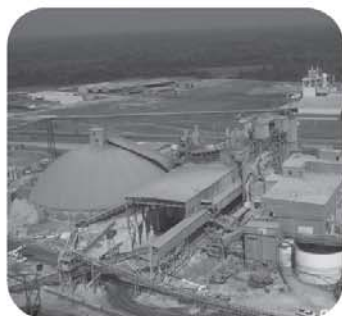


PowerFlex® 7000 Medium Voltage AC Drive Air-Cooled ('A' Frame) – Fourth Generation (ForGe) Control



Bulletin 7000A
Reference Manual



Important User Information

Solid-state equipment has operational characteristics differing from those of electro-mechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid-State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at <http://literature.rockwellautomation.com> describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

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

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

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

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc. is prohibited.

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.

IMPORTANT

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

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 consequences.

SHOCK HAZARD



Labels may be on or inside the equipment (for example, drive or motor) to alert people that dangerous voltage may be present.

BURN HAZARD



Labels may be on or inside the equipment (for example, drive or motor) to alert people that surfaces may reach dangerous temperatures.

Preface	Overview	Who should use this ManualP-1
		What is not in this ManualP-1
		Manual ConventionsP-2
		General PrecautionsP-3
		Who to call for CommissioningP-3
Chapter 1	Overview of Drive	Introduction 1-1
		Drive Configurations 1-2
		Topology 1-3
		Rectifier Designs
		Active Front End (AFE) Rectifier 1-4
		“Direct-to-Drive” Technology 1-5
		Motor Compatibility 1-6
		SGCT Features and Benefits 1-7
		Simplified Electrical Drawings
		2400 volt with AFE Rectifier 1-8
		3300/4160 volt with AFE Rectifier 1-9
		6600 volt with AFE Rectifier 1-10
		Control Overview 1-11
		Direct Vector Control 1-11
		Control Hardware 1-12
		Operator Interface 1-13
Chapter 2	Drive Installation	Safety and Codes2-1
		Unpacking and Inspection2-1
		Transportation and Handling2-2
		Overhead Lifting2-3
		Rod or Pipe Rollers2-4
		Fork Lift Trucks2-4
		Storage2-5
		Siting of the Drive2-5
		Site Considerations2-5
		Generator Note 2-6
		Installation2-7
		Shock Indication Labels2-7
		Installation of Exhaust Air Hood2-8
		Installation of Integral Transformer Cooling Fan2-12
		Neutral Resistor Assembly 2-13
		Installation of Neutral Resistor Assembly 2-14
		External Ducting2-15
		Cabinet Layout and Dimensional Drawings of Drive2-16
		PowerFlex 7000 “A” Frame Dimensional Drawing2-17
		Drive Layout2-18
		Config. #1 – Direct-to-Drive AFE Rectifier2-18
		Config. #2 – AFE Rectifier (Separate Isol. Transformer ...2-19
		Config. #3 – AFE Rectifier (Integral Isol. Transformer2-20

Chapter 2	Drive Installation (cont.)	
		Cabling Cabinet #1 (with Input Starters)2-21
		Cabling Cabinet #1 (without Input Starters) 2-22
		Cabling Cabinet #22-23
		Cabling Cabinet #32-24
		Converter Cabinet2-25
		Control/DC Link/Fan Cabinet2-26
		Low Voltage Control Tub2-27
		IEC Component and Device Designations2-29
		Power Wiring Selection2-29
		Cable Insulation2-30
		Wire Group Numbers2-31
		Power Cabling Access2-32
		To access the customer power cable terminations2-32
		Power Connections2-33
		Line/Motor Terminations2-33
		Power Cabling Installation Requirements2-33
		Dimension Views:
		Cabling Cabinet for Config. #1 <i>with</i> Input Starter2-34
		Cabling Cabinet for Config. #1 <i>without</i> Input Starter2-35
		Cabling Cabinet for Config. #2 2-36
		Cabling Cabinet for Config. #3 2-37
		Power and Control Wiring2-38
		Control Cables 2-38
		Encoder Installation Guidelines 2-38
		Grounding Practices2-41
		Grounding Guidelines and Practices for Drive Signal and Safety Grounds2-43
		Grounding Requirements and Specifications for Customer and Power Integrators2-43
		Identification of Types of Electrical Supplies – Grounded and Ungrounded Systems2-44
		Ground Bus2-44
		Interlocking2-44
Chapter 3	Operator Interface	
		Chapter Objectives3-1
		Terminology3-1
		Overview3-3
		Keypad3-3
		Function (Softkeys) Keys3-3
		Cursor (Selection) Keys3-4
		Data Entry Keys3-4

Chapter 3 Operator Interface (cont.)

What is a Screen?	3-5
Components	3-5
Information Windows	3-6
Accessing/Writing to Drive	3-7
Communication Error	3-7
Language Changing	3-8
General Operation	3-8
Operator Interface Power-up Sequence	3-9
Top Level Menu	3-11
How to:	
Obtain Help	3-12
Related Topics	3-12
Help On Help	3-13
Modify Operator Interface Operation (Utility)	3-14
Changing Backlight Delay	3-14
Changing Contrast	3-15
Setting Time	3-16
Setting Date	3-17
Selecting Meters	3-17
Viewing Revision Levels	3-20
Transfer Data in Memory	3-21
Picking an Access Level	3-21
Select a Parameter	3-22
Via Groups	3-22
Via Name	3-23
Via Code	3-24
Edit Text	3-26
Configure the Drive	3-28
Enter/Modify an Access Level	3-28
Drive Set-up	3-32
Language Selection	3-33
Modify Parameters	3-34
Numerical Value	3-34
Enumerated Value	3-36
Bit Encoded Value	3-37
Analog Ports	3-38
Fault Masks	3-39
User Definable External Text	3-42
PLC	3-43
XIO	3-45
Message Prompting	3-45
Store/Retrieve Configuration (NVRAM)	3-46
Initialize	3-46
Save	3-47
Load	3-47
Display Parameters	3-48
Custom Group	3-50

**Chapter 3 Operator Interface
(cont.)**

View Drive Status	3-51
View and Reset Alarms	3-51
Help for Alarms	3-52
Request Printouts	3-53
Perform Diagnostic Trending	3-54
Assigning a Trace	3-55
Setting the Trigger	3-56
Defining Sample Rate and Positioning	3-57
Starting the Trace	3-58
Flash Memory Transfers	3-59
Format Flash Card	3-61
View a Directory	3-62
Select a filename	3-62
Enter a filename	3-63
Loading Programs (Firmware)	3-63
Parameter Transfers	3-65
Upload to Operator Interface	3-66
Download from Operator Interface	3-66
Upload to Memory Card	3-66
Download from Memory Card	3-67
Parameter File Format	3-67
Loading Language Modules	3-68
System Programming	3-69
Advanced Screen Operations	3-70
Communications Statistics	3-70
Protocol Analyzer	3-71
Print Screen	3-72
Memory Dump	3-72
Database Download	3-74
Operator Interface Menu Hierarchy Chart	
What does it show?	3-75
How do you read it?	3-75
Example	3-76
PowerFlex 7000 “A” Frame Terminal Menu Tree	3-77
PCMCIA Memory Card Installation Data	
Description	3-79
Installing the Memory Card	3-79

Chapter 4 Commissioning

Start-up Commissioning Services	4-1
Drive Commissioning	4-1
Commissioning the Drive	4-2
Pre-Commissioning Responsibilities	4-3
PowerFlex 7000 “A” Frame Pre-Commissioning Checklist	4-4
Commissioning Preparation	4-8
Recommended Tools and Equipment	4-8
Technical Publications	4-9

Chapter 4 Commissioning (cont.)

Service Manual	4-9
Reference Manual	4-9
Important Note for Commissioning Engineer	4-10
Key Steps to Commissioning a PowerFlex 7000 Drive	4-11
Commissioning Datasheets	4-12
Commissioning Check List	4-13
Drive Application Review	4-16
Rockwell Automation Drive Line-up Drawings	4-16
Electrical System One-line Diagram	4-17
Verify One-line Diagram on Site	4-17
Inspect Process	4-17
Safety Tests	4-18
Lockout Tagout	4-18
Step Down Transformer Fusing	4-19
Fuse and O/L Protection	4-19
Installation Review	4-20
Inspect for Shipping Damage	4-20
Inspect Cabinets for Debris	4-20
Protective Barriers	4-20
Component Grounding	4-20
Information on Splice Kits	4-21
Power Cabling	4-21
Control Wiring	4-22
Service Data	4-23
Why this Information is Needed	4-23
Customer Information	4-24
Drive Nameplate Data	4-25
Miscellaneous Information	4-26
Drive Circuit Boards	4-27
Control Power Off Tests	4-28
Interlocking	4-28
Resistance Checks	4-30
SGCT Testing	4-31
SGCT Anode to Cathode Resistance	4-32
Snubber Resistance (SGCT Device)	4-33
Snubber Capacitance (SGCT Device)	4-34
Control Power Tests	4-35
Three-phase Input	4-35
Three-phase Input/Single Phase Input	4-36
Power Supply Tests	4-36
Circuit Board Healthy Lights	4-36
Control Power Transformer (CPT)	4-37
AC/DC Converter (PS1)	4-38
DC/DC Converter (PS2)	4-39
SGCT Power Supplies (IGDPS)	4-41
Converter Cabinet Components (2400V)	4-41
Converter Cabinet Components (3300/4160V)	4-42

**Chapter 4 Commissioning
(cont.)**

Converter Cabinet Components (6600V)	4-43
IGDPS Board LEDs	4-44
Gating Tests	4-45
Gating Tests Mode	4-45
SGCT Firing Test	4-47
System Test	4-48
System Test Mode	4-48
Start/Stop Control Circuit	4-50
Status Indicators	4-50
Analog I/O	4-51
Analog Inputs	4-51
Analog Outputs	4-52
Configurable Alarms	4-55
Application of Medium Voltage	4-55
Input Phasing Check	4-56
DC Current Test	4-57
Tuning Procedure	4-59
1. Rectifier	4-59
2. Motor Impedance	4-64
3. FluxSpeed Regulator (Induction Motors)	4-66
4. FluxSpeed Regulator (Synchronous Motors)	4-72
Running the Load	4-76
Motor Starting Torque	4-76
Reaching Specific Load Points	4-76
Drives Variables	4-77
Capturing Data	4-78
Drives Input Voltage Phasing Checks	4-78
Harmonic Analysis	4-80
DC Current Test	4-82
Load Test	4-83
Synchronous Transfer	4-85

**Chapter 5 Component Definition
and Maintenance**

Cabling Cabinet for Config. #1 (Direct-to-Drive)	5-1
Cabling Cabinet for Config. #1 (Direct-to-Drive, optional Input Starter)	5-2
Cabling Cabinet for Config. #2 (AFE Rectifier with Separate Isolation Transformer)	5-3
Cabling Cabinet for Config. #3 (AFE Rectifier with Integral Isolation Transformer)	5-4
Hall Effect Sensor Replacement	5-5
Current Transformer Replacement	5-6
Converter Cabinet Components	5-7
Converter Cabinet	5-8
Voltage-Sensing Assembly	5-8
Voltage-Sensing Circuit Board Assembly Replacement	5-9

Chapter 5	Component Definition and Maintenance (cont.)	
	Surge Arresters	5-10
	Description	5-10
	Operation	5-11
	Surge Arrester Replacement	5-11
	Field Test and Care	5-12
	PowerCage™	5-13
	SGCT and Snubber Circuit	5-16
	Uniform Clamping Pressure	5-17
	Checking Clamping Pressure	5-18
	Clamping Pressure Adjustment	5-18
	Temperature Sensing	5-19
	Symmetrical Gate Commutated Thyristor Replacement	5-21
	Heatsink Replacement	5-24
	PowerCage Gasket	5-25
	Replacement of PowerCage Gaskets	5-26
	Removal of old Gasket Material	5-26
	PowerCage Removal	5-27
	Snubber Resistors	5-29
	Testing Snubber Resistors	5-29
	Snubber and Sharing Resistor Replacement	5-30
	Sharing Resistors	5-32
	Testing Sharing Resistors	5-32
	Replacing Sharing Resistor	5-34
	Resistance Measurements	5-34
	Fiber Optic Cabling	5-35
	Air Pressure Sensor	5-36
	Air Pressure Sensor Replacement	5-36
	DC Link/Fan/Control Components	5-37
	Output Grounding Network Replacement	5-38
	Ground Filter Component Replacement	5-39
	Filter Capacitors	5-40
	Filter Capacitor Replacement	5-41
	Testing Filter Capacitors	5-42
	First Method	5-42
	Second Method	5-43
	Recommended Digital Multimeters (DMM)	5-45
	DC Link Reactor Replacement	5-46
	Fan Replacement	5-48
	DC Link Section	5-48
	Safety Notes	5-48
	Fan Installation	5-49
	Top of Integral Isolation Transformer Section	5-49
	Top of Integral Line Reactor/Input Starter Section	5-50
	Impeller Maintenance (DC Link/Fan Section)	5-51
	Impeller Removal from Motor Shaft	5-51
	Safety Notes	5-51
	Installation of Impeller Assembly onto Motor Shaft	5-52

Chapter 5 Component Definition and Maintenance (cont.)

Impeller Maintenance	5-54
Isolation Transformer Cooling Fan	5-54
Inlet Ring Removal and Replacement	5-54
Safety Notes	5-54
DC Link / Fan Section	5-55
Procedure	5-55
Top on Integral Isolation Transformer Section	5-55
Replacement of Air Filters	5-56
Procedure	5-56
Control Power Components	5-59
Ride-Through	5-59
AC/DC Power Supply	5-62
Description	5-62
Location	5-63
Terminal/Connections Description (Pioneer PS)	5-65
Terminal/Connections Description (Cosel PS)	5-66
Output Calibration	5-67
Replacement Procedure	5-67
Low Voltage Control Section	5-69
DC/DC Power Supply	5-71
Description	5-71
Terminal/Connections Descriptions	5-71
Replacement Procedure for DC/DC Power Supply	5-72
Printed Circuit Board Replacement	5-73
IO Connectors on Control Boards	5-74
Drive Processor Module	5-75
Drive Processor Module Replacement	5-77
Instructions to replace the Drive Processor Module	5-77
ACB Analog Control Board	5-79
Connectors on Analog Control Board	5-80
Test Points on Analog Control Board	5-81
Interface Module (IFM)	5-83
Analog Inputs and Outputs	5-83
Current Loop Transmitter	5-84
Isolated Process Receiver	5-85
Non Isolated Process Outputs	5-86
Auxiliary +24V Power Supply	5-86
ACB Analog Control Board Replacement	5-87
Tachometer Feedback Board	5-88
Encoder Options	5-88
Quadrature Encoder Operation	5-92
Positional Encoder Operations	5-93
Positional Encoder Guidelines	5-93
External Input/Output Boards	5-95
External Input/Output Board Replacement	5-96
Optical Interface Boards	5-97
Optical Interface Board Replacement	5-99

Chapter 5	Component Definition and Maintenance (cont.)	Downloading Firmware 5-101 Introduction 5-101 Overview 5-101 Preparation for Downloading Firmware 5-102 PF7000 in Download Mode 5-104 Reloading the Parameters 5-107 Setting Elapsed Time 5-108 Downloading the Terminal Firmware 5-108 DOSFWDL 5-109 Method 5-109 Setting up Diagnostic Trending 5-111 Diagnostic Setup 5-111 Setting up the Trend 5-112 Printing (Uploading) Data from the Drive 5-118 Overview 5-118 Method 5-119 Printing (Uploading) Control Data 5-125 Overview 5-125 Method 5-126 Environmental Considerations 5-132 Hazardous Materials 5-132 Disposal 5-133
Appendix A	Catalog Number Explanation	Catalog Number Explanation..... A-1 Service Duty Rating, Continuous Current Rating and Altitude Rating Code A-2 Supply Voltage, Control Voltage, Frequency and Control Power Transformer Selection A-2 PowerFlex 7000 Drive Selection Explanation A-3 When is a Tachometer Required? A-4 PowerFlex 7000 Drive Performance A-5 Glossary of Terms A-5 Typical Application Load Torque Profiles A-6
Appendix B	Torque Requirements	Torque Requirements for Threaded Fasteners B-1
Appendix C	Meggering	Drive Meggering C-1 Meggering the PowerFlex 7000A C-1 Equipment Required C-2 Procedure C-2

Appendix D Preventative Maintenance

Preventive Maintenance Check List	D-1
Operational Maintenance	D-1
Annual Maintenance	D-2
Initial Information Gathering	D-2
Physical Checks (NO Medium Voltage and NO Control Power)	D-2
Control Power Checks (NO Medium Voltage)	D-4
Final Power Checks before Restarting	D-4
Additional Tasks During Preventive Maintenance	D-5
Final Reporting	D-5
Time Estimations	D-6
Tool / Parts / Information Requirements	D-7
Maintenance Schedule	D-8
Preventative Maintenance Service Schedule	D-9
General Notes	D-11
Maintenance of MV Motor Control Equipment	D-11
Periodic Inspection	D-11
Contamination	D-12
High Voltage Testing	D-12
Maintenance after a Fault Condition	D-12
Part-specific Notes	D-13
Cooling Fans	D-13
Operating Mechanisms	D-13
Contacts	D-13
Vacuum Contactors	D-13
Power Cable and Control Wire Terminals	D-14
Coils	D-14
Batteries	D-14
Pilot Lights	D-14
Solid-State Devices	D-15
Locking and Interlocking Devices	D-15

Appendix E Specifications

Specifications	E-1
----------------------	-----

Overview

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 information specific to the PowerFlex 7000 “A” Frame drive. Therefore customer specific topics are not presented. These customer specific topics include:

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

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

Three manuals address this product line:

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

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

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

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

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

Manual Conventions

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

WARNING

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

ATTENTION

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

Both of the above could indicate:

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

SHOCK HAZARD

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

General Precautions

ATTENTION

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

ATTENTION

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

ATTENTION

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

Who to Call for Commissioning

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

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

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

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

Overview of Drive

Introduction

The PowerFlex® 7000 represents the third generation of medium voltage drives from Rockwell Automation, and is part of the PowerFlex family of AC drive products. The Allen-Bradley PowerFlex® family of Drives incorporates leading-edge technology, embedded communications, and significant commonality across multiple platforms, networks, operator interface programming and hardware.

The PowerFlex 7000 is a general purpose stand alone medium voltage drive that controls speed, torque, direction, starting, and stopping of standard induction 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, 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.

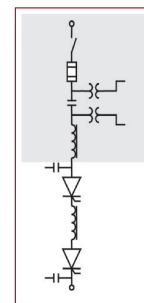
The design focus is on high reliability, ease of use, and lower total cost of ownership.

Drive Configurations – PowerFlex 7000 “A” Frame

Configuration #1 Direct-to-Drive (AFE with DTC DC Link)



- Elimination of isolation transformer results in lower losses and saved space
- An integrated system solution for fewer connections and reduced installation costs
- New or existing motors
- Small system footprint
- 3 cables in/3 cables out on entire system for easy installation
- Low line harmonics and high power factor (typical current THD < 5%, PF > 0.98)
- Fan control power and control circuit power supplied internally
- Input starter optional

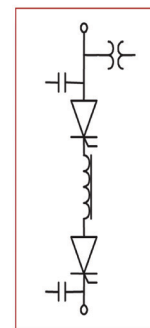


Direct-to-Drive
(Optional
Input
Starter)

Configuration #2 AFE Rectifier (Separate isolation transformer)



- Optimum installation flexibility with connection to indoor or outdoor isolation transformers
- Compact packaging for smallest footprint requirements
- New or existing motors
- 3 cables in/3 cables out for easy installation
- Low line harmonics and high power factor (typical current THD < 5%, PF > 0.98)
- Fan control power supplied internally (1-phase control circuit power supplied by customer, 120V/60 Hz, 110V/50 Hz, 20 amp)

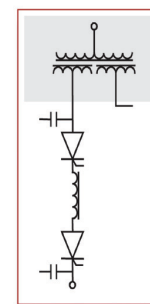


AFE
Rectifier

Configuration #3 AFE Rectifier (Integral isolation transformer)



- An integrated system solution for fewer connections and reduced installation costs
- Small system footprint
- New or existing motors
- 3 cables in/3 cables out for easy installation
- Integral cooling fans for VFD and transformer
- Low line harmonics and high power factor (typical current THD < 5%, PF > 0.98)
- Fan control power supplied internally (1-phase control circuit power supplied by customer, 120V/60 Hz, 110V/50 Hz, 20 amp)



Integral
Isolation
Transformer

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 and line converter switches.

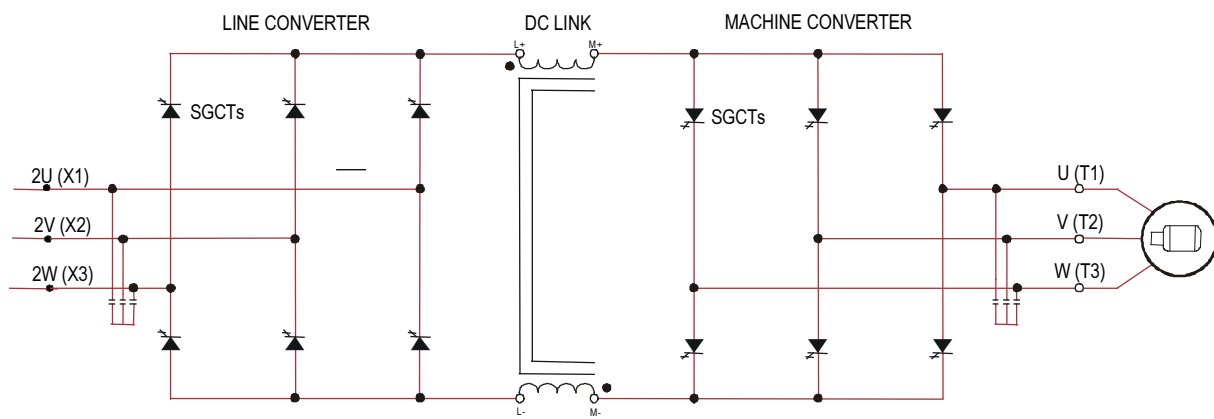


Figure 1. 1 – PWM-CSI AC Drive

Rectifier Designs

Active Front-End (AFE) Rectifier

An Active Front-End rectifier is particularly attractive since it does not require an isolation transformer to meet IEEE 519-1992.

Many competing 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, reduces operating costs and increases overall system efficiency.

The AFE rectifier requires a switching pattern that complies with similar rules as the inverter. The pattern used for the example shown in Figure 1.3 is a 42-pulse selective harmonic elimination (SHE) pattern, which eliminates the 5th, 7th and 11th harmonics. The integral input capacitors are designed to reduce the current harmonics of the higher order.

The filter resonant frequency is placed below 300 Hz (for a 60 Hz system) where no residual harmonics exist. 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 Figure 1.2) provides additional filtering and current limiting features to a line side short circuit fault. The line current and voltage waveforms are also shown in Figure 1.2. 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 near unity throughout a typical operating speed range for variable torque loads.

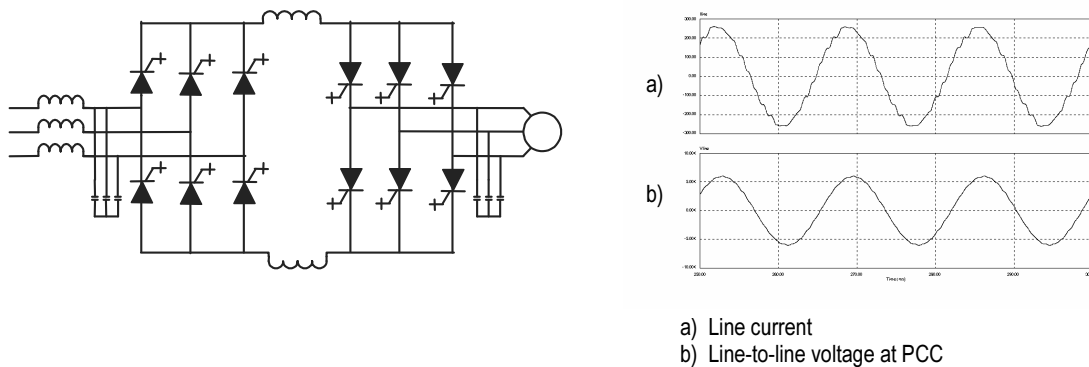


Figure 1.2 – AFE rectifier and its input current/voltage waveforms

The AFE rectifier can be used in conjunction with a rectifier duty isolation transformer or with an AC line reactor (as shown in Figure 1.2).

Isolation transformers are available:

- 1) Integral to the Drive
- 2) Remote indoor dry type, *or*
- 3) Outdoor oil-filled type

This allows for maximum flexibility in dealing with floor space, installation cost and control room air conditioner loading.

“Direct-to-Drive” Technology

Reduce the cost, size and weight of your medium voltage drive system with the Allen-Bradley PowerFlex 7000 with Direct-to-Drive technology. This is the first and only technology that allows you to directly connect a medium voltage drive to utility power without the requirement of an isolation transformer. Isolation transformers with multiple secondary windings are required for traditional AC drives to address line-side harmonic concerns and common mode voltage. However, typical isolation transformers are large, heavy, costly, complex and inefficient. Direct-to-Drive technology combines an Active Front End (AFE) rectifier to dramatically lower line-side harmonics and a patented DC link inductor to address common mode voltage at its source. By addressing harmonics and common mode voltage, the isolation transformer becomes redundant. This reduces system complexity to maximize uptime and increases system efficiency to lower operational costs. Exceptional output voltage and current waveforms, true of our entire product line, make this ideal for retrofit applications and allow the use of standard motors for new applications.

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 (5.4 °F) higher compared to across-the-line operation. Voltage waveform has dv/dt of less than 10 volts per microsecond. Reflected wave and dv/dt issues often associated with VSI (voltage source inverter) drives do not exist with the PowerFlex 7000. Typical motor waveforms are shown in Figure 1.3. 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 is capable of controlling motors up to 15 km (9.3 miles) away from the drive.

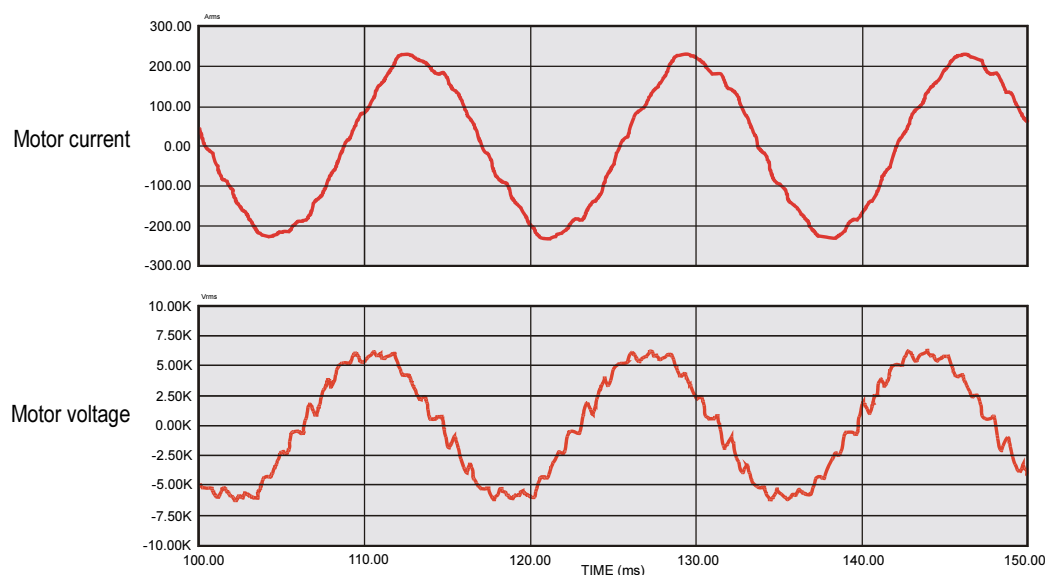


Figure 1.3 – Motor waveforms @ full load, full speed

SGCT Features and Benefits

An SGCT is a thyristor with an integrated gate drive. Positioning the gate drive close to the SGCT as shown in Figure 1.4, creates a low inductance path that provides more efficient and uniform gating of the device. As a result, the device is better suited to handle the fluctuating levels of voltage and current while it is switching on and off during gating.

An SGCT has low conduction and switching losses, low failure rate, and double sided cooling for low thermal stress. 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.

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. Ease of service
6. Non-rupture power device to contain any device failure within the device, eliminating a cascade failure mode.

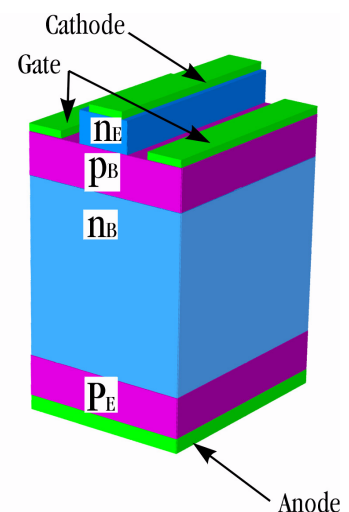
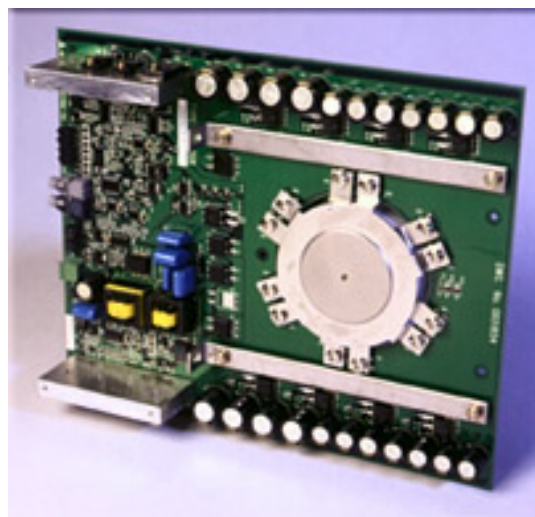
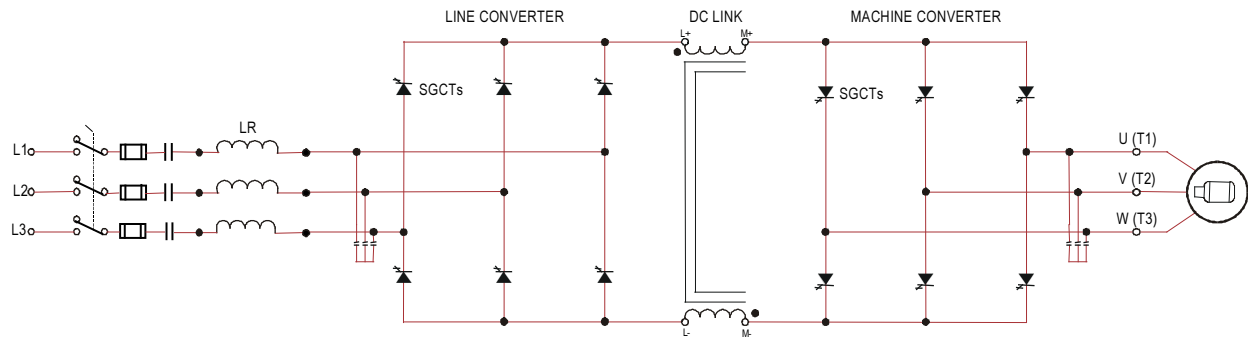


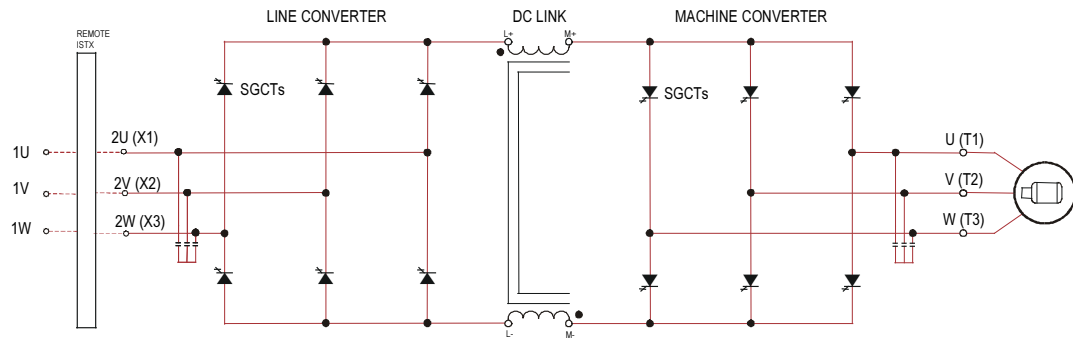
Figure 1.4 – SGCT with integrated gate drive (left) and unit cell structure (right)

Simplified Electrical Drawings – 2400V with AFE Rectifier

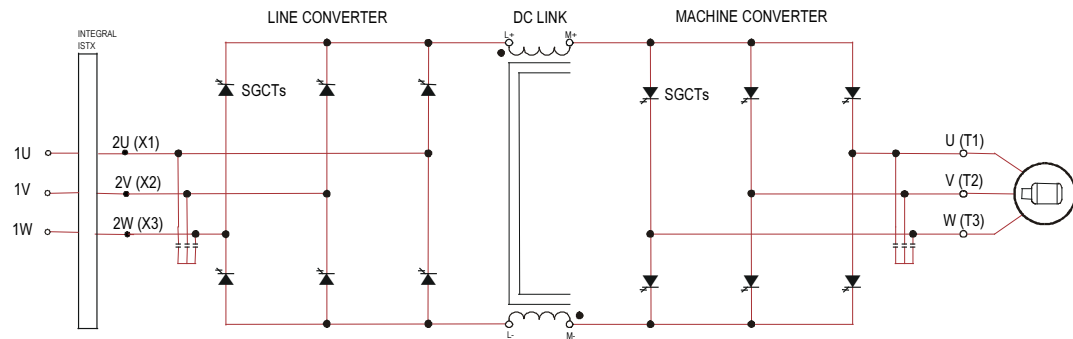


2400 Volt – AFE Rectifier, Configuration #1 – Direct-to-Drive

(Configurations without Integral Input Starter are available)

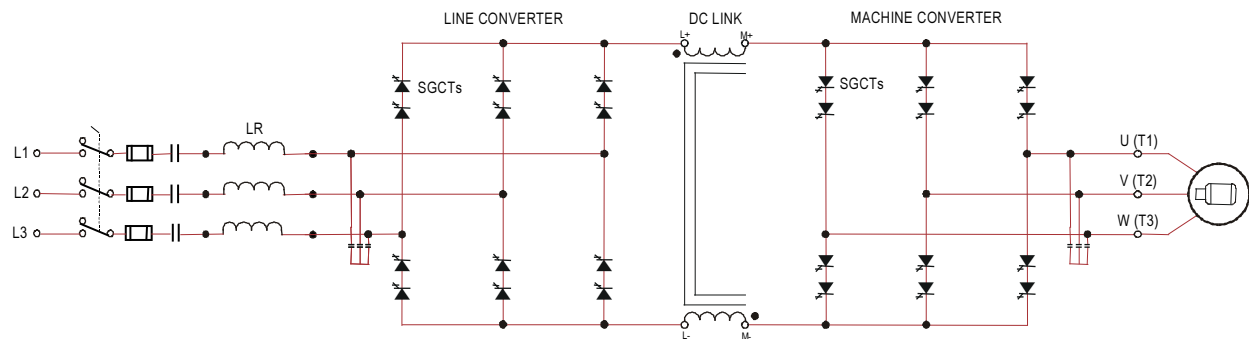


2400 Volt – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

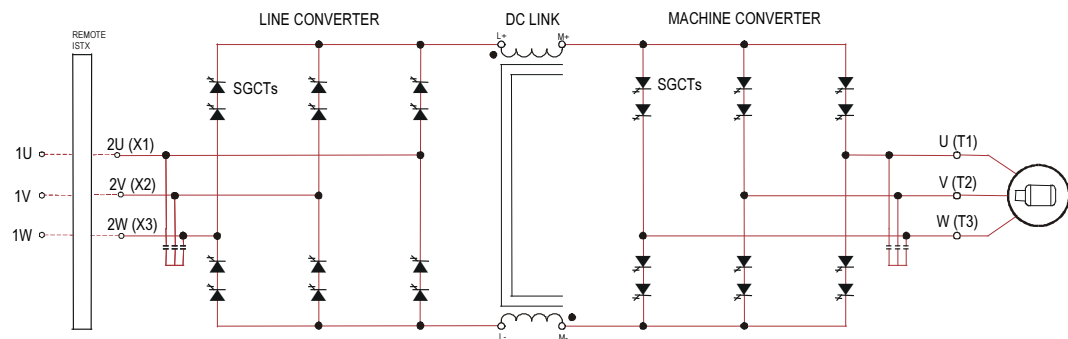


2400 Volt – AFE Rectifier, Configuration #3 – Integral Isolation Transformer

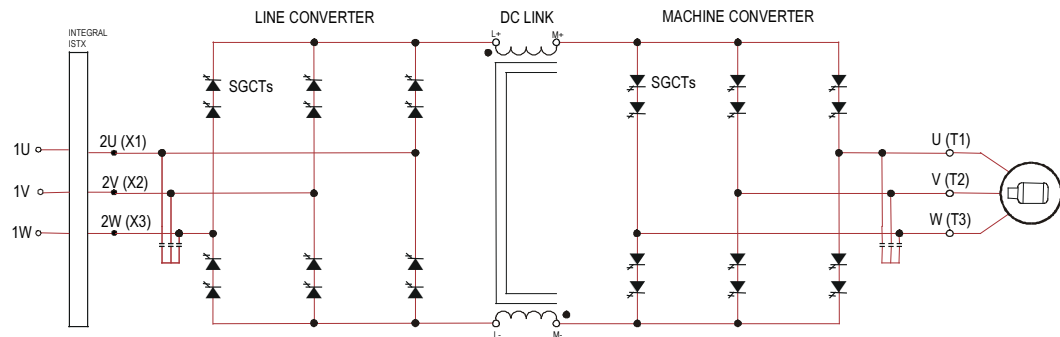
Simplified Electrical Drawings – 3300/4160V with AFE Rectifier



3300/4160 Volt – AFE Rectifier, Configuration #1 – Direct-to-Drive
(Configurations without Integral Input Starter are available)

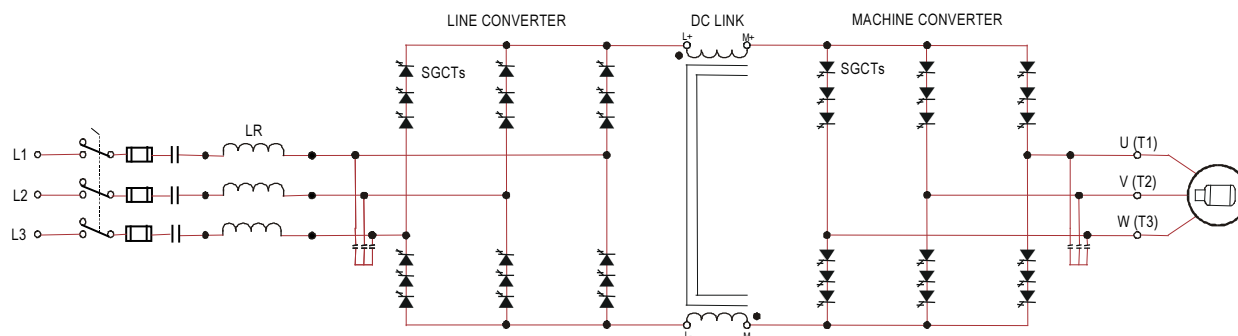


3300/4160 Volt – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

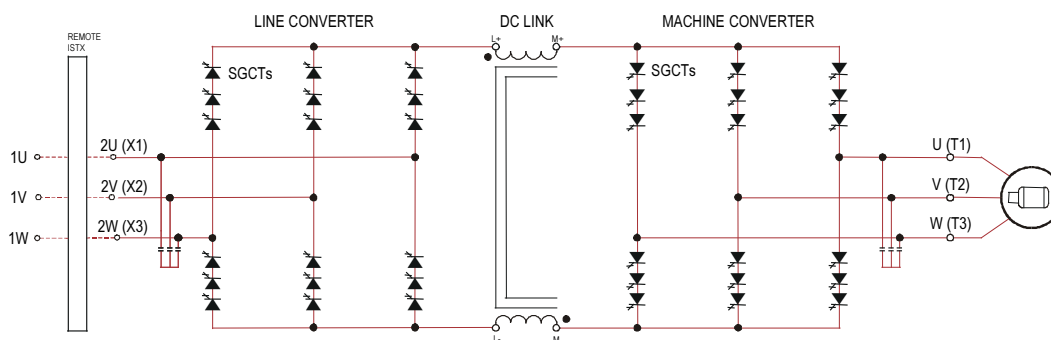


3300/4160 Volt – AFE Rectifier, Configuration #3 – Integral Isolation Transformer

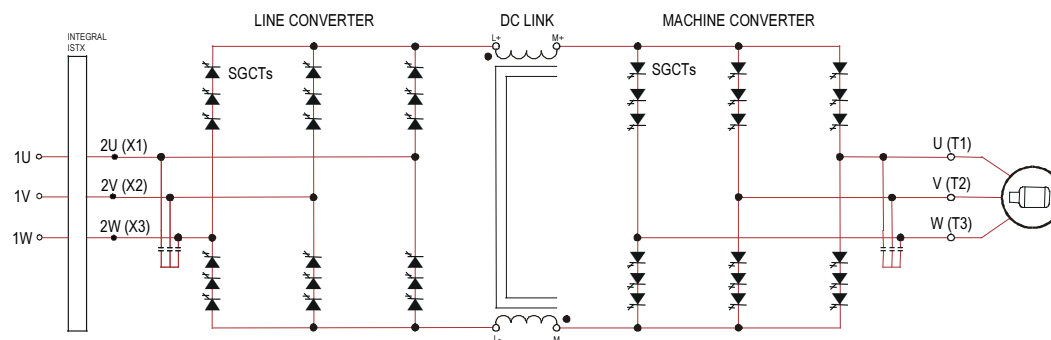
Simplified Electrical Drawings – 6600 V with AFE Rectifier



6600 Volt – AFE Rectifier, Configuration #1 – Direct-to-Drive
(Configurations without Integral Input Starter are available)



6600 Volt – AFE Rectifier, Configuration #2 – Separate Isolation Transformer



6600 Volt – AFE Rectifier, Configuration #3 – Integral Isolation Transformer

Control Overview

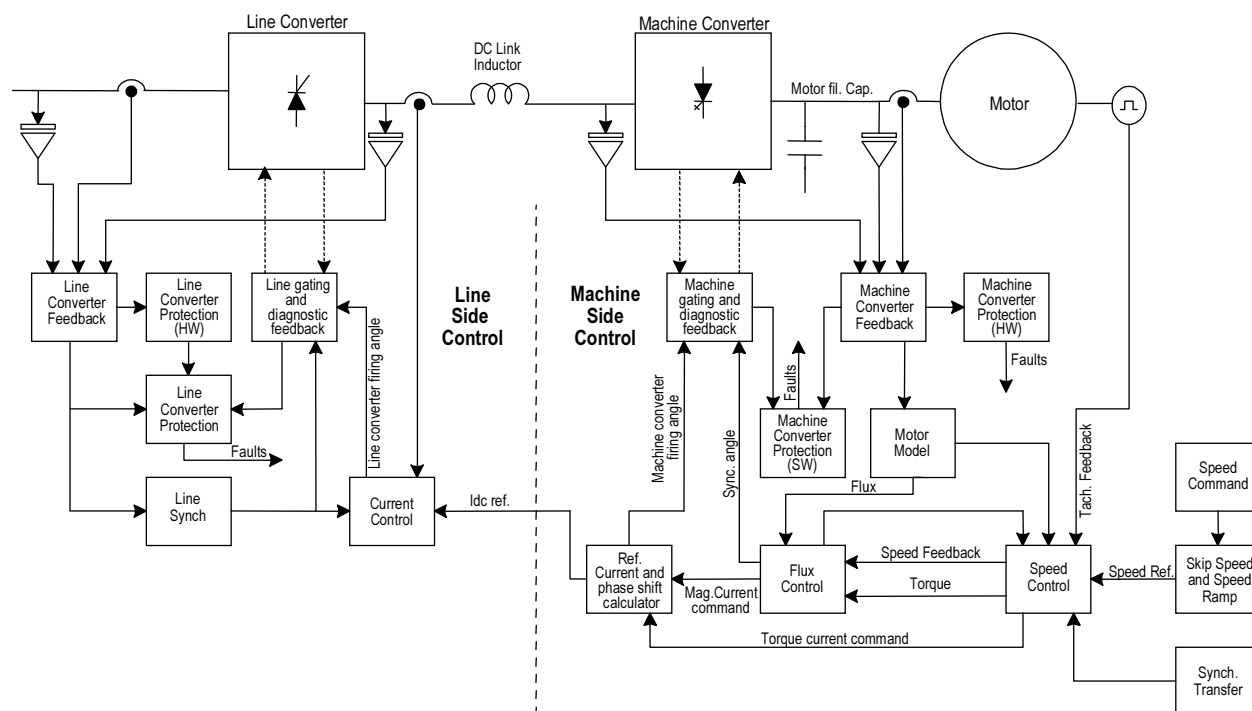


Figure 1.5– PowerFlex 7000 Function Block Diagram

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 5-25 radians per second, while the torque bandwidth range is 15-50 radians per second.

Control Hardware

The control hardware includes a Drive Processor Module (DPM) with an interface to six Optical Interface Boards (OIB) (depending on the voltage and number of switching devices) via the Optical Interface Base Board (OIBB), an Analog Control Board (ACB) and an external IO board (XIO). The control hardware is used for rectifier and inverter, induction or synchronous drive control and all configurations.

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

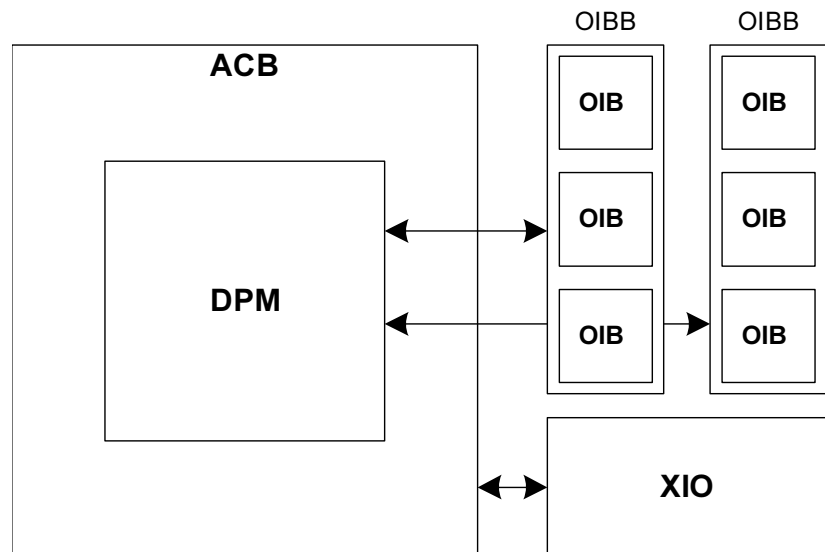


Figure 1.6 – Control Hardware Layout for PowerFlex 7000

Operator Interface

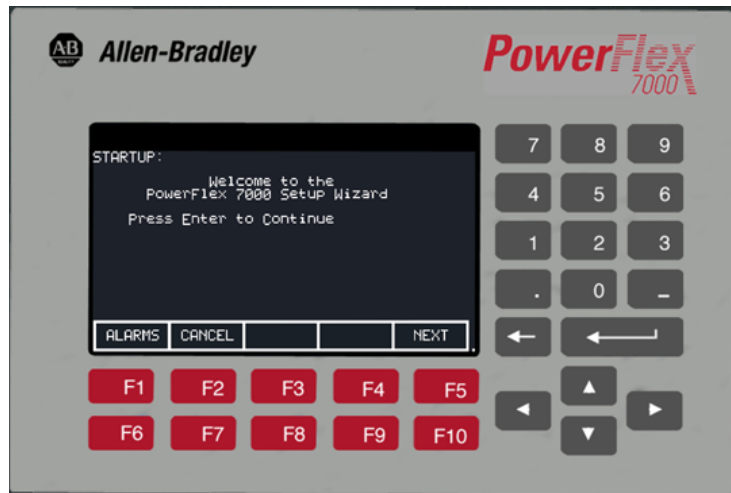


Figure 1.7 – PowerFlex 7000 Operator interface terminal

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.

Drive Installation

Safety and Codes

WARNING

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

Unpacking and Inspection

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

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

IMPORTANT

All claims for breakage and damage whether concealed or obvious must be made to the carrier by the Customer as soon as possible after receipt of the shipment. Rockwell Automation will be glad to 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_-EN-P for a more detailed description.

The drive must be transported on a pallet or via use of the lifting angle 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.

ATTENTION

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

IMPORTANT

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

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

Overhead Lifting

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

ATTENTION

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

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.

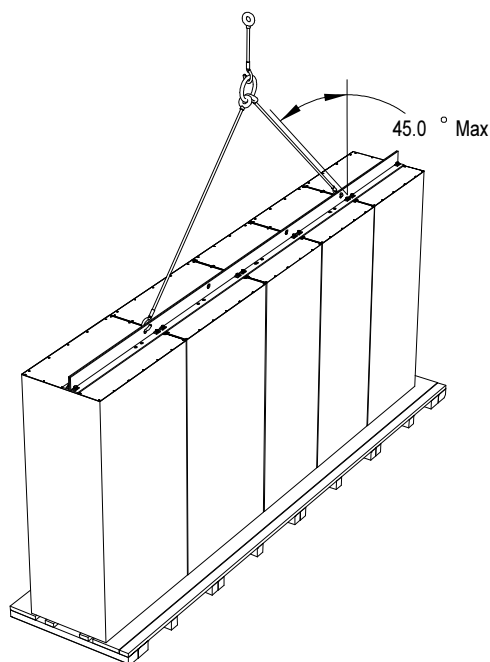


Figure 2.1 – Overhead Lifting

Transportation and Handling (cont.) 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 mm x 150 mm (2 in. x 6 in.) or equivalent and at least 300 mm (12 inches) longer than the drive must be placed under the shipping skid.
2. Carefully ease the shipping platform over the roller pipes until the drive weight is borne on the roller pipes.
3. The drive can be rolled to its designated location. Steady the load to prevent tipping.

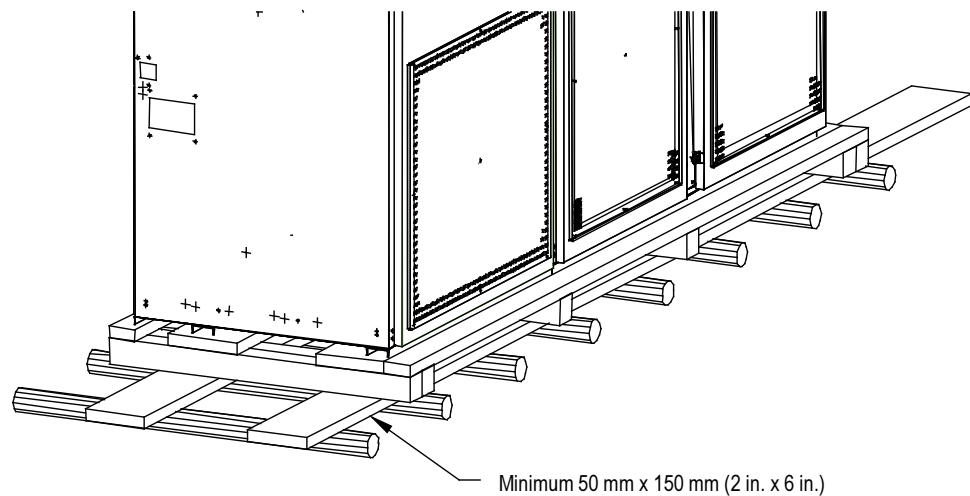


Figure 2.2 – Rod or Pipe Rollers

Fork Lift Trucks

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

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

Storage

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

Storage temperature should be maintained between -40°C and 70°C (-40°F and 185°F). If storage temperature fluctuates or if humidity exceeds 95%, space heaters should be used to prevent condensation. The drive should be stored in a heated building having adequate air circulation. The drive must never be stored outdoors.

Siting of the Drive

Site Considerations

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

- Elevation above sea level less than 1000 meters (3250 feet)
- Ambient air temperature between 0°C (32°F) and 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) above the drive.

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.

Siting of the Drive (cont.)

- (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 topology utilized in the PowerFlex 7000 medium voltage AC drive does not produce dv/dt or peak voltage problems, and 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.

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.

Generator Note:

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 worked on.

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). Engineering 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.

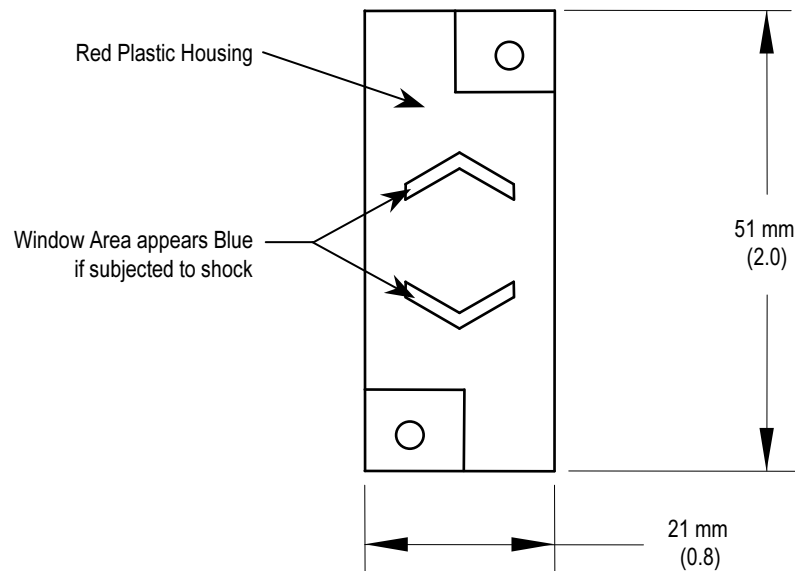


Figure 2.3 – Shock Indicator

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. (For drives with an acoustic hood, the components are shipped assembled. See Figure 2.5)

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.

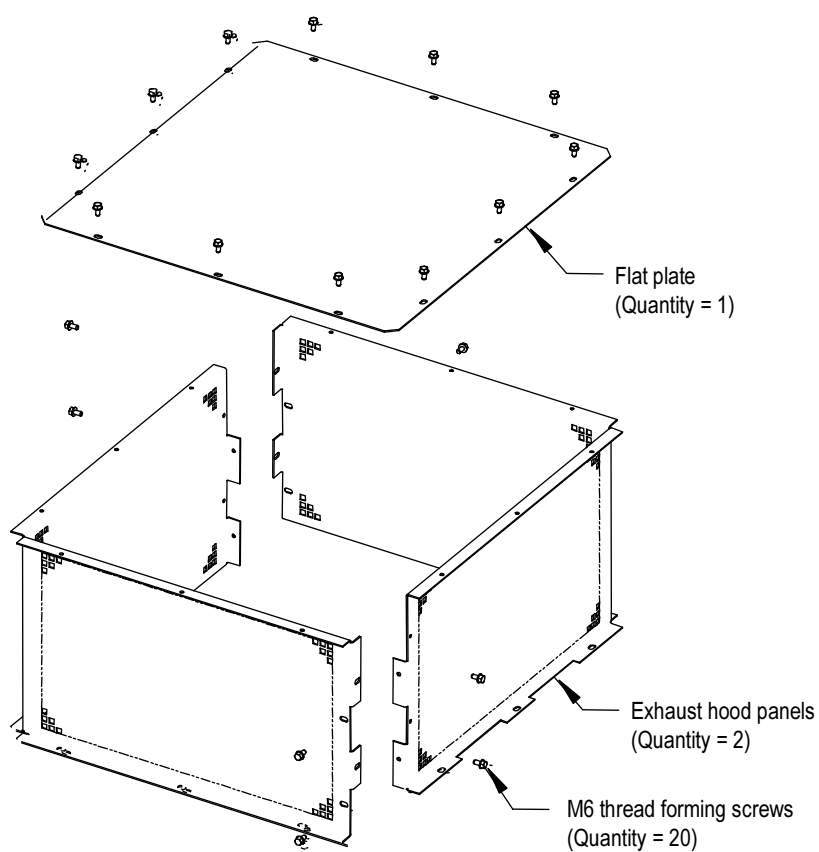


Figure 2.4 – Fan Hood Assembly

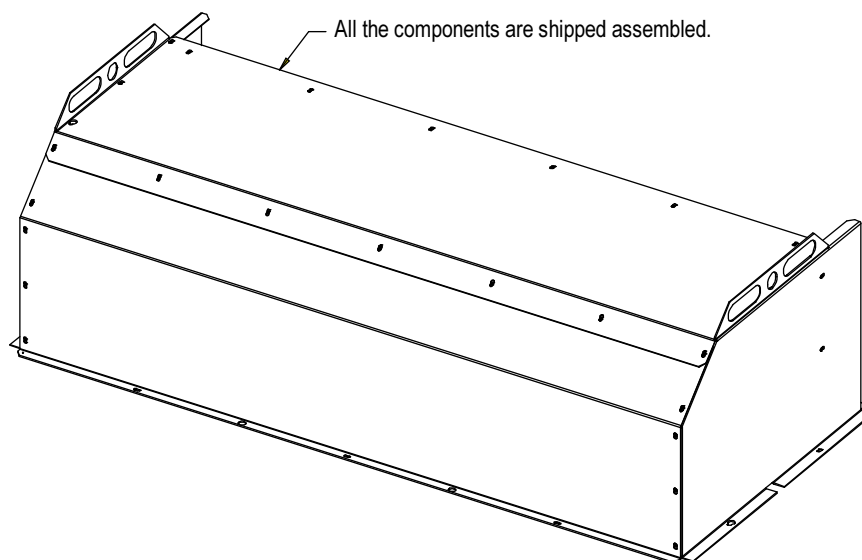


Figure 2.5 – Acoustic Fan Hood Assembly

Installation (cont.)

Locate the exhaust hood on top of the cabinet per Figure 2.6 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.

For drives with an acoustic hood (shown in Figure 2.5), locate the exhaust hood (refer to Figure 2.7).

ATTENTION



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

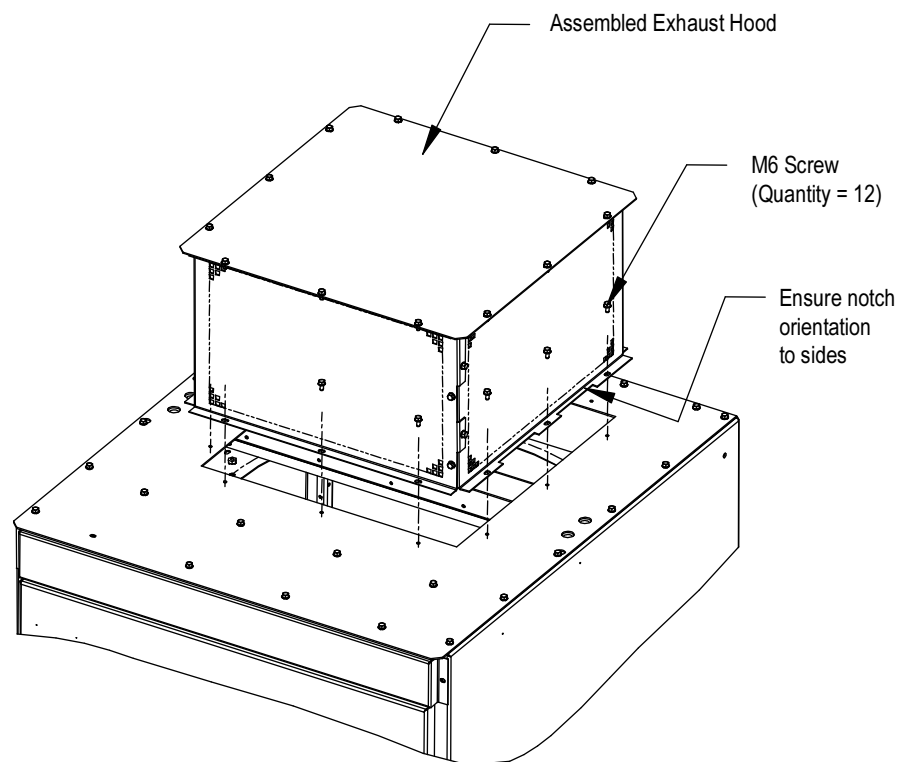


Figure 2.6 – Fan Hood Installation

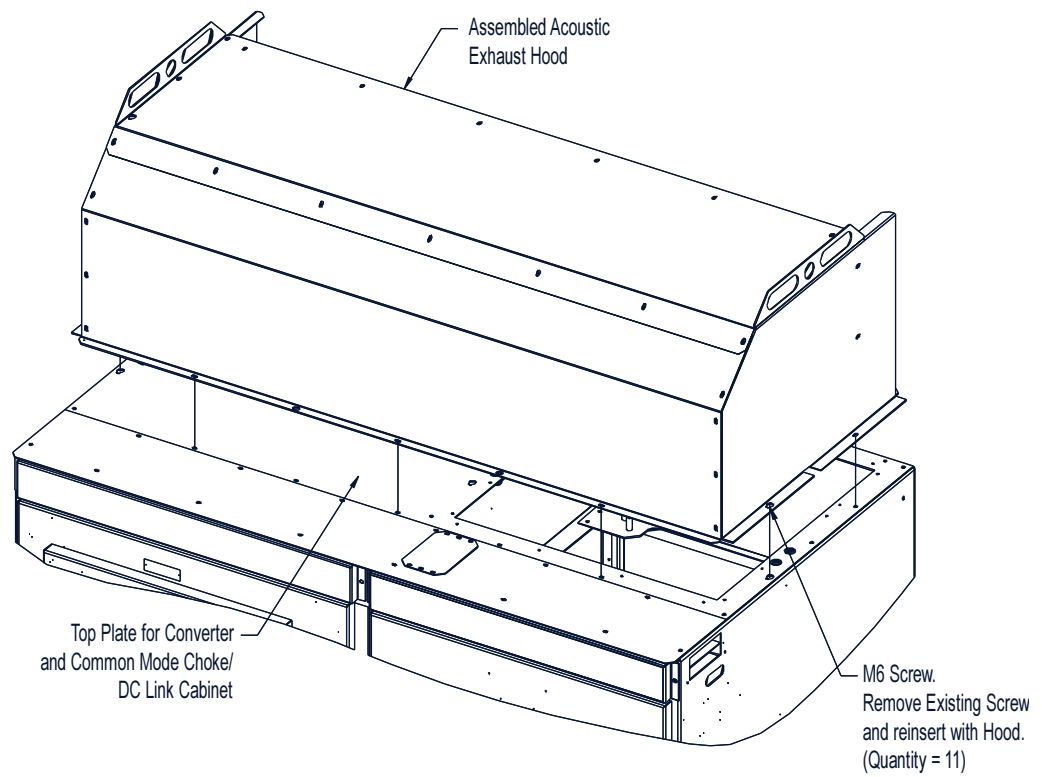


Figure 2.7 – Acoustic Fan Hood Installation

Installation (cont.)

Installation of Integral Transformer Cooling Fan

1. Remove the protective plate covering the fan opening on the top of Isolation Transformer cabinet and discard.
2. Locate the cooling fan on top of the cabinet. Position it over the opening and align the mounting holes and wire harness connections.
3. Affix the fan to the drive top plate with the M6 thread forming screws provided.
4. Connect the fan wire harness to fan.

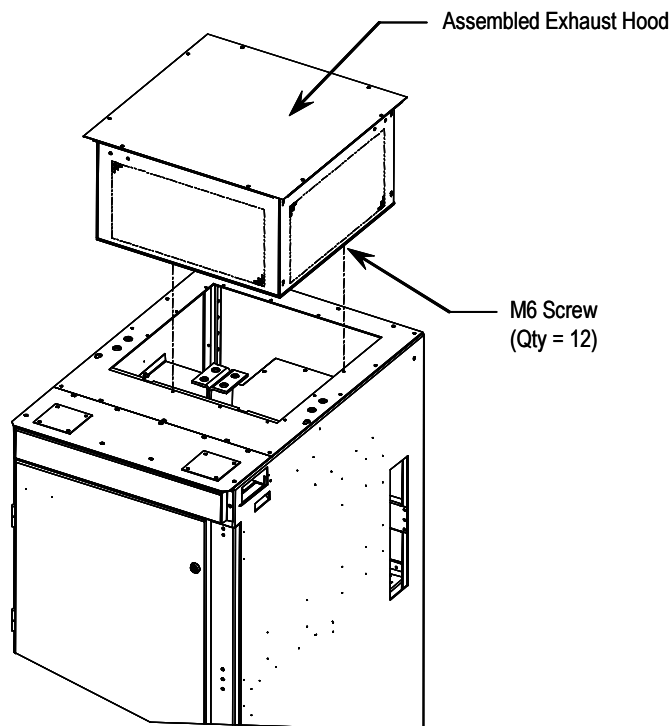


Figure 2.8 – Fan Installation for Integral Isolation Transformer

Neutral Resistor Assembly

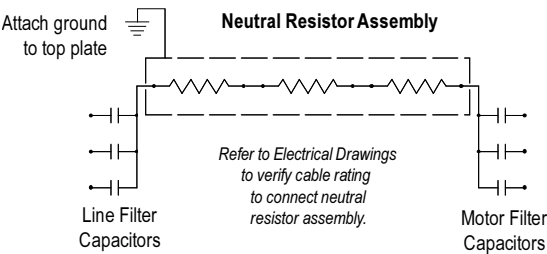
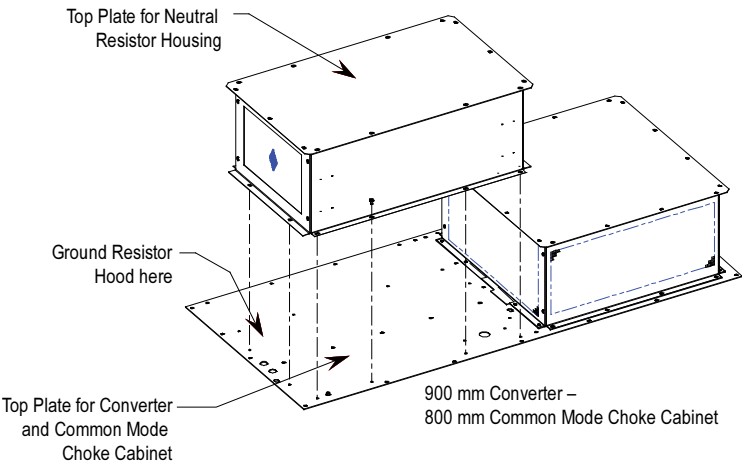


Figure 2.9 – Hood Assembly for Neutral Resistor

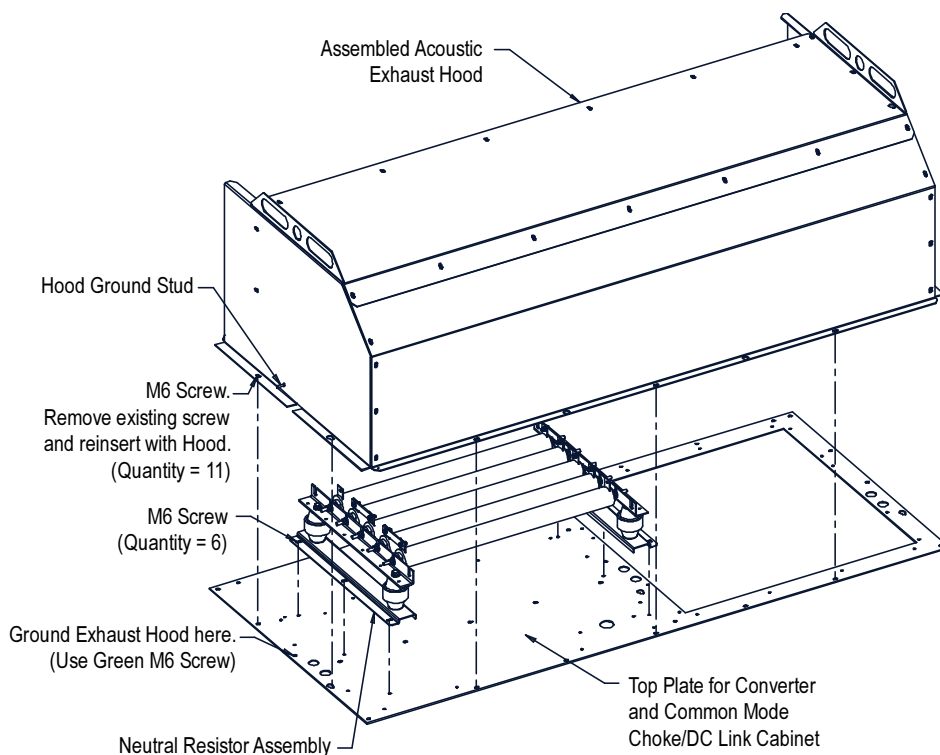


Figure 2.10 – Acoustic Hood Assembly for Neutral Resistor

Installation of Neutral Resistor Assembly (Drives with Common Mode Chokes)

On top of the converter cabinet, a sheet metal enclosure containing power resistors is to be installed.

1. Locate the resistor assembly on top of the cabinet as shown in Figure 2.9. (For acoustic hood assembly, refer to Figure 2.10.)
2. Affix the assembly to the top plate using M6 thread forming screws provided.
3. Remove the top plate of the resistor assembly to permit access to the wiring connection points.
4. Connect the resistor wiring and per the electrical diagram provided with the drive, a typical connection diagram is shown in Figure 2.9. Ensure that the resistor wiring is routed through the hole having a plastic bushing to protect the wire insulation. The neutral resistor assembly housing has a ground connection that is to be connected to the top plate of the drive.
5. Re-install the top plate of the neutral resistor housing.

External Ducting

The PowerFlex 7000's design allows for its exhaust air to be ducted outside of the control room. In this case, consideration must be given to the conditions present in the atmosphere outside the control room. When externally ducting the exhaust air and bringing in cleansed outside air, the following requirements must be met:

ATTENTION



If the drive configuration has more than one exhaust outlet, ensure that each outlet is ducted separately to prevent back-feeding of hot exhaust into the drive.

- External ducting including an external filtering system must not add more than 50 Pa (0.2 inches of water) pressure drop to the PowerFlex 7000 drive air flow system.
- The control room must provide slightly more make-up air creating a pressurized room. This slight pressurization ensures no unfiltered air is drawn into the room.
- The drive is intended to operate in conditions with no special precautions to minimize the presence of sand or dust, but not in close proximity to sand or dust sources. This is defined by IEC 7211 as being less than 0.2 mg/m^3 of dust. If outside air does not meet this condition, the air must be filtered to ASHRAE (American Association of Heating, Refrigeration and Air-Conditioning Engineers) Standard 52.2 MERV 11 (Minimum Efficiency Reporting Value). This filtration eliminates from 65% to 80% of the particulate in Range 2 ($1.0 - 3.0 \text{ }\mu\text{m}$) and 85% of the particulate in Range 3 ($3.0 - 10.0 \text{ }\mu\text{m}$). This filter system must be cleaned or changed regularly to ensure proper flow.
- The make-up air must be between $0 - 40$ degrees C.
- Relative humidity must be less than 95% non-condensing.
- Approximately ten percent of drive losses will still be rejected into the control room and must be addressed to maintain the temperature in the control room within specification.
- Failure to maintain proper flow of cooling air into the control room can result in the drive stopping on low differential pressure across the heatsinks.

Cabinet Layout and Dimensional Drawings of Drive

The following dimension drawing is a sample and may not accurately detail your drive. It is 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)

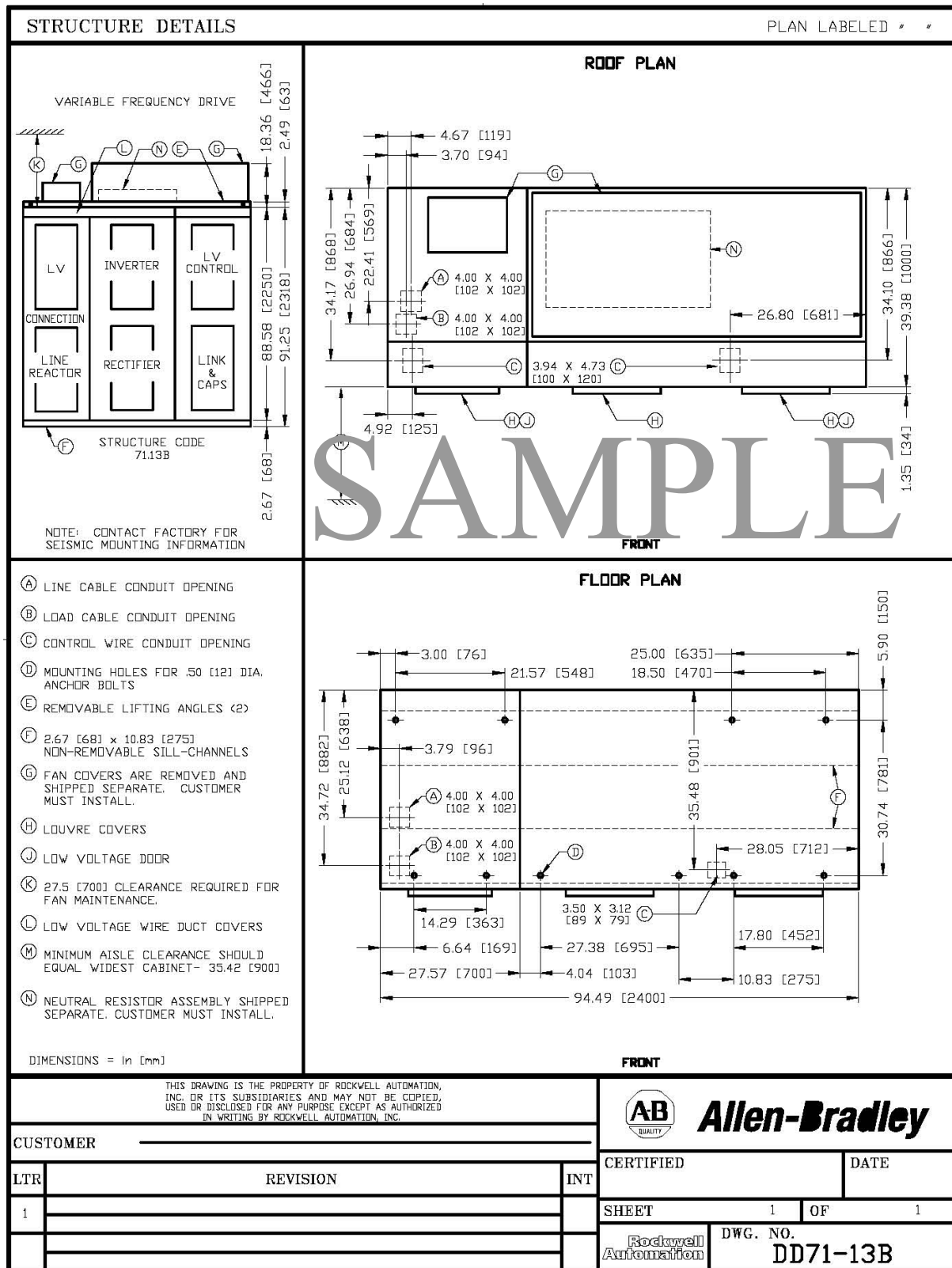
The **ROOF PLAN** shows:

- 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)
- 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 "A" Frame Dimensional Drawing



Note: Contact Factory for Seismic Mounting Information.

Drive Layout

The following diagrams are presented to show the typical layout of the three main configurations of the PowerFlex 7000 “A” Frame Drive.

