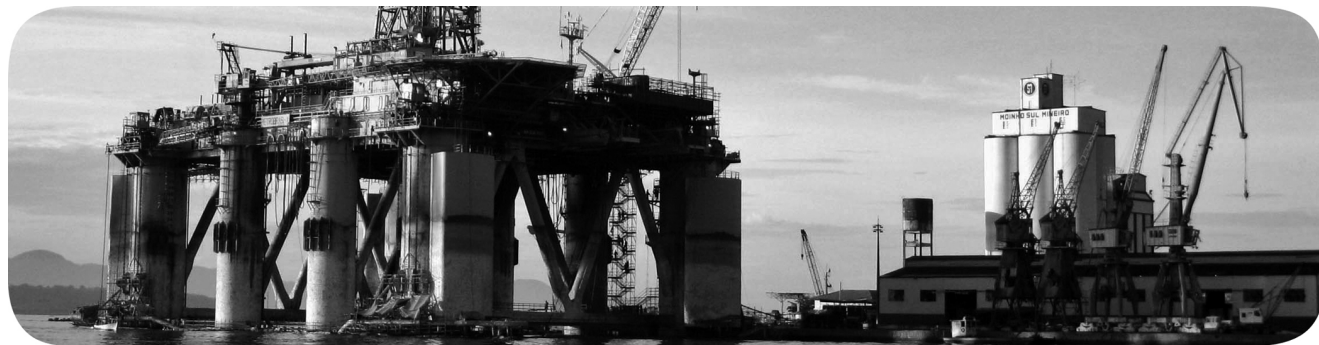
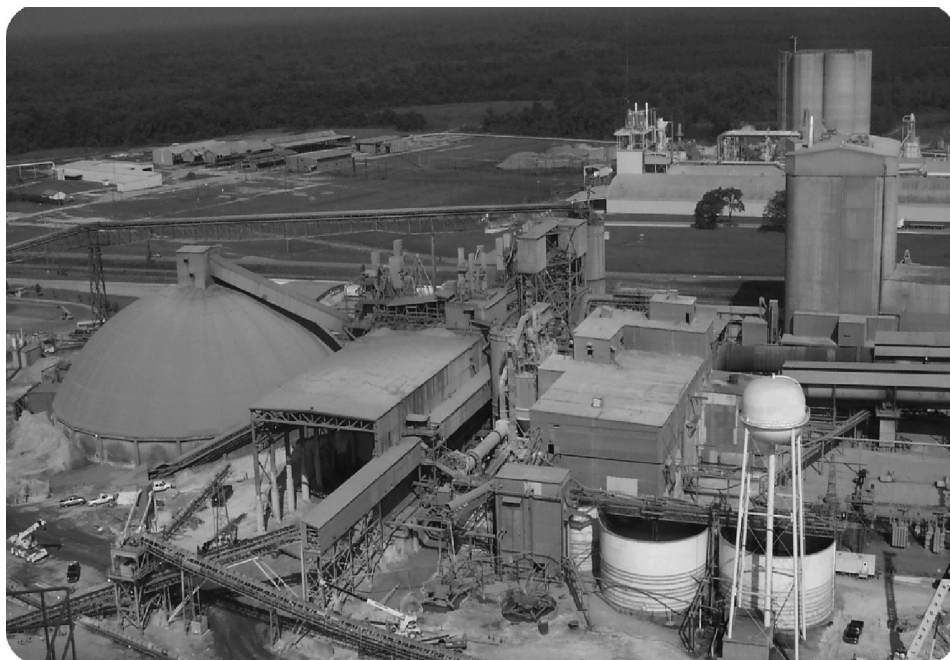


PowerFlex 7000 Medium Voltage AC Drive Air-Cooled ("B" Frame) — ForGe Control (Using PanelView 550)

Bulletin Number 7000



Important User Information

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

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

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

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

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

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

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.



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

IMPORTANT

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

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



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



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



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

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Summary of Changes

This table contains the changes made to this revision.

Topic	Page
Added warning for motor filter capacitors and indicative fault codes	41
Changed input frequency to $\pm 5\%$	271

This document provides procedural information for managing daily or recurring tasks involving the PowerFlex® 7000 medium voltage “B” frame drives (standard and heatpipe models). This document also includes specific information regarding customer responsibilities prior to commissioning.

Who Should Use This Manual

This manual is intended for use by personnel familiar with medium voltage and solid-state variable speed drive equipment. The manual contains material that enables regular operation and maintenance of the drive system.

What Is Not in this Manual

This manual provides information specific to maintaining the PowerFlex 7000 “B” Frame drive. It does not include topics such as:

- Physically transporting or siting the drive cabinetry
- Installing or commissioning procedures
- Dimensional and electrical drawings generated for each customer’s order
- Spare parts lists compiled for each customer’s order

Please refer to the following documents for additional product detail or instruction relating to PowerFlex 7000 “B” Frame drives:

- Drive-specific Technical Specifications
- Transportation and Handling Procedures: receiving and handling instructions for Medium Voltage variable frequency drive and related equipment
- Installation Guide: detailed installation and pre-commissioning procedures and information
- Commissioning Guide: required procedures and checklists for Rockwell Automation field service engineers
- Drive-specific User Manual: instructions for daily and recurring drive usage or maintenance tasks
- Drive-specific Technical Data: additional troubleshooting, parameters, and specification information for MV variable frequency drives

Rockwell Automation provides the site- and installation-specific electrical and design information for each drive during the order process cycle. If they are not available on site with the drive, contact Rockwell Automation.

If you have multiple drive types or power ranges, ensure you have the correct documentation for each specific PowerFlex 7000 product:

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

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.

Commissioning Support

After installation, Rockwell Automation Medium Voltage Support is responsible for commissioning support and activities in the PowerFlex 7000 product line.

Contact Rockwell Automation commissioning services by phone at 519-740-4100; request the Medium Voltage Support – Project Manager.

Rockwell Automation support 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

Additional Resources

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

Resource	Description
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.rockwellautomation.com/global/certification/overview.page	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at <http://www.rockwellautomation.com/global/literature-library/overview.page>.

To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Notes:

PowerFlex 7000 Overview

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

The PowerFlex 7000 meets most common standards from NEC, IEC, NEMA, UL, and CSA. It is available with the world's most common supply voltages at medium voltage, from 2400-6600 volts.

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

Topology

The PowerFlex 7000 uses a Pulse Width Modulated (PWM) – Current Source Inverter (CSI) for the machine side converter as shown in [Figure 3 on page 16](#). This topology applies to a wide voltage and power range. The power semiconductor switches used are easy-to-series for any medium voltage level. Semiconductor fuses are not required for the power structure due to the current limiting DC link inductor.

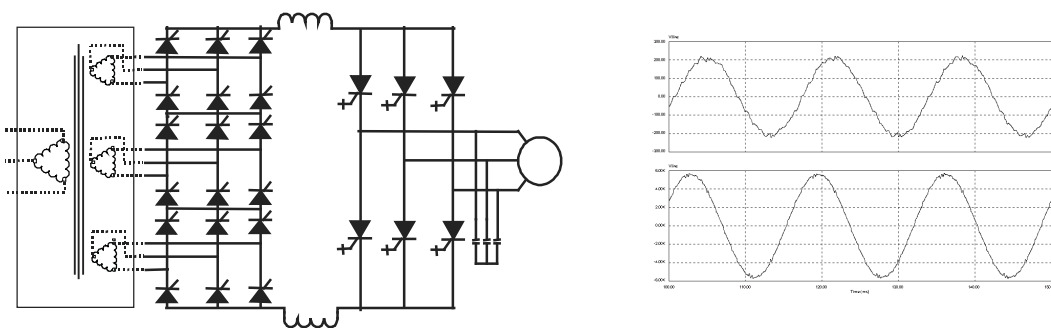


Figure 1 - PWM Current Source Inverter (active front-end) and input current/voltage waveforms (line current [top], line-to-line voltage [bottom])

With 6500 volt PIV rated power semiconductor devices, the number of inverter components is minimal. For example, only six inverter switching devices are required at 2400V, 12 at 3300-4160V, and 18 at 6600V.

The PowerFlex 7000 also provides inherent regenerative braking for applications where the load is overhauling the motor (i.e. downhill conveyors, etc.), or where high inertia loads (i.e. fans, etc.) are slowed down quickly. The drive uses Symmetrical Gate Commutated Thyristors (SGCTs) for machine converter switches, and Silicon-controlled rectifiers (SCRs) (for 18 pulse rectifier configurations) or SGCTs (for AFE rectifier configurations) for the line converter switches.

Rectifier Designs

Active Front-end (AFE) Rectifier

An active front end (AFE rectifier) does not require an isolation transformer to meet IEEE 519-1992. Depending on the topology, an isolation transformer can have up to 15 sets of secondary windings.

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 on page 13](#), is a 42-pulse selective harmonic elimination (SHE) pattern, which eliminates the 5th, 7th and 11th harmonics.

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](#)) 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](#). 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.

Use the AFE rectifier in conjunction with a rectifier duty isolation transformer or with an AC line reactor (as shown in [Figure 1](#) or [Figure 4 on page 16](#)).

Available isolation transformer configurations:

- Integral to the drive (“A” Frame only)
- Remote indoor dry type,
- Outdoor oil-filled type

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

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 (5.5 °F) higher compared to across-the-line operation. Voltage waveform has dv/dt of less than 10 volts per microsecond. The peak voltage across the motor insulation is the rated motor RMS voltage divided by 0.707.

Reflected wave and dv/dt issues often associated with voltage source inverter (VSI) drives are a non-issue with the PowerFlex 7000. [Figure 2](#) shows typical motor waveforms. The drive uses a selective harmonic elimination (SHE) pattern in the inverter to eliminate major order harmonics, plus 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. Rockwell Automation has tested this technology for controlling motors up to 15 km (9.3 miles) away from the drive.

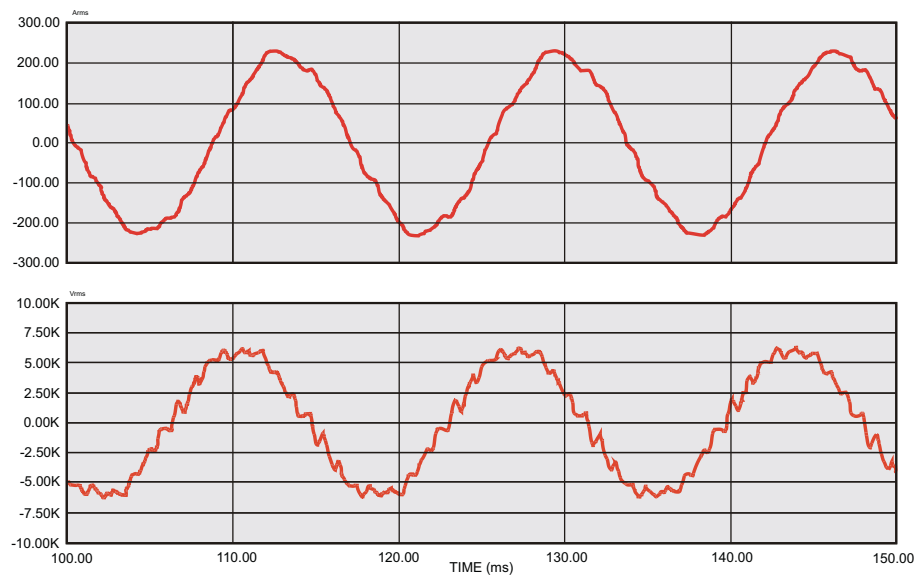


Figure 2 - Motor waveforms @ full load, full speed

Simplified Electrical Diagrams

2400V with AFE Rectifier

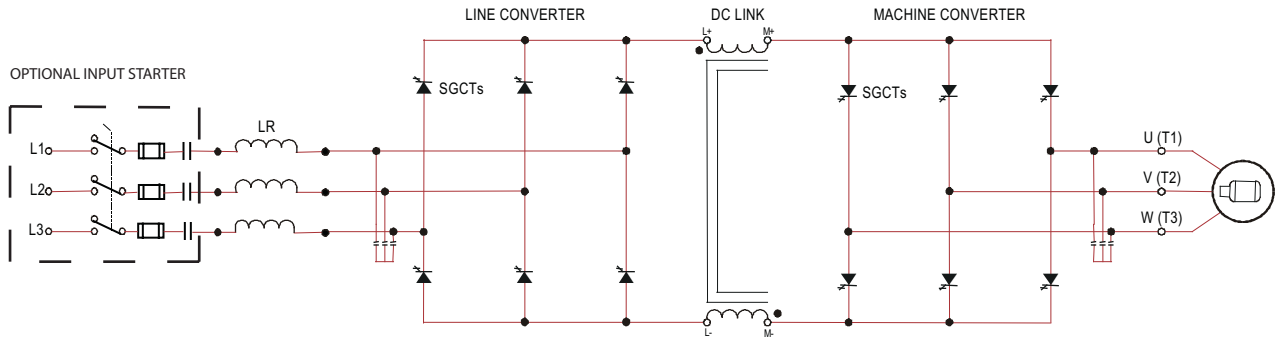


Figure 3 - 2400 Volt – AFE Rectifier, Configuration #1 – Direct-to-Drive

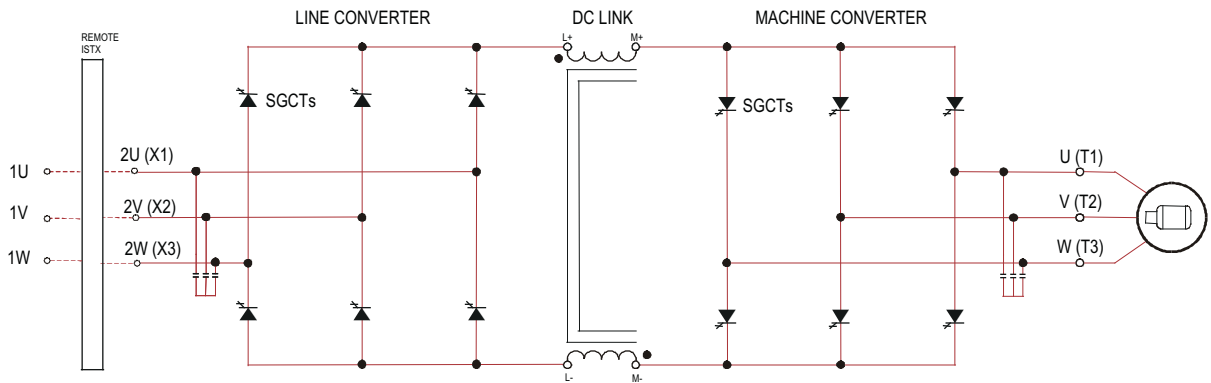


Figure 4 - 2400 Volt – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

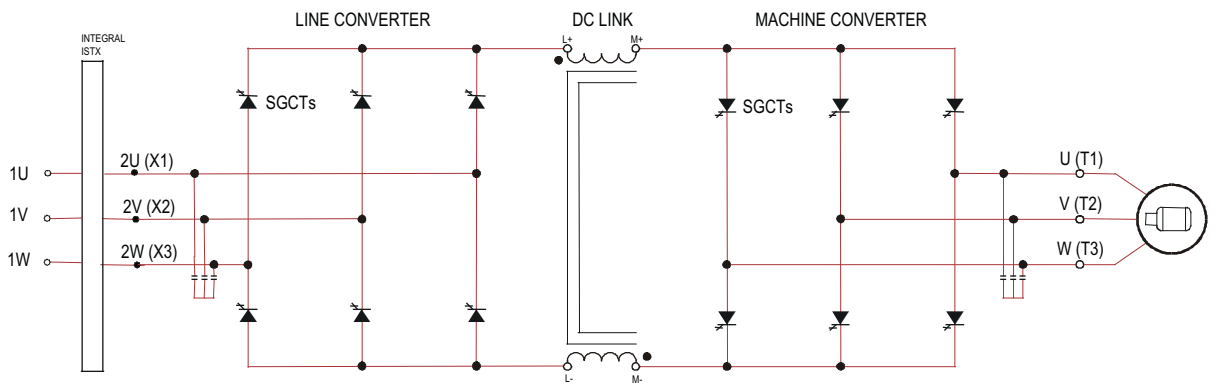


Figure 5 - 2400 Volt – AFE Rectifier, Configuration #3 – Integral Isolation Transformer

3300/4160V with AFE Rectifier

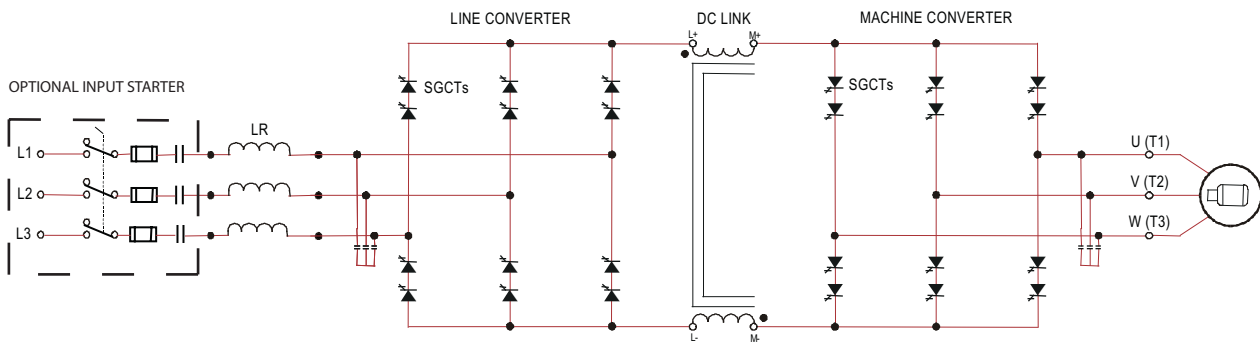
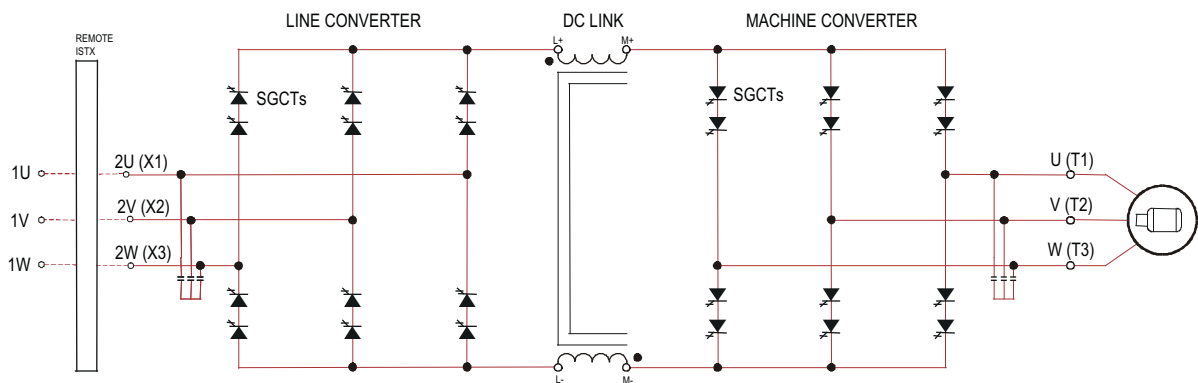


Figure 6 - 3300/4160 Volt – AFE Rectifier, Configuration #1 – Direct-to-Drive



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

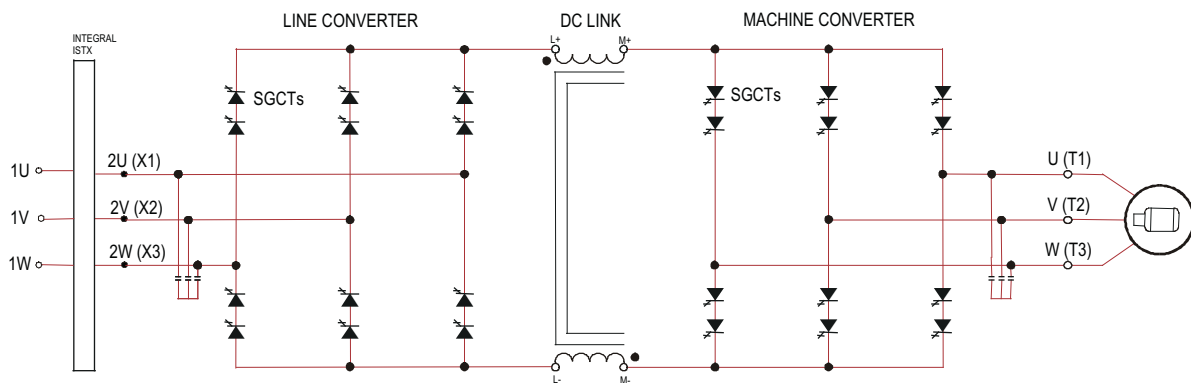


Figure 7 - 3300/4160 Volt – AFE Rectifier, Configuration #3 – Integral Isolation Transformer

6600 V with AFE Rectifier

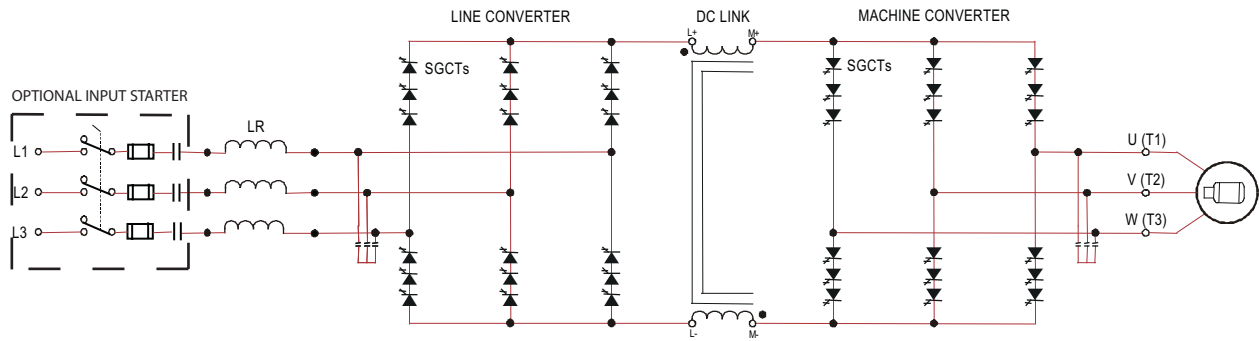


Figure 8 - 6600 Volt – AFE Rectifier, Configuration #1 – Direct-to-Drive

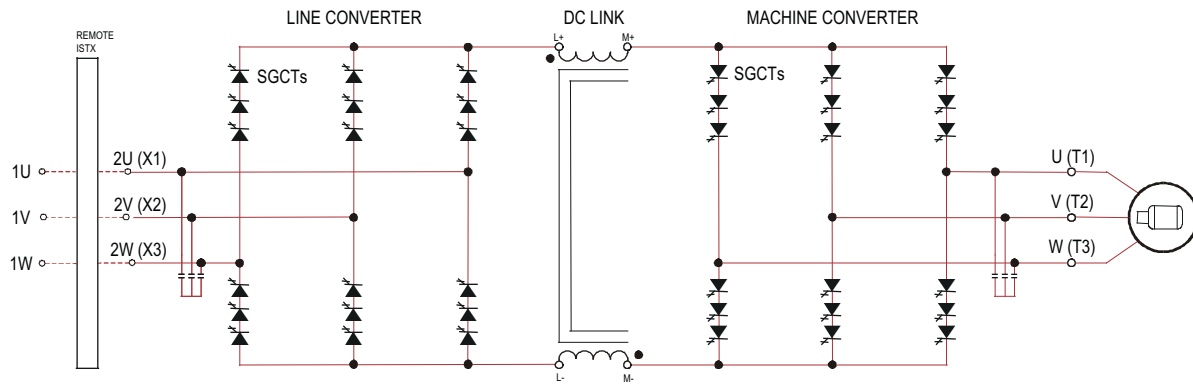


Figure 9 - 6600 Volt – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

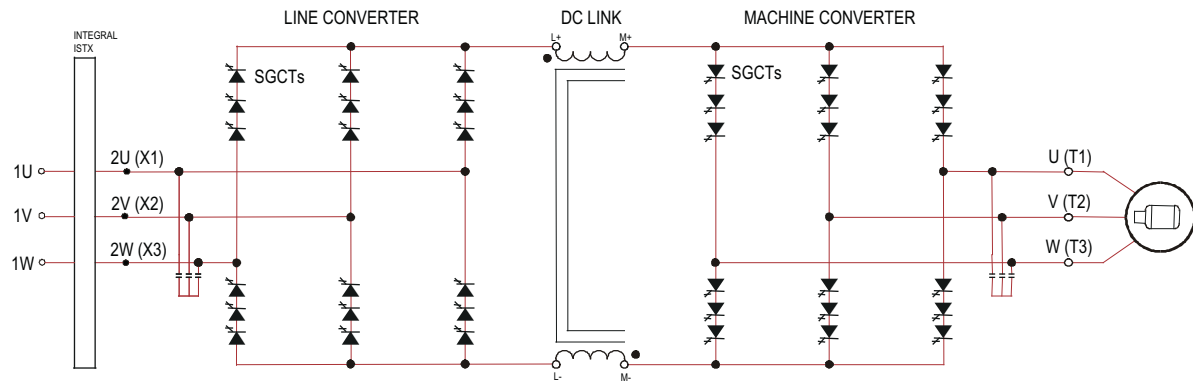


Figure 10 - 6600 Volt – AFE Rectifier, Configuration #3 – Integral Isolation Transformer

Operator Interface

The operator interface terminal features a 16-line, 40-character, pixel-based LCD display. The bar chart meters are configurable for common process variables including speed, voltage, and load.

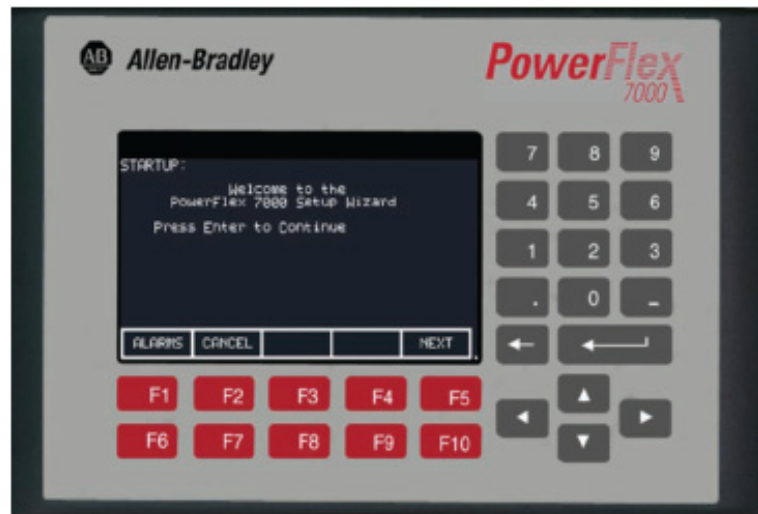


Figure 11 - Operator interface

The terminal provides access to drive control during start-up, monitoring, and troubleshooting. The setup wizard enables you to configure required parameter menus, using questions or prompts for desired operation. Warnings and comments include help text to assist you. The setup wizard, combined with the auto-tuning feature, enables you to tune the drive to the motor and load as quickly and accurately as possible, resulting in fast start-ups, smooth operation, and less down time.

Available test modes include low voltage gate check, and running at full current without motor connected.

Available enhanced diagnostic functions include separate fault and warning queues in non-volatile RAM (NVRAM), extended fault text strings, on-line help, and trend buffers for 16 variables.

Refer to [Initial Operator Interface Configuration on page 173](#) for information regarding the operator interface and procedures for loading and editing drive parameters through the interface.

Notes:

Component Definition and Maintenance

This section provides an overview of the control and cabling components of your PowerFlex 7000 “B” Frame drive. It also details a number of regular or recurring maintenance tasks that will keep your drive in peak operating condition.

The following illustrations identify the control and cabling components of your drives. Where appropriate, separate diagrams and instructions are available for both the standard and the heatpipe “B” Frame models. Assume any “B” Frame diagram not specifically identified as a heatpipe model represents a standard model.

For information regarding power wiring and cabling connections (as might be necessary for routine maintenance) please refer to the current PowerFlex 7000 “B” Frame Installation Manual.

Control / Cabling Cabinet Components

For converter cabinets, see [Converter Cabinet Components on page 43](#).

For DC link/fan cabinets, see [DC Link and Fan Cabinet Components on page 85](#).

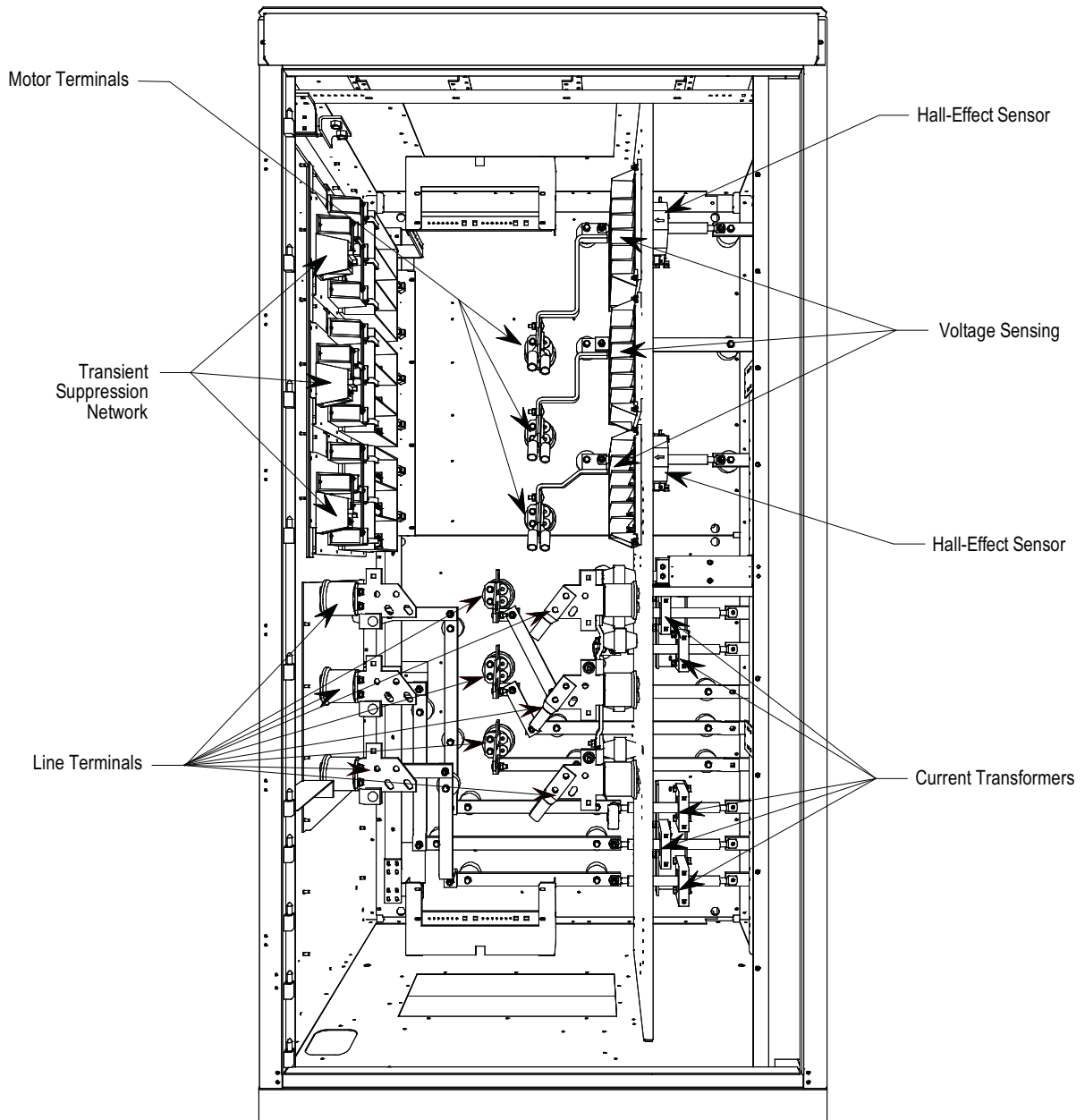


Figure 12 - Cabling cabinet for 18-pulse rectifier (motor filter capacitors not shown)

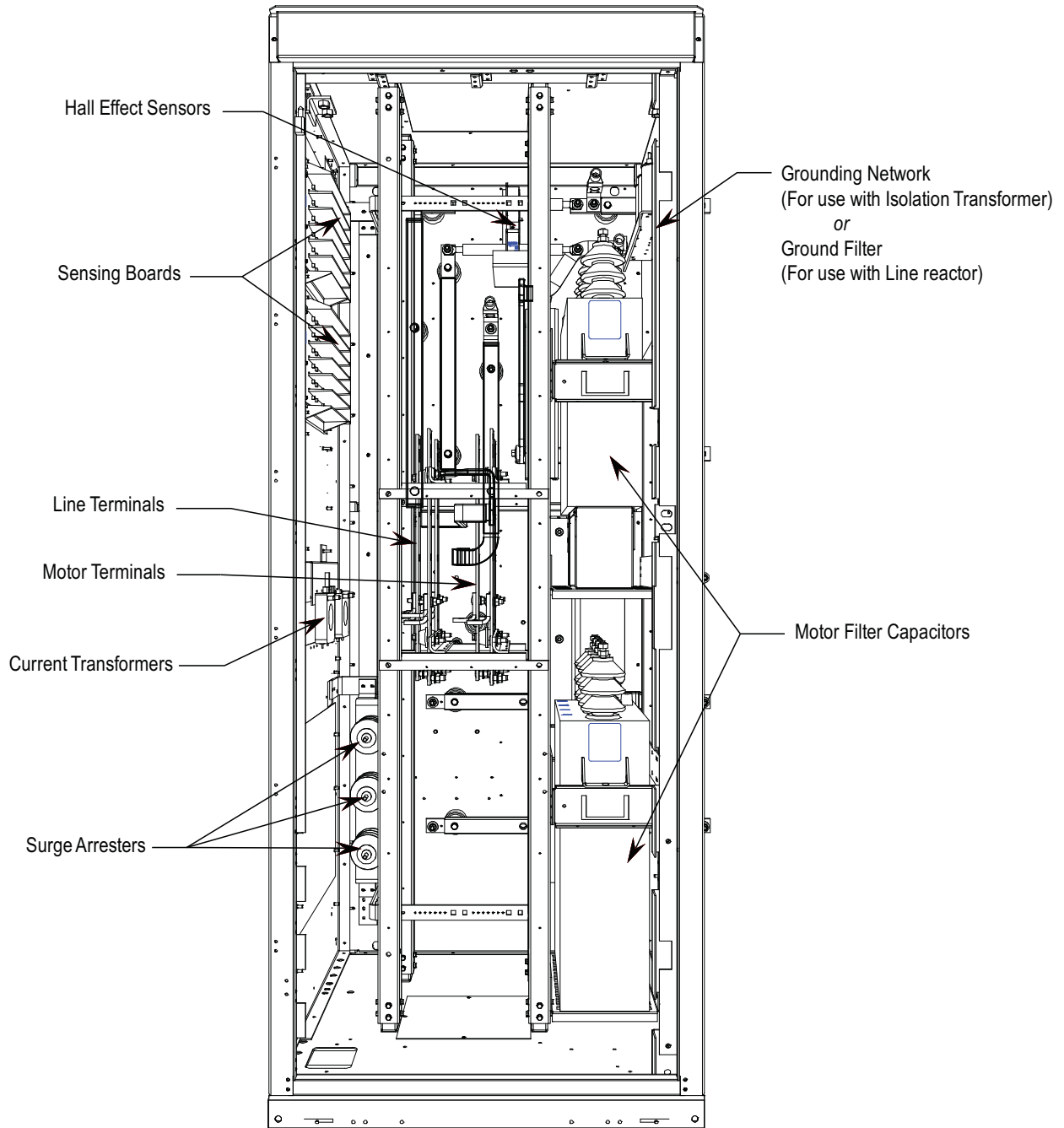


Figure 13 - Cabling cabinet for AFE rectifier (standard model)

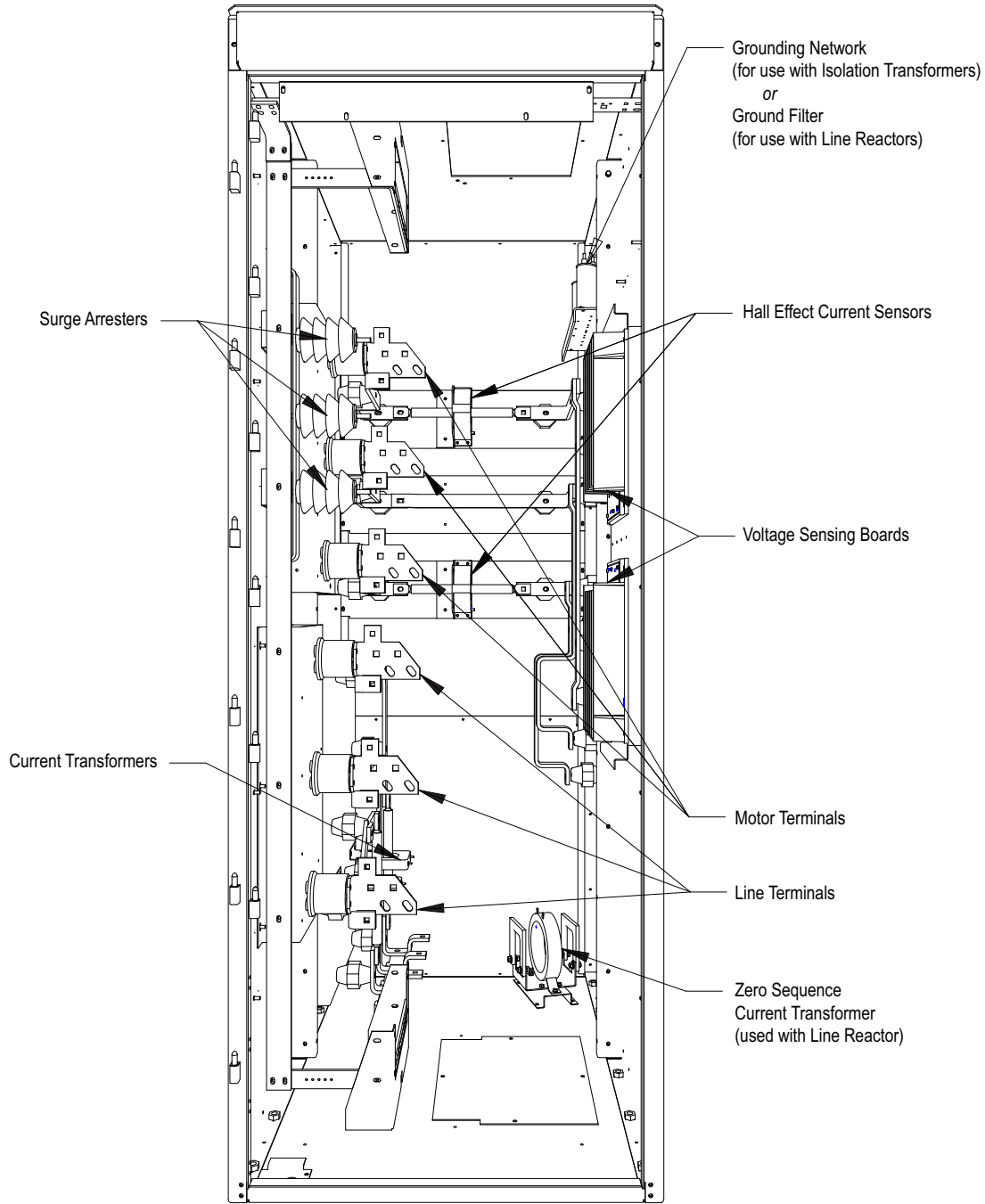


Figure 14 - Cabling cabinet for AFE rectifier (heatpipe model)

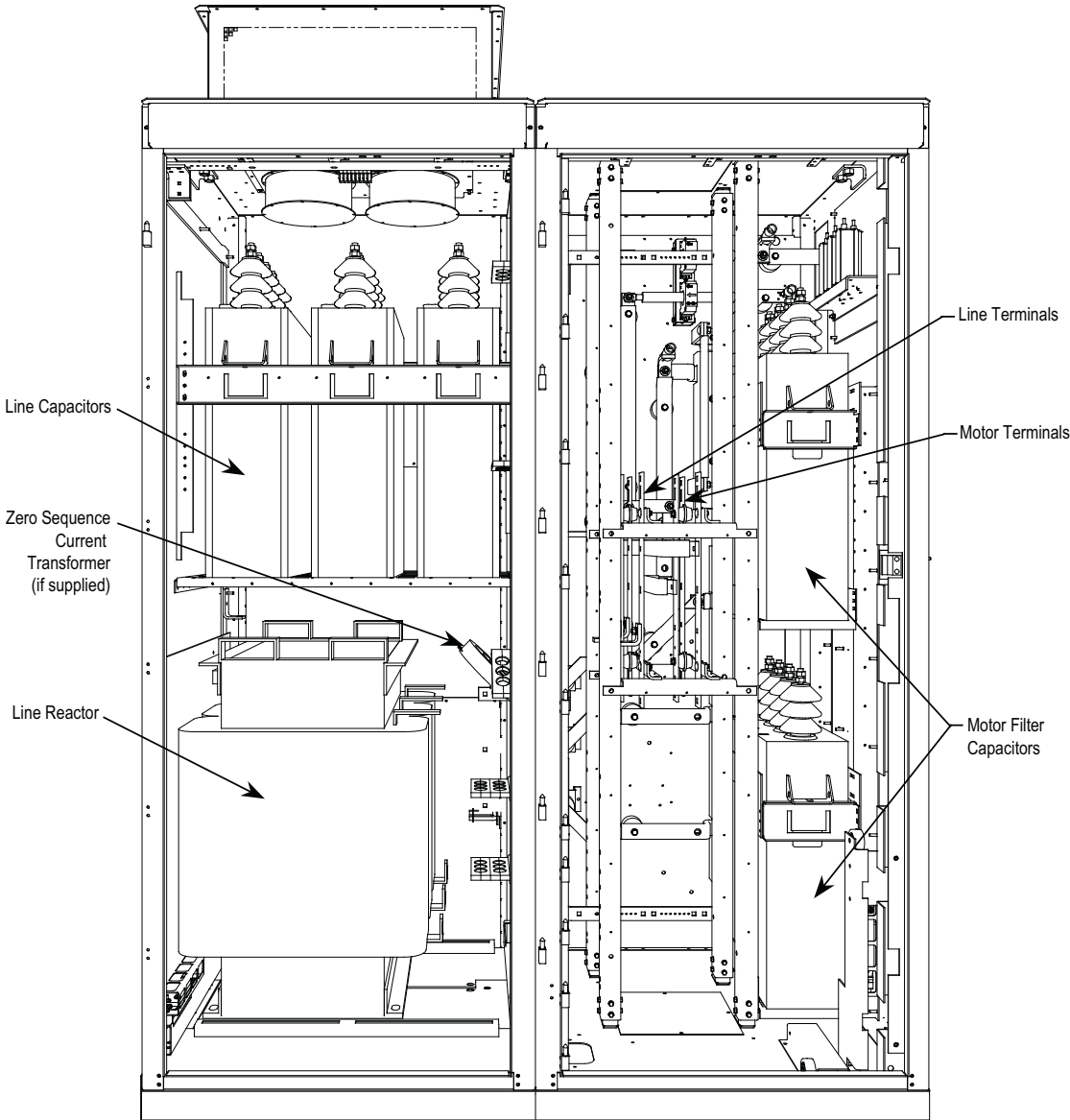


Figure 15 - AC line reactor cabinet with connection cabinet (standard model)

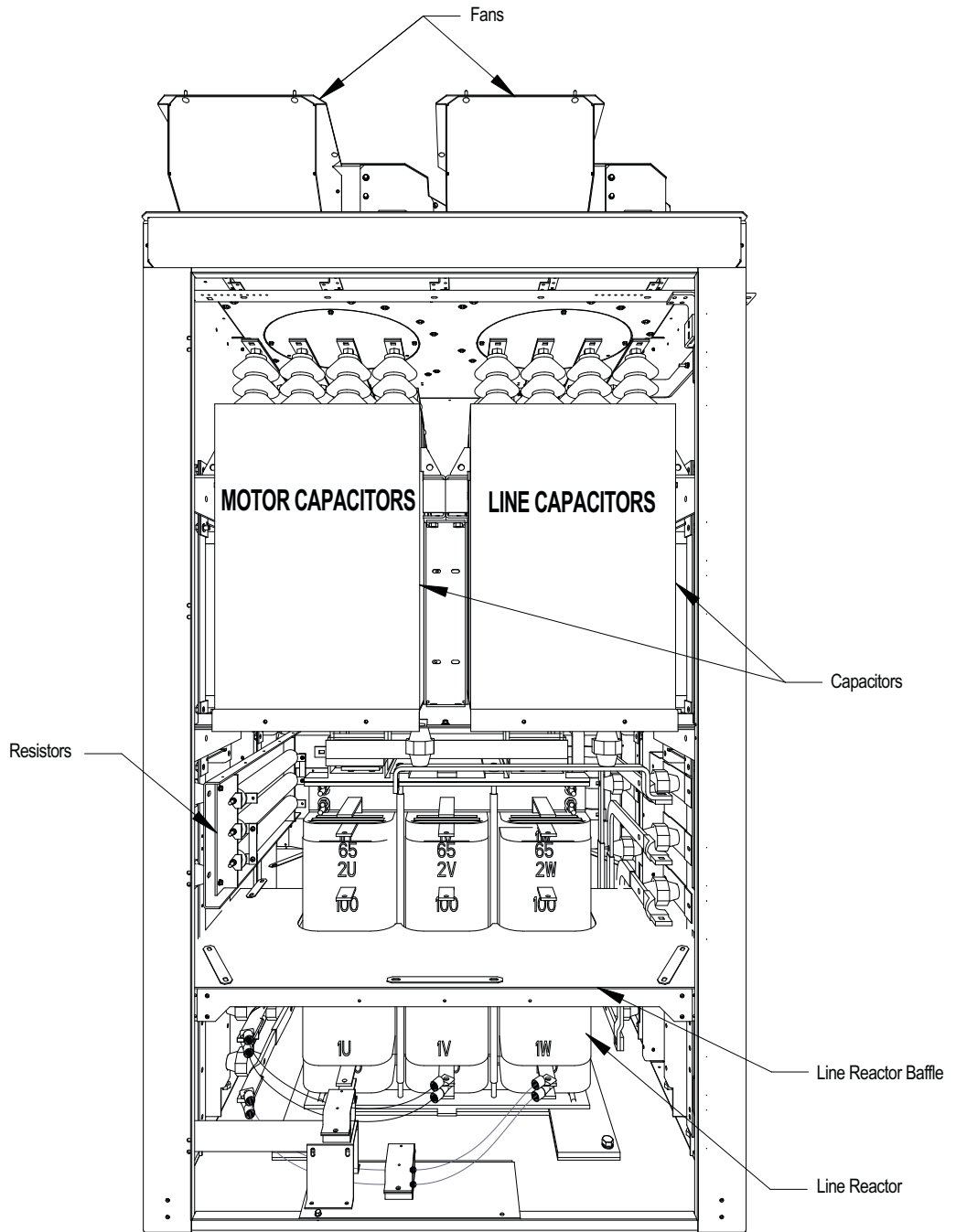


Figure 16 - AC Line Reactor with connection cabinet (heatpipe model)

Voltage-Sensing Assembly

The voltage-sensing assembly consists of the voltage sensing board and the mounting plate. The voltage sensing board has six independent channels that convert voltages as high as 10800V (7.2kV x 1.5 pu) down to low voltage levels that the PowerFlex 7000 control logic (i.e. Signal Conditioning Board - SCB) can use. To measure up to twelve independent voltage channels, link two assemblies together, with one assembly acting as the master assembly and the second as the slave assembly. In linked assemblies, the master assembly sends the twelve voltage signals to the SCB board. For drives requiring the synchronous transfer option, use one additional module.

This assembly uses a separate connector to output the transfer voltages directly to the SCB board.

The following table shows the input voltage ranges for each input terminal on the voltage-sensing board. There are four separate inputs taps for each independent channel. This assembly operates at a nominal input voltage of up to 7200V with a continuous 40% overvoltage. The output voltages scale to provide almost 10V peak for a 140% input voltage at the high end of each of the voltage ranges.

Each channel has four taps that provide a range of input voltages and software to provide a given amount of gain, so that 140% will correspond to the maximum numerical value of the analogue to digital converter.

Nominal input voltage range

Tap	Voltage Range
D	800 - 1449V
C	1450 - 2499V
B	2500 - 4799V
A	4800 - 7200V



ATTENTION: Reconnect the grounds on the voltage sensing boards. Failure to do so may result in injury, death or damage to equipment.

Replacing the Voltage-Sensing Circuit Board Assembly

The number of sensing boards is dependent upon the drive rectifier configuration.

1. Ensure there is no power to the equipment.



ATTENTION: To prevent electrical shock, disconnect the main power before working on the sensing board. Verify that all circuits are voltage-free, using a hot stick or appropriate high voltage-measuring device. Failure to do so may result in injury or death.

2. Mark the position of the ribbon cables and wires.

3. Remove the screws and lift the ring lugs from the terminals to remove the wires.
4. Release the locking mechanism located on each side of the ribbon cable connector and pull the ribbon cable straight out to prevent bending the pins.
5. Remove the four nuts and washers that secure the assembly to the studs welded to the frame.
6. Remove the old VSB and replace with the new VSB on the studs, using the existing hardware to secure the assembly. Do not over-torque the connections or you may break the studs.
7. Replace ring lugs on terminals. Plug in ribbon cables making sure that cables are positioned properly and fitting is secure (locking mechanism is engaged).
8. For personnel and equipment safety, ensure both grounding connections are re-connected to the sensing board.

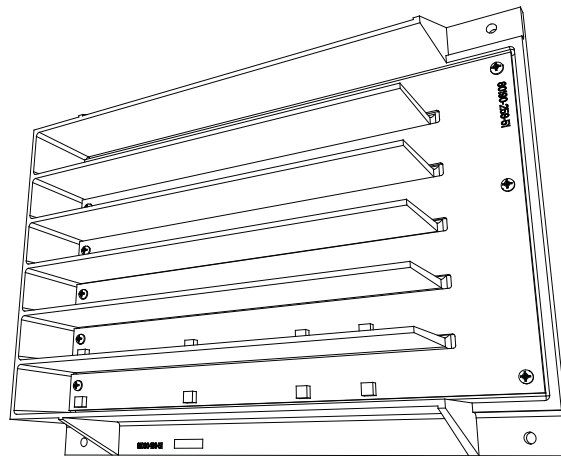


Figure 17 - Sensing board with mounting hardware placement

Input Transient Protection

The drive provides input transient protection in one of two forms:

- Transient Suppression Network (TSN), or
- Surge arresters

The TSN is optimized for 18-pulse rectifier designs. Surge arresters are optimized for AFE and D2D rectifier designs.

Transient Suppression Network (TSN)

The TSN module consists of an assembly of suppressors connected to each of the three phase input lines and the structure's ground bus. There are three assemblies for an 18-pulse drive.

A transient voltage spike in excess of the semiconductor rating will destroy or shorten the lifespan of the device. The TSN module suppresses transient overvoltages on the drive input, and is a standard feature of the drive. The two basic blocks of the TSN module are the MOV suppressor and the MOV fuse.

MOV Suppressor

The transient suppressors used in the module are heavy-duty metal oxide varistors or MOVs. Varistors are voltage dependent, nonlinear resistors. They have symmetrical voltage/current characteristics similar to back-to-back connected Zener diodes. The varistor has very high resistance below its voltage rating and appears as an open circuit.

The leakage current through the device would be very small in this region. When a voltage transient occurs in which the voltage exceeds the ‘knee’ in the curve, the varistor resistance changes from its high state by several orders of magnitude to a very low level. The voltage is clamped for a change in current of several orders of magnitude. Refer to [Figure 18](#) for an illustration of this state.

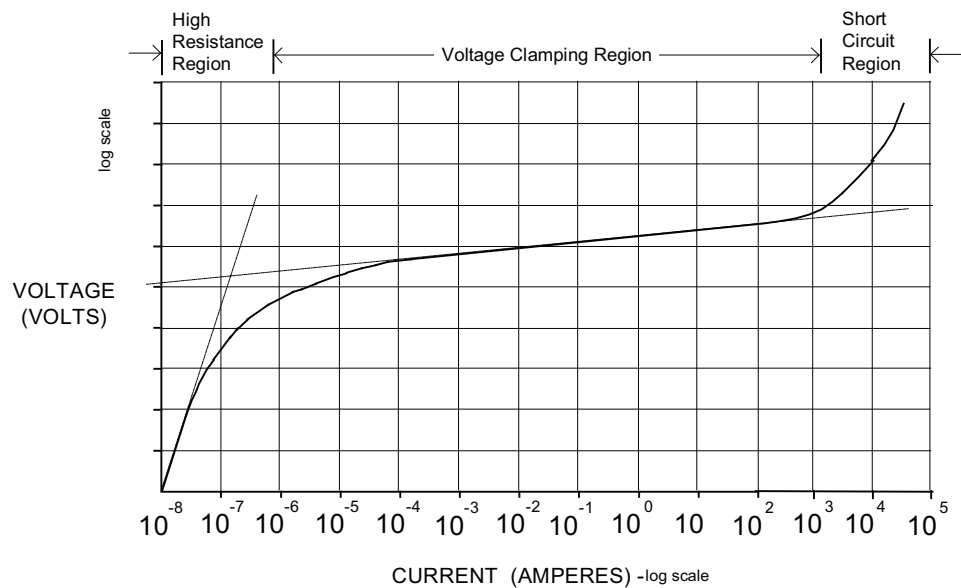


Figure 18 - Typical MOV V-I Characteristic Curve

When the MOV clips the voltage transient, the MOV absorbs the transient energy. The varistor has a limited energy absorbing capability and there is insufficient time to conduct heat out of the device. The MOV size depends on the steady-state voltage rating, the energy in the transient, and the repetition rate of the transients. A critical element in selecting a MOV for protection is the impedance in the line supplying the transient. The isolation transformer or the AC line reactor on the input of the drive provides this impedance, which is why an impedance level is necessary for these input devices.

MOV Fuse

A medium voltage fuse is in series with each of the Phase MOVs. As seen in [Figure 19 on page 31](#), these fuses may reside on either the assembly or remote from the assembly (on the Line Terminal module). Check the part number on your module and the information in this documentation to determine which assembly your drive requires.

The fuses provide overload protection for the conductors feeding the suppression network (and overturned protection if a short circuit occurs on the downstream side of the fuse.) These conductors will normally have a much smaller current carrying capacity than the drive input conductors; they are not protected by the drive input fuses. The fuses also isolate a failed MOV. Varistors initially fail in a short-circuited condition. The high follow-through current will open the fuse and remove the MOV from the circuit.

The fuses are E-rated, current-limiting fuses with a high interrupting rating. Because they are current-limiting, they limit both the magnitude and duration of fault currents. They are small dimension, ferrule-type fuses with a fiberglass body, and mount in standard fuse clips.

IMPORTANT Rockwell Automation selects the fuses sent with the Transient Suppression Network based on their characteristics (including internal resistance) for optimum MOV performance and protection. Do not substitute other fuses without contacting the factory first.

IMPORTANT Voltage sensing occurs after the MOV fuse and will detect open fuses in the drive control as a Master or Slave Undervoltage or Unbalance.

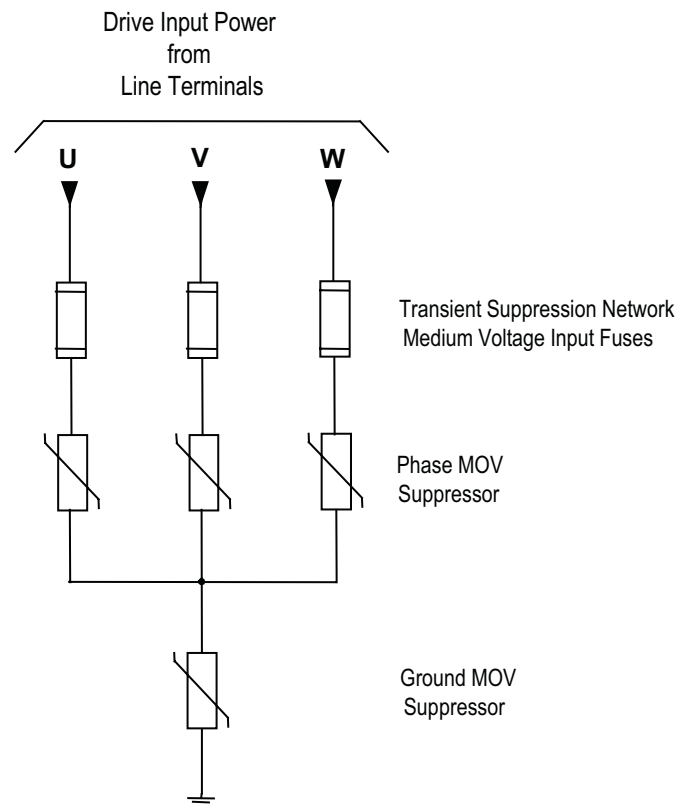


Figure 19 - Simplified wiring diagram

Replacing Transient Suppression Network Fuses

Two sizes of fuses (5 kV, 7.2 kV) are available within the TSN located inside the connection cabinet. The 18-pulse drive contains three TSNs.

1. Ensure there is no power to the equipment.



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

2. Fuses are held in a place with a fuse clip. To remove the fuse pull firmly.
3. To replace the fuse, hold it in position and push firmly until the fuse is seated within the fuse clip. Install fuses so that the rating is visible.

IMPORTANT Replace the fuse with another of the same rating. (See [Figure 20 on page 32](#) for location.)

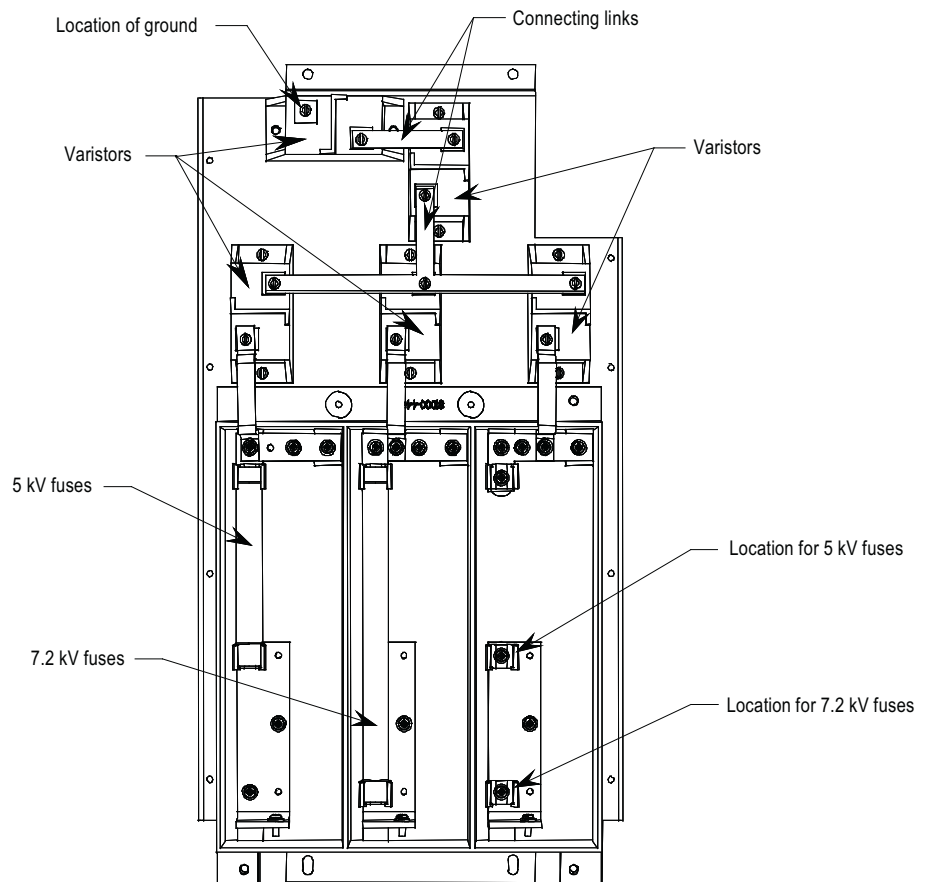


Figure 20 - Transient Suppression Network

Replacing Metal-Oxide Varistors

Metal-oxide varistors (MOV) are part of the TSN located within the connection cabinet.

1. Ensure there is no power to the equipment.



ATTENTION: To prevent electrical shock, disconnect the main power 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. Observe the locations of the connecting links.
3. Detach the connecting links by removing the screws.
4. Using a screwdriver remove the screws at the base.
5. Replace the MOV (polarity is not an issue).
6. Continue by replacing the screws and connecting links.

Each MOV panel is grounded. Ensure that one MOV (see [Figure 20 on page 32](#) for location) connects to the grounding lead.

Surge Arresters

These medium voltage drives use heavy duty distribution class surge arresters 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 MOVs, with or without an air gap in series, in sealed housing. They provide overvoltage protection similar to that of the TSN module. They differ from the TSN in that fusing is not mandatory for the operation of surge arresters.

There are 3 types of surge arresters depending on the voltage class of the drive:

Drive Voltage	2.4 kV	3.3 kV, 4.16 kV, 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 applies to the arrester in this case. The arresters operate under this condition continuously without any problems as indicated by their Maximum Continuous Operating Voltage (MCOV) rating.

Three Y-connected surge arresters attach to the incoming MV lines. The neutral point of the arresters connects to the ground bus.

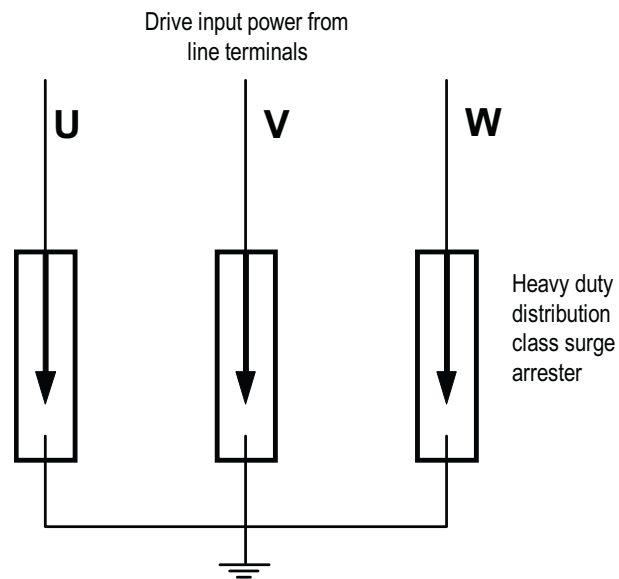


Figure 21 - Surge arresters on incoming MV lines

Operation

Arrester operation without a gap is the same as that of MOVs in the TSN. Depending on design, the arrester may also have a gap. Both gapped and un-gapped arresters provide adequate overvoltage protection.

The arresters can withstand most commonly-seen bus transients within their capability. If there is a harmonic filter on the MV bus connected to the drive, the filter must 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 without expelling any internal components.

When the incoming energy exceeds the handling capability of the arrester and causes arrester failure, the housing splits open to vent without causing damage to any adjacent components.

Replacing the Surge Arrester

1. Isolate and lock out all power to the drive.



ATTENTION: To prevent electrical shock, disconnect the main power 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. Wait a minimum of ten minutes for the drive to discharge stored energy.
3. Observe the location of the connecting leads.
4. Use proper method to ensure the leads are at ground potential. Use temporary grounding 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. Torque the surge arrester hardware to 28 Nm (21ft/lbs).

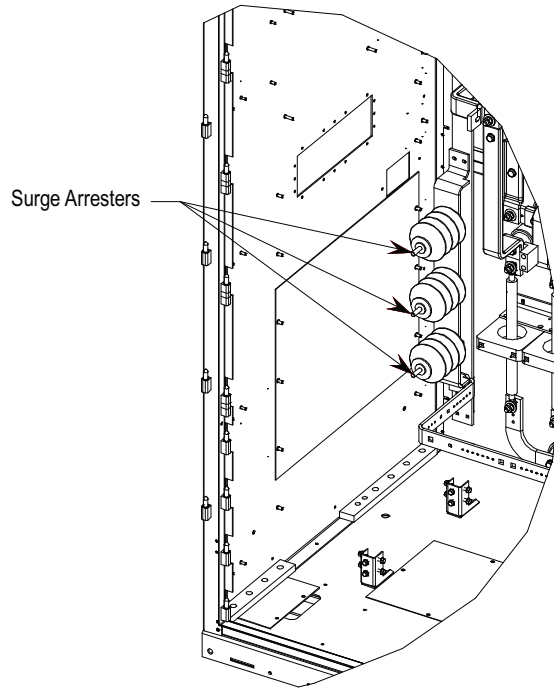


Figure 22 - Surge arresters (standard model)

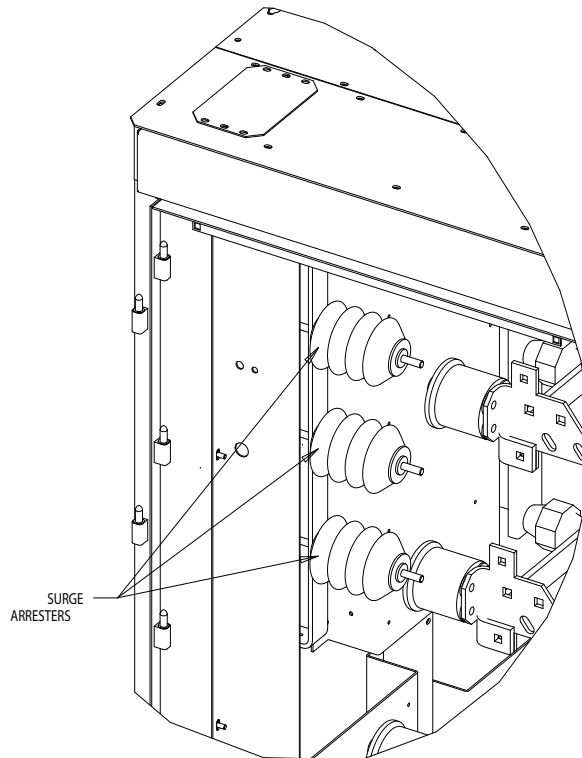


Figure 23 - Surge arresters (heatpipe model)

When you disconnect the surge arrester from drive, the arrester may retain a small amount of static charge. As a precautionary measure, install a temporary ground on the line-end of the arrester and discharge the stored energy. Remove temporary ground before reinstalling the arrester. To avoid electrical shock when removing the arrester from service, treat it as fully energized until you disconnect both the line and ground leads.

