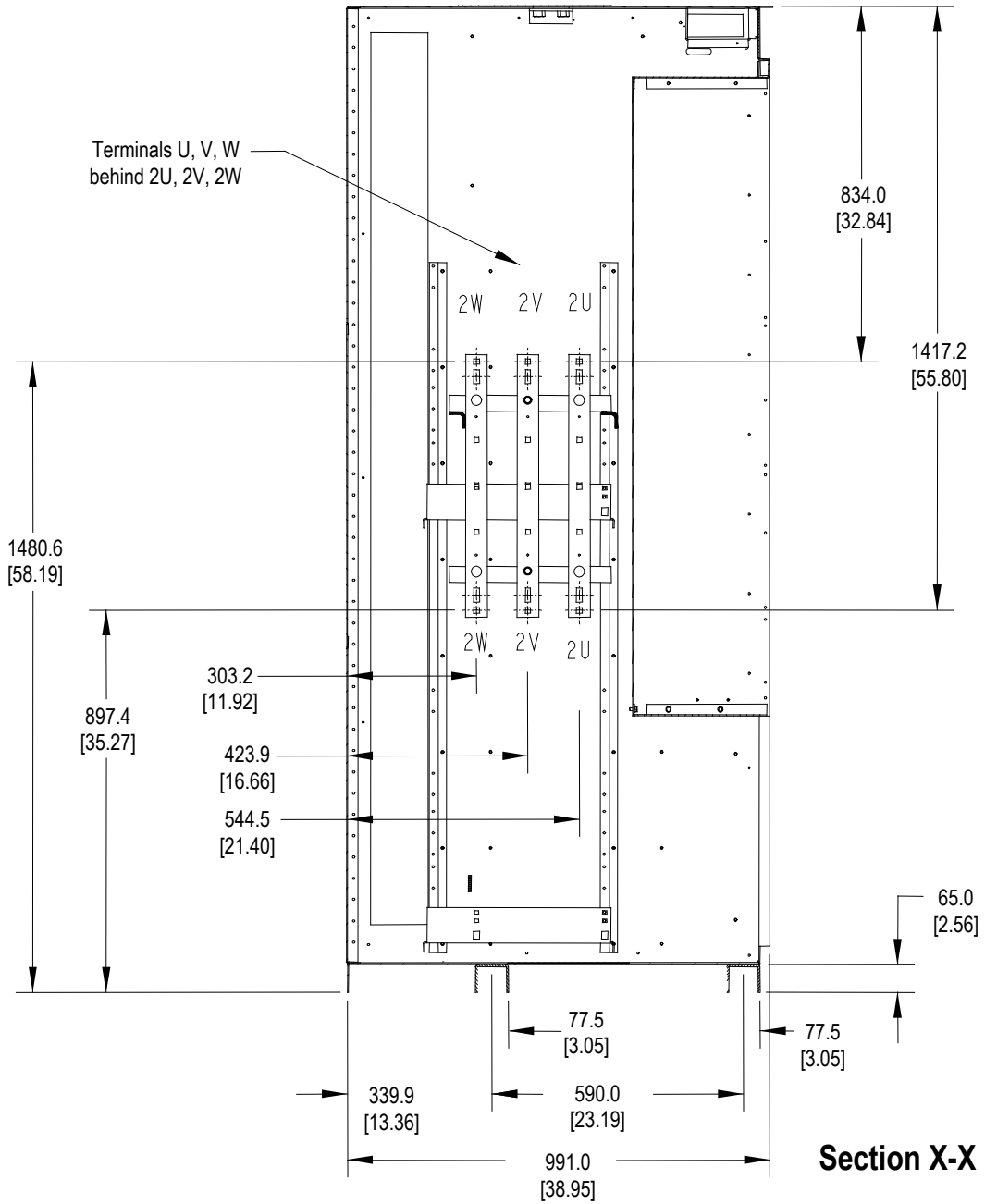


Figure 2.13 – Front View of 900 mm Control/Cabling Cabinet (6-pulse and PWM Rectifier)



**Figure 2.14 – Detail Power Terminal Dimensions
(6-pulse and PWM Rectifier)**

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.

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 re-connected 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.)

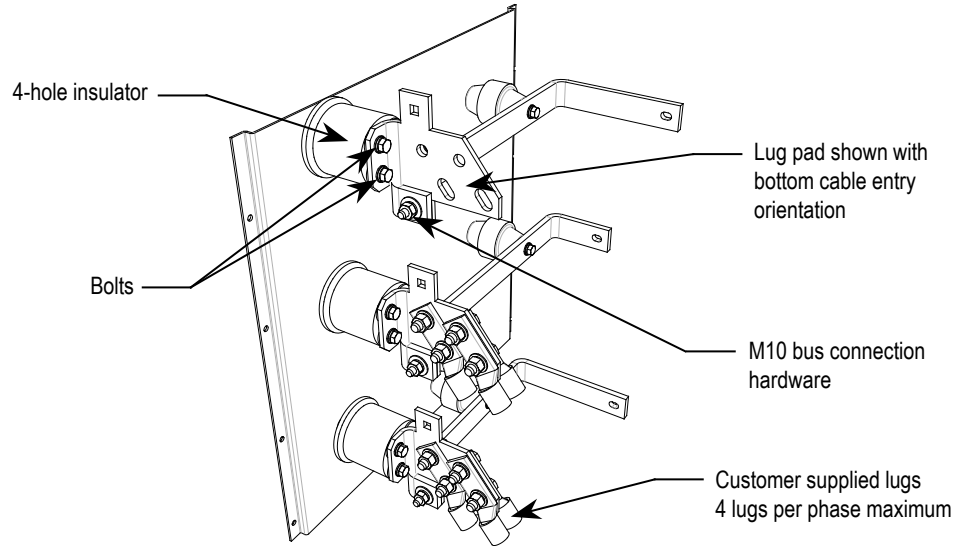
Of special concern is the tachometer signal. Two tachometer inputs are provided to accommodate a quadrature tachometer (senses motor direction). The tachometer power supply is isolated and provides +15 Volts and a ground reference. Many tachometer outputs have an open collector output, in which case 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.

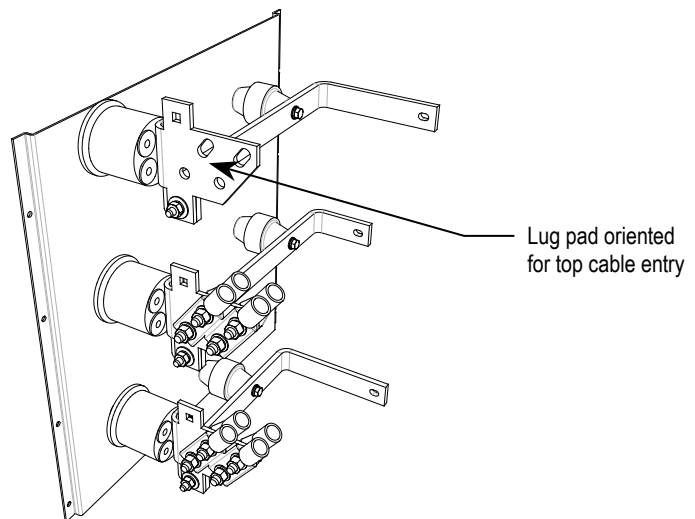
Information regarding termination of customer cables

Customer termination assemblies can accommodate either top or bottom customer cable entry. The assemblies as provided are for bottom cable entry.



**Figure 2.15 – Typical Line Cable Termination
(assembled for bottom cable entry – 18-pulse)**

For top line cable entry, it is necessary to remove the lug pads and re-orient them as shown in Figure 2.16. 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 2.16 – Typical Line Cable Terminal Assembly
(modified for top cable entry – 18-pulse)**

Grounding Practices

The purpose of grounding is to:

- provide for the safety of personnel
- limit dangerous voltages on exposed parts with respect to ground
- facilitate proper over current 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.

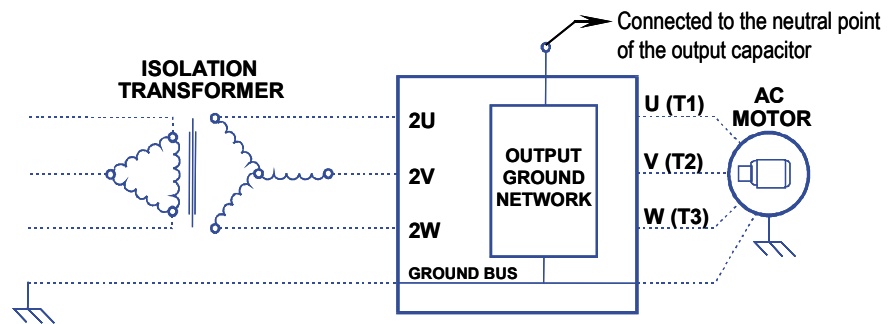


Figure 2.17 – Ground Connection Diagram with Isolation Transformer

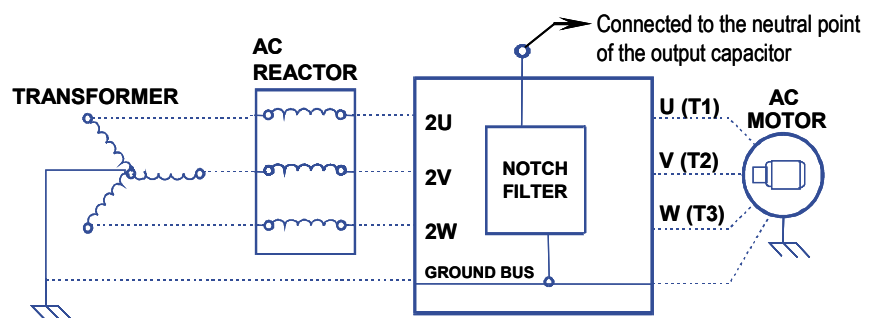


Figure 2.18 – Ground Connection Diagram with Line Reactor

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 the rated voltage of the supply.

Ground Bus

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

Interlocking

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

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

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

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

Notes:

Operator Interface

Chapter Objectives

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

- Modify information associated with the initial drive setup.
- View: - drive parameters,
 - drive status.
- View & 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 **Medium Voltage AC Drive Parameters • Technical Data (Publication 7000-TD001)** for information about the actual 'tags' within the drive and their use.

Terminology

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

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

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

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

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

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

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

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

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

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

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

Overview

The operator interface used on the PowerFlex 7000 Medium Voltage Drive is that of the PanelView 550 terminal (Figure 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).

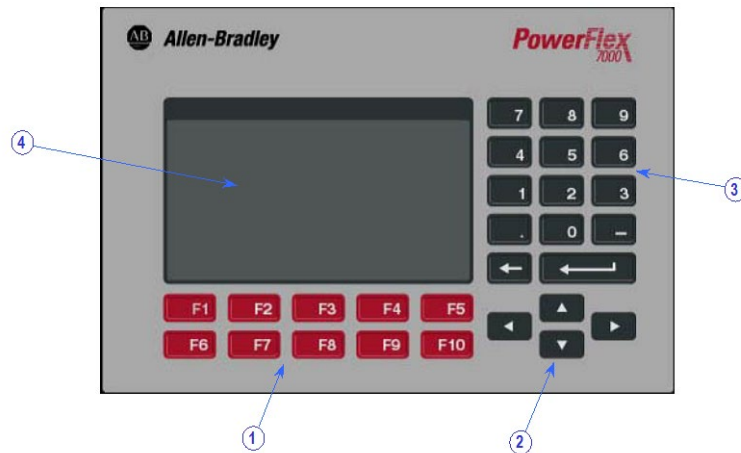


Figure 3.1– PowerFlex 7000 Operator Interface Terminal

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's 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.

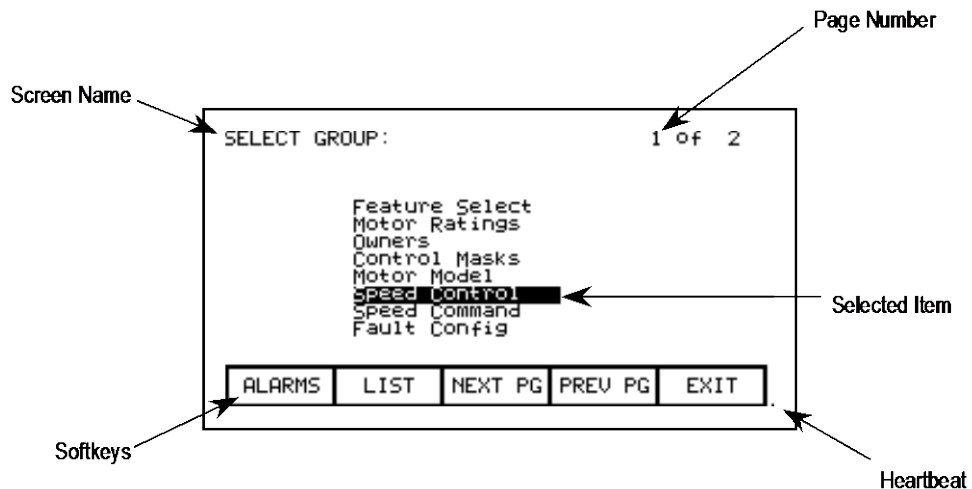


Figure 3.2 – Screen Components

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.

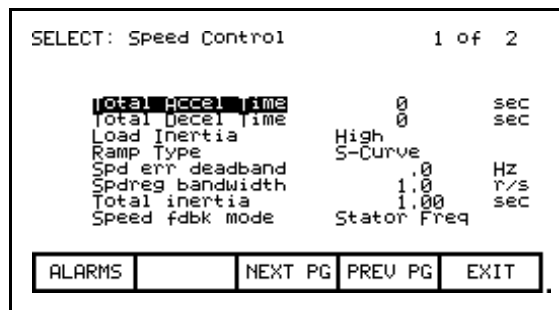


Figure 3.3 – Screen Name & Item

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 mitigating 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.

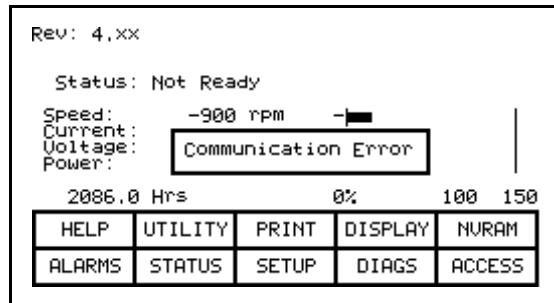


Figure 3.4 – Communications Error

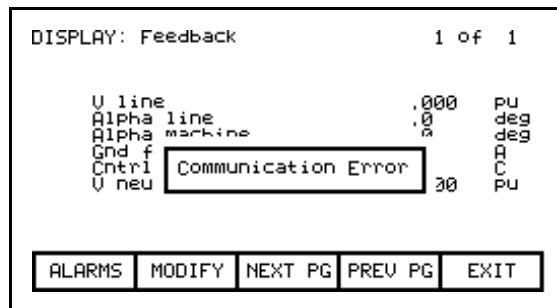


Figure 3.5 – Communications Error

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 RUN – drive is running in the forward direction
- REVERSE RUN – drive is running in the reverse direction
- WARNING – drive has a warning
- FAULTED – the drive is faulted
- DISCHARGING – waiting for input filter capacitors to discharge on a PWM rectifier before restart

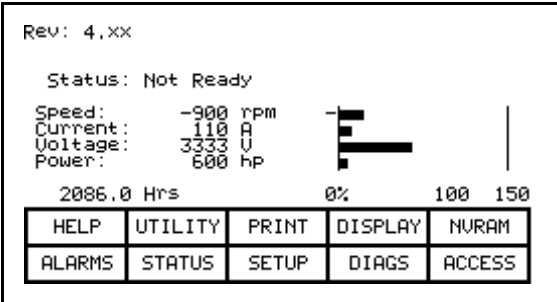


Figure 3.6 – Top Level Menu

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.

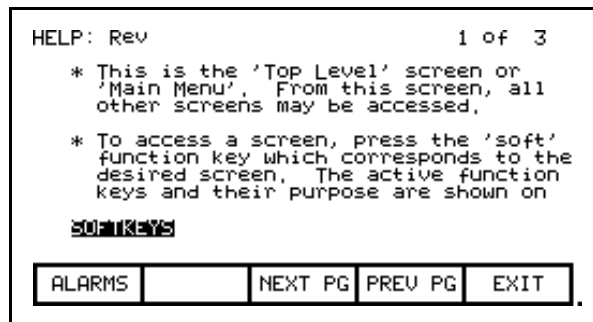


Figure 3.7 – Typical Help Screen

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 could 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.

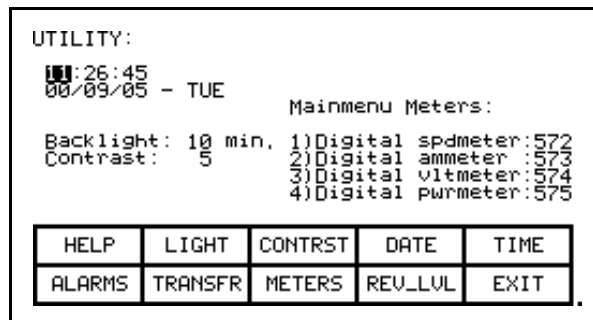


Figure 3.10 – Utility Operation Screen

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.

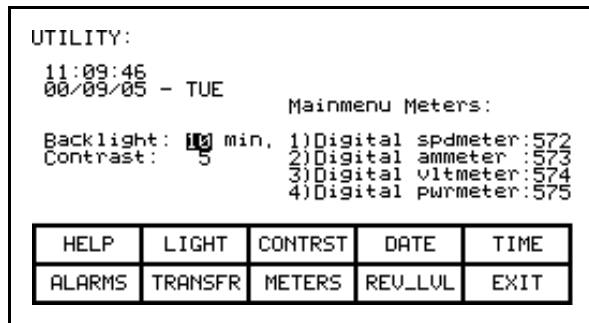


Figure 3.11 – Utility Light

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.

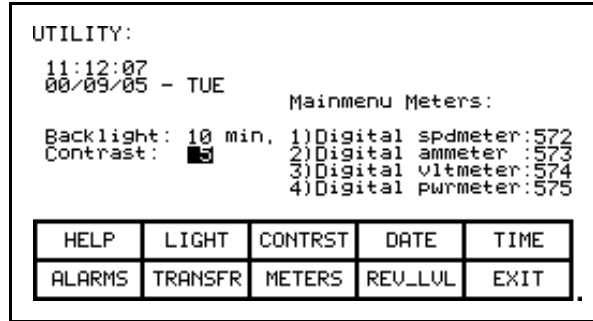


Figure 3.12 – Utility Contrast

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.

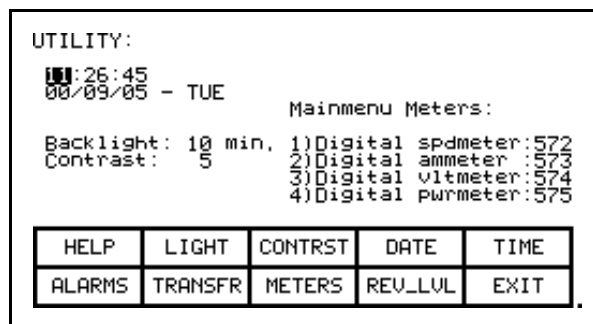


Figure 3.13 – Utility Time

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.

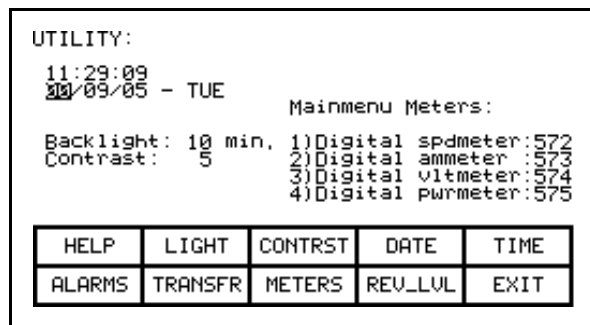


Figure 3.14 – Utility Date

Selecting Meters

The utility screen (Figure 3.10) shows the four tags assigned to the four meters on the 'Top Level Menu'. Pressing the [F8] key can change these. 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".

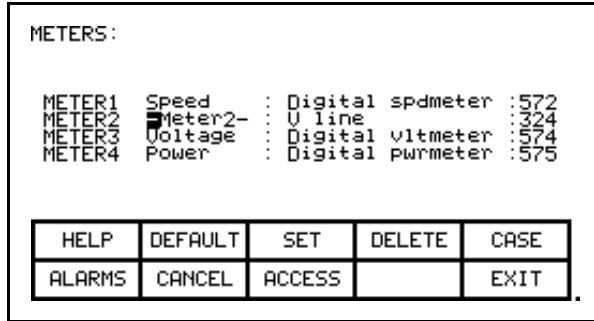


Figure 3.17 – Edit the Text

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

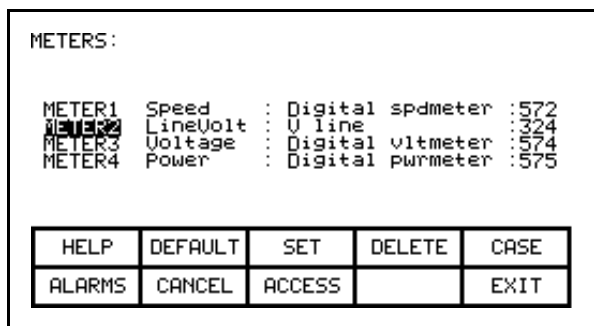


Figure 3.18 – Editing Completed

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.

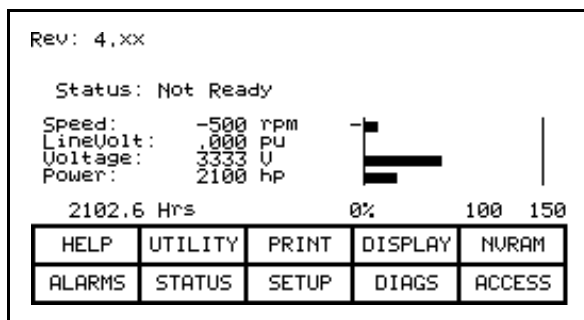


Figure 3.19 – Top Level Meter Modified

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					
PU550 BootCode			2.06					
Complete Drive			0.000					
RCP Firmware			1.000					
ICP Firmware			1.000					
CIP Firmware			1.000					
<table border="1" style="width: 100%; text-align: center;"> <tr> <td>ALARMS</td> <td></td> <td>TEXT</td> <td></td> <td>EXIT</td> </tr> </table>				ALARMS		TEXT		EXIT
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.

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

Figure 3.21 – Edit the Drive Name

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

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.

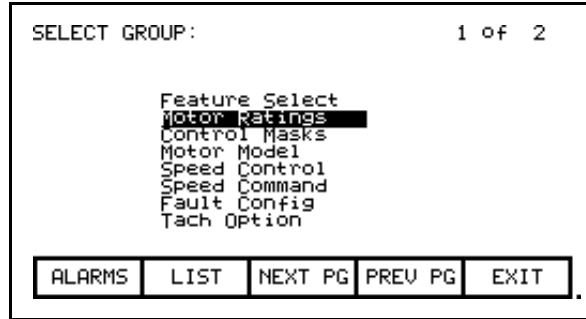


Figure 3.23 – Selecting a Group

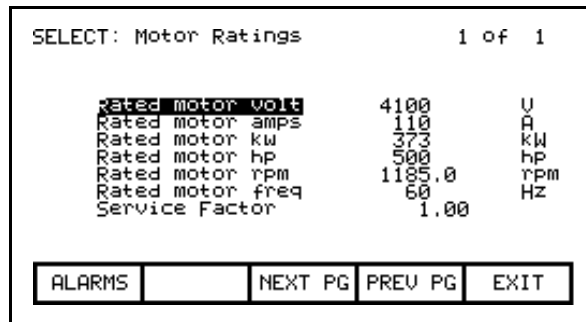


Figure 3.24 – Selecting a Member of a Group

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.

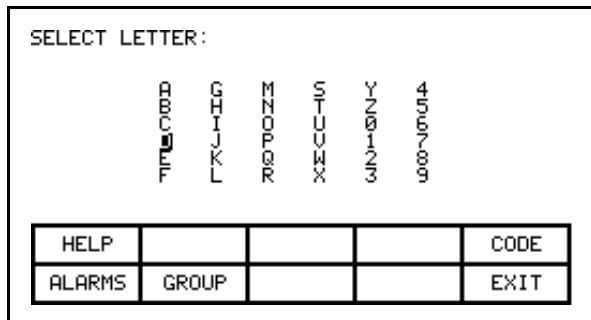


Figure 3.25 – Selecting via a Letter (Step 1)

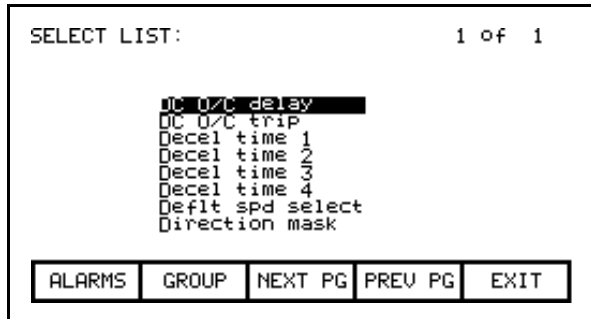


Figure 3.26 – Selecting Name via List (Step 2)

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.

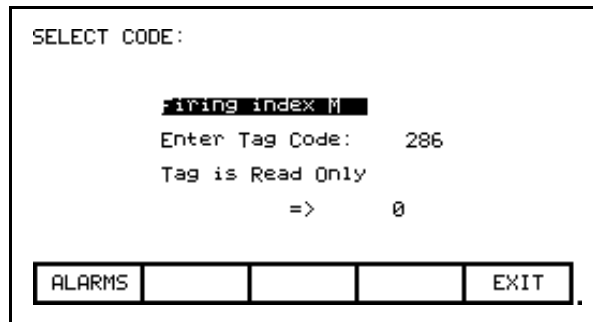


Figure 3.30 – Selected Tag Inappropriate

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.

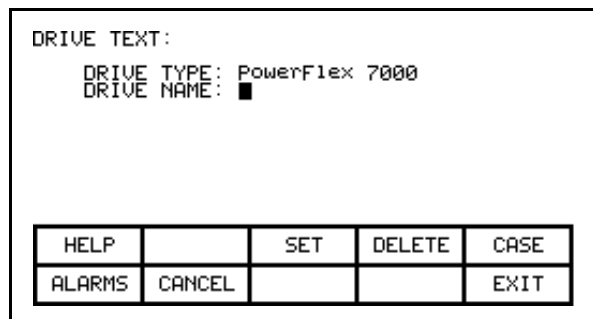


Figure 3.31 – Typical Text Edit Screen

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) if it exists on the Customer Interface Board. 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.

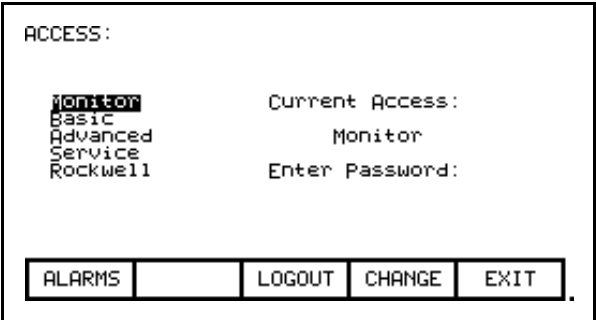


Figure 3.32 – Access Screen

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.

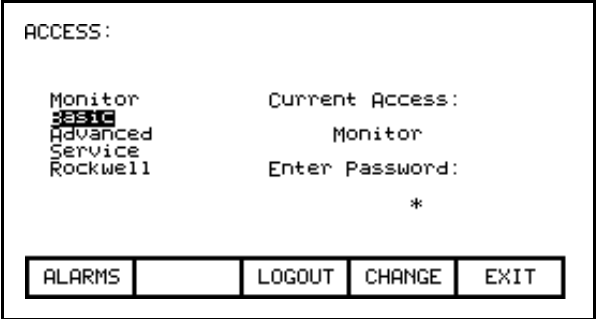


Figure 3.33 – Pin Entry

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.

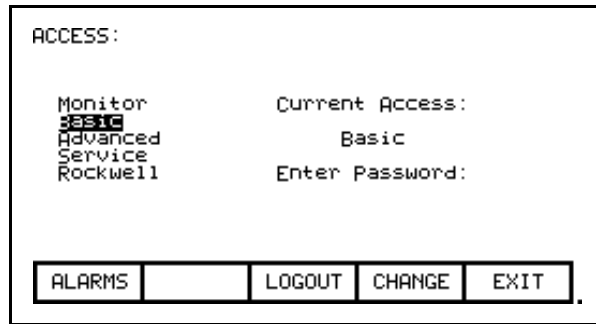


Figure 3.34 – Access Level Changed

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.

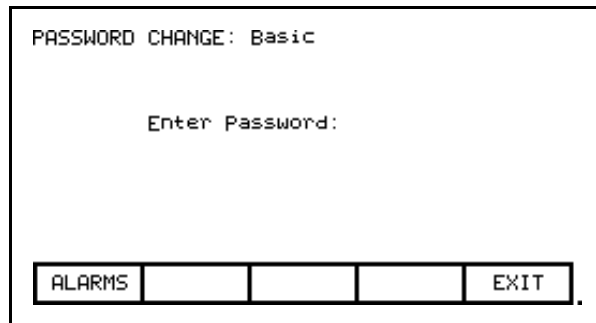


Figure 3.35 – PIN Change

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	U	
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		V
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.

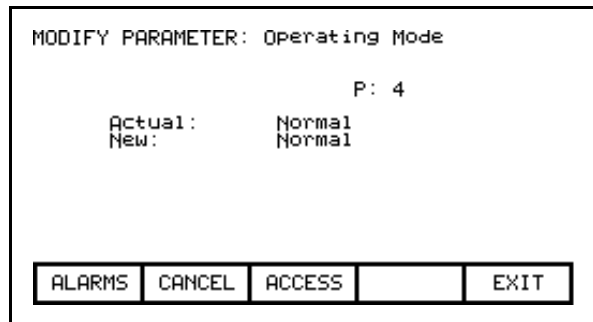


Figure 3.44 – Modify Enumerated Value

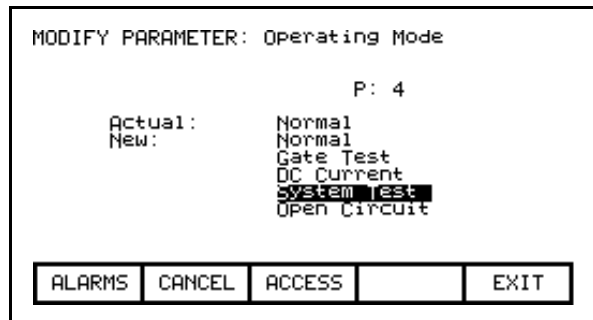


Figure 3.45 – Option List Viewed on Single Page

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.

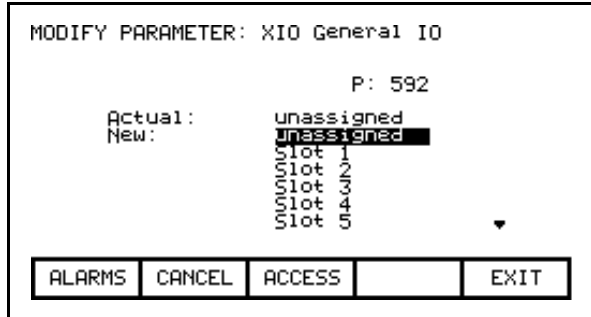


Figure 3.46 – Option List Viewed on Multiple Pages

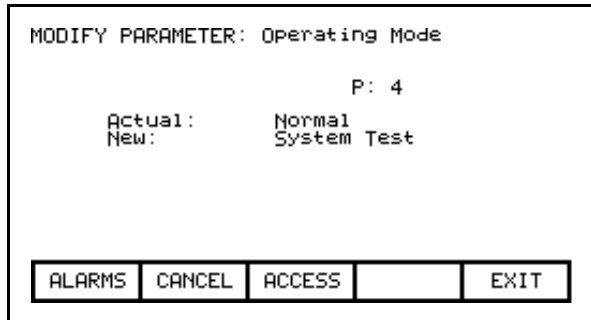


Figure 3.47 – Modification Completed

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.

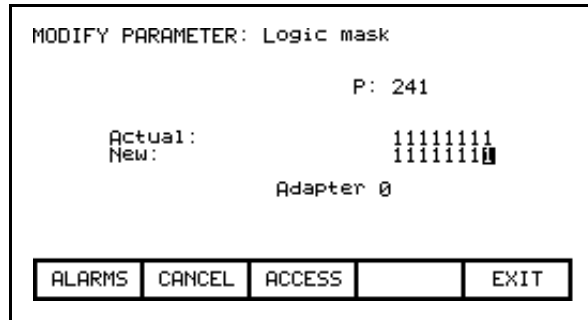


Figure 3.48 – Modify Bit Encoded Value

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 screen 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).

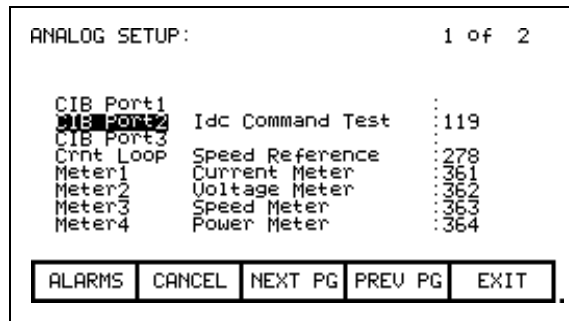


Figure 3.49 – Analog Setup

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).

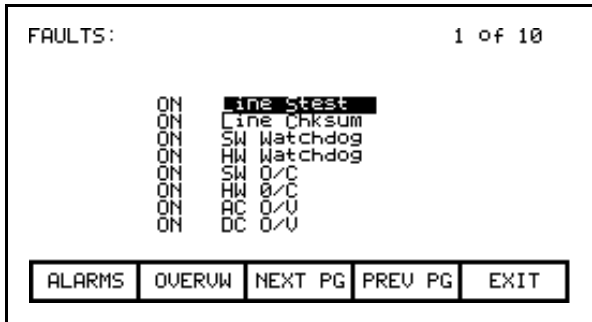


Figure 3.50 – Fault Screen

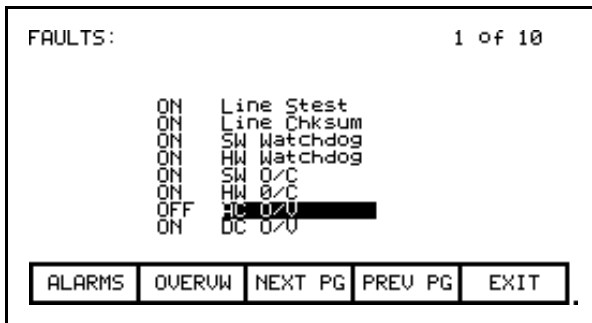


Figure 3.51 – Fault Mask OFF

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.

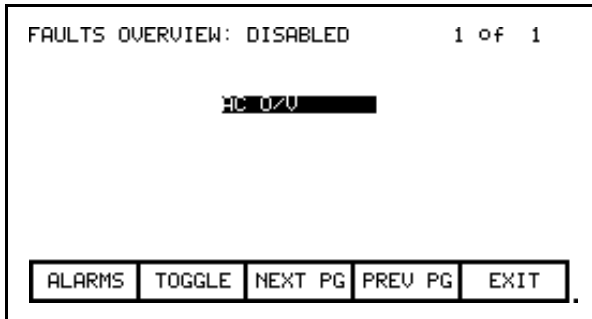


Figure 3.52 – AC O/V, Disabled

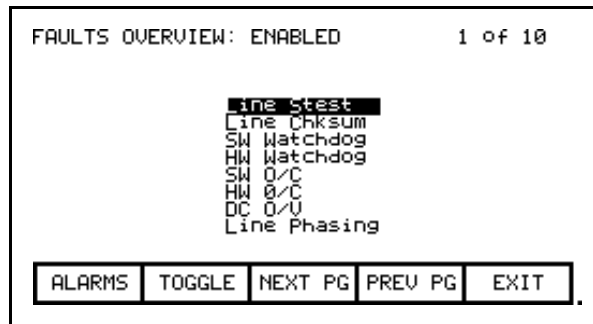


Figure 3.53 – Fault Overview, Enabled

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).

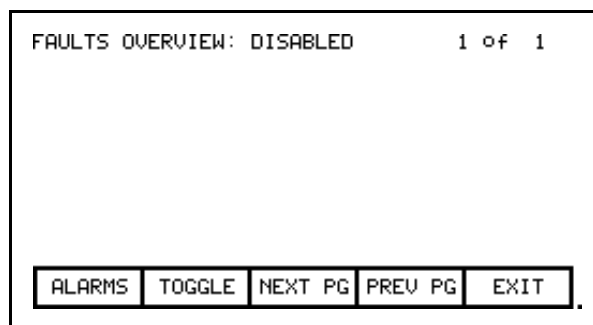


Figure 3.54 – AC O/V Removed From List

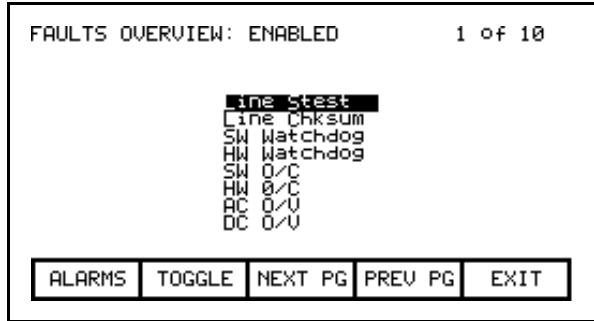


Figure 3.55 – AC O/V Now Enabled

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).

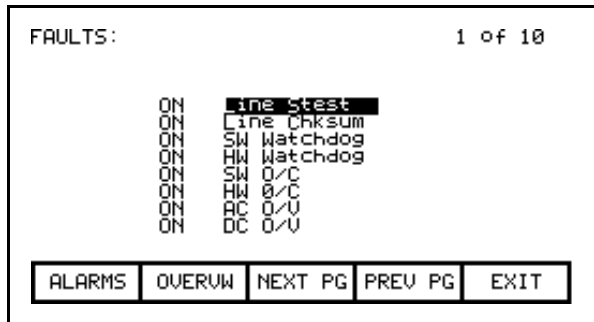


Figure 3.56 – AC O/V Mask is ON

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.

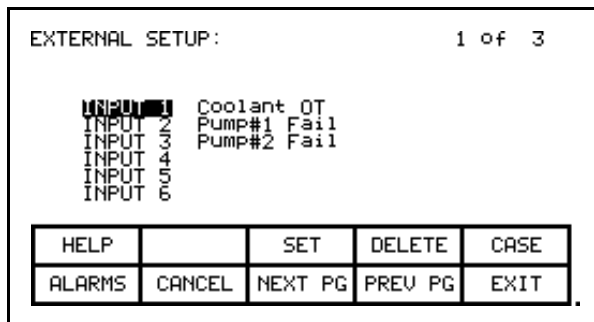


Figure 3.57 – External Setup Text

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.

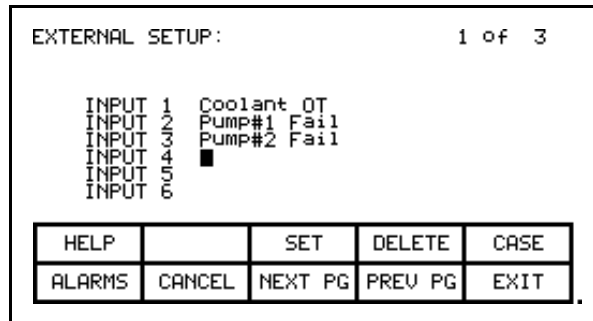


Figure 3.58 – Modify Text

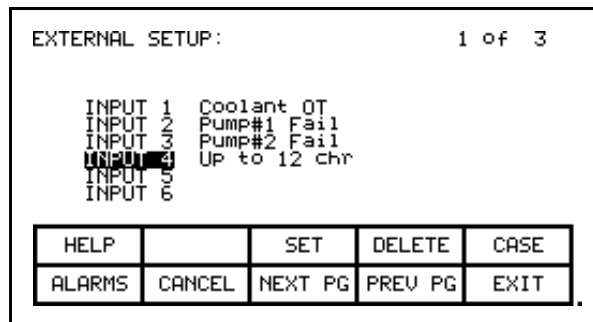


Figure 3.59 – Modification Completed

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	V 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**.

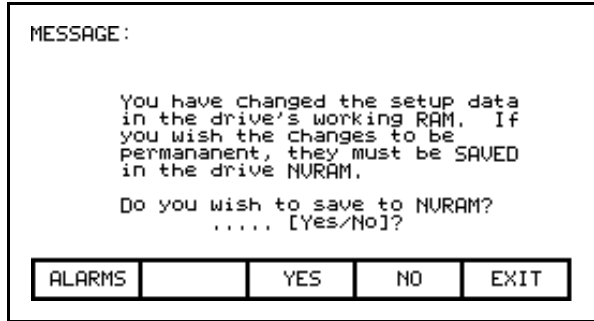


Figure 3.62 – Message Prompt Screen

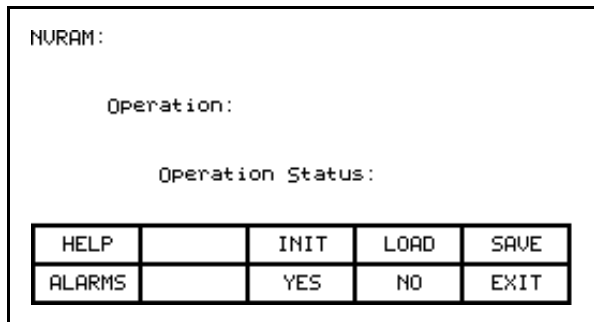


Figure 3.63 – NVRAM Screen

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.

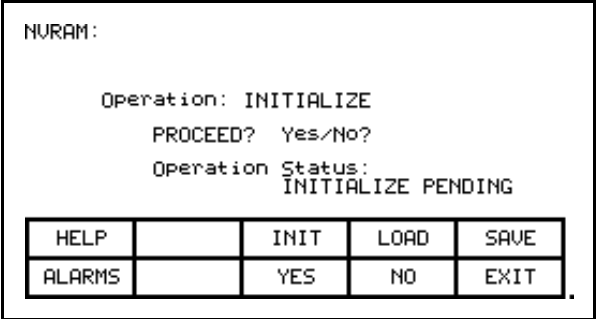


Figure 3.64 – Initialize Operation

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).

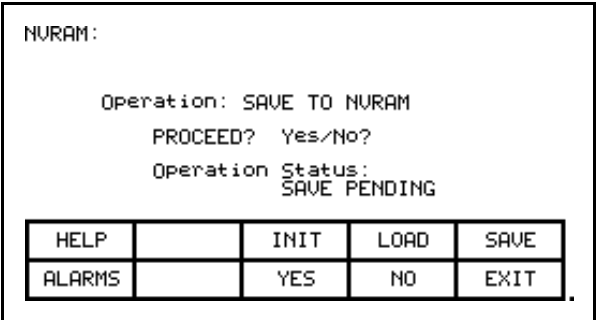


Figure 3.65 – Save Operation

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).

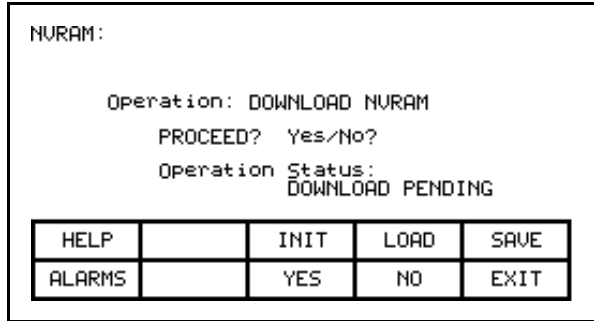


Figure 3.66 – Load Operation

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).

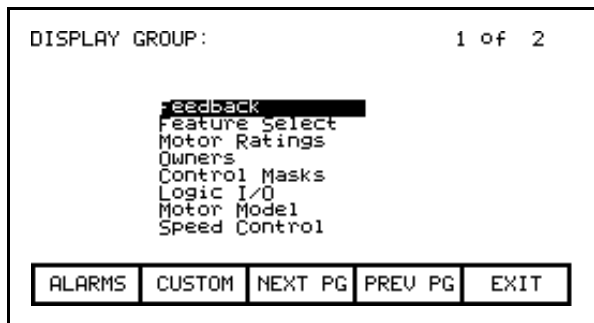


Figure 3.67 – Display Screen

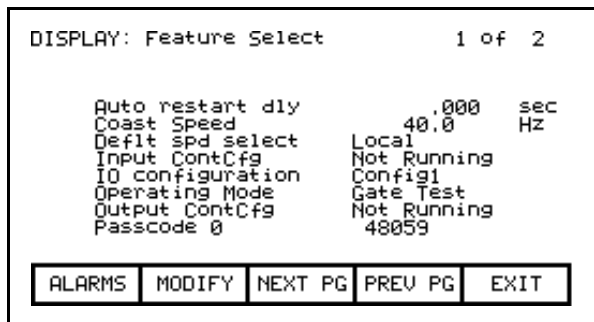


Figure 3.68 – Feature Select Group Chosen

DISPLAY: Logic I/O		1 of 1
Logic command	00	Hex
Logic status 1	00	Hex
Logic status 2	00	Hex
Local inputs	00	Hex
Local outputs	00	Hex
SCANport input	00	rpm
SCANport output	00	rpm

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

Figure 3.69 – Bit Encoded Parameter

VIEW PARAMETER: Local outputs			
Ready	00	Close Bypass	00
Running	00	At speed	00
Rev Rot'tn	00	Torque Lmt	00
Fault	00	Test Mode	00
Warning	00	Synching	00
Start Fans	00	Start Field	00
Close Input	00	Enable Field	00
Close Output	00	Reset Faults	00

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.

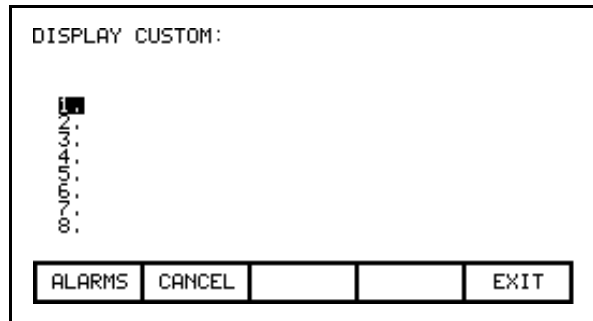


Figure 3.71 – Display Custom Screen

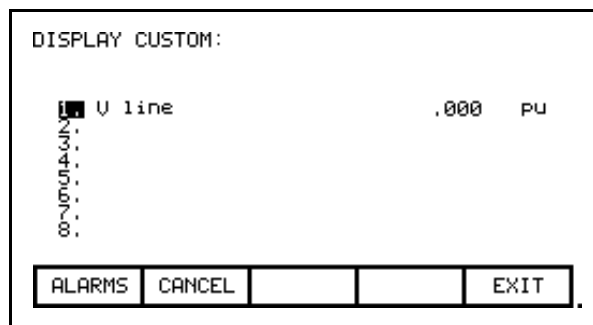


Figure 3.72 – V Line Assigned

The changes take affect immediately, however are not saved 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.

View Drive Status

The status of the drive is viewed by pressing the [F7] key from the Top Level Menu. This screen, shown in Figure 3.73, constantly displays the latest status of the drive.

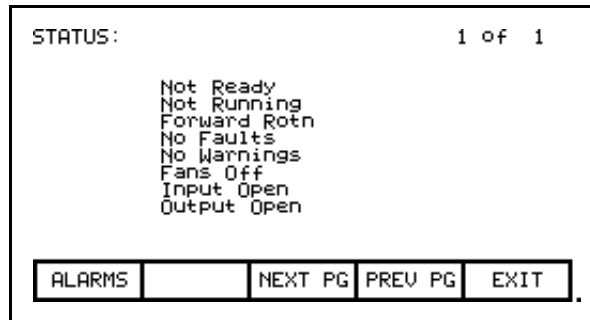


Figure 3.73 – Status Screen

View & Reset Alarms

All drive faults and warnings are logged to their respective queues. Collectively the faults and warnings are referred to as "Alarms". When a new alarm occurs, the F6 key on any screen will begin to flash in reverse video. Pressing the [F6] key on any screen will bring you to the screen as shown in Figure 3.74.

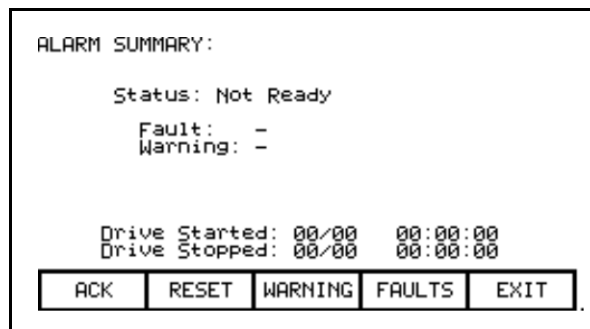


Figure 3.74 – Alarm Summary Screen

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

Note: Terminal FRN > 4.005.

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

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

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

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

A screen typical of Figure 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.

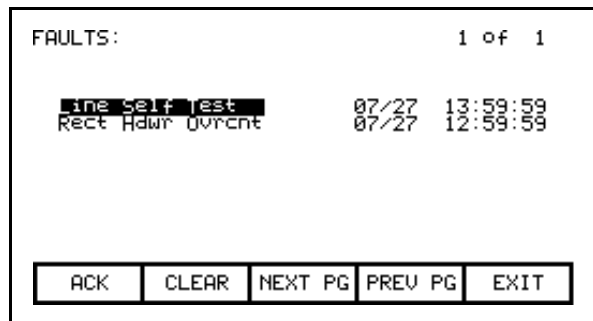


Figure 3.75 – Fault Queue

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.

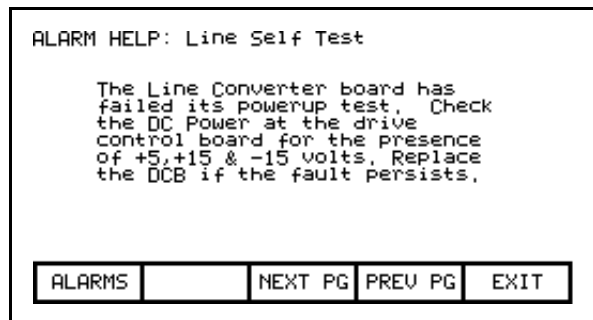


Figure 3.76 – Alarm Help



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.

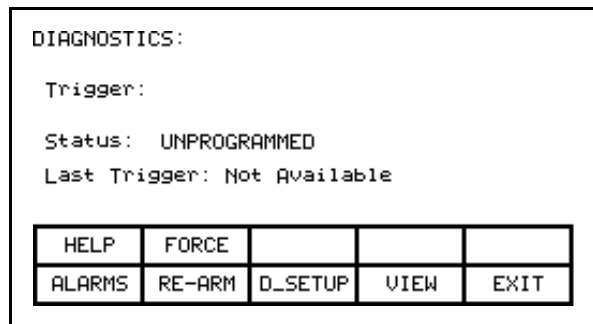


Figure 3.79 – Diagnostic Screen

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 values 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.

DIAGNOSTICS SETUP:		1 of 2		
S-Trigger: U line		<	.200 PU	
Trace 1	U line	:	324	
Trace 2		:	:	
Trace 3		:	:	
Trace 4		:	:	
Rate [mSec]:		5	Post Sample [%]:	10
HELP	COND	DATA	RATE	POST
ALARMS	CANCEL	ACCESS	TRIGGER	EXIT

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 effect, 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.


```

DIAGNOSTICS:

Trigger: U line          =      .000 PU
        Single

Status: Stopped

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

```

HELP	FORCE			
ALARMS	RE-ARM	D_SETUP	VIEW	EXIT

Figure 3.85 – Diagnostic Stopped

```

DIAGNOSTICS VIEW:                          7 of 13

```

	Trace 1 [HZ]	Trace 2 [HZ]	Trace 3 [PU]	Trace 4 [PU]
	4.9	4.9	.000	.000
T->				
	1.1	1.1	.000	.000
	2.2	2.2	.000	.000
	3.3	3.3	.000	.000
	4.4	4.4	.000	.000
	4.4	4.4	.000	.000

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

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 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.

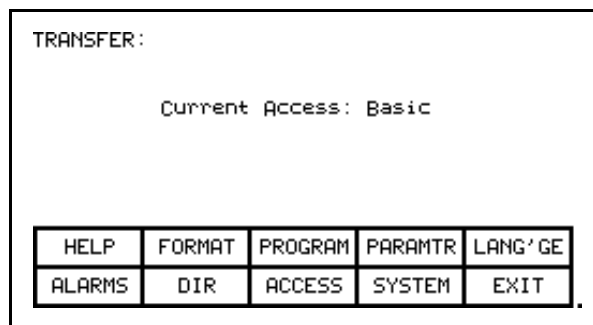


Figure 3.87 – Transfer Main Menu

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).

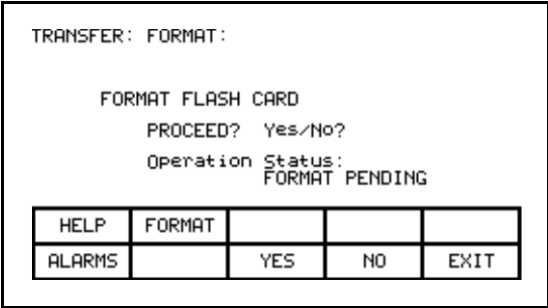


Figure 3.88 – Format the Flash Card

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:			
2-03-14	.PAR	99/07/30	09:10
FRENCH	.LNC	08/02/28	10:39
SPANISH	.LNC	07/06/12	10:17
PUMP	.PAR	09/10/20	11:17
RUSSIAN	.LNC	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.

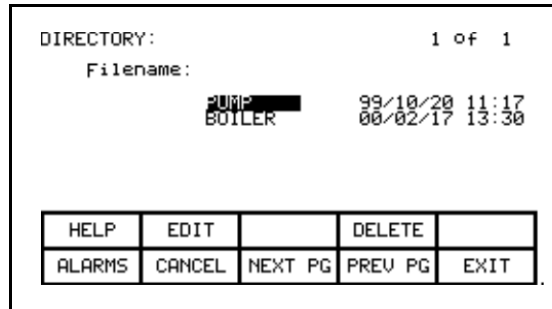


Figure 3.90 – Typical File Selection

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.

TRANSFER: PROGRAM:				
FILENAME: REV3_14.FMW				
DOWNLOAD FIRMWARE				
PROCEED? Yes/No?				
Operation Status:				
TRANSFER PENDING				
HELP		PROGRAM		
ALARMS	DIR	YES	NO	EXIT

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.

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

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.

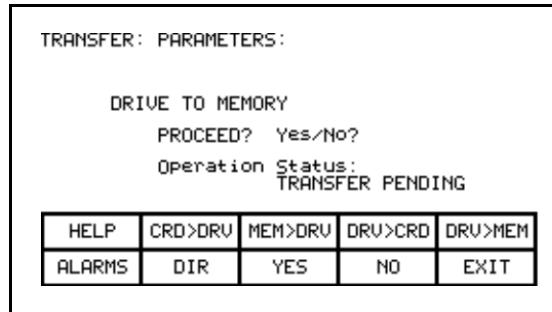


Figure 3.93 – Transfer Stored Parameters

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:				
	RENCH	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

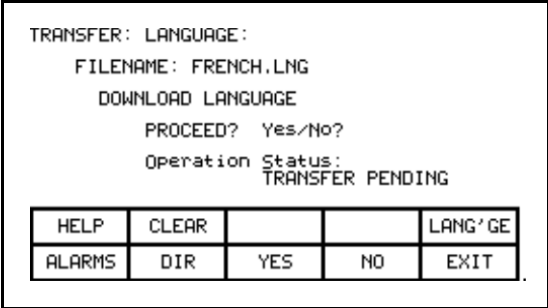


Figure 3.96 – Transfer Language Module

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.

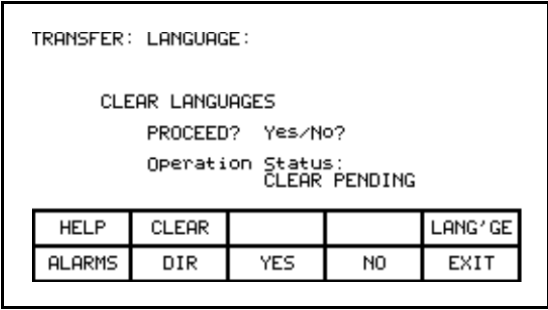


Figure 3.97 – Clear Languages

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.

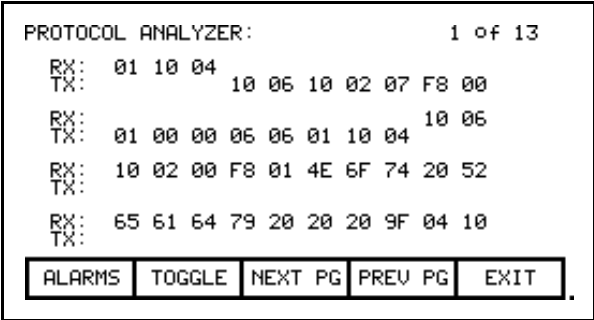


Figure 3.99 – Hexadecimal Displayed

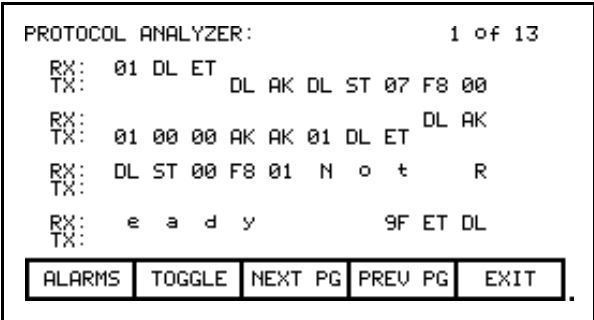


Figure 3.100 – Mixed Format Displayed

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 2F 30 30 00 31 2F 30 : 1.00.1.0
0010: 30 00 31 2F 30 30 00 45 : 0.1.00.E
0018: 5F 57 5C 59 73 58 00 31 : nglish.1
0020: 2E 30 30 00 40 01 40 00 : .00.0.0.
0028: 44 01 40 00 FF FF 45 01 : 0.0....E.
0030: 40 00 00 00 00 00 06 11 : 0.....0.
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.

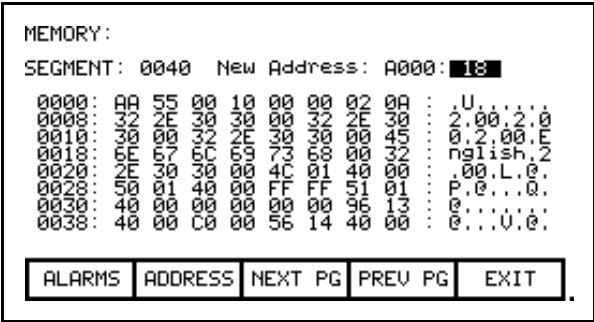


Figure 3.102 – Edit the Segment:Offset

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.

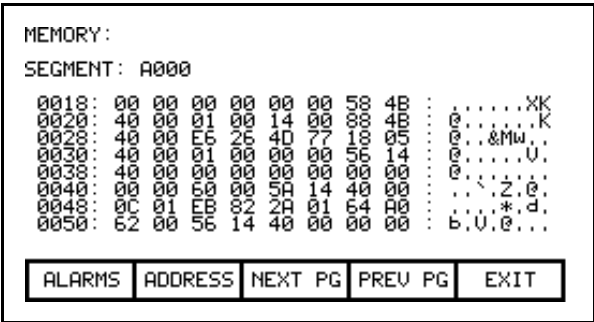


Figure 3.103 – Data at New Address

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.

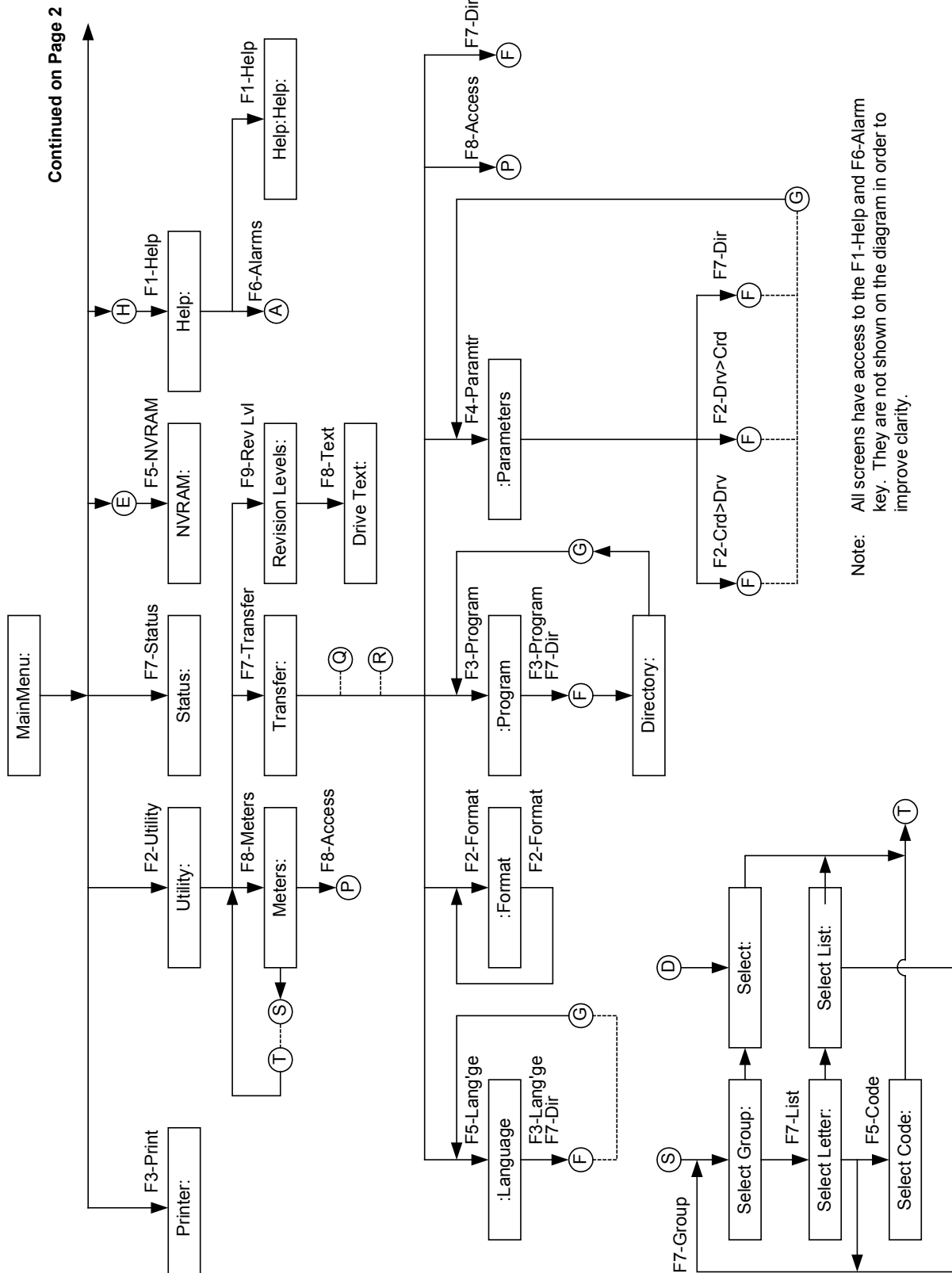


Figure 3.104 – Menu Hierarchy

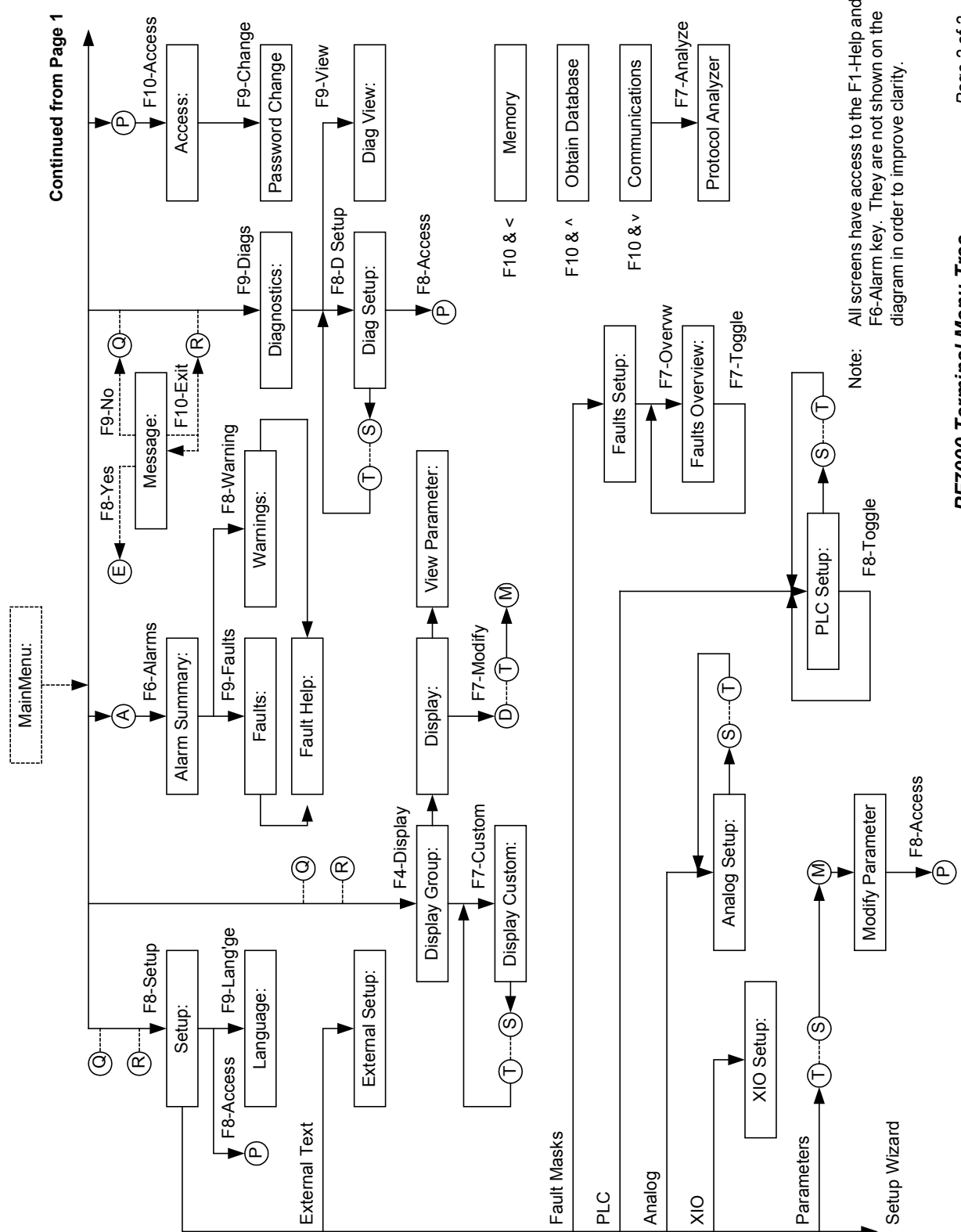


Figure 3.105 – Menu Hierarchy

PCMCIA Memory Card Installation Data

Description

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

ATTENTION



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.

ATTENTION



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.

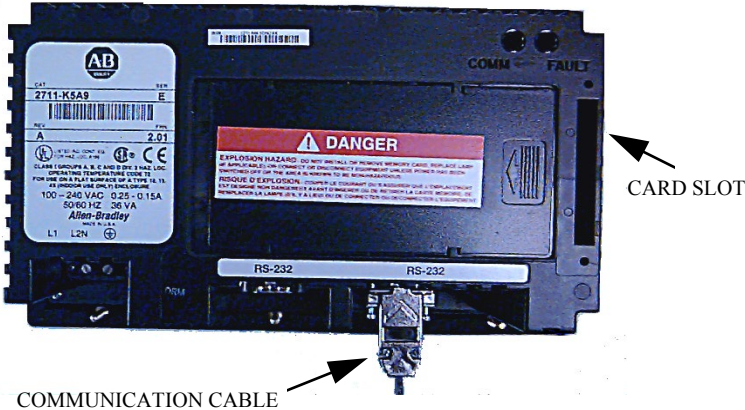
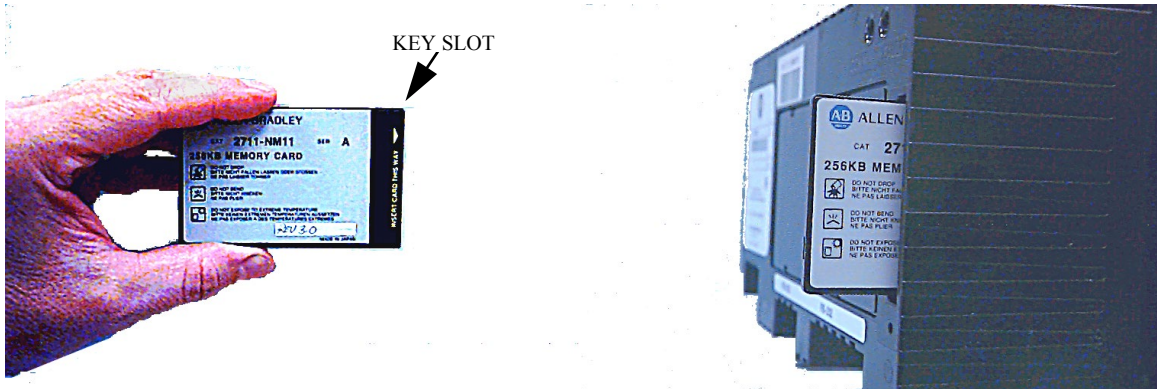


Figure 3.106 – Rear view of Operator Interface

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



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

ATTENTION



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

Commissioning

Start-up Commissioning Services

Start-up will be performed at the customer's site. Rockwell Automation requests a minimum of four- (4) weeks' notice to schedule each start-up.

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

Rockwell Automation recommends the following:

Drive Commissioning

1. A pre-installation meeting with the customer to review:
 - The Rockwell Automation Start-up Plan
 - The Start-up Schedule
 - The Drive(s) installation requirements
2. Inspect the drive's mechanical and electrical devices.
3. Perform a tug test on all internal connections within the drive and verify wiring.
4. Verify critical mechanical connections for proper torque requirements.
5. Verify and adjust mechanical interlocks for permanent location.
6. Confirm all inter-sectional wiring is connected properly.
7. Re-verify control wiring from any external control devices such as PLC5.
8. Confirm cooling system is operational.
9. Verification of proper phasing from isolation transformer to drive.
10. Confirm cabling of drive to motor, isolation transformer and line feed.
11. Collect test reports indicating megger / hipot test has been performed on line and motor cables.
12. Control power checks to verify all system inputs such as starts/stops, faults, and other remote inputs.

13. Apply medium voltage to the drive and perform operational checks.
14. Bump motor and tune drive to the system attributes. (If the load is unable to handle any movement in the reverse direction the load should be uncoupled prior to bumping the motor for directional testing).
15. Run the drive motor system throughout the operational range to verify proper performance.

Please Note: Customer personnel will be required on-site to participate in the start-up of the system.

Commissioning the Drive

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

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

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

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

ATTENTION

Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Recommended practice is to disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. If it is necessary to work in the vicinity of energized equipment, the safety related work practices of NFPA 70E, Electrical Safety requirements for Employee Work places, must be followed.

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

ATTENTION

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

Pre-Commissioning Responsibilities

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

Please print the following information:

Medium Voltage Support
Rockwell Automation
Fax: 1 (866) 465-0103 or
Fax: 1(519) 740-4756

Name:
Company:
Phone:
Fax:

Date:
Pages:

PowerFlex 7000 "B" Frame Pre-Commissioning Checklist

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

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

1. Receiving and Unpacking

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

2. Installation / Mounting

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

PowerFlex 7000 “B” Frame Pre-Commissioning Checklist

3. Safety

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

4. Control Wiring

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

PowerFlex 7000 "B" Frame Pre-Commissioning Checklist

5. Power Wiring

Initials	Date	
		<input type="checkbox"/> The power cable connections to the drive, motor and isolation transformer adhere to CEC, NEC, IEC or appropriate local standards.
		<input type="checkbox"/> The cable terminations, if stress cones are used, adhere to the appropriate standards.
		<input type="checkbox"/> Appropriate cable insulation levels are adhered to, as per Rockwell Automation specifications (refer to tables on page 2-29 of User Manual for Cable Insulation Requirements).
		<input type="checkbox"/> All shields for shielded cables must be grounded at the source end only.
		<input type="checkbox"/> If shielded cables are spliced, the shield must remain continuous and insulated from ground.
		<input type="checkbox"/> All wire sizes used are selected by observing all applicable safety and CEC / NEC / IEC regulations.
		<input type="checkbox"/> All power connections are torqued as per Rockwell Automation Specifications. (Refer to information in Appendix B "Torque Requirements")
		<input type="checkbox"/> All customer power cabling has been Meggered or Hi-Pot tested before connecting to drive system.
		<input type="checkbox"/> Power wiring phase rotation has been verified per the specific electrical diagrams supplied by Rockwell Automation.

6. Drive line-up Status

Initials	Date	
		<input type="checkbox"/> The medium voltage and low voltage power is available for startup activities.
		<input type="checkbox"/> The motor is uncoupled from the driven load.
		<input type="checkbox"/> The load is available for full load testing.

Commissioning Preparation

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

Recommended Tools and Equipment

Hand Tools

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

Electrical Equipment

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

Test Equipment

- 100 MHz oscilloscope with at least 2 channels and memory
- 600-Volt (1000V rating) digital multimeter with assorted clip leads
- 5000 Volt megohmmeter

Computer Requirements and Software

- Laptop computer (486 or higher installed with Microsoft (MS) Windows)
- Microsoft HyperTerminal (Provided with MS Windows)
- Rockwell Automation Software (RS) drive tools (Optional)
- RS Logix **
- Required computer cables
 - 9-Pin Null Modem (See Chapter 7 on Troubleshooting)
 - 9-Pin Serial (See Chapter 7 on Troubleshooting)
 - Remote I/O (SCANport DeviceNet...) *
 - PLC Communications Cable **

* Only required when Remote I/O has been provided with the drive.

** Only required when PLC has been provided with the drive

Technical Publications

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

PowerFlex 7000 “B” Frame Manual

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

PowerFlex 7000 Parameters

The PowerFlex 7000 Technical Data publication for **Parameters** is also required for Commissioning and Troubleshooting. Refer to **7000-TD001_-EN-P** for the latest firmware revision.

Additional Manuals

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

Resources Required to Complete Drive Commissioning

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

- Self powered gate driver board power supply cable (supplied with SCR rectifier drives only)
- Rockwell Automation electrical and mechanical diagrams
- PLC program (if supplied with a PLC)
- Commissioning data sheets
- All required manuals

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

PowerFlex 7000 “B” Frame Commissioning Checklist

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

It is recommended that this checklist be photocopied so as that it is readily available while performing drive commissioning.

- | | | |
|---------------------------------|---|--|
| Drive Application Review | <input type="checkbox"/> | Study Rockwell Automation prints provided with Drives System. |
| | <input type="checkbox"/> | Study the system one-line diagram and identify all sources of power. |
| | <input type="checkbox"/> | Verify one-line diagram. Trace power cables back to their sources and verify that equipment tag ID numbers agree with the customer’s one-line diagram. |
| | <input type="checkbox"/> | Inspect the process for hazards. Verify that the load is not turning due to process (A freewheeling motor will generate voltage). |
| Safety Tests | <input type="checkbox"/> | Lock out and tag all sources of power as per OSHA guidelines. |
| | <input type="checkbox"/> | Test for voltage potential in cabinet with appropriate safety equipment. |
| | <input type="checkbox"/> | Remove step down CPT or PT fuses and place them in a safe place outside of the drive cabinet (To be done with control power off). |
| | <input type="checkbox"/> | Check fuse and O/L values and compare them to the values specified on the schematic diagrams. |
| Installation Review | <input type="checkbox"/> | Examine the drive for shipping damage. |
| | <input type="checkbox"/> | Inspect cabinets for debris. |
| | <input type="checkbox"/> | Ensure that protective barriers removed for drive commissioning have been re-installed. |
| | <input type="checkbox"/> | Verify that the drive line-up and all associated equipment have system power grounding cable installed. |
| | <input type="checkbox"/> | Power cabling is appropriately rated and stress-coned, if required. |
| | <input type="checkbox"/> | Power cabling has been Hi-potted or Meggered. |
| | <input type="checkbox"/> | Power cabling has been torqued per table in Appendix B. |
| | <input type="checkbox"/> | Control reactor wiring has been correctly installed as shown on the Rockwell Automation electrical diagram. |
| | <input type="checkbox"/> | Control wiring routing has been examined to ensure that AC, DC and fiber optic wiring are separated from each other. |
| | <input type="checkbox"/> | All additional control not shown on the prints has been identified, documented and forwarded to the factory for future reference. |
| | <input type="checkbox"/> | Verify that all low voltage cables in the medium voltage cabinet have sufficient clearance from power components (3 inch [76.2 mm] minimum for 4160 V) |
| | <input type="checkbox"/> | Verify that all connectors, cables and components are secure. |
| | <input type="checkbox"/> | Verify tachometer wiring (if supplied with tachometer). |
| <input type="checkbox"/> | Verify that fan hood has been assembled and mounted properly. | |

PowerFlex 7000 “B” Frame Commissioning Checklist

- Service Data**
- Record customer name, location, date and drive ID number.
 - Record drive nameplate data.
 - Record motor nameplate data and compare it to the dimensional drawings.
 - Record tachometer nameplate data, if applicable.
 - Record harmonic filter nameplate data, if applicable.
 - Record source of control power, auxiliary cooling information, environmental conditions, drive password.
 - Record all Dip switch settings, jumper settings and revision levels on printed circuit boards.
- Control Power Off Tests**
- Configure mechanical interlocks.
 - Perform a resistance check on all devices and snubber circuits.
 - Verify that the 3-phase control power coming into the control section is within specification.
 - Verify that all additional sources of low voltage power are within specification and have grounded neutrals.
- Control Power On Tests**
- Power Supply Tests**
- Apply control power and verify that AC voltages are within specifications.
 - Verify the AC/DC output is 56 Volts DC at the input of the DC/DC converter and input to gate driver power supplies. Adjust if necessary.
 - Verify the 20V output of SGCT integrated power supplies.
 - Verify that all of the DC outputs in the DC/DC converter are at rated value.
 - Verify that healthy lights are on for all control boards and firing boards (Use wire harness for SCRs).
- Converter Tests**
- Confirm that SCR and SGCT gating pulse sequence are correct for all devices.

PowerFlex 7000 “B” Frame Commissioning Checklist

Programming the Operator Interface

- Verify preliminary parameter settings.
- Calibrate signal conditioners
- Set analog outputs
- Fault masks / External faults
- Analog I/O
- PLC In/Out

System Tests

- Perform a system test with low voltage control/test power.
- Prove all protection functions as desired.
- Verify that all emergency stop devices function.
- Calibrate the analog I/O.
- Verify that the fan is operating properly.

Medium Voltage Tests

Pre-Power Tests

- Inspect cabinets for debris (tools, hardware, metal shavings, etc.).
- Re-install control fuses (to be done with control power off).

Power Tests

- Measure input contactor drop out time. (2-cycle advance warning needed if input contactor is not part of drive line-up)
- Verify that line voltage is at rated value.
- Verify harmonic by checking voltage and current waveforms at SCBL board (PWM only)
- Perform a phasing check (18-pulse drives only).
- Review drive program settings for operating at reduced load.
- Perform an IDC Test.
- Autotune
- Program the drive for operation at full load.
- Run drive at rated load and rated speed, and record data.
- Capture waveforms of voltages and currents on the line and motor sides.

Paperwork

- Print **DRIVE SETUP**, which gives all parameters, firmware revisions, PLC links, etc.
- Complete the Commissioning Data Sheets.
- Mark up modified electrical drawings.
- Add revision notes to modified PLC program.
- Have the customer sign sign-off document.
- Provide customer with parameter settings, marked-up drawings, commissioning package, PLC program and Field Report.
- Forward PLC program, modified drawings, Commissioning Package and Field report to Medium Voltage Support group.

Drive Application Review

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

Rockwell Automation Drive line-up Drawings

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

Dimensional Drawings

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

Electrical Drawings

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

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

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

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

Electrical System One-line Diagram

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

Verify One-line Diagram on Site

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

Inspect Process

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

ATTENTION

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

Safety Tests

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

ATTENTION

Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Recommended practice is to disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. If it is necessary to work in the vicinity of energized equipment, the safety related work practices of NFTA 70E, Electrical Safety requirements for Employee Work places, must be followed.

ATTENTION

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

Lockout Tagout

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

ATTENTION

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

ATTENTION

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

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

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

Step Down Transformer Fusing

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

Fuse and O/L Protection

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

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

Installation Review

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

Inspect for Shipping Damage

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

Inspect Cabinets for Debris

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

Protective Barriers

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

Component Grounding

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

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

Information on Splice Kits

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

Power Cabling

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

ATTENTION

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

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

Verify that all cables are terminated on each end and are sufficiently torqued (see Appendix B "Torque Requirements").

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

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

Control Wiring

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

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

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

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

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

ATTENTION

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

Service Data

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

Why this Information is Needed

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

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

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

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

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

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

Customer Information

COMPANY		
ADDRESS		
CITY	PROV/STATE/COUNTRY	POSTAL/ZIP CODE
SERVICE CONTACT		
TELEPHONE	FAX	E-MAIL
APPLICATION	SERIAL NO.	
DRIVE TAG ID NO.		
COMMISSIONING ENGINEER	COMMISSIONING DATE	

Drive Nameplate Data

CATALOG NO.		SCHEMATIC DIAGRAM		
Control Cell				
MAX VOLTS		Hz		
Power Cell				
UNIT SERIES	Hz	BIL (kV)	CURRENT (Amps)	RECTIFIER TYPE
MAX VOLTS	MVA	NEMA TYPE	SERVICE FACTOR	
Motor Filter Capacitors				
MANUFACTURER	MODEL NO.	CONFIGURATION: WYE θ		
VOLTS	Hz	KVAR		
Line Filter Capacitors (PWM Rectifier Only)				
MANUFACTURER	MODEL NO.	CONFIGURATION: WYE θ		
VOLTS	Hz	KVAR		
DC Link				
MANUFACTURER	SERIAL NO.	MODEL		
CURRENT (Amps)	INDUCTANCE	INSULATION CLASS	TEMP RISE	
Input Reactor				
CONFIGURATION: LINE REACTOR θ ISOLATION TRANSFORMER θ		MANUFACTURER	MODEL NO.	SERIAL NO.
VOLTAGE: PRIMARY: SECONDARY:		KVA / CURRENT	TEMP. RISE	IMPEDANCE

Motor Nameplate Data

Motor		
MOTOR TYPE:		
INDUCTION θ	SYNCHRONOUS θ	
MANUFACTURER	MODEL NO.	SERIAL NO.
HP/kW	VOLTS	CURRENT
KVA	POWER FACTOR	CYCLES
RPM	SERVICE FACTOR	EFFICIENCY
CODE	TYPE	FRAME
<u>EXCITATION (Synchronous Only)</u>		EXCITER TYPE
VOLTS:	CURRENT:	
NEMA TYPE	RTD TYPE:	
	BEARING	STATOR

Tachometer/Encoder Nameplate Data

Speed Feedback		
TACHOMETER θ	POSITION ENCODER θ	STATOR FEEDBACK (NONE) θ
MANUFACTURER	MODEL NO.	SERIAL NO.
PPR	GEAR RATIO	

DRIVE CIRCUIT BOARDS			
ACRONYM	PART NUMBER	HARDWARE REVISION	SOFTWARE REVISION
DCB L	80190-239-		
DCB M	80190-239-		
FIO L (A,B,C)	80190-099-		---
FIO M (A,B,C)	80190-099-		---
SCB L	80190-279-		---
SCB M	80190-279-		---
CIB	80190-319-		
XIO ②	80190-299-		---
VSB L 1	81000-199-		---
VSB L 2	81000-199-		---
VSB M 1	81000-199-		---
Operator Interface	2711-KSASL11		PV Firmware ① PV Software ①
TFB L	80190-639-		---
TFB M	80190-639-		---
SCR SPGDB ②	80190-219-		---
IDGPS L (1-3)	80026-044-		---
IDGPS M (1-3)	80026-044-		---
PS1 (A-F) ② [AC/DC Converter]	80026-172-		---
PS2 [DC/DC Converter]	80026-173-		---
PS4 [24V DC Power supply]	80026-096-		---
CPT	80022-069-		---
UPS			---
PRINTER			---

① PV Firmware is located on a sticker on the back of the unit; PV Software is located on the main display screen.

② The drive can have more than one of this circuit board.