Configuration #1

Direct-to-Drive (AFE with DTC DC Link)

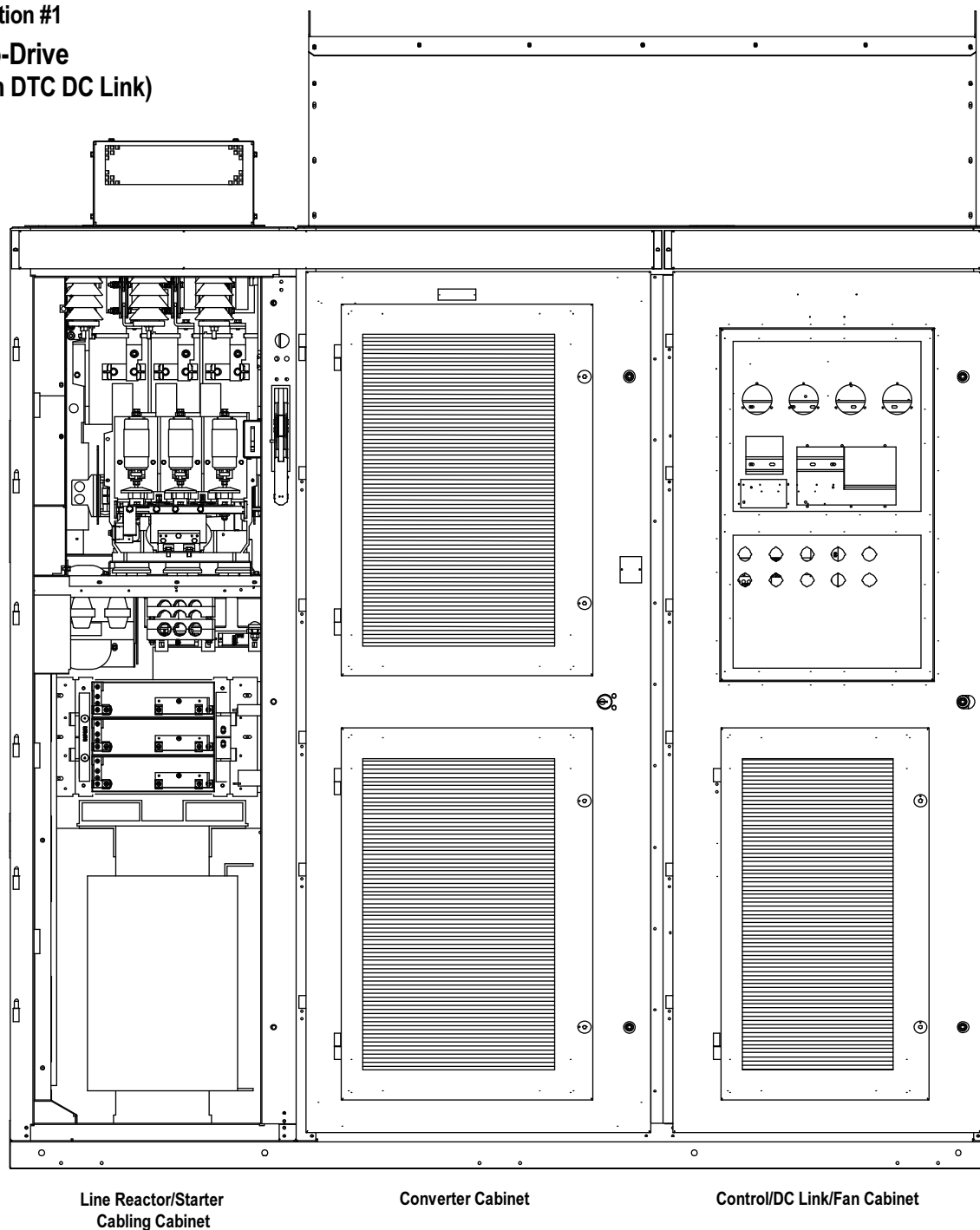


Figure 2.11 – Direct-to-Drive (AFE with DTD DC Link)

Configuration #2
AFE Rectifier
(Separate Isolation Transformer)

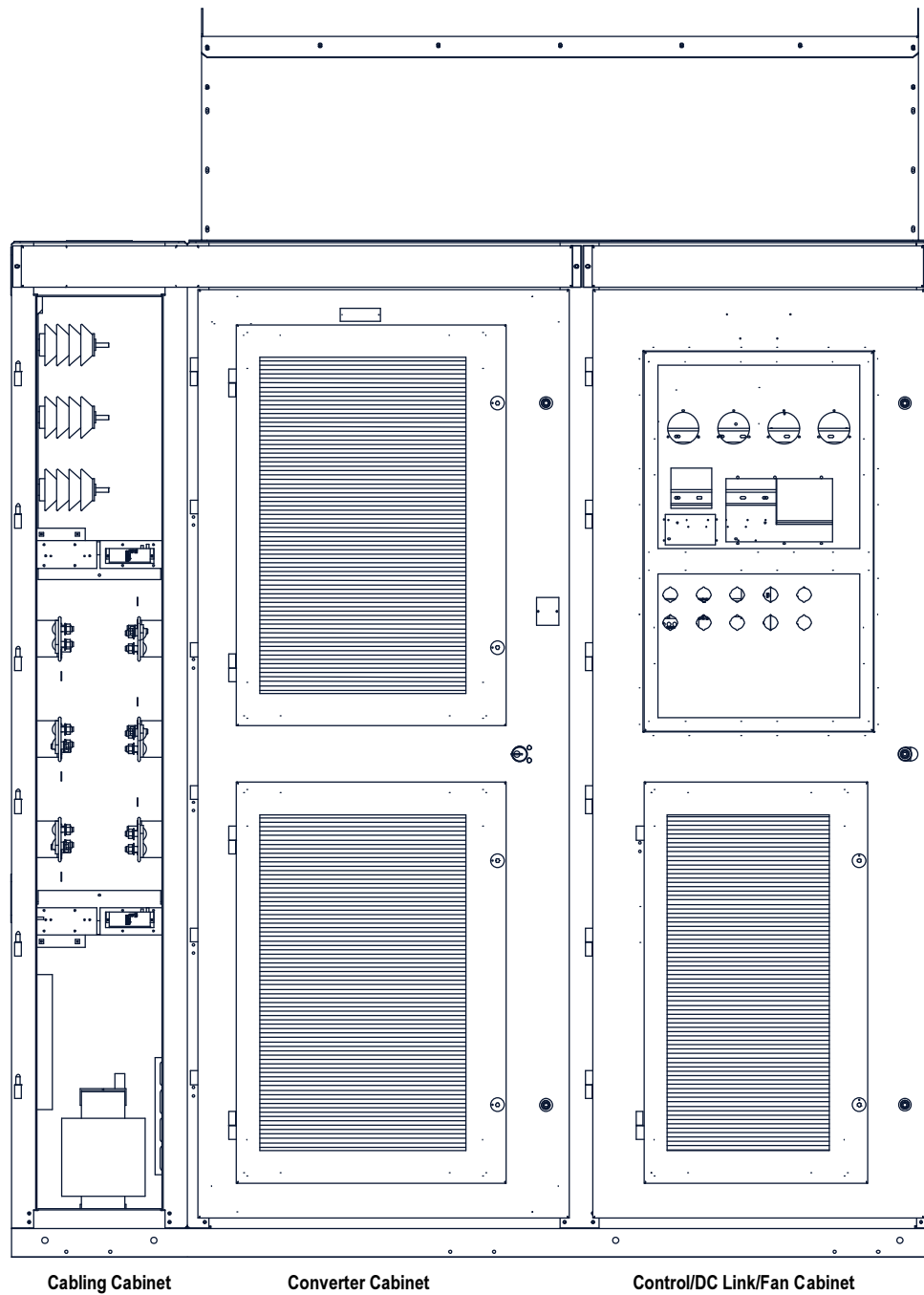


Figure 2.12 – AFE Rectifier (Separate Isolation Transformer)

Configuration #3

AFE Rectifier (Integral Isolation Transformer)

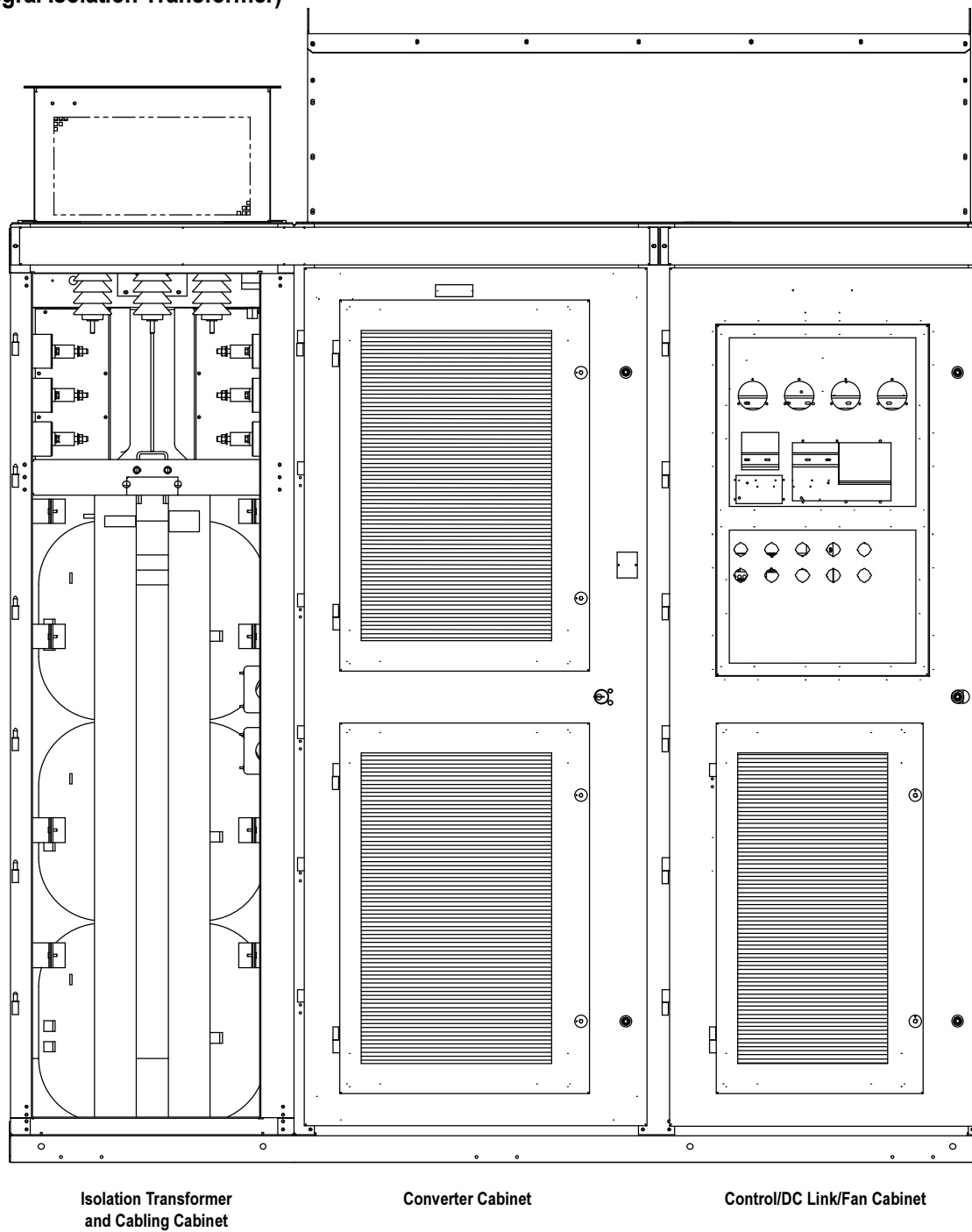


Figure 2.13 – AFE Rectifier (Integral Isolation Transformer)

Cabling Cabinet #1

The cabling cabinet of the drive with integral line reactor and input starter is located in the left-hand section. The mounting and location of the line reactor and input starter are shown along with customer cable termination locations. The circulating fans for the cabinet are located on top.

Note: This cabinet is also available *without* integral starter (see Figure 2.16). The width of the cabinet changes as a function of the drive voltage ratings.

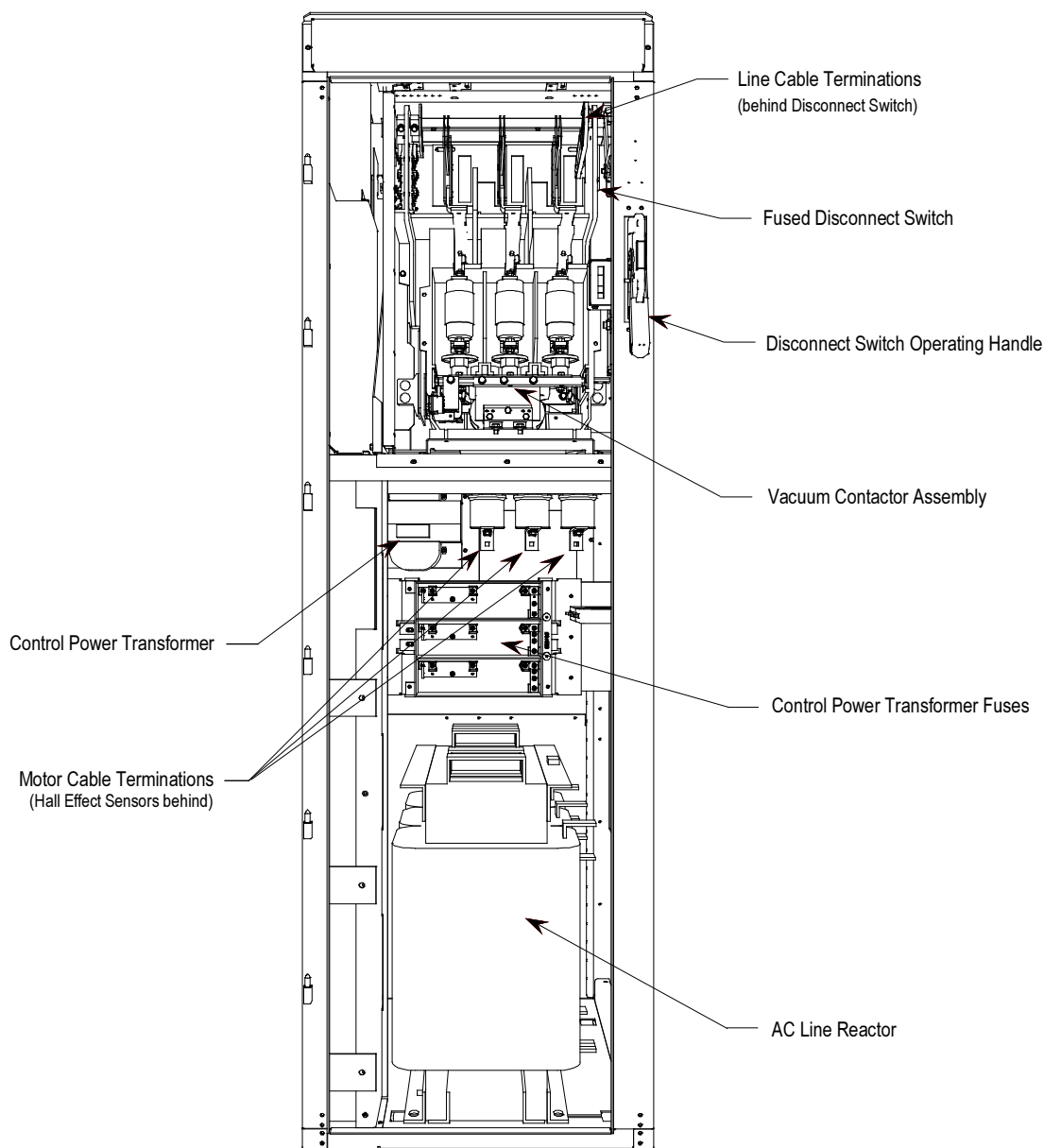


Figure 2.14 – Cabling Cabinet for Configuration #1 *with* Input Starters

Cabling Cabinet #1

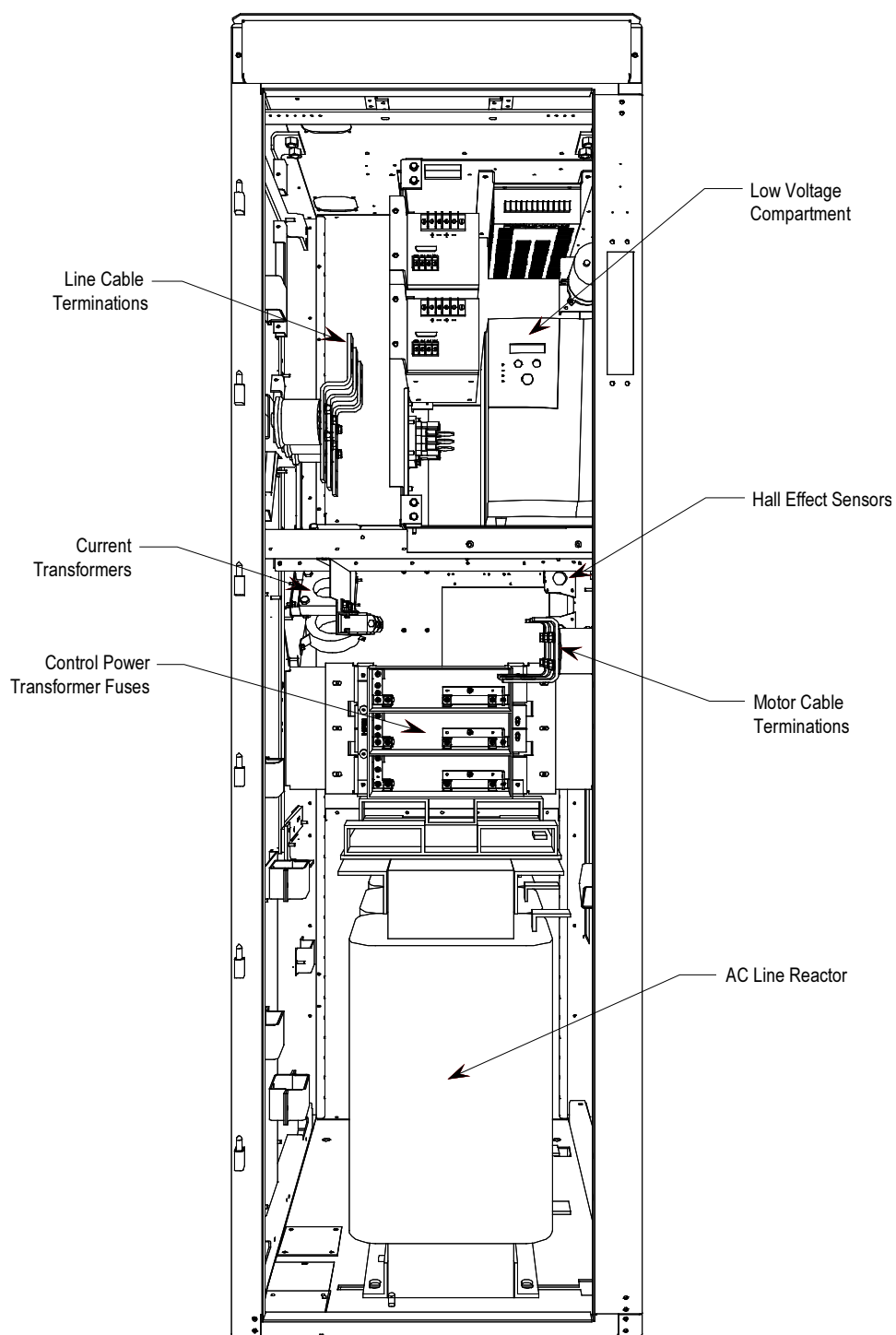


Figure 2.15 – Cabling Cabinet for Configuration #1 *without* Input Starters

Cabling Cabinet #2

Cabling cabinet #2 is located in the left hand section and shows the medium voltage area for customer cable terminations, three phase fan power transformer, and fuse assemblies for transformer.

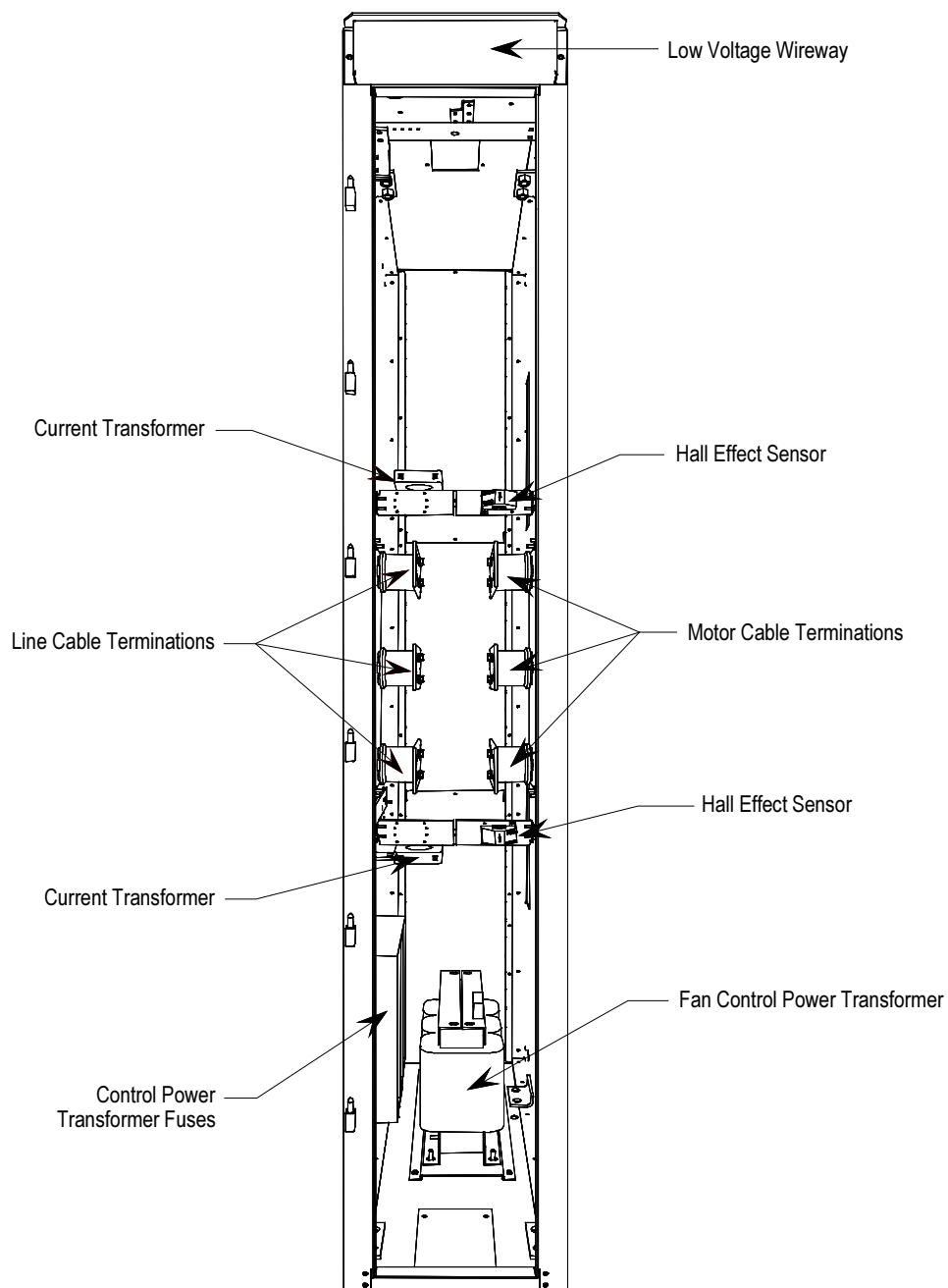


Figure 2.16 – Cabling Cabinet for Configuration #2

Cabling Cabinet #3

The cabling cabinet of the drive with integral isolation transformer is located in the left-hand section. The mounting and location of the isolation transformer is shown along with customer cable termination locations. The cooling fan for the isolation transformer is located on top.

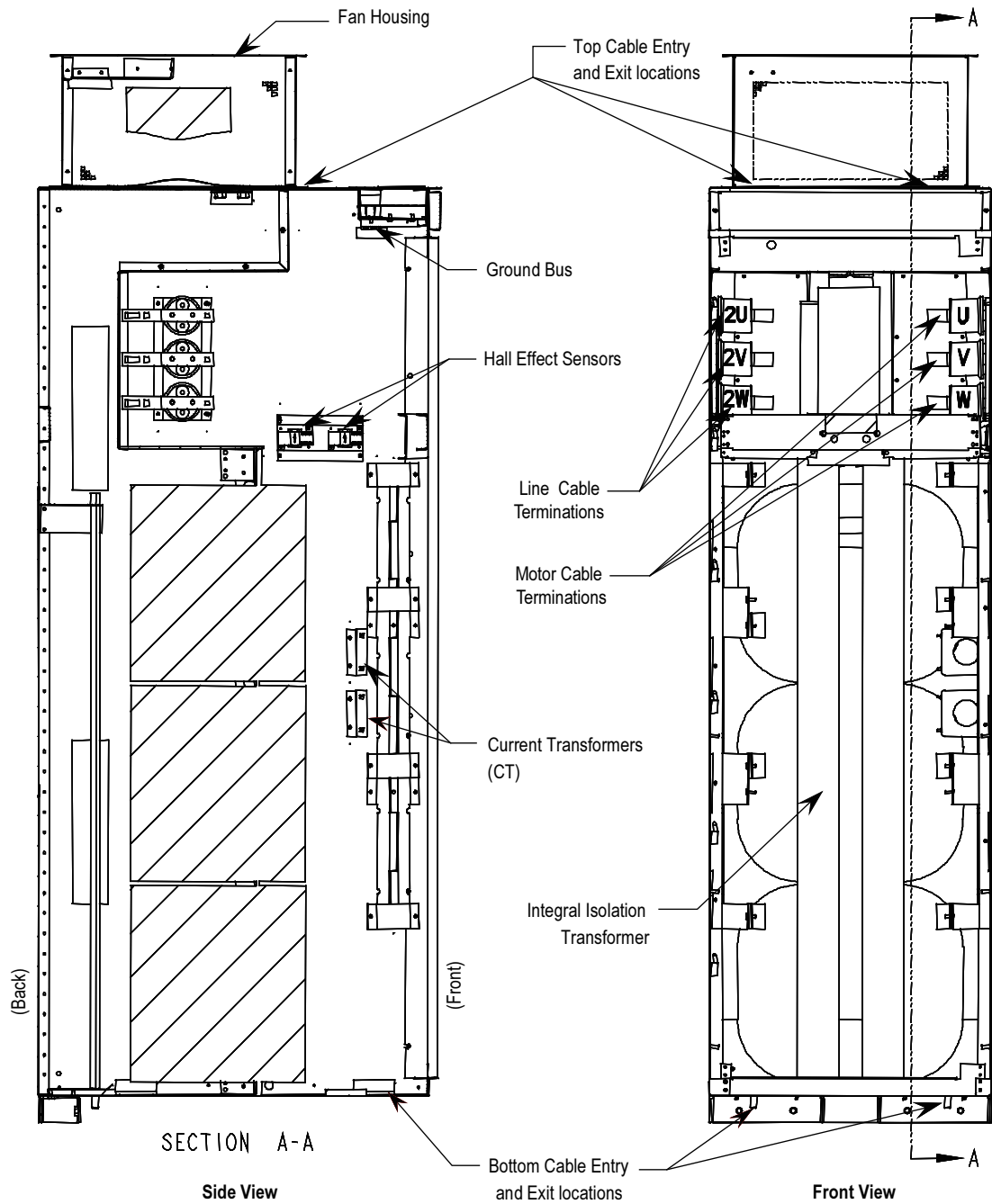
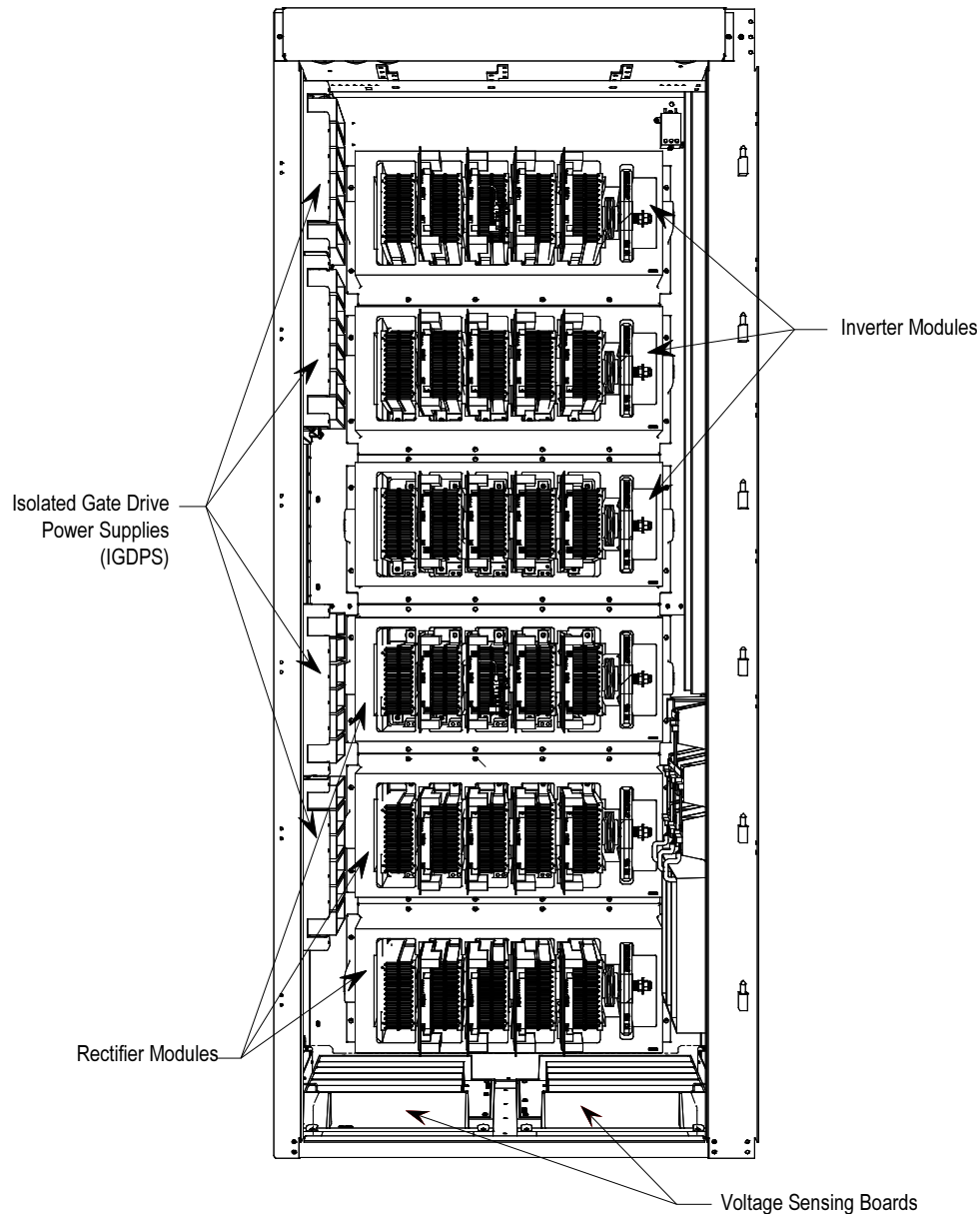


Figure 2.17 – Cabling Cabinet for Configuration #3

Converter Cabinet

The converter cabinet for all configurations of the PowerFlex 7000 “A” Frame drive is located in the middle section. The mounting and location of Inverter / rectifier modules are shown along with gate drive power supplies and voltage sensing modules.

Note: The width of the inverter / rectifier modules changes as a function of the drive voltage ratings (2400-6600V).

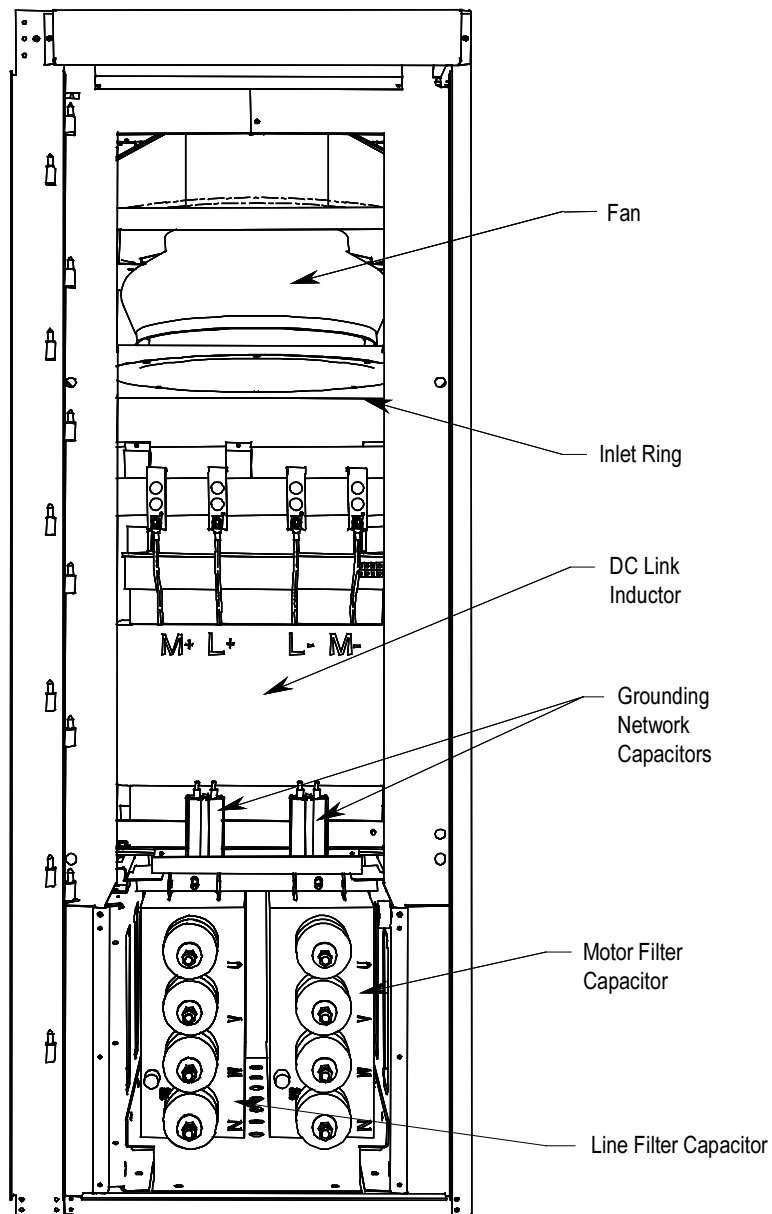


**Figure 2.18 – Major Components of the Converter Cabinet
(3300/4160V version shown)**

Control / DC Link / Fan Cabinet

The control / DC link / fan cabinet for all configurations of the PowerFlex 7000 “A” Frame drive is located in the right section. The mounting and location of the DC link inductor, line / load side capacitors, and main cooling fan are shown behind the low voltage control tub.

Note: The control / DC link / fan cabinet has the same layout for all drives at 2400-6600 volt ratings.



**Figure 2.19 – Major Components of Control / DC Link / Fan Cabinet
(with low voltage control tub removed)**

Low Voltage Control Tub (Located in Control / DC Link / Fan Cabinet)

The low voltage control tub is mounted in front of the DC link inductor in DC link / fan cabinet of the drive. Refer to Chapter 6, Component Definition and Maintenance, for complete content details of the low voltage section.

Note: The low voltage control tub has the same layout for all PowerFlex 7000 “A” Frame drive ratings.

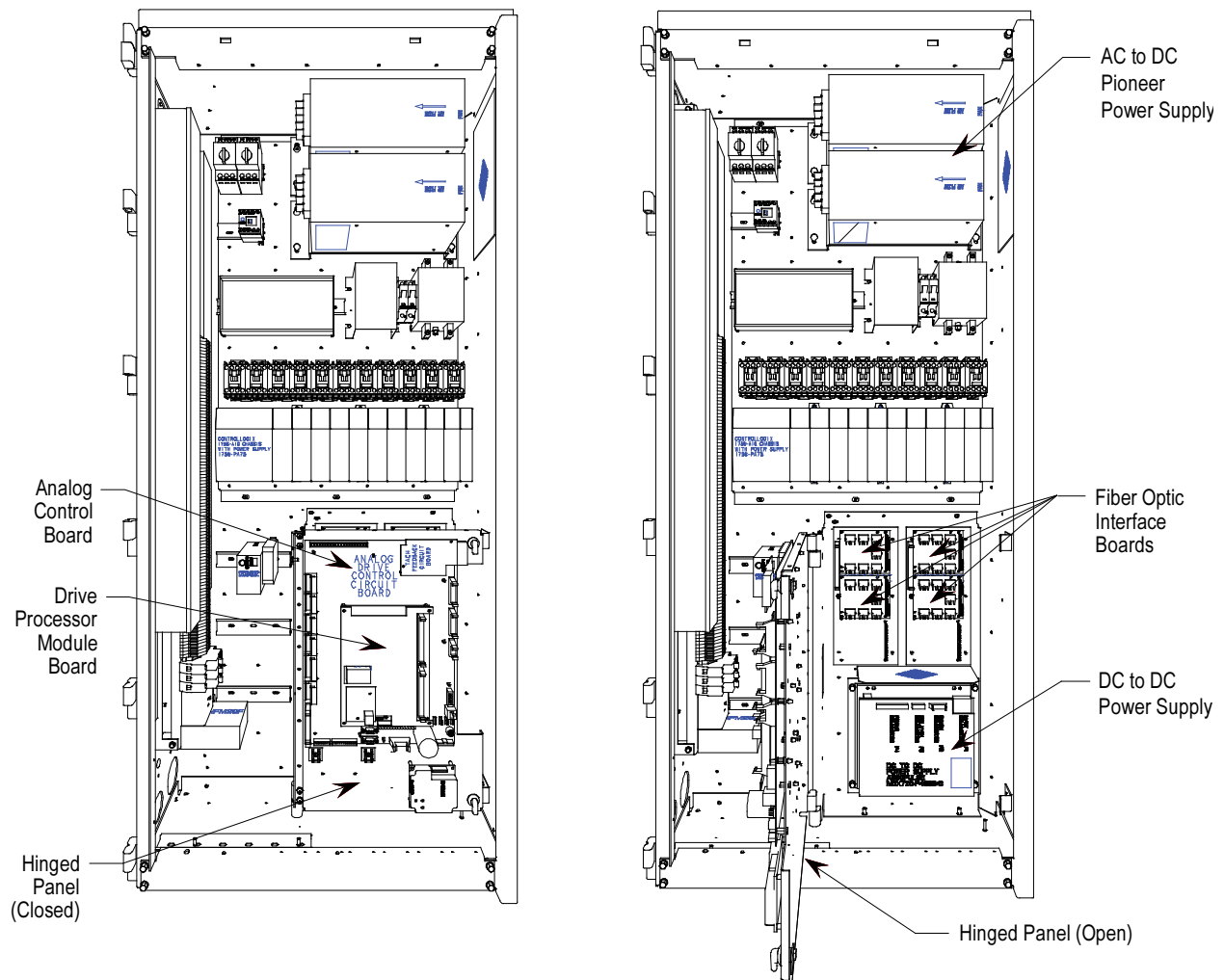


Figure 2.20 – Location of Low Voltage Control Tub (Pioneer Power Supply)

Low Voltage Control Tub **(Located in Control / DC Link /** **Fan Cabinet) (cont.)**

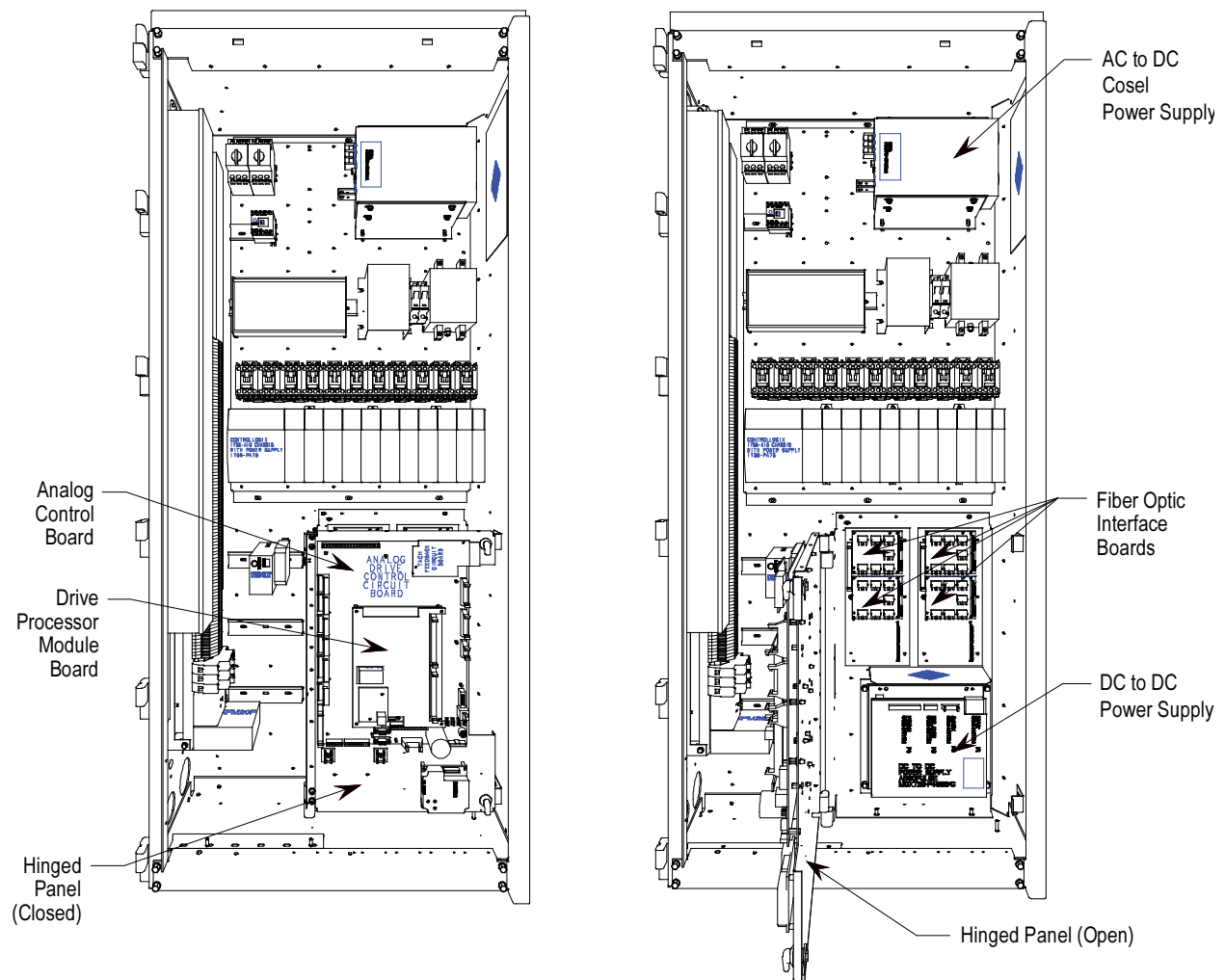


Figure 2.21 – Location of Low Voltage Control Tub (Cosel Power Supply)

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 electrical drawing (ED) set. The device designations used on the drawings and labeling are also listed with explanations on each drawing set.

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

Power Wiring Selection

The following tables identify general wire selections that will be encountered when installing the PowerFlex 7000 “A” Frame 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. However, NEC requires shielded cables for installations above 2 kV.

Power Wiring Selection (cont.)

Cable Insulation

The cable insulation requirements for the PowerFlex 7000 “A” Frame 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 AFE Drives with Separate Isolation Transformer

System Voltage (V, RMS)	Cable Insulation Rating (kV) (Maximum Peak Line-to-Ground)	
	①	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

① Cabling from secondary side of Isolation Transformer to input of VFD

Cable Insulation Requirements for “Direct-to-Drive” Technology or Integral Isolation Transformer

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

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

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

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

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

Table 2.A – Wire Group Numbers

The wire sizes must be selected individually, observing all applicable safety and CEC, IEC or 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 with an across-the-line starter. The distance between the drive and motor may affect the size of the conductors used.

Consult the wiring diagrams and appropriate CEC, IEC or 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 (DD).

To access the customer power cable terminations

Cable connections are located behind the medium voltage door of the Connection/Cabling cabinet. Location of power terminals for various drive configurations are as indicated in Figures 2.22 to 2.25.

In the case of the cabling cabinet with starter, the removal of internal barriers and duct covers located on the left side of the cabinet may be required to facilitate the routing of line cables. This can be accomplished by removing the hardware securing the barrier/cover and sliding it toward the front of the cabinet for removal. In addition the fan housing and cover plate (if already installed) located on the top of the cabinet must be removed to allow routing and termination of line cables. All barriers/covers must be replaced, by reversing the above sequence, before applying medium voltage.

The installer is responsible for modifying the power cable access plates to suit their requirements.

Note that appropriate connectors must be used to maintain the environmental rating of the enclosure.

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:

Line/Motor Terminations

- Drives with Connection to remote transformers: 2U, 2V, 2W
- Drives with integral transformers: 1U, 1V, 1W
- Drives with integral line reactor and input starter: L1, L2, L3
- Motor Connections: U, V, W
- Drives with integral line reactor, no input starter: 1U, 1V, 1W

Power Cabling Installation Requirements

To determine cable distance from top or bottom of input cabinet to termination points, refer to Figures 2.24, 2.22 and 2.25.

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.

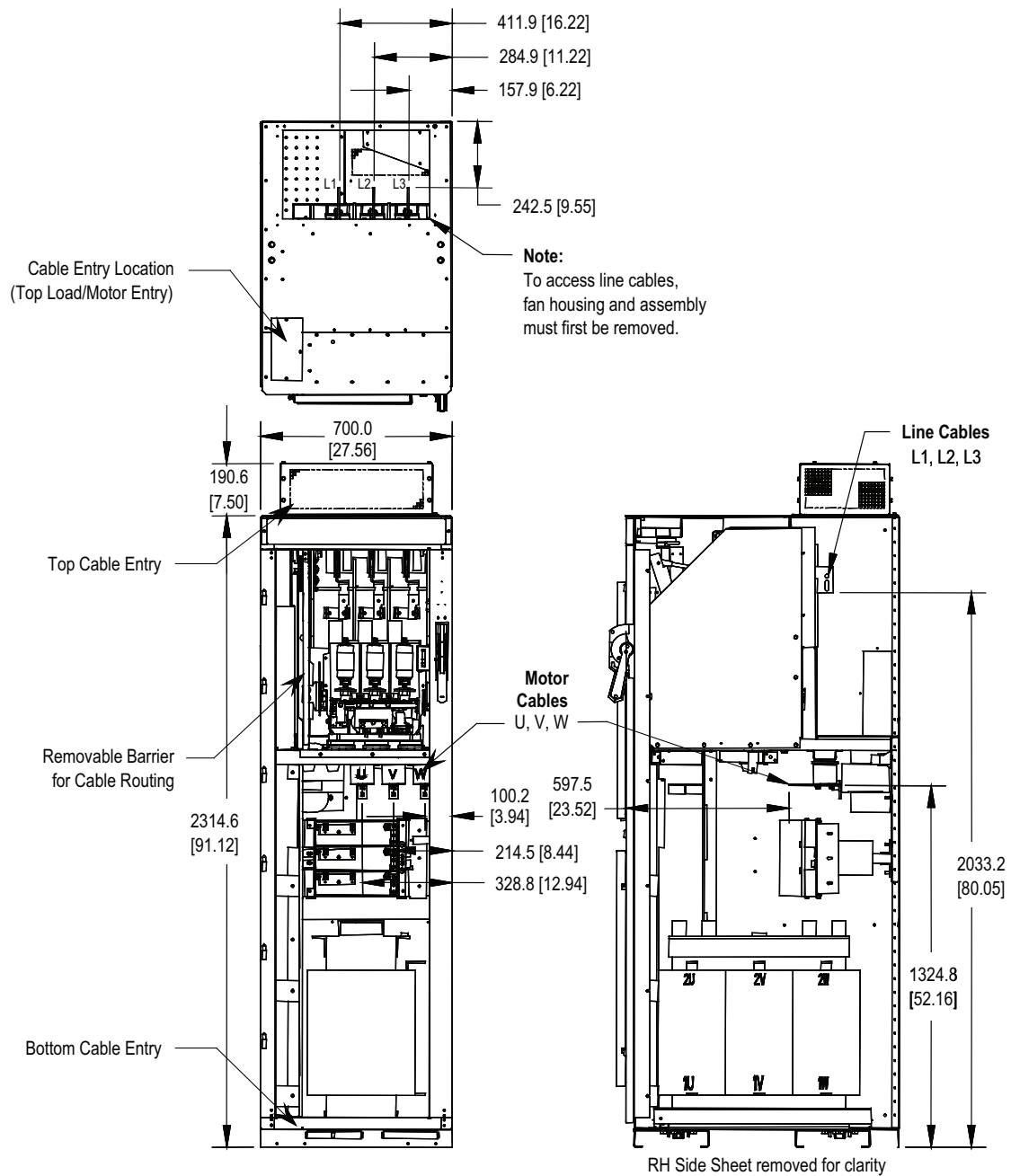


Figure 2.22 – Dimension Views of Cabling Cabinet for Configuration #1 with Input Starter

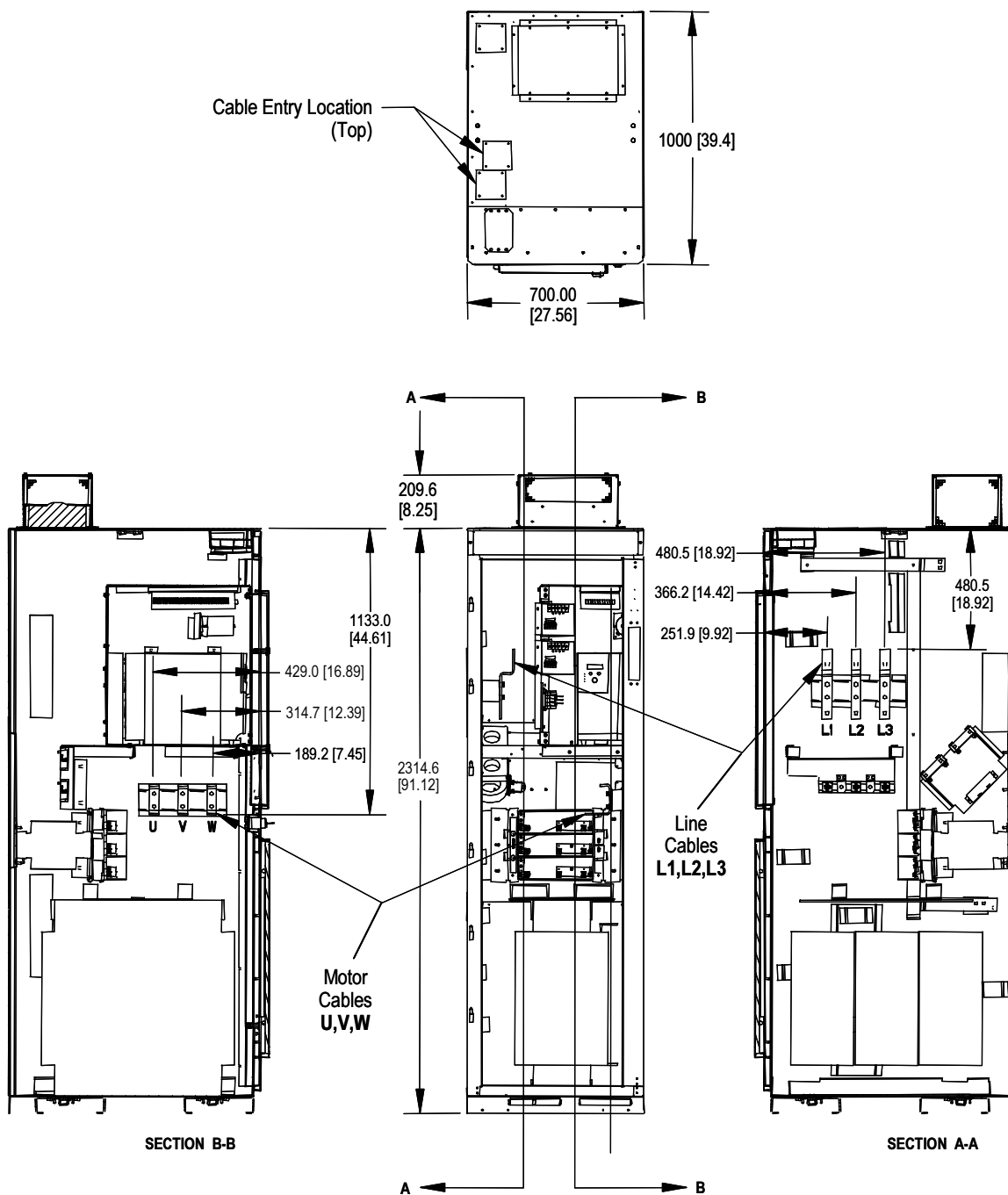


Figure 2.23 – Dimension Views of Cabling Cabinet for Configuration #1 *without* Input Starter

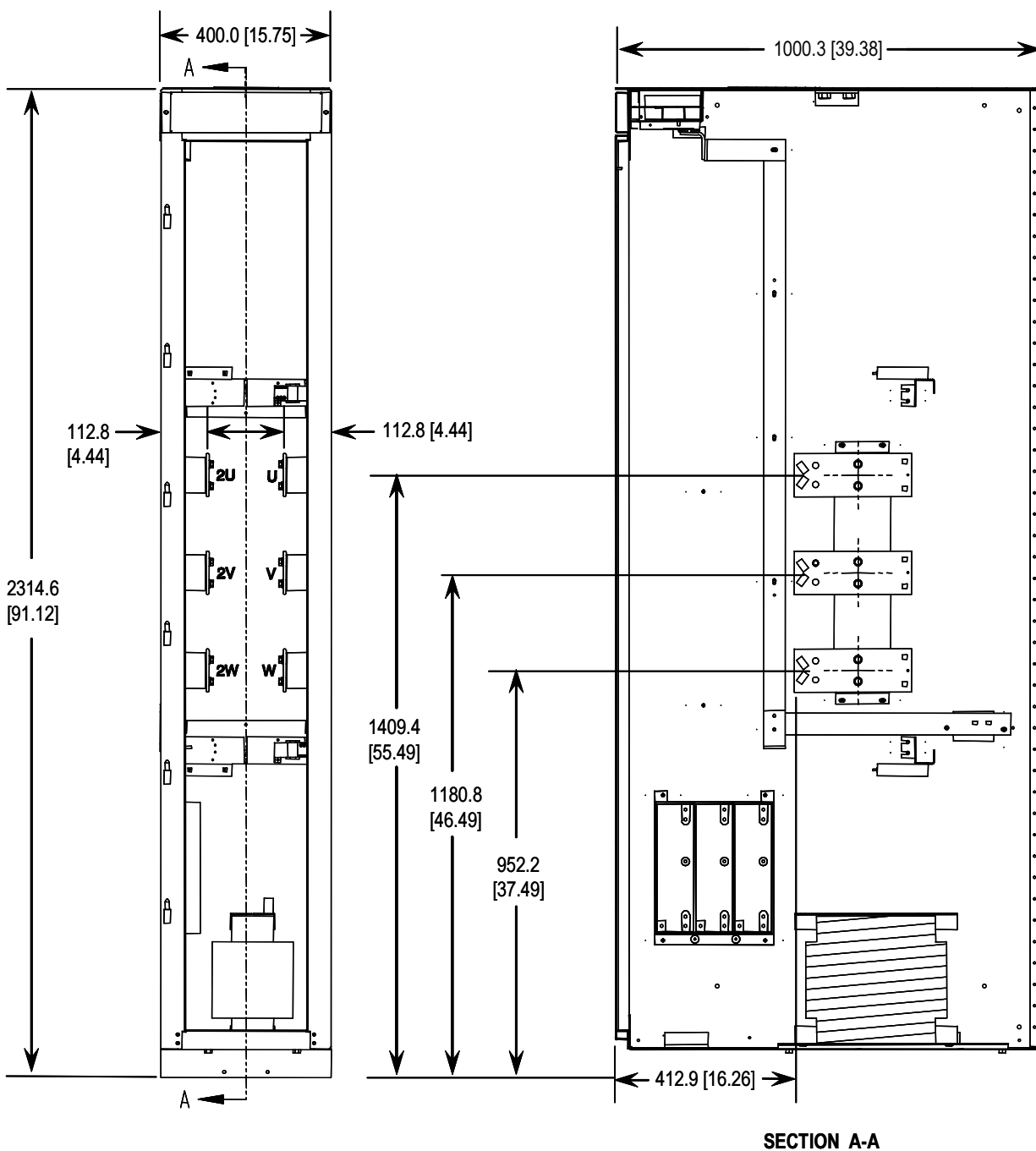


Figure 2.24 – Dimension Views of 400 mm Cabling Cabinet for Configuration #2 Line and Load Motor Terminals



$\vdash A$

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 #14 AWG. The low voltage signals (includes 4-20mA) are to be connected using twisted shielded cable, with a minimum #18 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 electrical drawings (ED) provided.

Encoder Installation Guidelines

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

• Protection from Radiated and Conducted Noise

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

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

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

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

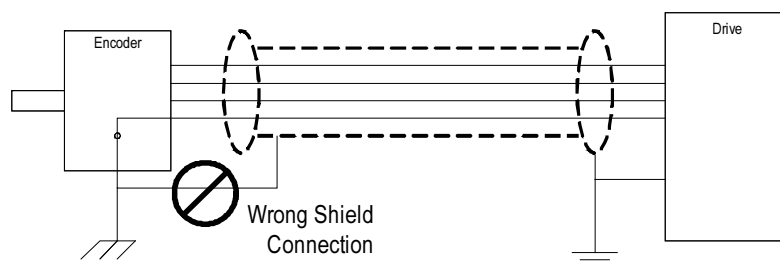


Figure 2.26 – Encoder Shield Ground

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

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

Power and Control Wiring (cont.)

• Signal Distortion

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

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

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

• Unused Inputs

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

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

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.

Grounding Practices (cont.)

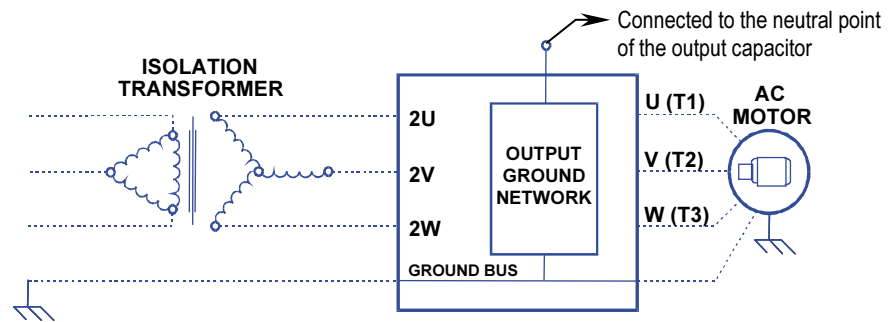


Figure 2.27 – Ground Connection Diagram with Isolation Transformer

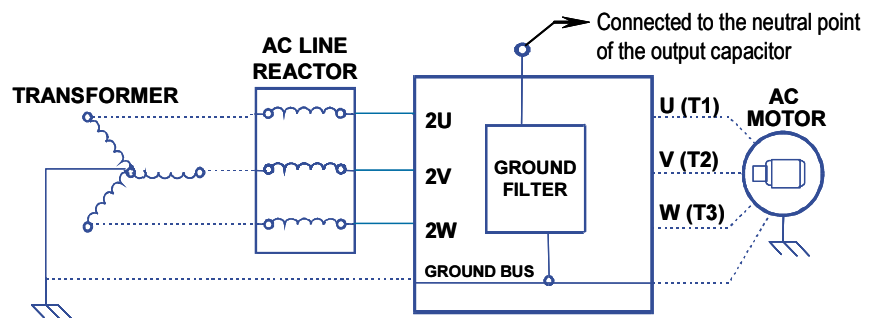


Figure 2.28 – Ground Connection Diagram with Line Reactor

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 is not adequate.

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

Each AC motor frame must be bonded to grounded building steel within 6 m (20 feet) of its location and tied to the drive's ground bus via ground wires within the power cables and/or conduit. The conduit or cable armor should be bonded to ground at both ends.

Grounding Guidelines and Practices for Drive Signal and Safety Grounds

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

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

or

- The metal sheath or foil may be left insulated from ground and the other conductors and the mesh cable screen grounded at one end only as stated above

Grounding Requirements and Grounding Specification for Customers and Power Integrators

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

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

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

- do not damage the grounding circuit,

or

- will not cause undue interference with or damage to protection or metering systems, or cause undue disturbance on power lines.

Identification of Types of Electrical Supplies – Grounded and Ungrounded Systems

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

Ground Bus

The drive ground bus runs along the top of the drive at the front. The ground bus is accessible at the top of each of the drive enclosures when the enclosure door is opened (and the low voltage compartment hinged out in the case of the DC link/fan 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 cabling cabinet, close to the line cable terminations.

Interlocking

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

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

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

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

Operator Interface

Chapter Objectives

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

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

The chapter deals only with the operation of the operator interface. Specific references to a particular parameter are only for illustrative purposes. Refer to **PowerFlex 7000 Medium Voltage AC Drive • Technical Data (Publication 7000-TD002_-EN-P)** for information about the actual 'tags' within the drive and their use.

Terminology

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

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

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

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

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

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

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

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

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

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

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

Overview

The operator interface used on the PowerFlex 7000 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).

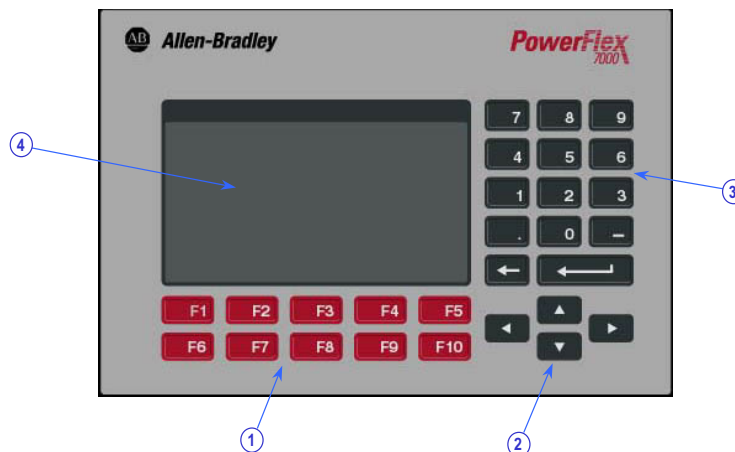


Figure 3.1– PowerFlex 7000 Drive Operator Interface Terminal

Keypad

The keypad of the operator interface consists of two rows of five function keys (item 1 of Figure 3.1) located below the operator interface display area (item 4 of Figure 3.1). In the lower right corner of the operator interface are four keys, which will be referred to as the cursor keys (item 2 of Figure 3.1). Above the cursor keys are data entry keys consisting of the numeric values 0-9, a decimal point (.), a negative (-), a backspace key and a data entry key (item 3 of Figure 3.1).

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

Function (Softkeys) Keys

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

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

Cursor (Selection) Keys

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

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

Some displays, such as the Utility screen, use these keys to modify the data value. Pressing the [cursor up] and [cursor down] keys will change the value by a fine amount, i.e. 1 unit. Using the [cursor left] and [cursor right] keys will change the value by a course amount, i.e. 10 units.

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

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

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

All four cursor keys have an auto feature such that after holding the key for 2 seconds, the key will automatically repeat at a rate of 5 'presses' per second.

Data Entry Keys

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

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

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

What is a Screen?

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

Components

Although the data displayed on any particular screen will vary, the general makeup of a screen is the same for all. Figure 3.2 shows a typical screen and its components.

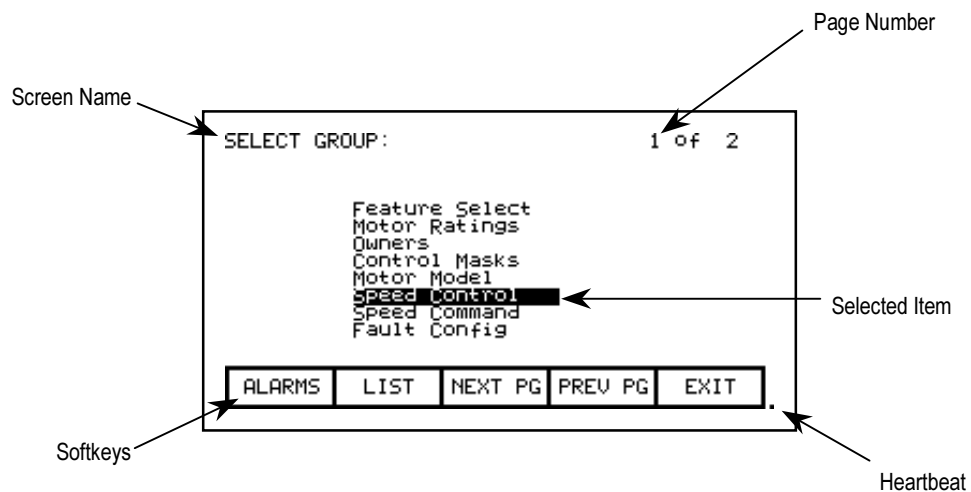


Figure 3.2 – Screen Components

The upper left-hand corner contains the name of the screen (i.e. SELECT GROUP:). Knowing the name of the screen will assist you in the orientation of the menu system. On some screens to the right of the screen name, will be the name of the selected item from the previous screen as shown in Figure 3.3.

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

Along the bottom of the screen are one or two rows of 'Softkeys' which represent the assignment to the actual function keys. In Figure 3.2, Softkeys F6-F10 are shown. Pressing F8 will display the next page of data.

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

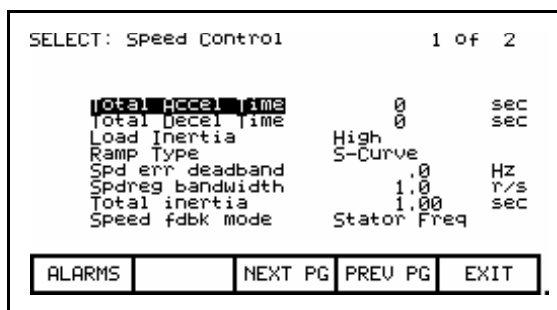


Figure 3.3 – Screen Name & Item

The remainder of the screen shows the data from the drive. The presentation of the data is dependent on the screen. Screens that allow an item to be selected show the current selection in reverse video. An example of this is shown in Figure 3.2 in which the Speed Control group is selected.

Information Windows

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

Accessing/Writing to Drive

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

You can selectively choose to download the complete database to the operator interface on command, thus eliminating the initial access delays. If uninterrupted, the operator interface will automatically download the database on power-up, or during periods of inactivity. Refer to the section on "Advanced Screen Operations - Database Download".

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

Communication Error

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

The window for the "Communication Error" can take on two forms. If a window has already been displayed showing "Accessing Drive" or "Writing to Drive", then the communication error message will be added to the window already in use. Some screens constantly read from the drive in order to show real-time data. An example of this is the 'Top Level Menu'. When a communication error occurs on a screen showing real-time data, a window is opened showing a box around the "Communication Error". Two examples of this are shown in Figures 3.4 and 3.5.

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

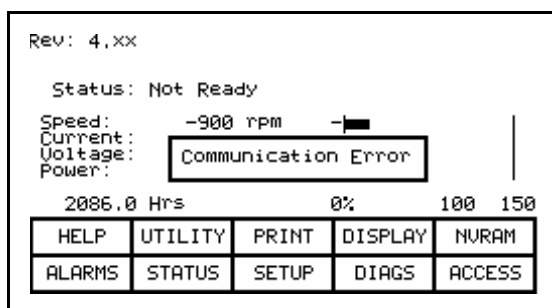


Figure 3.4 – Communications Error

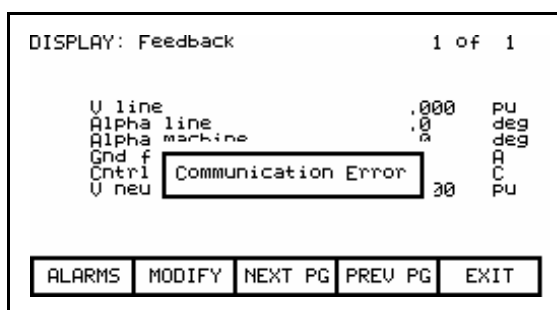


Figure 3.5 – Communications Error

Language Changing

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

General Operation

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

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

F1 - Help

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

F6 - Alarms

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

F8 - Next Page

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

F9 - Previous Page

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

F10- Exit

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

Operator Interface Power-up Sequence

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

- a) **Linking to Drive** - During this phase the operator interface is establishing communications with the drive communications board. The screen will also show information about the software product contained in the PowerFlex operator interface, such as:
 - software part number and revision level
 - date and time stamp of program creation

- b) **Obtaining Drive Database** - During this phase, the database of information about the drive is obtained from the drive. Obtaining the database at this point in time is optional and may be aborted by pressing any key on the operator interface. Obtaining the entire database does however speed up subsequent operations since relevant portions of the database do not have to be obtained. (Without obtaining the entire database, the operator interface will access portions of the drive database as required. This slows down the first access to the operation that requires the data. Subsequent operations requiring the same data are not affected). Aborting the download will not affect portions of the database already obtained.

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

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

Top Level Menu

This screen (Figure 3.6) represents the main menu from which all other screens (and the operations which they perform) are activated. To activate an operation, simply press the function key corresponding to the 'Softkey' shown on the screen. A screen for that operation will be displayed. Refer to the section entitled "How To:" for information about the various operations which may be performed.

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

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

- NOT READY – drive is not ready to start
- READY – drive will start when commanded
- FORWARD RN – drive is running in the forward direction
- REVERSE RN – drive is running in the reverse direction
- WARNING – drive has a warning
- FAULTED – the drive is faulted
- DISCHARGING – waiting for the input filter capacitor to discharge on an Active Front End drive before re-start

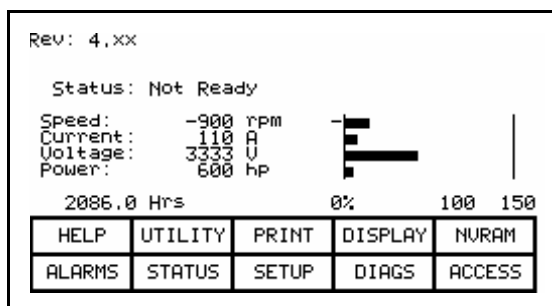


Figure 3.6 – Top Level Menu

How To:

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

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

Obtain Help

Help is obtained for any screen by pressing the [F1] function key. Figure 3.7 shows the help screen, which is displayed for the Top Level Menu. After the name of the screen (i.e. HELP:) is the name of the screen for which help is being accessed. (In this case the name of the Top Level Menu is REV.) This particular help screen contains three pages. To view page two, press the [F8] key. Page 2 is displayed. To return to page 1, press the [F9] key.

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

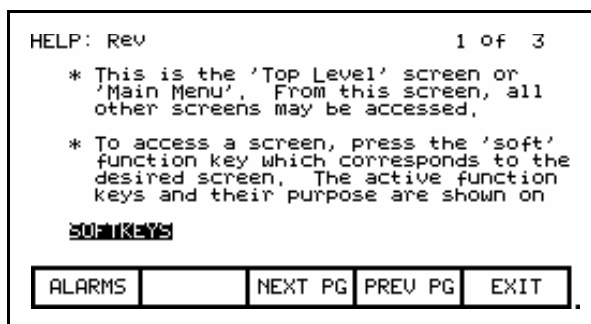


Figure 3.7 – Typical Help Screen

Related Topics

All of the help screens will have additional topics relating to the help currently being displayed. These topics are highlighted just above the Softkeys. Additional topics are selected via the [cursor left] and [cursor right] keys. Figure 3.7 shows the additional topic of "SOFTKEYS" selected. To access this information, press the [enter] key.

The help for the additional topic will be displayed as in Figure 3.8 . As with the original help screen, the related topic help may also have related topics.

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

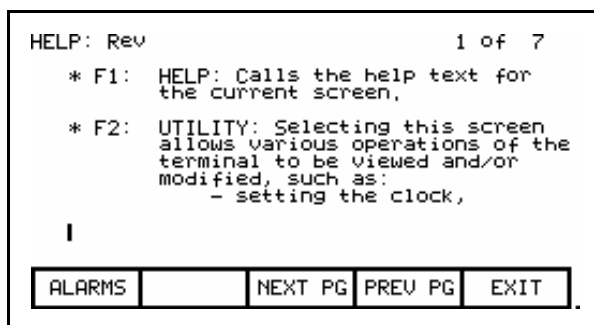


Figure 3.8 – Help on Related Topic (Softkey)

Help on Help

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

Pressing [F1] while in a help screen will give you a help screen describing how to use the help system. An example of a screen giving help on the help system is shown in Figure 3.9. As with the help screens previously described, the screens will contain related topics.

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

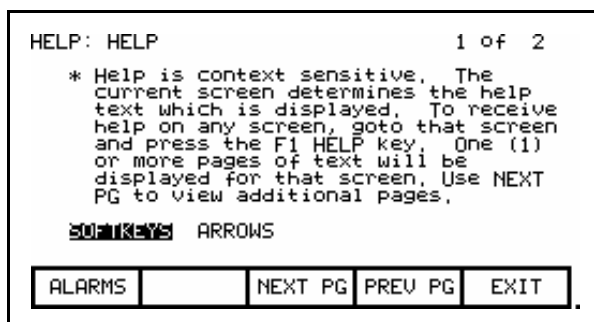


Figure 3.9 – Help on Help

Modify Operator Interface Operation (Utility)

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

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

You will access the Utility operation from the Top Level Menu by pressing the [F2] key. This results in the display of the screen shown in Figure 3.10 .

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

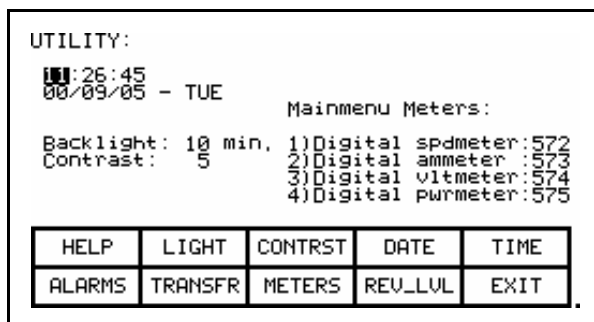


Figure 3.10 – Utility Operation Screen

Changing Backlight Delay

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

To change the duration of the delay, press the [F2] key. The current backlight delay will be shown in reverse video (Figure 3.11). The value can be adjusted from 0 to 60 minutes. A value of zero (0) will disable the delay, keeping the light on indefinitely. Press the [cursor up] or [cursor down] keys to change the value by a resolution of 1 minute. Press the [cursor left] and [cursor right] keys to change the value by a resolution of 10 minutes. To abort the change, press the [backspace] key and the setting will return to its original value. To accept the change press the [enter] key. The backlight delay has been saved.

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

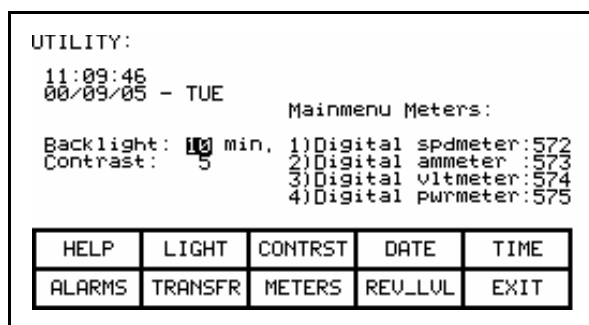


Figure 3.11 – Utility Light

Changing Contrast

The contrast controls the horizontal angle to which the display may be viewed. To change the contrast, press the [F3] key. The current value of the contrast will be shown in reverse video (Figure 3.12). Press the [cursor up] or [cursor down] keys to change the value of the contrast. The screen will change instantly to show the effect of the change. To abort the change, press the [backspace] key and the setting will return to its original value. To accept the change, press the [enter] key. The contrast setting has been saved.

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

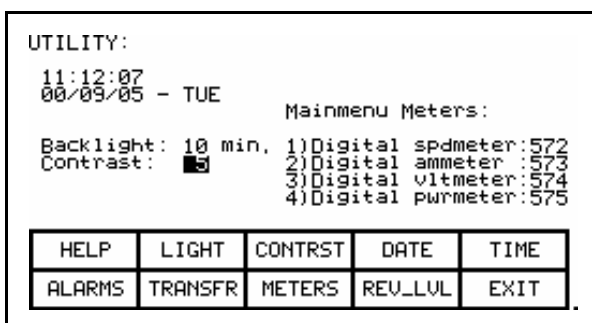


Figure 3.12 – Utility Contrast

Setting Time

The clock setting controls the time stamp that the drive uses on the information contained on the alarm summary screen. To change the time, press the [F5] key. The hour's position of the clock will be in reverse video (Figure 3.13). Press the [cursor up] or [cursor down] keys to change the value by a resolution of 1 unit. Press the [cursor left] and [cursor right] keys to change the value by a resolution of 10 units. To change the minutes press the [F5] key again and repeat the procedure. Likewise to change the seconds press the [F5] key again. Each press of the [F5] key will highlight the next position of the clock. The highlighted position may be modified via the cursor keys.

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

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

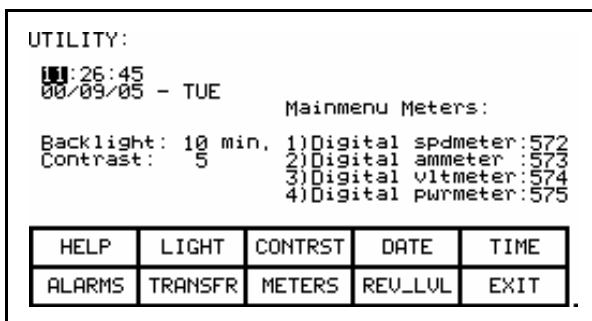


Figure 3.13 – Utility Time

Setting Date

The calendar setting controls the date stamp that the drive uses on the information contained on the alarm summary screen. To change the date, press the [F4] key. The year position of the calendar will be in reverse video (Figure 3.14). Press the [cursor up] or [cursor down] keys to change the value by a resolution of 1 unit. Press the [cursor left] and [cursor right] keys to change the value by a resolution of 10 units. To change the month press the [F4] key again and repeat the procedure. Likewise, to change the day, press the [F4] key again. Each press of the [F4] key will highlight the next position of the calendar. The highlighted position may be modified via the cursor keys.

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

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

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

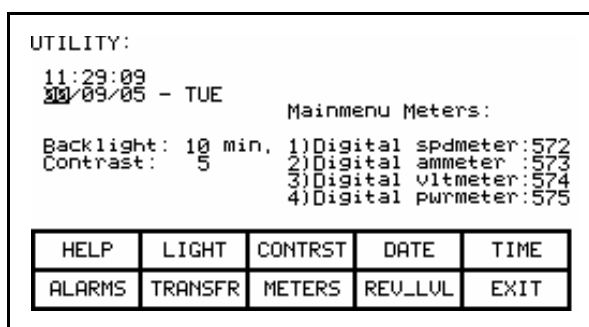


Figure 3.14 – Utility Date

Selecting Meters

The utility screen (Figure 3.10) shows the four tags assigned to the four meters on the 'Top Level Menu'. These can be changed by pressing the [F8] key. This displays a new screen (Figure 3.15) from which the selection and text associated with the meter is changed.

METERS:														
METER1	Speed	:	Digital spdmeter	:572										
METER2	Current	:	Digital ammeter	:573										
METER3	Voltage	:	Digital vltmeter	:574										
METER4	Power	:	Digital pwrmeter	:575										
<table border="1"> <tr> <td>HELP</td><td>DEFAULT</td><td>SET</td><td>DELETE</td><td>CASE</td></tr> <tr> <td>ALARMS</td><td>CANCEL</td><td>ACCESS</td><td></td><td>EXIT</td></tr> </table>					HELP	DEFAULT	SET	DELETE	CASE	ALARMS	CANCEL	ACCESS		EXIT
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 pwrmeter	:575										
<table border="1"> <tr> <td>HELP</td><td>DEFAULT</td><td>SET</td><td>DELETE</td><td>CASE</td></tr> <tr> <td>ALARMS</td><td>CANCEL</td><td>ACCESS</td><td></td><td>EXIT</td></tr> </table>					HELP	DEFAULT	SET	DELETE	CASE	ALARMS	CANCEL	ACCESS		EXIT
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".


```

METERS:

METER1 Speed      : Digital spdmeter :572
METER2 Meter2-    : V line           :324
METER3 Voltage    : Digital vltmeter :574
METER4 Power      : Digital pwrmeter :575

```

HELP	DEFAULT	SET	DELETE	CASE
ALARMS	CANCEL	ACCESS		EXIT

Figure 3.17 – Edit the Text

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

```

METERS:

METER1 Speed      : Digital spdmeter :572
METER2 LineVolt   : V line           :324
METER3 Voltage    : Digital vltmeter :574
METER4 Power      : Digital pwrmeter :575

```

HELP	DEFAULT	SET	DELETE	CASE
ALARMS	CANCEL	ACCESS		EXIT

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.

```

Rev: 4,xx

Status: Not Ready

Speed:    -500 rpm
LineVolt: 1000 PU
Voltage:  3333 V
Power:    2100 hp

```

2102.6 Hrs 0% 100 150

HELP	UTILITY	PRINT	DISPLAY	NURAM
ALARMS	STATUS	SETUP	DIAGS	ACCESS

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							
MUD Terminal	SOFTWARE P/N	REV.					
PU550 BootCode	80189-xxx-01	4.xx					
Complete Drive		2.06					
RCP Firmware		0.000					
ICP Firmware		1.000					
CIP Firmware		1.000					
<table><tr><td>ALARMS</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.