Field Test and Care

No field testing is necessary. The arresters do not require special care. At very dusty sites, however, you should clean the arrester when cleaning the entire drive.

Replacing Output Grounding Network Capacitors

PowerFlex 7000 18-pulse and select AFE drives come with an installed grounding network.

The number of capacitors varies depending on the system voltage.

1. Isolate and lock out all power to the drive.



ATTENTION: To prevent electrical shock, disconnect the main power 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 leads.
3. Remove the 6.4-mm (¼ inch) hardware and disconnect the leads connected to the terminals.
4. Four brackets secure the capacitor. Loosen the four screws at the base of the brackets and lift the capacitor out.
5. Place the new capacitor and tighten the screws securely.
6. Replace the ring lugs and 6.4-mm (¼ inch) hardware (see [Figure 22](#)).

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

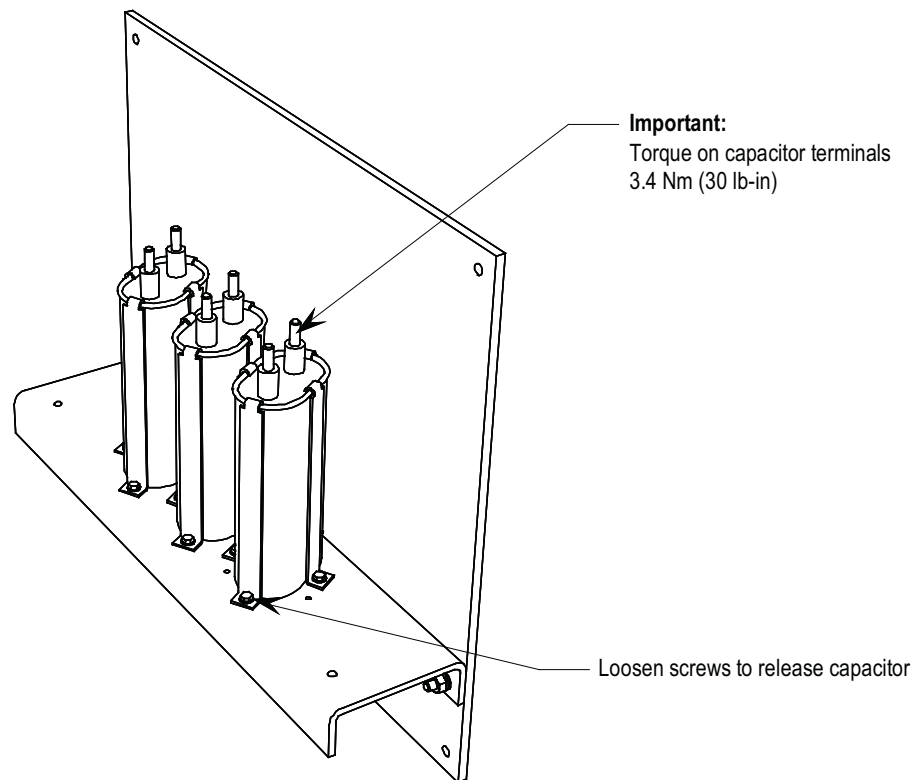


Figure 24 - Capacitor in grounding network

Replacing the Hall Effect Current Sensor (HECS)

1. Isolate and lock out all power to the drive.



ATTENTION: To prevent electrical shock, disconnect the main power 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 location of all wires and the orientation of the HECS. For quick reference when checking the orientation of the HECS, look for the white arrow.

IMPORTANT The Hall Effect Current Sensor (HECS) and wires must be in the proper orientation. Note the position before disassembly.

3. Remove the round bus bar. Remove the M10 hardware and slide the bar out.
4. Remove the output connector. Note the orientation.
5. Remove the four screws on the base of the Hall Effect sensor and remove the sensor.

6. Insert the new sensor. Orient the arrows as shown in [Figure 25](#).
7. Slide the bus bar back into place and secure with the M10 hardware.
8. Replace the output connector, noting the correct orientation.

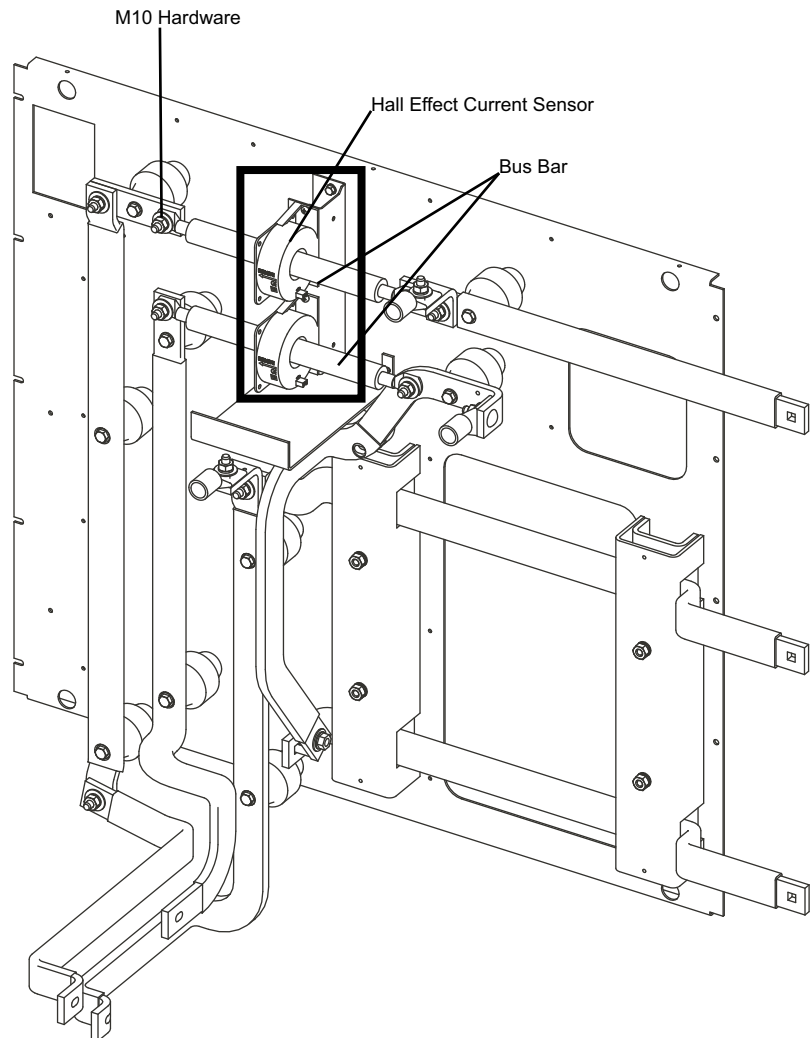


Figure 25 - Hall Effect Current Sensor located within cabinet

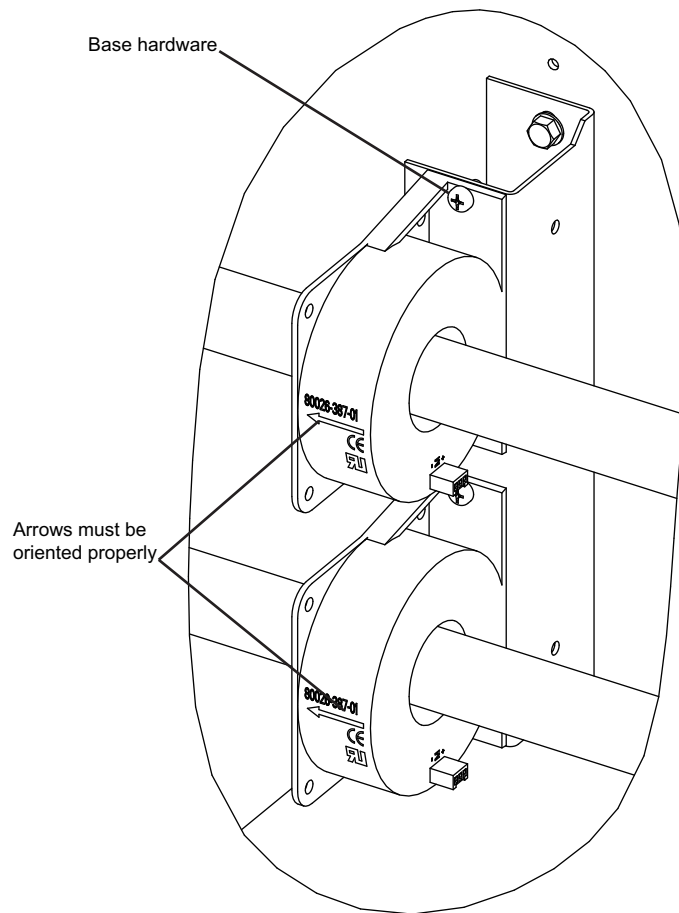


Figure 26 - Hall Effect Current Sensor (detail)

Replacing the Current Transformer (CT)

1. Isolate and lock out all power to the drive.



ATTENTION: To prevent electrical shock, disconnect the main power 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 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. Disassemble the bus bar to remove the CT. Remove the M10 hardware to slide out the bus bar.

5. Remove the four 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 four screws in the base
7. Reconnect the ring lugs. Do not overtighten or you will break the threaded stud. For torque specifications, refer to [Torque Requirements for Threaded Fasteners on page 239](#). Replace the bus bar and tighten into place.

Filter Capacitor Cabinet

Filter Capacitors

All “B” Frame drives use filter capacitors on the motor side. The AFE rectifier option also includes filter capacitors on the line side. Refer to [Figure 12 on page 22](#) (Cabling Cabinet for 18-pulse Rectifier), and [Figure 13 on page 23](#) (Cabling Cabinet for AFE Rectifier).

The filter capacitors are three-phase, oil-filled, four-bushing units. The three-phase capacitors are internal single-phase units connected in a Y configuration. The neutral point of the Y connects to the fourth bushing, which is available to use as a neutral point voltage measurement or other protection/diagnostics purposes. Depending on the drive configuration, the fourth bushing may or may not connect to circuitry. The metal cases of the capacitors are grounded through a stud on the capacitor housing.

The capacitors have internal “bleeding resistors” to discharge the capacitor and reduce its voltage below 50V in 5 minutes when disconnected. [Figure 27](#) shows a typical three-phase capacitor.

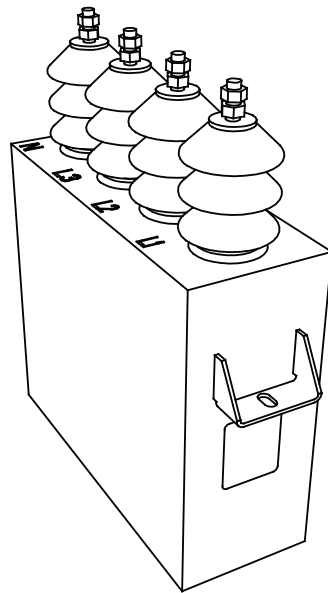


Figure 27 - Motor filter capacitor



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



WARNING: The following fault codes may also indicate a non-operational Motor Filter Capacitor (MFC):

F96 (Motor Overcurrent Fault)
F98 (Motor Neutral Overvoltage Fault)
F99 (Motor Flux Unbalance Fault)
F100 (Motor Current Unbalance Fault)
F103 (Motor Stall Fault)
F113 (DC Link Overcurrent Fault)
F114 (Ground Overcurrent Fault)
F115 (Neutral Resistor Overcurrent Fault)
F145 (Neutral Resistor Overload Fault)

Do not reset these faults until you have determined the root cause of the fault.

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

Replacing Filter Capacitors

1. Isolate and lock out all power to the drive.



ATTENTION: To prevent electrical shock, disconnect the main power 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 location of all the cables and mark them accordingly.
3. Remove the 4 power connections to the terminals, and the single ground connector from the drive to the capacitor frame, located at the back top right corner of the capacitor.
4. Remove the front bracket that holds the capacitor in place. At the rear of the capacitor, there is no hardware securing the capacitor; it fits into a slot in the assembly.
5. Remove the capacitor from the drive.

IMPORTANT Capacitors can weigh as much as 100 kg (220 lbs). Use two or more people to remove a capacitor.

6. Install the new capacitor, sliding it back until it fits into the slot. Fasten the front bracket.
7. Reconnect all the power cables and the ground connection. These use M14 hardware, but should only be tightened to 30 Nm (22 ft.-lbs.) due to capacitor mechanical constraints. You may want to fasten these connections before fully sliding the capacitor into place depending on the available space.
8. Follow the instruction labels on each capacitor to tighten the terminal connections.
9. Reinstall the removed sheet metal, and complete one final check to ensure connections are secure and correct.

Testing Filter Capacitors

1. Isolate and lock out all power to the drive.



ATTENTION: To prevent electrical shock, disconnect the main power 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.



ATTENTION: Verify the load is not running due to process. A freewheeling motor can generate voltage that feeds back to the equipment.

2. Perform visual inspection to ensure there is no oil leak or bulge in any of the capacitors.
3. Note the location of all the cables and mark them accordingly.
4. Disconnect power cables from the capacitor terminals on all four bushings and isolate them from the capacitor.
5. 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 take care to prevent a shock or injury. When moving the test connections from one phase to the next, wait five minutes minimum for the capacitor to discharge.

6. 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 +10% of the capacitor nameplate micro-Farad. If it is outside this range then replace the capacitor.

This example demonstrates the calculation for capacitance value.

Suppose a capacitor under test is rated at 400kVAR, 6600V, 50Hz, 29.2 μ F. Assume you are using 200V, 50Hz test power with the recorded voltage and current values for each test as shown 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

Calculate the capacitance using the first reading. In this case:

$V = 200V, I = 1.87$ for L1-N $X_c = V/I = 200/1.87 = 106.95$ $C = 1 / (2 \pi F X_c)$ $C = 1 / (2 \times 3.14 \times 50 \times 106.95)$ $C = 29.7 \mu F$	Where: F = frequency of the applied voltage.
--	---

Similarly, you can calculate the capacitance for the remaining two measurements for L2-N and L3-N.

Converter Cabinet Components

This section describes the converter cabinet components of your PowerFlex 7000 “B” Frame drive. It also details a number of regular or recurring maintenance tasks that will keep your drive in peak operating condition.

For control/cabling cabinets, see [Control / Cabling Cabinet Components on page 21](#).

For DC link/fan cabinets, see [DC Link and Fan Cabinet Components on page 85](#).

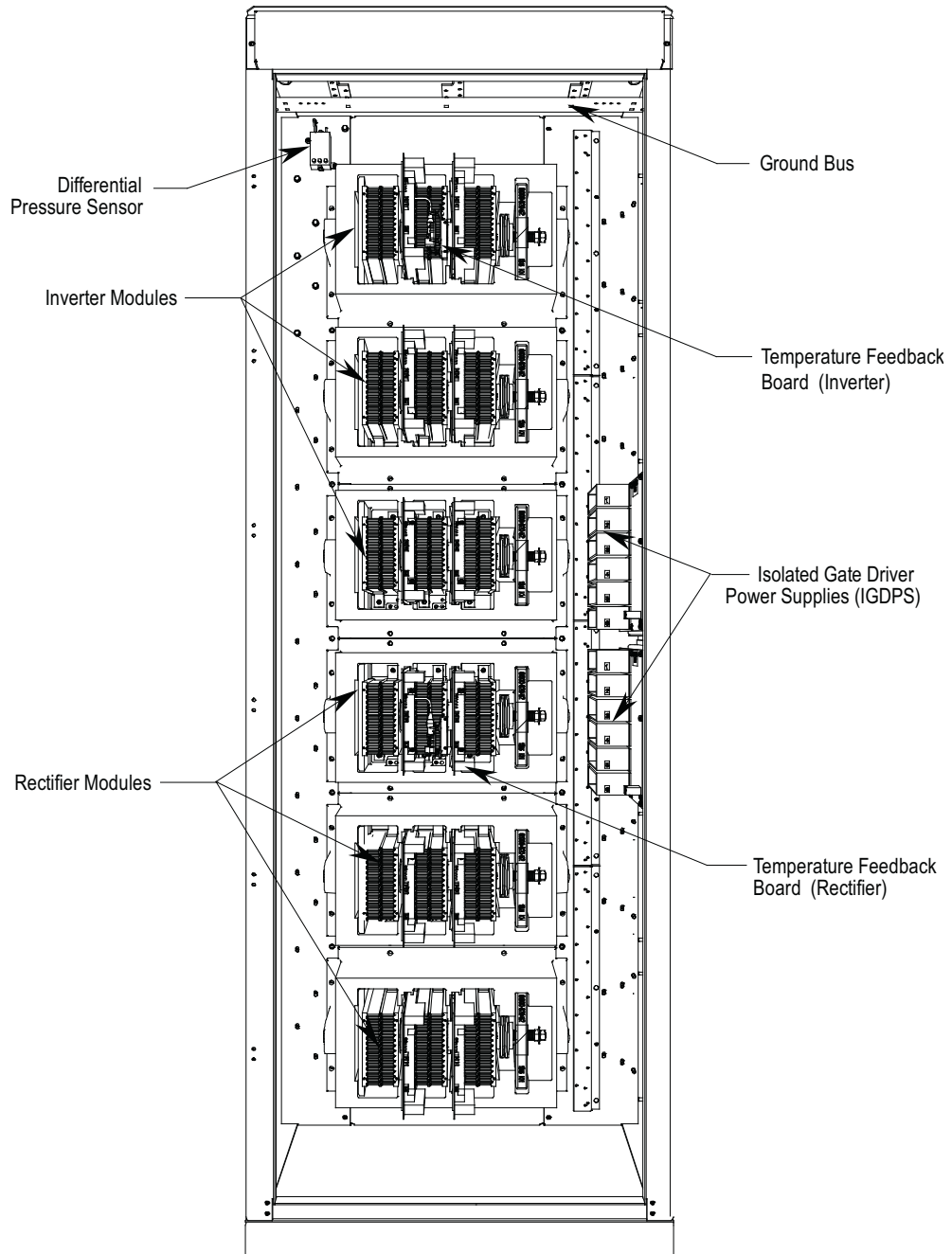


Figure 28 - Converter cabinet (standard model, 2400V)

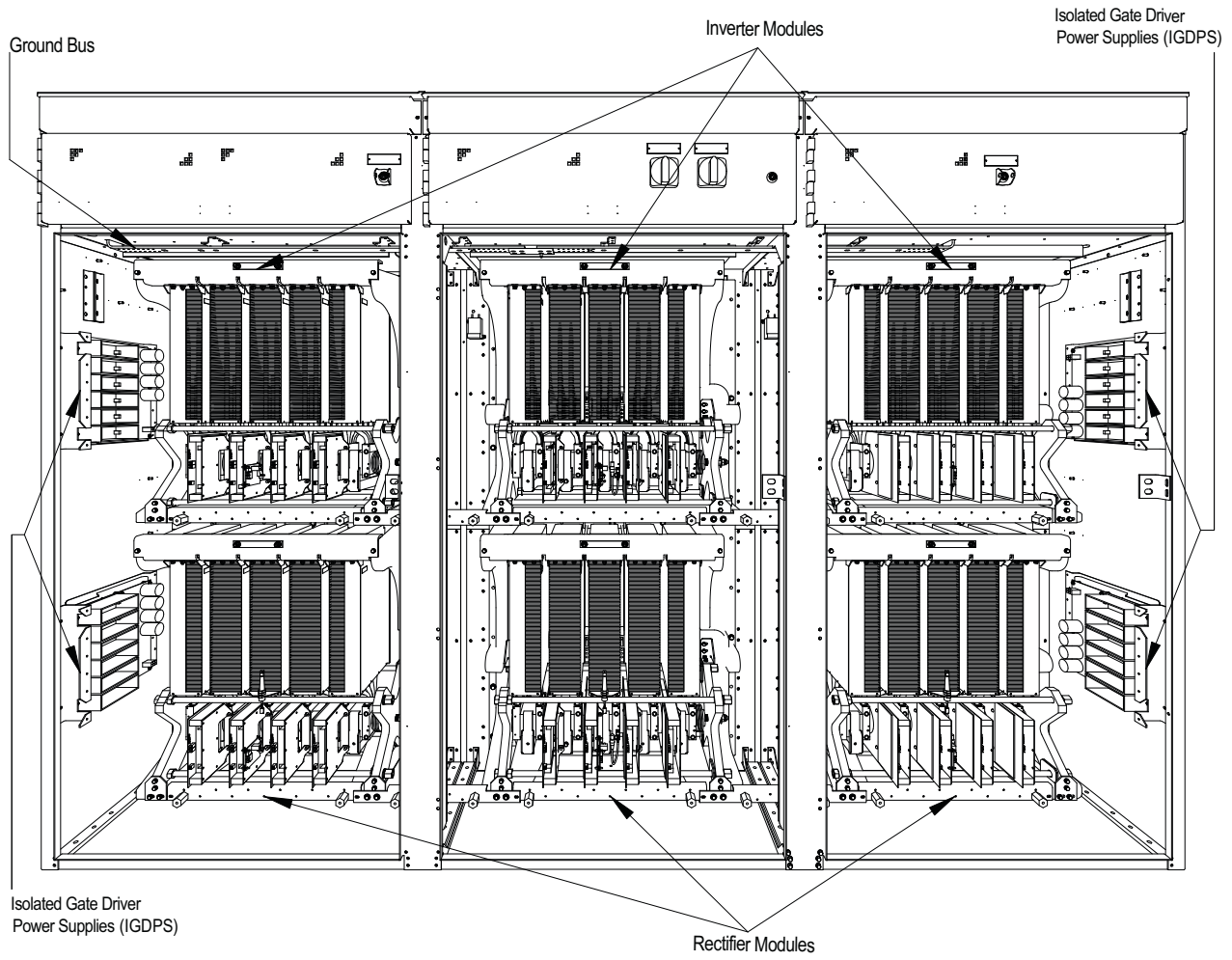


Figure 29 - Converter cabinet (heatpipe model)

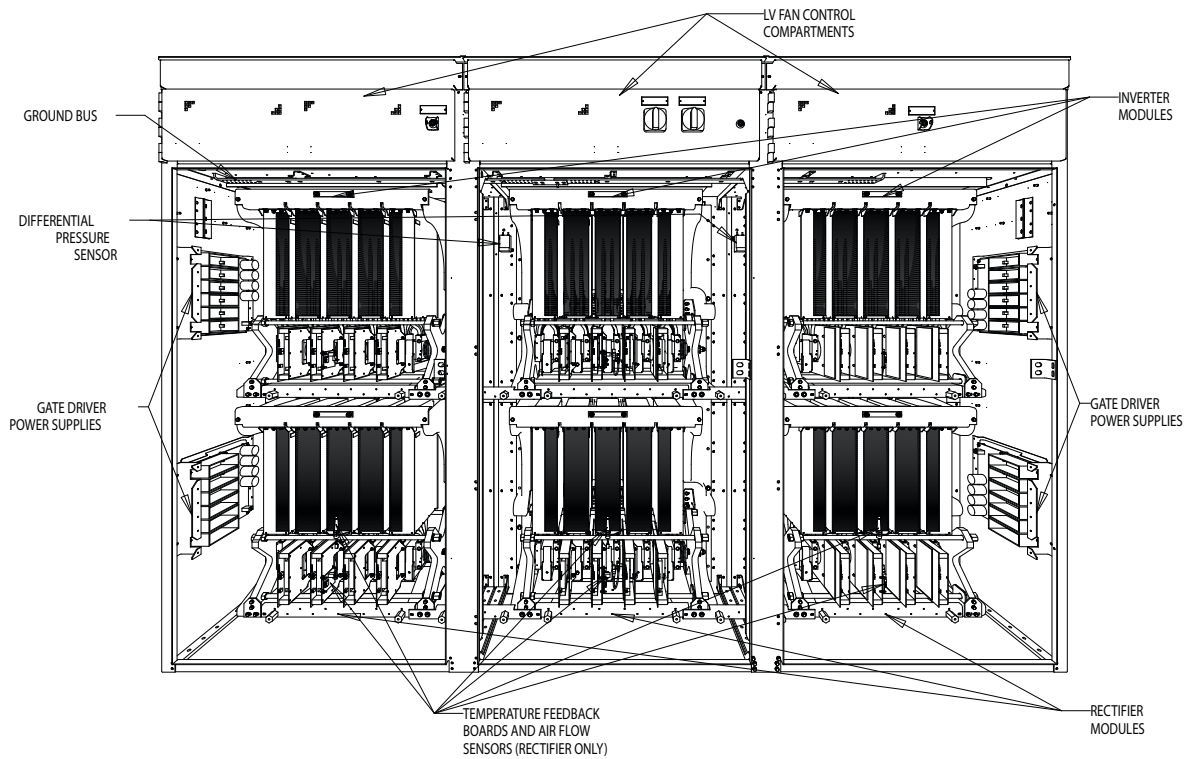


Figure 30 - Converter cabinet (there will be variances between 4160V and 6600V cabinets)

Converter Cabinet

The converter cabinet contains three rectifier modules and three inverter modules. [Figure on page 44](#) shows a 2300-volt converter with an AFE Rectifier.

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

Thermal sensors are available on the top module of the inverter and rectifier. The exact location depends on the drive configuration. These sensors connect to temperature feedback boards that return signals to the drive control.

PowerCage

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

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

Each drive consists of three PowerCage rectifier modules and three PowerCage inverter modules. There are three types of rectifiers:

- AFE and 18-pulse SCR.
- AFE type rectifiers use SGCTs as semiconductors.
- 18-pulse SCR rectifiers use SCRs as semiconductors.

All inverter modules use SGCTs as semiconductors.

The size of the PowerCage depends on the system voltage, and the components will also vary in the system current.

This table illustrates power semiconductor usage in the converter section.

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



ATTENTION: To prevent electrical shock, disconnect the main power 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.



ATTENTION: The PowerCage can house either SCRs or Symmetrical Gate Commutated Thyristors (SGCT). The SGCT circuit board is sensitive to static charges. Never handle these boards without proper grounding.



ATTENTION: Some circuit boards can be destroyed by static charges. Use of damaged circuit boards may also damage related components. Use a grounding wrist strap when handling sensitive circuit boards.

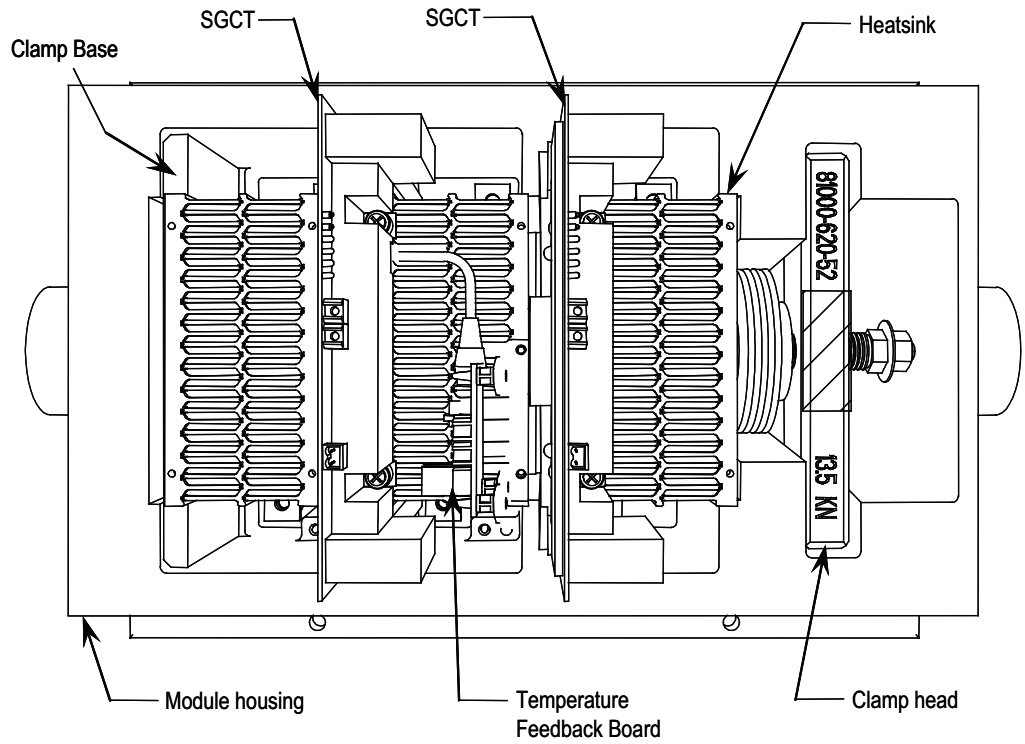


Figure 31 - 2 Device PowerCage

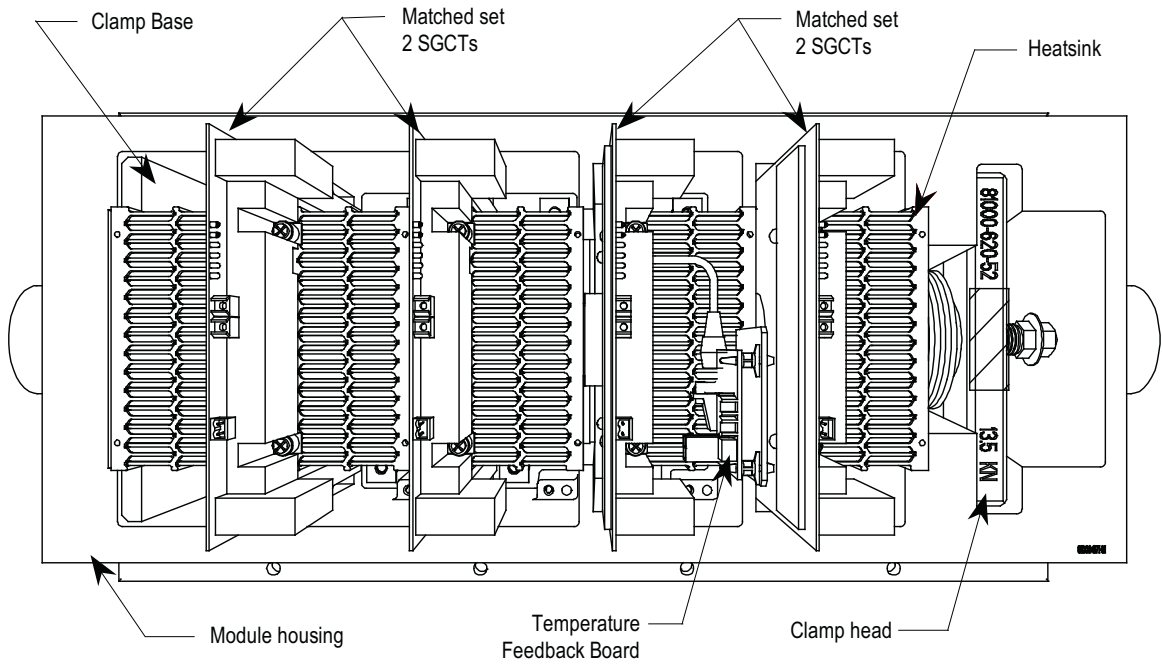


Figure 32 - 4 Device PowerCage (standard model)

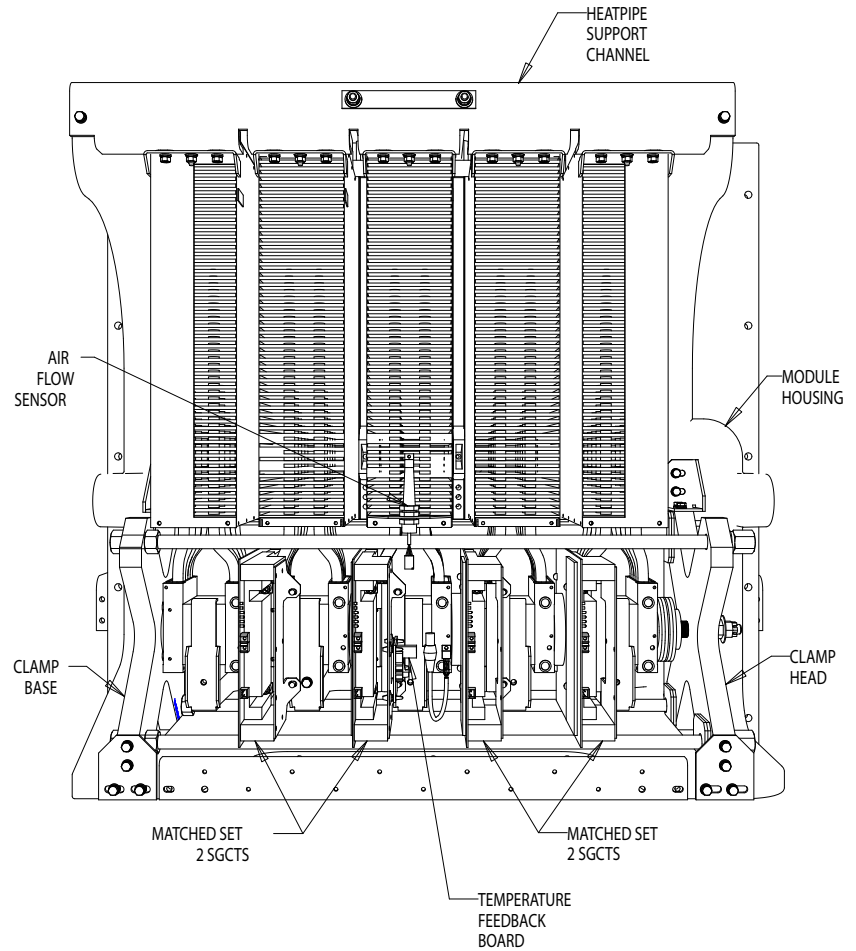


Figure 33 - 4 Device PowerCage (heatpipe model)

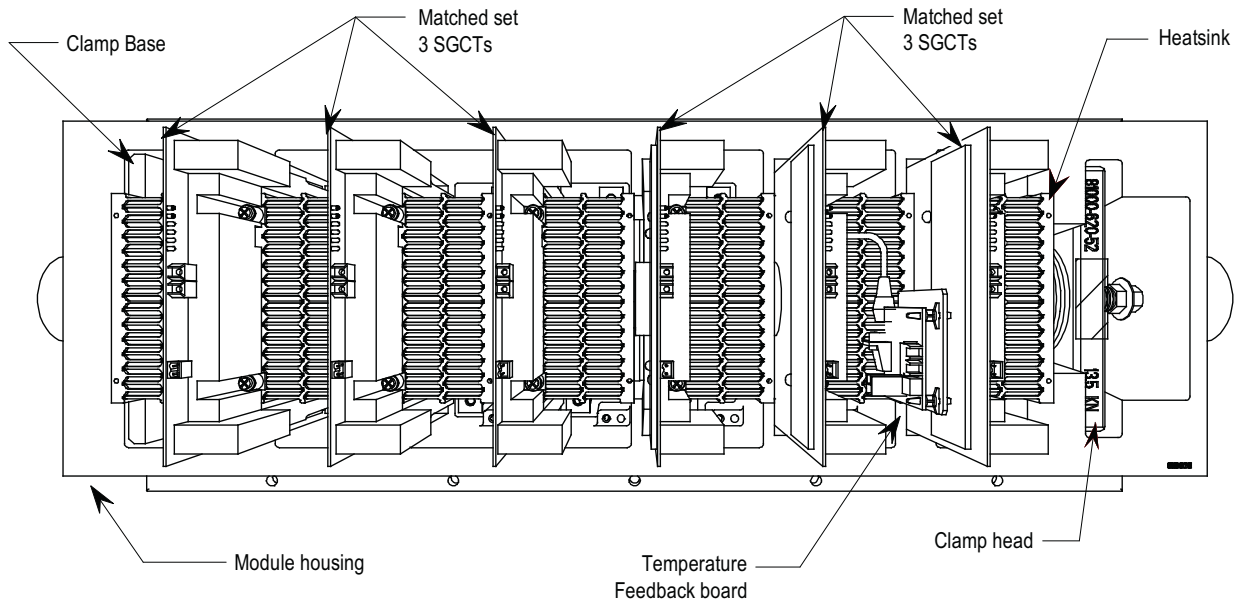


Figure 34 - 6 Device PowerCage

SGCT and Snubber Circuit

With all power semiconductor or thyristors, the SGCT requires a snubber circuit. The snubber circuit for the SGCT consists of a snubber resistor in series with a snubber capacitor.

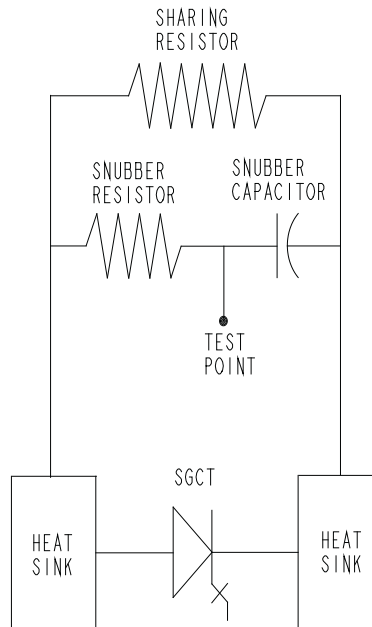


Figure 35 - SGCT and snubber circuit

In addition to the snubber circuit, a sharing resistor connects in parallel with the SGCT. The sharing resistor ensures the voltage's equal distribution among SGCTs connected in series. Connect SGCTs 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 provides sufficient design margin for electrical systems with 2400 V medium voltage supply. At 4160 V, connect two SGCTs in series to provide a net PIV of 13000 V to achieve the necessary design margin. Similarly, connect three SGCTs in series at 6.6 kV, providing a net PIV of 19500 V to achieve the necessary design margin.

To meet the cooling requirements of the SGCT, place the SGCT between two forced air-cooled heatsinks, one heatsink on the anode and the other heatsink on the cathode. The force on the SGCTs differs with the size of the device. The clamp assembly on the right hand side of the inverter module generates these forces.

The SGCTs require uniform pressure to help prevent damage and to ensure low thermal resistance. Achieve uniform pressure by loosening the heatsink mounting bolts, tightening the clamp, then tightening the heatsink bolts. See [Uniform Clamping Pressure on page 51](#) for instructions.

This design directs external filtered air through the heatsink slots to dissipate heat from the SGCTs. The door filter is designed to keep the heatsink slots stay clear of dust particles.

Uniform Clamping Pressure

Always maintain proper pressure on the thyristors. Follow this procedure whenever changing devices or loosening the clamp 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.), then loosen each bolt two complete turns.
3. Tighten the clamp to the proper force until you can turn the indicating washers 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 the clamp indicating washer.

Checking Clamping Pressure

Periodically inspect the clamping force in the PowerCage. Ensure there is no power to the equipment.



ATTENTION: To prevent electrical shock, disconnect the main power 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.

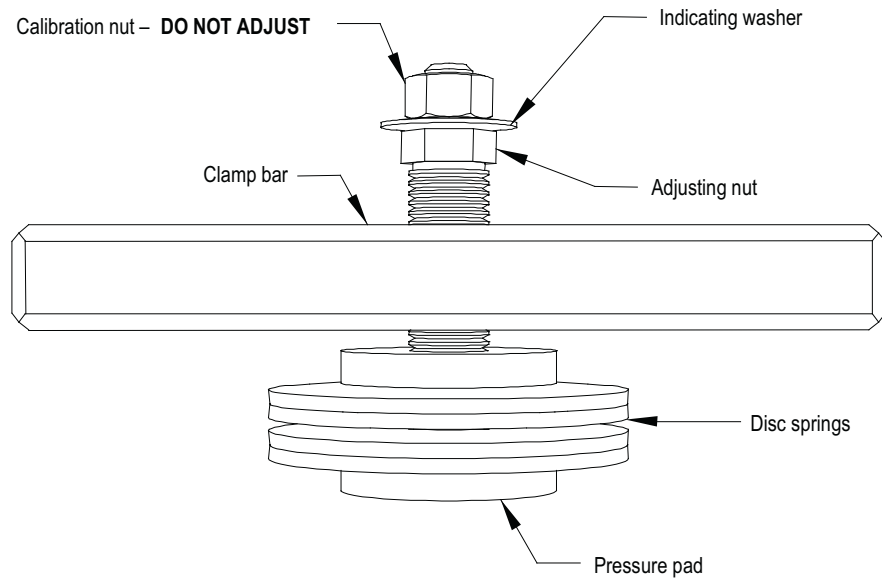


Figure 36 - Clamp head illustration

Clamping Pressure Adjustment

1. Disconnect all power to the drive.
2. Do not loosen the adjustment nut. If you loosen the clamping pressure, carry out the assembly procedure to ensure uniform pressure on the thyristors.
3. Tighten with a 21-mm wrench on the adjustment nut (upward motion) until you can turn the indicating washer by fingers with some resistance. IT SHOULD NOT SPIN FREELY.

IMPORTANT Never rotate the lock nut located outside the indicating washer at the end of the threaded rod. The rotation of the outer nut will affect the torque calibration, which is factory-defined. Only adjust the inside nut. (See [Figure 37 on page 53.](#))

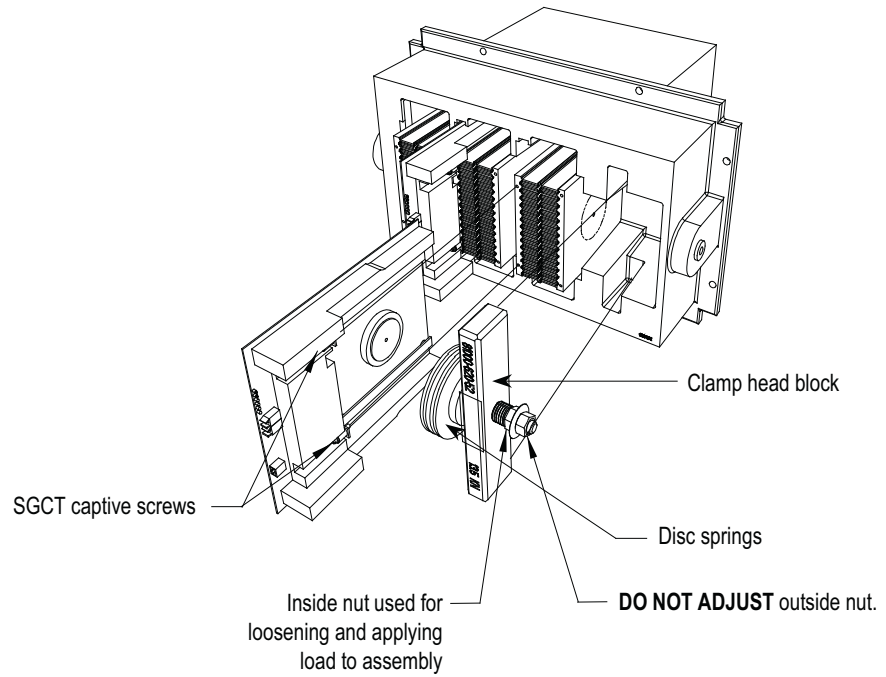


Figure 37 - Clamping assembly detail (standard model)

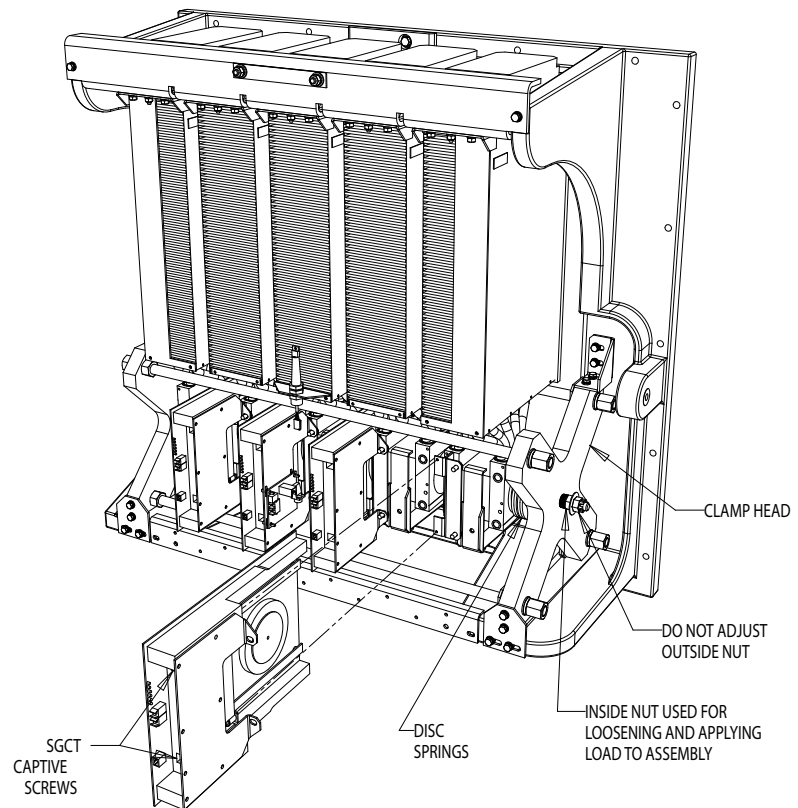


Figure 38 - Clamping assembly detail (heatpipe model)

Temperature Sensing

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

1. Ensure there is no power to the equipment.



ATTENTION: To prevent electrical shock, disconnect the main power 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 heatsink with the thermal sensor from the PowerCage. Remove clamp load (refer to [Figure 36 on page 52](#)).
3. Remove the device (SGCT or SCR) from the heatsink with the thermal sensor (refer to [Figure 31](#), [Figure 32](#), or [Figure 34 on page 50](#)).
4. Disconnect the fiber optic cable to the temperature feedback board.
5. Remove two M8 screws holding the heatsink in place.
6. Remove the heatsink with the temperature feedback board from the PowerCage.
7. Disconnect the plug connecting the thermal sensor and circuit board.
8. Remove the screw attaching the thermal sensor to the heatsink.
9. Replace with the new thermal sensor and cable assembly.
10. Note the small voltage difference between the thermal sensor and its heatsink. For proper function, 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 39](#)).
11. Reverse the removal order to replace the heatsink with the new thermal sensor.
12. Follow procedure [Uniform Clamping Pressure on page 51](#) to clamp the heatsinks to a uniform pressure.

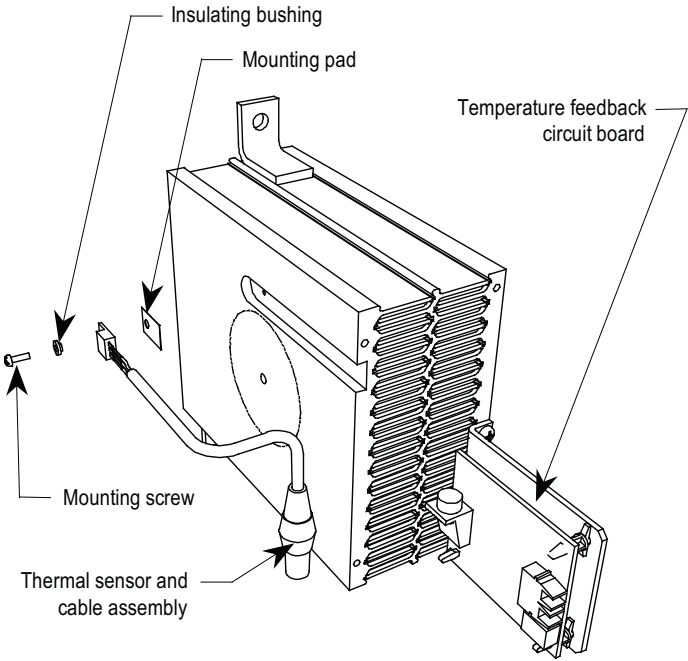


Figure 39 - Thermal sensor replacement (standard model)

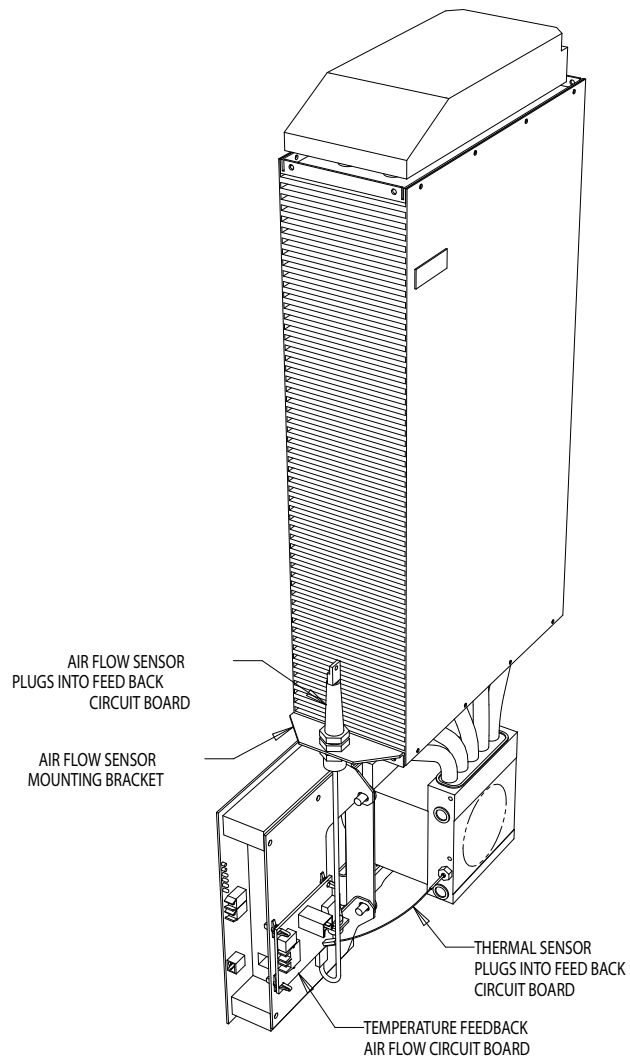


Figure 40 - Thermal sensor replacement (heatpipe model)

Replacing the Symmetrical Gate Commutated Thyristor

The Symmetrical Gate Commutated Thyristor (SGCT, or “device”) with attached circuit board is located within the PowerCage assembly.

You must replace SGCTs in matched sets:

- 4160V systems use sets of 2
- 6600V systems use sets of 3

The SGCT and associated control board are a single component. Never change the device or the circuit board 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

Refer to [Figure 37 on page 53](#) and [Figure 38 on page 53](#) for illustrations detailing the location of the SGCT in both standard and heatpipe models.

1. Isolate and lock out all power to the drive.



ATTENTION: To prevent electrical shock, disconnect the main power 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, 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: You may damage the fiber optic cables if you strike or bend them 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. Hold the component on the printed circuit board to prevent damage.

4. Remove the load on the clamp head assembly as described under [Checking Clamping Pressure on page 51](#).
5. Two brackets secure the board to the heatsink. Loosen the captive screws to free the circuit board. If necessary, adjust the position of the heatsinks to move the SGCT freely.
6. Slide the circuit board straight out.



ATTENTION: Static charges can damage or destroy the SGCT. Properly ground yourself before removing the replacement SGCT from the protective anti-static bag. Using damaged circuit boards may also damage related components. Use a grounding wrist strap for handling sensitive circuit boards.

- IMPORTANT** SGCTs come in matched sets in systems with more than one device per leg. When replacing the device, you must replace all SGCTs in the set even if only one has failed. Arrange the devices from left to right in sets (i.e. set 1+2, 3+4, 5+6).

7. While grounded, remove the SGCT from its anti-static bag.

8. Clean the heatsink with a soft cloth and rubbing alcohol.
9. Apply a thin layer of Electrical Joint Compound (Alcoa EJC No. 2 or approved equivalent) to the contact faces of the new SGCTs. 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 on page 51](#) to clamp the heatsinks to a uniform pressure.
13. Connect the power cable and fiber optic cables (do not exceed the bend radius).

Replacing Silicon Controlled Rectifier and SCR Self-Powered Gate Driver Boards (SPGDB)

Replacing the Silicon Controlled Rectifier (SCR) is similar to replacing the SGCT, except that you can replace the SCR and circuit board independently of one another.

1. Isolate and lock out all power to the drive.



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

2. Note the position of the fiber optic cables for reassembly.
3. To remove the SCR and SCR SPGDB, first remove the Gate Driver Power Supply connector (from snubber circuit), the fiber optic cable, and the SCR gate-cathode connection. Exceeding the minimum bend radius (50 mm/2 in.) of the fiber optic cables may result in damage.



ATTENTION: You may damage the fiber optic cables if you strike or bend them 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. Hold the component on the printed circuit board to prevent damage.

4. Remove the load on the clamp head assembly as described under [Checking Clamping Pressure on page 51](#).
5. Loosen the 2 captive screws with a long Phillips screwdriver until the circuit board is free. If necessary, adjust the position of the heatsinks to allow free movement of the SCR.

6. Slide the SCR and SCR SPGDB straight out.
7. While grounded, unplug the Gate-Cathode connector from the SCR SPGD board.



ATTENTION: Static charges can destroy or damage the SCR and SCR SPGD board. Properly ground yourself before removing the replacement SCR and SCR SPGD board from the protective anti-static bag. Using damaged circuit boards may also damage related components. Use a grounding wrist strap for handling sensitive circuit boards.

IMPORTANT Never adjust the orientation of the SCR using the Gate and Cathode Leads. These connections are sensitive; adjust the device orientation by turning the device itself.

To replace the SCR, follow steps 8-11 and 15-18.

To replace the SCR SPGDB, follow steps 12-18.

8. Loosen the tie wrap holding the G-C wire in place, and remove the device from the assembly.
9. Install the new device in the same position and using the same orientation as the original SCR, and firmly secure the G-C wires with the same tie wrap.
10. Connect the Gate-Cathode connector to the Gate Driver board.
11. Apply a thin layer of electrical joint compound (Alcoa EJC No.2 or approved equivalent) to the contact faces of the new SCRs. The recommended procedure is to apply the compound to the pole faces using a small brush and then gently wiping the pole face with an industrial wipe so that a thin film remains. Examine the pole face before proceeding to ensure that no brush bristles remain.

IMPORTANT Too much joint compound may result in contamination of other surfaces leading to system damage.

12. While grounded, use a long Phillips screwdriver to remove the 2 screws that hold the SCR SPGDB to the metal bracket on the red glastic assembly. Retain the hardware.
13. Pull the 4 plastic clips that secure the SCR SPGDB to the glastic assembly. Retain the hardware.
14. Install the new SCR SPGDB in the assembly with the 4 plastic clips and use the screws to secure the board to the metal bracket.
15. Clean the heatsink with a soft cloth and rubbing alcohol.
16. Slide the SCR and SPGDB back into place until the mounting bracket makes contact with the heatsink. Use the Phillips screwdriver to tighten the assembly to the heatsink.

17. Reapply the clamping load as described in [Uniform Clamping Pressure on page 51](#).
18. Connect the control power cable and the fiber optic cables, ensuring that you do not exceed the bend radius.

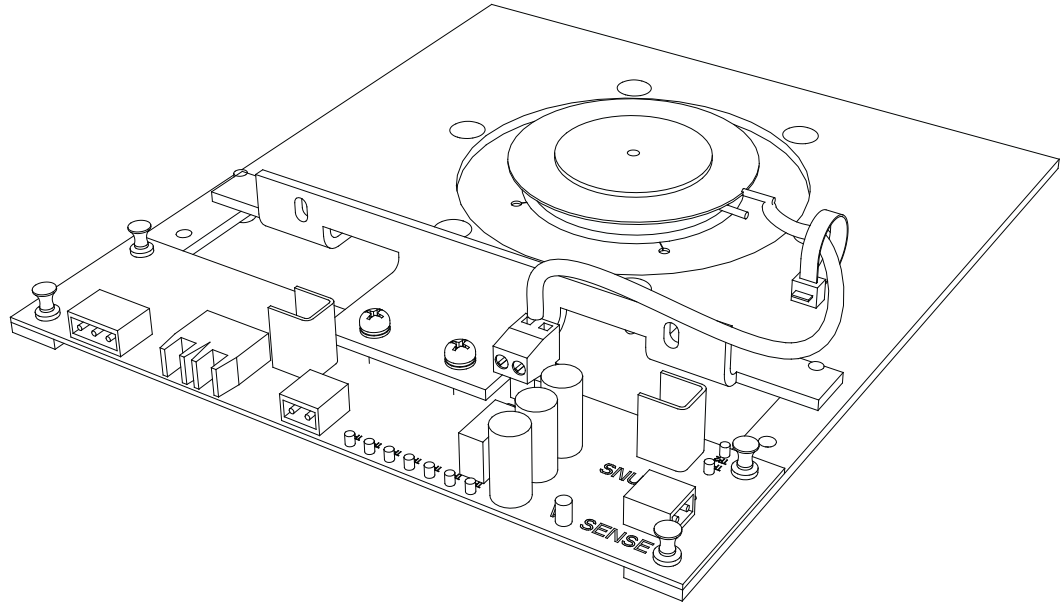


Figure 41 - SCR and SPGDB assembly

Replacing Heatsinks

There are four different styles of heatsinks used in PowerFlex air-cooled drives, depending on thermal requirements:

- Aluminum Type W have a plurality of short internal fins along the internal surfaces
- Aluminum Type M have internal fins with flat surfaces.
- Copper heatsinks have internal fins made from folded copper foil
- heatpipe sinks have a stack of aluminum fins

The lighter aluminum heatsink has a very fine ventilation pattern through the heatsink. The heavier copper heatsink has a basic ventilation pattern with larger

openings for airflow. You can install flow restrictor plates on some heatsinks to optimize airflow.

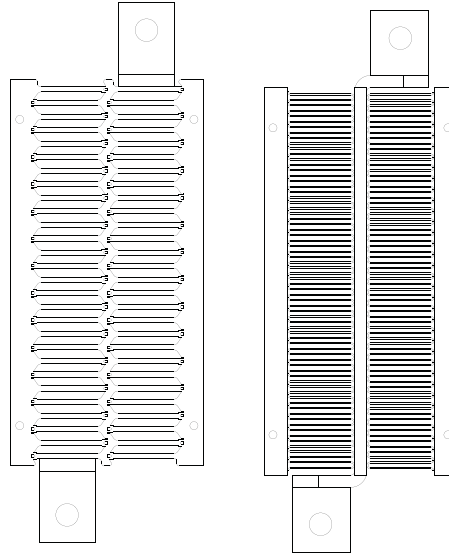


Figure 42 - Aluminum Type W (left) and copper (right) heatsinks

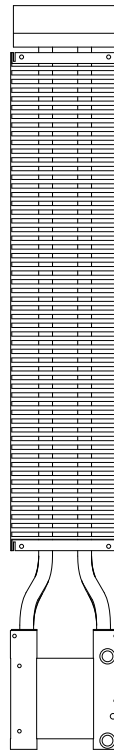


Figure 43 - Heatpipe heatsink

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

1. Isolate and lock out all power to the drive.



ATTENTION: To prevent electrical shock, disconnect the main power 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 as described in [Checking Clamping Pressure on page 51](#).
3. Completely remove the SGCT or SCR from the heatsink that is being replaced as described in [PowerCage on page 47](#) and following.
4. There are 2 bolts that secure the heatsink to the PowerCage. They are 13-mm bolts, and should be removed using several extenders to get the socket wrench out past all the sensitive gate driver boards.
5. Loosen the two bolts and carefully remove the heatsink from the PowerCage.
6. Install the new heatsink and hand-tighten the bolts.
7. Replace the SGCT or SCR as described in [PowerCage on page 47](#) and following.
8. Follow procedure [Uniform Clamping Pressure on page 51](#) to ensure the heatsinks are clamped to a uniform pressure.

PowerCage Gasket

All possible air leaks are sealed with a rubber gasket between the surface of the PowerCage and heatsink module in order to direct all air movement through the slots of the heatsink. The gasket maintains proper cooling of the SGCTs or SCRs.

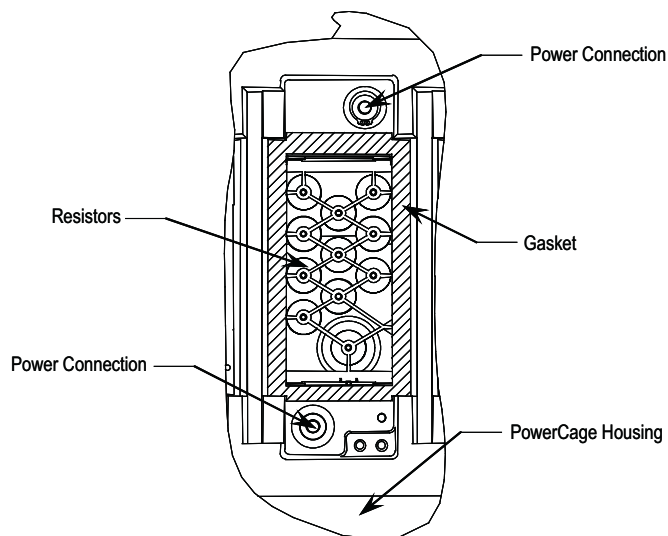
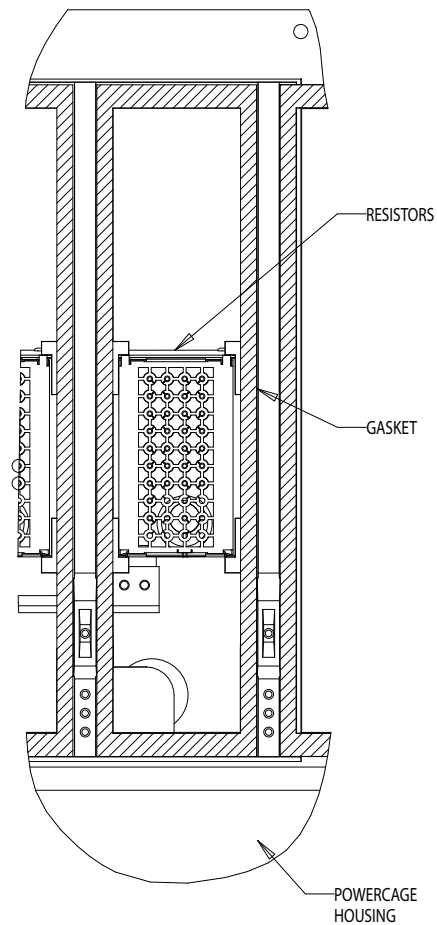


Figure 44 - PowerCage gasket location (standard model)**Figure 45 - PowerCage gasket location (heatpipe model)**

Replacing PowerCage Gaskets

The gaskets do not normally require replacement, but in the event that they become damaged, you may have to replace them.

Removing Old Gasket Material

Remove as much material as possible by hand to leave an even, bondable surface. Scrape off as much material as possible with a sharp knife, but avoid scoring the PowerCage. Clean away any loose pieces of gasket before proceeding with the gasket installation.

Clean the PowerCage with a general purpose household cleaner. 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 you will apply the

gasket. Liberally spray the surface with distilled water, then wipe dry 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. Center the gasket over the opening for the heatsinks with the narrow end positioned closest to the test points. Apply the porous surface of the gasket 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.

Removing the PowerCage

1. Ensure there is no power to the equipment.



ATTENTION: To prevent electrical shock, disconnect the main power 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. Before removing the PowerCage, remove all the components located within the PowerCage 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: Static charges can destroy or damage the SCR and SCR SPGD board. Properly ground yourself before removing the replacement SCR and SCR SPGD board from the protective anti-static bag. Using damaged circuit boards may also damage related components. Use a grounding wrist strap for handling sensitive circuit boards.

3. Remove the 13-mm bolts in the two flanges that connect the heatsink to the PowerCage, then remove the heatsink from the PowerCage. This reduces the PowerCage weight for easier handling.

4. To detach the PowerCage itself, remove the bolts on the outer flange. Carefully lift the PowerCage down, placing the forward face down. Do not over-torque these bolts when replacing the PowerCage.

IMPORTANT The PowerCage can be heavy. Use two people to 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. Use the suggested torquing sequence shown in [Figure 46](#).

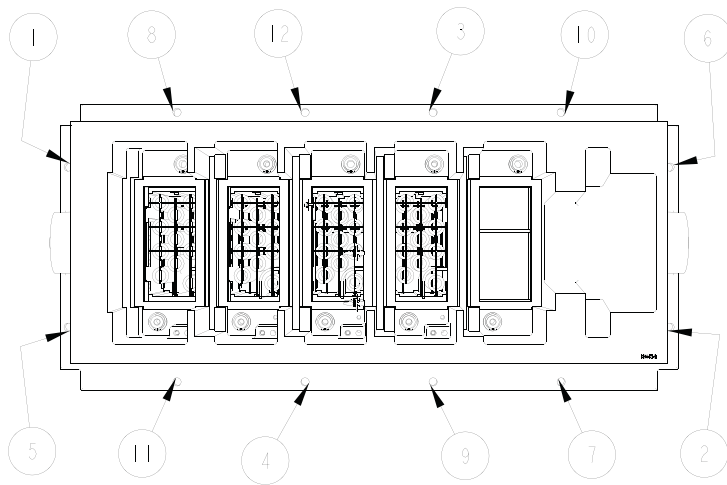


Figure 46 - Typical torque sequence

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

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

Snubber Resistors

Snubber resistors connect in series with the snubber capacitors. Together they form a simple RC snubber that connects across each thyristor (SCR or SGCT). The snubber circuit reduces the dv/dt stress on the thyristors and reduces the switching losses. The snubber resistors connect 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

You do not require access to the snubber resistor to test its resistance. There is a snubber circuit test point located under the heatsink within the PowerCage.

There is one test point for each device. To verify the resistance, follow the procedures outlined in the PowerFlex 7000 Commissioning Manual.

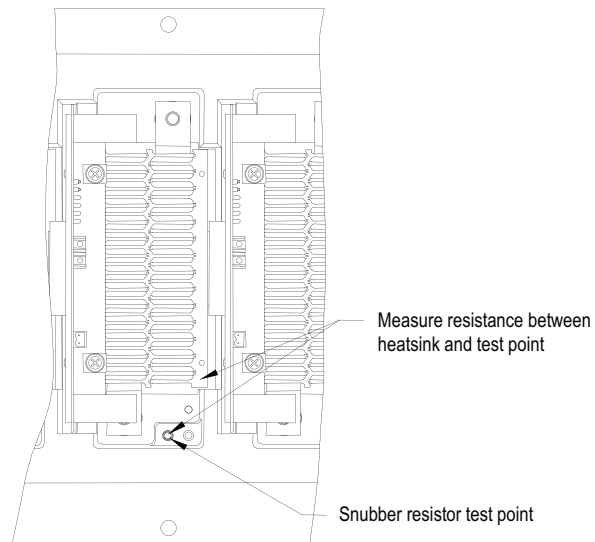


Figure 47 - Testing the snubber resistor

Replacing Snubber and Sharing Resistor

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

1. Remove the PowerCage as outlined in [Removing the PowerCage on page 64](#).
2. Note the connection of the leads for correct replacement.

- Detach the leads located on the bottom of the resistor assembly.