SPARE DRIVE CONTROL BOARDS			
ACRONYM	PART NUMBER	HARDWARE REVISION	SOFTWARE REVISION
DCB L	80190-239-		
DCB M	80190-239-		
FIO L or M	80190-099-		---
SCB L	80190-379-		---
SCB M	80190-379-		---
CIB	80190-319-		
XIO ②	80190-299-		---
VSB L or M	81000-199-		---
Operator Interface	2711-KSASL11-		PV Firmware ① PV Software ①
TFB L or M	80190-639-		---
SCR SPGDB ②	80190-219-		---
IDGPS L or M	80026-044-		---
SGCT		--	---
SCR		--	---
PS1 ② [AC/DC Converter]	80026-172-		---
PS2 [DC/DC Converter]	80026-173-		---
PS4 [24V DC Power supply]	80026-096-		---

- ① PV Firmware is located on a sticker on the back of the unit. PV Software is located on the main display screen.
- ② The drive can have more than one of this circuit board.

Control Power Off Tests

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

Interlocking

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

Where the input switching device is provided by others, Rockwell Automation will provide a key interlock on the medium voltage compartment of the drive, and a matching interlock for installation by others on the upstream device. The interlock shall be installed in a manner that ensures the power to the drive is off and the drive is electrically isolated whenever the key is freed.

Although Key interlocks shipped with all medium voltage equipment are aligned in the factory, they often move out of position during shipping or are often misaligned when the cabinet is set down on an uneven floor. The following instructions will assist the field engineers in quickly and accurately aligning the dead-bolt key interlock with its counterpart.

ATTENTION

Servicing energized industrial control equipment can be hazardous. Severe injury or death can result from electrical shock, burn, or unintended actuation of control equipment. Hazardous voltages may exist in the cabinet even with the circuit breaker in the off position. Recommended practice is to disconnect or lock out control equipment from power sources, and confirm discharge of stored energy in capacitors. If it is necessary to work in the vicinity of energized equipment, the safety related work practices of NFTA 70E, Electrical Safety requirements for Employee Work places, must be followed.

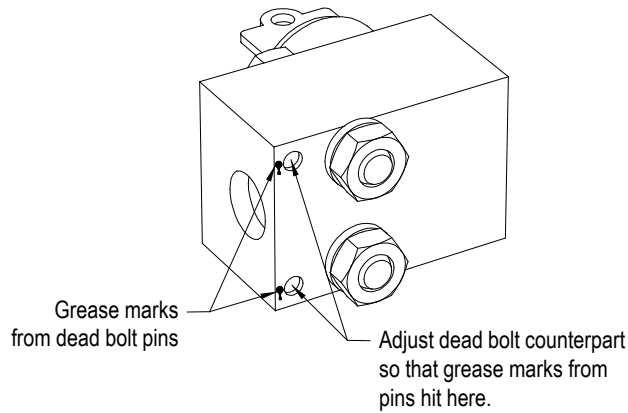


Figure 4.1 – Dead bolt assembly mounted to door

1. Lock out and isolate the drive from medium voltage. Verify with a hot stick that there is no medium voltage present.
2. Determine that the key interlock is correctly aligned by securely bolting the medium voltage doors of the cabinet closed and removing the key from the lock. The key should turn easily; if any force is required to turn the key, the dead bolt alignment requires adjustment.
3. Open the doors of the cabinet and inspect the key assembly. Place high visibility grease on the pins of the dead-bolt counterpart. The factory recommends using yellow torque sealant, however if it is unavailable almost any grease will do. (See Figure 4.1)

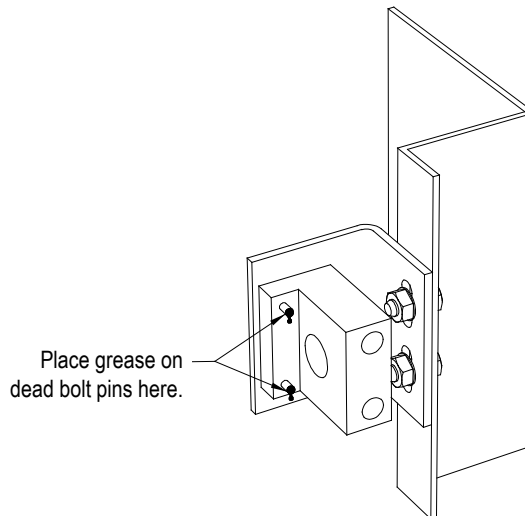


Figure 4.2 – Dead bolt counterpart mounted to cabinet

4. Bolt the cabinet door closed so the pins on the dead bolt counterpart make contact with the dead bolt assembly. Doing so should leave two marks of torque sealant or grease on the assembly where the pins made contact (See Figure 4.1 – Dead bolt assembly).
5. Slightly loosen the adjustment bolts on the counterpart and make the necessary movements on the counterpart to ensure that the pins align with the landing plates on the dead bolt assembly. As the amount of counterpart movement required is an estimate, it may take a couple attempts to properly align the assembly.
6. Clean the torque seal/grease from the key interlock once finished aligning the counterpart.

Once properly aligned, the key should turn freely when the cabinet door is fully bolted shut. If the key does not function when the door is tightly bolted closed, adjustments will have to be made to the depth of the counterpart. This can be done by adding shims on the landing plate where the counterpart is mounted.

Resistance Checks

Prior to applying control power to the drive, power semiconductor and snubber circuit resistance measurements must be taken. Doing so will confirm that no damage has occurred to the converter section during shipment. The instructions provided below detail how to test the following components:

- Inverter or PWM Rectifier Bridge
 - Anode to Cathode Resistance Test (Sharing Resistor and SGCT)
 - Snubber Resistance Test (Snubber Resistor)
 - Snubber Capacitance Test (Snubber Capacitor)
- SCR Rectifier Bridge
 - Anode to Cathode Resistance Test (Sharing Resistor and SCR)
 - Gate to Cathode Resistance Test (SCR)
 - Snubber Resistance Test (Snubber Resistor)
 - Snubber Capacitance Test (Snubber Capacitor)

ATTENTION



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

SGCT Testing

The following steps outline how to verify SGCT semiconductors and all associated snubber components. A quick reference to the expected resistance and capacitance values as well as a simple schematic diagram is located in the table below.

Table 4.A – SGCT Snubber Circuit Resistance and Capacitance Values

SGCT Rating	Sharing Resistor ❶	Snubber Resistor	Snubber Capacitor
1500 Amp	80 kΩ	7 Ω (PWMR) Ω	0.2 μf
1500 Amp	80 kΩ	7.3 Ω (Inverter) Ω	0.2 μf
800 Amp	80 kΩ	10 Ω	0.1 μf
400 Amp	80 kΩ	15 Ω (PWMR)	0.1 μf
400 Amp	80 kΩ	17.5 Ω (Inverter)	0.1 μf

❶ 2300V drives will not have a sharing resistor on devices.

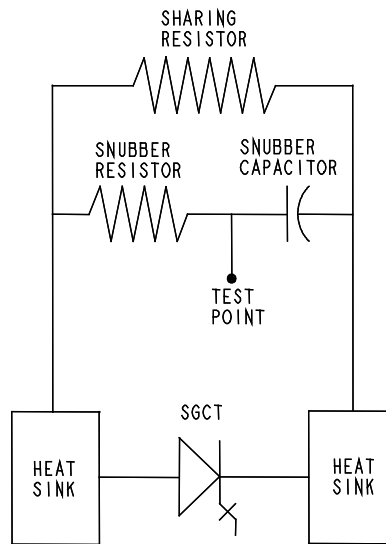


Figure 4.3 – SGCT Snubber Circuit Connections

SGCT Resistance Measurement	Measured Resistance	
	Inverter	Rectifier (PWM only)
SGCT Anode-Cathode Resistance (Heatsink to heatsink)	_____ – _____ kΩ (Lowest) (Highest)	_____ – _____ kΩ (Lowest) (Highest)
Snubber Resistance (Test Point – Heatsink above)	_____ – _____ Ω (Lowest) (Highest)	_____ – _____ Ω (Lowest) (Highest)
Snubber Capacitance (Test Point – Heatsink on Right)	_____ – _____ μF (Lowest) (Highest)	_____ – _____ μF (Lowest) (Highest)

If a device or snubber component is found to be damaged, it must be replaced using the detailed procedures in Component Definition and Maintenance.

SGCT Anode to Cathode Resistance

Performing an Anode to Cathode resistance test not only tests the integrity of the SGCT but also the integrity of the sharing resistor. An abnormal device resistance measurement will indicate either a shorted device or damaged sharing resistor.

Using an ohmmeter, measure the anode to cathode resistance each SGCT in the inverter bridge, looking for similar resistance values across each device. Easy access from the anode to cathode is available by going from heatsink to heatsink as shown in the diagram below:

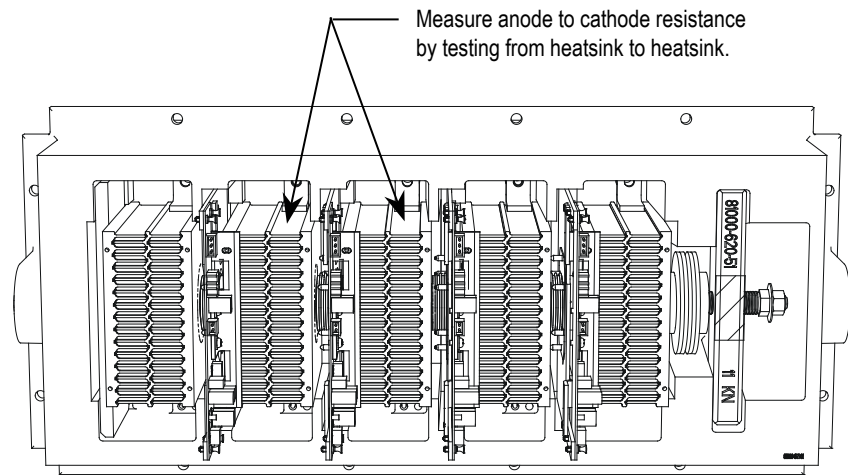


Figure 4.4 – Anode to Cathode Resistance Test Points

An SGCT when not gated on is an open circuit. A healthy device resistance value should be close to the value-sharing resistor, however due to parallel resistances in the firing card, the resistance value will be slightly lower.

Example: The resistance across the anode to cathode of a 800 amp device may be 57 k Ω even though the sharing resistor is 80 k Ω .

A failure of an SGCT can be detected by measuring a lower than normal resistance value; one device in the converter may read 15 k Ω whereas the rest of the devices in the converter measured close to 60 k Ω . This indicates a partially shorted device. A fully shorted device will read closer to 0 Ω and will be quickly identified. If the SGCT is found to be out of tolerance, refer to Chapter 6 – Component Definition and Maintenance for detailed instructions on how to replace the SGCT assembly.

Damage to a sharing resistor is easily detected if the SGCT is replaced and the anode to cathode resistance remains abnormal. If the resistor is found to be out of tolerance, refer to Chapter 6 – Component Definition and Maintenance for detailed instructions on how to replace the snubber/sharing resistor assembly.

Snubber Resistance (SGCT Device)

Access to the snubber resistor is not required to test the resistance. The snubber circuit test point is located within the PowerCage under the heatsinks. For each device, there is one test point. To verify the resistance, measure the resistance between the test point and the heatsink above.

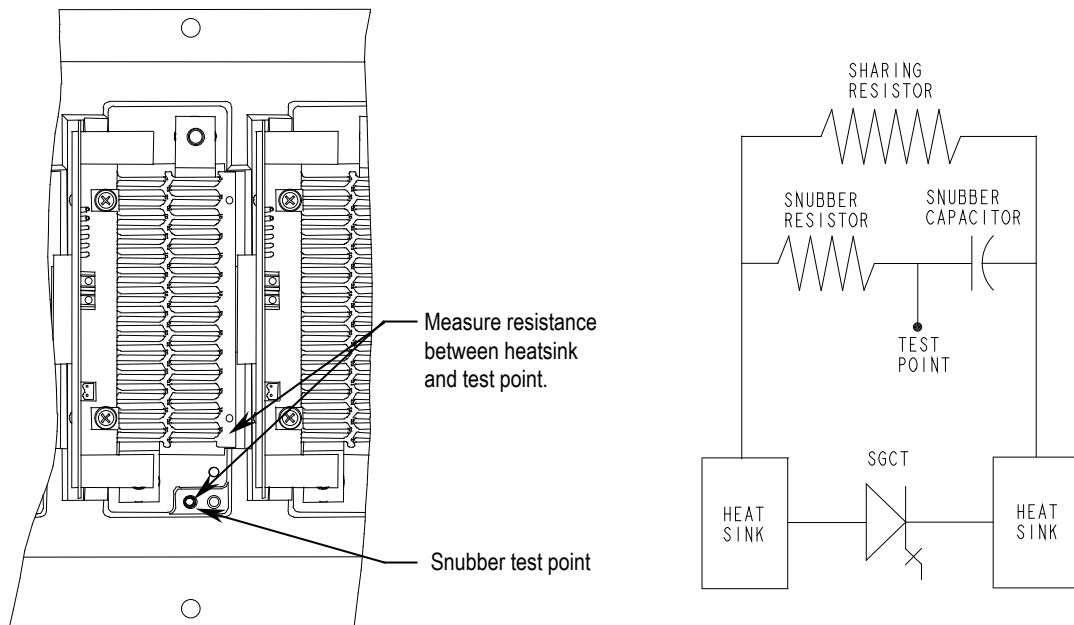


Figure 4.5 – Snubber Resistor Test

Refer to Table 4.A to determine the appropriate snubber resistance value for the current rating of the SGCT used.

If the resistor is found to be out of tolerance, refer to Chapter 6 – Component Definition and Maintenance for detailed instructions on how to replace the snubber resistor assembly.

Snubber Capacitance (SGCT Device)

Turn the multimeter from the resistance to capacitance measurement mode. Proceed to verify the snubber capacitor by measuring from the test point to the heatsink adjacent to the right.

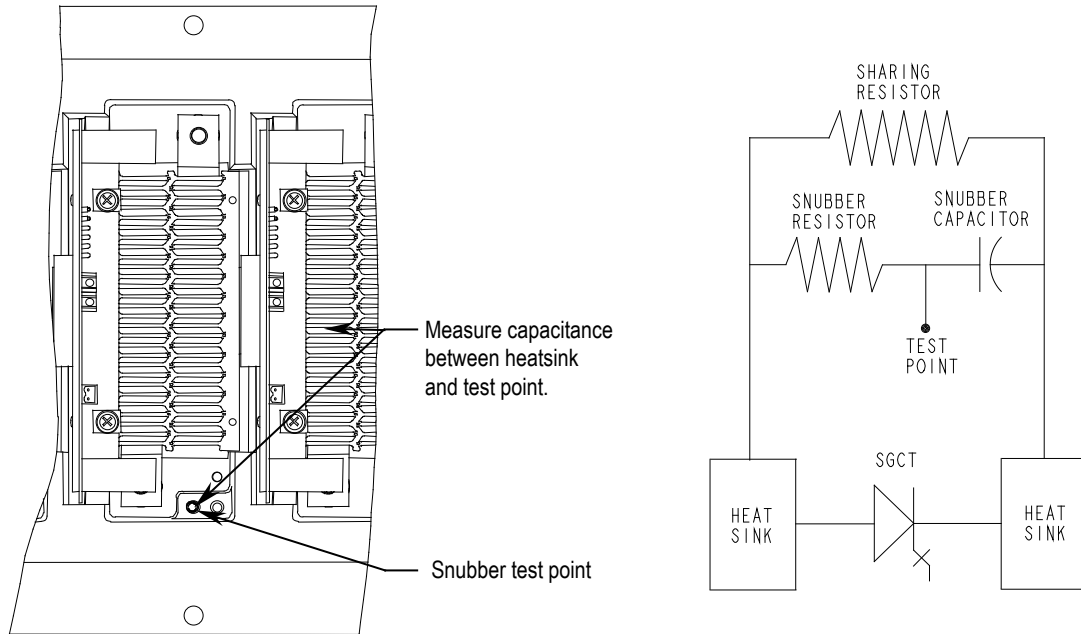


Figure 4.6 – Snubber Capacitor Test

Refer to Table 4.A to determine the appropriate snubber capacitance value for the current rating of the SGCT used.

The capacitance measured is actually affected by the snubber capacitor and other capacitance in the circuit, including capacitance from the Gate Driver circuit. You are actually looking for a consistent reading for all devices.

If the capacitor is found to be out of tolerance, refer to Chapter 6 – Component Definition and Maintenance for detailed instructions on how to replace the snubber capacitor.

SCR Testing

The following steps outline how to verify SCR semiconductors and all associated snubber components. A quick reference to the expected resistance and capacitance values as well as a simple schematic diagram is located in below:

Table 4.B – SCR Snubber Circuit Resistance and Capacitance Values

Drive Rating	Sharing Resistance	Snubber Resistance	Snubber Capacitance
2400V (6P), 6600V	80 kΩ	45 Ω	0.5 μf
3300V / 4160V	80 kΩ	60 Ω	0.5 μf
2400V (18P)	80 kΩ	60 Ω	0.68 μf

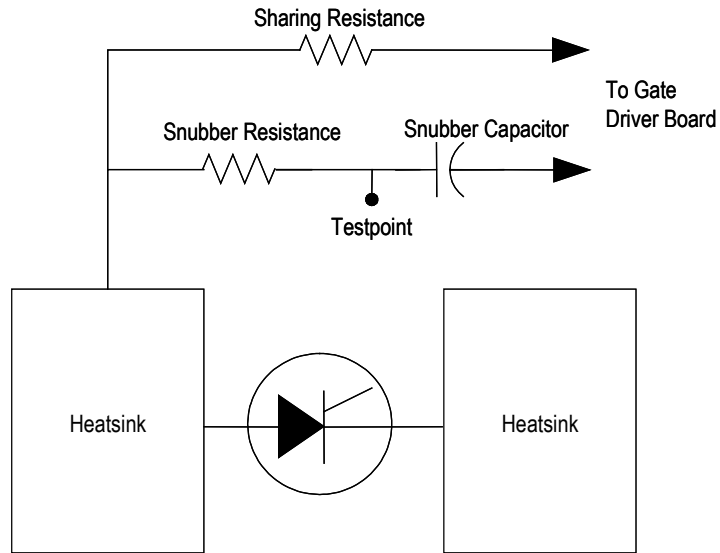


Figure 4.7 – SCR Snubber Circuit Connections

If a device or snubber component is found to be damaged, a detailed replacement procedure is located in Chapter 6 – Component Definition and Maintenance.

SCR Resistance Measurement	Measured Resistance
SCR Anode-Cathode Resistance (Heatsink to Heatsink)	_____ – _____ kΩ (Lowest) (Highest)
SCR Gate-Cathode Resistance (Across SCR Phoenix Connector)	_____ – _____ Ω (Lowest) (Highest)
Snubber Resistance (Test Point – Heatsink on Left)	_____ – _____ Ω (Lowest) (Highest)
Snubber Capacitance (Test Point – White Wire from Snubber Phoenix connector on Right)	_____ – _____ μF (Lowest) (Highest)
Sharing Resistance (Red Wire from Snubber Phoenix connector – Heatsink on Left)	_____ – _____ kΩ (Lowest) (Highest)

SCR Anode to Cathode Resistance

Performing an Anode to Cathode resistance test verifies the integrity of the SCR. Unlike the SGCT, the SCR uses the snubber circuit to power the self-powered gate driver boards. The resistance measurement taken across each SCR should be constant; an inconsistent value may indicate a damaged sharing resistor, self-powered gate driver board or SCR.

Using an ohmmeter, measure the anode to cathode resistance across each SCR in the rectifier bridge, while looking for similar resistance values across each device. Easy access from the anode to cathode is available by going from heatsink to heatsink as shown in the diagram below:

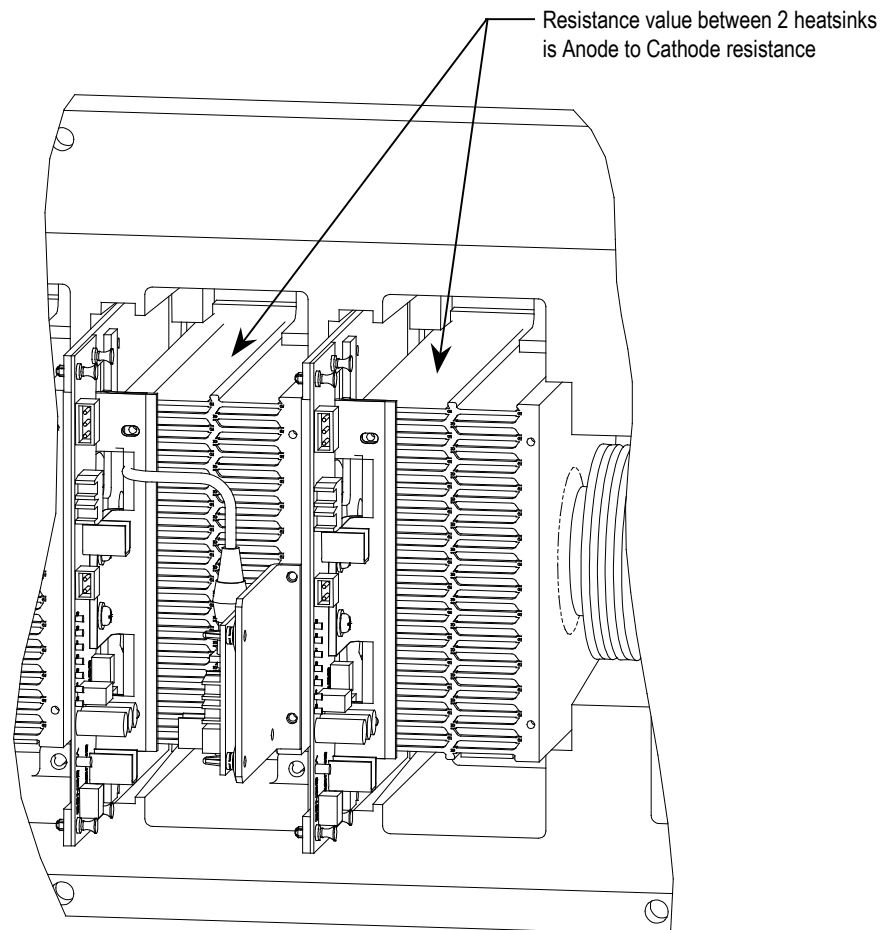


Figure 4.8 – Anode to Cathode Test

A good SCR and circuit should read between 22 and 24 k Ω .

An SCR that has failed from anode to cathode will commonly produce a resistance value of 0 for a shorted device or $\infty \Omega$ for an opened device. Unlike the SGCT, it is highly irregular for an SCR to have a partially shorted device. If an SCR is found to be out of tolerance, refer to Chapter 6 – Component Definition and Maintenance for detailed instructions on how to replace the SCR assembly.

SCR Sharing Resistance Test

To test the sharing resistor of an SCR module, disconnect the 2-pole plug of the self-powered gate driver board labeled SHARING and SNUBBER on the circuit board. The red wire of the plug is the sharing resistor. Measure the resistance between the red wire of the plug and the heatsink to the left. A value of 80 k-ohms indicates a healthy sharing resistor.

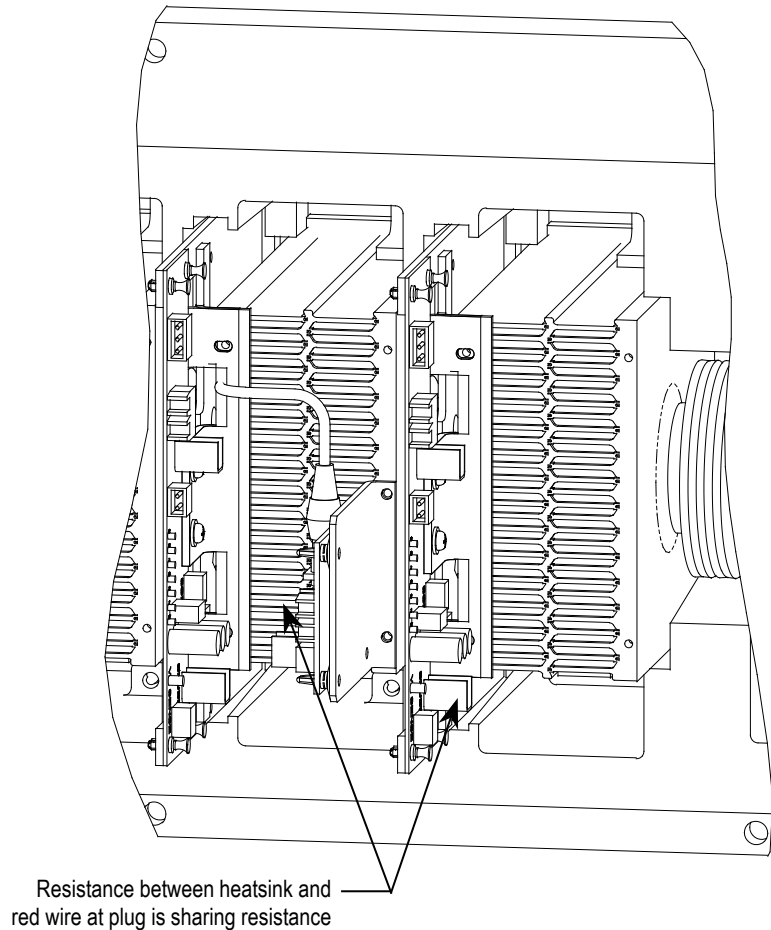


Figure 4.9 – SCR Sharing Resistance Test

Gate to Cathode Resistance

One test that can be performed on SCRs that cannot be performed on SGCTs is a Gate to Cathode Resistance Test. Performing a Gate to Cathode resistance measurement will identify damage to a SCR by revealing either an open or shorted gate to cathode connection. To test an SCR from gate to cathode, disconnect the SCR gate leads from the self powered gate driver board and measure the gate to cathode resistance on the SCR firing card Phoenix connector as shown below:

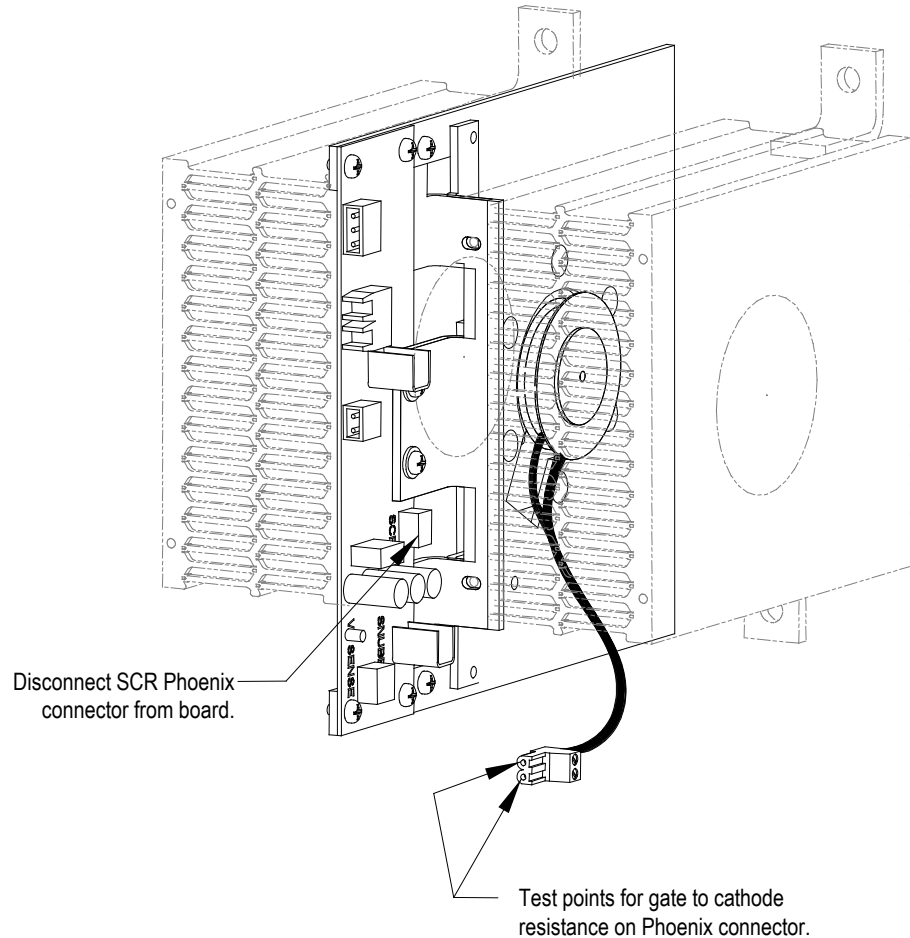


Figure 4.10 – SCR Gate to Cathode Test

The resistance value from gate to cathode should be between 10 Ω to 20 Ω . A value close to 0 Ω indicates that there is an internal short in the SCR. An extremely high value indicates that the gate connection in the device has broken.

If a Gate to Cathode test reveals a damaged SCR, a detailed replacement procedure is located in Chapter 6 – Component Definition and Maintenance.

Snubber Resistance (SCR Device)

Access to the snubber resistor is not required to test the resistance. The snubber circuit test point is located within the PowerCage under the heatsinks. For each device, there is one test point. To verify the resistance, measure the resistance between the test point and the heatsink above.

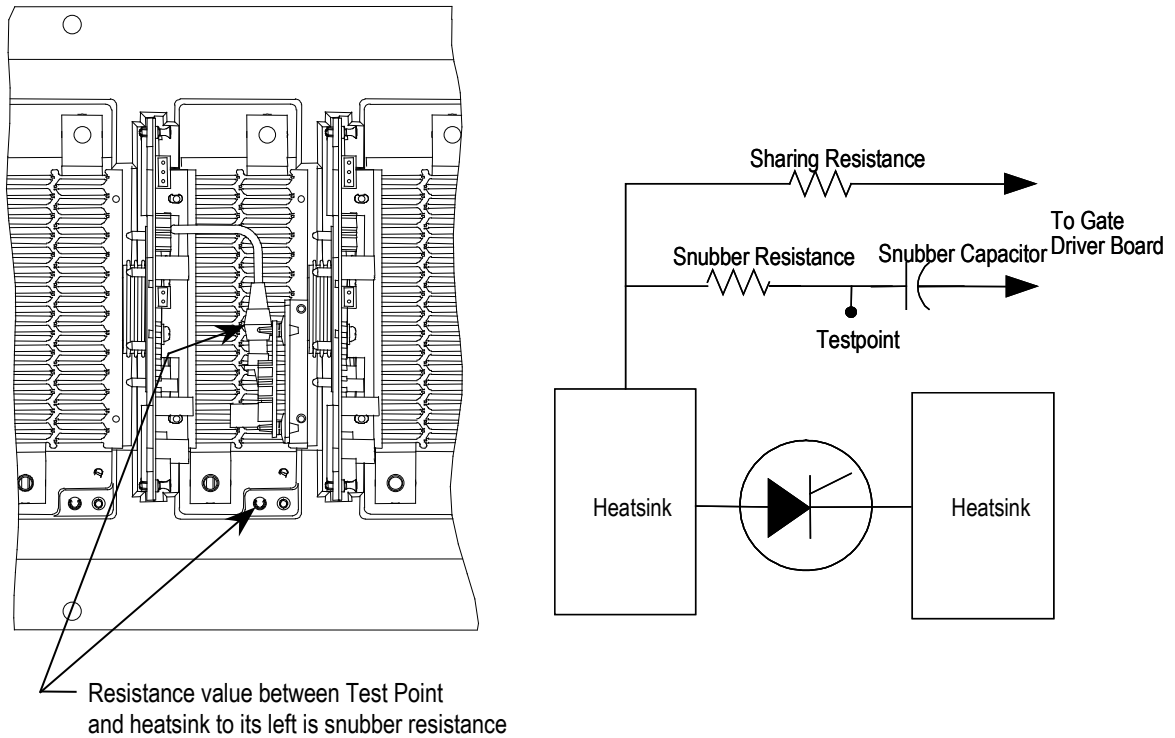


Figure 4.11 – Snubber Resistance Test

Refer to Table 4.B to determine the appropriate snubber resistance value for the current rating of the SCR used.

If the resistor is found to be out of tolerance, refer to Chapter 6 – Component Definition and Maintenance for detailed instructions on how to replace the snubber resistor assembly.

Snubber Capacitance (SCR Device)

Turn the multimeter from the resistance to capacitance measurement mode. Proceed to verify the snubber capacitor by measuring from the test point and the white wire at the 2-pole device snubber plug (labeled snubber).

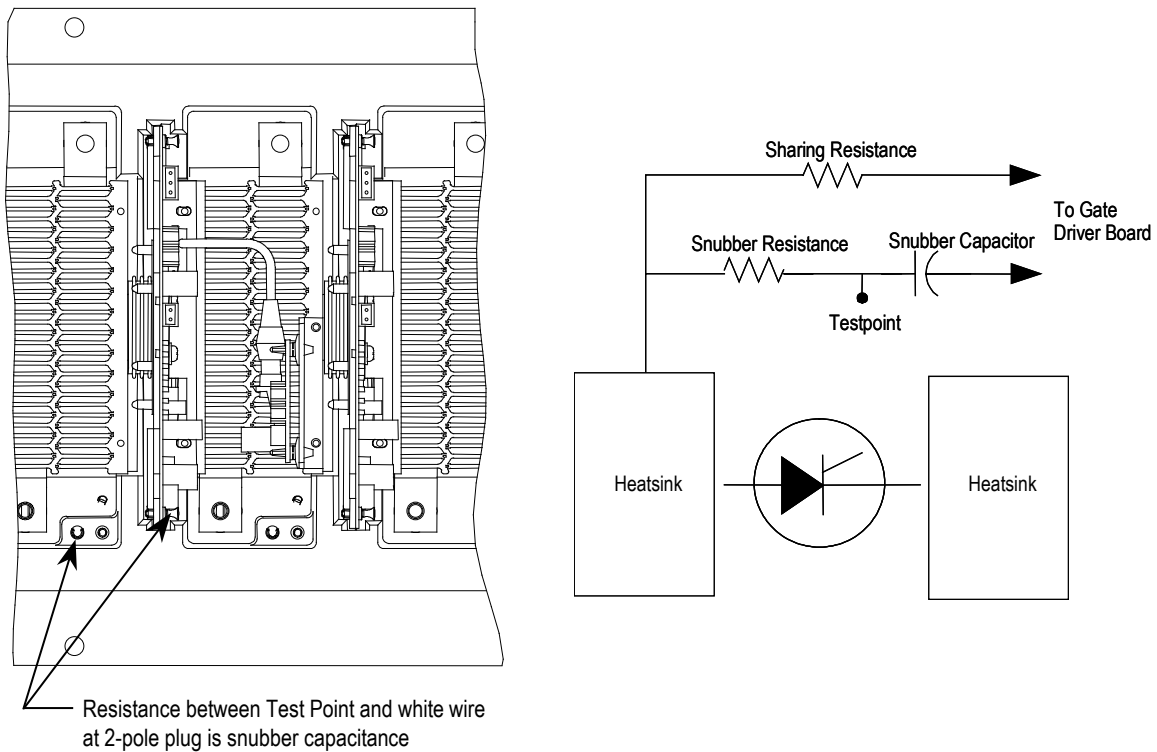


Figure 4.12 – Snubber Capacitance Test

To test the snubber capacitance, disconnect the plug of the self-powered gate driver board labeled SHARING and SNUBBER. The resistance between the white wire of the plug and the Test Point to its left is the snubber capacitance.

Refer to Table 4.B to determine the appropriate snubber capacitance value for the current rating of the SCR used. You should read the actual snubber capacitor value shown in the table.

If the capacitor is found to be out of tolerance, refer to Chapter 6 – Component Definition and Maintenance for detailed instructions on how to replace the snubber capacitor.

Control Power Tests

Prior to energizing the drive, verify that the control power being fed into the input breakers are rated as designated on the electrical diagram.

Although there are a variety of options available to customers that will effect the control power distribution within the drive, the input will always be as illustrated below:

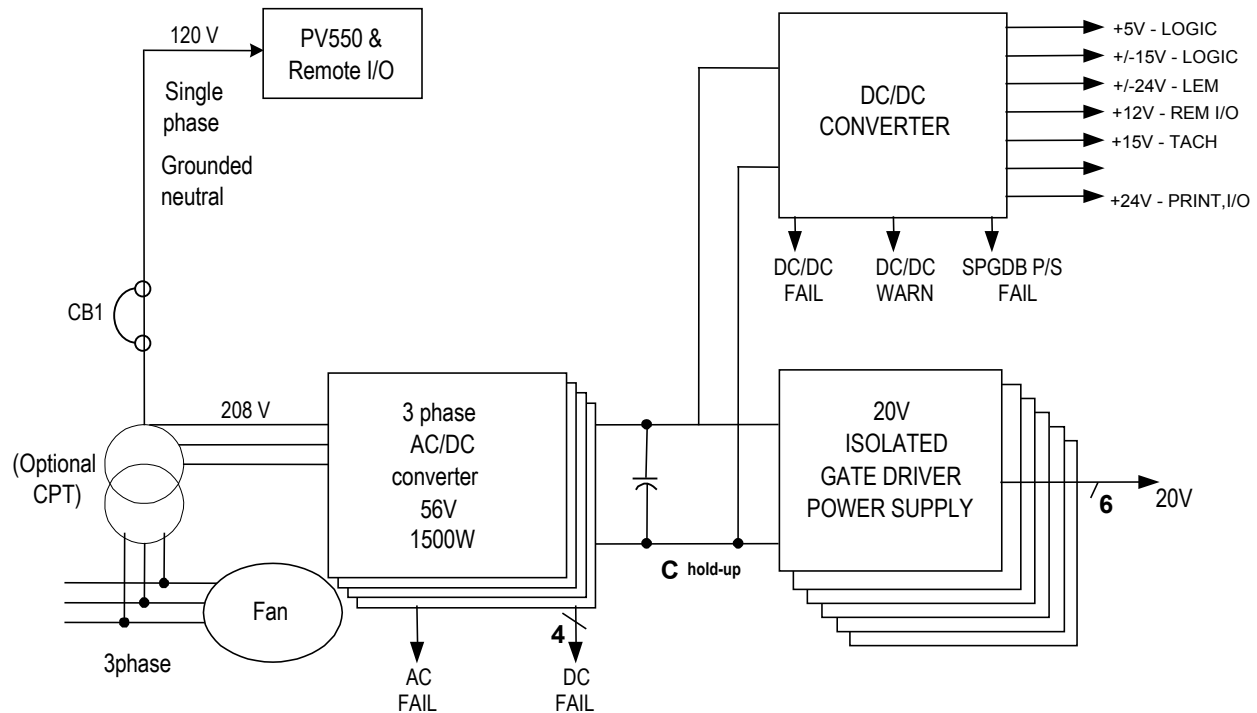


Figure 4.13 – Control Power Distribution

Three Phase Input

In the 3 phase input configuration, the customer supplies 3 phase control power into the Fan Disconnect Switch (Labeled FDS1 on the Electrical Schematics). From that point, the power is distributed to all the power supplies and controls within the drive. The 3-phase control should be measured at the input to FDS1. If the rating matches the designation on the electrical schematic, it is acceptable to apply control power to the drive. Take necessary measures to rectify the control power level in the event that it does not meet the design specifications.

Three Phase Input / Single Phase Input

This configuration has two sources of control power:

- Three phase control power for fan operation and drive control
- Single-phase control power to operate the Interface, I/O and additional auxiliaries.

Similar to the three-phase configuration, the input power for the fan and control must be verified at the primary of FDS1. However, the second source of control power must also be verified against the prints at Circuit Breaker 1 (Labeled CB1 on the Electrical Schematics).

If the ratings match the designation on the electrical schematic, it is acceptable to apply control power to the drive by closing CB1 and FDS1. Take necessary measures to rectify the control power levels in the event that they do not meet the design specifications.

Power Supply Tests

The variety of components installed within the PowerFlex 7000 “B” Frame requires a versatile control distribution design. As a result there are many power supplies incorporated within the drive design. The following section describes how to verify that all power supplies installed within the drive are functioning as designed.

Circuit Board Healthy Lights

Once all sources of control power have been verified and proven to be within specified levels, close the low voltage input breaker (CB1) and Fan Disconnect Switch (FDIS); doing so will apply control power to the drive.

Observe the healthy lights on all drive control boards to confirm that the unit has passed all power-up self-tests. The following table identifies the LEDs that should be illuminated, assuming the drive passes all self-tests and is in a ready state:

Component	LED Activated
AC/DC Converter Power Supply	NO Healthy LEDs Provided
DC/DC Converter Power Supply	1 Green LED on Case of Power Supply (No Label)
SGCT Power Supplies ❶	1 Green LED per section of Power Supply (No Label)
SGCT Integrated Firing Card	LED 4 (Green) LED 3 (Green) LED 1 (Red)
Drive Control Boards	1 Green LED – Healthy
Customer Interface Board	LED1 (Green) LED 2 (Green) LED 3 (Green)
Digital I/O	Various RED Surface Mounted LEDs based on I/O status
Remote I/O Adapter	LED configuration will change based on adapter. Refer to the adapter user's manual to identify the state the adapter is in.
Operator Interface Terminal	Displays Boot Sequence. Communications Error will occur in a fault situation. A small flashing indicator in bottom right corner indicates good communication.

❶ Number of supplies varies based on drive configuration.

Failure of LED to illuminate indicates a problem with the power-up self-test. See the troubleshooting section of the manual (Chapter 7) to identify how to troubleshoot the problem.

Control Power Transformer (CPT)

A control power transformer is supplied only in certain drive configurations. If there is no control transformer supplied in the drive being commissioned, please disregard the following information on setting the control voltage output level.

Measure the control voltage level at the secondary of the control power transformer located in the DC link low voltage cabinet of the drive. Ensure that the output of the transformer matches the specification on the electrical schematics.

The value of the output can be adjusted by changing the taps on the control transformer. Ensure that the power is disconnected at the Disconnect Switch prior to attempting to change the control transformer tap setting.

Input Control Voltage (V_{L-L})	U-V:	_____ V
	V-W:	_____ V
	W-U:	_____ V
Control Power Transformer Installed?	Yes θ	No θ
CPT Secondary Voltage (V_{L-L})	U-V:	_____ V
	V-W:	_____ V
	W-U:	_____ V
CPT Secondary Voltage (V_{L-N}) <i>or</i> , if no CPT: Input Control Voltage (V_{L-N})	U-N:	_____ V
	V-N:	_____ V
	W-N:	_____ V

AC/DC Converter (PS1)

Every PowerFlex 7000 “B” Frame drive will be supplied with at least one AC/DC converter. As the number of devices increases, so will the number of AC/DC converters installed. The electrical schematics provided by Rockwell Automation will identify how many AC/DC Converters have been installed in the application being commissioned.

Ensure the output of the supply is 56V DC. Refer to the Component Definition and Maintenance section (Chapter 6) if adjustment is necessary.

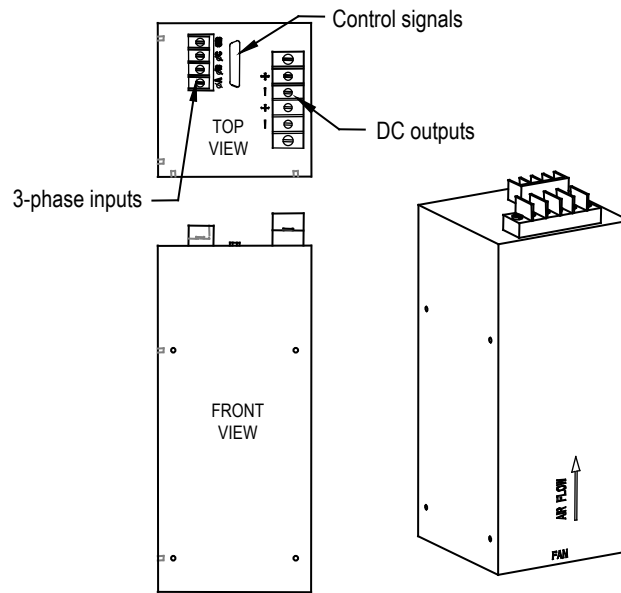


Figure 4.14 – Location of AC/DC power supply on low voltage panel

DC/DC Converter (PS2)

The DC/DC converter (refer to Figure 4.15) has no provision for output power adjustments. A green LED on the case of the power supply indicates that the power supply is functioning properly.

Using a digital multimeter, measure each of the outputs of the DC/DC converter to ensure that they meet the values specified on the electrical schematics.

Plug 1 (P1) – INPUT

Terminal Numbers	Description	Value
1 → 2	Input Power (+56 V)	

Plug 2 (P2) – CONTROL

Terminal Numbers	Description	Value
1 → 2	XIO PWR (+24 V 0.3 A) → XIOCOMM ±5%	

Plug 3 (P3) – SPGDB

Terminal Numbers	Description	Value
1 → 3	SPGDBPWR (+15 V 1 A) → SPGDBCOMM ±5%	

Plug 5 (P5) – SCLB

Terminal Numbers	Description	Value
1 → 2	+ LEMPWR (+24 V 1 A) → LCOMM ±1%	
3 → 2	- LEMPWR (-24 V 1 A) → LCOMM ±1%	
4 → 5	+15 V PWR (+15 V 1 A) → ACOMM ±3%	
6 → 5	-15 V PWR (-15 V 1 A) → ACOMM ±3%	
7 → 8	+5 V PWR (+5 V 1 A) → DGND (5.3 – 5.4)	
9 → 10	+15 V ENC (+15 V 1 A) → ENC CONN ±1%	

Plug 6 (P6) – SCMB

Terminal Numbers	Description	Value
1 → 2	+ LEMPWR (+24 V 1 A) → LCOMM ±1%	
3 → 2	- LEMPWR (-24 V 1 A) → LCOMM ±1%	
4 → 5	+15 V PWR (+15 V 1 A) → ACOMM ±3%	
6 → 5	-15 V PWR (-15 V 1 A) → ACOMM ±3%	
7 → 8	+5 V PWR (+5 V 1 A) → DGND (5.3 – 5.4)	
9 → 10	+15 V ENC (+15 V 1 A) → ENC CONN ±1%	

Plug 7 (P7) – CIB

Terminal Numbers	Description	Value
1 → 2	XIO PWR (+24 V 0.3 A) → XIOCOMM ±5%	
3 → 4	+15 V PWR (+15 V 1 A) → ACOMM ±3%	
5 → 4	-15 V PWR (-15 V 1 A) → ACOMM ±3%	
6 → 7	+5 V PWR (+5 V 0.1 A) → DGND (5.3 – 5.4)	
8 → 9	+SCNPWR (+12 V 0.1 A) → SCNCOMM ±1%	

If any values are out of the expected range, a bad DC/DC converter is suspect. For additional information on how to troubleshoot the DC/DC converter, refer to the troubleshooting section of the manual (Chapter 7).

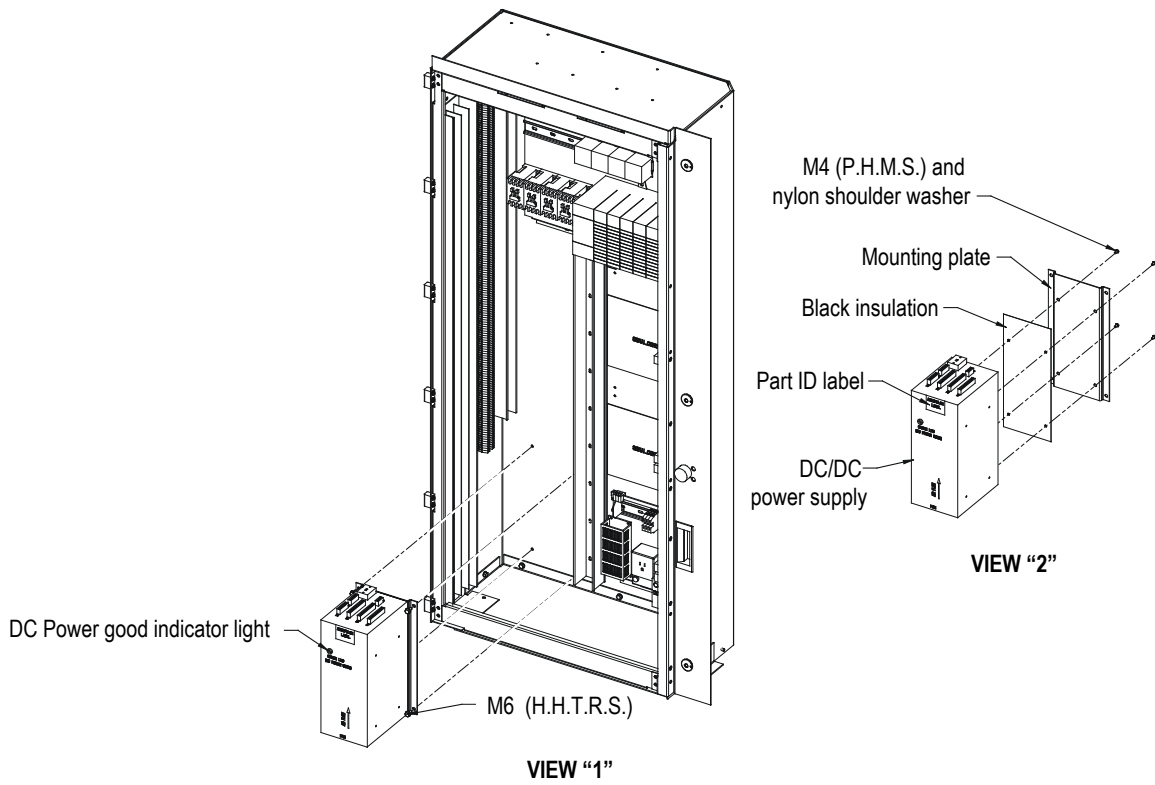


Figure 4.15 – DC/DC Converter (PS2)

SGCT Power Supplies (IGDPS)

Note: Refer to Figure 4.16 for location of IGDPS.

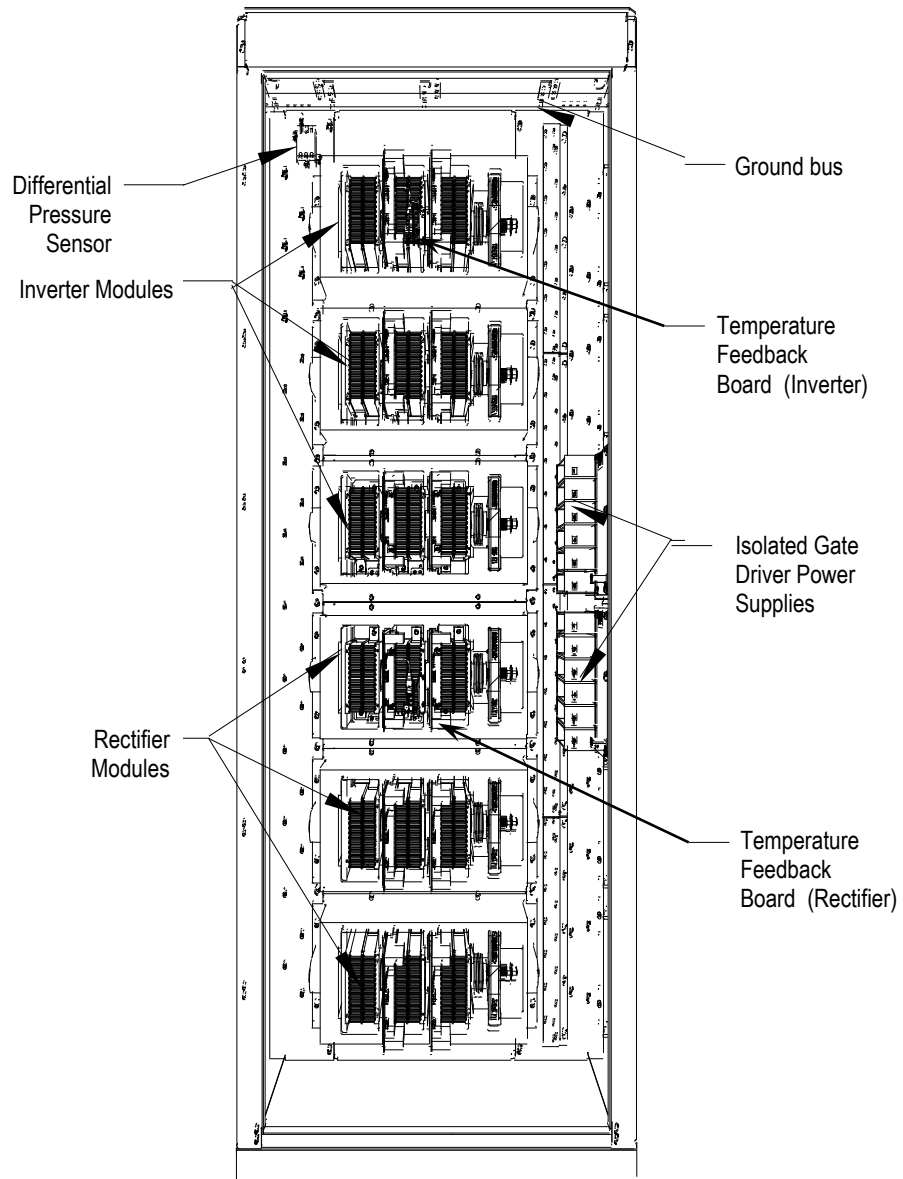


Figure 4.16 – Converter Cabinet Components

The circuitry for the IGDPS is encapsulated in epoxy. As a result the module can not be field repaired and there are no test points or adjustments available on this board. If one of the six isolated 20 V output fails, the entire board must be replaced.

Board LEDs

One operational green LED on each of the 6 outputs, visible from the input ends of the unit that detects failed 20V output.

- LED ON: output healthy
- LED OFF: output voltage is below 18Vdc

If the HV IGDPS is healthy, then all six LEDs will be illuminated. If this is not true, this may indicate either a bad connection to the board or a defective output module.

Record the following measurements to ensure all 6 outputs are functioning. They should be within $\pm 1\%$ of 20 V.

Test Points	Expected Value	Measured Value			
		#1	#2	#3	#4
Plug 8 Pin 1 → Pin 2	+20 V DC				
Plug 9 Pin 1 → Pin 2	+20 V DC				
Plug 10 Pin 1 → Pin 2	+20 V DC				
Plug 11 Pin 1 → Pin 2	+20 V DC				
Plug 12 Pin 1 → Pin 2	+20 V DC				
Plug 13 Pin 1 → Pin 2	+20 V DC				

There may be more than one IGDPS. Record voltages for all of them.

If a channel has failed, refer to the troubleshooting section of the manual for a replacement procedure.

Gating Tests

Once the drive converters have been tested without Medium Voltage and all the power supply output values have been verified, it is necessary to test the SCRs and SGCTs under low voltage control power.

The following procedures will describe how to perform the next level of device testing:

- Gating Test Mode
- SCR Firing Test
- SGCT Firing Test

If the results of the tests are not as described in the section below, refer to Chapter 6 – Component Definition and Maintenance, for detailed information on how to troubleshoot problems in the converter section of the drive.

Gating Test Mode

The following procedure explains how to enter gating test mode. This feature will simulate drive operation by applying gate signals to the SCRs and SGCTs while isolated from medium voltage. Prior to starting the drive for the first time, a gating test should be performed to ensure that each device is functional.

Some drive status I/O will be active while performing tests in Gating Test Mode (Test Mode 1). If the drive I/O is monitored remotely, process control should be notified in advance to avoid confusion.

ATTENTION



Ensure that the drive is isolated from medium voltage prior to starting this test.

From the main screen, press the ACCESS [F10] key and use the down arrow until you highlight **ADVANCED**. Press Enter and then EXIT [F10].

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

Now press SETUP [F8] to get to Parameters, and then Enter. You should be on Feature Select, the first group.

```

SETUP:

Parameters          Current Access:
Analog              Advanced
PLC
XIO
Fault Masks
External Text
Setup Wizard

ALARMS  ACCESS  LANG'GE  EXIT

```

```

SELECT GROUP:                      1 of 3

feature select
Motor Ratings
Autotuning
Control Masks
Motor Model
Reference Command
Speed Command
Speed Control

ALARMS  LIST  NEXT PG  PREV PG  EXIT

```

Press Enter, and then use the down arrow to get to Operating Mode.

```

SELECT: Feature Select              1 of 2

Auto Restart Dly          .0      sec
Coast Speed                2.0      Hz
Ctrl DC Power             Fault
Input ContCfg             All Faults
Input Open Delay          .0      min
Operating Mode            Normal
Output ContCfg            Not Running
Reference Select          Remote 4-20a

ALARMS  NEXT PG  PREV PG  EXIT

```

Press Enter and use the down arrow to get to Gating Test. Press Enter, and you will now be in gating test mode.

```

MODIFY PARAMETER: Operating Mode

P: 4

Actual: Normal
New:    Normal
       Gating Test
       DC Current
       System Test
       Open Circuit

ALARMS  CANCEL  ACCESS  EXIT

```

ATTENTION

Ensure that the drive is no longer running in test mode prior to applying medium voltage to the drive line-up. Failure to do so may result in equipment damage.

SCR Firing Test

In normal operation, the SCR firing cards derive their power from a voltage divider network that steps down the medium voltage to 20 volts maximum. As it is necessary to perform this test while isolated from medium voltage, a secondary source of power has to be provided to power the firing cards.

Supplied with each drive is a power cable that supplies 20 V DC from the DC/DC Converter power supply to the firing cards (SPGDB). This cable has one input to be connected to the DC/DC converter, and 18 sets of outputs that can be connected to the SCRs. The firmware ensures that this is achieved.

The procedure is as follows:

Plug the 4-pin Phoenix connector on the test cable into the DC/DC converter terminal labeled PB3. The other 3-pin connectors plug into the SCR self powered gate drive board terminals labeled TB3 – Test Power (See Figure 4.17 – Self-Power Gate Driver Board Test Power Terminal).

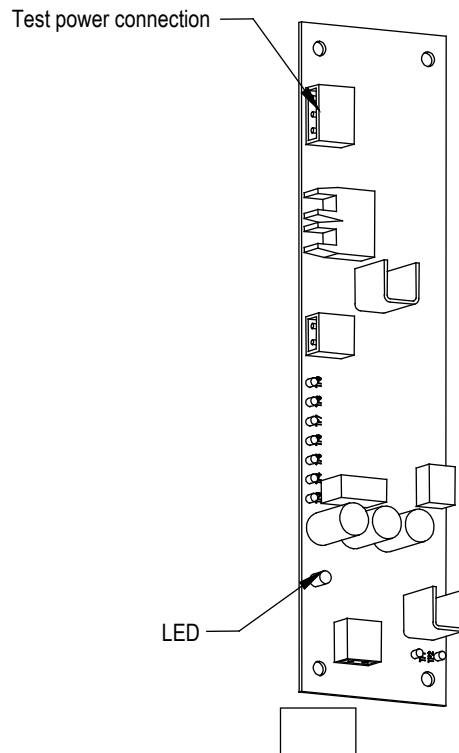


Figure 4.17 – Self-Powered Gate Driver Board Test Power Terminal

Put the drive in Gating Test Mode and the rectifier will automatically go into Test Pattern gating mode.

LED 1 – Gate Pulse (Orange) should light up and pulsate at the frequency that the device is firing. All the other LEDs will light up as the firmware sends a gating signal to every SCR.

There is also a Gating Test that fires the individual devices one at a time, in what is described as a Z-pattern. Basically, for each section, the Top Left device will turn on for 2 seconds, then turn off. The next device to the right will turn on for 2 seconds, and the pattern will continue. When you reach the end of the first stack of devices, the right device in the middle stack down will fire and the pattern continues right to left until the end of the middle stack is reached. Then the left device in the bottom stack will fire and the pattern will continue to the last device, where it will then return to the top.

This is a test to show that the correct fiber optic cables are going to the corresponding devices.

Normal gating test mode should not be attempted for SCR rectifiers as the test power from the power supply to the SPGD boards through the wiring harness does not have sufficient current to drive all of the boards at once.

During commissioning, it is not necessary to use an oscilloscope for SCR firing tests, although it will be required if SCR firing problems occur.

ATTENTION



Ensure that the test cable is removed from the drive and that it is taken out of Test Mode prior to applying Medium Voltage. Failure to do so may result in personal injury or equipment damage.

SGCT Firing Test

Unlike the SCR Self-powered gate Driver Board, the SGCT has an integrated firing circuit mounted on the device. The power for this circuit is derived from the SGCT Power Supplies (IGDPS), and preliminary observations are possible by monitoring the healthy lights on the firing circuit without putting the drive into gating test mode. There are 4 LEDs on the firing card. The following diagram illustrates the location of the LEDs:

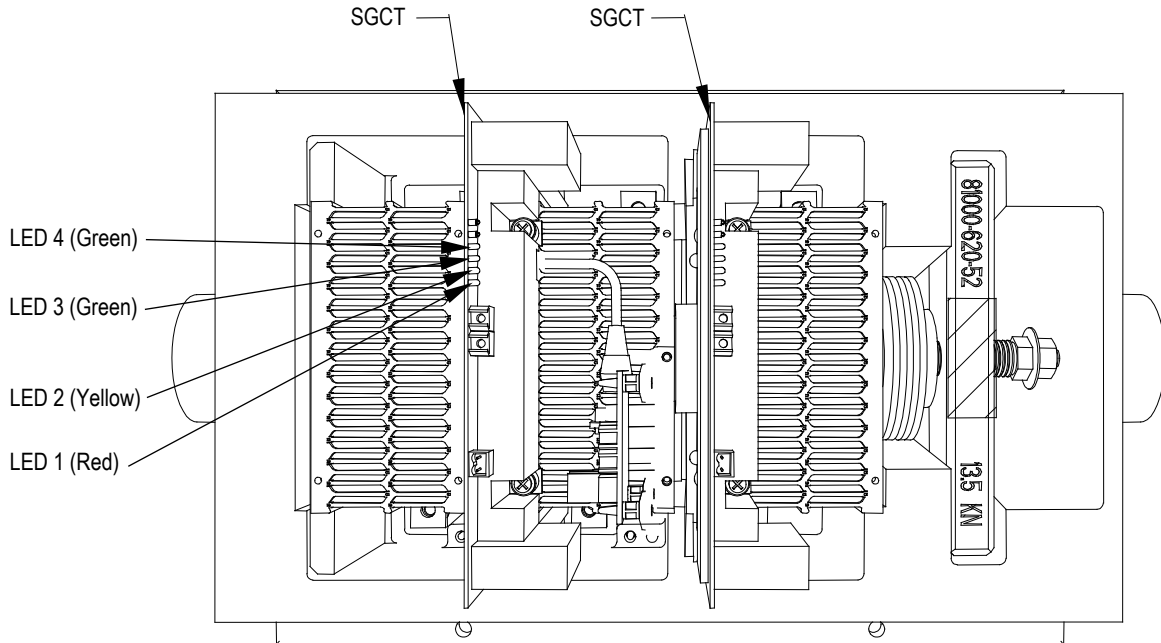


Figure 4.18 – SGCT Healthy LEDs

While the drive is sitting idle, without gating LEDs 4 (Green), 3 (Green), and 1 (RED) should be illuminated while LED 2 (Yellow) is off. If any other combinations of LEDs are illuminated, refer to Chapter 6 – Component Definition and Maintenance for instructions on how to troubleshoot the SGCT firing cards.

Put the drive in Gating Test Mode the inverter will automatically go into Test Pattern gating mode.

Monitor the SGCT LEDs and ensure that LEDs 4 (Green) and 3 (Green) remain illuminated, while LEDs 1 (Red) and 2 (Yellow) toggle on an off alternately at the frequency that the converter is operating at.

There is also a Gating Test that fires the individual devices one at a time, in what is described as a Z-pattern. Basically, for each section, the Top Left device will turn on for 2 seconds, then turn off. The next device to the right will turn on for 2 seconds, and the pattern will continue. When you reach the end of the first stack of devices, the right device in the middle stack down will fire and the pattern continues right to left until the end of the middle stack is reached. Then the left device in the bottom stack will fire and the pattern will continue to the last device, where it will then return to the top.

This is a test to show that the correct fiber optic cables are going to the corresponding devices.

Normal Gating Test mode will fire the inverter at the output frequency corresponding to the active reference (speed) command.

System Test

Prior to applying medium voltage, it is necessary to verify the entire low voltage control circuit to ensure the drive operates as desired. Failure to perform this test may result in damage to the drive or process in the event that the control does not operate as expected. This section of the manual provides instruction for the following five tests:

- System Test Mode
- Start/Stop Contactor Control
- Status Indicators
- Analog I/O
- Configurable Alarms

System Test Mode

The following procedure explains how to enter System Test Mode. This allows the drive to operate the drive's low voltage control circuit without medium voltage present.

Drive status I/O will be active while performing tests in System Test Mode. If the drive I/O is monitored remotely, process control should be notified in advance to avoid confusion.

ATTENTION



Ensure that the drive is isolated from medium voltage prior to starting this test.

Ensure you have Advanced access.

Now, from the main screen, press SETUP [F8] to get to Parameters, and then Enter. You should be on Feature Select, the first group.



Press Enter, and then use the down arrow to get to Operating Mode.

```

SELECT: Feature Select          1 of 2

Auto Restart Dly              .0      sec
Coast Speed                   2.0    Hz
Ctrl DC Power                 Fault
Input ContCfg                All Faults
Input Open Delay              .0      min
Operating Mode
Output ContCfg                Not Running
Reference Select              Remote 4-20a

ALARMS  NEXT PG  PREV PG  EXIT
    
```

Press Enter and use the down arrow to get to System Test. Press Enter, and you now will be in system test mode. From this point you can completely check the entire system without medium voltage. As long as you have test power to all your contactors, you can start, stop, E-Stop, trigger faults, check remote IO, check PLC inputs, and verify other functionality.

```

SELECT: Feature Select          1 of 2

Auto Restart Dly              .0      sec
Coast Speed                   2.0    Hz
Ctrl DC Power                 Fault
Input ContCfg                All Faults
Input Open Delay              .0      min
Operating Mode              System Test
Output ContCfg                Not Running
Reference Select              Remote 4-20a

ALARMS  NEXT PG  PREV PG  EXIT
    
```

ATTENTION



Ensure that the drive is no longer running in system test mode prior to applying medium voltage to the drive line-up. Failure to do so may result in equipment damage.

Start/Stop Control Circuit

Once the drive is in System Test mode, ensure that the stop/start circuit functions as desired. It may be necessary to study the electrical schematic drawings, prior to performing this test, in order to understand the control circuit.

Start the drive in local control while observing the system vacuum contactors or customer supplied circuit breakers. If troubleshooting is required in Rockwell Automation medium voltage switchgear, additional information is available in the following publications:

- Publication **1500-UM055** **-EN-P**, Medium Voltage Controller, Bulletin 1512B, Two-High Cabinet, 400 Amp • User Manual
- Publication **1503-IN050** **-EN-P**, OEM Starter Frame and Components • Installation Manual
- Publication **1502-UM050** **-EN-P**, Medium Voltage Contactor, Bulletin 1502, 400 Amp (Series D) • User Manual
- Publication **1502-UM052** **-EN-P**, Medium Voltage Contactor, Bulletin 1502, 400 Amp (Series E) • User Manual
- Publication **1502-UM051** **-EN-P**, Medium Voltage Contactor, Bulletin 1502, 800 Amp • User Manual

If the Medium Voltage contactors or circuit breakers perform as desired, stop the drive and perform the same test while operating in remote control.

Start the drive again and verify that all emergency stops installed in the system function as desired. Ensure that all electrical interlocks installed in the system function as desired. Make any necessary control wiring modifications at this time and re-test the system if necessary.

Status Indicators

Drive status is often feedback to a plant's process control either digitally through the PLC input/output feature (see Chapter 3 – Operator Interface, PLC page 3-43) or through relay logic. The following relays are provided with the drive as standard:

Relay Name	Relay Designation
Run Contact	RUN
Fault Contact	FLT
Warning Contact	WRN
Ready Contact	RDY

It is necessary to activate each status indicator used by the customer to ensure that they have connected their control to the drive correctly. This can be achieved by changing the drive status (ready, faulted, warning etc.).

Analog I/O

It is possible to configure all of the drive's analog inputs and outputs without running the motor. The following information describes how to set up the following drive features:

- Analog Inputs
 - Analog Reference Command Input Scaling (Local, Remote)
 - Minimum Setting
 - Maximum Setting
 - Digital Reference Command Input Scaling (Digital)
- Analog Outputs

All of the Analog I/O connections are made on the CIB.

Analog Inputs

- **Analog Command Input Scaling**
 - Prior to commencing the reference command input scaling it is necessary to ensure that the reference command input selection has been configured as desired. This requires setting Reference Select [P7] to the appropriate input source.
 - Set the utilized Reference Command minimum (L, R and D) to the desired value. The minimum reference command input setting on a drive without a tachometer is 6 Hz. Without tachometer control, do not set the reference command minimum parameter below 6 Hz. A control with tachometer feedback will allow a minimum speed of 1 Hz. With tachometer control, do not set the reference command minimum parameter below 1 Hz.
 - Set the utilized Reference command (L, R and D) Maximum parameters so that with full reference command inputs, the associated Reference command Variables read the desired maximum value.
 - The various reference command maximums usually have to be increased above the desired maximum value to compensate for the loading down of their 10 volt input rails by the attached potentiometer or isolator.

Example:

The customer 4-20mA speed input is coming to the Current Loop Receiver on the Customer Interface Board, and they want the maximum input to represent 60 Hz.

1. Reference Command Remote Maximum (Ref Cmd R Max) should be set for 60 Hz.
2. The Reference Select parameter should be set to 'Remote 4-20a'.
3. Have the source supply 20mA to the drive. This should be verified with a series Multimeter. Ensure that you are in Remote mode with the selector switch, and look at the parameter Speed Command In, which will represent that 20mA signal.
4. Ensure that it reads 60 Hz. If it does not, you can increase the Ref Cmd R Max value until this parameter reads 60 Hz.

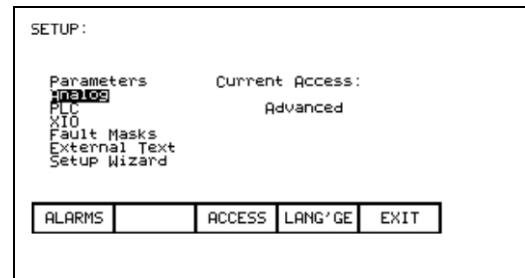
• **Digital Reference command Input Scaling**

The maximum value for a digital reference command is 32767; the minimum value is 0. Values that are negative or out of bounds will result in the drive slowing down to minimum speed.

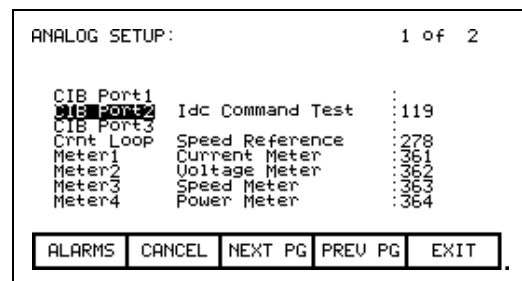
Analog Outputs

Review the electrical schematics to understand which meters or signals the user expects out of the analog output ports on the Customer Interface Board.

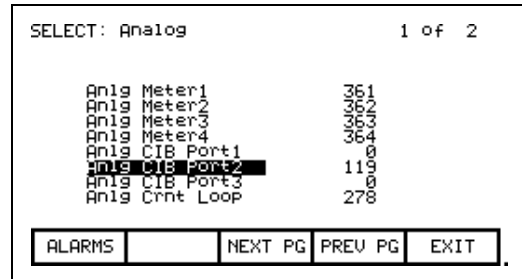
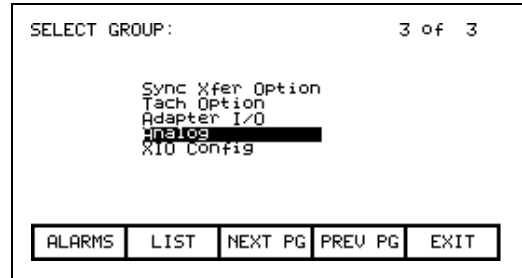
To assign a parameter to an analog output, ensure that you are at least in Advanced access. From the main screen, press SETUP (F8), and use the down arrow to highlight Analog. Press Enter.



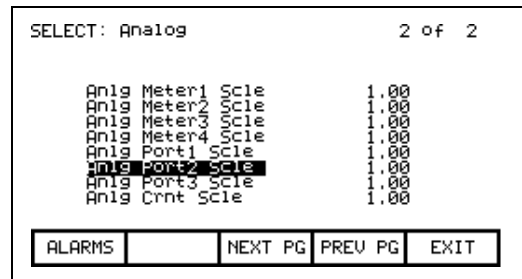
Use the down arrow to highlight the output you wish to assign. When you press Enter, you will be brought to the entire list of parameters. Use the arrow and enter keys to find the parameter you wish to assign, and press Enter. This will take you back to the Analog screen and you will see the new parameter name beside your selected output.



Press EXIT [F10], go up to Parameters. Press Enter, and then scroll down the list until you reach Analog. Press Enter, and you will see the same list of available ports and the assigned parameter number, but not the name.

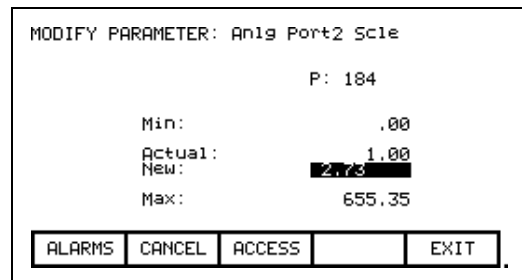


If you scroll down, you will reach the scaling factors for the 4 Meter Port and the 3 CIB Port outputs. All parameters are scaled to 0-10V, with 0 representing the minimum value given in Chapter 6 under Parameter Descriptions, and 10V representing the maximum value given in Chapter 6. These Scaling parameters (i.e. Anlg Port2 Scle) can be used to change the scaling.



Note: There are certain parameters whose minimum value is a negative number. In that case, the minimum value of the parameter (-10V) is scaled to 0V output, and the maximum value is scaled to 10V output.

Highlight the appropriate Analog Scale parameter and press Enter. You can enter your new value, and then press Enter, and EXIT (F10). Ensure you save to NVRAM when you are finished.



The analog outputs from the customer interface boards are stated as 0 to 10 volts, but in actual fact their outputs are typically 0.025 to 9.8 or 9.9 V. This is due to the rails being loaded down by an attached speed potentiometer or signal conditioner impedance. Incorporated signal conditioners usually have 0 to 10-volt inputs and 4 to 20 mA outputs. An additional error is incorporated in the signal conditioners, so if they are calibrated for 0 to 10 volts input, there will not be exactly 4 to 20 mA out.

It is now necessary to calibrate the external 4 to 20 mA signal conditioners.

1. Set a digital multimeter to mA and place it in line with the signal conditioners. If the output of the conditioner is terminated, the meter can be used as a load.
2. Assign a parameter to the Analog Output port that we wish to calibrate. This parameter should be one that we can change from minimum to maximum for test purposes only. IDC Command Test is a good example. See previous page on assigning an output.
3. Set IDC Command Test to 0.000 pu. This is the minimum. Adjust the Zero adjustment screw on the isolator to read 4 mA.
4. Set IDC Command Test to 1.500 pu. This is the maximum. Adjust the Span adjustment screw on the isolator to read 20 mA.
5. Repeat the process until no more adjustments are required.
6. Set IDC Command Test to 0.750 pu to ensure you read 12 mA (Half-scale). Set IDC Command Test to 0.000 pu.
7. Assign the required parameter to the Analog Output port we have calibrated.
8. Save all changes to NVRAM.

Configurable Alarms

Ensure that the configurable alarms have been programmed in the drive control. Instructions on where to locate the following External Fault related tasks in the manual are listed below:

- **Setting Fault Masks:** Chapter 3 – Operator Interface, Fault Masks. Page 3-42
- **Setting External Fault Text:** Chapter 3 – Operator Interface, User Definable External Text 3-45
- **Setting Fault Classes:** Chapter 4 – Commissioning

The external faults can be tested by lifting the wires to all external warning / fault inputs while running in system test mode. These wires are terminated at the Digital I/O boards. Opening the circuit at any point will verify the external fault's configuration and functionality. However, it is preferable to actually force the trips from the source. If that is not possible, then an acceptable alternative is to lift the wire at the protective device.

ATTENTION

Do not short the lifted wire to ground when testing the circuit or damage will occur to the Digital I/O board and possibly weld the equipment's trip contact.

18-pulse Phasing Test

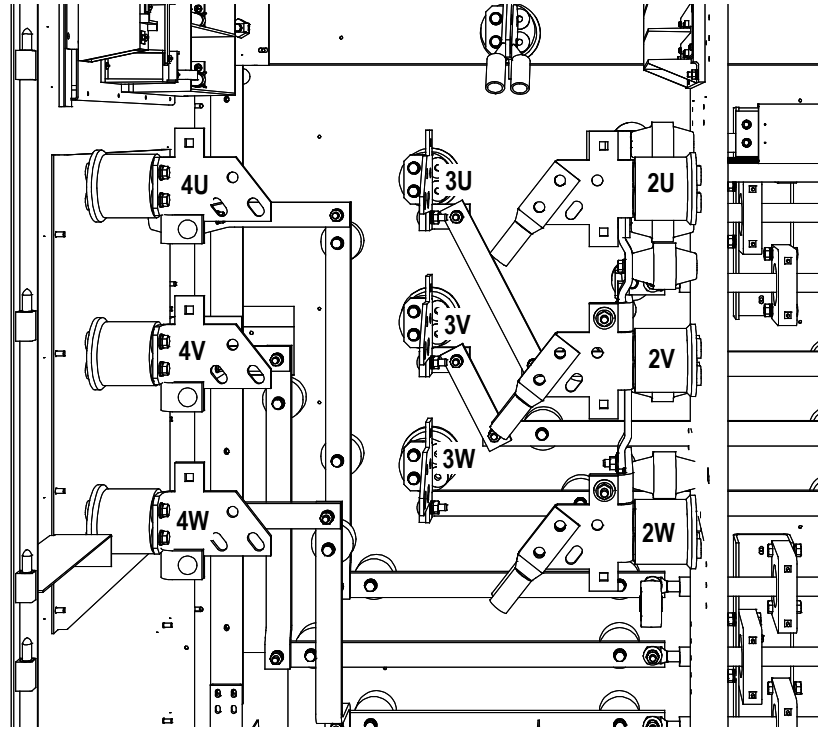
Prior to applying medium voltage and running the drive, it is important to verify the phase rotation on the input of all 18-pulse drives. The following tests do not need to be performed on PWM rectifier drives unless they incorporate synchronous transfer:

- Line Terminal Resistance Measurements
- Application of Medium Voltage Power
 - Compare the voltage feedback from all 9 test points in the SCB-L to ensure proper phasing.

Failure to perform the recommended tests will result in poor drive performance and may result in drive converter damage.

Line Terminal Resistance Measurements

Measuring the resistance between the drive line cable terminals will quickly identify if there is interwiring between the 0°, +20°, and -20° bridges in the isolation transformer.



There are low resistances between phases through a transformer winding and a high resistance between transformer windings. Therefore, the expected resistance measurements are listed in the table below:

Terminal Measurement Points	Expected Resistance
2U → 2V → 2W	Approximately 0 Ω
3U → 3V → 3W	Approximately 0 Ω
4U → 4V → 4W	Approximately 0 Ω
#U → #V → #W	Approximately ∞ Ω ∞Ω

If the measurement results are not as described above, the interwiring between the isolation transformer and drive needs to be re-inspected.

Application of Medium Voltage

Before running the drive on Medium Voltage, it is a good idea to set up the diagnostic trending feature to capture any information in the event of a fault during commissioning. **REMEMBER TO RESET THE TRENDING BEFORE LEAVING THE DRIVE IN PRODUCTION.**

The diagnostic trending operation of the drive allows you to capture the relationships of 8 parameters over a period of time. Trending is a valuable tool for trouble shooting the drive.

The length of the trend buffer is 100 samples.

From the main menu, press the Diagnostics Key (Diags [F9]). This key enters the user into the Diagnostics Menu. The Options within the Diagnostics Menu are listed as follows:

- RE-ARM
- D_SETUP
- VIEW

Re-Arm

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.

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:

- | | |
|--------------|--|
| 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 <u>after</u> the trigger point. Any value between 0 and 100% may be used. |
| 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 8 possible traces, although not all have to be active. |

Trigger	<p>Defines whether you want a continuous or a single-shot trigger. Pressing this key will place an S or a C in front of the trigger parameter. You will almost always want a Single-Shot (S) trigger.</p> <p>S = Single shot>>the trigger occurs once and stops, trigger must be manually re-armed</p> <p>C = Continuous capture>>auto re-arm enabled to collect new trends until stopped by viewing contents of captured data</p>								
Cond	<p>Defines the <u>Condition</u> that will cause the trigger. The possible options are:</p> <table> <tr> <td>= Equal to</td> <td>+ Boolean OR</td> </tr> <tr> <td>N= Not Equal to</td> <td>N+ Boolean NOR</td> </tr> <tr> <td>> Greater than</td> <td>& Boolean AND</td> </tr> <tr> <td>< Less than</td> <td>N& Boolean NAND</td> </tr> </table>	= Equal to	+ Boolean OR	N= Not Equal to	N+ Boolean NOR	> Greater than	& Boolean AND	< Less than	N& Boolean NAND
= Equal to	+ Boolean OR								
N= Not Equal to	N+ Boolean NOR								
> Greater than	& Boolean AND								
< Less than	N& Boolean NAND								
Data	<p>Defines the trigger value with respect to the Read-Only Parameter in Trace 1.</p>								

View

The view feature is used to observe the samples recorded during the last diagnostic trend.

How to Setup Trending

The trending setup is best illustrated through an example:

Trend Read-Only Parameters

- 1 – Status Flags (569)
- 2 – Pressure Value (447)
- 3 – Alpha Line (327)
- 4 – Speed Feedback (289)

- 5 – IDC Reference (321)
- 6 – IDC Feedback (322)
- 7 – Torque Reference (291)
- 8 – I Stator (340)

The sample rate is to be set at 0 msec. This will default to the fastest sample rate. 20% of the samples should be recorded after the trigger. The single trigger should occur when any fault occurs.

1. Press the Diagnostic Soft Key (DIAGS [F9]).
2. Press the Diagnostic Setup Soft Key (D_SETUP [F8]) to begin programming the diagnostic settings.
3. Cursor the backlit section to Trace 1 and press the enter key to begin programming. Scroll through the parameter list until Feedback – Status Flag2 (238) is located. Select this as Trace 1.
4. Select Trace 2 through 8 as described in the step above. Note that when you finish Trace 4, just press the down arrow and you will get to the screen showing traces 5-8.
5. Press the TRIGGER Soft Key until the letter S appears in front of the Trigger parameter.
6. Press the RATE Soft Key to program the trending sampling rate. This will be set to 0 msec in this example.
7. Press the DATA Soft Key to set the trigger level for the fault. This should be set to C.
8. Press the COND Soft Key to program the logic for the trigger level. In this example the COND will be set as an OR condition “+”
9. Press the POST Soft Key to set up how many samples will be recorded after the trigger. In this example the POST value will be set to 20%. The remaining 80% of the samples will be recorded prior to the trigger.

Once these settings have been programmed, the drive is ready to trend. Now the drive will trend data at the next fault.

The next test required to test phase rotation requires that medium voltage be applied to the drive input. Ensure that the drive is thoroughly inspected for debris and tools prior to energizing the drive. Furthermore, ensure that all protective barriers have been re-installed before continuing. Ensure that you have taken the drive out of System Test mode, and have returned to Normal operating mode.

Input Phasing Check

There are 9 voltage test points on the Line Signal Conditioning Board that will allow you to look at each voltage connection individually.

These test points are labeled as follows:

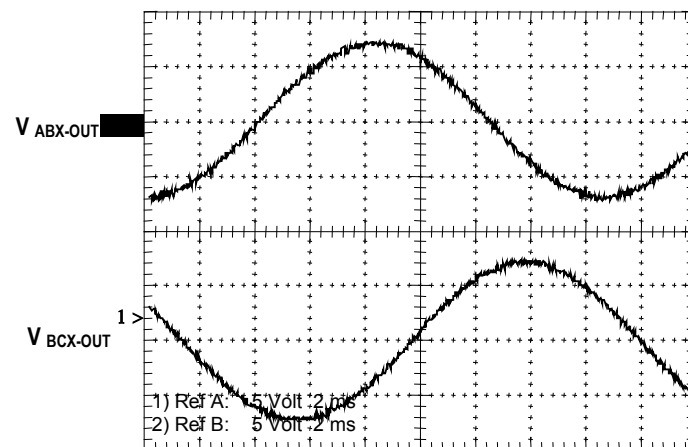
Table 4.C – SCBL Test Points and Associated Voltage Signals

Test Point Description	Isolation Transformer: Secondary Phasing and Bridge		Phase Relationship with respect to Vab1-Out (2U)
Vab1-Out	2U	Master	–
Vbc1-Out	2V	Master	-120°
Vca1-Out	2W	Master	-240°
Vab2-Out	3U	Slave 1	-20°
Vbc2-Out	3V	Slave 1	-140°
Vca2-Out	3W	Slave 1	-260°
Vab3-Out	4U	Slave 2	+20°
Vbc3-Out	4V	Slave 2	-100°
Vca3-Out	4W	Slave 2	-220°

All of these test points can be measured to either the Analog Ground on the board or the TE ground in the low voltage section. You can use Vab1-Out as your reference (trigger on this waveform) and verify all the other test points using the table above. It is easier to use zero crossings on your oscilloscope as the reference points when checking the phase shifts.

Essentially, you are verifying the following relationships:

1. V and W in each bridge should be lagging U by 120° and 240°, respectively.
2. 3U, 3V, and 3W should be **lagging** 2U, 2V, and 2W by 20° (-20°), respectively.
3. 4U, 4V, and 4W should be **leading** 2U, 2V, and 2W by 20° (+20°), respectively.



For 60 Hz systems, 360° = 16.7 ms.