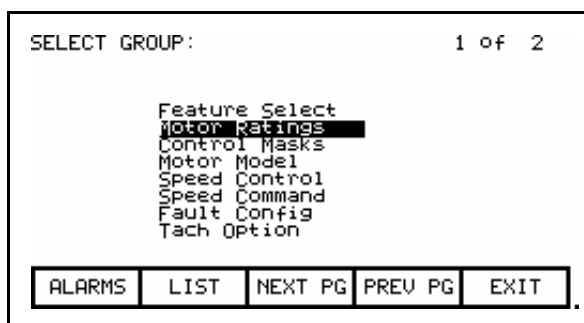


Figure 3.23 – Selecting a Group

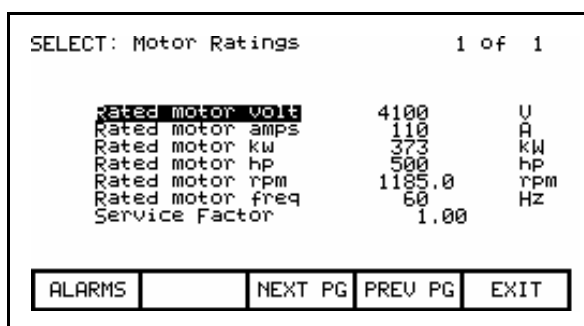


Figure 3.24 – Selecting a Member of a Group

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.

HELP	CODE
ALARMS	GROUP

Figure 3.25 – Selecting via a Letter (Step 1)

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

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.

A screenshot of a terminal window titled "SELECT CODE:". Below the title, there is a vertical cursor and the text "Enter Tag Code: 22". At the bottom of the window, there is a horizontal bar divided into five sections: "ALARMS", three empty boxes, and "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.

A screenshot of a terminal window titled "SELECT CODE:". Below the title, the text "Rated motor volt" is displayed in a highlighted box, followed by "Enter Tag Code: 22". At the bottom of the window, there is a horizontal bar divided into five sections: "ALARMS", three empty boxes, and "EXIT".

Figure 3.28 – Valid Tag Code

A screenshot of a terminal window titled "SELECT CODE:". Below the title, there is a vertical cursor, followed by "Enter Tag Code: 14" and "Invalid Tag Id Code". At the bottom of the window, there is a horizontal bar divided into five sections: "ALARMS", three empty boxes, and "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.

```

SELECT CODE:

  firing index M
Enter Tag Code:  286
Tag is Read Only
               =>  0

[ ALARMS ] [   ] [   ] [   ] [ EXIT ]

```

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.

```

DRIVE TEXT:

DRIVE TYPE: PowerFlex 7000
DRIVE NAME: █

[ HELP ] [ SET ] [ DELETE ] [ CASE ]
[ ALARMS ] [ CANCEL ] [   ] [   ] [ EXIT ]

```

Figure 3.31 – Typical Text Edit Screen

The screen shown in Figure 3.31 is typical of all screens using the edit text operation. All screens have the F3, F4 and F5 keys in common (if applicable). Once in the 'editing field' all operations are performed on the character in reverse video.

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

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

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

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

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

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

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

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

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

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

Configure the Drive

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

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

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

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

Enter/Modify an Access Level

The drive is protected from unauthorized changes via passwords consisting of a number between 0 and 65535. These passwords are associated with Access Levels. Each Access Level, (except for the first one 'Monitor') has its own password number (PIN). These values can be unique or all can be set to the same value.

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

The screen shown in Figure 3.32 is accessible from within a number of screens where the Access Level affects the operation of subsequent operations, such as:

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

```

ACCESS:

Monitor      Current Access:
Basic        Monitor
Advanced
Service
Rockwell     Enter Password:

[ALARMS] [ ] [LOGOUT] [CHANGE] [EXIT]

```

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.

```

ACCESS:

Monitor      Current Access:
Basic        Monitor
Advanced
Service
Rockwell     Enter Password:
               *

[ALARMS] [ ] [LOGOUT] [CHANGE] [EXIT]

```

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.

```

ACCESS:

Monitor      Current Access:
Basic        Basic
Advanced
Service
Rockwell     Enter Password:

[ALARMS] [ ] [LOGOUT] [CHANGE] [EXIT]

```

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.

```

PASSWORD CHANGE: Basic

Enter Password:

[ALARMS] [ ] [ ] [ ] [EXIT]

```

Figure 3.35 – PIN Change

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

If you entered the correct PIN, the screen now asks you for the new PIN. Type in the new PIN value using the data entry keys [0]-[9] followed by the [enter] key. The screen now asks you to verify the new PIN. Type in the new PIN again followed by the [enter] key as shown in Figure 3.36.

PASSWORD CHANGE: Basic				
Enter Password:				
Enter New Password: ****				
Verify New Password: ****				
Status: Password Changed				
ALARMS				EXIT

Figure 3.36 – PIN Change Completed

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

PASSWORD CHANGE: Basic				
Enter Password: ****				
Enter New Password:				
Verify New Password:				
Status: Invalid Password				
ALARMS				EXIT

Figure 3.37 – Invalid PIN

PASSWORD CHANGE: Basic				
Enter Password:				
Enter New Password: *				
Verify New Password: *				
Status: Invalid Verify				
ALARMS				EXIT

Figure 3.38 – Invalid PIN Verification

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

Drive Setup

This section describes how to:

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

You will access the "SETUP" screen from the Top Level Menu by pressing the [F8] key. This will result in the typical screen shown in Figure 3.39 .

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

At power-up, the operator interface access level is 'Monitor'. If this is the current mode and you wish to change any of the setup data, press the [F8] key now in order to change the access level before proceeding into any of the other setup operations available from this screen (Figure 3.40). Refer to the section **Enter/Modify an Access Level** .

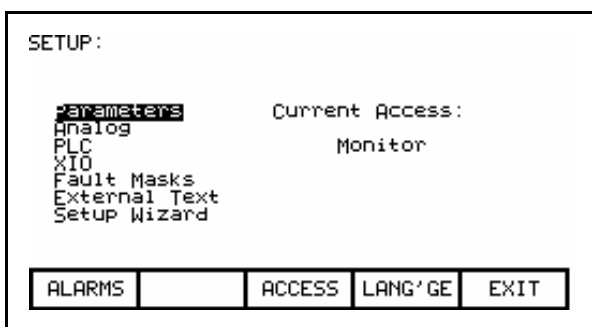


Figure 3.39 – Setup Screen



Figure 3.40 – Basic Access Level

Language Selection

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

To select an alternate language, press the [F9] key on the SETUP screen. The screen will show all language modules currently loaded as in Figure 3.41. Associated with each language is a module revision level. Use the [cursor up] and [cursor down] keys to select the desired language and press the [enter] key.

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

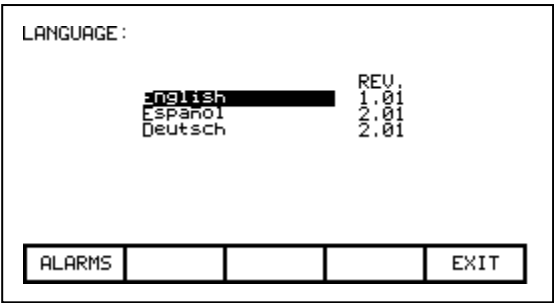


Figure 3.41 – Language Selection

Modify Parameters

To change a parameter, Use the up/down arrow keys on the SETUP screen to select the 'Parameters' option and press the [enter] key. This will begin the selection process of a parameter as described in the section entitled "Select a Parameter". The selection process to change a parameter can also be initiated while displaying the members of a parameter group on the DISPLAY screen (Figure 3.68) by pressing the [F7] key.

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

Numerical Value

When the parameter is a numerical value, the MODIFY PARAMETER screen typical of Figure 3.42 will be displayed. This screen shows:

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

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

Figure 3.42 – Parameter Data Entry

MODIFY PARAMETER: Rated motor volt			
P: 22			
Min:	4000	U	
Actual:	4100		
New:	4000		
Max:	4160		
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.

```

MODIFY PARAMETER: Operating Mode

                                P: 4

Actual:      Normal
New:         Normal

[ALARMS] [CANCEL] [ACCESS] [ ] [EXIT]
  
```

Figure 3.44 – Modify Enumerated Value

```

MODIFY PARAMETER: Operating Mode

                                P: 4

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

[ALARMS] [CANCEL] [ACCESS] [ ] [EXIT]
  
```

Figure 3.45 – Option List Viewed on Single Page

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

Having gained access, press the up or down cursor keys to obtain a list of possible options to select from. Use the up/down arrow keys to move the highlighting to the desired option (Figure 3.45). If more options exist than what can be displayed on a single screen, a triangle or inverted triangle symbol will indicate in which direction the list can be expanded (Figure 3.46).

Use the up/down cursor keys to scroll onto these additional options. Press the [enter] key to accept the new value as shown in Figure 3.47.

```

MODIFY PARAMETER: XIO General IO

                                P: 592

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

[ALARMS] [CANCEL] [ACCESS] [ ] [EXIT]

```

Figure 3.46 – Option List Viewed on Multiple Pages

```

MODIFY PARAMETER: Operating Mode

                                P: 4

Actual:    Normal
New:       System Test

[ALARMS] [CANCEL] [ACCESS] [ ] [EXIT]

```

Figure 3.47 – Modification Completed

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

Bit Encoded Value

When the parameter is a bit encoded value, the MODIFY PARAMETER screen typical of Figure 3.48 will be displayed. This screen shows:

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

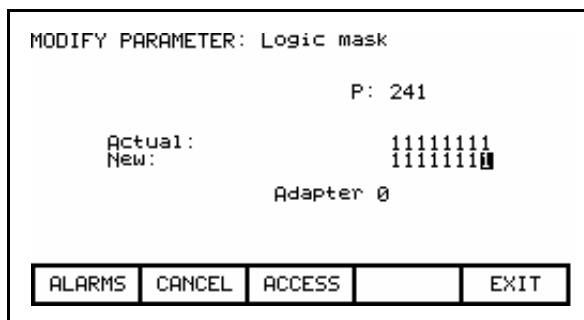


Figure 3.48 – Modify Bit Encoded Value

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

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

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

Analog Ports

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

This will display a series of screens as shown in Figure 3.49 . The screen shows the current tags and their tag code, which are associated with each of the analog ports. To change the tag attached to a port, use the [cursor up] and [cursor down] keys to highlight the desired port and press the [enter] key. (If nothing happens then you have not gained the required access to make changes. Exit to the SETUP screen and refer to the section entitled **Enter/Modify an Access Level** to gain access).

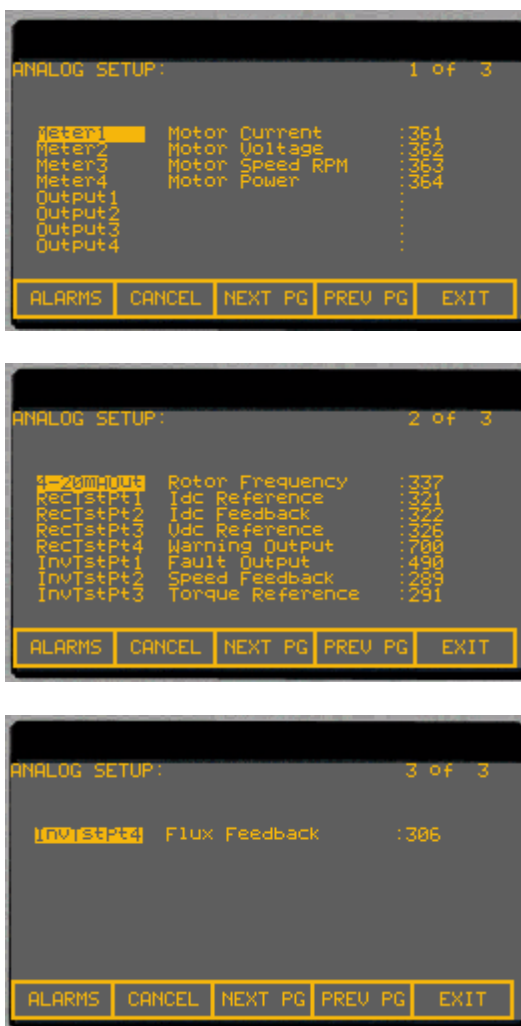


Figure 3.49 – Analog Setup

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

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

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).

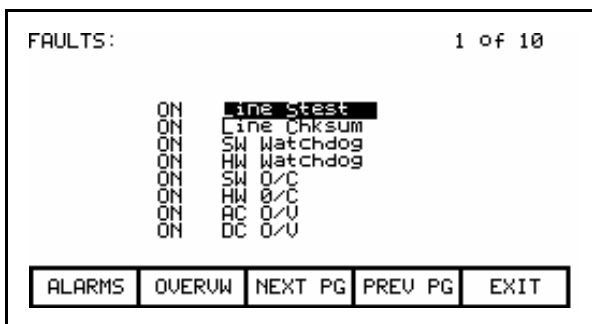


Figure 3.50 – Fault Screen

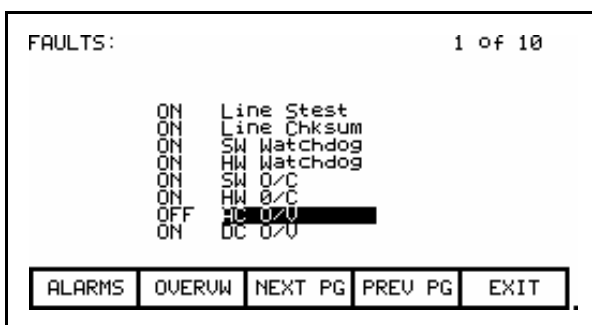


Figure 3.51 – Fault Mask OFF

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.

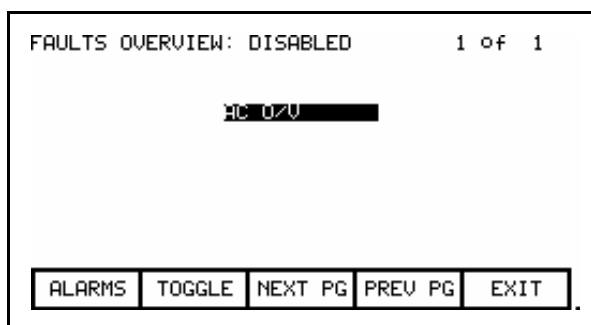


Figure 3.52 – AC O/V, Disabled

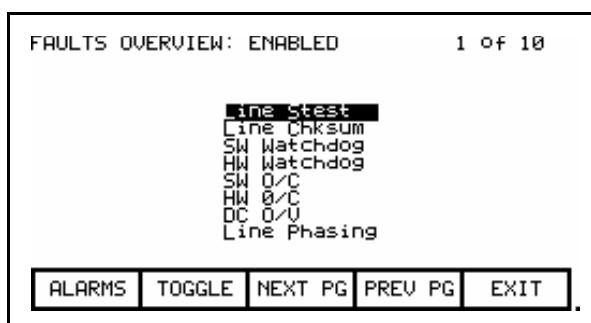


Figure 3.53 – Fault Overview, Enabled

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).

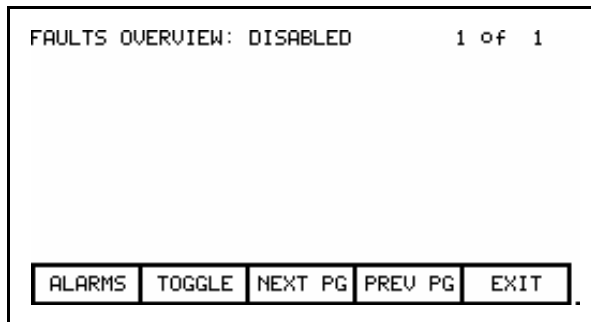


Figure 3.54 – AC O/V Removed From List

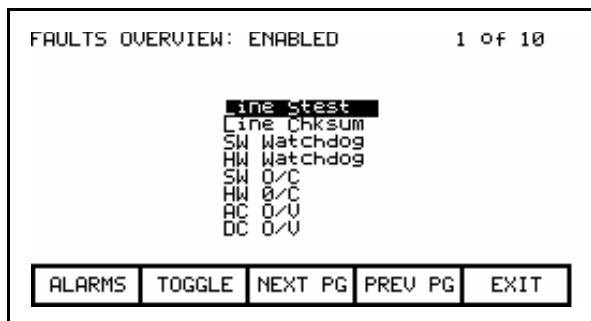


Figure 3.55 – AC O/V Now Enabled

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).

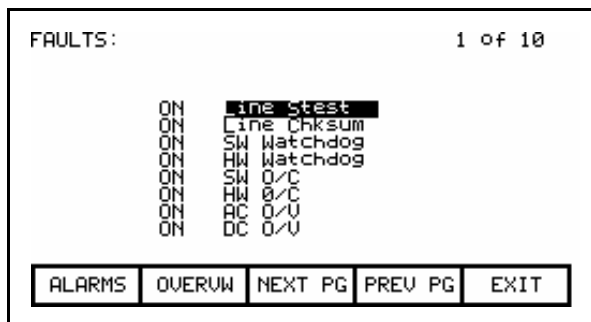


Figure 3.56 – AC O/V Mask is ON

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.

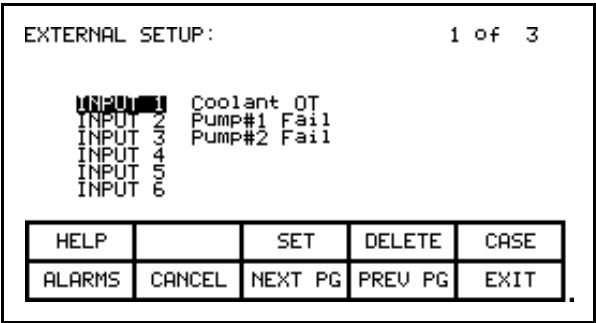


Figure 3.57 – External Setup Text

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.

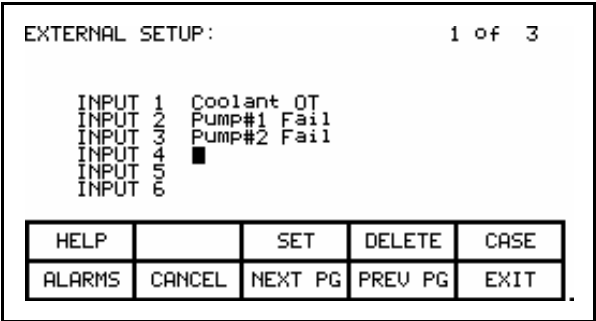


Figure 3.58 – Modify Text

EXTERNAL SETUP:		1 of 3
INPUT 1	Coolant OT	
INPUT 2	Pump#1 Fail	
INPUT 3	Pump#2 Fail	
INPUT 4	UP to 12 chr	
INPUT 5		
INPUT 6		

HELP		SET	DELETE	CASE
ALARMS	CANCEL	NEXT PG	PREV PG	EXIT

Figure 3.59 – Modification Completed

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

PLC

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

This will display a screen as shown in Figure 3.60 or 3.61. The PLC setup consists of eight words of input and eight words of output.

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

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

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

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

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
<div> ALARMS CANCEL TOGGLE EXIT </div>		

Figure 3.61 – PLC Output Links

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

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

XIO

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

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

Message Prompting

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

When you exit a group of screens on which you have changed the drive data, you will be prompted as in Figure 3.62 to save the data. If you wish to save the data, press [F8] 'Yes' and the NVRAM screen (refer to **Store/Retrieve Configuration**) will be entered (Figure 3.63). If you wish the data to reside as temporary data in RAM only, press [F9] 'No'. Pressing [F10] Exit will return you to the screen from which you previously exited.

Note that the data can still be saved at a later time by accessing the NVRAM screen directly from the Top Level Menu. Refer to **Store/Retrieve Configuration**.

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

Figure 3.62 – Message Prompt Screen

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

Figure 3.63 – NVRAM Screen

Store/Retrieve Configuration (NVRAM)

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

Initialize

The drive contains a default set of parameters and setup information. This can form a basis for configuring the drive. To initialize the drive with the default set of data, press the [F3] key. The screen will appear as in Figure 3.64, indicating the operation you are about to perform.

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

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

Figure 3.64 – Initialize Operation

Save

The changes that you have made to the drive data must be saved if you do not want to lose the data when the drive is powered off. To save the changes, press the [F5] key (Figure 3.65).

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

Figure 3.65 – Save Operation

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

Load

The changes that you stored in NVRAM are automatically used each time the drive is powered up. If you make changes to the data in the drive (without saving) and then wish to use the previously stored data, press the [F4] key (Figure 3.66).

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

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).

DISPLAY GROUP:		1 of 2		
<pre> feedback feature select Motor Ratings Owners Control Masks Logic I/O Motor Model Speed Control </pre>				
ALARMS	CUSTOM	NEXT PG	PREV PG	EXIT

Figure 3.67 – Display Screen

DISPLAY: Feature Select		1 of 2
Auto restart dly	.000	sec
Coast Speed	40.0	Hz
Deflt spd select	Local	
Input ContCfg	Not Running	
IO configuration	Config1	
Operating Mode	Gate Test	
Output ContCfg	Not Running	
Passcode 0	48059	
<div>ALARMS</div> <div>MODIFY</div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>		

Figure 3.68 – Feature Select Group Chosen

DISPLAY: Logic I/O		1 of 1
Logic command	0	Hex
Logic status 1	0	Hex
Logic status 2	0	Hex
Local inputs	0	Hex
Local outputs	0	Hex
SCANport input	0	
SCANport output	0	rpm
<div>ALARMS</div> <div>MODIFY</div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>		

Figure 3.69 – Bit Encoded Parameter

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

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.

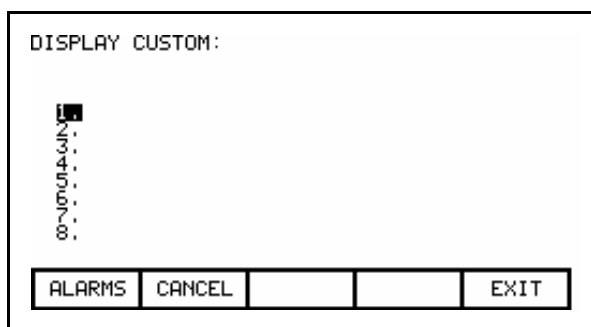


Figure 3.71 – Display Custom Screen

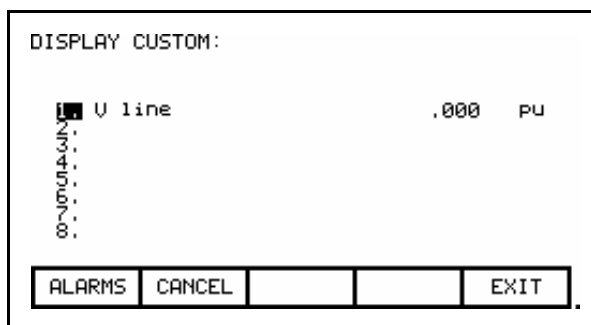


Figure 3.72 – V Line Assigned

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.

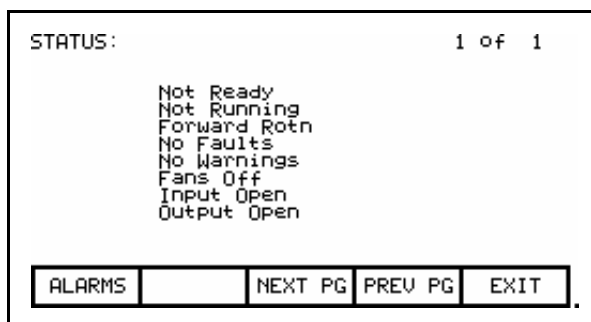


Figure 3.73 – Status Screen

View and Reset Alarms

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

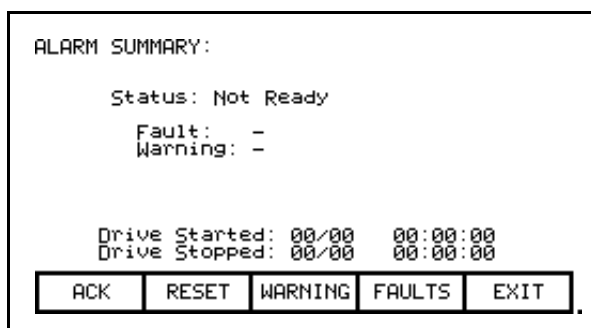


Figure 3.74 – Alarm Summary Screen

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.

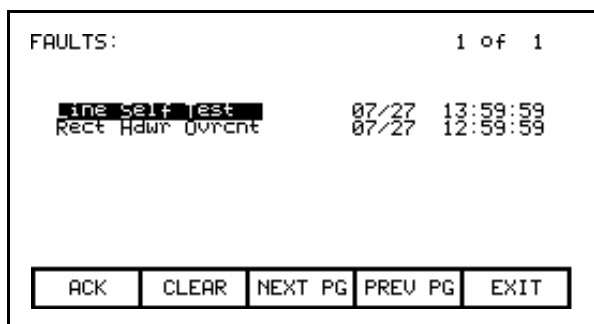


Figure 3.75 – Fault Queue

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.

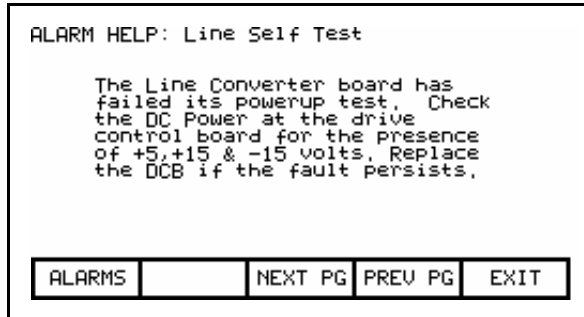


Figure 3.76 – Alarm Help

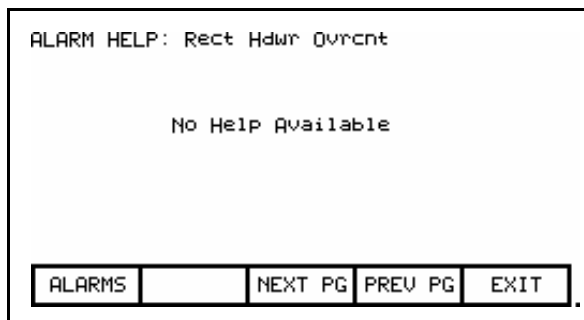


Figure 3.77 – No Alarm Help

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.

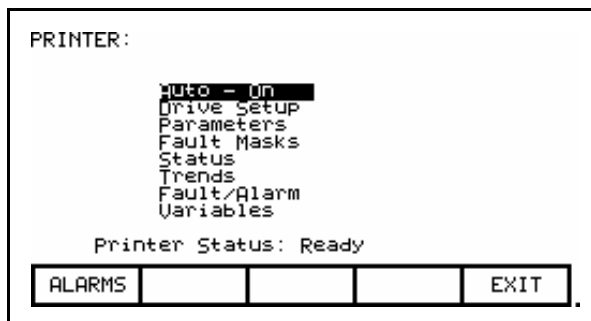


Figure 3.78 – Typical Printer Screen

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.

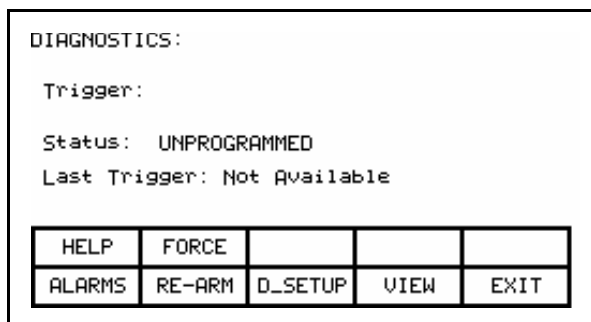


Figure 3.79 – Diagnostic Screen

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

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

Trigger Conditions:

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

The value (data) is set through the use of the numerical keypad. Use the data entry keys [0]-[9] to enter the new value. The [-] key can be typed at any time to enter a negative value. The [.] key is used to enter a decimal point for fractional values. The entered new value can be edited by pressing the [backspace] key. This key will delete the right most character (i.e. number, decimal point or negative sign) shown on the screen. Press the [enter] key to accept the new value as shown in Figure 3.82. If the new value that you entered is outside the limits defined, the new value will be pegged at the closest limit. For example: If you entered 900 when the minimum value was 1000, the new value will show 1000.

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

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

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

When you exit the screen, the trend is started and the screen such as Figure 3.83 will show the trigger condition and the status. Pressing the [F7] key on the DIAGNOSTICS screen may also start the trend.

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

Figure 3.83 – Diagnostic Armed

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

Figure 3.84 – Diagnostic Triggered

Once the data has started to be collected, the status will show 'triggered' as in Figure 3.84. When the buffer contains a complete capture, it will show "stopped" (if a single capture), as shown in Figure 3.85. The time and date at which the trigger occurred is displayed. The trend buffers may only be viewed when their status is 'stopped'. If in continuous mode, the capture will stop when the buffers are viewed. To view the trend buffers, press the [F9] key.

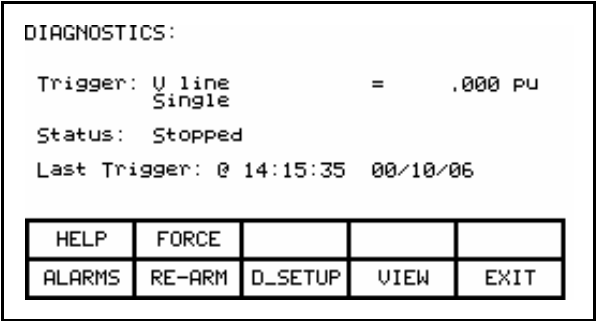


Figure 3.85 – Diagnostic Stopped

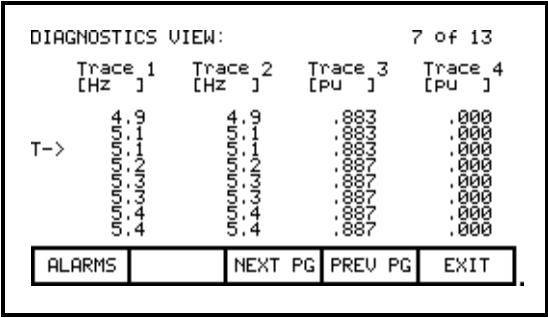


Figure 3.86 – View the Trend Buffer(s)

A screen such as Figure 3.86 will be shown. Upon initial entry, the screen will be positioned to the trigger point, shown by the "T->". To view data either side of the trigger point, press the [F8] and [F9] keys.

Changes made to the diagnostic list setup are not permanent unless they are saved to the NVRAM in the drive. Upon exiting the DIAGNOSTICS screen (Figure 3.79), you will be prompted to save the changes to NVRAM. Refer to the section "Message Prompting" for further details.

Flash Memory Transfers

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

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

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

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

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

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

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

You will access the Transfer operations from the Utility screen by pressing the [F7] key. This results in the display of the screen shown in Figure 3.87.

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

Figure 3.87 – Transfer Main Menu

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

Format Flash Card

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

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

To format a card press the [F2] key on the TRANSFER screen. The screen will appear as in Figure 3.88, indicating the operation you are about to perform and showing the current status of the operation. (If nothing happens then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled **Enter/Modify an Access Level** to gain access).

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

Figure 3.88 – Format the Flash Card

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

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

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

View a Directory

The directory of a flashcard is shown by pressing the [F7] key on the TRANSFER screen. The directory shows the filename and extension, along with a date and time stamp of when the file was created. A screen typical of Figure 3.89 will be shown.

DIRECTORY:		1 of 1	
Filename:			
2003-14	.FMW	99/07/30	09:10
FRENCH	.LNG	98/02/25	16:39
SPANISH	.LNG	97/06/12	13:17
PUMP	.PAR	99/10/20	11:17
RUSSIAN	.LNG	97/12/09	09:06
BOILER	.PAR	00/02/17	13:30

HELP	EDIT		DELETE	
ALARMS	CANCEL	NEXT PG	PREV PG	EXIT

Figure 3.89 – Typical Directory

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

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

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

Select a Filename

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

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

Enter a Filename

When a new file is being created, the DIRECTORY screen is used to enter the new filename. Upon entering the screen all existing files relevant to the operation are shown as shown in Figure 3.90.

DIRECTORY:		1 of 1	
Filename:			
PUMP		99/10/20 11:17	
BOILER		00/02/17 13:30	
HELP	EDIT	DELETE	
ALARMS	CANCEL	NEXT PG	PREV PG EXIT

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.

- If an operator interface has a memory card inserted when it is powered up or rebooted, and that card has a valid firmware file with the extension of .FMW, the operator interface will automatically load the first .FMW file it encounters on the card.
- 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.

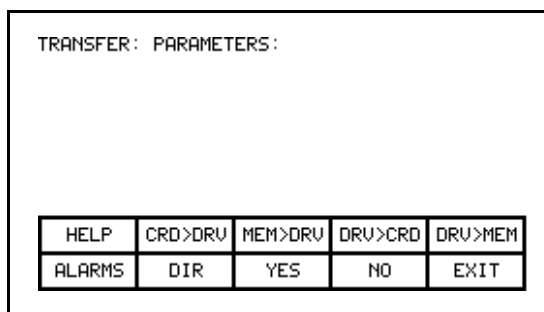


Figure 3.92 – Transfer Parameters Menu

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.

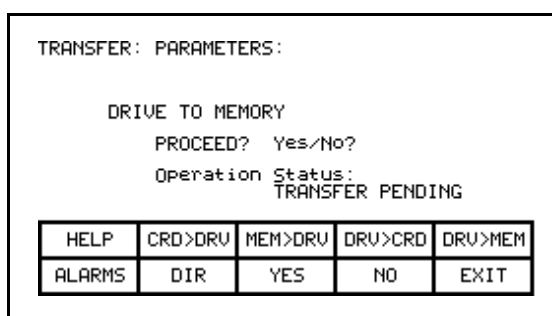


Figure 3.93 – Transfer Stored Parameters

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>DRV	MEM>DRV	DRV>CRD	DRV>MEM
ALARMS	DIR	YES	NO	EXIT

Figure 3.94 – Transfer File Parameters

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

Download from Memory Card

The parameters are read from a memory card and written to the drive by pressing the [F2] key. The operator interface will enter the DIRECTORY screen from which an existing parameter filename can be selected or entered. Refer to the sections entitled “**Select a filename**” and “**Enter a filename**”. When the filename has been obtained, the TRANSFER: PARAMETERS screen similar to that shown in Figure 3.94 (except the operation will show “FILE TO DRIVE”) will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

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

Parameter File Format

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

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

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

Loading Language Modules

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

From the TRANSFER screen, press the [F5] key. The operator interface will enter the DIRECTORY screen, from which an existing language module filename can be selected or entered, Figure 3.95. Refer to the sections entitled “Select a filename” and “Enter a filename”. (If nothing happens then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled **Enter/Modify an Access Level** to gain access).

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

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

Figure 3.95 – Language Directory

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

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.

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

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.

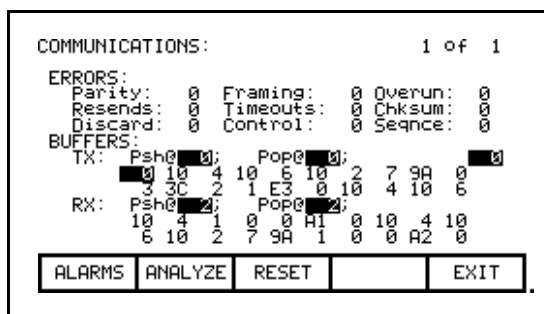


Figure 3.98 – Communications Statistics & Buffer

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.

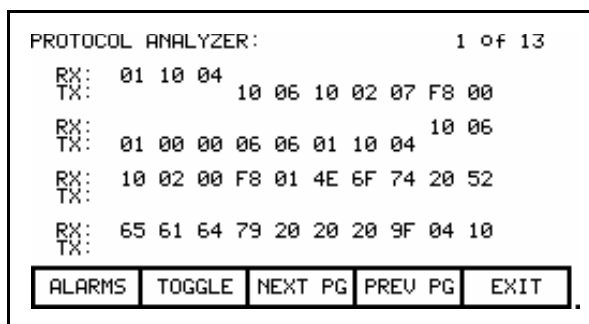


Figure 3.99 – Hexadecimal Displayed

```

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

```

Figure 3.100 – Mixed Format Displayed

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

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

Print Screen

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

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

Memory Dump

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

MEMORY:	
SEGMENT: 0040	
0000:	AA 55 00 10 00 00 02 0A : .U.....
0008:	31 2E 30 30 00 31 2E 30 : 1.00.1.0
0010:	30 00 31 2E 30 30 00 45 : 0.1.00.E
0018:	6E 67 6C 63 73 68 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.....
0038:	40 00 AC 00 82 12 40 00 : 0.....0.
<div> ALARMS ADDRESS NEXT PG PREV PG EXIT </div>	

Figure 3.101 – Data Segment Memory Dump

The initial screen, (Figure 3.101) shows the data segment by default. Each screen shows the segment (in hex) which is being viewed. In the left column is the starting address (in hex) for the row of data. Eight bytes of data are shown in Hex, followed by the equivalent 8 ASCII characters (if relevant). Additional data within the segment is viewed by pressing the [F8] and [F9] keys.

To change the segment and/or offset being viewed, press the [F7] key. A display similar to Figure 3.102 will be shown. Each successive press of the [F7] key toggles between highlighting the segment and offset value. The highlighted value is the field that is currently being edited.

MEMORY:	
SEGMENT: 0040 New Address: A000: 13	
0000:	AA 55 00 10 00 00 02 0A : .U.....
0008:	32 2E 30 30 00 32 2E 30 : 2.00.2.0
0010:	30 00 32 2E 30 30 00 45 : 0.2.00.E
0018:	6E 67 6C 63 73 68 00 32 : nglish.2
0020:	2E 30 30 00 4C 01 40 00 : .00.L.0.
0028:	50 01 40 00 FF FF 51 01 : P.0...0.
0030:	40 00 00 00 00 00 96 13 : 0.....
0038:	40 00 C0 00 56 14 40 00 : 0...U.0.
<div> ALARMS ADDRESS NEXT PG PREV PG EXIT </div>	

Figure 3.102 – Edit the Segment: Offset

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

The value may be edited via the [cursor left] key, which acts as a backspace to remove the last digit entered. The value is accepted by pressing either the [enter] or [F7] key. The edited segment:offset can be aborted by pressing the [delete] key. To accept the segment:offset value entered, press the [enter] key. The screen will show the data at the entered address, as shown in Figure 3.103.

MEMORY:																				
SEGMENT: A000																				
0018:	00	00	00	00	00	00	58	48	:	:	:	:	:	:	..XK					
0020:	40	00	01	00	14	00	88	48	:	:	:	:	:	:	@...K					
0028:	40	00	E6	26	40	77	18	05	:	:	:	:	:	:	@..&Mw..					
0030:	40	00	01	00	00	00	56	14	:	:	:	:	:	:	@.....U.					
0038:	40	00	00	00	00	00	00	00	:	:	:	:	:	:	@.....					
0040:	00	00	60	00	5A	14	40	00	:	:	:	:	:	:	..Z..@.					
0048:	0C	01	EB	82	2A	01	64	A0	:	:	:	:	:	:	..*.d.					
0050:	62	00	56	14	40	00	00	00	:	:	:	:	:	:	b.U.e...					
<table><tr><td>ALARMS</td><td>ADDRESS</td><td>NEXT PG</td><td>PREV PG</td><td>EXIT</td></tr></table>																ALARMS	ADDRESS	NEXT PG	PREV PG	EXIT
ALARMS	ADDRESS	NEXT PG	PREV PG	EXIT																

Figure 3.103 – Data at New Address

Database Download

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

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

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

Operator Interface Menu Hierarchy Chart

The screens of the operator interface are used to form a menu driven system to access the various operations in the drive. The hierarchy of this menu system is shown in Figures 3.104 and 3.105.

What does it show?

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

How do you read it?

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

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

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

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

Example

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

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

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

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

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

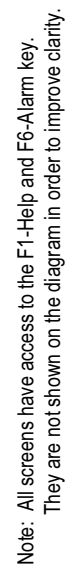


Figure 3.104 – Menu Hierarchy

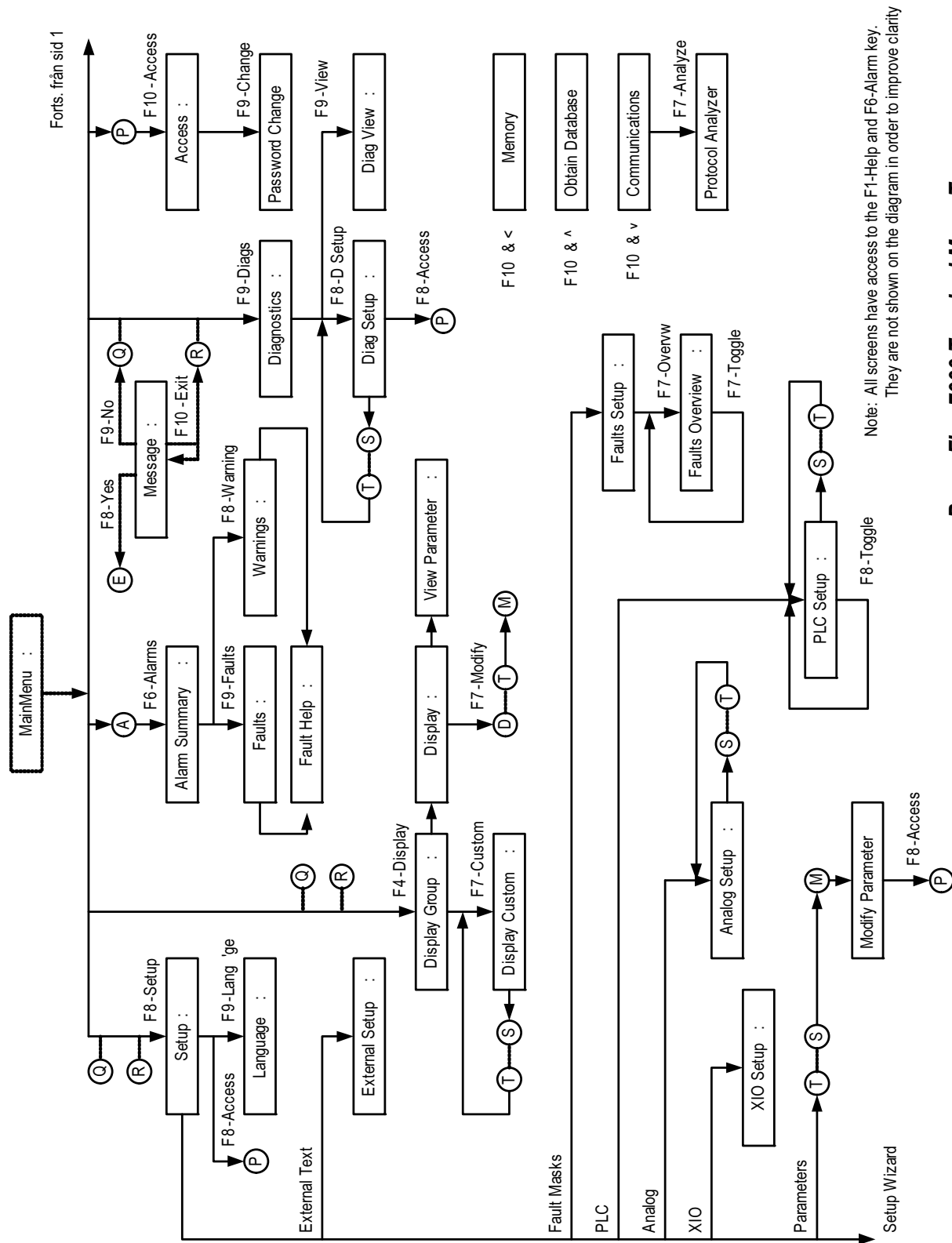


Figure 3.105 – Menu Hierarchy

PCMCIA Memory Card Installation Data

Description

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

WARNING



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

WARNING



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

Installing the Memory Card

1. Locate the vertical card slot on the back of the operator interface. See Figure 3.106.

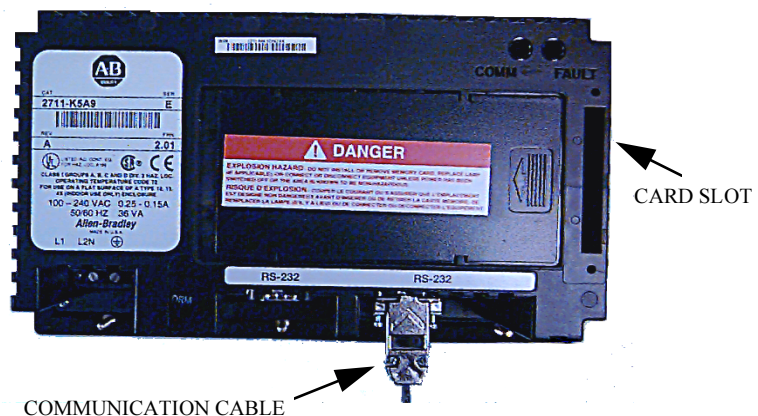


Figure 3.106 – Rear View of Operator Interface

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

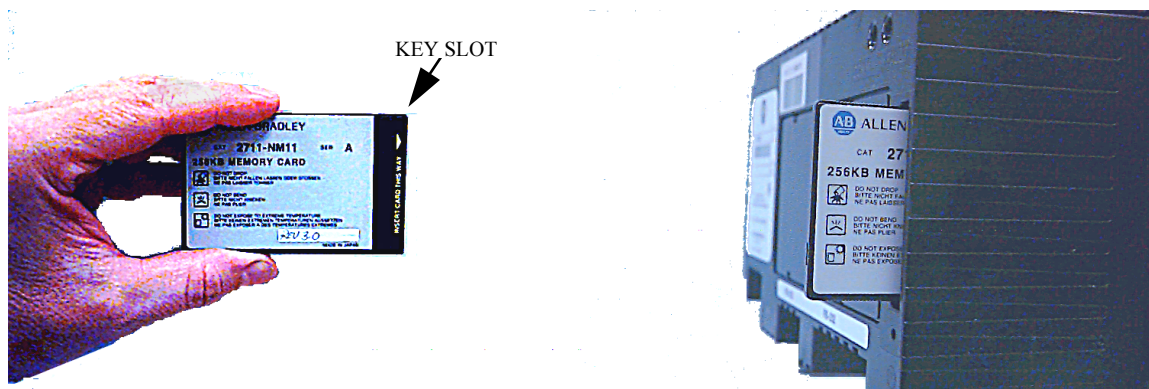


Figure 3.107 – Key Slot Orientation

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

WARNING



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

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

Rockwell Automation recommends the following:

Drive Commissioning

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

Start-up Commissioning Services (cont.)

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 'A' 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 Medium Voltage 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: _____

CSM 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 'A' 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 'A' 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 in Chapter 2 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.

NOTES OR COMMENTS:

[illegible]

Commissioning Preparation

The following section identifies all the tools and resources required to successfully commission a PowerFlex 7000 'A' 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 ❷
- Required computer cables
 - 9-Pin Null Modem ❸
 - 9-Pin Serial ❸
 - Remote I/O (SCANport DeviceNet...) ❶
 - PLC Communications Cable ❷

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

❷ Only required when PLC has been provided with the drive

❸ Refer to Publication 7000-UM151-EN-P, Chapter 5 – Component Definition and Maintenance.

Technical Publications

Each drive is shipped with the following publications:

- User Manual ❶ – provides general information required by the User
- Technical Data, PowerFlex 7000 Medium Voltage AC Drives, Firmware Version x.xxx ❶ - provides detailed information about the firmware parameters and troubleshooting information
- PowerFlex 7000 MV Drives General Handling Procedures, Installation Instructions (affixed to the enclosure)

If, applicable, the following publications are also included:

- PowerFlex 7000 AC Drive with Direct-to-Drive Technology Re-Installing a Common Mode Choke, Installation Instructions ❶
- Bulletin 1502 - 400 amp MV Contactor, Series E - User's Manual ❶
- IntelliVACTM Contactor Control Module User's Manual (Series E) Bulletin 1503VC*

❶ - These are located in a cardboard box within the drive enclosure.

Service Manual

A project-specific service manual is created for each drive order. Three (3) CD copies of the manual are mailed to the customer. The contents include:

- Safety guidelines
- Shipping, handling, and storage recommendations
- Installation procedure
- Dimensional drawing set
- Electrical drawing set
- Manuals/information sheets/specifications of principal R-A or third-party manufactured components
- General terms and conditions of sale
- Test procedures
- Recommended spare parts listing

Reference Manual

A generic Reference Manual is also available for each drive frame (“A”, “B”, and “C”). It goes into greater technical/service/replacement detail related to the drive components.

Contact your local Rockwell Automation Sales Office to order additional copies of the User Manuals and/or Reference Manuals.

IMPORTANT NOTE FOR COMMISSIONING ENGINEER

The COMMISSIONING ENGINEER is advised to go through this commissioning package and follow the steps outlined herein to commission PF7000 drive(s). It is the **responsibility** of the commissioning engineer to complete all datasheets included in this package and collect any other relevant information that may not have been included in the package. ***Important guidelines for capturing waveforms are also included in the package for quick reference. These must be reviewed and followed properly by the commissioning engineer.*** Anything that is not clear, please contact MV Tech Support for assistance:

Phone: **519-740-4790**

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

MVSupport_technical@ra.rockwell.com or MVSupport_services@ra.rockwell.com

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

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

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

NOTE: It should be noted that if the commissioning datasheets submitted by the commissioning engineer are incomplete and/or the required commissioning data, such as harmonic waveforms, dc test waveforms, sync xfer waveforms etc, are not captured correctly or the required data is missing, then it can delay the processing of expense invoices submitted by the engineer.

IMPORTANT: While the FSE is still at the site, he **MUST** send the following information to MV Tech Support for review via e-mail at mvsupport_service@ra.rockwell.com .

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

Key Steps to Commissioning a PF7000 Drive

As a guide for a commissioning engineer, the major steps involved in the commissioning of medium voltage PF7000 drives are outlined below in a sequential order. For detailed instructions, always refer to PowerFlex7000 User Manual.

- Review the drawings and identify all sources of energy that apply to the drive system and get better understanding of the application to which the drive system is applied.
- Follow Safety Procedures and apply LOTO before working on the equipment
- Complete all Power Off checks and note down motor and drive nameplate data
- Apply control power and perform Power On checks
- Perform Gating Test
- Program the drive after verifying the information on EDs and DDs against the equipment nameplate data.
- Perform System Test and verify operation of the drive and the associated controls
- Remove any jumpers used during system test
- Inspect the drive line-up and ensure that no tools are left inside the cabinets before closing them.
- Apply medium voltage and complete incoming line phasing checks and take harmonic measurements
- Perform DC Test. Ensure that the Diagnostic Trend is setup and ready before attempting the DC Test.
- Perform Stationary Autotune tests (first 2 autotune tests)
- Bump the motor for rotation check
- Complete Rotating Autotune tests (last autotune test)
- Save the parameters in NVRAM and also transfer them from Drive to Memory and also print the Drive Setup to your laptop
- Start the drive in normal operation, print variables and capture waveforms
- Complete commissioning documentation

PowerFlex 7000 “A” and “B” Frame Commissioning Datasheets

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

Please refer to the PowerFlex7000 User Manual for the Commissioning Procedure and necessary guidelines.

POWERFLEX 7000 MEDIUM VOLTAGE DRIVE

Drive Firmware Revision Level:
Terminal Firmware Revision Level:

JOB NUMBER:	
CUSTOMERNAME:	

ROCKWELL AUTOMATION CANADA
135 Dundas Street
Cambridge, Ontario, N1R 5X1
Canada

MV Support Contact Info:

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

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

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

Digital Pager: 1-519-654-5616

PowerFlex 7000 “A” and “B” Frame Drive Commissioning Check List

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

Drive Application Review

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

Safety Tests

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

Installation Review

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

PowerFlex 7000 “A” and “B” Frame Drive Commissioning Check List

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, power supplies, communication modules and protective relays.

Control Power Off Tests

- ☐ Verify mechanical interlocks.
- ☐ Perform a resistance check on all devices and snubber circuits.
- ☐ Verify that the 3-phase control power coming into the control section is within specification. Most drives will not have this option.
- ☐ Verify that all additional sources of low voltage power are within specification and have grounded neutrals.

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 at the input to gate driver power supplies. Adjust if necessary.
- ☐ Verify the 20V output of SGCT IGDPS boards.
- ☐ Verify that all of the DC outputs in the DC/DC converter are at rated value.
- ☐ Verify that healthy lights are on for all control boards and firing boards (Use wire harness with power supply adapter to test SCR gate driver boards).

Converter Tests

- ☐ Confirm that SCR and SGCT gating pulse sequence are correct for all devices.

Programming the Operator Interface

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

System Tests

- ☐ Perform a system test with low voltage control/test power.
- ☐ Prove all protection functions as desired.
- ☐ Verify that all emergency stop devices are functioning correctly.
- ☐ Calibrate the analog I/O.
- ☐ Verify that the drive cooling fan(s) is/are operating properly.
- ☐ Measure input contactor drop out time. (2-cycle advance warning needed if input contactor is not part of drive line-up)

PowerFlex 7000 “A” and “B” Frame Drive Commissioning Check List

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

- ☐ Verify that line voltage is at rated value.
- ☐ Perform a phasing check (*18-pulse drives only*).
- ☐ Verify input line harmonic by checking line voltage and current waveforms at ACB board (*only for AFE rectifier drive*). Save the waveforms.
- ☐ Perform IDC Test and verify dc current and voltage waveforms
- ☐ Autotune the drive
- ☐ Review parameters settings for operating the drive with unloaded motor
- ☐ Program the drive for operation at full load
- ☐ Run the drive at rated load and rated speed, and record variables.
- ☐ Capture line side and load side voltage and current waveforms under running condition.

Paperwork

- ☐ Print **DRIVE SETUP**, which gives all parameters, firmware revisions, PLC links, etc.
- ☐ Complete the Commissioning Datasheets.
- ☐ Mark up EDs with modifications or corrections done in the control circuit
- ☐ Add revision notes to modified PLC program.
- ☐ Have the customer sign sign-off documents.
- ☐ Provide customer with parameter settings, marked-up drawings, commissioning package, PLC program and Field Report.
- ☐ Forward Waveforms, PLC program, modified drawings, Commissioning Package and Field report to Medium Voltage Support group.

Drive Application Review

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

Rockwell Automation Drive Line-up Drawings

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

Dimensional Drawings

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

Electrical Drawings

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

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

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

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

Electrical System One-line Diagram

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

Verify One-line Diagram on Site

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

Inspect Process

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

ATTENTION

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

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.

Installation Review (cont.)

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

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

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

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

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

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

Customer Information

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

Motor Nameplate Data		
MOTOR TYPE:	INDUCTION <input type="checkbox"/>	SYNCHRONOUS <input type="checkbox"/>
MANUFACTURER:	MODEL NO.	SERIAL NO:
HP / KW:	VOLTS:	CURRENT:
KVA:	POWER FACTOR:	FREQUENCY:
RPM:	SERVICE FACTOR:	EFFICIENCY:
CODE:	TYPE:	FRAME:
NEMA TYPE:	RTD TYPE:	
	BEARING:	STATOR:
EXCITATION (For Synchronous Motors Only):		
EXCITER TYPE:	VOLTS:	CURRENT:

Tachometer/Encoder Nameplate Data		
TACHOMETER <input type="checkbox"/>	POSITION ENCODER <input type="checkbox"/>	STATOR FEEDBACK (NONE) <input type="checkbox"/>
MANUFACTURER:	MODEL NO.:	SERIAL NO.:
PPR:	GEAR RATIO:	

Drive Nameplate Data				
CATALOG NO.:		SCHEMATIC DIAGRAM:		
Control Cell				
MAX VOLTS:		Hz:		
Power Cell				
UNIT SERIES:	Hz:	BIL (kV):	CURRENT (Amp):	RECTIFIER TYPE:
MAX VOLTS:	MVA:	NEMA TYPE	SERVICE FACTOR:	
Motor Filter Capacitors				
MANUFACTURER:		MODEL NO.:	Number of Capacitors:	
			Each Cap KVAR:	
VOLTS:		Hz:		
Line Filter Capacitors (AFE Rectifier Only)				
MANUFACTURER:		MODEL NO.:	Number of Capacitors:	
			Each Cap KVAR:	
VOLTS:		Hz:		
DC Link				
MANUFACTURER:		SERIAL NO.:	MODEL:	
CURRENT (Amp)	INDUCTANCE (mH)	INSULATION CLASS	TEMP RISE	
Input Reactor				
CONFIGURATION		MANUFACTURER	MODEL NO.	SERIAL NO.
LINE REACTOR <input type="checkbox"/>	ISOL. TRANSFORMER <input type="checkbox"/>			
VOLTAGE		mH/KVA / CURRENT	TEMP. RISE	IMPEDANCE
PRIMARY:	SECONDARY:			

[illegible]

Drive Circuit Boards				
ACRONYM	PRODUCTION ASSEMBLY PART NUMBER	HARDWARE REVISION	FIRMWARE REVISION	
ACB	80190-560-		---	
DPM	80190-580-			
OIB L (A,B,C)	80190-099-		---	
OIBB	80190-600-		---	
OIB M (A,B,C)	80190-099-		---	
XIO ❶	80190-299-		---	
VSBL 1	81000-199-		---	
VSBL 2	81000-199-		---	
VSBM 1	81000-199-		---	
Operator Interface	2711-KSASL11		PV Firmware ❷	PV Software ❸
TFB L	80190-639- or 80190-539-		---	
TFB M	80190-639- or 80190-539-		---	
SCR SPGDB ❶	80190-219-		---	
IGDPS L (1-3)	80026-044-		---	
IGDPS M (1-3)	80026-044-		---	
PS1 (A-F) ❶ [AC/DC Converter]	80026-520 or 524 -		---	
PS2 [DC/DC Converter]	81002-440-		---	
PS4 [24V DC Power supply]			---	
CPT	80022-069-		---	
UPS			---	
PRINTER			---	

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

❷ **PV Firmware** is located on a sticker on the back of the unit.

❸ **PV Software** is located on the main display screen (top left corner).

Control Power Off Tests

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

Interlocking

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

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

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

ATTENTION

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

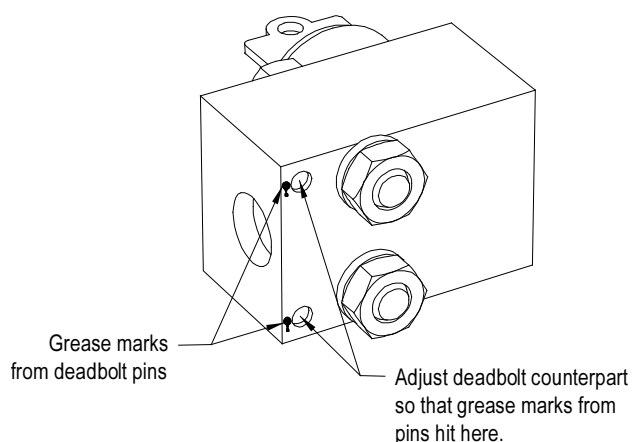


Figure 4.1 – Deadbolt Assembly Mounted to Door

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

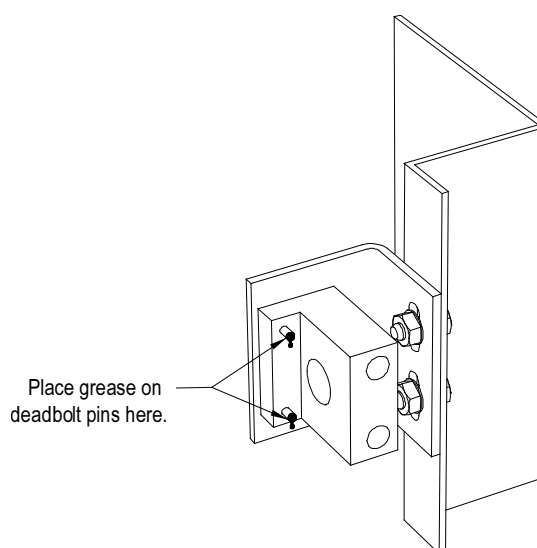


Figure 4.2 – Deadbolt Counterpart Mounted to Cabinet

Control Power Off Tests (cont.)

4. Bolt the cabinet door closed so the pins on the dead bolt counterpart make contact with the deadbolt assembly. Doing so should leave two marks of torque sealant or grease on the assembly where the pins made contact (See Figure 4. 3 – Deadbolt assembly).
5. Slightly loosen the adjustment bolts on the counterpart and make the necessary movements on the counterpart to ensure that the pins align with the landing plates on the deadbolt assembly. As the amount of counterpart movement required is an estimate, it may take a couple attempts to properly align the assembly.
6. Clean the torque seal/grease from the key interlock once finished aligning the counterpart.

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

Resistance Checks

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

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

ATTENTION

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

SGCT Testing

The following steps outline how to verify SGCT semiconductors and all associated snubber components. A quick reference to the expected resistance and capacitance values can be found in the table below. A simple schematic in Figure 4.3 shows how the snubber components are connected across a SGCT.

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

SGCT Rating	Sharing Resistor ❶	Snubber Resistor	Snubber Capacitor
1500 Amp	80 k Ω	6 Ω (AFE Rectifier)	0.2 μ f
1500 Amp	80 k Ω	7.5 Ω (Inverter)	0.2 μ f
800 Amp	80 k Ω	10 Ω	0.1 μ f
400 Amp	80 k Ω	15 Ω (AFE Rectifier)	0.1 μ f
400 Amp	80 k Ω	17.5 Ω (Inverter)	0.1 μ f

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

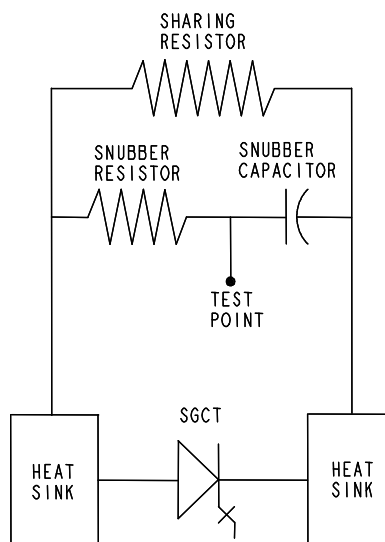


Figure 4.4 – SGCT Snubber Circuit Connections

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

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

Resistance Checks (cont.)

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 of 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:

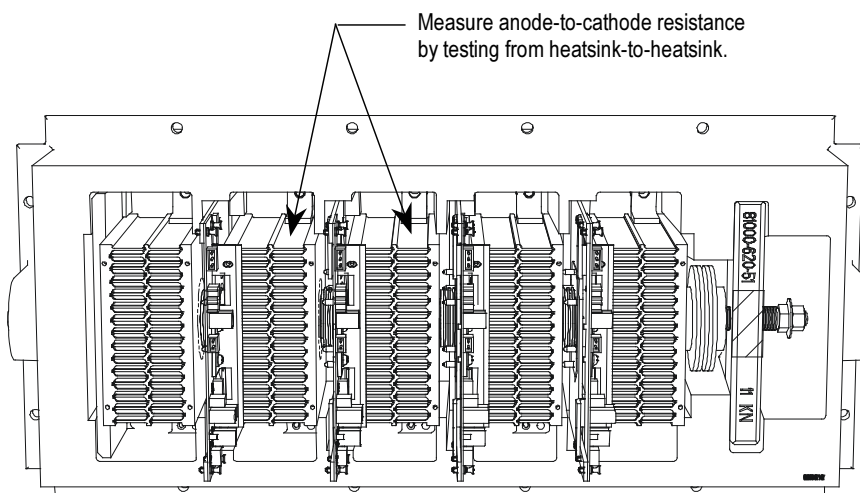


Figure 4.5 – Anode-to-Cathode Resistance Test Points

An SGCT when not gated on is an open circuit. A healthy device resistance value should be close to the value of the 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 5 – 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 5 – 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.

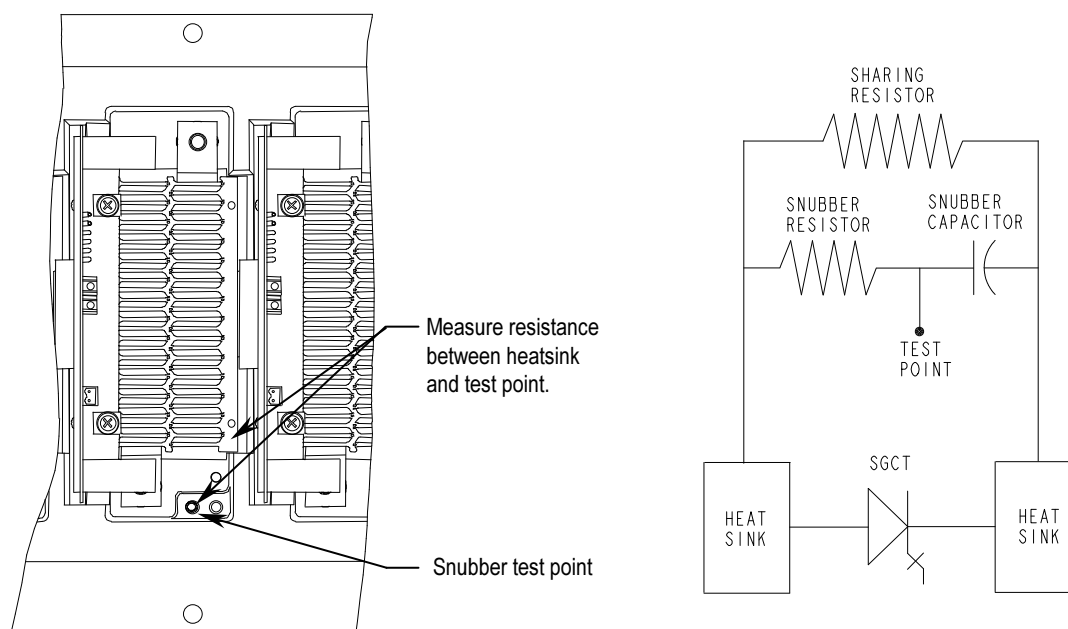


Figure 4.6 – Snubber Resistor Test

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 5 – Component Definition and Maintenance for detailed instructions on how to replace the snubber resistor assembly.

Resistance Checks (cont.)

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.

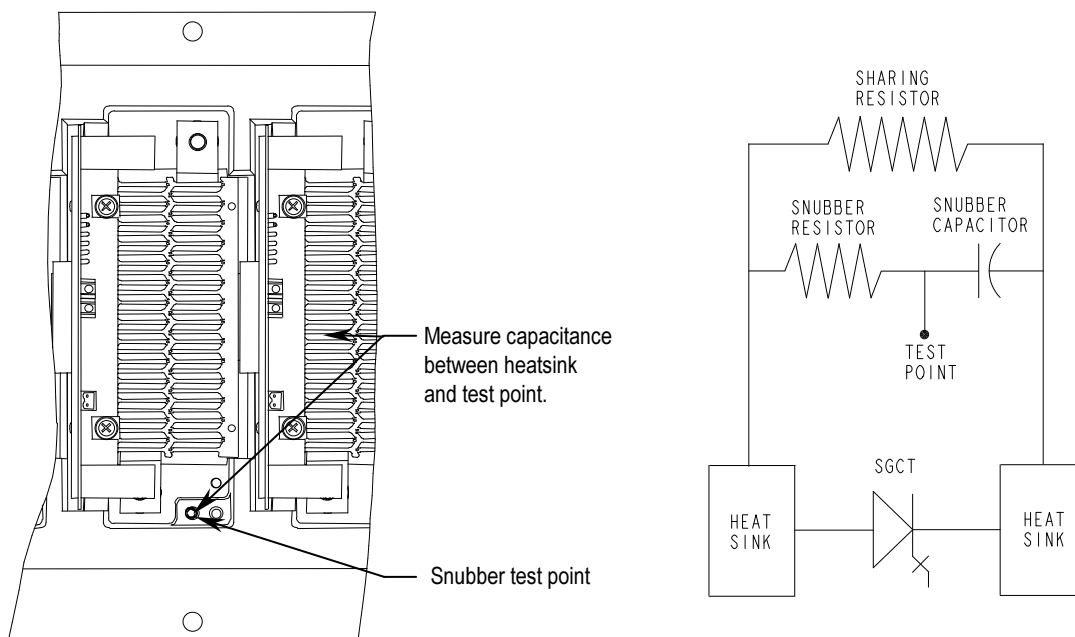


Figure 4.7 – Snubber Capacitor Test

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 5 – Component Definition and Maintenance for detailed instructions on how to replace the snubber capacitor.

Control Power Tests

IMPORTANT

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

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

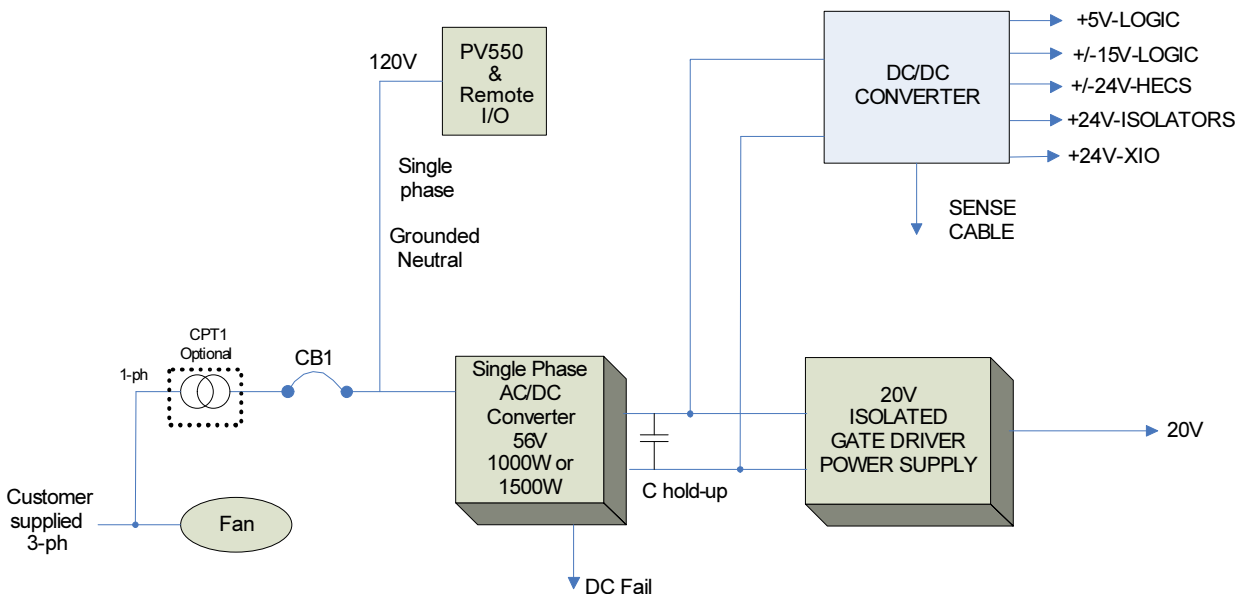


Figure 4.8 – Control Power Distribution

Three-Phase Input

In the 3-phase input configuration, the customer supplies 3-phase control power into the Disconnect Switch (Labeled DS1 on the Electrical Schematics). From that point, the power is distributed to the 3-phase fan and to the power supplies through a single phase CPT. The output of the single phase CPT powers all the power supplies and controls within the drive. The 3-phase control should be measured at the input to DS1. If the rating matches the designation on the electrical schematic, it is acceptable to apply control power to the drive. Take necessary measures to rectify the control power level in the event that it does not meet the design specifications.

Three-Phase Input / Single Phase Input

This configuration has one source of control power:

- Three-phase control power for fan operation which is also converted to single-phase control power to operate the Interface, power supplies, I/O and additional auxiliaries.

Similar to the three-phase configuration, the input power for the fan and control must be verified at the primary of DS1.

If the ratings match the designation on the electrical schematic, it is acceptable to apply control power to the drive by closing CB1 and DS1. Take necessary measures to rectify the control power levels in the event that they do not meet the design specifications.

Power Supply Tests

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

Circuit Board Healthy Lights

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

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

Component	LED Activated
AC/DC Converter Power Supply	No Healthy LEDs Provided
DC/DC Converter Power Supply	No Healthy LEDs provided
SGCT Power Supplies ❶	1 Green LED per section of Power Supply (No Label)
SGCT Integrated Firing Card	LED 4 (Green) LED 3 (Green) LED 1 (Red)
Analog Control Board (ACB)	2 Green LEDs – Healthy
DPM	LED 6 (Green) LED 9 (Green) LED 7 (Green) LED 11 (Green)
External I/O	Various YELLOW Surface Mounted LEDs based on I/O status
Remote I/O Adapter	LED configuration will change based on adapter. Refer to the adapter user's manual to identify the state the adapter is in.
Operator Interface Terminal	Displays Boot Sequence. Communications Error will occur in a fault situation. A small flashing indicator in bottom right corner indicates good communication.

❶ Number of supplies varies based on drive configuration.

Failure of LED to illuminate indicates a problem with the power-up self-test. Refer to Publication 7000-TD002_-EN-P for information on troubleshooting.

Control Power Transformer (CPT)

A control power transformer 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	<input type="checkbox"/>	No <input type="checkbox"/>
CPT Secondary Voltage (V_{L-L})	U-V		V
	V-W		V
	W-U		V
CPT Secondary Voltage (V_{L-N}) <u>or</u> , if no CPT: Input Control Voltage (V_{L-N})	U-N		V
	V-N		V
	W-N		V

Control Power Tests (cont.)

AC/DC Converter (PS1)

Every PowerFlex 7000 'A' or 'B' Frame drive will be supplied with at least one AC/DC power supply. As the number of devices increases *or* to provide a redundant power supply, the number of AC/DC power supplies installed may be more than one. The electrical schematics provided by Rockwell Automation will identify how many AC/DC power supplies have been installed in the drive being commissioned.

Ensure the output of the AC/DC power supply is 56V DC. If any adjustment is required, refer to the Component Definition and Maintenance section in Chapter 5.

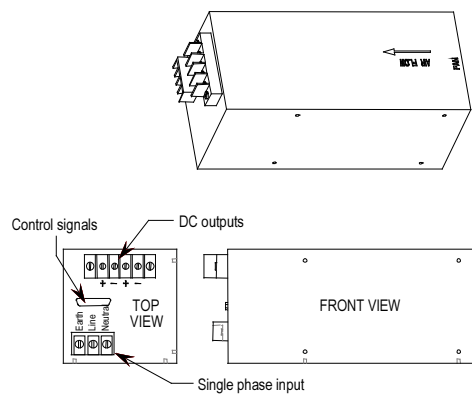


Figure 4.9 – Location of AC/DC Power Supply on Low Voltage Panel

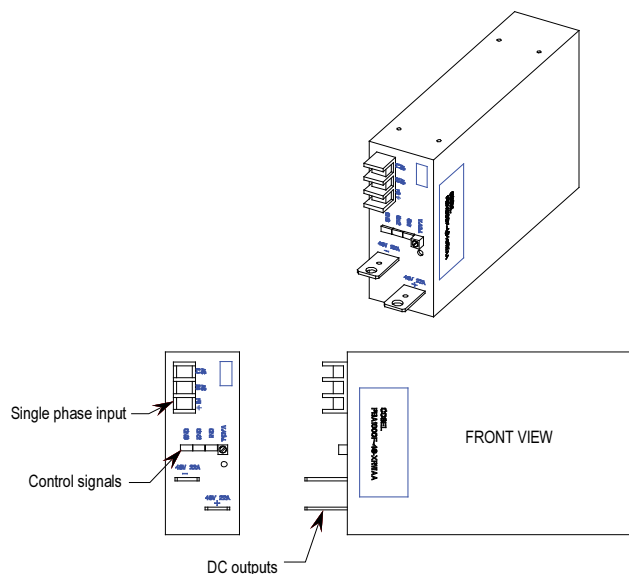


Figure 4.10 – Location of AC/DC Power Supply (Cosel) on Low Voltage Panel

DC/DC Converter (PS2)

The DC/DC converter has no provision for output power adjustments. A green LED on front case of the power supply indicates that the power supply is functioning properly. Using a Digital Multimeter, measure each of the outputs of the DC/DC converter to ensure that they meet the values specified on the electrical schematics. Compare these measured values to those displayed on the Operator Terminal under the Metering group.

Plug 1 (P1) – INPUT

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

Plug 2 (P2) – SENSE SIGNAL

Terminal Numbers	Description	Value

Plug 3 (P3) – ISOLATOR

Terminal Numbers	Description	Value
1 → 2	ISOLATOR (+24V,1A)--ISOL_COMM (COM4) ±5%	

Plug 4 (P4) – PWR

Terminal Numbers	Description	Value
1 → 2	+24V_XIO (+24V,2A)--XIO_COMM (COM3) ±5%	
3 → 4	+HECSPWR (+24V,1A)--LCOMM (COM2) ±1%	
5 → 4	-HECSPWR (-24V,1A)--LCOMM (COM2) ±1%	
6 → 7	+15V_PWR (+15V,1A)--ACOMM (COM1) ±0.5V	
8 → 7	-15V_PWR (-15V,1A)--ACOMM (COM1) ± 0.5V	
9 → 10	+5V_PWR (+5V,5A)--DGND (COM1) 5.1-5.5V	

Control Power Tests (cont.)

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, Chapter 3 of the Technical Data manual, publication **7000-TD002_-EN-P**.

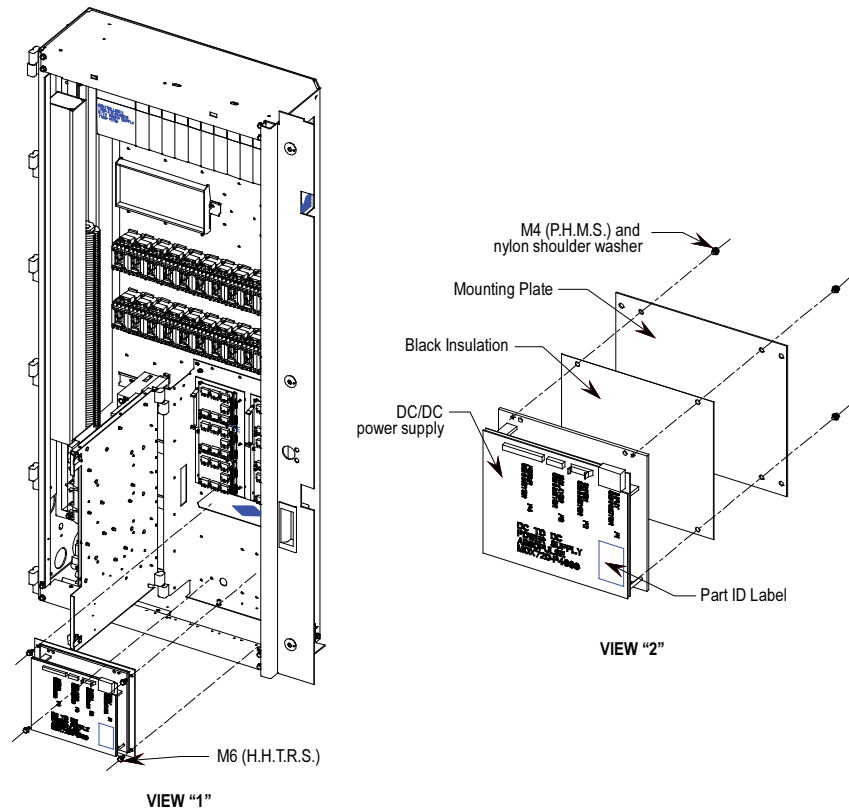


Figure 4.11 – DC/DC Converter (PS2)

SGCT Power Supplies (IGDPS)

Note: Refer to Figure 4.12 for location of IGDPS.