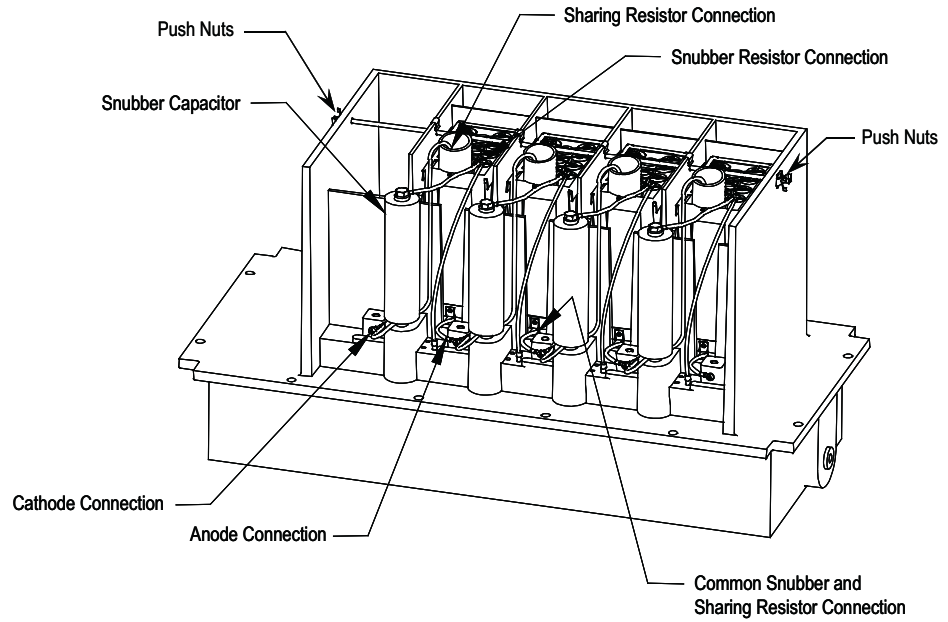


Figure 48 - PowerCage removal (SGCT Type PowerCage)

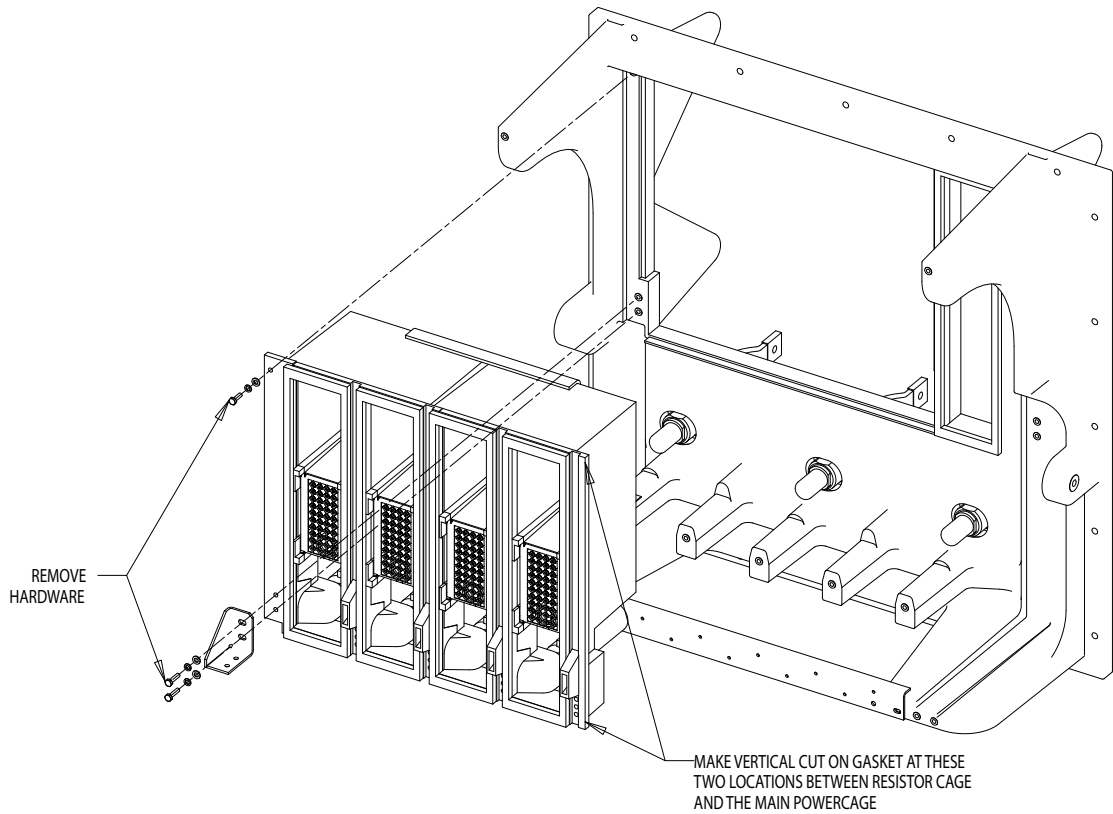


Figure 49 - PowerCage removal (heatpipe PowerCage)

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

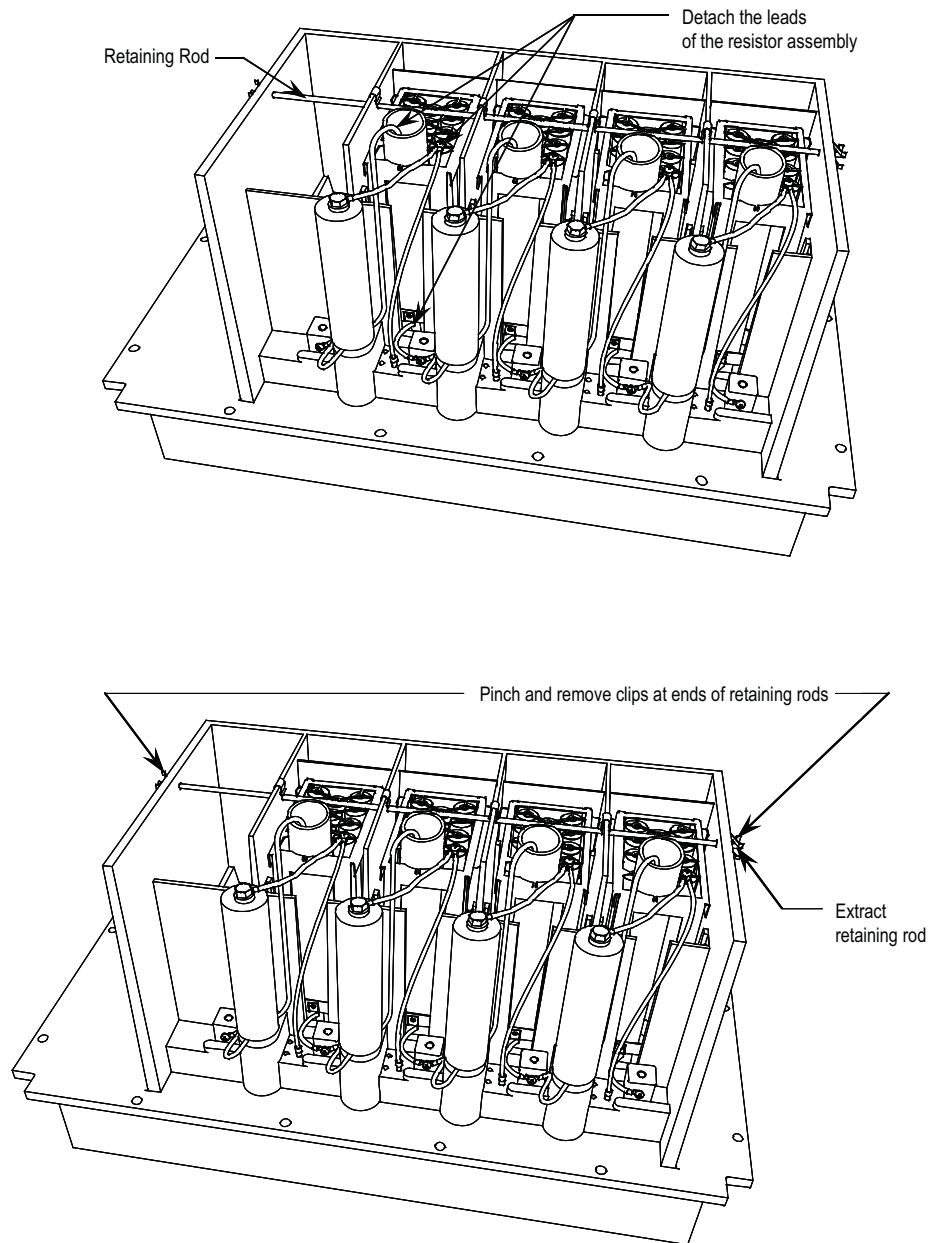


Figure 50 - Snubber and Sharing Resistor replacement (standard model)

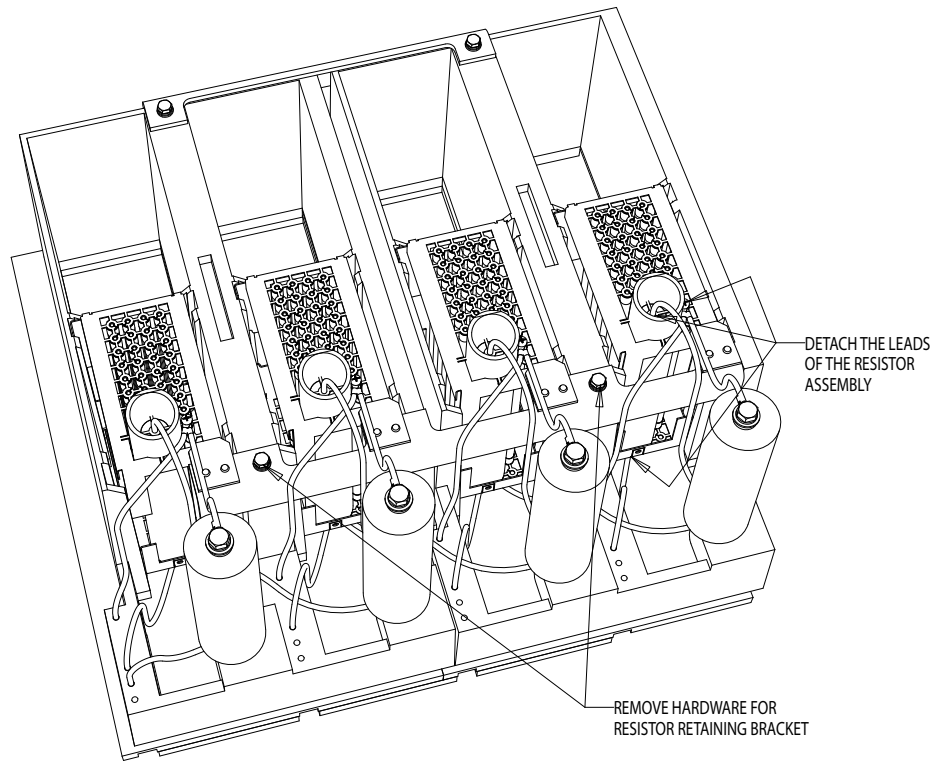


Figure 51 - Snubber and Sharing Resistor replacement (heatpipe model)

5. Use silicone gel to secure the snubber resistor assembly to the PowerCage. The gel minimizes possible damages to the resistor bank during transportation from the factory. You do not need to reapply it when inserting the new resistor bank. Remove the resistor bank from the PowerCage.

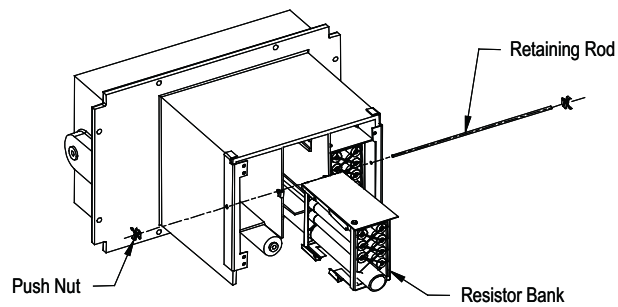


Figure 52 - Removing Resistor Bank from PowerCage

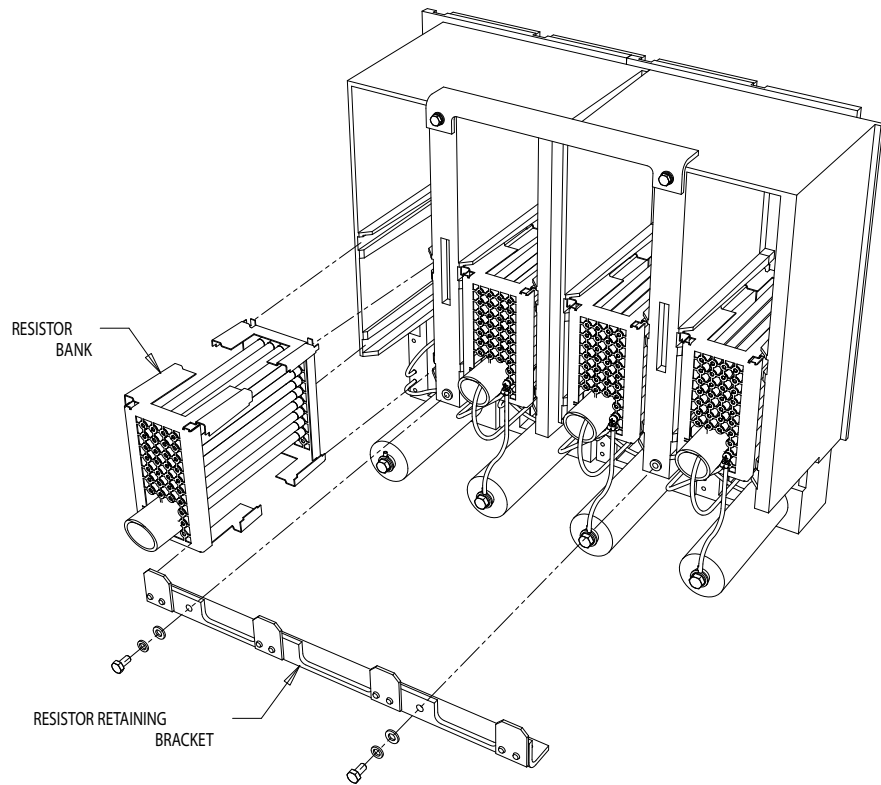


Figure 53 - Removing Resistor Bank from PowerCage (heatpipe model)

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 [Removing the PowerCage on page 64](#).

Sharing Resistors

Sharing resistors provides equal voltage sharing when using matched devices in series. SGCT PowerCages for 2300V systems do not need matched devices and have no sharing resistor.

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

You can verify the resistance value of the sharing resistors without removing the PowerCage from the cabinet. For more information, see [Snubber Testing on page 251](#).

SGCT PowerCages

Figure 54 shows the snubber circuit. Figure 55 shows the physical locations 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.

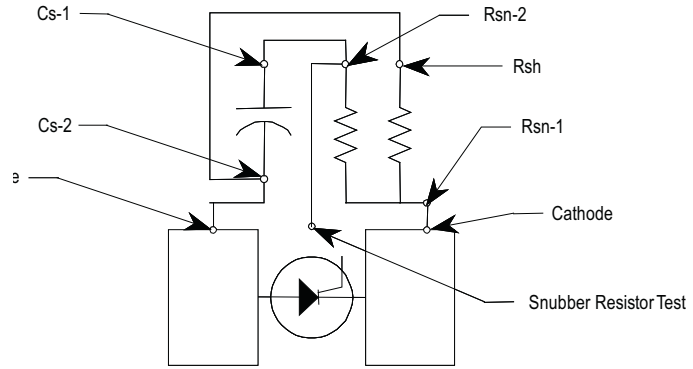


Figure 54 - Snubber Circuit for SGCT module

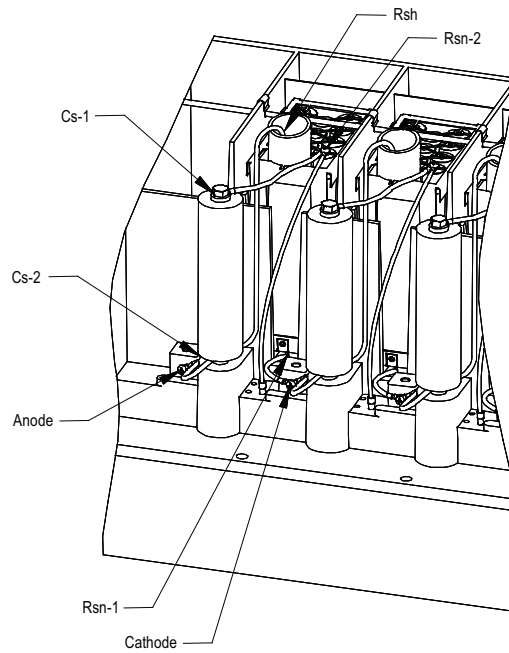


Figure 55 - Snubber Circuit Assembly for SGCT module

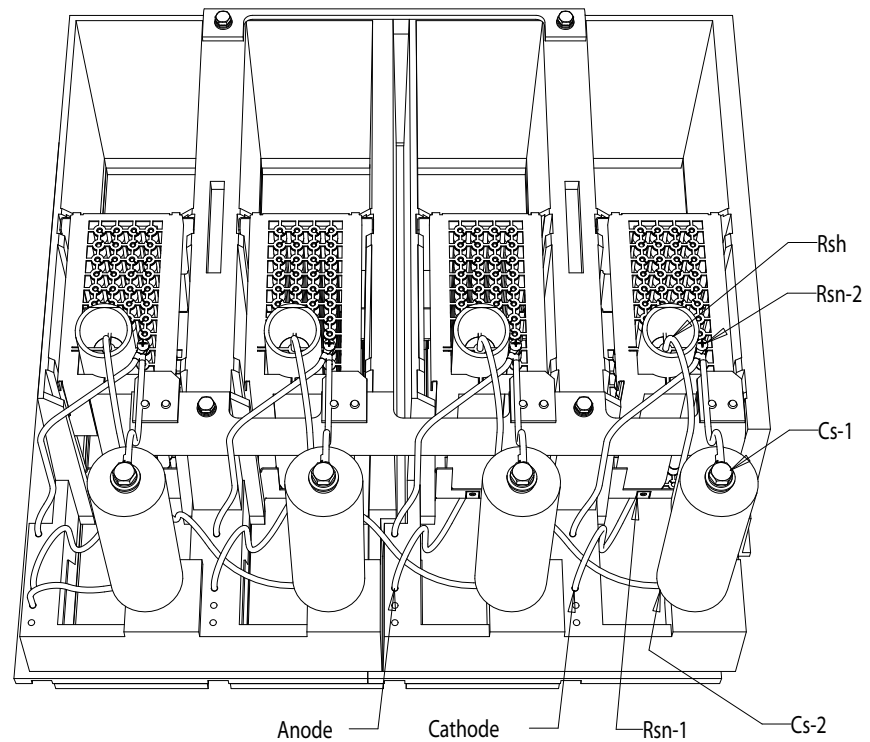


Figure 56 - Snubber Circuit Assembly (heatpipe model)

Replacing Sharing Resistors

Normally the sharing resistor is part of the snubber resistor assembly. Replacing the sharing resistor requires also replacing the snubber resistor.

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

SCR PowerCages

[Figure 57](#) shows the snubber circuit. [Figure 58](#) shows the physical locations of the same circuit.

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

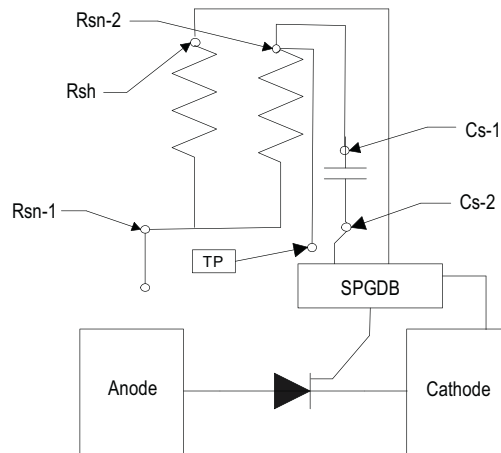


Figure 57 - Snubber Circuit for SCR Rectifier Module

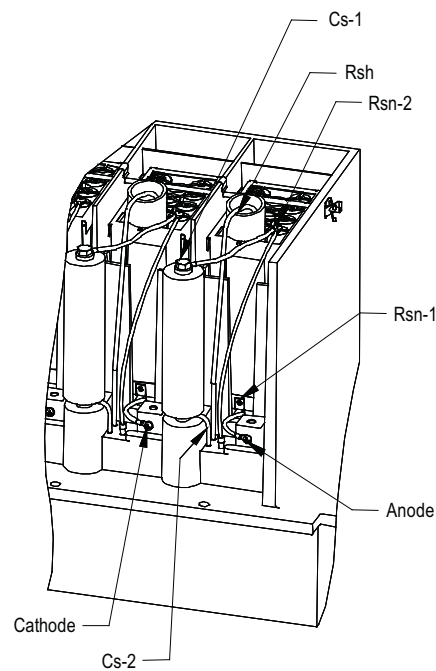


Figure 58 - Snubber Circuit Assembly for SCR Rectifier Module

Measuring Resistance

The anode-cathode resistance check measures 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, so the measurement will be slightly less than the resistance of the sharing resistor. A measurement between 60 k Ω and 75 k Ω indicates the SGCT is in good condition and that wiring to the

SGCT is correct. If the SGCT fails, it will be in the shorted mode, 0Ω . The anode-to-cathode resistance check will be 0Ω .

There is a test point 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. Place one probe of the multi-meter on the test point and the other probe on the appropriate heatsink to determine the value of the resistor or capacitor. See [Figure 59](#).

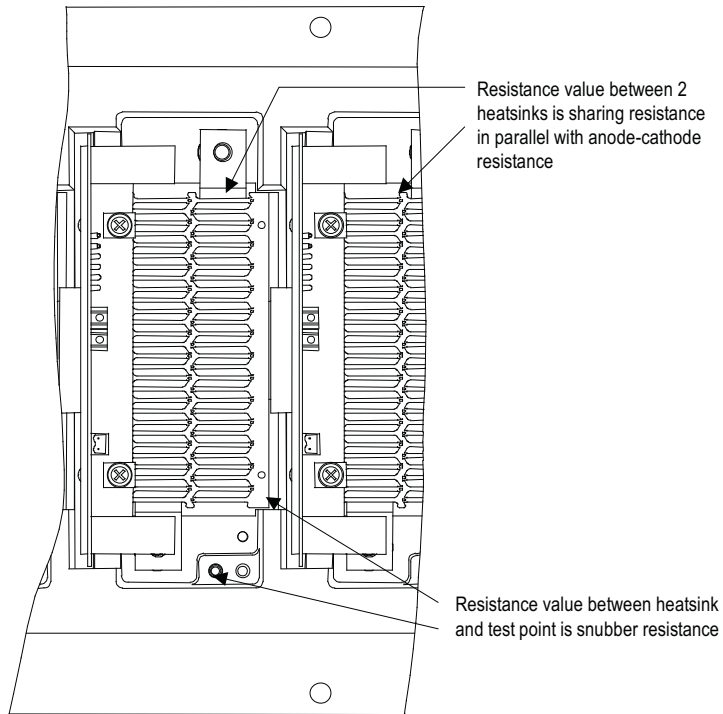


Figure 59 - Resistance Measurements SGCT PowerCage

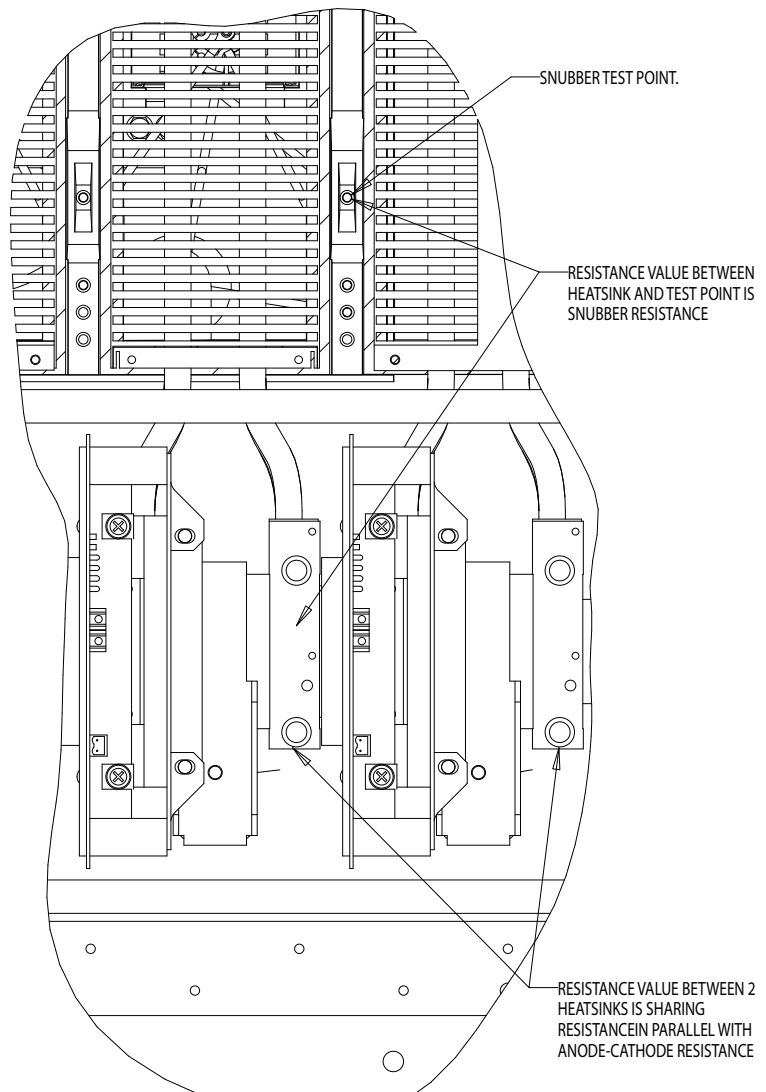


Figure 60 - Resistance Measurements (heatpipe model)

Snubber Capacitor Replacement

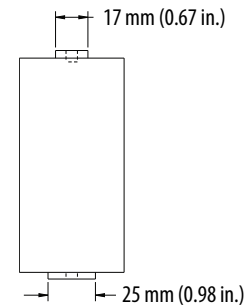
The snubber capacitors are part of the capacitor assembly located behind the PowerCage module.

IMPORTANT If the drive can be accessed from the rear, the snubber capacitors can be removed and replaced from the rear, with the PowerCage modules in place. If the drive cannot be accessed from the rear, the PowerCage modules must be removed to access the snubber capacitors. See [Removing the PowerCage on page 64](#).
Replace the capacitors one at a time. Do not remove all at once.

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

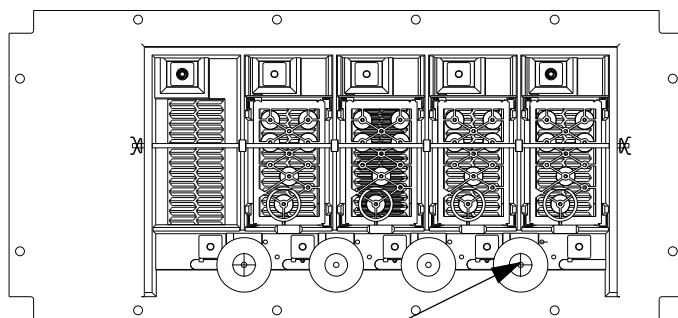


ATTENTION: You must insert the capacitor in the correct orientation. The 25 mm flange must be connected to the threaded stud on the PowerCage module.

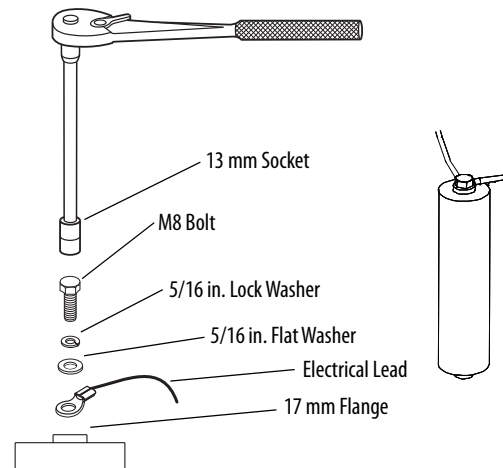


5. Connect the electrical leads and hardware on the 17 mm flange side of the replacement capacitor.

Torque M8 hardware to 7 N•m (60 lb•in).



M8 Hardware Location



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

Self-Powered Gate Driver Board – SPGDB

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

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

This board also determines the health of the SCR. It has the hardware necessary to diagnose SCR conditions and relay the status to the processor via a fail-safe light signal along a fiber optic cable.

Board Calibration

This board requires no field calibration.

Test Points

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

The yellow LED (LED 1) on the SGPDB indicates that the controlled SCR has a gating current flowing, which turns on the SCR.

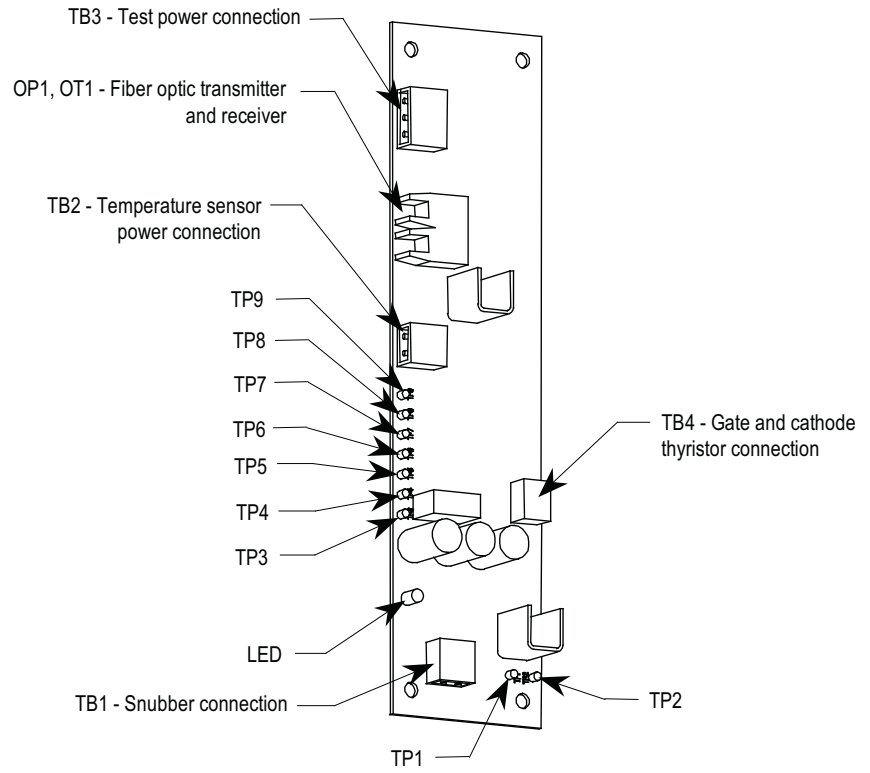


Figure 61 - Self-Powered Gate Driver Board

Terminal/Connections

TB1-1	Connection to SCR snubber circuit (capacitor connection end) used to extract energy from the snubber for SPGDB operation.
TB1-2	Connection to SCR sensing resistor which indicates conduction status of SCR being operated.
TB2-1	Positive 20V power supply connection to temperature sensor board. Provides power to temperature sensor board.
TB2-2	Common connection of positive 20V power supply to temperature sensor board.
TB3-1	Positive 15V power supply connection for test power used when commissioning drive or testing SPGDB.
TB3-2	Provides artificial sense voltage signal to allow SPGDB to gate the SCR when in test mode. When the appropriate test power cable is used, P/N 80018-298-51, this input is shorted to TB3-1 to obtain the sense voltage.
TB3-3	Common connection of positive 15V power supply used for test power
TB4-2	Cathode connection to SCR being controlled
TB4-1	Gate connection to SCR being controlled
OP1	Blue fiber optic cable receptacle – Gating pulse command from the processor
OT1	Grey fiber optic cable receptacle – Diagnostic status of the SCR

Testing Procedure for SCR Self-Powered Gate Driver Board

Testing Equipment

Ensure you have the following equipment available in order to perform testing tasks.

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

Procedure

1. Connect a clamped ABB #5STP03D6500 SCR to the gate-cathode leads of the SPGDB board (TB4-1/TB4-2).
2. Attach a temperature sensor board to the TB2-1/TB2-2 terminals.
3. Apply +15V test power to terminals TB3-1 and TB3-3 (TB3-1 is at +15V while TB3-3 is the +15V return). Leave TB3-2 open.
4. Measure TP4 to TP3, which should be +14.4V, +/-100mV.
5. Measure TP5 to TP3, which should be +5.0V, +/- 250mV.
6. Measure TB2-1 to TB2-2, which should be +14.4V, +/-100mV.
7. Measure the voltage at U4-pin2 to COM, which should be +1.0V, +/- 100mV.
8. Measure the voltage at U4-pin3 to COM, which should be 0V.

9. Measure the voltage at U4-pin7 to COM, which should be +3.6V, +/- 100mV.
10. Verify that the OT1 LED is off.
11. Measure TP7 to TP3, which should be 0V.
12. Measure TP9 to TP3, which should be +5.0V, +/- 250mV.
13. Measure TP8 to TP3, which should be 0V.
14. Measure TP1 to TP2, which should be 0V.
15. Connect a jumper between TB3-1 and TB3-2 and verify that the voltage at TP6 is +2.2V, +/-100mV.
16. Apply a 60Hz, 33% duty cycle signal to the OP1 fiber optic input.
17. Verify that the diagnostics transmitter LED, OT1, is on.
18. Verify that the signals at TP9 and TP8 are as shown in [Figure 62 on page 80](#).
19. Verify that the signal between TP1 and TP2 is as shown in [Figure 63 on page 81](#) and [Figure 64 on page 81](#).
20. Remove the jumper between TB3-1 and TB3-2.
21. Apply a constant fiber optic signal to the OP1 input.
22. Apply a 60 Hz, 33% duty cycle signal, at a 0 to +2V level, between the TB1-2 input and COM. Verify the signals as illustrated from [Figure 62](#) to [Figure 66 on page 82](#). Note that in [Figure 66 on page 82](#) there should be a 220 μ S, +/-20 μ S time between the rising edge of the U4-pin7 pulse and the falling edge of the TP7 signal.

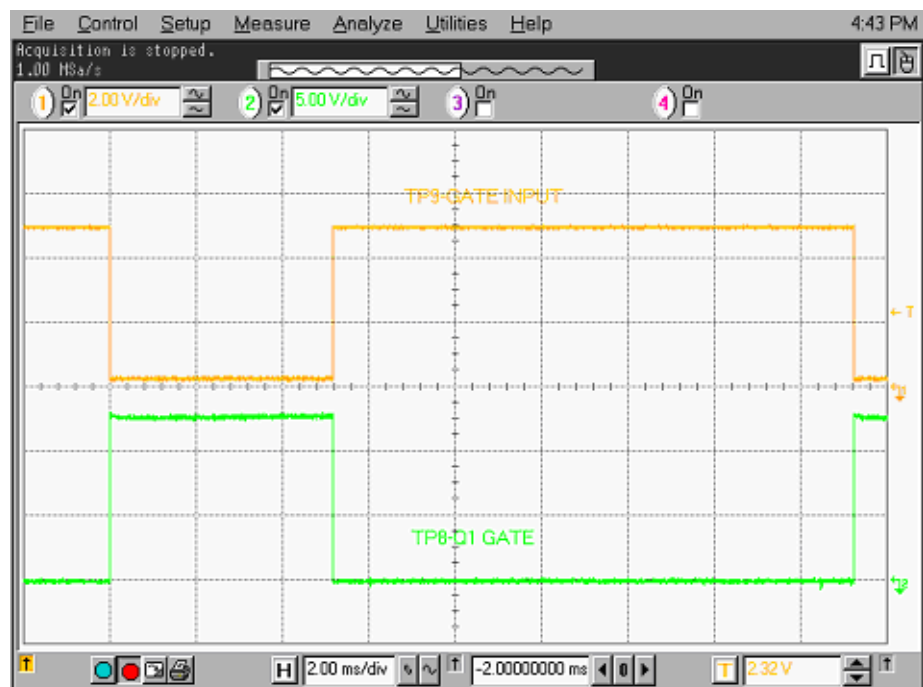


Figure 62 - Gating Pulses

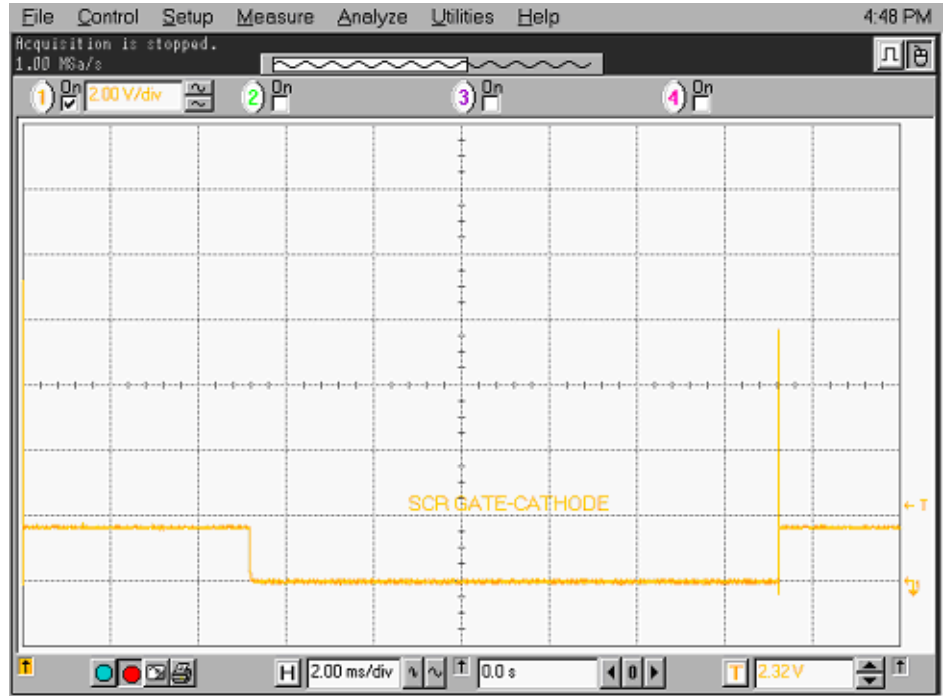


Figure 63 - SCR Gating Pulse

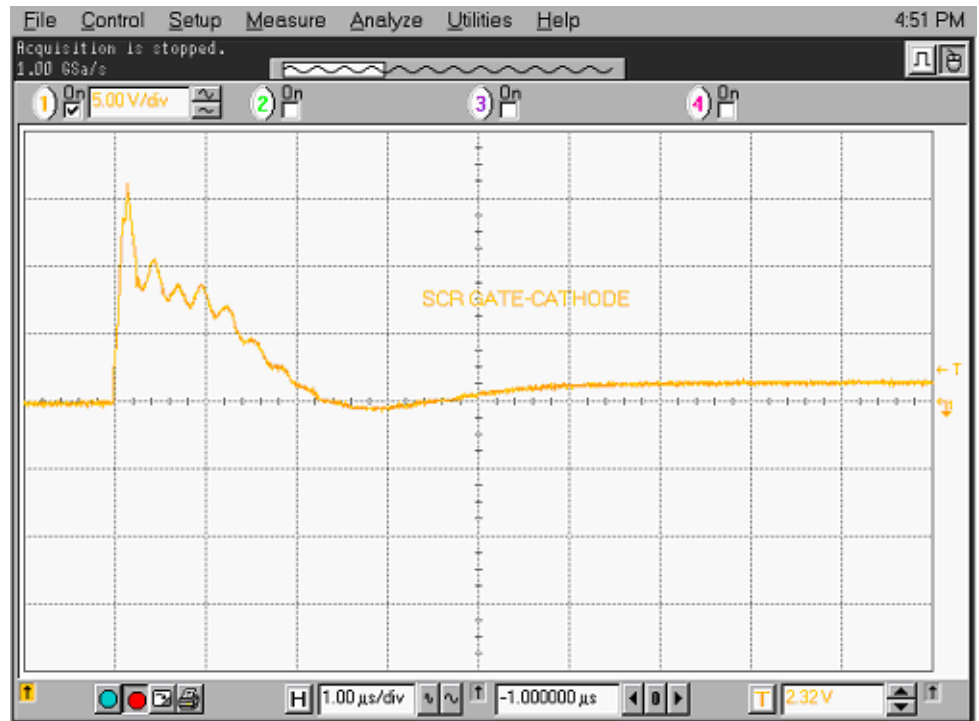


Figure 64 - Expanded SCR Gating Pulse

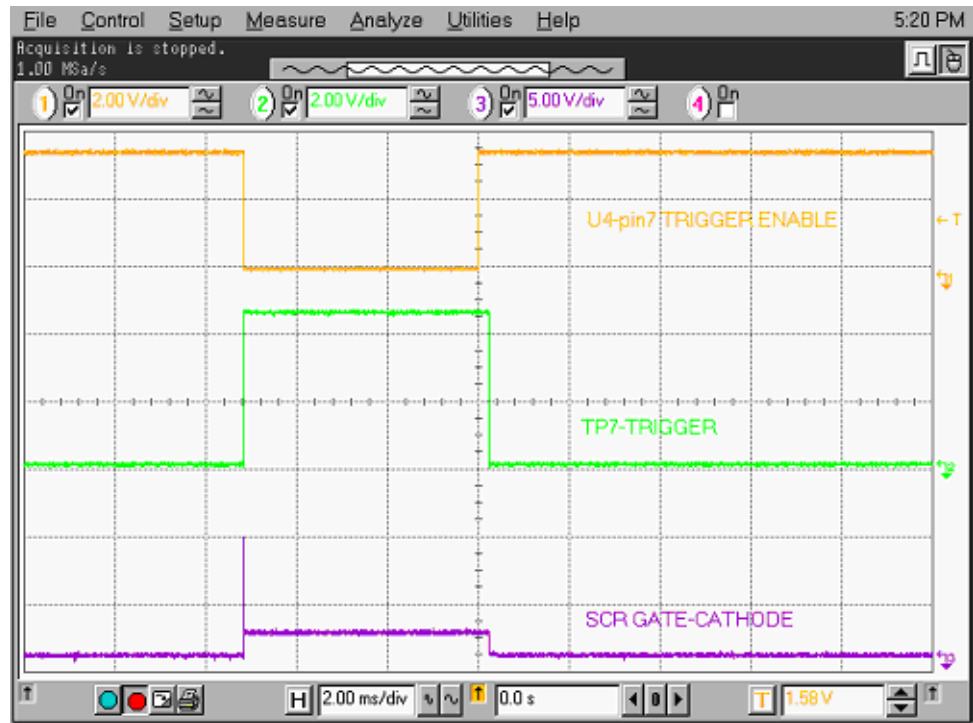


Figure 65 - V-Sense Trigger to SCR Gating Pulse



Figure 66 - Expansion of V Sense Trigger to SCR Gating Pulse

Fiber Optic Cabling

The equipment uses fiber optic cabling between the low voltage control and the medium voltage circuits. You should never need to change the routing of the fiber optic cables.

Each end of a fiber optic cable has 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 you must replace fiber optic cables, be careful to prevent the cables from straining or crimping as a resulting loss in light transmission will impact performance.

The minimum bend radius permitted for the fiber optic cables is 50 mm (2.0 inches).

When installing the fiber optic cable, match the connector color at the end of the cable with the connector socket color on the circuit board.

The product uses the following fiber optic cable lengths.

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 circuitry on the respective driver boards determines the thyristor's functional status, and sends this information to the main processor via a fail-safe light signal in the fiber optic. The main processor initiates the firing command for the thyristor and transmits the signal 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 the converter cabinet. It is located in the upper left area near the uppermost inverter module.

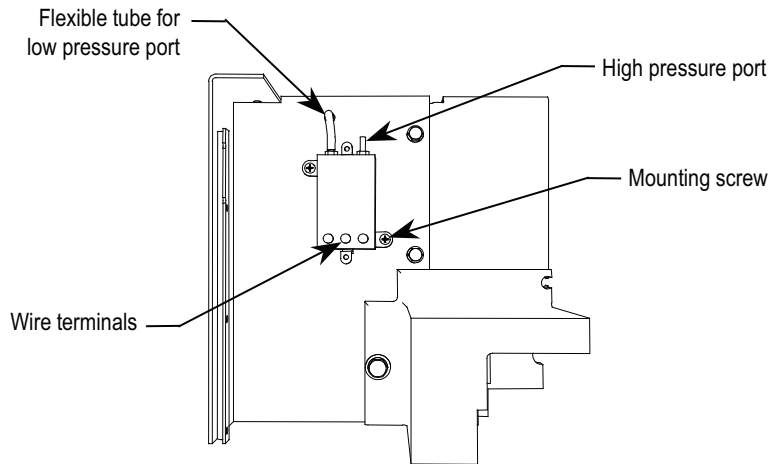


Figure 67 - Air Pressure Sensor

The air pressure sensor measures the difference in air pressure between the front and rear of the converter modules. It then sends a small direct current voltage signal to the control circuits.

Rockwell Automation currently uses Ashcroft air pressure sensors. In the event of reduced fan performance or air blockage, the sensor notes the reduced differential pressure and triggers a warning message to the console. One likely cause of such a performance reduction would be partially plugged filters at the air inlet.

If airflow becomes reduced to the point of risking thermal damage, the sensor triggers a fault signal that shuts down the drive. Also, in the event of fan failure, the sensor will detect the pressure change and stop the drive.

Replacing the Air Pressure Sensor

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 existing sealant where the clear tubing passes through the sheet metal barrier.
4. Installing the replacement airflow sensor is in the reverse order of its removal.

DC Link and Fan Cabinet Components

This section describes the DC link and fan cabinet components of your PowerFlex 7000 “B” Frame drive. It also details a number of regular or recurring maintenance tasks that will keep your drive in peak operating condition.

For control and cabling cabinets, see [Control / Cabling Cabinet Components on page 21](#).

For converter cabinets, see [Converter Cabinet Components on page 43](#).

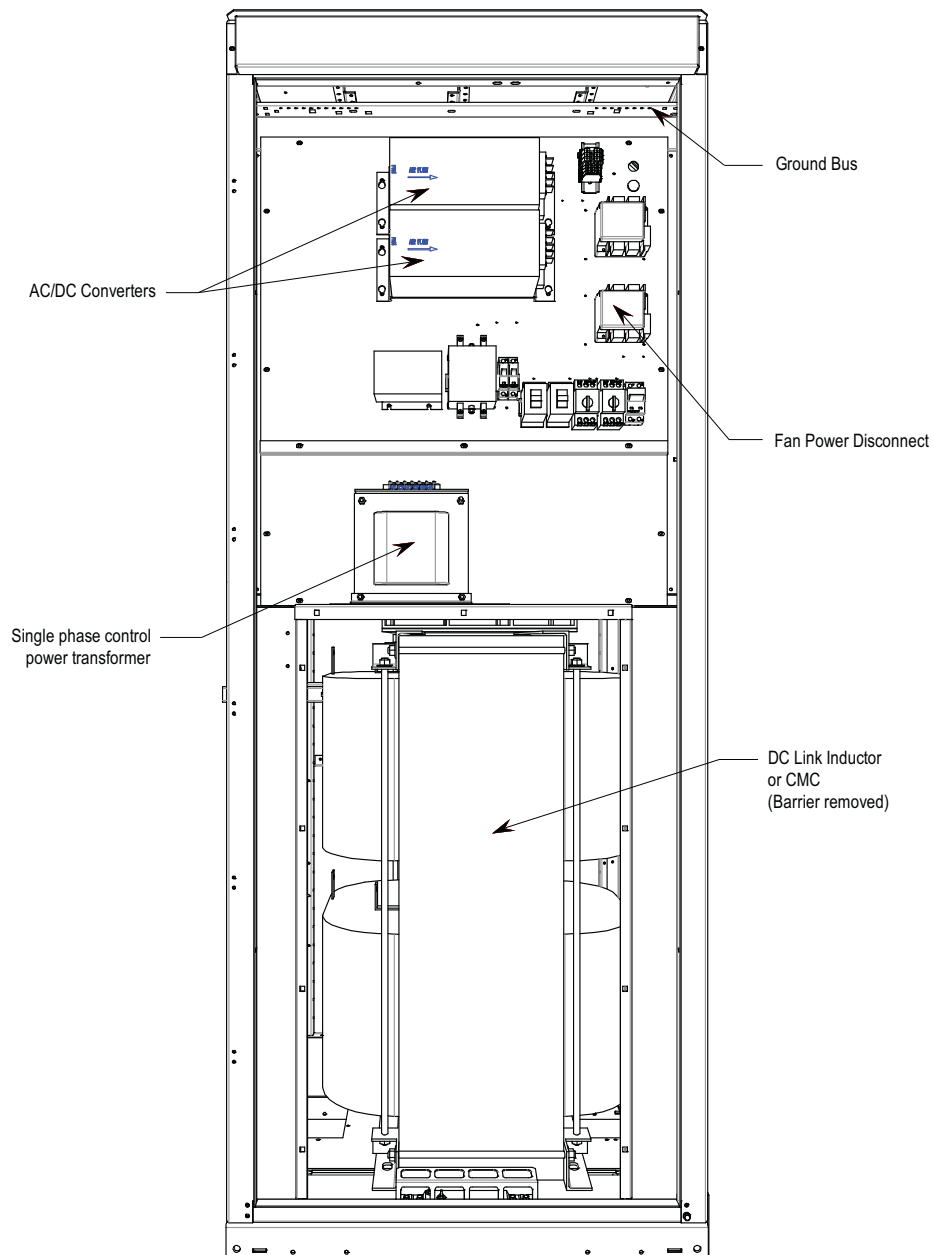


Figure 68 - DC Link/Fan cabinet with fan control panel (standard model)

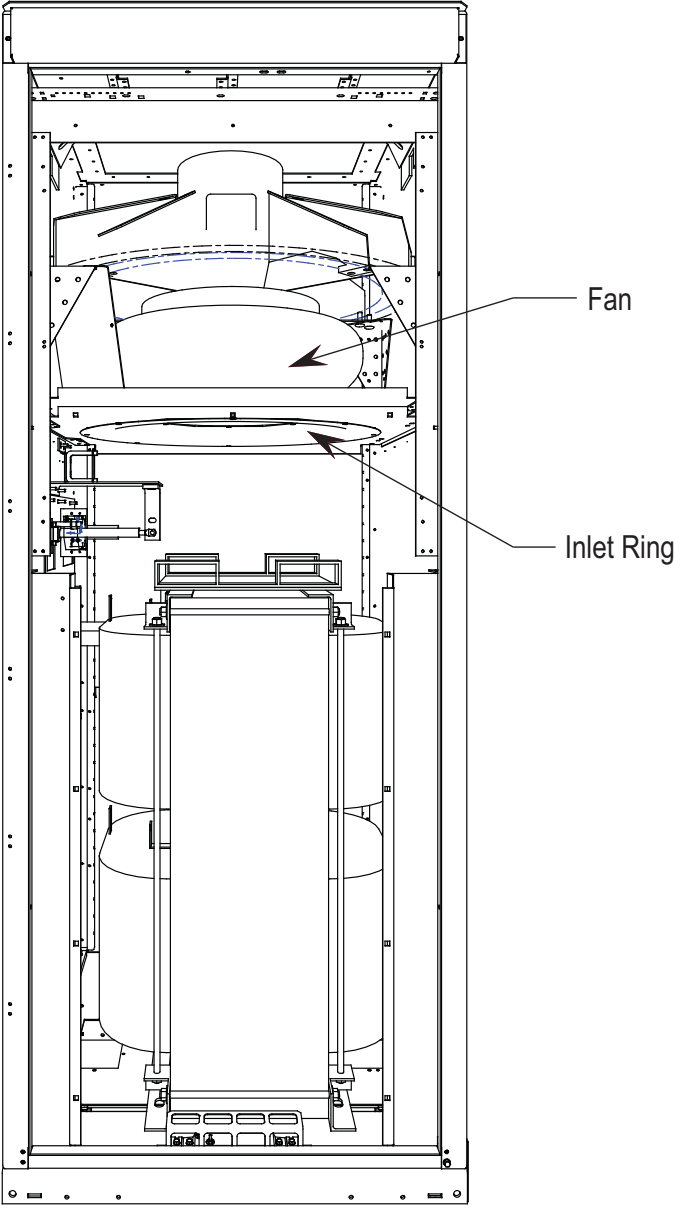


Figure 69 - DC Link/Fan cabinet with fan control panel removed to show main cooling fan

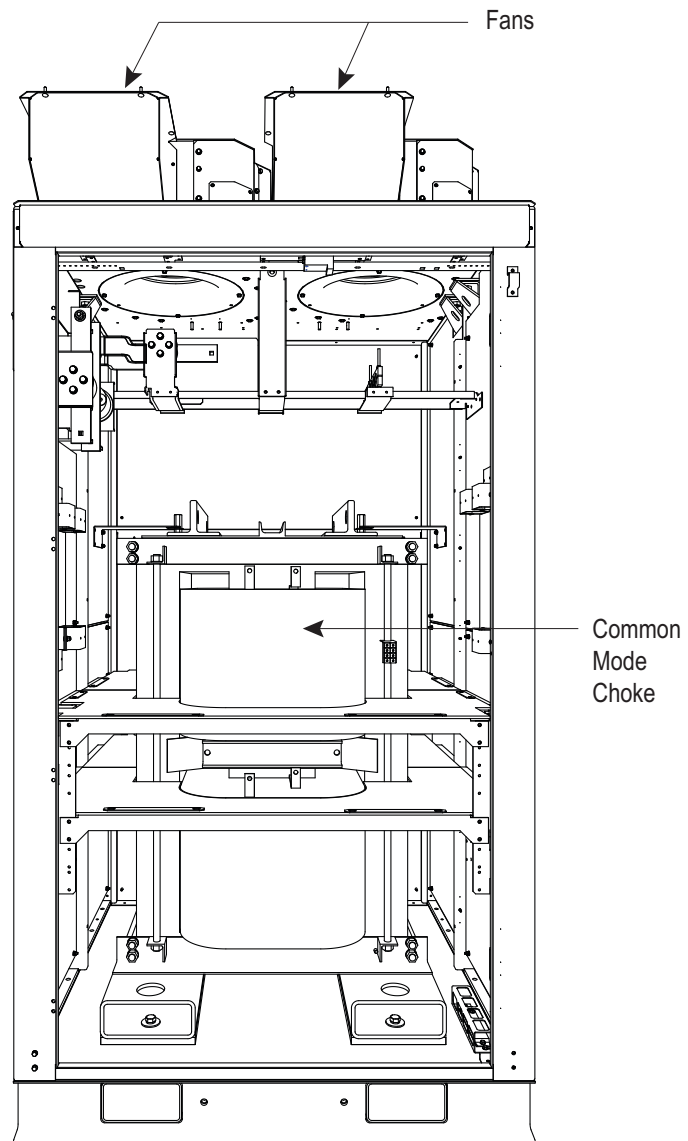


Figure 70 - DC Link/Fan cabinet with panel removed to show CMC (heatpipe model)

The door of the cabinet interlocks to remain closed until you disconnect the fan power. The fan power disconnect handle is on the right-hand side of the cabinet. The DC link and fan are behind the fixed fan control panels in the medium voltage compartment.

The DC link is on the floor plate of the cabinet. Airflow barriers assembled around the coils of the inductor direct a portion of the cooling air through the inductor.

Power connects to the inductor via flexible leads. There are four power connection points labeled L+, L-, M+, and M-. There is a current sensor on the M+ conductor.

The iron core of the DC link has thermal protection.

Above the DC link is the main drive cooling fan. The primary elements of the fan are the inlet ring, impeller and motor. The inlet ring is stationary and must not contact the rotating impeller.

An air exhaust hood is mounted on top of the cabinet; ensure you install it correctly to prevent foreign objects entering the drive. If there is a redundant fan option, it is mounted on the top of this cabinet, inside an enlarged exhaust hood.

DC Link Reactor

The DC Link maintains a ripple-free current between the rectifier and the inverter. The link is designed to cool the reactor with air drawn through its coils.

The DC link reactor does not normally require service. In the event of its replacement, however, Rockwell Automation must approve the replacement link.

To service the DC link, see [Figure 71 on page 89](#).

1. Lock out the drive's source power.
2. Open the DC link cabinet door and remove the screws holding the vertical sheet metal barrier in front of the DC link.
3. The DC link is equipped with flexible power leads. Disconnect the 4 power connections.
4. Remove the horizontal barrier around the DC link.
5. Remove the hardware that secures the DC link to the floor channel.
6. Disconnect the ground connection.
7. The DC link is heavy and has provision for lifting with forks of a lift truck.

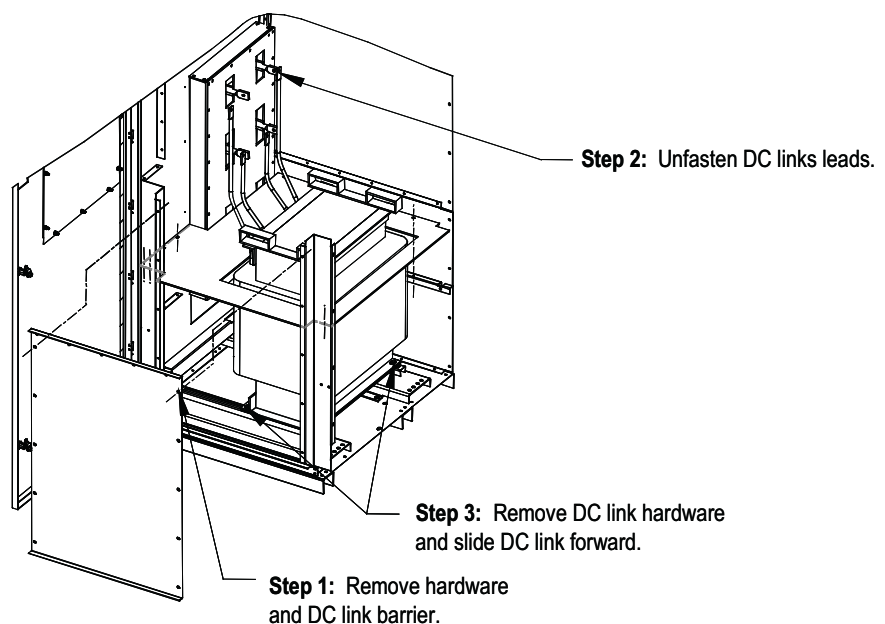
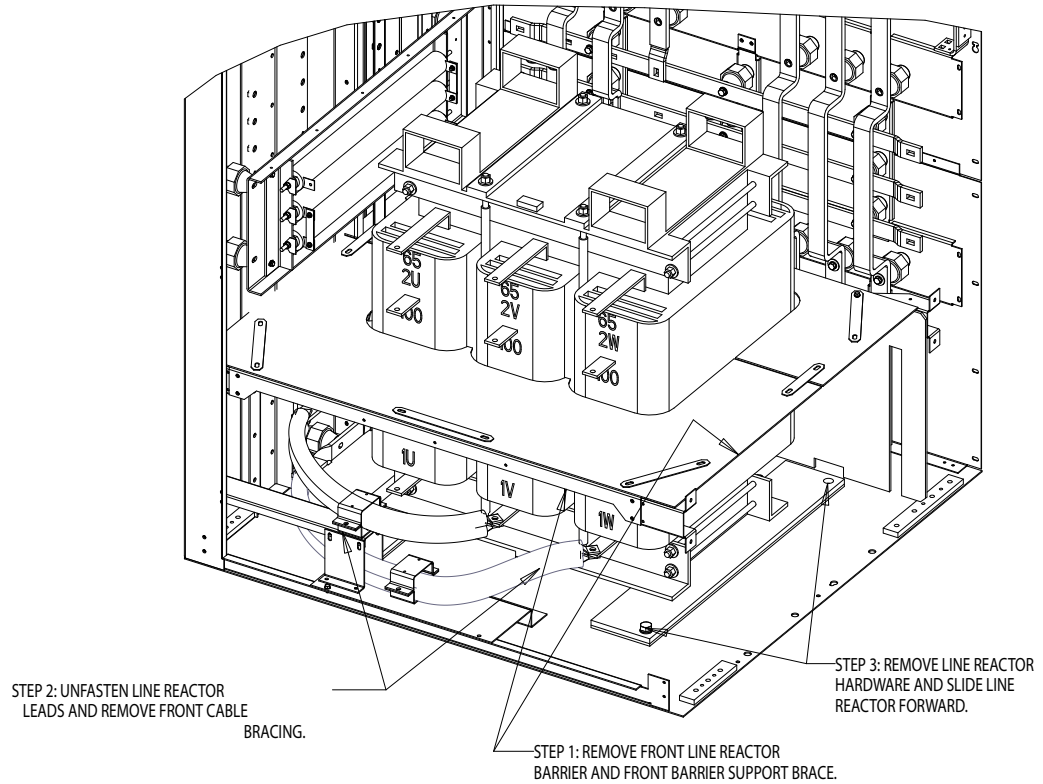


Figure 71 - DC Link removal (standard model)**Figure 72 - DC reactor removal (heatpipe model)**

Install the replacement DC link in the reverse order of its removal.

You must connect the flexible DC link leads to the appropriate terminal and route them to maintain electrical clearances. You must also verify that the nameplate ratings are the same or appropriate for the drive system. A different DC link will require different parameter settings.

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

Removing and Replacing Fans

The fan consists of a motor and impeller assembly. To replace the fan, remove the fan exhaust hood and cabinet top plate.

Safety Notes

- Fan replacement requires working at a significant height from the floor. Be careful to work from a safe, stable platform.
- The fan motor is heavy and requires suitable lifting provision.

- Lock out the fan power 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, use lifting hooks in the holes on the motor mounting brackets and draw the assembly vertically from the cabinet. Do not support the assembly on the impeller or you may damage the unit.

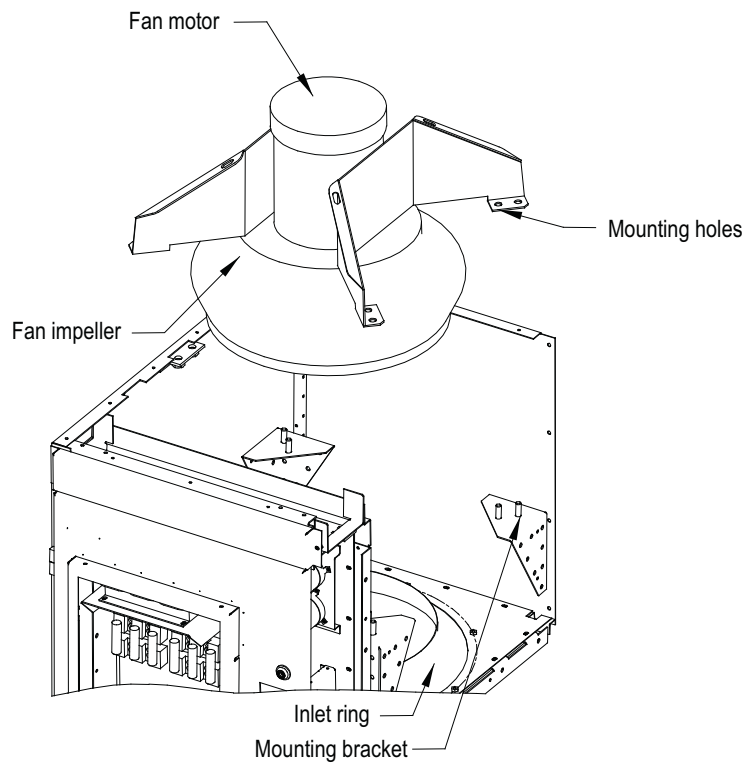


Figure 73 - Fan removal (standard model)

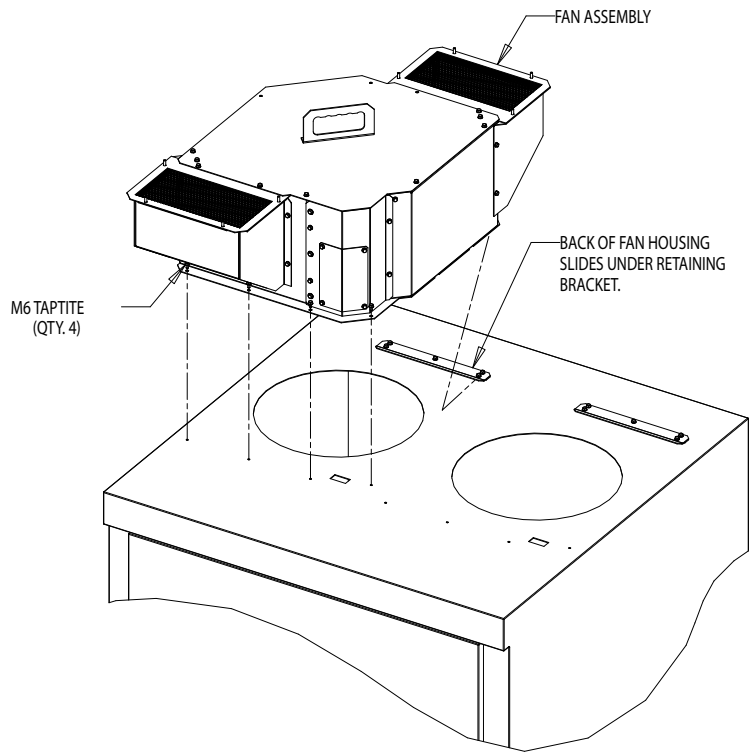


Figure 74 - Fan removal (heatpipe model)

Fan Installation

Take care when handling the fan as poor handling can adversely affect its balance.

Install the fan in the reverse order of its removal. After installation, rotate the impeller by hand to verify it is clear of the inlet ring.

Impeller Maintenance

The fan impeller connects to 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.

Impeller Removal from Motor Shaft

Safety Notes

The impeller is not designed 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.