For 50 Hz systems, 360° = 20 ms.

Refer to Figure 4.19 for a visual representation of the phasing checks.

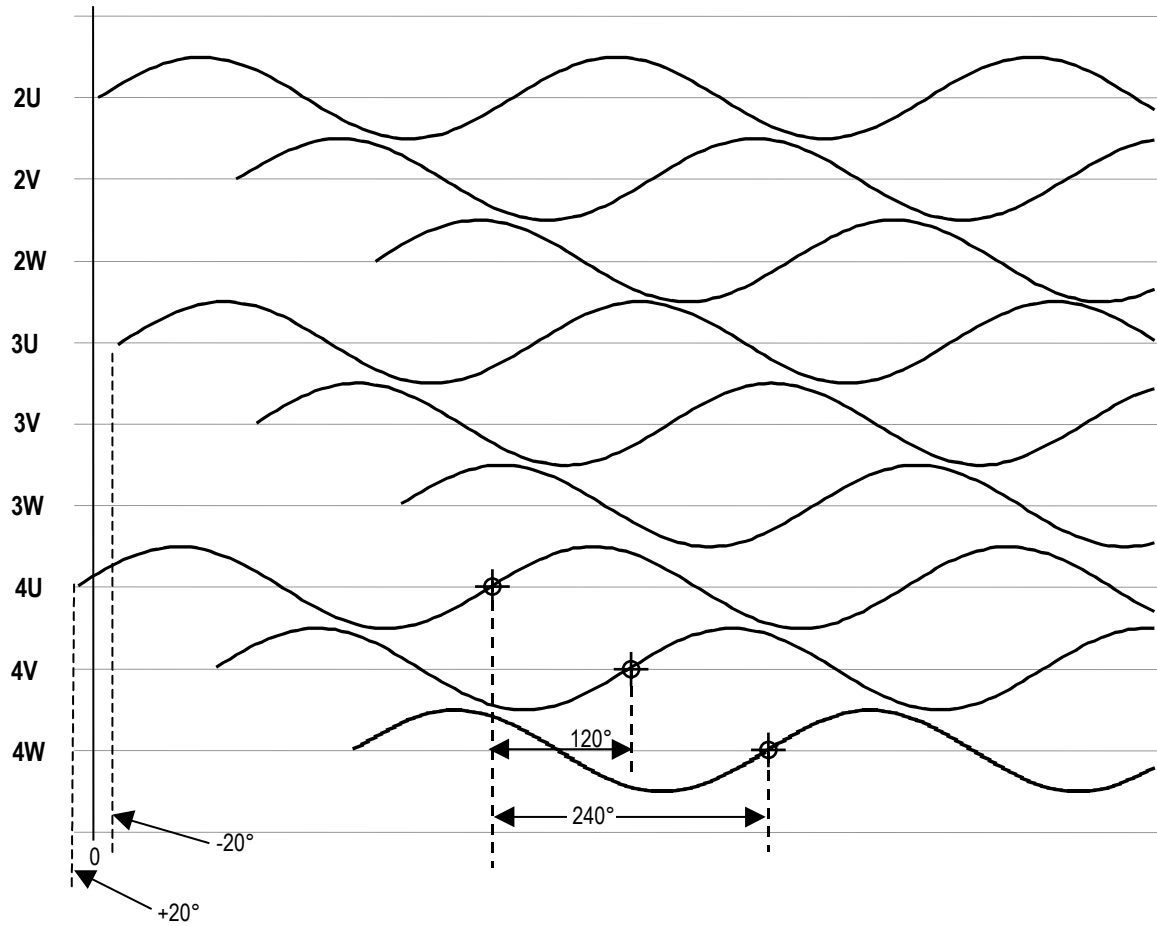


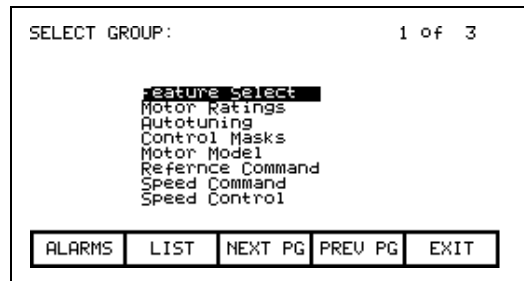
Figure 4.19 – 18-pulse phase sequence

DC Current Test

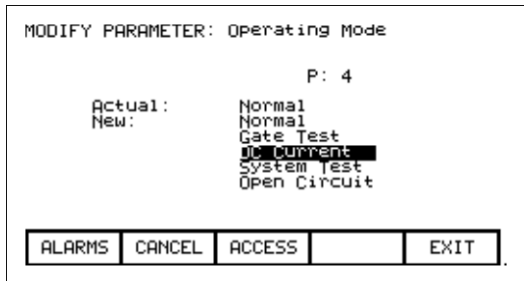
The following test will assist in verifying the isolation transformer phasing, as well as verifying DC Link connections. It involves putting the drive in DC Current Test and monitoring variable Alpha Line and IDCP test point while increasing the DC current through the drive rectifier. The following instructions detail how to DC current test:

Ensure that you have Advanced access.

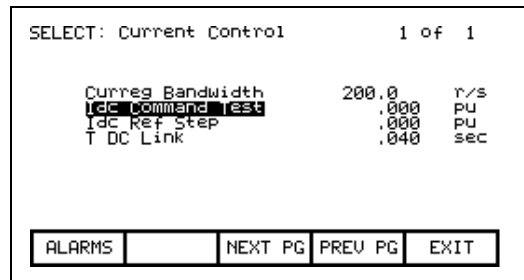
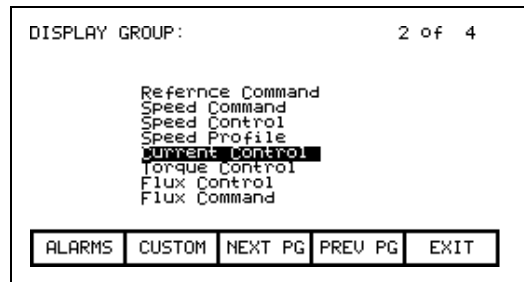
From the main screen press SETUP [F8], then press Enter, and press Enter again to access the Feature Select parameter group.

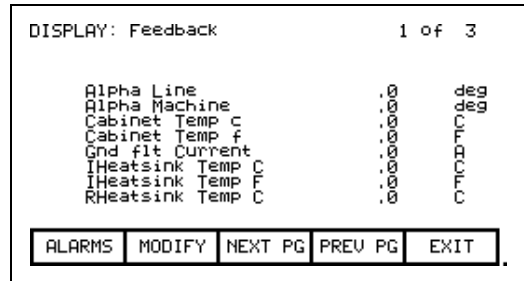


Scroll down until you highlight Operating Mode and press Enter. Scroll down to the DC Current option, highlight it, and press Enter. Then press EXIT [F10], until you make it out to the main screen. There is no need to save to NVRAM when the prompt appears.



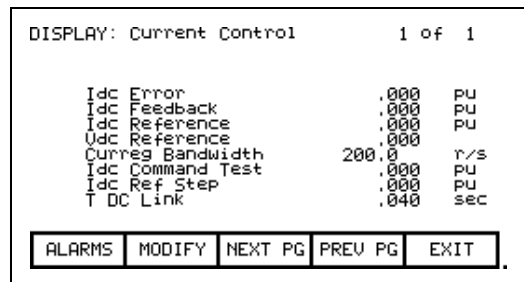
Press DISPLAY [F4] and scroll down until you reach the group Current Control. Press Enter and then press MODIFY [F7]. Scroll down to IDC Command Test and press Enter. Enter the number 0.1 pu and then press Enter. Press EXIT [F10] twice, scroll up to Feedback, and press Enter. The top parameter should be Alpha Line.





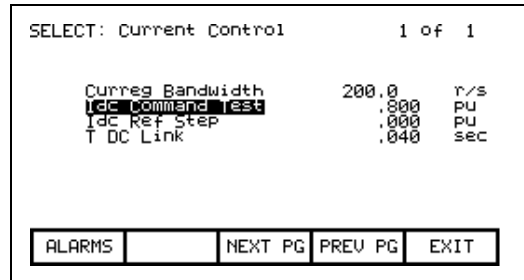
Press the start button and the drive should start running, pumping 0.1 pu (10%) of rated current through the DC link. Alpha Line should be approximately 90°-92°.

We can also check the Idc Reference and Feedback. Press EXIT [F10], and scroll back down to Current Control and press Enter. Idc reference should be at 0.100 pu and Idc Feedback should be around that same number. Ensure that Idc error stays around 0.

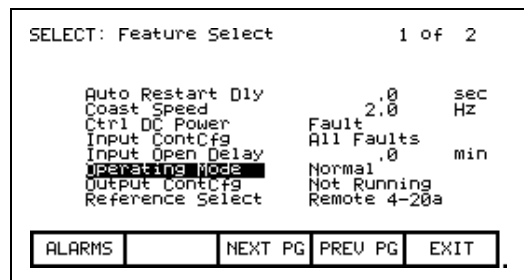


You can see the Idc waveform on the IDCP test point on the SCBL. This is not the test point in the center of the board, but the one on the left. This test point should have 18 ripples per cycle for an 18P drive, should not have the ripples drop down to 0, and should have approximately 0.5V offset for each 0.1 pu IDC. See the Troubleshooting chapter for sample waveforms.

Press MODIFY [F7], and increase Idc to .2 pu, and repeat the process. Go as high as 0.7 pu in .1 steps for 18P, and 0.3 pu in .1 steps for PWM, verifying each level as you increase the current. If there is a current meter somewhere on the input to the transformer/drive, check the current to ensure that it matches up with what you think we are pumping.



When we are satisfied everything is OK, bring the IDC current down in steps of .1 pu to 0, and then stop the drive. Return to the Feature Select parameter group and change Operating Mode back to Normal.



Tuning Procedure

The PowerFlex 7000 “B” Frame medium voltage drive must be tuned to the motor and load to which it is connected. There are six drive functions that require tuning. These are listed below in the order in which they are usually performed:

1. Commutation Inductance
2. Current Regulator
3. Motor stator resistance
4. Motor leakage inductance
5. Flux Regulator
6. Speed Regulator

The first four functions can be tuned with the motor stationary, but the tuning of the flux and speed regulators requires the motor to rotate.

NOTE: You will need to have a minimum of SERVICE level access to complete manual tuning. If you do not have SERVICE level access, please contact the factory.

1. Commutation Inductance

(Required for all drives with 3.004 Firmware or later. On earlier revisions, it is required only for 6-pulse and 18-pulse drives. Skip this test for PWM drives.)

The commutation inductance is used in the hardware reconstruction of the line voltage to compensate for commutation notches. It is also used in the calculation of the line converter retard limit to ensure proper operation under all conditions of line voltage and load current when regenerating. If the commutation inductance parameter is not correctly adjusted, the resulting distortion in the reconstructed line voltage may cause line synchronization faults.

The commutation inductance parameter is tuned with the drive operating in the dc current test mode. Although the commutation inductance was tuned during factory test, it must be retuned during commissioning because its value is determined by the impedance of the input transformer and harmonic filter (if present). The following autotune procedure can be used:

Commutation Inductance Autotuning

1. Set parameter "Autotune Select" in the Autotuning parameter group to Comm Induct. The drive will go into dc current test mode.
2. Start the drive. The dc current will increase in steps up to approximately rated current in about 2 seconds. When the current reaches its maximum value, the drive shuts off.

Parameter "Autotune Lc" in "Autotuning" is set to the measured value of commutation inductance, and parameter "Autotune select" is set to Off. If the test is successful, parameter "L commutation" in "Current Control" is set equal to "Autotune Lc". If the test fails, then parameter "L commutation" is not changed and a warning is issued indicating the cause of the failure:

L comm low - indicates that the measured commutation inductance is less than 0.02 pu. The commutation inductance must be tuned using the manual method described below.

L comm high - indicates that the measured commutation inductance is greater than 0.15 pu. The commutation inductance must be tuned using the manual method described below.

Commutation Inductance Manual Tuning (for 18P only)

1. Set parameter "Operating mode" in "Feature Select" to DC Current to enter dc current test mode.

SELECT: Current Control		1 of 1
Curreg Bandwidth	200.0	r/s
Idc Command Test	.000	pu
Idc Ref Step	.000	pu
L Commutation	.0500	pu
T DC Link	.040	sec

ALARMS		NEXT PG	PREV PG	EXIT
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Current Control Parameter Screen

2. Set parameter "Idc command test" in "Current Control" to 0.400 pu.
3. Set parameter "L commutation" in "Current Control" to an initial value of 0.05 pu.
4. Connect an oscilloscope to the test points labeled VABI-OUT and FAB1 on the SCBL board. Two sine waves of approximately equal amplitude should be seen, with the reconstructed line voltage FAB1 lagging the unfiltered voltage VABI-OUT by 90 degrees. Adjust the triggering and time base to display the positive half cycle of VABI-OUT with a scale of 20 degrees per major division.

5. Start the drive. The dc link current will rise to 0.4 pu. Commutation notches will appear in the unfiltered line voltage VABI-OUT as shown in the figure. Some distortion will appear in the reconstructed voltage FAB1 around the zero crossings.
6. Measure the average width in degrees of the commutation notch nearest the peak of the VABI-OUT waveform as seen in the following figures.
7. Record the values of the parameters "V line average", and "Idc reference" in "Current control"

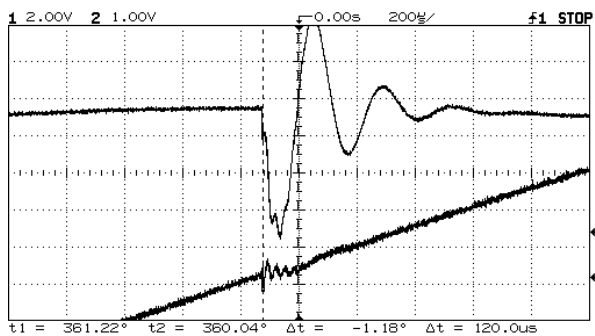
DISPLAY: Current Control			1 of 2
Idc Error	.000	PU	
Idc Feedback	.000	PU	
Idc Reference	.000	PU	
U Line Average	.000	PU	
Udc Reference	.000		
Umaster Average	.000	PU	
Uslave1 Average	.000	PU	
Uslave2 Average	.000	PU	

ALARMS MODIFY NEXT PG PREV PG EXIT

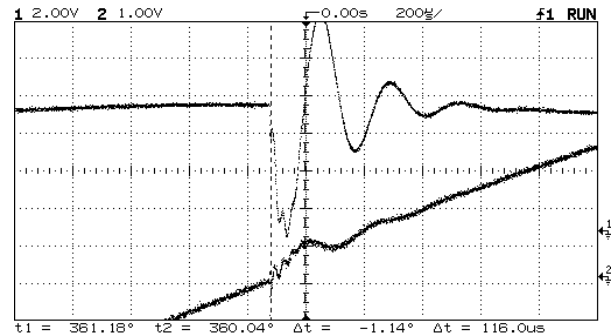
8. Calculate the commutation inductance using the following formula:

$$L \text{ commutation} = V \text{ line} \times \sin(\text{notch width}) / I_{dc} \text{ reference}$$

9. Set parameter "L commutation" to the calculated value. If there was visible distortion in the reconstructed voltage FAB1, the distortion should decrease. If the distortion increases, it is possible that the polarity of the line current feedback is backwards.



COMMUTATION INDUCTANCE TUNED CORRECTLY



COMMUTATION INDUCTANCE INCORRECTLY TUNED

10. Set parameter "Idc command test" to 0.800 pu. The dc current will increase and the commutation notches will become much larger.
11. Repeat steps 6 to 9. The higher current will produce a more accurate measurement of the commutation inductance.

12. Confirm that the commutation inductance is set to the correct value by increasing the horizontal and vertical magnification and observing the zero crossing of reconstructed voltage FAB1. Because the line converter firing angle is about 90 degrees, the commutation notch occurs near the zero crossing of the reconstructed voltage. The signal should be a straight line through the zero crossing with almost no visible distortion. Either increasing or decreasing parameter "L Commutation" should cause the distortion to increase.
13. Stop the drive. Set parameters "Operating mode" to normal and "Idc command test" to zero.

2. Current Regulator

The tuning of the current regulator is controlled by three parameters – two in the "Current Control" group, and one in the "Drive Hardware" group:

1. "Curreg bandwidth"
2. "T dc link"
3. "L dc link"

Of these three parameters, inductance "L dc link" is calculated from its nameplate rating, the current regulator bandwidth should be set to its default value of 200 rad/sec, and only "T dc link" is unknown and must be measured. Although the current regulator was tuned during factory test, it should be retuned during commissioning because the dc link time constant is affected by the impedance of the drive input transformer.

Current Regulator Autotuning

The current regulator can be tuned automatically using the following procedure:

1. Ensure that the parameters in the "Drive Hardware" and "Motor Ratings" groups have been set to the correct values. Otherwise, the calculated value of parameter "L dc link" in "Current Control" will not be correct.
2. Set parameter "Autotune select" in "Autotuning" to Current Reg. The drive will go into dc current test mode. The current regulator bandwidth is temporarily set to the value specified by parameter "Autotune Idc BW". The dc current command is set to the value specified by parameter "Autotune Idc cmd". The dc current step is set to the value specified by parameter "Autotune Idc stp".

3. Start the drive. The step response of the current regulator is measured and the dc link time constant is adjusted to produce a critically damped response. This test may take up to two minutes to perform. When the desired response has been achieved, the drive shuts off.

The current regulator bandwidth is set back to its normal value and parameter "Autotune select" is set to Off. Parameter "Autotune Tdc" indicates the results of the test. If the test is successful, parameter "T dc link" in "Current Control" is set equal to "Autotune Tdc". If the test fails, then parameter "T dc link" is not changed and a warning is issued indicating the cause of the failure:

T dc low - indicates that the measured dc link time constant is less than 0.020 second. The step response of the current regulator should be checked using the manual method described below.

T dc high - indicates that the measured dc link time constant is greater than 0.100 second. The step response of the current regulator should be checked using the manual method described below.

Current Regulator Manual Tuning

An appropriate value for the "T dc link" parameter can be determined from the current regulator step response while operating in dc current test mode. The following procedure should be followed:

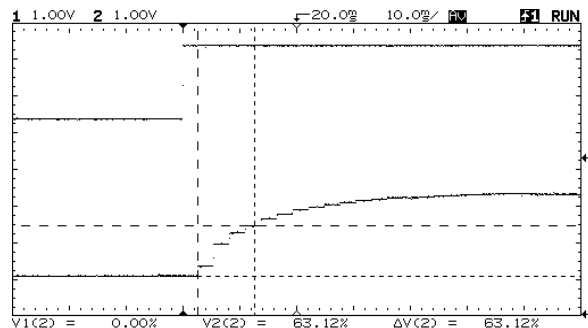
1. Be sure that all the parameters in the "Drive Hardware" and "Motor Ratings" groups have been set to the correct values. Otherwise, the calculated value of parameter "L DC link" in "Current Control" will not be correct.
2. Set parameter "Operating mode" in the "Feature Select" to DC Current to enter dc current test mode.

SELECT: Current Control		1 of 1
Curreg Bandwidth	200.0	r/s
I _{dc} Command Test	.000	pu
I _{dc} Ref Step	.000	pu
L Commutation	.0500	pu
T DC Link	.040	sec

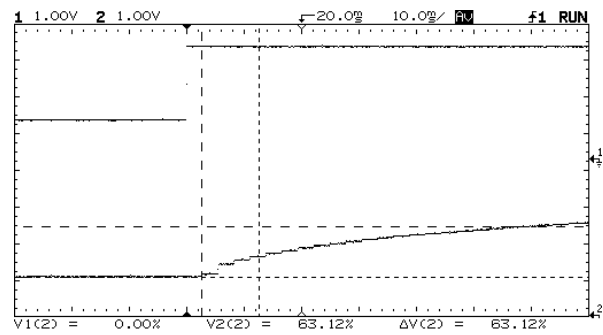
ALARMS		NEXT PG	PREV PG	EXIT
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Current Control Parameter Screen

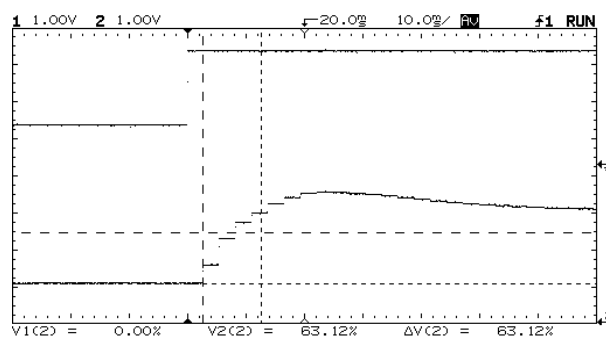
3. Set parameter "Idc command test" in "Current Control" to 0.400 pu.
4. Set parameter "Curreg Bandwidth" in "Current Control" to 100 rad/sec. A lower than the normal bandwidth makes the step response easier to measure.
5. Set parameter "T dc link" in "Current Control" to 0.020 sec, which is at the low end of the normal range of values and should produce an underdamped response.
6. Assign parameters "Idc Reference" and "Idc Feedback" in the "Current Control" group to 2 SCBL test points (Rect TP1 and 2). This can be done similarly to the way that the meter assignments were described earlier in the chapter. Then they can be displayed on your oscilloscope.
7. Start the drive. The dc link current will rise to 0.4 pu.
8. Set parameter "Idc ref step" in "Current Control" to 0.200 pu. The dc link current will step up and down by this amount at regular intervals.
9. Adjust the scope to trigger on the rising edge of the dc current reference and observe the dc current feedback on the other channel. The step response will probably have noticeable overshoot, indicating that the dc link time constant is set too low.
10. Adjust parameter "T dc link" until the current feedback rises to about 63% of its final value in 10 ms as shown in the figure. The overshoot should now be quite small. Increasing "T dc link" causes the rise time to increase. Since the desired step response is slightly underdamped, "T dc link" should not be increased beyond the value at which the overshoot disappears.



CURRENT REGULATOR TUNED CORRECTLY



CURRENT REGULATOR TUNED INCORRECTLY



CURRENT REGULATOR TUNED INCORRECTLY

11. Set parameter "Curreg bandwidth" to the normal value of 200 rad/sec. Confirm that the rise time of the current feedback is now approximately 5 ms and that the overshoot is not excessive.
12. Set parameter "Idc ref step" to zero. The dc link current will return to a steady level of 0.4 pu.
13. Stop the drive. Set parameters Operating Mode to Normal, and Idc Command Test to 0.

3. Stator Resistance

Parameter “R stator ” is used in the hardware reconstruction of the rotor flux. If this parameter is not adjusted correctly, the resulting distortion in the flux feedback may cause speed feedback or motor synchronization errors. Stator resistance must be tuned during commissioning because it is affected not only by motor parameters, but also by cable length. Stator resistance can be measured with the motor stationary. The following Autotune procedure can be used

ATTENTION

In the following steps, the rotation of the motor in an undesirable direction may occur. To guard against possible equipment damage, it is recommended that the motor is disconnected from the load and tested for direction prior to proceeding, should the equipment be sensitive to reverse direction rotation.

1. Ensure that the motor is stationary. If the motor is turning, the results of the test may be invalid. It is not necessary to lock the rotor.
2. Set parameter "Autotune select" in "Autotuning" to Stator Rest.
3. Start the drive. The output frequency ramps up to 2 Hz with the motor current remaining at zero.

The motor current then jumps up to approximately 0.10 pu for less than a second and the drive shuts off. This test produces a small amount of motor torque and some rotation may occur.

Parameter "Autotune Rs" is set to the measured Stator resistance and parameter "Autotune select" is set to Off. If the test is successful, parameter "Stator resistance" in "Motor Model" is set equal to "Autotune Rs". If the test fails, then parameter "Stator resistance" is not changed and a warning is issued indicating the cause of the failure:

R stator hi - this is probably caused by extremely long motor cables increasing the apparent stator resistance of the motor. The drive cannot operate with stator resistance greater than 0.20 pu.

4. Leakage Inductance

Parameter "L total leakage" is used in the hardware reconstruction of the rotor flux. If this parameter is not adjusted correctly, the resulting distortion in the flux feedback may cause speed feedback or motor synchronization errors. Leakage inductance must be tuned during commissioning because it is affected not only by motor parameters, but also by cable length. Leakage inductance can be measured with the motor being stationary. The following Autotune procedure can be used.

ATTENTION



In the following steps, the rotation of the motor in an undesirable direction may occur. To guard against possible equipment damage, it is recommended that the motor is disconnected from the load and tested for direction prior to proceeding, should the equipment be sensitive to reverse direction rotation.

1. Ensure that the motor is stationary. If the motor is turning, the results of the test may be invalid. It is not necessary to lock the rotor.
2. Set parameter "Autotune select" in "Autotuning" to Leakage Ind.
3. Start the drive. The output frequency ramps up to rated frequency in 2-3 seconds with the motor current remaining at zero. The motor current then jumps up to approximately rated current for less than a second and the drive shuts off. This test produces a small amount of motor torque and some rotation may occur.

Parameter "Autotune Ls" is set to the measured leakage inductance, and parameter "Autotune select" is set to Off. If the test is successful, parameter "L total leakage" in "Motor Model" is set equal to "Autotune Ls". If the test fails, then parameter "L total leakage" is not changed and a warning is issued indicating the cause of the failure:

L leakage lo - indicates that the measured leakage inductance is less than 0.15 pu. Possible causes are:

1. The motor is much larger than the drive and the motor nameplate parameters do not correspond to the actual motor ratings. In this case, the measured leakage inductance is probably correct and parameter "L total leakage" should manually be set equal to "Autotune Ls".

2. Because of the design of the motor, this method of measuring leakage inductance does not produce a valid result. The leakage inductance will have to be obtained from the motor data sheet, or if this is not possible, parameter "L total leakage" should be set to its default value of 0.20 pu.

L leakage hi - indicates that the measured leakage inductance is greater than 0.30 pu. Possible causes are:

1. The inductance of long motor cables is increasing the apparent leakage inductance of the motor. In this case, the measured leakage inductance is probably correct and parameter "L total leakage" should manually be set equal to "Autotune Ls".
2. The motor is very small (leakage inductance generally increases with decreasing motor size).
3. Because of the design of the motor, this method of measuring leakage inductance does not produce a valid result. The leakage inductance will have to be obtained from the motor data sheet. If this is not possible, parameter "L total leakage" should be set to its default value of 0.20 pu.

5. Flux Regulator

Induction Motor Flux Regulator

The tuning of the flux regulator for an induction motor is determined by three parameters:

1. Flxreg bandwidth in "Flux Control"
2. L magnetizing in "Motor Model"
3. T rotor in "Motor Model"

"Flxreg bandwidth" should be set to the default value of 10 r/s for almost all applications. "L magnetizing" and "T rotor" are usually unknown and must be measured. Both of these motor parameters change substantially with different operating conditions, but the variations do not significantly affect the operation of the flux regulator.

The other aspect of flux control is the variation of motor flux with speed. This is determined by two parameters:

1. Base speed in "Flux Control"
2. Flux command base speed in "Flux Command"

In most applications, the motor runs at constant flux below rated speed and constant voltage above rated speed. The motor flux is normally set to a level that provides rated voltage at rated speed and full load. The flux level required to achieve this is a function of the motor parameters. The flux regulator Autotuning determines a value of rotor flux that should provide rated motor voltage at full load and rated speed, and sets the flux command parameter to this value.

Flux Regulator Autotuning

The flux regulator is tuned with the motor running at constant speed using the following procedure:

1. Ensure that parameters "Rated motor rpm" in "Motor Rating" and "L total leakage" in "Motor Model" are set to the correct value.
2. Set parameter "Autotune select" in "Autotuning" to Flux Reg.
3. Start the drive. The motor accelerates normally up to the speed specified by parameter "Autotune spd cmd". The motor magnetizing inductance is calculated from the measured current and flux feedback and parameter "Autotune Lm" is set to this value. The flux command is then set to a value that should produce rated voltage at rated speed and load. The resulting change in the flux level may cause the magnetizing inductance to change. This process is repeated until the magnetizing inductance and flux commands stabilise. The drive then performs a normal stop.

Parameter "Autotune Lm" is set to the measured magnetizing inductance and parameter "Autotune select" is set to Off. Parameter "Flux Command Base Speed" in "Flux Command" is set to a value which is intended to produce rated voltage at rated speed and load. The value of parameter "Autotune T rotor" is calculated from parameters "L magnetizing" and "Rated Motor rpm" (which gives the rated slip).

If the flux regulator Autotuning is successful, then parameter "L magnetizing" in "Motor Model" is set equal to "Autotune Lm", parameter "T rotor" in "Motor Model" is set equal to "Autotune T rotor", and the flux regulator gains are recalculated. If the flux regulator Autotuning fails then parameters "L magnetizing" and "T rotor" are not changed and a warning is issued indicating the cause of the failure.

L magn low - indicates that the measured value of magnetizing inductance is less than 1.0 pu. This warning is intended to draw attention to an unusually low value of magnetizing inductance. This may occur if the motor is much larger than the drive and the nameplate parameters do not correspond to the actual motor ratings. In this case, the measured magnetizing inductance is probably correct and parameter "L magnetizing" should manually be set equal to "Autotune Lm".

L magn high - indicates that the measured value of magnetizing inductance is greater than 10.0 pu. This warning is intended to draw attention to an unusually high value of magnetizing inductance. This may occur if the motor is much smaller than the drive, and the nameplate parameters do not correspond to the actual motor ratings. The flux regulator should be tuned using the manual method described below.

T rotor low - indicates that the calculated value of rotor time constant is less than 0.2 seconds. This is caused by a value of "L magnetizing" or "Rated motor rpm" which is too low.

T rotor high - indicates that the calculated value of rotor time constant is greater than 5.0 seconds. This is caused by a value of "L magnetizing" or "Rated motor rpm" which is too high.

Flux Regulator Manual Tuning

1. Adjust the reference command to a value between 20 and 30 Hz.
2. Start the drive and wait for it to accelerate to the commanded speed.
3. Record the value of parameter "L magn measured" in "Motor Model".
4. Stop the drive.
5. Set parameter "L magnetizing" in "Motor Model" to the recorded value of "L magn measured"
6. Calculate an approximate value of the rotor time constant using the following formula:

$$T \text{ rotor} = \frac{L \text{ magnetizing}}{\text{Rated slip in rad/sec}}$$

Where,

$$\text{Rated slip in rads/sec} = 2\pi f \times \frac{(\text{synchronous speed in rpm} - \text{rated speed in rpm})}{\text{Synchronous speed in rpm}}$$

Set the parameter "T rotor" in "Motor Model" to the calculated value.

Synchronous Motor Flux Regulator

This section applies only to firmware revision 3.001 and higher.

Before the flux regulator can be tuned, the analog output for the field current reference must be set up.

Configuring the Field Current Reference

Excitation for the synchronous motor is provided by a current regulated field supply, either a dc supply for a slip ring or dc brushless machine, or a three phase ac supply for an ac brushless machine. The drive provides an analog current reference as an input to the field supply. The analog current reference has a range of 0-10V, where 0V corresponds to zero field current and 10V corresponds to maximum field current. The scaling of the analog current reference must be adjusted to achieve a linear relationship between the current reference and the actual field current. If this is not done, the flux regulator may be unstable. The scaling of the analog output can be adjusted using the following procedure:

1. Temporarily assign variable “Autotune Lmd” in “Autotuning” to the analog output used to control the field supply (e.g. CIB Port 1).
2. Set the analog output scale parameter (e.g. Analog CIB Port 1 Scale) in “Analog Parameters” to:

$$\text{Analog Scale} = \text{maximum analog input of field supply} / 10\text{V}$$

3. Set “Autotune Lmd” to a value of 10.00. Confirm that the reference input of the field supply is at its maximum value. Adjust the analog output scaling parameter if necessary.
4. Start the field supply and confirm that the field current goes to its maximum value. If necessary, adjust the field supply to achieve a field current slightly above rated.

CAUTION: Applying maximum field current to a stationary machine for an extended period may damage the exciter. Adjust the current as quickly as possible.

5. Stop the field supply. Assign variable “I Field Command” in “Flux Control” to the analog output used to control the field supply (e.g. CIB Port 1). The setup of the field current reference is complete and you can proceed with the tuning of the flux regulator.

Tuning the Flux Regulator

The tuning of the flux regulator for a synchronous machine is determined by four parameters:

1. Flxreg Bandwidth in "Flux Control"
2. L magnetizing in "Motor Model"
3. T rotor in "Motor Model"
4. Lmd in "Motor Model"

"Flux Regulator Bandwidth" should be set to the default value for almost all applications. "L magnetizing", "Lmd", and "T rotor" are usually unknown and must be measured. Although these motor parameters change with different operating conditions, the variations do not significantly affect the operation of the flux regulator.

The other aspect of flux control is the variation of motor flux with speed. This is determined by two parameters:

1. Base speed in "Flux Control"
2. Flux Command Base Speed in "Flux Command"

In most applications, the motor runs at constant flux below rated speed and constant voltage above rated speed. The motor flux is normally set to a level that provides rated voltage at rated speed and full load. The flux level required to achieve this is a function of the motor parameters. The flux regulator autotuning determines a value of rotor flux that should provide rated motor voltage at full load and rated speed and sets the flux command parameter to this value.

Flux Regulator Autotuning

Note: If a position encoder is fitted to the motor, the flux regulator autotuning is performed with the encoder feedback turned off because it is assumed that the encoder has not been aligned with the rotor axis yet. Since less starting torque is produced with the encoder feedback off, this test should be performed with reduced load. The encoder offset measurement is also most accurate with no load on the motor.

The flux regulator is tuned with the motor running at constant speed using the following procedure:

1. Ensure that the analog reference for the field current has been set up as described previously, and that parameter "L total leakage" has been set to the correct value.
2. Set parameter "Autotune Select" in "Autotuning" to "Flux Reg".

3. Start the drive. The motor accelerates normally up to the speed specified by parameter "Autotune Spd Cmd". The motor magnetizing inductance is calculated from the magnetizing current reference and the flux feedback and parameter "Autotune Lm" is set to this value. The flux command is then set to a value that should produce rated voltage at rated speed and load. The resulting change in the flux level may cause the magnetizing inductance to change. This process is repeated until the magnetizing inductance and flux command stabilize. If a position encoder is fitted to the motor, the angle between the measured flux and the encoder zero is measured and parameter "Encoder offset" is adjusted to align the encoder with the motor flux.
4. The field current reference is then held constant and the response of the flux to changes in stator magnetizing current is measured by stepping "Ix command" up and down at regular intervals. The size of the step in the stator current is specified by parameter "Autotune Isd Step". The step response measurement takes about 3 minutes. When the measurement is complete, the drive performs a normal stop.

Parameter "Autotune Lm" is set to the measured magnetizing inductance and parameter "Autotune Select" is set to Off. Parameter "Flux Command Base Speed" in "Flux Command" is set to a value calculated to produce rated voltage at rated speed and load. The value of parameters "Autotune T rotor" and "Autotune Lmd" are calculated from the step response data.

If the flux regulator autotuning is successful, then parameter "L magnetizing" in "Motor Model" is set equal to "Autotune Lm", parameter "T rotor" in "Motor Model" is set equal to "Autotune T rotor", and parameter "Lmd" in "Motor Model" is set equal to "Autotune Lmd". If the flux regulator autotuning fails then parameters "L magnetizing", "Lmd", and "T rotor" are not changed and a warning is issued indicating the cause of the failure.

L magn low – indicates that the measured value of magnetizing inductance is less than 1.0 pu. This warning is intended to draw attention to an unusually low value of magnetizing inductance. The most likely cause is incorrect scaling of the analog field current reference.

L magn high – indicates that the measured value of magnetizing inductance is greater than 15.0 pu. This warning is intended to draw attention to an unusually high value of magnetizing inductance. The most likely cause is incorrect scaling of the analog field current reference.

T rotor low – indicates that the calculated value of rotor time constant is less than 0.1 seconds

T rotor high – indicates that the calculated value of rotor time constant is greater than 5.0 seconds.

6. Speed Regulator

The tuning of the speed regulator is determined by two parameters in the "Speed Control" group:

1. Spdreg bandwidth
2. Total inertia

Parameter "Spdreg bandwidth" is set to a value determined by the requirements of the application, but parameter "Total inertia" is usually unknown and must be measured.

Speed Regulator Autotuning

The Autotuning determines the total inertia by measuring the change in speed that occurs when a low frequency sinusoidal torque perturbation is applied to the motor. The inertia measurement is not affected by the load torque as long as the drive does not hit torque limit. Do not disconnect the driven load from the motor, as it is the total inertia of motor and load that is being measured. The following procedure should be used:

1. Ensure that parameters "Autotune spd cmd" and "Autotune trq stp" in "Autotune" are set to default values.
2. Set parameter "Autotune select" in "Autotuning" to "Speed Reg".
3. Start the drive. The motor accelerates normally up to the speed specified by parameter "Autotune spd cmd". When the motor speed has settled at the commanded value, a sinusoidal perturbation specified by parameter "Autotune trq stp" is added to the torque command, causing the speed to vary. After the initial transient has decayed (this usually takes a few seconds), the variation in torque and speed are measured and used to calculate the total inertia. The torque perturbation is then removed and the drive performs a normal stop.

Parameter "Autotune inertia" is set to the measured inertia and parameter "Autotune select" is set to Off. If the test is successful, parameter "Total inertia" in "Speed Control" is set equal to "Autotune inertia", and the speed regulator gains are recalculated. If the test fails, then parameter "Total inertia" is not changed and a warning is issued indicating the cause of the failure:

Reg in limit - indicates that the torque command was greater than "Torque limit motoring" or "Torque limit braking". The measured inertia value is invalid. Parameter "Autotune trq stp" or parameter "Autotune spd cmd" must be set to a lower value and the test repeated.

Tuning abort - indicates that the deviation in motor speed was greater than 10 Hz. The measured inertia value is invalid. Parameter "Autotune trq stp" must be set to a lower value and the test repeated.

Inertia high - indicates that the measured total inertia is greater than 5 seconds. This warning is intended to draw attention to an unusually high inertia value. For a very high inertia load such as a large fan, this may be a valid result and parameter "Total inertia" should be manually set equal to "Autotune inertia". However, a high inertia measurement could also be produced by a value of "Autotune trq stp" which is too low.

Speed Regulator Manual Tuning

If it is not possible to tune the speed regulator using the autotune function, then the step response of the speed regulator can be tuned manually using the following procedure. To obtain accurate results, the load torque must be steady.

1. Set parameter "Spdreg bandwidth" in "Speed Control" to 1.0 rad/sec.

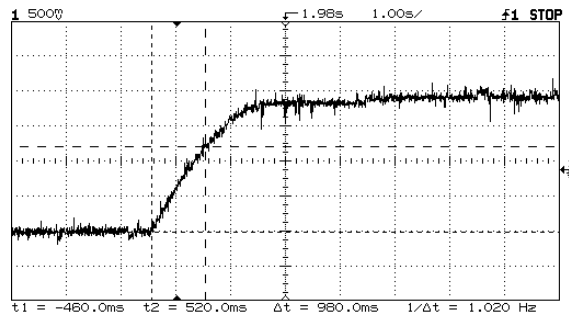
SELECT: Speed Control		1 of 1
Spd Fdbk Filter	10.0	r/s
Spdreg Bandwidth	1.0	r/s
Speed Fdbk Mode	Sensorless	
Total Accel Time	75.0	sec
Total Decel Time	69.0	sec
Inertia Type	High	
Total Inertia	1.00	sec

ALARMS NEXT PG PREV PG EXIT

Speed Control Parameter Screen

2. Set parameter "Total inertia" in "Speed Control" to an initial value of 1.0 sec.

3. Assign parameter 'Speed Error' in the "Current Control" group to a SCBL test point (Rect TP1 or 2). This can be done similarly to the way that the meter assignments were described earlier in the chapter. Then it can be displayed on your oscilloscope. Use the settings 2V/division and 1 sec/division.
4. Adjust the reference command to a value around the middle of the operating speed range.
5. Start the drive and wait for it to accelerate to the commanded speed.
6. Set parameter "Speed ref step" in "Speed Control" to 0.8 Hz. The drive speed will step up and down by this amount at regular intervals. The step of 0.8 Hz corresponds to 4 V on the test point. Since the speed error signal has a range of only 4 Hz in order to achieve the required resolution for small changes in speed, the signal may sometimes rollover (jump from +10V to -10V) during the speed step. If this occurs, it can be eliminated by adjusting the reference command up or down slightly.
7. Adjust the value of parameter "Total inertia " until the speed rises to approximately 63% of its final value in 1 second as shown in the figure. If the response time is too fast, it indicates that "Total inertia" is set too high and should be decreased. If the response is too slow, then "Total inertia" is set too low and should be increased.



CORRECTLY TUNED SPEED REGULATOR

8. Set parameter "Spdreg bandwidth" to the normal operating value. Confirm that the response time is equal to the inverse of the speed regulator bandwidth and that there is minimal overshoot. For example, if the speed regulator bandwidth is set to 2 rad/sec, the speed should rise to 63% of its final value in 0.5 second.
9. Set parameter "Speed ref step" to zero and stop the drive.

Calculating Total Inertia

If the system inertia cannot be measured, it can be calculated if the moment of inertia of the motor and load are known. The value of parameter "Total inertia" is defined as the time required to accelerate the motor and load to rated speed when rated torque is applied. It can be calculated using the following formula:

$$\text{Total inertia} = \frac{\text{total inertia of motor \& load in kg-m}^2 \times (\text{rated speed in rad/ sec})^2}{\text{rated power in watts}}$$

or

$$\text{Total inertia} = 6.21 \times 10^{-7} \frac{\text{total inertia of motor and load in lb-ft}^2 \times (\text{rated speed in rpm})^2}{\text{rated power in hp}}$$

If there is a gearbox between the motor and load, the inertia of the load must be referred to the motor side of the gearbox.

Running the Load

Motor Starting Torque

When starting without a tachometer or encoder, the drive operates in an open loop mode below approx. 3 Hz at which point the drive switches to closed loop speed control. The starting currents are set by three parameters; Torque Commands 0 (P86), 1 (P87), and Minimum (P101). Torque Command 0 sets the breakaway torque and Torque Command 1 is the torque at the transition point from open to closed loop. Torque Command Minimum operates in conjunction with Torque Command 1 to minimize speed overshoot at the transition point. If you are starting an uncoupled motor, or simply autotuning, the default starting torque values may be sufficient to run the motor. But the defaults are generally not high enough to start a loaded motor.

Be prepared to have to increase starting torque and endure Motor Stall faults during initial operation.

Reaching Specific Load Points

Verify the drive can reach rated speed and load. Monitor the Torque Reference (P291) and the displayed value of the motor current. If you are running into a torque limit the Torque Reference will be running near the Torque Limit Motoring (P84) limit. If you are not realizing rated motor current you may increase the Torque Limit Motoring slightly. If increasing the Torque Limit Motoring does not help to increase the motor amps and speed then the drive is most likely running out of input voltage.

Monitor the V Line Average (P135), and increase the tap setting on the drive feed if the measured value is less than 1.03 pu. It is desirable to have V Line Average read in the 1.03 to 1.07 pu range. Alpha Line (P327) should be greater than 15° while running at rated speed and load, indicating how far forward the rectifier is phased. The input voltage should be increased by tapping up the transformer.

Fill in the following table with data from the various load points. If possible, capture the running parameters with the printer, DriveTools, or Hyperterminal as a substitute for recording the data in the table below. This should be forwarded with all commissioning data back to Product Support for future reference.

It is also an excellent practice to capture and save critical drive waveforms at rated speed, rated load. A good list of waveforms to capture is indicated below:

- SCB-L unfiltered voltages (Vab1-out, Vbc1-out, Vca1-out, etc.) \supseteq
- SCB-L unfiltered currents (In1-out, Ic1-out)
- SCB-L DC link current (Idcp)
- SCB-M unfiltered voltages (Vab1-out, Vbc1-out, Vca1-out)
- SCB-M unfiltered currents (In1-out, Ic1-out)

\supseteq 18-pulse rectifiers have six additional voltage test points.

Capturing each waveform at 2 ms, 5 ms and 10 ms yields best results.

Below are examples of various waveforms taken from actual drives installed in the field. Please note that 18-pulse rectifier currents are on the secondary side of the isolation transformer.

Figures 4.20 to 4.23: PWM Rectifier, 4160V, 2000 HP, 249A

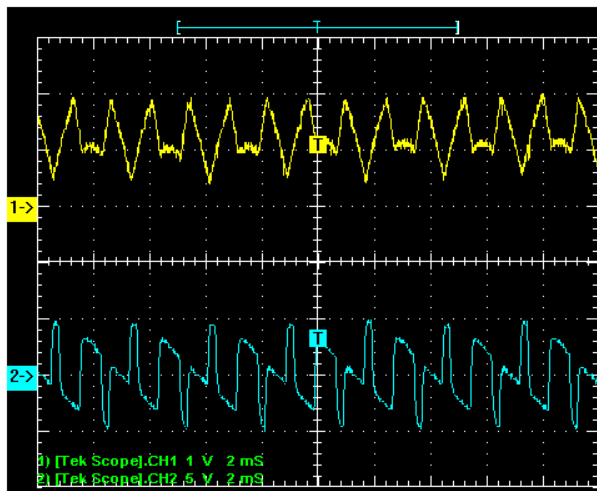


Figure 4.20 – DC Current Test @ .3 pu: Idcp (1) vs. Vdc_Avg (2)

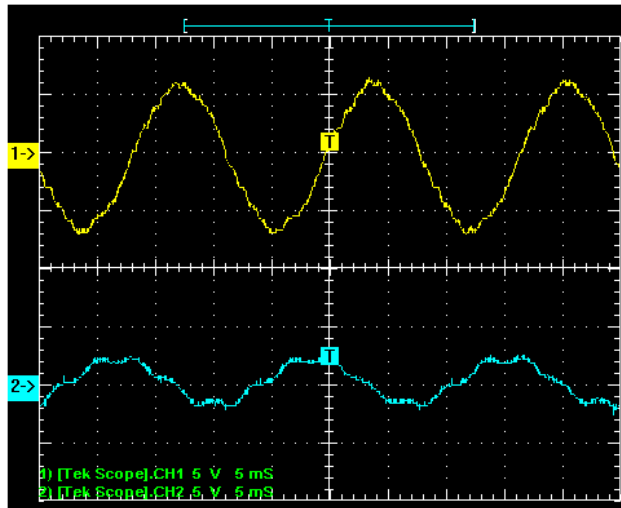


Figure 4.21 – Running Full Speed/Full Load: Line Side; Vab1_out (1) vs. Ia1_out (2)

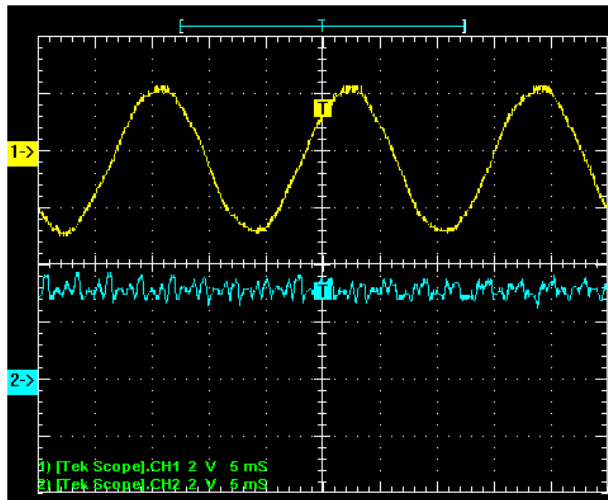


Figure 4.22 – Running Full Speed/Full Load: Line Side; Vab1_out (1) vs. Idcp (2)

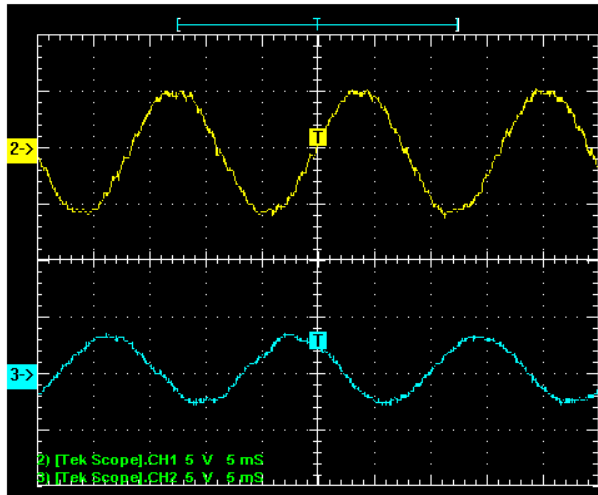


Figure 4.23 – Running Full Speed/Full Load: Motor Side; Vab1_out (1) vs. Ia3_out (2)

Figures 4.24 to 4.28: 18-pulse Rectifier, 6600V, 600 HP, 49A

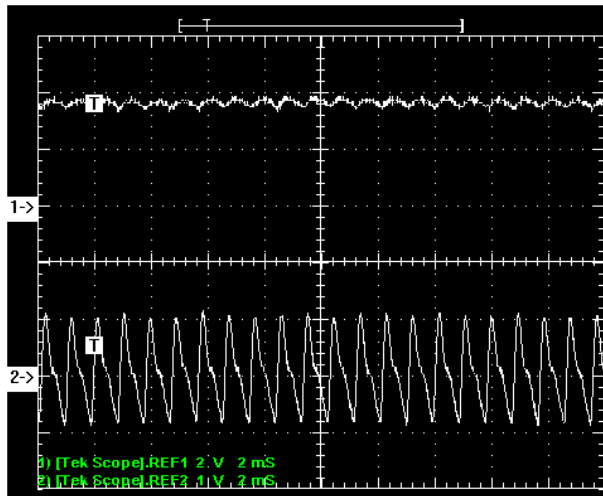


Figure 4.24 – Running DC Current Test Mode: .80 pu: Idcp (1) vs. Vdc_Avg (2)

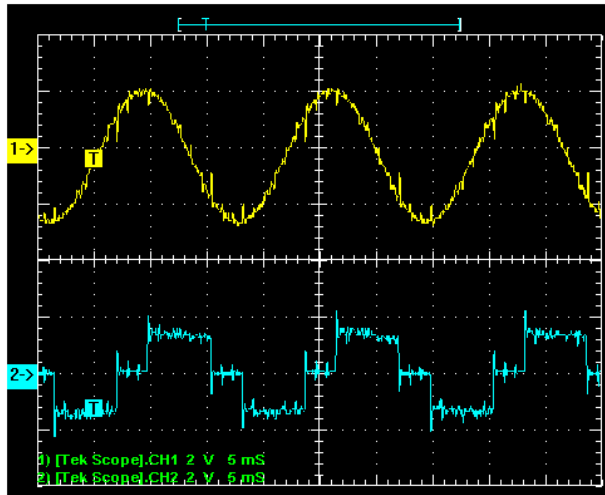


Figure 4.25 -- Running Full Speed, 90% Load: Line Side; Vab1_out (1) vs. Ia1_out (2)

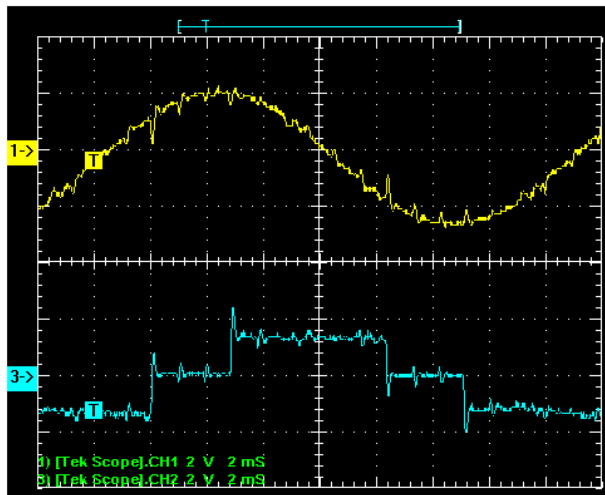


Figure 4.26 -- Running Full Speed, 90% Load: Line Side; Vab1_out (1) vs. Ia1_out (2)

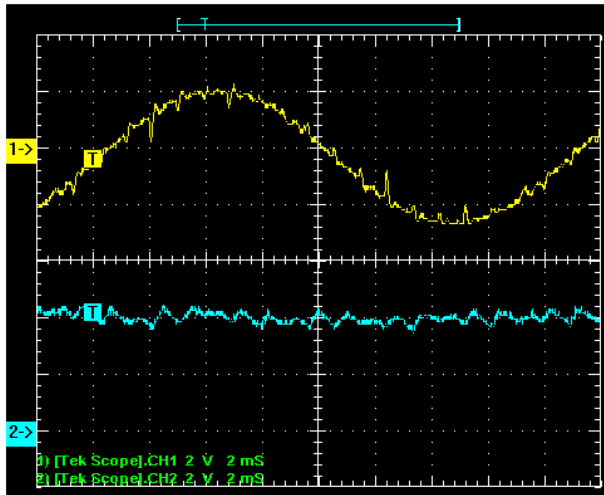


Figure 4.27 – Running Full Speed, 90% Load: Line Side; Vab1_out (1) vs. Idcp (2)

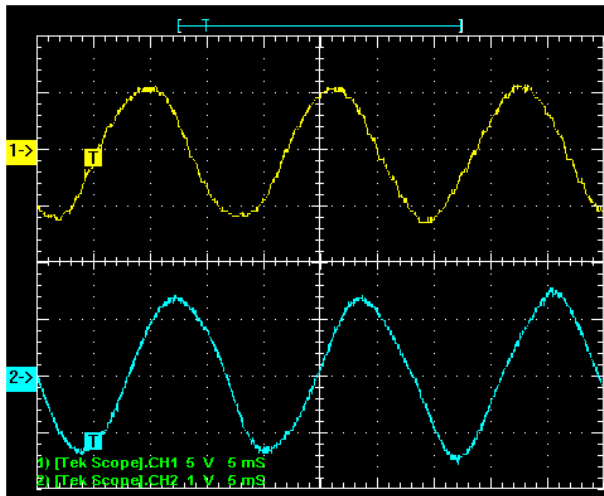


Figure 4.28 – Running Full Speed, 90% Load: Motor Side; Vab1_out (1) vs. Ia3_out (2)

Capturing Data

When all of the final commissioning procedures are completed and the drive is running, it is **VERY IMPORTANT TO CAPTURE ALL THE DRIVE DATA** for future reference.

The last step should be to **PRINT --> DRIVE SETUP**. This will print all the parameters (regardless of the user access level), the various firmware revisions, the exploded fault masks, the PLC links, and the Analog configuration.

All of this information is required to address future customer issues.

TEST #	MOTOR/DRIVE OPERATING POINT		DRIVE VARIABLES										
	%SPEED / RPM	AMPS	VOLTS (Vline)	Speed Ref (Hz)	Speed Fdbk (Hz)	Flux Ref (pu)	Torque Ref (pu)	I DC Ref (pu)	I DC Fdbk (pu)	Alpha Machine (degrees)	Alpha Line (degrees)	Inverter Heatsink Temp (°C)	Rectifier Heatsink Temp (°C)
1	25% / ___												
2	50% / ___												
3	75% / ___												
4	100% / ___												
5	___% / ___												
6	___% / ___												
7	___% / ___												
8	___% / ___												
9	___% / ___												
10	___% / ___												
11	___% / ___												
12	___% / ___												

Notes:

PowerFlex 7000 Functional Description

Introduction

The PowerFlex 7000 is an adjustable speed ac drive in which motor speed control is achieved through control of the motor torque. The motor speed is calculated or measured and the torque is adjusted as required to make the speed equal to the speed command. The motor and load determine the stator frequency and the drive synchronizes itself to the motor. This is in contrast to the volts/hertz ac drive in which the drive determines the stator frequency and does not attempt to synchronize its output to the motor.

The method of control used in PF7000 is known as direct rotor flux oriented vector control. The term rotor flux vector control indicates that the position of the stator current vector is controlled relative to the motor flux vector. Direct vector control means that the motor flux is measured, in contrast to the indirect vector control in which the motor flux is predicted. In both control methods, the stator current (I_s) is split into flux producing component (I_{sd}) and an orthogonal torque producing component (I_{sq}) which are controlled independently. The aim of vector control is to allow a complex ac motor to be controlled as if it were a simple dc motor with independent, decoupled field and armature currents. This allows the motor torque to be changed quickly without affecting the flux. For typical Medium Voltage motors the rotor time constant is in the range of seconds and therefore the flux cannot be changed quickly.

The PowerFlex 7000 drive can be used with either induction (asynchronous) or synchronous motors. Synchronous motor drives are identical to induction motor drives except for the addition of a current regulated field supply to the synchronous drive. The features that are unique to a synchronous motor drive are confined to the flux control function and the encoder option.

Description of Operation

A complete block diagram of the PF7000 control circuit is shown below. The major blocks are described in the following sections.

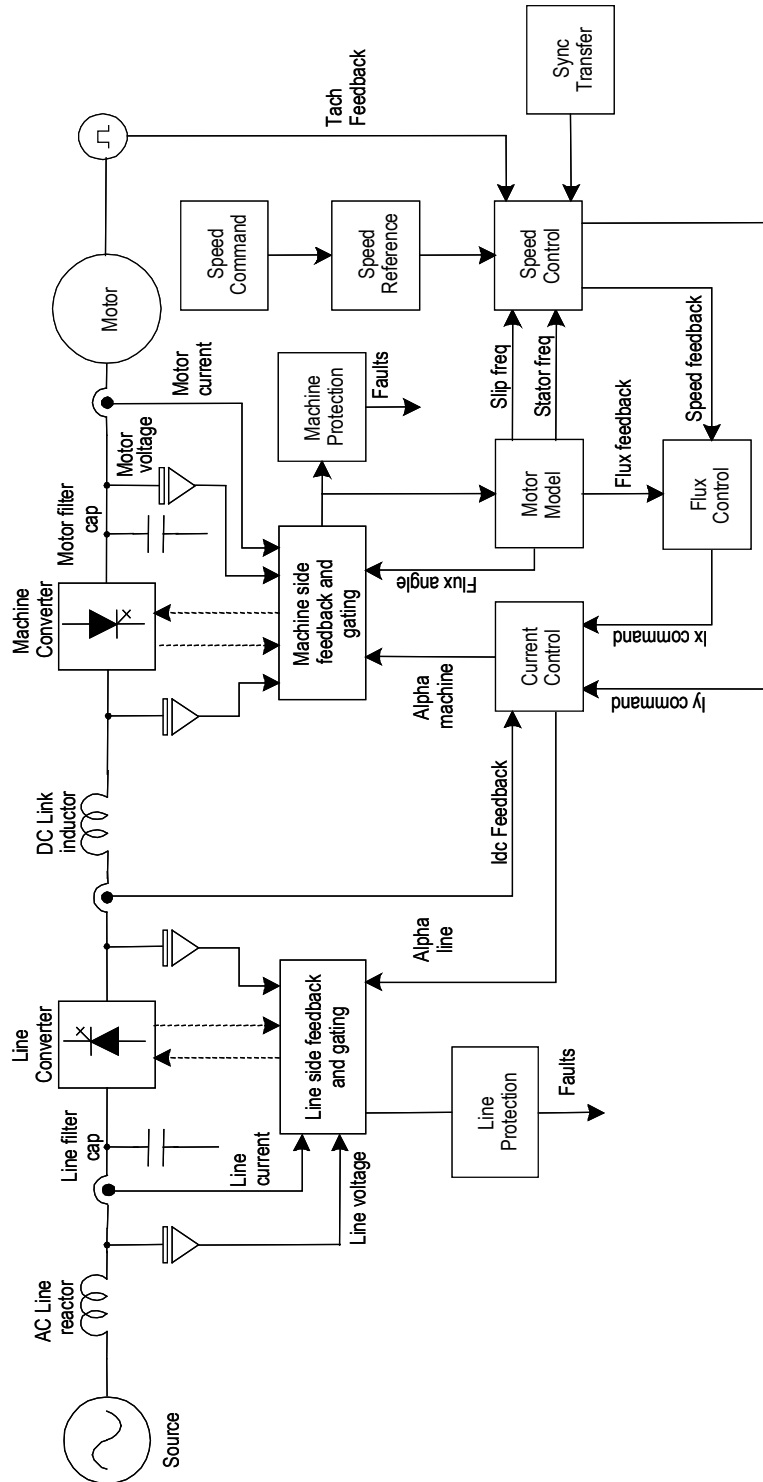


Figure 5.1 – Functional Block Diagram of PF 7000 control system

Speed Command

The function of Speed Command block is to select one of the 13 possible speed command inputs. Parameter *Reference Select* (2) in conjunction with Local/Remote selector switch is used to define the speed command input *Speed Command In* (276). When the selector switch is in *Local* position, the default speed command is the Analog Speed Potentiometer typically mounted on the LV panel. When the selector switch is in *Remote* position, the parameter *Reference Select* defines the source of speed command. The options available are:

- 3 analog inputs (Speed Pot, Remote 0-10V, Current Loop: 4-20mA or 0-20mA)
- 3 Preset speed commands
- 6 DPI/SCANport commands
- 1 Preset jog speed command

The above speed commands are used when the drive is in *Normal* mode of operation. However PF7000 has many special modes of operation e.g. test modes or auto-tuning for which different speed commands are selected. Table 5.A summarizes the speed command during these special modes.

Table 5.A – Speed Commands for special operating modes of PF7000

Special operating modes of PF7000	Speed Command In(276)
DC test mode	60Hz
Open Circuit	Rated Line Freq(17)
Open Loop	0.1*Rated Line Freq(17)
Rs autotune	2Hz
Ls autotune	Rated Line Freq(17)
Flux Reg autotune	Autotune Spd Cmd(213)
Speed Reg autotune	Autotune Spd Cmd(213)
Demagnetize	Rated Motor Freq(29)
Sync transfer requested	Bypass Freq(159)

The selected *Speed Command In* is clamped to a minimum and a maximum level by parameter *Spd Cmd Max* (290) and *Spd Cmd Min* (293) to give *Speed Command* (277). The maximum value of *Speed Command* cannot be greater than 125% of *Base Speed* (98).

Note: Contact the factory for applications that require output frequencies greater than 125% of the motor base speed.

Speed Command (cont.)

Three skip speeds *Skip Speed 1* (50), *Skip Speed 2* (51), *Skip Speed 3* (52) are provided to prevent the drive from continuously operating at a certain speed. This feature is sometimes needed to avoid mechanical vibrations occurring in a drive system at certain speeds. The skip speed zone around each Skip Speed is specified by the parameter *Skip Spd Band1* (53), *Skip Spd Band2* (54), *Skip Spd Band3* (55). If the desired *Speed Command* lies in a given skip speed zone, the *Speed Command* is clamped to the lowest value in the zone. E.g. if *Skip Speed 1* is 45 Hz with *Skip Spd Band1* as 1 Hz, then the skip speed range extends from 44.5Hz to 45.5Hz. If the desired speed command is set to 45 Hz, then the drive will avoid this speed and run at 44.5Hz.

The final stage in processing the command is whether the drive has been requested to run forward or reverse. The sign is changed if reverse rotation is selected or is set to zero if there is no run request.

Speed Reference

The function of the Speed Reference block is to determine the *Speed Reference* (278) from the desired *Speed Command* (277). PF7000 provides two options:

- S-curve
- Linear Ramp

To select, *S-curve* a non-zero value of *S-curve Percent* (475) is selected. Using parameter *S curve Acc1* (481), the drive automatically calculates the linear and the non-linear portions of the S-curve as shown in Figure 5.2. Following example shows how to use S-curve parameters:

Example

If *S curve Acc1* is set for 20sec with 20% in *S-curve Percent*, then the total acceleration time is increased by $0.2 \times 20 = 4$ seconds. The total acceleration time will now be 24 seconds with 4 seconds in the non-linear portion of the S-curve. Since the curve is symmetrical, each of the segments will be of 2 seconds duration.

The parameters for deceleration are calculated using parameter *S curve Dec1* (479) and *S-curve Percent* (475) and shown in Figure 5.2.

Linear Ramp is enabled if the *S-curve Percent* is set to zero. Independent four section ramps are provided for acceleration and deceleration. The ramp is specified by 4 Ramp Speeds, 4 Accel and Decel times and is shown in Figure 5.3.

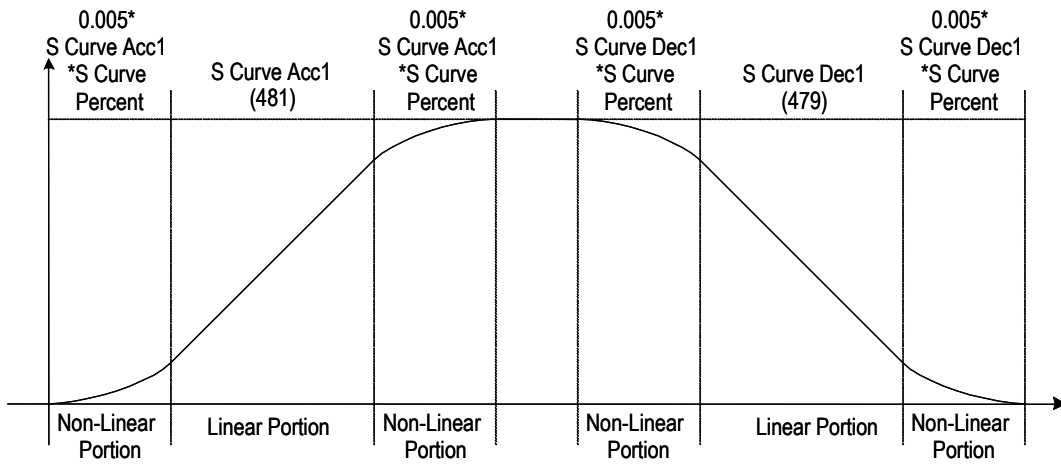


Figure 5.2 – Speed Reference: S-curve

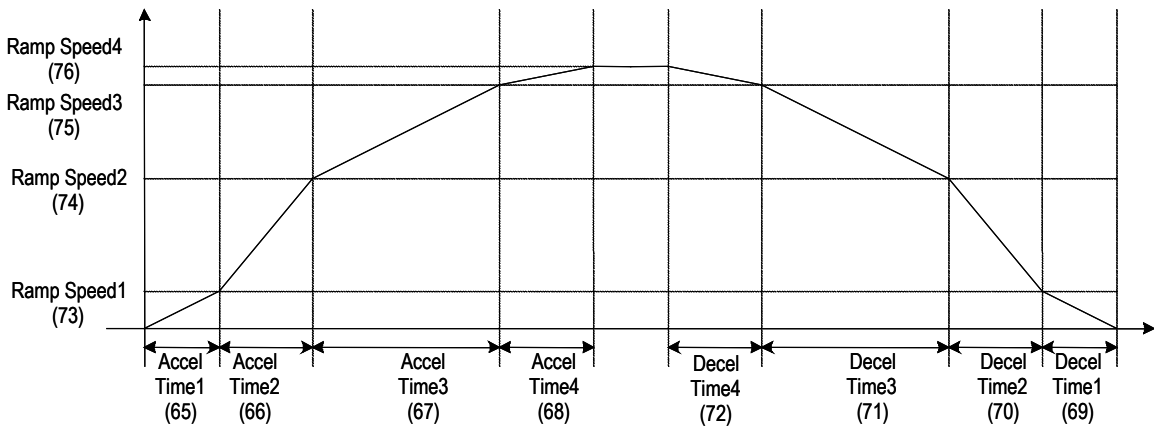


Figure 5.3 – Speed Reference: Linear Ramp

Speed Control

The function of the speed control block is to determine the torque-producing component (I_{sq}) of the stator current (I_s). The inputs to the block are the *Speed Reference* (278) from the speed ramp and the *Stator Freq* (448) and *Slip Frequency* (343) from the motor model. If drive is installed with an optional tachometer, then the motor speed is determined by counting the tach pulses.

In *Sensorless* operation, the *Slip Frequency* is subtracted from the *Stator Freq* and filtered to determine the *Speed Feedback* (289). In *Pulse Tach* mode, the speed is determined directly by using *Tach Feedback* (348). The *Speed Feedback* is subtracted from the *Speed Reference* to determine the *Speed Error* (472) which is processed by the speed PI regulator. The gains of the regulator are based on the *Total Inertia* (82) of the system and the desired *Spdreg Bandwidth* (81). The output of the speed regulator is the *Torque Reference* (291) whose rate of change is limited by *Trq Rate Limit* (83). The calculated *Torque Reference* is divided by the *Flux Reference* (305) to determine the torque component of the stator current *Isq Command* (292). To calculate the torque producing current supplied by the inverter *Iy Command* (294), the current supplied by the motor filter capacitor in torque production (orthogonal to motor flux) is calculated and subtracted from *Isq Command*.

In *Sensorless* mode, the drive uses *Trq Command 0* (86) and *Trq Command 1* (87) for an open loop start up. At frequencies greater than 3Hz, the drive closes the speed loop and disables the open loop start mode. In *Pulse Tach* mode, the drive is always in closed loop. The maximum torque a drive can deliver in motoring mode is determined by *Trq Lmt Motoring* (84). In regenerative mode the torque is limited to *Trq Lmt Braking* (85). It should be noted that at speeds above the *Base Speed* (98), the motor torque capability is de-rated and varies in inverse proportion to the speed.

Depending on the application, a drive can be configured in different torque control modes by setting the parameter *Trq Control Mode* (90). E.g. in stand-alone drives the parameter is set as *Speed Reg* allowing the drive to be in speed control mode. In Master-Slave or torque follower applications, the master drive is set in *Speed Reg* mode which enables the speed regulator. The torque reference produced by the Master drive is then passed on to the slave drive which is operating in *Ext Torq Cmd* mode. The slave drive then “follows” the torque command. Figure 5.4 shows other various modes of operation.

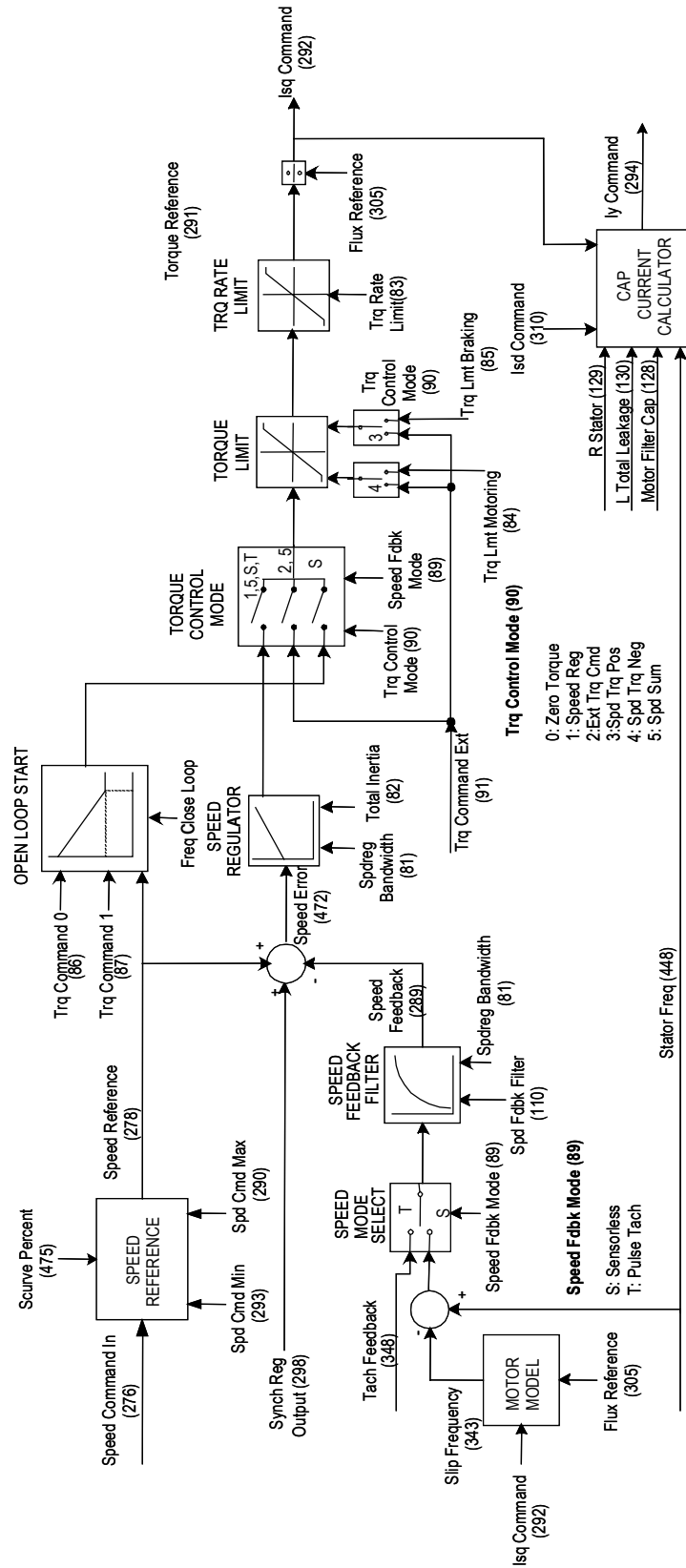


Figure 5.4 – Speed Control

Flux Control

The function of the flux control block (Figure 5.5) is to determine the magnetizing component (I_{sd}) of the stator current (I_s) needed to maintain the desired flux profile in the motor. The inputs are *Flux Feedback* (306) and *Stator Freq* (448) from the motor model, *Speed Feedback* (289) and *Torque Reference* (291) from the speed control block and the measured voltage at the input of the bridge *Vline Bridge* (696).

The *Flux Feedback* is subtracted from the *Flux Reference* (305) to determine the *Flux Error* (307), which is the input to the flux PI regulator. The gains are determined from desired *Flxreg Bandwidth* (97) and motor parameters *T Rotor* (132) and *L Magnetizing* (131). The output of the flux regulator is *Isd Command 1* (309). An open loop estimate of the magnetizing current, *Isd Command 0* (308) is determined by dividing the *Flux Reference* by parameter *L Magnetizing*. *Isd Command 0* and *Isd Command 1* are added to produce *Isd Command* (310) which is the magnetizing component of the stator current command. To calculate the magnetizing current supplied by the inverter *Ix Command* (312), the current supplied by the motor filter capacitor in magnetizing is calculated and subtracted from *Isd Command*. It should be noted that as the motor speed increases, *Ix Command* decreases. This is because as the motor voltage increases more of the magnetizing current requirement of the motor is met by the capacitor. At resonant point, *Ix Command* is nearly zero and becomes negative at speeds above resonance. *Iy Command* (from Speed Control block) and *Ix Command* are then passed to the Current Control block to determine the dc link current reference (*Idc Reference*) and the firing angles of the two converters (*Alpha Line* and *Alpha Machine*).

The flux profile in the drive is adjusted by the parameters *Flx Cmd No Load* (103) and *Flx Cmd Base Spd* (100). Using these parameters, *Flux Reference* is adjusted linearly with the desired *Torque Reference*. At light loads motor flux is decreased allowing reduction in losses while full flux is produced at rated load. The maximum flux reference is limited to *Flux Cmd Limit* (623). This limit is dependent on the input voltage *Vline Bridge* and the motor speed (*Speed Feedback*). If the drive operates at reduced line voltage, then *Flux Reference* is reduced. Also if the motor is running above the *Base Speed*, the flux profile is made inversely proportional to the speed of the motor resulting in the field weakening or the constant power mode of operation of the drive. This is accompanied by a decrease in the motor torque capability.

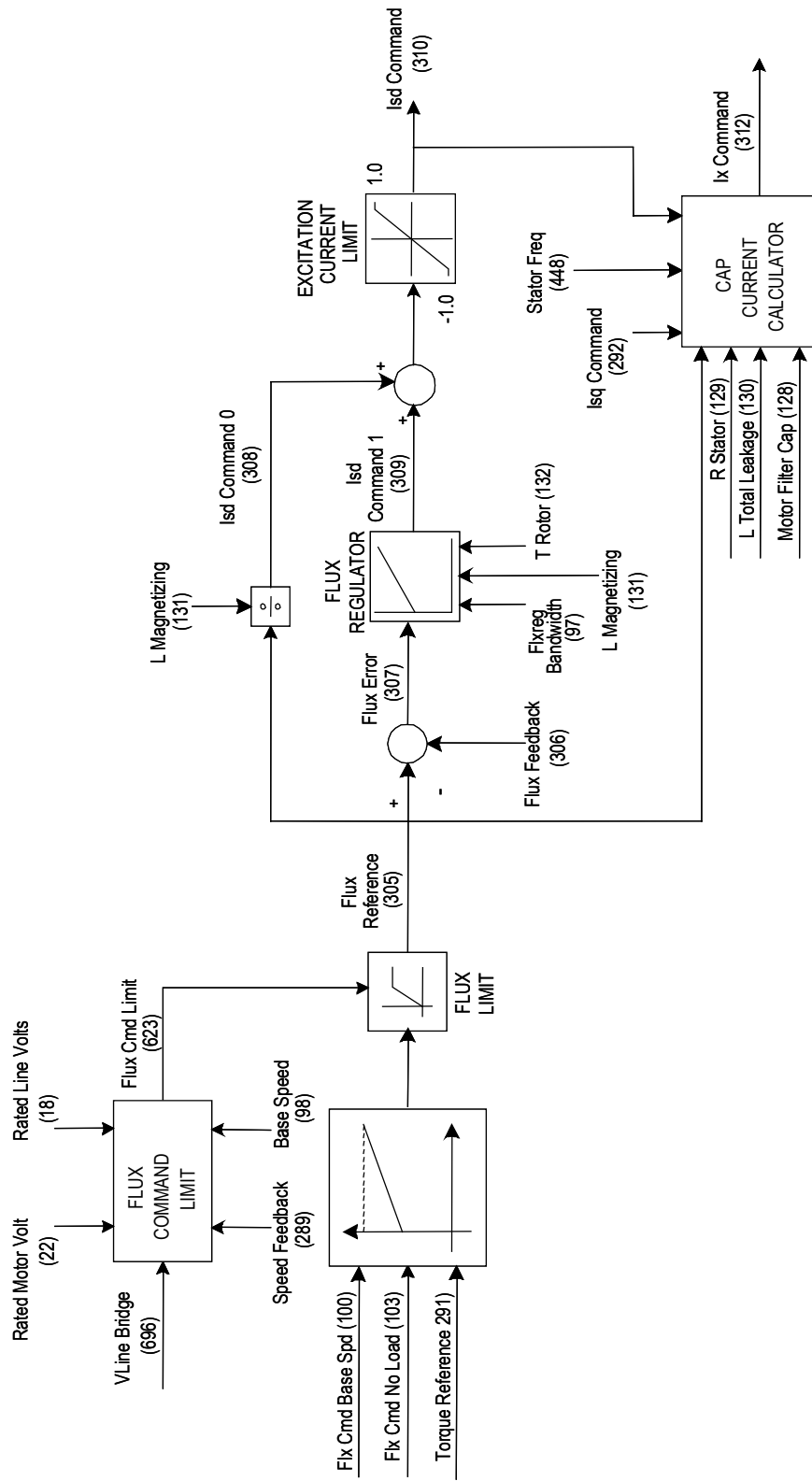


Figure 5.5 – Flux Control

Flux Control for Synchronous Motor

Most of the magnetization for a synchronous motor is supplied by the rotor field winding, unlike an induction motor where all of the magnetizing current is supplied through the stator. However, control of the motor flux through the field current is very slow because of the large time constant of the dc field winding and the current and voltage limitations of the field supply. To obtain sufficiently fast response from the flux regulator the magnetizing current is split into transient and steady state components, with the steady state component supplied through the rotor and the transient component through the stator.

The additions to the flux control required for synchronous machines are shown in the block diagram (Figure 5.6). The portion of the motor filter capacitor current supplied by the drive is then added to determine *I_x Command*, which is the magnetizing component of the dc link current command.

Parameter *I_{cd} Command Gain* (107) determines how the motor filter capacitor current is split between the motor and the drive. When this parameter is set to its minimum value of 0.0, all the capacitor current is supplied by the drive. The line current is higher than the motor current and the motor operates at approximately unity power factor. When this parameter is set to its maximum value of 1.0, the motor supplies all the capacitor current. The line current is less than the motor current and the motor operates at a lagging power factor with reduced field current.

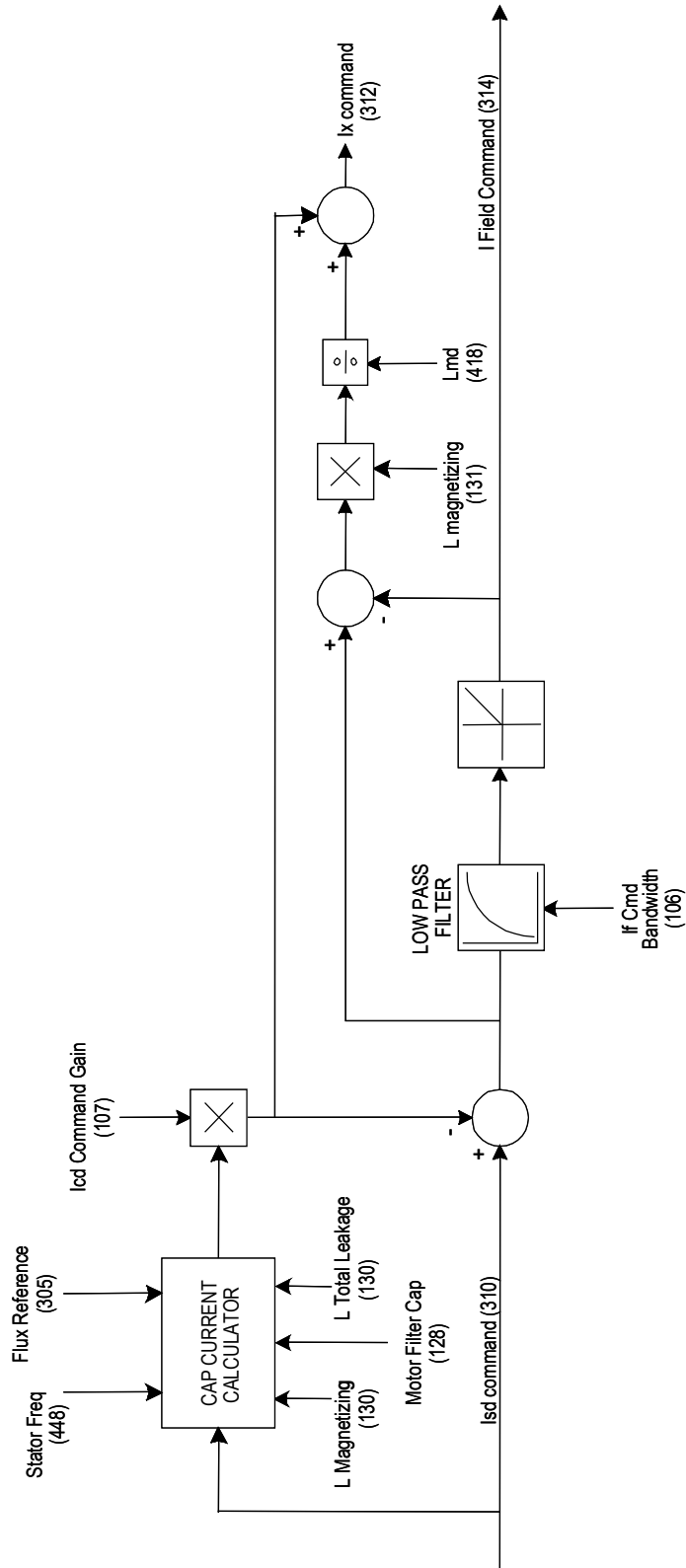


Figure 5.6 – Flux Control for Synchronous Motor

Current Control

The function of the current control block (Figure 5.7) is to determine the firing angles for the converters *Alpha Line* (327) and *Alpha Machine* (328). The inputs are the torque (*Iy Command*) and flux producing (*Ix Command*) components of the dc link current command from the speed control and flux control blocks respectively, and the measured dc link current *Idc Feedback* (322).

The square root of the sum of the squares of *Ix Command* and *Iy Command* determines the dc link current reference *Idc Reference* (321). This is subtracted from the measured dc current feedback is subtracted to determine *Idc Error* (323). This is processed by the current regulator to produce *Vdc Error* (332). To effectively control the dc link current an estimate of the motor side dc link voltage is done to calculate *Vdc Feedforward* (333) which is added to *Vdc Error* to produce the reference voltage for the line side converter *Vdc Reference* (326). The line converter firing angle is the inverse cosine of *Vdc Reference*. The machine converter firing angle is determined by taking the inverse tangent of the ratio of *Iy Command* to the *Ix Command*. The quadrant of operation is adjusted based on the signs of the current commands.