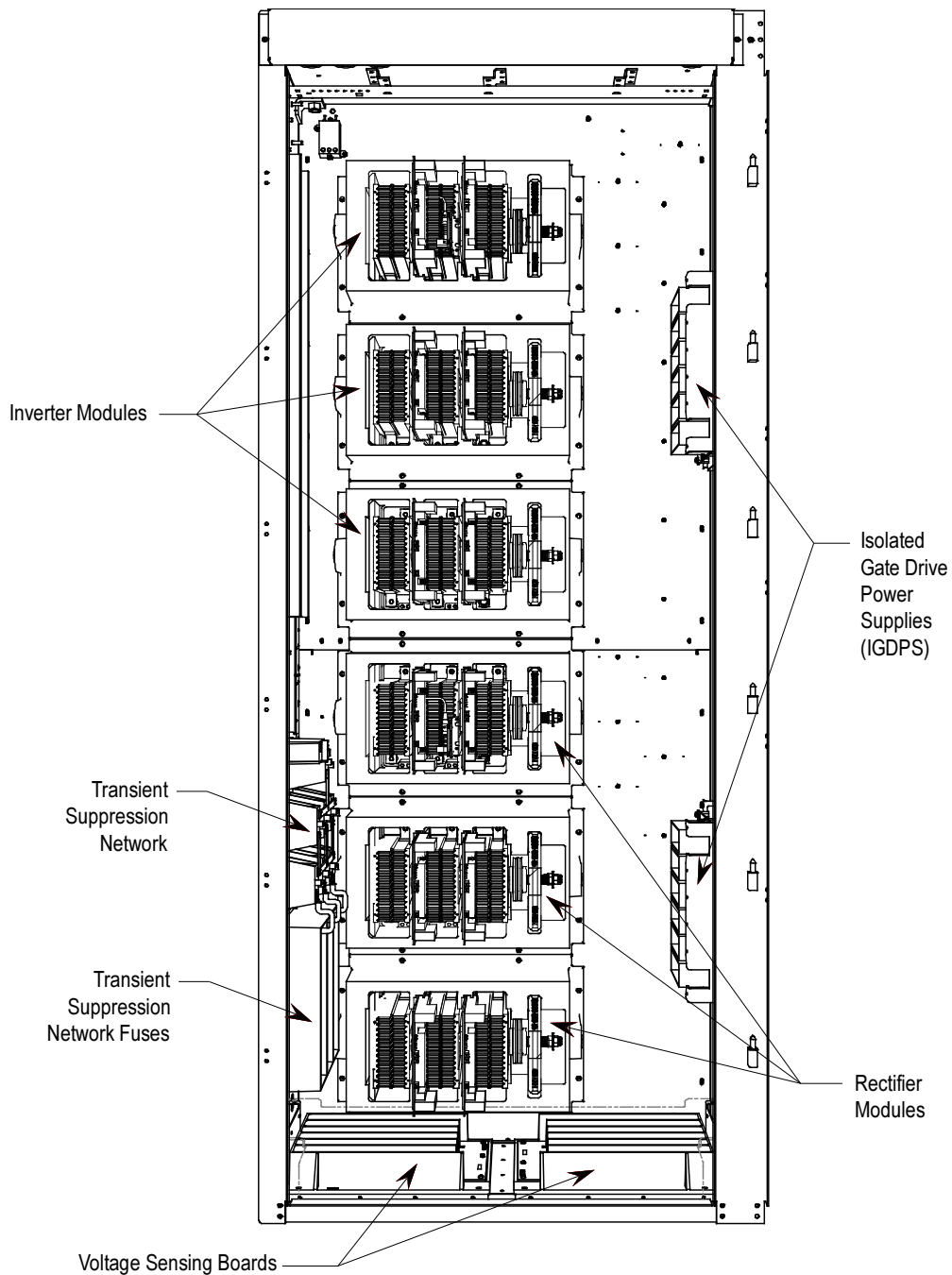


Figure 4.12 – Converter Cabinet Components (2400V)

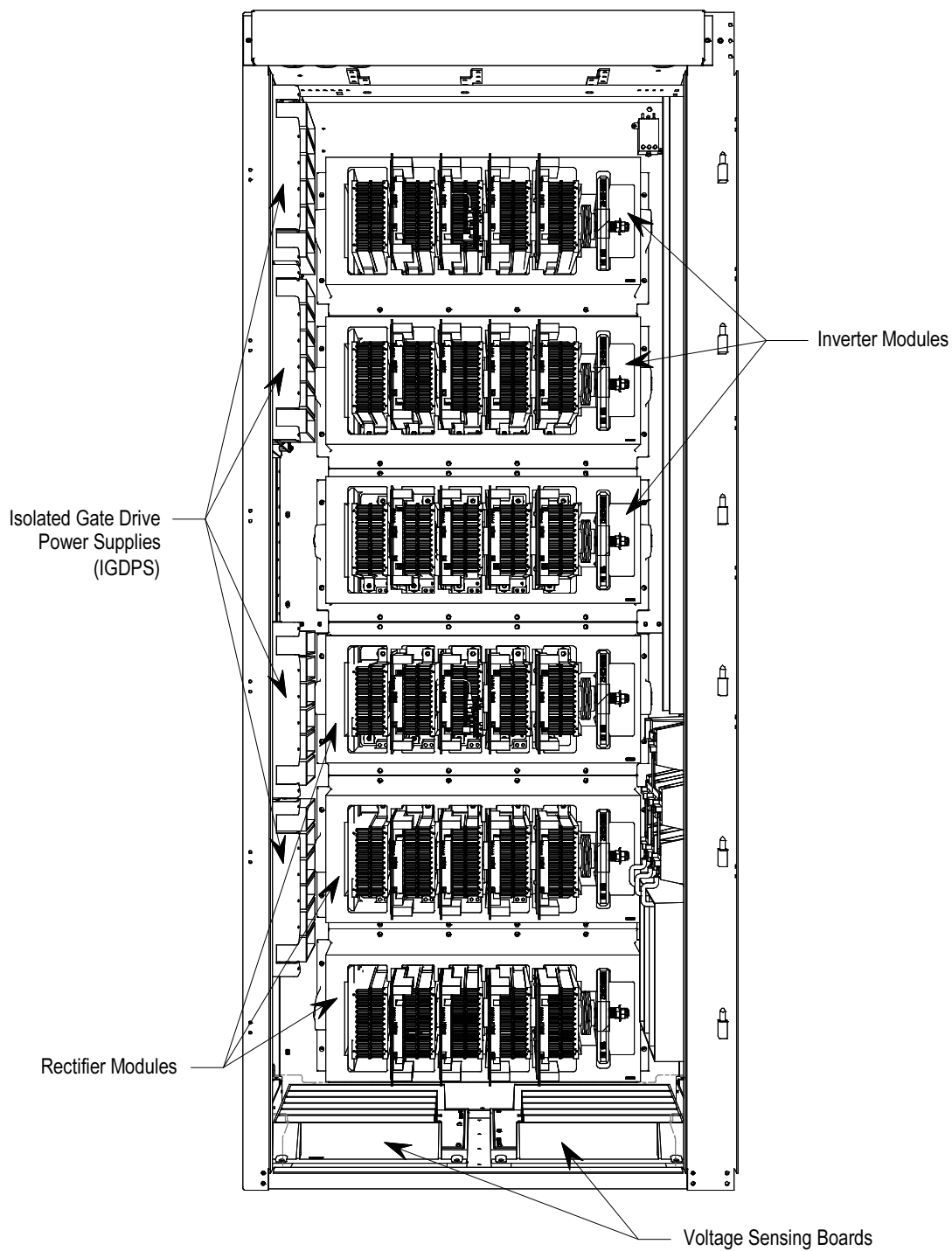


Figure 4.13 – Converter Cabinet Components (3300/4160V)

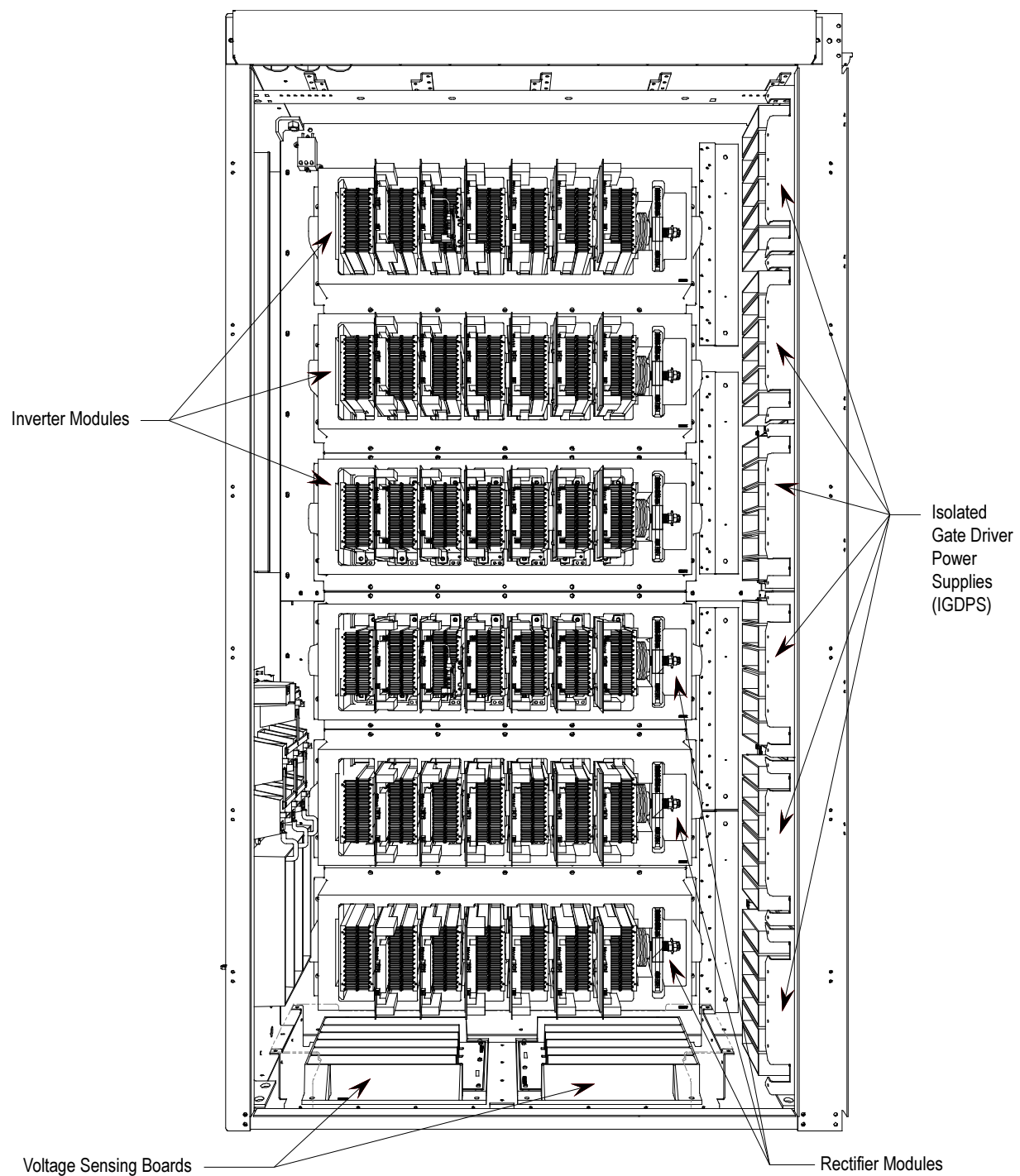


Figure 4.14 – Converter Cabinet Components (6600V)

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

IGDPS Board LEDs

There is one green LED on each of the 6 output channels of IGDPS. If the IGDPS is healthy, then all six LEDs will be illuminated. If any of the LEDs is not ON then the IGDPS might be defective and must be replaced. Record the following measurements to ensure all 6 outputs in each IGDPS are functioning. The output voltage should be within $20V \pm 1\%$. There may be more than one IGDPS in the drive.

Test Points	Expected Value	Measured Value					
		IGDPS#1	IGDPS#2	IGDPS#3	IGDPS#4	IGDPS#5	IGDPS#6
Plug 8 Pin 1 → Pin 2	+20 V DC						
Plug 9 Pin 1 → Pin 2	+20 V DC						
Plug 10 Pin 1 → Pin 2	+20 V DC						
Plug 11 Pin 1 → Pin 2	+20 V DC						
Plug 12 Pin 1 → Pin 2	+20 V DC						
Plug 13 Pin 1 → Pin 2	+20 V DC						

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 5 – 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. If the drive I/O is monitored remotely, process control should be notified in advance to avoid confusion.

ATTENTION



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

The PV550 display screens are given as an example. The actual screen data may differ.

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

SETUP:				
Parameters		Current Access:		
Analog		Advanced		
PLC				
XIO				
Fault Masks				
External Text				
Setup Wizard				
ALARMS		ACCESS	LANG'GE	EXIT

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

```

SETUP:

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

ALARMS  ACCESS  LANG'GE  EXIT
  
```

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

```

SELECT GROUP: 1 of 3

Feature Select
Motor Ratings
Autotuning
Motor Model
Speed Command
Speed Control
Speed Profile
Current Control

ALARMS  LIST  NEXT PG  PREV PG  EXIT
  
```

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

```

SELECT: Feature Select 1 of 2

Operating Mode      Normal
Speed Ref Select    Local
Speed Cmd Loss      Fault
Coast Speed         2.0 Hz
Auto Restart Dly    .0 sec
Input Cctr Cfg      All Faults
InpCctr OpenDly     .0 min
Output Cctr Cfg     Not Running

ALARMS  NEXT PG  PREV PG  EXIT
  
```

```

MODIFY PARAMETER: Operating Mode

P: 4

Actual: Normal
New: Normal
Gate Test
DC Current
System Test
Open Circuit
Open Loop

ALARMS  CANCEL  ACCESS  EXIT
  
```

ATTENTION

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

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:

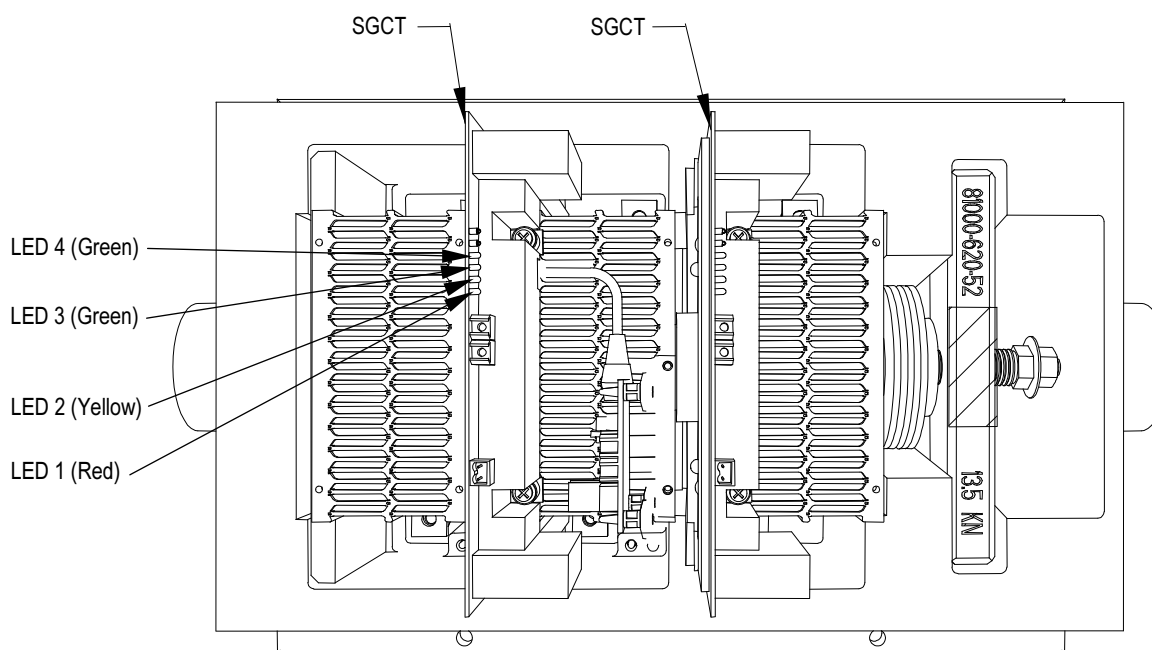


Figure 4.15 – SGCT Healthy LEDs

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 5 – Component Definition and Maintenance, for instructions on how to troubleshoot the SGCT firing cards.

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

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

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

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

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

System Test

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

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

System Test Mode

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

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

ATTENTION

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

The PV550 display screens are given as an example. The actual screen data may differ.

Ensure you have Advanced access.

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

```

SELECT GROUP: 1 of 3

Feature Select
Motor Ratings
Autotuning
Motor Model
Speed Command
Speed Control
Speed Profile
Current Control

ALARMS LIST NEXT PG PREV PG EXIT

```

Press Enter, Operating Mode is highlighted on the first line.

```

SELECT: Feature Select 1 of 2

Operating Mode Normal
Speed Ref Select Local
Speed Cmd Loss Fault
Coast Speed 2.0 Hz
Auto Restart Dly .0 sec
Input Ctctr Cfg All Faults
InpCtctr OpenDly .0 min
Output Ctctr Cfg Not Running

ALARMS NEXT PG PREV PG EXIT

```

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

```

SELECT: Feature Select 1 of 2

Operating Mode System Test
Speed Ref Select Local
Speed Cmd Loss Fault
Coast Speed 2.0 Hz
Auto Restart Dly .0 sec
Input Ctctr Cfg All Faults
InpCtctr OpenDly .0 min
Output Ctctr Cfg Not Running

ALARMS NEXT PG PREV PG EXIT

```

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.

System Test (cont.)

Start/Stop Control Circuit

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

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

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

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

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

Status Indicators

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

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

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

Analog I/O

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

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

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

Analog Inputs

- **Analog Command Input Scaling**
 - Prior to commencing the reference command input scaling it is necessary to ensure that the reference command input selection has been configured as desired. This requires setting Reference Select [P7] to the appropriate input source.
 - Set the utilized Reference Command minimum (SpdCmd Pot(L), SpdCmd Anlg Inp(R) and SpdCmd DPI (D) to the desired value. The minimum reference command input setting on a drive without 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.

System Test (cont.)

Example:

- **SpdCmd Anlg Inp (4-20mA) Reference command Input Scaling**

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

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

- **SpdCmd DPI (Digital) Reference command Input Scaling**

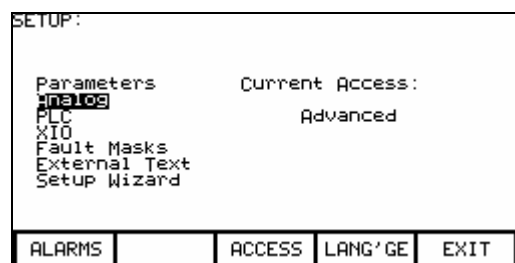
The maximum value for a digital reference command is 32767; the minimum value is 0. Values that are negative or out of bounds will result in the drive slowing down to minimum speed.

Analog Outputs

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

The PV550 display screens are given as an example. The actual screen data may differ.

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



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

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

ANALOG SETUP: 1 of 3		
Meter1	Motor Current	361
Meter2	Motor Voltage	362
Meter3	Motor Speed RPM	363
Meter4	Motor Power	364
Output1		
Output2	Idc Test Command	119
Output3		
Output4		
<div>ALARMS</div> <div>CANCEL</div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>		

SELECT GROUP: 3 of 3		
	Datalinks	
	Analog Outputs	
	DI0	
	Security	
	Parallel Drive	
	Drv Application	
	Process Control	
<div>ALARMS</div> <div>LIST</div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>		

SELECT: Analog Outputs 1 of 3		
Anlg Meter1		361
Anlg Meter2		362
Anlg Meter3		363
Anlg Meter4		364
Anlg Output1		
Anlg Output2		119
Anlg Output3		0
Anlg Output4		0
<div>ALARMS</div> <div></div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>		

If you scroll down, you will reach the scaling factors for the 4 Meter Port and the 3 ACB Port outputs. All parameters are scaled to 0-10V, with 0 representing the minimum value given in Chapter 5 under Parameter Descriptions, and 10V representing the maximum value given in Chapter 5. These Scaling parameters (i.e. Anlg Port2 Scle) can be used to change the scaling.

SELECT: Analog Outputs 2 of 3		
Anlg 4-20mAOut		337
AnlgMeter1 Scale		1.00
AnlgMeter2 Scale		1.00
AnlgMeter3 Scale		1.00
AnlgMeter4 Scale		1.00
Anlg Out1 Scale		1.00
Anlg Out2 Scale		1.00
Anlg Out3 Scale		1.00
<div>ALARMS</div> <div></div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>		

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.

System Test (cont.)

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

MODIFY PARAMETER: Anlg Out2 Scale	
P:	184
Min:	.00
Actual:	1.00
New:	2.73
Max:	655.35
<div>ALARMS</div> <div>CANCEL</div> <div>ACCESS</div> <div></div> <div>EXIT</div>	

The analog outputs from the ACB to IFM 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 3-39
- **Setting External Fault Text:** Chapter 3 – Operator Interface, User Definable External Text 3-42
- **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.

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 RE-ARM THE TRENDING BEFORE LEAVING THE DRIVE IN PRODUCTION.**

The diagnostic trending operation of the drive allows you to capture the relationships of 16 parameters over a period of time. Trending is a valuable tool for trouble shooting the drive.

Refer to Chapter 5 for instructions on setting up the Diagnostic Trending.

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

Input Phasing Check

There are 3 voltage test points on the ACB Board that will allow you to look at each voltage level individually.

These test points are labeled as follows:

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

Test Point Description	Isolation Transformer: Secondary Phasing and Bridge		Phase Relationship with respect to Vab1-Out (2U)
V2uv	2U	Master	0°
V2vw	2V	Master	-120°
V2wu	2W	Master	-240°

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 V2uv as your reference (trigger on this waveform) and verify all the other test points using the table above. It is easier to use zero crossings on your oscilloscope as the reference points when checking the phase shifts.

Essentially, you are verifying the following relationships:

1. V and W in each bridge should be lagging U by 120° and 240°, respectively.

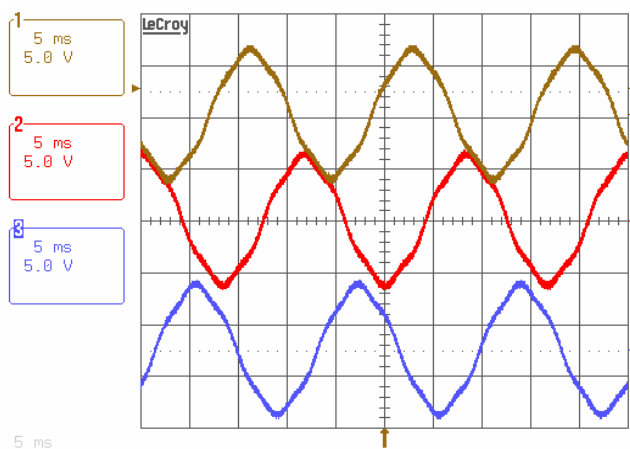


Figure 4.16 – CH1 is 2Vuv, CH2 is 2Vvw, CH3 is 2Vwu

For 60 Hz systems, $360^\circ = 16.7 \text{ ms}$.

For 50 Hz systems, $360^\circ = 20 \text{ ms}$.

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 Rectifier and Idc feedback while increasing the DC current through the drive rectifier. The following instructions detail how to run DC current test:

The PV550 display screens are given as an example. The actual screen data may differ.

Ensure that you have Service access.

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

SELECT GROUP: 1 of 3

Feature Select

- Motor Ratings
- Autotuning
- Control Masks
- Motor Model
- Reference Command
- Speed Command
- Speed Control

ALARMS LIST NEXT PG PREV PG EXIT

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.

MODIFY PARAMETER: Operating Mode

P: 4

Actual: Normal

New: Normal

- Gate Test
- DC Current
- System Test
- Open Circuit

ALARMS CANCEL ACCESS EXIT

Press DISPLAY [F4] and scroll down until you reach the group Current Control. Press Enter and then press MODIFY [F7]. Scroll down to IDC 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 Rectifier.

DISPLAY GROUP: 2 of 4

- Reference Command
- Speed Command
- Speed Control
- Speed Profile
- Current Control
- Torque Control
- Flux Control
- Flux Command

ALARMS CUSTOM NEXT PG PREV PG EXIT

SELECT: Current Control 1 of 1

Curreg Bandwidth	200.0	r/s
IDC Command Test	.000	pu
Idc Ref Step	.000	pu
↑ DC Link	.040	sec

ALARMS NEXT PG PREV PG EXIT

DISPLAY: Feedback		1 of 3
Alpha Line	.00	deg
Alpha Machine	.00	deg
Cabinet Temp C	.00	C
Cabinet Temp F	.00	F
Gnd flt Current	.00	A
IHeatsink Temp C	.00	C
IHeatsink Temp F	.00	F
RHeatsink Temp C	.00	C
<div>ALARMS</div> <div>MODIFY</div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>		

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

We can also check the Idc Reference and 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.

DISPLAY: Current Control		1 of 1
Idc Error	.000	pu
Idc Feedback	.000	pu
Idc Reference	.000	pu
Udc Reference	.000	pu
Curreg Bandwidth	200.0	r/s
Idc Command Test	.000	pu
Idc Ref Step	.000	pu
T DC Link	.040	sec
<div>ALARMS</div> <div>MODIFY</div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>		

The Idc waveform can be observed from T21 (Idc1) on the ACB board. The test point should show 6 ripples per cycle for a 6-pulse drive. The waveform should have an offset of 0.5V for each 0.1pu of Idc Test Command. The waveform should also never have any of the low points between ripples go to 0V. This would indicate a problem with the DC Link cabling. See the troubleshooting section for sample waveforms.

Press MODIFY [F7], and increase Idc to .2 pu, and repeat the process. Go as high as 0.7 pu in 0.1pu steps for 18P, and 0.3 pu in 0.1pu steps for AFE, verifying each level as you increase the current. For AFE, the Idc test is limited to 0.3 Idc reference. If there is a current meter somewhere on the input to the transformer/drive, check the current to ensure that it matches up with what you think we are pumping.

SELECT: Current Control		1 of 1
Curreg Bandwidth	200.0	r/s
Idc Command Test	.000	pu
Idc Ref Step	.000	pu
T DC Link	.040	sec
<div>ALARMS</div> <div></div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>		

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

SELECT: Feature Select		1 of 2
Auto Restart Dly	.0	sec
Coast Speed	2.0	Hz
Ctrl DC Power	Fault	
Input ContCfg	All Faults	
Input Open Delay	.0	min
Operating Mode	Normal	
Output ContCfg	Not Running	
Reference Select	Remote 4-20a	
<div>ALARMS</div> <div></div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>		

Tuning Procedure

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

1. Rectifier
2. Mtr Impedance
3. FluxSpeedReg

The first two functions can be tuned with the motor stationary, but third function requires the motor to rotate. In case the drive cannot complete the tuning, it should be carried out manually.

NOTE:

1. 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.
2. Make sure the following tuning parameters are set to default values:
 - Input Impedance (P#140)
 - T DC Link (P#115)
 - R Stator (P#129)
 - L Total Leakage (P#130)
 - Lm Rated (P#131)
 - T rotor (P#132)
 - Total Inertia (P#82)
 - Lmd (P#418)

1. Rectifier

The Rectifier tuning function calculates parameter *Input Impedance* (140) and *T DC Link* (115) in Current Control group.

• Input Impedance

Input Impedance is used in the software reconstruction of the line voltage to compensate for the drop in the line impedance. It is also used in the calculation of the line converter retard limit (for SCR rectifiers) to ensure proper operation under all conditions of line voltage and load current. If the *Input Impedance* parameter is not correctly adjusted, the resulting error in the reconstructed line voltage may cause line synchronization faults and incorrect reading of the incoming line voltage.

The *Input Impedance* parameter is tuned with the drive operating in the dc current test mode. Although the *Input Impedance* was tuned during factory test, it must be retuned during commissioning because its value is determined by the impedance of the input transformer and harmonic filter (if present).

Tuning Procedure (cont.)

• T DC Link

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

1. Current regulator bandwidth *CurReg Bandwidth*
2. DC Link time constant *T DC Link*
3. DC Link inductance in per unit *DCLnk Induct pu*

Of these three parameters, inductance *DCLnk Induct pu* is calculated from its nameplate rating, the current regulator bandwidth should be set to its default value of 200 rad/sec, and only *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.

The following auto-tune procedure is used to complete the rectifier side tuning:

Rectifier Auto-tuning

1. Ensure that the parameters in the *Drive Hardware* and *Motor Ratings* groups have been set to the correct values.
2. Set parameter *Autotune Select* in the Autotuning parameter group to *Rectifier*. The drive will go into *DC Current* test mode. The current regulator bandwidth is set to *Autotune Idc BW* (212).
3. Start the drive. The dc current will increase to 0.2pu and stay at that level for couple of seconds. The drive records the data under this condition and then ramps up to approximately rated current. After staying at the level for couple of seconds, the drive will again record the measured data and then ramp the current to zero. The current regulator bandwidth is set back to the original value. From the recorded data, the drive will calculate the *Autotune L Input* (P217) and *Autotune T DCLnk* (218). At the end of the tuning *Input Impedance* is set to *Autotune L Input* and *T DC Link* is set to *Autotune T DCLnk*. During tuning if the values are determined to be out of range, the drive will issue warnings indicated below. Try to tune the drive again, but if the warnings persist, verify the result by tuning the drive manually.

Warnings during Rectifier tuning and their interpretation:

L Input Low - indicates that the measured L Input is less than 0.02 pu. The L Input must be tuned using the manual method described below.

L Input High - indicates that the measured L Input is greater than 0.5 pu. The L Input must be tuned using the manual method described below.

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

T DC Link High - indicates that the measured dc link time constant is greater than 0.150 second. The step response of the current regulator should be checked using the manual method described below.

NOTE: The display screens are given as an example. The actual screen data may differ.

Input Impedance Manual Tuning

1. Set parameter *Operating Mode* in *Feature Select* to *DC Current* to enter dc current test mode.
2. If not already at default value, set parameter *Input Impedance* in “Current Control” to an initial value of 0.05 pu.

SELECT: Current Control			1 of 1
CurReg Bandwidth	200.0	r/s	
Idc Test Command	.000	pu	
Idc Ref Step	.000	pu	
T DC Link	.040	sec	
Input Impedance	.0500	pu	
Feedforward Filt	2.0	Hz	
PFC LeadingLimit	.00		
PFC LaggingLimit	.00		
<div>ALARMS</div> <div>NEXT PG</div> <div>PREV PG</div> <div>EXIT</div>			

Current Control Parameter Screen

3. Energize the drive by closing the input contactor.
4. Record the value of the rectifier input voltage by looking at parameter *Rec Input Voltage* (P696). Let this value be V_{in0} .
5. For SCR drives set parameter *Idc Command Test* in Current Control to 0.800 pu. For AFE drives set the parameter to 0.300 pu. Let this value be I_{dc} .
6. Start the drive and wait for a few seconds for steady state conditions to be established.

Tuning Procedure (cont.)

7. Record the value of the rectifier input voltage by looking at parameter Rec Input Voltage (P696). Let this value be V_{in1} .
8. The value of input impedance for AFE drives is calculated as follows:

$$L_{in} = \frac{V_{in0} - V_{in1}}{I_{dc} + C_{in}(V_{in0} - V_{in1})} \Rightarrow \text{for PWM drives}$$

C_{in} is the value of input filter capacitor given by *Line Filter Cap* (P133)

9. The value of input impedance for SCR drives is calculated as follows:

$$L_{in} = \frac{3(V_{in0} - V_{in1})}{I_{dc}} \Rightarrow \text{for SCR drives}$$

10. Stop the drive. Set parameters *Operating Mode* to *Normal* and *Idc Command Test* to zero.

T DC Link (P#115) 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 *T 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
Idc Test Command	.000	pu
Idc Ref Step	.000	pu
T DC Link	.040	sec
Input Impedance	.0500	pu
Feedforward Fil	2.0	Hz
PFC LeadingLimit	.00	
PFC LaggingLimit	.00	
ALARMS		NEXT PG PREV PG EXIT

Current Control Parameter Screen

3. Set parameter *Idc Test Command* in *Current Control* to 0.225 pu for AFE rectifier drives and 0.400pu for SCR drives.
4. Set parameter *CurReg Bandwidth* in *Current Control* to 100 rad/sec. A lower than the normal bandwidth makes the step response easier to measure.
5. Set parameter *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 under-damped response.
6. Assign parameters *Idc Reference* and *Idc Feedback* in the *Current Control* group to 2 DPM test points e.g. RTP1 and RTP2. This can be done similarly to the way that the meter assignments were described earlier in the chapter. Then they can be displayed on the oscilloscope.
7. Start the drive. Set parameter *Idc Ref Step* in *Current Control* to 0.075pu for AFE rectifier drive and 0.200 pu for SCR drives. The dc link current will step up and down by this amount at regular intervals.
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 under-damped, *T DC Link* should not be increased beyond the value at which the overshoot disappears.

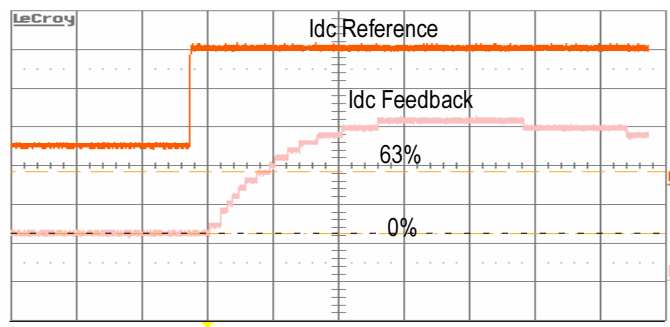


Figure 4.17 – Current Regulator Tuned Incorrectly

Tuning Procedure (cont.)

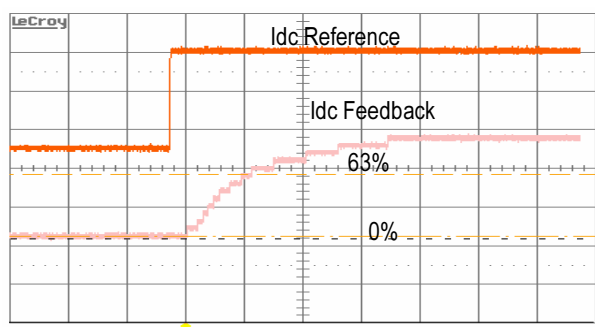


Figure 4.18 – Current Regulator Tuned Correctly

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 given by *Idc Test Command*.
13. Stop the drive. Set parameters *Operating Mode* to *Normal*, and *Idc Test Command* to 0.000pu.

2. Motor Impedance

The motor impedance tuning function calculates stator resistance *R Stator* (129) and total leakage inductance *L Total Leakage* (130) in Motor model Group. These parameters are used in the reconstruction of the rotor flux. If these parameters are not adjusted correctly, the resulting distortion in the flux feedback may cause speed feedback or motor synchronization errors. These parameters must be tuned during commissioning because it is affected not only by motor parameters, but also by cable length. The tuning should be done with the motor stationary.

ATTENTION



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

The following auto-tune procedure can be followed.

Motor Impedance Auto-tuning

1. Ensure that the motor is stationary. If the motor is turning, the results of the test may be invalid. It is not necessary to lock the rotor.
2. Set parameter *Autotune Select* in *Auto-tuning* to *Motor Impedance*.
3. Start the drive. In the first half of the test the output frequency is zero and the dc current is ramped to 0.6pu for a few seconds. This step will calculate R Stator. After this the current is ramped down to zero.
4. In the second half of the step the output frequency ramps up to rated frequency with the dc current equal to 1.0pu for a few seconds. This test may produce a small amount of motor torque and some rotation may occur. This step will calculate the *L Total Leakage*. The current is ramped down and parameter *Autotune Select* is set to *Off*.

Parameter *Autotune RStator* (219) is set to the measured Stator resistance. *R Stator* (129) in *Motor Model* is set equal to *Autotune R Stator*. If the test fails or the values are out of range, a warning is issued indicating the cause of the failure.

Parameter *Autotune LLeakage* (220) is set to the measured leakage inductance. *L total leakage* (P130) in *Motor Model* is set equal to *Autotune LLeakage*. If the test fails, a warning is issued indicating the cause of the failure.

Following warnings can occur during this test:

R stator High - this is probably caused by extremely long motor cables increasing the apparent stator resistance of the motor. The drive cannot operate with stator resistance greater than 0.50 pu.

L Leakage Low - indicates that the measured leakage inductance is less than 0.10 pu. Possible causes are:

1. The motor is much larger than the drive and the motor nameplate parameters do not correspond to the actual motor ratings.
2. Because of the design of the motor, this method of measuring leakage inductance does not produce a valid result. The leakage inductance will have to be obtained from the motor data sheet, or if this is not possible, parameter *L Total Leakage* should be set to its default value of 0.20 pu.

Tuning Procedure (cont.)

L Leakage High - indicates that the measured leakage inductance is greater than 0.35 pu. Possible causes are:

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

3. FluxSpeed Regulator [INDUCTION MOTORS]

Note: For synchronous motors, please refer FluxSpeed Regulator for Synchronous motor.

This method combines the auto-tuning of the Flux and Speed regulator in a single step. It calculates parameters, *Lm Rated* (P131), *T Rotor* (P132) in *Motor Model* Group and *Total Inertia* (82) in *Speed Control* group.

Note: During this auto-tune step the motor will run at speed set in *Autotune Spd Cmd*. The default setting is 30Hz. Make sure the motor rotates during this auto-tune. Motor rotation must be verified either physically or monitoring *FlxFbk VoltModel* (342). It is possible that stall condition may calculate wrong tuning parameters. If it happens, make sure the tuning parameters *Lm Rated*, *T Rotor*, *Total Inertia* are set to default before starting this tuning again.

• Flux Regulator

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

1. *FlxReg Bandwidth* in Flux Control
2. *Lm Rated* in Motor Model
3. *T Rotor* in Motor Model

FlxReg Bandwidth should be set to the default value of 10 r/s for almost all applications. *Lm Rated* and *T Rotor* are usually unknown and must be measured. Both of these motor parameters change substantially with different operating conditions, but the variations do not significantly affect the operation of the flux regulator.

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

1. *Base Speed* in *Flux Control*
2. *FlxCmd RatedLoad* in *Flux Control*

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

• Speed Regulator

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

1. *SpdReg Bandwidth*
2. *Total Inertia*

Parameter *SpdReg Bandwidth* is set to a value determined by the requirements of the application, but parameter *Total Inertia* is usually unknown and must be measured. The auto-tuning determines the total inertia by measuring the change in speed that occurs when a low frequency sinusoidal torque perturbation is applied to the motor. The inertia measurement is not affected by the load torque as long as the drive does not hit torque limit. Do not disconnect the driven load from the motor, as it is the total inertia of motor and load that is being measured.

The following procedure should be used to perform FluxSpeed Reg auto-tuning:

FluxSpeed Reg Auto-tuning [Induction Motor]

1. Ensure that parameters *Rated Motor RPM* in *Motor Ratings* and *L Total Leakage* in *Motor Model* are set to the correct value. Ensure that parameters *Autotune Spd Cmd* and *Autotune Trq Stp* in *Autotune* are set to default values.
2. Set parameter *Autotune Select* in *Autotuning* to *FluxSpeed Reg*.
3. Start the drive. The motor accelerates normally up to the speed specified by parameter *Autotune Spd Cmd*. The motor magnetizing inductance is calculated from the measured current and flux feedback and parameter *Autotune L Magn* is set to this value. The flux command is then set to a value that should produce rated voltage at rated speed and load. The resulting change in the flux level may cause the magnetizing inductance to change. This process is repeated until the magnetizing inductance and flux commands stabilise.

Tuning Procedure (cont.)

4. After completing the flux regulator tuning, the drive waits for a few seconds and adds a sinusoidal perturbation specified by parameter *Autotune Trq Stp* to the torque command, causing the speed to vary. After the initial transient has decayed (this usually takes a few seconds), the variation in torque and speed are measured and used to calculate the *Total Inertia*. The torque perturbation is then removed and the drive performs a normal stop.

Parameter *Autotune L Magn* (221) is set to the measured magnetizing inductance. Parameter *FlxCmd RatedLoad* in Flux Control Group is set to a value which is intended to produce rated voltage at rated speed and load. The value of parameter *Autotune T Rotor* is calculated from parameters *Lm Rated* and *Rated Motor RPM* (which gives the rated slip). If the auto-tuning is successful, then parameter *Lm Rated* (131) in *Motor Model* is set equal to *Autotune L Magn*, parameter *T Rotor* (P132) in *Motor Model* is set equal to *Autotune T Rotor*, and the flux regulator gains are recalculated, parameter *Total Inertia* (82) in *Speed Control* is set equal to *Autotune Inertia* and the regulator gains are calculated.

If the auto-tuning fails then a warning is issued indicating the cause of the failure. Following are the list of possible warnings:

L Magnetize Low - indicates that the measured value of magnetizing inductance is less than 1.0 pu. This warning is intended to draw attention to an unusually low value of magnetizing inductance. This may occur if the motor is much larger than the drive and the nameplate parameters do not correspond to the actual motor ratings.

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

T Rotor Low - indicates that the calculated value of rotor time constant is less than 0.2 seconds. This is caused by a value of *Lm Rated* or *Rated Motor RPM* which is too low.

T Rotor High - indicates that the calculated value of rotor time constant is greater than 5.0 seconds. This is caused by a value of *Lm Rated* or *Rated Motor RPM* which is too high.

Regulator Limit - indicates that the torque command was greater than *Trq Limit Motoring* or *Trq Limit Braking*. The measured inertia value is invalid. Parameter *Autotune Trq Stp* or parameter *Autotune Spd Cmd* must be set to a lower value and the test repeated.

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

Inertia high - indicates that the measured total inertia is greater than 20 seconds. This warning is intended to draw attention to an unusually high inertia value. For a very high inertia load such as a large fan, this may be a valid result and parameter *Total Inertia* should be manually set equal to *Autotune Inertia*. However, a high inertia measurement could also be produced by a value of *Autotune Trq Stp* which is too low.

Flux Regulator Manual Tuning [Induction Motor]

1. Adjust the reference command to a value between 20 and 30 Hz.
2. Start the drive and wait for it to accelerate to the commanded speed.
3. Record the value of parameter *Lm Measured* (134) in *Motor Model*.
4. Stop the drive.
5. Set parameter *Lm Rated* in *Motor Model* to the recorded value of *Lm Measured*.
6. Calculate an approximate value of the rotor time constant using the following formula:

$$T_{rotor} = \frac{LmRated}{Rated Slip}$$

Where

$$Rated Slip = (2\pi Freq_{motor}) \times \frac{(Sync RPM - Rated RPM)}{Sync RPM}$$

Set the parameter *T Rotor* in *Motor Model* to the calculated value.

Tuning Procedure (cont.)

Speed Regulator Manual Tuning [Induction Motor]

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

1. Set parameter *SpdReg Bandwidth* in *Speed Control* to 1.0 rad/sec.

SELECT: Speed Control			1 of 1
Total Accel Time	32.0	sec	
Total Decel Time	32.0	sec	
Inertia Type	Low		
Total Inertia	1.00	sec	
Speed Fbk Mode	Sensorless		
SpdReg Bandwidth	1.0	r/s	
Speed Ref Step	1.0	Hz	
<div> ALARMS NEXT PG PREV PG EXIT </div>			

Speed Control Parameter Screen

2. Set parameter *Total Inertia* in *Speed Control* to an initial value of 1.0 sec if it is a low inertial application (pumps etc). Set the parameter to 5.0 seconds if it is a high inertia application (e.g. ID Fans).
3. Assign parameter *Speed Error* in the *Speed Control* group to a test point e.g. ITP1 on the DPM. This can be done similarly to the way that the meter assignments were described earlier in the chapter. Then it can be displayed on your oscilloscope.
4. Adjust the reference command to a value around the middle of the operating speed range.
5. Start the drive and wait for it to accelerate to the commanded speed.
6. Set parameter *Speed Ref Step* in *Speed Control* to 0.8 Hz. The drive speed will step up and down by this amount at regular intervals. The step of 0.8 Hz corresponds to 0.8V or 800mV on the test point. To capture the error set the scope at 200mV/division and 200msec/division. Trigger the scope on negative edge as shown in Figure.
7. Adjust the value of parameter *Total Inertia* until the speed rises to approximately 63% of its final value in 1 second as shown in the figure. If the response time is too fast, it indicates that *Total Inertia* is set too high and should be decreased. If the response is too slow, then *Total Inertia* is set too low and should be increased.

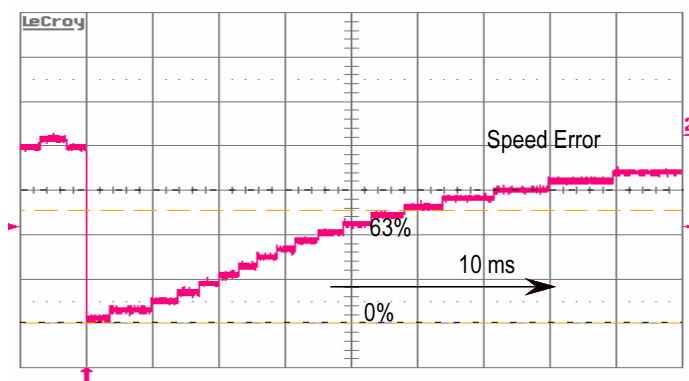


Figure 4.19 –Correctly Tuned Speed Regulator

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.

Tuning Procedure (cont.)

4. FluxSpeed Regulator [SYNCHRONOUS MOTORS]

IMPORTANT

Before the FluxSpeed 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. ACB Port 1.
2. Set the analog output scale parameter e.g. Anlg Out1 Scale in *Analog Output* to:

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

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

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. ACB Port 1). The setup of the field current reference is complete and you can proceed with the tuning of the FluxSpeed regulator.

FluxSpeed Reg Auto-tuning [Synchronous Motor]

The tuning of the FluxSpeed regulator for a synchronous machine is determined by following parameters:

1. FlxReg Bandwidth in Flux Control
2. Lm Rated in Motor Model
3. T Rotor in Motor Model
4. Lmd in Motor Model
5. SpdReg Bandwidth in Speed Control
6. Total Inertia in Speed Control

The FluxSpeed Regulator tuning function calculates parameters, *Lm Rated* (131), *T Rotor* (132) in *Motor Model* Group and *Total Inertia* (82) in *Speed Control* group. This is combined Auto-tuning for Flux and Speed regulator.

NOTE: *During this autotune step the motor will run at speed set in auto tune speed Cmd. The default setting is 30HZ. Make sure the motor rotates during this autotune. Motor rotation must be verified either physically or monitoring “FlxFbk VoltModel” (P#342). It is possible that stall condition may calculate wrong tuning parameters. If It happens, make sure the tuning parameters [Lm rated, T rotor, Total Inertia) are set to default before starting this tuning again.*

• Flux Regulator

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

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

1. Base Speed in Flux Control
2. FlxCmd RatedLoad in Flux Control

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

Tuning Procedure (cont.)

- **Speed Regulator**

Refer details given for Induction motor section.

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

FluxSpeed regulator Auto-tuning [Synchronous Motor]

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

1. Ensure that the analog reference for the field current has been set up as described previously, and that parameter *L Total Leakage* has been set to the correct value.
2. Set parameter *Autotune Select* in *Autotuning* to *FluxSpeed Reg.*
3. Start the drive. The motor accelerates normally up to the speed specified by parameter *Autotune Spd Cmd*. The motor magnetizing inductance is calculated from the magnetizing current reference and the flux feedback and parameter *Autotune Lm* is set to this value. The flux command is then set to a value that should produce rated voltage at rated speed and load. The resulting change in the flux level may cause the magnetizing inductance to change. This process is repeated until the magnetizing inductance and flux command stabilize. If a position encoder is fitted to the motor, the angle between the measured flux and the encoder zero is measured and parameter *Encoder offset* is adjusted to align the encoder with the motor flux.

The field current reference is then held constant and the response of the flux to changes in stator magnetizing current is measured by stepping “Ix command” up and down at regular intervals. The size of the step in the stator current is specified by parameter *Autotune Isd Step*. The step response measurement takes about 3 minutes. During this step parameter *Lmd*, *T Rotor*, *Lm Rated* will be calculated.

When the motor speed has settled at the commanded value, a sinusoidal perturbation specified by parameter *Autotune Trq Stp* is added to the torque command, causing the speed to vary. After the initial transient has decayed (this usually takes a few seconds), the variation in torque and speed are measured and used to calculate the total inertia. The torque perturbation is then removed and the drive performs a normal stop.

Parameter *FlxCmd RatedLoad* in *Flux Control* is set to a value calculated to produce rated voltage at rated speed and load. The value of parameters *Autotune T rotor* and *Autotune Lmd* are calculated from the step response data.

If the flux regulator auto-tuning is successful, then parameter *Lm Rated* in *Motor Model* is set equal to *Autotune L Magn*, parameter *T Rotor* in *Motor Model* is set equal to *Autotune T Rotor*, and parameter *Lmd* in *Motor Model* is set equal to *Autotune Lmd*. Parameter *Total Inertia*(63) in *Speed Control* is set equal to *Autotune Inertia*. If the flux regulator auto-tuning fails a warning is issued indicating the cause of the failure.

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

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

T Rotor Low – indicates that the calculated value of rotor time constant is less than 0.2 seconds

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

Regulator Limit - indicates that the torque command was greater than *Trq Lmt Motoring* or *Trq Lmt Braking*. The measured inertia value is invalid. Parameter *Autotune Trq Stp* or parameter *Autotune Spd Cmd* must be set to a lower value and the test repeated.

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

Inertia high - indicates that the measured total inertia is greater than 20.0 seconds. This warning is intended to draw attention to an unusually high inertia value. For a very high inertia load such as a large fan, this may be a valid result and parameter *Total Inertia* should be manually set equal to *Autotune Inertia*. However, a high inertia measurement could also be produced by a value of *Autotune Trq Stp* which is too low.

Running the Load

Motor Starting Torque

When starting without 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 sensorless (P86), 1 (P87), Torque Command 0 sensorless sets the breakaway torque and Torque Command 1 sensorless is the torque at the transition point from open to closed loop. Torque Command Minimum operates in conjunction with Torque Command 1 to minimize speed overshoot at the transition point. If you are starting an uncoupled motor, or simply auto-tuning, the default starting torque values may be sufficient to run the motor. But the defaults are generally not high enough to start a loaded motor.

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

Reaching Specific Load Points

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

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

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

DRIVE VARIABLES													
TEST #	MOTOR/DRIVE OPERATING POINT		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)
	%SPEED / RPM	AMPS											
1	25%/___												
2	50%/___												
3	75%/___												
4	100%/___												
5	___%/___												
6	___%/___												
7	___%/___												
8	___%/___												
9	___%/___												
10	___%/___												
11	___%/___												
12	___%/___												

Capturing Data

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

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

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

GUIDELINES FOR DATA CAPTURE

This section provides some guidelines for capturing required commissioning data and setting up oscilloscope to capture the waveforms. For detailed instructions, always refer to PowerFlex7000 user manual. Some sample waveforms have been included for reference purpose.

Drive Input Voltage Phasing Checks

After applying medium voltage to the drive, perform an input voltage phasing check.

Summary:

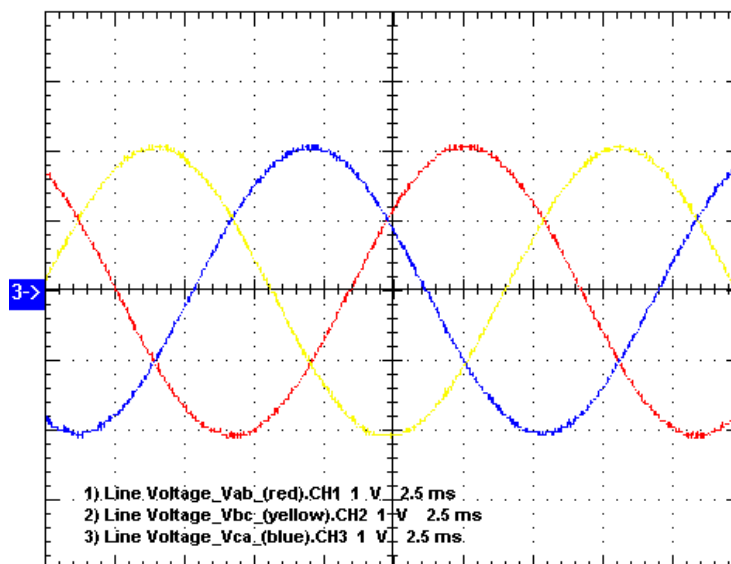
- Drive input contactor should be closed. If the drive input contactor configuration is set to NOT RUNNING, you will have to temporarily change it to ALL FAULTS.
- Ensure that the drive is not running when capturing these waveforms.
- Capture the three line voltage waveforms at ACB test points
 - **Master winding:** V2uv, V2vw & V2wu
- Label the waveforms as “V2uv”, “V2vw” and “V2wu”, etc.
- Save the worksheet as “Input Phasing”.

Table 4.D – Oscilloscope Setting

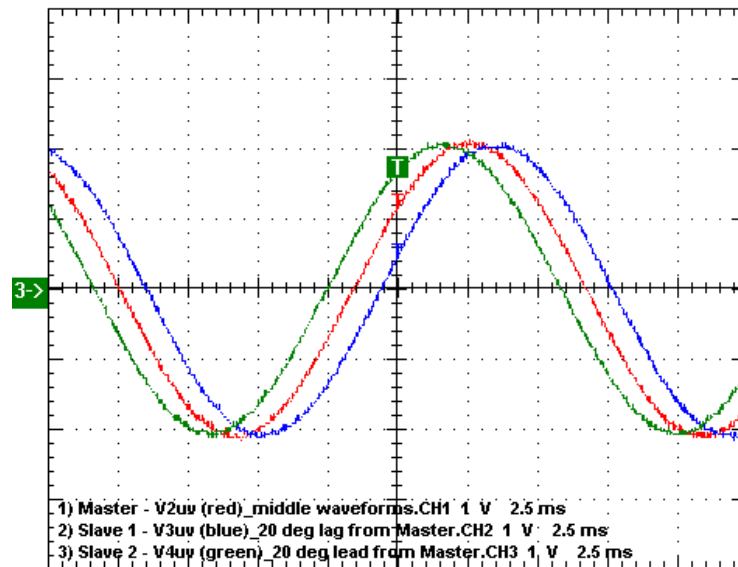
Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label	Sheet Name
Ch. 1	10ms/div.	2U Line Voltage	V2uv	V2uv	Input Phasing
Ch. 2		2V Line Voltage	V2vw	V2vw	
Ch. 3		2W Line Voltage	V2wu	V2wu	

Note: Use the same settings on the oscilloscope when capturing waveforms for the two Slave bridges. If you are using a 2-channel oscilloscope, then first capture two waveforms and move them onto a wavestar worksheet and after that capture the remaining waveforms and move them onto the same wavestar worksheet.

Sample Waveforms



Sample Waveforms captured on ACB test points showing incoming line voltage phasing [Ch1: V2uv (red), Ch2: V2vw (yellow), Ch3: V2wu (blue)]



Sample waveforms captured on ACB test points showing 20 deg Phase Shift between Master and two Slave Bridges
 [Ch1-Master: **V2uv** (red), Ch2-Slave 1: **V3uv** (blue), Ch3-Slave 2: **V4uv** (green)]

Harmonic Analysis (required for AFE drives only)

Measure the harmonic (resonance) levels at the input to the drive.

NOTE: If you notice considerable distortion in the waveforms then you **MUST** send those waveforms to MV Support via e-mail at mvsupport_technical@ra.rockwell.com and then call at 519-740-4790 (option 1) to discuss the issue and action plan. During after-hours, you can call MV Support pager (Pager # 519-654-5616) to talk with MV Tech Support Specialist. If you are out side North America, then call at 1-440-646-3434 and ask for MV Tech Support.

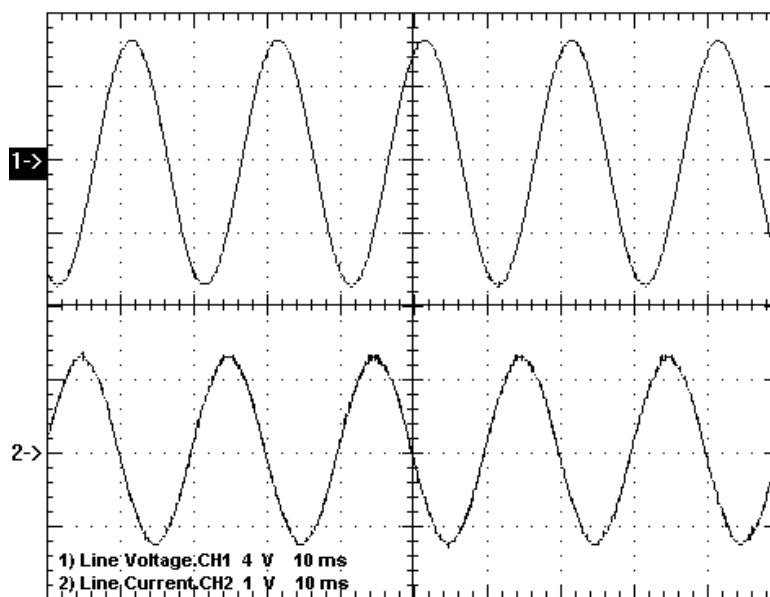
Summary:

- Drive input contactor should be closed. If the drive input contactor configuration is set to NOT RUNNING, you will have to temporarily change it to ALL FAULTS.
- Ensure that the drive is not running when capturing these waveforms.
- Capture line voltage at ACB test point “V2uv” and line current at ACB test point “I2u”.
- Label the waveforms as “V2uv”, and “I2u”.
- Save the worksheet as “Harmonics (Drive Not Running)”.

Table 4.E – Oscilloscope Setting

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label	Sheet Name
Ch. 1	10ms/div.	Line Voltage	V2uv	V2uv	Harmonics (Drive Not Running)
Ch. 2		Line Current	I2u	I2u	

Sample Waveforms



Sample waveforms captured on SCBL test points under Drive Not Running Condition [Ch1: **V2uv**, Ch2: **I2u**]

DC Current Test

Perform DC Test. Refer to the commissioning section of the PoweFlex7000 user manual for a more detailed procedure.

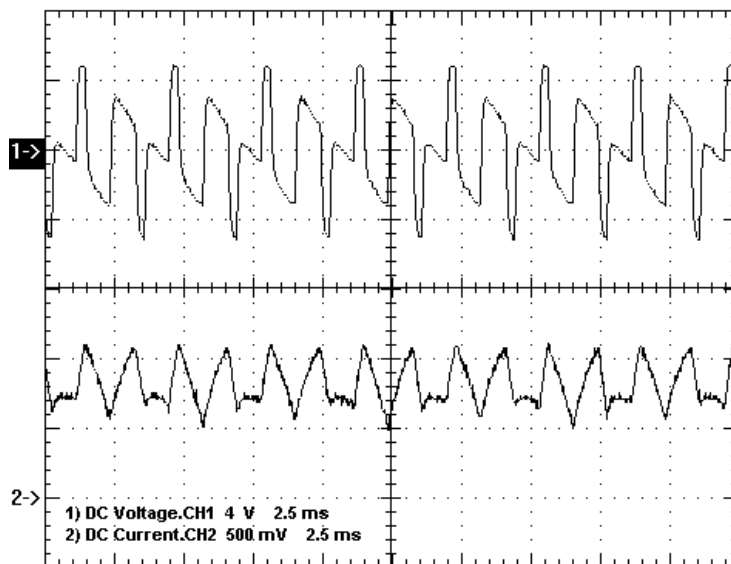
Summary:

- Make sure the Diagnostic Trend has been setup and is armed.
- Run the DC Test with Idc Command Test (P119) set to 0.1pu. Increase Idc Command Test from 0.1 → 0.3pu (**for AFE drives**) or from 0.1 → 0.7pu (**for 18-pulse drives**) in steps of 0.1pu. At each step, verify DC link current regulation by monitoring Idc Error (P323) and Alpha Line (P327).
- Capture DC link voltage waveform at ACB test point “**Vdcr1**” and DC link current waveform at ACB test point “**Idc1**” at 0.3pu (for AFE drives) or at 0.7pu (for 18-pulse drives).
- Label the waveforms as “Vdcr1”, and “Idc1”.
- Save the worksheet as “DC Test @ 0.3pu” (for AFE drives) or “DC Test @ 0.7pu” (for 18-pulse drives).

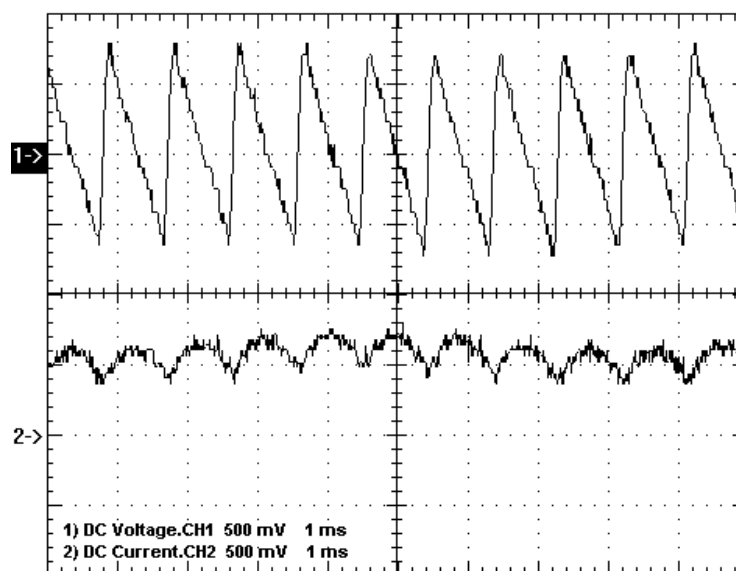
Table 4.F – Oscilloscope Setting

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label	Sheet Name
Ch. 1	2ms/div.	DC Link Voltage	Vdcr1	Vdcr1	DC Test
Ch. 2		DC Link Current	Idc1	Idc1	

Sample Waveforms:



Sample waveforms of DC Test recorded on a **AFE** Drive
Idc Cmd Test = 0.2pu [Ch1- **Vdcr1**, Ch2 – **Idc1** at ACB test points]



Sample waveforms of DC Test recorded on **18-Pulse** Drive
 Idc Cmd Test = 0.5pu [Ch1: **Vdcr1**, Ch2: **Idc1** at ACB test points]

Load Test

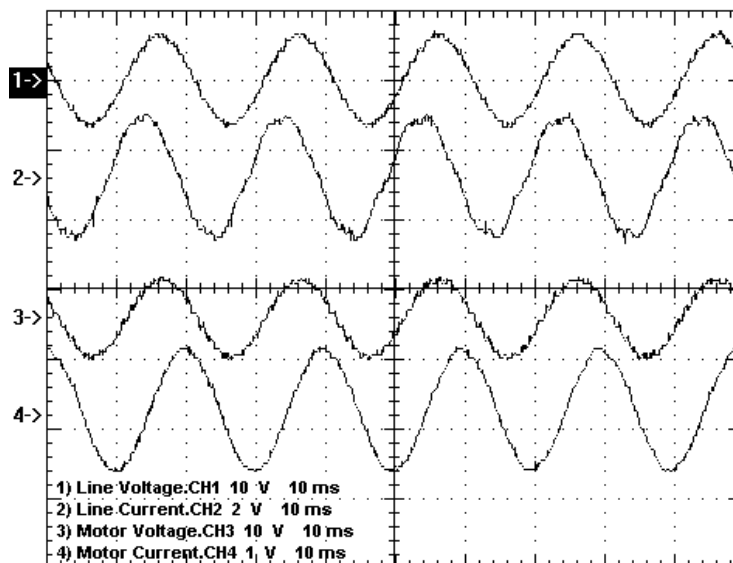
After autotuning of the drive, run the motor on load and capture the following waveforms at 50% load and at 100% load. If the system is not ready for 100% load test, then capture the waveforms at the max load you are allowed to run the drive at. Also, print variables at 50% and 100% load points. Before printing variables make sure the drive Access Level is at SERVICE.

- Capture line voltage & current waveforms at ACB test points “V2uv” & “I2u”.
- Label the waveforms as “V2uv” and “I2u”.
- Capture motor voltage & current waveforms at ACB test points “Vuv” & “Iu”
- Label the waveforms as “Vuv” and “Iu”.
- Save the worksheet as “Line and Load Voltage and Current Waveforms at 1048 rpm, 31 A”, for example.

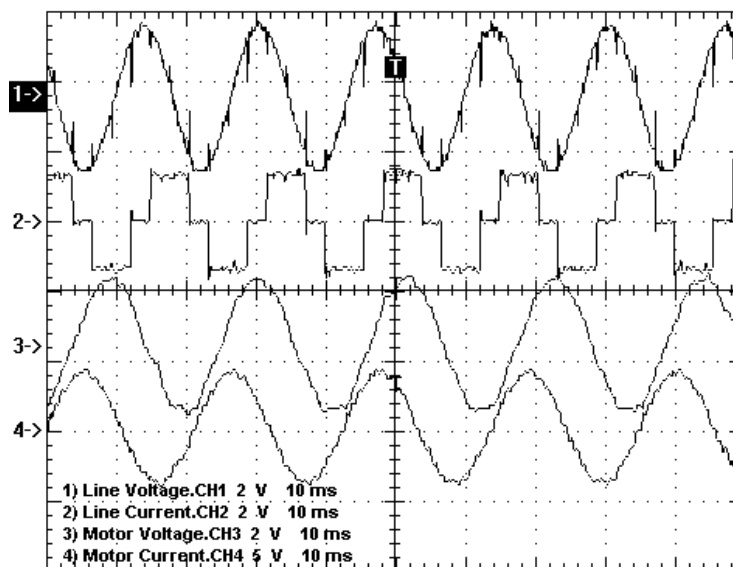
Table 4.G – Oscilloscope Setting

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label	Sheet Name
Ch. 1	10ms/div.	Line Voltage	V2uv	V2uv	[see above]
Ch. 2		Line Current	I2u	I2u	
Ch. 3		Motor Voltage	Vuv	Vuv	
Ch. 4		Motor Current	Iu	Iu	

Sample Waveforms:



Sample waveforms recorded on a **AFE** Drive running under full load condition
 (Ch1: Line Voltage, Ch2 - Line Current, Ch3 - Motor Voltage, Ch4 - Motor Current)



Sample waveforms recorded on **18-Pulse** Drive running at 75% load
 (Ch1: Line Voltage, Ch2 - Line Current, Ch3 - Motor Voltage, Ch4 - Motor Current)

Synchronous Transfer

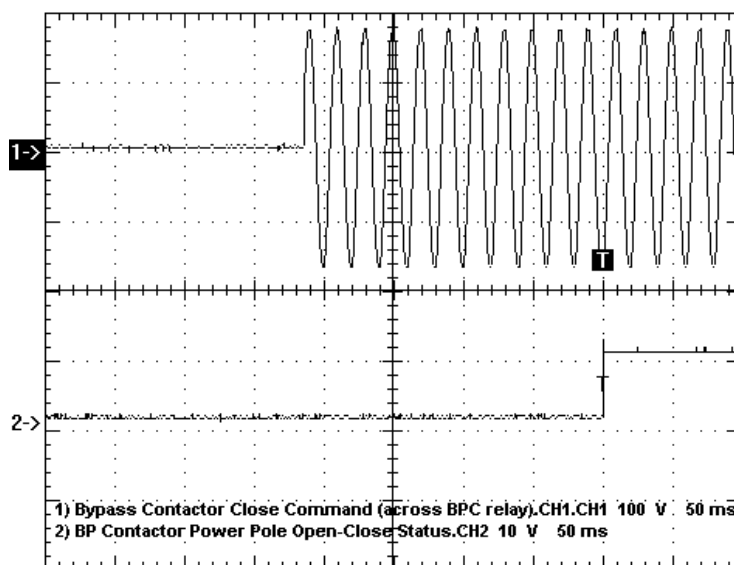
When commissioning a drive employing synchronous transfer, the following waveforms should be captured and submitted with the commissioning package. Refer to the “*Synchronous Transfer Commissioning Guidelines*” for a detailed commissioning procedure.

While measuring the bypass (BP) contactor closing time:

- Capture 120V bypass close command from the BP Contactor Close output (J1-12) at the ACB (refer to electrical drawing for specific wire/terminal number).
- Capture the 9V signal across the bypass contactor vacuum bottles (refer to the tech note PF7000_GEN-78 for details).
- Label the waveforms as “BP_Close_Cmd” and “Actual_Closure”.
- Save the worksheet as “Bypass Contactor Close Delay”.

Table 4.H – Oscilloscope Setting

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label
Ch. 1	25ms/div.	BP Contactor Close Command	BP Contactor Close Cmd	BP_Close_Cmd
Ch. 2		Actual Closure of BP	Across 2K-Ohm resistor connected in series with 9V battery	Actual_Closure



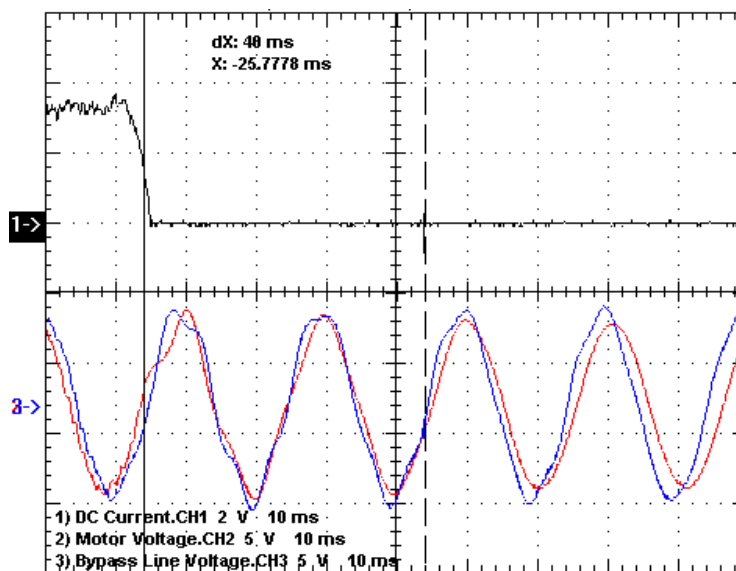
Ch1: Bypass Contactor Close Command (BPC output at ACB, J1-12 & 402)
 Ch2: Actual Closure of Bypass Contactor (using 9V battery across contactor vacuum bottles)

While simulating a synchronous transfer to determine the best lead angle:

- Make sure the Diagnostic Trend has been setup and is armed.
- Capture motor voltage at ACB test point “**Vuv**” & bypass voltage at ACB test point “**Vuvs**”.
- Capture and trigger on falling edge of the DC Link current waveform at ACB test point “**Idc1**”.
- Label the waveforms as “**Vuv**”, “**Vuvs**” and “**Idc1**”.
- Save the worksheet as “Drift @ 15 Degree Lead Angle”, for example.

Table 4.I – Oscilloscope Setting

Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label
Ch. 1	10ms/div.	DC Link Current	Idc1	Idc1
Ch. 2		Motor Voltage	Vuv	Vuv
Ch. 3		Bypass Line Voltage	Vuvs	Vuvs



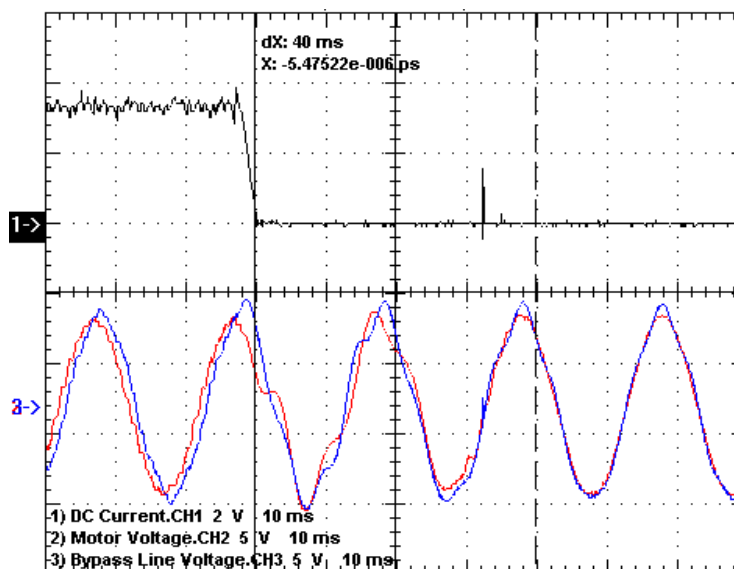
Synchronous Transfer Test to verify Sync Lead Angle (50Hz System)
Ch1: **Idc1** (black), Ch2: **Vuv** (red), Ch3: **Vuvs** (blue)

While performing a live synchronous transfer:

- Capture motor voltage at ACB test point “**Vuv**” & bypass voltage at ACB test point “**Vuvs**”.
- Capture and trigger on falling edge of the DC Link current waveform at ACB test point “**Idc1**”.
- Label the waveforms as “**Vuv**”, “**Vuvs**” and “**Idc1**”.
- Save the worksheet as “Synch on Motor 01”, for example.