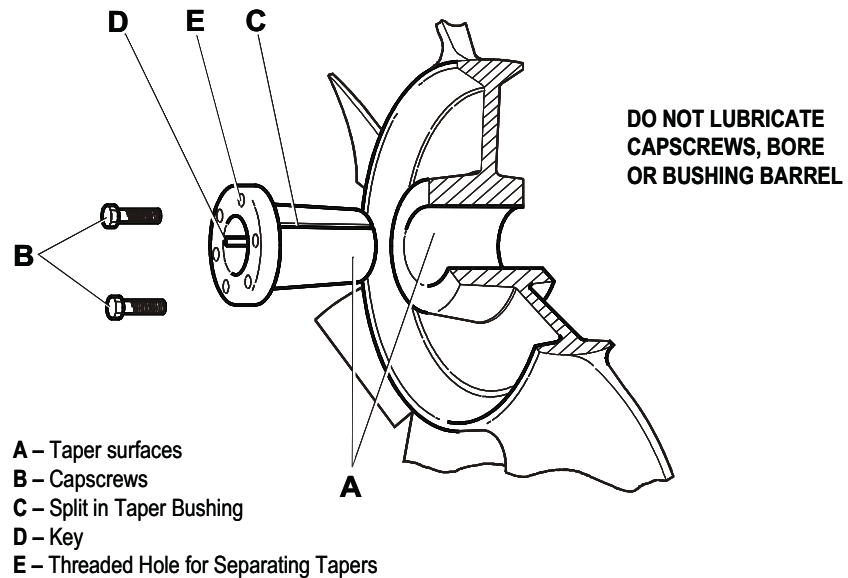


Figure 75 - Impeller Removal

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.



ATTENTION: Do not lubricate capscrews, bore, or bushing barrel, as this will hinder clamping force of the bushing on the shaft and the impeller bore.

Installing Impeller Assembly onto Motor Shaft

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. Ensure 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.

Some common causes of excessive vibration include:

- 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.

The inlet ring is the large circular part located on the underside of a horizontal barrier beneath the fan impeller. The position enables the impeller to sit inside without touching the ring. The ring sits inside the impeller 10 mm (0.40 inches).

Safety Notes

This procedure requires contact with the internal electrical connectors and devices. Disconnect all power to the drive before beginning the work. Failing to do so may result in serious injury or death.

Ensure you can prevent the inlet ring from falling after you have removed all of the bolts.



ATTENTION: To prevent electrical shock, disconnect the main power 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.

If rear panel access is possible, remove rear middle panel of the DC link/fan portion of the cabinet and remove the inlet ring from the back.

If rear panel access is not possible, follow this procedure:

1. Remove the DC Link barrier and impeller access panel ([Figure 73 on page 90](#)). Remove electrical components in front of the inlet ring access panel.
2. Remove bolts from the inlet ring; do 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. You may have to shift the DC link.
4. To install the new ring, reverse the above procedure. Rotate the fan impeller by hand to check clearance inside the inlet ring. Move the ring and retighten bolts to mitigate interference.
5. Replace access panels and electrical components.

Replacing Air Filters

Air filters are located at the cooling air intake grill mounted on the door in front of the converter, line reactor and transformer cabinets.

You must periodically remove and clean, or remove and replace, the filter material. The frequency with which you renew the filters depends on the cleanliness of the available cooling air.

You can replace filters in an operational drive, but the procedure is easier to perform while the drive is shut down.

Procedure (see [Figure 76 on page 96](#)):

1. Using an 8mm Hex key, loosen the ¼ turn fasteners and swing open the hinged grill assembly.
2. Remove filter material. If the drive is running, you must replace the filter as soon as possible to prevent foreign material from falling into the drive.

Be careful when removing the filter to prevent accumulated dirt 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:

- Vacuum Clean – A few passes of a vacuum cleaner on the inlet side of the filter will remove accumulated dust and dirt in seconds.
- Blow with Compressed Air – point compressed air nozzle in opposite direction of operating air flow (Blow from exhaust side toward intake side)
- 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)
- 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.

Use only Rockwell Automation-supplied or -approved replacement filters. Replace the filters in the reverse order of its removal. Check that there are no openings to allow foreign matter to enter the drive.

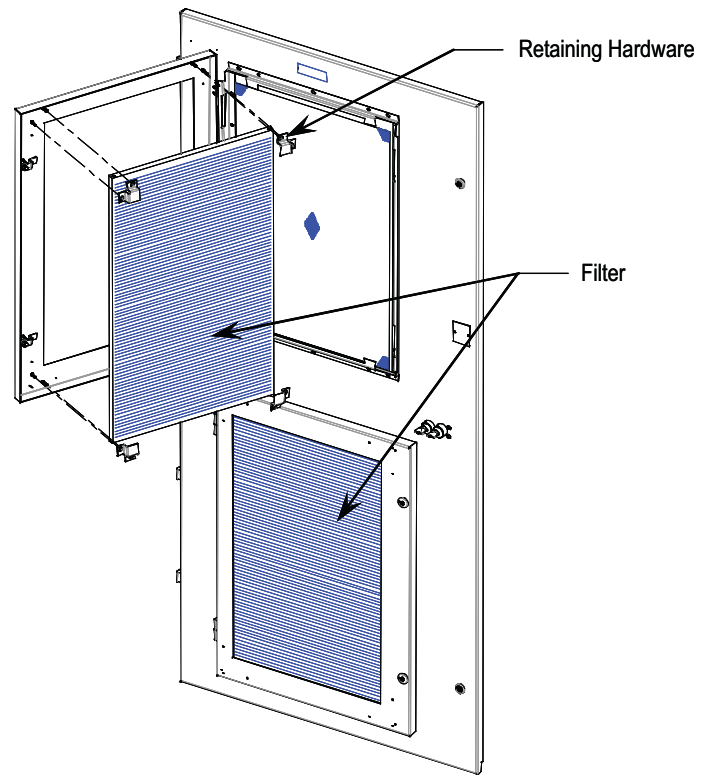


Figure 76 - Filter replacement

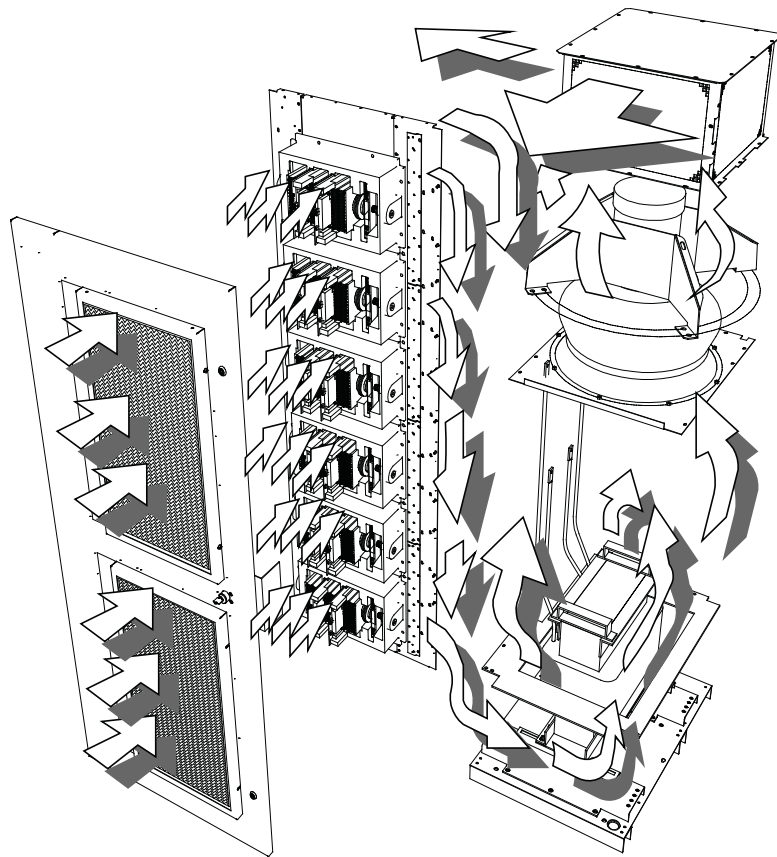


Figure 77 - Air flow pattern for snubber cooling

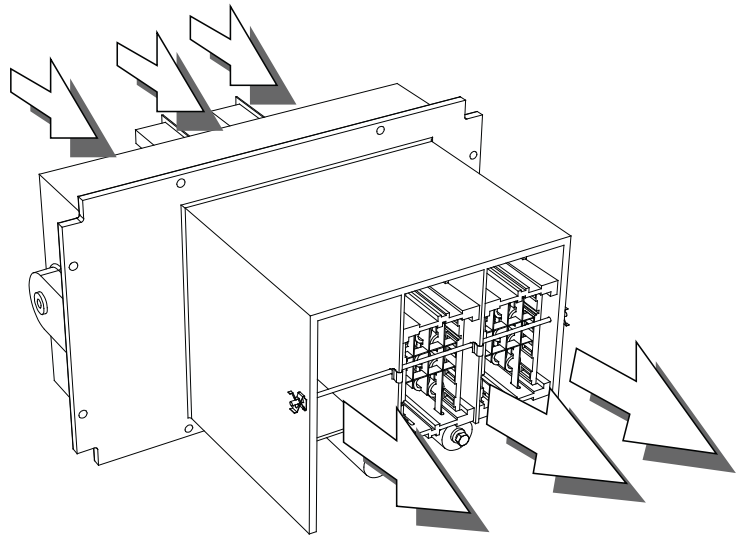


Figure 78 - Air flow through PowerCage

Control Power Components

There are two configurations for distributing control power for the drive, dependent on your selected drive option.

- Line Reactor Drive (refer to [Figure 79](#))
- Remote Transformer and Starter (refer to [Figure 80 on page 99](#))

Ride-Through

Standard controls with 5 cycle ride-through: The drive main control boards will remain energized for a total of 5 cycles after control power interruption. If you cannot restore control power during the 5 cycles, the drive performs a controlled shutdown.

[Figure 79](#) illustrates the control power distribution for PWM drives with integral starter/line reactor.

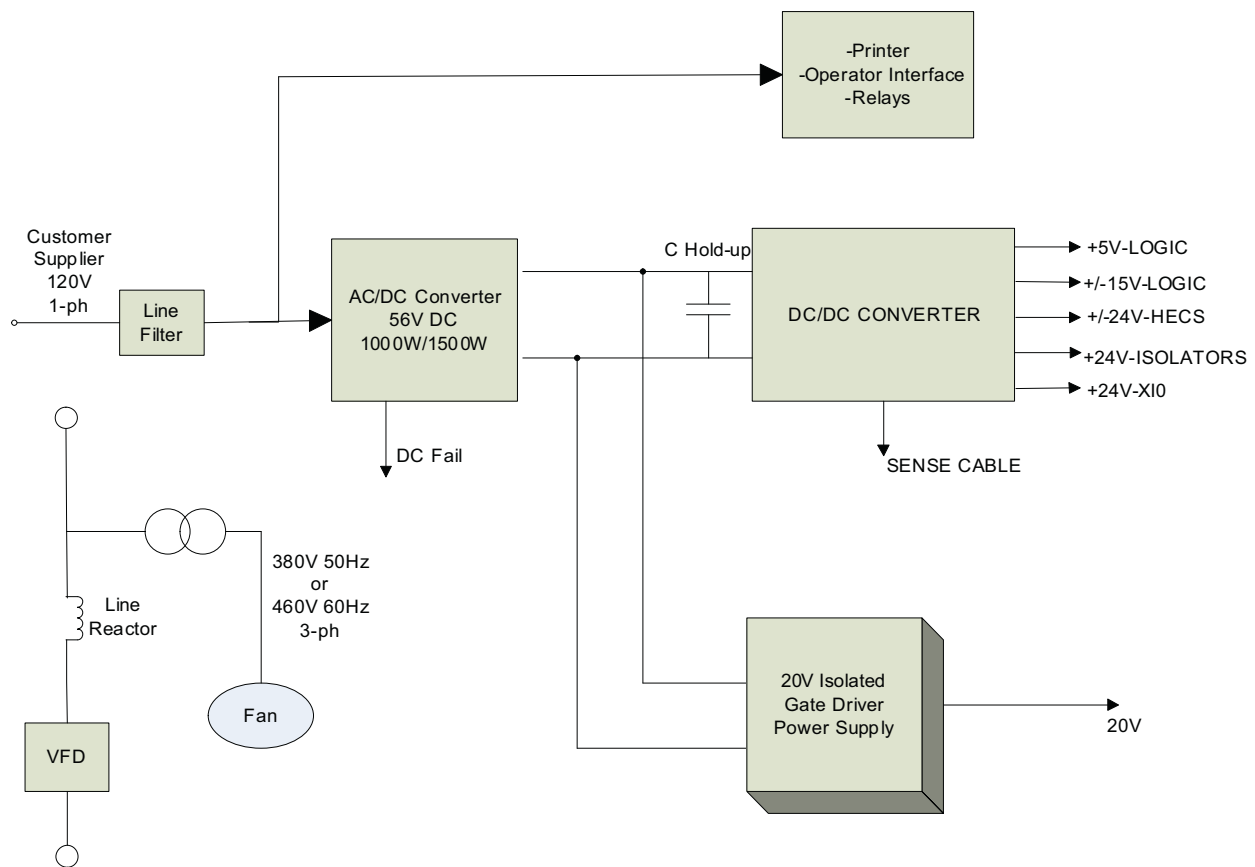


Figure 79 - AFE Line Reactor drives

[Figure 80](#) illustrates the control power distribution for AFE drives with remote transformer/starter or integrated line reactor with remote starter.

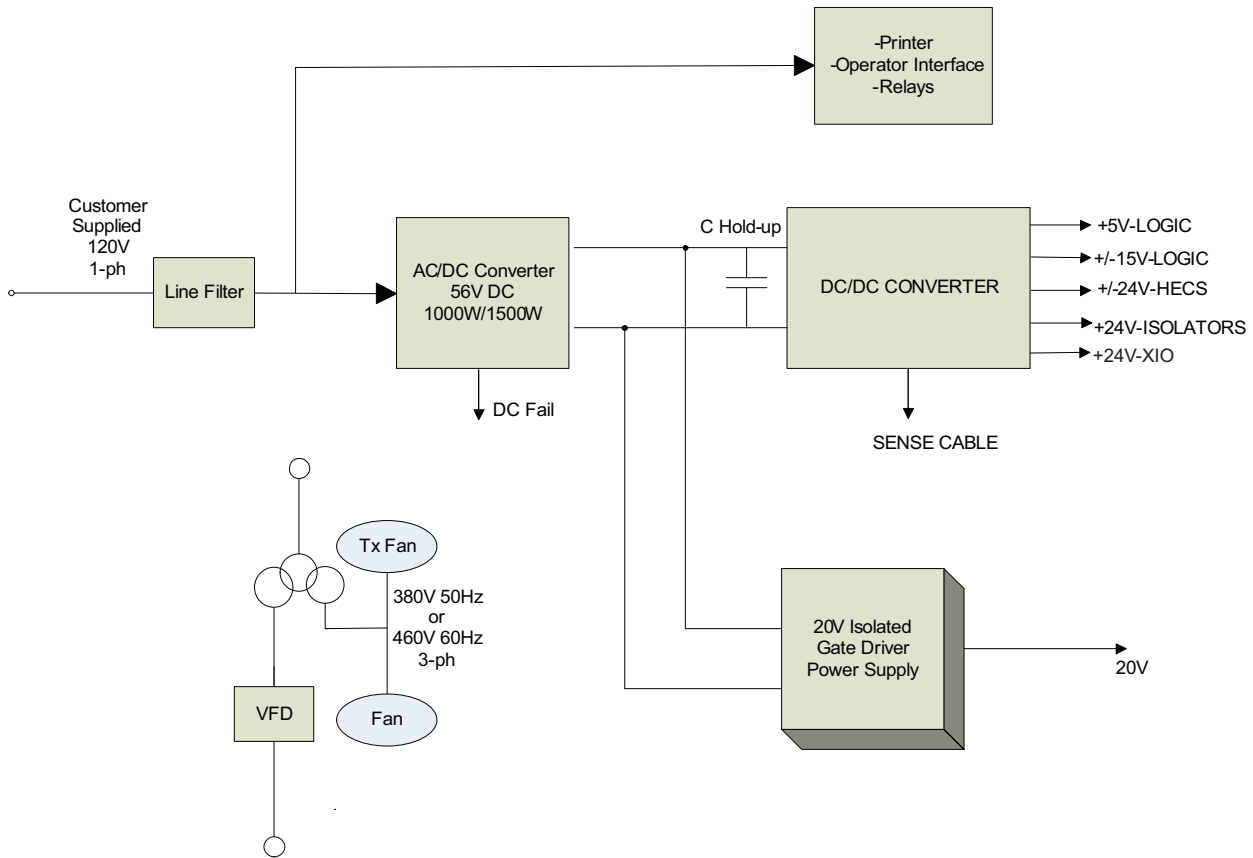


Figure 80 - AFE Remote Transformer / Starter

AC/DC Power Supply

The load demands on the AC/DC converters are the DC/DC converter and up to six IGDPS modules. The DC/DC is a fixed load; however, the quantity of IGDPS modules will vary depending upon the drive configuration.

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.

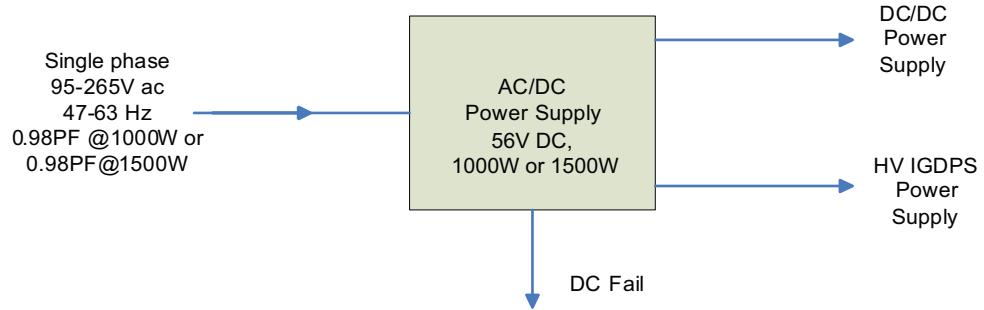


Figure 81 - AC/DC Converter Power Supply

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

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 82](#).

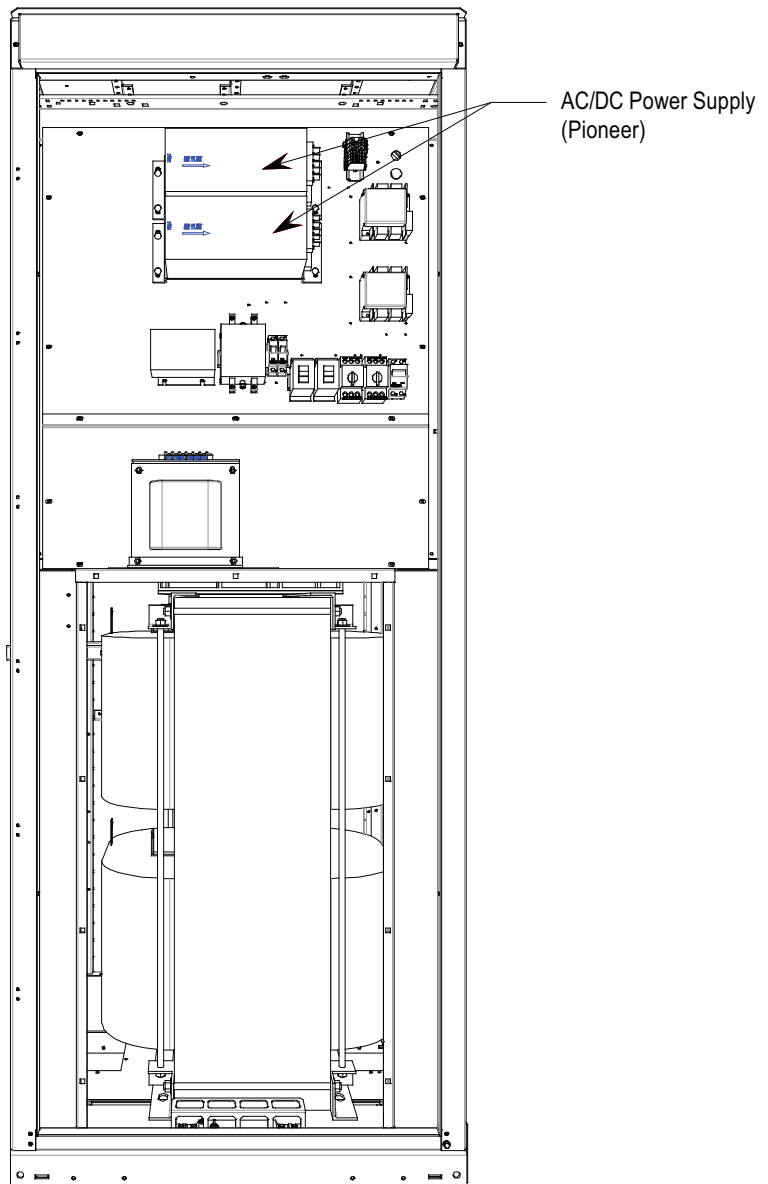


Figure 82 - Location of AC/DC Pioneer power supply on LV panel (standard model)

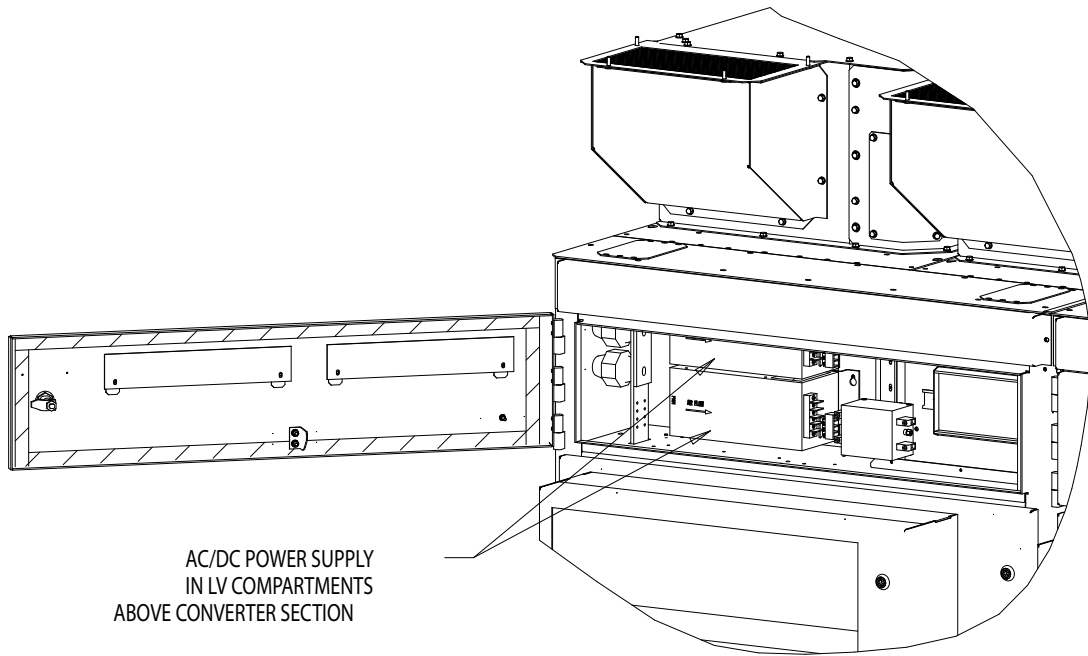


Figure 83 - Location of AC/DC power supply on LV panel (heatpipe model)

Terminal / Connections Descriptions

The terminal connections are shown in [Figure 84](#).

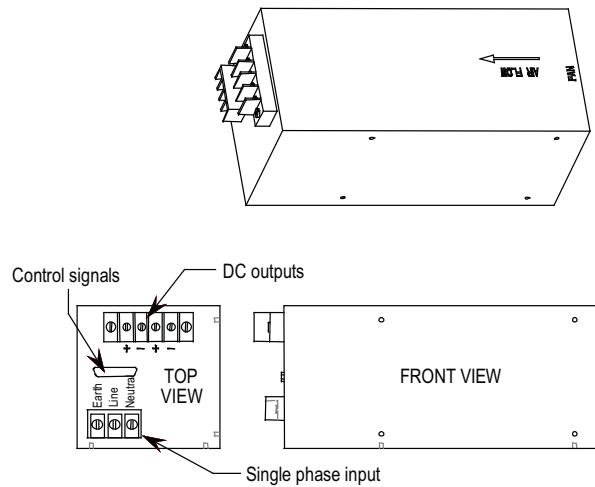


Figure 84 - Terminal locations on AC/DC Pioneer power supply

	PIN#	LABEL
P1-AC input	1	EARTH
	2	LINE
	3	NEUTRAL
P2-DC output	1	+56V
	2	+56V COMM
	3	+56V
	4	+56V COMM
P3-FAIL output	3	DC POWER FAIL (OUTPUT POWER GOOD)
	15	CURRENT SHARING
	14	DC POWER FAIL COMMON

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, reconnect the power supply to the circuit and re-measure the output. Readjust if necessary.

If it is not possible to maintain 56 V DC, the power supply may be faulty.

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 85](#)/[Figure 86](#).
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. Ensure 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.

8. Reapply control power and verify voltage levels.

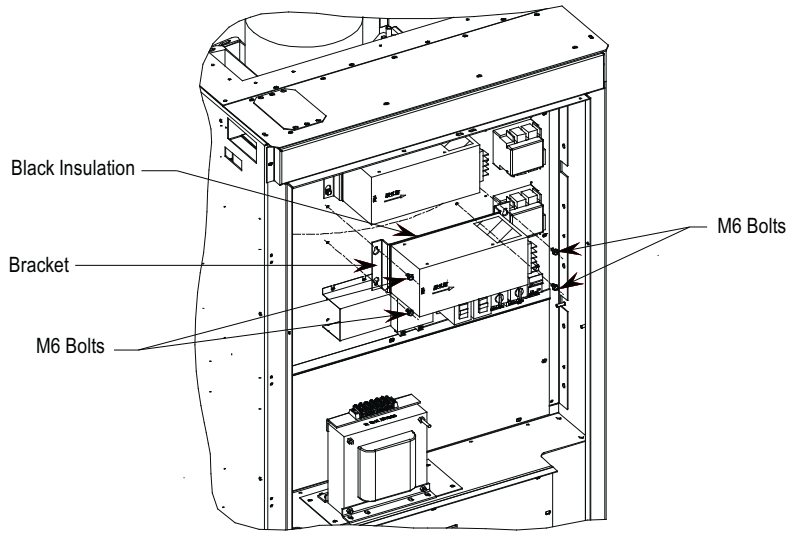


Figure 85 - Replacing AC/DC power supply on LV panel (standard model)

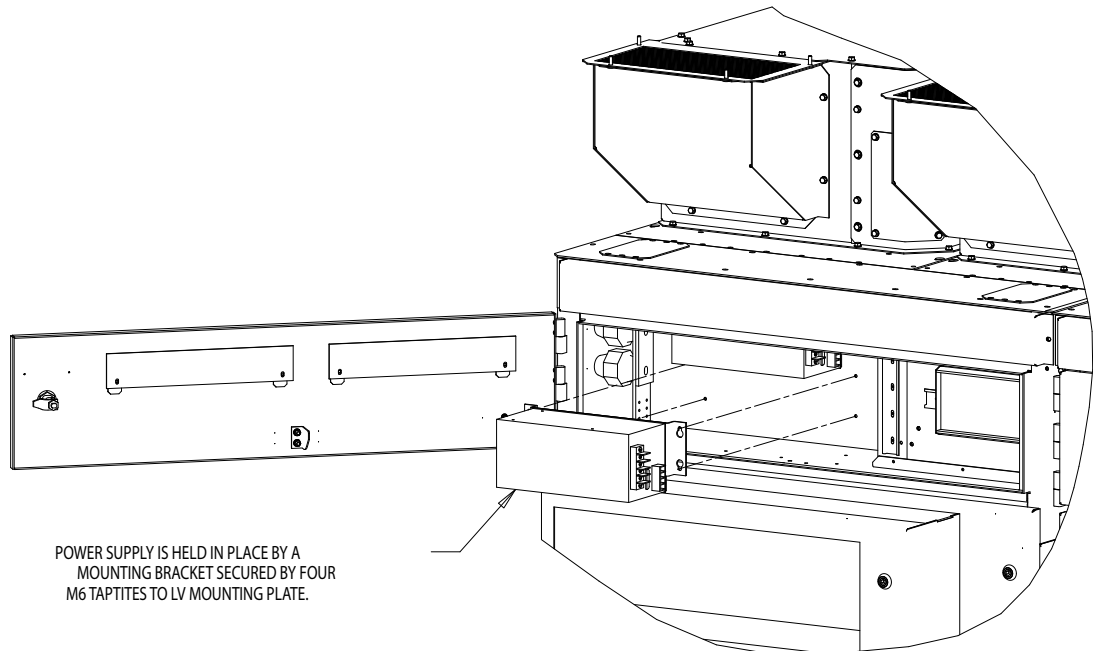


Figure 86 - Replacing AC/DC power supply on LV panel (heatpipe model)

UPS Option

The PowerFlex 7000 “B” Frame drive has the option for internal and external UPS power to keep the control power active within the drive in the event of a control power loss. The following diagram shows the current configuration of the internal UPS option.

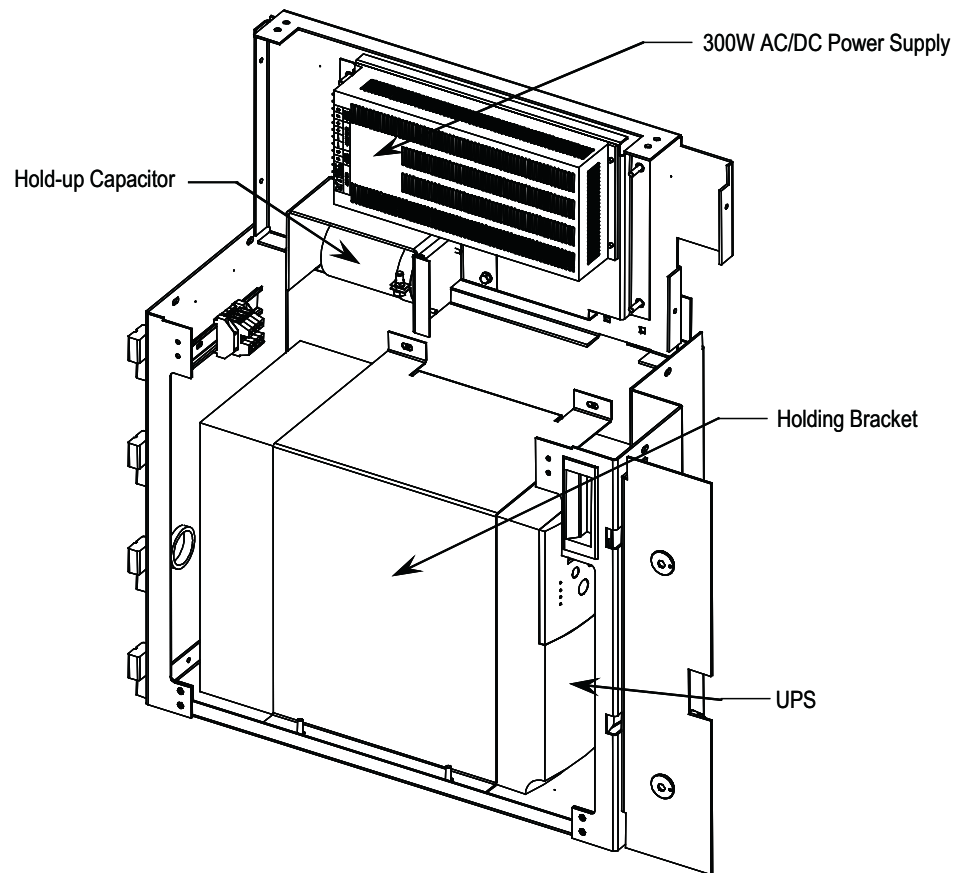


Figure 87 - 300W AC/DC power supply

The UPS is installed in the incoming cabling section, below the LV control section.

The UPS will keep control power to all the critical 120VAC loads and an extra AC/DC power supply that feeds the DC/DC power supply for powering all the drive control components. The main drive cooling fan, and the AC/DC power supply that feeds the IGDPS boards are not powered from this UPS.

The UPS uses the AS400 communication protocol, and feeds several status signals back to the ACB to control responses to various conditions including low batteries, loss of input power, UPS on bypass, etc.

If the customer has an external UPS, the firmware will not expect any of the signals mentioned in the above section, and will not display any information relating to the UPS status. The firmware will operate in the same manner with respect to the operation of the drive with an internal or external UPS.

The output of the UPS feeds a 300W AC/DC power supply. This is 20% of the standard AC/DC power supply used in the drive because the load represented by the DC/DC power supply is much smaller than the load of the IGDPS boards, and we are able to reduce the size accordingly. We still use the standard AC/DC

power supply to feed the IGDPS boards. The 300W AC/DC power supply has its AC input monitored by the UPS, and the DC output is monitored by the ACB board for fault conditions.

There is also a hold-up capacitor on the output of the 300W AC/DC power supply to maintain the 56VDC in the event of a failure of the power supply.

Replacing the UPS

1. Isolate and lock out the control power.
2. Remove the hardware that fastens the holding bracket to the cabinet assembly and remove the holding bracket.
3. Disconnect the input and output wiring connected to and from the UPS.
4. Disconnect the 15-pin status plug from the UPS
5. Remove the UPS, and install the new UPS.
6. Reconnect all the connections removed in the previous steps.
7. Before reconnecting the mounting bracket, apply control power to the unit and ensure the UPS is configured for the AS400 communication protocol. Refer to the manual that comes with the UPS for instructions.
8. Once this has been confirmed, install the mounting bracket.

Low Voltage Control Section

The low voltage control section 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 88](#) for a generic representation of a low voltage tub arrangement.

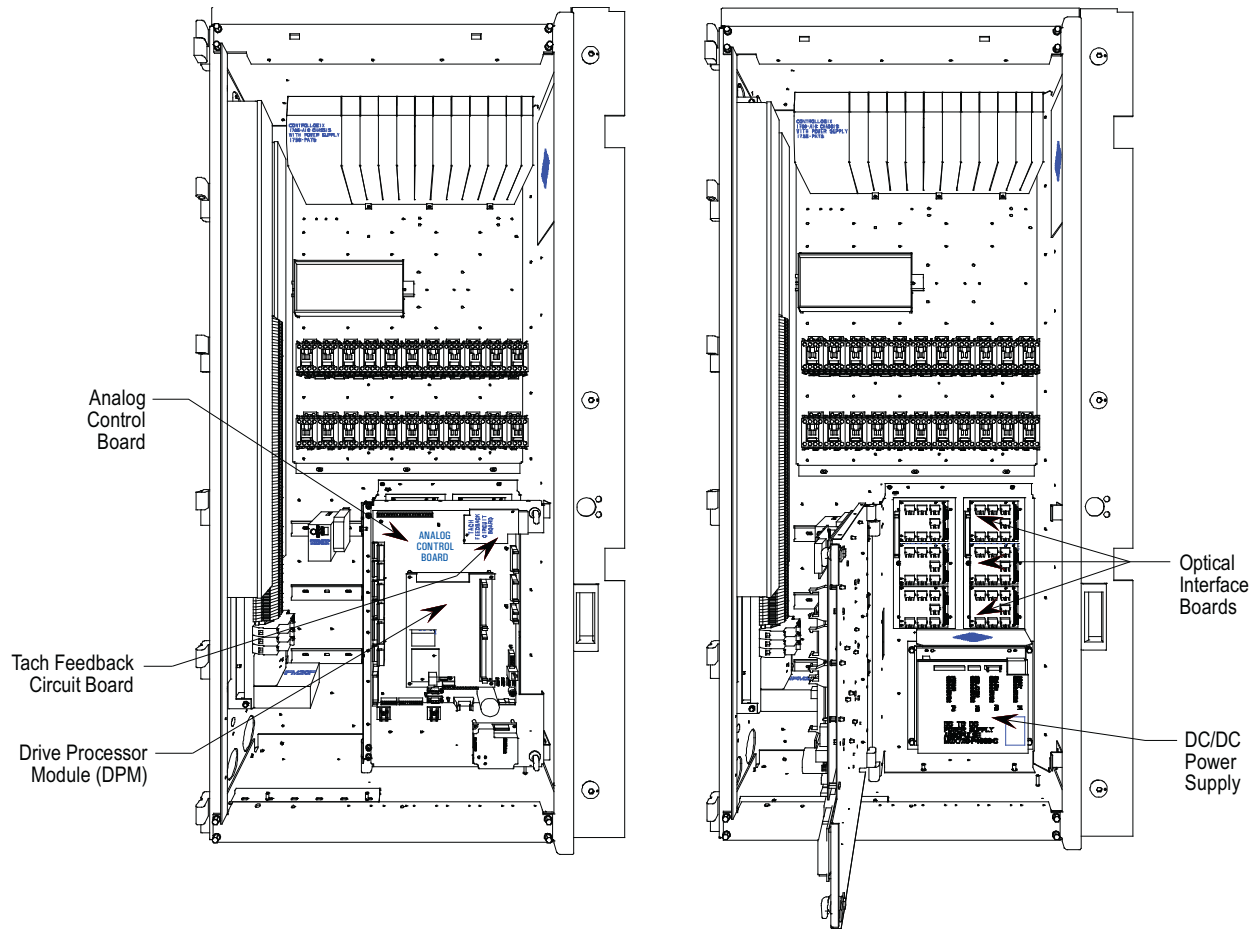


Figure 88 - Low voltage tub compartment

DC/DC Power Supply

The DC/DC power supply provides a source of regulated DC voltages for various logic control boards and circuits., using a regulated 56V DC source.

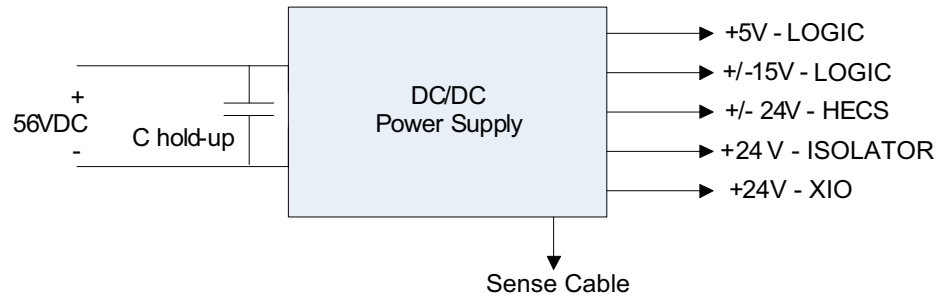


Figure 89 - DC/DC converter power supply

The capacitor at the input terminals enables the equipment to ride through power dips. If the capacitor (C hold-up) loses the 56V input, it maintains the voltage level for a period of time to enable a controlled shut-down. 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 provides 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 drive switches to the other power supply automatically to provide the output power.

Terminal/Connections Descriptions

P1 – DC Input	PIN NO.	LABEL	DESCRIPTION ONLY
	1	+56V	+56V input
	2	+56V COMM	+56V common
	3	EARTH	earth ground

P2 – SENSE (To ACB)	PIN NO.	LABEL	DESCRIPTION ONLY
	1	+56V	+56V input supply
	2	+56V RTN	+56V input supply return
	3	NC	Not Connected
	4	NC	Not Connected
	5	+24V	Isolated +24V Supply
	6	+24V RTN	Isolated +24V Supply return
	7	NC	Not Connected
	8	NC	Not Connected
	9	+5VA	Primary +5V supply, before OR'ing diode
	10	DGND(com1)	+5V, +/-15V Common
	11	+5VB	Secondary +5V supply, before OR'ing diode
	12	DGND(com1)	+5V, +/-15V Common
	13	ID0	Power Supply ID Pin 0
	14	ID1	Power Supply ID Pin 1

P3 – ISOLATOR (To Isolator Modules)	PIN NO.	LABEL	DESCRIPTION ONLY
	1	ISOLATOR (+24V,1A)	+24V,1A/com4
	2	ISOL_COMM (com4)	0V/com4
	3	EARTH	EARTH

P4 – PWR (To ACB)	PIN NO.	LABEL	DESCRIPTION ONLY
	1	+24V_XIO (+24V,2A)	+24V,2A/com3
	2	XIO_COMM (com3)	0V/com3
	3	+HECSPWR (+24V,1A)	+24V,1A/com2
	4	LCOMM (com2)	0V/com2
	5	-HECSPWR (-24V,1A)	-24V,1A/com2
	6	+15V_PWR (+15V,1A)	+15V,1A/com1
	7	ACOMM (com1)	0V/com1
	8	-15V_PWR (-15V,1A)	-15V,1A/com1
	9	+5V_PWR (+5V,5A)	+5V,5A/com1
	10	DGND (com1)	0V/com1
	11	EARTH	earth ground

Replacing a DC/DC Power Supply

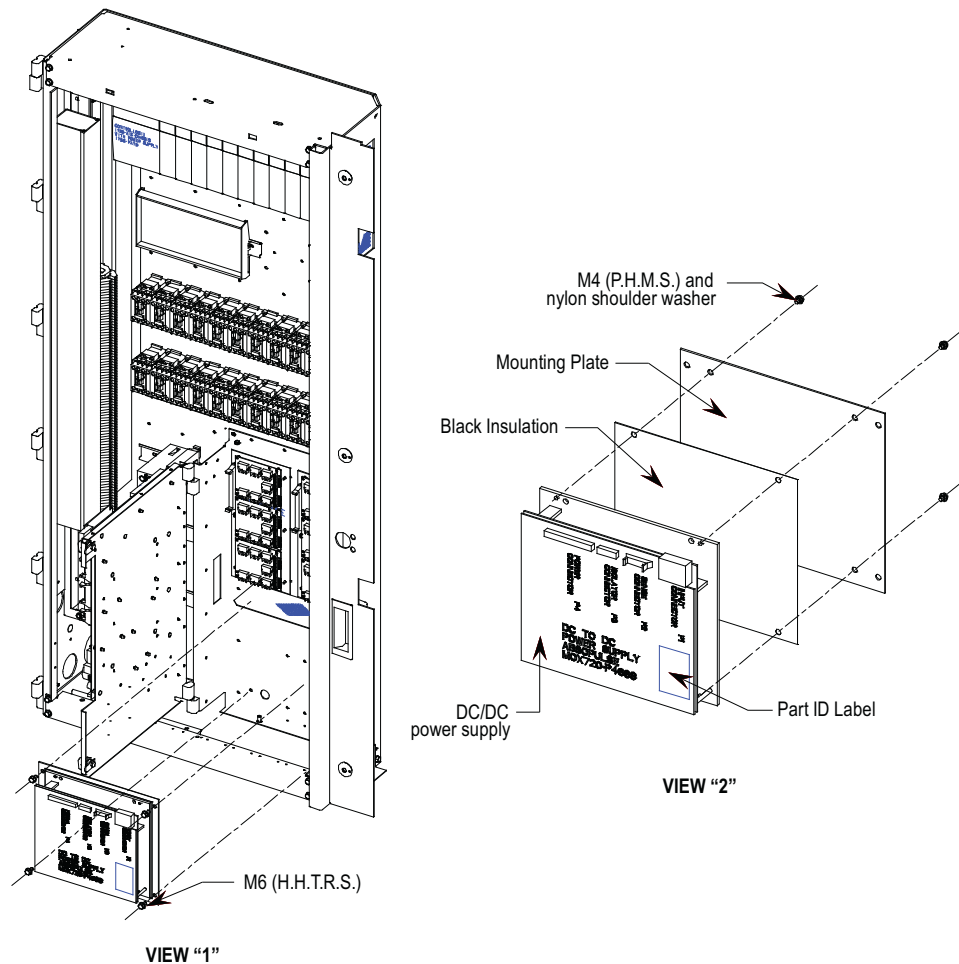


Figure 90 - Replacing a DC/DC power supply

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 four (4) M6 (H.H.T.R.S.) so you can remove the DC/DC power supply assembly from the low voltage panel (view 1).
4. Remove four (4) M4 (P.H.M.S.) and nylon shoulder washers from the back of the mounting plate (view 2)
5. Install the new DC/DC power supply. Ensure you replace the black insulation between the DC/DC power supply and the mounting plate. Repeat steps 4, 3, 2, 1 in this order to replace unit (view 2). E
6. Reconnect the P4 plug ground wire to the ground by the M10 bolt.

Take the following precaution when replacing printed circuit boards.

- Disconnect all drive power.

- Leave the replacement board in the anti-static bag until needed.
- Use an 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 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.

Control Board IO Connectors

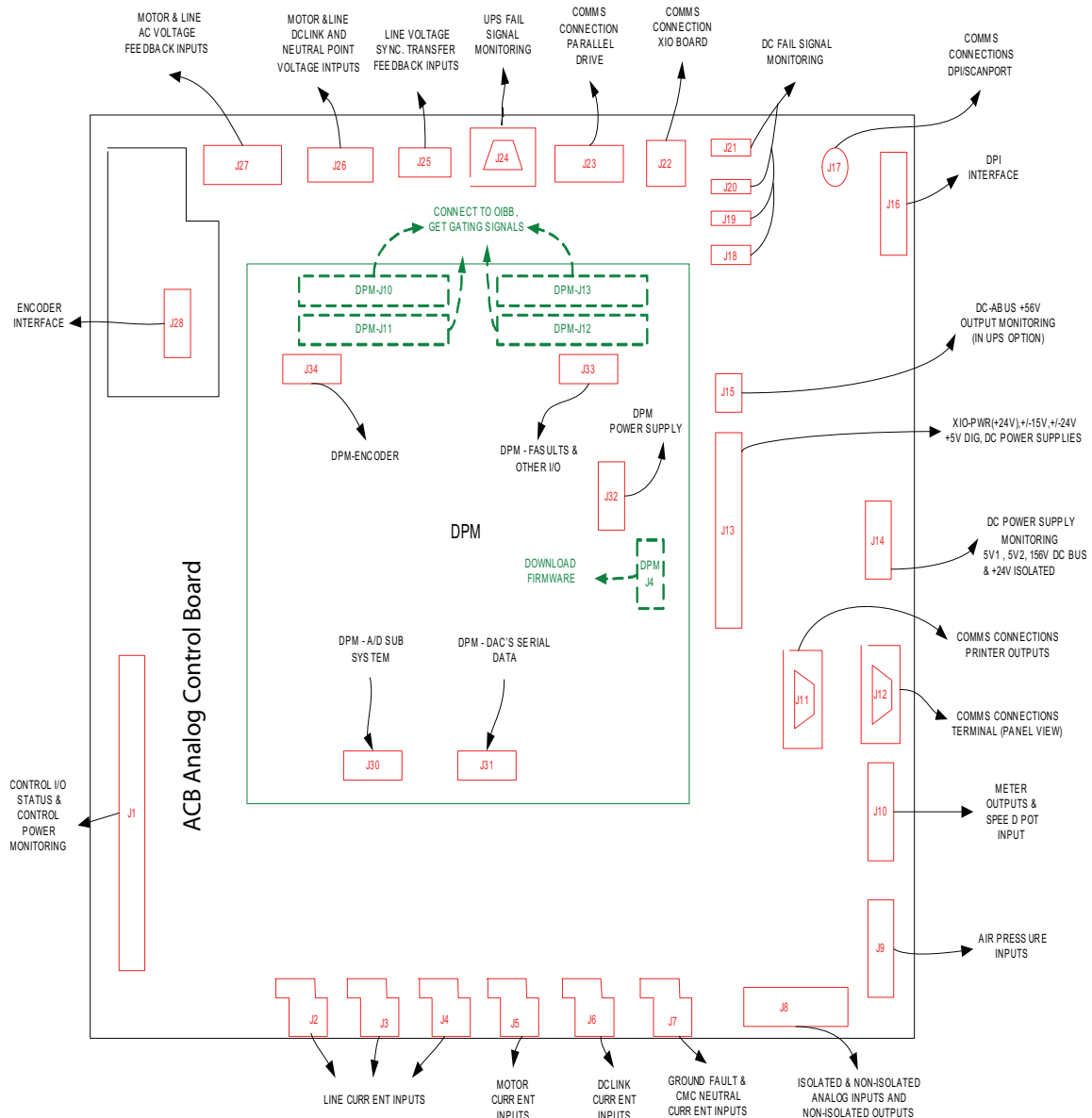


Figure 91 - Control Board IO connectors

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.

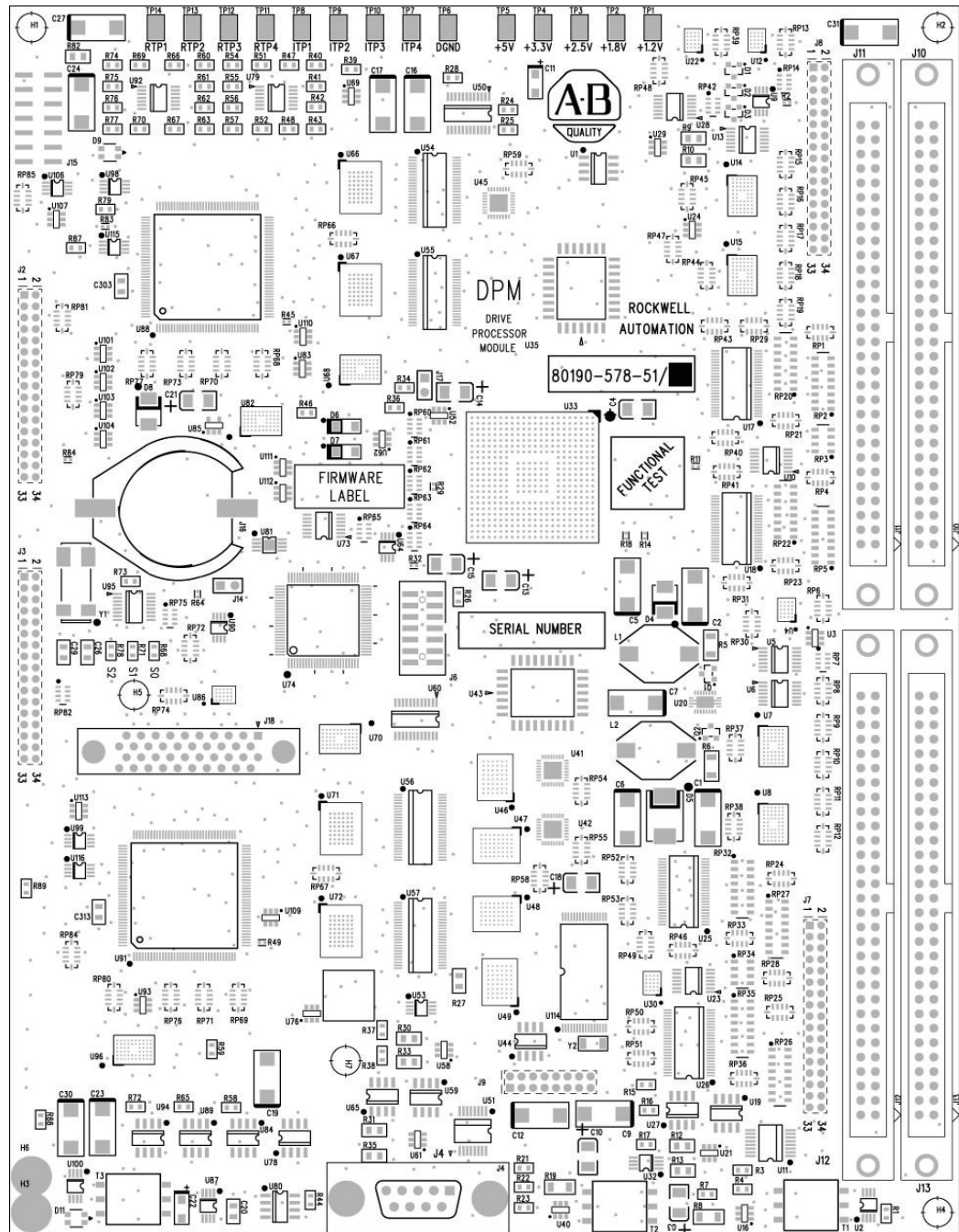


Figure 92 - Drive Processor Module (DPM)

Diagnostic test points on the DPM have a voltage output range of -5 to +5V. The following list identifies test points on the DPM.

Table 1 - 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-TP7	ITP1	Digital to Analog output – Assignable diagnostic test point
DPM-TP8	ITP2	Digital to Analog output – Assignable diagnostic test point
DPM-TP9	ITP3	Digital to Analog output – Assignable diagnostic test point
DPM-TP10	ITP4	Digital to Analog output – Assignable diagnostic test point
DPM-TP11	RTP1	Digital to Analog output – Assignable diagnostic test point
DPM-TP12	RTP2	Digital to Analog output – Assignable diagnostic test point
DPM-TP13	RTP3	Digital to Analog output – Assignable diagnostic test point
DPM-TP14	RTP4	Digital to Analog output – Assignable diagnostic test point

This table defines the states of LEDs D9 and D11 on the DPM board, which uses D9 for the Inverter side processor, and D11 for the Rectifier side processor. The other two LEDs (D6 and D7) are the watchdogs for the Inverter and Rectifier code respectively.

Table 2 - Description of D6 and D7 Function

Color	Rate or Count (Pulse)	Meaning
Green	Solid	Application firmware is running

Table 3 - Description of D9 and D11 Function: Boot Code Status

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	Application Running
Red	Solid	Operation Failed
Red	2 Count	POST – RAM Failed
Red	3 Count	POST – NVRAM Failed
Red	4 Count	POST – DPRAM Failed
Red	8 Count	FPGA Loading Failed
Red	9 Count	POST – USART Failed: 1 Green Count = Port 1 2 Green Count = Port 2

Color	Rate or Count (Pulse)	Meaning
Red	10 Count	End of Code Reached
Red	11 Count	Download – CRC Error
Red	14 Count	Download – Overflow Error

If the application is running, there are two other possible states for D9 and D11, described below.

Table 4 - Alternate D9 and D11 descriptions

LED	State	Meaning
D9 (Inv)	Off	Parameter Load Timeout
D11 (Rect)	Red	FPGA Real-time Clock Failed

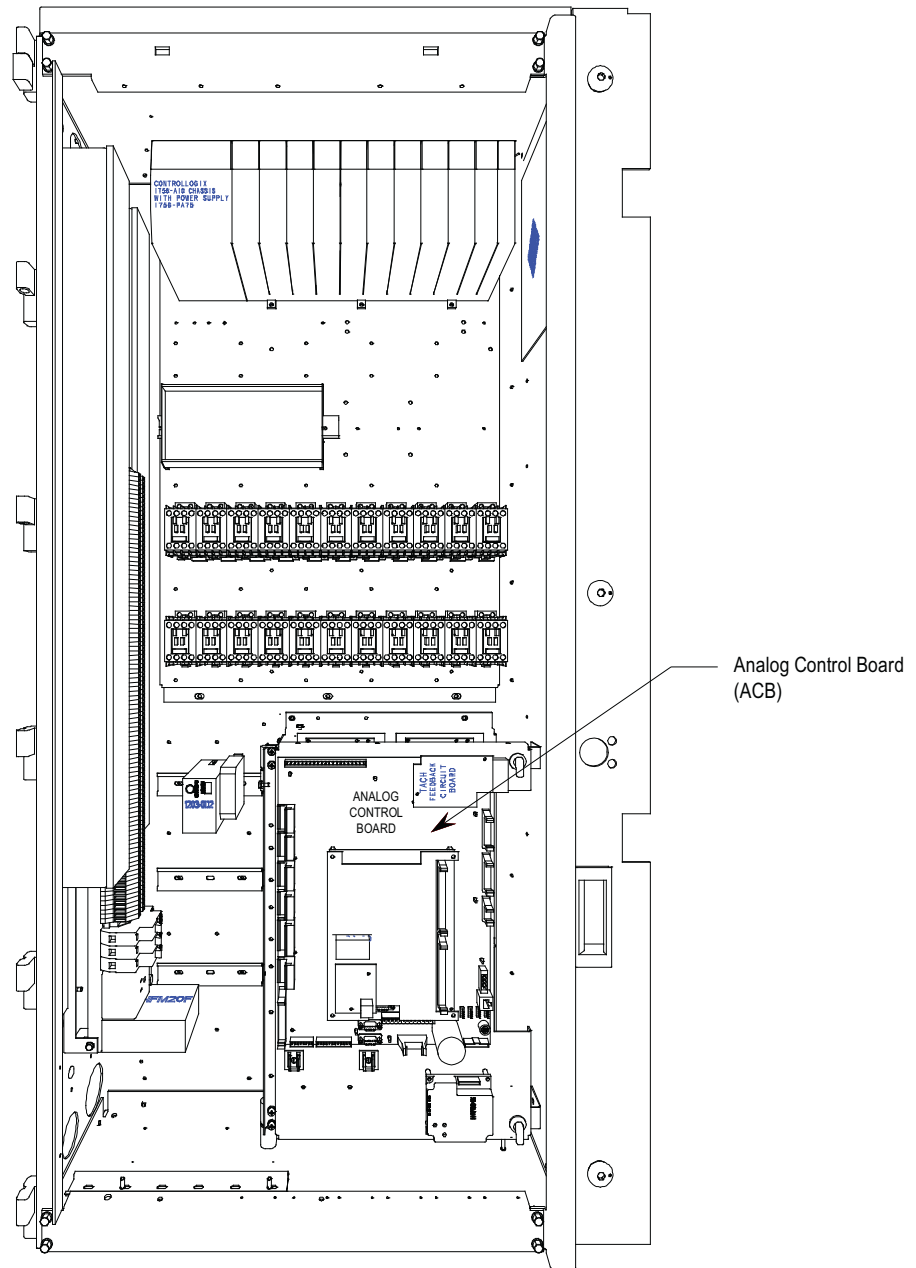
Replacing the Drive Processor Module

Before replacing the Drive Processor Module, record all of the programmed drive parameters and settings; specifically, the parameters, fault masks, fault descriptions, and PLC links. This information resides in NVRAM on each board, and as a result you may lose your settings with a new board. Save parameters in the terminal memory. Other options include a flashcard, HyperTerminal, the door-mounted printer, or DriveTools™ to record the parameters to a file. The printer and HyperTerminal options enable you to print configuration information. Otherwise, record information by hand. If a board fails, you likely cannot save parameters after the failure.

It is important to save all parameters after commissioning or servicing the drive. If you do not have a copy of the initial configuration or current parameters, contact your Rockwell sales or service representative or Product Support to check if they have a copy.

1. Record all drive configuration using one of the options above.
2. Isolate and lock out all medium voltage and control voltage power to the drive.
3. Remove the transparent sheet on top of the Drive Processor Module by removing the 4 screws.
4. Use a grounding 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. 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 replacing the DPM.

9. Reverse steps 7 – 3 to re-install the boards into the low voltage control cabinet.
10. Apply control power to the drive. The DPMs ship without installed firmware, so the drive will shift into download mode. Install firmware in the drive following the guidelines the Installation Manual.
11. Program the drive. Refer to Technical Data “Medium Voltage AC Drive Parameters” – Publication 7000-TD002_-EN-P. Save the parameters to NVRAM and externally, using the options described earlier in this section.

**Figure 93 - ACB and DPM Replacement**

Analog Control Board (ACB)

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

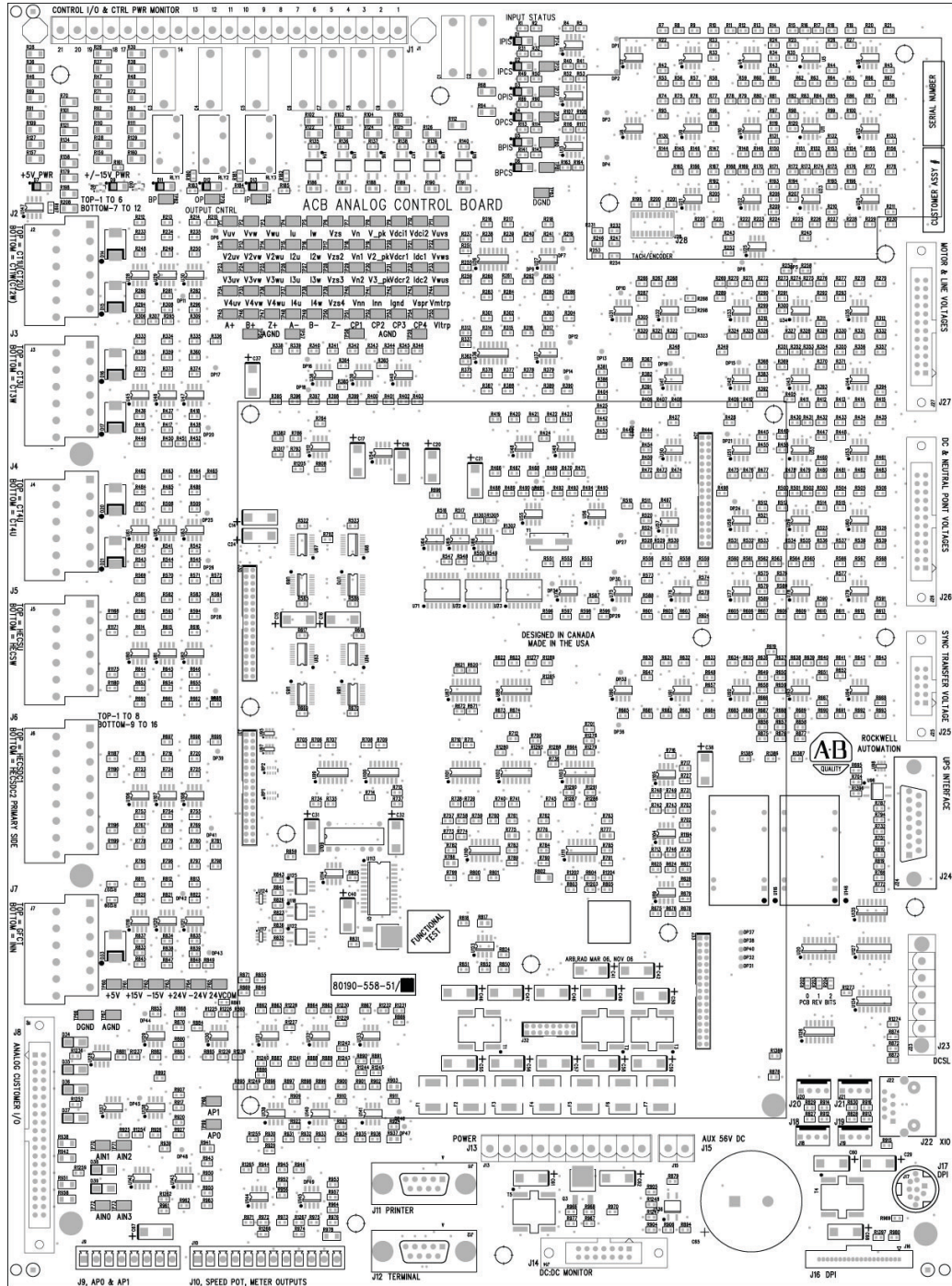


Figure 94 - ACB analog control board

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 board also has isolated Digital I/O for e-stops, contactor control and status feedback. All of the test points for the currents, system voltages, control voltages, and flux are on these boards.

Table 5 - 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, AINO
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 6 - 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	Vvus	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)

Test points	Name	Description
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

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	Vltrp	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

Test points	Name	Description
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

LEDs

There are two power LEDs on the ACB labeled D7 and D9:

- D9 is the $\pm 15V$ DC voltage-OK signal
- D7 is the +5V DC voltage present signal.

Interface Module (IFM)

The Interface Module makes all customer-usable connections to the ACB. The pin numbers listed on the following pages refer to IFM pin numbers.

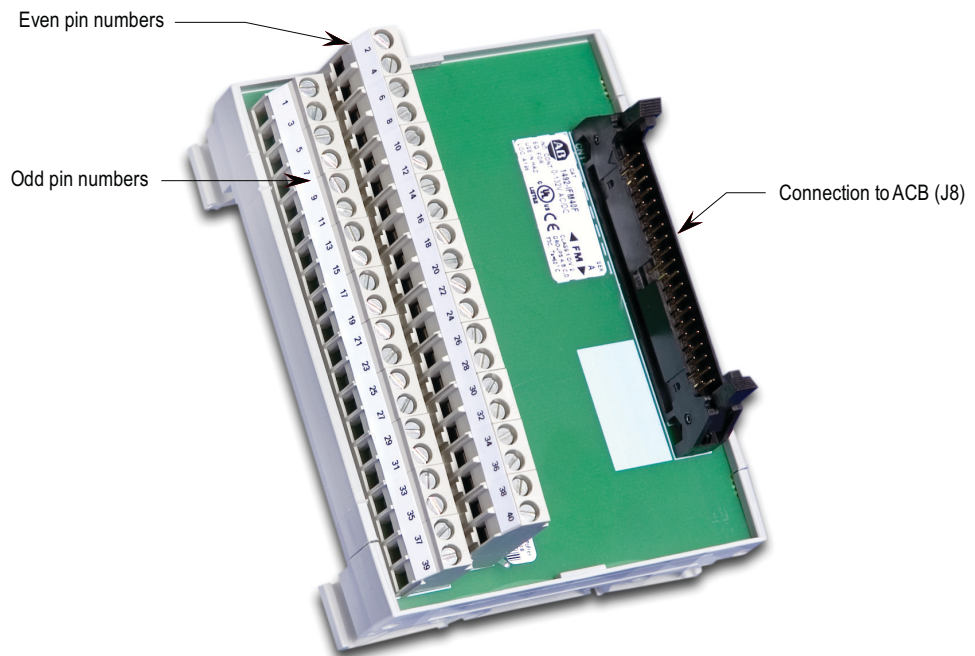


Figure 95 - Interface Module (IFM)

Analog Inputs and Outputs

The PowerFlex 7000 “B” Frame offers one isolated process current loop transmitter and three isolated process current loop receivers, embedded into the control. These are accessible on the ACB.

The isolated Process Output is configured as 4-20 mA. The three isolated process inputs are individually configurable for either a range of -10/0/+10V or 4-20 mA.

The following information details the connections for each input and output.

Current Loop Transmitter

The current loop transmitter sends a 4-20mA output to an external receiver. The loop compliance on the transmitter is 12.5V. Loop compliance is the maximum voltage at which a transmitter can generate to achieve the maximum current and is usually a function of the power supply voltage. Therefore, the PowerFlex 7000 “B” Frame transmitter can drive a receiver with an input resistance up to 625 ohms. The figure below shows a block diagram of the transmitter.