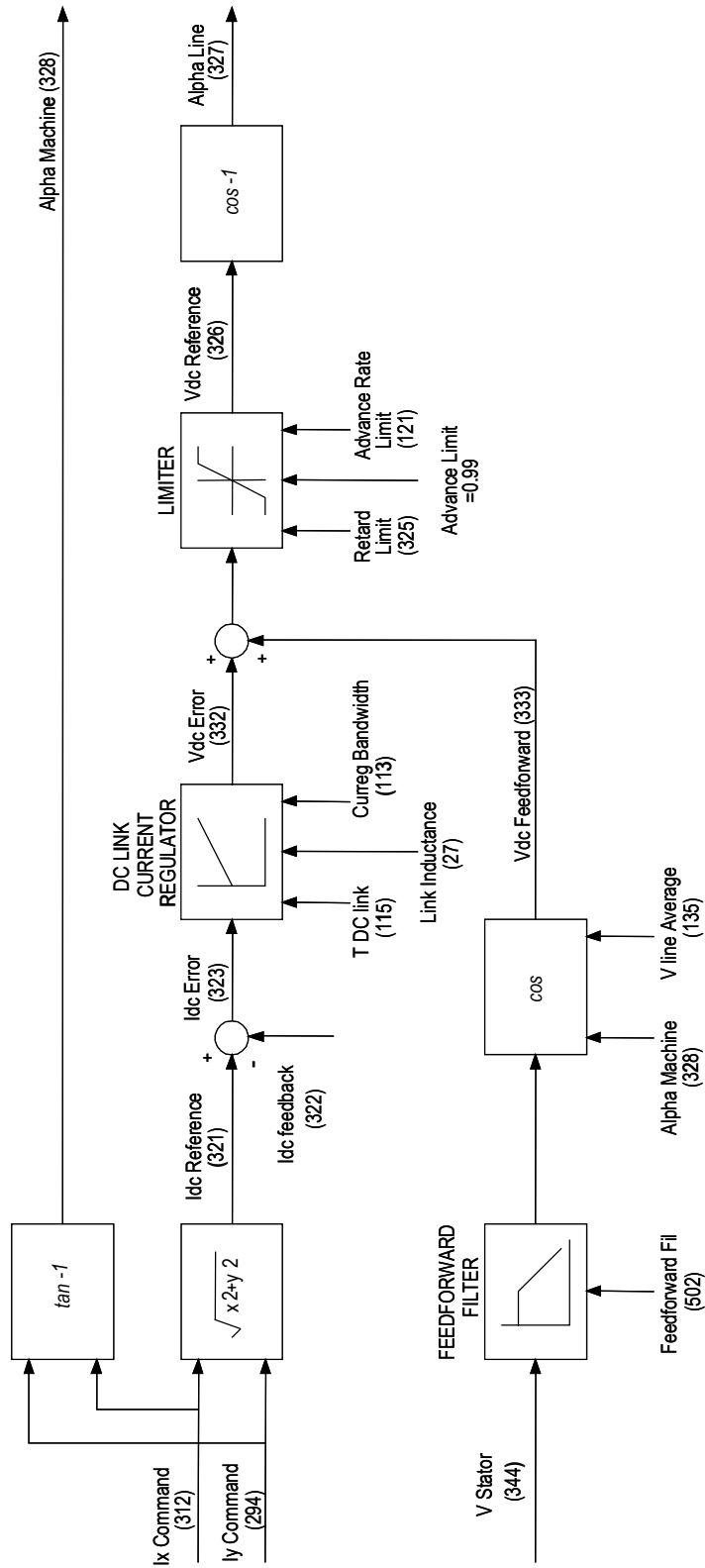


Figure 5.7 – Current Control

Line Converter Feedback

The function of the line converter feedback block is to process (scale and filter) the line side voltage and current feedback signals before being sampled by the drive control software. It represents most of the analog portion of the line side Signal Conditioning Board (SCBL) and the Drive Control Board. The line converter Voltage Feedback Board (VFB) provides a total of six voltage feedback signals representing the three ac (V_{a1} , V_{b1} , V_{c1}), two dc (V_{dc+} , V_{dc-}) and one line side filter capacitor voltages referenced to ground. The three line-to-ground voltages are subtracted from each other to produce the three line to line voltages ($V_{ab1-out}$, $V_{bc1-out}$, $V_{ca1-out}$). These line voltages are filtered (V_{ab1} , V_{bc1} , V_{ca1}) and sampled by software for synchronization and protection. The two dc voltages are subtracted to determine the line side dc link voltage (V_{dc}), which is used for hardware dc link over-voltage protection. In PWM drives, the neutral point of the line filter capacitor is measured (V_n) and used for line side neutral over-voltage protection.

Current transformers (CT) in two of the ac input lines provide the input line current feedback (I_{a1-out} , I_{c1-out}). These currents are then filtered and processed by a variable gain stage (I_{a1} , I_{c1}). Inverting and adding the two current feedback signals reproduces the current in the remaining phase (I_{b1}). A Hall Effect Current Sensor (HECS) is used for monitoring the dc link current and used for hardware over-current protection. In addition the average value of the dc link current feedback is measured using a $V-f$ converter and used by the dc link current controller to calculate the firing angle for the rectifier.

The preceding description applies to 6-SCR and PWM rectifier options. For drives with the 18 pulse front-end, another VFB is daisy chained with the first one providing additional six line-to-ground voltages from the slave bridges. The slave 1 voltages are monitored using (V_{ab2} , V_{bc2} , V_{ca2}) while slave 2 voltage are monitored using (V_{ab3} , V_{bc3} , V_{ca3}). In addition current feedback from slave bridges I_{a2} , I_{c2} and I_{a3} , I_{c3} are also brought in for protection. As in 6-pulse drives, inverting and adding the two current feedback signals reproduces the current in the remaining phase (I_{b1} , I_{b2}). Also for 18 pulse drives, the three ac line to ground voltages are summed together to determine the neutral to ground voltage (V_{ng}) on the input transformer.

Machine Converter Feedback

The function of the machine converter feedback block is to process (scale and filter) the raw voltage and current feedback signals to the form required by the drive control software. It represents most of the analog portion of the machine side Signal Conditioning Board (SCBM) and the Drive Control Board. The machine converter VFB provides a total of six voltage feedback signals representing the three ac (V_{a1} , V_{b1} , V_{c1}), two dc (V_{dc+} , V_{dc-}) and one machine side filter capacitor neutral voltage referenced to ground. The motor line to ground voltages are subtracted from each other and filtered to produce the three motor line to line voltages (V_{ab1} , V_{bc1} , V_{ca1}).

The two dc voltages are subtracted to determine the machine side dc link voltage (V_{dc}), which is used for hardware dc link over-voltage protection. The motor line to ground voltages are summed to determine the motor neutral to ground voltage (V_{ng}) and is used for motor neutral over-voltage protection.

Hall Effect Current Sensor (HECS) provide stator current feedback in two of the motor phases (I_{a3-out} , I_{c3-out}). These currents are then filtered and processed by a variable gain stage (I_{a3} , I_{c3}) before being sampled for protection. Inverting and adding the two current feedback signals reproduces the current in the remaining phase (I_{b3}).

The motor line voltages and currents are further used to calculate the motor flux (F_{ab} , F_{bc} , F_{ca}) using a hardware analog model. The measured flux (V_d and V_q) is then used in the motor model block (described in the next section) for synchronization and drive control.

For drives with Synchronous Transfer option, an additional VFB is used for sensing three line-to-ground bypass voltages. These line-to-ground voltages are subtracted from each other to yield two line-to-line voltages ($V_{abxfer-out}$, $V_{bcxfer-out}$). These are further filtered (V_{abxfer} , V_{bcxfer}) and sampled by the software for synchronizing the drive output voltage to the bypass voltage.

If drive is installed with an optional tachometer, the feedback cable is plugged into the SCBM. The motor speed is then determined by counting the tach pulses in the FPGA on the machine side Drive Control Board.

Motor Model

The function of the motor model block (Figure 5.8) is to determine the rotor flux position (*Flux Angle*), flux feedback (*Flux Feedback*), applied stator frequency (*Stator Freq*), slip frequency (*Slip Frequency*) and motor operating variables like stator current (*I Stator*), stator voltage (*V Stator*), torque (*Torque*), power (*Motor Power*) and power factor (*Mtr Pwr Factor*).

The PowerFlex 7000 uses Rotor Flux oriented control to achieve independent control of motor flux and torque. This is achieved by synchronizing the machine converter gating to *Flux Angle*. To determine the flux feedback, stator frequency and the synchronizing reference frame the drive uses either the Voltage or the Current model. For speeds greater than 3Hz, the drive uses the voltage model (hardware analog flux model) to calculate the *Flux from Voltage*, *Flux Angle V* and *Stator Freq V*. Below 3Hz, the drive uses the current model to calculate *Flux from Current*, *Flux Angle C* and *Stator Freq C*. The current model is based on indirect vector control and uses the d-q components of stator current along with motor parameters *T Rotor* and *L Magnetizing*. Based on the operating speed of the drive and the speed feedback mode (*Sensorless* or *Pulse Tach*), a flux select algorithm determines the model to be used. Motor model also calculates the *Slip Frequency* which is used in the calculation of the motor speed (Speed Control) in *Sensorless* mode and for determining the rotor flux position in *Pulse Tach* mode.

The synchronously rotating frame (*Flux Angle*) is used in transforming the measured motor currents and voltages into *d-q* components. The direct axis components (I_{sd} and V_{sd}) are in phase with the rotor flux, while the quadrature axis components (I_{sq} and V_{sq}) are displaced 90 degrees from the rotor flux. The stator current (*I Stator*) and voltage magnitudes (*V Stator*) are calculated by taking the square root of the sum of the squares of the respective d-q components. The motor *Torque* is calculated by multiplying the *Flux Feedback* and I_{sq} with motor torque constant. *Torque* multiplied by the motor speed gives the *Motor Power*. *Mtr Power Factor* is determined as the ratio of motor active power and the apparent power.

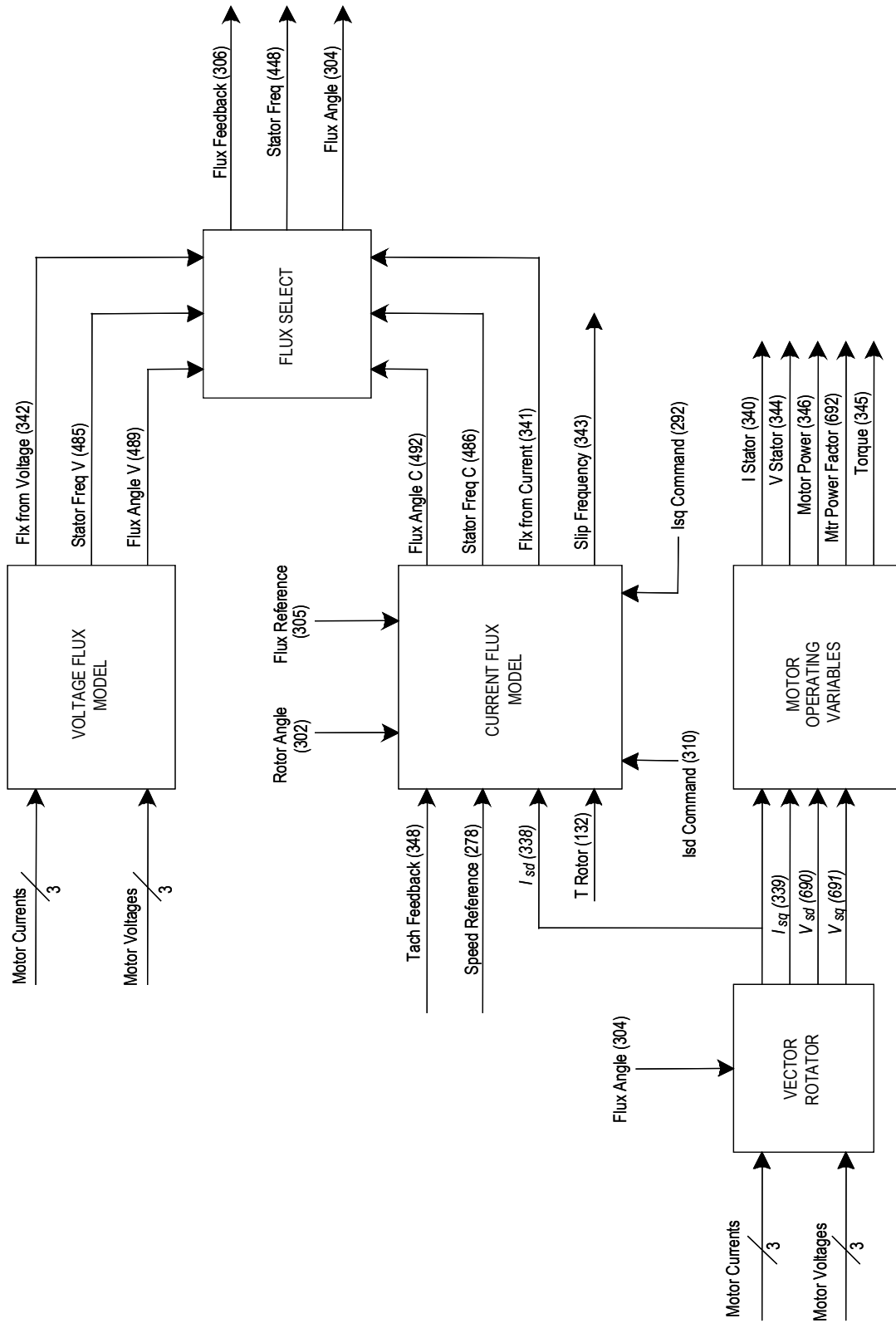


Figure 5.8 – Motor Model

Line/Machine Converter Protection

Except for the dc link over-current, line side dc link over-voltage and machine side dc link over voltage, the drive protection is customer configurable in the software. Adjustable parameters specifying the trip level and time delay are provided for each fault (see **Medium Voltage AC Drive Parameters**, Publication 7000-TD001_-EN-P). A detailed list of all the faults and warnings (alarms) is provided in Chapter 7 (Troubleshooting).

The response to a drive alarm falls into three categories:

For **Class 1 faults** (with the exception of dc link over-current, line side dc link over-voltage and machine side dc link over-voltage), the line converter is immediately phased back to retard limit until the dc link current drops to zero. The gating for both converters is disabled and the contactors (if installed) are opened. At this point the motor will coast and its speed will depend on the characteristics of the load. For some high inertia loads, the motor may coast for a long time.

The dc link over-current and dc link over-voltage (line and machine) are special cases in that the fault detection is performed by hardware because a very fast response is required. The hardware fault detection responds to instantaneous values. Also the drive response to these faults is different from other Class1 faults because it freezes the SGCT gating (both converters if a PWM rectifier based drive and only the inverter side if a 6P/18P SCR drive) until the dc link current has dropped to zero. The gating is then disabled and contactors are opened.

For **Class 2 faults** the motor is brought to a normal stop before the gating is disabled and the contactors opened. Typical examples of Class2 faults are motor overload, drive overload and loss of load.

For most **Warnings** no action is taken and drive maintains its normal operation. A warning could be an indication of a problem in drive e.g. an *Air Filter* warning is an indication of a blocked air filter. In addition there are a few warnings in the drive that may cause momentary interruption in the operation of the drive e.g. *Master UV*, *Line Loss* or *Bus Transient*. The action taken is similar to a Class1 fault and the normal operation is resumed once the transient condition has disappeared. If a drive experiences *Master UV* or *Line Loss*, then *Auto Restart Dly* (3) should be set to a non-zero value in order to resume normal operation.

It is important to understand how contactors (input and output) behave in an event of fault. If the input contactor is set for *Not Running* or *All Faults* via parameter *Input ContCfg* (1), then the contactor opens on any fault (Class1, Critical or Class2) in the drive. This happens after the dc link current has been brought to zero and the gating for all converters disabled. If the contactor is set for *Critical Flt*, then the contactor will open only when a critical fault (explained above) happens in the drive. For all other faults (Class1 or Class2) the input contactor will remain closed after the drive has been shut off.

An output contactor, whose configuration is specified by *Output ContCfg* (5), opens for any fault in the drive. This happens after the dc link current has been brought to zero and the gating for all converters disabled.

Power Semiconductor Diagnostics

The PowerFlex 7000 drive tests for the failure of the power semiconductors (SCRs or SGCTs) before running and while running. The method used to detect failed devices is different for starting (offline diagnostics) and for running (on-line diagnostics), but the same hardware is used in both situations. The drive control receives a feedback signal via a fiber-optic cable from each device gate driver, which can indicate whether or not it is healthy. SCR diagnostics are based on sensing the voltage across the device while SGCT has smart diagnostics built in the gate driver board. The feedback and the gating have a certain relationship when the device is healthy or failed. This is shown in Figure 5.10. The following section describes the diagnostics in detail. The description applies to all 6P, 18P and PWM PowerFlex 7000 drives.

Power Semiconductor Diagnostics (cont.)

Off line Detection of Failed SCRs/SGCTs

- **Line Converter – 6P-SCR, 18P-SCR and PWM**

The rectifier diagnostics are performed when medium voltage is first applied by closing the input contactor and when the drive receives a start command. *From 4.001 onwards, the drive also performs off line diagnostics when a drive reset command is issued.* These diagnostics are capable of detecting a bad device, loss of feedback fiber optic and loss of gating fiber optic. The diagnostics consist of two stages. A passive diagnostic test followed by an active diagnostic test. In the passive diagnostics test no devices are gated.

- **SCR Rectifier Passive Off-Line Diagnostics**

For SCR rectifiers, when the line voltage is applied to the drive but the drive is not running, the voltage across the line converter thyristors is high and positive for half cycle except during intervals around the zero of the line voltage. The gate driver transmits light whenever the device is forward biased with a large enough voltage as shown in Figure 5.9. Since the drive is not gating (no light) the feedback normally toggles state every cycle of the utility voltage. However the feedback will not toggle state if the device is shorted, or if the feedback fiber-optic path is incomplete. If this occurs, the drive faults and issues an *Offline SC* fault for the device.

- **PWM Rectifier Passive Off-Line Diagnostics**

For PWM rectifiers the feedback for these devices should always be high. However a high feedback level will not be received if a device is shorted or if the feedback fiber-optic path is incomplete. The drive presumes the device has failed and determines which devices would be safe to gate for the more detailed active offline diagnostic test.

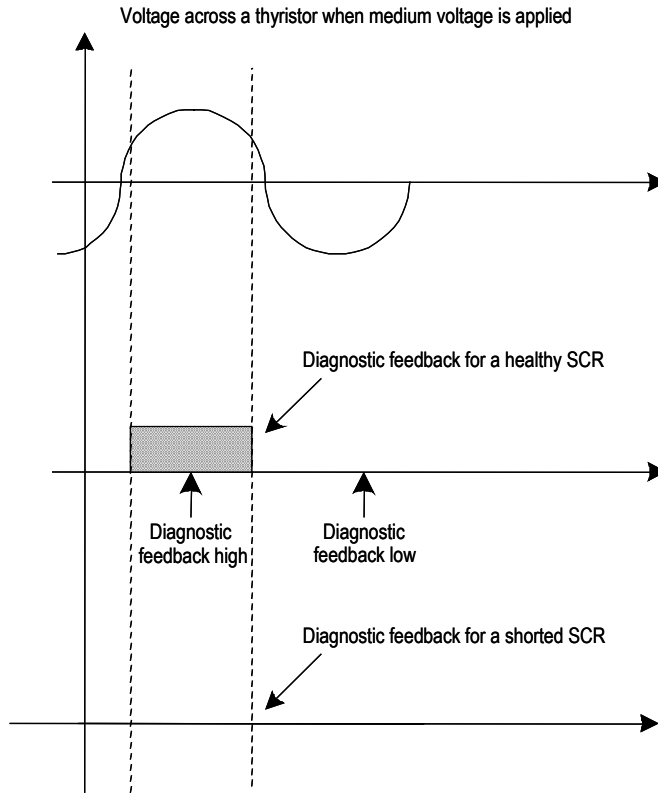


Figure 5.9 – Voltage across a thyristor when MV is applied

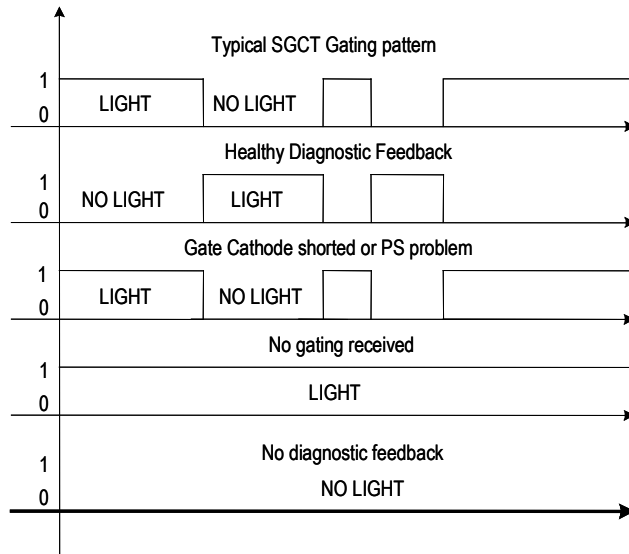


Figure 5.10 – SGCT diagnostics

Power Semiconductor Diagnostics (cont.)

SCR Rectifier Active Off-Line Diagnostics

In the active diagnostic test, each device is gated at maximum blocking voltage. For a healthy SCR, the feedback will normally change from high to low when gated. However the drive will receive a high state both before and after gating if the device is open-circuited, there is an incomplete gating fiber-optic path or a damaged gate driver. When this occurs the drive will issue an *Offline OC fault* for the device. If the drive receives a low signal in both states, there may be shorted device or an incomplete feedback fiber optic. If this occurs drive will issue an *Offline SC* fault for the device. Failed or open-circuited snubber connections will shift the device blocking voltage (when not running) which may cause either fault to appear. It should be noted that during the active diagnostics stage a dc link voltage which is close to rated voltage will appear due to interaction with the snubber circuit.

- **PWM Rectifier Active Off-Line Diagnostics**

For the PWM rectifier, the active diagnostic test can differentiate between a failed device and a broken fiber-optic path because the gate driver toggles the feedback differently when gated as shown in Figure 5.10. As in the SCR rectifier active offline diagnostics, each device is gated at peak blocking voltage (if MV is available). Devices which could cause a line to line short circuit are not gated. If the drive detects a failed device a *Device Flt* is issued for the device. A weak gate power supply may also cause a device fault. If the drive receives no light signal both before and after gating, then there may be an incomplete feedback fiber-optic and an *Fbk FO Loss* fault will be issued. A completely failed or unplugged power supply will also cause this fault. If the drive always receives feedback both before and after gating, the device may not have received the gating signal and a *Gat FO Loss* fault will be issued. *From 4.001 onwards, the drive will not allow the contactor to be closed if it detects enough failed devices to cause a line to line short circuit.*

- **Machine Converter off line diagnostics**

The inverter diagnostics are performed when the drive control is powered up and when the drive receives a start command. *From 4.001 onwards, the drive also performs off line diagnostics when a drive reset command is issued.* These diagnostics are capable of detecting a bad device, loss of feedback fiber optic and loss of gating fiber optic.

The inverter off-line diagnostics are similar to the PWM rectifier diagnostics except that: no passive diagnostic is done, no consideration is given to line-to-line short-circuits and the input contactor is not involved. The inverter off-line diagnostics will generate *Device Flt Fbk FO Loss* and *Gat FO Loss* faults.

On-line detection of Failed SCRs/SGCTs

When the gating is enabled for both converters, the feedback from the gate drivers is constantly switching on and off, usually several times per cycle. The diagnostics feedback signals from each device are monitored and the protective measures are performed.

- **SCR On-Line Diagnostics**

For SCR rectifier drives, the drive detects both open and shorted devices while running. Due to notching and interaction with the other phases, the SCR feedback diagnostic changes state many times per cycle, although it is only valid just before and after firing the device. Just before firing a device, the drive takes several samples of the diagnostic feedback from the SCR. If every sample indicates that the device was on before it was fired, the drive considers that the device may be shorted, and starts a timer. When this timer exceeds the number of line cycles specified by the parameter *Rec Dvc Diag Dly* (266) the drive generates an *Online SC* fault. Each device has its own timer. A delay of zero will generate a fault immediately. A delay of 2 will generate a fault after 2 cycles which indicates that the fault has been seen three times in a row.

Shortly after the drive fires an SCR it checks the feedback from the gate driver boards. If the feedback shows that the device did not fire the drive considers that the device may be open-circuited and starts a timer. If the fault persists for 6 cycles, the drive generates an *Online OC* fault. As with the short circuit fault, each device has its own timer, however the delay is not adjustable.

Both on-line device diagnostics are not available at all modes of operation due to the nature of the feedback from the gate driver. No diagnostics are done when the rectifier firing angle is less than 15 degrees. No diagnostics are done when the dc current is discontinuous.

- **SGCT on-line diagnostics**

The PWM rectifier and inverter generate only one type of on-line diagnostic fault. Due to the intelligent gate driver board the drive is able to check the status of every SGCT in a bridge any time a device in the bridge is fired. The drive takes a sample of every device's feedback before and after firing the bridge. If both samples indicate that the device is not functioning correctly the drive starts a timer for that device. When this timer reaches the value specified by parameter *Rec Dvc Diag Dly* (266) for the PWM rectifier, or *Inv Dvc Diag Dly* (268) for the inverter the drive generates an *Online Flt*. The actual time to trip will vary with the switching frequency of the bridge in question. A bridge changes state at three times the switching frequency. For a PWM rectifier switching at 420 Hz (7pulse at 60 Hz), the bridge changes state at 1260 Hz. This means the delay is in multiples of around 0.8 ms.

Test Modes

The PowerFlex 7000 AC drive is provided with test modes to check the functionality of the drive during commissioning. These test modes are selected using the parameter *Operating Mode* in the *Feature Select* group. When Test Mode is set to the default value of *Normal*, the drive is in the normal operating mode. The parameter cannot be changed while the drive is running.

Setting *Operating Mode* to *Gate Test* allows the gating checks to be performed on the rectifier and the inverter. Both the input and output contactors must be open and medium voltage must not be applied to the drive. This test is carried out in conjunction with two additional parameters *Inv Gating Test* and *Rect Gating Test*. Upon selecting *Gate Test*, both the parameters are automatically set to *Test Pattern*. A brief description follows in this section.

Setting *Inv Gating Test* to *Test Pattern* will fire the inverter devices in a sequential Z pattern at a low frequency (1Hz) and is verified by observing the LEDs on the SGCT gate driver board. Setting *Inv Gating Test* to *Time Pattern* or *Normal Gate* will result in the inverter devices firing as in normal mode of operation. The frequency of the gating is controlled by parameter *Speed Command In* (276). Setting *Inv Gating Test* to *Off* stops the inverter test gating sequence.

In 6 or 18 pulse SCR PowerFlex drives, the gate driver boards derive power from medium voltage. Hence to check the line converter gating in *Gate Test* mode where there is no MV available, a special power harness is required. The line converter gating is quickly checked by setting the *Rect Gating Test* to *Test Pattern*. This will fire the rectifier devices in a sequential Z pattern at a low frequency (1Hz) with only one device on at a time and is verified by observing the LEDs on the SCR gate driver boards. For 6 pulse SCR drives with series devices, selecting *Time Pattern* will fire two series devices at a time. The relative timing between the gating pulses can be verified by observing at the test points. To set the rectifier gating in normal operation select *Normal Gate*. The SCR firing is at the input line frequency. In this mode, ensure that for 6 and 18 pulse SCR drives only two devices are connected to the power harness. For 6 pulse PWM drives no power harness is required as the SGCTs are powered by the Gate Power Supply.

SHOCK HAZARD

Disconnect all ends of cable before applying medium voltage power. Failure to disconnect cable before applying medium voltage can result in damage to equipment, serious personal injury or death.

ATTENTION

Application of medium voltage to the drive input or output when it is operating in gate test mode may cause severe damage to the drive.

To test the line converter and to tune the dc link current regulator and the line commutating impedance, the drive *Operating Mode* is selected as *DC Current*. In this test mode, the line converter operates normally, but the machine converter gating is modified to gate both the positive and negative legs in the same phase in order to short-circuit the dc link current through the machine converter. The short circuit current is slowly rotated among the three phases with overlap between phases to ensure that an open circuit does not occur during commutation. There is no current in the motor and the output contactor (if installed in the drive) is opened). The dc current command is set equal to the value specified by parameter *Idc Command Test* (119) in the *Current Control* group. In this test mode the line converter firing angle *Alpha Line* (327) will be close to 90 degrees. This is because it takes very small dc voltage to build current in a shorted dc link.

Setting *Operating Mode* to *System Test* selects the system test mode. This mode is used to test the drive as a system, including interfaces with external devices such as programmable controllers, without applying power to the drive or motor. The drive behaves as if it was running normally but device gating disabled. Since the input, output, and bypass contactors operate normally in this mode, it must be ensured that the drive and motor are isolated from medium voltage. If the drive detects medium voltage in this test mode, a fault *MV in SystemTest* is issued and the input contactor is opened.

ATTENTION

It is the responsibility of the operator to ensure that the drive and motor are isolated from medium voltage when the drive is operating in system test mode with the input, output, and bypass contactors closed.

Setting *Operating Mode* to *Open Circuit*, selects the open circuit test mode. This mode is used to test the drives at rated output voltage and frequency without connecting it to a motor. In open circuit test mode, ac current sufficient to produce rated voltage at the drive output is forced through the output filter capacitors. When the drive is started in this mode, it ramps up to rated frequency and synchronizes its output voltage with the line voltage. The current reference is set to a value that will produce voltage at the drive output set by the parameter *Flx Cmd Base Spd* (100).

ATTENTION

Open circuit test mode should not be used when the drive is connected to a load unless an output contactor is provided.

Setting *Operating Mode* to *Open Loop* \supseteq selects a diagnostic mode in which the drive is run in an open loop manner without closing any of the feedback loops on the motor side (Speed and Flux regulators). Parameters *Trq Command 0* and *Trq Command 1* are used to inject motor current at a small stator frequency (typically 10% of Rated Line Frequency). Motor will be turning in this mode and drive analog flux feedback variables *Flux from Voltage* (342) and *Stator Freq V* (485) are used to ensure the reliability of the analog feedback.

\supseteq This feature is available in firmware release 4.001 and higher for drives running induction motors only.

Flying Start (Induction Motor)

Using this feature, the PowerFlex 7000 AC drive is capable of restarting a motor that is not stationary but is already rotating. In normal operation, the output of the drive is synchronized with the motor flux, which is derived from the stator voltage and current feedback. If there is no motor current, then whether the motor is rotating or stationary, it does not generate any significant voltage and it is not possible to determine the stator frequency. If there is no detectable stator voltage, the drive assumes that the motor is stationary, because this is the most likely case. Therefore, when the drive is started, the frequency starts from an initial value of zero and ramps up until motor flux is detected. Significant flux is created in the motor only when the slip frequency (i.e. the difference between the applied stator frequency and rotor frequency) is small. When the drive is started with the motor stationary, the initial slip frequency is small and the motor flux builds up fairly quickly. But, if the motor is already spinning, then very little flux will be induced until the stator frequency is quite close to the rotor frequency, at which time the motor flux will suddenly rise to a level sufficient for the drive to detect and synchronize to. If the drive reaches the commanded speed without detecting any motor flux, then it will trip on a motor stall fault. There are four possible causes of a motor stall when starting:

1. The motor has pulled out and stalled during starting due to insufficient torque. The remedy for this is to increase the value of some or all of the parameters *Trq Command 0*, *Trq Command 1* and *Accel Time 1*.
2. The motor was already rotating but the flying start failed because the drive passed through the low slip region too quickly to allow the motor flux to build up. The solution to this problem is to increase the value of parameter *Accel Time 1*. Most medium voltage motors have a rotor time constant in the range of 1 to 5 seconds, and it can take a few seconds for the flux to rise to a detectable level. Until flux is detected, the drive does not use the normal speed ramp but continues to accelerate at the rate defined by parameters *Accel Time 1* and *Ramp speed 1*.
3. The motor is rotating in the direction opposite to the commanded direction of rotation. The slip frequency will increase instead of decreasing as the drive accelerates and no flux will be induced in the motor.
4. The motor is rotating in the commanded direction but at a speed higher than the commanded speed. The drive will reach the commanded speed and trip before the slip frequency is low enough to induce flux in the motor.

If the motor is coasting at a high enough speed (above about 40 Hz) and the output contactor is closed, then the motor will self excite with the drive motor filter capacitors and generate a high stator voltage that the drive can detect. With software release 4.001, the drive will re-synchronize to this voltage and drive will quickly restart.

If the optional tachometer feedback is installed, then the drive knows the speed of the motor at all times and can perform a flying start for any speed or direction of rotation.

Flying Start (Synch Motor)

With a synchronous motor, flying start is much quicker and more reliable because a detectable stator voltage is produced whenever the field is applied and the motor is rotating, even with zero stator current. When the drive is started, rated field current is applied to the motor but the stator current remains at zero until the end of the ramp start delay to allow the rotor flux to build up. If the stator frequency is greater than about 2 Hz, sufficient stator voltage is generated to allow the drive to detect the speed and direction of the motor and synchronize itself to the motor flux. If the flux feedback does not reach the level specified by parameter *Flux minimum* (156) the drive assumes that the motor is stationary and starts from zero frequency.

If an optional position encoder is installed, a flying start can be performed for any speed or direction of rotation.

Tachometer/Encoder Option

The optional tachometer/encoder provides two significant enhancements to the drive control:

1. Provides an accurate measurement of motor speed at all times
2. Extends closed loop speed and torque control down to nearly zero speed.

A pulse tachometer, also called a pulse generator or incremental encoder, produces a pulse train output with a frequency proportional to shaft speed. The machine side Signal Conditioning Board (SCBM) provides optically isolated inputs for a quadrature pulse tachometer. Single-phase tachometer can also be used if reverse rotation never occurs. Parameter *Tach Type* (233) specifies which type is used.

Dividing the number of tach pulses by the sampling period yields the tach output frequency, from which the shaft speed can be calculated using the tach pulses per revolution (ppr) specified by parameter *Tach pulse/rev* (234). The tach resolution determines the minimum motor speed that can be measured. If high starting torque or very low speed operation is required, a high resolution such as 1024 or 2048 ppr must be provided. Otherwise, a low resolution such as 240 or 360 ppr is adequate.

The analog flux signal is not usable for stator frequencies less than about 3 Hz. To control flux and torque at low speeds, the PowerFlex 7000 drive switches to current model based on indirect vector control. With indirect control, the position of the rotor flux is not directly measured but is indirectly predicted by adding the calculated slip angle to the measured rotor angle. The rotor angle is obtained by integrating the output of the pulse tach (the zero position is arbitrary).

The slip frequency required to provide the desired flux and torque is calculated by the motor model. The slip frequency is integrated to get the slip angle and added to the measured rotor angle to obtain the flux angle. Indirect control can be used at any speed, but its weakness is that the calculated slip is sensitive to errors in the motor parameters. Errors in slip frequency increase the coupling between flux and torque which adversely affects the stability of the flux control. Since large motors generally have lower magnetizing current and lower slip than small motors, they are more sensitive to parameter errors (i.e. a small error in slip produces a large error in torque and flux).

Because of its salient pole construction, the position of the rotor flux in a synchronous machine is not arbitrary but is determined by the physical position of the rotor. A synchronous machine therefore requires an absolute position encoder instead of an incremental encoder for indirect vector control. The encoder must also be aligned with the direct axis of the rotor. To avoid having to physically align the encoder, an offset angle specified by parameter *Encoder Offset* (644) is added to the encoder output to compensate for the difference between the encoder zero and the direct axis of the rotor. Parameter *Enc Direction* (643) is provided to reverse the encoder rotation in software if it does not match the rotation of the motor. There is no parameter to specify the encoder resolution; it is inferred from the number of motor poles.

Synchronous Transfer

Synchronous transfer is an optional feature of the PowerFlex 7000 drive which allows either a single or multi-motors to be transferred between the drive and a fixed frequency supply in either direction without stopping and with a very short interruption of power. Compared to a simple non-synchronous transfer in which power to the motor is interrupted for a significant length of time, the transient drop in motor speed is much less with synchronous transfer.

In order to perform a synchronous transfer, a drive output contactor and a bypass contactor are required as shown in Figure 5.11. The name bypass indicates that the function of this contactor is to connect the motor directly to the fixed frequency supply, bypassing the drive. An additional Voltage Feedback Board (VFB) is used to measure the bypass voltage on the line side of the bypass contactor. These inputs are brought in through the machine side Signal Conditioning Board (SCBM) and used in synchronizing the motor voltage directly to the bypass voltage resulting in a reliable synchronous transfer. In addition the measurement of bypass voltage allows certain protection features to be built in. The synchronous transfer is automatically aborted if the drive detects an over-voltage or under-voltage or reverse sequence in the bypass voltage.

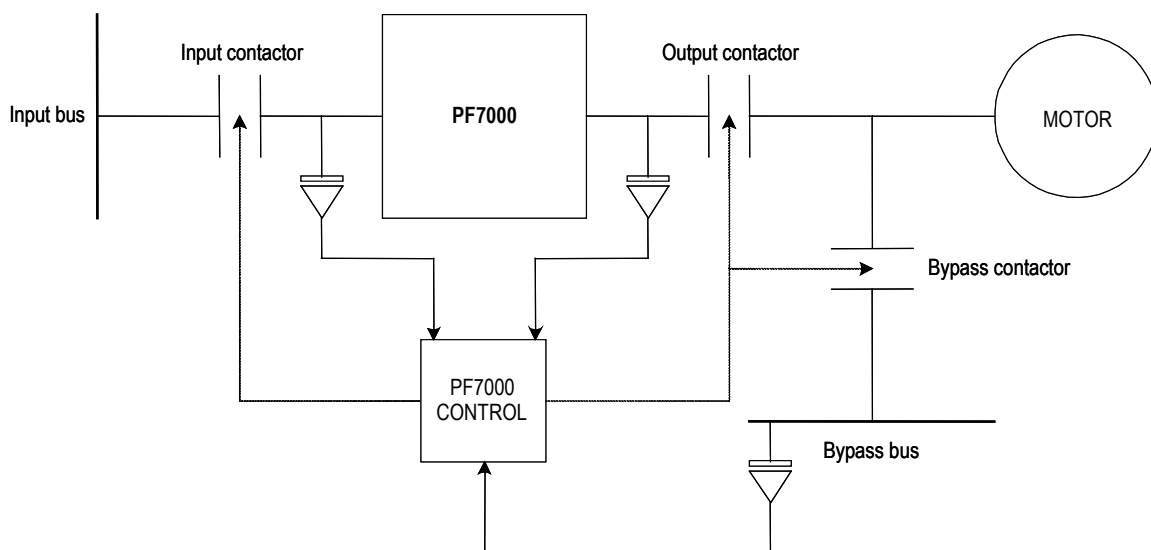


Figure 5.11 – A typical synchronous transfer set up using PF7000

For single motor applications, the drive is capable of performing synchronous transfer without the need for a Programmable Logic Controller (PLC). The command to close the bypass contactor and the status of the bypass contactor are realized using the digital IO on machine side SCB while the command to close the drive output contactor and the status of the drive output (DO) contactor are realized using the digital IO on the line side SCB. In addition to a DO contactor, an application may require an output (OP) contactor. This is controlled via machine side SCB. The run time commands *Request to Bypass (Synch)* and *Transfer to drive (De-synch)* are wired to the standard XIO board. Synchronous transfer will not be performed if the phase sequence of the bypass voltage is not positive.

ATTENTION



If the phase rotation and phase angle of the bypass voltage compared to the drive input voltage are not correct, damage may occur to the drive, motor, couplings and driven equipment if a transfer to bypass is attempted.

For all multiple motor synchronizing applications, a PLC is used for overall control of the synchronous transfer operation. Typically, the PLC gives control of the bypass contactor to the drive before performing the transfer, and takes back control after the transfer is completed.

Note: The following note applies only to applications using PLCs.

ATTENTION

Since the programmable controller and not the drive controls the output and bypass contactors, the transfer command must always go via the PLC and never directly to the drive from another controlling device (e.g. a Remote I/O adapter).

The following section will describe the sequence of operation on single motor synchronous transfer without using a PLC.

Transfer to Bypass

When the motor is running on the drive and a synchronous transfer is required, the transfer takes place in the following sequence:

1. The drive is given a *Request to Bypass* command, which must remain active until the synchronous transfer is complete. If the transfer command is removed before the bypass contactor is requested to close, the drive will abort the transfer and return to normal running. When the drive receives the transfer command, it accelerates the motor up to the measured *Bypass Freq* (159). If the drive is unable to achieve synchronous speed, it may be necessary to increase parameter *Trq Lmt Motoring* (84).
2. When the motor reaches synchronous speed, the synchronizing regulator is activated whose response is controlled by parameter *Sync Reg Gain* (225). It adjusts the drive *Speed Reference* as required, to synchronize the motor to the bypass with the motor voltage leading the bypass voltage by an angle specified by parameter *Sync Lead Angle* (226). This parameter is used to compensate for the drifts in the motor and bypass voltage before the bypass contactor closes. If the phase error tends to oscillate, it may be necessary to adjust parameters *Sync Reg Gain* or *Spdreg Bandwidth*.

Synchronous Transfer (cont.)

3. When the phase error between the motor voltage and bypass voltage has remained less than the value specified by parameter *Sync Error Max* (228) for the time interval specified by parameter *Sync Time* (229) the drive activates its *bp contactor close* output.
4. After a time delay specified by *Sync Off Delay* (227) the drive shuts off. It is important that this parameter is set to the correct value. This should be at least 1 cycle less than the contactor closing time. If this time delay is set too short, the motor voltage could drift out of phase with the bypass voltage. If the time delay is set too long, a drive overcurrent fault may occur because the drive is unable to control its output voltage and frequency once the bypass contactor has closed.

ATTENTION

If parameter *Sync Off Delay* is set incorrectly, damage may occur to the drive, motor, couplings, and driven load if a transfer to bypass is attempted.

5. When the *bp contactor status* input indicates that the bypass contactor has closed, the drive deactivates the *do contactor close* output. When the output contactor opens, the drive is disconnected from the motor, leaving the output filter capacitors charged to bypass voltage.
6. The synchronous transfer is now complete and the motor is running on bypass.
7. If in (3), the drive is unable to synchronize within the time specified by parameter *Sync Xfer Time* (230) the synchronous transfer is aborted. At this point the drive can either fault or issue a warning. This is controlled by the parameter *Sync Xfer Option* (419). If selected as *Enable Fault* the drive faults and ramps the motor down to a stop, else if it is selected as *Enable Warn*, the drive keeps running at the last commanded speed.

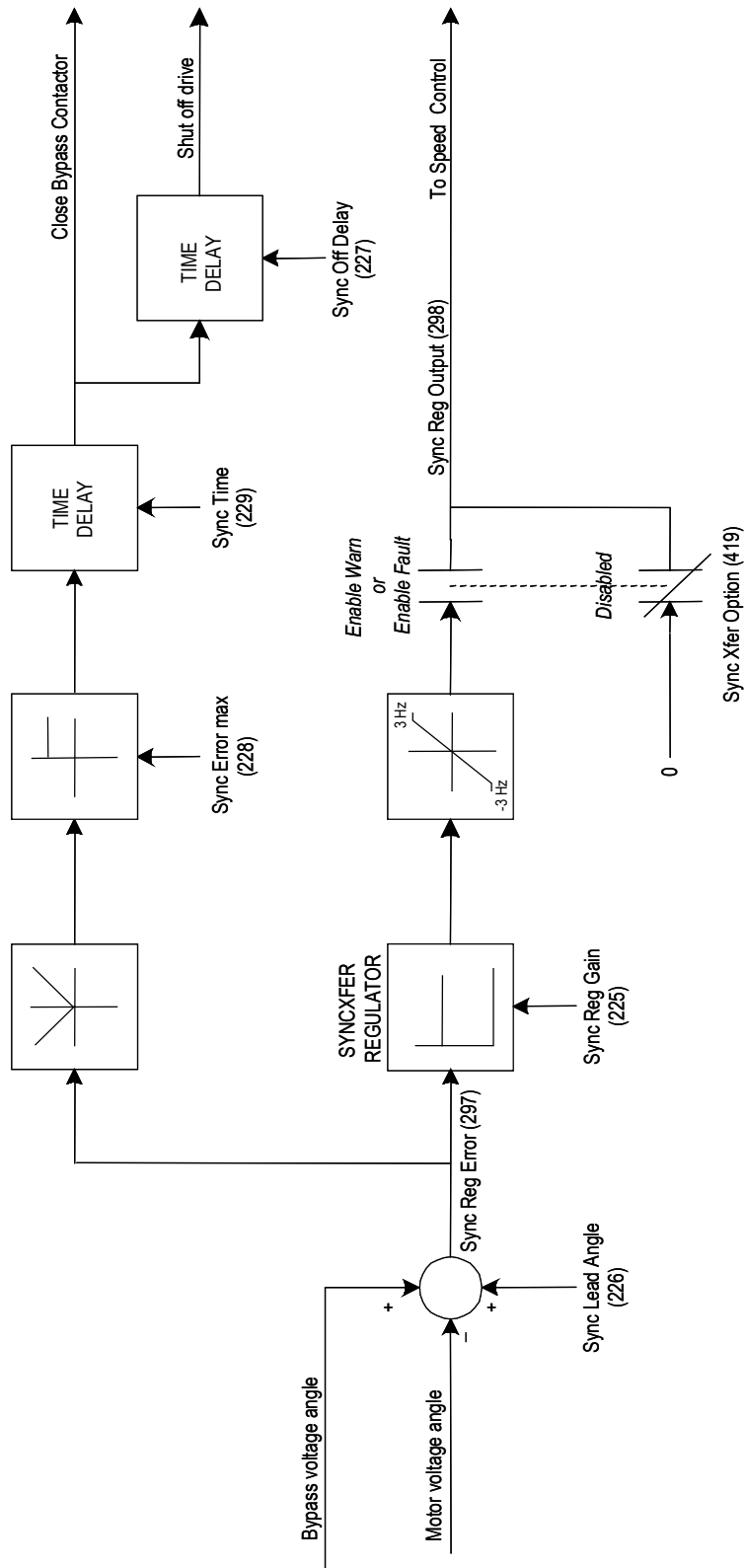


Figure 5.12 – Transfer to Bypass

Synchronous Transfer (cont.)

Transfer to Drive

To transfer a motor running on the bypass back to the drive a *Transfer to Drive* command is requested. Following sequence of events take place:

1. The drive is given a *Transfer to Drive* command. After a normal start command is given, the drive closes the output contactor. After the *do contactor close* input indicates that the output contactor has closed, there is a short delay (~1second) to allow the output filter capacitors to charge to the bypass voltage. Within this time, the drive synchronizes to the capacitor voltage with the motor still running on bypass. The drive then deactivates its *bp contactor close* output.
2. When the *bp contactor status* input indicates that the bypass contactor has opened, the drive goes to run mode. As the drive brings the motor torque up to the level required by the load, the motor speed will drop slightly before returning to the commanded speed.
3. The *Transfer to Drive* command is removed. The transfer is now complete and the motor is running on the drive.

WARNING



Operating a synchronous transfer system (specifically during the ‘Transfer to Drive’ operation, also known as the de-sync operation) with a non-operational Motor Filter Capacitor (MFC) can lead to serious personal injury and/or property damage.

These following fault codes may also indicate a non-operational MFC:

- F21 (Motor Overcurrent Fault)
- F23 (Motor Stall Fault)
- F24 (Motor Flux Unbalance Fault)
- F33 (Motor Current Unbalance Fault)
- F44 (Inverter Overvoltage Fault)
- F67 (Motor Neutral Overvoltage Fault)
- F171 (DC Link Overcurrent Fault)
- F173 (Ground Overcurrent Fault)
- F203 (Neutral Resistor Overload Fault)
- F206 (Neutral Resistor Overcurrent Fault)

Do not reset these faults until you confirm the root cause. Refer to the ‘Filter Capacitors’ on page 6-15 to determine if the MFC is the root cause

Analog Outputs

A total of thirteen programmable analog outputs are provided on various boards. There are two analog outputs on each SCB and 1 on the CIB, which are intended for diagnostic purposes and are available as test points for connection to an oscilloscope or chart recorder. These analog outputs are 8-bit, non-isolated, with a range of -10V to +10V. The CIB has one isolated 4-20mA or 0-20mA analog output and 7 non-isolated analog outputs for connection to external devices such as meters or isolation modules. The allocation of the analog outputs is shown below:

No.	Output	Board	Description
1	Rect_TP1	SCBL	DAC_TP1
2	Rect_TP2	SCBL	DAC_TP2
3	Inv_TP1	SCBM	DAC_TP1
4	Inv_TP2	SCBM	DAC_TP2
5	Cib_TP4	CIB	CIB_TP4
6	4-20mA	CIB	Connector J4b
7	CIB_Port1	CIB	Connector J5b
8	CIB_Port2	CIB	Connector J5b
9	CIB_Port3	CIB	Connector J5b
10	Meter Port 1	CIB	Connector J9
11	Meter Port 2	CIB	Connector J9
12	Meter Port 3	CIB	Connector J9
13	Meter Port 4	CIB	Connector J9

Any parameter or variable can be assigned to any analog output. The variables are scaled by using the corresponding scaling factor.

Notes:

Component Definition and Maintenance

Control / Cabling Cabinet Components

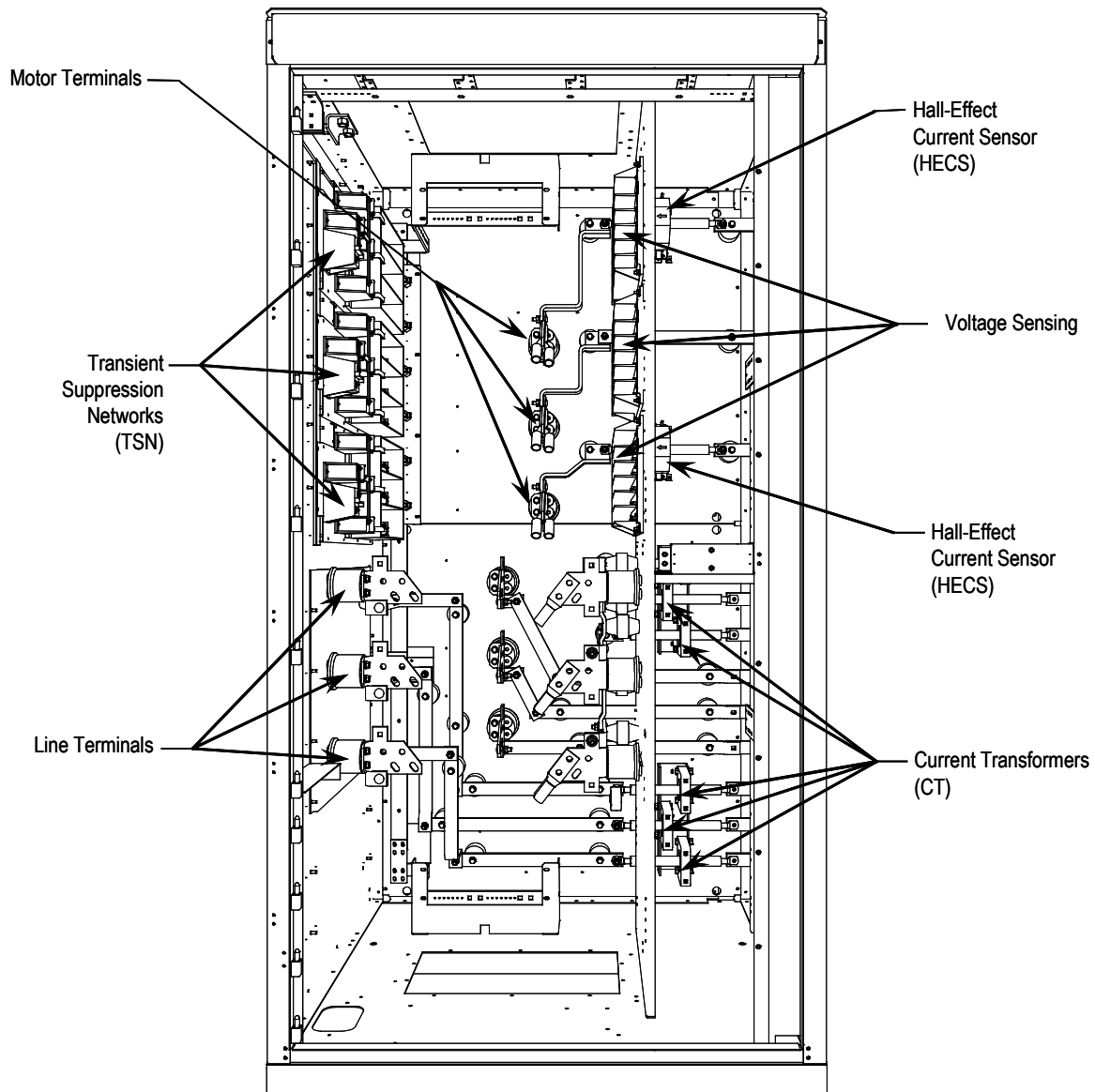


Figure 6.1 – Control and Cabling Cabinet
(18-pulse Rectifier version shown)

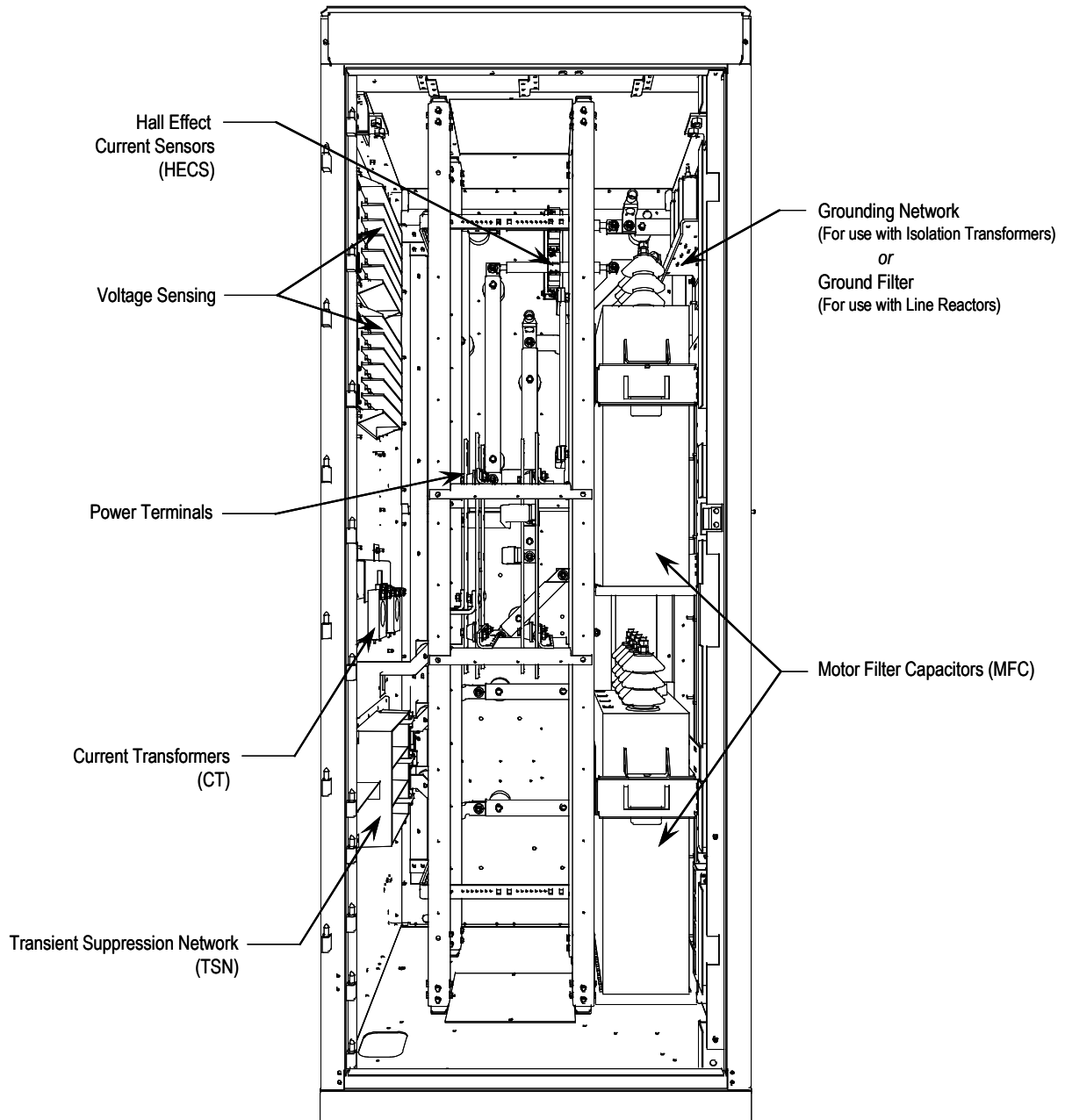


Figure 6.2 –Cabling Cabinet for 6-pulse/PWM Rectifier

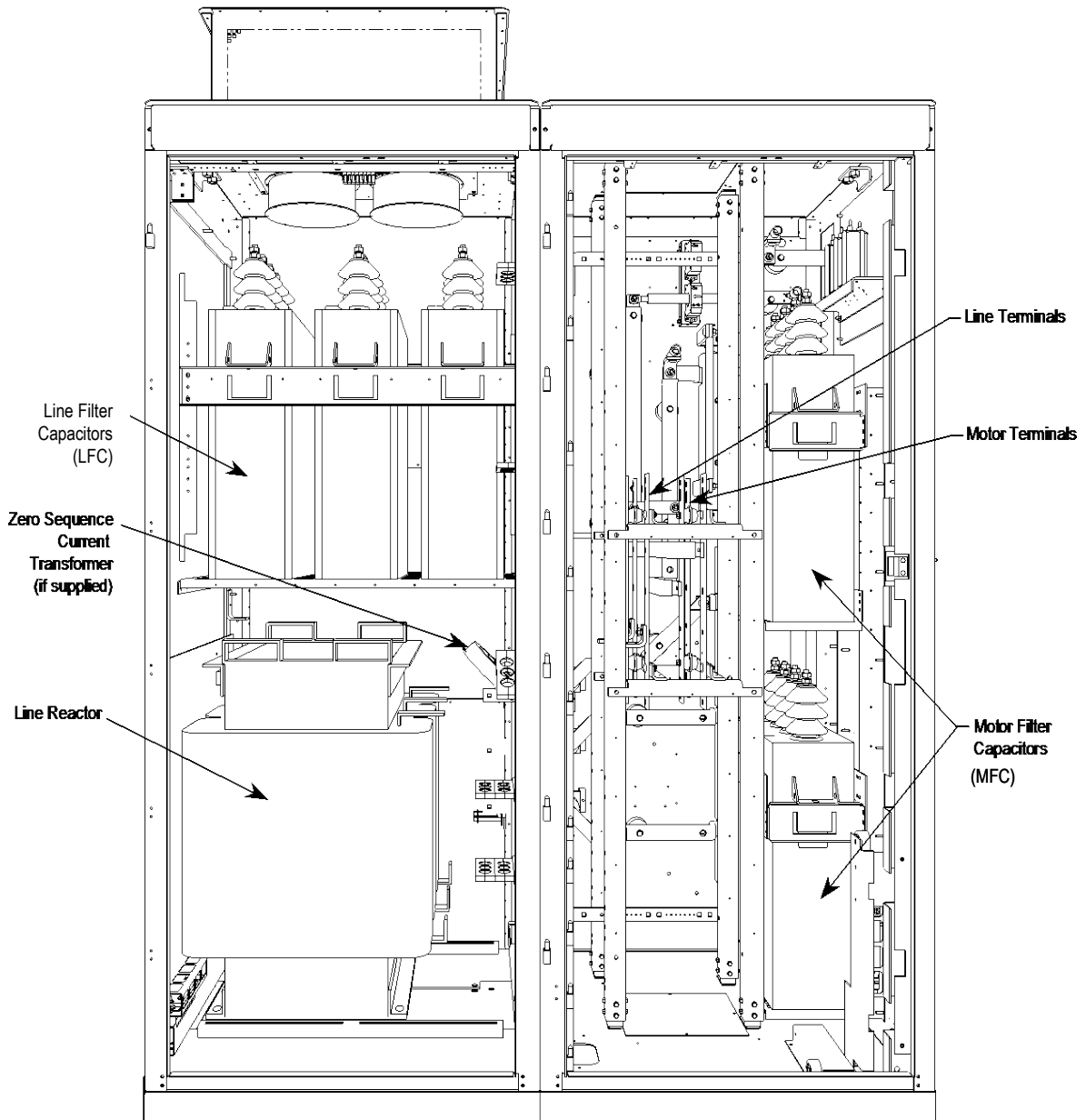


Figure 6.3 – AC Line Reactor Cabinet with Connection Cabinet

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 6.A – 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 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.

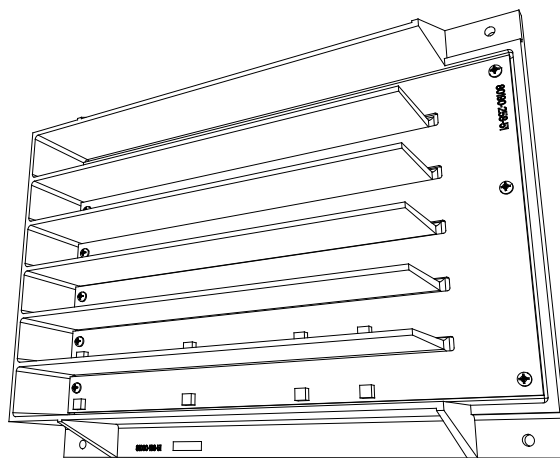


Figure 6.4 – Sensing Board with mounting hardware placement

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 is a separate assembly for each set of three phase input voltages: 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 6.5.

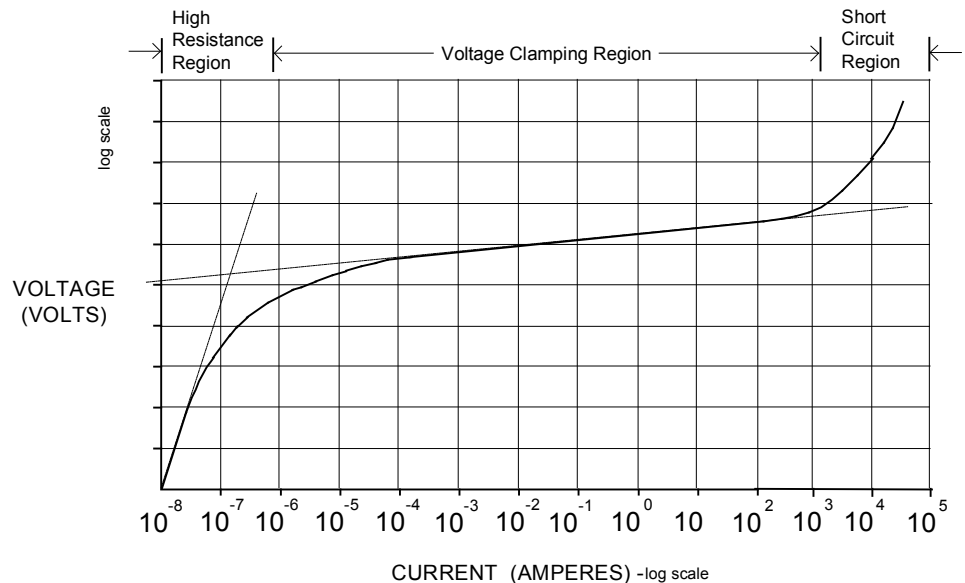


Figure 6.5 – Typical MOV V-I Characteristic Curve

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 6.7, 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.

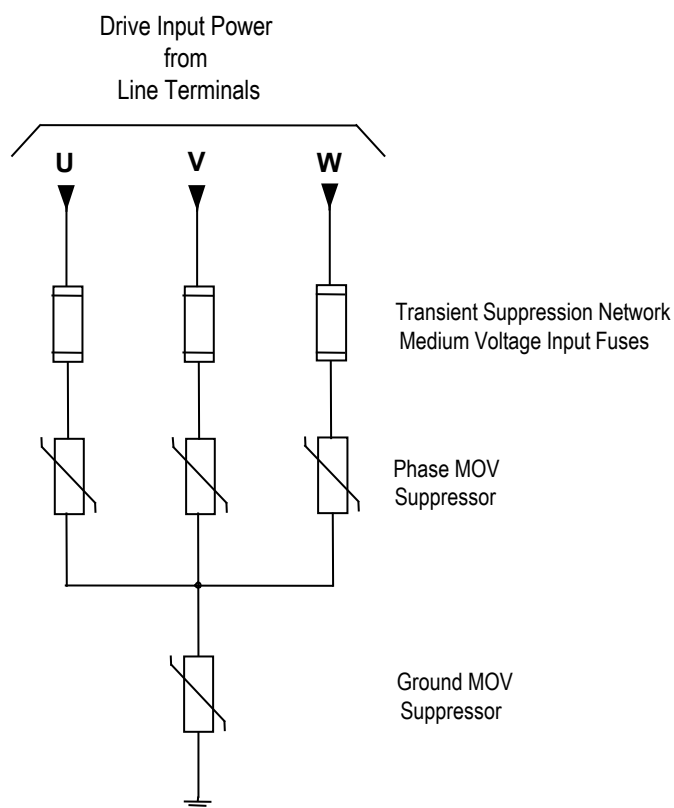


Figure 6.6 – Simplified Wiring Diagram

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 6.7 for location.)

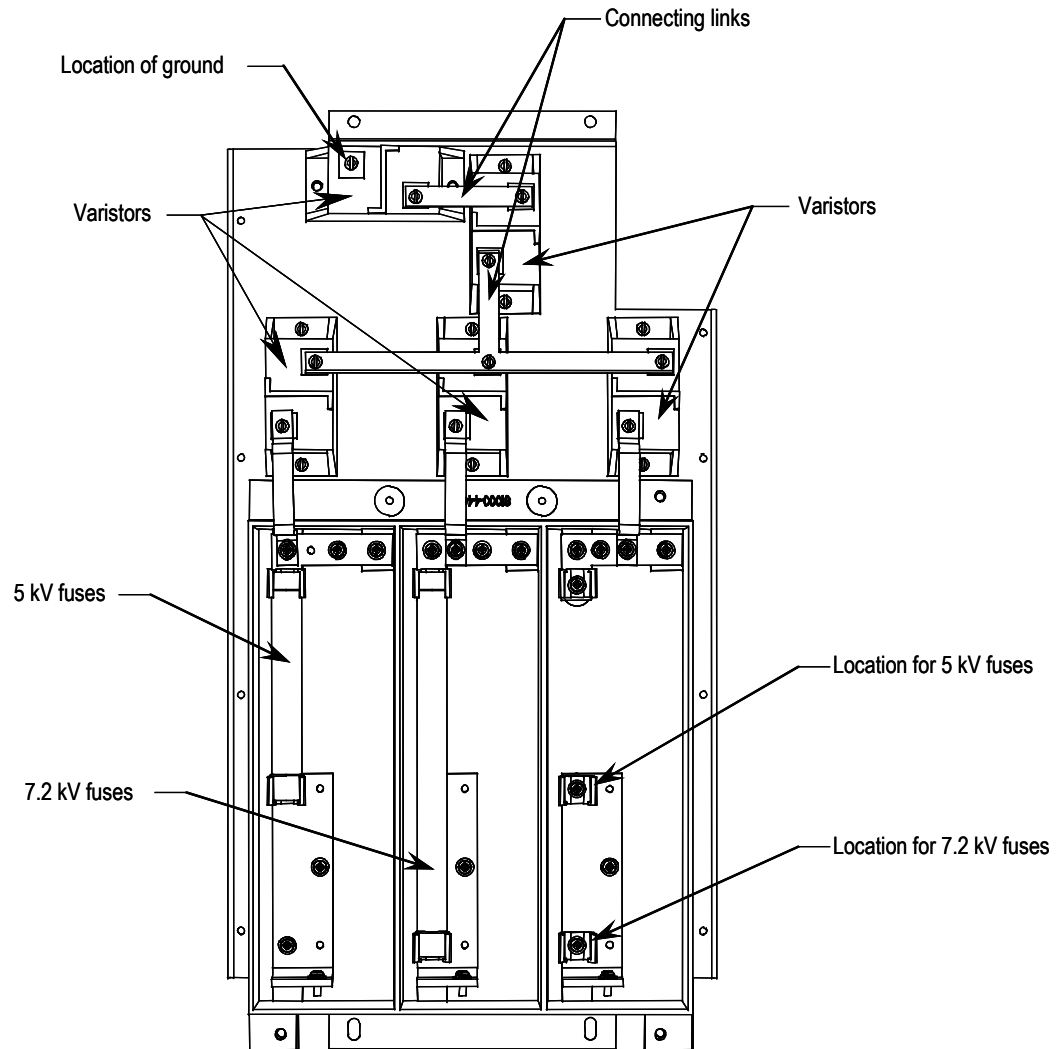


Figure 6.7 –Transient Suppression Network

Metal-Oxide Varistor Replacement

Metal-oxide varistors (MOV) are part of the Transient Suppression Network located within the connection cabinet. The PWM-R drive contains one varistor panel while the 18-pulse drive contains three.

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 6.7 for location) is connected to the grounding lead.

Output Grounding Network Capacitor Replacement

PowerFlex 7000 18-pulse, some 6-pulse and some PWM-R drives will come with a grounding network installed. All other 6-pulse/PWM-R drives will have a notch filter in place of the grounding network.

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 6.9)

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

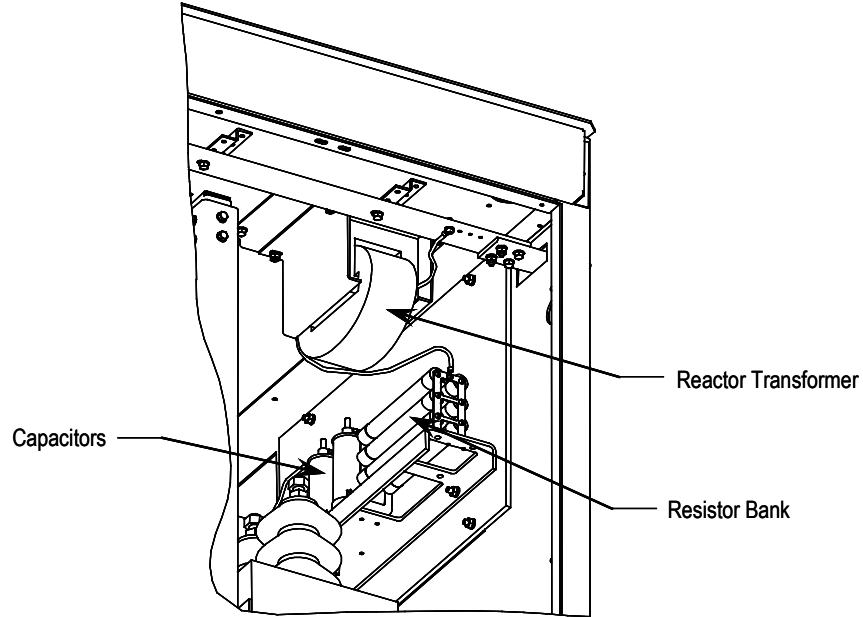


Figure 6.8 – Location of Notch Filter in “B” Frame Drive

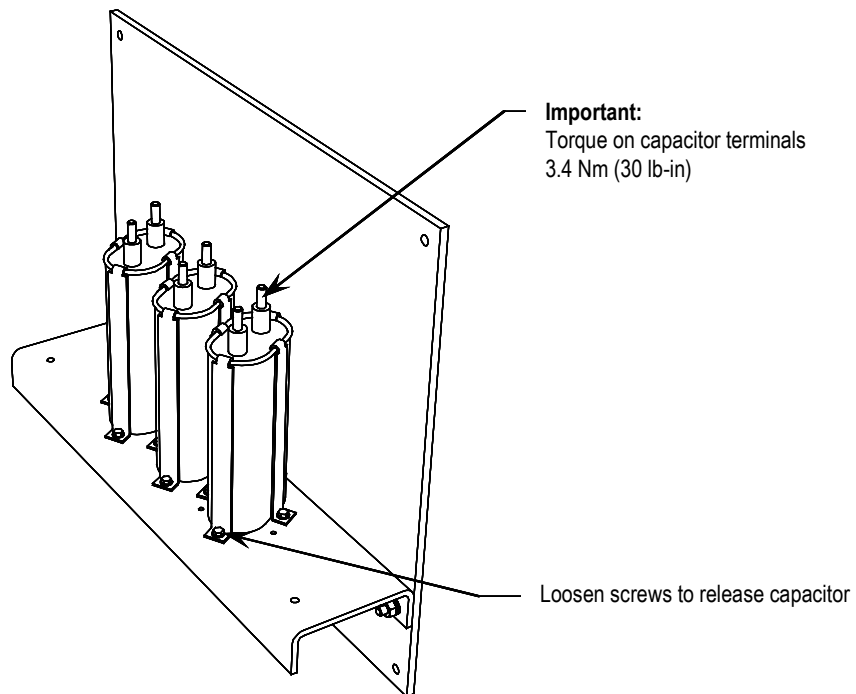


Figure 6.9 – Capacitor in Grounding Network

Ground Filter Component 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 failed capacitor/resistor bank.
4. Loosen and remove mounting screws as indicated in Figure 6.10 and remove the failed 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 6.10)

IMPORTANT

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

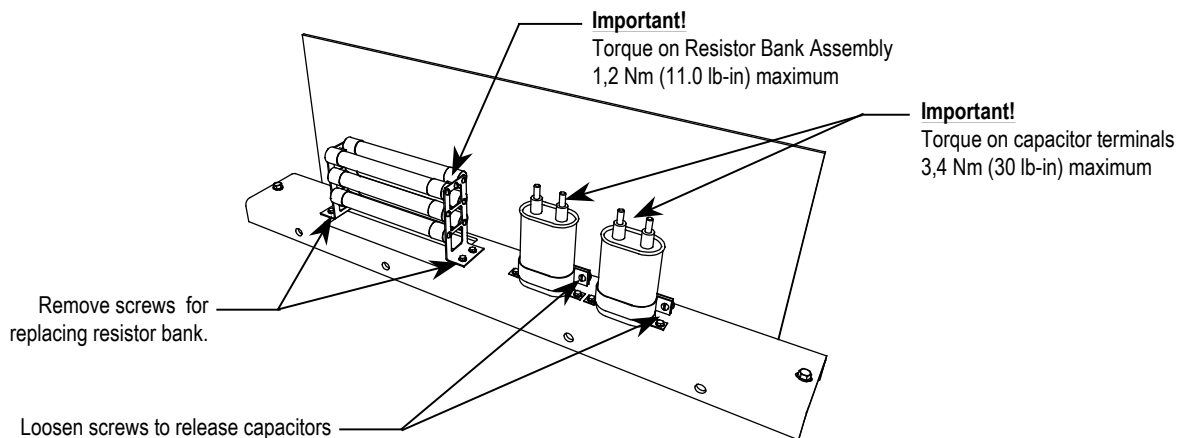


Figure 6.10 – Notch Filter Capacitor Resistor

Hall Effect Current 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 current 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 current sensor. For quick reference when checking the orientation of the Hall Effect current sensor, look for the white arrow.

IMPORTANT

The Hall Effect current 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 current sensor.
6. Replace the Hall Effect current 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.

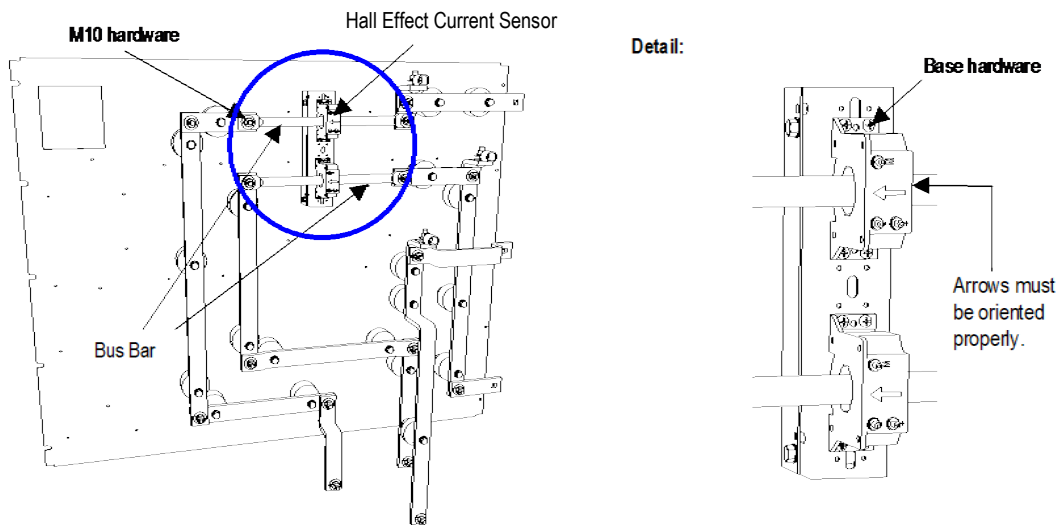


Figure 6.11 – Hall Effect Current Sensor located within cabinet with detail

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.

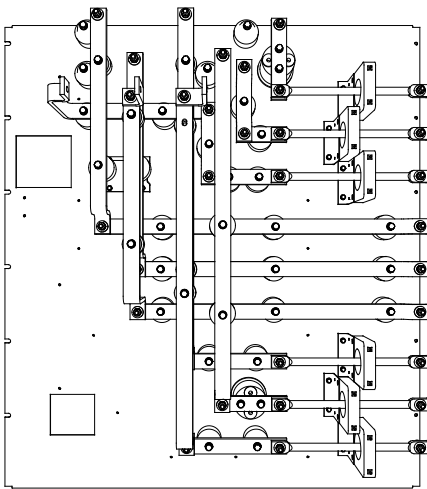


Figure 6.12 – Replacement of Current Transformer

Filter Capacitor Cabinet

Filter Capacitors

Filter capacitors are used on the motor side for all 18-pulse and PWM rectifier drive options. The PWM rectifier option also includes filter capacitors on the line side. Refer to Figure 2.6 (Cabling Cabinet for 18-pulse Rectifier) and Figure 2.7 (Cabling Cabinet for 6-pulse/PWM 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 a 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:

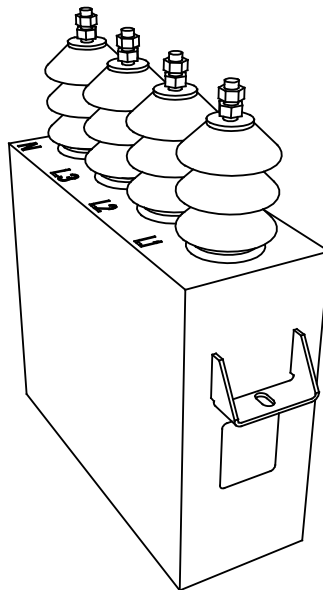


Figure 6.13 – Motor Filter Capacitor

WARNING



Allow 5-10 minutes for motor capacitors to safely discharge voltage prior to opening cabinet doors.

WARNING

These following fault codes may also indicate a non-operational MFC:

- F21 (Motor Overcurrent Fault)
- F23 (Motor Stall Fault)
- F24 (Motor Flux Unbalance Fault)
- F33 (Motor Current Unbalance Fault)
- F44 (Inverter Overvoltage Fault)
- F67 (Motor Neutral Overvoltage Fault)
- F171 (DC Link Overcurrent Fault)
- F173 (Ground Overcurrent Fault)
- F203 (Neutral Resistor Overload Fault)
- F206 (Neutral Resistor Overcurrent Fault)

Do not reset these faults until you confirm the root cause.

Operating a synchronous transfer system (specifically during the ‘Transfer to Drive’ operation, also known as the de-sync operation) with a non-operational Motor Filter Capacitor (MFC) can lead to serious personal injury and/or property damage.

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. **THESE CAPACITORS CAN WEIGH AS MUCH AS 100 kg (200 lbs), SO YOU WILL REQUIRE 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.

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. Perform visual inspection to ensure there is no oil leak or bulge in any of the capacitors.
4. Note the location of all the cables and mark them accordingly.
5. Disconnect power cables from the capacitor terminals on all four bushings and isolate them from the capacitor.
6. 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 or other voltage-measuring device verify that the capacitor is fully discharged before touching it.

7. 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 illustrate 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

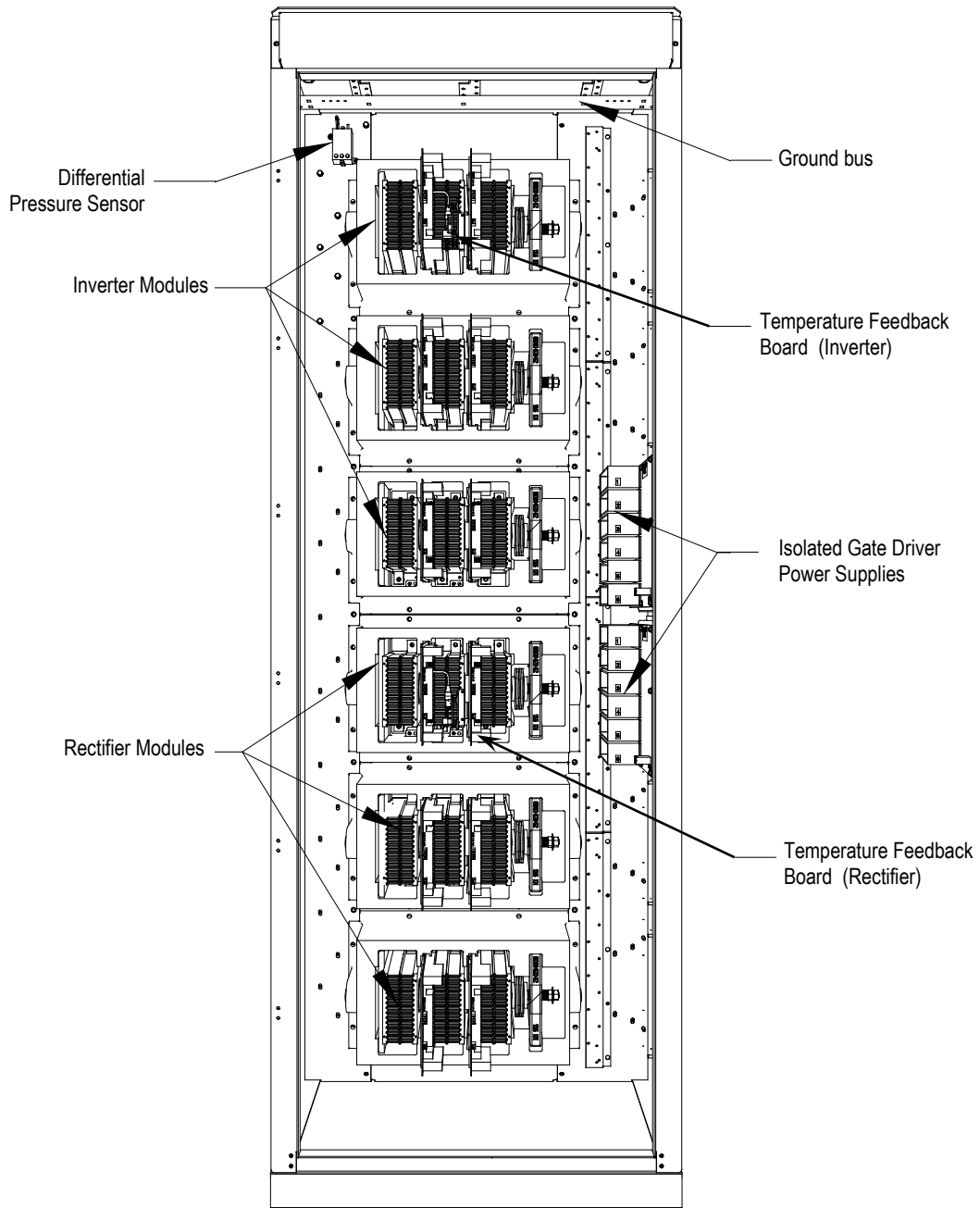


Figure 6.14 – Converter Cabinet Components

Converter Cabinet

The converter cabinet contains three rectifier modules and three inverter modules. Figure 6.14 shows a 2300-volt converter with a Pulse Width Modulation Rectifier (PWMR).

Isolated Gate Driver Power Supplies (IGDPS) are mounted on the cabinet's right side sheet.

Thermal sensors are installed on the top module of the inverter and rectifier. The exact location depends on the drive configuration. These sensors are connected to Temperature Feedback Boards, which bring the signals back to the drive control.

PowerCage™

A PowerCage is a converter module, consisting of the following elements:

- epoxy resin housing
- power semi-conductors with gate driver circuit boards
- heatsinks
- clamp
- snubber resistors
- snubber capacitors
- sharing resistors

All drives have six PowerCages: three rectifier modules and three inverter modules. There are three types of rectifiers: 6-pulse PWMR, 6-pulse SCR, and 18-pulse SCR.

6-pulse PWMR type rectifiers use SGCTs as semi-conductors.

6-pulse SCR, and 18-pulse SCR rectifiers use SCRs as semi-conductors.

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 in the system current.

The power semi-conductor usage in the converter section is as follows:

Configuration	Inverter SGCTs	Rectifier SGCTs	Rectifier SCRs
2300V, 6P	6	0	6
2300V, 18P	6	0	18
2300V, PWM	6	6	0
3300/4160V, 6P	12	0	12
3300/4160V, 18P	12	0	18
3300/4160V, PWM	12	12	0
6600V, 6P	18	0	18
6600V, 18P	18	0	18
6600V, PWM	18	18	0

ATTENTION



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

ATTENTION



The PowerCage can house either SCRs or Silicon Gate Commutated Thyristors (SGCT). The SGCT circuit board is sensitive to static charges. It is important that these boards should not be handled without proper grounding.

ATTENTION



Some circuit boards can be destroyed by static charges. Use of damaged circuit boards may also damage related components. A grounding wrist strap is recommended for handling sensitive circuit boards.