Table 4.J – Oscilloscope Setting

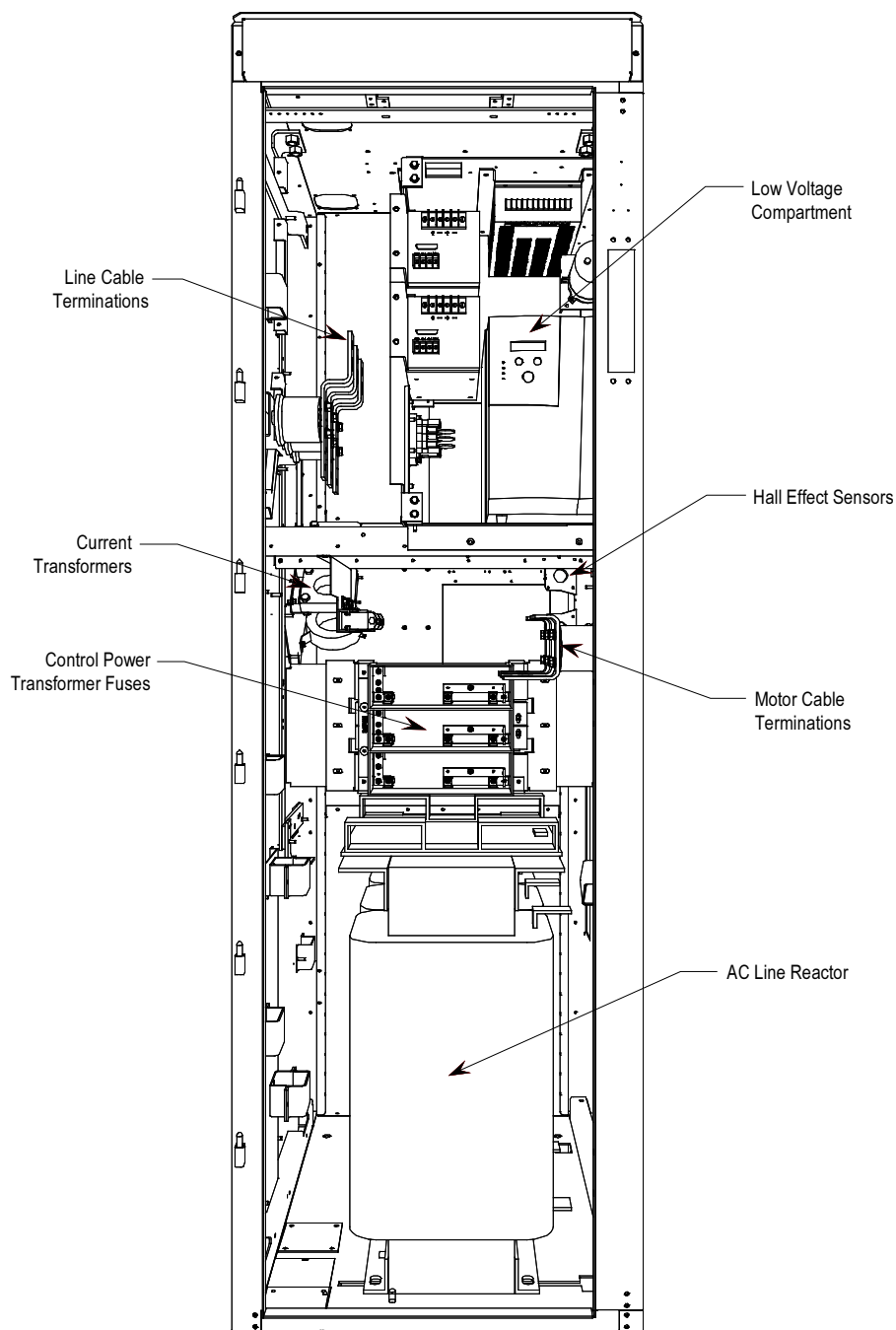
Oscilloscope	Time Base	Waveform	Test-Point	Waveform Label
Ch. 1	10ms/div.	DC Link Current	Idc1	Idc1
Ch. 2		Motor Voltage	Vuv	Vuv
Ch. 3		Bypass Line Voltage	Vuvs	Vuvs



Live Synchronous Transfer Capture (50Hz System)
Ch1: **Idc1** (black), Ch2: **Vuv** (red), Ch3: **Vuvs** (blue)

Component Definition and Maintenance

Cabling Cabinet Components



**Figure 5.1 – Cabling Cabinet for Configuration #1
(Direct-to-Drive)**

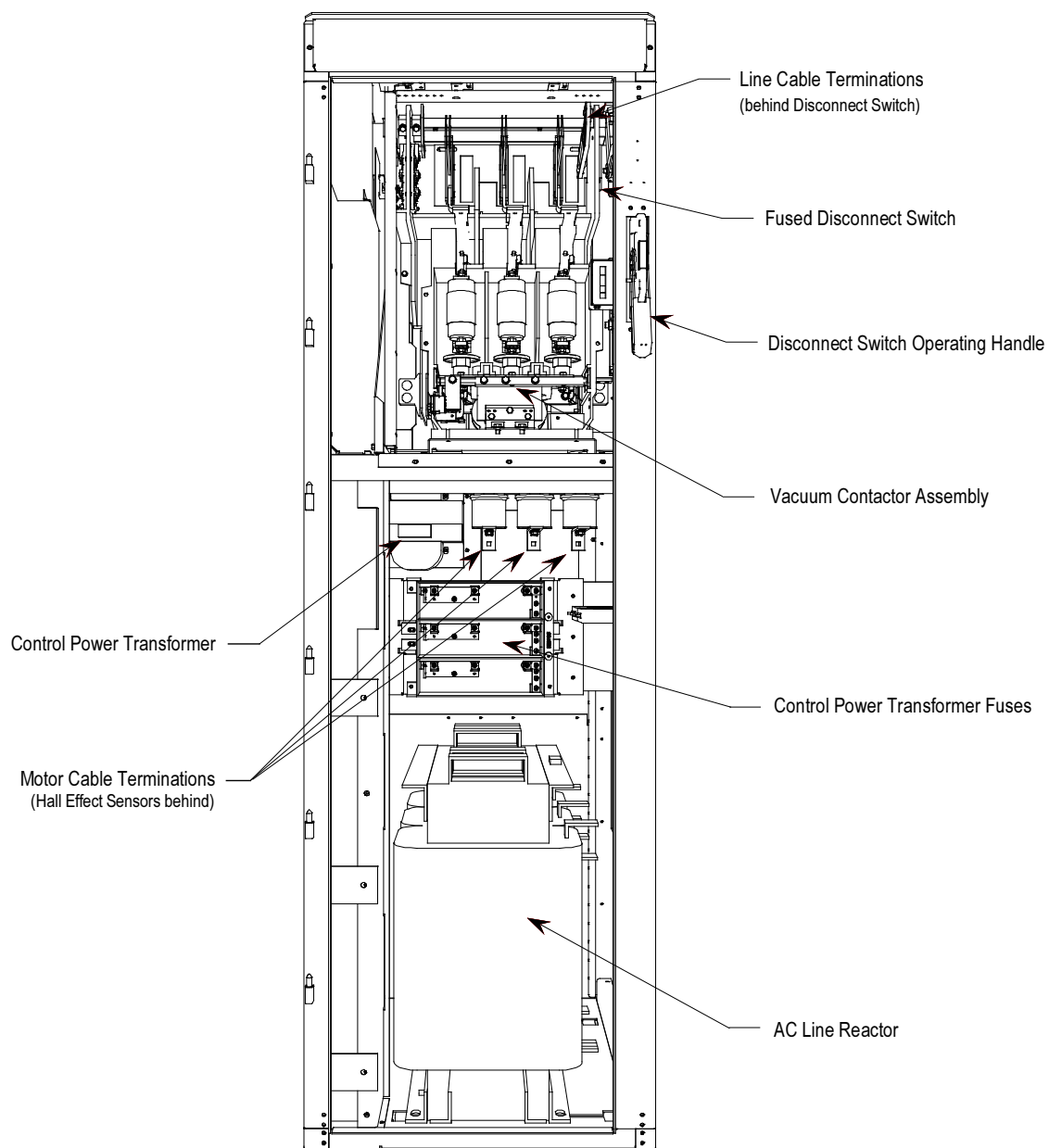
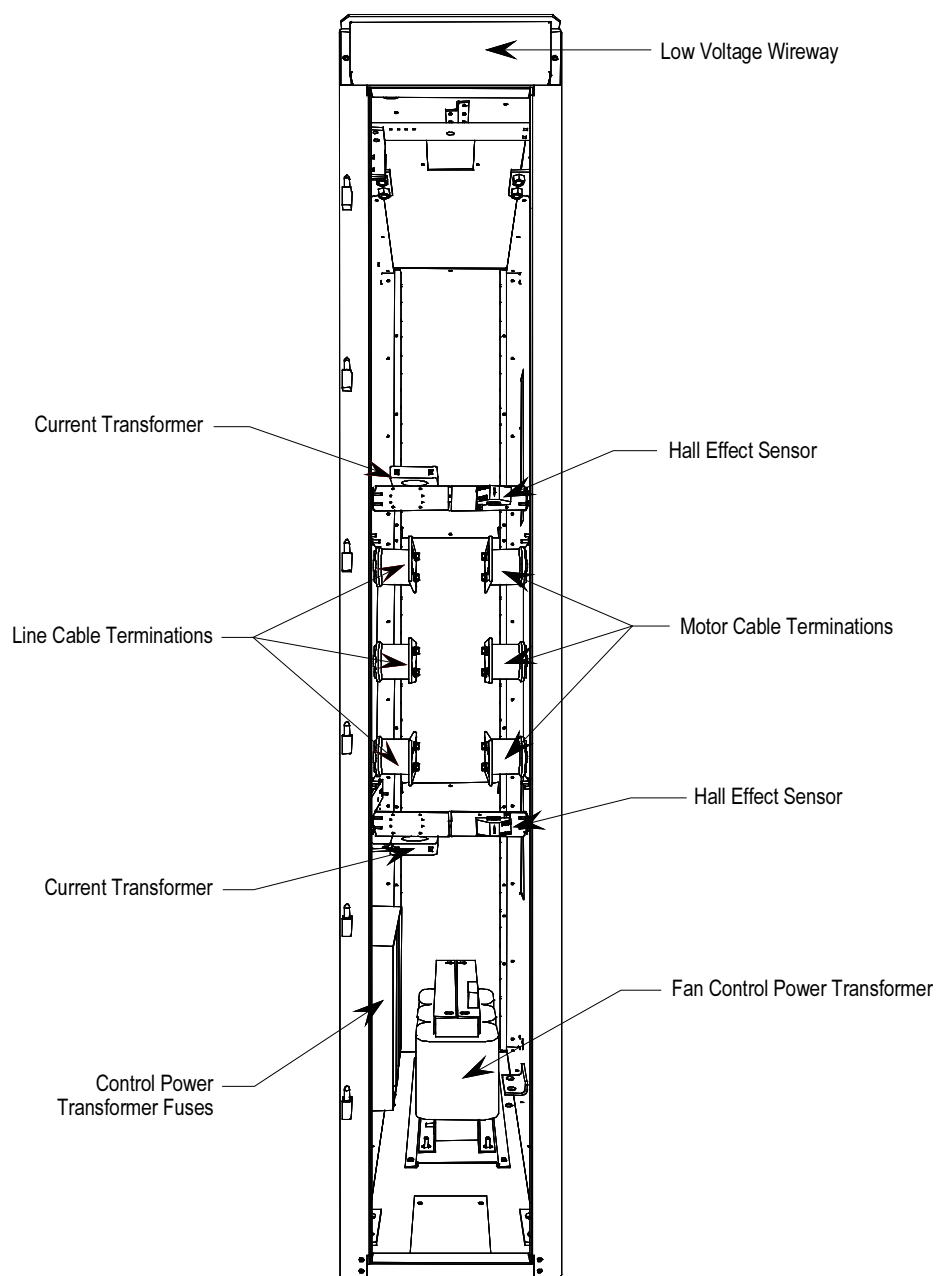
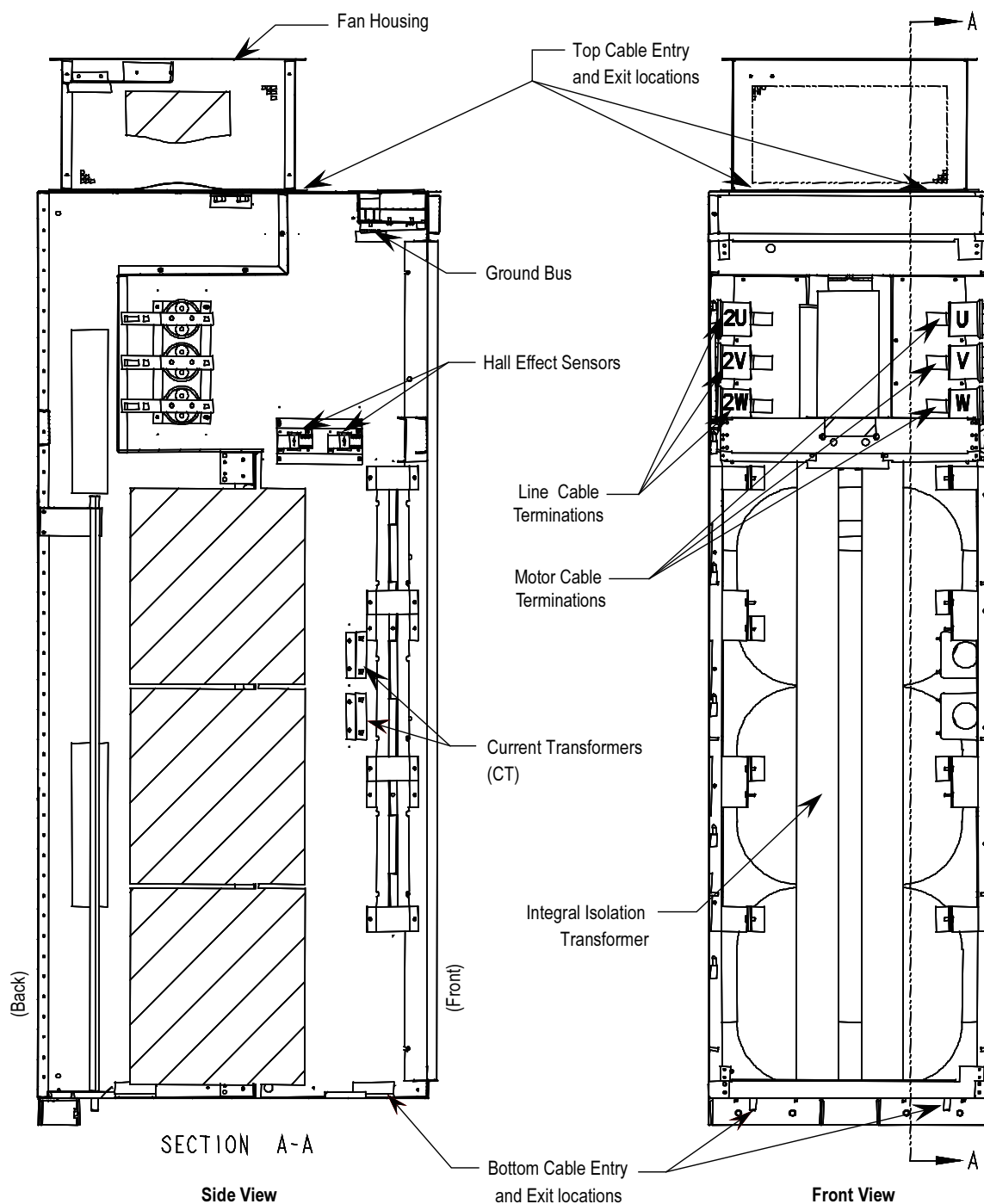


Figure 5.2 – Cabling Cabinet for Configuration #1
(Direct-to-Drive, optional input starter shown)



**Figure 5.3 – Cabling Cabinet for Configuration #2
(AFE Rectifier with Separate Isolation Transformer)**



**Figure 5.4 – Cabling Cabinet for Configuration #3
(AFE Rectifier with Integral Isolation Transformer)**

Hall Effect Sensor Replacement

1. Ensure there is no power to the equipment.

ATTENTION



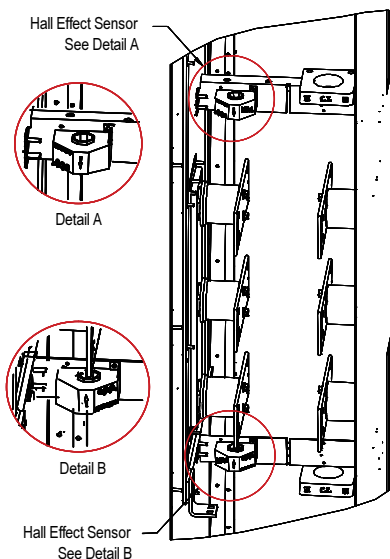
To prevent electrical shock, ensure the main power has been disconnected before working on the Hall Effect sensor. Verify that all circuits are voltage free using a hot stick or appropriate voltage-measuring device. Failure to do so may result in injury or death.

2. Note the location of all wires and the orientation of the Hall Effect sensor. For quick reference when checking the orientation of the Hall Effect sensor, look for the white arrow.

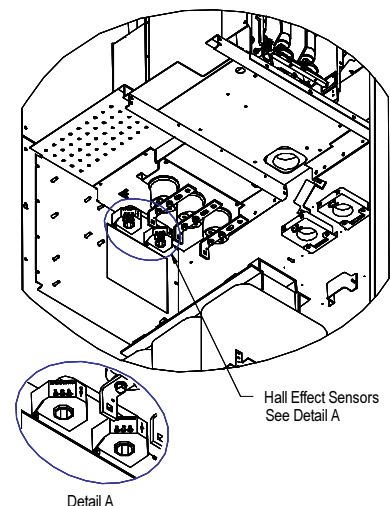
IMPORTANT

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

3. The load cable must be disassembled to allow removal of the Hall Effect sensor. Remove the hardware to allow the cable to slide out.
4. Remove the plug connecting the sensing wire to the Hall Effect sensor.
5. Remove the four screws on the base of the Hall Effect sensor, and remove the Hall Effect sensor.
6. Replace the Hall Effect sensor. Note the arrow must be oriented as shown in the illustration below.
7. Slide the load cable back into place and secure the hardware.
8. Plug the connector back into the sensor. The plug is keyed so that it cannot be plugged in incorrectly.



Cabling Cabinet



Line Reactor/Starter Cabinet

Figure 5.5 – Hall Effect 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 line cable must be disassembled to allow removal of the CT. Remove the hardware to allow the cable to slide out.
5. Remove the two screws located in the base of the CT and remove the CT.
6. Replace the CT, ensuring the proper orientation. Fasten the CT securely with the two screws in the base.
7. Reconnect the ring lugs.
8. Slide the line cable back into place and secure the hardware.

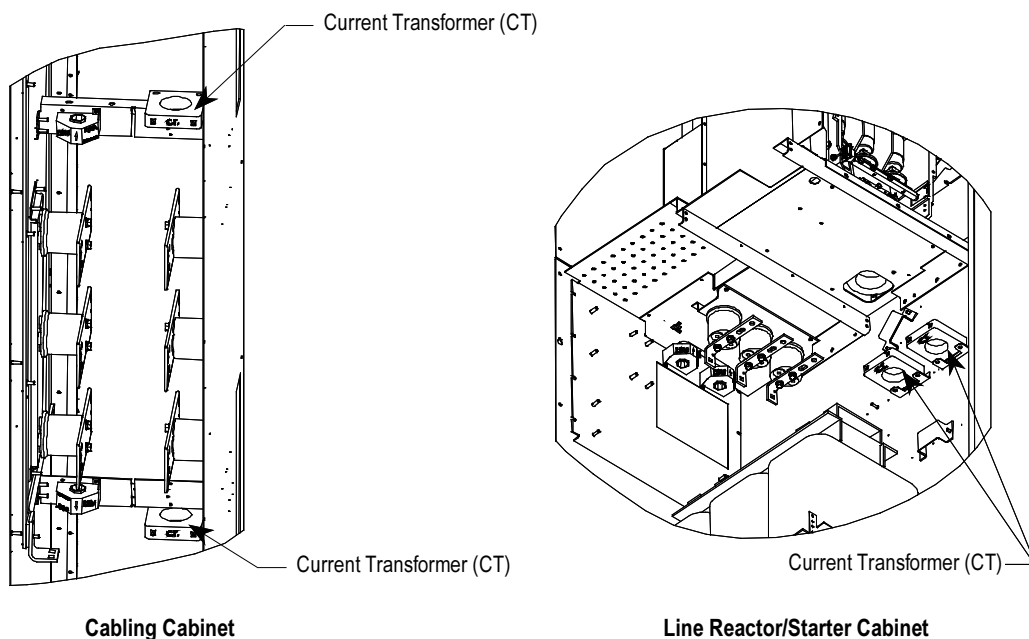


Figure 5.6 – Replacement of Current Transformer

Converter Cabinet Components

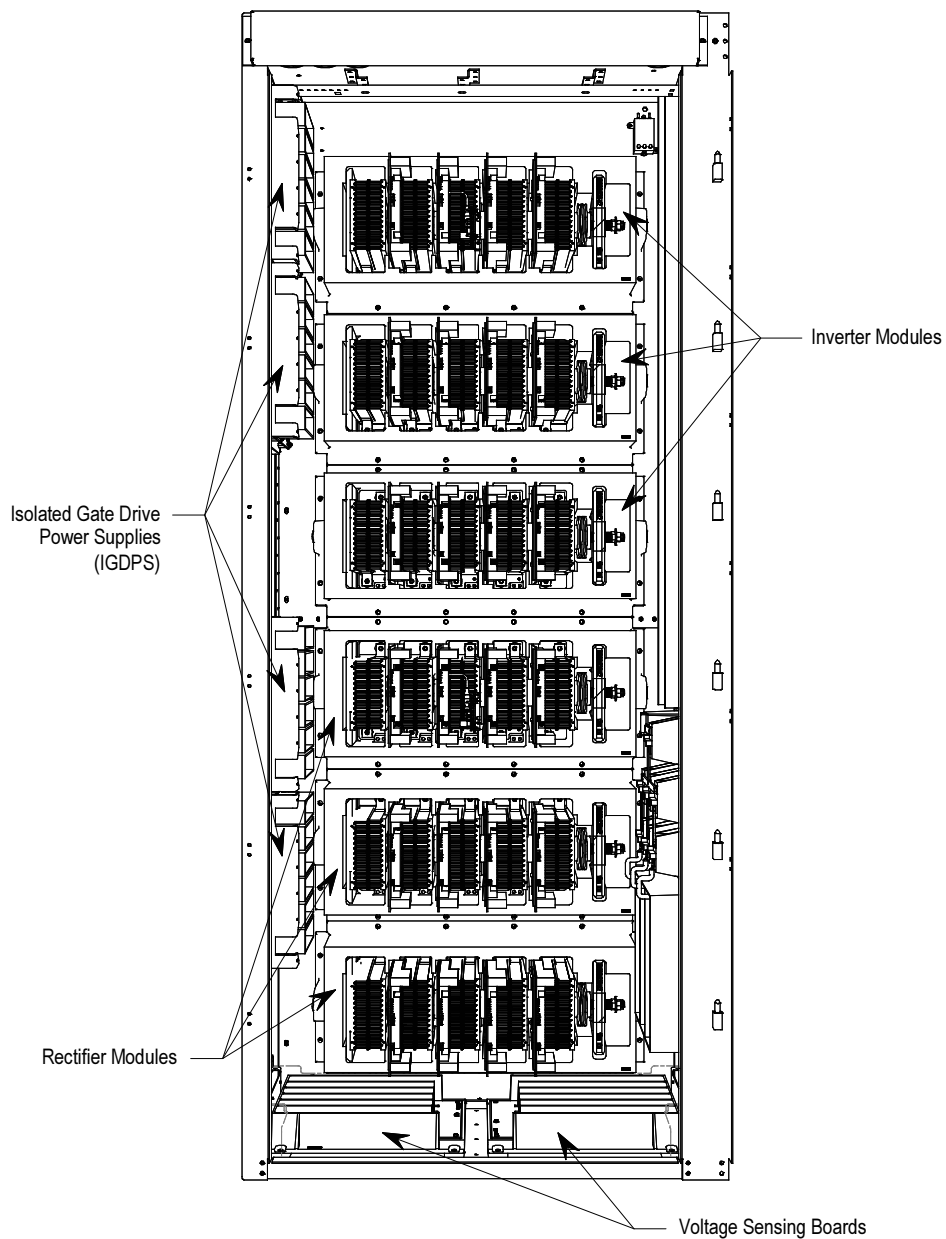


Figure 5.7 – Converter Cabinet Components (3300/4160 V version)

Note: For **2400V** version, refer to page 4-41.
For **6600V** version, refer to page 4-43.

Converter Cabinet

The converter cabinet contains three rectifier modules and three inverter modules. Figure 5.7 shows a 3300/4160 V converter with a PWM Rectifier.

Isolated Gate Driver Power Supplies (IGDPS) are mounted on the cabinet's right side sheet (6600 V, 2400 V Drives) and on the cabinet's left side sheet (3300 V, 4160 V Drives).

Thermal sensors are installed on the top module of the inverter and rectifier. The exact location depends on the drive configuration.

Voltage-Sensing Assembly

The voltage-sensing assembly consists of two voltage sensing boards, mounting plate and protective cover. Each voltage sensing assembly has six independent channels which convert voltages up to 10800V (7.2kV @ 1.5 pu) down to low voltage levels which can be used by the PowerFlex 7000 control logic. For drives that require the synchronous transfer option, one extra assembly is used. This extra assembly uses a separate connector to output the transfer voltages directly to the ACB 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 5.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 Circuit Board Assembly 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 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. Remove clear plastic cover.
3. Mark the position of the ribbon cables and wires.
4. Remove the screws and lift the ring lugs from the terminals to remove the wires.
5. 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.
6. Remove the 4 nuts and washers that secure the assembly to the studs welded to the frame.
7. Remove the old VSB and replace the new VSB on the studs, using the existing hardware to secure the assembly. **Do not overtighten the connections** or you may break the studs.
8. Replace all ring lugs on terminals. Plug in ribbon cables making sure that cables are positioned properly and fitting is secure (locking mechanism is engaged).
9. **For personnel and equipment safety, ensure both grounding connections are re-connected to the sensing board.**
10. Replace clear plastic cover and re-fasten in place.

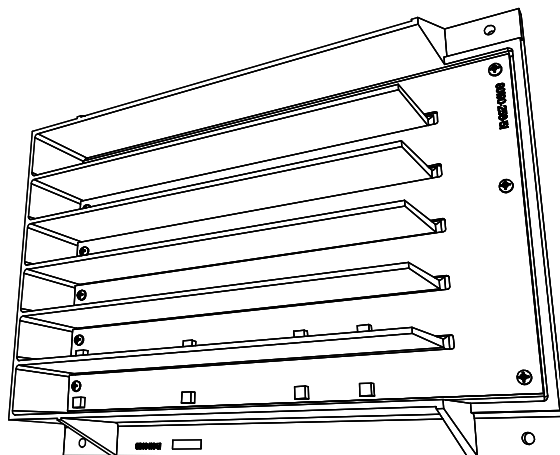


Figure 5.8 – Sensing Board with mounting hardware placement

Surge Arresters

Description

Heavy duty distribution class surge arresters are used for transient overvoltage protection in the drives with AFE rectifiers. The arresters are certified as per ANSI/IEEE Std C62.11-1993.

The surge arresters are basically MOVs, with or without an air gap in series, packed in sealed housing. They provide overvoltage protection similar to what the TSN module does. They differ from the TSN in that fusing is not required for the operation of surge arresters.

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

Drive voltage	2.4 kV	3.3 kV	4.16kV, 4.8 kV	6.0-6.9 kV
Arrester rating (RMS)	3 kV	6 kV		9 kV
Arrester MCOV (RMS)	2.55	5.10		7.65

The most severe temporary overvoltage occurs when one phase is grounded in an ungrounded system. The full line-to-line voltage is applied to the arrester in this case. The arresters are designed to operate under this condition continuously without any problems as shown by their Maximum Continuous Operating Voltage (MCOV) rating.

There are three Y-connected surge arresters attached to the incoming MV lines. The neutral point of the arresters is connected to the ground bus.

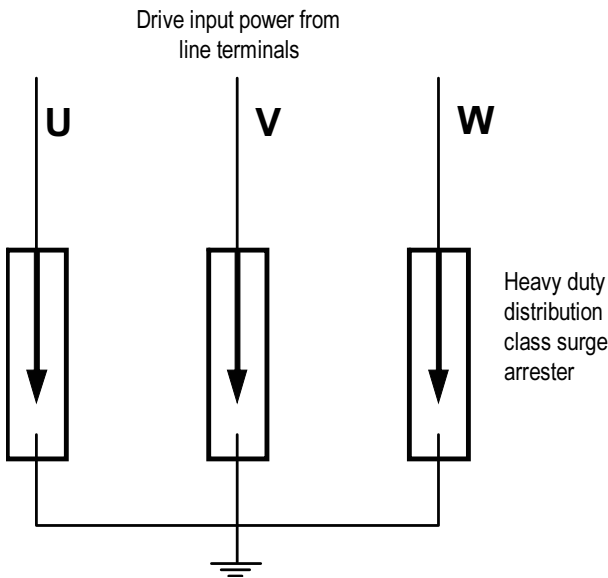


Figure 5.9 – Surge Arresters

Operation

The operation of arresters without a gap is the same as that of MOVs. Depending on design, the arrester may also be gapped. Both gapped and un-gapped arresters provide adequate overvoltage protection.

The arresters are able to withstand or ride through most commonly seen bus transients within their capability. However, caution should be taken if there is a harmonic filter on the MV bus to which PF7000 is connected. The filter should satisfy relevant international or local standards, such as IEEE Std 1531— Clause 6.4, to avoid high inrush currents.

The surge arrester is certified as per ANSI/IEEE Std C62.11-1993. Certification tests include high current short duration tests, low current long duration tests and fault current withstand tests. The fault current withstand tests consist of different combinations of kA and number of cycles, including a 20kA 10-cycle test, under which the arresters are non-fragmenting and without expelling any internal components.

When the incoming energy exceeds the handling capability of the arrester and causes arrester failure, the housing is designed to split open to vent without causing damage to any adjacent components.

Surge Arrester Replacement

1. Ensure there is no power to the equipment. Isolate the drive by lock out/tag out.

ATTENTION



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

2. Wait for a minimum of 10 minutes to allow the stored energy in the drive to be discharged.
3. Observe the location of the connecting leads.
4. Using proper method to ensure the leads are at ground potential. Use temporary ground when necessary.
5. Detach the connecting leads.
6. Loosen the bolt that attaches the surge arrester to the ground bus. Remove the arrester. Remove temporary ground when applicable.
7. Replace the surge arrester with an equivalent one (make sure that the voltage rating is the same).
8. Connect the leads to the surge arrester.
9. Surge arrester hardware to be torqued to 28 Nm (21 ft/lbs).

Surge Arresters (cont.)

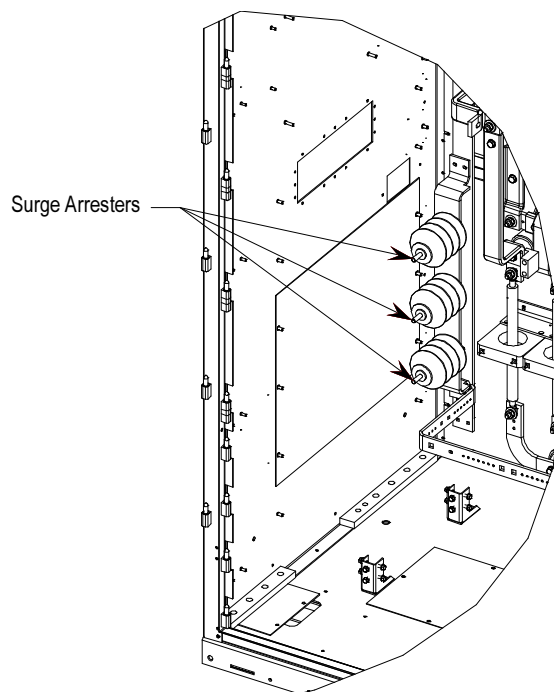


Figure 5.10 – Surge Arresters

Note: When the surge arrester is disconnected from MV, it is possible that a small amount of static charge is retained by the arrester. As a precautionary measure, install a temporary ground on the line-end of the arrester and discharge the stored energy. Remove temporary ground before the arrester is reinstalled. To avoid electrical shock when removing the arrester from service, consider it to be fully energized until both the line and ground leads are disconnected.

Field Test and Care

No field testing is necessary. The arresters do not require special care. However at very dusty sites, it is suggested to clean the arrester when the whole drive is cleaned.

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

Each drive consists of three PowerCage rectifier modules and three PowerCage inverter modules.

AFE type rectifiers use SGCTs as semi-conductors.

All inverter modules use SGCTs as semi-conductors.

The size of the PowerCage will vary depending on the system voltage.

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

Configuration	Inverter SGCTs	Rectifier SGCTs	Rectifier SCRs
2400V, AFE	6	6	0
3300/4160V, AFE	12	12	0
6600V, AFE	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.

PowerCage™ (cont.)**ATTENTION**

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.

The inverter module is the module that contains the SGCT power device necessary for producing the motor voltages and currents. There are three inverter modules in each drive; the number of SGCTs per module depends on the voltage rating of the motor. To understand a module, a description of a single SGCT and its peripheral equipment is all that is required.

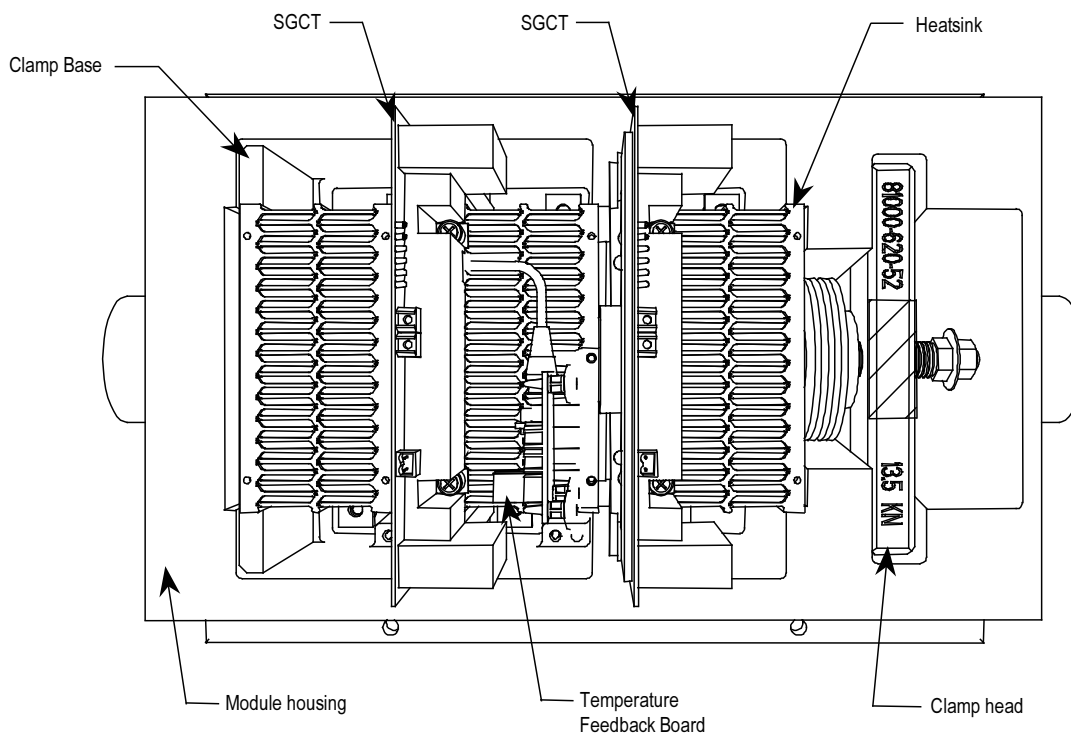


Figure 5.11 – 2-Device PowerCage

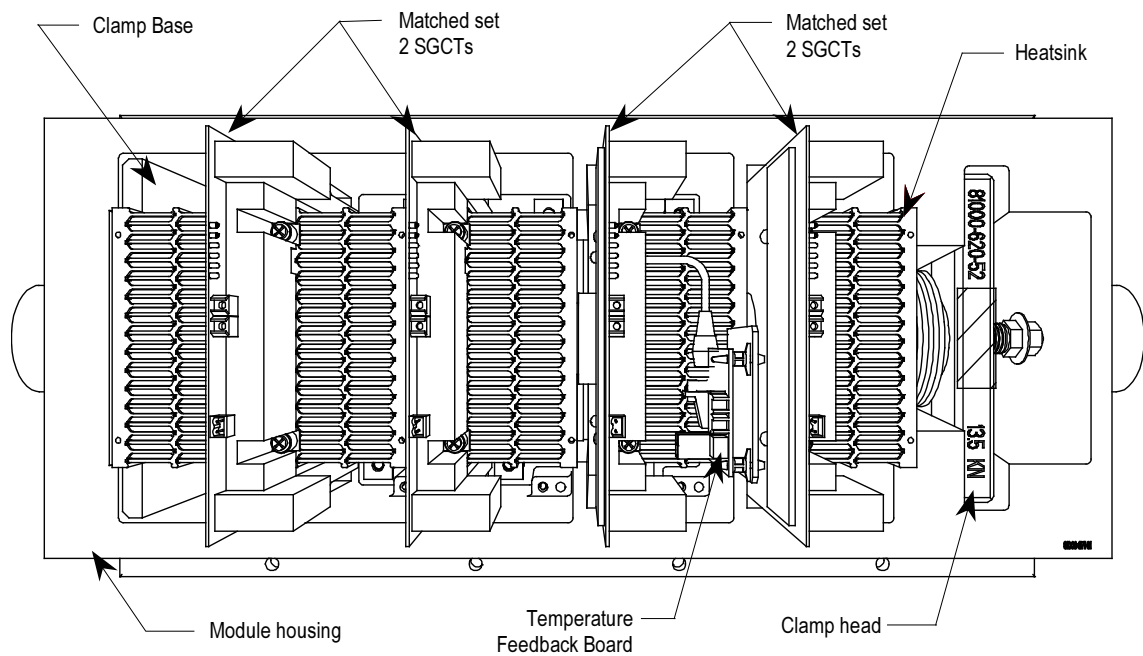


Figure 5.12 – 4-Device PowerCage

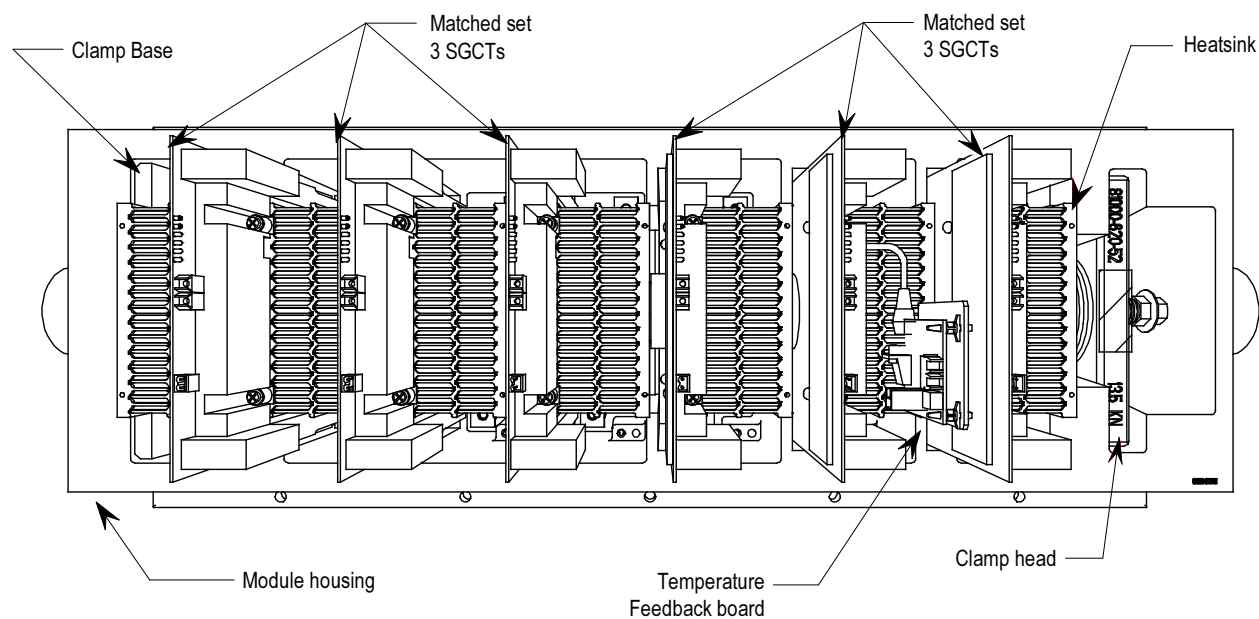


Figure 5.13 – 6-Device PowerCage

SGCT and Snubber Circuit

As 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.

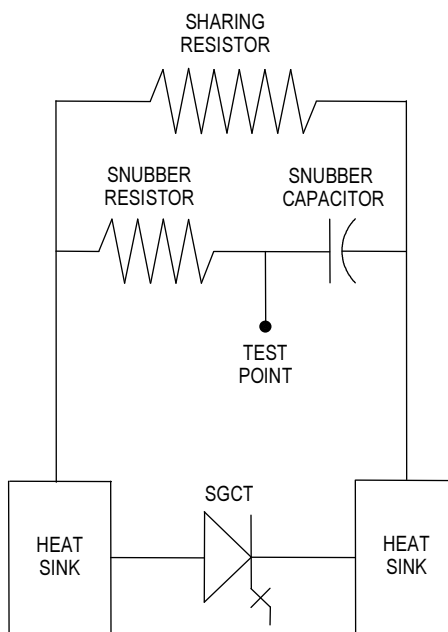


Figure 5.14 – SGCT and snubber circuit

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 6500 V. This single device will provide sufficient design margin for electrical systems with 2400 V medium voltage supply. At 4160 V, 2 SGCTs must be connected in series to provide a net PIV of 13000 V to achieve the necessary design margin. Similarly, three SGCTs must be connected in series at 6600 V, providing a net PIV of 19500 V to achieve the necessary design margin.

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 clamp assembly on the right hand side of the inverter module generates these forces.

SGCT	Device Diameter	Clamp Force
400 A SGCT	38 mm	8.6 kN
800 A SGCT	47 mm	13.5 kN
1500 A SGCT	63 mm	20 kN

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 with dust particles.

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.

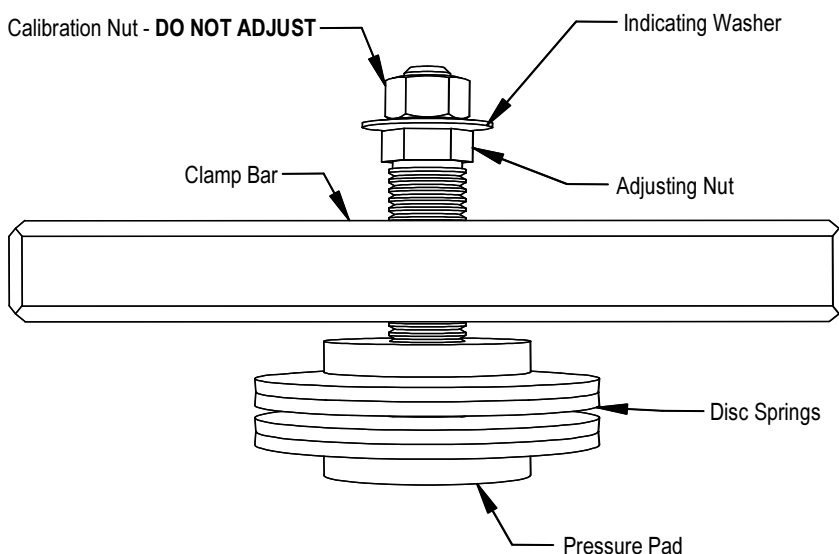


Figure 5.15 – Clamp Head Illustration

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 indicating washer 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 calibration 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 Figures 5.15 and 5.16.)

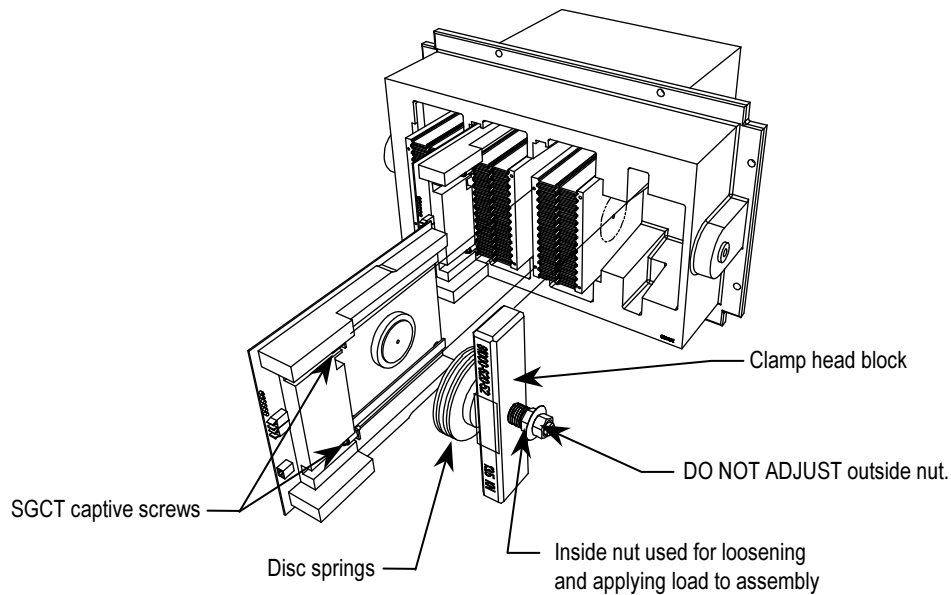


Figure 5.16 – Detail of the clamping assembly

Temperature Sensing

Thermal sensors are located on heatsink(s) in the converter. The thermal sensor is mounted on the heatsink with the temperature feedback 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 Preface 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 5.15).

Temperature Sensing (cont.)

4. Remove the device (SGCT) that is secured to the heatsink with the thermal sensor. (Refer to Figure 5.11, 5.12, 5.13, 5.16 or 5.17).
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 5.17).
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.

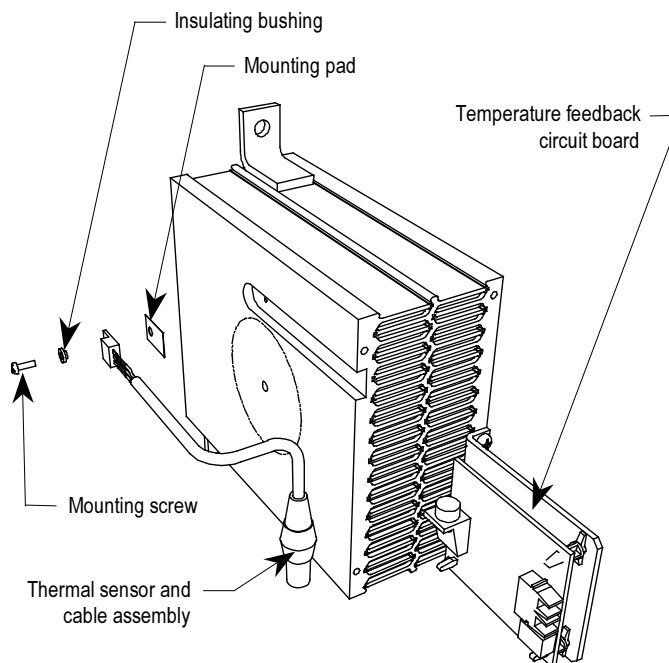


Figure 5.17 – Replacing the Thermal Sensor

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:

- 3300V and 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 1 while gating
LED 1	Red	LED ON indicates the gate is OFF, and Flashes alternately with LED 2 while gating

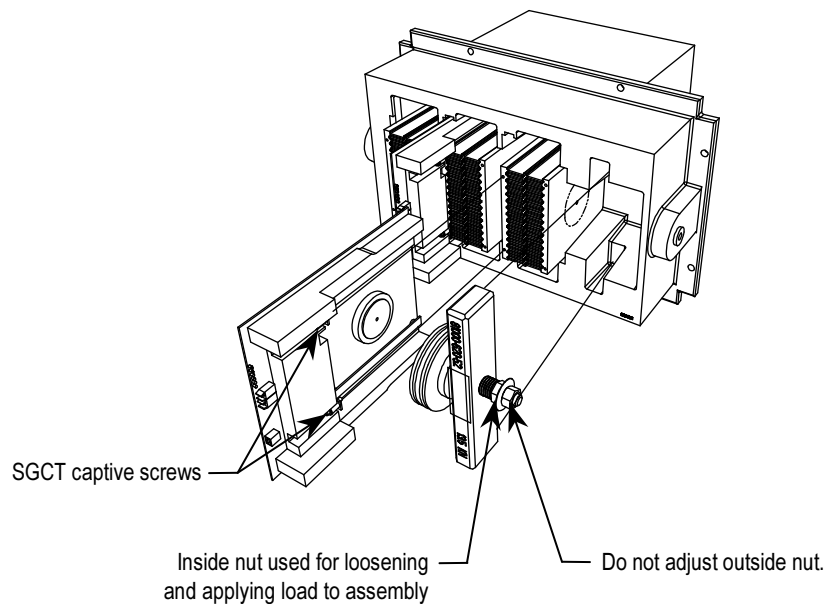


Figure 5.18 – Replacing the SGCT

Symmetrical Gate Commutated Thyristor Replacement (cont.)

1. Ensure there is no power to the equipment.

ATTENTION

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

2. Note the position of the fiber optic cables for assembly.
3. To remove the SGCT, it is necessary to remove the gate driver power cable and fiber optic cables. Exceeding the minimum bend radius (50 mm [2 in.]) of the fiber optic cables may result in damage.

ATTENTION

The fiber optic cables can be damaged if struck or bent sharply. The minimum bend radius is 50 mm (2 inches). The connector has a locking feature that requires pinching the tab and gently pulling straight out. The component on the printed circuit board should be held to prevent damage.

4. Remove the load on the clamp head assembly as described on page 6-19.
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

Replacement SGCTs will be supplied, grouped in matched sets. This means that all of the SGCTs in a leg have been grouped together based on their electrical performance. Grouping similarly matched devices ensures balanced load sharing of a leg of devices. When replacing the device, it is necessary to replace all the SGCTs in a matched set, even if only one has failed.

7. Clean the heatsink with a soft cloth and rubbing alcohol.
8. While grounded, remove the SGCT from the anti-static bag it is supplied in.
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).

Heatsink Replacement

The PowerFlex drive uses an aluminum or copper heatsink, depending on the drive rating.

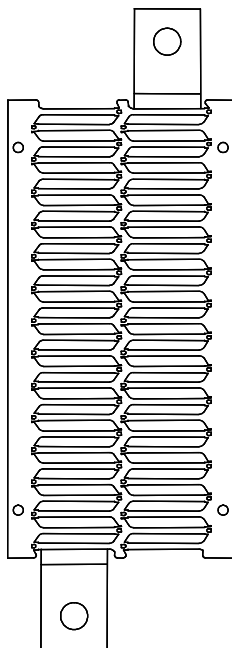


Figure 5.19 – Heatsink

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 6-19.
3. Completely remove the SGCT from the heatsink that is being replaced per the instructions on pages 6-22 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 per the instructions on pages 5-21 to 5-23.
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 is maintained.

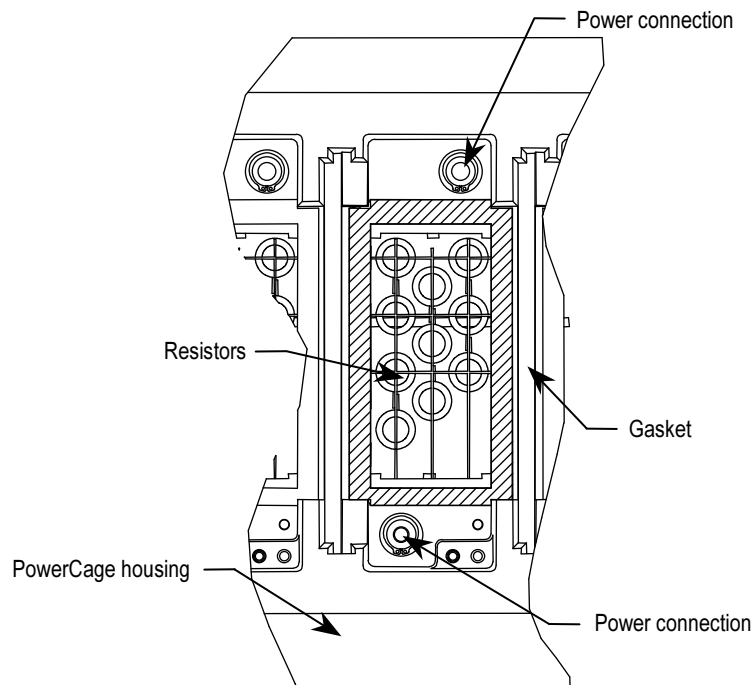


Figure 5.20 – PowerCage Gasket Location

PowerCage Gasket (cont.)

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 can be destroyed or damaged by static charges. Personnel must be properly grounded before removing circuit boards from the PowerCage. Use of damaged circuit boards may also damage related components. A grounding wrist strap is recommended for handling.

3. Remove the M8 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 5.21.

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

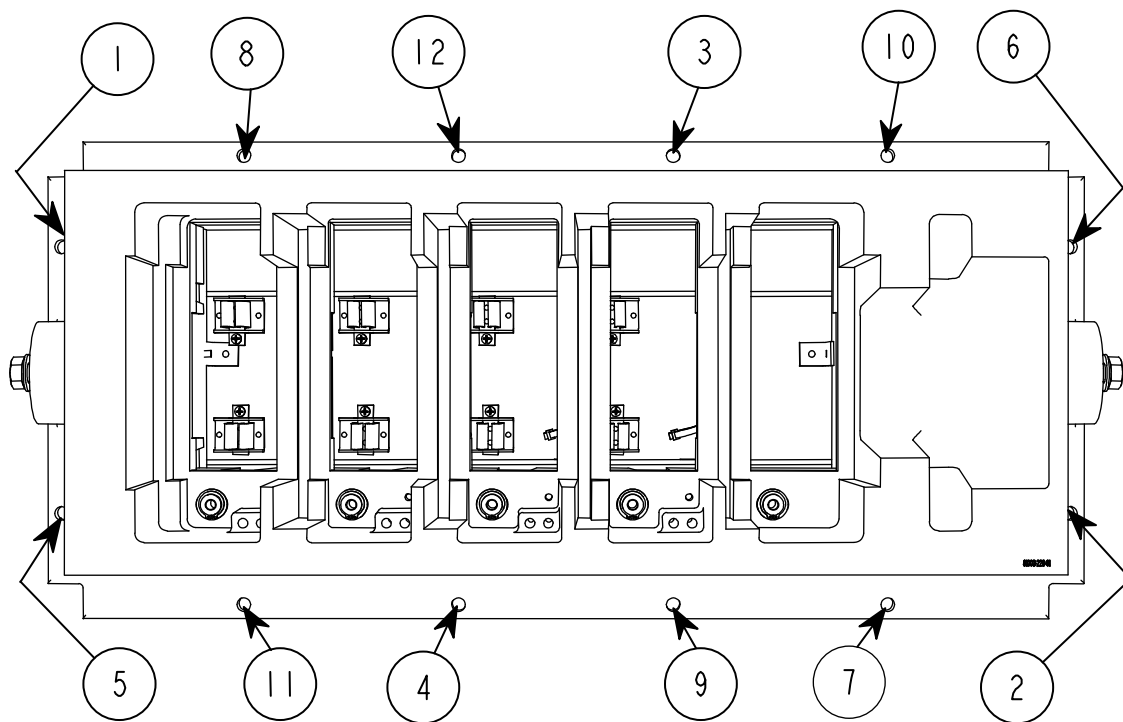


Figure 5.21 – Typical Torque sequence

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 (SGCT). The purpose of the snubber circuit is to reduce the voltage stress (dv/dt and peak) 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 its resistance. Located within the PowerCage under the heatsink is a snubber circuit test point. For each device, there is one test point. To verify the resistance, follow the procedures outlined in Chapter 4 – Commissioning.

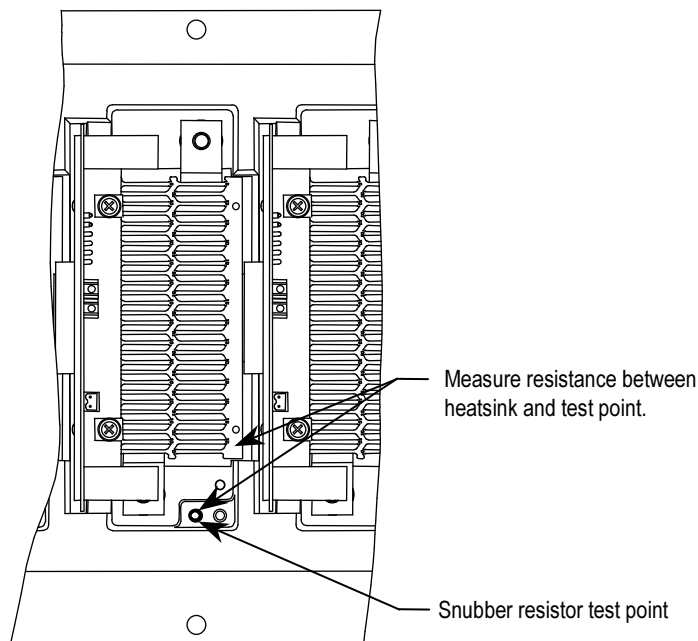


Figure 5.22 – Testing the Snubber Resistor

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.

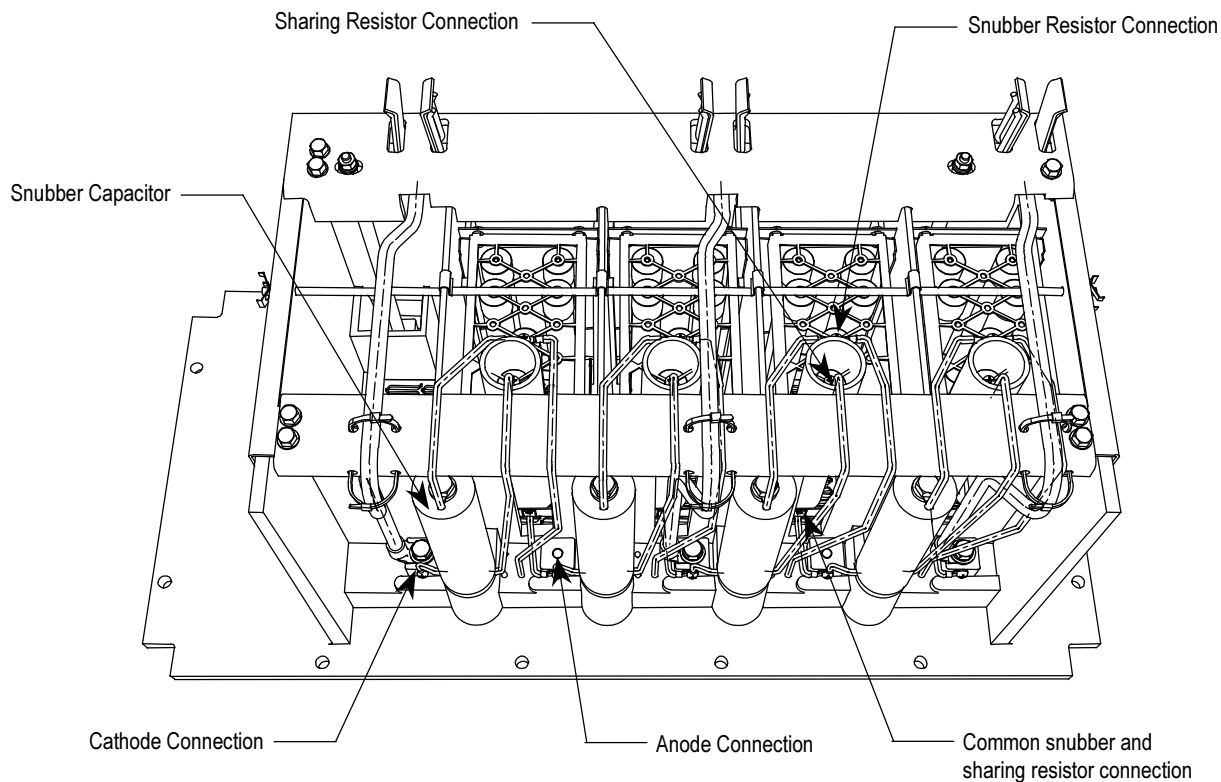


Figure 5.23 – Removal of Power Cage

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

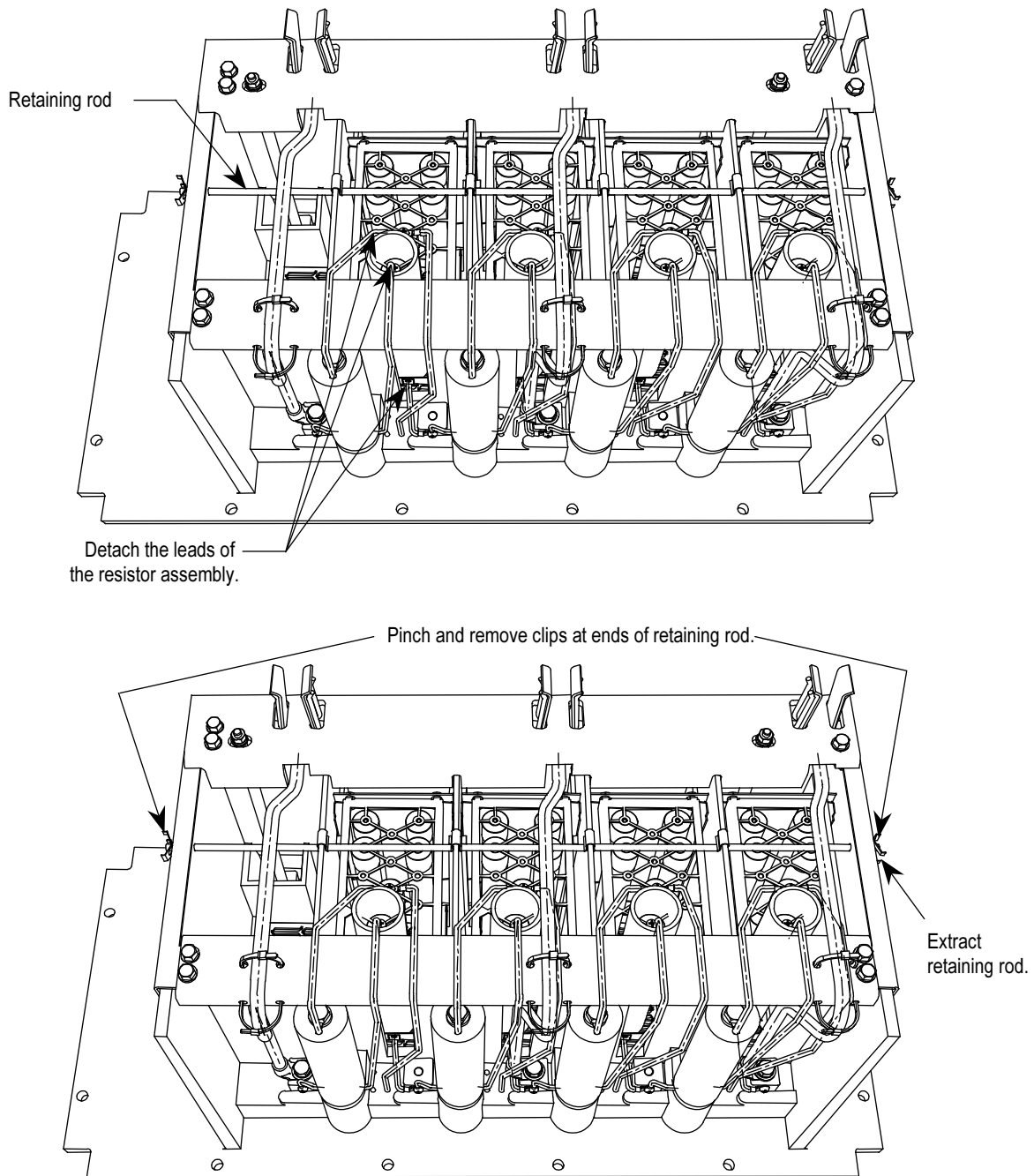


Figure 5.24 – Snubber and sharing resistor replacement

Snubber and Sharing Resistor Replacement (cont.)

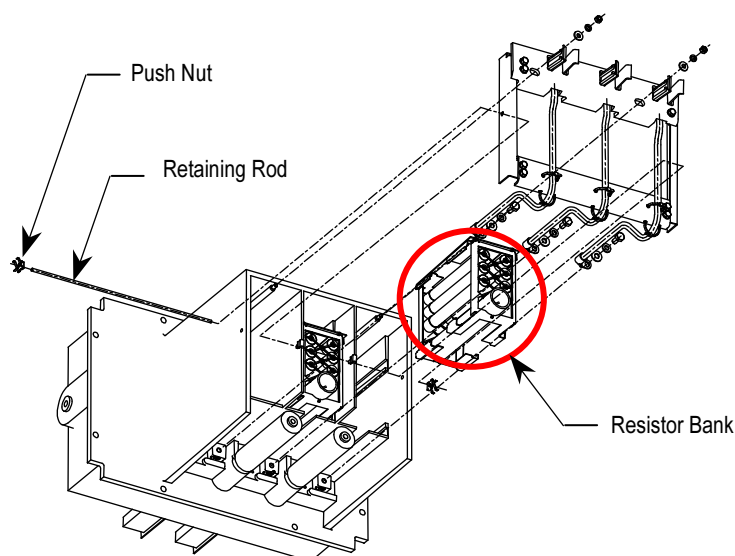


Figure 5.25 – Removing resistor bank from PowerCage

5. Remove the resistor bank from the Power Cage.
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 2400V systems do not need matched devices and have no sharing resistor.

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 5.26. Figure 5.30 shows the physical locators of the same circuit. Measure the resistance across two adjacent heatsinks. A value between 60 k Ω and 75 k Ω indicates a good sharing resistor.

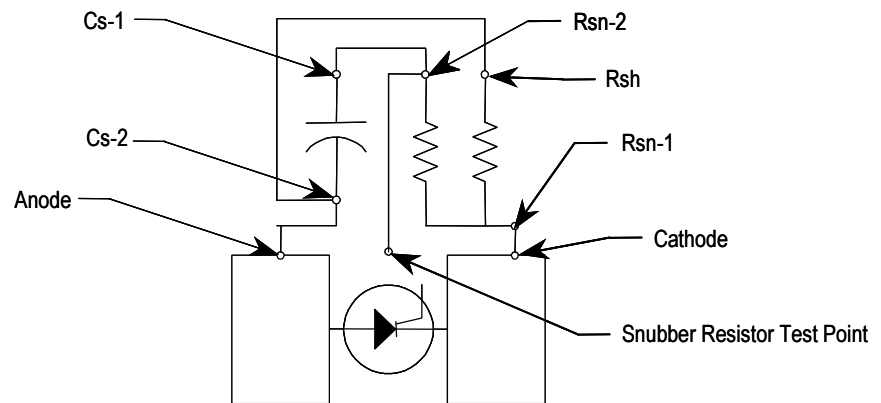


Figure 5.26 – Snubber Circuit for SGCT module

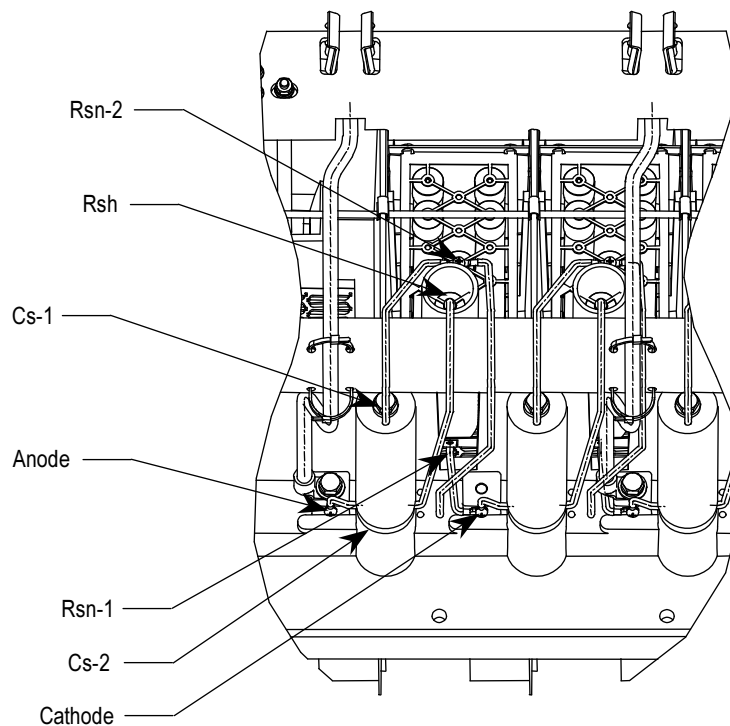


Figure 5.27 – Snubber Circuit Assembly for SGCT module

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.

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 that of 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, $0\text{ }\Omega$. The anode to cathode resistance check will be $0\text{ }\Omega$.

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 anode heatsink in order to measure the snubber resistor value and the snubber capacitor. (See Figure 5.28.) Remove the snubber terminal connection to TB1 of the SPGD board and measure between the test point and the wire that is connected to pin 1 of the TB1 female connector. Replace the snubber terminal connection once the measurement is complete.

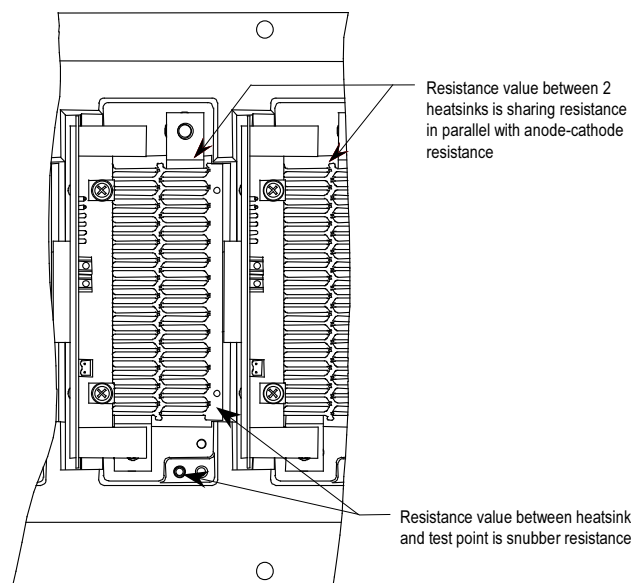


Figure 5.28 – Resistance Measurements SGCT PowerCage

Fiber Optic Cabling

The equipment is provided with fiber optic cabling as a means of interfacing the low voltage control to the medium voltage circuits. The user of the equipment should never need to change the routing of the fiber optic cables.

Each end of a fiber optic cable is provided with a connector that plugs and latches into its respective location on a circuit board. To disconnect a fiber optic cable, depress the ridged plastic tab at the end connector and pull. To install a fiber optic cable insert the fiber optic port of the circuit board so that the plastic tab latches into place.

If the user finds it necessary to replace fiber optic cables, great care must be taken to prevent the cables from becoming strained or crimped as a resulting loss in light transmission will result in loss in performance.

The minimum bend radius permitted for the fiber optic cables is 50 mm (2.0 inches).

When installing the fiber optic cable, the colour of the connector at the end of the cable must match the colour of the connector socket on the circuit board.

Lengths of fiber optic cables used in the product include:

Duplex	Simplex
5.0 meter	5.0 meter
5.5 meter	6.0 meter
6.0 meter	10.0 meter
6.5 meter	
7.0 meter	

There is one duplex fiber optic for each thyristor, which manages gating and diagnostic functions. The healthy status of the thyristor is determined by the circuitry on the respective driver boards. This information is then sent to the main processor via a fail-safe light signal in the fiber optic. The firing command for the thyristor is initiated by the main processor and transmitted to the appropriate gate driver board via the gating fiber optic.

The color codes of the connectors are:

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

Air Pressure Sensor

An air pressure sensor is located in both the converter cabinet and the integral rectifier transformer cabinet (if applicable). In both cases, it is located in the upper left-hand quadrant of the cabinet.

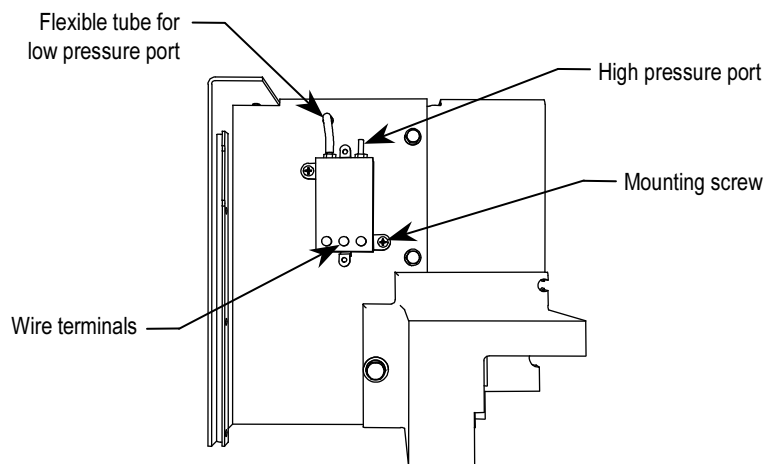


Figure 5.29 – Air Pressure Sensor

The air pressure sensor measures the difference in air pressure between the front and rear of the converter modules/integral rectifier transformer. A small direct current voltage signal is transmitted to the control circuits.

In the event of reduced fan performance or air blockage for either the converter or the transformer, 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 inlet.

If, as a result of blockage or fan failure, flow becomes so reduced that there is a risk of thermal damage for either the converter or transformer, a fault signal will cause drive shutdown.

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 / Fan / Control Components

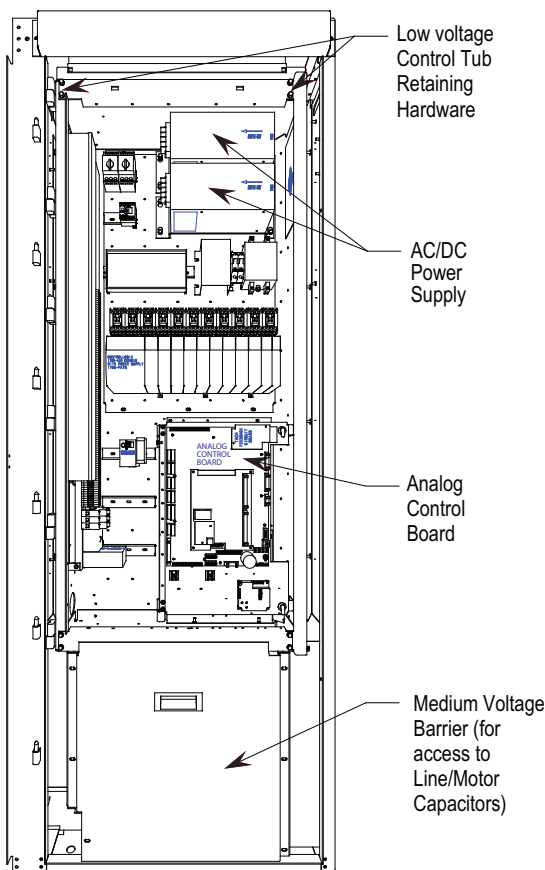


Figure 5.30 – DC Link and Fan cabinet with low voltage control tub shown

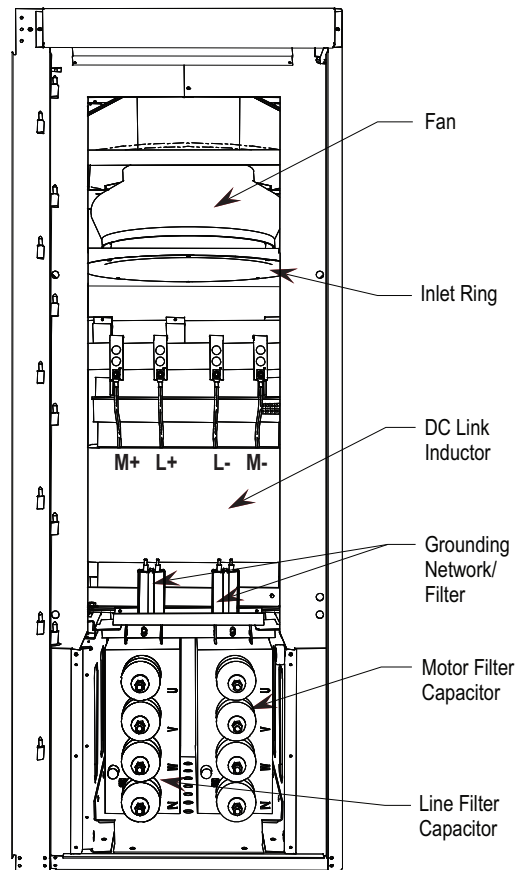


Figure 5.31 – DC Link and Fan Cabinet with low voltage control tub removed

When the door is opened, control components are accessible. Behind the low voltage swing-out panel 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 above the capacitors.

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

The D.C. link is equipped with thermal protection for the windings.

There is a current sensor on the M+ conductor.

Above the D.C. link is the 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.

D.C. Link / Fan / Control Components (cont.)

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

Output Grounding Network Replacement

PowerFlex 7000 drives may have either a grounding network or a ground 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 ($\frac{1}{4}$ inch) hardware and disconnect the leads connected to the terminals.
4. Four brackets are used to secure the capacitor. Loosen the four screws at the base of the brackets and lift the capacitor out.
5. Place the new capacitor and tighten the screws securely.
6. Replace the ring lugs and 6.4-mm ($\frac{1}{4}$ inch) hardware. (See Figure 5.32)

IMPORTANT

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

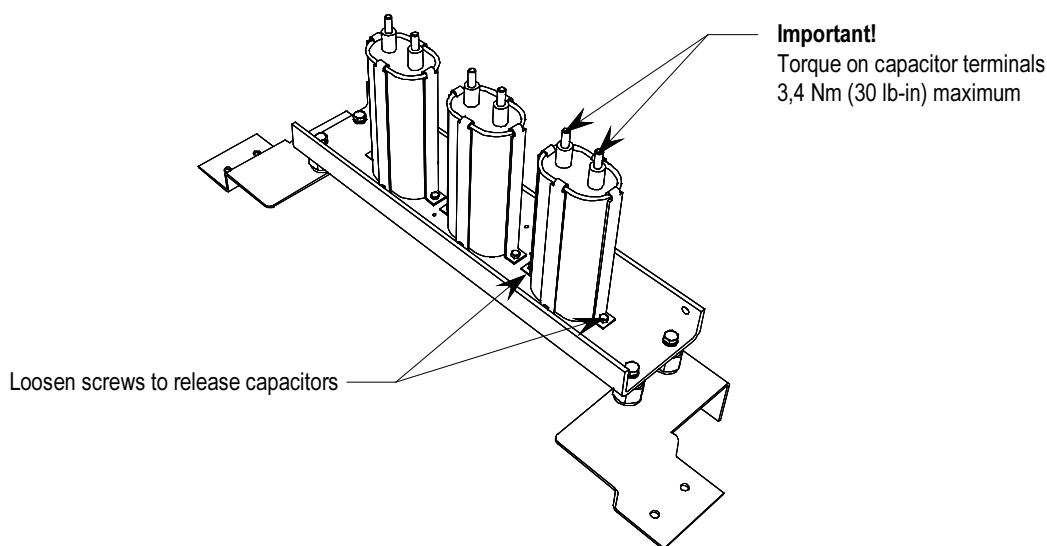


Figure 5.32 – Output Grounding Network

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 5.33 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 below.

IMPORTANT

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

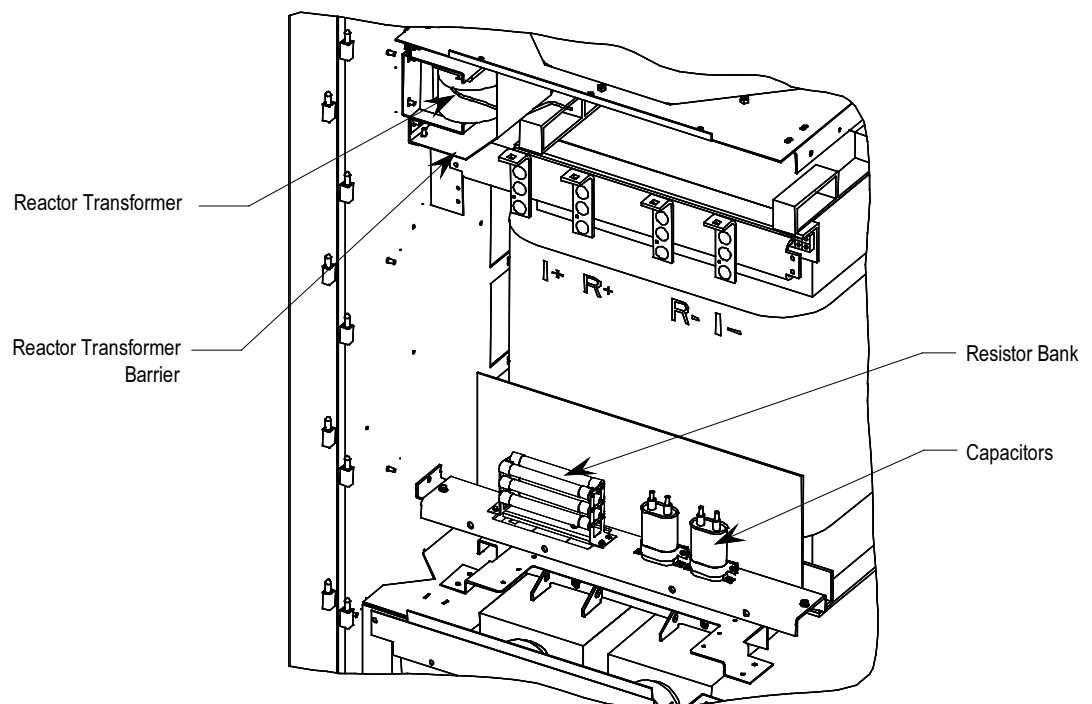


Figure 5.33 – Ground Filter Component Replacement

D.C. Link / Fan / Control Components (cont.)

Filter Capacitors

Filter capacitors are used on the motor side for all drives. The AFE rectifier also includes filter capacitors on the line side. Refer to Figure 5.31 (DC Link and Fan Cabinet with control panel removed).

The filter capacitors are three-phase four-bushing units and “oil-filled”. The three-phase capacitors are comprised of internal single-phase units that are connected in a Y configuration. The neutral point of the Y is connected to the fourth bushing, which is accessible and can be used for neutral point voltage measurement or other protection/diagnostics purposes. Depending on the drive configuration, the fourth bushing may or may not be connected to circuitry. The metal cases of the capacitors are grounded through a stud on the capacitor housing.

The capacitors are equipped with internal “bleeding resistors” to discharge the capacitor and reduce its voltage below 50V in 5 minutes when left disconnected. A typical three-phase capacitor is shown below:

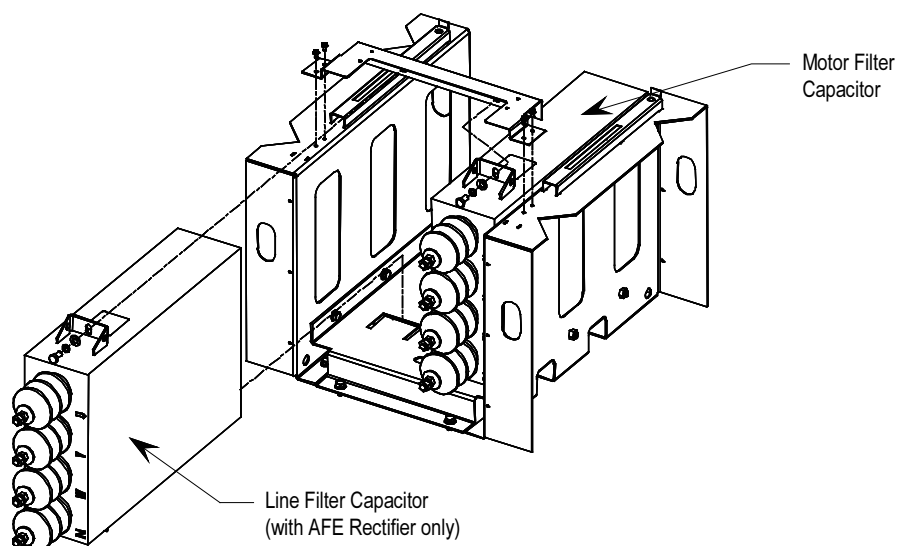


Figure 5.34 – Motor Filter Capacitor

WARNING

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

Generator Note:

WARNING

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 worked on.