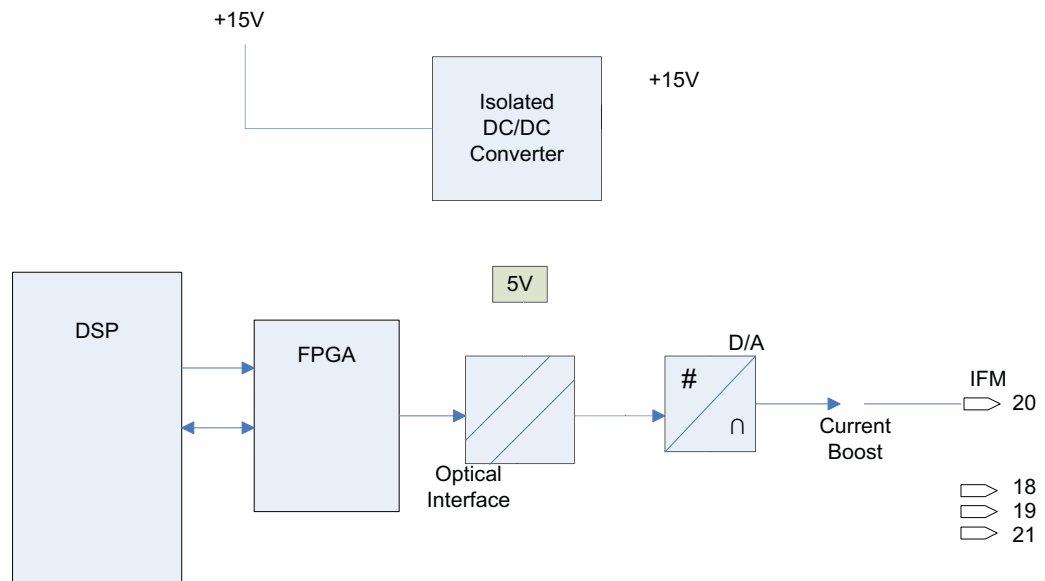


Figure 96 - Process Loop Transmitter block diagram

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 K ohms. When used as a current loop input, the transmitter must have a minimum loop compliance of 2 volts to satisfy the 100 ohm input impedance. Regardless of input configuration, each input is individually isolated to $\pm 100V$ DC or 70V RMS AC.

A block diagram of the receiver is shown below.

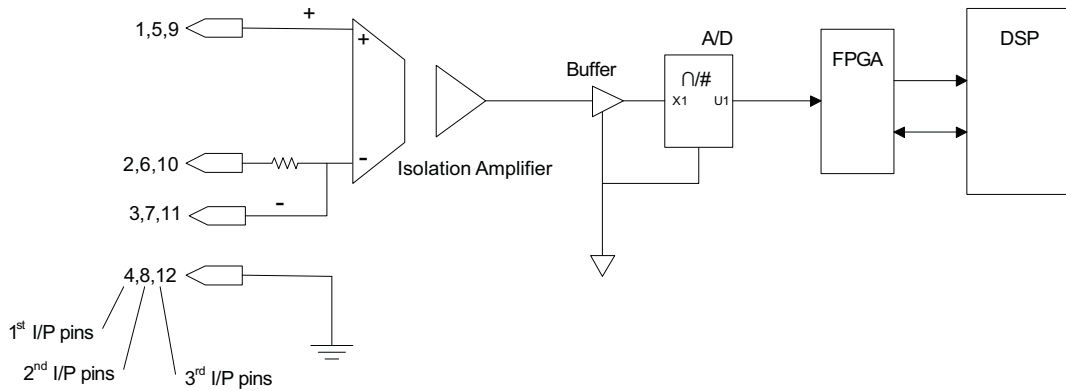


Figure 97 - Process Loop Receiver block diagram

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.

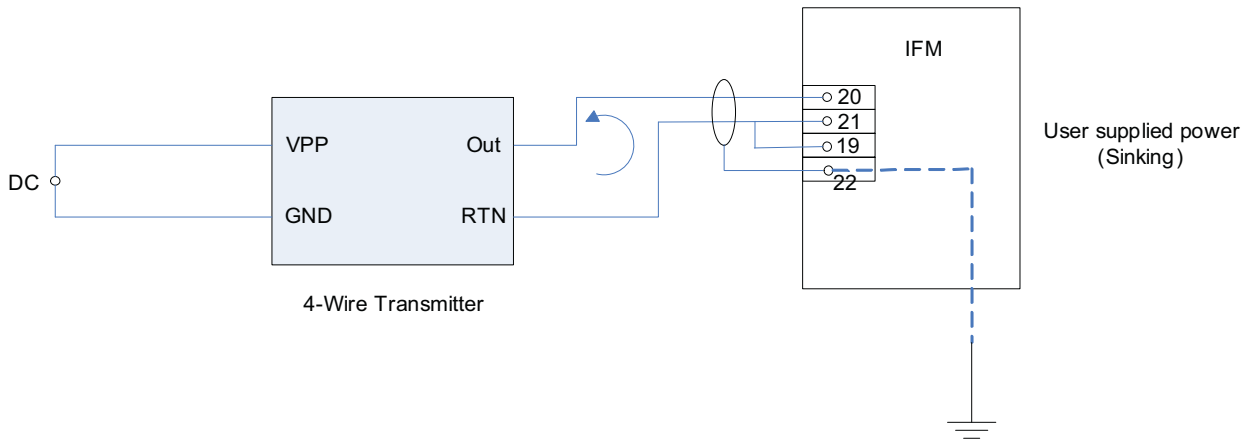


Figure 98 - Process Loop Receiver connections

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 referenced to the Drive AGND; isolate them if you require them to drive outside the frame enclosure.

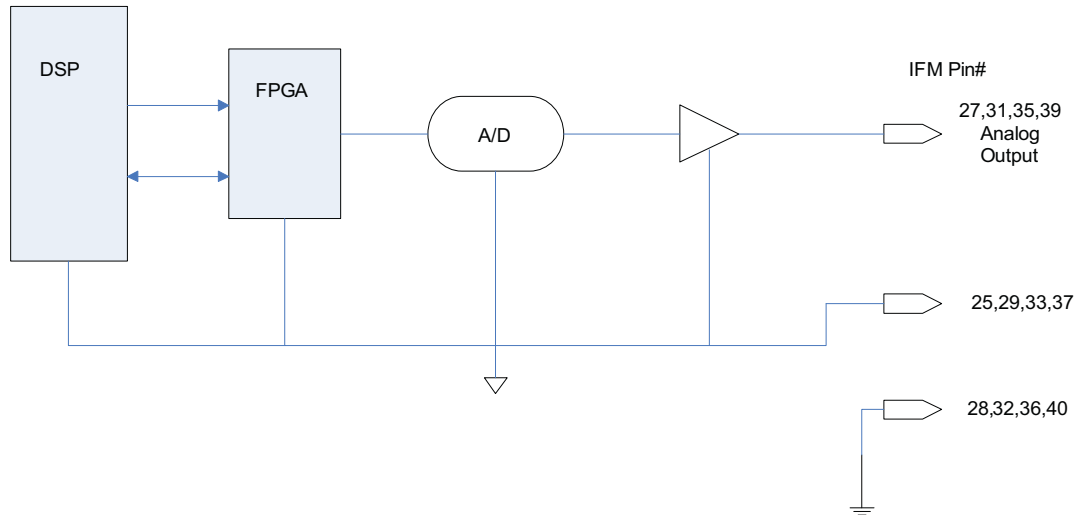


Figure 99 - Non-isolated configurable ACB analog outputs

Auxiliary +24V Power Supply

The DC/DC converter has a built-in isolated 24V power supply (Connector P3). Use this supply for any equipment requiring up to 24 watts at +24 volts. You can also use it to power any custom drive options, such as isolation modules for additional Process Control Outputs. The health of this power supply is monitored in the drive.

PIN NO.	DESCRIPTION
1	ISOLATOR (+24V, 1A)
2	ISOL_COMM (com4)
3	EARTH

Replacing the ACB Analog Control Board

To replace the ACB Analog Control Boards:

1. Isolate and lock out all power to the drive.
2. Remove the transparent sheet on top of the Drive Processor Module and the Drive Processor Module itself 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. 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. Reverse steps 8 – 2 reinstall the boards into the low voltage control cabinet.
10. Apply low voltage power and complete both system and medium voltage tests to ensure the new board functions properly.

Tachometer Feedback Board

Encoder Options

There are two positional encoder interface boards usable 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 the type of encoder board, observe the following conditions.

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 enables connecting the drive 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. You cannot configure these inputs for use with a single ended encoder. The board only supports differential encoders. The board also provides a galvanically isolated 12V/3Watt supply to power the attached encoder. You can configure the 20B-

ENC-1 Encoder interface for +5V operation, however Rockwell Automation recommends operation at 12V.

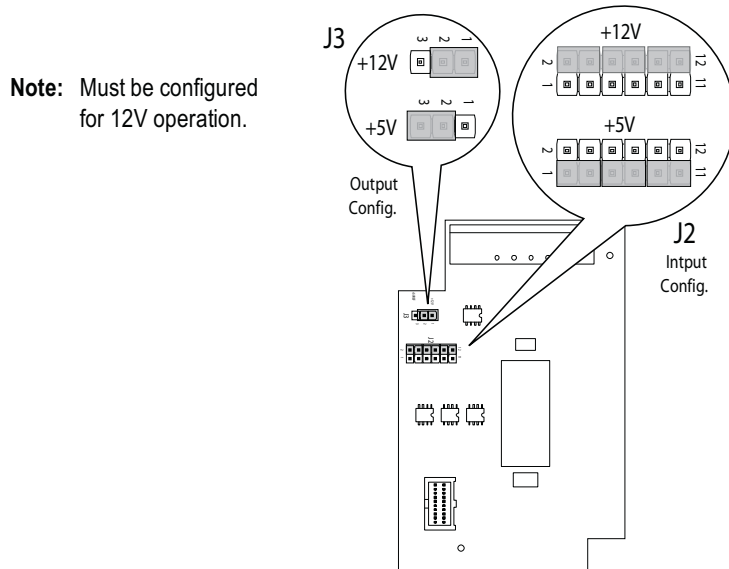


Figure 100 - Encoder Interface (20B-ENC-1 and 20B-ENC-1-MX3)

Operation at +5V does not support long cable lengths, given the need to regulate power within 5% at the encoder. Cable resistance and capacitance makes it difficult to regulate power at the encoder to 4.75V. Longer cables may decrease voltage below 4.75V, causing encoder malfunction. As a general rule, using 18Avg cabling with an Rdc of 19.3ohm/km limits the cable length to 12 m (42ft) from the board to the encoder.

The 20B-ENC-1-MX3 encoder option is functionally identical to the 20B-ENC-1 encoder with the addition of conformal coating.

Input Connections

All encoder interface connections occur at J1, as follows.

- J1 Pin 1 A+
- J1 Pin 2 A-
- J1 Pin 3 B+
- J1 Pin 4 B-
- J1 Pin 5 Z+
- J1 Pin 6 Z-
- J1 Pin 7 Encoder Power Return
- J1 Pin 8 Encoder Power (+12V @ 3 Watts)

80190-759-01, 80190-759-02 Universal Encoder Interface

The Universal Encoder Interface enables connections between the drive and to an absolute position encoder or a standard quadrature encoder, providing 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, use the 12 single ended inputs. For quadrature encoders, use the 6 differential inputs.

Either encoder with frequencies up to 200 KHz connects 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 with active control power may damage the board. Disconnect the control power before removing the board.

Table 7 - Encoder Configurations

ENC_TYPE	POL_QRDNT	CD_DQUAD	CONFIGURATION
Installed	Installed	Installed	Single Quadrature Encoder Option (Factory Default)
Installed	Installed	Removed	Dual Quadrature Encoder Option without Redundancy
Installed	Removed	Removed	Dual Quadrature Encoder Option with Redundancy
Installed	Removed	Installed	Single Quadrature Option (CDSEL/DQUAD) must be removed for Redundancy
Removed	Installed	Installed	Gray Code Absolute Encoder Low True
Removed	Installed	Removed	Natural Binary Absolute Encoder Low True
Removed	Removed	Installed	Gray Code Absolute Encoder High True
Removed	Removed	Removed	Natural Binary Absolute Encoder High True

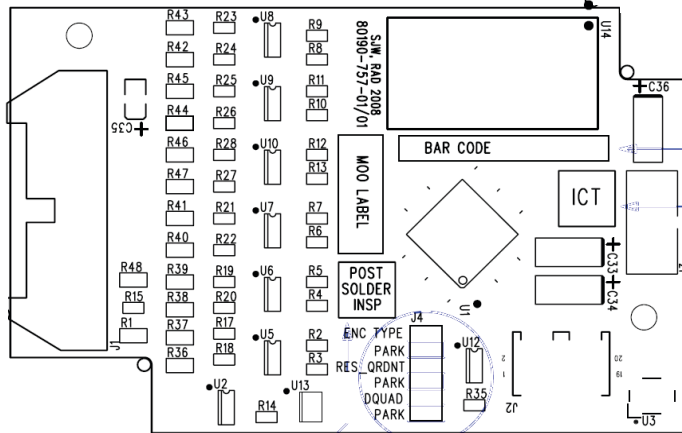


Figure 101 - Universal Encoder Board

Connections to the Universal Encoder Interface occur via a 1492-IFM20F interface module. The connections to the IFM are detailed below.

Table 8 - Encoder Functions

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

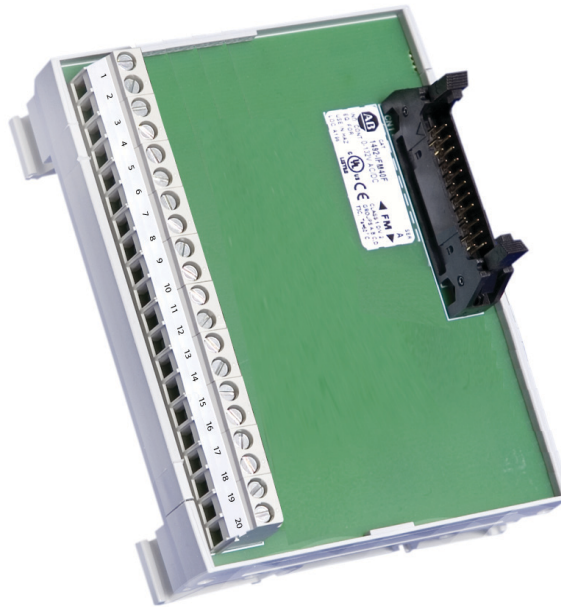


Figure 102 - 20-pin Interface Module (IFM)

Quadrature Encoder Operation

The Universal Encoder Interface accepts either single or dual quadrature encoders. Configure the board to accept the encoders through jumpers on J4.

Boards shipped from the factory come default to single quadrature encoder configuration. For dual encoder configurations, the primary encoder wires to pins 1- 7 on the 1492-IFM20 module.

To select the dual encoder option, remove the CD_QUAD jumper and place it in PARK. This configures 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 the 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.

IMPORTANT Consult the factory for availability of dual Quadrature Encoder options.

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

Positional Encoder Operations

Besides quadrature encoders, the Universal Encoder Interface also accepts positional (absolute) encoders. The Interface converts parallel positional data to a serial stream and transmits it to the DPM. The board also generates “pseudo” quadrature differential signals, including a zero position mark, derived from the binary data to the DPM.

IMPORTANT Consult the factory for availability of Positional Encoder options.

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 inverts the incoming gray code data then converts it to binary for transmission to the DPM.
2. Natural Binary, Low True. The board does not convert incoming data but does invert it.
3. Gray code, High True. The board converts incoming gray code data to binary without inverting the input data.
4. Natural Binary, High True. The board converts positional data to the serial stream without inverting or converting it.

Positional Encoder Guidelines

When selecting a positional encoder, follow these guidelines for optimal performance.

1. Code Selection: Purchase absolute encoders with either Gray code or Binary output format. Gray code is a form of binary code where only a single bit changes at a time for each sequential number or position. The fact that only a single bit changes at a time make it easier for the Universal Encoder Interface to read valid positional data and not ambiguous data. If we compare the Natural Binary code to Gray code for the transition from 255 to 256, we see:

	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 the frequency filter components and input hysteresis create delays. Differences in these delays could cause errors due to reading a bit as ON when switching 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 decreasing 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 connect through a network cable (CAN Link) to the Analog Control Board (ACB). You can connect this cable 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, 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 a software option to assign each XIO a specific function (General IO, External IO or Liquid Cooling).

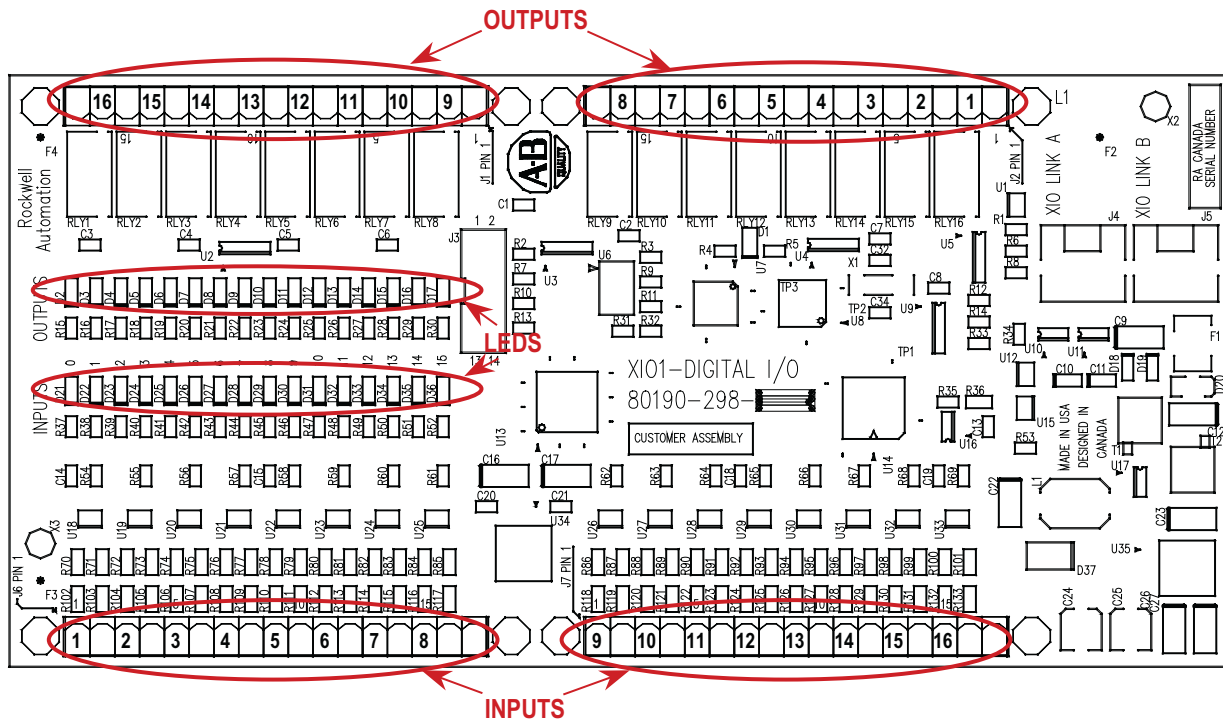


Figure 103 - XIO Board

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 you use Link A for “upstream” (closest to the ACB), and Link B for “downstream” (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 at Power on, during firmware download and with unprogrammed drive)

Table 9 - 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

Replacing the External Input/Output Board

1. Disconnect and lock out all medium voltage and control voltage power to the drive.
2. Mark the location and orientation of all the plugs, cables, and connectors into the XIO board. Use the electrical drawing as a reference.
3. Ground your static strap, and disconnect all of the power 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 secures the board. The assembly does not come with the new board, so you must remove the old board from the assembly and install the new board 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 both system and medium voltage tests to ensure the new board functions properly.

Optical Interface Boards (OIB)

The Optical Interface Boards are the interface between the DPM and the Gate Driver circuitry. The drive control decides which device to fire, and signals the OIB boards. The OIB board converts that electrical signal to an optical signal that it transmits 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.

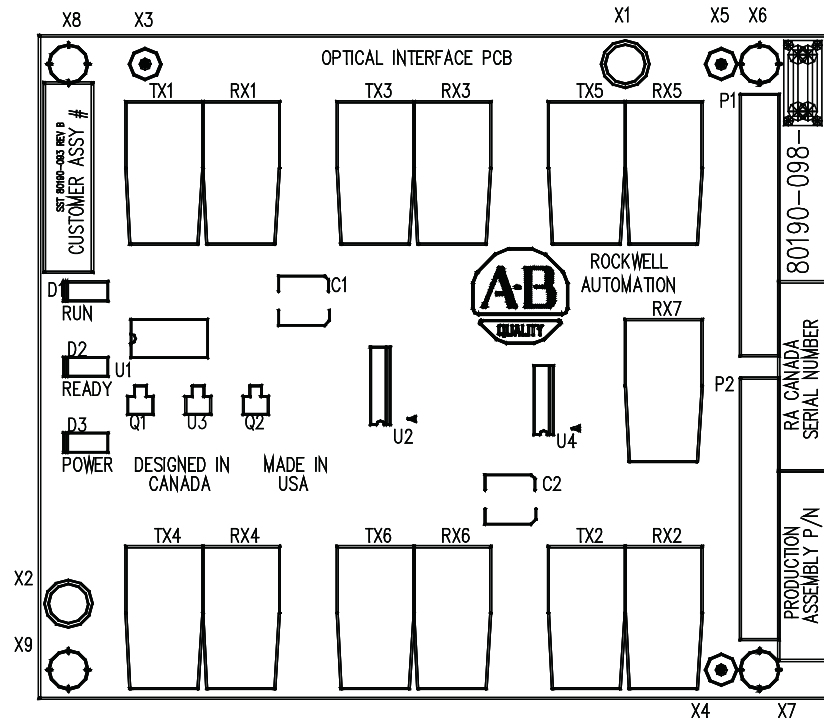


Figure 104 - Optical Interface Board

The OIB boards mount directly onto 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. The OIBBs interface to the DPM using two ribbon cables to connect to J11 and J12.

Each OIB board can handle the firing and diagnostic duplex fiber optic connector for 6 devices, whether they are SCRs or SGCTs. Physically, on the OIBBs, there is provision for 18 devices for the inverter and the rectifier. The top OIB board on the OIBB is for the 'A' devices, the middle OIB board on the OIBB is for the 'B' devices, and the bottom OIB board on the OIBB is for the 'C' devices. Test points for the OIB gating diagnostic and temperature feedback signals are on the OIBB.

Each OIB board also has input RX7 for a signal from a Temperature Feedback Board. The quantity and location of thermistor connections is dependant on the drive configuration. Typically there is one temperature sensor from the Line Converter and one temperature sensor from the Machine Converter, each going into the respective OIB board in the 'A' position. However some drive configurations only require one thermistor feedback connection. The temperature feedback connection on OIBC is not implemented on the OIBB and is never used. For more information, see the drawings supplied with your drive. The alarm and trip setpoints for each of these signals are programmable in software.

There are 3 LEDs on the OIB board, and the following table illustrates the status and description for the LED states.

LED	Status	Description
D1	Red – On	Run – The OIB has received an Enable signal. 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.

Replacing the Optical Interface Board

1. Isolate and lock out all power to the drive.
2. Mark the location and orientation of all the fiber optic cables. Use the electrical drawing for reference.
3. Ground your static strap, and disconnect all of the connections. You may need 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 gating, system, and medium voltage tests to confirm board performance.

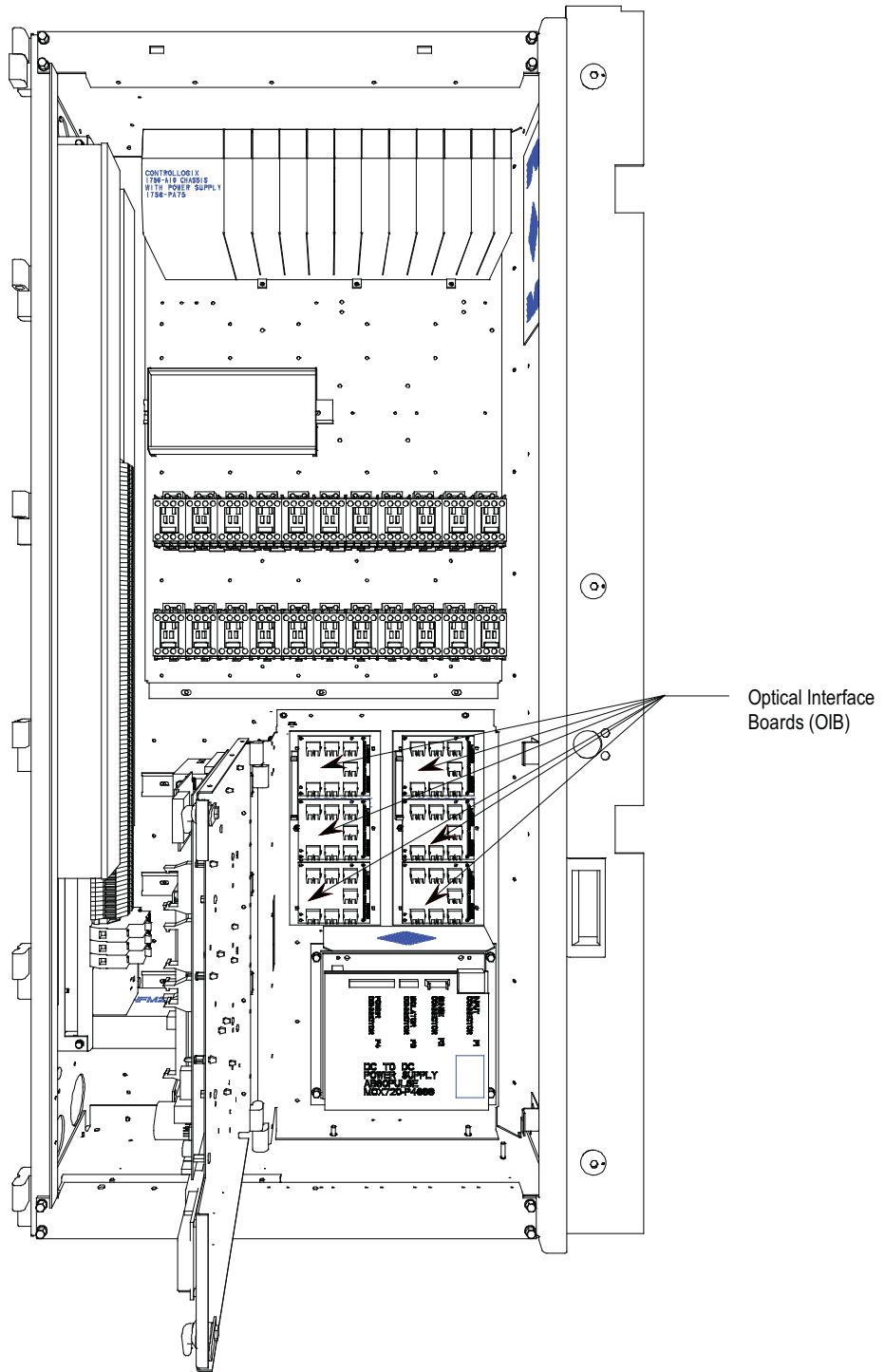


Figure 105 - OIB replacement (mounting plate accessible)

This board provides the mechanical and electrical interconnections between the OIBs and the DPM. It connects to either J11 or J12 on the DPM via a 60 conductor shielded ribbon cable. Attach the cable's drain wire to the screw terminal J8. The remaining connectors on the board complete the electrical

connection of the installed OIBs to the DPM. Each OIB can support from one to three OIBs.

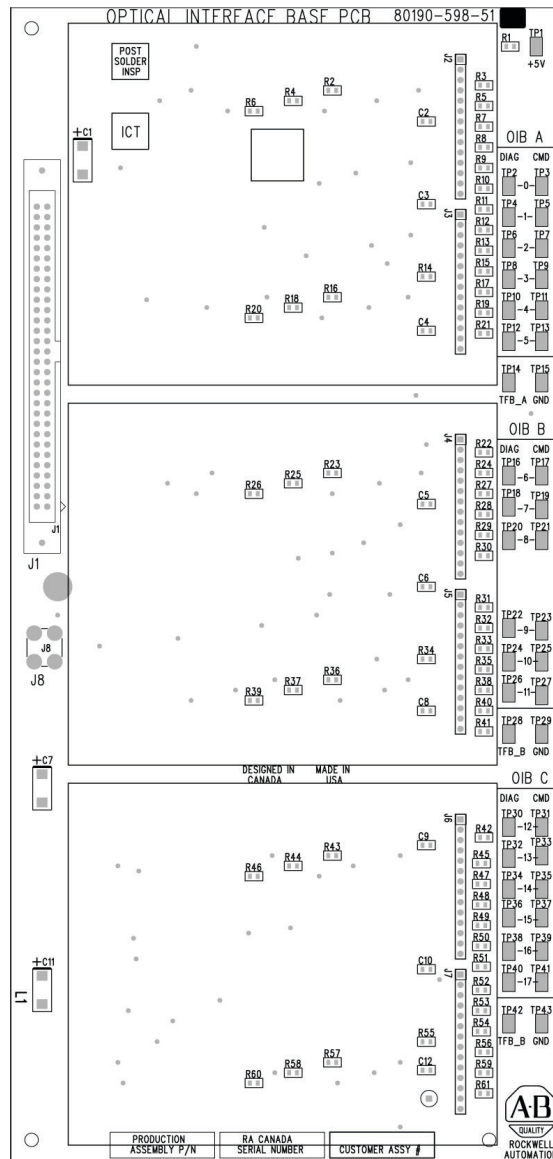


Figure 106 - Optical interface base board (OIBB)

Optical Interface Base Board Test Points

In addition to the command and diagnostic test points, there are three ground reference test points. These reference points are electrically identical, but their locations facilitate oscilloscope or chart recorder test leads connections.

Table 10 - Test Points on Optical Interface Base Board (OIBB)

Test Point	Signal Name	Description
TP1	+5V	Positive 5V Power Supply
TP2	DIAG_0	OIB A, RX1 Diagnostic Feedback
TP3	CMD_0	OIB A, TX1 Firing Command Signal
TP4	DIAG_1	OIB A, RX2 Diagnostic Feedback
TP5	CMD_1	OIB A, TX2 Firing Command Signal
TP6	DIAG_2	OIB A, RX3 Diagnostic Feedback
TP7	CMD_2	OIB A, TX3 Firing Command Signal
TP8	DIAG_3	OIB A, RX4 Diagnostic Feedback
TP9	CMD_3	OIB A, TX4 Firing Command Signal
TP10	DIAG_4	OIB A, RX5 Diagnostic Feedback
TP11	CMD_4	OIB A, TX5 Firing Command Signal
TP12	DIAG_5	OIB A, RX6 Diagnostic Feedback
TP13	CMD_5	OIB A, TX6 Firing Command Signal
TP14	TFB_A	OIB A Temperature Feedback Signal
TP15	GND	Ground Reference for TP1 – TP14
TP16	DIAG_6	OIB B, RX1 Diagnostic Feedback
TP17	CMD_6	OIB B, TX1 Firing Command Signal
TP18	DIAG_7	OIB B, RX2 Diagnostic Feedback
TP19	CMD_7	OIB B, TX2 Firing Command Signal
TP20	DIAG_8	OIB B, RX3 Diagnostic Feedback
TP21	CMD_8	OIB B, TX3 Firing Command Signal
TP22	DIAG_9	OIB B, RX4 Diagnostic Feedback
TP23	CMD_9	OIB B, TX4 Firing Command Signal
TP24	DIAG_10	OIB B, RX5 Diagnostic Feedback
TP25	CMD_10	OIB B, TX5 Firing Command Signal
TP26	DIAG_11	OIB B, RX6 Diagnostic Feedback
TP27	CMD_11	OIB B, TX6 Firing Command Signal
TP28	TFB_B	OIB B Temperature Feedback Signal
TP29	GND	Ground Reference for TP16 – TP28
TP30	DIAG_12	OIB C, RX1 Diagnostic Feedback
TP31	CMD_12	OIB C, TX1 Firing Command Signal
TP32	DIAG_13	OIB C, RX2 Diagnostic Feedback
TP33	CMD_13	OIB C, TX2 Firing Command Signal
TP34	DIAG_14	OIB C, RX3 Diagnostic Feedback
TP35	CMD_14	OIB C, TX3 Firing Command Signal
TP36	DIAG_15	OIB C, RX4 Diagnostic Feedback
TP37	CMD_15	OIB C, TX4 Firing Command Signal
TP38	DIAG_16	OIB C, RX5 Diagnostic Feedback
TP39	CMD_16	OIB C, TX5 Firing Command Signal

Test Point	Signal Name	Description
TP40	DIAG_17	OIB C, RX6 Diagnostic Feedback
TP41	CMD_17	OIB C, TX6 Firing Command Signal
TP42	TFB_C	OIB C Temperature Feedback Signal – There is no provision in the drive for the use of this signal, it is only provided for Rockwell internal testing.
TP43	GND	Ground Reference for TP30 – TP42

Downloading Drive Processor Firmware

All PowerFlex 7000 Medium Voltage 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 section describes how to download new or updated firmware to the drive using the DPM data port. The drive stores downloaded firmware 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 you power up the system, the drive executes the Application Code contained in the on-board flash memory. If it does not have valid firmware, then the entire system shifts into a download mode to await a firmware download via the serial data port J4 on the DPM.

You can also force the download mode from the drive terminal if you have 'ADVANCED' access privileges for the drive. If you have the relevant secure PIN for that access, select UTILITY-TRANSFER-SYSTEM on the terminal to put the drive into download mode.

Ensure you save the current drive parameters to NVRAM, to the Operator Interface Terminal, and to any other external source such as the Flash Card, DriveTools, or printed to a hardcopy.

Press [F10] (Access), and select Advanced. Press [Enter], or enter the password (if prompted) for Advanced access.

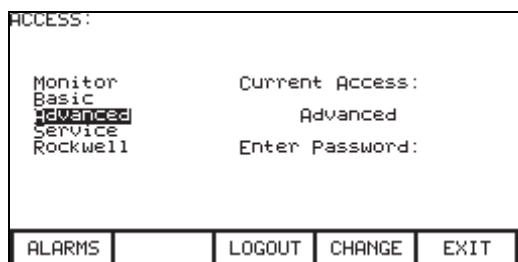


Figure 107 - Operator Interface terminal access

Press [F10] to Exit, then [F5] for NVRAM. Press [F5] again to SAVE, and [F8] for YES. The drive should save the parameters to NVRAM. Press [F10] again to EXIT.

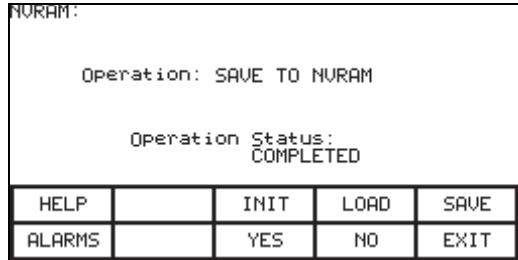


Figure 108 - Operator interface — save to NVRAM

To save to the Operator Interface Terminal and Flash Card, Press [F2] (UTILITY), [F7] (TRANSFER), and [F4] (PARAMETERS). You should now see the following screen:

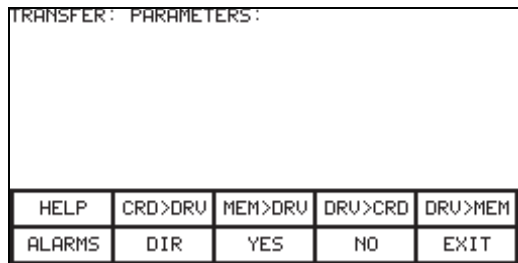


Figure 109 - Operator interface — transfer parameters

To save parameters to the Operator Interface Terminal, press [F5] (DRV>MEM). To save to the Flash Card, insert the card in the terminal. Remove the back cover and insert the card in the slot on the terminal. Then press [F4] (DRV>CRD).

When saving to the card, choose a file name. Use the ▲ or ▼ keys to select the character, and then use ► to move to the next character. Press [Enter] when finished.

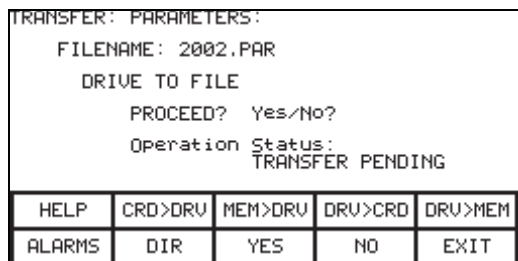


Figure 110 - Operator interface — Operation status

Press [F8] for YES when prompted, and the interface will copy the parameters to the card. Press [F10] to EXIT.

This chart illustrates a typical pin-out of a complete null-modem cable.

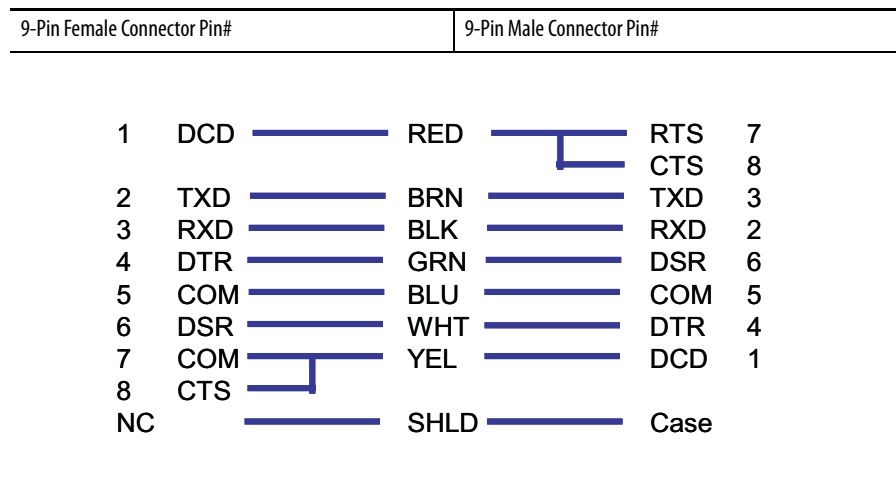


Figure 111 - Null-modem cable pin-outs

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. Stop the drive, and press E-Stop. This is just a precaution, as all versions of firmware 7.xxx and later will prevent a download while running.

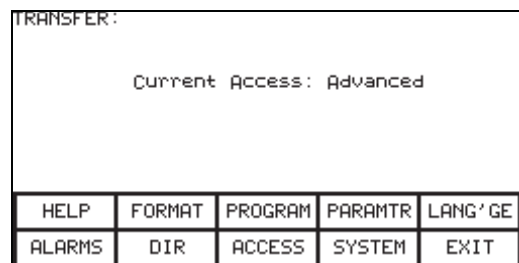


Figure 112 - Advanced features access level confirmation

Press [F9] for SYSTEM, and a screen will appear telling you that you are in download mode.

There is also a status LED labeled D1 on the DPM, which provides indication of the programming process. The following illustrates the states of the LED:

- Solid Green – the Application firmware is running. The system is not in Download mode.
- Green .25Hz – the board is in download mode.
- Green .5Hz – the board is in download mode and is currently being flashed with new firmware.

After putting the drive in download mode, the terminal displays a message:
“SYSTEM IS IN DOWNLOAD MODE

Connect your PC to DPM data port
And download new firmware.
Press any Key to Continue ...”

If you press any key after this message the PanelView™ terminal displays a
“COMMUNICATION ERROR” message.

Connect your PC to the DPM data port J4. Locate the PowerFlex 7000 Medium Voltage Forge Drive firmware an executable file. Double click on the file to download the firmware. The executable program will open the following screen.

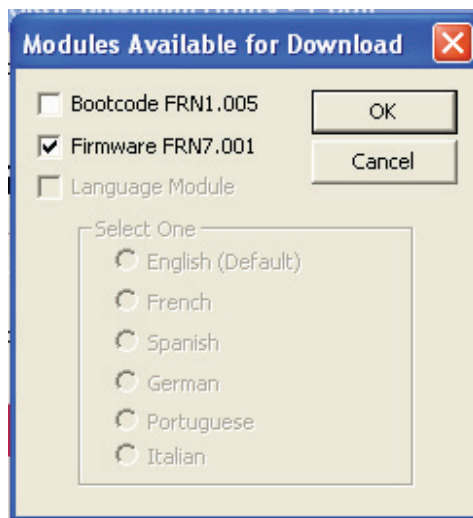


Figure 113 - Selecting modules for download

The DPM are preloaded with the necessary bootcode. Select the Firmware checkbox and click OK to starts the firmware download. The following screen appears.

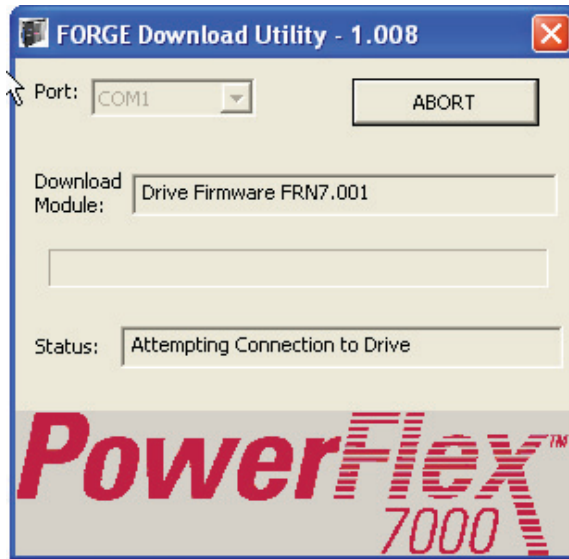


Figure 114 - Commencing the download

The interface screen tracks the download progress.

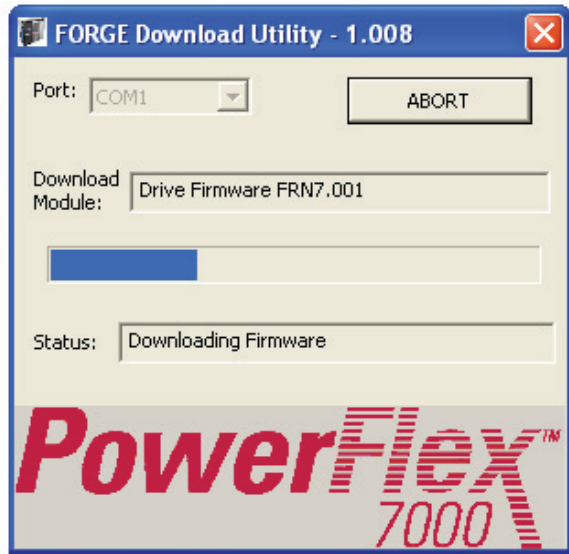


Figure 115 - Download progress bar

When the download finishes, the window displays the following message.

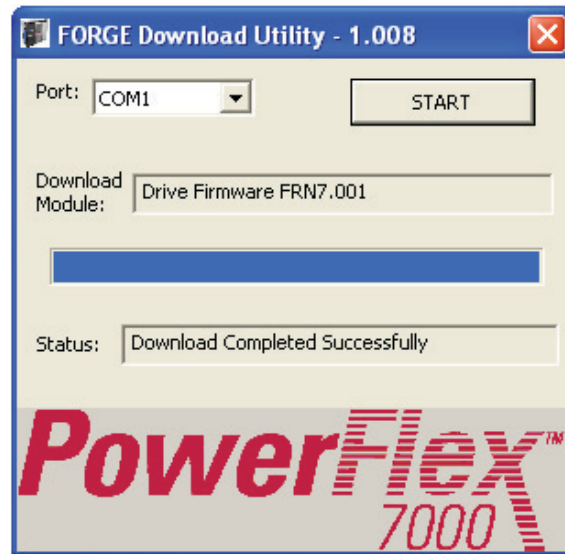


Figure 116 - Download status complete

If the DPM does not have the bootcode or needs an upgrade, select the Bootcode (see [Figure 113 on page 141](#)) and click OK. After downloading the bootcode proceed with the drive firmware download.

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.

IMPORTANT Refer to the release notes before upgrading firmware.

To reload the parameters from the Operator Interface, enter the appropriate secure PIN to access the ADVANCED features.

Follow the same steps to get to the UTILITIES – TRANSFER – PARAMETERS screen (refer to [Downloading Drive Processor Firmware on page 138](#)). Choose F3 (MEM>DRV). When the interface prompts for confirmation, press [F8] for YES.

The system transfers parameters. There are differences between parameters for different revision levels, so you may receive error messages, and a Transfer Incomplete message.

You can also transfer from a memory card to the drive by pressing [F2] (CRD>DRV). The interface prompts you to choose from the available parameter listings on the card. Select the desired option using the arrow keys,

and press [Enter]. Press [F8] to accept the selection and begin the transfer. When finished, press [F10] (EXIT) to return to the main screen.

Review the loaded parameters and ensure the correct settings for the drive. You may need to change parameters for the specific drive application, as determined by reviewing the release notes beforehand. Also correct any information such as the drive name, the operating hours, or the external fault text, if necessary.

Press [F5] (NVRAM), and save the edited parameters to NVRAM.

Cycle the control power again to ensure the drive comes up with no faults or warnings, and the drive is ready for operation. At this point you should consider saving 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

The drive firmware download process resets the operating hours displayed on the terminal to zero. Restore the actual operating hours using a utility program (Sethobb.exe) supplied with the firmware package. To set the elapsed time, follow the steps described below.

- Turn off control power to the drive control boards and the terminal.
- Remove the terminal 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 [Enter].
- 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 [Enter]. The application box closes automatically.
- Disconnect your laptop and reconnect the terminal to ACB (Port-J12). Restore the terminal power.
- After powering on the terminal, confirm the hours display on the main screen.

Downloading the Terminal Firmware

The Operator Terminal provides an interface with the PowerFlex7000 drive. To communicate with the drive, the terminal requires valid firmware, or it cannot connect to the Analog Control Board (ACB).

This section describes the two methods of downloading firmware into the terminal.

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 detects new firmware and download it from the card. You will see a series of codes on the screen (2 – 20 – 21 ...), then the drive application firmware will start. The process may take several minutes. When the download finishes, remove the card from the terminal. (If you leave the card in the terminal, it will reload the firmware each time someone powers up the terminal).

DOSFWDL

The DOSFWDL program copies the .FMW file via a laptop serial port to the terminal serial port. The program is usually included in the firmware package. This example uses a firmware file called “FRN_4006.FMW”.

IMPORTANT If using newer firmware, ensure the filename is max. 8 characters long. You can rename the file, but keep the filename extension as.FMW. Also, when prompted for the filename, ensure you enter the correct filename as illustrated in the following example.

1. Turn off the terminal power. Disconnect the terminal’s serial cable 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 the dosfwdl.exe program. On your laptop, you should see the screen similar to one shown below.

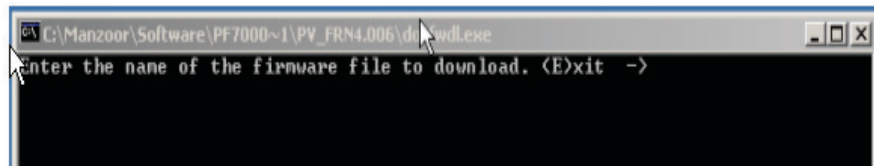


Figure 117 - Select firmware filename

3. Enter the firmware filename (e.g., FRN_4006.FMW) as shown in the screen below and press [Enter].

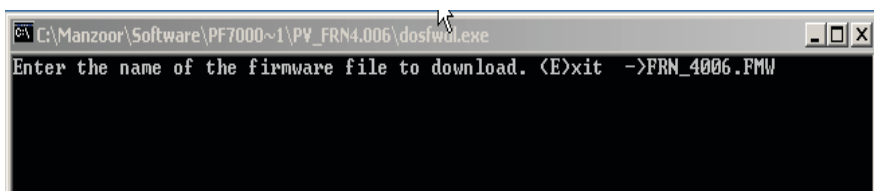


Figure 118 - Firmware filename entered

- When prompted, enter the laptop's port address.



Figure 119 - Prompt for port

- Wait for the prompt shown below before restoring power to the terminal.

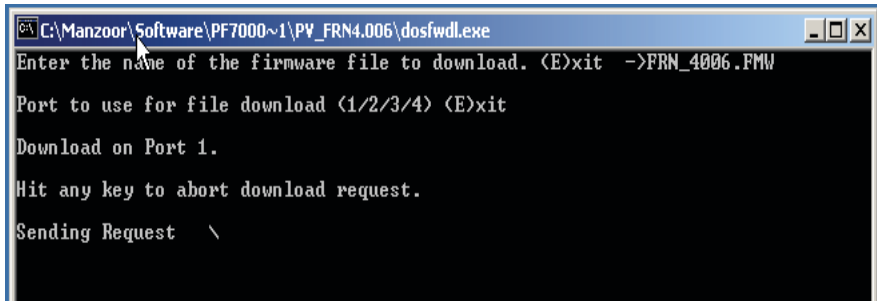


Figure 120 - Preparing to download

- When you restore terminal power, the firmware download begins automatically. The following message appears on your laptop screen.



Figure 121 - File verification

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

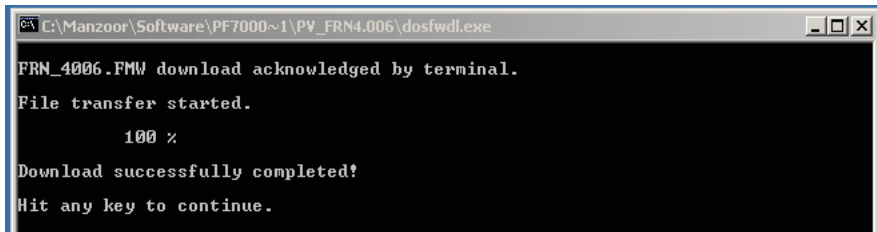


Figure 122 - File transfer status

- Once the firmware download is complete, the message “Download successfully completed!” appears. Press any key to close the DOSFWDL program.

9. Remove the serial cable from your laptop and connect it to ACB board port J12. The terminal will begin communication with the drive.

Configuring 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 you can assign for trending is 16. The length of the trend buffer is 100 samples.

Diagnostic Configuration

The diagnostic setup defines the source of the diagnostic trigger. This section describes the information you must configure before using the diagnostic tool.

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 trigger point. Any value between 0 and 100% may be used.
Trigger	<p>Defines whether you want a continuous or a single-shot trigger. Pressing this key will place an S or a C in front of the trigger parameter. You will almost always want a Single-Shot (S) trigger.</p> <p>S = Single shot >> the trigger occurs only once and stops. The trigger must be manually re-armed. The Re-Arm function clears the memory buffer, which contains the data stored from the previous trend. It is necessary to reset the trending feature in order for a second trigger to occur, unless you have continuous trigger enabled.</p> <p>C = Continuous capture >> auto re-arm is enabled to collect new trends until stopped by viewing contents of captured data.</p>
Cond	<p>Defines the condition that will cause the trigger. The possible options are:</p> <p>= Equal to N= Not Equal to > Greater than < Less than</p> <p>+ Boolean OR N+ Boolean NOR & Boolean AND N& Boolean NAND</p>
Data	Defines the trigger value with respect to the read-only parameter in Trace 1.

Defining the Trend

You must have Basic or higher access permissions to program the drive's trending feature. To change Access level to Basic, press [F10] on the interface's main screen to select the 'Access' function. Press ▼ to scroll to the Basic option, and press [Enter] to change the access level to Basic. Press [F10] to exit to the main screen.

The interface uses the parameter assigned to Trace1 for trigger purpose. The Condition and Data defined in steps 11 and 12 must be satisfied for the trend to trigger. In most cases you will assign the parameter 569 "DrvStatus Flag1" to Trace1 for trigger purpose. Use the value 18 Hex for Data (Step-12 below) 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.

Reset the Alarm or Fault in the drive, but do not re-arm the trend until you print (upload) the trend data into your laptop. Print the alarm queue as well to help identify the alarm or fault condition detected by the drive.

1. Press [F9] on the main screen to access the 'Diagnostics' function, as illustrated below.



Figure 123 - Select Diagnostics function

- Press [F8] to open the 'Diagnostics Setup' screen as shown in the picture below.

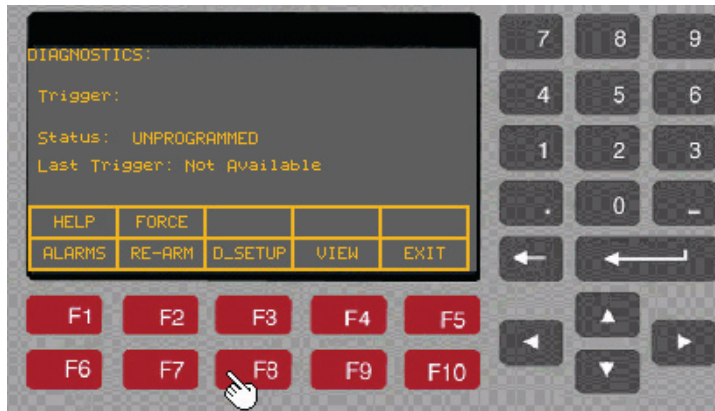


Figure 124 - Selecting 'Diagnostics Setup'

- Select Trace-1, and press [Enter].

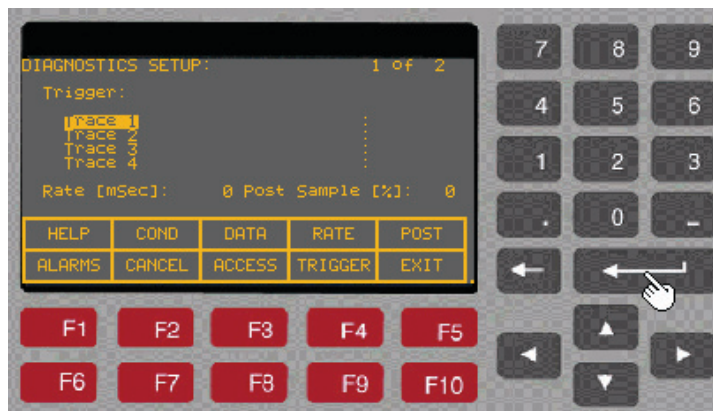


Figure 125 - Configure Trace 1

4. This opens the 'Select Group' screen as shown below. There are three ways to find the desired a parameter: (a) search by group using ▲ or ▼ to scroll and [Enter] to select; (b) press [F7] to search by alphabetical order, selecting the first letter of the parameter name and pressing [Enter], (c) press [F7], then [F5] to search by parameter linear number (code). The following example illustrates selecting the parameter using a Linear number (i.e., entering the code).



Figure 126 - Diagnostics — Select Group

5. Press [F7] to open the 'Select Letter' screen as shown below.

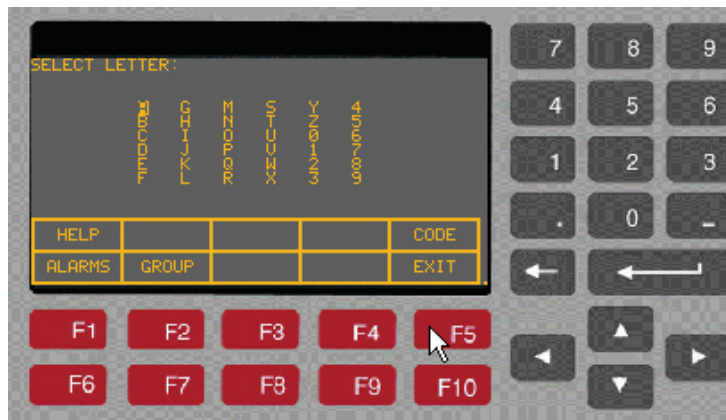


Figure 127 - Diagnostics — Select Letter

6. Press [F5] to open the 'Select Code' screen as shown below.



Figure 128 - Diagnostics — Select code

7. Enter the parameter linear number (569 in the examples shown) then press [Enter]. The parameter description appears on the screen as shown in the picture below.



Figure 129 - Diagnostics — View selected code

8. Press [Enter] to open the 'Diagnostics Setup' screen and assign the selected parameter to Trace 1. Press ▼ to scroll to Trace 2 and repeat steps 3 – 8 above to assign a parameter to Trace 2.



Figure 130 - Diagnostics — Select Trace 2

9. Repeat above steps until you have assigned the desired parameters to all the traces from Trace1 to Trace16.
10. Press [F9] to view the Trigger screen. The first letter in the second line on the screen toggles between C (Continuous) and S (Single shot). Select S for Single shot.
11. Press [F2] to view the Condition screen. The cursor automatically selects the “=” (equal sign). This defines the trigger condition. Press ▲ or ▼ to select “+” (plus sign) as the trigger condition for this example.

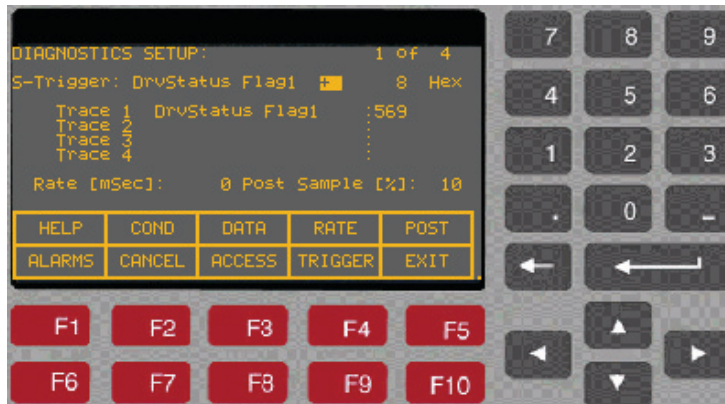


Figure 131 - Diagnostics — Select trigger condition

12. Press [F3]. The cursor highlights the data field. For this example, enter 8 then press [Enter].



Figure 132 - Diagnostics — Select trigger data

13. Press [F4] to highlight the Rate field. Enter 0, which is the fastest sample rate (1 msec/sample), then press [Enter].



Figure 133 - Diagnostics — Select trigger rate

14. Press [F5] to highlight the Post Sample field. Enter 10 to specify the percentage of post-trigger samples, then press [Enter].

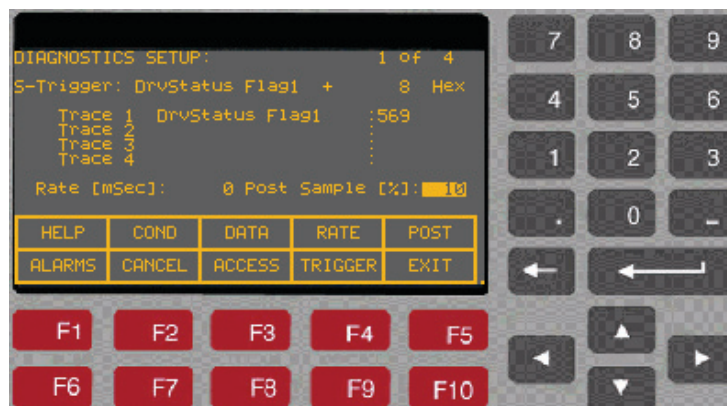


Figure 134 - Diagnostics — Select post-trigger samples

15. Press [F10] to return to the 'Diagnostic' screen. Verify that the status is 'Running', meaning the Diagnostic Trend is ready to capture the data whenever the trigger condition is satisfied. If the Status shows 'Stopped', press [F7] to re-arm the tool and change the status to 'Running'.



Figure 135 - Diagnostics — verify status

16. Press [F10] to exit to the main screen.

Printing (Uploading) Data from the Drive

You can upload and save drive data such as drive setup, parameters, variables, trend data, fault masks, alarm queues etc., onto a laptop using the HyperTerminal program. When using HyperTerminal to upload the data, the program prompts you to select a file for data storage. Open a new Notepad (text) file and save that file on the laptop before uploading 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 to a 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.)

1. To create an empty Notepad (.txt) file, run the Notepad program (Start >Program > Accessories > Notepad). A blank Notepad window will appear as shown below.

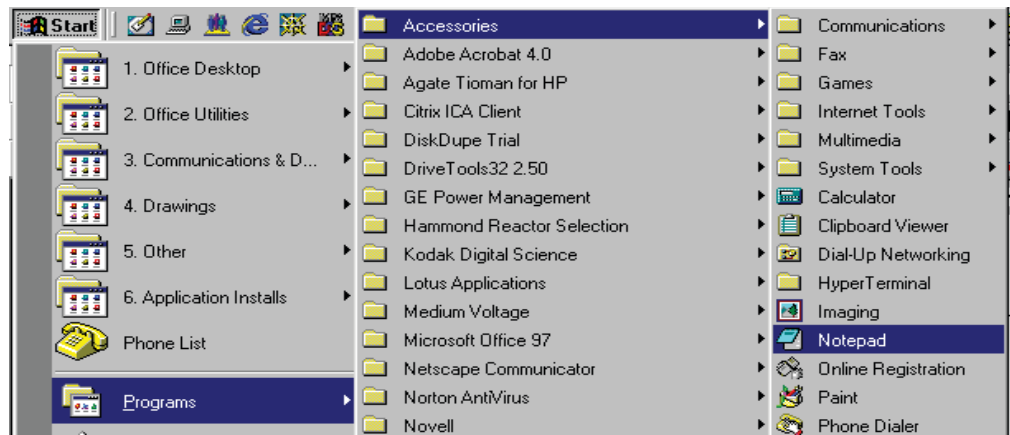


Figure 136 - Opening Notepad

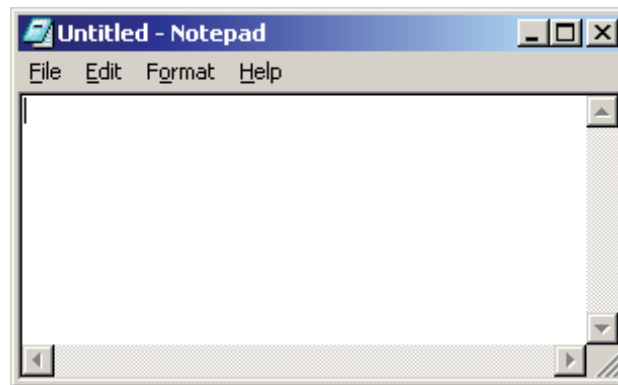


Figure 137 - Blank Notepad file

2. From the File menu, select Save As.

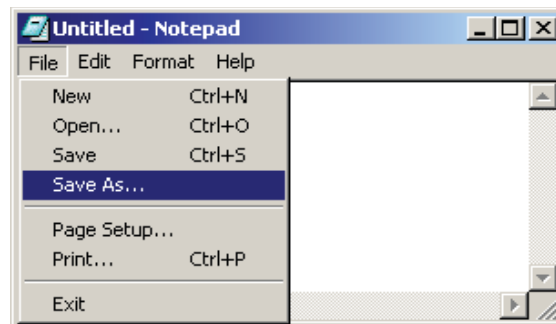


Figure 138 - Saving a blank file

3. In the Save As window, enter a filename (for instance, example.txt) and select the directory from the drop list. In this example the selected directory is C:\temp. Click Save.

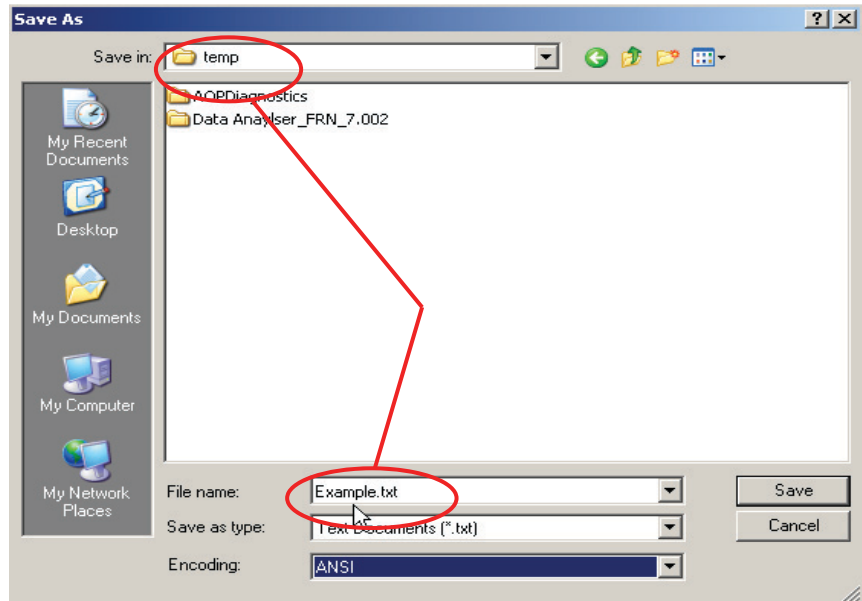


Figure 139 - Selecting filename and directory

4. Once you create the empty file, close the Notepad program.
5. Run the HyperTerminal program.
6. On the 'Connection Description' window, enter a name (for instance, Parameters) for the new connection as shown below, then click OK.

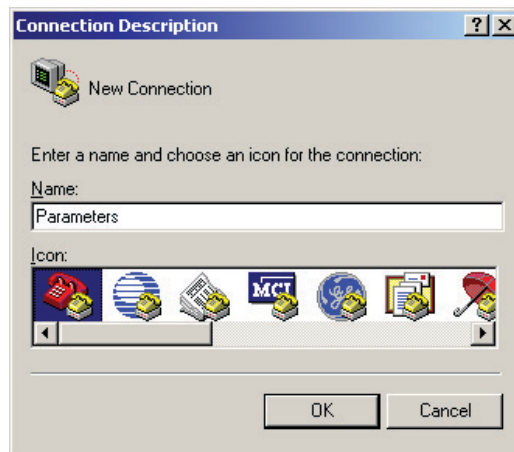


Figure 140 - HyperTerminal Connection Description window

7. In the 'Connect to' window, select COM1 from the drop list next to 'Connect Using,' then click OK.



Figure 141 - HyperTerminal connections, cont'd.

8. In the 'COM1 Properties' window, specify the port settings as shown below, then click OK.

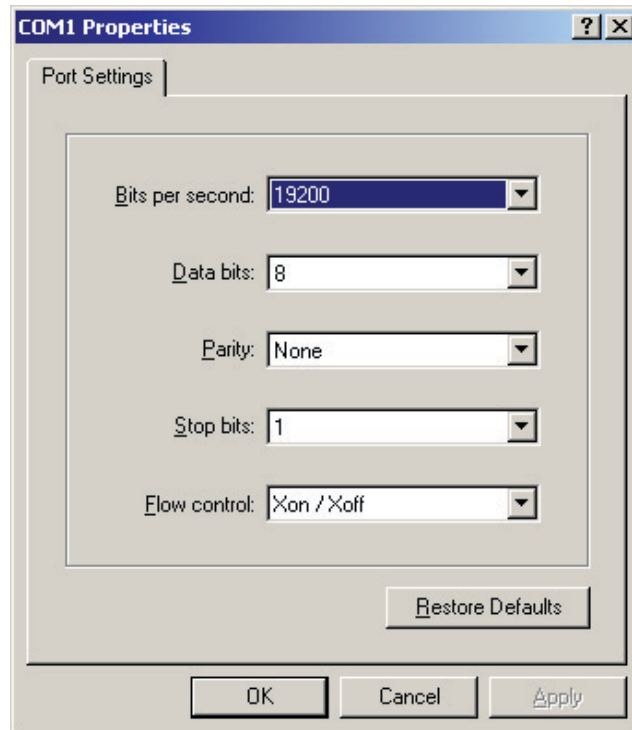


Figure 142 - HyperTerminal COM1 properties

Click OK to close the HyperTerminal program. Following message appears.