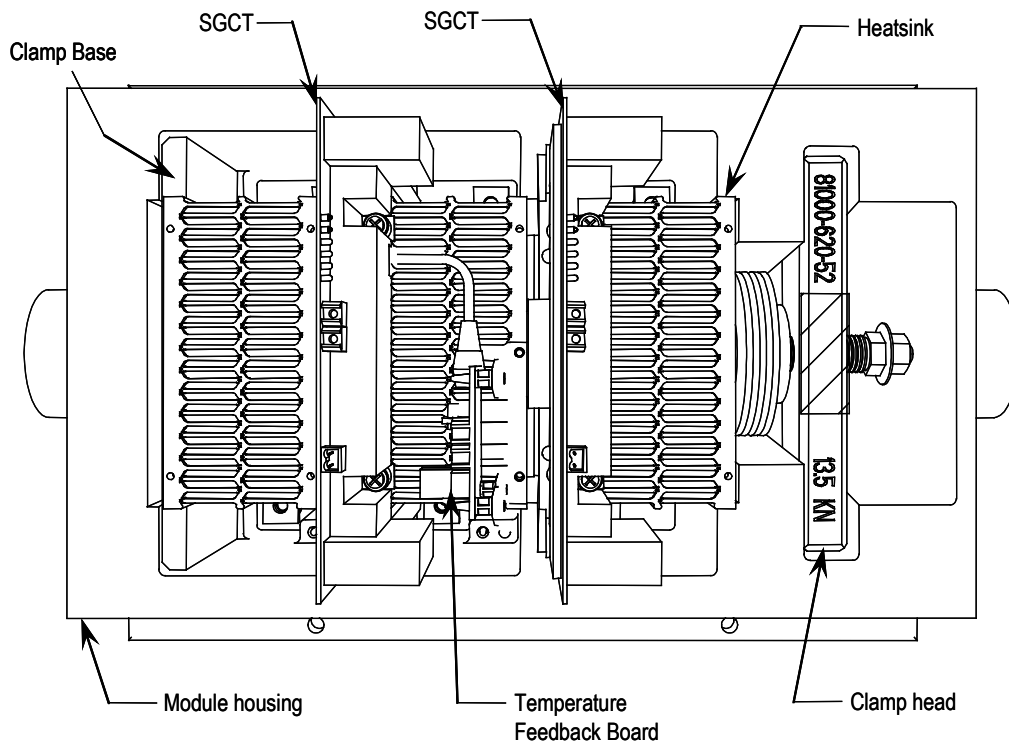


Figure 6.15 – 2-Device PowerCage

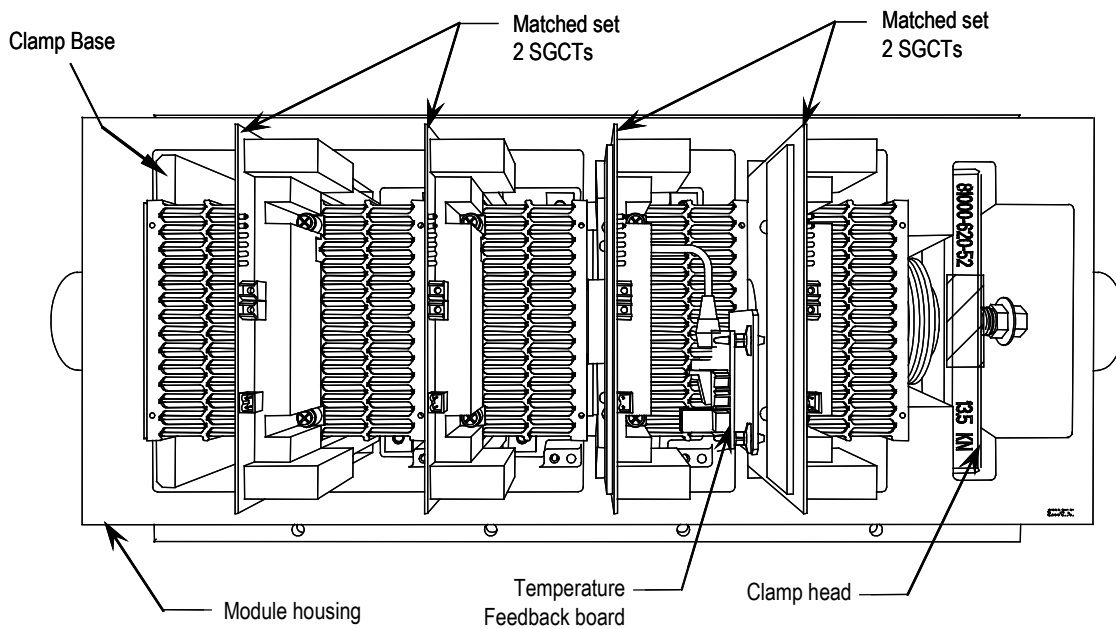


Figure 6.16 – 4-Device PowerCage

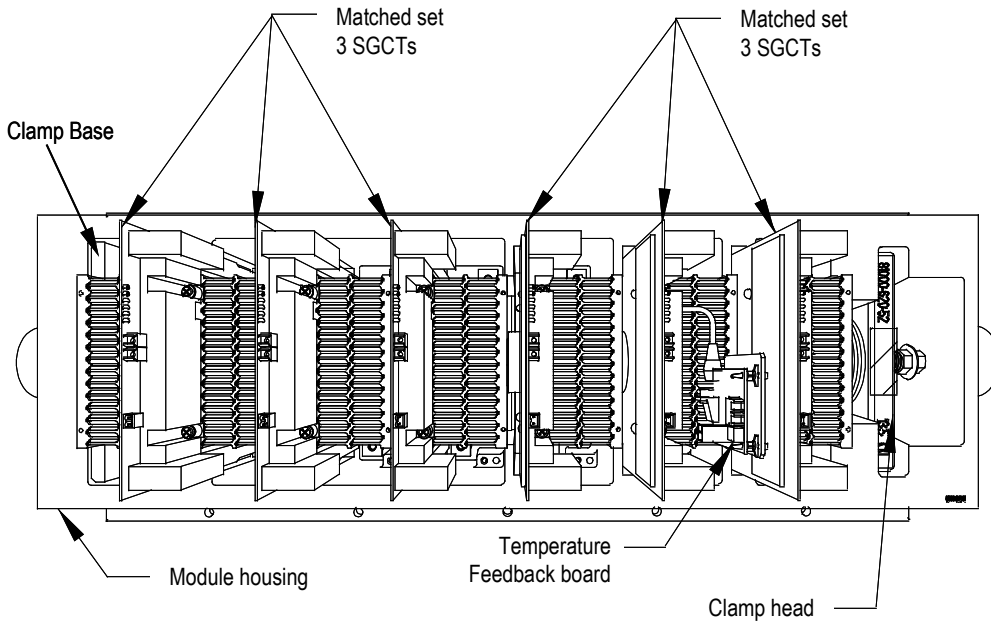


Figure 6.17 – 6-Device PowerCage

SGCT and Snubber Circuit

With all power semi-conductor 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.

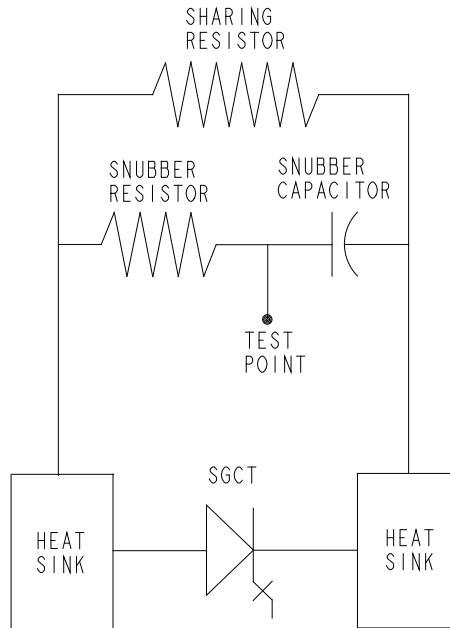


Figure 6.18 – SGCT and snubber circuit

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. This single device will provide sufficient design margin for electrical systems with 2.3 kV medium voltage supply. 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 forced air-cooled heatsinks, one heatsink on the anode and the other heatsink on the cathode. The force placed on the SGCTs differs with the size of the device. The clamp assembly on the right hand side of the inverter module generates these forces.

Pressure on the SGCTs must be uniform to prevent damage and to ensure low thermal resistance. Uniform pressure can be achieved by loosening the heatsink mounting bolts, tightening the clamp and then tightening the heatsink bolts. See section “Uniform Clamping Pressure” for instructions.

External filtered air will be directed through the slots of the heatsinks to carry away the generated heat from the SGCTs. The door filter is necessary to ensure the slots on the heatsinks do not get plugged.

Uniform Clamping Pressure

It is very important to maintain proper pressure on the thyristors. Follow this procedure whenever changing devices, or whenever the clamp is loosened completely.

1. Apply a thin layer of Electrical Joint Compound (Alcoa EJC No. 2 or approved equivalent) to the clamp head pressure pad face.
2. Torque the heatsink bolts to 13.5 N-m (10 ft-lb.) and then loosen each bolt two complete turns.
3. Tighten the clamp to the proper force until the indicating washers can just be turned by the fingers with some resistance.
4. Torque the heatsink bolts to 13.5 N-m (10 ft-lb.) starting with the center heatsink and moving outward alternating left to right.
5. Check clamp indicating washer.

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.

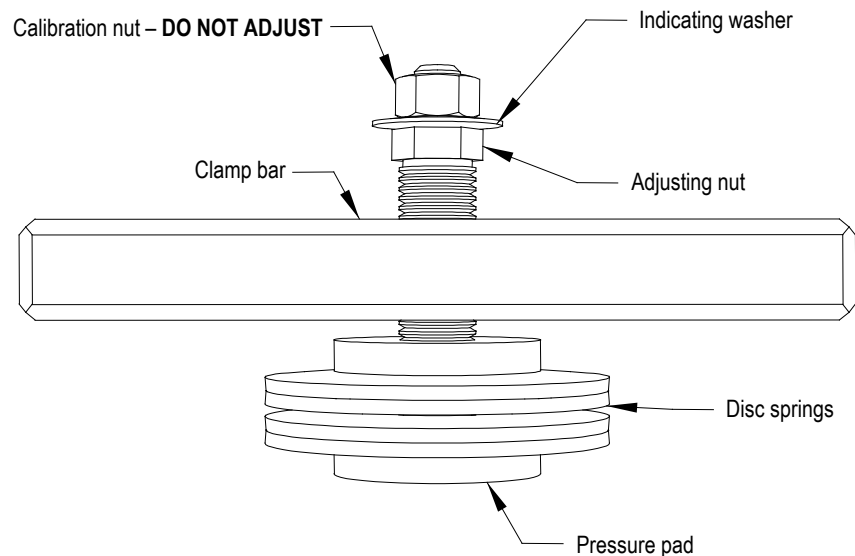


Figure 6.19 – Clamp Head Illustration

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. If the clamping pressure is let off, the assembly procedure must be carried out to ensure uniform pressure on the thyristors.
3. Tighten with a 21-mm wrench on the adjustment nut (upward motion) until the indicating washer can be turned by fingers with some resistance. **IT SHOULD NOT SPIN FREELY.**

IMPORTANT

Never rotate the lock nut located outside the indicating washer at the end of the threaded rod. The rotation of the outer nut will affect the torque calibration, which is factory set. Only adjust the inside nut. (See Figure 6.20.)

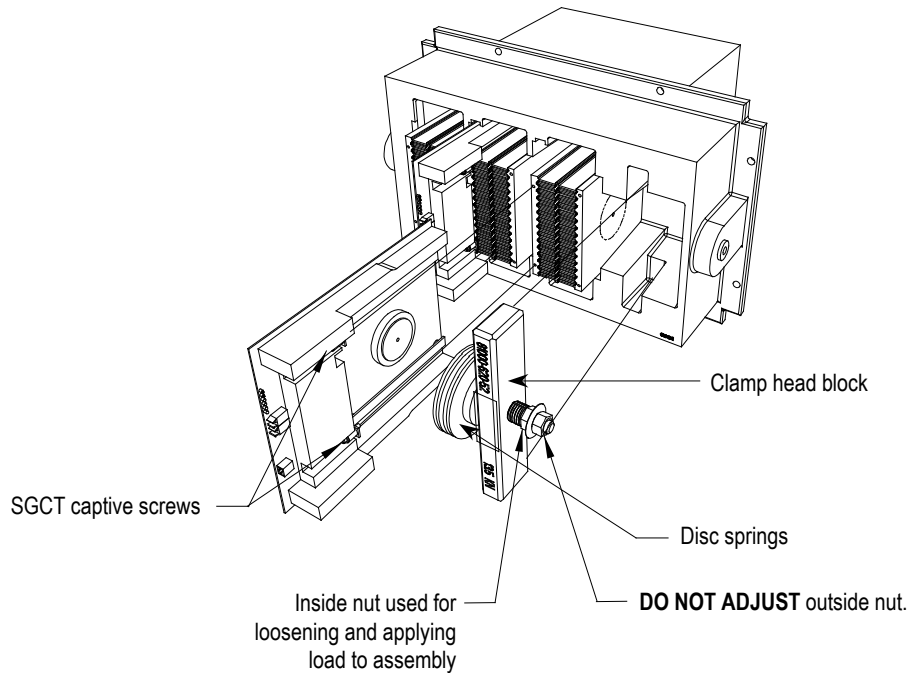


Figure 6.20 – Detail of the clamping assembly

Temperature Sensing

Thermal sensors are located on one heatsink in the rectifier and one heatsink in the inverter. The thermal sensors are mounted on the heatsink with the temperature feedback circuit board.

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. To replace a thermal sensor, refer to page P-2 regarding electrostatic discharge.
3. The heatsink with the thermal sensor must be removed from the PowerCage. Remove clamp load (refer to Figure 6.19).
4. Remove the device (SGCT or SCR) that is secured to the heatsink with the thermal sensor. (Refer to Figure 6.15., 6.16 or 6.17).
5. Disconnect the fiber optic cable to the temperature feedback board.
6. Remove two M8 screws holding the heatsink in place.
7. Remove the heatsink with the temperature feedback board from the PowerCage.
8. Disconnect the plug that connects the thermal sensor to the circuit board.
9. Remove the screw that attaches the thermal sensor to the heatsink.
10. Replace with the new thermal sensor and cable assembly.
11. Note there is a small voltage difference between the thermal sensor and its heatsink. For proper function, it is essential to mount the small insulating pad between the thermal sensor and the heatsink and the insulating bushing between the thermal sensor mounting screw and the thermal sensor (see Figure 6.21).
12. Replacement of the heatsink with the new thermal sensor is in the reverse order of removal.
13. Follow procedure “Uniform Clamping Pressure” to ensure the heatsinks are clamped to a uniform pressure.

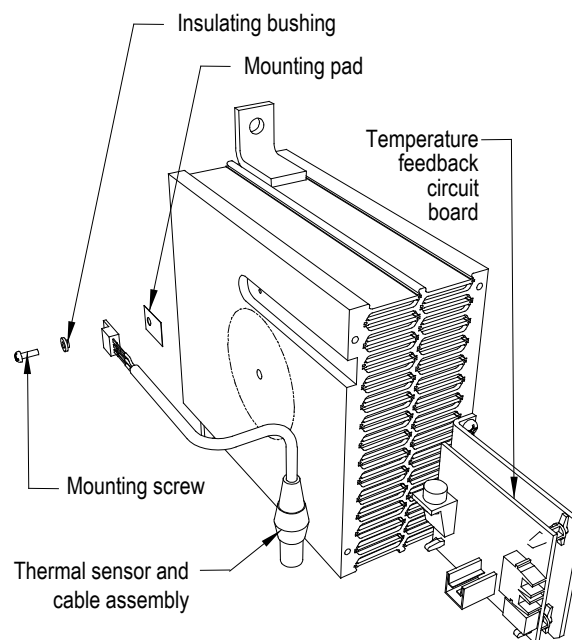


Figure 6.21 – Replacing the Heat Sensor

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

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

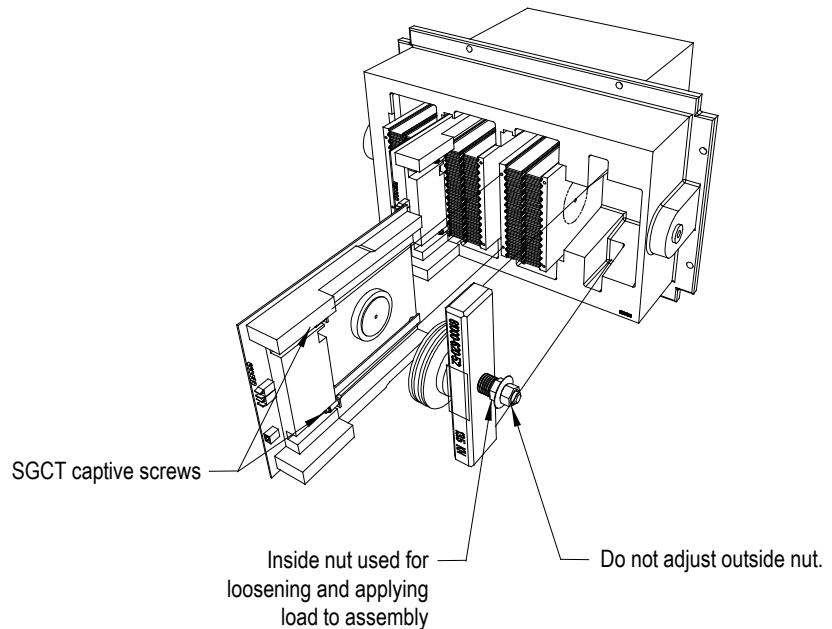


Figure 6.22 – Replacing the SGCT

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 under 'Checking Clamping Pressure' on page 6-23.
5. Two brackets secure the board to the heatsink. Loosen the captive screws until the circuit board is free. It may be necessary to adjust the position of the heatsinks to allow free movement of the SGCT.
6. Slide the circuit board straight out.

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.

IMPORTANT

SGCTs come in matched sets in systems with more than one device per leg. When replacing the device, it is necessary to replace both SGCTs in the pair even if only one has failed. The devices are arranged from left to right in pairs (i.e. pairs 1+2, 3+4, 5+6).

7. While grounded, remove the SGCT from the anti-static bag it is supplied in.
8. Clean the heatsink with a soft cloth and rubbing alcohol.
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 heatsink.
11. Tighten the captive screws located in the brackets.
12. Follow procedure “Uniform Clamping Pressure” to ensure the heatsinks are clamped to a uniform pressure.
13. Connect the 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 under 'Checking Clamping Pressure' on page 6-23.
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 heatsinks 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 using the Gate and Cathode Leads. These connections are sensitive and the device orientation should only be adjusted by turning the device itself.

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. Loosen 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 the same 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.

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. Clean the heatsink with a soft cloth and rubbing alcohol.
16. Slide the SCR and SCRGD Board back into place until the mounting bracket makes contact with the heatsink. Use the Phillips screwdriver to tighten the assembly to the heatsink.
17. Reapply the clamping load as described in 'Uniform Clamping Pressure' above.
18. Connect the control power cable and the fiber optic cables, ensuring that the bend radius is not exceeded.

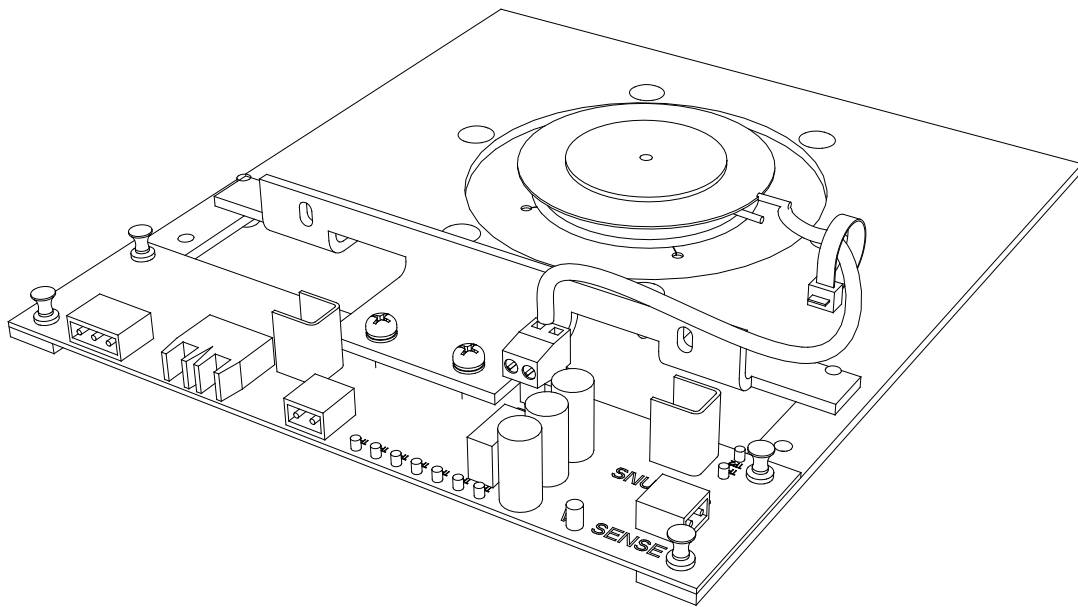
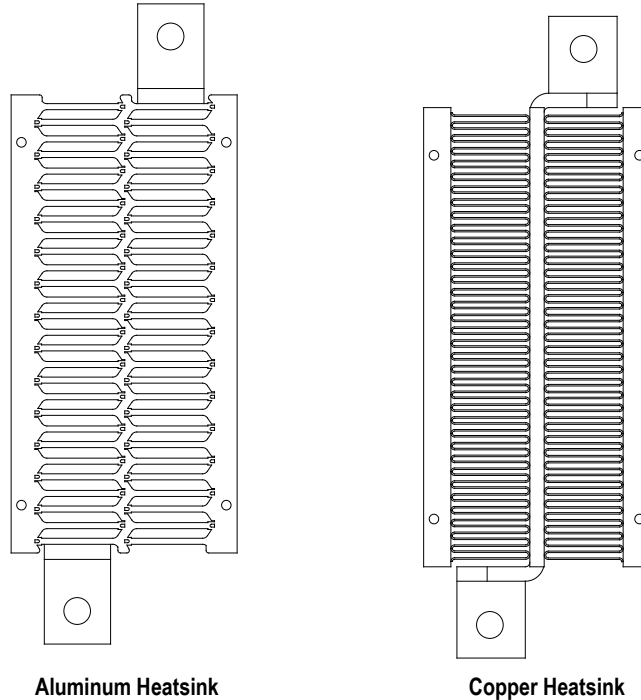


Figure 6.23 – SCR and SPGD assembly

Heatsink Replacement

There are 2 different styles of heatsinks used in the PowerFlex drive depending on current ratings and thermal requirements. The lighter aluminum heatsink has a very fine ventilation pattern through the heatsink. The heavier copper heatsink has a basic ventilation pattern with larger openings for airflow, and will often have a grill mounted on the front of the heatsink to help restrict the flow.



The copper heatsinks can weigh about 9kg (20 lbs.), while the aluminum heatsinks will only weigh approximately 4kg (9 lbs.)

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. Remove the load from the clamp head per the procedure on page 6-23 under ‘Checking Clamping Pressure’.
3. Completely remove the SGCT or SCR from the heatsink that is being replaced per the instructions on pages 6-24 to 6-27.
4. There are 2 bolts that secure the heatsink to the PowerCage. They are 13-mm bolts, and should be removed using several extenders to get the socket wrench out past all the sensitive gate driver boards.
5. Loosen the two bolts and carefully remove the heatsink from the PowerCage.
6. Install the new heatsink and hand-tighten the bolts.
7. Replace the SGCT or SCR per the instructions on pages 6-24 to 6-27.
8. Follow procedure “Uniform Clamping Pressure” to ensure the heatsinks are clamped to a uniform pressure.

PowerCage Gasket

To ensure all air movement is through the slots of the heatsinks, all possible air leaks have been sealed with a rubber gasket. This gasket is placed between the surface of the PowerCage and heatsink module. It is necessary to have the gasket in place to ensure proper cooling of the SGCTs or SCRs are maintained.

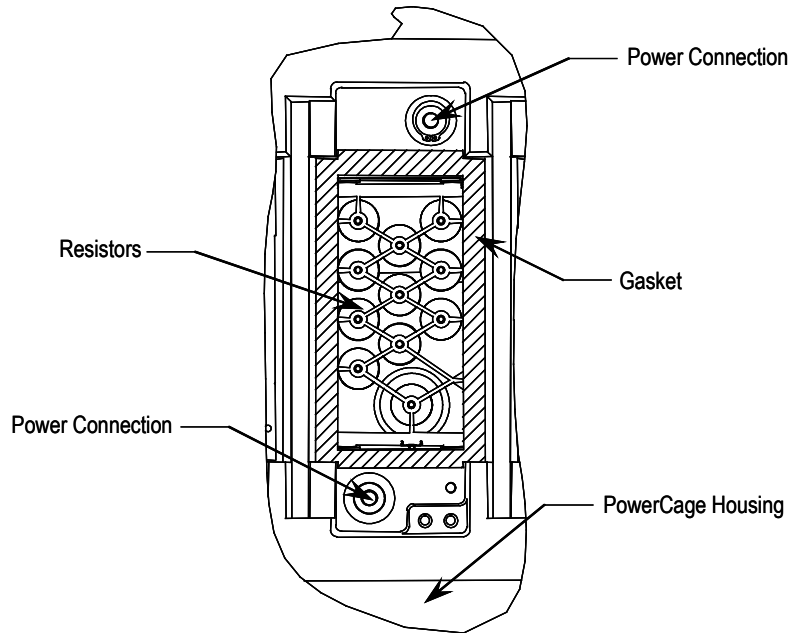


Figure 6.24 – PowerCage Gasket Location

Replacement of PowerCage Gaskets

The gaskets do not normally require replacement, but in the event that they become damaged, they may require replacement.

Removal of old Gasket Material

Pull all the material possible off by hand. Scrape off as much material as possible with a sharp knife. Do not score the PowerCage with the knife. All the material will not come off! Remove as much as possible to leave an even surface to bond to. Clean away any loose pieces of gasket. Then proceed with installation of the gasket.

The PowerCage must be cleaned with Spray Nine (another all purpose household cleaner could be used). **Do not** spray onto the PowerCage as it promotes electrical tracking. Apply the cleaner to a paper towel and wipe the surface of the PowerCage where the gasket will be applied. Liberally spray the surface with distilled water. Wipe the surface with a clean paper towel.

Apply a thin bead of Loctite 454 adhesive to the PowerCage surface in a zigzag pattern using the original nozzle size. Use the tip to spread the adhesive around to cover at least 50% of the area. There should be sufficient quantity of adhesive to remain wet long enough for the gasket to be applied. The adhesive uses the moisture in the air as it cures. The higher the humidity the faster the adhesive will cure.

IMPORTANT

This adhesive will bond anything quickly, including fingers!

Position the gaskets ensuring the gasket is oriented correctly. The gasket should be centered over the opening for the heatsinks with the narrow end positioned closest to the test points. The porous surface of the gasket should be applied to the PowerCage. The gasket will bond almost immediately. Apply some pressure to the gasket for 15-30 seconds.

After all the gaskets have been placed check to see that the gasket has bonded properly. Repair any loose areas.

PowerCage Removal

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 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, as well as remove the SGCT or SCR, circuit boards, and thermal sensor.

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.

PowerCage Removal (cont.)

3. Remove the 13-mm bolts in the two flanges that connect the heatsink to the PowerCage, then remove the heatsink from the PowerCage. This will reduce the weight of the PowerCage making it easier to handle.
4. To detach the PowerCage itself, the bolts on the outer flange need to be removed. Carefully lift the PowerCage down, placing the forward face down. Do not overtorque these bolts when replacing the PowerCage.

IMPORTANT

The PowerCage can be heavy and it is preferred that two people should extract the PowerCage from the drive to prevent injury or damage to the module.

5. Refer to appropriate section for component replacement.
6. When replacing the PowerCage, it is important to place the bolts on the outer flange in 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 6.25.

Note: The PowerCage is shown with switching components, heatsinks and clamps removed for ease of lifting.

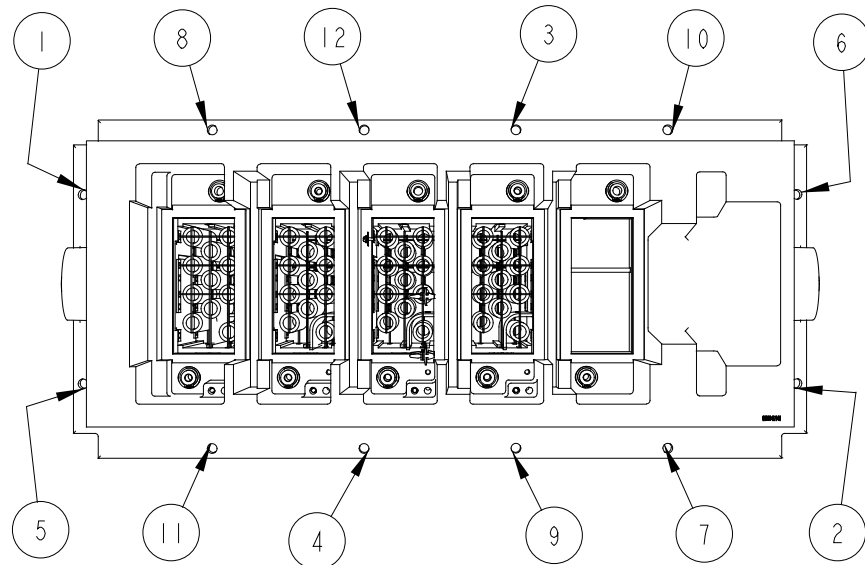


Figure 6.25 – Typical Torque sequence

7. Replace interior assembly in the reverse order of removal.

Snubber Resistors

Snubber resistors are connected in series with the snubber capacitors. Together they form a simple RC snubber that is connected across each thyristor (SCR or SGCT). The purpose of the snubber circuit is to reduce the dv/dt stress on the thyristors and to reduce the switching losses. The snubber resistors are connected as sets of various wire-wound resistors connected in parallel. The number of resistors in parallel depends on the type of the thyristor and the configuration and frame size of the drive.

Testing Snubber Resistors

Access to the snubber resistor is not required to test the resistance. There is a snubber circuit test point located under the heatsink within the PowerCage. There is one test point for each device. To verify the resistance, follow the procedures outlined in Chapter 4 – Commissioning.

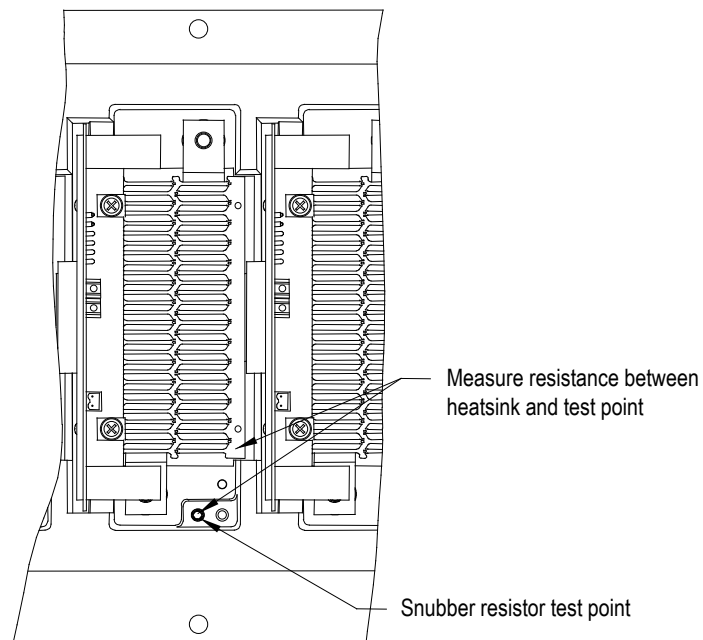


Figure 6.26 – Testing the Snubber Resistor

Snubber and Sharing Resistor Replacement

The snubber and sharing resistors are part of the resistor assembly located behind the PowerCage.

1. Remove the PowerCage as outlined in “PowerCage Removal”.
2. Note the connection of the leads for correct replacement.
3. Detach the leads located on the bottom of the resistor assembly.

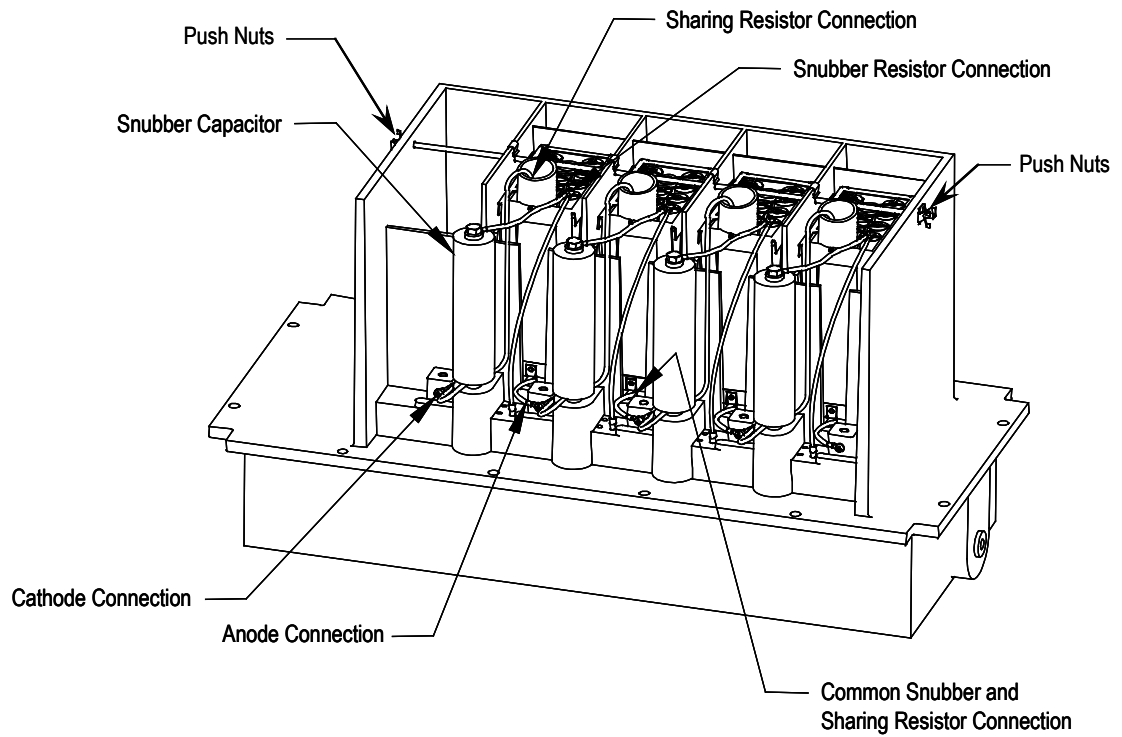


Figure 6.27 – Removal of Power Cage
(SGCT Type PowerCage shown)

4. Remove the push nuts on the end of the retaining rod. Pinch the clip together and pull off. Pull out the retaining rod.

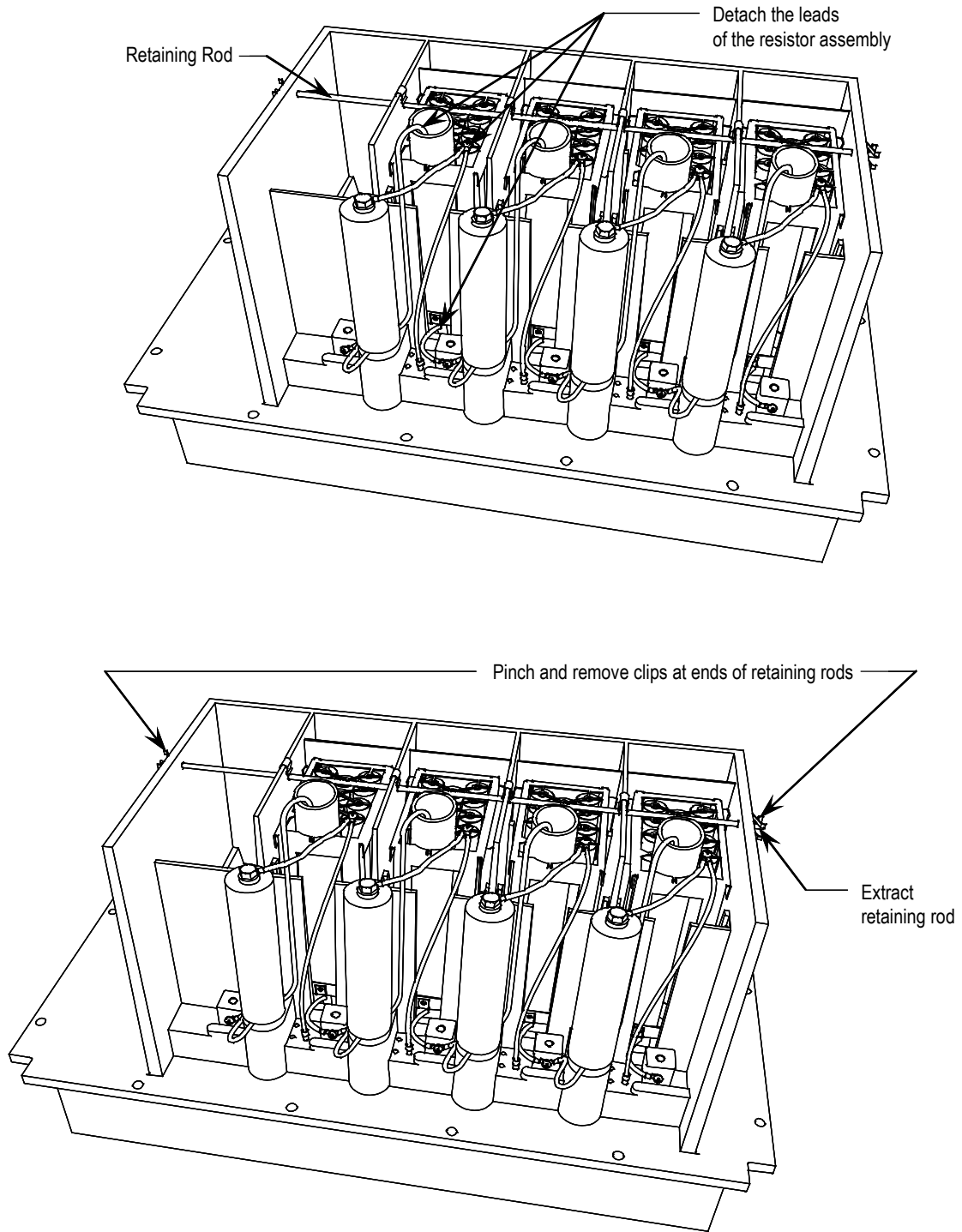


Figure 6.28 – Snubber and sharing resistor replacement

Snubber and Sharing Resistor Replacement (cont.)

5. Silicon gel is used to secure the snubber resistor assembly to the PowerCage. It is also used to minimize possible damages to the resistor bank during transportation from the factory. It does not need to be re-applied when inserting the new resistor bank. Remove the resistor bank from the PowerCage.

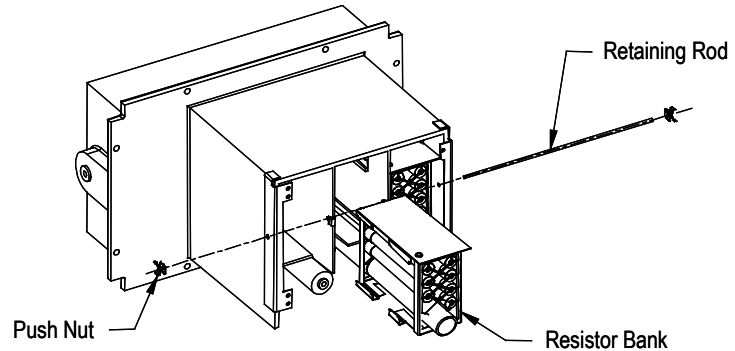


Figure 6.29 – Removing resistor bank from PowerCage

6. Place the new resistor bank assembly back into the PowerCage.
7. Slide the retaining rod into place and push the clips back into place.
8. Connect the leads to the resistor bank
9. Install the PowerCage as outlined in “PowerCage Removal”.

Sharing Resistors

Sharing resistors provide equal sharing of the voltage when matched devices are used in series. SGCT PowerCages for 2300V systems do not need matched devices and have no sharing resistor.

SCR PowerCages always have sharing resistors even if matched devices are not required. Sharing resistors in SCR PowerCages provide a diagnostic function.

Testing Sharing Resistors

It is possible to verify the resistance value of the sharing resistors without removing the PowerCage from the cabinet. Follow the procedures in Chapter 4 – Commissioning.

SGCT PowerCages

The snubber circuit is shown in Figure 6.30. Measure the resistance across two adjacent heatsinks. A value between 60 kΩ and 75 kΩ indicates a good sharing resistor.

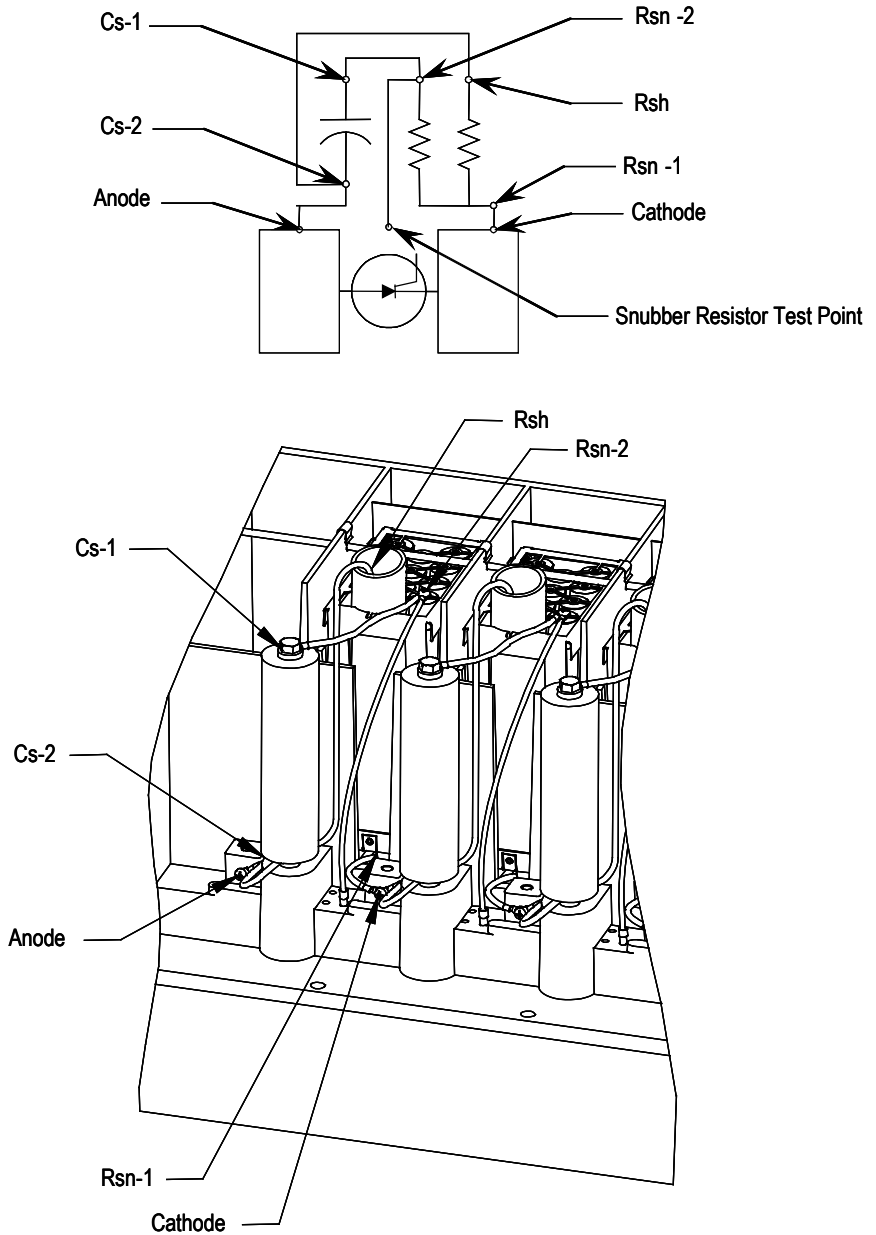


Figure 6.30 – Snubber Circuit for SGCT module

Sharing Resistors (cont.)

Replacing Sharing Resistor

Normally the sharing resistor is part of the snubber resistor assembly. Replacement of the sharing resistor will require replacing the snubber resistor also.

The sharing and snubber resistors are normally located on the backside of the PowerCage. See the instructions for removing and replacing snubber resistors.

SCR PowerCages

The snubber circuit is shown in Figure 6.31. Disconnect the 2-pole plug to the Gate Driver Board that is marked TB1 on the circuit board. Measure the resistance from the point of the plug that connects to the point labeled V.SENSE on the Gate Driver Board to the anode side heatsink. A value of 80 k Ω indicates a good sharing resistor.

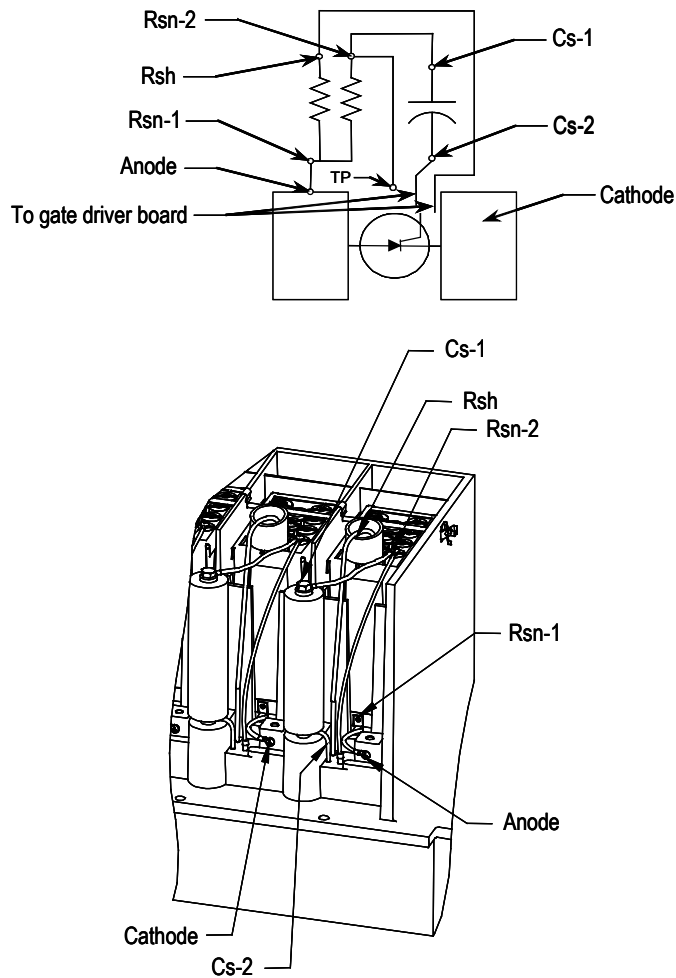


Figure 6.31 – Snubber Circuit for SCR Rectifier Module

Resistance measurements

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 $60\text{ k}\Omega$ and $75\text{ k}\Omega$ indicates the SGCT is in good condition and that wiring to the SGCT is correct. If the SGCT fails, it will be in the shorted mode, $0\ \Omega$. The anode to cathode resistance check will be $0\ \Omega$.

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 heatsink to determine the value of the resistor or capacitor. See Figure 6.32.

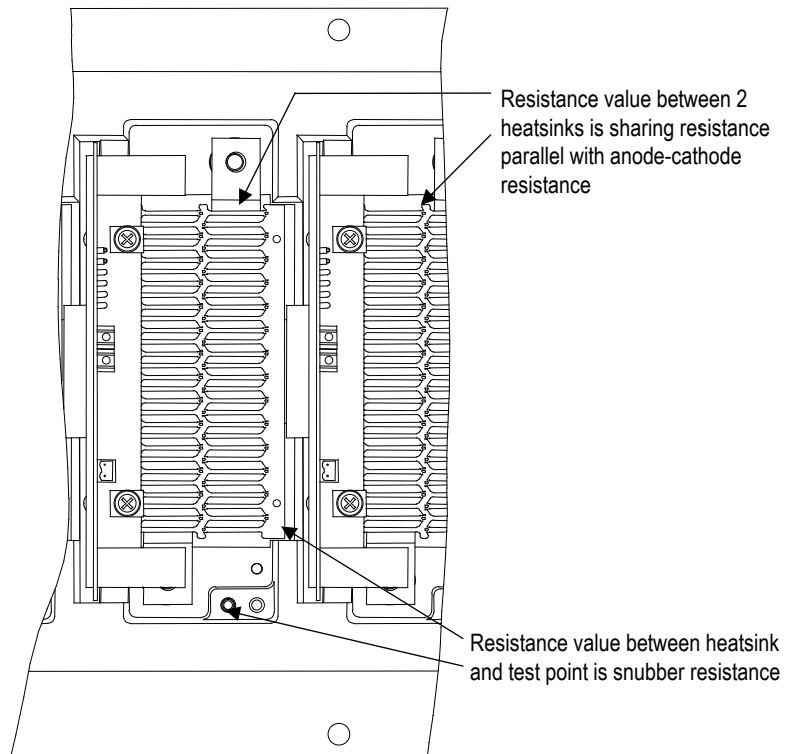


Figure 6.32 – Resistance Measurements SGCT PowerCage

Snubber Capacitor Replacement

The snubber capacitors are part of the capacitor assembly located behind the PowerCage module.

IMPORTANT

If the drive can be accessed from the rear, the snubber capacitors can be removed and replaced from the rear, with the PowerCage modules in place.

If the drive cannot be accessed from the rear, the PowerCage modules must be removed to access the snubber capacitors. See PowerCage Module Removal on page 6-37.

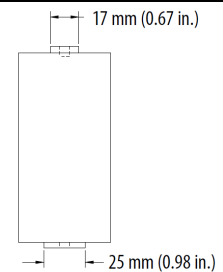
Replace the capacitors one at a time. Do not remove all at once.

1. Using a 13 mm socket wrench, remove the M8 bolt on the end of the capacitor and retain hardware.
2. Hand rotate the capacitor counter-clockwise to unscrew it from the threaded stud connecting it to the PowerCage module.
3. Apply a drop of Loctite 425 to the thread of the 25 mm flange side of the replacement capacitor.
4. Hand-tighten the replacement capacitor onto the threaded stud.

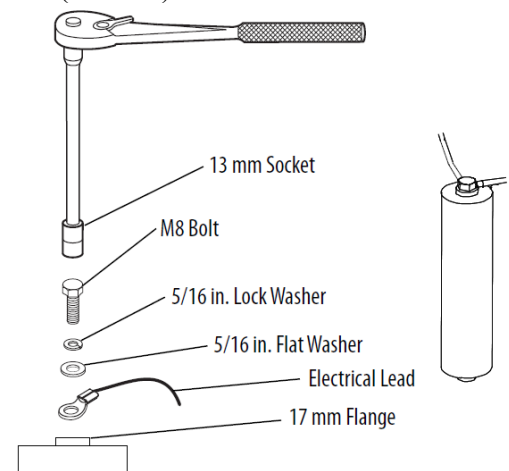
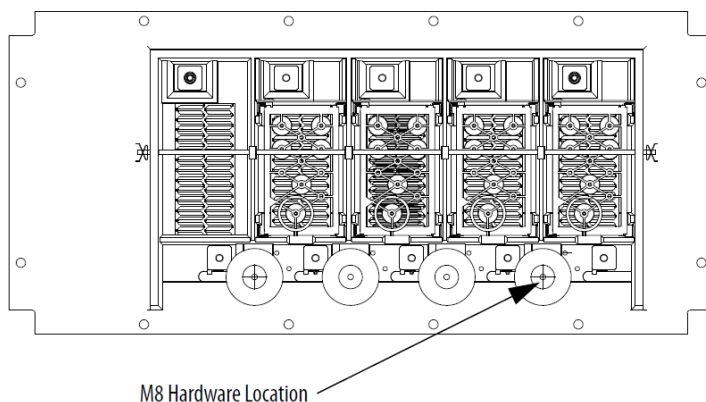
ATTENTION



You must insert the capacitor in the correct orientation. The 25 mm flange must be connected to the threaded stud on the PowerCage module.



5. Connect the electrical leads and hardware on the 17 mm flange side of the replacement capacitor.
Torque M8 hardware to 7 N•m (60 lb•in).



6. Bundle and secure the connecting wires using wire ties.

Self-Powered Gate Driver Board – SPGDB

Description

This board is used in drives where SCRs are used as the rectifying device on the input of the drive. The SCRs require a gating pulse in order to turn on, and this is achieved by using the SPGDB.

The SPGDB receives its command from the drive processor, via a light signal, which is transmitted through a fiber optic cable. The power source for the SPGDB is from the snubber network of the SCR, a patent pending design of Rockwell Automation. This unique design gives the SPGDB the ability to conserve the amount of energy that it supplies to the SCR. This reduces the amount of energy required by the drive to operate, thus making the drive more efficient.

Also, this board will determine the health of the SCR. It has the hardware necessary to diagnose the condition of the SCR. This status is relayed to the processor via a fail-safe light signal transmitted through a fiber optic cable.

Board Calibration

No field calibration is required for this board.

Test points description

- TP1** – SCR gate output (attach oscilloscope between TP1 and TP2 to see gating pulses)
- TP2** – SCR cathode output
- TP3** – Common reference point for all other test point measurements, except for TP1, which uses TP2 as its reference point
- TP4** – The positive 20 V rail used for the SPGDB operation
- TP5** – The positive 5 V rail used for the SPGDB operation
- TP6** – The sense voltage taken from the sense resistor across the SCR being controlled
- TP7** – Trigger signal, which remains active for a fixed period of time after the SCR being controlled, has turned on and the voltage across it has collapsed
- TP8** – Internal gating signal that indirectly turns on the SCR that is being controlled
- TP9** – Gating signal received from the commanding drive control board, through the appropriate fiber optic cable

The yellow LED (LED 1) on the SGPDB indicates that the SCR being controlled has a gating current flowing which is used to turn the SCR on.

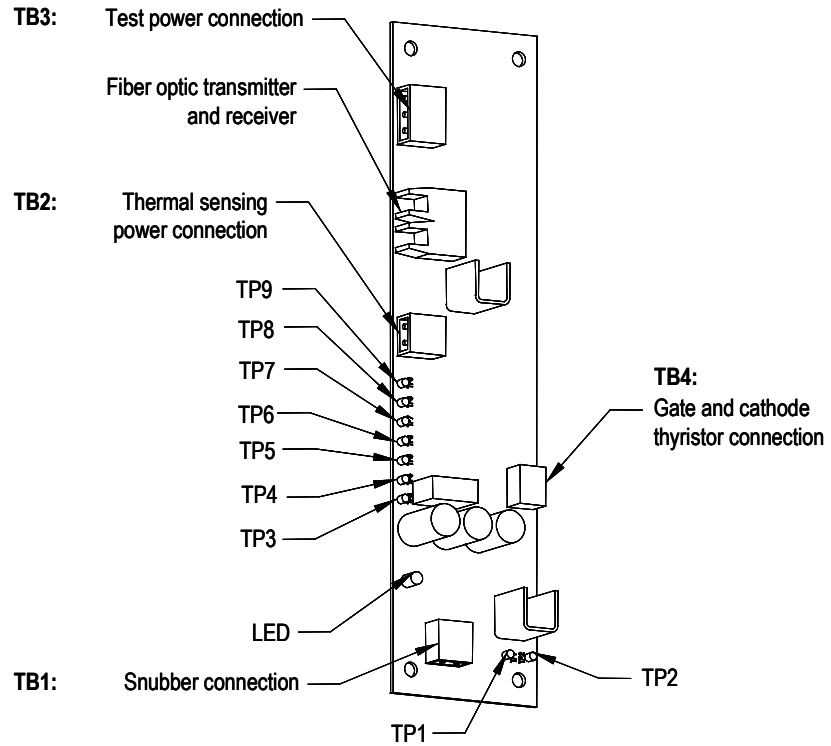


Figure 6.33 – Self-Powered Gate Driver Board

Terminal/connections description

- TB1-1** – Connection to SCR snubber circuit used to extract energy from the snubber for SPGDB operation
- TB1-2** – Connection to SCR sensing resistor which indicates conduction status of SCR being operated
- TB2-1** – Positive 20V power supply connection to temperature sensor board. Provides power to temperature sensor board.
- TB2-2** – Common connection of positive 20V power supply to temperature sensor board
- TB3-1** – Positive 15V power supply connection for test power used when commissioning drive or testing SPGDB
- TB3-2** – Provides artificial sense voltage signal to allow SPGDB to gate the SCR when in test mode. When the appropriate test power cable is used, P/N 81001-262-51, this input is shorted to TB3-1 to obtain the sense voltage.
- TB3-3** – Common connection of positive 15V power supply used for test power
- TB4-2** – Cathode connection to SCR being controlled
- TB4-1** – Gate connection to SCR being controlled
- OP1** – Blue fiber optic cable receptacle – Firing pulse command from the processor
- OT1** – Grey fiber optic cable receptacle – Diagnostic status of the SCR

Testing procedure for SCR self-powered gate driver board

Equipment needed:

- Digital oscilloscope
- Function generator w/duty cycle control
- DC power supply (+15V @ 300 mA required)
- Digital multimeter
- Temperature sensor board (80190-639-02)

Procedure:

1. Connect a clamped ABB #5STP03D6500 SCR to the gate-cathode leads of the SPGDB board (TB4-1/TB4-2).
2. Attach a temperature sensor board to the TB2-1/TB2-2 terminals.
3. Apply +15V test power to terminals TB3-1 and TB3-3 (TB3-1 is at +15V while TB3-3 is the +15V return). Leave TB3-2 open.
4. Measure TP4 to TP3, which should be +14.4V, +/-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. 6.34.
19. Verify that the signal between TP1 and TP2 is as shown in Figures 6.35 and 6.36.
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 6.37 and 6.38. Note that in Figure 6.38 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.

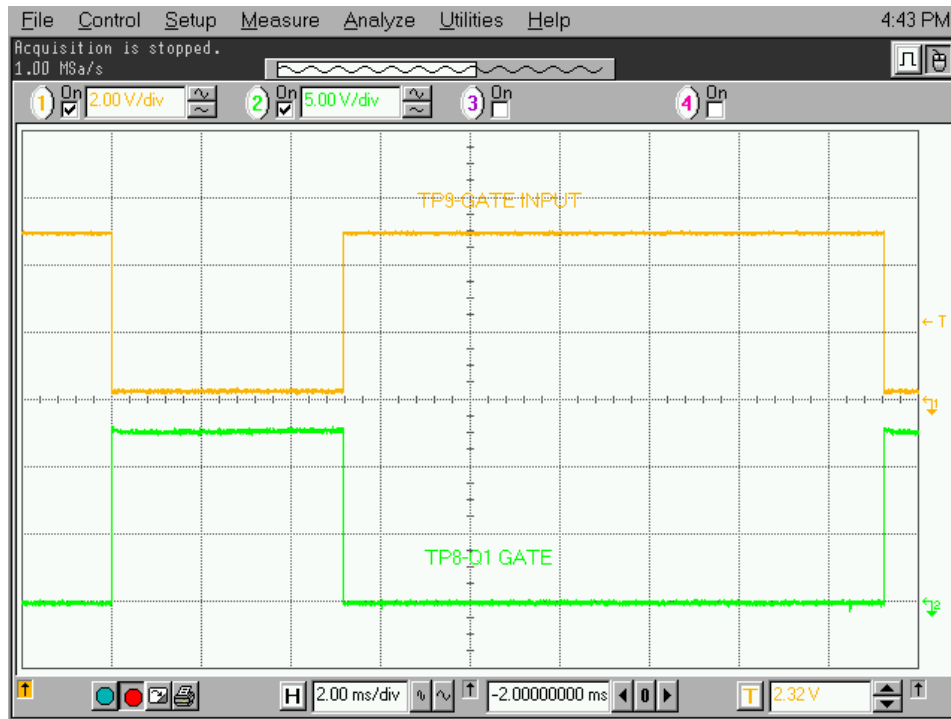


Figure 6.34 – Gating pulses

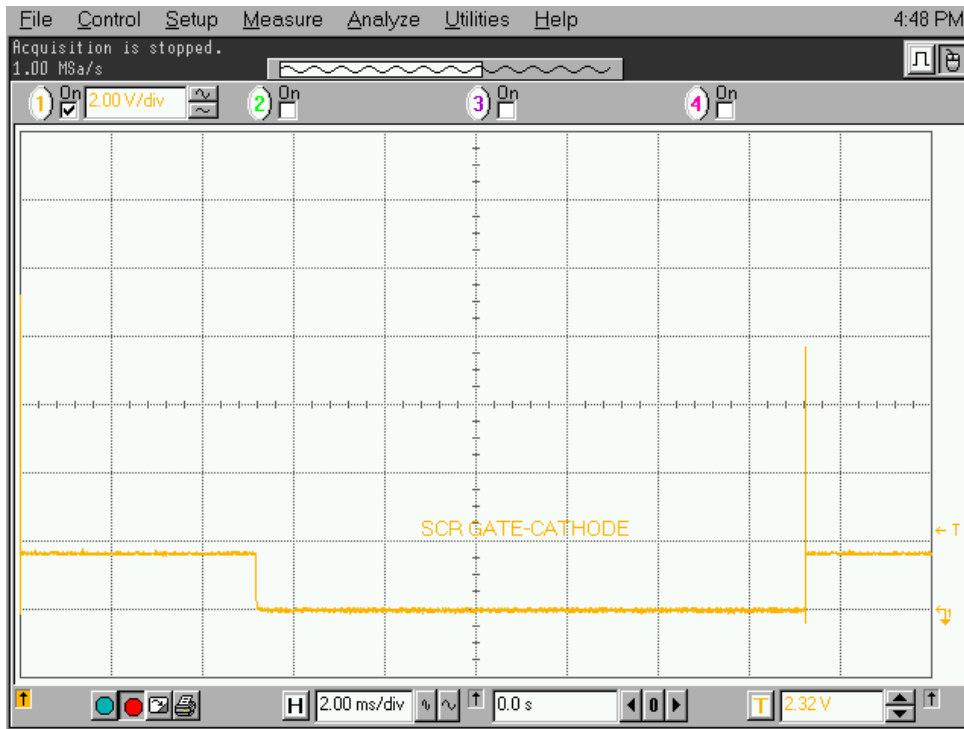


Figure 6.35 – SCR gating pulse

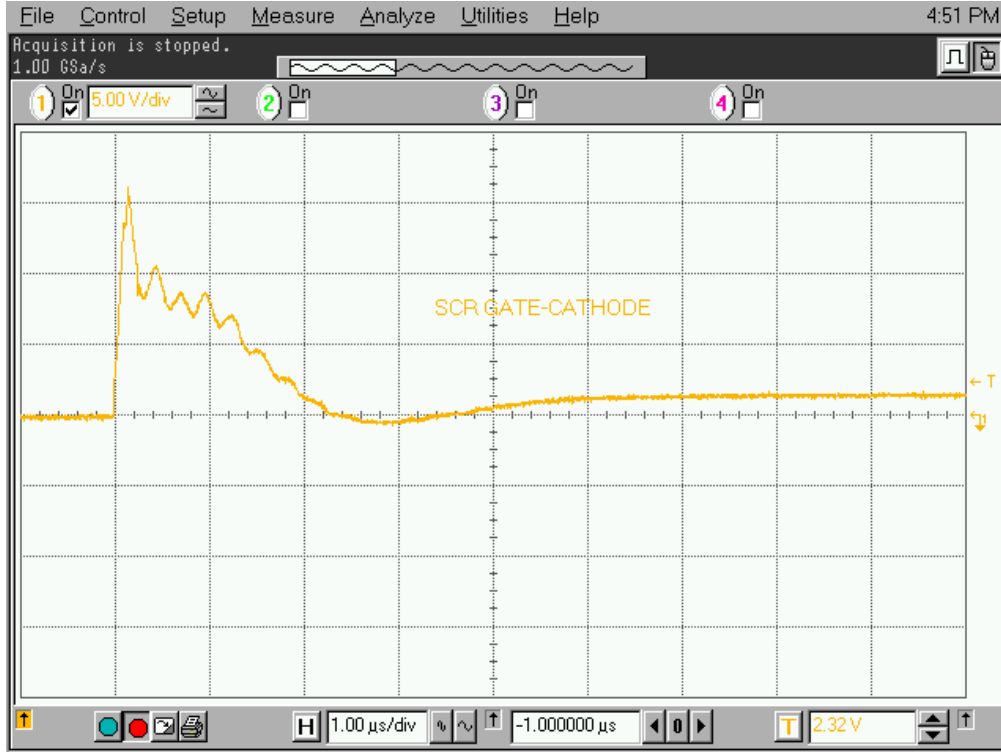


Figure 6.36 – Expanded SCR gating pulse

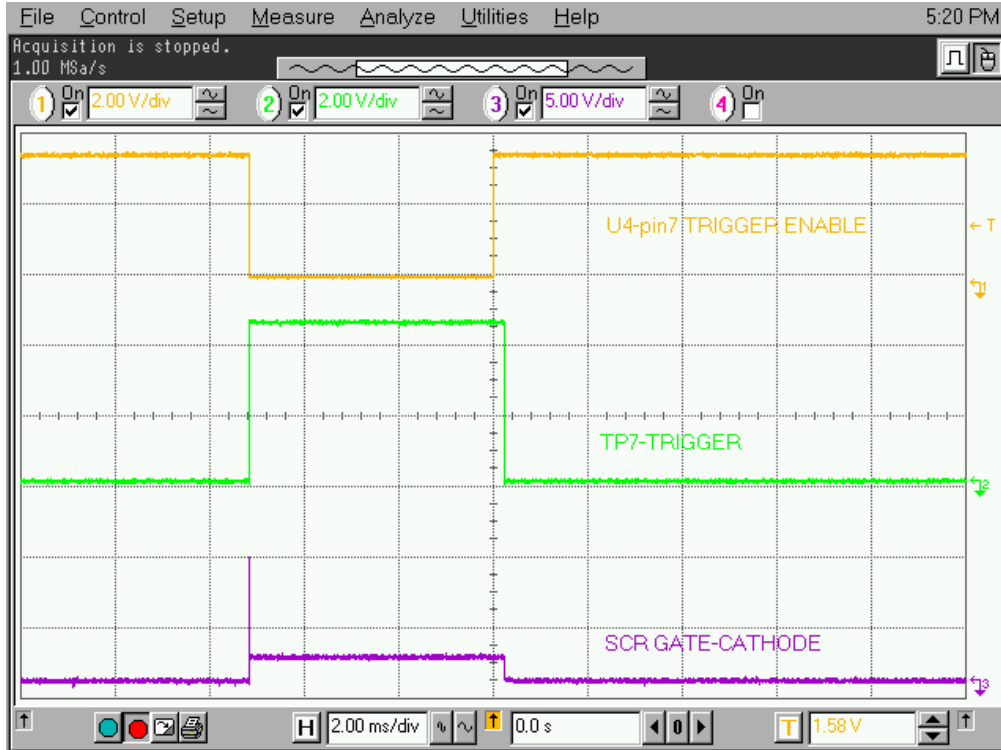


Figure 6.37 – V Sense Trigger to SCR gating pulse

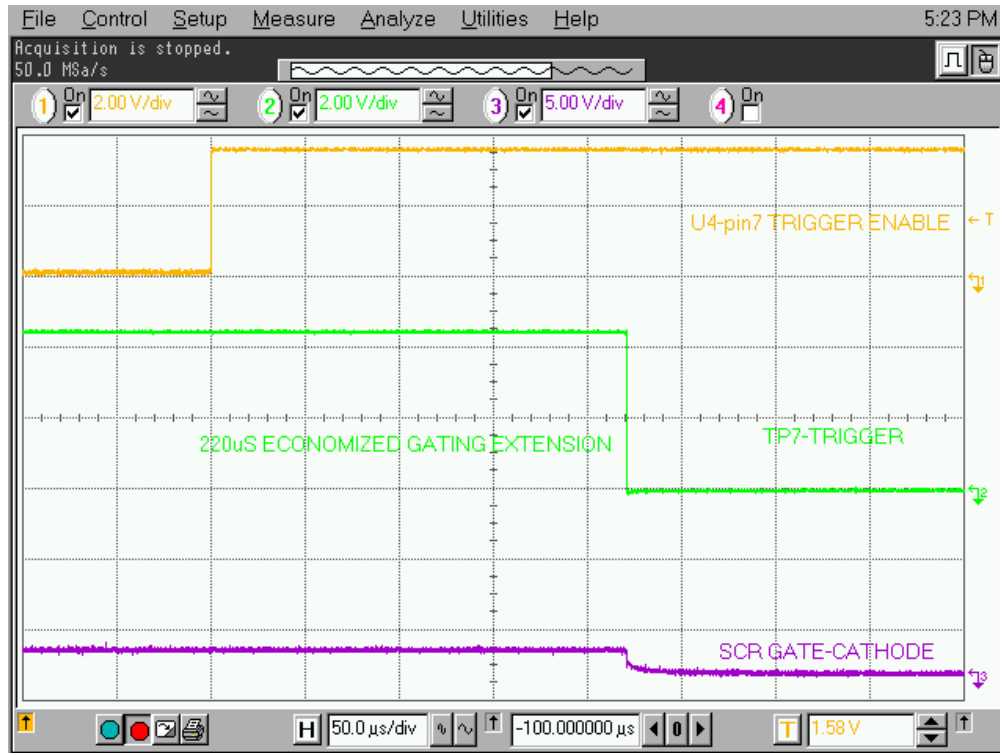


Figure 6.38 – Expansion of V Sense Trigger to SCR gating pulse

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 code of the connectors are:

- BLACK or GREY – is the transmitting end of the fiber optic.
- BLUE – is the receiving end of the fiber optic.

Air Pressure Sensor

An air pressure sensor is located in the converter cabinet. It is located in the upper left area near the uppermost inverter module.

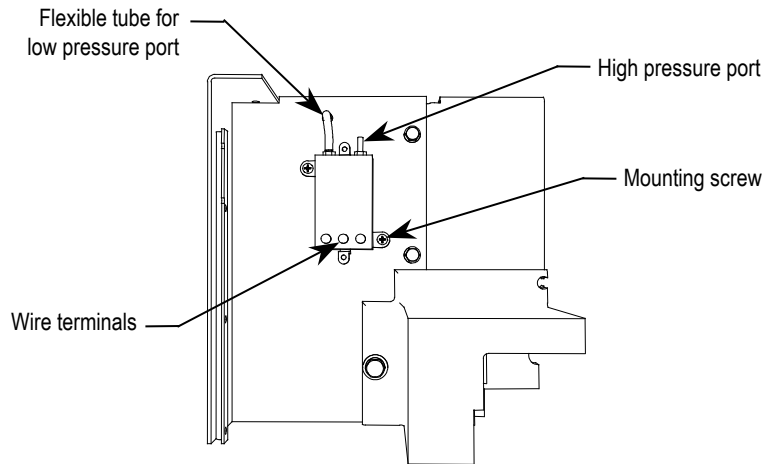


Figure 6.39 – Air Pressure Sensor

The air pressure sensor compares the air pressure in front of the converter modules with the air pressure behind the converter modules. A small direct current voltage signal is transmitted to the control circuits.

There have been two different air pressure sensor manufacturers – Ashcroft and Greystone. Ashcroft is our current pressure transducer manufacturer.

In the event of reduced fan performance or air blockage, the measured differential pressure will be reduced and a warning message will appear on the console. A likely cause of the warning message would be laden filters at the air inlet.

If airflow becomes reduced so that there is risk of thermal damage, a fault signal will cause drive shutdown. Also, in the event of fan failure, the sensor will detect the pressure change and the drive will be stopped.

Air Pressure Sensor Replacement

1. Remove the wires at the sensor and note their designation.
2. Disconnect the clear tube on the low pressure port. Remove the two mounting screws of the sensor.
3. Check the integrity of the sealant that has been applied where the clear tubing passed through the sheet metal barrier.
4. Installation of the replacement airflow sensor is in the reverse order of its removal.

D.C. Link and Fan Cabinet Components

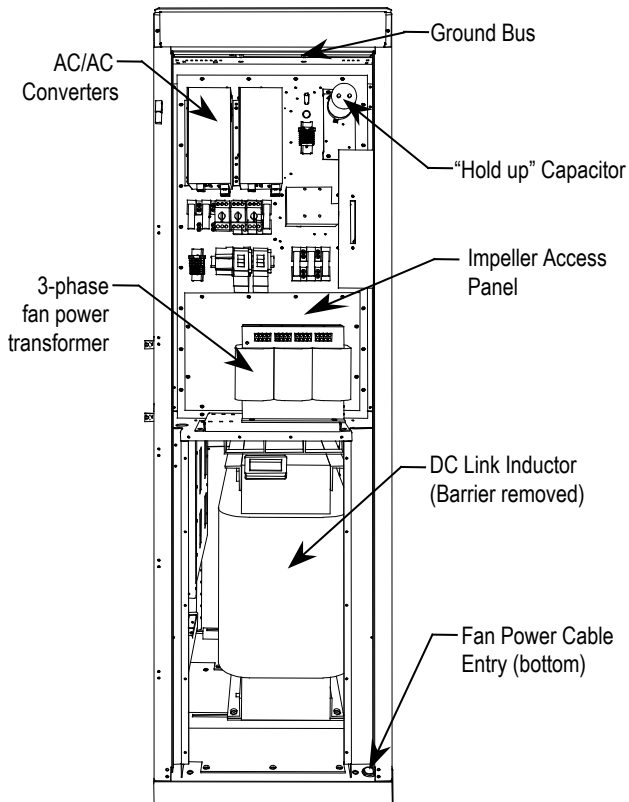


Figure 6.40 – DC Link and Fan cabinet with control panel shown

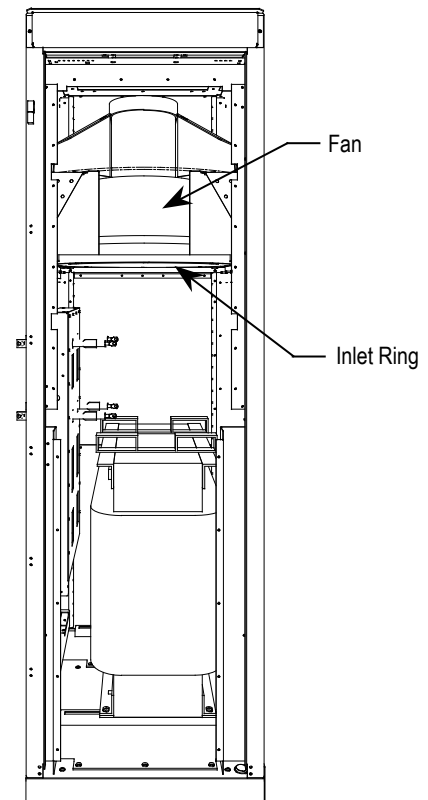


Figure 6.41 – DC Link and Fan Cabinet with fan control panel removed

The door of the cabinet is interlocked such that it cannot be opened unless the fan power is disconnected. The fan power disconnect handle is mounted on the right-hand side of the cabinet.

When the door is opened, fan control components are accessible. Behind the fixed fan control panels is the medium voltage compartment where the DC link and fan are located.

The D.C. link is mounted on the floor plate of the cabinet. Airflow barriers are assembled around the coils of the inductor to direct a portion of the cooling air through the inductor.

Power connections are made to the inductor via its flexible leads. There are four power connection points labeled L+, L-, M+, and M-.

The iron core of the D.C. link is equipped with thermal protection.

There is a current sensor on the M+ conductor.

Above the D.C. link is the main drive cooling fan.

The primary elements of the fan are the inlet ring, impeller and motor.

The inlet ring is stationary and must not contact the rotating impeller.

Mounted on top of the cabinet is an air exhaust hood. The exhaust hood must be installed to prevent foreign objects entering the drive.

If there is a redundant fan option, it is mounted on the top of this cabinet, inside an enlarged exhaust hood.

DC Link Reactor

The DC Link maintains a ripple-free current between the rectifier and the inverter.

The DC link reactor does not normally require service. In the event of its replacement, it must be ensured that Rockwell Automation approves its replacement link.

The link has been constructed to ensure that it is cooled by air drawn through its coils.

To service the DC link, see Figure 6.42.

- 1) Ensure that source power to the drive is locked out.
- 2) Access to the DC link is gained by opening the door to the DC link cabinet and removing screws that retain the vertical sheet metal barrier in front of the DC link.
- 3) Disconnect the 4 power connections. The DC link is equipped with flexible power leads.
- 4) Remove the horizontal barrier around the DC link.
- 5) Remove the hardware that secures the DC link to the floor channel.
- 6) Disconnect the ground connection.

The DC link is heavy and has provision for lifting with forks of a lift truck.

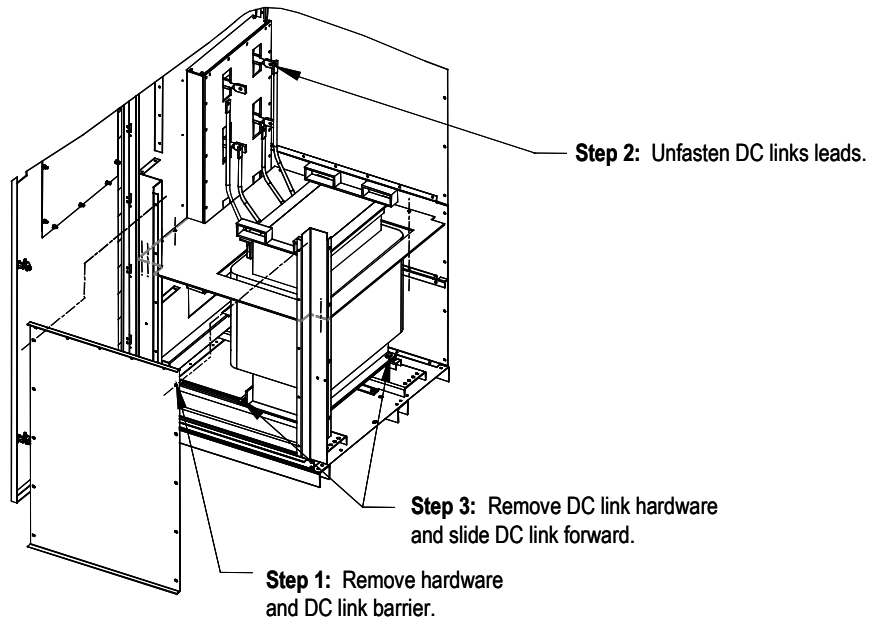


Figure 6.42 – DC link removal

Installation of the replacement DC link is performed in the reverse order of its removal.

The installer must ensure that the flexible DC link leads are connected to the appropriate terminal and routed so that electrical clearances are maintained. You must also verify that the nameplate ratings are the same or appropriate for the drive system. A different DC link will require different parameter settings.

The DC link maintains a ripple-free current between the line converter and the machine converter. Thermal protection of the DC link reactor is provided by two normally closed contacts wired to the I/O module. These contacts will open at 190°C and cause a fault/alarm message to be displayed.

Fan Removal and Replacement

The fan consists of a motor and impeller assembly. To replace the fan it is necessary to remove the fan exhaust hood and top plate of its cabinet.

Safety notes

Fan replacement requires working at a significant height from the floor. Care should be taken to make a suitable platform from which to work.

The fan motor is heavy and will require suitable lifting provision. Ensure that fan power is locked out during fan maintenance.

Remove the eight nuts that secure the motor frame to the sidesheets of the cabinet. Disconnect the power leads to the motor. Note the terminal locations so that proper fan rotation is maintained.

To extract the fan, lifting hooks are placed in the holes of the motor mounting brackets and the assembly is withdrawn vertically from the cabinet. Do not support the assembly on the impeller or damage may result.

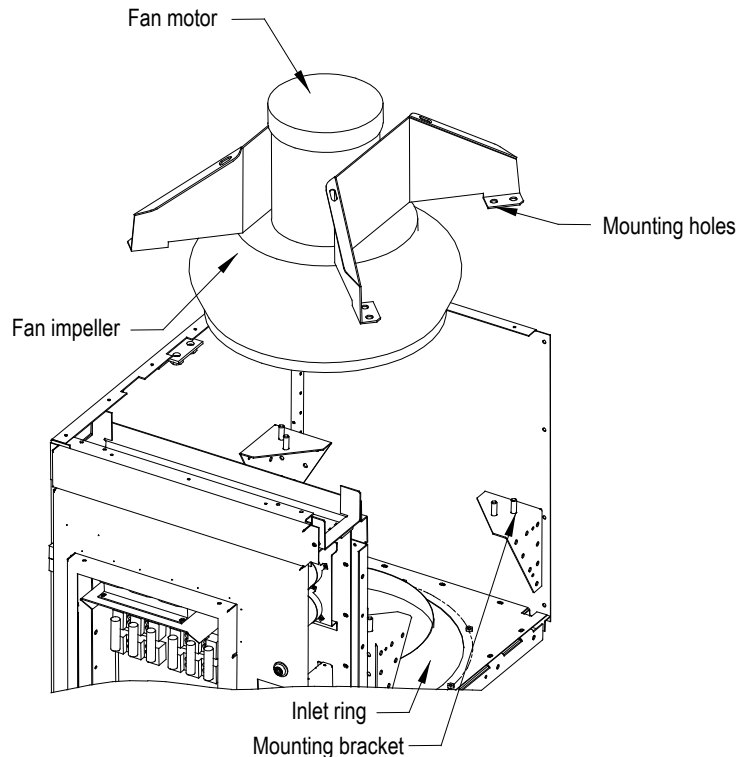


Figure 6.43 – Fan removal

Fan Installation

Care must be taken in handling of the fan as its balance could be affected by poor handling.

Fan installation is performed in the reverse order of its removal. Upon completion of installation, rotate the impeller by hand to ensure that there is no contact with the inlet ring.

Impeller Maintenance

Impeller Removal from Motor Shaft

The fan impeller is held onto the motor shaft with a split tapered bushing. This bushing is positioned on the motor shaft and through the center of the impeller. Two capscrews, when tightened to 10.2 N-m (7.5 ft-lbs.), lock the bushing onto the motor shaft and the impeller to the bushing.

Safety notes

The impeller is fragile. Do not allow the impeller to support the weight of the motor.

If vertical, the impeller and bushing may fall when loosening capscrews. Physical injury or component damage may result.

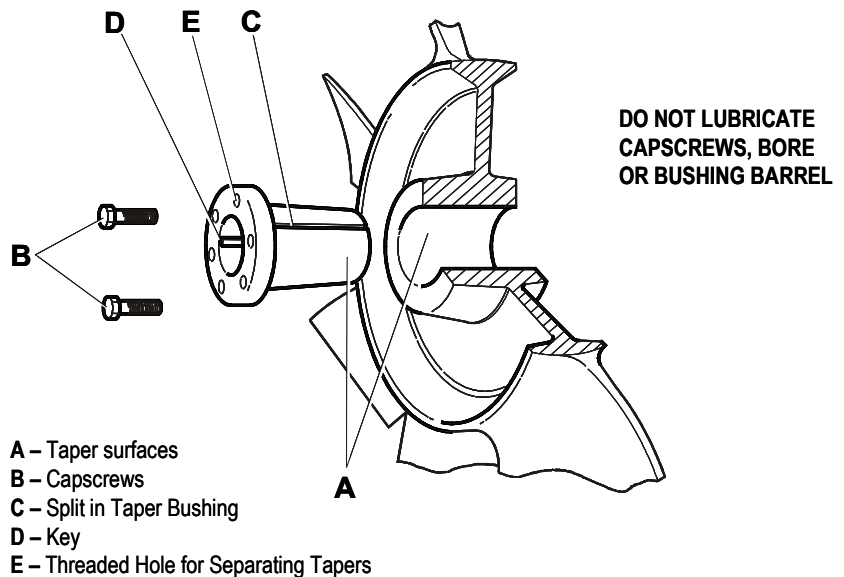


Figure 6.44 – Impeller Removal

Impeller Maintenance (cont.)

1. Record the distance from the end of the motor shaft to the bushing. The new impeller must be installed in the same location. Failure to do so will result in gaps between the impeller and the intake ring resulting in loss of air flow, or rubbing of the impeller against the inlet ring or motor assembly during operation.
2. Remove both capscrews from the bushing. The impeller or bushing may fall as screws are loosened.
3. Thread the capscrews by hand into the two threaded holes in the bushing flange.
4. Tighten each bolt part of a turn successively, to push the impeller off the bushing. Screwing down the capscrews into these holes will force the bushing away from the impeller hub, releasing the compression on the shaft. Be careful that the impeller does not fall as the clamping force is released.
5. Pull the bushing off the shaft and remove the impeller. If the assembly has been in place for some time, it may be necessary to use a wheel puller to remove the bushing. Never use a wheel puller on the impeller.

NOTE: DO NOT LUBRICATE CAPSCREWS, BORE, OR BUSHING BARREL, AS THIS WILL HINDER CLAMPING FORCE OF THE BUSHING ON THE SHAFT AND THE IMPELLER BORE

Installation of Impeller Assembly onto Motor Shaft

The fan impeller is held onto the motor shaft with a split tapered bushing. This bushing is positioned on the motor shaft and through the center of the impeller. Capscrews, when tightened to 10.2 N-m (7.5 ft-lbs.), lock the bushing onto the motor shaft and the impeller to the bushing.

The bushing barrel and the bore of the impeller are tapered which assures concentric mounting and keeps the impeller running evenly. The capscrews, when tightened, lock the bushing in the impeller and over the motor shaft.

The bushing is split down the middle, so that when the locking capscrews force the bushing into the tapered bore in the impeller assembly, the bushing will grip the shaft with a positive clamping fit. The impeller and bushing assembly have keyways that line up with the shaft and are held in place with compression.