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.

ATTENTION

Verify the load is not turning due to the process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

2. Remove medium voltage barrier below the low voltage panel to access capacitor. (See Figure 5.30).
3. Short all four bushings together and to ground on both capacitors before handling the connections.
4. Note the location of all the cables and mark them accordingly.
5. Remove the 4 power connections to the terminals, and the single ground connector from the drive to the capacitor frame.
6. Remove the grounding network and top bracket that holds the capacitor in place. At the bottom of the capacitor, there is no hardware securing the capacitor; it fits into a slot in the assembly.
7. Remove the capacitor from the drive. **THESE CAPACITORS CAN WEIGH AS MUCH AS 100 kg (220 lbs), SO YOU WILL REQUIRE TWO PEOPLE TO REMOVE A CAPACITOR.**

IMPORTANT

Do not lift capacitor by bushings. Doing so may damage bushings and result in oil leakage.

8. Install the new capacitor, sliding it back until it fits into the slot. Fasten the top bracket and grounding network.
9. 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.
10. Remove any shorting/grounding conductors.
11. Reinstall the sheet metal that was removed, and complete one final check to ensure connections are secure and correct.

D.C. Link / Fan / Control Components (cont.)

Testing Filter Capacitors

Two methods of testing/checking the capacitors are explained below. The first method is simple, easy, and takes least amount of time to check the capacitors. In this method, you would need a digital multimeter (**DMM**) to measure the capacitance in micro-Farad (μF) across each phase-to-neutral of the capacitors. It is recommended that you should use this method since it avoids the chance of creating re-torque issues because you don't have to disconnect the capacitors unless the readings are off by 15% or more. For accurate measurements, Rockwell recommends that you should use one of the DMMs shown in Figure 5.35.

The second method involves disconnecting all capacitors from the circuit, and testing each capacitor individually by applying 120V across each phase-to-neutral and measuring the current in each phase. This method is most accurate and can be used to confirm the integrity of the capacitor when the readings from the first method appear to be unsatisfactory.

First Method

1. Ensure there is no power to the equipment before testing the capacitor.

ATTENTION

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

ATTENTION

Verify the load is not running due to process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

2. Follow appropriate safety steps to isolate the equipment from medium voltage.
3. Verify that there is no voltage present on the capacitor by using a hot stick or any other appropriate voltage-measuring device.
4. Perform visual inspection to ensure there is no oil leak or bulge in any of the capacitors.

5. Using a DMM measure the capacitance across each phase-to-neutral of capacitors without removing any connections. If the difference between the highest and the lowest readings is below 15% then all capacitors are in good condition.
6. If the difference between the highest and the lowest readings is off by 15% or more, then you might have a bad capacitor.
7. Before disconnecting the capacitors, note the location of all the cables and mark them accordingly.
8. Disconnect power cables/bus bars from the capacitor terminals on all four bushings and isolate them from the capacitor. (Refer to “Filter Capacitor Replacement” guidelines in the Classic User Manual - Component Definition and Maintenance chapter (Chapter 6) for using proper torque when reconnecting the capacitors)

Second Method

1. Ensure there is no power to the equipment before testing the capacitor.

ATTENTION

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

ATTENTION

Verify the load is not running due to process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

2. Follow appropriate safety steps to isolate the equipment from medium voltage.
3. Verify that there is no voltage present on the capacitor by using a hot stick or any other appropriate voltage-measuring device.
4. Perform visual inspection to ensure there is no oil leak or bulge in any of the capacitors.

D.C. Link / Fan / Control Components (cont.)

5. Note the location of all the cables and mark them accordingly.
6. Disconnect power cables from the capacitor terminals on all four bushings and isolate them from the capacitor. (Refer to “Filter Capacitor Replacement” guidelines in the Classic User Manual - Component Definition and Maintenance chapter (Chapter 6) for using proper torque when reconnecting the capacitors)
7. Connect a low voltage single-phase test power, for instance 110V or 220V, across a phase and the neutral of the capacitor. Switch on the test power and measure the test voltage and current drawn by the capacitor. Repeat the test for all three phases and note down the test voltage and current.

ATTENTION



The capacitor will charge during this test so care must be taken to prevent a shock or injury. When moving the test connections from one phase to the next, wait for at least five minutes until the capacitor is discharged. Using a hot stick or other voltage-measuring device, verify that the capacitor is fully discharged before touching it.

8. Now, calculate the capacitance from the measured values of test voltage and current. For a good capacitor, the calculated capacitance value for each of the three readings should be within $\pm 15\%$ 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.

e.g. - the capacitor under test is rated at 400 kVAR, 6600 V, 50 Hz, 29.2 μ F. You are using 200 V, 50 Hz 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.

Recommended Digital Multimeters (DMM) to be used for checking filter capacitors



BK Precision LCR/ESR Meter, Model 885



Fluke 179



Fluke 12



Fluke 29



Fluke 87V

Figure 5.35 – Recommended Digital Multimeters (DMM)

DC Link Reactor Replacement

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

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.

The DC link reactor does not normally require service. In the event of its replacement, it must be ensured that Rockwell Automation approves the 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 5.36.

WARNING

The DC Link may be hot!

1. Ensure that source power to the drive is locked out and that the filter caps are fully discharged.
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 and low voltage panel in front of the DC link. Swing the low voltage panel to the left and disassemble the closing barriers located on the left and right-hand side of the panel by removing the nuts and washers which secure them to the sides of the structure.

Note: In some instances, depending on the size of the DC link, it may be necessary to completely remove the low voltage panel from the drive cabinet. This can be accomplished by lifting the panel off its hinges and shifting or rotating it to a position where it does not obstruct the opening to the DC link cabinet. Ensure that equipment used to lift and support the panel during DC link replacement is adequate for this purpose.

3. Disconnect the 4 power connections. The DC link is equipped with flexible power leads.
4. Disconnect wires at terminal block on DC link for thermal switch.
5. Remove the hardware that secures the DC link.
6. Disconnect the ground connection.

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

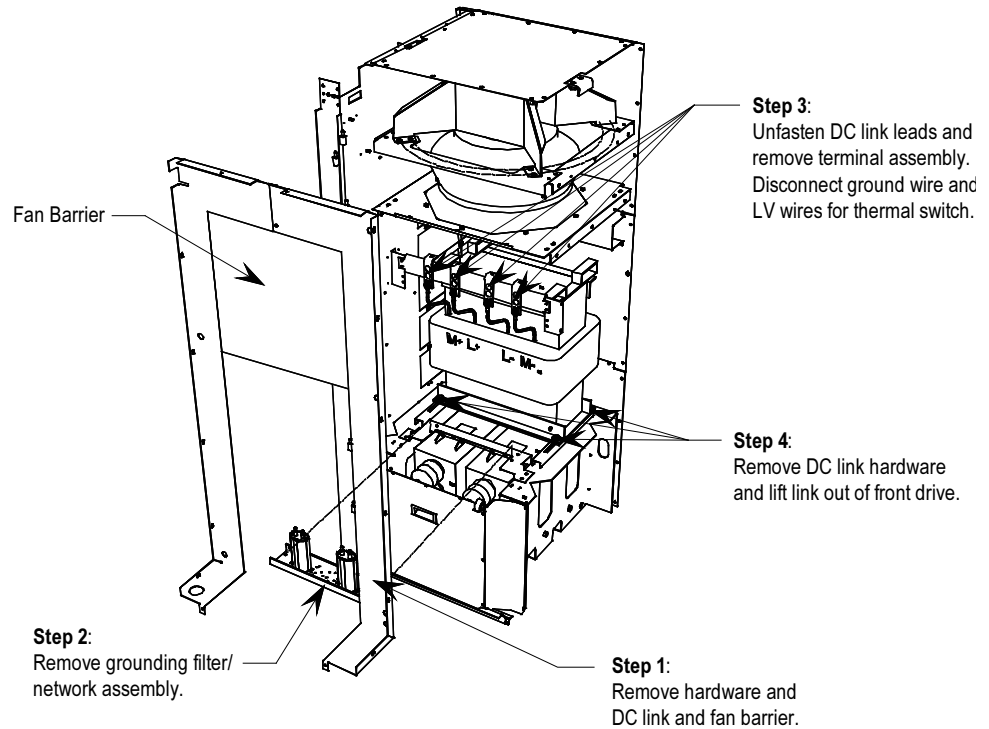


Figure 5.36 – DC link removal

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.

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 Replacement

There are several models of cooling fans used in PowerFlex drives. Differing fan types may be used in the various locations throughout the drive.

DC Link Section

The fan consists of a motor impeller assembly. To replace the fan, it is necessary to remove the fan exhaust hood. See Figure 5.37.

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.

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 weighs approximately 45 kg (100 lbs) 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 side sheets 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.

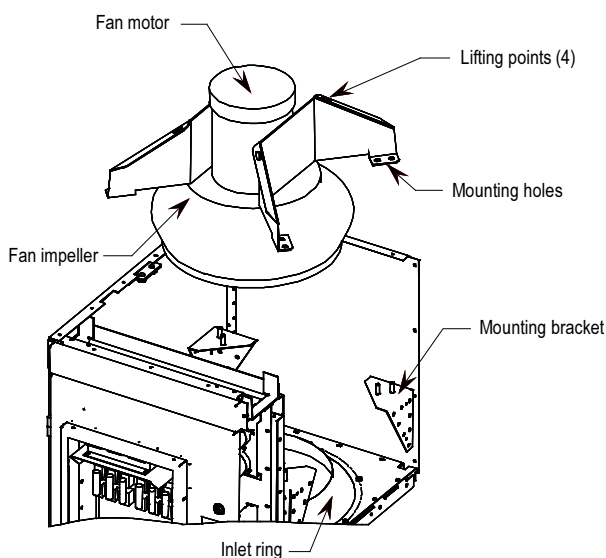


Figure 5.37 – Fan Removal

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.

Top of Integral Isolation Transformer Section

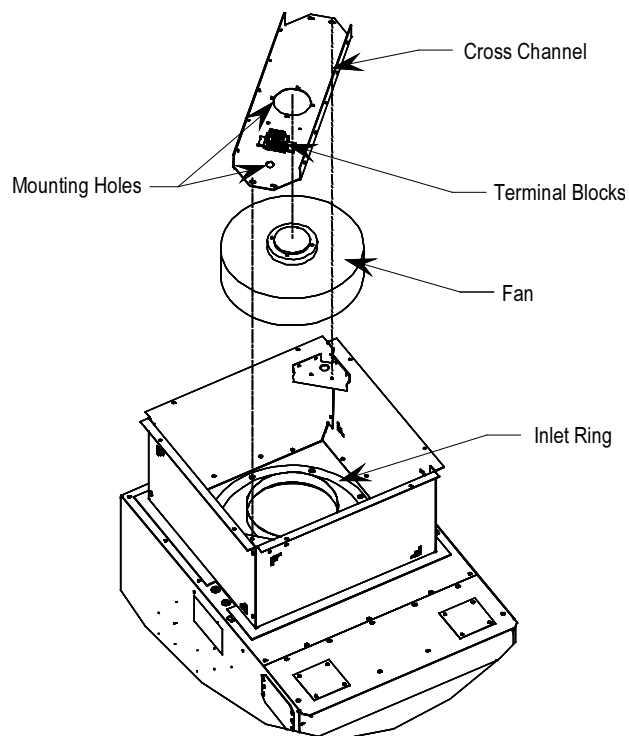


Figure 5.38 – Isolation Transformer Fan Removal

1. Remove the top plate of the ventilation housing and label fan supply leads before disconnecting.
2. Remove the bolts retaining the cross channel and withdraw the fan and channel from housing.
3. Disassemble and replace the fan.
4. Reassemble in the reverse order of removal.

Fan Replacement (cont.)

Top of Integral Line Reactor and Input Starter Section

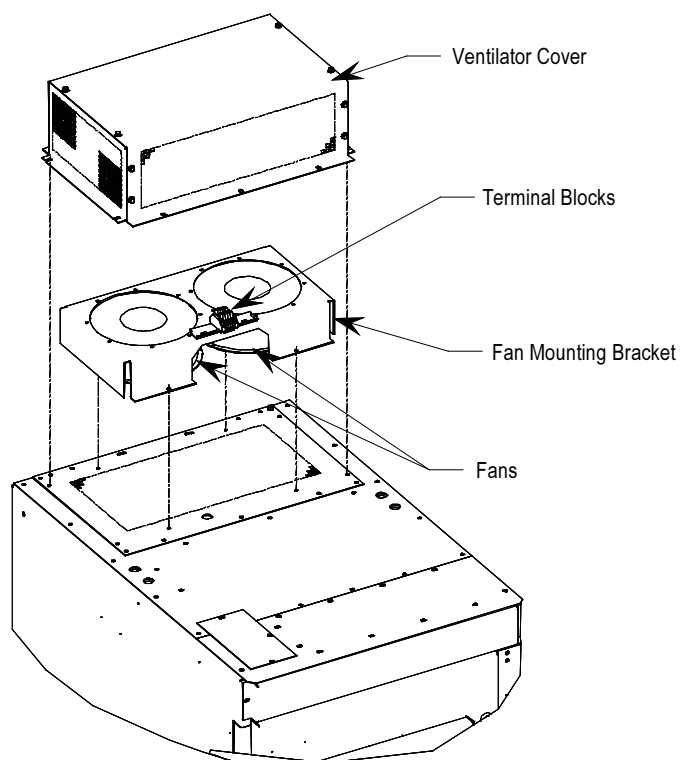


Figure 5.39 – Starter/Line Reactor Cabinet Fan Removal

1. Remove the top ventilation cover from the exterior of the cabinet.
2. Remove mounting screws and invert fan mounting bracket to expose fan mounting hardware.
3. Unplug or disconnect fan leads from terminal blocks and replace fan.
4. Reassemble in the reverse order of removal.

Impeller Maintenance (DC Link / Fan Section)

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 cap screws, 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 cap screws. Physical injury or component damage may result.

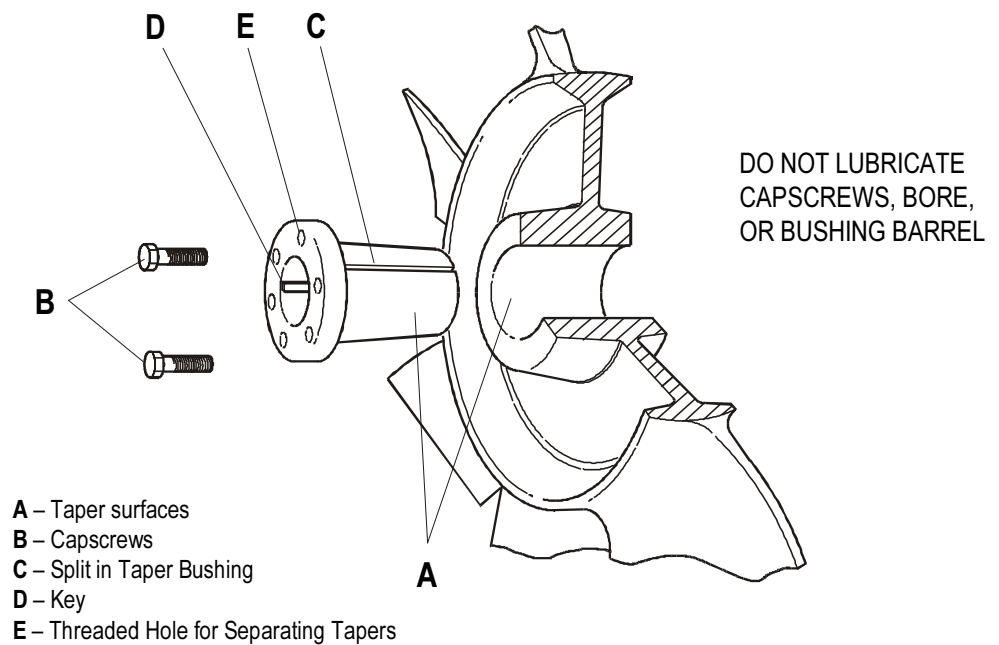


Figure 5.40 – Cutaway View of Fan Impeller and Bushing

**Impeller Maintenance
(DC Link / Fan Section)
(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 cap screws from the bushing. The impeller or bushing may fall as screws are loosened.
3. Thread the cap screws 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 cap screws 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. Cap screws, 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 cap screws, 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 cap screws 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 cap screws 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 cap screws 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 cap screws 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.

Impeller Maintenance

Isolation Transformer Cooling Fan

The isolation transformer fan motor and impeller is an integral unit and cannot be serviced separately.

Inlet Ring Removal and Replacement

The inlet ring is the large circular part located beneath the fan impeller. It is positioned such that the impeller sits outside but does not touch the ring. The ring sits inside the impeller 10 mm (0.40 inches). Refer to the cutaway view of fan impeller and bushing (Figure 5.40).

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.

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.

DC Link / Fan Section

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.

Procedure

If rear panel access is not possible, follow this procedure:

1. Remove bolts and swingout low voltage panel (see Fig. 5.30).
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 all panels and barriers opened or removed during inlet ring replacement.

Top of Integral Isolation Transformer Section

1. Remove fan as described in "Fan Replacement".
2. Disassemble bolts and remove inlet ring.
3. To install 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.
4. Replace all panels and barriers opened or removed during inlet ring replacement.

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 5.41):

- Using an 8 mm (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.**

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.

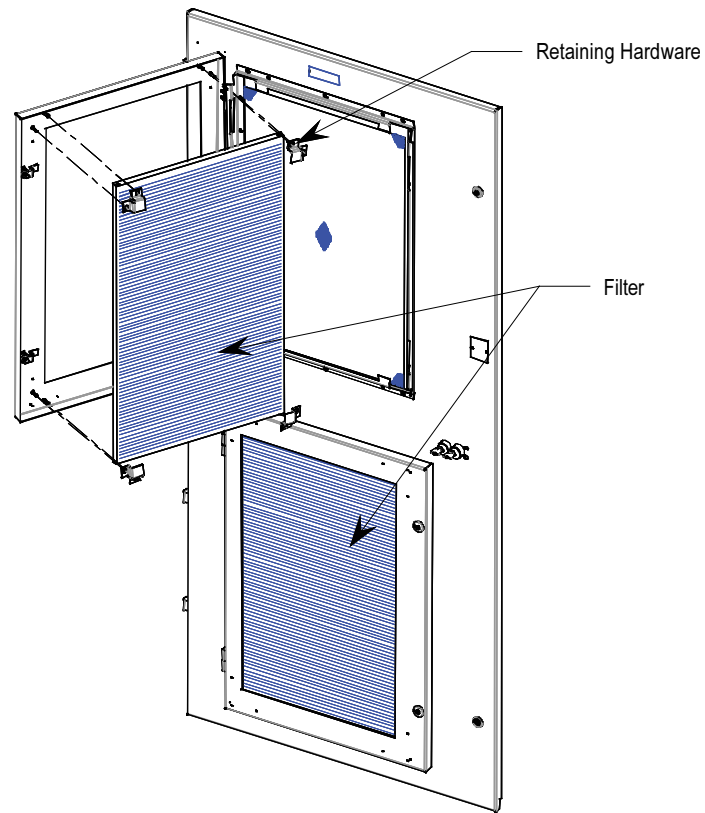


Figure 5.41 – Filter Replacement

Replacement of Air Filters (cont.)

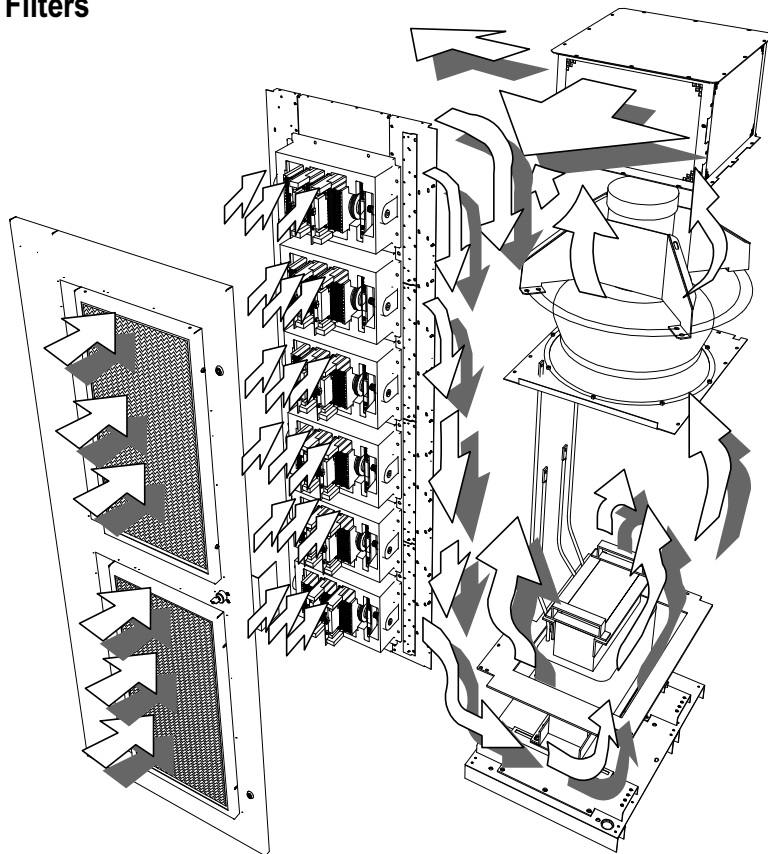


Figure 5.42 – Air Flow Pattern for Drive Cooling

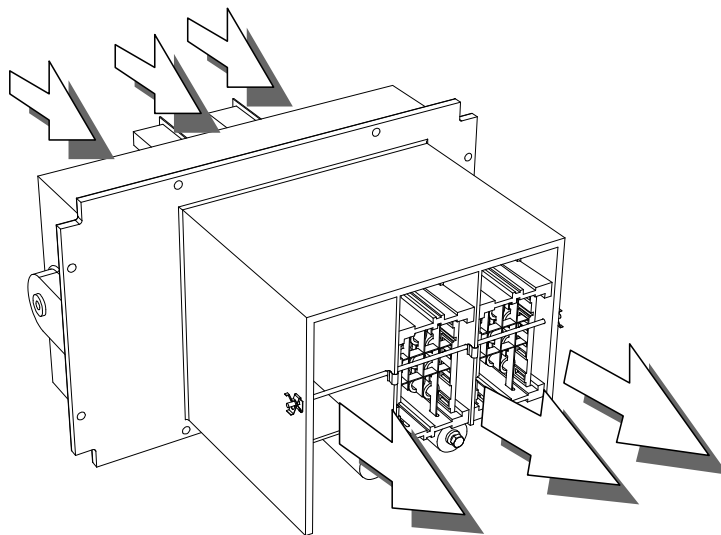


Figure 5.43 – Air flow through PowerCage

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:

- ## Ride-Through

Figure 5.44 illustrates the control power distribution for AFE drives with integral starter/line reactor.

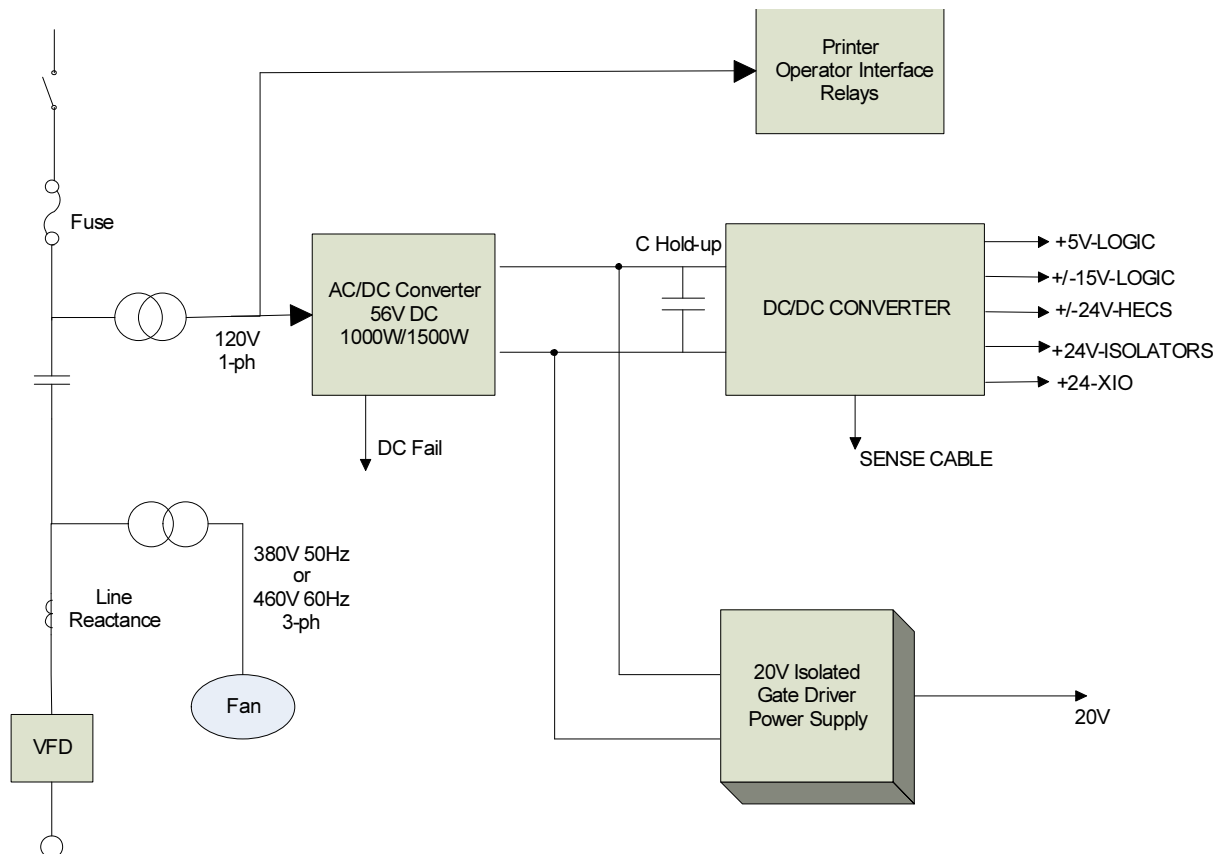


Figure 5.44 – AFE Rectifier with DTD DC Link (Configuration #1)

Control Power Components (cont.)

Figure 5.45 illustrates the control power distribution for AFE drives with remote transformer/starter (A) or integrated line reactor with remote starter (B).

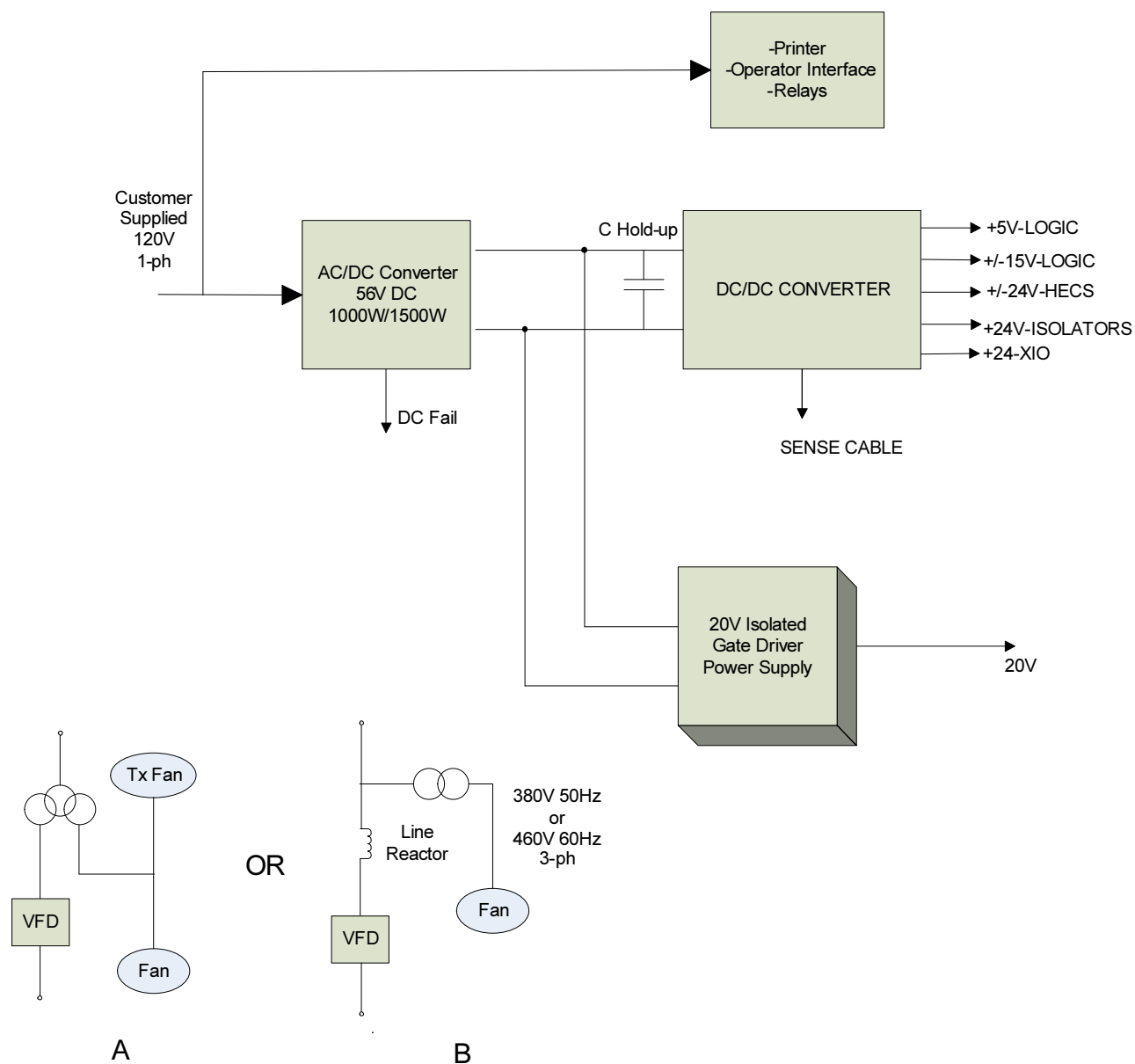


Figure 5.45 – AFE Rectifier with Separate Isolation Transformer (Configuration #2)

Figure 5.46 illustrates the control power distribution for AFE drives with integral transformer and remote starter.

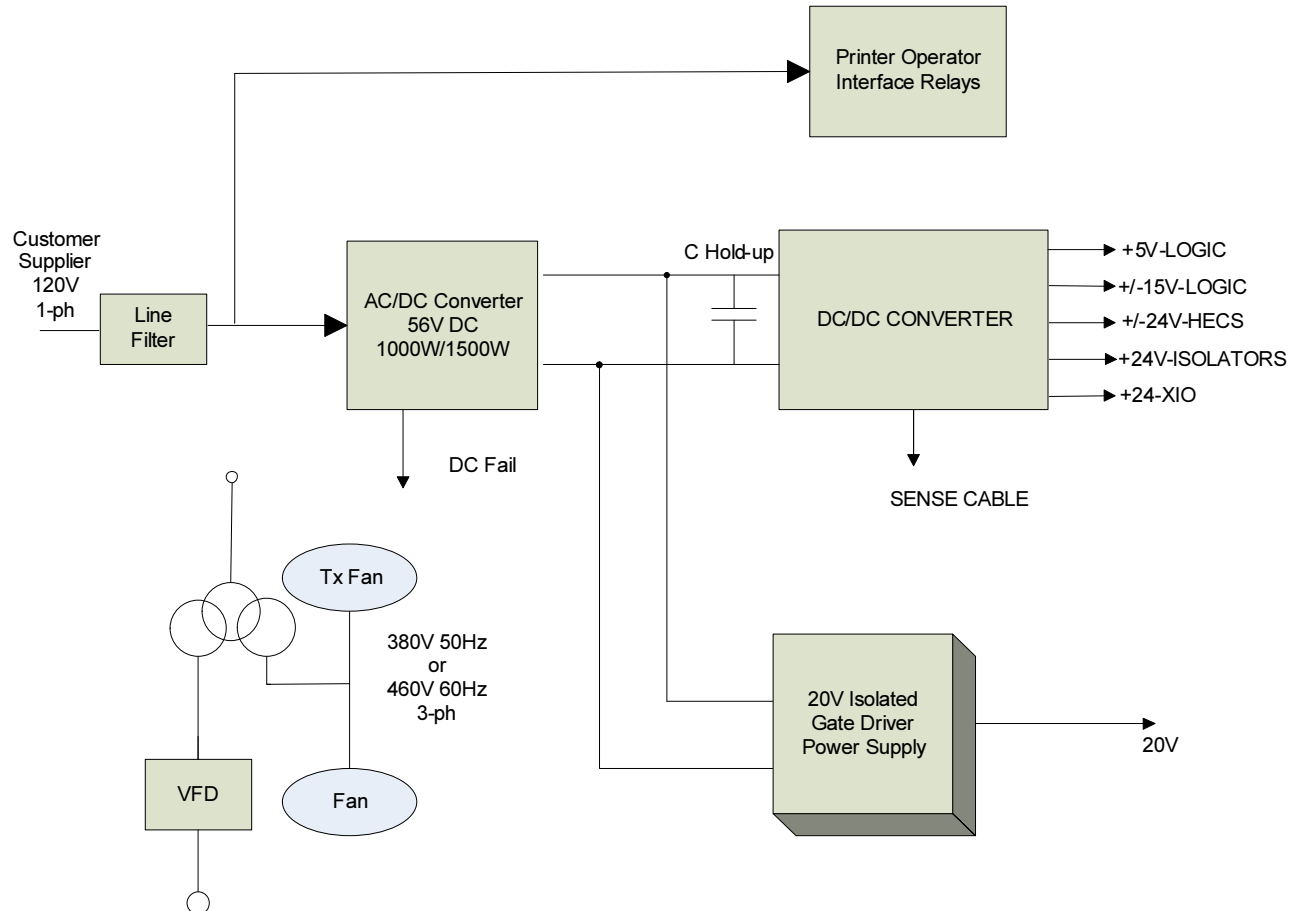


Figure 5.46 – AFE Rectifier with Integral Isolation Transformer (Configuration #3)

AC/DC Power Supply

The load demands on the AC/DC converters are the DC/DC converter and up to six IGDPS modules. The DC/DC is a fixed load; however, the quantity of IGDPS modules will vary depending upon the drive configuration.

Description

The AC/DC power supply accepts single phase voltage and produces a regulated 56V DC output for the DC/DC power supply and the HV IGDPS modules that power the SGCTs. The input and output voltages are monitored and fail signals are annunciated upon either voltage going below a pre-set level.

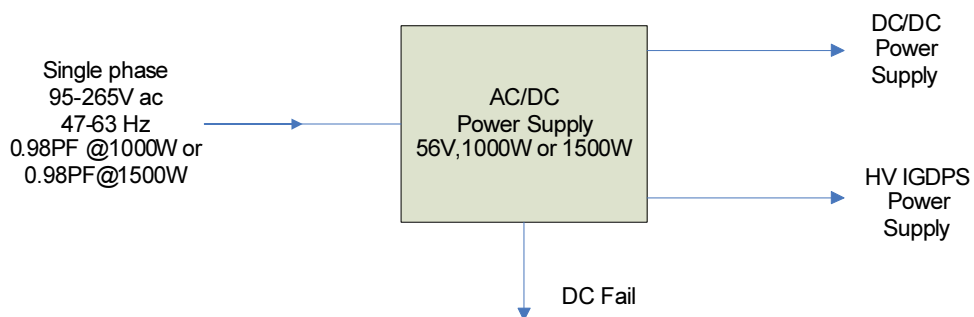


Figure 5.47 – AC/DC Converter Power Supply

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

Location

The AC/DC power supply is located in the low voltage panel at the top right-hand section of the drive. A typical low voltage compartment is shown in Figure 5.48.

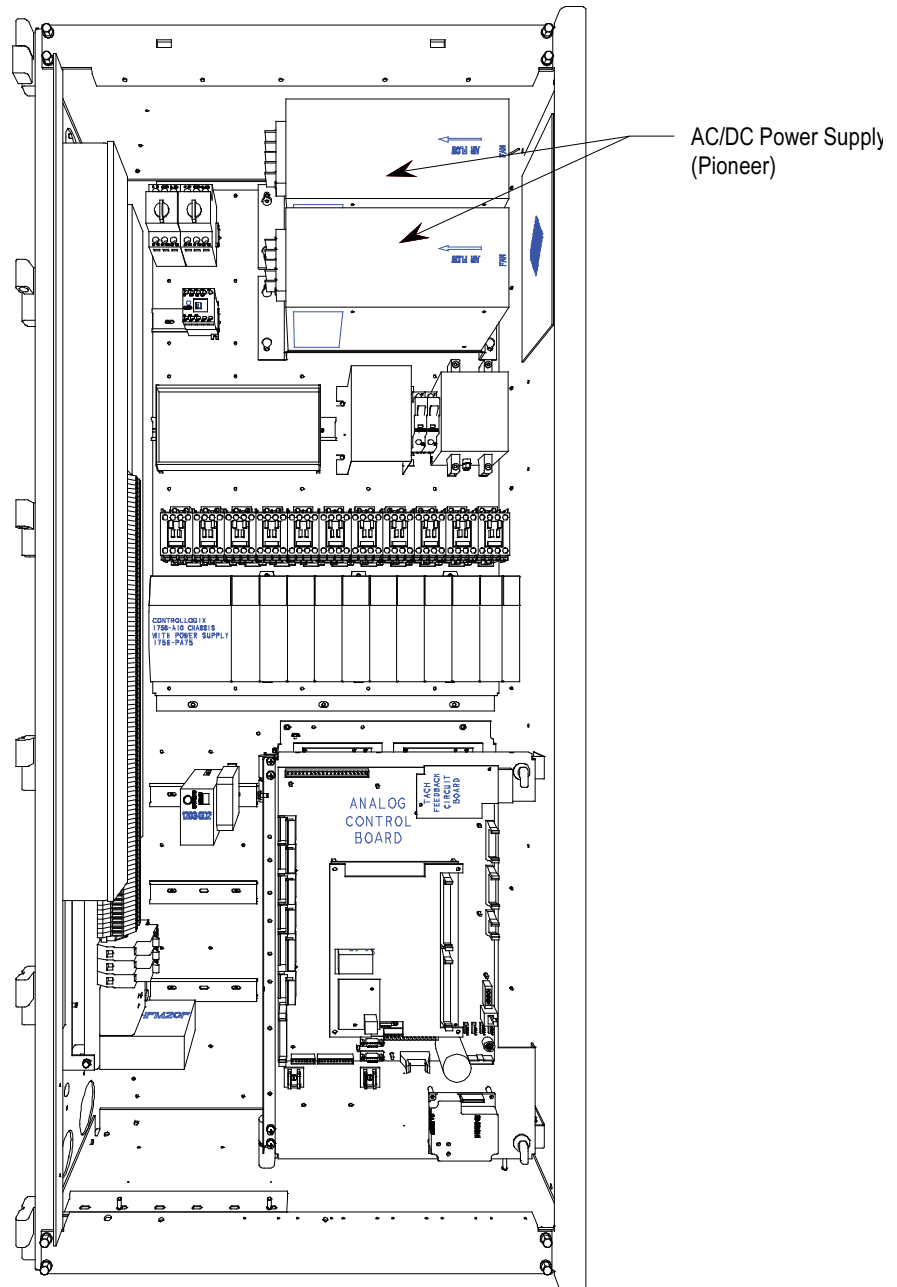


Figure 5.48 – Location of AC/DC Pioneer Power Supply on Low Voltage Panel

AC/DC Power Supply (cont.)

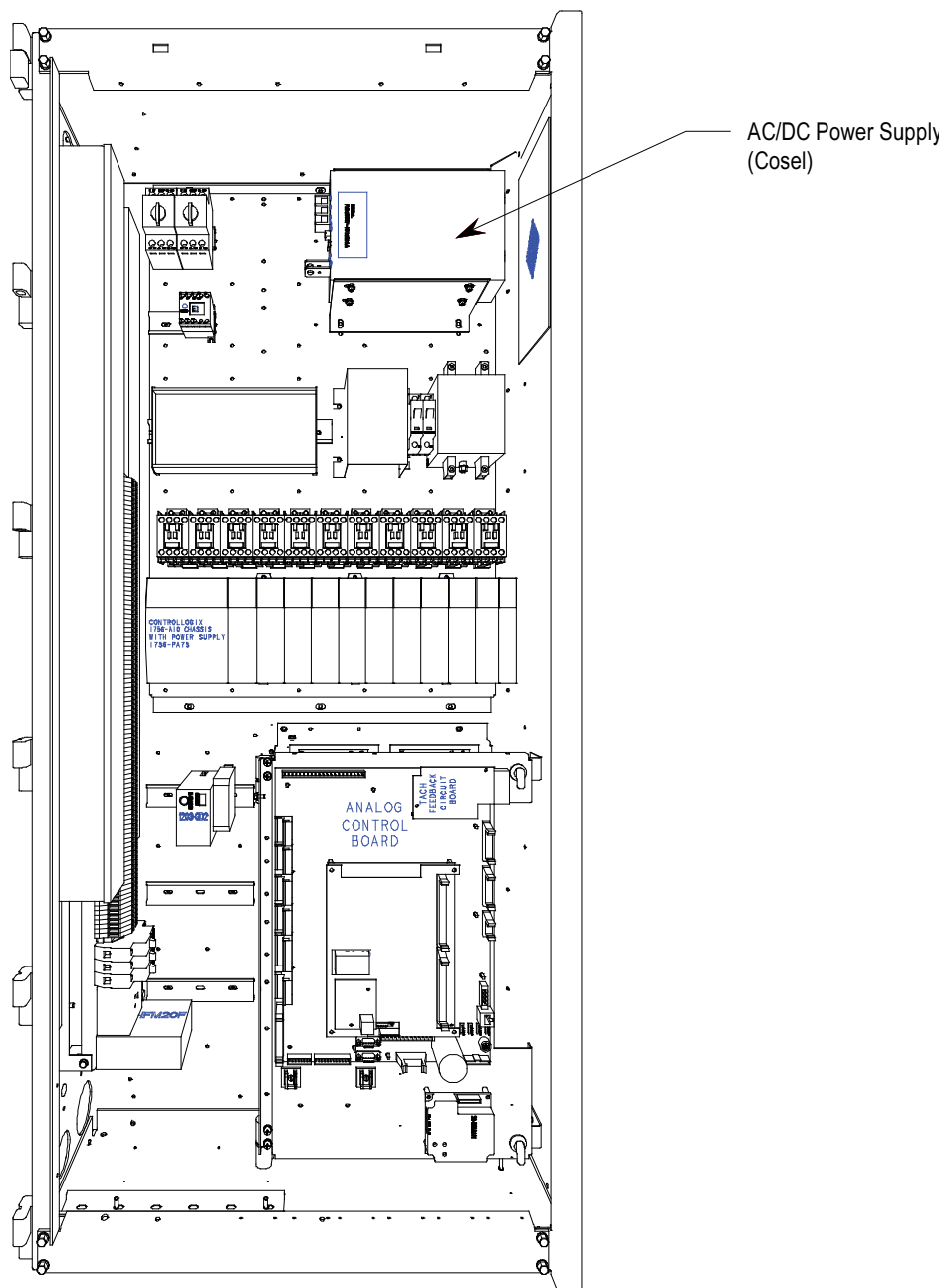


Figure 5.49 – Location of AC/DC Cosel Power Supply on Low Voltage Panel

Terminal / Connections Descriptions (Pioneer Power Supply)

The terminal connections are shown below in Figure 5.50.

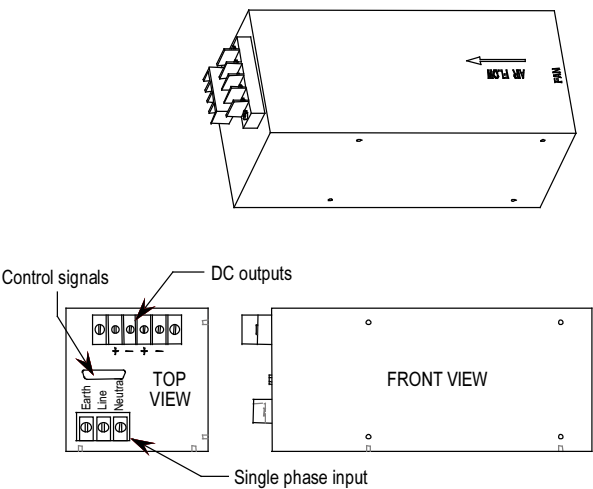


Figure 5.50 – Terminal locations on AC/DC Pioneer power supply

<u>P1-AC input</u>	PIN#	LABEL
	1	EARTH
	2	LINE
	3	NEUTRAL
<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)
	15	CURRENT SHARING
	14	DC POWER FAIL COMMON

AC/DC Power Supply (cont.)

Terminal / Connections Descriptions (Cosel Power Supply)

The terminal connections are shown below in Figure 5.51.

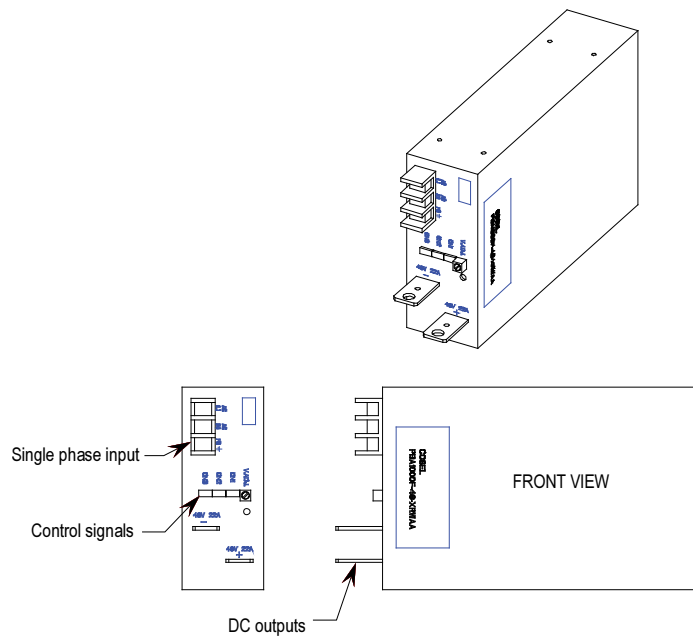


Figure 5.51 – Terminal locations on Cosel AC/DC power supply

P1-AC input

PIN#	LABEL
AC (L)	LIVE
AC (N)	NEUTRAL
NC	No Connection
FG	EARTH

P2-DC output

PIN#	LABEL
+	+56V
-	+56V COMM

P3-FAIL output

PIN#	LABEL
CN1	1-2 Connected
	3-4 Connected
	5,6,7,8,9,10 N/C
CN2	N/C
CN3	7 - Alarm
	8 - Alarm GND

Output Calibration

Ensure the output of the supply is 56V DC.

There is a potentiometer on the top of the power supply that adjusts the 56 Volt DC output for the power supply. Isolate the output of the power supplies; multiple supplies in series will affect your measurements. With the control power on and the output of the AC/DC Converter isolated from the drive control, adjust the potentiometer until the output equals 56 volts DC. Perform this test on each power supply. When all adjustments are complete, re-connect the power supply to the circuit and re-measure the output. Readjust if necessary.

If it is not possible to maintain 56 V DC, the power supply may be faulty.

Replacement Procedure

1. Ensure control power has been isolated and locked out.
2. Disconnect the terminals at the unit.
3. Remove the four M6 bolts per Figure 5.52 or 5.53.
4. Extract the power supply complete with bracket from the drive.
5. Remove the bracket(s) from the failed power supply (four M4 screws and nylon shoulder washers).
6. Attach bracket to replacement power supply.
Note: Make sure the Black Insulation(s) is between the AC/DC power supply and the mounting plate(s).
7. Repeat Steps 5, 4, 3, 2 and 1 in this order to replace the unit (see Figure 5.52 or 5.53).
8. Reapply control power and verify voltage levels.

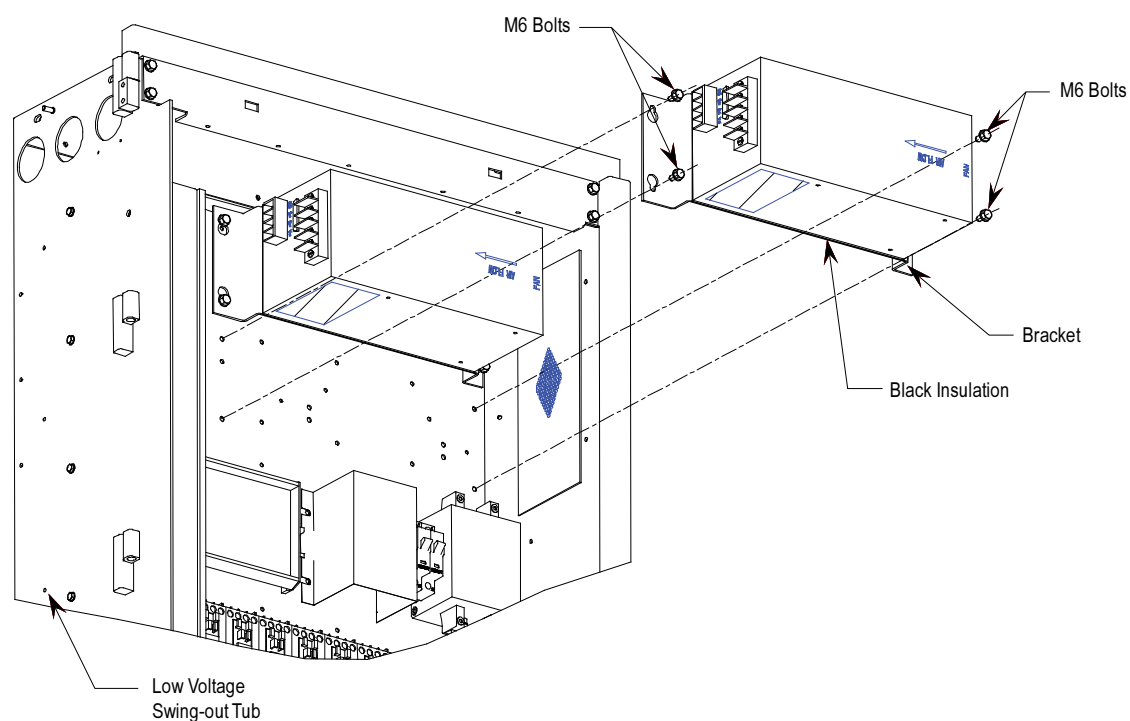


Figure 5.52 – Replacement of Pioneer AC/DC Power Supply on Low Voltage Panel

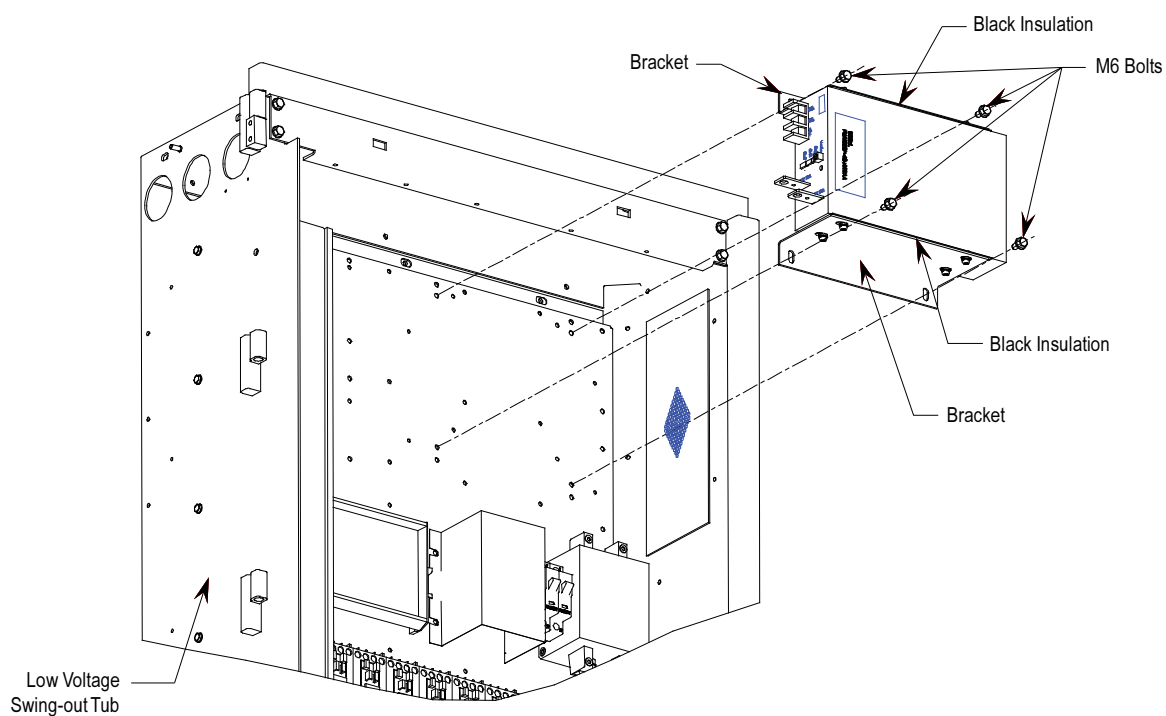


Figure 5.53 – Replacement of Cosel AC/DC Power Supply on Low Voltage Panel

Low Voltage Control Section

The low voltage control section 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 5.54 for a generic representation of a low voltage tub arrangement.

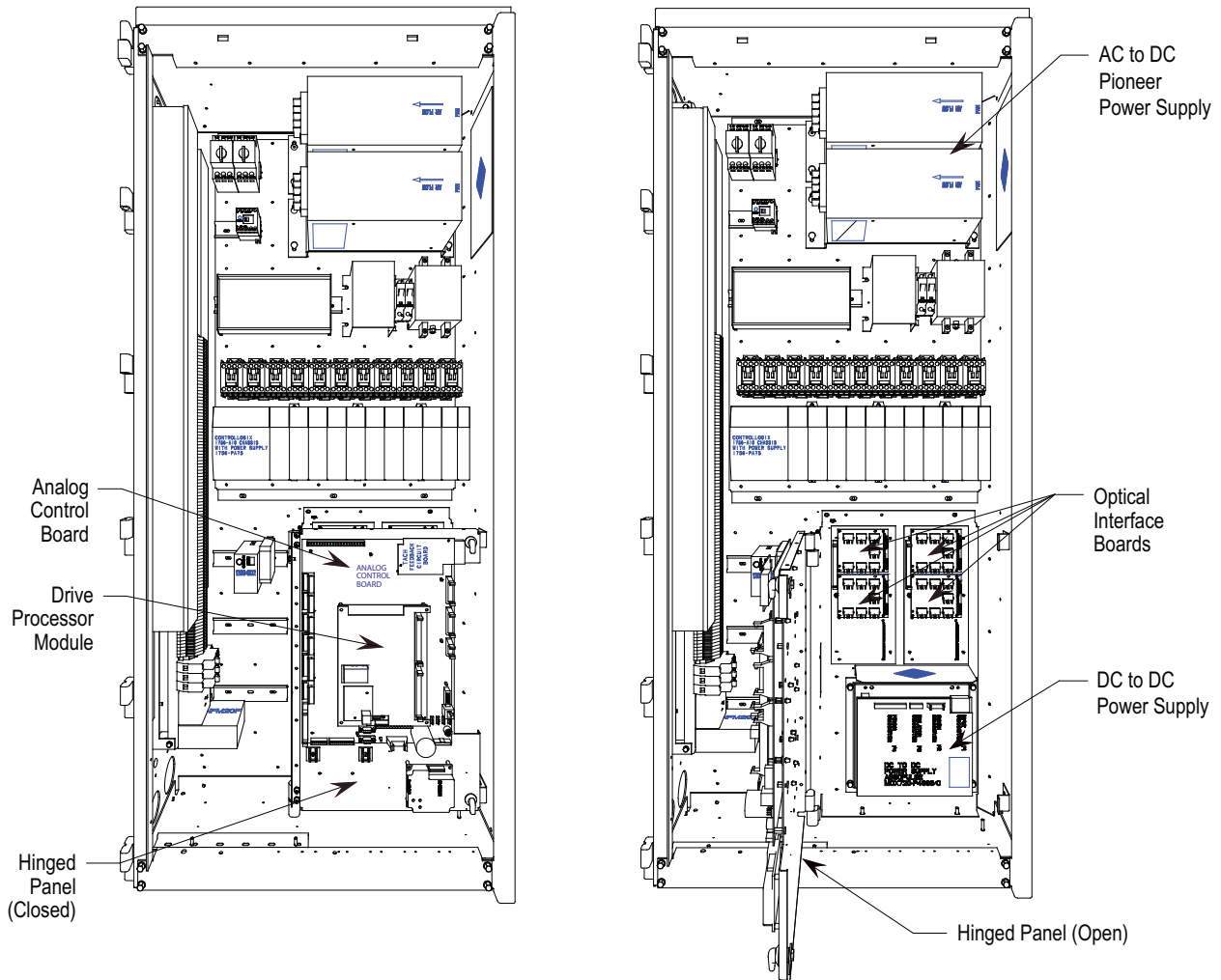


Figure 5.54 – Low Voltage Tub Compartment (Pioneer Power Supply)

Low Voltage Control Section (cont.)

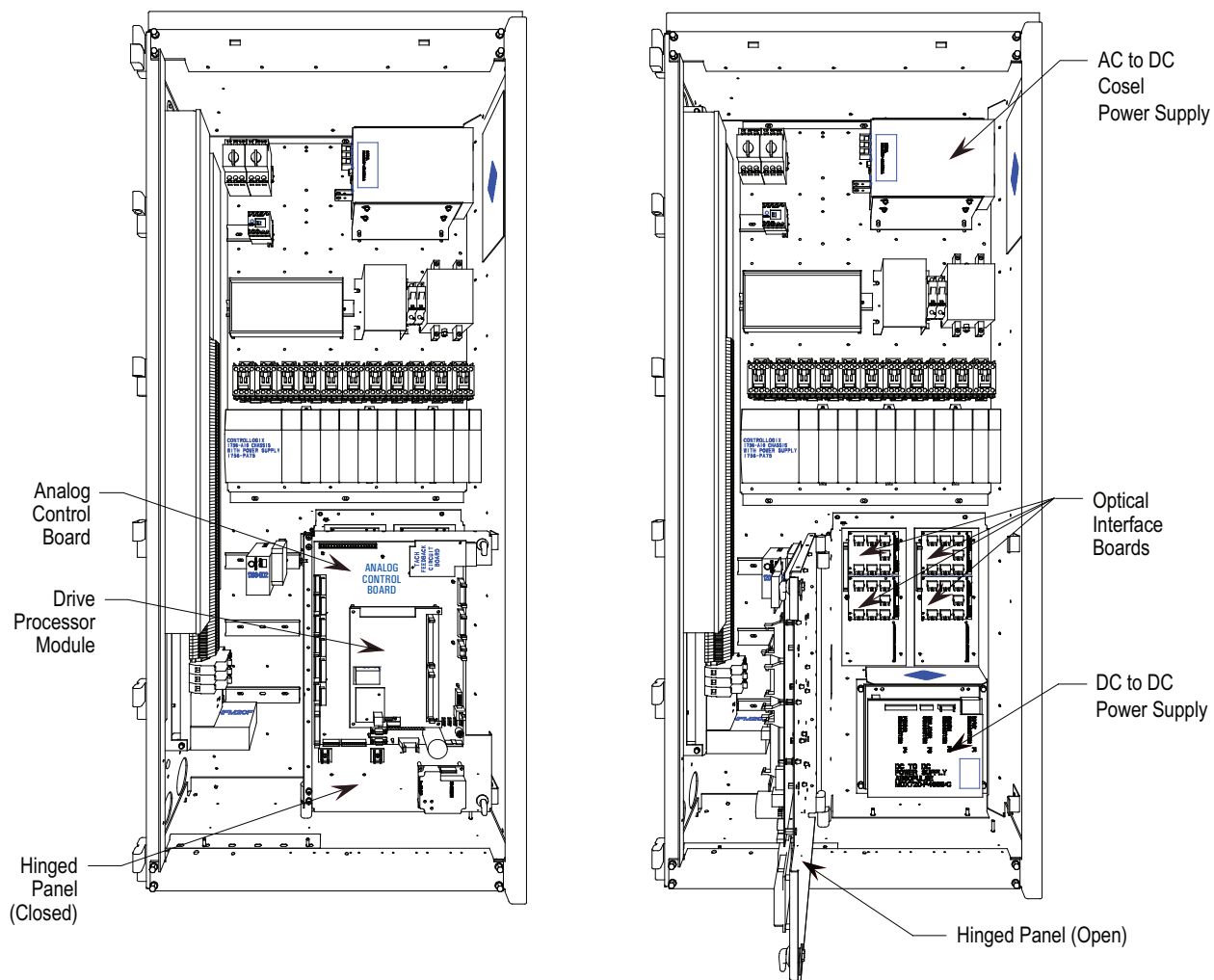


Figure 5.55 – Low Voltage Tub Compartment (Cosel Power Supply)

DC/DC Power Supply

Description

The DC/DC power supply is used as a source of regulated DC voltages for various logic control boards and circuits. The input to this power supply is from a regulated 56V DC source.

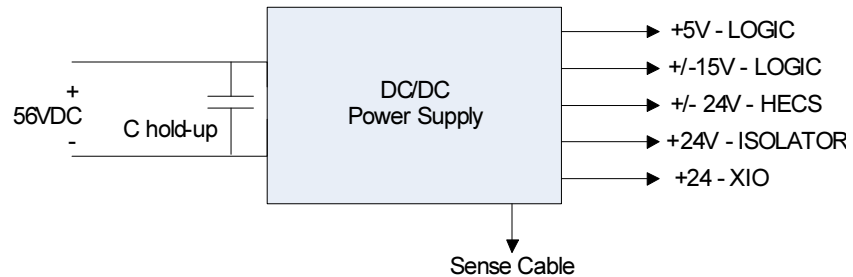


Figure 5.56 – DC/DC converter power supply

The capacitor at the input terminals is for power dip ride-through purposes. Upon loss of the 56V input, the capacitors (C hold-up) will maintain the voltage level. This component is not required in all configurations.

Due to the critical nature of the ACB/DPM Logic power source, the DC/DC power supply has been designed to provide redundancy for the +5V rail. There are two separate +5V outputs, each capable of powering the logic boards. In the event of one failing, the other power supply will be automatically switched in to provide the output power.

Terminal/Connections Descriptions

P1 – DC Input

PIN NO.	LABEL	DESCRIPTION ONLY
1	+56V	+56V input
2	+56V COMM	+56V common
3	EARTH	earth ground

P2 – SENSE (To ACB)

PIN NO.	LABEL	DESCRIPTION ONLY
1	+56V	+56V input supply
2	+56V RTN	+56V input supply return
3	NC	Not Connected
4	NC	Not Connected
5	+24V	Isolated +24V Supply
6	+24V RTN	Isolated +24V Supply return
7	NC	Not Connected
8	NC	Not Connected
9	+5VA	Primary +5V supply, before OR'ing diode
10	DGND(com1)	+5V, +/-15V Common
11	+5VB	Secondary +5V supply, before OR'ing diode
12	DGND(com1)	+5V, +/-15V Common
13	ID0	Power Supply ID Pin 0
14	ID1	Power Supply ID Pin 1

**DC/DC Power Supply
(cont.)****Terminal/connections descriptions (cont.)****P3 – ISOLATOR
(To Isolator Modules)**

PIN NO.	LABEL	DESCRIPTION ONLY
1	ISOLATOR (+24V,1A)	+24V,1A/com4
2	ISOL_COMM (com4)	0V/com4
3	EARTH	EARTH

**P4 – PWR
(To ACB)**

PIN NO.	LABEL	DESCRIPTION ONLY
1	+24V_XIO (+24V,2A)	+24V,2A/com3
2	XIO_COMM (com3)	0V/com3
3	+HECSPWR (+24V,1A)	+24V,1A/com2
4	LCOMM (com2)	0V/com2
5	-HECSPWR (-24V,1A)	-24V,1A/com2
6	+15V_PWR (+15V,1A)	+15V,1A/com1
7	ACOMM (com1)	0V/com1
8	-15V_PWR (-15V,1A)	-15V,1A/com1
9	+5V_PWR (+5V,5A)	+5V,10A/com1
10	DGND (com1)	0V/com1
11	EARTH	earth ground

Replacement Procedure for DC/DC Power Supply

(Refer to Figure 5.57)

1. With the drive energized, check that all output voltages are present. (View 1)
2. De-energize the drive, isolate and lock out the control power, and remove all wire connections from the unit. (View 1)
3. Remove quantity of (4) M6 (H.H.T.R.S.) that will allow the DC/DC Power Supply Assembly to be removed from the Low Voltage Panel. (View 1)
4. Remove quantity of (4) **M4 (P.H.M.S.) and Nylon Shoulder Washers** from the back of the Mounting Plate. (View 2)
5. Replace old DC/DC Power Supply with the new one.
NOTE: Make sure the **Black Insulation** is between the DC/DC Power Supply and the Mounting Plate. Repeat Steps 4, 3, 2, 1 in this order to replace unit. (View 2)
6. Ensure the ground wire of P4 plug is connected to the ground by M10 bolt

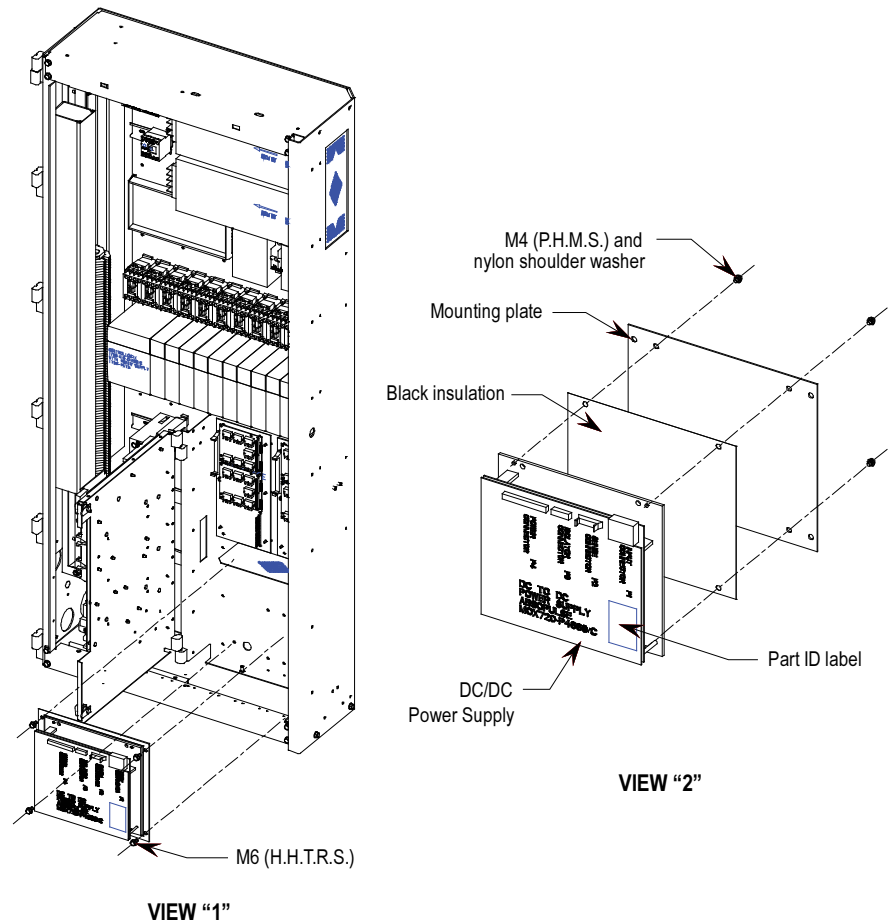


Figure 5.57 – Replacement of DC/DC power supply

Printed Circuit Board Replacement

The replacement of printed circuit boards should be handled in a careful manner.

There are some basic precautions that should be taken. They include the following:

- Remove all power to the drive.
- Do not remove the replacement board from the anti-static bag until necessary.
- Use anti-static wrist strap, grounded in the Low Voltage Control Section

There are no direct screw/terminal connections on any of the Low Voltage circuit boards. All wire/terminal connections are made with plugs that plug into the circuit boards. This means that changing boards only requires the removal of the plugs, minimizing the chance of mistakes when reconnecting all of the wiring.

IO Connectors on Control Boards

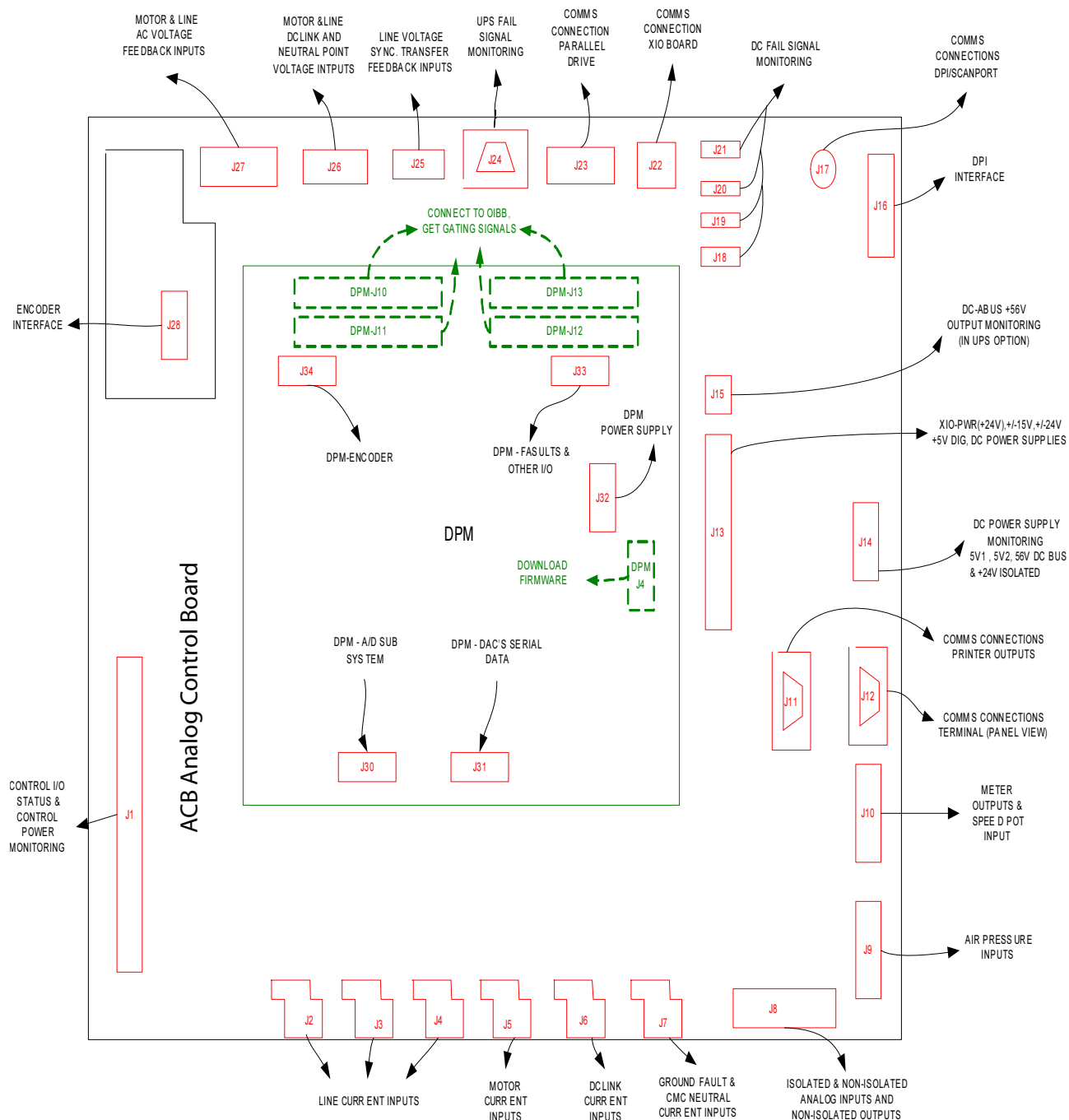


Figure 5.58 – IO Connectors on Control Boards

Drive Processor Module

This board contains the control processors. It is responsible for all the drive control processing and stores all of the parameters used for the drive control.

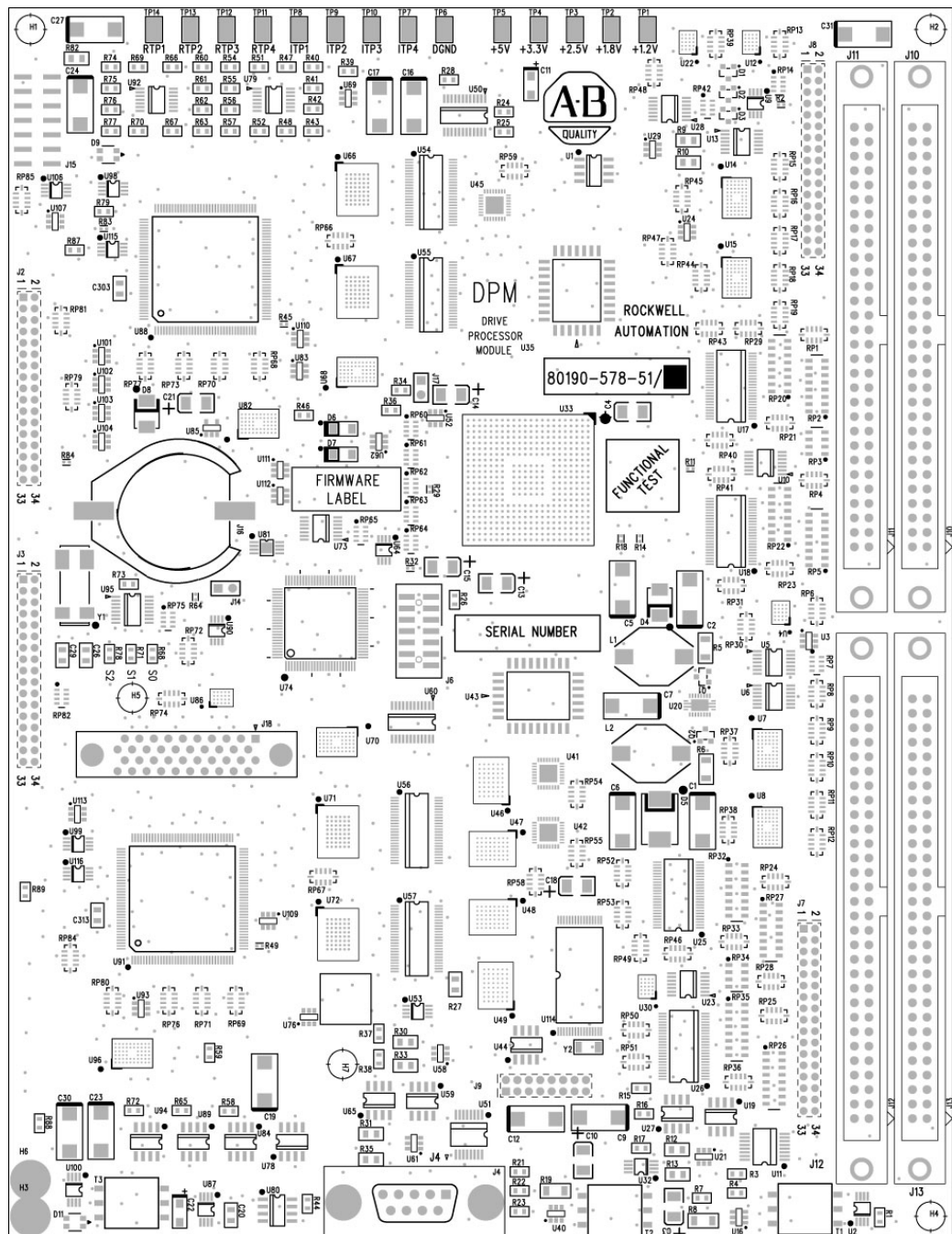


Figure 5.59 – Drive Processor Module (DPM)

Drive Processor Module (cont.)

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

Table 5.B – Test Points on Drive Processor Module

Test points	Name	Description
DPM-TP1	+1.2V	+1.2V DC power supply
DPM-TP2	+1.8V	+1.8V DC power supply
DPM-TP3	+2.5V	+2.5V DC power supply
DPM-TP4	+3.3V	+3.3V DC power supply
DPM-TP5	+5V	+5V DC power supply
DPM-TP6	DGND	Digital ground
DPM-TP8	ITP1	Digital to Analog output – Assignable diagnostic test point
DPM-TP9	ITP2	Digital to Analog output – Assignable diagnostic test point
DPM-TP10	ITP3	Digital to Analog output – Assignable diagnostic test point
DPM-TP7	ITP4	Digital to Analog output – Assignable diagnostic test point
DPM-TP11	RTP4	Digital to Analog output – Assignable diagnostic test point
DPM-TP12	RTP3	Digital to Analog output – Assignable diagnostic test point
DPM-TP13	RTP2	Digital to Analog output – Assignable diagnostic test point
DPM-TP14	RTP1	Digital to Analog output – Assignable diagnostic test point

This table defines the states of LEDs D9 and D11 on the DPM board. D9 is used for the Inverter side processor and D11 is for the Rectifier side processor. The other two LEDs (D6 and D7) are the watchdogs for the Inverter and Rectifier code respectively.

Table 5.C – Description of D9 and D11 Function

Color	Rate or Count (Pulse)	Meaning
Green	10 Count	PreExecution OK
Red	.25 Hz	No Bootcode
Green	.25 Hz	No Application
Green	.5 Hz	Downloading via Serial Port
Green	2 Hz	Serial Port Active – i.e. Terminal
Green	1 Hz	Waiting/Loading Application
Green	Solid	Operation Running or Successful
Red	Solid	Operation Failed
Red	2 Count	POST – RAM Failed
Red	3 Count	POST – NVRAM Failed
Red	4 Count	POST – DPRAM Failed
Red	8 Count	FPGA Loading Failed
Red	9 Count	POST – USART Failed: 1 Green Count = Port 1 2 Green Count = Port 2
Red	10 Count	End of Code Reached
Red	11 Count	Download – CRC Error
Red	14 Count	Download – Overflow Error

Drive Processor Module Replacement

Before replacing the Drive Processor Module, it is important to record all of the programmed drive parameters and settings. Specifically, the parameters, fault masks, fault descriptions, and PLC links are critical. This information is stored in NVRAM on each, and as a result you may lose your settings with a new board. The best method to record parameters is to use the memory on the terminal. Other options include a flashcard, HyperTerminal, the door-mounted printer, or DriveTools™ to record the parameters to a file. The printer and HyperTerminal options allow you to print all of the drive setup information. Otherwise, recording information by hand is the only option left. In the situation where a board has failed, you probably will not be able to save parameters after the failure. That is why it is important to save all parameters when you are finished commissioning or servicing the drive. In this case you should contact the customer to see if they have a copy of the last parameters, or contact Product Support to check if they have a copy.