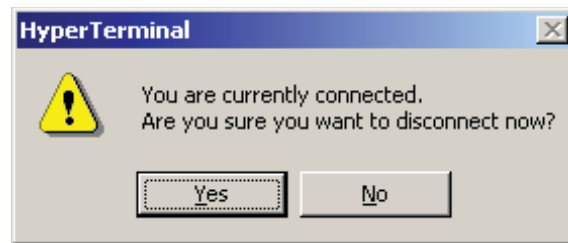


Figure 143 - Hyper Terminal disconnection prompt

9. Click Yes, and at the prompt, click Yes again to save the session and close the program.

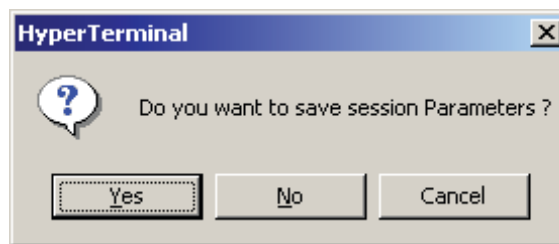


Figure 144 - HyperTerminal — save session data

10. To upload 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).
11. Restart the HyperTerminal program. On the 'Connection Description' window click Cancel.

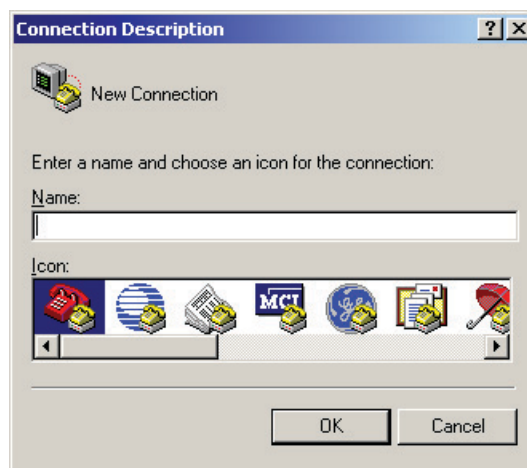


Figure 145 - Reopening HyperTerminal

12. From the File menu, click Open. In the Open dialog box, locate the HyperTerminal connection you just created (e.g. Parameters), then click Open.

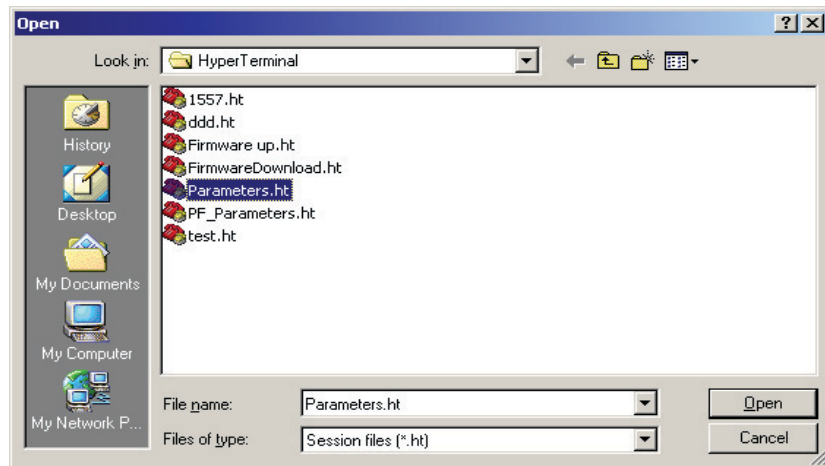


Figure 146 - HyperTerminal — open the created connection

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

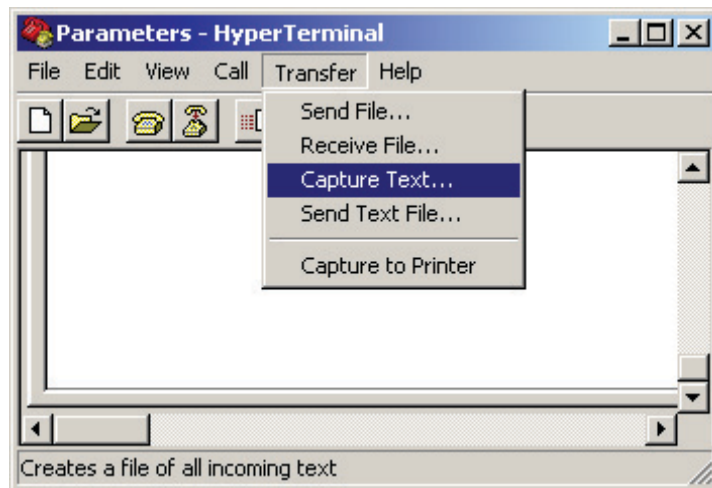


Figure 147 - HyperTerminal — Capture text

14. In the Capture Text dialog, click Browse and search the file Example.txt that you created in previous steps.

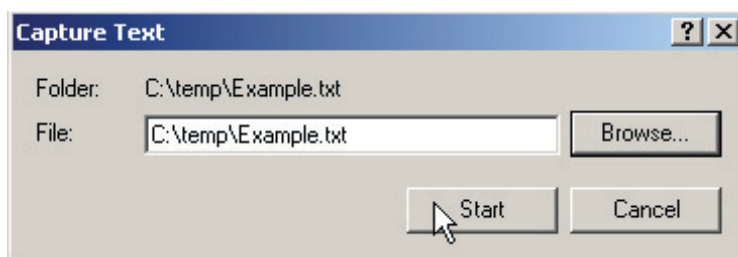


Figure 148 - HyperTerminal - specify text filename

15. Click Start. HyperTerminal now acts as a dummy printer and waits for the information to be transmitted from the drive to the laptop.

- On the drive terminal, press [F3] (PRINT) at the main screen as shown below.

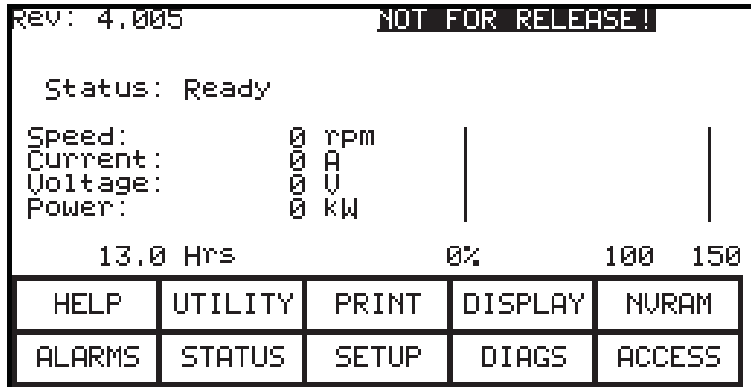


Figure 149 - Printing to HyperTerminal from the drive interface

- The terminal displays the Printer options, as shown below. Use ▲ or ▼ to scroll to the item you want to print (i.e., upload the info into laptop) and press Enter. The drive will print the selected information to your laptop through the specified file (in this example, C:\temp\Example.txt). Repeat this step to upload any other data into your laptop.

The most common downloadable selections are:

- Drive Setup: for complete setup including parameters, fault masks and revisions
 - Trend Data: for analyzing the drive trending
 - Variables: snapshot of real-time operational data
- Stop the communication between your laptop and the drive and close the file Example.txt. On the laptop, click on Transfer menu and select Stop option under Capture Text ... as shown in the screenshot below.

IMPORTANT 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.

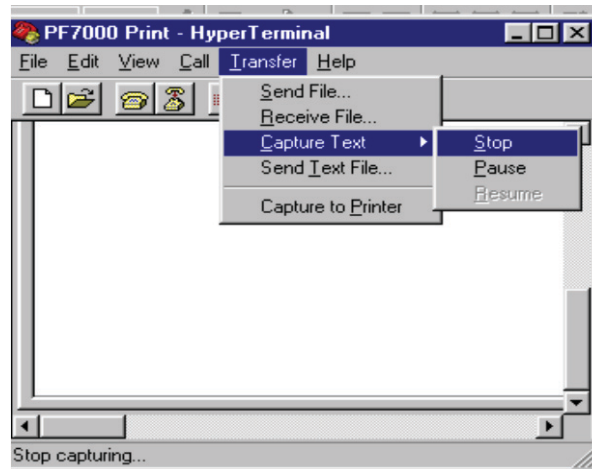


Figure 150 - HyperTerminal —stop transfer

19. Close the HyperTerminal program and disconnect the laptop from the drive.

Printing (Uploading) Control Data

PF7000 drives with ForGe control have a specifically-allocated memory location to capture and store critical data in the event of a fault condition. This data is referred to as “Control Data”. There are 8 buffers that store data sequentially on a first-in first-out basis, ensuring the data of the eight most-recent faults is always available for analysis.

This section describes the process for retrieving control data.

For required components and cable diagrams, refer to [Printing \(Uploading\) Data from the Drive on page 154](#).

1. Connect your laptop to the drive using a 9-pin null-modem cable to DPM data port (J4).

2. Run the HyperTerminal program. At the 'Connection Description' window, enter any name for new connection under the Name field as shown below and then click OK.



Figure 151 - HyperTerminal — Naming control data connection

3. In the 'Connect to' window, select COM1 from the drop list and click OK.
4. In the 'COM1 Properties' window, configure the port settings as shown below and click OK.

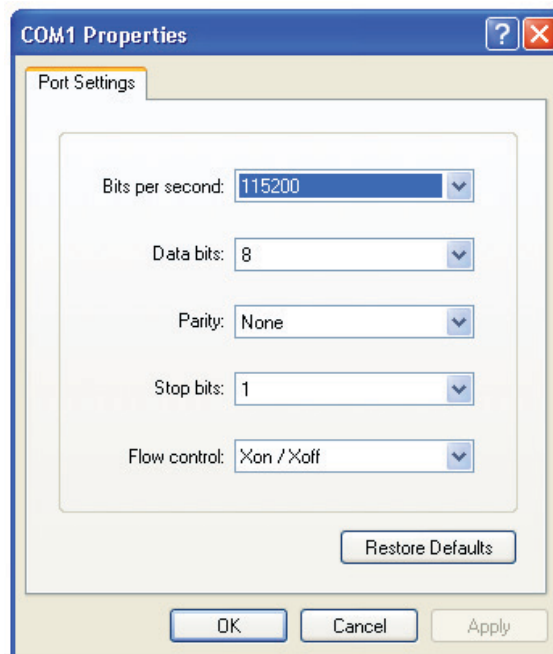


Figure 152 - HyperTerminal — upload control data configuration

5. Close HyperTerminal program. When prompted, click Yes to save the connection.
6. To print (upload) the control data, restart the HyperTerminal program, and in the 'Connection Description' window, click Cancel.

7. From the File menu, select Open. Locate the HyperTerminal connection that you just created (ForGe_CONNECTION in this example), and click Open.
8. Press the ENTER key. This should bring up the following options menu in the HyperTerminal window.

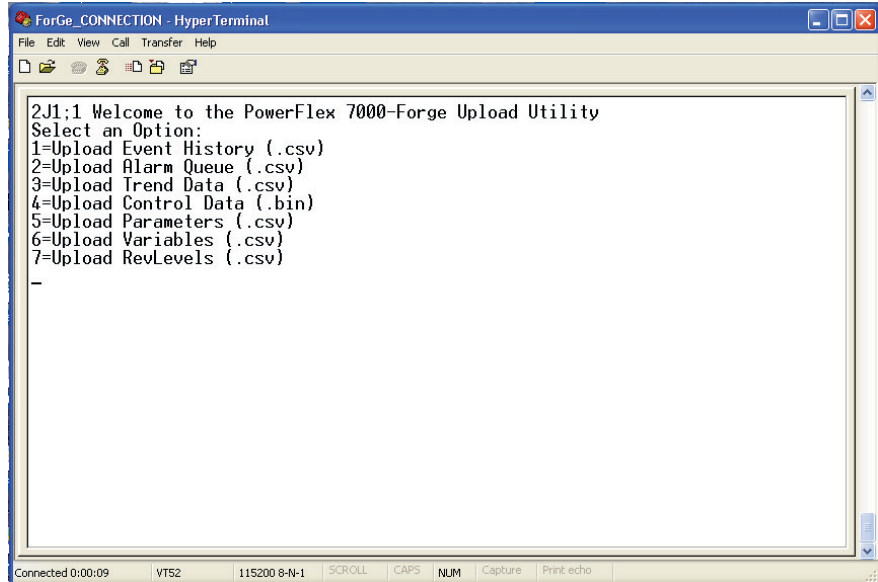


Figure 153 - HyperTerminal — Upload utility main menu

9. From the Options menu, choose an option by pressing the corresponding number to upload (print) the data. To upload Control Data, select option 4.
10. Start the transfer by selecting Receive File ... from the Transfer menu as shown below.

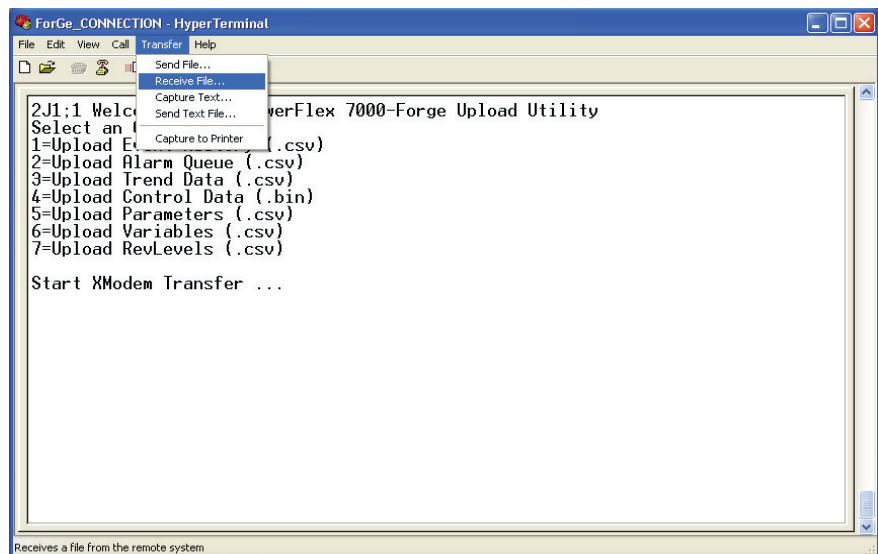


Figure 154 - HyperTerminal — Transfer menu options

11. In the Receive File window, click Browse and select the directory to which you want to save the data file. Ensure you set the Receiving Protocol to Xmodem, then click Receive.

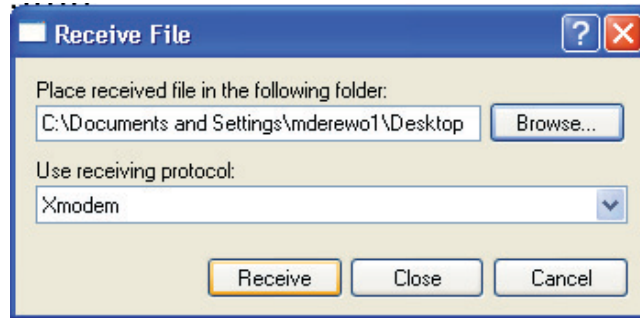


Figure 155 - HyperTerminal — Receive file transfer protocols

12. In the Receive Filename dialog, enter the file name, using the correct extension as given in the options menu. For Control Data use “.bin”; for all other data use “.csv”. Click OK.

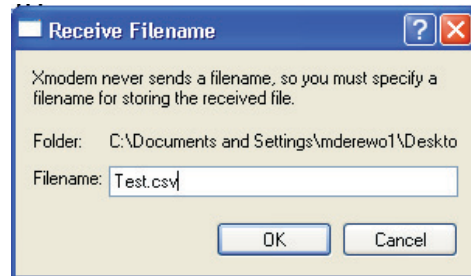


Figure 156 - HyperTerminal — Receive file name/extension

HyperTerminal provides a dialog box to track the file transfer progress. When the data transfer is complete, the above dialog box closes automatically. Once you have printed all the data files, close the HyperTerminal program and unplug the null-modem cable from the DPM board.

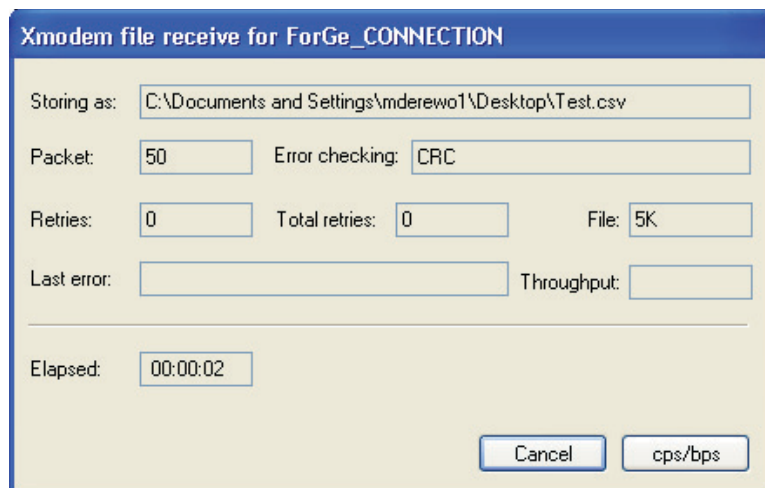


Figure 157 - HyperTerminal — file upload tracking dialog

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.

Rockwell Automation is actively seeking alternatives to potentially hazardous materials for which no feasible alternatives exist today in the industry. In the interim, the following precautionary information is provided for your protection and for the protection of the environment. Please contact the factory for any environmental information on any material in the drive or with any general questions regarding environmental impact.

Capacitor Dielectric Fluid

The fluids used in the filter capacitors and the snubber capacitors are generally considered very safe and are fully sealed within the capacitor housings. Shipping and handling of this fluid is typically not restricted by environmental regulations. In the unlikely event that capacitor fluid leaks out, avoid ingestion or contact with skin or eyes as slight irritation could result. Rubber gloves are recommended for handling.

To clean up, soak into an absorbent material and discard into an emergency container, or, if significant leakage occurs, pump fluid directly into the container. Do not dispose into any drain or into the environment in general or into general landfill refuse. Dispose of according to local regulations. If disposing of an entire capacitor, the same disposal precautions should be taken.

Printed Circuit Boards

Printed circuit boards may contain lead in components and materials. Circuit boards must be disposed of according to local regulations and must not be disposed of with general landfill refuse.

Lithium Batteries

This drive contains four small lithium batteries. Three are mounted on the printed circuit boards and one is located in the PanelView user interface. Each battery contains less than 0.05g of lithium, which is fully sealed within the batteries. Shipping and handling of these batteries is typically not restricted by environmental regulations, however, lithium is considered a hazardous substance.

Lithium batteries must be disposed of according to local regulations and must not be disposed of with general landfill refuse.

Chromate Plating

Some sheet steel and fasteners are plated with zinc and sealed with a chromate-based dip (gold-colored finish). Shipping and handling of the chromate plating parts is typically not restricted by environmental regulations, however, chromate is considered a hazardous substance. Dispose of chromate plated parts according to local regulations, not with general landfill refuse.

In Case Of Fire

This drive is highly protected against arcing faults and therefore it is very unlikely the drive would be the cause of a fire. In addition, the materials in the drive are self-extinguishing (i.e. they will not burn without a sustained external flame). If, however, the drive is subjected to a sustained fire from some other source, some of the polymer materials in the drive will produce toxic gases. As with any fire, individuals involved in extinguishing the fire or anyone in close proximity should wear a self-contained breathing apparatus to protect against any inhalation of toxic gases.

Disposal

When disposing of the drive, it should be disassembled and separated into groups of recyclable material as much as possible (i.e. steel, copper, plastic, wire, etc.). These materials should then be sent to local recycling facilities. In addition, all disposal precautions mentioned above must also be taken for those particular materials.

Preventive Maintenance Check List

The preventive maintenance activities on the PF7000 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 [Replacing Air Filters on page 95](#) for a detailed description of the process.

Annual Maintenance

These maintenance tasks should be performed on an annual basis. These are recommended tasks, and depending on the installation conditions and operating conditions, you may find that the interval can be lengthened. For example, we do not expect that torqued power connections will require tightening every year. Due to the critical nature of the applications run on MV drives, the key word is preventive. Investing approximately 8.0 hours per year on these tasks is time well spent in adding insurance against unexpected downtime.

Initial Information Gathering

Some of the important information to be recorded includes:

- Print Drive Setup
- Print Fault/Warning Queues
- Save Parameters to NVRAM
- Save Parameters to Operator Interface
- Circuit Board Part Numbers / Serial Numbers / Revision Letters*

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



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

Physical Checks

NO Medium Voltage and NO Control Power

- Power Connection Inspection:
 - Inspect PF7000 drive, input/output/bypass contactor sections, and all associated drive components for loose power cable connections and ground cable connections: torque them to the required torque specifications.
 - Inspect the bus bars and check for any signs of overheating / discoloration and tighten the bus connections to the required torque specifications.
 - Clean all cables and bus bars that exhibit dust build-up.
 - Use torque sealer on all connections.
- Carry out the integrity checks on the signal ground and safety grounds.
- Check for any visual/physical evidence of damage and/or degradation of components in the low voltage compartments.
 - This includes Relays, Contactors, Timers, Terminal connectors, Circuit breakers, Ribbon cables, Control Wires, etc.; Causes could be corrosion, excessive temperature, or contamination.
 - Clean all contaminated components using a vacuum cleaner (DO NOT use a blower), and wipe clean components where appropriate.
- Check for any visual/physical evidence of damage and/or degradation of components in the medium voltage compartments (inverter/rectifier, cabling, DC Link, contactor, load break, harmonic filter, etc).
 - This includes main cooling fan, power devices, heatsinks, circuit boards, insulators, cables, capacitors, resistors, current transformers, potential transformers, fuses, wiring, etc.; Causes could be corrosion, excessive temperature, or contamination.
 - Verify that torque on heatsink bolts (electrical connections to bullet assemblies) is within specifications (13.5 N-m).
 - Clean all contaminated components using a vacuum cleaner (DO NOT use a blower), and wipe clean components where appropriate.
 - NOTE: An important component to check for contamination is the heatsink. The fine grooves in the aluminum heatsinks can capture dust and debris.
- Carry out the physical inspection and verification for the proper operation of the contactor/isolator interlocks, and door interlocks.
 - Carry out the physical inspection and verification for the proper operation of the key interlocks.
 - Physical verification of the additional cooling fans mounted in the AC Line Reactor cabinet, Harmonic Filter cabinet for mounting and connections.
 - Carry out the cleaning of the fans and ensure that the ventilation passages are not blocked and the impellers are freely rotating without any obstruction.

- Carry out the insulation meggering of the drive, motor, isolation transformer/line reactor, and the associated cabling.
- Refer to User Manual, Appendix D – Meggering, for meggering procedure.
- Check clamp head indicator washers for proper clamp pressure, and adjust as necessary.
- Refer to User Manual, Chapter 5 – Component Definition and Maintenance for details on proper clamp pressure.

Control Power Checks (No Medium Voltage)

- Apply 3 Phase Control power to the PF7000 drive, and test power to all of the vacuum contactors (input, output, and bypass) in the system, verifying all contactors can close and seal in.
 - Refer to Publication 1502-UM050_-EN-P for a detailed description of all contactor maintenance
- Verify all single-phase cooling fans for operation.
 - This includes the cooling fans in the AC/DC Power supplies and the DC/DC converter.
- Verify the proper voltage levels at the CPT (if installed), AC/DC Power Supplies, DC/DC converter, isolated gate power supply boards.
 - Refer to the Commissioning Guide 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 (pre-Restart)

- 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 Preventive Maintenance Tasks

- Investigation of customer's concerns relating to drive performance
 - Relate any problems found during above procedures to customer issues.
- Informal instruction on drive operation and maintenance for plant maintenance personnel
 - Reminder of safety practices and interlocks on MV equipment, and on specific operating concerns
 - Reminder of the need to properly identify operating conditions
- Recommendation for critical spare parts which should be stocked in-plant to reduce production downtime
 - Gather information on all spare parts on site, and compare that with factory-recommended critical spares to evaluate whether levels are sufficient.
 - Contact MV Spare Parts group for more information.
- Vacuum Bottle Integrity Testing using a Vacuum Checker or AC Hipot
 - Refer to Publications 1502-UM050_EN-P (Series D) and 1502-UM052_EN-P (Series E) for a detailed description of all 400A contactor maintenance.

Final Reporting

- A complete, detailed report on all steps in the Preventive Maintenance procedures should be recorded to identify changes.
 - A completed copy of this checklist should be included.
 - A detailed description of ALL ADJUSTMENTS AND MEASUREMENTS that were taken during the process should be included in an addendum (Interlock Adjustments, Loose Connections, Voltage Readings, Megger Results, Parameters, etc.)

IMPORTANT This information should be communicated to MV product support so that future support activities will have the latest site information available. Fax this information to (519) 740-4756.

Time Estimations

Operational Maintenance	0.5 hours per filter
Annual Maintenance	
• Initial Information Gathering	0.5 hours
• Physical Checks	
– Torque Checks	2.0 hours
– Inspection	2.0 hours
– Cleaning **	2.5 hours **
– Meggering	1.5 hours
• Control Power Checks	
– Contactor Adjustments **	2.0 hours **
– Voltage Level Checks	1.0 hours
– Firing Check	0.5 hours
– System Test **	2.0 hours **
• Medium Voltage Checks	
– Final Inspection	0.5 hours
– Phasing Check **	1.5 hours **
– Autotuning**	2.0 hours **
– Operation to Maximum Load	Site Dependent
• Additional Tasks	
– Investigation **	Depends on Nature of the Problem **
– Informal Training/Refresher **	2.0 hours **
– Spare Parts Analysis **	1.0 hours **
– Vacuum Bottle Integrity Check **	3.0 hours **
Final Report	3.0 hours

Note: ** indicates that the time may not be required depending on the nature of the maintenance and the condition of the drive system. These times are only estimations.

Tool/Parts/Information Requirements

The following is a list of the tools recommended for proper maintenance of the PF7000 drives. Not all of the tools may be required for a specific drive preventive procedure, but if we were to complete all of the tasks listed above the following tools would be required.

Tools

- 100 MHz Oscilloscope with minimum 2 Channels and memory
- 5kV DC Megger
- Digital Multimeter
- Torque Wrench

- Laptop Computer with Relevant Software and Cables
- Assorted Hand Tools (Screwdrivers, Open Ended Metric Wrenches, Metric Sockets, etc.)
- 5/16 Allen Keys
- Speed Wrench
- Feeler Gauge
- Vacuum Bottle Checker or AC-Hipot
- Minimum of 7.5 kV Hotstick / Potential Indicator
- Minimum of 10 kV Safety Gloves
- Vacuum Cleaner with Anti-static Hose
- Anti-static Cleaning Cloth
- No. 30 Torx Driver

Documentation

- PF7000 User Manual – Publication 7000-UM151_-EN-P
- PF7000 Technical Data (Parameters, Troubleshooting) – Publication 7000-TD002_-EN-P
- PF7000 MV Drives General Handling Procedures – Publication 7000-IN002_-EN-P
- MV 400A Vacuum Contactor, Series D User Manual – Publication 1502-UM050_-EN-P
- MV 400A Vacuum Contactor, Series E User Manual – Publication 1502-UM052_-EN-P
- Drive-Specific Electrical and Mechanical Prints
- Drive-Specific Spare Parts List

Materials

- Torque Sealer (Yellow) Part number --- RU6048
- Electrical Joint Compound ALCOA EJC no. 2 or approved equivalent (for Power Devices)
- Aeroshell no. 7 Part number 40025-198-01 (for Vacuum Contactors)

Initial Operator Interface Configuration

The PowerFlex 7000 “B” Frame medium voltage drive uses the PanelView 550 terminal as the operator interface ([Figure 158 on page 174](#)). The medium voltage drive terminal only uses the PanelView interface hardware, incorporating unique software with a modified faceplate.

This chapter describes how to configure the operator interface. To complete initial drive programming, see [Drive Programming and Parameters on page 193](#). Specific references to a particular parameter are only for illustrative purposes. Refer to the PowerFlex 7000 Medium Voltage AC Drive Technical Data for further information regarding drive parameters.

The interface limits user access to specific configuration features on the basis of defined security levels. For more information on defining these levels, see [Configuring Access Levels on page 198](#).

Terminology

Editing field – An area of a screen in which you can type data via the keypad.

Flash – A type of memory that indefinitely stores information and is unaffected by power loss. The drive uses this format for firmware, parameters, and data file storage.

NVRAM – Non-Volatile Random Access Memory is unaffected by power loss. The drive uses this format for long term data storage (for example, parameters and alarm queues).

Parameter – A memory location at which the drive reads or writes data. You must configure operational parameters before using the drive. Configuring a parameter changes the drive behavior. You may add additional parameters or change them while the drive is in use, in order to adjust its operation, (i.e. editing a speed parameter).

Operation – Tasks that the drive performs, or that you must do with the drive. Completing a task may involve multiple screens; for example, modifying a parameter is an operation requiring two or more screens.

PanelView 550 – The PanelView 550 integrates a hardware terminal and a software package into a single operator interface. The medium voltage drive uses the hardware portion of the product with different software than default PanelView software.

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

PowerFlex operator interface – The PanelView 550 interface hardware and the unique software contained within it, enabling the unit to function with the medium voltage drive.

Read-only parameter – A memory location that is readable but not writable. A read-only parameter contains real-time data that the operating system uses to read the current drive conditions, such as running speed.

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

XIO – the eXternal Inputs and Output adapters that transmit hard-wired signals to the drive.

Keypad

The keypad of the operator interface consists of two rows of five function keys (item 1 of [Figure 158](#)) located below the operator interface display area (item 4 of [Figure 158](#)). In the lower right corner of the operator interface are the four cursor keys, indicated as ▲ or ▼ ◀ or ▶ (item 2 of [Figure 158](#)). 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 158](#)).

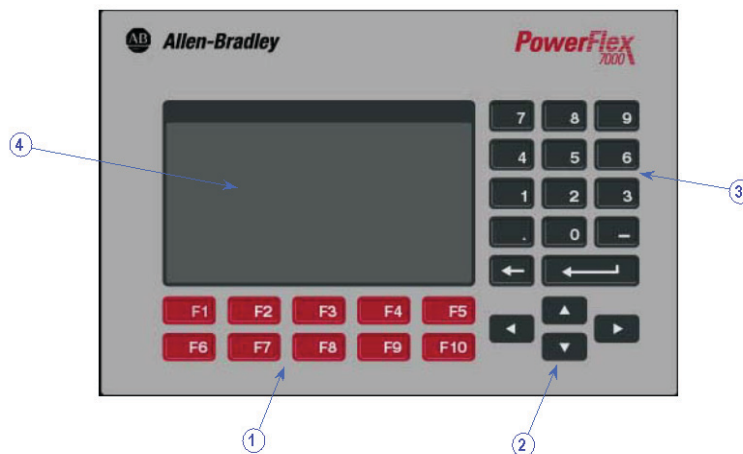


Figure 158 - PowerFlex 7000 “B” Frame Operator Interface Terminal

All keys are of a membrane type. The key function activates when you release the key.

Function (Softkeys) Keys

Along the bottom of the display area are the 'softkeys'. These are the physical function keys. Each key's function will vary between displays. The bottom row of keys (i.e. [F6]-[F10]) is always visible. The upper row appears only if necessary. 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 visible on some displays, the [F1]-HELP key is always active. ([F2]-[F5]) are only active if visible.

Cursor (Selection) Keys

Use the cursor keys to select an item on the display. When you select an item, that item appears highlighted. To change the selection, press the key in the desired direction. If there are multiple pages to a screen, moving the highlight will automatically scroll to the next page.

Some displays, such as the Utility screen, use these keys to modify the data value. Pressing ▲ or ▼ changes the value by a single unit at a time. Pressing ◀ or ▶ changes the value by a course amount (i.e. 10 units).

For entries requiring a HEX value, use ▲ or ▼ to scroll to the desired HEX value.

For parameters containing an enumeration string, use ▲ or ▼ to scroll the options list. When you make a selection, press [Enter]. A triangle symbol or inverted triangle to the right of the list indicates more selections than will fit on the screen. Use the cursor keys to scroll to additional selections.

For parameters comprised of bit fields, use ◀ or ▶ to move to the required field. Use ▲ or ▼ to toggle the bit between possible states.

All four cursor keys have a “hold” feature. If you hold a key for 2 seconds, the related function repeats at a rate of 5 ‘presses’ per second, as if you were pressing the key.

Data Entry Keys

Use these keys to enter data. Pressing [0] to [9] types the corresponding value in the editing field. Pressing [-] changes the value to a negative number. Pressing [.] enables you to enter a fractional value.

Edit field values using the ← [Backspace] key. This key deletes characters from right to left. The help screen uses this key to return to the previous level of help.

The [Enter] key function varies depending on the screen. During a selection operation, the [Enter] key accepts the selection and proceeds to the next screen in the operation. If you are in the process of entering data, press [Enter] to accept the field data.

Screen Components

The operator interface combines a menu screen with the data drive to provide user access to configurable drive operations. Some operations require multiple screens to complete; scroll or navigate between the menus and screens that contain longer pages than the terminal interface can display.

Although the data displayed on any particular screen will vary, the general composition of a screen is similar for all. [Figure 159](#) shows a typical screen and its components.

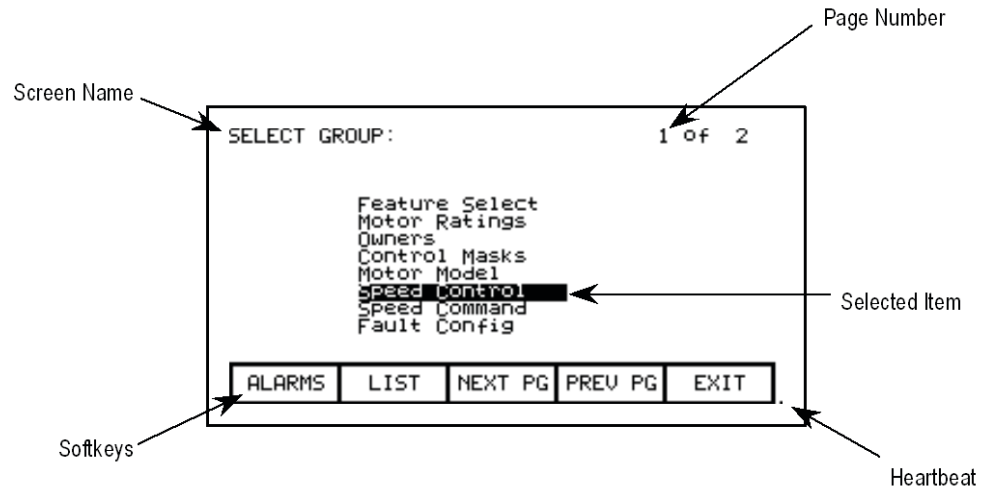


Figure 159 - Screen Components

The screen name appears in the upper left corner, as shown in [Figure 159](#), and helps provide menu orientation. Some screens display the selected item from the previous screen to the right of the current screen name.

For screens with multiple pages, both the current page number and the total pages for this screen appear in the upper right corner. Pressing [F8] displays the next page of data.

In the lower right corner is a small dot, shown in [Figure 159](#) as the “heartbeat”. This dot indicates the healthy state of the operator interface, and in normal conditions flashes at a rate of .5 Hz. During communication errors, the dot flashes at a rate of .1 Hz.

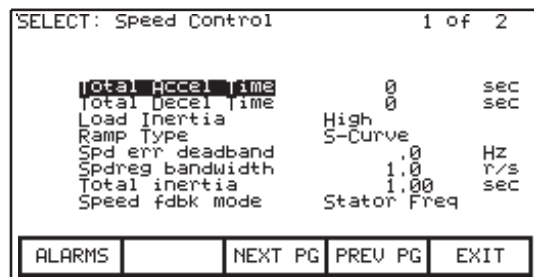


Figure 160 - Screen name and selected item

The remainder of the screen displays drive data related to the selected menu options. Screens that include item selection highlight the default or current selection, as shown in [Figure 160](#).

Interface Operations

Security: Access Levels

Secure access levels protect the drive from unauthorized parameter changes, and filter accessible information. Each access level includes the access permissions of all lower access levels.

Monitor: The default access level; access to a small subset of the parameter database. No change access to any configuration information.

Basic: Permits changes to any viewable parameter.; sufficient for configuring and maintaining the drive for the majority of applications.

Advanced: Permits configuration access to the entire drive.

Two additional secured levels for trained service personal are only accessible for making physical hardware changes to the drive.

Individual PIN security protects all levels, except the first. Use the ▲ or ▼ keys to select the access level. Enter the PIN for the relevant access and press [Enter] to change the access level.

Refer to the User Manual for complete information on the use of Access Levels.

Information Windows

Certain operations communicate directly with the drive, which may cause a performance lag. The interface will display status messages relating to the ongoing operation.

Accessing/Writing to Drive

On initial start-up, the interface knows little about the drive. At each screen, the interface receives and stores information from the drive, and displays the message, “Accessing Drive...”. The interface will not accept user input until it completes the access task. Using the same screen for the same data will then be faster, since the interface can access locally-stored data.

Optionally, you can download the complete database to the interface to mitigate the initial access delays. If uninterrupted, the interface automatically downloads the database on power-up, or during periods of inactivity.

Some operations must write information to the drive, during which the interface displays, “Writing to Drive...” The interface does not accept user input until the task finishes.

Communication Errors

Many things might disrupt interface communication with the drive. In the event of a disruption, the interface provides a status window, and will not accept further user input until it completes the current task.

The “Communication Error” message has two forms. If the interface is already “Accessing Drive” or “Writing to Drive”, then the error message appears in the current window. For screens displaying real-time data from the drive, such as the “Top Level Menu”, a new window displays the “Communication Error”. Two examples appear in [Figure 161](#).

In both cases, once the interface reconnects to the drive, the message closes and the operation finishes.

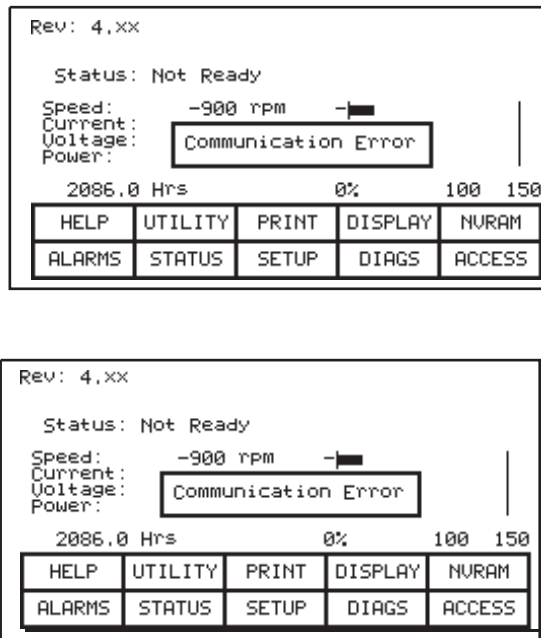


Figure 161 - Communication Errors

Operator Interface Menu

Hierarchy Chart

The interface screens provide menu-driven access to the drive operations. [Figure 162 on page 181](#) and [Figure 163 on page 182](#) illustrate the menu hierarchy, and show the relationship between screens and a particular operation. They also illustrate the path to a particular screen.

This chart does not cover usage of the operator interface, but is useful reference for both initial configuration and further parameter programming.

Reading the Chart

Each box represents a screen, and shows the screen name. From a particular screen, a downward arrow indicates other screens that are accessible from the current screen, and the function key required to call each screen. Pressing [F10] on any screen returns exits and returns to the preceding screen.

A lateral arrow indicates screens accessible by pressing [Enter] while making a selection. Pressing [F10] exits and returns to the preceding screen.

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

The soft function keys that calls the HELP and ALARMS screens are not shown. All screens can call either function using [F1] and [F6] respectively.

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 concentrates more on the flow of screens and how it relates to the chart, rather than the actual function of each screen. The symbols refer to those of the chart. Descriptions of movement, i.e. lateral, refer to flow depicted on the chart.

From the MAINMENU, press [F4] to open the DISPLAY GROUP screen. Scroll to a parameter group and press [Enter]. This laterally moves us to the DISPLAY screen. Since you selected a parameter group, pressing [F7] opens a selection operation (symbol 'D') in which the SELECT screen appears, enabling you to use the cursor keys to select a parameter.

Pressing [Enter] laterally moves us to the symbol T, ending the selection process. For this example, the symbol T laterally moves to the symbol M that defines a new parameter modification process. The MODIFY PARAMETER screen appears.

To modify the parameter, you must have the correct access to it. Press [F8] to call the ACCESS screen, represented by the symbol P. Select the correct access level on this screen and press [F10] to exit. This returns to the MODIFY PARAMETER screen. When you are finished editing the parameter, press [F10] to return to the SELECT screen (via symbols M and T). Pressing [F10] again returns to the DISPLAY screen (via the symbol D). Pressing [F10] again will return you to the DISPLAY GROUP and finally to either the MAINMENU or the MESSAGE screens.

If you have modified any drive data, pressing [F10] calls the MESSAGE screen with a prompt to save changes permanently to NVRAM. To leave changes as temporary, press [F9] for 'No' and continue to the MAINMENU. If you press [F8] for 'Yes', the NVRAM screen appears, and you can save the data. Exiting the NVRAM screen returns to the MAINMENU. Pressing [F10] key on the MESSAGE screen will returns to the DISPLAY GROUP screen.

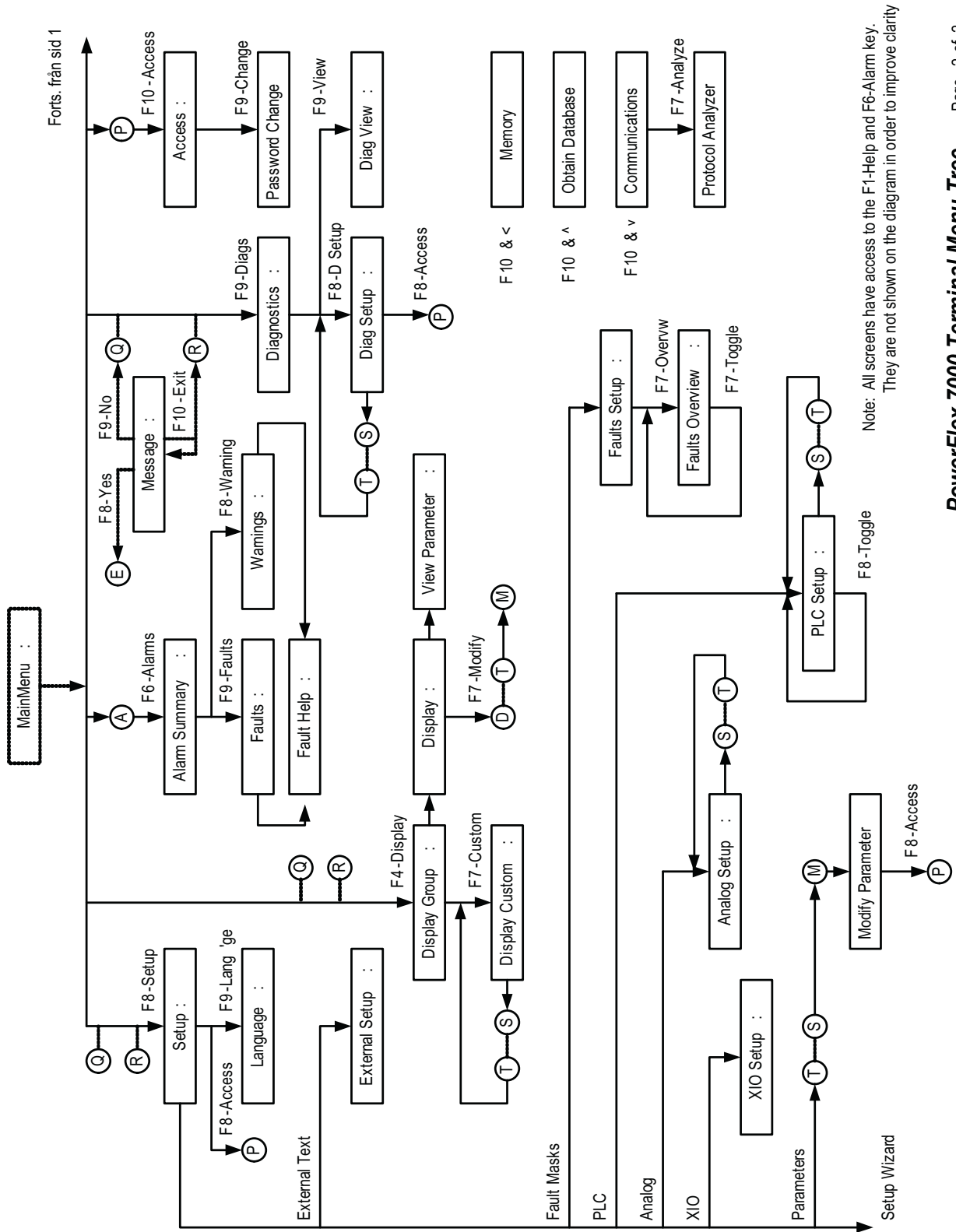


Figure 163 - Menu hierarchy, cont'd

Configuring the Interface

General Operation

Screen contents vary depending on the operation. You can access most operations using the function keys on the bottom of the screen. Function keys generally change from one screen to the next, although some functions are consistent across multiple screens:

- F1 - Help: This operation is available on every screen, even if the softkey is not available. Help is context-sensitive, providing content specific to the current screen.
- F6 - Alarms: Always displays the Alarm Summary screen. A new alarm will cause this key to flash.
- F8 - Next Page: Navigates screens containing multiple pages.
- F9 - Previous Page: Navigates screens containing multiple pages.
- F10 - Exit: Returns to the previous screen.

Operator Interface Power-up Sequence

When you start or reset the operator interface, it performs two operations:

- Linking to Drive: The interface establishes communications with the drive communications board. The screen shows 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
- Obtaining Drive Database: the interface is downloading the drive database. This process is optional; abort the process by pressing any key on the interface. Obtaining the entire database does speed up subsequent operations, since relevant portions of the database are available in flash memory. (Otherwise, the interface continues to access the drive database directly, which significantly slows the first operation requiring that data. Subsequent operations requiring the same data are not affected). Aborting the download will not affect portions of the database already obtained.

Once the interface downloads the database, it will boot in one of two modes, depending on how the current drive configuration:

- a) On an unconfigured drive, the operator interface boots in 'Setup Wizard' mode. Until you complete the configuration, this is the default start-up mode. You can cancel the wizard at any time by pressing the appropriate softkey.
- b) On a configured drive, the top-level menu appears after start-up. You can access the Setup Wizard at any time from the Setup menu.

Top-Level Menu

This screen ([Figure 164](#)) provides menu access to all other operations. To select an operation, press the corresponding softkey.

The menu screen identifies the drive and its overall operative state. Four digital meters track selected drive parameters. A Hobbs meter displays the drive’s current up-time.

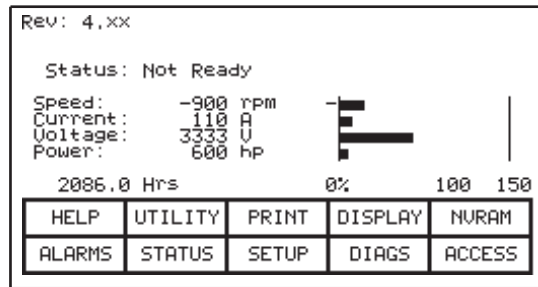


Figure 164 - Top-level menu

Status indicates one of the following:

- NOT READY—drive is not ready to start
- READY—drive will start on command
- 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

Accessing the Help Function

Access the Help from any screen by pressing [F1]. After the screen name is the name of the screen from which you called the Help function; in sample show in [Figure 164](#), the Help call originated from the “REV” screen. If the Help screen contains multiple pages, use [F8]and [F9] to navigate between the pages.

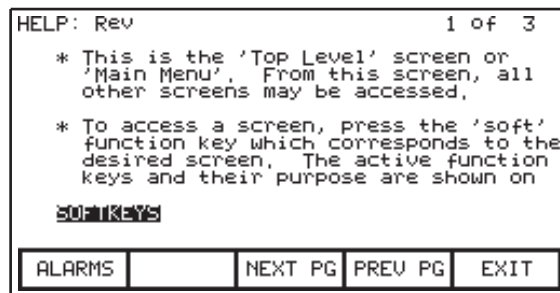


Figure 165 - Typical Help screen

Exit the Help and return to the original screen at any time by pressing [F10].

Related Topics

The Help system provides additional information relating to the current topic as links highlighted above the softkeys. Select an additional topic via the ◀ or ▶ keys. [Figure 165](#) shows the additional topic of “SOFTKEYS”. To view this information, press [Enter].

The help for the additional topic appears as shown in [Figure 166](#). Related help topics may also have additional related topics.

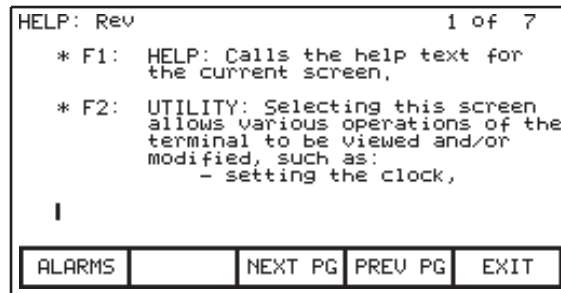
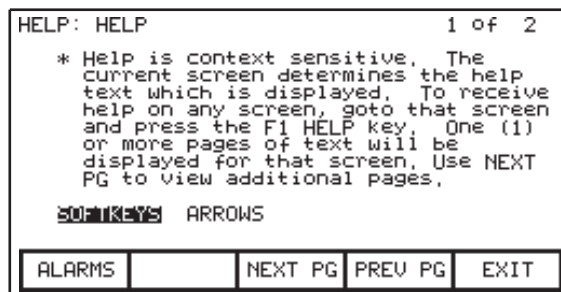


Figure 166 - Help—Related Topics screen

Pressing [F1] from a help screen provides instructions for using the help system.



To return to the previous help screen, press [Backspace]. To exit the Help completely and return to the screen from which you originally requested help, press [F10]. Press [Backspace] to return to the previous help topic.

Using the Interface Configuration Utility

Use the Utility mode to configure the operator interface, including:

- setting the clock and calendar
- changing the delay for the display backlight shutoff
- changing the contrast of the display
- defining the meters that will be displayed on the Top Level Menu
- viewing the revision levels of all software in the drive line-up.
- transferring data between the operator interface ‘flash’ memory, ‘flash’ memory card and the drive.
- loading a new language module.

Access the Utility mode from the top-level menu by pressing [F2].

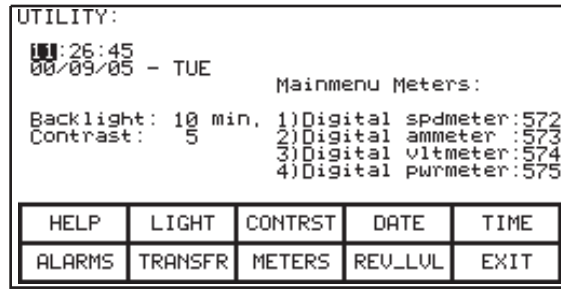


Figure 167 - Utility Operation (configuration) screen

During configuration, the selected value appears highlighted as shown in [Figure 167](#). Select a value to edit it.

IMPORTANT You can abort configuration from any screen by pressing any of the assigned function keys (other than F1).

Changing Backlight Delay

The interface display is backlit. To preserve the life of the lamp, backlighting automatically shuts off after a period of inactivity on the keypad. Restore the backlight by pressing any key, which has no other affect on the interface when pressed with the backlight off

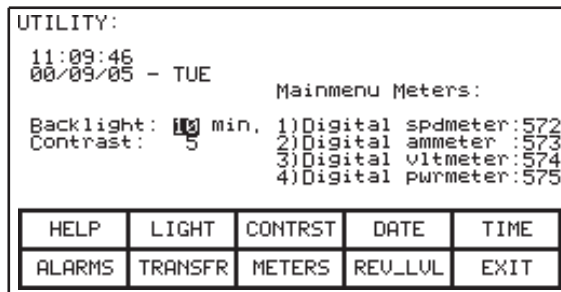


Figure 168 - Configuring display backlight

To change the duration of the delay, press [F2]. The current backlight delay is highlighted. Adjust for values between 0 to 60 minutes. Zero (0) disables the delay, keeping the light on indefinitely. Press ▲ or ▼ to change the value by 1-minute increments. Press ◀ or ▶ to change the value by 10-minute increments. Press [Backspace] to abort the edit. Press [Enter] to save the changes.

Changing Contrast

Press [F3] to access contrast configuration (Figure 169). Press ▲ or ▼ to change the contrast value. To abort the change, press [Backspace]. Press [Enter] to save the changes.

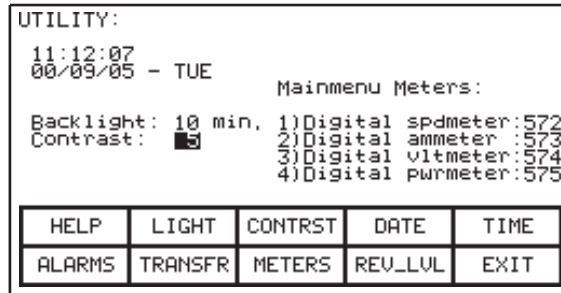


Figure 169 - Configuring display contrast

Setting Time

The clock controls the time stamp on drive information appearing on the alarm summary screen.

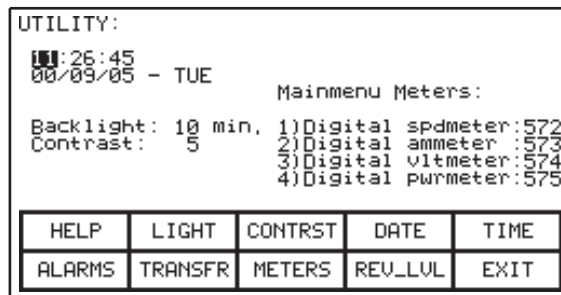


Figure 170 - Setting the clock

To change the hour, press [F5]. Press ▲ or ▼ to increment the clock by 1 unit. Press ◀ or ▶ to increment the clock by ten units.

To change the minutes press [F5] again and repeat the procedure (repeat again to change the seconds).

To abort the change, press [Backspace]. Press [Enter] to save the changes.

Setting Date

Like the clock, the calendar affects the date stamp on drive information appearing on the alarm summary screen.

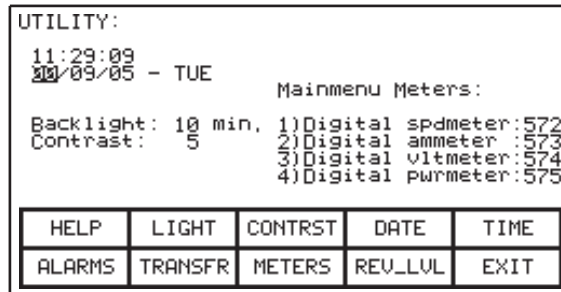


Figure 171 - Setting the calendar

The calendar uses the MM/DD/YY format.

To change the month, press [F4]. Press ▲ or ▼ to increment the calendar by 1 month. Press ◀ or ▶ to increment the calendar by 10 months.

To change the day press [F4] again and repeat the procedure (repeat again to change the year).

To abort the change, press [Backspace]. Press [Enter] to save the changes.

You can not set the day of the week. The interface determines the day of the week based on your date selection.

Selecting Meters

The utility screen (Figure 167) shows tags assigned to four meters on the top-level menu. You can change these meters by pressing [F8] to configure meter selection, as shown below.

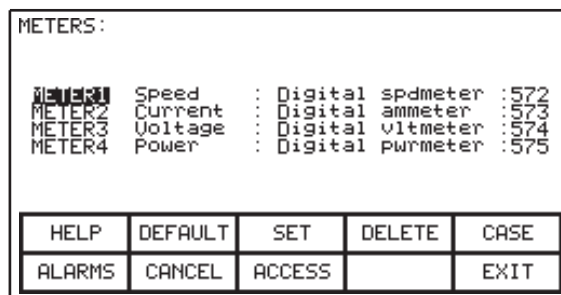


Figure 172 - Configuring meter displays

To change a meter, press ▲ or ▼ to select a meter and press [Enter]. If nothing happens, you do not have access to this feature. Refer to [Configuring Access](#)

[Levels on page 198](#). Correct the access issues, and press [F8] to continue on this screen.

See also [Selecting a Parameter on page 193](#) for more information on tag selection. Complete the selection process to assign the tag to the meter. The meter name changes to a default string (i.e. V Line) as shown in [Figure 173](#) for meter 2.

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

Figure 173 - Configuring meter tags

The text consists of 8 characters and appears on the top level menu with tag value and units.

To change a meter, press ▲ or ▼ to select a meter and press [Enter]. To modify the text, press ►. If nothing happens, you do not have access to this feature. Refer to [Configuring Access Levels on page 198](#). Correct the access issues, and press [F8] to continue on this screen.

The cursor highlights the first character position of the string as shown in [Figure 174](#). Refer to the section entitled “Edit Text”.

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

Figure 174 - Editing text

When editing is complete, the screen will appear as in [Figure 175](#).

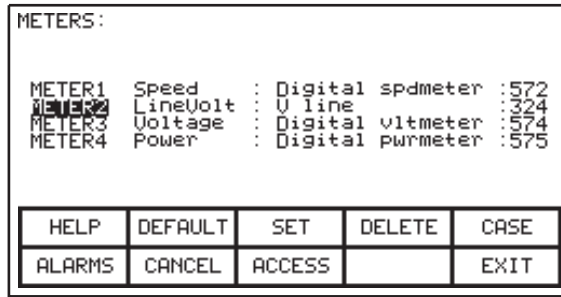


Figure 175 - Editing complete

The operator interface contains a default set of meters. Select the default set by pressing [F2] from the 'Meters' screen to view default text and tags as shown in [Figure 172 on page 188](#).

Edits do not take affect until you press [F10] and exit the screen. Cancel any edits prior to exiting the screen by pressing [F7].

[Figure 176](#) shows the results of the edits as they appear in the top-level meter display.

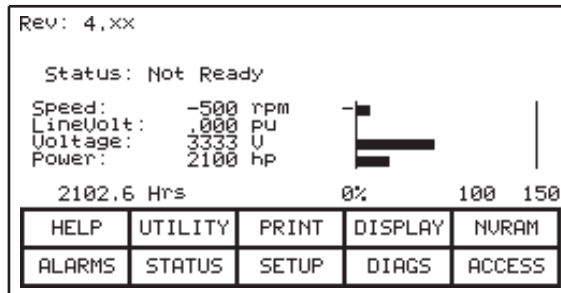


Figure 176 - Modified top-level meter display

Software Revision Levels

You will need to know the software revision level for your interface, for maintenance and upgrade purposes. To see this information, press [F9].



The revision screen typically shows:

- the type of drive
- a unique, 16-character, user-definable string as drive identifier
- terminal software revision level and its part number
- terminal bootcode revision level
- various drive board revision levels

These are identified by name.

To edit the drive identifier text string, press [F8]. If nothing happens, you do not have access to this feature. Refer to [Configuring Access Levels on page 198](#). Correct the access issues, and return to this screen to continue.

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

Figure 177 - Editing the drive name

To modify the text in the edit screen as show in [Figure 177](#), refer to the section entitled “Edit Text”, noting the following exception. When you finish typing text (as in [Figure 178](#)) the [Enter] key has no effect. Press [F10] to accept the edited string.

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

Figure 178 - Editing complete

If necessary, cancel the edits before exiting this screen by pressing [F7].

Transfer Data in Memory

The operator interface contains long term storage in two forms. Flash memory contained in the operator interface stores the firmware, optional language

modules, and the drive parameters. This information can also reside on a removable flash card that you can transfer to another drive.

To transfer information from the two forms of memory, press [F7]. This displays flash memory operations screen. For more information on programming the drive (including configuring operational parameters), refer to [Drive Programming and Parameters on page 193](#).

Changing Language

When the drive language changes (through the interface or an external device), the interface updates invalidated database strings and the server character set, and links all strings to the new language. During this process, the interface displays a “Language Changing...” message.

For more information on programming the drive (including configuring operational parameters), refer to [Drive Programming and Parameters on page 193](#).

Drive Programming and Parameters

Rockwell Automation drives ship with a number of factory-set parameters. Other operational parameters are client-specific; you must configure these as part of the installation process. Rockwell Automation personnel may verify or edit these parameters during commissioning, or once the drive is operating under expected load. Scheduled maintenance or equipment replacement may also require changes to operating parameters, post-installation.

This section details the process of programming the drive and configuring operational parameters (tags). Specific references to a particular parameter are only for illustrative purposes. Refer to PowerFlex™ 7000 Medium Voltage AC Drive Technical Data (publication 7000-TD002) for information about using or modifying actual parameter tags within your drive.

Configuring Parameters

Selecting a Parameter

Most drive configuration is parameter-based. Select parameters (tags) by first selecting a parameter group.

Via Groups

The default group selection lists all the groups available to the current access level and operation.

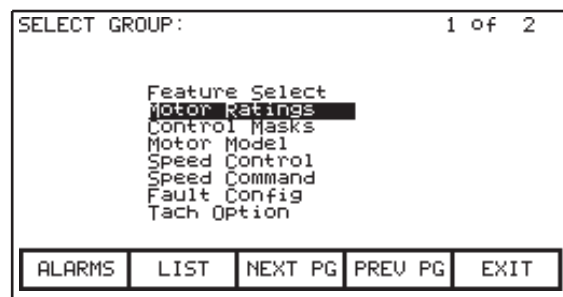


Figure 179 - Select parameter group

When selecting a parameter, any groups containing read-only parameters are not visible. Access levels also determine which groups appear. If there are multiple pages of groups, press [F8] and [F9] to scroll through additional pages.

Press ▲ or ▼ to select a group, and press [Enter]. The SELECT screen (Figure 180) lists the members of that group, with the group name appearing after the screen name for reference.

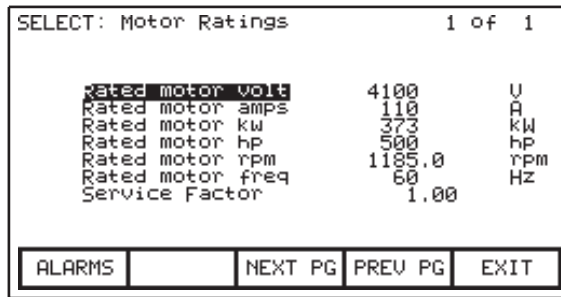


Figure 180 - Select group member

Use ▲ or ▼ to navigate the list and [F8] or [F9] to change the page. Press [Enter] to select a tag to configure.

Via Name

If you know the parameter name but not its group, on the SELECT GROUP screen (Figure 179), press [F7] to access the SELECT LETTER feature, shown below.

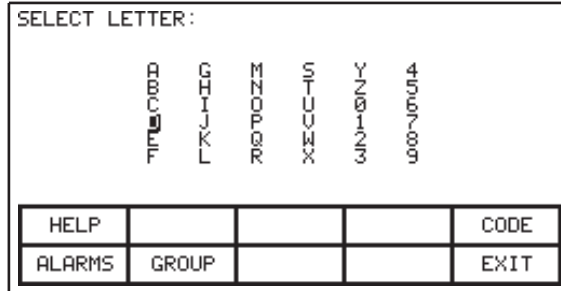


Figure 181 - Select letter

Use the cursor keys to select the first letter of the parameter name, and press [Enter]. This displays a listing of all parameter names beginning with the selected letter.

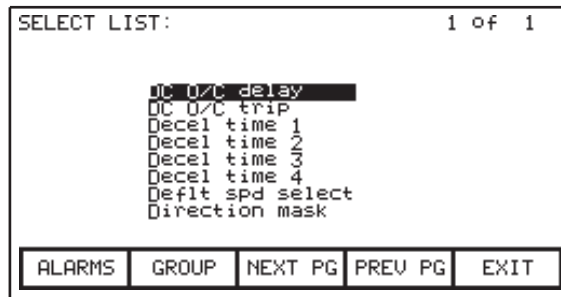


Figure 182 - Select parameter name from listing

The interface filters listings on the basis of the current user's access level. The listing also only includes parameter tags appropriate to the current operation.

Use the cursor keys to navigate the list, or [F8] and [F9] to scroll the page. Press [Enter] to select the parameter.

Press [F7] to return to the Selection Via Group page.

Via Code

On the SELECT LETTER screen ([Figure 182](#)) you can also select a parameter via a code by pressing [F5]. Every parameter has a unique ID code to identify it to devices that cannot parse a name (for example, a PLC).

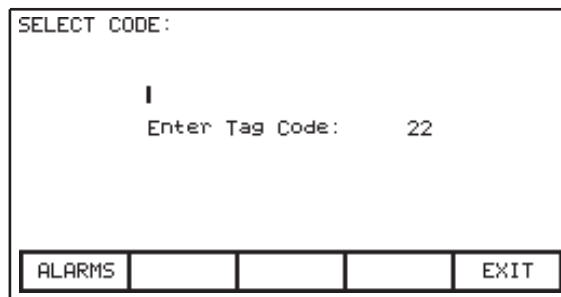


Figure 183 - Select parameter (tag) code

Use the data entry keys [0]-[9] to type the code on the SELECT CODE screen. Edit the entry with the [Backspace] key. When finished, press [Enter].

When you enter a valid code, the screen displays the parameter name to verify your selection before continuing. If correct, press [Enter] key. If incorrect, type another code.

Invalid codes prompt the following error message:

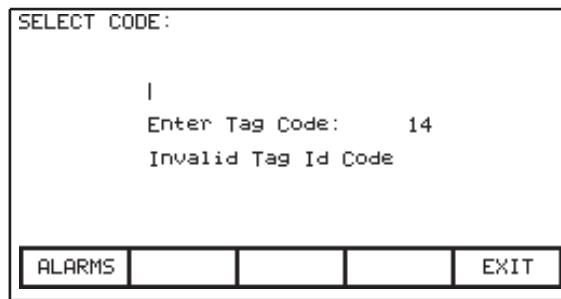


Figure 184 - Invalid Tag Code

When you have a valid tag code, press [Enter] to continue.

If you select a read-only parameter code, you cannot exit the screen with this read-only parameter. Type a new code or press [F10] to return to the previous screen without making a selection.

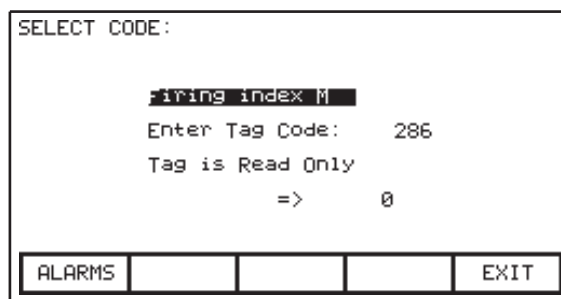


Figure 185 - Selected Tag Read-only

Text Editing

Several operations require text entry, including:

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

The keypad does not contain any alpha keys for text. Use the following procedures for text entry.