To Assemble:

1. Make sure the shaft and keyway are clean and smooth. Clean the shaft and bore with rubbing alcohol or non oily solvent. Check the key size with both the shaft and bushing keyways.
2. Put the capscrews through the clearance holes in the bushing and put the bushing loosely into the impeller, lining up the screws with the threaded holes on the impeller hub. **Do not** press, drive or hammer the bushing into the bore.
3. Start the capscrews by hand, turning them just enough to engage the threads. Do not use a wrench at this time. The bushing should be loose enough in the impeller to move freely.
4. Slide the impeller and bushing assembly onto the motor shaft, ensuring the same distance from the end of the shaft to the bushing as in step 1 of impeller removal.
5. Fit the key into keyway. Do not force impeller and bushing onto shaft. If they do not fit easily, check the shaft, bushing and key sizes.
6. Tighten the capscrews progressively with a wrench. Do this evenly as though mounting an automobile wheel. Turn one a quarter turn, then the next a quarter turn, then go back and turn the other a quarter turn and so on. Torque to 10.2 N-m (7.5 ft-lbs.)
7. Peen the end of the motor shaft at the keyway with a chisel or center punch to prevent the key from falling out of position.

Fan Balance

Fan impellers are statically and dynamically balanced within acceptable tolerances at the factory. Damage in shipping or from poor handling or installation may upset the unit's balance. An impeller that is not properly balanced can lead to excessive vibration causing undue wear on the entire unit.

If vibration is excessive, shut down the fan and determine the cause.

Common causes of excessive vibration:

- Support structure not sufficiently rigid or level. Vibration amplified by resonance in duct work or support structure.
- Bearing locking collar or mounting bolts loose. Impeller or bushing loose.
- Material accumulation on impeller.
- Wheel rubbing on inlet ring.

Inlet Ring Removal and Replacement

The inlet ring is the large circular part located on the underside of a horizontal barrier beneath the fan impeller. It is positioned such that the impeller sits inside but does not touch the ring. The ring sits inside the impeller 10 mm (0.40 inches).

Safety Notes

This procedure will require coming in contact with the internal electrical connectors and devices. **It is EXTREMELY important that ALL POWER BE REMOVED FROM THE DRIVE! Failing to do so may result in serious injury or death.**

Precautions must be taken to prevent the inlet ring from falling after all of the bolts have been removed

Procedure

ATTENTION

To prevent electrical shock, ensure the main power has been disconnected before working within the DC Link and Fan Area. 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.

NOTE: If rear panel access is possible, remove rear middle panel of the DC link / fan portion of the cabinet and remove the inlet ring from the back.

If rear panel access is not possible, follow this procedure:

1. Remove DC Link Barrier and Impeller Access Panel (see Fig. 6.40). Remove electrical components in front of the inlet ring access panel.
2. Remove bolts from the inlet ring being careful not to allow the ring to fall.
3. Remove inlet ring via the bottom access panel by moving it around the DC link and diagonally out the door. Shifting of the DC link may be required.
4. To install the new ring, reverse the above procedure. Rotate the fan impeller by hand to ensure that there is no contact with the inlet ring. Move the ring and retighten bolts to eliminate interference.
5. Replace access panels and electrical components.

Replacement of Air Filters

Air filters are located at the cooling air intake grille mounted on the door in front of the converter, line reactor and transformer cabinets.

It is necessary to periodically remove and clean, or remove and replace the filter material. The frequency with which the filters are renewed depends on the cleanliness of the supplied cooling air.

It is possible to renew the filters while the drive is running, but the procedure is easier to perform while the drive is shut down.

Procedure (see Figure 6.45):

- Using a 5/16" Hex key, loosen the ¼ turn fasteners and swing open the hinged grill assembly.
- Remove filter material.

Note that if the drive is running, the filter must be replaced as soon as possible so that foreign material is not drawn into the drive.

Care must be taken in removing the filter, to prevent dirt that has accumulated on the inlet side of the filter from being sucked into the drive. It may be difficult to remove the filter material without tearing it due to the suction at the air inlet.

Recommended cleaning method of filters:

1. **Vacuum Clean** – A few passes of a vacuum cleaner on the inlet side of the filter will remove accumulated dust and dirt in seconds.
2. **Blow with Compressed Air** – point compressed air nozzle in opposite direction of operating air flow (Blow from exhaust side toward intake side)
3. **Cold Water Rinse** – Under normal conditions the foam media used in the filters, require no oily adhesives. Collected dirt is washed away quickly and easily using just a standard hose nozzle with plain water. **(Ensure filter is completely dry before reinstalling)**
4. **Immersion in Warm Soapy Water** – Where stubborn air-borne dirt is present, the filter may be dipped in a solution of warm water and mild detergent. Then simply rinse in clear clean water, **let stand until completely dry and free of moisture, and return to service.**

Replacement of Air Filters (cont.)

When replacing with a new filter, the filter must be provided by Rockwell Automation or approved for use by Rockwell Automation. Replacement of the filters is performed in the reverse order of its removal. Check that there are no openings that would allow foreign matter to enter the drive.

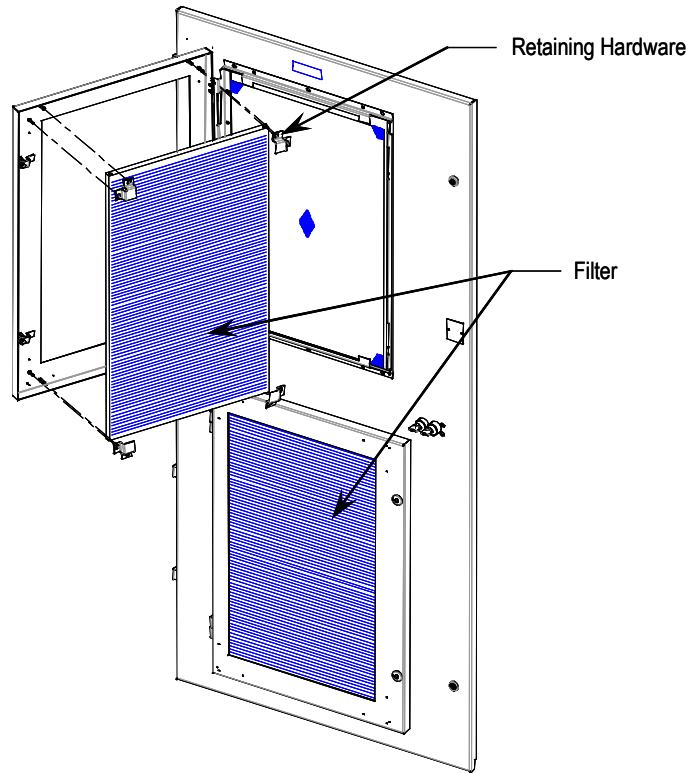


Figure 6.45 – Filter Replacement

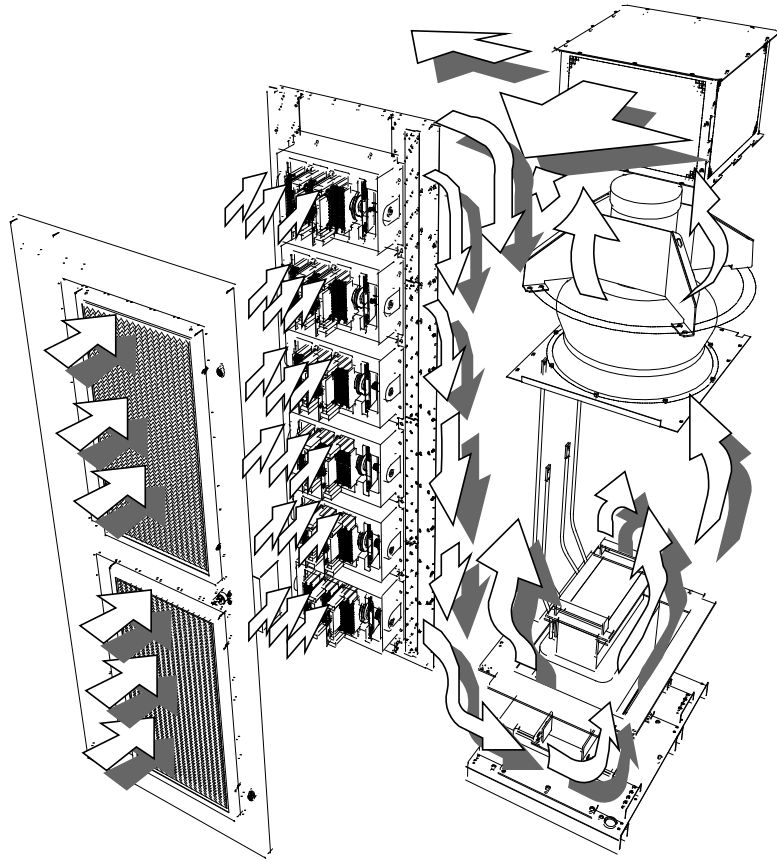


Figure 6.46 – Air Flow Pattern for Snubber Cooling

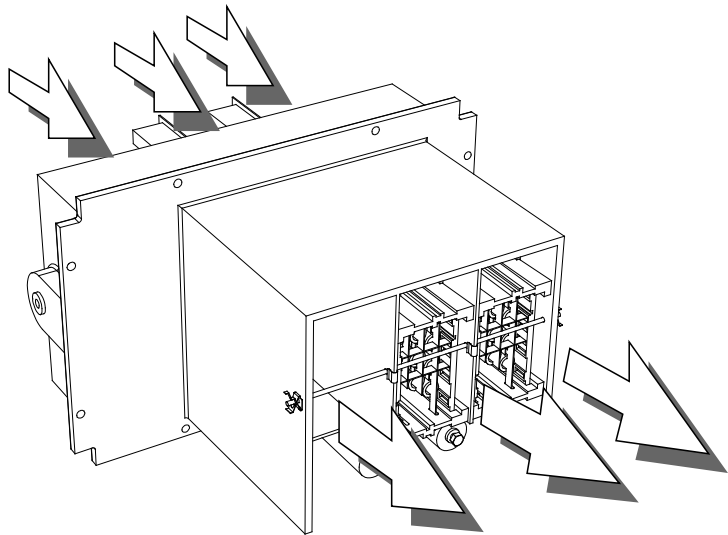


Figure 6.47 – Air flow through PowerCage

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. Standard control with 5 cycle ride-through, or
2. Standard control with extended ride-through capabilities.

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.

Standard controls with extended ride-through capabilities – The drive controls will remain energized for an extended period time greater than 5 cycles after control power is interrupted. The length of time the boards will remain energized is dependent on the capacity of the UPS and power consumption of loads connected to the UPS.

Figure 6.48 illustrates the control design with standard offering and 5 cycle ride-through. The ride-through is provided by the hold-up capacitors on the output of the AC/DC converter. The stored energy in the capacitors is sufficient to maintain 56 V supply to the DC/DC and IGDPS loads for 5 cycles. Other loads such as the printer, PV550, pilot lights, relays, etc. will remain in the same state prior to interruption of control power.

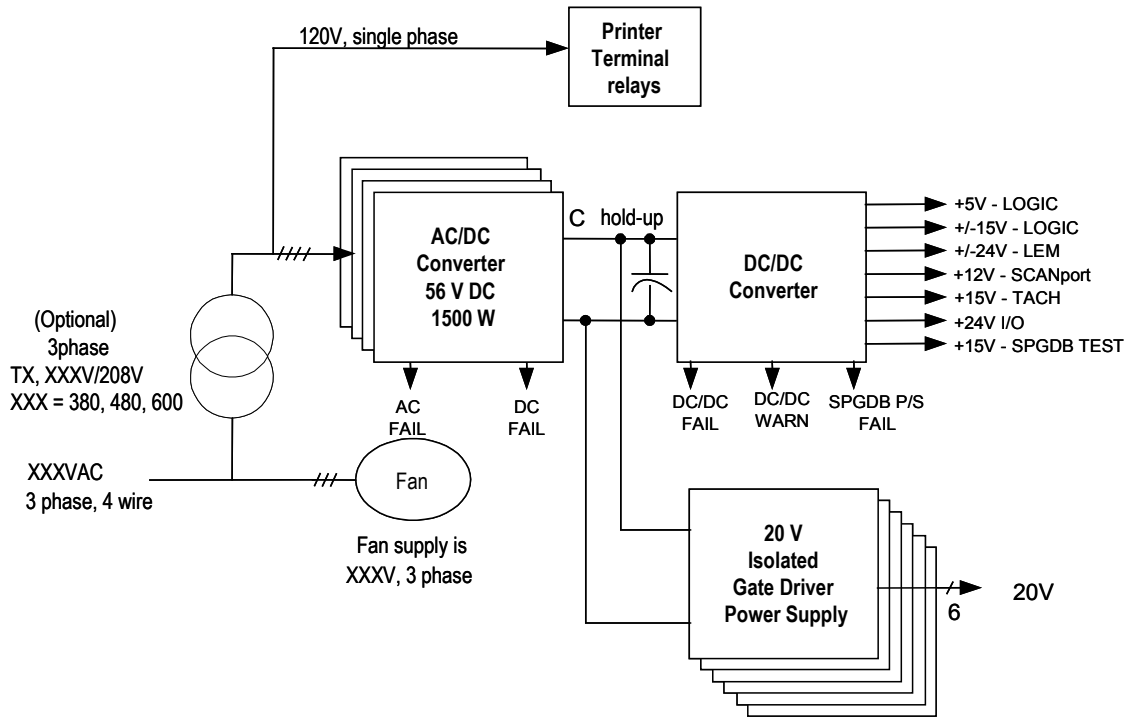


Figure 6.48 – Standard PowerFlex 7000 “B” Frame control power distribution (without UPS option)

Figure 6.49 illustrates the extended ride-through capabilities of the control circuit. An UPS must be installed to provide the energy to supply the AC/DC converter for an extended period of time in case of a loss of control power. It is assumed that if control power is interrupted, the medium voltage will also be interrupted and the drive will not be required to operate the motor until both control and medium voltage is re-applied.

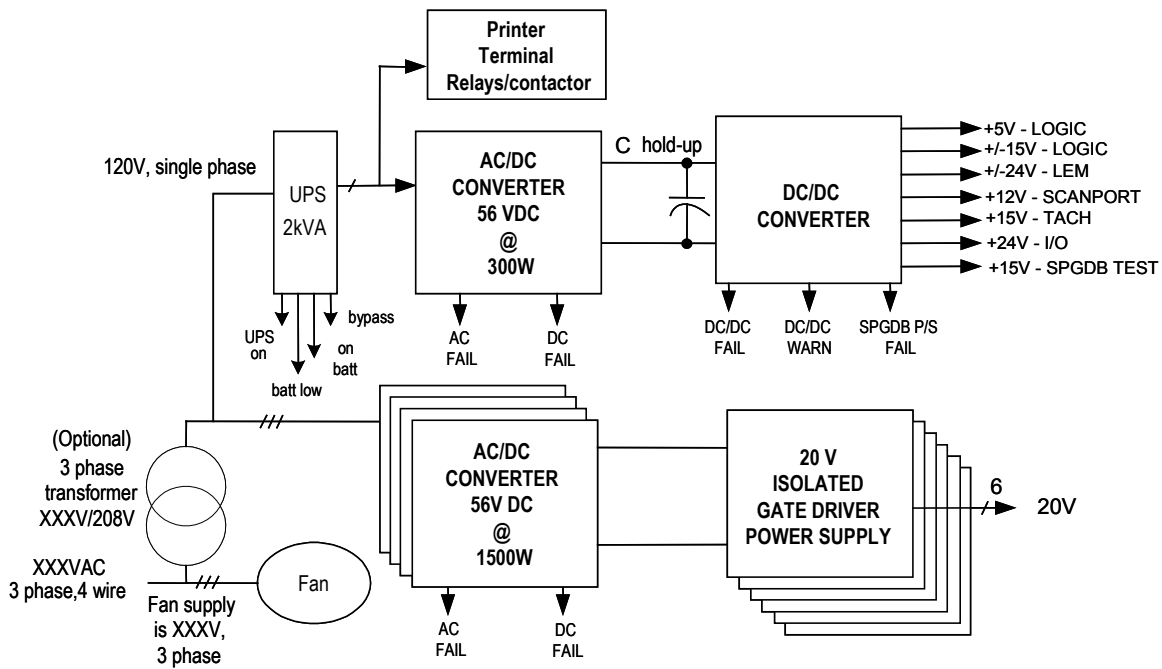


Figure 6.49 – Standard PowerFlex 7000 “B” Frame control power distribution (with UPS option)

To reduce the size of UPS needed, the loads on the AC/DC converters are separated into two distinct loads: the IGDPS boards and the DC/DC power supply.

The IGDPS load is only needed when the drive is in the normal operating mode and running the motor. During interruption of control and medium voltage, the IGDPS load demand on the AC/DC will be not be required. Only the DC/DC will remain energized for an extended period of time after loss of control power. The DC/DC converter will power the main control boards and keeps them fully functional.

AC/DC Power Supply

Each AC/DC converter is rated for 1500W at 50°C and 1525 m (5000 feet). Above these two limits, de-rating factors are used to reduce the capacity of the converter. The converter must always have a minimum 20% margin; that is, its power output must not exceed 80% of its maximum rating. 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. These factors are used in determining the quantity of AC/DC converters needed per drive.

If more than one module is needed, the modules are connected in parallel and operate in a current sharing mode. In parallel operation, there will be just one AC Fail signal, and each module DC Fail signal will be individually monitored.

Description

The AC/DC power supply accepts 3 \emptyset voltage and produces a regulated 56Vdc 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.

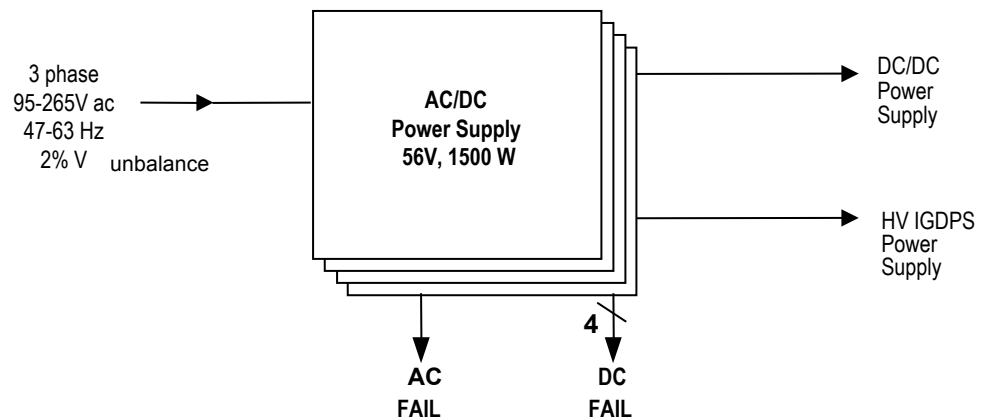


Figure 6.50 – AC/DC converter power supply

AC FAIL: Upon loss of AC line (V input ≤ 90 VAC), this open collector output goes from low to high before loss of output regulation.

DC FAIL: Upon loss of DC output ($50.4\text{VDC} \leq V$ output ≤ 53.8 VDC, -7% , $\pm 3\%$) this output goes from low to high.

AC/DC Power Supply (cont.) Location

The AC/DC power supply is located on the low voltage incoming compartment. A typical low voltage compartment is shown in Figure 6.51.

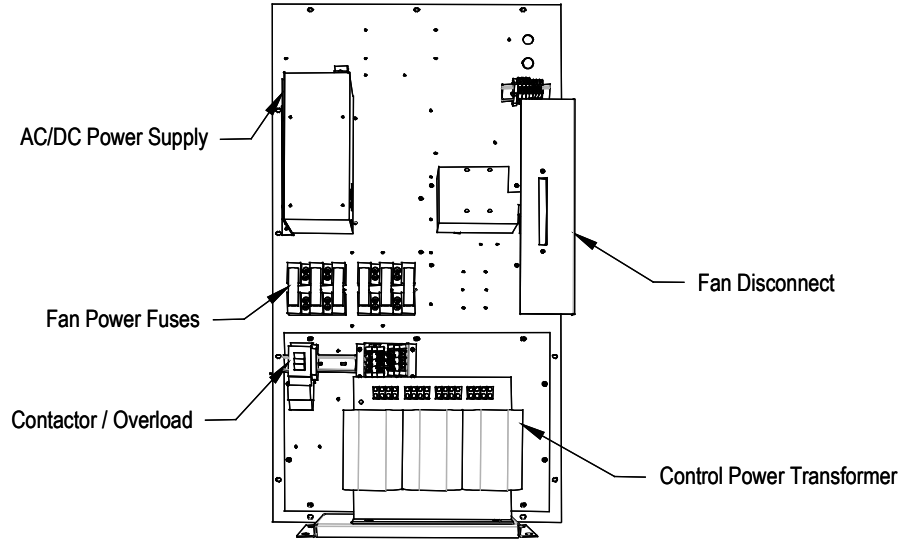


Figure 6.51 – Location of AC/DC power supply on low voltage panel

Terminal / Connections descriptions

The terminal connections are shown in Figure 6.52.

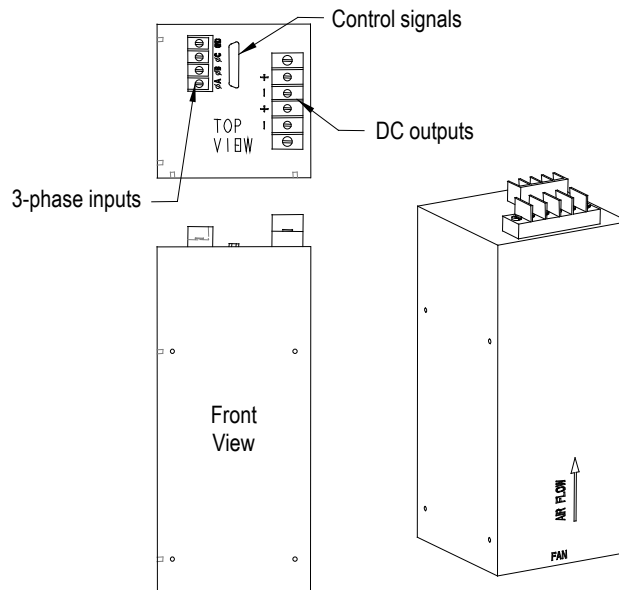


Figure 6.52 – Terminal locations on AC/DC power supply

<u>P1-AC input</u>	PIN#	LABEL
	1	EARTH
	2	LINE 1
	3	LINE 2
	4	LINE 3
<u>P2-DC output</u>	PIN#	LABEL
	1	+56V
	2	+56V COMM
	3	+56V
	4	+56V COMM
<u>P3-FAIL output</u>	PIN#	LABEL
	3	DC POWER FAIL (OUTPUT POWER GOOD)
	14	AC/DC FAIL COMM (LOGIC RETURN)
	15	CURRENT SHARING
	16	AC POWER FAIL (POWER FAIL)

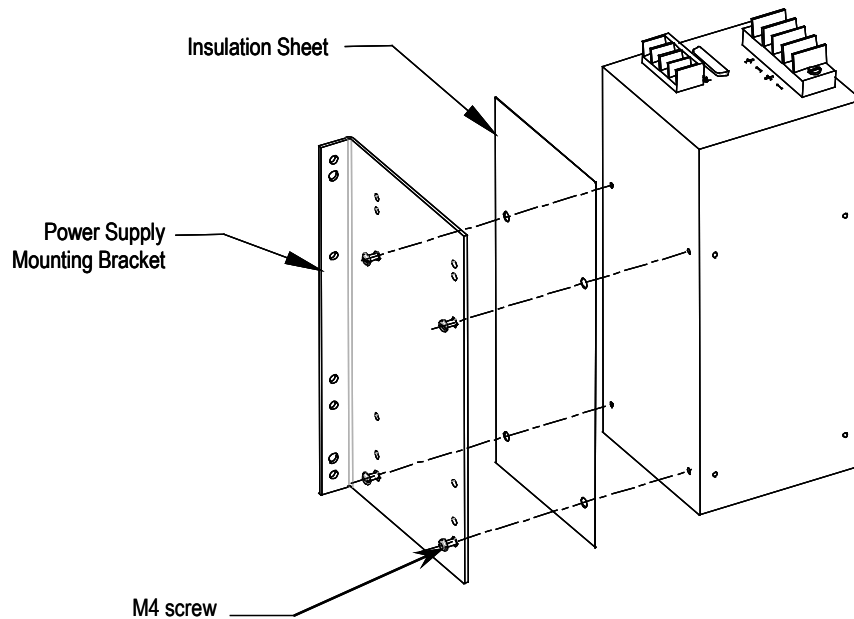
Ensure the output of the supply is 56V DC.

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 parallel 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, re-connect the power supply to the circuit and re-measure the output. Adjust if necessary.

If it is not possible to maintain 56 V DC, the power supply may be faulty.

AC/DC Power Supply (cont.) Replacement procedure

1. Ensure 3-phase control power has been isolated and locked out.
2. Disconnect the terminals at the top of the unit.
3. Remove the two M6 bolts per Figure 6.53.
4. Extract the power supply complete with left-side mounting bracket from the drive.
5. Remove the mounting bracket from the failed power supply (four M4 screws). Retain the insulation sheet.
6. Attach mounting bracket to replacement power supply. Ensure that the insulating sheet between the bracket and power supply is installed.
7. Install new power supply in drive; install M6 bolts.
8. Re-connect terminals at the top of the unit.
9. Reapply control power and verify voltage levels.

**Figure 6.53 – Replacement of AC/DC Power Supply**

UPS Option

The PowerFlex 7000 'B' 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:

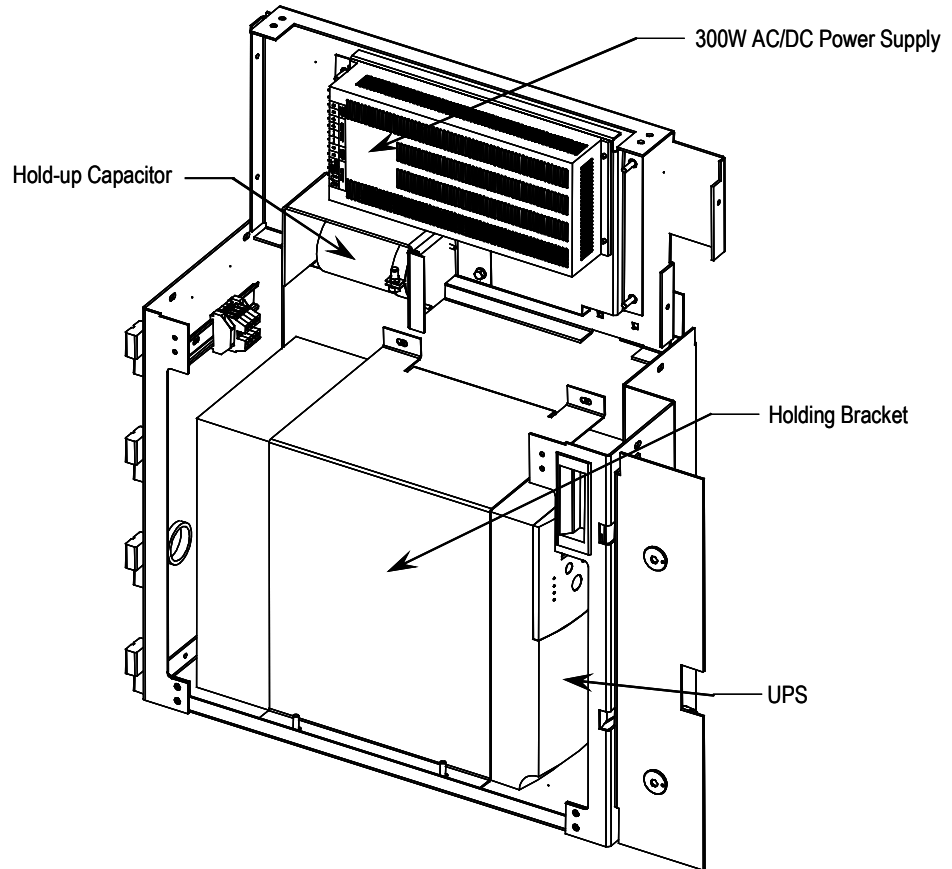


Figure 6.54 – 300W AC/DC Power Supply

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 programmed 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 also has AC and DC fail signals that are fed back to the Customer Interface Board for processing.

There is also a hold-up capacitor on the output of the 300W AC/DC Power Supply to keep the 56VDC up in the event of a failure of the power supply.

UPS Replacement Procedure

1. Ensure 3-Phase 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 25 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.

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

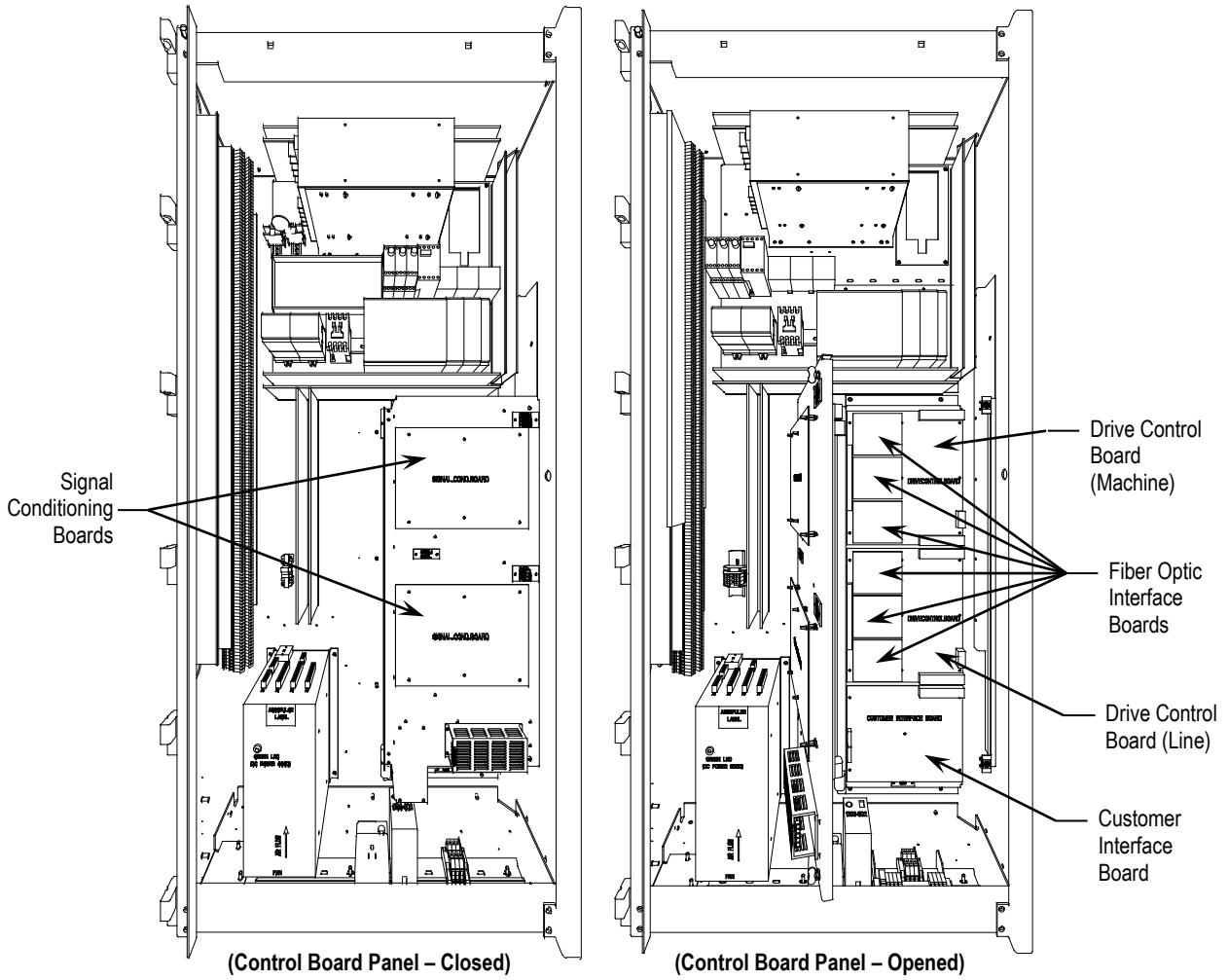


Figure 6.55 – Low Voltage Tub Compartment

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.

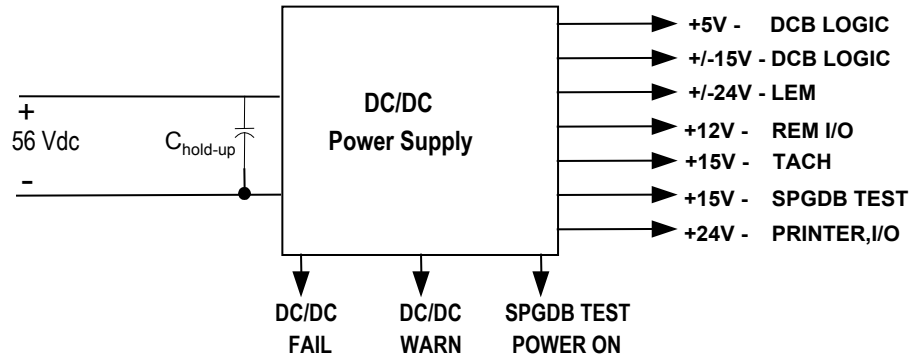


Figure 6.56 – DC/DC converter power supply

The capacitor at the input terminals is for power dip ride-through purposes. Upon loss of the 56V input, the capacitors ($C_{\text{hold-up}}$) will maintain the voltage level.

Due to the critical nature of the DCB Logic power source, the DC/DC power supply has been designed to provide redundancy for these voltages. Each of the DCB Logic outputs is supplied internally with two separate sources of power. In the event of one failing, the other power supply will be automatically switched in to provide the output power.

DC FAIL – Each output to be internally monitored with a single output fail. This output goes from low to high when any of the non-redundant outputs fail or both of the redundant outputs of one particular voltage fails (output voltage is < 95%).

DC WARNING – Each redundant output to be internally monitored with a single output warning. This output goes from low to high before loss of output regulation of any one of the redundant outputs (output voltage is < 95%).

SPGDB TEST POWER ON – The +15V output on COM4 will have its load current monitored. This open collector output goes from low to high when the load current exceeds 20 mA. The purpose of this signal is to inform the user that the test harness for the SCRs is still attached to the DC/DC converter.

LEDs

Green operational LED on front of unit detects DC FAIL output.

- LED ON: outputs good
- LED OFF: outputs bad

Terminal/connections descriptions

<u>P1-DC input</u>	PIN#	LABEL	DESCRIPTION ONLY
	1	+56V	+56V input
	2	+56V COMM	+56V common
	3	EARTH	earth ground
<u>P2-CONTROL</u>	PIN#	LABEL	DESCRIPTION ONLY
	1	XIO_PWR (+24V,3A)	+24V,3A/com5
	2	XIOCOMM (com5)	0V/com5
<u>P3-SPGDB</u>	PIN#	LABEL	DESCRIPTION ONLY
	1	SPGDBPWR (+15V,1A)	+15V,1A/com4
	2	SPGDBPWR (+15V,1A)	+15V,1A/com4
	3	SPGDBCOMM (com4)	0V/com4
	4	SPGDBCOMM (com4)	0V/com4
<u>P4-CIB</u>	PIN#	LABEL	
	1	DC FAIL	
	2	DC WARNING	
	3	SPGDBFAIL	
	4	DC/DCFAILCOMM	
	5	EARTH	
<u>P5-SCBL</u>	PIN#	LABEL	DESCRIPTION ONLY
	1	+LEMPWR (+24V,1A)	+24V,1A/com2
	2	LCOMM (com2)	0V/com2
	3	-LEMPWR (-24V,1A)	-24V,1A/com2
	4	+15V_PWR (+15V,1A)	+15V,1A/com1
	5	ACOMM (com1)	0V/com1
	6	-15V_PWR (-15V,1A)	-15V,1A/com1
	7	+5V_PWR (+5V,10A)	+5V,10A/com1
	8	DGND (com1)	0V/com1
	9	+15V_ENC (+15V,1A)	+15V,1A/com3
	10	ENC_COMM (com3)	0V/com3
	11	DGND (com1)	0V/com1

<u>P6-SCBM</u>	PIN#	LABEL	DESCRIPTION ONLY
	1	+LEMPWR (+24V,1A)	+24V,1A/com2
	2	LCOMM (com2)	0V/com2
	3	-LEMPWR (-24V,1A)	-24V,1A/com2
	4	+15V_PWR (+15V,1A)	+15V,1A/com1
	5	ACOMM (com1)	0V/com1
	6	-15V_PWR (-15V,1A)	-15V,1A/com1
	7	+5V_PWR (+5V,10A)	+5V,10A/com1
	8	DGND (com1)	0V/com1
	9	+15V_ENC (+15V,1A)	+15V,1A/com3
	10	ENC_COMM (com3)	0V/com3
	11	DGND (com1)	0V/com1

<u>P7-CIB</u>	PIN#	LABEL	DESCRIPTION ONLY
	1	XIO_PWR (+24V,3A)	+24V,3A/com5
	2	XIOCOMM (com5)	0V/com5
	3	+15V_PWR (+15V,1A)	+15V,1A/com1
	4	ACOMM (com1)	0V/com1
	5	-15V_PWR (-15V,1A)	-15V,1A/com1
	6	+5V_PWR (+5V,10A)	+5V,10A/com1
	7	DGND (com1)	0V/com1
	8	+SCNPWR (+12V,1A)	+12V,1A/com1
	9	SCNCOMM (com1)	0V/com1
	10	DGND (com1)	0V/com1

Replacement Procedure for DC/DC Power Supply

1. With the drive energized, check to see if the indicator light is ON or OFF. If it is OFF, replacement is necessary. (View 1)
2. De-energize the drive, isolate and lock out the 3-phase control power, and remove all wire connections from the top of 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)

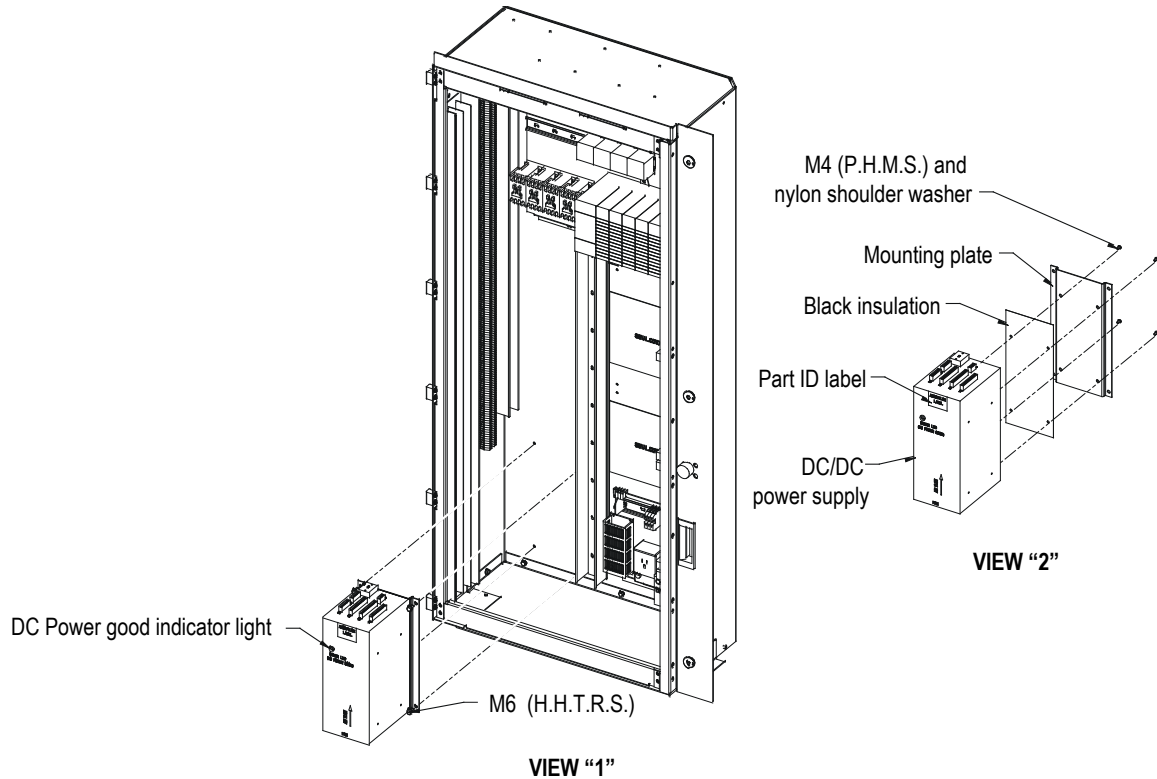


Figure 6.57 – Replacement of DC/DC power supply

Printed Circuit Board Replacement

The replacement of printed circuit boards should be handled in a careful and deliberate 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 on 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.

Drive Control Boards

There are two Drive Control Boards (DCBs) in the Low Voltage Control Section. There is one board to control the Rectifier or Line-Side devices (DCB-L) and one board to control the Inverter or Machine-Side devices (DCB-M). These boards in their unprogrammed state are the same and are interchangeable. The DCB-M is the top board. The DCB-L is the middle board, directly connected to the Customer Interface Board (CIB).

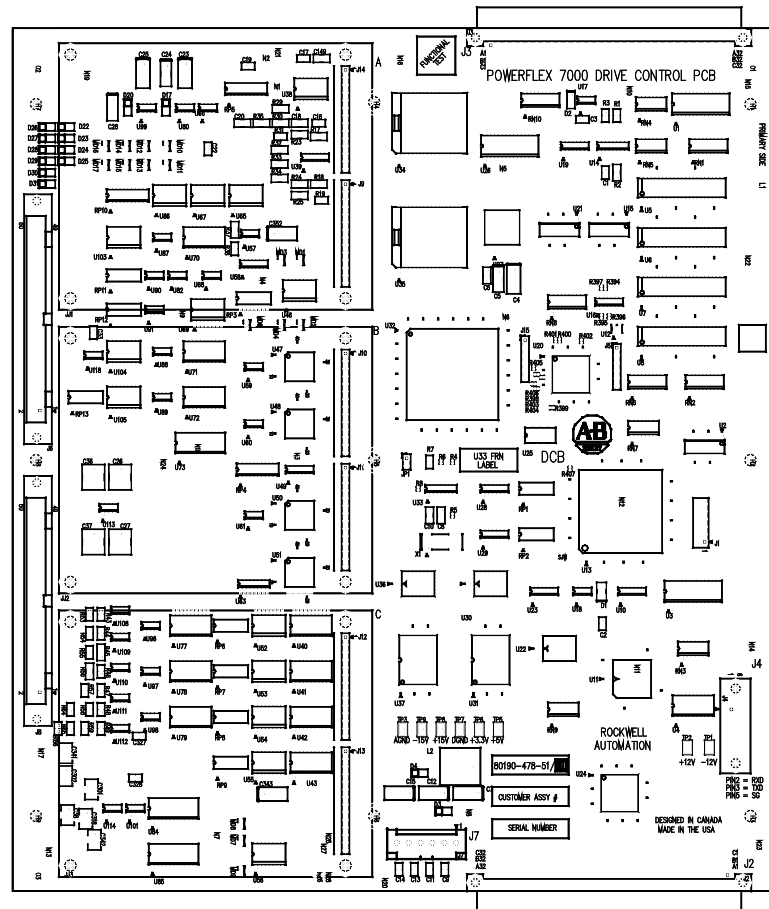


Figure 6.58 – DCB Board

These boards are responsible for all of the drive control processing and store all of the parameters used for the drive control. They are programmed at the same time that the CIB is programmed, through a null-modem cable and the CIB (J8) port.

There is a Status LED on the DCB, labeled D1. The following Table illustrates the states of the LED. Except where specific boards are mentioned in the Condition description, this table is applicable to all Circuit Boards in the Control Section.

LED STATUS	CONDITION
Solid Green	Application Firmware Running
Flashing Green @ 0.25 Hz	Download Mode
Flashing Green @ 0.50 Hz	Download Mode – Currently being Programmed
Flashing Green @ 1.0 Hz	Ready
Flashing Green @ 2.0 Hz	Testing Flash Memory
1 Green Pulse	Waiting for Release upon Startup
2 Green Pulses	DCB-L – Waiting for DCB-M Status
3 Green Pulses	DCB-L – Waiting for CIB Status
10 Green Pulses	Tests Passed
Off	DCB in Test Mode
Solid Red	POST Failure – DSP
Flashing Red @ 0.25 Hz	Waiting for CIB
Flashing Red @ 0.50 Hz	Waiting for DCB
Flashing Red @ 1.0 Hz	Waiting for Adjacent Board
2 Red Pulses	POST failure - RAM
3 Red Pulses	POST failure – NVRAM
4 Red Pulses	POST failure – DPRAM
5 Red Pulses	POST failure – Application Flash
6 Red Pulses	POST failure – Text Flash
7 Red Pulses	POST failure – External DPRAM
8 Red Pulses	Failed FPGA Loading
9 Red Pulses	POST failure – USART – 1 Green Flash = Port 1 POST failure – USART – 2 Green Flashes = Port 2
10 Red Pulses	Returned from Application and Halted
11 Red Pulses	Programming Error - CRC
12 Red Pulses	Programming Error – Connection
13 Red Pulses	Programming Error – Feedback
14 Red Pulses	Programming Error – Overflow

There is also a healthy LED labeled D2 on each DCB. This LED is an indication of several things, including a healthy watchdog between the adjacent board, and healthy DC voltages. The light will go out if either of the DC voltages (except the 5V) drops too low, or if the watchdog is absent for 10 consecutive samples. The watchdog is annunciated every 1 ms. The DCB OK contact on the SCB operates in parallel to the D2 LED. When D2 is on, DCB OK is closed.

Drive Control Boards (cont.) Drive Control Board Replacement

Before replacing the DCB-L or the DCB-M, 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, Drive Executive 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.

The DCB-L, DCB-M, and CIB are all connected together using solid plug connections. This means that the best way to change any of the boards without physically stressing the connections and boards is to remove all 3 from the drive and change the board externally.

Instructions to replace the Drive Control Boards

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. Loosen the two metal tabs on the top and bottom right of the panel on which the SCB-L and SCB-M are mounted. The panel is hinged on the right side, and should swing open to allow access to the DCB-L, DCB-M and CIB boards. There is no need to remove any connections from the SCB.
4. Note and mark the location and orientation of all the ribbon cables, plugs and connectors into the DCB-L, DCB-M and CIB. Use the electrical drawing as a reference.
5. Using your static strap, disconnect the fiber optic cables from the sheet metal by cutting the tie-wraps. The purpose is to create enough slack to allow the FOI Boards to be moved slightly out of the way, allowing access to remove the boards. Use great care when handling Fiber Optics, as any damage can affect transmission capabilities.

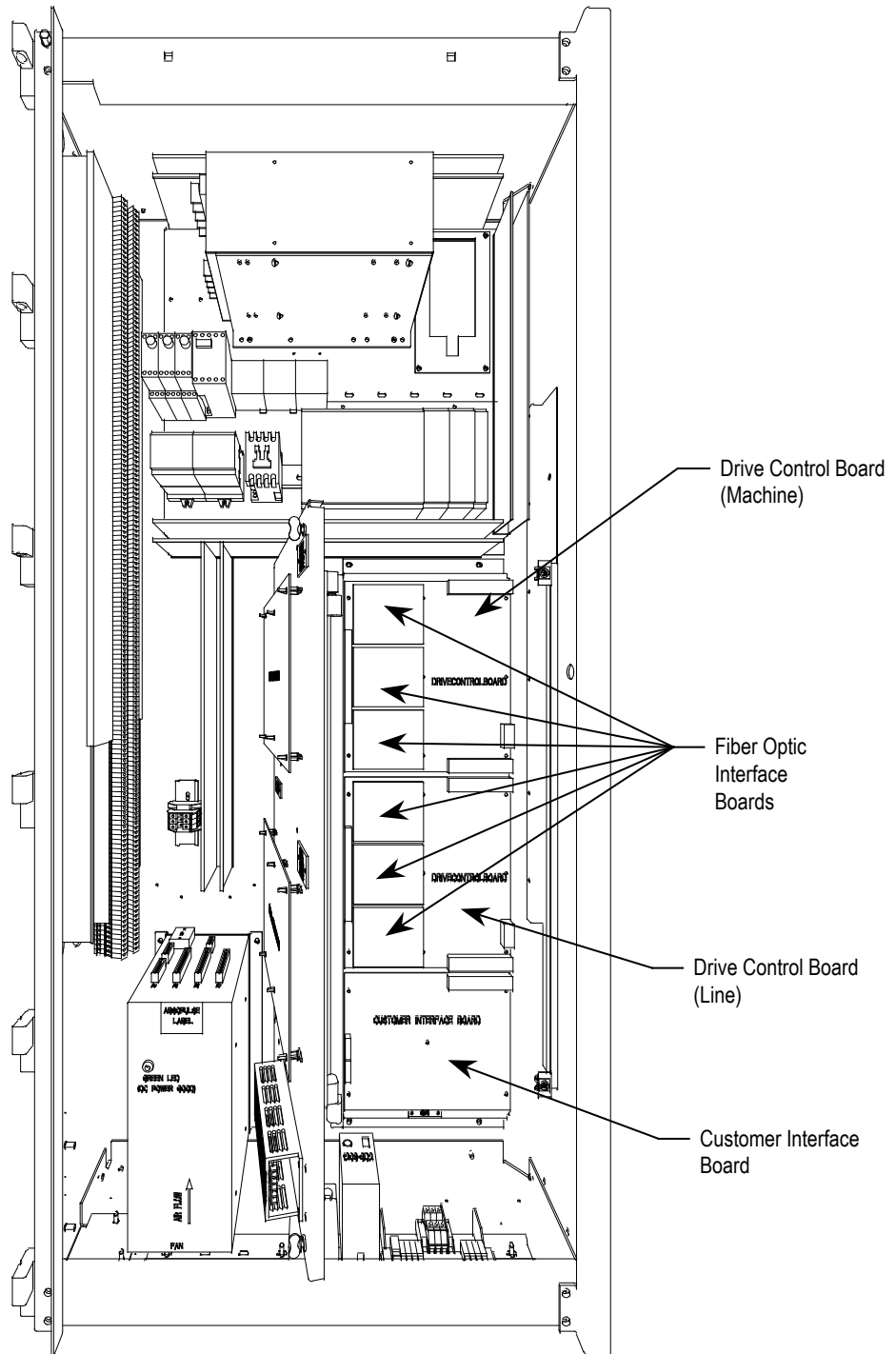


Figure 6.59 – DCB/CIB Board Replacement (Mounting Plate Accessible)

Drive Control Boards (cont.)

6. Remove the Fiber Optic Interface (FOI) Boards from the DCBs. There are standoffs and pins from the DCB that slide into the FOI boards, but they are physically attached only using the standoff connectors, and you have to be firm, but CAREFUL, in freeing the FOI boards.
7. There are numerous plastic clips holding all 3 boards to the plate. Loosen the connectors and remove all 3 boards as one unit. If you need to place the boards on a surface, ensure you have a static pad to protect the boards.
8. Separate the boards and replace the damaged DCB with the new part. Verify the part number is the same, and note the revision letters.
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 DCBs 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'.
11. Program the drive. Refer to Technical Data "Medium Voltage AC Drive Parameters" – Publication **7000-TD001_-EN-P**. The parameters should also be saved to NVRAM and then externally to the drive using the options described earlier in this section.

Analog Inputs and Outputs

The PowerFlex 7000 “B” Frame offers one isolated process current loop transmitter and one isolated process current loop receiver, embedded into the control. These are accessible on the CIB.

Each of these can be configured independently as either 0-20mA or 4-20mA. (Refer to Programming Manual).

The following information will show the connections for each.

Current Loop Transmitter

The current loop transmitter will transmit either 0-20mA or 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 transmitter can drive a receiver with an input resistance up to 625 ohms. The figure below shows a block diagram of the transmitter.

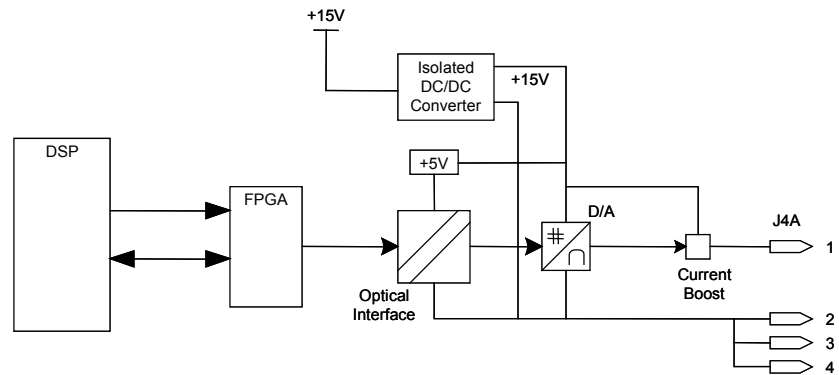


Figure 6.61 – Process Loop Transmitter Block Diagram

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 1 (+ connection) and either pins 2, 3, 4 (- connection).

The recommended connection is shown below. 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.

**Customer Interface Board
(cont.)**

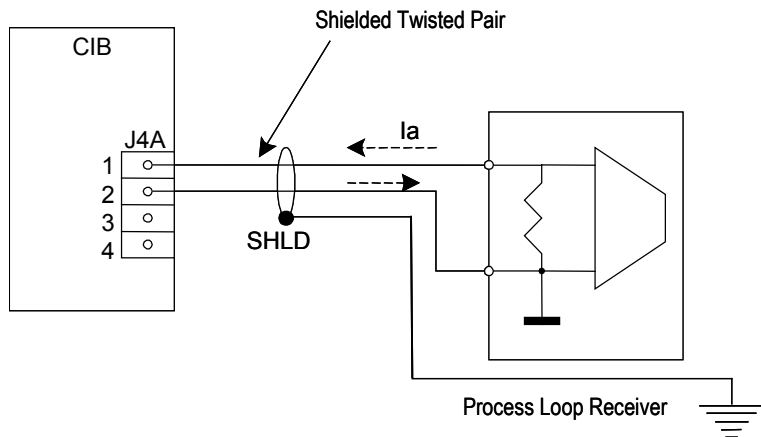


Figure 6.62 – Recommended Connection to CIB Transmitter

Current Loop Receiver

The receiver can accept either 0-20mA or 4-20mA inputs from an external transmitter. The transmitter must have a minimum loop compliance of 5V to satisfy the input impedance of 250 ohms.

A block diagram of the receiver is shown below.

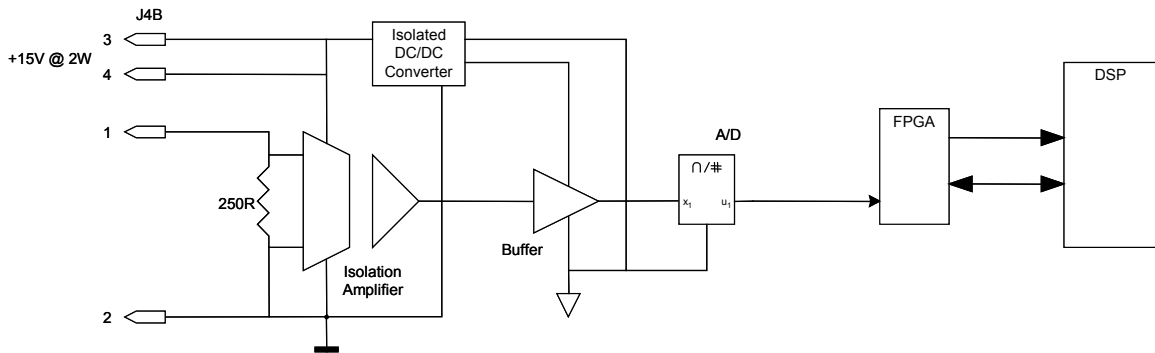


Figure 6.63 – Process Loop Receiver Block Diagram

The receiver can accept either 2-wire or 4-wire transmitters, and therefore the connections to this port are dependent on the type of external transmitter used. The figure below shows the recommended connections. Again, the type of shielded cable used is application specific as per the transmitter.

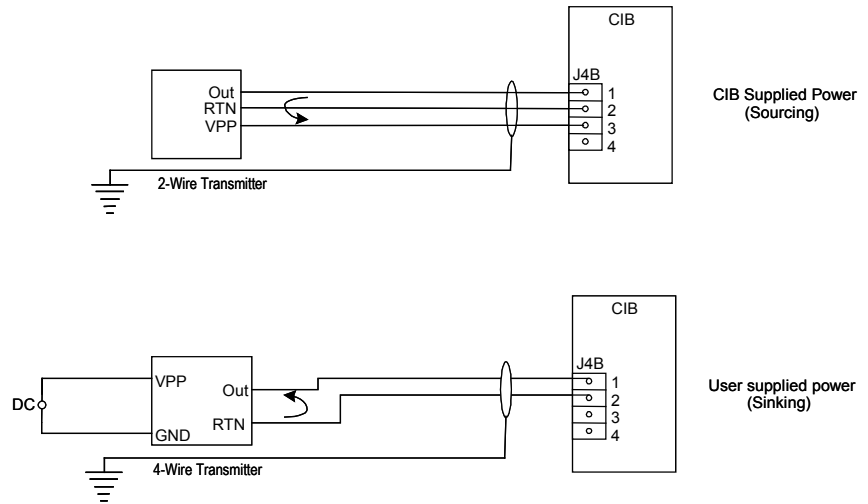


Figure 6.64 – Process Loop Receiver Connections

LEDs

There are 5 LEDs on the CIB, labeled D1 to D5. They are designated as follows:

LED	Designation	Description
D1	OBP1	This LED is similar in function to D1 on the DCB. It is the On-Board Programming LED, and the DCB table should be used to evaluate the status of the LED
D2	MOD A	SCANport Communication Status LED <ul style="list-style-type: none"> - Flashing Red – All valid adapters are Lost - Flashing Red/Green – At least one, but not all, of the valid adapters are lost - Green – All valid adapters are OK - Off – No adapters are connected or active
D3	MOD B	DPI Communication Status LED <ul style="list-style-type: none"> - Flashing Red – All valid adapters are Lost - Flashing Red/Green – At least one, but not all, of the valid adapters are lost - Green – All valid adapters are OK - Off – No adapters are connected or active
D4	XIO LINK	XIO Link Status LED <ul style="list-style-type: none"> - Solid Green – XIO #1 has been configured and detected - Off – XIO #1 either is not configured or not detected
D5	HEALTHY	The healthy LED will be green as long as all control voltages on the CIB are OK, and the CIB Watchdog is operating correctly

Customer Interface Board (cont.)

Customer Interface Board Replacement

The DCB-L, DCB-M, and CIB are all connected together using solid plug connections. This means that the best way to change any of the boards without physically stressing the connections and boards is to remove all 3 from the drive and change the board externally.

Instructions to replace the Customer Interface Board

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. Loosen the two metal tabs on the top and bottom right of the panel on which the SCB-L and SCB-M are mounted. The panel is hinged on the right side, and should swing open to allow access to the DCB-L, DCB-M and CIB boards. There is no need to remove any connections from the SCB.
4. Note and mark the location and orientation of all the ribbon cables, plugs and connectors into the DCB-L, DCB-M and CIB. Use the electrical drawing as a reference.
5. Using your static strap, disconnect the fiber optic cables from the sheet metal by cutting the tie-wraps. The purpose is to create enough slack to allow the FOI Boards to be moved slightly out of the way, allowing access to remove the boards. Use great care when handling Fiber Optics, as any damage can affect transmission capabilities.
6. Remove the Fiber Optic Interface (FOI) Boards from the DCBs. There are standoffs and pins from the DCB that slide into the FOI boards, but they are physically attached only using the standoff connectors, and you have to be firm, but CAREFUL, in freeing the FOI boards.
7. There are numerous plastic clips holding all 3 boards to the plate. Loosen the connectors and remove all 3 boards as one unit. If you need to place the boards on a surface, ensure you have a static pad to protect the boards.
8. Separate the boards and replace the damaged CIB with the new part. Verify the part number is the same, and note the revision letters.
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 CIBs 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’.
11. Program the drive. Refer to Technical Data “Medium Voltage AC Drive Parameters” – publication 7000-TD001_-EN-P. The parameters should also be saved to NVRAM and then externally to the drive using the options described earlier in this section.

Signal Conditioning Boards

The Signal Conditioning Boards (SCB) receive 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, and contactor control and status feedback. All of the test points for the currents, system voltages, control voltages, and flux are on these boards.

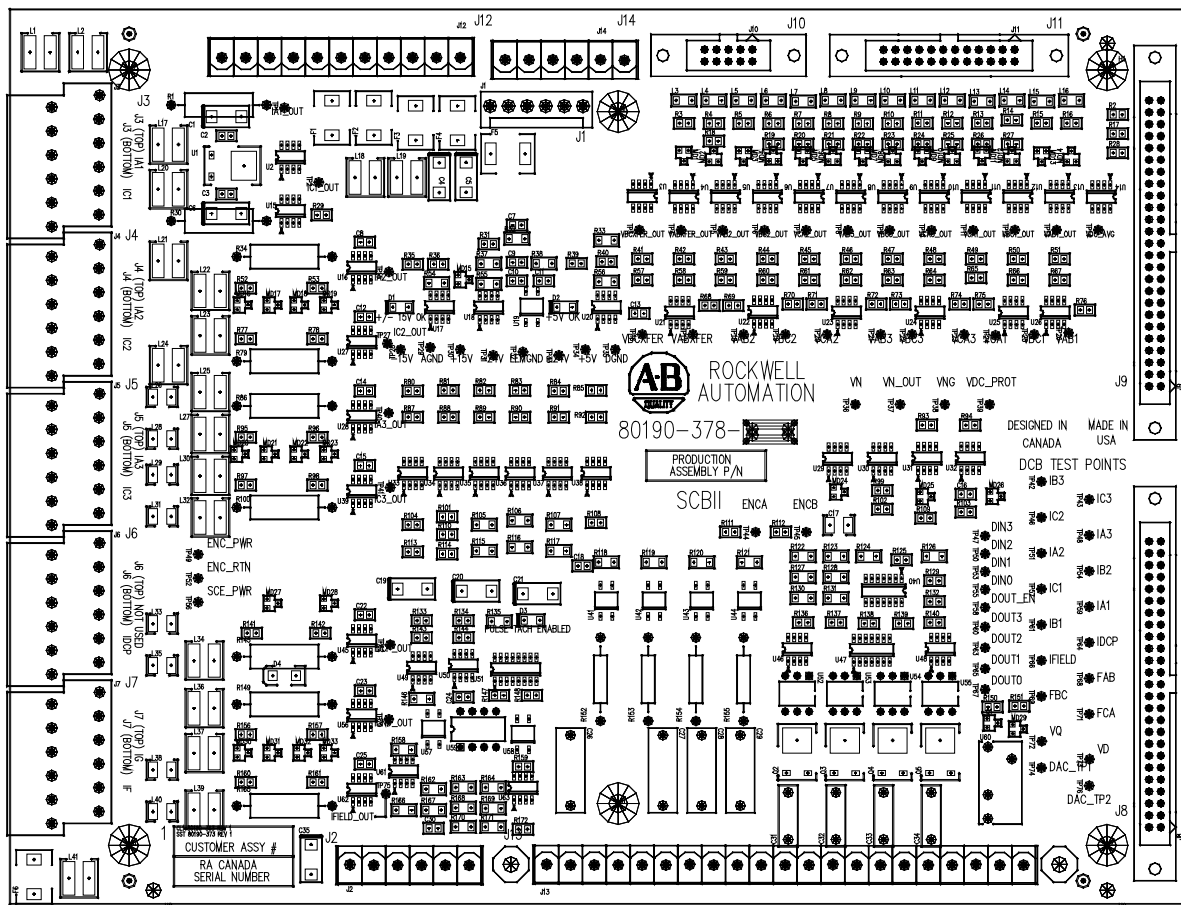


Figure 6.65 – SCB Board

Customer Interface Board (cont.)

The following table illustrates the most commonly used test points.

New SCB Board (80190-378-xx)		Old SCB Board (80190-278-xx)		Description
TP #	Label	TP #	Label	
3	VBCXFR_OUT	1	VBCXFR_OUT	Voltage BC on Line Side of Bypass Contactor, unfiltered
4	VABXFR_OUT	2	VABXFR_OUT	Voltage AB on Line Side of Bypass contactor, unfiltered
5	VAB2_OUT	3	VAB2_OUT	Voltage AB on Slave 1 input winding, unfiltered
6	VBC2_OUT	4	VBC2_OUT	Voltage BC on Slave 1 input winding, unfiltered
7	VCA2_OUT	5	VCA2_OUT	Voltage CA on Slave 1 input winding, unfiltered
8	VAB3_OUT	6	VAB3_OUT	Voltage AB on Slave 2 input winding, unfiltered
9	VBC3_OUT	7	VBC3_OUT	Voltage BC on Slave 2 input winding, unfiltered
10	VCA3_OUT	8	VCA3_OUT	Voltage CA on Slave 2 input winding, unfiltered
11	VAB1_OUT	9	VAB1_OUT	Voltage AB on Master input winding (SCBL) or Motor (SCMB), unfiltered
12	VBC1_OUT	10	VBC1_OUT	Voltage BC on Master input winding (SCBL) or Motor (SCBM), unfiltered
13	VCA1_OUT	11	VCA1_OUT	Voltage CA on Master input winding (SCBL) or Motor (SCBM), unfiltered
14	VDC_AVG	12	VDC_AVG	DC Link Average Voltage across Inverter Side (SCBL only), calculated
28	-15V	24	-15V	-15V DC Analog Power
29	AGND	25	AGND	Analog Power Common
30	+15V	26	+15V	+15V DC Analog Power
31	-24V	27	-24V	-24V DC Hall-Effect Transducer Power
32	LEMGND	28	LEMGND	Hall-Effect Transducer Power Common
33	+24V	29	+24V	+24V DC Hall-Effect Transducer Power
34	+5V	30	+5V	+5V DC Digital Power
35	DGND	31	DGND	Digital Power Common
36	VN	32	VN	Voltage from Filter Capacitor Neutral Point, unfiltered
38	VNG	35	VNG	Converter Neutral-Ground Voltage, calculated
64	IDCP	42	IDCP	DC Link Current Feedback, filtered
66	IFIELD	45	IFIELD	Synchronous Motor Field Current Feedback, filtered
74	DAC_TP1	76	DAC_TP1	Assignable Test Point (Rect_TP1 [SCBL] or INV_TP1 [SCMB] parameters)
75	DAC_TP1	77	DAC_TP1	Assignable Test Point (Rect_TP2 [SCBL] or INV_TP2 [SCMB] parameters)
1	IA1_OUT	N/A	Across R17	Current Phase A, Master Bridge, unfiltered ⊃
2	IC1_OUT	N/A	Across R29	Current Phase C, Master Bridge, unfiltered ⊃
15	IA2_OUT	N/A	Across R33	Current Phase A, Slave 1 Bridge, unfiltered ⊃
27	IC2_OUT	N/A	Across R66	Current Phase C, Slave 1 Bridge, unfiltered ⊃
40	IA3_OUT	N/A	Across R75	Current Phase A, Slave 2 Bridge (SCBL) or Motor (SCBM), unfiltered ⊃
41	IC3_OUT	N/A	Across R89	Current Phase C, Slave 2 Bridge (SCBL) or Motor (SCBM), unfiltered ⊃
62	IDCP_OUT	N/A	Across R138	DC Link Feedback Current (SCBL), unfiltered
70	IGND_OUT	N/A	Across R140	Zero Sequence Feedback Current (SCBL), unfiltered
75	IFIELD_OUT	N/A	Across R156	Field Current Feedback (SCBL), unfiltered
67	DOUT0	63	DOUT0	Digital Output command for DI Contactor (SCBL) or Bypass Contactor (SCBM)
65	DOUT1	62	DOUT1	Digital Output Command for Bypass Enable (SCBM)
60	DOUT3	69	DOUT3	Digital Output Command for DO Contactor (SCBL) or OP Contactor (SCBM)
55	DIN0	N/A		Digital Input Status for DI Contactor (SCBL) or Bypass Ctr (SCBM)
53	DIN1	N/A		Digital Input Status for DI Isolation Switch (SCBL) or Bypass Isol. Sw. (SCBM)
50	DIN2	N/A		Digital Input Status for OP Contactor (SCBL) or OP Contactor (SCBM)
47	DIN3	N/A		Digital Input Status for OP Isolation Switch (SCBL) or OP Isol. Sw. (SCBM)
44	ENCA	N/A		Pulse Train from the Input of the Encoder Signal, Channel A
45	ENCB	N/A		Pulse Train from the Input of the Encoder Signal, Channel B

⊃ Requires the usage of isolated probes or isolation channels on the oscilloscope to avoid damaging the PF7000 Drive.

**Signal Conditioning Boards
(cont.)**

There is a separate SCB for each DCB, and they are labeled SCB-L and SCB-M. These boards are NOT the same and therefore not interchangeable. They are separate part numbers. The main reasoning for the difference is that Current Feedback from the Line-Side Current Transformers and Current Feedback from the Machine-Side Hall Effect sensors requires different scaling resistors. These resistors are mounted directly on the boards for drives with lower current requirements. A drive with higher current requirements may require an external parallel resistor connected across the CT/Hall Effect sensor input plug connector.

There are two LEDs on the SCB labeled D2 and D3. D2 is the $\pm 15\text{VDC}$ voltage-OK signal, and D3 is the $+5\text{VDC}$ voltage-OK signal.

Signal Conditioning Board Replacement

To replace the Signal Conditioning 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 ribbon cables, plugs, and connectors into the SCB-L or SCB-M. Use the electrical drawing as a reference.
3. Using your static strap, disconnect all of the connections.
4. Remove the SCB from the low voltage control cabinet. Verify that the new part number matches the part number on the old SCB. Installing the SCB-L in the place of the SCB-M (or the opposite) can result in serious damage to the drive as the feedback scaling will be wrong.
5. Install the new SCB in the low voltage control cabinet.
6. Reconnect all plug 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.

External Input/Output Boards

The External Input/Output (XIO) Boards are connected through a network cable (CAN Link) to the Customer Interface Board. This cable should be connected to XIO Link A (J4). The XIO board handles all external Digital Input and Output signals and sends them to the CIB 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).

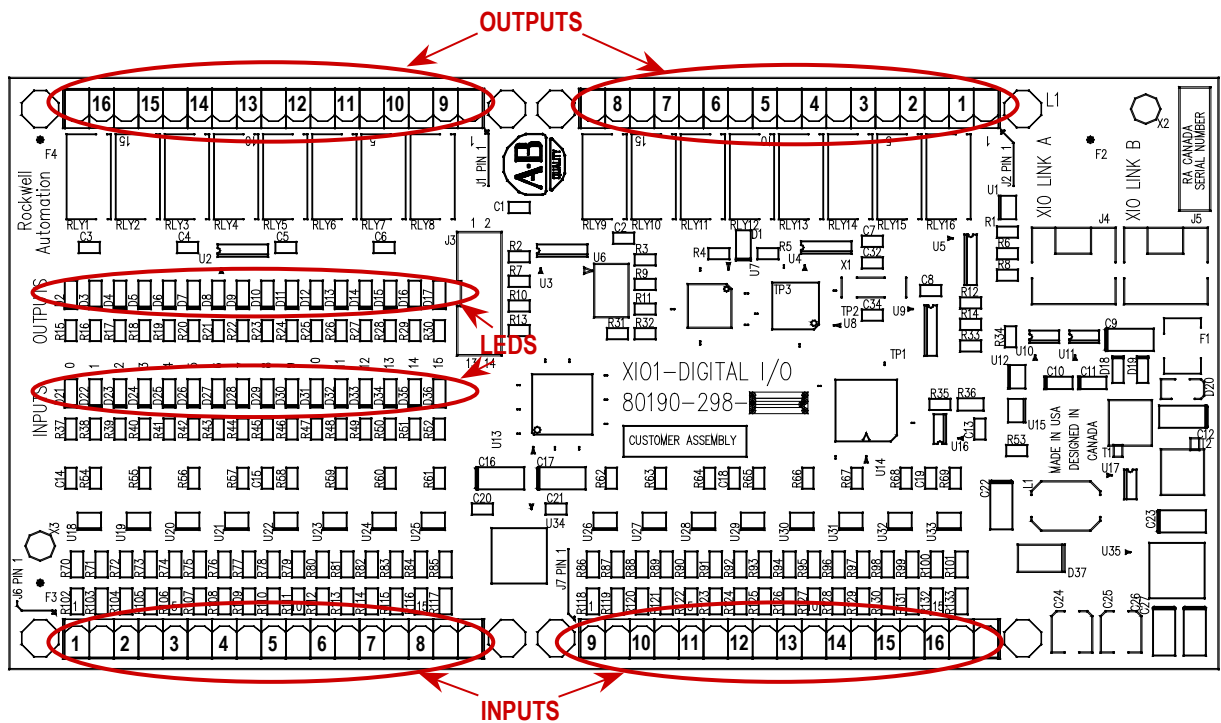


Figure 6.66 – XIO Board

External Input/Output Board (cont.)

The standard drive comes with one XIO board, although additional boards can be paralleled through the same type of CAN Link connection, from XIO Link B (J5) on the first board to XIO Link A (J4) on the second board, and so on. Specific applications may require the additional inputs and outputs. There is a component on the XIO board that will display the XIO board number. There is also an LED on the XIO board labeled D1 that indicates the status of the board. The following table illustrates the possible states.

LED Status	Description
Solid Green	Communication to CIB OK
Solid Red	Board Failure
Alternate Flashing of Red and Green	No Communication Available to CIB board (Normal during boot up or when unprogrammed)

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.

Fiber Optic Interface Boards

The Fiber Optic Interface (FOI) Boards are the interface between the Drive Control Boards and the Gate Driver circuitry. The drive control decides which device to fire, and sends an electrical signal to the FOI boards. The FOI 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 Black 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.

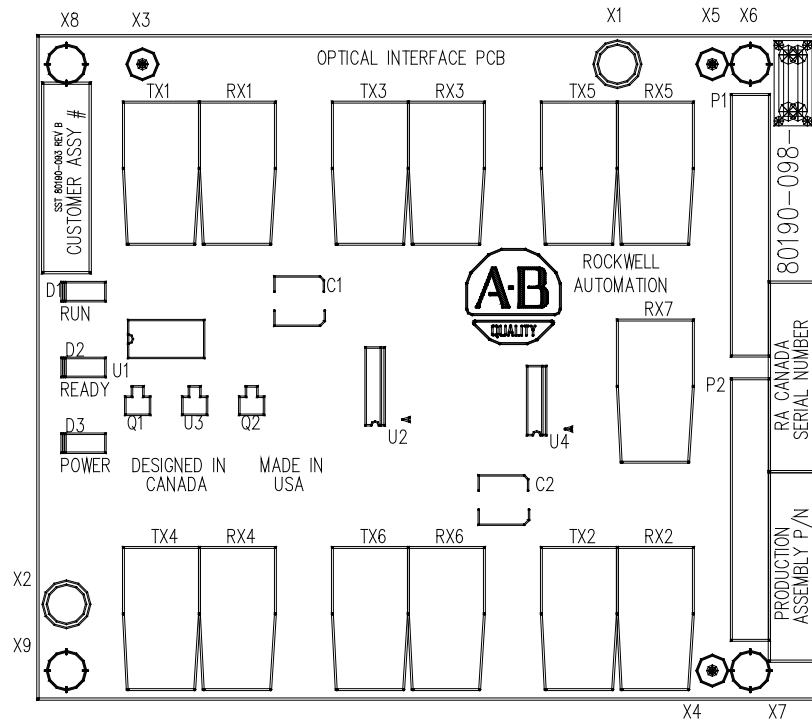


Figure 6.67 – Fiber Optic Interface Board

The FOI boards are mounted directly on the DCBs using two parallel 14-pin connectors for the electrical connection, and plastic clips to provide the mechanical strength. Each FOI board can handle the Firing and Diagnostic duplex fiber optic connector for 6 devices, whether they are SCRs or SGCTs. Physically, on the Drive Control Boards, there is provision for 18 devices for the inverter and the rectifier. This is enough capacity to handle the highest rated drive that we currently produce. The top FOI board on the DCB is for the ‘A’ devices, the middle FOI board on the DCB is for the ‘B’ devices, and the bottom FOI board on the DCB is for the ‘C’ devices.

Fiber Optic Interface Boards (cont.)

Each FOI board also has an input for a signal from a Thermistor Feedback Board. On the standard offering, there is one thermistor from the Line Converter and one thermistor from the Machine Converter, each going into the respective FOI board in the 'A' position. There is capability in the control for 2 thermistors per converter. The alarm and trip setpoints for each of these signals is programmable in software.

There are 3 LEDs on the FOI board, and the following table illustrates the status and description for the LED states:

LED	Status	Description
D1	Red – On	Run – The FOI board has received the Enable signal from DCB, and is enabled to send and receive signals
D2	Yellow – On	Ready – The FOI board has received sufficient power for all transmit ports
D3	Green – On	Power – the FOI board has received a voltage signal greater than 2V

Fiber Optic Interface Board Replacement

To replace the Fiber Optic 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.
4. Remove the FOI board from the DCB. There are four standoffs that snap into place on the FOI, 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 FOI on the DCB. Ensure the standoffs snap into place.
6. Reconnect all fiber optic 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.

Downloading the Drive Firmware

Introduction

With the introduction of the PowerFlex 7000 Medium Voltage Drive, all drive control functions are loaded on the Drive Control Boards (DCBs) with firmware via a serial connection on the Customer Interface Board (CIB). The firmware for all participating boards in the system is packaged into a single file (with the extension .XFW) and downloaded to the drive using the XMODEM protocol. This protocol is readily available on Windows based PC systems in the form of HyperTerminal.

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.

This document describes how to download new or updated firmware to the drive using the HyperTerminal program. The firmware downloaded via this means is stored in non-volatile Flash memory.

Overview

From the point of view of OBP (On Board Programming) or downloading firmware to the drive boards, there are currently three devices which can participate:

- Inverter DCB (Drive Control Board – Machine)
- Rectifier DCB (Drive Control Board - Line)
- Communications Board (CIB Board)

When the system is powered up, the three control boards communicate with each other and execute the Application Code contained in the on-board flash memory. If any single board 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 port (J8) on the CIB. This port is normally used by the printer, if supplied.

The system may also be placed into download mode from the drive Terminal. To do this, refer to the section “**Download Mode**” described below.

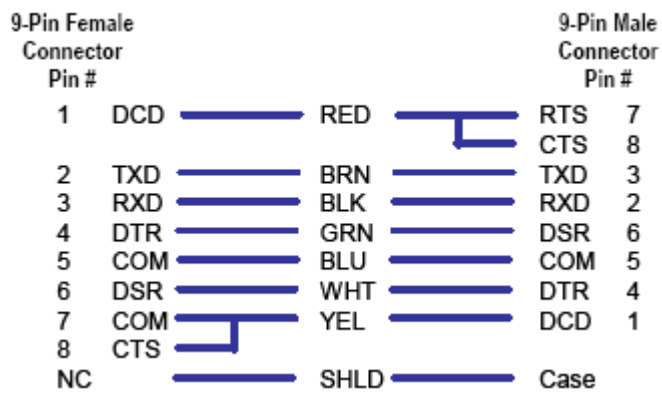
Any drive that is shipped with no firmware, or any drive that has new DCB or CIB installed with none or incompatible firmware (a repair situation) will automatically go into firmware download mode on power-up. Otherwise you have to put the system into download mode using Terminal as explained below.

Preparation for Downloading Firmware

Required

- Laptop loaded 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 CIB Communication Port (**J8**). *(A serial cable with pins 2-3 swapped at one end will also work)*
- Latest copy of the drive firmware file (filename.XFW)
- Drive Access level must be at least 'Advanced' or higher (Service or Rockwell).

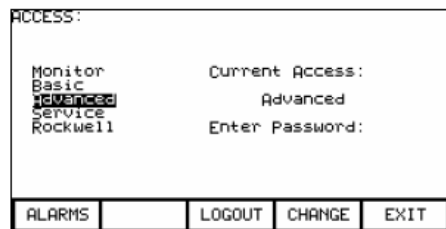
Here is a typical pin out of a complete null-modem cable.



Saving Original Settings

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 and you should have Advanced level access.



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	DRU>CRD	DRU>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.

Download Mode

If the drive is running, you will not be able to place it into firmware download mode. Ensure the drive is stopped, and the E-Stop is pressed. This is just a precaution, as all versions of firmware 2.xxx and later will not allow you to attempt a firmware download while running.

To place the drive in firmware download mode, you need to obtain a minimum of ‘**ADVANCED**’ access level. Once that has been obtained, then from the main screen select **UTILITY (F2)** -> **TRANSFER (F7)** -> **SYSTEM (F9)**. This will place the drive into firmware download mode.

When the system is in download mode, the status of LEDs on CIB board labeled OBP1 (D1), and on two **DCBs** labeled D1, provide indication of the firmware download process. These LEDs are bicolor and may flash at different rates to indicate the current condition. The following illustrates the states of LEDs:

Solid Green – the Application firmware is running. The system is not in download mode.

Green 0.25Hz – the board is in download mode

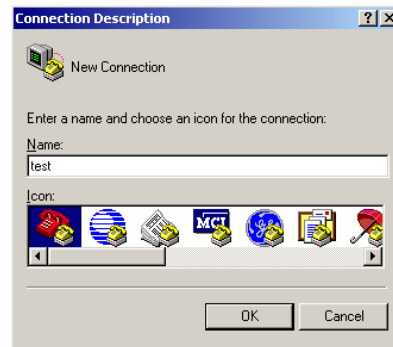
Green 0.5Hz – the board is in download mode and is currently being flashed with new firmware

Method

The following illustrates how to download firmware on the PF7000 Drive. The method involves two steps, which are explained below:

Step-1: Configuring HyperTerminal Connection

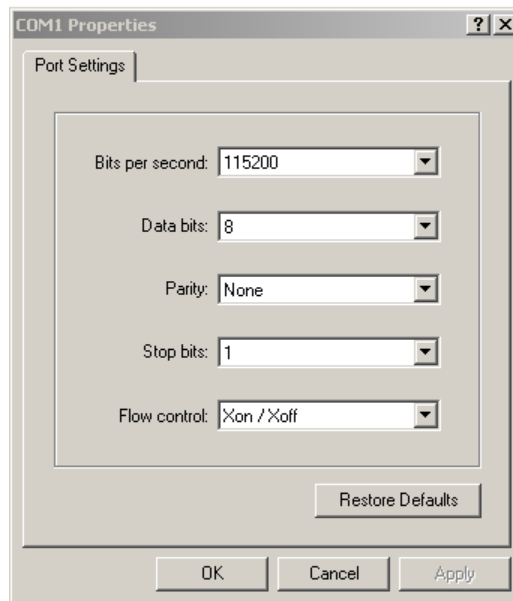
- Run HyperTerminal program
- The ‘**Connection Description**’ window will pop up. Enter any name for new connection in the **Name** field as shown below, and then click **OK**.



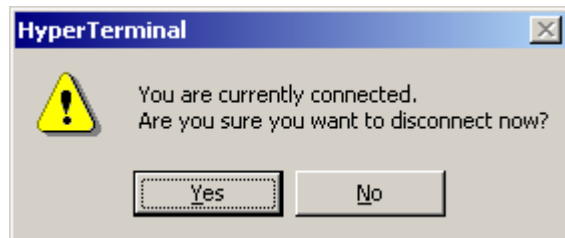
- From 'Connect to' window, select **COM1** from the dropdown list as shown below, and then click **OK**.



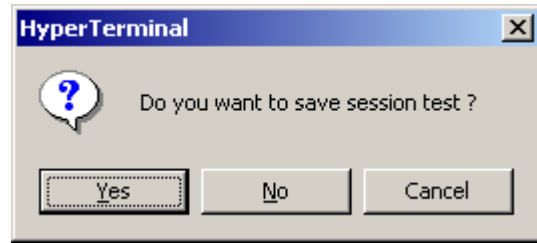
- At the 'COM1 Properties' window, set port settings as shown below and then click **OK**.



- Now, close HyperTerminal program. A message box will pop as shown below. Click **Yes**.



- You will be prompted to save the connection that you just created. Click **Yes**. This will close the HyperTerminal program.



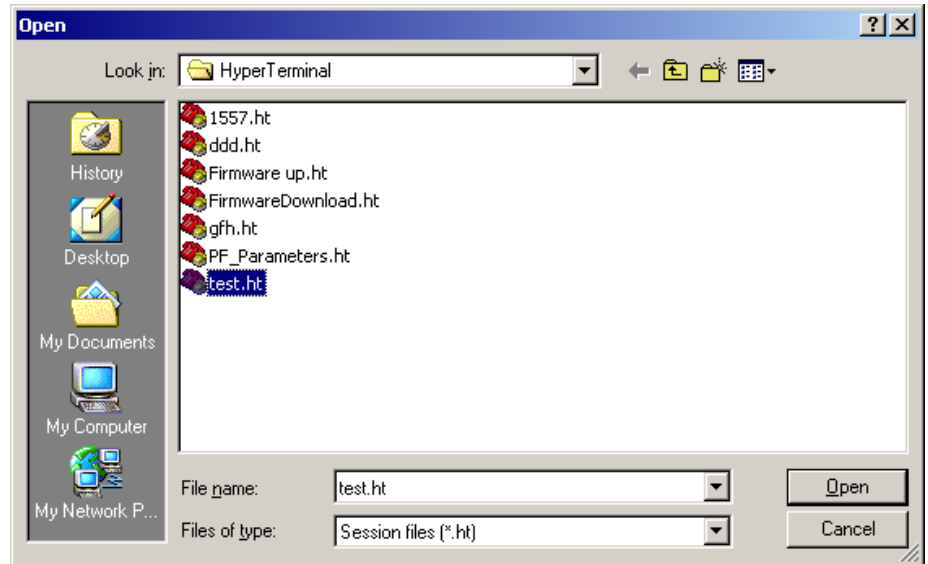
The first step is complete. Now, you are ready to download the firmware into the drive. For this you need to follow the steps as outlined below.