Instructions to replace the Drive Processor Module

1. Record all drive setup information using any of the options above, if possible.
2. Ensure that all medium voltage and control voltage power to the drive is isolated and locked out.
3. It is required to first remove the transparent sheet on top of the Drive Processor Module by removing the 4 screws.
4. Use static strap before removing any connectors.
5. Remove the connectors J4, J11 and J12 after proper identification and marking if necessary. Use the electrical drawing as the reference.
6. Remove the 4 screws on the corners of the board fastening the board to the standoffs on the Analog Control Board ACB.
7. Gently remove the Drive Processor Module from the four, 34 pin female connectors and one, 16 pin female connector on the ACB.
8. **Remove the DIM module from the DPM and plug it on the new DPM before the replacement of DPM.**
9. Follow Steps 7 – 3 in reverse to re-install the boards back into the low voltage control cabinet.
10. Apply control power to the drive. The DPMs are shipped with no firmware installed, so the drive will automatically go into download mode. Install firmware in the drive following the guidelines in ‘Installing Firmware’.

Drive Processor Module (cont.)

11. Program the drive. Refer to Technical Data “Medium Voltage AC Drive Parameters” – Publication **7000-TD002-EN-P**. The parameters should also be saved to NVRAM and then externally to the drive using the options described earlier in this section.

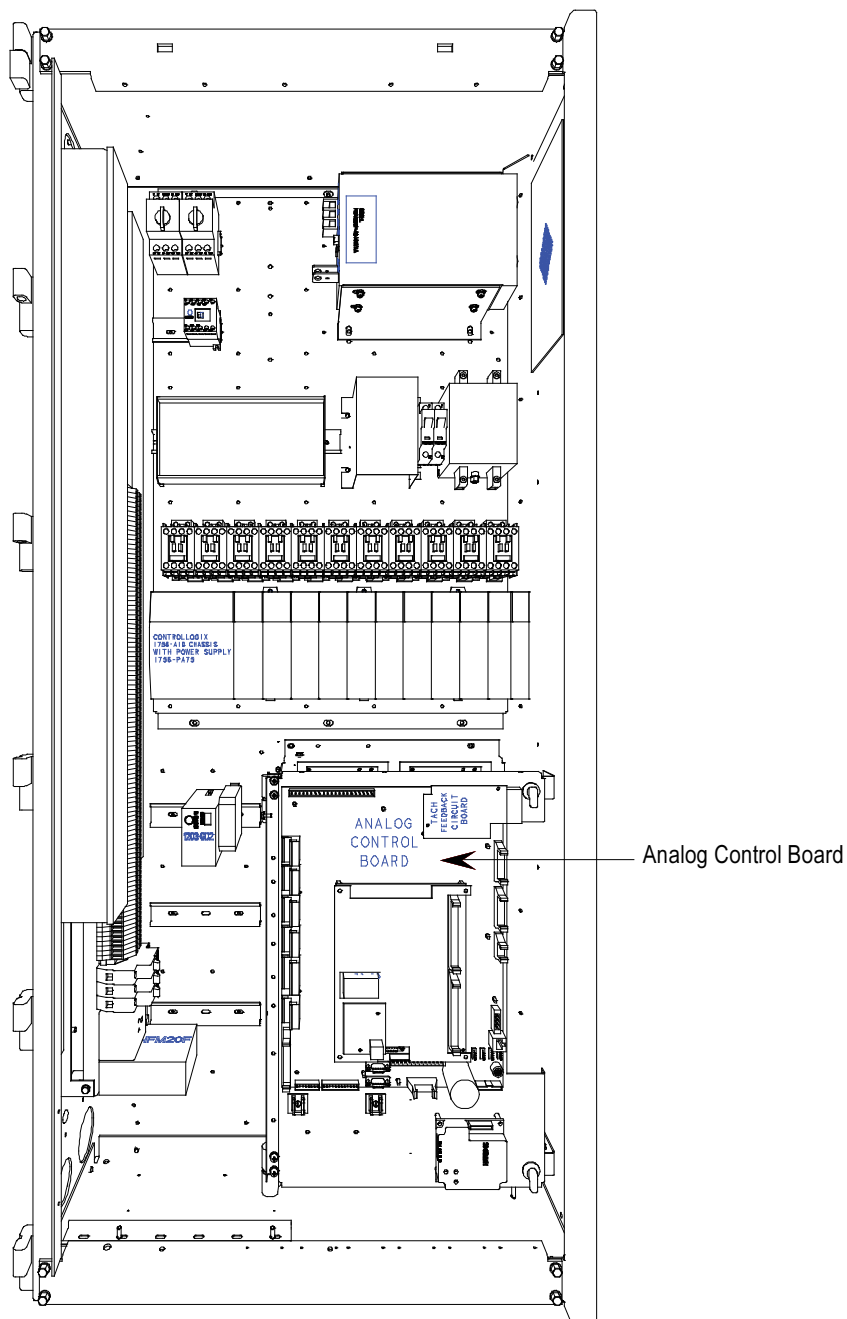


Figure 5.60 – ACB and DPM Replacement

ACB Analog Control Board

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

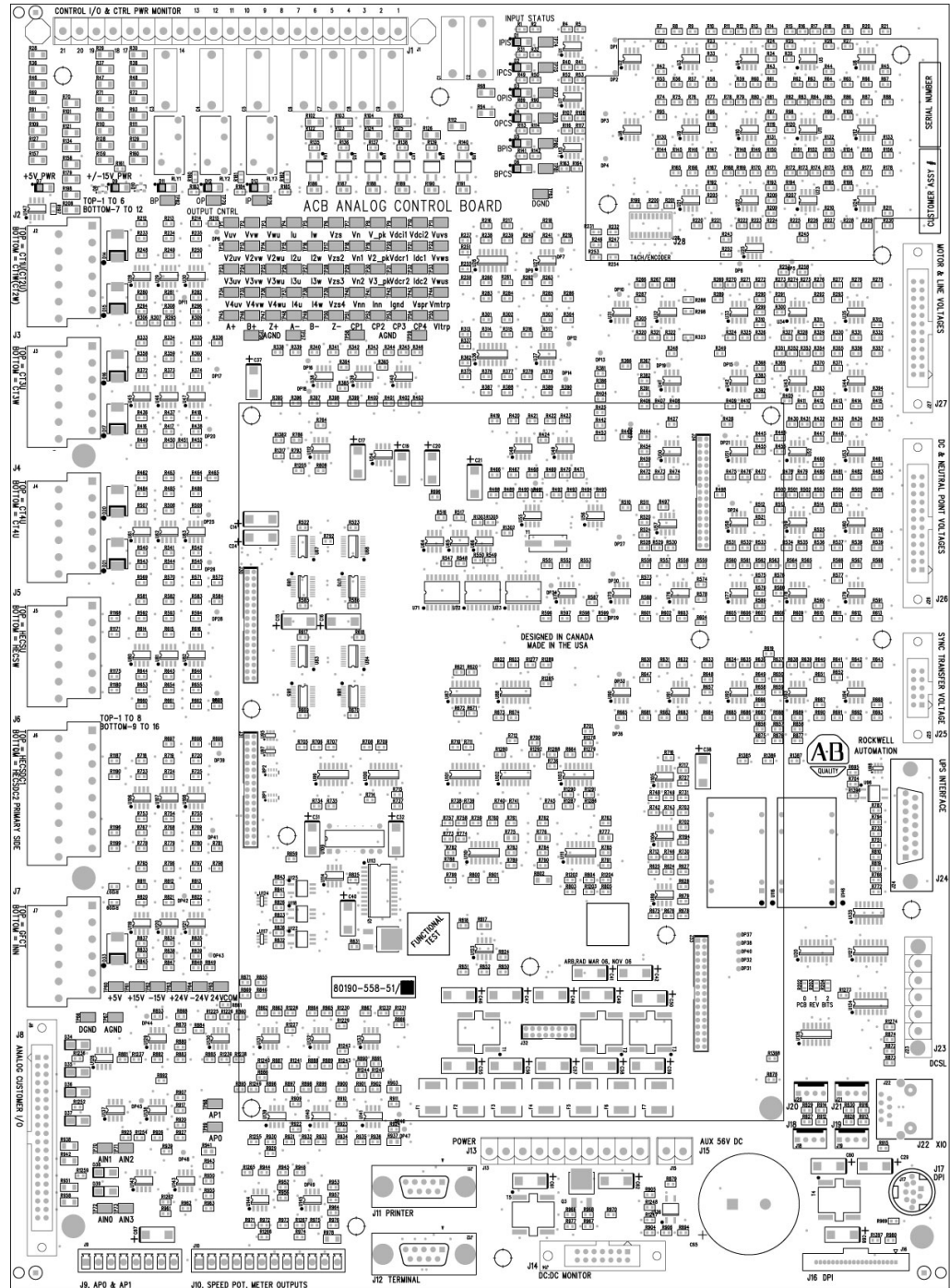


Figure 5.61 – ACB Analog Control Board

ACB Analog Control Board (cont.)

The Analog Control Board (ACB) receives all of the Analog Signals from the drive's internal components. This includes the current and voltage feedback signals. The boards also have isolated Digital I/O for fan status, 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.

Table 5.D – Connectors on Analog Control Board

ACB Connectors	Description
ACB-J1	Control I/O & Control Power Monitor
ACB-J2	Line current inputs, CT2U, CT2W
ACB-J3	Line current inputs, CT3U, CT3W
ACB-J4	Line current inputs, CT4U, CT4W
ACB-J5	Motor current inputs, HECSU, HECSW
ACB-J6	DClink current inputs, HECSDC1, HECSDC2
ACB-J7	Ground fault & CMC Neutral current inputs, GFCT, INN
ACB-J8	Isolated & Non-isolated analog inputs, AIN1, AIN2, AIN3 and Non-isolated outputs, AOUT1, AOUT2, AOUT3, AOUT4
ACB-J9	Air pressure inputs, AP0, AP1
ACB-J10	Meter outputs, AOUT5, AOUT6, AOUT7, AOUT8 and Speed Pot input, AIN0
ACB-J11	Communication connections, printer outputs
ACB-J12	Communication connections, Terminal
ACB-J13	DC power supplies, XIO(+24V), +/-15V, +/-24V, +5V
ACB-J14	DC power supply monitoring, 5V1, 5V2, DC-BUS
ACB-J15	DC-ABUS +56V output monitoring (UPS option)
ACB-J16	DPI interface
ACB-J17	Communication connections, scan port
ACB-J18	DC fail signal monitoring
ACB-J19	DC fail signal monitoring
ACB-J20	DC fail signal monitoring
ACB-J21	DC fail signal monitoring
ACB-J22	Communication connection, XIO link CAN interface
ACB-J23	Communication connection, parallel drive
ACB-J24	UPS fail signal monitoring
ACB-J25	Line voltage synchronous transfer feedback voltage inputs VSA, VSB, VSC
ACB-J26	Motor & line DC link and Neutral Point Voltage inputs
ACB-J27	AC Motor & Line voltage feedback inputs
ACB-J28	Encoder interface
ACB-J30	DPM connection, A/D SUB system
ACB-J31	DPM connection, DACs serial data
ACB-J32	DPM power supply, +5V
ACB-J33	DPM connection, Faults & other I/O
ACB-J34	DPM connection, Encoder

Table 5.E – Test Points on Analog Control Board

Test points	Name	Description
ACB-TP1	Vuv	Motor Voltage Feedback, UV
ACB-TP2	Vvw	Motor Voltage Feedback ,VW
ACB-TP3	Vwu	Motor Voltage Feedback ,WU
ACB-TP4	Iu	Motor Current ,HECSU
ACB-TP5	Iw	Motor Current ,HECSW
ACB-TP6	Vzs	Zero Sequence Generation Motor side ,VZS
ACB-TP7	Vn	Motor Side Filter CAP Neutral Voltage, MFCN
ACB-TP8	V_pk	Motor Over Voltage Detection for UVW
ACB-TP9	Vdci1	Motor Side DCLINK Voltage for Bridge #1, VMDC1
ACB-TP10	Vdci2	Motor Side DCLINK Voltage for Bridge #2, VMDC2
ACB-TP11	Vuvs	Line Voltage Synchronous Feedback, VSAB
ACB-TP12	V2uv	Line Voltage Feedback ,2UV
ACB-TP13	V2vw	Line Voltage Feedback ,2VW
ACB-TP14	V2wu	Line Voltage Feedback ,2WU
ACB-TP15	I2u	Line current, CT2U
ACB-TP16	I2w	Line current, CT2W
ACB-TP17	Vzs2	Zero Sequence Generation Line side, VZS2
ACB-TP18	Vn1	Line Filter CAP Neutral Voltage for Bridge #1, LFCN1
ACB-TP19	V2_pk	AC over voltage detection for 2UVW
ACB-TP20	Vdcr1	Line side DCLINK Voltage for Bridge#1, VLDC1
ACB-TP21	Idc1	DCLINK current, HECSDC1
ACB-TP22	Vvws	Line Voltage Synchronous Feedback ,VSBC
ACB-TP23	V3uv	Line Voltage Feedback ,3UV
ACB-TP24	V3vw	Line Voltage Feedback ,3VW
ACB-TP25	V3wu	Line Voltage Feedback ,3WU
ACB-TP26	I3u	Line current, CT3U
ACB-TP27	I3w	Line current ,CT3W
ACB-TP28	Vzs3	Zero Sequence Generation Line side ,VZS3
ACB-TP29	Vn2	Line Filter CAP Neutral Voltage for Bridge #2 ,LFCN2
ACB-TP30	V3_pk	AC over voltage detection for 3UVW
ACB-TP31	Vdcr2	Line side DCLINK Voltage for Bridge#2, VLDC2
ACB-TP32	Idc2	DCLINK current ,HECSDC2
ACB-TP33	Vwus	Line Voltage Synchronous Feedback, VSAC
ACB-TP34	V4uv	Line Voltage Feedback ,4UV
ACB-TP35	V4vw	Line Voltage Feedback ,4VW
ACB-TP36	V4wu	Line Voltage Feedback ,4WU
ACB-TP37	I4u	Line current ,CT4U
ACB-TP38	I4w	Line current, CT4W
ACB-TP39	Vzs4	Zero Sequence Generation Line side ,VZS4 (spare one)
ACB-TP40	Vnn	CMC Neutral Voltage, VNN
ACB-TP41	Inn	CMC Neutral current ,INN
ACB-TP42	Ignd	Ground Fault current, GFCT
ACB-TP43	Vspr	Spare channel for inputs
ACB-TP44	Vmtrp	Motor Over Voltage Detection set point
ACB-TP45	A+	Encoder A+ input
ACB-TP46	B+	Encoder B+ input
ACB-TP47	Z+	Encoder Z+ input
ACB-TP48	A-	Encoder A-input
ACB-TP49	B-	Encoder B- input
ACB-TP50	Z-	Encoder Z- input

ACB Analog Control Board (cont.)

Table 5.E – Test Points on Analog Control Board (cont.)

Test points	Name	Description
ACB-TP51	CP1	Control Power monitoring for channel 1
ACB-TP52	CP2	Control Power monitoring for channel 2
ACB-TP53	CP3	Control Power monitoring for channel 3
ACB-TP54	CP4	Control Power monitoring for channel 4
ACB-TP55	Vltp	AC Over Voltage Detection set point for 2UVW&3UVW
ACB-TP56	AGND	Analog ground
ACB-TP57	AGND	Analog ground
ACB-TP58	AGND	Analog ground
ACB-TP59	AGND	Analog ground
ACB-TP60	+5V	+5V DC power supply
ACB-TP61	+15V	+15V DC power supply
ACB-TP62	-15V	-15V DC power supply
ACB-TP63	+24V	+24V DC power supply
ACB-TP64	-24V	-24V DC power supply
ACB-TP65	24VCOM	+/- 24V common
ACB-TP66	DGND	Digital ground
ACB-TP67	AGND	Analog ground
ACB-TP68	AP1	Analog Control Inputs, Air pressure input, AP1
ACB-TP69	AP0	Analog Control Inputs, Air pressure input, AP0
ACB-TP70	AIN1	Analog Control Input ,AIN1
ACB-TP71	AIN2	Analog Control Input ,AIN2
ACB-TP72	AIN0	Analog Control Input ,AIN0
ACB-TP73	AIN3	Analog Control Input ,AIN3
ACB-TP74	IPIS	Input Isolating Switch
ACB-TP75	IPCS	Input Contactor Status
ACB-TP76	IP	Input Contactor Command
ACB-TP77	OPIS	Output Isolating Switch
ACB-TP78	OPCS	Output Contactor Status
ACB-TP79	OP	Output Contactor Command
ACB-TP80	BPIS	Bypass Isolating Switch
ACB-TP81	BPCS	Bypass Contactor Status
ACB-TP82	BP	Bypass Contactor Command
ACB-TP83	DGND	Digital Ground Return

Interface Module (IFM)

The Interface Module is used to make all customer useable connections to the ACB. The pin numbers listed on the following pages refer to IFM pin numbers.

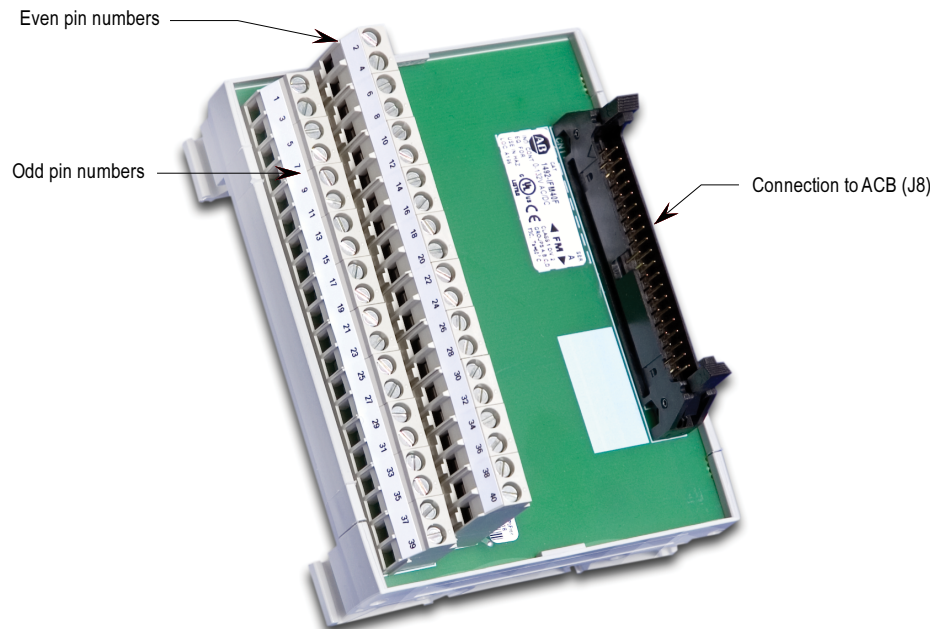


Figure 5.62 – Interface Module

Analog Inputs and Outputs

The PowerFlex 7000 offers one isolated process current loop transmitter and three isolated process current loop receivers, embedded into the control. These are accessible on the ACB.

The isolated Process Output is configured as 4-20 mA. The three isolated process inputs are individually configurable for either a range of -10/0/+10V or 4-20 mA (Refer to Programming Manual).

The following information will show the connections for each input and output.

ACB Analog Control Board (cont.)

Current Loop Transmitter

The current loop transmitter will transmit 4-20mA output to an external receiver. The loop compliance on the transmitter is 12.5V. Loop compliance is the maximum voltage at which a transmitter can generate to achieve the maximum current and is usually a function of the power supply voltage. Therefore, the PowerFlex 7000 transmitter can drive a receiver with an input resistance up to 625 ohms. The figure below shows a block diagram of the transmitter.

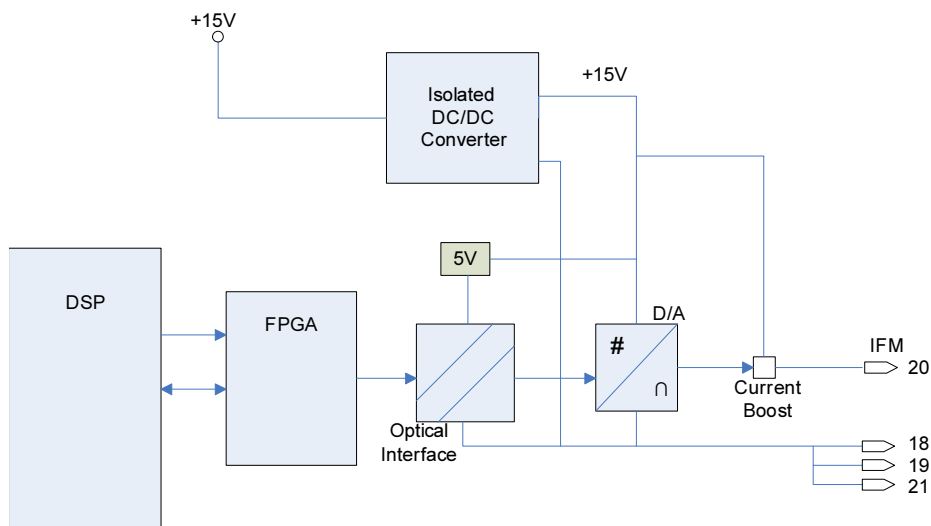


Figure 5.63 – Process Loop Transmitter Block Diagram

This type of transmitter is known as a 4-wire transmitter, and will “sink” current from a receiver. The receiver is connected by two wires only from pins 20 (+ connection) and either pins 18, 19, 21 (- connection).

The recommended connection is shown above. The type of shielded cable used is application specific and is determined by the length of the run, the characteristic impedance and the frequency content of the signal.

Isolated Process Receiver

These inputs are individually configurable to accept either a -10/0/+10V input signal or a 4-20 mA signal. When configured for voltage input, each channel has an input impedance of 75 Kohms. When used as a current loop input, the transmitter must have a minimum loop compliance of 2 volts to satisfy the 100 ohm input impedance. Regardless of input configuration, each input is individually isolated to $\pm 100\text{V DC}$ or 70V RMS AC.

A block diagram of the receiver is shown below.

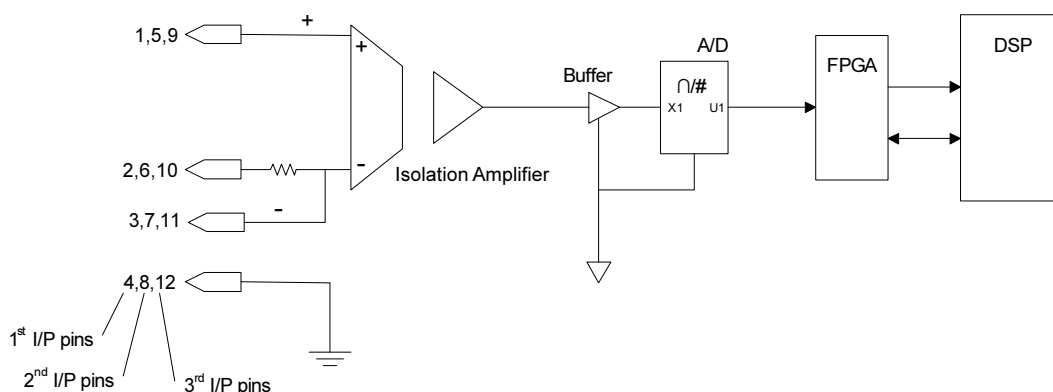


Figure 5.64 – Process Loop Receiver Block Diagram

The receiver can accept 4-wire transmitters. The figure below shows the recommended connections. Again, the type of shielded cable used is application specific as per the transmitter. Pin numbers shown are for connection to the first of three isolated process receivers.

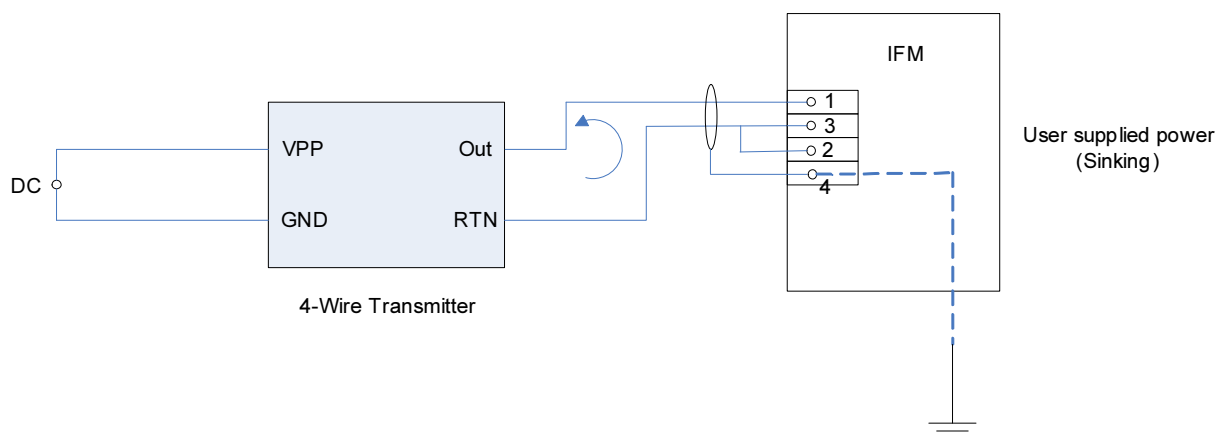


Figure 5.65 – Process Loop Receiver Connections

ACB Analog Control Board (cont.)

Non Isolated Process Outputs

The drive supplies four non isolated -10/0/+10 V outputs for customer use. These outputs can drive loads with impedances as low as 600 ohms. These outputs are all referenced to the Drive AGND and therefore should be isolated if they are required to drive outside the PowerFlex ‘A’ frame enclosure.

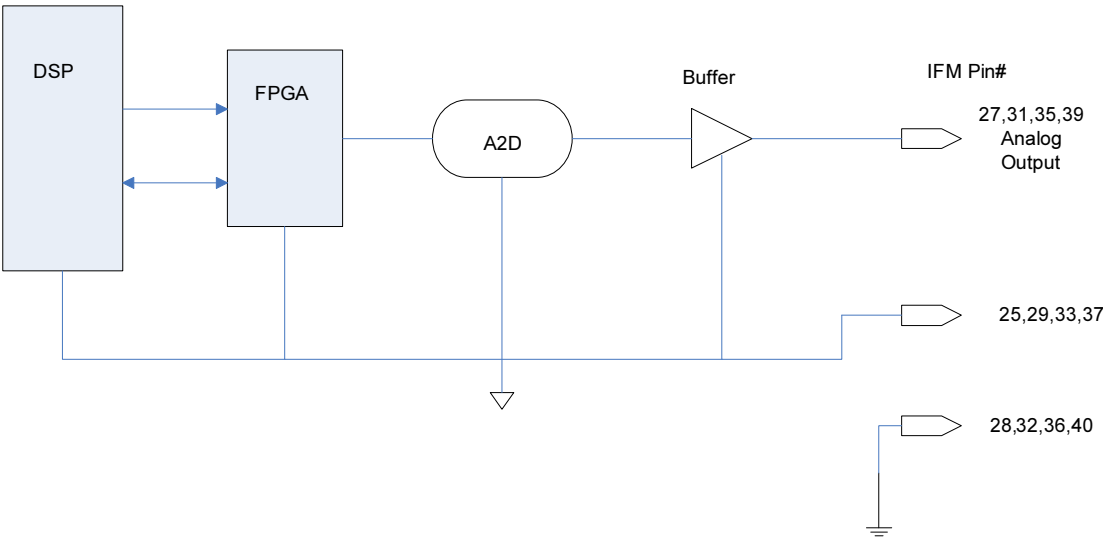


Figure 5.66 – Non-isolated Configurable Analog Outputs on ACB

Auxiliary +24V Power Supply

An Isolated 24V Power Supply is built into the DC/DC converter (Connector P3). This supply may be used for any customer supplied equipment requiring up to 24 watts at +24 volts. This supply may also be used to power any custom drive options, such as isolation modules for additional Process Control Outputs. The health of this power supply is monitored in the drive.

<u>PIN NO.</u>	<u>DESCRIPTION</u>
1	ISOLATOR (+24V, 1A)
2	ISOL_COMM (com4)
3	EARTH

The ACB is common for both the line and motor side current feedbacks. Different scaling resistors are mounted on the terminal block for line side and machine side

There are two LEDs on the ACB labeled D7 and D9. D9 is the ±15V DC voltage-OK signal, and D7 is the +5V DC voltage-OK signal.

ACB Analog Control Board Replacement

To replace the ACB Analog Control Boards,

1. Ensure that all medium voltage and control voltage power to the drive is isolated and locked out.
2. It is required to remove the transparent sheet on top of the Drive Processor Module and the Drive Processor Module also before removing the ACB. Remove the transparent sheet on top of the DPM by removing the 4 screws
3. Use static strap before removing any connectors.
4. Remove the connectors J4, J11 and J12 on DPM after proper identification and marking if necessary. Use the electrical drawing as the reference. Remove the 4 screws holding it on the standoffs above the ACB.
5. Gently remove the DPM mounted on the four, 34 pin connectors.
6. Remove the screws holding encoder interface board and gently remove the board mounted on the 8 pin connector
7. Remove the connectors J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J12, J13, J14, J16, J22, J24, J25, J26, J27 on ACB after proper identification and marking if necessary. Use the electrical drawing as the reference.
8. Remove the ACB board by removing the 4 screws, and 6 standoffs screwed to support the DPM & encoder interface board.
9. Follow Steps 8 – 2 in reverse to re-install the boards back into the low voltage control cabinet.
10. Apply Low Voltage power and complete a System Test and Medium Voltage tests to ensure the new board functions properly.

Tachometer Feedback Board Encoder Options

There are two positional encoder interface boards that may be used with the PowerFlex 7000 Forge Control. The encoder interface boards do not have any user accessible test points; however, buffered and isolated versions of each of the signals A+, A-, B+, B-, Z+ and Z- are available on the ACB at test points TP45-TP50.

Regardless of which type of encoder board, the following conditions should be adhered to:

1. Do not attach encoders with open collector outputs to the drive. Acceptable outputs are Analog Line Driver or Push Pull.
2. The drive will not operate properly if using single ended Quadrature encoders. Rockwell Automation recommends using differential inputs only for these types of encoders. Single ended outputs are only acceptable for Positional Encoders.

20B-ENC-1 & 20B-ENC-1-MX3 Encoder Interface

This encoder interface allows the drive to be connected to a standard Quadrature Encoder. The 20B-ENC encoder interface provides 3 optically isolated differential encoder inputs for A and B phases as well as a Z track. These inputs cannot be configured for use with a single ended Encoder. Differential encoders only are supported. The board also provides a galvanically isolated 12V/3Watt supply to power the attached encoder. The 20B-ENC-1 Encoder interface may be configured for +5V operation, however Rockwell recommends operation at 12V.

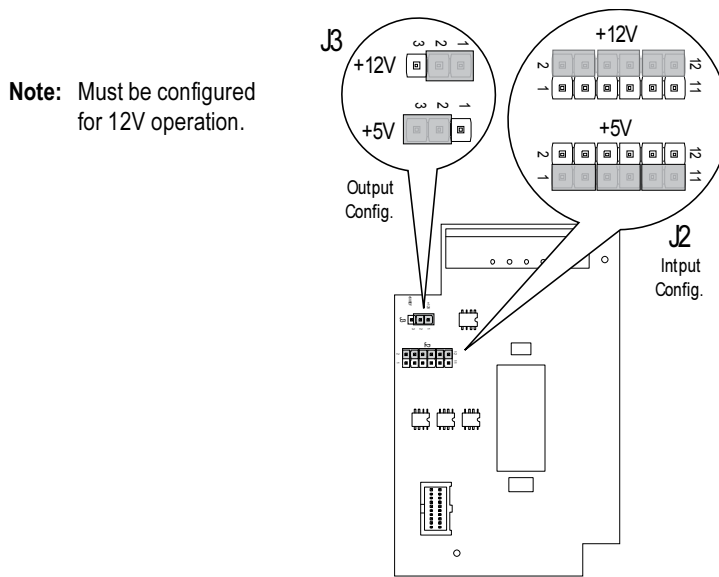


Figure 5.67 – Encoder Interface (20B-ENC-1 and 20B-ENC-1-MX3)

Operation at +5V does not allow for long cable lengths. The reason for this is that it requires the power to be regulated within 5% at the encoder. Due to the resistance and capacitance of the cable it would be very hard to keep the power regulated at the encoder to 4.75V. With longer runs of cable this could drop below the 4.75V and the encoder would not operate properly. As a general rule, using 18Avg cabling with an Rdc of 19.3 ohm/km the longest cable distance from the board to the encoder is limited to 12 m (42ft).

The 20B-ENC-1-MX3 encoder option is functionally identical to the 20B-ENC-1 encoder with the addition of conformal coating. Figure 5.67 shows the recommended jumper positions for use with the PowerFlex 7000 Drive.

Input Connections:

All encoder interface Connections are made to J1. The connections are as follows:

- J1 Pin 1 A+
- J1 Pin 2 A-
- J1 Pin 3 B+
- J1 Pin 4 B-
- J1 Pin 5 Z+
- J1 Pin 6 Z-
- J1 Pin 7 Encoder Power Return
- J1 Pin 8 Encoder Power (+12V @ 3 Watts)

Tachometer Feedback Board (cont.)

80190-759-01, 80190-759-02 Universal Encoder Interface

The Universal Encoder Interface allows the drive to be connected to an absolute position encoder or a standard quadrature encoder and also provides the option for dual or redundant quadrature encoders. The Universal Encoder Interface provides 12 single ended or 6 differential, optically isolated inputs as well as a 12V/3Watt galvanically isolated encoder power source. When using absolute encoders the 12 single ended inputs are used. For quadrature encoders the 6 differential inputs are used.

Either type of encoder with frequencies up to 200 KHz, can be interfaced to the Universal Encoder Interface.

The 80190-759-02 Universal Encoder Interface is functionally identical to the 80190-759-01 with the addition of conformal coating. The Universal Encoder interface is configured via jumpers installed on the 12-position header J4. The header has three positions labeled 'Park' and used to store the jumpers when indicated as "Removed" in the table below. Each function is selected by moving its corresponding jumper from the 'park' location to the selected function location if labeled "Installed". The following table describes the functions available.

ATTENTION



Removing the Universal Encoder Interface while control power is applied may result in damage to the board. Only remove the board when the control power is Off.

Table 5.F – Encoder Configurations

ENC_TYPE	POL_QRDNT	CD_DQUAD	CONFIGURATION
Installed	Installed	Installed	Single Quadrature Encoder Option (Factory Default)
Installed	Installed	Removed	Dual Quadrature Encoder Option without Redundancy
Installed	Removed	Removed	Dual Quadrature Encoder Option with Redundancy
Installed	Removed	Installed	Single Quadrature Option (CDSEL/DQUAD) must be removed for Redundancy
Removed	Installed	Installed	Gray Code Absolute Encoder Low True
Removed	Installed	Removed	Natural Binary Absolute Encoder Low True
Removed	Removed	Installed	Gray Code Absolute Encoder High True
Removed	Removed	Removed	Natural Binary Absolute Encoder High True



Table 5.G – Encoder Functions

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

Tachometer Feedback Board (cont.)

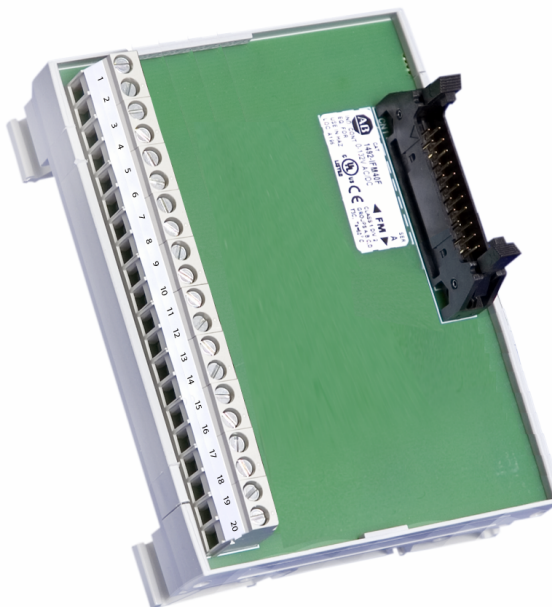


Figure 5.69 – 20-pin Interface Module (IFM)

Quadrature Encoder Operation

The Universal Encoder Interface will accept either single or dual quadrature encoders. Configuration of the board to accept the encoders is done through jumpers on J4.

Boards shipped from the factory come defaulted to single quadrature encoder configuration. ❶

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

To select the dual encoder option, remove the CD_QUAD jumper and place it in PARK. This will configure the board to accept two individual quadrature encoders. In this mode, the drive can switch between encoders for applications such as Synchronous Transfer between two motors with each having their own encoder.

For redundant encoder option, remove both the CD_QUAD and POL_QRDNT jumpers and place them in PARK. With this configuration, the drive will switch over to the redundant encoder when it detects a problem with the primary encoder.

❶ Consult factory for availability of dual Quadrature Encoder options.

ATTENTION

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

Positional Encoder Operations ②

Besides quadrature encoders, the Universal Encoder Interface will also accept positional (absolute) encoders. Parallel positional data is converted to a serial stream and transmitted to the DPM when requested by the drive. The board will also generate “pseudo” quadrature differential signals, including a zero position mark, derived from the binary data to the DPM.

There are three different positional encoder configurations available. For all of these configurations remove the ENC_TYPE jumper. The other jumpers configure the board for the type of positional data (Gray Code or Natural Binary) set by CD_DQUAD and High or Low True data set by POL_QRDNT.

1. **Gray code, Low True.** In this configuration the board will invert the incoming gray code data and then convert it to binary for transmission to the DPM.
2. **Natural Binary, Low True.** No conversion is done on the incoming data but it is inverted.
3. **Gray code, High True.** In this configuration, the incoming gray code data is simply converted to binary. No inversion is done on the input data.
4. **Natural Binary, High True.** The positional data is simply converted to the serial stream. No inversion or conversion is done on the data.

② Consult factory for availability of Positional Encoders.

Positional Encoder Guidelines

When selecting a positional encoder there are certain guidelines that should be followed for optimal performance.

1. **Code Selection:** Absolute encoders can be purchased with either Gray code or Binary output format. Gray code is a form of binary code where only a single bit changes at a time for each sequential number or position. The fact that only a single bit changes at a time make it easier for the Universal Encoder Interface to read valid positional data and not ambiguous data. If we compare the Natural Binary code to Gray code for the transition from 255 to 2556, here is what we get:

	Binary Code	Gray Code
255	011111111	010000000
256	100000000	110000000

All nine bits changed in the Binary Code while only the MSB of the Gray code changed. In the Universal Encoder Interface there are delays created by the frequency filter components and input hysteresis. Differences in these delays could cause errors due to reading a bit as ON when it is actually transitioning to OFF or vice versa. In the case of Gray code since only one bit ever changes the ambiguity error is never more than one count. For this reason and to reduce inrush currents, Rockwell Automation recommends using Gray code Positional Encoders.

2. **Data Polarity:** Absolute encoders typically have a High True output. If the encoder model does not have a High/True (or Non Inverted/Inverted) option you should assume it to be High True. In the case of a 10bit High True encoder the zero position is represented by 0000000000. Whereas a Low/True encoder the zero position is 1111111111. On the Universal Encoder Interface the position data is inverted in hardware. That is a '1' will turn on an Optocoupler producing a '0'. Therefore a High True encoder would produce 1111111111 for the zero position. With the POL_QRDNT jumper you can control the polarity of the input. With the jumper installed (factory default) it is setup to accept High True encoders and an extra inversion is done in the Universal Encoder Interface. If you are using a Low True encoder then this jumper needs to be removed so that the zero position is inverted by the optocouplers alone.

The other role of the POL_QRDNT jumper is to correct the data in the event the encoder was mounted so that a CCW rotation produced decrementing counts. If this is the case the POL_QRDNT jumper should be configured to the opposite of what it should normally be for the data polarity. For example if the Universal Encoder Interface is configured to operate with High True encoders (POL_QRDNT installed), remove it to correct for encoder mounting.

External Input/Output Boards

The External Input/Output (XIO) Boards are connected through a network cable (CAN Link) to the Analog Control Board (ACB). This cable may be connected to either XIO Link A (J4) or XIO Link B (J5). The XIO board handles all external Digital Input and Output signals and sends them to the ACB through the cable. There are 16 Isolated Inputs and 16 Isolated Outputs on the card, and they are used for Runtime I/O including Start, Stop, Run, Fault, Warning, Jog, and External Reset signals. The boards also handle the standard drive fault signals (Transformer/Line Reactor Overtemperature, DC Link Overtemperature, etc.) and several spare configurable fault inputs. There is an option in software to assign each XIO a specific function (General IO, External IO or Liquid Cooling).

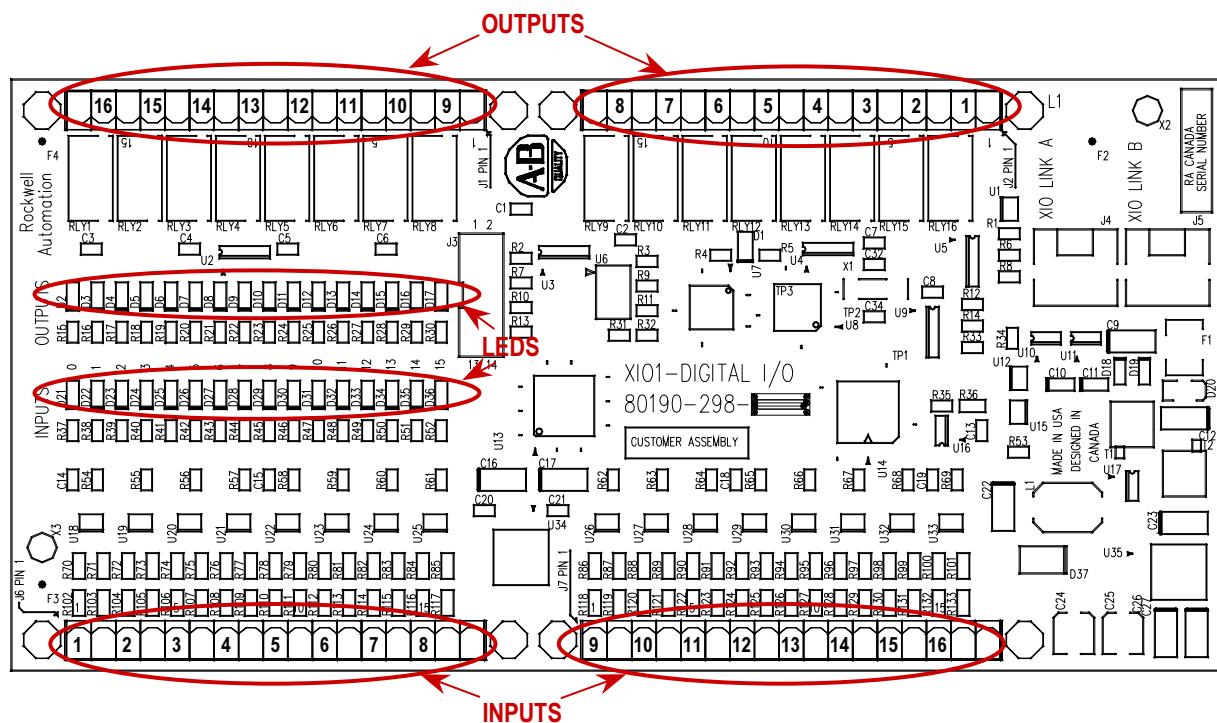


Figure 5.70 – XIO Board

The standard drive comes with one XIO board; additional boards (up to 5) can be daisy chained together from XIO Link B (J5) on the first board to XIO Link A (J4) on the second board, for a total of 6 XIO cards. However, at this time the drive only supports the use of addresses 1 to 3, depending on the drive's features and application. U6 on the XIO board displays the board's address which is automatically calculated from the XIO board's position in the network.

XIO Link A and B ports are interchangeable but it may make wiring easier to follow if Link A is used for “upstream”, that is, closest to the ACB, and Link B is used for “downstream” or farthest from the ACB.

LED D1 and display U6 indicate the status of the board. The following table illustrates the possible states for D1.

LED Status	Description
Solid Green	Normal Operation
Solid Red	Board Failure
Alternate Flashing of Red and Green	No Communication Available to ACB board (Normal during boot-up or unprogrammed)

Table 5.F – Status of U6 Display

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

External Input/Output Board Replacement

To replace the External Input/Output Boards:

1. Ensure that all medium voltage and control voltage power to the drive is isolated and locked out.
2. Note and Mark the location and orientation of all the plugs, cables, and connectors into the XIO board. Use the electrical drawing as a reference.
3. Using your static strap, disconnect all of the connections.
4. Remove the XIO board assembly from the low voltage control cabinet. The XIO board mounts on a DIN rail, so a special 3-piece assembly is used to secure the board. The assembly does not come with the new board, so the old board needs to be removed from the assembly and the new board installed in its place.
5. Install the new XIO board assembly in the low voltage control cabinet.
6. Reconnect all connections and verify the locations.
7. Apply Low Voltage power and complete a System Test and Medium Voltage tests to ensure the new board functions properly.

Optical Interface Boards

The Optical Interface (OIB) Boards are the interface between the DPM and the Gate Driver circuitry. The drive control decides which device to fire, and sends an electrical signal to the OIB boards. The OIB board converts that electrical signal to an optical signal, which is transmitted via fiber optics to the gate driver cards. Typically, the Transmit ports are Grey and the Receive ports are Blue. The gate driver accepts that signal and turns the device on and off accordingly. The diagnostic fiber optic signals work the same way, but the source is the gate driver boards and the destination is the drive control boards. Each OIB contains one extra fiber optic receiver (RX7), which is used for temperature measurement.

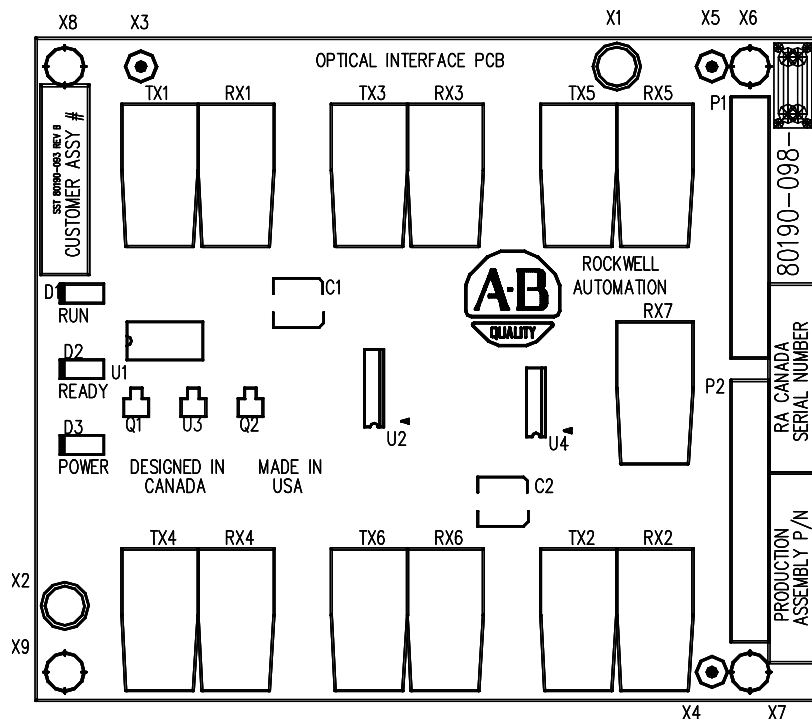


Figure 5.71 – Optical Interface Board

The OIB boards are mounted directly on the Optical Interface Base Board (OIBB) using two parallel 14-pin connectors for the electrical connection, and plastic clips to provide the mechanical strength. There is one OIBB for the inverter, and one OIBB for the rectifier device. The OIBBs are interfaced to the DPM using two ribbon cables to connect to J11 and J12.

Each OIB board can handle the Firing and Diagnostic duplex fiber optic connector for 6 devices, whether they are SCRs or SGCTs. Physically, on the OIBBs, there is provision for 18 devices for the inverter and the rectifier. This is enough capacity to handle the highest rated drive that we currently produce. The top OIB board on the OIBB is for the 'A' devices, the middle OIB board on the OIBB is for the 'B' devices, and the bottom OIB board on the OIBB is for the 'C' devices.

Optical Interface Boards
(cont.)

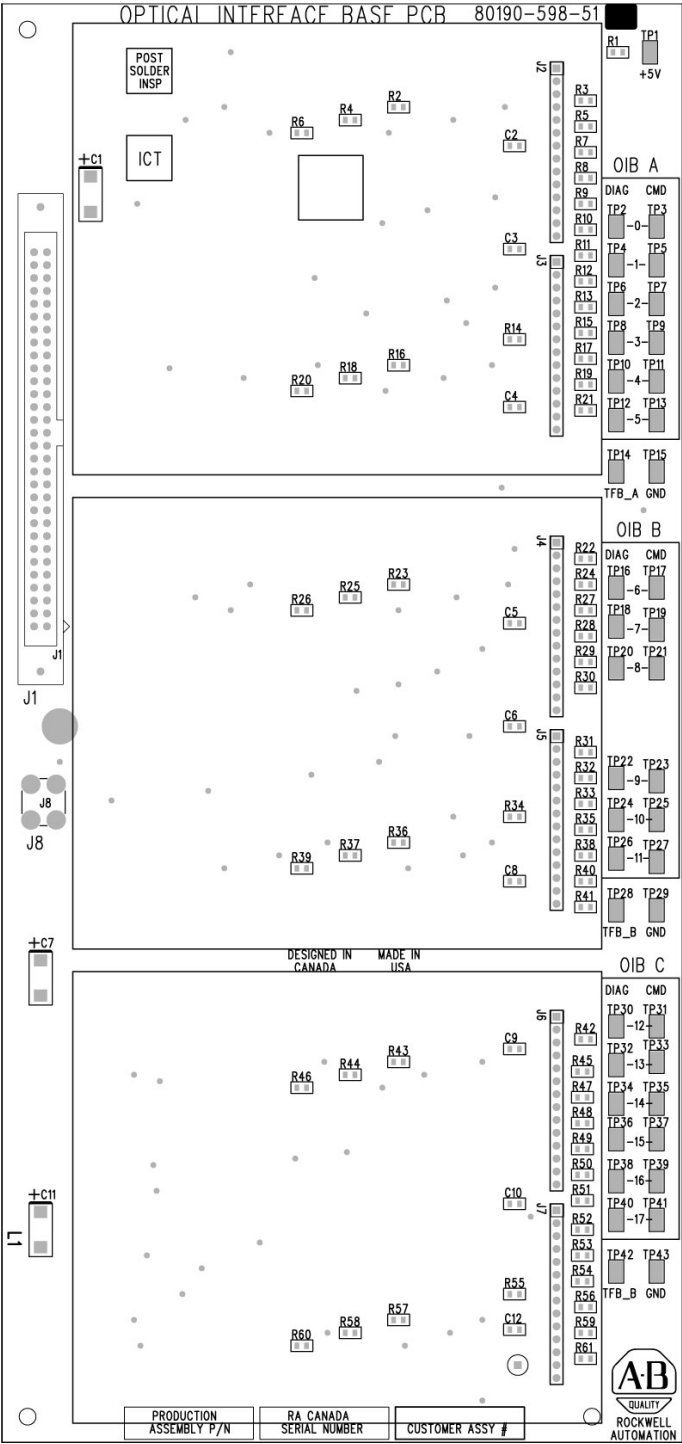


Figure 5.72 – Optical Interface Base Board (OIBB)

Each OIB also has input RX7 for a signal from a Temperature Feedback Board. The quantity and location of thermistor connections is dependant on the drive configuration. Typically there is one temperature sensor from the Line Converter and one temperature sensor from the Machine Converter, each going into the respective OIB in the 'A' position. However some drive configurations only require one thermistor feedback connection. The temperature feedback connection on OIBC is not implemented on the OIBB and is never used. For more information, see the drawings supplied with your drive. The alarm and trip setpoints for each of these signals is programmable in software.

There are 3 LEDs on the OIB, and the following table illustrates the status and description for the LED states:

LED	Status	Description
D1	Red – On	Run – The OIB has received an Enable signal. The drive control software is in control of all gating.
D2	Yellow – On	Ready –The OIB power supply is sufficient for proper operation.
D3	Green – On	Power – The OIB has received a voltage signal greater than 2V.

Optical Interface Board Replacement

To replace the Optical Interface Boards:

1. Ensure that all medium voltage and control voltage power to the drive is isolated and locked out.
2. Note and mark the location and orientation of all the fiber optic cables. Use the electrical drawing for reference.
3. Using your static strap, disconnect all of the connections. It may be necessary to remove the 60 core cable connectors on the Optical interface base and the ground connection for access to the standoffs
4. Remove the OIB board from the OIBB. There are four standoffs that snap into place on the OIB, and they need to be carefully handled when disconnecting the boards. There is also the 28-pin connection between the boards, and this connection should be handled carefully as you do not want to bend the pins.
5. Install the new OIB on the OIBB. Ensure the standoffs snap into place.
6. Reconnect all fiber optic connections and verify the locations.
7. Apply Low Voltage power and complete a Gating Test, System Test and Medium Voltage tests to ensure the new board functions properly.

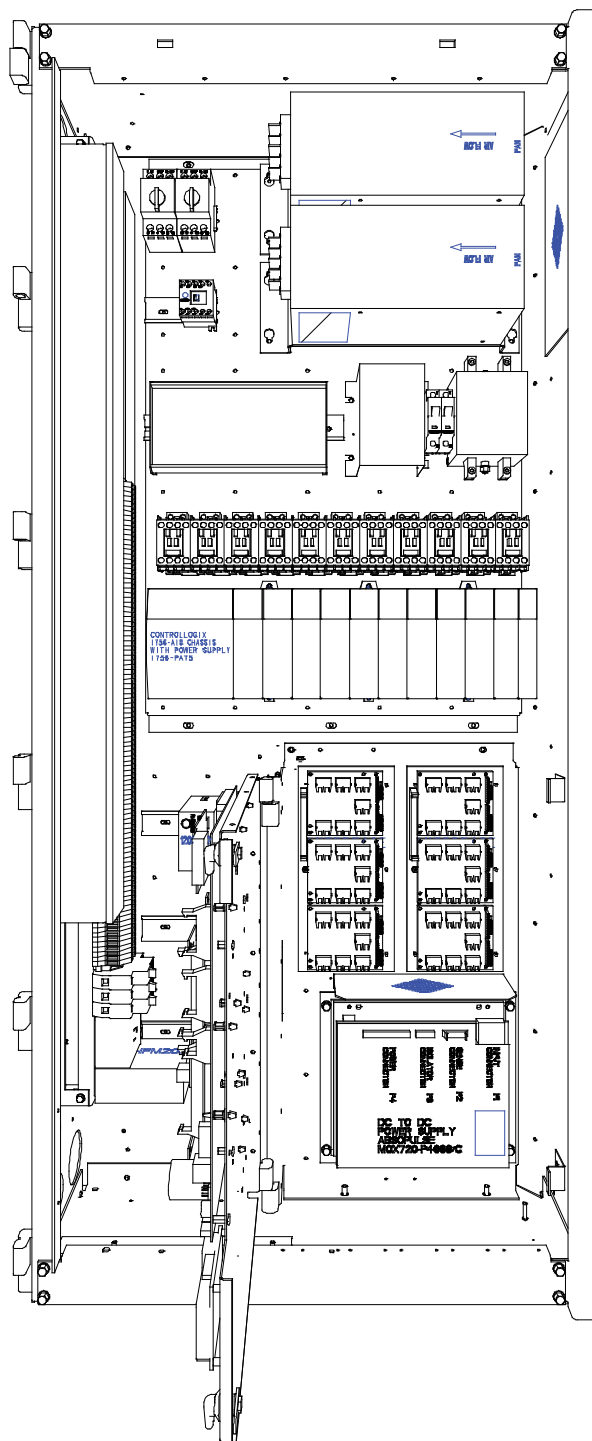


Figure 5.73 – OIB Replacement (Mounting Plate Accessible)

Downloading Firmware

Introduction

With the introduction of the PowerFlex 7000 Medium Voltage Drive, all drive control functions are loaded on the Drive Processor Module (DPM) with firmware via a serial connection on the Drive Processor Module data port J4. The firmware is packaged into a single executable file (with the extension .exe).

This document describes how to download new or updated firmware to the drive using the DPM data port. All firmware downloaded via this means is stored in non-volatile Flash memory.

The latest firmware and the associated release notes are available on the Medium Voltage intranet site, or can be obtained from Medium Voltage Product Support.

Overview

When the system is powered up, the drive executes the Application Code contained in the on-board flash memory. If it does not have valid firmware, then the entire system will drop into a download mode. In the download mode the system is waiting to receive a firmware download via the serial data port J4 on the DPM.

The system may also be placed into download mode from the Drive Terminal. This can only be accomplished if you have obtained a minimum of 'ADVANCED' level access. Once that has been obtained, from the main screen selecting UTILITY-TRANSFER-SYSTEM will place the drive into download mode.

Preparation for Downloading Firmware

Ensure the parameters are saved to NVRAM, and saved to the Operator Interface Terminal, and saved to any other external source such as the Flash Card, DriveTools, or printed to a hardcopy.

Hit F10 (Access), and highlight Advanced. Press Enter, or enter the password value (if password required) and you should have Advanced level access.

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

Hit F10 to Exit, and then F5 for NVRAM. Press F5 for SAVE, and F8 for YES. The parameters should now be saved to NVRAM. Press F10 again to EXIT.

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

To save to the Operator Interface Terminal and Flash Card, Press F2 (UTILITY), F7 (TRANSFER), and F4 (PARAMETERS). You should now be on the following screen:

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

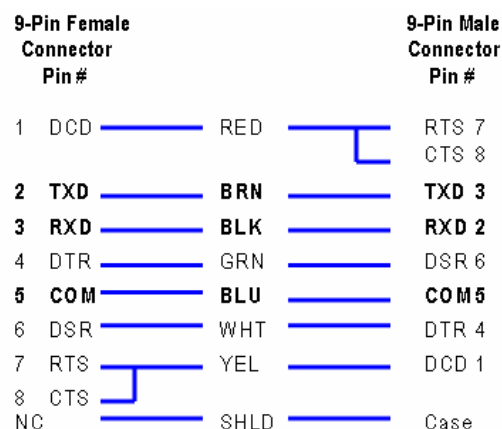
In order to save parameters to the Operator Interface Terminal, press F5 (DRV>MEM). To save to the Flash Card, you must first insert the card in the terminal. Remove the back cover and insert the card in the slot on the terminal. It can only go in one way. Then press F4 (DRV>CRD).

Saving to the card means that you will have to choose a file name. Use the Up and Down arrows to select the character, and then use the Right arrow to go to the next character. Press the Enter key when finished.

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

Press F8 for YES, and the parameters will be transferred to the card. Press F10 to EXIT.

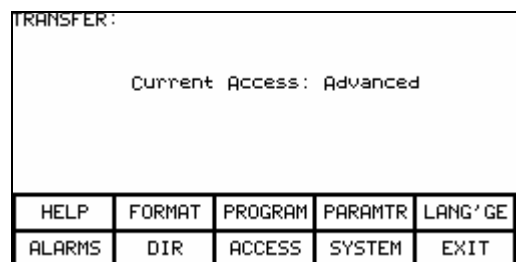
Here is a typical pin out of a complete null-modem cable. Essentially, only 3 pins (2, 3 and 5) are all that is required.



Preparation for Downloading Firmware (cont.)

PF7000 in Download Mode

To place the drive in download mode, you should be in the UTILITY – TRANSFER screen. You will not be able to do this if the drive is running. Ensure the drive is stopped, and the E-Stop is pressed. This is just a precaution, as all versions of firmware 7.xxx and later will not allow you to attempt a download while running.



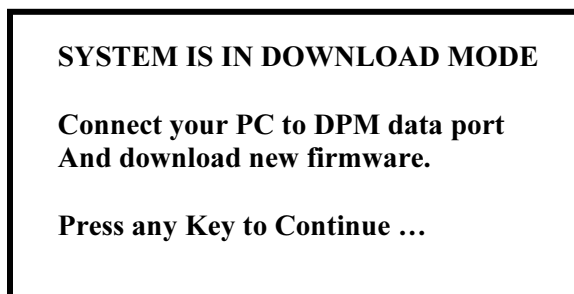
This time press F9 for SYSTEM, and a screen will appear telling you that you are in download mode, and to recycle control power once the download is complete.

There are two status LEDs (D9 and D11) on the DPM, which provides indication of the programming process. The following illustrates the states of the LED:

Solid Green – when both LEDs are solid green, the Application firmware is running.

Flashing Green – when either D9 or both LEDs are flashing, the board is in download mode. (If the DPM bootcode is ≥ 1.005 , then only D9 will be flashing and D11 will stay solid. But if the bootcode is ≤ 1.005 , then both LEDs will be flashing.)

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



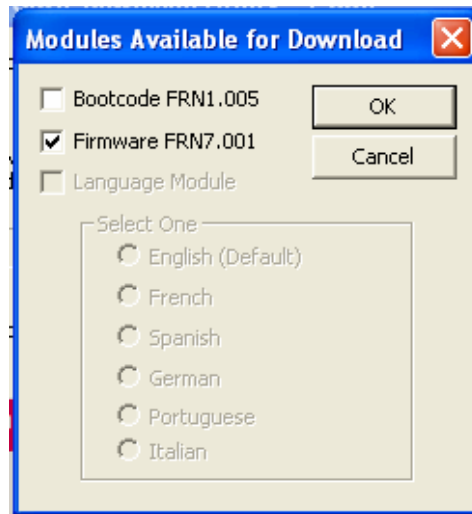
If you press any Key after this message the PanelView will show:

COMMUNICATION ERROR

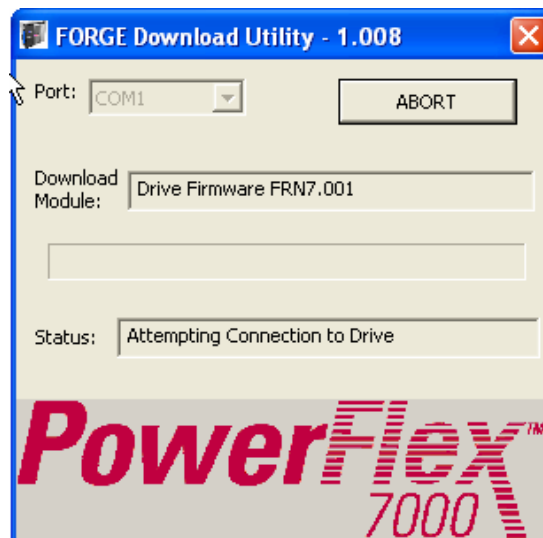
Connect your PC to the DPM data port J4. Locate the PowerFlex 7000 Medium Voltage Drive firmware an executable file



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

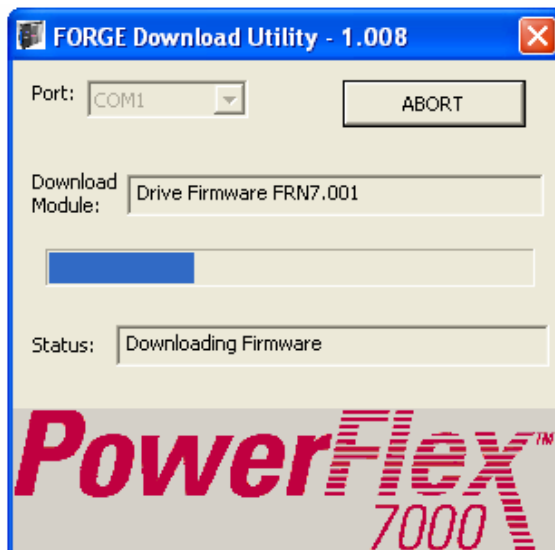


The DPM are preloaded with Bootcode and select the Firmware by clicking in the checkbox against Firmware and click OK. This will start the process of the downloading of firmware, attempting connection to the drive. The following screen will be displayed:

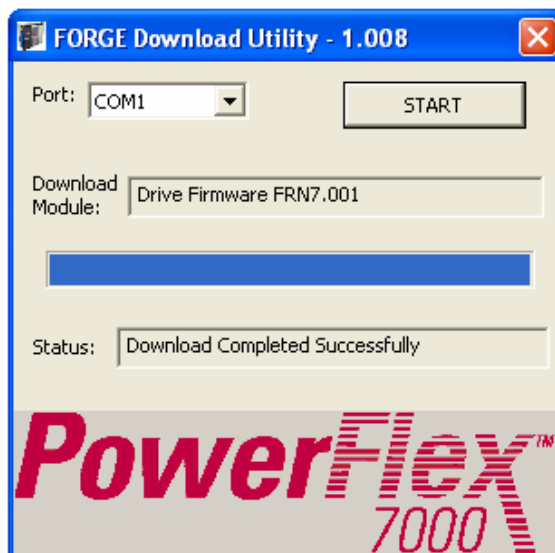


Preparation for Downloading Firmware (cont.)

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



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



If the DPM does not have bootcode or needs an upgrade, then first select the Bootcode by clicking in the checkbox against Bootcode and click OK. After downloading the bootcode proceed with the drive firmware download as explained earlier.

After downloading new firmware, the DPM resets automatically.

Reloading the Parameters

For major revision level upgrades, the majority of the parameters that were stored in the Operator Interface or other external means can still be used, but there may be things such as new parameters, changed scaling on an existing parameter, or added functionality to existing parameters that may have to be addressed. IT IS IMPORTANT TO REFER TO THE RELEASE NOTES BEFORE UPGRADING FIRMWARE.

To reload the parameters from the Operator Interface, once again obtain ADVANCED level access.

Then follow the same steps to get to the UTILITIES – TRANSFER – PARAMETERS screen. Then choose F3 (MEM>DRV). This will prompt you for confirmation, and you can press F8 for YES.

The parameters will then be transferred. There are differences between parameters for different revision levels, so you may get some errors, and a Transfer Incomplete message.

You can also transfer from the Card to the Drive using F2 (CRD>DRV), and the difference is that you will first get a screen asking you to choose from all the available parameter listings on the card. Select the one you want using the arrow keys, and press Enter. Then you can press F8 for Yes and transfer the parameters. Once the parameters are transferred, press the F10 (EXIT) key to get back to the main screen.

It is important to go through the parameters and ensure the settings are proper for the drive. New parameters may need to be changed for the specific drive application, and this should be understood from reviewing the release notes beforehand. You should also correct any information such as the drive name, the operating hours, or the external fault text, if present.

You should then press F5 (NVRAM), and save the parameters to NVRAM.

Then cycle control power one more time, and the drive should come up with no faults or warnings, and the drive will be ready to run. At this point you may also want to save the parameters to the Operator Interface terminal, the Flash Card, via software, or as a hardcopy. This will provide a record of the new settings.

Setting Elapsed Time

When you replace the existing DPM board in the drive with a new board, the operating hours counter will start from zero. Therefore, if you want to keep the actual operating hours in the drive, you can restore them by running a utility program (Sethobb.exe), which is usually supplied with the firmware package. You can also request a copy of the program by e-mail at **MVSupport_Technical@ra.rockwell.com**. Follow the steps below to set the elapsed time in the drive.

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

Downloading the Terminal Firmware

The Operator Terminal is an interface used to interact with a PowerFlex7000 drive. In order to communicate with the drive, the Terminal needs a valid firmware. If it lacks the software, it does not have the necessary information to communicate with the Analog Control Board (ACB).

There are two methods of downloading the firmware into the Terminal, which are described below.

Using Flash Memory Card

If using a Flash Memory Card (2711-NM4 or 2711-NM8 or 2711-NM16), copy the appropriate file to the Flash Card in the root directory. Ensure that there are no other files on the card containing the .FMW extension.

Power off the Terminal and insert the memory card. Apply power to the terminal. The terminal on power-up will sense new firmware and download it from the card. You will see a series of codes on the screen (2 – 20 – 21 ...) and then the drive application firmware will start. The process may take several minutes. When the download is finished, remove the card from the Terminal. (If you leave the card in the terminal, it will reload the firmware each time the terminal is powered up).

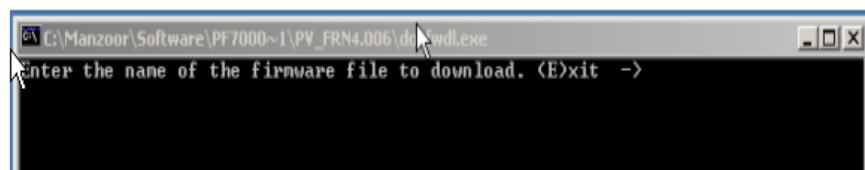
DOSFWDL

This is a DOS program which copies the .FMW file out the serial port of the laptop to the serial port of the terminal. The program is usually included in the firmware package. The method is described below. In this example, we are using firmware file **FRN_4006.FMW**.

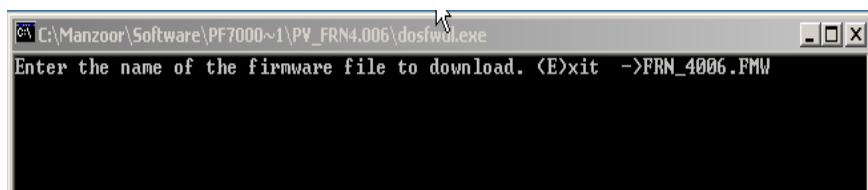
Note: If you are using a newer firmware, just make sure the filename is max 8 character long. You can rename the file, but keep the filename extension as .FMW. Also, when you are prompted to enter the filename, make sure you enter the correct filename as illustrated in the following example.

Method

1. Make sure the Terminal is powered off. Disconnect Terminal's serial cable connector from Analog Processor Board (ACB) and connect it to the serial port on your laptop. (You may need a gender changer.)
2. Turn on your laptop and run **dosfwdl.exe** program. On your laptop, you should see the screen similar to one shown below.

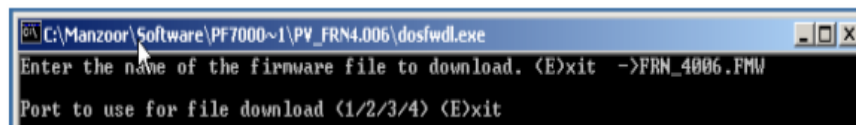


3. Type in the firmware filename (e.g., **FRN_4006.FMW**) as shown in the screen below and then hit **Enter** key.



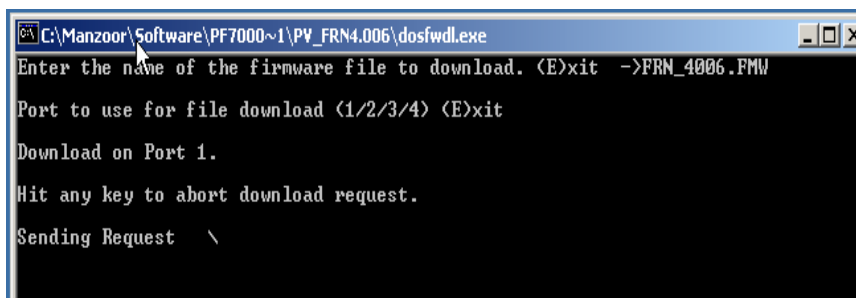
Downloading the Terminal Firmware (cont.)

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



```
C:\Manzoor\Software\PF7000~1\PV_FRN4.006\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
```

- 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.