Screens requiring text entry have the F3, F4, and F5 keys in common. Use the cursor keys to move to the editing field; the screen highlights the text entry field when active.

Use ◀ or ▶ to move to the next position in the field. Press ▲ or ▼ to cycle through the character sets in each position. (Note that from the first character of a set, pressing ▼ wraps immediately to the last character of the set.)

There are four character sets. Press [F3] to cycle through each of the following:

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

IMPORTANT Character sets may vary depending on the drive's default language option.

A special set consisting of A-Z, 0-9, and the underscore character, is available for filenames. You cannot selected this set via [F3] or modified it by pressing [F5].

To change case on a letter in the edit field, press [F5].

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

To abort the text edit, press [Backspace] to restore the string to its original contents.

Press [Enter] to complete the text entry. Changes are permanent only after you press [F10] to exit the screen.

IMPORTANT Character sets may only be valid for the currently-selected language. Any characters for a selected language other than the four sets defined above, will only display properly in the selected language. Other languages may not contain the appropriate display characters.

Configure the Drive

Configuring the drive motor and application involves defining a number of operational parameters within the drive via the operator interface, including:

- changing a parameter setting.
- assigning a parameter to an analog port.
- enabling or disabling ("masking") selected faults.
- defining custom faults attached to external inputs.
- configuring the XIO.
- defining data sent to an optional PLC connection.
- saving and restoring drive settings.
- selecting an alternate language (if previously loaded in operator interface).

There are two methods for configuring the drive. This section describes the more complete method to configure the drive for any application. You may also configure the majority of drive applications using the Setup Wizard, accessible from the SETUP screen by selecting 'Setup Wizard' from the options list and pressing [Enter].

Regardless of the method used for configuration, the default factory parameters are available from the Drive Identity Module (DIM). The DIM enables Rockwell Automation to customize each drive at the factory for the intended application, using all known information at the time of building the drive.

Configuring Access Levels

The drive uses PIN-protected access levels to limit the risk of unauthorized changes. PINs consist of a number between 0 and 65535. Each access level, except for the first one, 'Monitor', has its own PIN. PIN values can be unique, or you can set them all to the same value.

The 'Monitor' level does not have an associated PIN. With this access level, users can view the drive configuration but not change it. In addition to providing protection, access levels also filter viewable information for each level. On any level other than 'Monitor', viewable information is configurable.

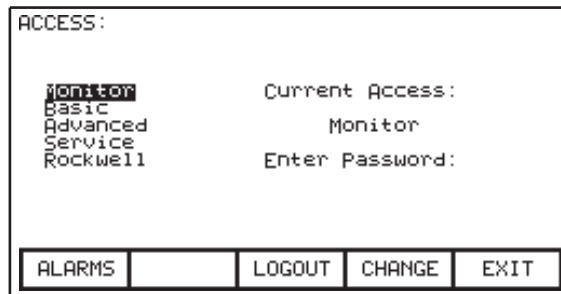


Figure 186 - Access screen

The access screen ([Figure 186](#)) is accessible from anywhere the access level affects user operations, including:

- [F10] on the top level menu
- [F8] on the MODIFY PARAMETER screen
- [F8] key on the SETUP screen
- [F8] key on the TRANSFER Screen
- [F8] key on the DIAGNOSTIC SETUP screen

[Figure 186](#) shows the current access level. To select a different access level, press ▲ or ▼ to select the level, then enter the PIN using the numeric keys [0]-[9]. For security, the interface masks the PIN with asterisks in the editing field, as shown below.

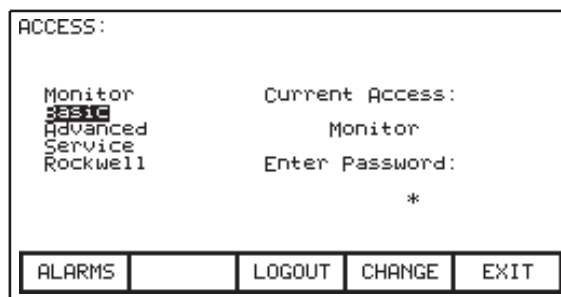


Figure 187 - PIN entry (masked)

Edit the PIN entry using the [Backspace] key. When finished, press [Enter]. Correct PIN entry will show a similar change in access level to [Figure 188](#):

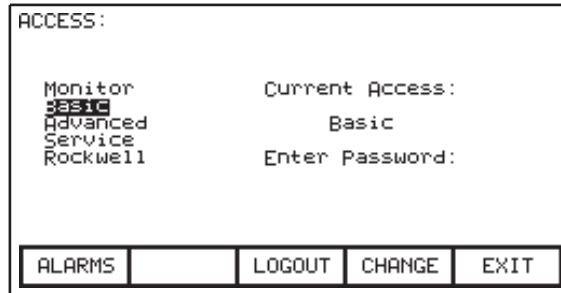


Figure 188 - Access level changed

When you complete the necessary configurations, reset the drive access level to 'Monitor' for protection from unauthorized modifications. From the ACCESS screen, press [F8] to restore 'Monitor'-level access.

The default PIN for both 'Basic' and 'Advanced' access is zero (0), or [Enter]. Change the PIN from the ACCESS screen using ▲ or ▼ to select the access level. Press [F9] to open the PASSWORD CHANGE utility ([Figure 189](#)).

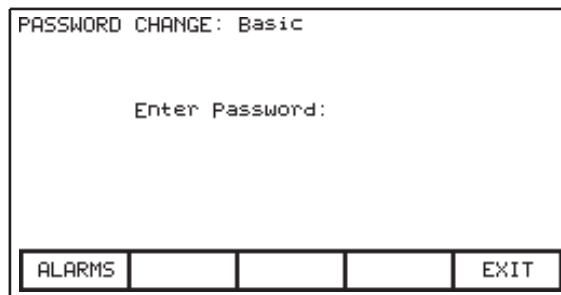


Figure 189 - Changing the Access PIN

Enter the current PIN using the data keys [0]-[9] and press [Enter]. The interface masks the entry with asterisks in the edit field. Use [Backspace] to edit the entry if necessary.

When prompted, type the new PIN and press [Enter]. Verify the new PIN by typing it again and pressing [Enter], as shown below.

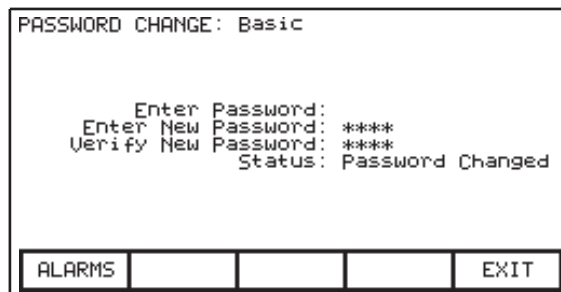


Figure 190 - Verifying PIN change

If you initially enter an invalid PIN or incorrectly verify the new PIN, the interface provides error messages. Return to the appropriate line and retype the correct or new PIN, then press [Enter].

Once the interface accepts the PIN change, press [F10] to exit.

Drive Configuration

This section describes how to:

- select alternate languages
- enter data in drive parameters
- assign tags to an analog port
- enable and disable a fault via a mask
- assign text to optional external fault inputs
- re-enter Setup Wizard
- configure the XIO link
- define tags as readable by a PLC.

Press [F8] to access the SETUP screen from the top level menu.



Figure 191 - Setup screen

The SETUP screen shows the current access level. 'Monitor'-level access restricts drive configuration access to view-only; you cannot edit settings. You must have 'Basic' access or higher to modify drive operations.

At power-up, the interface defaults to 'Monitor'-level access. Press [F8] to change the access level before beginning other configuration operations available from

this screen ([Figure 192](#)). Refer to [Configuring Access Levels on page 198](#) for more information.



Figure 192 - Basic access level

Language Selection

The drive supports multiple languages. The operator interface supports these via modules you must load from flash card (refer to [Flash Memory Transfers on page 224](#)).

To select an alternate language, press [F9] from the SETUP screen to see a list of currently-loaded language modules.

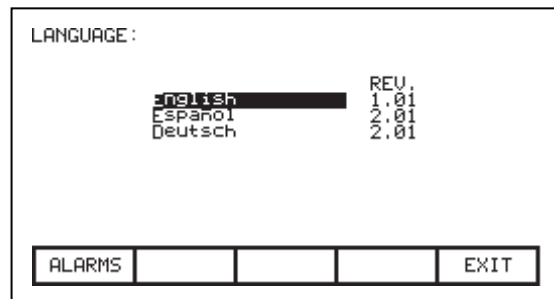


Figure 193 - Language listing

Each language also lists a revision level. Use ▲ or ▼ to select a language and press [Enter]. The interface switches to the selected language.

Other devices attached to the drive may request a language change. If this occurs, the operator interface will change languages if the required language module is available.

Modify Parameters

To change a parameter, use ▲ or ▼ on the SETUP screen to select the 'Parameters' option and press [Enter]. You can also select a parameter from a group on the DISPLAY screen ([Figure 213 on page 214](#)) by pressing [F7].

IMPORTANT To edit ANY parameter, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

The type of parameter you select determines the screen that follows.

Numerical Value

Selecting a parameter with a numerical value prompts the MODIFY PARAMETER screen, as in this example:

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

Figure 194 - Parameter data entry—numeric value

This screen shows:

- the parameter name (i.e. Rated motor volt)
- the parameter tag code (i.e. 22)
- the parameter’s configurable minimum and maximum limits (i.e. 4000 to 4160)
- the parameter data unit
- the current configured parameter value

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

Figure 195 - Modify Numerical Value

Use the data entry keys [0]-[9] to enter the new value. Type [-] to enter a negative value. Use [.] to enter a decimal point for fractional values. Edit the value by pressing [Backspace]. Press [Enter] to accept the new value as shown in [Figure 195](#). If the new value is outside the defined limits, the interface will not accept the new value. For example: If you type 900 when the minimum value is 4000, the value does not change.

Some data is HEX-only. For HEX values, use ▲ or ▼ to scroll through values 0-F for the right most digit. To accept the first digit and select a value for the second, press ►. Press [Enter] to accept the value. Edit HEX values by pressing [Backspace].

IMPORTANT The interface does not implement new values until you press [F10] to exit the screen. Prior to this you can modify the new value by repeating the above procedure, or cancel by pressing [F7]. Cancelling returns the option to the original value.

The interface does not implement new values until you press [F10] to exit the screen. Prior to this you can modify the new value by repeating the above procedure, or cancel by pressing [F7]. Cancelling returns the option to the original value.

Enumerated Value

For enumerated value parameters, the MODIFY PARAMETER screen looks like this:

MODIFY PARAMETER: Operating Mode				
				P: 4
Actual:		Normal		
New:		Normal		
ALARMS	CANCEL	ACCESS		EXIT

Figure 196 - Modify enumerated value parameters

This screen contains:

- the name of the selected parameter (i.e. Operating Mode)
- the parameter tag code (i.e. 4)
- the current parameter value

IMPORTANT To edit ANY parameter, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

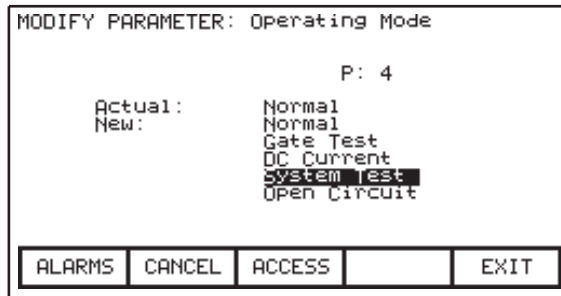


Figure 197 - Option List Viewed on Single Page

Use ▲ or ▼ to scroll through the options list. A triangle indicates additional pages of options in the list; scroll up or down to view, and press [Enter] to select a value

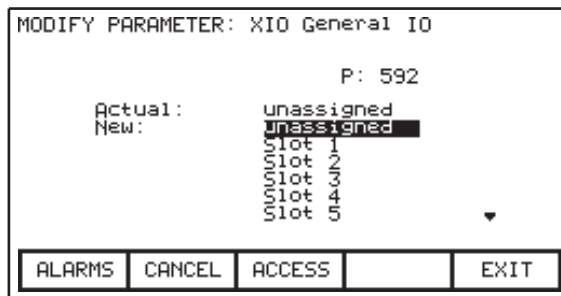


Figure 198 - Option List Viewed on Multiple Pages

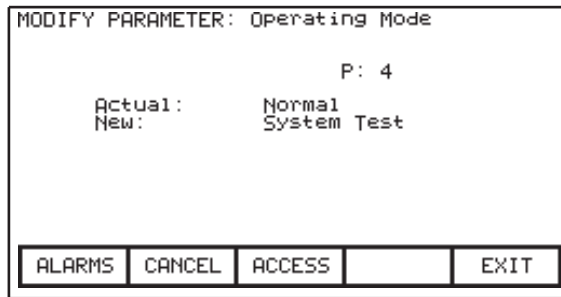


Figure 199 - Modification Completed

IMPORTANT The interface does not implement new values until you press [F10] to exit the screen. Prior to this you can modify the new value by repeating the above procedure, or cancel by pressing [F7]. Cancelling returns the option to the original value.

Bit-Encoded Value

When you select a bit-encoded parameter, the interface displays the following screen:

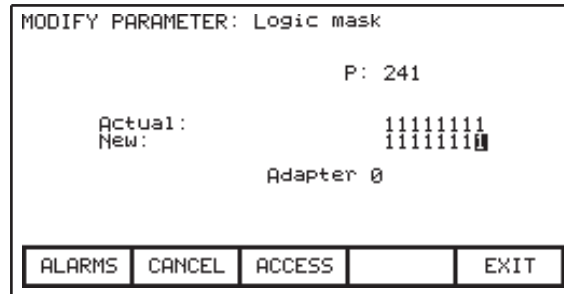


Figure 200 - Modify Bit Encoded Value

This screen shows:

- the name of the selected parameter (i.e. Logic Mask)
- the parameter tag code (i.e. 241)
- the selected bit (Adapter 0)
- the current value of the parameter bits.

IMPORTANT To edit ANY parameter, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

On this screen, use ◀ or ▶ to select bits within the parameter. The interface displays the name of each selected bit. Use ▲ or ▼ to toggle the bit state.

IMPORTANT The interface does not implement new values until you press [F10] to exit the screen. Prior to this you can modify the new value by repeating the above procedure, or cancel by pressing [F7]. Cancelling returns the option to the original value.

Analog Ports

You can assign any parameter to the drive's external analog ports. To configure an analog port, select 'Analog' from the SETUP screen and press [Enter].

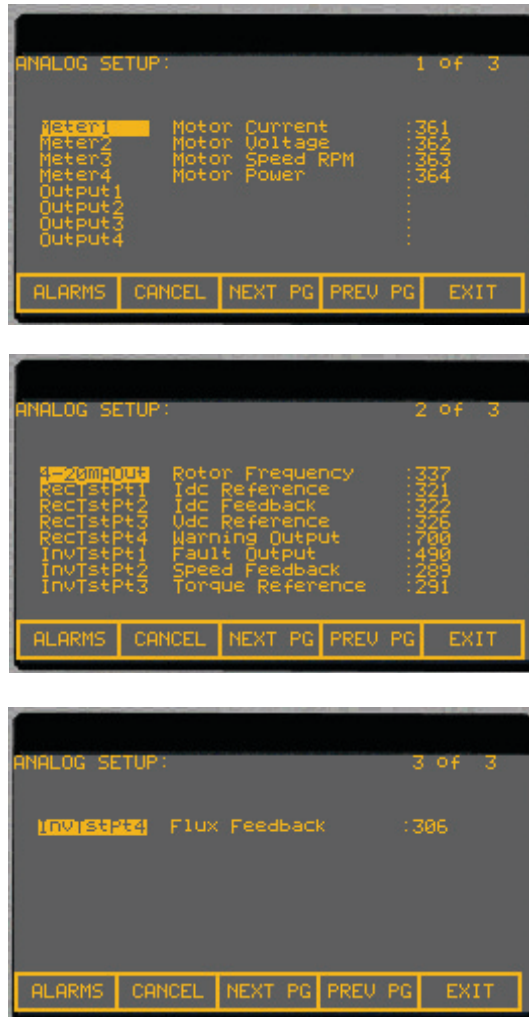


Figure 201 - Analog configuration

This screen shows the current tags and codes for each analog port.

To change the tag attached to a port, use ▲ or ▼ to select a port and press [Enter].

IMPORTANT To edit ANY parameter, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

Refer to [Selecting a Parameter on page 193](#) for more information on selecting options. When you complete the selection, the interface assigns the selected tag

to the port. To remove a specific assignment to the selected port, press [Backspace].

IMPORTANT The interface does not implement new values until you press [F10] to exit the screen. Prior to this you can modify the new value by repeating the above procedure, or cancel by pressing [F7]. Cancelling returns the option to the original value.

Fault Masks

You can selectively enable or disable certain drive faults. To view or modify the current fault mask settings, on the SETUP screen use ▲ or ▼ to select 'Fault Masks' and press [Enter].

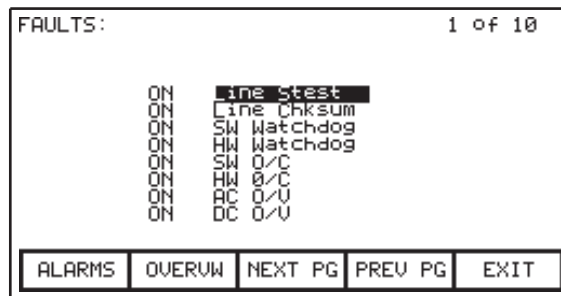


Figure 202 - Fault screen

The Fault screen lists all user-maskable faults and their current state. OFF indicates the fault is disabled. The normal state is ON, or enabled.

To enable or disable a mask, use ▲ or ▼ to select a fault and press [Enter]. Pressing [Enter] on a selected mask toggles the mask's state ON or OFF.

IMPORTANT To edit ANY parameter, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

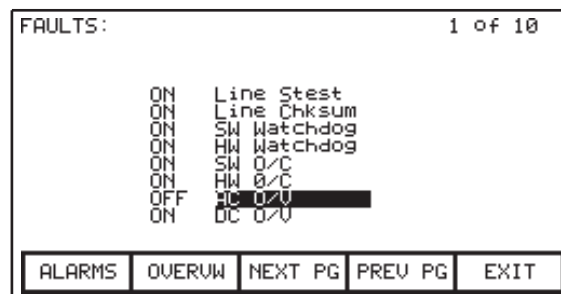


Figure 203 - Fault Mask OFF

The FAULT screen shows all fault masks regardless of their current state. To view fault masks according to their state, press [F7] on the FAULTS SETUP screen. This will display the FAULTS OVERVIEW screen, which may be similar to one of the samples below:

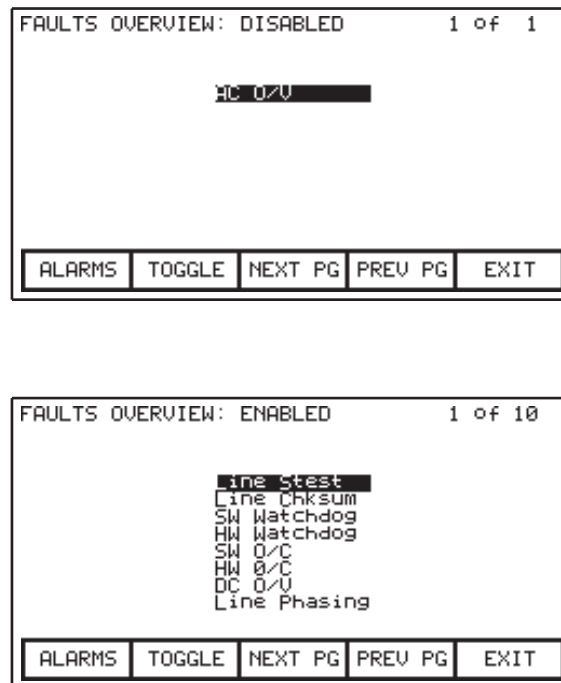


Figure 204 - Faults overview: View faults by state

The screen name indicates your selected view option (Disabled or Enabled faults). To change state selection, press [F7] to toggle the display to the other state.

To change a mask state on the FAULTS OVERVIEW screen, use ▲ or ▼ to select the desired mask and press [Enter]. In the first sample in [Figure 204](#) above, “AC O/V” is selected and disabled. Pressing [Enter] enables its mask and removes it from this screen. Pressing [F7] toggles the screen to show the enabled faults, including the enabled AC O/V mask.

IMPORTANT To edit ANY parameter, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

IMPORTANT The interface does not implement new values until you exit the screen. Prior to this you can modify the new value by repeating the above procedure, or cancel by pressing [F7]. Cancelling returns the option to the original value.

User-Definable External Text

You can customize the text for the drive's external fault inputs, which the interface uses on the alarm and the fault mask screens. To customize the text, select 'External Text' on the SETUP screen.

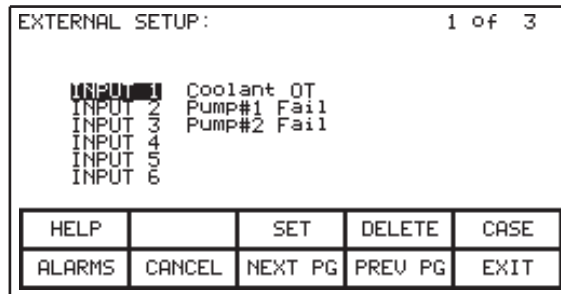


Figure 205 - External Setup Text

To modify the text attached to a particular fault input, use ▲ or ▼ to select an input and press ►. This highlights the first character in the string.

IMPORTANT To edit ANY parameter, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

Refer to [Text Editing on page 196](#) for information on editing parameter text. When you complete the text entry, press [Enter] to see screens similar to this example:

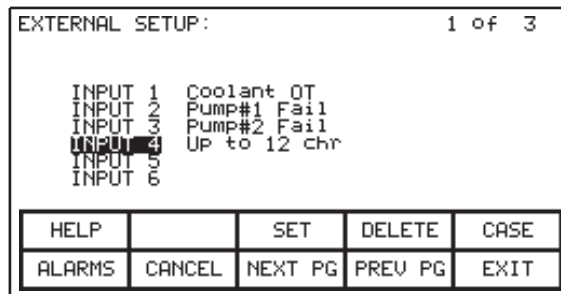


Figure 206 - Modification Completed

IMPORTANT The interface does not implement new values until you press [F10] to exit the screen. Prior to this you can modify the new value by repeating the above procedure, or cancel by pressing [F7]. Cancelling returns the option to the original value.

PLC

You can optionally connect the drive to a PLC via a RIO (Remote Input/Output) adapter. The PLC reads the drive as a rack of information. The tags associated with each word within a rack are user-definable. To configure the PLC link, select 'PLC' on the SETUP screen and press [Enter].

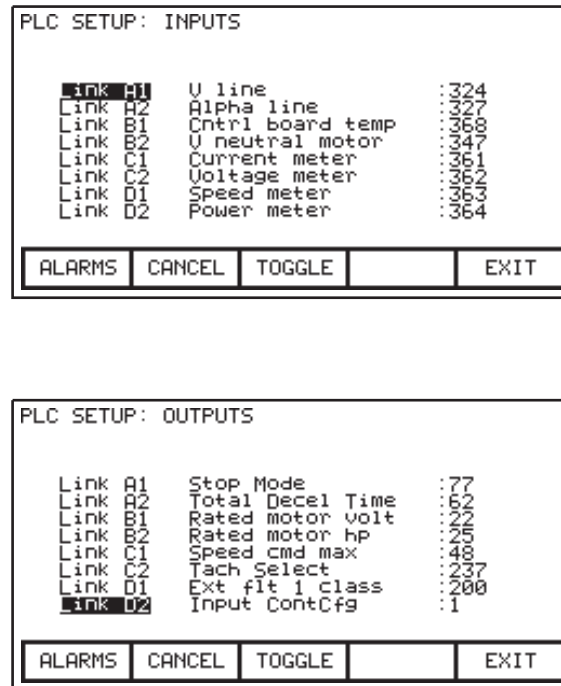


Figure 207 - PLC Input/output links

The PLC setup consists of eight words of input and eight words of output, appearing on separate screens, shown in [Figure 207](#). Press [F8] to toggle between INPUT and OUTPUT screens.

The layout of the PLC rack depends on 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). The drive assigns tags to rack module locations in pairs (or “links”) that consist of two input and two output words. You can assign a total of four links to the RIO adapter.

The screens show the current tags and tag codes associated with each link. To edit a link tag, use ▲ or ▼ to select a link and press [Enter].

IMPORTANT To edit ANY parameter, you require an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

Refer to [Selecting a Parameter on page 193](#) for more information on selecting options. When selecting a tag for output words, only editable parameters appear. Both parameters and read-only parameters appear for input words.

To remove an assignment for the selected link, press [Backspace].

IMPORTANT The interface does not implement new values until you exit the screen. Prior to this you can modify the new value by repeating the above procedure, or cancel by pressing [F7]. Cancelling returns the option to the original value.

XIO

The drive uses XIO adapters to hardwire to discrete inputs and outputs. Each drive contains one or more of these modules, which has a unique address according to where it attaches on the link. This address value appears on the module's LED display. Configure the drive with these address values to link them to specific drive parameters.

To configure the XIO, select 'XIO' on the SETUP.

IMPORTANT This feature is currently inactive and is reserved for future enhancements.

Message Prompting

The drive stores all configuration changes in volatile memory, meaning that if the drive loses power, it also loses record of those changes. To permanently record changes, the drive must store configurations in NVRAM memory.

When you finish configuring drive data, the interface prompts you to save the data as shown:

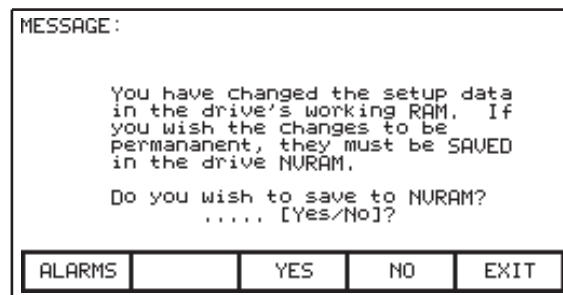


Figure 208 - Prompt to save configuration data

Press [F8] for 'Yes' to save the data. The interface will track the save status:

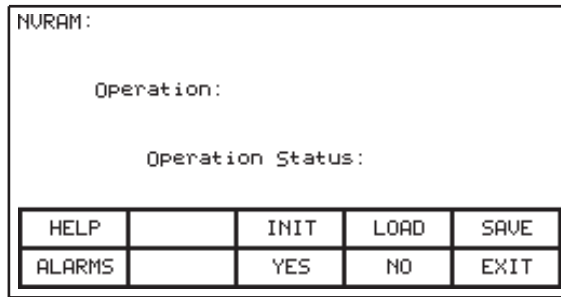


Figure 209 - NVRAM status screen

To save the data in temporary RAM only, press [F9] for 'No'. Press [F10] to return you to the previous screen.

Store/Retrieve Configuration (NVRAM)

Save the data later by accessing the NVRAM screen from the top-level menu (press [F5]). From the NVRAM screen you can access several drive memory operations, if you have the proper access level. Refer to [Configuring Access Levels on page 198](#) for more details.

Initialize

The drive contains a default set of parameters and operational information that form the basis for drive configuration. To initialize the drive with the default data, press [F3] on the top-level menu.

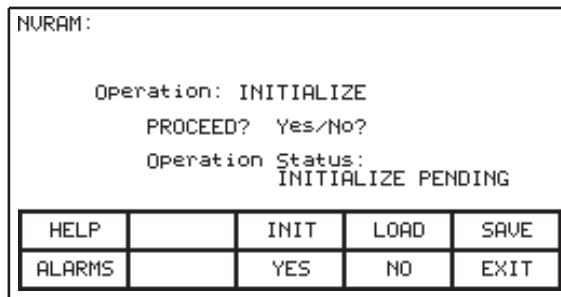


Figure 210 - Initialize operation

When prompted to confirm the operation, press [F8] to proceed or [F9] to abort. Initialization overwrites the data currently in the drive, but does not affect previous changes saved to NVRAM.

Save

Save the drive configuration changes if you do not want to lose the data when the drive powers off. To save the changes, press [F5].

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

Figure 211 - Save operation

To confirm the operation, press [F8] to proceed or [F9] to abort. Saving the data overwrites any previously-stored data in the NVRAM.

Load

When the drive powers up, it uses configurations stored in NVRAM. If you reconfigure drive data (without saving), then wish to use the previously stored data, press [F4]:

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

Figure 212 - NVRAM download operation

To confirm the download, press [F8] to proceed, or [F9] to abort. Loading the data overwrites the drive's current configuration data.

Display Parameters

You can configure the interface to constantly display the drive parameters. From the top-level menu, press [F4]. The DISPLAY GROUP screen shows one or

more pages of groups, depending on the current access level. Use the ▲ or ▼ to choose a display group, and press [Enter].

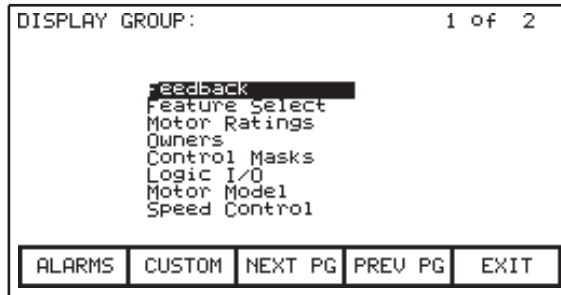


Figure 213 - Display groups

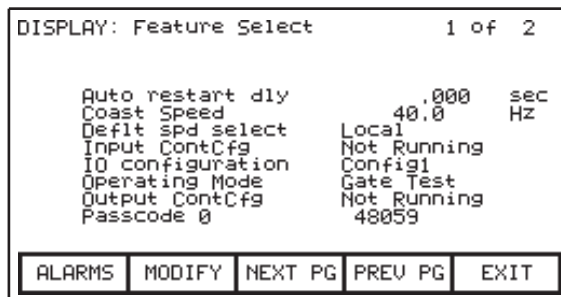


Figure 214 - Feature Select Group Chosen

The DISPLAY screen (Figure 213, Figure 214) shows the selected group name (“FEATURE SELECT”), and one or more pages of group options, as well as the tag value and its unit of measurement.

Bit-encoded values display a hex value for the parameter value. Use ▲ or ▼ to select the bit-encoded parameter and press [Enter].

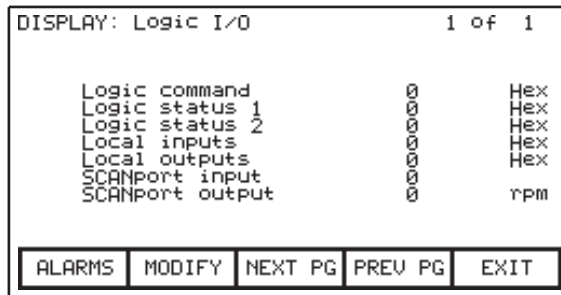


Figure 215 - Bit-encoded parameter

The VIEW PARAMETER screen displays the selected parameter, decoded per bit as shown below.

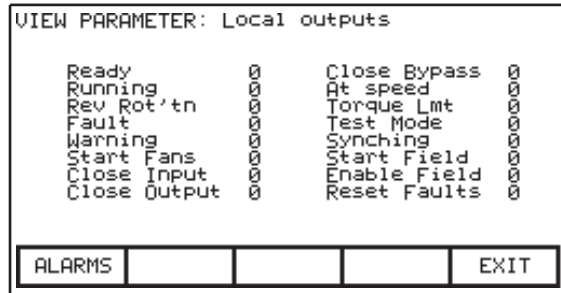


Figure 216 - Bit description for local outputs

The screen shows the name of the bit and the current bit value within the parameter.

The drive updates all of these values on a continual basis.

You can modify parameters from the DISPLAY screen. If the current group contains editable parameters, press [F7] to select a parameter. Refer to [Modify Parameters on page 202](#) for further details.

If you have modified any drive parameters, the interface prompts you to permanently save your changes when exiting the DISPLAY GROUP screen. Refer to [Message Prompting on page 211](#) for further details.

Custom Group

From the DISPLAY GROUP screen ([Figure 213 on page 214](#)), press [F7] to select a custom-defined group. This custom group contains selected tags from one or more other groups in a single screen for more convenient viewing.

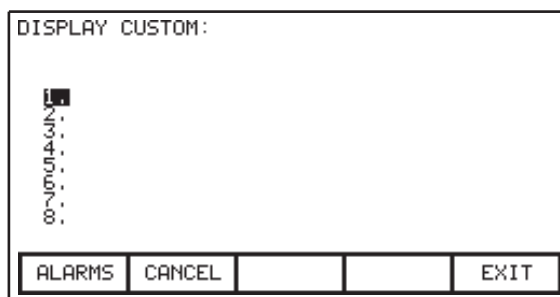


Figure 217 - Display Custom screen

To assign a tag to the display, use ▲ or ▼ to select an item position and press [Enter]. Refer to [Selecting a Parameter on page 193](#) for more information on selecting options.

When you complete the selection process, the interface assigns the selected tag to the item, as in the example below.

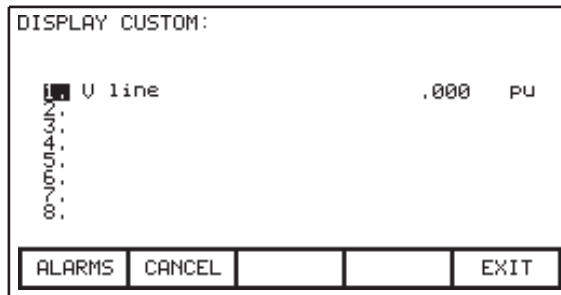


Figure 218 - V Line assigned

To remove a tag from the highlighted item, press [Backspace].

IMPORTANT The interface does not implement new values until you press [F10] to exit the screen. Prior to this you can modify the new value by repeating the above procedure, or cancel by pressing [F7]. Cancelling returns the option to the original value.

View Drive Status

View the drive status at any time by pressing [F7] from the top-level menu. This screen constantly displays the current drive state.

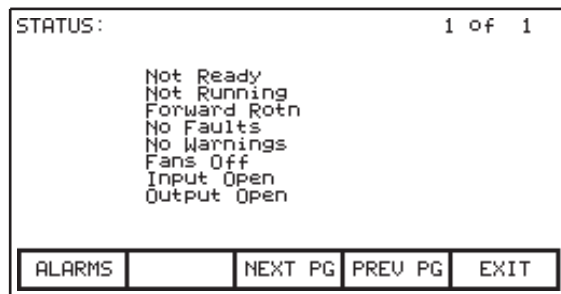


Figure 219 - Status screen

View and Reset Alarms

The drive logs all faults and warnings to their respective queues. Collectively the faults and warnings comprise a message category called “Alarms”. When a new alarm occurs, the F6 key on any screen begins to flash. Pressing [F6] when it flashes opens the ALARM SUMMARY screen.

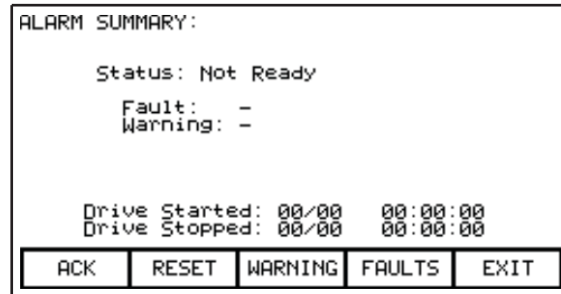


Figure 220 - Alarm Summary Screen

The screen displays the current drive status, as well as the last active fault that tripped the drive, and any pending warning.

IMPORTANT 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.

The alarm summary includes a time and date stamp, indicating the last start/stop time for the drive.

To acknowledge the alarm(s), press [F6], which stops the flashing. (If a new alarm occurs, the [F6] key will flash again.)

Press [F7] to reset any latched faults in the drive. This has no action upon either the fault or warning queues; if faults persist, they will re-queue as new faults.

The drive stores faults and warnings in separate queues. As both function similarly, this section details only the fault queue as an example. To access the fault queue, press [F9] from the ALARM SUMMARY screen.

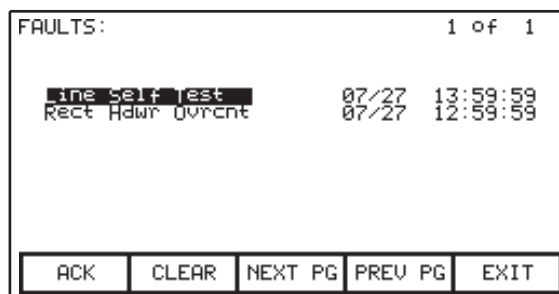


Figure 221 - Fault queue

The FAULT QUEUE screen shows all faults in chronological order of occurrence with a date and timestamp, most recent first. Use [F8] and [F9] to scroll if there are multiple pages in the queue. The interface does not delete entries from the queue you manually select and delete entries using [F7]. If the queue becomes full, the interface discards the oldest entries.

Help for Alarms

Help text is available for some alarms. Use ▲ or ▼ to select an alarm and press [Enter]. An ALARM HELP screen, such as the sample below, appears.

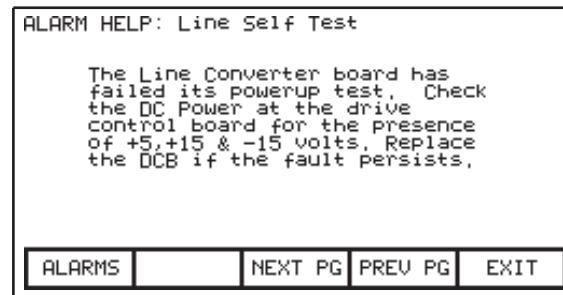


Figure 222 - Alarm Help

The interface provides an error message if there is no help available for a selected alarm.

Request Printouts

When the drive contains an optional printer, you print hard copies of the terminal data by requesting printouts from the PRINTER screen. Press [F3] from the top-level menu.

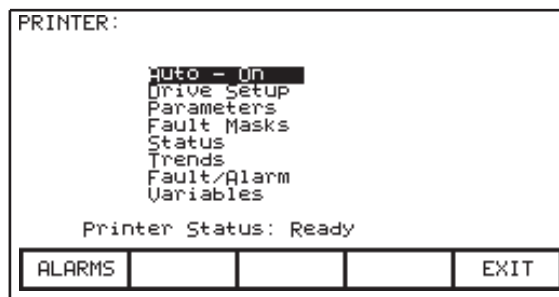


Figure 223 - Typical printer screen

A typical printer screen shows the current printer status and the available report types. (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.) Use ▲ or ▼ to select a report and press [Enter] to send the report to the printer.

The printer can automatically print out the alarms as they occur if you select this feature as one of the report formats. In [Figure 223](#), the “AUTO - ON” option indicates this feature is enabled. To disable the alarm printout feature, use ▼ to select the option and press [Enter]. The option registers “AUTO - OFF” (if a printer is attached). Pressing [Enter] toggles the option setting.

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 applies
- define the trigger condition to begin the trend
- define the sampling rate and position of the trigger
- view the results of the trend

Press [F9] to access the DIAGNOSTIC TREND screen from the top-level menu.

DIAGNOSTICS:				
Trigger:				
Status: UNPROGRAMMED				
Last Trigger: Not Available				
HELP	FORCE			
ALARMS	RE-ARM	D_SETUP	VIEW	EXIT

Figure 224 - Diagnostic screen

From this screen, you can perform additional diagnostic trending functions. The screen shows the current status of the trend (Unprogrammed, Running, Triggered, Stopped). If there are defined triggers, the trigger parameter, trigger condition, and the type of trigger also appear.

If the interface has already captured data, the display includes a time stamp indicating trigger's last occurrence. View the captured data by pressing [F9].

If a defined trigger is currently “Stopped”, re-start it by pressing [F7]. If the status is “Running”, you can force the trigger to occur by pressing [F2]. Note that in doing so, that the trigger condition does not actually occur, but the drive buffers all data for viewing as if the condition has occurred.

To define a trend, press [F8] to open the configuration screen.

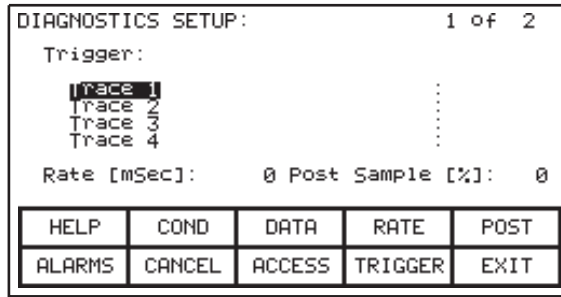


Figure 225 - Diagnostics setup

From this screen, assign tags to a trace. The tag which you assign to the first trace 'Trace 1' becomes the trigger parameter.

By default, when assigning a tag to Trace 1, the trigger value (i.e. data) is the tag's minimum value and the trigger condition is 'equal to'. Assign a tag to Trace 1 before defining the trigger value or condition. Use this screen to configure the interval between samples (i.e. Rate), and the trigger point location within the view buffer. By default, the trigger occurs in the middle of the buffer; change this by indicating the percentage of samples that follow (i.e. Post) the trigger point.

Assigning a Trace

To assign a tag to a trace, use ▲ or ▼ to select a trace from the list and press [Enter].

IMPORTANT To edit ANY parameter, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

Refer to [Selecting a Parameter on page 193](#) for more information on selecting options.

When you have completed the selection process, the interface assigns the tag to the trace, as shown below. To remove a tag from the highlighted trace, press [Backspace].

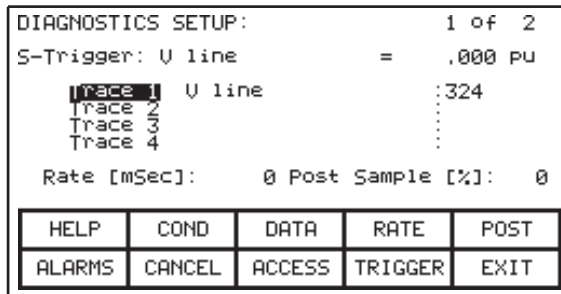


Figure 226 - Assign a trace

Setting the Trigger

After assigning a tag to Trace 1, configure the trigger value by defining the following:

- trigger type (press [F9])
- trigger condition (press [F2])
- trigger value (press [F3])

There are two types of triggers:

- single trigger: occurs once and stops; you must manually re-arm. (Default)
- continuous trigger: re-arms itself, continues to collect new trends until viewing collected data stops it.

The interface indicates the current type of trigger as 'S' or 'C', prefixed to the Trigger label (see [Figure 226](#)). To toggle types, press [F9].

Set the trigger condition and trigger value using [F2] and [F3] respectively. Highlight any field to edit.

Set the condition to one of following options using ▲ or ▼ to scroll through the list. Press [Enter] to accept the selected option.

Trigger Conditions:

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

Set the value (data) using the data entry keys [0]-[9]. Use [-] to indicate a negative value. Use [.] to enter a decimal point for fractional values. Edit the field value by pressing [Backspace] to clear the field from right to left. Press [Enter] to accept the new value, as shown in [Figure 227](#).

If you attempt to enter a new value outside the value's defined limits the interface defaults the value to the nearest limit. For example: if you enter 900 when the minimum value is 1000, the new value will be 1000.

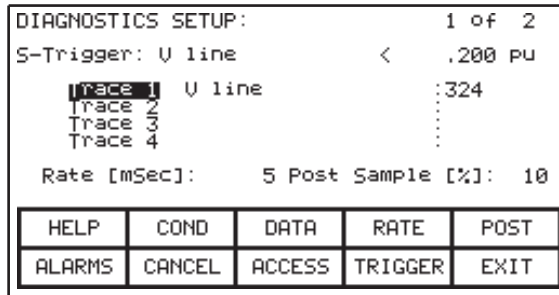


Figure 227 - Trigger condition

Some data is HEX-only. For HEX values, use ▲ or ▼ to scroll through values 0-F for the right most digit. To accept the first digit and select a value for the second, press ►. Press [Enter] to accept the value. Edit HEX values by pressing [Backspace].

Defining Sample Rate and Positioning

Press [F4] to configure sample rates, from 0 msec (maximum collection speed) to 20.000 seconds.

When the drive collects samples, it uses part of the buffer to store values prior to the trigger point, and the remainder of the buffer for values after the trigger. Press [F5] to define the percentage of the trend buffer to allocate to values collected after the trigger occurrence. Edit this data field in the same manner as the trigger data.

Starting the Trace

IMPORTANT The interface does not implement new values until you press [F10] to exit the screen. Prior to this you can modify the new value by repeating the above procedure, or cancel by pressing [F7]. Cancelling returns the option to the original value.

The trend begins as soon as you press [F10], and the interface displays a screen similar to the example below, show both trigger condition and status. Pressing [F7] 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 228 - 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 229 - Diagnostic triggered

Once the drive begins collecting data, the diagnostic status shows 'TRIGGERED'. When the buffer configured for a single trigger contains a complete capture, the message displays 'STOPPED' (see [Figure 230](#)), along with the occurrence time and date stamp. The trend buffers are viewable only when 'STOPPED'.

In continuous mode, the capture stops when you press [F9] to view the buffers.

DIAGNOSTICS:				
Trigger: U line = .000 pu				
Single				
Status: Stopped				
Last Trigger: @ 14:15:35 00/10/06				
HELP	FORCE			
ALARMS	RE-ARM	D_SETUP	VIEW	EXIT

Figure 230 - Diagnostic stopped

DIAGNOSTICS VIEW:				7 of 13
Trace 1 [HZ]	Trace 2 [HZ]	Trace 3 [PU]	Trace 4 [PU]	
4.9	4.9	.000	.000	
T->.1	.1	.000	.000	
.1	.1	.000	.000	
.2	.2	.000	.000	
.3	.3	.000	.000	
.4	.4	.000	.000	
.4	.4	.000	.000	
ALARMS				NEXT PG PREV PG EXIT

Figure 231 - View the Trend Buffer(s)

Initially, the trend view screen (similar to [Figure 231](#)) identifies the trigger point by the “T ->”. To view data either side of the trigger point, press [F8] or [F9].

Changes made to the diagnostic list setup are not permanent until you save them to the NVRAM. The interface will prompt you on exiting the DIAGNOSTICS screen to save the changes to NVRAM. Refer to [Message Prompting on page 211](#) for further details.

Flash Memory Transfers

The drive uses flash memory to store data in a stable format that is not lost when power is disrupted. The operator interface contains flash memory in two forms. The first is built into the operator interface, and stores the interface’s firmware and drive parameters. You can also store this information on a removable flash memory card.

This second form of (removable) flash enables you to physically transfer data from one drive to another drive. All files on the flash card use a DOS format, readable or writable by any PC containing a PCMCIA drive. PowerFlex 7000 drives support flash memory cards with the following INTEL memory chips:

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

The following memory cards from Rockwell Automation employ these chips:

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

Transferring information between these two forms of flash memory and the drive may require you to:

- format a flash card
- open the file directory on a flash card containing the DOS file format
- select and load a program (firmware) from the flashcard to 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 previously-saved in the operator interface
- load a language module from the flash card.

Access the Transfer operations from the UTILTY screen by pressing [F7] from the top-level menu.

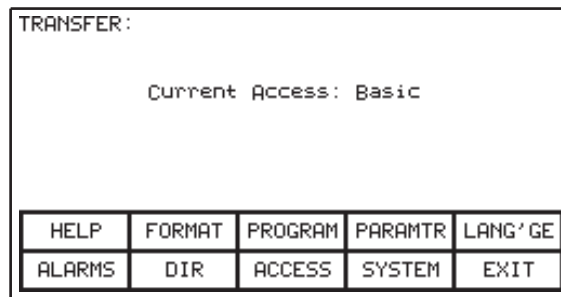


Figure 232 - Transfer Main Menu

You can access additional flash memory or transfer functionality from this screen.

IMPORTANT To edit ANY option, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive parameters. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

Format Flash Cards

Flash card files have a characteristic unlike normal DOS files. Once written, you cannot modify them. You can add new files, but you cannot selectively remove them.

When using a new flash card or removing all files from an existing card, you must format the card first. This erases any data on the card and creates a DOS file structure.

To format a card press [F2] on the TRANSFER screen.

IMPORTANT This feature requires an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access this function. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

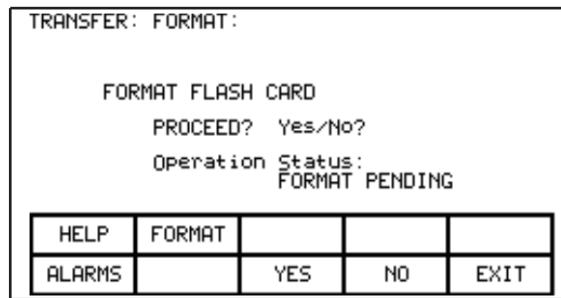


Figure 233 - Format the Flash Card

The interface prompts you to confirm the operation. Press [F8] to proceed, or [F9] to abort. Formatting the card overwrites all existing data on the flash card, and can take up to several minutes. The screen status indicates when the formatting is complete or if an error occurred.

Format additional cards from this screen by pressing [F2].

View a Directory

View the card directory by pressing [F7] on the TRANSFER screen. The directory shows the filename and extension, along with the file creation date and time stamp.

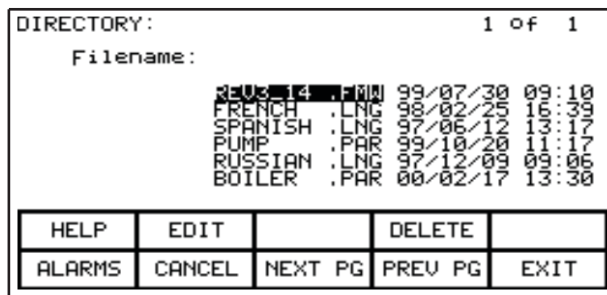


Figure 234 - Flash card directory

When you view the directory from the TRANSFER screen, at the listing includes all files on the flash card. When you view the directory from another operations screens, only the files that are relevant to the current operation are visible.

Only the card's root directory is visible, as the operator interface does not support sub-directories.

Select/Enter a Filename

From the DIRECTORY screen is entered, use ▲ or ▼ to select a file and press [Enter] to proceed with the operation.

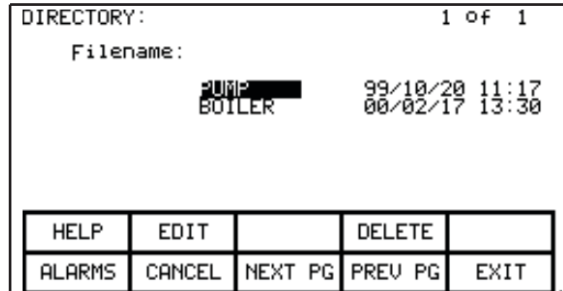


Figure 235 - Typical File Selection

Press [F10] to abort the selection and return to the previous screen.

When you create a new file, use the DIRECTORY screen to enter the new filename. You can use an existing filename as a basis for a new one by selecting an existing one, pressing [F2], and editing. Refer to [Text Editing on page 196](#) for further details. When finished, press [Enter] to proceed with the operation.

Loading Firmware

Firmware is the programming the drive runs to provide all of the operator interface functionality. Load firmware from the flash card in one of two ways:

- If a memory card is present when you initially power up or reboot the operator interface, and that card has a valid firmware file with the extension of .FMW, the operator interface automatically loads the first .FMW file on the card. —OR—
- You can select and load a .FMW file from the card to the operator interface, as described in the following section.

From the TRANSFER screen, press [F3] to access the DIRECTORY screen. Refer to [Select/Enter a Filename on page 227](#) for instructions on selecting a file from the listing.

IMPORTANT To use this feature, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to use this function. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

Once you select a file, the TRANSFER: PROGRAM screen shows the filename, the operation in progress, and the current status of that operation.

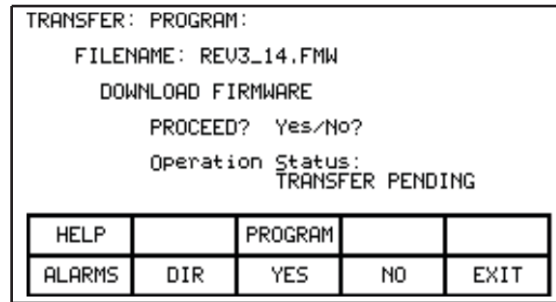


Figure 236 - Load New Firmware

The interface prompts you to confirm the operation. Press [F8] to proceed, or [F9] to abort.

IMPORTANT Downloading firmware will overwrite the existing firmware on the drive.

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

Because firmware updates over-write current operations in progress, all other operator interface functions stop during a download. Once the download begins, the operator interface’s screen cannot update any status information. For this reason, use the two LEDs on the back of the operator interface as system indicators:

- Flashing green - operating system is healthy and the transfer is proceeding.
- Solid red - the transfer failed. You must load firmware via the first method described above. Cycling power to the operator interface, or simultaneously pressing the ◀, ▶, and [Enter] keys simultaneously with the flash card inserted. If the card holds multiple firmware files, the drive loads the first one automatically; you must repeat this process in order to select the correct firmware file.

When the transfer completes successfully, the new firmware automatically begins operation on boot-up. Refer to [Operator Interface Power-up Sequence on page 183](#) for information on powering up the interface.



WARNING: Any time you boot up the operator interface with a flash card containing a valid firmware *.FMW file, the operator interface will attempt to load new firmware. For this reason, do not leave a memory card containing firmware files in the operator interface after you complete a firmware download.

Parameter Transfers

The drive stores operational parameters locally on the drive itself. Use the operator interface to review and modify these parameters. When you change a drive control board, you must copy the parameters onto the new board. The operator interface simplifies this process by reading the parameters from the old drive control board and storing them temporarily in either the interface or on a flash card. After you install the new board, the interface downloads the stored parameters to the new board.

The flash card provides an added benefit when multiple drives use the same parameters. You can configure parameters on the first drive, then copy the configuration to a flash card, take the flash card to the remaining drives, and download them to the other interfaces.

IMPORTANT This feature does not replace saving parameters to the drive NVRAM. Refer to [Store/Retrieve Configuration \(NVRAM\) on page 212](#). After downloading parameters, you must still save them within the drive to make them permanent.

To transfer parameters, press [F4] from the TRANSFER screen. Within this screen it is possible to perform four different parameter transfers.

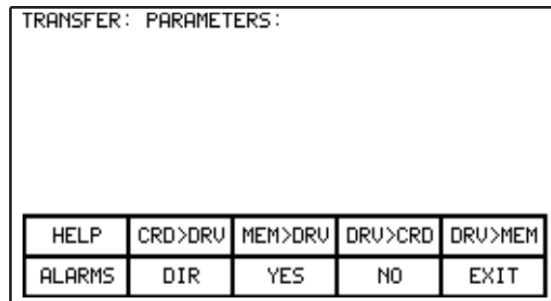


Figure 237 - Transfer Parameters Menu

Upload to Operator Interface

Press [F5] to read parameters from the drive and upload them to the operator interface. The screen prompts for confirmation. Press [F8] to proceed, or [F9] to abort. Performing a “DRIVE TO MEMORY” transfer overwrites any previous parameters stored within the operator interface.

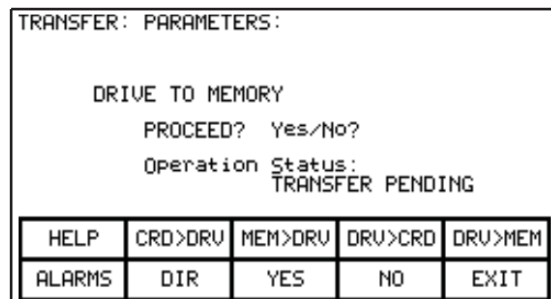


Figure 238 - Transfer Stored Parameters

Download from Operator Interface

Press [F3] to download the parameters stored in the operator interface to the drive. The screen will be similar to [Figure 238](#), except the operation will show “MEMORY TO DRIVE”. Press [F8] to confirm the operation, or [F9] to abort. Performing a “MEMORY TO DRIVE” transfer overwrites the active parameters in the drive, but does not affect the parameters stored in NVRAM.

After you download parameters, the screen prompts you permanently save the new configuration. Refer to [Message Prompting on page 211](#) for further details.

Upload to Memory Card

Press [F4] to read the parameters from the drive and copy to a memory card. On the DIRECTORY screen, enter a parameter filename. Refer to [Select/Enter a Filename on page 227](#). When you enter the filename, the TRANSFER: PARAMETERS screen displays the filename, the operation in progress, and the current operation status.

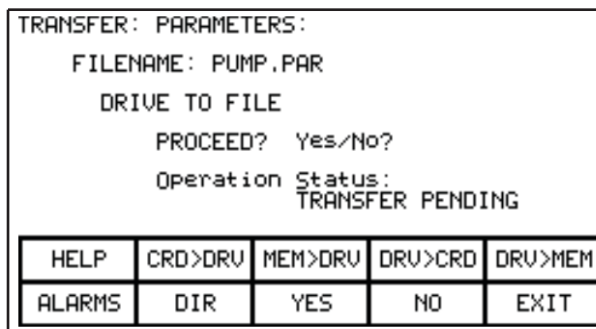


Figure 239 - Transfer File Parameters

The screen prompts for confirmation. Press [F8] to proceed, or [F9] to abort. Press [F4] to restart an aborted transfer or one that failed. To select or enter a different filename, press [F7].

Download from Memory Card

Press [F2] to copy the parameters from a flash card to the drive. On the DIRECTORY screen, select or enter an existing parameter filename. Refer to [Select/Enter a Filename on page 227](#). When you enter the filename, the TRANSFER: PARAMETERS (similar to [Figure 239](#), except the operation will show “FILE TO DRIVE”) displays the filename, the operation in progress, the current operation status.

The screen prompts for confirmation. Press [F8] to proceed, or [F9] to abort. Press [F4] to restart an aborted transfer or one that failed. To select or enter a different filename, press [F7].

Parameter File Format

The stored parameter file on the flash card is in a DOS file format. You can create the parameter file off-line on a PC using any ASCII text editor, then copy it to the memory card via a PCMCIA card drive.

This section is not necessary to operate the interface. It is required knowledge if you wish to create a parameter file off-line and then download into a drive.

You must use the filename extension “*.PAR” to indicate a parameter file. The file format is:

- 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.
- Remaining Lines:
 - each line contains one parameter, consisting of the linear parameter number followed by a semi-colon, and the parameter value followed by a semi-colon, as in these examples:
1;0;
2;0;
5;2;

Loading Language Modules

To use a language in the operator interface, load it into the operator interface from the flash card.

From the TRANSFER screen, press [F5]. On the DIRECTORY screen, select or enter an existing language module filename. Refer to [Select/Enter a Filename on page 227](#).

IMPORTANT To edit drive operations, you must have an access level above 'Monitor'. Press [F8] and enter the appropriate PIN to access and modify drive operations. Refer to [Configuring Access Levels on page 198](#) for more information on access security.

When you select a filename, the TRANSFER: LANGUAGE screen displays the filename, the operation in progress, and showing the operation status.

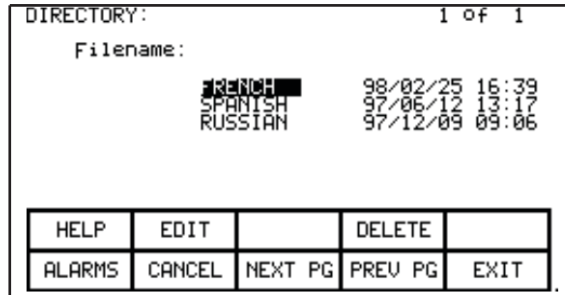


Figure 240 - Language Directory

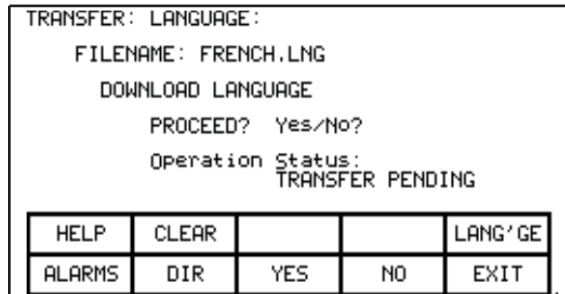


Figure 241 - Transfer Language Module

The screen prompts for confirmation. Press [F8] to proceed, or [F9] to abort. If you attempt to download a language module that already exists, the transfer fail.

To download a newer version of a language, you must first remove all languages in the operator interface (this is a characteristic of flash memory) by pressing [F2] on the TRANSFER:LANGUAGE screen. The screen prompts for confirmation. Press [F8] to proceed, or [F9] to abort.

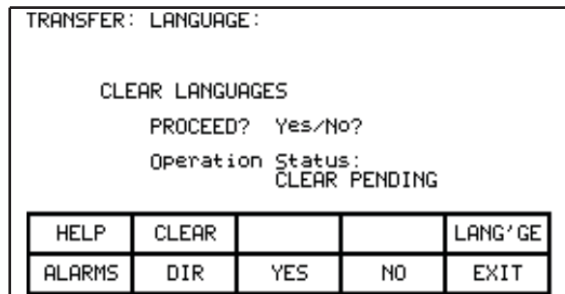


Figure 242 - Clear Languages

Press [F5] to restart an aborted download or one that failed. To select or enter a different filename, press [F7].

System Programming

You can also update the firmware for the complete drive system via serial port #2 on the customer interface board. Press [F9] from the transfer screen to place the drive system into download mode.

Advanced Screen Operations

There are a number of advanced functions built into the operator interface that are not required to operate the drive. They are meant as service tools for trained technicians and are included here only for completeness.

All operations are accessed via a two-key sequence.

Communications Statistics

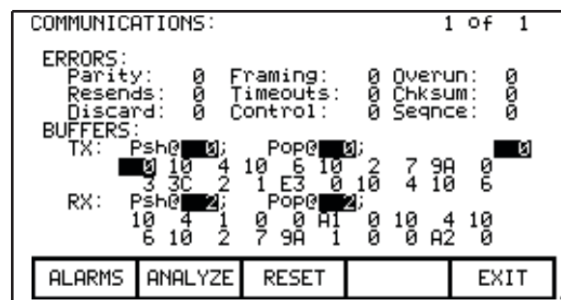


Figure 243 - Communications Statistics & Buffer

[Figure 243](#) shows statistics for serial communications between the operator interface and the drive, and the Transmit (TX) and Receive (RX) buffers' contents. Call the statistics function from any screen (except PRINTER) by pressing [F10] + ▼ simultaneously.

Figure 244 - Communications Statistics & Buffer

ERRORS indicate the occurrences of a particular error since the last time you reset the counters.

- 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 [F8].

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 [F7]. The screen shows the data and the relationship of the data exchanged between the operator interface and the drive board. This data appears in one of two formats:

- the data shown in hexadecimal ([Figure 245](#))
- the data shown as a mixture ([Figure 246](#)) of:
 - control characters
 - printable ASCII characters
 - hexadecimal data.

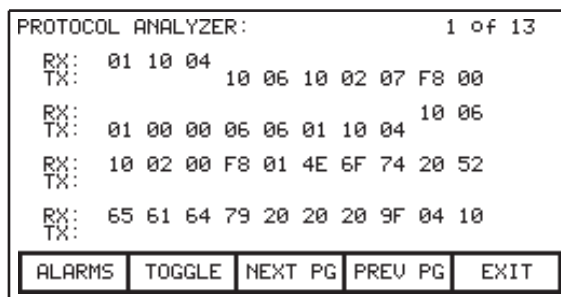


Figure 245 - Hexadecimal Displayed

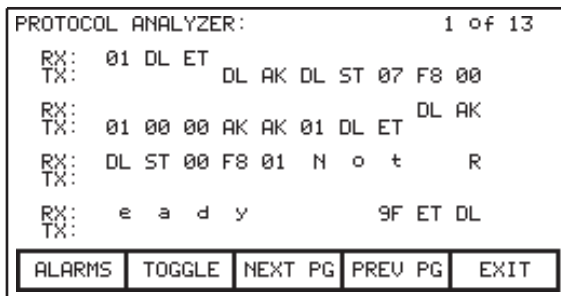


Figure 246 - Mixed Format Displayed

Pressing [F7] changes the displayed data format. When data appears 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 creates a “screen dump” of the operator interface display. This uses a second RS232 port communicating at 9600 baud to an external computer. The receiving computer requires special software to receive and interpret the data.

Call this function from any screen by pressing [F10] + **▶** simultaneously. The screen clears, and a message indicates that the interface is transmitting the screen print, and the job progress. When complete, the original screen reappears.

Memory Dump

The memory dump enables you monitor any directly accessible memory (i.e. memory that does not require access through a port). Call this function from any screen (except PRINTER) by pressing [F10] + **◀** simultaneously.

```

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

```

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

Figure 247 - Data Segment Memory Dump

The initial screen, ([Figure 247](#)) shows the data segment by default. Each screen shows the current segment (in hex). The left column displays the starting address (in hex) for that row of data, eight bytes of data (in hex), and the equivalent eight ASCII characters (if relevant). Additional data within the segment is available by pressing [F8] or [F9].

To change the current segment and/or offset, press [F7] to edit the segment:offset (Figure 248). Pressing [F7] toggles between the segment and offset values, and the highlight indicates which field to edit.

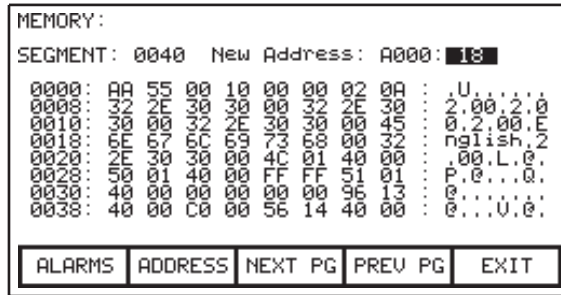


Figure 248 - Edit the Segment: Offset

Edit the segment:offset address via the numeric keypad (values [0]-[9]) and arrow keys. To enter a value [A]-[F], use ▲ or ▼ to cycle through the values; you can also enter numeric values this way.

When you enter a character using an arrow key, press ► to accept the character and move to the next position in the field. Use ◀ to edit or remove the previous character. When finished, press [Enter] or [F7] to accept the field entry. Press [Delete] to abort the edit.

The screen displays the data at the relevant address, as shown in Figure 249.