Step-2: Downloading the Firmware

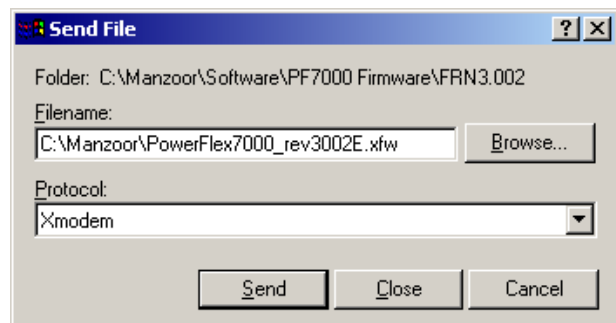
- Connect the null-modem cable between your laptop's serial port and the serial port '**J8**' on the **CIB**.
- Place the drive in download mode, if it was not already in download mode. Refer to "**Download Mode**" described above.
- Restart HyperTerminal program. When you see the '**Connection Description**' window, click **Cancel**.



- From the **File** menu, click **Open...** The **Open** window will appear. Locate the HyperTerminal Connection that you created earlier, and then click **Open**.

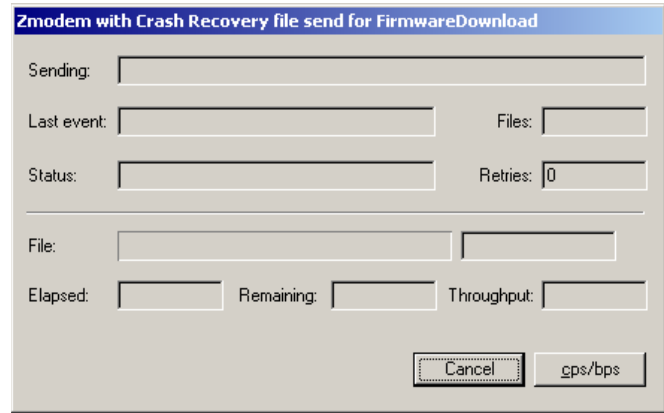


- If the drive is in download mode, the character **C** will appear every 3 seconds inside the HyperTerminal window.
- At the HyperTerminal window, click on **Transfer** menu and select '**Send file...**'. The '**Send File**' window will appear as shown below:



- At the **Send File** window, click **Browse** button and locate the firmware file saved in your laptop. The firmware file must have **.XFW** filename extension.

- Under **Protocol**, click the arrow on the right to open the dropdown list. Select **Xmodem** from the list and then click on **Send** button. This will start the download process, and a window similar to the one shown below will appear showing download progress.



- After the download is complete, the “**Download Successful**” message will appear inside the HyperTerminal window. At this point the system is still in download mode. Now, close the HyperTerminal program and disconnect your laptop from the drive and cycle the control power to drive control boards.
- After the boards are powered up, you need to transfer the parameters from the Terminal memory back to drive. Refer to “**Reloading the Parameters**” described below.

NOTE: While the system is powered down, the system should be inspected for a DIM module. This is an external memory module mounted on the CIB, in P50-40. If this module is installed and at an earlier major database revision than the new firmware installed, it should be removed. The drive will give you an INVALID DIM fault when you re-power the drive with the module still installed.

Reloading the Parameters

Once power is reapplied, the drive may come up with all the parameters from NVRAM. But if you have upgraded the firmware from one main revision level to another (i.e. 2.002 to 3.001), the NVRAM will be cleared. All other information such as operating hours, external fault messages, specific drive name, trending setup, etc. are also cleared. If you have upgraded the firmware from one minor revision level to another (i.e. 3.002 to 3.004), the NVRAM will still be intact.

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 (F2)**-> **TRANSFER (F7)** -> **PARAMETERS (F4)**. 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. This is normal when going from 4.002 to 5.005 or backwards.

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 (refer to "**Setting Elapsed Time**"), 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 HyperTerminal, via software, or as a hardcopy. This will provide a record of the new settings.

Loading Additional Languages

HyperTerminal can also be used to load new languages into the drive system. This is accomplished by connecting a serial cable between the PC and the serial port J46 on the DCB, which is adjacent to the CIB. The use of HyperTerminal and the Configuration settings are the same as that used to download new firmware. The language module has an extension of .LFW.

Setting Elapsed Time

The drive firmware download process resets the operating hours displayed on the Terminal back to zero. You can restore the actual operating hours using a utility program (Sethobb.exe) supplied with the firmware package. To set the elapsed time, follow the steps described below:

- Turn off control power to the drive control boards and the Terminal.
- Remove the Terminal connector from CIB (Port-J7).
- Connect your laptop to CIB (Port-J7) 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 CIB (Port-J7) 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 CIB. 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).

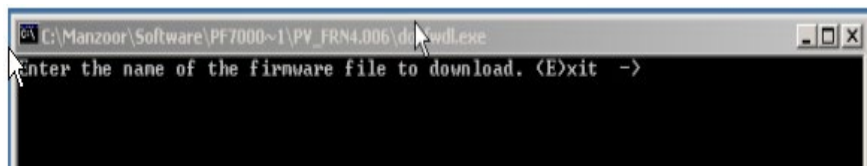
DOSFWDL

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**.

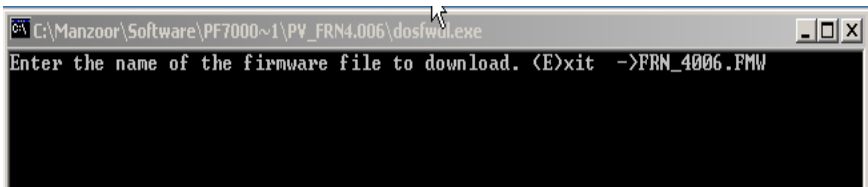
Note: If you are using a newer firmware, just make sure the filename is max 8 character long. You can rename the file, but keep the filename extension as **.FMW**. Also, when you are prompted to enter the filename, make sure you enter the correct filename as illustrated in the following example.

Method

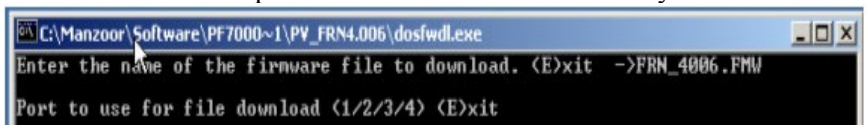
1. Make sure the Terminal is powered off. Disconnect Terminal's serial cable connector from CIB board and connect it to the serial port on your laptop. (You may need a gender changer.)
2. Turn on your laptop and run **dosfwdl.exe** program. On your laptop, you should see the screen similar to one shown below.



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



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



- 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\dosfwdl.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\dosfwdl.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\dosfwdl.exe
FRN_4006.FMW download acknowledged by terminal.
File transfer started.
34 %

```

```

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

```

- 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.
- Now, remove the serial cable from your laptop and connect it to CIB board port J7. 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 a classic drive, the maximum number of parameters that can be assigned for trending is 8. 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 8 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.

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 "Status Flags" 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.

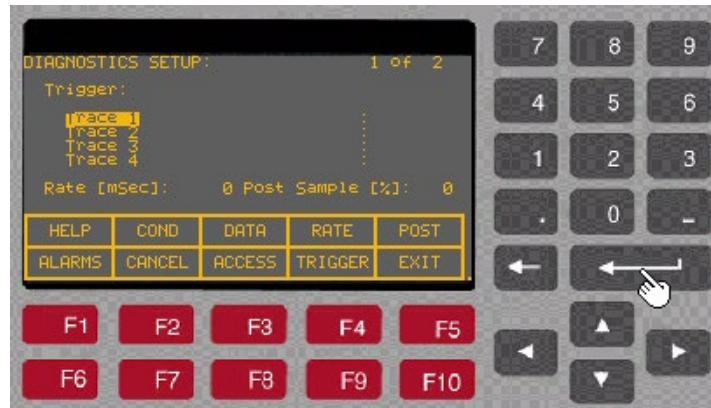
1. Press **F9** [**DIAGS**] key on the main screen to display 'Diagnostics' screen as shown in the picture below.



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



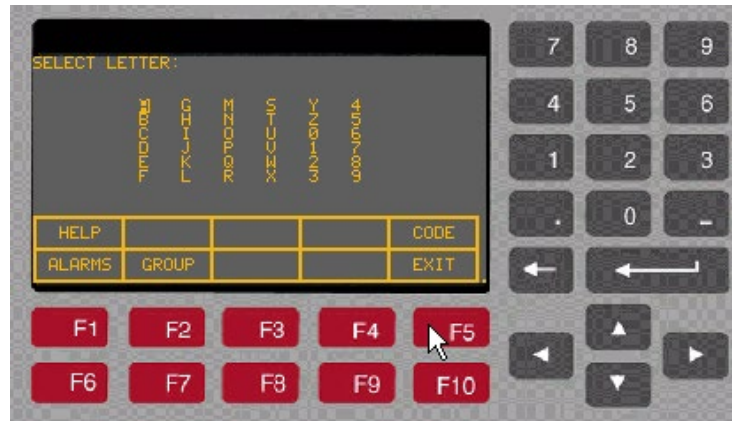
3. With **Trace-1** selected, press **Enter** key as shown in the picture below.



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.



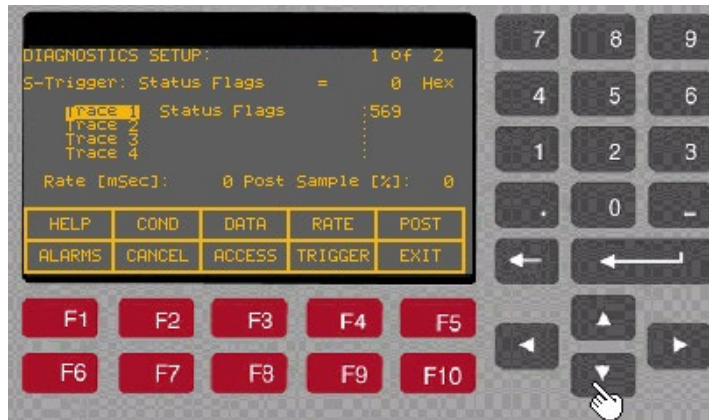
6. Press **F5** [*CODE*]. The display will change to '*Select Code*' screen as shown in the picture below.



7. 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.



8. 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**.

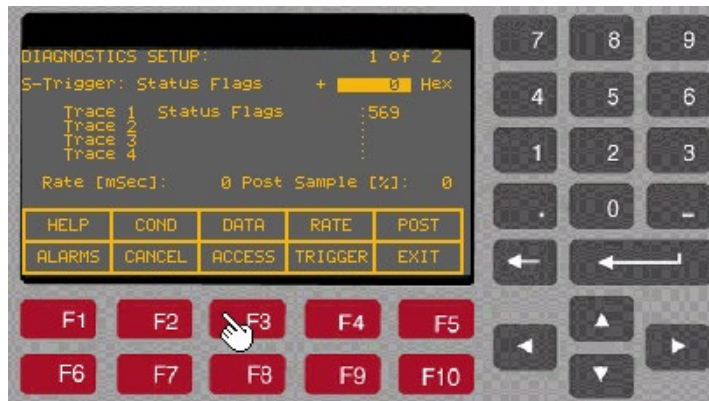


9. Repeat above steps until you have assigned the desired parameters to all the traces from Trace1 to Trace8.
10. Now press **F9 [TRIGGER]** key. The first letter in the second line on the screen will toggle between **C** and **S**. The letter **C** stands for Continuous and **S** stands for Single shot. Select S for single shot.

11. Press **F2** [**CONDITION**] key. The cursor will move to the “=” equal sign. This defines the trigger condition. Press up or down arrow keys to select + sign as the trigger condition for our example.



12. Press **F3** [**DATA**] key. The cursor moves to the data field. In our example we will enter **18** 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.



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



- 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**.



- Now press **F10 [EXIT]** to exit to the main screen.

Printing (Uploading) Data from the Drive

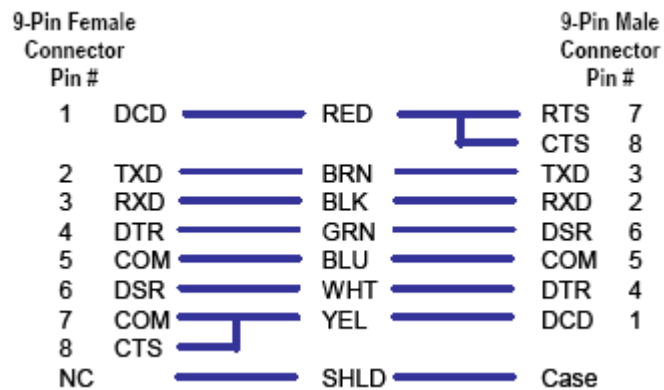
Overview

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 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 CIB Communication Port (**J8**). (*A serial cable with pins 2-3 swapped at one end will also work*)

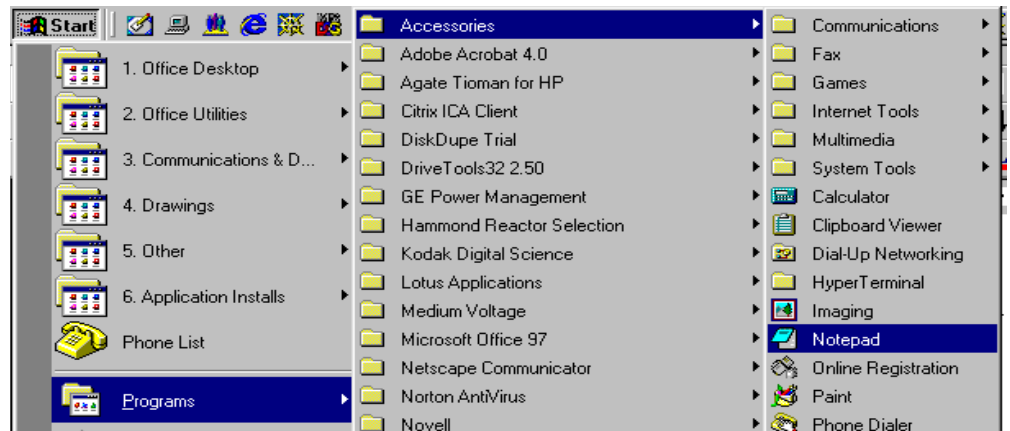
Here is a typical pin out of a complete null-modem cable.



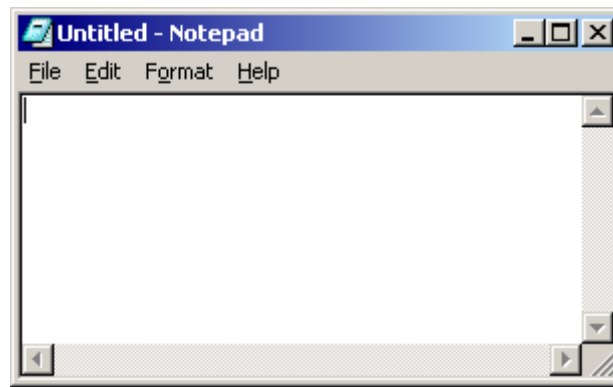
Method

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

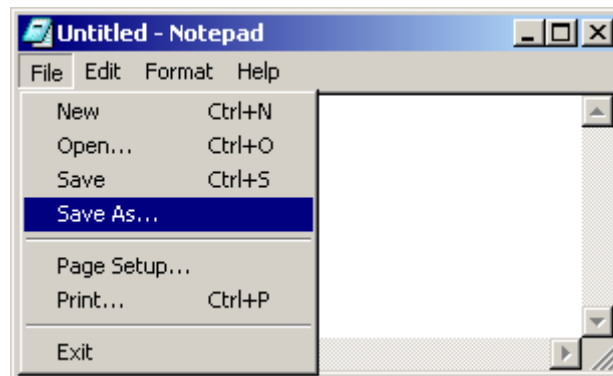
- Run **NotePad** Program (**Start** → **Program** → **Accessories** → **Notepad**)



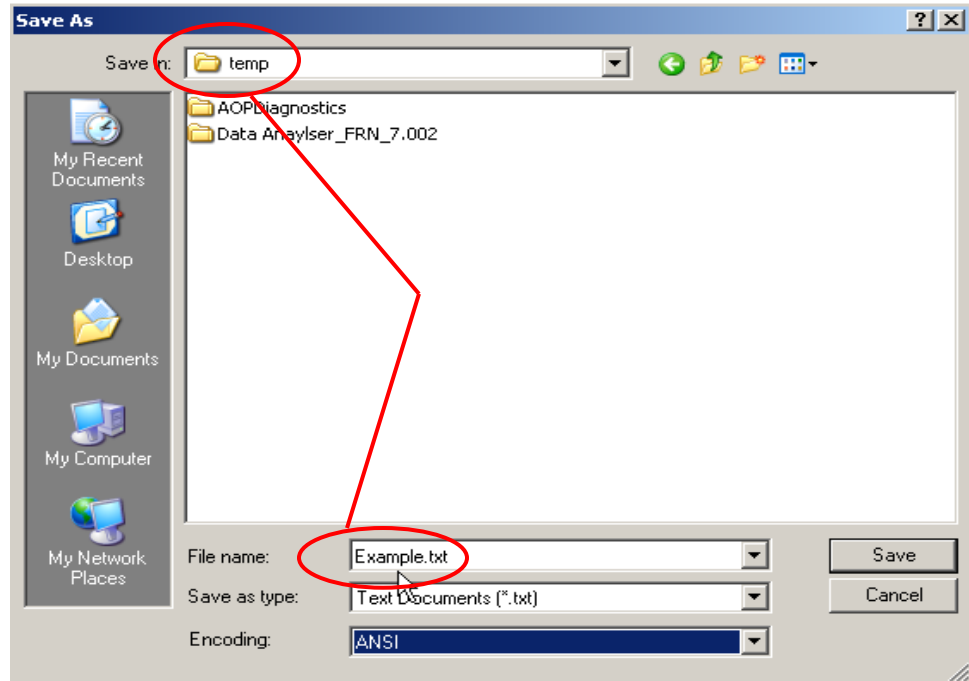
- A blank Notepad window will appear as shown below.



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



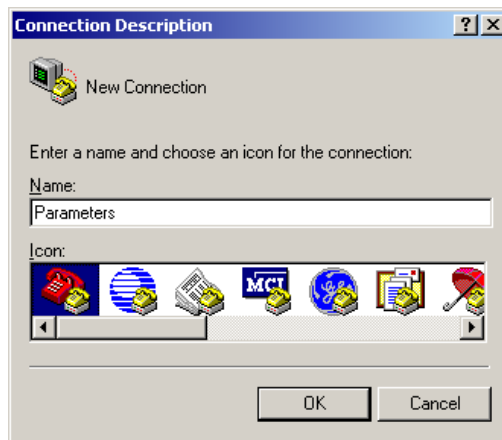
- On the **Save As** window, enter a filename (for instance, *example.txt*) in the field next to **File name** and select the directory from the dropdown list next to **Save in** at the top of the window. In this example the selected directory is C:\temp. Now, click on **Save** button.



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

Step-2: Setting up HyperTerminal Connection

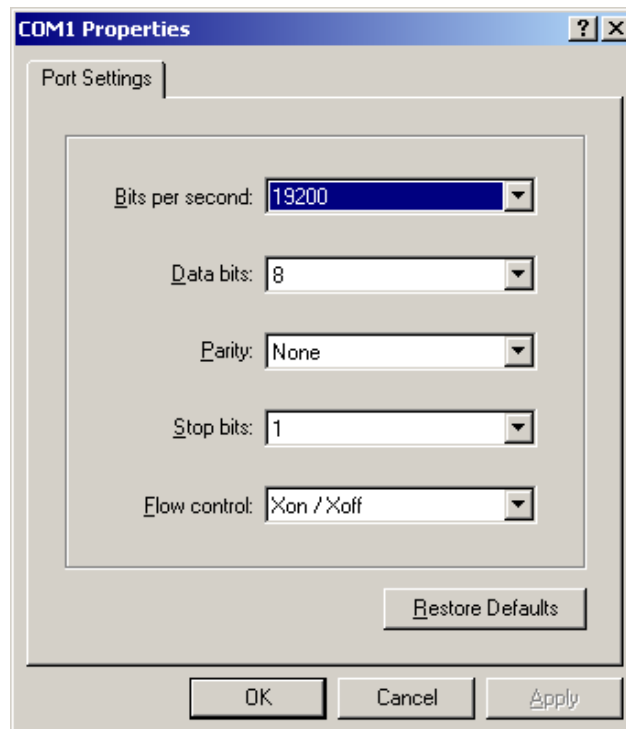
- Run **HyperTerminal** program
- On the '**Connection Description**' window, enter a name (for instance, *Parameters*) for the New Connection under the **Name** field as shown below and then click **OK**.



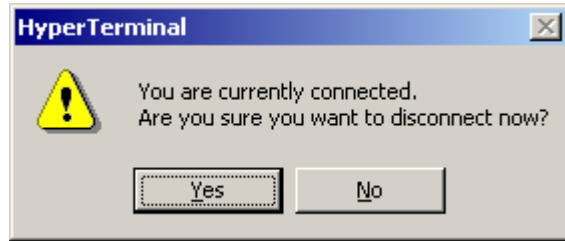
- Now, the 'Connect to' window will appear. Select **COM1** from the dropdown list next to 'Connect Using' and then click **OK**, as shown below.



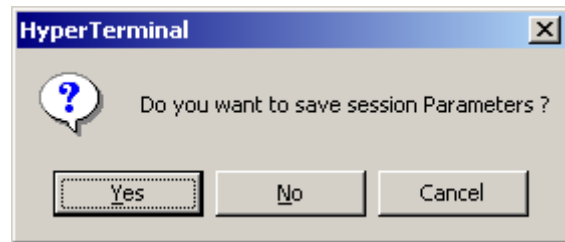
- Now, the 'COM1 Properties' window will appear. Set the port settings as shown below and then click **OK**.



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



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

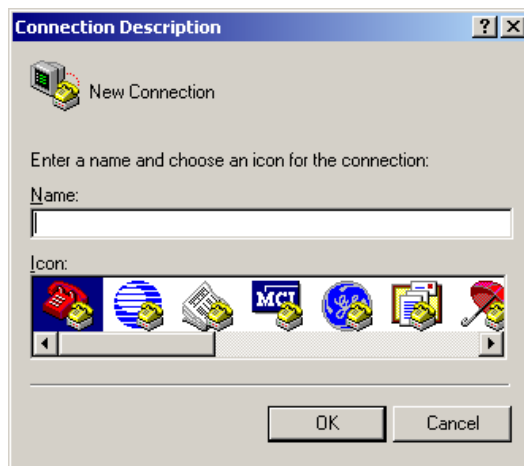


- Click **Yes** to terminate the HyperTerminal program.

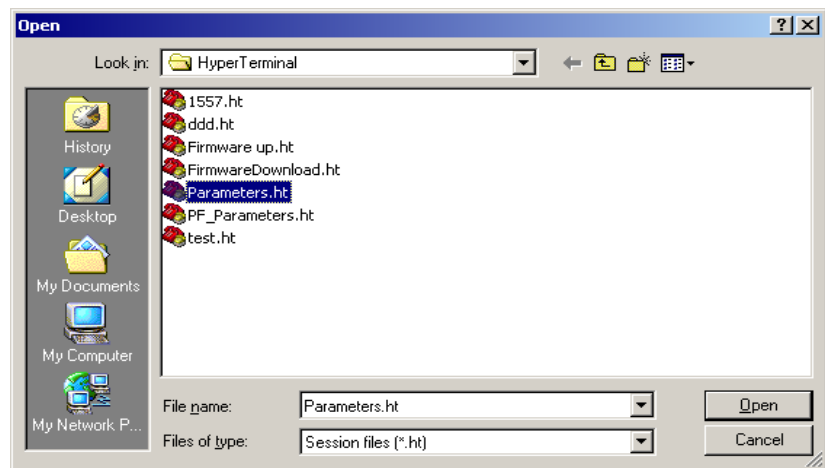
Step-3: Uploading the Data from the drive

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

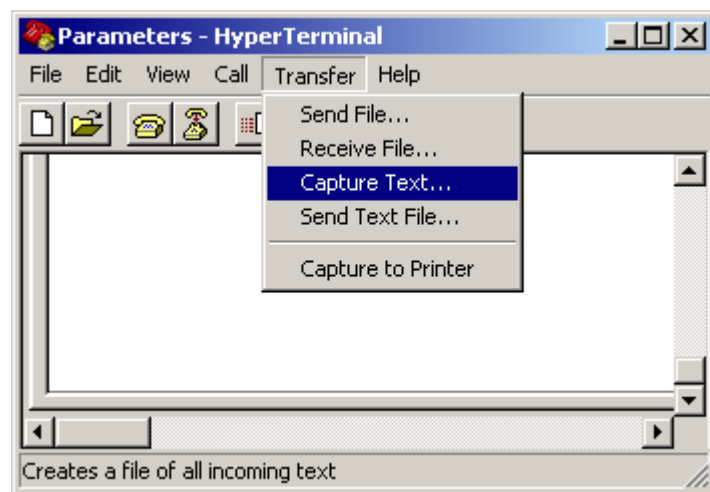
- Connect a null-modem cable between your computer’s serial port and the serial port ‘**J8**’ on the **CIB**.
- Restart HyperTerminal program. On the ‘**Connection Description**’ window click **Cancel**.



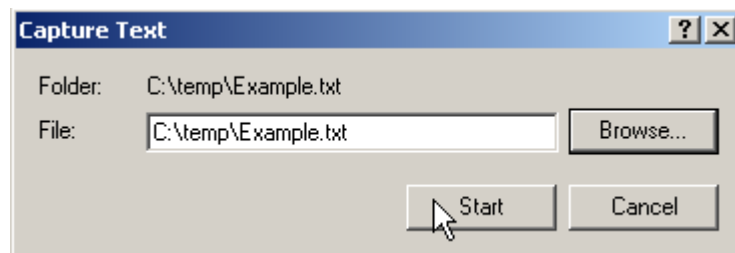
- From the **File** menu, click **Open**....At the *Open* dialog box, locate the HyperTerminal connection you just created in step-2, (eg. **Parameters**) and then click **Open**.



- 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.

- 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 V
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

```

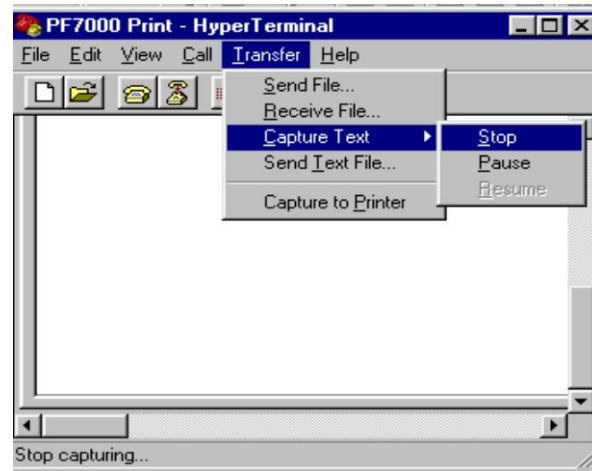
- Now, using Up or Down (↕) arrow keys on the Terminal keypad select the item you want to print (ie., upload the info into laptop) and press **Enter** key (↵). The required information will be transferred to your laptop and stored in the file C:\temp\Example.txt. Repeat this step to upload other data 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.

It is important to 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.

Setting up the PowerFlex 7000 “B” Frame Trending Feature

The trending setup is best illustrated through an example:

Trend Read-Only Parameters:

- 1 – Status Flag (569)
- 2 – Alpha Line (327)
- 3 – Speed Feedback (289)
- 4 – Torque Reference (291)
- 5 – IDC Reference (321)
- 6 – IDC Feedback (322)
- 7 – I Stator (340)
- 8 – V Stator (344)

The sample rate is to be set at 0 msec. This will default to the fastest sample rate. 20% of the samples should be recorded after the trigger. The single trigger should occur when any fault or warning occurs.

1. Press the Diagnostic Soft Key (DIAGS [F9]).
2. Press the Diagnostic Setup Soft Key to (D_SETUP [F8]) begin programming the diagnostic settings.
3. Cursor the back-lit section to Trace 1 and press the enter key to begin programming. Scroll through the parameter list until Feedback – Status Flag (569) is located. Select this as Trace 1.
4. Select Trace 2 through 8 as described in the step above. Note that when you finish Trace 4, just press the down arrow and you will get to the screen showing traces 5-8.
5. Press the TRIGGER Soft Key until the letter S appears in front of the Trigger parameter.
6. Press the RATE Soft Key to program the trending sampling rate. This will be set to 0 msec in this example.
7. Press the DATA Soft Key to set the trigger level for fault or warning. This should be set to 18.
8. Press the COND Soft Key to program the logic for the trigger level. In this example the COND will be set as an OR condition “+”
9. Press the POST Soft Key to set up how many samples will be recorded after the trigger. In this example the POST value will be set to 20%. The remaining 80% of the samples will be recorded prior to the trigger.

Once these settings have been programmed the drive is ready to trend. Now the drive will trend data at the next fault.

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 4 small lithium batteries. 3 are mounted to printed circuit boards and 1 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

See publication [7000-UM202](#) for a detailed preventative maintenance schedule.

The preventive maintenance activities on the PF7000 Air-Cooled Drive (A-Frame or B-Frame) can be broken down into two categories:

- **Operational Maintenance** – can be completed while the drive is running.
- **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

This process really involves only one task: Changing or Cleaning the Air Filters. The PF7000 drives require consistent, unrestricted airflow to keep the power devices cool. The air filter is the main source of blockage in the air path.

The drive will provide an air filter alarm whenever the pressure differential across the devices drops to a drive-specific level. Referring to the Air Filter Block parameter, this can be anywhere from 7% to 17% blocked, depending on the heatsink and device configuration. This may seem like a small number, but it takes significant blockage to begin to lower the voltage from the pressure sensor. The percentage is a measure of voltage drop, and should not be viewed as a percentage of the opening that is covered. They are not related linearly.

- Once you receive an Air Filter Warning, you should immediately make plans to change or clean the filter. You should still have days or weeks until the drive reaches an Air Filter Fault, but this is dependent on site-specific particle conditions.

This can be done while the drive is running. Refer to *User Manual, Chapter 6 – Component Definition and Maintenance* for a detailed description of the process.

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.**

Annual Maintenance (cont.)

- **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 6 – Component Definition and Maintenance for details on proper clamp pressure.

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 *User Manual, 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.

Annual Maintenance (cont.)

Additional Tasks During Preventive Maintenance

- Investigation of customer's concerns relating to drive performance
 - Relate any problems found during above procedures to customer issues.
- Informal instruction on drive operation and maintenance for plant maintenance personnel
 - Reminder of safety practices and interlocks on MV equipment, and on specific operating concerns
 - Reminder of the need to properly identify operating conditions
- Recommendation for critical spare parts which should be stocked in-plant to reduce production downtime
 - Gather information on all spare parts on site, and compare that with factory-recommended critical spares to evaluate whether levels are sufficient.
 - Contact MV Spare Parts group for more information.
- Vacuum Bottle Integrity Testing using a Vacuum Checker or AC Hipot
 - Refer to Publications **1502-UM050_EN-P** (Series D) and **1502-UM052_-EN-P** (Series E) for a detailed description of all 400A contactor maintenance.

Final Reporting

- A complete, detailed report on all steps in the Preventive Maintenance procedures should be recorded to identify changes.
 - A completed copy of this checklist should be included.
 - A detailed description of ALL ADJUSTMENTS AND MEASUREMENTS that were taken during the process should be included in an addendum (Interlock Adjustments, Loose Connections, Voltage Readings, Megger Results, Parameters, etc.)
- THIS INFORMATION SHOULD BE COMMUNICATED TO MV PRODUCT SUPPORT SO THAT FUTURE SUPPORT ACTIVITIES WILL HAVE THE LATEST SITE INFORMATION AVAILABLE.
 - This can be faxed to (519) 740-4756

Time Estimations

- Operational Maintenance 0.5 hours per filter
- Annual Maintenance
 - Initial Information Gathering 0.5 hours
 - Physical Checks
 - Torque Checks 2.0 hours
 - Inspection 2.0 hours
 - Cleaning ** 2.5 hours **
 - Meggering 1.5 hours
 - Control Power Checks
 - Contactor Adjustments ** 2.0 hours **
 - Voltage Level Checks 1.0 hours
 - Firing Check 0.5 hours
 - System Test ** 2.0 hours **
 - Medium Voltage Checks
 - Final Inspection 0.5 hours
 - Phasing Check ** 1.5 hours **
 - Autotuning** 2.0 hours **
 - Operation to Maximum Load Site Dependent
 - Additional Tasks
 - Investigation ** 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.

Annual Maintenance (cont.)

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-UM150_-EN-P
- PF7000 Parameters Manual – Publication 7000-TD001_-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)
- Aershell no. 7 Part number 40025-198-01 (for Vacuum Contactors)

Notes:

Troubleshooting (Firmware 5.xxx)

Documenting Shutdowns

All faults, warnings, or messages displayed on the Operator Interface should be thoroughly documented by the user prior to resetting those messages. This will assist maintenance personnel in correcting problems and ensuring they do not recur.

Acronyms and Abbreviations Used in this Manual

Acronym/ Abbreviation	Description
A/D	Analog/Digital
AC	Alternating Current
ADC	Analog to Digital Converter
Cap	Capacitor
Ch	Channel
Chn	Channel
CIB	Customer Interface Board
Cmd	Command
CT	Current Transformer
Ctctr	Contactactor
Cur	Current
DAC	Digital to Analog Converter
DC	Direct Current
DCB	Drive Control Board
DD	Dimensional Drawings
DIM	Drive Identity Module
DO	Drive Output
DPI	Drive Peripheral Interface
DrvIn	Drive Input
ED	Electrical Drawings
Fbk	Feedback
Flt	Fault
Filtr	Filter
FO	Fiber-Optic
FOB	Fiber-Optic Interface Board
FOI	Fiber-Optic Interface
FPGA	Field-Programmable Gate Array
GND	Ground
Gnrl	General
HCS	Hall Effect Current Sensor
Hi	High
HW	Hardware
I	Current
Init	Initialize
Inv	Inverter
IO	Input/Output
Isoltn Sw	Isolation Switch
L	Inductance
L	Line
LED	Light-emitting diode
Liq	Liquid

Acronym/ Abbreviation	Description
Lo	Low
LV	Low Voltage
M	Machine
Magnztz	Magnetizing
Max	Maximum
Min	Minimum
Mstr	Master
MTR	Motor
NVRAM	Non-Volatile Random Access Memory
OC	Overcurrent
OL	Overload
OP	Output
OT	Overtemperature
OV	Overvoltage
PLL	Phase Lock Loop
PS	Power Supply
Pu	Per Unit
PWM	Pulse-Width Modulation
Rect	Rectifier
Rot'n	Rotation
SCB	Signal Conditioning Board
SCR	Silicon-Controlled Rectifier
SGCT	Symmetrical-Gate Commutated Thyristor
Slv	Slave
Spd	Speed
SPGD	Self-Powered Gate Driver
SW	Software
Sync	Synchronous
Tach	Tachometer
TFB	Temperature Feedback Board
Trp	Trip
TSN	Transient Suppression Network
UB	Unbalance
UPS	Uninterrupted Power Supply
USART	Universal Synchronous/Asynchronous Transmitter/Receiver
V	Volt
VSB	Volt Sensing Board
Wrn	Warning
Xfer	Transfer
XIO	External Input/Output

FAULT MESSAGES

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
AC/DC#1 DC Fail	143	The output of the specified AC/DC Power Supply has seen the 56VDC output voltage drop below the hardwired trip level. The trip level is fixed in hardware as 52VDC ± 1.7VDC, depending on hardware tolerances. All of the outputs of the optional multiple AC/DC power supplies are individually monitored and displayed separately.	<ul style="list-style-type: none"> – Measure the input voltage and verify it is within limits – Measure the output voltage and confirm whether the output level indeed falls below the trip level – Verify fault detection wiring is per the drawings, and measure the voltage on the trip signals back to the CIB. The 5VDC is supplied from the CIB to the fault circuit, and is pulled low on the power supply when healthy. – Verify the internal cooling fan is operational – Replace the Power Supply if required
AC/DC#2 DC Fail	144		
AC/DC#3 DC Fail	145		
AC/DC#4 DC Fail	146		
AC/DC#5 DC Fail	147		
AC/DC#6 DC Fail	148		
AC300 DC Fail	153	Optional for drives with an internal or external UPS option – The 300W AC/DC converter specially fed by the UPS has seen the 56VDC output voltage drop below the hardwired trip level. The trip level is fixed in hardware as 51.5VDC ± 1.4VDC, depending on hardware tolerances.	<ul style="list-style-type: none"> – Measure the input voltage and verify it is within limits – Measure the output voltage and confirm whether the output level indeed falls below the trip level – Verify fault detection wiring is per the drawings, and measure the voltage on the trip signals back to the CIB. The 5VDC is supplied from the CIB to the fault circuit, and is pulled low on the power supply when healthy. – Replace the Power Supply if required
Adapter 1 Loss	309	There has been a loss of communication between the CIB and the identified SCANport Adapter (Polled Communication). The drive will configure the specific Adapter Loss 1-6 as a fault when the associated bits in Adapter Loss Mask (P175) is set to a 1.	<ul style="list-style-type: none"> – Ensure that the SCANport device is powered – Verify the SCANport light status and ensure the device is operating properly – Verify the customer SCANport network is properly communicated with the device – Check CIB LED MOD A status – Cycle control power to the drive – Change the Adapter and/or CIB if all attempts to restore communication fail
Adapter 2 Loss	310		
Adapter 3 Loss	311		
Adapter 4 Loss	312		
Adapter 5 Loss	313		
Adapter 6 Loss	314		
Adaptr1 ForceFlt	129	There has been a loss of communication between the identified DPI adapter and the customer’s communication network. The communication between the drive and the DPI adapter may still be active. This is a requirement for DPI communications. If the loss of communication from the network to the adapter is required to be a warning, this must be set in the adapter itself, not within the drive.	<ul style="list-style-type: none"> – Verify the adapter LED status and ensure the device is operating properly – Verify the customer network is properly communicated with the device – Check CIB LED status and compare to the information in Chapter 6 of the User’s Manual – Change the Adapter if all attempts to restore communication fail
Adaptr2 ForceFlt	130		
Adaptr3 ForceFlt	131		
Adaptr4 ForceFlt	132		
Adaptr5 ForceFlt	133		
Adaptr6 ForceFlt	134		

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Air Filter	73	The Pressure drop at the input to the converter section sensed by the pressure transducer (as a voltage) has dropped below the value set in Pressure Value Trip (P319). This is dependent on the operation of the Main Cooling Fan.	<ul style="list-style-type: none"> – Verify fan rotation – Check for blocked airflow in the filters/ heatsinks/ ducting (if installed) – Clean as required – Improper Trip settings – Verify Pressure Value voltage level when running with clear air flow, and compare to expected values for that specific drive type – Verify Alarm and Trip set-up procedure was completed adequately and adjust as necessary – Verify for drives with external ducting that there is sufficient air to the drive input – Verify supply voltage to differential pressure transducer, and confirm output is stable
Auxiliary Prot'n	141	Standard External Fault/Warning Input included to allow the end-user to install a protective relay/system status contact that can activate a drive fault or warning, depending on configuration of Aux Prot Class (P445)	<ul style="list-style-type: none"> – Check device responsible for the auxiliary contact to this input, and investigate cause of the open contact status – Check the 120V signal through the external device – Check the XIO board inputs and parameter status bits
Bad Reference	246	The CIB verifies a 2.5VDC reference in the A-D converters during initial power up. If this is missing, the A-D converters will not respond as expected, and could cause problems with functions including reference commands	<ul style="list-style-type: none"> – Cycle control power to see if fault still exists (Note: It can be reset, as it is only checked on initial power up: Resetting the fault is NOT an indication the problem is cleared – Replace CIB if fault persists
Cab Temp High (C-Frame Only)	229	The drive has a temperature switch in several cabinets, and all the N/C switches are connected in series and fed back to the XIO input. The levels are set differently for different cabinets.	<ul style="list-style-type: none"> – Identify which switch has opened, and focus on that cabinet – Check for proper air flow within the identified section – Verify muffin fans are operating correctly – Verify ambient temperature is within tolerances
CIB A/Ds	240	CIB Hardware Fault	<ul style="list-style-type: none"> – CIB Hardware Problem
CIB Time Base	239	CIB Hardware Fault	<ul style="list-style-type: none"> – Cycle control voltage to the drive, and if the problem still exists the CIB board should be replaced
CIB Heartbeat	197	The heartbeat link between the CIB and the DCB-L has been lost.	<ul style="list-style-type: none"> – Possible Failed CIB or DCB-L – Check LED status and compare with table in the manual – Cycle control voltage to the boards, and if the problem still exists replace the CIB/DCB-L boards as necessary

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Conductivity Hi (C-Frame Only)	227	The measured coolant conductivity is greater than 2 $\mu\text{S}/\text{cm}^3$.	<ul style="list-style-type: none"> – Verify that no foreign debris has entered the system (iron piping, non-deionized water, etc.) – Change the de-ionizing cartridge and run the system, verifying that the conductivity is decreasing
Coolant Level Lo (C-Frame Only)	228	The measured coolant level within the reservoir has dropped below the second (lowest) level sensor and the drive has faulted. This sensor is set for the minimum level required to ensure there will be no air drawn into the system through the reservoir.	<ul style="list-style-type: none"> – Verify that the drive cooling system does not have any coolant leaks – repair if found – Add the proper amount of de-ionized water to get the level above the warning sensor (de-ionized water will evaporate, not the glycol)
Coolant Temp Hi (C-Frame Only)	226	The measured coolant temperature has exceeded 54°C (129°F).	<ul style="list-style-type: none"> – Verify the heat exchanger fans are operating – Verify that the thermostatic valve is fully opened – Check that all valves are in the normal operating position – Verify that the drive is operating within specified load and ambient conditions
Coolant Temp Lo (C-Frame Only)	225	The measured coolant temperature has dropped below 4°C (40°F). It will not clear until the coolant temperature reaches 10°C (50°F). This fault will only occur if the drive is not running, to stop you from starting with a low coolant temperature. If you are already running when the coolant level drops, you will only get a warning.	<ul style="list-style-type: none"> – Verify that the thermostatic bypass valve (V10) was not left open – Verify that the ambient temperature within the drive control room is not below specification – Warm up the control room ambient to get the drive to an operational level

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Current Sens	178	Current Sensor fault	<ul style="list-style-type: none"> – If you have the Line HECS/CT code, the line current measurement is not what is expected at this level of dc current. Either of the CT DC HECS and there burden resistors may be damaged or programmed incorrectly. For example, the DC HECS may actually be 2500:1, the drawings and parameters indicate 4000:1. Another cause would be an unplugged DC HECS. – If you have the CT Phs Seqn code, the CTs are likely swapped. For example the CT/wiring for 2U has been switched with 2W. – If you have the CT Phs/Alpha code, the rectifier is firing with the wrong firing angle relative to the angle measured from the line current. This can occur when the CTs on an 18-pulse rectifier are switched between master and slaves. – If you have the Cap/CT Error code, this only occurs for PWM rectifiers when energized and not running. The line current measured by the CTs does not match the expected line current based on the capacitor parameters and measured voltage. Possible causes are incorrect capacitor, CT or burden resistor parameters, and in some cases, blown TSN fuses. – If you have the Motor HECS code, this only occurs when running on the motor in open loop mode. The drive compares the motor current to the dc current, and flags this fault if there is a significant difference. If there were no Line HECS/CT codes, then the likely cause of this fault in an incorrectly programmed motor HECS value or burden resistor. Other causes could be a defective or unplugged motor HECS.
DAN Comm	45	Drive Area network communication fault. This is applicable to parallel drive only	<ul style="list-style-type: none"> – Check RS485/RS232 converter. Red LED should be steady, and green and yellow transmit and receive LEDs should be flashing. – Check RS485 cable between drives – Check RS232 cable between Inverter Drive Control Board and serial converter

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
DC Link Flow Low (C-Frame Only)	231	The flow switch in the DC Link coolant path has detected the flow is less than optimal, indicating a problem with the flow path. This is not designed to specifically measure flow. This is a switch that differentiates between flow and no flow.	<ul style="list-style-type: none"> – Verify pressure values in the cooling system are nominal – Verify the cooling path is not restricted because of tube crimping – Check flow switch for proper operation – It may be required to disconnect cooling path and complete a check on the DC Link for blockages
DC Link OC HW	170	The measured I DC Link Feedback (P322) has exceeded DC Overcurrent Trip (P169) or 75% of the device rating, whichever is lower. The drive faults instantaneously.	<ul style="list-style-type: none"> – Verify that the parameters for drive and device ratings, and installed current sensing components are set accordingly – Verify that the DC Link LEM is wired properly and properly powered – Verify the Burden Resistor value – Complete a DC Current Test to verify the feedback corresponds to the IDC Command
DC Link OC SW	171	The Measured I DC Link Feedback (P322) has exceeded DC Overcurrent Trip (P169) for the duration set in DC Overcurrent Delay (P170). This fault should never occur on it's own, but only after a DC Link OC HW fault.	<ul style="list-style-type: none"> – Setup trending to capture DC Link Feedback and other related read-only parameters (Contact factory if you require assistance) – Check Alpha Line, and verify that the value is not too low (15°) and the current regulator is not in limit; Decrease Flux Command Base Speed or increase incoming Line Voltage – Restart the drive to allow the start up diagnostics to detect any shorted thyristors, but only attempt this once if shorted SCRs are detected – This fault code may also indicate a non-operational Motor Filter Capacitor (MFC). Refer to the 'Filter Capacitor' section on page 6-15. – Operating a synchronous transfer system (specifically the Transfer-to-Drive function) with a non-operational MFC can lead to serious personnel injury and/or property damage.
DC Link OT	137	The thermal switch in the drive DC Link Reactor has detected an over-temperature and has opened. There is a thermal switch in each DC Link winding, and they are connected in series.	<ul style="list-style-type: none"> – Verify operating conditions (ambient/ altitude/ load levels/ ventilation and fans) and verify that the DC Link Reactor is within ratings – Check the 120V signal through the thermal switch – Verify the drive cooling circuit is operating correctly (Air Pressure value or liquid-cooling path) – Check the XIO board inputs and parameter status bits – Determine through elimination whether there is a faulty switch and replace if necessary

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
DC/DC Fail	155	The last of the 5VDC or the 15VDC supplies from the DC/DC power supply to the drive control logic has failed, or any of the other voltages that are non-redundant have failed. This fault means that you will have no voltage on a required output.	<ul style="list-style-type: none"> – Measure the input voltage to the DC/DC power supply and verify it is at 56VDC – Measure the output voltage and compare to expected values listed in Chapter 4 of the User's Manual – Verify fault detection wiring is per the drawings, and measure the voltage on the trip signals back to the CIB. The 5VDC is supplied from the CIB to the fault circuit, and is pulled low on the power supply when healthy. – Verify the output from the alarm signal is wired correctly. – If 5V DC signal from CIB is not pulled low when connected to the DC/DC power supply, then the power supply is the cause. Replace the power supply.
DPI Interface	243	<p>This fault typically occurs when you have the Communication Type (P147) set for 500k (DPI only), and you have a SCANPort adapter connected to the CIB. SCANPort operates at 125k, and the DPI can operate at both speeds. This can also occur if the SCANPort network attempts to access Port 5, which is internally assigned to DPI.</p> <p>Note: 'MOD A' LED on the CIB indicates a healthy SCANPort Adapter when Green. 'MOD B' LED on the CIB indicates a healthy DPI Adapter when Green.</p>	<ul style="list-style-type: none"> – Ensure Communication Type is set for 125k for any drive with SCANPort connections – Ensure you are not using a SCANPort splitter with Port 5 active as the drive internally has assigned Port 5 to DPI, and this conflict will create a fault – Cycle power to ensure you Communication Type change takes effect – The final cause could be a CIB Hardware problem, and the board should be replaced if the above actions are unsuccessful
DI Contactor	18	The Drive Input Contactor has opened without command from the PF7000 drive.	<ul style="list-style-type: none"> – The drive system needs to have complete control over all contactors, so investigation of the specific contactor fault is required – Verify contactor feedback – Verify the control power circuit for the contactor – Check permissive string to the contactor control relay (refer to drawing) -Check contactor/breaker for physical malfunction (auxiliaries) – Check SCB inputs and outputs
DO Contactor	19	The Drive Output Contactor has opened without command from the PF7000 drive.	
OP Contactor	34	The system output contactor has opened without command from the PF7000 drive.	
BP Contactor	20	The Bypass Contactor has opened without command from the PF7000 drive.	

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
DI Iso Switch	29	The Drive Input Isolation Switch is in the opposite state than expected, or the state has changed during operation.	<ul style="list-style-type: none"> – Depending on the mode of operation (Normal, System Test, Open-Circuit Test, DC Current Test, or Open-Loop), there are specific states for all the possible system isolation switches (Refer to the description of the Parameter 192 – IsolSw/Ctctr Cfg in the parameters manual) – Ensure the isolation switches are in the proper position – Verify wiring feedback – Verify isolation switch mechanical auxiliary setup
DO Iso Switch	30	The Drive Output Isolation Switch is in the opposite state than expected, or the state has changed during operation.	
OP Iso Switch	32	The System Output Isolation Switch is in the opposite state than expected, or the state has changed during operation.	
BP Iso Switch	31	The Bypass Isolation Switch is in the opposite state than expected, or the state has changed during operation.	
Drive OL	191	A Drive Overload condition has been detected, where the overload condition is calculated using DC Current Feedback (P322) and an algorithm based on Drive Overload Trip (P163) as the absolute trip level, Drive Overload Delay (P164) as the base trip delay, and Drive Overload Min (P269) as initial detection level.	<ul style="list-style-type: none"> – Transient Loading – Check torque limit and overload settings and compare loading to torque settings and trip settings – Open Burden Resistor – Check Current feedback and check the burden resistors
Dvc AK/Snubb	195	Device Anode-Cathode or Snubber fault	– NOT USED IN 5.xxxx
External 1-16	1-16	These are the optional additional External Faults available when there is an additional XIO board installed. This is configured with XIO Ext Faults (P593), and this message will appear if the specific input (1-16) is configured in Fault Config as a Class 1 or Class 2 fault.	<ul style="list-style-type: none"> – Review XIO Board Drawing: – Identify source of Input from External Fault XIO Board print and investigate the cause of the fault – Verify voltage signals from external sources
Ext Cooling Loss (C-Frame only)	224	The drive has detected the loss of the ability to provide cooling for the drive. This is detected through feedback from the Heat Exchanger Cooling fans contactors and overloads.	<ul style="list-style-type: none"> – Review the inputs to the drive Liquid Cooling XIO and determine the source of the missing signals – Investigate the Heat Exchanger fans and control for a cause
Field Loss	35	This fault indicates that the field current is either missing or insufficient. This is done through an indirect method by checking if the drive is in Flux Regulator limit for the delay set in Field Loss Delay (P559). This means your exciter reference I Field Command (P314) is at 100% for the time of the delay.	<ul style="list-style-type: none"> – Verify the field current from the exciter is present – Verify the analog output from the drive is reaching the field exciter control circuit

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Gate Test Pwr On	196	The temporary power supply harness used for Gating Tests on the SCR rectifiers has not been removed from the DC/DC Power Supply, and you have attempted to start the drive.	<ul style="list-style-type: none"> – Remove the test harness from the drive immediately after Gate Test is finished – Verify fault detection wiring is per the drawings, and measure the voltage on the trip signals back to the CIB. The 5VDC is supplied from the CIB to the fault circuit, and is pulled low on the power supply when healthy. – Replace the DC/DC Power Supply if the harness is removed and the fault can not be cleared
GND Offset	245	CIB Hardware Fault	<ul style="list-style-type: none"> – CIB Hardware Problem – Cycle control Power to the drive, and if the problem still exists the board should be replaced
Ground OC	173	The Ground Current measured on the Ground Fault CT has exceeded the value in Ground Fault Overcurrent Trip (P171) for the duration set in Ground Fault Overcurrent Delay (P172). The GFCT (Zero-Sequence CT) is not installed in all drives.	<ul style="list-style-type: none"> – Verify the Burden resistor has not opened – Verify parameters are set properly – Megger the drive and motor and input transformer/AC line reactor to search for a ground fault in the system – This fault code may also indicate a non-operational Motor Filter Capacitor (MFC). Refer to the 'Filter Capacitor' section on page 6-15. – Operating a synchronous transfer system (specifically the Transfer-to-Drive function) with a non-operational MFC can lead to serious personnel injury and/or property damage.
Input Prot'n #1	135	Standard External Fault/Warning Input included to allow the end-user to install a protective relay (IE Input Feed Protection Relay) auxiliary contact that can activate a drive fault or warning, depending on configuration of InputProt1 Class (P440).	<ul style="list-style-type: none"> – Check device responsible for the auxiliary contact to this input and investigate the fault indicated by the device's fault message – Investigate internal and external causes for this fault code – Check the 120V signal through the external device – Check the XIO board inputs and parameter status bits
InputProt'n #2	140	Standard External Fault/Warning Input included to allow the end-user to install a protective relay (IE Input Feed Protection Relay) auxiliary contact that can activate a drive fault or warning, depending on configuration of InputProt2 Class (P444).	<ul style="list-style-type: none"> – Check device responsible for the auxiliary contact to this input and investigate the fault indicated by the device's fault message – Investigate internal and external causes for this fault code – Check the 120V signal through the external device – Check the XIO board inputs and parameter status bits

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Input Xfmr/LR OT	136	The temperature switch in the drive Input Isolation Transformer or Line Reactor has detected an over-temperature and opened. There is a thermal switch in each phase winding, and they are connected in series.	<ul style="list-style-type: none"> – Verify operating conditions (ambient/ altitude/ current levels/ ventilation and fans/ cooling oil) and verify that the Rectifier Transformer/Reactor is within ratings – Check the 120V signal through the thermal switch – Verify that it is not a faulty switch – Check the XIO board inputs and parameter status bits – Determine through elimination whether there is a faulty switch and replace if necessary
Inv HeatSink FO	76	While Not Running, the Fiber Optic signal from the TFB on the Inverter Heatsink, connected to Channel A fiber optic receiver RX7 on FOI-M-A is not present. This is only a fault while not running. If this occurs while running it will appear as a warning.	<ul style="list-style-type: none"> – Check TFB and FOI board for power – Check the Fiber Optic cables are properly seated in the transmitters and receivers – Check the fiber optic cable for kinks, bends, breaks that could be blocking the signal
Inv Temp Ch B FO	77	Not Normally Used: While Not Running, the Fiber Optic signal from the optional TFB connected to Channel B fiber optic receiver RX7 on FOI-M-B is not present. This is only a fault while not running. If this occurs while running it will appear as a warning.	<ul style="list-style-type: none"> – This can occur if the sensor is not connected to the TFB
Inv HS Low Temp	40	If the measured temperature IHeatsink Temp C (P253) is less than 2°C, and the drive is not running, the drive will display this fault.	<ul style="list-style-type: none"> – Verify that the ambient in the control room is not below 2°C – Verify power to the TFB
Inv ChB Low Temp	41	If the measured temperature Temp I Ch B C (P552) is less than 2°C, and the drive is not running, the drive will display this fault. This is not enabled on most drives, and the parameter is a high-level parameter.	<ul style="list-style-type: none"> – There could be a mechanical problem with the temperature sensor or with the cable feeding the signal back to the TFB – Swap with the rectifier hardware to identify the bad component
Inv Heatsink OT	69	The temperature detection on the Inverter Heatsink, connected to Channel A fiber optic receiver RX7 on FOI-M-A, has exceeded Inverter Heatsink Temperature Trip (P315).	<ul style="list-style-type: none"> – Confirm actual temperature in parameters is not higher than the trip value – If so, investigate the conditions of the drive (ambient/ loading/ elevation / ventilation/ filter status /heatsink clogging)
Inv ChannelB OT	70	Not Normally Used - The temperature detection on an Inverter Heatsink, connected to fiber optic receiver RX7 on FOI-M-B, has exceeded Inverter Temperature Trip Channel B (P570)	<ul style="list-style-type: none"> – Check the sensor and temperature offline (ambient) for accuracy
Inv HS Sensor	38	While Not Running, The drive has detected a missing temperature sensor connected to the TFB on the inverter heatsink. A missing sensor can result in either a Fiber Optic Loss fault or a Sensor fault because a missing sensor can be interpreted as either 0°C or over 100°C, and both are unrealistic values.	<ul style="list-style-type: none"> – Verify sensor is completely seated properly on TFB. – Measure sensor resistance. – Replace if necessary.

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Inv ChB Sensor	39	While Not Running, Not normally used: The drive has detected a missing temperature sensor connected to the optional TFB connected to the fiber optic receiver RX7 on FOI-M-B. A missing sensor can result in either a Fiber Optic Loss fault or a Sensor fault because a missing sensor can be interpreted as either 0°C or over 100°C, and both are unrealistic values.	
Inv HCS Power	28	The power supplied to the Motor Hall-Effect Current Sensors ($\pm 24\text{VDC}$) is monitored on the control board and will fault the drive if the voltage is out of tolerance.	<ul style="list-style-type: none"> – Verify the DC voltage on the DC/DC supply, at the SCB-M terminals, and at the Current Sensors – Check the Current Sensor wiring and ensure all connections are per the Electrical Drawing
IsoTx Air Filter (A-Frame Only)	71	The Pressure sensed by the pressure transducer in the Integral Isolation Transformer section (as a voltage) has dropped below the value set in Pressure Value Transformer Trip (P654).	<ul style="list-style-type: none"> – Verify fan rotation – Check for blocked airflow in the filters / ducting (if installed) – Clean as required – Improper Trip settings – Verify Pressure Value voltage level when running with clear air flow – Verify Alarm and Trip set-up procedure was completed adequately and adjust as necessary, and compare with expected values for that specific drive type – Verify for drives with external ducting that there is sufficient air to the drive input – Verify supply voltage to pressure transducer, and confirm output is stable
Line DC Link OV	172	The DC Link Voltage measured on the Line side of the DC Link has exceeded Line DC Overvoltage Trip (P173) for the duration set in Line DC Overvoltage Delay (P174).	<ul style="list-style-type: none"> – Verify that the parameters are set properly – Verify that there is no problems with steady-state overvoltages on the input to the drive – Ensure all SGCTs are powered – Verify VSB resistors, grounds, connections, and tap settings – Complete a Gating Test on the rectifier and inverter to confirm devices are firing – Verify that the waveforms measured on the SCB-L are as expected
Line Fltr Cap OV	176	The measured line voltage Vline Bridge (P696) has exceeded Line Overvoltage Trip (P165) for the duration set in Line Overvoltage Delay (P166). This is the only uncompensated voltage, representing the voltage on the input to the bridge. All other voltages in the line-side are compensated using L commutation.	<ul style="list-style-type: none"> – Verify the parameters are set properly – Verify VSB connections and tap settings, resistor values, and grounds – This is less likely to be caused by a true Line Overvoltage and more likely to be due to the effects of capacitive leading VARs on a high-impedance system – Tap down the input if possible

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Line Harmonic OV	200	The drive has detected a steady-state resonance-induced overvoltage on the line. This is defined at the level set in Harmonic OV Trip (P675) for the delay Harmonic OV Delay (P676) (on top of normal line voltage) for 1 second. The drive only detects the 5 th harmonic to eliminate nuisance faults from capacitor charging events.	<ul style="list-style-type: none"> – Verify waveforms show excessive harmonics using oscilloscope on SCBL unfiltered voltage testpoints – Investigate sources for excessive harmonics on customer power system – Contact factory for possible re-tuning of input filter
Line HCS Power	175	The power supplied to the DC Link Hall-Effect Current Sensor ($\pm 24\text{VDC}$) is monitored on the control board and will fault the drive if the voltage is out of tolerance.	<ul style="list-style-type: none"> – Verify the DC voltage on the DC/DC supply, at the SCB-L terminals, and at the Current Sensor – Check the Current Sensor wiring and ensure all connections are per the Electrical Drawing
Line Heartbeat	25	The DCB-M has detected the loss of the heartbeat signal from the DCB-L	<ul style="list-style-type: none"> – Verify DC Control voltages to both DCBs – Possible Failed DCB – Check LED status of both boards and compare with table in the manual – Recycle power and replace board if necessary
Line Neutral OV	192	For SCR rectifiers, the Neutral-to-Ground voltage calculated from the measured line voltages has exceeded Ground Fault Overvoltage Trip (P587) for the duration set in Ground Fault Overvoltage Delay (P588). For PWM rectifier, the Neutral-to-Ground voltage is measured directly from the Line Filter Capacitor Neutral. In both cases, the actual value is displayed in V Neutral Line (P589)	<ul style="list-style-type: none"> – DESIGNED FOR PWM-Rectifier ONLY: – Insulation Failure – Megger the motor insulation/motor cables/drive insulation to ground – Verify the integrity of the input grounding network if applicable – Megger the input Isolation Transformer Secondary/Input Cables to ground – Verify Parameter settings are appropriate for AC Line Reactor or Isolation Transformer drives – Verify the integrity of Line Filter Capacitors (for PWM rectifier drives), looking for short circuits or signs of physical damage. Refer to Chapter 6 of the User's Manual for detailed instructions on Testing Filter Capacitors.
Line OC	166	The measured Line Current has exceeded Line Overcurrent Trip (P161) for the duration set in Line Overcurrent Delay (P162).	<ul style="list-style-type: none"> – CHECK FOR SHORTED SCRs – DO NOT ATTEMPT TO RESET THIS FAULT UNTIL YOU HAVE VERIFIED THE SCRS ARE NOT SHORTED – Investigate Possible damage to the input isolation transformer if there have been several aborted starts with Line OC faults – Verify that the drive sizing is not too small for the Rated Motor Current – Verify Parameters are set properly – Verify the Burden resistors are not opened and there are no loose grounds

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Line OV	159	The calculated Line Voltage has exceeded Line Overvoltage Trip (P165) for the duration set in Line Overvoltage Delay (P166). This is calculated by looking at the compensated individual bridge voltages Master, Slave1 and Slave2 (P136-138), and comparing them to 1/3 of Line Overvoltage Trip.	<ul style="list-style-type: none"> – Verify the parameters are set properly – Verify VSB connections and tap settings, resistor values, and grounds – Verify that the parameter L Commutation (P140) was tuned properly. – If voltage is too high, change tap settings on the input source to lower voltage to an acceptable level
Line ADC_DAC	210	Line DCB Internal Hardware Fault	<ul style="list-style-type: none"> – Board Malfunction – Cycle Control Power, to see if the Fault condition remains and Replace DCB-L if necessary
Line DMA Overrun	217	Line DCB Internal Hardware Fault	
Line Timer0	208	Line DCB Internal Hardware Fault	
Line Timer1	209	Line DCB Internal Hardware Fault	
Line FPGA	207	Line DCB Internal Hardware Fault	
Line FOB ChA	211	This fault occurs if the Line Fiber Optic Interface Board A is not connected, but is required based on the number of devices specified (Drive Type and Line Voltage Dependent).	<ul style="list-style-type: none"> – Improper parameter settings for Rectifier Series Devices or Rectifier Type – Verify parameters – Damaged FOI Board – Check the LED status on the FOI board – replace if necessary – DCB-L pin damage – Inspect the pins on the DCB-L and ensure there is no damage – Replace the DCB-L if necessary
Line FOB ChB	212	This fault occurs if the Line Fiber Optic Interface Board B is not connected, but is required based on the number of devices specified (Drive Type and Line Voltage Dependent).	
Line FOB ChC	213	This fault occurs if the Line Fiber Optic Interface Board C is not connected, but is required based on the number of devices specified (Drive Type and Line Voltage Dependent).	
Line FOB ChA PS	214	The 5VDC power supply to the Line Fiber Optic Interface Board A from the Line DCB is not present.	<ul style="list-style-type: none"> – Bad 5VDC supply – Check the 5VDC test point on the DCB-L – Verify LED status on the FOI Board – Check all the pins that mount the FOI board to the DCB and ensure none are bent/broken
Line FOB ChB PS	215	The 5VDC power supply to the Line Fiber Optic Interface Board B from the Line DCB is not present.	
Line FOB ChC PS	216	The 5VDC power supply to the Line Fiber Optic Interface Board C from the Line DCB is not present.	

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Master CurrentUB	163	The measured and calculated phase currents in the Master Bridge have exceeded the value set in Line Current Unbalance Trip (P108) for the duration set in Line Current Unbalance Delay (P109).	<ul style="list-style-type: none"> – Verify that all Current Transformer connections are connected properly and that no wires are reversed – Ring-out wires to verify connections – Check grounding on CTs – Ensure that all plugs are firmly connected in the SCBL – Check that all input voltages are balanced – Verify Parameter settings – Check the burden resistors – Verify the Input Capacitor values if installed – Verify that there are no open sharing resistors. – Verify all Line Thyristors are firing in Gating Test Mode – Check the Line Filter Capacitors (for PWM rectifier drives). Refer to Chapter 6 of the User's Manual for detailed instructions on Testing Filter Capacitors.
Master VoltageUB	160	The measured phase voltages in the Master Bridge have exceeded the value set in Line Voltage Unbalance Trip (P271) for the duration set in Line Voltage Unbalance Delay (P272).	<ul style="list-style-type: none"> – CHECK TSN FUSING – Verify the VSB connections and tap settings, and check resistance of VSB board – Megger board to confirm integrity – Check actual voltage values on the Operator Interface terminal for each bridge and the total line voltage – Check for possible source voltage supply problems – Use Multimeter and Oscilloscope to check voltages on the drive voltage test points
Motor Current UB	33	The measured current unbalance on the drive output has exceeded Mtr I UB Trip (P208) for the duration set in Mtr I UB Delay (P214).	<ul style="list-style-type: none"> – Verify the current sensor wiring and Burden Resistors from the Motor current sensors – Verify the HCS power – Investigate the possibility of Motor winding or cabling problems – This fault code may also indicate a non-operational Motor Filter Capacitor (MFC). Refer to the 'Filter Capacitor' section on page 6-15. – Operating a synchronous transfer system (specifically the Transfer-to-Drive function) with a non-operational MFC can lead to serious personnel injury and/or property damage.

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Motor DC Link OV	17	DC Link Voltage on the motor side, measured through the Voltage Sensing Board, has exceeded Motor DC Overvoltage Trip (P193) for the duration set in Motor DC Overvoltage Delay (P194).	<ul style="list-style-type: none"> – Verify the motor is connected and the Output Contactor is not open – Verify there is no open SGCTs Complete a Resistance and Firing check – Check VSB circuit (grounds) through to SCB-M – Check Burden resistor values – Check the trip parameter setting
Motor Flux UB	24	The measured Motor Flux has exceeded Motor Flux Unbalance Trip (P585) for the duration set in Motor Flux Unbalance Delay (P586).	<ul style="list-style-type: none"> – Verify the VSB resistors are not open and that they are balanced – Check for a grounded phase on the drive system using a megger test – This fault code may also indicate a non-operational Motor Filter Capacitor (MFC). Refer to the 'Filter Capacitor' section on page 6-15. – Operating a synchronous transfer system (specifically the Transfer-to-Drive function) with a non-operational MFC can lead to serious personnel injury and/or property damage.
Motor FOB ChA	53	This fault occurs if the Motor Fiber Optic Interface Board A is not connected, but is required based on the number of devices specified (Motor Voltage Dependent).	<ul style="list-style-type: none"> – Improper parameter settings for Inverter Series Devices – Verify parameters – Damaged FOI Board - Check the LED status on the FOI board – replace if necessary – DCB-M pin damage – Inspect the pins on the DCB-M and ensure there is no damage – Replace the DCB-M if necessary
Motor FOB ChB	54	This fault occurs if the Motor Fiber Optic Interface Board B is not connected, but is required based on the number of devices specified (Motor Voltage Dependent).	
Motor FOB ChC	55	This fault occurs if the Motor Fiber Optic Interface Board C is not connected, but is required based on the number of devices specified (Motor Voltage Dependent).	
Motor FOB ChA PS	56	The 5VDC power supply to the Motor Fiber Optic Interface Board A from the Motor DCB is not present.	
Motor FOB ChB PS	57	The 5VDC power supply to the Motor Fiber Optic Interface Board B from the Motor DCB is not present.	
Motor FOB ChC PS	58	The 5VDC power supply to the Motor Fiber Optic Interface Board C from the Motor DCB is not present.	
Motor Heartbeat	167	The DCB-L has detected the loss of the heartbeat signal from the DCB-M.	
			<ul style="list-style-type: none"> – Verify DC Control voltages to both DCBs – Possible Failed DCB – Check LED status of both boards and compare with table in the manual – Recycle power and replace board if necessary

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Motor Load Loss	74	The drive has detected a loss of load condition. This is activated as a fault using the parameter Load Loss Detect (P199), and the necessary setpoints are Load Loss Level (P246), Load Loss Delay (P231), and Load Loss Speed (P259).	<ul style="list-style-type: none"> – Verify the parameter settings – Ensure that the load should not normally be in an unloaded condition – This is designed for applications likely to lose the load (downhole pump – hollow-shaft motor) and we do not want to run with the loss of load
Motor Neutral OV	67	The Neutral-to-Ground voltage measured from the Output Filter Capacitor Neutral point has exceeded Ground Fault Overvoltage Trip (P189) for the duration set in Ground Fault Overvoltage (P190). This value is displayed in V Motor Neutral (P347).	<ul style="list-style-type: none"> – Insulation Failure – Megger the motor insulation/motor cables/drive insulation to ground – Verify the integrity of the output grounding network if applicable – Megger the input Isolation Transformer Secondaries/Input Cables to ground – Verify Parameter settings are appropriate for AC Line Reactor or Isolation Transformer drives – This fault code may also indicate a non-operational Motor Filter Capacitor (MFC). Refer to the ‘Filter Capacitor’ section on page 6-15. – Operating a synchronous transfer system (specifically the Transfer-to-Drive function) with a non-operational MFC can lead to serious personnel injury and/or property damage.
Motor OC	21	The measured motor current I Stator (P340) has exceeded Motor Overcurrent Trip (P177) for the duration set in Motor Overcurrent Delay (P178).	<p>Possible Causes:</p> <ul style="list-style-type: none"> – Real OC/Transients – Bad Burden resistor/Current Sensor Circuit Failure – Check components – Parameter settings too low compared to torque limit – Verify Parameter settings – Current regulator in limit (check line voltage and Alpha line while running) – This fault code may also indicate a non-operational Motor Filter Capacitor (MFC). Refer to the ‘Filter Capacitor’ section on page 6-15. – Operating a synchronous transfer system (specifically the Transfer-to-Drive function) with a non-operational MFC can lead to serious personnel injury and/or property damage.
Motor OL	65	A Motor Overload condition has been detected, where the overload condition is calculated using I Stator(P340) and an algorithm based on Motor Overload Trip (P179) as the absolute trip level, Motor Overload Delay (P180) as the base trip delay, and Motor Overload Min (P351) as the point where the overload calculation begins.	<ul style="list-style-type: none"> – Transient Loading - Check torque limit and overload settings and Compare loading to torque settings and trip settings – Burden Resistor – Check LEM feedback and Check the burden resistors

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Motor OV	22	The measured Motor AC Voltage has exceeded Motor Overvoltage Trip (P181) for the duration set in Motor Overvoltage Delay (P182).	Possible Causes: <ul style="list-style-type: none"> – Parameter setting incorrect (flux command/trip values) – VSB damage – Check VSB resistors, grounds, and verify tap settings are correct – Self-Excitation – Check for flying start/induced motor rotation
Motor Overspeed	66	The motor Speed Feedback (P289) has exceeded Motor Overspeed Trip (P185) for the duration set in Motor Overspeed Delay (P186).	<ul style="list-style-type: none"> – Check for unbalance on the motor and line feedback voltages – Improper Settings – Check parameter settings for Reference Command Maximum and Ensure it is not too close to Overspeed Trip increase – Adjust Speed Regulator Bandwidth to control overshoot, and ensure acceleration rate near maximum speed is not too great – Check for load transients – For Tachometers, ensure the ppr is set properly and the feedback is valid – Check tachometer pulse train with an oscilloscope
Motor Protection	138	Standard External Fault/Warning Input included to allow the end-user to install a protective relay (IE Bulletin 825 Motor Protection Relay) auxiliary contact that can activate a drive fault or warning, depending on configuration of Motor Prot Class (P443).	<ul style="list-style-type: none"> – Check device responsible for the auxiliary contact to this input and investigate the fault indicated by the device's fault message – Investigate internal and external causes for this fault code – Check the 120V signal through the external device – Check the XIO board inputs and parameter status bits

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Motor Stall	23	The drive has detected a motor stall condition, with a delay set by Motor Stall Delay (P191). The different methods of Motor Stall detection depend on whether a tachometer/encoder is installed or not. Sensorless faults involve the motor not building up enough flux feedback to be detected by the drive, while tachometer feedback methods look at the difference between the tachometer/encoder feedback and the speed command.	Possible Causes: <ul style="list-style-type: none"> – Insufficient torque on starting– Increase Torque Command 0 and 1 to avoid motor stalls when starting if Speed Feedback Mode is Sensorless – Insufficient torque – Increase Torque Limit Motoring to avoid motor stalls while running – Reverse Load Rotation – Ensure the load is not rotating in the opposite direction – Increase motor stall delay – Ensure Tachometer Feedback is functional where applicable – Ensure the motor is not spinning forward at a speed greater than Reference Command – This fault code may also indicate a non-operational Motor Filter Capacitor (MFC). Refer to the ‘Filter Capacitor’ section on page 6-15. – Operating a synchronous transfer system (specifically the Transfer-to-Drive function) with a non-operational MFC can lead to serious personnel injury and/or property damage.
Motor ADC_DAC	52	Motor DCB Internal Hardware Fault	– Board Malfunction – Cycle Control Power to see if the Fault remains, and Replace DCB-M if necessary
Motor DMA Overrun	59	Motor DCB Internal Hardware Fault	
Motor FPGA	49	Motor DCB Internal Hardware Fault	
Motor Timer0	50	Motor DCB Internal Hardware Fault	
Motor Timer1	51	Motor DCB Internal Hardware Fault	
Mstr Xfr Err	46	Master transfer Error This is applicable to parallel drive only	– The master drive cannot find a slave drive able to take over as master – Possible causes are: slave drive not ready, or slave drive masked off

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Mtr Cap OV	44	Motor filter capacitor Over Voltage fault. This is for ESP application	<ul style="list-style-type: none"> – This is drive output Voltage [Surface voltage terminology used in ESP application]. The drive gives this fault in an ESP application only. – The protection uses P#181 setting but drive calculates the motor filter cap voltage [Surface V] which is different from motor voltage in ESP application. – Check the voltage sensing board for any resistor failure – Check for any open circuit at the drive output. – Check the devices at the inverter. – This fault code may also indicate a non-operational Motor Filter Capacitor (MFC). Refer to the 'Filter Capacitor' section on page 6-15. – Operating a synchronous transfer system (specifically the Transfer-to-Drive function) with a non-operational MFC can lead to serious personnel injury and/or property damage.
MV in Gate Test	26	The drive has Medium Voltage applied and the user attempted to place the drive in Gating Test mode.	<ul style="list-style-type: none"> – Check input contactor control and Status – Ensure that the isolation switch is in the open position and locked out – Confirm with hot-stick and status parameters
MV in System Test	27	The drive has Medium Voltage applied and the user attempted to place the drive in System Test mode.	<ul style="list-style-type: none"> – Check input contactor control and Status – Ensure that the isolation switch is in the open position and locked out – Confirm with hot-stick and status parameters
No DO/OP Ctctr	37	This fault is specifically used for Open Circuit Test Mode, which demands that an Output Contactor be specified in IsoSw/Ctctr Cfg (P192). If the contactor is not specified, you will get this fault in Open Circuit Test Mode. This is to help avoid inexperienced people putting the drive in open circuit test mode without actually open circuiting the output with either a contactor or by disconnecting the cable.	<ul style="list-style-type: none"> – If there truly is no Output Contactor in the system, then you can mask the fault. Then there will be a No DO/OP Ctctr warning, and you can continue with the test.
Open Cct UV	36	Under Voltage during open circuit test	<ul style="list-style-type: none"> – During open circuit test mode the drive trips on this fault if difference between flux command base speed value and drive output voltage is more than 40%, and speed ramped to 95% of the line frequency. – Check if any short circuit at the drive output – Make sure motor is not connected
OutPut Open	43	DO or OP open fault	<ul style="list-style-type: none"> – Drive sees DO or OP contactor open. – Check for open circuit at the drive output

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
PD Capcty Lo	47	Parallel Drive Capacity Low. This is applicable to parallel drive only	<ul style="list-style-type: none"> – The available drive capacity is less than 50% of the motor rated current. The drive cannot run.
Pressure Loss (C-Frame Only)	223	The measured system pressure has dropped below a preset trip level. The standard operating pressure is around 50psi. The pressure switch is not designed to be an accurate measure of pressure, but is designed as a Pressure/No Pressure indication. Typically anything less than 20psi will activate this switch.	<ul style="list-style-type: none"> – Check that the pumps are operating – Verify that there are no leaks in the system – Verify that there is no blockage in the system
Printer USART	242	CIB Hardware Fault	<ul style="list-style-type: none"> – CIB Hardware Problem – Cycle control Power to the drive, and if the problem still exists the board should be replaced
Pump/Fan Pwr Off (C-Frame Only)	230	The control power to the pumping system and the heat exchanger fans is not present.	<ul style="list-style-type: none"> – Verify the disconnect switch is closed and that there are no blown fuses – Measure the voltage at the pump and fan inputs to ensure voltage is present – Trace the feedback to the drive from the circuit, looking for loose wiring or incorrect auxiliaries
R Neutral OC	206	Neutral Resistor Over Current. This is applicable to Direct to Drive only	<ul style="list-style-type: none"> – Check the neutral R for open – Check devices on rectifier and inverter for short circuits – This fault code may also indicate a non-operational Motor Filter Capacitor (MFC). Refer to the 'Filter Capacitor' section on page 6-15. – Operating a synchronous transfer system (specifically the Transfer-to-Drive function) with a non-operational MFC can lead to serious personnel injury and/or property damage.
Rect Heatsink FO	198	While Not Running, the Fiber Optic signal from the TFB on the Rectifier Heatsink, connected to Channel A fiber optic receiver RX7 on FOI-L-A is not present. This is only a fault while not running. If this occurs while running it will appear as a warning.	<ul style="list-style-type: none"> – Check TFB and FOI board for power – Check the Fiber Optic cables are properly seated in the transmitters and receivers – Check the fiber optic cable for kinks/bends/breaks that could be blocking the signal
Rect Temp ChB FO	199	Not Normally Used: While Not Running, the Fiber Optic signal from the optional TFB connected to Channel B fiber optic receiver RX7 on FOI-L-B is not present. This is only a fault while not running. If this occurs while running it will appear as a warning.	
Rec HS Low Temp	204	If the measured temperature RHeatsink Temp C (P254) is less than 2°C, and the drive is not running, the drive will display this fault.	<ul style="list-style-type: none"> – Verify that the ambient in the control room is not below 2°C – Verify power to the TFB

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Rec ChB Low Temp	205	If the measured temperature Temp R Ch B C (P556) is less than 2°C, and the drive is not running, the drive will display this fault. This is not enabled on most drives, and the parameter is a high-level parameter.	<ul style="list-style-type: none"> – There could be a mechanical problem with the temperature sensor or with the cable feeding the signal back to the TFB – Swap with the inverter hardware to identify the bad component
Rect HeatSink OT	193	The temperature detection on the Rectifier Heatsink, connected to Channel A fiber optic receiver RX7 on FOI-L-A, has exceeded Rectifier Heatsink Temperature Trip (P315).	<ul style="list-style-type: none"> – Confirm actual temperature in parameters is not higher than the trip value – If so, investigate the conditions of the drive (ambient/ loading/ elevation / ventilation/ filter status /heatsink clogging)
Rect ChannelB OT	194	Not Normally Used - The temperature detection on a Rectifier Heatsink, connected to fiber optic receiver RX7 on FOI-L-B, has exceeded Rectifier Temperature Trip Channel B (P525).	<ul style="list-style-type: none"> – Check TFB and FOI board for power and fiber optic integrity – Check the sensor and temperature offline (ambient) for accuracy
Rec HS Sensor	201	The drive has detected a missing temperature sensor connected to the TFB on the rectifier heatsink. A missing sensor can result in either a Fiber Optic Loss fault or a Sensor fault because a missing sensor can be interpreted as either 0°C or over 100°C, and both are unrealistic values.	<ul style="list-style-type: none"> – Verify sensor is completely seated properly on TFB. – Measure sensor resistance. – Replace if necessary.
Rec ChB Sensor	202	Not normally used: The drive has detected a missing temperature sensor connected to the optional TFB connected to the fiber optic receiver RX7 on FOI-L-B. A missing sensor can result in either a Fiber Optic Loss fault or a Sensor fault because a missing sensor can be interpreted as either 0°C or over 100°C, and both are unrealistic values.	
RNeutral OL	203	The neutral resistor required for Direct-to-Drive technology has reached an overload condition. This is determined from parameters R Neutral (P680), R Neutral Rating (P681). The current through the neutral resistor is calculated by measuring the voltage across the resistor and knowing the resistance. I Common Mode (P697) displays that current, and R Neutral OL (P682) shows the overload accumulator. The resistor is allowed 500% for 10 seconds every 5 minutes, and P682 is normalized to fault whenever the value reaches 1.00.	<ul style="list-style-type: none"> – Verify the resistor ratings – Verify that the drive Voltage Feedback Splitter board is operating properly – Investigate the possibility of voltage unbalances on the input or output of the drive that would create a voltage differential across the resistor – Contact the factory for further instructions – This fault code may also indicate a non-operational Motor Filter Capacitor (MFC). Refer to the 'Filter Capacitor' section on page 6-15. – Operating a synchronous transfer system (specifically the Transfer-to-Drive function) with a non-operational MFC can lead to serious personnel injury and/or property damage.

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
SCB Incompat	177	Signal Conditioning Board Incompatible	<ul style="list-style-type: none"> – This is for DTD drive only – The SCB -280 and 380 are used in DTD drive. The boards have different filter that cause this fault. – Use -380 board on SCBL and SCBM
Slave1 CurrentUB	164	The measured and calculated phase currents in the Slave 1 Bridge have exceeded the value set in Line Current Unbalance Trip (P108) for the duration set in Line Current Unbalance Delay (P109).	<ul style="list-style-type: none"> – Verify that all Current Transformer connections are connected properly and that no wires are reversed – Ring-out wires to verify connections – Check grounding on CTs – Ensure that all plugs are firmly connected in the SCBL – Check that all input voltages are balanced
Slave2 CurrentUB	165	The measured and calculated phase currents in the Slave2 Bridge have exceeded the value set in Line Current Unbalance Trip (P108) for the duration set in Line Current Unbalance Delay (P109).	<ul style="list-style-type: none"> – Verify Parameter settings – Check the burden resistors – Verify the Input Capacitor values if installed – Verify that there are no open sharing resistors – Verify all Line Thyristors are firing in Gating Test Mode
Slave1 Phasing	168	The voltage phasing on the Slave1 bridge is not phased the same as the voltages on the Master bridge.	<ul style="list-style-type: none"> – Verify cables are terminated correctly – Verify the feedback wires from the terminals to the VSB is terminated correctly – The faults can be masked, and then the voltages and phasing can be checked using the test points on the SCB-L, being aware that there will be phase differences between the master and secondary bridges depending on the drive configuration. Refer to Manual.
Slave2 Phasing	169	The voltage phasing on the Slave 2 bridge is not phased the same as the voltages in the Master Bridge.	
Slave1 VoltageUB	161	The measured phase voltages in the Slave 1 Bridge have exceeded the value set in Line Voltage Unbalance Trip (P271) for the duration set in Line Voltage Unbalance Delay (P272).	<ul style="list-style-type: none"> – CHECK TSN FUSING – Verify the VSB connections and tap settings, and check resistance of VSB board – Megger board to confirm integrity – Check actual voltage values on the Operator Interface terminal for each bridge and the total line voltage – Check for possible source voltage supply problems – Use Multimeter and Oscilloscope to check voltages on the drive voltage test points
Slave2 VoltageUB	162	The measured phase voltages in the Slave2 Bridge have exceeded the value set in Line Voltage Unbalance Trip (P271) for the duration set in Line Voltage Unbalance Delay (P272).	