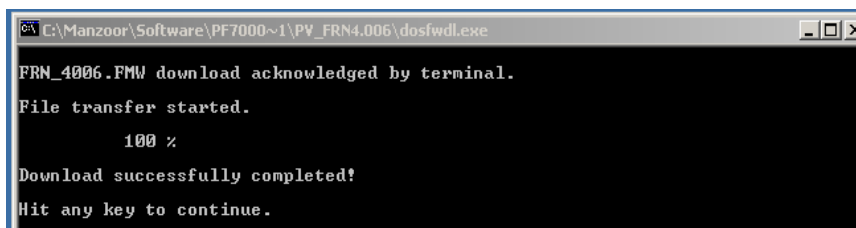


```
C:\Manzoor\Software\PF7000~1\PV_FRN4.006\dosfwdl.exe
FRN_4006.FMW download acknowledged by terminal.
Terminal verifying file and preparing for transfer.
```

- 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.
```

8. Once the firmware download is complete, the message “***Download successfully completed!***” will appear on your laptop screen. At this point, press any key to close the **DOSFWDL** program.
9. Now, remove the serial cable from your laptop and connect it to ACB board port J12. The Terminal will now start communicating with the drive.

Setting up Diagnostic Trending

The diagnostic trending is a valuable tool for troubleshooting faults in the drive. It is a method of capturing the variation in the values of different variables over a period of time prior to and after a fault or warning condition. In the PF7000 drive with ForGe control, the maximum number of parameters that can be assigned for trending is 16. The length of the trend buffer is 100 samples.

Diagnostic Setup

The diagnostic setup is used to define the source of the diagnostic trigger. Information that has to be programmed in the diagnostic setup is listed below:

Trace	The Read-Only Parameter which is assigned to a particular list. The item linked to Trace 1 is used as the trigger value . There are 16 traces in total, although not all have to be active.
Rate	The time delay between sample periods. Any value between 0 and 20,000 msec can be set. Use numeric keypad to enter the value and press the enter key to accept.
Post	The percentage of the list which will occur after the after the trigger point. Any value between 0 and 100% may be used.
Trigger	Defines whether you want a continuous or a single-shot trigger. Pressing this key will place an S or a C in front of the trigger parameter. You will almost always want a Single-Shot (S) trigger.

S = Single shot >> the trigger occurs only once and stops. The trigger must be manually re-armed. The Re-Arm function clears the memory buffer, which contains the data stored from the previous trend. It is necessary to reset the trending feature in order for a second trigger to occur, unless you have continuous trigger enabled.

Setting up Diagnostic Trending (cont.)

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

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

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

Data Defines the trigger value with respect to the read-only parameter in Trace 1.

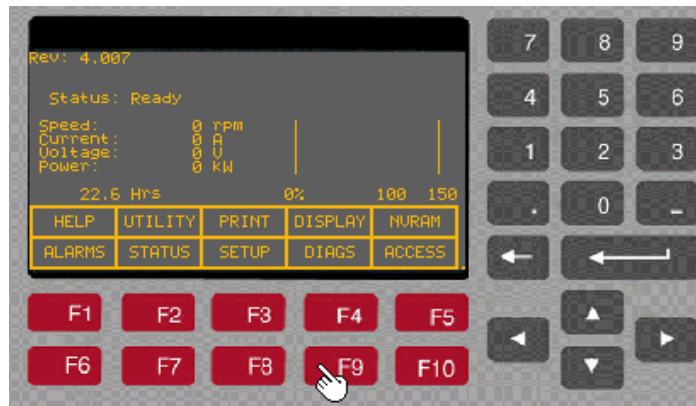
Setting up the Trend

The Access level must be **Basic** or higher level before programming the drive's trending feature. To change Access level to **Basic**, press **F10** [Access] key on the main screen. The display will change to 'Access' screen. Select **Basic** by pressing down-arrow key and then press **Enter** key. The Access level will change to **Basic**. Press **F10** [EXIT] key again to exit to the main screen.

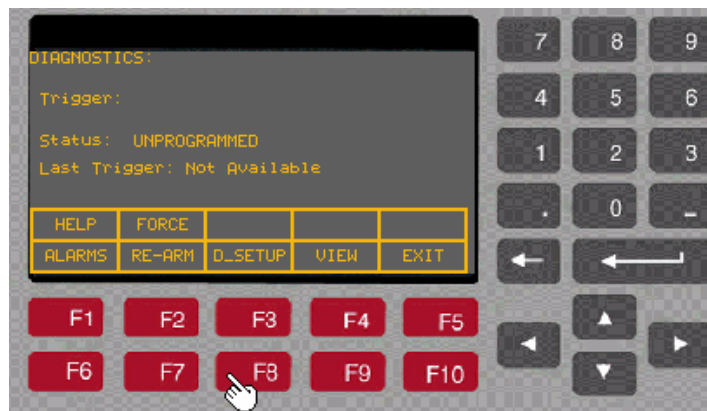
Note: The parameter assigned to **Trace1** is used for trigger purpose. The **Condition** and **Data** defined in steps 11 and 12 must be satisfied for the trend to trigger. In most cases the parameter **569 "DrvStatus Flag1"** is assigned to Trace1 for trigger purpose. A value of **18 Hex** for **Data** (Step-12 below) is used to capture the trend when the drive detects either an Alarm or a Fault condition. If you are interested in the fault condition only then set **Data** as **8 Hex**. If you are interested in Alarm condition only then set **Data** as **10 Hex**.

You can reset the Alarm or Fault in the drive, but don't Re-Arm the trend until you print (upload) the trend data into your laptop. Print the Alarm Queue as well, so that you know which alarm or fault condition was detected by the drive.

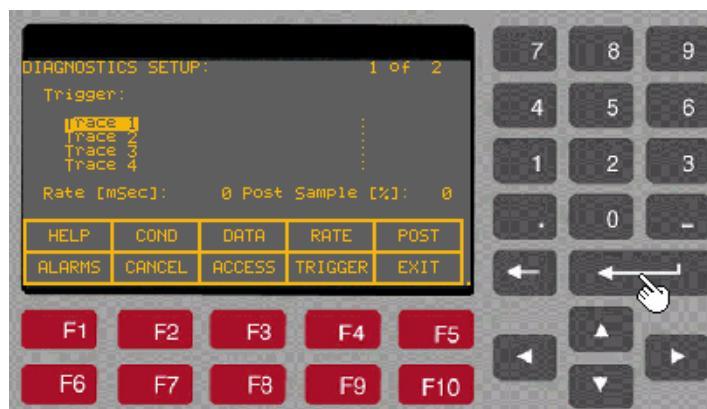
1. Press **F9** [**DIAGS**] key on the main screen to display '**Diagnostics**' screen as shown in the picture below.



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



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

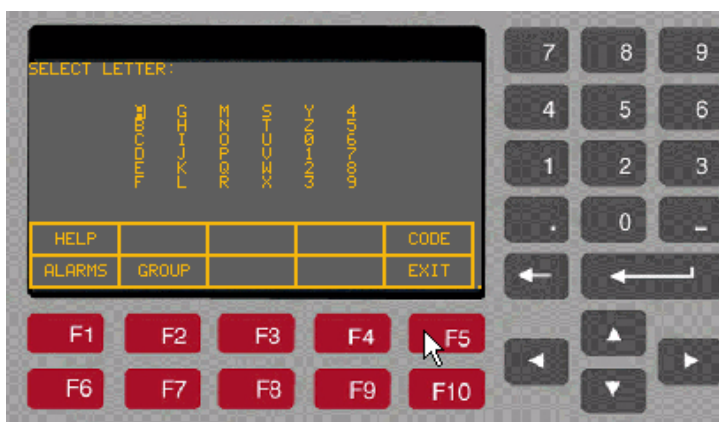


Setting up Diagnostic Trending (cont.)

4. The display will change to '*Select Group*' screen as shown in the picture below. Now there are three ways to find the desired a parameter, (i) search by group (select the group by pressing up or down arrow keys and then press Enter key), (ii) search by Alphabetical order (press F7 key to move to the letters screen from there you can search the parameter by highlighting the first letter of the parameter and then pressing the Enter key), (iii) by entering the parameter linear number (press F7 and then F5 for the Code). In the following example we will select the parameter by using a Linear number (i.e., we will enter the Code). For this follow the steps outlined below.



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



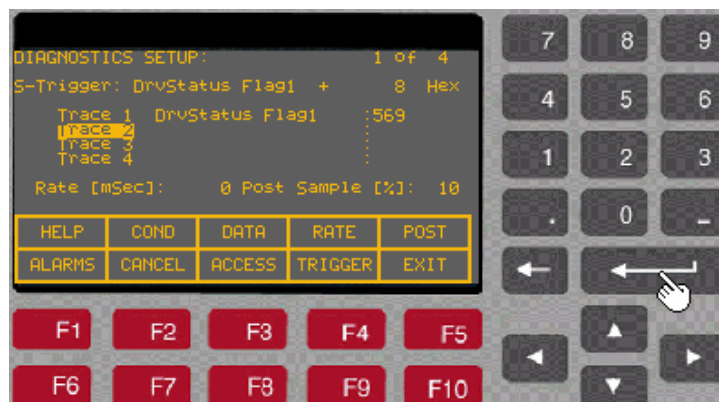
6. Press **F5** [*CODE*]. The display will change to '*Select Code*' screen as shown in the picture below.



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.

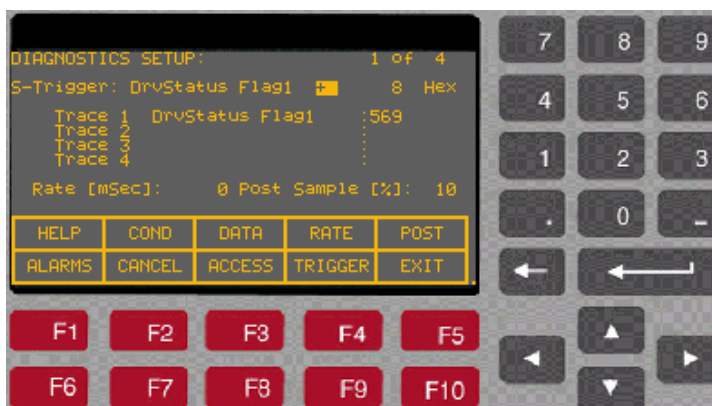


8. Press **Enter** key again. The display will change to the 'Diagnostics Setup' screen and the desired parameter gets assigned to **Trace 1**. Now, press the down arrow key to move the cursor to **Trace 2** and repeat steps 3 – 8 above to assign a parameter to **Trace 2**.

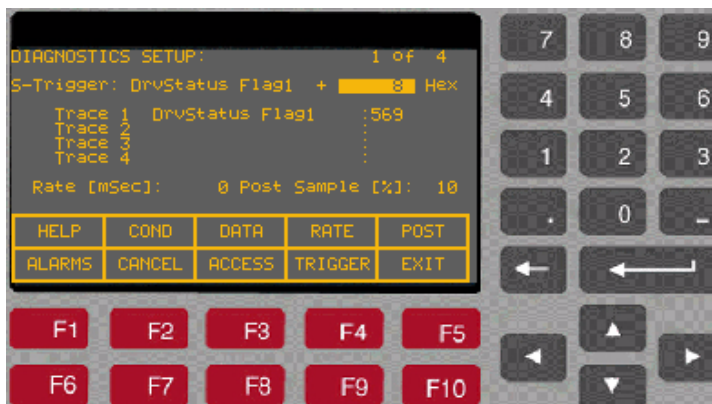


Setting up Diagnostic Trending (cont.)

9. Repeat above steps until you have assigned the desired parameters to all the traces from Trace1 to Trace16.
10. Now press **F9** [**TRIGGER**] key. The first letter in the second line on the screen will toggle between **C** and **S**. The letter **C** stands for 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 **8** and then press **Enter** key.



13. Press **F4** [**RATE**] key. The cursor moves to the rate field. Here we will enter **0**, which is the fastest sample rate (1 msec/sample) and then press **Enter** key.



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



15. Now, press **F10 [EXIT]** key to exit to 'Diagnostic' screen. On the 'Diagnostics' screen, verify that the Status is 'Running', which means the Diagnostic Trend is ready and will capture the data whenever the trigger condition is satisfied. If the Status shows 'Stopped' then press **F7 [Re-Arm]** key. This will change the Status to **Running**.



16. Now press **F10 [EXIT]** to exit to the main screen.

Printing (Uploading) Data from the Drive

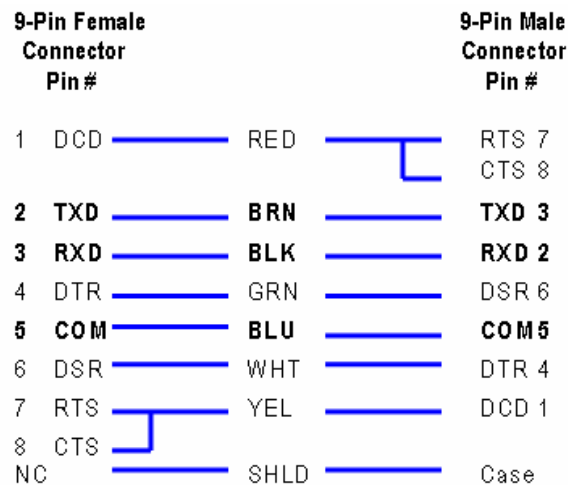
Overview

The data from the drive; such as drive setup, parameters, variables, trend data, fault masks, alarm queues etc., can be uploaded and saved into laptop using HyperTerminal program. When using the HyperTerminal program to upload the data, you will be prompted to select a file to store this data. Therefore, you need to open an empty Notepad file and then save that file on your pc before uploading the data from the drive. The following example illustrates the method to create an empty **.txt** file (example1.txt) and upload (or print) the data from drive into laptop.

Required:

- Laptop with Windows HyperTerminal program
- A null-modem cable with a 9-pin female connector for the laptop serial port, and a 9-pin male connector for the ACB Printer Port (**J11**).
(A serial cable with pins 2-3 swapped at one end will also work)

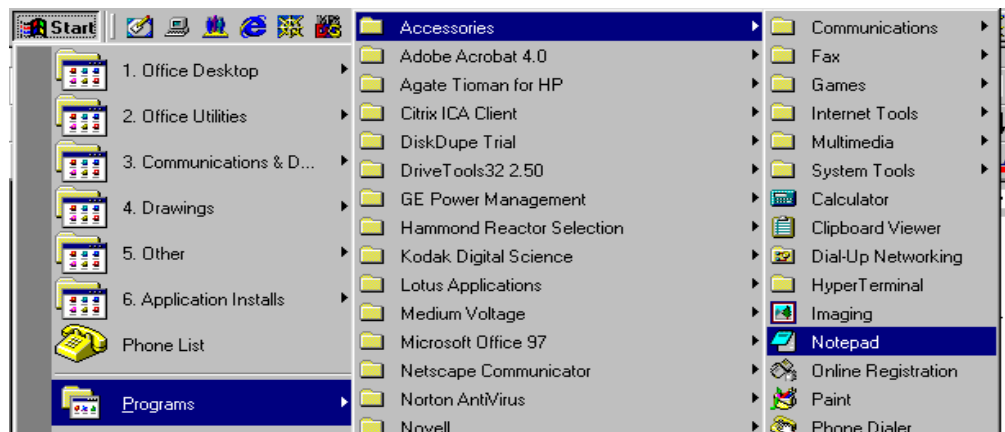
Here is a typical pin out of a complete null-modem cable. Essentially, only 3 pins (2, 3 and 5) are all that is required.



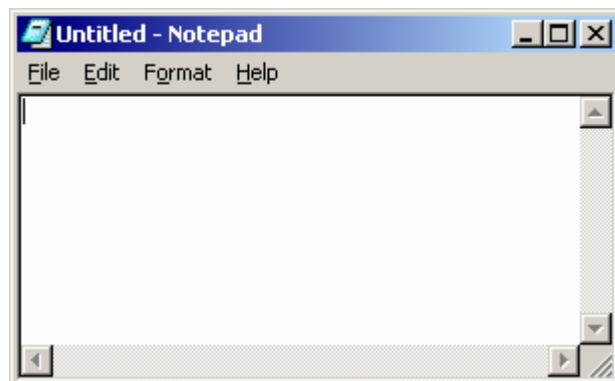
Method

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

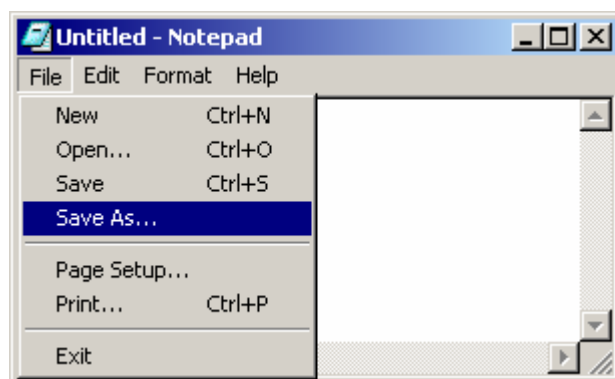
- Run **NotePad** Program (**Start** → **Program** → **Accessories** → **Notepad**)



- A blank Notepad window will appear as shown below.

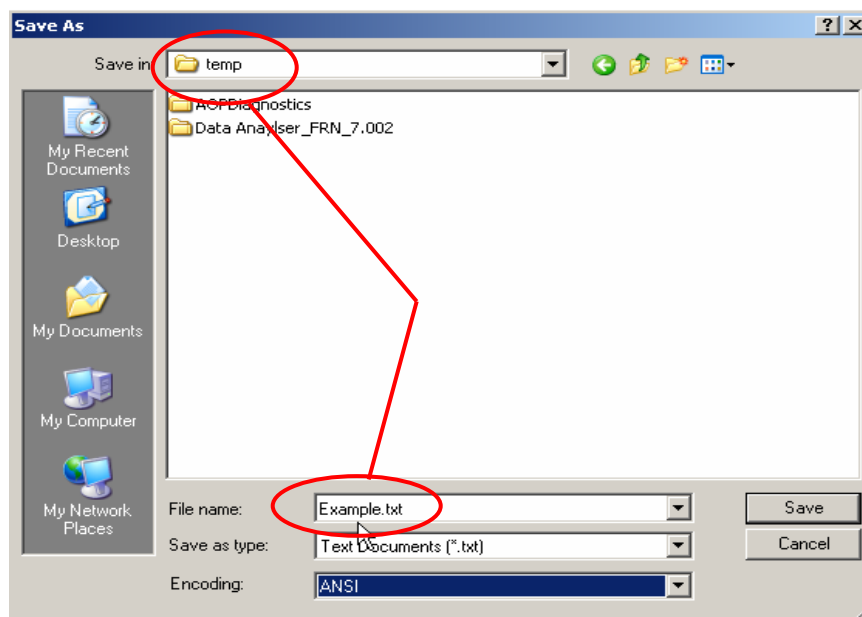


- From the File menu select **Save As**, as shown below.



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

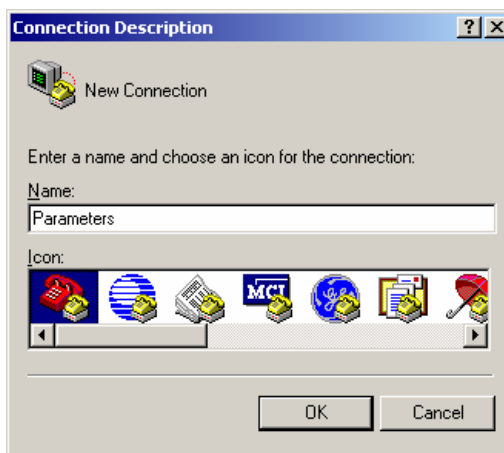
- On the **Save As** window, enter a filename (for instance, *example.txt*) in the field next to **File name** and select the directory from the dropdown list next to **Save in** at the top of the window. In this example the selected directory is C:\temp. Now, click on **Save** button.



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

Step-2: Setting up HyperTerminal Connection

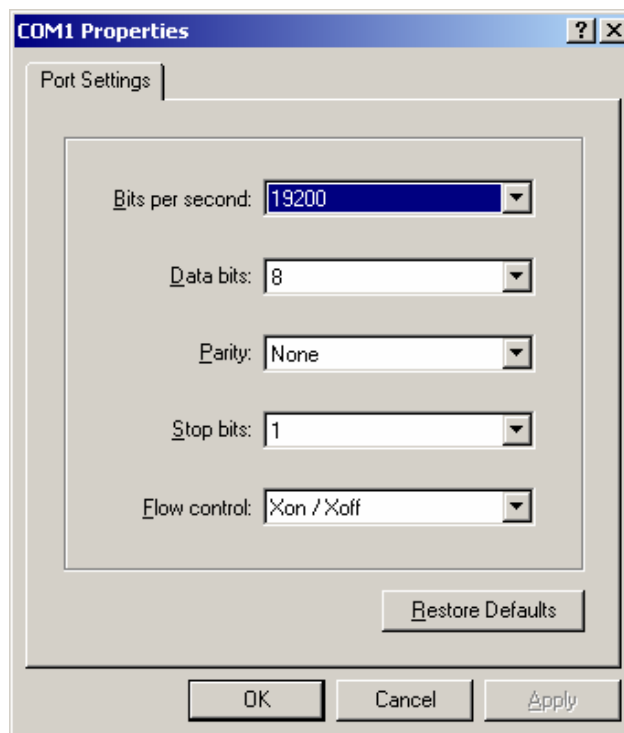
- Run **HyperTerminal** program
- On the '**Connection Description**' window, enter a name (for instance, *Parameters*) for the New Connection under the **Name** field as shown below and then click **OK**.



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

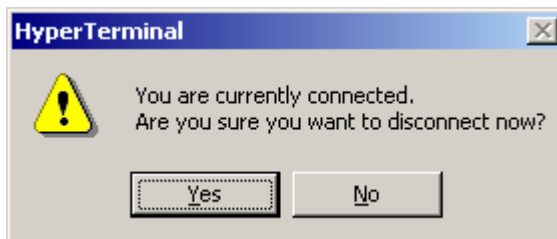


- Now, the '**COM1 Properties**' window will appear. Set the port settings as shown below and then click **OK**.

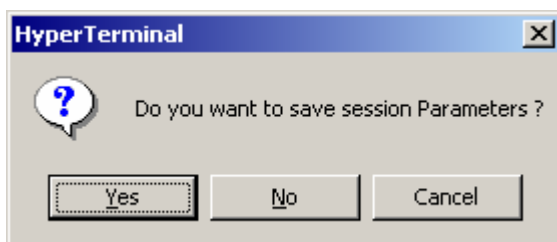


- Now, close the HyperTerminal program. Following message box will appear.

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



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

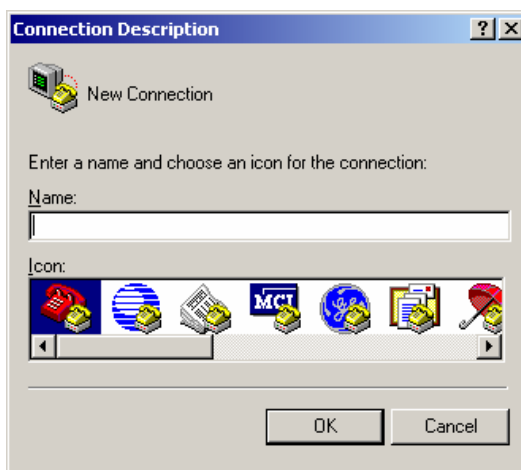


- Click **Yes** to terminate the HyperTerminal program.

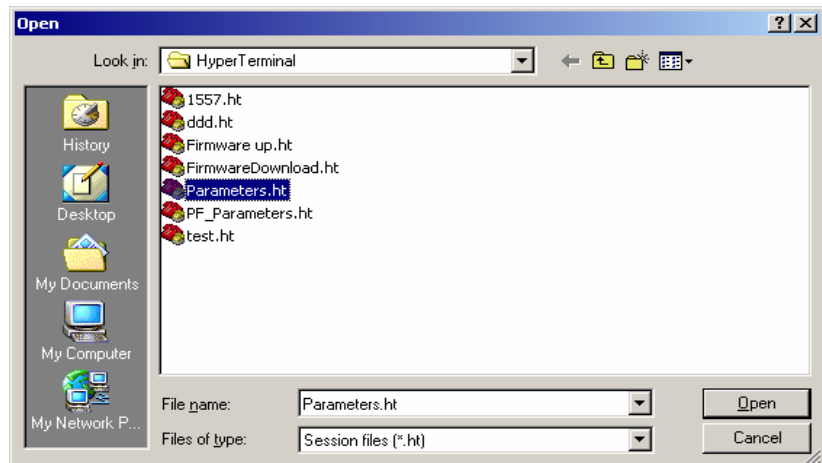
Step-3: Uploading the Data from the drive

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

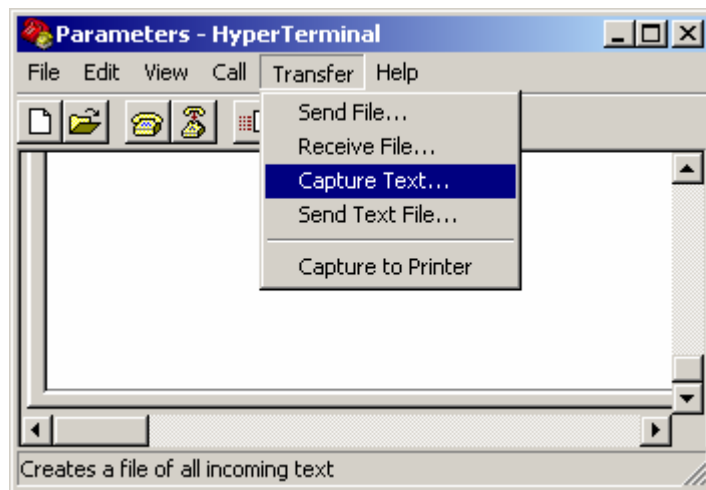
- Connect a null-modem cable between your computer's serial port and the serial port '**J11**' on the **Analog Control Board (ACB)**.
- Restart HyperTerminal program. On the '**Connection Description**' window click **Cancel**.



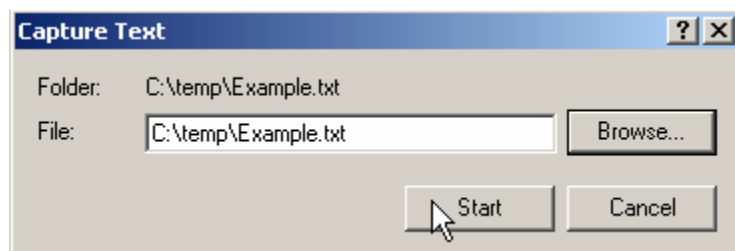
- From the **File** menu, click **Open....** At the **Open** dialog box, locate the HyperTerminal connection you just created in step-2, (e.g. **Parameters**) and then click **Open**.



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



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



- Now click **Start** button.

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

- HyperTerminal will now act as a dummy printer and is waiting for the information to be transmitted from the drive to the laptop. From the drive **Terminal**, hit **F3 (PRINT)** at the main screen as shown below:

```

REV: 4.005          NOT FOR RELEASE!

Status: Ready

Speed:      0 rpm
Current:    0 A
Voltage:    0 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 (i.e., upload the info into laptop) and press **Enter** key (↵). The required information will be transferred to your laptop and stored in the file C:\temp\Example.txt. Repeat this step to upload other data into your laptop.

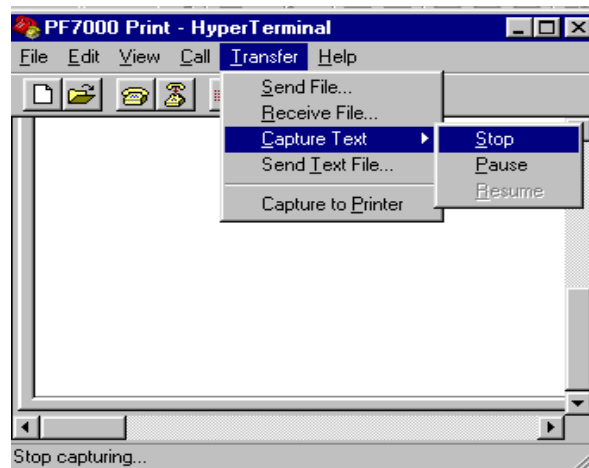
Note: The most desirable selections are:

- **Drive Setup:** for complete setup, which include Parameters, Fault Masks and Revisions
- **Trend Data:** for analyzing the drive trending
- **Variables:** snapshot of real-time data while the drive running.

IMPORTANT

Note that while the data is being transferred, the Printer Status will show Transfer in Process. Once the data transfer is complete, the Printer Status changes to either Auto-Off or Auto-On.

- The last step is to stop the communication between your laptop and the drive and close the file Example.txt. At your laptop, click on **Transfer** menu and select **Stop** option under **Capture Text ...** as shown in the screenshot below.



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

Printing (Uploading) Control Data

Overview

In PF7000 drives with ForGe control, a specific memory location has been set aside to capture and store critical data in the event of a fault condition. This data is referred to as "Control Data". There are total 8 buffers where the data is stored sequentially on first-in first-out basis, which ensures the data of 8 most recent faults is always available. The data can be retrieved for analysis.

The method of retrieving Control Data is explained below.

Required

- Laptop with Windows HyperTerminal program
- A null-modem cable with a 9-pin female connector for the laptop serial port, and a 9-pin male connector for Drive Processor Module (DPM) data port (J4). *(A serial cable with pins 2-3 swapped at one end will also work)*

Printing (Uploading) Control Data (cont.)

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

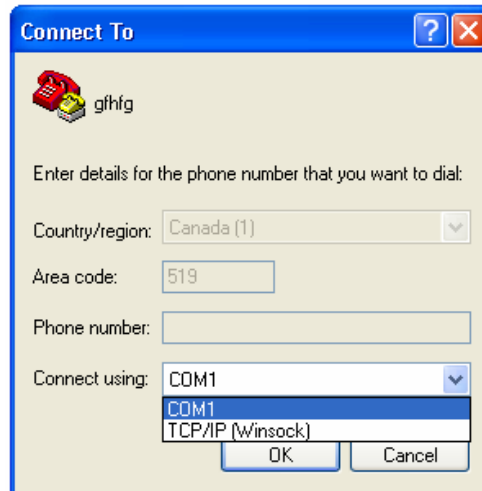
9-Pin Female Connector Pin #			9-Pin Male Connector Pin #
1	DCD	RED	RTS 7 CTS 8
2	TXD	BRN	TXD 3
3	RXD	BLK	RXD 2
4	DTR	GRN	DSR 6
5	COM	BLU	COM 5
6	DSR	WHT	DTR 4
7	RTS	YEL	DCD 1
8	CTS		
NC		SHLD	Case

Method

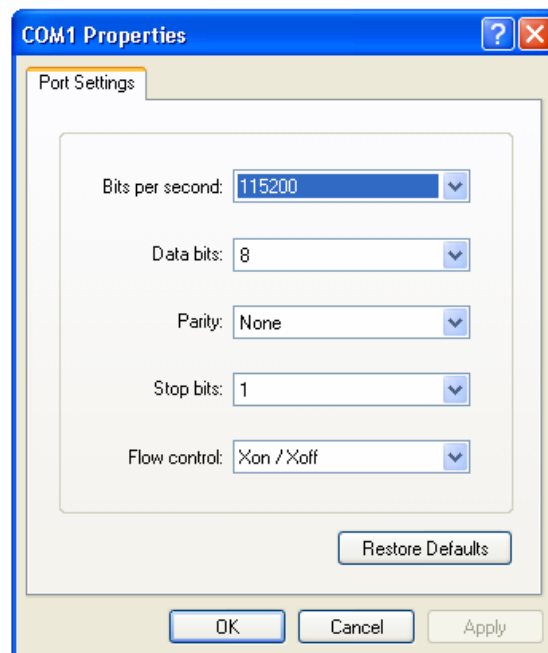
1. Connect your laptop to the drive using a 9-pin null-modem cable to DPM data port (J4).
2. *Set up HyperTerminal connection*
 - Run HyperTerminal program
 - At the '**Connection Description**' window, enter any name for new connection under the **Name** field as shown below and then click **OK**.



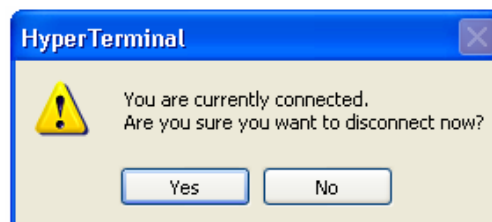
- The '**Connect to**' window will appear as shown below. Select **COM1** from the dropdown list next to '**Connect using**' and then click **OK**.



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

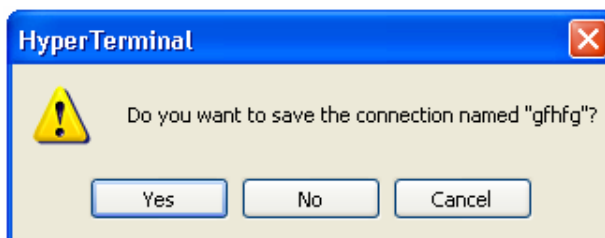


- Now close HyperTerminal program. At this point following message box will appear.



Printing (Uploading) Control Data (cont.)

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



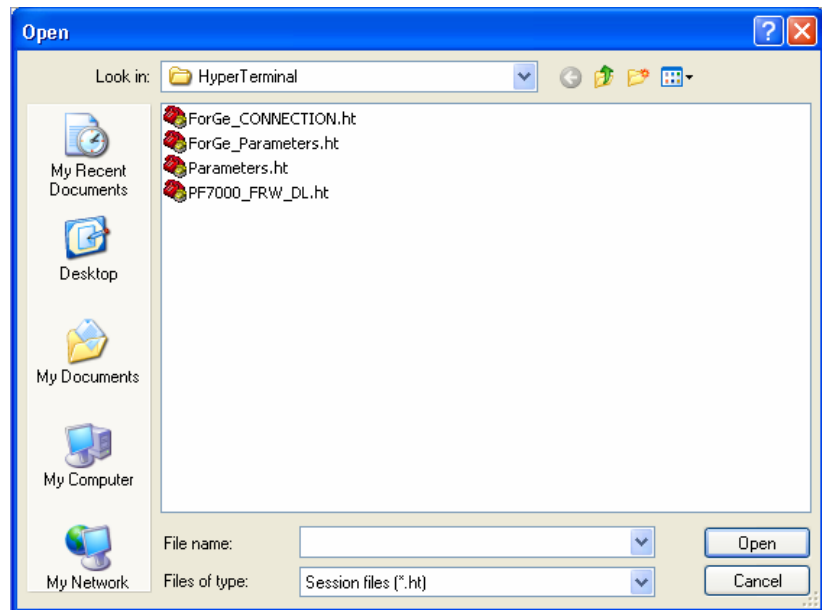
- Click **Yes** to terminate the HyperTerminal Program.

3. *Printing Control Data*

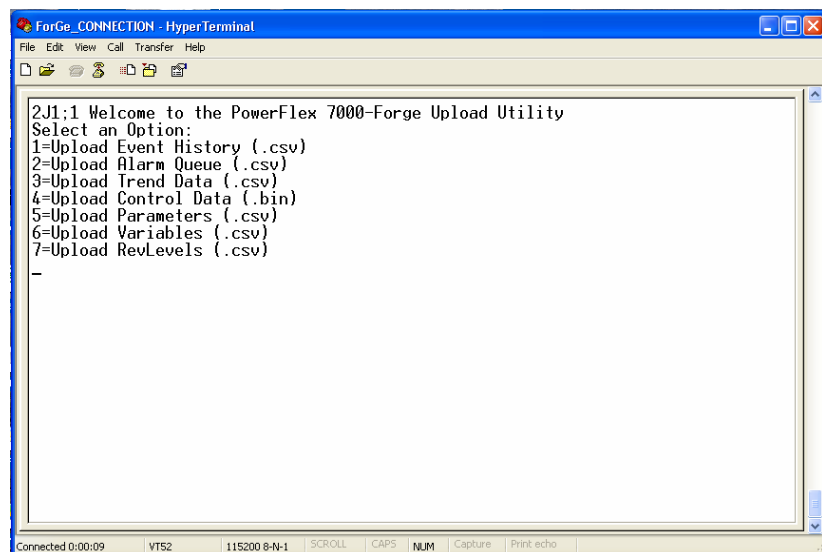
- Restart HyperTerminal program.
- At the '**Connection Description**' window as shown below, click **Cancel**.



- From the **File** menu, click **Open...** The **Open** window will appear. Locate the HyperTerminal connection that you just created in step-2 above (**ForGe_CONNECTION** in this example) and then click **Open**.

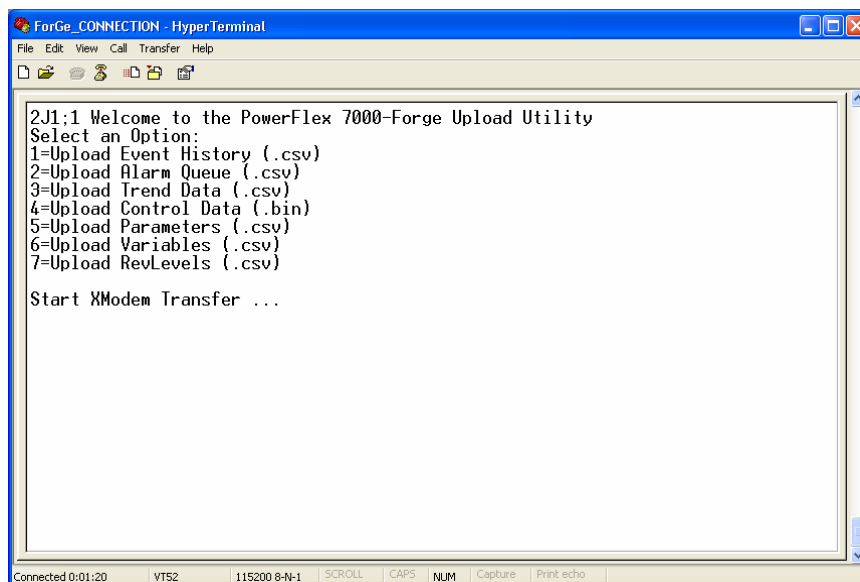


- Press the **ENTER** key. This should bring up the following options menu in the HyperTerminal window.

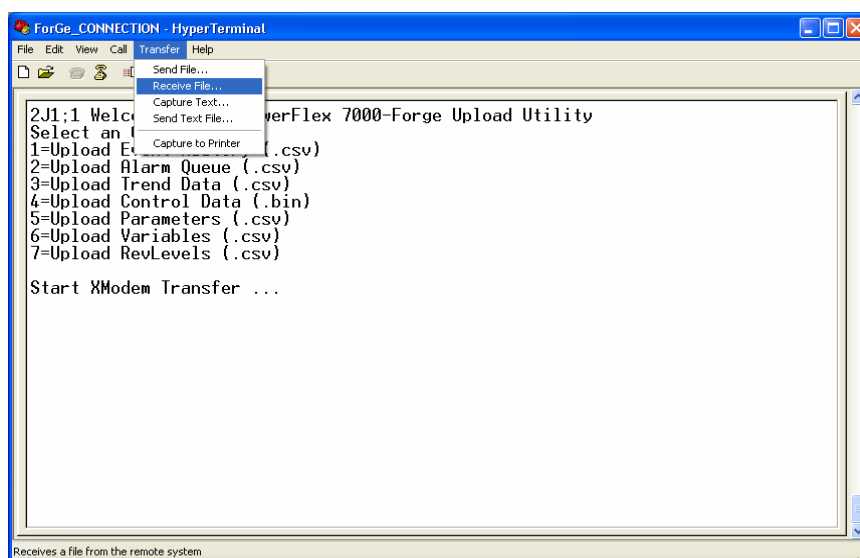


- From the above menu select the desired option by pressing the corresponding number to upload (print) the data. To upload **Control Data**, select option **4**.

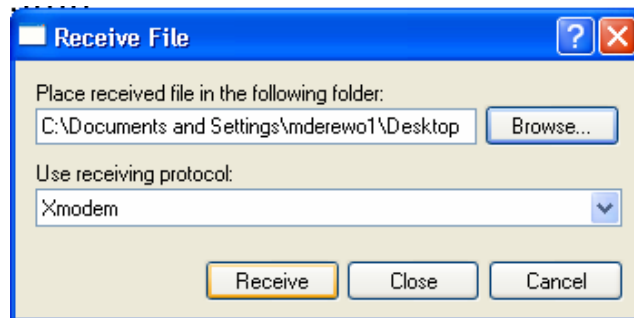
Printing (Uploading) Control Data (cont.)



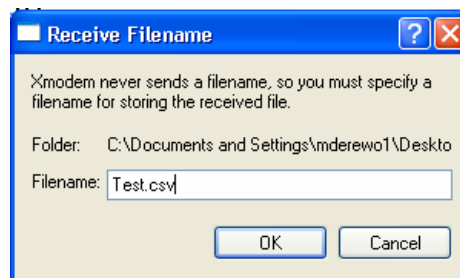
- After selecting the desired option, you need to start the transfer by selecting **Receive File ...** from the **Transfer** menu as shown below.



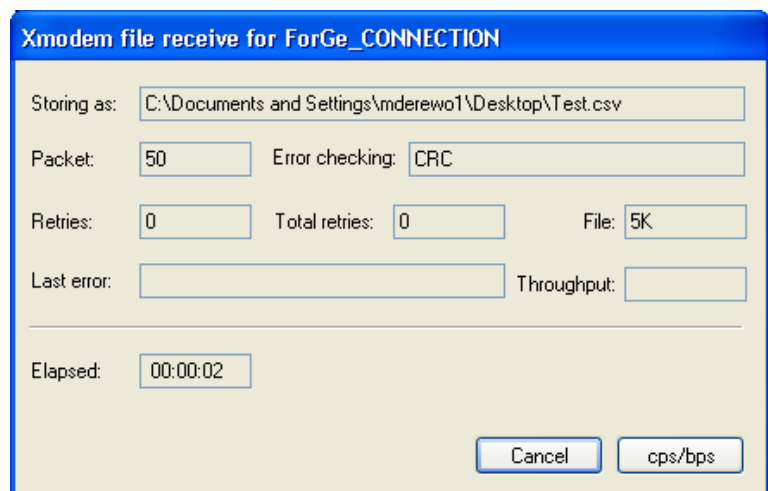
- The **Receive File** window will pop. Click **Browse** button and select the directory where you want to save the data file. Make sure the **Receiving Protocol** is set to **Xmodem**, then click **Receive**.



- Now, the **Receive Filename** dialog will appear. Here you need to enter the file name, but make sure you also enter a correct extension as given in the options menu. For **Control Data** use **.bin** extension. For all other data use **.csv** extension. Click **OK**.



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



- When the data transfer is complete, the above dialog box will close automatically. This way use can select any option you want to print (upload). Once you have printed all the data files, you can then shutdown the HyperTerminal program and unplug the null-modem cable from the DPM board.

Environmental Considerations

Hazardous materials

Environmental protection is a top priority for Rockwell Automation. The facility that manufactured this medium voltage drive operates an environmental management system that is certified to the requirements of ISO 14001. As part of this system, this product was reviewed in detail throughout the development process to ensure that environmentally inert materials were used wherever feasible. A final review has found this product to be substantially free of hazardous material.

Please be assured that Rockwell Automation is actively seeking alternatives to potentially hazardous materials for which no feasible alternatives exist today in the industry. In the interim, the following precautionary information is provided for your protection and for the protection of the environment. Please contact the factory for any environmental information on any material in the drive or with any general questions regarding environmental impact.

- **Capacitor Dielectric Fluid**

The fluids used in the filter capacitors and the snubber capacitors are generally considered very safe and are fully sealed within the capacitor housings. Shipping and handling of this fluid is not restricted under any 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. Shipping and handling of these boards is not restricted under any regulations, however, lead is considered a hazardous substance. 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 one small 3V lithium battery on the DPM board. The battery part # 346567-Q01 or BR2335 contains approximately 0.09 g of lithium metal. These batteries meet shipping regulations at the time of publication, however there are specific marking and packaging requirements. Properly packaged single, spare or expired batteries may be shipped consigned as UN3090 PI 968 Part 1. A maximum of two spare cells may be packaged with the DPM, provided they are mechanically separated from each other during shipment. Shipping cartons shall bear the warning: “Primary Lithium Batteries – Forbidden for transport aboard passenger aircraft.”

Lithium batteries 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.

Catalog Number Explanation for PowerFlex 7000 Variable Frequency Drives

First Position	Second Position	Third Position	Fourth Position	Fifth Position	Sixth Position	Seventh Position
7000	–	A	40	D	A	– RPD TD – 1 - ... etc.
Bulletin Number	Service Duty/ Altitude Code	Current Rating	Enclosure Type	Line and Control Voltages	Rectifier Configuration/ Line Impedance Type	Options (Refer to PowerFlex 7000 Medium Voltage Drives Global Price List)

Code	Description
7000A	"A" Frame (Air Cooled)
7000	"B" Frame (Air Cooled)
7000L	"C" Frame (Liquid Cooled)

Code	Description
D	Type 1 w/gasket (IP21)
T	Type 1 w/gasket (IP21) – Seismic rated
K	Type 12 w/vents and filters (IP42)
U	Type 12 w/vents and filters (IP42) – Seismic rated

Code	Description
A	Normal Duty, 0-1000 m Altitude Maximum 40°C Ambient
B	Normal Duty, 1001-5000 m Altitude Reduced Ambient (from 40°C offering) 1001 – 2000 m = 37.5°C 2001 – 3000 m = 35°C 3001 – 4000 m = 32.5°C 4001 – 5000 m = 30°C
C	Heavy Duty, 0-1000 m Altitude Maximum 40°C Ambient
D	Heavy Duty, 0-5000 m Altitude Reduced Ambient (from 40°C offering) – Same as 'B' above
E	Normal Duty, 0-1000 m Altitude Maximum 35°C Ambient
F	Normal Duty, 1001-5000 m Altitude Reduced Ambient (from 35°C offering) 1001 – 2000 m = 32.5°C 2001 – 3000 m = 30°C 3001 – 4000 m = 27.5°C 4001 – 5000 m = 25°C
G	Heavy Duty, 0-1000 m Altitude Maximum 35°C Ambient
J	Normal Duty, 0-1000 m Altitude Maximum 50°C Ambient
L	Heavy Duty, 0-1000 m Altitude Maximum 50°C Ambient
N	Normal Duty, 0-1000 m Altitude Maximum 20°C Ambient
Z	Custom Configuration (Contact Factory)

Code	Description
40	40 Amp
46	46 Amp
53	53 Amp
61	61 Amp
70	70 Amp
81	81 Amp
93	93 Amp
105	105 Amp
120	120 Amp
140	140 Amp
160	160 Amp
185	185 Amp
215	215 Amp
250	250 Amp
285	285 Amp
325	325 Amp
375	375 Amp
430	430 Amp
495	495 Amp
575	575 Amp
625	625 Amp
657	657 Amp
720	720 Amp

Code	Description
RPD TD	AFE Rectifier with Integral Line Reactor and Direct-to-Drive DC Link
RPTX	AFE Rectifier with provision for connection to separate Isolation Transformer (standard DC Link)
RPTXI	AFE Rectifier with integral Isolation Transformer (standard DC Link)
RPLR	AFE Rectifier with Integral Line Reactor and Standard DC Link (No longer offered for sale)
R6TX	6-pulse Rectifier with provision for connection to separate Isolation transformer (standard DC Link) (No longer offered for sale)
R18TX	18-pulse Rectifier with provision for connection to separate Isolation Transformer (standard DC Link)

See Table A-1

Not all amperages are available at all ambient/altitude configurations. Refer to Price Lists for

Table A-1 – Supply Voltage, Control Voltage, Frequency and Control Power Transformer Selection

Voltage		Frequency (Hz)	Modification Number	
Nominal Line	Control		With a C.P.T. ❶	Without a C.P.T. ❷
2400	120	60	A	AD
	120-240		AA	—
3300	110	50	CY	CDY
	220		CP	CDP
4160	110	50	EY	EDY
	220		EP	EDP
	120	60	E	ED
	120-240		EA	—
6600	110	50	JY	JDY
	220		JP	JDP
	110-220		JAY	—

❶ A Control Power Transformer modification must be selected (6, 6B ...etc.) to size the transformer.

❷ Control Circuit Power is supplied from a separate/external source.

PowerFlex 7000 Drive Selection Explanation

The PowerFlex 7000 medium voltage AC drive selection tables are based on two (2) types of drive service duty ratings:

- 1) **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.

- 2) **Heavy Duty (150% overload for one (1) Minute, once every 10 minutes)** – used for Constant Torque (CT) applications only.

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 different codes that define service duty and altitude in the drive catalog number (see page A-1).

For example,

Catalog number 7000A – **A105**DED-R6TXI, has a continuous current rating of 105 amps, with a “normal duty” service rating up to 1000 meters altitude.

Catalog number 7000A – **B105**DED-R6TXI 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.

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.

Table A-2 –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 the shaft mounting type, examples are the Avtron 585 and 685 models or the Northstar (Lakeshore) RIM Tach HS85, 12 to 15V models or equivalent. 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).
- When cable lengths exceed 305 m (1000 ft.) for the Northstar or 610 m (2000 ft.) for the Avtron, consult the factory.

Table A-3 – 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 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-4 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-4 – PowerFlex 7000 Drive Torque Capabilities

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

** Drive will require over sizing to achieve greater than 100% continuous torque.

Glossary of Terms

Breakaway Torque:

Torque required to start a machine from standstill.

Accelerating Torque:

Torque required to accelerate a load to a given speed, in a certain period of time. The following formula may be used to calculate the average torque to accelerate a known inertia (WK^2):

$$T = (WK^2 \times \text{change in RPM}) / 308t$$

where, **T** = acceleration torque in (lb-ft).

WK^2 = 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-5 – 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	50	100	Normal	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

* NOTE: PowerFlex 7000 "A" Frame suitable only for normal duty service rating.

Torque Requirements for threaded fasteners

Unless otherwise specified the following values of torque are to be used in maintaining the equipment.

DIAMETER	PITCH	MATERIAL	Torque (N-m)	Torque (lb.-ft.)
M2.5	0.45	Steel	0,43	0.32
M4	0.70	Steel	1,8	1.3
M5	0.80	Steel	3,4	2.5
M6	1.00	Steel	6,0	4.4
M8	1.25	Steel	14	11
M10	1.50	Steel	29	21
M12	1.75	Steel	50	37
M14	2.00	Steel	81	60
1/4 "	20	Steel S.A.E. 5	12	9.0
3/8"	16	Steel S.A.E. 2	27	20

Meggering

Drive Meggering

When a ground fault occurs, there are three zones in which the problem may appear: input to the drive, the drive, output to the motor. The ground fault condition indicates a phase conductor has found a path to ground. Depending on the resistance of the path to ground, a current with magnitude ranging from leakage to fault level exists. Based on our experiences in drive systems, the highest probability for the source of the fault exists in either the input or output zones. The drive itself rarely has been a source of a ground fault when it is properly installed. This is not to say there will never be any ground fault problems associated with the drive, but the chances are the fault is outside of the drive. Also, the procedure for meggering the drive is more complex than meggering outside the drive.

With these two factors, it is recommended to first megger the input and output zones when encountering a ground fault. If the location of the ground fault can not be located outside the drive, the drive will need to be meggered. This procedure must be performed with due care as the hazards to drive exist if the safety precautions in the procedure are not followed. This is due to the fact the megger procedure applies high voltage to ground: all the control boards in the drive have been grounded and if not isolated, they will have high potential applied to them causing immediate damage.

Meggering the PowerFlex 7000A

ATTENTION

Use caution when performing a Megger test. High voltage testing is potentially hazardous and may cause severe burns, injury or death. Where appropriate, the cause of the test equipment should be connected to ground.

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

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

ATTENTION

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

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

Equipment Required

- Torque Wrench and 7/16 inch socket
- Phillips Screwdriver
- 2500/5000 Volt Megger

Procedure

1. Isolate and Lock Out the Drive System from High Voltage

Disconnect any incoming power sources, medium voltage sources should be isolated and locked out and all control power sources should be turned off at their respective circuit breaker(s).

Verify with a potential indicator that power sources have been disconnected, and that the control power in the drive is de-energized.

2. Isolate the Power Circuit from System Ground (Float the drive)

It is necessary to remove the grounds on the following components within the drive (Refer to the electrical diagrams provided with the equipment to assist in determining the points which need to be disconnected):

- Voltage Sensing Boards (VSB)
- Output Grounding Network (OGN)

Voltage Sensing Boards

Remove all ground connections from all of the VSBs in the drive. This has to be done at the screw terminals on the VSB rather than the ground bus. There are two grounds on each board marked “GND 1”, and “GND 2”.

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

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

Output Grounding Network

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

Note: Injecting a high voltage on the ground cable during a Megger test will degrade the cable insulation.

3. Disconnect Connections between Power Circuit and Low Voltage Control

Voltage Sensing Boards

The connections between the low voltage control and the power circuit are made through ribbon cable connectors. The cables will be plugged into connectors on the Voltage Sensing Board marked “J1”, “J2”, and “J3”, and terminate on the Signal Conditioning Boards. Every ribbon cable connection made on the VSBs should be marked for identification from the factory. Confirm the marking matches the connections, and disconnect the ribbon cables and move them clear of the VSB. If these ribbon cables are not removed from the VSB, then high potential will be applied directly to the low voltage control through the SCBs, and cause immediate damage to those boards.

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

Potential Transformer Fuses

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

Transient Suppression Network

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

4. Meggering the Drive

Note: Verify the drive and any connected equipment is clear of personnel and tools prior to commencing the Megger test. Barricade off any open or exposed conductors. Conduct a walk-around inspection before commencing the test.

All three phases on the line and machine sides of the drive are connected together through the DC Link and Snubber Network. Therefore a test from any one of the input or output terminals to ground will provide all the sufficient testing required for the drive.

Note: Be sure the Megger is discharged prior to disconnecting it from the equipment.

Connect the Megger to the drive following the specific instructions for that model. If the Megger has a lower voltage setting (normally 500V or 1000V), apply that voltage for 5 seconds as a precursor for the higher voltage rating. This may limit the damage if you forgot to remove any grounds. If the reading is very high, apply 5kV from any drive input or output terminal to ground. Perform a Megger test at 5 kV for 1 minute and record the result.

The test should produce a reading greater than the minimum values listed below. If the test results produced a value lower than these values start segmenting the drive system down into smaller components and repeat the test on each segment to identify the source of the ground fault. This implies isolating the line side of the drive from the machine side by removing the appropriate cables on the DC Link reactor.

The DC Link reactor may have to be completely isolated from the drive, at which point all four of its power cables must be disconnected. It is imperative to ensure the electrical components to be meggered are electrically isolated from ground. Items that may produce lower than expected readings are surge capacitors at the motor terminals, motor filter capacitors at the output of the drive. The meggering procedure must follow a systematic segmentation of electrical components to isolate and locate a ground fault.

Type of Drive	Minimum Megger Value
Liquid Cooled Drive	200 M Ohms
Air Cooled Drive	1k M Ohm
Drive with input/output Caps Disconnected	5k M Ohm
Isolation Transformer	5k M Ohm
Motor	5k M Ohm

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

Note: Humidity and dirty standoff insulators may also cause leakage to ground because of tracking. You may have to clean a 'dirty' drive prior to commencing the Megger test.

5. Reconnecting Connections between Power Circuit and Low Voltage Control

Reconnect the ribbon cables “J1”, J2” and “J3” in all the VSBs. Do not cross the cable connections. Mixing the feedback cables may result in serious damage to the drive.

6. Reconnect the Power Circuit to the System Ground

Voltage Sensing Boards

Securely reconnect the two ground conductors on the VSBs.

The two ground connections on the VSB provide a reference point for the VSB and enable the low voltage signal to be fed to the SCBs. If the ground conductor was not connected, the monitored low voltage signal could then rise up to medium voltage potential which is a serious hazard that must be avoided at all times. You must always ensure the ground conductors on the VSB are securely connected before applying medium voltage to the drive.

ATTENTION

Failure to connect both ground connections on the voltage sensing board will result in high potential in the Low Voltage cabinet within the drive which will result in damage to the drive control and possible injury or death to personnel.

Output Grounding Network

Reconnect the ground connection on the OGN capacitor. The bolt connection should be torque down to 3.4 Nm (30 lb-in). Exceeding the torque rating of this connection may result in damage to the capacitor.

ATTENTION

Failure to reconnect the OGN ground may result in the neutral voltage offset being impressed on the motor cables and stator, which may result in equipment damage. For drives that did not originally have the OGN connected (or even installed), this is not a concern.

Preventative Maintenance Schedule

Preventive Maintenance Check List

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 Chapter 5 – 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 or changed since the last Preventive Maintenance activities)

WARNING

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

Physical Checks (NO Medium Voltage and NO Control Power)

➤ Power Connection Inspection

- Inspect PF7000 drive, input/output/bypass contactor sections, and all associated drive components for loose power cable connections and ground cable connections: torque them to the required torque specifications.
- Inspect the bus bars and check for any signs of overheating / discoloration and tighten the bus connections to the required torque specifications.
- Clean all cables and bus bars that exhibit dust build-up.
- Use torque sealer on all connections.

➤ Carry out the integrity checks on the signal ground and safety grounds.

- **Check for any visual/physical evidence of damage and/or degradation of components in the low voltage compartments.**
 - This includes Relays, Contactors, Timers, Terminal connectors, Circuit breakers, Ribbon cables, Control Wires, etc.; Causes could be corrosion, excessive temperature, or contamination.
 - Clean all contaminated components using a vacuum cleaner (DO NOT use a blower), and wipe clean components where appropriate.
- **Check for any visual/physical evidence of damage and/or degradation of components in the medium voltage compartments (inverter/rectifier, cabling, DC Link, contactor, load break, harmonic filter, etc).**
 - This includes main cooling fan, power devices, heatsinks, circuit boards, insulators, cables, capacitors, resistors, current transformers, potential transformers, fuses, wiring, etc.; Causes could be corrosion, excessive temperature, or contamination.
 - Verify 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 **Appendix C** for meggering procedure.
- Check clamp head indicator washers for proper clamp pressure, and adjust as necessary.
 - Refer to page 5-17, “Uniform Clamping Pressure” and “Checking Clamping Pressure” for details on proper clamp pressure.

Annual Maintenance (cont.)

Control Power Checks (No Medium Voltage)

- Apply Control power to the PowerFlex drive, and test power to all of the vacuum contactors (input, output, and bypass) in the system, verifying all contactors can close and seal in.
 - Refer to Publication **1502-UM050_-EN-P** for a detailed description of all contactor maintenance.
- Verify all single-phase cooling fans for operation.
 - This includes the cooling fans in the AC/DC Power supplies and the DC/DC converter.
- Verify the proper voltage levels at the CPT (if installed), AC/DC Power Supplies, DC/DC converter, isolated gate power supply boards.
 - Refer to Chapter 4 – Commissioning for appropriate procedures/voltage levels for the above checks.
- Verify the proper gate pulse patterns using Gate Test Operating Mode.
- If there have been any changes to the system during the outage, place the drive in System Test Operating Mode and verify all functional changes.

Final Power Checks before Restarting

- Ensure all cabinets are cleared of tools, and all component connections are back in place and in the running state.
- Put all equipment in the normal operating mode, and apply medium voltage.
- If there were any input or output cables removed, verify the input phasing, and bump the motor for rotation.
- If there were any changes to the motor, input transformer, or associated cabling, you will have to retune the drive to the new configuration using Autotuning.
- Save all parameter changes (if any) to NVRAM.
- Run the application up to full speed/full load, or to customer satisfaction.
- Capture the drive variables while running, in the highest access level if possible.

Additional Tasks During Preventive Maintenance

- Investigation of customer's concerns relating to drive performance
 - Relate any problems found during above procedures to customer issues.
- Informal instruction on drive operation and maintenance for plant maintenance personnel
 - Reminder of safety practices and interlocks on MV equipment, and on specific operating concerns
 - Reminder of the need to properly identify operating conditions
- Recommendation for critical spare parts which should be stocked in-plant to reduce production downtime
 - Gather information on all spare parts on site, and compare that with factory-recommended critical spares to evaluate whether levels are sufficient.
 - Contact MV Spare Parts group for more information.
- Vacuum Bottle Integrity Testing using a Vacuum Checker or AC Hipot
 - Refer to Publication **1502-UM050_-EN-P** for a detailed description of all 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 or e-mailed to MVSupport_Technical@ra.rockwell.com

**Annual Maintenance
(cont.)****Time Estimations**

- Operational Maintenance 0.5 hours per filter
- Annual Maintenance
 - Initial Information Gathering 0.5 hours
 - Physical Checks
 - Torque Checks 2.0 hours
 - Inspection 2.0 hours
 - Cleaning ** 2.5 hours **
 - Meggering 1.5 hours
 - Control Power Checks
 - Contactor Adjustments ** 2.0 hours **
 - Voltage Level Checks 1.0 hours
 - Firing Check 0.5 hours
 - System Test ** 2.0 hours **
 - Medium Voltage Checks
 - Final Inspection 0.5 hours
 - Phasing Check ** 1.5 hours **
 - Autotuning** 2.0 hours **
 - Operation to Maximum Load Site Dependent
 - Additional Tasks
 - Investigation ** Depends on Nature of the Problem **
 - Informal Training/Refresher ** 2.0 hours **
 - Spare Parts Analysis ** 1.0 hours **
 - Vacuum Bottle Integrity Check ** 3.0 hours **
 - Final Report 3.0 hours

Note: ** indicates that the time may not be required depending on the nature of the maintenance and the condition of the drive system. These times are only estimations.

Tool / Parts / Information Requirements

The following is a list of the tools recommended for proper maintenance of the PF7000 drives. Not all of the tools may be required for a specific drive preventive procedure, but if we were to complete all of the tasks listed above the following tools would be required.

Tools

- 100 MHz Oscilloscope with minimum 2 Channels and memory
- 5kV DC Megger
- Digital Multimeter
- Torque Wrench
- Laptop Computer with Relevant Software and Cables
- Assorted Hand Tools (Screwdrivers, Open Ended Metric Wrenches, Metric Sockets, etc.)
- 5/16 Allen Keys
- Speed Wrench
- Feeler Gauge
- Vacuum Bottle Checker or AC-Hipot
- Minimum of 15kV Hotstick / Potential Indicator
- Minimum of 10kV Safety Gloves
- Vacuum Cleaner with Anti-static hose
- Anti-static Cleaning Cloth
- No. 30 Torx Driver

Documentation

- PF7000 User's Manual – Publication 7000-UM151_-EN-P
- PF7000 Parameters Manual – Publication 7000-TD002_-EN-P
- 400A Vacuum Contactor Manual – Publication 1502-UM050_-EN-P
- Drive-Specific Electrical and Mechanical Prints
- Drive-Specific Spare Parts List

Materials

- Torque Sealer (Yellow) Part number --- RU6048
- Electrical Joint Compound ALCOA EJC No. 2 or approved equivalent (For Power Devices)
- Aeroshell no. 7 Part number 40025-198-01 (for Vacuum Contactors)

PowerFlex 7000 Maintenance Schedule

Rockwell recognizes that following a defined maintenance schedule will deliver the maximum product availability. By rigorously following this maintenance schedule, the Customer can expect the highest possible uptime. This Annual Preventative Maintenance Program includes a visual inspection of all drive components visible from the front of the unit, resistance checks on the power components, power supply voltage level checks, general cleaning and maintenance, checking of all accessible power connections for tightness, and other tasks. For more details, please refer to Chapter 5 (Component Definition and Maintenance) of this User Manual.

I – Inspection

This indicates that the component should be inspected for signs of excessive accumulation of dust/dirt/etc. or external damage (e.g. looking at Filter Capacitors for bulges in the case, inspecting the heatsinks for debris clogging the air flow path, etc.).

M – Maintenance

This indicates a maintenance task that is outside the normal preventative maintenance tasks, and can include the inductance testing of Line Reactors/DC Links, or the full testing of an isolation transformer.

R – Replacement

This indicates that the component has reached its mean operational life, and should be replaced to decrease the chance of component failure. It is very likely that components will exceed the design life in the drive, and that is dependent on many factors such as usage, heating, etc.

C – Cleaning

This indicates the cleaning of a part that can be reused, and refers specifically to the door-mounted air filters in the liquid-cooled drives and some air-cooled drives.

Rv – Review

This refers to a discussion with Rockwell Automation to determine whether any of the enhancements/changes made to the Drive Hardware and Control would be valuable to the application.

RFB/R – Refurbishment/Replacement

The parts can be refurbished at lower cost OR the parts can be replaced with new ones.

Rockwell Automation PowerFlex 7000 Preventative Maintenance Service Schedule

Interval Period (in years)		0	1	2	3	4	5	6	7	8	9	10
Commissioning Activities		S										
Air-Cooling System ①	Door Mounted Air Filters ② ③	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R
	Main Cooling Fan Motor		I	I	I	I	I	I	RFB/R	I	I	I
	Redundant Cooling Fan Motor (if supplied)		I	I	I	I	I	I	RFB/R	I	I	I
	Small Aux. Cooling Fans "Caravel"		I	I	I	I	R	I	I	I	I	R
Liquid-Cooling System ③	Mesh Filters ③	C	C	C	C	C	C	C	C	C	C	C
	De-ionizing Filter Cartridge ③	R	R	R	R	R	R	R	R	R	R	R
	All Fittings/Connections/Hose Clamps		I	I	I	I	I	I	I	I	I	I
	Redundant Cooling Pump Motors/Pumps		I	I	I	I	I	I	I	I	I	I
	Redundant Cooling Pump Motor Seals		I	I	I	I	I	I	I	I	I	R
	Thermostatic Valve Element		I	I	I	I	I	I	R	I	I	I
Power Switching Components	Power Devices (SGCTs/SCRs)		I	I	I	I	I	I	I	I	I	I
	Snubber Resistors/Sharing Resistors/HECS		I	I	I	I	I	I	I	I	I	I
	Rectifier Snubber Capacitors		I	I	I	I ④	I	I	I	I ④	I	Rv/R ④
	Inverter Snubber Capacitors		I	I	I	I	I	I	I	I	I	R
	Integrated Gate Driver Power Supply		I	I	I	I	RFB/R	I	I	I	I	RFB/R
Integral Magnetics/Power Filters	Isolation Transformer/Line Reactor		I	I	I	I	M	I	I	I	I	M
	DC Link/Common Mode Choke		I	I	I	I	M	I	I	I	I	M
	Line/Motor Filter Capacitors		I	I	I	I	M	I	I	I	I	M
Control Cabinet Components	AC/DC and DC/DC Power Supplies		I	I	I	I	RFB/R	I	I	I	I	RFB/R
	Control Boards		I	I	I	I	I	I	I	I	I	I
	Batteries (DCBs and CIB)		I	I	R	I	I	R	I	I	R	I
	Batteries (UPS) ⑤		I	I	I	I	R	I	I	I	I	R
Connections	Low Voltage Terminal Connections/Plug-in Connections		I	I	I	I	I	I	I	I	I	I
	Medium Voltage Connections		I	I	I	I	I	I	I	I	I	I
	Heatsink Bolted Connections		I	I	I	I	I	I	I	I	I	I
	Medium Voltage Connections (Rectifier) ⑥		–	–	–	I ④	–	–	–	I ④	–	I ④
	Medium Voltage Connections (Inverter) ⑦		–	–	–	–	–	–	–	–	–	I
Enhancements	Firmware		–	–	Rv	–	–	Rv	–	–	Rv	–
	Hardware		–	–	Rv	–	–	Rv	–	–	Rv	–
Operational Conditions	Parameters		I	I	Rv	I	I	Rv	I	I	Rv	I
	Variables		I	I	Rv	I	I	Rv	I	I	Rv	I
	Application Concerns		I	I	Rv	I	I	Rv	I	I	Rv	I
Spare Parts	Inventory/Needs		I	I	Rv	I	I	Rv	I	I	Rv	I

① Only applies to air-cooled VFDs (i.e. 'A' Frame and 'B' Frame)

② If filter supplied is not a washable type, replace filter. If filter supplied is a washable type, wash or replace (depending on state of filter).

③ Only applies to liquid-cooled VFDs (i.e. 'C' Frame)

④ A 4-year replacement interval applies to 6-pulse or 18-pulse versions. Active Front End rectifiers have a 10-year rectifier snubber capacitor replacement interval.

⑤ Replace UPS batteries yearly for 50°C rated VFDs.

⑥ When rectifier snubber capacitors are replaced, the MV connections for rectifier need to be inspected.

⑦ When inverter snubber capacitors are replaced, the MV connections for inverter need to be inspected.

⑧ These components may be serviced while the VFD is running.

Rockwell Automation PowerFlex 7000 Preventative Maintenance Service Schedule (cont.)

Interval Period (in years)		11	12	13	14	15	16	17	18	19	20
Commissioning Activities											
Air-Cooling System ①	Door Mounted Air Filters ② ③	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R	C/R
	Main Cooling Fan Motor	I	I	I	RFB/R	I	I	I	I	I	I
	Redundant Cooling Fan Motor (if supplied)	I	I	I	RFB/R	I	I	I	I	I	I
	Small Aux. Cooling Fans "Caravel"	I	I	I	I	R	I	I	I	I	R
Liquid-Cooling System ③	Mesh Filters ③	C	C	C	C	C	C	C	C	C	C
	De-ionizing Filter Cartridge ③	R	R	R	R	R	R	R	R	R	R
	All Fittings/Connections/Hose Clamps	I	I	I	I	I	I	I	I	I	I
	Redundant Cooling Pump Motors/Pumps	I	I	I	I	I	I	I	I	I	I
	Redundant Cooling Pump Motor Seals	I	I	I	I	I	I	I	I	I	R
	Thermostatic Valve Element	I	I	I	R	I	I	I	I	I	I
Power Switching Components	Power Devices (SGCTs/SCRs)	I	R	I	I	I	I	I	I	I	I
	Snubber Resistors/Sharing Resistors/HECS	I	I	I	I	I	I	I	I	I	I
	Rectifier Snubber Capacitors	I	I ④	I	I	I	I ④	I	I	I	Rv/R ④
	Inverter Snubber Capacitors	I	I	I	I	I	I	I	I	I	R
	Integrated Gate Driver Power Supply	I	I	I	I	RFB/R	I	I	I	I	RFB/R
Integral Magnetics/Power Filters	Isolation Transformer/Line Reactor	I	I	I	I	M	I	I	I	I	M
	DC Link/Common Mode Choke	I	I	I	I	M	I	I	I	I	M
	Line/Motor Filter Capacitors	I	I	I	I	M	I	I	I	I	M
Control Cabinet Components	AC/DC and DC/DC Power Supplies	I	I	I	I	RFB/R	I	I	I	I	RFB/R
	Control Boards	I	I	I	I	I	I	I	I	I	I
	Batteries (DCBs and CIB)	I	R	I	I	R	I	I	R	I	I
	Batteries (UPS) ⑤	I	I	I	I	R	I	I	I	I	R
Connections	Low Voltage Terminal Connections/Plug-in Connections	I	I	I	I	I	I	I	I	I	I
	Medium Voltage Connections	I	I	I	I	I	I	I	I	I	I
	Heatsink Bolted Connections	I	I	I	I	I	I	I	I	I	I
	Medium Voltage Connections (Rectifier) ⑥	–	I ④	–	–	–	I ④	–	–	–	I ④
	Medium Voltage Connections (Inverter) ⑦	–	–	–	–	–	–	–	–	–	I
Enhancements	Firmware	–	Rv	–	–	Rv	–	–	Rv	–	–
	Hardware	–	Rv	–	–	Rv	–	–	Rv	–	–
Operational Conditions	Parameters	I	Rv	I	I	Rv	I	I	Rv	I	I
	Variables	I	Rv	I	I	Rv	I	I	Rv	I	I
	Application Concerns	I	Rv	I	I	Rv	I	I	Rv	I	I
Spare Parts	Inventory/Needs	I	Rv	I	I	Rv	I	I	Rv	I	I

① Only applies to air-cooled VFDs (i.e. 'A' Frame and 'B' Frame)

② If filter supplied is not a washable type, replace filter. If filter supplied is a washable type, wash or replace (depending on state of filter).

③ Only applies to liquid-cooled VFDs (i.e. 'C' Frame)

④ A 4-year replacement interval applies to 6-pulse or 18-pulse versions. Active Front End rectifiers have a 10-year rectifier snubber capacitor replacement interval.

⑤ Replace UPS batteries yearly for 50°C rated VFDs.

⑥ When rectifier snubber capacitors are replaced, the MV connections for rectifier need to be inspected.

⑦ When inverter snubber capacitors are replaced, the MV connections for inverter need to be inspected.

⑧ These components may be serviced while the VFD is running.

General Notes

Maintenance of Medium Voltage Motor Control Equipment

ATTENTION



Servicing energized Medium Voltage Motor Control Equipment can be hazardous. Severe injury or death can result from electrical shock, bump, or unintended actuation of controlled equipment. Recommended practice is to disconnect and lockout control equipment from power sources, and release stored energy, if present.

For countries following NEMA standards, refer to National Fire Protection Association Standard No. NFPA70E, Part II and (as applicable) OSHA rules for Control of Hazardous Energy Sources (Lockout/Tagout) and OSHA Electrical Safety Related Work Practices safety related work practices, including procedural requirements for lockout-tagout, and appropriate work practices, personnel qualifications and training requirements, where it is not feasible to de-energize and lockout or tagout electric circuits and equipment before working on or near exposed circuit parts.

For countries following IEC standards, refer to local codes and regulations.

Periodic Inspection

Medium Voltage Motor control equipment should be inspected periodically. Inspection intervals should be based on environmental and operating conditions and adjusted as indicated by experience. An initial inspection within 3 to 4 months after installation is suggested. Refer to the following standards for general guidelines for setting-up a periodic maintenance program.

For countries following NEMA standards, refer to National Electrical Manufacturers Association (NEMA) Standard No. ICS 1.1 (Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control) for MV Drives and ICS 1.3 (Preventive Maintenance of Industrial Control and Systems Equipment) for MV Controllers.

For countries following IEC standards, refer to IEC 61800-5-1 Sec. 6.5 for MV Drives and IEC 60470 Sec. 10, IEC 62271-1 Sec. 10.4 for MV Controllers.

General Notes (cont.)**Contamination**

If inspection reveals that dust, dirt, moisture or other contamination has reached the control equipment, the cause must be eliminated. This could indicate unsealed enclosure openings (conduit or other) or incorrect operating procedures. Replace any damaged or embrittled seals and repair or replace any other damaged or malfunctioning parts (e.g., hinges, fasteners, etc.). Dirty, wet or contaminated control devices must be replaced unless they can be cleaned effectively by vacuuming or wiping. Compressed air is not recommended for cleaning because it may displace dirt, dust, or debris into other parts or equipment, or damage delicate parts.

High Voltage Testing

High voltage insulation resistance (IR) or dielectric withstanding voltage (megger) tests should not be used to check solid-state control equipment. When meggering electrical equipment such as transformers or motors, solid-state devices must be bypassed before performing the test. Even though no damage may be readily apparent after a megger test, the solid-state devices are degraded and repeated application of high voltage can lead to failure.

Maintenance after a Fault Condition

Opening of the short circuit protective device (such as fuses or circuit breakers) in a properly coordinated motor branch circuit is an indication of a fault condition in excess of operating overload. Such conditions can cause damage to medium voltage motor control equipment. Before restoring power, the fault condition must be corrected and any necessary repairs or replacements must be made to restore the medium voltage motor control equipment to good working order. Refer to NEMA Standards Publication No. ICS-2, Part ICS2-302 for procedures. Use only replacement parts and devices recommended by Allen-Bradley to maintain the integrity of the equipment. Ensure the parts are properly matched to the model, series and revision level of the equipment. After maintenance or repair of the equipment, always test the control system for proper functioning under controlled conditions (that avoid hazards in the event of a control malfunction). For additional information, refer to NEMA ICS 1.3, PREVENTIVE MAINTENANCE OF INDUSTRIAL CONTROL AND SYSTEMS EQUIPMENT, published by the National Electrical Manufacturers Association, and NFPA70B, ELECTRICAL EQUIPMENT MAINTENANCE, published by the National Fire Protection Association.

Part-specific Notes

Cooling Fans

Inspect fans used for forced air cooling. Replace any that have bent, chipped, or missing blades, or if the shaft does not turn freely. Apply power momentarily to check operation. If unit does not operate, check and replace wiring, fuse, or fan motor as appropriate. Clean or change air filters as recommended in the Users Manual.

Operating Mechanisms

Check for proper functioning and freedom from sticking or binding. Replace any broken, deformed or badly worn parts or assemblies according to individual product User Manuals. Check for and securely retighten any loose fasteners. Lubricate, if specified in individual product instructions. Many devices are factory lubricated. If lubrication during use or maintenance of these devices is needed, it will be specified in their individual product instructions and/or User Manual. Note: Allen-Bradley magnetic starters, contactors and relays are designed to operate without lubrication. Do not lubricate these devices, because oil or grease on the pole faces (mating surfaces) of the operating magnet may cause the device to stick in the "ON" mode.

Contacts

Check contacts for excessive wear and dirt accumulations. Vacuum or wipe contacts with a soft cloth if necessary to remove dirt. Contacts are not harmed by discoloration and slight pitting. Contacts should never be filed, as dressing only shortens contact life. Contact spray cleaners should not be used as their residues on magnet pole faces or in operating mechanisms may cause sticking and can interfere with electrical continuity. Contacts should only be replaced after contact face material has become badly worn. Always replace contacts in complete sets to avoid misalignment and uneven contact pressure.

Vacuum Contactors

Contacts of vacuum contactors are not visible, so contact wear must be checked indirectly. Vacuum bottles should be replaced when:

1. The contactor wear indicator line shows need for replacement, or
2. The vacuum bottle integrity tests show need for replacement.

Replace all vacuum bottles in the contactor at the same time to avoid misalignment and uneven contact wear. If the vacuum bottles do not require replacement, check and adjust overtravel to the value listed in the product User Manual.

**Part-specific Notes
(cont.)****Power Cable and Control Wire Terminals**

Loose connections in power circuits can cause overheating that can lead to equipment malfunction or failure. Loose connections in control circuits can cause control malfunctions. Loose bonding or grounding connections can increase hazards of electrical shock and contribute to electromagnetic interference (EMI). Check the tightness of all terminals and bus bar connections and tighten securely any loose connections. Replace any parts or wiring damaged by overheating, and any broken wires or bonding straps. Refer to the User Manual for torque values required for power cable and bus hardware connections.

Coils

If a coil exhibits evidence of overheating (cracked, melted or burned insulation), it must be replaced. In that event, check for and correct overvoltage or undervoltage conditions, which can cause coil failure. Be sure to clean any residue of melted coil insulation from other parts of the device or replace such parts.

Batteries

Replace batteries periodically as specified in product manual or if a battery shows signs of electrolyte leakage. Use tools to handle batteries that have leaked electrolyte; most electrolytes are corrosive and can cause burns. Dispose of the old battery in accordance with instructions supplied with the new battery or as specified in the product manual.

Pilot Lights

Replace any burned out lamps or damaged lenses. Do not use solvents or cleaning agents on the lenses.

Solid-State Devices

ATTENTION

Use of other than factory recommended test equipment for solid-state controls may result in damage to the control or test equipment or unintended actuation of the controlled equipment. Refer to paragraph titled HIGH VOLTAGE TESTING.

Solid-state devices require little more than a periodic visual inspection. Discolored, charred or burned components may indicate the need to replace the component or circuit board. Necessary replacements should be made only at the PC board or plug-in component level. Printed circuit boards should be inspected to determine whether they are properly seated in the edge board connectors. Board locking tabs should also be in place. Solid-state devices must also be protected from contamination, and cooling provisions must be maintained – refer to paragraphs titled CONTAMINATION and COOLING DEVICES. Solvents should not be used on printed circuit boards.

Locking and Interlocking Devices

Check these devices for proper working condition and capability of performing their intended functions. Make any necessary replacements only with Allen-Bradley renewal parts or kits. Adjust or repair only in accordance with Allen-Bradley instructions found in the product User Manuals.

Specifications

Specifications

Description	Specifications	
Power Rating (Air Cooled)	200 to 1250 hp (150 to 933 kW)	
Motor Type	Induction or Synchronous	
Input Voltage Rating	2400V, 3300V, 4160V, 6600V	
Input Voltage Tolerance	± 10% of Nominal	
Voltage Sag ❶	-30%	
Control Power Loss Ride-Through	5 Cycles (Std)	
Input Protection	Surge Arrestors	
Input Frequency	50/60 Hz, +/- 5%	
Power Bus Short-circuit Current Withstand	5 Cycle	
3300 V – 6000 V ❷	25 kA RMS SYM	
Basic Impulse Level ❸	50 kV (0 – 1000 m)	
Power Bus Design	Copper – Tin plated	
Ground Bus	Copper – Tin plated 6 x 51 mm (¼ x 2 in.)	
Customer Control Wire Way	Separate and Isolated	
Input Power Circuit Protection	Vacuum Contactor with Fused Isolating Switch (optional)	
Input Impedance Device	Isolation Transformer or AC Line Reactor	
Output Voltage	0 – 2300 V	
	0 – 3300 V	
	0 – 4000 V	
	0 – 6000 or 6300 V	
Inverter Design	PWM	
Inverter Switch	Symmetrical Gate Commutated Thyristor (SGCT)	
Inverter Switch Failure Mode	Non-rupture, Non-arc	
Inverter Switch Failure Rate (FIT)	100 per 1 Billion Hours Operation	
Inverter Switch Cooling	Double Sided, Low Thermal Stress	
Inverter Switching Frequency	420-540 Hz	
Number of Inverter SGCTs	Voltage	SGCTs (per phase)
	2400 V	2
	3300 V	4
	4160 V	4
	6600 V	6
SGCT PIV Rating (Peak Inverse Voltage)	Voltage	PIV
	2400 V	6500 V
	3300 V	6500 V
	4160 V	6500 V
	6600 V	6500 V
Rectifier Designs	AFE (Active Front End)	
Rectifier Switch	SGCT	
Rectifier Switch Failure Mode	Non-rupture, Non-arc	
Rectifier Switch Failure Rate (FIT)	100 (SGCT) per 1 Billion Hours Operation	
Rectifier Switch Cooling	Double Sided, Low Thermal Stress	

- ❶ Voltage Sag tolerance is reduced to -25% when control power is supplied from medium voltage via CPT.
 ❷ Short-circuit fault rating based on input protection device (contactor or circuit breaker).
 ❸ BIL rating based on altitudes < 1000 m (3,300 ft.) Refer to factory for derating on altitudes >1000 m).

Specifications (cont.)

Description	Specifications	
Number of Rectifier Devices per phase	Voltage	AFE
	2400 V	2
	3300 V	4
	4160 V	4
	6600 V	6
Output Waveform to Motor	Sinusoidal Current / Voltage	
Medium Voltage Isolation	Fiber Optic	
Modulation Techniques	SHE (Selective Harmonic Elimination) Synchronous Trapezoidal PWM Asynchronous and Synchronous SVM (Space Vector Modulation)	
Control Method	Digital Sensorless Direct Vector Full Vector Control with Tach Feedback (Optional)	
Tuning Method	Auto Tuning via Setup Wizard	
Speed Regulator Bandwidth	5-25 Radians / Second	
Torque Regulator Bandwidth	15-50 Radians / Second	
Speed Regulation	0.1% without Tachometer Feedback 0.01-0.02% with Tachometer Feedback	
Acceleration/Deceleration Range	Independent Accel/Decel – 4 x 1200 sec.	
Acceleration/Deceleration Ramp Rates	4 x Independent Accel/Decel	
S Ramp Rate	Independent Accel/Decel – 2 x 1200 sec.	
Critical Speed Avoidance	3 x Independent with Adjustable Bandwidth	
Stall Protection	Delay / Speed	
Load Loss Detection	Adjustable level, delay, speed set points	
Control Mode	Speed or Torque	
Current Limit	Adjustable in Motoring and Regenerative	
Output Frequency Range	0.2-75 Hz	
Service Duty Rating Overload Rating	Normal Duty	Heavy Duty
	110% Overload for 1 minute every 10 minutes (Variable Torque Load)	150% Overload for 1 minute every 10 minutes (Constant or Variable Torque Load)
Typical VFD Efficiency	> 97.5% Contact Factory for Guaranteed Efficiency of Specific Drive Rating	
Input Power Factor	0.98 minimum, 30 – 100% Load	
IEEE 519 Harmonic Guidelines ⁴	IEEE 519 Compliant	
VFD Noise Level	< 85 dB(A) per OSHA standard 3074	
Regenerative Braking Capability	Inherent – No Additional Hardware or Software Required	
Flying Start Capability	Yes – Able to Start into and Control a Spinning Load in Forward or Reverse Direction	
Operator Interface	40-character, 16-line formatted text	
Languages	English	German
	French	Chinese
	Spanish	

⁴ Under certain conditions, power system analysis will be required.

Description	Specifications
Control Power	220/240 V or 110/120 V, 1 phase – 50/60 Hz (20 Amp)
External I/O	16 Digital Inputs, 16 Digital Outputs
External Input Ratings	50/60 Hz AC or DC 120-240 V – 1 mA
External Output Ratings	50-60 Hz AC or DC 30-260 V – 1 amp
Analog Inputs	(3) Isolated, 4-20mA or 0-10 V
Analog Resolution	<ul style="list-style-type: none"> Analog input 12 Bit (4-20 mA) Analog input 13 Bit (0-10V)
Analog Outputs	<ul style="list-style-type: none"> (1) Isolated, 4-20 mA (8) Non-isolated, 0-10 V
Communication Interface	DPI
Scan Time	Internal DPI – 2 ms min., 4 ms max.
Communications Protocols (Optional)	R I/O Lon Works DeviceNet CAN open Ethernet RS485 HVAC Profibus RS485 DF1 Modbus RS232 DF1 Interbus USB ControlNet
Enclosure	NEMA 1, IP21
Lifting Device	Standard / Removable
Mounting Arrangement	Mounting Sill Channels
Structure Finish	Epoxy Powder – Paint Exterior Sandtex Light Grey (RAL 7038) – Black (RAL 8022) Internal – Control Sub Plates – High Gloss White (RAL 9003)
Interlocking	Key provision for customer input Disconnecting Device
Corrosion Protection	Unpainted Parts (Zinc Plates / Bronze Chromate)
Fiber Optic Interface	Rectifier – Inverter – Cabinet (Warning/Trip)
Door Filter	Painted Diffuser with Matted Filter Media
Door Filter Blockage	Air Flow Restriction Trip/Warning
Ambient Temperature	0° to 40°C (32°F to 104°F) 0° to 50°C (32°F to 122°F) Optional
Storage and Transportation Temperature Range	-40°C to 70°C (-40°F to 185°F)
Relative Humidity	95% Non-Condensing
Altitude (Standard)	0 to 3300 ft. (0 to 1000 m)
Altitude (Optional)	0 to 16400 ft. (1001 to 5000 m)
Seismic (UBC Rating)	1, 2, 3, 4
Standards	NEMA, IEC, CSA, UL, ANSI, IEEE

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444

Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640

Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Medium Voltage Products, 135 Dundas Street, Cambridge, ON, N1R 5X1 Canada, Tel: (1) 519.740.4100, Fax: (1) 519.623.8930, www.ab.com/mvb

Publication 7000A-RM001A-EN-P – January 2011

Copyright © 2011 Rockwell Automation, Inc. All rights reserved. Printed in Canada.