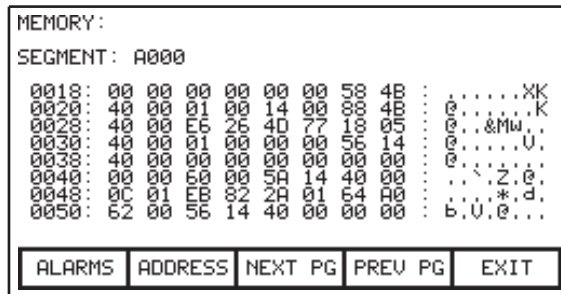


Figure 249 - Data at New Address

Database Download

The database download operation enables the operator interface to obtain required information on demand. Call this function from any screen by pressing [F10] + ▲ simultaneously.

Obtaining the entire drive database is a lengthy process, during which the interface displays the current database segment in download, and percentage complete. If the download is successful, the interface indicates completion and waits for user confirmation. If unsuccessful, the interface return to the screen from which you called the function. Abort the download at any time by pressing any key on the operator interface. Any already-downloaded segment of the database is valid. Subsequent download requests will resume from the termination point of the previous download.

This function always returns to the screen from which you called the function.

PCMCIA Memory Card

Installation Data

Use the following instructions to insert the memory card into the card slot on the back of the PowerFlex 7000 “B” Frame operator interface.



WARNING: Keep the memory card free from moisture, extreme temperatures, and direct sunlight. Do not subject memory card to flexing or extreme shock. Failure to observe these cautions could result in damage to the card.

Installing the Memory Card

1. Locate the vertical card slot on the back of the operator interface ([Figure 250](#)).

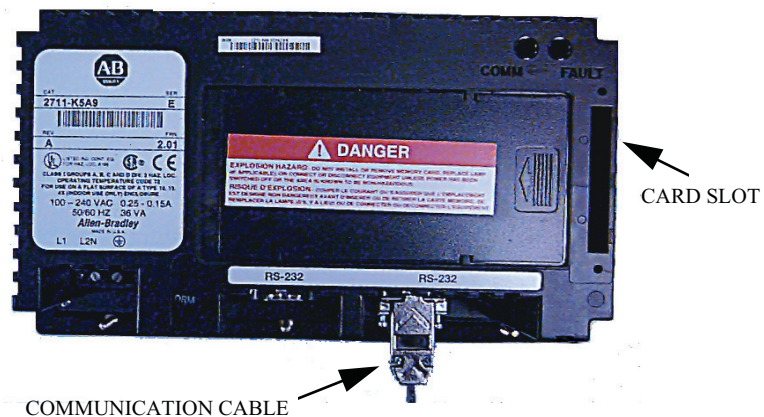


Figure 250 - Rear view of operator interface

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

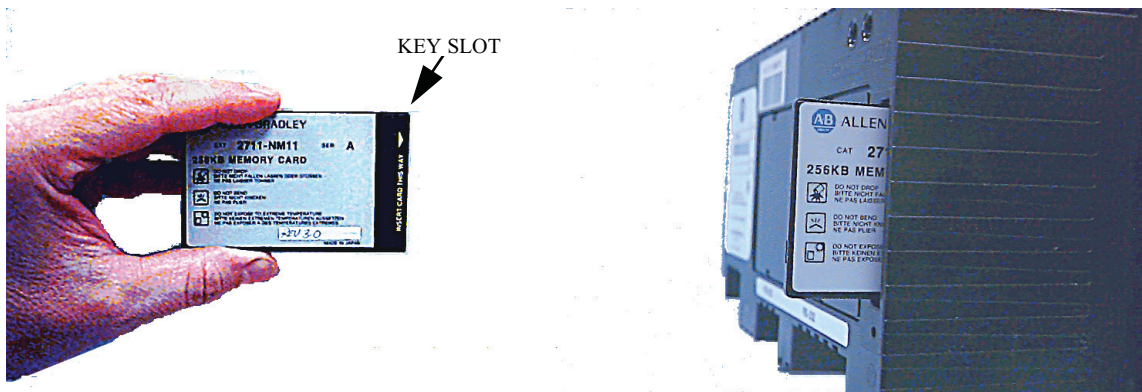


Figure 251 - Key slot orientation

3. Insert the card into the card slot and push until the card is firmly seated. Do not force the card into the slot. Forcing the card into the slot may damage the connector pins.

General Reference

Torque Requirements for Threaded Fasteners

Unless otherwise specified, use the following values of torque 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. 2l	27	20

Preventative Maintenance Schedule

Rockwell Automation recognizes that following a defined maintenance schedule improves your drive's performance and operational lifespan. By rigorously following this maintenance schedule, you can expect the highest possible uptime. Annual maintenance 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.

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 Drive Preventative Maintenance Schedule

Period Interval (Years)		0	1	2	3	4	5	6	7	8	9	10
Air-Cooling System	Door Mounted Air Filters ^{(1) (2)}	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
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 ⁽³⁾⁽⁴⁾		I	I	I	I/R ⁽⁴⁾	I	I	I	I/R ⁽⁴⁾	I	Rv/R ⁽⁴⁾
	Inverter Snubber Capacitors ⁽⁵⁾⁽⁶⁾		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
	Self-Powered SGCT Power Supply (SPS)		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/CMC		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
	Battery Module (UPS) ⁽⁷⁾		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) ⁽³⁾		-	-	-	I ⁽³⁾	-	-	-	I ⁽³⁾	-	I ⁽³⁾
	Medium Voltage Connections (Inverter) ⁽⁵⁾		-	-	-	-	-	-	-	-	-	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) 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).
- (2) These components may be serviced while the VFD is running.
- (3) When rectifier snubber capacitors are replaced, the MV connections for the rectifier need to be inspected.
- (4) A 4-year rectifier snubber capacitor replacement interval applied only to drives with 6-pulse or 18-pulse rectifiers shipped before 2012 (rectifier snubber capacitors are blue). However, current enhanced replacement rectifier snubber capacitors extend this to a 10-year replacement interval (replacement rectifier snubber capacitors are black). A 10-year rectifier snubber capacitor replacement interval has always applied to drives with AFE rectifiers.
- (5) When inverter snubber capacitors are replaced, the MV connections for the inverter need to be inspected.
- (6) A 10-year inverter snubber capacitor replacement interval applies to all drive configurations.
- (7) Replace UPS batteries annually for 50°C rated VFDs.

Rockwell Automation PowerFlex 7000 Drive Preventative Maintenance Schedule

Period Interval (Years)		11	12	13	14	15	16	17	18	19	20
Air-Cooling System	Door Mounted Air Filters ⁽¹⁾ ⁽²⁾	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	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 ⁽³⁾ ⁽⁴⁾	I	I/R ⁽⁴⁾	I	I	I	I/R ⁽⁴⁾	I	I	I	I
	Inverter Snubber Capacitors ⁽⁵⁾ ⁽⁶⁾	I	I	I	I	I	I	I	I	I	I
	Integrated Gate Driver Power Supply	I	I	I	I	RFB/R	I	I	I	I	I
	Self-Powered SGCT Power Supply (SPS)	I	I	I	I	RFB/R	I	I	I	I	I
Integral Magnetics/Power Filters	Isolation Transformer/Line Reactor	I	I	I	I	M	I	I	I	I	I
	DC Link/CMC	I	I	I	I	M	I	I	I	I	I
	Line/Motor Filter Capacitors	I	I	I	I	M	I	I	I	I	I
Control Cabinet Components	AC/DC and DC/DC Power Supplies	I	I	I	I	RFB/R	I	I	I	I	I
	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
	Battery Module (UPS) ⁽⁷⁾	I	I	I	I	R	I	I	I	I	I
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) ⁽³⁾	–	I ⁽³⁾	–	–	–	I ⁽³⁾	–	–	–	–
	Medium Voltage Connections (Inverter) ⁽⁵⁾	–	–	–	–	–	–	–	–	–	–
Enhancements	Firmware	–	Rv	–	–	Rv	–	–	Rv	–	–
	Hardware	–	Rv	–	–	Rv	–	–	Rv	–	–
Operational Conditions	Parameters	I	Rv	I	I	Rv	I	I	Rv	I	–
	Variables	I	Rv	I	I	Rv	I	I	Rv	I	–
	Application Concerns	I	Rv	I	I	Rv	I	I	Rv	I	–
Spare Parts	Inventory/Needs	I	Rv	I	I	Rv	I	I	Rv	I	–

- (1) 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).
- (2) These components may be serviced while the VFD is running.
- (3) When rectifier snubber capacitors are replaced, the MV connections for the rectifier need to be inspected.
- (4) A 4-year rectifier snubber capacitor replacement interval applied only to drives with 6-pulse or 18-pulse rectifiers shipped before 2012 (rectifier snubber capacitors are blue). However, current enhanced replacement rectifier snubber capacitors extend this to a 10-year replacement interval (replacement rectifier snubber capacitors are black). A 10-year rectifier snubber capacitor replacement interval has always applied to drives with AFE rectifiers.
- (5) When inverter snubber capacitors are replaced, the MV connections for the inverter need to be inspected.
- (6) A 10-year inverter snubber capacitor replacement interval applies to all drive configurations.
- (7) Replace UPS batteries annually for 50°C rated VFDs.

Tachometer Usage

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 11 - PowerFlex Speed Regulation

Tachometer	Frequency Output		
	<6 Hz	6-15 Hz	>15 Hz
Without Tachometer	Not applicable	0.1%	0.1%
With Tachometer	0.02%	0.01%	0.01%

Notes:

- Speed regulation is based on a percentage of motor synchronous speed.
- Tachometer to be mounted on the AC machine
- Operational 15 V DC Power Supply mounted in drive to power the tachometer as a standard option with the tachometer feed back card.
- Customer is responsible for providing and mounting of tachometer
- Sleeve bearing motors require the tachometer to have an axial movement tolerance.
- Recommended tachometers are shaft mounting type.
- Magneto resistive models are more adaptable to harsh environments.
- When installing, the tachometer body and electronics must be isolated from ground (options available from the tachometer manufacturer to accomplish this).
- There are usually limits on tachometer cable lengths. Ensure the maximum length is suitable for the application.

Recommended Tach PPR	
Motor RPM	Tach ppr
3600	600
3000	600
1800	1024
1500	1024
1200	2048
1000	2048

Recommended Tach PPR	
Motor RPM	Tach ppr
900	2048
720	2048
600	2048

PowerFlex 7000 Drive Performance (Torque Capabilities)

The PowerFlex 7000 drives have been tested on a dynamometer to verify performance under locked rotor, accelerating, and low speed-high torque conditions. [Table 12](#) shows the PowerFlex 7000 drive torque capabilities as a percent of motor rated torque, independent of the drive’s momentary overload conditions.

Table 12 - 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 N.m (lb.-ft.)
- W = force N or kgf (lb.)
- K = gyration radius m (ft.)
- WK^2 = total system inertia (kgf x m² [lb.-ft.²]) 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 13 - 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 opened	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, starting unloaded	CT	100	100	100	Contact factory	Yes
Conveyors						
Belt type, loaded	CT	150	130	100	Heavy	Yes
Drag type	CT	175	150	100	Contact factory	Yes
Screw type, loaded	CT	200	100	100	Contact factory	Yes
EXTRUDERS (rubber or plastic)	CT	150	150	100	Contact factory	Yes
FANS (centrifugal, ambient)						
Damper closed	VT	25	60	50	Normal	No
Damper open	VT	25	110	100	Normal	No
FANS (centrifugal, hot gases)						
Damper closed	VT	25	60	100	Normal	No
Damper open	VT	25	200	175	Contact factory	No
FANS (propeller, axial flow)	VT	40	110	100	Normal	No
KILNS (rotary, loaded)	CT	250	125	125	Contact factory	Yes
MIXERS						
Chemical	CT	175	75	100	Contact factory	Yes
Liquid	CT	100	100	100	Heavy	Yes
Slurry	CT	150	125	100	Heavy	Yes
Solids	CT	175	125	175	Contact factory	Yes
PULPER	VT	40	100	150	Contact factory	No
PUMPS						

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		
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	1000	Heavy	Yes
Slurry handling, discharge open	CT	150	100	100	Heavy	Yes
Turbine, Centrifugal, deep-well	VT	50	100	100	Normal	No
Vane-type, positive displacement	CT	150	150	175	Contact factory	Yes
SEPARATORS, AIR (fan type)	VT	40	100	100	Normal	No

Line & Load Cable Sizes

Max. Line Cable Sizes

PRODUCT				INPUT (LINE SIDE)				
Bulletin	Description (V/ Freq./Rect.)	Drive rating (A)	Drive Structure Code	Drive Enclosure Opening Inches (mm) ¹	Max. Size & No. Incoming Cables: NEMA ²⁻⁴⁻⁵⁻⁶⁻⁸⁻⁹	Max. Size & No. Incoming Cables: IEC ²⁻⁴⁻⁵⁻⁶⁻⁸⁻⁹	Vertical Space Avail. for Stress Cones Inches (mm)	
'B' Frame (Air- Cooled)	PF7000	2400V/60Hz/RPDTD	46-430	70.40, 70.41, 70.44, 70.45	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	2400V/60Hz/RPDTD	46-375	70.40C, 70.41C, 70.44C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/phase	(1) 253mm ² 5kV or 8kV/phase	34.4 (874)
	PF7000	3300V/50Hz/RPDTD	46-430	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	3300V/50Hz/RPDTD	46-375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/phase	(1) 253mm ² 5kV or 8kV/phase	34.4 (874)
	PF7000	4160V/50Hz/RPDTD	46-375	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	4160V/50Hz/RPDTD	46-375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/phase	(1) 253mm ² 5kV or 8kV/phase	34.4 (874)
	PF7000	4160V/60Hz/RPDTD	46-430	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 8kV or 15kV/phase	28.5 (725)
	PF7000	4160V/60Hz/RPDTD	46-375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/phase	(1) 253mm ² 8kV or 15kV/phase	34.4 (874)
	PF7000	6600V/50Hz/RPDTD	46-285	70.46, 70.47, 70.48, 70.49	9.79x10.97 (249x279) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 8kV or 15kV/phase	28.5 (725)
	PF7000	6600V/50Hz/RPDTD	40-285	70.46C, 70.47C, 70.49C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 8kV or 15kV/phase	(1) 253mm ² 8kV or 15kV/phase	34.4 (874)
	PF7000	6600V/60Hz/RPDTD	40-285	70.46, 70.47, 70.48, 70.49	9.79x10.97 (249x279) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	6600V/60Hz/RPDTD	40-285	70.46C, 70.47C, 70.49C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 8kV or 15kV/phase	(1) 253mm ² 5kV or 8kV/phase	34.4 (874)
	PF7000	2400V/60Hz/RPTX	46-430	70.1, 70.2, 70.25, 70.26	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	3300V/50Hz/RPTX	46-430	70.10, 70.27, 70.28, 70.30	9.79x10.97 (249x279) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	4160V/50Hz/RPTX	46-430	70.10, 70.27, 70.29, 70.30	9.79x10.97 (249x279) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	4160V/60Hz/RPTX	46-430	70.2, 70.26, 70.27, 70.28, 70.29, 70.31	9.79x10.97 (249x279) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	6600V/50Hz/RPTX	40-285	70.11, 70.28, 70.30, 70.31	9.79x10.97 (249x279) ¹	(2) 500MCM 15kV/phase	(2) 127mm ² 5kV or 8kV/phase	28.5 (725)

PRODUCT				INPUT (LINE SIDE)				
Bulletin	Description (V/Freq./Rect.)	Drive rating (A)	Drive Structure Code	Drive Enclosure Opening Inches (mm) ¹	Max. Size & No. Incoming Cables: NEMA 2-4-5-6-8-9	Max. Size & No. Incoming Cables: IEC 2-4-5-6-8-9	Vertical Space Avail. for Stress Cones Inches (mm)	
‘B’ Frame (Air-Cooled) cont’d.	PF7000	2400V/60Hz/RP18TX	46-430	70.8	9.79x21.06 (249x535) ¹	(2) 500MCM 5kV or 8kV/sec. Winding	(2) 253mm ² 5kV or 8kV/sec. Winding	17.7 (449)
	PF7000	3300V/50Hz/RP18TX	46-430	70.9	9.79x21.06 (249x535) ¹	(2) 500MCM 8kV or 15kV/sec. Winding	(2) 253mm ² 8kV or 15kV/sec. Winding	17.7 (449)
	PF7000	4160V/50Hz/RP18TX	46-430	70.9, 70.18	9.79x21.06 (249x535) ¹	(2) 500MCM 8kV or 15kV/sec. Winding	(2) 253mm ² 8kV or 15kV/sec. Winding	17.7 (449)
	PF7000	4160V/60Hz/RP18TX	46-430	70.8, 70.9	9.79x21.06 (249x535) ¹	(2) 500MCM 8kV or 15kV/sec. Winding	(2) 253mm ² 8kV or 15kV/sec. Winding	17.7 (449)
	PF7000	6600V/50Hz/RP18TX	40-215	70.9	9.79x21.06 (249x535) ¹	(2) 350MCM 15kV/sec. Winding	(2) 177mm ² 15kV/sec. Winding	17.7 (449)
	PF7000	6600V/50Hz/RP18TX	250-430	70.18	9.79x21.06 (249x535) ¹	(2) 350MCM 15kV/sec. Winding	(2) 177mm ² 15kV/sec. Winding	17.7 (449)
	PF7000	6600V/60Hz/RP18TX	40-215	70.9	9.79x21.06 (249x535) ¹	(2) 350MCM 15kV/sec. Winding	(2) 177mm ² 15kV/sec. Winding	17.7 (449)
	PF7000	6600V/60Hz/RP18TX	250-430	70.18	9.79x21.06 (249x535) ¹	(2) 350MCM 15kV/sec. Winding	(2) 177mm ² 15kV/sec. Winding	17.7 (449)

Notes:

This data is informative only; do not base final design criteria solely on this data. Ensure you follow national and local installation codes, industry best practices, and cable manufacturer recommendations.

- Some ‘A’ Frames, most ‘B’ Frames, and all ‘C’ Frames have a single enclosure opening provision for both line and load cables (designated by ¹). Most ‘A’ Frames and some ‘B’ Frames have separate opening provisions for line and load cables. All cabling capacities shown in this table are “worst case” conditions when both line and load cabling enters and exits in the same direction.
- Cable sizes are based on overall dimensions of compact-stranded three-conductor shielded cable (common for industrial cable tray installations). Maximum sizing stated accounts for minimum rated cable insulation requirements and the next higher-rated cable (i.e., 8kV is not commercially available in many areas of the world, therefore Rockwell Automation provides an 8kV (minimum rating) as well as a 15kV rating, when applicable. Enclosure openings will accommodate the thicker insulation on the higher-rated cable. IEC ratings show the equivalent to the NEMA sizes. The exact cable mm² size shown is not commercially available in many cases; use the next smaller standard size.
- Cable enters termination point horizontally in this case, therefore orient space for the stress cones horizontally also.
- Minimum cable bend radius recommendations vary by national codes, cable type, and cable size. Consult local codes for guidelines and requirements. General relationship of cable diameter to bend radius is typically between 7x — 12x (e.g., if the cable diameter is 1 inch [2.54cm] the minimum bend radius could range between 7-12 inches [18.8-30.48cm]).
- For minimum cable insulation requirements, refer to the “PowerFlex 7000 Medium Voltage AC Drive User Manual” for your particular frame (‘A’, ‘B’, or ‘C’ Frame). Stated voltages are peak line-to-ground. PLEASE NOTE: Some cable manufacturers rate cabling based on RMS line-to-line.
- Ground lug capabilities: ‘A’ Frame—two (2) mechanical range lugs for ground cable connections; ‘B’, or ‘C’ Frame—up to ten (10) mechanical range lugs for ground cable connections are available, typically these frames supply four (4). Mechanical range lugs can accommodate cable size #6-250MCM (13.3 - 127mm²).
- 18 Pulse VFDs (R18TX) have nine (9) line-side connections from the secondary isolation transformer windings entering the VFD. Lug pads are available for each connection. The lug pad and enclosure can generally accommodate 2 cables per connection, 18 cables in total (applies to all “B” and “C” configurations).
- Maximum cable size for “B” Frame (2 per phase) and ‘C’ Frame (4 per phase) is 500MCM (253mm²), limited by lug pad assembly size and clearance requirements.
- As cabling methods can vary widely, maximum cable sizes shown do not account for the size of the conduit hub. Verify size of conduit hub(s) against the “Drive enclosure openings” shown.

Max. Load Cable Sizes

PRODUCT				OUTPUT (MOTOR SIDE)				
Bulletin	Description (V/ Freq./Rect.)	Drive rating (A)	Drive Structure Code	Drive Enclosure Opening Inches (mm) ¹	Max. Size & No. Incoming Cables: NEMA ^{2,4-5-6-8-9}	Max. Size & No. Incoming Cables: IEC ^{2,4-5-6-8-9}	Vertical Space Avail. for Stress Cones Inches (mm)	
'B' Frame (Air-Cooled)	PF7000	2400V/60Hz/RPDTD	46-430	70.40, 70.41, 70.44, 70.45	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	2400V/60Hz/RPDTD	46-375	70.40C, 70.41C, 70.44C w/close-coupled starter	6.52x9.88 (168x251)	(1) 500MCM 5kV or 8kV/phase OR (2) 250MCM 5kV or 8kV/phase	(1) 253mm ² 5kV or 8kV/phase OR (2) 127mm ² 5kV or 8kV/phase	16.2 (411)
	PF7000	3300V/50Hz/RPDTD	46-430	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	3300V/50Hz/RPDTD	46-375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/phase OR (2) 250MCM 5kV or 8kV/phase	(1) 253mm ² 5kV or 8kV/phase OR (2) 127mm ² 5kV or 8kV/phase	16.2 (411)
	PF7000	4160V/50Hz/RPDTD	46-375	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	4160V/50Hz/RPDTD	46-375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/phase OR (2) 250MCM 5kV or 8kV/phase	(1) 253mm ² 5kV or 8kV/phase OR (2) 127mm ² 5kV or 8kV/phase	16.2 (411)
	PF7000	4160V/60Hz/RPDTD	46-430	70.43, 70.44, 70.45, 70.47	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 8kV or 15kV/phase	28.5 (725)
	PF7000	4160V/60Hz/RPDTD	46-375	70.43C, 70.44C, 70.45C, 70.47C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV or 8kV/phase OR (2) 250MCM 5kV or 8kV/phase	(1) 253mm ² 5kV or 8kV/phase OR (2) 127mm ² 5kV or 8kV/phase	16.2 (411)
	PF7000	6600V/50Hz/RPDTD	46-285	70.46, 70.47, 70.48, 70.49	9.79x10.97 (249x279) ¹	(1) 500MCM 8kV/phase	(1) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	6600V/50Hz/RPDTD	40-285	70.46C, 70.47C, 70.49C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV OR (2) 250MCM 8kV or 15kV/phase	(1) 253mm ² OR (2) 127mm ² 8kV or 15kV/phase	16.2 (411)
	PF7000	6600V/60Hz/RPDTD	40-285	70.46, 70.47, 70.48, 70.49	9.79x10.97 (249x279) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	6600V/60Hz/RPDTD	40-285	70.46C, 70.47C, 70.49C w/close-coupled starter	5.61x7.19 (142x183)	(1) 500MCM 5kV OR (2) 250MCM 8kV or 15kV/phase	(1) 253mm ² OR (2) 127mm ² 8kV or 15kV/phase	16.2 (411)
	PF7000	2400V/60Hz/RPTX	46-430	70.1, 70.2, 70.25, 70.26	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	3300V/50Hz/RPTX	46-430	70.10, 70.27, 70.28, 70.30	9.79x10.97 (249x279) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	4160V/50Hz/RPTX	46-430	70.10, 70.27, 70.29, 70.30	9.79x10.97 (249x279) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
	PF7000	4160V/60Hz/RPTX	46-430	70.2, 70.26, 70.27, 70.28, 70.29, 70.31	9.79x10.97 (249x279) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	28.5 (725)
PF7000	6600V/50Hz/RPTX	40-285	70.11, 70.28, 70.30, 70.31	9.79x10.97 (249x279) ¹	(2) 250MCM 8kV or 15kV/phase	(2) 253mm ² 8kV or 15kV/phase	28.5 (725)	

PRODUCT				OUTPUT (MOTOR SIDE)				
Bulletin	Description (V/ Freq./Rect.)	Drive rating (A)	Drive Structure Code	Drive Enclosure Opening Inches (mm) ¹	Max. Size & No. Incoming Cables: NEMA 2-4-5-6-8-9	Max. Size & No. Incoming Cables: IEC 2-4-5-6-8-9	Vertical Space Avail. for Stress Cones Inches (mm)	
'B' Frame (Air- Cooled) cont'd.	PF7000	2400V/60Hz/RP18TX	46-430	70.8	9.79x21.06 (249x535) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	16.4 (415)
	PF7000	3300V/50Hz/RP18TX	46-430	70.9	9.79x21.06 (249x535) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	16.4 (415)
	PF7000	4160V/50Hz/RP18TX	46-430	70.9, 70.18	9.79x21.06 (249x535) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	16.4 (415)
	PF7000	4160V/60Hz/RP18TX	46-430	70.8, 70.9	9.79x21.06 (249x535) ¹	(2) 500MCM 5kV or 8kV/phase	(2) 253mm ² 5kV or 8kV/phase	16.4 (415)
	PF7000	6600V/50Hz/RP18TX	40-215	70.9	9.79x21.06 (249x535) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 8kV or 15kV/phase	16.4 (415)
	PF7000	6600V/50Hz/RP18TX	250-430	70.18	9.79x21.06 (249x535) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 8kV or 15kV/phase	16.4 (415)
	PF7000	6600V/60Hz/RP18TX	40-215	70.9	9.79x21.06 (249x535) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 8kV or 15kV/phase	16.4 (415)
	PF7000	6600V/60Hz/RP18TX	250-430	70.18	9.79x21.06 (249x535) ¹	(2) 500MCM 8kV or 15kV/phase	(2) 253mm ² 8kV or 15kV/phase	16.4 (415)

Notes:

This data is informative only; do not base final design criteria solely on this data. Ensure you follow national and local installation codes, industry best practices, and cable manufacturer recommendations.

- Some 'A' Frames, most 'B' Frames, and all 'C' Frames have a single enclosure opening provision for both line and load cables (designated by ¹). Most 'A' Frames and some 'B' Frames have separate opening provisions for line and load cables. All cabling capacities shown in this table are "worst case" conditions when both line and load cabling enters and exits in the same direction.
- Cable sizes are based on overall dimensions of compact-stranded three-conductor shielded cable (common for industrial cable tray installations). Maximum sizing stated accounts for minimum rated cable insulation requirements and the next higher-rated cable (i.e., 8kV is not commercially available in many areas of the world, therefore Rockwell Automation provides an 8kV (minimum rating) as well as a 15kV rating, when applicable. Enclosure openings will accommodate the thicker insulation on the higher-rated cable. IEC ratings show the equivalent to the NEMA sizes. The exact cable mm² size shown is not commercially available in many cases; use the next smaller standard size.
- Cable enters termination point horizontally in this case, therefore orient space for the stress cones horizontally also.
- Minimum cable bend radius recommendations vary by national codes, cable type, and cable size. Consult local codes for guidelines and requirements. General relationship of cable diameter to bend radius is typically between 7x — 12x (e.g., if the cable diameter is 1 inch [2.54cm] the minimum bend radius could range between 7-12 inches [18.8-30.48cm]).
- For minimum cable insulation requirements, refer to the "PowerFlex 7000 Medium Voltage AC Drive User Manual" for your particular frame ('A', 'B', or 'C' Frame). Stated voltages are peak line-to-ground. PLEASE NOTE: Some cable manufacturers rate cabling based on RMS line-to-line.
- Ground lug capabilities: 'A' Frame—two (2) mechanical range lugs for ground cable connections; 'B' or 'C' Frame—up to ten (10) mechanical range lugs for ground cable connections are available, typically these frames supply four (4). Mechanical range lugs can accommodate cable size #6-250MCM (13.3 - 127mm²).
- 18 Pulse VFDs (R18TX) have nine (9) line-side connections from the secondary isolation transformer windings entering the VFD. Lug pads are available for each connection. The lug pad and enclosure can generally accommodate 2 cables per connection, 18 cables in total (applies to all "B" and "C" configurations).
- Maximum cable size for "B" Frame (2 per phase) and "C" Frame (4 per phase) is 500MCM (253mm²), limited by lug pad assembly size and clearance requirements.
- As cabling methods can vary widely, maximum cable sizes shown do not account for the size of the conduit hub. Verify size of conduit hub(s) against the "Drive enclosure openings" shown.

Snubber Testing

Control Power Off Tests

Perform the following checks before applying control power to the drive. Rockwell Automation recommends that you complete these checks in the sequence they are presented here.

IMPORTANT This section is also available in the PowerFlex “B” Frame Commissioning Guide; refer to that document for additional information on drive testing.

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 NFPA 70E, Electrical Safety requirements for Employee Work places, must be followed.

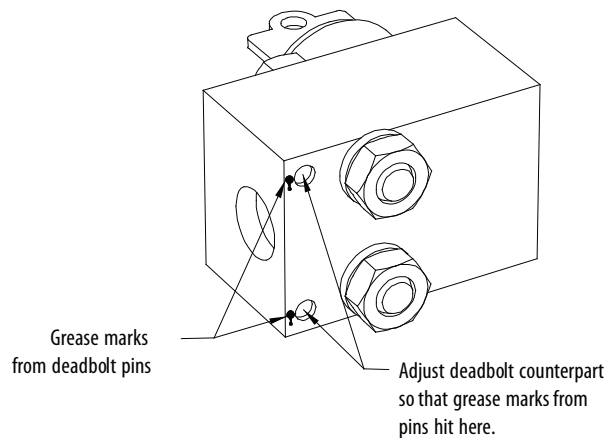


Figure 252 - Deadbolt assembly mounted to door

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 253](#))

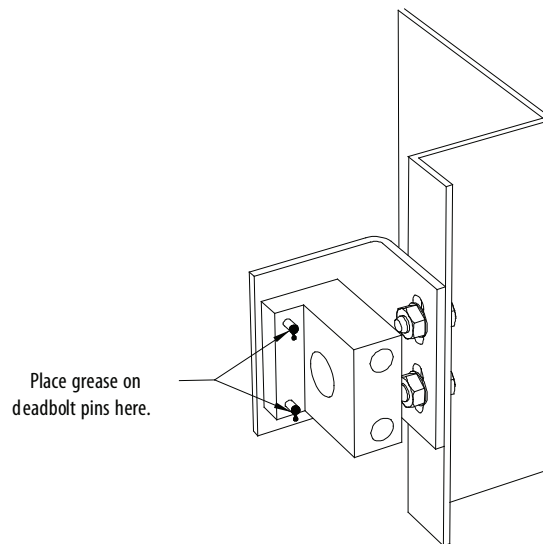


Figure 253 - Deadbolt counterpart mounted to cabinet

4. Bolt the cabinet door closed so the pins on the dead bolt counterpart make contact with the deadbolt assembly. Doing so should leave two marks of torque sealant or grease on the assembly where the pins made contact (see [Figure 252 on page 252](#)).

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 to confirm 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 as well as a simple schematic diagram is located in the table below. A simple schematic diagram in [Figure 254 on page 254](#) shows how the snubber components are connected across an SGCT.

SGCT Rating	Sharing Resistor ¹	Snubber Resistor	Snubber Capacitor
1500 Amp	80kΩ	6Ω (AFE Rectifier)	0.2µf
1500 Amp	80kΩ	7.5Ω (Inverter)	0.2µf
800 Amp	80kΩ	10Ω	0.1µf
400 Amp	80kΩ	15Ω (AFE Rectifier)	0.1µf
400 Amp	80kΩ	17.5Ω (Inverter)	0.1µf

¹— 2300V drives will not have a sharing resistor on devices.

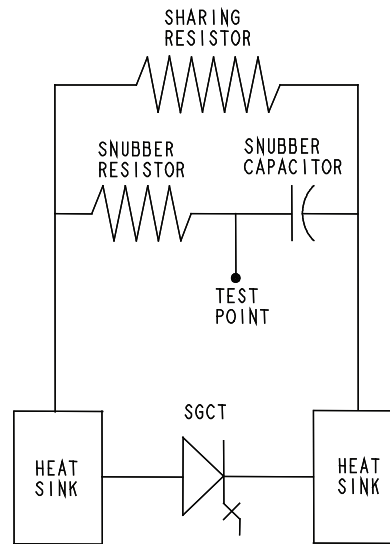


Figure 254 - SGCT Snubber Circuit Connections

Table 14 - SGCT/snubber resistance values

SGCT Resistance Measurement	Measured Resistance			
	Inverter		Rectifier (AFE only)	
SGCT Anode-Cathode Resistance (Heatsink to Heatsink) k-Ω	(Lowest)	(Highest)	(Lowest)	(Highest)
Snubber Resistance (Test point: Heat sink 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 on page 21](#).

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 [Figure 255](#):

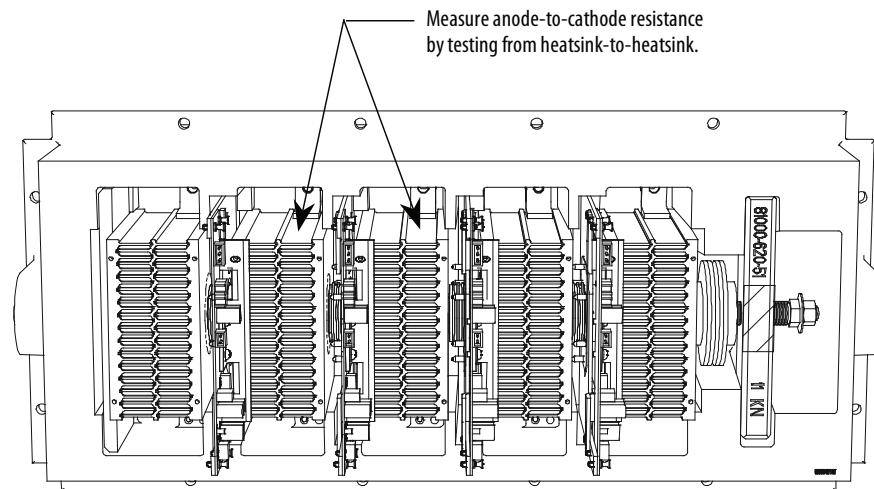


Figure 255 - Anode-to-Cathode resistance test points

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 .

You can detect SGCT failures 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 measure close to 60 k Ω . This indicates a partially shorted device. A fully shorted device will read closer to 0 Ω and is easily identified. If the SGCT is out of tolerance, refer to [Component Definition and Maintenance on page 21](#) for detailed instructions on how to replace the SGCT assembly.

Damage to a sharing resistor is detectable if the SGCT is replaced and the anode-to-cathode resistance remains abnormal. If the resistor is found to be out of

tolerance, refer to [Component Definition and Maintenance on page 21](#) 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.

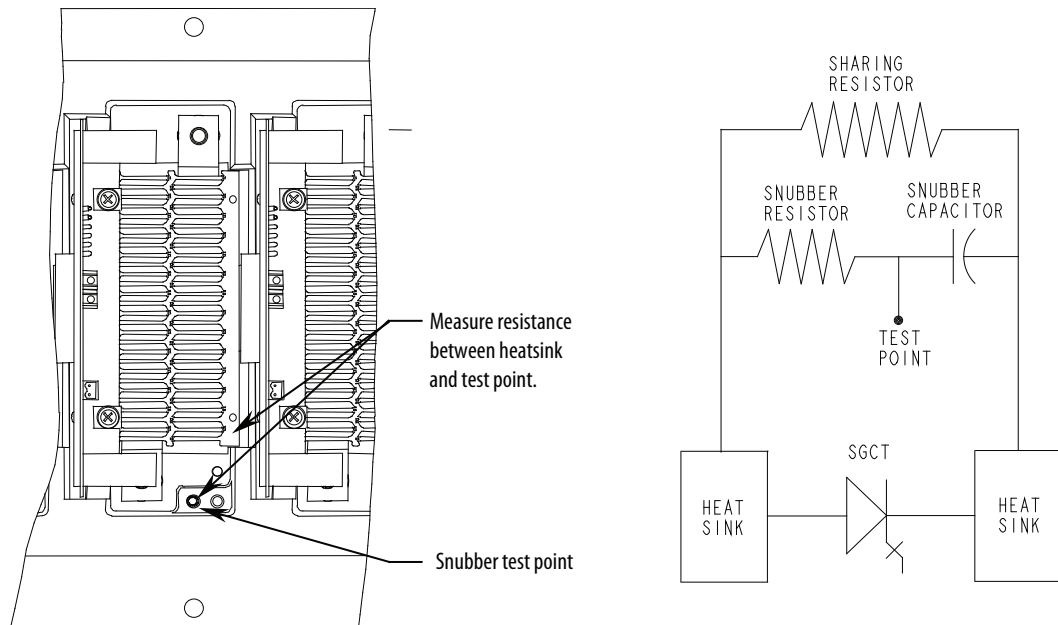


Figure 256 - Snubber resistor test

Refer to [Table 14 on page 254](#) 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 [Component Definition and Maintenance on page 21](#) for detailed instructions on replacing the snubber resistor assembly.

Snubber Capacitance (SGCT Device)

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

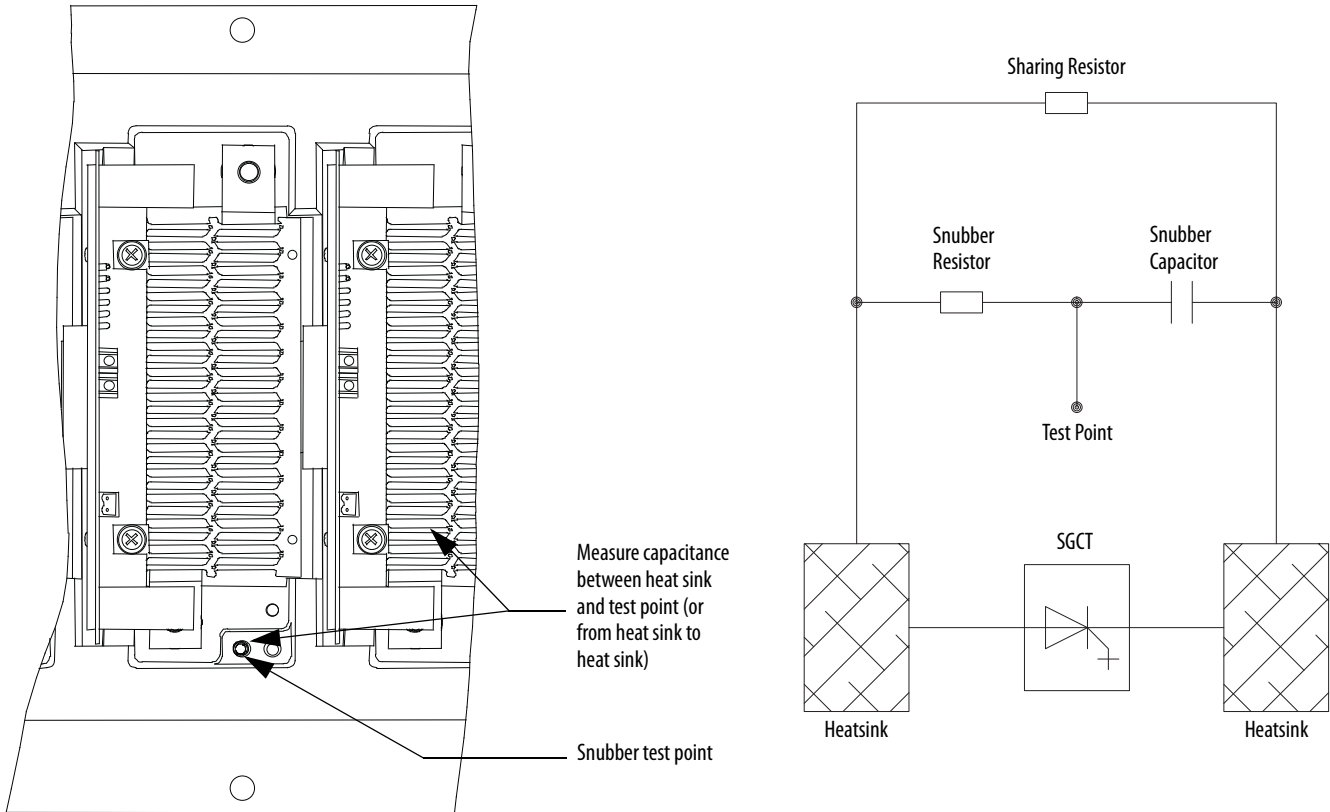


Figure 257 - Subber capacitor test

Refer to [Table 14 on page 254](#) 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 out of tolerance, refer to [Component Definition and Maintenance on page 21](#) for detailed instructions on how to replace the snubber capacitor.

SCR Testing

The following procedure verifies SCR semiconductors and all associated snubber components. For quick reference to the expected resistance and capacitance values, refer to [Table 15](#) below. A simple schematic diagram in [Figure 258](#) shows the snubber component connections across an SGCT.

Table 15 - SCR Snubber Circuit Resistance and Capacitance Values

SCR Rating	Sharing Resistance	Snubber Resistance	Snubber Capacitance
350, 400, 815 Amp	80kΩ	60Ω	0.5 μf

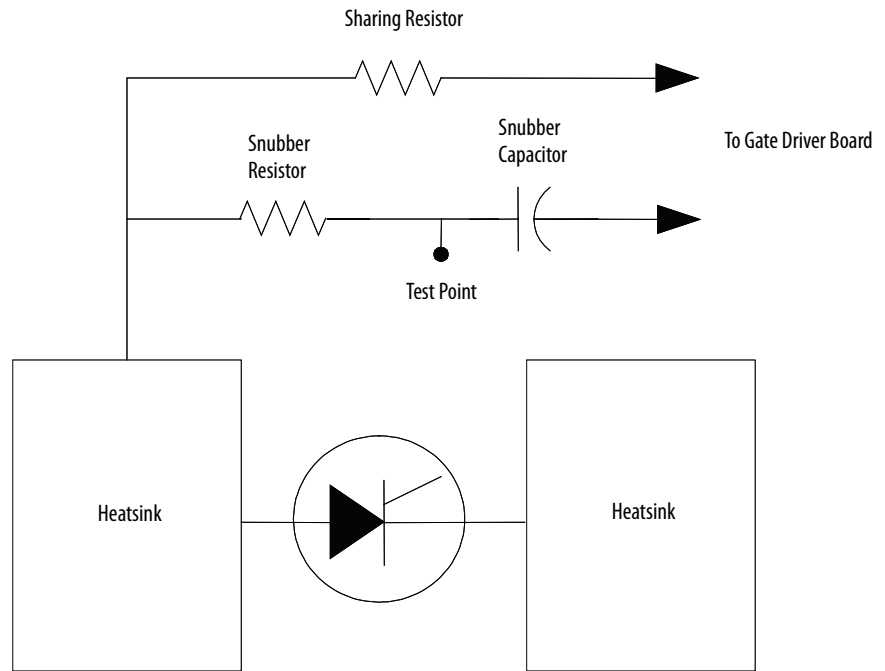


Figure 258 - SCR snubber circuit connections

If you find a damaged device or snubber component, follow the detailed replacement procedure located in [Component Definition and Maintenance on page 21](#).

SCR Resistance Measurement	Measured Resistance			
	Inverter		Rectifier (AFE only)	
SCR Anode-Cathode Resistance (Heatsink to Heatsink) k-Ω				
	(Lowest)	(Highest)	(Lowest)	(Highest)
SCR Gate-Cathode Resistance (across SCR Phoenix Connector)Ω				
Snubber Resistance (Test point: Heat sink above) Ω				
	(Lowest)	(Highest)	(Lowest)	(Highest)
Snubber Capacitance (Test Point – Heatsink on Right) μF				
	(Lowest)	(Highest)	(Lowest)	(Highest)
Sharing Resistance (Red wire from snubber Phoenix connector—Heatsink on left) k-Ω				
	(Lowest)	(Highest)	(Lowest)	(Highest)

SCR Anode-to-Cathode Resistance

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

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

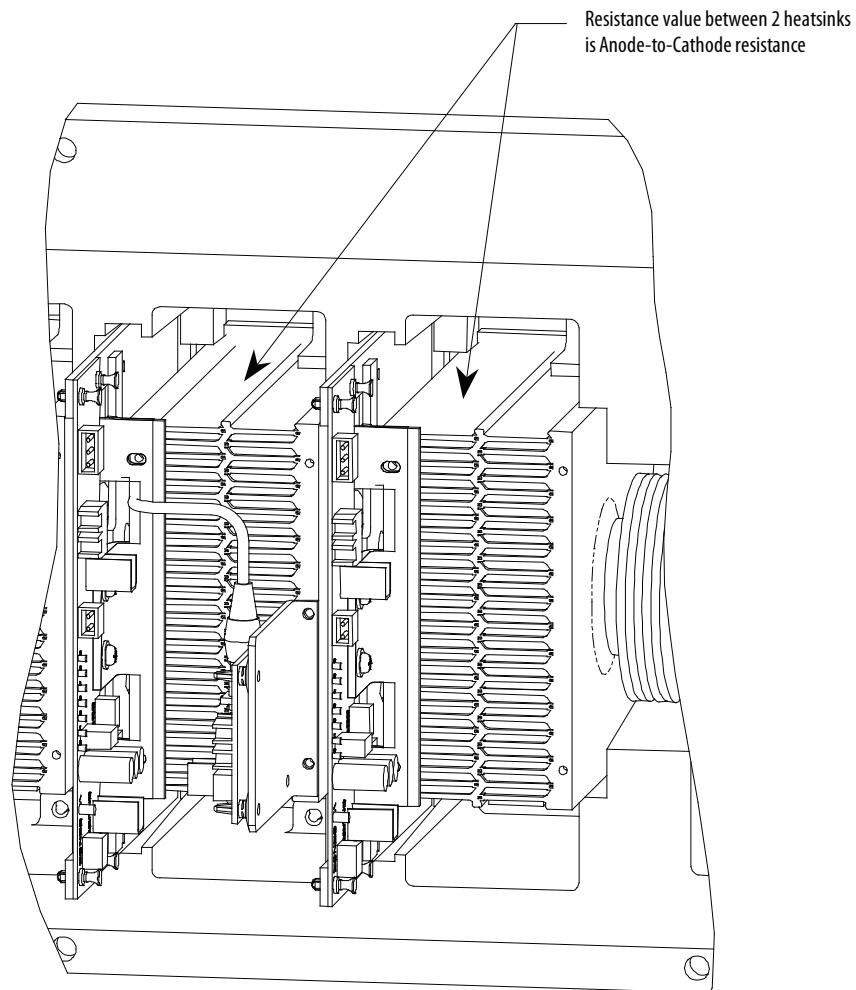


Figure 259 - Anode-to-cathode test

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

An SCR that has failed from anode-to-cathode will commonly produce a resistance value of 0 for a shorted device or $\infty\Omega$ for an opened device. Unlike the SGCT, it is highly irregular for an SCR to have a partially shorted device. If an SCR is found to be out of tolerance, refer to [Component Definition and](#)

[Maintenance on page 21](#) for detailed instructions on how to replace the SCR assembly.

SCR Sharing Resistance Test

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

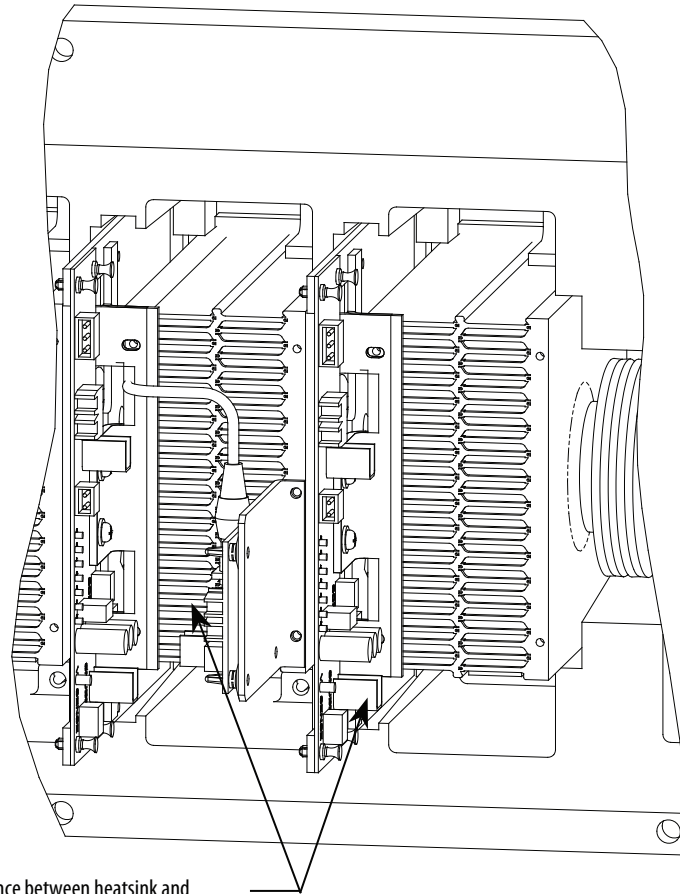


Figure 260 - SCR sharing resistance test

Gate-to-Cathode Resistance

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

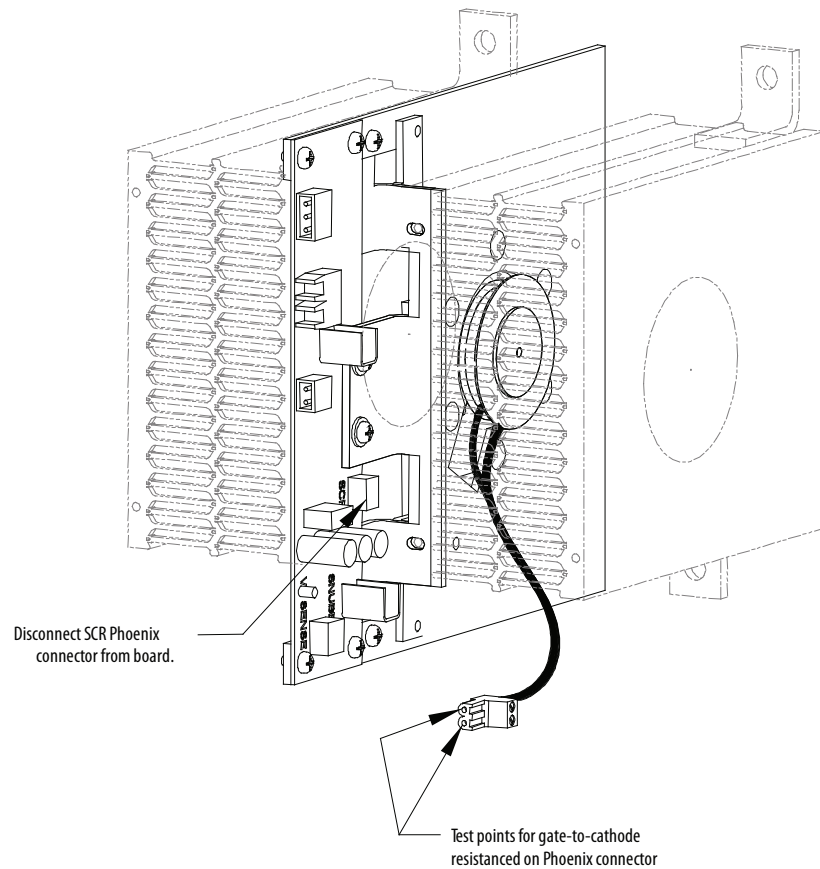


Figure 261 - SCR gate-to-cathode test

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

If a Gate-to-Cathode test reveals a damaged SCR, refer to [Component Definition and Maintenance on page 21](#) for the SCR replacement procedure.

Snubber Resistance (SCR Device)

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

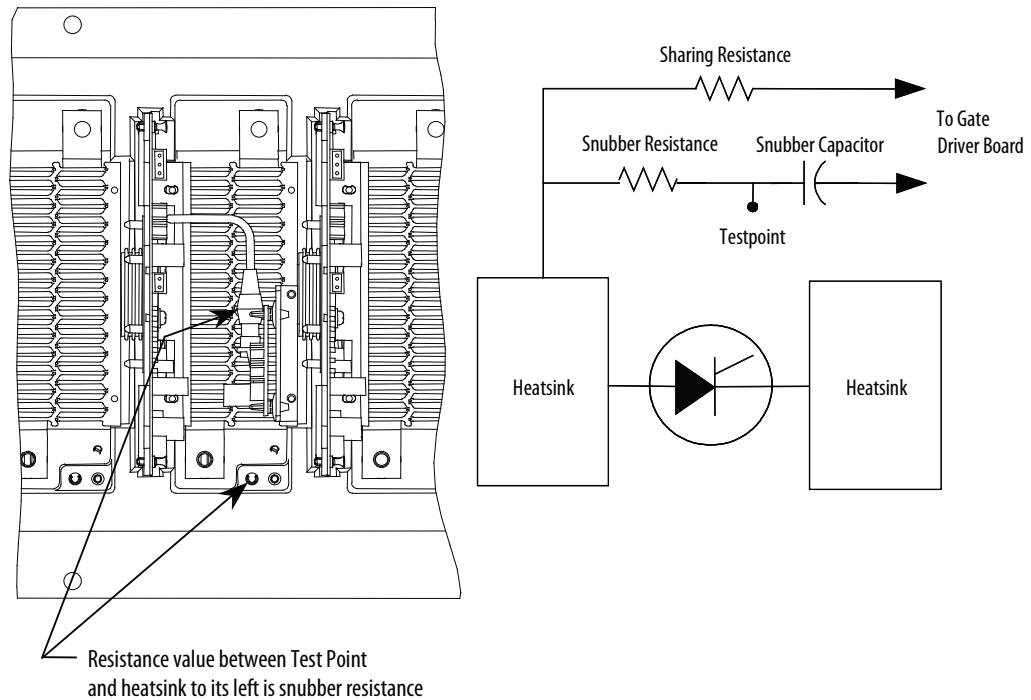


Figure 262 - Snubber resistance test

Refer to [Figure 15 on page 258](#) to determine the appropriate snubber resistance value for the current rating of the SCR used.

If the resistor is found to be out of tolerance, refer to [Component Definition and Maintenance on page 21](#) for the snubber resistor assembly replacement procedure.

Snubber Capacitance (SCR Device)

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

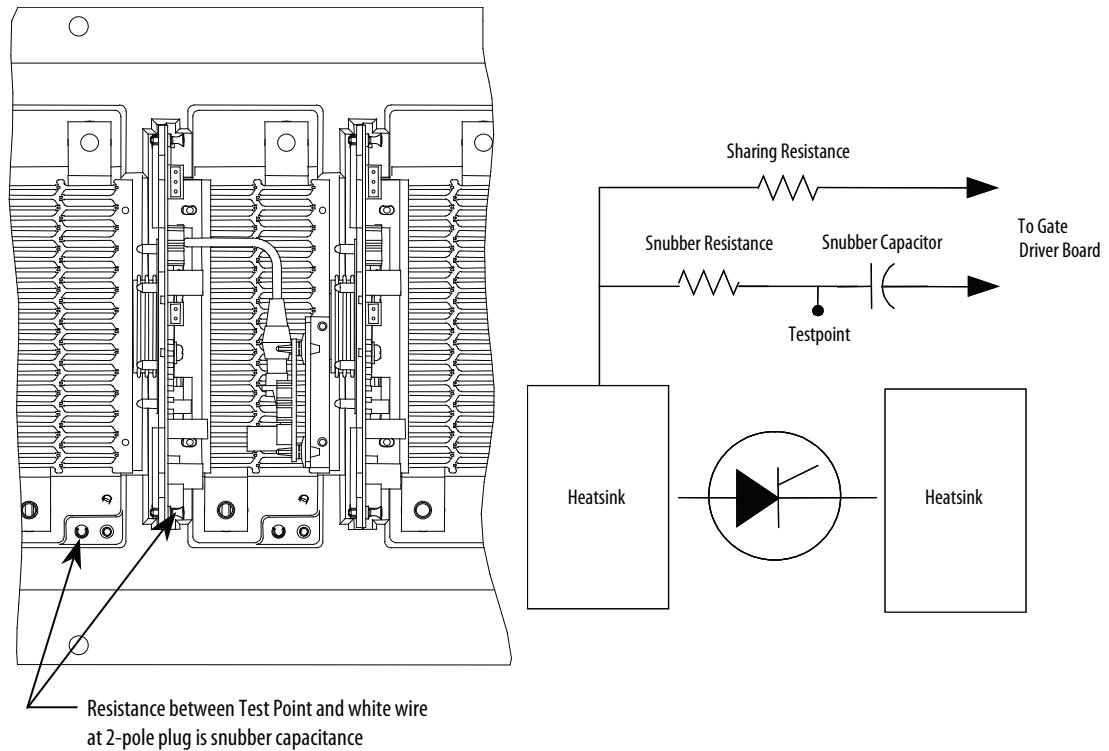


Figure 263 - Snubber capacitance test

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

Refer to [Figure 15 on page 258](#) to determine the appropriate snubber capacitance value for the current rating of the SCR used. Read the actual snubber capacitor value shown in the table.

If the capacitor is out of tolerance, refer to [Component Definition and Maintenance on page 21](#) for the snubber capacitor replacement procedure.

Notes:

Meggering

Drive Meggering

When a ground fault occurs, there are three zones in which the problem may appear: input to the drive, the drive, output to the motor. The ground fault condition indicates a phase conductor has found a path to ground. Depending on the resistance of the path to ground, a current with magnitude ranging from leakage to fault level exists. Based on our experiences in drive systems, the highest probability for the source of the fault exists in either the input or output zones. The drive itself rarely has been a source of a ground fault when it is properly installed. This is not to say there will never be any ground fault problems associated with the drive, but the chances are the fault is outside of the drive. Also, the procedure for meggering the drive is more complex than meggering outside the drive.

With these two factors, it is recommended to first megger the input and output zones when encountering a ground fault. If the location of the ground fault can not be located outside the drive, the drive will need to be meggered. This procedure must be performed with due care as the hazards to drive exist if the safety precautions in the procedure are not followed. This is due to the fact the megger procedure applies high voltage to ground: all the control boards in the drive have been grounded and if not isolated, they will have high potential applied to them causing immediate damage.

Meggering the PowerFlex 7000



ATTENTION: Use caution when performing a Megger test. High voltage testing is potentially hazardous and may cause severe burns, injury or death. Where appropriate, connect the test equipment to ground.

Ensure you check the insulation levels before energizing power equipment. Megger tests provide a resistance measurement from the phase-to-phase and phase-to-ground by applying a high voltage to the power circuitry. Perform this test to detect ground faults without damaging any drive equipment.

This test involves “floating” the drive and all connected equipment to a high potential while measuring the leakage current to ground. Floating the drive

means to temporarily remove any existing paths to ground necessary for normal operation of the drive.



ATTENTION: There are risks of serious or fatal injury to personnel if you do not follow safety guidelines.

Following this procedure to perform Megger tests on the PowerFlex 7000B. Failure to comply with this procedure may result in poor Megger reading and damage to drive control boards.

Meggering Procedures

Required Equipment

- Torque Wrench and 7/16 inch socket
- Phillips Screwdriver
- 2500/5000 Volt Megger

Procedure

1. Isolate and lock out the drive system from any high voltage source.

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”).

You must 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 to disconnect):

- Voltage Sensing Boards (VSB)
- Output Grounding Network (OGN)

Voltage Sensing Boards

- a. Remove all ground connections from all of the VSBs in the drive. Do this 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

- b. Remove the ground connection on the OGN (if installed). Lift this connection 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 are 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.

- a. Confirm the marking matches the connections, and disconnect the ribbon cables and move them clear of the VSB. If you do not remove these ribbon cables from the VSB, then high potential applies directly to the low voltage control through the SCBs, causing immediate damage to those boards.

Note: The VSB ribbon cable insulation is not rated for the potential applied during a Megger test. You must 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 removes 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. Megger 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 connect 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.



ATTENTION: Discharge the Megger prior to disconnecting it from the equipment.

- a. Connect the Megger to the drive following the specific instructions for that model.
- b. 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.
- c. 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.

You may need to completely isolate the DC Link reactor from the drive, at which point you must disconnect all four power cables. You must ensure that you have electrically isolated all electrical components to be meggered 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

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.

IMPORTANT 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. Reconnect connections between power circuit and low voltage control.
 - a. 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

- a. 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 you do not connect the ground conductor, the monitored low voltage signal could then rise up to medium voltage potential, which is a serious hazard to avoid at all times. Always ensure the ground conductors on the VSB are securely connected before applying medium voltage to the drive.

Failure to connect both ground connections on the voltage sensing board will result in high potential in the low voltage cabinet within the drive that will damage the drive control, and possible cause injury or death to personnel.

Output Grounding Network

- b. Reconnect the ground connection on the OGN capacitor. The bolt connection should torque down to 3.4 Nm (30 lb.-in). Exceeding the torque rating of this connection may result in damage to the capacitor. Failure to reconnect the OGN ground may result in impressing the neutral voltage offset on the motor cables and stator, which may result in equipment damage. For drives that did not originally have the OGN connected (or even installed), this is not a concern.

Transient Suppression Network

- c. Re-install the fuses on the TSN.

Notes:

Specifications



ATTENTION: In the event of discrepancies between information published in generic manual specifications and those included with your specific design or electrical drawings, take the DD or EE ratings as correct values.

“B” Frame Drive Specifications

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

Description	
Number of Inverter SGCTs	Voltage
	2400V 3300V 4160V 6600V
Inverter PIV Rating (Peak Inverse Voltage)	Voltage
	2400V 3300V 4160V 6600V
Rectifier Designs	Direct-to-Drive (transformerless AFE rectifier) AFE with separate isolation transformer 18 Pulse with separate isolation transformer
Rectifier Switch	SCR (18 Pulse), SGCT (AFE Rectifier)
Rectifier Switch Failure Mode	Non-rupture, Non-arc
Rectifier Switch Failure Rate (FIT)	50 (SGCT) 100 (SCR) per 1 Billion Hours Operation
Rectifier Switch Cooling	Double Sided, Low Thermal Stress
Number of Rectifier Devices per phase	Voltage
	2400V 3300V 4160V 6600V
Output Current THD (1 st ...49 th)	< 5%
Output Waveform to Motor	Sinusoidal Current / Voltage
Medium Voltage Isolation	Fiber Optic
Modulation techniques	Selective Harmonic Elimination (SHE) Synchronous Trapezoidal PWM Asynchronous or Synchronous SVM (Space Vector Modulation)
Control Method	Digital Sensorless Direct Vector Full Vector Control with Encoder Feedback (Optional)
Tuning Method	Auto Tuning via Setup Wizard
Speed Regulator Bandwidth	1...10 rad/s
Torque Regulator Bandwidth	15...50 rad/s
Speed Regulation	0.1% without Encoder Feedback 0.01...0.02% with Encoder Feedback
Acceleration/Deceleration Range	Independent Accel/Decel – 4 x 30 s
Acceleration/Deceleration Ramp Rates	4 x Independent Accel/Decel
S Ramp Rate	Independent Accel/Decel – 2 x 999 s
Critical Speed Avoidance	3 x Independent with Adjustable bandwidth
Stall Protection	Adjustable time delay
Load Loss Detection	Adjustable level, delay, speed set points
Control Mode	Speed or Torque
Current Limit	Adjustable in Motoring and Regenerative

Description	
Output Frequency Range	0.2...75 Hz (Standard) 75 Hz...85Hz (Optional - need specific Motor Filter Capacitor [MFC])
Service Duty Rating	Normal Duty
	110% Overload for 1 min. every 10 min. (Variable Torque Load)
Typical VFD Efficiency	> 97.5% (AFE) > 98% (18 Pulse) Contact Factory for Guaranteed Efficiency of Specific Drive Rating
Input Power Factor	AFE Rectifier
	0.95 minimum, 10...100% Load
IEEE 519 Harmonic Guidelines ⁽⁶⁾	IEEE 519 - 1992 Compliant
VFD Noise Level	< 85 dB (A) per OSHA Standard 3074
Regenerative Braking Capability	Inherent – No Additional Hardware or Software Required
Flying Start Capability	Yes – Able to Start into and Control a Spinning Load in Forward or Reverse Direction
Operator Interface	10 in. Color Touchscreen – Cat# 2711P-T10C4A9 (VAC) Built-in PDF viewer Redesigned PanelView™ Plus 6 Logic Module with 512 Mb of memory
Languages	English, French, Spanish, Portuguese, German, Chinese, Italian and Russian
Control Power	220/240V or 110/120V, Single phase - 50/60 Hz (20 A)
External I/O	16 Digital Inputs, 16 Digital Outputs
External Input Ratings	50...60 Hz AC or DC 120...240 V – 1 mA
External Output Ratings	50...60 Hz AC or DC 30...260 V – 1 A
Analog Inputs	Three Isolated, 4...20 mA or 0...10V (250 Ω)
Analog Resolution	Analog input 12 Bit (4...20 mA) Internal parameter 32 Bit resolution Serial Communication 16 Bit resolution (.1Hz) (Digital Speed Reference)
Analog Outputs	One Isolated, Eight Non-isolated, 4...20 mA or 0...10V (600 Ω)
Communication Interface	Ethernet IP/DPI
Scan Time	Internal DPI – 2 ms min., 4 ms max.
Communications Protocols (Optional)	DeviceNetLon Works Ethernet I/PCan Open ProfibusRS485 HVAC ModbusRS485 DF1 InterbusRS232 DF1 ControlNetUSB
Enclosure	NEMA 1 (standard)
	NEMA 12 (optional)
Lifting Device	Standard / Removable
Mounting Arrangement	Mounting Sill Channels

Description	
Structure Finish	Epoxy Powder – Paint Exterior Sandtex Light Grey (RAL 7038) – Black (RAL 8022) Internal – Control Sub Plates – High Gloss White (RAL 9003)
Interlocking	Key provision for customer input Disconnecting Device
Corrosion Protection	Unpainted Parts (Zinc Plated / Bronze Chromate)
Ambient Temperature	0...40 °C (32...104 °F) / 0...50 °C (32...122 °F) - optional
Fiber Optic Interface	Rectifier – Inverter – Cabinet (Warning / Trip)
Door Filter	Painted Defuser with Matted Filter Media
Door Filter Blockage	Air Flow Restriction Trip / Warning
Storage and Transportation Temperature Range	-40...70 °C (-40...158 °F)
Relative Humidity	Max. 95%, non-condensing
Altitude (Standard)	0...1000 m (0...3300 ft)
Altitude (Optional)	1001...5000 m (0...16,400 ft)
Seismic (UBC Rating)	1, 2, 3, 4
Standards	NEMA, IEC, CSA, UL, ANSI, IEEE

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

Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	https://rockwellautomation.custhelp.com/
Local Technical Support Phone Numbers	Locate the phone number for your country.	http://www.rockwellautomation.com/global/support/get-support-now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	http://www.rockwellautomation.com/global/support/direct-dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	http://www.rockwellautomation.com/global/literature-library/overview.page
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	http://www.rockwellautomation.com/global/support/pcdc.page

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