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
Spd Cmd Loss	317	The drive has lost communication with the device responsible for providing the speed command to the drive. This has been set to announce as a fault. The drive will configure the Speed Command Loss as a fault when the associated bit in Adapter Loss Mask (P175) is set to a 1. Setting the bit to 0 will cause the drive to indicate a warning and run at the last commanded speed.	<ul style="list-style-type: none"> – Ensure that the SCANport device is powered – Verify the SCANport light status and ensure the device is operating properly – Verify the customer SCANport network is properly communicated with the device – Check CIB LED status – Cycle control power to the drive – Change the Adapter and/or CIB if all attempts to restore communication fail
Sync Xfer Failed	75	A Synchronous Transfer was not completed in the time specified in Synchronous Transfer Time (P230) and the drive has faulted. This fault will only occur if the parameter Sync Xfer Option (P419) is configured as Enable Fault. If the parameter is set as Enable Warn, the drive will go back to last speed command and issue a warning.	<ul style="list-style-type: none"> – Instability at Synchronous Speed - Check for stability of the synchronous transfer process/ speed regulator – Load can not reach Synchronous Speed <ul style="list-style-type: none"> – Check load conditions for torque limit or low alpha line (low line voltage) – Consult factory for review of synchronous transfer parameters
Tach Loss F	42	Tach Loss fault	<ul style="list-style-type: none"> – Check the tach feedback
Temp Feedback Ls (C-Frame only)	232	This fault occurs only if the drive is not running. The drive has detected missing temperature feedback from the cooling system. A missing sensor can be interpreted as either 0°C or over 100°C, and both are unrealistic values, so it is considered a Feedback Loss.	<ul style="list-style-type: none"> – Verify sensor is completely seated properly on TFB. – Measure sensor resistance. – Verify Fiber Optics are properly seated on TFB – Verify the TFB has power – Replace if necessary.
Terminal USART	241	CIB Hardware Fault	<ul style="list-style-type: none"> – CIB Hardware Problem – Cycle control Power to the drive, and if the problem still exists the board should be replaced
XIO Interface	244	CIB Hardware Fault	<ul style="list-style-type: none"> – CIB Hardware Problem – Cycle control Power to the drive, and if the problem still exists the board should be replaced
U1A Device Flt	117	INVERTER SGCT FAULT This fault will only occur during the initial contactor closure and the diagnostic sequence after a start command. The inverter monitors the state of the feedback before a gate pulse is given, and monitors the feedback after a gate pulse has been sent. The SGCT has smart diagnostics, so the feedback may indicate short before firing, and if the pulse is received and the device is really shorted, the diagnostic will toggle the feedback to let you know the problem is with the device, or the power supply for that device.	<ul style="list-style-type: none"> – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed – Check the LED status of the SGCT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify the associated 20V power supply is powered and active – Verify all the power connections to the SGCT firing card are seated properly
U1B Device Flt	123		
U1C Device Flt	480		
U4A Device Flt	120		
U4B Device Flt	126		
U4C Device Flt	483		
V3A Device Flt	119		
V3B Device Flt	125		
V3C Device Flt	482		
V6A Device Flt	122		
V6B Device Flt	128		
V6C Device Flt	485		
W2A Device Flt	118		
W2B Device Flt	124		
W2C Device Flt	481		
W5A Device Flt	121		

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
W5B Device Fit	127	The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting faults before any destructive action is taken from the next action	
W5C Device Fit	484		
U1A Fbk FO Loss	93	<p>INVERTER SGCT FAULT (Feedback Fiber-Optic Loss)</p> <p>This fault will only occur during the initial contactor closure and the diagnostic sequence after a start command. The inverter monitors the state of the feedback before a gate pulse is given, and monitors the feedback after a gate pulse has been sent. This fault occurs when the feedback was low from the device before gating, and is still low from the device after gating. The drive then assumes the feedback must be the problem.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting faults before any destructive action is taken from the next action</p>	<ul style="list-style-type: none"> – Check that the fiber optic cables are seated properly in the Optical Interface Board and the SCGT firing card – Check that the fiber optic cable is not pinched or damaged – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed – Check the LED status of the SCGT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify the associated 20V power supply is powered and active – Verify all the power connections to the SCGT firing card are seated properly
U1B Fbk FO Loss	99		
U1C Fbk FO Loss	468		
U4A Fbk FO Loss	96		
U4B Fbk FO Loss	102		
U4C Fbk FO Loss	471		
V3A Fbk FO Loss	95		
V3B Fbk FO Loss	101		
V3C Fbk FO Loss	470		
V6A Fbk FO Loss	98		
V6B Fbk FO Loss	104		
V6C Fbk FO Loss	473		
W2A Fbk FO Loss	94		
W2B Fbk FO Loss	100		
W2C Fbk FO Loss	469		
W5A Fbk FO Loss	97		
W5B Fbk FO Loss	103		
W5C Fbk FO Loss	472		
U1A Gat FO Loss	105	<p>INVERTER SGCT FAULT (Gating Fiber-Optic Loss)</p> <p>This fault will only occur during the initial contactor closure and the diagnostic sequence after a start command. The inverter monitors the state of the feedback before a gate pulse is given, and monitors the feedback after a gate pulse has been sent. This fault occurs when the feedback was high from the device before gating, and is still high from the device after gating. The drive then assumes the gating pulse must not have reached the device.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting faults before any destructive action is taken from the next action</p>	<ul style="list-style-type: none"> – Check that the fiber optic cables are seated properly in the Optical Interface Board and the SCGT firing card – Check that the fiber optic cable is not pinched or damaged – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed – Check the LED status of the SCGT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify the associated 20V power supply is powered and active – Verify all the power connections to the SCGT firing card are seated properly
U1B Gat FO Loss	111		
U1C Gat FO Loss	474		
U4A Gat FO Loss	108		
U4B Gat FO Loss	114		
U4C Gat FO Loss	477		
V3A Gat FO Loss	107		
V3B Gat FO Loss	113		
V3C Gat FO Loss	476		
V6A Gat FO Loss	110		
V6B Gat FO Loss	116		
V6C Gat FO Loss	479		
W2A Gat FO Loss	106		
W2B Gat FO Loss	112		
W2C Gat FO Loss	475		
W5A Gat FO Loss	109		
W5B Gat FO Loss	115		
W5C Gat FO Loss	478		

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
U1A Online Flt	81	<p>INVERTER SGCT FAULT</p> <p>This fault will occur during operation of the drive. The drive has detected that the feedback from the device was not correct, and does not wait to determine the exact problem. The drive polls the entire bridge 3 times before and 3 times after each gating command. All 6 of these readings for each device must be consistent for the fault to occur. There is also a parameter called Inverter Device Diagnostic Delay (P268), which allows you to change the number of consecutive firings to eliminate nuisance faults. It will still poll 3 times before and after each firing, but will now require the condition to exist for the number of consecutive firings set in the Diagnostic Delay parameter for a fault to occur.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting faults before any destructive action is taken from the next action</p>	<ul style="list-style-type: none"> – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed – Check the LED status of the SCGT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify the associated 20V power supply is powered and active – Verify all the power connections to the SCGT firing card are seated properly – For nuisance faults, contact the factory about extending the Diagnostic Delay
U1B Online Flt	87		
U1C Online Flt	462		
U4A Online Flt	84		
U4B Online Flt	90		
U4C Online Flt	465		
V3A Online Flt	83		
V3B Online Flt	89		
V3C Online Flt	464		
V6A Online Flt	86		
V6B Online Flt	92		
V6C Online Flt	467		
W2A Online Flt	82		
W2B Online Flt	88		
W2C Online Flt	463		
W5A Online Flt	85		
W5B Online Flt	91		
W5C Online Flt	466		
2U1A Device Flt	291	<p>PWM RECTIFIER SGCT FAULT</p> <p>This fault will occur during the initial contactor closure, the diagnostic sequence after a start command, or the diagnostic sequence after a stop command. The rectifier monitors the state of the feedback before a gate pulse is given, and monitors the feedback after a gate pulse has been sent. The SGCT has smart diagnostics, so the feedback may indicate short before firing, and if the pulse is received and the device is really shorted, the diagnostic will toggle the feedback to let you know the problem is with the device, or the power supply for that device.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting faults before any destructive action is taken from the next action. The main example of this is closing the input contactor on a shorted bridge.</p>	<ul style="list-style-type: none"> – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed – Check the LED status of the SCGT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify the associated 20V power supply is powered and active – Verify all the power connections to the SCGT firing card are seated properly
2U1B Device Flt	297		
2U1C Device Flt	336		
2U4A Device Flt	294		
2U4B Device Flt	300		
2U4C Device Flt	339		
2V3A Device Flt	293		
2V3B Device Flt	299		
2V3C Device Flt	338		
2V6A Device Flt	296		
2V6B Device Flt	302		
2V6C Device Flt	341		
2W2A Device Flt	292		
2W2B Device Flt	298		
2W2C Device Flt	337		
2W5A Device Flt	295		
2W5B Device Flt	301		
2W5C Device Flt	340		

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
2U1A Fbk FO Loss	267	<p>PWM RECTIFIER SGCT FAULT (Feedback Fiber-Optic Loss)</p> <p>This fault will occur during the initial contactor closure, the diagnostic sequence after a start command, or the diagnostic sequence after a stop command. The rectifier monitors the state of the feedback before a gate pulse is given, and monitors the feedback after a gate pulse has been sent. This fault occurs when the feedback was low from the device before gating, and is still low from the device after gating. The drive then assumes the feedback must be the problem.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting faults before any destructive action is taken from the next action</p>	<ul style="list-style-type: none"> – Verify that the Feedback Fiber-Optic from the SCGT to the FOI board is not damaged or disconnected – Verify that the Gate Pulse has been received by the SGCT board using Gating Test Mode – Complete a resistance check described in Chapter 4, checking the devices, sharing resistors, and snubber circuitry – Replace all faulty components
2U1B Fbk FO Loss	273		
2U1C Fbk FO Loss	324		
2U4A Fbk FO Loss	270		
2U4B Fbk FO Loss	276		
2U4C Fbk FO Loss	327		
2V3A Fbk FO Loss	269		
2V3B Fbk FO Loss	275		
2V3C Fbk FO Loss	326		
2V6A Fbk FO Loss	272		
2V6B Fbk FO Loss	278		
2V6C Fbk FO Loss	329		
2W2A Fbk FO Loss	268		
2W2B Fbk FO Loss	274		
2W2C Fbk FO Loss	325		
2W5A Fbk FO Loss	271		
2W5B Fbk FO Loss	277		
2W5C Fbk FO Loss	328		
2U1A Gat FO Loss	279	<p>PWM RECTIFIER SGCT FAULT (Gating Fiber-Optic Loss)</p> <p>This fault will occur during the initial contactor closure, the diagnostic sequence after a start command, or the diagnostic sequence after a stop command. The rectifier monitors the state of the feedback before a gate pulse is given, and monitors the feedback after a gate pulse has been sent. This fault occurs when the feedback was high from the device before gating, and is still high from the device after gating. The drive then assumes the gating pulse must not have reached the device.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting faults before any destructive action is taken from the next action</p>	<ul style="list-style-type: none"> – Check that the fiber optic cables are seated properly in the Optical Interface Board and the SCGT firing card – Check that the fiber optic cable is not pinched or damaged – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed – Check the LED status of the SCGT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify all the power connections to the SCGT firing card are seated properly
2U1B Gat FO Loss	285		
2U1C Gat FO Loss	330		
2U4A Gat FO Loss	282		
2U4B Gat FO Loss	288		
2U4C Gat FO Loss	333		
2V3A Gat FO Loss	281		
2V3B Gat FO Loss	287		
2V3C Gat FO Loss	332		
2V6A Gat FO Loss	284		
2V6B Gat FO Loss	290		
2V6C Gat FO Loss	335		
2W2A Gat FO Loss	280		
2W2B Gat FO Loss	286		
2W2C Gat FO Loss	331		
2W5A Gat FO Loss	283		
2W5B Gat FO Loss	289		
2W5C Gat FO Loss	334		

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
2U1A Online Flt	255	<p>PWM RECTIFIER SGCT FAULT</p> <p>This fault will occur during operation of the drive. The drive has detected that the feedback from the device was not correct, and does not wait to determine the exact problem. The drive polls the entire bridge 3 times before and 3 times after each gating command. All 6 of these readings for each device must be consistent for the fault to occur. There is also a parameter called Rectifier Device Diagnostic Delay (P266), which allows you to change the number of consecutive firings to eliminate nuisance faults. It will still poll 3 times before and after each firing, but will now require the condition to exist for the number of consecutive firings set in the Diagnostic Delay parameter for a fault to occur.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting faults before any destructive action is taken from the next action</p>	<ul style="list-style-type: none"> – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed – Check the LED status of the SCGT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify the associated 20V power supply is powered and active – Verify all the power connections to the SCGT firing card are seated properly – Reset the drive and let the offline diagnostics further define the problem – For nuisance faults, contact the factory about extending the Diagnostic Delay
2U1B Online Flt	261		
2U1C Online Flt	318		
2U4A Online Flt	258		
2U4B Online Flt	264		
2U4C Online Flt	321		
2V3A Online Flt	257		
2V3B Online Flt	263		
2V3C Online Flt	320		
2V6A Online Flt	260		
2V6B Online Flt	266		
2V6C Online Flt	323		
2W2A Online Flt	256		
2W2B Online Flt	262		
2W2C Online Flt	319		
2W5A Online Flt	259		
2W5B Online Flt	265		
2W5C Online Flt	322		
2U1A Offline OC	366	<p>6P or 18P SCR RECTIFIER FAULT (Offline Open-Circuit)</p> <p>For SCR rectifiers, this fault will occur after the initial contact closure, or during the diagnostic sequence after a start command. After the Short-Circuit test described below, the drive fires each device, and verifies that the feedback from that device went low. If the feedback does not go low, the drive assumes the SCR must be Open-Circuited.</p>	<ul style="list-style-type: none"> – Complete a resistance check on the rectifier, including the gate-cathode resistance, the snubber and sharing resistors – Complete a firing check on the rectifier – Verify the snubber circuitry, and the sharing resistors – Verify fiber optic integrity from FOI board transmitter to SCRGD board receiver – Replace all faulty components
2U1B Offline OC	372		
2U1C Offline OC	402		
2U4A Offline OC	369		
2U4B Offline OC	375		
2U4C Offline OC	405		
2V3A Offline OC	368		
2V3B Offline OC	374		
2V3C Offline OC	404		
2V6A Offline OC	371		
2V6B Offline OC	377		
2V6C Offline OC	407		
2W2A Offline OC	367		
2W2B Offline OC	373		
2W2C Offline OC	403		
2W5A Offline OC	370		
2W5B Offline OC	376		
2W5C Offline OC	406		
3U1B Offline OC	438		
3U4B Offline OC	441		
3V3B Offline OC	440		
3V6B Offline OC	443		
3W2B Offline OC	439		
3W5B Offline OC	442		
4U1C Offline OC	444		
4U4C Offline OC	447		
4V3C Offline OC	446		

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
4V6C Offline OC	449		
4W2C Offline OC	445		
4W5C Offline OC	448		
2U1A Offline SC	378	<p>6P or 18P SCR RECTIFIER FAULT (Offline Short-Circuit)</p> <p>For SCR rectifiers, this fault will occur after the initial contact closure, or during the diagnostic sequence after a start command. This is the first test on the rectifier. When all devices blocking, the feedback from the devices should toggle from open to short to open every time the line voltage sine wave passes through zero. If this is consistently showing short (no feedback), then the drive assumes that the device is Short-Circuited.</p>	<ul style="list-style-type: none"> – Complete a resistance check on the rectifier, including the gate-cathode resistance, the snubber and sharing resistors – Complete a firing check on the rectifier – Verify the snubber circuitry, and the sharing resistors – Verify fiber optic integrity from SCRGD board transmitter to FOI board receiver – Replace all faulty components
2U1B Offline SC	384		
2U1C Offline SC	408		
2U4A Offline SC	381		
2U4B Offline SC	387		
2U4C Offline SC	411		
2V3A Offline SC	380		
2V3B Offline SC	386		
2V3C Offline SC	410		
2V6A Offline SC	383		
2V6B Offline SC	389		
2V6C Offline SC	413		
2W2A Offline SC	379		
2W2B Offline SC	385		
2W2C Offline SC	409		
2W5A Offline SC	382		
2W5B Offline SC	388		
2W5C Offline SC	412		
3U1B Offline SC	450		
3U4B Offline SC	453		
3V3B Offline SC	452		
3V6B Offline SC	455		
3W2B Offline SC	451		
3W5B Offline SC	454		
4U1C Offline SC	456		
4U4C Offline SC	459		
4V3C Offline SC	458		
4V6C Offline SC	461		
4W2C Offline SC	457		
4W5C Offline SC	460		
2U1A Online OC	342	<p>6P or 18P SCR RECTIFIER FAULT (Online Open-Circuit)</p> <p>For SCR rectifiers, this fault will occur during operation. After a firing signal is sent to a device, the drive monitors the feedback status to ensure the voltage drops to zero across that device, indicating it has been turned on. If the feedback does not drop to zero before approximately 30-50 μsec, the drive will assume the device is open and a fault will occur. There is a 6 cycle fixed delay, which means that this has to occur for 6 consecutive firings before the fault is instigated.</p>	<ul style="list-style-type: none"> – Complete a resistance check on the rectifier, including the gate-cathode resistance, the snubber and sharing resistors – Complete a firing check on the rectifier – Verify the snubber circuitry, and the sharing resistors – Verify fiber optic integrity from FOI board transmitter to SCRGD board receiver – Replace all faulty components
2U1B Online OC	348		
2U1C Online OC	390		
2U4A Online OC	345		
2U4B Online OC	351		
2U4C Online OC	393		
2V3A Online OC	344		
2V3B Online OC	350		
2V3C Online OC	392		
2V6A Online OC	347		
2V6B Online OC	353		
2V6C Online OC	395		
2W2A Online OC	343		
2W2B Online OC	349		
2W2C Online OC	391		
2W5A Online OC	346		
2W5B Online OC	352		
2W5C Online OC	394		

FAULT MESSAGE	FAULT CODE	DESCRIPTION	RECOMMENDED ACTIONS
3U1B Online OC	414		
3U4B Online OC	417		
3V3B Online OC	416		
3V6B Online OC	419		
3W2B Online OC	415		
3W5B Online OC	418		
4U1C Online OC	420		
4U4C Online OC	423		
4V3C Online OC	422		
4V6C Online OC	425		
4W2C Online OC	421		
4W5C Online OC	424		
2U1A Online SC	354	<p>6P or 18P SCR RECTIFIER FAULT (Online Short-Circuit)</p> <p>For SCR rectifiers, this fault will occur during operation. Before an individual leg is fired, the drive takes 5 samples of the voltage across that device. This is because the notching on the line could cause individual readings to be low. If they are all low, the device is assumed to be short-circuited and a fault occurs. There is also a parameter called Rectifier Device Diagnostic Delay (P266), which allows you to change the number of consecutive firings to eliminate nuisance faults. It will still check 5 times before each firing, but will now require the condition to exist for the number of consecutive firings set in the Diagnostic Delay parameter for a fault to occur.</p>	<ul style="list-style-type: none"> – For multiple device faults, the risk of a line to line short exists, so tests with MV isolated should be attempted – Complete a resistance check on the rectifier, including the gate-cathode resistance, the snubber and sharing resistors – Complete a firing check on the rectifier – Verify the snubber circuitry, and the sharing resistors – Verify fiber optic integrity from SCRGD board transmitter to FOI board receiver – Replace all faulty components – For nuisance faults, contact the factory about extending the Diagnostic Delay
2U1B Online SC	360		
2U1C Online SC	396		
2U4A Online SC	357		
2U4B Online SC	363		
2U4C Online SC	399		
2V3A Online SC	356		
2V3B Online SC	362		
2V3C Online SC	398		
2V6A Online SC	359		
2V6B Online SC	365		
2V6C Online SC	401		
2W2A Online SC	355		
2W2B Online SC	361		
2W2C Online SC	397		
2W5A Online SC	358		
2W5B Online SC	364		
2W5C Online SC	400		
3U1B Online SC	426		
3U4B Online SC	429		
3V3B Online SC	428		
3V6B Online SC	431		
3W2B Online SC	427		
3W5B Online SC	430		
4U1C Online SC	432		
4U4C Online SC	435		
4V3C Online SC	434		
4V6C Online SC	437		
4W2C Online SC	433		
4W5C Online SC	436		

WARNING MESSAGES

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
AC/DC#1 DC Fail	95	The output of the specified AC/DC Power Supply has seen the 56VDC output voltage drop below the hardwired trip level. The trip level is fixed in hardware as 52VDC ± 1.7VDC, depending on hardware tolerances. All of the outputs of the optional multiple AC/DC power supplies are individually monitored and displayed separately. THIS WILL ONLY APPEAR IF YOU HAVE A REDUNDANT POWER SUPPLY.	<ul style="list-style-type: none"> – Measure the input voltage and verify it is within limits – Measure the output voltage and confirm whether the output level indeed falls below the trip level – Verify fault detection wiring is per the drawings, and measure the voltage on the trip signals back to the CIB. The 5VDC is supplied from the CIB to the fault circuit, and is pulled low on the power supply when healthy. – Verify the internal cooling fan is operational – Replace the Power Supply if required
AC/DC#2 DC Fail	96		
AC/DC#3 DC Fail	97		
AC/DC#4 DC Fail	98		
AC/DC#5 DC Fail	99		
AC/DC#6 DC Fail	100		
AC300 AC Fail	103	The AC Fail signal from the 300W AC/DC power supplies has been activated. This is treated as a warning since a real loss of this input voltage will result in a subsequent DC fail signal. This happens at 85VAC.	<ul style="list-style-type: none"> – Investigate possibility of loss of input voltage to the AC/DC Power Supply – Verify output voltage – Check alarm signal connections – Replace Power Supply if necessary.
AC/DC PS AC Fail	102	The AC Fail signal from the 1500W AC/DC power supplies has been activated. We treat this as a warning since a real loss of this input voltage will result in a subsequent DC fail signal. This will occur at 127VAC L-L for 3-phase supplies, and 90VAC for single-phase supplies.	<ul style="list-style-type: none"> – Investigate possibility of loss of input voltage to the AC/DC Power Supply – Verify output voltage – Check alarm signal connections – Replace Power Supply if necessary.
Adapter 1 Loss	175	There has been a loss of communication between the CIB and the identified SCANport Adapter (Polled Communication). This will appear as a warning in the drive when the associated bits in Adapter Loss Mask (P175) are set to a 0.	<ul style="list-style-type: none"> – Ensure that the SCANport device is powered – Verify the SCANport light status and ensure the device is operating properly – Verify the customer SCANport network is properly communicated with the device – Check CIB LED status – Cycle control power to the drive – Change the adapter if all attempts to restore communication fail
Adapter 2 Loss	176		
Adapter 3 Loss	177		
Adapter 4 Loss	178		
Adapter 5 Loss	179		
Adapter 6 Loss	180		

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
Air Filter	29	The Pressure drop at the input to the converter section sensed by the pressure transducer (as a voltage) has dropped below the value set in Pressure Value Alarm (P320). This is dependent on the operation of the Main Cooling Fan.	<ul style="list-style-type: none"> – Verify fan rotation – Check for blocked airflow in the filters/ heatsinks/ ducting (if installed) – Clean as required – Improper Alarm settings – Verify Pressure Value voltage level when running with clear air flow, and compare to expected values for that specific drive type – Verify Alarm and Trip set-up procedure was completed adequately and adjust as necessary – Verify for drives with external ducting that there is sufficient air to the drive input – Verify supply voltage to differential pressure transducer, and confirm output is stable
Autotune TimeLmt	53	Indicates that the autotune test could not measure the parameter in the allotted time.	<ul style="list-style-type: none"> – REFER TO THE POWERFLEX 7000 SERIES B MANUAL (CHAPTER 4 – COMMISSIONING) ON AUTOTUNE PROCEDURES, RESULTS, AND ACTIONS
Auxiliary Prot'n	71	Standard External Fault/Warning Input included to allow the end-user to install a protective relay/system status contact that can activate a drive fault or warning, depending on configuration of Aux Prot Class (P445)	<ul style="list-style-type: none"> – See associated Fault Description
Bus Transient	123	The drive has detected a transient of rapid loss of line, and has placed both bridges in freewheel mode until event clears.	<ul style="list-style-type: none"> – Check system for capacitive switching events – Contact factory for detailed actions
Buss Fault Line	200	DEVELOPMENT ERROR – NOT ACTIVE	–
Buss Fault Motor	194	DEVELOPMENT ERROR – NOT ACTIVE	–
Buss Flt Ext Mem	162	DEVELOPMENT ERROR – NOT ACTIVE	–
Buss Flt FPGA	161	DEVELOPMENT ERROR – NOT ACTIVE	–
Bypass OV	184	The measured Line-Side Bypass Voltage has exceeded Line Overvoltage Trip (P165) for the duration set in Line Overvoltage Delay (P166).	<ul style="list-style-type: none"> – Verify the parameters are set properly – Check for possible line voltage transients – Verify VSB connections and tap settings, resistor values, and grounds – If voltage is too high, change tap settings on the input source to lower voltage to an acceptable level
Bypass Rvs Rotn	187	The phase sequence on the voltage measured on the primary side of the Bypass Contactor is not the same as the phase sequence on the output of the drive.	<ul style="list-style-type: none"> – The drive will not allow a synchronous transfer unless the phasing is the same – Confirm the phase sequences and swap cables if necessary

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
Bypass UV	185	The measured Line-Side Bypass Voltage is less than Line Undervoltage Trip (P167) for the period set by Line Undervoltage Delay (P166).	<ul style="list-style-type: none"> – Verify the VSB connections and tap settings, and check resistance of VSB board – Megger board to confirm integrity – Check for possible source voltage supply problems – Use Multimeter and Oscilloscope to check voltages on the drive test points
Bypass Volt UB	186	The measured Line-Side Bypass Voltage has exceeded the value set in Line Voltage Unbalance Trip (P271) for the duration set in Line Voltage Unbalance Delay (P272).	<ul style="list-style-type: none"> – Verify the VSB connections and tap settings, and check resistance of VSB board – Megger board to confirm integrity – Check for possible source voltage supply problems – Use Multimeter and Oscilloscope to check voltages on the drive voltage test points
CIB Battery Low	159	The battery on the CIB that powers the NVRAM has reached a preset low level of 2.6VDC.	<ul style="list-style-type: none"> – Replace the PowerCap on the CIB board
Conductivity Hi (C-FRAME ONLY)	147	The measured conductivity is greater than 1 $\mu\text{S}/\text{cm}^3$.	<ul style="list-style-type: none"> – Verify that no foreign debris has entered the system (iron piping, non-deionized water, etc.) – There is no immediate need for action, but be prepared to change the de-ionizing cartridge and run the system, verifying that the conductivity is decreasing
Coolant Level Lo (C-FRAME ONLY)	148	The level of the coolant in the reservoir has dropped below the low level warning indicator, activating the warning.	<ul style="list-style-type: none"> – You will lose coolant over time through evaporation, but you should still verify that there are no slow leaks in the system – Add de-ionized water to the system since this is what normally evaporates, and check the coolant mixture with a glycol tester
Coolant Temp Low (C-FRAME ONLY)	145	The measured coolant temperature has dropped below 10°C (50°F). The warning will not clear until the temperature rises above 15°C (58°F).	<ul style="list-style-type: none"> – Verify that the thermostatic bypass valve (V10) was not left open – Warm up the control room ambient to get the drive to an operational level
Coolant Temp Hi (C-FRAME ONLY)	146	The measured coolant temperature has exceeded 48°C (120°F). The warning can not be cleared until the temperature has dropped below 44°C (110°F).	<ul style="list-style-type: none"> – Verify the heat exchanger fans are operating – Verify that the thermostatic valve is fully opened – Check that all valves are in the normal operating position
Ctrl Power Loss	191	This warning tells the drive that the control power has dipped, and this is used in the Autorestart feature algorithm as an indicator to tell the drive to stop gating and wait for control power to return	<ul style="list-style-type: none"> – Investigate reliability of the control power – Ensure the drive operates as expected when there is a control power outage (UPS must be installed)

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
DI Contctr Fdbk	118	This warning indicates that the drive has sensed MV on the front end, but there is no input contactor status coming back to the drive	<ul style="list-style-type: none"> – Verify the contactor is closed – Confirm the feedback path from the contactor to the XIO – Replace XIO if required
DI Contctr Open	18	The input contactor has been commanded to close and the contactor closed feedback has not been detected.	<ul style="list-style-type: none"> – Ensure the associated starter unit is set to Normal mode – Verify the feedback from the contactor status (normally control relay auxiliary and contactor mechanical auxiliary) is wired properly and powered – Verify that there is control power to the contactor – Verify the associated SCB I/O – Verify that the Holding Coil or Closing Coil is not shorted – Review Contactor control wiring – These warnings may also occur during the autorestart feature, as the loss of power may also result in the inability to hold in the contactor during the outage
DI Contctr Clsd	19	The input contactor has been commanded to open and the contactor open feedback has not been detected.	
DO Contctr Open	20	The output contactor has been commanded to close and the contactor closed feedback has not been detected.	
DO Contctr Clsd	21	The output contactor has been commanded to open and the contactor open feedback has not been detected.	
OP Contctr Open	46	The system output contactor has been commanded to close and the contactor closed feedback has not been detected.	
OP Contctr Clsd	47	The system output contactor has been commanded to open and the contactor open feedback has not been detected.	
BP Contctr Open	37	The bypass contactor has been commanded to close and the contactor closed feedback has not been detected.	
BP Contctr Clsd	38	The bypass contactor has been commanded to open and the contactor open feedback has not been detected.	

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS	
DI IsoSw Open	42	The Drive Input Isolation Switch is Open when it is expected to be closed, which is in Normal mode, DC Current test mode, Open Loop test mode, and Open Circuit test mode,	<ul style="list-style-type: none"> – In DC Current test modes, the isolation switches are expected to be closed for DC Current test; although only the input contactor is required the test will run with warnings if the switches are open – Ensure the isolation switches are in the proper position for the specific operating mode (Refer to the description of the Parameter 192 – IsolSw /Ctctr Cfg in the parameters manual) – Verify wiring feedback – Verify isolation switch mechanical auxiliary setup 	
DI IsoSw Clsd	324	The Drive Input Isolation Switch is Closed when it is expected to be open, which is in System Test mode and Gating Test mode.		
DO IsoSw Open	43	The Drive Output Isolation Switch is Open when it is expected to be closed, which is in Normal mode, DC Current test mode, and Open Loop test mode.		
DO IsoSw Clsd	325	The Drive Output Isolation Switch is Closed when it is expected to be open, which is in Open Circuit mode, System Test mode and Gating Test mode		
OP IsoSw Open	45	The System Output Isolation Switch is Open when it is expected to be closed, which is in Normal mode, DC Current test mode, and Open Loop test mode.		
OP IsoSw Clsd	326	The System Output Isolation Switch is Closed when it is expected to be open, which is in Open Circuit mode, System Test mode and Gating Test mode		
BP IsoSw Open	44	The Bypass Isolation Switch is Open when it is expected to be closed, which is in Normal mode, DC Current test mode, and Open Loop test mode.		
BP IsoSw Clsd	327	The Bypass Isolation Switch is Closed when it is expected to be open, which is in Open Circuit mode, System Test mode and Gating Test mode		
DC/DC Redundant	101	The main outputs of the DC/DC power supply (+5VDC, ±15VDC) have failed, but the redundant outputs are still active. This is set at 95% of rated value for 15VDC outputs, and 5.00VDC for 5.3VDC output.		<ul style="list-style-type: none"> – Redundant Supply is paralleled, so there is no way to confirm output voltage level – Verify the output from the alarm signal is wired correctly – Replace Power Supply when possible
DC Link OT	67	The thermal switch in the drive DC Link Reactor has detected an over-temperature and has opened, but was set up as a warning.. There is a thermal switch in each DC Link winding, and they are connected in series.		<ul style="list-style-type: none"> – See associated Fault Description
DC Link OC	115	The measured IDC Link Feedback (P322) has exceeded DC Overcurrent Trip (P169), and instantaneously causes a warning.	<ul style="list-style-type: none"> – See associated Fault Description 	

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
DC Link Range	126	The value entered for the parameter Link Inductance (P27) is below a minimum value for the programmed Drive/Motor ratings. 6P Rectifier – 0.85 pu 18P Rectifier – 0.42 pu PWM Rectifier – 0.55 pu	<ul style="list-style-type: none"> – Review DC Link nameplate data – Review Motor and Drive nameplate data and verify that all parameters were entered properly – Contact factory if the above seems OK
DcLnd Mstr	342	Slave Declined Master-slave only	<ul style="list-style-type: none"> – Slave has lost communication with hub PLC, or slave is masked off in parameter <i>Master Mask</i>
DCBL Battery Low	125	The PowerCap on the DCB-L that powers the NVRAM where the parameters are stored is below 2.6 V DC.	<ul style="list-style-type: none"> – Replace the PowerCap after recording all the parameters to the terminal, through Hyperterminal, with a printer or with DriveTools – Reinstall the parameters
DCBM Battery Low	188	The PowerCap on the DCB-M is below 2.6 V DC..	<ul style="list-style-type: none"> – This is not critical unless you ever put this board in the rectifier position – Replace the PowerCap
Desync Delay On	48	A transfer from the Line back to Drive (desync) has been commanded, but it has been less than 1 minute since the transfer from Drive to Line (sync) was completed. As a result, the Output Motor Filter Capacitors have not had time to adequately discharge.	<ul style="list-style-type: none"> – Wait for 1 minute and attempt the desync transfer again.
DPI Power Loss	109	The 12VDC used for SCANport/DPI communications has dropped below the set trip level.	<ul style="list-style-type: none"> – Verify DC/DC power supply output – Confirm wiring to the CIB from the DC/DC Power Supply
DPI Ram Overflow	163	DEVELOPMENT ERROR – There is an internal communication error in the drive control	<ul style="list-style-type: none"> – Noise/Grounding Issues – Confirm grounding is per the RA drawings – Contact the Factory
Drive OL	111	A Line Overload warning has been detected, where the overload condition is calculated using DC Current Feedback (P322) and Line Overload Warning (P270) as the point where the overload warning occurs. (P270) is programmed as a percentage of the difference between Line Overload Minimum (P269) and Line Overload Trip (P163).	<ul style="list-style-type: none"> – Transient Loading – Check torque limit and overload settings and Compare loading to torque settings and trip settings
Drv in Test Mode	50	The drive Operating Mode (P4) is set to DC Current Test Mode when an Autotune Test that turns the motor is initiated	<ul style="list-style-type: none"> – Place drive back in Normal Mode before attempting Autotune
Duplcte Mstr	341	Duplicate Master-master only	<ul style="list-style-type: none"> – The <i>Powerup Config</i> parameter is set to Master in more than one drive. The first drive to power up will become the master

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
External 1-16	1-16	These are the optional additional External Faults available when there is an additional XIO board installed. This is configured with XIO Ext Faults (P593), and this message will appear if the specific input (1-16) is configured in Fault Config as a Warning.	<ul style="list-style-type: none"> – See associated Fault Description
Fan On	30	The drive control is receiving a hardwired fan feedback even though the fan has not been commanded to run.	<ul style="list-style-type: none"> – Check Fan feedback wiring and confirm with ED
Fan 1 Loss	31	Drives with a Redundant Fan (P141) will give this warning if Fan 1 is running, there were no problems with Fan 2, and Fan 1 is lost. Fan 2 will start and the drive will continue running.	<ul style="list-style-type: none"> – Investigate the cause of the Fan 1 loss (OL / damaged relay) – Verify Fan 2 is operating with the proper current levels – At the next possible shutdown, reset the warnings and Fan 1 can be run again
Fan 2 Loss	32	Drives with a Redundant Fan (P141) will give this warning if Fan 2 is running, there were no problems with Fan 1, and Fan 2 is lost. Fan 1 will start and the drive will continue running.	<ul style="list-style-type: none"> – Investigate the cause of the Fan 2 loss (OL / damaged relay) – Verify Fan 1 is operating with the proper current levels – At the next possible shutdown, reset the warnings and Fan 2 can be run again
Fan1 ContctrOpen	22	When the drive is running, the feedback from the Fan 1 Contactor auxiliary and Isolation Switch is lost, but the drive will not trip and wait for Power Supply faults or Air Pressure faults to fault the drive.	<ul style="list-style-type: none"> – If the drive faults, investigate problems with the fan contactors or the fan overloads – If the drive is still running with this warning, there is a problem with the Fan Isolation Switch auxiliary
Fan2 ContctrOpen	199	When the drive is running, the feedback from the Fan 2 Contactor auxiliary and Isolation Switch is lost, but the drive will not trip and wait for Power Supply faults or Air Pressure faults to fault the drive.	
Gate Test Pwr On	119	The gating harness is plugged into the DC/DC power supply, and the drive has detected some current flow	<ul style="list-style-type: none"> – This will occur whenever attempting a gating test – If there is no gating harness installed, replace the DC/DC power supply
Gnrl IO Config	127	The XIO card which was being assigned to the General I/O is not a card which can be used for this purpose.	<ul style="list-style-type: none"> – Select the proper slot containing the XIO card which is compatible for General I/O usage using XIO General Input/Output (P592)
Gnrl IO Conflict	128	The XIO card previously being used for General I/O has been reassigned for another purpose.	<ul style="list-style-type: none"> – Check the configuration of all XIO slots using XIO General Input/Output (P592) and XIO External Faults (P593), and reassign if necessary.
Ground Differ	160	This represents an excessive difference between the Analog and the Digital grounds, measured on the CIB Board	<ul style="list-style-type: none"> – This could be a problem with the grounding in the drive system – Verify grounds are per the drawings – Replace CIB to eliminate board as a problem – Contact Factory if problem persists

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
HeatExchnger Fan (C-FRAME ONLY)	144	The drive has detected a problem from the Liquid-to-Air heat exchanger fans.	<ul style="list-style-type: none"> – Verify the Fan O/L settings and conditions – Verify the Fan Control Relay status and auxiliary contact signals.
Hub Comm Wrn	340	Hub (PLC) Communication Loss	<ul style="list-style-type: none"> – Check ControlNet adapter and cable
Inertia High	54	Indicates that the Autotune Inertia (P223) was measured higher than 5.0 seconds.	<ul style="list-style-type: none"> – REFER TO THE POWERFLEX 7000 SERIES B MANUAL (CHAPTER 4 – COMMISSIONING) ON AUTOTUNE PROCEDURES, RESULTS, AND ACTIONS
Input Close Dly	39	For PWM drives, this warning indicates that a start command has been given, but the drive is still waiting for the DC voltage to discharge from the line filter capacitors. This can be observed by the status 'Discharging', on the main screen. This time can be based on the capacitor properties, or Parameter 583 – Input Contactor Close Delay (whichever is longer)	<ul style="list-style-type: none"> – Wait for the drive Ready status to appear, allowing you to start the drive – Verify the time in Parameter 583 is not too long
Input Prot'n #1	65	Standard External Fault/Warning Input included to allow the end-user to install a protective relay (IE Input Feed Protection Relay) auxiliary contact that can activate a drive fault or warning, depending on configuration of InputProt1 Class (P440).	<ul style="list-style-type: none"> – See associated Fault Description
Input Prot'n #2	70	Standard External Fault/Warning Input included to allow the end-user to install a second protective relay (IE Input Feed Protection Relay) auxiliary contact that can activate a drive fault or warning, depending on configuration of InputProt2 Class (P445).	<ul style="list-style-type: none"> – See associated Fault Description
Input Xfmr/LR OT	66	The temperature switch in the drive Input Isolation Transformer or Line Reactor has detected an over-temperature and opened. There is a thermal switch in each phase winding, and they are connected in series.	<ul style="list-style-type: none"> – See associated Fault Description
Inv Heatsink FO	197	While Running, the Fiber Optic signal from the TFB on the Inverter Heatsink, connected to Channel A fiber optic receiver RX7 on FOI-M-A is not present. This is only a fault while not running. If this occurs while running it will appear as a warning.	<ul style="list-style-type: none"> – Check TFB and FOI board for power – Check the Fiber Optic cables are properly seated in the transmitters and receivers – Check the fiber optic cable for kinks, bends, breaks that could be blocking the signal
Inv ChannelB FO	198	Not Normally Used: While Running, the Fiber Optic signal from the optional TFB connected to Channel B fiber optic receiver RX7 on FOI-M-B is not present. This is only a fault while not running. If this occurs while running it will appear as a warning.	<ul style="list-style-type: none"> – This can occur if the sensor is not connected to the TFB – NOTE: This is a warning because the drive should not fault on the loss of the signal while running. There is no imminent danger to the drive, but the user needs to be aware that there is a temperature feedback signal missing.

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
Inv Heatsink OT	24	The temperature detection on the Inverter Heatsink, connected to Channel A fiber optic receiver RX7 on FOI-M-A, has exceeded Inverter Heatsink Temperature Warning (P316).	<ul style="list-style-type: none"> – Confirm actual temperature in parameters is not higher than the warning value – If so, investigate the conditions of the drive (ambient / loading/ elevation / ventilation/ filter status / heatsink clogging) – Check the sensor and temperature offline (ambient) for accuracy
Inv ChannelB OT	25	Not Normally Used – The temperature detection on an Inverter Heatsink, connected to fiber optic receiver RX7 on FOI-M-B, has exceeded Inverter Temperature Warning Channel B (P571).	–
Inv HS Sensor	195	While Running, the drive has detected a missing temperature sensor connected to the TFB on the inverter heatsink. A missing sensor can result in either a Fiber Optic Loss fault or a Sensor fault because a missing sensor can be interpreted as either 0°C or over 100°C, and both are unrealistic values.	<ul style="list-style-type: none"> – Verify sensor is completely seated properly on TFB. – Measure sensor resistance. – Replace if necessary. – NOTE: This is a warning because the drive should not fault on the loss of the signal while running. There is no imminent danger to the drive, but the user needs to be aware that there is a temperature feedback signal missing.
Inv ChB Sensor	196	Not normally used: While Running, the drive has detected a missing temperature sensor connected to the optional TFB connected to the fiber optic receiver RX7 on FOI-M-B. A missing sensor can result in either a Fiber Optic Loss fault or a Sensor fault because a missing sensor can be interpreted as either 0°C or over 100°C, and both are unrealistic values.	
Inv Gate pwr	333	Inverter Gate driver power supply warning	– The device feedback was not right due to the power loss in the gate driver board. This may not 20Vdc PS problem to SGCT but it can be on PS problem on gate driver card.
Invalid Alarm Bit	89	DEVELOPMENT ERROR - An unused bit in the first 16 bits in either a fault or warning word has been set and detected by the Alarm Queue server. Either a used bit has been overlooked in the Faults/Warnings database, or the control is incorrectly setting an alarm word.	– Contact the factory
Invalid DIM	90	The drive tried to access the DIM, but either encountered a problem with the checksum on the DIM, or the DIM was not installed	<ul style="list-style-type: none"> – This fault may occur on drives upgrading major revisions of firmware (i.e. 2.xxx to 3.xxx), with the older DIM installed, or if the DIM has a failure – Remove the DIM
Invid Mstr R	344	Invalid Master request-slave only	– Drive tried to become master when another master was already active
Iso Fn1 Cntr	329	Isolation Transformer Fan 1 contactor	– Isolation transformer Fan 1 status is NOT HIGH while the drive asked the contactor to be closed.

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
Iso Fn2 Cntr	330	Isolation Transformer Fan 2 contactor	– Isolation transformer Fan 2 status is NOT HIGH while the drive asked the contactor to be closed
Iso Fn1 Loss	331	Isolation Transformer Fan 1 Loss	– Drive looks for Fan 1 status or air pressure. If any of this lost the drive give this warning.
Iso Fn2 Loss	332	Isolation Transformer Fan 2 Loss	– Drive looks for Fan 2 status or air pressure. If any of this lost the drive give this warning.
IsoTx Air Filter (A-Frame Only)	26	The Pressure sensed by the pressure transducer in the integral Isolation Transformer section (as a voltage) has dropped below the value set in Pressure Value Transformer Warning (P655).	<ul style="list-style-type: none"> – Verify fan rotation – Blocked airflow in the filters / ducting (if installed) – Clean as required – Improper Warning settings – Verify Pressure Value voltage level when running with clear air flow – Verify Alarm and Trip set-up procedure was completed adequately and adjust as necessary – Verify for drives with external ducting that there is sufficient air to the drive input – Verify supply voltage to pressure transducer, and confirm output is stable
IxoTx Fan On	328	Isolation Transformer Fan ON warning	– Isolation transformer Fan status is high while it should be low.
L Comm Low	55	Indicates that the Autotune Lc (P217) measured was less than 0.02 pu and the L Commutation (P140) will have to be tuned manually.	– REFER TO THE POWERFLEX 7000 SERIES B MANUAL (CHAPTER 4 – COMMISSIONING) ON AUTOTUNE PROCEDURES, RESULTS, AND ACTIONS
L Comm High	56	Indicates that the Autotune Lc (P217) measured was greater than 0.15 pu and the L Commutation (P140) will have to be tuned manually.	
L Leakage Low	59	Indicates that the Autotune Ls (P220) measured was less than 0.15 pu.	– REFER TO THE POWERFLEX 7000 SERIES B MANUAL (CHAPTER 4 – COMMISSIONING) ON AUTOTUNE PROCEDURES, RESULTS, AND ACTIONS
L Leakage High	60	Indicates that the Autotune Ls (P220) measured was greater than 0.30 pu.	
L Magnetize Low	61	Indicates that the Autotune L mag (P221) measured was less than 2.00 pu, and L magnetizing (P131) will have to be tuned manually.	
L Magnetize High	62	Indicates that the Autotune L mag (P221) measured was greater than 10.00 pu, and L magnetizing (P131) will have to be tuned manually.	
Line Cap Range	124	In PWM rectifier drives, the calculated per unit value of the Line Filter Capacitor (P133), based on the values entered for Line Capacitor kVAR (P15), Line Capacitor Volts (P16), and Line Capacitor Frequency (P32) is outside of the normal range of 0.35-0.55pu.	– Verify capacitor nameplate data and compare with information entered in drive

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
Line DC Link OV	116	The measured Line DC voltage has exceeded Line DC Overvoltage Trip (P173), and instantaneously causes a warning.	<ul style="list-style-type: none"> – See associated Fault Description
Line Loss	120	The drive has detected a loss of input voltage from losing the frequency (PLL) lock on the input voltage. This is designed to be a faster method of detecting an undervoltage. The drive responds to this warning as it does to a Master UV warning.	<ul style="list-style-type: none"> – Verify the VSB connections and tap settings, and check resistance of VSB board – Megger board to confirm integrity – Check TSN fusing – Check actual voltage values on the Terminal for each bridge and the total line voltage – Check for possible source voltage supply problems
Liq IO Config (C-Frame Only)	131	The XIO card which was being assigned to the Liquid Cooling System Faults Input is not a card which can be used for this purpose	<ul style="list-style-type: none"> – Select the proper slot containing the XIO card which is compatible for Liquid Cooling System Faults usage.
Liq IO Conflict (C-Frame Only)	132	The XIO card previously being used for Liquid Cooling System Faults has been reassigned for another purpose.	<ul style="list-style-type: none"> – Check the configuration of all XIO slots and reassign if necessary.
Logx IO Config	133	The XIO card which was being assigned to Logix IO (basic PLC functionality) is not a card which can be used for this purpose	<ul style="list-style-type: none"> – Select the proper slot containing the XIO card which is compatible for Logix IO usage.
Logx IO Conflict	134	The XIO card previously being used for Logix IO (basic PLC functionality) has been reassigned for another purpose.	<ul style="list-style-type: none"> – Check the configuration of all XIO slots and reassign if necessary.
Master UV	112	The measured value V Master Average (P136) is less than Line Undervoltage Trip (P167) with respect to 1/3 Rated Line Voltage (P18) [for 18-pulse drives], and Rated Line Voltage (P18) [for 6-pulse and PWM drives] for the period set by Line Undervoltage Delay (P168).	<ul style="list-style-type: none"> – Verify the VSB connections and tap settings, and check resistance of VSB board – Megger board to confirm integrity – Check TSN fusing – Check actual voltage values on the Terminal for each bridge and the total line voltage – Check for possible source voltage supply problems – Use Multimeter and Oscilloscope to check voltages on the drive test points
Motor Cap Range	23	The calculated per unit value of the Motor Filter Capacitor (P128), based on the values entered for Motor Capacitor kVAR (P20), Motor Capacitor Volts (P21), and Motor Capacitor Frequency (P28) is outside of the normal range of 0.26-0.55 pu.	<ul style="list-style-type: none"> – Verify capacitor nameplate data and compare with information entered in drive – Contact factory

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
Motor DC Link OV	192	DC Link Voltage on the motor side, measured through the Voltage Sensing Board, has exceeded Motor DC Overvoltage Trip (P193), and instantaneously causes a warning.	<ul style="list-style-type: none"> – Verify the motor is connected and the Output Contactor is not open – Verify there is no open SGCTs Complete a Resistance and Firing check – Check VSB circuit (grounds) through to SCB-M – Check Burden resistor values – Check the trip parameter setting
Motor Load Loss	41	The drive has detected a loss of load condition. This is activated as a warning using the parameter Load Loss Detect (P199), and the necessary setpoints are Load Loss Level (P246), Load Loss Delay (P231), and Load Loss Speed (P259).	<ul style="list-style-type: none"> – Verify the parameter settings – Ensure that the load should not normally be in an unloaded condition
Motor OL	17	A Motor Overload warning has been detected, where the overload condition is calculated using I Stator (P340) and Motor Overload Warning (P351) as the point where the overload warning occurs. P351 is programmed as a percentage of the difference between Motor Overload Min (P350) and Motor Overload Trip (P179).	<ul style="list-style-type: none"> – Transient Loading - Check torque limit and overload settings and Compare loading to torque settings and trip settings
Motor OV	193	The measured Motor AC Voltage has exceeded Motor Overvoltage Trip (P181) for the duration set in Motor Overvoltage Delay (P182), but this has occurred with the drive NOT gating (as in a Sync Transfer event)	Possible Causes: Noise from contactor closure Self-Excitation – Check for flying start/induced motor rotation
Motor Protection	68	Standard External Fault/Warning Input included to allow the end-user to install a protective relay (IE Bulletin 825 Motor Protection Relay) auxiliary contact that can activate a drive fault or warning, depending on configuration of Motor Prot Class (P443).	<ul style="list-style-type: none"> – See associated Fault Description
Mtr Cap OV W	334	Motor Filter Capacitor Over Voltage	<ul style="list-style-type: none"> – This warning occurs when drive is not gating. It may be when motor is coasting. – This is drive output V [Surface voltage terminology used in ESP application]. The drive gives this warning in an ESP application only. – The protection uses P#181 setting but drive calculates the motor filter cap voltage [Surface V] which is different from motor voltage in ESP application.
No DO/OP Ctctr	190	This warning is specifically used for Open Circuit Test Mode, which demands that an Output Contactor be specified in IsoSw/Ctctr Cfg (P192). You will get this warning if the No DO/OP Ctctr fault is masked, and you are attempting Open-Circuit Test.	<ul style="list-style-type: none"> – If there truly is no Output Contactor in the system, then you can mask the fault. Then there will be a No OP Ctctr warning, and you can continue with the test. – ENSURE THE OUTPUT OF THE DRIVE IS TRULY OPEN-CIRCUITED

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
No PLL Lock	117	The drive has lost synchronization with the incoming line voltage, and has announced a Phase Lock Loop warning.	<ul style="list-style-type: none"> – Capture the voltage waveforms from the SCB-L test points and examine for inconsistency – Verify that the drive power system is properly grounded – Check for noise on the control power in the drive – Check the grounding for all signal and control wiring – Verify the Commutation Inductance parameter is valid and retune if required
No Tach Installd	36	The drive has sensed that there is no tachometer/encoder connected, but the Speed Feedback Mode (P89) has been set to Pulse Tach.	<ul style="list-style-type: none"> – Verify whether there is a tachometer required for the system, and set the parameter Speed Feedback Mode accordingly – Investigate the tachometer for damage – Verify the wiring from the drive to the tachometer is per the Electrical Drawing – Verify the +15VDC supplying the tachometer is not low/missing
NVRAM Cleared	87	The parameters stored in the NVRAM of the DCB are corrupt and have been set to default values. This can occur if new firmware has been loaded into the DCB or Power Capacitors are low.	<ul style="list-style-type: none"> – Reload parameters from Terminal Memory. DriveTools, Flashcard, or from a hardcopy – Replace PowerCap on DCB-L – If parameters still can not be saved, replace the DCBs
Opt Flt Config	129	The XIO card which was being assigned to the Optional Faults Input is not a card which can be used for this purpose.	<ul style="list-style-type: none"> – Select the proper slot containing the XIO card which is compatible for Optional Faults usage.
Opt Flt Conflict	130	The XIO card previously being used for Optional Faults has been reassigned for another purpose.	<ul style="list-style-type: none"> – Check the configuration of all XIO slots and reassign if necessary.
Parameter Range	88	A parameter was read from NVRAM or the DIM, which was outside the valid range. The parameter has been set to a default value. The Linear # of this parameter has been stored in "Parameter Error", under the Feedback grouping.	<ul style="list-style-type: none"> – If this was a result of an INIT operation, contact the factory – If this was a result of a LOAD operation, correct the parameter value and perform a SAVE operation – Check the settings on the DIM to determine whether it is limiting the paramter's max or min values.
Phantom Alarm	93	DEVELOPMENT ERROR - An unused bit in the last 16 bits in either a fault or warning word has been set and detected by the Alarm Queue server. These bits are never used in firmware. Either a used bit has been overlooked in the Faults/Warnings database, or the control is incorrectly setting an alarm word.	<ul style="list-style-type: none"> – Noise/Grounding Issue – Contact the factory

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
Pump Failure (C-FRAME ONLY)	143	The drive has detected a fault from one of the pumps in the cooling circuit.	<ul style="list-style-type: none"> – Verify the Pump O/L settings and conditions – Verify the Pump Control Relay status and auxiliary contact signals.
Queues Cleared	91	This means that the drive had to clear the fault and warning queues after an upgrade of the firmware	<ul style="list-style-type: none"> – This was an issue because the memory structure changed in 3.xxx firmware – No action is required
R Stator High	52	Autotune Rs (P219) measured during the autotune test was higher than 0.20 pu, indicating the presence of extremely long motor leads.	<ul style="list-style-type: none"> – REFER TO THE POWERFLEX 7000 SERIES B MANUAL (CHAPTER 4 – COMMISSIONING) ON AUTOTUNE PROCEDURES, RESULTS, AND ACTIONS – Ensure motor windings are connected properly.
Rec Gate Pwr	205	Rectifier Gate driver power supply warning	<ul style="list-style-type: none"> – The device feedback was not right due to the power loss in the gate driver board. This may not only 20VDC PS problem to SGCT but it can also be on PS problem on gate driver card. – This warning can come due to device failure or device online diagnostic
Rec Heatsink FO	203	While Not Running, the Fiber Optic signal from the TFB on the Rectifier Heatsink, connected to Channel A fiber optic receiver RX7 on FOI-L-A is not present. This is only a fault while not running. If this occurs while running it will appear as a warning.	<ul style="list-style-type: none"> – Check TFB and FOI board for power – Check the Fiber Optic cables are properly seated in the transmitters and receivers – Check the fiber optic cable for kinks, bends, breaks that could be blocking the signal
Rec ChannelB FO	204	Not Normally Used: While Not Running, the Fiber Optic signal from the optional TFB connected to Channel B fiber optic receiver RX7 on FOI-L-B is not present. This is only a fault while not running. If this occurs while running it will appear as a warning.	<ul style="list-style-type: none"> – This can occur if the sensor is not connected to the TFB – NOTE: This is a warning because the drive should not fault on the loss of the signal while running. There is no imminent danger to the drive, but the user needs to be aware that there is a temperature feedback signal missing.
Rec Heatsink OT	121	The temperature detection on the Rectifier Heatsink, connected to Channel A fiber optic receiver RX7 on FOI-L-A, has exceeded Rectifier Heatsink Temperature Warning (P112).	<ul style="list-style-type: none"> – Confirm actual temperature in parameters is not higher than the warning value – If so, investigate the conditions of the drive (ambient / loading / elevation / ventilation/ filter status / heatsink clogging)
Rec ChannelB OT	122	Not Normally Used – The temperature detection on a Rectifier Heatsink, connected to fiber optic receiver RX7 on FOI-L-B, has exceeded Rectifier Temperature Warning Channel B (P526).	<ul style="list-style-type: none"> – Check TFB and FOI board for power and fiber optic integrity – Check the sensor and temperature offline (ambient) for accuracy

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
Rec HS Sensor	201	While Running, the drive has detected a missing temperature sensor connected to the TFB on the rectifier heatsink. A missing sensor can result in either a Fiber Optic Loss fault or a Sensor fault because a missing sensor can be interpreted as either 0°C or over 100°C, and both are unrealistic values.	<ul style="list-style-type: none"> – Verify sensor is completely seated properly on TFB. – Measure sensor resistance. – Replace if necessary. – NOTE: This is a warning because the drive should not fault on the loss of the signal while running. There is no imminent danger to the drive, but the user needs to be aware that there is a temperature feedback signal missing.
Rec ChB Sensor	202	Not normally used: While Running, the drive has detected a missing temperature sensor connected to the optional TFB connected to the fiber optic receiver RX7 on FOI-L-B. A missing sensor can result in either a Fiber Optic Loss fault or a Sensor fault because a missing sensor can be interpreted as either 0°C or over 100°C, and both are unrealistic values.	
Reg in Limit	51	Either the Speed Regulator or the Flux Regulator autotune test hit the regulator limit and the results of the test are not valid.	– REFER TO THE POWERFLEX 7000 SERIES B MANUAL (CHAPTER 4 – COMMISSIONING) ON AUTOTUNE PROCEDURES, RESULTS, AND ACTIONS
Slip Range	189	This warning appears when unusual values for slip appear, indicating there is either an error in data or an unusual motor. The rated slip for this warning has to be > 10%, or < 0.01%	<ul style="list-style-type: none"> – Verify Motor Nameplate Data – Contact the factory with the motor data and the application information
Slave 0-7 OffL	348-355	Slave (0-7) DAN Communication Loss-Master only	– Slave is Off line.
Slave1 UV	113	The measured value V Slave1 Average (P137) is less than Line Undervoltage Trip (P167) as a percentage of 1/3 Rated Line Voltage (P18), for the period set by Line Undervoltage Delay (P168).	<ul style="list-style-type: none"> – Verify the VSB connections and tap settings, and check resistance of VSB board – Megger board to confirm integrity – Check TSN fusing – Check actual voltage values on the Terminal for each bridge and the total line voltage
Slave2 UV	114	The measured value V Slave2 Average (P138) is less than Line Undervoltage Trip (P167) as a percentage of 1/3 Rated Line Voltage (P18), for the period set by Line Undervoltage Delay (P168).	<ul style="list-style-type: none"> – Check for possible source voltage supply problems – Use Multimeter and Oscilloscope to check voltages on the drive test points
Slv RfsdMstr	343	Slave refused Master-master only	– Slave has lost communication with hub PLC, or slave is masked off in parameter <i>Master Mask</i>

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
Speed Cmd Loss	183	The drive has lost communication with the device responsible for providing the speed command to the drive. This has been set to annunciate as a warning.	<ul style="list-style-type: none"> – Ensure that the SCANport device is powered – Verify the SCANport light status and ensure the device is operating properly – Verify the customer SCANport network is properly communicated with the device – Check CIB LED status – Cycle control power to the drive
SpdProfile Limit	92	The sum of the individual ramp times has exceeded the maximum value for Total Acceleration Time	<ul style="list-style-type: none"> – Review Ramp settings and adjust accordingly to ensure they do not exceed the Total Acceleration Time
Sync Xfer Failed	40	A Synchronous Transfer was not completed in the time specified in Synchronous Transfer Time (P230). This warning will occur if the Sync Transfer fault is masked, and the drive will continue to run at the last Reference Command before a synchronization command was initiated.	<ul style="list-style-type: none"> – Verify that the setup for Synchronous Transfer has been completed – Verify that the drive can reach synchronous speed – Once stability has been verified, the parameters can be altered to reduce restrictions on synchronous transfer
T DC Link High	58	Indicates that the Autotune Tdc (P218) measured was greater than 0.100 pu, and the T DC Link (P115) will have to be tuned manually.	<ul style="list-style-type: none"> – REFER TO THE POWERFLEX 7000 SERIES B MANUAL (CHAPTER 4 – COMMISSIONING) ON AUTOTUNE PROCEDURES, RESULTS, AND ACTIONS
T DC Link Low	57	Indicates that the Autotune Tdc (P218) measured was less than 0.020 pu, and the T DC Link (P115) will have to be tuned manually.	
T Rotor Low	63	Indicates that the Autotune T rotor (P222) measured was less than 0.2 sec, and T rotor (P132) will have to be tuned manually.	
T Rotor High	64	Indicates that the Autotune T rotor (P222) measured was greater than 5.0 sec, and T rotor (P132) will have to be tuned manually.	
Tach Loss W	33	The tachometer feedback has varied from the reference command by the value set in Tach Loss Trip(P235) for the duration set in Tach Loss Delay (P236).	<ul style="list-style-type: none"> – The drive should annunciate the warning and continue to run on Stator feedback – Verify that the parameter Tachometer Feedback (Line or Motor) is/ is not giving the correct feedback while running – Investigate the tachometer for damage – Scope the tachometer pulses on SCB and verify they are not corrupted by for example dust in the Optic disc of the tach. – Verify the wiring from the drive to the tachometer is per the Electrical Drawing – Verify the +15VDC supplying the tachometer is not low/missing
Tach Power	35	+15VDC from the DC/DC power supply, sensed on the CIB, is less than the 95% alarm level.	<ul style="list-style-type: none"> – Check the output of the DC/DC power supply – Check the wiring from the power supply to the CIB – Verify the tachometer/encoder wiring

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
Tach Reversed	34	The drive has sensed that the 2 channels (generally A and B) are reversed.	<ul style="list-style-type: none"> – Set the parameter Tachometer Select to 'None' and verify the parameter Tachometer Feedback (Line or Motor) shows the reverse speed – Reverse the tachometer channels
Temp Feedback Ls (C-Frame Only)	152	While Running, the drive has detected a missing temperature feedback. A missing sensor can be interpreted as either 0°C or over 100°C, and both are unrealistic values.	<ul style="list-style-type: none"> – Verify sensor is completely seated properly on TFB. – Measure sensor resistance. – Replace if necessary. – NOTE: This is a warning because the drive should not fault on the loss of the signal while running. There is no imminent danger to the drive, but the user needs to be aware that there is a temperature feedback signal missing.
Tuning Abort	49	Autotuning was unable to complete the commanded autotune test in a preset time limit of 2 minutes.	<ul style="list-style-type: none"> – Investigate why the Autotune Test aborted, and Retry Autotune Test – Verify Autotune default parameters are sufficient to complete test – Attempt Manual Tuning
UPS Battery Low	106	Warning that the UPS Battery is low.	<ul style="list-style-type: none"> – This is not very useful as the UPS battery low occurs at the point where the UPS can no longer run and a fault is initiated.
UPS Failed	107	The UPS has had an internal failure. This is a warning because we do not want a signal/wiring error to fault the drive. We are relying on the subsequent power supply faults to protect the drive.	<ul style="list-style-type: none"> – Investigate the cause for the UPS failure – Check batteries – Verify input voltage/UPS wiring – Refer to UPS manual – Replace UPS if required
UPS on Battery	105	Warning that the UPS is now on battery power	<ul style="list-style-type: none"> – Check for the reason that the UPS was required, and rectify the situation before the battery power expires
UPS on Bypass	104	Warning that the UPS is now on Bypass. This occurs when the drive has switched to UPS, but a UPS fault has forced the system to switch to Bypass, if available.	<ul style="list-style-type: none"> – Investigate cause for initial transfer to UPS, and correct. – Then investigate why the UPS failed and was forced to go to bypass
USART Power Loss	110	Warning that USART voltage detected on the CIB is low.	<ul style="list-style-type: none"> – Check all DC/DC voltages test points on CIB (+5V, +15V, +3.3V) – Replace DC/DC PS or CIB as required.
Xfer Disable	345	Transfer Disabled-master only	<ul style="list-style-type: none"> – Transfer of master not allowed while drive is stopping

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
XIO Card #1-6 Loss	81-86	An XIO card has dropped off the communications link between the XIO cards and the CIB.	<ul style="list-style-type: none"> – Reset the board in an attempt to re-establish communications. – Check all connections between the Customer Interface Board and the jumpers between individual adapters – Verify the status of all XIO adapters by comparing the LED status to the table in the manual.
XIO Power Loss	108	The 24V to the XIO boards has dropped below the set trip level, which is 95% of rated voltage.	<ul style="list-style-type: none"> – Verify DC/DC power supply output – Confirm wiring to the CIB from the DC/DC Power Supply – Check XIO LED status and compare to values in the manual
Zero Slip	28	The value for Rated Motor RPM (P26) is the same as speed calculated from Motor Poles (P99) and Rated Motor Frequency (P29).	<ul style="list-style-type: none"> – Verify Rated Motor RPM is less than synchronous speed
U1A Device Wrn	228	<p>INVERTER SGCT WARNING FOR REDUNDANT DEVICES or N-1 CAPABILITY ONLY</p> <p>This warning will only occur during the initial contactor closure and the diagnostic sequence after a start command. The inverter monitors the state of the feedback before a gate pulse is given, and monitors the feedback after a gate pulse has been sent. The SGCT has smart diagnostics, so the feedback may indicate short before firing, and if the pulse is received and the device is really shorted, the diagnostic will toggle the feedback to let you know the problem is with the device, or the power supply for that device.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting problems before any destructive action is taken from the next action</p>	<ul style="list-style-type: none"> – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed in matched sets during the next outage – Check the LED status of the SCGT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify the associated 20V power supply is powered and active – Verify all the power connections to the SCGT firing card are seated properly – NOTE: For Redundant devices, there will be no change in the drive operation. For N-1 drives, the drive will attempt to run at a load/speed combination that does not exceed the voltage rating of the remaining devices.
U1B Device Wrn	234		
U1C Device Wrn	246		
U4A Device Wrn	231		
U4B Device Wrn	237		
U4C Device Wrn	249		
V3A Device Wrn	230		
V3B Device Wrn	236		
V3C Device Wrn	242		
V6A Device Wrn	233		
V6B Device Wrn	239		
V6C Device Wrn	251		
W2A Device Wrn	229		
W2B Device Wrn	235		
W2C Device Wrn	247		
W5A Device Wrn	232		
W5B Device Wrn	238		
W5C Device Wrn	250		

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
U1A Online Wrn	216	<p>INVERTER SGCT WARNING FOR REDUNDANT DEVICES or N-1 CAPABILITY ONLY</p> <p>This warning will occur during operation of the drive. The drive has detected that the feedback from the device was not correct, and does not wait to determine the exact problem. The drive polls the entire bridge 3 times before and 3 times after each gating command. All 6 of these readings for each device must be consistent for the warning to occur. There is also a parameter called Inverter Device Diagnostic Delay (P268), which allows you to change the number of consecutive firings to eliminate nuisance faults. It will still poll 3 times before and after each firing, but will now require the condition to exist for the number of consecutive firings set in the Diagnostic Delay parameter for a warning to occur.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting faults before any destructive action is taken from the next action</p>	<ul style="list-style-type: none"> – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed – Check the LED status of the SCGT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify the associated 20V power supply is powered and active – Verify all the power connections to the SCGT firing card are seated properly – For nuisance faults, contact the factory about extending the Diagnostic Delay – NOTE: For Redundant devices, there will be no change in the drive operation. For N-1 drives, the drive will attempt to run at a load/speed combination that does not exceed the voltage rating of the remaining devices.
U1B Online Wrn	222		
U1C Online Wrn	240		
U4A Online Wrn	219		
U4B Online Wrn	225		
U4C Online Wrn	243		
V3A Online Wrn	218		
V3B Online Wrn	224		
V3C Online Wrn	242		
V6A Online Wrn	221		
V6B Online Wrn	227		
V6C Online Wrn	245		
W2A Online Wrn	217		
W2B Online Wrn	223		
W2C Online Wrn	241		
W5A Online Wrn	220		
W5B Online Wrn	226		
W5C Online Wrn	244		

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
2U1A Device Wrn	264	<p>PWM RECTIFIER SGCT WARNING FOR REDUNDANT DEVICE CAPABILITY ONLY</p> <p>This warning will occur during the initial contactor closure, the diagnostic sequence after a start command, or the diagnostic sequence after a stop command. The rectifier monitors the state of the feedback before a gate pulse is given, and monitors the feedback after a gate pulse has been sent. The SGCT has smart diagnostics, so the feedback may indicate short before firing, and if the pulse is received and the device is really shorted, the diagnostic will toggle the feedback to let you know the problem is with the device, or the power supply for that device.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting warnings before any destructive action is taken from the next action. The main example of this is closing the input contactor on a shorted bridge.</p>	<ul style="list-style-type: none"> – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed – Check the LED status of the SCGT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify the associated 20V power supply is powered and active – Verify all the power connections to the SCGT firing card are seated properly – NOTE: There is only the Redundant option available on the Rectifier, and only on 6P drives (SCR orPWM). You can not have N-1 operation on the rectifier since we can not control the line voltage.
2U1B Device Wrn	270		
2U1C Device Wrn	282		
2U4A Device Wrn	267		
2U4B Device Wrn	273		
2U4C Device Wrn	285		
2V3A Device Wrn	266		
2V3B Device Wrn	272		
2V3C Device Wrn	284		
2V6A Device Wrn	269		
2V6B Device Wrn	275		
2V6C Device Wrn	287		
2W2A Device Wrn	265		
2W2B Device Wrn	271		
2W2C Device Wrn	283		
2W5A Device Wrn	268		
2W5B Device Wrn	274		
2W5C Device Wrn	286		
2U1A Online Wrn	252	<p>PWM RECTIFIER SGCT WARNING FOR REDUNDANT DEVICES CAPABILITY ONLY</p> <p>This warning will occur during operation of the drive. The drive has detected that the feedback from the device was not correct, and does not wait to determine the exact problem. The drive polls the entire bridge 3 times before and 3 times after each gating command. All 6 of these readings for each device must be consistent for the warning to occur. There is also a parameter called Rectifier Device Diagnostic Delay (P266), which allows you to change the number of consecutive firings to eliminate nuisance warnings. It will still poll 3 times before and after each firing, but will now require the condition to exist for the number of consecutive firings set in the Diagnostic Delay parameter for a warning to occur.</p> <p>The firmware now completes a diagnostics sequence immediately after any drive reset, with the goal of detecting warnings before any destructive action is taken from the next action</p>	<ul style="list-style-type: none"> – Complete a resistance check per the instructions in the manual – NOTE: SGCTs may not have completely shorted, and still could read in the kΩ range – Any devices with low suspect readings should be changed – Check the LED status of the SCGT gate driver card for abnormal readings – Complete a Gating Test mode check on the devices – Verify the associated 20V power supply is powered and active – Verify all the power connections to the SCGT firing card are seated properly – Reset the drive and let the offline diagnostics further define the problem – For nuisance faults, contact the factory about extending the Diagnostic Delay – NOTE: There is only the Redundant option available on the Rectifier, and only on 6P drives (SCR orPWM). You can not have N-1 operation on the rectifier since we can not control the line voltage.
2U1B Online Wrn	258		
2U1C Online Wrn	276		
2U4A Online Wrn	255		
2U4B Online Wrn	261		
2U4C Online Wrn	279		
2V3A Online Wrn	254		
2V3B Online Wrn	260		
2V3C Online Wrn	278		
2V6A Online Wrn	257		
2V6B Online Wrn	263		
2V6C Online Wrn	281		
2W2A Online Wrn	253		
2W2B Online Wrn	259		
2W2C Online Wrn	277		
2W5A Online Wrn	256		
2W5B Online Wrn	262		
2W5C Online Wrn	280		

WARNING MESSAGE	WARNING CODE	DESCRIPTION	RECOMMENDED ACTIONS
2U1A Offline SC	300	<p>6P SCR RECTIFIER WARNING (Offline Short-Circuit) FOR REDUNDANT DEVICE CAPABILITY ONLY</p> <p>For SCR rectifiers, this warning will occur after the initial contact closure, or during the diagnostic sequence after a start command. This is the first test on the rectifier. When all devices blocking, the feedback from the devices should toggle from open to short to open every time the line voltage sine wave passes through zero. If this is consistently showing short (no feedback), then the drive assumes that the device is Short-Circuited.</p>	<ul style="list-style-type: none"> – Complete a resistance check on the rectifier, including the gate-cathode resistance, the snubber and sharing resistors – Complete a firing check on the rectifier – Verify the snubber circuitry, and the sharing resistors – Verify fiber optic integrity from SCRGD board transmitter to FOI board receiver – Replace all faulty components – NOTE: There is only the Redundant option available on the Rectifier, and only on 6P drives (SCR orPWM). You can not have N-1 operation on the rectifier since we can not control the line voltage.
2U1B Offline SC	306		
2U1C Offline SC	318		
2U4A Offline SC	303		
2U4B Offline SC	309		
2U4C Offline SC	321		
2V3A Offline SC	302		
2V3B Offline SC	308		
2V3C Offline SC	320		
2V6A Offline SC	305		
2V6B Offline SC	311		
2V6C Offline SC	323		
2W2A Offline SC	301		
2W2B Offline SC	307		
2W2C Offline SC	319		
2W5A Offline SC	304		
2W5B Offline SC	310		
2W5C Offline SC	322		
2U1A Online SC	288	<p>6P SCR RECTIFIER WARNING (Online Short-Circuit) FOR REDUNDANT DEVICE CAPABILITY ONLY</p> <p>For SCR rectifiers, this warning will occur during operation. Before an individual leg is fired, the drive takes 5 samples of the voltage across that device. This is because the notching on the line could cause individual readings to be low. If they are all low, the device is assumed to be short-circuited and a warning occurs. There is also a parameter called Rectifier Device Diagnostic Delay (P266), which allows you to change the number of consecutive firings to eliminate nuisance warnings. It will still check 5 times before each firing, but will now require the condition to exist for the number of consecutive firings set in the Diagnostic Delay parameter for a warning to occur.</p>	<ul style="list-style-type: none"> – For multiple device faults, the risk of a line to line short exists, so tests with MV isolated should be attempted – Complete a resistance check on the rectifier, including the gate-cathode resistance, the snubber and sharing resistors – Complete a firing check on the rectifier – Verify the snubber circuitry, and the sharing resistors – Verify fiber optic integrity from SCRGD board transmitter to FOI board receiver – Replace all faulty components – For nuisance faults, contact the factory about extending the Diagnostic Delay – NOTE: There is only the Redundant option available on the Rectifier, and only on 6P drives (SCR orPWM). You can not have N-1 operation on the rectifier since we can not control the line voltage.
2U1B Online SC	294		
2U1C Online SC	312		
2U4A Online SC	291		
2U4B Online SC	297		
2U4C Online SC	315		
2V3A Online SC	290		
2V3B Online SC	296		
2V3C Online SC	314		
2V6A Online SC	293		
2V6B Online SC	299		
2V6C Online SC	317		
2W2A Online SC	289		
2W2B Online SC	295		
2W2C Online SC	313		
2W5A Online SC	292		
2W5B Online SC	298		
2W5C Online SC	316		

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 R6LR R18TX RPLR RPTX RPDTD ❶	Options

- ❶ **R6TX** – 6-pulse rectifier for connection to remote transformer
- R6LR** – 6-pulse rectifier with integral line reactor
- R18TX** – 18-pulse rectifier for connection to remote transformer
- RPLR** – PWM rectifier with integral line reactor
- RPTX** – PWM 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 (WK²):

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

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

Notes:

Drive Logic Command

Drive Logic Command Word – Database 2.001

The following is the Logic Command from the output of the Parser.
It is a READ only variable in the Drive.

Bit	Function	Value	Description	Notes
0	Stop Command	0	Stop	
1	Start Command (pulsed)	1	Start on Rising Edge only	
2	Jog	1	Jog at preset speed	
3	Clear Fault Queue	1	Clear Fault Queue	
4	Clear Warning Queue	1	Clear Warning Queue	
5	Drive Reset	1	Reset All Alarms (Faults and Warnings)	
6	Direction	1	Reverse Rotation	
		0	Forward Rotation.	
7	Start Profile	0	Accel 1 (Default)	Must be maintained until at Speed.
		1	Accel 2	
8	Stop Profile	0	Decel 1 (Default)	Must be maintained until Drive stopped.
		1	Decel 2	
10,9	Not Used			
12,11	Synchronization	0 0	No command	
		0 1	Transfer to Line (Bypass)	
		1 0	Transfer to Motor	
		1 1	Illegal. Ignore this command	
13	Force Stop	1	Force a Stop to the Drive	DPI Forced on Network Errors
14	Force Fault	1	Force a Class2 Fault in the Drive	DPI Forced on Network Errors
15	Not Used			

Logic Status Word – Database 2.001

The following is the Logic Status word from the Drive.
It is common for all SCANport/DPI product specific peripherals.

Bit	Function	Value	Description	Notes
0	Ready	1	Drive is Ready	
1	Running	1	Drive is Running	
2	Commanded Direction	1	Drive has been commanded to run forward	0 = Reverse Command
3	Rotating Direction	1	Drive is rotating in the forward direction	0 = Reverse Rotation.
4	Accelerating	1	Drive is accelerating to commanded speed	0 = Drive is at speed
5	Decelerating	1	Drive is decelerating to commanded speed	0 = Drive is at speed or stopped
6	At Speed	1	Drive has reached the commanded speed	
7	On Bypass	1	Motor is on bypass	0 = Motor connected to Drive
8	Reverse Disabled	1	The reverse function is disabled.	
9	Drive Fault	1	Drive has faulted	
10	Drive Warning	1	Drive has encountered a warning	
11	Local Lock	1	A DPI or XIO has local control of the drive	
12	Forced Stop	1	A DPI adapter or CIB has forced the drive to stop due to internal problems	
13,15	Preset Speeds	0 0 0	External Reference 0 (Speed Pot)	
		0 0 1	External Reference 1 (Analog Input)	
		0 1 0	External Reference 2 (Current Loop Input)	
		0 1 1	Preset 1	
		1 0 0	Preset 2	
		1 0 1	Preset 3	
		1 1 0	Jog Preset	
		1 1 1	DPI Adapter Reference	

Product Specific Logic Command – Database 2.001

To be used with gateway adapters such as RIO or DeviceNet.

Bit	Function	Value	Description	Notes
0	Stop	1	Stop Drive using Stop Profile	
1	Start (Pulsed)	1	Start Drive on rising edge using Start Profile	
2	Jog	1	Jog at default or Preset Speed	
3	Clear Faults	1	Clear most recent Fault in Queue	
4	Clear Warnings	1	Clear most recent Warning in Queue	
5	Clear Queues	1	Clear both Fault and Warning Queues	
6	Direction	0	Forward	
		1	Reverse	
7	Disable Reverse	1	Disable Reverse Direction (Maintained)	Done in Logic Parser
8	DPI Local/Remote Profile	0	Remote	All adapters can control the drive (Full multiplexed control)
		1	Local	Only the adapter that has been granted permission has control of the Drive (Includes XIO Front Panel Selector Switch)
10,9	Synchronous Transfer	0 0	No Command	
		0 1	Transfer to Line	
		1 0	Transfer to Drive	
		1 1	Illegal	
11	Start Profile	0	Accel 1 (Default)	Must be maintained until at Speed.
		1	Accel 2	
12	Stop Profile	0	Decel 1 (Default)	Must be maintained until drive stopped.
		1	Decel 2	
15,13	Speed Command Select	0 0 0	No Command	
		0 0 1	External Ref0 (Front Panel Pot)	
		0 1 0	Preset 1	
		0 1 1	Preset 2	
		1 0 0	Preset 3	
		1 0 1	External Ref1 (Programmed Reference)	
		1 1 0	Manual Reference (Local DPI Adapter)	
		1 1 1	Not Used	

Drive Logic Command Word – Database 3.001 and later

The following is the Logic Command from the output of the Parser.
It is a READ only variable in the Drive.

Bit	Function	Value	Description	Notes
0	Stop Command	0	Stop	
1	Start Command (pulsed)	1	Start on Rising Edge only	
2	Jog	1	Jog at preset speed	
3	Clear Fault Queue	1	Clear Fault Queue	
4	Clear Warning Queue	1	Clear Warning Queue	
5	Drive Reset	1	Reset All Alarms (Faults and Warnings)	
6	Direction	1	Reverse Rotation	
		0	Forward Rotation.	
7	Start Profile	0	Accel 1 (Default)	Must be maintained until at Speed.
		1	Accel 2	
8	Stop Profile	0	Decel 1 (Default)	Must be maintained until Drive stopped.
		1	Decel 2	
10,9	Not Used			
12,11	Synchronization	0 0	No command	
		0 1	Transfer to Line (Bypass)	
		1 0	Transfer to Motor	
		1 1	Illegal. Ignore this command	
13	Force Stop	1	Force a Stop to the Drive	DPI Forced on Network Errors
14	Force Fault	1	Force a Class2 Fault in the Drive	DPI Forced on Network Errors
15	Not Used			

Logic Status Word – Database 3.001 and later

The following is the Logic Status word from the Drive.
It is common for all SCANport/DPI product specific peripherals.

Bit	Function	Value	Description	Notes
0	Ready	1	Drive is Ready	
1	Running	1	Drive is Running	
2	Commanded Direction	1	Drive has been commanded to run forward	0 = Reverse Command
3	Rotating Direction	1	Drive is rotating in the forward direction	0 = Reverse Rotation.
4	Accelerating	1	Drive is accelerating to commanded speed	0 = Drive is at speed
5	Decelerating	1	Drive is decelerating to commanded speed	0 = Drive is at speed or stopped
6	At Speed	1	Drive has reached the commanded speed	
7	On Bypass	1	Motor is on bypass	0 = Motor connected to Drive
8	Reverse Enabled	1	The reverse command feature is enabled.	Changed in FRN 3.001 from Reverse Disabled
9	Drive Fault	1	Drive has faulted	
10	Drive Warning	1	Drive has encountered a warning	
11	Local Lock	1	A DPI or XIO has local control of the drive	
12	Forced Stop	1	A DPI adapter or CIB has forced the drive to stop due to internal problems	
15,13	Preset Speeds	0 0 0	External Reference 0 (Speed Pot)	
		0 0 1	External Reference 1 (Analog Input)	
		0 1 0	External Reference 2 (Current Loop Input)	
		0 1 1	Preset 1	
		1 0 0	Preset 2	
		1 0 1	Preset 3	
		1 1 0	Jog Preset	
		1 1 1	DPI Adapter Reference	

Product Specific Logic Command – Firmware 3.001 and 3.002

To be used with gateway adapters such as RIO or DeviceNet.

Bit	Function	Value	Description	Notes
0	Stop	1	Stop Drive using Stop Profile	
1	Start (Pulsed)	1	Start Drive on rising edge using Start Profile	
2	Jog	1	Jog at default or Preset Speed	
3	Clear Faults	1	Clear most recent Fault in Queue	
4	Clear Warnings	1	Clear most recent Warning in Queue	
5	Clear Queues	1	Clear both Fault and Warning Queues	
6	Direction	0	Forward	
		1	Reverse	
7	Disable Reverse	1	Disable Reverse Direction (Maintained)	Done in Logic Parser
8	DPI Local/Remote Profile	0	Remote	All adapters can control the drive (Full multiplexed control)
		1	Local	Only the adapter that has been granted permission has control of the Drive (Includes XIO Front Panel Selector Switch)
10,9	Synchronous Transfer	0 0	No Command	
		0 1	Transfer to Line	
		1 0	Transfer to Drive	
		1 1	Illegal	
11	Start Profile	0	Accel 1 (Default)	Must be maintained until at Speed.
		1	Accel 2	
12	Stop Profile	0	Decel 1 (Default)	Must be maintained until drive stopped.
		1	Decel 2	
15-13	Speed Command Select	0 0 0	No Command	
		0 0 1	External Ref0 (Front Panel Pot)	
		0 1 0	Preset 1	
		0 1 1	Preset 2	
		1 0 0	Preset 3	
		1 0 1	External Ref1 (Programmed Reference)	
		1 1 0	Manual Reference (Local DPI Adapter)	
		1 1 1	Not Used	

Product Specific Logic Command – Firmware 3.004 to 5.003

To be used with gateway adapters such as RIO or DeviceNet.

Bit	Function	Value	Description	Notes
0	Stop	1	Stop Drive using Stop Profile	
1	Start (Pulsed)	1	Start Drive on rising edge using Start Profile	
2	Jog	1	Jog at default or Preset Speed	
3	Clear Fault Queue	1	Clear Fault in Queue	
4	Clear Warning Queue	1	Clear Warning in Queue	
5	Reset Faults	1	Reset Faults and Warnings	
7,6	Direction	0 1	Forward	
		1 0	Reverse	
		1 1	Not Used	
8	DPI Local/Remote Profile	0	Remote	All adapters can control the drive (Full multiplexed control)
		1	Local	Only the adapter that has been granted permission has control of the Drive (Includes XIO Front Panel Selector Switch)
10,9	Synchronous Transfer	0 0	No Command	
		0 1	Transfer to Line	
		1 0	Transfer to Drive	
		1 1	Illegal	
11	Start Profile	0	Accel 1 (Default)	Must be maintained until at Speed.
		1	Accel 2	
12	Stop Profile	0	Decel 1 (Default)	Must be maintained until drive stopped.
		1	Decel 2	
15-13	Speed Command Select	0 0 0	No Command	
		0 0 1	External Ref0 (Front Panel Pot)	
		0 1 0	Preset 1	
		0 1 1	Preset 2	
		1 0 0	Preset 3	
		1 0 1	External Ref1 (Programmed Reference)	
		1 1 0	Manual Reference (Local DPI Adapter)	
		1 1 1	Not Used	

Notes:

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. When a ground fault occurs, it 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 exists if the safety precautions in the procedure is 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 7000 is to be performed. Failure to comply to 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 inductor 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

Disconnect 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 your 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. Re-Connecting 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. Re-Connect the Power Circuit to the System Ground

Voltage Sensing Boards

Securely re-connect 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 30 Nm (22 lb-ft). 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.

Rockwell Automation Support

Use the following resources to access support information.

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

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